

CHAPTER

20

**STANDARD
PRACTICES -
AIRFRAME**



**737-7/8/8200/9/10
AIRCRAFT MAINTENANCE MANUAL**

**CHAPTER 20
STANDARD PRACTICES - AIRFRAME**

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20-EFFECTIVE PAGES			20-10-07			20-10-10 (cont)		
1 thru 7	Sep 15/2023		401	May 15/2023		403	May 15/2022	
8	BLANK		402	May 15/2023		404	May 15/2022	
20-CONTENTS			403	May 15/2023		405	Sep 15/2022	
1	May 15/2023		404	May 15/2023		406	BLANK	
2	May 15/2023		405	May 15/2023		20-10-11		
3	Jan 15/2023		406	May 15/2023		401	Sep 15/2021	
4	Sep 15/2022		407	May 15/2023		R 402	Sep 15/2023	
5	Sep 15/2022		R 408	Sep 15/2023		403	Jan 15/2022	
O 6	Sep 15/2023		409	May 15/2023		404	Sep 15/2021	
O 7	Sep 15/2023		410	May 15/2023		405	Sep 15/2021	
8	Sep 15/2022		411	May 15/2023		406	May 15/2023	
9	Sep 15/2022		412	May 15/2023		407	Sep 15/2022	
10	Sep 15/2022		413	May 15/2023		408	Sep 15/2021	
R 11	Sep 15/2023		414	May 15/2023		409	Sep 15/2022	
O 12	Sep 15/2023		415	May 15/2023		410	Sep 15/2022	
O 13	Sep 15/2023		416	May 15/2023		20-10-11		
14	BLANK		417	May 15/2023		801	Sep 15/2021	
20-00-00			418	May 15/2023		802	BLANK	
201	Sep 15/2021		419	May 15/2023		20-10-14		
202	Sep 15/2021		420	May 15/2023		401	May 15/2023	
203	Sep 15/2021		421	May 15/2023		402	Sep 15/2022	
204	BLANK		422	May 15/2023		403	Sep 15/2022	
20-09-01			423	May 15/2023		404	Sep 15/2022	
201	Sep 15/2021		424	May 15/2023		20-10-15		
202	BLANK		20-10-08			401	Sep 15/2021	
20-10-02			401	Sep 15/2021		402	Sep 15/2021	
401	Sep 15/2021		402	Sep 15/2021		20-10-17		
402	BLANK		403	Sep 15/2021		401	Sep 15/2021	
20-10-04			404	BLANK		402	Sep 15/2021	
401	Jan 15/2023		20-10-09			403	Sep 15/2021	
402	Sep 15/2021		401	May 15/2022		404	Sep 15/2021	
403	Sep 15/2021		402	Sep 15/2021		20-10-20		
404	Jan 15/2023		R 403	Sep 15/2023		201	Sep 15/2021	
405	Jan 15/2023		R 404	Sep 15/2023		202	BLANK	
406	Jan 15/2023		20-10-10			20-10-21		
407	Jan 15/2023		401	May 15/2022		401	Jan 15/2023	
408	Jan 15/2023		402	May 15/2022		402	May 15/2023	

A = Added, R = Revised, D = Deleted, O = Overflow, C = Customer Originated Change

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20-10-21 (cont)			20-10-28			20-10-35 (cont)		
403	Jan 15/2023		201	Sep 15/2021		209	Sep 15/2021	
404	Jan 15/2023		202	Sep 15/2021		210	Sep 15/2021	
405	Jan 15/2023		20-10-30			211	Sep 15/2021	
406	Jan 15/2023		201	May 15/2023		212	Sep 15/2021	
407	Jan 15/2023		202	Sep 15/2022		213	May 15/2023	
408	BLANK		203	Sep 15/2022		214	May 15/2023	
20-10-24			204	May 15/2023		215	May 15/2023	
R 301	Sep 15/2023		205	Sep 15/2022		216	May 15/2023	
302	BLANK		206	May 15/2023		217	May 15/2023	
20-10-24			20-10-31			218	May 15/2023	
401	Sep 15/2021		401	Sep 15/2021		219	May 15/2023	
402	Sep 15/2021		402	Sep 15/2021		220	May 15/2023	
403	Sep 15/2021		403	Sep 15/2021		221	May 15/2023	
404	Sep 15/2021		404	BLANK		222	Sep 15/2021	
20-10-25			20-10-33			223	Sep 15/2021	
201	Sep 15/2021		401	Jan 15/2023		224	Sep 15/2021	
202	Sep 15/2021		402	Jan 15/2022		225	Sep 15/2021	
20-10-26			403	Jan 15/2023		226	Sep 15/2021	
401	Sep 15/2021		404	Jan 15/2022		20-10-37		
402	Sep 15/2021		20-10-34			601	Sep 15/2022	
403	Sep 15/2021		701	Sep 15/2022		602	May 15/2023	
404	Sep 15/2021		702	Sep 15/2022		603	May 15/2022	
405	Sep 15/2021		703	Jan 15/2022		604	Sep 15/2021	
406	Sep 15/2021		704	Sep 15/2021		605	Sep 15/2021	
407	Sep 15/2021		705	Sep 15/2022		606	Sep 15/2021	
408	Sep 15/2021		706	Sep 15/2022		607	Sep 15/2021	
409	Sep 15/2021		707	Jan 15/2022		608	BLANK	
410	Sep 15/2021		708	BLANK		20-10-39		
411	Sep 15/2021		20-10-35			R 501	Sep 15/2023	
412	Sep 15/2021		201	Sep 15/2021		R 502	Sep 15/2023	
413	Sep 15/2021		202	Sep 15/2022		O 503	Sep 15/2023	
414	Sep 15/2021		203	May 15/2022		R 504	Sep 15/2023	
20-10-27			204	Sep 15/2021		R 505	Sep 15/2023	
201	Sep 15/2021		205	Sep 15/2022		R 506	Sep 15/2023	
202	Sep 15/2021		206	Sep 15/2021		R 507	Sep 15/2023	
			207	Sep 15/2021		O 508	Sep 15/2023	
			208	Sep 15/2021		A 509	Sep 15/2023	

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Subject/Page	Date	COC	Subject/Page	Date	COC	Subject/Page	Date	COC
20-10-39 (cont)			20-10-51 (cont)			20-10-51 (cont)		
A 510	BLANK		215	Sep 15/2021		416	May 15/2022	
20-10-41			216	Sep 15/2021		417	Sep 15/2022	
401	Sep 15/2021		217	Sep 15/2021		418	May 15/2022	
402	Sep 15/2021		218	Sep 15/2021		419	May 15/2022	
403	Sep 15/2021		219	Sep 15/2021		420	May 15/2022	
404	Sep 15/2021		220	Sep 15/2021		20-10-51		
20-10-44			221	Sep 15/2021		801	Sep 15/2021	
R 401	Sep 15/2023		222	Sep 15/2021		802	Sep 15/2021	
402	Sep 15/2021		223	Sep 15/2021		803	Sep 15/2021	
403	Sep 15/2021		224	Sep 15/2021		804	Sep 15/2021	
404	Sep 15/2021		225	Sep 15/2021		805	Sep 15/2021	
405	Sep 15/2021		226	Sep 15/2021		806	Sep 15/2021	
406	Sep 15/2021		227	Sep 15/2021		807	Sep 15/2021	
407	Sep 15/2021		228	Sep 15/2021		808	Sep 15/2021	
R 408	Sep 15/2023		229	Sep 15/2021		809	Sep 15/2021	
A 409	Sep 15/2023		230	Sep 15/2021		810	Sep 15/2021	
A 410	BLANK		231	Sep 15/2021		811	Sep 15/2021	
20-10-47			232	Sep 15/2021		812	Sep 15/2021	
201	Sep 15/2022		233	Sep 15/2021		813	Sep 15/2021	
202	Sep 15/2021		234	BLANK		814	Sep 15/2021	
203	Sep 15/2021		20-10-51			815	Sep 15/2021	
204	BLANK		401	Sep 15/2021		816	Sep 15/2021	
20-10-51			402	Sep 15/2022		817	Sep 15/2021	
201	Sep 15/2021		403	Sep 15/2022		818	Sep 15/2021	
202	Sep 15/2021		404	Sep 15/2022		819	Sep 15/2021	
203	Sep 15/2021		405	Sep 15/2022		820	Sep 15/2021	
204	Sep 15/2021		406	Sep 15/2022		821	May 15/2022	
205	Sep 15/2021		407	May 15/2022		822	May 15/2022	
206	Sep 15/2021		408	May 15/2022		823	May 15/2022	
207	Sep 15/2021		409	May 15/2022		824	May 15/2022	
208	Sep 15/2021		410	May 15/2022		825	May 15/2022	
209	Sep 15/2021		411	May 15/2022		826	May 15/2022	
210	Sep 15/2021		412	May 15/2023		827	May 15/2022	
211	Sep 15/2021		413	May 15/2022		828	May 15/2022	
212	Sep 15/2021		414	May 15/2022		829	Sep 15/2021	
213	Sep 15/2021		415	May 15/2022		830	Sep 15/2021	
214	Sep 15/2021							

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20-10-51 (cont)			20-10-51 (cont)			20-10-51 (cont)		
831	May 15/2023		867	Sep 15/2021		898.5	Sep 15/2021	
832	May 15/2023		868	Sep 15/2021		898.6	Sep 15/2021	
833	May 15/2023		869	Sep 15/2021		898.7	Sep 15/2021	
834	May 15/2023		870	Sep 15/2021		898.8	Sep 15/2021	
835	May 15/2023		871	Sep 15/2021		898.9	Sep 15/2021	
836	May 15/2023		872	Sep 15/2021		898.10	Sep 15/2021	
837	Sep 15/2021		873	May 15/2023		898.11	Sep 15/2021	
838	Sep 15/2021		874	May 15/2023		R 898.12	Sep 15/2023	
839	Sep 15/2021		875	Sep 15/2021		R 898.13	Sep 15/2023	
840	Sep 15/2021		876	Sep 15/2021		R 898.14	Sep 15/2023	
841	Sep 15/2021		877	Sep 15/2021		R 898.15	Sep 15/2023	
842	Sep 15/2021		878	Sep 15/2021		898.16	Jan 15/2022	
843	Sep 15/2021		879	Sep 15/2021		898.17	Jan 15/2023	
844	Sep 15/2021		880	Sep 15/2021		898.18	May 15/2023	
845	Sep 15/2021		881	Sep 15/2021		898.19	Jan 15/2022	
846	Sep 15/2021		882	Sep 15/2021		898.20	Jan 15/2022	
847	Sep 15/2021		883	Sep 15/2021		898.21	Jan 15/2022	
848	Sep 15/2021		884	Sep 15/2021		898.22	Jan 15/2022	
849	Sep 15/2021		885	Sep 15/2021		898.23	Jan 15/2022	
850	Sep 15/2021		886	Sep 15/2021		898.24	Jan 15/2022	
851	Sep 15/2021		887	Sep 15/2021		898.25	Jan 15/2022	
852	Sep 15/2021		888	Sep 15/2021		898.26	Jan 15/2022	
853	Sep 15/2021		889	Sep 15/2021		898.27	Jan 15/2022	
854	Sep 15/2021		890	Sep 15/2021		898.28	Jan 15/2022	
855	May 15/2022		891	Sep 15/2021		898.29	Jan 15/2022	
856	Sep 15/2021		892	Sep 15/2021		898.30	Jan 15/2022	
857	May 15/2022		893	Sep 15/2021		898.31	Jan 15/2022	
858	Sep 15/2021		894	Sep 15/2021		898.32	Jan 15/2022	
859	Sep 15/2021		895	Sep 15/2021		898.33	Jan 15/2022	
860	May 15/2022		896	Sep 15/2021		898.34	Jan 15/2022	
861	May 15/2022		897	Sep 15/2021		898.35	Jan 15/2022	
862	Sep 15/2021		898	Sep 15/2021		898.36	Jan 15/2022	
863	May 15/2022		898.1	Sep 15/2021		898.37	Jan 15/2022	
864	Sep 15/2021		898.2	Sep 15/2021		898.38	Jan 15/2022	
865	Sep 15/2021		898.3	Sep 15/2021		898.39	Jan 15/2022	
866	Sep 15/2021		898.4	Sep 15/2021		898.40	Jan 15/2022	

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20-10-51 (cont)			20-10-52 (cont)			20-10-75 (cont)		
898.41	Jan 15/2022		811	Sep 15/2021		208	Sep 15/2021	
898.42	Jan 15/2022		812	BLANK		209	Sep 15/2021	
20-10-52			20-10-53			210	Sep 15/2021	
201	Sep 15/2021		401	Sep 15/2021		211	Sep 15/2021	
202	Sep 15/2021		402	Sep 15/2021		212	Sep 15/2021	
203	Sep 15/2021		20-10-61			213	Sep 15/2021	
204	Sep 15/2021		401	Sep 15/2021		214	Sep 15/2021	
205	Sep 15/2021		402	Sep 15/2022		215	Sep 15/2021	
206	Sep 15/2021		403	Jan 15/2022		216	Sep 15/2021	
207	Sep 15/2021		404	Jan 15/2022		217	Sep 15/2021	
208	Sep 15/2021		405	Jan 15/2022		218	BLANK	
209	Sep 15/2021		406	Jan 15/2022		20-10-77		
210	Sep 15/2021		20-10-72			201	May 15/2023	
211	Sep 15/2021		201	May 15/2023		202	May 15/2023	
212	Sep 15/2021		202	May 15/2023		203	May 15/2023	
213	Sep 15/2021		203	May 15/2023		204	May 15/2023	
214	Sep 15/2021		204	May 15/2023		205	May 15/2023	
215	Sep 15/2021		205	May 15/2023		206	May 15/2023	
216	Sep 15/2021		206	May 15/2023		207	May 15/2023	
217	Sep 15/2021		207	May 15/2023		208	May 15/2023	
218	BLANK		208	May 15/2023		209	May 15/2023	
20-10-52			209	May 15/2023		R 210	Sep 15/2023	
401	Sep 15/2021		210	May 15/2023		211	May 15/2023	
402	Sep 15/2021		211	May 15/2023		212	May 15/2023	
403	Sep 15/2021		212	May 15/2023		213	May 15/2023	
404	BLANK		213	May 15/2023		214	BLANK	
20-10-52			214	May 15/2023		20-10-78		
801	Sep 15/2021		215	May 15/2023		201	Sep 15/2021	
802	Sep 15/2021		216	BLANK		202	Sep 15/2021	
803	Sep 15/2021		20-10-75			203	Sep 15/2021	
804	Sep 15/2021		R 201	Sep 15/2023		204	Sep 15/2021	
805	Sep 15/2021		R 202	Sep 15/2023		205	Sep 15/2021	
806	May 15/2023		R 203	Sep 15/2023		206	BLANK	
807	Jan 15/2022		R 204	Sep 15/2023		20-10-79		
808	Jan 15/2022		205	Sep 15/2021		201	Sep 15/2021	
809	Jan 15/2022		206	Sep 15/2021		202	Sep 15/2021	
810	Sep 15/2021		207	Sep 15/2021		203	Sep 15/2021	

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Subject/Page	Date	COC	Subject/Page	Date	COC	Subject/Page	Date	COC
20-10-79 (cont)			20-15-11			20-40-12		
204	Sep 15/2021		201	Sep 15/2021		201	Jan 15/2023	
205	Sep 15/2021		202	May 15/2022		202	Sep 15/2021	
206	Sep 15/2021		203	May 15/2022		203	Jan 15/2023	
207	Sep 15/2021		204	May 15/2022		204	Jan 15/2023	
208	BLANK		205	May 15/2022		205	Jan 15/2023	
20-10-80			206	May 15/2022		206	Sep 15/2021	
201	Sep 15/2021		207	May 15/2022		207	Jan 15/2023	
202	Sep 15/2021		208	May 15/2022		208	Sep 15/2021	
203	Sep 15/2021		209	May 15/2022		209	Sep 15/2021	
204	Sep 15/2021		210	Sep 15/2021		210	Sep 15/2021	
205	Sep 15/2021		20-20-21			211	Sep 15/2021	
206	Sep 15/2021		601	Sep 15/2021		212	BLANK	
207	Sep 15/2021		602	Sep 15/2021		20-50-11		
208	Sep 15/2021		20-20-31			201	Sep 15/2021	
209	Sep 15/2021		R 601	Sep 15/2023		R 202	Sep 15/2023	
210	Sep 15/2021		R 602	Sep 15/2023		203	Sep 15/2021	
211	Sep 15/2021		603	Sep 15/2021		204	Sep 15/2021	
212	Sep 15/2021		604	May 15/2022		205	Sep 15/2021	
213	Sep 15/2021		605	Sep 15/2021		206	Sep 15/2021	
214	BLANK		606	BLANK		R 207	Sep 15/2023	
20-10-91			20-30-00			R 208	Sep 15/2023	
R 401	Sep 15/2023		A 201	Sep 15/2023		O 209	Sep 15/2023	
R 402	Sep 15/2023		A 202	BLANK		O 210	Sep 15/2023	
403	Sep 15/2021		20-30-11			O 211	Sep 15/2023	
404	Sep 15/2021		A 201	Sep 15/2023		O 212	Sep 15/2023	
R 405	Sep 15/2023		A 202	Sep 15/2023		O 213	Sep 15/2023	
406	Jan 15/2023		A 203	Sep 15/2023		O 214	Sep 15/2023	
407	Jan 15/2023		A 204	BLANK		O 215	Sep 15/2023	
408	Jan 15/2023		20-40-11			O 216	Sep 15/2023	
409	Jan 15/2023		201	Sep 15/2021		O 217	Sep 15/2023	
410	Jan 15/2023		202	Sep 15/2021		O 218	Sep 15/2023	
411	Jan 15/2023		203	Sep 15/2021		O 219	Sep 15/2023	
412	BLANK		204	Sep 15/2021		O 220	Sep 15/2023	
20-10-93			205	Sep 15/2021		221	May 15/2022	
401	Sep 15/2021		206	Sep 15/2021		222	May 15/2022	
402	Sep 15/2021					223	May 15/2022	

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20-50-11 (cont)			20-60-06			20-70-24 (cont)		
224	Sep 15/2021		701	Sep 15/2021		227	Sep 15/2021	
225	Sep 15/2021		702	BLANK		228	Sep 15/2021	
226	Sep 15/2021		20-60-07			229	Sep 15/2021	
227	Sep 15/2021		201	Sep 15/2021		230	Sep 15/2021	
228	Sep 15/2021		202	Sep 15/2021		231	Sep 15/2021	
229	May 15/2023		203	Sep 15/2021		232	Sep 15/2021	
230	Sep 15/2021		204	Sep 15/2021				
231	Sep 15/2021		20-60-08					
232	Sep 15/2021		701	Sep 15/2021				
233	Sep 15/2021		702	BLANK				
234	Sep 15/2021		20-70-24					
235	Sep 15/2021		201	Sep 15/2021				
236	Sep 15/2021		R 202	Sep 15/2023				
237	Sep 15/2021		203	Jan 15/2023				
238	Sep 15/2021		204	Jan 15/2023				
20-60-01			205	Jan 15/2023				
201	Sep 15/2021		206	Jan 15/2023				
202	Sep 15/2021		207	Jan 15/2023				
203	Sep 15/2021		208	Jan 15/2023				
204	BLANK		209	Jan 15/2023				
20-60-02			210	Jan 15/2023				
R 201	Sep 15/2023		211	Jan 15/2023				
R 202	Sep 15/2023		212	Jan 15/2023				
O 203	Sep 15/2023		213	Jan 15/2023				
204	BLANK		214	Jan 15/2023				
20-60-02			215	Sep 15/2021				
R 601	Sep 15/2023		216	Sep 15/2021				
R 602	Sep 15/2023		217	Sep 15/2021				
O 603	Sep 15/2023		218	Sep 15/2021				
604	BLANK		219	Sep 15/2021				
20-60-02			220	Sep 15/2021				
R 701	Sep 15/2023		221	Sep 15/2021				
R 702	Sep 15/2023		222	Sep 15/2021				
20-60-05			223	Sep 15/2021				
201	Sep 15/2021		224	Sep 15/2021				
202	Sep 15/2021		225	Sep 15/2021				
			226	Sep 15/2021				

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<u>SUBJECT</u>	<u>CHAPTER SECTION SUBJECT</u>	<u>CONF</u>	<u>PAGE</u>	<u>EFFECT</u>
<u>STANDARD PRACTICES - MAINTENANCE PRACTICES</u>	20-00-00		201	SIA ALL
Airworthiness Limitation Precautions TASK 20-00-00-910-801			201	SIA ALL
Enhanced Zonal Inspection Program (EZAP) Precautions TASK 20-00-00-910-802			202	SIA ALL
<u>FLOOR PANEL PROTECTION - MAINTENANCE PRACTICES</u>	20-09-01		201	SIA ALL
Floor Panel Damage Prevention During Maintenance TASK 20-09-01-610-801			201	SIA ALL
<u>BEARINGS AND BUSHINGS - REMOVAL/INSTALLATION</u>	20-10-02		401	SIA ALL
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<u>CONTROL CABLE AIR AND PRESSURE SEALS - REMOVAL/INSTALLATION</u>	20-10-04		401	SIA ALL
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1. Airworthiness Limitation Precautions

A. General

- (1) Critical Design Configuration Control Limitations (CDCCLs)
 - (a) All occurrences of CDCCLs found in this chapter of the AMM are identified by this note after each applicable CDCCL design feature:
 - 1) NOTE: CDCCL - Refer to the task: Airworthiness Limitation Precautions, TASK 20-00-00-910-801, for important information on Critical Design Configuration Control Limitations (CDCCLs).
 - (b) Design features that are CDCCLs are defined and controlled by Special Federal Aviation Regulation (SFAR) 88, and can be found in the Special Compliance Items/Airworthiness Limitations document. CDCCLs are a means of identifying certain design configuration features intended to preclude a fuel tank ignition source for the operational life of the airplane. CDCCLs are mandatory and cannot be changed or deleted without the approval of the FAA office that is responsible for the airplane model Type Certificate, or applicable regulatory agency. A critical fuel tank ignition source prevention feature may exist in the fuel system and its related installation or in systems that, if a failure condition were to develop, could interact with the fuel system in such a way that an unsafe condition would develop without this limitation. Strict adherence to configuration, methods, techniques, and practices as prescribed is required to ensure the CDCCL is complied with. Any use of parts, methods, techniques or practices not contained in the applicable CDCCL must be approved by the FAA office that is responsible for the airplane model Type Certificate, or applicable regulatory agency.
- (2) Airworthiness Limitation Instructions (ALIs)
 - (a) All occurrences of fuel tank system ALIs found in this chapter of the AMM are identified by this note after each applicable ALI inspection feature:
 - 1) NOTE: ALI - Refer to the task: Airworthiness Limitation Precautions, TASK 20-00-00-910-801, for important information on airworthiness limitation instructions (ALIs).
 - (b) Inspection features that are ALIs are defined and controlled by Special Federal Aviation Regulation (SFAR) 88, and can be found in the Special Compliance Items/Airworthiness Limitations document. These ALIs identify inspection features related to fuel tank ignition source prevention which must be done to maintain the design level of safety for the operational life of the airplane. These inspection features are mandatory and cannot be changed or deleted without the approval of the FAA office that is responsible for the airplane model Type Certificate, or applicable regulatory agency. Strict adherence to methods, techniques and practices as prescribed is required to ensure the ALI is complied with. Any use of methods, techniques or practices not contained in these ALIs must be approved by the FAA office that is responsible for the airplane model Type Certificate, or applicable regulatory agency.

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B. Critical Design Configuration Control Limitations (CDCCLs)

SUBTASK 20-00-00-910-001



OBEY THE MANUFACTURER'S PROCEDURES WHEN YOU DO MAINTENANCE THAT HAS AN EFFECT ON A CDCCL. IF YOU DO NOT OBEY THE PROCEDURES, IT CAN INCREASE THE RISK OF A SOURCE OF FUEL TANK IGNITION. INJURIES TO PERSONNEL, AND DAMAGE TO EQUIPMENT CAN OCCUR IF THERE IS A FIRE OR EXPLOSION.

- (1) Make sure you follow the procedures for items identified as CDCCLs.

C. Airworthiness Limitation Instructions (ALIs)

SUBTASK 20-00-00-910-002



OBEY THE MANUFACTURER'S PROCEDURES WHEN YOU DO MAINTENANCE THAT HAS AN EFFECT ON AN ALI. IF YOU DO NOT OBEY THE PROCEDURES, IT CAN INCREASE THE RISK OF A SOURCE OF FUEL TANK IGNITION. INJURIES TO PERSONNEL, AND DAMAGE TO EQUIPMENT CAN OCCUR IF THERE IS A FIRE OR EXPLOSION.

- (1) Make sure you follow the procedures for items identified as ALIs.

————— **END OF TASK** —————



TASK 20-00-00-910-802

2. Enhanced Zonal Inspection Program (EZAP) Precautions

A. General

- (1) Enhanced Zonal Analysis Procedure (EZAP) and associated Electrical Wiring Interconnection System (EWIS)
 - (a) Enhanced Zonal Analysis Procedure (EZAP) is an analytical procedure required by Part 25, Appendix H, Section H25.5(a)(1) that identifies the physical and environmental conditions contained in each zone of an airplane, analyzes the effects of these conditions on electrical wiring and components, and assesses the possibilities for smoke and fire. The end result of the analysis are inspection and restoration tasks in the form of EWIS ICA.
 - (b) Electrical Wiring Interconnection System (EWIS): means any wire, power feeder, wiring device, or combination of these, including termination devices, installed in any area of the airplane for the purpose of transmitting electrical energy, including data and signals, between two or more intended termination points. EWIS is defined in full by 14 CFR section 25.1701.

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- (c) The Zonal Inspection Program includes a general visual and, if required, physical check of the general condition and security of attachment of the accessible systems and structures items contained in defined zones. This includes checks for degradation such as chafing of tubing, loose duct supports, damage to wiring and connected EWIS, cable and pulley wear, fluid leaks, electrical bonding, general condition of fasteners, inadequate drainage, etc., and general corrosion, not covered in the MSG-3 analysis. The zonal inspection is not intended as a quality assurance after maintenance check for determining proper reassembly of systems, components, structures, or powerplants. The zonal program packages a number of General Visual (GV) Inspections into one or more zonal inspections. The program includes any GV inspection tasks required to assure security of attachment and general condition of any system or structural items within the zone.
 - (2) Equivalent Tools, Fixtures, Test Equipment, and Consumable Materials
 - (a) When the procedures in this manual identify tools, equipment, and consumable materials, you can use equivalent alternatives. If you use alternative tools, equipment, or consumable materials, make sure that they give the same results and are as safe to the parts and personnel as the tools, equipment, or consumable materials specified in the procedure.
- B. Enhanced Zonal Analysis Procedure (EZAP) and associated Electrical Wiring Interconnection System (EWIS).**

SUBTASK 20-00-00-910-003



OBEY THE MANUFACTURER'S PROCEDURES WHEN YOU DO EZAP MAINTENANCE, OR MAINTENANCE THAT HAS AN EFFECT ON EWIS. IF YOU DO NOT OBEY THE PROCEDURES, IT CAN INCREASE THE RISK OF AN IGNITION SOURCE FOR FIRES. INJURIES TO PERSONS, AND DAMAGE TO EQUIPMENT CAN OCCUR.

- (1) Make sure you follow the procedures for items identified as EZAP.

———— **END OF TASK** ————

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FLOOR PANEL PROTECTION - MAINTENANCE PRACTICES

1. General

A. This procedure has this task:

- (1) Floor Panel Damage Prevention During Maintenance

TASK 20-09-01-610-801

2. Floor Panel Damage Prevention During Maintenance

A. To prevent possible damage to floor panels during maintenance, do these steps:

SUBTASK 20-09-01-980-001

- (1) Let only one person at a time use the ladder, stand, or scaffolding.

SUBTASK 20-09-01-820-001

- (2) Use plywood bearing pads that are a minimum of 0.5 in. (1.3 cm) thick and 1 ft² (929.0 cm²) under each leg, if you have these conditions:
 - (a) You use ladders, stands, or scaffolding with leg-bearing surfaces. Leg-bearing surfaces include rollers, screws, and sharp edges.
 - (b) You have a leg-bearing surface of less than 8 in² (51.6 cm²) for each leg.

———— **END OF TASK** ————

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BEARINGS AND BUSHINGS - REMOVAL/INSTALLATION

TASK 20-10-02-900-801

1. Bearings and Bushings - Removal/Installation

A. References

Reference	Title
SOPM 20-50-03	Bearing and Bushing Replacement

B. Procedure

SUBTASK 20-10-02-960-001

- (1) For the removal and installation of bearings and bushings (SOPM 20-50-03).

———— **END OF TASK** ————

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CONTROL CABLE AIR AND PRESSURE SEALS - REMOVAL/INSTALLATION

1. General

- A. This procedure has these tasks:
- (1) Control Cable Air Seal Removal.
 - (2) Control Cable Air Seal Installation.
 - (3) Control Cable Half Ball Pressure Seal Removal.
 - (4) Control Cable Half Ball Pressure Seal Installation.

TASK 20-10-04-000-801

2. Control Cable Air Seal Removal

Figure 401

A. **General**

- (1) This task is the removal of the control cable air seal plate [1] for the nose landing gear manual extension release mechanism.

B. **Location Zones**

Zone	Area

114	Area Above and Outboard of Nose Landing Gear Wheel Well - Right

C. **Control Cable Air Seal Removal**

SUBTASK 20-10-04-000-001

- (1) Remove the two small restraining rings and one large restraining ring from the ends of the control cable air seal plate [1].

SUBTASK 20-10-04-000-002

- (2) Remove the control cable air seal plate [1] from the nose wheel well panel.

SUBTASK 20-10-04-000-003

- (3) Remove the control cable air seal plate [1] from the cable.

———— **END OF TASK** ————

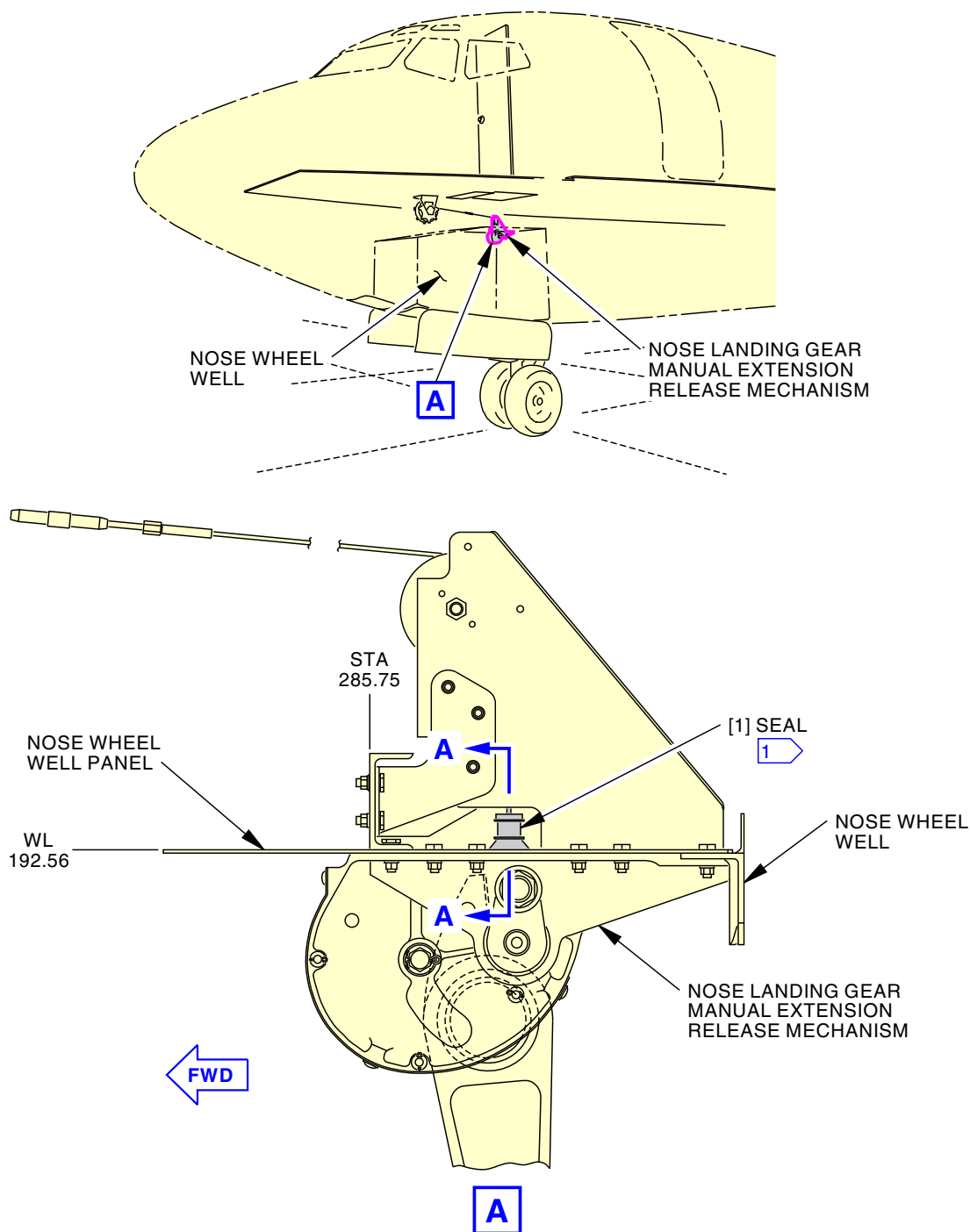
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1 INSTALL PER BAC5502 EXCEPT DO NOT FILL THE SEAL WITH LUBRICANT.

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Control Cable Air Seal Installation
Figure 401/20-10-04-990-801 (Sheet 1 of 2)

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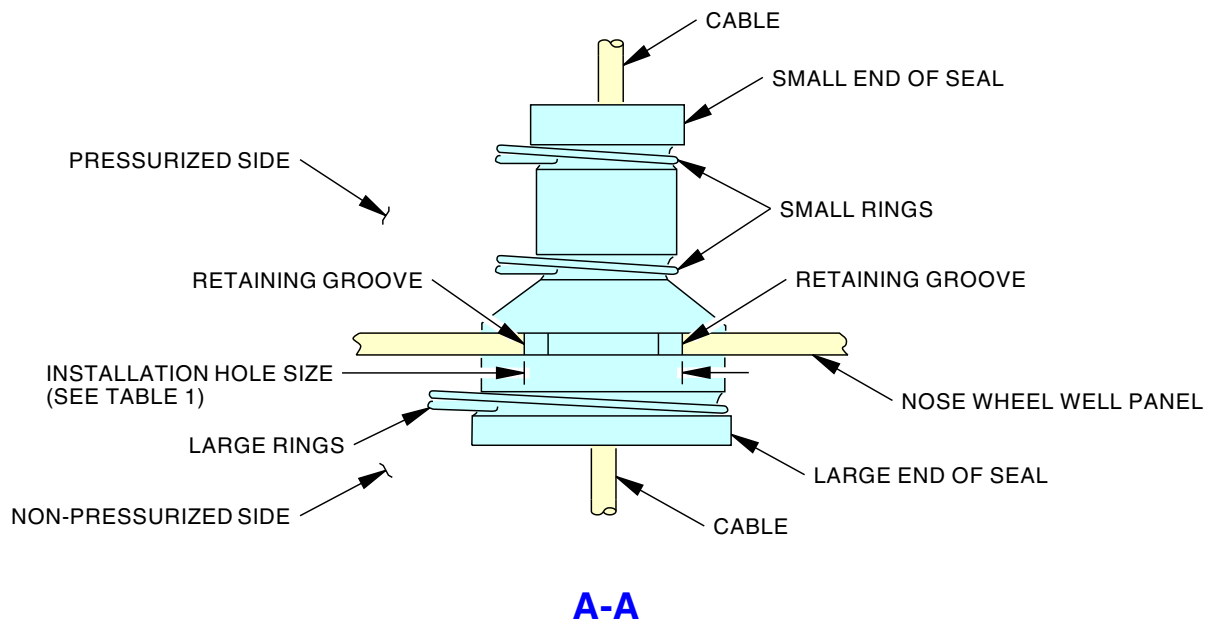
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Control Cable Air Seal Installation
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TASK 20-10-04-400-801

3. Control Cable Air Seal Installation

A. General

- (1) This task is the installation of the control cable air seal plate [1] for the nose landing gear manual extension release mechanism.

B. References

Reference	Title
12-26-00-600-801	Control Cable Lubrication (P/B 301)
32-35-11-400-801	Nose Gear Manual Extension Release Mechanism Installation (P/B 401)

C. Consumable Materials

Reference	Description	Specification
D00633	Grease - Aircraft General Purpose	BMS3-33

D. Location Zones

Zone	Area
114	Area Above and Outboard of Nose Landing Gear Wheel Well - Right

E. Prepare for the Installation

SUBTASK 20-10-04-640-001

- (1) Apply grease, D00633 to the cable for the full length of travel in the seal plate [1], plus 20 inches on each side. This is the task: Control Cable Lubrication, TASK 12-26-00-600-801.

F. Control Cable Air Seal Installation

SUBTASK 20-10-04-420-001

- (1) Install the control cable air seal plate [1] as follows:

NOTE: Do not fill the seal plate [1] with lubricant. The seal plate [1] will receive lubricant during cable movement.

SUBTASK 20-10-04-350-001

- (2) Make sure that there are no sharp edges on the hole where the seal will install.
- (a) If there are sharp edges, break the edges with a chamfer or radius of approximately 0.01 inch. This will prevent damage to the seal.

SUBTASK 20-10-04-420-002

- (3) Put the seal plate [1] on the cable through the non-pressurized side of the nose wheel well panel with the small end of the seal plate [1] up.

SUBTASK 20-10-04-420-003

- (4) Put the seal plate [1] through the nose wheel panel hole.
- (a) Make sure that the retaining groove of the seal plate [1] is positioned correctly with the panel.
- (b) Make sure that the small end of the seal plate [1] is positioned correctly in the pressurized side of the panel.

SUBTASK 20-10-04-420-004

- (5) Install the two smaller restraining rings into the grooves of the small end of the seal plate [1] on the pressurized side of the panel.

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SUBTASK 20-10-04-420-005

- (6) Install the one larger ring into the groove of the large end of the seal plate [1] on the non-pressurized side of the panel.

G. Control Cable Air Seal Installation Test

SUBTASK 20-10-04-480-001

- (1) Make sure that the control cable and air seal plate [1] is correctly installed, as follows:
 - (a) Make sure that the cable has sufficient lubricant.
 - (b) Make sure there is no cable deflection.
 - (c) Make sure that the cable moves freely.

SUBTASK 20-10-04-480-002

- (2) Refer to this task, Nose Gear Manual Extension Release Mechanism Installation, TASK 32-35-11-400-801, for the test requirements for the nose gear manual extension mechanism.

————— END OF TASK —————

TASK 20-10-04-000-802

4. Control Cable Half Ball Pressure Seal Removal

(Figure 402)

A. General

- (1) This task includes the steps to remove the control cable half ball pressure seals.

B. Control Cable Half Ball Pressure Seal Removal

SUBTASK 20-10-04-020-001

- (1) Remove the two screws [4] and washers [3] that attach the seal plate [1], seal cover [2], and half ball pressure seal [5] to the pressure floor web.

SUBTASK 20-10-04-020-002

- (2) Remove the two half ball pressure seals [5] from the seal cover [2].

SUBTASK 20-10-04-020-003

- (3) If it is necessary to replace the seal plate [1] or seal cover [2], do these steps:
 - (a) Disconnect the turnbuckle adjacent to the pressure bulkhead.
 - (b) Remove the seal plate [1] and seal cover [2] from the bulkhead.

————— END OF TASK —————

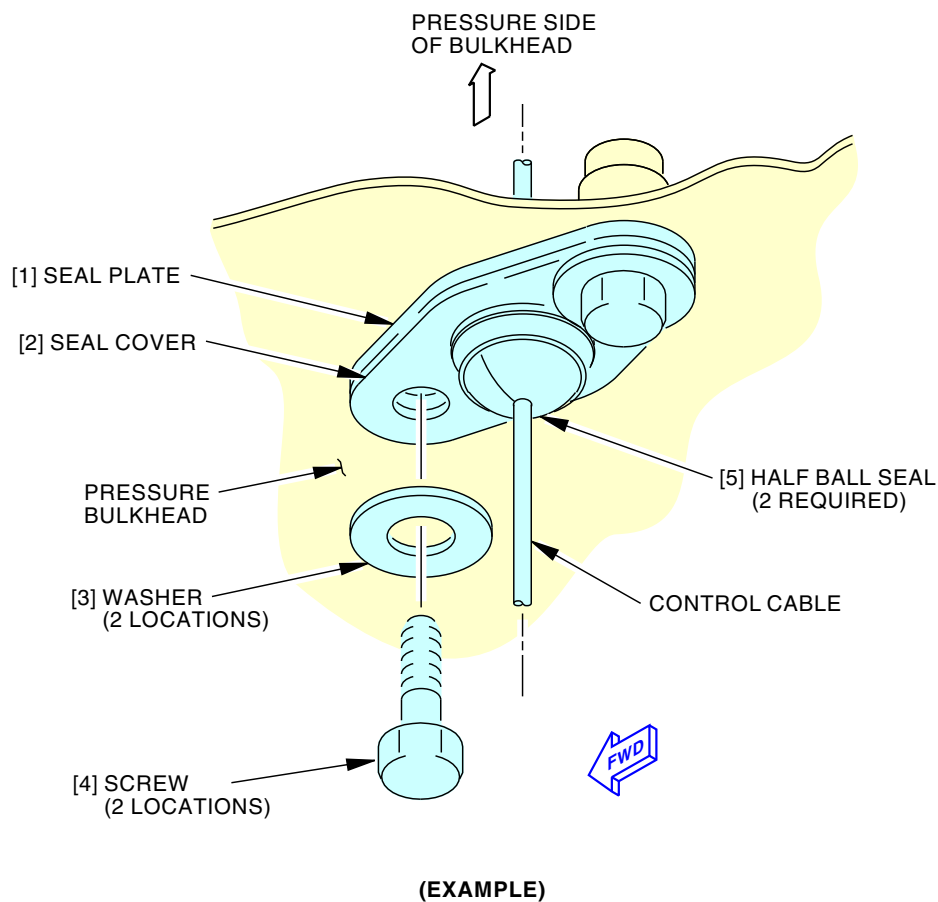
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Control Cable Half Ball Pressure Seal Installation
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TASK 20-10-04-400-802

5. Control Cable Half Ball Pressure Seal Installation

(Figure 402)

A. General

- (1) This task is the installation of the control cable half ball pressure seals.

B. References

Reference	Title
12-26-00-600-801	Control Cable Lubrication (P/B 301)
32-34-11-400-801	Main Gear Manual Extension Control Mechanism Installation (P/B 401)

C. Consumable Materials

Reference	Description	Specification
D00633	Grease - Aircraft General Purpose	BMS3-33

D. Prepare for the Installation

SUBTASK 20-10-04-640-002

- (1) Apply grease, D00633 to the cable for the full length of travel in the half ball pressure seal [5] (TASK 12-26-00-600-801).

SUBTASK 20-10-04-420-006

- (2) If you removed the seal plate [1] or seal cover [2], do these steps:
- (a) Install the seal plate [1] and seal cover [2] to the non-pressurized side of the pressure bulkhead.
 - (b) Make sure that the cable goes through the center hole of the seal plate [1] and seal cover [2] after installation.

E. Control Cable Half Ball Pressure Seal Installation

SUBTASK 20-10-04-420-007

- (1) Connect the two half ball pressure seals [5] on the cable and put them in the center hole of the seal plate [1] and seal cover [2].

SUBTASK 20-10-04-420-008

- (2) Loosely install the two screws [4] and washers [3].

SUBTASK 20-10-04-420-009

- (3) Adjust the half ball pressure seals [5] to attain minimum cable deflection and tighten the two screws [4].

SUBTASK 20-10-04-820-001

- (4) If necessary, refer to the specific system rigging instructions to adjust the control cable.
- (a) Care must be exercised to assure minimum cable friction after seal installation.
 - (b) Install the half ball pressure seals [5] and adjust the cable after rigging to achieve minimum misalignment.

F. Control Cable Half Ball Pressure Seal Installation Test

SUBTASK 20-10-04-200-001

- (1) Make sure that the cable and pressure seals are correctly installed.
- (a) Make sure that the cable has sufficient lubricant.
 - (b) Make sure there is no cable deflection.

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(c) Make sure that the cable moves freely.

SUBTASK 20-10-04-480-003

- (2) Refer to this task, Main Gear Manual Extension Control Mechanism Installation, TASK 32-34-11-400-801, for the test requirements for the main gear manual extension mechanism.

———— **END OF TASK** ————

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E/E RACK-MOUNTED COMPONENTS AND PRINTED CIRCUIT CARD - REMOVAL/INSTALLATION

1. General

A. This procedure has these tasks:

- (1) The removal of the Electrical / Electronic (E/E) box from the rack.
- (2) The installation of the E/E box.
- (3) Adjustment of the lever latch fork.
- (4) The removal of a printed circuit card.
- (5) The installation of a printed circuit card.

TASK 20-10-07-000-801

2. E/E Box Removal

(Figure 401)

A. **References**

Reference	Title
20-40-12-000-802	ESDS Handling for Metal Encased Unit Removal (P/B 201)
20-40-12-400-803	Conductive Dust Cap and Connector Cover Installation (P/B 201)

B. **Location Zones**

Zone	Area
117	Electrical and Electronics Compartment - Left
118	Electrical and Electronics Compartment - Right

SIA ALL; AIRPLANES WITH REXNORD AEROSPACE MECHANISM EXTRACTOR.

C. **E/E Box Removal Procedure**

SUBTASK 20-10-07-860-001

- (1) Open the applicable circuit breakers to remove electrical power.

SUBTASK 20-10-07-910-001



CAUTION

DO NOT TOUCH THE UNIT BEFORE YOU DO THE PROCEDURE FOR DEVICES THAT ARE SENSITIVE TO ELECTROSTATIC DISCHARGE. ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE UNIT.

- (2) If the Electrical / Electronic (E/E) box is sensitive to electrostatic discharge, make sure you do this task: ESDS Handling for Metal Encased Unit Removal, TASK 20-40-12-000-802.

SUBTASK 20-10-07-020-001



CAUTION

DO NOT TOUCH THE CONNECTOR PINS, OR OTHER CONDUCTORS. IF YOU TOUCH THESE CONDUCTORS, ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE COMPONENTS.

- (3) Remove the connections from the front of the E/E box if it is necessary.

SUBTASK 20-10-07-020-002

- (4) Turn the knob on the front hold-down extractor counterclockwise to disengage the clutch.

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SIA ALL; AIRPLANES WITH REXNORD AEROSPACE MECHANISM EXTRACTOR. (Continued)

SUBTASK 20-10-07-020-003

- (5) Do these steps to disconnect the front hold-down extractor:

NOTE: Apply light pressure down on the E/E box handle while you disconnect the front hold-down extractor.

- (a) Turn the keeper to align the deep slot with the T-hook.
- (b) Lower the front hold-down extractor to be clear of the T-hook.

SUBTASK 20-10-07-420-001



DO NOT TOUCH THE CONNECTOR PINS, OR OTHER CONDUCTORS. IF YOU TOUCH THESE CONDUCTORS, ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE COMPONENTS.

- (6) Install conductive or anti-static caps to the connectors.

SUBTASK 20-10-07-020-004

- (7) Carefully move the E/E box out from the tray and remove the E/E box.

NOTE: Move the front of the E/E box from side to side approximately $\frac{1}{8}$ in. (3 mm) to help disconnect the E/E box from the electrical connector.

SUBTASK 20-10-07-420-002

- (8) If the E/E box is not sensitive to electrostatic discharge, put protective covers on the electrical connector(s).

SUBTASK 20-10-07-420-003

- (9) If the E/E box is sensitive to electrostatic discharge, do this task: Conductive Dust Cap and Connector Cover Installation, TASK 20-40-12-400-803.

SIA ALL; AIRPLANES WITH HOLLINGSEAD EXTRACTOR.

D. E/E Box Removal Procedure

SUBTASK 20-10-07-860-002

- (1) Open the applicable circuit breakers to remove electrical power.

SUBTASK 20-10-07-910-002



DO NOT TOUCH THE UNIT BEFORE YOU DO THE PROCEDURE FOR DEVICES THAT ARE SENSITIVE TO ELECTROSTATIC DISCHARGE. ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE UNIT.

- (2) If the E/E box is sensitive to electrostatic discharge, make sure you do this task: ESDS Handling for Metal Encased Unit Removal, TASK 20-40-12-000-802.

SUBTASK 20-10-07-020-005



DO NOT TOUCH THE CONNECTOR PINS, OR OTHER CONDUCTORS. IF YOU TOUCH THESE CONDUCTORS, ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE COMPONENTS.

- (3) Remove the connections from the front of the E/E box, if it is necessary.

SUBTASK 20-10-07-020-006

- (4) Turn the knob on the front hold-down extractor counterclockwise until you can see the red band.

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SIA ALL; AIRPLANES WITH HOLLINGSEAD EXTRACTOR. (Continued)

SUBTASK 20-10-07-020-007

- (5) Do these steps to disconnect the front hold-down extractor:

NOTE: Apply light pressure down on the E/E box handle while you disconnect the front hold-down extractor.

- (a) Turn the latch counterclockwise to disengage the front hold-down extractor from the T-hook.
- (b) Lower the front hold-down extractor to be clear of the T-hook.

SUBTASK 20-10-07-020-008



DO NOT TOUCH THE CONNECTOR PINS, OR OTHER CONDUCTORS. IF YOU TOUCH THESE CONDUCTORS, ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE COMPONENTS.

- (6) Carefully move the E/E box out from the tray and remove the E/E box.

SUBTASK 20-10-07-420-004

- (7) If the E/E box is not sensitive to electrostatic discharge, put protective covers on the electrical connector(s).

SUBTASK 20-10-07-420-005

- (8) If the E/E box is sensitive to electrostatic discharge, do this task: Conductive Dust Cap and Connector Cover Installation, TASK 20-40-12-400-803.

SIA ALL; AIRPLANES WITH HARTWELL EXTRACTOR.

E. E/E Box Removal Procedure

SUBTASK 20-10-07-860-003

- (1) Open the applicable circuit breakers to remove electrical power.

SUBTASK 20-10-07-910-003



DO NOT TOUCH THE UNIT BEFORE YOU DO THE PROCEDURE FOR DEVICES THAT ARE SENSITIVE TO ELECTROSTATIC DISCHARGE. ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE UNIT.

- (2) If the E/E box is sensitive to electrostatic discharge, make sure you do this task: ESDS Handling for Metal Encased Unit Removal, TASK 20-40-12-000-802.

SUBTASK 20-10-07-020-009



DO NOT TOUCH THE CONNECTOR PINS, OR OTHER CONDUCTORS. IF YOU TOUCH THESE CONDUCTORS, ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE COMPONENTS.

- (3) Remove the connections from the front of the E/E box, if it is necessary.

SUBTASK 20-10-07-020-010

- (4) Turn the knob on the front hold-down extractor counterclockwise to disengage the clutch.

SUBTASK 20-10-07-020-011

- (5) Do these steps to disconnect the front hold-down extractor:

NOTE: Apply light pressure down on the E/E box handle while you disconnect the front hold-down extractor.

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SIA ALL; AIRPLANES WITH HARTWELL EXTRACTOR. (Continued)

- (a) Compress the keeper to disengage the extractor from the T-hook.
- (b) Lower the front hold-down extractor to be clear of the T-hook.

SUBTASK 20-10-07-020-012



CAUTION

DO NOT TOUCH THE CONNECTOR PINS, OR OTHER CONDUCTORS. IF YOU TOUCH THESE CONDUCTORS, ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE COMPONENTS.

- (6) Carefully move the E/E box out from the tray and remove the E/E box.

SUBTASK 20-10-07-420-006

- (7) If the E/E box is not sensitive to electrostatic discharge, put protective covers on the electrical connector(s).

SUBTASK 20-10-07-420-007

- (8) If the E/E box is sensitive to electrostatic discharge, do this task: Conductive Dust Cap and Connector Cover Installation, TASK 20-40-12-400-803.

SIA ALL; AIRPLANES WITH LEVER LATCH HANDLES.

F. E/E Box Removal Procedure

SUBTASK 20-10-07-860-004

- (1) Open the applicable circuit breakers to remove electrical power.

SUBTASK 20-10-07-910-004



CAUTION

DO NOT TOUCH THE UNIT BEFORE YOU DO THE PROCEDURE FOR DEVICES THAT ARE SENSITIVE TO ELECTROSTATIC DISCHARGE. ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE UNIT.

- (2) If the E/E box is sensitive to electrostatic discharge, make sure you, do this task: ESDS Handling for Metal Encased Unit Removal, TASK 20-40-12-000-802.

SUBTASK 20-10-07-020-013



CAUTION

DO NOT TOUCH THE CONNECTOR PINS, OR OTHER CONDUCTORS. IF YOU TOUCH THESE CONDUCTORS, ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE COMPONENTS.

- (3) Remove the connections from the front of the E/E box, if it is necessary.

SUBTASK 20-10-07-020-014

- (4) Do these steps to disconnect the lever latch:
 - (a) Depress the lever latch allowing the lever to move away from the handles.
 - (b) Move the lever in an opening direction forcing the unit away from the shelf-mounted connector.

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SIA ALL; AIRPLANES WITH LEVER LATCH HANDLES. (Continued)

SUBTASK 20-10-07-020-015



DO NOT TOUCH THE CONNECTOR PINS, OR OTHER CONDUCTORS. IF YOU TOUCH THESE CONDUCTORS, ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE COMPONENTS.

- (5) Carefully move the E/E box out from the tray and remove the E/E box.

SUBTASK 20-10-07-420-008

- (6) If the E/E box is not sensitive to electrostatic discharge, put protective covers on the electrical connector(s).

SUBTASK 20-10-07-420-009

- (7) If the E/E box is sensitive to electrostatic discharge, do this task: Conductive Dust Cap and Connector Cover Installation, TASK 20-40-12-400-803.

SIA ALL; AIRPLANES WITH BARRY-TYPE RETAINING FASTENERS.

G. E/E Box Removal Procedure

SUBTASK 20-10-07-040-001

- (1) Open the applicable circuit breakers to remove electrical power.

SUBTASK 20-10-07-580-001



DO NOT TOUCH THE UNIT BEFORE YOU DO THE PROCEDURE FOR DEVICES THAT ARE SENSITIVE TO ELECTROSTATIC DISCHARGE. ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE UNIT.

- (2) If the E/E box is sensitive to electrostatic discharge, make sure you do this task: ESDS Handling for Metal Encased Unit Removal, TASK 20-40-12-000-802.

SUBTASK 20-10-07-020-016



DO NOT TOUCH THE CONNECTOR PINS, OR OTHER CONDUCTORS. IF YOU TOUCH THESE CONDUCTORS, ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE COMPONENTS.

- (3) Remove the connections from the front of the E/E box, if it is necessary.

SUBTASK 20-10-07-020-017

- (4) To unlock the Barry-type retaining fasteners, turn the fastener counter-clockwise.
(a) Pull and turn the fasteners counter-clockwise, if it is necessary.

SUBTASK 20-10-07-020-018



DO NOT TOUCH THE CONNECTOR PINS, OR OTHER CONDUCTORS. IF YOU TOUCH THESE CONDUCTORS, ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE COMPONENTS.

- (5) Carefully move the E/E box out from the tray and remove the E/E box.

SUBTASK 20-10-07-420-010

- (6) If the E/E box is not sensitive to electrostatic discharge, put protective covers on the electrical connector(s).

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SIA ALL; AIRPLANES WITH BARRY-TYPE RETAINING FASTENERS. (Continued)

SUBTASK 20-10-07-580-002

- (7) If the E/E box is sensitive to electrostatic discharge, do this task: Conductive Dust Cap and Connector Cover Installation, TASK 20-40-12-400-803.

SIA ALL

———— **END OF TASK** ————

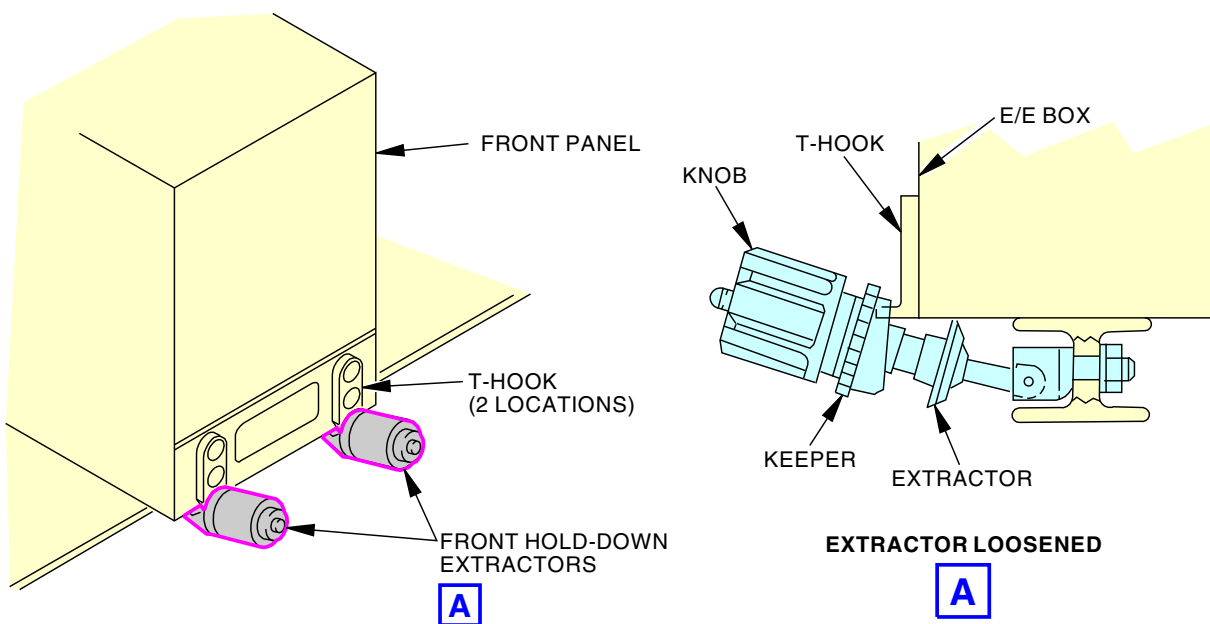
EFFECTIVITY
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D633AM101-SIA

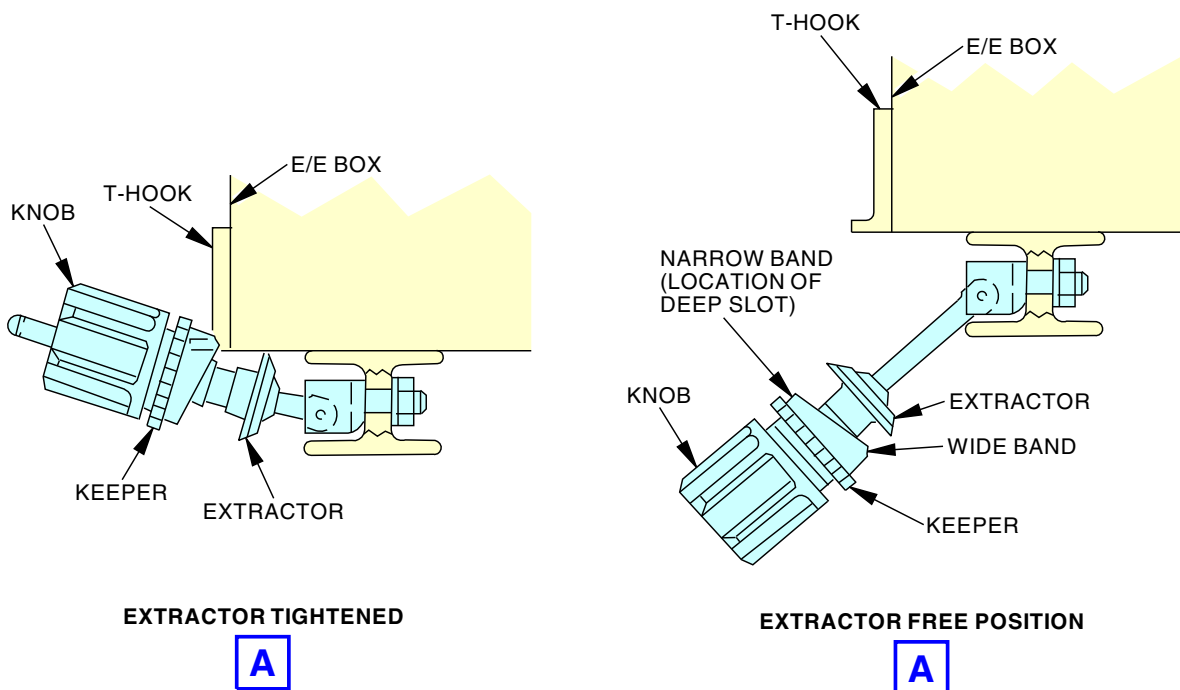
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INSTALLED E/E BOX



EXTRACTOR TIGHTENED

EXTRACTOR FREE POSITION

REXNORD AEROSPACE MECHANISMS EXTRACTOR

2411067 S00061526848_V1

E/E Box Installation
Figure 401/20-10-07-990-801 (Sheet 1 of 6)

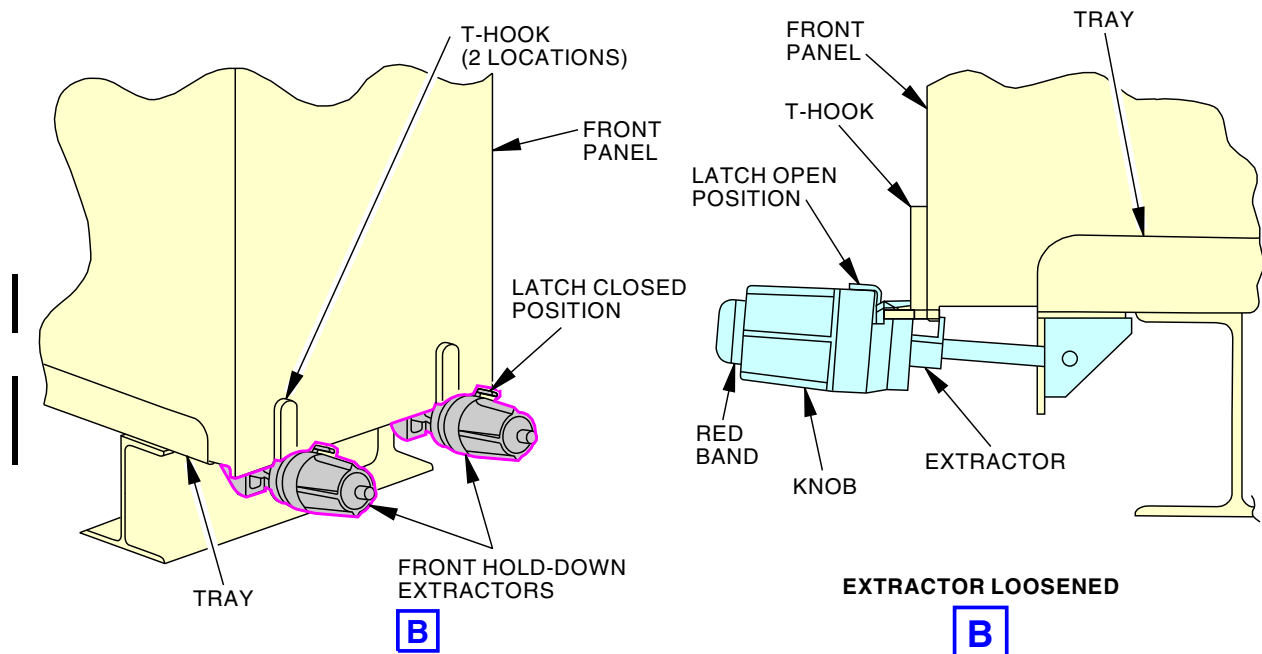
EFFECTIVITY
SIA ALL

D633AM101-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

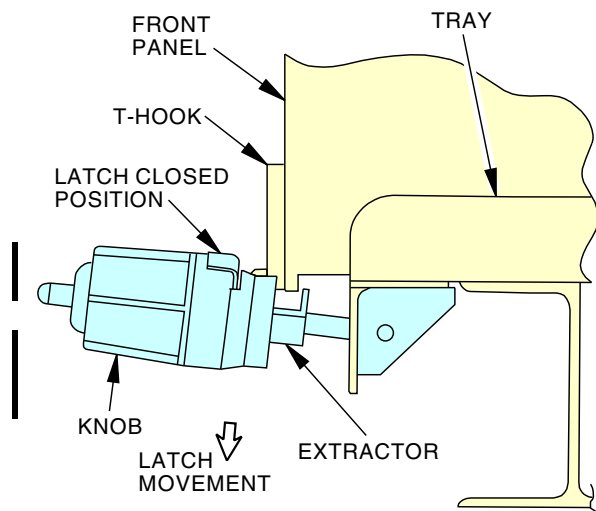
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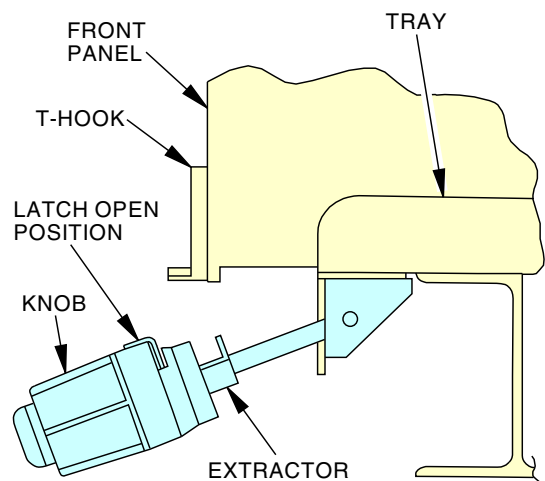


INSTALLED E/E BOX

EXTRACTOR LOOSENED



EXTRACTOR TIGHTENED



EXTRACTOR FREE POSITION

HOLLINGSEAD EXTRACTOR

2411068 S00061526849_V2

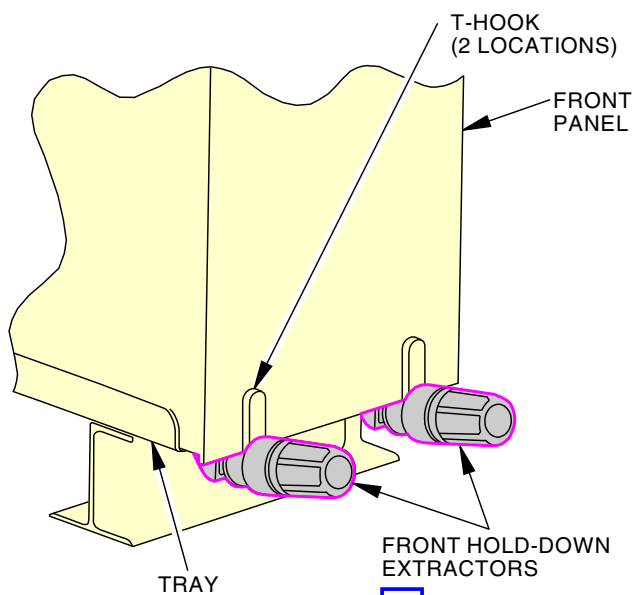
E/E Box Installation
Figure 401/20-10-07-990-801 (Sheet 2 of 6)

EFFECTIVITY
SIA ALL

20-10-07

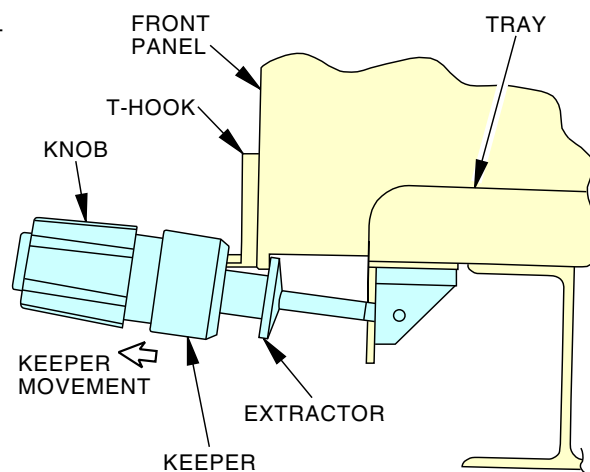
D633AM101-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details



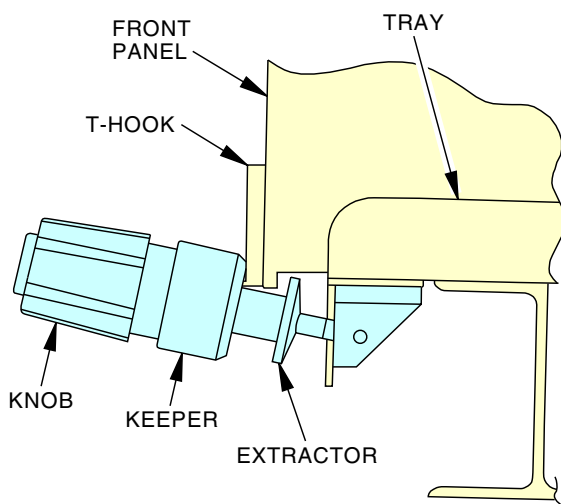
C

INSTALLED E/E BOX



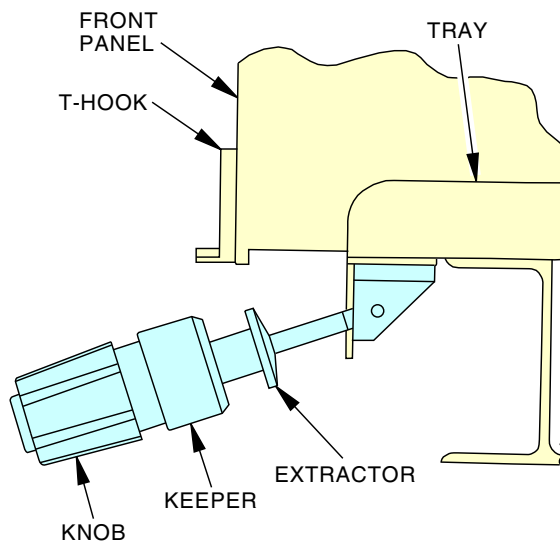
EXTRACTOR LOOSENED

C



EXTRACTOR TIGHTENED

C



EXTRACTOR FREE POSITION

C

HARTWELL EXTRACTOR

2411069 S00061526850_V1

E/E Box Installation
Figure 401/20-10-07-990-801 (Sheet 3 of 6)

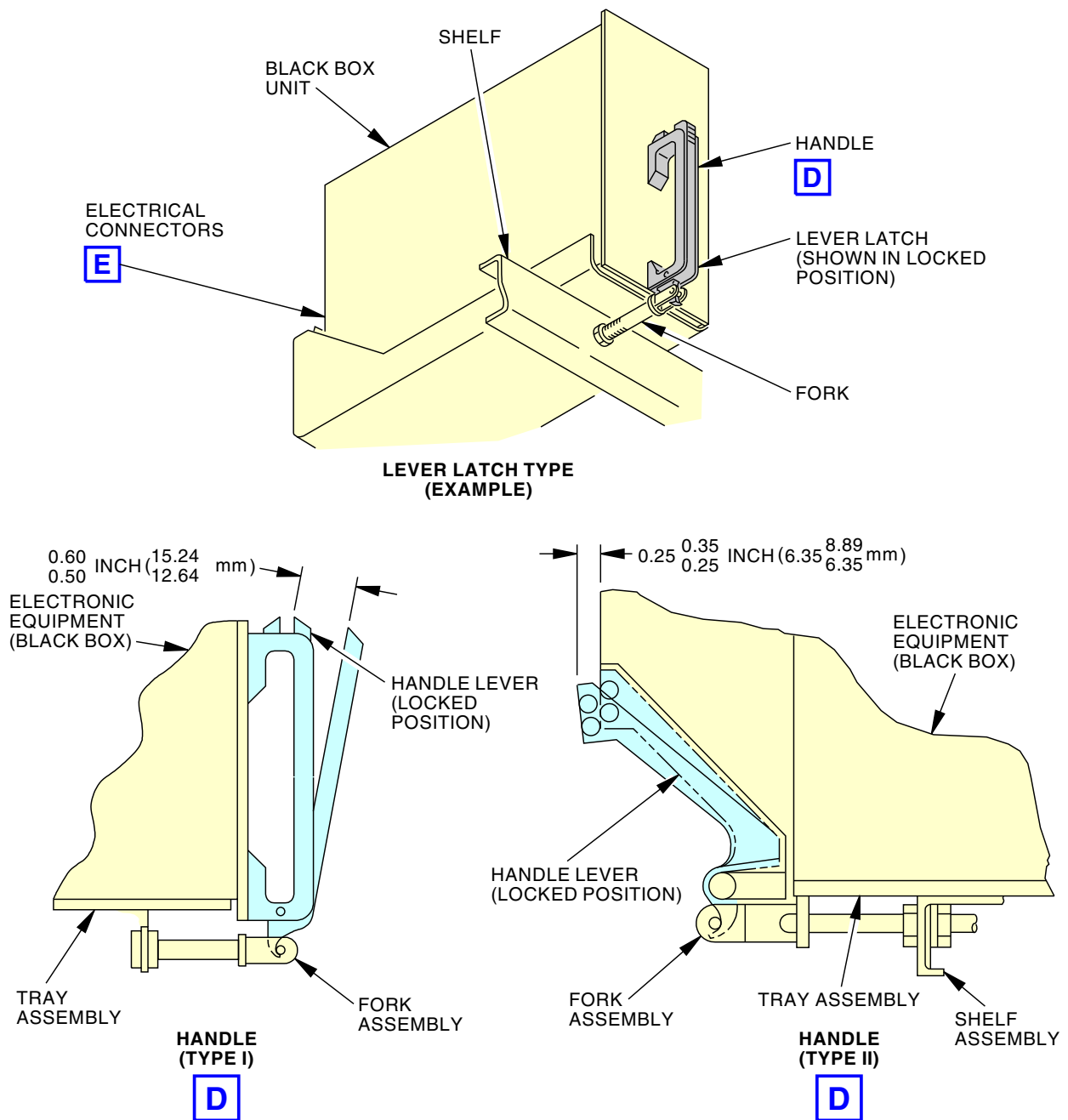
EFFECTIVITY
SIA ALL

D633AM101-SIA

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NOTE:

ADJUST FRONT HOLD DOWNS AS FOLLOWS:
WITH PLUG ON THE REAR OF UNIT FULLY ENGAGED AND THE HANDLE LEVER ON THE FRONT OF THE UNIT AT THE DIMENSION SHOWN, ADJUST FORKS BY ROTATING TO A POSITION WHERE THEY START TO EXERT PRESSURE ON THE LOCKING LEVER.

2411070 S00061526851_V1

**E/E Box Installation
Figure 401/20-10-07-990-801 (Sheet 4 of 6)**

EFFECTIVITY
SIA ALL

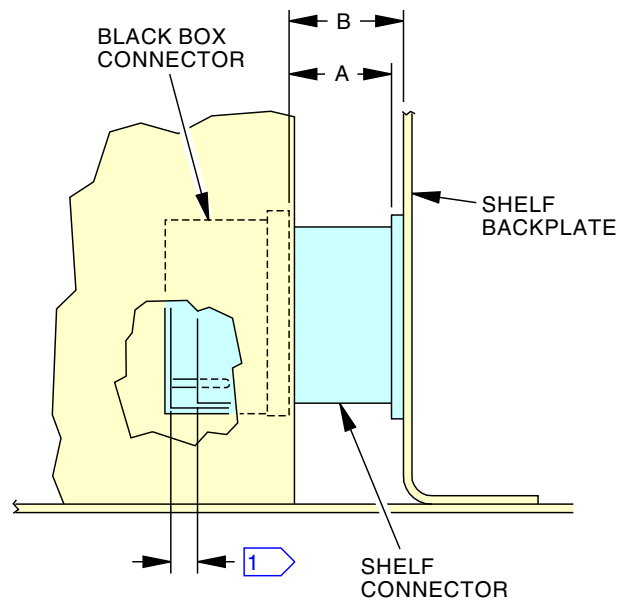
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**MATED ELECTRICAL CONNECTORS
(EXAMPLE)**

E

CONNECTOR TYPE	A INCH (mm) MAXIMUM	B INCH (mm) MAXIMUM
AD2		0.297 (7.544)
AMP		0.297 (7.544)
DPA	0.157 (3.988)	
DPD	0.138 (3.505)	
DPE	UNKNOWN	UNKNOWN
DPDMA	0.138 (3.505)	
DPD2	0.138 (3.505)	
DPXA		0.297 (7.544)
DPXB		0.297 (7.544)
DPX2		0.297 (7.544)
SR-RAI		0.581 (14.757)

NOTE:

DIMENSIONS CAN BE MEASURED WITH PUTTY OR A PAPER SLEEVE OR RING OF A SUITABLE LENGTH THAT WILL BE CRUSHED WHEN THE CONNECTOR IS MATED PROPERLY.

1 0.09 INCH (2.286 mm) MAXIMUM FOR ANY CONNECTOR FULLY MATED (ALTERNATE METHOD)

2411071 S00061526852_V1

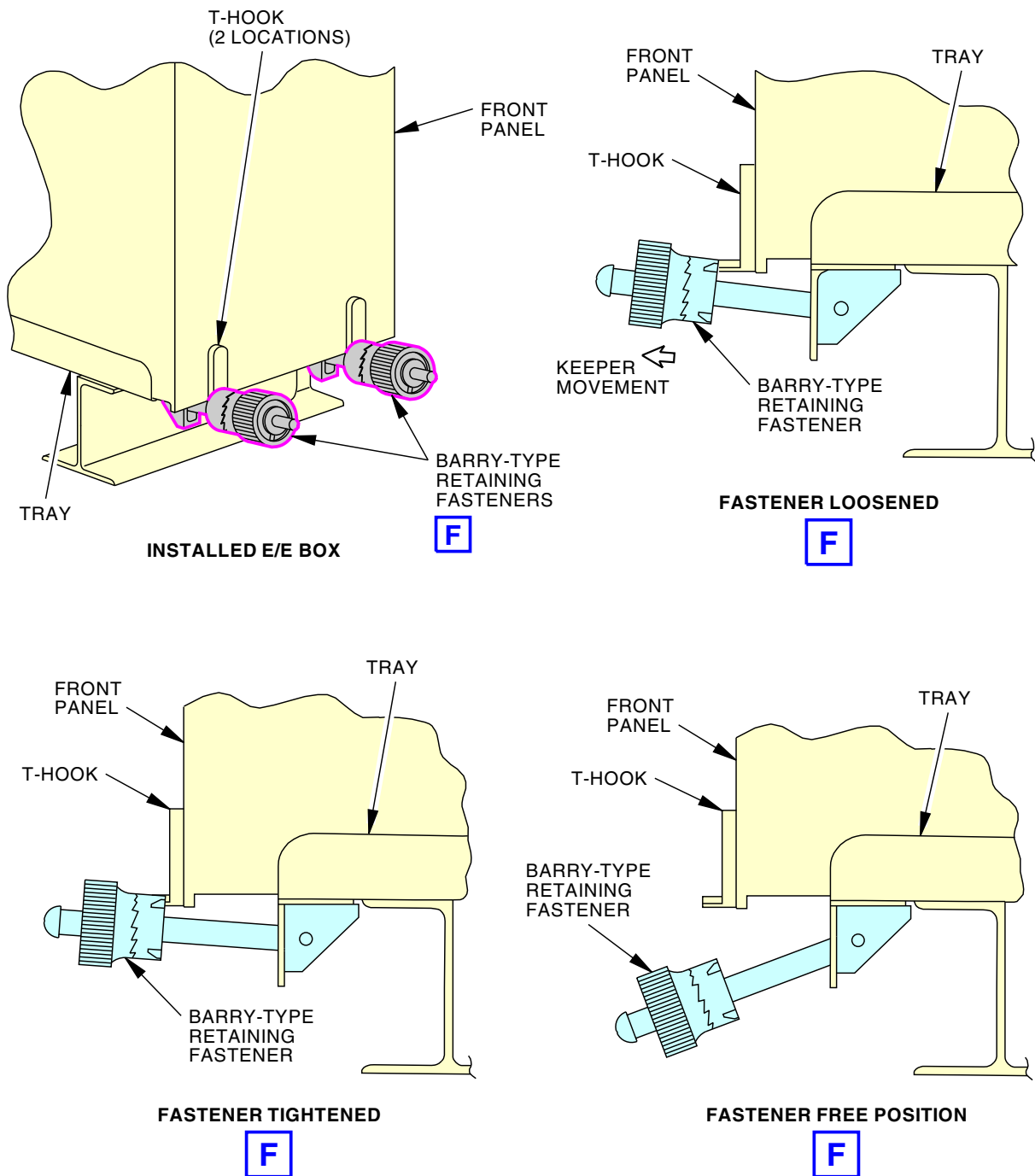
**E/E Box Installation
Figure 401/20-10-07-990-801 (Sheet 5 of 6)**

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BARRY-TYPE RETAINING FASTENER

3027982 S0000799400_V1

E/E Box Installation
Figure 401/20-10-07-990-801 (Sheet 6 of 6)

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TASK 20-10-07-400-801

3. E/E Box Installation

(Figure 401)

A. References

Reference	Title
20-40-12-000-803	Conductive Dust Cap and Connector Cover Removal (P/B 201)
20-40-12-400-802	ESDS Handling for Metal Encased Unit Installation (P/B 201)
SWPM 20-30-00 Electrical Connection of Equipment	Standard Wiring Practices Manual

B. Location Zones

Zone	Area
117	Electrical and Electronics Compartment - Left
118	Electrical and Electronics Compartment - Right

SIA ALL; AIRPLANES WITH REXNORD AEROSPACE MECHANISM EXTRACTOR.

C. E/E Box Installation Procedure

SUBTASK 20-10-07-860-005

- (1) Make sure the applicable circuit breakers for the Electrical / Electronic (E/E) box are open.

SUBTASK 20-10-07-210-001

- (2) Compare the quantity and location of the rubber plugs with the decal installed on the tray, if applicable.

NOTE: Each rubber plug location will agree with a block dot on the decal installed on the tray.

- (a) Install or remove rubber plugs if it is necessary.

SUBTASK 20-10-07-910-005

- (3) If the E/E box is sensitive to electrostatic discharge, do these steps:



CAUTION

DO NOT TOUCH THE UNIT BEFORE YOU DO THE PROCEDURE FOR DEVICES THAT ARE SENSITIVE TO ELECTROSTATIC DISCHARGE. ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE UNIT.

- (a) Do this task: ESDS Handling for Metal Encased Unit Installation, TASK 20-40-12-400-802.
- (b) Do this task: Conductive Dust Cap and Connector Cover Removal, TASK 20-40-12-000-803.

SUBTASK 20-10-07-020-019

- (4) If the E/E box is not sensitive to electrostatic discharge, remove the protective covers from the electrical connector(s).

SUBTASK 20-10-07-210-002



CAUTION

MAKE SURE THAT THE ELECTRICAL PINS ON THE E/E BOX CONNECTOR AND TRAY CONNECTOR ARE NOT BENT OR DAMAGED. IF YOU INSTALL THE E/E BOX WITH DAMAGED PINS, DAMAGE TO THE E/E BOX, TRAY ELECTRICAL CONNECTOR, OR SYSTEM COMPONENTS CAN OCCUR.

- (5) Visually make sure the electrical pins of the E/E box and tray connector are not bent or damaged.

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SIA ALL; AIRPLANES WITH REXNORD AEROSPACE MECHANISM EXTRACTOR. (Continued)

- (a) Replace components if they are damaged, refer to SWPM 20-30-00 Electrical Connection of Equipment.

SUBTASK 20-10-07-420-011

- (6) Carefully start to install the E/E box into the tray.

NOTE: For easier installation of the E/E box, lift the front of the E/E box approximately $\frac{1}{8}$ in. (3 mm) above the tray surface.

SUBTASK 20-10-07-420-012

- (7) Continue to move the E/E box into the tray and engage the electrical connector.

NOTE: The hold-down extractor mechanism does not always provide enough force to completely engage the E/E box with the electrical connector. The E/E box must first be fully engaged and seated before using the hold-down extractor mechanism to secure the installation.

SUBTASK 20-10-07-210-003

- (8) Make sure the electrical connector is engaged.

SUBTASK 20-10-07-210-004

- (9) Move the E/E box to make sure of a tight fit.

SUBTASK 20-10-07-820-001

- (10) Turn the keeper to put the deep slot near to and aligned with the T-hook.

SUBTASK 20-10-07-420-013

- (11) Put the extractor on the T-hook and turn the keeper 180 degrees.

SUBTASK 20-10-07-420-014

- (12) To tighten the front hold-down extractor, turn the knob clockwise until the clutch engages fully.

NOTE: You will feel clicks while you turn the knob.

SUBTASK 20-10-07-420-015

- (13) Tighten the extractor.

SUBTASK 20-10-07-420-016

- (14) Re-tighten the extractor.

- (a) Press firmly on the front of the unit.

NOTE: This is to make sure the unit is fully seated before re-tightening.

- (b) Re-tighten the extractor knobs.

SUBTASK 20-10-07-420-017

- (15) Install the connections to the front of the E/E box, if it is necessary.

SUBTASK 20-10-07-860-006

- (16) Close the applicable circuit breakers for the E/E box.

SIA ALL; AIRPLANES WITH HOLLINGSEAD EXTRACTOR.

D. E/E Box Installation Procedure

SUBTASK 20-10-07-860-007

- (1) Make sure the applicable circuit breakers for the E/E box are open.

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SIA ALL; AIRPLANES WITH HOLLINGSEAD EXTRACTOR. (Continued)

SUBTASK 20-10-07-210-005

- (2) Compare the quantity and location of the rubber plugs with the decal installed on the tray, if applicable.

NOTE: Each rubber plug location will agree with a block dot on the decal installed on the tray.

- (a) Install or remove rubber plugs if it is necessary.

SUBTASK 20-10-07-910-006

- (3) If the E/E box is sensitive to electrostatic discharge, do these steps:



CAUTION

DO NOT TOUCH THE UNIT BEFORE YOU DO THE PROCEDURE FOR DEVICES THAT ARE SENSITIVE TO ELECTROSTATIC DISCHARGE. ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE UNIT.

- (a) Do this task: ESDS Handling for Metal Encased Unit Installation, TASK 20-40-12-400-802.
- (b) Do this task: Conductive Dust Cap and Connector Cover Removal, TASK 20-40-12-000-803.

SUBTASK 20-10-07-020-020

- (4) If the E/E box is not sensitive to electrostatic discharge, remove the protective covers from the electrical connector(s).

SUBTASK 20-10-07-210-006



CAUTION

MAKE SURE THAT THE ELECTRICAL PINS ON THE E/E BOX CONNECTOR AND TRAY CONNECTOR ARE NOT BENT OR DAMAGED. IF YOU INSTALL THE E/E BOX WITH DAMAGED PINS, DAMAGE TO THE E/E BOX, TRAY ELECTRICAL CONNECTOR, OR SYSTEM COMPONENTS CAN OCCUR.

- (5) Visually make sure the electrical pins of the E/E box and tray connector are not bent or damaged.
 - (a) Replace components if they are damaged, refer to SWPM 20-30-00 Electrical Connection of Equipment.

SUBTASK 20-10-07-420-018

- (6) Carefully start to install the box into the tray.

NOTE: For easier installation of the E/E box, lift the front of the E/E box approximately about $\frac{1}{8}$ in. (3 mm) above the tray surface.

SUBTASK 20-10-07-420-019

- (7) Continue to move the box into the tray and engage the electrical connector.

SUBTASK 20-10-07-820-002

- (8) Align the front hold-down extractor with the T-hook.

SUBTASK 20-10-07-420-020

- (9) Put the extractor on the T-hook and turn the latch clockwise.

SUBTASK 20-10-07-420-021

- (10) Turn the knob on the front hold-down extractor clockwise until you cannot see the red band and the clutch engages.

SUBTASK 20-10-07-420-022

- (11) Tighten the extractor.

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SIA ALL; AIRPLANES WITH HOLLINGSEAD EXTRACTOR. (Continued)

SUBTASK 20-10-07-420-023

- (12) Re-tighten the extractor.

- (a) Press firmly on the front of the unit.

NOTE: This is to make sure the unit is fully seated before re-tightening.

- (b) Re-tighten the extractor knobs.

SUBTASK 20-10-07-210-008

- (13) Make sure the electrical connector is engaged.

SUBTASK 20-10-07-420-024

- (14) Install the connections to the front of the E/E box, if it is necessary.

SUBTASK 20-10-07-860-008

- (15) Close the applicable circuit breakers for the E/E box.

SIA ALL; AIRPLANES WITH HARTWELL EXTRACTOR.

E. E/E Box Installation

SUBTASK 20-10-07-860-009

- (1) Make sure the applicable circuit breakers for the E/E box are open.

SUBTASK 20-10-07-210-009

- (2) Compare the quantity and location of the rubber plugs with the decal installed on the tray, if applicable.

NOTE: Each rubber plug location will agree with a block dot on the decal installed on the tray.

- (a) Install or remove rubber plugs if it is necessary.

SUBTASK 20-10-07-910-007

- (3) If the E/E box is sensitive to electrostatic discharge, do these steps:



CAUTION

DO NOT TOUCH THE UNIT BEFORE YOU DO THE PROCEDURE FOR DEVICES THAT ARE SENSITIVE TO ELECTROSTATIC DISCHARGE. ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE UNIT.

- (a) Do this task: ESDS Handling for Metal Encased Unit Installation, TASK 20-40-12-400-802.
- (b) Do this task: Conductive Dust Cap and Connector Cover Removal, TASK 20-40-12-000-803.

SUBTASK 20-10-07-020-021

- (4) If the E/E box is not sensitive to electrostatic discharge, remove the protective covers from the electrical connector(s).

SUBTASK 20-10-07-210-010



CAUTION

MAKE SURE THAT THE ELECTRICAL PINS ON THE E/E BOX CONNECTOR AND TRAY CONNECTOR ARE NOT BENT OR DAMAGED. IF YOU INSTALL THE E/E BOX WITH DAMAGED PINS, DAMAGE TO THE E/E BOX, TRAY ELECTRICAL CONNECTOR, OR SYSTEM COMPONENTS CAN OCCUR.

- (5) Visually make sure the electrical pins of the E/E box and tray connector are not bent or damaged.

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SIA ALL; AIRPLANES WITH HARTWELL EXTRACTOR. (Continued)

- (a) Replace components if they are damaged, refer to SWPM 20-30-00 Electrical Connection of Equipment.

SUBTASK 20-10-07-420-025

- (6) Carefully start to install the box into the tray.

NOTE: For easier installation of the E/E box, lift the front of the E/E box approximately about $\frac{1}{8}$ in. (3 mm) above the tray surface.

SUBTASK 20-10-07-420-026

- (7) Continue to move the box into the tray and engage the electrical connector.

SUBTASK 20-10-07-820-003

- (8) Compress the keeper to engage the T-hook on the E/E box.

SUBTASK 20-10-07-420-027

- (9) To tighten the front hold-down extractors, turn the knob clockwise until the clutch engages fully.

NOTE: You will feel clicks while you turn the knob.

SUBTASK 20-10-07-210-011

- (10) Move the E/E box to make sure of a tight fit.

SUBTASK 20-10-07-420-028

- (11) Tighten the extractor.

SUBTASK 20-10-07-420-029

- (12) Re-tighten the extractor.

- (a) Press firmly on the front of the unit.

NOTE: This is to make sure the unit is fully seated before re-tightening.

- (b) Re-tighten the extractor knobs.

SUBTASK 20-10-07-210-012

- (13) Make sure the electrical connector is engaged.

SUBTASK 20-10-07-420-030

- (14) Install the connections to the front of the E/E box, if it is necessary.

SUBTASK 20-10-07-860-010

- (15) Close the applicable circuit breakers for the E/E box.

SIA ALL; AIRPLANES WITH LEVER LATCH HANDLES.

F. E/E Box Installation

NOTE: For airplanes with lever latch handles.

SUBTASK 20-10-07-860-011

- (1) Make sure the applicable circuit breakers for the E/E box are open.

SUBTASK 20-10-07-210-013

- (2) Compare the quantity and location of the rubber plugs with the decal installed on the tray, if applicable.

NOTE: Each rubber plug location will agree with a block dot on the decal installed on the tray.

- (a) Install or remove rubber plugs if it is necessary.

SUBTASK 20-10-07-910-008

- (3) If the E/E box is sensitive to electrostatic discharge, do these steps:

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SIA ALL; AIRPLANES WITH LEVER LATCH HANDLES. (Continued)



DO NOT TOUCH THE UNIT BEFORE YOU DO THE PROCEDURE FOR DEVICES THAT ARE SENSITIVE TO ELECTROSTATIC DISCHARGE. ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE UNIT.

- (a) Do this task: ESDS Handling for Metal Encased Unit Installation, TASK 20-40-12-400-802.
- (b) Do this task: Conductive Dust Cap and Connector Cover Removal, TASK 20-40-12-000-803.

SUBTASK 20-10-07-020-022

- (4) If the E/E box is not sensitive to electrostatic discharge, remove the protective covers from the electrical connector(s).

SUBTASK 20-10-07-210-014



MAKE SURE THAT THE ELECTRICAL PINS ON THE E/E BOX CONNECTOR AND TRAY CONNECTOR ARE NOT BENT OR DAMAGED. IF YOU INSTALL THE E/E BOX WITH DAMAGED PINS, DAMAGE TO THE E/E BOX, TRAY ELECTRICAL CONNECTOR, OR SYSTEM COMPONENTS CAN OCCUR.

- (5) Visually make sure the electrical pins of the E/E box and tray connector are not bent or damaged.
 - (a) Replace components if they are damaged, refer to SWPM 20-30-00 Electrical Connection of Equipment.

SUBTASK 20-10-07-420-031

- (6) Carefully start to install the box into the tray with the lever in the open position.

NOTE: For easier installation of the E/E box, lift the front of the E/E box approximately about $\frac{1}{8}$ in. (3 mm) above the tray surface.

SUBTASK 20-10-07-420-032

- (7) Continue to move the box into the tray until the lever engages the shelf-mounted fork and the electrical connector engages.

SUBTASK 20-10-07-820-004

- (8) Move lever latch to its locked position and verify proper adjustment.
 - (a) To adjust the lever latch fork, do this task: Lever Latch Fork Adjustment, TASK 20-10-07-820-801.

SUBTASK 20-10-07-210-015

- (9) Make sure the electrical connector is engaged.

SUBTASK 20-10-07-210-017

- (10) Pull the E/E box to make sure of a tight fit.

NOTE: This is to make sure that the connector and the lever latch are fully engaged.

SUBTASK 20-10-07-420-033

- (11) Install the connections to the front of the E/E box, if it is necessary.

SUBTASK 20-10-07-860-012

- (12) Close the applicable circuit breakers for the E/E box.

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SIA ALL; AIRPLANES WITH BARRY-TYPE RETAINING FASTENERS.

G. E/E Box Installation Procedure

NOTE: For airplanes with Barry-type extractors.

SUBTASK 20-10-07-040-002

- (1) Make sure that the applicable circuit breakers for the E/E box are open.

SUBTASK 20-10-07-200-001

- (2) Compare the quantity and location of the rubber plugs with the decal installation on the tray, if applicable.

NOTE: Each rubber plug location will agree with a black dot on the decal installed on the tray.

- (a) Install or remove rubber plugs if it is necessary.

SUBTASK 20-10-07-580-003

- (3) If the E/E box is sensitive to electrostatic discharge, do the steps that follow.



CAUTION

DO NOT TOUCH THE UNIT BEFORE YOU DO THE PROCEDURE FOR DEVICES THAT ARE SENSITIVE TO ELECTROSTATIC DISCHARGE. ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE UNIT.

- (a) Do this task: ESDS Handling for Metal Encased Unit Installation, TASK 20-40-12-400-802.
- (b) Do this task: Conductive Dust Cap and Connector Cover Removal, TASK 20-40-12-000-803.

SUBTASK 20-10-07-020-023

- (4) If the E/E box is sensitive to electrostatic discharge, remove the protective covers from the electrical connector(s).

SUBTASK 20-10-07-200-002



CAUTION

MAKE SURE THAT THE ELECTRICAL PINS ON THE E/E BOX CONNECTOR AND TRAY CONNECTOR ARE NOT BENT OR DAMAGED. IF YOU INSTALL THE E/E BOX WITH DAMAGED PINS, DAMAGE TO THE E/E BOX, TRAY ELECTRICAL CONNECTOR, OR SYSTEM COMPONENTS CAN OCCUR.

- (5) Visually make sure that the electrical pins of the E/E box and tray connector are not bent or damaged.
- (a) Replace components if they are damaged, refer to SWPM 20-30-00 Electrical Connection of Equipment.

SUBTASK 20-10-07-420-034

- (6) Carefully start to install the E/E box into the tray.
- (a) For easier installation of the E/E box, lift the front of the E/E box approximately $\frac{1}{8}$ in. (3 mm) above the tray surface.

SUBTASK 20-10-07-420-035

- (7) Continue to move the E/E box into the tray and engage the electrical connector.

NOTE: The hold-down extractor mechanism does not always provide enough force to completely engage the E/E box with the electrical connector. The E/E box must first be fully engaged and seated before using the hold-down extractor mechanism to secure the installation.

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SIA ALL; AIRPLANES WITH BARRY-TYPE RETAINING FASTENERS. (Continued)

SUBTASK 20-10-07-200-003

- (8) Make sure the electrical connector is engaged.

SUBTASK 20-10-07-420-036

- (9) Tighten the Barry-type retaining fastener by hand.

SUBTASK 20-10-07-200-004

- (10) Move the E/E box to make sure of a tight fit.

SUBTASK 20-10-07-420-037

- (11) Re-tighten the Barry-type retaining fastener by hand.

SUBTASK 20-10-07-400-001

- (12) Install the connections to the front of the E/E box, if it is necessary.

SUBTASK 20-10-07-440-001

- (13) Close the applicable circuit breakers for the E/E box.

SIA ALL

———— **END OF TASK** ————

TASK 20-10-07-820-801

4. Lever Latch Fork Adjustment

(Figure 401)

NOTE: For airplanes with lever latch handles.

A. Prepare For Adjustment

SUBTASK 20-10-07-020-024

- (1) To remove the unit with the lever latch, do this task: E/E Box Removal, TASK 20-10-07-000-801.

SUBTASK 20-10-07-020-025

- (2) If installed, loosen jamnut on fork assembly.

SUBTASK 20-10-07-010-001

- (3) Examine all parts of latching mechanism for serviceability.

B. Adjust Lever Latch Fork

SUBTASK 20-10-07-420-038

- (1) Install unit back on shelf until connectors are partially engaged, do this task: E/E Box Installation, TASK 20-10-07-400-801.

SUBTASK 20-10-07-420-039

- (2) Engage lever latch hook with fork assembly pin.

SUBTASK 20-10-07-420-040

- (3) Start closing lever latch handle.

NOTE: It is possible to determine full connector engagement by feel. A sudden increase in handle pressure, resistance to handle movement, indicates that the connectors are fully engaged.

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SUBTASK 20-10-07-820-005

- (4) Adjust the fork assembly until resistance to handle movement occurs within the required gap tolerance, as shown in Figure 401.

NOTE: Loosen the nut at the shelf area for fork adjustment.



CAUTION

MAKE SURE THERE IS SUFFICIENT THREAD ENGAGEMENT IN THE LATCH FORK. WITHOUT SUFFICIENT THREAD ENGAGEMENT THE LATCH LEVER COULD FAIL, ALLOWING THE BLACK BOX TO SLIDE OUT OF POSITION.

- (a) Make sure there is sufficient thread engagement in the latch fork.

SUBTASK 20-10-07-820-006

- (5) Close handle until latched.

SUBTASK 20-10-07-420-041

- (6) Tighten jamnut to snug fit.

———— **END OF TASK** ————

TASK 20-10-07-000-802

5. Printed Circuit Card Removal

(Figure 402)

A. References

Reference	Title
20-40-12-000-801	ESDS Handling for Printed Circuit Board Removal (P/B 201)

B. Procedure

SUBTASK 20-10-07-860-013

- (1) Make sure you remove electrical power from the printed circuit card.

SUBTASK 20-10-07-910-009



CAUTION

DO NOT TOUCH THE CIRCUIT CARD BEFORE YOU DO THE PROCEDURES FOR DEVICES THAT ARE SENSITIVE TO ELECTROSTATIC DISCHARGE. ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE CIRCUIT CARD OF THE ELECTRONIC UNIT.

- (2) Make sure you, do this task: ESDS Handling for Printed Circuit Board Removal, TASK 20-40-12-000-801.

SUBTASK 20-10-07-010-002

- (3) Open the cardfile door.

SUBTASK 20-10-07-020-026

- (4) Remove the printed circuit card assembly:
 - (a) Turn the two ejector levers approximately 90 degrees to give the printed-circuit card a lateral play.
 - (b) While you push the two latch levers, turn the two lock release levers to release the latch lock.
 - (c) Turn the ejectors on the printed-circuit card assembly until the printed-circuit card disengages from the electrical connector.
 - (d) Carefully move the printed-circuit card assembly out along the guide.

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- (e) Remove the printed-circuit card assembly.

———— **END OF TASK** ————

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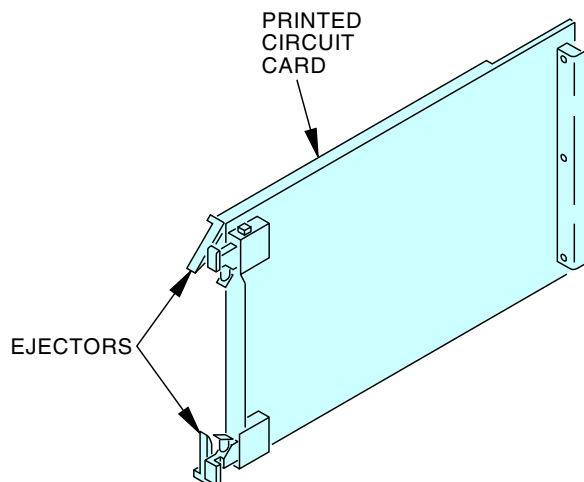
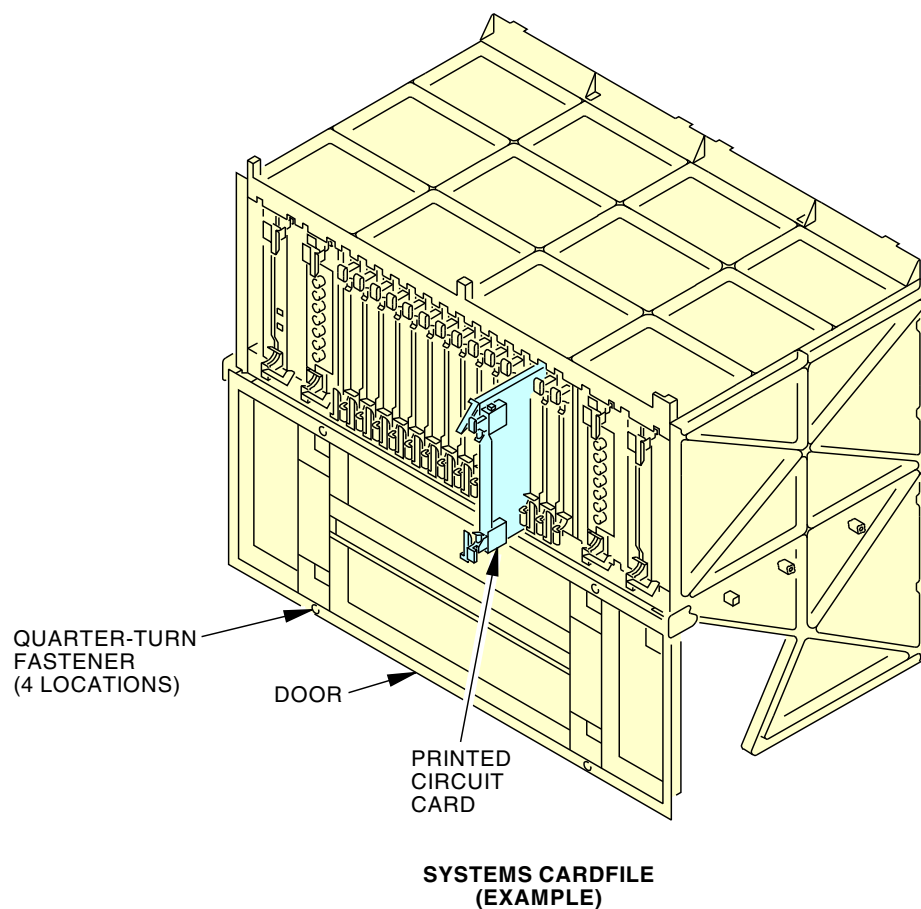
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Printed Circuit Card Installation
Figure 402/20-10-07-990-802

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TASK 20-10-07-400-802

6. Printed Circuit Card Installation

(Figure 402)

A. References

Reference	Title
20-40-12-400-801	ESDS Handling for Printed Circuit Board Installation (P/B 201)

B. Procedure

SUBTASK 20-10-07-860-014

- (1) Make sure electrical power is removed from the printed circuit card.

SUBTASK 20-10-07-910-010



DO NOT TOUCH THE PRINTED CIRCUIT CARD BEFORE YOU DO THE PROCEDURE FOR DEVICES THAT ARE SENSITIVE TO ELECTROSTATIC DISCHARGE. ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE PRINTED CIRCUIT CARD.

- (2) Make sure you, do this task: ESDS Handling for Printed Circuit Board Installation, TASK 20-40-12-400-801.

SUBTASK 20-10-07-210-016

- (3) Make sure the edge connector has no bent pins.

SUBTASK 20-10-07-420-042

- (4) Install the printed circuit card assembly:
- (a) Install the printed-circuit card assembly
 - (b) Carefully move the printed-circuit card assembly in along the guide.
 - (c) Turn the ejectors on the printed-circuit card assembly until the printed-circuit card engages in to the electrical connector.
 - (d) While you push the two latch levers, turn the two lock levers to lock the latch.
 - (e) Manually turn the ejector levers to tighten the printed circuit card assembly.

NOTE: The levers should be approximately vertical.

————— **END OF TASK** —————

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CONTROL CABLE STOPS - REMOVAL/INSTALLATION

1. General

A. This procedure has these tasks:

- (1) A removal of the control cable stops.
- (2) An installation of the control cable stops.

TASK 20-10-08-960-801

2. Control Cable Stops Removal

(Figure 401)

A. Procedure

SUBTASK 20-10-08-020-001

- (1) Remove the lockwire that attaches the control cable stop to the swaged cable terminal stud.

SUBTASK 20-10-08-020-002

- (2) Move the control cable stop longitudinally away from the swaged cable terminal stud until the control cable stop disengages.

SUBTASK 20-10-08-980-001

- (3) Move the control cable stop laterally to permit the cable to go through the slot in the control cable stop.

————— **END OF TASK** —————

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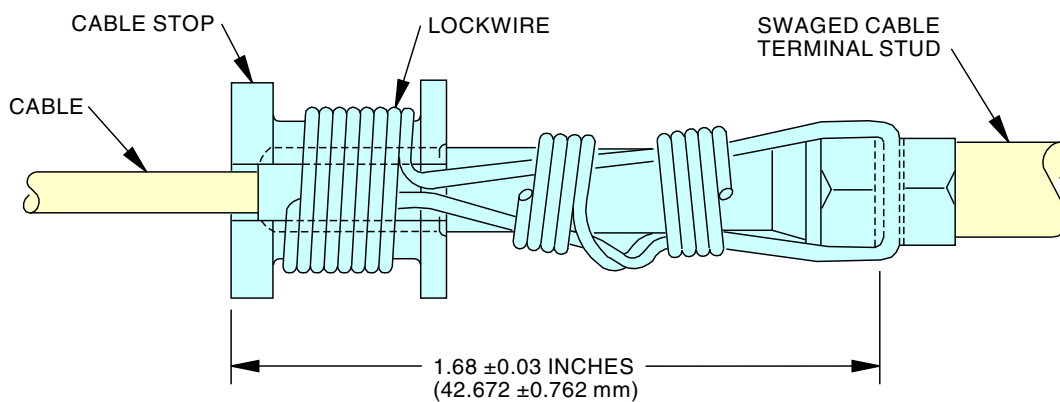
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Control Cable Stops Installation
Figure 401/20-10-08-990-801

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TASK 20-10-08-420-801

3. Control Cable Stops Installation

(Figure 401)

A. References

Reference	Title
20-10-44-400-801	Lockwire, Cotter Pins, and Lockrings - Installation (P/B 401)

B. Procedure

SUBTASK 20-10-08-420-001

- (1) Put the large center hole of the control cable stop near the swaged cable terminal stud.

SUBTASK 20-10-08-420-002

- (2) Move the slot of the control cable stop along the cable.

SUBTASK 20-10-08-420-003

- (3) Push the control cable stop on the end of the swaged cable terminal stud until the control cable stop fully engages.

SUBTASK 20-10-08-820-001

- (4) To adjust the control cable stop, twist the swaged cable terminal stud to get the dimension shown.

SUBTASK 20-10-08-420-004

- (5) Install a lockwire from the control cable stop to the swaged cable terminal stud, do this task: Lockwire, Cotter Pins, and Lockrings - Installation, TASK 20-10-44-400-801.

———— **END OF TASK** ————

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CONTROL CABLE PULLEYS - REMOVAL/INSTALLATION

1. General

- A. This procedure has these tasks:
- (1) A removal of the control cable pulleys.
 - (2) An installation of the control cable pulleys.
- B. (Figure 401) shows examples of control cable pulleys. If this procedure does not agree with specified maintenance procedures, use the specified maintenance procedures.

TASK 20-10-09-000-801

2. Control Cable Pulleys Removal

(Figure 401)

A. **References**

Reference	Title
20-10-10-000-801	Turnbuckle Lock Removal (P/B 401)

B. **Tools/Equipment**

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt.", which stands for Optional.

Reference	Description
SPL-1569	Clamp - Control Cable Part #: A20005-9 Supplier: 81205

C. **Procedure**

SUBTASK 20-10-09-020-001

- (1) Install cable control cable clamp, SPL-1569 on the cable between the pulley to keep light tension.

NOTE: Keep light tension on cables not removed so that cable drums will not unwrap and the cable will not move out of the pulley guides. As an option, you can install rigging pins through the applicable drum or quadrant to isolate cable sections.

SUBTASK 20-10-09-020-002

- (2) Loosen the turnbuckle nearest to the control cable pulley to release tension. (Turnbuckle Lock Removal, TASK 20-10-10-000-801)

SUBTASK 20-10-09-020-003

- (3) Remove the bolt from the pulley disk.

SUBTASK 20-10-09-020-004

- (4) Remove the pulley disk.

————— **END OF TASK** —————

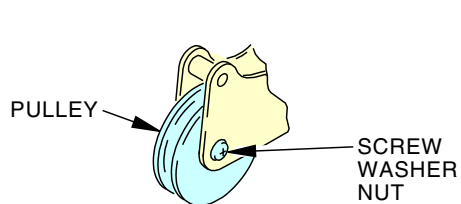
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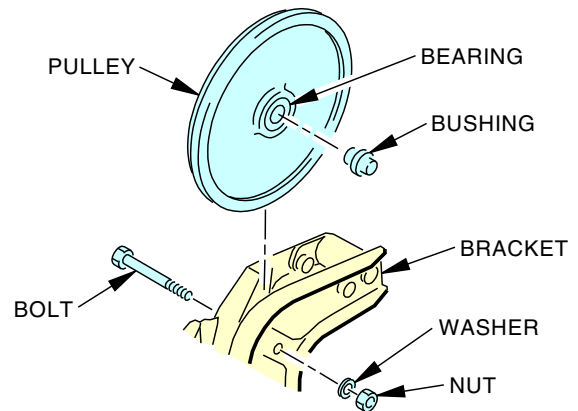
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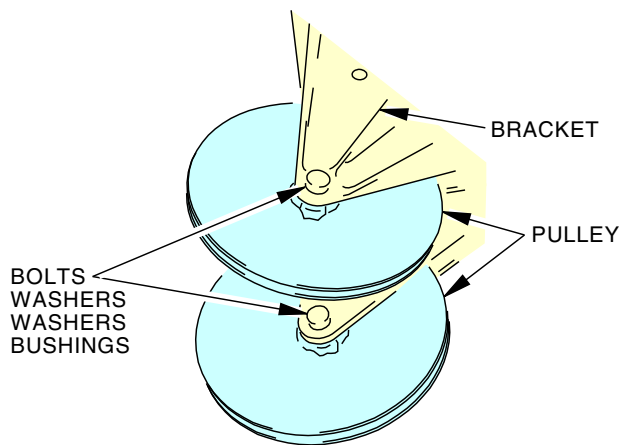
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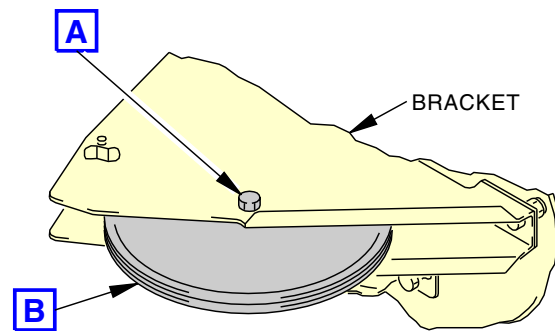
SINGLE PULLEY INSTALLATION



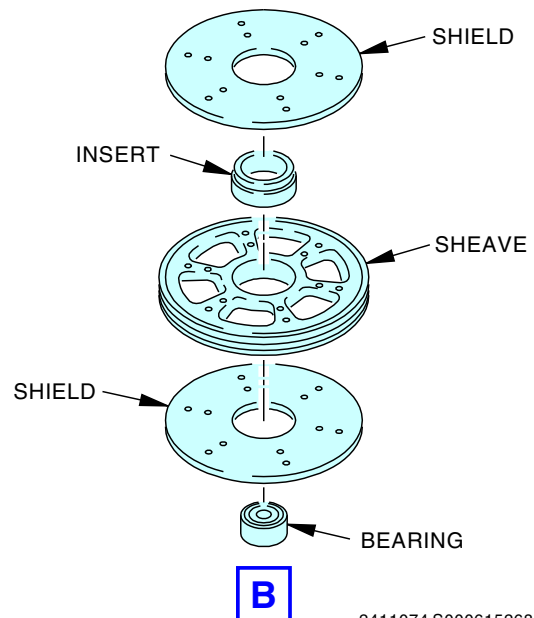
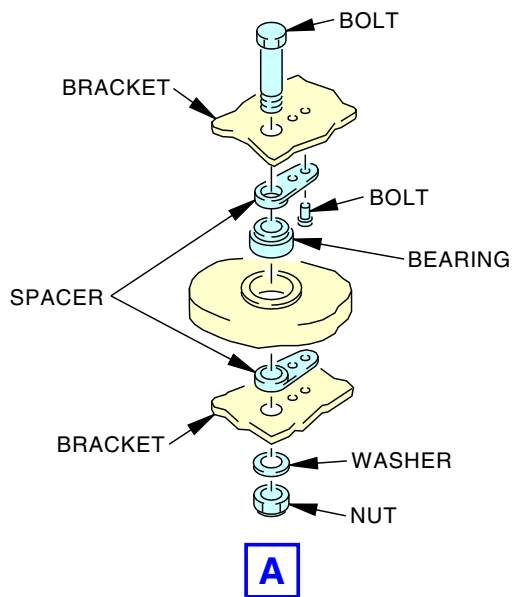
PULLEY WITH BEARING AND BUSHING



DOUBLE PULLEY INSTALLATION



DETAILED PULLEY



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Control Cable Pulleys Installation
Figure 401/20-10-09-990-801

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TASK 20-10-09-400-801

3. Control Cable Pulleys Installation

(Figure 401)

A. References

Reference	Title
20-10-10-400-801	Turnbuckle Lock Installation (P/B 401)

B. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

Reference	Description
COM-1553	Tensiometer - Cable, Low Tension (200 lbs and below) Part #: 102-03108 Supplier: 21844 Part #: 102-03120 Supplier: 21844 Part #: ACM-200 Supplier: 13331 Part #: ACX-250-1 Supplier: 13331 Part #: T60-1001-C8-1A Supplier: 0N8U4
COM-1554	Tensiometer - Cable, High Tension (200 lbs and above) Part #: 102-03120 Supplier: 21844 Part #: ACM-300 Supplier: 13331 Part #: ACM-600 Supplier: 13331 Part #: ACX-500-1 Supplier: 13331 Part #: T5-8008-106-00 Supplier: 0N8U4 Part #: T60-1001-C9-1A Supplier: 0N8U4
SPL-1569	Clamp - Control Cable Part #: A20005-9 Supplier: 81205

C. Control Cable Pulleys Installation

SUBTASK 20-10-09-420-001

- (1) Install the components applicable to the control cable pulley.

SUBTASK 20-10-09-420-002

- (2) Install the turnbuckles with the turnbuckle barrel installed an equal distance on the two threaded terminals.

NOTE: Do not let more than three threads show out of the turnbuckle barrel.

SUBTASK 20-10-09-020-005

- (3) Remove the cable control cable clamp, SPL-1569, and rigging pins from the control cable and drums.

SUBTASK 20-10-09-420-003

- (4) Tighten the cable as shown in the temperature-tension chart of the applicable system chapter.
 - (a) Do a check of the cable tension with a low tension cable tensiometer, COM-1553, or high tension cable tensiometer, COM-1554.

NOTE: Attach the tensiometer to the cable at least 6 in. (15 cm) from the turnbuckle terminal or other fittings.

SUBTASK 20-10-09-420-004

- (5) For all turnbuckles that were adjusted, do this task: Turnbuckle Lock Installation, TASK 20-10-10-400-801.

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SUBTASK 20-10-09-710-001

- (6) Operate the controls, as specified in the applicable system chapter, through full travel.
- (a) Make sure that the controls move freely.
 - (b) Make sure that the force is not excessive or abnormal.

———— **END OF TASK** ————

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TURNBUCKLE LOCK - REMOVAL/INSTALLATION

1. General

- A. This procedure has these tasks:
- (1) A removal of the turnbuckle lock
 - (2) An installation of the turnbuckle lock.

TASK 20-10-10-000-801

2. Turnbuckle Lock Removal

(Figure 401 or Figure 402)

A. Locking Clips Removal

SUBTASK 20-10-10-860-001

- (1) Twist the turnbuckle locking clip (Figure 401).

SUBTASK 20-10-10-860-002

- (2) Push the locking hook out of the hole in the center of the turnbuckle barrel.

SUBTASK 20-10-10-020-001

- (3) Move the turnbuckle locking clip out from the turnbuckle slot.

B. Lockwire Removal (Alternate Method to Locking Clips)

SUBTASK 20-10-10-020-002



USE EYE PROTECTION WHEN YOU CUT THE LOCKWIRE. WHEN THE LOCKWIRE IS CUT, PIECES CAN HIT YOUR EYES AND CAUSE INJURY TO PERSONS.

- (1) Cut the stainless steel soft annealed wire from the turnbuckle and discard it (Figure 402).

———— **END OF TASK** ————

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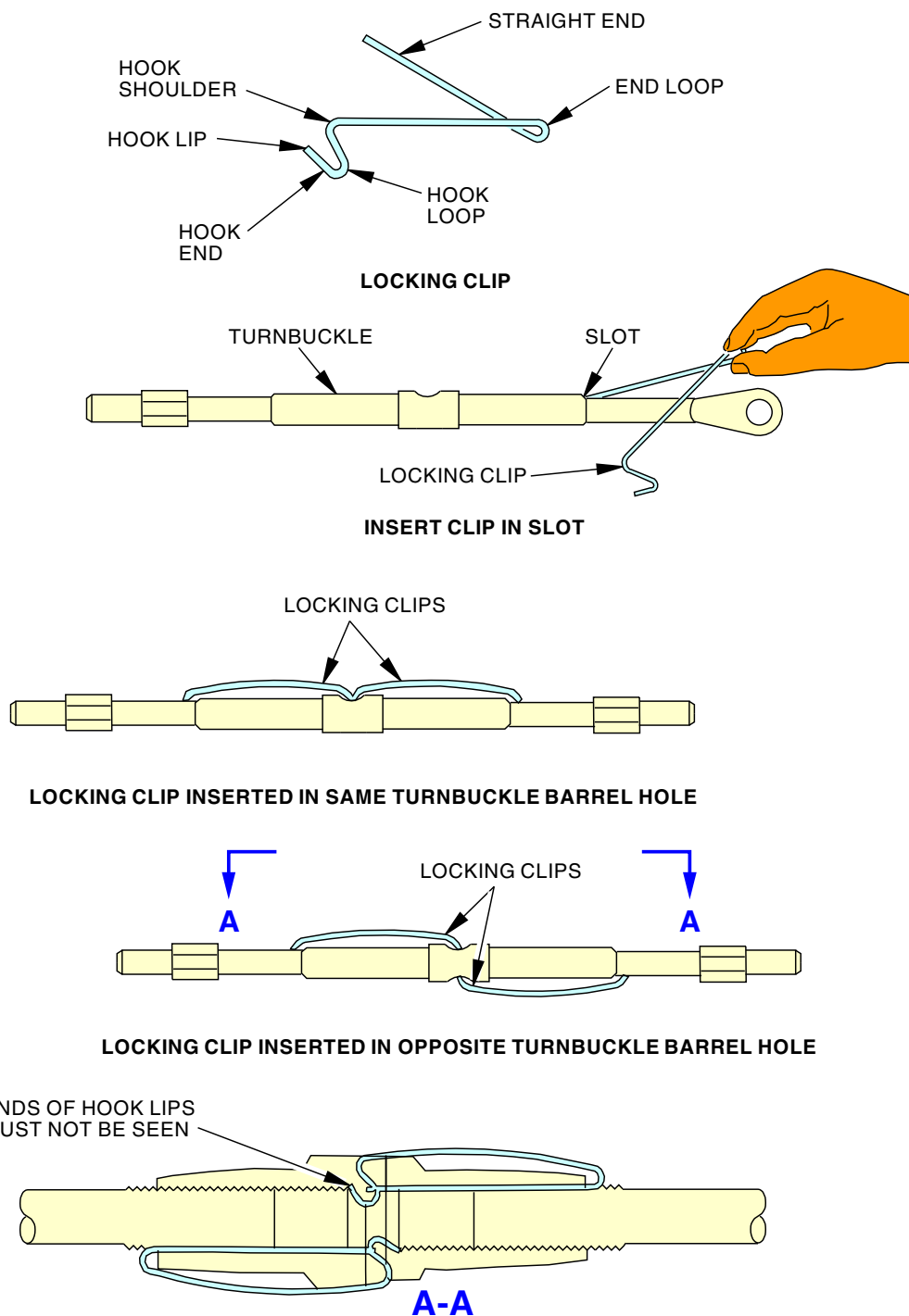
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Turnbuckle Locking Clip Installation
Figure 401/20-10-10-990-804

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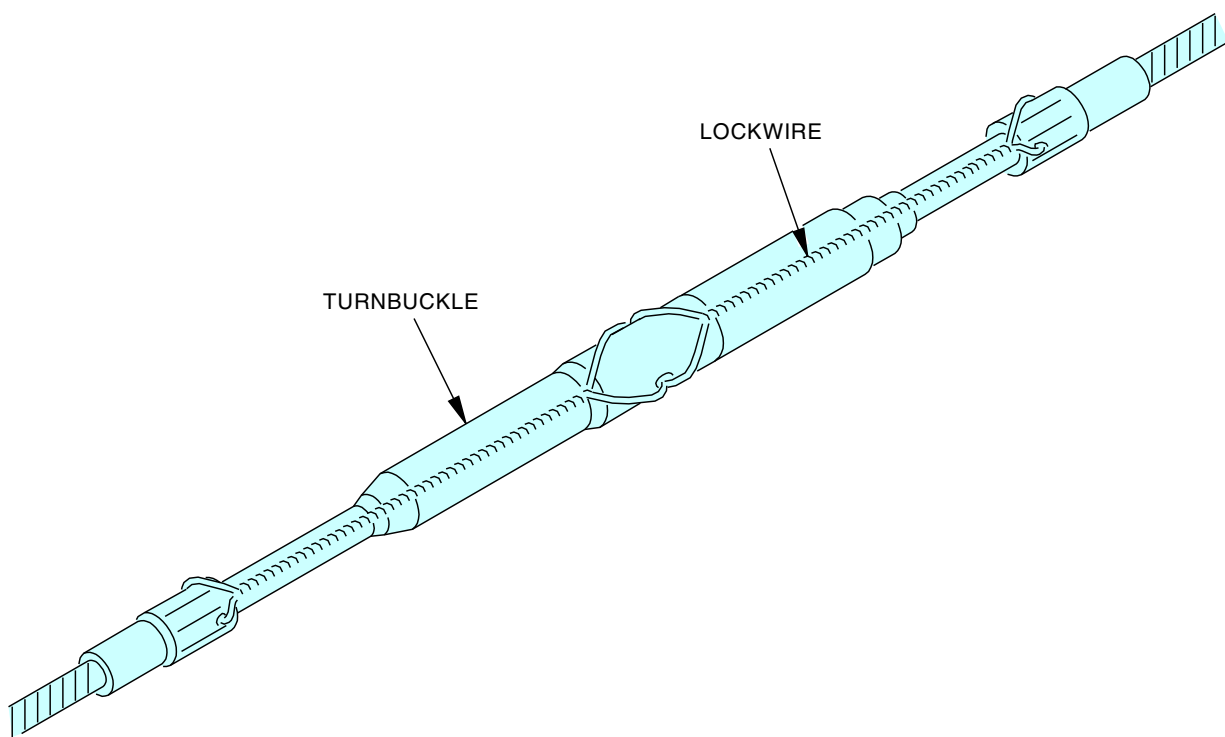
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Turnbuckle Lockwire Installation
Figure 402/20-10-10-990-805

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TASK 20-10-10-400-801

3. Turnbuckle Lock Installation

(Figure 401 or Figure 402)

A. Consumable Materials

Reference	Description	Specification
C00528	Compound - Corrosion Preventive, Petroleum Hot Application (Soft Film)	MIL-C-11796 Class III

B. Locking Clip Installation

SUBTASK 20-10-10-420-001



DO NOT USE THE TURNBUCKLE LOCKING CLIPS AGAIN. IF YOU USE THEM AGAIN, THEY CAN BE DEFECTIVE.

- (1) Tighten the turnbuckle until not more than three threads are out of the barrel and until cable tension is correct.

SUBTASK 20-10-10-820-001

- (2) Align the slot in the barrel and cable terminal.

SUBTASK 20-10-10-420-002

- (3) Put the straight end of the locking clip into the aligned slot (Figure 401).

SUBTASK 20-10-10-420-003

- (4) Put the locking clip hook over the hole in the center of the turnbuckle.

SUBTASK 20-10-10-420-004

- (5) Engage the hook into the hole.

SUBTASK 20-10-10-420-005

- (6) Push the hook shoulder to engage the hook in the turnbuckle.

SUBTASK 20-10-10-420-006

- (7) Do steps 3 through 5 again to lock the second terminal.

NOTE: The locking clips can be put in the same side or in the opposite side of the turnbuckle holes.

SUBTASK 20-10-10-820-002

- (8) Turn the turnbuckle slightly.

- (a) Make sure that the two turnbuckle locking clips are correctly installed.

SUBTASK 20-10-10-210-001

- (9) Visually examine the turnbuckle locking clip.

- (a) Make sure that the hook is engaged in the turnbuckle.

C. Lockwire Installation (Alternate Method to Locking Clips)

SUBTASK 20-10-10-600-001

- (1) Apply a thin coat of compound, C00528, to barrel and cable terminals.

SUBTASK 20-10-10-420-007

- (2) Engage turnbuckle barrel equally with cable terminals.

- (a) Turn barrel until not more than three threads are exposed outside the barrel and proper cable tension is reached.

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SUBTASK 20-10-10-420-008

- (3) Insert correct diameter stainless steel soft annealed wire into either cable terminal (Figure 402).
- (a) Use 0.020 in. (0.508 mm) wire for 1/16 in. (1.59 mm) cable.
 - (b) Use 0.032 in. (0.813 mm) wire for 3/32 in. (2.38 mm) or 1/8 in. (3.18 mm) cable.
 - (c) Use 0.041 in. (1.041 mm) wire for 5/32 in. (3.97 mm) through 5/16 in. (7.94 mm) cable.

SUBTASK 20-10-10-420-009



DO NOT USE TOO MUCH FORCE ON THE WIRE. TOO MUCH FORCE CAN CAUSE DAMAGE TO THE WIRE.

- (4) Twist wire.

SUBTASK 20-10-10-420-010

- (5) Insert ends of wire through opposite holes in barrel.
- (a) Pull wire through.
 - (b) If tool is used, apply only on ends of wire.

SUBTASK 20-10-10-420-011

- (6) Twist wire down to hole in terminal.
- (a) Insert end of one wire in hole.
 - (b) Pull through and twist ends together.
 - (c) Cut off length in excess of 5/8 in. (16 mm) of twisted ends.

SUBTASK 20-10-10-420-012

- (7) Push twisted ends back to lie flat against terminal.

————— **END OF TASK** —————

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PRESSURE-SENSITIVE DECALS - REMOVAL/INSTALLATION

1. General

- A. This procedure has these tasks:
- (1) A removal of the pressure-sensitive decals.
 - (2) An installation of the pressure-sensitive decals.
- B. Apply external decal sections in a sequence where the ends make an overlap downstream from the line of flight.
- C. All exterior decals require edge sealing using paint or an edge sealer unless specified differently.
- D. Clean plastic film decals with naphtha. Do not use adhesive activator.
- E. You can remove air bubbles in the eight hours after you apply the decal. Make a small hole in the decal film with a sharp pointed instrument, at the edge of bubble, and push air out through the hole.
- F. You can also install interior decals with the same procedure you use for pressure-sensitive placards. These are the tasks:
- Pressure Sensitive Placard Removal, TASK 20-10-14-000-801,
Pressure Sensitive Placard Installation, TASK 20-10-14-400-801.

TASK 20-10-11-000-801

2. Pressure-Sensitive Decal Removal

(Figure 401)

A. **References**

Reference	Title
51-21-11-150-801	Paint Stripping (P/B 701)

B. **Tools/Equipment**

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

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Reference	Description
COM-2481	Sealant Removal Tool (meets BSS7384 requirements) Part #: 1-6390-A Supplier: 63318 Part #: 10810 Supplier: \$0855 Part #: 10811 Supplier: \$0855 Part #: 10812 Supplier: \$0855 Part #: 234350 Supplier: 5HCF1 Part #: 235072 Supplier: 5HCF1 Part #: 235073 Supplier: 5HCF1 Part #: 235074 Supplier: 5HCF1 Part #: 235075 Supplier: 5HCF1 Part #: 235076 Supplier: 5HCF1 Part #: 311/03 Supplier: F6892 Part #: 311/14 Supplier: F6892 Part #: 311/25 Supplier: F6892 Part #: 311/37 Supplier: F6892 Part #: AS1 Supplier: \$1351 Part #: AS2 Supplier: \$1351 Part #: AS3 Supplier: \$1351 Part #: DAD5013 Supplier: 7RKH2 Part #: DFD5019 Supplier: 7RKH2 Part #: JNT411B60 Supplier: 3DN12 Part #: JNT411B90 Supplier: 3DN12 Part #: SCD5019 Supplier: 7RKH2 Part #: ST982LF-9 Supplier: 81205 Part #: TS1275-4 Supplier: 22975
COM-2615	Light - Work Part #: 9610C Supplier: 0A748 Part #: EP326-25S-25 Supplier: 15664 Part #: EP326-25S-50 Supplier: 15664 Opt Part #: EP-300-026-50 Supplier: 15664 Opt Part #: EP215-16I-25 Supplier: 15664 Opt Part #: EP326-16E-50 Supplier: 15664 Opt Part #: EP326-16S-50 Supplier: 15664
STD-3925	Heater - Blower, Explosion Proof, Electric

C. Consumable Materials

Reference	Description	Specification
B00068	Alcohol - Denatured, Ethyl (Ethanol)	AMS 3002, MIL-E-51454 Type II
B00130	Alcohol - Isopropyl	TT-I-735
G00034	Cotton Wiper - Process Cleaning Absorbent Wiper (Cheesecloth, Gauze)	AMS3819 Class 1 Grade A or B Form 1 (Supersede BMS15-5 CL A)

D. Procedure

SUBTASK 20-10-11-020-001

- (1) To remove external decals, do this task: Paint Stripping, TASK 51-21-11-150-801 on the decal.
 - (a) Be careful to protect adjacent structure and paint from the paint stripping material.

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SUBTASK 20-10-11-020-002



CAUTION

THE TEMPERATURE OF THE SURFACE TO WHICH THE DECAL IS APPLIED MUST NOT BE MORE THAN 130°F.

- (2) To remove internal decals, use heat or solvent.
- (a) To remove decals with heat, do these steps:
- 1) Heat the decal with a explosion proof electric blower - heater, STD-3925 or a work light, COM-2615, to approximately 120°F until the adhesive becomes soft.
- NOTE: If you use too much heat, the decal will melt. If the decal melts, remove it with alcohol, B00130 or alcohol, B00068 and a cotton wiper, G00034.



CAUTION

ONLY USE APPROVED SCRAPERS ON THE AIRPLANE SKIN. SCRAPERS THAT ARE NOT APPROVED CAN MAKE SCRATCHES ON THE SKIN, AND CAUSE FATIGUE CRACKS.

- 2) Lift the corner of the decal with a sealant removal tool, COM-2481.
 - 3) Remove the decal from the surface.
- (b) Remove decals with solvent:
- 1) Apply alcohol, B00068 or alcohol, B00130 to the decal with a brush or cloth.
 - 2) When the decal has wrinkles (after approximately two minutes), apply alcohol, B00130 or alcohol, B00068 again.
 - 3) After approximately two minutes, move the soft decal off of the surface or remove with a spatula.
- (c) If necessary, clean the surface with a cotton wiper, G00034 that is moist with alcohol, B00130 or alcohol, B00068.

————— **END OF TASK** —————

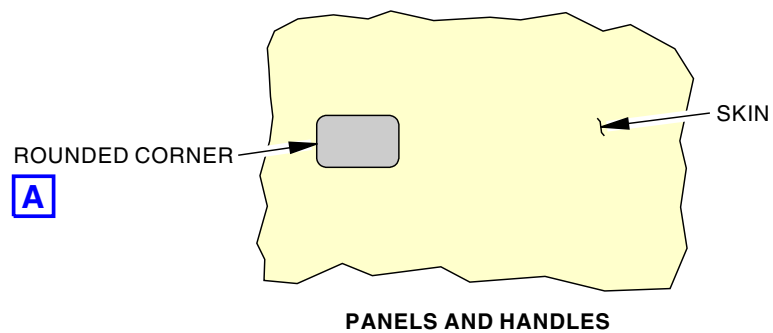
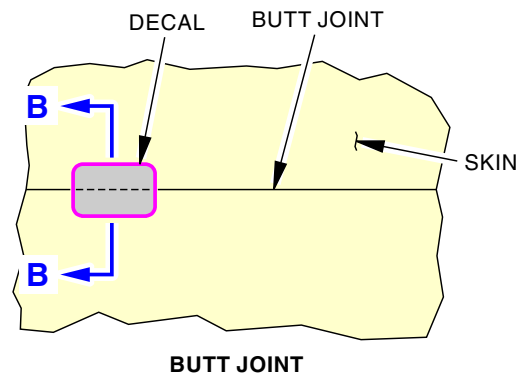
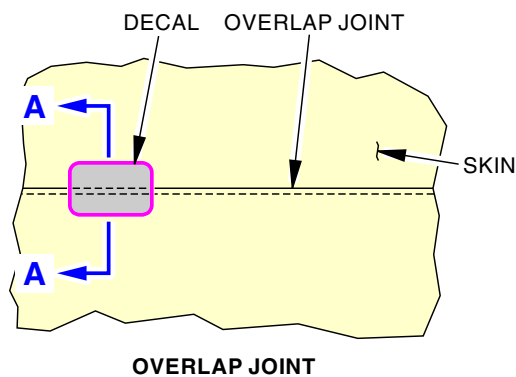
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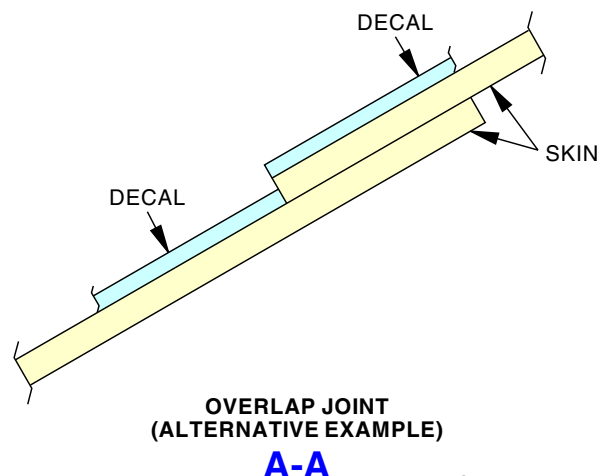
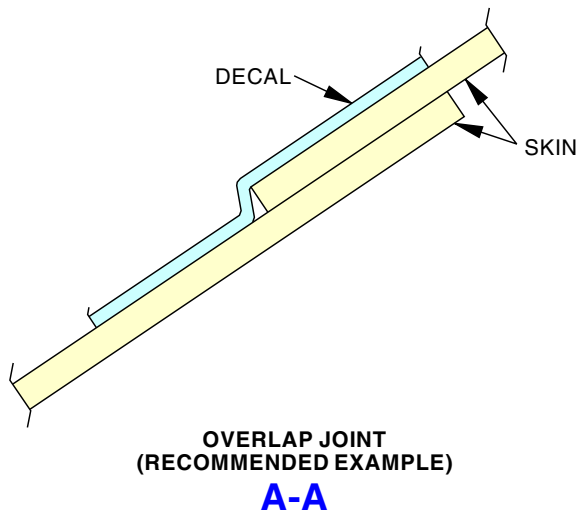
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EXAMPLES OF IRREGULAR SURFACES



2411076 S00061526877_V1

Decal Application Over Irregular Surfaces
Figure 401/20-10-11-990-801 (Sheet 1 of 2)

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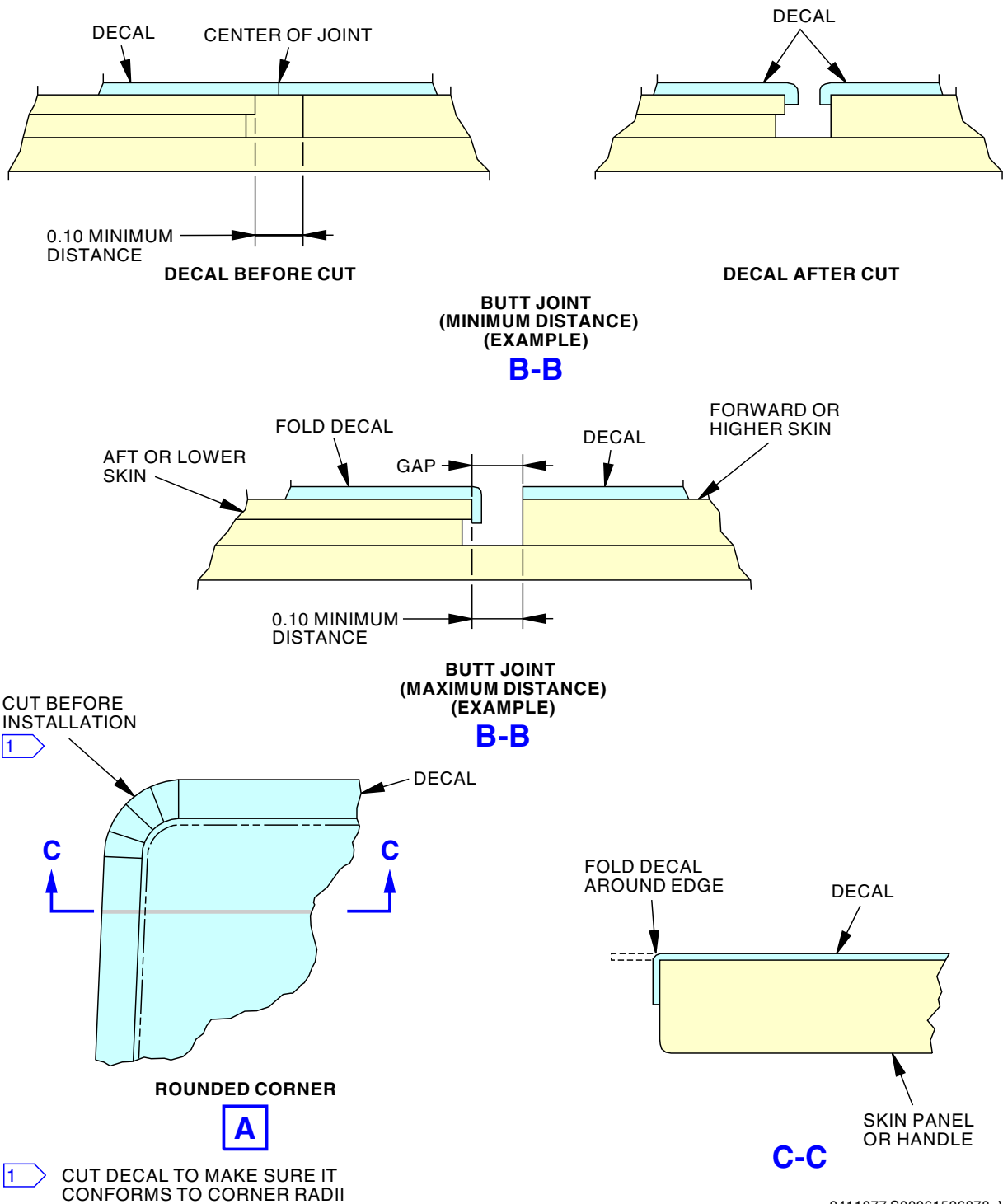
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Decal Application Over Irregular Surfaces
Figure 401/20-10-11-990-801 (Sheet 2 of 2)

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TASK 20-10-11-400-801

3. Pressure-Sensitive Decal Installation

(Figure 401)

A. References

Reference	Title
51-21-00-100-801	Airplane Surface Preparation for Application of Finish (P/B 701)
51-21-31-350-801	Removal and Control of Corrosion for Aluminum and Aluminum Alloys (P/B 701)
51-22-00 P/B 201	SEALS AND SEALING - MAINTENANCE PRACTICES
SOPM 20-50-05	Application of Aluminum Foil and Other Markers

B. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt.", which stands for Optional.

Reference	Description
COM-2481	Sealant Removal Tool (meets BSS7384 requirements) Part #: 1-6390-A Supplier: 63318 Part #: 10810 Supplier: \$0855 Part #: 10811 Supplier: \$0855 Part #: 10812 Supplier: \$0855 Part #: 234350 Supplier: 5HCF1 Part #: 235072 Supplier: 5HCF1 Part #: 235073 Supplier: 5HCF1 Part #: 235074 Supplier: 5HCF1 Part #: 235075 Supplier: 5HCF1 Part #: 235076 Supplier: 5HCF1 Part #: 311/03 Supplier: F6892 Part #: 311/14 Supplier: F6892 Part #: 311/25 Supplier: F6892 Part #: 311/37 Supplier: F6892 Part #: AS1 Supplier: \$1351 Part #: AS2 Supplier: \$1351 Part #: AS3 Supplier: \$1351 Part #: DAD5013 Supplier: 7RKH2 Part #: DFD5019 Supplier: 7RKH2 Part #: JNT411B60 Supplier: 3DN12 Part #: JNT411B90 Supplier: 3DN12 Part #: SCD5019 Supplier: 7RKH2 Part #: ST982LF-9 Supplier: 81205 Part #: TS1275-4 Supplier: 22975
SPL-8870	Cutter - Scotchcal Part #: ST732-190 Supplier: 81205 Part #: ST732-250 Supplier: 81205 Part #: ST732-312 Supplier: 81205

C. Consumable Materials

Reference	Description	Specification
B00068	Alcohol - Denatured, Ethyl (Ethanol)	AMS 3002, MIL-E-51454 Type II

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Reference	Description	Specification
B00083	Solvent - VM&P Naphthas	TT-N-95 Type II, ASTM D-3735 Type III
B00130	Alcohol - Isopropyl	TT-I-735
B00137	Abrasive - Garnet Coated Paper	
G00034	Cotton Wiper - Process Cleaning Absorbent Wiper (Cheesecloth, Gauze)	AMS3819 Class 1 Grade A or B Form 1 (Supersede BMS15-5 CLA)
G00270	Tape - Scotch Flatback Masking 250	ASTM D6123 (Supersedes A-A-883)

D. Prepare the Surfaces for Installation

SUBTASK 20-10-11-110-001

- (1) To clean corroded aluminum surfaces, do this task: Removal and Control of Corrosion for Aluminum and Aluminum Alloys, TASK 51-21-31-350-801.

SUBTASK 20-10-11-110-002

- (2) Clean wax-coated aluminum surfaces until area shows a water-break-free surface, do this task: Airplane Surface Preparation for Application of Finish, TASK 51-21-00-100-801.

SUBTASK 20-10-11-110-003



WARNING

DO NOT GET SOLVENTS IN YOUR MOUTH, YOUR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM SOLVENTS. SOLVENTS ARE DANGEROUS MATERIALS. SOLVENTS CAN BE FLAMMABLE. OBEY THE MATERIAL SAFETY DATA SHEETS (MSDS) FOR SOLVENTS. OBEY LOCAL REGULATIONS FOR THE CORRECT PROCEDURES TO USE OR DISCARD SOLVENTS. SOLVENTS CAN CAUSE INJURIES TO PERSONNEL AND DAMAGE TO EQUIPMENT.

- (3) Use solvent, B00083 or alcohol, B00130 and a cotton wiper, G00034 to clean polyester or phenolic plastics that are not painted.

- (a) Dry surface with a cotton wiper, G00034.

NOTE: Do not let air dry.

SUBTASK 20-10-11-110-004

- (4) Lightly sand cork surfaces with abrasive, B00137, 150 grit, until you get a clean cork surface.

NOTE: The sanded surface must be 0.38 in. (9.65 mm) wider than the decal area.

- (a) Remove sanding dust with a cotton wiper, G00034.

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SUBTASK 20-10-11-110-005



WARNING

DO NOT GET SOLVENTS IN YOUR MOUTH OR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM SOLVENTS. PUT ON A RESPIRATOR, PROTECTIVE SPLASH GOGGLES, AND GLOVES WHEN YOU USE SOLVENTS. KEEP THE SOLVENTS AWAY FROM SPARKS, FLAME, AND HEAT. SOLVENTS ARE POISONOUS AND FLAMMABLE. SOLVENTS CAN CAUSE INJURIES TO PERSONNEL, AND DAMAGE TO EQUIPMENT.

- (5) Clean all other surfaces thoroughly with alcohol, B00068 or alcohol, B00130, and cotton wiper, G00034, except in preparation for application of the Refuel Panel Placard (BAC27NSF223) which requires the use of alcohol, B00068 or alcohol, B00130, in place of solvent, B00083.

NOTE: Verify that no grease is present on the surface prior to the application of the Refuel Panel Placard.

- (a) Dry the surface with a cotton wiper, G00034.

NOTE: Do not let air dry.

E. Prepare the Decal for Installation

SUBTASK 20-10-11-800-001

- (1) On decals with an area less than 1 ft² (929 cm²), remove the backing and put the decal face down on a smooth surface.

SUBTASK 20-10-11-420-001

- (2) On decals with an area more than 1 ft² (929 cm²), use Scotch Flatback Masking Tape 250, G00270, to put the decal on the receiving surface.

- (a) Cut a sheet of carrier tape approximately 4 in. (10 cm) longer than the decal and approximately the same width.

NOTE: When you use premasked decals, you can use the premask as a carrier.

- (b) Put the carrier over the decal, with the edge you will hang 2.5 ±0.5 in. (6.4 ±1.3 cm) beyond the decal edge.

- (c) Hang the carrier on the receiving surface with cotton wiper, G00034.

- (d) Rub the carrier on with a sealant removal tool, COM-2481.

NOTE: Use short strokes and work from the middle of the joint to the edges. Be sure to remove all wrinkles and air bubbles.

- (e) Fold the carrier and decal back at the joint, along the surface with the backing up.

NOTE: Use masking tape to hold in this position.

- (f) Remove the decal backing.

SUBTASK 20-10-11-800-002

- (3) On strip decals, remove about 12 in. (30 cm) of backing and put the decal face down on a smooth surface.

F. Procedure

SUBTASK 20-10-11-420-002

- (1) To apply decal to a smooth (nonbreak) surface, do these steps:

- (a) Put the decals with areas less than 1 ft² (929 cm²) in position and bond one edge to the surface.

- 1) Hold the remainder of the decal taut and a small distance from the surface with a piece of backing on the adhesive side.

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- (b) For decals with an area greater than 1 ft² (929 cm²), move the carrier into position.
 - 1) Hold the free end taut and a small distance from the surface with a piece of backing on the adhesive side.
- (c) Align and bond approximately 3 in. (7.6 cm) of strip decals to the receiving surface.
 - 1) Use the applied section as a joint and strip up to 3 ft (91 cm) of the backing.
 - 2) If necessary, apply activator to the adhesive.
 - 3) Align the stripping and hold it taut and a small distance away from the receiving surface.
- (d) Start at the joint and rub the decal on the surface with the sealant removal tool, COM-2481 with short fan-like strokes.

NOTE: Do not let the adhesive touch the surface until the sealant removal tool, COM-2481 pushes it down.
- (e) Continue to apply strip decals until you apply all of the decal.
- (f) When you apply strip decals around a corner and a splice occurs, overlap the decal 1.25 ±0.75 in. (3.18 ±1.91 cm).

SUBTASK 20-10-11-420-003

- (2) To apply decals to a surface with a butt or overlap joint, do these steps:



CAUTION

DO NOT CAUSE DAMAGE TO THE AIRPLANE SKIN WHEN YOU CUT THE DECAL. NICKS, CUTS, SCRATCHES, OR SCRIBE LINES WILL DECREASE THE FATIGUE STRENGTH AND LIFE OF THE STRUCTURE.

- (a) If you damage the skin or sealant, obey all the specified steps, cautions and references to inspect and repair the sealant and skin (PAGEBLOCK 51-22-00/201) and the applicable structural repair manual.
- (b) To apply decals on a butt joint between two surfaces which move with respect to each other or butt joint, do one of these steps:
 - 1) For distances of 0.10 in. (2.54 mm) and more, cut the decal at the approximate center of the distance.
 - a) Fold the decal around the two edges (Figure 401).
 - 2) For distances of less than 0.10 in. (2.54 mm), cut the decal aligned with the forward or top skin edge.
 - a) Fold the decal around the aft or bottom skin edge (Figure 401).
- (c) To apply decals across overlap joints, do one of these steps:
 - 1) Fold the decal smoothly and continuously around the edge of the overlap joint (Figure 401).

NOTE: This is the recommended procedure.
 - 2) Cut the decal aligned with the overlap edge and touch the remainder of the decal to the overlap edge (Figure 401).

NOTE: You can use this method when the decal extends along the overlap joint for a long distance.

SUBTASK 20-10-11-420-004

- (3) To apply decals over surfaces with raised or recessed rivets and fasteners, do these steps:

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DO NOT CAUSE DAMAGE TO THE AIRPLANE SKIN WHEN YOU CUT THE DECAL. NICKS, CUTS, SCRATCHES, OR SCRIBE LINES WILL DECREASE THE FATIGUE STRENGTH AND LIFE OF THE STRUCTURE.

- (a) If you damage the skin or sealant, obey all the specified steps, cautions and references to inspect and repair the sealant and skin (PAGEBLOCK 51-22-00/201) and the applicable structural repair manual.
- (b) Use scotchcal cutter, SPL-8870 to cut decals around the heads of fasteners or rivets.
- (c) Push the decal firmly in position around the rivet or fastener.
- (d) Make a small hole in the decal film, with a sharp pointed instrument, at each rivet on decals applied over pressurized areas.

SUBTASK 20-10-11-000-001

- (4) To apply decals to external emergency exit handles, do these steps:
 - (a) Before you remove the backing paper, put the decal on the handle and cut the decal overlap around each rounded corner (Figure 401).
 - (b) Remove the backing paper and apply the decal. Push the overlap around the edges of the handle.

SUBTASK 20-10-11-800-003

- (5) To remove carrier, or premask and masking tape, pull back parallel to the decal surface.

NOTE: If you will paint the adjacent area, leave the premask in position.

SUBTASK 20-10-11-390-001

- (6) Seal the edges or overcoat (SOPM 20-50-05).

————— **END OF TASK** —————

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PRESSURE-SENSITIVE DECALS - REPAIRS

1. General

- A. This procedure contains one task. The task is to repair external decals.
- B. To repair damaged external decals, apply patches of equivalent decals.

NOTE: Replace damaged internal decals.

TASK 20-10-11-000-802

2. Repair External Pressure Sensitive Decals

A. References

Reference	Title
51-22-00 P/B 201	SEALS AND SEALING - MAINTENANCE PRACTICES

B. Procedure

SUBTASK 20-10-11-020-003

- (1) Cut away all loose decal film but be careful not to cut the airplane skin.

SUBTASK 20-10-11-800-004



CAUTION

DO NOT CAUSE DAMAGE TO THE AIRPLANE SKIN WHEN YOU CUT THE DECAL. NICKS, CUTS, SCRATCHES, OR SCRIBE LINES WILL DECREASE THE FATIGUE STRENGTH AND LIFE OF THE STRUCTURE.

- (2) Cut a patch of decal film of the same type and color as the initial decal.
 - (a) Make sure the patch is of sufficient size to make an overlap of 0.25 in. (6.35 mm) on the part of the decal that is not damaged.
 - 1) If you damage the skin or sealant, obey all the specified steps, cautions and references to inspect and repair the sealant and skin (SEALS AND SEALING - MAINTENANCE PRACTICES, PAGEBLOCK 51-22-00/201 and the applicable structural repair manual).

SUBTASK 20-10-11-420-005

- (3) Apply the patch.

SUBTASK 20-10-11-390-002

- (4) Seal all around the repair with the applicable edge sealer.

———— **END OF TASK** ————

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PRESSURE SENSITIVE PLACARDS - REMOVAL/INSTALLATION

1. General

A. This procedure has these tasks:

- (1) A removal of the pressure sensitive placards.
- (2) An installation of the pressure sensitive placards.

B. Vinyl placards are prepared on a material that will not easily follow the contour of rough or textured surfaces. The placard will touch only the high spots and have a poor bond. Use an adhesive with vinyl placards to get a smooth surface and a firm bond for the placard. Foil markers are made on a soft metal that, when applied, will have the contour of the surface and make a good bond. If the surface is textured, you can apply adhesive to get a smoother surface and more satisfactory installation of foil markers.

TASK 20-10-14-000-801

2. Pressure Sensitive Placard Removal

A. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

Reference	Description
COM-2481	Sealant Removal Tool (meets BSS7384 requirements) Part #: 1-6390-A Supplier: 63318 Part #: 10810 Supplier: \$0855 Part #: 10811 Supplier: \$0855 Part #: 10812 Supplier: \$0855 Part #: 234350 Supplier: 5HCF1 Part #: 235072 Supplier: 5HCF1 Part #: 235073 Supplier: 5HCF1 Part #: 235074 Supplier: 5HCF1 Part #: 235075 Supplier: 5HCF1 Part #: 235076 Supplier: 5HCF1 Part #: 311/03 Supplier: F6892 Part #: 311/14 Supplier: F6892 Part #: 311/25 Supplier: F6892 Part #: 311/37 Supplier: F6892 Part #: AS1 Supplier: \$1351 Part #: AS2 Supplier: \$1351 Part #: AS3 Supplier: \$1351 Part #: DAD5013 Supplier: 7RKH2 Part #: DFD5019 Supplier: 7RKH2 Part #: JNT411B60 Supplier: 3DN12 Part #: JNT411B90 Supplier: 3DN12 Part #: SCD5019 Supplier: 7RKH2 Part #: ST982LF-9 Supplier: 81205 Part #: TS1275-4 Supplier: 22975

B. Consumable Materials

Reference	Description	Specification
B00083	Solvent - VM&P Naphthas	TT-N-95 Type II, ASTM D-3735 Type III
B00130	Alcohol - Isopropyl	TT-I-735

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Reference	Description	Specification
B00143	Solvent - Trichlorotrifluorethane (Freon)	MIL-C-81302

C. Removal

SUBTASK 20-10-14-020-001



ONLY USE APPROVED SCRAPERS ON THE AIRPLANE SKIN. SCRAPERS THAT ARE NOT APPROVED CAN MAKE SCRATCHES ON THE SKIN, AND CAUSE FATIGUE CRACKS.

- (1) Lift the corner of the placard with a sealant removal tool, COM-2481.

SUBTASK 20-10-14-110-001

- (2) Remove remaining adhesive film with solvent, B00143, solvent, B00083, or alcohol, B00130.

————— **END OF TASK** —————

TASK 20-10-14-400-801

3. Pressure Sensitive Placard Installation

A. Consumable Materials

Reference	Description	Specification
A00016	Adhesive - Pressure Sensitive Film For Interior Non-Structural Bonding	BMS5-91
A00119	Adhesive - Synthetic Rubber Cement, Naphtha Soluble	BMS5-55
A00134	Adhesive - Synthetic Rubber, Buna-N, 1 Part, Fuel Resistant	BMS5-14
A00870	Adhesive - Urethane Adhesive for Bonding, 2 Part, Room Temp Cure (for automatic blending)	BMS5-105 Type II
B00083	Solvent - VM&P Naphthas	TT-N-95 Type II, ASTM D-3735 Type III
B00130	Alcohol - Isopropyl	TT-I-735
B00137	Abrasive - Garnet Coated Paper	
B00143	Solvent - Trichlorotrifluorethane (Freon)	MIL-C-81302
C00012	Coating - Akzo Nobel Clear Polyurethane Topcoat, 683-3-2 Base with X-310A Catalyst (Akzo Nobel Aerospace Coatings)	
G00034	Cotton Wiper - Process Cleaning Absorbent Wiper (Cheesecloth, Gauze)	AMS3819 Class 1 Grade A or B Form 1 (Supersede BMS15-5 CL A)
G00270	Tape - Scotch Flatback Masking 250	ASTM D6123 (Supersedes A-A-883)

B. Prepare for the Installation

SUBTASK 20-10-14-800-001

- (1) If the placard uses adhesive, A00016, no special placard preparation is necessary.

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SUBTASK 20-10-14-840-001

- (2) If the placard has no backing adhesive, prepare placard as follows:
- Make the rear surface of the placard rough with abrasive, B00137.
 - Clean the placard with solvent, B00083.
 - Remove the release paper from one side of adhesive, A00016.
 - Apply adhesive, A00016, to the rear of placard.
 - Cut the unwanted adhesive, A00016.
 - Laminate adhesive, A00016, to the placard with one of these steps:
 - Roll placard on hot roll laminator heated to 140°F (60°C).
 - Heat the placard to not more than 140°F (60°C) with a dry air blast or other applicable source and rub release paper with cotton wiper, G00034.
- NOTE:** Heat makes the bond between the adhesive and release paper soft. Be careful not to move the release paper.

C. Pressure Sensitive Placard Installation

SUBTASK 20-10-14-110-002

- (1) Clean the surface with solvent, B00143, alcohol, B00130, or solvent, B00083.

SUBTASK 20-10-14-800-002

- (2) Dry fully.

SUBTASK 20-10-14-420-001

- (3) Install the placard.

NOTE: Moisture must not be present on the placard or surface to which it will be applied. Do not touch adhesive with finger or allow it to be contaminated.

- (a) For an aluminum marker that is being applied to primed or painted rough interior surfaces, do these steps:



MAKE SURE THE MASKED AREA IS IN THE CORRECT POSITION. YOU CAN REMOVE DRY ADHESIVE WITH NAPHTHA CLEANER. IF YOU TRY TO REMOVE CURED ADHESIVE, YOU WILL CAUSE DAMAGE TO THE SURFACE.

- Mask an area approximately 1/16 in. (1.59 mm) smaller than the placard with masking tape or attach a mask of necessary size.
 - For adhesive, A00870, install marker within working life of adhesive.
 - Use a brush to apply adhesive, A00119, or adhesive, A00870, to the prime contact area.
 - Let adhesive, A00119, dry fully (approximately 15 minutes).
 - Remove Scotch Flatback Masking Tape 250, G00270, or mask.
 - Remove the release paper from the placard.
 - Apply the placard to the center of the surface and be careful to prevent air pockets.
 - Rub the placard with firm hand pressure and cheesecloth pad.
 - If the primed surface shows around the placard, remove unwanted adhesive with solvent, B00083.
- (b) For aluminum markers being applied to cadmium plated surfaces, unpainted laminated polyester, unpainted phenolic or unpainted rough surfaces, do these steps:

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- 1) Apply a light brush of adhesive, A00134, to the cleaned surface.
NOTE: Do not apply adhesive, A00134, on primed or painted surfaces.
- 2) Let adhesive, A00134, dry (15-20 minutes).
- 3) Apply the placard to the center of the surface.

SUBTASK 20-10-14-800-003

- (4) Seal the edges per BAC5312.
 - (a) If you painted up to the edges of the placard, seal the edges of the placard with paint.
 - 1) If the placard has a premask, remove the premask only after you apply the last layer of paint up to the placard.
NOTE: The paint will flow sufficiently well to seal the edges. If this condition does not occur, seal the edges by the recommended procedure.
 - 2) Use a brush to apply clear base Akzo Nobel 683-3-2 coating, C00012, (683-3-2 and X-310A catalyst (edge sealer)).
NOTE: Make sure you have a dry film thickness of 0.0015 in. (0.0381 mm) to 0.0020 in. (0.0508 mm).
 - 3) Let the adhesive cure for the minimum of 1/2 hour, then seal the edges of pressure-sensitive placard with clear base Akzo Nobel 683-3-2 coating, C00012, (683-3-2 and X-310A catalyst (edge sealer)).
NOTE: The edge seal should extend a minimum of 0.5 in. (1.3 cm) on the substrate and 0.5 in. (1.3 cm) on the surface of the placard.

———— **END OF TASK** ————

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RECESSED BOSS SEAL FITTINGS - REMOVAL/INSTALLATION

1. General

A. This procedure has these tasks:

- (1) Removal of adapter fittings and positioning fittings (boss fittings).
- (2) Installation of adapter (straight) fittings.
- (3) Installation of the positioning (elbow) fittings.

TASK 20-10-15-000-801

2. Boss Fitting Removal

A. Procedure

SUBTASK 20-10-15-020-001

- (1) Loosen the jamnut.

SUBTASK 20-10-15-020-002

- (2) Disconnect the hose or tube, from the fitting as applicable.

SUBTASK 20-10-15-020-003

- (3) Remove the fitting from the boss.

————— END OF TASK —————

TASK 20-10-15-400-801

3. Adapter (Straight) Fitting Installation

A. References

Reference	Title
20-50-11-910-801	Standard Torque Values (P/B 201)

B. Procedure

SUBTASK 20-10-15-640-001

- (1) Lubricate a new O-ring and backup ring and install them in the fitting groove.

SUBTASK 20-10-15-420-001

- (2) Lubricate a new O-ring and put it in the groove under the nut hex.

SUBTASK 20-10-15-420-002



MAKE SURE THAT YOU INSTALL THE BACKUP RING CORRECTLY. IF YOU DO NOT INSTALL THE BACKUP RING CORRECTLY, A LEAK CAN OCCUR AND CAUSE DAMAGE TO EQUIPMENT.

- (3) Install the fitting into the boss and tighten to the correct torque for the size of the fitting, Standard Torque Values, TASK 20-50-11-910-801.

————— END OF TASK —————

TASK 20-10-15-400-802

4. Positioning (Elbow Type) Fitting Installation

A. References

Reference	Title
20-50-11-910-801	Standard Torque Values (P/B 201)

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B. Procedure

SUBTASK 20-10-15-420-003

- (1) Install the jamnut on the fitting and turn it to the stop.

SUBTASK 20-10-15-640-002

- (2) Lubricate a new O-ring and install it in the groove between the two sets of threads.

SUBTASK 20-10-15-420-004

- (3) Lubricate a new O-ring and backup ring with the applicable system lubricant and install them in the fitting groove.

SUBTASK 20-10-15-420-005



MAKE SURE THAT YOU INSTALL THE BACKUP RING CORRECTLY. IF YOU DO NOT INSTALL THE BACKUP RING CORRECTLY, A LEAK CAN OCCUR AND CAUSE DAMAGE TO EQUIPMENT.

- (4) Install the fitting into the boss until it touches bottom, then loosen until the fitting aligns with the hose or tube (one turn maximum).

SUBTASK 20-10-15-420-006

- (5) Hold the fitting stable and tighten the jamnut to the correct torque for the size of the fitting, Standard Torque Values, TASK 20-50-11-910-801.

SUBTASK 20-10-15-420-007

- (6) Connect the hose or tube, to the fitting and tighten according to Standard Torque Values, TASK 20-50-11-910-801.

———— **END OF TASK** ————

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O-RINGS - REMOVAL/INSTALLATION

1. General

A. This procedure has these tasks:

- (1) A removal of O-Rings.
- (2) An installation of O-Rings.

B. You may install O-Rings over sharp edges. Sharp edges include threaded fasteners, keyways, slots, splines, and ports.

TASK 20-10-17-000-801

2. O-Rings Removal

(Figure 401)

A. Removal

SUBTASK 20-10-17-210-001

- (1) Examine the old O-rings for cuts, abrasions, deformities, and surface defects.

SUBTASK 20-10-17-020-001

- (2) Remove the used O-Rings with an appropriate hook or tool.
 - (a) Be careful not to scratch the groove or adjacent surfaces.

SUBTASK 20-10-17-020-002

- (3) Cut the used O-ring and discard.

———— **END OF TASK** ————

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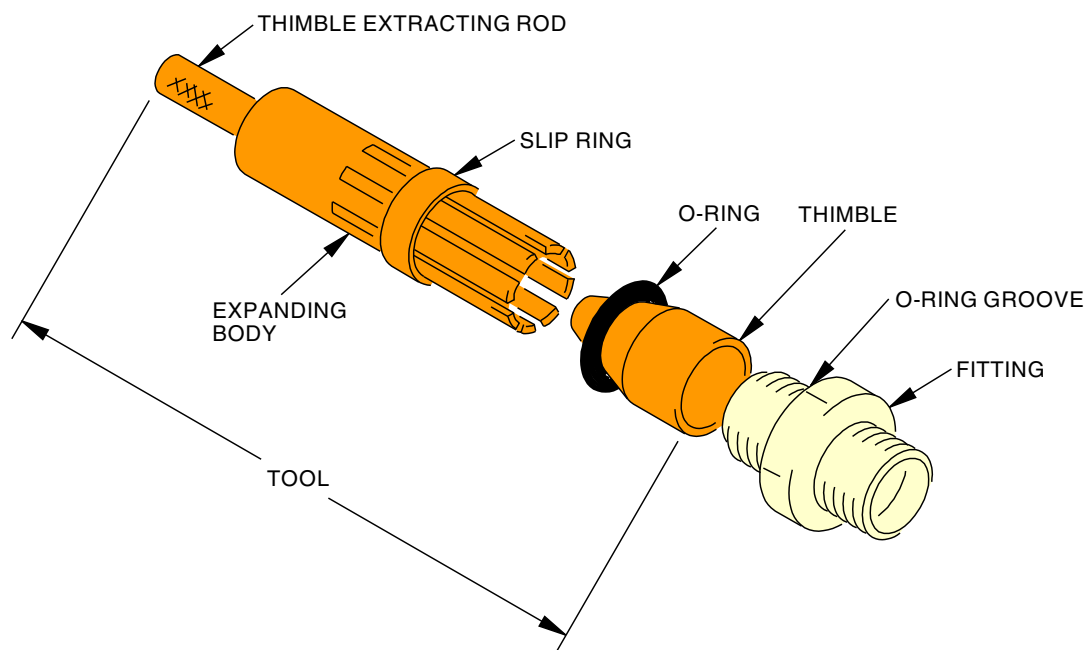
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O-Ring Installation
Figure 401/20-10-17-990-801

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TASK 20-10-17-400-801

3. **O-Rings Installation**

(Figure 401), (Table 401)

A. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

Reference	Description
SPL-1575	Kit - O-Ring Tool, Installation Part #: SP-0786 Supplier: 62209 Part #: ST848 Supplier: 81205 Part #: ST848R Supplier: 81205 Opt Part #: PSAT-KIT Supplier: 1V757

B. Procedure

SUBTASK 20-10-17-800-001

(1) Use one of the installation tools in the O-ring toolkit, SPL-1575.

Table 401/20-10-17-993-801 Installation tools

TOOL NO.	TUBE OR HOSE FITTING SIZE
ST848 -187	1/16
-250	1/4
-312	5/16
-375	3/8
-500	1/2
-625	5/8
-750	3/4
-1000	1
-1250	1-1/4
-1500	1-1/2
-1750	1-3/4

SUBTASK 20-10-17-640-001



ALWAYS REPLACE USED O-RINGS WITH NEW O-RINGS. USED O-RINGS CAN CAUSE LEAKAGE AND DAMAGE TO EQUIPMENT.

(2) Lubricate the O-ring with a thin layer of the fluid used with the component or system.

SUBTASK 20-10-17-420-001



DO NOT MAKE THE O-RING INNER DIAMETERS LARGER DURING INSTALLATION THAN THE LIMIT GIVEN. IF YOU MAKE THE O-RING TOO LARGE, YOU CAN CAUSE THE DAMAGE TO THE O-RING.

(3) Put the thimble over the fitting.

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SUBTASK 20-10-17-420-002

- (4) Put the O-ring on the thimble.

SUBTASK 20-10-17-420-003

- (5) Move the expanding body over the thimble and against the O-ring, then push the O-ring into the groove.

SUBTASK 20-10-17-020-003

- (6) Use the extracting rod to remove the expanding body from the thimble.

SUBTASK 20-10-17-020-004

- (7) Remove the thimble.

SUBTASK 20-10-17-210-002

- (8) Examine the O-ring for twists and pinches caused by installation.
(a) Make sure you align the O-ring with no twists before you close the gland.

———— **END OF TASK** ————

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Hydraulic Caps and Plugs - Maintenance Practices

1. General

A. This task gives maintenance practices for hydraulic fitting caps and plugs.

TASK 20-10-20-800-801

2. Cap and Plug Hydraulic Fittings

A. General

- (1) This procedure lists the recommended caps and plugs for hydraulic fittings on tube ends and components.
- (2) Caps and plugs are used on the ports and disconnected hydraulic lines to prevent leakage and contamination.

B. Procedure

SUBTASK 20-10-20-860-001



USE ONLY THE SPECIFIED CAPS OR PLUGS. OTHER CAPS AND PLUGS CAN CAUSE INJURIES TO PERSONNEL, AND DAMAGE TO EQUIPMENT.

- (1) Determine the applicable cap or plug (Table 201).

NOTE: Do not use protective metal or plastic caps or plugs for system pressure testing. Use protective caps or plugs before and after test as needed, to prevent system contamination.

Table 201/20-10-20-993-801 Recommended Caps and Plugs

CAPS/PLUGS	TUBE SIZE	FLARELESS/ SHORT FLARELESS	PART NUMBER
PLUG	20, 24	SHORT FLARELESS	AS4662
CAP, FITTING ASSEMBLY	20, 24	SHORT FLARELESS	AS4694
PLUG	04 thru 20	FLARELESS	BACP20BM
PLUG	02 thru 32	FLARELESS	AS21913
CAP ASSEMBLY	04 thru 24	FLARELESS	BACC14AD*[1]*[2]
CAP	04 thru 20	FLARELESS	BACC14AV
PLUG	02 thru 12	FLARELESS	BACP20AU
PLUG	02 thru 32	FLARELESS	AS5169

*[1] BACC14AD()(NO CODE) (NO CODE) is inactive for design and procurement. Use AS5233V()P as a CLASS V supersession. Carbon steel parts are prone to corrosion.

*[2] BACC14AD()D(NO CODE) is inactive for design and procurement. Use AS5233W() as a CLASS II supersession.

- (2) Install the applicable cap or plug on tube ends and components.

———— **END OF TASK** ————

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ALUMINUM FOIL MARKERS - REMOVAL/INSTALLATION

1. General

- A. This procedure has these tasks:
 - (1) A removal of aluminum foil markers.
 - (2) An installation of aluminum foil markers.
- B. Replace aluminum foil markers that have creases, damaged edges, or words you cannot read.
- C. Replace aluminum foil markers that are not satisfactorily bonded to external primed or painted surfaces.
- D. Replace aluminum foil markers that are not satisfactorily bonded to internal primed or painted surfaces.
- E. Remove and replace aluminum foil markers that are not satisfactorily bonded to bare metal surfaces.

NOTE: For aluminum foil markers that you install on textured surfaces or that do not bond satisfactorily, you can use the procedure for pressure sensitive placards. This gives a better installation (TASK 20-10-14-400-801).

- F. Do not install a new aluminum foil marker on a used aluminum foil marker. Remove the used aluminum foil marker and install the new aluminum foil marker.

TASK 20-10-21-000-801

2. Aluminum Foil Markers Removal

A. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

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Reference	Description
COM-2481	Sealant Removal Tool (meets BSS7384 requirements) Part #: 1-6390-A Supplier: 63318 Part #: 10810 Supplier: \$0855 Part #: 10811 Supplier: \$0855 Part #: 10812 Supplier: \$0855 Part #: 234350 Supplier: 5HCF1 Part #: 235072 Supplier: 5HCF1 Part #: 235073 Supplier: 5HCF1 Part #: 235074 Supplier: 5HCF1 Part #: 235075 Supplier: 5HCF1 Part #: 235076 Supplier: 5HCF1 Part #: 311/03 Supplier: F6892 Part #: 311/14 Supplier: F6892 Part #: 311/25 Supplier: F6892 Part #: 311/37 Supplier: F6892 Part #: AS1 Supplier: \$1351 Part #: AS2 Supplier: \$1351 Part #: AS3 Supplier: \$1351 Part #: DAD5013 Supplier: 7RKH2 Part #: DFD5019 Supplier: 7RKH2 Part #: JNT411B60 Supplier: 3DN12 Part #: JNT411B90 Supplier: 3DN12 Part #: SCD5019 Supplier: 7RKH2 Part #: ST982LF-9 Supplier: 81205 Part #: TS1275-4 Supplier: 22975

B. Consumable Materials

Reference	Description	Specification
B00062	Solvent - Acetone (99.5% Grade)	ASTM D 329 (Supersedes O-A-51)
B00184	Solvent - Presealing, Cleaning Solvent	BMS11-7
B00344	Solvent - Xylene, Nitration Grade	ASTM D843
G00034	Cotton Wiper - Process Cleaning Absorbent Wiper (Cheesecloth, Gauze)	AMS3819 Class 1 Grade A or B Form 1 (Supersede BMS15-5 CLA)

C. Aluminum Foil Markers Removal

SUBTASK 20-10-21-020-001

- (1) Put a sealant removal tool, COM-2481, or equivalent object, under the edge of the placard and remove the marker from the adhesive area.

SUBTASK 20-10-21-110-001

- (2) On primed, painted, or plastic interior surfaces, use solvent, B00344, to remove all adhesive from surfaces and markers.

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SUBTASK 20-10-21-110-002



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- (3) On metal surfaces, use a cotton wiper, G00034, that is wet with solvent, B00062, or solvent, B00184, to remove all adhesive from surfaces and markers.

END OF TASK

TASK 20-10-21-400-801

3. Aluminum Foil Markers Installation

A. Consumable Materials

Reference	Description	Specification
A00119	Adhesive - Synthetic Rubber Cement, Naphtha Soluble	BMS5-55
A00134	Adhesive - Synthetic Rubber, Buna-N, 1 Part, Fuel Resistant	BMS5-14
A00253	Adhesive - Room Temperature Curing Two Part Epoxy	BMS5-109 Type II Class 2
A00870	Adhesive - Urethane Adhesive for Bonding, 2 Part, Room Temp Cure (for automatic blending)	BMS5-105 Type II
B00046	Acid - Corrosion Removing, Metal Conditioning, Phosphoric	MIL-C-10578
B00083	Solvent - VM&P Naphthas	TT-N-95 Type II, ASTM D-3735 Type III
B00137	Abrasive - Garnet Coated Paper	
B00148	Solvent - Methyl Ethyl Ketone (MEK)	ASTM D740
B00344	Solvent - Xylene, Nitration Grade	ASTM D843
C00012	Coating - Akzo Nobel Clear Polyurethane Topcoat, 683-3-2 Base with X-310A Catalyst (Akzo Nobel Aerospace Coatings)	
G00034	Cotton Wiper - Process Cleaning Absorbent Wiper (Cheesecloth, Gauze)	AMS3819 Class 1 Grade A or B Form 1 (Supersede BMS15-5 CL A)

B. Prepare for the Installation

SUBTASK 20-10-21-020-002

- (1) Do not install a new aluminum foil marker on a used aluminum foil marker.

SUBTASK 20-10-21-080-001

- (2) Remove the used foil marker, clean the surface and then install the new foil marker.

SUBTASK 20-10-21-820-001

- (3) If it is necessary, use an electric typewriter with pica type set at the highest impression level to add data to the placard.

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SUBTASK 20-10-21-820-002

- (4) Make sure that all typed data is clear with letters that do not cut through the aluminum foil marker.

SUBTASK 20-10-21-800-001

- (5) If it is necessary, cut the aluminum foil marker to the necessary dimension before you remove the protective backing.

SUBTASK 20-10-21-100-001

- (6) Clean the surface to apply the aluminum foil marker.
 - (a) To clean aluminum surfaces, do these steps:
 - 1) Clean aluminum surfaces that have corrosion with a wire brush.



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- 2) Clean surfaces that have grease with solvent, B00083.
 - 3) Apply a solution of one-fourth phosphoric acid and three-fourths water, by volume, with a brush, rag, or sponge to the surface.
 - 4) Let the acid, B00046, stay on the metal approximately 1/2 minute.
 - 5) Rub the surface with a damp cotton wiper, G00034, and then with a dry cotton wiper, G00034, until the surface is dry and free of corrosion.
 - (b) Use solvent, B00344, to clean polyester, epoxy, phenolic or polyurethane surfaces that are not painted.
 - (c) To clean aluminized paint (EC-843) coated surfaces, do these steps:
 - 1) Sand with abrasive, B00137.
 - 2) Clean with solvent, B00083.
 - (d) To clean cork surfaces, do these steps:
 - 1) Lightly sand with abrasive, B00137, until you get a clean cork surface.
 - 2) Rub the surface with a clean cotton wiper, G00034, to remove any dust.
 - (e) Clean all other surfaces with solvent, B00083.

SUBTASK 20-10-21-800-002

- (7) On cadmium-plated surfaces, laminated not painted polyester materials, laminated not painted phenolic materials, and rough surfaces that are not painted, do these steps:
 - (a) Apply a light layer of adhesive, A00134, to the cleaned surface.
 - (b) Let the adhesive dry for 5 to 20 minutes. The adhesive must be tacky but will not bond to a clean finger when lightly touched.

SUBTASK 20-10-21-800-003

- (8) Do these steps on primed or painted rough interior surfaces:

NOTE: This procedure is not used on external surfaces open to the weather.

- (a) Apply a light layer of adhesive, A00119, or adhesive, A00870, to the cleaned surface.

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- 1) If you use adhesive, A00870, mix the base resin and catalyst in accordance with the manufacturer's instructions.
- (b) For adhesive, A00119, let the adhesive dry for 5 to 20 minutes.
 - 1) Make sure that adhesive, A00119, is tacky but will not bond to a clean finger when lightly touched.

C. Aluminum Foil Marker Installation

SUBTASK 20-10-21-860-001

- (1) Keep the contact pressure on the marker until you get the minimum handle time.

SUBTASK 20-10-21-480-001

- (2) Use supports for surfaces of thin panels during the installation of markers.

SUBTASK 20-10-21-420-001

- (3) Do not use an aluminum foil marker that is not flat or is damaged.

SUBTASK 20-10-21-840-001

- (4) Do not touch or contaminate the adhesive on the aluminum foil marker after you remove the protective backing.

SUBTASK 20-10-21-840-002

- (5) Make sure that the aluminum foil marker and the open surface are free of moisture.

SUBTASK 20-10-21-840-003

- (6) During the installation of a large or complicated aluminum foil marker, keep a small section of backing attached.

NOTE: A small section of backing will help you to touch and move the aluminum foil marker.

SUBTASK 20-10-21-420-002

- (7) To install a cellophane-backed aluminum foil marker, do these steps:
 - (a) Put the aluminum foil marker in 50°F (10°C) - 120°F (49°C) water for approximately 30 to 120 seconds.
 - (b) Remove the aluminum foil marker from the water and remove unwanted water with a clean, cotton wiper, G00034.
 - (c) With dry hands, move a finger across the edge of the aluminum foil marker and move back the cellophane.
 - (d) Carefully remove the backing from the aluminum foil marker.

SUBTASK 20-10-21-420-003

- (8) To install a paper-backed aluminum foil marker, do these steps:
 - (a) Remove the paper backing from the aluminum foil marker.
 - 1) Do not touch the adhesive coating.
 - 2) Where the paper backing has a cut, bend the paper backing lightly along the cut line.
 - a) To prevent damage to the marker, hold the backing and move it slowly away from the aluminum foil marker.
 - 3) Where the paper backing does not have a cut, move a finger across the edge of the aluminum foil marker to move back one edge of the paper backing.

NOTE: The backing can also have a tab which will help to remove the backing.

SUBTASK 20-10-21-420-004

- (9) To install aluminum foil markers without self-contained adhesive, do these steps:

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- (a) On primed, painted, or plastic interior airplane surfaces that are not open to the weather, do these steps:
 - 1) Apply a light layer of adhesive, A00119, or adhesive, A00870, to the rear of the aluminum foil marker.
 - a) If you use adhesive, A00870, mix the base resin and catalyst in accordance with the manufacturer's instructions.
 - 2) For adhesive, A00119, let the adhesive dry until it is tacky but not bond to a clean finger when lightly touched.
- (b) On bare metal surfaces, do these steps:
 - 1) Apply a light layer of adhesive, A00134, to the rear of the aluminum foil marker.
 - 2) Let the adhesive dry until it is tacky but not bond to a clean finger when lightly touched.
- (c) On primed or painted exterior surfaces, do these steps:
 - 1) Apply a light layer of adhesive, A00870, to the rear of the aluminum foil marker.
 - a) Mix the base resin and catalyst in accordance with the manufacturer's instructions.

SUBTASK 20-10-21-420-005

- (10) Put the aluminum foil marker in the correct position and push down to attach it.

SUBTASK 20-10-21-420-006

- (11) Use a roller and start at one end of the marker and roll the marker into position.
 - (a) Make sure that there are no air bubbles.
 - (b) To prevent roll marks, do not let the edge of the roller touch the aluminum foil marker.

SUBTASK 20-10-21-800-004

- (12) To remove air bubbles, make a small hole with a pin and make a smooth surface with a roller.

SUBTASK 20-10-21-110-003



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- (13) If it is necessary, remove unwanted adhesive.
 - (a) Use solvent, B00148, for adhesive, A00134, and adhesive, A00870, or solvent, B00083, for adhesive, A00119.
 - 1) Do not use solvent, B00148, on the solvent sensitive surfaces.

SUBTASK 20-10-21-020-003

- (14) To remove the protective paper facing, strip it parallel to the surface of the aluminum foil marker.

SUBTASK 20-10-21-210-001

- (15) Make sure that there is a good bond on the edge of the aluminum foil marker.
 - (a) Make sure that the edge is not lifted.

SUBTASK 20-10-21-390-001

- (16) For the protection of markers from fuel, hydraulic fluid, or outdoor weather, do this step:

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- (a) Seal the marker edges or put an overcoat on the markers by brush or spray with adhesive, A00253, or Akzo Nobel 683-3-2 coating, C00012.

———— **END OF TASK** ————

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LUBRICATION FITTINGS - SERVICING

1. General

- A. This procedure contains this task.
(1) A temporary lubrication for blown-out lubrication fittings.

TASK 20-10-24-600-801

2. Temporary Lubrication for Blown Out Lubrication Fittings

A. **General**

- (1) This task contains temporary lubrication instructions for lubrication fittings that were blown out.
(a) This procedure is only to be used in the event that a grease fitting has been blown out and the maintenance to repair the fitting is inconvenient, but lubrication is necessary to continue service.

B. **Tools/Equipment**

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

Reference	Description
COM-7616	Adapter - Rubber Tipped Part #: LX-1418 Supplier: 7MZE3 Opt Part #: B411 Supplier: 0FKM1
STD-438	Gun - Grease

C. **Procedure**

SUBTASK 20-10-24-010-001

- (1) Gain access to the blown-out lubrication fitting(s).

SUBTASK 20-10-24-940-001

- (2) Using the applicable grease gun, STD-438 and the proper grease for the location, attach the rubber tipped adapter, COM-7616 to the grease gun, STD-438.

SUBTASK 20-10-24-940-002

- (3) Press the rubber tipped adapter, COM-7616 firmly against the opening where the lubrication fitting was blown out.

SUBTASK 20-10-24-640-001

- (4) Gently pump the grease into the fitting opening, making sure that the rubber tipped adapter, COM-7616 remains firmly seated against the opening.

SUBTASK 20-10-24-140-001

- (5) Clean up any excess grease.

SUBTASK 20-10-24-410-001

- (6) Close any panels opened for access.

SUBTASK 20-10-24-840-001

- (7) Return the aircraft to normal.

————— **END OF TASK** —————

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LUBRICATION FITTINGS - REMOVAL/INSTALLATION

1. General

A. This procedure has these tasks:

- (1) A removal of the lubrication fitting.
- (2) An installation of the lubrication fitting.

B. This procedure contains the installation instructions for a lubrication fitting (press-in type). Refer to the repair instructions in the Component Maintenance Manual for lubrication fittings on landing gear components.

TASK 20-10-24-000-801

2. Lubrication Fitting Removal

(Figure 401)

A. Lubrication Fitting Removal

SUBTASK 20-10-24-020-001

- (1) Remove damaged or broken lubrication fittings.

SUBTASK 20-10-24-160-001

- (2) Clean the area before installing a new fitting.

———— **END OF TASK** ————

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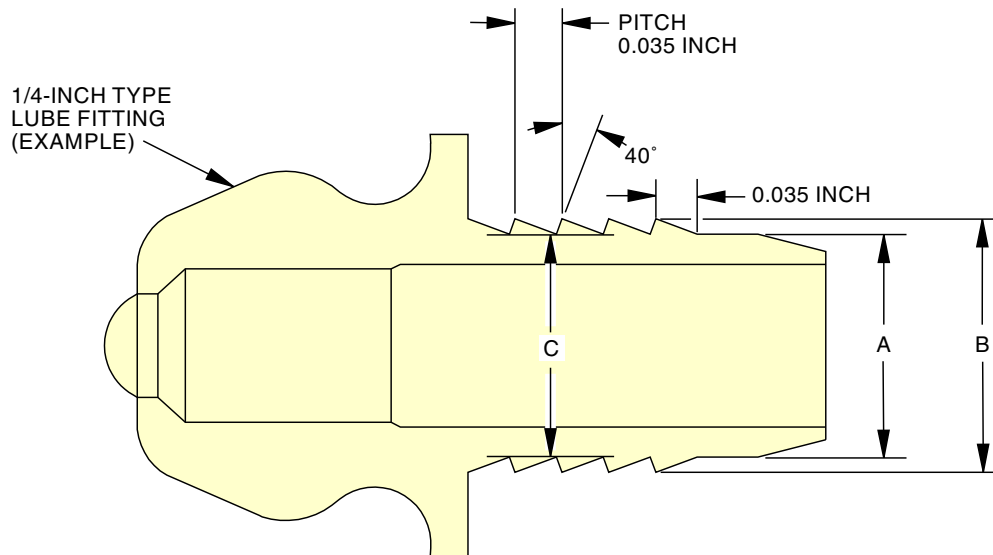
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LUBE HOLE DIA (X) (INCHES)	LUBE FITTING DIA (INCHES)
0.194 MAX	3/16 1
0.195-0.247	1/4 MODIFIED 1
0.248-0.249	1/4 2
0.250-0.254	1/4 1

NOTE: DESIGN LUBE HOLE DIA IS 0.188/0.189 INCH.

ALL DIMENSIONS ARE IN INCHES
X (NOT SHOWN) = HOLE DIA IN MATING COMPONENT
A = SHANK DIA (X MINUS 0.007/0.012)
B = SERRATION OD (X PLUS 0.005/0.010)
C = SERRATION ROOT OD (X MINUS 0.003/0.010)



INSTALL WITH ADHESIVE



INSTALLATION WITH ADHESIVE OPTIONAL

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Lubrication Fitting Modification and Installation
Figure 401/20-10-24-990-801

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TASK 20-10-24-420-801

3. Lubrication Fitting Installation

(Figure 401)

A. General

- (1) This task contains instructions for the installation of new lubrication fittings and lubrication fittings that were blown out.

B. Consumable Materials

Reference	Description	Specification
A00026	Compound - Sealing, Locking And Retaining, Single Component	ASTM D5363
A50086	Primer - Loctite 7471 Primer T Activator	
B00068	Alcohol - Denatured, Ethyl (Ethanol)	AMS 3002, MIL-E-51454 Type II
B00130	Alcohol - Isopropyl	TT-I-735
G00262	Nitrogen - Liquid	A-A-59503 Type II, MIL-PRF-27401 Type II
G01659	Swab - Cotton Or Rayon, (Disposable)	

C. Lubrication Fitting Installation

SUBTASK 20-10-24-840-002

- (1) Get an applicable standard fitting to install in the hole.

SUBTASK 20-10-24-160-002



CAUTION

BE CAREFUL NOT TO CONTAMINATE THE BEARING, JOINT OR ITEM THAT IS LUBRICATED THROUGH THE FITTING HOLE. DAMAGE TO EQUIPMENT MAY OCCUR.

- (2) Do these steps to clean the lubrication fitting hole:
- (a) Use swab, G01659, to remove as much grease as possible from the inner surface of the lubrication fitting hole.
 - (b) Clean the hole to a depth of at least 0.5 in. (12.7 mm) with alcohol, B00068, or alcohol, B00130, on a clean cotton swab.
 - (c) Clean the hole until you can see no more grease or dirt removed from the hole.

SUBTASK 20-10-24-420-001



CAUTION

MAKE SURE YOU USE THE CORRECT TOOL TO INSTALL THE LUBRICATION FITTING. MOVE THE FITTING IN A STRAIGHT LINE TO PREVENT DAMAGE TO THE MATING PART.

- (3) Use a drive tool to install the lubrication fitting.

D. Blown-Out Fittings Lubrication

SUBTASK 20-10-24-840-003

- (1) Get a special approved or an oversized fitting to install in the hole.

SUBTASK 20-10-24-160-003

- (2) Do these steps to clean the lubrication fitting hole:

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- (a) Use swab, G01659, to remove as much grease as possible from the inner surface of the lubrication fitting hole.



BE CAREFUL NOT TO CONTAMINATE THE BEARING, JOINT OR ITEM THAT IS LUBRICATED THROUGH THE FITTING HOLE. DAMAGE TO EQUIPMENT MAY OCCUR.

- (b) Clean the hole to a depth of at least 0.5 in. (12.7 mm) with alcohol, B00068, or alcohol, B00130, and a clean swab, G01659.
- (c) Clean the hole until you can see no more grease or dirt removed from the hole.

SUBTASK 20-10-24-390-001

- (3) Do these steps to apply the Loctite 7471 Primer T Activator, A50086:

- (a) Use swab, G01659, to apply a thin layer of Loctite 7471 Primer T Activator, A50086, to the inner diameter of the hole.
- 1) Apply the primer to a maximum depth of 0.4 in. (10.2 mm).
- (b) Let the primer air dry at approximately 70°F (21°C) for at least five minutes before you apply the adhesive compound, A00026.

SUBTASK 20-10-24-420-002



DO NOT APPLY TOO MUCH ADHESIVE TO THE MATING SURFACES OF THE FITTING AND THE ADJACENT PART. TOO MUCH ADHESIVE ON THE FITTING WILL CAUSE A BLOCKAGE TO THE LUBRICATION HOLE AND CAUSE DAMAGE TO EQUIPMENT.

- (4) Do these steps to install the lubrication fitting:
- (a) Use swab, G01659, to apply a thin layer of adhesive compound, A00026, to the inner diameter of the hole (between 0.25 in. (6.35 mm) and 0.40 in. (10.16 mm) in depth).
- (b) Put the lubrication fitting into nitrogen, G00262, for at least one minute to make sure the fitting is fully cool.



MAKE SURE YOU USE THE CORRECT TOOL TO INSTALL THE LUBRICATION FITTING. MOVE THE FITTING IN A STRAIGHT LINE TO PREVENT DAMAGE TO THE MATING PART.

- (c) Use a drive tool to install the lubrication fitting.
- NOTE: Install the lubrication fitting into the hole in the mating part immediately. If you do not install the fitting immediately it will become too warm.
- (d) Let the lubrication fitting cure for 12 hours at room temperature before you use it.

———— **END OF TASK** ————

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RIG PINS - MAINTENANCE PRACTICES

1. General

- A. This procedure has one task:
(1) Rig pin maintenance practices.

TASK 20-10-25-910-801

2. Rig Pin Maintenance Practices

A. **General**

- (1) This procedure provides a list of rigging pins.
(2) The list gives:
(a) Rig pin assembly number.
(b) Equivalent MS part number.
(c) AMM pin reference number.
(d) ATA number.

B. **Procedure**

SUBTASK 20-10-25-480-001

- (1) Use the table that follows to determine the correct rigging pin for the application.

Table 201/20-10-25-993-801

F70207 Assembly Number	EQUIVALENT MS PART NO.	AMM Pin Reference Number	ATA No.
-4	MS20392-2	ST-4	27-41-51
-7	MS20392-4	E-4, NS4, LGP2	27-11-00, 27-61-00, 27-31-00, 32-51-00, 32-31-00, 32-44-00
-8	MS20392-4	R-5	27-21-00, 27-81-00
-9	MS20392-4	A/S-4, A/S-15, E-1, E-5, LGEA1, LGEA2, LGEA3, MNGEA	27-11-00, 27-61-00, 27-31-00, 27-41-51, 32-34-00, 32-35-00
-14	MS20392-4	R-1, R-2, LGB1, LGB2, LGP1	27-21-00, 32-41-00, 32-44-00
-66	-----	E-2, E-3	27-31-00
-85	MS20392-4	S/B-1, NS2, NS5, NS10	27-62-00, 32-51-00
-88	MS20392-4	NS1, LGB3, LGB4	27-11-00, 27-61-00, 27-51-22, 32-51-00, 32-41-00
-113	MS20392-3	A/S-8	27-51-11
-114	MS20392-3	-----	27-51-14
-115	-----	R-3, R-4	27-21-00, 32-51-00
-116	-----	-----	27-51-00
-129	MS20392-2	-----	32-41-00

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————— END OF TASK —————

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CAPTIVE SCREWS - REMOVAL/INSTALLATION

1. General

- A. This procedure has these tasks:
- (1) A removal of captive screws.
 - (2) An installation of captive screws.

TASK 20-10-26-000-801

2. Captive Screws Removal

(Figure 401)

A. General

- (1) This task includes the steps to remove the captive screws.

B. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

Reference	Description
SPL-14272	Adapter - Removal Part #: RNC7913-10 Supplier: 17446
SPL-14273	Sleeve - Removal Part #: T2136SL-10 Supplier: 17446

C. Captive Screw Removal

SUBTASK 20-10-26-000-001

- (1) For removal adapter component part numbers, see Table 401.

Table 401/20-10-26-993-801

RECOMMENDED SUPPLIER	REMOVAL ADAPTOR	REMOVAL SLEEVE	SPACE WASHER (IF REQUIRED)
HUCK INTERNATIONAL DEUTSCH OPERATIONS	adapter, SPL-14272	sleeve, SPL-14273	T1319SP-100-XXX ^{*[1]}

^{*[1]} XXX specifies thickness in increments of 0.063 in. (1.600 mm)..

- (2) Measure distance A with screw fully retracted.
- (3) Engage threaded portion of the Removal Adapter to Hand Tool Puller.
- (4) Set dimension B from top of the adaptor to correspond with distance A. Use a 3/32 inch Hex key, turn clockwise to increase B dimension as required. Screw Removal Adaptor onto Hand Tool.
- (5) Engage Removal Sleeve to the stud of the fastener to be removed and thread it all the way except for one thread while maintaining fully retracted position on screw.
- (6) Place Removal Tool slot around the head of screw to be removed. Inner stud slot shall push against the head.
- (7) Squeeze handle of the Hand Tool fully to unflare captive screw sleeve by pulling sleeve out of the hole.

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- (8) For extra long screws to be removed where distance A exceeds 0.600 in. (15.240 mm), Spacer Washer shall be used and placed under the tool. Washer is available in thickness of 1/16 inch increments.

————— **END OF TASK** —————

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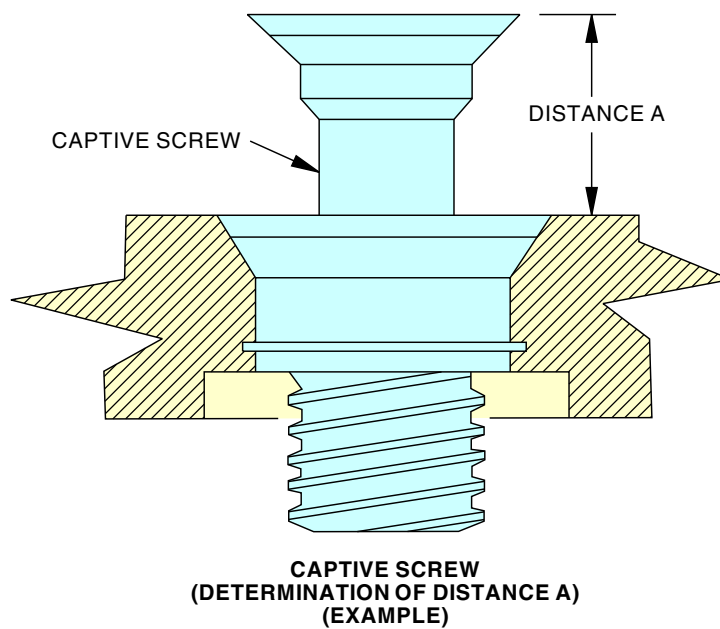
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Captive Screw Installation
Figure 401/20-10-26-990-801 (Sheet 1 of 6)

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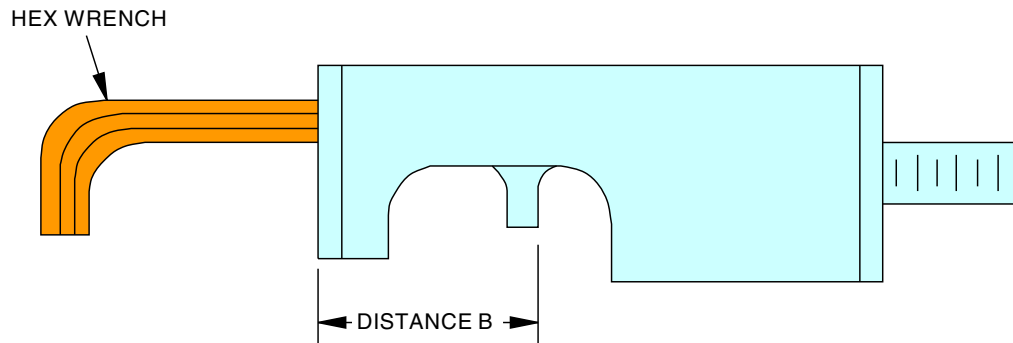
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Captive Screw Installation
Figure 401/20-10-26-990-801 (Sheet 2 of 6)

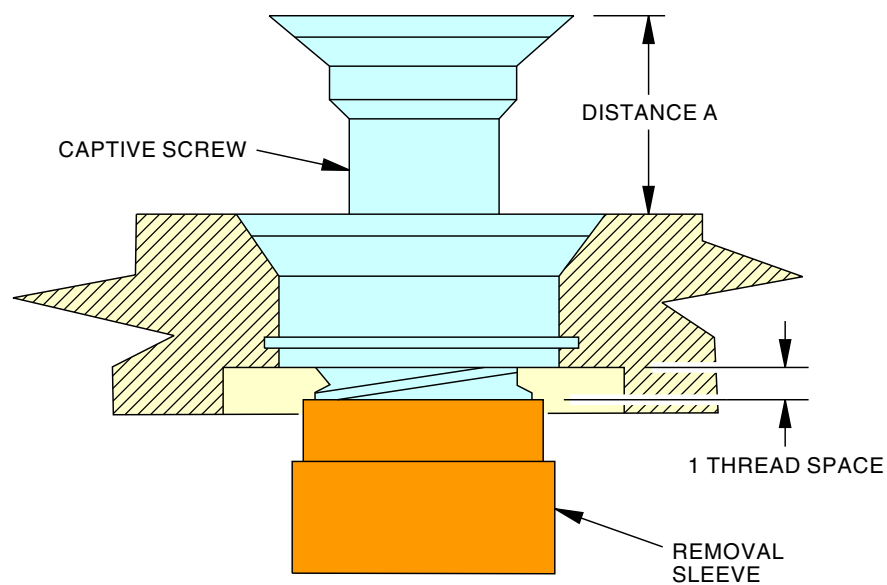
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Captive Screw Installation
Figure 401/20-10-26-990-801 (Sheet 3 of 6)

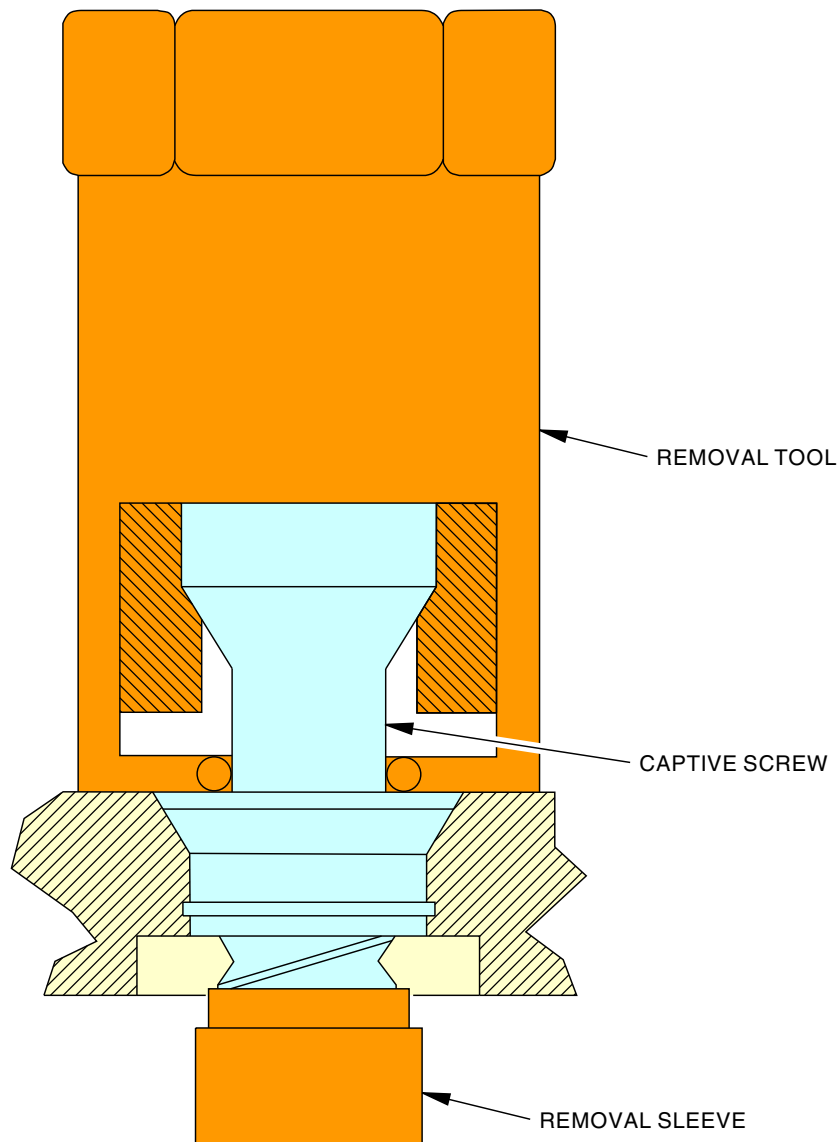
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Captive Screw Installation
Figure 401/20-10-26-990-801 (Sheet 4 of 6)

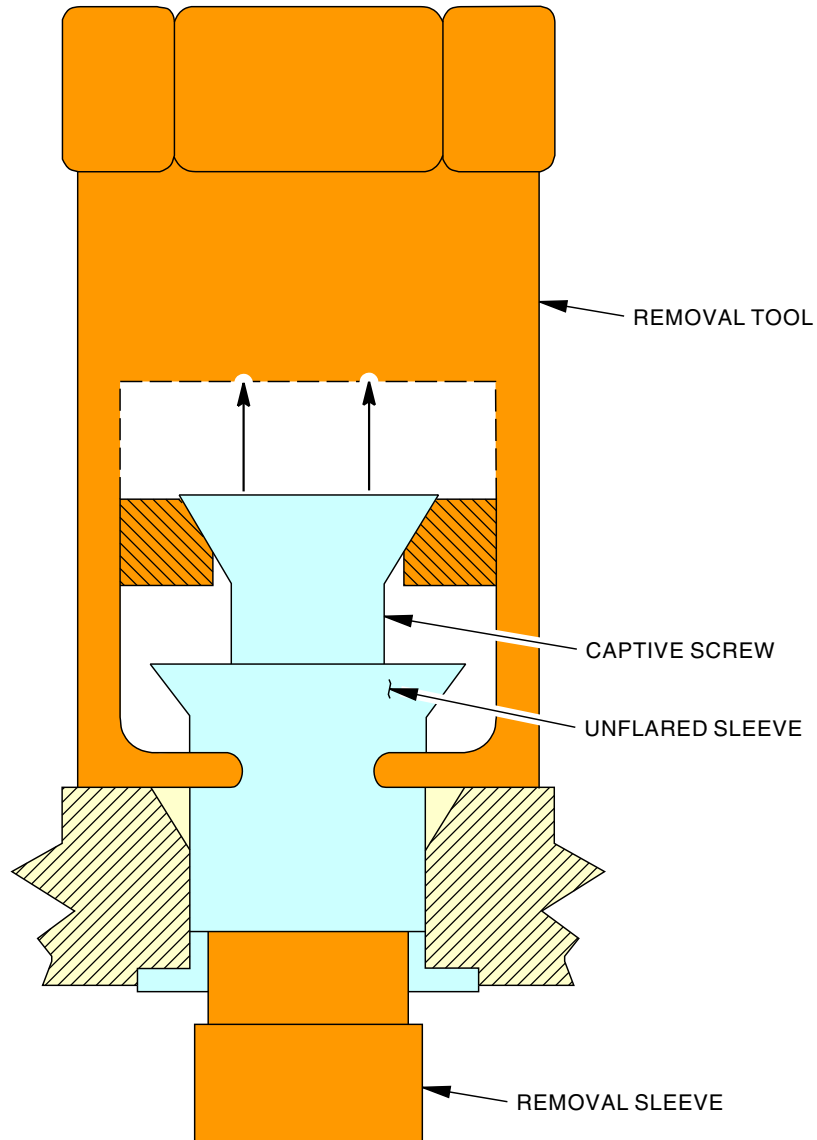
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Captive Screw Installation
Figure 401/20-10-26-990-801 (Sheet 5 of 6)

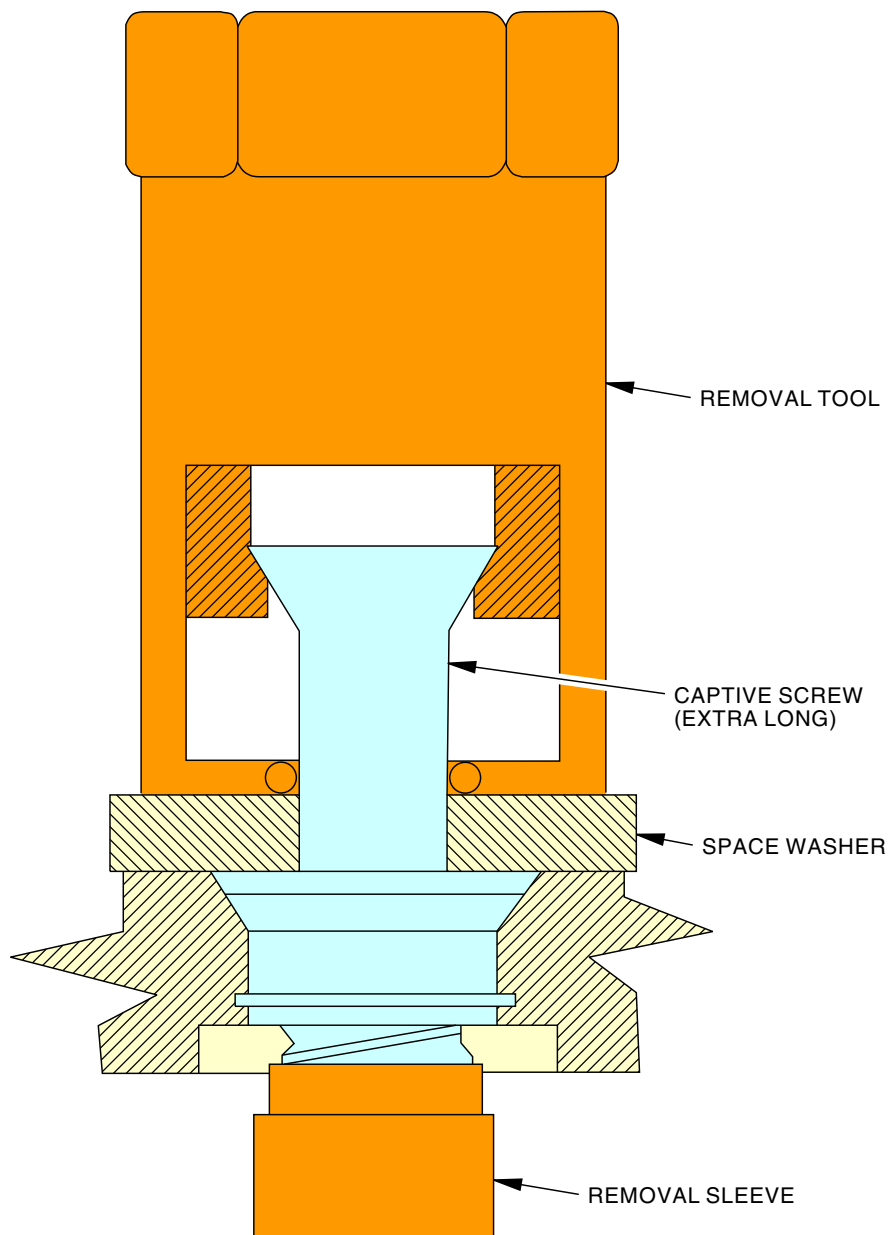
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Captive Screw Installation
Figure 401/20-10-26-990-801 (Sheet 6 of 6)

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TASK 20-10-26-400-801

3. Captive Screws Installation

(Figure 402 or Figure 403 or Figure 404)

A. General

(1) This task includes the steps to install the Captive Screws.

B. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt.", which stands for Optional.

Reference	Description
SPL-14274	Assembly - Hand Tool Part #: H8603 Supplier: 17446
SPL-14275	Nose Piece Part #: HN7513-10 Supplier: 17446
SPL-14276	Assembly - Handle Part #: TA7533 Supplier: 17446
SPL-14277	Puller Part #: HP7523-10 Supplier: 17446
SPL-14278	Air Hydraulic Tool Part #: DTP3000 Supplier: 17446
SPL-14279	Spline Driver Part #: T3098DR Supplier: 17446
SPL-14280	Adapter Part #: T3151AD Supplier: 17446
SPL-14281	Thrust Washer Part #: T3134WA-1 Supplier: 17446
SPL-14282	Puller Part #: HP7523-10F Supplier: 17446

C. Captive Screws Installation

SUBTASK 20-10-26-400-001

(1) For recommended installation tooling, see Table 402.

Table 402/20-10-26-993-802

RECOMMENDED SUPPLIER	THREAD SIZE CODE	NOMINAL THREAD DIA.	HAND TOOL ASSEMBLY	AIR HYDRAULIC TOOL
HUCK INTERNATIONAL DEUTSCH OPERATIONS	10	0.190-32UNF-3A	hand tool, SPL-14274	Air Hydraulic Tool, SPL-14278

SUBTASK 20-10-26-400-002

(2) Hand Installation.

(a) For recommended components part numbers for the hand tool, see Table 403.

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Table 403/20-10-26-993-803

RECOMMENDED SUPPLIER	HAND TOOL ASSEMBLY	NOSE PIECE	PULLER	HANDLE ASSEMBLY
HUCK INTERNATIONAL DEUTSCH OPERATIONS	hand tool, SPL-14274	nose piece, SPL-14275	puller, SPL-14277	handle assembly, SPL-14276

- (b) Place screw assembly into prepared hole in panel.
- (c) Engage the nose piece of the hand tool to the threaded end of the captive screw (screw shall be engaged in tool as far as possible until the end of the sleeve makes contact with the flaring surface of the nose piece).
- (d) Squeeze handles of tool together to flare sleeve, excessive force is not required.
- (e) Remove tool from fastener by unscrewing.
- (f) Should flare require additional tightening, repeat procedure, exerting additional squeezing force.

SUBTASK 20-10-26-400-003

(3) Air Hydraulic Installation

- (a) For recommended air hydraulic tool, see Figure 403.
 - 1) Lubricated shop air should be used.
 - 2) Air supply requirements: 90 psi (621 kPa) to 100 psi (689 kPa).
- (b) Components for the Air Hydraulic tool are shown in Table 404.

Table 404/20-10-26-993-804

RECOMMENDED SUPPLIER	SPLINE DRIVER	ADAPTER	THRUST WASHER	PULLER	NOSE PIECE
HUCK INTERNATIONAL DEUTSCH OPERATIONS	spline driver, SPL-14279	adapter, SPL-14280	thrust washer, SPL-14281	puller, SPL-14282	nose piece, SPL-14275

- 1) To replace puller do these steps:
 - a) Disconnect tool from air supply.
 - b) Unscrew lock ring and remove air motor assembly.
 - c) Remove nose piece from cylinder.
 - d) Slide puller assembly towards rear of cylinder for access to set screw holding spine driver in position.
- (c) Select grip thickness, see Table 405.

Table 405/20-10-26-993-805

GRIP CODE	TOP PANEL GRIP THICKNESS
A	0.075 in. (1.90 mm) to 0.089 in. (2.26 mm)
B	0.090 in. (2.29 mm) to 0.125 in. (3.18 mm)
C	0.126 in. (3.20 mm) to 0.187 in. (4.75 mm)
D	0.188 in. (4.78 mm) to 0.250 in. (6.35 mm)
E	0.251 in. (6.38 mm) to 0.312 in. (7.92 mm)
F	0.313 in. (7.95 mm) to 0.375 in. (9.52 mm)

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Table 405/20-10-26-993-805 (Continued)

GRIP CODE	TOP PANEL GRIP THICKNESS
G	0.376 in. (9.55 mm) to 0.437 in. (11.10 mm)
H	0.438 in. (11.13 mm) to 0.500 in. (12.70 mm)
J	0.501 in. (12.73 mm) to 0.562 in. (14.27 mm)
M	0.563 in. (14.30 mm) to 0.625 in. (15.88 mm)

- (d) Insert captive screw assembly through prepared hole in panel.
- (e) Adjust pressure regulator to 40 psi (276 kPa) to 50 psi (345 kPa) for size -10 (dia.) steel collars.
- (f) Hold fastener from head side with appropriate driver to prevent rotation.
- (g) With air motor direction knob set to forward direction (knob to right as looking from rear of tool) place nose piece against threaded end of fastener and activate motor trigger (on pistol grip) to engage puller threads.
- (h) Depress Hydraulic booster activation button (lower button on pistol grip) to move nose piece forward, flaring skirted portion of fastener sleeve. Release button when flared portion of sleeve is seated against the panel.
- (i) Change air motor direction knob to reverse position (knob to left when looking from rear of tool) and press motor trigger to disengage puller threads from fastener.

———— **END OF TASK** ————

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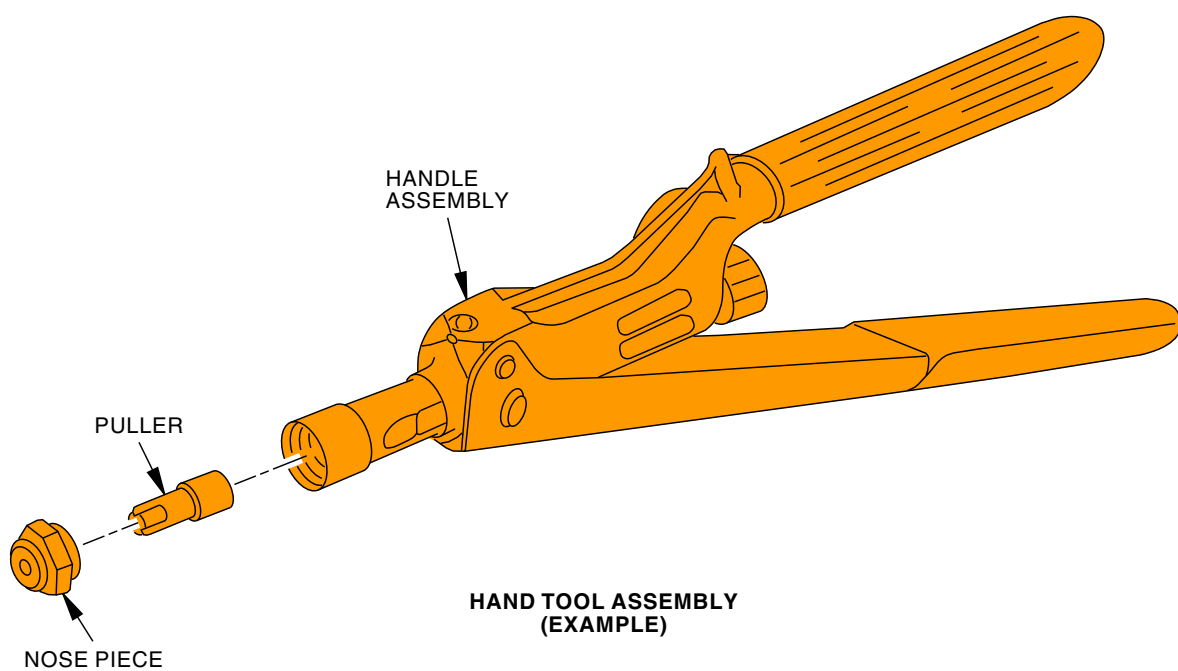
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Hand Tool
Figure 402/20-10-26-990-807

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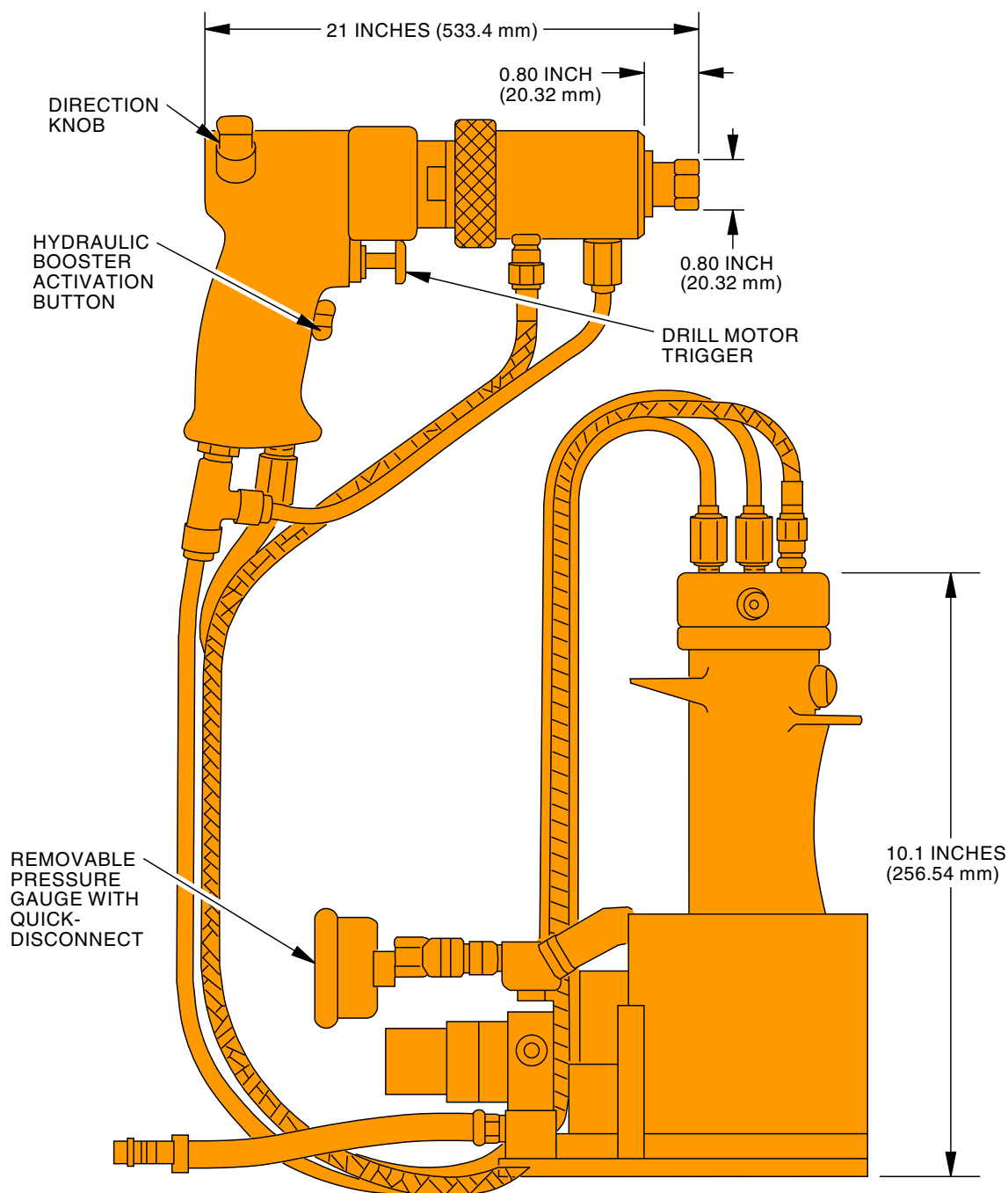
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Air Hydraulic Tool P/N DTP3000
Figure 403/20-10-26-990-808

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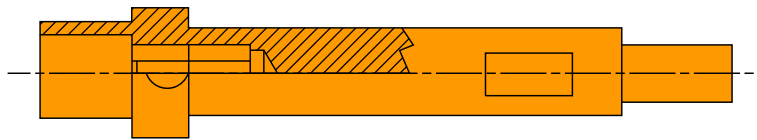
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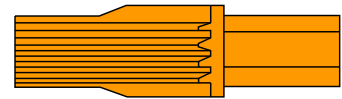
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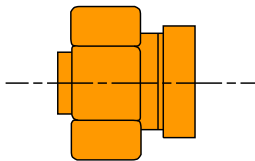
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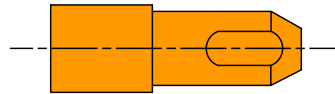
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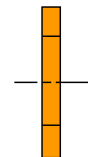
SPLINE DRIVER



NOSE PIECE FOR
CAPTIVE SCREW



PULLER



THRUST WASHER

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Puller Assembly Components
Figure 404/20-10-26-990-809

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HEAT DEVICES - MAINTENANCE PRACTICES

1. General

- A. This procedure contains one task:
- (1) Precautions for Heat Devices.

TASK 20-10-27-910-801

2. Precautions for Heat Devices

A. General

- (1) This procedure has the minimum recommended safety procedures for the operation of heat guns, soldering guns, soldering irons, and other heat devices.
- (2) You must also obey the regulations of your airline and local agencies.
- (3) In this procedure heat guns, soldering guns, and soldering irons are referred to as heat devices.
- (4) We recommend you use crimped splices and sleeves with nylon ties or heat shrinkable covering in areas that could have flammable fumes.

B. Tools/Equipment

Reference	Description
STD-4057	Combustible Gas Indicator - Explosion Proof Gastech Model 1314 Super Surveyor

C. Precautions

SUBTASK 20-10-27-880-001



DO NOT USE HEAT DEVICES NEAR FLAMMABLE FLUIDS OR FUMES. HEAT OR SPARKS FROM HEAT DEVICES CAN CAUSE EXPLOSIONS AND FIRES.

- (1) Use heat devices only in safe areas.
 - (a) Do not use heat devices in areas that are less than 100 ft (30 m) from the airplane if these conditions are present:
 - 1) Airplane fueling
 - 2) Airplane defueling
 - 3) The fuel tanks are open.
 - (b) Do not use heat devices in areas where smoking is not permitted.

D. How to Measure Fume Levels

SUBTASK 20-10-27-750-001



DO NOT USE HEAT DEVICES UNLESS AN AREA HAS NO FUMES. A FUME LEVEL OF ZERO IS THE ONLY SAFE LEVEL. HEAT OR SPARKS FROM HEAT DEVICES CAN CAUSE EXPLOSIONS AND FIRES.

- (1) Measure the fumes:
 - (a) Use the gas indicator, STD-4057 to measure the fume level.

NOTE: The following conditions can occur.

 - 1) A liquid fuel or fume source is near.

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- 2) The local fuel fume level are high or the ventilation is not sufficient.
- (b) Make sure the fuel fume levels are at zero.
- (c) Continue to monitor the fume levels during the repair
- (d) Keep a good flow of air in the fuel tanks

NOTE: You can make the fuel tanks safer with nitrogen inert equipment installed to maintain the fuel system oxygen content at 10% or less by volume.

E. How to Keep the Area Safe

SUBTASK 20-10-27-800-001

- (1) If it is possible for other persons to move flammable fluids into the area, obey these steps:
 - (a) Do not use a possible ignition source near open fuel tanks, fuel vents, or fuel leaks where fume concentrations cannot be known or controlled.
 - (b) Make sure a person monitors the work area.

NOTE: A person who can measure the risk of the repair to be done must identify the emergency or fire fighting equipment necessary at the work area of the repair.
The person must be authorized to monitor airplane fire safety.
 - (c) Do not start or continue to do work on a fuel system component while equipment that can cause the fuel to burn is near.
 - (d) Keep the number of maintenance and safety persons included to a minimum.

———— **END OF TASK** ————

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TORX-PLUS FASTENERS - MAINTENANCE PRACTICES

1. General

- A. This procedure has one task.
(1) Torx-Plus Maintenance Practices.

TASK 20-10-28-900-801

2. Torx-Plus Maintenance Practices

(Figure 201)

A. **General**

- (1) This task has the list of Torx-Plus bits to use with Torx-Plus fasteners.

B. **Procedure**

SUBTASK 20-10-28-910-001



MAKE SURE THAT YOU USE THE CORRECT TORX-PLUS DRIVE BIT ON TORX-PLUS FASTENERS. IF YOU DO NOT USE THE CORRECT TORX-PLUS DRIVE BIT, YOU CAN STRIP THE FASTENER AND CAUSE DAMAGE TO THE EQUIPMENT.

- (1) Refer to the table and figure that follow for the applicable Torx-Plus drive bit to use on Torx-Plus fasteners.

NOTE: Torx-Plus drive bits are designated by the letters "IP" (Figure 201).

Torx-Plus Drive Bit and Fastener numbers

Torx-Plus Bit	BACB31G(*)	BACB31U(*)	BACS12JE(*)	BACS12JL(*)
10IP			06, 08	
15IP	3	3	3	3
25IP	4	4	4	4
30IP	5	5	5	
40IP	6	6	6	
45IP	7			
50IP	8			
55IP	9, 10			
60IP	12			

————— **END OF TASK** —————

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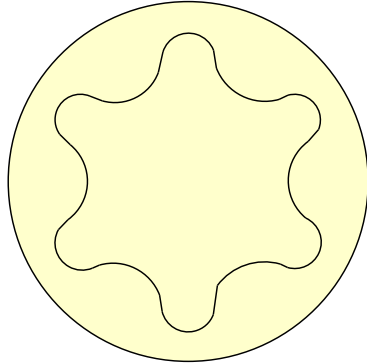
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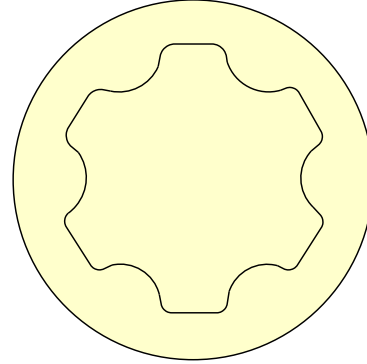
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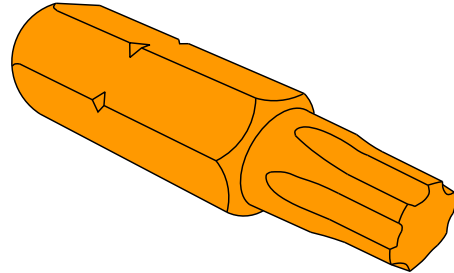
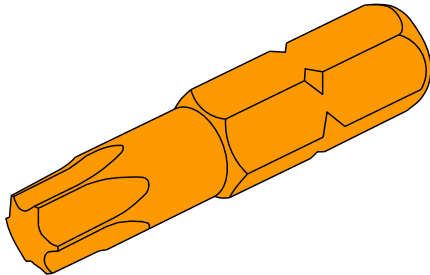
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TORX



TORX - PLUS



TORX - PLUS FASTENERS

NOTE:

TORX DRIVE BITS ARE DESIGNATED BY THE LETTER "T".

TORX-PLUS DRIVE BITS ARE DESIGNATED BY THE LETTER "IP".

2833445 S0000658785_V1

Torx-Plus Fasteners
Figure 201/20-10-28-990-801

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TEFLON BACKUP RINGS - REMOVAL/INSTALLATION

1. General

- A. This procedure has these tasks:
- (1) A removal of teflon backup rings.
 - (2) An installation of teflon backup rings.

TASK 20-10-31-000-801

2. Teflon Backup Rings Removal

(Figure 401)

A. Procedure

SUBTASK 20-10-31-020-001

- (1) If you see a broken teflon ring, remove it.
 - (a) Use an appropriate hook or tool.
 - (b) Use care not to scratch the groove or the adjacent surfaces.

———— **END OF TASK** ————

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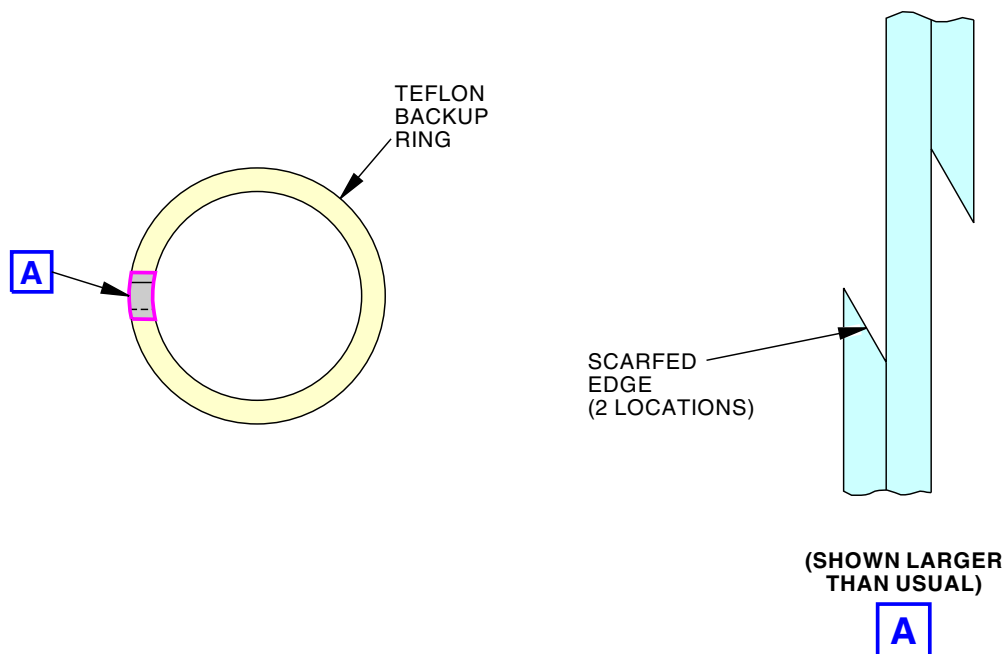
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Teflon Backup Ring Installation
Figure 401/20-10-31-990-801

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TASK 20-10-31-400-801

3. Teflon Backup Rings Installation
(Figure 401)

A. Procedure

SUBTASK 20-10-31-420-001

- (1) Install split-teflon backup rings with the direction of the spiral clockwise.
 - (a) Make sure the scarfed ends face as shown in Figure 401.

————— END OF TASK —————

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PERSONNEL EQUIPMENT SAFETY HARNESS - MAINTENANCE PROCEDURES

1. General

- A. This procedure contains these tasks:
- (1) Wing Upper Surface Vacuum Arrest System.
 - (2) Horizontal Stabilizer Surface Vacuum Arrest System.
 - (3) Near Engine Pylon Vacuum Arrest System.
- B. Receptacles for the safety harness are on the top of the wing and the horizontal stabilizer. Maintenance persons who work high above the ground will attach their safety harnesses to these receptacles.

TASK 20-10-30-400-801

2. Wing Upper Surface Vacuum Arrest System

(Figure 201)

A. General

- (1) This task includes the steps to install the vacuum arrest system to the wing upper surface.
- (2) Do not place the vacuum pads on any non-metallic or bonded structure, including aluminum honeycomb bonded panels.

B. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

Reference	Description
COM-12523	Equipment - Personnel, Upper Wing - Vacuum Pad - Lifeline Kit Part #: 15703-00 Supplier: 71TV7
COM-12524	Equipment - Personnel, Vacuum Pad - Flightline Kit Part #: 15702-00 Supplier: 71TV7

C. Procedure

SUBTASK 20-10-30-400-001

- (1) Install the vacuum pad lifeline kit, COM-12523, or vacuum pad flightline kit, COM-12524.
 - (a) Install the vacuum pads in the area identified in Figure 201.
 - (b) Make sure that the energy absorber is in place.
 - (c) Make sure that there are no slack ropes at the edges.
 - (d) Make sure that there are no missing features, temporary fasteners, or fastener removals in the locations that follow.
 - 1) Within 30 in. (762 mm) of the edge of any vacuum pad.
 - 2) At the upper stringer to the upper rib chord bolt locations at the adjacent wing rib locations.
 - a) This includes any rib directly beneath the pad location and one rib inboard and outboard of the vacuum pad location.
 - 3) Make sure that the vacuum pads are at least 12 in. (305 mm) from the panel edges at the front and rear spars.

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- 4) Make sure that the vacuum pads are not placed over splice joints or access panels.

NOTE: This is to maintain vacuum integrity.

- (2) Put on the full body safety harness.
(3) Attach the hook end of the vacuum pad assembly to the body.

———— **END OF TASK** ————

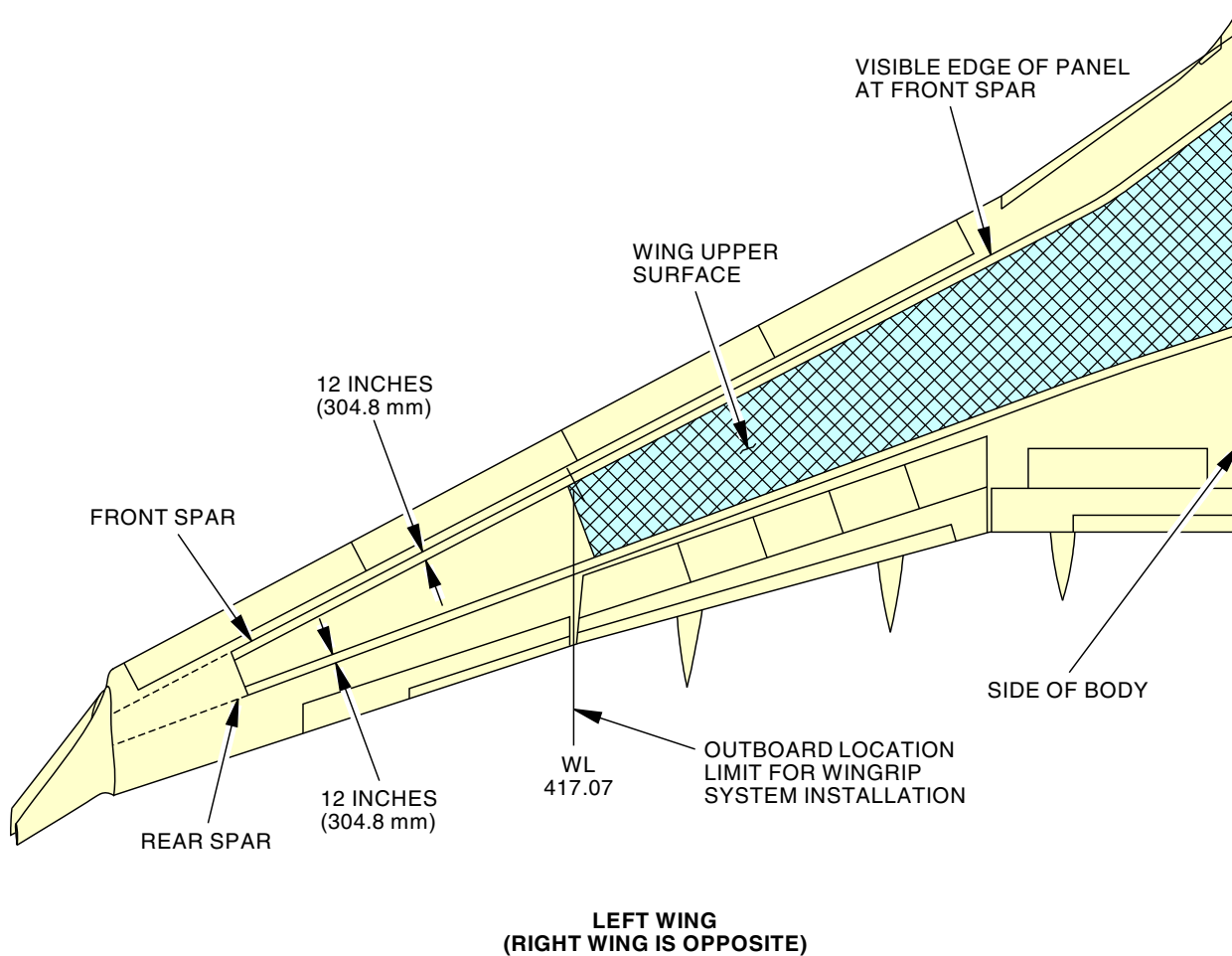
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 WINGRIP SYSTEM INSTALLATION AREA
(PADS MUST NOT BE CLOSER THAN 12.0 INCHES (304.8 mm) FROM THE VISIBLE EDGE OF THE WING SKIN PANELS ALONG THE FRONT AND REAR SPARS.)

3013248 S0000785778_V1

Vacuum Arrest System Usage - Wing Upper Surface
Figure 201/20-10-30-990-801

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TASK 20-10-30-400-802

3. Horizontal Stabilizer Vacuum Arrest System

(Figure 202)

A. General

- (1) This procedure is to install the vacuum arrest system to the horizontal stabilizer.
- (2) Do not place the vacuum pads on any non-metallic or bonded structure, including aluminum honeycomb bonded panels.

B. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

Reference	Description
COM-12524	Equipment - Personnel, Vacuum Pad - Flightline Kit Part #: 15702-00 Supplier: 71TV7

C. Procedure

SUBTASK 20-10-30-400-002

- (1) Install the vacuum pad flightline kit, COM-12524.
 - (a) Install the vacuum pads in the area identified in Figure 202.
 - (b) Make sure that the energy absorber is in place.
 - (c) Make sure that there is no slack ropes at the edges.
 - (d) Make sure that there is no missing fasteners, temporary fasteners, or fastener removals in the locations that follow.
 - 1) Within 30 in. (762 mm) of the edge of any vacuum pad.
 - 2) At the upper stringer to the upper rib chord bolt locations at the adjacent stabilizer rib locations.
 - a) This includes any rib directly beneath the pad location and one rib inboard and outboard of the vacuum pad location.
 - 3) Make sure that the vacuum pads are located away from panel edges.
 - 4) Make sure that the vacuum pads are not placed over splice joints or access panels.
- (2) Put on the full body safety harness.
- (3) Attach the hook end of the vacuum pad assembly to the body harness.

————— END OF TASK —————

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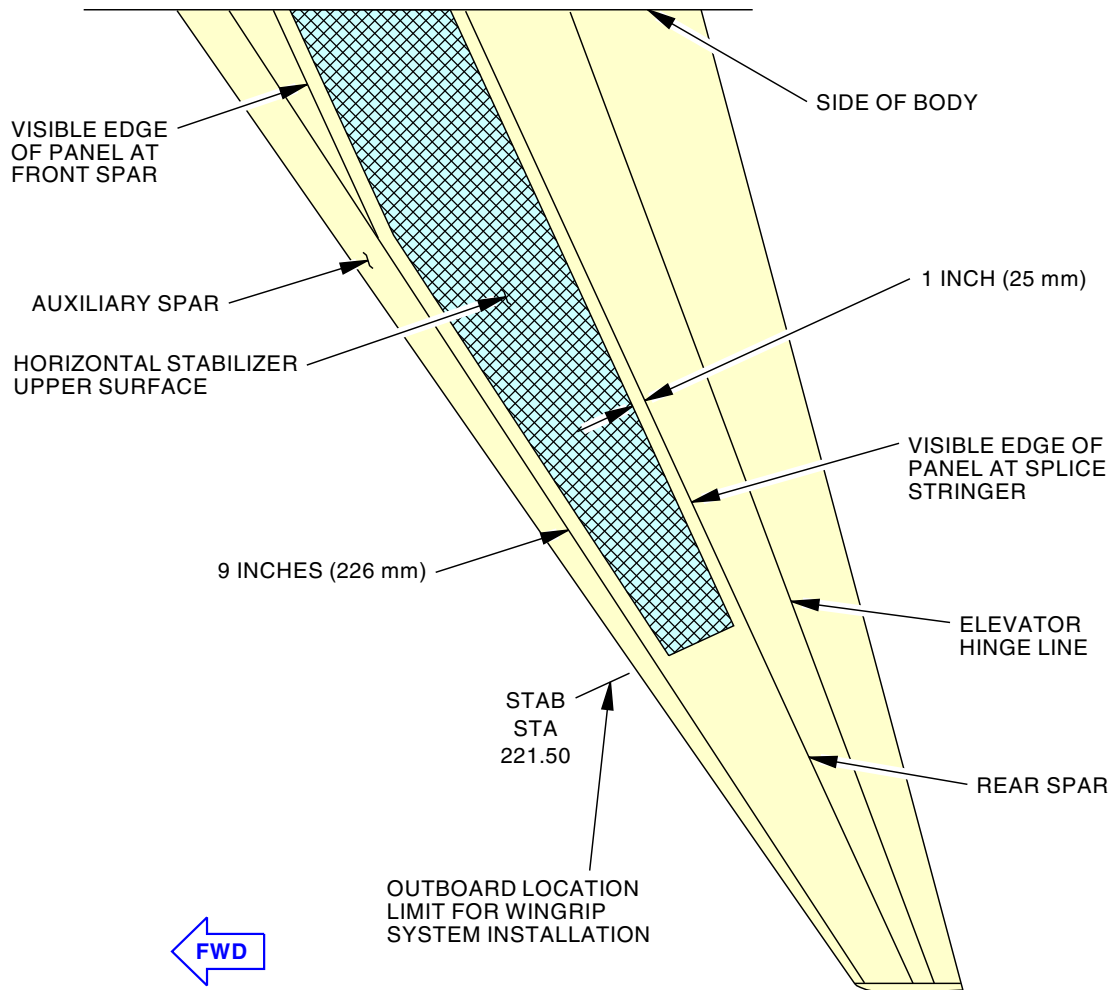
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 WINGRIP SYSTEM INSTALLATION AREA
(PADS MUST NOT BE CLOSER THAN 9 INCHES (228 mm)
FROM THE VISIBLE EDGE OF THE HORIZONTAL STABILIZER
SKIN PANEL ALONG THE FRONT SPAR AND 1 INCH (25 mm)
FROM THE VISIBLE EDGE OF THE HORIZONTAL STABILIZER
SKIN PANEL ALONG THE SPLICE STRINGER.)

3013249 S0000785779_V1

Vacuum Arrest System Usage - Horizontal Stabilizer
Figure 202/20-10-30-990-802

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TASK 20-10-30-400-803

4. Near Engine Pylon Vacuum Arrest System

A. General

- (1) This procedure is to install the vacuum arrest system to the near engine pylon.
- (2) Do not place the vacuum pads on any non-metallic or bonded structure, including aluminum honeycomb bonded panels

B. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

Reference	Description
COM-12524	Equipment - Personnel, Vacuum Pad - Flightline Kit Part #: 15702-00 Supplier: 71TV7

C. Procedure

SUBTASK 20-10-30-400-003

- (1) Install the vacuum pad flightline kit, COM-12524.
 - (a) Install the vacuum pads.
 - (b) Make sure that the energy absorber is in place.
 - (c) Make sure that there are no slack ropes at the edges.
 - (d) Make sure that there are no missing fasteners, temporary fasteners, or fastener removals in the locations that follow.
 - 1) Within 30 in. (762 mm) of the edge of any vacuum pad.
 - 2) At the upper stringer to the upper rib chord bolt locations at the rib locations adjacent to the engine pylon.
 - a) This includes any ribs directly beneath the pad location and one rib inboard and outboard of the vacuum pad location.
 - 3) Make sure that the vacuum pads are located away from panel edges.
 - 4) Make sure that the vacuum pads are not placed over splice joints or access panels.
- (2) Put on the body safety harness
- (3) Attach the hook end of the vacuum pad assembly to the body harness.

NOTE: This is to maintain vacuum integrity.

————— END OF TASK —————

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POWER DEVICE CARTRIDGE - REMOVAL/INSTALLATION

1. General

- A. This procedure contains two tasks.
- (1) The first task is the removal of cartridge.
 - (2) The second task is the installation of cartridge.

TASK 20-10-33-000-801

2. Power Device Cartridge (Squib) Removal

A. **References**

Reference	Title
20-40-11-910-801	Static Grounding (P/B 201)
24-22-00-860-802	Remove Electrical Power (P/B 201)

B. **Tools/Equipment**

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

Reference	Description
COM-1565	Wrist Strap - Adjustable, Conductive, Static Control Part #: 09070 Supplier: 62576 Part #: 2214 Supplier: 62576 Opt Part #: 14810 Supplier: 62576 Opt Part #: 2211 Supplier: 55203 Opt Part #: 2212 Supplier: 55203 Opt Part #: 2213 Supplier: 55203
COM-1793	Multimeter - Digital/Analog (or equivalent meter meets task requirements) Part #: 117 Supplier: 89536 Part #: 260-8XPI Supplier: 55026 Part #: 287 Supplier: 89536 Part #: 289 Supplier: 89536 Part #: 87V Supplier: 89536 Part #: FLUKE 27 II Supplier: 89536 Part #: FLUKE-77-4 Supplier: 89536 Opt Part #: 187 Supplier: 89536 Opt Part #: 189 Supplier: 89536 Opt Part #: 21 Supplier: 89536 Opt Part #: 27 Supplier: 89536 Opt Part #: 77 SERIES III Supplier: 89536 Opt Part #: 87 Supplier: 89536 Opt Part #: FLUKE 27 Supplier: 89536 Opt Part #: MODEL 27 Supplier: 89536
STD-1168	Cap - Shorting or Faraday Cap

C. **Procedure**

SUBTASK 20-10-33-940-001

- (1) Ground the airplane, do this task: Static Grounding, TASK 20-40-11-910-801.

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SUBTASK 20-10-33-940-002

- (2) Make sure you remove electrical power before you remove the squib, do this task: Remove Electrical Power, TASK 24-22-00-860-802.
 - (a) If you use the external power plug to ground aircraft, connect the external power cable again after electrical power is removed.

SUBTASK 20-10-33-760-001

- (3) You must wear a static control wrist strap, COM-1565 during the removal of the squib.



WARNING

USE A WRIST STRAP WITH A MINIMUM GROUNDING LEAD RESISTANCE OF 250 KILOHMS AND A MAXIMUM OF 1.5 MEGOHMS. USE OF A LOW RESISTANCE WRIST STRAP CAN CAUSE INJURY TO PERSONS IF A HIGH VOLTAGE SOURCE IS TOUCHED.

- (a) Do the following steps to do a resistance test of the static control wrist strap, COM-1565:
 - 1) Use an digital/analog multimeter, COM-1793 to make sure the static control wrist strap, COM-1565, assembly has a minimum resistance of 250 kilohms and a maximum of 1.5 megohms.
 - 2) Put the static control wrist strap, COM-1565, on the wrist of the person that will remove the squib.
 - 3) Use an digital/analog multimeter, COM-1793 to make sure the resistance is less than 10 megohms.

SUBTASK 20-10-33-480-001

- (4) Connect the static control wrist strap, COM-1565 to an applicable electrostatic ground jack.

SUBTASK 20-10-33-940-003



WARNING

PUT CAPS ON THE BOTTLE SQUIBS AND FLOW VALVE SQUIBS. IF YOU DO NOT PUT CAPS ON THE SQUIBS, THE SQUIBS CAN FIRE ACCIDENTALLY AND CAUSE INJURIES TO PERSONNEL.

- (5) Stray voltage on the airplane can cause the squib to discharge. Make sure any stray voltage is discharged before you remove the aircraft electrical connector.

SUBTASK 20-10-33-020-001



WARNING

MAKE SURE THAT ELECTRICAL POWER IS DEACTIVATED. THIS WILL PREVENT SHOCK AND INJURY TO THE PERSONNEL.

- (6) Remove the electrical connector.

SUBTASK 20-10-33-480-002

- (7) Make sure the shorting or faraday cap, STD-1168 (protective cap) is installed on the squib whenever the airplane electrical connector is removed from the squib.

SUBTASK 20-10-33-940-004

- (8) After the shorting or faraday cap, STD-1168 (protective cap) is attached to the squib, the wrist strap may be removed.

————— END OF TASK —————

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TASK 20-10-33-400-801

3. Power Device Cartridge (Squib) Installation

A. References

Reference	Title
24-22-00-860-802	Remove Electrical Power (P/B 201)

B. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

Reference	Description
COM-1565	Wrist Strap - Adjustable, Conductive, Static Control Part #: 09070 Supplier: 62576 Part #: 2214 Supplier: 62576 Opt Part #: 14810 Supplier: 62576 Opt Part #: 2211 Supplier: 55203 Opt Part #: 2212 Supplier: 55203 Opt Part #: 2213 Supplier: 55203
COM-1793	Multimeter - Digital/Analog (or equivalent meter meets task requirements) Part #: 117 Supplier: 89536 Part #: 260-8XPI Supplier: 55026 Part #: 287 Supplier: 89536 Part #: 289 Supplier: 89536 Part #: 87V Supplier: 89536 Part #: FLUKE 27 II Supplier: 89536 Part #: FLUKE-77-4 Supplier: 89536 Opt Part #: 187 Supplier: 89536 Opt Part #: 189 Supplier: 89536 Opt Part #: 21 Supplier: 89536 Opt Part #: 27 Supplier: 89536 Opt Part #: 77 SERIES III Supplier: 89536 Opt Part #: 87 Supplier: 89536 Opt Part #: FLUKE 27 Supplier: 89536 Opt Part #: MODEL 27 Supplier: 89536
STD-1168	Cap - Shorting or Faraday Cap

C. Procedure

SUBTASK 20-10-33-940-005

- (1) Make sure you remove electrical power before you install the squib, do this task: Remove Electrical Power, TASK 24-22-00-860-802.

SUBTASK 20-10-33-940-006

- (2) Wear a static control wrist strap, COM-1565 during the installation of the squib.

SUBTASK 20-10-33-760-002



USE A WRIST STRAP WITH A MINIMUM GROUNDING LEAD RESISTANCE OF 250 KILOHMS AND A MAXIMUM OF 1.5 MEGOHMS. USE OF A LOW RESISTANCE WRIST STRAP CAN CAUSE INJURY TO PERSONS IF A HIGH VOLTAGE SOURCE IS TOUCHED.

- (3) Do these steps to do a resistance test of the static control wrist strap, COM-1565:

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- (a) Use an digital/analog multimeter, COM-1793 to make sure the static control wrist strap, COM-1565, assembly has a minimum resistance of 250 kilohms and a maximum of 1.5 megohms.
- (b) Put the static control wrist strap, COM-1565, on the wrist of the person that will install the squib.
- (c) Use an digital/analog multimeter, COM-1793 to make sure the resistance is less than 10 megohms.

SUBTASK 20-10-33-480-003

- (4) Connect the static control wrist strap, COM-1565 to an applicable electrostatic ground jack.

SUBTASK 20-10-33-940-007

 WARNING	PUT CAPS ON THE BOTTLE SQUIBS AND FLOW VALVE SQUIBS. IF YOU DO NOT PUT CAPS ON THE SQUIBS, THE SQUIBS CAN FIRE ACCIDENTALLY AND CAUSE INJURIES TO PERSONNEL.

- (5) Make sure the shorting or faraday cap, STD-1168 (protective cap) is installed on the squib whenever the airplane electrical connector is removed from the squib.

SUBTASK 20-10-33-480-004

- (6) Stray voltage on the airplane can cause the squib to discharge. Make sure any stray voltage is discharged before you install the aircraft electrical connector.

SUBTASK 20-10-33-420-001

- (7) Remove the shorting or faraday cap, STD-1168 (protective cap) and install the electrical connector.

SUBTASK 20-10-33-940-008

- (8) After the electrical connector is installed, the static control wrist strap, COM-1565 may be removed.

———— **END OF TASK** ————

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METAL SURFACES - CLEANING/PAINTING

1. General

- A. Use this procedure for faying surface bonds and bonding jumper installation. Do not use abrasives or wire brushes on CRES, plated surfaces, or clad aluminum that is not painted.
- B. This procedure is for cleaning by one of the following methods:
 - (1) Hand Clean Metal Surfaces with Abrasives.
 - (2) Clean Metal Surface with a Rotary Bonding Brush.
 - (3) Clean with a Rotary Abrasive Disk.
 - (4) Remove Paint from Metal Surfaces with solvent, B00139 or solvent, B00083.
 - (5) Clean Bare, Clad, or Plated Metal with solvent, B00139.

TASK 20-10-34-120-801

2. Hand Clean Metal Surfaces with Abrasives

A. **General**

- (1) Do not use abrasives on plated surfaces, clad aluminum, or CRES that is not painted.
- (2) This is the only procedure you can use to clean titanium.

B. **Consumable Materials**

Reference	Description	Specification
B00062	Solvent - Acetone (99.5% Grade)	ASTM D 329 (Supersedes O-A-51)
G00034	Cotton Wiper - Process Cleaning Absorbent Wiper (Cheesecloth, Gauze)	AMS3819 Class 1 Grade A or B Form 1 (Supersede BMS15-5 CLA)

C. **Procedure**

SUBTASK 20-10-34-100-001

- (1) Make the surface wet with solvent, B00062 and wipe or scrub the surface with a cotton wiper, G00034
 - (a) Spray or flow the solvent, B00062 on the surface to assist in cleaning or rinsing.
 - (b) Wipe up the excessive solvent and allow the surface to drain dry.

SUBTASK 20-10-34-120-001



CAUTION

DO NOT LET PARTICLES FROM THE ABRASIVE CAUSE CONTAMINATION OF THE MECHANISMS OR ELECTRICAL EQUIPMENT. DAMAGE CAN OCCUR.

- (2) Manually use a circular or elliptical movement of the abrasive to get an equally smooth surface.

SUBTASK 20-10-34-100-002

- (3) Make the surface wet with solvent, B00062 and wipe or scrub the surface with a cotton wiper, G00034

———— **END OF TASK** ————

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TASK 20-10-34-140-801

3. **Clean Metal Surfaces with a Rotary Bonding Brush**

(Figure 701)

A. General

- (1) Use this procedure to remove paint from metal or to remove Alodine, Iridite, or light anodize from aluminum. Do not use a bonding brush on plated surfaces or on metals that are not painted, for example, CRES, titanium, or clad aluminum. Clean these surfaces with solvent.

B. Consumable Materials

Reference	Description	Specification
B00062	Solvent - Acetone (99.5% Grade)	ASTM D 329 (Supersedes O-A-51)
B00102	Abrasive - Aluminum Oxide Coated Cloth	AMS3819 Class 1 Grade A or B Form 1 (Supersede BMS15-5 CLA)
G00034	Cotton Wiper - Process Cleaning Absorbent Wiper (Cheesecloth, Gauze)	

C. Procedure

SUBTASK 20-10-34-930-001

- (1) Identify the bonding brush housings by color.

NOTE: The colors show which bonding brush housings you will use on which metal. The chart below gives color codes for identification of bonding brushes for individual metals.

Table 701/20-10-34-993-801

BONDING BRUSH COLOR CODE		
METAL	COLOR CODE	COLOR IDENTIFICATION
Aluminum	None	None
Ferritic	Blue	J7-42-5200
Magnesium	Green	J7-42-5700
Beryllium	Brown	J7-42-5400

SUBTASK 20-10-34-140-001



CAUTION

DO NOT USE CARBON STEEL BONDING BRUSHES. STEEL PARTICLES ON METAL SURFACES CAN CAUSE CORROSION.

- (2) Use a drill motor or other applicable drive to apply a stainless steel bonding brush of the correct size to clean the necessary diameter.
- (a) Apply brush intermittently and keep the cutting face parallel with the surface.
- (b) Examine results after each time you apply the brush and continue operation until necessary area is clean.

NOTE: Keep the decrease in surface metal to a minimum.

- (c) If it is a problem to get through an anodic film, clean it with abrasive cloth, B00102.

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SUBTASK 20-10-34-100-003

- (3) Make the surface wet with solvent, B00062 and wipe or scrub the surface using a cotton wiper, G00034.
- (a) Spray or flow the solvent, B00062 on the surface to assist in cleaning or rinsing.
- (b) Wipe up the excessive solvent and allow the surface to drain dry.

———— END OF TASK ————

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BRUSH OR DISK DIA. (INCH)	PILOT DIA. (INCH)	SHANK DIA. (INCH)	BONDING BRUSHES			
			WIRE SIZE (INCH)		OSBORN NO.	MORRIS NO.
			MAX	MIN		
11/32	1/4	1/4	0.005	0.004		
1/2	3/32	1/4	0.005	0.004	94-SV-37	P-31-SS
1/2	1/8	1/4	0.005	0.004	94-SV-47	P-32-SS
1/2	5/32	1/4	0.005	0.004	94-SV-48	P-33-SS
1/2	3/16	1/4	0.005	0.004	94-SV-36	P-34-SS
3/4	3/16	1/4	0.006	0.005		P-31-516-SS
3/4	1/4	1/4	0.006	0.005		P-31-517-SS
3/4	5/16	1/4	0.006	0.005		P-31-53-SS
1.0	3/16	1/4	0.008	0.006		P-36-SS
1.0	1/4	1/4	0.008	0.006		P-36-S1-SS
1.0	5/16	1/4	0.008	0.006		P-36-S5-SS

BONDING BRUSHES			DISK MANDRELS
BRUSH OR DISK DIA. (INCH)	MANUFAC- TURERS BRUSH CO.	BOEING ST NO.	BOEING ST NO.
11/32		ST913K-34-24	ST913M-34-24
1/2	220-NN	ST913K-50-09	ST913M-50-09
1/2	221-NN	ST913K-50-12	ST913M-50-12
1/2	222-NN	ST913M-50-16	ST913M-50-16
1/2	223-NN	ST913M-50-19	ST913M-50-19
3/4	224-NN	ST913K-75-19	ST913M-75-19
3/4	225-NN	ST913K-75-25	ST913M-75-25
3/4	226-NN	ST913K-75-31	ST913M-75-31
1.0	227-NN	ST913K-100-19	ST913M-100-19
1.0	228-NN	ST913K-100-25	ST913M-100-25
1.0	229-NN	ST913K-100-31	ST913M-100-31

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**Rotary Bonding Brushes and Abrasive Disk Mandrels
Figure 701/20-10-34-990-801**

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TASK 20-10-34-120-802

4. Clean with a Rotary Abrasive Disk

(Figure 701)

A. General

- (1) Use this task to remove anodize, Iridite, Alodine, BMS 3-11 resistant finish, or equivalent hard finishes that are not painted. You can also remove paint with this task, but the disk will become quickly clogged.
- (2) Do not use this procedure on plated surfaces or metals that are not painted, for example, CRES, titanium, or clad aluminum.

B. Consumable Materials

Reference	Description	Specification
B00062	Solvent - Acetone (99.5% Grade)	ASTM D 329 (Supersedes O-A-51)
B00102	Abrasive - Aluminum Oxide Coated Cloth	
G00034	Cotton Wiper - Process Cleaning Absorbent Wiper (Cheesecloth, Gauze)	AMS3819 Class 1 Grade A or B Form 1 (Supersede BMS15-5 CL A)

C. Procedure

SUBTASK 20-10-34-120-002



DO NOT LET PARTICLES FROM THE ABRASIVE CAUSE CONTAMINATION OF THE MECHANISMS OR ELECTRICAL EQUIPMENT. DAMAGE CAN OCCUR.

- (1) Use a drill motor or other applicable drive to apply an abrasive disk (abrasive cloth, B00102) of correct size to clean the necessary diameter.
 - (a) Apply the disk intermittently with light pressure and keep the face of the disk parallel to the metal surface.
 - (b) Examine results after each time you apply the disk and continue operation until necessary area is clean.

NOTE: Keep the decrease in surface metal to minimum.

SUBTASK 20-10-34-100-004

- (2) Make the surface wet with solvent, B00062 and wipe or scrub the surface with a cotton wiper, G00034

————— END OF TASK —————

TASK 20-10-34-110-801

5. Remove Paint from Metal Surfaces with Lacquer Thinner or Solvent

A. General

- (1) Use this procedure to remove lacquer-based primer or enamel from clad aluminum or other metal surfaces. Do not use lye, alkaline paint remover, or hydroxides to clean surfaces.

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B. Consumable Materials

Reference	Description	Specification
B00068	Alcohol - Denatured, Ethyl (Ethanol)	AMS 3002, MIL-E-51454 Type II
B00139	Solvent - Lacquer Thinner	A-A-857
G00034	Cotton Wiper - Process Cleaning Absorbent Wiper (Cheesecloth, Gauze)	AMS3819 Class 1 Grade A or B Form 1 (Supersede BMS15-5 CL A)

C. Remove Paint

SUBTASK 20-10-34-110-001



DO NOT GET SOLVENTS IN YOUR MOUTH, YOUR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM SOLVENTS. SOLVENTS ARE DANGEROUS MATERIALS. SOLVENTS CAN BE FLAMMABLE OR CAUSE DAMAGE TO THE ENVIRONMENT. REFER TO THE MATERIAL SAFETY DATA SHEETS (MSDS) AND THE LOCAL SAFETY PRECAUTIONS.

- (1) Apply solvent, B00139 or alcohol, B00068 to the specified area with a cotton wiper, G00034.

SUBTASK 20-10-34-110-002

- (2) Use a clean part of the cloth each time you apply solvent to the surface.
(a) Make sure you do not get solvent on adjacent surfaces.

SUBTASK 20-10-34-110-003

- (3) When the specified area is fully clean, immediately rub dry with cotton wiper, G00034.

————— END OF TASK —————

TASK 20-10-34-110-802

6. Clean Bare, Clad, or Plated Metal with Solvent

A. General

- (1) Use this procedure to clean plated surfaces and CRES, titanium, or clad aluminum that is not painted.

B. Consumable Materials

Reference	Description	Specification
B00083	Solvent - VM&P Naphthas	TT-N-95 Type II, ASTM D-3735 Type III
B00130	Alcohol - Isopropyl	TT-I-735
G00034	Cotton Wiper - Process Cleaning Absorbent Wiper (Cheesecloth, Gauze)	AMS3819 Class 1 Grade A or B Form 1 (Supersede BMS15-5 CL A)
G02439	Brush - Nylon Bristle	

C. Procedure

SUBTASK 20-10-34-110-004

- (1) Apply solvent, B00083 or alcohol, B00130 to the surfaces with a cotton wiper, G00034.

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SUBTASK 20-10-34-110-005

- (2) Rub with the necessary force to remove contamination you can see.

NOTE: A brush, G02439 dampened with solvent can be used to help loosen contamination from the surface.

SUBTASK 20-10-34-110-006

- (3) Immediately dry surfaces with a clean cotton wiper, G00034.

———— **END OF TASK** ————

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Fiber Optics - Maintenance Practices

1. General

- A. This task shows how to do a check on a fiber-optic cable for light loss.

TASK 20-10-35-200-801

2. Fiber Optic Cable - Detailed Inspection

(Figure 201, Figure 202, Figure 203)

A. General

- (1) You have to do the light loss check for both directions on the fiber-optic cable.
- (2) In this task, the term "Cable Under Test" is for the target fiber-optic cable in the light loss check.
- (3) These are the necessary tools to do this task:
 - (a) Stabilized Light Source (SLS) - 850/1300 nm wavelength optical light source, COM-11205
 - (b) Optical Power Meter (OPM) - 850/1300 nm wavelength optical power meter, COM-11206
 - (c) Source Test cable - SC-SC source test cable, COM-11246

NOTE: The Source Test cable is a SC cable that is connected to the light source during the reference measurement. It stays connected to the light source for the remaining of the test procedure.

- (d) Receive Test cable - SC-SC source test cable, COM-11246

NOTE: The Receive Test cable is a SC cable that is connected to the light meter during the reference measurement.

- (e) SC-SC multimode fiber optic adapter, COM-11245

NOTE: A SC adapter is used to connect two SC type cables.

- (f) Breakout Test Assemblies:

- 1) There are two breakout test assemblies: Breakout Test Assembly-A and Breakout Test Assembly-B. One breakout test assembly is needed for each end of the fiber-optic Cable Under Test.
- 2) A breakout test assembly is constructed by one of these configurations:
 - a) For ARINC 600 type connectors, use an applicable Breakout box and a SC-SC source test cable, COM-11246.

NOTE: These LRUs have the ARINC 600 type connector:

DPC - Display Processing Computer
HUD - Head-Up Display

B. References

Reference	Title
SWPM 20-12-20	BACC69A FIBER OPTIC CABLE ASSEMBLIES

C. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

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Reference	Description
COM-11205	Light Source - Optical, 850/1300 nm Wavelength Part #: SLS525 Supplier: 88N44 Opt Part #: 252A Supplier: 0XY53 Opt Part #: 570XL-SC Supplier: 333V3
COM-11206	Power Meter - Optical, 850/1300 nm Wavelength Part #: OPM510 Supplier: 88N44 Opt Part #: 555B Supplier: 0XY53 Opt Part #: 560XL Supplier: 333V3
COM-11245	Adapter - Fiber Optic, SC-SC Multimode Part #: F-28SM-03 Supplier: 0LDN2 Opt Part #: F-28SM-01 Supplier: 0LDN2
COM-11246	Test Cable - Source, SC-SC Part #: F0808MT1-A01-003.3 Supplier: 92607
COM-15047	Adapter - Snap On Connector, SC Part #: 1062 Supplier: 333V3
SPL-11784	Adapter Cable - Fiber Optic (BACC68E15C06N) Part #: CIT-BFTA100-A34-060 Supplier: 92607
SPL-14575	Breakout Box - Fiber Optic, ARINC 600 Connector (Display Processing Computer) Part #: J46002-16 Supplier: 81205
SPL-14897	Breakout Box - Fiber Optic, ARINC 600 Connector (Head-Up Display) Part #: J46002-17 Supplier: 81205

D. Prepare for the Inspection

SUBTASK 20-10-35-860-001

- (1) Remove the electrical power to the Line Replaceable Unit (LRU) at the two ends of the Cable Under Test.

SUBTASK 20-10-35-860-002

- (2) Make sure that all test cables and test equipment are clean and in good condition.

E. Measurement of Reference Level.

(Figure 201)

SUBTASK 20-10-35-860-003



MAKE SURE THAT THE FIBER-OPTIC CONNECTOR AND RECEPTACLE ARE CLEAN WHEN YOU CONNECT THEM. DIRTY CONNECTORS CAN CAUSE DAMAGE TO EQUIPMENT.

- (1) Examine the fiber-optic connectors for damage and contamination.
 - (a) For the inspection and cleaning of fiber-optic connectors, refer to SWPM 20-12-20.

SUBTASK 20-10-35-420-001

- (2) Connect the Source Test cable (SC-SC source test cable, COM-11246) to the 850/1300 nm wavelength optical light source, COM-11205.

SUBTASK 20-10-35-420-002

- (3) Use a SC-SC multimode fiber optic adapter, COM-11245 to connect the Source Test cable to the Receive Test cable (SC-SC source test cable, COM-11246).

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SUBTASK 20-10-35-420-003

- (4) Connect the other end of the Receive Test cable (SC-SC source test cable, COM-11246) to the SC snap on connector adapter, COM-15047 then connect to the 850/1300 nm wavelength optical power meter, COM-11206.

SUBTASK 20-10-35-860-004

- (5) Turn on power to the 850/1300 nm wavelength optical light source, COM-11205 and 850/1300 nm wavelength optical power meter, COM-11206.

SUBTASK 20-10-35-860-005

- (6) Select operating wavelength (850 nm) of the system to test on both instruments.
- (7) Allow both instruments to stabilize for a minimum of 2 minutes.

SUBTASK 20-10-35-860-006

- (8) Set the reference level to 0.00 dB in accordance with the operating instructions for the 850/1300 nm wavelength optical power meter, COM-11206.

SUBTASK 20-10-35-020-001



DO NOT LOOK INTO THE END OF A FIBER-OPTIC CABLE. THERE IS A RISK OF LASER RADIATION, WHICH YOU WILL NOT SEE. LASER RADIATION IS DANGEROUS FOR YOUR EYES.



INSTALL THE PROTECTIVE CAPS IMMEDIATELY AFTER YOU DISCONNECT THE CABLE. IT IS EASY TO CAUSE DAMAGE TO THE FIBER-OPTIC CABLE.



DO NOT PULL OR TWIST THE FIBER-OPTIC CABLE WITH A STRONG OR A SUDDEN FORCE. DAMAGE TO THE CABLE OR THE CONNECTOR CAN OCCUR.



DO NOT BEND THE FIBER-OPTIC CABLE MORE THAN THE MINIMUM BEND RADIUS. THE CABLE IS EASILY DAMAGED.

- (9) Disconnect the Receive Test cable from the SC-SC multimode fiber optic adapter, COM-11245.
 - (a) Do not turn off the power on the 850/1300 nm wavelength optical light source, COM-11205 or the 850/1300 nm wavelength optical power meter, COM-11206.
 - (b) Do not disconnect the Source Test cable from the 850/1300 nm wavelength optical light source, COM-11205.

NOTE: Keep the Source Test cable connected to the 850/1300 nm wavelength optical light source, COM-11205 to stabilize the light source.

NOTE: The 850/1300 nm wavelength optical light source, COM-11205, Source Test cable and SC adapter should stay connected together throughout the test.

SUBTASK 20-10-35-020-002

- (10) Disconnect the Receive Test cable from the 850/1300 nm wavelength optical power meter, COM-11206.

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F. Measurement of Light Loss in One Direction

(Figure 202)

SUBTASK 20-10-35-020-003



WARNING

DO NOT LOOK INTO THE END OF A FIBER-OPTIC CABLE. THERE IS A RISK OF LASER RADIATION, WHICH YOU WILL NOT SEE. LASER RADIATION IS DANGEROUS FOR YOUR EYES.



WARNING

ALWAYS USE GLOVES IF YOU MUST TOUCH BROKEN FIBER-OPTIC CABLES. IF YOU TOUCH CABLES WITH YOUR BARE HANDS, FIBERS CAN GO INTO YOUR BODY THROUGH YOUR SKIN. THIS WILL CAUSE YOU INJURY.



CAUTION

INSTALL THE PROTECTIVE CAPS IMMEDIATELY AFTER YOU DISCONNECT THE CABLE. IT IS EASY TO CAUSE DAMAGE TO THE FIBER-OPTIC CABLE.



CAUTION

DO NOT PULL OR TWIST THE FIBER-OPTIC CABLE WITH A STRONG OR A SUDDEN FORCE. DAMAGE TO THE CABLE OR THE CONNECTOR CAN OCCUR.



CAUTION

DO NOT BEND THE FIBER-OPTIC CABLE MORE THAN THE MINIMUM BEND RADIUS. THE CABLE IS EASILY DAMAGED.

- (1) Disconnect the connectors at the two ends of the Cable Under Test.
 - (a) If necessary, remove the LRU(s) at the two ends of the Cable Under Test.
 - 1) Refer to the AMM for the removal procedure(s) for the applicable LRU(s).

SUBTASK 20-10-35-860-007



CAUTION

MAKE SURE THAT THE FIBER-OPTIC CONNECTOR AND RECEPTACLE ARE CLEAN WHEN YOU CONNECT THEM. DIRTY CONNECTORS CAN CAUSE DAMAGE TO EQUIPMENT.

- (2) Examine the fiber-optic connectors for damage and contamination.
 - (a) For the inspection and cleaning of fiber-optic connectors on the airplane side, refer to SWPM 20-12-20.

SUBTASK 20-10-35-420-004

- (3) Connect the Breakout Test Assembly-A to one end of the Cable Under Test.
 - (a) Do these steps to test the Breakout Test Assembly-A for ARINC 600 type connector:

NOTE: In this case, the Breakout Test Assembly-A is an assembly of a correct Breakout box from the "Fiber Optic Breakout Box for ARINC 600 Connectors" table and a SC-SC source test cable, COM-11246.

 - 1) Select the correct Breakout box from Table 201:

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Table 201/20-10-35-993-804 Fiber Optic Breakout Box for ARINC 600 Connectors

Connector Location	Breakout Box
Display Processing Computer (DPC)	fiber optic breakout box, SPL-14575
Head-Up Display (HUD)	HUD fiber optic breakout box, SPL-14897

- 2) Connect a SC-SC source test cable, COM-11246 to the correct pin on the Breakout box.
- 3) Connect the Breakout box to the Cable Under Test.
 - a) Insert the Breakout box into the slot for the LRU that removed.

SUBTASK 20-10-35-420-005

- (4) Connect the Breakout Test Assembly-B to the other end of cable under test.
 - (a) Do the following steps to test the Breakout Test Assembly-B for Non - ARINC 600 type connector.

NOTE: In this case, the Breakout Test Assembly-B is an assembly of the correct cable from the "Fiber Optic Breakout Cable for Non - ARINC 600 Connectors".

- 1) Select the correct Breakout Cable from Table 202:

Table 202/20-10-35-993-810 Fiber Optic Breakout Cable for Non-ARINC 600 Connectors

Connector Location:	Breakout Cable:
Capt & F/O Outboard/Inboard Display	fiber optic adapter cable, SPL-11784
Head-Up Display Overhead Unit	fiber optic adapter cable, SPL-11784

- 2) Connect a SC-SC source test cable, COM-11246 to the correct pin on the Breakout cable.
- 3) Connect the Breakout cable to the Cable Under Test.

SUBTASK 20-10-35-420-006

- (5) Connect the Breakout Test Assembly-A to the SC adapter, Source Test cable and 850/1300 nm wavelength optical light source, COM-11205 assembly.
 - (a) Make sure that you connect the correct pin on the Breakout Test Assembly-A.

NOTE: A test cable assembly may have many channels or cables associated with the pins on the connector.

SUBTASK 20-10-35-420-007

- (6) Connect the other end of Breakout Test Assembly-B to the 850/1300 nm wavelength optical power meter, COM-11206.

SUBTASK 20-10-35-860-008

- (7) Record the light loss in dB on the display of the 850/1300 nm wavelength optical power meter, COM-11206.

SUBTASK 20-10-35-860-009

- (8) Evaluate the recorded light loss. Refer to the "Evaluate the Light Loss Measurement" section.
 - (a) If the recorded light loss is less than 2 dB or less than the maximum permitted limit, continue to the "Measure Light Loss in the Opposite Direction" section.

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G. Measure Light Loss in the Opposite Direction

SUBTASK 20-10-35-860-010

- (1) Make sure that you do not disconnect the Breakout Test Assembly-A and the Breakout Test Assembly-B from the Cable Under Test.

SUBTASK 20-10-35-020-004



DO NOT LOOK INTO THE END OF A FIBER-OPTIC CABLE. THERE IS A RISK OF LASER RADIATION, WHICH YOU WILL NOT SEE. LASER RADIATION IS DANGEROUS FOR YOUR EYES.



DO NOT PULL OR TWIST THE FIBER-OPTIC CABLE WITH A STRONG OR A SUDDEN FORCE. DAMAGE TO THE CABLE OR THE CONNECTOR CAN OCCUR.



INSTALL THE PROTECTIVE CAPS IMMEDIATELY AFTER YOU DISCONNECT THE CABLE. IT IS EASY TO CAUSE DAMAGE TO THE FIBER-OPTIC CABLE.

- (2) Disconnect the Breakout Test Assembly-A from the SC adapter.
 - (a) Make sure to keep the SC adapter, the Source Test cable and the 850/1300 nm wavelength optical light source, COM-11205 connected together.

SUBTASK 20-10-35-860-011

- (3) Move the SC adapter, Source Test cable and the 850/1300 nm wavelength optical light source, COM-11205 to the opposite end of the Cable Under Test.

SUBTASK 20-10-35-020-005



DO NOT LOOK INTO THE END OF A FIBER-OPTIC CABLE. THERE IS A RISK OF LASER RADIATION, WHICH YOU WILL NOT SEE. LASER RADIATION IS DANGEROUS FOR YOUR EYES.



DO NOT PULL OR TWIST THE FIBER-OPTIC CABLE WITH A STRONG OR A SUDDEN FORCE. DAMAGE TO THE CABLE OR THE CONNECTOR CAN OCCUR.

- (4) Disconnect the 850/1300 nm wavelength optical power meter, COM-11206 from the Breakout Test Assembly-B.

SUBTASK 20-10-35-420-008



MAKE SURE THAT THE FIBER-OPTIC CONNECTOR AND RECEPTACLE ARE CLEAN WHEN YOU CONNECT THEM. DIRTY CONNECTORS CAN CAUSE DAMAGE TO EQUIPMENT.

- (5) Connect the Breakout Test Assembly-B to the SC adapter, Source Test cable and 850/1300 nm wavelength optical light source, COM-11205.

SUBTASK 20-10-35-860-012

- (6) Move the 850/1300 nm wavelength optical power meter, COM-11206 to the opposite end of Cable Under Test.

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SUBTASK 20-10-35-420-009



CAUTION

MAKE SURE THAT THE FIBER-OPTIC CONNECTOR AND RECEPTACLE ARE CLEAN WHEN YOU CONNECT THEM. DIRTY CONNECTORS CAN CAUSE DAMAGE TO EQUIPMENT.

- (7) Connect the 850/1300 nm wavelength optical power meter, COM-11206 to the Breakout Test Assembly-A.

SUBTASK 20-10-35-860-013

- (8) Record the light loss in dB on the display of the 850/1300 nm wavelength optical power meter, COM-11206.

SUBTASK 20-10-35-860-014

- (9) Evaluate the recorded light loss. Refer to the "Evaluate the Light Loss Measurement" section.

H. Evaluate the Light Loss Measurement

(Figure 203)

SUBTASK 20-10-35-860-015

- (1) Make sure that the measured light loss is less than 2 dB.

NOTE: When measuring a concatenated or non-concatenated cable assembly, 2 dB or less is the permitted light loss. If the light loss is more than 2 dB, the maximum permitted limit must be calculated.

- (a) If the light loss is more than 2 dB, do these steps to calculate the maximum permitted loss:

- 1) Add together the number of connectors in the cable under test and connectors on test cable assemblies used.
- 2) Divide the number of connectors by 2 to get the number of mated pairs.
- 3) If Configuration 1 or Configuration 2 is used for Breakout Test Assembly-A, add one mated pair.

NOTE: This additional mated pair is for the connection between the Breakout box and the SC cable.

- 4) If Configuration 1 or Configuration 2 is used for Breakout Test Assembly-B, add one mated pair.

NOTE: This additional mated pair is for the connection between the Breakout box and the SC cable.

- 5) If the total number of the mated pairs is equal or less than 3, then the light loss is failed.

NOTE: Only calculate the maximum permitted limit when the total number of the mated pairs is equal or more than four.

- 6) Multiply the number of measured mated pairs by 0.5 dB.

NOTE: The allowed light loss for each mated pair of multi-mode connectors, taking into account measurement inaccuracy, is 0.5 dB.

- 7) Add 0.4 dB as an uncertainty factor to get the maximum permitted limit.
- 8) Make sure that the measured light loss is less than the maximum permitted limit.

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I. Put the Airplane Back to Its Usual Condition

SUBTASK 20-10-35-860-016

- (1) Turn off power to the 850/1300 nm wavelength optical light source, COM-11205 and 850/1300 nm wavelength optical power meter, COM-11206.

SUBTASK 20-10-35-020-006



DO NOT LOOK INTO THE END OF A FIBER-OPTIC CABLE. THERE IS A RISK OF LASER RADIATION, WHICH YOU WILL NOT SEE. LASER RADIATION IS DANGEROUS FOR YOUR EYES.



INSTALL THE PROTECTIVE CAPS IMMEDIATELY AFTER YOU DISCONNECT THE CABLE. IT IS EASY TO CAUSE DAMAGE TO THE FIBER-OPTIC CABLE.



DO NOT PULL OR TWIST THE FIBER-OPTIC CABLE WITH A STRONG OR A SUDDEN FORCE. DAMAGE TO THE CABLE OR THE CONNECTOR CAN OCCUR.

- (2) Disconnect all test cable assemblies from the fiber-optic cable under test.

SUBTASK 20-10-35-860-017



MAKE SURE THAT THE FIBER-OPTIC CONNECTOR AND RECEPTACLE ARE CLEAN WHEN YOU CONNECT THEM. DIRTY CONNECTORS CAN CAUSE DAMAGE TO EQUIPMENT.



DO NOT BEND THE FIBER-OPTIC CABLE MORE THAN THE MINIMUM BEND RADIUS. THE CABLE IS EASILY DAMAGED.

- (3) Make sure that you inspect all fiber-optic connectors and/or LRU(s) before you make a connection.
 - (a) For the inspection of the fiber-optic connectors on the airplane side, refer to SWPM 20-12-20.

SUBTASK 20-10-35-420-010

- (4) Connect the connectors at the two end of the Cable Under Test to the airplane.
 - (a) If you removed the LRU(s) at the end(s) of the Cable Under Test, install the LRU(s).
 - 1) Refer to the AMM for the installation procedures of the applicable LRU(s).

———— **END OF TASK** ————

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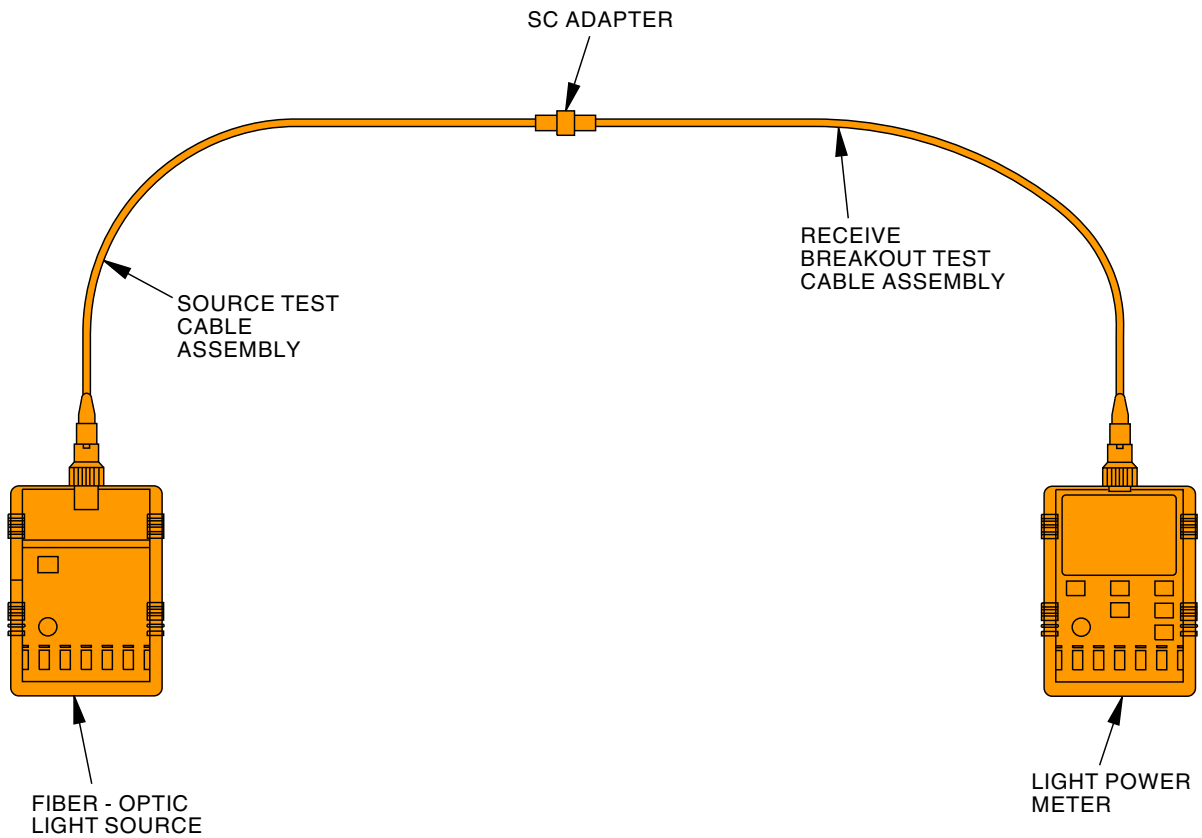
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2500897 S0000587626_V1

Reference Level Measurement
Figure 201/20-10-35-990-801

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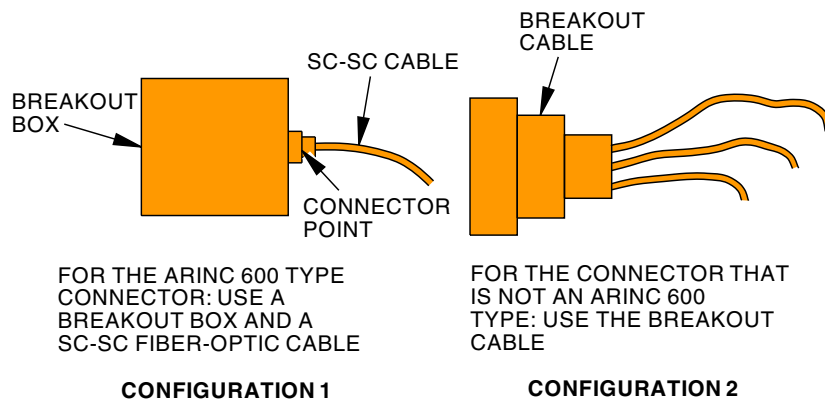
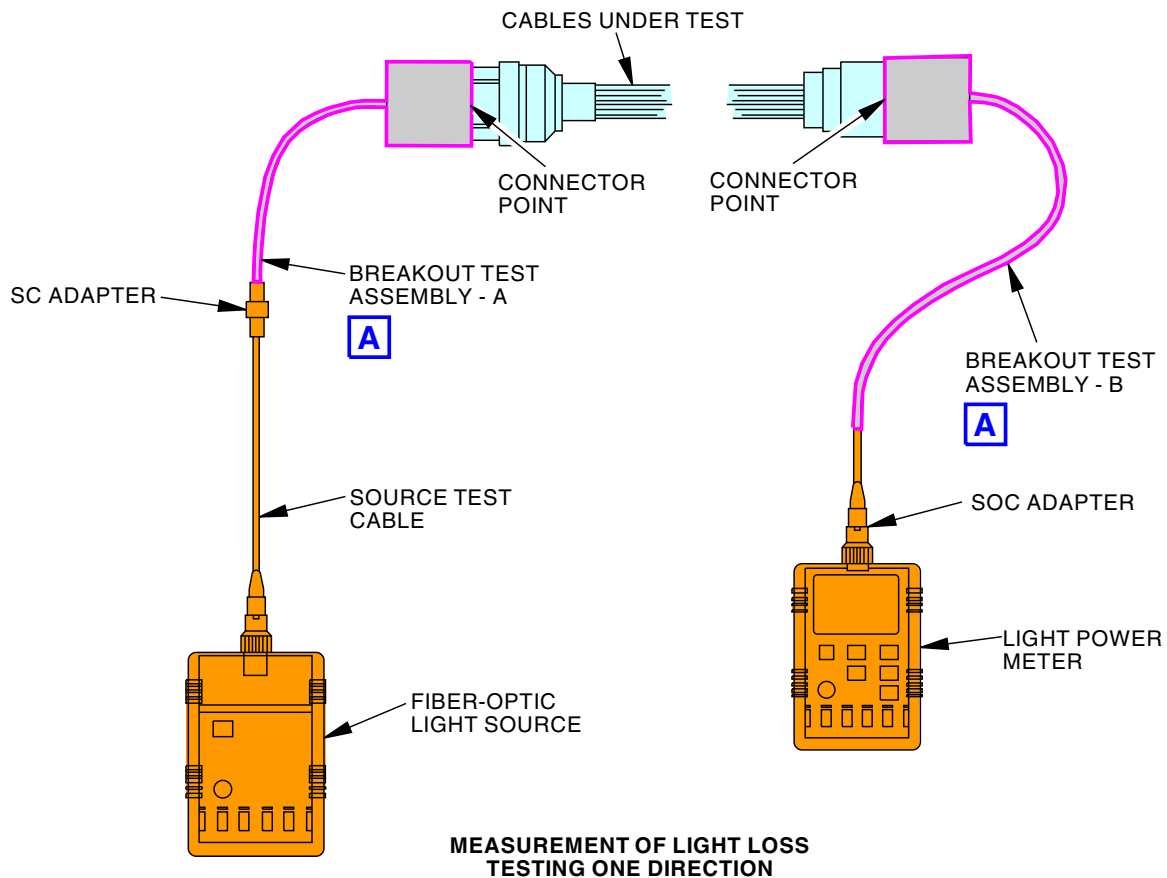
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BREAKOUT TEST ASSEMBLY - A OR B

A

2500898 S0000587627_V3

**Measurement of Light Loss
Figure 202/20-10-35-990-802 (Sheet 1 of 2)**

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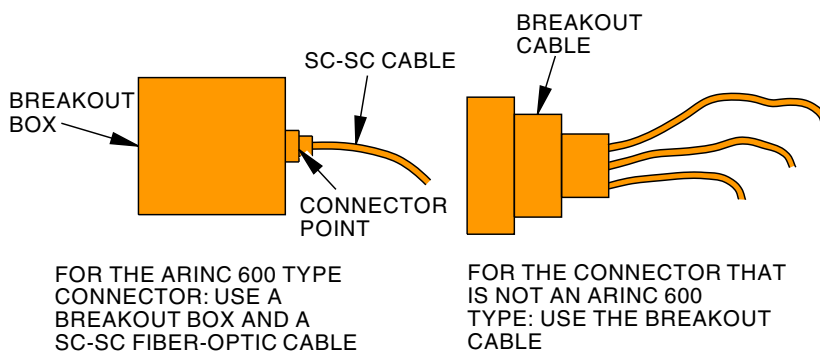
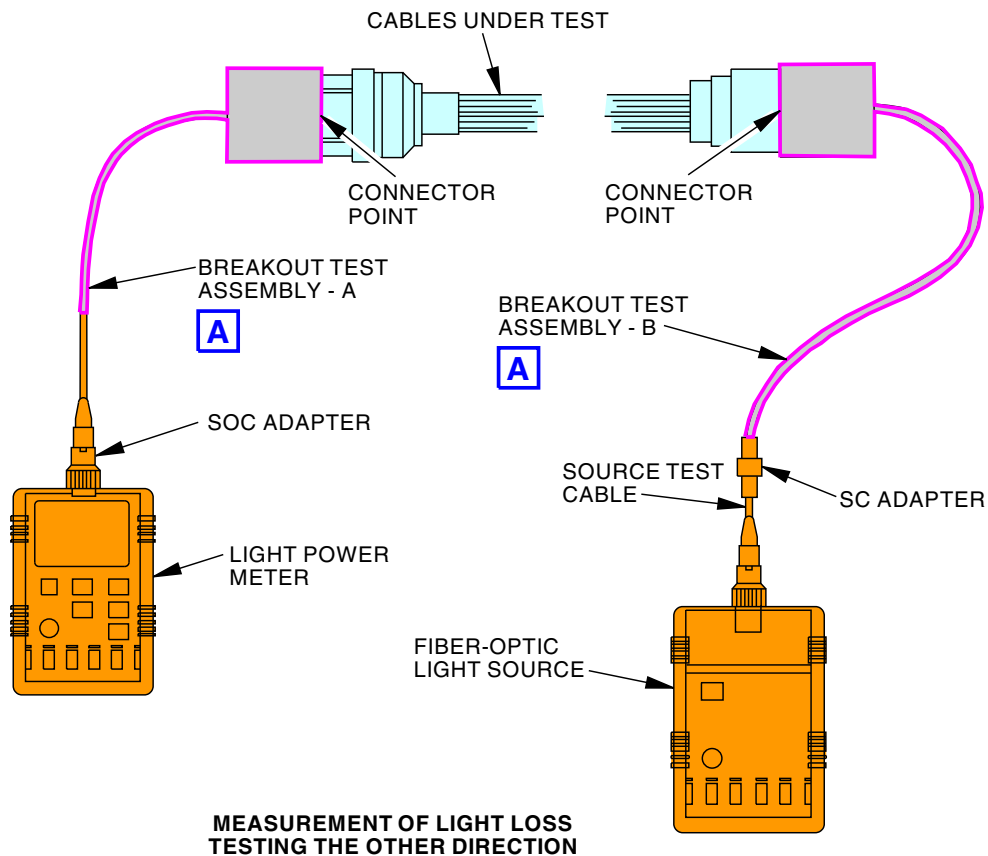
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CONFIGURATION 1

CONFIGURATION 2

BREAKOUT TEST ASSEMBLY - A OR B

A

2500899 S0000587628_V3

Measurement of Light Loss
Figure 202/20-10-35-990-802 (Sheet 2 of 2)

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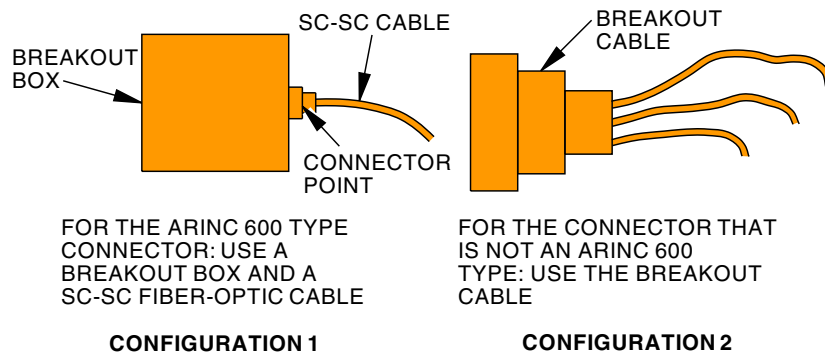
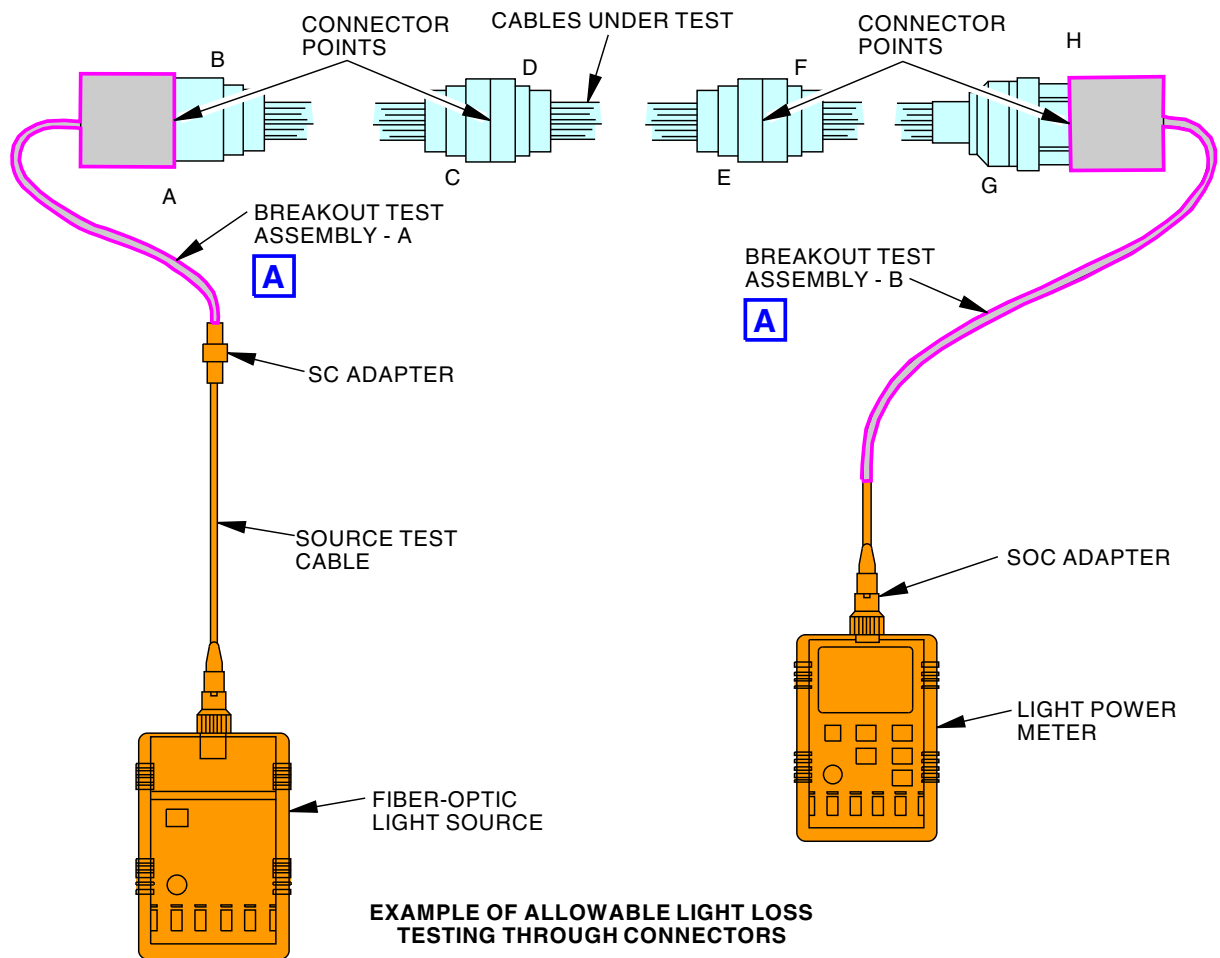
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BREAKOUT TEST ASSEMBLY - A OR B

A

2500900 S0000587630_V3

**Example of Allowable Light Loss Through Connectors
Figure 203/20-10-35-990-803**

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TASK 20-10-35-200-802

3. Fiber Optic Cable on a Module - Special Detailed Inspection

A. General

- (1) This procedure shows you how to examine and clean the fiber-optic connector(s) on these Line Replaceable Unit (LRU):
 - (a) Display Processing Computer (DPC).
 - (b) Captain and First Officer MAX Display System (MDS) display units.
- (2) There are four (4) cleaning procedures:
 - (a) Cleaning fiber-optic end face with dry swab
 - (b) Cleaning fiber-optic end face with wet swab
 - (c) Cleaning fiber-optic end face with cartridge pen
 - (d) Cleaning fiber-optic end face with the CleanBlast cleaning system.

B. References

Reference	Title
SWPM 20-12-21	BACC68A AND BACC68D FIBER OPTIC CONNECTORS
SWPM 20-74-02	ASSEMBLY OF BACI10AL, BACI10AM, AND BACI10AP RECTANGULAR CONNECTOR INSERTS
SWPM 20-74-13	ASSEMBLY OF BACC65AN, BACC65AP, BACC65AV, AND BACC65AW CONNECTORS
SWPM 20-74-14	Assembly of BACC65BJ and BACC65BK Connectors

C. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

Reference	Description
COM-11803	Inspection Tip - Fiber Optic Part #: FBP-737MAX Supplier: 0Z3C6 Part #: FBP-787-1 Supplier: 0Z3C6 Part #: FBPP-BAP3 Supplier: 51190
COM-12161	Inspection and Cleaning Kit - Fiber Optic Part #: FCL-P1000 Supplier: 0Z3C6 Opt Part #: FCL-P1102 Supplier: 0Z3C6
COM-12162	Inspection Guide - LRU, Fiber Optic Part #: FBP-737MAX Supplier: 0Z3C6 Part #: FBP-787-1 Supplier: 0Z3C6 Part #: FBPT-A801-1002R Supplier: 0Z3C6
COM-12163	Inspection Guide - LRU, Fiber Optic Part #: FBP-737MAX Supplier: 0Z3C6 Part #: FBP-787-1 Supplier: 0Z3C6 Part #: FBPT-A801-2001R Supplier: 0Z3C6
COM-12165	Inspection Guide - LRU Shipside Connector, Fiber Optic Part #: FBP-737MAX Supplier: 0Z3C6 Part #: FBP-787-1 Supplier: 0Z3C6 Part #: FBPT-A801-1002P Supplier: 0Z3C6

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Reference	Description
COM-12167	Inspection Guide - LRU Shipline Connector, Fiber Optic Part #: FBP-737MAX Supplier: 0Z3C6 Part #: FBPT-A801-4001P Supplier: 0Z3C6
COM-12492	Display Unit - Inspection, Fiber Optic Part #: FBP-737MAX Supplier: 0Z3C6 Part #: FBP-787-1 Supplier: 0Z3C6 Part #: FBP-HD4I Supplier: 0Z3C6 Opt Part #: FBP-HD1 Supplier: 0Z3C6
COM-12493	Probe - Inspection, Fiber Optic Opt Part #: FBP-P5-IRH Supplier: 0Z3C6
COM-13567	Connector Cleaner - Fiber Optic Part #: 12910 Supplier: 0Z3C6
COM-13669	Patch Cord Tip - Inspection, Fiber Optic (1.25 Mm Generic LC) Part #: FBP-737MAX Supplier: 0Z3C6 Part #: FBP-787-1 Supplier: 0Z3C6 Part #: FBPT-U12M Supplier: 0Z3C6
COM-15076	Microscope - Digital Analysis, Fiber Optic Part #: FBP-737MAX Supplier: 0Z3C6 Part #: FBP-787-1 Supplier: 0Z3C6 Part #: FBP-P5000I Supplier: 51190

D. Consumable Materials

Reference	Description	Specification
B00068	Alcohol - Denatured, Ethyl (Ethanol)	AMS 3002, MIL-E-51454 Type II
B00130	Alcohol - Isopropyl	TT-I-735
B50019	Solvent - Azeotropic Mixture Of HCFC-141b & Methanol - MicroCare Genesolv 2004	
B50234	Solvent - Westover Scientific CleanBlast Solvent, (P/N FCLP-SOL1)	
B50235	Solvent - 3M Novec 72DA Engineered Fluid	
G50641	Swab - ITW Texwipe TX762 Absorbond Swab With Long Handle	
G50642	Swab - ITW Texwipe TX740B Medium CleanFoam Swab With Long Handle	
G50646	Aerosol - Ultrajet Canned Air (ITW Chemtronics - ES1020, Replaces ES1725)	
G50647	Cot - Finger	ASTM D3772, A-A-50855
G50648	Gloves - Rubber Surgical, Powder Free	ASTM D3577
G50915	Aerosol - Ultrajet All-Way Canned Air (ITW Chemtronics - ES1620)	
G50916	Aerosol - Ultrajet 70 Canned Air (ITW Chemtronics - ES1015)	
G50917	Swab - ITW Texwipe TX757B Micro CleanFoam Swab	

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Reference	Description	Specification
G50918	Swab - ITW Texwipe TX758B Micro Alpha Swab	
G50919	Swab - ITW Texwipe TX759B Micro Absorbond Swab	
G50920	Swab - MicroCare WS302 CleanRoom Swab	
G50921	Swab - MicroCare WS301 CleanRoom Swab	
G50922	Swab - MicroCare WS303 CleanRoom Swab	
G50923	Swab - Sticklers CleanStixx, MCC-P25 (Yellow Label)	
G50924	Swab - Sticklers CleanStixx, MCC-S12 (Green Label)	
G50925	Swab - Sticklers CleanStixx, MCC-S16 (Orange Label)	
G50926	Kit - The Light Brigade Fiber Optic Cleaning Kit (P/N E-250)	

E. Prepare for the Inspection

SUBTASK 20-10-35-800-001

(1) Zones at the end face of a fiber-optic contact (Figure 204):

- (a) Zone A - Core
- (b) Zone B - Cladding
- (c) Zone C - Epoxy Bond Line
- (d) Zone D - Ceramic Ferrule.

SUBTASK 20-10-35-800-002

(2) Fiber-optic End Face Damage Definition (Figure 205):

- (a) There are three types of damages:
 - 1) Chip or Pit - Material missing from the end face.
 - 2) Crack - Structural defect that goes into the material of the end face.
 - 3) Scratch - A linear defect on the surface of the end face of the contact.
- (b) Table 203 shows the limit for each type of damages.

NOTE: A damage that is equal or less than the limit is satisfactory. A damage that is greater than the limit is unsatisfactory and unserviceable. If unserviceable damage is found on a fiber-optic contact, the LRU has to be replaced.

Table 203/20-10-35-993-809

Damage	Zone	Limit	
		Quantity	Size
Chip or Pit	A	-	Total of 5 percent or less of the zone area
	B	-	Total of 10 percent or less of the zone area
	C	No limit	-
	D	No limit	-

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Table 203/20-10-35-993-809 (Continued)

Damage	Zone	Limit	
		Quantity	Size
Crack	A	No damage	-
	B	No damage	-
	C	No limit	-
	D	No damage	-
Scratch	A	3	3 micrometer maximum width of one or more
	B	No limit	6 micrometer maximum width of one or more
	C	No limit	-
	D	No limit	-

SUBTASK 20-10-35-800-003

(3) Fiber-optic End Face Unwanted Material Definition (Figure 206):

(a) There are three types of unwanted materials:

- 1) Contamination - Material on the end face of the fiber-optic contact that cannot be removed with a procedure to clean the end face.
- 2) Debris - Material on the end face of the fiber-optic contact that can be removed with a procedure to clean the end face.
- 3) Film - Material on the end face of the fiber-optic contact that can be removed with a procedure to clean the end face.

(b) Table 204 shows the limits for each type of unwanted materials.

NOTE: Unwanted material that is equal or less then the limit is satisfactory. Unwanted material that is greater than the limit is unsatisfactory, and the fiber-optic contact needs to be cleaned.

Table 204/20-10-35-993-808

Unwanted Material	Zone	Limit	
		Quantity	Size
Contamination	A	-	Total of 5 percent or less of the zone area
	B	-	Total of 10 percent or less or the zone area
	C	No limit	-
	D	No limit	-
Debris	A	5	3 micrometer maximum width of one or more
	B	5	3 micrometer maximum width of one or more
	C	5	10 micrometer maximum width of one or more
	D	5	10 micrometer maximum width of one or more

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Table 204/20-10-35-993-808 (Continued)

Unwanted Material	Zone	Limit	
		Quantity	Size
Film	A	No film	-
	B	No film	-
	C	No film	-
	D	No film	-

F. Fiber-Optic Connector Inspection and Cleaning

SUBTASK 20-10-35-420-011

- (1) Connect the fiber optic inspection probe, COM-12493, to the fiber optic inspection display unit, COM-12492, or connect the fiber optic digital analysis microscope, COM-15076, to the fiber optic inspection display unit, COM-12492.

SUBTASK 20-10-35-420-012

- (2) Attach an applicable fiber optic inspection tip, COM-11803, to the fiber optic inspection probe, COM-12493, or fiber optic digital analysis microscope, COM-15076.

SUBTASK 20-10-35-800-004

- (3) Select the applicable LRU inspection adapter to examine the LRU.

Inspection Adapter for Fiber-Optic Connector on an LRU

LRU Name	LRU Inspection Adapter
Display Processing Computer	LRU fiber optic inspection guide, COM-12163, and LRU shipside connector fiber optic inspection guide, COM-12167, or fiber optic inspection patch cord tip, COM-13669
Captain and First Officer Display Units	LRU inspection guide, COM-12162, and inspection guide, COM-12165

SUBTASK 20-10-35-820-001

- (4) Align the LRU inspection adapter in the engaging end of the fiber-optic connector on the LRU.

SUBTASK 20-10-35-800-005

- (5) Carefully put the tip of the inspection probe in an applicable contact hole of the fiber-optic connector.

SUBTASK 20-10-35-750-001

- (6) Examine the end faces of the fiber-optic contacts for damage or unwanted materials.
 - (a) Make sure that the magnification of the inspection probe is set to 200X or equivalent low magnification.
 - (b) Refer to the Fiber-optic End Face Damage Definition section for the types of damage and the limit for each type of damages.
 - (c) Refer to the Fiber-optic End Face Unwanted Material Definition section for the types of unwanted material and the limit for each type of unwanted materials.

SUBTASK 20-10-35-800-006

- (7) If the end face of a fiber-optic contact has an unsatisfactory damage, replace the LRU.

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SUBTASK 20-10-35-800-007

- (8) If the end face(s) of the fiber-optic contact(s) have unsatisfactory unwanted materials, do these steps:
- (a) Remove the LRU inspection adapter from the fiber-optic connector.
NOTE: You will need this LRU inspection adapter again if you are going to clean the fiber-optic contact with the CleanBlast Cleaning System.
 - (b) Clean the end face(s) of the fiber-optic contact(s) with one or more of these cleaning procedures:
 - 1) Cleaning fiber-optic end face with dry swab.
 - 2) Cleaning fiber-optic end face with wet swab.
 - 3) Cleaning fiber-optic end face with cartridge pen.
 - 4) Cleaning fiber-optic end face with CleanBlast cleaning system.
 - (c) Examine the end face(s) of the fiber-optic contact(s) again after you cleaned them.
 - 1) Clean the end face(s) of the fiber-optic contact(s) again if they still have unsatisfactory unwanted materials.
 - (d) If the end face of a fiber-optic contact still has unsatisfactory unwanted materials after you cleaned it two (2) times, replace the LRU.

G. Cleaning Fiber-Optic End Face with Dry Swab

SUBTASK 20-10-35-800-008

- (1) If the hands are not clean, put on finger cots, G50647, or powder free rubber surgical gloves, G50648.

SUBTASK 20-10-35-100-001

- (2) If the LRU has a connector with a socket insert, remove the alignment sleeve insert, refer to SWPM 20-12-21, SWPM 20-74-02, SWPM 20-74-13, and SWPM 20-74-14.

SUBTASK 20-10-35-800-009

- (3) Select a swab from Fiber Optic Cleaning Kit, G50926, or Table 205.

Table 205/20-10-35-993-807 Swab

Tool	Part Number
Swab	Texwipe TX740B swab, G50642
	MicroCare WS301 CleanRoom Swab, G50921
	MicroCare WS302 CleanRoom Swab, G50920
	MicroCare WS303 CleanRoom Swab, G50922
	Sticklers MCC-P25 CleanStixx swab, G50923
	Sticklers MCC-S12 CleanStixx swab, G50924
	Sticklers MCC-S16 CleanStixx swab, G50925
	Texwipe TX758B swab, G50918
	Texwipe TX757B swab, G50917

SUBTASK 20-10-35-800-010

- (4) Roll the swab across the end face of the fiber-optic contact.

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SUBTASK 20-10-35-400-001

- (5) If an alignment sleeve insert was removed from the connector, install the alignment sleeve insert, refer to SWPM 20-12-21, SWPM 20-74-02, SWPM 20-74-13, and SWPM 20-74-14.

H. Cleaning Fiber-Optic End Face with Wet Swab

SUBTASK 20-10-35-800-011

- (1) If the hands are not clean, put on finger cots, G50647, or powder free rubber surgical gloves, G50648.

SUBTASK 20-10-35-100-002

- (2) If the LRU has a connector with a socket insert, remove the alignment sleeve insert, refer to SWPM 20-12-21, SWPM 20-74-02, SWPM 20-74-13, and SWPM 20-74-14.

SUBTASK 20-10-35-100-003

- (3) Select a swab from Fiber Optic Cleaning Kit, G50926, or Table 206.

Table 206/20-10-35-993-806 Swab

Tool	Part Number
Swab	Texwipe TX740B swab, G50642
	MicroCare WS301 CleanRoom Swab, G50921
	MicroCare WS302 CleanRoom Swab, G50920
	MicroCare WS303 CleanRoom Swab, G50922
	Sticklers MCC-P25 CleanStixx swab, G50923
	Sticklers MCC-S12 CleanStixx swab, G50924
	Sticklers MCC-S16 CleanStixx swab, G50925
	Texwipe TX758B swab, G50918
	Texwipe TX757B swab, G50917

SUBTASK 20-10-35-100-004

- (4) Select a solvent from Fiber Optic Cleaning Kit, G50926, or Table 207.

Table 207/20-10-35-993-805 Solvent

Material	Part Number
Solvent	alcohol, B00068
	alcohol, B00130
	CleanBlast cleaner solvent, B50234
	3M Novec 72DA fluid, B50235
	MicroCare Genesolv 2004 solvent, B50019

SUBTASK 20-10-35-100-005

- (5) Put a small quantity of the solvent on the end of the swab to make it moist.
(a) Make sure that the swab is not too wet.

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SUBTASK 20-10-35-100-006



CAUTION

BE CAREFUL WHEN YOU RUB THE SWAB ON THE END FACE OF THE TERMINAL. TOO MUCH FORCE CAN CAUSE SCRATCHES ON THE END FACE OF THE TERMINAL.

- (6) Carefully rub the swab on the end face of the fiber-optic contact in a circular movement.

SUBTASK 20-10-35-100-007

- (7) Dry the fiber optic contact with one of these materials:
- (a) woven polyester swab, Texwipe TX762 swab, G50641
 - (b) woven polyester swab, Texwipe TX759B swab, G50919
 - (c) canned air, Ultrajet 70 canned air, G50916
 - (d) canned air, Ultrajet All-Way canned air, G50915
 - (e) canned air, Ultrajet canned air, G50646.

SUBTASK 20-10-35-800-012

- (8) If an alignment sleeve insert was removed from the connector, install the alignment sleeve insert, refer to SWPM 20-12-21, SWPM 20-74-02, SWPM 20-74-13, and SWPM 20-74-14.

I. Cleaning Fiber-Optic End Face with Cartridge Pen

SUBTASK 20-10-35-100-009

- (1) If the hands are not clean, put on finger cots, G50647, or powder free rubber surgical gloves, G50648.

SUBTASK 20-10-35-100-010

- (2) For a fiber-optic contact in a socket insert, do these steps:
- (a) Remove the cover and guide cap from the tip of the cartridge pen, fiber optic connector cleaner, COM-13567.
 - (b) Align the tip of the cartridge pen and alignment sleeve.
 - (c) Push the tip of the cartridge pen forward until it makes a click.
 - (d) Remove the tip of the cartridge pen from the alignment sleeve.
 - (e) Put the guide cap and cover on the tip of the cartridge pen.

SUBTASK 20-10-35-100-011

- (3) For a fiber-optic contact in a pin insert, do these steps:
- (a) Remove the cover from the guide cap of the cartridge pen, fiber optic connector cleaner, COM-13567.
 - (b) Make sure that the guide cap stays on the end of the cartridge pen.
 - (c) Align the tip of the cartridge pen and end of the fiber-optic contact.
 - (d) Push the tip of the cartridge pen forward until it makes a click.
 - (e) Remove the cartridge pen from the end of the fiber-optic contact.
 - (f) Put the cover on the guide cap.

J. Cleaning Fiber-Optic End Face with CleanBlast System

SUBTASK 20-10-35-100-012

- (1) A fiber optic inspection and cleaning kit, COM-12161, is necessary for this cleaning procedure.

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SUBTASK 20-10-35-100-013

- (2) If the hands are not clean, put on finger cots, G50647, or powder free rubber surgical gloves, G50648.

SUBTASK 20-10-35-100-014

- (3) Select the applicable LRU inspection adapter to clean the LRU.

SUBTASK 20-10-35-100-015

- (4) Align the LRU inspection adapter in the engaging end of the fiber-optic connector on the LRU.

SUBTASK 20-10-35-100-016

- (5) Carefully insert the cleaning probe with the cleaning tip from the fiber optic inspection and cleaning kit, COM-12161, into the applicable contact hole on the fiber-optic connector.

SUBTASK 20-10-35-100-017

- (6) Clean the fiber-optic contact.

SUBTASK 20-10-35-400-002

- (7) Remove the LRU inspection adapter from the fiber-optic connector.

———— **END OF TASK** ————

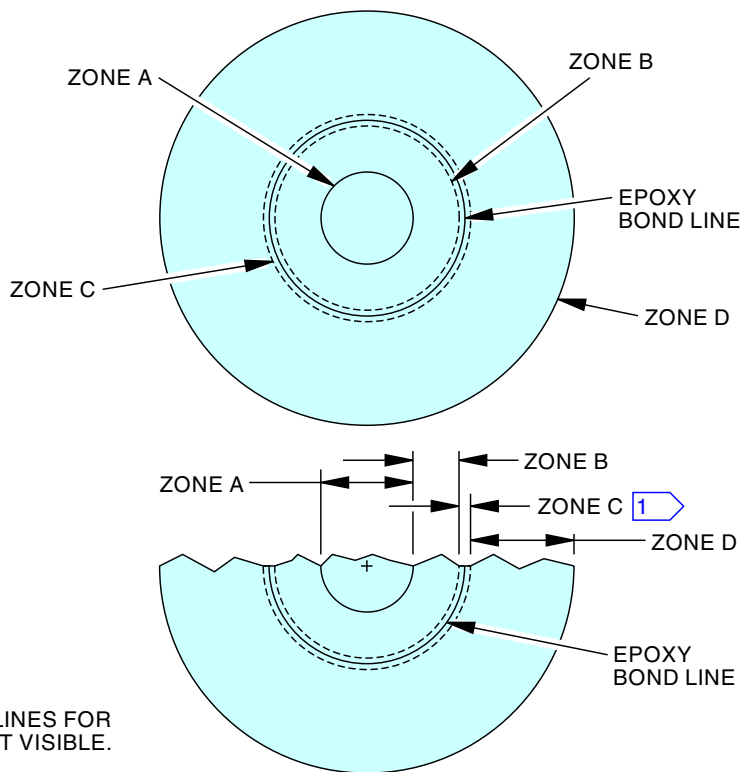
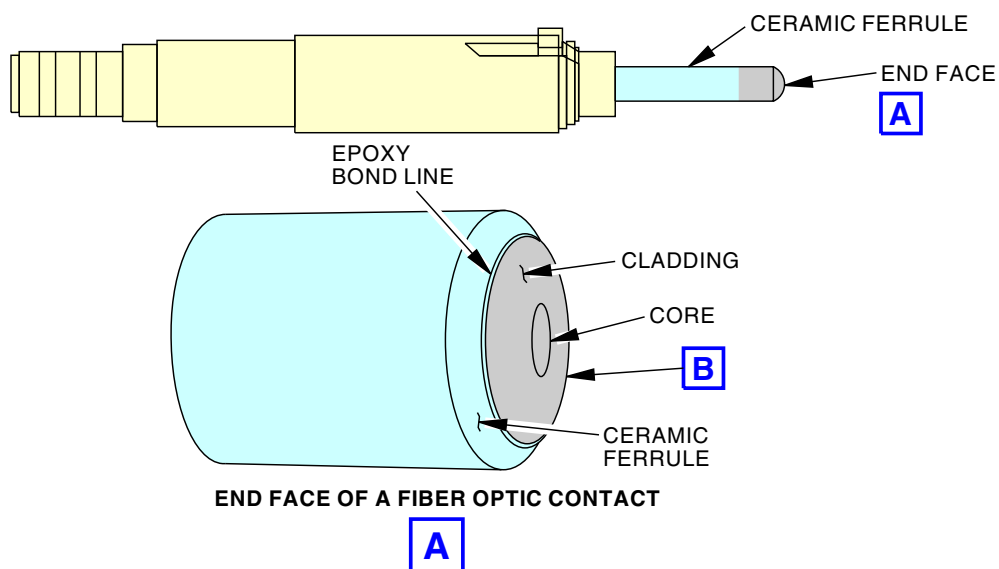
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1 THE BOUNDARY LINES FOR ZONE C ARE NOT VISIBLE.

ZONE LOCATIONS OF THE END FACE OF A FIBER OPTIC CONTACT

2567553 S0000613925_V1

Fiber-Optic End Face - Zones
Figure 204/20-10-35-990-804

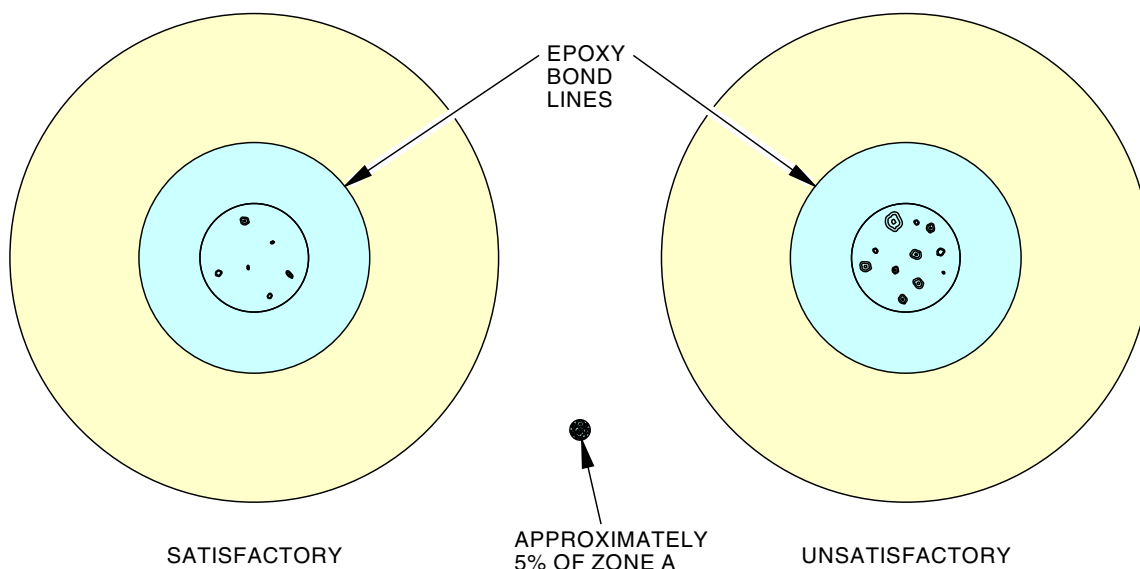
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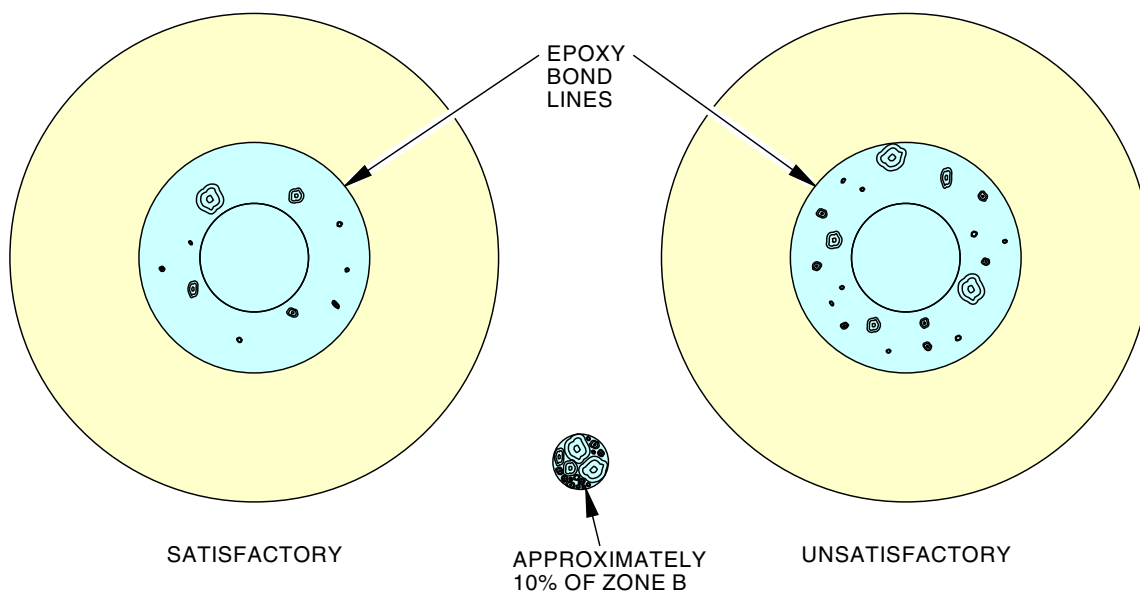
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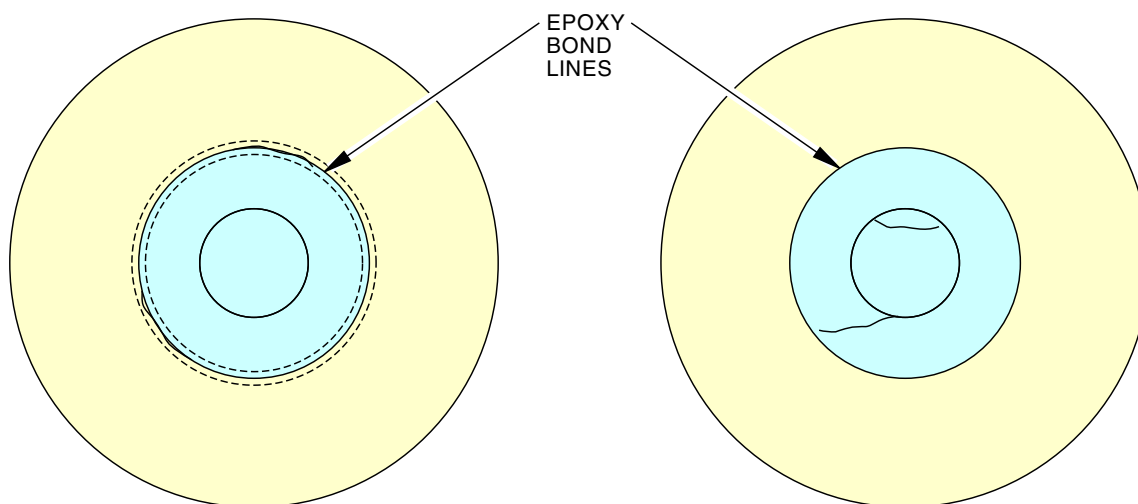
END FACE OF A FIBER OPTIC CONTACT - CHIP OR PIT IN ZONE A



END FACE OF A FIBER OPTIC CONTACT - CHIP OR PIT IN ZONE B

2567568 S0000613927_V1

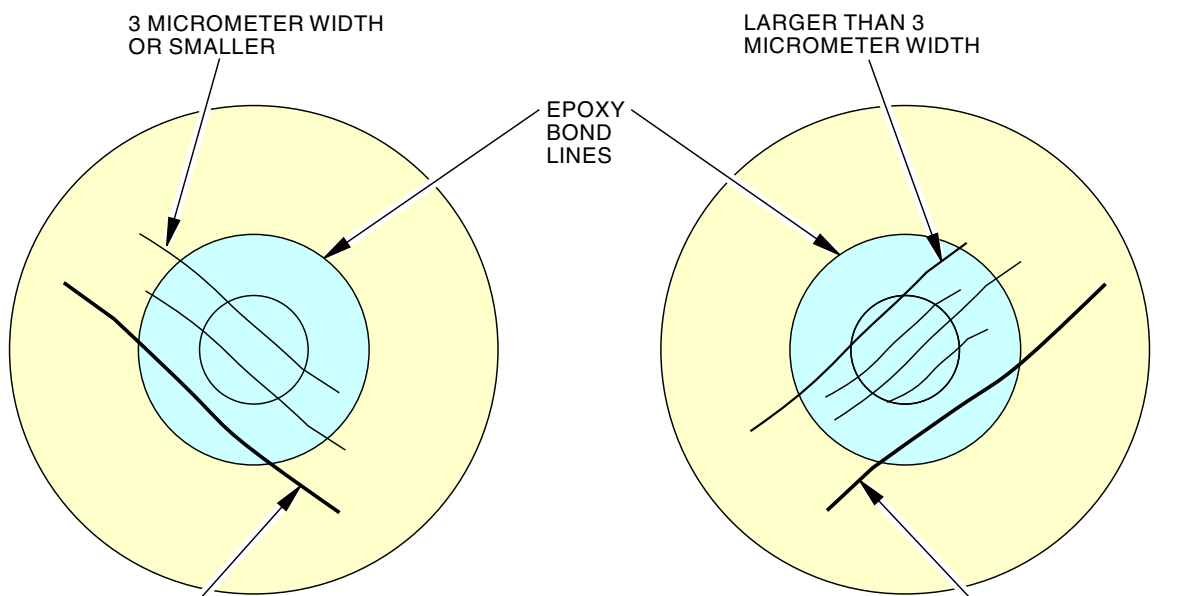
Fiber-Optic End Face - Damage Limits
Figure 205/20-10-35-990-805 (Sheet 1 of 2)



SATISFACTORY

UNSATISFACTORY

END FACE OF A FIBER OPTIC CONTACT - CRACK



3 MICROMETER WIDTH
OR SMALLER

LARGER THAN 3
MICROMETER WIDTH

6 MICROMETER WIDTH
OR SMALLER

LARGER THAN 6
MICROMETER WIDTH

SATISFACTORY

UNSATISFACTORY

END FACE OF A FIBER OPTIC CONTACT - SCRATCH

2567569 S0000613928_V1

Fiber-Optic End Face - Damage Limits
Figure 205/20-10-35-990-805 (Sheet 2 of 2)

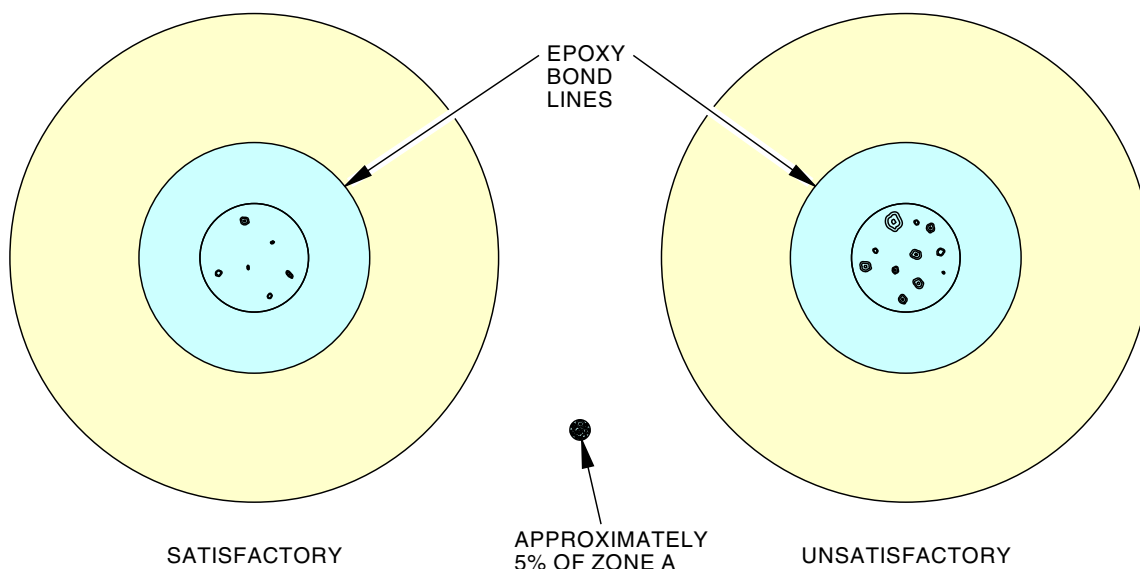
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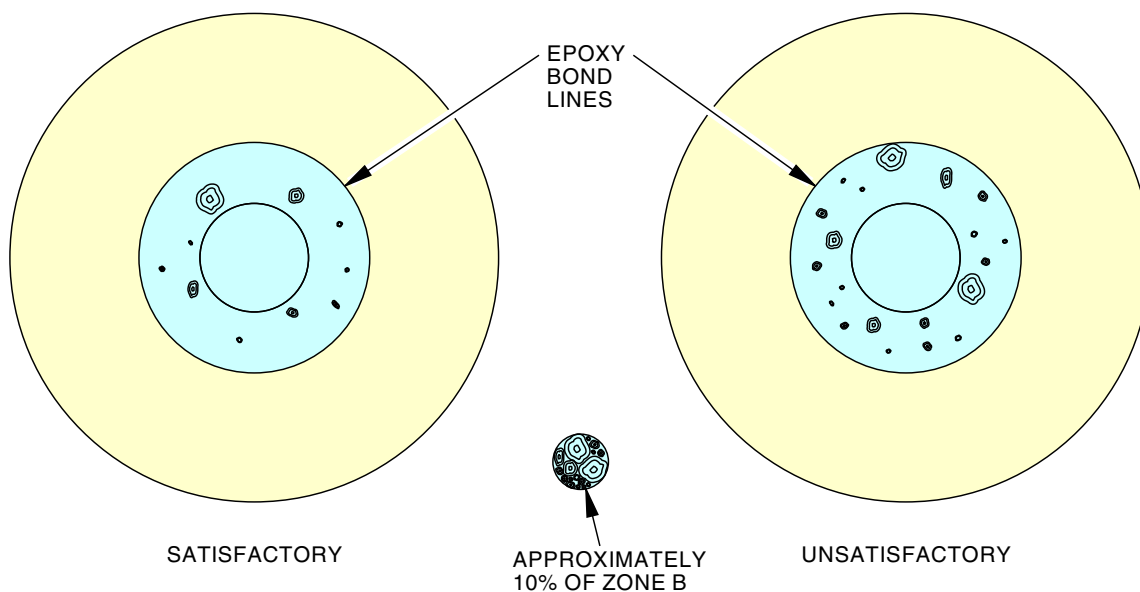
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END FACE OF A FIBER OPTIC CONTACT - CONTAMINATION IN ZONE A



END FACE OF A FIBER OPTIC CONTACT - CONTAMINATION IN ZONE B

2567571 S0000613929_V1

Fiber-Optic End Face - Unwanted Material
Figure 206/20-10-35-990-806 (Sheet 1 of 2)

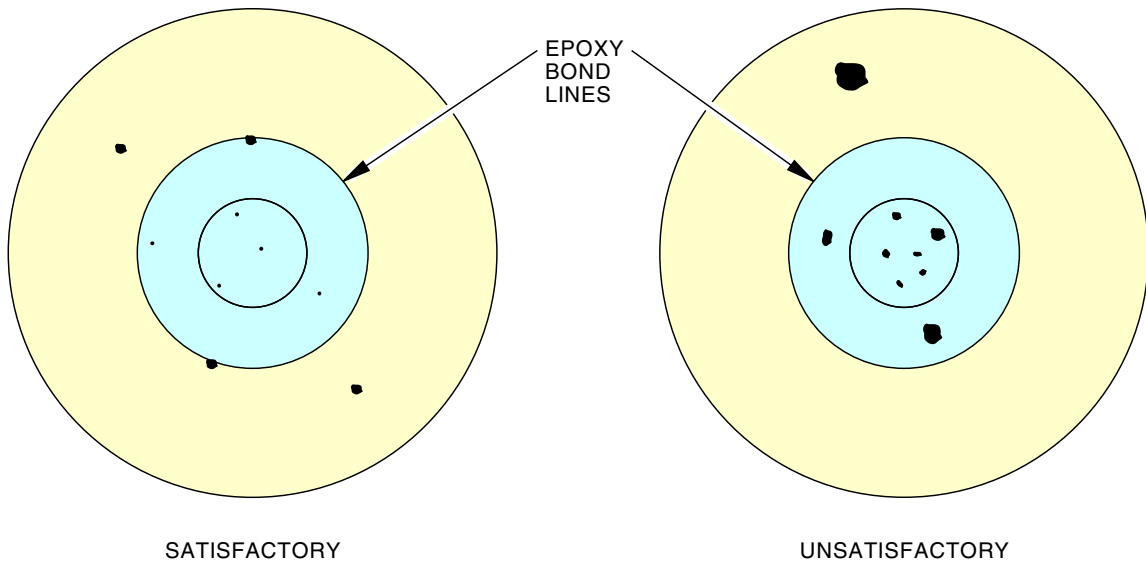
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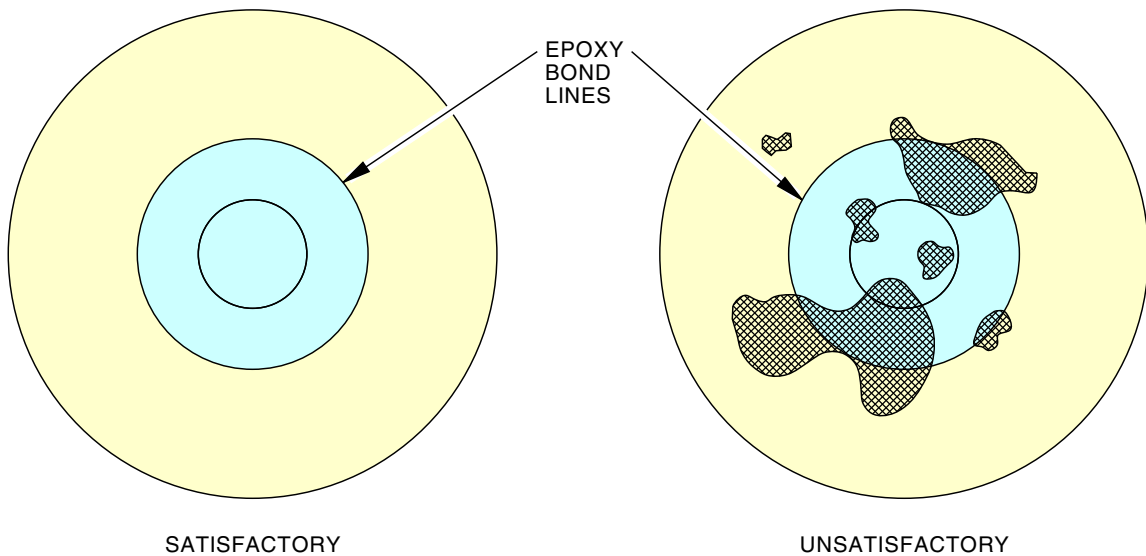
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END FACE OF A FIBER OPTIC CONTACT - DEBRIS



END FACE OF A FIBER OPTIC CONTACT - FILM

2567572 S0000613930_V1

Fiber-Optic End Face - Unwanted Material
Figure 206/20-10-35-990-806 (Sheet 2 of 2)

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ELECTRICAL BONDING - INSPECTION/CHECK

1. General

- A. This procedure provides an requirements for airplane electrical bonding.
- B. This procedure has one task:
 - (1) An inspection of electrical bonding.

TASK 20-10-37-120-801

2. Electrical Bonding Inspection

(Figure 601, Figure 602, Figure 603, Figure 604)

A. General

- (1) This task provides information to help an operator determine which bonding meter to select for electrical bonding inspections.
 - (a) The information in this procedure is used to describe the fire zone, flammable zone, flammable leakage zone, and National Electrical Code (NEC) hazardous locations.
 - (b) An operator should also take into consideration their environmental conditions that could impact the zone and location information.
 - (c) Boeing recommends that the bonding meter, COM-15065 be used for all bonding checks. If it is not available, the non-intrinsically safe bonding meter, COM-614 can be used outside of the fire zones, flammable zones, flammable leakage zones, and areas classified as NEC Class I, Division I or II hazardous locations.

NOTE: For milliohms range measurements, use intrinsically safe approved bonding meter, COM-1550 and for ohms range measurements, use bonding meter, COM-15065.

B. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

Reference	Description
COM-614	Bonding Meters - Non-Intrinsically Safe (For use in outside Class I, Divisions I & II non-hazardous locations. For hazardous locations, use COM-1550). Part #: 247000 Supplier: 00426 Part #: 620LK Supplier: 1CRL2 Part #: BLR-0003-XX Supplier: KC432 Part #: BT51 Supplier: 00426 Part #: M1 Supplier: 3AD17 Part #: M1B Supplier: 3AD17 Part #: T477W (C15292) Supplier: 06659 Opt Part #: 247001 Supplier: 00426

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(Continued)

Reference	Description
COM-1550	Bonding Meter - Approved, Intrinsically Safe (Approved for use in Class I, Divisions I & II hazardous (classified) locations. Outside these hazardous locations, COM-614 can be used in lieu of COM-1550). Part #: 620LK Supplier: 1CRL2 Part #: M1 Supplier: 3AD17 Part #: M1B Supplier: 3AD17 Part #: T477W (C15292) Supplier: 06659
COM-15065	Bonding Meter - 20 Ohms to 200 Ohms Range (or Better); Approved, Intrinsically Safe (Approved for use in Class I, Divisions I & II hazardous (classified) locations) Part #: 620LK-P5 Supplier: 1CRL2

C. Select a Bonding Meter

SUBTASK 20-10-37-750-001

- (1) Inside the zones that follow, Boeing recommends that the intrinsically safe approved bonding meter, COM-1550 be used.
 - (a) Fire Zone
 - 1) In a fire zone, ignition sources are normally present.
 - 2) A single failure can cause a flammable mixture to be present.
 - 3) Fire Zone locations are as follows (Figure 601):
 - a) Engines
 - b) Tail Cone
 - (b) Flammable Zone
 - 1) In a flammable zone, flammable fluid is normally present.
 - 2) An ignition source is not present normally after a single failure.
 - 3) Flammable Zone locations are as follows (Figure 602):
 - a) Wing - Center Fuel Tank: Rib 1 to Rib 5
 - b) Wing - Main Tank: Rib 5 to Rib 22 (WS 204.25 to WS 643.50)
 - c) Wing - Surge Tank: Rib 22 to Rib 25 (WS 616.75 to WBL 643.50)
 - d) Wing - Dry Bay
 - (c) Flammable Leakage Zone
 - 1) Leakage of flammable vapors can occur as a result of the following:
 - a) One failure
 - b) Leakage during normal operation
 - 2) All flames, smoking, sparks, and other ignition sources must not occur.
 - 3) Tools and test equipment that can make a spark must not be used.
 - 4) Flammable Leakage Zone locations are as follows (Figure 603):
 - a) Nose Landing Gear and Main Landing Gear Wheel Wells
 - b) Wing-to-Body Fairings
 - c) Engine Struts and Nacelles

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- d) Wing Leading Edges
 - e) ECS Bay
 - f) Wing Trailing Edges
 - g) Horizontal Stabilizer
 - h) Empennage and Rudder
 - i) Fuselage Aft of the Pressure Bulkhead
- (d) National Electrical Code (NEC) Class I, Division I and II Hazardous Locations (Figure 604)

NOTE: Figure 604 is for the condition with open fuel tanks.

- 1) Class I, Division I Hazardous Locations (or equivalent standard):
 - a) Locations where ignitable concentrations of flammable gases or vapors can exist under standard operational conditions.
 - b) Locations where ignitable concentrations of flammable gases or vapors may exist frequently because of repair or maintenance operations.
 - c) Locations where ignitable concentrations of flammable gases or vapors can exist because of leakage.
 - d) Locations where equipment problems or incorrect operation of equipment or processes can release ignitable concentrations of flammable gases or vapor, and can also cause failure of electrical equipment at the same time.
- 2) Class I, Division II Hazardous Locations (or equivalent standard):
 - a) Locations where flammable liquids or gases are handled, processed, or used, but where the liquid, vapors, or gases will usually be in closed containers or closed systems. The containers or systems will not allow the release of liquid, gas, or vapor in sufficient quantity or produce an ignitable fuel and air mixture unless the container or system fails or is damaged.
- 3) See Figure 604 for the locations of the NEC Class I, Division I & II Hazardous Locations.

D. Procedure

SUBTASK 20-10-37-100-001

- (1) For electrical bonding requirements, refer to the Standard Wiring Practices Manual (SWPM). Inside the zones that follow, Boeing recommends that the intrinsically safe approved bonding meter be used.

———— **END OF TASK** ————

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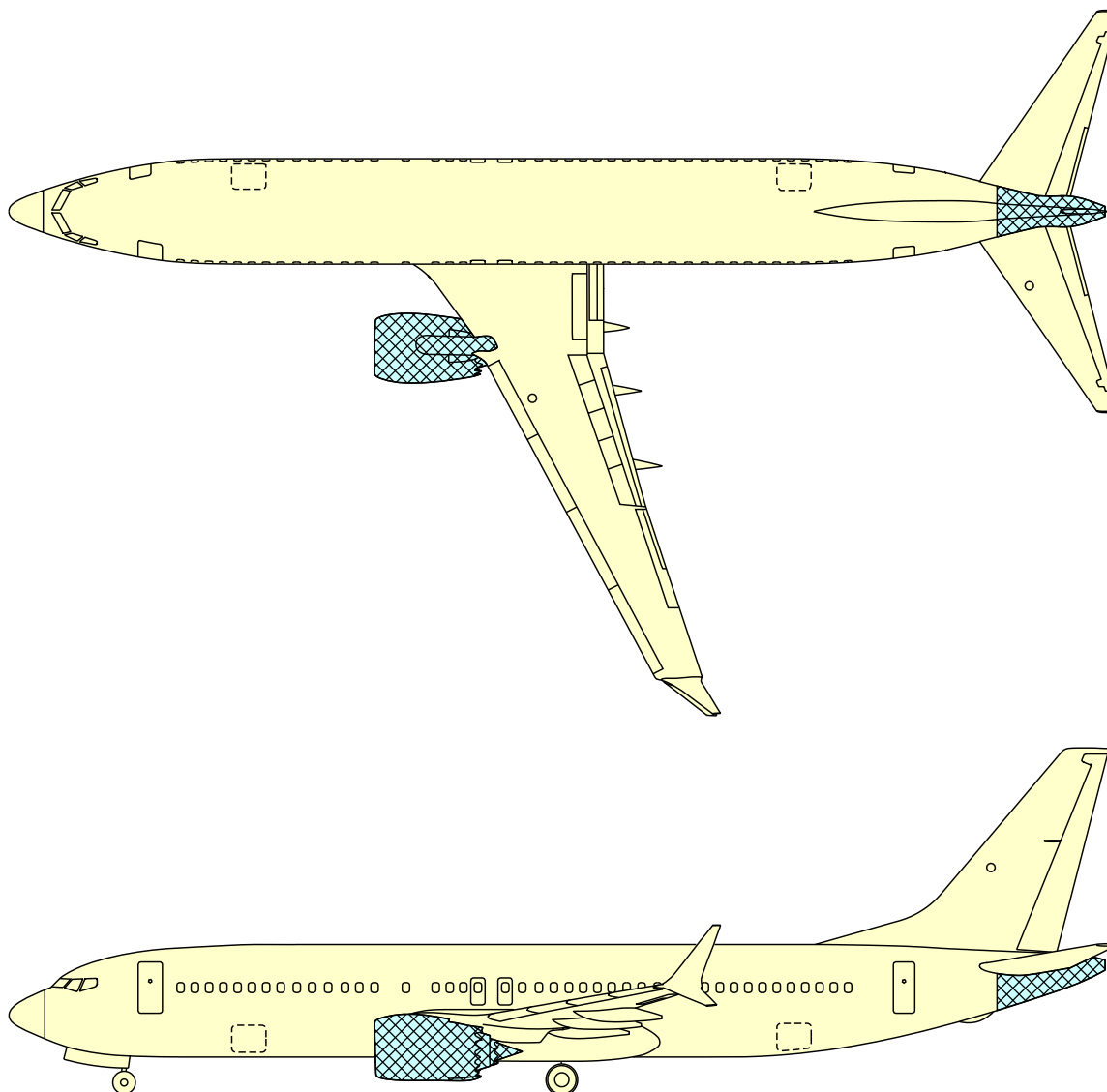
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LEGEND:

 FIRE ZONES

2411091 S00061526948_V1

Fire Zone Locations
Figure 601/20-10-37-990-801

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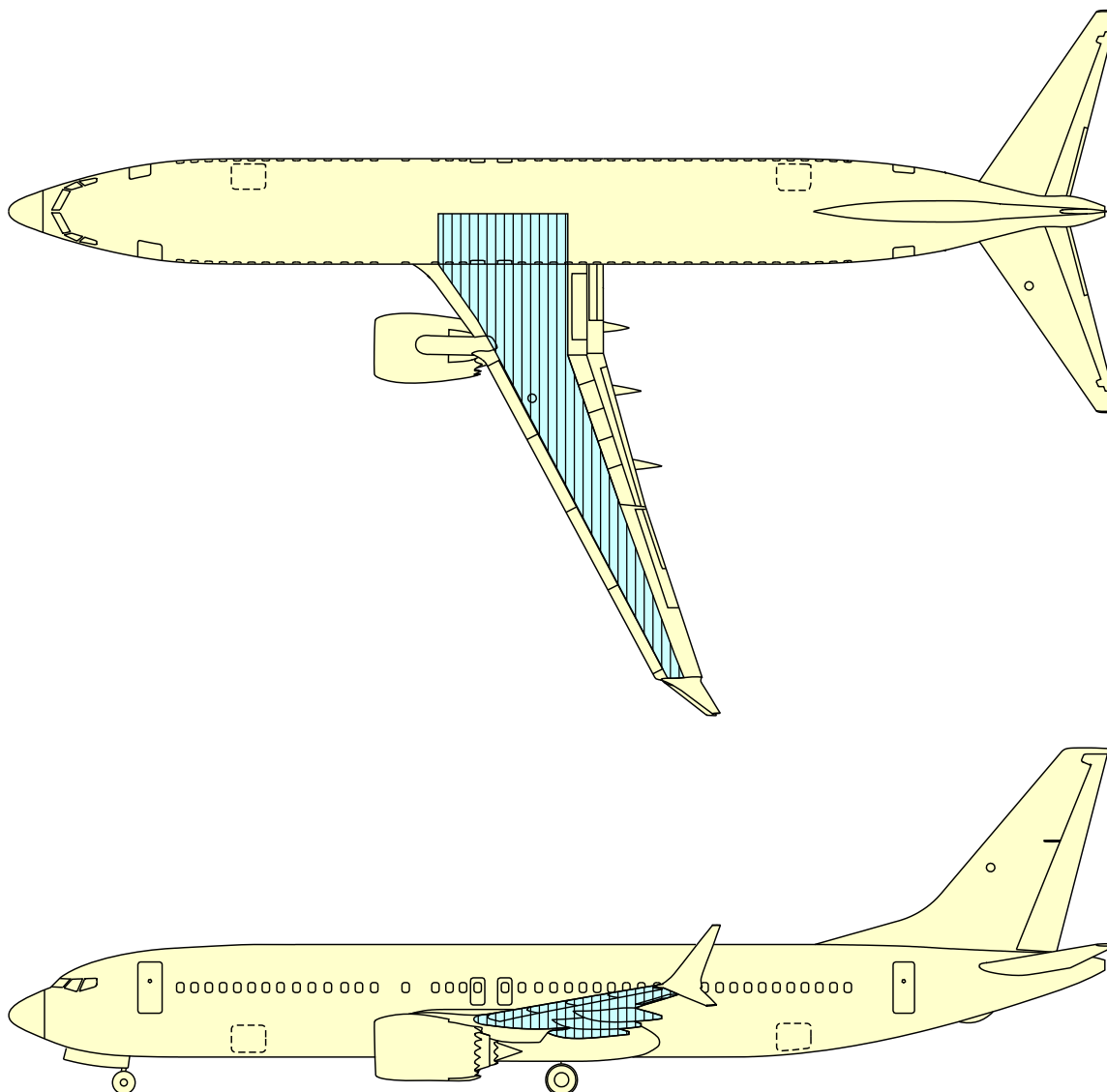
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LEGEND:



FLAMMABLE ZONES

2411092 S00061526949_V1

Flammable Zone Locations
Figure 602/20-10-37-990-802

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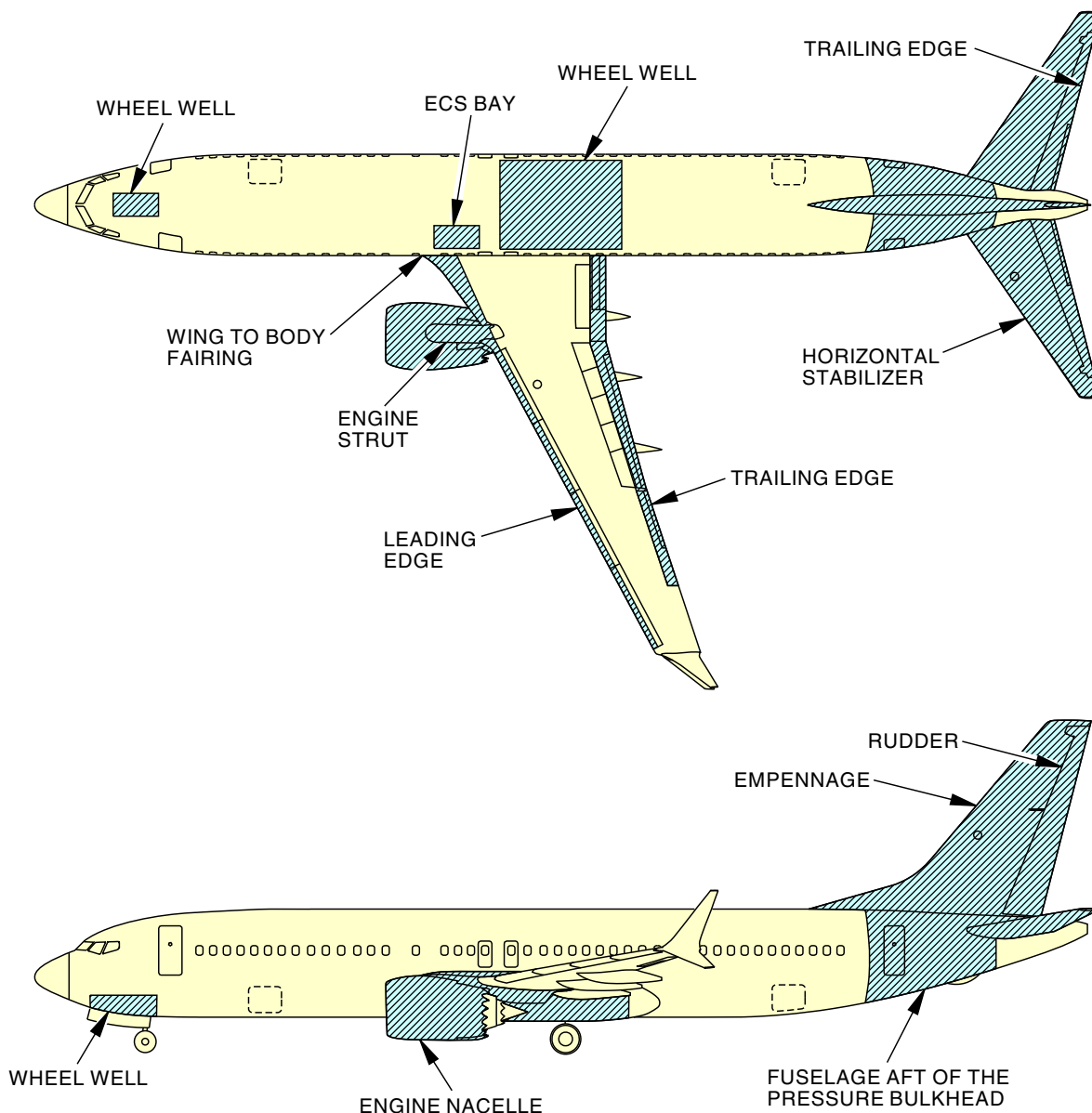
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LEGEND:



FLAMMABLE LEAKAGE ZONES

2411093 S00061526950_V1

Flammable Leakage Zone Locations
Figure 603/20-10-37-990-803

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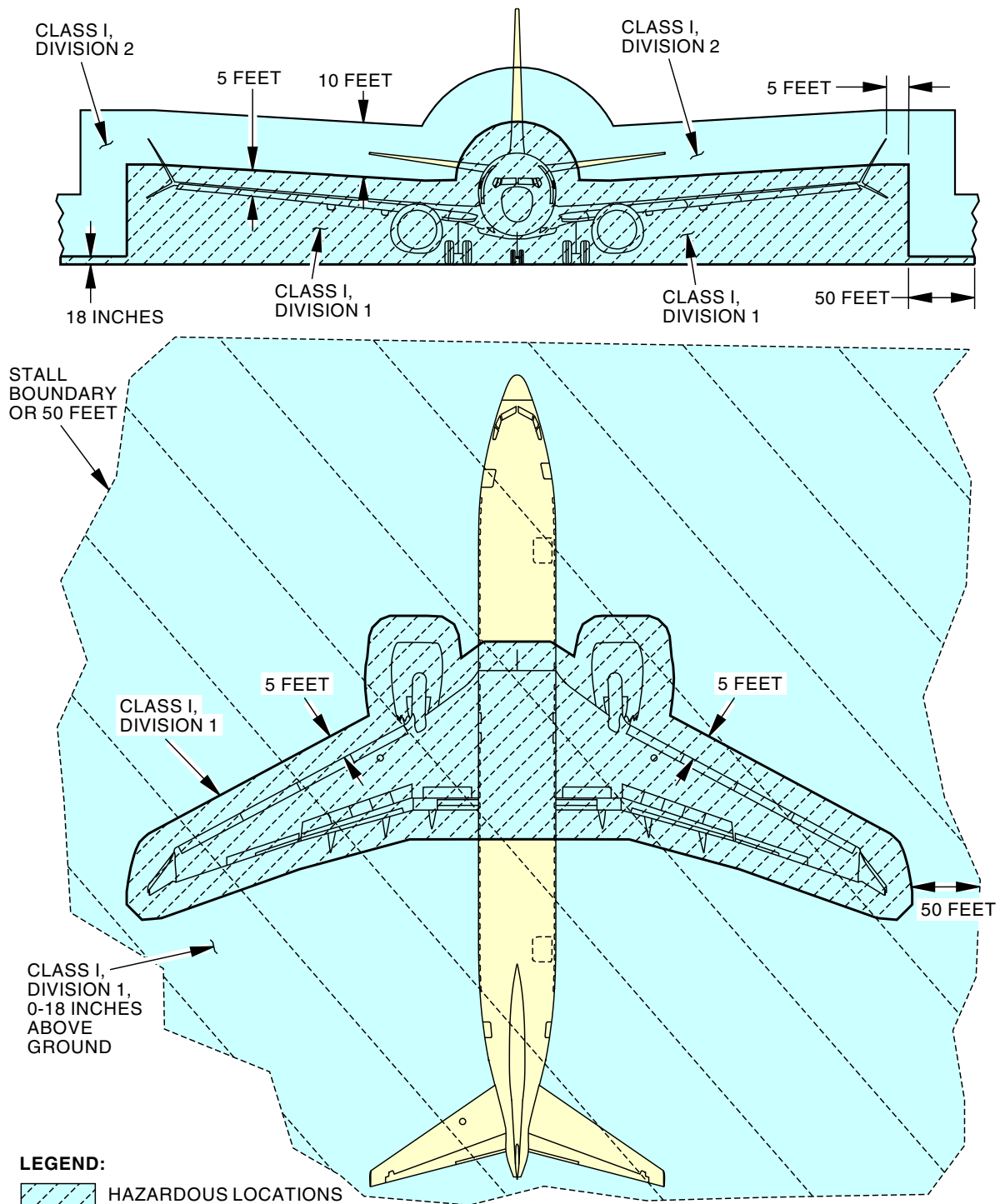
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Hazardous Locations - Open Fuel Tank(s)
Figure 604/20-10-37-990-804

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INSULATION RESISTANCE TESTING - INSPECTION/CHECK

1. General

A. This procedure contains the task for performing Low Voltage Insulation Resistance Inspections.

TASK 20-10-39-700-801

2. Insulation Resistance Testing - Special Detail Inspection

(Figure 501)

A. General

- (1) Insulation resistance testing (IRT) may be used to determine the integrity of component windings or wiring in motors, transformers (Linear Variable Differential Transformer (LVDT), Rotary Variable Differential Transformer (RVDT), Synchros), actuators, and aircraft wiring installations. The wire insulation coating inside these components deteriorates over time. Other factors that can cause a motor to fail prematurely include moisture or contamination of the insulation. Failure to find degraded insulation can lead to intermittent failure inflight and schedule interruptions
- (2) IRT provides a qualitative value on the condition of conductor insulation and the internal insulation of various components. There are two types of tests provided:
 - (a) Proof Test: Quick test that flows Direct Current (DC) voltage to the Unit Under Test (UUT). Current flows into the conductor and begins to charge the insulation; called capacitive charging. As the charging current first begins to build, the resistance reading on the meter (insulation resistance multimeter, COM-17798) face will indicate a low value, but then charges quickly and the meter should indicate a high megohm value if insulation is in a good condition.
 - (b) Predictive Test (Short-Time Resistance Test): After the initial current charge above, a second current flows if there is absorption current. The Dielectric Absorption Rate (DAR) is dependent upon the contamination of the insulation. For example, if moisture is present in the insulation, absorption current will be high, indicating a lower resistance value. Absorption current takes longer to build than the capacitive charging current. Therefore, this test is an automated timed test providing a ratio of 60s/30s to identify moisture or contamination in connectors, motors, transformers, actuators, and aircraft wiring installations.
- (3) Wiring and applicable passive components (motors, transformers (including LVDT/RVDT/Synchros), actuators may be tested together or individually. Disconnect sensitive controller(s), e.g. Signal Conditioning Unit (SCU), Flap/Slat Electronics Unit (FSEU), Proximity Sensor Electronics Unit (PSEU) and any Control System Electronic unit (CSEU) flight control module (Power Supply Module (PSM), Spoiler Control Module (SCM), SAM, Yaw Damper Module (YDM), RRCM) that would be damaged by IRT.
- (4) Do not use the meter (insulation resistance multimeter, COM-17798) around explosive gas, vapor, or in damp or wet environments.
- (5) Do not apply more than 2500 VDC to aircraft wiring or components.
 - (a) Testing at 3000 VDC or greater may result in arcing between aircraft connector pins in high humidity. Do not test greater than 2500 VDC to prevent this condition.
 - (b) Any wiring or components that have been tested at 1000 V or greater may have degraded due to arcing. Upon test completion at greater than 600 VDC, we recommend those tested at greater than 600 VDC be retested at 500 VDC to check for degraded insulation.
- (6) Tests should only be performed on de-energized circuits.

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- (7) To prevent accidental application of high voltage to sensitive circuitry, always make sure that the circuit is isolated by performing traditional resistance measurement or insulation resistance testing at no greater than 50 VDC.
- (8) During IRT checks of wiring only, each end of the wire should be disconnected.
 - (a) For shielded wiring, this means the shield is likely no longer connected to aircraft structure (ground). Therefore, the technician must read the wire to the shield to know if there is moisture or insulation breakdown within the harness.
- (9) During testing, perform the following minimum readings for the specified contacts (pins):
 - (a) Continuity from contact to contact
 - (b) Short circuits between the contacts
 - (c) Short circuits from each contact to structure ground.

B. References

Reference	Title
24-22-00-860-802	Remove Electrical Power (P/B 201)

C. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt.", which stands for Optional.

Reference	Description
COM-17798	Multimeter - Digital, Insulation Resistance Part #: 1004-745 Supplier: U0146 Part #: 1507 Supplier: 4U744 Part #: 1587 Supplier: 89536 Part #: 1587 FC Supplier: 4U744 Part #: MIT2500 Supplier: U0146 Part #: MIT410/2 Supplier: U0146

D. Prepare for the Insulation Resistance Test

NOTE: Preparation is very important to decrease the airplane ground time and should be done before the airplane is grounded.

SUBTASK 20-10-39-800-001

- (1) Use the following applicable documents to find the locations of the wire bundles and Line Replaceable Unit (LRU), and if necessary component insulation resistance values, that may be triggering intermittent faults:
 - (a) Aircraft Maintenance Manual (AMM)
 - (b) Fault Isolation Manual (FIM)
 - (c) Wiring Diagram Manual (WDM)
 - (d) Component Maintenance Manual (CMM)
 - (e) Fleet Team Digest (FTD)
 - (f) Standard Wiring Practices Manual (SWPM)
 - (g) Service Letter (SL)
 - (h) Maintenance Tip (MT)
 - (i) Other service document.

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SUBTASK 20-10-39-800-002

- (2) Prepare the applicable pages from the documents.

NOTE: The pages will provide quick reference on the airplane during troubleshooting.

SUBTASK 20-10-39-760-001

- (3) Make sure that the electrical power is removed (Remove Electrical Power, TASK 24-22-00-860-802).

NOTE: Electrical power must be off to prevent incorrect fault indications or fault messages from occurring.

SUBTASK 20-10-39-010-001

- (4) Get access to the applicable wire bundles and LRUs.

SUBTASK 20-10-39-800-003

- (5) Select the applicable troubleshooting configuration:

- (a) Proof Test (Hard Fault) – Wiring
- (b) Dielectric Absorption Rate (DAR) Test (Predictive Health Check) – Wiring
- (c) Dielectric Absorption Rate (DAR) Test (Predictive Health Check) – Passive Components.

SUBTASK 20-10-39-800-004

- (6) Continue to the steps for the applicable troubleshooting configuration.

E. Proof Test – Wiring Only



500V DC TESTERS CAN BE AN IGNITION SOURCE. MAKE SURE THAT YOU DO NOT USE A POSSIBLE IGNITION SOURCE AROUND OPEN FUEL TANKS, FUEL VENTS OR SPILLED FUEL. FUEL FUMES CAN BE NOT STABLE AND CAUSE POSSIBLE IGNITION. IF YOU DO NOT OBEY THIS WARNING, INJURY TO PERSONNEL AND DAMAGE TO EQUIPMENT CAN OCCUR.



DO NOT ACCIDENTALLY LET SENSITIVE ELECTRONIC COMPONENTS TOUCH HIGH VOLTAGE. THIS CAN CAUSE DAMAGE TO EQUIPMENT.

NOTE: Quick test to capacitive charge the insulation and test for leakage. As the charging current first begins to build, the resistance reading on the meter face will indicate a low value, but then charges quickly and the meter should indicate a high megohm value if insulation is in a good condition.

SUBTASK 20-10-39-760-002

- (1) Review the WDM to ensure sensitive components are isolated from high voltage, pay special attention to all terminal blocks and splices for circuit under test.

SUBTASK 20-10-39-020-001

- (2) Disconnect all connectors associated with the wire being tested.

SUBTASK 20-10-39-210-001

- (3) Examine the electrical connectors for bent or broken pins/sockets, dirt, and damage.

SUBTASK 20-10-39-420-001

- (4) On the applicable LRUs, install conductive dust cap and connector cover.

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SUBTASK 20-10-39-480-001

- (5) Do these steps to connect the insulation resistance tester to the applicable connector:

NOTE: For this example, assume the wire bundle consists of 5 conductor shielded wiring. To facilitate rapid testing, the technician may connect one test lead to contact #1 and the other test lead to all other four contacts, the shield and the ground tied together. All possible insulation leaks may be tested with 5 measurements. For example:

Test #1: Connect Test Lead A to pin 1 & Test Lead B to pins 2, 3, 4, 5, shield & ground

Test #2: Connect Test Lead A to pin 2 & Test Lead B to pins 1, 3, 4, 5, shield & ground

Test #3: Connect Test Lead A to pin 3 & Test Lead B to pins 1, 2, 4, 5, shield & ground

Test #4: Connect Test Lead A to pin 4 & Test Lead B to pins 1, 2, 3, 5, shield & ground

Test #5: Connect Test Lead A to pin 5 & Test Lead B to pins 1, 2, 3, 4, shield & ground.

- (a) Follow the tester instructions to install test probes, set tester to 50 VDC range and select insulation test function.
- (b) Connect the probes to the circuit to be measured.
- (c) Push, hold, and then release the "Insulation Resistance" button to momentarily apply applicable test voltage.
 - 1) The secondary display shows the test voltage applied to the circuit under test. The high voltage symbol along with a primary display showing the resistance in MΩ appears. The TEST icon appears on the lower portion of the display until the test button is released.
 - 2) When resistance is higher than the maximum display range, the meter displays the > symbol and the maximum resistance for the range.
- (d) If 50 VDC measurement was open or > 5 megaohms, set tester to 500 VDC range.
 - 1) Connect the probes to the circuit to be measured.
 - 2) Push, hold, and then release the "Insulation Resistance" button to momentarily apply applicable test voltage.
 - a) The secondary display shows the test voltage applied to the circuit under test. The high voltage symbol along with a primary display showing the resistance in MΩ appears. The TEST icon appears on the lower portion of the display until the test button is released.
 - b) When resistance is higher than the maximum display range, the meter displays the > symbol and the maximum resistance for the range.
- (e) Record the lowest resistance in the circuit.
- (f) Continue in this manner until finishing measurements between all wires in the harness, shield, connector shell if applicable and structure (ground) as in the example above.
- (g) For connectors that contain more than 5 wires, continue testing for all combinations of wire to wire, wire to shield and wire to structure (ground).
- (h) After performing the insulation resistance test procedure described, if any measured insulation resistance is less than 50 megaohms or greater than 10 microamps, this wire should be considered degraded and the wire should be repaired or replaced.

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F. Dielectric Absorption Rate – Wiring



500V DC TESTERS CAN BE AN IGNITION SOURCE. MAKE SURE THAT YOU DO NOT USE A POSSIBLE IGNITION SOURCE AROUND OPEN FUEL TANKS, FUEL VENTS OR SPILLED FUEL. FUEL FUMES CAN BE NOT STABLE AND CAUSE POSSIBLE IGNITION. IF YOU DO NOT OBEY THIS WARNING, INJURY TO PERSONNEL AND DAMAGE TO EQUIPMENT CAN OCCUR.

NOTE: Dielectric Absorption Ratio (DAR) is the ratio of the 1-minute insulation resistance to the 30 second insulation resistance. Insulation tests should only be performed on de-energized circuits. This is an automated timed test providing a ratio of 60s/30s to identify moisture or contamination in connectors, motors, transformers, actuators, and aircraft wiring installations.

SUBTASK 20-10-39-020-002

- (1) Disconnect all connectors associated with the wire being tested.

SUBTASK 20-10-39-210-002

- (2) Examine the electrical connectors for bent or broken pins/sockets, dirt, and damage.

SUBTASK 20-10-39-420-002

- (3) On the applicable LRUs, install conductive dust cap and connector cover.

SUBTASK 20-10-39-480-002

- (4) Do these steps to connect the insulation resistance tester to the applicable connector:

NOTE: For this example, assume the wire bundle consists of 5 conductor shielded wiring. To facilitate rapid testing, the technician may connect one test lead to contact #1 and the other test lead to all other four contacts, the shield and the ground tied together. All possible insulation leaks may be tested with 5 measurements. For example:

Test #1: Connect Test Lead A to pin 1 & Test Lead B to pins 2, 3, 4, 5, shield & ground

Test #2: Connect Test Lead A to pin 2 & Test Lead B to pins 1, 3, 4, 5, shield & ground

Test #3: Connect Test Lead A to pin 3 & Test Lead B to pins 1, 2, 4, 5, shield & ground

Test #4: Connect Test Lead A to pin 4 & Test Lead B to pins 1, 2, 3, 5, shield & ground

Test #5: Connect Test Lead A to pin 5 & Test Lead B to pins 1, 2, 3, 4, shield & ground.

- (a) Follow the tester instructions to install test probes, set tester to 50 VDC range and select insulation test function.
- (b) Connect the probes to the circuit to be measured.
- (c) Push, hold, and then release the “Insulation Resistance” button to momentarily apply 50 VDC.
 - 1) The secondary display shows the test voltage applied to the circuit under test. The high voltage symbol along with a primary display showing the resistance in MΩ appears. The TEST icon appears on the lower portion of the display until the test button is released.
 - 2) When resistance is higher than the maximum display range, the meter displays the > symbol and the maximum resistance for the range.
 - 3) Make sure that the circuit is isolated, open or > 5 megaohms.
- (d) Set the test mode to DAR by pressing PI/DAR button until DAR is displayed on the meter (insulation resistance multimeter, COM-17798).
- (e) Connect the probes to the circuit to be measured.
- (f) Push and release the “Insulation Resistance” button to start the 60 second 500 VDC test.

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- (g) The secondary display shows the test voltage applied to the circuit under test. The high voltage symbol along with a primary display showing the resistance in MΩ appears. The TEST icon appears on the lower portion of the display until the test is complete.
- (h) When the test is completed, the PI or DAR value is displayed on the primary display. If the IR value does not climb or decrease during testing, after 1 minute the meter's display will show ERR. Also, DAR values are not always provided due to ranges out of limits. This is normal. Simply evaluate by referring to the lowest witnessed IR value.
- (i) Record the DAR.
- (j) Continue in this manner until finishing measurements between all wires in the harness, shield, connector shell if applicable and structure (ground) as in the example above.
- (k) For connectors that contain more than 5 wires, continue testing for all combinations of wire to wire, wire to shield and wire to structure (ground).
- (l) After performing the insulation resistance test procedure described, if any measured insulation resistance is less than 50 megaohms or greater than 10 microamps or less than 1.0 DAR, perform the following:
 - 1) DAR values change with moisture and temperature. Compare measurements with like wiring; e.g. similar system wiring. If like wiring reads ok, then consider wiring and/or connector insulation is contaminated or contains moisture.
 - a) Isolate by testing portions of the wiring by disconnecting interconnecting connectors/terminals.
 - 2) Once isolated, clean, and schedule for repair or replacement if necessary.

G. Dielectric Absorption Rate – Passive Components



500V DC TESTERS CAN BE AN IGNITION SOURCE. MAKE SURE THAT YOU DO NOT USE A POSSIBLE IGNITION SOURCE AROUND OPEN FUEL TANKS, FUEL VENTS OR SPILLED FUEL. FUEL FUMES CAN BE NOT STABLE AND CAUSE POSSIBLE IGNITION. IF YOU DO NOT OBEY THIS WARNING, INJURY TO PERSONNEL AND DAMAGE TO EQUIPMENT CAN OCCUR.

NOTE: Dielectric Absorption Ratio (DAR) is the ratio of the 1-minute insulation resistance to the 30 second insulation resistance. Insulation tests should only be performed on de-energized circuits. This is an automated timed test providing a ratio of 60s/30s to identify moisture or contamination in connectors, motors, transformers, actuators, and aircraft wiring installations. DAR values change with moisture and temperature. Follow instructions to compare with like wiring if low readings result in moist &/or hot locations.

Component Maintenance Manuals (CMM) provide insulation resistance test procedures and values in order to evaluate health of each component. Review CMM procedure and use the generic equipment procedure below to evaluate health of components on-wing during intermittent fault isolation or to conduct health checks. While most passive components utilize industry standards of 100 megohms minimum resistance and/or 1.2 DAR at 500 VDC, please ensure to review CMM values and connection points prior to testing.

SUBTASK 20-10-39-020-003

- (1) Disconnect the applicable connectors from the unit under test.

SUBTASK 20-10-39-210-003

- (2) Examine the electrical connectors for bent or broken pins/sockets, dirt, and damage.

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SUBTASK 20-10-39-480-003

NOTE: For this example, assume we are testing a passive component on-wing at its connector using Figure 501, a flap position sensor consisting of an input drive frame driving one resolver and one transmitter.

- (3) Do these steps to connect the insulation resistance tester to the applicable component.

Perform DAR Insulation Resistance Test from the LRU connector and record the resistance values between:

- Resolver to Case
- Transmitter to Case
- Transmitter to Resolver

To facilitate rapid testing, the technician may use a breakout box or harness to connect multiple points together as discussed in previous IRT tests above.

- (a) Follow the tester instructions to install test probes, set tester to 50 VDC range and select insulation test function.
- (b) Connect the probes to the circuit to be measured.
- (c) Push, hold, and then release the "Insulation Resistance" button to momentarily apply 50 VDC.
 - 1) The secondary display shows the test voltage applied to the circuit under test. The high voltage symbol along with a primary display showing the resistance in MΩ appears. The TEST icon appears on the lower portion of the display until the test button is released.
 - 2) When resistance is higher than the maximum display range, the meter displays the > symbol and the maximum resistance for the range.
 - 3) Make sure that the circuit is isolated, open or > 5 megaohms.
- (d) Set the test mode to DAR by pressing PI/DAR button until DAR is displayed on the meter (insulation resistance multimeter, COM-17798).
- (e) Connect the probes to the circuit to be measured.
- (f) Push and release the "Insulation Resistance" button to start the 60 second 500 VDC test.
- (g) The secondary display shows the test voltage applied to the circuit under test. The high voltage symbol along with a primary display showing the resistance in MΩ appears. The TEST icon appears on the lower portion of the display until the test is complete.
- (h) When the test is completed, the PI or DAR value is displayed on the primary display. If either value used to calculate PI or DAR was greater than the maximum display range, or the 1-minute value was greater than 5000 megohms, the primary display will show Err. This is a good reading.
- (i) Record the DAR.
- (j) The insulation resistance between all terminals and case and between all mutually isolated terminals should not be less than 50 megaohms or greater than 10 microamps or less than 1.0 DAR at 500 VDC. Verify particular component values in the applicable AMM, FIM or CMM.
- (k) If values exceed the CMM values, perform the following:
 - 1) DAR values change with moisture and temperature. Compare measurements with like components; e.g. similar flap position sensor. If like component reads ok, then consider component insulation is contaminated or contains moisture.

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- 2) Clean LRU connector and retest. If still out of limits, and like components test ok, consider scheduling for replacement.

H. Put the Airplane Back to Its Usual Condition

SUBTASK 20-10-39-420-003

- (1) When the test is complete, do the following steps:
 - (a) On the applicable LRU, Remove conductive dust cap and connector cover.
 - (b) Reconnect the applicable electrical connector(s) to the applicable LRU(s).

———— **END OF TASK** ————

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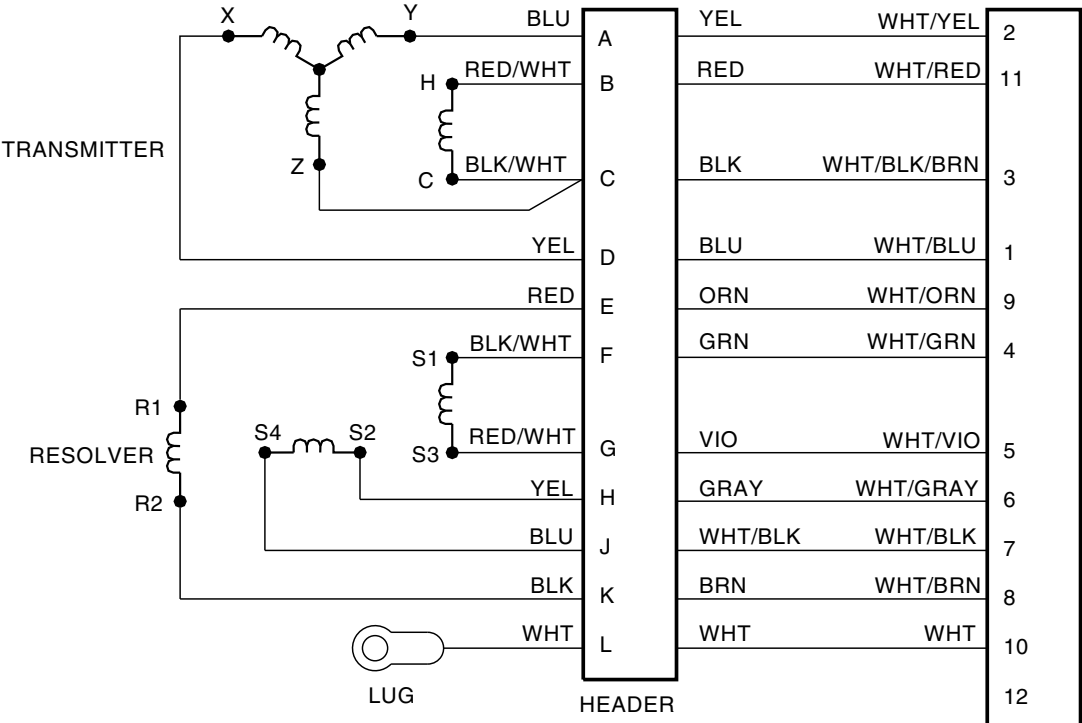
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Dielectric Absorption Rate – Passive Components Testing (Example)
Figure 501/20-10-39-990-801

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CONTROL CABLE GROMMET - REMOVAL/INSTALLATION

1. General

A. This procedure has these tasks:

- (1) A removal of the control cable grommet.
- (2) An installation of the control cable grommet.

B. You can replace the control cable grommets in the $\frac{3}{4}$ in. (19.05 mm), 1 in. (25.40 mm), and $1\frac{1}{4}$ in. (31.75 mm) holes with the control cable removed or installed. You have two alternatives for the replacement of an NAS1368 plastic grommet with the control cable installed:

- (1) You can use a replacement NAS1368 grommet and cut one side of the grommet for installation.
- (2) You can use a BACG20H nylon grommet, which is a divided grommet.

TASK 20-10-41-000-801

2. Control Cable Grommet Removal

(Figure 401)

A. Control Cable Grommet Removal

SUBTASK 20-10-41-020-001

- (1) Cut the grommet to remove the grommet from the bulkhead.

———— **END OF TASK** ————

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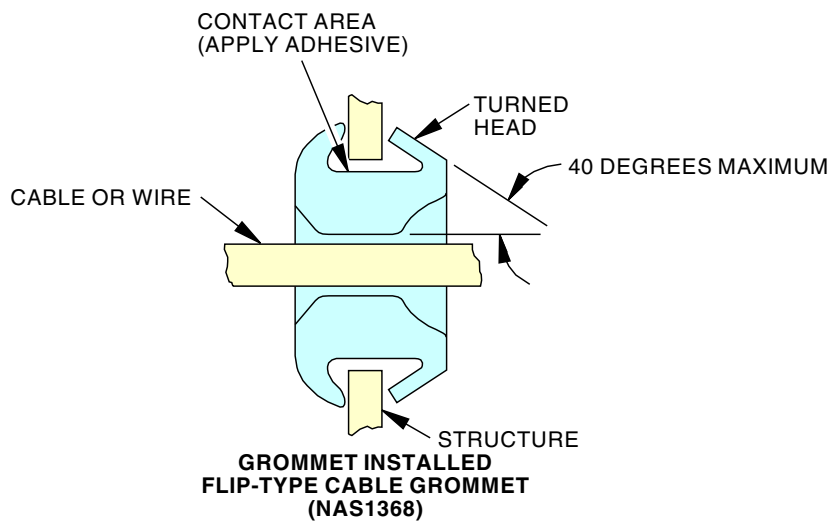
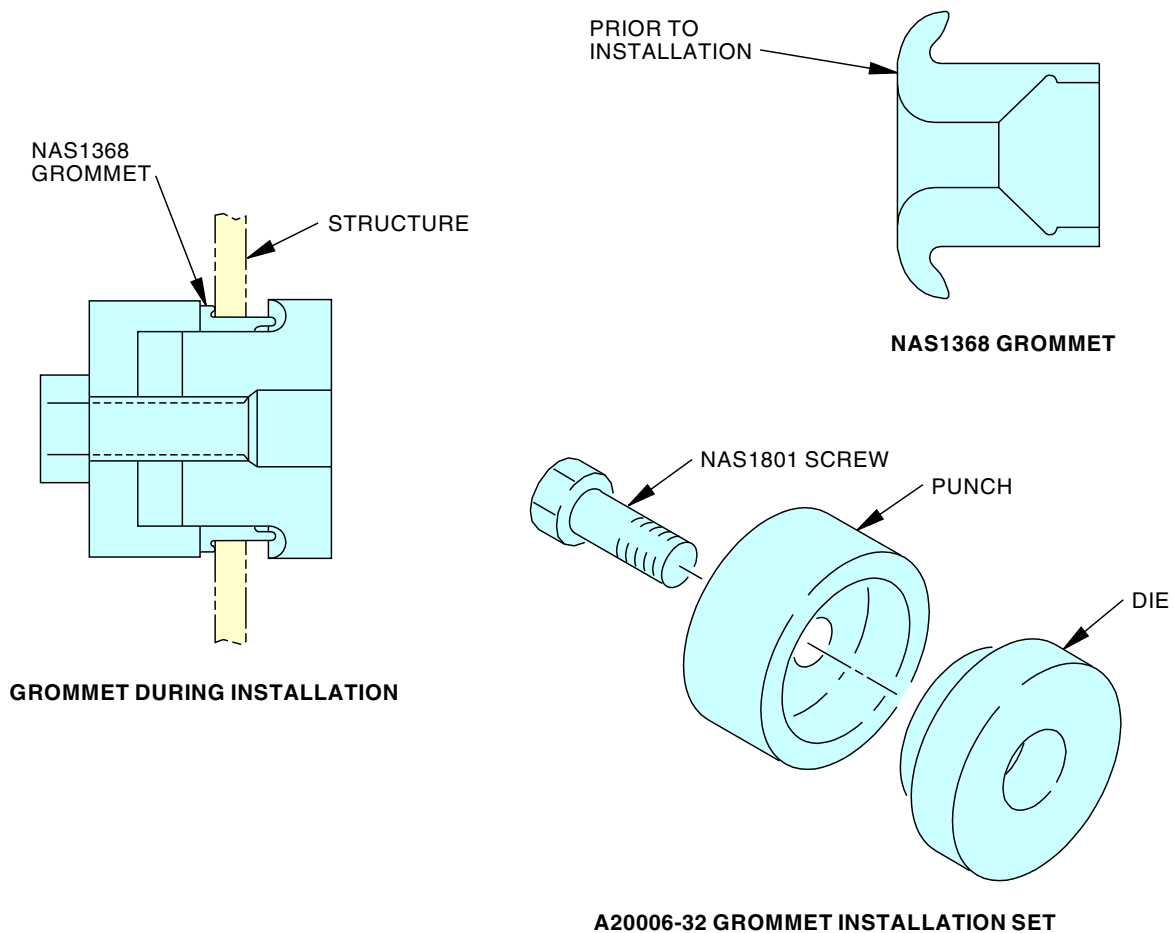
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Control Cable Grommets Installation
Figure 401/20-10-41-990-801

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TASK 20-10-41-400-801

3. Control Cable Grommet Installation

(Figure 401)

A. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

Reference	Description
SPL-1549	Set - Installation, NAS 1368 Grommets Part #: A20006-32 Supplier: 81205 Opt Part #: ST1065C Supplier: 81205

B. Consumable Materials

Reference	Description	Specification
A00119	Adhesive - Synthetic Rubber Cement, Naphtha Soluble	BMS5-55
A00134	Adhesive - Synthetic Rubber, Buna-N, 1 Part, Fuel Resistant	BMS5-14
A00153	Adhesive - Low Odor, Synthetic Rubber Cement	BMS5-30
A00273	Adhesive - Epoxy Polyamide, 2 Part, Natural Colored	BMS5-126 Type II Class 1
A00435	Adhesive - Epoxy Polyamide, 2 Component, Natural Color	BMS5-126 Type III Class 1
B00062	Solvent - Acetone (99.5% Grade)	ASTM D 329 (Supersedes O-A-51)
B00130	Alcohol - Isopropyl	TT-I-735

C. Control Cable Grommet Installation with the Control Cable Removed

SUBTASK 20-10-41-110-001



DO NOT GET SOLVENTS IN YOUR MOUTH, YOUR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM SOLVENTS. SOLVENTS ARE DANGEROUS MATERIALS. SOLVENTS CAN BE FLAMMABLE OR CAUSE DAMAGE TO THE ENVIRONMENT. REFER TO THE MATERIAL SAFETY DATA SHEETS (MSDS) AND THE LOCAL SAFETY PRECAUTIONS.

- (1) Clean the bulkhead area that will touch the grommet with solvent, B00062, or alcohol, B00130.

SUBTASK 20-10-41-640-001

- (2) Apply adhesive, A00273, or adhesive, A00435, on the NAS1368 grommet area that will touch the bulkhead.

SUBTASK 20-10-41-420-001

- (3) Put the grommet in the bulkhead hole.

SUBTASK 20-10-41-480-001

- (4) Put the grommet tool NAS 1368 grommet installation set, SPL-1549, around the grommet and tighten the NAS1801 screw.

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SUBTASK 20-10-41-080-001

- (5) Remove the grommet tool.

NOTE: The grommet can be loose in the bulkhead hole, but it should not fall out.

D. Control Cable Grommet Installation with the Control Cable Installed

SUBTASK 20-10-41-110-002



DO NOT GET SOLVENTS IN YOUR MOUTH, YOUR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM SOLVENTS. SOLVENTS ARE DANGEROUS MATERIALS. SOLVENTS CAN BE FLAMMABLE OR CAUSE DAMAGE TO THE ENVIRONMENT. REFER TO THE MATERIAL SAFETY DATA SHEETS (MSDS) AND THE LOCAL SAFETY PRECAUTIONS.

- (1) Clean the bulkhead area that will touch the grommet with solvent, B00062, or alcohol, B00130.

SUBTASK 20-10-41-420-002

- (2) Do these steps to install the NAS1368 grommet:
- (a) Cut one side of the NAS1368 grommet.
 - (b) Place the grommet over the control cable.
 - (c) Apply adhesive, A00273, or adhesive, A00435, on the NAS1368 grommet area that will touch the bulkhead.
 - (d) Install the grommet in the bulkhead hole.
 - (e) Align the slit part of the grommet at the 12 o'clock position.

SUBTASK 20-10-41-420-003

- (3) Do this step to install the BACG20H grommet:
- (a) Apply adhesive, A00119, or adhesive, A00153, or adhesive, A00134, on the BACG20H grommet area that will touch the bulkhead.
 - (b) Install the grommet in the bulkhead hole.
 - (c) Align the cut part of the grommet at the 12 o'clock position.

————— **END OF TASK** —————

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LOCKING DEVICES - REMOVAL/INSTALLATION

1. General

A. This procedure has these tasks:

- (1) A removal of the lockwire, cotter pins, and lockrings.
- (2) An installation of the lockwire, cotter pins, and lockrings.
- (3) A removal of the safety cable.
- (4) An installation of the safety cable.

TASK 20-10-44-000-801

2. Lockwire, Cotter Pins, and Lockrings - Removal

(Figure 401, Figure 402, Figure 403)

A. Remove the Lockwire, Cotter Pins, and Lockrings

SUBTASK 20-10-44-020-001

- (1) Cut and remove the lockwire or remove the cotter pin or lockring.

———— **END OF TASK** ————

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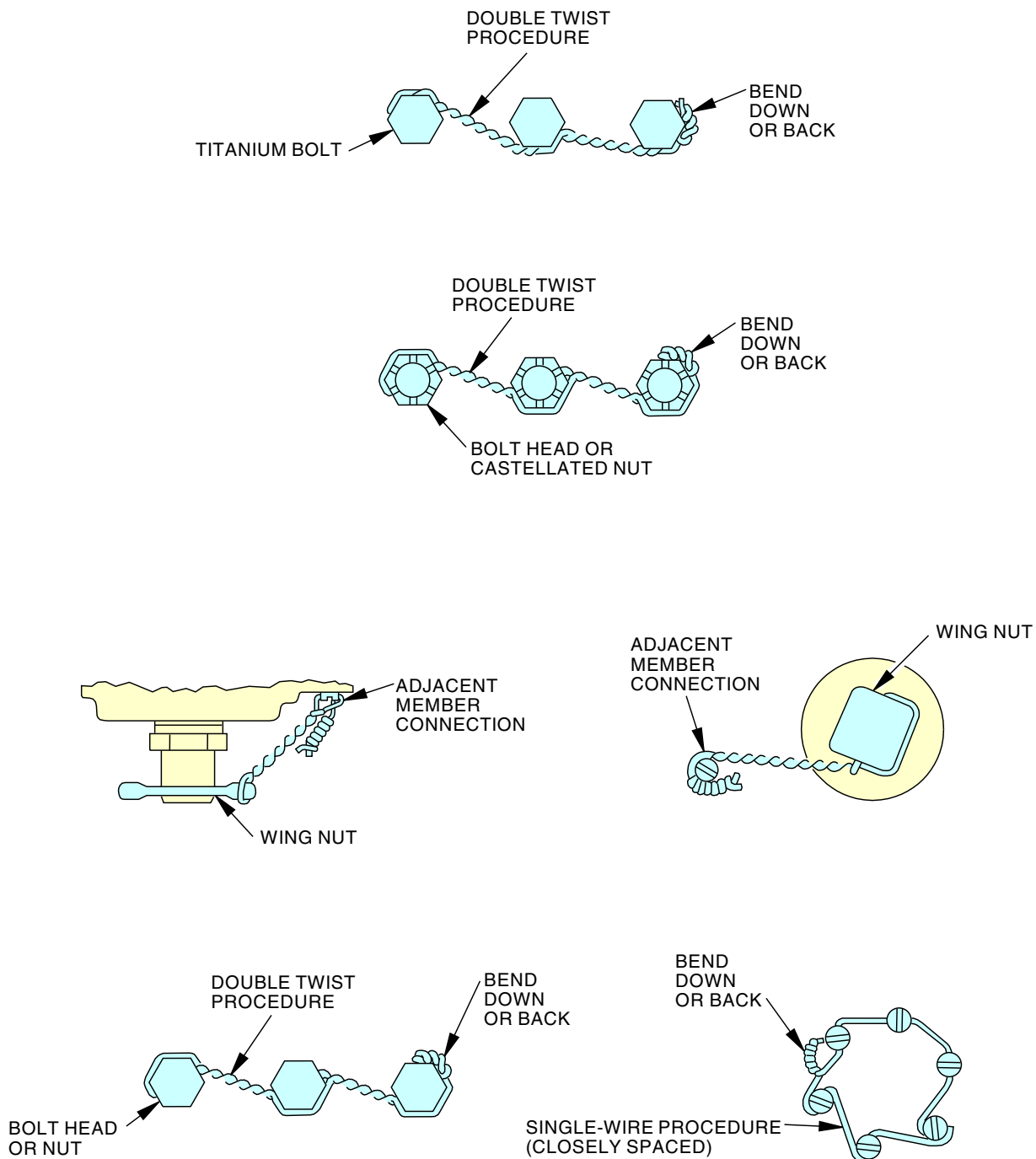
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Lockwire Installation
Figure 401/20-10-44-990-801

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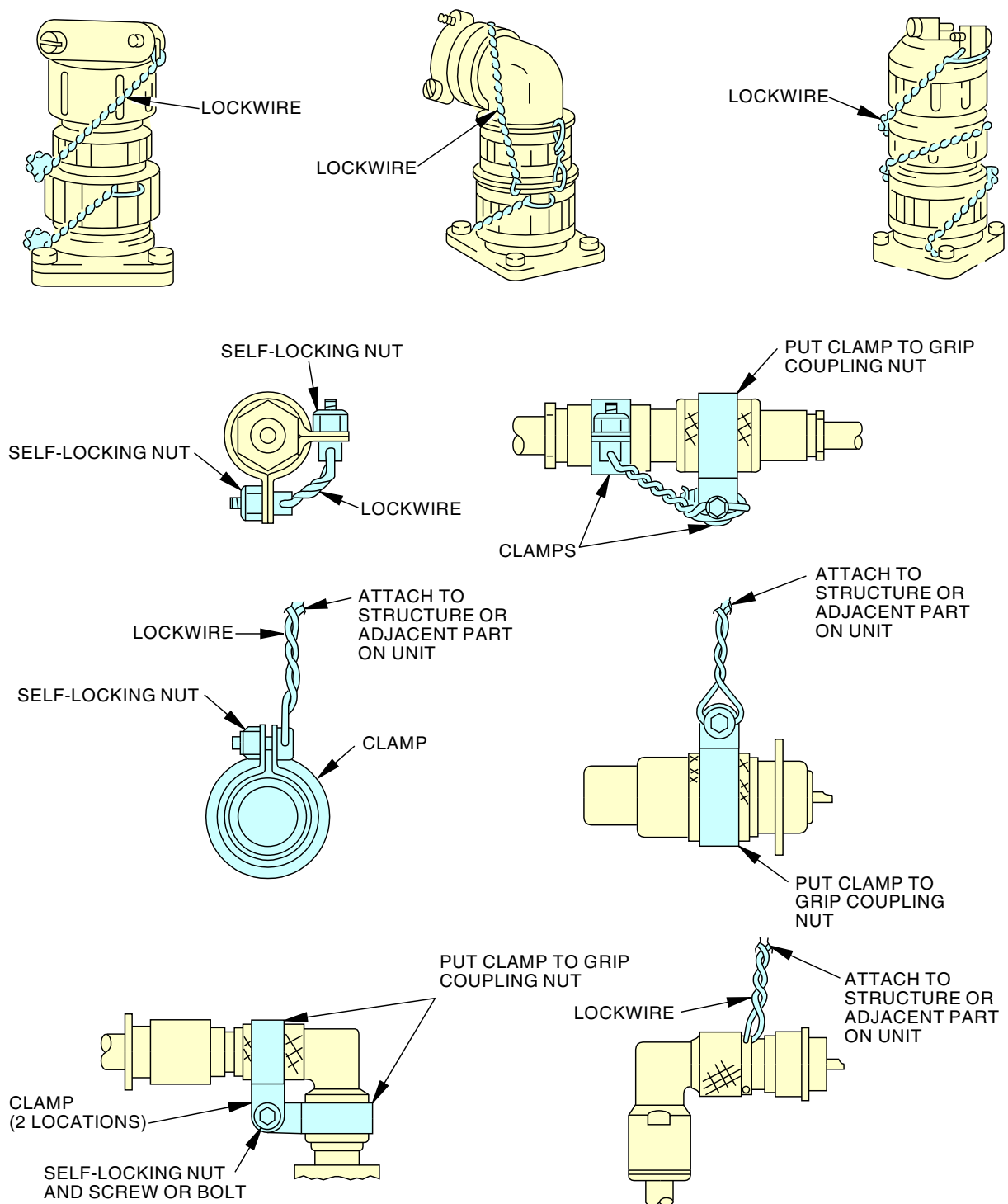
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Connector Lockwire Installation
Figure 402/20-10-44-990-802

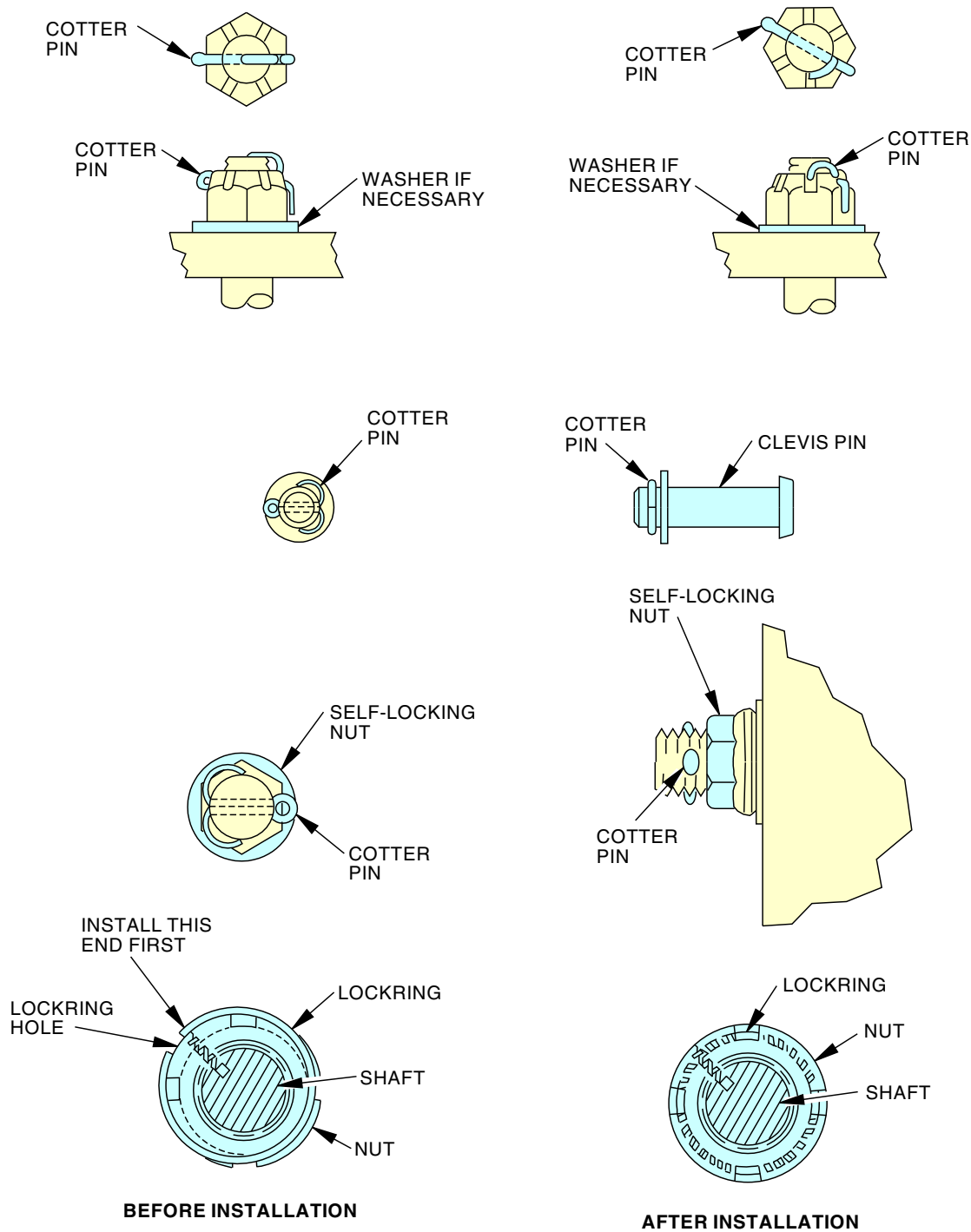
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Locking Pins Installation
Figure 403/20-10-44-990-803

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TASK 20-10-44-400-801

3. Lockwire, Cotter Pins, and Lockrings - Installation

(Figure 401, Figure 402, Figure 403)

A. General

- (1) CRES, MONEL, and INCONEL lockwire (safety wire) interchangeability:
 - (a) CRES, MONEL, and INCONEL lockwires are interchangeable when the same length and diameter are used. They are not interchangeable in areas (systems) where temperatures are more than 700°F (371°C). Or where the magnetic properties of CRES can cause a magnetic field that can cause some problems to sensitive instruments.
 - (b) INCONEL must be used for all areas where the temperature is more than 700°F (371°C).
 - (c) If a specific lockwire material is listed in a maintenance procedure, Boeing recommends to use the listed material if available. Otherwise, follow the interchangeability data above.
- (2) Copper wire (Wire sealing):
 - (a) Application of copper wire (safety cable) is a practice for the security of selected switches, levers, switchguards, etc., to deter inadvertent operation, to allow for physical breakout in an emergency, to identify to the Flight Crew and Engineers that, when present and intact, the relevant switches, levers, switchguards, etc., are in their correct configuration positions, to show that no person has used the emergency equipment.

NOTE: Safety cable must be installed on a switch guard if the switch guard had lockwire before maintenance.

 - 1) Copper wire, 0.015 in. (0.381 mm) diameter is the only option for switch guard safety cabling.
 - (b) Wireseal the following emergency equipment: portable fire extinguishers, first aid kits, emergency valve, and oxygen regulators.
 - 1) Copper wire, 0.020 in. (0.508 mm) diameter, must be used on safety critical/emergency devices, and where a lead seal is required, such as on portable fire extinguishers, first aid kits, emergency valves and oxygen regulators.

NOTE: You must not deviate from the Portable Fire Extinguisher (PFE) manufacturer's specification. Copper wire can only be used as a wireseal on a PFE when the PFE drawing or the Component Maintenance Manual (CMM) specifies its use.
 - 2) Make a 3- to 6-twist pigtail near the ends of the wire, then compress the metal pellet on the wire in such a manner that the wire cannot be removed unless you break the pellet or the wire.
 - (c) Copper wire is not interchangeable with CRES, MONEL, and INCONEL lockwire.
- (3) Clad 5056 Aluminum alloy wire should be used for lockwire which touches magnesium to prevent galvanic corrosion.
- (4) Lockwiring guidelines:
 - (a) Do not use lockwire more than once.
 - (b) Install lockwire so it is in tension when the parts become loose.
 - (c) Make three to six twists at the end of the wire. Bend the twists back or under to give the ends protection so they will not catch something.
 - (d) Use the double twist procedure for all lockwire unless a single wire procedure is specified.

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- (e) Install and twist the safety wire so the loop around the head stays down. (If the loop tended to come up over the bolt head there would be a slack loop.)
- (f) For multiple fasteners spaced less than 4 in. (10 cm) apart, the maximum number which can be safety wired together shall be the number than can be wired with a 24 in. (61 cm) length of wire.
- (g) For fasteners 4 in. (10 cm) to 6 in. (15 cm) apart, wire together in series no more than three fasteners.
- (h) Where fasteners are more than 6 in. (15 cm) apart, do not tie them in series unless tie points are provided on adjacent parts to shorten the wire span to less than 6 in. (15 cm).
- (i) Use a right-handed twist for all double twist installations.
- (j) Safety wire diameter shall be between 1/3 and 3/4 of the hole diameter, 0.032 in. (0.813 mm) diameter minimum.
- (k) Safety wire 0.020 in. (0.508 mm) in diameter may be used if:
 - 1) The safety wire hole is 0.045 in. (1.143 mm) diameter or smaller, or
 - 2) The spacing between parts is less than two inches and the safety wire hole diameter is between 0.045 in. (1.143 mm) and 0.062 in. (1.575 mm) in diameter.

TWIST PER INCH					
SAFETY WIRE DIA. INCH	LESS THAN 0.019	0.019 TO 0.026	0.023 TO 0.042	0.043 TO 0.065	MORE THAN 0.065
Twist/Inch	11 to 14	9 to 12	7 to 10	5 to 8	4 to 7

Lockwire Material Specification

NASM20995()	
CRES	C
MONEL	NC
INCONEL	N
Copper	CY

B. Install the Lockwire, Cotter Pins, and Lockrings

SUBTASK 20-10-44-800-001

- (1) Use these types of wires for lockwire:
 - (a) Use monel, inconel, or corrosion-resistant lockwire in high temperature areas.
 - (b) Use copper wire, 0.020 in. (0.508 mm) in diameter, on emergency equipment only.
NOTE: Use it where a wireseal is necessary on emergency equipment to show no person has used the equipment. Emergency equipment includes portable fire extinguishers, first aid kits, emergency valve, and oxygen regulators.
NOTE: You must not deviate from the PFE manufacturer's specification. Copper wire can only be used as a wireseal on a PFE when the PFE drawing or the CMM specifies it's use.
 - (c) Use copper wire (safety cable), 0.015 in. (0.381 mm) diameter on switches, levers, and switchguards.
NOTE: Use it where a safety cable is necessary on switches, levers and switchguards to show no person has used the switch, lever or opened the switchguard.
 - (d) Use Clad 5056 aluminum alloy wire for lockwire that touches magnesium to prevent galvanic corrosion.

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- (e) This table shows standard wire sizes.

Table 401/20-10-44-993-801

BAC Standard Wire Sizes	
MATERIAL	SIZE (INCH)
Monel or Inconel	.020 .032 .040 .051 .091
Corrosion Resistant Steel	.020 .032 .041 .047 .091
Aluminum Alloy	.020 .032 .041 .047 .091

SUBTASK 20-10-44-420-001

- (2) Use these steps to install lockwire to bolts and screws (Figure 401, Figure 402, Figure 403):
- On all fittings where you install lockwire, attach the fitting to the mating part or an adjacent part.
 - Install lockwire for right threads as shown.
 - Install lockwire for left threads opposite to that shown.
 - Make sure the loop of double wire goes around, not above, the head of the bolt or screw.



DO NOT LOOSEN OR TIGHTEN A NUT OR A BOLT OUT OF ITS SPECIFIED TORQUE RANGE. DAMAGE CAN OCCUR.

- (e) When you install lockwires on nuts and bolts, tighten the nuts and bolts to the low values of the torque range.

NOTE: If necessary, continue to tighten until a slot aligns with the safety hole.

SUBTASK 20-10-44-420-002

- (3) To install lockwire on electrical connectors, (Figure 402).
- Use the instructions for the installation of lockwires to bolt and screws when you install lockwires on electrical connectors.

SUBTASK 20-10-44-420-003

- (4) To install cotter pins (Figure 403), do the applicable step:
- To install cotter pins in castellated nuts, install the pin with the head parallel to the slot in the nut.
 - Bend the cotter pin ends to the bolt end or to the castellated nut's slit adjacent to the pin end.
 - To install cotter pins and washers on clevis pins, put the pin through the hole on the bolt and bend the pin ends around the side of the bolt.
 - To install cotter pins in non-castellated nuts, install the pin through the hole on the bolt and bend the pin ends back on each side of the bolt approximately 90 degrees.

SUBTASK 20-10-44-420-004

- (5) To install lockrings (Figure 403), do these steps:
- Put the bent hook of the lockring into an aligned locking hole in the shaft and nut but do not spring the ring.
 - Move the lockring over the flange into the groove with minimum expansion of the lockring.

————— END OF TASK —————

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TASK 20-10-44-000-802

4. Safety Cable Removal

A. Remove the Safety Cable

SUBTASK 20-10-44-020-002

- (1) Cut and remove the safety cable.

————— END OF TASK —————

TASK 20-10-44-400-802

5. Safety Cable Installation

A. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

Reference	Description
COM-2046	Tool - Installation, Safety Cable, 0.032 Inch Dia, 5 Inch Tool Nose Part #: BM325 Supplier: 70958 Opt Part #: M305 Supplier: 70958
COM-2048	Tool - Installation, Safety Cable, 0.020 Inch Dia Part #: BM203 Supplier: 70958 Part #: SCT203 Supplier: 11851 Part #: SCT207 Supplier: 11851

B. Install the Safety Cable

SUBTASK 20-10-44-420-005

- (1) The use of corrosion and heat resistant safety cable is acceptable in place of safety wire only if specified by engineering documents.

SUBTASK 20-10-44-420-006

- (2) A maximum of 3 fasteners can be safety-cabled together in series.

SUBTASK 20-10-44-420-007

- (3) The maximum space between fasteners to be safety-cabled together must not exceed 6 in. (152 mm).

SUBTASK 20-10-44-420-008

- (4) Make sure that the safety cable is installed so that the only tension imposed on the cable is from the safety cable installation tool, COM-2048, or safety cable installation tool, COM-2046.

NOTE: Nicks, frays, kinks and other mutilations of the safety cable between tension points are not acceptable.

SUBTASK 20-10-44-420-009

- (5) The maximum hole diameter shall be in accordance with this table:

Maximum Cable Hole Diameters

Cable Diameter	Max Hole Diameter
0.022 in. (0.559 mm) to 0.026 in. (0.660 mm)	0.035 in. (0.889 mm)
0.032 in. (0.813 mm) to 0.038 in. (0.965 mm)	0.080 in. (2.032 mm)
0.040 in. (1.016 mm) to 0.046 in. (1.168 mm)	0.080 in. (2.032 mm)

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SUBTASK 20-10-44-420-010

- (6) The safety cable must meet the flex requirements of this table:

Safety Cable Flex Limits

Space Between Fastener	Maximum Flex at Center
0.0 in. (0.0 mm) to 0.5 in. (12.7 mm)	0.125 in. (3.175 mm)
0.5 in. (12.7 mm) to 1.0 in. (25.4 mm)	0.250 in. (6.350 mm)
1.0 in. (25.4 mm) to 2.0 in. (50.8 mm)	0.375 in. (9.525 mm)
2.0 in. (50.8 mm) to 3.0 in. (76.2 mm)	0.375 in. (9.525 mm)
3.0 in. (76.2 mm) to 4.0 in. (101.6 mm)	0.500 in. (12.700 mm)
4.0 in. (101.6 mm) to 5.0 in. (127.0 mm)	0.500 in. (12.700 mm)
5.0 in. (127.0 mm) to 6.0 in. (152.4 mm)	0.625 in. (15.875 mm)

SUBTASK 20-10-44-420-011

- (7) Make sure that the die indentation extends a minimum length from the outer end of the ferrule as specified in this table:

NOTE: Correctly crimped ferrules have a general triangular shape.

Minimum Die Indentation Length

Cable Diameter	Minimum Extension
0.032 in. (0.813 mm), 0.040 in. (1.016 mm)	0.100 in. (2.54 mm)
0.022 in. (0.559 mm)	0.075 in. (1.905 mm)

- (a) The cut cable shall extend a maximum of 0.06 in. (1.52 mm) beyond the installed ferrule.

————— **END OF TASK** —————

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**SEALS ON OPEN ELECTRICAL TERMINALS IN FLAMMABLE LEAKAGE ZONES - MAINTENANCE
PRACTICES**

1. General

- A. This procedure has this task:
- (1) The task is to seal the uninsulated electrical terminals and connections in the flammable leakage zones.
- B. When you replace or install components on the lighting systems in flammable leakage zones, seal these uninsulated items:
- (1) Lamp terminals
 - (2) Terminal strips
 - (3) Circuit breakers
 - (4) Transformers
 - (5) Switches
 - (6) Hardwire
 - (7) Wire junctions.
 - (8) Lamp terminals with a rubber sleeve are open.
- C. Do not seal the dual grounds in the flammable leakage zones or the wire junctions in fuel tanks.
- D. Do not seal the generator terminals on the engines or APU.
- E. Install wire and protectors on all secondary switch leads and seal all secondary switch terminals in the flammable leakage zones. Insulated splices are not open.
- F. To identify flammable leakage zones, (SWPM 20-30-00), Protection of Electrical Connections in a Flammable Leakage Zone.

TASK 20-10-47-390-801

2. Seal the Unprotected Terminals

(Figure 201)

A. References

Reference	Title
SWPM 20-30-00 Electrical Connection of Equipment	Standard Wiring Practices Manual

B. Tools/Equipment

Reference	Description
STD-1080	Brush - Paint

C. Consumable Materials

Reference	Description	Specification
B00083	Solvent - VM&P Naphthas	TT-N-95 Type II, ASTM D-3735 Type III
G00034	Cotton Wiper - Process Cleaning Absorbent Wiper (Cheesecloth, Gauze)	AMS3819 Class 1 Grade A or B Form 1 (Supersede BMS15-5 CLA)

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D. Procedure

SUBTASK 20-10-47-110-001

- (1) Remove all dirt and grease for a minimum of 1.00 in. (25.40 mm) adjacent to the area you will seal.
 - (a) Use a cotton wiper, G00034 moist with solvent, B00083.

SUBTASK 20-10-47-390-001



DO NOT SEAL THE SHANK OF LAMP TERMINALS THAT ARE MOVABLE SPRING-LOADED PART OF THE BAYONET LAMP SOCKET BASE. SEAL ONLY THE TERMINAL END AND ATTACHED HARDWARE. SEALANT ON THE SHANK LIMITS MOVEMENT OF THE LAMP CONTACT.

- (2) Use a paint brush, STD-1080 to apply one layer of sealant to the uninsulated areas.
 - (a) Refer to SWPM 20-30-00 Electrical Connection of Equipment, Protection of Electrical Connections in a Flammable Leakage Zone, for approved sealants.

SUBTASK 20-10-47-390-002

- (3) On ring torque terminals, apply sealant as follows:
 - (a) Apply sealant to the uninsulated parts of the terminal.

———— **END OF TASK** ————

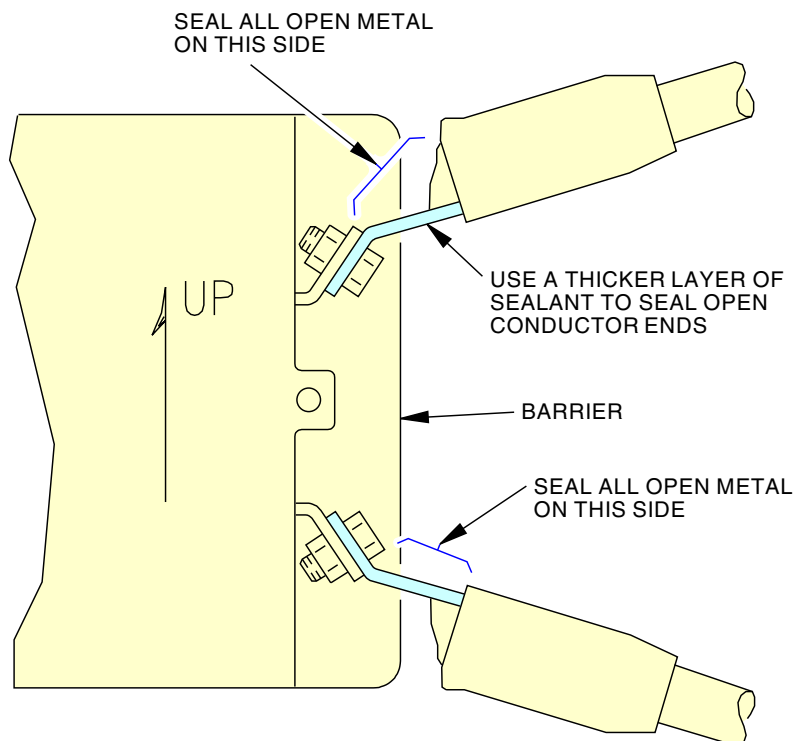
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Sealant Installation on Ring Tongue Terminals
Figure 201/20-10-47-990-801

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DETERMINE INSTALLATION TORQUE FOR TUBES/FITTINGS/HOSES

TASK 20-10-51-910-801

1. Tube Material and End Fitting Determination for Hydraulic Tube Assembly

(Figure 202)

A. General

- (1) This task provides the steps on how to find the material specification and size for hydraulic tube assemblies and associated end fittings. The information in this task can be used when a specific torque value is not given in the procedure. For further information, please refer to Service Letter per model (Table 201).

Table 201/20-10-51-993-841 Service Letter for All Models

Models
737-SL-29-118
747-SL-29-077
757-SL-29-053
767-SL-29-066
777-SL-29-040

B. Procedure

SUBTASK 20-10-51-910-001

- (1) Use the Boeing drawing system to determine tube material and end fittings:
- (a) Review the Parts List (PL) for the Tube Assembly
- NOTE: GA notes indicate hydraulic system, tube size and material
- NOTE: Material specification may be referred to by either the short or long nomenclature on the PL. For hydraulic tubes assemblies, TI is equivalent to 3AL-2.5V titanium, CRES is equivalent to 21-6-9 corrosion resistant steel, and AL is equivalent to 6061-T6 aluminum.
- (b) Determine the outer diameter in inches
- NOTE: Dimension may also be referred to as a size or dash number. For example, a Hydraulic System A with dimension 3/8 can also be defined as sixteenths of an inch = $6/16$ = size 06 or —6.
- (c) Review breakdown of tube sizes and corresponding thread sizes. (Table 202)

Table 202/20-10-51-993-842 Typical Tube Size Designation/Corresponding Thread

Tube - Actual Diameter (inches)	Tube Size in Sixteenths of an Inch	Typical Dash No. Designation	Typical Size Designation	Corresponding Thread Size for Threaded End
1/4	4	-4	04	0.4375-20
3/8	6	-6	06	0.5625-18
1/2	8	-8	08	0.7500-16
5/8	10	-10	10	0.8750-14
3/4	12	-12	12	1.0625-12

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Table 202/20-10-51-993-842 Typical Tube Size Designation/Corresponding Thread (Continued)

Tube - Actual Diameter (inches)	Tube Size in Sixteenths of an Inch	Typical Dash No. Designation	Typical Size Designation	Corresponding Thread Size for Threaded End
1	16	-16	16	1.3125-12
1-1/4	20	-20	20	1.6250-12
1-1/2	24	-24	24	1.8750-12
2	32	-32	32	2.5000-12

- (d) Review the same entry in the Parts List (PL) to determine the end fittings for the Tube Assembly.

NOTE: For example, may need 2 each P/N AS1581T06 sleeves ("T" in P/N means titanium material) and 2 each P/N BACN10YA6L B-nuts (N10YA nut made from titanium material). (See Figure 202)

NOTE: Contact Boeing if no drawing system access is available.

SUBTASK 20-10-51-800-001

- (2) Use Tubing Specification and Wall Thickness table for Hydraulic Tubes:

NOTE: The table shows the standard tube materials, related procurement specification, tube diameter and wall thickness. The tube materials and respective outside diameters/wall thickness listed in the table include 3AL-2.5V titanium, 21-6-9 corrosion resistant steel (CRES) and 6061-T6 aluminum.

- (a) Information is provided for all models in Table 203

Table 203/20-10-51-993-843 Tube Specification and Wall Thickness Table for All Models

Models	Location in AMM
737-300/400/500	20-10-51/801
737-600/700/800/900	20-10-51/801
737-7/8/8200/9	20-10-51/801
747-100/200	20-11-05/801
747-400	20-11-05/801
747-8	20-11-05/801
757	20-10-09/801
767	20-10-09/801
777	20-10-09/801

SUBTASK 20-10-51-800-002

- (3) Use Cross Reference of Tubing table to correspond to Boeing Material Specification (BMS):

- (a) Information is provided for all models in Table 204

Table 204/20-10-51-993-844

Models	Location in AMM
737-300/400/500	20-10-51/801
737-600/700/800/900	20-10-51/801

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Table 204/20-10-51-993-844 (Continued)

Models	Location in AMM
737-7/8/8200/9	20-10-51/801
747-100/200	20-11-05/801
747-400	20-11-05/801
747-8	20-11-05/801
757	20-10-09/801
767	20-10-09/801
777	20-10-09/801

SUBTASK 20-10-51-800-003

- (4) Use Hydraulic Tubing Material Identification in Multi-Model Maintenance Tip to determine the material of hydraulic tubing:
- (a) Information is provided for all models in Table 205

Table 205/20-10-51-993-845 Multi-Model Maintenance Tip Table for All Models

Models
737NG-737 MT 29-014
747-8 MT 29-027
747-400 MT 29-007
757 MT 29-007
767 MT 29-012
777 MT 29-008

SUBTASK 20-10-51-200-001

- (5) Use the Illustrated Parts Catalog (IPC) to find the type of material that you will attach each end of the tubing to:
- NOTE:** This step is necessary to determine the torque value that you will apply to the reconnectable fittings on the ends of the tube assembly. For example: A titanium B-nut that will be assembled to an aluminum fitting will require a lower torque value than is required for a similar fitting made from titanium or CRES material.
- (a) Hydraulic fittings have the material code marked on the wrench pas area. Use Table 206 to identify the materials

Table 206/20-10-51-993-846 Hydraulic Fitting Material Codes

Codes	Material
"No Code" or "-"	Carbon Steel with Cadmium Plate Finish
"D"	2014/2024 Aluminum - Green Anodize Finish ("D" code now inactive)
"H"	15-5PH CRES - no Finish (dull gray to metallic bright)- See also "V" code. "H" used for earlier fittings in the 15-5PH CRES material, such as flareless BACS13BX sleeves and BACU24AB unions ("H" + "P" suffix code used for these fittings in 15-5PH CRES material with Cadmium plate finish)
"J"	304 CRES - no finish (dull gray to metallic bright)

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Table 206/20-10-51-993-846 Hydraulic Fitting Material Codes (Continued)

Codes	Material
"K"	3169 CRES - no finish (dull gray to metallic bright)
"P"	15-5PH CRES with Cadmium Plate Finish*
"R"	321 CRES - no Finish (dull gray to metallic bright)
"S"	347 CRES (now cancelled)
"T"	6AL-4V Titanium - usually Gray from Fluoride Phosphate Finish
"V"	15-5PH CRES - no Finish (dull gray to metallic bright)*
"W"	7075 Aluminum - Brown Anodize Finish
"V — P"	15-5PH CRES with Cadmium Plate Finish

SUBTASK 20-10-51-910-002

(6) Select and apply the correct torque value as follows:

(a) Use Table 207 to locate the correct torque values per model for Flareless Tubing Fittings:

Table 207/20-10-51-993-847 Installation Torque for Flareless Tubing Fittings Table for All Models

Models	Location in AMM
737-300/400/500	20-50-11/201
737-600/700/800/900	20-50-11/201
737-7/8/8200/9	20-50-11/201
747-400	20-51-01/201
748-8	20-51-01/201
757	20-11-00/201
767	20-11-00/201
777	20-11-00/201

(b) Use Table 208 to locate the correct torque values per model for Flareless Fittings in pressurized area:

NOTE: Pressurized area refers to parts of the airplane that are subject to cabin pressure. These are cockpit, passenger and cargo.

Table 208/20-10-51-993-848 Installation Torque for Flareless Fittings in Pressurized Area

Models	Location in AMM
737-300/400/500	20-10-51/401
737-600/700/800/900	20-10-51/401
737-7/8/8200/9	20-10-51/401
747-400	20-51-01/401
747-8	20-11-05/401
757	20-10-09/401
767	20-10-09/401
777	20-10-09/401

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———— END OF TASK ————

TASK 20-10-51-910-802

2. Torque Values for Tubes, Hoses or Fittings installed to Components Determination

(Figure 20-10-52-990-805, Figure 201, Figure 202)

A. General

- (1) This task will help determine the correct torque value for Tubes, Hoses or Fittings installed to Components. For further information, refer to Service Letter per model. (Table 201)

B. References

Reference	Title
20-10-52-990-805	Figure: Hydraulic Hose Identification (P/B 201)

C. Procedure

SUBTASK 20-10-51-200-002

- (1) Determine torque for Hydraulic Tube or Hose End with seal (e.g. Union P/N MS21902) installed in Component Boss Port: (Figure 201)
- (a) Determine the materials:
- 1) Tube Assembly (see Tube Material and End Fitting Determination for Hydraulic Tube Assembly, TASK 20-10-51-910-801).
 - 2) Hose End (see Figure 20-10-52-990-805).
 - 3) Union (see Figure 202).
- (b) Use Component Maintenance Manual (CMM) to determine the component material.
- NOTE: Most components have flareless union fittings on their external ports. Determine the material of the union fitting (see Table 206).
- NOTE: Contact Boeing if no CMM access is available.
- (c) Select the correct torque (see Table 209).

Table 209/20-10-51-993-850 Selecting Torque for Tube or Hose Assembly on Mating Union or Component

--		Mating Union Fitting or Component Material (if no union fitting is present)		
		Aluminum	Corrosion Resistant Steel (CRES)	Titanium (Ti)
Tube Material or Tube End / Hose End Fitting Material	Aluminum or Annealed CRES	Use Aluminum Values	Use Aluminum Values	Use Aluminum Values
	Corrosion Resistant Steel(CRES)	Use Aluminum Values	Use CRES/Titanium Values	Use CRES/Titanium Values
	Titanium (Ti)	Use Aluminum Values	Use CRES/Titanium Values	Use CRES/Titanium Values

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USE TWO WRENCHES WHEN YOU TIGHTEN THE TUBE CONNECTORS. USE ONE WRENCH TO HOLD THE MATING TUBE ADAPTER. USE THE OTHER WRENCH TO TURN THE TUBE CONNECTOR. IF YOU DO NOT OBEY THIS INSTRUCTION, YOU CAN CAUSE DAMAGE TO THE TUBES.

- (d) Apply torque value for the end of the tube or hose assembly attached to the union fitting clockwise (see Table 207 and Table 208).

NOTE: Do not align or rotate fittings or tube assemblies after the joint has been tightened. Rotating the joint after tightening may cause leaks.

SUBTASK 20-10-51-200-003

- (2) Determine torque for Hydraulic Tube or Hose End installed to Union Fitting that has a Recessed Seal Boss End and Seal (e.g. Union Fitting P/N BACA14AZ with Flareless End per AS33541 and Boss End per BACD2037): (Figure 201)

- (a) Determine the materials:

- 1) Tube Assembly (see Tube Material and End Fitting Determination for Hydraulic Tube Assembly, TASK 20-10-51-910-801).
- 2) Hose End (See Figure 20-10-52-990-805).
- 3) Union (see Figure 202).

- (b) Use Component Maintenance Manual (CMM) to determine the component material.

NOTE: Most components have flareless union fittings on their external ports. Determine the material of the union fitting (see Table 206).

NOTE: Contact Boeing if no CMM access is available.

- (c) Select the correct torque (see Table 209).



USE TWO WRENCHES WHEN YOU TIGHTEN THE TUBE CONNECTORS. USE ONE WRENCH TO HOLD THE MATING TUBE ADAPTER. USE THE OTHER WRENCH TO TURN THE TUBE CONNECTOR. IF YOU DO NOT OBEY THIS INSTRUCTION, YOU CAN CAUSE DAMAGE TO THE TUBES.

- (d) Apply torque value for the end of the tube or hose assembly attached to the union fitting clockwise (see Table 207 and Table 208).

NOTE: Do not align or rotate fittings or tube assemblies after the joint has been tightened. Rotating the joint after tightening may cause leaks.

SUBTASK 20-10-51-200-004

- (3) Determine torque for Hydraulic Swivel Elbow Fitting (e.g. P/N BACE21BR) installed to Standard Union Fitting with Seal (e.g. Union P/N MS21902) in Component Boss Port: (Figure 201)

- (a) Determine the materials of Elbow Fitting and Union (see Figure 202).

- (b) Use Component Maintenance Manual (CMM) to determine the component material.

NOTE: Most components have flareless union fittings on their external ports. Determine the material of the union fitting (see Table 206).

NOTE: Contact Boeing if no CMM access is available.

- (c) Select the correct torque (see Table 209).

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USE TWO WRENCHES WHEN YOU TIGHTEN THE TUBE CONNECTORS. USE ONE WRENCH TO HOLD THE MATING TUBE ADAPTER. USE THE OTHER WRENCH TO TURN THE TUBE CONNECTOR. IF YOU DO NOT OBEY THIS INSTRUCTION, YOU CAN CAUSE DAMAGE TO THE TUBES.

- (d) Apply torque value for the end of the tube or hose assembly attached to the union fitting clockwise (see Table 207 and Table 208).

NOTE: Do not align or rotate fittings or tube assemblies after the joint has been tightened. Rotating the joint after tightening may cause leaks.

———— **END OF TASK** ————

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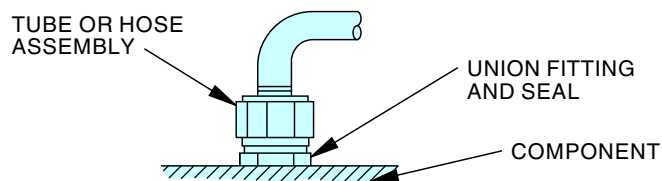
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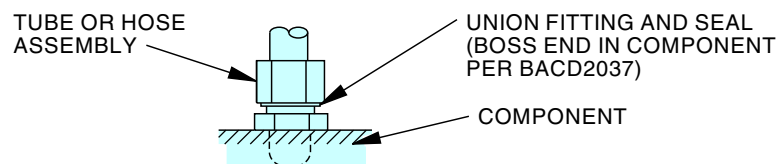
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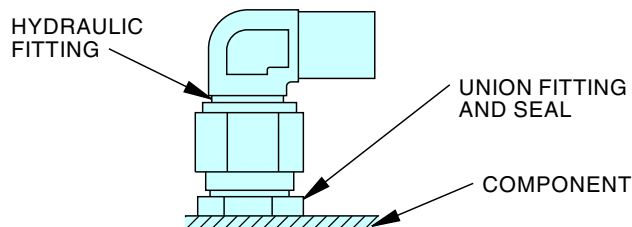
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HYDRAULIC TUBE OR HOSE END TO UNION WITH SEAL (eg., UNION P/N MS21902) INSTALLED IN COMPONENT BOSS PORT



HYDRAULIC TUBE OR HOSE END INSTALLED TO UNION FITTING THAT HAS A RECESSED SEAL BOSS END AND SEAL (eg., UNION FITTING P/N BACA14AZ WITH FLARELESS END PER AS33514 AND BOSS PER BACD2037)



SWIVEL ELBOW FITTING (eg., P/N BACE21BR) INSTALLED TO STANDARD UNION FITTING WITH SEAL (eg., UNION P/N MS21902) IN COMPONENT BOSS PORT

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Tubes, Hoses, and Fittings Installed to Components
Figure 201/20-10-51-990-847

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SLEEVE AND B-NUT FITTINGS							
FITTING TYPE	ILLUSTRATION	PART NUMBER	MATERIAL DATA				EXAMPLE OF P/N
			AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA	
SLEEVE, INTERNALLY SWAGED		BACS13BX	CRES	H = 15-5PH, NO FINISH; HP = 15-5PH, CADMIUM PLATE FINISH	NATURAL SILVERY COLOR OR YELLOWISH BROWN (CADMIUM PLATED)		BACS13BX06HP
SLEEVE, WELDED		AS1581	TITANIUM (CRES VERSION NOT USED)	T = 6Al-4V	NATURAL SILVERY COLOR		AS1581T06
NUT, TUBE COUPLING, LIGHTWEIGHT, REDUCED CROSS-SECTION		BACN10YA	TITANIUM	NONE (BASE P/N = 6Al-4V)	DULL GRAY OR, IF DRY FILM LUBRICATED (N SUFFIX CODE), DARK		BACN10YA6N
		BACN10YE	CRES	NONE (BASE P/N = 15-5PH)	NATURAL SILVERY COLOR ("L" CODE = DRY FILM ON ID ONLY)		BACN10YE6L
		BACN10YL	ALUMINUM	NONE (BASE P/N = 7075)	BROWN		BACN10YL06
NUT, COUPLING, WIRED FLARELESS, 3,000 PSI		BACN11AU	TITANIUM	NUT - NONE (BASE P/N = 6Al-4V); WIRE - CRES (BACN11BB)	DARK GRAY, FROM DRY FILM LUBRICATION	NEW	BACN11AU06 NOTE: PHASE-IN TO AIRPLANE PRODUCTION UNDERWAY
NUT, TUBE COUPLING, STANDARD, CROSS-SECTION		MS21921 (SEE STANDARD AS21921)	CRES	V-P = 15.5PH WITH CADMIUM PLATE FINISH (REPLACES "-" OR NO CODE CARBON STEEL)	YELLOWISH BROWN (CADMIUM PLATED)	CODES J, K, R, S - SEE BACN10YE; CODE T - SEE BACN10YA; CODE W - SEE BACN10YL	MS21921V4P
				V = 15-5PH (NO FINISH)	NATURAL SILVERY COLOR		
				J (304), K (316), R (321)	NATURAL SILVERY COLOR		
			ALUMINUM	W = 7075	BROWN		
			TITANIUM	T = 6Al-4V	DULL GRAY		

NOTE:

NOT KEPT UP TO DATE - ALWAYS CONSULT LATEST REVISION OF FITTING STANDARD FOR P/N AND SUPERSESSION DATA.

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**Hydraulic Fitting Identification Information
Figure 202/20-10-51-990-848 (Sheet 1 of 25)**

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UNION FITTINGS						
FITTING TYPE	ILLUSTRATION	PART NUMBER	MATERIAL DATA			
			AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA
STANDARD FLARELESS UNION (NO REDUCER PROVISIONS)		MS21902 (SEE STANDARD AS21902)	CARBON STEEL	NO CODE (REPL BY V--P)	YELLOWISH BROWN	"-" OR "NO CODE" - USE CODE V-P; CODES J, K, R - SEE AS5230J; CODE T - SEE AS5230T; CODE W - SEE AS5230W
			CRES	J (304), K (316), R (321) V (15-5PH) NO FINISH V--P (15-5PH WITH CADMIUM PLATE FINISH)	NATURAL SILVERY COLOR NATURAL SILVERY COLOR YELLOWISH BROWN	
			ALUMINUM	W = 7075	BROWN	
			TITANIUM	T (6Al-4V)	DULL GRAY	
FLARELESS UNION REDUCER		MS21916 (REDUCER - SEE STANDARD AS21916)	CARBON STEEL	NO CODE (REPL BY V--P)	YELLOWISH BROWN	"-" OR "NO CODE" - USE CODE V-P; CODES J, K, R - SEE AS5230J; CODE T - SEE AS5230T; CODE W - SEE AS5230W
			CRES	J (304), K (316), R (321) V (15-5PH) NO FINISH V--P (15-5PH WITH CADMIUM PLATE FINISH)	NATURAL SILVERY COLOR NATURAL SILVERY COLOR YELLOWISH BROWN	
			ALUMINUM	W = 7075	BROWN	
			TITANIUM	T (6Al-4V)	DULL GRAY	
		BACR17E	TITANIUM	T (6Al-4V)	DULL GRAY	BACR17E8-4

NOTE:
NOT KEPT UP TO DATE - ALWAYS CONSULT LATEST REVISION OF FITTING STANDARD FOR P/N AND SUPERSESSION DATA.

2411179 S00061527077_V1

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UNION FITTINGS (CONTINUED)							
FITTING TYPE	ILLUSTRATION	PART NUMBER	MATERIAL DATA				EXAMPLE OF P/N
			AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA	
LIGHTWEIGHT FLARELESS SWAGE UNION		BACU24AB (ONE SWAGED END)	CRES	H (15-5PH)	NATURAL SILVERY COLOR		BACU24AB10HP
				HP (15-5PH WITH CADMIUM PLATE FINISH - ON AI TUBE ONLY)	YELLOWISH BROWN		
LIGHTWEIGHT FLARELESS WELD UNION		AS1582 (ONE WELDED END)	ALUMINUM	W = 7075	BROWN		AS1582T08
			TITANIUM	T (6Al-4V)	NATURAL SILVERY COLOR		
FLARELESS BULKHEAD UNION (NO REDUCER PROVISIONS)		MS21924 (SEE STANDARD AS21924)	CARBON STEEL	NO CODE (REPL BY V-P)	YELLOWISH BROWN	" " OR "NO CODE" - USE CODE V-P; CODES K, S - USE CODE J; CODE W, J, K, R, S, T - SEE AS1007 IN CODES W, J, T, RESPECTIVELY	MS21924V4P
			CRES	J (304), K (316), R (321)	NATURAL SILVERY COLOR		
				V (15-5PH) NO FINISH	NATURAL SILVERY COLOR		
				V-P (15-5PH WITH CADMIUM PLATE FINISH)	YELLOWISH BROWN		
			ALUMINUM	W (7075)	BROWN		
			TITANIUM	T (6Al-4V)	DULL GRAY		
FLARELESS BULKHEAD UNION, REDUCER		BACU24AA (REDUCER ONLY, AVAILABLE IN EXTENDED LENGTH)	CARBON STEEL	" " OR NO CODE	YELLOWISH BROWN	CODES "NO CODES" J, K, R - SEE AS1007J; CODE D, SEE AS1007W; CODE T - SEE AS1007T	BACU24AA0812J
			CRES	J (304), K (316), R (321)	NATURAL SILVERY COLOR		
			ALUMINUM	D (2024)	GREEN		
			TITANIUM	T (6Al-4V)	DULL GRAY		

NOTE:

NOT KEPT UP TO DATE - ALWAYS CONSULT LATEST REVISION OF FITTING STANDARD FOR P/N AND SUPERSESSION DATA.

2411180 S00061527078_V1

**Hydraulic Fitting Identification Information
Figure 202/20-10-51-990-848 (Sheet 3 of 25)**

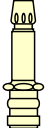
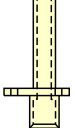
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EXTERNALLY SWAGED (PERMASWAGE TYPE) ADAPTER UNION FITTINGS						
FITTING TYPE	ILLUSTRATION	PART NUMBER	MATERIAL DATA			
			AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA
ADAPTER, EXTERNALLY SWAGED TO FLARELESS BULKHEAD, REDUCER		BACA14BP	CRES	NO CODE (21-6-9, ANNEALED)	GREEN ON TIP AND HEX FLATS, YELLOWISH BROWN	
			ALUMINUM	D (6061-T6, OVERAGED)	GREEN, EXCEPT FOR BULKHEAD END (GOLDISH ANODIZE)	
ADAPTER, EXTERNALLY SWAGED TO BOSSED FLANGE		BACA14BM	CRES	NO CODE (21-6-9, ANNEALED)	GREEN ON TIP AND BACK OF FLANGE, YELLOWISH BROWN	CODE J - USE CODE JA; CODE DA - USE CODE DA SUFFIX CODE E = EXTENDED LENGTH OPTION
			ALUMINUM	D (6061-T6, OVERAGED)	GREEN, EXCEPT FOR BULKHEAD END (GOLDISH ANODIZE)	
						BACA14BP1212J
						BACA14BM0606JA

NOTE:
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2411181 S00061527079_V1

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Figure 202/20-10-51-990-848 (Sheet 4 of 25)**

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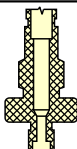
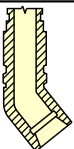
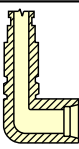
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FLARELESS FITTINGS WITH BOEING RECESSED SEAL BOSS END						
FITTING TYPE	ILLUSTRATION	PART NUMBER	MATERIAL DATA			
			AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA
ADAPTER, STRAIGHT, FLARELESS TUBE TO RECESSED SEAL BOSS		BACA14AZ	CRES	J (304), K (316), R (321)	NATURAL SILVERY COLOR	NOTE: SIZE DESIGNATION IN P/N HAS "A" INCLUDED, EG., SIZE 08 IS "8A"
			ALUMINUM	D (2024)	GREEN	
			TITANIUM	T (6Al-4V)	DULL GRAY	
ADAPTER, 45 DEGREE, FLARELESS TUBE TO RECESSED SEAL BOSS		BACA14BA	CARBON STEEL	NO CODE (WITH CADMIUM PLATE FINISH)	YELLOWISH BROWN	NOTE: SIZE DESIGNATION IN P/N HAS "B" INCLUDED, EG., SIZE 12 IS "12B", AVAILABLE IN NON-REDUCER ONLY
			CRES	J (304), K (316), R (321)	NATURAL SILVERY COLOR	
			ALUMINUM	W (7075)	BROWN	
ADAPTER, 90 DEGREE, FLARELESS TUBE TO RECESSED SEAL BOSS		BACA14BB	CARBON STEEL	NO CODE (WITH CADMIUM PLATE FINISH)	YELLOWISH BROWN	NOTE: SIZE DESIGNATION IN P/N HAS "B" INCLUDED, EG., SIZE 12 IS "12B", AVAILABLE IN NON-REDUCER ONLY
			CRES	J (304), K (316), R (321)	NATURAL SILVERY COLOR	
			ALUMINUM	W (7075)	BROWN	
						EXAMPLE OF P/N
						BACA14AZ8A10J
						BACA14BA12BJ
						BACA14BB8BJ

NOTE:
NOT KEPT UP TO DATE - ALWAYS CONSULT LATEST REVISION OF FITTING STANDARD FOR P/N AND SUPERSESSION DATA.

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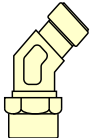
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FITTING SHAPES WITH FLARELESS ENDS						
FITTING TYPE	ILLUSTRATION	PART NUMBER	MATERIAL DATA			
			AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA
ELBOW, 45 DEGREE, SWIVEL REDUCER (LIGHTWEIGHT REDUCED BODY)		BACE21BR	CRES	JN (304) - WITH DRY FILM LUBE	NATURAL SILVERY COLOR	CODES JN, P, T - SEE AS4137 IN CODES J, P, T, RESPECTIVELY
			TITANIUM	P (15-5PH WITH CADMIUM PLATE FINISH)	YELLOWISH BROWN	
		AS4137	CRES	T (6Al-4V)	DARK GRAY	AS4137V0806P NOTE: PHASE-IN TO AIRPLANE PRODUCTION UNDERWAY.
			TITANIUM	J (304), DRY FILM ON NUT ID	NATURAL SILVERY COLOR	
				V (15-5PH), DRY FILM ON NUT ID	NATURAL SILVERY COLOR	
				V--P (15-5PH WITH CADMIUM PLATE FINISH)	YELLOWISH BROWN	
				T (6Al-4V), DRY FILM ON NUT ID	DARK GRAY	

NOTE:
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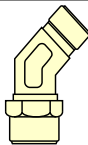
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FITTING SHAPES WITH FLARELESS ENDS (CONTINUED)						
FITTING TYPE	ILLUSTRATION	PART NUMBER	MATERIAL DATA			EXAMPLE OF P/N
			AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	
ELBOW, 45 DEGREE, SWIVEL, REDUCER (STANDARD WEIGHT)		BACE21AU	CARBON STEEL	"NO CODE" WITH N SUFFIX	YELLOWISH BROWN (WITH DRY FILM LUBE ON SWIVEL NUT)	CODES N, M, RM - SEE BACE21BR P, J, RESPECTIVELY; CODES "NO CODE", D, J, K, S - SEE NAS1761 "a", W, J, K, S, RESPECTIVELY; NOTE: BACE21BR IN CODES JN, P, T NOW SUPERSEDED BY AS4137J, P, T RESPECTIVELY
			ALUMINUM	L (2014/2024)	GREEN (DRY FILM LUBE)	
				R (2014/2024)	GREEN (DRY FILM LUBE-SWIVEL NUT ONLY)	
			CRES	M SUFFIX FOR CODES J (304), K (316), S (347)	NATURAL SILVERY COLOR (WITH DRY FILM LUBE)	
				RM SUFFIX CODE FOR R (321)	NATURAL SILVERY COLOR (WITH DRY FILM LUBE)	
		ALUMINUM	W (7075)	BROWN (DRY FILM LUBE-SWIVEL NUT ONLY)		
		NAS1761	ALUMINUM	D (2014/2024)	GREEN	CODES "NO CODES", T, J, K, S - SEE BACE21BR CODES P, T, J, RESPECTIVELY; CODE W - SEE BACE21AU CODE W NOTE: BACE21BR IN CODES JN, P, T NOW SUPERSEDED BY AS4137J, P, T, RESPECTIVELY
			CRES	J (304), K (316), S (347)	NATURAL SILVERY COLOR	
			ALUMINUM	W (7075)	BROWN	
			TITANIUM	T (6Al-4V)	DULL GRAY	

NOTE:
NOT KEPT UP TO DATE - ALWAYS CONSULT LATEST REVISION OF FITTING STANDARD FOR P/N AND SUPERSESSION DATA.
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**Hydraulic Fitting Identification Information
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FITTING SHAPES WITH FLARELESS ENDS (CONTINUED)									
FITTING TYPE	ILLUSTRATION	PART NUMBER	MATERIAL DATA				EXAMPLE OF P/N		
			AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA			
ELBOW, 45 DEGREE, BULKHEAD, REDUCER, (LIGHTWEIGHT REDUCED BODY)		BACE21BM	CRES	J (304)	NATURAL SILVERY COLOR	CODES J, P, T - SEE AS4130V--P, J, T, RESPECTIVELY	BACE21BM1208T		
			TITANIUM	P (15-5PH WITH CADMIUM PLATE FINISH)	YELLOWISH BROWN				
				T (6AI-4V)	DULL GRAY				
		AS4130	CRES	J (304), DRY FILM ON NUT ID	NATURAL SILVERY COLOR		AS4130V0806P NOTE: PHASE-IN TO AIRPLANE PRODUCTION UNDERWAY.		
				V (15-5PH), DRY FILM ON NUT ID	NATURAL SILVERY COLOR				
				V--P (15-5PH WITH CADMIUM PLATE FINISH)	YELLOWISH BROWN				
			TITANIUM		T (6AI-4V), DRY FILM ON NUT ID	DARK GRAY			
		ELBOW, 45 DEGREE, FLARELESS, NON-REDUCER, STANDARD WEIGHT		BACE21AT	CARBON STEEL	"-" OR NO CODE	YELLOWISH BROWN	"NO CODE" P, T, J, K, S, R - SEE BACE21BM CODES P, T, J, RESPECTIVELY; CODE W - SEE AS1010W NOTE: BACE21BM IN CODES J, P AND T IS NOW SUPERSEDED BY AS4130 IN CODES V-P, J AND T RESPECTIVELY.	BACE21AT1008W
					CRES	J (304, K (316), R (321), S (347)	NATURAL SILVERY COLOR		
					ALUMINUM	W (7075)	BROWN		
MS21907 (SEE STANDARD AS21907)	CRES			V--P (15-5PH WITH CADMIUM PLATE FINISH)	YELLOWISH BROWN	CODES "NO CODE" P, T, J, K - SEE BACE21BM CODES P, T, J, RESPECTIVELY; CODE S - SEE CODE R; CODE W - SEE AS1010W; CODES V-P, R, V - SEE AS4130 IN CODES V-P, J AND V, RESPECTIVELY.	MS21907V4P		
				J (304), K (316), R (321)	NATURAL SILVERY COLOR				
				ALUMINUM	W (7075)			BROWN	
	TITANIUM				T (6AI-4V)	DULL GRAY			

NOTE:

NOT KEPT UP TO DATE - ALWAYS CONSULT LATEST REVISION OF FITTING STANDARD FOR P/N AND SUPERSESSION DATA.

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**Hydraulic Fitting Identification Information
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FITTING SHAPES WITH FLARELESS ENDS (CONTINUED)							
FITTING TYPE	ILLUSTRATION	PART NUMBER	MATERIAL DATA				EXAMPLE OF P/N
			AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA	
ELBOW, 45 DEGREE, FLARELESS, NON-REDUCER, STANDARD WEIGHT		AS1010	CARBON STEEL	"NO CODE" OR F	YELLOWISH BROWN	(NO CODE)(-OR F) - SEE AS4130V-P; (NO CODE)D - SEE AS1010(NO CODE)W; (NO CODE)J, K, R, S - SEE AS4130J (NO CODE)T - SEE AS4130T; G - SEE AS4130V-P; G - (D, F, J, K, R, S, T, W) - SEE AS1010G (D, F, J, K, R, S, T, W) - ; GD - SEE AS1010GW-; GF - SEE AS4130V-P; G (J, K, S) - SEE AS4130J GT - SEE AS4130T-	AS1010W0808 NOTE: (1) PHASE-IN TO AIRPLANE PRODUCTION UNDERWAY; (2) SUFFIX "G" FOLLOWING BASIC P/N IS FOR PARTS WITH AS4377 STYLE G FITTING END - THE PARTS ARE NOT FOR USE IN PORTS (SEE AS1010 STANDARD FOR DETAILS)
			CRES	J (304), K (316), R (321), S (347)	NATURAL SILVERY COLOR		
			TITANIUM	T (6Al-4V)	DULL GRAY		
				W (2024-T6)	GREEN		
			ALUMINUM	W (7075)	BROWN		
ELBOW, 90 DEGREE, SWIVEL, REDUCER, (LIGHTWEIGHT, REDUCED BODY)		BACE21BT	CRES	JN (304) WITH DRY FILM LUBE ON SWIVEL NUT P (15-5PH WITH CADMIUM PLATE FINISH)	NATURAL SILVERY COLOR YELLOWISH BROWN	CODES JN, P, T - SEE AS4138 IN CODES J, V--P, T, RESPECTIVELY	BACE21BT1208T
			TITANIUM	T (6Al-4V)	DULL GRAY		
		AS4138		J (304) DRY FILM ON NUT ID V (15-5PH) DRY FILM ON NUT ID	NATURAL SILVERY COLOR NATURAL SILVERY COLOR		
			CRES	V--P (15-5PH WITH CADMIUM PLATE FINISH)	YELLOWISH BROWN		
			TITANIUM	T (6Al-4V), DRY FILM ON NUT ID	DARK GRAY		
						AS4138V0806P NOTE: PHASE-IN TO AIRPLANE PRODUCTION UNDERWAY	

NOTE:
NOT KEPT UP TO DATE - ALWAYS CONSULT LATEST REVISION OF FITTING STANDARD FOR P/N AND SUPERSESSION DATA.

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FITTING SHAPES WITH FLARELESS ENDS (CONTINUED)						
FITTING TYPE	ILLUSTRATION	PART NUMBER	MATERIAL DATA			
			AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA
ELBOW, 90 DEGREE, SWIVEL, REDUCER (STANDARD BODY)		BACE21AW	CARBON STEEL	"NO CODE" WITH N SUFFIX	YELLOWISH BROWN (WITH DRY FILM LUBE ON SWIVEL NUT)	CODES L, R - USE CODE W; CODES N, (JM, KM, SM, RM, M) AND T - SEE BACE21BT IN CODES P, J AND T. RESPECTIVELY; NOTE: BACE21BT IN CODES JN, P AND T NOW SUPERSEDED BY AS4138 CODES J, V-P AND T, RESPECTIVELY.
			ALUMINUM	L (2014/2024)	GREEN (DRY FILM LUBE)	
			ALUMINUM	R (2014/2024)	GREEN (DRY FILM LUBE, SWIVEL NUT ONLY)	
			CRES	M SUFFIX - CODES J (304), K (316), S (347), R (321)	NATURAL SILVERY COLOR (WITH DRY FILM LUBE)	
			ALUMINUM	W (7075)	BROWN (WITH DRY FILM ON SWIVEL NUT ONLY)	
ELBOW, 90 DEGREE, SWIVEL, REDUCER (STANDARD BODY)		NAS1762	CARBON STEEL	"-" OR NO CODE	YELLOWISH BROWN	CODES "NO CODE", J, K, S AND T - SEE BACE21BT IN CODES P, J AND T, RESPECTIVELY; CODE W - SEE BACE21AW CODE W. NOTE: BACE21BT IN CODES JN, P AND T NOW SUPERSEDED BY AS4138 CODES J, V-P AND T, RESPECTIVELY.
			CRES	J (304), K (316), S (347)	NATURAL SILVERY COLOR	
			ALUMINUM	W (7075)	BROWN	
			TITANIUM	T (6Al-4V)	DULL GRAY	
						EXAMPLE OF P/N BACE21AW1208W NAS1762J0812

NOTE:
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**Hydraulic Fitting Identification Information
Figure 202/20-10-51-990-848 (Sheet 10 of 25)**

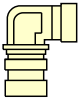
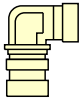
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FITTING SHAPES WITH FLARELESS ENDS (CONTINUED)						
FITTING TYPE	ILLUSTRATION	PART NUMBER	MATERIAL DATA			
			AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA
ELBOW, 90 DEGREE, BULKHEAD, REDUCER (LIGHTWEIGHT REDUCED BODY)		BACE21BN	CRES	J (304)	NATURAL SILVERY COLOR	CODES J, P, T - SEE AS4132 IN CODES J, V-P, T, RESPECTIVELY.
				P (15-5PH WITH CADMIUM PLATE FINISH)	YELLOWISH BROWN	
			TITANIUM	T (6Al-4V)	DULL GRAY	
		AS4132	CRES	J (304) V (15-5PH), DRY FILM ON NUT ID V--P (15-5PH WITH CADMIUM PLATE FINISH)	NATURAL SILVERY COLOR NATURAL SILVERY COLOR YELLOWISH BROWN	AS4132V0806P NOTE: PHASE-IN TO AIRPLANE PRODUCTION UNDERWAY.
ELBOW, 90 DEGREE, FLARELESS, STANDARD WEIGHT		BACE21AS (REDUCER ONLY)	TITANIUM	T (6Al-4V), DRY FILM ON NUT ID	DARK GRAY	"NO CODE" J, K, R, S, T - SEE BACE21BN IN CODES J, P, T, RESPECTIVELY; NOTE: BACE21BN IN CODES J, P AND T NOW SUPERSEDED BY AS4132 IN CODES J, V-P AND T RESPECTIVELY.
			CARBON STEEL	"-" OR NO CODE	YELLOWISH BROWN	
			CRES	J (304), K (316), R (321), S (347)	NATURAL SILVERY COLOR	
			ALUMINUM	W (7075)	BROWN	
			TITANIUM	T (6Al-4V)	DULL GRAY	BACE21AS1008W

NOTE:
NOT KEPT UP TO DATE - ALWAYS CONSULT LATEST REVISION OF FITTING STANDARD FOR P/N AND SUPERSESSION DATA.

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**Hydraulic Fitting Identification Information
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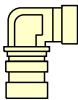
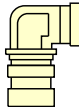
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FITTING SHAPES WITH FLARELESS ENDS (CONTINUED)							
FITTING TYPE	ILLUSTRATION	PART NUMBER	MATERIAL DATA				EXAMPLE OF P/N
			AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA	
ELBOW, 90 DEGREE, FLARELESS, STANDARD WEIGHT		MS21908 (SEE STANDARD AS21908, NON-REDUCER)	CRES	V (15-5PH)	NATURAL SILVERY COLOR	"NO CODE" J, K, S, T, V - SEE BACE21BN IN CODES K, P, T, RESPECTIVELY; CODE S - USE CODE R; CODES R, V, V-P - SEE AS4132 IN CODES J, V, V-P, RESPECTIVELY; CODE W - SEE AS1008 CODE W; NOTE: BACE21BN IN CODES J, P AND T IS NOW SUPERSEDED BY AS4130 IN CODES J, V-P AND T RESPECTIVELY.	
				V-P (15-5PH WITH CADMIUM PLATE FINISH)	YELLOWISH BROWN		
				J (304), K (316), R (321), S (347)	NATURAL SILVERY COLOR		
				ALUMINUM	W (7075)		BROWN
			TITANIUM	T (6Al-4V)	DULL GRAY		
ELBOW, 90 DEGREE, FLARELESS, STANDARD WEIGHT		AS1008	CARBON STEEL	"NO CODE" OR F	YELLOWISH BROWN	(NO CODE)(- OR F) - SEE AS4132V-P; (NO CODE)D - SEE AS1008 (NO CODE)W; (NO CODE)J, K, R, S - SEE AS4132J; (NO CODE)T -SEE AS4132T; G - SEE AS4132V-P; G-(D, F, J, K, R, S, T, W)- SEE AS1008G (D, F, J, K, R, S, T, W); GD - SEE AS1008GW-; GF - SEE AS41320V-P; G (J, K, S) - SEE AS4132J GT - SEE AS4132T	
				CRES	J (304), K (316), R (321), S (347)		NATURAL SILVERY COLOR
			TITANIUM	T (6Al-4V)	DULL GRAY	AS1008W0808 NOTE: PHASE-IN TO AIRPLANE PRODUCTION UNDERWAY	
				D (2024-T6)	GREEN		
			ALUMINUM	W (7075)	BROWN		

NOTE:
NOT KEPT UP TO DATE - ALWAYS CONSULT LATEST REVISION OF FITTING STANDARD FOR P/N AND SUPERSESSION DATA.

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FITTING SHAPES WITH FLARELESS ENDS (CONTINUED)						
FITTING TYPE	ILLUSTRATION	PART NUMBER	MATERIAL DATA			
			AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA
ELBOW, 90 DEGREE REDUCER (LIGHTWEIGHT REDUCED BODY)		BACE21BL	CRES	J (304)	NATURAL SILVERY COLOR	CODES J, P, T - SEE AS4131 IN CODES V-P, J, T RESPECTIVELY
			TITANIUM	T (6Al-4V)	DULL GRAY	
		AS4131	CRES	J (304), DRY FILM ON NUT ID	NATURAL SILVERY COLOR	AS413V0806P NOTE: PHASE-IN TO AIRPLANE PRODUCTION UNDERWAY.
				V (15-5PH), DRY FILM ON NUT ID	NATURAL SILVERY COLOR	
ELBOW, 90 DEGREE REDUCER		BACE21AR (STANDARD WEIGHT)	TITANIUM	V--P (15-5PH WITH CADMIUM PLATE FINISH)	YELLOWISH BROWN	"NO CODE" J, K, R, S, T - SEE BACE21BL IN CODES J, P, T, RESPECTIVELY; CODE W SEE AS1004, CODE W; NOTE: BACE21BL IN CODES J, P, T, NOW SUPERSEDED BY AS4131 IN CODES J, V--P, T, RESPECTIVELY.
			TITANIUM	T (6Al-4V), DRY FILM ON NUT ID	DARK GRAY	
			CARBON STEEL	"-" OR NO CODE	YELLOWISH BROWN	
		AS1004	CRES	J (304)	NATURAL SILVERY COLOR	AS1004VW0808 NOTE: PHASE-IN TO AIRPLANE PRODUCTION UNDERWAY
			ALUMINUM	W (7075)	BROWN	
			TITANIUM	T (6Al-4V)	DULL GRAY	
NOTE: NOT KEPT UP TO DATE - ALWAYS CONSULT LATEST REVISION OF FITTING STANDARD FOR P/N AND SUPERSESSION DATA.			ALUMINUM	D (2024-T6)	GREEN	(NO CODE) D - SEE AS1004 (NO CODE) W; (NO CODE) J, K, R, S - SEE AS4131J (NO CODE) T - SEE AS4131T.
			CRES	W (7075)	BROWN	
			TITANIUM	J (304), K (316), R (321), S (347)	NATURAL SILVERY COLOR	
			TITANIUM	T (6Al-4V)	DULL GRAY	

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Hydraulic Fitting Identification Information
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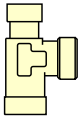
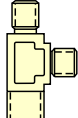
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FITTING SHAPES WITH FLARELESS ENDS (CONTINUED)						
FITTING TYPE	ILLUSTRATION	PART NUMBER	MATERIAL DATA			
			AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA
TEE, FLARELESS, REDUCER, LIGHTWEIGHT		BACT16BL	CRES	J (304)	NATURAL SILVERY COLOR	CODES J, P, T - SEE AS4133 IN CODES J, V-P, T RESPECTIVELY.
			TITANIUM	T (6Al-4V)	DULL GRAY	
			CRES	J (304)	NATURAL SILVERY COLOR	AS4133V080606P NOTE: PHASE-INTO AIRPLANE PRODUCTION UNDERWAY.
				V (15-5PH)	NATURAL SILVERY COLOR	
		AS4133		V--P (15-5PH WITH CADMIUM PLATE FINISH)	YELLOWISH BROWN	
TEE, FLARELESS, REDUCER, STANDARD WEIGHT		BACT16AS	TITANIUM	T (6Al-4V), DRY FILM ON NUT ID	DARK GRAY	CODES J, K, S, R, "NO CODE", T - SEE BACT16BL IN CODES J, P, T, RESPECTIVELY; CODE W - SEE AS1005 CODE W; NOTE: BACT16BL IN CODES J, P, T NOW SUPERSEDED BY AS4133 CODES J, V-P AND T, RESPECTIVELY.
			CARBON STEEL	"-" OR NO CODE	YELLOWISH BROWN	
			CRES	J (304), K (316), R (321), S (347)	NATURAL SILVERY COLOR	
			ALUMINUM	W (7075)	BROWN	
			TITANIUM	T (6Al-4V)	DULL GRAY	

NOTE:
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**Hydraulic Fitting Identification Information
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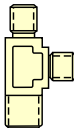
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FITTING SHAPES WITH FLARELESS ENDS (CONTINUED)						
FITTING TYPE	ILLUSTRATION	PART NUMBER	MATERIAL DATA			
			AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA
TEE, FLARELESS, REDUCER, STANDARD WEIGHT		MS21905 (SEE STANDARD AS21905 NON-REDUCER)	CARBON STEEL	"-" OR NO CODE	YELLOWISH BROWN	CODE "NO CODE" - SEE BACT16BL IN CODE P; CODE P SEE AS4133
			CRES	J (304)	NATURAL SILVERY COLOR	CODE P; CODE W - SEE AS1005
			ALUMINUM	W (7075)	BROWN	CODES J, K - SEE SUPERSEDED BACT16BL
			TITANIUM	T (6Al-4V)	DULL GRAY	CODE J; CODE S - SEE AS4133 CODE J; CODE V - SEE AS4133V.
TEE, BULKHEAD-ON-SIDE, LIGHTWEIGHT, REDUCER		AS1005	ALUMINUM (ONLY MATERIAL CODE USED BY BOEING)	W (7075)	BROWN	USE AS4133 FOR ALL MATERIAL APPLICATIONS EXCEPT ALUMINUM.
			CRES	J (304)	NATURAL SILVERY COLOR	CODES J, P, T - SEE AS4133 IN CODES J, V-P AND T RESPECTIVELY.
		BACE16BM	TITANIUM	T (6Al-4V)	DULL GRAY	BACT16BM060410T
			CRES	V (15-5PH) WITH CADMIUM PLATE FINISH	NATURAL SILVERY COLOR	AS4135V080608P
		AS4135	CRES	J (304)	NATURAL SILVERY COLOR	NOTE: PHASE-IN TO AIRPLANE PRODUCTION UNDERWAY.
			TITANIUM	T (6Al-4V), DRY FILM ON NUT ID	YELLOWISH BROWN	

NOTE:

NOT KEPT UP TO DATE - ALWAYS CONSULT LATEST REVISION OF FITTING STANDARD FOR P/N AND SUPERSESSION DATA.

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**Hydraulic Fitting Identification Information
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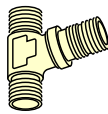
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FITTING SHAPES WITH FLARELESS ENDS (CONTINUED)						
FITTING TYPE	ILLUSTRATION	PART NUMBER	MATERIAL DATA			
			AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA
TEE, BULKHEAD-ON-SIDE, STANDARD WEIGHT, REDUCER		BACT16AW	CARBON STEEL	"-" OR NO CODE	YELLOWISH BROWN	CODES "NO CODE", J, K, R, S, T - SEE BACT16BM IN CODES J, P, T, RESPECTIVELY; CODE W - SEE AS1009, CODE W; CODES J, P, T NOW SUPERSEDED BY AS4135 IN CODES J, V-P AND T, RESPECTIVELY.
			CRES	J (304)	NATURAL SILVERY COLOR	
			ALUMINUM	W (7075)	BROWN	
			TITANIUM	T (6Al-4V)	DULL GRAY	
TEE, BULKHEAD-ON-SIDE, STANDARD WEIGHT, NON-REDUCER		MS21909 (SEE STANDARD AS21909)	CRES	J (304)	NATURAL SILVERY COLOR	CODES "NO CODE", J, K, S, R AND T - SEE BACT16BM IN CODES P, J AND T, RESPECTIVELY; CODES V-P, R AND V - SEE AS4135 IN CODES P, J AND V, RESPECTIVELY; CODE W - SEE AS1009 IN NON-REDUCER SIZES ONLY; NOTE: BACT16BM IN CODES J, P, T NOW SUPERSEDED BY AS4135 IN CODES J, V-P AND T, RESPECTIVELY.
				V-P	YELLOWISH BROWN	
			ALUMINUM	W (7075)	BROWN	
			TITANIUM	T (6Al-4V)	DULL GRAY	
						MS21909V4P

NOTE:

NOT KEPT UP TO DATE - ALWAYS CONSULT LATEST REVISION OF FITTING STANDARD FOR P/N AND SUPERSESSION DATA.

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FITTING SHAPES WITH FLARELESS ENDS (CONTINUED)						
FITTING TYPE	ILLUSTRATION	PART NUMBER	MATERIAL DATA			
			AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA
TEE, BULKHEAD-ON-SIDE, STANDARD WEIGHT, REDUCER		AS1009	CARBON STEEL	"-" (NO CODE)	YELLOWISH BROWN	CODES (NO CODE) (-, F) - SEE AS4135V; CODES (NO CODE) (D) - USE (NO CODE)(W); CODES (NO CODE) (J, K, R, S) - SEE AS4135J; CODES (NO CODE) (T) - SEE AS4135T; CODE G "-" - SEE AS4135V-P; CODE G, CODES D, F, J, K, R, S, T, W USE G, D, F, J, K, R, S, T, W
			CRES	J (304), K (316), R (321), S (347)	NATURAL SILVERY COLOR	NOTE: "-" IN P/N IS DROPPED; CODE GD - SEE GW G CODES J, K, R, S SEE AS4135J; CODE GF - SEE AS4135V-P; GJ, K, R, S - SEE AS4135J; AS1009G T SEE AS4135T.
			ALUMINUM	W (7075)	BROWN	NOTE: "-" IN P/N IS DROPPED; CODE GD - SEE GW G CODES J, K, R, S SEE AS4135J; CODE GF - SEE AS4135V-P; GJ, K, R, S - SEE AS4135J; AS1009G T SEE AS4135T.
			TITANIUM	T (6Al-4V)	DULL GRAY	NOTE: "-" IN P/N IS DROPPED; CODE GD - SEE GW G CODES J, K, R, S SEE AS4135J; CODE GF - SEE AS4135V-P; GJ, K, R, S - SEE AS4135J; AS1009G T SEE AS4135T.
						EXAMPLE OF P/N AS1009W080806 NOTES: (1) PHASE-IN TO AIRPLANE PRODUCTION UNDERWAY. (2) SUFFIX "G" FOLLOWING BASIC P/N IS FOR PARTS WITH AS4377 STYLE G FITTING END - STYLE G PARTS NOT FOR USE IN PORTS (SEE AS1009 STANDARD FOR DETAILS).

NOTE:

NOT KEPT UP TO DATE - ALWAYS CONSULT LATEST REVISION OF FITTING STANDARD FOR P/N AND SUPERSESSION DATA.

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**Hydraulic Fitting Identification Information
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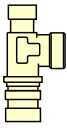
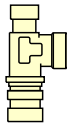
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FITTING SHAPES WITH FLARELESS ENDS (CONTINUED)							
FITTING TYPE	ILLUSTRATION	PART NUMBER	MATERIAL DATA				EXAMPLE OF P/N
			AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA	
TEE, BULKHEAD-ON-RUN, LIGHTWEIGHT, REDUCER		BACT16BN	CRES	J (304)	NATURAL SILVERY COLOR	CODES J, P, T - SEE AS4134 IN CODES J, V-P AND T RESPECTIVELY.	BACT16BN121008T
				P (15-5PH WITH CADMIUM PLATE FINISH)	YELLOWISH BROWN		
			TITANIUM	T (6Al-4V)	DULL GRAY		
		AS4134	CRES	J (304)	NATURAL SILVERY COLOR		AS4134V080608P NOTE: PHASE-IN TO AIRPLANE PRODUCTION UNDERWAY.
				V (15-5PH)	NATURAL SILVERY COLOR		
TEE, BULKHEAD-ON-RUN, STANDARD WEIGHT, REDUCER		BACT16AX	TITANIUM	V-P (15-5PH WITH CADMIUM PLATE FINISH)	YELLOWISH BROWN	CODES "NO CODE", T AND J, K, S, R - SEE BACT16BN IN CODES P, T AND J, RESPECTIVELY; CODE W - SEE AS1003, CODE W; CODES J, P, T - SEE AS4134 IN CODES J, V-P AND T, RESPECTIVELY.	BACT16AX120810J
				T (6Al-4V), DRY FILM ON NUT ID	DARK GRAY		
			CRES	V--P	YELLOWISH BROWN		
				V	DULL GRAY TO METALLIC BRIGHT		
			ALUMINUM	W (7075)	BROWN		

NOTE:
NOT KEPT UP TO DATE - ALWAYS CONSULT LATEST REVISION OF FITTING STANDARD FOR P/N AND SUPERSESSION DATA.
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**Hydraulic Fitting Identification Information
Figure 202/20-10-51-990-848 (Sheet 18 of 25)**

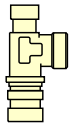
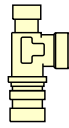
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FITTING SHAPES WITH FLARELESS ENDS (CONTINUED)						
FITTING TYPE	ILLUSTRATION	PART NUMBER	MATERIAL DATA			
			AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA
TEE, BULKHEAD-ON-RUN, STANDARD WEIGHT, NON-REDUCER		MS21912 (SEE STANDARD AS21912)	CARBON STEEL	"-" OR NO CODE (4130)	YELLOWISH BROWN	CODES "-", J, K, T - SEE BACT16BN IN CODES J, P AND T, RESPECTIVELY; CODES S, V - SEE AS4134 CODES J, V; CODE W - SEE AS1003 CODE W.
			CRES	J	NATURAL SILVERY COLOR	NOTE: BACT16BN SUPERSEDED BY AS4134; BACT16BN CODES J, P, T NOW SUPERSEDED BY AS4134 CODES J, V-P AND T, RESPECTIVELY.
			ALUMINUM	W (7075)	BROWN	
			TITANIUM	T (6Al-4V)	DULL GRAY	
TEE, BULKHEAD-ON-RUN, (STANDARD WEIGHT, REDUCER)		AS1003	CARBON STEEL	"-" (NO CODE)	YELLOWISH BROWN	CODES (NO CODE) (-, F) - SEE AS4135V-P; CODES (NO CODE) W - SEE AS1003W; CODES (NO CODE) (J, K, R, S) - SEE AS4134J; CODES (NO CODE) T - SEE AS4135T; G - (NO CODE) - SEE AS4135V-P; AS4135V-P; G - (NO CODE) D, F, J, K, R, S, T, W - SEE G (CODES D, F, J, K, R, S, T, W, RESPECTIVELY.
			CRES	J (304), K (316), R (321), S (347)	NATURAL SILVERY COLOR	NOTE: "- " IS REMOVED FROM P/N; GD - USE GW GF - SEE AS4134V--P; G (CODES J, K, R, S) - SEE AS4134J; GT - SEE AS4135T.
			ALUMINUM	W (7075)	BROWN	
			TITANIUM	T (6Al-4V)	DULL GRAY	

NOTE:

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**Hydraulic Fitting Identification Information
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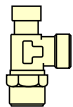
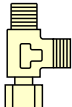
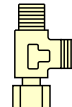
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FITTING SHAPES WITH FLARELESS ENDS (CONTINUED)						
FITTING TYPE	ILLUSTRATION	PART NUMBER	MATERIAL DATA			
			AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA
TEE, SWIVEL-ON-RUN, LIGHTWEIGHT, REDUCER		BACT16BR	CRES	JN (304), DRY FILM ON NUT ID	NATURAL SILVERY COLOR	CODES JN, P, T SUPERSEDED BY AS4139 CODES J, P, T, RESPECTIVELY.
			TITANIUM	T (6Al-4V)	DULL GRAY	
			CRES	JN (304), DRY FILM ON NUT ID V (15-5PH) V--P (15-5PH WITH CADMIUM PLATE FINISH)	NATURAL SILVERY COLOR NATURAL SILVERY COLOR YELLOWISH BROWN	
TEE, SWIVEL-ON-RUN, STANDARD WEIGHT, REDUCER		BACT16AY	TITANIUM	T (6Al-4V)	DULL GRAY	CODES M, N - SEE BACT16BR CODES J, P RESPECTIVELY; W CODE STILL ACTIVE.
			CARBON STEEL	N (CARBON STEEL WITH DRY FILM ON SWIVEL NUT)	YELLOWISH BROWN	
			CRES	K (316), M (304), S (347)	NATURAL SILVERY COLOR	
TEE, SWIVEL-ON-RUN, STANDARD WEIGHT, NON-REDUCER		NAS1763	ALUMINUM	W (7075-T73)	BROWN	CODES --, J, K, S, T - SEE BACT16BR CODES J, P, T RESPECTIVELY; CODE W - SEE BACT16AY IN CODE W.
			CARBON STEEL	-- WITH CADMIUM PLATE FINISH	YELLOWISH BROWN	
			CRES	J (304), K (316), S (347)	NATURAL SILVERY COLOR	
			ALUMINUM	W (7075)	BROWN	
			TITANIUM	T (6Al-4V)	DULL GRAY	

NOTE:
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**Hydraulic Fitting Identification Information
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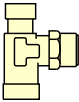
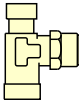
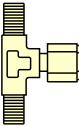
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FITTING SHAPES WITH FLARELESS ENDS (CONTINUED)						
FITTING TYPE	ILLUSTRATION	PART NUMBER	MATERIAL DATA			
			AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA
TEE, SWIVEL-ON-SIDE, LIGHTWEIGHT, REDUCER		BACT16BT	CRES	JN (304), DRY FILM ON NUT ID	NATURAL SILVERY COLOR	CODES JN, P, T - SEE AS4140 IN CODES J, V-P, T RESPECTIVELY.
			TITANIUM	T (6Al-4V)	DULL GRAY	
TEE, SWIVEL-ON-SIDE, LIGHTWEIGHT, REDUCER		AS4140	CRES	JN (304), DRY FILM ON NUT ID	NATURAL SILVERY COLOR	AS4140V080806P NOTE: PHASE-IN TO AIRPLANE PRODUCTION UNDERWAY.
				V (15-5PH)	NATURAL SILVERY COLOR	
				V-P (15-5PH WITH CADMIUM PLATE FINISH)	YELLOWISH BROWN	
			TITANIUM	T (6Al-4V), DRY FILM ON NUT ID	DULL GRAY	
TEE, SWIVEL-ON-SIDE, STANDARD WEIGHT, REDUCER		BACT16AZ	CARBON STEEL	N OR NO CODE WITH DRY FILM ON NUT	YELLOWISH BROWN	CODES M, RN, N - SEE BACT16BT IN CODES J, P RESPECTIVELY; CODE W STILL ACTIVE.
			CRES	M - J (304), K (316), RN (321) OR S (347) WITH DRY FILM ON NUT	NATURAL SILVERY COLOR	
			ALUMINUM	W (7075) WITH DRY FILM ON NUT	BROWN	
		NAS1764	CARBON STEEL	"-" OR NO CODE	YELLOWISH BROWN	CODES "-", J, K, S, T - SEE BACT16BT IN CODES J, P, T RESPECTIVELY; CODE W - SEE BACT16AZ IN CODE W.
			CRES	J (304), K (316), S (347)	NATURAL SILVERY COLOR	
			ALUMINUM	W (7075)	BROWN	
			TITANIUM	T (6Al-4V)	DULL GRAY	

NOTE:

NOT KEPT UP TO DATE - ALWAYS CONSULT LATEST REVISION OF FITTING STANDARD FOR P/N AND SUPERSESSION DATA.

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FITTING SHAPES WITH FLARELESS ENDS (CONTINUED)									
FITTING TYPE	ILLUSTRATION	PART NUMBER	MATERIAL DATA				EXAMPLE OF P/N		
			AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA			
CROSS, REDUCER ONLY		BACC27AC	CARBON STEEL	F	YELLOWISH BROWN	CODES F, J, K, R, T - SEE AS4136 CODES V--P, J, T RESPECTIVELY; CODE W - SEE AS1006W.	BACC27AC 12061006J		
			CRES	J (304), K (316), R (321)	NATURAL SILVERY COLOR				
			ALUMINUM	W (7075)	BROWN				
			TITANIUM	T (6Al-4V)	DULL GRAY				
CROSS, REDUCER AND NON-REDUCER			AS4136	CRES	J (304)	NATURAL SILVERY COLOR	AS4136V 0806O608P NOTE: PHASE-IN TO AIRPLANE PRODUCTION UNDERWAY.		
					V (15-5PH)	NATURAL SILVERY COLOR			
					V--P (15-5PH WITH CADMIUM PLATE FINISH)	YELLOWISH BROWN			
					T (6Al-4V), DRY FILM ON NUT ID	DARK GRAY			
CROSS, NON-REDUCER				MS21906 (SEE STANDARD AS21906)	CARBON STEEL	"-" OR NO CODE	YELLOWISH BROWN	CODES V, V--P, "-," J, R, S, T - SEE AS4136 CODES V, V--P, J, T, RESPECTIVELY; CODE W IS NOW SUPERSEDED BY AS1006W (NON-REDUCER SIZE COMBINATIONS ONLY)	MS21906V4P
					CRES	J (304), K (316), S (347)	NATURAL SILVERY COLOR		
						V (15-5PH)	NATURAL SILVERY COLOR		
						V--P (15-5PH WITH CADMIUM PLATE FINISH)	YELLOWISH BROWN		
					ALUMINUM	W (7075)	BROWN		
					TITANIUM	T (6Al-4V)	DULL GRAY		

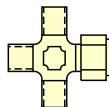
NOTE:
NOT KEPT UP TO DATE - ALWAYS CONSULT LATEST REVISION OF FITTING STANDARD FOR P/N AND SUPERSESSION DATA.
2411199 S00061527097_V1

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FITTING SHAPES WITH FLARELESS ENDS (CONTINUED)							
FITTING TYPE	ILLUSTRATION	PART NUMBER	MATERIAL DATA				EXAMPLE OF P/N
			AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA	
CROSS, REDUCER		AS1006	CARBON STEEL	NO CODE	YELLOWISH BROWN	CODES J, K, R, S - SEE AS4136 CODE J; CODE T - SEE AS4136 CODE T; CODE W IS ACTIVE.	AS1006W08080808 NOTE: PHASE-IN TO AIRPLANE PRODUCTION UNDERWAY.
			CRES	J (304), K (316), R (321), S (347)	NATURAL SILVERY COLOR		
			ALUMINUM	W (7075)	BROWN		
			TITANIUM	T (6Al-4V)	DULL GRAY		
CROSS, SWIVEL-ON-ONE-LEG, STANDARD WEIGHT, REDUCER		BACC27AD	CARBON STEEL	F (WITH CADMIUM PLATE FINISH)	YELLOWISH BROWN	CODES F, FN - SEE AS4141 CODES V--P; CODES J, K, R - SEE AS4141J; CODES (NO CODE) (NO CODE), (NO CODE) N USE CODES W AND WN	BACC27AD 10080412WN (1) N SUFFIX = DRY FILM LUBE ON SWIVEL NUT (2) BACC27AD P/N NOW SPECIFIED WITH 1ST PORT BEING THE LARGER PORT (FORMERLY SMALLER PORT WAS 1ST PORT)
			CRES	J (304), K (316), R (321)	NATURAL SILVERY COLOR		
			ALUMINUM	W (7075)	BROWN		

NOTE:
NOT KEPT UP TO DATE - ALWAYS CONSULT LATEST REVISION OF FITTING STANDARD FOR P/N AND SUPERSESSION DATA.
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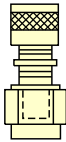
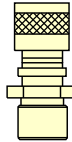
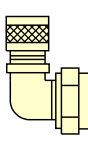
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AXIAL SWAGE FITTING CONFIGURATIONS WITH ONE OR MORE FLARELESS ENDS						
FITTING TYPE	ILLUSTRATION	PART NUMBER	MATERIAL DATA			
			AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA
STRAIGHT, FEMALE FLARELESS ADAPTER		AS5792	TITANIUM	T (6Al-4V)	DULL GRAY WITH BLUE STRIPE ON SWAGE ENDS	
STRAIGHT, MALE FLARELESS ADAPTER		AS5793	TITANIUM	T (6Al-4V)	DULL GRAY WITH BLUE STRIPE ON SWAGE ENDS	
ELBOW, 90 DEGREE, FEMALE FLARELESS		AS5801	TITANIUM	T (6Al-4V)	DULL GRAY WITH BLUE STRIPE ON SWAGE ENDS	
ELBOW, 45 DEGREE, FEMALE FLARELESS		AS5803	TITANIUM	T (6Al-4V)	DULL GRAY WITH BLUE STRIPE ON SWAGE ENDS	
						EXAMPLE OF P/N
						AS5792T0806
						AS5793T0806
						AS5801T0806
						AS5803T0806

NOTE:

NOT KEPT UP TO DATE - ALWAYS CONSULT LATEST REVISION OF FITTING STANDARD FOR P/N AND SUPERSESSION DATA.
2411201 S00061527099_V1

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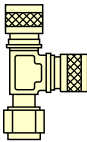
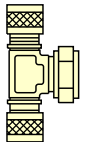
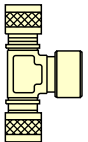
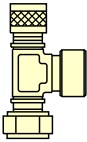
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AXIAL SWAGE FITTING CONFIGURATIONS WITH ONE OR MORE FLARELESS ENDS (CONTINUED)						
FITTING TYPE	ILLUSTRATION	PART NUMBER	MATERIAL DATA			
			AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA
TEE, FEMALE FLARELESS ON RUN		AS5804	TITANIUM	T (6Al-4V)	DULL GRAY WITH BLUE STRIPE ON SWAGE ENDS	
TEE, FEMALE FLARELESS ON BRANCH		AS5806	TITANIUM	T (6Al-4V)	DULL GRAY WITH BLUE STRIPE ON SWAGE ENDS	
TEE, MALE FLARELESS ON BRANCH		AS5807	TITANIUM	T (6Al-4V)	DULL GRAY WITH BLUE STRIPE ON SWAGE ENDS	
TEE, FEMALE FLARELESS ON RUN		AS5809	TITANIUM	T (6Al-4V)	DULL GRAY WITH BLUE STRIPE ON SWAGE ENDS	
TEE, MALE FLARELESS ON RUN		AS5810	TITANIUM	T (6Al-4V)	DULL GRAY WITH BLUE STRIPE ON SWAGE ENDS	
						EXAMPLE OF P/N
						AS5804T080808
						AS5806T080606
						AS5807T080808
						AS5809T080808
						AS5810T080606

NOTE:
NOT KEPT UP TO DATE - ALWAYS CONSULT LATEST REVISION OF FITTING STANDARD FOR P/N AND SUPERSESSION DATA.

2411202 S00061527100_V1

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FLARELESS TUBING ASSEMBLY - REMOVAL/INSTALLATION

1. General

A. This procedure contains these tasks:

- (1) A removal of the flareless tubing assembly.
- (2) An installation of the flareless tubing assembly.
- (3) A check of the electrical resistance specifications in the fuel tank.
- (4) An installation of flareless fittings in pressurized areas.
- (5) A check of the tubing clearances.
- (6) A check of the space between tubing clamps.



DO NOT USE THIS PROCEDURE ON OXYGEN TUBING. GREASE, DIRT, OR OTHER FLAMMABLE MATERIALS IN THE OXYGEN TUBING CAN CAUSE A FIRE OR EXPLOSION.

- B. You can use these procedures to remove and install all flareless tubing except tubing for the oxygen systems and water and waste systems. Refer to AMM Chapter 38 for repairs on Water and Waste Systems.
- C. You must identify the tubing assembly configuration and the tubing material before removal.
- D. When you disconnect the tubing, always use the necessary precautions to prevent leakage of fluids. If fluids fall on the airplane, identify the fluid and clean the area as specified for that fluid.
- E. When you remove, install, or do work with hydraulic tube assemblies, obey the guidelines that follow:
- (1) When you remove tubes, make sure the tubes and port fittings have tags that identify the correct connection locations.
 - (2) Do not move or change the tube bends. If you move or change the bend in the tube, these bad effects can occur:
 - (a) If you move or change the bend in the tube, it can become possible that the tube will align with the incorrect port. If this occurs, incorrect reconnection or cross-connection of the tubes can become possible.
 - (b) If you move or change the bend in the tube, it can become possible that the tube will have too much stress. Stress can cause cracks in the tubes.
 - (3) Do this task: Clean (Wet Wash) the External Surfaces of the Airplane, TASK 12-40-00-100-801 or Clean (Waterless Wash) the External Surfaces of the Airplane, TASK 12-40-00-100-802.
- F. You can use the nuts and fittings again if they are not damaged and there is a good seal on the assembly. Make sure the threads on the nuts and fittings turn smoothly.
- G. Flareless BACS13AP sleeves that are not correctly set can cause leaks. It is recommended that you set flareless sleeves by machine. Set the flareless sleeves by hand only when you cannot set them by machine.

NOTE: It is recommended that cadmium-plated corrosion-resistant steel or cadmium-plated steel fittings be used as replacements for aluminum fittings in the high pressure and normal brake return systems between the antiskid module and parking brake module. Cadmium-plated corrosion-resistant steel or cadmium-plated steel fittings can be used as replacements for aluminum fittings in other systems.

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- H. When you install the tubing, align the fittings and tubing so you can tighten the B-nuts by hand before you tighten the B-nuts with a wrench. Do not use the fitting nuts to align the tubing and connections.

NOTE: Move the sleeve until it touches the mating surface. Do not use the nut to pull the tube into position. Leakage from the fittings or the tubing can occur if you cause damage to the fittings or the tubing.

I. B-Nut torquing:

- (1) The correct torquing can be applied to B-nut only if the tubing material is identified correctly (aluminum, titanium or steel).
- (2) If the normal finish color of the B-nut is covered by the gray drilube coating, a color-coded ring is applied on the back side of the B-nut.

Table 401/20-10-51-993-801

TUBE MATERIAL	TUBE FINISH	COLOR	B-NUT (MAY BE COVERED WITH DRILUBE)
ALUMINUM	Primer	Green	GOLD OR BROWN
CRES	None, Primer, or Primer Plus Enamel	Natural, Green or Gray	SILVER, BRIGHT
TITANIUM	None	Natural	DULL GRAY

- (3) If a steel or titanium B-nut connects to an aluminum tube or fitting, use the lower torque value (aluminum).

TASK 20-10-51-000-801

2. Flareless Tubing Assembly Removal

A. References

Reference	Title
12-40-00-100-801	Clean (Wet Wash) the External Surfaces of the Airplane (P/B 201)
12-40-00-100-802	Clean (Waterless Wash) the External Surfaces of the Airplane (P/B 201)
32-41-51-000-801	Hydraulic Brake Accumulator Removal (P/B 401)

B. Flareless Tubing Assembly Removal

SUBTASK 20-10-51-010-001

 WARNING	REMOVE ALL PRESSURE FROM THE SYSTEM BEFORE YOU START THE REMOVAL OF THE FLARELESS TUBING ASSEMBLY. A PRESSURIZED SYSTEM CAN CAUSE INJURY TO PERSONNEL AND DAMAGE TO EQUIPMENT.

- (1) Depressurize the applicable system.
 - (a) For the hydraulic brake system tubing, remove the hydraulic pressure from the brake accumulator (TASK 32-41-51-000-801).

SUBTASK 20-10-51-020-009

- (2) Get access to the tube assembly fittings.

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SUBTASK 20-10-51-020-001

- (3) Remove the support clamps on the tubing you will remove.

SUBTASK 20-10-51-020-002



MAKE SURE THAT EACH TUBE AND THE PORT FITTING HAVE TAGS TO IDENTIFY THE CORRECT INSTALLATION LOCATION. IF YOU DO NOT PUT TAGS ON, YOU CAN ATTACH THE TUBES TO THE INCORRECT PORT FITTINGS. IF CROSS-CONNECTION OCCURS, INCORRECT OPERATION OF AIRPLANE SYSTEMS CAN OCCUR AND CAUSE INJURY TO PERSONS AND DAMAGE TO EQUIPMENT.

- (4) Install tags on the tubes and port fittings to clearly identify the correct connection locations.

SUBTASK 20-10-51-020-003

- (5) If it is necessary, loosen the adjacent tubing assemblies and clamps.

SUBTASK 20-10-51-020-004

- (6) Remove the tubing assembly from the airplane.

SUBTASK 20-10-51-420-001

- (7) Install caps on the ports and hydraulic lines to prevent leakage and contamination.

SUBTASK 20-10-51-160-001



REMOVE THE HYDRAULIC FLUID LEAKAGE IMMEDIATELY. HYDRAULIC FLUID CAN CAUSE DAMAGE TO EQUIPMENT.

- (8) Clean all hydraulic fluid from the area.
- (a) Do this task: Clean (Wet Wash) the External Surfaces of the Airplane, TASK 12-40-00-100-801 or Clean (Waterless Wash) the External Surfaces of the Airplane, TASK 12-40-00-100-802.

————— END OF TASK —————

TASK 20-10-51-400-801

3. Flareless Tubing Assembly Installation

(Figure 401, Figure 402)

A. References

Reference	Title
12-40-00-100-801	Clean (Wet Wash) the External Surfaces of the Airplane (P/B 201)
12-40-00-100-802	Clean (Waterless Wash) the External Surfaces of the Airplane (P/B 201)

B. Consumable Materials

Reference	Description	Specification
D00053	Grease - Gasoline And Oil Resistant	SAE AMS-G-6032 (NATO G-363)
D00054	Fluid - Hydraulic Assembly Lubricant - MCS 352B (Formerly Monsanto MCS 352B)	
D00062	Lubricant - Pneumatic System	SAE AMS-G-4343 (NATO G-392)

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Reference	Description	Specification
D00070	Fluid - Hydraulic, Petroleum Base	MIL-PRF-5606 (Replaces MIL-H-5606)
D00106	Fluid - Hydraulic, Petroleum Base, For Preservation And Operation	MIL-PRF-6083 (NATO C-635)
D00153	Fluid - Hydraulic Fluid, Fire Resistant (Interchangeable And Intermixable With BMS 3-11 Type V)	BMS3-11 Type IV
D00467	Fluid - Landing Gear Shock Strut	BMS3-32 Type II
D50004	Compound - Antiseize	BMS3-28
D50269	Fluid - Hydraulic Fluid, Fire Resistant (Interchangeable And Intermixable With BMS 3-11 Type IV)	BMS3-11 Type V

C. Flareless Tubing Assembly Installation

SUBTASK 20-10-51-020-008

- (1) Remove caps from the ports and hydraulic lines.

SUBTASK 20-10-51-160-002



CAUTION

REMOVE THE HYDRAULIC FLUID LEAKAGE IMMEDIATELY. HYDRAULIC FLUID CAN CAUSE DAMAGE TO EQUIPMENT.

- (2) Clean all hydraulic fluid from the installation area.
- (a) Do this task: Clean (Wet Wash) the External Surfaces of the Airplane, TASK 12-40-00-100-801 or Clean (Waterless Wash) the External Surfaces of the Airplane, TASK 12-40-00-100-802.

SUBTASK 20-10-51-210-001

- (3) Examine the tube ends and fittings for defects or contamination that can prevent a good seal when you install them.
- (a) If it is necessary, clean the area.

SUBTASK 20-10-51-210-002

- (4) Look for worn areas or dents on the tube.
- (a) If it is necessary, replace the tube.

SUBTASK 20-10-51-640-001

- (5) Apply the applicable thread compound to the system immediately before installation as follows (Table 402, Figure 401):
- (a) Apply the thread compound to the outer diameter of the external threads, shoulder, and conical seal surface of the sleeve.
- NOTE: Thread compound is not required when you assemble Dri-Lubed B-nuts.
- (b) Do not get the thread compound on the internal surfaces of the tube or inner surface of the bore of the fitting.

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Table 402/20-10-51-993-802 Thread Compounds

SYSTEM	APPROVED THREAD COMPOUND (Straight Thread Fittings)
Compressed Gas (Not Oxygen)	compound, D50004
Deicing or Anti-icing	compound, D50004
Instrument Air	compound, D50004
Pneumatic	compound, D50004, or lubricant, D00062
Air Conditioning	compound, D50004, or lubricant, D00062
Fire Protection	compound, D50004
Coolant	fluid, D00070, or fluid, D00467
Water Injection	compound, D50004
Fuel	fluid, D00070, or fluid, D00467
Lubrication	fluid, D00070, or fluid, D00467
Hydraulic MIL-PRF-5606	fluid, D00070, or fluid, D00467
Hydraulic BMS3-11	MCS 352B fluid, D00054, or hydraulic fluid, D00153, or hydraulic fluid, D50269
Hydraulic MIL-PRF-6083	fluid, D00070, fluid, D00106, or fluid, D00467
Miscellaneous Tubing	compound, D50004, or grease, D00053

SUBTASK 20-10-51-420-002

- (6) Put the tubing assembly in the airplane and keep the tube clamps loose to permit you to align the tube in the fitting.

- (a) Make sure that you do not clamp the tube at the repair fitting location.

NOTE: Clamps are sized to fit standard tube diameters. If a repair swage is clamped, the clamp can move off of the uniform surface because the tube can migrate or flex.

SUBTASK 20-10-51-820-001

- (7) Align the tube and fitting by hand and make the tube end touch the bottom of the fitting.

SUBTASK 20-10-51-210-003

- (8) Look at the tags to make sure that the tubes are aligned with the correct port fittings.

SUBTASK 20-10-51-420-003

- (9) Keep the tube end at the bottom and aligned in the fitting.

- (a) Turn the B-nut by hand until the B-nut touches the bottom of the sleeve shoulder.

SUBTASK 20-10-51-420-004



USE TWO WRENCHES TO TIGHTEN THE TUBE COUPLING NUTS. USE ONE TO HOLD THE MATING PART, AND THE OTHER TO TIGHTEN THE COUPLING NUT. IF YOU DO NOT USE TWO WRENCHES, DAMAGE TO THE TUBES AND MATING PART CAN OCCUR.

- (10) Tighten the flareless tubing assembly with a torque wrench to the installation torque, if it is one of the following types (Table 405):

- (a) Steel, Titanium, and Cres Tubes:

- 1) 21-6-9 Cres and all other Cres tube ends with BACS13BX swaged sleeves

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- 2) MIL-T-6845, MIL-T-8504 and MIL-T-8808 Cres flared tube ends
- 3) MIL-T-6845 (304-1/8 hard) Cres with BACS13AP preset sleeve with a minimum wall thickness shown in the table below:

Table 403/20-10-51-993-803 Minimum Wall Thickness

Tube Dash No.	Wall Thickness
-4	0.020 in. (0.51 mm)
-5	0.020 in. (0.51 mm)
-6	0.028 in. (0.71 mm)
-8	0.035 in. (0.89 mm)
-10	0.049 in. (1.24 mm)
-12	0.049 in. (1.24 mm)
-16	0.065 in. (1.65 mm)

- 4) Hose end fittings with steel inserts (nipples).
 - 5) All titanium tube ends.
- (b) Aluminum and Annealed Cres Tubes:
- 1) Aluminum with BACS13BX swaged sleeves
 - 2) 6061-T6 aluminum and Annealed Cres with BACS13AP sleeves with a minimum wall thickness shown in the table below:

Table 404/20-10-51-993-804 Minimum Wall Thickness

Tube Dash No.	Wall Thickness
-3	0.028 in. (0.71 mm)
-4	0.028 in. (0.71 mm)
-5	0.028 in. (0.71 mm)
-6	0.028 in. (0.71 mm)
-8	0.028 in. (0.71 mm)
-10	0.028 in. (0.71 mm)
-12	0.028 in. (0.71 mm)
-16	0.035 in. (0.89 mm)
-20	0.049 in. (1.24 mm)
-24	0.049 in. (1.24 mm)

- 3) Flareless type hose end fittings with aluminum inserts (nipples)
 - 4) Aluminum flared tube ends.
- (c) Tube Material Specifications:
- 1) 6061-T6 aluminum - MIL-T-7081, WW-T-700/6, AMS4083
 - 2) Annealed Cres - MIL-T-8504, MIL-T-8606, MIL-T-8808
 - 3) 1/8 hard Cres - MIL-T-6845
 - 4) 21-6-9 Cres - BMS7-185
 - 5) TI-3AL-2.5V - AS5620 and AMS4946.

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Table 405/20-10-51-993-805 Installation Torque

NOMINAL TUBE DIAMETER	TUBE DASH NO.	STEEL, TITANIUM, AND CRES TUBES TORQUE	ALUMINUM & ANNEALED CRES TUBES TORQUE
3/16 in. (4.76 mm)	-3	100 ±5 in-lb (11.3 ±0.6 N·m)	80 ±4 in-lb (9.0 ±0.5 N·m)
¼ in. (6.35 mm)	-4	140 ±7 in-lb (15.8 ±0.8 N·m)	110 ±6 in-lb (12.4 ±0.6 N·m)
5/16 in. (7.94 mm)	-5	190 ±10 in-lb (21.5 ±1.1 N·m)	140 ±7 in-lb (15.8 ±0.8 N·m)
¾ in. (9.52 mm)	-6	270 ±14 in-lb (30.5 ±1.5 N·m)	170 ±9 in-lb (19.2 ±1.0 N·m)
½ in. (12.70 mm)	-8	500 ±25 in-lb (56.5 ±2.8 N·m)	280 ±14 in-lb (31.6 ±1.6 N·m)
⅝ in. (15.88 mm)	-10	700 ±35 in-lb (79.1 ±4.0 N·m)	360 ±18 in-lb (40.7 ±2.1 N·m)
¾ in. (19.05 mm)	-12	900 ±45 in-lb (101.7 ±5.1 N·m)	450 ±23 in-lb (50.8 ±2.6 N·m)
1 in. (25.40 mm)	-16	1200 ±60 in-lb (135.6 ±6.8 N·m)	750 ±38 in-lb (84.7 ±4.3 N·m)
1¼ in. (31.75 mm)	-20	1600 ±80 in-lb (180.8 ±9.1 N·m)	900 ±45 in-lb (101.7 ±5.1 N·m)
1½ in. (38.10 mm)	-24	2000 ±100 in-lb (226.0 ±11.3 N·m)	900 ±45 in-lb (101.7 ±5.1 N·m)
2 in. (50.80 mm)	-32	2000 ±100 in-lb (226.0 ±11.3 N·m)	--

SUBTASK 20-10-51-420-005

- (11) If the flareless tubing assembly is a reducer fitting, use the boss or bulkhead size to get the correct torque and tighten the assembly.

SUBTASK 20-10-51-420-006



CAUTION

USE TWO WRENCHES TO TIGHTEN THE TUBE COUPLING NUTS. USE ONE TO HOLD THE MATING PART, AND THE OTHER TO TIGHTEN THE COUPLING NUT. IF YOU DO NOT USE TWO WRENCHES, DAMAGE TO THE TUBES AND MATING PART CAN OCCUR.

- (12) Tighten the flareless tubing assembly with a torque wrench to the installation torques, if it is an assembly as follows (Table 405):
- (a) Steel, Titanium, and Cres Tubes:
- 1) MIL-T-6845 (304-1/8 hard) Cres with BACS13AP preset sleeve with a wall thickness shown in the table below:

Table 406/20-10-51-993-806 Wall Thickness

Tube Dash No.	Wall Thickness	Torque
-8	0.028 in. (0.71 mm)	375 in-lb (42.4 N·m)
-10	0.035 in. (0.89 mm)	575 in-lb (65.0 N·m)
-12	0.042 in. (1.07 mm)	725 in-lb (81.9 N·m)

- (b) Aluminum and Annealed Cres Tubes:

- 1) 6061-T6 aluminum and annealed Cres with BACS13AP sleeves with a wall thickness shown in the table below:

Table 407/20-10-51-993-807 Wall Thickness

Tube Dash No.	Wall Thickness	Torque
-6	0.020 in. (0.51 mm)	160 in-lb (18.1 N·m)

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Table 407/20-10-51-993-807 Wall Thickness (Continued)

Tube Dash No.	Wall Thickness	Torque
-10	0.020 in. (0.51 mm)	250 in-lb (28.2 N·m)
-12	0.020 in. (0.51 mm)	325 in-lb (36.7 N·m)

SUBTASK 20-10-51-420-007

- (13) Tighten the flareless tubing assembly with a torque wrench to the installation torque, if it is a material listed above as follows (Table 405):

- (a) Hold the union with a wrench and tighten the B-nut to the installation torque value.

NOTE: If a leak is found, the B-nut can be loosened and tightened again.

- 1) Do not use the B-nut to align the tube.
- 2) Do not let the B-nut touch the bottom of the sleeve shoulder.

SUBTASK 20-10-51-420-008



CAUTION

USE TWO WRENCHES TO TIGHTEN THE TUBE COUPLING NUTS. USE ONE TO HOLD THE MATING PART, AND THE OTHER TO TIGHTEN THE COUPLING NUT. IF YOU DO NOT USE TWO WRENCHES, DAMAGE TO THE TUBES AND MATING PART CAN OCCUR.

- (14) On nuts that you can not get access to with a torque wrench, tighten the nuts with your hand as follows:

- (a) Hand tighten until a clear increase in torque occurs, then tighten 1/6 to 1/3 turn more.

- (b) Tighten the flareless fittings with the BACS13AP sleeves two times (tighten, loosen, and tighten again).

- 1) Make sure that the maximum tube collapse after you tighten the BACS13AP sleeves is 0.015 in. (0.38 mm) less than the tube inside diameter (Figure 402).

SUBTASK 20-10-51-420-009



CAUTION

ALWAYS KEEP THE CLAMPS TIGHT. TIGHT CLAMPS KEEP THE AREA BETWEEN THE TUBE AND THE CLAMP SURFACES FREE OF UNWANTED MATERIALS AND CONTAMINATION. IF SURFACES ARE NOT CLEAN, DAMAGE BY FRICTION CAN OCCUR.

- (15) Tighten all of the tube clamps.

- (a) Make sure that you do not clamp the tube at the repair fitting location.

NOTE: Clamps are sized to fit standard tube diameters. If a repair swage is clamped, the clamp can move off of the uniform surface because the tube can migrate or flex.

SUBTASK 20-10-51-710-001

- (16) If you disconnected more than one hydraulic tube and you think there is a possibility you connected the tubes incorrectly or cross-connected the tubes, do an operational check:

NOTE: Use your own judgement to determine if a check is necessary.

- (a) Do the post-installation test of one or more of the components to which the tubes are connected as a check.

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SUBTASK 20-10-51-710-002

- (17) If you disconnected electrical wires to get access to the tubes and you think there is a possibility you connected the wires incorrectly or cross-connected the wires, do an operational check:

NOTE: Use your own judgement to determine if a check is necessary.

- (a) Do the post-installation test of one or more of the components to which the wires are connected as a check.

———— **END OF TASK** ————

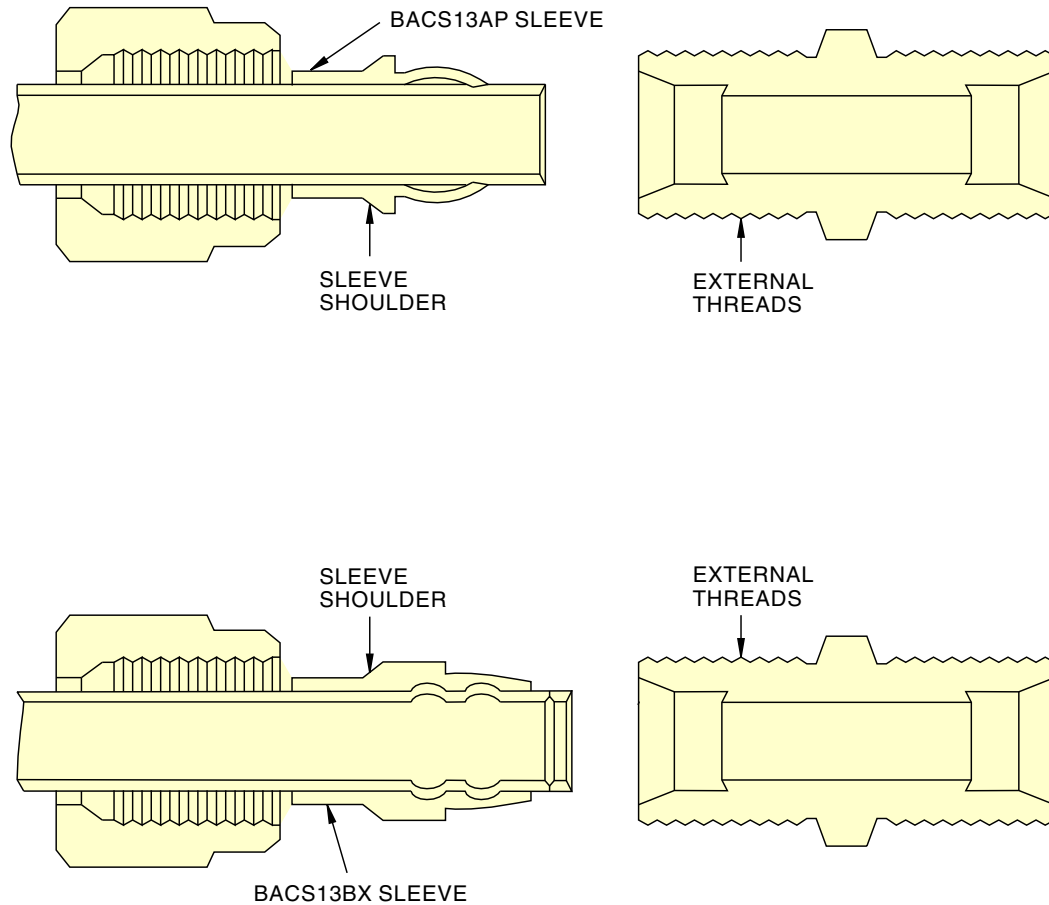
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LUBRICATION POINTS

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Flareless Tubing Assembly Lubrication Points
Figure 401/20-10-51-990-801

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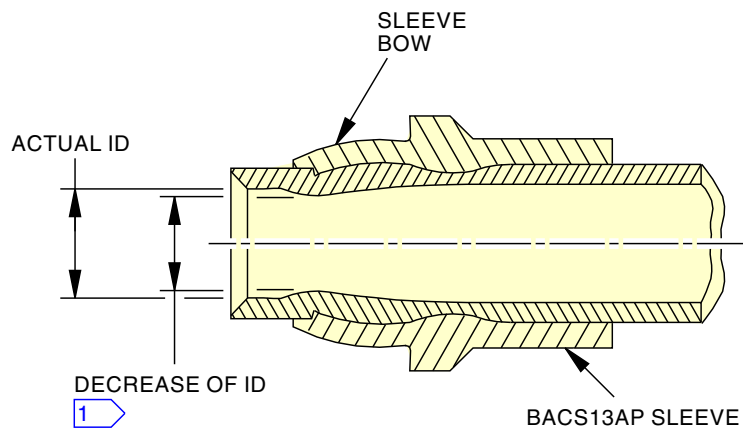
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1 MAKE SURE THE DECREASE OF ID IS NOT MORE THAN
 0.005 INCH AFTER PRESET OR 0.015 INCH AFTER MANY
 TIGHTENINGS

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Maximum Collapse of Preset Flareless Sleeve
Figure 402/20-10-51-990-802

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TASK 20-10-51-760-801

4. Electrical Resistance Specifications in the Fuel Tank Check

(Figure 403)

A. General

- (1) This task has steps to measure the electrical bonding resistance of hydraulic tubes in the fuel tank.
- (2) Refer to the procedure: BULKHEAD FITTINGS - REMOVAL/INSTALLATION, PAGEBLOCK 29-11-55/401, to replace the bulkhead fittings for the hydraulic tubes in the fuel tank.
- (3) This task has one or more steps which are a means to satisfy Critical Design Configuration Control Limitation (CDCCL) requirements. A CDCCL note will follow the step to which it applies. Any step or sub-step that precedes or follows a CDCCL identified step is not subject to the CDCCL requirement.
 - (a) For important information on CDCCL requirements, refer to this task: Airworthiness Limitation Precautions, TASK 28-00-00-910-801.

NOTE: This is applicable to Airworthiness Limitation 28-AWL-10.

B. References

Reference	Title
28-00-00-910-801	Airworthiness Limitation Precautions (P/B 201)
28-11-00-910-802	Purging and Fuel Tank Entry (P/B 201)
29-11-55 P/B 401	BULKHEAD FITTINGS - REMOVAL/INSTALLATION

C. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

Reference	Description
COM-1550	Bonding Meter - Approved, Intrinsically Safe (Approved for use in Class I, Divisions I & II hazardous (classified) locations. Outside these hazardous locations, COM-614 can be used in lieu of COM-1550). Part #: 620LK Supplier: 1CRL2 Part #: M1 Supplier: 3AD17 Part #: M1B Supplier: 3AD17 Part #: T477W (C15292) Supplier: 06659

D. Electrical Resistance Specifications in the Fuel Tank Check

SUBTASK 20-10-51-910-003

 WARNING	OBEY THE PRECAUTIONS FOR PURGING AND FUEL TANK ENTRY. IF YOU DO NOT OBEY THE PRECAUTIONS, INJURIES TO PERSONNEL AND DAMAGE TO EQUIPMENT CAN OCCUR.

- (1) Do all the applicable steps in this task: Purging and Fuel Tank Entry, TASK 28-11-00-910-802.

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SUBTASK 20-10-51-760-001



WARNING

MAKE SURE THAT THE DANGEROUS GAS CONCENTRATION IS LESS THAN 10 PERCENT OF THE LOWER EXPLOSIVE LIMIT IF THE METER USED IS NOT EXPLOSION PROOF. AN EXPLOSION CAN CAUSE INJURY TO PERSONNEL AND DAMAGE TO EQUIPMENT.

- (2) Do a check of the electrical bonding resistance with the intrinsically safe approved bonding meter, COM-1550.

SUBTASK 20-10-51-760-002

 28-AWL-10: CDCCL

- (3) Measure the electrical bonding resistance across the in-line union/tee fittings (tube-to-tube) that you replaced (Figure 403).

NOTE: CDCCL- Refer to the task: Airworthiness Limitation Precautions, TASK 28-00-00-910-801, for important Information on Critical Design Configuration Control Limitations (CDCCLs).

NOTE: This is applicable to Airworthiness Limitation 28-AWL-10.

 28-AWL-10: CDCCL

- (a) Make sure that the electrical bonding resistance is 0.00095 ohm (0.95 milliohm) or less.

NOTE: CDCCL- Refer to the task: Airworthiness Limitation Precautions, TASK 28-00-00-910-801, for important Information on Critical Design Configuration Control Limitations (CDCCLs).

NOTE: This is applicable to Airworthiness Limitation 28-AWL-10.

———— **END OF TASK** ————

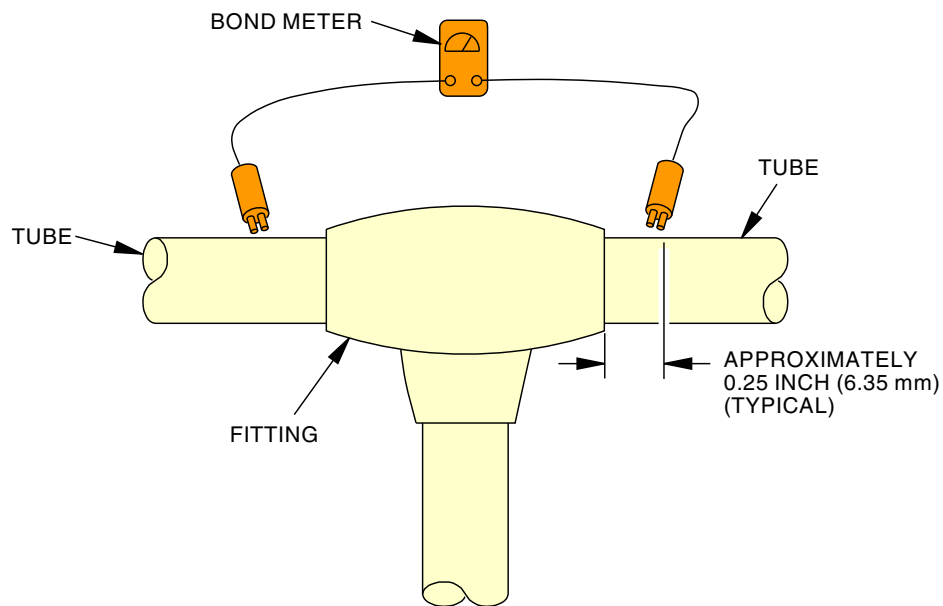
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Resistance Measurement Across Tee/Union Fittings
Figure 403/20-10-51-990-803

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TASK 20-10-51-400-802

5. Flareless Fittings in Pressurized Areas Installation

A. Procedure

SUBTASK 20-10-51-420-010



USE TWO WRENCHES TO TIGHTEN THE TUBE COUPLING NUTS. USE ONE TO HOLD THE MATING PART, AND THE OTHER TO TIGHTEN THE COUPLING NUT. IF YOU DO NOT USE TWO WRENCHES, DAMAGE TO THE TUBES AND MATING PART CAN OCCUR.

- (1) Tighten the flareless fittings with the BACS13AP sleeves two times (tighten, loosen, and tighten again).

NOTE: Be careful to make sure that the fittings will not have leaks after you tighten them.

SUBTASK 20-10-51-420-011

- (2) Tighten flareless fittings with BACS13BX, welded-on, or NAS1760-type sleeves as follows:
- (a) Tighten the fitting to the applicable torque shown in Table 408.
 - (b) Loosen the fitting to release the torque.
 - (c) Tighten the fitting to the torque shown in Table 408.

Table 408/20-10-51-993-808 Installation Torques

Tube Size	Titanium Cres Tube	Aluminum
¼ in. (6.35 mm)	210 in-lb (23.7 N·m)	170 in-lb (19.2 N·m)
⅜ in. (9.52 mm)	400 in-lb (45.2 N·m)	250 in-lb (28.2 N·m)
½ in. (12.70 mm)	750 in-lb (84.7 N·m)	420 in-lb (47.5 N·m)
⅝ in. (15.88 mm)	1050 in-lb (118.6 N·m)	540 in-lb (61.0 N·m)
¾ in. (19.05 mm)	1350 in-lb (152.5 N·m)	675 in-lb (76.3 N·m)
1 in. (25.40 mm)	1800 in-lb (203.4 N·m)	1125 in-lb (127.1 N·m)
1¼ in. (31.75 mm)	2400 in-lb (271.2 N·m)	1350 in-lb (152.5 N·m)
1½ in. (38.10 mm)	3000 in-lb (339.0 N·m)	1350 in-lb (152.5 N·m)

SUBTASK 20-10-51-760-003

- (3) If you install flareless fittings in the fuel tanks, do this task: Electrical Resistance Specifications in the Fuel Tank Check, TASK 20-10-51-760-801.

SUBTASK 20-10-51-790-001

- (4) Do a leak test on the repair installations of the flareless fittings in pressurized areas as follows:
- (a) Pressurize the system for a minimum of 15 minutes.
 - (b) With the system pressurized, use a clean white cloth to do a check on the tube-to-fitting interface for signs of hydraulic leakage.

NOTE: You can tighten the tube again to the torque value shown above, if you find leakage. If leakage occurs in subsequent leak tests, you must replace the repair installation.

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SUBTASK 20-10-51-710-003

- (5) If you disconnected more than one hydraulic tube and you think there is a possibility you connected the tubes incorrectly or cross-connected the tubes, go back and verify that the connections are correct:

NOTE: Use your own judgement to determine if a check is necessary.

- (a) After verifying the connections, do the post-installation test of one or more of the components to which the tubes are connected as a check.

SUBTASK 20-10-51-710-004

- (6) If you disconnected electrical wires to get access to the tubes and you think there is a possibility you connected the wires incorrectly or cross-connected the wires, go back and verify that the connections are correct:

NOTE: Use your own judgement to determine if a check is necessary.

- (a) After verifying the connections, do the post-installation test of one or more of the components to which the wires are connected as a check.

————— **END OF TASK** —————

TASK 20-10-51-200-801

6. Tubing Clearances Check

(Figure 404)

A. General

- (1) This task gives you the minimum clearances necessary between tubes and all other components (hoses, fittings, structure, and other tubes). These clearances prevent tube damage in all positions of operation.
- (2) High vibration areas are the areas that follow:
- (a) Engine core.
 - (b) Engine nacelle.
 - (c) APU compartment.

B. Definitions

- (1) Supported Tube Locations
- (a) Tubes at supported locations are tubes that are clamped to the aircraft structure and have up to 3.0 in. (76.2 mm) on each side from where the tube is clamped to the structure.
- (2) Non-Supported Tube Locations
- (a) Tubes at non-supported locations are tubes that do not meet the definition of tubes at supported locations.

C. Procedure

SUBTASK 20-10-51-220-001

- (1) For hydraulic system tubing, do the checks that follow.
- (a) At supported locations, make sure that the tube clearance is a minimum of 0.10 in. (2.54 mm).

NOTE: Where the tube is attached directly with a clamp to structure, the minimum clearance is the thickness of the clamp.

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- (b) At non-supported locations, make sure that the tube clearance is a minimum of 0.20 in. (5.08 mm).
 - 1) Install loop-type clamps to maintain clearance, if necessary.
 - a) Make sure that you do not force the clamp into place.
 - b) Make sure that you use a clamp that is compatible with BMS3-11 hydraulic oil (M85052/2 or equivalent clamp).
 - c) Use one of the methods that follow (Figure 404).
 - <1> Back-to-back clamping in the vertical or horizontal position.
 - <a> Make sure that you do not use back-to-back clamping in the high vibration areas that follow.
 - Engine core.
 - Engine nacelle.
 - APU compartment.
 - <2> Side-by-side clamping.
 - <3> Butterfly clamping.
- (c) Make sure that the tube clearance with electrical wiring is a minimum of 0.50 in. (12.70 mm).
 - 1) Install loop-type clamps and spacers to maintain clearance, as necessary.
 - a) Make sure that you do not force the clamps or spacers into place.
 - b) Make sure that you use clamps and spacers that are compatible with BMS3-11 hydraulic oil (M85052/2 or equivalent clamp for tube/BACC10JU clamp for wire bundle/NAS43DD spacer).
 - c) Use variations of the clamping configurations shown in Figure 404.
- (d) Make sure that the tubes are clear of any mechanism that operates.
 - 1) At supported locations, make sure that the clearance is a minimum of 0.25 in. (6.35 mm).
 - 2) At non-supported locations, make sure that the clearance is a minimum of 0.38 in. (9.65 mm).

SUBTASK 20-10-51-220-002

- (2) For tubing in systems other than hydraulic systems, do the checks that follow:
 - (a) Make sure that the tube clearance from electrical wires and cables is a minimum of 2.0 in. (50.8 mm) for the systems that follow:
 - 1) Flammable gas.
 - 2) Fuel.
 - 3) Oxygen.
 - (b) At supported locations, make sure that the tube clearance is a minimum of 0.10 in. (2.54 mm).
 - (c) At non-supported locations, make sure that the tube clearance is a minimum of 0.20 in. (5.08 mm).

NOTE: Where the tube is attached directly with a clamp to structure, the minimum clearance is the thickness of the clamp.

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SUBTASK 20-10-51-220-003

- (3) If one tube goes across a tube, or if two tubes are in parallel, make sure that the tubes are clear of one another.
- (a) The minimum clearance in areas other than high vibration areas is 0.25 in. (6.35 mm).
- 1) If the clearance is less than 0.25 in. (6.35 mm), do the steps that follow.
- a) Loosen the existing clamps in the area.
- b) Loosen the fittings at the ends of the tube, if necessary.
- c) Adjust the tubes to make the 0.25 in. (6.35 mm) clearance.
- d) Install new back-to-back clamps to maintain the clearance, if necessary.
- <1> Make sure that the clamps are compatible with BMS3-11 hydraulic oil (M85052/2 or equivalent clamps).
- <2> Make sure that you do not force the clamps into place.
- e) Retighten the clamps in the area.
- f) Retighten the fitting ends if they were loosened.

SUBTASK 20-10-51-220-004

- (4) To get the necessary clearance where loop-type clamps are attached to structure, use BACS18AF2 or BACS18AF4 spacers.
- (a) Make sure that you do not use NAS42 or NAS43 spacers for hydraulic tubing.

SUBTASK 20-10-51-220-005

- (5) To get the necessary clearance where U-type clamps are used, use BACS18AN spacers.
- (a) Make sure that you do not use NAS42 or NAS43 spacers for hydraulic tubing.

SUBTASK 20-10-51-220-006

- (6) Make sure that the tubes are clear of the control cables between the break points or fairleads and the control cable linkage.
- (a) The minimum clearance is 0.625 in. (15.875 mm).

SUBTASK 20-10-51-220-007

- (7) Make sure the clearance between the tubes and the clamp blocks and the channels on the clamp blocks is a minimum of 0.05 in. (1.27 mm).
- (a) If the clearance is less than 0.05 in. (1.27 mm), do one of the steps that follow.
- 1) Adjust the spacer tube length.
- 2) Adjust the clamp and the tube fit-up.

NOTE: This will correct the force on the tubes in the clamp block.

————— **END OF TASK** —————

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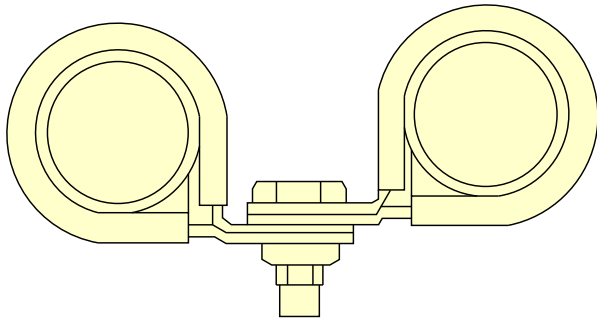
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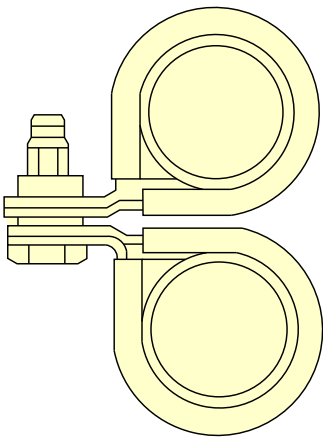
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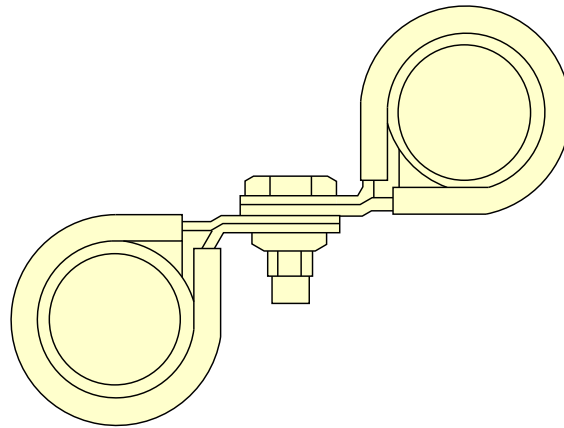
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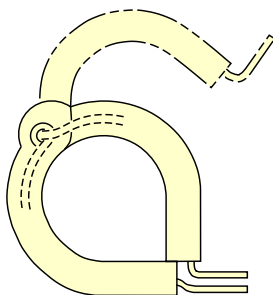
SIDE-BY-SIDE CLAMP



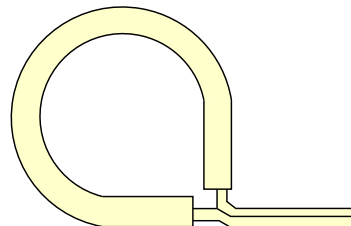
BACK-TO-BACK CLAMP



BUTTERFLY CLAMP



LOOP CLAMP



CLAMPING TO MAINTAIN CLEARANCES

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Tubing Clearances Check Clamps
Figure 404/20-10-51-990-804

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TASK 20-10-51-200-802

7. Space Between Tubing Clamps Check

A. Procedure

SUBTASK 20-10-51-220-008

- (1) Make sure the space between the tubing clamps is within the limits shown in Table 409, unless it is specified differently.

Table 409/20-10-51-993-809 Maximum Space Between Tubing Clamps

TUBE OD	MATERIAL	CLAMP SPACE - VISUAL	CLAMP SPACE - SPECIAL ^{*[1]}
¼ in. (6.35 mm)	Steel, Titanium	16.0 in. (40.6 cm)	12.0 in. (30.5 cm)
⅜ in. (9.52 mm)	Steel, Titanium	20.0 in. (50.8 cm)	15.0 in. (38.1 cm)
⅜ in. (9.52 mm)	Aluminum	16.5 in. (41.9 cm)	12.0 in. (30.5 cm)
½ in. (12.70 mm)	Steel, Titanium	23.0 in. (58.4 cm)	17.0 in. (43.2 cm)
½ in. (12.70 mm)	Aluminum	19.0 in. (48.3 cm)	14.0 in. (35.6 cm)
⅝ in. (15.88 mm)	Steel, Titanium	22.0 in. (55.9 cm)	18.5 in. (47.0 cm)
⅝ in. (15.88 mm)	Aluminum	22.0 in. (55.9 cm)	16.5 in. (41.9 cm)
¾ in. (19.05 mm)	Steel, Titanium	27.5 in. (69.9 cm)	20.5 in. (52.1 cm)
¾ in. (19.05 mm)	Aluminum	24.0 in. (61.0 cm)	18.0 in. (45.7 cm)
1 in. (25.40 mm)	Steel, Titanium	30.0 in. (76.2 cm)	22.5 in. (57.2 cm)
1 in. (25.40 mm)	Aluminum	26.5 in. (67.3 cm)	19.5 in. (49.5 cm)
1¼ in. (31.75 mm)	Steel, Titanium	31.5 in. (80.0 cm)	23.5 in. (59.7 cm)
1¼ in. (31.75 mm)	Aluminum	28.5 in. (72.4 cm)	21.0 in. (53.3 cm)

*[1] Special: Wing Rear Spar, Engine Strut, Engine Aft Fairing.

————— END OF TASK —————

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FLARELESS TUBING ASSEMBLY - REPAIRS

1. General

- A. The customer must consult Boeing before conducting any repairs to oxygen system tubing.
- B. This procedure has these tasks:
 - (1) Tube and Fitting Leakage
 - (2) Retightening of Fitting Joints with Persistent Hydraulic Leaks
 - (3) Tube repair
 - (4) Titanium Hydraulic Tubing, 3000 psi - Roll Swaging Harrison 53211 Sleeves and 53212 Unions using the Harrison 6777 Swage Machine
 - (5) Install the CRYOLIVE Flareless Sleeve Assembly.
 - (6) Swage the BACS13BX Flareless Sleeves with the Internal Elastomer Swage Equipment
 - (7) BACS13BX Flareless Sleeve Swaging on Stainless Steel and Titanium Hydraulic Tubing
 - (8) BACS13AP Flareless Sleeve Preset
 - (9) BACC42W H-Coupling Installation
 - (10) 3P02111/3PHS111 Cryofit Coupling Installation
 - (11) Externally Swaged (Permaswage) Fittings Installation
 - NOTE:** The use of Permaswage fitting to repair potable water line tubes is not recommended because of possible microbe growth in the cavity of the fitting.
 - (12) Axial Swage Fitting Union (8,000 psi rated - Rynglok)
 - (13) Axial Swage Fitting Installation (5,000 psi rated - Union) or Male/Female Adapter Fittings
 - (14) Axial Swage Fitting Installation (5,000 psi rated - Shape, Elbow, Tee)
 - (15) Hydraulic Tubing Repair with Flexible Hoses
 - (16) Repair Size 16 (1 inch) and Size 20 (1-1/4 inch) 6061-T4 Aluminum Tubing in the Hydraulic System of the Airplane
 - (17) Part Marking of Flareless Tubing Assemblies
 - (18) Possible Tube Repair Scenarios - Axial Swage Fittings
- C. Airplane line numbers 3100 and on have been delivered with both B-nut fittings and Axial Swage fittings. However, it is an option to use the Axial Swage fittings for applicable tube repairs on all 737-MAX aircraft.
- D. This procedure gives the approved repairs for hydraulic, pneumatic, water, electrical rigid conduit, pitot/static tubing, cargo fire protection tubing, and other tube assemblies.
 - (1) Repair procedures include the replacement of damaged tube ends or the replacement of small damaged tube parts. You can use flareless tubes and sleeves, H-Coupling assemblies, Cryofit couplings, Permaswage fittings, Cryolive assemblies, or Rynglok unions.
 - (2) For repair of electrical flexible conduit, do this task: SWPM 20-10-91.
- E. You can replace existing axial swage shape (elbow and tee, 5,000 psi rated) fittings on the aircraft (Axial Swage Fitting Installation (5,000 psi rated - Shape, Elbow and Tee), TASK 20-10-51-400-809).
- F. For the approved repair of aluminum fuel system tubes, refer to the Component Maintenance Manual (CMM).
- G. You can repair 6061-T4 aluminum tubes using 6061-T4 or 6061-T6 aluminum tube and flareless fittings. It is not acceptable to repair 6061-T6 aluminum tube with 6061-T4 aluminum tube or use 6061-T4 tube in place of 6061-T6 aluminum tube.

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- H. You can use approved 304-1/8 Hard or 21-6-9 corrosion-resistant steel tube material for replacement or repair of titanium tube assemblies. You can also use approved 304-1/8 Hard corrosion-resistant steel tube material for replacement or repair of 21-6-9 corrosion-resistant steel tube assemblies. When a new tube is fabricated to replace an existing tube assembly, the replacement tube assembly should be marked with a part number similar to, but not the same, as the original tube. (Refer to the task for Part Marking of Flareless Tubing Assemblies.)



USE CADMIUM PLATED STEEL FITTINGS WHEN YOU REPLACE ALUMINUM LINES WITH CORROSION RESISTANT STEEL LINES. GALVANIC CORROSION WILL OCCUR IF CADMIUM PLATED STEEL IS NOT USED.

- I. Replacements for aluminum lines may be made from corrosion resistant steel material.
- J. When you do repairs, the type of flareless tube sleeves will tell you the installation method to use.
- (1) Use the approved power swaging equipment, or roller swaging, to do all swaged-on sleeves and fittings.
 - (2) You can preset BACS13AP flareless sleeves by machine. Preset by hand only when a hydraulic or pneumatic-operated presetting tool is not available. If you must preset by hand, we recommend you preset some samples. Cut the samples into sections longitudinally and make an inspection of the ring cut depth before you preset the part to be repaired.
 - (3) You can install the Cryolive sleeve assembly, consisting of Cryolive sleeve, coupling nut and protective cover/inspection tool, by removing the assembly from liquid nitrogen and sliding it onto the tube end. Note that the size 10, 12, and 16 coupling nuts used with the Cryolive sleeve are slightly longer than standard MS type coupling nuts and are not interchangeable with MS type coupling nuts.
- K. The H-coupling assembly is a repair coupling which has a union coupling, a slide, and a nut. You can install the H-coupling assembly in straight sections of the tube. Use two end wrenches of applicable size. This assembly is approved for fuel and hydraulic high pressure lines of 21-6-9, titanium 3AL-2.5V, and 304-1/8 hard CRES tubing. The H-coupling assembly is also approved for the repair of 304 CRES annealed and 6061-T6 aluminum tubing lines of 3000 psi (10342.1 kPa) or less.
- L. You can use a Cryofit coupling for the inline repair of 3AL-2.5V titanium tubing. To install the Cryofit coupling in a straight tube section, shrink fit the coupling in its position.
- M. You can use the Permaswage coupling for inline repair of 6061-T6 aluminum, 21-6-9 CRES or 304-1/8 hard CRES, and 3AL-2.5V titanium tubing.
- N. 5,000 psi rated Axial Swage
- (1) You can use the Axial Swage union or Adapter fittings (5,000 psi rated) for inline repair of 3,000 psi rated 3AL-2.5V titanium tubing or 21-6-9 CRES tubing.
 - (2) You can use the Axial Swage shape fittings (5,000 psi rated - tee and elbows) to replace existing Axial Swage fittings (5,000 psi rated) of the same configuration.
 - (3) The Axial Swage fittings (5,000 psi rated) are made of lightweight 6AL-4V titanium alloy and are not to be used in oxygen systems, fuel cells, or in the repair of tubes installed in the engines.
 - (4) The 5,000 psi rated Axial Swage fittings and tooling are color-coded blue to distinguish them from the 8,000 psi rated Axial Swage fittings and tooling.
- O. 8,000 psi rated Axial Swage
- (1) You can use the Axial Swage union (8,000 psi rated - Rynglok) for inline repair of 3AL-2.5V titanium tubing, 21-6-9 CRES tubing, 304 1/8 hard CRES tubing, or 6061-T6 aluminum tubing.

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- (2) The 8,000 psi rated Axial Swage union in sizes 04, 06, 08, 10, and 12 have no color coding on the outside.
- (3) The 8,000 psi rated Axial Swage union in sizes 16 and 20 have a black band on the collars at the permanent ends.
- (4) There is no color code for the Axial Swage (8,000 psi rated) union tooling.
- P. The tooling for the 5,000 psi rated Axial Swage fittings and the tooling for the 8,000 psi rated Axial Swage fittings are not interchangeable.
 - (1) The tooling for the 5,000 psi rated Axial Swage fitting cannot be used to swage the 8,000 psi rated Axial Swage fitting.
 - (2) The tooling for the 8,000 psi rated Axial Swage fitting cannot be used to swage the 5,000 psi rated Axial Swage fitting.
- Q. You can use the 8,000 psi rated Axial Swage union (Rynglok) for inline repair of 6061-T6 aluminum, 21-6-9 CRES or 304-1/8 hard CRES, and 3AL-2.5V titanium tubing. Rynglok unions are made of lightweight 6AL-4V titanium alloy and are not to be used in oxygen systems, in fuel cells, or in the repair of tubes installed in engines.



DO NOT USE FITTING NUTS TO ALIGN THE FITTINGS. FITTING NUTS USED TO ALIGN FITTINGS DURING THE TUBE INSTALLATION WILL INCREASE THE RISK OF LEAKAGE, BLOW-OFF, OR OTHER FAILURE.

- R. When you repair a section of a tube, correctly align the tube and the fittings. Make sure the fittings touch the bottom at the two ends of the repaired section.
- S. Do a pressure test on completed repairs in all general areas. In pressurized areas, pressurize the system for 15 minutes minimum to do a leak test. To make sure there are no signs of hydraulic leakage, rub the area with a finger or a white cloth.
- T. When you remove, install, or do work with hydraulic tube assemblies, obey the guidelines that follow:
 - (1) Make sure that you do not clamp the tube at the repair fitting location.
NOTE: Clamps are sized to fit standard tube diameters. If a repair swage is clamped, the clamp can move off of the uniform surface because the tube can migrate or flex.
 - (2) When you remove tubes, make sure the tubes and the port fittings have tags that identify the correct connection locations.
 - (3) Do not move or change the tube bends. If you move or change the bend in the tube, these bad effects can occur:
 - (a) If you move or change the bend in the tube, it can become possible that the tube will align with the incorrect port. If this occurs, incorrect reconnection or cross-connection of the tubes can become possible.
 - (b) If you move or change the bend in the tube, it can become possible that the tube will have too much stress. Stress can cause cracks in the tubes.
 - (4) If you disconnected more than one hydraulic tube and you think there is a possibility you connected the tubes incorrectly or cross-connected the tubes, do an operational check:
NOTE: Use your own judgement to determine if a check is necessary.
 - (a) Do the post-installation test of one or more components to which the tubes are connected as a check.

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- (5) If you disconnected electrical wires to get access to the hydraulic tube and you think there is a possibility you connected the wires incorrectly or cross-connected the wires, do an operational check:

NOTE: Use your own judgement to determine if a check is necessary.

- (a) Do the post-installation test of one or more components to which the wires are connected as a check.
- U. Hydraulic system pressure specifications are below:
- (1) Maximum working pressure:
- (a) Anytime repairs to the tubes are made on the airplane, or when any hydraulic component is to be checked.
- (2) Proof pressure:
- (a) If the tubes are repaired and to be tested in the shop.
- (3) Burst pressure:
- (a) This is for design reference only.
- V. B-Nut torquing:
- (1) The correct torquing can be applied to B-nut only if the tubing material is identified correctly (aluminum, titanium or steel).
- (2) If the normal finish color of the B-nut is covered by the gray drilube coating, a color-coded ring is applied on the back side of the B-nut.

Table 801/20-10-51-993-810

TUBE MATERIAL	TUBE FINISH	COLOR	B-NUT (MAY BE COVERED WITH DRILUBE)
ALUMINUM	Primer	Green	GOLD OR BROWN
CRES	None, or Primer	Natural, or Green	SILVER, BRIGHT
TITANIUM	None	Natural	DULL GRAY

- (3) If a steel or titanium B-nut connects to an aluminum tube or fitting, use the lower torque value (aluminum).



DO NOT LET COMPONENTS HANG FROM FLEXIBLE HOSES. FLEXIBLE HYDRAULIC HOSES KINK EASILY AND CAUSE LEAKAGE.

- W. When you do repairs to Kevlar hydraulic hoses, remember Kevlar hoses kink more easily than CRES (steel) wire braided hoses.

TASK 20-10-51-360-801

2. Tube and Fitting Leakage

A. General

- (1) Use this procedure to help find and repair hydraulic leaks in tubes and fittings.
- (a) Leakages and Failures in Tubes can be caused by the following:
- 1) Fatigue cracks that start because of damage from an external impact.
- 2) Fatigue cracks that start from vibration as a result of incorrect support.

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- 3) Fatigue cracks that start because of a preload that is induced during installation.
- 4) Fatigue because of loss of the tube wall from chafing contact with another tube, structure or other component.
- 5) Fatigue from stress because of excess ovality at a tube bend.

B. References

Reference	Title
20-10-15 P/B 401	RECESSED BOSS SEAL FITTINGS - REMOVAL/INSTALLATION
20-10-17 P/B 401	O-RINGS - REMOVAL/INSTALLATION
20-10-51 P/B 401	FLARELESS TUBING ASSEMBLY - REMOVAL/INSTALLATION
20-10-51-400-801	Flareless Tubing Assembly Installation (P/B 401)

C. Procedure

SUBTASK 20-10-51-790-002

- (1) Do a leak check to check for the location of the leak.
 - (a) Pressurize the system for a minimum of 15 minutes.
 - (b) With the system pressurized, do a check of the tubes and fittings for signs of hydraulic leakage.
 - 1) Use a clean white cloth to find hydraulic leakage.
 - 2) Record the location of the leak.
 - a) If the hydraulic tube is pressurized, some leaks will be easy to find because the fluid will spray some distance from the source. (See Figure 801, sheet 1)
 - b) If the hydraulic tube is not pressurized, the source of the leak may not be clear. In this condition, examine areas above and around the fluid for the possible source.

NOTE: The source of the leak may be some distance away from the visible fluid.
 - c) For aluminum tubes examine at or below the end sleeve for signs of corrosion that can cause a leak. (See Figure 801, sheet 2)

SUBTASK 20-10-51-860-001

- (2) Depressurize the system.

SUBTASK 20-10-51-211-001

- (3) Do a visual inspection of the tube installation that is the source of the leakage.
 - (a) Check for the following:
 - 1) Worn clamps.
 - 2) Missing clamps.
 - 3) Interference.
 - 4) Dents.
 - 5) Chafing.
 - (b) Repair/Replace the tube assembly if necessary.
 - 1) Use this procedure to replace the tube assembly: FLARELESS TUBING ASSEMBLY - REMOVAL/INSTALLATION, PAGEBLOCK 20-10-51/401.
 - 2) Use this procedure to repair the tube assembly: Tube Repair, TASK 20-10-51-300-801.

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- (c) Correct the cause of the chafing if present and replace any worn or missing clamps.

SUBTASK 20-10-51-211-002

- (4) If the leak is at a Hydraulic joint, examine for the following:
- (a) Damage to joints, for example rough seal surfaces, cracked fittings or cracks in tubing. (See Figure 801, sheet 3)
 - 1) Replace damaged parts.
 - (b) Incorrectly torqued or swaged connections. (See Figure 801, sheet 4)
 - 1) To repair or replace these parts, refer to procedures:
 - a) Flareless Tubing Assembly Installation, TASK 20-10-51-400-801
 - b) Retightening of Fitting Joints with Persistent Hydraulic Leaks, TASK 20-10-51-360-802
 - c) FLARELESS TUBING ASSEMBLY - REPAIRS, 20-10-51/801 for improperly swaged connections for specific permanently swaged fitting joints.
 - (c) Insufficient or incorrect support of hydraulic lines.
 - 1) To reposition existing clamps or install additional clamps if necessary use procedure Flareless Tubing Assembly Installation, TASK 20-10-51-400-801.
 - (d) Foreign material in the join.
 - 1) Remove and clean off the foreign material as necessary, then reassemble and re-torque the joint.
 - (e) Incorrectly installed, mismatched or pre-loaded parts.
 - 1) For correcting the fit-up or installation of parts, refer to procedure Retightening of Fitting Joints with Persistent Hydraulic Leaks, TASK 20-10-51-360-802.
 - (f) Seized or galled threads. (See Figure 801, sheet 5)
 - 1) Replace damaged parts.
 - (g) Stress corrosion cracking from over-torque on the fitting joint, put together with the effects of external contaminants. (See Figure 801, sheet 6)
 - 1) Replace damaged parts.

NOTE: Install hydraulic fittings carefully, take care when applying torque to mating fittings. Retightening or applying a higher torque than recommended to a mating part can introduce stresses to the fitting that can contribute to cracks. If a crack already exists and a higher torque is applied to stop a leak, it will make the crack and leakage worse.

SUBTASK 20-10-51-211-003

- (5) If the leak is at a threaded 'boss' joint that uses O-rings this most commonly occurs due to mistakes during assembly, check for the following: (See Figure 801, sheet 7)
- (a) Incorrect positioning of the O-ring on the fitting.
 - (b) Damaged O-ring seal.
 - (c) Insufficient wrench torque to squeeze the O-ring and make the seal.
 - (d) Incorrect O-ring selection.

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- 1) To correct these leaks refer to procedure RECESSED BOSS SEAL FITTINGS - REMOVAL/INSTALLATION, PAGEBLOCK 20-10-15/401 and O-RINGS - REMOVAL/INSTALLATION, PAGEBLOCK 20-10-17/401.

———— **END OF TASK** ————

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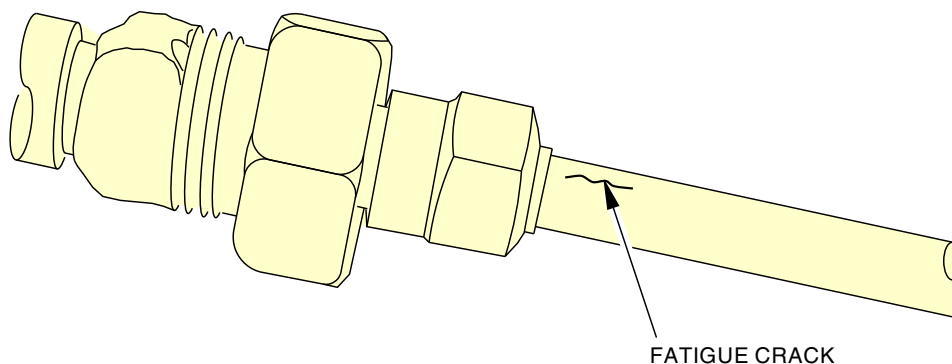
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PRESSURIZED TUBE LEAK

NOTE:

EXAMPLE OF LEAK FROM FATIGUE CRACK ADJACENT TO WELD SLEEVE (TUBE SIDE OF WELD) ON TITANIUM HYDRAULIC TUBE ASSEMBLY.

2411110 S00061526988_V1

**Tube and Fitting Leakage Identification
Figure 801/20-10-51-990-809 (Sheet 1 of 7)**

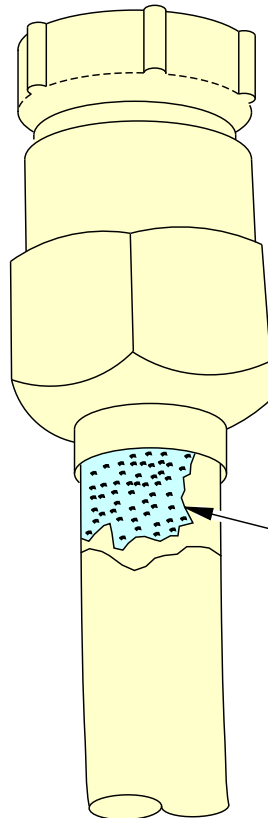
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EXAMPLE OF TUBE CORROSION
AT FLARELESS SLEEVE ON
ALUMINUM TUBE MATERIAL

ALUMINUM TUBE CORROSION

2411111 S00061526989_V1

Tube and Fitting Leakage Identification Figure 801/20-10-51-990-809 (Sheet 2 of 7)

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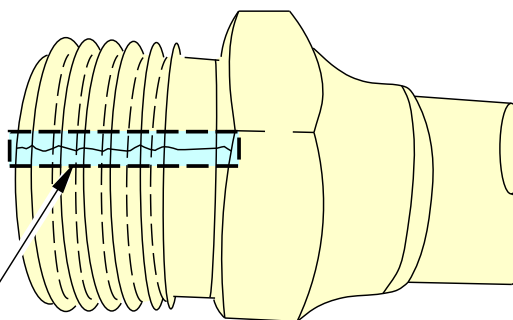
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CRACK IN CORROSION
RESISTANT STEEL (CRES)
BACU24AB INTERNALLY
SWAGED UNION FITTING

CRACKED FITTINGS

2411112 S00061526990_V1

Tube and Fitting Leakage Identification
Figure 801/20-10-51-990-809 (Sheet 3 of 7)

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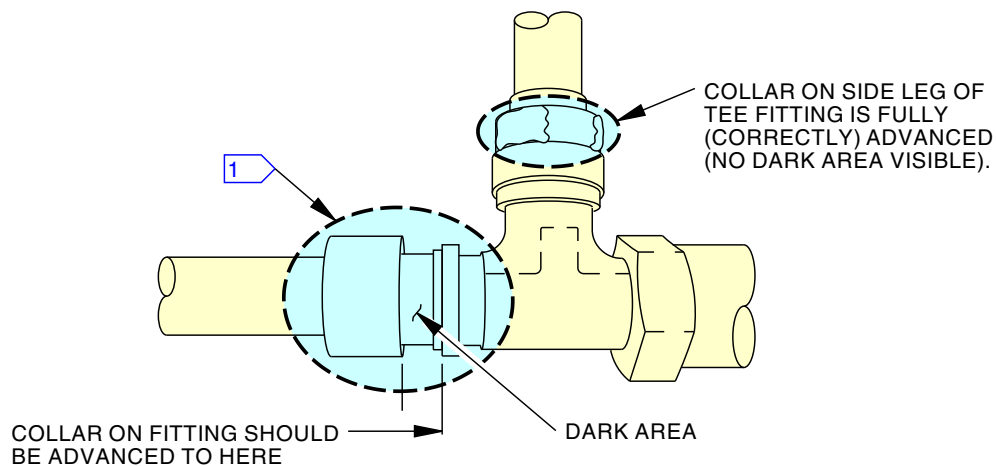
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COMBINATION AXIALLY SWAGED/FLARELESS TEE FITTING WITH
INCOMPLETELY SWAGED END

1 POSITION OF COLLAR ON TEE FITTING THAT LEAKED IN
SERVICE DUE TO INCOMPLETE SWAGE (DARK AREA SHOWS
THAT COLLAR IS NOT FULLY ADVANCED - FOR
COMPARISON, SEE SIDE LEG).

2411113 S00061526991_V1

Tube and Fitting Leakage Identification
Figure 801/20-10-51-990-809 (Sheet 4 of 7)

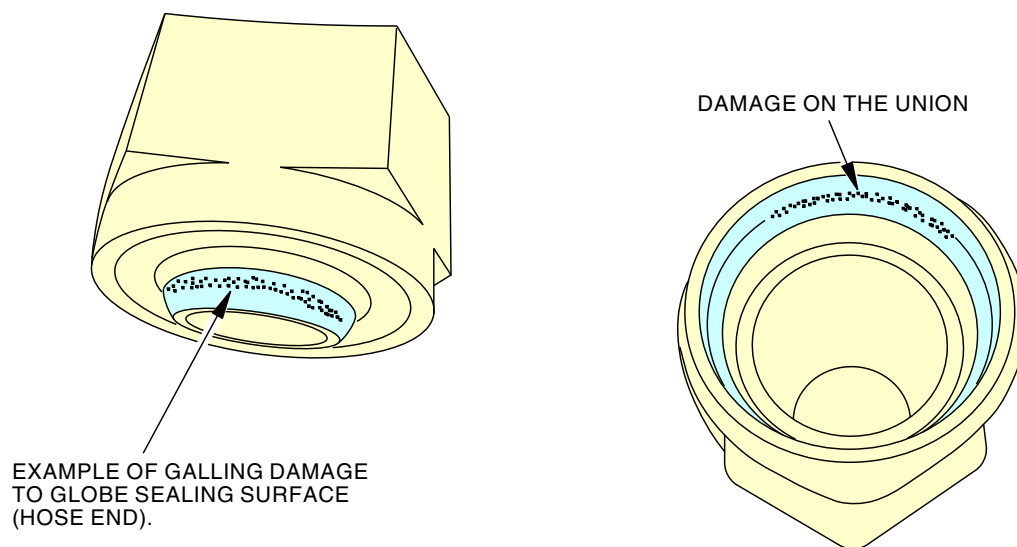
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GALLING DAMAGE

2411114 S00061526992_V1

Tube and Fitting Leakage Identification
Figure 801/20-10-51-990-809 (Sheet 5 of 7)

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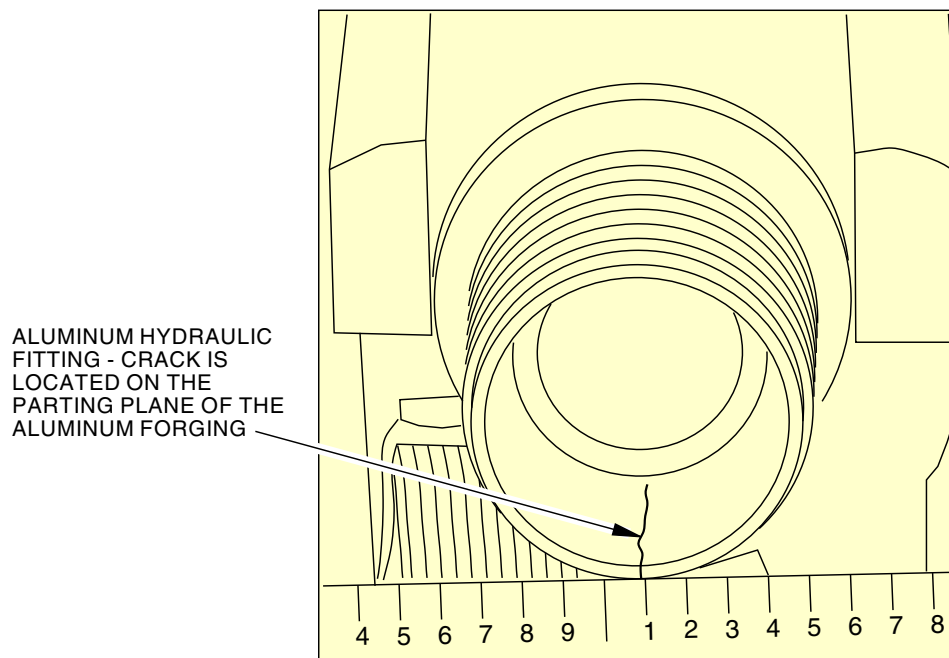
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STRESS CORROSION CRACKING

2411115 S00061526993_V1

Tube and Fitting Leakage Identification
Figure 801/20-10-51-990-809 (Sheet 6 of 7)

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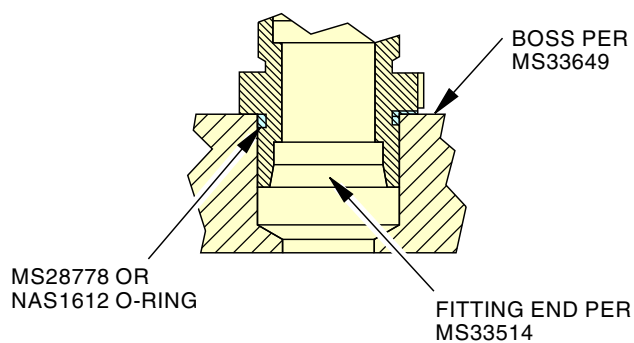
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**MS33649
SINGLE SEAL BOSS STRAIGHT
THREADED "BOSS" JOINT**

2411116 S00061526994_V1

**Tube and Fitting Leakage Identification
Figure 801/20-10-51-990-809 (Sheet 7 of 7)**

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TASK 20-10-51-360-802

3. Retightening of Fitting Joints with Persistent Hydraulic Leaks

A. General

- (1) Use this procedure to help resolve a persistent hydraulic leak at a tube joint that is not located in a pressurized area, a strut, a fuel tank, or a cargo area.
 - (a) For joints located in a pressurized area, a strut, a fuel tank, or a cargo area, use this tightening procedure: Flareless Fittings in Pressurized Areas Installation, TASK 20-10-51-400-802.
- (2) Use this procedure only for flareless joints that have continual leakage that cannot be resolved.
 - (a) Do not use this procedure as a routine torque tightening method for flareless fittings.
- (3) For repairs and replacements of the flareless tubing assemblies, refer to the applicable flareless tubing assembly approved repairs above.

B. References

Reference	Title
20-10-51-200-802	Space Between Tubing Clamps Check (P/B 401)
20-10-51-400-801	Flareless Tubing Assembly Installation (P/B 401)
20-10-51-400-802	Flareless Fittings in Pressurized Areas Installation (P/B 401)
20-10-51-993-802	Table: Thread Compounds (P/B 401)
20-10-51-993-805	Table: Installation Torque (P/B 401)
20-10-51-993-808	Table: Installation Torques (P/B 401)

C. Procedure

SUBTASK 20-10-51-280-001

- (1) Do a leak check to confirm the location of the leak.
 - (a) Pressurize the system for a minimum of 15 minutes.
 - (b) With the system pressurized, do a check of the tube-to-fitting interface for signs of hydraulic leakage.
 - 1) Use a clean white cloth to find hydraulic leakage.
 - 2) Record the location of the leak.

SUBTASK 20-10-51-864-001

- (2) Depressurize the system.

SUBTASK 20-10-51-211-004

- (3) Do a visual inspection of the tube installation that is the source of the leakage.
 - (a) Check for the external damage that follows:
 - 1) Worn clamps.
 - 2) Missing clamps.
 - 3) Interference.
 - 4) Dents.
 - (b) If external damage is found, replace the tube assembly.
 - 1) Use this procedure: Flareless Tubing Assembly Installation, TASK 20-10-51-400-801.

SUBTASK 20-10-51-030-001

- (4) Loosen the flareless fittings to check for preload on the tube assembly.

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- (a) Check for side-to-side or end-to-end preload in the line.
 - 1) If there is preload, adjust the tube assembly. Do this procedure: Space Between Tubing Clamps Check, TASK 20-10-51-200-802.
 - a) If the preload cannot be relieved, replace the tube assembly.
 - <1> Use this procedure: Flareless Tubing Assembly Installation, TASK 20-10-51-400-801.

SUBTASK 20-10-51-020-005

- (5) Remove the tube assembly that is the source of the leakage to check for sealing surface damage on mating fittings.
 - (a) Check the mating surfaces of the tube-to-fitting interface for damage.
 - 1) Examples of such damage are as follows:
 - a) Machining flaws.
 - b) Galling or scratches.
 - c) Dimples.
 - d) Cracks.
 - (b) If damage is found, replace the damaged part.
 - 1) Use this procedure: Flareless Tubing Assembly Installation, TASK 20-10-51-400-801.

SUBTASK 20-10-51-430-001

- (6) If flareless fittings with BACS13AP preset sleeves are used (Figure 802), do the steps that follow:
 - (a) Apply the appropriate lubricant to the BACS13AP sleeves, found in Table 20-10-51-993-802.
 - (b) Tighten the flareless fittings with BACS13AP sleeves two times (tighten, loosen, and tighten again) to nominal torque shown in Table 20-10-51-993-805.

SUBTASK 20-10-51-430-002

- (7) If the flareless fittings with internally swaged BACS13BX (Figure 803), internally swaged BACS13BD (Figure 803), or welded-on NAS1760-type sleeves (Figure 804) are used, do the steps that follow:
 - (a) Apply the appropriate lubricant to the BACS13BX, BACS13BD, or welded-on NAS1760-type sleeves, found in Table 20-10-51-993-802.
 - (b) Tighten the flareless fittings with BACS13BX, BACS13BD, or welded-on NAS1760-type sleeves as follows:
 - 1) Tighten the fitting to the torque shown in Table 20-10-51-993-805.
 - 2) Loosen the fitting to release the torque.
 - 3) Tighten the fitting to the torque value specified in Table 20-10-51-993-808.

SUBTASK 20-10-51-280-002

- (8) Do a leak test on the installations of the flareless fittings.
 - (a) Pressurize the system for 15 minutes minimum.
 - (b) With the system pressurized, do a check at the tube-to-fitting interface for signs of hydraulic leakage.
 - 1) Use a clean white cloth to find hydraulic leakage.
 - 2) If you find leakage, do the steps that follow.

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- a) De-pressurize the system.
- b) Loosen the fitting.
- c) Check the mating surfaces of the tube-to-fitting interface for signs of damage.
 - <1> Examples of such damage are as follows:
 - <a> Machining flaws.
 - Gallings or scratches.
 - <c> Dimples.
 - <d> Cracks.
 - <2> If damage is found, replace any damaged assemblies. Do this procedure: Flareless Tubing Assembly Installation, TASK 20-10-51-400-801.
- d) If no signs of damage are found on the mating surfaces of flareless fittings with BACS13AP sleeves, retighten the fittings using the steps that follow:
 - <1> Use the appropriate lubricant found in Table 20-10-51-993-802.
 - <2> Tighten the fittings two times (tighten, loosen, and tighten) to nominal torque shown in Table 20-10-51-993-805.
 - <3> Re-pressurize the system.
 - <4> Repeat the leak test.
 - <5> If you find leakage, replace one or both of the mating fittings and tube assemblies.
 - <a> Use this procedure: Flareless Tubing Assembly Installation, TASK 20-10-51-400-801.
- e) If no signs of damage are found on the mating surfaces of flareless fittings with BACS13BX, BACS13BD, or welded-on NAS1760-type sleeves, retighten the fittings using the steps that follow:
 - <1> Use the appropriate lubricant found in Table 20-10-51-993-802.
 - <2> Tighten the fitting to the torque shown in Table 20-10-51-993-805.
 - <3> Loosen the fitting to release the torque.
 - <4> Tighten the fitting to the torque value specified in Table 20-10-51-993-808.
 - <5> Re-pressurize the system.
 - <6> Repeat the leak test.
 - <a> If you find leakage, replace one or both of the mating fittings and tube assemblies. Do this procedure: Flareless Tubing Assembly Installation, TASK 20-10-51-400-801.

———— **END OF TASK** ————

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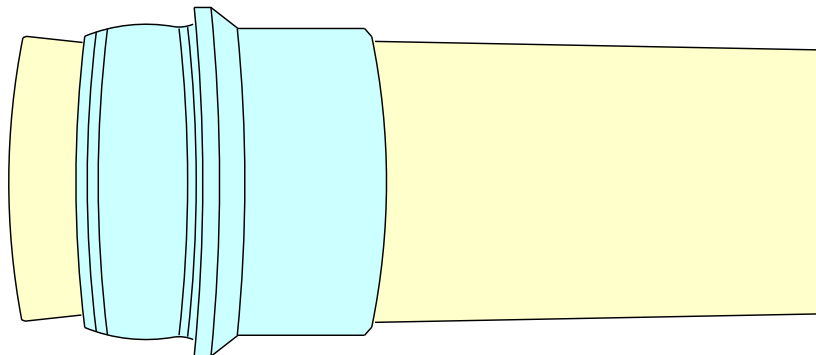
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BACS13AP Flareless Preset Sleeve
Figure 802/20-10-51-990-810

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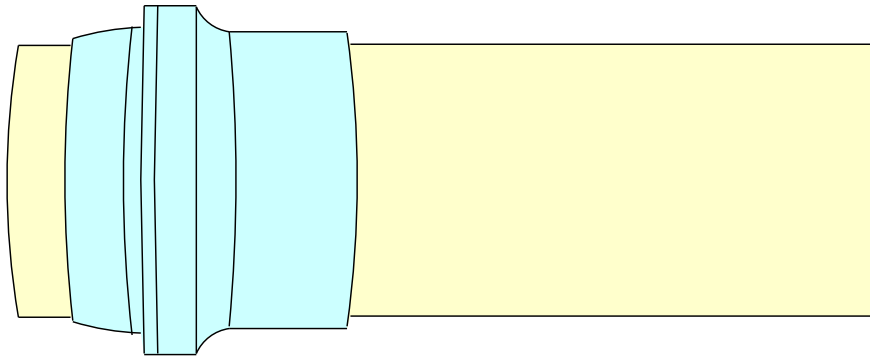
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BACS13BX/BACS13BD Flareless Internally Swaged Sleeve
Figure 803/20-10-51-990-811

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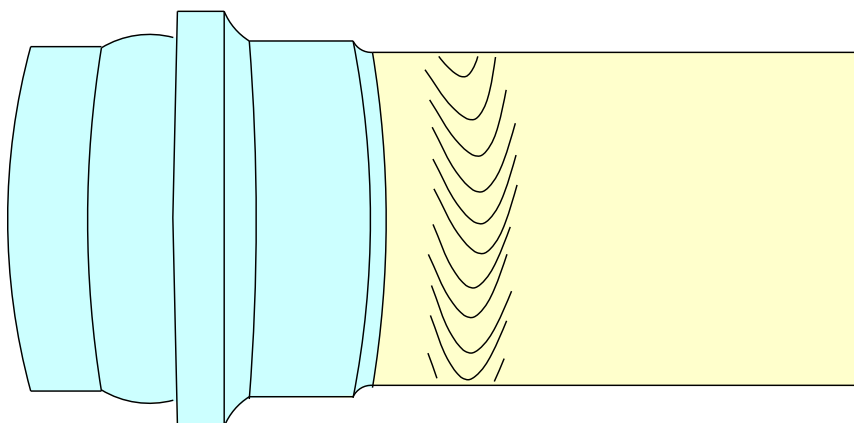
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NAS1760 Flareless Weld Sleeve
Figure 804/20-10-51-990-812

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TASK 20-10-51-300-801

4. Tube Repair

(Figure 805, Figure 806, Figure 807, Figure 808, Figure 809, Figure 810, Figure 811, Figure 812, Figure 813, and Figure 814)

A. General



DO NOT REPAIR COIL TUBES. NORMAL MOVEMENT OF THE COIL MAY BE RESTRICTED BY THE REPAIR.

- (1) You can repair tubes if you obey the permitted repair limits. When it is possible do the following:
 - (a) Replace the damaged tube.
 - (b) Replace the damaged part with a tube splice.
 - (c) Repair the damaged tube with a fitting if the damaged area is sufficiently small.
 - (d) Completely remove all corrosion and treat affected surface area as described in the Corrosion Prevention Manual.
- (2) When you remove, install or do work with hydraulic tube assemblies, obey the guidelines that follow:
 - (a) When you remove tubes, make sure that the tubes and port fittings have tags that clearly identify the correct connection locations.
 - (b) Do not move or change the tube bends. If you move or change the bends in the tube, these bad effects can occur:
 - 1) If you move or change a bend in the tube, it can become possible that the tube will align with the incorrect port. If this occurs, incorrect reconnection or cross-connection of the tubes can become possible.
 - 2) If you move or change the bend in the tube, it can become possible that the tube will have too much stress when it is connected. Stress can cause cracks in the tubes.
 - (c) If you must bend the tube assemblies to fit the installation, do not bend more than permitted by the ovality limits in Figure 805 and Table 802. It is recommend to use a bend block or equivalent hand bender. Make sure the bend block supports the tube bend beyond the neutral axis of the bend, as shown in Figure 805, and that the bend-ovality allowables are not exceeded.

Table 802/20-10-51-993-811 Permitted Ovality and Wrinkle of Hydraulic Tube Bends

SYSTEM OPERATING PRESSURE	TUBE OUTER DIAMETER (OD)	TUBE MATERIAL	ALLOWABLE WRINKLE HEIGHT	ALLOWABLE OVALITY (PERCENTAGE OF SPECIFIED OD) ^{*[1]*[2]}

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Table 802/20-10-51-993-811 Permitted Ovality and Wrinkle of Hydraulic Tube Bends (Continued)

Liquid: 1000 psi to 3000 psi (including return lines)	All Sizes	Stainless Steel	0.010 in. (0.254 mm)	5
		Aluminum	0.010 in. (0.254 mm)	5
		3AL-2.5V Titanium	None visible	3
Pneumatic and Oxygen: Pressure above 1500 psi or Temperature above 60°F (16°C)	All Sizes	Stainless Steel	0.010 in. (0.254 mm)	5
Other Liquid Systems: Pressure less than 1000 psi Pneumatic and Oxygen Systems	Less than 1.0	Stainless Steel	0.040 in. (1.016 mm)	10
		Aluminum Alloy & Copper	0.020 in. (0.508 mm)	10
	1.0 to 2.0	Stainless Steel	0.060 in. (1.524 mm)	10
		Aluminum Alloy & Copper	0.030 in. (0.762 mm)	10
	2.0 to 3.0	Stainless Steel	0.080 in. (2.032 mm)	5
		Aluminum Alloy & Copper	0.040 in. (1.016 mm)	5
	3.0 or over	Stainless Steel	0.100 in. (2.540 mm)	5
		Aluminum Alloy & Copper	0.050 in. (1.270 mm)	5

*[1] Specified diameter is the drawing specified tube diameter.

*[2] Percent (ovality) = $([OD \text{ Max} - OD \text{ Min}] / OD \text{ Specified}) \times 100$. The OD is measured in the same plane.

- (d) Do not repair dents or chafed areas. Replace the tube or tube section if the defect depth is more than the values in Table 803. It is not necessary for you to repair or replace the tubes with defect depth less than these values.

Table 803/20-10-51-993-812 Permitted Tube Problem Depth - Hydraulic Pressure (3,000 psi) and Return Lines (1,500 psi)

TUBE MATERIAL (PRESSURE)	PROBLEM TYPE	TUBE OUTER DIAMETER (IN.)*[2]						
		1/4	3/8	1/2	5/8	3/4	1	1-1/4
Ti-3Al-2.5V 21-6-9 (3,000 psi)	CHAFED	0.006	0.007	0.008	0.010	0.011	0.012	0.030 (Ti)
	DENT	0.005	0.007	0.010	0.015	0.018	0.020	0.030 (Ti)

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Table 803/20-10-51-993-812 Permitted Tube Problem Depth - Hydraulic Pressure (3,000 psi) and Return Lines (1,500 psi) (Continued)

Ti-3Al-2.5V 21-6-9 (1500 psi)	CHAFED	0.006	0.007	0.008	0.010	0.011	0.012	0.050 (Ti)
	DENT	0.005	0.007	0.010	0.015	0.018	0.020	0.030
304 1/8 HARD (3,000 psi)	CHAFED	0.006	0.007	0.008	0.010	0.011	0.012	N/A
	DENT	0.005	0.010	0.020	0.03	0.040	0.040	N/A
6061-T6 (1,000 psi) except*[1]	CHAFED	0.015	0.015	0.010	0.005	0.004 0.015*[1]	0.003 0.015*[1]	0.003 0.015*[1]
	DENT	0.015	0.015	0.010	0.005	0.005	0.005	0.005

*[1] Suction line (150 psi), is a tube or hose between a hydraulic pump inlet and the reservoir that supplies the pump.

*[2] The limits were verified by hydraulic impulse fatigue and burst testing (for additional information, see SAE-AIR 1388).

(3) Electrical rigid conduit repair.

(a) Smooth dents are permitted to the electrical rigid conduit with these limits (Table 804):

- 1) Dent depth damage is not more than 20 percent of outer diameter.
- 2) The conduit is not dented or has a crack that causes it to have kinks, to rub, or to show the inner wire.
- 3) The dent is smooth and does not make a sharp wrinkle on the outer surface of the conduit.
- 4) There are no cracks in the conduit.
- 5) Dents are not permitted on rigid electrical conduits in the fuel tanks.

(b) Repair or replace electrical rigid conduits if the damage is more than 0.060 in. (1.524 mm) the limits.

(c) If you must form the electrical rigid conduit tube to fit an installation, do not bend more than permitted by the forming limits (Figure 805, Table 805) .

Table 804/20-10-51-993-813 Smooth Dent Damage Limits for Electrical Rigid Conduits

CONDUIT SIZE (OD)	MAXIMUM DENT DEPTH
0.25 in. (6.4 mm)	0.050 in. (1.27 mm)
0.31 in. (7.9 mm)	0.063 in. (1.60 mm)
0.38 in. (9.7 mm)	0.075 in. (1.90 mm)
0.50 in. (12.7 mm)	0.100 in. (2.54 mm)
0.63 in. (16.0 mm)	0.125 in. (3.18 mm)
0.75 in. (19.0 mm)	0.150 in. (3.81 mm)
0.88 in. (22.4 mm)	0.175 in. (4.44 mm)
1.00 in. (25.4 mm)	0.200 in. (5.08 mm)
1.25 in. (31.8 mm)	0.250 in. (6.35 mm)
1.50 in. (38.1 mm)	0.300 in. (7.62 mm)
1.75 in. (44.4 mm)	0.350 in. (8.89 mm)

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Table 804/20-10-51-993-813 Smooth Dent Damage Limits for Electrical Rigid Conduits (Continued)

2.00 in. (50.8 mm)	0.400 in. (10.16 mm)

Table 805/20-10-51-993-814 Permitted Forming Limits for Electrical Rigid Conduits

CONDUIT SIZE (OD)	CONDUIT MATERIAL	ALLOWABLE WRINKLE HEIGHT	ALLOWABLE OVALITY (PERCENT OF SPECIFIED OD)
1.0 OR LESS	STAINLESS STEEL	0.040 in. (1.02 mm)	10
	ALUMINUM ALLOY	0.020 in. (0.51 mm)	10
OVER 1.0	STAINLESS STEEL	0.060 in. (1.52 mm)	10
	ALUMINUM ALLOY	0.030 in. (0.76 mm)	10

- (4) To repair a damaged tube section, cut out the damaged tube section and replace it with a fitting or with an assembled tube and fitting assembly.
- (5) To replace a BACA14BP fitting, you must use another BACA14BP fitting. To install the new BACA14BP fitting on the new tube section, use this procedure: FLARELESS TUBING ASSEMBLY - REMOVAL/INSTALLATION, PAGEBLOCK 20-10-51/401.
- NOTE:** Use BACA14BP fittings only for replacement of other BACA14BP fittings unless approved by The Boeing Company on a case-by-case basis. The MS flareless screw-together ends on this fitting are prone to deformation and galling from repeated assembly and disassembly and may leak.
- (6) To replace a BACU24AB swage union, cut out the damaged fitting and replace it with a B-nut, BACS13BX sleeve, BACS13AP sleeve or a CRYOLIVE flareless sleeve assembly and an MS21924 bulkhead union, or a P/N DAS5792T axial swage adapter with either an MS21902 union or an MS21924 bulkhead union (Figure 808, Table 806, Table 812).

Table 806/20-10-51-993-815 Replacement of a damaged BACU24AB Union

FITTINGS REPLACING BACU24AB				TUBE CUTOUT LENGTHS REQUIRED (IN.)							
SLEEVE PART NO.	SWAGE METHOD	UNION PART NO.	DIM.	04	06	08	10	12	16	20	24
BACS13BX	Harrison Roller Swage Kit 66330K01	MS21924	A	1.562	1.705	1.886	2.100	2.341	2.319	N/A	N/A
35211	Harrison Swage Machine 6777	MS21924	A	1.562	1.705	1.886	2.100	2.341	2.319	N/A	N/A
BACS13BX	Harrison Portable Swagers 5175, 5720, or equivalent stationary 5570	MS21924	B	0.487	1.612	1.791	1.965	2.199	2.122	2.119	2.049

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Table 806/20-10-51-993-815 Replacement of a damaged BACU24AB Union (Continued)

BACS13AP	Hand or Machine Preset	MS21924	C	1.422	1.547	1.726	1.900	2.134	N/A	N/A	N/A
CRYOIVE Assembly	N/A	MS21924	B	1.487	1.612	1.791	1.965	2.100	2.122	N/A	N/A

(7) To make tube repairs, use tube sections of the same material and use the fittings as shown in Figure 806, Table 807, Table 808, Table 809, and Table 810.

Table 807/20-10-51-993-816 Tools Required for Repair Method

REF LETTER FOR TABLES A AND B	TOOL REQUIRED
A	Harrison Portable Swagers No. 5175 and 5720 or equivalent stationary Swager No. 5770
B	Pressure Presetting Tools ST878D
C	Hand Presetting Tools ST879A
D	Harrison Roller Swage Tool Kit 6633K01
D (1)	Harrison Roller Swaging Machine 6777
E	DMC Permaswage Kits: DLT Series - Consult DMC for tool kit numbers - One pump unit, DLT02MAPP1000 (pneumatic, 10,000 psi) or - DLT05MAPM1000 (manual, 10,000 psi) is necessary for swaging with the tool kits shown
F	AMCI: FRK3P02111-001
G	None necessary - hand tools only
H	Aeroquip Rynglok Kit RTS8-02-006 for sizes 04, 06, 08, 10, 12, 16, and 20 of the 8,000 psi rated Axial Swage - Rynglok - fitting.
I	DMC Tool Kit P/N DAT08AEFKT5000 for sizes 04, 06, 08, 10, 12, 16 (includes hand pump). All sizes can be operated in both directions (forward and reverse). 5,000 psi rated.
I	DMC Tool Kit P/N DATA08AEFKT5001 for sizes 04, 06, 08, 10, 12, 16, 20 (includes hand pump). All sizes can be operated in both directions (forward and reverse). 5,000 psi rated.
I	DMC Tool Kit P/N DAT08AEFKT5003 for sizes 04, 06, 08, 10, 12 (includes hand pump). All sizes can be operated in both directions (forward and reverse). 5,000 psi rated.

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Table 807/20-10-51-993-816 Tools Required for Repair Method (Continued)

REF LETTER FOR TABLES A AND B	TOOL REQUIRED
I	Eaton Aeroquip Tool Kit P/N RTLK5-01S-007 (includes hand pump) for sizes 04 (forward and reverse), 06 (tooling for both forward and reverse), 08 (forward and reverse), 10 (tooling for both forward and reverse), 12 (tooling for both forward and reverse), and 16 (tooling for both forward and reverse). 5,000 psi rated.
I	Eaton Aeroquip Tool Kit P/N RCLK5C02S002 (includes hand pump and cutting/deburring tooling) for sizes 04 (universal), 06 (universal), 08 (universal), 10 (forward and reverse), and 12 (forward and reverse). 5,000 psi rated.
I	Eaton Aeroquip Tool Kit P/N RTLK5-01S111 (includes hand pump) for sizes 04 (universal), 06 (universal), 08 (universal), 10 (forward and reverse), and 12 (forward and reverse). 5,000 psi rated.

Table 808/20-10-51-993-817 Associated Approved Fittings

PART NUMBER	ASSOCIATED APPROVED FITTINGS	
	FITTING NUTS ^{*[1]*[3]}	UNIONS ^{*[2]}
BACS13AP (BITE-Type) BABS13BX (Elastomer Swage) BACS13BX (Roller Swage)	For Aluminum tubes less than size 20, use: - BACN10YL-Alum - MS21921-Alum or Steel - BACN10CS-Alum or Steel For size 20 and 24 Aluminum tubes used with short flareless fittings, use: - AS4660-Alum	For Aluminum tubes less than size 20, use: - MS21902-Alum or Steel - MS21924-Alum or Steel For size 20 and 24 Aluminum tubes used with short flareless fittings, use: - AS4663-Alum
	For CRES tubes, use: - BACN10YE-CRES - MS21921-CRES, Steel, or Ti - BACN10CS-CRES, or Steel - BACN10YA-Ti	For CRES tubes, use: - MS21902-CRES, Steel, or Ti - MS21924-CRES, Steel, or Ti
	For Ti tubes, use: - BACN10YA-Ti - BACN10YE-CRES - MS21921-Ti, CRES - AS4660-Ti (sizes 20 and 24 only)	For Ti tubes, use: - MS21902-CRES or Ti - MS21924-CRES or Ti - AS4660-Ti (sizes 20 and 24 only) - 35212 swaged union

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Table 808/20-10-51-993-817 Associated Approved Fittings (Continued)

PART NUMBER	ASSOCIATED APPROVED FITTINGS	
35211 Sleeve (Roller Swage)	For Ti tubes, use: - BACN10YA-Ti - BACN10YE-CRES - MS21921-Ti, CRES - AS4660-Ti (sizes 20 and 24 only)	For Ti tubes, use: - MS21902-CRES or Ti MS21924-CRES or Ti - AS4660-Ti (sizes 20 and 24 only) - 35212 swaged union
35212 Union (Roller Swage)	N/A	N/A
CRYOLIVE Assembly 921721	For Aluminum tubes, use: - 921721W-Sizes 04 thru 12 only For CRES tubes, use: - 921721J For Ti tubes, use: 921721T	For Ti tubes, use: - MS21902-CRES or Ti - MS21924-CRES or Ti

*[1] Do not use aluminum nuts or unions on tube materials other than aluminum.

*[2] Associated approved fittings for other unions, reducers, elbows, and tees with MS33514 or MS33515 fitting ends; and for short flareless fitting applications, other unions, reducers, elbows and tees with AS4658 or AS4659 fitting ends.

*[3] Use only the Cryolive flareless sleeve assembly, consisting of the cryolive sleeve, coupling nut and plastic cap. The cryolive flareless sleeve assembly, in sizes 10, 12, and 16, requires use of a longer length AMCI P/N 9211699 (material code)(size) N coupling nut. The longer length coupling nuts are not interchangeable with standard BACN10- and MS21921 coupling nuts.

Table 809/20-10-51-993-818 Alternative Wall Thicknesses for Tube Repairs

MATERIAL	TUBE SIZES (IN)								
	04	05	06	08	10	12	16	20	24
	.250	.312	.375	.500	.625	.750	1.00	1.25	1.50
21-6-9	.016	.020	.020	.026	.033	.039	.052		
3AL-2.5V	.016		.019	.026	.032	.039	.052	.070	
6061-t6	.035	.035	.035	.035	.035	.035	.035	.035	.049
304 1/8 H	.020	.020	.028	.035	.049	.058	.065*[1]	.035*[1]	.049*[1]

*[1] Not qualified for 3000 psi systems, lower pressures only.

Note: Alternative wall thicknesses for tube repairs of 3000 psi and lower system pressure applications. When performing a hydraulic tube repair with the same tube material, the alternate tube wall thicknesses listed in the above table may be used in place of wall thicknesses developed with the airplane when performing a repair on tubes in systems with 3000 psi or less operating pressure.

Cres 321 tubing per MIL-T-8808 may be used as a substitute for 304 tubing per MIL-T-8504, 6061-T6 aluminum tubing per MIL-T-7081 or AMS 4083. 6061-T6 aluminum per MIL-T-7081 or AMS 4083 may be used as a substitute for 6061-T6 aluminum tubing per WW-T-700/6. Contact The Boeing Company when considering use of tube materials other than those specified.

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Table 810/20-10-51-993-819 Typical Finishes for Hydraulic Tubing

TUBING MATERIAL	LOCATION ON AIRPLANE	TUBING SURFACE	FINISH RECOMMENDATION AND OPTIONS	FINISH CODE FOR COMMERCIAL AIRPLANES
Titanium	All	Inside	None	F-25.01
		Outside	None	F-25.01
CRES	All	Inside	Passivate	F-17.25
		Outside	Passivate Optional: Passivate + Primer (green) Passivate + Primer (green) + Paint (white)	F-17.25 F-17.25 + F-20.02 or F-20.49 F-17.25 + F-20.02 or F-20.49 + F-21.30
Aluminum	Fuel Tanks	Inside and Outside	Alodine (transparent gold)	F-17.08 or F-17.27 (F-17.08 and F-17.27 cover application of alodine to inside and outside of tube)
	All Other	Inside and Outside	Alodine (transparent gold)	F-17.08 or F-17.27 (F-17.08 and F-17.27 cover application of alodine to inside and outside of tube)

(8) A repair of a tube section can be in one of three groups. The groups have a relation to the location of the tube damage and the quantity of damage. The three groups are as follows:

- Replace a tube center section that has a short damaged segment with a single union or a fitting joint with a male and a female axially swaged adapter fitting (Figure 809, Table 811 and Table 812).
- Replace a tube end section that has a flareless end fitting you can move apart, with an assembled tube and fitting assembly or an axially swaged adapter fitting (Figure 810).
- Replace a tube center section that has excessive damage with an assembled tube and fitting assembly, or axially swaged adapter fittings and a tube assembly (Figure 811).

Table 811/20-10-51-993-821 Tube Cutout Lengths (Inches)

UNION PART NO.	SLEEVE PART NO.	TUBE SIZE (IN.)								
		04	05	06	08	10	12	16	20	24
MS21902	BACS13AP	.59	.56	.68	.76	.86	1.05	N/A	N/A	N/A
MS21902	BACS13BX (Harrison Elastomer Swager) CRYOLIVE Assembly	.63	.60	.72	.80	.90	1.09	.96	.96	.96

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Table 811/20-10-51-993-821 Tube Cutout Lengths (Inches) (Continued)

MS21902	BACS13BX (Harrison Roller Swager) 35212 (Harrison Roller Swager 6777)	.82	N/A	.95	1.03	1.21	1.40	1.40	N/A	N/A
MS21924	BACS13AP	1.18	1.18	1.29	1.42	1.55	1.78	N/A	N/A	N/A
MS21924	BACS13BX (Harrison Elastomer Swager) CRYOLIVE Assembly	1.22	1.22	1.33	1.46	1.59	1.82	1.68	1.67	1.67
MS21924	BACS13BX (Harrison Roller Swager) 35211 (Harrison Roller Swager 6777)	.41	N/A	1.56	1.69	1.90	2.13	2.13	N/A	N/A
Axial Swage Union 8010T - Rynglok (8,000 psi rated)	None Necessary	.30	N/A	.30	.35	.35	.35	.40	.40	N/A
Axial Swage Union AS5969T/ DAS5969T (5,000 psi rated)	None Necessary	.30	N/A	.30	.35	.35	.35	.40	.40	N/A
Standard Extended Length Axial Swage Union, AS6322 (5000 psi rated)	None Necessary	1.000	N/A	1.000	1.000	1.000	1.000	1.000	1.000	N/A

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Table 811/20-10-51-993-821 Tube Cutout Lengths (Inches) (Continued)

Extended Length Axial Swage Union, AS6322E (5000 psi rated)	None Necessary	2.360	N/A	2.736	3.150	3.647	3.933	5.048	5.594	N/A
Permswage Cryofit H-Coupling	None Necessary	0.15 INCH MAXIMUM								

Table 812/20-10-51-993-822 Tube Cutout Dimensions for Installing DAS5792T/DAS5793T Adapter Fittings

AXIAL SWAGE ADAPTER FITTING P/N	SLEEVE PART NO.	TUBE SIZE					
		04	06	08	10	12	16
"J" AS5792T/ DAS5792T Female Flareless (5,000 psi rated)	None Necessary	0.669 ±0.030 in.	0.694 ±0.030 in.	0.810 ±0.030 in.	0.979 ±0.030 in.	1.003 ±0.030 in.	1.134 ±0.030 in.
"K" AS5793T/ DAS5793T Male Flareless (5,000 psi rated)	None Necessary	0.665 ±0.150 in.	0.694 ±0.150 in.	0.811 ±0.150 in.	0.878 ±0.175 in.	0.954 ±0.175 in.	0.969 ±0.200 in.

B. References

Reference	Title
20-10-51 P/B 401	FLARELESS TUBING ASSEMBLY - REMOVAL/INSTALLATION
20-50-11-910-801	Standard Torque Values (P/B 201)

C. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt.", which stands for Optional.

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Reference	Description
COM-1794	Swager - Portable Tube, Hand Swaging, 1/4 - 1" Dia. Stainless Steel or Titanium Tubing Part #: 5175K-200 Supplier: 08199 Part #: 5720K-200 Supplier: 08199 Part #: 6520 Supplier: 08199 Part #: 6633K-01 Supplier: 08199 Part #: 6777 Supplier: 08199 Opt Part #: 5570 Supplier: 08199

D. Tube Repair

SUBTASK 20-10-51-350-001

- (1) For hydraulic tubing specifications and wall thicknesses, refer to Table 813.

NOTE: Table 813 applies to hydraulic tubing outside of the engine fire zones, and more than 18 in. (457 mm) from the engine firewall. For tubing inside the engine fire zones, and within 18 in. (457 mm) of the engine firewall, refer to the propulsion maintenance manual for tubing specifications.

NOTE: You can replace damaged titanium tubing or aluminum tubing with 21-6-9 CRES (BMS 7-185) or 304 1/8 Hard CRES (MIL-T-6845).

Table 813/20-10-51-993-823 Tubing Specifications and Wall Thickness for 737 Hydraulic Tubes

	-4	-6	-8	-10	-12	-16	-20	-24
Aluminum 6061-T6 AMS 4083 (R)	NU ^{*[1]}	0.035 in. (0.89 mm)	0.035 in. (0.89 mm)	0.035 in. (0.89 mm)	0.035 in. (0.89 mm)	0.035 in. (0.89 mm)	0.049 in. (1.24 mm)	0.049 in. (1.24 mm)
CRES 21-6-9 BMS 7-185 (P,R)	0.016 in. (0.41 mm)	0.020 in. (0.51 mm)	0.026 in. (0.66 mm)	0.033 in. (0.84 mm)	0.039 in. (0.99 mm)	0.052 in. (1.32 mm)	NU	NU
TITANIUM 3AL-2.5V AMS 4946 (P,R)	0.016 in. (0.41 mm)	0.019 in. (0.48 mm)	0.026 in. (0.66 mm)	0.032 in. (0.81 mm)	0.039 in. (0.99 mm)	0.051 in. (1.30 mm)	0.074 in. (1.88 mm)	NU
CRES 304 1/8 HARD MIL-T-6845 (P,R)	0.020 in. (0.51 mm)	0.028 in. (0.71 mm)	0.035 in. (0.89 mm)	0.049 in. (1.24 mm)	0.058 in. (1.47 mm)	0.065 in. (1.65 mm)	NU	NU

*[1] NU = This tubing size is "Not Used" in the 737 hydraulic systems. P = Use in pressure (3,000 psi or 20,684 kPa) lines
. R = Use in return lines (600 psi or 4,137 kPa).

SUBTASK 20-10-51-800-004

- (2) Use the tube materials shown in the table below:

Table 814/20-10-51-993-824 Cross Reference of Tubing to BMS/MIL Specification

TUBING MATERIAL	BMS	MIL	OTHER
ALUMINUM 6061-T6, T4	---	WW-T-700/6 WW-T-7081 ^{*[1]}	AMS4083
CRES 21-6-9	7-185	---	---
1/8 HARD CRES 304-1/8h	---	T-6845	AMS 5566

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Table 814/20-10-51-993-824 Cross Reference of Tubing to BMS/MIL Specification (Continued)

TUBING MATERIAL	BMS	MIL	OTHER
ANNEALED CRES 304	---	T-8504	AMS 5567
ANNEALED CRES 321	---	T-8808	AMS 5556 AMS 5557
TITANIUM 3AL-2.5V	---	---	AMS 4946

*[1] Low Pressure, Non-Hydraulic Systems Only

SUBTASK 20-10-51-800-005

(3) Use the hydraulic system design pressures during the repairs (Table 815).

Table 815/20-10-51-993-825 Hydraulic System Design Pressures

COMPONENT	Maximum Working Pressure	Proof Pressure	Burst Pressure
Pressure lines (including hoses and fittings) and units with air under full system pressure (such as accumulators).	3000 psi (20,684 kPa)	6000 psi (41,369 kPa)	12,000 psi (82,737 kPa)
Return and case drain lines, fittings and units	600 psi (4137 kPa)	900 psi (6205 kPa)	1500 psi (10,342 kPa)
Return line hoses	600 psi (4137 kPa)	1500 psi (10,342 kPa)	3000 psi (20,684 kPa)
Pump Supply Reservoirs, units, lines, and fittings	65 psi (448 kPa)	100 psi (689 kPa)	200 psi (1379 kPa)
Airbleed Line (Upstream of the regulator)	250 psi (1724 kPa)	500 psi (3447 kPa)	1000 psi (6895 kPa)
Drains and vents open to the atmosphere	15 psi (103 kPa)	50 psi (345 kPa)	75 psi (517 kPa)

SUBTASK 20-10-51-940-001

(4) Make a decision about the type of repair necessary.

(a) Make a decision about the group the repair (Table 807, Table 808, Table 809, Table 810, Figure 806).

SUBTASK 20-10-51-940-002

(5) Find the necessary tube cutout length when you use a single union or axially swaged adapter fittings and a tube or hose assembly to replace a damaged tube area (Table 811, Table 812, Figure 809).

SUBTASK 20-10-51-420-012

(6) To use assembled tube ends or a center section to do a repair, find the cutout length and install as follows:

(a) Make an estimate of the total length (L1) of the repair section necessary to replace the damaged tube (Figure 810, Figure 811).

(b) Cut and trim the repair tube as follows (Figure 807):

- 1) Use the correct size ratchet chipless cutter.
- 2) Turn the cutter drive screw counter clockwise to retract the cutter wheel.
- 3) Put the cutter over the tube.

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- 4) Turn the screw clockwise until the cutter touches the tube at the necessary cut location.
- 5) Turn the screw 1/8 to 1/4 turn and rotate the cutter until the cutter is easy to rotate.
- 6) Cut the tube.
- 7) Remove the tool.
- 8) To deburr the tube use the correct stem subassembly and deburring tool.
 - a) Assemble the tool (Figure 807).
- 9) Push down on the plunger and install the tool into the end of the tube.
- 10) Release the plunger.
- 11) Let the plug fill the inside of the tube.
- 12) Rotate the deburring tool until the inside burr is removed.
- 13) Remove the tool with the plug expanded

NOTE: The expanded plug should remove metal particles from the inside of the tube.

- a) Make sure that no metal particles fall inside the tube.

- (c) Install the necessary flareless sleeves or alternate end fittings to the repair tube, do the applicable tasks:
 - 1) Do this task: Install the CRYOLIVE Flareless Sleeve Assembly, TASK 20-10-51-400-803.
 - 2) Do this task: Swage the BACS13BX Flareless Sleeves with the Internal Elastomer Swage Equipment, TASK 20-10-51-300-803.
 - 3) Do this task: BACS13BX Flareless Sleeve Swaging on Stainless Steel or Titanium Hydraulic Tubing, TASK 20-10-51-300-804.
 - 4) Do this task: BACS13AP Flareless Sleeve Preset, TASK 20-10-51-300-805.
 - 5) Do this task: Axial Swage Fitting Installation (5,000 psi rated - Union) or Male/Female Adapter Fittings, TASK 20-10-51-400-808.
- (d) Assemble and tighten the flareless fittings which are part of the repair section.
- (e) Measure all of the tube assembly length (L1) (Figure 810, Figure 811).
- (f) Find the necessary cutout length (L2) as shown in Figure 810, Figure 811, Figure 812, and Table 816.

Table 816/20-10-51-993-826 Procedure to Find the Tube Cutout Length L2

FITTINGS USED FOR REPAIR TUBE ASSEMBLY			L2 CUTOUT LENGTH FORMULA ^[1]	
FLARELESS SLEEVE		UNION PART NO.	FOR TUBE END SECTION	FOR TUBE CENTER SECTION
PART NO.	SWAGE METHOD			
BACS13BX	Harrison Portable Swagers 5175 and 5720 or equivalent stationary swager 5570	MS21902 or equivalent	L1 minus 2P	L1 minus 2P
BACS13BX	Harrison Roller Swage Kit 6633K01	MS21902 or equivalent	L1 minus 2Z ₁	L1 minus 2Z ₂

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Table 816/20-10-51-993-826 Procedure to Find the Tube Cutout Length L2 (Continued)

BACS13AP	Hand or Machine Preset	MS21902 or equivalent	L1 minus 2H	L1 minus 2H
CRYOLIVE Assembly 921721	N/A	MS21902 or equivalent	L1 minus 2P	L1 minus 2P
35211	Harrison Roller Swage Machine 6777	MS21902 or equivalent	L1 minus 2Z ₂	L1 minus 2Z ₂
BACS13BX	Harrison Portable Swagers 5175 or 5720 or equivalent stationary swager 5570	Permaswage Cryofit H-Fitting	L1 minus (P+0.10)	N/A
BACS13BX	Harrison Roller Swage Kit 6633K01	Permaswage Cryofit H-Fitting	L1 minus (Z ₁ +0.10)	N/A
BACS13AP	Hand or Hachine Preset	Permswage Cryofit H-Fitting	L1 minus (H+0.10)	N/A
CRYOILIVE Assembly 921721	N/A	Permaswage Cryofit H-Fitting	L1 minus (P+0.10)	N/A
35211	Harrison Roller Swage Machine 6777	Permaswage Cryofit H-Fitting	L1 minus 2Z ₂	L1 minus 2Z ₂
N/A	N/A	Rynglok Permaswage Cryofit H-Coupling		L1 plus 0.20

*[1] See the Figure for Flareless Sleeve Tube End Values for values for H, P, Z₁ and Z₂.

- (g) Remove the pressure from the systems where you will do the repairs.
- (h) Cut out the damaged tube (L2).
- (i) Trim the tube ends (Figure 807).
- (j) When you make the installation, refer to the applicable section as follows:
 - 1) To use the Harrison Elastomer Swager to install BACS13BX flareless sleeves, do this task: Swage the BACS13BX Flareless Sleeves with the Internal Elastomer Swage Equipment, TASK 20-10-51-300-803.
 - a) Make sure that the correct P dimension is used (Figure 812).
 - 2) To use the tube swager, COM-1794, for installation of BACS13BX flareless sleeves, do this task: BACS13BX Flareless Sleeve Swaging on Stainless Steel or Titanium Hydraulic Tubing, TASK 20-10-51-300-804.
 - 3) To use the Harrison 6777 Roller Swage Machine for installing 35211 sleeves or 35212 unions, do this task: Titanium Hydraulic Tubing, 3000 psi - Roll Swaging Harrison 35211 Sleeves and 35212 Unions Using the Harrison 6777 Swage Machine, TASK 20-10-51-300-802.
 - 4) To install the Cryolive flareless sleeve assembly, do this task: Install the CRYOLIVE Flareless Sleeve Assembly, TASK 20-10-51-400-803.

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- a) Use only the complete Cryolive flareless sleeve assembly, consisting of a Cryolive sleeve, coupling nut, and plastic cap.

NOTE: The Cryolive flareless sleeve assembly, in sizes 10, 12, and 16, requires use of a longer length coupling nut. The longer length coupling nuts are not interchangeable with standard BACN10- and MS21921 coupling nuts.

- b) Refer to Table 817 for approved Cryolive sleeve, coupling nut, and plastic cap combinations.

Table 817/20-10-51-993-827 CRYOLIVE Flareless Sleeve/Coupling Nut/Plastic Cap Combinations

TUBE SIZE	COUPLING NUT MATERIAL	COMBINATION - SLEEVE/COUPLING NUT/PLASTIC CAP PART NO. ^{*[1]}
04	304 CRES	921721J04
	7075-T73 Al	921721W04
	6AL-4V Ti	921721T04
06	304 CRES	921721J06
	7075-T73 Al	921721W06
	6AL-4V Ti	921721T06
08	304 CRES	921721J08
	7075-T73 Al	921721W08
	6AL-4V Ti	921721T08
10	304 CRES	921721J10
	7075-T73 Al	921721W10
	6AL-4V Ti	921721T10
12	304 CRES	921721J12
	7075-T73 Al	921721W12
	6AL-4V Ti	921721T12
16	304 CRES	921721J16
	7075-T73 Al	(Combination not Approved)
	6AL-4V Ti	921721T16

^{*[1]} Do not replace coupling nuts included with the CRYOLIVE flareless sleeve/coupling nut/plastic cap combinations. Use only the coupling nut provided with the assembly.

- 5) To install the BACS13AP flareless sleeves, do this task: BACS13AP Flareless Sleeve Preset, TASK 20-10-51-300-805.
- 6) To install H-couplings (BACC42W), do this task: BACC42W H-Coupling Installation, TASK 20-10-51-400-804.
- 7) To install Cryofit unions (3P02111) or (3PHS111), do this task: 3P02111/3PHS111 Cryofit Coupling Installation, TASK 20-10-51-400-805.
- 8) To install Permaswage fittings (BACU24BS), do this task: TASK 20-10-51-400-806.
- 9) To install Axial Swage unions (8,000 psi rated - Rynglok), do this task: Axial Swage Fitting Union Installation (8,000 psi rated - Rynglok), TASK 20-10-51-400-807.
- 10) To Install Axial Swage unions (5,000 psi rated - DAS5969T, AS6322T) or adapter fittings (5,000 psi rated - DAS5792T, DAS5793T), do this task: Axial Swage Fitting Installation (5,000 psi rated - Union) or Male/Female Adapter Fittings, TASK 20-10-51-400-808.

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- 11) To install Axial Swage shape fittings (5,000 psi rated), do this task: Axial Swage Fitting Installation (5,000 psi rated - Shape, Elbow and Tee), TASK 20-10-51-400-809.
- (k) Install the repair section.
- 1) To tighten the nuts, do this task: Standard Torque Values, TASK 20-50-11-910-801.
- (l) When you use a Cryofit union or an H-Coupling in the repair section, install it after you tighten the flareless fittings in their positions.
- (m) When you use a Permaswage union in the repair section, you must make allowance for swage growth.
- NOTE: Tighten the repair section in position after installation of the Permaswage union.
- (n) When you replace a tube bend section, make sure that you keep the minimum straight length specifications for all fittings (Figure 813).
- (o) When you use a Cryolive flareless sleeve/coupling nut in conjunction with a permanent Cryofit, H-Coupling, Permaswage, Axial Swage fitting (5,000 psi rated, or 8,000 psi rated-Rynglok), tighten the flareless coupling nut hand-tight before installing the permanent fitting to minimize axial preload on the Cryolive sleeve.

SUBTASK 20-10-51-710-005

- (7) If you disconnected more than one hydraulic tube and you think there is a possibility you connected the tubes incorrectly or cross-connected the tubes, do an operational check:

NOTE: Use your own judgement to determine if a check is necessary.

- (a) Do the post-installation test of one or more of the components to which the tubes are connected as a check.

SUBTASK 20-10-51-710-006

- (8) If you disconnected electrical wires to get access to the tubes and you think there is a possibility you connected the wires incorrectly or cross-connected the wires, do an operational check:

NOTE: Use your own judgement to determine if a check is necessary.

- (a) Do the post-installation test of one or more of the components to that the wires are connected as a check.

———— **END OF TASK** ————

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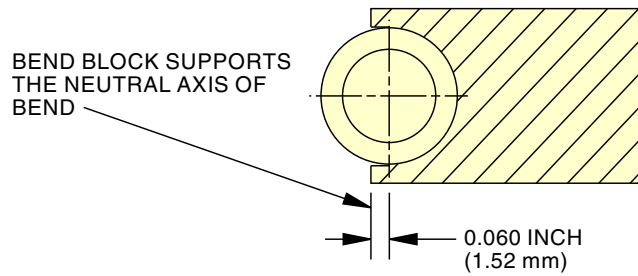
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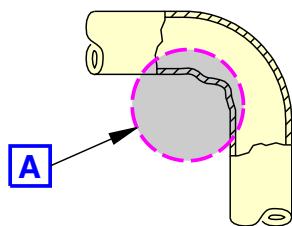
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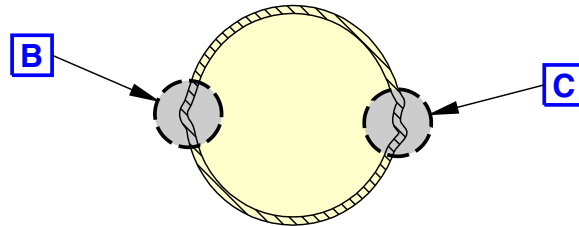
NOTE:

IF THE OVALITY OF ANY PART OF THE BEND IS MORE THAN THE MAXIMUM PERMITTED OVALITY, DISCARD THE TUBE.

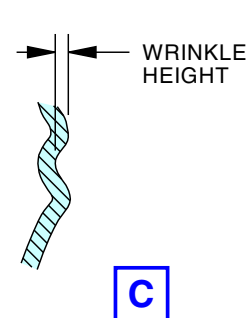
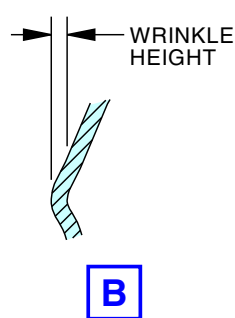
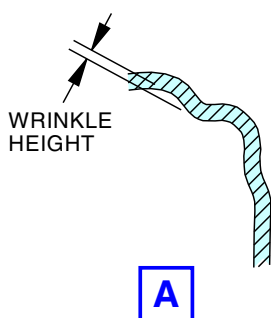
TUBE BEND BLOCK



**RADIAL
WRINKLE**



**LONGITUDINAL
WRINKLE**



WRINKLE MEASUREMENTS

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Permitted Ovality and Wrinkle of Hydraulic Tube and Electrical Rigid Conduit Bends Figure 805/20-10-51-990-813

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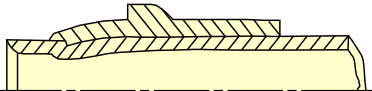
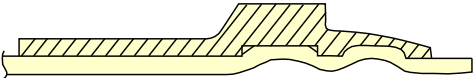
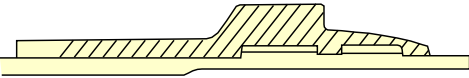
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CAUTION:

DO NOT USE CADMIUM PARTS ON TITANIUM TUBES. CORROSION WILL OCCUR IF YOU USE CADMIUM PARTS ON TITANIUM TUBES.

TUBE JOINING		TUBE MATERIAL	TOOLS REQUIRED**	APPROVED SIZES
ILLUSTRATION	PART NUMBER*	4		
	BACS13AP (BITE-Type) 1	6061T6	B, C	04, 06, 08, 10, 12
		304 ANN.	B, C	04, 06, 08, 10, 12
		304 1/8 Hard	B, C	04, 06, 08, 10, 12
	BACS13BX (Elastomer Swage) 2	6061T6	A	06, 08, 10, 12, 16, 20 3, 24 3
		304 ANN.	A	16, 20
		304 1/8 Hard	A	06, 08, 10, 12, 16, 20 3, 24 3
		21-6-9	A	04, 06, 08, 10, 12, 16
	BACS13BX (Roller Swage) 2	21-6-9	D	04, 06, 08, 10, 12, 16
		Ti-3Al-2.5V	D	04, 06, 08, 10, 12, 16, 20

* SEE TABLE FOR ASSOCIATED APPROVED FITTINGS.

** SEE TABLE FOR TOOLS REQUIRED FOR REPAIR METHOD.

**REPAIR METHOD - RECONNECTABLE WITH FLARELESS FITTING SLEEVES
TABLE A**

2411121 S00061527001_V1

**Tube Material and Fitting Selection Tables
Figure 806/20-10-51-990-814 (Sheet 1 of 4)**

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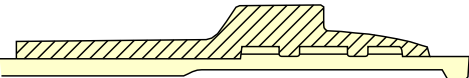
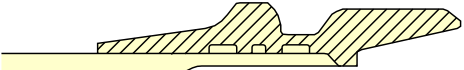
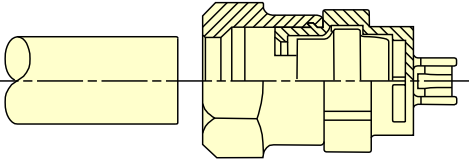
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CAUTION:

DO NOT USE CADMIUM PARTS ON TITANIUM TUBES. CORROSION WILL OCCUR IF YOU USE CADMIUM PARTS ON TITANIUM TUBES.

TUBE JOINING		TUBE MATERIAL 	TOOLS REQUIRED **	APPROVED SIZES
ILLUSTRATION	PART NUMBER*			
	35211 SLEEVE (Roller Swage)	Ti-3Al-2.5V	D(1)	04, 06, 08, 10, 12, 16, 20
	35212 UNION (Roller Swage)	Ti-3Al-2.5V	D(1)	04, 06, 08, 10, 12, 16, 20
	CRYOLIVE Assembly 921721	6061T6	G	04, 06, 08, 10, 12, 16
		21-6-9	G	04, 06, 08, 10, 12, 16
		Ti-3Al-2.5V	G	04, 06, 08, 10, 12, 16
		304 1/8 Hard	G	04, 06, 08, 10, 12, 16

* SEE TABLE FOR ASSOCIATED APPROVED FITTINGS.

** SEE TABLE FOR TOOLS REQUIRED FOR REPAIR METHOD.

**REPAIR METHOD - RECONNECTABLE WITH FLARELESS FITTING SLEEVES
TABLE A (CONTINUED)**

2411122 S00061527002_V1

**Tube Material and Fitting Selection Tables
Figure 806/20-10-51-990-814 (Sheet 2 of 4)**

EFFECTIVITY
SIA ALL

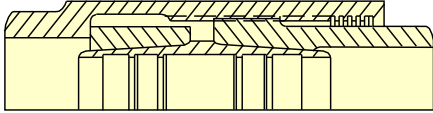
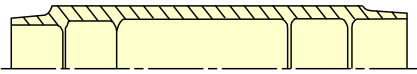
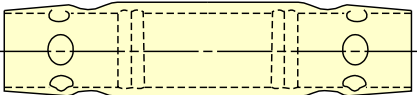
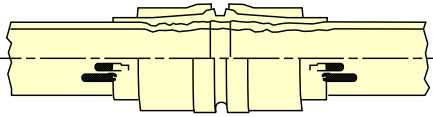
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TUBE JOINING		TUBE MATERIAL 4	TOOLS REQUIRED**	APPROVED SIZES
ILLUSTRATION	PART NUMBER			
	BACC42W Repair H-Coupling BACC42W-T	6061T6	G	04, 06, 08, 10
		304 ANN.	G	04, 06, 08, 10, 12, 16
		304 1/8 Hard	G	04, 06, 08, 10, 12, 16
		21-6-9	G	04, 06, 08, 10, 12, 16
		Ti-3Al-2.5V	G	04, 06, 08, 10
	3P02111 or 3PHS111 Cryofit	Ti-3Al-2.5V	F	04, 06, 08, 10, 12, 16
	Permaswage D10282-D (Al)	6061T6	E	04, 06, 08, 10, 12, 16
	Permaswage D10282 - (Cres)	Ti-3Al-2.5V	E	04, 06, 08, 10, 12, 16
		304 1/8 Hard	E	04, 06, 08, 10, 12, 16
		21-6-9	E	04, 06, 08, 10, 12, 16
	Rynglok 80101T - (TITANIUM)	6061T6	H	04, 06, 08, 10, 12, 16
		Ti-3Al-2.5V	H	04, 06, 08, 10, 12, 16, 20
		304 1/8 Hard	H	04, 06, 08, 10, 12, 16
		21-6-9	H	04, 06, 08, 10, 12, 16

** SEE TABLE FOR TOOLS REQUIRED FOR REPAIR METHOD.

**REPAIR METHOD - PERMANENT UNIONS, TUBE-TO-TUBE
TABLE B**

2411123 S00061527003_V1

**Tube Material and Fitting Selection Tables
Figure 806/20-10-51-990-814 (Sheet 3 of 4)**

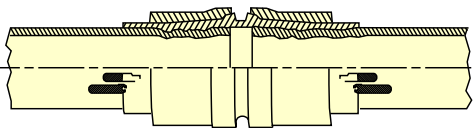
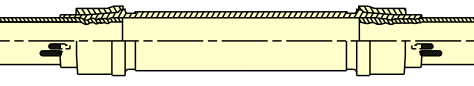
EFFECTIVITY
SIA ALL

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	AXIAL SWAGE UNION (5000 PSI RATED) AS5969	Ti-3Al-2.5V	I	04, 06, 08, 10, 12, 16
		21-6-9	I	04, 06, 08, 10, 12, 16
		6061T6 5	I	04, 06, 08, 10, 12, 16
	EXTENDED LENGTH AXIAL SWAGE UNION (5000 PSI RATED) AS6322	Ti-3Al-2.5V	I	04, 06, 08, 10, 12, 16, 20
		21-6-9	I	04, 06, 08, 10, 12, 16, 20
		6061T6 5	I	04, 06, 08, 10, 12, 16, 20

**REPAIR METHOD - PERMANENT UNIONS, TUBE-TO-TUBE
TABLE B
(CONTINUED)**

NOTE:

SEE FIGURE FOR TUBE MATERIAL AND FITTING SELECTION TO MAKE AN ORDER FOR PARTS.

- 1 STANDARD CADMIUM-PLATED SLEEVE BACS13AP (SIZE)
- 2 STANDARD CADMIUM-PLATED SLEEVE BACS13BX (SIZE) HP
- 3 THE BACSBX SLEEVE CAN BE USED TO REPAIR SIZE 20 AND 24 ALUMINUM TUBES WITH SHORT FLARELESS FITTINGS. IT CAN ALSO BE USED TO REPAIR SIZE 20 ALUMINUM TUBES AND SIZE 20 AND 24 CRES TUBES WITH STANDARD FLARELESS FITTINGS.
- 4 WHEN PERFORMING A HYDRAULIC TUBE REPAIR WITH THE SAME TUBE MATERIAL, THE ALTERNATE TUBE WALL THICKNESSES MAY BE USED IN PLACE OF WALL THICKNESSES DELIVERED WITH THE AIRPLANE WHEN PERFORMING A REPAIR ON TUBES IN SYSTEMS WITH 3000 PSI OR LESS OPERATING PRESSURE.
- 5 ONLY FOR THE AXIAL SWAGE UNIONS WITH A CODE LETTER "D" AT THE END OF BASIC PART STANDARD NUMBER.

2411128 S00061527008_V2

**Tube Material and Fitting Selection Tables
Figure 806/20-10-51-990-814 (Sheet 4 of 4)**

EFFECTIVITY
SIA ALL

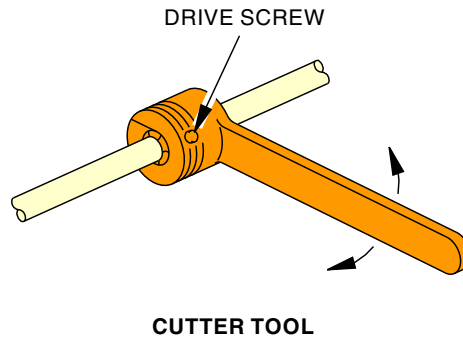
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TUBE SIZE	CHIPLESS CUTTER PART NUMBER	CUTTER WHEEL PART NUMBER
04	D12530-001	D12530-009
06	D12530-001	D12530-009
08	D12531-001	D12531-009
10	D12531-001	D12531-009
12	D12531-001	D12531-009

**DMC CHIPLESS CUTTERS AND CUTTER WHEELS
TABLE A**

2411129 S00061527009_V1

DMC Tools
Figure 807/20-10-51-990-815 (Sheet 1 of 2)

EFFECTIVITY
SIA ALL

D633AM101-SIA

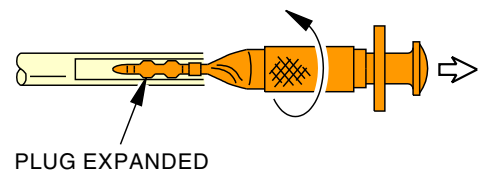
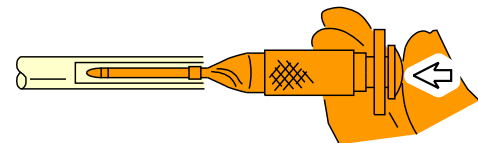
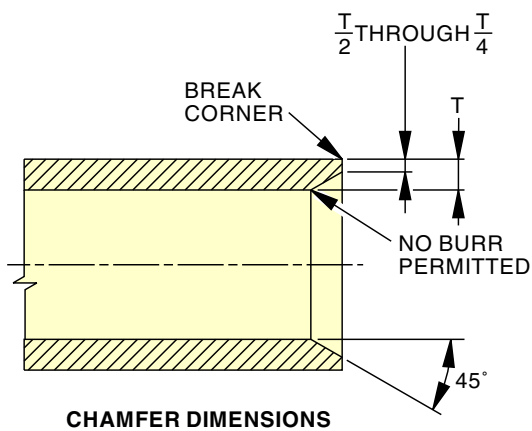
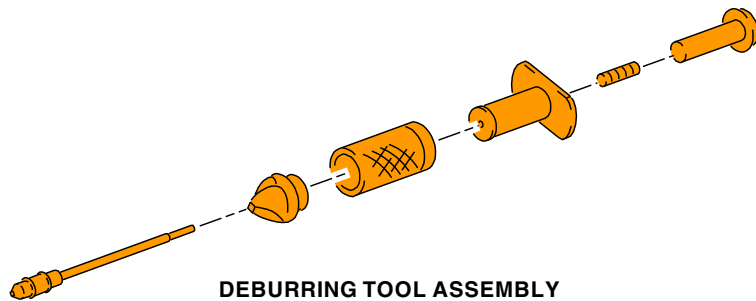
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TUBE SIZE	TUBE WALL THICKNESS (INCHES)	STEM SUBASSEMBLY PART NUMBER	DEBURRING TOOL PART NUMBER
04	0.016-0.028	D9851-13-04	D9851
04	0.028-0.050	D9851-13-03	D9851
06	0.016-0.035	D9851-13-06	D9851
06	0.035-0.058	D9851-13-07	D9851
08	0.016-0.042	D9850-13-08	D9850
10	0.016-0.058	D9850-13-10	D9850
12	0.016-0.058	D9850-13-12	D9850
16	0.016-0.058	D9849-13-16	D9849
20	0.016-0.058	D9849-13-20	D9849

**DMC STEM SUBASSEMBLIES, DEBURRING TOOLS, AND
REQUIRED CHAMFER DIMENSIONS
TABLE B**

2411130 S00061527010_V1

**DMC Tools
Figure 807/20-10-51-990-815 (Sheet 2 of 2)**

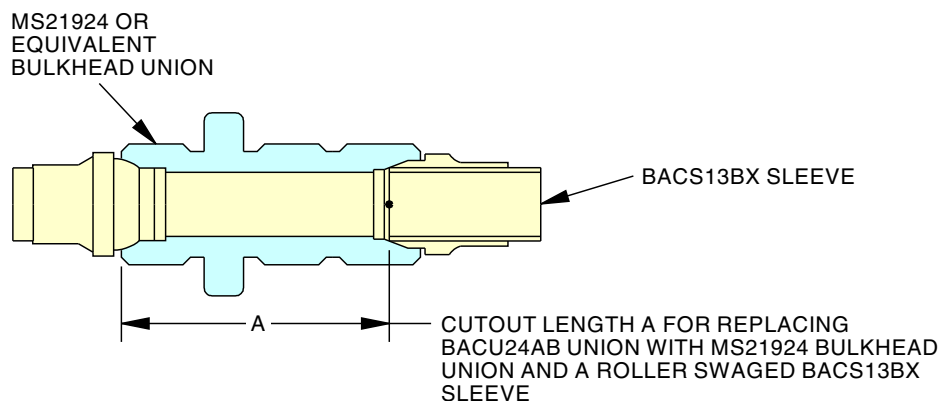
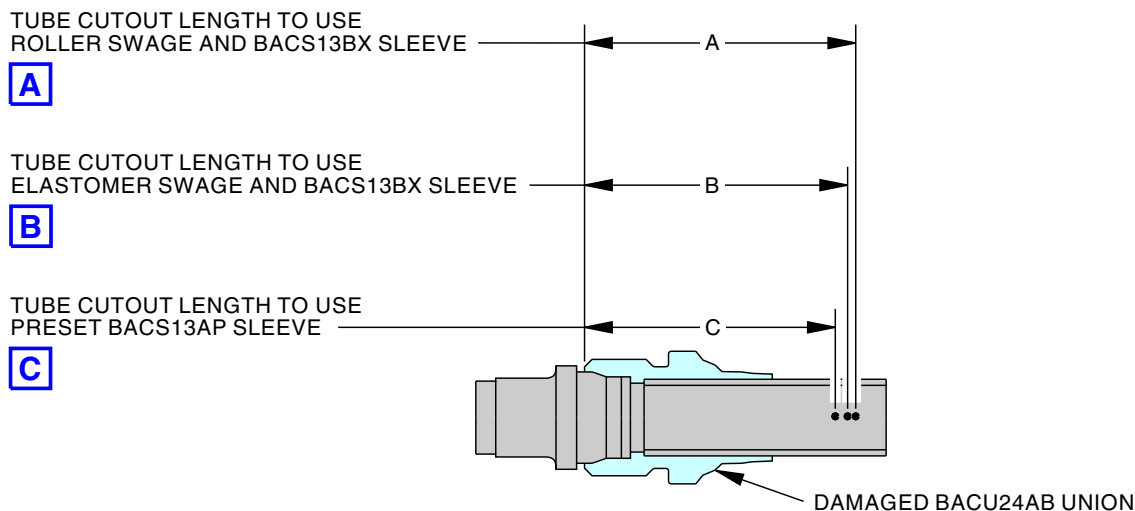
EFFECTIVITY
SIA ALL

20-10-51

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A

NOTE:

SEE TABLE FOR REPLACEMENT OF A DAMAGED BACU24AB UNION.
COUPLING NUTS ARE NOT SHOWN.

2411134 S00061527014_V1

Tube Cutout Lengths for Replacement of Damaged BACU24AB Swage Unions
Figure 808/20-10-51-990-818 (Sheet 1 of 3)

EFFECTIVITY
SIA ALL

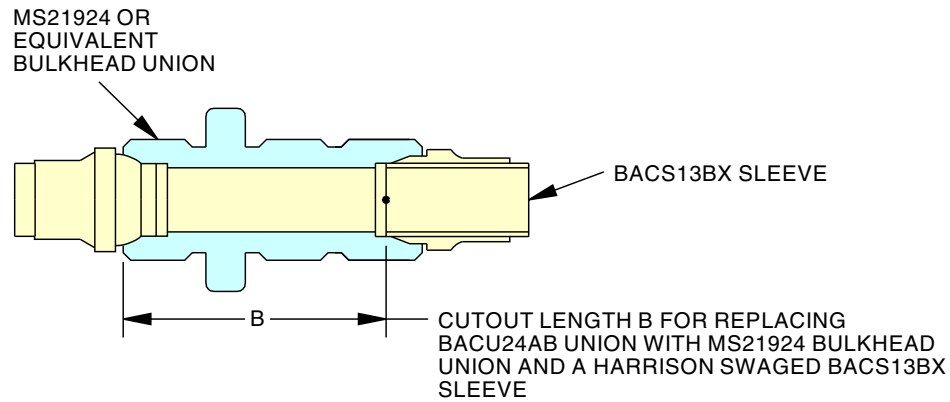
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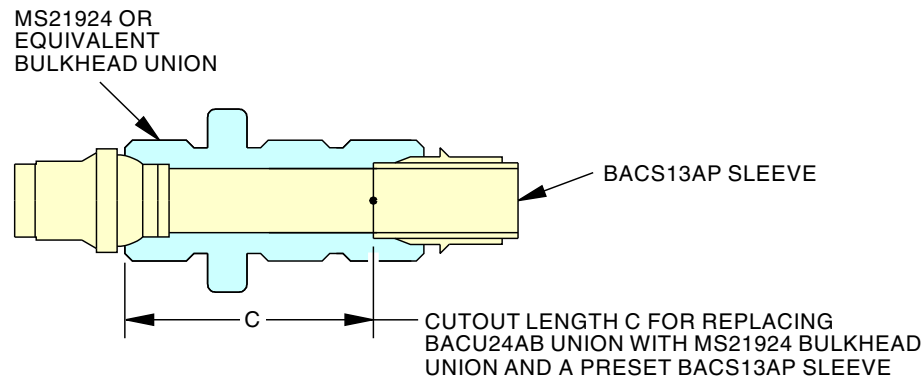
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B



C

NOTE:

SEE TABLE FOR REPLACEMENT OF A DAMAGED BACU24AB UNION.
COUPLING NUTS ARE NOT SHOWN.

2411135 S00061527015_V1

**Tube Cutout Lengths for Replacement of Damaged BACU24AB Swage Unions
Figure 808/20-10-51-990-818 (Sheet 2 of 3)**

EFFECTIVITY
SIA ALL

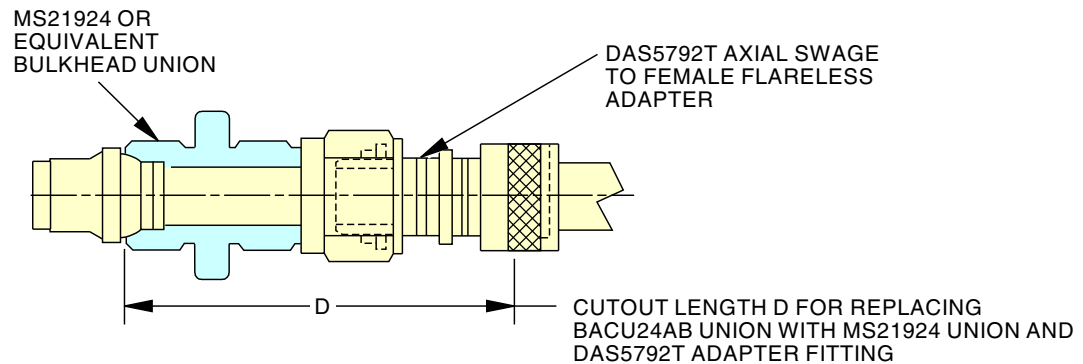
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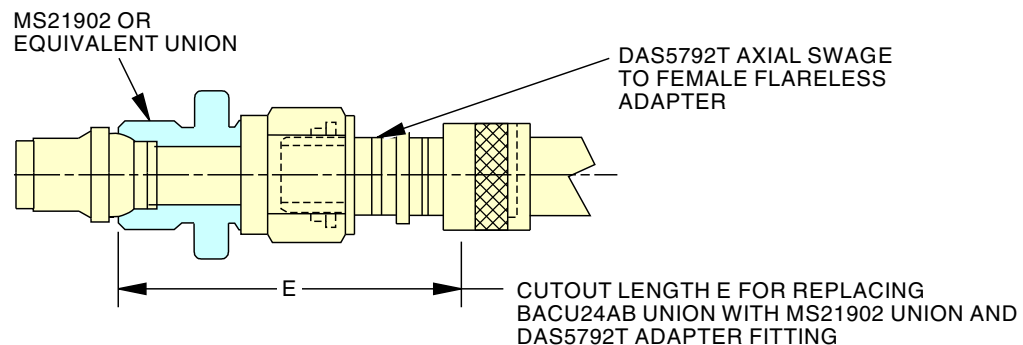
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D



E

NOTE:

SEE TABLE FOR TUBE CUTOUT DIMENSIONS FOR DAS5792T/DAS5793T ADAPTER FITTINGS.

2411136 S00061527016_V1

Tube Cutout Lengths for Replacement of Damaged BACU24AB Swage Unions
Figure 808/20-10-51-990-818 (Sheet 3 of 3)

EFFECTIVITY
SIA ALL

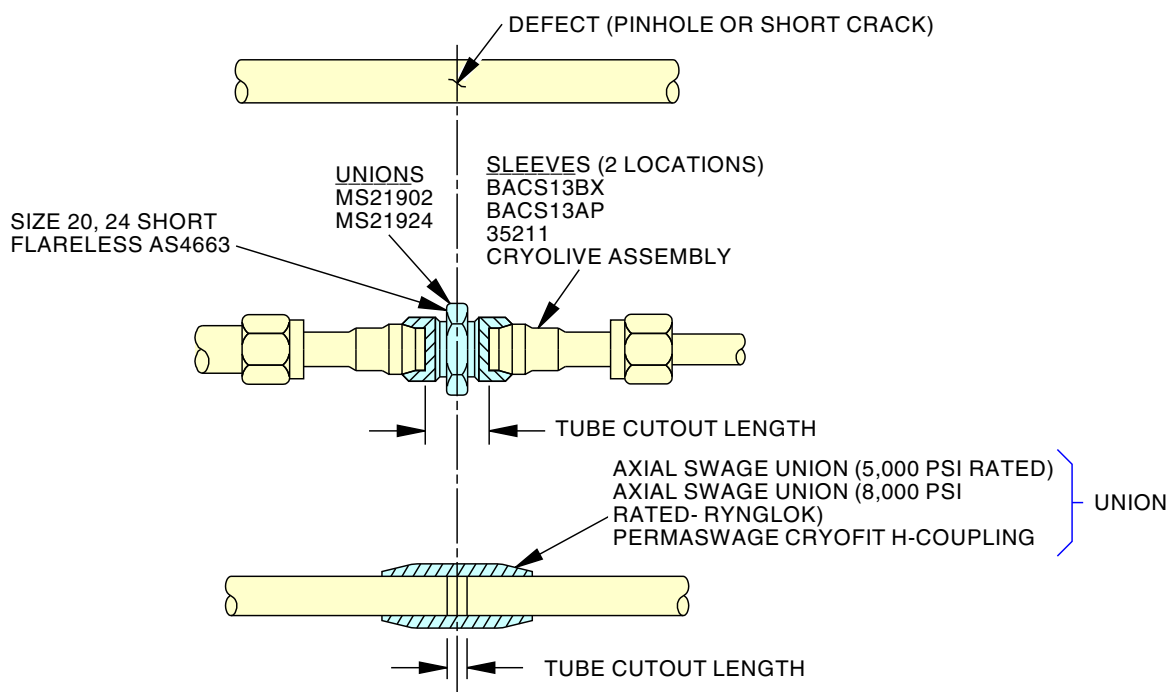
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NOTE:

SEE TABLE FOR TUBE CUTOUT LENGTHS.
FITTING NUTS ARE NOT SHOWN.

2411131 S00061527011_V2

Tubing Repair with Unions - Short Damage
Figure 809/20-10-51-990-816

EFFECTIVITY
SIA ALL

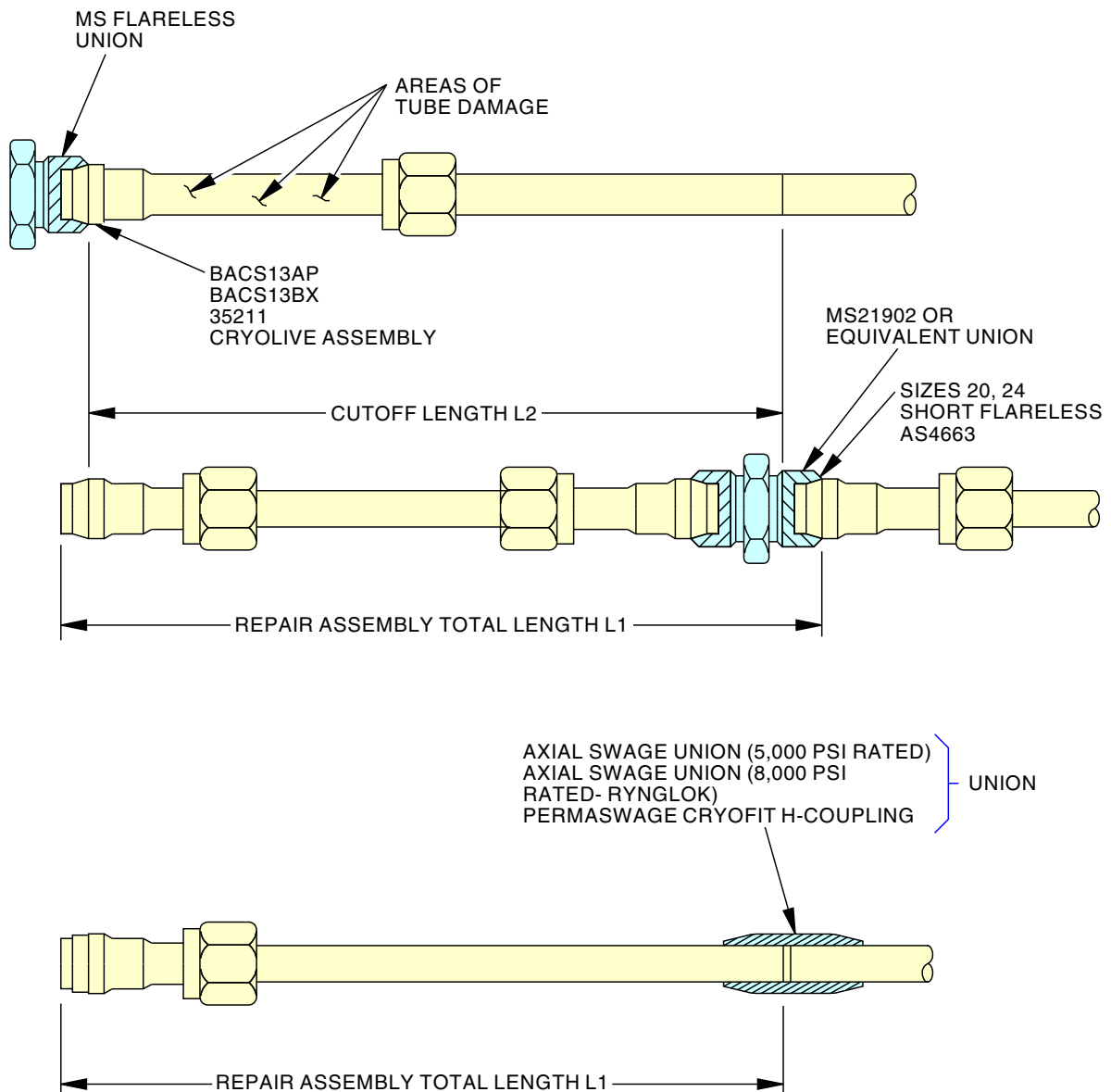
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NOTE:

SEE FIGURE FOR TUBE CUTOUT LENGTHS FOR REPLACEMENT OF DAMAGED BACU24AB SWAGE UNIONS.
SEE TABLE FOR PROCEDURE TO FIND THE TUBE CUTOUT LENGTH L2.

2411132 S00061527012_V2

Tubing Repair by End Replacement
Figure 810/20-10-51-990-817 (Sheet 1 of 2)

EFFECTIVITY
SIA ALL

D633AM101-SIA

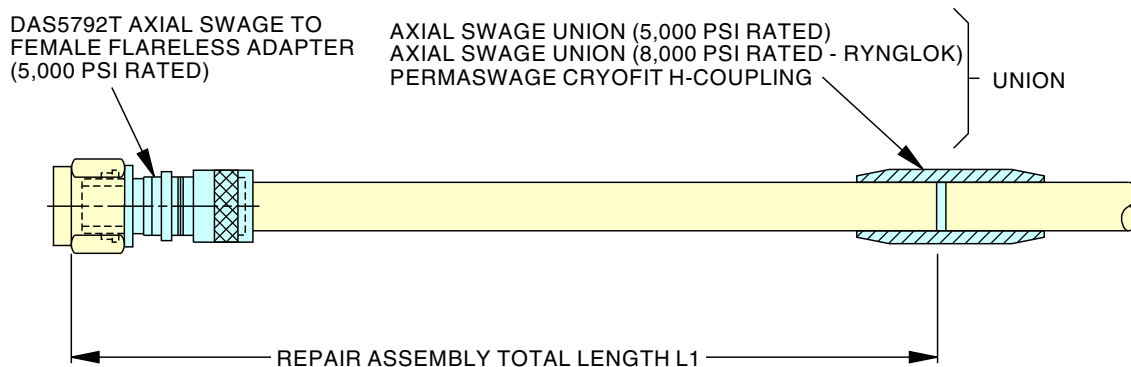
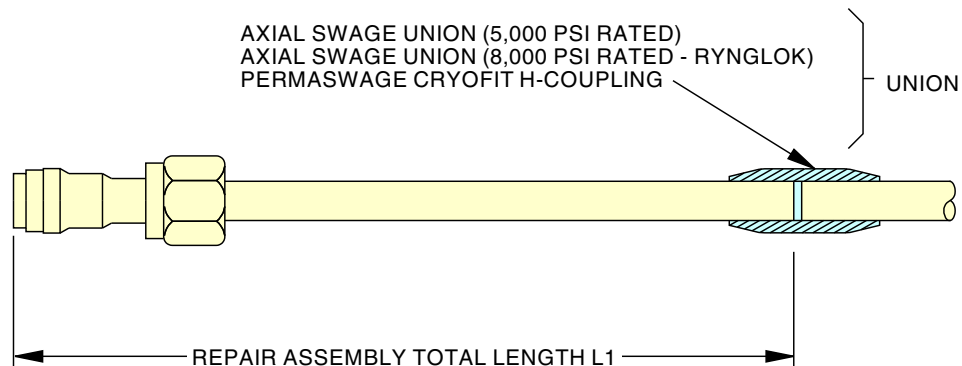
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NOTE:

SEE FIGURE FOR TUBE CUTOUT LENGTHS FOR REPLACEMENT OF DAMAGED BACU24AB SWAGE UNIONS.

2411133 S00061527013_V1

Tubing Repair by End Replacement
Figure 810/20-10-51-990-817 (Sheet 2 of 2)

EFFECTIVITY
SIA ALL

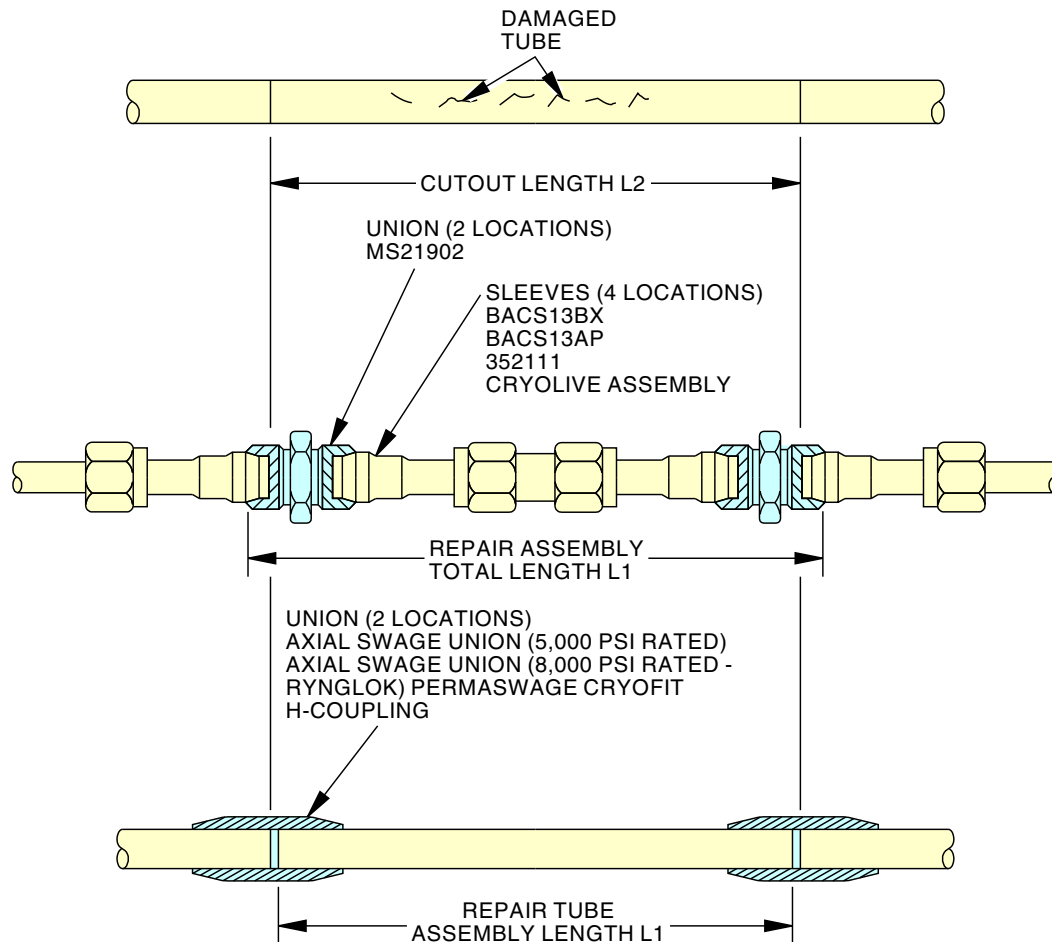
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NOTE:

SEE FIGURE FOR TUBE CUTOUT LENGTHS FOR REPLACEMENT OF DAMAGED BACU24AB SWAGE UNIONS.

SEE TABLE FOR PROCEDURE TO FIND THE TUBE CUTOUT LENGTH L2.

2411137 S00061527017_V1

Tubing Repair by Section Replacement, Straight or Bend - Extensive Damage
Figure 811/20-10-51-990-819 (Sheet 1 of 2)

EFFECTIVITY
SIA ALL

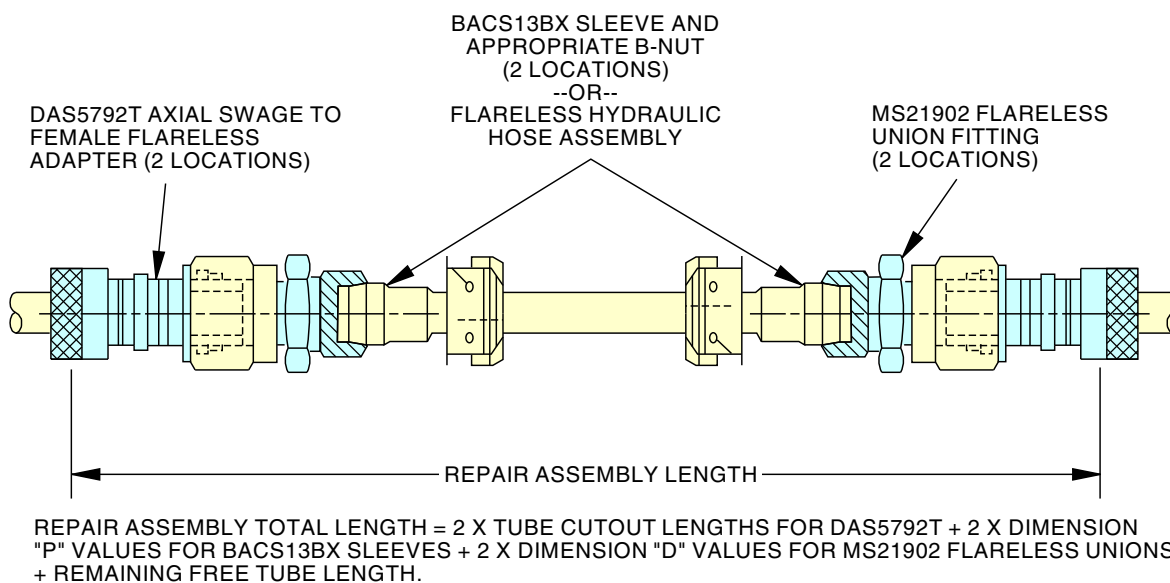
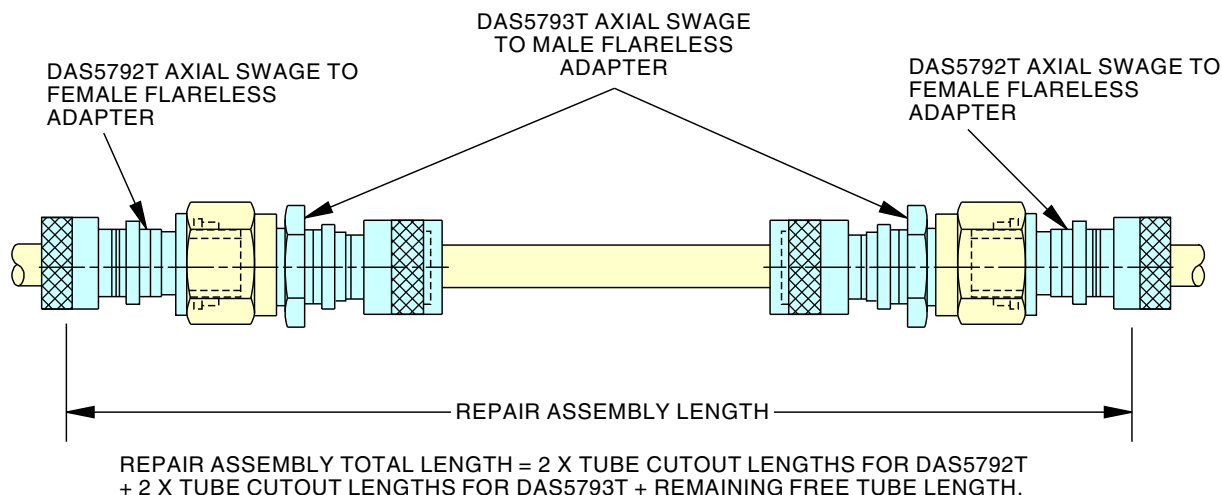
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NOTE:

SEE FIGURE FOR TUBE CUTOUT LENGTHS FOR REPLACEMENT OF DAMAGED BACU24AB SWAGE UNIONS.

SEE TABLE FOR TUBE CUTOUT DIMENSIONS FOR INSTALLING DAS5792T/DAS5793T ADAPTER FITTINGS.

2411138 S00061527018_V1

Tubing Repair by Section Replacement, Straight or Bend - Extensive Damage Figure 811/20-10-51-990-819 (Sheet 2 of 2)

EFFECTIVITY
SIA ALL

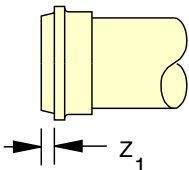
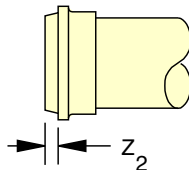
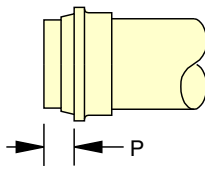
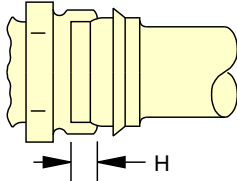
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FLARELESS SLEEVE JOINT TYPE	TUBE SIZES								
	04	05	06	08	10	12	16	20	24
BACS13BX (Roller Swaged) 	0.140	N/A	0.137	0.190	0.195	0.195	0.195	N/A	N/A
35211 (Harrison Roller Swaged) 	0.210	N/A	0.207	0.250	0.255	0.255	0.255	N/A	N/A
BACS13BX (Elastomer Swaged) 	0.214	0.230	0.230	0.285	0.330	0.330	0.392	0.395 1 0.355 2	0.465 1 0.350 2
BACS13AP (Preset) 	0.234	0.250	0.250	0.305	0.350	0.350	N/A	N/A	N/A

NOTE:

ALL DIMENSIONS ARE IN INCHES.

1 ALL EXCEPT SHORT FLARELESS

2 SHORT FLARELESS

2411153 S00061527035_V1

**Flareless Sleeve Tube End Values
Figure 812/20-10-51-990-821**

EFFECTIVITY
SIA ALL

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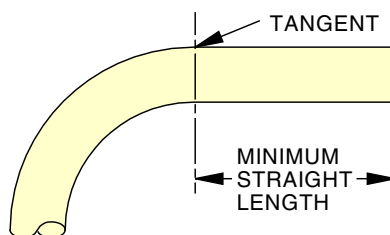
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FITTING TYPE	TUBE END MINIMUM STRAIGHT LENGTH - INCHES								
	04	05	06	08	10	12	16	20	24
BACS13BX (Harrison Elastomer Swager) and CRYOLIVE Flareless Sleeve Assembly	1.23	1.25	1.28	1.39	1.48	1.51	1.47	1.46	1.46
BACS13BX (Harrison Roller Swager)	2.25	2.25	2.25	2.25	2.25	2.25	2.25	N/A	N/A
BACS13AP (BITE Type)	0.80	0.90	1.00	1.10	1.15	1.15	N/A	N/A	N/A
D10282 * (Permaswage)	1.07	N/A	1.15	1.65	1.70	1.80	1.90	2.15	N/A
BACC42W * (H-Coupling)	2.80	2.80	2.80	2.80	2.80	2.80	2.80	N/A	N/A
3p02111 * (Cryofit)	0.71	0.81	0.90	0.98	1.17	1.35	1.76	N/A	N/A
35211 Sleeve (Harrison Roller Swager)	1.30	N/A	1.30	1.38	1.42	1.40	1.40	N/A	N/A
35212 Union (Harrison Roller Swager)	1.22	N/A	1.30	1.48	1.46	1.50	1.50	N/A	N/A
80101T Axial Swage Fitting (8,000 psi rated 8010T - Rynglok)	1.236	N/A	1.362	1.480	1.628	1.777	2.109	2.143	N/A
DAS5969T, DAS5792T, DAS5793T, DAS5801T, DAS5803T, DAS5804T, DAS5806T, DAS5972T and other Axial Swage Fittings (5,000 psi rated)	0.90	N/A	1.12	1.54	1.69	1.84	2.17	N/A	N/A
AS6322, AS6322E Axial Swage Fittings (5,000 psi rated)	1.24	N/A	1.36	1.48	1.63	1.78	2.11	2.14	N/A

* Based on 1/2 fitting length

2411139 S00061527019_V2

**Minimum Straight Length Specifications for Repair Fitting Installations Adjacent to Tube Bends
Figure 813/20-10-51-990-820**

EFFECTIVITY
SIA ALL

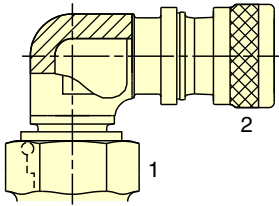
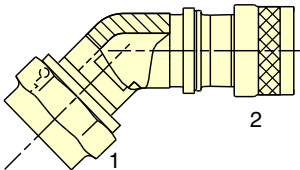
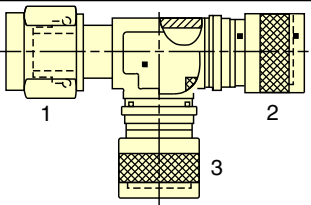
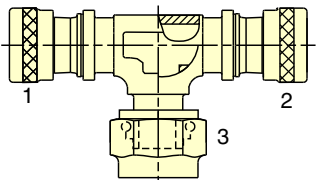
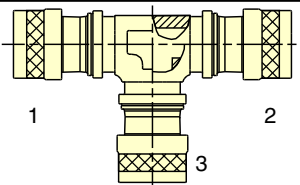
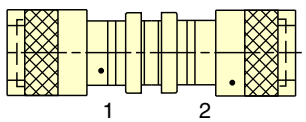
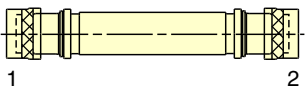
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SEQ. NUMBER	DMC PART NUMBER	DESCRIPTION	PART DEFINITION	
			CONFIGURATION (CROSS-HATCHING INDICATES AXIAL SWAGE ENDS)	POST DESIGNATIONS
1	DAS5801T /AS5801T	ELBOW 90 DEGREE, FEMALE FLARELESS, 3000 psi		PORT NO. 1 = FEMALE FLARELESS END. PORT NO. 2 = AXIAL SWAGE END.
2	DAS5803T /AS5803T	ELBOW 45 DEGREE, FEMALE FLARELESS, 3000 psi		PORT NO. 1 = FEMALE FLARELESS END. PORT NO. 2 = AXIAL SWAGE END.
3	DAS5804T /AS5804T	TEE, FEMALE FLARELESS ON RUN, 3000 psi		PORT NO. 1 = FEMALE FLARELESS END ON THE RUN. PORT NO. 2 = AXIAL SWAGE END ON THE RUN. PORT NO. 3 = AXIAL SWAGE END ON THE SIDE.
4	DAS5806T /AS5806T	TEE, FEMALE FLARELESS ON BRANCH, 3000 psi		PORT NO. 1 = LARGEST AXIAL SWAGE END ON THE RUN. PORT NO. 2 = REMAINING AXIAL SWAGE END ON THE RUN. PORT NO. 3 = FEMALE FLARELESS END ON THE SIDE.
5	DAS5972T /AS5972T	FITTING ASSEMBLY, TEE, AXIALLY SWAGED, HYDRAULIC, 5080 psi		PORT NO. 1 = LARGEST AXIAL SWAGE END ON THE RUN. PORT NO. 2 = REMAINING AXIAL SWAGE END ON THE RUN. PORT NO. 3 = AXIAL SWAGE END ON THE SIDE.
6	DAS5969T /AS5969T	UNION, AXIALLY SWAGED, HYDRAULIC, 5080 psi		PORT NO. 1 = LARGEST AXIAL SWAGE END. PORT NO. 2 = REMAINING AXIAL SWAGE END.
7	AS6322T	EXTENDED LENGTH UNION, AXIALLY SWAGED, HYDRAULIC, 5080 psi		PORT NO. 1 = LARGEST AXIAL SWAGE END. PORT NO. 2 = REMAINING AXIAL SWAGE END.

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**Tube Material and Fitting Selection
Figure 814/20-10-51-990-823**

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TASK 20-10-51-300-802

5. Titanium Hydraulic Tubing, 3000 psi - Roll Swaging Harrison 35211 Sleeves and 35212 Unions Using the Harrison 6777 Swage Machine

(Figure 806, Figure 807, Figure 808, Figure 809, Figure 810, Figure 811, Figure 815, Figure 816)

A. General

- (1) The sleeves, unions, and nuts used for this repair are listed in Figure 806 and Table 808.
- (2) Get the necessary tools and dies as listed in the operating manual with the Harrison 6777 Swage Machine.

NOTE: This task does not apply to repair of aluminum and CRES tubing.

B. Titanium Hydraulic Tubing, 3000 psi Repair

SUBTASK 20-10-51-300-001

- (1) To do the repairs, do these steps:
 - (a) Cut and chamfer tubes (Figure 807).
 - 1) Length requirements are shown in Figure 808, Figure 809, Figure 810, and Figure 811 as applicable.
 - 2) Correct for swage growth according to data provided in the manufacturer's operating manual.
 - (b) Clean the tube with Methyl Ethyl Ketone or an equivalent cleaning agent and blow air through the tube to remove particles.
 - (c) Use swage dies (Figure 815).
 - (d) Use swage torques (Figure 816).
 - (e) After swaging the tube ends, inspect the after-swage inside diameter of the tube end to the values (Figure 815).
 - 1) Inspect swage area for any signs of roller wear or defective rollers.
 - (f) Make sure that there are no scratches or other damage on the seal areas of the sleeve and union.
 - (g) Conduct a Proof Pressure Test of the tube assembly:
 - 1) Connect the Harrison sleeve and union of the tube assembly and torque it to the specified value.
 - 2) Pressurize the tube to 6000 psi (41,369 kPa).
 - 3) There shall be no leakage in proof testing.
 - 4) If there is leakage, loosen and retighten the fitting.
 - a) If leakage persists, remove the tube and inspect tube end and test fittings for defects.

————— **END OF TASK** —————

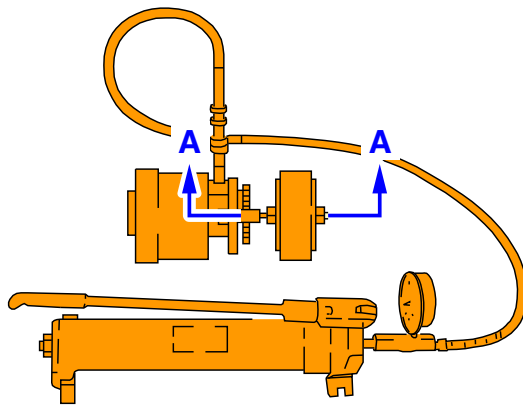
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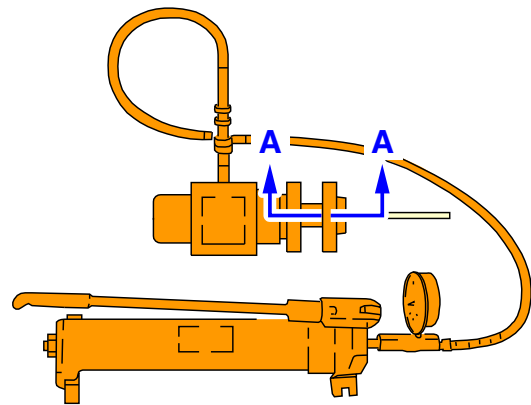
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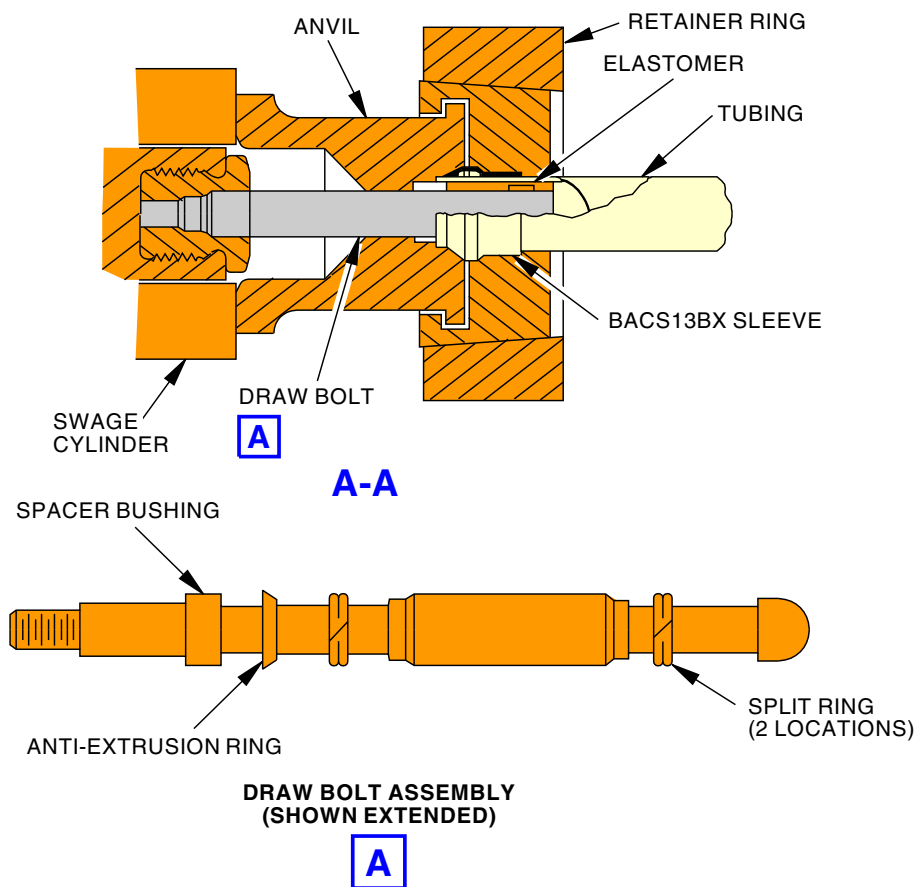
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HARRISON MODEL 5720



HARRISON MODEL 5175



2411145 S00061527026_V1

Harrison Portable Swagers for BACS13BX Sleeves
Figure 815/20-10-51-990-824 (Sheet 1 of 5)

EFFECTIVITY
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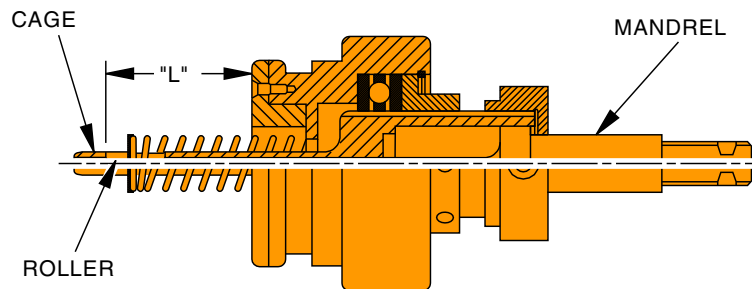
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SIZE	EXPANDER ASSEMBLY	MANDREL	ROLLERS	CAGE
-04	7320-04016	7321-04016	7322-04016	7323-04016
-06	7320-06019	7321-06019	7322-06019	7323-06019
-08	7320-08026	7321-08026	7322-08026	7323-08026
-10	7320-10032	7321-10032	7322-10032	7323-10032
-12	7320-12039	7321-12039	7322-12039	7323-12039
-16	7320-16051	7321-16051	7322-16051	7323-16051

**EXPANDERS P/N AND SPARE PARTS P/N REQUIRED
TO ROLLER SWAGE 35211 AND 35212 TO 3AL-2.5V TITANIUM TUBING**

TUBE O.D.	SET LENGTH "L" (INCHES) $\pm .005$
-04	1.010
-06	1.205
-08	1.310
-10	1.382
-12	1.474
-16	1.600

TOOL ADJUSTMENT

HARRISON 6777 MACHINE

2411146 S00061527027_V2

**Harrison Portable Swagers for BACS13BX Sleeves
Figure 815/20-10-51-990-824 (Sheet 2 of 5)**

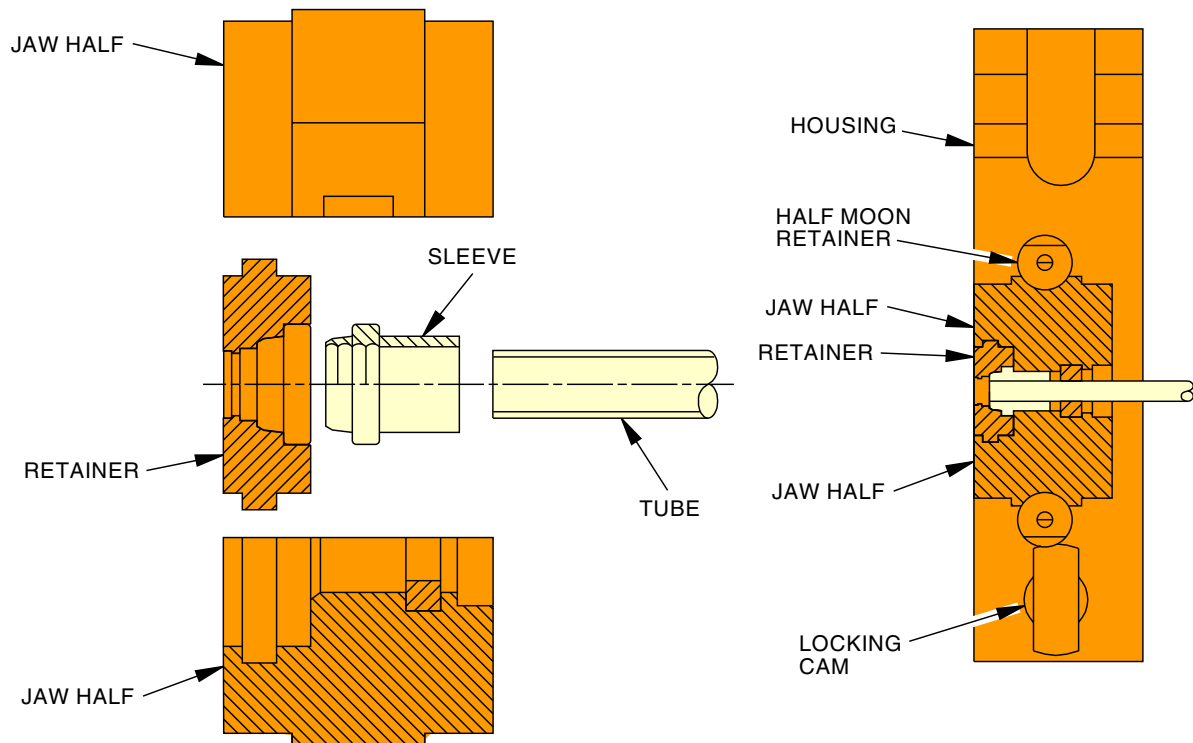
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TUBE AND SLEEVE DIA. (INCH)	TWO HALF JAWS	RETAINER
1/4	6884-04	6885-104
3/8	6884-06	6885-106
1/2	6884-08	6885-108
5/8	6884-10	6885-110
3/4	6884-12	6885-112
1	6884-16	6885-116

HARRISON 6777 MACHINE

2411147 S00061527028_V1

Harrison Portable Swagers for BACS13BX Sleeves
Figure 815/20-10-51-990-824 (Sheet 3 of 5)

EFFECTIVITY
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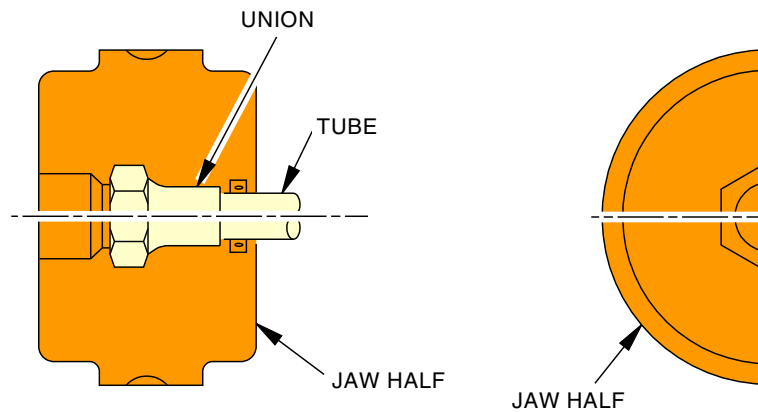
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AIRCRAFT MAINTENANCE MANUAL



TUBE AND SLEEVE DIA. (INCH)	TWO HALF JAWS
1/4	6886-04
3/8	6886-06
1/2	6886-08
5/8	6886-10
3/4	6886-12
1	6886-16

EXTERNAL ROLLER SWAGE TOOLS FOR UNIONS

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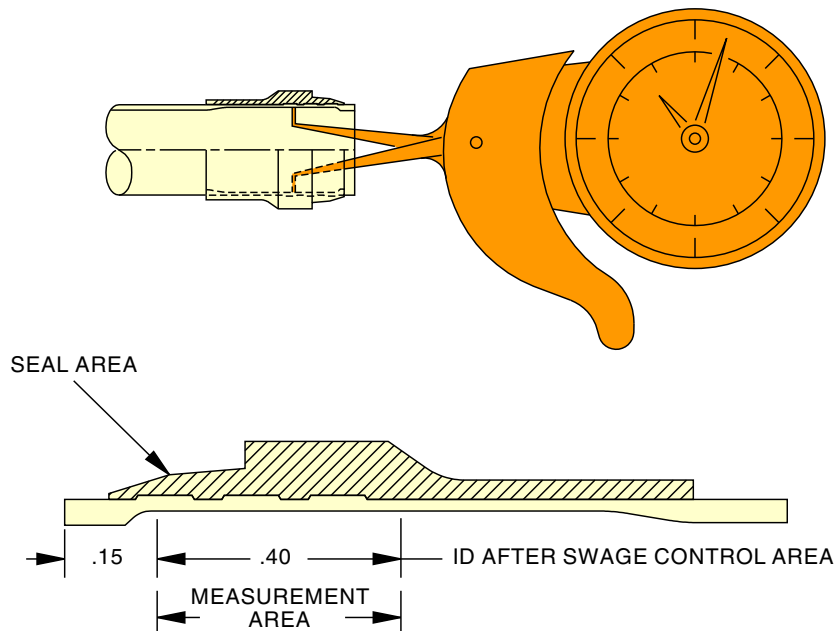
Harrison Portable Swagers for BACS13BX Sleeves
Figure 815/20-10-51-990-824 (Sheet 4 of 5)

EFFECTIVITY	
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NOTE:

I.D. AFTER SWAGE REQUIREMENTS-MEASURING
METHOD FOR 35211 SLEEVE AND 35212 UNION

TUBE O.D./DASH NO.	TUBE WALL (INCH)	TORQUE (POUND-INCH)	I.D. AFTER SWAGE (INCH)
TUBE MATERIAL: 3AL-2.5V TITANIUM PER AMS4946			
0.250/-04	0.016	6-7	0.225-0.232
0.375/-06	0.019	11-12	0.347-0.354
0.500/-08	0.026	20-22	0.458-0.465
0.625/-10	0.032	40-43	0.575-0.587
0.750/-12	0.039	40-43	0.684-0.695
1.000/-16	0.051	65-68	0.913-0.919

**SWAGING TORQUE AND I.D. AFTER SWAGE REQUIREMENTS
FOR 35211 SLEEVE AND 35212 UNIONS**

2411149 S00061527030_V2

**Harrison Portable Swagers for BACS13BX Sleeves
Figure 815/20-10-51-990-824 (Sheet 5 of 5)**

EFFECTIVITY
SIA ALL

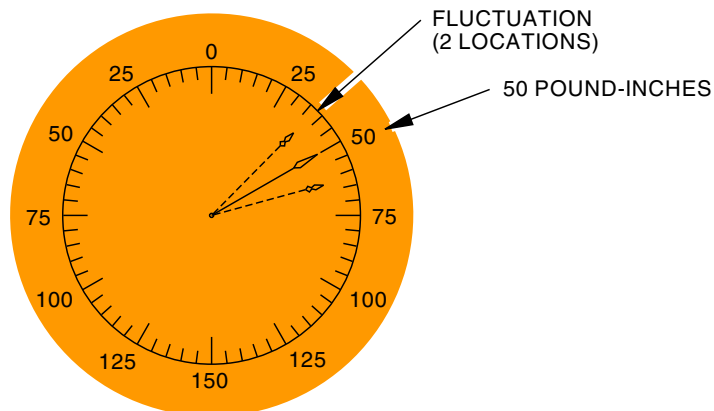
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TORQUE WRENCH DIAL - PROCEDURE TO READ TORQUE

TUBE SIZE	MATERIAL		SWAGE TORQUE (POUNDS-INCH)	
	WALL THICKNESS - INCHES			
	3AL-2.5V TITANIUM 1	21Cr-6Ni-9Mn CRES 2	MIN	MAX
04	0.016	0.016	4	5
06	0.019	0.020	12	15
08	0.026	0.026	20	25
10	0.032	0.033	40	45
12	0.039	0.039	40	45
16	0.051	0.052	80	85

**SWAGE TORQUES NECESSARY TO ROLLER SWAGE
BACS13BX SLEEVES TO Ti-3AL-2.5V CWSR OR
21-6-9 CRES TUBE USING HARRISON 6633K01
ROLLER SWAGING KIT**

1 AS SPECIFIED IN SPECIFICATION AMS4946/AS5620

2 AS SPECIFIED IN SPECIFICATION BMS7-185

2411140 S00061527020_V2

**Swage Torques, Sleeve Dimensions, and Wall Thicknesses for Roller Swaging
Figure 816/20-10-51-990-825 (Sheet 1 of 3)**

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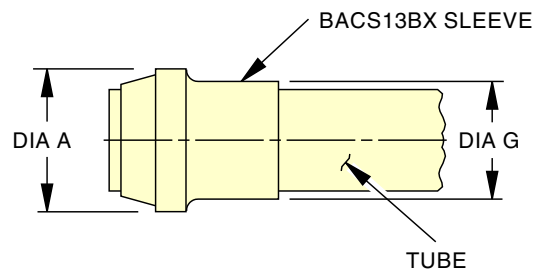
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DIAMETER	TUBE SIZE					
	04	06	08	10	12	16
A MAX	0.374	0.493	0.673	0.789	0.964	1.214
G MAX	0.298	0.423	0.550	0.686	0.822	1.070

MAXIMUM PERMITTED SHOULDER AND SKIRT DIAMETERS (INCH)

2411141 S00061527021_V1

Swage Torques, Sleeve Dimensions, and Wall Thicknesses for Roller Swaging
Figure 816/20-10-51-990-825 (Sheet 2 of 3)

EFFECTIVITY
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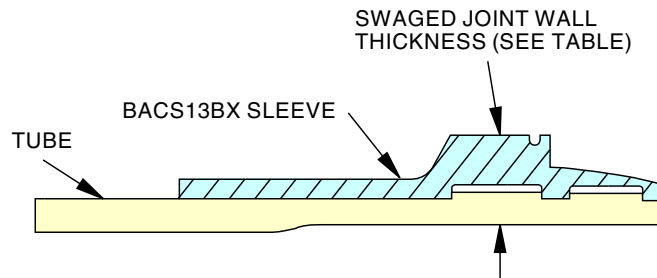
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SECTION OF ROLLER SWAGED JOINT

TUBE SIZE	TUBE DIMENSIONS		SWAGED JOINT WALL THICKNESS FOR "NOMINAL" TUBE WALLS - INCHES	
	"NOMINAL" WALL THICKNESS - INCHES			
	Ti-3AL-2.5V	21-6-9 CRES		
04	0.016	0.016	0.068	↑ TOLERANCE +0.002 -0.003 ↓
06	0.019	0.020	0.066	
08	0.026	0.026	0.100	
10	0.032	0.033	0.101	
12	0.039	0.039	0.132	
16	0.051	0.052	0.143	

SWAGED JOINT WALL THICKNESS SPECIFICATION

¹ "NOMINAL" WALL THICKNESS DEFINITION: TUBE WALL THICKNESS WITHOUT TOLERANCES AS SPECIFIED BY TUBE SPECIFICATION: AMS4946 FOR Ti-3AL-2.5V AND BMS7-185 FOR 21-6-9 CRES.

² IF THE THICKNESS OF A MEASURED TUBE WALL IS DIFFERENT THAN THE "NOMINAL", ADD OR SUBTRACT THE DIFFERENCE FROM THE NECESSARY SWAGED JOINT WALL THICKNESS FOR "NOMINAL" TUBE WALLS.

EXAMPLE: 1. MEASURED 10 SIZE TITANIUM 3AL-2.5V TUBE WALL = 0.035 INCH
2. WALL DIFFERENCE IS 0.035 INCH, MINUS 0.032 INCH = 0.003 INCH
3. ADD 0.003 INCH TO 0.101 INCH = 0.104 INCH

2411142 S00061527022_V2

Swage Torques, Sleeve Dimensions, and Wall Thicknesses for Roller Swaging
Figure 816/20-10-51-990-825 (Sheet 3 of 3)

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TASK 20-10-51-400-803

6. Install the CRYOLIVE Flareless Sleeve Assembly

(Figure 817)

A. General



WARNING

USE PROTECTION WHEN YOU USE LIQUID NITROGEN. MAKE SURE THAT THE AREA HAS A GOOD FLOW OF AIR. LIQUID NITROGEN CAN CAUSE INJURIES TO PERSONNEL.



WARNING

SLOWLY AND CAREFULLY PUT WARM ITEMS IN LIQUID NITROGEN. IF YOU DO NOT USE LIQUID NITROGEN CORRECTLY, IT CAN CAUSE INJURIES TO PERSONNEL.

- (1) The CRYOLIVE flareless sleeves, shown in Figure 817, are installed as part of an assembly consisting of the sleeve, a coupling and nut and plastic cap that acts as an assembly tool and a protective cover for the tube end until the tube is installed on the airplane. The assembly is stored in liquid nitrogen until ready for use. During installation, the assembly is removed from the liquid nitrogen, slipped onto the tube end and allowed to warm to room temperature. The sleeve shrink fits into position at the correct distance from the tube end as it warms to room temperature.
NOTE: Do not use CRYOLIVE flareless sleeve assemblies on any oxygen lines or on fluid lines inside the fire zones on engines or APU's. The CRYOLIVE flareless sleeve assembly is not qualified for these applications.
- (2) The cryolive flareless sleeve/coupling nut/protective cap assembly, STD-1353 can be used with 304 1/8 hard CRES, Ti-3Al-2.5V, 21-6-9 CRES and 6061-T6 aluminum tubes. (Figure 806)
 - (a) Titanium coupling nuts (part of CRYOLIVE assembly 921721T-) or CRES coupling nuts (part of CRYOLIVE assembly 921721J-) can be used with the CRYOLIVE sleeve on 304 1/8 hard CRES, Ti-3Al-2.5V or 21-6-9 CRES tubes.
 - (b) Aluminum coupling nuts (part of CRYOLIVE assembly 921721W-) and aluminum mating fittings must be used to avoid galvanic corrosion when the CRYOLIVE flareless sleeve assembly is installed on 6061-T6 aluminum tube.
- (3) The coupling nut used with the cryolive flareless sleeve/coupling nut/protective cap assembly, STD-1353 in sizes 10, 12, and 16 is longer than the standard MS21921/BACN10-coupling nut in the same sizes and is not interchangeable with the MS21921/BACN10-nuts. See Table 817 for approved Cryolive sleeve, coupling nut and plastic cap combinations.
- (4) Ensure that the CRYOLIVE flareless sleeve cryolive flareless sleeve/coupling nut/protective cap assembly, STD-1353 is installed so that the joint will not be subjected to axial preload during final torquing of the joint.

B. References

Reference	Title
29-09-00-860-802	Hydraulic Reservoirs Depressurization (P/B 201)

C. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

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Reference	Description
COM-1355	Gloves, Insulated Part #: OE-GLOVE Supplier: 30974 Opt Part #: EO-GLOVE-LINER- (S-M-L) Supplier: 30974
COM-1356	Work Box, Insulated Part #: WB910825-01 Supplier: 30974
STD-203	Container - Oil Resistant, 1 U.S.-Gal (3.8 l)
STD-1353	Assembly - Cryolive, Flareless Sleeve/Coupling Nut/Protective Cap
STD-1354	Tongs

D. Consumable Materials

Reference	Description	Specification
B00184	Solvent - Presealing, Cleaning Solvent	BMS11-7
G00262	Nitrogen - Liquid	A-A-59503 Type II, MIL-PRF-27401 Type II

E. Procedure

SUBTASK 20-10-51-040-001

- (1) Remove pressure from the system where you will do repairs. Do this task: Hydraulic Reservoirs Depressurization, TASK 29-09-00-860-802.
 - (a) Allow the hydraulic fluid to drain in to a suitable container (example, 1 U.S.-gal (3.81 l) oil resistant container, STD-203).

SUBTASK 20-10-51-800-006

- (2) Make sure that the tube end where you will install the cryolive flareless sleeve/coupling nut/protective cap assembly, STD-1353 is round, smooth and free of scratches and burrs.

SUBTASK 20-10-51-110-001



DO NOT GET SOLVENTS IN YOUR MOUTH, EYES, OR SKIN. DO NOT BREATHE FUMES FROM SOLVENTS. REFER TO PRODUCT MATERIAL SAFETY DATA SHEETS (MSDS AND LOCAL REQUIREMENTS FOR PROPER HANDLING. SOLVENTS ARE HAZARDOUS MATERIALS AND MAY BE FLAMMABLE OR HARMFUL TO THE ENVIRONMENT.

- (3) Use solvent, B00184 or equivalent to clean the tube in the area where you will install the cryolive flareless sleeve/coupling nut/protective cap assembly, STD-1353.

SUBTASK 20-10-51-800-007

- (4) Put on the insulated gloves, COM-1355.

SUBTASK 20-10-51-880-001



USE PROTECTION WHEN YOU USE LIQUID NITROGEN. MAKE SURE THAT THE AREA HAS A GOOD FLOW OF AIR. LIQUID NITROGEN CAN CAUSE INJURIES TO PERSONNEL.



SLOWLY AND CAREFULLY PUT WARM ITEMS IN LIQUID NITROGEN. IF YOU DO NOT USE LIQUID NITROGEN CORRECTLY, IT CAN CAUSE INJURIES TO PERSONNEL.

- (5) Put nitrogen, G00262 into an insulated work box, COM-1356.

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- (6) Remove the cryolive flareless sleeve/coupling nut/protective cap assembly, STD-1353 from the main storage container and put it into the liquid nitrogen.
- (a) Make sure that the assembly is fully covered by the liquid nitrogen.

SUBTASK 20-10-51-510-001

- (7) Move the cryolive flareless sleeve/coupling nut/protective cap assembly, STD-1353 which is in the liquid nitrogen to the repair location.

SUBTASK 20-10-51-420-013

- (8) Install the cryolive flareless sleeve/coupling nut/protective cap assembly, STD-1353:
- (a) Using tongs, STD-1354, remove the cryolive flareless sleeve/coupling nut/protective cap assembly, STD-1353 from the liquid nitrogen and allow the excess liquid nitrogen to run off.



DO NOT LET LIQUID NITROGEN TOUCH YOUR GLOVE OR OTHER CLOTHING. THE LIQUID NITROGEN CAN SOAK THE MATERIAL AND CAUSE INJURY TO YOU.

- (b) Grasp the cryolive flareless sleeve/coupling nut/protective cap assembly, STD-1353 with the gloved hand and immediately slide it onto the tube end until the assembly bottoms on the tube.
- 1) Make sure that the tube end is visible in the slotted end of the protective cap.

SUBTASK 20-10-51-880-002

- (9) Allow the cryolive flareless sleeve/coupling nut/protective cap assembly, STD-1353 to warm and shrink on to the tube.

SUBTASK 20-10-51-540-001

- (10) The tube end must be fully bottomed against the inside end of the cap so that the sleeve is correctly positioned on the tube end. If the tube end is not bottomed against the inside end of the cap, remove the plastic cap and measure the tube "P" dimension as shown in Figure 812.
- (a) If the "P" dimension is larger than the value shown, the installation must be replaced.
- (11) When ready to complete final joining/torquing of the cryolive flareless sleeve/coupling nut/protective cap assembly, STD-1353 to the mating fitting, remove and discard the plastic cap by unscrewing the coupling nut as shown in Figure 817.

———— **END OF TASK** ————

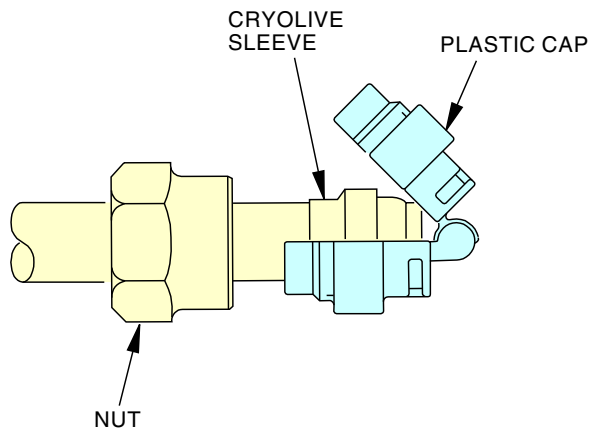
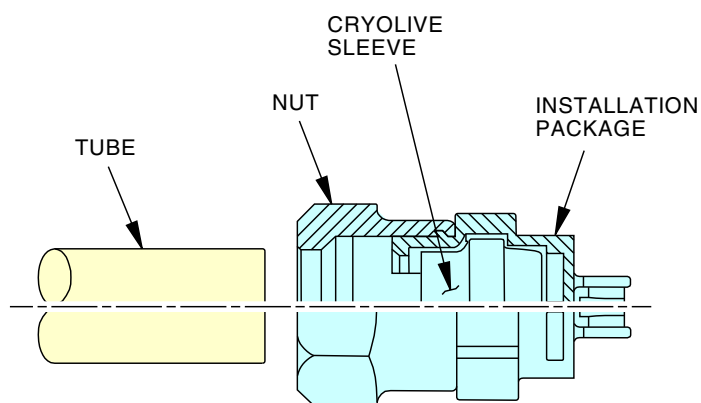
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NOTE:
REMOVAL OF PLASTIC CAP AFTER INSTALLATION.

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CRYOLIVE Flareless Sleeve Assembly
Figure 817/20-10-51-990-827

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TASK 20-10-51-300-803

7. **Swage the BACS13BX Flareless Sleeves with the Internal Elastomer Swage Equipment**
(Figure 815, Figure 818, Figure 819)

A. References

Reference	Title
29-09-00-860-802	Hydraulic Reservoirs Depressurization (P/B 201)

B. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

Reference	Description
COM-1388	Kit, Power Swaging - Stationary Automatic (1/4 - 3/4 Tube Size) Part #: 6520 Supplier: 08199 Opt Part #: 5570 Supplier: 08199
COM-1789	Kit - Hand Swaging, Portable (1/4-1/2 Inch Tube Size) Part #: 5175K-200 Supplier: 08199
COM-1790	Kit - hand Swaging, Portable (5/8 to 1-1/2 Tube Size) Part #: 5720K-200 Supplier: 08199
STD-203	Container - Oil Resistant, 1 U.S.-Gal (3.8 l)

C. Consumable Materials

Reference	Description	Specification
D50174	Anti Scoring Extreme Pressure Lube No. 3	
D50381	Lubricant - Oakdraw DSY 4300	BAC5001-4
G50256	Water, Regular	

D. Procedure

SUBTASK 20-10-51-040-002

- (1) Remove pressure from the system where you will do repairs. Do this task: Hydraulic Reservoirs Depressurization, TASK 29-09-00-860-802.
 - (a) Allow the hydraulic fluid to drain into a suitable container (example, 1 U.S.-gal (3.81 l) oil resistant container, STD-203).

SUBTASK 20-10-51-940-003

 WARNING	POINT THE TUBE AWAY FROM PERSONS AND EQUIPMENT WHEN YOU SWAGE. DRAWBOLTS CAN BREAK AND COME QUICKLY OUT OF THE TUBE. THE DRAWBOLTS CAN HIT PERSONS OR EQUIPMENT AND CAUSE INJURY OR DAMAGE.

- (2) Get the necessary tools as shown in the instruction manual supplied with portable (1/4-1/2 inch tube size) hand swaging kit, COM-1789, swaging kit, COM-1388, or portable (5/8 to 1-1/2 tube size) hand swaging kit, COM-1790.

SUBTASK 20-10-51-640-002

- (3) Apply a light layer of anti-scoring lubricant, D50174, Oakdraw DSY 4300 lubricant, D50381, or water, G50256, to the outer surfaces of the bushings and expanders of the drawbar assemblies.

NOTE: Do not let the lubricant go into the grooves of the sleeve. Lubricant in the grooves will prevent correct swaging.

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(a) Make sure the tube and sleeve are clean and dry.

SUBTASK 20-10-51-340-001

(4) Apply the necessary swage pressure, shown in Table 818, and hold the pressure for a minimum of two seconds.

Table 818/20-10-51-993-829 Swage Pressures

TUBE SIZE	SWAGER MODEL NO.	21-6-9 CRES PER BMS7-185		6061T AL PER WW-T-700/6 OR MIL-T-7081 OR AMS4083		6061-T4 AL PER MIL-T-7081 OR AMS4081		304 AND 321 ANNEALED CRES PER MIL-T-8504 AND MIL-T-8808		304-1/8 HARD CRES PER MIL-T-6845	
		Wall (in.)	Swage Pres-sure (PSI)* ^[1]	Wall (in.)	Swage Pres-sure (PSI) ±5%	Wall (in.)	Swage Pres-sure (PSI) ±5%	Wall (in.)	Swage Pres-sure (PSI)* ^[1]	Wall (in.)	Swage Pres-sure (PSI)* ^[1]
			BACS13BX		BACS13BX		BACS13BX		BACS13BX		BACS13BX
04	5175 (portable)	0.016	475	N/A	N/A	N/A	N/A	N/A	N/A	0.020	475* ^[2]
05	5175 (portable)	0.020	1000	0.035	450* ^[3]	N/A	N/A	N/A	N/A	N/A	N/A
06	5175 (portable)	0.020	1150	0.028 0.035	500* ^[3]	N/A	N/A	0.035	940* ^[3]	0.035	1150* ^[2]
08	5175 (portable)	0.026	2000	0.035	950* ^[3]	N/A	N/A	N/A	N/A	0.35	2000* ^[2]
10	5570 (stationary)	0.033	1000	0.020 0.028 0.035	280* ^[3] 320* ^[3] 355* ^[3]	0.035	250	N/A	N/A	0.049	1000
10	5720 (portable)	0.033	850	0.035	375	N/A	N/A	0.035 0.049	425	0.035 0.049	850* ^[2]
12	5570 (stationary)	0.039	900	0.035	400* ^[3]	N/A	N/A	N/A	N/A	N/A	N/A
12	5720 (portable)	0.039	1600	0.035	600	N/A	N/A	N/A	N/A	0.035 0.049 0.058	1300 1350 1600
16	5720 (portable)	0.052	3050	0.035	950* ^[3]	0.035	750* ^[3]	N/A	N/A	0.035 0.065	1650* ^[3] 3050
20	5570 (stationary) 5720 (portable)	N/A	N/A	0.049	N/A	0.035	700* ^[3]	0.035	1650* ^[3] * ^[4]	N/A	N/A
24	5720 (portable)	N/A	N/A	0.049	N/A	N/A	N/A	0.035 0.049	2550* ^[3] * ^[4] 2280* ^[3] * ^[5]	N/A	N/A

*[1] Minimum swage pressure - if you must swage again, increase in 5% increments.

*[2] Swage pressures necessary to install BACS13BX flareless sleeves on tube materials with the Harrison portable and stationary swager.

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- *[3] Not qualified for 3000 psi (20,684 kPa). Use for lower pressures only.
- *[4] Swage pressure for BACS13BX sleeves with standard or shortened "P" dimensions.
- *[5] Swage pressure for BACS13BX sleeves with shortened "P" dimensions only.

SUBTASK 20-10-51-220-009

- (5) Do a check of the groove depth with a Tiplar or Mueller bore gage (Figure 819).

SUBTASK 20-10-51-220-010

- (6) Do a check on the external dimensions of the swaged fitting (Figure 818).

SUBTASK 20-10-51-220-011

- (7) Make sure the tooling die marks on the outside diameter of the tube do not have a height or depth larger than 10% of the tube wall specified thickness.

NOTE: Other permitted defects include marks or scratches on the outer tube which are less than 0.20 in. (5.08 mm) in length and 0.002 in. (0.051 mm) in depth.

SUBTASK 20-10-51-210-004

- (8) Make sure the seal areas of the sleeves and unions are not scratched or damaged during fabrication.

SUBTASK 20-10-51-210-005

- (9) Make sure each seal area keeps the usual finish specifications.

SUBTASK 20-10-51-220-012

- (10) Make sure the tool and die marks on the external skirt and shoulder areas of the sleeves and unions are not more than 0.002 in. (0.05 mm) in height.

SUBTASK 20-10-51-220-013

- (11) Make sure the tool and die marks on the external skirt and shoulder areas of the sleeves and unions do not touch the nut.

———— **END OF TASK** ————

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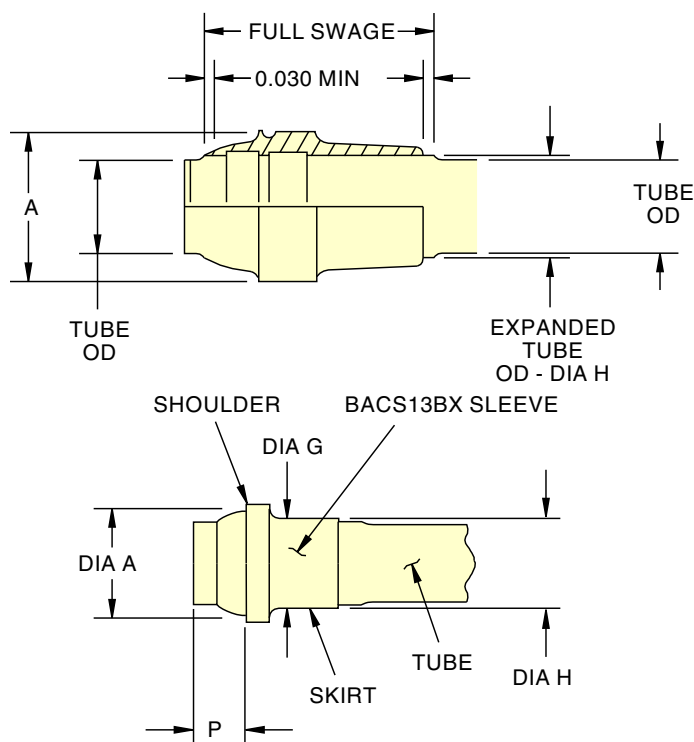
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DIMENSION	SIZE								
	04	05	06	08	10	12	16	20	
P ±0.010	0.214	0.230	0.230	0.285	0.330	0.330	0.392	0.395 1 0.355 2	0.465 1 0.350 2
A max	0.374	0.437	0.493	0.673	0.789	0.964	1.214	1.474	1.723
G max	0.298	0.364	0.423	0.550	0.686	0.822	1.070	1.323	1.573
H max	0.260	0.322	0.385	0.511	0.636	0.761	1.011	1.262	1.517

NOTE:

ALL DIMENSIONS ARE IN INCHES.

**DIMENSIONS OF FLARELESS TUBE ENDS AND
BACS13BX SLEEVES AFTER ELASTOMERIC SWAGING**

- 1 ALL EXCEPT SHORT FLARELESS
- 2 SHORT FLARELESS

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**BACS13BX Flareless Sleeve Dimensions After Elastomeric Swaging
Figure 818/20-10-51-990-828**

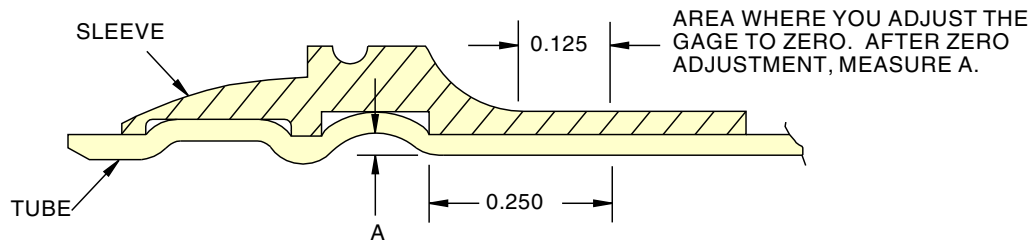
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BACS13BX (TWO GROOVES)

TUBE SIZE	DEPTH 2A - INCHES	
	MINIMUM	MAXIMUM
04	0.020	0.032
05	0.020	0.032
06	0.020	0.032
08	0.020	0.032
10	0.022	0.034
12	0.026	0.038
16	0.028	0.040
20	0.026	0.042
24	0.026	0.042

**BACS13BX SWAGE
GROOVE DEPTH LIMITS**

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**Groove Depth Measurement for BACS13BX Sleeves
Figure 819/20-10-51-990-829**

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TASK 20-10-51-300-804

8. **BACS13BX Flareless Sleeve Swaging on Stainless Steel or Titanium Hydraulic Tubing**
(Figure 816)

A. References

Reference	Title
29-09-00-860-802	Hydraulic Reservoirs Depressurization (P/B 201)

B. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

Reference	Description
COM-1794	Swager - Portable Tube, Hand Swaging, 1/4 - 1" Dia. Stainless Steel or Titanium Tubing Part #: 5175K-200 Supplier: 08199 Part #: 5720K-200 Supplier: 08199 Part #: 6520 Supplier: 08199 Part #: 6633K-01 Supplier: 08199 Part #: 6777 Supplier: 08199 Opt Part #: 5570 Supplier: 08199
STD-203	Container - Oil Resistant, 1 U.S.-Gal (3.8 l)

C. Procedure

SUBTASK 20-10-51-040-003

- (1) Remove pressure from the system where you will do repairs, do this task: Hydraulic Reservoirs Depressurization, TASK 29-09-00-860-802.

- (a) Allow the hydraulic fluid to drain into a suitable container (example, 1 U.S.-gal (3.81 l) oil resistant container, STD-203).

SUBTASK 20-10-51-940-004

- (2) Get the necessary tools as told in the operating instruction manual supplied with the tube swager, COM-1794.

SUBTASK 20-10-51-350-002

- (3) Apply the necessary torque, shown in Figure 816, to the expander mandrel.

SUBTASK 20-10-51-220-014

- (4) After you swage, make sure the BACS13BX sleeve and tube agree with the specifications of Figure 816.

- (a) Do not trim the tube after you roller swage.
 - (b) If it is necessary, remove the burrs with an approved deburring tool.

SUBTASK 20-10-51-210-006

- (5) Make sure the seal areas of the sleeves are not scratched or damaged during fabrication.

SUBTASK 20-10-51-210-007

- (6) Make sure each seal area keeps the 63 RHR (no annular tool marks) finish specifications of its standard.

SUBTASK 20-10-51-220-015

- (7) Make sure the die marks on the external skirt and shoulder areas of the sleeves are not more than 0.002 in. (0.051 mm) in height.

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SUBTASK 20-10-51-220-016

- (8) Make sure the die marks on the external skirt and shoulder areas of the sleeves do not touch the nut.

SUBTASK 20-10-51-210-008

- (9) Make sure the tube inner surfaces at the swage area do not have scratches or marks caused by defective rollers.

————— END OF TASK —————

TASK 20-10-51-300-805

9. BACS13AP Flareless Sleeve Preset

(Figure 820, Figure 821, Figure 822)

A. General

- (1) It is recommended to pressure preset the sleeves, but you can also preset by hand. If you must preset by hand, it is recommended you preset some samples first. Then you can preset the section to repair. On samples, cut away the sleeve to make sure the ring cut on the tube makes a circle around the tube circumference and has a depth of 0.002 in. (0.051 mm).

B. References

Reference	Title
29-09-00-860-802	Hydraulic Reservoirs Depressurization (P/B 201)

C. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

Reference	Description
COM-1785	Rivet Puller - Lockbolt Part #: G85D-S Supplier: 11815 Opt Part #: G85D Supplier: 05693
SPL-1589	Kit - Preset Tube Fitting, "Sleeve Set", (Not for Titanium Tubing) (Set of 25 Ea. Dies, Mandrels, & Clamps) Part #: ST878D Supplier: 81205 Part #: ST879A-1 Supplier: 81205
SPL-1590	Holder - Tube Fitting, Preset Part #: ST879AF-1 Supplier: 81205
STD-203	Container - Oil Resistant, 1 U.S.-Gal (3.8 l)

D. Procedure

SUBTASK 20-10-51-040-004

- (1) Remove pressure from the system where you will do repairs. Do this task: Hydraulic Reservoirs Depressurization, TASK 29-09-00-860-802.
 - (a) Allow the hydraulic fluid to drain into a suitable container (example, 1 U.S.-gal (3.81 l) oil resistant container, STD-203).

SUBTASK 20-10-51-350-003

- (2) Do these steps to do the pressure preset with the Cherry lockbolt rivet puller, COM-1785:
 - (a) Attach the thrust sleeve and die holder to the Cherry lockbolt rivet puller, COM-1785.
 - (b) Install the mandrel and the preset die in the Cherry (Figure 820, Table 819).

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Table 819/20-10-51-993-830 Preset Pressures for Cherry G-85 Lockbolt Gun with ST878D Presetting Tool Assembly

TUBE SIZE	WALL THICKNESS (INCH)	TOOL NO.	RECOMMENDED AIR PRESSURE (PSI)	
			ALUMINUM	STEEL
			6061-T6	AISI 304-1/8 HARD
3/16	0.020-0.035	ST878D-3-020 ST878D-3-035	22.5	30.0
1/4	0.020-0.035	ST878D-4-020 ST878D-4-035	27.5	40.0
5/16	0.020-0.035	ST878D-5-020 ST878D-5-035	30.0	40.0
3/8	0.020-0.035	ST878D-6-020 ST878D-6-035	30.0	52.5
1/2	0.028-0.035	ST878D-8-028 ST878D-8-035	42.5	75.0
5/8	0.028-0.083	ST878D-10-028 ST878D-10-083	50.0	80.0
3/4	0.020-0.049	ST878D-12-020 ST878D-12-049	52.5	85.0

- (c) Connect the air pressure line and use the correct pressure (Figure 820, Table 819).
- (d) Do several cycles of the Cherry lockbolt rivet puller, COM-1785 and make sure the pressure is set correctly.
- (e) Assemble the split-clamp die, the clamp nut, and the thrust sleeve.
- (f) Put the assembly into the die holder.
- (g) Put the B-nut on the tube and make the tube end touch the bottom of the die holder.
- (h) Start the Cherry lockbolt rivet puller, COM-1785.
- (i) Hold the tube in its position while the die installs the sleeve on the tube.
- (j) Maintain the pressure while you preset the sleeve on the tube.
- (k) Unclamp the nut.
- (l) Remove the tube and die from the holder.
- (m) Open the die to show the preset sleeve.

SUBTASK 20-10-51-350-004

- (3) To preset the sleeve by hand, do these steps:
 - (a) Use the correct mandrel for the preset tube sleeve set fitting kit, SPL-1589 and tube fitting holder, SPL-1590 (Figure 821).
 - (b) Lubricate the threads, sleeve shoulder, and conical seal area of the fitting.
NOTE: Do not lubricate the tube.
 - (c) Assemble the sleeve on the tube.
 - (d) Insert the tube into the preset tube sleeve set fitting kit, SPL-1589 and tube fitting holder, SPL-1590 union.
 - (e) Tighten the nut as shown in Table 820 and Table 821.

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- (f) If the preset tube sleeve set fitting kit, SPL-1589 and tube fitting holder, SPL-1590 is not available, you can preset the sleeves with a carbon steel union and nut as shown in Table 820 and Table 821.

Table 820/20-10-51-993-831 Displacement Turns and Torque Values for Hand Preset of Flareless Sleeves - Steel Tubing

TUBE OUTER DIAMETER ^{*[1]}		1/4	5/16	3/8	1/2	5/8	3/4	1	1-1/4
Wall Thickness (in.)	304	0.020	0.020	0.028	0.035	0.049	0.058	N/A	N/A
	21-6-9	0.016	0.020	0.020	0.026	0.033	0.039	N/A	N/A
Procedure A (Displacement, Turns) ^{*[2]}		1-1/6	1-1/6	1-1/6	1-1/6	1-1/6	1-1/6	N/A	N/A
Procedure B Torque ^{*[3]} (in-lb)	304	145	200	290	545	780	900	N/A	N/A
	21-6-9	145	200	290	545	780	1200	N/A	N/A

*[1] Use an internal mandrel preset tool on tubes with thinner walls (refer to ST879A). When in doubt, make a test preset to make sure the ring cut minimum depth is 0.002 in. (0.051 mm).

*[2] Measure displacement from the point where the fitting, sleeve, and nut are firmly hand-tightened, and wrench is necessary to further tighten.

*[3] Apply torque, loosen, and apply indicated torque three times.

Table 821/20-10-51-993-832 Displacement Turns and Torque Values for Hand Preset of Flareless Sleeves - Aluminum Tubing

TUBE OUTER DIAMETER ^{*[1]}		1/4	5/16	3/8	1/2	5/8	3/4	1	1-1/4
Wall Thickness (in.)	6061-T6	0.035	0.035	0.035	0.035	0.035	0.035	N/A	N/A
Procedure A ^{*[2]} (Displacement, Turns)		1-1/6	1-1/6	1-1/6	1	1	1	N/A	N/A
Procedure B Torque ^{*[3]} (in-lb)	6061-T6	110	140	170	280	360	450	N/A	N/A

*[1] Use an internal mandrel preset tool on tubes with inner walls (refer to ST879A). When in doubt, make a test preset to make sure the ring cut minimum depth is 0.002 in. (0.051 mm).

*[2] Measure displacement from the point where the fitting, sleeve, and nut are firmly hand-tightened, and a wrench is necessary to further tighten.

*[3] Apply torque, loosen, and apply indicated torque three times.

SUBTASK 20-10-51-220-017

- (4) After you preset, make sure the BACS13AP sleeve and tube joint have the properties that follow (Figure 822):

- (a) Corrosion resistant steel tubing (MIL-T-6845):

- 1) Make sure the sleeves have a maximum of 0.005 in. (0.13 mm) longitudinal end play.
- 2) Make sure the sleeves do not turn freely on the tube under finger pressure (without the use of force).

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- (b) Annealed corrosion resistant tubing (MIL-T-8504 and MIL-T-8808) and aluminum alloy tubing (MIL-T-7081 or WW-T-700/6):

NOTE: Sleeves can have 0.015 in. (0.38 mm) maximum longitudinal end play and turn on the tube under finger pressure.

- (c) These conditions apply to all tubing materials:

- 1) Make sure the tube inner diameter does not decrease more than 0.005 in. (0.13 mm) (Figure 822).
- 2) Make sure the sealing surface of the sleeve bow is free of scratches, marks, or other defects.
- 3) The tube end is permitted to flare if the flare diameter does not prevent entrance of the MS21902 or MS21924 union into the MS flareless fitting end.

———— **END OF TASK** ————

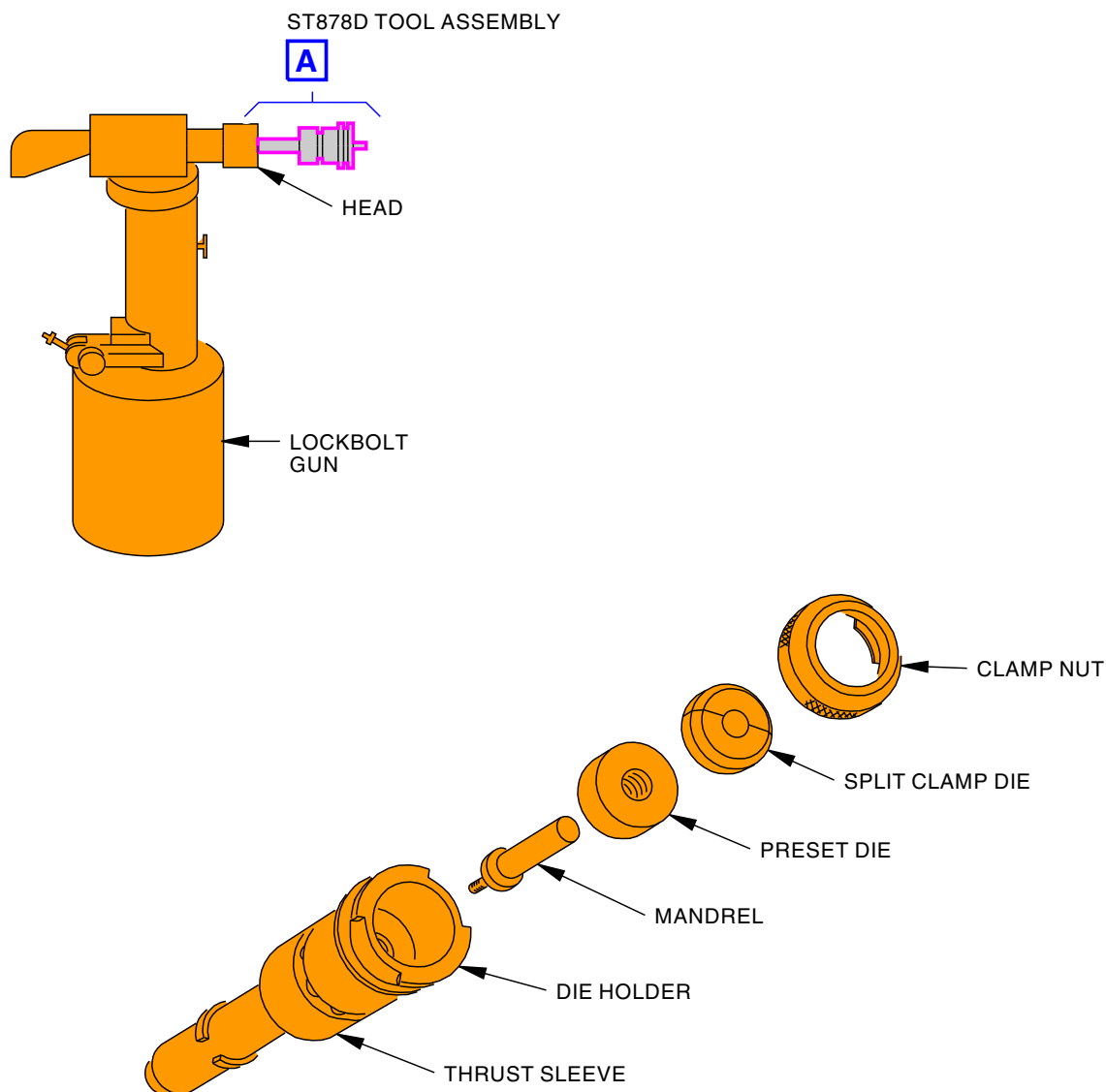
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ST878D TOOL ASSEMBLY

A

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Preset Pressures (PSI) for the Cherry G-85 Lockbolt Gun with ST878D Presetting Tool Assembly
(BACS13AP Sleeves)
Figure 820/20-10-51-990-830

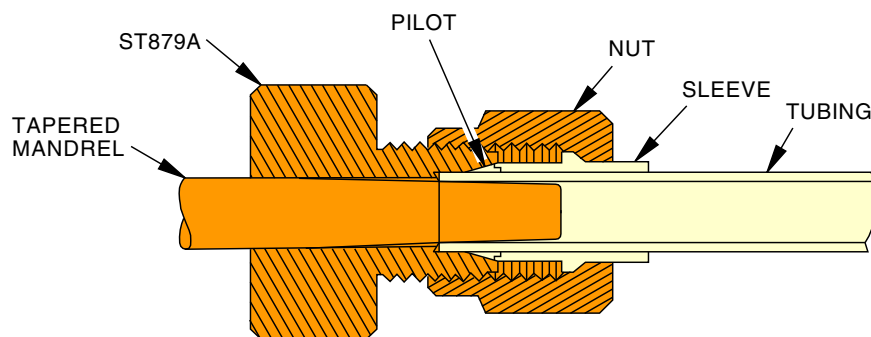
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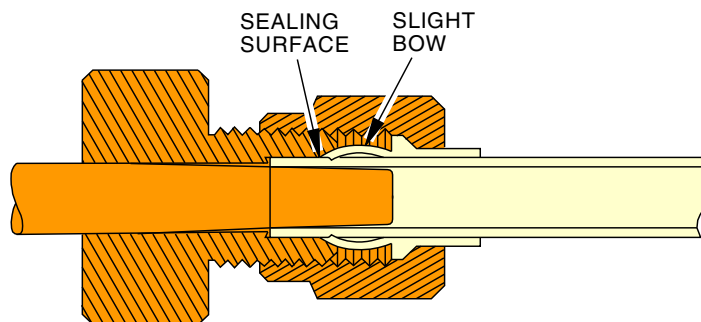
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BEFORE PRESET BY HAND



AFTER PRESET BY HAND

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Preset by Hand with Preset Tool ST879A
Figure 821/20-10-51-990-831

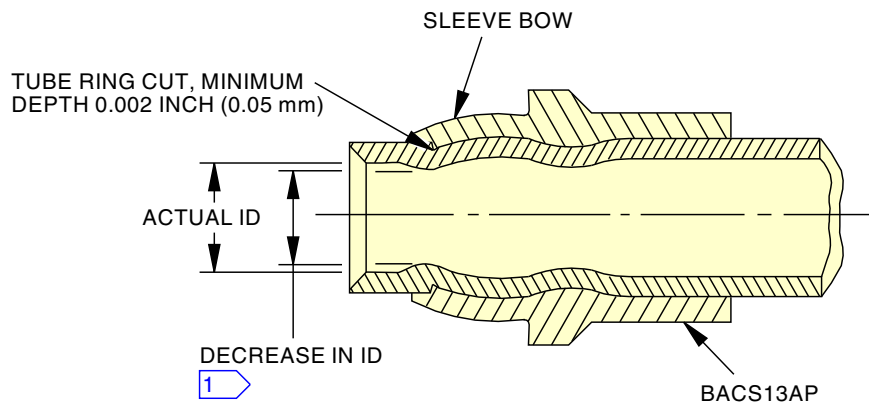
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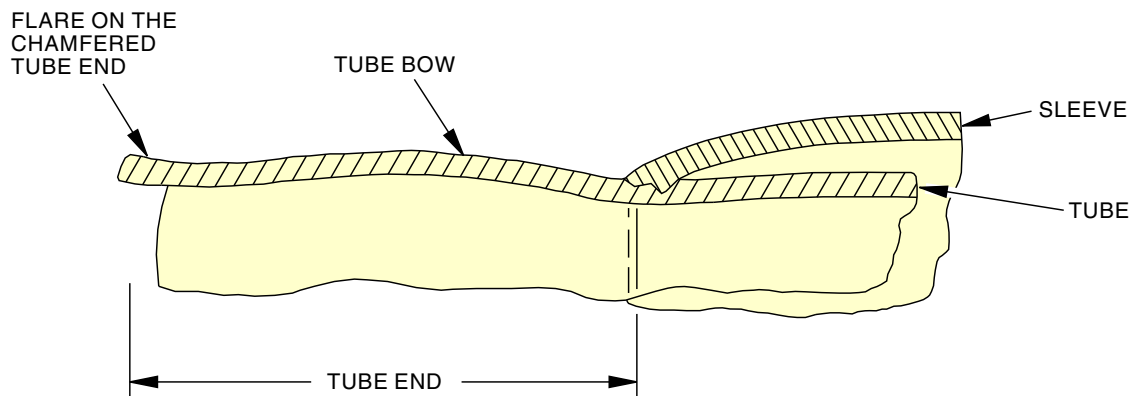
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ASSEMBLED AND PRESET SLEEVE



TUBE END DEFORMATION

1 MAKE SURE THE ID DOES NOT DECREASE MORE THAN 0.005 INCH (0.13 mm) AFTER PRESET OR 0.015 INCH (0.38 mm) AFTER YOU TIGHTEN MANY TIMES.

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**Properties of Preset BACS13AP Flareless Sleeve/Tube End
Figure 822/20-10-51-990-832**

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TASK 20-10-51-400-804

10. **BACC42W H-Coupling Installation**

(Figure 823)

A. General



WARNING

DO NOT USE THIS FITTING ON OXYGEN LINES OR ON FLUID LINES IN THE FIRE ZONES OF THE ENGINES. DAMAGE TO EQUIPMENT AND INJURY TO PERSONNEL CAN OCCUR.

- (1) The BACC42W H-coupling has a union, coupling, slide, and nut. You can use the H-coupling on fuel and hydraulic high pressure (3000 psi (20,684 kPa)) lines of Ti-3AL-2.5V, CRES 21-6-9, and CRES 304 1/8 hard tubing. This repair is also approved for line repair of CRES 304 annealed and 6061-T6 aluminum lines in 3000 psi (20,684 kPa) or lower pressure applications. You can use this repair on tubing that is installed and in use.
- (2) You can repair defects that have a maximum width of 0.375 in. (9.525 mm). You must make splices on larger defects. The minimum workable splice section with two H-couplings and a length of tube is 4.5 in. (114.3 mm) (Figure 810).

B. References

Reference	Title
29-09-00-860-802	Hydraulic Reservoirs Depressurization (P/B 201)

C. Tools/Equipment

Reference	Description
STD-203	Container - Oil Resistant, 1 U.S.-Gal (3.8 l)
STD-1357	Assembly - Tube Coupling

D. Consumable Materials

Reference	Description	Specification
B00184	Solvent - Presealing, Cleaning Solvent	BMS11-7

E. Procedure

SUBTASK 20-10-51-860-002

- (1) Remove pressure from the system where you will do repairs. Do this task: Hydraulic Reservoirs Depressurization, TASK 29-09-00-860-802.
 - (a) Allow the hydraulic fluid to drain into a suitable container (example, 1 U.S.-gal (3.81 l) oil resistant container, STD-203).

SUBTASK 20-10-51-110-002



WARNING

DO NOT GET SOLVENTS IN YOUR MOUTH, EYES, OR SKIN. DO NOT BREATHE FUMES FROM SOLVENTS. REFER TO PRODUCT MATERIAL SAFETY DATA SHEETS (MSDS AND LOCAL REQUIREMENTS FOR PROPER HANDLING. SOLVENTS ARE HAZARDOUS MATERIALS AND MAY BE FLAMMABLE OR HARMFUL TO THE ENVIRONMENT.

- (2) Use solvent, B00184 or equivalent to clean the tube in the area where you will install the H-coupling tube coupling assembly, STD-1357.

NOTE: The number after the W in the part number gives the size of the coupling in sixteenths. For example, BACC42W56 fits 3/8-inch tube size. The BACC42W is superseded by BACC42W-T which is used on Ti-3AL-2.5V and all other hydraulic tubing. You can use BACC42W on all hydraulic tubes except Ti-3AL-2.5V.

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SUBTASK 20-10-51-350-005

- (3) Cut the tube.

SUBTASK 20-10-51-110-003

- (4) Chamfer and remove the burrs from the inside diameter and outside diameter edges.

SUBTASK 20-10-51-110-004



DO NOT GET SOLVENTS IN YOUR MOUTH, EYES, OR SKIN. DO NOT BREATHE FUMES FROM SOLVENTS. REFER TO PRODUCT MATERIAL SAFETY DATA SHEETS (MSDS AND LOCAL REQUIREMENTS FOR PROPER HANDLING. SOLVENTS ARE HAZARDOUS MATERIALS AND MAY BE FLAMMABLE OR HARMFUL TO THE ENVIRONMENT.

- (5) Clean the edges with solvent, B00184 or an equivalent cleaning solvent.

SUBTASK 20-10-51-940-005

- (6) Install tape on the nut side of the clearance with a minimum of 0.56 in. (14.22 mm) from the tube end and a maximum of 0.675 in. (17.145 mm) from the center of the clearance (Figure 823).

SUBTASK 20-10-51-940-006

- (7) Use the same measurements to make a mark (index line) on the coupling side of the tube.

SUBTASK 20-10-51-940-007

- (8) Find and make a mark (marking dots) on the nut and coupling side of the tube (Figure 823).

NOTE: These marks will be used for the last inspection check (dimension "C").

SUBTASK 20-10-51-420-014

- (9) Install the tube coupling assembly, STD-1357 over the coupling side of the tube.

SUBTASK 20-10-51-210-009

- (10) Make sure the large radius and the large diameter end of the sleeve are toward the center of the union.

SUBTASK 20-10-51-420-015

- (11) Install the nut and sleeve over the tape on the nut side of the tube.

SUBTASK 20-10-51-210-010

- (12) Make sure the sleeve large bore is toward the clearance.

SUBTASK 20-10-51-820-002

- (13) Align the tubes and move the union until it touches the tape on the nut side on the tube.

SUBTASK 20-10-51-210-011

- (14) Make sure the union meets or cover the index line on the coupling side of the tube.

SUBTASK 20-10-51-940-008

- (15) Install tape on the coupling side of the tube, with the tape edge even with the end of the union.

SUBTASK 20-10-51-420-016

- (16) Push the sleeve and coupling body on the ends of the union.

NOTE: Make sure the tape does not move and the coupling body does not turn.

SUBTASK 20-10-51-420-017

- (17) Engage the threads of the nut with the coupling body and tighten the nut hand tight.

SUBTASK 20-10-51-420-018

- (18) Hold the coupling body with a wrench and tighten the coupling assembly nut to the stop.

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SUBTASK 20-10-51-210-012

- (19) Examine the completed repair to make sure you can see the two marking dots (Figure 823).

NOTE: If you cannot see the two dots, this shows that the sleeve and coupling are not fully seated against the center land of the union.

SUBTASK 20-10-51-210-013

- (20) Make sure dimension "C" did not increase.

SUBTASK 20-10-51-200-005

- (21) Do an inspection as follows:

- (a) Remove the nut.
- (b) Make sure the slide and coupling are no more than 0.015 in. (0.38 mm) from the union shoulder.
- (c) Make sure the union touches the tape.
- (d) If the clearance between the slide or coupling and the union is more than 0.015 in. (0.38 mm), install the nut and tighten it until you get the necessary clearance.
- (e) Install the nut again and tighten the nut.
 - 1) If the union does not touch the tape, remove the coupling and a sufficient tube length.
 - a) Install a new repair section.

———— **END OF TASK** ————

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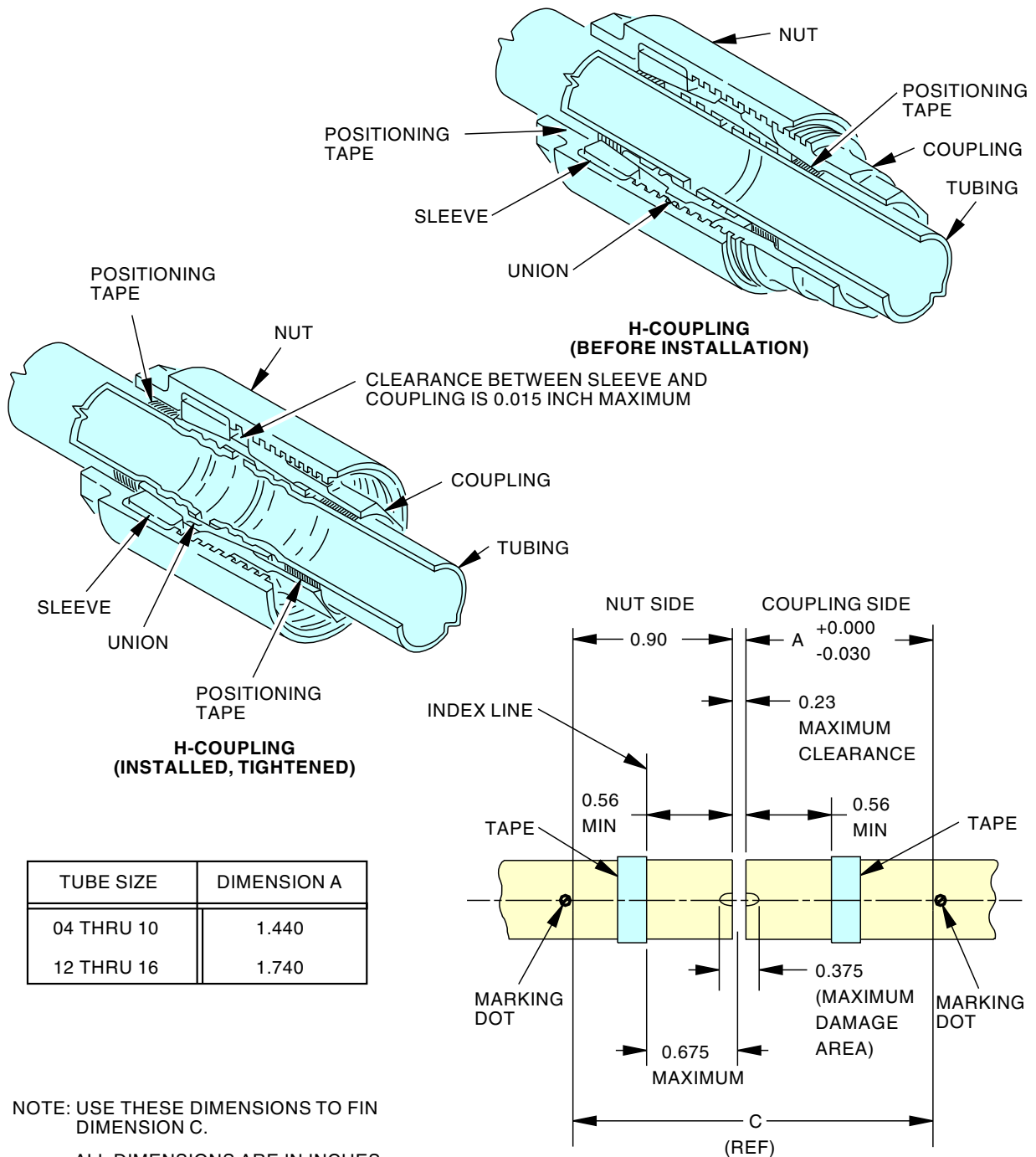
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H-Coupling Installation
Figure 823/20-10-51-990-833

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TASK 20-10-51-400-805

11. 3P02111/3PHS111 Cryofit Coupling Installation

(Figure 824)

A. General

 WARNING	DO NOT USE THIS FITTING ON OXYGEN LINES OR ON FLUID LINES IN THE FIRE ZONES OF THE ENGINES. DAMAGE TO EQUIPMENT AND INJURY TO PERSONNEL CAN OCCUR.

- (1) The Cryofit coupling is a fitting which you can use to repair Ti-3AL-2.5V tubing as shown in Figure 806. To install the fitting in a straight section, shrink fit it in it's position.

B. References

Reference	Title
29-09-00-860-802	Hydraulic Reservoirs Depressurization (P/B 201)

C. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt.", which stands for Optional.

Reference	Description
COM-1355	Gloves, Insulated Part #: OE-GLOVE Supplier: 30974 Opt Part #: EO-GLOVE-LINER- (S-M-L) Supplier: 30974
COM-1356	Work Box, Insulated Part #: WB910825-01 Supplier: 30974
STD-203	Container - Oil Resistant, 1 U.S.-Gal (3.8 l)
STD-1354	Tongs
STD-4058	Kit - Cryofit Repair, Model FRK3P02111-001

D. Consumable Materials

Reference	Description	Specification
A50138	Compound - Threadlocker - Wicking Action (Loctite 290)	MIL-S-46163 Type III
B00184	Solvent - Presealing, Cleaning Solvent	BMS11-7
G00262	Nitrogen - Liquid	A-A-59503 Type II, MIL-PRF-27401 Type II
G00270	Tape - Scotch Flatback Masking 250	ASTM D6123 (Supersedes A-A-883)

E. Procedure

SUBTASK 20-10-51-860-003

- (1) Remove pressure from the system where you will do repairs. Do this task: Hydraulic Reservoirs Depressurization, TASK 29-09-00-860-802.
- (a) Allow the hydraulic fluid to drain into a suitable container (example, 1 U.S.-gal (3.81 l) oil resistant container, STD-203).

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SUBTASK 20-10-51-110-005



DO NOT GET SOLVENTS IN YOUR MOUTH, EYES, OR SKIN. DO NOT BREATHE FUMES FROM SOLVENTS. REFER TO PRODUCT MATERIAL SAFETY DATA SHEETS (MSDS AND LOCAL REQUIREMENTS FOR PROPER HANDLING. SOLVENTS ARE HAZARDOUS MATERIALS AND MAY BE FLAMMABLE OR HARMFUL TO THE ENVIRONMENT.

- (2) Use solvent, B00184 or equivalent to clean the tube in the area where you will install the Cryofit coupling cryofit repair kit, STD-4058.

SUBTASK 20-10-51-420-019

- (3) Use Scotch Flatback Masking Tape 250, G00270 to make a mark on the tube to make sure you put the Cryofit coupling over the center of the tube repair.

SUBTASK 20-10-51-320-001

- (4) Cut the tube.

SUBTASK 20-10-51-350-006

- (5) Chamfer and remove burrs from the inside diameter and outside diameter edges.

SUBTASK 20-10-51-110-006

- (6) Clean the edges with solvent, B00184 or an equivalent solvent.

SUBTASK 20-10-51-110-007

- (7) Apply a thin layer (one to two drops) of Compound, A50138 around the tube circumference in the area under the serrations.

NOTE: Be careful not to let the Loctite into the tube.

SUBTASK 20-10-51-500-001

- (8) Put on insulated gloves, COM-1355.

SUBTASK 20-10-51-110-008



USE PROTECTION WHEN YOU USE LIQUID NITROGEN. MAKE SURE THAT THE AREA HAS A GOOD FLOW OF AIR. LIQUID NITROGEN CAN CAUSE INJURIES TO PERSONNEL.

- (9) Put nitrogen, G00262 into a small, insulated work box, COM-1356.

SUBTASK 20-10-51-110-009



SLOWLY AND CAREFULLY PUT WARM ITEMS IN LIQUID NITROGEN. IF YOU DO NOT USE LIQUID NITROGEN CORRECTLY, IT CAN CAUSE INJURIES TO PERSONNEL.

- (10) Remove the Cryofit coupling from the main storage container and put it into the small container of liquid nitrogen.
 - (a) Make sure the fitting is fully covered by nitrogen, G00262.

SUBTASK 20-10-51-940-009

- (11) Move the Cryofit coupling in the nitrogen, G00262 (-320°F (-196°C)) to the repair location.

SUBTASK 20-10-51-420-020

- (12) Slip the coupling (from the installation kit) over the ends to ensure that the tubes are round and free of burrs. The test coupling should slide freely.

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SUBTASK 20-10-51-480-001

- (13) Position the test coupling so that both tubes are visible in the coupling window.
- (a) For 3PO2111 couplings, make sure that a gap of less than 0.120 in. (3.05 mm) exists between the tube ends.
 - (b) For 3PHS111 couplings, make sure that the gap is less than 0.300 in. (7.62 mm).

SUBTASK 20-10-51-080-001

- (14) Remove the test coupling and place the marking gauge over one of the tube ends.
- (a) Using a marking pen, color in the rectangular slot in the gauge to provide an installation mark on the tube.
 - (b) Follow the same procedure to mark the remaining tube end.

SUBTASK 20-10-51-480-002

- (15) Place an installation stop (O-ring) or SNAP-ON coupling in the middle of the mark on one of the tube ends.

SUBTASK 20-10-51-480-003

- (16) Check the location by positioning the test coupling so that it is butted against the stop.
- (a) Make sure that both tube ends are visible in the window and the test coupling covers approximately half of the installation mark on each tube.

SUBTASK 20-10-51-820-003

- (17) Adjust the tubes and installation stop as necessary.
- (18) Remove the test coupling.

SUBTASK 20-10-51-420-021

- (19) Make sure that the tube ends within half the coupling length of the end are free of scratches.

SUBTASK 20-10-51-840-001

- (20) If a fitting must be installed over a tube end containing a scratch, apply a thin layer (one to two drops) of Compound, A50138 around the tube circumference in the area under the serration.

NOTE: Loctite is not required for tube ends without scratches.

- (a) Make sure you do not let the Loctite into the tube.

SUBTASK 20-10-51-840-002

- (21) For a 3PO2111, remove a Cryofit coupling from the liquid nitrogen and immediately place it into a pre-chilled, extended time tool.

- (22) Close the tool and immediately return the coupling/tool to the liquid nitrogen.

NOTE: This step is omitted for 3PHS111 couplings since they are preassembled in the tool and furnished in Lexan Plastic Packaging from the manufacturer.

SUBTASK 20-10-51-840-003

- (23) Place the cooled tube chiller over the tubes to be joined.

NOTE: This step may be omitted. However, placing Cryofit coupling in contact with a tube which has not been pre-chilled with Liquid nitrogen may initiate premature warming and shrinkage of the coupling.

- (a) Remove the chiller after 20 to 30 seconds.

SUBTASK 20-10-51-420-022

- (24) Install the coupling and following the steps below in rapid sequence: (Figure 824)
- (a) Remove the chiller.

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- (b) Using the cooled tongs, STD-1354, remove the Cryofit installation package from the Liquid nitrogen and grasp the package between thumb and forefinger.
- (c) Deflect the tube without the installation stop to allow the coupling to be slipped over the tube end.
- (d) Slip the coupling on the tube, realign the tubes and slide the coupling against the installation stop.
- (e) Make sure that the Cryofit coupling is against the installation stop and that the fitting is in correct position relative to the installation marks.
- (f) Allow the coupling to warm and shrink on to the tube. Remove the Cryofit installation package and the installation stop.

SUBTASK 20-10-51-200-006

- (25) Verify that both ends of the coupling lie within the installation marks on both tubes.
- (a) If one or both ends of the fitting do not cover a portion of the installation mark, replace the fitting installation.

NOTE: This is because the installation is incorrect.

———— **END OF TASK** ————

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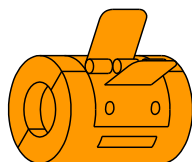
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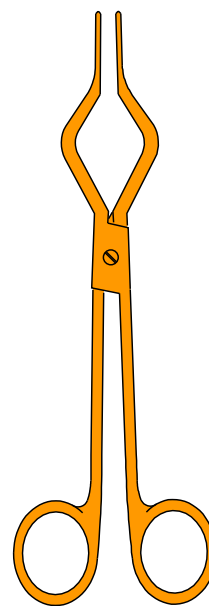
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**SNAP-ON
INSTALLATION STOP**



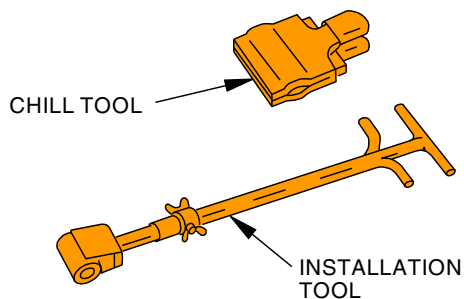
EXTENDED TIME TOOL



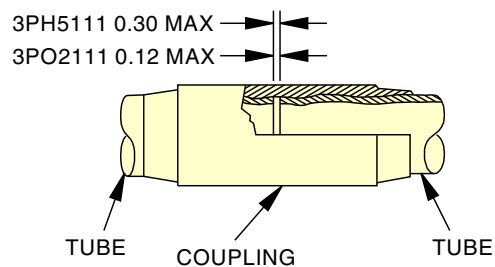
TONGS



O-RINGS INSTALLATION STOP



NOTE:
CRYOFIT KITS INCLUDE ADDITIONAL ITEMS.



CRYOFIT COUPLING INSTALLATION

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**Cryofit Coupling 3P02111 and 3PH5111 Repair
Figure 824/20-10-51-990-834 (Sheet 1 of 2)**

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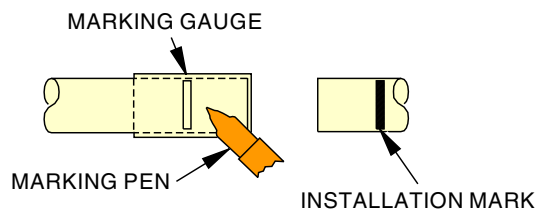
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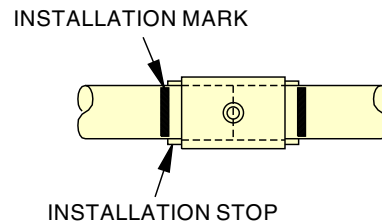
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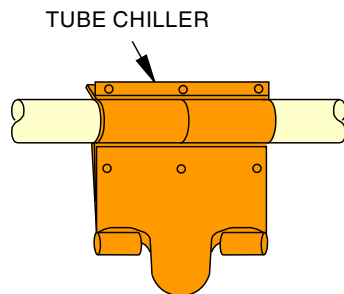
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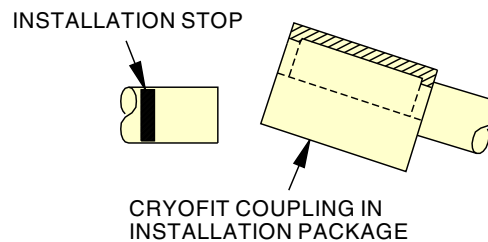
APPLICATION OF INSTALLATION MARK



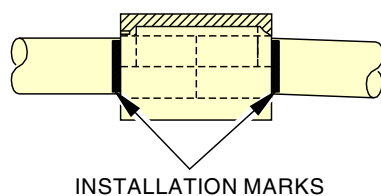
INSTALLATION STOP



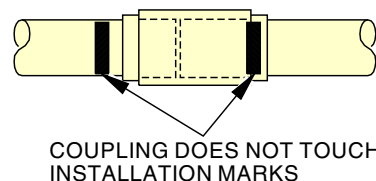
TUBE CHILLER APPLICATION



**CORRECT POSITIONING OF
CROFIT FITTING ON TUBE**



ACCEPTABLE



UNACCEPTABLE

NOTE: **POSITION OF INSTALLED FITTING ON TUBE**
CRYOFIT KITS INCLUDE ADDITIONAL ITEMS.

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**Cryofit Coupling 3P02111 and 3PH5111 Repair
Figure 824/20-10-51-990-834 (Sheet 2 of 2)**

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TASK 20-10-51-400-806

12. Externally Swaged (Permaswage) Fittings Installation

(Figure 825, Figure 826, Figure 827 and Figure 828)

A. General

- (1) To do the externally swaged fitting (Permaswage) repair procedure, use the DLT series swaging tool and the BACU24BS or D10282 in-line tube unions (sizes 04, 06, 08, 10, 12, 16 and 20). You can use CRES externally swaged (Permaswage) fittings, as shown in Figure 806, with 304-1/8 hard CRES tube to repair Ti-3AL-2.5V and 21-6-9 CRES. Repair 6061T6 aluminum tubing with aluminum fittings with D suffix in the basic part number.

NOTE: The use of permaswage fitting to repair potable water line tubes is not recommended because of possible microbe growth in the cavity of the fitting.

- (2) When you do a repair, remove the part of the tube with the defect. Put in a tube splice and install the splice with two fittings. Fittings and tubing material sizes are shown in Figure 825.
- (3) The splice must be shorter than the removed tube section. At a maximum length, make the splice shorter than the tube section by four times the growth value shown in Figure 827 (four fittings). This permits an increase in length as a result of swaging. As a minimum length, make the splice longer than 0.300 in. (7.62 mm) less than the cut-out. This permits tube gaps (not more than 0.150 in. (3.81 mm) as shown in Figure 826.

NOTE: Include the length growth caused by swaging when you work with short tube sections with small flexibility. Short tube sections or tube repairs between rigidly installed fittings can buckle.

- (4) DMC Permaswage Lightweight series (DLT Series) - Tool numbers are listed in Table 822. You can get tool kits in different size combinations. Contact DMC for tool kit part numbers. Make sure that the DLT Series tooling has been inspected to the following DMC Tooling Control Documents:

NOTE: One pump is required to actuate the power units, as shown in Table 822 (Designed Metal Connections, P.O. Box 61188, 14800 S Figueroa St, Los Angeles, CA 90061).

- (a) MCP-016 - Inspection Criteria of DMC, DLT Series, Swage Head Assembly - Standard Permaswage, 3,000 psi (20684.3 kPa) Application.
- (b) SOPG-01-05 - Instructional Manual for 3,000 psi Systems
- (c) DMC-1320 - DLT - Tools Prevention Maintenance

Table 822/20-10-51-993-833 Swage and Inspection Tool Part Numbers

TUBE SIZE	SWAGE TOOL ASSEMBLY	SWAGE HEAD ASSEMBLY	POWER UNIT ^{*[1]}	INSPECTION GAGE
04	DLTFRPSKT3300	DLT05PSHA3004	DLT05MAPW0000	D12-9892-04
06	DLTFRPSKT3300	DLT10PSHA3006	DLT10MAPW0000	D-12-9892-06
08	DLTFRPSKT3300	DLT20PSHA3008	DLT20MAPW0000	D12-9892-08
10	DLTFRPSKT3300	DLT20PSHA3010	DLT20MAPW0000	D1209892-10
12	DLTFRPSKT3300	DLT30PSHA3012	DLT30MAPW0000	D1209892-12
16	DLTFRPSKT3300	DLT40PSHA4016	DLT40MAPW0000	DNR9892-016
20	DLTFRPSKT3300	DLT40PSHA3020	DLT40MAPW0000	D12-9892-20

^{*[1]} One of the following pumps is necessary to actuate the power units: DLT02MAPP1000 pneumatic pump 10,000 psi; DLT05MAPM1000 manual pump 10,000 psi.

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B. References

Reference	Title
20-10-51-760-801	Electrical Resistance Specifications in the Fuel Tank Check (P/B 401)
29-09-00-860-802	Hydraulic Reservoirs Depressurization (P/B 201)

C. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

Reference	Description
SPL-541	Kit - Tube Repair, 3000 PSI Part #: DLTFRPSKT3300 Supplier: 14798 Part #: PLTFRPSKT3000 Supplier: 14798 Opt Part #: DLTFRPSKT3000 Supplier: 14798 Opt Part #: DLTFRPSKT3028A Supplier: 14798
STD-203	Container - Oil Resistant, 1 U.S.-Gal (3.8 l)

D. Consumable Materials

Reference	Description	Specification
B00138	Abrasive - Silicon Carbide Coated Cloth	
B00184	Solvent - Presealing, Cleaning Solvent	BMS11-7
C00064	Coating - Aluminum Chemical Conversion	BAC5719 Type II Class A (MIL-DTL-5541 Class 1A)
C00259	Coating - Chemical And Solvent Resistant Finish, Corrosion Inhibiting Primer	BMS10-11 Type I

E. Prepare Tube for Installation

SUBTASK 20-10-51-040-005

- (1) Remove pressure from the system where you will do repairs, do this task: Hydraulic Reservoirs Depressurization, TASK 29-09-00-860-802.
 - (a) Allow the hydraulic fluid to drain into a suitable container (example, 1 U.S.-gal (3.8 l) oil resistant container, STD-203).

SUBTASK 20-10-51-940-010



DO NOT USE THIS FITTING ON OXYGEN LINES OR ON FLUID LINES IN THE FIRE ZONES OF THE ENGINES. DAMAGE TO EQUIPMENT AND INJURY TO PERSONNEL CAN OCCUR.



DO NOT USE PERMASWAGE FITTINGS TO REPAIR THESE COMPONENTS. IF YOU USE PERMASWAGE FITTINGS FOR THESE COMPONENTS, INJURIES TO PERSONNEL, AND DAMAGE TO EQUIPMENT CAN OCCUR.

- (2) Boeing does not approve Permaswage fittings for these applications:
 - (a) For the repair of tubing in the fuel system (such as fuel pressure sensing lines)
 - (b) On pneumatic ducts
 - (c) Potable water lines or waste water drain lines
 - (d) The repair of electrical conduits

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SUBTASK 20-10-51-940-011

- (3) Use the tools, tube repair kit, SPL-541, shown in Table 822.

SUBTASK 20-10-51-940-012

- (4) Cut out the damaged section of the tube:
- (a) Make sure the section you cut out of the tube is a straight section with a minimum straight length as shown in Figure 825.
NOTE: Make sure the fitting and swage tool will fit.
 - (b) Use one Permaswage fitting for the repair if the damaged section is no more than 0.150 in. (3.81 mm) long.
NOTE: In this case, the cut can be through the center of the damaged section.
 - (c) If the damage is too near to a bend (less than 0.500 in. (12.70 mm)) or longer than 0.150 in. (3.81 mm), use a tube splice and two fittings to make the repair (Figure 825).

SUBTASK 20-10-51-940-013

- (5) For tube cutouts with a bend, use the cutout tube section as a template to mark and cut the new tube segment.

NOTE: The maximum gap between the tube ends is approximately 0.150 in. (3.81 mm) for the union installation.

SUBTASK 20-10-51-110-010

- (6) Clean the tube in the swage area:
- (a) Use solvent, B00184 or equivalent to clean the not painted tube sections that you will repair.
 - (b) Make sure the sections are free of dirt, grease, and other unwanted material for a distance equal to the values shown in Figure 825.
 - (c) Remove paint and anodize from the tubes in an area equal to the values shown in Figure 825.
 - 1) Use the methods shown in Table 823.

Table 823/20-10-51-993-834 Cleaning and Paint Removal Procedures for Aluminum Tubes

MATERIAL SURFACE	PROCEDURE TO CLEAN TUBE
Bare or Alodine	Solvent clean
Anodize	Hand apply abrasive material, 180-grit or finer: - Fed Spec P-P-121 - Fed Speck P-C-451 - Abrasive Scotch Brite, Type A
Primer/Paint	1. Hand apply abrasive material, 240-grit or finer 2. Lacquer thinner (refer to TT-T-266)(flammable) MEK (refer to TT-T-261)(flammable) for primed surfaces (MIL-P-6889) and lacquer base paint/enamel

- (d) Make sure the cleaned surfaces are smooth, uniform, bright, and free of unwanted materials.
- (e) Use a brush to apply coating, C00064 to the open surfaces of aluminum tubes.

SUBTASK 20-10-51-940-014

- (7) Remove the burrs from the tube ends:

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- (a) To remove burrs from the inner bore of the tube ends, use DMC plug-type deburring tools or equivalent.
 - 1) Refer to Figure 807 for the correct deburring procedure.
 - 2) Remove burrs from the tube inner diameter each time you cut the tube.
 - 3) Make sure that the shavings do not get into the system.
 - 4) Do not release the spring pressure of the deburring tool while you pull the tool from the tube.
- (b) If it is necessary to remove burrs from the tube outer diameter, use abrasive, B00138 to remove particles.

NOTE: It is not usually necessary to remove burrs from the tube outer diameter.

SUBTASK 20-10-51-940-015

- (8) Use one of these steps to apply witness marks:
 - (a) Use a felt pen or equivalent to apply witness marks as shown in Figure 827.
 - 1) Use DMC tools D12580-1, -2, -3, or equivalent.
 - (b) Make marks directly on the tube to show the minimum insertion depths as shown in Figure 827.
 - (c) Swage fittings to the marks.

SUBTASK 20-10-51-370-001

- (9) Apply paint to bare areas.
 - (a) For example, apply paint to tool marks and areas where you removed paint (fittings and painted tubes).

SUBTASK 20-10-51-370-002

- (10) Apply coating, C00064 to open areas of aluminum and primer, C00259 to all other tubes and fittings.

F. Procedure

SUBTASK 20-10-51-860-004

- (1) Remove pressure from the system where you will do repairs. Do this task: Hydraulic Reservoirs Depressurization, TASK 29-09-00-860-802.
 - (a) Allow the hydraulic fluid to drain into a suitable container (example, 1 U.S.-gal (3.81 l) oil resistant container, STD-203).

SUBTASK 20-10-51-940-016

- (2) Use a union and a tube as shown in Table 824.

NOTE: Keep the Permaswage fittings in their container until you are ready to install them.

Table 824/20-10-51-993-835 Fitting/Tube Material Combinations for Repair with Permaswage Unions

DMC PART NO. ^{*[1]}	FITTING MATERIAL	FOR USE WITH TUBE MATERIAL	APPROVED TUBE SIZES OD/WALL						
			04	06	08	10	12	16	20
D10282-() ^{*[2]}	21-6-9 CRES	21-6-9 CRES	0.016	0.020	0.026	0.033	0.039	0.052	--
D10282-() ^{*[2]}	21-6-9 CRES	3AL-2.5V Ti	0.016	0.019	0.026	0.032	0.039	0.051	0.070

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**Table 824/20-10-51-993-835 Fitting/Tube Material Combinations for Repair with Permaswage Unions
(Continued)**

D10282-() ^{*[2]}	21-6-9 CRES	304-1/8 HARD CRES (MIL-T- 6845)	0.020	0.028	0.035	0.049	0.058	0.065	--
D10282D() ^{*[2]}	6061T6 AL (MIL-T- 7081)	6061T6 AL (MIL-T-7081)	0.035	0.035	0.035	0.035	0.035	0.035	0.049
BACU24BS (SIZE)(SIZE)J ^{*[2]}	21-6-9	21-6-9 CRES	0.016	0.020	0.026	0.033	0.039	0.052	--
BACU24BS (SIZE)(SIZE)J ^{*[2]}	21-6-9	3AL-2.5V Ti	0.016	0.019	0.026	0.032	0.039	0.051	0.070
BACU24BS (SIZE)(SIZE)J ^{*[2]}	21-6-9	304-1/8 HARD CRES (MIL-T- 6845)	0.020	0.028	0.035	0.049	0.058	0.065	--
BACU24BS (SIZE)(SIZE)D ^{*[2]}	6061T AL	6061T6 AL (MIL-T-7081)	0.035	0.035	0.035	0.035	0.035	0.035	0.049

^{*[1]} Material code "J" with the Boeing part number or no material code (-) with the DMC part number indicates 21-6-9 CRES fitting with two internal grooves on each end, one each filled with silicone. Material code "D" on either the Boeing or DMC part number indicates 6061T Aluminum fitting with two internal grooves on each end, all filled with silicone. Aluminum unions without all grooves filled with the silicone sealant are not approved for Boeing airplanes.

^{*[2]} The BACU24BS (SIZE)(SIZE) J union (both sizes the same) and the D10282-(SIZE) union are interchangeable. In addition, the BACU24BS (SIZE)(SIZE) D union (both sizes the same) and D10282D (SIZE) D union are interchangeable. The Corrosion Resistant Steel (CRES) D10282-(SIZE) and Aluminum D10282D(SIZE) Permaswage unions are improved replacements for the standard CRES D10036D (SIZE) and Aluminum D10036D (SIZE) unions, respectively. The D10036 unions are functionally interchangeable with the D10282 unions. BACU24BS (SIZE)(SIZE) J - (both sizes the same), BACU24BS (SIZE)(SIZE) D - (both sizes the same), D10282-(SIZE) and D10282D (SIZE) union are not shown in DMC catalogs, but you can make an order directly to Designed Metal Connections, 14800 South Figueroa St., Los Angeles, CA 90248.

SUBTASK 20-10-51-350-007

(3) Make sure the tube is sufficiently long to do the repair (Figure 825).

SUBTASK 20-10-51-110-011

(4) Clean the tube as shown in Table 823.

(5) Cut the tube.

(a) If you do not join the tube immediately, seal the tube ends with a cap.

SUBTASK 20-10-51-210-014

(6) Examine the unions for silicone seals (Table 824).

SUBTASK 20-10-51-420-023

(7) Move the union over the tube ends.

(a) Center the union on the witness marks or put it in position at the correct insertion depth.

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SUBTASK 20-10-51-350-008



DO NOT ADJUST THE PUMP TO A PRESSURE THAT CAN CAUSE THE SWAGE TOOL TO BE ABOVE THE LEVEL SPECIFIED. IF YOU ADJUST PRESSURE TO MORE THAN SPECIFIED, INJURY TO PERSONNEL AND DAMAGE TO EQUIPMENT CAN OCCUR.

- (8) Swage the union to the tube as shown in the manufacturer's recommended procedures.

SUBTASK 20-10-51-350-009

- (9) Swage each end three times.
- (a) After the initial swage, move the swage head between 30 and 45 degrees from the previous swage position before you swage again.

SUBTASK 20-10-51-110-012

- (10) Lubricate the head and lower die block regularly.

SUBTASK 20-10-51-210-015

- (11) Examine the end plates for loose retaining screws.

SUBTASK 20-10-51-220-018

- (12) Examine the finished swage as shown in the manufacturer's recommended procedure or measure with Vernier caliper for dimensions as shown in Figure 828.

SUBTASK 20-10-51-760-004

- (13) In the fuel tanks and vapor areas, do a check of the electrical resistance specifications across each tube/fitting interface (TASK 20-10-51-760-801).

SUBTASK 20-10-51-760-005

- (14) Make resistance measurements for all Permaswage repair installations in wing tanks and fuel vapor areas (TASK 20-10-51-760-801).

SUBTASK 20-10-51-790-003

- (15) For Permaswage fitting repairs in general areas, do a leak test as follows:
- (a) Pressurize the system for 15 minutes minimum.
- (b) Make sure there is no sign of hydraulic leaks.
- 1) Use your finger or a white cloth to do a check for leaks.

SUBTASK 20-10-51-210-016

- (16) Examine the tube-to-fitting interface for hydraulic leaks you can see.

NOTE: You must replace fittings you cannot seal.

- (a) If dimensional or leakage specifications are not met, you can swage again.
- 1) After swaging again, do a leak test.

SUBTASK 20-10-51-370-003

- (17) Apply primer, C00259 to the Alodine areas of the finished tube joint where the bare metal is open.

SUBTASK 20-10-51-820-004

- (18) If you disconnected more than one hydraulic tube and you think there is a possibility you connected the tubes incorrectly or cross-connected the tubes, do an operational check:

NOTE: Use your own judgement to determine if a check is necessary.

- (a) Do the post-installation test of one or more of the components to which the tubes are connected as a check.

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SUBTASK 20-10-51-820-005

- (19) If you disconnected electrical wires to get access to the tubes and you think there is a possibility you connected the wires incorrectly or cross-connected the wires, do an operational check:

NOTE: Use your own judgement to determine if a check is necessary.

- (a) Do the post-installation test of one or more of the components to which the wires are connected as a check.

———— **END OF TASK** ————

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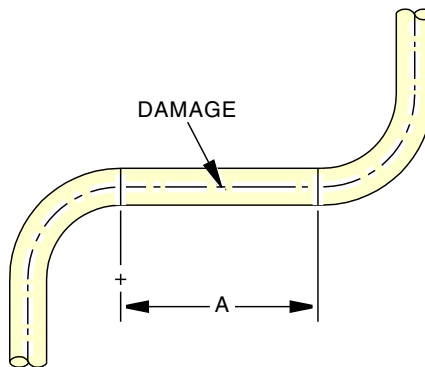
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SIZE	TUBE SIZE						
	04	06	08	10	12	16	20
Fitting length	1.540/ 1.530	1.690/ 1.680	2.700/ 2.686	2.780/ 2.766	2.920/ 3.906	3.209/ 3.195	3.664/ 3.650
A tube length (min)	2.15	2.30	3.30	3.40	3.55	3.80	4.30

NOTE:
ALL DIMENSIONS ARE IN INCHES.

2411163 S00061527051_V1

Minimum Straight Length for Permaswage Fitting Installation
Figure 825/20-10-51-990-835

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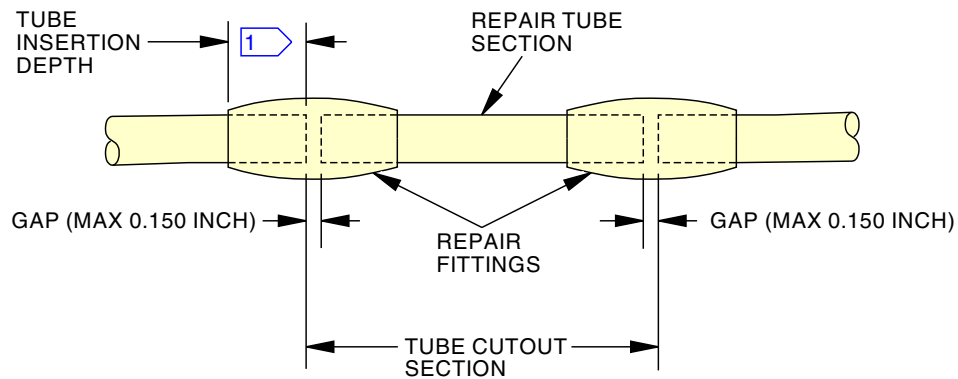
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MATERIAL	TUBE SIZE						
	04	06	08	10	12	16	20
Cres/Ti	0.02	0.02	0.03	0.04	0.057	0.049	0.05
Al	None	0.04	0.06	0.06	0.061	0.048	0.06

SWAGE GROWTH VALUES (INCH)

1 THE A DIMENSION IS SHOWN IN THE FIGURE FOR WITNESS MARK LOCATION AND USUAL MARKING PROCEDURES.

2411164 S00061527052_V1

Tube Splice Repair
Figure 826/20-10-51-990-836

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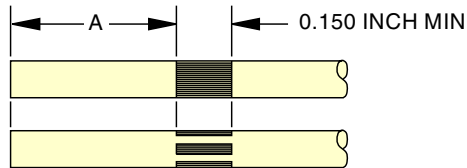
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DIMENSION	TUBE SIZE AND INSERTION DEPTH - INCHES					
	04	06	08	10	12	16
A	0.69	0.77	1.27	1.31	1.38	1.52

MARK FOR THE MINIMUM TUBE INSERTION DEPTHS

2411165 S00061527053_V1

Witness Mark Location and Usual Marking Procedures
Figure 827/20-10-51-990-837

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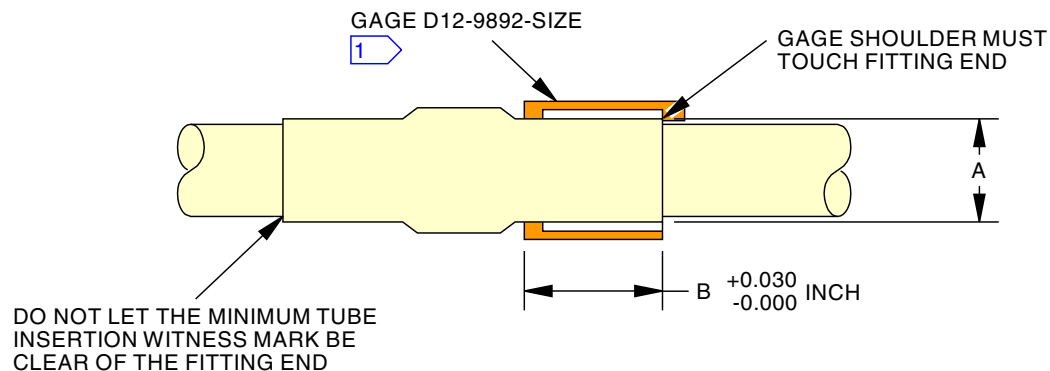
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TUBE DIAMETER	SWAGED DIAMETER MAX A DIMENSIONS	SWAGED LENGTH MIN B DIMENSIONS
1/4 (04)	0.315	0.46
3/8 (06)	0.447	0.53
1/2 (08)	0.606	1.02
5/8 (10)	0.735	1.02
3/4 (12)	0.863	1.02
1 (16)	1.181	1.406
1-1/4 (20)	1.390	1.406

AFTER SWAGE DIMENSIONS (INCH)

1 USE DNR9892-016 FOR SIZE 16.

2411166 S00061527054_V1

Final Swage Dimensions
Figure 828/20-10-51-990-838

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TASK 20-10-51-400-807

13. **Axial Swage Fitting Union Installation (8,000 psi rated - Rynglok)**

(Figure 829, Figure 830, Figure 831, Figure 832)

A. General



DO NOT USE THIS FITTING ON OXYGEN LINES OR ON FLUID LINES IN THE FIRE ZONES OF THE ENGINES. DAMAGE TO EQUIPMENT AND INJURY TO PERSONNEL CAN OCCUR.



DO NOT USE RYNGLOK FITTINGS TO REPAIR THESE COMPONENTS. IF YOU USE RYNGLOK FITTINGS FOR THESE COMPONENTS, INJURIES TO PERSONNEL, AND DAMAGE TO EQUIPMENT CAN OCCUR.

- (1) Boeing does not approve Rynglok (8,000 psi rated) fittings for these applications:
 - (a) For the repair of tubing in the fuel system (such as fuel pressure sensing lines) or fuel tanks.
 - (b) On pneumatic ducts.
 - (c) Potable water lines or waste water drain lines.
 - (d) The repair of electrical conduits.
- (2) The Axial Swage (8,000 psi rated - Rynglok) in-line tube unions (Figure 829), sizes 04, 06, 08, 10, 12, and 16, are used with 304 1/8 hard CRES tube to repair 3AL-2.5V titanium and 21-6-9 CRES. The same unions plus a size 20 are used with 6061-T6 aluminum tube, provided the bare areas of the tubing are painted after swaging to limit the possibility for galvanic corrosion to occur. To determine tube material and size, do the following: Tube Material and End Fitting Determination for Hydraulic Tube Assembly, TASK 20-10-51-910-801.

NOTE: Do not use Axial Swage (8,000 psi rated - Rynglok) tube to tube fittings on fluid lines inside airplane fuel tanks, in engine areas, or on lines used in oxygen systems. The Axial Swage (8,000 psi rated - Rynglok) tube to tube fitting is not qualified for these applications.

- (3) When you do a repair, remove the part of the tube with the damage. If the area of the tube damage is less than the value listed in Figure 809 and Table 811, use one Axial Swage union (8,000 psi rated - Rynglok) for repair.
- (4) If the tube damage is longer than the value listed in Table 811, put in a tube splice and install the splice with two fittings. The splice must be equal to or slightly shorter than the removed tube section. The minimum length of tubing to be removed is shown in Table 826. Fittings and tubing material sizes are shown in Table 825.

Table 825/20-10-51-993-836 Approved Fitting/Tube Material Combinations for Repair with Rynglok Unions (8,000 psi Rated)

AEROQUIP PART NUMBER	FOR USE WITH TUBE MATERIALS	APPROVED TUBE SIZES OD/WALL (INCHES)						
		04	06	08	10	12	16	20

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Table 825/20-10-51-993-836 Approved Fitting/Tube Material Combinations for Repair with Rynglok Unions (8,000 psi Rated) (Continued)

Axial Swage (8,000 psi rated 8010T - Rynglok) (Titanium Material)	21-6-9 CRES	0.016	0.020	0.026	0.033	0.039	0.052	N/A
	304 1/8 Hard CRES	0.020	0.028	0.035	0.049	0.058	0.065	N/A
	6061-T6 Aluminum	0.035	0.035	0.035	0.035	0.035	0.035	0.035
	3AL-2.5V Titanium	0.016	0.019	0.026	0.032	0.039	0.051	N/A

Table 826/20-10-51-993-837 Splice Repair with More Than One Axial Swage (5,000 psi Rated and 8,000 psi Rated - Rynglok) Tube-to-Tube Union - Minimum Removed Tube Section

TUBE DASH NUMBER	TUBE OUTER DIAMETER (INCHES)	AXIAL SWAGE FITTING UNION, 5,000 PSI RATED OR 8,000 PSI RATED - RYNGLOK, MINIMUM REMOVED TUBE SECTION (INCHES)
04	0.250	2.38
06	0.375	2.64
08	0.500	2.92
10	0.625	3.18
12	0.750	3.56
16	1.000	4.15
20	1.250	4.81

B. References

Reference	Title
20-10-51-910-801	Tube Material and End Fitting Determination for Hydraulic Tube Assembly (P/B 201)
29-09-00-860-801	Hydraulic Reservoirs Pressurization (P/B 201)
29-09-00-860-802	Hydraulic Reservoirs Depressurization (P/B 201)
29-09-00-860-803	Hydraulic Reservoir Pressurization System Leakage Test (P/B 501)

C. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

Reference	Description
COM-1803	Swager - Rynglok Hydraulic Fitting Part #: RCSK8-02-004 Supplier: 00624 Part #: RCSK8-02-006 Supplier: 00624 Part #: RTSK8-02-013 Supplier: 00624
STD-203	Container - Oil Resistant, 1 U.S.-Gal (3.8 l)

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D. Consumable Materials

Reference	Description	Specification
B00068	Alcohol - Denatured, Ethyl (Ethanol)	AMS 3002, MIL-E-51454 Type II
C00064	Coating - Aluminum Chemical Conversion	BAC5719 Type II Class A (MIL-DTL-5541 Class 1A)
C00259	Coating - Chemical And Solvent Resistant Finish, Corrosion Inhibiting Primer	BMS10-11 Type I

E. Procedure

SUBTASK 20-10-51-860-005

- (1) Remove pressure from the system where you will do repairs, do this task: Hydraulic Reservoirs Depressurization, TASK 29-09-00-860-802.
 - (a) Allow the hydraulic fluid to drain into a suitable container (example, 1 U.S.-gal (3.81 l) oil resistant container, STD-203).

SUBTASK 20-10-51-360-001

- (2) Use the tools contained in swager hydraulic fitting, COM-1803.

NOTE: The RCSK tool kits have tools to cut and deburr. The RTSK tool kits do not have tools to cut and deburr. If you use an RTSK tool kit, use tools to cut and deburr that are not in the tool kit.

SUBTASK 20-10-51-360-002

- (3) Cut out the damaged section of the tube using a chipless tube cutter (Figure 807) and the following:
 - (a) Make sure the section you cut out of the tube is a straight section with a minimum straight length as shown in Figure 813.

NOTE: This is to make sure that the fitting and the swage tool will fit.
 - (b) Use one Axial Swage union (8,000 psi rated - Rynglok) for the repair if the damaged section is not longer than the dimensions listed in Figure 809 and Table 811.
 - 1) If the damage is within the dimensions, you can make the cut through the center of the damaged section.

SUBTASK 20-10-51-150-001

- (4) Remove the paint and the anodize from the tubes to the dimensions shown in Figure 813.

SUBTASK 20-10-51-110-013

- (5) Clean the non-painted tube sections that you will repair with alcohol, B00068.

SUBTASK 20-10-51-370-004

- (6) Use a brush to apply coating, C00064 to the cut ends of the tube.

SUBTASK 20-10-51-360-003

- (7) Seal the tube ends with a cap if you do not join the tubing immediately.

SUBTASK 20-10-51-360-004

- (8) Apply positioning and inspection marks on the tube to be repaired using the appropriate gage from the swager hydraulic fitting, COM-1803 and a Sanford Sharpie (or equivalent) felt tip pen with a fine or extra fine point (Figure 830, Figure 831, Figure 832).

NOTE: The RCSK tool kits have tools to cut and deburr. The RTSK tool kits do not have tools to cut and deburr. If you use an RTSK tool kit, use tools to cut and deburr that are not in the tool kit.

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- (a) Bottom the gage on the cut edge of the tube before making the marks.

SUBTASK 20-10-51-360-005

- (9) Move the Axial Swage union (8,000 psi rated - Rynglok) over the tube ends.

SUBTASK 20-10-51-360-006

- (10) Put the edge of the fitting ring over the center of the positioning mark (nominal tube insertion) as shown in Figure 831.

NOTE: The edge of the fitting ring may be anywhere along the length of the positioning mark but the nominal position is recommended.

SUBTASK 20-10-51-360-007



DO NOT ADJUST THE PUMP TO A PRESSURE THAT CAN CAUSE THE SWAGE TOOL TO BE ABOVE THE LEVEL SPECIFIED. IF YOU ADJUST PRESSURE TO MORE THAN SPECIFIED, INJURY TO PERSONNEL AND DAMAGE TO EQUIPMENT CAN OCCUR.

- (11) Swage the union to the tube as shown in the Aeroquip Rynglok Installation Guide supplied with the swager hydraulic fitting, COM-1803.

NOTE: The fitting must always be fully installed in the tool to maximize tool life.

SUBTASK 20-10-51-360-008

- (12) Examine the finished installation for correct ring advancement using the appropriate size inspection gage from the swager hydraulic fitting, COM-1803.

- (a) Make sure that the inspection gage fits over the ring area as shown in Figure 832 so that the ring is flush with the center portion of the union.

SUBTASK 20-10-51-780-001

- (13) Pressurize the hydraulic system to operating pressure for the system which was repaired. Do this task: Hydraulic Reservoirs Pressurization, TASK 29-09-00-860-801.

SUBTASK 20-10-51-790-004

- (14) Examine the tube-to-union interface for hydraulic leakage. Do this Task: Hydraulic Reservoir Pressurization System Leakage Test, TASK 29-09-00-860-803.

- (a) If leakage is found, cut out the union and repair the tube by section replacement.

SUBTASK 20-10-51-370-005

- (15) Apply coating, C00064 to bare areas of the aluminum tubing where paint was removed, followed by a coat of primer, C00259.

— END OF TASK —

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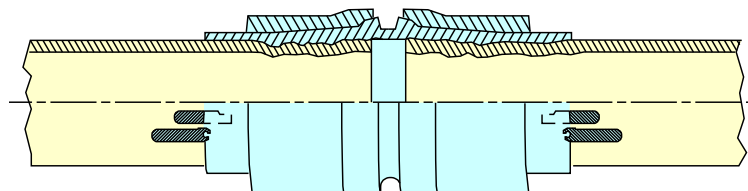
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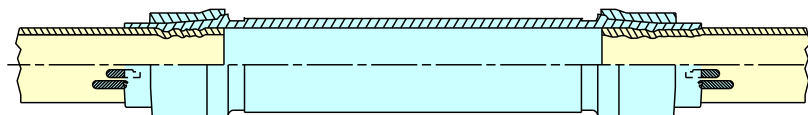
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AXIAL SWAGE UNION
(5,000 PSI RATED AND 8,000 PSI RATED - RYNGLOK)



EXTENDED LENGTH AXIAL SWAGE UNION
(5,000 PSI RATED)

2411167 S00061527056_V2

Axial Swage Tube to Tube Union (5,000 psi Rated and 8,000 psi Rated)
Figure 829/20-10-51-990-839

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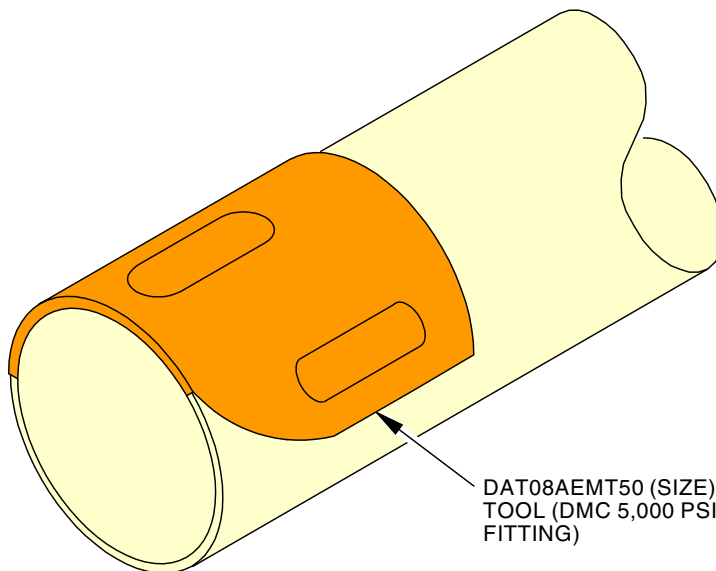
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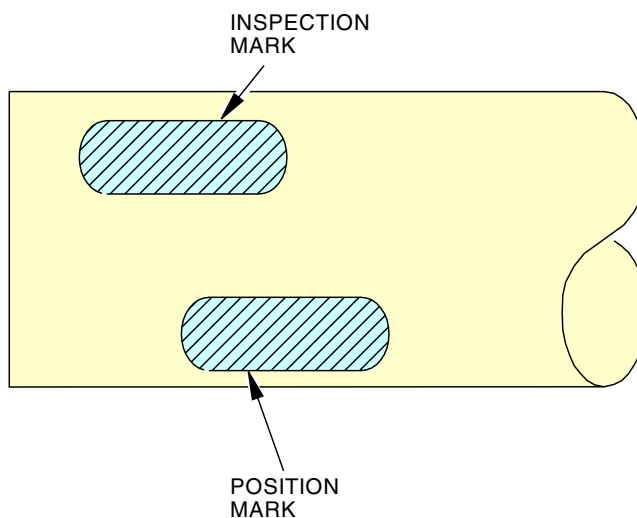
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DAT08AEMT50 (SIZE) MARKING
TOOL (DMC 5,000 PSI RATED
FITTING)

LTSGO-01-SIZE MARKING TOOL
(AEROQUIP 5,000 PSI RATED
FITTING)

RTSGO-01-SIZE MARKING TOOL
(AEROQUIP 8,000 PSI RATED
RYNGLOK FITTING)



2411168 S00061527057_V1

Mark Location During Rynglok Fitting Installation
Figure 830/20-10-51-990-840

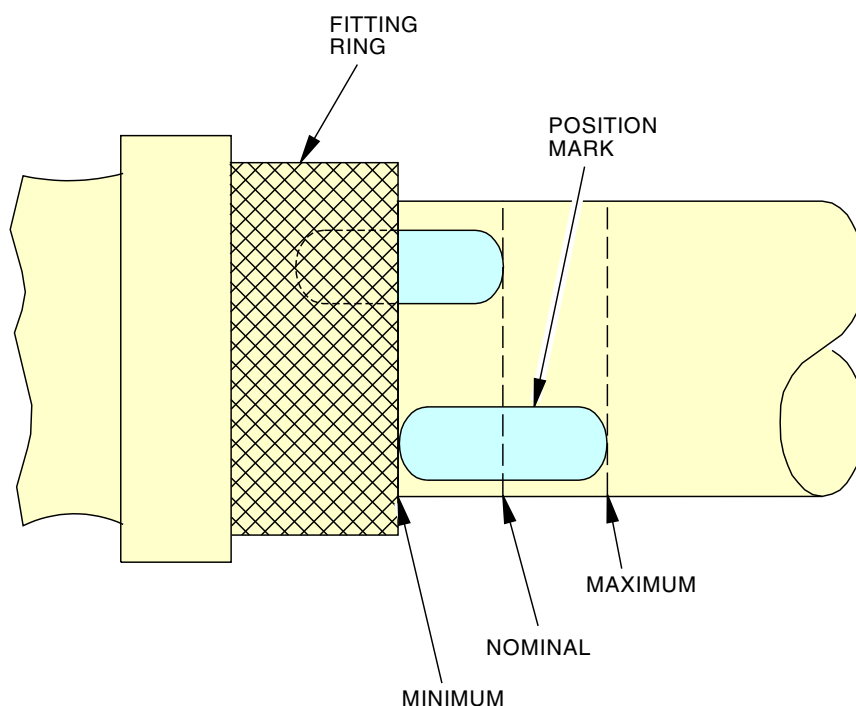
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Fitting Position for Tube Insertion
Figure 831/20-10-51-990-841

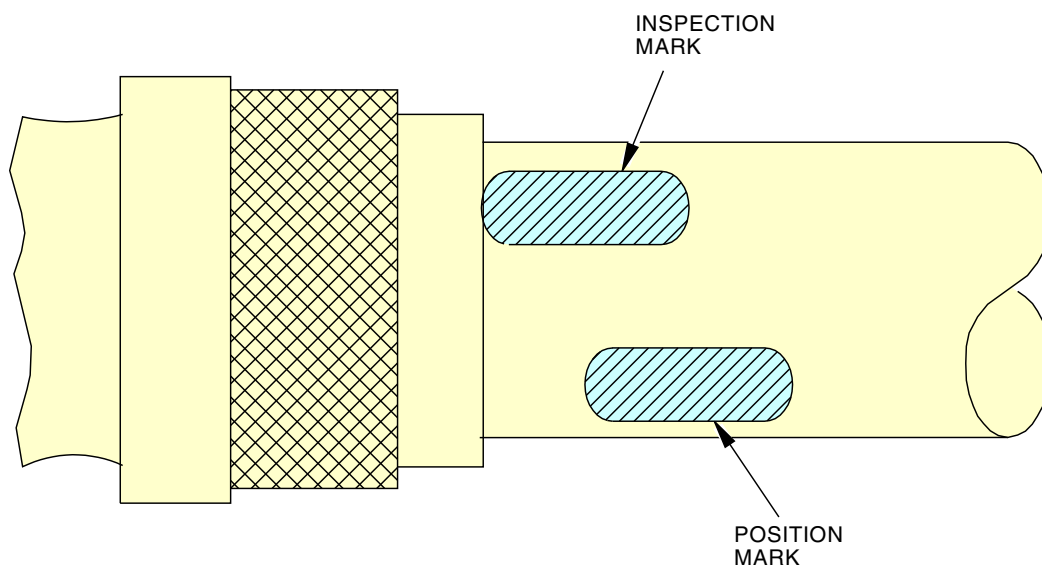
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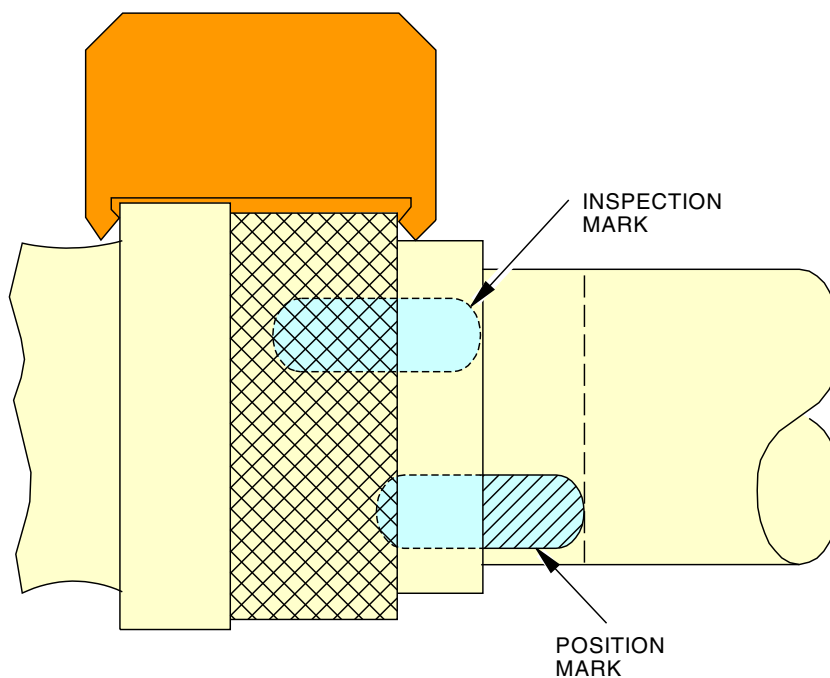
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MINIMUM INSPECTION MARK AFTER SWAGING



MAXIMUM INSPECTION MARK AFTER SWAGING

2411170 S00061527059_V1

Use of Inspection Gage After Swage of Axial Swage Fittings (5,000 psi Rated or 8,000 psi Rated - Rynglok)
Figure 832/20-10-51-990-842

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TASK 20-10-51-400-808

14. Axial Swage Fitting Installation (5,000 psi rated - Union) or Male/Female Adapter Fittings

A. General

- (1) Make sure that you do not use Axial Swage shape fittings (tees, elbows) to repair tubes.



WARNING

DO NOT USE AXIAL SWAGE FITTINGS TO REPAIR THESE COMPONENTS. IF YOU USE AXIAL SWAGE FITTINGS FOR THESE COMPONENTS, INJURY TO PERSONNEL AND DAMAGE TO EQUIPMENT CAN OCCUR.

- (2) Boeing does not approve Axial Swage Union or Adapter Fittings (5,000 psi rated) for the applications that follow.
 - (a) The repair of tubing in the fuel system (such as fuel pressure sensing lines) or fuel tanks.
 - (b) On pneumatic ducts.
 - (c) On potable water lines or waste water drain lines.
 - (d) The repair of electrical conduits.



WARNING

DO NOT USE THIS FITTING ON OXYGEN LINES OR ON FLUID LINES IN THE FIRE ZONES OF THE ENGINES. DAMAGE TO EQUIPMENT AND INJURY TO PERSONNEL CAN OCCUR.

- (3) Do not use the Axial Swage tube-to-tube union or adapter fittings on fluid lines inside the airplane fuel tanks, in engine areas, or on lines used in oxygen systems. The Axial Swage tube-to-tube union and adapter fittings are not qualified for these applications.
- (4) The 5,000 psi rated Axial Swage union or adapter fittings can be used to repair the 3,000 psi 3Al-2.5V titanium and 21-6-9 CRES hydraulic tubing.
- (5) The 5,000 psi rated Axial Swage union or adapter fittings and tooling are color-coded blue to distinguish them from the 8,000 psi rated Axial Swage fittings and tooling.
- (6) The 5,000 psi rated Axial Swage tube-to-tube union or adapter fittings, sizes 04, 06, 08, 10, 12, and 16, are approved for use with 3Al-2.5V titanium tubing and 21-6-9 CRES tubing to repair Ti-3Al-2.5V titanium and 21-6-9 CRES tubing (Figure 829).

NOTE: Sizes 04, 06, 08, 10, and 12 are approved for use on the 737NG.

- (7) When you do a repair, remove the part of the tube with the damage. If the area of the tube damage is:
 - (a) Less than the maximum tube cutout length dimension (illustrated in figure and listed in table), use one Axial Swage union fitting for repair (Figure 809 and Table 811).
 - (b) Greater than the maximum tube cutout length for Axial Swage unions, and less than 1 inch, use one Standard Length Axial Swage union.
 - (c) Greater than 1 inch, and less than the maximum tube cutout length for Extended Length Axial Swage unions, use one Extended Length Axial Swage union.

NOTE: If you are repairing an Axial Swage union, the Extended Length Axial Swage union is recommended to replace the Axial Swage union.

- (8) If the tube damage is longer than the tube cutout length dimension (illustrated in figure and listed in table), put in a tube splice and install the splice with two fittings (tube-to-tube union, or adapters plus flareless tube assembly or hose assembly as illustrated in) (Figure 809 and Table 811).
 - (a) The splice must be equal to or slightly shorter than the removed tube section.

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- (b) The minimum length of tubing to be removed (Table 826).
(9) Fittings and tubing material sizes (Table 827).

Table 827/20-10-51-993-838 Tube and Material Sizes

DMC PART NUMBER	FOR USE WITH TUBE MATERIALS	APPROVED TUBE SIZES OD/WALL (IN.)					
		04	06	08	10	12	16
Titanium Material:	21-6-9 CRES	0.016	0.020	0.026	0.033	0.039	0.052
DAS5969T, Tube-to-Tube Union DAS5792T, Female Adapter DAS5793T, Male Adapter AS6322T, Tube-to-Tube Union	3AL-2.5V Titanium	0.016	0.019	0.026	0.032	0.039	0.051

B. References

Reference	Title
29-09-00-860-801	Hydraulic Reservoirs Pressurization (P/B 201)
29-09-00-860-802	Hydraulic Reservoirs Depressurization (P/B 201)

C. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

Reference	Description
COM-8946	Kit - Axial Swage Tube Repair With Pump, 5000 PSI Part #: DAT08AEFKT5000 (04 - 16 Tube) Supplier: 14798 Part #: DAT08AEFKT5001 (04 - 20 Tube) Supplier: 14798 Part #: DAT08AEFKT5003 (04 - 12 Tube) Supplier: 14798 Part #: RCLK5C01S020 Supplier: 00624 Opt Part #: RCLK5C01S010 Supplier: 00624 Opt Part #: RCLK5C01S025 Supplier: 00624
STD-203	Container - Oil Resistant, 1 U.S.-Gal (3.8 l)

D. Consumable Materials

Reference	Description	Specification
B00068	Alcohol - Denatured, Ethyl (Ethanol)	AMS 3002, MIL-E-51454 Type II
C00064	Coating - Aluminum Chemical Conversion	BAC5719 Type II Class A (MIL-DTL-5541 Class 1A)

E. Axial Swage Fitting Installation

SUBTASK 20-10-51-860-006

- (1) Remove pressure from the system where you will do the repairs, do this task: Hydraulic Reservoirs Depressurization, TASK 29-09-00-860-802.
(a) Drain the hydraulic fluid into a suitable container.

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- 1) An example of a suitable container is a 1 U.S.-gal (3.81 l) oil resistant container, STD-203.

SUBTASK 20-10-51-800-008

- (2) Use the tools contained in tube repair kit, COM-8946.

NOTE: The tube repair kit, COM-8946, contains sizes 04 through 20. However, only sizes 04, 06, 08, 10, and 12 are applicable to 737MAX aircraft. Operators with multiple airplane models may need the complete kit (sizes 04 through 20) if their other aircraft require the use of sizes 16 and 20.

NOTE: The RCSK tool kits have tools to cut and deburr. The RTSK tool kits do not have tools to cut and deburr. If you use an RTSK tool kit, use tools to cut and deburr that are not in the tool kit.

SUBTASK 20-10-51-000-001

- (3) Cut out the damaged section of the tube using a chipless tube cutter (Figure 807).

- (a) Make sure that the section you cut out of the tube is a straight section with a minimum straight length (Figure 813).

NOTE: This will make sure the fitting and the swage tool will fit.

- (b) Cut can be through the center of the damaged section, if the damage is within the dimensions (Figure 809 and Table 811).

SUBTASK 20-10-51-150-002

- (4) Remove the paint and the anodize from the tubes to the dimensions (Figure 813).

SUBTASK 20-10-51-100-001

- (5) Clean the non-painted tube sections that you will repair with alcohol, B00068.

SUBTASK 20-10-51-800-009

- (6) Use a brush to apply coating, C00064, to the cut ends of the tube.

SUBTASK 20-10-51-390-001

- (7) Seal the tube ends with a cap if you do not join the tube immediately.

SUBTASK 20-10-51-930-001

- (8) Apply positioning and inspection marks on the tube to be repaired using the appropriate gage from the tube repair kit, COM-8946, and a Sanford Sharpie (or equivalent) felt tip pen with a fine or extra-fine point (Figure 830, Figure 831, and Figure 832).

NOTE: The RCSK tool kits have tools to cut and deburr. The RTSK tool kits do not have tools to cut and deburr. If you use an RTSK tool kit, use tools to cut and deburr that are not in the tool kit.

- (a) Bottom the gage on the cut edge of the tube before making the marks.

SUBTASK 20-10-51-400-001

- (9) Move the Axial Swage union or adapter fitting (5,000 psi rated) over the tube ends.

SUBTASK 20-10-51-400-002

- (10) Put the edge of the fitting ring over the center of the positioning mark (nominal tube insertion) (Figure 831).

- (a) Make sure that the edge of the fitting ring is anywhere along the length of the positioning mark.

NOTE: Nominal position is recommended.

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SUBTASK 20-10-51-400-003



WARNING

DO NOT ADJUST THE PUMP TO A PRESSURE THAT CAN CAUSE THE SWAGE TOOL TO BE ABOVE THE LEVEL SPECIFIED. IF YOU ADJUST PRESSURE TO MORE THAN SPECIFIED, INJURY TO PERSONNEL AND DAMAGE TO EQUIPMENT CAN OCCUR.

- (11) Make sure that you do not make a pump adjustment that can cause the swage tool hydraulic pressure to be outside the manufacturer's recommendations.
 - (a) The manufacturer's recommendations for the tool is 8000 psi (55,158 kPa) to 8500 psi (58,605 kPa) maximum.

- (12) Swage the union or adapter fitting to the tube as shown in the installation guide supplied with the swaging equipment.

NOTE: The fitting must always be fully installed in the tool to maximize tool life.

SUBTASK 20-10-51-211-005

- (13) Examine the finished installation for correct ring advancement.
 - (a) Use the appropriate size inspection gage from the tube repair kit, COM-8946.
 - 1) The inspection gage should fit over the ring area (Figure 832).

NOTE: This is so the ring is flush with the center portion of the union.

SUBTASK 20-10-51-780-002

- (14) Pressurize the hydraulic system to operating pressure for the system that was repaired (TASK 29-09-00-860-801).

————— END OF TASK —————

TASK 20-10-51-400-809

15. Axial Swage Fitting Installation (5,000 psi rated - Shape, Elbow and Tee)

A. General



CAUTION

PUT AN IDENTIFIER ON THE TUBES ON EACH SIDE OF THE CONNECTION BEFORE YOU DISCONNECT. IF YOU CONNECT THEM AT AN INCORRECT LOCATION, DAMAGE TO THE COMPONENTS WILL OCCUR.

- (1) Make sure that you do not cross-connect tube assemblies.
 - (a) Label all separated connections so that the correct tube identification and position is maintained.



WARNING

DO NOT USE THIS FITTING ON OXYGEN LINES OR ON FLUID LINES IN THE FIRE ZONES OF THE ENGINES. DAMAGE TO EQUIPMENT AND INJURY TO PERSONNEL CAN OCCUR.

- (2) Boeing does not approve Axial Swage shape fittings for the applications that follow:
 - (a) The repair of tubing in the fuel system (such as fuel pressure sensing lines) or fuel tanks.
 - (b) The repair of tubing in the hydraulic system (a shape fitting may not be used for a splice repair of hydraulic tubing. A shape fitting can only be used to replace the same shape fitting in the hydraulic system.)
 - (c) On pneumatic ducts.
 - (d) On potable water lines or waste water drain lines.

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- (e) The repair of electrical conduits.
- (3) The 5,000 psi rated Axial Swage shape (elbow and tee) fittings are installed in the main landing gear wheel well area.
- (4) The 5,000 psi rated Axial Swage fittings and tooling are color-coded blue to distinguish them from the 8,000 psi rated Axial swage fittings and tooling.
- (5) The use of 5,000 psi rated Axial Swage elbow and tee configurations for repair is limited to replacement of existing parts in the same configuration.
- (6) Do not use the 5,000 psi rated Axial Swage elbow and tee fittings for tube repair (a shape fitting may not be used for a splice repair of hydraulic tubing. A shape fitting can only be used to replace the same shape fitting in the hydraulic system).
- (7) The Axial swage shape fittings (5,000 psi rated) listed in Table 827 and illustrated in Figure 814, for sizes 04, 06, 08, 10, and 12 are used with 3Al-2.5V titanium tubing and 21-6-9 CRES tubing.

NOTE: The tube repair kit, COM-8946 tool kit contains sizes 04 through 20. However, only sizes 04, 06, 08, 10, and 12 are applicable to 737MAX aircraft. Operators with multiple airplane models may need the complete kit (sizes 04 through 20) if their other aircraft require the use of sizes 16 and 20.



DO NOT USE THIS FITTING ON OXYGEN LINES OR ON FLUID LINES IN THE FIRE ZONES OF THE ENGINES. DAMAGE TO EQUIPMENT AND INJURY TO PERSONNEL CAN OCCUR.

- (8) Do not use the Axial Swage shape fittings on fluid lines inside the airplane fuel tanks, in engine areas, or on lines used in oxygen systems. The Axial swage shape fittings are not qualified for these applications.
- (9) When you do a repair that involves replacement of an Axial Swage shape fitting, it may be necessary to remove the tubes intersecting the Axial Swage shape fitting along with the Axial Swage shape fitting at the opposite ends of the affected tubes.
- (10) It is important to make sure that you have the necessary parts and Axial Swage tooling available before you begin the repair. Possible Tube Repair Scenarios - Axial Swage Fittings, TASK 20-10-51-800-801 provides a tube repair scenario demonstrating the steps required to replace a hydraulic tube, where related end fittings and a portion of a mating tube must also be replaced.

B. References

Reference	Title
29-09-00-860-801	Hydraulic Reservoirs Pressurization (P/B 201)
29-09-00-860-802	Hydraulic Reservoirs Depressurization (P/B 201)

C. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

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Reference	Description
COM-8946	Kit - Axial Swage Tube Repair With Pump, 5000 PSI Part #: DAT08AEFKT5000 (04 - 16 Tube) Supplier: 14798 Part #: DAT08AEFKT5001 (04 - 20 Tube) Supplier: 14798 Part #: DAT08AEFKT5003 (04 - 12 Tube) Supplier: 14798 Part #: RCLK5C01S020 Supplier: 00624 Opt Part #: RCLK5C01S010 Supplier: 00624 Opt Part #: RCLK5C01S025 Supplier: 00624

D. Procedure

SUBTASK 20-10-51-040-006

- (1) Remove pressure from the system where you will do the repairs. Do this task: Hydraulic Reservoirs Depressurization, TASK 29-09-00-860-802.

SUBTASK 20-10-51-020-006

- (2) Back off swivel nuts on the Axial Swage elbow tee system.

SUBTASK 20-10-51-350-010

- (3) Cut the mating tube in a straight section.
 - (a) Use a chipless tube cutter (Figure 807).
 - 1) Make sure that the straight section where you cut the mating tube has a minimum straight length as shown in Figure 813.

NOTE: This will make sure the fitting and the swage tool will fit.
 - 2) Use one Axial Swage union fitting (5,000 psi rated) for the splice repair of the mating tube.

SUBTASK 20-10-51-020-007

- (4) Remove the fittings, the tube assembly, and the cut tube section as an assembly.

SUBTASK 20-10-51-800-010

- (5) Discard the fittings, the tube assembly, and the cut tube section.

SUBTASK 20-10-51-800-011

- (6) Put the items that follow in position for installation.
 - (a) The new Axial Swage elbow fitting (5,000 psi rated) or the new Axial Swage tee fitting (5,000 psi rated).
 - (b) The new tube.

SUBTASK 20-10-51-420-024

- (7) Tighten the swivel nuts hand-tight.

SUBTASK 20-10-51-420-025

- (8) Cut a section of the new tube so that it will match the cut section of the old tube.
 - (a) Make sure to prepare the ends of the new tube for swaging.

SUBTASK 20-10-51-420-026

- (9) Install the new tube.
 - (a) Put the new tube section and the Axial Swage union fitting in position for installation.
 - (b) Torque the swivel nuts on the flareless ends of the Axial Swage shape fittings.
 - (c) Make sure that the Axial swage union (5,000 psi rated) and Axial Swage shape fittings are in place.

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- (d) Swage the parts as shown in the installation guide for the swaging equipment.

NOTE: The fitting must always be fully installed in the tool to maximize tool life.

SUBTASK 20-10-51-440-001

- (10) Pressurize the hydraulic system, do this task: Hydraulic Reservoirs Pressurization, TASK 29-09-00-860-801.

————— END OF TASK —————

TASK 20-10-51-350-801

16. Hydraulic Tubing Repair with Flexible Hoses

(Figure 833)

A. General

- (1) The Boeing Company recommends that the operator do these procedures:
- (a) Make a record of the flexible hoses that you install as temporary repairs for rigid lines.
 - (b) Make a schedule for the regular inspection of flexible hose installations.
 - (c) Make sure the installation stays an airworthy repair until the system is put back to its initial configuration.
 - (d) Make a procedure to make sure that flexible hoses, installed as temporary repairs, are replaced as soon as possible.
- NOTE: You must replace the hoses no later than the scheduled time check approved by the assigned principal maintenance inspector.
- (2) You can use many different repair techniques. The Boeing Company cannot know about or control these repair techniques. It is your responsibility to decide if this procedure is applicable to your repair techniques.
- (3) This procedure is not acceptable for engine hydraulic tube repair or for the replacement of rigid or flexible coiled tubing. Engine hydraulic tubes are those tubes below or forward of the firewall, and within the engine cowls. Consult Boeing when considering a repair to any engine hydraulic tube or coiled tube.
- (4) Use the hydraulic tubing repair kit, SPL-5276 or equivalent

B. References

Reference	Title
20-10-52-400-803	Flexible Hose Installation (P/B 401)
29-09-00-860-802	Hydraulic Reservoirs Depressurization (P/B 201)

C. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

Reference	Description
SPL-5276	Repair Kit, Hydraulic Tubing (3000 psi) (Approved for Titanium) Part #: 65-92528-11 (Spares Kit) Supplier: 81205 Part #: 65-92528-37 (Spares Kit) Supplier: 81205

D. Install the Flexible Hose

(Figure 833)

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DO NOT LET COMPONENTS HANG FROM FLEXIBLE HOSES. FLEXIBLE HYDRAULIC HOSES KINK EASILY AND CAUSE LEAKAGE.

NOTE: Kevlar hydraulic hoses kink more easily than CRES (steel) wire braided hoses.

NOTE: Kevlar fibers are usually not damaged by kinking. After the hose is pressurized, all signs of kinking may disappear. However, the inner Teflon tube may be damaged and eventually leak. Kinking is especially critical for larger hoses such as the ADP pressure hoses (1¼ in. (31.75 mm)).

SUBTASK 20-10-51-220-019

(1) Use a flexible hose that has the specifications that follow:

- (a) Make sure the flexible hose is specified for at least the same operating pressure and fluid type as the system in which you will install the flexible hose.

NOTE: The 737 airplanes use the new kevlar reinforced hydraulic hose. This hose may be used provided the guidelines of Figure 833, and Table 828 are met.

- (b) Make sure the new flexible hose has a minimum of the same inner diameter as the damaged tube.
- (c) Make sure the new flexible hose is sufficiently long to replace the damaged tube or the damaged section of the tube.
- (d) Make sure the new flexible hose has sufficient slack, flex, twisting, bending, clearance, and support specifications as shown below and in Figure 833.
- 1) Slack - Do not install the hose assemblies in a way that will cause a mechanical load on the hose. Hoses will change length from +2 to -4 percent when pressurized. Supply sufficient slack or bend to make the allowance for a change in length and length tolerances.
 - 2) Flex - When hose assemblies will have much vibration or flexing, make sure there is sufficient slack between the rigid fittings. Install the hose so flexing does not occur at the end fittings. The hose must stay straight for at least two hose diameters from the end fittings. Do not use clamp locations that will restrict or prevent the hose from flexing.
 - 3) Twisting - Make sure you install the hoses without twists to prevent loose nuts and possible rupture of the hose. You can use swivel connections at one or two ends to release the twist stresses.
 - 4) Bending - To prevent sharp bends in the hose assembly, use elbow fittings, hose with elbow type end fittings, or the applicable bend radii, as shown in Table 828.

Table 828/20-10-51-993-839 Minimum Hose Bend Radius

HOSE	HOSE INNER DIAMETER	MINIMUM HOSE BEND RADIUS MEASURED AT INNER BEND
AS115-04	¼ in. (6.35 mm)	1.50 in. (38.1 mm)
AS115-06	¾ in. (9.52 mm)	2.50 in. (63.5 mm)
AS115-08	½ in. (12.70 mm)	2.88 in. (73.2 mm)
AS115-10	⅝ in. (15.88 mm)	3.25 in. (82.6 mm)
AS115-12	¾ in. (19.05 mm)	4.00 in. (101.6 mm)

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Table 828/20-10-51-993-839 Minimum Hose Bend Radius (Continued)

HOSE	HOSE INNER DIAMETER	MINIMUM HOSE BEND RADIUS MEASURED AT INNER BEND
AS4568-16	1 in. (25.40 mm)	7.50 in. (190.5 mm)
AS4568-20	1¾ in. (44.45 mm)	15.00 in. (381.0 mm)

- 5) Clearance - Make sure the hose assembly is clear of all other lines, equipment, and adjacent structure under all operating conditions. The hoses must have the minimum clearance specifications shown in Table 829.

Table 829/20-10-51-993-840 Minimum Hose Bend Clearance

HOSE CLEARANCE TO	MINIMUM CLEARANCE
Control Cables and Linkages	1.0 in. (25.4 mm) ^{*[1]}
Cable at Pulleys	0.5 in. (12.7 mm)
Cable at Mid-span	2.0 in. (50.8 mm)
Electrical Wiring	0.5 in. (12.7 mm)
Hydraulic Tubes or Hoses	0.2 in. (5.1 mm)

*[1] Measured at a relative position where the hose is closest to the cable or linkage.

- 6) Support - Make sure the hose assembly has supports that do not cause deflection of rigid lines because of the relative motion that can occur. Use sufficient clamps to follow the contour of the structure to prevent hose abrasive wear, kinking, and entanglement during flexing. At a minimum, put clamps at locations where the tube clamps were. Make sure the hose is not rigidly supported by tight, rigid clamps around its outer diameter. If a hose between rigid connections must move longitudinally, clamps must be of a type that will not cause wear on the hose casing. Make sure the connections have supports at the tube, not at the hose.

SUBTASK 20-10-51-860-007

- (2) For the hydraulic system where you will do the repair, do this task: Hydraulic Reservoirs Depressurization, TASK 29-09-00-860-802.

SUBTASK 20-10-51-960-001

- (3) If you can replace all of the damaged tube with a flexible hose, do these steps:
- (a) Remove the damaged tube.
 - (b) If necessary, prepare the ends of the tubes to which you will install the flexible hose.
 - 1) Use the applicable fittings as shown in Tube Repair, TASK 20-10-51-300-801.

SUBTASK 20-10-51-960-002

- (4) If the damaged tube is too long to replace by a flexible hose, do the steps that follow:
- (a) Cut out the damaged tube section to accept the flexible hose.
 - (b) Prepare the ends of the cut tube with the applicable fittings as told in the Tubing Repair paragraph.

SUBTASK 20-10-51-420-027

- (5) Do this task: Flexible Hose Installation, TASK 20-10-52-400-803.

SUBTASK 20-10-51-860-008

- (6) Supply the usual operating pressure to the repaired tube.

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SUBTASK 20-10-51-210-017

- (7) Examine the hose and connections for leaks.

SUBTASK 20-10-51-220-020

- (8) Make sure the repair agrees with all specifications for slack, flex, twisting, bending, clearance, and support.

———— **END OF TASK** ————

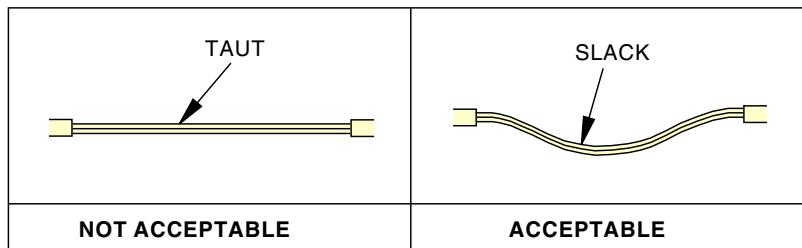
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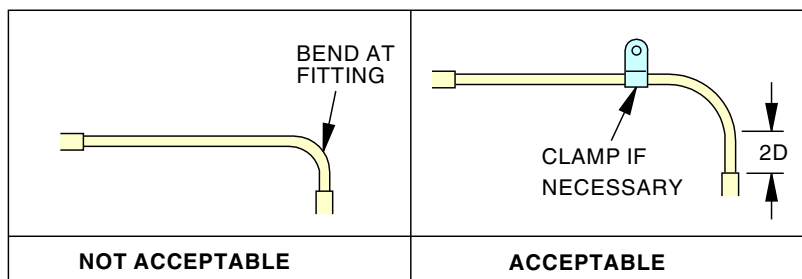
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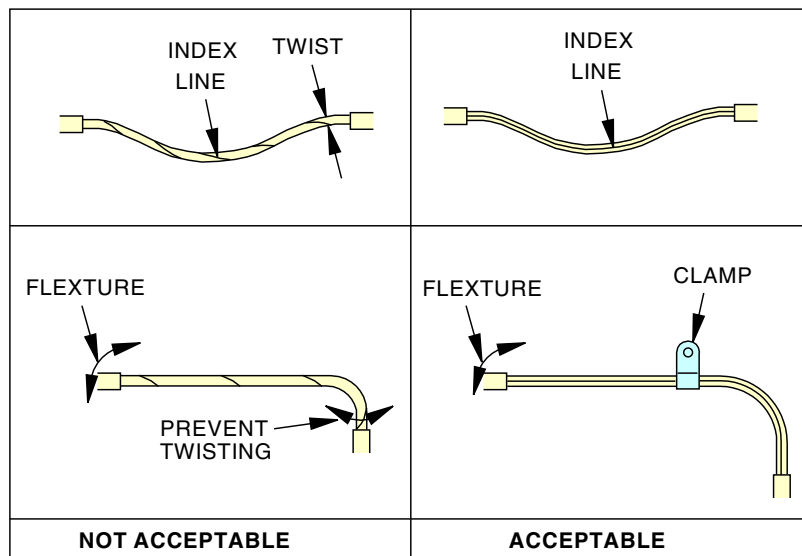
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SLACK



FLEX



TWISTING

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**Hydraulic Tubing Repair with Flexible Hose
Figure 833/20-10-51-990-843 (Sheet 1 of 2)**

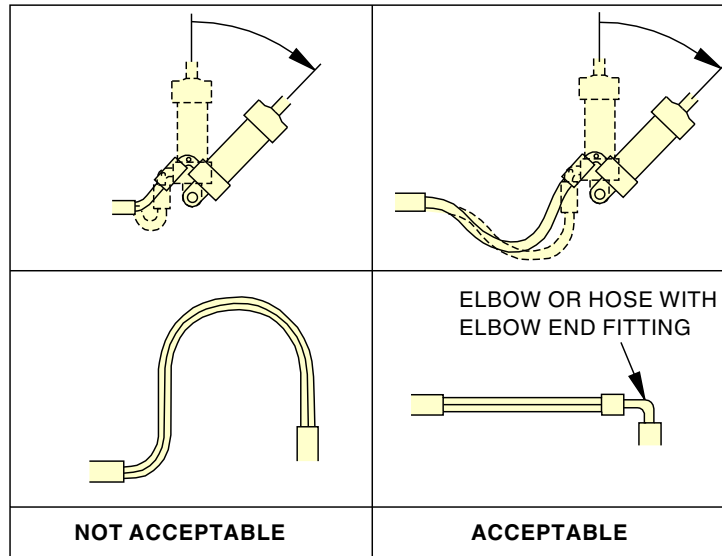
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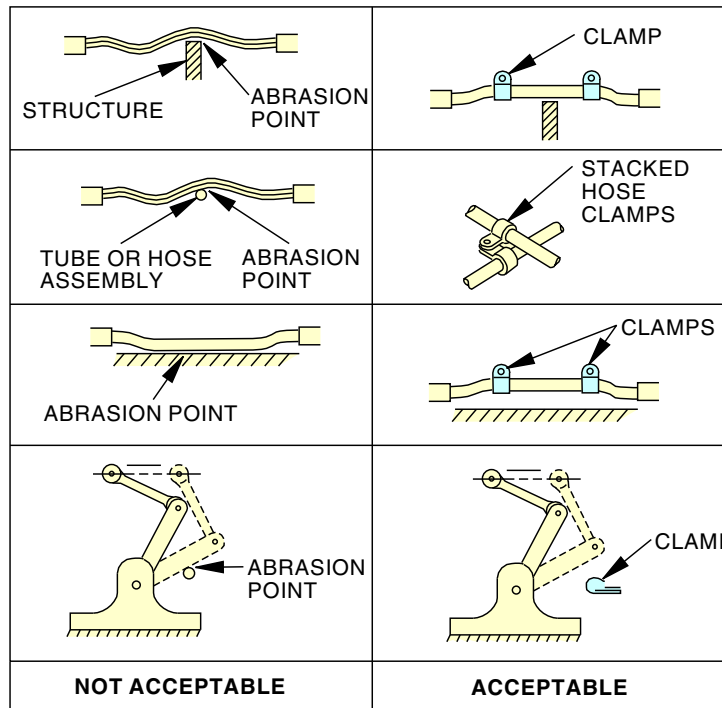
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BENDING



CLEARANCE

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Hydraulic Tubing Repair with Flexible Hose
Figure 833/20-10-51-990-843 (Sheet 2 of 2)

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TASK 20-10-51-300-806

17. Repair Size 16 (1 inch) and Size 20 (1-1/4 inch) 6061-T4 Aluminum Tubing in the Hydraulic System of the Airplane

A. General



DO NOT USE THIS PROCEDURE ON OXYGEN TUBING. GREASE, DIRT, OR OTHER FLAMMABLE MATERIALS IN THE OXYGEN TUBING CAN CAUSE A FIRE OR EXPLOSION.

- (1) The hydraulic system in the airplane contains both 6061-T4 and T6 aluminum tubes.
- (2) This is a repair method that applies only to 6061-T4 hydraulic aluminum tubes in Sizes 16 (1 inch) and 20 (1-1/4 inch) and uses 6061-T6 aluminum tube material for making a splice. 6061-T6 material may be used as an alternate material for repair of 6061-T4 aluminum tubes, but 6061-T4 aluminum tube material may NOT be used to repair 6061-T6 aluminum tubes.
- (3) Approved repairs to 6061-T6 aluminum hydraulic tube material are covered elsewhere in this AMM.
- (4) Repair is accomplished using only the BACS13BX sleeve, the elastomer swaging process, and other applicable methods specified in this procedure for flareless tube repairs.
- (5) The wear depth limit for 6061-T4 tubes is 1/3 the wall thickness of the tube.

B. References

Reference	Title
20-10-51 P/B 401	FLARELESS TUBING ASSEMBLY - REMOVAL/INSTALLATION
20-50-11-910-801	Standard Torque Values (P/B 201)
29-09-00-860-802	Hydraulic Reservoirs Depressurization (P/B 201)

C. Tools/Equipment

Reference	Description
STD-203	Container - Oil Resistant, 1 U.S.-Gal (3.8 l)

D. Procedure

SUBTASK 20-10-51-040-007

- (1) Remove the pressure from the systems where you will do the repairs. Do this task: Hydraulic Reservoirs Depressurization, TASK 29-09-00-860-802.
 - (a) Drain the hydraulic fluid into a suitable container.
 - 1) An example of a suitable container is a 1 U.S.-gal (3.81 l) oil resistant container, STD-203.

SUBTASK 20-10-51-350-011

- (2) Decide if 6061-T6 aluminum tube splice is necessary or if the damage is small enough to repair by installing a flareless MS21902 union between two BACS13BX sleeves.
 - (a) Refer to Figure 809 and Table 811 to find the necessary tube cutout length when you use a single flareless MS21902 union to replace a damaged tube area.

SUBTASK 20-10-51-350-012

- (3) Make an estimate of the total length (L1) of the 6061-T6 aluminum tube repair section necessary to replace the damaged tube (Figure 810, Figure 811).

SUBTASK 20-10-51-300-002

- (4) Cut and trim the repair tube as follows: (Figure 807)

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- (a) Use the correct size ratchet chipless cutter.
- (b) Turn the cutter drive screw counter clockwise to retract the cutter wheel.
- (c) Put the cutter over the tube.
- (d) Turn the screw clockwise until the cutter touches the tube at the necessary cut location.
- (e) Turn the cutter screw 1/8 to 1/4 turn and rotate the cutter until the cutter is easy to rotate.

NOTE: The tube should now be cut.

- (f) Remove the tool.
- (g) To deburr the tube, use the correct stem subassembly and deburring tool.
 - 1) To assemble the tool, refer to Figure 807.
- (h) Push down on the plunger and install the tool into the end of the tube.
- (i) Release the plunger.
 - 1) Let the plug fill the inside of the tube.
- (j) Rotate the deburring tool until the inside burr is removed.
- (k) Remove the tool with the plug expanded.

NOTE: The expanded plug should remove particles from the inside of the tube.

- 1) Make sure that you do not drop metal particles in the area of the repair.

SUBTASK 20-10-51-300-003

- (5) Swage the necessary flareless BACS13BX sleeves to the repair tube (Swage the BACS13BX Flareless Sleeves with the Internal Elastomer Swage Equipment, TASK 20-10-51-300-803).

SUBTASK 20-10-51-300-004

- (6) Assemble and tighten the flareless fittings which are part of the repair section (FLARELESS TUBING ASSEMBLY - REMOVAL/INSTALLATION, PAGEBLOCK 20-10-51/401).

SUBTASK 20-10-51-300-005

- (7) Measure all of the tube assembly length with BACS13BX sleeves (L1) (Figure 810, Figure 811).

SUBTASK 20-10-51-300-006

- (8) To find the necessary cutout length (L2) as shown in Figure 810, and Figure 811, use the procedure given in Table 816 for BACS13BX sleeves and Harrison Portable Swagers with MS21902 unions.

SUBTASK 20-10-51-300-007

- (9) Cut out the damaged tube (L2). Trim the tube ends as shown in Figure 807.

SUBTASK 20-10-51-300-008

- (10) To use assembled tube ends or a center section to do a repair, find the cutout length and install in the steps that follow:
 - (a) When you make the installation, do this task: Swage the BACS13BX Flareless Sleeves with the Internal Elastomer Swage Equipment, TASK 20-10-51-300-803.
 - (b) Install the repair section and tighten the nuts, do this task: Standard Torque Values, TASK 20-50-11-910-801.

———— **END OF TASK** ————

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TASK 20-10-51-930-801

18. **Part Marking of Flareless Tubing Assemblies**

A. General

- (1) Use this task to part-mark the hydraulic tubes that do not have part-numbers.
 - (a) Use one of the methods that follow to apply the original tube part-number on the installed hydraulic-tubes that have lost identification.
 - (b) Use one of the methods that follow to apply a new part-number on a field-manufactured replacement- tube. First, select a new tube part-number. This new tube part-number will include the data to let you easily identify and find the part for future use (65C26841-1002REPL). For example, if the tubes require repair or replacement, the new tube part-number will help you find the tubes.

B. References

Reference	Title
20-10-27-910-801	Precautions for Heat Devices (P/B 201)

C. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

Reference	Description
COM-446	Heat Gun - Variable Temperature, 100 to 1000 deg F Part #: VT-751D (120 volts) Supplier: 83284 Part #: VT-752D (220 volts) Supplier: 83284

D. Consumable Materials

Reference	Description	Specification
B50073	Alcohol - Isopropyl	ASTM D 770
B50095	Solvent	BAC5750
C00033	Coating - Protective Enamel, Flexibility Use	BMS10-60 Type II
C50066	Coating - Protective Enamel, Clear	BMS10-60 Type I Class B
G00251	Abrasive - Mat, Non-Woven, Non-Metallic	A-A-58054
G02061	Marker - Permanent, Felt Tip Pen	
G50262	Wiper - Cleaning	BMS15-5
G50393	Tape - Adhesive, Label	BAC5307 Type III Polyester (Mylar)
G50395	Ink - Laundry Marking	TT-I-542
G50396	Ink - Marking, Silk Screen	Standard Overhaul Practices Manual (SOPM) 20-50-10
G50410	Stamp Pad (Commercially Available)	

E. Part Marking of Flareless Tubing Assemblies

SUBTASK 20-10-51-930-002

- (1) Rubber Stamp Method
 - (a) Clean the tube surface with solvent, B50095.
 - 1) Remove oxide from the tubing surface with abrasive mat, G00251.

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- (b) Select an ink, G50396, that is applicable to the tube material and visible on the tube surface.
- (c) Hand Stamp the new tube part-number on the tube.
 - 1) For tubes longer than 24 in. (610 mm), mark the new part number in the following locations:
 - a) In the area 6 in. (152 mm) or less of each end.
 - b) The newest straight area that is not in a clamp area.
 - 2) Apply liquid ink, G50396, to stamp pad, G50410.
 - 3) Apply the part number to the tube surface with the stamp.
- (d) Apply a clear coating, C00033.

SUBTASK 20-10-51-930-003

- (2) Hand Letter Method
 - (a) Clean the tube surface with solvent, B50095.
 - 1) Remove oxide from the tubing surface with abrasive mat, G00251
 - (b) Use ink, G50395, or marker, G02061, to mark the part-number on the tube.
 - 1) For tubes longer than 24 in. (610 mm), mark the new part number in the following locations:
 - a) In the area 6 in. (152 mm) or less of each end.
 - b) The newest straight area that is not in a clamp area.

SUBTASK 20-10-51-930-004



DO NOT USE TAPES OR ADHESIVE LABELS IN THE FUEL TANK ASSEMBLIES. FUEL CAN WASH AWAY THE TAPE AND ADHESIVE LABELS. IF YOU DO NOT OBEY, DAMAGE TO THE FUEL SYSTEM CAN OCCUR.

- (3) Tape or Adhesive Label Method
 - (a) Clean the tube surface with wiper, G50262, moist in alcohol, B50073.
 - 1) Remove remaining solvent with clean wiper, G50262.
 - (b) Cut adhesive tape, G50393, length to encircle the tube a minimum of two times on a 0.250 in. (6.350 mm) to 0.500 in. (12.700 mm) diameter tube.
 - 1) For tubes with diameters of 0.625 in. (15.875 mm) or more, encircle the tube two times with adhesive tape, G50393.
 - (c) Attach adhesive tape, G50393, with the part number.
 - 1) For tubes longer than 24 in. (610 mm), mark the new part number in the following locations:
 - a) In the area 6 in. (152 mm) or less of each end.
 - b) The newest straight area that is not in a clamp area.
 - 2) Use the original identification tapes, part number BACT11Y-(), to mark the replacement tubes.
 - a) Do this task: Precautions for Heat Devices, TASK 20-10-27-910-801.

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MAKE SURE THAT THE HEAT GUN DOES NOT BECOME HOTTER THAN 200.0°F (93.3°C). IF YOU DO NOT OBEY, DAMAGE TO THE EQUIPMENT CAN OCCUR.

- b) Use a heat gun, COM-446, to seal the edge of the tape.
 - c) Make sure that the tape edge is melted and securely sealed to the underlying tape.
 - d) Make sure that the melted area extends across the width of the tape.
- (d) Apply a clear coating, C50066.

————— END OF TASK —————

TASK 20-10-51-800-801

19. Possible Tube Repair Scenarios - Axial Swage Fittings

(Figure 834, Figure 835, Figure 836)

A. General

- (1) This procedure has three possible tube scenarios. These scenarios are to demonstrate how a tube repair should be approached for tubes attached to permanent axial swage fittings in the main wheel well.

B. References

Reference	Title
29-09-00-860-801	Hydraulic Reservoirs Pressurization (P/B 201)
29-09-00-860-802	Hydraulic Reservoirs Depressurization (P/B 201)
29-09-00-860-803	Hydraulic Reservoir Pressurization System Leakage Test (P/B 501)

C. Possible Scenario 1 (Tube-to-Tube Splice)

(Figure 834)

NOTE: Repair Damage on Tube Near Aileron Centering Mechanism on the Rear Spar.

SUBTASK 20-10-51-300-009

- (1) Prepare for the repair:
- (a) Identify the damaged tube and the parts necessary to do the repair.
 - 1) Locate the damaged area.
 - 2) Identify the damaged tube as part number 272A4451-1009 (0.375 in. (9.525 mm) diameter and 0.019 in. (0.483 mm) wall thickness titanium, ends permanently attached).
 - 3) Follow the tube in both directions to determine where you can make a splice using AS5969T/DAS5969T axial swage fittings.
 - a) The straight portion of the tube directly below the bend that has the damage is straight and long enough for a splice with one axial swage union fitting.
 - b) The portion of the tube above the damage has a straight section long enough for a splice with one axial swage union fitting close to the permanent union fitting attaching the 272A4451-1009 tube to the next tube.
 - c) See Figure 834 for the splice locations.
 - 4) Determine where to cut the 272A4451-1009 tube.

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- 5) Determine what parts and tooling are needed to do the repair.
 - a) Required Fittings (New)
 <1> AS5969T0606/DAS5969T0606 Tube-to-Tube Union (two)
 - b) Required Tubes (New)
 <1> 272A4451-1009 (one)
 - c) Required Tools
 <1> See Table 807 for the required tooling.

SUBTASK 20-10-51-000-002

- (2) Remove the Damaged Tube Section:
 - (a) Remove pressure from the hydraulic system. Do this task: Hydraulic Reservoirs Depressurization, TASK 29-09-00-860-802.
 - (b) Cut the 272A4451-1009 tube.
 - 1) Loosen or remove tube support clamps, as necessary, to cut the tube for splicing.
 - 2) Cut the tube in two places, approximately halfway between the bends.
 - (c) Remove the cut portion of the tube.
 - 1) Loosen or remove tube support clamps (as necessary).
 - 2) Keep the damaged tube for reference.
 - (d) Deburr and chamfer the tube ends that are still connected to the airplane structure.
 - (e) Make witness marks on the tube ends that are still connected to the airplane structure (see FLARELESS TUBING ASSEMBLY - REPAIRS, 20-10-51/801 and the fitting manufacturer's instructions).
 - (f) Cut the new 272A4451-1009 tube.
 - 1) Use the damaged 272A4451-1009 tube that was removed from the airplane as a template.
 - 2) Deburr and chamfer the new 272A4451-1009 tube.
 - 3) Make witness marks on the new tube (see FLARELESS TUBING ASSEMBLY - REPAIRS, 20-10-51/801 and the fitting manufacturer's instructions).

SUBTASK 20-10-51-300-010

- (3) Do the Repair:
 - (a) Slide the AS5969T0606/DAS5969T0606 union fittings on the ends of the 272A4451-1009 tubes that are attached to the airplane structure.
 - (b) Slide the new 272A4451-1009 tube section into the AS5969T0606/DAS5969T0606 union fittings.
 - (c) Reinstall and tighten any support clamps that were removed from 272A4451-1009.
 - 1) Make sure that you do not clamp the tube at the repair fitting location.
NOTE: Clamps are sized to fit standard tube diameters. If a repair swage is clamped, the clamp can move off of the uniform surface because the tube can migrate or flex.
 - 2) Make sure that there is no preload on the new 272A4451-1009 tube when the support clamps are tightened.
 - 3) Make sure that there is enough clearance to the adjacent tubes or the structure.

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- (d) Make a felt tip mark across each fitting and tube to mark the position of the AS5969T0606/DAS5969T0606 union fittings on the 272A4451-1009 tubes that are attached to the airplane structure and on the new 272A4451-1009 tube section.
- NOTE: These marks will be used for clocking the new 272A4451-1009 tube.
- (e) Position one AS5969T0606/DAS5969T0606 union fitting to the witness marks and the clocking marks on the 272A4451-1009 tube that is attached to the airplane structure and to the new 272A4451-1009 tube.
- (f) Swage the AS5969T0606/DAS5969T0606 union fitting to the 272A4451-1009 tube that is attached to the airplane structure and the new 272A4451-1009 tube.
- 1) Swage one fitting end at a time.
 - 2) Use FLARELESS TUBING ASSEMBLY - REPAIRS, 20-10-51/801 and the tool manufacturer's instructions.
 - 3) Make sure that fitting is centered on the tube ends at both sides of the joint.
 - 4) Make sure that the tube and fitting remain in position to the witness marks and the clocking marks.
- (g) Position the remaining AS5969T0606/DAS5969T0606 union fitting to the witness marks and the clocking marks on the 272A4451-1009 tube that is attached to the airplane structure and to the new 272A4451-1009 tube section at the other end of the splice.
- (h) Swage the AS5969T0606/DAS5969T0606 union fitting to the 272A4451-1009 tube that is attached to the airplane structure and the new 272A4451-1009 tube section.
- 1) Swage one fitting end at a time.
 - 2) Use FLARELESS TUBING ASSEMBLY - REPAIRS, 20-10-51/801 and the tool manufacturer's instructions.
 - 3) Make sure that fitting is centered on the tube ends at both sides of the joint.
 - 4) Make sure that the tube and fitting remain in position to the witness marks and the clocking marks.
- (i) After the swaging is complete, do the steps that follow.
- 1) Make sure that the fittings are correctly installed.
 - a) Use a go/no-go gage that is supplied with the tooling to verify that the fittings are installed correctly or check the dimensions using the tool manufacturer's instructions.
 - 2) Reinstall any loose support clamps.
 - a) Make sure that all support clamps are in place and secure at each location on the tube.
 - b) Make sure that you do not clamp the tube at the repair fitting location.
- NOTE: Clamps are sized to fit standard tube diameters. If a repair swage is clamped, the clamp can move off of the uniform surface because the tube can migrate or flex.
- (j) Pressurize the hydraulic system. Do this task: Hydraulic Reservoirs Pressurization, TASK 29-09-00-860-801.
- (k) Do a leak check. Do this task: Hydraulic Reservoir Pressurization System Leakage Test, TASK 29-09-00-860-803.

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D. Possible Scenario 2 (Replacement of Elbow, Tee Adapter, and Two Tube Sections)
(Figure 835)

NOTE: Repair Damage at Bend in Tube of P/N 272A4453-1007.

SUBTASK 20-10-51-300-011

(1) Prepare for the Repair:

(a) Required Tooling

- 1) DMC Tooling for Axially Swaged 5,000 psi rated fittings, sizes 04 and 06

(b) Required Fittings (New)

- 1) AS5801T0404/DAS5801T0404 Elbow, Axial Swage to flareless swivel
- 2) AS5806T060406/DAS5806T060406 Tee, Axial Swage on run to flareless swivel
- 3) AS5969T0606/DAS5969T0606 Union, Axial Swage, tube-to-tube

(c) Required Tubes (New)

- 1) Tube P/N 272A4453-1007 (no end fittings)
- 2) Tube P/N 272A4453-1001 (no end fittings).

SUBTASK 20-10-51-040-008

(2) Procedure:

(a) Remove pressure on the hydraulic system. Do this Task: Hydraulic Reservoirs Depressurization, TASK 29-09-00-860-802.

(b) Remove the old components.

- 1) Back off swivel nuts on AS5801T0404/DAS5801T0404 and AS5806T060406/DAS5806T060406 fittings.
- 2) Cut tube P/N 272A4453-1001 in a straight section.
- 3) Remove, as an assembly, the fittings, the -1007 tube, and the cut section of the -1001 tube.
- 4) Discard the fittings, the -1007 tube, and the cut section of the -1001 tube.

(c) Install the new components.

- 1) Put the new fittings, the -1007 tube, and the support clamps in place.
 - a) Make sure that you do not clamp the tube at the repair fitting location.

NOTE: Clamps are sized to fit standard tube diameters. If a repair swage is clamped, the clamp can move off of the uniform surface because the tube can migrate or flex.

- 2) Hand-tighten the swivel nuts.
- 3) Cut an appropriate section of new -1001 tube to replace the cut section.
- 4) Put the new section of the -1001 tube in place.
- 5) Splice the tube with AS5969T tube-to-tube union.
- 6) Torque the swivel nuts on the fittings.
 - a) Use a backup wrench on the fitting wrench pad.
- 7) Secure the tube support clamps.

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- a) Make sure that you do not clamp the tube at the repair fitting location.

NOTE: Clamps are sized to fit standard tube diameters. If a repair swage is clamped, the clamp can move off of the uniform surface because the tube can migrate or flex.

- 8) Swage the parts using the tool manufacturer's instructions.
- (d) Pressurize the system. Do this task: Hydraulic Reservoirs Pressurization, TASK 29-09-00-860-801.
- (e) Do a leak check of the system. Do this task: Hydraulic Reservoir Pressurization System Leakage Test, TASK 29-09-00-860-803.

E. Possible Scenario 3 (Replacement of Permanent Tee Fitting and Three Tube Sections)

(Figure 836)

NOTE: Repair Damage in Main Landing Gear Wheel Well Pressure Deck.

SUBTASK 20-10-51-300-012

(1) Prepare for the Repair:

- (a) Identify the damaged tube, the parts, and the tooling necessary to do the repair.
- 1) Locate the damaged area.
 - 2) Identify the tube as part number 272A4452-1029 (0.375 in. (10 mm) diameter and 0.019 in. (0.483 mm) diameter).
 - 3) Follow the tube in both directions to determine where you can make a splice.
 - a) The left section of the tube is very straight which is suitable for a splice. However, this section of the tube is behind a stringer which could make access to the splice area difficult.
 - b) The tube leading aft is permanently attached (axial swage) to the tee fitting. The tube length is less than the minimum tube length that can be replaced without replacing the tee fitting (see Figure 813 and Figure 815). Replace the tee fitting and portions of tubes 272A4452-1001, 272A4452-1026, and 272A4452-1029 using splice repairs in straight sections of each tube.
 - 4) Determine where to cut each tube that will be replaced.
 - a) The 272A4452-1001 tube: cut approximately halfway (forward to aft direction) along the straight length before the bend.
 - b) The 272A4452-1026 tube: cut approximately halfway between the support clamps that hold the 272A4452-1026 and 272A4452-1029 tubes.
 - c) The 272A4452-1029 tube: cut behind the stringer at the location on the left side of the bend, approximately halfway between the support clamps that hold the 272A4452-1026 and 272A4452-1029 tubes.
 - 5) Determine the parts and tools that will be required to replace the tubes and fittings.
 - a) Required Tooling
 - <1> See Table 807 for required tooling
 - b) Required Fittings (New)
 - <1> AS5972T060606/DAS5972T060606 Tee (one)
 - <2> AS5969T0606/DAS5969T0606 Tube-to-Tube Union (three)
 - c) Required Tubes (New)
 - <1> 272A4452-1001 (no end fittings)

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<2> 272A4452-1026 (no end fittings)

<3> 272A4452-1029 (no end fittings).

SUBTASK 20-10-51-000-003

(2) Remove the Damaged Tube Section:

- (a) Remove pressure from the hydraulic system. Do this task: Hydraulic Reservoirs Depressurization, TASK 29-09-00-860-802.
- (b) Tag each tube run outside of the sections that will be removed.
- (c) Loosen or remove tube support clamps (as necessary).
 - 1) For 272A4452-1026 Tube:
 - a) Remove and retain the support clamps along the portion of the tube to the left.
 - b) Make sure to remove the support clamp far enough to move the tube section away from the pressure deck so that you can cut the tube for splicing.
 - 2) For 272A4452-1029 Tube:
 - a) Remove and retain the support clamps along the portion of the tube to the left.
 - b) Make sure to move the support clamp far enough to move the tube section from behind the stringer so that you can cut the tube for splicing.
- (d) Cut each tube that you will replace.
 - 1) Cut one tube at a time.
 - 2) Tag each tube run after you remove each tube section.
 - 3) Make a record of the original installation.

NOTE: This will help to make sure there is no tube cross-connection when the replacement tubes are installed.

SUBTASK 20-10-51-300-013

(3) Do the Repair:

- (a) Remove the 272A4452-1026 tube.

NOTE: Remove this tube first. This will allow access to the 272A4452-1029 tube.

- 1) Remove the support clamps (as necessary).
- 2) Move the tube away from the structure.
- 3) Cut the tube approximately halfway between the support clamp locations.
- 4) Cut the tube adjacent to the tee fitting (AS5972T060606/DAS5972T060606).

NOTE: This will allow the remaining section of the tube to be moved away from the stringer for the second cut where the splice will be placed.

- 5) Remove the cut portion of the tube.
 - a) Save this section of tube for reference.
- 6) Deburr and chamfer the part of the 272A4452-1026 tube that is still attached to the airplane structure.
- 7) Make witness marks (see FLARELESS TUBING ASSEMBLY - REPAIRS, 20-10-51/801 and the fitting manufacturer's instructions).
- 8) Mark and cut a new section of 272A4452-1026 tubing.
 - a) Use the cut section of tubing that was removed from the airplane to determine where the new tube should be cut.

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- b) Use the Axial Swage Fitting Installation (5,000 psi rated - Union) or Male/Female Adapter Fittings, TASK 20-10-51-400-808 for making a splice repair with a AS5969T0606/DAS5969T0606 union.
 - c) Deburr and chamfer both ends of the new tube section.
 - d) Make witness marks on both ends of the new tube section (see FLARELESS TUBING ASSEMBLY - REPAIRS, 20-10-51/801 and the fitting manufacturer's instructions).
- (b) Remove the 272A4452-1029 tube.
- 1) Remove the support clamps (as necessary).
 - 2) Move the tube away from the structure.
 - 3) Cut the tube approximately halfway between the support clamp locations.
 - 4) Cut the tube adjacent to the tee fitting (AS5972T060606/DAS5972T060606).
NOTE: This will allow the remaining section of the tube to be moved away from the stringer for the second cut where the splice will be placed.
 - 5) Remove the cut portion of the tube.
 - a) Save this section of tube for reference.
 - 6) Deburr and chamfer the part of the 272A4452-1029 tube that is still attached to the airplane structure.
 - 7) Make witness marks (see FLARELESS TUBING ASSEMBLY - REPAIRS, 20-10-51/801 and the fitting manufacturer's instructions).
 - 8) Mark and cut a new section of 272A4452-1029 tubing.
 - a) Use the cut section of tubing that was removed from the airplane to determine where the new tube should be cut.
 - b) Use the Axial Swage Fitting Installation (5,000 psi rated - Union) or Male/Female Adapter Fittings, TASK 20-10-51-400-808 for making a splice repair with a AS5969T0606/DAS5969T0606 union.
 - c) Deburr and chamfer both ends of the new tube.
 - d) Make witness marks on both ends of the new tube (see FLARELESS TUBING ASSEMBLY - REPAIRS, 20-10-51/801 and the fitting manufacturer's instructions).
- (c) Remove the 272A4452-1001 tube.
- 1) Remove the support clamps (as necessary).
 - 2) Move the tube away from the structure.
 - 3) Cut the tube at the locations shown in Figure 836.
 - 4) Remove the AS5972T060606/DAS5972T060606 tee fitting and the cut portion of the tube.
 - a) Save this section of tube for reference.
 - 5) Deburr and chamfer the part of the 272A4452-1001 tube that is still attached to the airplane structure.
 - 6) Make witness marks (see FLARELESS TUBING ASSEMBLY - REPAIRS, 20-10-51/801 and the fitting manufacturer's instructions).
 - 7) Mark and cut a new section of 272A4452-1001 tubing.



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- a) Use the cut section of tubing that was removed from the airplane to determine where the new tube should be cut.
- b) Use the Axial Swage Fitting Installation (5,000 psi rated - Union) or Male/Female Adapter Fittings, TASK 20-10-51-400-808 for making a splice repair with a AS5969T0606/DAS5969T0606 union.
- c) Deburr and chamfer both ends of the new tube section.
- d) Make witness marks on both ends of the new tube section (see FLARELESS TUBING ASSEMBLY - REPAIRS, 20-10-51/801 and the fitting manufacturer's instructions).

SUBTASK 20-10-51-420-028

(4) Pre-assemble the tubes and fittings:

- (a) Slide the AS5969T0606/DAS5969T0606 union fittings on the prepared ends of the 272A4452-1001, 272A4452-1026, and 272A4452-1029 tubes that are still attached to the airplane structure.
- (b) Slide the replacement 272A4452-1029 tube section into the AS5969T0606/DAS5969T0606 union that is on the remaining section of 272A4452-1029 section that is attached to the airplane structure.
- (c) Slide the replacement 272A4452-1026 tube section into the AS5969T0606/DAS5969T0606 union that is on the remaining section of the 272A4452-1026 section that is attached to the airplane structure.
- (d) Slide the side leg of the new AS5972T060606/DAS5972T060606 tee fitting on the end of the new 272A4452-1026 tube.
- (e) Slide the free end of the new 272A4452-1029 tube into one run leg of the new AS5972T060606/DAS5972T060606 tee fitting.
- (f) Slide the forward end of the new 272A4452-1001 tube into the AS5972T060606/DAS5972T060606 tee fitting.
- (g) Reinstall and tighten the support clamps on the 272A4452-1001, 272A4452-1026, and 272A4452-1029 tubes.
 - 1) Make sure the AS5972T060606/DAS5972T060606 tee fitting stays in position.
 - 2) Make sure that you do not clamp the tube at the repair fitting location.

NOTE: Clamps are sized to fit standard tube diameters. If a repair swage is clamped, the clamp can move off of the uniform surface because the tube can migrate or flex.

- (h) On the new 272A4452-1001, 272A4452-1026, and 272A4452-1029 tubes, mark the position of the AS5969T0606/DAS5969T0606 union.
 - 1) Make a felt tip mark across each fitting and tube.

NOTE: This will indicate the correct clocking during final installation.
 - 2) Make sure that the new AS5972T060606/DAS5972T060606 tee fitting, AS5969T0606/DAS5969T0606 union fittings, and the replacement tubes are in the correct position.
 - a) Make sure that they are correctly routed with no clearance issues and with no preload introduced.
- (i) Mark the position of the AS5972T060606/DAS5972T060606 tee fitting on the 272A4452-1001, 272A4452-1026, and 272A4452-1029 tubes.

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- 1) Make a felt tip mark across each fitting and tube.

NOTE: This will indicate the correct clocking during final installation.

SUBTASK 20-10-51-420-029

- (5) Do the final installation of the tubes and fittings:

- (a) Remove the 272A4452-1026 and 272A4452-1029 tube sections.

- 1) Loosen and remove the clamps on the 272A4452-1026 and 272A4452-1029 tubes (as necessary).

- a) Make sure that you do not clamp the tube at the repair fitting location.

NOTE: Clamps are sized to fit standard tube diameters. If a repair swage is clamped, the clamp can move off of the uniform surface because the tube can migrate or flex.

- 2) Remove the end of the 272A4452-1026 tube from the AS5972T060606/DAS5972T060606 tee fitting.

- a) Swing the 272A4452-1026 tube to allow access to the 272A4452-1029 tube for swaging.

- 3) Remove the end of 272A4452-1029 tube from the AS5972T060606/DAS5972T060606 tee fitting.

- a) Move the tube away from the stringer far enough to allow for access to swage the tube to the AS5969T0606/DAS5969T0606 union fitting.

- (b) Swage the fittings to 272A4452-1029 tube section.

- 1) Position the AS5969T0606/DAS5969T0606 union fitting to the witness marks on the end of the 272A4452-1029 tube that is attached to the airplane structure.

- a) Make sure that the fitting is centered on the tube ends at both sides of the joint.

- 2) Swage the fitting using Axial Swage Fitting Installation (5,000 psi rated - Union) or Male/Female Adapter Fittings, TASK 20-10-51-400-808 and the fitting manufacturer's instructions.

- 3) Position the AS5969T0606/DAS5969T0606 union fitting to the witness marks and to the clocking mark on the end of the new 272A4452-1029 tube.

- a) Make sure that the fitting is centered on the tube ends at both sides of the joint.

- 4) Swage the fitting using Axial Swage Fitting Installation (5,000 psi rated - Union) or Male/Female Adapter Fittings, TASK 20-10-51-400-808 and the fitting manufacturer's instructions.

- 5) Position the end of the 272A4452-1029 tube into the forward end of the AS5972T060606/DAS5972T060606 tee fitting.

- 6) Reposition the AS5972T060606/DAS5972T060606 tee and the 272A4452-1026 and the 272A4452-1029 tubes.

- 7) Reposition and tighten the support clamps on the straight portions to the left on the 272A4452-1026 and 272A4452-1029 tubes.

- a) Make sure that you do not tighten the forward support clamp on the 272A4452-1029 tube.

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- b) Make sure that you do not clamp the tube at the repair fitting location.

NOTE: Clamps are sized to fit standard tube diameters. If a repair swage is clamped, the clamp can move off of the uniform surface because the tube can migrate or flex.

- (c) Swage the fittings to the 272A4452-1026 tube section.

- 1) Reposition the end of the 272A4452-1026 tube into the side leg of the AS5972T060606/DAS5972T060606 tee fitting.
- 2) Position the AS5969T0606/DAS5969T0606 union fitting to the witness marks on the end of the 272A4452-1026 tube that is attached to the airplane structure.
- 3) Swage the DAS5969T0606 union and 272A4452-1026 tube.
 - a) Move the 272A4452-1026 tube away from the airplane structure if necessary for access.
 - b) Use Axial Swage Fitting Installation (5,000 psi rated - Union) or Male/Female Adapter Fittings, TASK 20-10-51-400-808 and the fitting manufacturer's instructions.
- 4) Position the AS5969T0606/DAS5969T0606 union fitting to the witness marks and the clocking mark on the end of the new 272A4452-1026 tube.
 - a) Make sure that the AS5972T060606/DAS5972T060606 tee fitting is in the correct position at the end of the 272A4452-1026 tube.
- 5) Swage the AS5969T0606/DAS5969T0606 union and 272A4452-1026 tube.
 - a) Use Axial Swage Fitting Installation (5,000 psi rated - Union) or Male/Female Adapter Fittings, TASK 20-10-51-400-808 and the fitting manufacturer's instructions.

- (d) Swage the fittings to the 272A4452-1001 tube section.

- 1) Position the AS5972T060606/DAS5972T060606 tee fitting to the witness marks and clock position mark on the 272A4452-1029 tube.
- 2) Position the AS5972T060606/DAS5972T060606 tee fitting to the witness marks and clock position mark on the 272A4452-1026 tube.
- 3) Position the AS5969T0606/DAS5969T0606 union fitting to the witness marks on the end of the 272A4452-1001 tube that is attached to the airplane structure.
- 4) Make sure that the opposite end of the 272A4452-1001 tube is correctly positioned in the AS5972T060606/DAS5972T060606 tee fitting.
- 5) Swage the AS5969T0606/DAS5969T0606 union fitting and the 272A4452-1001 tube that is attached to the airplane structure.
 - a) Use Axial Swage Fitting Installation (5,000 psi rated - Union) or Male/Female Adapter Fittings, TASK 20-10-51-400-808 and the fitting manufacturer's instructions.
- 6) Position the new 272A4452-1001 tube to the clocking mark on the AS5972T060606/DAS5972T060606 tee fitting.
- 7) Position the new AS5969T0606/DAS5969T0606 union fitting to the witness marks and the clocking mark on the new 272A4452-1001 tube.
- 8) Swage the AS5969T0606/DAS5969T0606 union fitting and the new 272A4452-1001 tube.

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- a) Use Axial Swage Fitting Installation (5,000 psi rated - Union) or Male/Female Adapter Fittings, TASK 20-10-51-400-808 and the fitting manufacturer's instructions.
- 9) Position the AS5972T060606/DAS5972T060606 tee fitting to the fitting marks and the clocking position mark on the 272A4452-1001 tube.
- 10) Swage the AS5972T060606/DAS5972T060606 tee fitting and the 272A4452-1001 tube.
 - a) Use Axial Swage Fitting Installation (5,000 psi rated - Union) or Male/Female Adapter Fittings, TASK 20-10-51-400-808 and the fitting manufacturer's instructions.
- (e) After the swaging is complete, do the steps that follow.
 - 1) Make sure that the fittings are correctly installed.
 - a) Use a go/no-go gage that is supplied with the tooling to verify that the fittings are installed correctly, or check the dimensions using the tool manufacturer's instructions.
 - 2) Reinstall any loose support clamps.
 - a) Make sure that all support clamps are in place and secure at each location on each tube.
 - b) Make sure that you do not clamp the tube at the repair fitting location.

NOTE: Clamps are sized to fit standard tube diameters. If a repair swage is clamped, the clamp can move off of the uniform surface because the tube can migrate or flex.
 - 3) Remove any tagging used for marking the tubes for installation.
- (f) Pressurize the hydraulic system. Do this task: Hydraulic Reservoirs Pressurization, TASK 29-09-00-860-801.
- (g) Do a leak check. Do this task: Hydraulic Reservoir Pressurization System Leakage Test, TASK 29-09-00-860-803.

———— **END OF TASK** ————

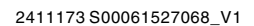
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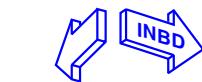
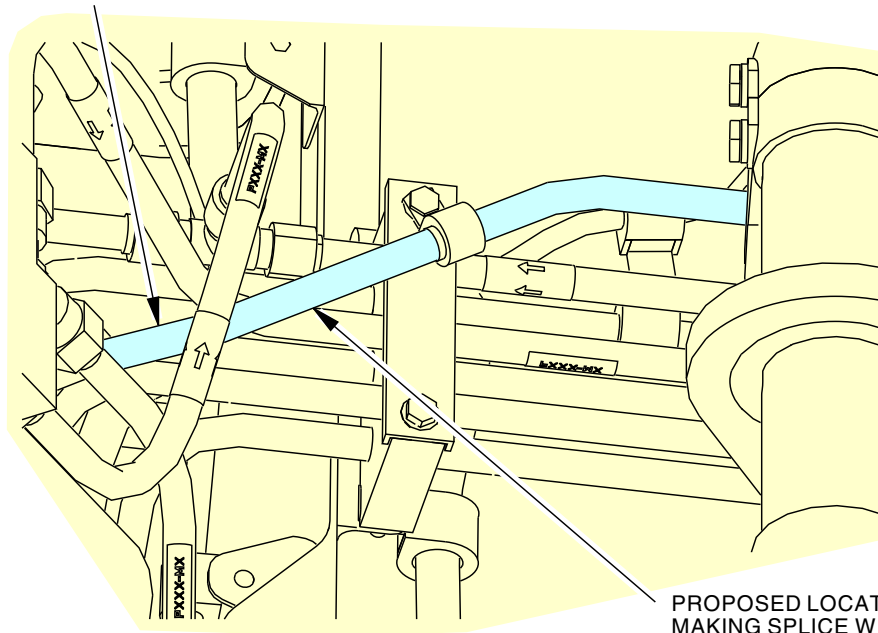


Scenario 1
Figure 834/20-10-51-990-844 (Sheet 1 of 2)

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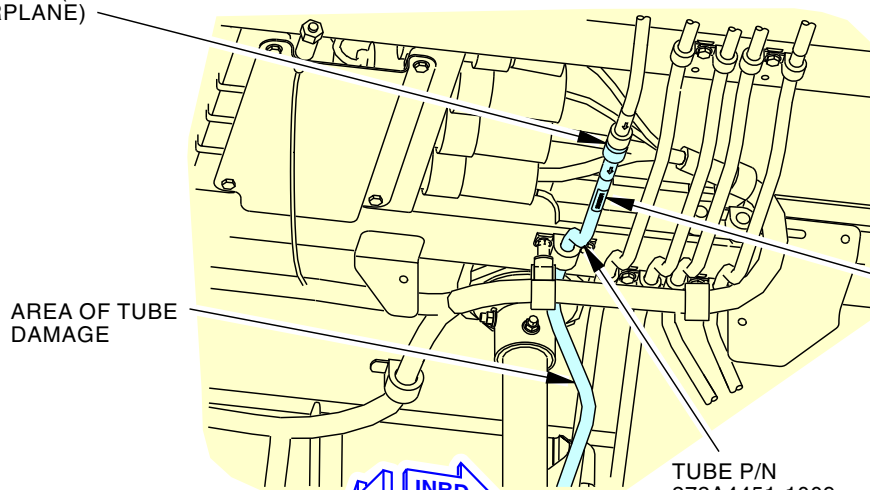
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TUBE P/N 272A4451-1009



B

EXISTING DAS5969T
TUBE-TO-TUBE UNION
FITTING (DELIVERED ON
AIRPLANE)



C

TUBE P/N
272A4451-1009

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Scenario 1
Figure 834/20-10-51-990-844 (Sheet 2 of 2)

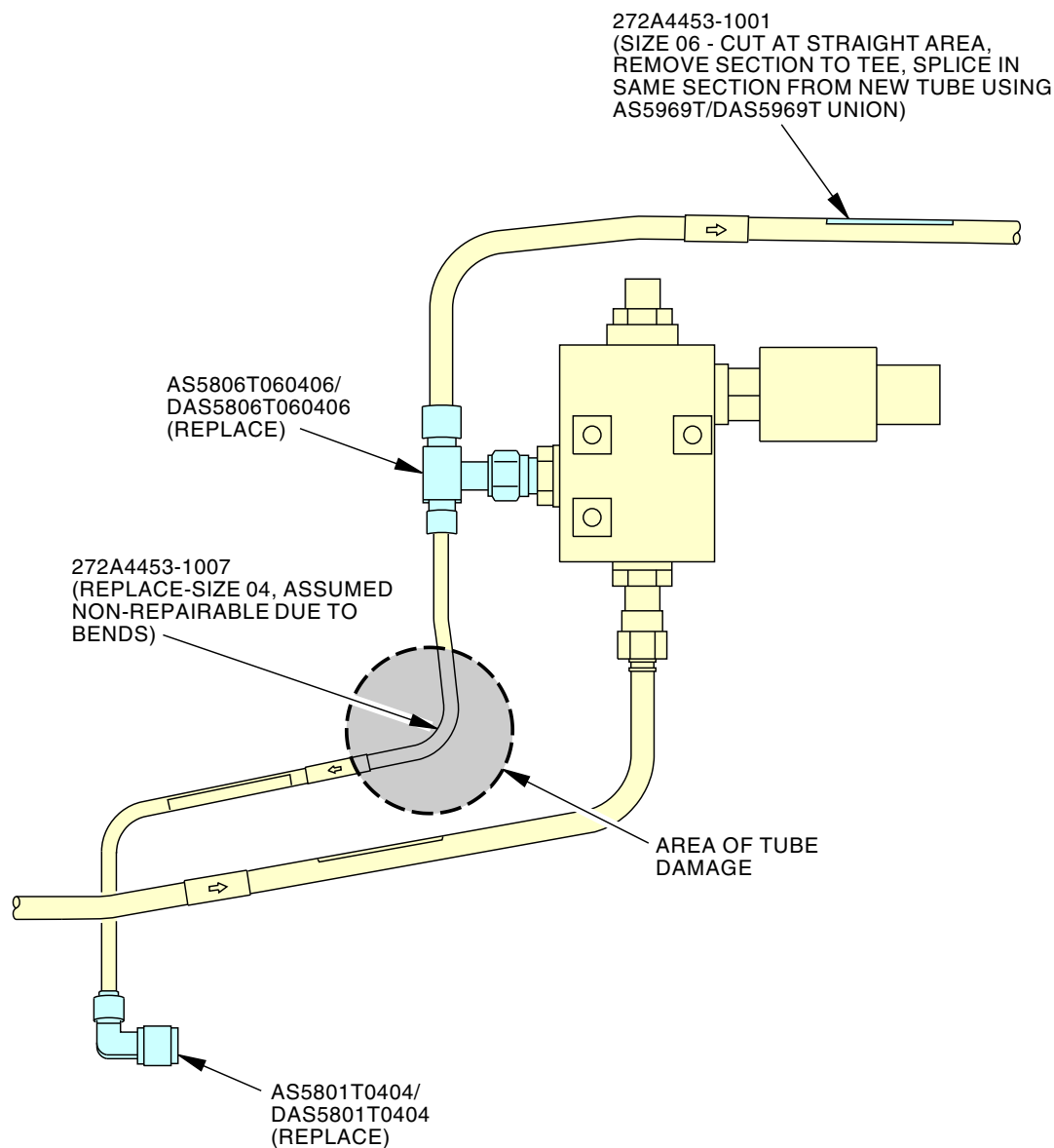
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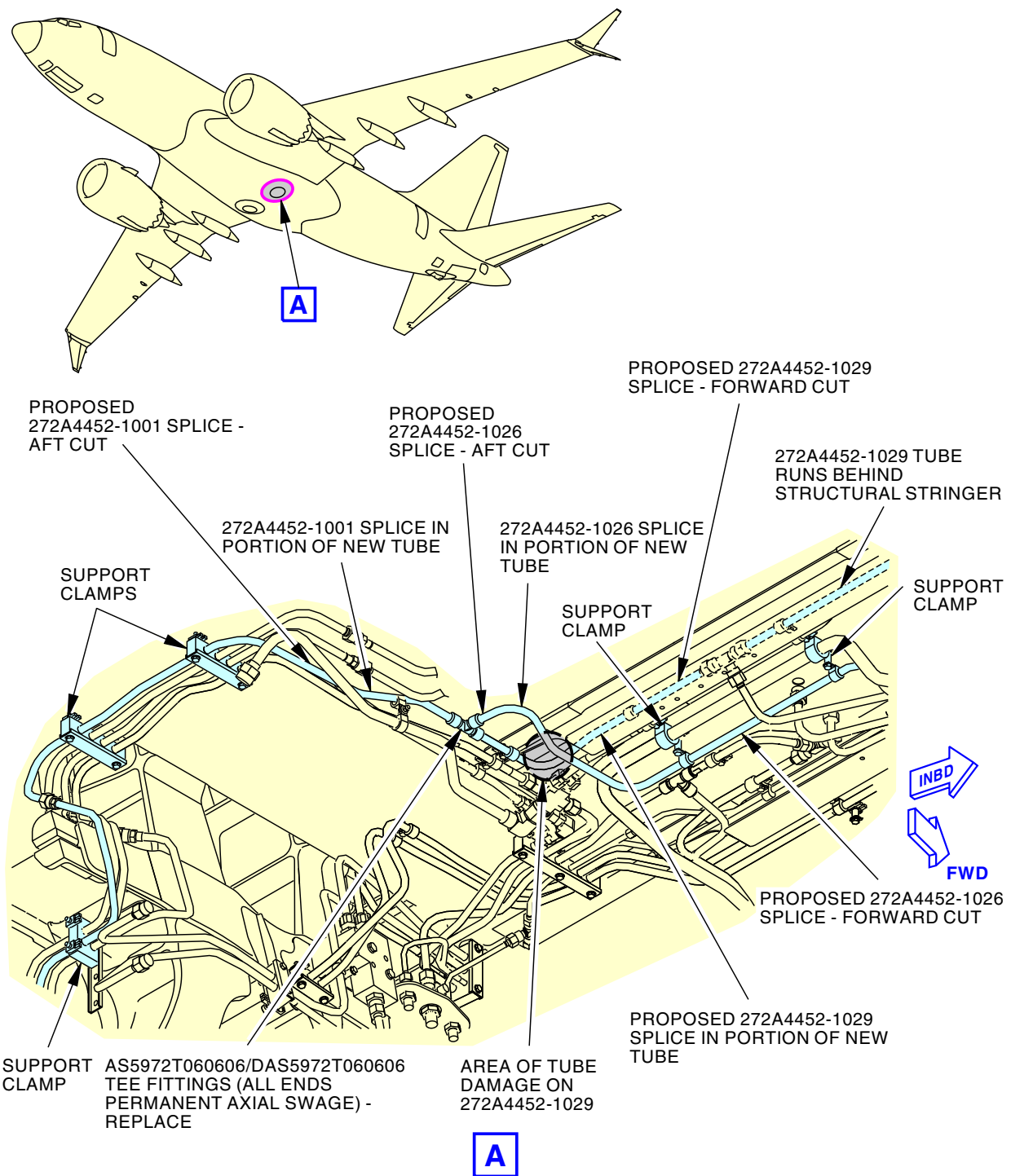
Scenario 2
Figure 835/20-10-51-990-845

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**Scenario 3
Figure 836/20-10-51-990-846**

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FLEXIBLE HOSE - MAINTENANCE PRACTICES

1. General

A. This procedure gives maintenance practices for hydraulic hoses.

TASK 20-10-52-211-801

2. CRES Hydraulic Hose - Examination

(Figure 201, Figure 202)

A. General

- (1) CRES hydraulic hoses can also be referred to as "Teflon Hoses."
- (2) Teflon hoses are not subject to aging. The design objective for Teflon hoses is that they are not life-limited.
- (3) Teflon is inert to contaminants found in aircraft applications. However, corrosive contaminants on a hose, particularly chlorine compounds, have resulted in corrosion pitting of the CRES wire braiding. Corrosion pitting of CRES hydraulic tubing has also been found in wheel wells and other areas. Periodic cleaning with a Boeing recommended cleaning solution (AIRPLANE CLEANING AND POLISHING - MAINTENANCE PRACTICES, PAGEBLOCK 12-40-00/201) along with coating of the hoses with corrosion preventative compound or equivalent could be beneficial.
- (4) Hose leakage and failure can be caused by:
 - (a) External damage that can cause a fatigue crack in the inner Teflon tube.
 - (b) Vibration as a result of incorrect support.
 - (c) Preload induced in the hose during installation that will result in a fatigue related failure of the hose.

B. References

Reference	Title
12-40-00 P/B 201	AIRPLANE CLEANING AND POLISHING - MAINTENANCE PRACTICES
20-10-52 P/B 401	FLEXIBLE HOSE - REMOVAL/INSTALLATION

C. CRES Hydraulic Hose Examination

SUBTASK 20-10-52-211-001

- (1) CRES hoses should be examined for the conditions that follow:
 - (a) Kinks.
 - (b) Twisting.
 - (c) Chafing.
 - (d) Corrosion.
 - (e) Broken wires.
 - (f) Leakage.
 - (g) Missing/incorrect support.
 - (h) Bird-caging.
- (2) Hoses that are found to be damaged should be replaced and the condition that caused the damage should be corrected.
 - (a) To replace the hose, do this procedure: FLEXIBLE HOSE - REMOVAL/INSTALLATION, PAGEBLOCK 20-10-52/401.

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- (3) Replace hoses if two or more wires in one plait are broken, or if several wires are broken in the same area. (Figure 201)
 - (a) Broken wires can be found by careful visual inspection and/or carefully running a soft cloth over the outside of the hose.
 - (b) To replace the hose, do this procedure: FLEXIBLE HOSE - REMOVAL/INSTALLATION, PAGEBLOCK 20-10-52/401.
- (4) Special attention must be given to examine the sleeve and wire braid for damage at the hose end (hose-to-fitting transition).
 - (a) Replace hoses that have damaged fire sleeves (installed in high temperature areas). Do this procedure FLEXIBLE HOSE - REMOVAL/INSTALLATION, PAGEBLOCK 20-10-52/401.
- (5) Do a detailed visual inspection of the hose for bird-caging. (Figure 202)

NOTE: Bird-caging is a failure condition where the metal braiding is extended to a diameter more than the outer diameter of the braid ring.

 - (a) If bird-caging is found in the hose assembly, replace the hose.

———— **END OF TASK** ————

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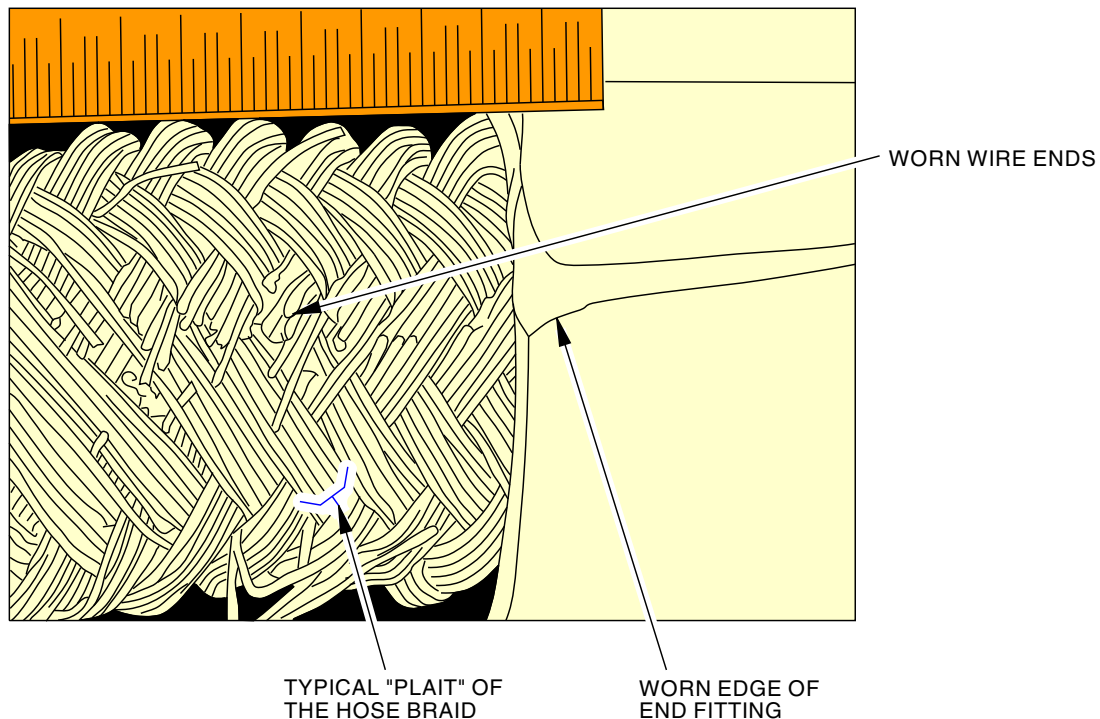
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CRES BRAIDED HOSE DAMAGE

NOTE:

EXAMPLE OF DAMAGED/FRACTURED WIRES IN HOSE SUPPORT BRAID
AT ONE END OF A RUPTURED HOSE CAUSED BY CHAFING AND
TWISTING OF THE HOSE IN SERVICE.

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Hose Leakage Identification
Figure 201/20-10-52-990-801

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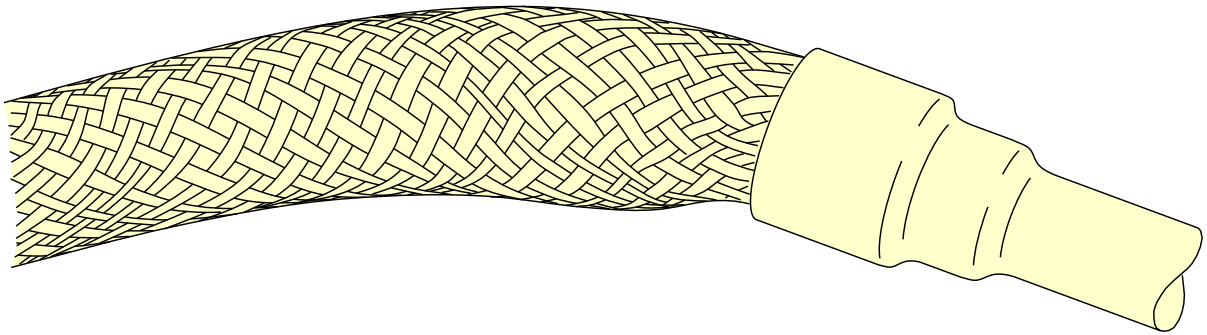
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EXAMPLE OF BIRD-CAGING

2411204 S00061527105_V1

Hose Wear
Figure 202/20-10-52-990-802

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TASK 20-10-52-400-801

3. **Spiral Sleeving - Installation**

(Figure 203)

A. General

- (1) This task gives the procedure to install spiral sleeving on hydraulic tubes and hoses.
- (2) Teflon or Nylon spiral cut sleeving can be used on hose assemblies or tube assemblies. The approved sleeving material is in Table 201 below:

Table 201/20-10-52-993-801 Approved Sleeving Material

NAME	SPECIFICATION	RECOMMENDED MATERIALS
Nylon Sleeving	AS1294	Spirap 500036
		Spirap 500037
		V00779
		V05593
Teflon Sleeving		Spirap 500024
		V00779
		V05593
		V09106

- (3) The use of self-fusing silicone tape to secure the ends of the spiral cut sleeving that is installed around the hose or tube should only be used as a temporary repair if heat shrink tubing is not immediately available.

B. Install the Spiral Sleeving

SUBTASK 20-10-52-420-001

- (1) Wrap the spiral cut sleeving around the hose or tube.
 - (a) Make sure that each end of the sleeving is no closer than 0.5 in. (12.7 mm) from the end fitting.
 - (b) Cut the spiral sleeving ends perpendicular to the lead of the coil or the longitudinal axis of the coil.

NOTE: This is to avoid sharp edges.

- 1) Make sure to break any sharp corners at the cut.

SUBTASK 20-10-52-420-002

- (2) Secure the ends of the spiral cut sleeving.
 - (a) If it is available, use heat shrink tubing to secure both ends.
 - 1) See Table 202 for approved heat shrinking materials:

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Table 202/20-10-52-993-802 Approved Heat Shrinking Materials

NAME	SPECIFICATION	RECOMMENDED MATERIALS
Heat Shrinkable Sleeving	MIL-I-23053	*[1]
	MIL-R-46846	*[1]
		Raychem RT850 (V06090) Raychem RT876 (V06090) Raychem MIL-LT (V06090) Plastronics PLF100 (V00Q87) Raychem RNF100 (V06090)

*[1] Refer to the applicable Qualified Parts List, or equivalent list, of the specification listed for approved material part numbers and vendors.

- (b) If heat shrink tubing is not available, use self-fusing silicone tape until heat shrink tubing is available to use.

NOTE: Boeing recommends that the operator use self-fusing silicone tape only as a temporary repair.

- 1) Use self-fusing silicone tape and tie wraps to secure the sleeving.
a) See Table 203 below for allowable silicone tape material:

Table 203/20-10-52-993-803 Approved Silicone Tape Materials

NAME	SPECIFICATION	RECOMMENDED MATERIAL
Silicone Tape		Permacel 2650, V99742
		Scotch 70, V76381

————— END OF TASK —————

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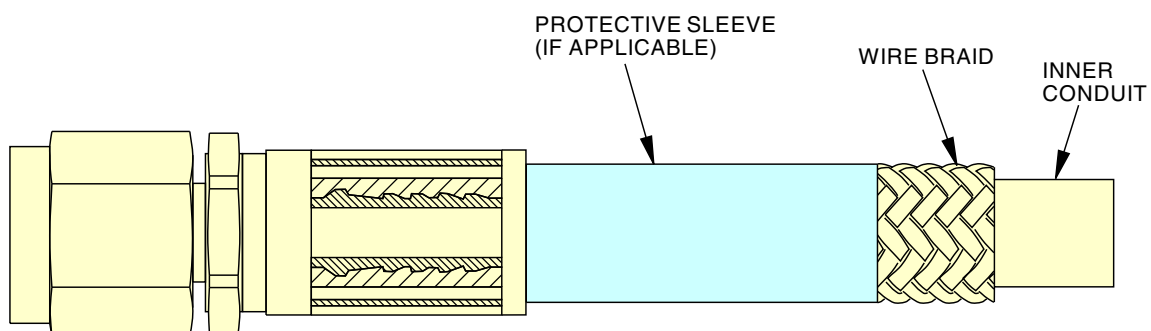
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CRES Spiral Sleeving
Figure 203/20-10-52-990-803

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TASK 20-10-52-400-802

4. Protective Lacing - Installation

(Figure 204)

A. Consumable Materials

Reference	Description	Specification
A00027	Adhesive - Silicone Rubber, 1 Part, RTV	BAC5010 Type 60
G00057	Tape - PTFE Flim With Acrylic Adhesive, 3M 63 Tape	
G02503	Lacing - Varflex Nylon Untreated Sleeving, 1/8 Inch I.D. (Ref P/N 65-96194-1)	A-A-59301

B. Procedure - Install the Protective Lacing

SUBTASK 20-10-52-400-001

- (1) Install the protective Varflex lacing sleeve, G02503, as shown in Figure 204, except on nose landing gear.

SUBTASK 20-10-52-400-002

- (2) Install the protective Varflex lacing sleeve, G02503 on nose landing gear, as shown in Figure 204.
- (a) Prior to pulling lock lace through, (step 3), apply adhesive, A00027 to the lace.
- (b) Pull laces into place, (step 3), this will bond the laces in place.
- (c) Apply two layers of 3M 63 tape, G00057 over the lacing.
- 1) Spirally wrap each layer with a 50% overlap and reverse the direction of the spiral with each layer.
- 2) Extend the tape 1.0 in. (25.4 mm) to 1.5 in. (38.1 mm) beyond each end of the lacing.

————— END OF TASK —————

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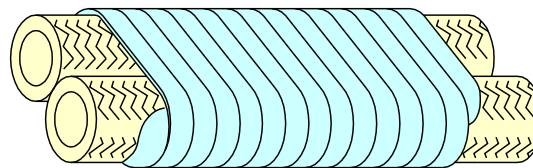
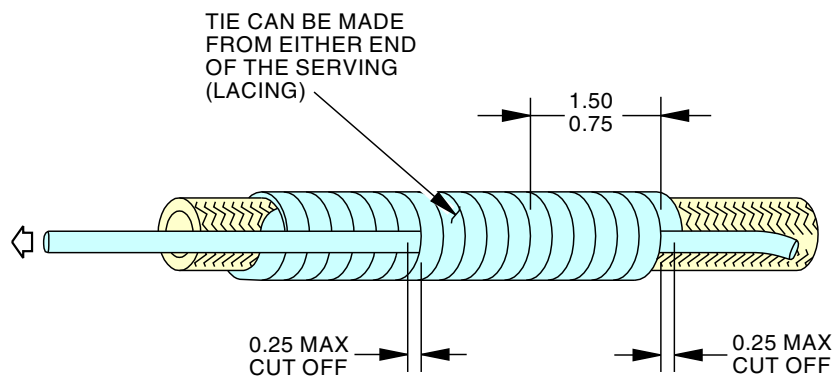
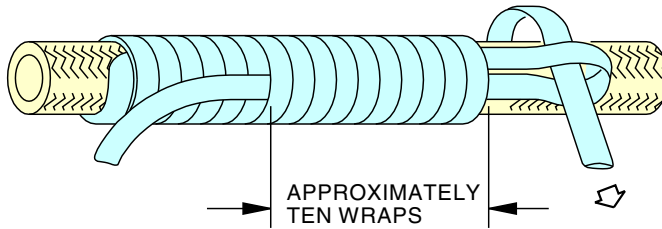
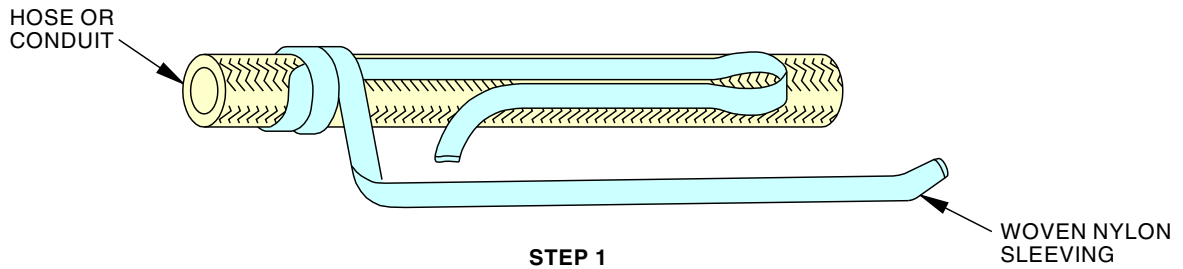
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FOR TWO OR MORE HOSES

NOTE:
ALL DIMENSIONS ARE IN INCHES.

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Protective Lacing Installation
Figure 204/20-10-52-990-804

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TASK 20-10-52-910-801

5. Correct Torque Value Determination for a Hydraulic Hose Assembly

(Figure 205)

A. General

- (1) This task will help determine the correct torque value for Hydraulic Hose Assembly. For further information, please refer to Service Letter per model (see Table 204).

Table 204/20-10-52-993-804 Service Letter for All Models

Models
737-SL-29-118
747-SL-29-077
757-SL-29-053
767-SL-29-066
777-SL-29-040

B. References

Reference	Title
20-10-51-993-846	Table: Hydraulic Fitting Material Codes (P/B 201)

C. Procedure

SUBTASK 20-10-52-200-001

- (1) Evaluate the hose part number to verify the fitting end sizes and materials on the hose. See example nameplates in Table 205, Table 206, Table 207 and Figure 205 for additional data.

Table 205/20-10-52-993-805 Example Hose Definition 1: Hydraulic Hose P/N BACH8A04EN0294K

Breakdown	Definition
BACH8A	Basic Hose Part Number (P/N)
04	Hose size (04 = 0.250 Inch Dia.)
EN	Fitting End Size "E" = Expander End No. 1 — 06 (0.375 inch) "N" = Nominal End No. 2 — 04 (0.250 inch) Note: an "R" code letter appearing here = Reducer
029	Length in Whole Inches 029 X 1.0 = 29.0 Inches
4	Fractional Length in Eighths of an Inch Increments 4 X 0.125 = 0.500
K	Braided Polyester Abrasion Sleeve (Blue Color)

NOTE: Basic hose P/N, BACH8A, defines a 3,000 PSI operating pressure, PTFE inner tube with corrosion resistant Steel (CRES) wire braid reinforcement, lightweight Hydraulic hose with straight flareless CRES end fittings.

Table 206/20-10-52-993-806 Example Hose Definition 2: Hydraulic Hose P/N AS115-06K0344

Breakdown	Definition
AS115	Basic Hose Part Number (P/N)
06	Hose Size (06 = 0.375 Inch Dia.)

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Table 206/20-10-52-993-806 Example Hose Definition 2: Hydraulic Hose P/N AS115-06K0344
(Continued)

Breakdown	Definition
K	Integral Braided Polyester Abrasion Sleeve (Blue Color)
034	Length in Whole Inches 034 X 1.0 = 34.0 in. (864 mm)
4	Fractional Length in Eighths of an Inch Increments 4 X 0.125 =0.500 in. (12.70 mm)

NOTE: Basic hose P/N, AS115, defines a 3,000 PSI operating pressure, PTFE inner tube with corrosion resistant Steel (CRES) wire braid reinforcement, lightweight hydraulic hose with straight flareless CRES end fittings.

Table 207/20-10-52-993-807 Example Hose Definition 3: "Para-Aramid" Reinforced Hydraulic Hose P/N AS4568G0344SS

Breakdown	Definition
AS4568	Basic Hose Part Number (P/N)
G	Hose Size (G = 0.375 Inch)
-	Sleeve Code, (-) = No Sleeve
034	Length in Whole Inches, 034 X 1.0 = 34.0 in. (864 mm)
4	Fractional Length in Eighths of an Inch Increments 4 x 0.125 =0.500 in. (12.70 mm)
S	1st Straight Fitting End (Hose Size)
S	2nd Straight Fitting End (Hose Size)

NOTE: Basic hose P/N, AS4568, defines a 3,000 PSI operating pressure, PTFE inner tube with "Para-Aramid" braid reinforcement, lightweight hydraulic hose with straight flareless titanium end fittings, reduce/expander options available.

SUBTASK 20-10-52-200-002

- (2) Use the Illustration Parts Catalog (IPC) to determine the materials of the parts that you will attach the hose ends to.

NOTE: A mating fitting made from aluminum material requires lower torque value than a titanium or CRES fitting.

NOTE: Components that are attached to hose ends usually have flareless union fittings installed to the external ports. See Table 20-10-51-993-846 to identify hydraulic fitting materials.

SUBTASK 20-10-52-910-001

- (3) Select and apply the correct torque values. Use Table 208 to locate the correct torque values per model:

Table 208/20-10-52-993-808 Installation Torque for Flareless Tubing Fittings Table for all Models

Models	Location in AMM
737-300/400/500	20-50-11/201
737-600/700/800/900	20-50-11/201
737-7/8/8200/9	20-50-11/201
747-400	20-51-01/201
747-8	20-51-01/201

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**Table 208/20-10-52-993-808 Installation Torque for Flareless Tubing Fittings Table for all Models
(Continued)**

Models	Location in AMM
757	20-11-00/201
767	20-11-00/201
777	20-11-00/201

———— **END OF TASK** ————

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HYDRAULIC HOSE IDENTIFICATION						
HOSE CONFIGURATION AND USAGE	ILLUSTRATION	PART NUMBER	HOSE SIZES	END SIZES (NON-REDUCER - SAME AS HOSE SIZE)	MATERIAL AND RATING DATA	
					HOSE BRAID MATERIAL/END FITTING MATERIAL	PRESSURE RATING
STRAIGHT-TO-STRAIGHT, NON-REDUCER		AS115	04 THROUGH 16	04 THROUGH 16	CRES/CRES	3,000 PSI
STRAIGHT-TO-45 DEGREE, NON-REDUCER		AS116	04 THROUGH 16	04 THROUGH 16	CRES/CRES	3,000 PSI
STRAIGHT-TO-90 DEGREE, NON-REDUCER		AS117	04 THROUGH 16	04 THROUGH 16	CRES/CRES	3,000 PSI
45 DEGREE-TO-45 DEGREE, NON-REDUCER		AS118	04 THROUGH 16	04 THROUGH 16	CRES/CRES	3,000 PSI
45 DEGREE-TO-90 DEGREE, NON-REDUCER		AS119	04 THROUGH 16	04 THROUGH 16	CRES/CRES	3,000 PSI
90 DEGREE-TO-90 DEGREE, NON-REDUCER		AS120	04 THROUGH 16	04 THROUGH 16	CRES/CRES	3,000 PSI
EXAMPLE OF PART NUMBER: AS115 08 K 024 2 BASIC P/N HOSE SIZE (08) FRACTION OF HOSE LENGTH IN EIGHTHS OF AN INCH (0.25 INCH) K = INTEGRAL BLUE POLYESTER ABRASION SLEEVE HOSE LENGTH IN WHOLE INCHES BOEING APPROVED SLEEVE CODES : " " = NO SLEEVING B = NYLON ABRASION SLEEVE F = POLYOLEFIN ABRASION SLEEVE H = INTEGRAL SILICONE FIRESLEEVE (15 MINUTE) K = INTEGRAL BLUE POLYESTER ABRASION SLEEVE L = COIL ABRASION SLEEVE PROCUREMENT SPECIFICATION IS AS1339						

NOTE:

NOT KEPT UP TO DATE - ALWAYS CONSULT LATEST REVISION OF FITTING STANDARD FOR P/N AND SUPERSESSION DATA.

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Hydraulic Hose Identification
Figure 205/20-10-52-990-805 (Sheet 1 of 5)

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HYDRAULIC HOSE IDENTIFICATION (CONTINUED)						
HOSE CONFIGURATION AND USAGE	ILLUSTRATION	PART NUMBER	HOSE SIZES	END SIZES (NON-REDUCER - SAME AS HOSE SIZE)	MATERIAL AND RATING DATA	
					HOSE BRAID MATERIAL/END FITTING MATERIAL	PRESSURE RATING
STRAIGHT-TO-STRAIGHT, EXPANDER-REDUCER		BACH8A	04 THROUGH 12	04 THROUGH 16	CRES/CRES	3,000 PSI
STRAIGHT-TO-45 DEGREE, EXPANDER-REDUCER		BACH8B	04 THROUGH 12	04 THROUGH 16	CRES/CRES	3,000 PSI
STRAIGHT-TO-90 DEGREE, EXPANDER-REDUCER		BACH8C	04 THROUGH 12	04 THROUGH 16	CRES/CRES	3,000 PSI
EXAMPLE OF PART NUMBER: BASIC P/N: BACH8A 08 ER 020 4 B			BOEING APPROVED SLEEVE CODES : " " = NO SLEEVING B = NYLON ABRASION SLEEVE F = POLYOLEFIN ABRASION H = INTEGRAL SILICONE FIRESLEEVE (15 MINUTE) K = INTEGRAL BLUE POLYESTER ABRASION SLEEVE L = COIL ABRASION SLEEVE PROCUREMENT SPECIFICATION IS AS1339.			
FITTING ENDS (SEE STANDARD): NO. 1 END - SIZE 10, STRAIGHT NO. 2 END - SIZE 06, STRAIGHT						
E = EXPANDER N = NORMAL (SAME AS HOSE SIZE) R = REDUCER						

NOTE:
NOT KEPT UP TO DATE - ALWAYS CONSULT LATEST REVISION OF FITTING STANDARD FOR P/N AND SUPERSESSSION DATA.
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Hydraulic Hose Identification
Figure 205/20-10-52-990-805 (Sheet 2 of 5)

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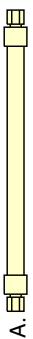
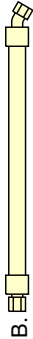
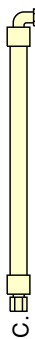
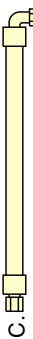
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HYDRAULIC HOSE IDENTIFICATION (CONTINUED)						
HOSE CONFIGURATION AND USAGE	ILLUSTRATION	PART NUMBER	HOSE SIZE	MINIMUM END SIZE	MAXIMUM END SIZE	MATERIAL AND RATING DATA
						HOSE BRAID MATERIAL/END FITTING MATERIAL PRESSURE RATING
A. STRAIGHT-TO-STRAIGHT, EXPANDER/REDUCER		BACH6M	04	04	06	MULTI-LAYER CRES/CRES 3,000 PSI
B. STRAIGHT-TO-45 DEGREE, EXPANDER/REDUCER		BACH6P	06	04	08	MULTI-LAYER CRES/CRES 3,000 PSI
C. STRAIGHT-TO-90 DEGREE, EXPANDER/REDUCER	 NOTE: SEE BOEING STANDARD BACH6MTHRUH6V	BACH6R	08	06	10	MULTI-LAYER CRES/CRES 3,000 PSI
A. STRAIGHT-TO-STRAIGHT, EXPANDER/REDUCER		BACH6S	10	08	12	MULTI-LAYER CRES/CRES 3,000 PSI
B. STRAIGHT-TO-45 DEGREE, EXPANDER/REDUCER		BACH6T	12	10	16	MULTI-LAYER CRES/CRES 3,000 PSI
C. STRAIGHT-TO-90 DEGREE, EXPANDER/REDUCER	 NOTE: SEE BOEING STANDARD BACH6MTHRUH6V	BACH6V	16	12	16	MULTI-LAYER CRES/CRES 3,000 PSI
EXAMPLE OF PART NUMBER: BACH6 P 035 4 AT N BASIC P/N HOSE SIZE (06) HOSE LENGTH IN WHOLE INCHES N = PTFE ABRASION SLEEVE PURPLE BM S3-11 BAND CRES FITTINGS END NO. 1: SIZE 06, 90 DEGREE ELBOW END NO. 2: SIZE 04, STRAIGHT FITTING FRACTION OF HOSE LENGTH IN EIGHTHS OF AN INCH (0.50 INCH)		BOEING APPROVED SLEEVE CODES: CONSULT BOEING STANDARD BACH6MTHRUH6V FOR TABLES SHOWING SLEEVE CODES AND END FITTING SIZE COMBINATIONS. PROCUREMENT SPECIFICATION IS BPS-H-95. NOTE: BACH6MTHRUH6V IS NOW INACTIVE FOR BOEING DESIGN AND PROCUREMENT.				

NOTE:

NOT KEPT UP TO DATE - ALWAYS CONSULT LATEST REVISION OF FITTING STANDARD FOR P/N AND SUPERSESSION DATA.
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Hydraulic Hose Identification
Figure 205/20-10-52-990-805 (Sheet 3 of 5)

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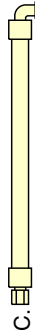
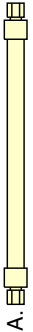
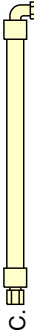
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HYDRAULIC HOSE IDENTIFICATION (CONTINUED)

HOSE CONFIGURATION AND USAGE	ILLUSTRATION	PART NUMBER	HOSE SIZE	MINIMUM END SIZE	MAXIMUM END SIZE	MATERIAL AND RATING DATA	
						HOSE BRAID MATERIAL/END FITTING MATERIAL	PRESSURE RATING
A. STRAIGHT-TO-STRAIGHT, EXPANDER/REDUCER		BACH5M	04	04	06	CRES/304 CRES OR ALUM*	1,500 PSI
B. STRAIGHT-TO-45 DEGREE, EXPANDER/REDUCER		BACH5P	06	04	08	CRES/304 CRES OR ALUM*	1,500 PSI
C. STRAIGHT-TO-90 DEGREE, EXPANDER/REDUCER		BACH5R	08	06	10	CRES/304 CRES OR ALUM*	1,500 PSI
*NOTE: SEE BOEING STANDARD BACH5MTHRUH5X.							
A. STRAIGHT-TO-STRAIGHT, EXPANDER/REDUCER		BACH5T	12	10	16	CRES/304 CRES OR ALUM*	1,000 PSI
B. STRAIGHT-TO-45 DEGREE, EXPANDER/REDUCER		BACH5V	16	12	20	CRES/304 CRES OR ALUM*	1,000 PSI
C. STRAIGHT-TO-90 DEGREE, EXPANDER/REDUCER		BACH5W	20	16	20	CRES/304 CRES OR ALUM*	1,000 PSI
*NOTE: SEE BOEING STANDARD BACH5MTHRUH5X.							
EXAMPLE OF PART NUMBER:		BACH5 P 040 6 AT T					
		BASIC P/N HOSE SIZE (06) HOSE LENGTH IN WHOLE INCHES					
		T = TFE ABRASION SLEEVE CRES FITTINGS FRACTION OF HOSE LENGTH IN EIGHTHS OF AN INCH (0.75 INCH)					
		END NO. 1: SIZE 04 STRAIGHT END NO. 2: SIZE 06 90 DEGREE ELBOW					
		L SUFFIX = COUPLING NUTS DRILLED FOR LOCKWIRE					
		BOEING APPROVED SLEEVE CODES:					
		BLANK = NONE					
		F = FIRE SLEEVE					
		S = SPIRAL WRAP POLYAMIDE OR TEFLON ABRASION SLEEVE					
		T = TUBULAR TEFLON ABRASION SLEEVE					
		P = TUBULAR POLYOLEFIN ABRASION SLEEVE					
		CONSULT BOEING STANDARD BACH5MTHRUH5X FOR TABLE SHOWING END FITTING SIZE COMBINATIONS;					
		PROCUREMENT SPECIFICATION IS AS1946					

NOTE:

NOT KEPT UP TO DATE - ALWAYS CONSULT LATEST REVISION OF FITTING STANDARD FOR P/N AND SUPERSESSION DATA.

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Hydraulic Hose Identification
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HYDRAULIC HOSE IDENTIFICATION (CONTINUED)						
HOSE CONFIGURATION AND USAGE	ILLUSTRATION	PART NUMBER	HOSE SIZE	MINIMUM END SIZE	MAXIMUM END SIZE	MATERIAL AND RATING DATA
						HOSE BRAID MATERIAL/END FITTING MATERIAL PRESSURE RATING
STRAIGHT-TO-STRAIGHT, NON-REDUCER		AS1633	04 THROUGH 24	04	24	CRES/CRES 1,000 PSI (SIZES 04 THROUGH 20) 750 PSI (SIZE 24)
STRAIGHT-TO-45 DEGREE, NON-REDUCER		AS1634	04 THROUGH 24	04	24	CRES/CRES 1,000 PSI (SIZES 04 THROUGH 20) 750 PSI (SIZE 24)
STRAIGHT-TO-90 DEGREE, NON-REDUCER		AS1635	04 THROUGH 24	04	24	CRES/CRES 1,000 PSI (SIZES 04 THROUGH 20) 750 PSI (SIZE 24)
45 DEGREE-TO-45 DEGREE, NON-REDUCER		AS1636	04 THROUGH 24	04	24	CRES/CRES 1,000 PSI (SIZES 04 THROUGH 20) 750 PSI (SIZE 24)
45 DEGREE-TO-90 DEGREE, NON-REDUCER		AS1637	04 THROUGH 24	04	24	CRES/CRES 1,000 PSI (SIZES 04 THROUGH 20) 750 PSI (SIZE 24)
90 DEGREE-TO-90 DEGREE, NON-REDUCER		AS1638	04 THROUGH 24	04	24	CRES/CRES 1,000 PSI (SIZES 04 THROUGH 20) 750 PSI (SIZE 24)
EXAMPLE OF PART NUMBER: AS1638 H 24 2 H 270 A BASIC P/N: AS1638 HOSE SIZE (08) HOSE LENGTH IN WHOLE INCHES HOSE CLASS CODE (A = CLASS 1, B = CLASS 2) ANGULAR ORIENTATION OF END FITTINGS IN 1 DEGREE INCREMENTS (270 DEGREES) H = INTEGRAL FIRESLEEVE FRACTION OF HOSE LENGTH IN EIGHTHS OF AN INCH (0.25 INCH) AS1634, AS1635, AS1636, AS1637, AS1638 HOSE SIZE INFORMATION: E = SIZE 04 G = SIZE 06 H = SIZE 08 J = SIZE 10 K = SIZE 12 M = SIZE 16 N = SIZE 20 P = SIZE 24 BOEING APPROVED SLEEVE CODES: B = SPIRAL ABRASION SLEEVE H = INTEGRAL FIRE SLEEVE K = INTEGRAL BLUE POLYESTER ABRASION SLEEVE PROCUREMENT SPECIFICATION IS AS1633; HOSE FITTING PER AS620.						

NOTE:

NOT KEPT UP TO DATE - ALWAYS CONSULT LATEST REVISION OF FITTING STANDARD FOR P/N AND SUPERSESSION DATA.

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**Hydraulic Hose Identification
Figure 205/20-10-52-990-805 (Sheet 5 of 5)**

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AIRCRAFT MAINTENANCE MANUAL
FLEXIBLE HOSE - REMOVAL/INSTALLATION

1. General

- A. You must consult with Boeing before conducting any repairs to oxygen tubing system.
- B. This procedure has these tasks:
 - (1) A removal of the flexible hose.
 - (2) An installation of the flexible hose.
- C. This procedure gives general instructions for the installation of flexible hoses. If there is a special procedure for a specified system, use the special procedure.
- D. Flexible hoses do not have a specified life limit. Inspect flexible hoses to the applicable operator's standard.

TASK 20-10-52-000-801

2. Flexible Hose Removal

(Figure 401)

A. Procedure

SUBTASK 20-10-52-480-001

 CAUTION	PUT CAPS ON THE HOSES AND FITTINGS. OPEN LINES LET CONTAMINATION INTO THE SYSTEM AND LET LEAKAGE OF FLUID OUT. CONTAMINATION CAN CAUSE DAMAGE TO SYSTEM COMPONENTS, AND FLUID LEAKAGE CAN CAUSE CORROSION.

- (1) Install caps on the hose assemblies and mating connections.

NOTE: Caps keep out moisture and unwanted material until the hose is again connected to its system.

SUBTASK 20-10-52-020-001

- (2) Remove the flexible hose.
 - (a) Do not use the hose if two or more wires in one plait are broken, or if several wires are broken in a concentrated area.

———— **END OF TASK** ————

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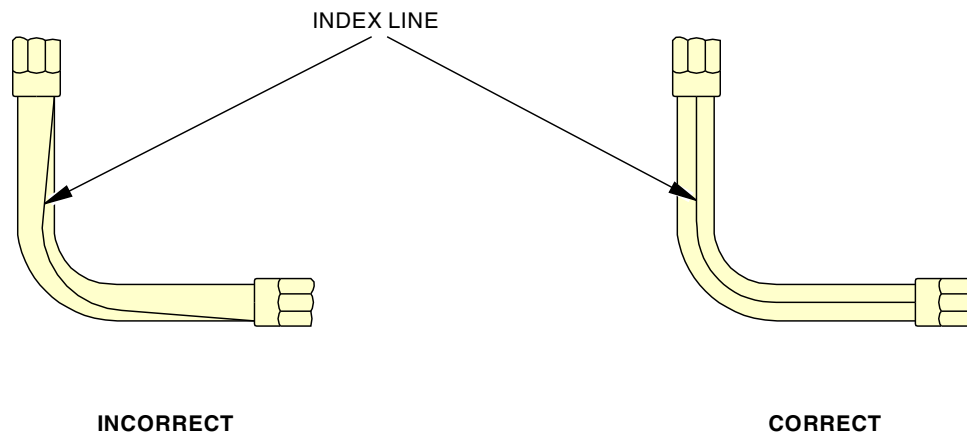
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Flexible Hose Installation
Figure 401/20-10-52-990-806

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TASK 20-10-52-400-803

3. **Flexible Hose Installation**

(Figure 401)

A. References

Reference	Title
20-50-11-910-801	Standard Torque Values (P/B 201)

B. Procedure

SUBTASK 20-10-52-210-001

- (1) Make sure all the hose fittings are clean and free of defects.

NOTE: Hoses that look like they have been kinked must be replaced.

SUBTASK 20-10-52-640-001

- (2) Lubricate the external threads as necessary with the correct lubricant.

SUBTASK 20-10-52-420-003

- (3) Put the hose in position and tighten the fitting by hand.

SUBTASK 20-10-52-420-004

- (4) Install the clamps and adjust the slack.

SUBTASK 20-10-52-210-002

- (5) Examine the installation for the correct alignment and length.

SUBTASK 20-10-52-420-005



USE THE INDEX LINE ON THE SIDE OF THE HOSE TO SHOW IF IT IS TWISTED. IF THE HOSE IS TWISTED, IT CAN CAUSE HOSE FAILURE OR LEAKS IN THE HOSE COUPLING.

- (6) Tighten the B-nut to the correct torque. Do this task: Standard Torque Values, TASK 20-50-11-910-801.

SUBTASK 20-10-52-420-006

- (7) Tighten the coupling-type ends. Do this task: Standard Torque Values, TASK 20-50-11-910-801.

NOTE: Use two wrenches, one on each end, to prevent twisted flexible tubing.

———— **END OF TASK** ————

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FLEXIBLE HOSE - REPAIRS

1. General

A. This procedure contains these tasks:

- (1) A replacement of unserviceable hydraulic rigid tubes with flexible hoses as a temporary repair.
- (2) A temporary repair of flexible hydraulic hoses.



PUT CAPS ON THE HOSES AND FITTINGS. OPEN LINES LET CONTAMINATION INTO THE SYSTEM AND LET LEAKAGE OF FLUID OUT. CONTAMINATION CAN CAUSE DAMAGE TO SYSTEM COMPONENTS, AND FLUID LEAKAGE CAN CAUSE CORROSION.

B. Keep caps on hoses and connections to keep moisture or other contamination out of the system until the hose is connected again.

TASK 20-10-52-300-801

2. Hydraulic Tubing Repair

(Figure 801)

A. General

- (1) You can use many possible repair procedures. The airline must make a decision if a procedure is applicable and safe. This procedure is not applicable to engine hydraulic tube repair or for replacement of coiled flexible tubing.

B. References

Reference	Title
20-10-51-400-802	Flareless Fittings in Pressurized Areas Installation (P/B 401)
29-09-00-860-801	Hydraulic Reservoirs Pressurization (P/B 201)
29-09-00-860-802	Hydraulic Reservoirs Depressurization (P/B 201)
29-09-00-860-803	Hydraulic Reservoir Pressurization System Leakage Test (P/B 501)

C. Procedure - Flexible Hose Installation

SUBTASK 20-10-52-860-001

- (1) Make a record of the flexible hoses that you install as temporary repairs for rigid lines.

SUBTASK 20-10-52-200-003

- (2) Make a schedule for regular inspections of the flexible hose installation. Do this to make sure the installation stays an airworthy repair until the system is put back to its initial configuration.

SUBTASK 20-10-52-800-001

- (3) Make a procedure to make sure that you replace flexible hoses as soon as possible. This must not be later than an operator-scheduled time check that has been approved by the assigned principal maintenance inspector.

SUBTASK 20-10-52-220-001

- (4) Use a flexible hose that has these properties:
 - (a) The pressure and the fluid properties of the hose must be applicable and correct for the system it will be used on.
 - (b) The inner diameter of the hose must not be less than the inner diameter of the damaged tube.

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- (c) The length of the hose must be sufficient to keep the slack, flex, twisting, bending, clearance, and support acceptable, as shown in Figure 801.
- 1) Slack - Do not install hose assemblies in a way that will cause a mechanical load on the hose. Hoses will change length from +2 to -4 percent when pressurized. Give sufficient slack or bend to let the length change.
 - 2) Flex - When very much vibration or flexing occurs to hose assemblies, there must be sufficient slack between the rigid fittings. Install the hose to prevent flexing at the end fitting(s). The hose must stay straight for at least two hose diameters from the end fitting(s). Avoid clamp locations that will limit or prevent hose flexing.
 - 3) Twisting - Install hoses without twists. Twists can cause the hose to break or the nuts to loosen. Use swivel connections at one of the two ends to prevent twist stresses.
 - 4) Bending - To prevent sharp bends in the hose assembly, use elbow fittings, a hose with elbow-type end fittings, or the appropriate bend radii shown in Table 801.
 - 5) Clearance - The hose assembly must be clear of all other lines, equipment, and adjacent structure under every operating condition. Hoses must have the minimum clearance shown in Table 802.

Table 801/20-10-52-993-809 Minimum Hose Bend Radius

AS 115 HOSE	HOSE INSIDE DIAMETER	MINIMUM HOSE BEND RADIUS MEASURED INSIDE OF BEND
-04	¼ in. (6.35 mm)	1.50 in. (38.1 mm)
-06	⅜ in. (9.52 mm)	2.50 in. (63.5 mm)
-08	½ in. (12.70 mm)	2.88 in. (73.2 mm)
-10	⅝ in. (15.88 mm)	3.25 in. (82.6 mm)
-12	¾ in. (19.05 mm)	4.00 in. (101.6 mm)

Table 802/20-10-52-993-810 Minimum Clearance

HOSE CLEARANCE TO	MINIMUM CLEARANCE
CONTROL CABLE LINKAGES	1.0 in. (25.4 mm) ^{*[1]}
CABLE AT PULLEYS	0.5 in. (12.7 mm)
CABLE AT MIDSPAN	2.0 in. (50.8 mm)
ELECTRICAL WIRING	0.5 in. (12.7 mm)
HYDRAULIC TUBES OR LINES	0.2 in. (5.1 mm)

*[1] *[1] Measured at the position where the hose is closest to the cable or linkage.

- 6) Support - Make sure the hose assembly is held by supports that will not cause deflection of rigid lines if movement occurs. Use sufficient clamps to follow the contour of the structure. This prevents hose abrasive wear, kinks, and entanglement during flexure. At a minimum, put clamps at locations where the tube clamps were. Make sure the hose is not rigidly held by tight, rigid clamps about its outer diameter. If the hose between the rigid connections must move longitudinally, make sure the clamps are of a type that will not cause wear on the hose casing. The supports must hold the connections at the tube, not the hose.

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SUBTASK 20-10-52-860-002

- (5) Remove the pressure from the hydraulic system where you will do the repair. Do this task: Hydraulic Reservoirs Depressurization, TASK 29-09-00-860-802.

SUBTASK 20-10-52-350-001

- (6) If you will replace all of the damaged tube with a flexible hose, do these steps:
- (a) Remove the damaged tube.
 - (b) If it is necessary, prepare the ends of the tubes to which you will install the flexible hose. For selection of the applicable fittings, do this task: Flareless Fittings in Pressurized Areas Installation, TASK 20-10-51-400-802.

SUBTASK 20-10-52-300-001

- (7) If the damaged tube is too long to be replaced by a flexible hose, do these steps:
- (a) Cut the damaged tube section from the line.
 - (b) Install the applicable fittings on the tubes. To install them, do this task: Flareless Fittings in Pressurized Areas Installation, TASK 20-10-51-400-802.
 - (c) Install the tubing on the fittings.

SUBTASK 20-10-52-860-003

- (8) Supply the usual pressure to the line. Do this task: Hydraulic Reservoirs Pressurization, TASK 29-09-00-860-801.

SUBTASK 20-10-52-210-003

- (9) Check the hose and the connections for leaks. Do this task: Hydraulic Reservoir Pressurization System Leakage Test, TASK 29-09-00-860-803.

SUBTASK 20-10-52-200-004

- (10) Do a check to make sure the slack, flex, twisting, bending, clearance, and support is correct.

———— **END OF TASK** ————

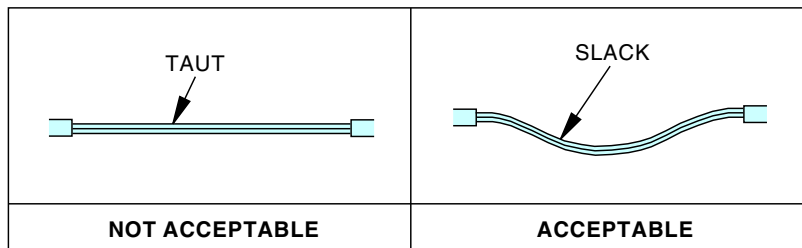
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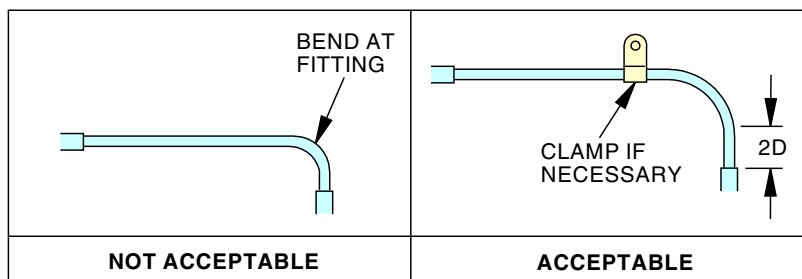
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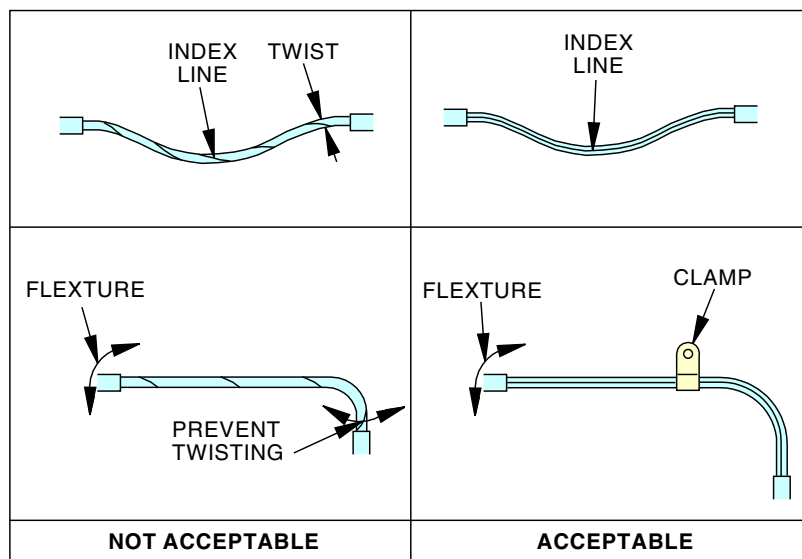
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SLACK



FLEX



TWISTING

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Hydraulic Tubing Repair
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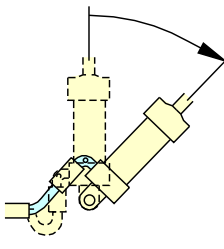
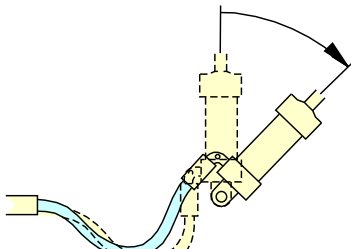
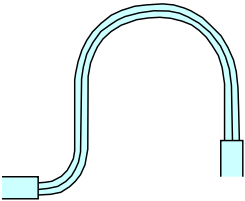
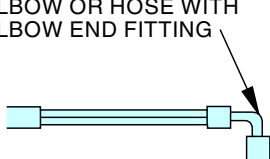
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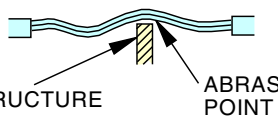
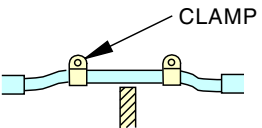
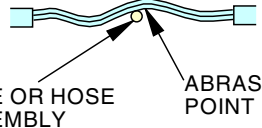
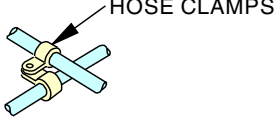
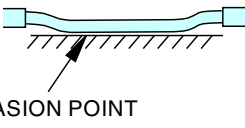
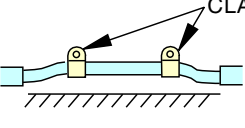
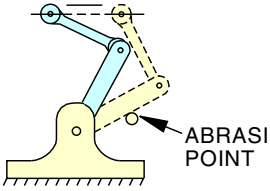
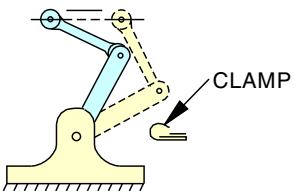
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NOT ACCEPTABLE	ACCEPTABLE

BENDING

	
	
	
	
NOT ACCEPTABLE	ACCEPTABLE

CLEARANCE

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TASK 20-10-52-300-802

3. Temporary Repair of Flexible Hydraulic Hoses

(Figure 801, and Figure 802)

A. General

- (1) This task is for the temporary repair of flexible hydraulic hoses with a different flexible hose.
 - (a) It is to the discretion of the operator to determine whether this task is applicable to their operations.
- (2) The Boeing Company recommends that the operator do these steps:
 - (a) Make a record of the flexible hoses that you install as temporary repairs for flexible lines.
 - (b) Make a schedule for the regular inspection of flexible hose installations.
 - 1) Make sure that the installation stays in an airworthy repair until the system is put back to its original configuration.
 - (c) Create a plan to ensure that the flexible hoses that are installed as temporary repairs are replaced as soon as possible.
 - 1) You must replace the hoses no later than the scheduled removal time determined by the assigned principal maintenance inspector.
- (3) This task is not applicable for replacement of hydraulic hoses on the engines. In general, hydraulic hoses with damaged firesleeves must be replaced.
 - (a) Engine hydraulic hoses are hoses below or forward of the firewall and within the engine cowl.
- (4) Hoses in the, hydraulic tubing repair kit, SPL-5276, or equivalent, can be used when temporarily replacing a damaged hydraulic hose with another hydraulic hose.

B. References

Reference	Title
29-09-00-860-801	Hydraulic Reservoirs Pressurization (P/B 201)
29-09-00-860-802	Hydraulic Reservoirs Depressurization (P/B 201)

C. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

Reference	Description
SPL-5276	Repair Kit, Hydraulic Tubing (3000 psi) (Approved for Titanium) Part #: 65-92528-11 (Spares Kit) Supplier: 81205 Part #: 65-92528-37 (Spares Kit) Supplier: 81205

D. Prepare for the Installation

SUBTASK 20-10-52-300-002

- (1) Choose a flexible hose to do the temporary repair.
 - (a) Choose a flexible hose that is qualified for at least the same operating pressure, temperature, and fluid type as the system in which you will install the flexible hose.
 - (b) Make sure that the new flexible hose has the same inner diameter (or a larger inner diameter) as the original flexible hose.

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- (c) Make sure that the end fitting sizes and configurations (such as straights, 45 degree bends, or 90 degree bends) on the replacement hose match those of the original flexible hose (Figure 802).
 - 1) You can do expansion using one of the methods as follows:
 - a) Use a hose assembly with expander end fittings.
 - b) Use a non-expander replacement hose assembly and reconnectable fittings that have different size ends to make the transition.
- (d) Make sure that the new flexible hose meets the installation requirements for the items as follows (Figure 801).
 - 1) Slack:
 - a) Make sure that you do not install the flexible hose in a way that will cause a mechanical load on the hose.
NOTE: Hoses will change length from +2/-4 percent when pressurized.
 - 2) Flex:
 - a) Make sure that there is slack between the rigid fittings where hose assemblies will be exposed to vibration or flexing.
 - b) Make sure that the hose is straight for at least two hose diameters from the end fittings.
NOTE: This will help make sure that the hose will not flex at the end fittings.
 - c) Make sure that you do not use clamps at locations that will stop the hose from flexing.
 - 3) Twisting:
 - a) Make sure that you install the hoses without twists.
NOTE: This will help prevent loose nuts and rupture of the hoses.
<1> Use swivel fittings with positioning ends at one or two ends of the temporary replacement hose, if it is necessary (Figure 802).
NOTE: This will help to closely match the configuration of the original hose and will help relieve the twist stresses.
 - 4) Bending:
 - a) Use elbow fittings, hoses with elbow type end fittings or the applicable end fittings, or the applicable bend radii shown in Table 801.
NOTE: This will help prevent sharp bends in the hose assembly.
<1> Make sure to take into account the change in allowable minimum bend radii due to external sleeving.
<a> For replacement with hoses that have "C" coded sleeves, multiply the minimum hose bend radii by 1.2 to calculate the minimum allowable bend radii (Figure 802).
 - 5) Clearance
 - a) Make sure that the hose assembly is clear of all other lines, equipment, and adjacent structure under all operating conditions.
 - b) Make sure that the hoses meet the minimum clearance requirements shown in (Table 803).



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Table 803/20-10-52-993-811 Minimum Hose Clearance

HOSE CLEARANCE TO	MINIMUM CLEARANCE
CONTROL CABLE LINKAGES	1.0 in. (25.4 mm)* ^[1]
CABLE AT PULLEYS	0.5 in. (12.7 mm)
CABLE AT MIDSPAN	2.0 in. (50.8 mm)
ELECTRICAL WIRING	0.5 in. (12.7 mm)
HYDRAULIC TUBES OR HOSES	0.2 in. (5.1 mm)
FIXED STRUCTURE IN A SUPPORTED LOCATION	0.1 in. (2.5 mm)
FIXED STRUCTURE IN AN UNSUPPORTED LOCATION	0.25 in. (6.4 mm)

*[1] Measured at the position where the hose is closest to the cable or linkage.

6) Support

- a) Make sure that the hose assembly has supports at the same points as the original flexible hose (at a minimum).

NOTE: This will help prevent contact with the mating or adjacent parts due to relative motion.

<1> Size clamps as necessary.

NOTE: This will help to account for change in the hose diameter from the original flexible hose (due to extra sleeving, etc.).

E. Flexible Hydraulic Hoses Installation

SUBTASK 20-10-52-040-001

- (1) Remove hydraulic pressure from the system on which you will do a repair. Hydraulic Reservoirs Depressurization, TASK 29-09-00-860-802.

SUBTASK 20-10-52-020-002

- (2) Remove the damaged hose.

SUBTASK 20-10-52-420-007

- (3) If you can replace all of the damaged hose with one flexible hose, install the new temporary flexible hose.

SUBTASK 20-10-52-420-008

- (4) If the damaged hose is too long to replace by one flexible hose, do these steps:

- (a) Use two or three shorter hoses to make the necessary length hose.

- 1) Make sure that you do not use more than three shorter hoses to make the necessary length hose.

- (b) Use a union or smaller fitting as a splice between the shorter hoses.

- (c) Make sure that the total length of the two or three shorter hoses and splice fittings is close to the length of the original, damaged hose.

NOTE: A total length that is too long will create kinks or bends in the hoses; a total length too short will create a tension load on the hoses.

- (d) Use the necessary installation torque on the mating hoses and splice fittings.

- 1) The torque is determined based on size and material of the splice fitting and hose end fittings.

NOTE: For example, when the materials of the two mating parts are dissimilar, select the torque value based on the lower-strength material.

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SUBTASK 20-10-52-440-001

- (5) Supply hydraulic pressure to the system on which you did the temporary repair. Do this task: Hydraulic Reservoirs Pressurization, TASK 29-09-00-860-801.

SUBTASK 20-10-52-280-001

- (6) Examine the temporary flexible hose repair and connections for leaks.

SUBTASK 20-10-52-700-001

- (7) Make sure that the temporary repair installation operates.
- (a) Do a functional test for the system on which the temporary repair was made, as necessary.
- 1) Make sure that there is clearance with the temporary repair hose.
 - 2) Make sure that there is no interference through the range of hose operation.
 - 3) Make sure that the temporary repair meets the requirements with the following items
 - a) Slack
 - b) Flex
 - c) Twisting
 - d) Bending
 - e) Clearance
 - f) Support.

————— **END OF TASK** —————

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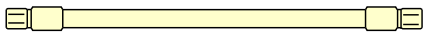
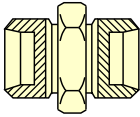
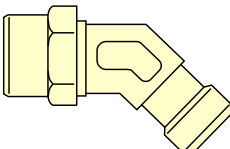
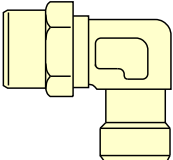
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FITTING TYPE	PART NUMBER	MATERIAL
HYDRAULIC HOSE 	AS115-(SIZE) (C) ¹ (LENGTH-INCHES) (FRACTIONAL LENGTH IN EIGHTHS OF AN INCH) ²	
TUBE-TO-TUBE FLARELESS UNION 	MS21902V (SIZE) (P)	15-5PH CRES MATERIAL WITH CADMIUM PLATE FINISH
	MS21902 (SIZE) (T)	6AL-4V TITANIUM MATERIAL
FLARELESS SWIVEL TO MALE FLARELESS 45 DEGREE ELBOW 	BACE21BR (SWIVEL LEG SIZE) (MALE PORT LEG SIZE) (P)	15-5PH CRES WITH CADMIUM PLATE FINISH
	BACE21BR (SWIVEL LEG SIZE) (MALE PORT LEG SIZE) (T)	6AL-4V TITANIUM
FLARELESS SWIVEL TO MALE FLARELESS 90 DEGREE ELBOW 	BACE21BT (SWIVEL LEG SIZE) (MALE PORT SIZE) (P)	15-5PH CRES WITH CADMIUM PLATE FINISH
	BACE21BT (SWIVEL LEG SIZE) (MALE PORT SIZE) (T)	6AL-4V TITANIUM

NOTE:

- ¹ CODE LETTER "C" REFERS TO 15 MINUTE FIRESLEEVE PER AS1072
- ² TEMPORARY REPLACEMENT OF A DAMAGED HOSE MAY BE MADE USING HOSES OTHER THAN AS115. FOR EXAMPLE, HOSE COMBINATIONS WITH ONE 45 DEGREE ELBOW END FITTING (AS116) OR ONE 90 DEGREE ELBOW END FITTING (AS117), OR WITH A COMBINATION OF FITTING ENDS MORE SIMILAR TO THE DAMAGED HOSE MAY BE USED AS LONG AS THE GUIDELINES IN THE PROCEDURE ARE FOLLOWED.

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Possible Repair of Flexible Hydraulic Hoses Figure 802/20-10-52-990-808 (Sheet 1 of 2)

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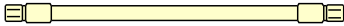
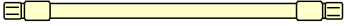
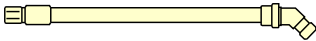
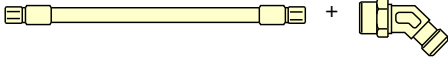
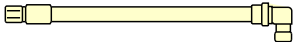
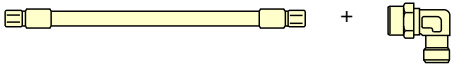
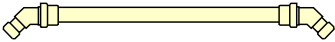
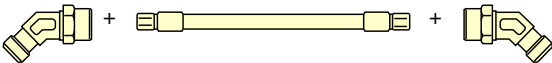
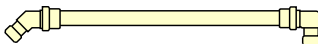
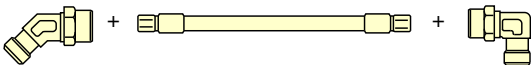
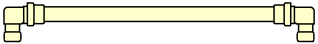
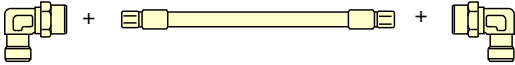
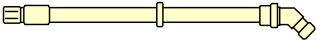
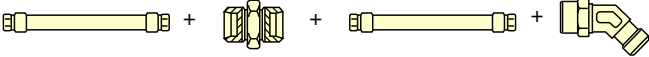
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DAMAGED HOSE	POSSIBLE TEMPORARY REPLACEMENT COMBINATION
 AS115 (STRAIGHT TO STRAIGHT)	 AS115
 AS116 (STRAIGHT TO 45 DEGREE END)	 AS115 BACE21BR
 AS117 (STRAIGHT TO 90 DEGREE END)	 AS115 BACE21BT
 AS118 (45 DEGREE TO 45 DEGREE END)	 BACE21BR AS115 BACE21BR
 AS119 (45 DEGREE TO 90 DEGREE END)	 BACE21BR AS115 BACE21BT
 AS120 (90 DEGREE TO 90 DEGREE END)	 BACE21BT AS115 BACE21BT
 AS115 (STRAIGHT TO STRAIGHT) - LONG LENGTH	 AS115 MS21902 AS115 NOTE: USE A MAXIMUM OF THREE SHORTER HOSES WITH UNION FITTINGS TO MAKE UP THE REQUIRED REPLACEMENT LENGTH FOR THE DAMAGED ORIGINAL HOSE.
 HOSE P/N OTHER THAN AS115, STRAIGHT TO ELBOW (45 DEGREE) - LONG LENGTH	 AS115 MS21902 AS115 BACE21BR NOTE: USE A MAXIMUM OF THREE SHORTER HOSES WITH UNION FITTINGS TO MAKE UP THE REQUIRED REPLACEMENT LENGTH FOR THE DAMAGED ORIGINAL HOSE.

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FLUID LINE TUBING CLAMPS - REMOVAL/INSTALLATION

1. General

- A. This procedure has these tasks:
 - (1) A removal of the block clamps.
 - (2) An installation of the block clamps.
 - (3) A removal of P-clamps.
 - (4) An installation of P-clamps.
- B. Different types of clamps hold the fluid systems tubing:
 - (1) Loop or P-clamps where normal support is required.
 - (2) Saddle clamps where more support is required.
 - (3) Block clamps in the area of high vibration, or where a number of tubes or hoses must be supported in one location.
- C. Loop or saddle clamps holding hydraulic tubes or hoses must be cushioned metal clamps.

TASK 20-10-53-000-801

2. Block Clamps Removal

A. Procedure

SUBTASK 20-10-53-020-001

- (1) Remove the nuts, bolts and washers that hold the block clamp assembly together.

SUBTASK 20-10-53-020-002

- (2) Remove the block clamp assembly.

SUBTASK 20-10-53-020-003

- (3) If there is a tape under the clamp blocks, remove and discard used tape from the tube.

———— **END OF TASK** ————

TASK 20-10-53-400-801

3. Block Clamps Installation

A. Procedure

SUBTASK 20-10-53-020-004

- (1) Remove and discard all used tape from the tube.

SUBTASK 20-10-53-420-003

- (2) Put the tubes in the applicable notches in one-half of the block clamp assembly.

SUBTASK 20-10-53-420-004

- (3) Put the other half of the block clamp assembly in position.

SUBTASK 20-10-53-420-005

- (4) Put the channel over the half of the block clamp assembly that the bolt head will touch.

SUBTASK 20-10-53-420-006

- (5) Put the washers on the bolts and put the bolts through the holes in the block clamp assembly.

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SUBTASK 20-10-53-420-007

- (6) Put the washer and nut on the threaded end of the bolt and tighten the nut.

NOTE: Make sure the washers are under the bolt head and the nut so the bolt head does not wear into the block clamp channel.

————— **END OF TASK** —————

TASK 20-10-53-000-802

4. P-Clamps Removal

A. Procedure

SUBTASK 20-10-53-020-005

- (1) Remove the fastener from the clamp and the structure.

SUBTASK 20-10-53-020-006

- (2) Remove the pan dirt strap from the clamp.

SUBTASK 20-10-53-020-007

- (3) Remove the clamp away from the tubes and structure.

————— **END OF TASK** —————

TASK 20-10-53-400-802

5. P-Clamp Installation

A. Procedure

SUBTASK 20-10-53-420-008

- (1) Put the P-clamp on the tube.

SUBTASK 20-10-53-420-009

- (2) Put the pan dirt strap in the hole of the clamp.

SUBTASK 20-10-53-420-010

- (3) Put the fasteners on the clamp and structure.

SUBTASK 20-10-53-210-001

- (4) Make sure everything is tight.

————— **END OF TASK** —————

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STENCIL MARKINGS - REMOVAL/INSTALLATION

1. General

- A. This procedure has these tasks:
 - (1) A removal of the stencil markings.
 - (2) An installation of the stencil markings.
- B. For decorative finishes used on airplane external surfaces, do this task: Decorative Exterior Paint System Application, TASK 51-21-99-300-801.
- C. Paint used for markings is determined by the surface you will paint and the type of finish necessary. Paint must be compatible with the initial surface finish.

TASK 20-10-61-000-801

2. Stencil Markings Removal

A. References

Reference	Title
51-21-11-150-801	Paint Stripping (P/B 701)
51-21-21-370-801	Prepare the Surface to be Painted (P/B 701)
51-21-99-300-801	Decorative Exterior Paint System Application (P/B 701)

B. Consumable Materials

Reference	Description	Specification
C00319	Primer - Urethane Compatible, Corrosion Resistant	BMS10-79 Type II

C. Removal

SUBTASK 20-10-61-420-001

- (1) Remove the old markings if necessary:
 - (a) Strip the markings. To strip them, do this task: Paint Stripping, TASK 51-21-11-150-801.
 - (b) Prepare the surface for the coating. To prepare the surface, do this task: Prepare the Surface to be Painted, TASK 51-21-21-370-801.
 - (c) Apply primer, C00319 that is equivalent to the initial material. To apply it, do this task: Decorative Exterior Paint System Application, TASK 51-21-99-300-801.

————— END OF TASK —————

TASK 20-10-61-400-801

3. Stencil Markings Installation

A. General

- (1) Make sure clean surfaces do not become dirty when you clean the adjacent surfaces.
- (2) Use a polyethylene wash bottle to apply solvents. Identify the contents.
- (3) Do not contaminate adjacent areas when you spray.
- (4) Make sure all coatings or finishes are uniform and free from unusual particles.
- (5) Apply the stencil marking paint with spray equipment only.
- (6) Make sure all coating or finish materials are correctly mixed and labeled. Discard materials with expired pot life.
- (7) Make sure the painted markings are well made and have a solid, homogeneous color.

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B. References

Reference	Title
51-21-11-150-801	Paint Stripping (P/B 701)
51-21-21-370-801	Prepare the Surface to be Painted (P/B 701)
51-21-72-370-801	BMS10-79 Primer - Application (P/B 701)
51-21-72-370-804	BMS10-11 Primer - Application (P/B 701)
51-21-73-370-802	BMS10-60 Topcoat Application (P/B 701)
51-21-73-370-803	BMS10-11 Topcoat Application (P/B 701)
51-21-73-370-804	Chemical Reactivator Application (P/B 701)

C. Tools/Equipment

Reference	Description
STD-1104	Bottle - HDPE Polyethylene, Capacity 500ml, with LDPE Polyethylene Internal Plug and Self Seal Polypropylene Screw Cap
STD-1133	Gun - Spray, Paint, with Interchangeable Nozzles

D. Consumable Materials

Reference	Description	Specification
B00083	Solvent - VM&P Naphthas	TT-N-95 Type II, ASTM D-3735 Type III
C00032	Coating - Protective Enamel, General Use	BMS10-60 Type I
C00175	Primer - Urethane Compatible, Corrosion Resistant	BMS10-79 Type III
C00259	Coating - Chemical And Solvent Resistant Finish, Corrosion Inhibiting Primer	BMS10-11 Type I
C00260	Coating - Chemical And Solvent Resistant Finish, Epoxy Resin Enamel	BMS10-11 Type II
C00319	Primer - Urethane Compatible, Corrosion Resistant	BMS10-79 Type II
G00034	Cotton Wiper - Process Cleaning Absorbent Wiper (Cheesecloth, Gauze)	AMS3819 Class 1 Grade A or B Form 1 (Supersede BMS15-5 CL A)
G00270	Tape - Scotch Flatback Masking 250	ASTM D6123 (Supersedes A-A-883)
G50262	Wiper - Cleaning	BMS15-5

E. Prepare the Surface for Stencil Markings

SUBTASK 20-10-61-950-001

- (1) Mask or put a protective cover on all adjacent surfaces that you will not clean, treat, or coat.

SUBTASK 20-10-61-110-001

- (2) Solvent clean the surface.

NOTE: This is to remove loose soil and unwanted grease or oil.

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WARNING

DO NOT GET SOLVENTS IN YOUR MOUTH, YOUR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM SOLVENTS. SOLVENTS ARE DANGEROUS MATERIALS. SOLVENTS CAN BE FLAMMABLE. OBEY THE MATERIAL SAFETY DATA SHEETS (MSDS) FOR SOLVENTS. OBEY LOCAL REGULATIONS FOR THE CORRECT PROCEDURES TO USE OR DISCARD SOLVENTS. SOLVENTS CAN CAUSE INJURIES TO PERSONNEL AND DAMAGE TO EQUIPMENT.



WARNING

SOLVENTS ARE TOXIC AND HIGHLY FLAMMABLE. AVOID PROLONGED INHALATION OF VAPORS OR CONTACT WITH THE SKIN. TAKE PRECAUTIONS AGAINST FIRE.



CAUTION

DO NOT USE SOLVENTS OTHER THAN THOSE SPECIFIED. THEY CAN CAUSE DAMAGE TO THE FINISH.

- (a) Use the applicable solvent.
- (b) Use a polyethylene bottle (500ml), STD-1104 to apply solvent to the work surface or to a clean wiper.
NOTE: Do not put the wiper into the solvent container.
NOTE: Do not get the solvent on a larger area than is necessary.
- (c) Rub the surface with a cotton wiper, G00034 or a soft brush.
- (d) Rinse the surface with clean solvent and a clean cotton wiper, G00034.
- (e) Remove unwanted solvent.
- (f) Let the surface drain.
- (g) Rub the surface dry.

SUBTASK 20-10-61-120-001

- (3) Sand the surface with 320-grit or finer abrasive paper.
 - (a) Make sure that you do not sand down to the base material.

SUBTASK 20-10-61-110-002

- (4) Solvent clean the surface again.
NOTE: This is to remove sanding dust.

SUBTASK 20-10-61-110-003

- (5) If you sanded to the base material, do the steps that follow.
 - (a) If the base material is metal, use a brush-on stripper to remove the coating from the damaged area (Paint Stripping, TASK 51-21-11-150-801, Brush-On Stripping).
 - (b) If the base material is plastic, see this task for paint stripping: Paint Stripping, TASK 51-21-11-150-801.
 - (c) Solvent clean the area to remove contamination.
 - (d) Feather the edge to the area adjacent to the damaged area.
 - 1) Use 320-grit or finer abrasive paper.
 - (e) Solvent clean the area to remove sanding dust.
 - (f) Wipe the surface with a clean, dry wiper, G50262.

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- (g) Prepare the surface for paint. Do this task: Prepare the Surface to be Painted, TASK 51-21-21-370-801.

SUBTASK 20-10-61-950-002

- (6) Apply the stencil masking.
- (a) Make sure that all stencil cuts are sharp and do not have burrs.
- (b) Attach the stencil tightly with Scotch Flatback Masking Tape 250, G00270.

NOTE: This is to make sure that the paint does not go below the edges.

SUBTASK 20-10-61-950-003

- (7) Apply masking to prevent overspray onto adjacent surfaces, if necessary.

SUBTASK 20-10-61-160-001

- (8) Reactivate the surface.
- (a) For plastic laminates and painted surfaces, use one of the methods that follow to reactivate the surface.
- 1) Method 1: Chemically reactivate the surface (Chemical Reactivator Application, TASK 51-21-73-370-804).
- NOTE:** Chemically reactivate the surface if the painted surface and the stencil coating are BMS10-60.
- 2) Method 2: Sand the surface.
- a) Lightly sand the surface with 280-grit or finer abrasive paper.
- b) Solvent clean the surface to remove sanding dust.
- (b) For stainless steel surfaces, do the steps that follow to reactivate the surface.
- 1) Abrasive clean the surface.
- a) Use 180-grit or finer aluminum oxide abrasive to clean the area.
- 2) Solvent clean the surface.
- (c) For Alclad, Aluminum alloys, and all other materials, no surface reactivation is necessary.

SUBTASK 20-10-61-370-001

- (9) Prepare the stencil paint using the manufacturer's instructions.
- (a) Use Table 401 to select a stencil paint:

Table 401/20-10-61-993-801 Stencil Paint Selection

SUBSTRATE		LETTER HEIGHT AND WIDTH		FINISH
PAINTED	UNPAINTED	≥ 2 in. (51 mm)	< 2 in. (51 mm)	
--	X	--	X	BMS10-11, Type II
X	--	X	X	BMS10-60 ^{*[1]}
--	X	X	--	BMS10-11, Type I + BMS10-11, Type II ^{*[2]} BMS10-79, Type II or III + BMS10-60 ^{*[3]}

*[1] BMS10-11, Type II enamel may be used if the finish requirements are met and then substrate topcoat is BMS10-11, Type II.

*[2] Interior applications.

*[3] Exterior applications.

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SUBTASK 20-10-61-370-002

- (10) For insignia markings and for stencils with a letter size more than 2 in. (51 mm) in height and width, apply primer to the surface.

NOTE: The application of primer to previously painted surfaces is optional.

- (a) Make sure that you do not apply primer to surfaces that have been treated with BMS10-127 chemical reactivator.

F. Install Stencil Markings

SUBTASK 20-10-61-380-001



DO NOT GET SOLVENTS IN YOUR MOUTH, EYES, OR SKIN. DO NOT BREATHE FUMES FROM SOLVENTS. REFER TO PRODUCT MATERIAL SAFETY DATA SHEETS (MSDS) AND LOCAL REQUIREMENTS FOR PROPER HANDLING. SOLVENTS ARE HAZARDOUS MATERIALS AND MAY BE FLAMMABLE OR HARMFUL TO THE ENVIRONMENT.

- (1) Apply the stencil paint with the paint spray gun with interchangeable nozzles, STD-1133.

NOTE: Make sure that no paint gets under the stencil masking.

- (a) Use the procedures in the applicable tasks to apply the paint.
- 1) BMS10-79, Type II primer, C00319 or Type III primer, C00175: BMS10-79 Primer - Application, TASK 51-21-72-370-801.
 - 2) BMS10-60, Type I topcoat coating, C00032: BMS10-60 Topcoat Application, TASK 51-21-73-370-802.
 - 3) BMS10-11, Type I primer, C00259: BMS10-11 Primer - Application, TASK 51-21-72-370-804.
 - 4) BMS10-11, Type II topcoat coating, C00260: BMS10-11 Topcoat Application, TASK 51-21-73-370-803.
- (b) Make sure that the marking is a solid color.
- (c) Make sure there is a sufficiently wet layer to give uniform flow but not to cause runs and sags.

SUBTASK 20-10-61-950-004

- (2) Remove the masking materials immediately after the application of the stencil paint, while the paint is still wet.

NOTE: This is to minimize rough edges.

SUBTASK 20-10-61-370-003

- (3) Cure the stencil paint.
- (a) For BMS10-79 cure times, see BMS10-79 Primer - Application, TASK 51-21-72-370-801.
 - (b) For BMS10-60 cure times, see BMS10-60 Topcoat Application, TASK 51-21-73-370-802.
 - (c) For BMS10-11, Type I, cure times, see BMS10-11 Primer - Application, TASK 51-21-72-370-804.
 - (d) For BMS10-11, Type II, cure times, see BMS10-11 Topcoat Application, TASK 51-21-73-370-803.

SUBTASK 20-10-61-220-001

- (4) Measure the dry film thickness of the stencil paint.
- (a) For BMS10-79 dry film thicknesses, see BMS10-79 Primer - Application, TASK 51-21-72-370-801.

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- (b) For BMS10-60 dry film thicknesses, see BMS10-60 Topcoat Application, TASK 51-21-73-370-802.
- (c) For BMS10-11, Type I, dry film thicknesses, see BMS10-11 Primer - Application, TASK 51-21-72-370-804.
- (d) For BMS10-11, Type II, dry film thicknesses, see BMS10-11 Topcoat Application, TASK 51-21-73-370-803.

SUBTASK 20-10-61-370-004

- (5) If you applied BMS10-79, Type II primer, C00319 or Type III primer, C00175, apply BMS10-60 topcoat coating, C00032 (BMS10-60 Topcoat Application, TASK 51-21-73-370-802).
 - (a) Cure the BMS10-60 topcoat (BMS10-60 Topcoat Application, TASK 51-21-73-370-802).
 - (b) Measure the dry film thickness of the stencil paint (BMS10-60 Topcoat Application, TASK 51-21-73-370-802).

SUBTASK 20-10-61-370-005

- (6) If you applied BMS10-11, Type I primer, C00259, apply BMS10-11, Type II topcoat coating, C00260 (BMS10-11 Topcoat Application, TASK 51-21-73-370-803).
 - (a) Cure the BMS10-11, Type II topcoat (BMS10-11 Topcoat Application, TASK 51-21-73-370-803).
 - (b) Measure the dry film thickness of the stencil paint (BMS10-11 Topcoat Application, TASK 51-21-73-370-803).

G. Put the Airplane Back to Its Usual Condition

SUBTASK 20-10-61-950-005

- (1) Remove all masking material.

SUBTASK 20-10-61-800-001

- (2) Remove the rough edges from the markings with aliphatic naphtha solvent, B00083 or with a burnishing tool after the marking cures.

———— **END OF TASK** ————

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COAXIAL CABLE AND ANTENNA - MAINTENANCE PRACTICES

1. General

A. Time Domain Reflectometer (TDR)

- (1) Use a TDR to examine coaxial cables. The TDR can locate opens, shorts, crimps and other defects in coaxial cables of lengths up to 1200 ft (366 m) long. The TDR can also be used on a twisted pair or parallel wires which are the same length.
- (2) The TDR transmits pulses of energy down the cable. The TDR then monitors the impedance changes in the pulse energy that is reflected back. You can see these reflections on the liquid crystal display (LCD). You then find failures in the cable from the properties of the waveform shown on the LCD.

B. Frequency Domain Reflectometer (FDR)

- (1) Use a FDR to do a health check of a RF system's coaxial cables and antenna as an entire unit or as individual components.
- (2) The FDR can locate opens, shorts, improper crimps, bends, moisture, loose connectors, and defective antenna elements that lead to weak or intermittent RF operation. You may also use the FDR to test the antenna elements from the equipment rack for troubleshooting or directly at the antenna to ensure reliable operation prior to installation.

TASK 20-10-72-210-801

2. Coaxial Cable Inspection with a Time Domain Reflectometer

A. General

- (1) Use the time domain reflectometer, COM-5187, or multi carrier time domain reflectometer, SPL-17763 (optional), to examine the coaxial cable.
- (2) Refer to the Time Domain Reflectometer (TDR) instruction manual for information on how to test the coaxial cable.

B. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

Reference	Description
COM-5187	Reflectometer - Time Domain (TDR) Part #: 1205CXB Supplier: 93929 Part #: 1270A Supplier: 93929 Part #: 6021-5154 Supplier: 1UW81 Part #: W1101 Supplier: FB3T5 Opt Part #: 1205CXA Supplier: 93929 Opt Part #: 900AST Supplier: 53387
SPL-17763	Reflectometer - Multi Carrier Time Domain (MCTDR) Part #: W1101 Supplier: FB3T5

————— **END OF TASK** —————

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TASK 20-10-72-211-801

3. Coaxial Cable and Antenna System Inspection with a Frequency Domain Reflectometer

(Figure 201)

A. General

- (1) This procedure has the steps to do a health check of a Radio Frequency (RF) system's coaxial cables and antenna. This procedure can be done on the entire unit or on individual components.
- (2) You can use a frequency domain reflectometer, COM-15185 (FDR) to locate opens, shorts, improper crimps, bends, moisture, loose connectors, and defective antenna elements that lead to weak or intermittent RF operation. You can also use the FDR to test the antenna elements from the equipment rack for troubleshooting or directly at the antenna to make sure that reliable operation prior to installation.
- (3) The FDR performs a VSWR (voltage standing wave ratio) test by transmitting a continuous RF sweep of the cables and antenna at their operating frequencies and then monitoring the absorption of the wave by the antenna. The FDR identifies standing or reflected waves due to loose connections, corrosion, moisture, or defective cable, or faulty antenna which changes the system impedance resulting in a reflected or standing wave. Standing waves not only decrease output transmission, resulting in weak, intermittent operation, but may also harm the transmitter if the reflection is quite large. The recommended FDR is an easy to use handheld tester, with a Go/No-Go function by use of a limit line and simple distance to fault measurement. It can be used to quickly identify improper connections, defective cables and faulty antennas easily from the Equipment rack, eliminating disassembly of the airplane to test the RF system.
- (4) Refer to the Instruction or Operation Manual of the frequency domain reflectometer, COM-15185 and radio frequency adapter kit, COM-17510 for specific instructions on set-up and tests for the coaxial cable and antenna system.

NOTE: The Kit P/N 7003A001-4 includes SiteHawk Analyzer P/N SK-6000-TC and Radio Frequency Adapter Kit P/N 4240-401.

- (a) To do a health check of the entire coaxial cable and antenna system, you must remove the black box from the EE rack and connect the tester directly to the rack's bench plug coax receptacle. There is no need to make any other disconnections unless the health check fails. The check will give a simple Go/No-Go indication of the health of the entire cable and antenna system. In the case of a No-Go indication, any faults may be isolated via the FDR's "distance to fault" function. Use the "distance to fault" readout and applicable system wire diagram to help isolate the failure to a specified connector, cable segment or antenna.
- (b) The FDR facilitates both simple Go/No-Go testing, as well as in depth testing. Use the Instruction or Operation Manual for specific instructions to:
 - 1) **DATA SAVE:** Stores parameters and able to upload from a USB or via Bluetooth. User can recall settings and immediately test. For example: User selects "SATCOM High Gain Transmit VSWR" and then plugs into bench connector and reads display.
 - 2) **PROGRAMMING:** Provides means to create simple Go/No-Go testing.
 - 3) **CALIBRATION:** Use the OSL Calibration Compo (Open, Short, 50 ohm Load 50 ohm) to calibrate prior to use.
 - 4) **VSWR and RETURN LOSS (RL) TESTING:** Displays the readings in Return loss or VSWR, the user simply selects the display they desire.

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- 5) DISTANCE TO FAULT: Displays distance in ft/in or M/cm to the VSWR or return loss fault without disconnecting.

B. References

Reference	Title
20-10-07 P/B 401	E/E RACK-MOUNTED COMPONENTS AND PRINTED CIRCUIT CARD - REMOVAL/INSTALLATION
20-10-07-000-801	E/E Box Removal (P/B 401)
20-10-07-400-801	E/E Box Installation (P/B 401)

C. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

Reference	Description
COM-9903	Cable - Adapter, Two Single Banana Plugs to BNC Male Part #: 5268-C-XX Supplier: 5D6S9 Opt Part #: 2241-C-36 Supplier: 4U744
COM-15185	Reflectometer - Frequency Domain (FDR) Part #: FH-AV-KIT Supplier: 70998 Part #: W4101 Supplier: FB3T5 Opt Part #: 7003A001-4 Supplier: 21844
COM-17510	Adapter Kit - Radio Frequency Part #: 4240-401 Supplier: 70998
COM-19606	Power Supply - DC, Portable Part #: 72-13095 Supplier: 02929 Part #: TP3016M Supplier: \$1338
COM-19665	Adapter - Bias Tee, Coaxial Part #: ZNBT-60-1W+ Supplier: 026J2
COM-20544	Adapter - RF, Type N(m) to Type C(m), 50 ohm Part #: PE9538 Supplier: 53919
COM-20545	Adapter - RF, Type N(f) to Type C(f), 50 ohm Part #: PE9539 Supplier: 53919

D. System test with the Antenna Connected

SUBTASK 20-10-72-860-001

- (1) Do these steps to prepare the applicable cable, antenna system, and frequency domain reflectometer, COM-15185 for testing:
 - (a) Push the Power button for 5 seconds.
 - 1) Unit will automatically boot into the Sitehawk Analyzer's Measure Match Application.
 - (b) Press File Cabinet icon (three square dots) to recall previously saved set-up or manually input settings.

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- 1) SiteHawk status, calibration result, and tracing data can be saved to the instrument, and can be recalled to be displayed on the sweep display area. The parameters for this instrument setting include the scale, trace, cursor and analysis. These parameters are saved in the status files. Data in STATUS+CAL (.cst) or STATUS (.sta) data files can be recalled and displayed with the current data trace.

NOTE: STATUS+CAL (.cst) files will save the settings and calibration if the unit was calibrated when the file was saved. STATUS (.sta) files only save the setting, but not calibration.

- a) Push the FILE icon to display the file menu. See Figure 201.
- b) Push the Save Type to select file type STATUS+CAL (.cst) or STATUS (.sta).
- c) Select load.
- d) Select the data file from the list.
- e) Push Load.

NOTE: The active and the recalled trace data will be displayed together in the sweep display area. In the example, Tr1 is the active trace, the recalled trace data is indicated with OFF and the file name.

- f) Push OFF to remove the recalled trace data.

2) Select MEASURE MATCH MODE

- a) Push trace measurement field to display menu
- b) Select SWR from the Measurement Mode menu.

NOTE: When making a match measurement, select SWR (Standing Wave Ratio) units for the Y (vertical) scale.

- c) Select the number of Data Measurement points (default to 801).
- d) Set the Frequency range:

NOTE: Changing the frequency settings will automatically turn the calibration off. You always set the frequency before calibrating the unit. Once start/stop frequencies are entered manually, be sure to follow instructions to calibrate prior to use.

- <1> Set start and stop frequencies for the applicable RF system under test using Table 201.

<a> Example - For SATCOM Transmit (Uplink) Circuit, set the start/stop frequency at a wider span the system's frequency range as specified in the chart. The chart shows that the start/stop frequency should be set at a minimum of 1600 MHz and 1700 MHz to test the system's operating frequency of 1626.5 MHz and 1660.5 MHz.



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- 3) **CALIBRATE:** For best results, you can set the frequency and calibrate the Bird Site Analyzer immediately before taking measurements.

NOTE: Use a precision open, short, load (OSL) calibration standard or "Calibration Combo" for accurate measurement results.

NOTE: When using an extension cable, a phase stable cable is needed to ensure performance and accuracy. Connect the RF test cable and the adapter (extension) and then calibrate to the end of this extension. If the cable or adapters are removed, you must calibrate again.

NOTE: Changing frequency settings will automatically turn calibration off. Always set the frequency before calibrating the unit.

- a) Push the Calibrate icon.
- b) Connect the Cal Combo "Open" connector to the end of the extension cable's bench connector adapter.
- c) Push the Open softkey.
- d) Wait for the unit to sweep and a Green Check to display.
- e) Connect the Cal Combo "Short" connector to the end of the extension cable's bench connector adapter.
- f) Wait for the unit to sweep and a Green Check to display.
- g) Connect the Cal Combo "Load" connector to the end of the extension cable's bench connector adapter.
- h) Push the Load soft key.
- i) Wait for the unit to sweep and a Green Check to display.

NOTE: During calibration, the color of the icon display is yellow.

NOTE: Whenever the SiteHawk has been calibrated, a COR ON indicator is shown in the lower right corner of the display. Anytime the frequency is changed, the calibration is turned OFF and the COR ON disappears, requiring the unit to be recalibrated.

- 4) The limit line helps to set off those parts of a trace that are outside the acceptance (limit) values. It shows as a red horizontal line at the limit line value. The part of the trace that is not acceptable will display in white. Additionally, identification of signals which fall outside the acceptable limits can be identified using a failure flag and an alarm. Use Table 201 to set the limit to the Max VSWR for the RF system under test.

- a) Push the Limit Icon.
- b) Select Limit (On/Off). Push to toggle the limit line On and Off.
- c) Set Value. Sets the position of the limit line on the vertical scale (Y axis). Push the field to enter a value.
- d) Select FailFlag (On/Off). Push to toggle the fail flag On and Off. The words PASS or FAIL will be shown in the sweep display area to indicate if the active signal is within or outside the limits set by the limit line.



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Table 201/20-10-72-993-801 737 RF SYSTEM FREQUENCY RANGE CHART

Cable and Antenna System	System Operating Frequency	Maximum Voltage Standing Wave Ratio and (Return Loss)
*[1] SATCOM (Iridium)	1616 to 1626 MHz	2.0 (9.54 dB)
TCAS/ATC	1030 1090 MHz	2.0 (9.54 dB)
DME	960 to 1215 MHz	1.80
VHF	118 to 137 MHz	2.0 (9.54 dB)
VOR	108 to 118 MHz	3.1 (2.87 dB)
ILS (Localizer)	108 to 113 MHz	5.2
ILS (Glideslope)	327 to 337 MHz	2.0 (9.54 dB)
Rad Alt (LRR)	4275 to 4325 MHz	1.7 (11.73 dB)
HF *[2]	2 to 30 MHz	1.5 (13.98 dB)
Marker Beacon	75 MHz	1.7 (11.73 dB)
*[3]GPS (BOEING - S242T104-101)	1575 to 1585 MHz	1.5 (13.98 dB)
*[3]GPS (BOEING - S242T104-102)	1575 to 1585 MHz	2.0 (9.54 dB)
GPS*[4]*[5](STC - S613Z001/956-0027-001/AT575-143H)	1575 to 1585 MHz	2.0 (9.54 dB)
GPS (STC - AT575-343W)	1575 to 1585 MHz	1.5 (13.98 dB)
ELT	121.5 to 406 MHz	2.5 (7.36 dB)
SYSTEM INTERFACE*[6]	2 to 6000 MHz	1.2 (20.83 dB)

*[1] The SATCOM HiGain antenna is not tested on-wing because it is active. The "Coaxial Cables and Connectors check with the antenna disconnected" procedure can be used to test the system cable and connectors.

*[2] HF FDR check does not test antenna. HF FDR check tests cables from HF Transceiver to the HF Coupler and the HF connection to the cables via the Coupler Tray. When HF coupler is de-energized, it connects an internal 50 ohm load to the HF Transceiver RX/TX output. This facilitates testing from the HF Transceiver without the need to access the Coupler. Test connection of HF Coupler Tray to HF Antenna to structure using M1 or T477W Bonding meter.

*[3] Bias Tee is not needed.

*[4] These are active GPS antennas and must be tested with the steps in the "Active GPS System Check" section below. If the equipment necessary for the steps in the "Active GPS System Check" is not available, the systems interface coaxial cables and connectors can be tested with the steps in the "Coaxial Cables and Connectors check with the antenna disconnected" procedure.

*[5] Bias Tee is needed.

*[6] The "Coaxial Cables and Connectors check with the antenna disconnected" procedure is used to test a systems coaxial cables and connectors with the FDR and kits 50 ohm dummy load.

- 5) Remove the black box at facilitate testing of the cable and antenna system, do this task: E/E Box Removal, TASK 20-10-07-000-801.



CAUTION

DO NOT TOUCH THE CONNECTOR PINS, OR OTHER CONDUCTORS. IF YOU TOUCH THESE CONDUCTORS, ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE COMPONENTS.

- (c) Connect the SiteHawk to the device for the test.
- 1) Connect the test cable or phase stable cable (including the bench plug adapter) to the FDR's N-type connector.

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- 2) Connect to the RF System's applicable coax rack connector, where the black box was installed.
- 3) Wait 10 Seconds for the sweep to complete the update.
- (d) Interpreting the Measurement.
 - 1) The graph contains the elements below:
 - a) The Vertical grid scale (y axis) shows standing wave ratio data values.
 - b) The Horizontal grid scale (x axis) shows the frequency or distance data values.
 - c) Marker values. For example: If markers are set at system operating frequencies.
 - d) The Trace number (Tr1) and color are used to identify the trace.
 - 2) Make sure that the entire standing wave ratio (SWR) measurement falls under the Max VSWR value in Table 201. See the limit line set in step 4 above.
 - a) If the system passes, put the airplane back to its usual condition.
 - b) If the system fails, isolate the fault. Use the steps in the "Fault Isolation of Coaxial Cable and Antenna System" section below.

E. Active GPS System Check

NOTE: This procedure is used for biasing of active Global Positioning System (GPS) antennas in order to perform a VSWR or Return Loss test.

SUBTASK 20-10-72-700-001

- (1) Do the instructions in the "General" and "Procedure" sections above to power-on, prepare and calibrate the frequency domain reflectometer, COM-15185 for this test.
 - (a) Refer to the applicable start/stop frequencies and limits for your GPS antenna (Table 1)
 - (b) Remove the Integrated Navigation Radio (INR) receiver from the electronic mounted rack. Refer to: E/E RACK-MOUNTED COMPONENTS AND PRINTED CIRCUIT CARD - REMOVAL/INSTALLATION, PAGEBLOCK 20-10-07/401
- (2) Do the active GPS system check as follows:
 - (a) Connect the RF adapter, COM-20544(N-type male connector) input directly to the RF adapter, COM-20545(N-type female connector) of the frequency domain reflectometer, COM-15185.
 - (b) Connect the frequency domain reflectometer, COM-15185test coaxial cable to the Bias Tee RF+DC output of the RF adapter, COM-20545(N-type female connector).
 - (c) Install the applicable EE bench plug adapter to the end of the frequency domain reflectometer, COM-15185 test coaxial cable.
 - (d) Connect the BNC Male to single banana plugs adapter, COM-9903 to the tee adapter, COM-19665 (BNC female connector).
 - (e) Connect the BNC Male to single banana plugs adapter, COM-9903to the portable dc power supply, COM-19606.
 - 1) Connect the RED banana jack to the RED (+) port of the power supply.
 - 2) Connect the BLACK banana jack to the BLACK (-) port of the power supply.
 - (f) Switch on and set the power supply to 28 volts DC and max amperage of 500mA (0.5A).
 - (g) Connect the test cable (with the bench plug adapter) to the INR receivers bench plug.

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- (h) Press the RED output button on the portable dc power supply, COM-19606 to supply 28VDC at a maximum current of 0.5 amps.
- (i) Wait 10 seconds for the sweep to complete.
- (j) Make sure that the entire SWR or RL falls under the MAX SWR or RL values for the applicable operating frequencies (Table 1).
 - 1) The vertical grid scale (y axis) shows SWR or RL data values.
 - 2) The horizontal grid scale (x axis) shows the frequency or distance data values.
- (k) If the system passes, put the airplane back to its usual condition.
- (l) If the system fails, isolate the fault. Use the steps in the "Fault Isolation of Coaxial Cable and Antenna System" section below.

F. Coaxial Cables and Connectors Check with the Antenna Disconnected

NOTE: This procedure is used to test and identify loose, wet or degraded connections in any airplane RF interface system (coaxial cables and connectors).

NOTE: The LRU and Antenna are typically disconnected, then the FDR bench plug connector is inserted into the EE rack connector. The FDR kits 50 ohm dummy load is connected to the antenna end of the coaxial cable. The FDR is swept at the system's operating frequency, normally found in the Aircraft Maintenance Manual (AMM), Systems Description Section (SDS) or Component Maintenance Manual (CMM).

SUBTASK 20-10-72-700-002

- (1) Do the instructions in the "General" and "Procedure" sections above to power-on, prepare and calibrate the frequency domain reflectometer, COM-15185 for this test. Use the applicable start/stop frequencies for the system.
 - (a) Use the SET LIMIT LINE instructions above, in section B. Set the limit to 1.2 for SWR or 20.83 dB for RL.
 - (b) Remove the applicable LRU from the electronic mounted rack. Refer to: E/E RACK-MOUNTED COMPONENTS AND PRINTED CIRCUIT CARD - REMOVAL/INSTALLATION, PAGEBLOCK 20-10-07/401.
- (2) Do the system interface check as follows:
 - (a) Disconnect the antenna connector to sweep the cable and connectors.
 - (b) Connect the antenna end of the coaxial cable to the frequency domain reflectometer, COM-15185 50 ohm dummy load, or the calibration tools 50 ohm "LOAD" connection.
 - (c) Connect the test coaxial cable of the frequency domain reflectometer, COM-15185 to its N-type female connector.
 - (d) Install the applicable EE bench plug adapter to the end of the test coaxial cable of the frequency domain reflectometer, COM-15185.
 - (e) Connect the test cable (including the bench plug adapter) to the applicable bench plug, where the LRU was installed.
 - (f) Wait 10 seconds for the sweep to complete.
 - (g) Make sure that the entire SWR or RL falls under the MAX SWR or RL values for the applicable operating frequencies (Table 201).
 - 1) The vertical grid scale (y axis) shows SWR or RL data values.
 - 2) The horizontal grid scale (x axis) shows the frequency or distance data values.
 - (h) If the system passes, put the airplane back to its usual condition.

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- (i) If the system fails, isolate the fault. Use the steps in the "Fault Isolation of Coaxial Cable and Antenna System" section below.

G. Fault Isolation of Coaxial Cable and Antenna System

SUBTASK 20-10-72-860-002

- (1) Select Fault Location Mode.
- (a) Push trace measurement field to display Measurement Mode menu.
- (b) Push to select DTF_SWR from the following Measurement Mode drop down menu.
NOTE: When making Distance to Fault measurement, select DTF_SWR units for the Y (vertical) scale.
- (c) Set number of Data Points:
- 1) Push the Points data field and enter the number of Data Points desired (default to 801).
- (d) Set Start and Stop Frequencies for the applicable RF system from Table 201.
- (e) Set Start and Stop Distance:
- 1) Stop distance should be about 20% longer than actual length. Actual length of the cable is found in the applicable system's WDM.
- (f) Select Units to m (meters) or ft (feet).
- (g) Enter Cable data using one of the flowing methods.:
- NOTE: Manually enter cable velocity value and Cable Loss Value or select the cable type from the cable list.
- 1) Push velocity and enter the cable velocity (Table 202):
- a) Select Velocity
- b) Set Speed Value
- c) Select Cable Loss
- d) Set Cable Loss Value (must be dB/ft or dB/m).

Table 202/20-10-72-993-802 Cable Probable Velocity of Propagation (Vp)

TYPE OF CABLE	PROBABLE Vp
Jelly Filled	.64
Polyethylene (PIC, PE, or SPE)	.66
PTFE (Teflon) or TFE	.70
Pulp Insulation	.72
Foam or Cellular PE (FPE)	.78
Semi-solid PE (SSPE)	.84
Air (Helical spacers)	.98

- 2) Push the cable list, and then select the cable type from the list. The cable values will automatically enter for testing.
- NOTE: The Cable List contains known cable values for a variety of cable types. The Cable List can be edited to add cables.
- (h) Calibrate the frequency domain reflectometer, COM-15185. Refer to Calibration steps above.

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- (i) Connect the frequency domain reflectometer, COM-15185 to the cable and antenna system being tested.
- (j) Wait for a minimum of 10 seconds for the sweep to complete the update.
- (k) To see the full sweep:
 - 1) Push the Scale icon then press TOP and enter 0 to adjust the scale.
 - 2) Press BOTTOM and enter -70.

SUBTASK 20-10-72-970-001

- (2) Interpreting the Fault Location Measurement.
 - (a) Isolate by using the FDR's distance to the fault readout, the applicable system schematic and the wiring diagram.
 - (b) Each connector or jumper will show as a spike. If it is larger than the typical value (for example: Max VSWR), check the connector for damage.
 - (c) Spikes where there are no components represent faults. Record the distance and then examine the line at that point for damage.
 - (d) The largest spike is usually due to the antenna. Typically the trace after the antenna can be ignored.

SUBTASK 20-10-72-970-002

- (3) Make sure that the fault location by replacing defective component with 50 ohm load (calibration combination or dummy load).
 - (a) Disconnect the component (cable, connector, antenna)
 - (b) Connect the 50 ohm terminator to the open end of the applicable cable
 - (c) Do the health check again.
 - 1) Make sure that the VSWR test is PASS.
 - a) If the test is not PASS, adjust distance to the fault test and continue to move 50 ohm load to further isolate.

H. Fault Isolation of Coaxial Cable and Antenna System at Microwave Frequency

NOTE: This procedure lets the user test an airplane's RF interface system at a higher than normal frequency to identify loose, wet or degraded connections.

NOTE: The procedure may be done with the antenna connected, instead of using a dummy load in place, but the user should ignore the antenna's higher than normal return loss since the antenna is not operating at its normal frequency. In the case of chronic faults, if all the cabling and connections test as good, then it is recommended to connect the FDR Kit's 50-ohm dummy load in place of the antenna to make sure the antenna connector is also good.

SUBTASK 20-10-72-970-003

- (1) Select the Fault Location Mode
 - (a) Push trace measurement field to display Measurement Mode menu.
 - (b) Push to select DTF_RL from the Measurement Mode drop down menu.

NOTE: When making Distance to Fault measurement, select DTF_RL units for the Y (vertical) scale.
 - (c) Set number of Data Points
 - 1) Push the points data field and enter the number of Data Points necessary (default to 801).

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- (d) Set Start/Stop Frequencies to 5GHz and 6GHz.
- (e) Set Start/Stop Distance.
 - 1) Make sure that the stop distance is at least 20% longer than correct length.
NOTE: If a maximum distance of less than the total length of the cable system is selected, the trace will not show the end of the cable system (antenna).
NOTE: To display the full cable system always set the maximum distance to a value that is a few feet or meters greater than the entire length of the cable system.
NOTE: The correct length of the cable is found in the applicable system's WDM (Wiring Diagram Manual).
- (2) Set Limit Line:
NOTE: The limit line helps to set off those parts of a trace that are outside the acceptance (limit) values. It shows as a red horizontal line at the limit line value. The part of the trace that is not acceptable will display in white. The signals which fall outside the acceptable limits can be identified with a failure flag and an alarm (Table 201).
 - (a) Push the Limit Icon.
 - (b) Select Limit (On/Off):
 - 1) Push to toggle the limit line On and Off.
 - (c) Set the limit to 1.2 for SWR (Standing Wave Ratio) or 20.83 dB for RL.
NOTE: This sets the position of the limit line on the vertical scale (Y axis).
 - 1) Push the field to enter 1.2 for SWR (Standing Wave Ratio) or 20.83 dB for RL.
 - (d) Select FailFlag (On/Off). Push to toggle the fail flag On and Off. The words PASS or FAIL will be shown in the sweep display area to indicate.
- (3) Enter Cable data using one of the flowing methods:
NOTE: Manually enter cable velocity value and Cable Loss Value or select the cable type from the cable list.
 - (a) Push velocity and enter the cable velocity (Table 202):
 - 1) Select Velocity.
 - 2) Set Speed Value.
 - 3) Select Cable Loss.
 - 4) Set Cable Loss Value (must be dB/ft or dB/m).
 - (b) Push the cable list, and then select the cable type from the list. The cable values will automatically enter for testing.
NOTE: The Cable List contains known cable values for a variety of cable types. The Cable List can be edited to add or delete cables.
- (4) Calibrate the frequency domain reflectometer, COM-15185. Refer to "Calibration" section.
- (5) Connect the frequency domain reflectometer, COM-15185 to the cable and antenna system being tested.
- (6) Wait for a minimum of 10 seconds for the sweep to complete the update.
- (7) To see the full sweep:
 - (a) Push the Scale icon then press TOP and enter 0 to adjust the scale.
 - (b) Press BOTTOM and enter -70.



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- (8) Interpreting the Fault Location Measurement (Figure 202):
 - (a) Isolate by using the FDR's distance to the fault readout, the applicable system schematic and the wiring diagram.
 - (b) Each connector or jumper will show as a spike. If it is larger than the typical value (for example: Max VSWR), check the connector for damage.
 - (c) Spikes where there are no components represent faults. Record the distance and then examine the line at that point for damage.
 - (d) The largest spike is usually due to the antenna. Typically the trace after the antenna can be ignored.
 - (e) Make sure that the distance to antenna is correct, refer to the applicable system's WDM (Wiring Diagram Manual).
- (9) Make sure of the the fault location by replacing defective component with 50 ohm load (calibration combo or a dummy load).
 - (a) Disconnect the component (cable, connector, antenna).
 - (b) Connect the 50 ohm terminator to the open end of the applicable cable.
 - (c) Do the Health Check again.
 - 1) Make sure that the VSWR (Voltage Standing Wave Ratio) or the RL test result is PASS.
 - a) If the test is not PASS, adjust distance to the fault test and continue to move 50 ohm load to further isolate.

I. Put the Airplane Back to Its Usual Condition

SUBTASK 20-10-72-080-001

- (1) Disconnect the TDR adapter cable from the EE Rack Bench Plug.

SUBTASK 20-10-72-080-002

- (2) Remove the 50 ohm terminator from the other end of the applicable cable if used for troubleshooting.

SUBTASK 20-10-72-410-001

- (3) To install the applicable black box, do this task: E/E Box Installation, TASK 20-10-07-400-801.

SUBTASK 20-10-72-420-001

- (4) Connect any cables previously disconnected for troubleshooting.

———— **END OF TASK** ————

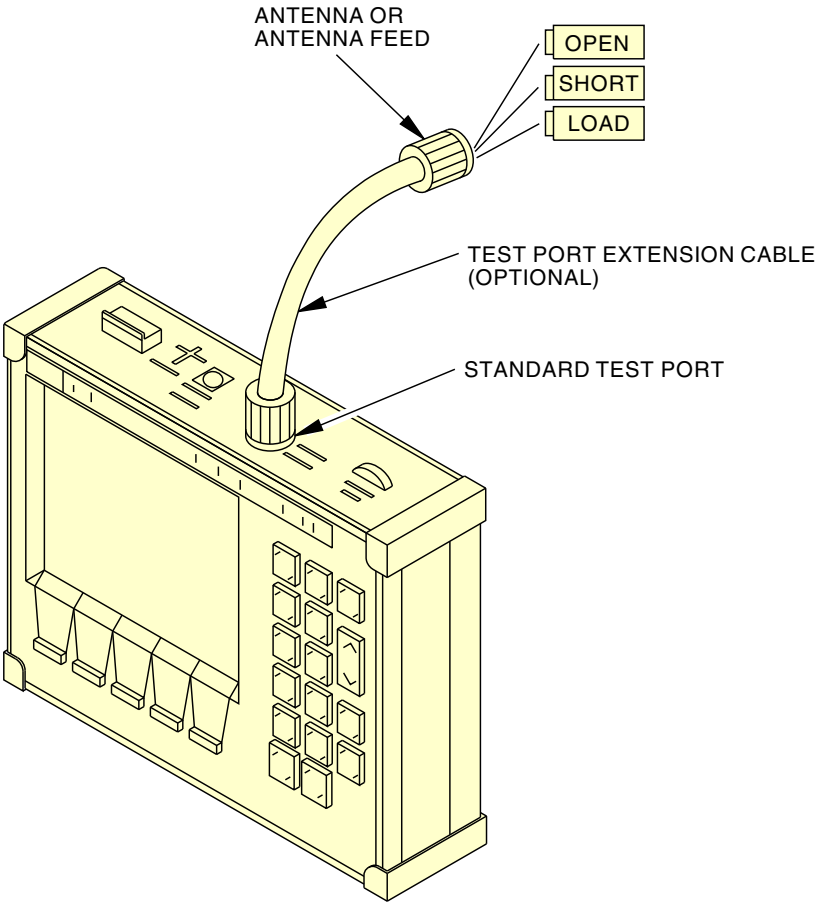
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FREQUENCY DOMAIN REFLECTOMETER
(EXAMPLE)

2582292 S0000622141_V1

Frequency Domain Reflectometer
Figure 201/20-10-72-990-801

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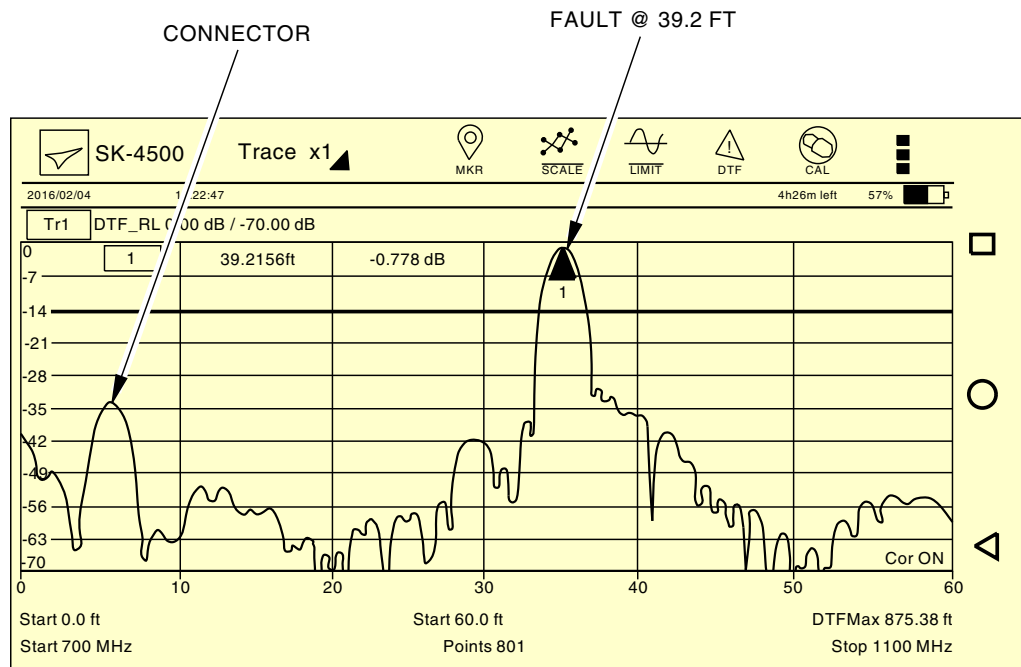
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TYPICAL FAULT LOCATION MEASUREMENT FOR AN ANTENNA SYSTEM
(EXAMPLE)

3019150 S0000791618_V1

Typical Fault Location Measurement for an Antenna System
Figure 202/20-10-72-990-802 (Sheet 1 of 2)

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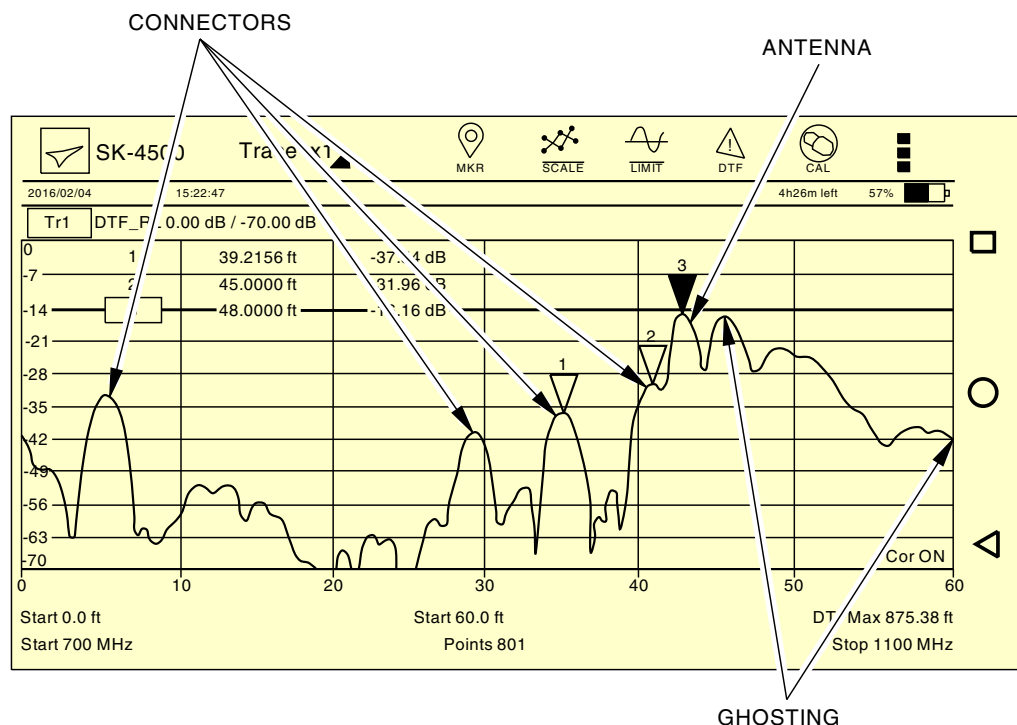
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TYPICAL COMPONENT RETURN LOSS	
ANTENNA AT RESONANCE	-14 dB
CONNECTOR	-25 dB
JUMPER	-35 dB
LIGHTNING PROTECTOR	-25 dB
TRANSMISSION LINE	-30 dB

LIST OF TYPICAL COMPONENT RETURN LOSSES
(EXAMPLE)



SATISFACTORY TEST
(EXAMPLE)

3019151 S0000791622_V1

Typical Fault Location Measurement for an Antenna System
Figure 202/20-10-72-990-802 (Sheet 2 of 2)

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THERMAL IMAGING - MAINTENANCE PRACTICES

1. General

A. This procedure contains this task:

- (1) Thermal Imaging Checks

TASK 20-10-75-750-801

2. Thermal Imaging Checks

A. **General**

- (1) Recommended Equipment

- (a) An infrared camera, COM-15040, is the recommended equipment. When performing electrical system tests, it is recommended to use a infrared camera, COM-15040, with a high temperature range and low thermal sensitivity (also known as Noise Equivalent Temperature Difference (NETD)) of $\leq 32^{\circ}\text{F}$ at 86°F ($\leq 0.05^{\circ}\text{C}$ at 30°C). It is also recommended for you to use an infrared camera, COM-15040, with auto focus and auto ranging to enable ease of use and consistent testing.

- (2) Usage

- (a) Thermal imaging is a qualitative inspection that focuses on temperature differences as opposed to actual temperatures. Look for differences between equivalent components in equivalent load conditions. This can be compared to a recorded database or another operational system, such as duplicate system (left or right) or another aircraft.

- 1) It is good to keep your measurements while you record the load conditions at the time of each scan. This will allow you to create a database and properly evaluate your measurements against normal operating conditions.

- (3) Images in this task are examples only. The images may not agree with your airplane model or airplane configuration.

B. **Tools/Equipment**

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

Reference	Description
COM-15040	Camera - Infrared Part #: FLK-TI480-PRO Supplier: 4U744 Opt Part #: T440 Supplier: 093V7 Opt Part #: TI400 Supplier: 89536 Opt Part #: TI450 Supplier: 89536

C. **Thermal Imaging Checks**

SUBTASK 20-10-75-810-001

- (1) Electrical Tests

- (a) Thermal imaging (TI) may be used to identify the location of electrical system faults using an infrared camera, COM-15040, to identify three basic thermal patterns associated with electrical failure:

- 1) High resistance caused by poor surface contact such as loose, corroded, over-tightened, over/under crimped, dirty contacts. These conditions decrease electron flow and cause the connection to become hot.

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- 2) A short, over-loaded circuit or multi-phase imbalance problem. Shorts or unbalanced loads cause increased electron flow, increasing heat flow in the wiring to the load.
 - 3) An open circuit is viewed as a cool connection. An open contact, switch, or blown fuse may be easily identified by a cool indication (Figure 201 (Sheet 1)).
- (b) Inspect connections and wiring.
- 1) Operate the system with the highest possible load (min 40%), and try to point the infrared camera, COM-15040, as perpendicular to the object as possible for consistent readings.



MAKE SURE THAT YOU WEAR PERSONAL PROTECTIVE EQUIPMENT WHEN OPENING PANELS AND INSPECTING HIGH POWER SOURCES. IF YOU DO NOT WEAR THE PERSONAL PROTECTIVE EQUIPMENT, INJURY TO PERSONNEL OR DAMAGE TO EQUIPMENT CAN OCCUR.

- 2) Use the infrared camera, COM-15040, to easily examine wiring and connections. Opening of panels or enclosures can be necessary for a direct view of the connections.
 - 3) Look for connections that have a higher temperature indication compared with equivalent connections under equivalent loads. This could indicate a loose, over tightened, over/under crimped terminals, broken wiring strands, or corroded connections with increased resistance.
 - a) Connection-related hot spots usually appear warmest at the spot of highest resistance, cooling with distance from that spot. Notice whether the heat continues back along the wire toward the connection (connection-related problem) or toward the load (load related problem).
 - b) In some cases a cold component is abnormal because of the current being shunted away from the high-resistance connection. You can also find broken or undersized wires or defective insulation.
 - 4) Per the NETA (International Electrical Testing Association) guidelines, a difference in temperature (DT) between similar components under similar loads exceeding 25°F or 14°C, requires further investigation.
 - a) Upon identifying a hot spot, isolation of the root cause may be done with standard tooling (multi-meter, ammeter) to verify if caused by a loose connection, dirty relay contact, etc. (Figure 202 (Sheet 1)).
- (c) Examine Fuses
- 1) If a fuse shows up hot on a thermal scan, it may be at or near its current capacity. But, not all problems are hot. A blown fuse, or an open circuit for example, would produce a cooler than normal temperature (Figure 203 (Sheet 1)).
- (d) Inspect Motor Control Center (MCC) or Common Motor Start Controller (CMSC)
- 1) To evaluate a MCC or CMSC under load, open up each compartment and compare the relative temperatures of key components: bus bars, controllers, starters, contactors, relays, fuses, breakers, disconnects, feeders, and transformers. Incorporate the guidelines above for examination of connections and fuses and identification of phase imbalance (Figure 204 (Sheet 1)).
- (e) Examine Three-Phase Circuits

EFFECTIVITY
SIA ALL

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- 1) Compare all three phases, side- by-side, and check for temperature differences exceeding 25°F or 14°C. A cooler than-normal circuit or leg might signal a failed component. More heavily loaded phases will show warmer. Hot conductors may be undersized, overloaded, or have a defective connections as described above. Voltage drops across fuses, circuit breakers, and relay contacts can also create an unbalanced condition, prematurely damaging the motor. Follow the unwanted heat to the root trouble spot. Before you assume that the cause has been found, verify with a multi-meter or clamp-on ammeter (Figure 205 (Sheet 1)).
- (f) Examine Pitot Static Probe/AOA Sensor Heating Elements
 - 1) Check for partially open or shorted heating elements which are known to cause intermittent operation in flight.
 - a) Technician A, prepare a infrared camera, COM-15040, by focusing on target before you turn on probe heat.
 - b) Technician B, turn on probe heat
 - c) Technician A, use infrared camera, COM-15040, to watch probes come up to temperature.
 - <1> Good Pitot Static probe will display the hottest point at the tip with probe element visible, then gradually cooling moving towards the base.
 - <2> Good AOA Sensor will display an outboard half nearly the same temp, then gradually cooling toward the base (Figure 206 (Sheet 1)).
- (g) Pressurization Leak Tests
 - 1) An infrared camera, COM-15040, with the recommended sensitivity above, easily picks up temperature differences > 0.5°F or 0.3°C between air inside and outside the airplane. This allows identification of leaking windows, door seals, and outflow valves.
 - a) When the aircraft is pressurized, technician A should walk around the aircraft identifying possible leaks with the infrared camera, COM-15040.
 - <1> Make sure that to monitor the actual temperatures displayed on the infrared camera, COM-15040.
 - b) Technician B, in communication with technician A, verifies leaks using an ultra-sonic leak detector and marks the location (Figure 207 (Sheet 1)).
- (h) Pack Leak Tests
 - 1) Troubleshoot pack operation by identifying proper flow and leaks.
 - a) Operate both packs
 - b) View Air Cycle Machine (ACM) compressor and turbine operation and compare with the other side.
 - c) View the heat exchanger and compare it with the one on the other side.
 - d) Look for the correct operation of the ACM & heat exchanger and leaks.
 - 2) See example below of too hot air exiting turbine 65°F (18°C) turbine outlet and 130°F (54°C) plenum inlet than left side. Found right pack HEX leaking (Figure 208 (Sheet 1)).
- (i) Bleed Air Leak Tests
 - 1) Chronic and intermittent bleed air leaks can be found with thermal imaging.



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- a) Before you apply bleed air, walk around aircraft with the infrared camera, COM-15040. Record anomalies in potential leak areas; engine pylon, leading edges, wing root to pack(s). This is to mitigate confusion because of sun, heat transfer, and reflective surfaces.
 - b) Operate the bleed air and walk around the aircraft to identify possible leaks with the infrared camera, COM-15040.
 - <1> Make sure that you carefully monitor the actual temperatures that display on the infrared camera, COM-15040.
 - c) Once you identify a hot area, turn off bleed air and remove panels to further isolate them with the infrared camera, COM-15040.
 - d) Once panel is removed, bleed air leaks are easily pinpointed to clamps, valve body, seals, etc. (Figure 209 (Sheet 1)).
- (j) Hydraulic Tests
- 1) Thermography permits visualization of hydraulic fluid flow; readily identifying proper heat exchanger operation, leaks, valve condition (open, closed, partially open/closed), oil filter bypass condition, accumulator pre-charge level, reservoir contamination, and hydraulic bypassing within a component.
 - a) Examine the heat exchanger operation by viewing flow of hot to cold fluid. Record temperature and compare with other side, or previously recorded database.
 - b) Inspect for a filter bypass condition by viewing filter for marked temperature drop, indicating bypassing fluid (Figure 210 (Sheet 1)).
 - c) Inspect for actuator bypass condition by viewing internal leakage (Figure 210 (Sheet 1)).
 - d) Examine for an incorrect accumulator pre-charge condition
 - e) Inspect the reservoir for possible contamination (water shows as foam) (Figure 210 (Sheet 1)).
- (k) Water/Mold Detection
- 1) Sources of moisture, "Rain in the Plane," and moisture trapped in insulation blankets may be identified using the infrared camera, COM-15040. Scheduled inspections to find moisture can prevent catastrophic damage that could be caused from undetected mold or pools of water (Figure 211 (Sheet 1)).
- (l) Fluid Level
- 1) Fluid levels can be checked without the removal of components. For example, fire bottles, accumulators, reservoirs, etc. may be easily checked for fluid level and contamination (Figure 212 (Sheet 1)).
- (m) Motor/Pump/Bearings
- 1) The infrared camera, COM-15040, can be used to identify worn bearings, abnormal pump flow, bearing lubrication failure, and pump to motor coupling misalignment that can cause premature wear to bearings (Figure 213 (Sheet 1)).

————— **END OF TASK** —————

EFFECTIVITY
SIA ALL

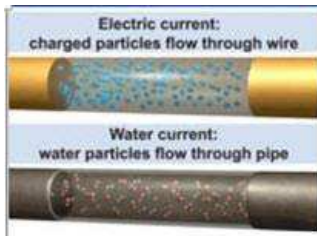
D633AM101-SIA

ECCN 9E991 BOEING PROPRIETARY - See title page for details

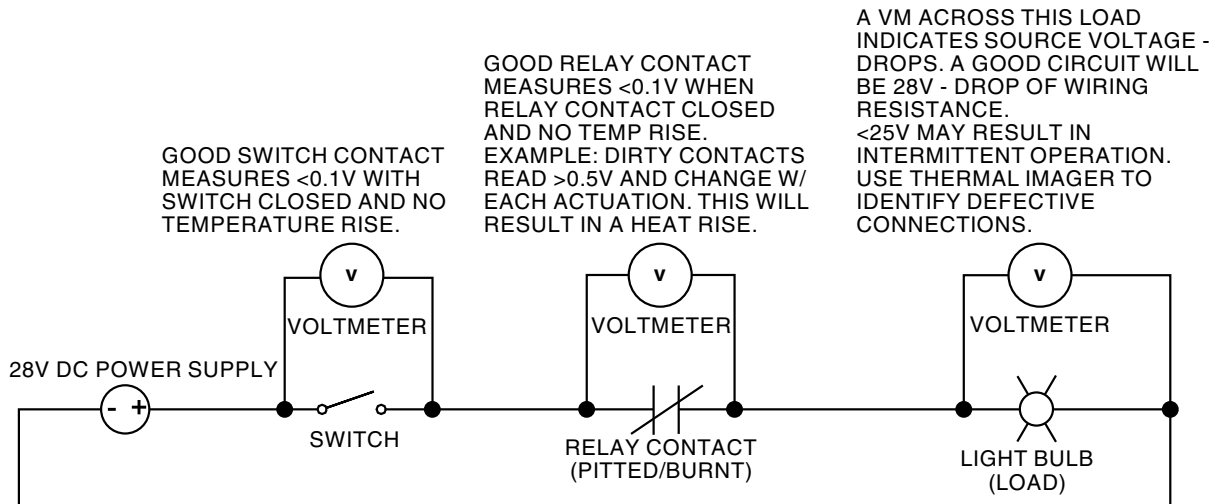
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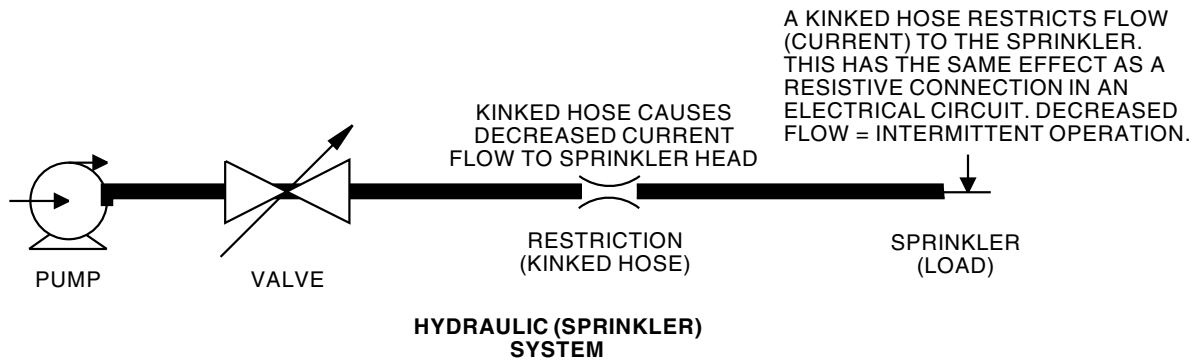
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ELECTRICAL - EVALUATION



ELECTRICAL SYSTEM



2535598 S0000600840_V1

Electrical Evaluation
Figure 201/20-10-75-990-801

EFFECTIVITY
SIA ALL

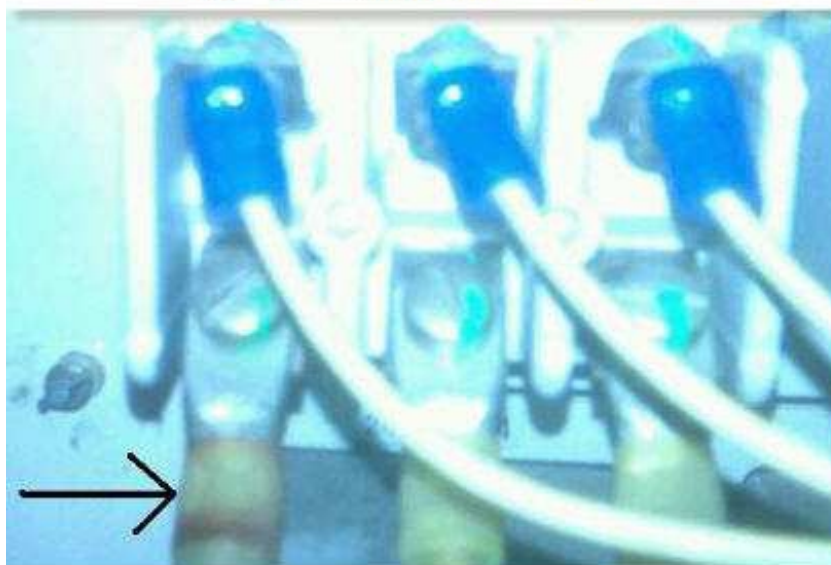
20-10-75

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Following heat to hottest point, identified
improperly crimped terminal



2535599 S0000600849_V1

Improperly Crimped Terminal
Figure 202/20-10-75-990-802

EFFECTIVITY
SIA ALL

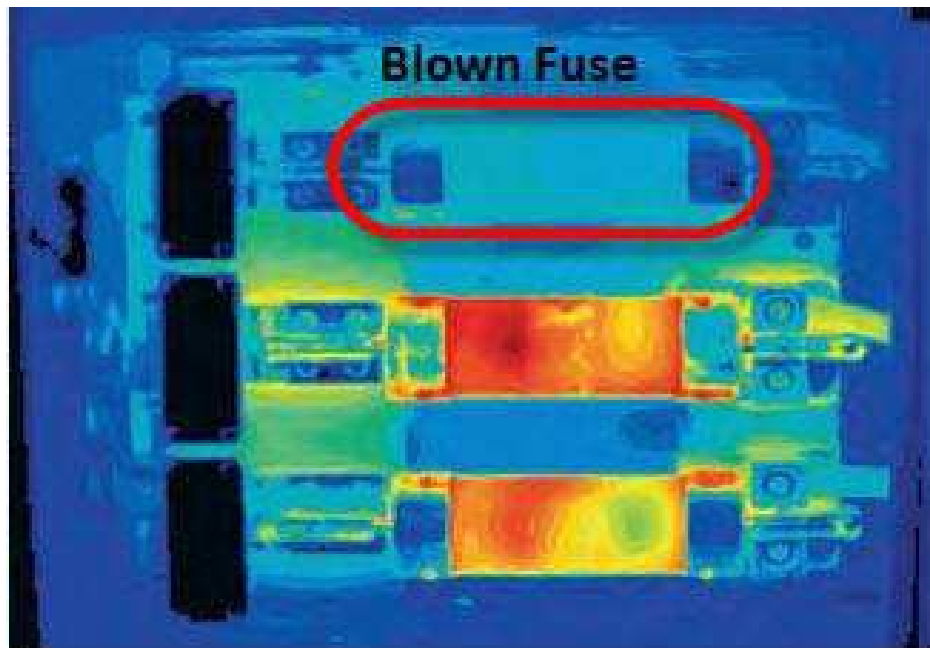
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2535601 S0000600854_V1

Blown Fuse
Figure 203/20-10-75-990-804

EFFECTIVITY
SIA ALL

D633AM101-SIA

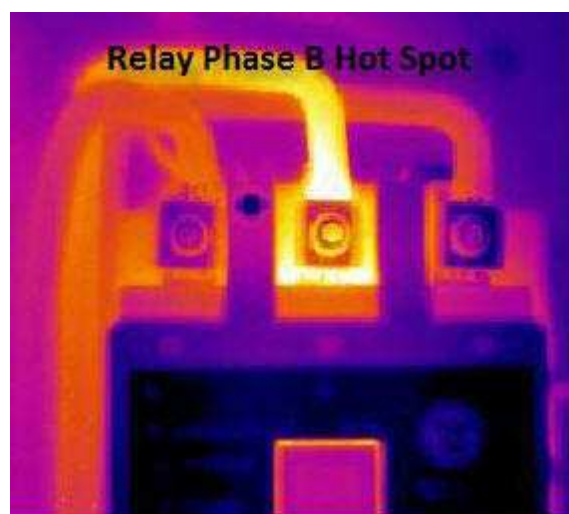
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2535602 S0000600855_V1

Loose Bus Bar / Relay Phase B Hot Spot / Relay Contacts Worn with Carbon Buildup
Figure 204/20-10-75-990-805

EFFECTIVITY
SIA ALL

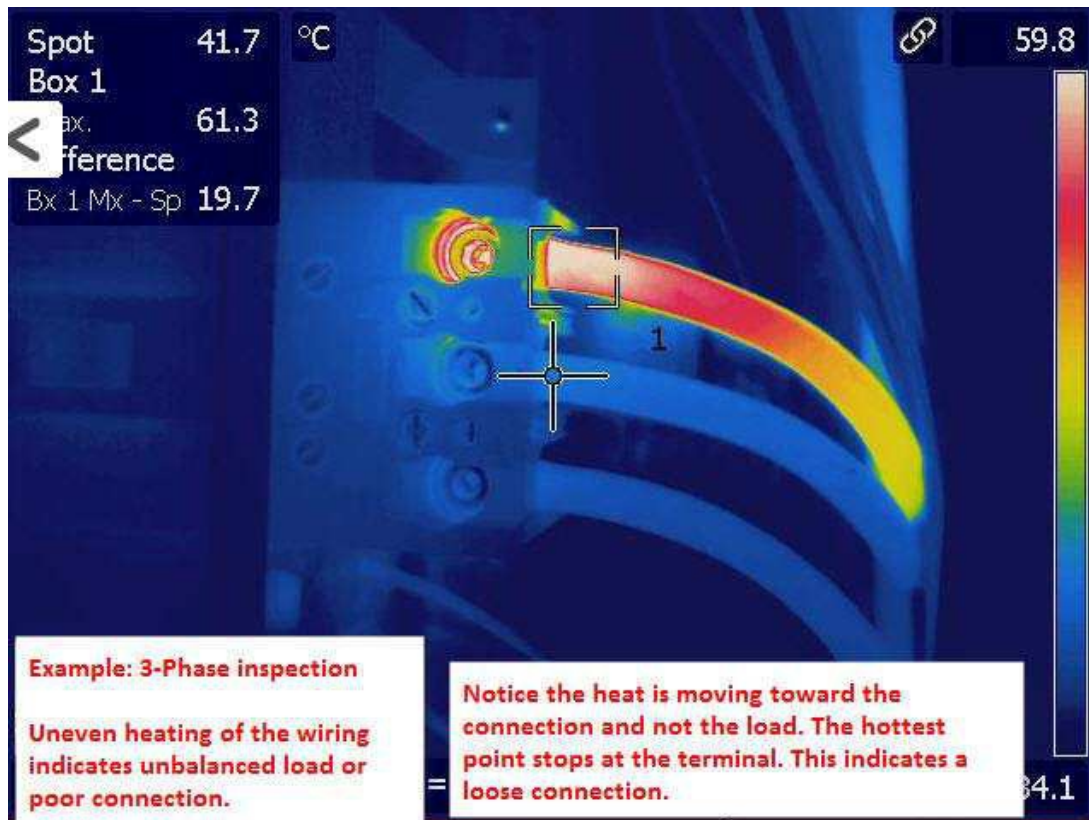
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BOEING
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2535605 S0000600858_V1

3-Phase Inspection
Figure 205/20-10-75-990-808

EFFECTIVITY
SIA ALL

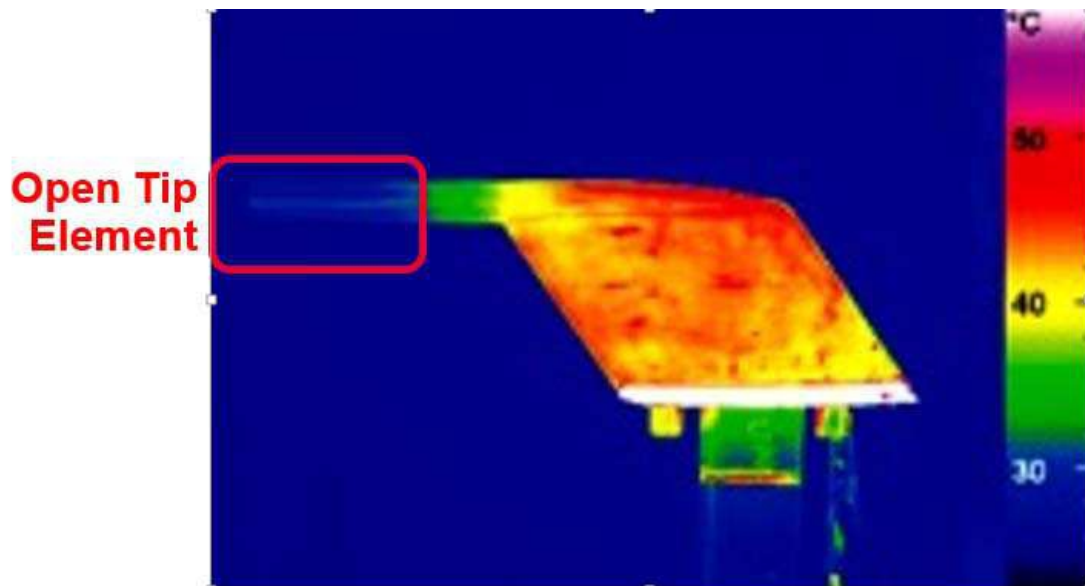
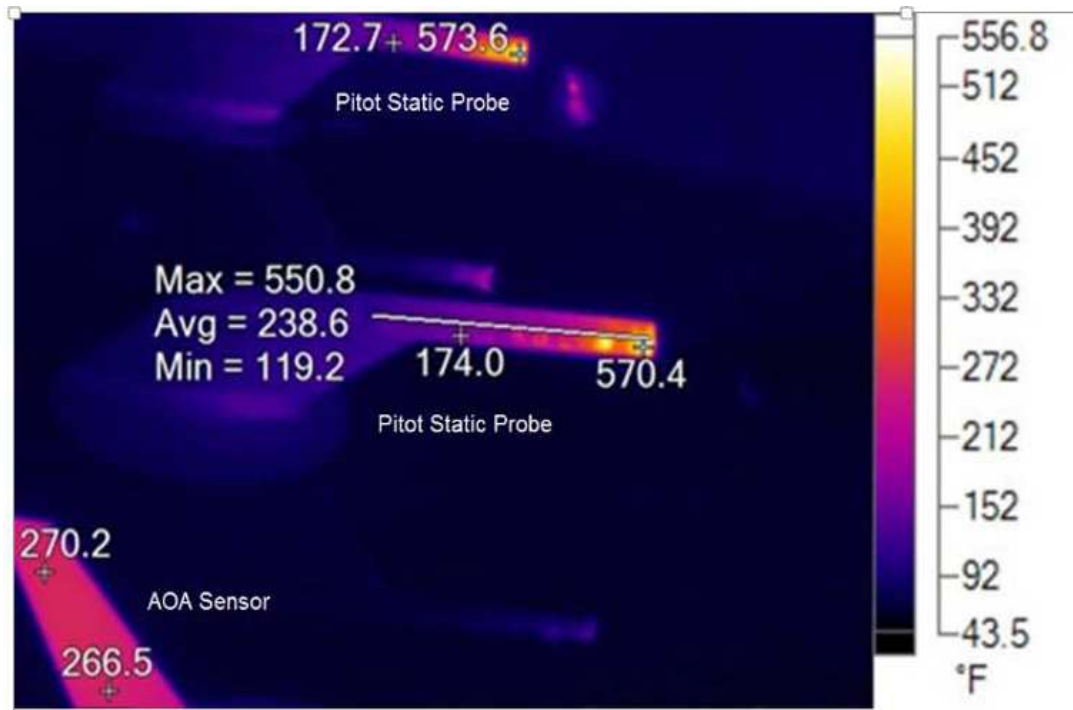
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2535606 S0000600859_V1

Pitot Static Probe and AOA Sensor
Figure 206/20-10-75-990-809

EFFECTIVITY
SIA ALL

D633AM101-SIA

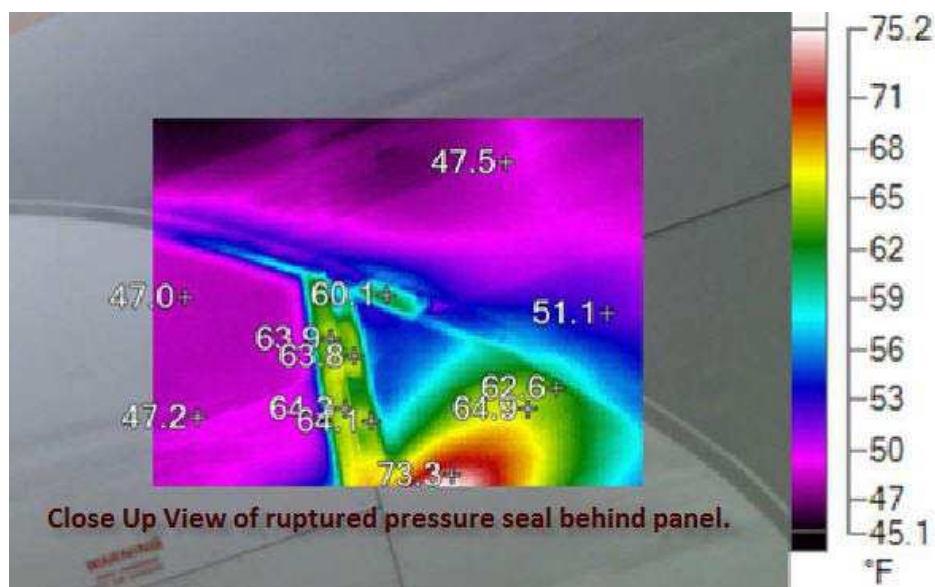
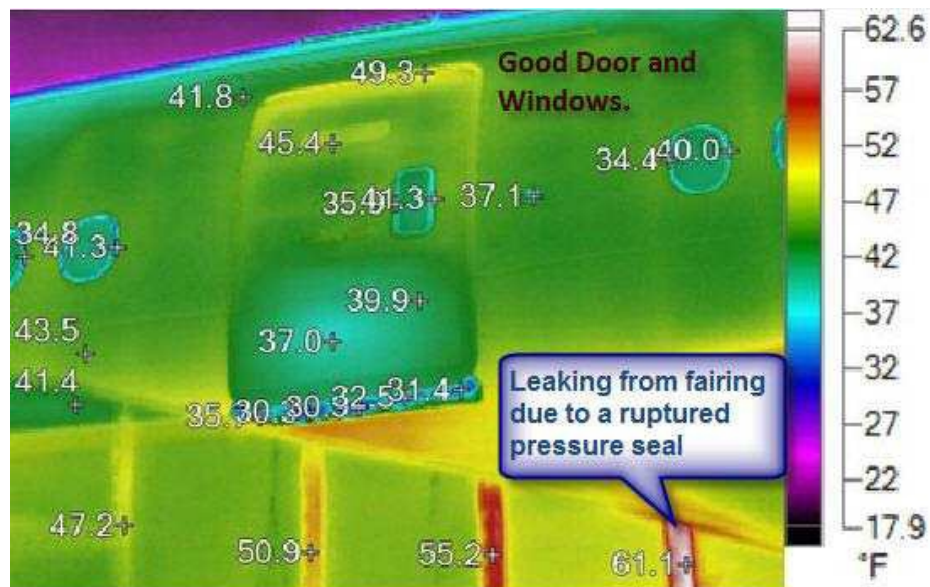
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2535607 S0000600865_V1

Leak from Fairing Due to Ruptured Pressure Seal
Figure 207/20-10-75-990-811

EFFECTIVITY
SIA ALL

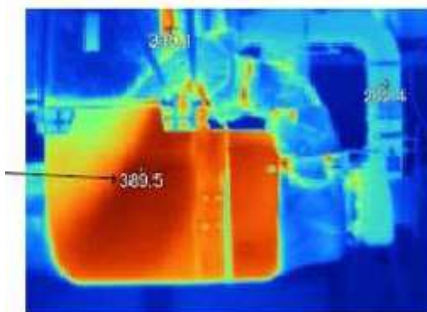
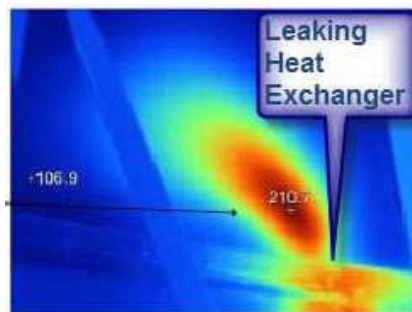
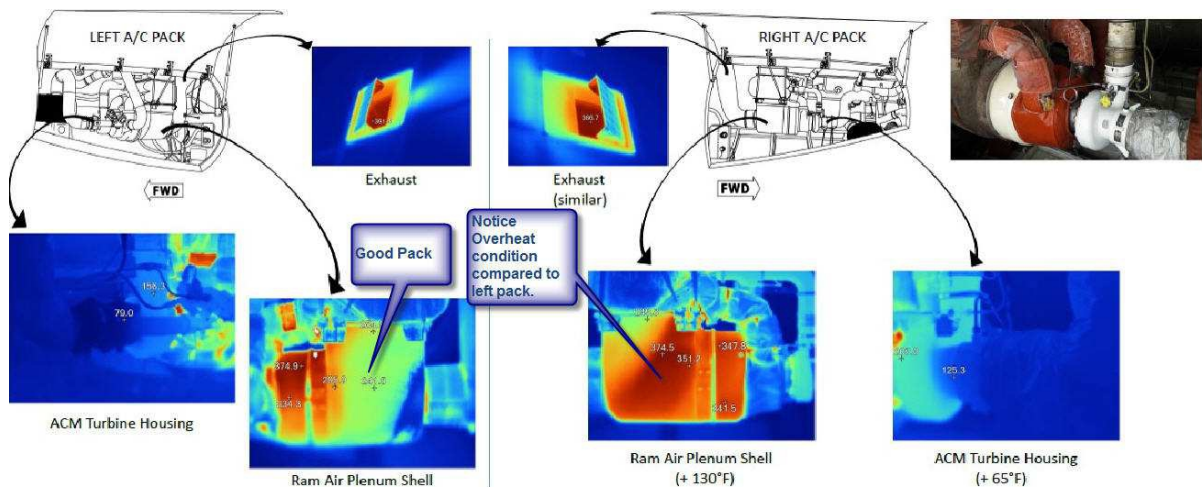
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2535609 S0000600867_V1

**Too Hot of Air Exiting Turbine - Leaking Heat Exchanger
Figure 208/20-10-75-990-813**

EFFECTIVITY
SIA ALL

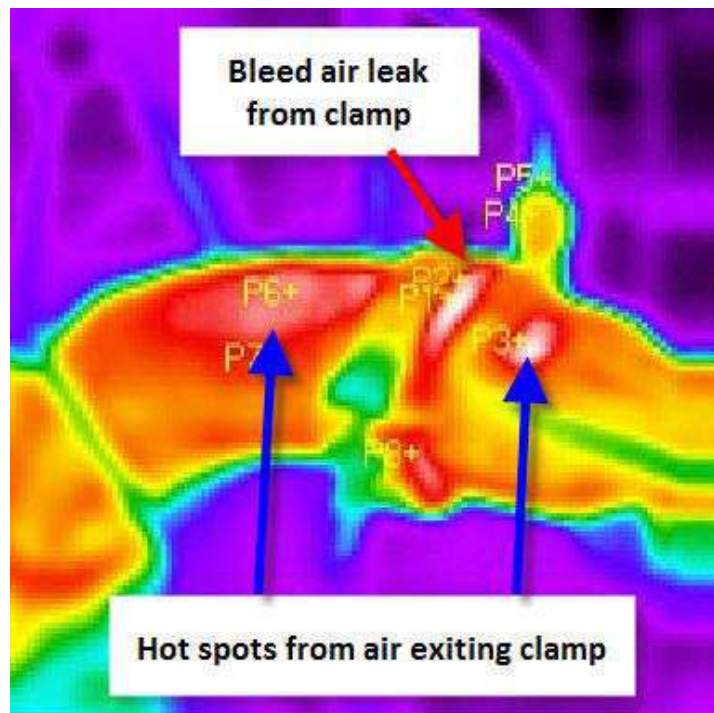
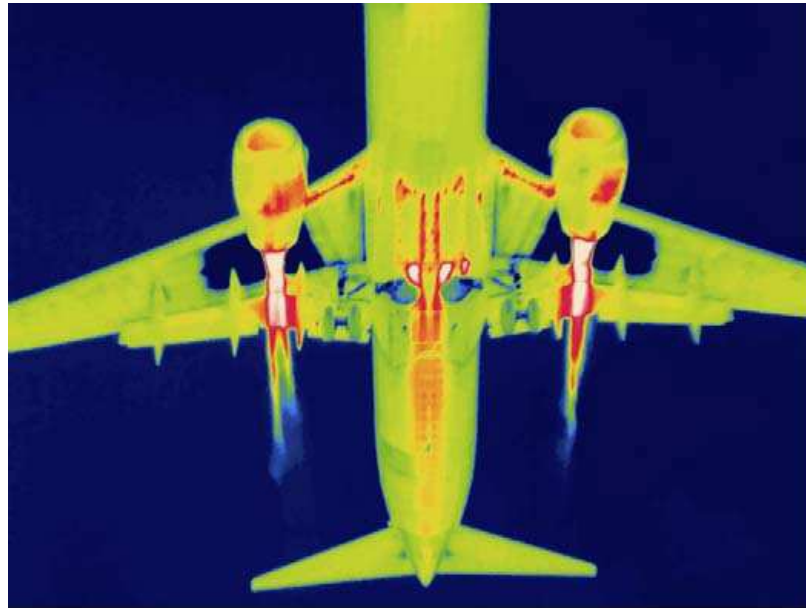
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2535610 S0000600869_V1

Bleed Air Leak Tests - Airplane Belly View
Figure 209/20-10-75-990-814

EFFECTIVITY	
SIA ALL	

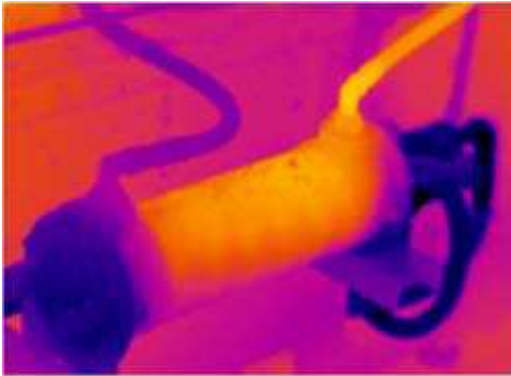
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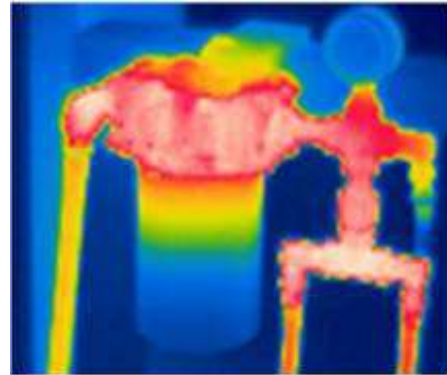
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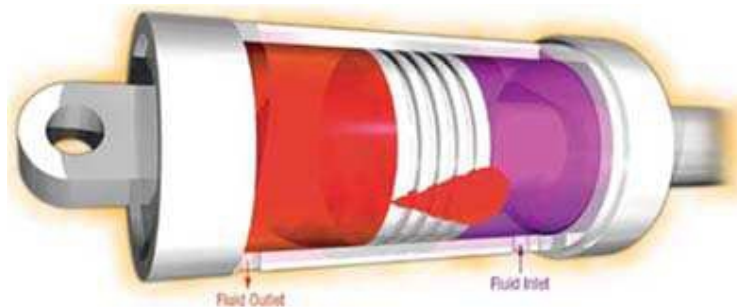
BOEING
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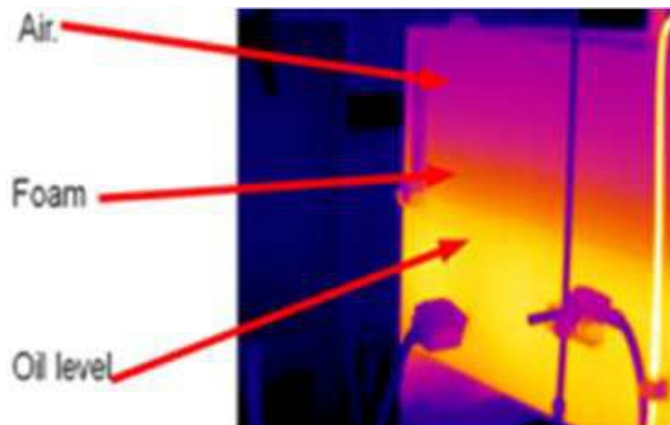
**HEAT EXCHANGER PROPER
OPERATION**



FILTER BYPASS



ACTUATOR BYPASS



RESERVOIR CONTAMINATION

2535611 S0000600870_V1

Filter Bypass, Actuator Bypass, Accumulator Pre-Charge, Reservoir Contamination
Figure 210/20-10-75-990-815

EFFECTIVITY
SIA ALL

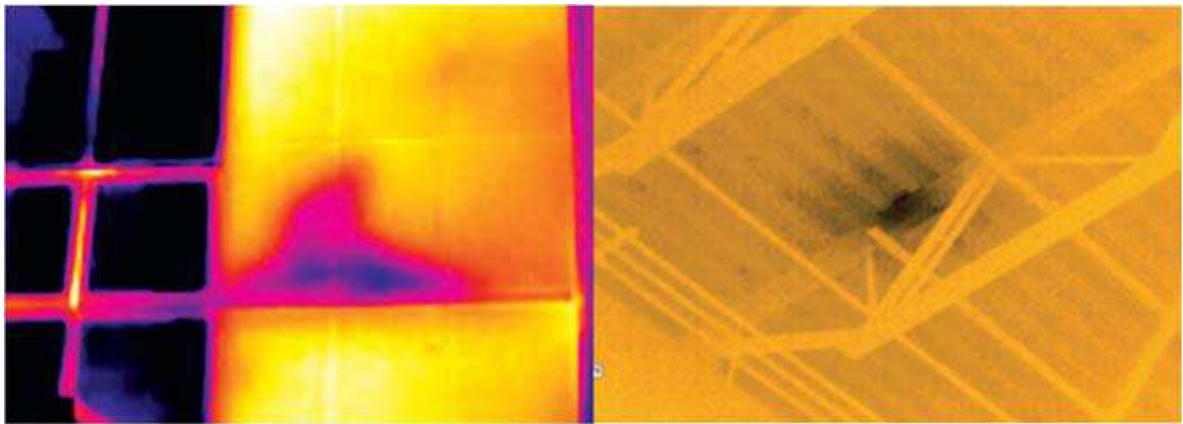
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2535612 S0000600872_V1

Water/Mold Detection
Figure 211/20-10-75-990-817

EFFECTIVITY
SIA ALL

D633AM101-SIA

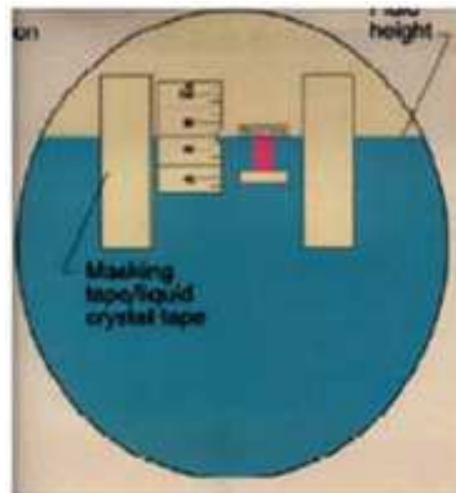
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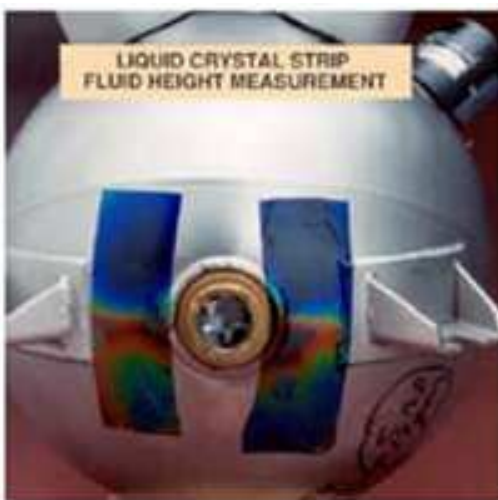
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VISUAL PICTURE OF THE
BOTTLES IN THE CARGO BAY



SCHEMATIC DIAGRAM OF
THE TEST METHOD



LIQUID CRYSTAL FLUID LEVEL



INFRARED PICTURE OF THE
FLUID LEVEL

2535613 S0000600873_V1

Fluid Level
Figure 212/20-10-75-990-818

EFFECTIVITY
SIA ALL

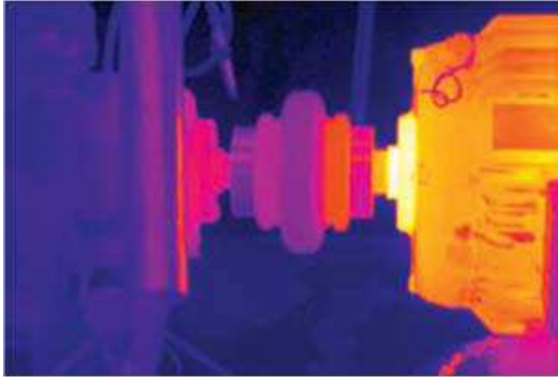
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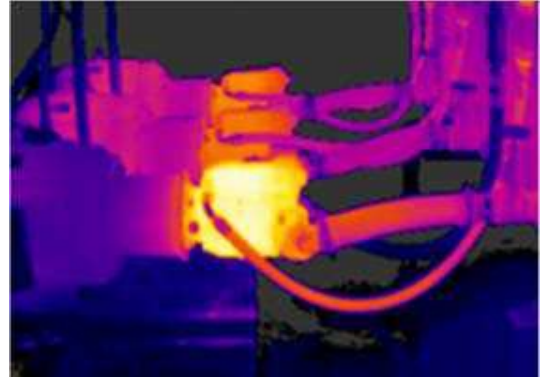
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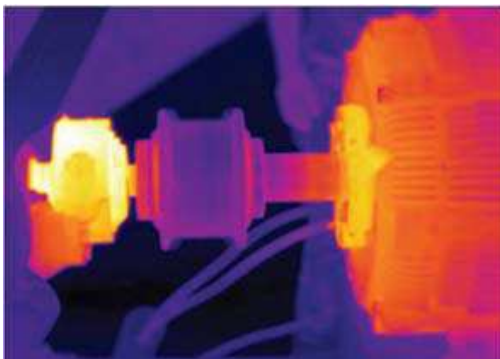
BOEING
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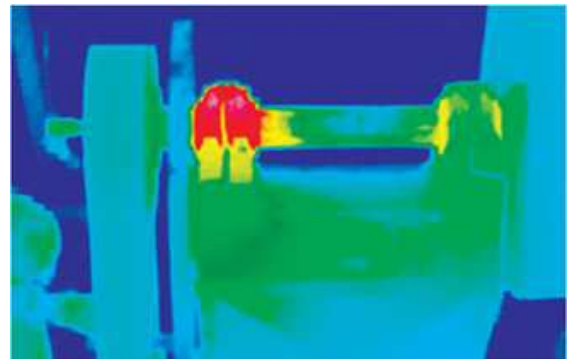
**MOTOR BEARING
(MUCH HOTTER THAN CASE)**



**PUMP HOTTER THAN OTHERS. MAY BE
DUE TO OVER/UNDER PRESSURE,
ABNORMAL FLOW, CAVITATION, WEAR**



**HOT BEARING MAY INDICATE
ISSUES WITH ALIGNMENT,
LUBRICATION OR WEAR**



**EASY TO COMPARE. NOTICE
BEARING ON RIGHT SIDE HOT
WHEN COMPARED TO LEFT**

2535614 S0000600874_V1

**Motor/Pump/Bearings
Figure 213/20-10-75-990-819**

EFFECTIVITY
SIA ALL

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PITOT PROBE HEAT PREVENTATIVE MEASURES - MAINTENANCE PRACTICES

1. General

- A. This procedure has these tasks:
 - (1) Pitot Probe Heater Resistance Check - Check I
 - (2) Pitot Probe Heater Power Consumption Check - Check II
 - (3) Pitot Probe Heater Insulation Resistance Check - Check III
- B. The objective of this test procedure is to perform a health check on the 737 Pitot Probe Heat system and related airplane wiring.
- C. Obey all WARNINGS and CAUTIONS during this task.
- D. The power consumption test will simulate Component Maintenance Manual (CMM) heat (115VAC) test. Minimize the operation of the de-icing heater during ground operation for maximum service life and personnel safety. The probe(s) may be cycled on for 5 minutes. Ensure a 5 minute cool down time if the same probe must be re-tested.
- E. The Pitot Probe Heater Insulation Resistance Check requires access to the rear of the probe, either by removing the probe or by removing flight deck access panels. Recommend performing this check concurrently with scheduled maintenance tasks that require the flight deck access panels to be removed.

TASK 20-10-77-200-801

2. Pitot Probe Heater Resistance Check - Check I

A. **General**

- (1) This task does a check of the resistance of the pitot heater system to identify continuity deterioration of relays, connectors, and wiring.

B. **References**

Reference	Title
24-22-00-860-801	Supply Electrical Power (P/B 201)
24-22-00-860-802	Remove Electrical Power (P/B 201)

C. **Tools/Equipment**

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt.", which stands for Optional.

Reference	Description
COM-1322	Multimeter (Analog / Digital with sufficient internal voltage to measure long cable distances) Part #: 117 Supplier: 89536 Part #: 260-8XPI Supplier: 55026 Part #: FLUKE 289 Supplier: 89536 Opt Part #: MODEL 8 MK7 Supplier: 00426

D. **Procedure**

SUBTASK 20-10-77-860-037

- (1) Make sure that the probe is at ambient temperature.

NOTE: The preferred method to do a check of the probe temperature is to use an infrared thermometer or thermal imager. The alternative method is to set the probe heaters to off for more than one hour.

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SUBTASK 20-10-77-860-001



MAKE SURE THAT YOU REMOVE ANY TYPE OF PROTECTIVE COVER OR MATERIAL BEFORE OPERATING ANY PROBE HEATER OR ANTI-ICE TYPE HEATED SURFACE. DAMAGE CAN OCCUR TO THE EQUIPMENT WHEN THE PROBES BECOME HOT.

- (2) Remove all covers from the pitot, angle of attack, and total air temperature probes.

SUBTASK 20-10-77-860-002

- (3) Do this task: Remove Electrical Power, TASK 24-22-00-860-802.
- (a) Make sure that the external power cable is disconnected from the airplane.
- (b) Make sure that the GRD POWER AVAILABLE light on the P5-4 panel is OFF.

SUBTASK 20-10-77-860-003

- (4) Open these circuit breakers and install safety tags:

CAPT Electrical System Panel, P18-3

Row	Col	Number	Name
C	1	C00523	HEATERS CAPT PITOT
C	2	C00238	HEATERS TEMP PROBE
C	3	C01072	HEATERS ALPHA VANE LEFT
C	4	C00236	HEATERS ELEV PITOT LEFT
D	3	C01071	HEATERS ALPHA VANE RIGHT
D	4	C00237	HEATERS ELEV PITOT RIGHT
D	5	C00525	HEATERS F/O PITOT
D	6	C00524	HEATERS AUX PITOT

NOTE: The circuit breakers are opened to remove parallel electrical paths to make sure that accurate measurements are recorded.

- (a) Make sure that the airplane stays de-energized.

SUBTASK 20-10-77-860-004

- (5) Set the PROBE HEAT A and B switches on the P5-9 panel to ON.

SUBTASK 20-10-77-700-013

- (6) Do a check of the resistance for each of the pitot probe heaters as follows:
- (a) Get access to these circuit breakers:

CAPT Electrical System Panel, P18-3

Row	Col	Number	Name
C	1	C00523	HEATERS CAPT PITOT
C	4	C00236	HEATERS ELEV PITOT LEFT
D	4	C00237	HEATERS ELEV PITOT RIGHT
D	5	C00525	HEATERS F/O PITOT
D	6	C00524	HEATERS AUX PITOT

- (b) Do these steps for each circuit breaker:
- 1) Connect the multimeter, COM-1322, as follows:
- a) Put the red probe on the circuit breaker terminal =L.
- b) Put the black probe on aircraft ground.
- 2) Measure and record the resistance in Table 201.

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SUBTASK 20-10-77-860-005

- (7) Set the PROBE HEAT A and B switches on the P5-9 panel to AUTO.

SUBTASK 20-10-77-860-006

- (8) Remove the safety tags and close these circuit breakers:

CAPT Electrical System Panel, P18-3

Row	Col	Number	Name
C	1	C00523	HEATERS CAPT PITOT
C	2	C00238	HEATERS TEMP PROBE
C	3	C01072	HEATERS ALPHA VANE LEFT
C	4	C00236	HEATERS ELEV PITOT LEFT
D	3	C01071	HEATERS ALPHA VANE RIGHT
D	4	C00237	HEATERS ELEV PITOT RIGHT
D	5	C00525	HEATERS F/O PITOT
D	6	C00524	HEATERS AUX PITOT

SUBTASK 20-10-77-860-038

- (9) Do this task: Supply Electrical Power, TASK 24-22-00-860-801.

SUBTASK 20-10-77-700-006

- (10) Do a check of the recorded data as follows:
- Make sure that all resistance values in Table 201 are between 45 to 65 ohms.
 - If the resistance values are not in range, isolate the root cause at the next maintenance opportunity as follows:
 - Disconnect the applicable pitot probe connector.
 - Make sure that the heater resistance is 45 to 65 ohms.

Table 201/20-10-77-993-801 RESISTANCE TEST TABLE

Test Point	Positive Lead Connection	Negative Lead Connection	Resistance Requirement 45 to 65 ohms	Remarks
1	HEATERS CAPT PITOT HEAT	Ground		Captain Pitot Probe
2	HEATERS ELEV PITOT LEFT	Ground		Elevator Left Pitot Probe
3	HEATERS AUX PITOT	Ground		Auxiliary Pitot Probe
4	HEATERS F/O PITOT	Ground		First Officer Pitot Probe
5	HEATERS ELEV PITOT RIGHT	Ground		Elevator Right Pitot Probe

————— END OF TASK —————

EFFECTIVITY
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TASK 20-10-77-200-802

3. Pitot Probe Heater Power Consumption Check - Check II

A. General

- (1) This task does a check of the power consumption of the pitot probe heater system.
- (2) The check will determine the current condition of the electrical sub-components of the pitot probe system by comparing the power consumption values with the Component Maintenance Manual (CMM) reference value.
- (3) It is recommended to perform this check when there are minimal wind conditions and the ambient air temperature is between 68°F (20°C) and 86°F (30°C).
- (4) The AC amperage value is recorded with an amperage clamp every 60 seconds for a maximum of 5 minutes.

NOTE: An additional multimeter without the amperage clamp connected can be used to measure and record the voltage.

B. References

Reference	Title
24-22-00-860-801	Supply Electrical Power (P/B 201)
24-22-00-860-802	Remove Electrical Power (P/B 201)

C. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

Reference	Description
COM-1322	Multimeter (Analog / Digital with sufficient internal voltage to measure long cable distances) Part #: 117 Supplier: 89536 Part #: 260-8XPI Supplier: 55026 Part #: FLUKE 289 Supplier: 89536 Opt Part #: MODEL 8 MK7 Supplier: 00426
COM-13988	Clamp-on - Current, AC/DC (used with Fluke multimeters or other manufacturer's meter) Part #: i30 Supplier: 89536

D. Preparation

SUBTASK 20-10-77-860-039

- (1) Make sure that the probe is at ambient temperature.

NOTE: The preferred method to do a check of the probe temperature is to use an infrared thermometer or thermal imager. The alternative method is to set the probe heaters to off for more than one hour.

SUBTASK 20-10-77-860-007



CAUTION

MAKE SURE THAT YOU REMOVE ANY TYPE OF PROTECTIVE COVER OR MATERIAL BEFORE OPERATING ANY PROBE HEATER OR ANTI-ICE TYPE HEATED SURFACE. DAMAGE CAN OCCUR TO THE EQUIPMENT WHEN THE PROBES BECOME HOT.

- (2) Remove all covers from the pitot, angle of attack, and total air temperature probes.

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SUBTASK 20-10-77-860-008



WARNING

REMOVE ELECTRICAL POWER FROM THE EXTERNAL POWER SOURCE. IF YOU DO NOT REMOVE ELECTRICAL POWER, YOU CAN CAUSE INJURIES TO PERSONNEL AND DAMAGE TO EQUIPMENT.

- (3) Do this task: Remove Electrical Power, TASK 24-22-00-860-802.



WARNING

MAKE SURE EXTERNAL POWER IS NOT CONNECTED TO THE AIRCRAFT UNTIL ALL ELECTRICAL MAINTENANCE IS COMPLETED. THIS WILL PREVENT INJURY TO PERSONS.

- (a) Make sure that the external power cable is disconnected from the airplane.
(b) Make sure that the GRD POWER AVAILABLE light on the P5-4 panel is OFF.

SUBTASK 20-10-77-860-009

- (4) Open these circuit breakers and install safety tags:

CAPT Electrical System Panel, P18-3

Row	Col	Number	Name
C	1	C00523	HEATERS CAPT PITOT
C	2	C00238	HEATERS TEMP PROBE
C	3	C01072	HEATERS ALPHA VANE LEFT
C	4	C00236	HEATERS ELEV PITOT LEFT
D	3	C01071	HEATERS ALPHA VANE RIGHT
D	4	C00237	HEATERS ELEV PITOT RIGHT
D	5	C00525	HEATERS F/O PITOT
D	6	C00524	HEATERS AUX PITOT

SUBTASK 20-10-77-860-010



WARNING

DO NOT TOUCH THE HOT METAL OF THE HEATER PROBE WHEN THE PROBES ARE HOT. LET THEM BECOME COOL, OR ONLY TOUCH THE OTHER PARTS OF THE PROBE. THE PROBES CAN BURN YOU.

- (5) Connect the AC/DC current clamp, COM-13988, to the multimeter, COM-1322.
(a) Follow the AC/DC current clamp, COM-13988, users manual to use the AC voltage setting to measure amperage.

NOTE: All amperage measurements are in AC amperage.

SUBTASK 20-10-77-860-011

- (6) Do this task: Supply Electrical Power, TASK 24-22-00-860-801.

E. Procedure

SUBTASK 20-10-77-730-001

- (1) Do a check of the power consumption of the captain pitot probe heater as follows:
(a) Get access to this circuit breaker:

CAPT Electrical System Panel, P18-3

Row	Col	Number	Name
C	1	C00523	HEATERS CAPT PITOT

- (b) Put the AC/DC current clamp, COM-13988, around the wire for terminal =L.

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SUBTASK 20-10-77-860-012

- (2) Remove the safety tag and close this circuit breaker:

CAPT Electrical System Panel, P18-3

<u>Row</u>	<u>Col</u>	<u>Number</u>	<u>Name</u>
C	1	C00523	HEATERS CAPT PITOT

SUBTASK 20-10-77-760-001



PROBE HEAT APPLICATION TIME SHOULD BE KEPT TO A MINIMUM.
PROBES MAY OVERHEAT IF PROBE HEAT IS APPLIED TOO LONG.

- (3) Set the PROBE HEAT A switch on the P5-9 panel to ON.
- (a) Measure and record the AC voltage at the circuit breaker in Table 202.
- (b) Measure and record the AC amperage in Table 202, for each minute, up to a maximum of 5 minutes.

SUBTASK 20-10-77-860-013

- (4) Set the PROBE HEAT A switch on the P5-9 panel to AUTO.

SUBTASK 20-10-77-860-014

- (5) Open this circuit breaker and install safety tag:

CAPT Electrical System Panel, P18-3

<u>Row</u>	<u>Col</u>	<u>Number</u>	<u>Name</u>
C	1	C00523	HEATERS CAPT PITOT

SUBTASK 20-10-77-760-002

- (6) Do a check of the power consumption of the left elevator pitot probe heater as follows:
- (a) Get access to this circuit breaker:

CAPT Electrical System Panel, P18-3

<u>Row</u>	<u>Col</u>	<u>Number</u>	<u>Name</u>
C	4	C00236	HEATERS ELEV PITOT LEFT

- (b) Put the AC/DC current clamp, COM-13988, around the wire for terminal =L.

SUBTASK 20-10-77-860-015

- (7) Remove the safety tag and close this circuit breaker:

CAPT Electrical System Panel, P18-3

<u>Row</u>	<u>Col</u>	<u>Number</u>	<u>Name</u>
C	4	C00236	HEATERS ELEV PITOT LEFT

SUBTASK 20-10-77-760-003



PROBE HEAT APPLICATION TIME SHOULD BE KEPT TO A MINIMUM.
PROBES MAY OVERHEAT IF PROBE HEAT IS APPLIED TOO LONG.

- (8) Set the PROBE HEAT A switch on the P5-9 panel to ON.
- (a) Measure and record the AC voltage at the circuit breaker in Table 202.
- (b) Measure and record the AC amperage in Table 202, for each minute, up to a maximum of 5 minutes.

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SUBTASK 20-10-77-860-016

- (9) Set the PROBE HEAT A switch on the P5-9 panel to AUTO.

SUBTASK 20-10-77-860-017

- (10) Open this circuit breaker and install safety tag:

CAPT Electrical System Panel, P18-3

<u>Row</u>	<u>Col</u>	<u>Number</u>	<u>Name</u>
C	4	C00236	HEATERS ELEV PITOT LEFT

SUBTASK 20-10-77-760-004

- (11) Do a check of the power consumption of the auxiliary pitot probe heater as follows:

- (a) Get access to this circuit breaker:

CAPT Electrical System Panel, P18-3

<u>Row</u>	<u>Col</u>	<u>Number</u>	<u>Name</u>
D	6	C00524	HEATERS AUX PITOT

- (b) Put the AC/DC current clamp, COM-13988, around the wire for terminal =L.

SUBTASK 20-10-77-860-018

- (12) Remove the safety tag and close this circuit breaker:

CAPT Electrical System Panel, P18-3

<u>Row</u>	<u>Col</u>	<u>Number</u>	<u>Name</u>
D	6	C00524	HEATERS AUX PITOT

SUBTASK 20-10-77-760-005



PROBE HEAT APPLICATION TIME SHOULD BE KEPT TO A MINIMUM.
PROBES MAY OVERHEAT IF PROBE HEAT IS APPLIED TOO LONG.

- (13) Set the PROBE HEAT B switch on the P5-9 panel to ON.
- (a) Measure and record the AC voltage at the circuit breaker in Table 202.
- (b) Measure and record the AC amperage in Table 202, for each minute, up to a maximum of 5 minutes.

SUBTASK 20-10-77-860-019

- (14) Set the PROBE HEAT B switch on the P5-9 panel to AUTO.

SUBTASK 20-10-77-860-020

- (15) Open this circuit breaker and install safety tag:

CAPT Electrical System Panel, P18-3

<u>Row</u>	<u>Col</u>	<u>Number</u>	<u>Name</u>
D	6	C00524	HEATERS AUX PITOT

SUBTASK 20-10-77-760-006

- (16) Do a check of the power consumption of the first officer pitot probe heater as follows:

- (a) Get access to this circuit breaker:

CAPT Electrical System Panel, P18-3

<u>Row</u>	<u>Col</u>	<u>Number</u>	<u>Name</u>
D	5	C00525	HEATERS F/O PITOT

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SUBTASK 20-10-77-860-021

- (17) Remove the safety tag and close this circuit breaker:

CAPT Electrical System Panel, P18-3

<u>Row</u>	<u>Col</u>	<u>Number</u>	<u>Name</u>
D	5	C00525	HEATERS F/O PITOT

SUBTASK 20-10-77-760-007



CAUTION

PROBE HEAT APPLICATION TIME SHOULD BE KEPT TO A MINIMUM.
PROBES MAY OVERHEAT IF PROBE HEAT IS APPLIED TOO LONG.

- (18) Set the PROBE HEAT B switch on the P5-9 panel to ON.
- (a) Measure and record the AC voltage at the circuit breaker in Table 202.
 - (b) Measure and record the AC amperage in Table 202, for each minute, up to a maximum of 5 minutes.

SUBTASK 20-10-77-860-022

- (19) Set the PROBE HEAT B switch on the P5-9 panel to AUTO.

SUBTASK 20-10-77-860-023

- (20) Open this circuit breaker and install safety tag:

CAPT Electrical System Panel, P18-3

<u>Row</u>	<u>Col</u>	<u>Number</u>	<u>Name</u>
D	5	C00525	HEATERS F/O PITOT

SUBTASK 20-10-77-760-008

- (21) Do a check of the power consumption of the right elevator pitot probe heater as follows:
- (a) Get access to this circuit breaker:

CAPT Electrical System Panel, P18-3

<u>Row</u>	<u>Col</u>	<u>Number</u>	<u>Name</u>
D	4	C00237	HEATERS ELEV PITOT RIGHT

SUBTASK 20-10-77-860-024

- (22) Remove the safety tag and close this circuit breaker:

CAPT Electrical System Panel, P18-3

<u>Row</u>	<u>Col</u>	<u>Number</u>	<u>Name</u>
D	4	C00237	HEATERS ELEV PITOT RIGHT

SUBTASK 20-10-77-760-009



CAUTION

PROBE HEAT APPLICATION TIME SHOULD BE KEPT TO A MINIMUM.
PROBES MAY OVERHEAT IF PROBE HEAT IS APPLIED TOO LONG.

- (23) Set the PROBE HEAT B switch on the P5-9 panel to ON.
- (a) Measure and record the AC voltage at the circuit breaker in Table 202.
 - (b) Measure and record the AC amperage in Table 202, for each minute, up to a maximum of 5 minutes.

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SUBTASK 20-10-77-860-025

- (24) Set the PROBE HEAT B switch on the P5-9 panel to AUTO.

SUBTASK 20-10-77-860-026

- (25) Do this task: Remove Electrical Power, TASK 24-22-00-860-802.

SUBTASK 20-10-77-860-027

- (26) Remove the AC/DC current clamp, COM-13988.

SUBTASK 20-10-77-860-028

- (27) Close these circuit breakers:

CAPT Electrical System Panel, P18-3

Row	Col	Number	Name
C	1	C00523	HEATERS CAPT PITOT
C	2	C00238	HEATERS TEMP PROBE
C	3	C01072	HEATERS ALPHA VANE LEFT
C	4	C00236	HEATERS ELEV PITOT LEFT
D	3	C01071	HEATERS ALPHA VANE RIGHT
D	4	C00237	HEATERS ELEV PITOT RIGHT
D	5	C00525	HEATERS F/O PITOT
D	6	C00524	HEATERS AUX PITOT

SUBTASK 20-10-77-860-041

- (28) Do this task: Supply Electrical Power, TASK 24-22-00-860-801.

SUBTASK 20-10-77-730-002

- (29) Do a check of the recorded data in Table 202 as follows:

- (a) Is the current value in the 5 minute row outside the range of 0.15 to 0.85 amps?

YES___ NO___

- 1) If NO was checked, the system meets performance requirements and no further action is required.
- 2) If YES was checked, it is recommended to replace the applicable pitot probe at the next maintenance opportunity.

Table 202/20-10-77-993-802 AMPERAGE TABLE

Aircraft Identifier:			Date:		
	CAPT	ELEV PITOT LEFT	AUX PITOT	F/O PITOT	ELEV PITOT RIGHT
CB Voltage:					
Minutes	Current	Current	Current	Current	Current
1					
2					
3					
4					
5					

————— END OF TASK —————

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TASK 20-10-77-200-803

4. Pitot Probe Heater Insulation Resistance Check - Check III

A. General

- (1) This task does a check of the Insulation Resistance (IR) of the pitot probe heater and the interface wiring.
- (2) Insulation checks should only be performed on de-energized circuits.
- (3) The IR check requires access to the rear of the probe to disconnect the negative wires. Access can be gained by removal of the probe or flight deck access panels. It is recommend to perform this check concurrently with scheduled maintenance tasks that require the flight deck access panels to be removed.
- (4) The check will determine the condition of the electrical sub-components of the pitot probe system by measuring the IR Dielectric Absorption Rate (DAR).
 - (a) The DAR check can find moisture, oil, or contamination damage causing leakage current and shorted probe coils. The DAR is the ratio of two time-resistance readings taken after 30 and 60 seconds. With good insulation, the IR will start low and then increase as the capacitive leakage current and absorption current decrease. The DAR is calculated by dividing the 60 second value by the 30 second value. A low DAR index usually indicates problems with the insulation. The insulation resistance multimeter, COM-17798 or equivalent, provides an automated timed test that calculates a ratio of 60/30 seconds to identify moisture or contamination in connectors, heater coils and wiring.
- (5) Refer to INSULATION RESISTANCE TESTING - INSPECTION/CHECK, PAGEBLOCK 20-10-39/501 before performing this procedure.

B. References

Reference	Title
20-10-39 P/B 501	INSULATION RESISTANCE TESTING - INSPECTION/CHECK
24-22-00-860-801	Supply Electrical Power (P/B 201)
24-22-00-860-802	Remove Electrical Power (P/B 201)
27-31-94-000-801	Feel System Pitot Probe Removal (P/B 401)
27-31-94-400-801	Feel System Pitot Probe Installation (P/B 401)
34-11-01-000-801	Pitot Probe - Removal (P/B 401)
34-11-01-400-801	Pitot Probe - Installation (P/B 401)

C. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

Reference	Description
COM-17798	Multimeter - Digital, Insulation Resistance Part #: 1004-745 Supplier: U0146 Part #: 1507 Supplier: 4U744 Part #: 1587 Supplier: 89536 Part #: 1587 FC Supplier: 4U744 Part #: MIT2500 Supplier: U0146 Part #: MIT410/2 Supplier: U0146

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D. Procedure

SUBTASK 20-10-77-860-040

- (1) Make sure that the probe is at ambient temperature.

NOTE: The preferred method to do a check of the probe temperature is to use an infrared thermometer or thermal imager. The alternative method is to set the probe heaters to off for more than one hour.

SUBTASK 20-10-77-860-029



MAKE SURE THAT YOU REMOVE ANY TYPE OF PROTECTIVE COVER OR MATERIAL BEFORE OPERATING ANY PROBE HEATER OR ANTI-ICE TYPE HEATED SURFACE. DAMAGE CAN OCCUR TO THE EQUIPMENT WHEN THE PROBES BECOME HOT.

- (2) Remove all covers from the pitot, angle of attack, and total air temperature probes.

SUBTASK 20-10-77-860-030

- (3) Do this task: Remove Electrical Power, TASK 24-22-00-860-802.

- (a) Make sure that the external electrical power cable is disconnected from the airplane.
(b) Make sure that the GRD POWER AVAILABLE light on the P5-4 panel is OFF.

SUBTASK 20-10-77-860-031

- (4) Open these circuit breakers and install safety tags:

CAPT Electrical System Panel, P18-3

<u>Row</u>	<u>Col</u>	<u>Number</u>	<u>Name</u>
C	1	C00523	HEATERS CAPT PITOT
C	2	C00238	HEATERS TEMP PROBE
C	3	C01072	HEATERS ALPHA VANE LEFT
C	4	C00236	HEATERS ELEV PITOT LEFT
D	3	C01071	HEATERS ALPHA VANE RIGHT
D	4	C00237	HEATERS ELEV PITOT RIGHT
D	5	C00525	HEATERS F/O PITOT
D	6	C00524	HEATERS AUX PITOT

NOTE: The circuit breakers are opened to remove parallel electrical paths to make sure that accurate measurements are recorded.

- (a) Make sure that the airplane stays de-energized.

SUBTASK 20-10-77-860-032

- (5) Set the PROBE HEAT A and B switches on the P5-9 panel to ON.

SUBTASK 20-10-77-700-014

- (6) Do a check of the IR of the pitot probe heaters as follows:

- (a) Get access to these circuit breakers:

CAPT Electrical System Panel, P18-3

<u>Row</u>	<u>Col</u>	<u>Number</u>	<u>Name</u>
C	1	C00523	HEATERS CAPT PITOT
C	4	C00236	HEATERS ELEV PITOT LEFT
D	4	C00237	HEATERS ELEV PITOT RIGHT
D	5	C00525	HEATERS F/O PITOT
D	6	C00524	HEATERS AUX PITOT

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(b) Do these steps for each pitot probe and applicable circuit breaker:

- 1) Connect the insulation resistance multimeter, COM-17798, as follows:
 - a) Put the red probe on the circuit breaker terminal =L.
 - b) Put the black probe on aircraft ground.
- 2) Disconnect the pitot probe ground wire at the probe or structure (TASK 34-11-01-000-801 or TASK 27-31-94-000-801).

NOTE: This prevents incorrect resistance values caused by parallel electrical paths to ground.

- a) Make sure that the disconnected negative connection is isolated from the aircraft structure.



WARNING

MAKE SURE THAT YOU DO NOT USE A POSSIBLE IGNITION SOURCE AROUND OPEN FUEL TASKS, FUEL VENTS OR SPILLED FUEL. 500V DC TESTERS CAN BE AN IGNITION SOURCE. FUEL FUMES CAN BE NOT STABLE AND CAUSE POSSIBLE IGNITION. IF YOU DO NOT OBEY, INJURY TO PERSONNEL AND DAMAGE TO EQUIPMENT CAN OCCUR.

- 3) Do the IR check with an insulation resistance multimeter, COM-17798, as follows:
 - a) Follow the tester instructions to install test probes.
 - b) Set the test voltage to 500 VDC.
 - c) Set the test mode to DAR.
 - d) Start the DAR test.

NOTE: The primary display shows the resistance in megaohms.

- e) Record the IR value at 1 minute and the DAR value in Table 203.

NOTE: If the IR values at 30 and 60 seconds are more than the maximum display range, the DAR value can show as "ERR" or "- - -". These are satisfactory IR and DAR values.

SUBTASK 20-10-77-860-033

- (7) Connect the disconnected pitot probe ground wires (TASK 34-11-01-400-801 or TASK 27-31-94-400-801).

SUBTASK 20-10-77-860-034

- (8) Set the PROBE HEAT A and B switches on the P5-9 panel to AUTO.

SUBTASK 20-10-77-860-035

- (9) Remove the safety tags and close these circuit breakers:

CAPT Electrical System Panel, P18-3

<u>Row</u>	<u>Col</u>	<u>Number</u>	<u>Name</u>
C	1	C00523	HEATERS CAPT PITOT
C	2	C00238	HEATERS TEMP PROBE
C	3	C01072	HEATERS ALPHA VANE LEFT
C	4	C00236	HEATERS ELEV PITOT LEFT
D	3	C01071	HEATERS ALPHA VANE RIGHT
D	4	C00237	HEATERS ELEV PITOT RIGHT
D	5	C00525	HEATERS F/O PITOT
D	6	C00524	HEATERS AUX PITOT

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SUBTASK 20-10-77-860-042

(10) Do this task: Supply Electrical Power, TASK 24-22-00-860-801.

SUBTASK 20-10-77-860-036

(11) Do the pitot probe installation test (TASK 34-11-01-400-801 or TASK 27-31-94-400-801).

NOTE: Pitot system leak tests are only required if the hose fittings were disconnected to accomplish this test.

SUBTASK 20-10-77-700-012

(12) Do a check of the recorded data in Table 203 as follows:

(a) Are any values measured less than or equal to the IR or DAR requirement?

YES___ NO___

- 1) If NO was checked, the system meets performance requirements and no further action is required.
- 2) If YES was checked, continue with the next steps.

(b) Is the IR less than 1 megaohm?

YES___ NO___

- 1) If NO was checked, it is recommended to perform an additional check of the DAR at the next interval to determine if the IR decreases more.
- 2) If YES was checked, it is recommended to disconnect the applicable probe and perform the IR check to isolate the fault between the probe and wiring.

Table 203/20-10-77-993-803 IR/DAR DATA TABLE

	Positive Lead Connection	Negative Lead Connection	Insulation Resistance (IR) > 1 Megaohm	Dielectric Absorption Rate (DAR) ≥ 1.0	Remarks
1	HEATERS CAPT PITOT	Ground			Captain Pitot Probe
2	HEATERS ELEV PITOT LEFT	Ground			Left Elevator Pitot Probe
3	HEATERS AUX PITOT	Ground			Auxiliary Pitot Probe
4	HEATERS F/O PITOT	Ground			First Officer Pitot Probe
5	HEATERS ELEV PITOT RIGHT	Ground			Right Elevator Pitot Probe

————— **END OF TASK** —————

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POWER QUALITY - MAINTENANCE PRACTICES

1. General

- A. This procedure has this task:
(1) Power Quality Checks.

TASK 20-10-78-760-801

2. Power Quality Checks

(Figure 201)

A. General

- (1) Usage
- (a) Enables user to identify the presence of intermittent, transient and unbalanced power conditions in aircraft systems; i.e. Power sources (ground power unit (GPU), auxiliary power unit (APU) and engine generator (ENG GEN) and unbalanced loading from branch circuits. Undiagnosed, this imbalance contributes to nuisance tripping of ground/universal fault interrupters, circuit breakers. Unbalanced power also results in high stator winding current leading to overheating and reduced life of 3-Phase components.
- 1) The top causes of these conditions are due to loose connections, degraded relay contacts, unbalanced loads, and overloading.

B. References

Reference	Title
20-10-75-750-801	Thermal Imaging Checks (P/B 201)

C. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

Reference	Description
COM-15045	Analyzer - Power Quality Part #: FLUKE-437-II Supplier: 89536 Part #: HDPQ XPLOER 400 Supplier: 23207 Part #: PW3198-01/500 PRO Supplier: 1ZJQ1

D. Procedure

SUBTASK 20-10-78-200-001

- (1) Inspect Power Quality
- (a) Start by de-energizing the circuit, if possible. Follow local instructions for Lockout/Tagout (LOTO) and Personal Protective Equipment (PPE).
- (b) Connect power quality analyzer, COM-15045 on the supply side first (GPU, APU, ENG GEN), before distribution to loads.
- 1) While the analyzer does not disturb any connections, removal of panel(s) will be necessary to expose individual phase conductors and terminals. The current clamps [1] and voltage clips [2] must be installed around and on each individual phase (Figure 201).
- a) The current clamps [1] should be placed around all three phases and neutral. Be sure to connect phase "A" clamp around circuit phase "A", then "B" around "B", etc. Arrow on clamp must point toward the load for proper display.

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- b) The voltage clips [2] should be attached to an exposed connection (i.e. terminal block). Connect all 3 phases, neutral and ground.
 - <1> If circuit is energized, connect ground lead first for safety.
- 2) Follow analyzer instructions for proper analyzer setting.
- (c) Operate only one power generation source (GPU or APU or ENG GEN) at a time.
- (d) Place system under load. Follow AMM to operate various high load devices.
 - 1) Operate 3-phase loads; hydraulic pumps, fuel pumps, lighting, etc.
- (e) Test for proper connection
 - 1) Select "Volt/Amps/Hertz" screen to make sure readings are within specifications:
 - a) For example: GPU, APU and ENG GEN voltage and frequency should be close to the nominal values of 115 V and 400Hz. See SSM/WDM for 115VAC/400Hz connections.
 - 2) Select Scope Button to view waveforms.
 - a) Make sure that the voltage and frequency phases have the correct waveforms.
 - b) Note any obvious distortion
 - 3) Select "Phasor" function to make sure that the current clamp hookup to match phase rotation and note correct phase shift.
 - a) Voltage is heavy arrow and current is thin arrow (Figure 201). Phase current and volts should be nearly in phase. If 180 out of phase, make sure that the current clamps [1] arrows are facing toward the load.
 - b) In a 3-phase power system, the phase shift between voltages and between currents should be close to 120°.

SUBTASK 20-10-78-760-001

(2) Evaluate Power Quality

- (a) Monitor Stable Power.
 - 1) Go back to Volts/Amps/Hertz screen.
 - a) Check voltage readings for imbalance issues.
 - <1> Voltage on any one phase should not vary more than 2% of the average of the 3 phases.
 - b) Check current readings for imbalance issues.
 - <1> Current unbalance must not be more than 10%. In case of too high unbalance, use other measuring modes, such as "unbalance" mode, to further analyze the power system.
 - 2) Go to scope, phasor and trend screens to evaluate distortion, unbalance phase, and intermittent spikes.
- (b) Monitor Power Transition - Continue monitoring as above.
 - 1) While maintaining the same load, switch between individual power sources; GPU, APU and ENG GEN.
 - 2) Look for smooth transitions and comparable readings.

SUBTASK 20-10-78-810-001

(3) Fault Analysis

- (a) If a fault exists when using only one of the generating systems (GPU, APU or ENG GEN):

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- 1) Fault may exist
 - a) Internal to the generating source or.
 - b) Between the generating source, and the aircraft bus tie contactor terminal connection.
- 2) See troubleshooting section to isolate faulty component.
- (b) If a fault exists when using multiple sources; GPU and APU, or GPU and ENG GEN, or APU and ENG GEN:
 - 1) Isolate problem between applicable aircraft bus tie contactors and loads by:
 - a) Cycle individual loads one at a time (hydraulic pump, fuel pump, etc.) until unbalanced load circuit is identified.
 - 2) See troubleshooting section to isolate faulty components.

SUBTASK 20-10-78-200-002

(4) Troubleshooting

(a) Circuit analysis

- 1) Follow local instructions for LOTO and PPE throughout this section.
- 2) De-energize the circuit, if possible, and move the analyzer if necessary to continue the fault isolation process.
- 3) Use the analyzer's "Unbalance", "In Rush", and "Trend" modes to isolate fault to an individual circuit.
 - a) "Unbalance" mode offers a Meter, Scope, Trend, and a Phasor display.
 - b) "In Rush" mode allows inspection of 3-phase components high current draw due to a degrading pump/motor or internal connection.
 - c) "Trend" mode allows identification of transient faults.

SUBTASK 20-10-78-800-001

(5) Component Analysis

- (a) Once an individual source circuit (GPU, APU, ENG GEN) or load circuit (i.e. "Boost Pump CTR Tank Left") is identified as the cause of the imbalance:
 - 1) Continue isolating to the specific component (connector, broken conductor strands, degraded relay contact):
 - a) Thermal Imaging - Infrared (IR) camera easily identifies current imbalance, voltage imbalance (drop) via heat signature (TASK 20-10-75-750-801 for Electrical Tests).
 - b) Clamp-on ammeter - Verify current imbalance identified by IR camera.
 - c) Multi-meter - Verify voltage imbalance identified by IR camera. For example, test voltage drop across relay contacts, and connections.

———— **END OF TASK** ————

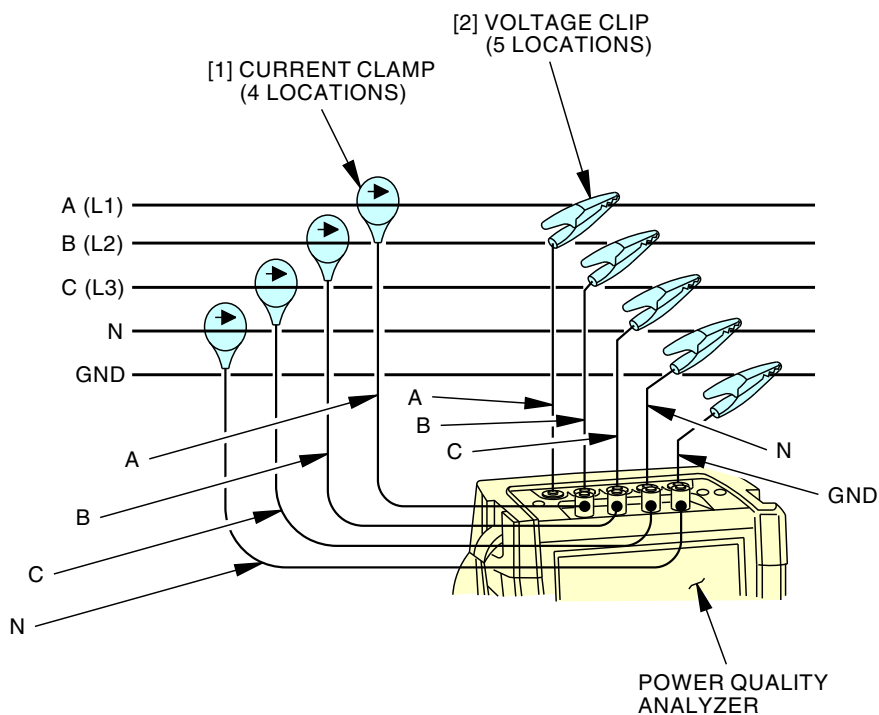
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CONNECTION OF ANALYZER TO 3-PHASE DISTRIBUTION SYSTEM
(EXAMPLE)

2582136 S0000622460_V1

Power Quality Check
Figure 201/20-10-78-990-801 (Sheet 1 of 2)

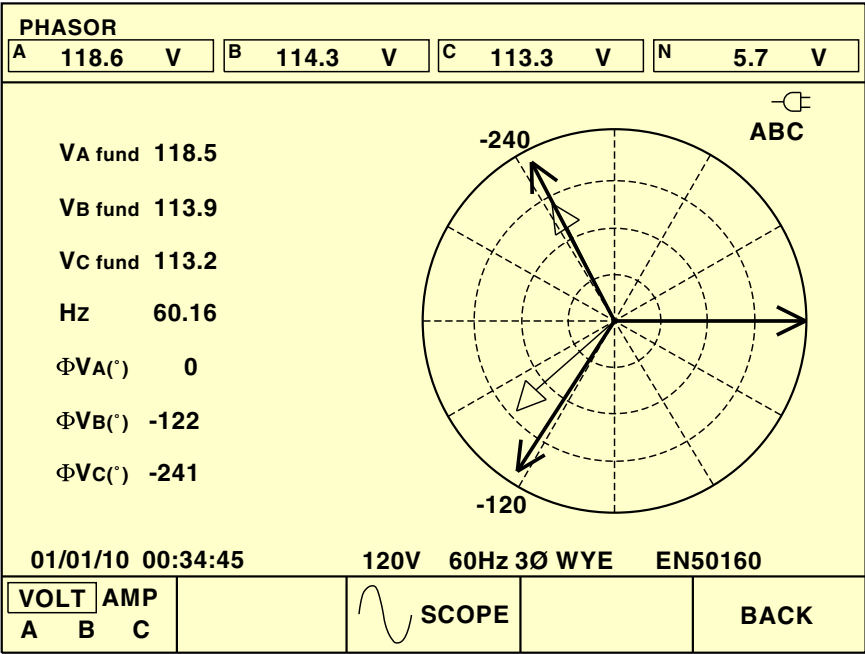
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VECTOR DIAGRAM FOR CORRECTLY CONNECTED ANALYZER
(EXAMPLE)

2582137 S0000622461_V1

Power Quality Check
Figure 201/20-10-78-990-801 (Sheet 2 of 2)

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ULTRASONIC LEAK DETECTION - MAINTENANCE PRACTICES

1. **General**

A. This procedure has this task:

(1) Ultrasonic Leak Detection Checks.

(a) This procedure may be performed as a Preventative Health Maintenance measure or to troubleshoot leaks (bleed air, air ducts, air conditioning, pressurization, emergency evacuation slides, tire pressure retention, oxygen lines and valves, pitot static lines and components), and internal bypassing inside hydraulic valves and actuators.

TASK 20-10-79-270-801

2. **Ultrasonic Leak Detection Checks**

(Figure 201, Figure 202)

A. **General**

(1) Recommended Equipment

(a) An ultrasonic leak probe, SPL-1473, is the recommend equipment. When performing ultrasonic leak detection, use a leak detector that meets or exceeds ASTM E1002.

(b) An acoustic digital camera, COM-18702, is the recommend equipment. Recommend using a camera with an adjustable frequency range between 2kHz to 50kHz.

(2) Usage

(a) An ultrasonic leak probe, SPL-1473, converts and amplifies inaudible ultrasonic sounds into audible "natural" sounds by lowering the received frequency into the audible range. The unaided human ear can only detect sound between 20 Hz and 20 kHz; well below what is required to detect pressure leaks that are normally found in the ultrasonic 35kHz to 45kHz range.

1) Detect pressure leaks, vacuum leaks and hydraulic bypassing

a) Provides effective indication and location of leaks. When a gas or liquid escapes through a crack from a high-pressure system to a low-pressure system it results in turbulence, which produces ultrasound.

b) Accurately identifies leaking valves, solenoids, gaskets and connections.

(b) An acoustic digital camera, COM-18702, provides a means to quickly sweep a wide area to detect and locate leaks in compressed air, compressed gas, and vacuum systems. The frequency range covers 2kHz to 52kHz with a maximum operating distance of 164 ft (50 m). The acoustic digital camera, COM-18702, has a visible light camera that captures a live-view image of the inspection area, while the acoustic sensor-array aligns a sound-source heatmap with the image.

(3) Images in this task are examples only. The images may not agree with your airplane model or airplane configuration.

B. **References**

Reference	Title
21-00-00-800-801	Supply Conditioned Air to the Airplane (P/B 201)
29-11-00-860-801	Hydraulic System A or B Pressurization (P/B 201)
34-11-00-790-802	Static and Total Air Pressure System - Pressurization (P/B 201)
36-00-00-860-801	Supply Pressure to the Pneumatic System (Selection) (P/B 201)

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(Continued)

Reference	Title
36-00-00-860-805	Supply Pressure Upstream of the PRSOV with Engines Off (P/B 201)

C. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

Reference	Description
COM-18702	Digital Camera - Acoustic Part #: FLK-ii900 Supplier: 4U744 Part #: FLK-ii910 Supplier: 4U744
SPL-1473	Probe - Kit, Ultrasonic Leak Part #: B00033 Supplier: 62373 Part #: ST6760A-1 Supplier: 81205

D. Ultrasonic Leak Detection Checks



MAKE SURE THAT YOU OBEY ALL SAFETY PRECAUTIONS AND FOLLOW THE GENERAL MAINTENANCE PRACTICES. IF YOU DO NOT OBEY, YOU CAN CAUSE PERSONNEL INJURY AND EQUIPMENT DAMAGE.



MAKE SURE YOU OBEY THE PROPER PROCEDURES FOR COMPRESSION AND DECOMPRESSION WHEN YOU USE PERSONS IN A PRESSURIZED AREA. PRESSURE CHANGES THAT CAUSE PAIN MUST NOT BE DONE. IF YOU DO NOT OBEY THE PRECAUTIONS, INJURY TO PERSONS CAN OCCUR.



MAKE SURE ONLY THE PERSONS NECESSARY FOR THIS TEST ARE IN THE PRESSURIZED AIRCRAFT. EACH PERSON MUST SPEAK TO ALL OTHER PERSONS ON THE INTERPHONE OR GROUND COMMUNICATION SYSTEMS. CABIN PRESSURE TESTS CAN CAUSE INJURY TO PERSONS.

SUBTASK 20-10-79-790-001

- (1) Do the cabin pressurization leak test as follows:

NOTE: Two persons are necessary for this task. One person examines the airplane with the acoustic camera from out of the airplane, while the other person in the airplane uses the ultrasonic detector to identify the leakage.

- (a) Do the cabin pressurization (TASK 21-00-00-800-801).
(b) Examine the windows, doors, and other possible leak locations with the acoustic digital camera, COM-18702, to find the leakage.

- 1) When you find the leaks, move the camera to make sure that the leaks you found are not reflections.

NOTE: Leaks will stay stable while the user moves. Reflections will move while the user moves.

- (c) Speak with the person in the airplane to identify the location of the leaks with the ultrasonic leak probe, SPL-1473.

NOTE: Use an ultrasonic leak detector with the recommended sensitivity.

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SUBTASK 20-10-79-790-002

(2) Do the air conditioning leak check as follows:

- (a) Operate the air conditioning (TASK 21-00-00-800-801).
- (b) Examine the packs and ducting with the acoustic digital camera, COM-18702, for possible leaks.
 - 1) When you find the leaks, move the camera to make sure that the leaks you found are not reflections.

NOTE: Leaks will stay stable while the user moves. Reflections will move while the user moves.

- (c) If you find leaks, you must identify the location of the leaks with the ultrasonic leak probe, SPL-1473.

NOTE: Some valves have pressure bleed orifices that can possibly show as leaks. If you are not sure, identify the leaking orifice and compare with the other side.

SUBTASK 20-10-79-790-003

(3) Do the bleed air leak check as follows:

(a) For the airframe do the following steps:

- 1) Operate the bleed air (TASK 36-00-00-860-801).
- 2) Examine the aircraft with the acoustic digital camera, COM-18702, for possible leaks.
 - a) When you find the leaks, move the camera to make sure that the leaks you found are not reflections.

NOTE: Leaks will stay stable while the user moves. Reflections will move while the user moves.

- 3) If you find leaks, you must identify the location of the leaks with the ultrasonic leak probe, SPL-1473.

NOTE: Once panel is removed, bleed air leaks are easily pinpointed to clamps, valve body and seals.

(b) For the engine do the following steps:

- 1) Operate the bleed air (TASK 36-00-00-860-801).
- 2) Open the Pressure Regulating and Shutoff Valve Controller (PRSOVC) to back pressure lines and ducts up to the High Pressure Shutoff Valve (HPSV) (TASK 36-00-00-860-805).
- 3) Examine the engine with the acoustic digital camera, COM-18702, for possible leaks.
 - a) When you find the leaks, move the camera to make sure that the leaks you found are not reflections.

NOTE: Leaks will stay stable while the user moves. Reflections will move while the user moves.

- 4) If you find leaks, you must identify the location of the leaks with the ultrasonic leak probe, SPL-1473.

NOTE: Some valves have pressure bleed orifices that possibly show as leaks. If you are not sure, identify the leaking orifice and compare with the other side.

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SUBTASK 20-10-79-790-004

- (4) Do the hydraulic system bypassing check as follows:
- (a) Operate the hydraulic system (TASK 29-11-00-860-801).
 - 1) Examine the hydraulic valves/lines with the acoustic digital camera, COM-18702, for possible bypassing.
 - 2) If you find the bypassing, you must identify the location of the bypassing with the ultrasonic leak probe, SPL-1473.

SUBTASK 20-10-79-790-006

- (5) Do the parking brake bleed down issue as follows:
- (a) Operate the hydraulic system (TASK 29-11-00-860-801).

NOTE: It can be necessary to occasionally re-pressurize the system to do all of the leak check.
 - (b) Set the parking brake.
 - (c) Examine the pressure return lines with the acoustic digital camera, COM-18702, for possible leaks.
 - 1) When you find the leaks, move the camera to make sure that the leaks you found are not reflections.

NOTE: Leaks will stay stable while the user moves. Reflections will move while the user moves.
 - (d) If you find leaks, you must identify the location of the leaks with the ultrasonic leak probe, SPL-1473.

SUBTASK 20-10-79-790-007

- (6) Do the pitot static check as follows:
- (a) Increase pitot and static to the maximum test pressures (TASK 34-11-00-790-802).
 - (b) Examine the pitot and static lines and components with the acoustic digital camera, COM-18702, for possible leaks.
 - 1) When you find the leaks, move the camera to make sure that the leaks you found are not reflections.

NOTE: Leaks will stay stable while the user moves. Reflections will move while the user moves.
 - (c) If you find leaks, you must identify the location of the leaks with the ultrasonic leak probe, SPL-1473.

SUBTASK 20-10-79-790-005

- (7) Do the oxygen system leak check as follows:
- (a) Examine the oxygen lines and components with the acoustic digital camera, COM-18702, for possible leaks.
 - 1) Make sure that you do not contact with the oxygen lines or components.
 - 2) When you find the leaks, move the camera to make sure that the leaks you found are not reflections.

NOTE: Leaks will stay stable while the user moves. Reflections will move while the user moves.
 - (b) If you find leaks, you must identify the location of the leaks with the ultrasonic leak probe, SPL-1473.

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SUBTASK 20-10-79-790-008

(8) Do the leak check of evacuation slides, tires and other pressurized components as follows:

(a) Examine the slides, tires or other pressurized components with the acoustic digital camera, COM-18702, for possible leaks.

1) When you find the leaks, move the camera to make sure that the leaks you found are not reflections.

NOTE: Leaks will stay stable while the user moves. Reflections will move while the user moves.

(b) If you find leaks, you must identify the location of the leaks with the ultrasonic leak probe, SPL-1473.

————— **END OF TASK** —————

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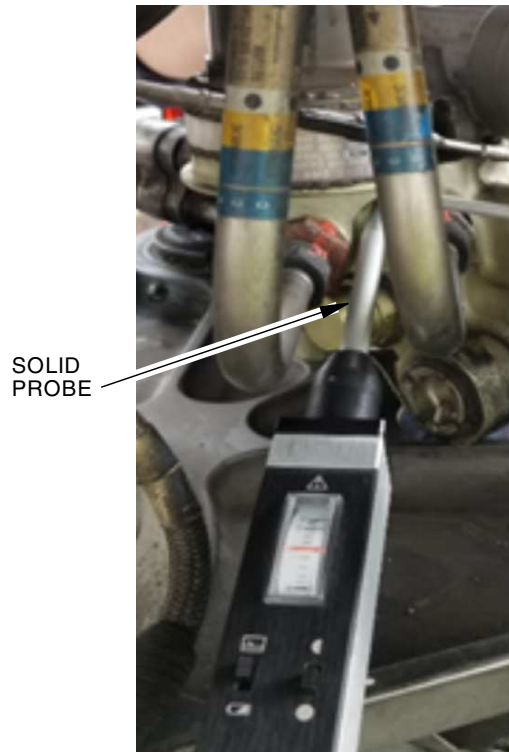
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**AIR CONDITIONING CHECK
(EXAMPLE)**

ACOUSTIC PROBE



SOLID
PROBE

**HYDRAULIC BYPASSING CHECK
(EXAMPLE)**

2923642 S0000705114_V1

**Ultrasonic Leak Probe
Figure 201/20-10-79-990-801**

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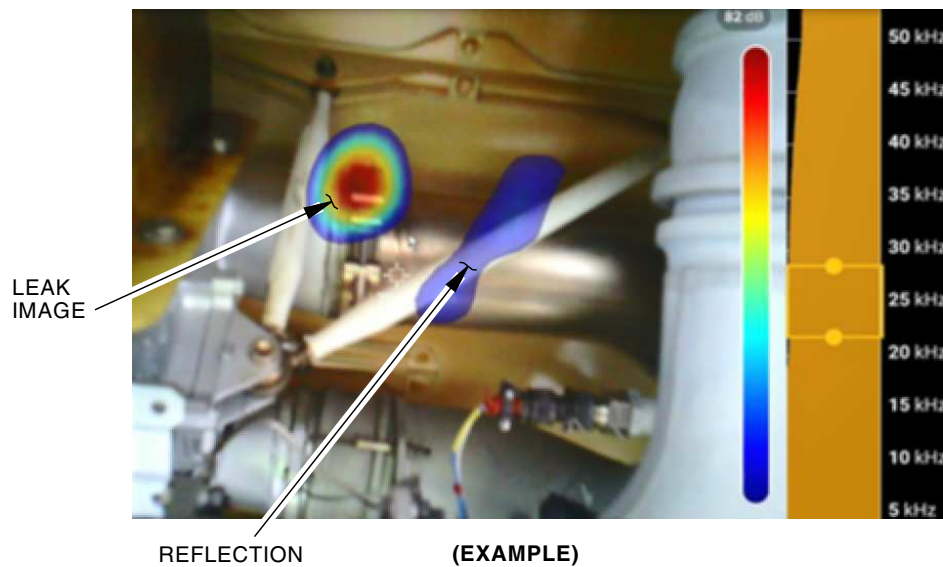
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**AIR CONDITIONING CHECK
(EXAMPLE)**



(EXAMPLE)

A

2923643 S0000705116_V1

**Acoustic Digital Camera
Figure 202/20-10-79-990-802**

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INTERMITTENT WIRING - MAINTENANCE PRACTICES

1. General

A. This procedure has this task:

- (1) Intermittent Wiring Special Detailed Inspection.

TASK 20-10-80-280-801

2. Intermittent Wiring Special Detailed Inspection

(Figure 201, Figure 202, Figure 203)

A. **General**

- (1) This task shows how to locate the source of an intermittent wiring fault using the wire shake inspection.
- (2) This test will require a minimum of two people. One person monitors the multimeters and another to shake the wire.
- (3) A value change in resistance on one of the multimeters will find the intermittent fault condition.
- (4) Most of the intermittent wiring faults will be found at the connectors, terminals, and splices.
- (5) Most of the intermittent wiring faults will be found outside of the fuselage pressure seal.
- (6) These are the necessary tools to do this task:
 - (a) Multimeter(s) - digital/analog multimeter, COM-1793
 - (b) Meter Lead Kit - meter lead kit, SPL-15027.

B. **References**

Reference	Title
20-40-12-000-803	Conductive Dust Cap and Connector Cover Removal (P/B 201)
20-40-12-400-803	Conductive Dust Cap and Connector Cover Installation (P/B 201)
24-22-00-860-801	Supply Electrical Power (P/B 201)
24-22-00-860-802	Remove Electrical Power (P/B 201)

C. **Tools/Equipment**

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt.", which stands for Optional.

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Reference	Description
COM-1793	Multimeter - Digital/Analog (or equivalent meter meets task requirements) Part #: 117 Supplier: 89536 Part #: 260-8XPI Supplier: 55026 Part #: 287 Supplier: 89536 Part #: 289 Supplier: 89536 Part #: 87V Supplier: 89536 Part #: FLUKE 27 II Supplier: 89536 Part #: FLUKE-77-4 Supplier: 89536 Opt Part #: 187 Supplier: 89536 Opt Part #: 189 Supplier: 89536 Opt Part #: 21 Supplier: 89536 Opt Part #: 27 Supplier: 89536 Opt Part #: 77 SERIES III Supplier: 89536 Opt Part #: 87 Supplier: 89536 Opt Part #: FLUKE 27 Supplier: 89536 Opt Part #: MODEL 27 Supplier: 89536
SPL-15027	Kit - Meter Lead Part #: K28006-1 Supplier: 81205

D. Prepare for the Wire Shake Inspection

NOTE: Preparation is very important to decrease the airplane ground time and should be done before the airplane is grounded.

SUBTASK 20-10-80-300-001

- (1) Use the following applicable documents to find the locations of the wire bundles and Line Replaceable Units (LRUs) which cause the intermittent faults:
 - (a) Aircraft Maintenance Manual (AMM)
 - (b) Fault Isolation Manual (FIM)
 - (c) Wiring Diagram Manual (WDM)
 - (d) Fleet Team Digest (FTD)
 - (e) Standard Wiring Practices Manual (SWPM)
 - (f) Service Letter (SL)
 - (g) Maintenance Tip (MT)
 - (h) Other service document.

SUBTASK 20-10-80-300-002

- (2) Prepare the applicable pages from the documents.
NOTE: The pages will provide quick reference on the airplane during troubleshooting.

SUBTASK 20-10-80-860-002

- (3) Do this task: Remove Electrical Power, TASK 24-22-00-860-802.
NOTE: Electrical power must be off to prevent incorrect fault indications or fault messages from occurring.

SUBTASK 20-10-80-300-004

- (4) Get access to the applicable wire bundles and LRUs.

SUBTASK 20-10-80-300-005

- (5) Select the applicable troubleshooting configuration:

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- (a) Circuits Containing One Wire
- (b) Circuits Containing Two Wires
- (c) ARINC 429 Data Bus Wires.

SUBTASK 20-10-80-300-006

- (6) Continue to the steps for the applicable troubleshooting configuration.

E. Circuits Containing One Wire

(Figure 201)



DO NOT TOUCH THE CONNECTOR PINS, OR OTHER CONDUCTORS. IF YOU TOUCH THESE CONDUCTORS, ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE COMPONENTS.

SUBTASK 20-10-80-760-001

- (1) Disconnect the applicable electrical connector D1 from the applicable LRU 1.

SUBTASK 20-10-80-760-002

- (2) Do this task on the applicable LRU 1: Conductive Dust Cap and Connector Cover Installation, TASK 20-40-12-400-803.

SUBTASK 20-10-80-760-003

- (3) Examine the electrical connector D1 for bent or broken pins/sockets, dirt, and damage.

SUBTASK 20-10-80-760-004

- (4) Do these steps to connect the multimeter M1 (digital/analog multimeter, COM-1793) to the connector D1:
 - (a) Put the multimeter M1 to the resistance function.
 - (b) Connect the lead A from the multimeter M1 to the correct pin/socket A of the electrical connector D1.
 - (c) Connect the lead B from the multimeter M1 to the airplane ground or to the correct pin/socket B of the electrical connector D1 which is grounded.

NOTE: The multimeter M1 will read the resistance of the LRU 2 to the airplane ground. The LRU 2 can be a sensor, valve, actuator, transducer, proximity switch, or some other component.

SUBTASK 20-10-80-760-005

- (5) If the LRU 2 does not have a value of resistance, do the following steps:
 - (a) Remove the LRU 2 from the electrical connector D5.
 - (b) Examine the electrical connector D5 for bent or broken pins/sockets, dirt, and damage.
 - (c) Install the Load Resistor (47 ohm) to the correct pins/sockets on the electrical connector D5.

NOTE: The multimeter M1 will read the resistance (47ohm) of the Load Resistor.

SUBTASK 20-10-80-760-006

- (6) If necessary, the Jumper Adapter can be used for the continuity check with the multimeter's resistance function or continuity function.

NOTE: With the multimeter's resistance function, movement of connectors, terminal blocks, wire bundles will momentarily increase resistance.

SUBTASK 20-10-80-760-007

- (7) Continue to the Procedure for the Wire Shake Inspection.

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F. Circuits Containing Two Wires

(Figure 202)



DO NOT TOUCH THE CONNECTOR PINS, OR OTHER CONDUCTORS. IF YOU TOUCH THESE CONDUCTORS, ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE COMPONENTS.

SUBTASK 20-10-80-760-008

- (1) Disconnect the applicable electrical connector D1 from the applicable LRU 1.

SUBTASK 20-10-80-760-009

- (2) Examine the electrical connector D1 for bent or broken pins/sockets, dirt, and damage.

SUBTASK 20-10-80-760-010

- (3) Do this task on the applicable LRU 1: Conductive Dust Cap and Connector Cover Installation, TASK 20-40-12-400-803.

SUBTASK 20-10-80-760-011

- (4) Do these steps to connect two multimeters M1 and M2 (two digital/analog multimeter, COM-1793) to the electrical connector D1:

- (a) Put the multimeters M1 and M2 to the resistance function.
- (b) Connect the lead A from the multimeter M1 to the correct pin/socket A of the electrical connector D1.

NOTE: The multimeter M1 will read the resistance of the LRU 2 . The LRU 2 can be a sensor, valve, actuator, transducer, proximity switch, or some other component.

- (c) Connect the lead B from the Y Junction to the correct pin/socket B of the electrical connector D1.
- (d) Connect the lead C from the multimeter M2 to the airplane ground.

NOTE: The multimeter M2 should read an open circuit and will check for a short circuit to the airplane ground.

SUBTASK 20-10-80-760-012

- (5) If the LRU 2 does not have a value of resistance, do the following steps:

NOTE: The multimeter M1 will read the resistance (47 ohm) of the Load Resistor.

NOTE: The multimeter M2 should read an open circuit and will examine for a short circuit to the airplane ground.

- (a) Remove the LRU 2 from the electrical connector D5.
- (b) Do this task on the applicable LRU 2: Conductive Dust Cap and Connector Cover Installation, TASK 20-40-12-400-803.
- (c) Examine the electrical connector D5 for bent or broken pins/sockets, dirt, and damage.
- (d) Install the Load Resistor (47 ohm) to the correct pins/sockets on the electrical connector D5.

SUBTASK 20-10-80-760-013

- (6) Continue to the Procedure for the Wire Shake Inspection.

G. ARINC 429 Data Bus Wires

(Figure 203)

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DO NOT TOUCH THE CONNECTOR PINS, OR OTHER CONDUCTORS. IF YOU TOUCH THESE CONDUCTORS, ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE COMPONENTS.

SUBTASK 20-10-80-760-014

- (1) Disconnect all the data bus connectors from the applicable LRUs.

SUBTASK 20-10-80-760-015

- (2) Examine the data bus connectors for bent or broken pins/sockets, dirt, and damage.

SUBTASK 20-10-80-760-016

- (3) Do this task on the applicable LRUs: Conductive Dust Cap and Connector Cover Installation, TASK 20-40-12-400-803.

SUBTASK 20-10-80-760-017

- (4) Do these steps to connect two multimeters M1 and M2 (two digital/analog multimeter, COM-1793), to the data bus connector D1:

NOTE: The multimeters will be connected to the data bus connector of the LRU 1 that does not receive the data.

- (a) Put the multimeters M1 and M2 to the resistance function.
- (b) Connect the lead A from the multimeter M1 to the correct pin/socket A of the data bus connector D1.
- (c) Connect the lead B from the Y Junction to the correct pin/socket B of the data bus connector D1.
- (d) Connect the lead C from the multimeter M2 to the airplane ground.

NOTE: The multimeters M1 and M2 should read open.

SUBTASK 20-10-80-760-018

- (5) If the multimeters M1 and M2 show a high resistance, do the following steps:

NOTE: An LRU is possibly connected to the data bus when the multimeters M1 and M2 show a high resistance.

- (a) Find the applicable LRU(s) that is possibly connected to the data bus.
- (b) Remove the applicable LRU(s).
- (c) Do this task on the applicable LRU(s): Conductive Dust Cap and Connector Cover Installation, TASK 20-40-12-400-803.

SUBTASK 20-10-80-760-019

- (6) Examine the data bus connector D10 for bent or broken pins/sockets, dirt, and damage.

SUBTASK 20-10-80-760-020

- (7) Connect the Load Resistor (47 ohm) to the correct pins/sockets on the data bus connector D10 of the LRU 4 that sends the data to the LRU 1 that receives the data.

NOTE: The multimeter M1 will read the resistance (47ohm) of the Load Resistor.

NOTE: The multimeter M2 will examine for a short circuit to the airplane ground.

SUBTASK 20-10-80-760-021

- (8) Continue to the Procedure for the Wire Shake Inspection.

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H. Procedure for the Wire Shake Inspection

SUBTASK 20-10-80-211-001



KEEP TOOLS, TOOL TRAYS, AND OTHER WORK ITEMS OFF OF THE WIRES. OBJECTS PUT ON THE WIRE BUNDLES OR THEIR RELATED COMPONENTS CAN CAUSE DAMAGE TO THE WIRES, INSULATION, AND CONNECTORS.



DO NOT PUT PRESSURE ON THE WIRE BUNDLES, ELECTRONIC SYSTEMS, OR STRUCTURES IN THE COMPARTMENT. PRESSURE CAN CAUSE DAMAGE TO WIRE BUNDLES AND ELECTRICAL CONNECTIONS.



DO NOT CUT, CAUSE NICKS, OR CAUSE OTHER DAMAGE TO THE CABLES, WIRES, METAL-BRAIDED SHIELD, OR OVERBRAID. DAMAGE TO THESE COMPONENTS CAN CAUSE MALFUNCTIONS, OR DAMAGE TO OTHER EQUIPMENT.

- (1) To locate the intermittent fault on the wire, do the following steps:
 - (a) Shake the wire bundle at every connector, terminal, and splice outside the fuselage pressure seal.
 - 1) If one of the multimeters shows a change in value, replace the defective component per SWPM.
 - 2) If none of the multimeters show a change in value, continue to the next step.
 - (b) Shake the wire bundle at every connector, terminal, and splice inside the fuselage pressure seal.
 - 1) If one of the multimeters shows a change in value, replace the defective component per SWPM.
 - 2) If none of the multimeters show a change in value, continue to the next step.
 - (c) Shake the entire wire bundle outside the fuselage pressure seal.
 - 1) If one of the multimeters shows a change in value, replace the defective component per SWPM.
 - 2) If none of the multimeters show a change in value, continue to the next step.
 - (d) Shake the entire wire bundle inside the fuselage pressure seal.
 - 1) If one of the multimeters shows a change in value, replace the defective component per SWPM.
 - 2) If necessary, repeat all of the above steps if none of the multimeters show a change in value.
 - (e) When the test is complete, do the following steps:
 - 1) Do this task on the applicable LRU: Conductive Dust Cap and Connector Cover Removal, TASK 20-40-12-000-803.
 - 2) Reconnect the applicable electrical connector(s) to the applicable LRU(s).

I. Put the Airplane Back to Its Usual Condition

SUBTASK 20-10-80-860-001

- (1) If necessary, do this task: Supply Electrical Power, TASK 24-22-00-860-801.

————— END OF TASK —————

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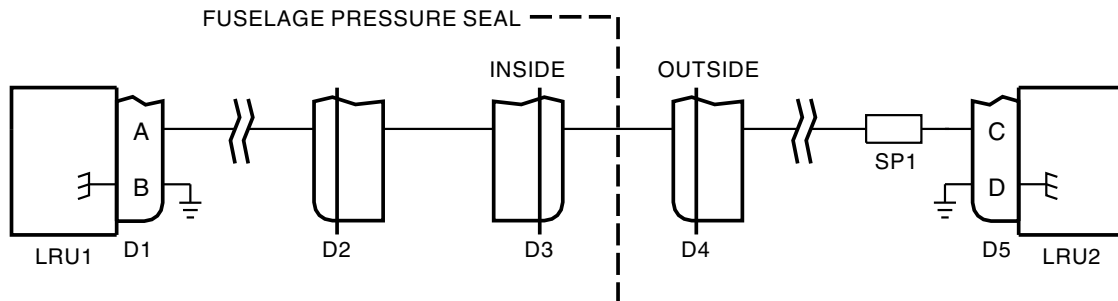
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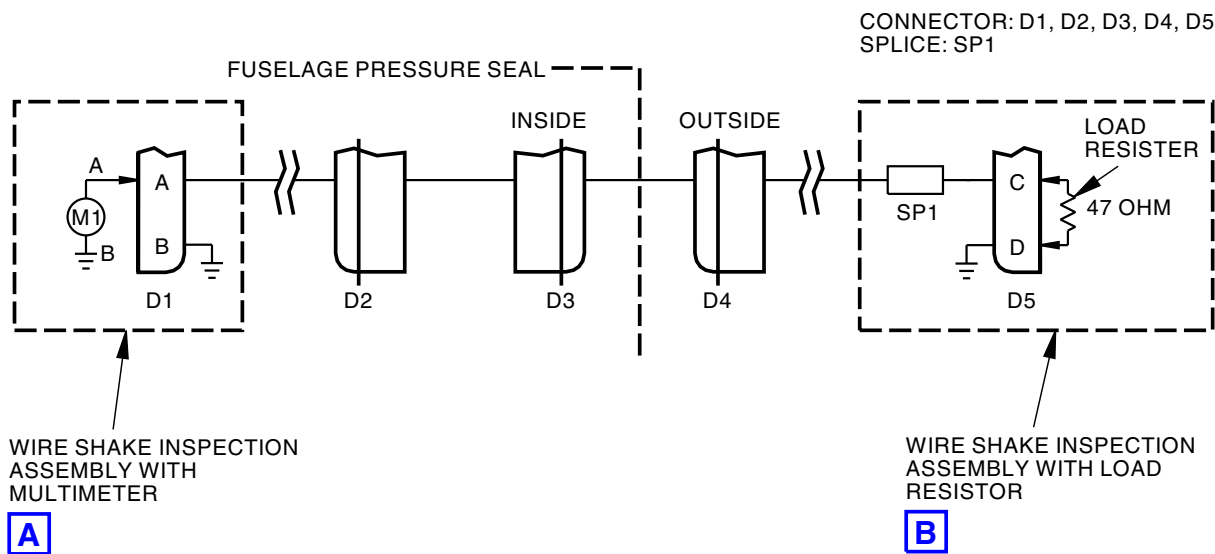
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CIRCUITS CONTAINING ONE WIRE



CIRCUITS WITH MULTIMETER AND METER-LEAD KIT CONNECTED USING LOAD RESISTOR

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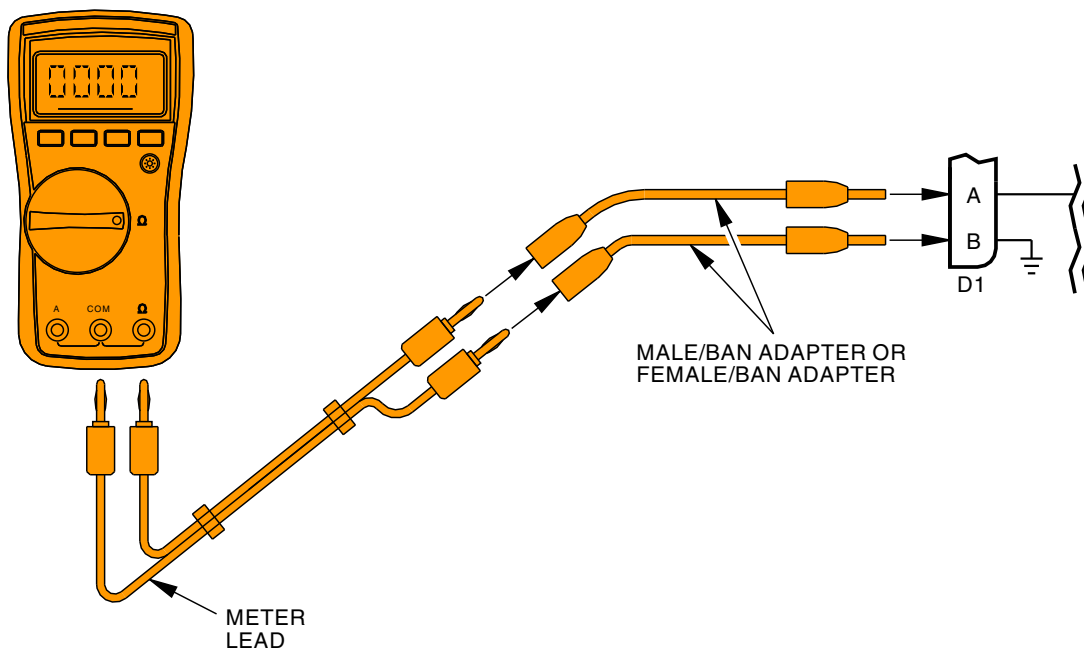
Circuits Containing One Wire (Example)
Figure 201/20-10-80-990-801 (Sheet 1 of 3)

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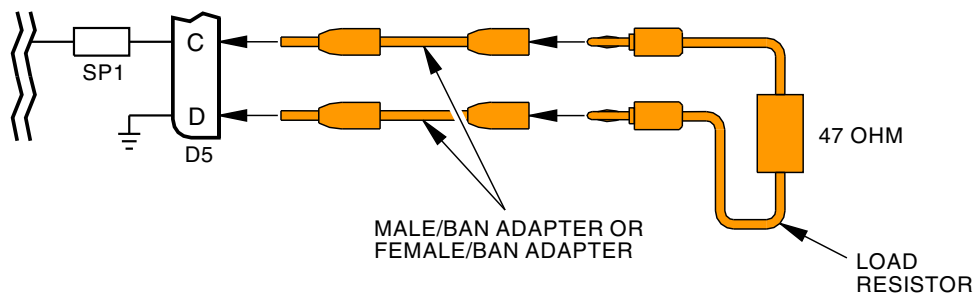
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WIRE SHAKE INSPECTION ASSEMBLY WITH MULTIMETER

A



WIRE SHAKE INSPECTION ASSEMBLY WITH LOAD RESISTOR

B

2581938 S0000622383_V1

Circuits Containing One Wire (Example)
Figure 201/20-10-80-990-801 (Sheet 2 of 3)

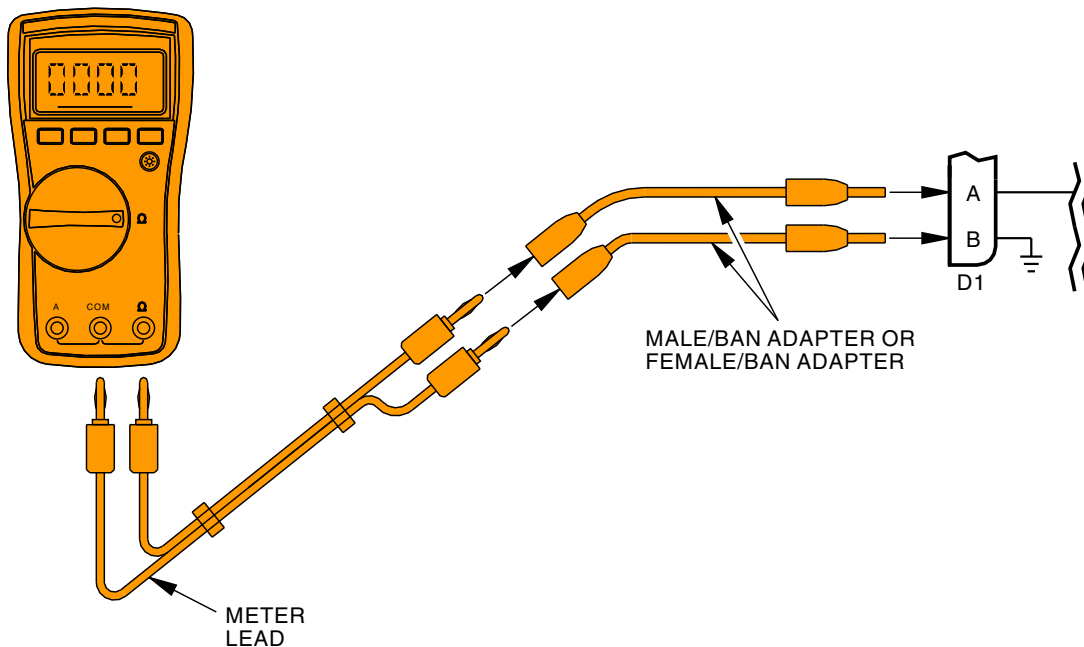
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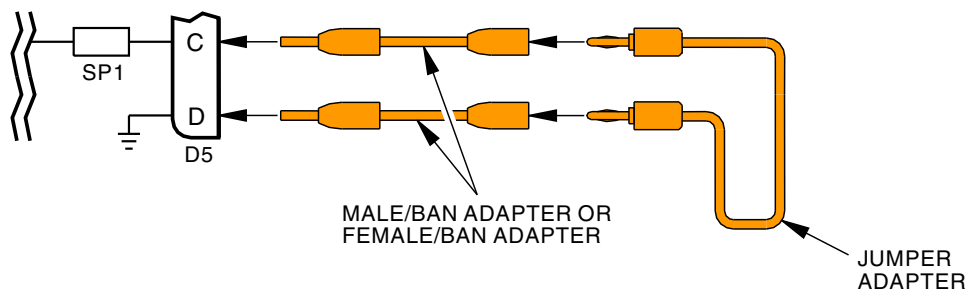
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WIRE SHAKE INSPECTION ASSEMBLY WITH MULTIMETER

A



WIRE SHAKE INSPECTION ASSEMBLY WITH JUMPER ADAPTER

B

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Circuits Containing One Wire (Example)
Figure 201/20-10-80-990-801 (Sheet 3 of 3)

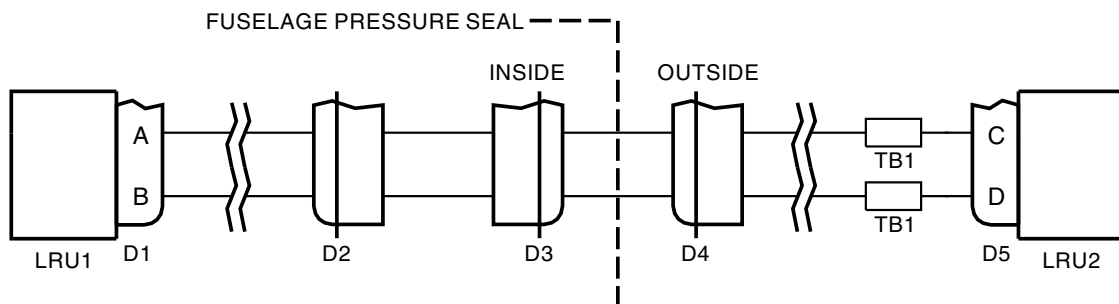
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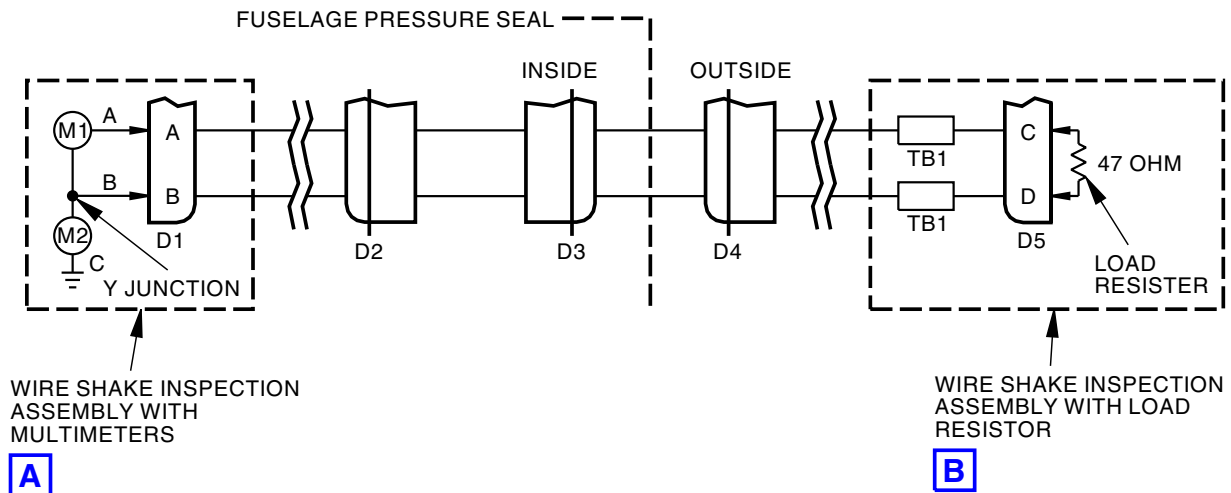
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CIRCUITS CONTAINING TWO WIRES

CONNECTOR: D1, D2, D3, D4, D5
TERMINAL BLOCK: TB1



CIRCUITS WITH MULTIMETER AND METER-LEAD KIT CONNECTED USING LOAD RESISTOR

2581940 S0000622385_V1

Circuits Containing Two Wires (Example)
Figure 202/20-10-80-990-802 (Sheet 1 of 2)

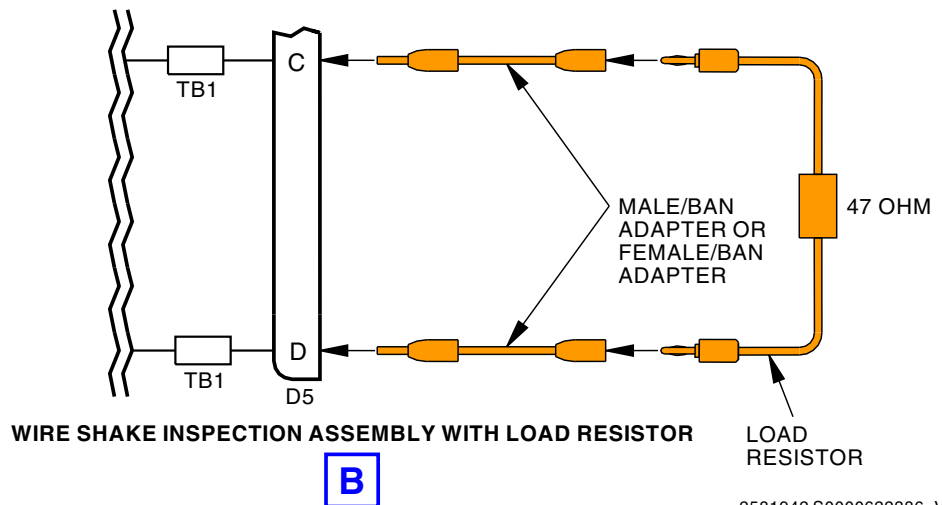
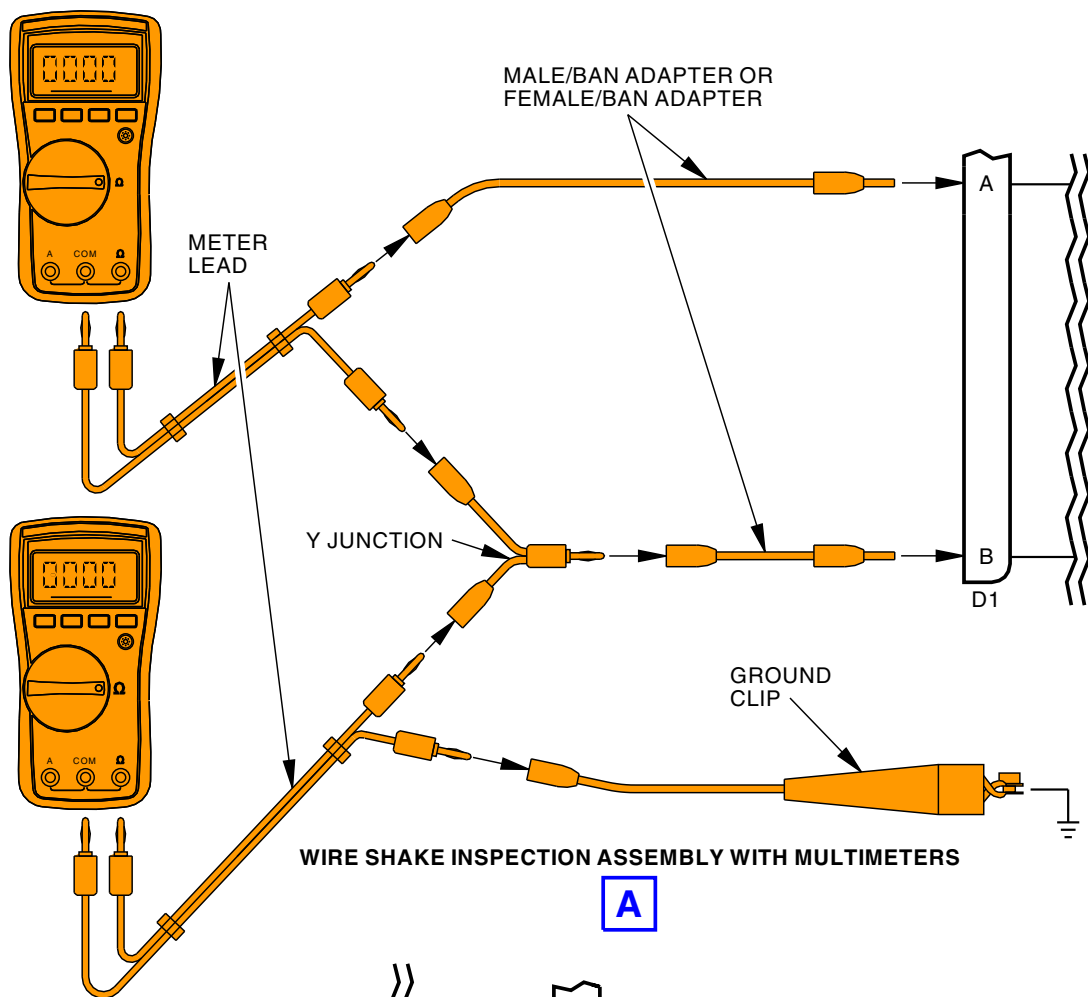
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**Circuits Containing Two Wires (Example)
Figure 202/20-10-80-990-802 (Sheet 2 of 2)**

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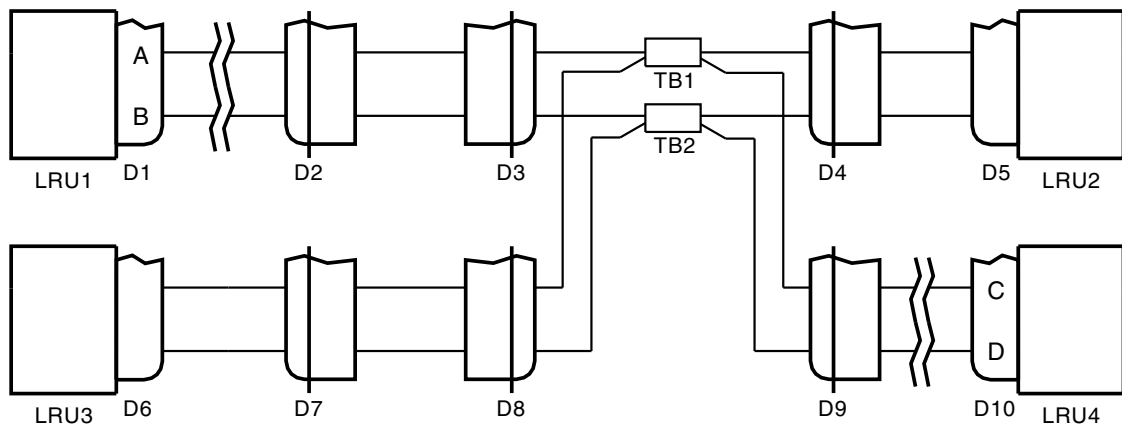
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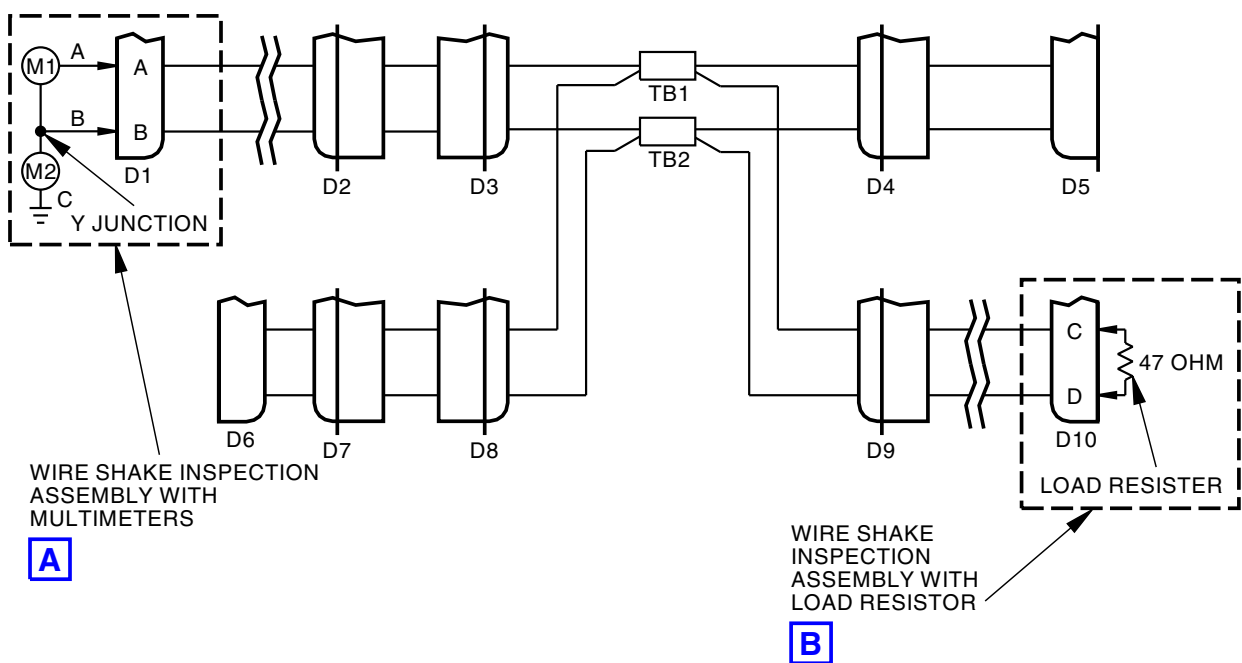
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ARINC 429 DATA BUS WIRES

CONNECTOR: D1, D2, D3, D4, D5, D6, D7, D8, D9, D10
TERMINAL BLOCK: TB1, TB2

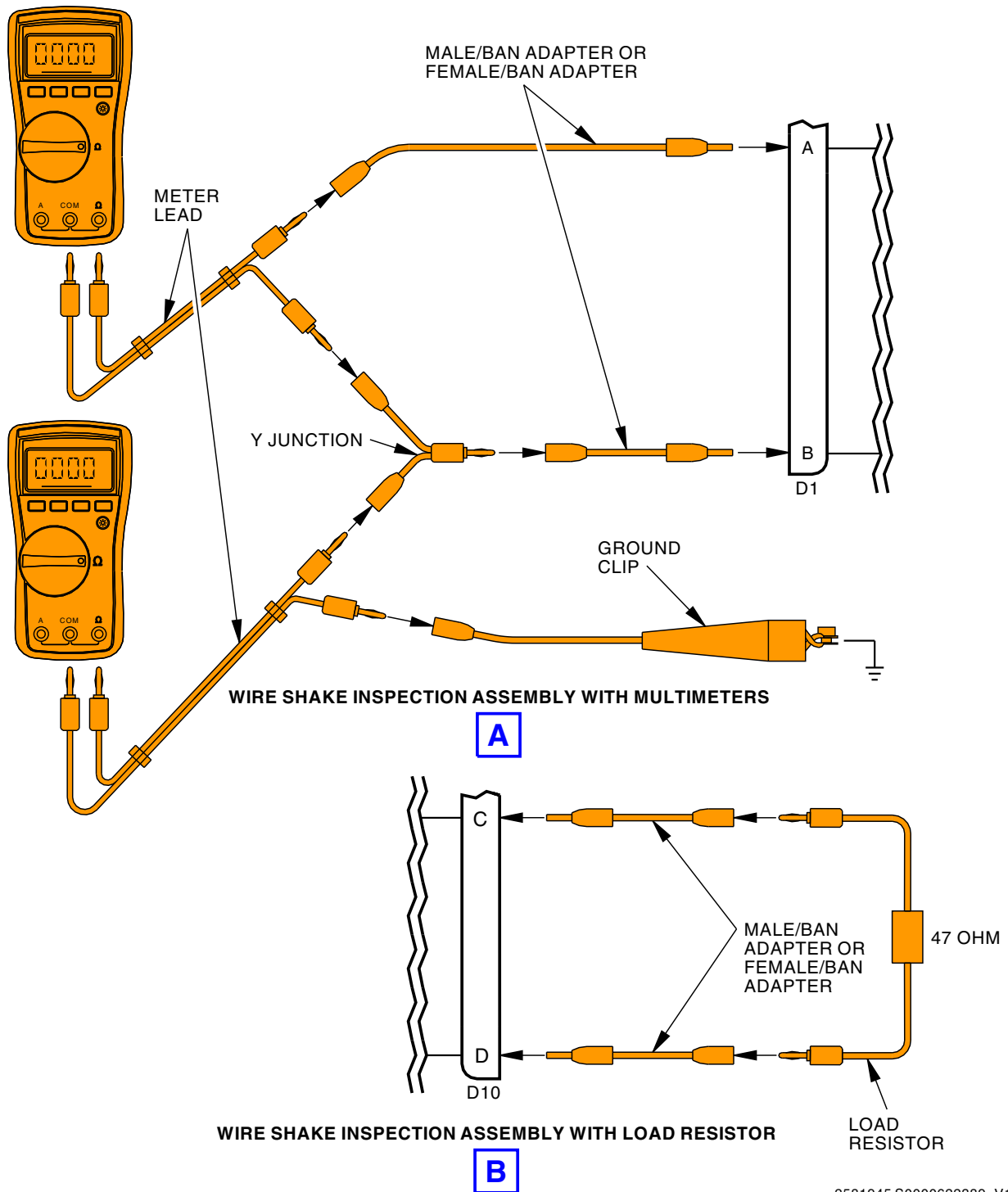


CIRCUITS WITH MULTIMETERS AND METER-LEAD KIT CONNECTED USING LOAD RESISTOR

2581943 S0000622388_V1

ARINC 429 Data Bus Wires (Example)
Figure 203/20-10-80-990-803 (Sheet 1 of 2)

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**ARINC 429 Data Bus Wires (Example)
Figure 203/20-10-80-990-803 (Sheet 2 of 2)**

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CONTROL CABLES - REMOVAL/INSTALLATION

1. General

A. This procedure has these tasks:

- (1) A removal of the control cables, except for the stabilizer control cables.

NOTE: To remove the stabilizer control cables, do the following task: (Stabilizer Control Cable Removal, TASK 27-41-82-000-801).

- (2) An installation of the control cables, except for the stabilizer control cables.

NOTE: To install the stabilizer control cables, do the following task: (Stabilizer Control Cable Installation, TASK 27-41-82-400-801).

B. The installation procedure contains prefabricated and nonprefabricated cables for easier installation when portable swaging machines are available.

C. It is recommended that both cable assemblies on either side of a cable loop be replaced at the same time.

NOTE: Replacing both cable assemblies will help the system stay in correct rig configuration since new and used cables stretch at different rates.

TASK 20-10-91-000-801

2. Control Cables Removal

(Figure 401)

A. **References**

Reference	Title
20-10-04-000-802	Control Cable Half Ball Pressure Seal Removal (P/B 401)
20-10-09-000-801	Control Cable Pulleys Removal (P/B 401)
20-10-10-000-801	Turnbuckle Lock Removal (P/B 401)

B. **Tools/Equipment**

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

Reference	Description
SPL-1569	Clamp - Control Cable Part #: A20005-9 Supplier: 81205

C. **Consumable Materials**

Reference	Description	Specification
G00270	Tape - Scotch Flatback Masking 250	ASTM D6123 (Supersedes A-A-883)

D. **Control Cables Removal**

SUBTASK 20-10-91-930-001

- (1) Use Scotch Flatback Masking Tape 250, G00270, to make a mark on the cable and fittings.

NOTE: The masking tape lets you refer to the initial position when you install the new cable.

SUBTASK 20-10-91-020-001

- (2) Do this task: Turnbuckle Lock Removal, TASK 20-10-10-000-801.

SUBTASK 20-10-91-020-002

- (3) Do this task: Control Cable Half Ball Pressure Seal Removal, TASK 20-10-04-000-802.

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SUBTASK 20-10-91-420-001

- (4) Install control cable clamp, SPL-1569, on the cable you do not remove to keep light tension on the cable.

NOTE: Light tension on the cable will prevent wind off on the cable drums. Light tension will also make sure that the cables do not move out of the pulley guides.

SUBTASK 20-10-91-480-002

- (5) If you can isolate the cable between rigging pin locations, it is acceptable to install rigging pins through the applicable drum or quadrant.

SUBTASK 20-10-91-420-002

- (6) Do these steps to remove the cable:
- (a) If it is necessary, do this task: Control Cable Pulleys Removal, TASK 20-10-09-000-801.
 - (b) Remove the cable.
 - (c) Remove Scotch Flatback Masking Tape 250, G00270, marked on the cable and fittings.

———— **END OF TASK** ————

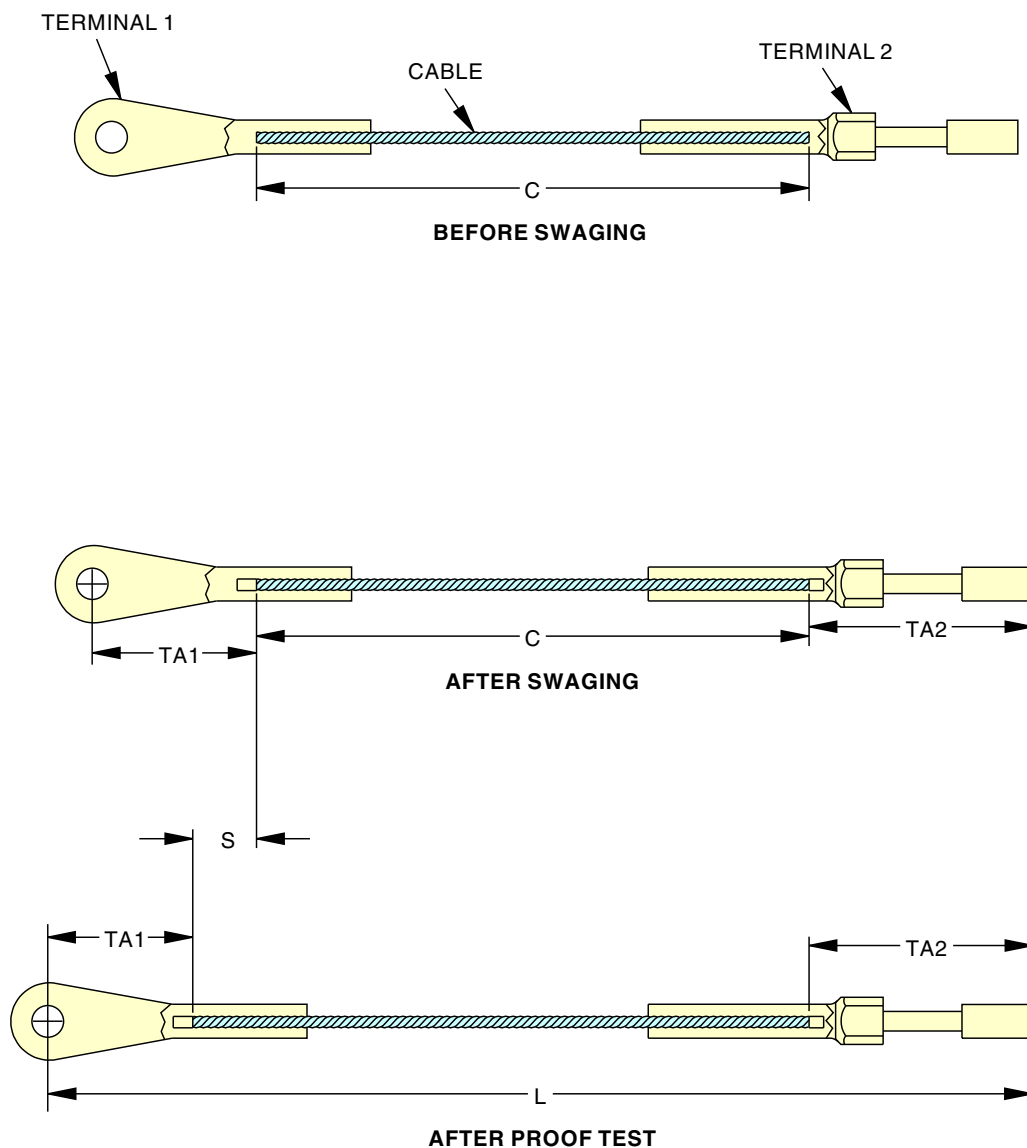
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$C = L - (TA1 + TA2 + S)$ WHERE:
C = CUT LENGTH OF CABLE
L = FINAL ASSEMBLY LENGTH
S = AMOUNT OF INCREASED CABLE LENGTH AFTER PROOF TEST
TA1 = TERMINAL 1 ALLOWANCE AFTER SWAGING
TA2 = TERMINAL 2 ALLOWANCE AFTER SWAGING

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**Control Cables Installation
Figure 401/20-10-91-990-801 (Sheet 1 of 2)**

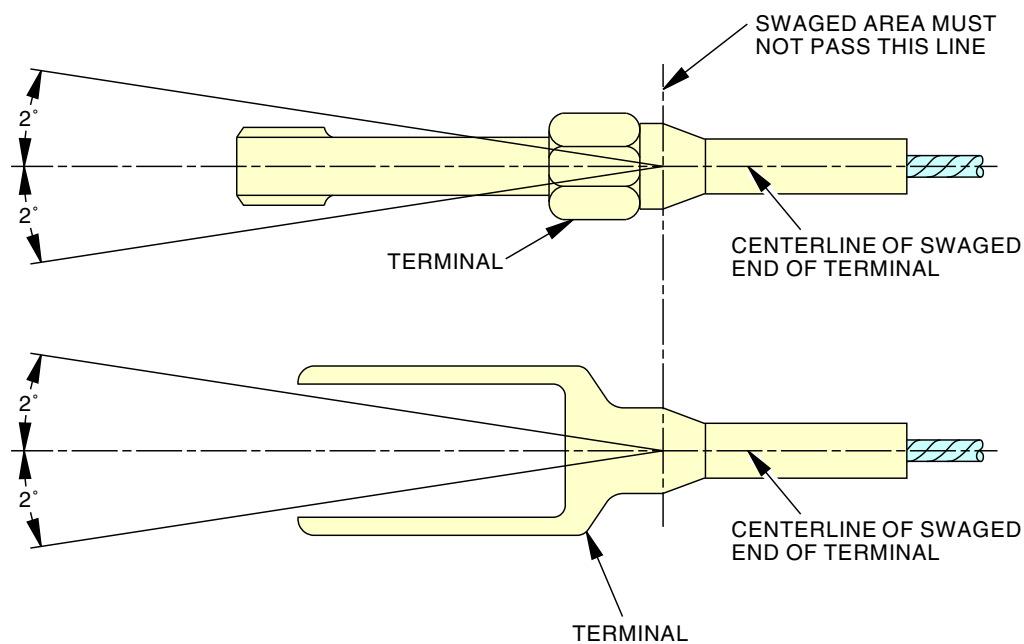
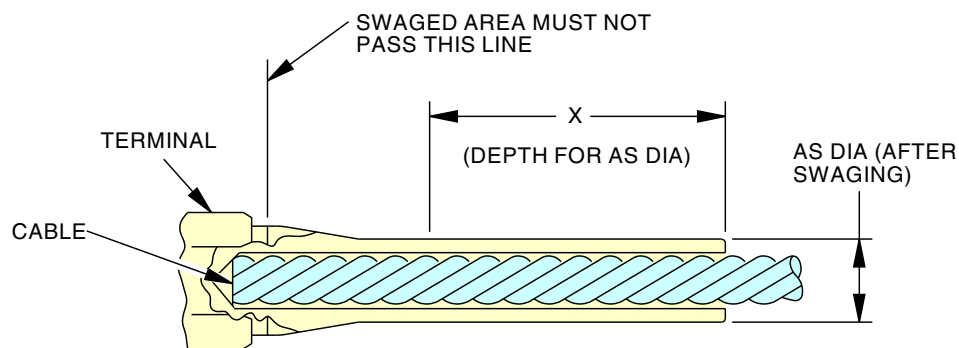
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Control Cables Installation
Figure 401/20-10-91-990-801 (Sheet 2 of 2)

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TASK 20-10-91-400-801

3. Control Cables Installation

(Figure 401)

A. General

- (1) If this procedure does not agree with a specified maintenance procedure, use the specified maintenance procedure.
- (2) Detailed data for control cables is in FLIGHT CONTROLS, CHAPTER 27 and LANDING GEAR, CHAPTER 32.
- (3) It is recommended that airplanes supplied with the cables that contain higher zinc coating (Grade D or Grade K) be re-tensioned three to four months into service. This will bring the tension of the control cables within the desired range. After the cables are re-tensioned, the high zinc cables (Grade D or Grade K) will continue to relax at a rate that is equivalent to the Grade B cables.
- (4) It is recommended that cable assemblies on each side of a cable loop be replaced at the same time using the same grade material in order to minimize asymmetric relaxation.

B. References

Reference	Title
20-10-04-400-802	Control Cable Half Ball Pressure Seal Installation (P/B 401)
20-10-09-400-801	Control Cable Pulleys Installation (P/B 401)
20-10-10-400-801	Turnbuckle Lock Installation (P/B 401)
27	FLIGHT CONTROLS
27-09-14-860-801	Control Cables Identification and Assembly Specifications (P/B 201)
32	LANDING GEAR

C. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt.", which stands for Optional.

Reference	Description
COM-1583	Kit - Swager, Portable Cable Part #: ATI520HK Supplier: 00784 Part #: ATI520JK Supplier: 00784
COM-4837	Pull Tester, Cable Terminal (1/16 thru 1/4 inch diameter cables) Part #: ATI520CTK Supplier: 00784

D. Consumable Materials

Reference	Description	Specification
C00308	Compound - Corrosion Preventive, Petrolatum Hot Application	MIL-C-11796
D00633	Grease - Aircraft General Purpose	BMS3-33
G00034	Cotton Wiper - Process Cleaning Absorbent Wiper (Cheesecloth, Gauze)	AMS3819 Class 1 Grade A or B Form 1 (Supersede BMS15-5 CLA)
G00270	Tape - Scotch Flatback Masking 250	ASTM D6123 (Supersedes A-A-883)

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E. Prefabricated Cable Installation

SUBTASK 20-10-91-420-003

- (1) Use Scotch Flatback Masking Tape 250, G00270 to make a mark on the cable and fittings.
NOTE: The masking tape lets you refer to the initial position when you install the new cable.
- (2) Install the cable.
 - (a) Attach the new cable to the old cable.
NOTE: If you do not attach the new cable to the old cable, you will have a problem in routing the new cable.
 - (b) Pull the old cable out, which pulls the new cable through at the same time.
 - (c) Keep light tension on the new cable.

SUBTASK 20-10-91-410-001

- (3) Do this task: Control Cable Pulleys Installation, TASK 20-10-09-400-801.

SUBTASK 20-10-91-410-002

- (4) Do this task: Control Cable Half Ball Pressure Seal Installation, TASK 20-10-04-400-802.

F. Nonprefabricated Cable Installation

SUBTASK 20-10-91-820-001

- (1) Identify the cable you remove.
 - (a) Refer to the applicable system chapter to prepare a new cable.
 - (b) Refer to Figure 401, to calculate cable length.NOTE: The total length of the cable after assembly and the test will be longer than the lengths of the terminals and the cable before they are assembled. The terminals will be longer after they are swaged, and the cable will be longer after the proof test. Make sure that you include an allowance for each of these changes before you cut the cable to the required length.

SUBTASK 20-10-91-420-004

- (2) Install only those fittings that will permit cable installation.
 - (a) If the wire rope has a nylon jacket, remove the nylon from the end of the wire rope before you put the rope in the terminal.
 - 1) Remove a length of nylon to give 0.50 in. (12.70 mm) maximum clearance between the terminal and the jacket after the rope is installed in the terminal.
 - (b) Put the cut end of the wire rope into the full depth of the bore of the terminal.
 - 1) If the bore of the terminal does not go completely through, make sure that the wire rope is at the full depth as follows:
 - a) Measure the depth of the bore.
 - b) Mark this as a length from the end of the wire rope before you install and swage the fittings.
 - (c) Terminals can be staked on the wire rope to keep them in the correct position before they are swaged.
 - 1) The maximum allowable stake depth after swaging is 0.003 in. (0.076 mm).
 - 2) The stake must be within the minimum swage length given by Table 401 or Table 402.

SUBTASK 20-10-91-830-001

- (3) Use the portable cable swager kit, COM-1583, to install the fittings as follows:

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- (a) The swaging must smoothly cold-work the fitting until its dimensions agree with the data given by Table 401 and Table 402.
- (b) During the swaging process, do not let the die touch these areas of the fitting:
 - The hex
 - The fork
 - The eye of the terminal.
- (c) Do not swage the same terminal a second time.
- (d) The completed swage dimensions are as follows:

Table 401/20-10-91-993-801 Terminal Dimensions After Swaging

Cable Diameter	1/16 in. (1.588 mm)	3/32 in. (2.381 mm)	1/8 in. (3.175 mm)	5/32 in. (3.969 mm)	3/16 in. (4.762 mm)
X (Minimum)	0.700 in. (17.780 mm)	0.800 in. (20.320 mm)	1.050 in. (26.670 mm)	1.290 in. (32.766 mm)	1.310 in. (33.274 mm)
AS Diameter (Maximum)	0.138 in. (3.505 mm)	0.190 in. (4.826 mm)	0.219 in. (5.563 mm)	0.250 in. (6.350 mm)	0.313 in. (7.950 mm)
AS Diameter (Minimum) ^{*[1]}	0.133 in. (3.378 mm)	0.185 in. (4.699 mm)	0.214 in. (5.436 mm)	0.243 in. (6.172 mm)	0.306 in. (7.772 mm)
AS Diameter (Minimum) ^{*[2]}	0.128 in. (3.251 mm)	0.180 in. (4.572 mm)	0.209 in. (5.309 mm)	0.236 in. (5.994 mm)	0.299 in. (7.595 mm)

^{*[1]} BASIC MINIMUM DIAMETER AFTER SWAGING

^{*[2]} IN THE AREA OF THE ORIGINAL DESIGN TAPER, THE END OF THE SWAGED AREA CAN HAVE THIS MINIMUM DIAMETER

Table 402/20-10-91-993-802 Terminal Dimensions After Swaging

Cable Diameter	7/32 in. (5.556 mm)	1/4 in. (6.350 mm)	9/32 in. (7.144 mm)	5/16 in. (7.938 mm)	3/8 in. (9.525 mm)
X (Minimum)	1.550 in. (39.370 mm)	1.700 in. (43.180 mm)	1.890 in. (48.006 mm)	2.060 in. (52.324 mm)	3.120 in. (79.248 mm)
AS Diameter (Maximum)	0.375 in. (9.525 mm)	0.438 in. (11.125 mm)	0.500 in. (12.700 mm)	0.563 in. (14.300 mm)	0.625 in. (15.875 mm)
AS Diameter (Minimum) ^{*[1]}	0.368 in. (9.347 mm)	0.431 in. (10.947 mm)	0.492 in. (12.497 mm)	0.555 in. (14.097 mm)	0.617 in. (15.672 mm)
AS Diameter (Minimum) ^{*[2]}	0.361 in. (9.169 mm)	0.424 in. (10.770 mm)	0.484 in. (12.294 mm)	0.547 in. (13.894 mm)	0.609 in. (15.469 mm)

^{*[1]} BASIC MINIMUM DIAMETER AFTER SWAGING

^{*[2]} IN THE AREA OF THE ORIGINAL DESIGN TAPER, THE END OF THE SWAGED AREA CAN HAVE THIS MINIMUM DIAMETER

- (e) The swaged terminal must have no pits, die marks, cracks that could be seen with a 10-power lens.
 - 1) Small nicks or dents are satisfactory if the swaged surface is 63 microinches or smoother.
- (f) The threaded, eye, or fork end of the terminal must be straight with the centerline of the swaged end (Figure 401).

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(g) The cable assembly must not have the following:

- Kinks
- Damaged nylon jacket
- Popped cores
- Broken wire strands
- Wire ends above the terminal ends.

SUBTASK 20-10-91-820-002

(4) Apply a proof load to the cable and to the installed fittings (Table 403, Table 404).

NOTE: This will check the swaging and this will also stretch the cable.

NOTE: If you use pre-stretched cable you do not have to use a proof load. You can use other applicable procedures to do a check on the swaging.

NOTE: The proof load for stabilizer trim cables shall be 900 ±25 lb (408 ±12 kg).

Table 403/20-10-91-993-803 Proof Loads For Cable Assemblies

WIRE ROPE TYPE		CABLE DIAMETER ^{*[1]}				
		1/16 in. (1.588 mm)	3/32 in. (2.381 mm)	1/8 in. (3.175 mm)	5/32 in. (3.969 mm)	3/16 in. (5 mm)
		PROOF LOAD				
BMS 7-265 OR MIL- DTL-83420 Carbon Steel, Tin- Zinc Coated (Composition "A (TZ)")	7X7	288 +25 / -0 lb (131 +12 / - 0 kg)	552 +25 / -0 lb (250 +12 / -0 kg)	---	---	---
	7X19	---	600 +25 / -0 lb (272 +11 / -0 kg)	1200 +60 / -0 lb (544 +28 / -0 kg)	1680 +85 / -0 lb (762 +39 / -0 kg)	2520 +125 / -0 lb (1143 +57 / -0 kg)
BMS 7-265 OR MIL- DTL-83420 Corrosion Resistant Steel (CRES) (Composition "B")	7X7	288 +25 / -0 lb (131 +12 / - 0 kg)	552 +25 / -0 lb (250 +12 / -0 kg)	---	---	---
	7X19	---	552 +25 / -0 lb (250 +12 / -0 kg)	1056 +50 / -0 lb (479 +23 / -0 kg)	1440 +70 / -0 lb (653 +32 / -0 kg)	2220 +110 / -0 lb (1007 +50 / -0 kg)

*[1] THE DIAMETER OF THE WIRE ROPE TELLS YOU THE PROOF LOAD TO USE ON NYLON JACKETED CABLE. DO NOT INCLUDE THE JACKETED CABLE. DO NOT INCLUDE THE JACKET IN THE DIAMETER.

Table 404/20-10-91-993-804 Proof Loads For Cable Assemblies

WIRE ROPE TYPE		CABLE DIAMETER ^{*[1]}				
		7/32 in. (5.556 mm)	1/4 in. (6.350 mm)	9/32 in. (7.144 mm)	5/16 in. (7.938 mm)	3/8 in. (9.525 mm)
		PROOF LOAD				

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Table 404/20-10-91-993-804 Proof Loads For Cable Assemblies (Continued)

WIRE ROPE TYPE		CABLE DIAMETER ^{*[1]}				
BMS 7-265 OR MIL- DTL-83420 Carbon Steel, Tin- Zinc Coated (Composition "A (TZ)")	7X19	3360 +170 / - 0 lb (1524 +77 / -0 kg)	4200 +210 / -0 lb (1905 +95 / - 0 kg)	4800 +240 / -0 lb (2177 +109 / - 0 kg)	5880 +295 / -0 lb (2667 +134 / - 0 kg)	8640 +435 / -0 lb (3919 +197 / -0 kg)
BMS 7-265 OR MIL- DTL-83420 Corrosion Resistant Steel (CRES) (Composition "B")	7X19	3000 +150 / - 0 lb (1361 +68 / -0 kg)	3840 +190 / -0 lb (1742 +86 / - 0 kg)	4680 +230 / -0 lb (2123 +105 / - 0 kg)	5400 +270 / -0 lb (2449 +123 / - 0 kg)	7200 +360 / -0 lb (3266 +163 / -0 kg)

^{*[1]} THE DIAMETER OF THE WIRE ROPE TELLS YOU THE PROOF LOAD TO USE ON NYLON JACKETED CABLE. DO NOT INCLUDE THE JACKETED CABLE. DO NOT INCLUDE THE JACKET IN THE DIAMETER.

SUBTASK 20-10-91-160-001

- (5) Rub the full length of the cable with cotton wiper, G00034.

SUBTASK 20-10-91-640-001



CAUTION

DO NOT APPLY SOLVENTS, GREASE, OR OIL TO STAINLESS STEEL CONTROL CABLES. THESE MATERIALS CAN COLLECT CONTAMINATION THAT CAN CAUSE DAMAGE TO THE INTERNAL SURFACES OF THE CRES CABLE STRANDS. THIS CAN DECREASE THE SERVICE LIFE OF THE CABLE.

- (6) Lubricate the cable.

NOTE: Only lubricate carbon steel cables. It is not necessary to lubricate Corrosion Resistant Steel (CRES) cables. CRES cables can be wiped with a clean cloth.

- (a) Apply a light, thin layer of grease, D00633, to the carbon steel cable.
- (b) Wipe the cable with a clean rag to leave a thin film of grease between the strands on the cable.

SUBTASK 20-10-91-930-002

- (7) Make marks on the positions of the fittings not installed on the cable before installation.

SUBTASK 20-10-91-820-003

- (8) Put tape on the old cable so it will not unravel.

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SUBTASK 20-10-91-820-004

- (9) Cut off the cable end fitting of the old cable and make a splice to attach the old cable to the new cable.

NOTE: If you do not attach the new cable to the old cable, you will have a problem in routing the new cable. Make the splice of minimum diameter and sufficiently strong not to break when you pull the cable through. Make the splice on only the center strands of the cable. Put tape on the loose outer strands.

NOTE: If a person can assist with control cable installation, have them remove retainer pins and fairleads as new cable passes through pulley. Connect retainer pins and fairleads when new cable is in place. Continue with the next pulley until done.

SUBTASK 20-10-91-820-005

- (10) Pull the old cable out with light tension on the new cable.

SUBTASK 20-10-91-420-005

- (11) Install the remaining fittings and apply a proof load to fittings (Figure 401).
- (a) Use the terminal pull tester, COM-4837, to apply a proof load to each remaining fitting independently.
 - (b) Apply the proof load evenly in not less than 3 seconds and hold the load for a minimum of 5 seconds.

SUBTASK 20-10-91-160-002

- (12) If necessary, remove unwanted corrosion preventive compound, C00308, from the surface of the control cable with a clean cotton wiper, G00034.

NOTE: Clean all of the cable, including through the fairleads and air seals, and over the pulleys, quadrants, and drums.

SUBTASK 20-10-91-640-002



DO NOT APPLY SOLVENTS, GREASE, OR OIL TO STAINLESS STEEL CONTROL CABLES. THESE MATERIALS CAN COLLECT CONTAMINATION THAT CAN CAUSE DAMAGE TO THE INTERNAL SURFACES OF THE CRES CABLE STRANDS. THIS CAN DECREASE THE SERVICE LIFE OF THE CABLE.

- (13) Lubricate the cable.

NOTE: Only lubricate carbon steel cables. It is not necessary to lubricate CRES cables. CRES cables can be wiped with a clean cloth.

- (a) Apply a light thin layer of grease, D00633, to the carbon steel cable.
- (b) Wipe the cable with a clean rag to leave a thin film of grease between the strands on the cable.

SUBTASK 20-10-91-420-006

- (14) Install the turnbuckles with the turnbuckle barrel installed an equal distance on the two threaded terminals. Do not let more than three threads show out of the barrel.

SUBTASK 20-10-91-020-003

- (15) Remove the cable clamps and rigging pins from the control cable and drums.

SUBTASK 20-10-91-080-001

- (16) If applicable, remove the tension regulator tool from the elevator control cable.

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SUBTASK 20-10-91-420-007

- (17) Tighten the cable as told in the temperature - tension chart in the system chapter.

NOTE: Use a tensiometer to do a check on the cable tension. Apply the tensiometer to the cable at least 6 in. (152 mm) from the turnbuckle terminal or other fittings. To make sure that you have the correct cable tension, permit a minimum of one hour at constant ambient temperature (± 5 °F [± 3 °C]) for the airplane temperature to become stable.

SUBTASK 20-10-91-710-001

- (18) If a new cable is installed, operate the system for a number of test cycles, with cables tightened to two times the working tension.

NOTE: See the applicable chapter for tension specifications.

SUBTASK 20-10-91-820-006

- (19) Make the last rigging adjustments.

NOTE: Refer to the applicable chapter for rigging load.

SUBTASK 20-10-91-210-001

- (20) Adjust the seals to stop deflection of the cables and to make sure that the cables are free to move. Do this task: Control Cable Half Ball Pressure Seal Installation, TASK 20-10-04-400-802.

SUBTASK 20-10-91-220-001

- (21) The minimum clearance from the adjacent structure shall be as follows.

NOTE: The clearances that follow are general guidelines only. Refer to the applicable chapter to find any special conditions for a specific system.

- (a) Between different cable systems - 0.50 in. (12.70 mm).

NOTE: A clearance of 2.00 in. (50.80 mm) is recommended.

- (b) Between structure, wiring, tubing and fixed equipment:

1) At a fairlead - 0.50 in. (12.70 mm).

2) At a rubstrip - 0.10 in. (2.54 mm).

NOTE: A clearance of 1.50 in. (38.10 mm) is recommended below the cable, and 1.00 in. (25.40 mm) is recommended in the other directions.

- (c) Between doors, landing gear, and components that move - 2.00 in. (50.80 mm).

NOTE: A clearance of 4.00 in. (101.60 mm) is recommended.

SUBTASK 20-10-91-420-008

- (22) Install a turnbuckle lock on all of the turnbuckles that were adjusted. Do this task: Turnbuckle Lock Installation, TASK 20-10-10-400-801.

SUBTASK 20-10-91-020-005

- (23) Remove Scotch Flatback Masking Tape 250, G00270 marked on the cable and fittings.

SUBTASK 20-10-91-710-002

- (24) Operate controls through full travel to make sure that cables move freely with minimum force.

SUBTASK 20-10-91-860-001

- (25) Do this task: Control Cables Identification and Assembly Specifications, TASK 27-09-14-860-801.

————— END OF TASK —————

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CONTROL CABLE END RETAINING PLATES - REMOVAL/INSTALLATION

1. General

A. This procedure has this task:

- (1) Control Cable End Retaining Plate - Installation.

TASK 20-10-93-400-801

2. Control Cable End Retaining Plate - Installation

(Figure 401)

A. **General**

- (1) This task is the installation of the control cable end retaining plate.

B. **Control Cable End Retaining Plate Installation**

SUBTASK 20-10-93-420-001

- (1) Put the cable end [1] through the large orifice of the retaining plate [2].

SUBTASK 20-10-93-420-002

- (2) Move the cable end [1] to the small orifice of the retaining plate [2].

SUBTASK 20-10-93-420-003

- (3) Turn the retaining plate [2] to align the large orifice in the retaining plate [2] with the orifice in the quadrant [7].

SUBTASK 20-10-93-420-004

- (4) Install the bolt [3], washer [4] (if applicable), washer [5], and nut [6].

———— **END OF TASK** ————

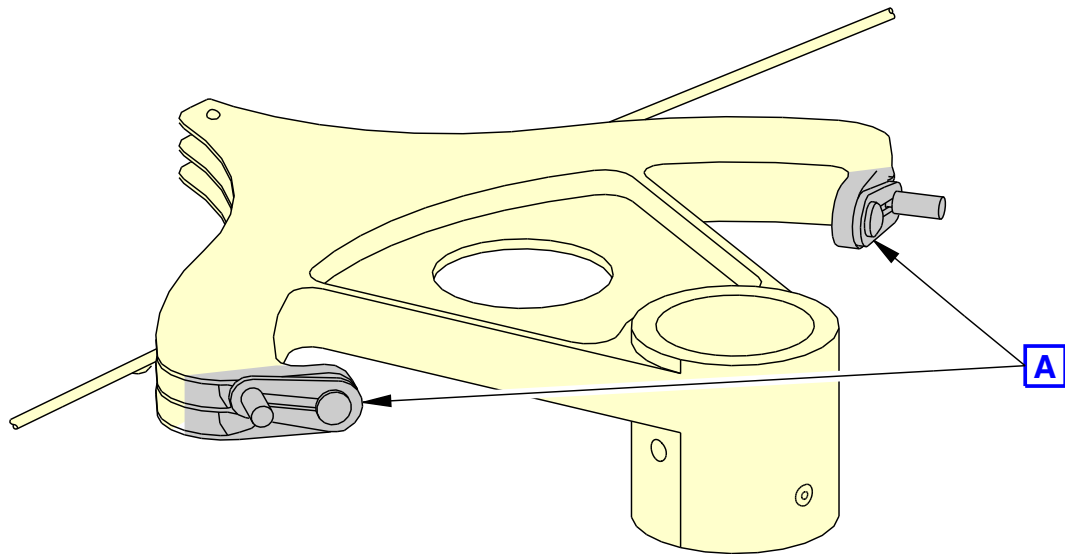
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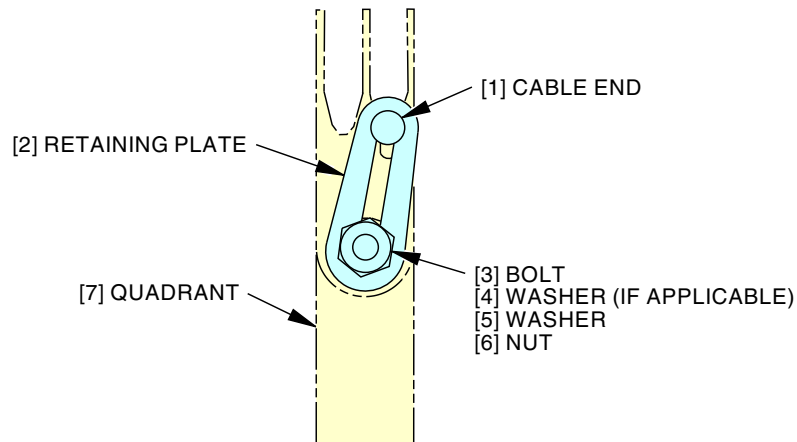
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**CABLE QUADRANT
(EXAMPLE)**



1 ROTATE RETAINING PLATE TO THE QUADRANT GROOVE THAT THE CABLE TERMINATES IN FOR EACH CABLE INSTALLATION AS SHOWN PRIOR TO TIGHTENING BOLT

2970933 S0000749867_V1

**Control Cable End Retaining Plate Installation
Figure 401/20-10-93-990-801**

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ON-AIRPLANE SOFTWARE INSTALLATION - MAINTENANCE PRACTICES

1. General

- A. This procedure gives general information about software installation on the airplane.
- (1) The complete software installation procedure is in the applicable AMM chapter-section for the component. It is possible there is more than one software installation task for an LRU. The different tasks use different methods of software installation.

TASK 20-15-11-470-801

2. On-Airplane Software Installation

(Figure 201)

A. General

- (1) This task gives information about software installation on the airplane.
 - (a) The data that follows includes general information on load times, load methods and software loaders. For details, see the applicable AMM task for the LRU.
- (2) Software Installation Time Impacts
 - (a) The time necessary to install software in components is different and it is affected by many factors:
 - 1) Retrieval of the correct software, applicable equipment and the Maintenance Manual procedures.
 - 2) Setup procedures.
 - 3) Method used to install software.
 - 4) Data transfer time.
 - 5) Software configuration check.
 - 6) Return to usual airplane configuration.
 - 7) Airline completion procedures.
- (3) Software Load Time Details
 - (a) The software install time in minutes is the time from start of data load until the data transfer is complete.
 - (b) The install time depends on:
 - 1) The type and size of software files.
 - 2) The unique protocols and processors of the data loader.
 - 3) The unique internal protocols and processors of the component.
 - (c) Typical software load times are:
 - 1) Operational Program Software (OPS): approximately 5 to 16 minutes. Some install in one minute and some take as long as 45 minutes.
 - 2) Operational Program Configuration (OPC): approximately 1 to 3 minutes.
 - 3) Databases (DB): approximately 1 to 3 minutes and possibly as long as 60 to 70 minutes.
 - (d) You know that the correct software is installed if the correct software part number shows when you do the software configuration check.
- (4) Data Loaders
 - (a) This procedure gives general information about data loading.

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- (b) On-airplane software installation is done when you use a portable maintenance device (PMD) or the forward displays to install software with the baseline, standard Onboard Network System (ONS) or the forward displays. Software is distributed electronically to the airplane's Network File Server (NFS) Mass Storage Device (MSD).
- (c) There is also an optional portable data loader (PDL) port. The PDL is removed from the airplane when the task is complete, but some operators keep the data loader stowed on the airplane. A portable data loader can only load legacy systems that are indicated on the data loader selector panel or that are loadable with a connector on the LRU.

NOTE: The portable data loader port on the P61 Panel is optional and may not be installed on your airplane.

NOTE: Modern software loaders that meet the security requirements defined in ARINC 645-1 are recommended to be used. Check with your software loader supplier for current capabilities of the equipment you have.

- (d) A data loader control panel is installed on the P61 panel. The control panel has interface wiring to components that can receive software installation from a data loader in the flight compartment or from the ONS. The control panel has a switch position for applicable components. There are INOP labels on switch positions that are not available for software installation.
- (e) There is an (optional) portable data loader (PDL) port on the P61 Maintenance BITE Panel. All airplanes have an RJ45 ONS port on the P61 panel.

- 1) The two ports are not used at the same time.
 - a) When a PDL is connected to the PDL port, then the PDL will be the primary data source for data loading.
- 2) The RJ45 port, M2979 on the P61 panel, connects the PMD to the ONS for software loading from the ONS MSD.

NOTE: There are two methods to data load on the MAX when you use the ONS. For one method, it is necessary to interface with a PMD and the other method uses the forward displays.

- (f) Figure 201 shows examples of the Data Loader Control Panel and the Maintenance BITE Panel.

(5) Software Installation Methods

(a) Typical Software Installation Methods:

- 1) Use the Onboard Network System (ONS) to install software. ONS is the primary, default data loader on the MAX. The ONS software installation method requires a PMD connected to the ethernet RJ45 port or the forward displays interface.
- 2) Use Data Loaders to install software. A portable data loader (PDL), or Maintenance Laptop (ML), or portable maintenance access terminal (PMAT) is equipment that is moved to the airplane to install software. They are removed from the airplane when the task is complete.

NOTE: The portable data loader port on the P61 Panel is optional and may not be installed on your airplane.

(b) Alternate Software Installation Methods

- 1) Short load:
 - a) During a short load, only pieces of software that are different from what is already in the component are installed during data transfer.



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- b) This can cause a software load time that is much shorter than the time given in Table 201.
 - c) The display processing computer (DPC) for the MAX Display System (MDS) is an example of a component that is capable of short loads, but that functionality is not enabled at this time.
- 2) Parallel loading:
- a) Parallel loading is when you install software into two common LRUs simultaneously. The ONS can load the same common parts to multiple targets at the same time when supported by the airplane architecture. For example, the ONS can parallel load the same software part to Channel 1 and 2 of the same EEC.
- 3) Batch loading:
- a) When you select and install multiple software parts to an LRU in one data load session. The ONS and WWU are capable of batch loading.
- 4) Crossloading:
- a) Crossloading is a function when there are multiple, common LRUs. First, you install a common software part into one of the LRUs, or do a check to make sure the part is installed. Then, you use a system function to crossload (install) the software part. The software is hosted on the source LRU (left side or Number 1, for example) and is installed into the target LRU (right side or Number 2). For example, use the Forward Attendant Control Panel (ACP) to crossload (or install) software into the Aft ACP.
- 5) LRU Front Panel Install:
- a) Some LRUs have their own data load technique and the data load is done on the front of the LRU. For example, the Enhanced Ground Proximity Warning Computer (EGPWC) front panel has a USB port where you install a memory stick (or, USB flash drive) to install the terrain database (TDB).
- 6) Cabin Systems:
- a) Cabin Systems, such as In-Flight Entertainment (IFE), Prerecorded Announcement Machine (PRAM), and Passenger Address (PA) have their own data load protocol. The systems have a built-in data loader or they have a proprietary data loader to load the software. Or, some cabin systems come preloaded with software and it is not possible to install software on the airplane.
- (6) Table 201 - Software Load Times
- (a) The table below shows software installation times for components that are approved for on-airplane software installation. Not all components are installed on all airplanes. If a component is installed on an airplane, then there is a software installation procedure applicable to that airplane. The software installation procedure is in the AMM chapter-section that shows in the table.
 - (b) The types of software installed in a component on one airplane can be different than the types of software installed in the component on a different airplane.
 - 1) A component on the list can have some hardware part numbers that are approved for software installation and other hardware part numbers that are not approved for software installation.
 - 2) Refer to airline part number records to find software part numbers for applicable components.

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- (c) Software load times are approximate times in minutes for software installed when you use ONS. These install times are given only as an aid to help you schedule work. Software installs can fail, and failure of the data transfer will increase the total time necessary for software installation. What follows are details on software install fails.
- A power interruption/transition (APU-ground power) during a data load may cycle the power inadvertently on the ONS or the target LRU and disrupt a load sequence.
 - The forward displays, or the maintenance laptop (ML) or other portable maintenance device (PMD) connected to the ONS may or may not show a failure notice, depending upon the nature of the failure.
 - A status update that's slowed or halted on the PMD or forward display is the best indicator that the load has been disrupted. Cycling power and restarting the data load is the recommended solution. Cycle power to the dataloader, to the ONS (if used), and to the receiving system LRU.
 - Transfer times can vary greatly between different hardware suppliers.
 - File sizes can vary over time and will impact transfer durations.
- (d) The times given in the table below (in minutes) are for the installation of one piece of software into one component.
- 1) If a component has more than one piece of software, then you must add the time for each piece to find the total data transfer time for the component.
 - 2) If a system has more than one of the given component, and software is to be installed in each one, you must multiply the time given in the table by the total number of components to find the total data transfer time for the system.
 - a) For example, if a left and a right component are installed on the airplane, you must multiply the time given in the table by two to find the total data transfer time for the two components.
 - b) Some systems can cross-load software between components. Usually it is faster to cross-load software than to install software with a data loader. The Flight Management Computer System (FMCS) is an example of a system that can cross-load.
- (e) Software load times, that show in minutes in the table below, assumes that the part is staged to the ONS Mass Storage Device (MSD). It is necessary to stage (load) the software to the MSD before you start a data load sequence.

NOTE: The data in this table is for reference only and the data that follows includes optional hardware and software parts that are not always installed on every airplane.

NOTE: The software load times are approximate time in minutes and are for software installed with ONS.

Table 201/20-15-11-993-801 Table 201

ATA	LRU	SOFTWARE NAME	LOAD TIME (Minutes) ^{*[1]}	LOAD METHOD ^{*[2]}	RESTART REQUIRED?	SOFTWARE INSTALL INTERVAL
22-11	FLIGHT CONTROL COMPUTER (FCC)	FCC OPS	8	ONS, PDL, PMAT	YES	AS REQUIRED

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Table 201/20-15-11-993-801 Table 201 (Continued)

ATA	LRU	SOFTWARE NAME	LOAD TIME (Minutes)*[1]	LOAD METHOD*[2]	RESTART REQUIRED?	SOFTWARE INSTALL INTERVAL
23-15	SATCOM SDU	SDU USER ORT	1-4	ONS, PDL, PMAT	YES	AS REQUIRED
23-15	SDU (cont.)	SDU SECURE ORT	1-4	ONS, PDL, PMAT	YES	AS REQUIRED
23-27	ACARS CMU	CMU OPS SW	45-50	ONS, PDL, PMAT	YES	AS REQUIRED
23-27	CMU (cont.)	ACARS SW	5-7	ONS, PDL, PMAT	YES	AS REQUIRED
23-27	CMU	CMU DB	1-2	ONS, PDL, PMAT	YES	AS REQUIRED
23-27	CMU	CMU SW	5-8	ONS, PDL, PMAT	YES	AS REQUIRED
23-42	ATTENDANT CONTROL PANEL SYSTEM (ACPS)	ACP OPS	5-6	ONS, PDL, PMAT, CROSSLOAD	YES	AS REQUIRED
23-42	ACPS (cont.)	ACP LDB	1-2	ONS, PDL, PMAT, CROSSLOAD	YES	AS REQUIRED
23-42	ACPS	ACP CDB	2-3	ONS, PDL, PMAT, CROSSLOAD	YES	AS REQUIRED
27-61	SPOILER CONTROL ELECTRONICS (SCE)	SCE DPL 1	3	ONS, PDL	YES	AS REQUIRED
27-61	SCE (cont.)	SCE DPL 2	3	ONS, PDL	YES	AS REQUIRED
27-61	SCE	SCE DPL 3	3	ONS, PDL	YES	AS REQUIRED
31-31	DIGITAL FLIGHT DATA AQUISITION UNIT (DFDAU)	MANDATORY OPS	1	ONS	YES	AS REQUIRED
31-31	DFDAU (cont.)	MANDATORY DB	1	ONS	YES	AS REQUIRED
31-31	DFDAU	AVIONICS DATA STREAM OPS	1	ONS	YES	AS REQUIRED
31-31	DFDAU	ACMS BASELINE DB	1	ONS	NO	AS REQUIRED
31-31	DFDAU	ACMS AHM DB	1	ONS	NO	AS REQUIRED

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Table 201/20-15-11-993-801 Table 201 (Continued)

ATA	LRU	SOFTWARE NAME	LOAD TIME (Minutes) ^{*[1]}	LOAD METHOD ^{*[2]}	RESTART REQUIRED?	SOFTWARE INSTALL INTERVAL
31-31	DFDAU	ACMS DAR AMI	1	ONS	YES	AS REQUIRED
31-31	DFDAU	ACMS OPS	1	ONS	NO	AS REQUIRED
31-31	DFDAU	ACMS SERVICE ENGR DB	1	ONS	NO	AS REQUIRED
31-31	DFDAU	ACMS OPERATOR AMI	1	ONS	NO	AS REQUIRED
31-31	DFDAU	DFDAU OSS	1	ONS	YES	AS REQUIRED
31-65	DISPLAY PROCESSING COMPUTER (DPC)	DPC OMF DF	1-2	ONS	YES	AS REQUIRED
31-65	DPC (cont.)	DPC OPS	3-4	ONS	YES	AS REQUIRED
31-65	DPC	DPC OSS	1-2	ONS	YES	AS REQUIRED
34-36	HEAD-UP DISPLAY (HUD) COMPUTER	HUD COMPUTER OPS	11-12	ONS, PDL, PMAT	YES	AS REQUIRED
34-36	HUD COMPUTER (cont.)	HUD COMPUTER OPC	1	ONS, PDL, PMAT	YES	AS REQUIRED
34-49	EGPWS COMPUTER	EGPWS OSS	1	ONS, PDL, PMAT	YES	AS REQUIRED
34-49	EGPWS COMPUTER (cont.)	TERRAIN DATA BASE (TDB)	7-8	EGPWC USB PORT ^{*[2]}	YES	30-60 DAYS
34-61	FLIGHT MANAGEMENT COMPUTER SYSTEM (FMCS)	CDU OPS	23-25	ONS, PDL, PMAT	YES	AS REQUIRED
34-61	FMCS (cont.)	CDU OPC	1	ONS, PDL, PMAT	YES	AS REQUIRED
34-61	FMCS (cont.)	FMC OPS	16-18	ONS, PDL, PMAT	YES	AS REQUIRED
34-61	FMCS (cont.)	FMC MEDB	10-12	ONS, PDL, PMAT	YES	AS REQUIRED
34-61	FMCS (cont.)	FMC OPC	1	ONS, PDL, PMAT	YES	AS REQUIRED

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Table 201/20-15-11-993-801 Table 201 (Continued)

ATA	LRU	SOFTWARE NAME	LOAD TIME (Minutes)*^[1]	LOAD METHOD*^[2]	RESTART REQUIRED?	SOFTWARE INSTALL INTERVAL
34-61	FMCS (cont.)	FMC NAV DB	5-60	ONS, PDL, PMAT	YES	28 DAYS
46-13	CREW WIRELESS LAN UNIT (CWLK)	CWLK WAP OS	3-5	ONS	YES	AS REQUIRED
46-13	WIRELESS WAN UNIT (WWU)	WWU OPC	1-2	ONS	YES	AS REQUIRED
46-13	WWU (cont.)	WWU OPS	16-17	ONS	YES	AS REQUIRED
46-13	NETWORK FILE SERVER (NFS)	NFS SERVER OS	10-12	ONS	YES	AS REQUIRED
46-13	NFS (cont.)	NFS OPC	10-12	ONS	YES	AS REQUIRED
46-13	NFS (cont.)	NFS NETMANAGER APP	10-12	ONS	YES	AS REQUIRED
46-13	NFS (cont.)	NFS MEF OPS	10-12	ONS	YES	AS REQUIRED
46-13	NFS (cont.)	NFS OAS AIRLINE CERT UMS	5-10	ONS	YES	AS REQUIRED
46-13	NFS (cont.)	NFS OAS AIRLINE CRL UMS	5-10	ONS	YES	AS REQUIRED
46-13	NFS (cont.)	NFS OAS EXCOMM UMS	5-10	ONS	YES	AS REQUIRED
46-13	NFS (cont.)	NFS MEF UMS	5-10	ONS	YES	AS REQUIRED
46-13	NFS (cont.)	NFS OMF OPS	5-10	ONS	YES	AS REQUIRED
46-13	NFS (cont.)	NFS OMF OSS	5-10	ONS	YES	AS REQUIRED
46-13	NFS (cont.)	NFS NSP OPS	5-10	ONS	YES	AS REQUIRED
46-13	NFS (cont.)	NFS NSP OPC	5-10	ONS	YES	AS REQUIRED
46-13	NFS (cont.)	NFS DATA MONITOR OPS	5-10	ONS	YES	AS REQUIRED
46-13	NFS (cont.)	NFS DATA RECORDER OPS	5-10	ONS	YES	AS REQUIRED
46-13	NFS (cont.)	NFS DATA RECORDER OSS	5-10	ONS	YES	AS REQUIRED
46-13	NFS (cont.)	NFS AIRPLANE ID UMS	5-10	ONS	YES	AS REQUIRED
46-13	NFS (cont.)	NFS BOOT OS	5-10	ONS	YES	AS REQUIRED

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Table 201/20-15-11-993-801 Table 201 (Continued)

ATA	LRU	SOFTWARE NAME	LOAD TIME (Minutes) ^{*[1]}	LOAD METHOD ^{*[2]}	RESTART REQUIRED?	SOFTWARE INSTALL INTERVAL
46-13	NFS (cont.)	NFS OAS AIRPLANE KEYS UMS	5-10	ONS	YES	AS REQUIRED
46-13	NFS (cont.)	NFS ENGINE HEALTH MGMT OPS	5-10	ONS	YES	AS REQUIRED
46-13	NFS (cont.)	NFS ENGINE HEALTH MGMT UMS	5-10	ONS	YES	AS REQUIRED
46-13	NFS (cont.)	NFS OMF UMS	5-10	ONS	YES	AS REQUIRED
49-61	AUXILIARY POWER UNIT (APU)	APU ECU OPS	2-3	ONS, PDL, PMAT	YES	AS REQUIRED
73-21	ELECTRONIC ENGINE CONTROL (EEC)	EEC OPS	3-5	ONS	YES	AS REQUIRED
73-21	EEC (cont.)	EEC EHM	1-3	ONS	YES	AS REQUIRED

*[1] The ONS supports multi-part loads. For example, when you load a single part, this is approximately 5-6 minutes, but when you load multiple parts, this is approximately 10 minutes. The times that show are not intended to show time per software part.

*[2] Multiple systems on the airplane have front panel access for data loading, but not all of them show here. The supplier gives software for LRU front panel data loads directly to the operator. Therefore, The Boeing Company does not have copies of this software, generally does not have software part numbers or part names, and Boeing typically does not install this software.

(7) The Onboard Data Load Function (ODLF) process requires that:

- (a) You have all necessary software.
- (b) The airplane is on the ground with external, electrical power.
- (c) All circuit breakers to power up the loaded LRU and the Data Loader are closed.
- (d) If necessary, the upper and lower selector switches on the P61 Data Loader Control Panel are set to the correct position.
- (e) You start the data load with the applicable data loader (ONS, PMAT, PDL, PMD, etc.)

(8) Optional Portable Data Loaders (PDL)

- (a) An optional PDL has a cable that is connected to the optional Portable Data Loader port on the Maintenance BITE Panel at the P61 panel. The circuit breaker that supplies power for the PDL must be open when a PDL is connected or disconnected.
- (b) The PDL and the PDL Port are optional. The PDL is not a Boeing supplied parts. Refer to the data loader supplier for instructions for PDL operation.

NOTE: Modern software loaders that meet the security requirements defined in ARINC 645-1 are recommended to be used. Check with your software loader supplier for current capabilities of the equipment you have.

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- (9) SEL CONFIG prompt on CDU
 - (a) The SEL CONFIG prompt shows on the INIT/REF INDEX page on the FMCS control display unit (CDU).
 - (b) The SEL CONFIG page will show software part numbers for some systems. For example, the flight data acquisition unit (FDAU) will show software part numbers when selected.
 - (c) To show software part numbers, first set the data loader control panel to the applicable system. Then push the line select key adjacent to SEL CONFIG.
 - 1) If the configuration supports this page, then software part numbers will show for the selected system.
 - 2) If the configuration does not support the SEL CONFIG function or if the selected system is not operational, then the selected page will be blank.
 - 3) The selected system controls the format of the SEL CONFIG page.
- (10) For ATA LRUs that report to ONS, the Onboard Maintenance Function (OMF) shows software part numbers.
 - (a) When you use the PMD or the Multifunction Display (MFD), select the Onboard Maintenance function.
 - (b) Then, make the Line Maintenance function selection.
 - (c) Select the System Configuration option.
 - (d) Select the ATA and the specific system LRU and then select Continue.
 - (e) Wait for ONS to query the target system and to show the current configuration.

B. Software Installation

SUBTASK 20-15-11-470-001

- (1) See the table above and go to the applicable AMM chapter-section for the specific LRU and applicable software installation method.
 - (a) To find your software configuration check, see the table above and then go to the applicable chapter-section in the AMM.
 - (b) You know that the correct software is installed if the correct software part number shows when you do the software configuration check.

————— **END OF TASK** —————

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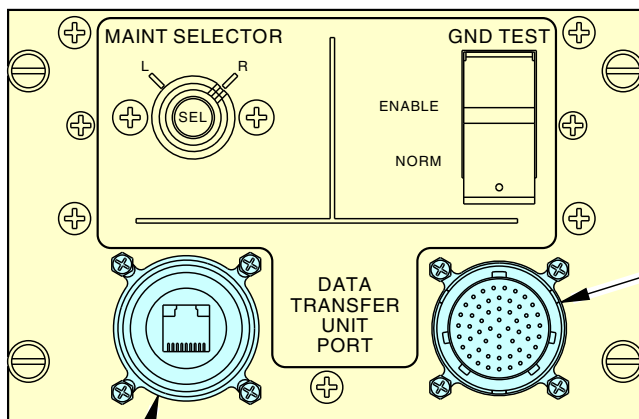
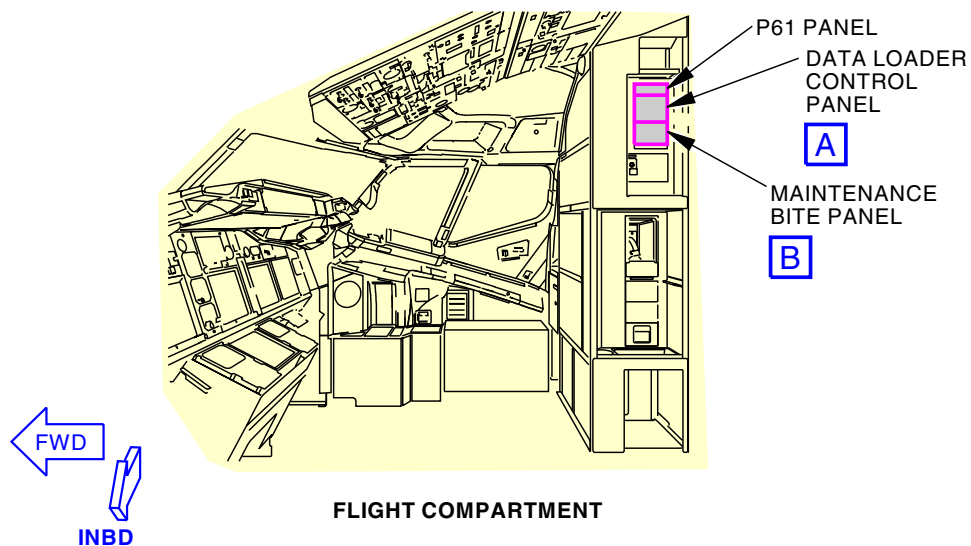
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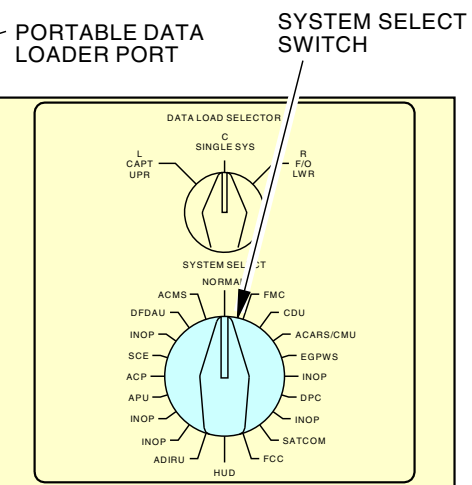


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MAINTENANCE BITE PANEL (EXAMPLE)

[B]



DATA LOADER CONTROL PANEL (EXAMPLE)

[A]

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On-Airplane Software Installation
Figure 201/20-15-11-990-801

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SELF-LUBRICATING BEARINGS AND BUSHINGS - INSPECTION/CHECK

1. General

A. This procedure has these tasks:

- (1) An inspection/check of self-lubricated bearings and bushings.
- (2) An inspection/check of special bushing and bearing configurations.
 - (a) Special bushings and bearings are those with holes, keyways, flanges, threads, or other special properties.

TASK 20-20-21-210-801

2. Bearing and Bushings - Inspection/Check

A. Procedure - Check of Self-Lubricated Bearings and Bushings

SUBTASK 20-20-21-210-001



LUBRICATE ONLY THE COMPONENTS THAT HAVE LUBRICATION FITTINGS. DO NOT LUBRICATE TEFLON BEARINGS AND BUSHINGS. LUBRICANTS CAUSE DAMAGE TO THE TEFLON, AND DECREASE THE LIFE OF THE BEARINGS.

- (1) Examine the bearings or bushings to make sure they are not too worn or too loose as follows:

NOTE: If you find more than 0.010 in. (0.25 mm) internal diametrical play, you must carefully examine the bearing or bushing. Reject a bearing that has signs of galling of the bearing surfaces. If there is play but not galling, then examine the parts for a failure condition given at each maintenance inspection. These bearings and bushing do not always have noise when they are loose.

- (a) Try to move and turn the assembly to make sure the bearing or bushing is not too worn.
- (b) Make sure the bearing is not loosely held by its housing or turns in its housing.
- (c) Make sure there is not damage, cracks or too much corrosion on the bearing or housing

SUBTASK 20-20-21-210-002

- (2) If you can turn the bearing, or if removal of bolts permits you to turn the bearing, do the steps that follow:

NOTE: If you can see the lining after bolt removal, refer to the bench check instructions and examine the lining material.

- (a) Turn the bearing without a load on the bearing.
 - 1) Make sure it is not too worn, is rough, or has too much drag.
- (b) Turn the bearing while you apply a load.
 - 1) Make sure it is not too worn, is rough, or has too much drag.

SUBTASK 20-20-21-210-003

- (3) Examine the bearings and bushings to make sure there is not lining material that comes out of the housing too far.

NOTE: Some bushings and bearings have some lining material that comes out a small distance when they are made. These bearing and bushings can be serviceable.

————— **END OF TASK** —————

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TASK 20-20-21-210-802

3. Special Bearing and Bushing Configuration - Inspection/Check

A. Procedure - Special Bearing and Bushing Configurations - Check

SUBTASK 20-20-21-210-004

- (1) Examine aluminum bearing races for serviceable surface treatment or plating, and for corrosion and cracks.

SUBTASK 20-20-21-210-005

- (2) Examine special configurations bearings with threads, holes, keyways, flanges, or equivalent properties for cracks in these areas.

NOTE: These special configurations can cause stress risers in these areas.

SUBTASK 20-20-21-210-006

- (3) Do this task: Bearing and Bushings - Inspection/Check, TASK 20-20-21-210-801.

————— END OF TASK —————

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CONTROL CABLES - INSPECTION/CHECK

1. General

- A. This procedure has these tasks:
 - (1) An inspection of the control cables wire rope
 - (2) An inspection of the control cable fittings
 - (3) An inspection of the pulleys
- B. These three tasks may be performed concurrently to one location of the control cable system on the airplane if desired for convenience.
- C. Use these procedures to verify the integrity of the control cable system.
- D. The procedures must be performed along the entire cable run in each system.
- E. To ensure verification of the portions of the cables that are in contact with pulleys and quadrants, the control cables must be moved by operation of the applicable system's controls to expose those portions of the cables.
- F. This procedure gives the inspections for control cables. If the inspections for specified control cables are different from these inspections, use the inspections for the specified control cables.
- G. Control cables are made of strands of thin wires. Each strand is one unit of hard steel. Thus, if one strand is broken, the control cable is not fully weak.
- H. Control cable type and construction are identified by two numbers. The first number is the number of strands. The second number is the number of wires in a strand. For example, a 7x7 flexible cable has seven strands, each of which has seven wires. The more strands a cable has, the more flexible it is. Thus, use 7x7 and 7x19 cables when cables go through pulleys or when you must bend the wires.
- I. Wires break most frequently where cables go through fairleads or around pulleys. Examine these areas carefully.

TASK 20-20-31-200-801

2. Inspection of the Control Cable Wire Rope

(Figure 601)

NOTE: This procedure is a scheduled maintenance task.

A. References

Reference	Title
12-26-00-600-801	Control Cable Lubrication (P/B 301)

B. Prepare for the Inspection

SUBTASK 20-20-31-100-001



DO NOT APPLY SOLVENTS, GREASE, OR OIL TO STAINLESS STEEL CONTROL CABLES. THESE MATERIALS CAN COLLECT CONTAMINATION THAT CAN CAUSE DAMAGE TO THE INTERNAL SURFACES OF THE CRES CABLE STRANDS. THIS CAN DECREASE THE SERVICE LIFE OF THE CABLE.

- (1) Clean the cables (as necessary) for the inspection (TASK 12-26-00-600-801).

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SUBTASK 20-20-31-200-001

- (2) Perform a detailed visual inspection to make sure that the cable does not contact parts other than pulleys, quadrants, cable seals, or grommets installed to control cable routing.

NOTE: The minimum cable clearance from other parts is 0.20 in. (5.1 mm), except 0.10 in. (2.5 mm) within 10 in. (254 mm) of a pulley or quadrant.

- (a) Look for evidence of contact with other parts. Correct the condition if evidence of contact is found.

C. Control Cable Runs Inspection

SUBTASK 20-20-31-200-002

- (1) Replace the cable assembly if:

- (a) A wear pattern exists where the individual wires in a strand appear to blend together (outer wires worn by more than 40 percent) (Figure 601).
- (b) If a kink is found.
- (c) If corrosion is found.

D. Control Cable Wire Rope Inspection

NOTE: Most cables are identified by the manufacturer using a color tracer filament or thread per MIL-83420H. The condition of the colored nonmetallic threads within a control cable does not affect the performance or strength of the cable.

NOTE: To do a check for broken wires, rub a cloth along the cable. The cloth will catch on any broken wires

SUBTASK 20-20-31-160-001

- (1) Replace the 7X7 cable assembly if:

- (a) There are two or more broken wires in 12 in. (305 mm) of continuous cable.
- (b) There are three or more broken wires anywhere in the total cable assembly.

SUBTASK 20-20-31-200-003

- (2) Replace the 7X19 cable assembly if:

- (a) There are four or more broken wires in 12 in. (305 mm) of continuous cable.
- (b) There are six or more broken wires anywhere in the total cable assembly.

SUBTASK 20-20-31-210-001

- (3) Inspect the carbon steel control cable lubrication.

- (a) If the cable shows signs of damage, rub a cloth along the cable to find the broken wires.

NOTE: The cloth will catch on broken wires.

- (b) Make sure that there is sufficient lubrication on the control cable.

- (c) If the lubrication is not sufficient, do this task: Control Cable Lubrication, TASK 12-26-00-600-801.

NOTE: Do not apply the grease or oil to the stainless steel (CRES) control cables.

————— END OF TASK —————

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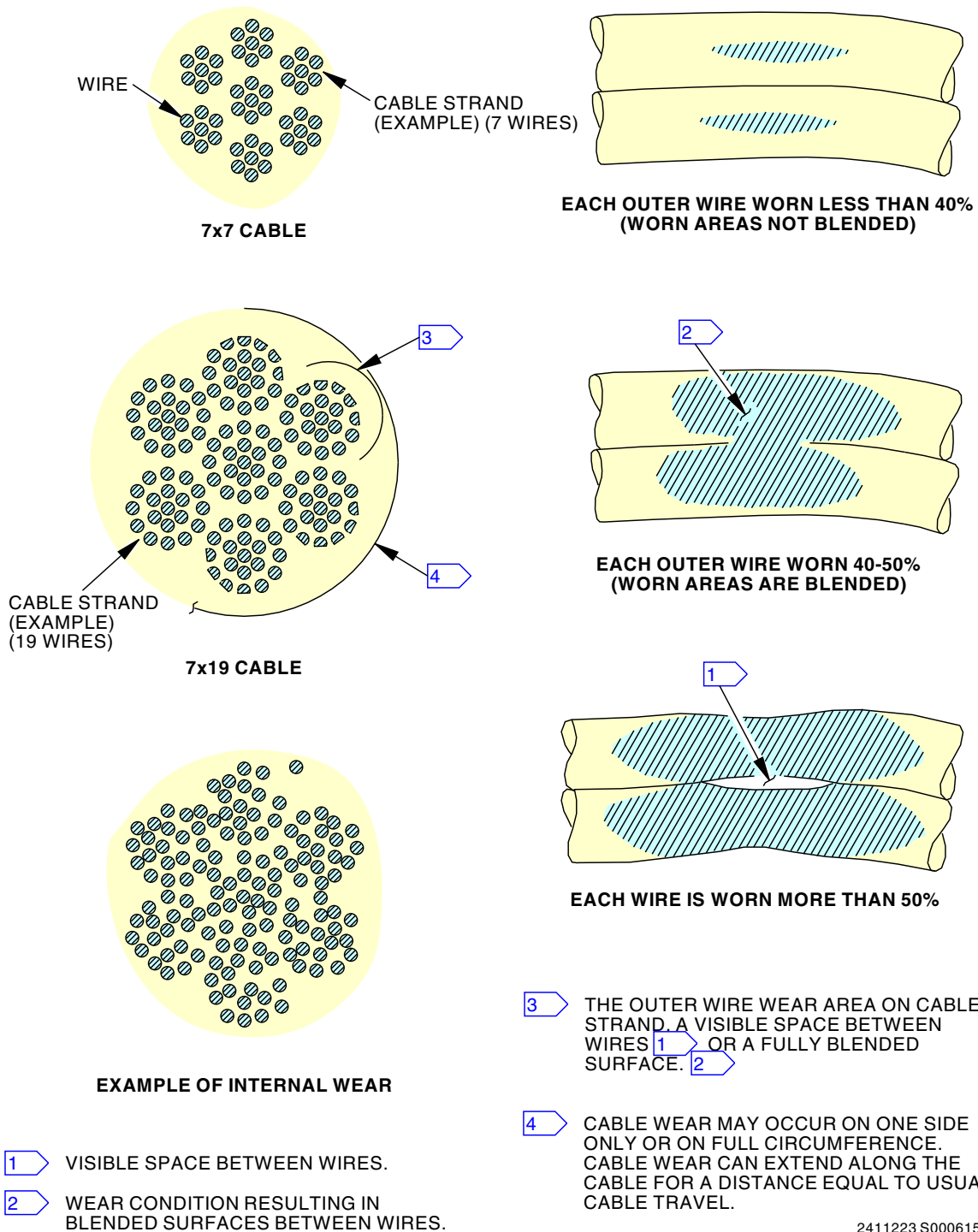
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Cable Wear Patterns
Figure 601/20-20-31-990-801

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TASK 20-20-31-200-802

3. Inspection of the Control Cable Fittings

NOTE: This procedure is a scheduled maintenance task.

A. Procedure

SUBTASK 20-20-31-200-004

- (1) Perform a detailed visual inspection to make sure that the means of locking the joints are intact (wire locking, cotter pins, turnbuckle clips, etc.).
 - (a) Install any missing parts.

SUBTASK 20-20-31-200-005

- (2) Perform a detailed inspection of the swaged portions of swaged end fittings for surface cracks or corrosion.
 - (a) Replace the cable assembly if cracks or corrosion are found.

SUBTASK 20-20-31-200-006

- (3) Perform a detailed visual inspection of the unswaged portion of the end fitting.
 - (a) Replace the cable assembly if a crack is found, if corrosion is present, or if the end fitting is bent more than 2 degrees.

SUBTASK 20-20-31-200-007

- (4) Perform a detailed visual inspection of the turnbuckle.
 - (a) Replace the turnbuckle if a crack is visible or if corrosion is present.

————— **END OF TASK** —————

TASK 20-20-31-200-803

4. Inspection of Pulleys

NOTE: This procedure is a scheduled maintenance task.

A. Procedure

SUBTASK 20-20-31-200-008

- (1) Perform a detailed visual inspection to make sure that pulleys are free to rotate.
 - (a) Replace pulleys which are not free to rotate.

SUBTASK 20-20-31-200-009

- (2) Perform a detailed visual inspection of the pulleys for conditions shown in Figure 602.
 - (a) Replace pulleys which are not in a normal condition.

————— **END OF TASK** —————

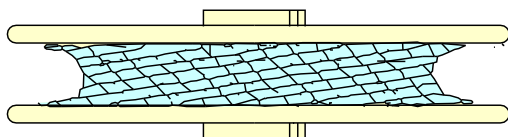
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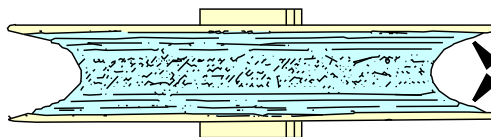
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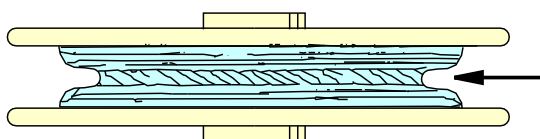
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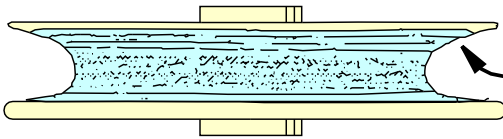
CABLE TENSION TOO HIGH



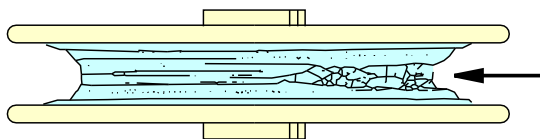
PULLEY NOT ALIGNED CORRECTLY



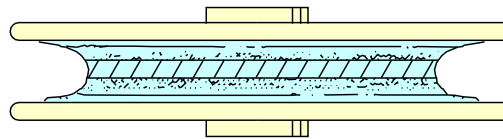
PULLEY GROOVE WITH
EXCESSIVE WEAR



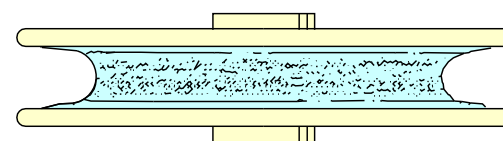
CABLE NOT ALIGNED CORRECTLY



PULLEY WILL NOT TURN



NORMAL CONDITION



NORMAL CONDITION

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Pulley Wear Patterns
Figure 602/20-20-31-990-802

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SPECIFICATIONS AND MATERIALS - MAINTENANCE PRACTICES

1. General

- A. This procedure contains this task:
- (1) Specifications and Materials

TASK 20-30-00-800-801

2. Specifications and Materials

A. **General**

- (1) Specifications and materials sections contain lists of consumable materials that can be necessary during regular maintenance of the airplane.
- (2) Whenever possible, consumable materials will be referenced in the Maintenance Manual by a material specification.
- (3) In the event a material is shown with no material specification, the material will be a specific vendor product or it will be commercially available.
- (4) For specific vendor information on a product, you should refer to the U-File or the IPC Specification Cross-reference Index. Or, you should refer to the qualified products list of the applicable material specification.
- (5) Material other than those listed can be tested using the procedures in Boeing document D6-17487, Certification Testing of Aircraft Maintenance Materials, to verify that any substitute material will not be injurious to airplane surfaces when used as specified by the manufacturer.

B. **References**

Reference	Title
20-30-11-910-801	Adhesives, Cements, and Sealants (P/B 201)

C. **Procedure**

SUBTASK 20-30-00-800-001

- (1) Use this task for information on airframe consumable materials:
 - (a) Adhesives, Cements, and Sealers (Adhesives, Cements, and Sealants, TASK 20-30-11-910-801).

————— END OF TASK —————

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ADHESIVES, CEMENTS, AND SEALANTS - MAINTENANCE PRACTICES

1. General

- A. This procedure lists adhesives, cements, and sealants for airplane maintenance. There are no procedural steps in this procedure.

TASK 20-30-11-910-801

2. Adhesives, Cements, and Sealants

A. General

- (1) The list of adhesives, cements, and sealers has been moved to the introduction section of the AMM.

Table 201/20-30-11-993-801 Permitted Substitutes for Initial Specified Sealant

Permitted Substitutes for Initial Specified Sealant								
Initial Specified Sealants	Permitted Alternate Sealants							
	BMS 5-45	BMS 5-63	BMS 5-95	BMS 5-142 ^{*[1]}	PR-1826 ^{*[2]}	PR-1828	BMS 5-150	BMS 5-168 ^{*[3]}
BMS 5-19	Yes	No	No	No	Yes	No	No	Yes
BMS 5-26	See Table 203	No	No	No	Yes	Yes	No	Yes
BMS 5-32	Yes	No	Yes	Yes	Yes	Yes	No	Yes
BMS 5-45	---	No	No	No	Yes	No	No	Yes
BMS 5-63	No	---	No	No	No	No	No	No
BMS 5-79	Yes	No	See Table 202	Yes	Yes	Yes	No	Yes
BMS 5-95	Yes ^{*[4]}	No	---	Yes	Yes	Yes	Yes (class B-2 only)	Yes ^{*[4]}
BMS 5-142	Yes	No	Yes	---	Yes	Yes	Yes	Yes
BMS 5-168	Yes	No	No	No	No	No	No	---

*[1] This alternative is not permitted for mating surface seal, pre-pack sealing, and wet fastener installation procedures.

*[2] This sealant has a primer that must also be used.

*[3] See Table 205

*[4] Substitution is not allowed for faying surface sealing of fuselage skin lap splices or door skin lap splices (a skin lap splice is a joint where one skin overlaps another skin and the two skins are fastened together at this overlap area). Substitution is not allowed for faying surface sealing common to any unprimed fuselage skin or door skin surface. Substitution is not allowed for faying surface sealing common to unprimed nacelle or pylon/strut box structure. Substitution is not allowed for wet fastener installation common to nacelle or pylon/strut box structure. Substitution is not allowed for landing gear components. Substitution is not applicable to usage per any of the BAC 5117-XX specifications. Substitution is not applicable to Class E sealant.

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Table 202/20-30-11-993-802 BMS 5-79 Sealant Alternatives

BMS 5-79 Sealant Alternatives	
Initial Material	Alternate Material
BMS 5-79	BMS 5-95
Class B-1/2	Class B-2
Class B-2	Class B-2
Class B-4	None
Class B-8	None
Class C-24	Class C-20
Class C-48	Class C-80
Class D-2	BMS 5-16

Table 203/20-30-11-993-803 BMS 5-26 Superseded by BMS 5-45

BMS 5-26, Types, Classes, Grade	Superseded by BMS 5-45, Classes, Grade
Type I, Class A-1/2, Grade 1	Class A-2, Grade 1 or Grade 2
Type I, Class A-2, Grade 1	Class A-2, Grade 1 or Grade 2
Type I, Class B-1/2	Class B-1/2
Type I, Class B-2	Class B-2
Type II, Class A-2, Grade 1	Class A-2, Grade 1
Type II, Class A-2, Grade 2	Class A-2, Grade 2
Type II, Class B-2	Class B-2
Type II, Class C-24	Class C-24
Type II, Class C-48	Class C-48
Type II, Class C-168	Class C-168

Table 204/20-30-11-993-804 BMS 5-95 Availability and Uses

BMS 5-95, Types, Classes	Availability, Uses
Type I	Available in Form B (bulk), Form K (kit), or Form P (mixed and frozen sealant (also known as Premixed and Frozen (PMF))).
Type II	Available in Form P (also known as Premixed and Frozen (PMF)) only. Superseded by Type I for future design and procurement.
Class B	For filleting, injection, and prepacking and faying surface applications.
Class C	For brush and faying surface sealing applications where a long squeeze-out life is required.
Class E	For spray application as a coating.

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Table 204/20-30-11-993-804 BMS 5-95 Availability and Uses (Continued)

BMS 5-95, Types, Classes	Availability, Uses
Class F	For spray application as a primer.
Class G	For spray, brush, or roller applications where long squeeze-out life and lower viscosity are required.

Table 205/20-30-11-993-805 Differences Between BMS 5-45 and BMS 5-168 Requirements

PROPERTIES	BMS5-45	BMS5-168 CLASS A-2, GRADE 1 AND CLASS B
Specific Gravity (maximum)		
Class A	1.65	1.60
Class B	1.30	1.40
Tack free time (maximum)		
Class A-2 Grade 1	36 h	8 h
Class B-2	12 h	8 h
Curing Rate (time to 30 Type A durometer hardness (maximum))		
Class A-2 Grade 1	72 h	8 h
Class B-2	24 h	8 h
Squeeze-out life		
Class B-2	6 h	4 h

— END OF TASK —

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AIRPLANE GROUNDING - MAINTENANCE PRACTICES

1. General

A. This procedure contains these tasks:

- (1) Static Grounding
- (2) Electrical Bonding
- (3) Measurement of Airplane Electrical Resistance to Ground

B. If operators choose not to do these recommended tasks, they should develop alternate procedures which adequately protect personnel and equipment. Local fire codes and customs may require alternative or additional procedures to those shown here.

TASK 20-40-11-910-801

2. Static Grounding

(Figure 201)

A. General

- (1) Static grounding is not necessary if the airplane is parked for turnaround flight and no maintenance is to be done.
- (2) During pressure refueling of the airplane:
 - (a) An electrical bond is necessary between the airplane and the refueling vehicle.
- (3) Static grounding is necessary when performing maintenance tasks using these devices:
 - (a) Power tools
 - (b) Electrical power sources
 - (c) Lights
 - (d) Powered instruments
 - (e) Flammable conditions (such as painting and solvent application)
- (4) When static grounding is necessary, connect the airplane to an identified and approved static ground point.



WARNING

THE EXTERNAL POWER PLUG MUST HAVE AN EARTH-GROUND. THE EARTH-GROUND MUST OPERATE CORRECTLY WHEN YOU USE THE EXTERNAL POWER PLUG TO STATICALLY GROUND THE AIRPLANE. IF YOU DO NOT STATICALLY GROUND THE AIRPLANE CORRECTLY, INJURY TO PERSONNEL AND DAMAGE TO EQUIPMENT CAN OCCUR.

- (a) If an approved static ground point is not available, the external power plug gives an alternative connection to static ground. The external power plug must have an earth-ground that is operating correctly.
- (5) Where a grid system is used, any number of individual grounds will provide a common ground, since all grounds are interconnected. If an area does not have a grid system, use a single approved and identified ground as the common ground for all grounding cables.



WARNING

ALL WORK AROUND THE AIRPLANE MUST STOP WHEN LIGHTNING OCCURS AT A DISTANCE OF 6 MILES (10 KILOMETERS) OR LESS. ALL PERSONNEL MUST GO IN A BUILDING OR THE AIRPLANE. LIGHTNING CAN KILL PERSONNEL OR CAUSE INJURY.

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(WARNING PRECEDES)

 WARNING	DO NOT CONNECT A HEADSET, OR TOUCH CONNECTIONS TO THE AIRPLANE WHEN THERE IS LIGHTNING, OR IN STRONG ELECTROMAGNETIC FIELDS. LIGHTNING, AND ELECTRICAL CURRENT CAN CAUSE INJURIES TO PERSONNEL.

- (6) Stop ground servicing operations, external to the airplane, during electrical storms.
- (7) The airplane is normally electrostatically grounded through conductive tires (Airplane Electrical Resistance to Ground Measurement, TASK 20-40-11-760-802). However, static grounding is necessary for:
 - (a) Airplanes having inadequate conductivity to ground through the tires.
 - (b) Airplanes on parking sites that have inadequate conductivity.

B. Location Zones

Zone	Area
731	Left Main Landing Gear - Outboard Door
741	Right Main Landing Gear - Outboard Door

C. Grounding Procedure:

SUBTASK 20-40-11-480-001

 WARNING	DO NOT CONNECT A HEADSET, OR TOUCH CONNECTIONS TO THE AIRPLANE WHEN THERE IS LIGHTNING, OR IN STRONG ELECTROMAGNETIC FIELDS. LIGHTNING, AND ELECTRICAL CURRENT CAN CAUSE INJURIES TO PERSONNEL.

 WARNING	ALWAYS ATTACH THE GROUNDING CABLE TO THE GROUND CONNECTION FIRST. DO NOT ATTACH THE CABLE TO THE AIRCRAFT AND THEN TO THE GROUND CONNECTION. THIS WILL PREVENT SHOCK AND INJURY TO THE PERSONNEL.

 CAUTION	ATTACH GROUNDING CABLES ONLY TO SPECIFIED POINTS ON THE AIRPLANE. INCORRECTLY ATTACHED GROUNDING CABLES CAN CAUSE SCRATCHES WHICH CAN CAUSE CORROSION AND CRACKS ON STRESSED PARTS.

- (1) Attach grounding cable to a ground and to the airplane in the following sequence:
 - (a) Connect the grounding cable to an approved, identified static ground point.
NOTE: These points may be located in the parking surface or in another fixed location.
 - (b) Connect the grounding cable to approved grounding attach point on the airplane (Figure 201).
 - 1) Connect the grounding cable to the jack pad during landing gear retraction tests. The jack pad must be completely installed and the grounding stud on it must be unpainted and free from oil.

SUBTASK 20-40-11-020-001

- (2) Before the airplane is moved, remove the ground cables in reverse sequence of attachment.

————— **END OF TASK** —————

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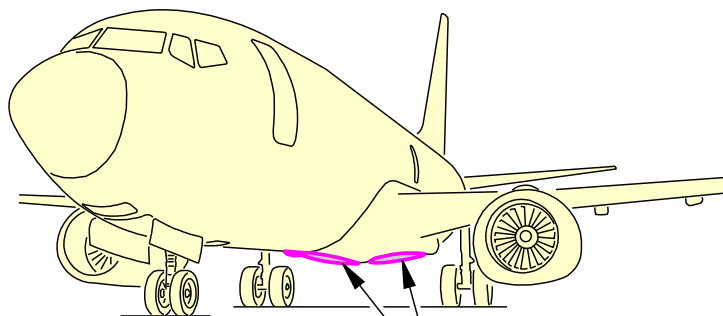
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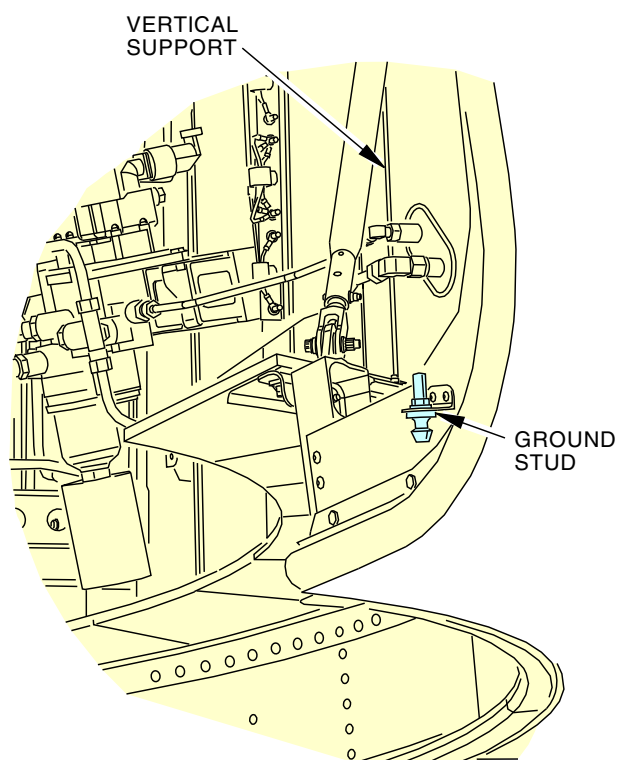


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MAIN WHEEL WELL
GROUND STUD
LOCATION

A



MAIN WHEEL WELL GROUND STUD
LOCATION

A

2411225 S00061527262_V1

Static Ground Point Location
Figure 201/20-40-11-990-801

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TASK 20-40-11-760-801

3. Electrical Bonding

A. Procedure:

SUBTASK 20-40-11-420-001



DO NOT CONNECT A HEADSET, OR TOUCH CONNECTIONS TO THE AIRPLANE WHEN THERE IS LIGHTNING, OR IN STRONG ELECTROMAGNETIC FIELDS. LIGHTNING, AND ELECTRICAL CURRENT CAN CAUSE INJURIES TO PERSONNEL.



ATTACH THE BONDING CABLES ONLY TO THE SPECIFIED POINTS ON THE AIRCRAFT. THE ATTACHED BONDING CABLES THAT ARE NOT CORRECTLY ATTACHED CAN CAUSE CORROSION AND CRACKS ON THE STRESSED PARTS. THE BOND WIRES ATTACHED TO THE DOORS OR THE FAIRINGS THAT ARE MADE FROM THE COMPOSITE MATERIALS DO NOT GIVE A GOOD BOND. THIS WILL PREVENT DAMAGE TO THE AIRCRAFT.

- (1) Connect a bonding cable to a known bonding or grounding point on the airplane.

SUBTASK 20-40-11-480-002

- (2) Connect the other end of the bonding cable to a known bonding or grounding point on the support equipment in use.

SUBTASK 20-40-11-020-002

- (3) Before the airplane is moved, remove the ground cables in the opposite sequence that you attached them.

————— END OF TASK —————

TASK 20-40-11-760-802

4. Airplane Electrical Resistance to Ground Measurement

A. References

Reference	Title
24-22-00-860-802	Remove Electrical Power (P/B 201)
24-41-11-200-804	External Power Receptacle Neutral Pin to Ground Continuity Check (P/B 601)
SWPM 20-02-10	Airplane Flammable Leakage Zones

B. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

Reference	Description
COM-6457	Meter - Insulation (Range: 1-1,000 VDC or equivalent, select meter per test requirements) Part #: 1864-9700 Supplier: 62015 Part #: 1865PLUS Supplier: 62015 Part #: 1865PLUSCE Supplier: 62015 Part #: 2471F Supplier: 21844 Opt Part #: 1865-00-CE Supplier: 62015

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C. Prepare for the Measurement

SUBTASK 20-40-11-840-001

- (1) Make sure that the airplane is not parked on painted surfaces.

SUBTASK 20-40-11-860-001

- (2) Do this task: External Power Receptacle Neutral Pin to Ground Continuity Check, TASK 24-41-11-200-804.

SUBTASK 20-40-11-000-001

- (3) Do this task: Remove Electrical Power, TASK 24-22-00-860-802.

SUBTASK 20-40-11-940-001



DO NOT USE A MEGOHMMETER NEAR A FUEL TANK VENT. IT CAN CAUSE AN EXPLOSION OR FIRE. FIRE AND EXPLOSIONS CAN CAUSE INJURIES TO PERSONNEL, AND DAMAGE TO EQUIPMENT.

- (4) Use these precautions for possible fuel vapors when you use a megohmmeter to measure the discharger resistance.
 - (a) Use an insulation meter, COM-6457, or equivalent meter, with a 500 VDC test voltage and a maximum 5 milliampere short circuit current.
 - (b) Do not use a megohmmeter at these locations:
 - 1) Area adjacent to or below a wing fuel tank vent, in a 5 ft (1.524 m) diameter column, from vent to ground.
 - 2) Area defined as a Flammable Leakage Zone in SWPM 20-02-10.
 - 3) Zero to 18 in. (457 mm) above the ground in the area around the airplane.
 - (c) Make sure that:
 - 1) Area is well ventilated.
 - 2) Metal work stands are grounded.
 - 3) Megohmmeter is plugged into a grounded receptacle.
 - 4) Megohmmeter is insulated from the metal work stand.

D. Airplane Electrical Resistance to Ground Measurement

SUBTASK 20-40-11-480-003

- (1) Connect an insulation meter, COM-6457, or equivalent, to a known bonding/ground point in the wheel well.

SUBTASK 20-40-11-480-004

- (2) Connect the other end of the insulation meter, COM-6457, or equivalent, to an identified ground point on the ramp.

SUBTASK 20-40-11-420-002

- (3) Set the insulation meter, COM-6457, or equivalent, to the 50 VDC range.

SUBTASK 20-40-11-970-001

- (4) Measure the resistance to ground and record the resistance in the maintenance log.

NOTE: The resistance should be less than 1.0 megohm. If the resistance is 1.0 megohm or more, this may be the result of a bad grounding location. There may be a very high surface resistance on the airplane.

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- (a) If the resistance is more than 1.0 megohm, tell the flight crews of subsequent flights in this airplane, the conductivity to ground is not sufficient through the tires to electrostatically ground this airplane on a parking surface.

NOTE: Positive ground procedures may apply.

SUBTASK 20-40-11-210-001

- (5) Make sure the airplane is not parked over painted surfaces.
 - (a) Make sure the tires have sufficient conductivity.

SUBTASK 20-40-11-970-002

- (6) Repeat the measurement at other parking site locations where successful measurements have been made.

NOTE: This will make sure the airplane has sufficient conductivity.

E. Put the Airplane Back to Its Usual Condition

SUBTASK 20-40-11-080-001

- (1) Disconnect the end of the insulation meter, COM-6457, or equivalent, from the ground point on the ramp.

SUBTASK 20-40-11-080-002

- (2) Disconnect the insulation meter, COM-6457, or equivalent, from the bonding/ground point in the wheel well.

———— **END OF TASK** ————

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ELECTROSTATIC DISCHARGE SENSITIVE (ESDS) DEVICES - MAINTENANCE PRACTICES

1. General

- A. This procedure has these tasks:
- (1) Wrist Strap continuity test.
 - (2) The ESDS handling for printed circuit board removal.
 - (3) The ESDS handling for printed circuit board installation.
 - (4) The ESDS handling for removal of metal encased units.
 - (5) The ESDS handling for installation of metal encased units.
 - (6) The installation of conductive dust caps and connector covers.
 - (7) The removal of conductive dust caps and connector covers.
- B. Many electronic line replaceable units (LRUs) contain micro-circuits and other sensitive devices which can be damaged internally by electrostatic discharges. These LRUs are identified as ESDS. The placards installed on the ESDS LRUs show that you must be careful. The persons who remove, install, and move the ESDS LRUs must know about static electricity and how to protect ESDS LRUs from static discharges.
- C. Electrostatic charges can be caused by these: human bodies, hair, clothing, floors, equipment racks, and equipment units. An electrostatic discharge is electrostatic energy transmitted between substances of different electrical potentials. Electrostatic discharges from nylon clothing or human hair onto polyethylene or steel can damage ESDS components. Damage to the internal components of an ESDS LRU can cause failure with one static discharge. System properties can change with time because of many static discharges.
- D. The function of this procedure is to show the maintenance persons how to handle the ESDS LRUs. This procedure contains the precautions that are necessary to safely touch the units that are identified by the ESDS placard. Three types of decals are used to identify the units with ESDS sensitive circuits. The military and commercial symbols are used on some units, while the international (JEDEC) symbol is used on most ESDS placards. The ESDS printed circuit boards that are LRU's are identified with a "STATIC SENSITIVE" placard (Figure 201).
- E. The placards on the outer area of the cardfiles show the cards that contain electrostatic sensitive devices.

TASK 20-40-12-820-801

2. Wrist Strap Continuity Test

A. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

Reference	Description
COM-1565	Wrist Strap - Adjustable, Conductive, Static Control
	Part #: 09070 Supplier: 62576
	Part #: 2214 Supplier: 62576
	Opt Part #: 14810 Supplier: 62576
	Opt Part #: 2211 Supplier: 55203
	Opt Part #: 2212 Supplier: 55203
	Opt Part #: 2213 Supplier: 55203

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Reference	Description
COM-1793	Multimeter - Digital/Analog (or equivalent meter meets task requirements) Part #: 117 Supplier: 89536 Part #: 260-8XPI Supplier: 55026 Part #: 287 Supplier: 89536 Part #: 289 Supplier: 89536 Part #: 87V Supplier: 89536 Part #: FLUKE 27 II Supplier: 89536 Part #: FLUKE-77-4 Supplier: 89536 Opt Part #: 187 Supplier: 89536 Opt Part #: 189 Supplier: 89536 Opt Part #: 21 Supplier: 89536 Opt Part #: 27 Supplier: 89536 Opt Part #: 77 SERIES III Supplier: 89536 Opt Part #: 87 Supplier: 89536 Opt Part #: FLUKE 27 Supplier: 89536 Opt Part #: MODEL 27 Supplier: 89536

B. Wrist Strap Continuity Test

SUBTASK 20-40-12-700-001

- (1) Connect the jack end of the static control wrist strap, COM-1565, into the ground or common receptacle of digital/analog multimeter, COM-1793.

SUBTASK 20-40-12-820-001

- (2) Adjust the digital/analog multimeter, COM-1793, to the applicable resistance range.

SUBTASK 20-40-12-820-002

- (3) Touch the red lead of digital/analog multimeter, COM-1793, to the resistor portion of static control wrist strap, COM-1565.
 - (a) Make sure the measured resistance is in the acceptable range from 250 kilohms to 1.5 megohms

SUBTASK 20-40-12-980-001

- (4) Put static control wrist strap, COM-1565, on the wrist of the person who will be handling the ESDS unit.

SUBTASK 20-40-12-820-003

- (5) Hold the red lead of digital/analog multimeter, COM-1793, between the person's forefinger and thumb.
 - (a) Make sure the measured resistance is in the acceptable range of less than 10 megohms

SUBTASK 20-40-12-080-001

- (6) Remove the jack end of the static control wrist strap, COM-1565, from the ground or common receptacle of digital/analog multimeter, COM-1793.

SUBTASK 20-40-12-090-001

- (7) Discard static control wrist strap, COM-1565, if it does not operate in the acceptable range.

————— **END OF TASK** —————

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TASK 20-40-12-000-801

3. **ESDS Handling for Printed Circuit Board Removal**

(Figure 201)

A. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

Reference	Description
COM-1565	Wrist Strap - Adjustable, Conductive, Static Control Part #: 09070 Supplier: 62576 Part #: 2214 Supplier: 62576 Opt Part #: 14810 Supplier: 62576 Opt Part #: 2211 Supplier: 55203 Opt Part #: 2212 Supplier: 55203 Opt Part #: 2213 Supplier: 55203
COM-1566	Bags - Conductive, Static Shielding Part #: 13020 Supplier: 63070 Part #: 13670 Supplier: 62576 Part #: 2100RX4X6 Supplier: 55203 Part #: 2120R6X7 Supplier: 55203 Part #: SCS 2121211 Supplier: 6Y703 Opt Part #: 2120R Supplier: 55203
COM-1567	Container - Conductive, Antistatic Part #: PCC-700-ADE Supplier: 62049 Opt Part #: 2217-12 Supplier: 9A807

B. ESDS Handling for Printed Circuit Board Removal

SUBTASK 20-40-12-860-001

- (1) Make sure you remove electrical power from the printed circuit board.

SUBTASK 20-40-12-750-001

 WARNING	USE A WRIST STRAP WITH A MINIMUM GROUNDING LEAD RESISTANCE OF 250 KILOHMS AND A MAXIMUM OF 1.5 MEGOHMS. USE OF A LOW RESISTANCE WRIST STRAP CAN CAUSE INJURY TO PERSONS IF A HIGH VOLTAGE SOURCE IS TOUCHED.

- (2) Do this task: Wrist Strap Continuity Test, TASK 20-40-12-820-801, to do a resistance test of the static control wrist strap, COM-1565:

 CAUTION	THE GROUNDING LEAD ON THE WRIST STRAP MUST TOUCH THE SKIN TO GIVE THE PROTECTION THAT IS NECESSARY. FAILURE TO USE THE WRIST STRAP CORRECTLY CAN CAUSE DAMAGE TO THE ESDS PRINTED CIRCUIT BOARDS.

- (a) Connect the static control wrist strap, COM-1565, to an applicable electrostatic ground jack of the card file.

SUBTASK 20-40-12-020-001

- (3) Remove the printed circuit board with the applicable removal task.

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SUBTASK 20-40-12-860-002

- (4) Put the printed circuit board in a static shielding bag, COM-1566, or antistatic conductive container, COM-1567, with an ESDS placard.

SUBTASK 20-40-12-860-003

 CAUTION	DO NOT USE STAPLES OR ADHESIVE TAPES TO CLOSE THE BAG OR CONTAINER. IF YOU DO NOT USE THE CORRECT MATERIAL TO CLOSE THE PACKING, DAMAGE CAN OCCUR TO THE PRINTED-CIRCUIT BOARD.

- (5) Use 100% cotton twine to close the antistatic conductive container, COM-1567.

NOTE: The static shielding bag, COM-1566, or antistatic conductive container, COM-1567, must be put in a rigid container to make sure it stays in a satisfactory condition.

SUBTASK 20-40-12-860-004

- (6) Do not remove the static control wrist strap, COM-1565, until you close the applicable access door.

————— **END OF TASK** —————

TASK 20-40-12-400-801

4. ESDS Handling for Printed Circuit Board Installation

(Figure 201)

A. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

Reference	Description
COM-1565	Wrist Strap - Adjustable, Conductive, Static Control Part #: 09070 Supplier: 62576 Part #: 2214 Supplier: 62576 Opt Part #: 14810 Supplier: 62576 Opt Part #: 2211 Supplier: 55203 Opt Part #: 2212 Supplier: 55203 Opt Part #: 2213 Supplier: 55203
COM-1566	Bags - Conductive, Static Shielding Part #: 13020 Supplier: 63070 Part #: 13670 Supplier: 62576 Part #: 2100RX4X6 Supplier: 55203 Part #: 2120R6X7 Supplier: 55203 Part #: SCS 2121211 Supplier: 6Y703 Opt Part #: 2120R Supplier: 55203
COM-1567	Container - Conductive, Antistatic Part #: PCC-700-ADE Supplier: 62049 Opt Part #: 2217-12 Supplier: 9A807

B. ESDS Handling for Printed Circuit Board Installation

SUBTASK 20-40-12-860-005

- (1) Make sure electrical power is removed from the printed circuit board.

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SUBTASK 20-40-12-750-002



WARNING

USE A WRIST STRAP WITH A MINIMUM GROUNDING LEAD RESISTANCE OF 250 KILOHMS AND A MAXIMUM OF 1.5 MEGOHMS. USE OF A LOW RESISTANCE WRIST STRAP CAN CAUSE INJURY TO PERSONS IF A HIGH VOLTAGE SOURCE IS TOUCHED.

- (2) Do this task: Wrist Strap Continuity Test, TASK 20-40-12-820-801, to do a resistance test of the static control wrist strap, COM-1565:



CAUTION

THE GROUNDING LEAD ON THE WRIST STRAP MUST TOUCH THE SKIN TO GIVE THE PROTECTION THAT IS NECESSARY. FAILURE TO USE THE WRIST STRAP CORRECTLY CAN CAUSE DAMAGE TO THE ESDS PRINTED CIRCUIT BOARDS.

- (a) Connect the static control wrist strap, COM-1565, to an applicable electrostatic ground jack of the card file.

SUBTASK 20-40-12-860-006

- (3) Remove the ESDS printed circuit board from the static shielding bag, COM-1566, or antistatic conductive container, COM-1567.

SUBTASK 20-40-12-860-007

- (4) Install the printed circuit board with the applicable installation procedure.

SUBTASK 20-40-12-860-008

- (5) Do not remove the static control wrist strap, COM-1565, until you close the applicable access door.

————— END OF TASK —————

TASK 20-40-12-000-802

5. ESDS Handling for Metal Encased Unit Removal

(Figure 201)

A. General

- (1) This task gives instructions to touch an ESDS metal encased unit during removal.

B. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

Reference	Description
COM-1565	Wrist Strap - Adjustable, Conductive, Static Control Part #: 09070 Supplier: 62576 Part #: 2214 Supplier: 62576 Opt Part #: 14810 Supplier: 62576 Opt Part #: 2211 Supplier: 55203 Opt Part #: 2212 Supplier: 55203 Opt Part #: 2213 Supplier: 55203

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Reference	Description
COM-1566	Bags - Conductive, Static Shielding Part #: 13020 Supplier: 63070 Part #: 13670 Supplier: 62576 Part #: 2100RX4X6 Supplier: 55203 Part #: 2120R6X7 Supplier: 55203 Part #: SCS 2121211 Supplier: 6Y703 Opt Part #: 2120R Supplier: 55203
COM-1567	Container - Conductive, Antistatic Part #: PCC-700-ADE Supplier: 62049 Opt Part #: 2217-12 Supplier: 9A807

C. ESDS Handling for Metal Encased Unit Removal

SUBTASK 20-40-12-860-009

- (1) Make sure you remove electrical power from the metal encased unit.

SUBTASK 20-40-12-750-003



USE A WRIST STRAP WITH A MINIMUM GROUNDING LEAD RESISTANCE OF 250 KILOHMS AND A MAXIMUM OF 1.5 MEGOHMS. USE OF A LOW RESISTANCE WRIST STRAP CAN CAUSE INJURY TO PERSONS IF A HIGH VOLTAGE SOURCE IS TOUCHED.

- (2) Do this task: Wrist Strap Continuity Test, TASK 20-40-12-820-801, to do a resistance test of the static control wrist strap, COM-1565:



PUT ON A WRIST STRAP THAT IS ATTACHED TO A GROUND BEFORE YOU MAKE ELECTRICAL CONNECTIONS TO AN ELECTRICAL EXPLOSIVE DEVICE. STATIC ELECTRICITY CAN CAUSE AN EXPLOSION.

- (a) Connect the static control wrist strap, COM-1565, on the wrist of the person that will remove the device.



THE GROUNDING LEAD ON THE WRIST STRAP MUST TOUCH THE SKIN TO GIVE THE PROTECTION THAT IS NECESSARY. FAILURE TO USE THE WRIST STRAP CORRECTLY CAN CAUSE DAMAGE TO THE ESDS PRINTED CIRCUIT BOARDS.

- (b) Connect the static control wrist strap, COM-1565, to an electrostatic ground jack on the E/E rack or to an unpainted surface of the primary structure.

SUBTASK 20-40-12-860-010

- (3) Remove the ESDS unit with the applicable removal task.

SUBTASK 20-40-12-420-001

- (4) Do this task: Conductive Dust Cap and Connector Cover Installation, TASK 20-40-12-400-803.

SUBTASK 20-40-12-860-011

- (5) Put the ESDS unit in the static shielding bag, COM-1566, or antistatic conductive container, COM-1567, with an ESDS placard.

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DO NOT USE STAPLES OR ADHESIVE TAPES TO CLOSE THE BAG OR CONTAINER. IF YOU DO NOT USE THE CORRECT MATERIAL TO CLOSE THE PACKING, DAMAGE CAN OCCUR TO THE PRINTED-CIRCUIT BOARD.

- (a) Use 100% cotton twine or ESDS/antistatic tape to close the static shielding bag, COM-1566, or antistatic conductive container, COM-1567.

NOTE: The static shielding bag, COM-1566, or antistatic conductive container, COM-1567 must be put in a rigid container to make sure it stays in a satisfactory condition.

SUBTASK 20-40-12-860-012

- (6) Remove the static control wrist strap, COM-1565.

————— **END OF TASK** —————

TASK 20-40-12-400-802

6. ESDS Handling for Metal Encased Unit Installation

(Figure 201)

A. General

- (1) This task gives instructions to touch an ESDS metal encased unit during installation.

B. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

Reference	Description
COM-1565	Wrist Strap - Adjustable, Conductive, Static Control Part #: 09070 Supplier: 62576 Part #: 2214 Supplier: 62576 Opt Part #: 14810 Supplier: 62576 Opt Part #: 2211 Supplier: 55203 Opt Part #: 2212 Supplier: 55203 Opt Part #: 2213 Supplier: 55203
COM-1566	Bags - Conductive, Static Shielding Part #: 13020 Supplier: 63070 Part #: 13670 Supplier: 62576 Part #: 2100RX4X6 Supplier: 55203 Part #: 2120R6X7 Supplier: 55203 Part #: SCS 2121211 Supplier: 6Y703 Opt Part #: 2120R Supplier: 55203
COM-1567	Container - Conductive, Antistatic Part #: PCC-700-ADE Supplier: 62049 Opt Part #: 2217-12 Supplier: 9A807

C. ESDS Handling for Metal Encased Unit Installation

SUBTASK 20-40-12-860-013

- (1) Make sure electrical power is removed from the metal encased unit.

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SUBTASK 20-40-12-750-004



WARNING

USE A WRIST STRAP WITH A MINIMUM GROUNDING LEAD RESISTANCE OF 250 KILOHMS AND A MAXIMUM OF 1.5 MEGOHMS. USE OF A LOW RESISTANCE WRIST STRAP CAN CAUSE INJURY TO PERSONS IF A HIGH VOLTAGE SOURCE IS TOUCHED.

- (2) Do this task: Wrist Strap Continuity Test, TASK 20-40-12-820-801, to do a resistance test of the static control wrist strap, COM-1565:



CAUTION

THE GROUNDING LEAD ON THE WRIST STRAP MUST TOUCH THE SKIN TO GIVE THE PROTECTION THAT IS NECESSARY. FAILURE TO USE THE WRIST STRAP CORRECTLY CAN CAUSE DAMAGE TO THE ESDS PRINTED CIRCUIT BOARDS.

- (a) Connect the static control wrist strap, COM-1565, to an electrostatic ground jack on the E/E rack or to an unpainted surface of the primary structure.

SUBTASK 20-40-12-000-001

- (3) Remove the ESDS unit from the static shielding bag, COM-1566, or antistatic conductive container, COM-1567.

SUBTASK 20-40-12-420-002

- (4) Do this task: Conductive Dust Cap and Connector Cover Removal, TASK 20-40-12-000-803.

SUBTASK 20-40-12-860-014

- (5) Install the ESDS unit with the applicable installation task.

SUBTASK 20-40-12-860-015

- (6) Remove the static control wrist strap, COM-1565.

————— END OF TASK —————

TASK 20-40-12-000-803

7. Conductive Dust Cap and Connector Cover Removal

(Figure 201)

A. Conductive Dust Cap and Connector Cover Removal

SUBTASK 20-40-12-020-002



CAUTION

DO NOT TOUCH THE CONDUCTOR PINS OR OTHER CONDUCTORS ON THE SMYD. IF YOU TOUCH THESE CONDUCTORS, ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE SMYD.

- (1) Remove all of the conductive dust caps and the connector covers from the unit to be installed.

SUBTASK 20-40-12-020-003

- (2) Install the ESDS unit with the applicable installation task.

————— END OF TASK —————

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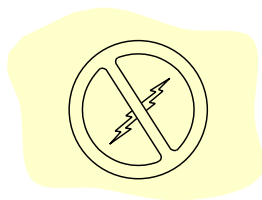
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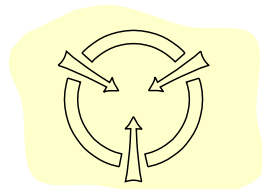
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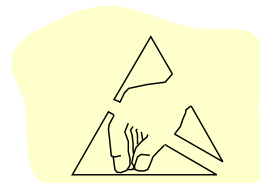
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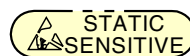
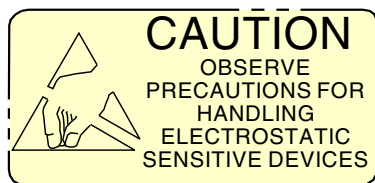
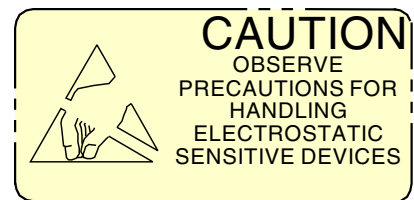
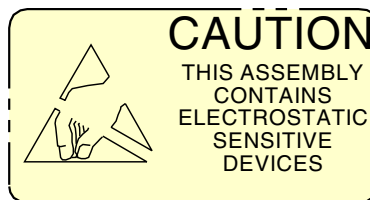
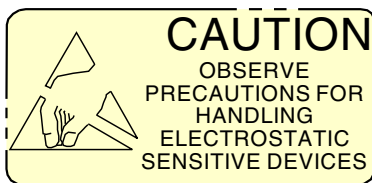


GOVERNMENT



INTERNATIONAL
(BOEING)

TYPES OF ESDS SYMBOLS



BOEING ESDS DECALS (EXAMPLE)

2411226 S00061527271_V1

Static Discharge Sensitive Devices Identifiers
Figure 201/20-40-12-990-801

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TASK 20-40-12-400-803

8. **Conductive Dust Cap and Connector Cover Installation**

(Figure 201, Table 201, Table 202)

A. **General**

- (1) Conductive dust caps and connector covers must be installed on the connectors of ESDS units when the units are removed.
- (2) Use ITT Cannon dust caps and connectors as applicable (stamped "CONDUCTIVE") (Table 201).

Table 201/20-40-12-993-801 ITT CANON Dust Caps and Connectors

PART NUMBER	MARKING ON CAP	CONNECTOR
025-1155-001	BKAD1-A&B-R	BKAD1-A-R BKAD1-B-R
025-1156-001 025-1157-001	BKAD1-C-R BKAD2&3-A&B-R	BKAD2-A-R BKAD2-B-R BKAD3-A-R BKAD3-B-R
025-1158-001	BKAD2&3-C-R	BKAD2-C-R BKAD3-C-R

- (3) Use Souriau dust caps and connectors as applicable (Table 202).

Table 202/20-40-12-993-802 SOURIAU Dust Caps and Connectors

PART NUMBER	TYPE CONNECTOR	SHELL SIZE
8660-1404	Power	1
8660-1405	Signal	1
8660-1406	Power	2 & 3
8660-1407	Signal	2 & 3

B. **Conductive Dust Cap and Connector Cover Installation**

SUBTASK 20-40-12-420-003

 CAUTION	DO NOT TOUCH THE CONDUCTOR PINS OR OTHER CONDUCTORS ON THE SMYD. IF YOU TOUCH THESE CONDUCTORS, ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE SMYD.

- (1) Remove the ESDS unit as shown in the applicable removal procedure.

NOTE: Make sure a static sensitive placard is installed adjacent to the electrical connector(s).

SUBTASK 20-40-12-420-004

- (2) Install conductive dust covers on the connectors with a static sensitive placard and standard dust covers on the connectors that do not have the placard.

NOTE: The conductive dust caps and the connector covers are black in color. The conductive dust caps and the connector covers from the installed unit can be used on the removed unit. Conductive bags can be used as an alternate to conductive dust caps and covers.

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SUBTASK 20-40-12-860-016

- (3) Move the unit, as shown in the applicable procedure, with the conductive dust caps and connector covers installed.

———— **END OF TASK** ————

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STANDARD TORQUE VALUES - MAINTENANCE PRACTICES

1. General

A. This procedure has one task:

- (1) Standard Torque Values

TASK 20-50-11-910-801

2. Standard Torque Values

A. **General**

- (1) If the fastener torque value and the nut torque value are different, use the torque range that has the lowest maximum value.

NOTE: Boeing specifications SOPM 20-50-01 and BAC 5009 for bolt installation allows substitution of bolt grip length to account for part tolerance variations and hardware availability.

- (2) Lubrication

- (a) If one of the compounds that follow is applied to the fastener, use the torque value for "lubed fastener."

- 1) BMS3-33 grease, D00633
- 2) BMS3-38 corrosion inhibiting material, G50136
- 3) MIL-PRF-23827 Grease grease, D00013
- 4) MIL-PRF-46010 lubricant, D00110
- 5) Bostik Never Seez Pure Nickel Special Never Seez NSBT, D50237
- 6) Cetyl Alcohol lubricant, D50197
- 7) Dry Film Lubricant or Solid Film Lubricant

- (3) Fastener and nut combination rotating member:

- (a) If the torque is applied to the fastener head, and the joint is fay-sealed or not fay-sealed, then use the torque value in the column labeled "TURN THE FASTENER HEAD AND/OR FAY SEAL".
- (b) If the torque is applied to the nut, and the joint is fay-sealed, then use the torque value in the column labeled "TURN THE FASTENER HEAD AND/OR FAY SEAL".
- (c) If torque is applied to the nut, and the joint is not fay-sealed, then use the torque value in the column labeled "TURN THE NUT AND NO FAY SEAL".

B. **Consumable Materials**

Reference	Description	Specification
C00308	Compound - Corrosion Preventive, Petrolatum Hot Application	MIL-C-11796
D00010	Compound - Thread Antiseize, High Temperature	MIL-PRF-907
D00013	Grease - Aircraft And Instrument Grease	MIL-PRF-23827 (NATO G-354) (Supersedes MIL-G-23827)
D00110	Lubricant - Solid Film, Heat Cured, Corrosion Inhibiting	MIL-PRF-46010
D00633	Grease - Aircraft General Purpose	BMS3-33

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(Continued)

Reference	Description	Specification
D50197	Lubricant - Cetyl Alcohol	SAE AS87132 (Supersedes MIL-L-87132)
D50237	Compound - Antiseize, Pure Nickel Special - Never Seez NSBT	BAC5008
G50136	Compound - Corrosion Inhibiting, Non-drying Paste	BMS3-38

C. Standard Fastener Installation

SUBTASK 20-50-11-420-001

- (1) Tighten the bolt, nut, fitting, clamps, or connector (Figure 201, Table 201, Table 202, Table 203, Table 204, Table 205, Table 206, Table 207, Table 208, Table 209, Table 210, Table 211, Table 212, Table 213, Table 214, Figure 202).
 - (a) Lubricate the threads with one of these materials if required:
 - 1) corrosion preventive compound, C00308.
 - 2) grease, D00013.
 - 3) compound, D00010.
 - (b) Tighten the bolts, nuts, fitting, clamps, or connectors to the correct torque.
 - (c) Make sure that one male tread (minimum), plus the chamfer of the male tread, extends above the top of the nut.

NOTE: If the male thread does not have a chamfer, the male thread must extend one and one-half treads (minimum) above the top of the nut.

SUBTASK 20-50-11-420-002

- (2) Tighten the nut or fastener which install in composite and plastic materials and structures, and their combinations with metal structures (Table 227, Table 228, Table 229, Table 230, Table 231, Table 232, Table 233, Table 234, Table 235, Table 236, Table 237).
 - (a) Make sure that the structural members are aligned prior to fastener installation to prevent scraping the fastener threads or damage to the hole.
 - (b) Nuts are lubricated by the manufacturer.
 - 1) Do not degrease or lubricate fasteners or nuts unless specified on the Engineering drawing.
 - (c) Nuts must not engage the first incomplete thread next to the bolt shank.
 - (d) All nut threads must be engaged.
 - 1) The complete chamfer on the end of the fastener must protrude above the nut.

D. Torque Tables

SUBTASK 20-50-11-580-001

- (1) Refer to the figures and tables that follow for the torque data:
 - (a) Torque Wrench Adapter, Figure 201.
 - (b) Nuts and Bolts, Table 201, Table 202, Table 203, Table 204, Table 205, Table 206, Table 207, Table 208, Table 209, Table 210, Table 211, Table 212, Table 213, and Table 214.

NOTE: These tables are applicable to install fasteners and nuts in a metal structure.

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Table 201/20-50-11-993-801 220 KSI TENSION FASTENERS AND NUTS (EXCEPT BACB31G)

FASTENER CLASS	220 KSI			
FASTENER PART NUMBER	BACB30MT, BACB30TR, BACB30NH, BACB30US, BACS21EK			
NUT PART NUMBER	BACN10HC, BACN10HR, BACN10JG, BACN10YN, BACN11X			
NOMINAL THREAD SIZE	DRY FASTENERS		LUBED FASTENERS	
	TURN THE NUT AND NO FAY SEAL	TURN THE FASTENER HEAD AND/OR FAY SEAL	TURN THE NUT AND NO FAY SEAL	TURN THE FASTENER HEAD AND/OR FAY SEAL
0.1900-32	82 in-lb (9 N·m) to 88 in-lb (10 N·m)	97 in-lb (11 N·m) to 103 in-lb (12 N·m)	53 in-lb (6 N·m) to 57 in-lb (6 N·m)	58 in-lb (7 N·m) to 62 in-lb (7 N·m)
0.2500-28	107 in-lb (12 N·m) to 113 in-lb (13 N·m)	121 in-lb (14 N·m) to 129 in-lb (15 N·m)	73 in-lb (8 N·m) to 77 in-lb (9 N·m)	78 in-lb (9 N·m) to 82 in-lb (9 N·m)
0.3125-24	204 in-lb (23 N·m) to 216 in-lb (24 N·m)	243 in-lb (27 N·m) to 258 in-lb (29 N·m)	155 in-lb (18 N·m) to 165 in-lb (19 N·m)	175 in-lb (20 N·m) to 185 in-lb (21 N·m)
0.3750-24	388 in-lb (44 N·m) to 412 in-lb (47 N·m)	485 in-lb (55 N·m) to 515 in-lb (58 N·m)	291 in-lb (33 N·m) to 309 in-lb (35 N·m)	320 in-lb (36 N·m) to 340 in-lb (38 N·m)
0.4375-20	655 in-lb (74 N·m) to 695 in-lb (79 N·m)	815 in-lb (92 N·m) to 865 in-lb (98 N·m)	388 in-lb (44 N·m) to 412 in-lb (47 N·m)	427 in-lb (48 N·m) to 453 in-lb (51 N·m)
0.5000-20	1067 in-lb (121 N·m) to 1133 in-lb (128 N·m)	1261 in-lb (142 N·m) to 1339 in-lb (151 N·m)	558 in-lb (63 N·m) to 592 in-lb (67 N·m)	631 in-lb (71 N·m) to 670 in-lb (76 N·m)
0.5625-18	1504 in-lb (170 N·m) to 1597 in-lb (180 N·m)	1746 in-lb (197 N·m) to 1854 in-lb (209 N·m)	873 in-lb (99 N·m) to 927 in-lb (105 N·m)	970 in-lb (110 N·m) to 1030 in-lb (116 N·m)
0.6250-18	2037 in-lb (230 N·m) to 2163 in-lb (244 N·m)	2231 in-lb (252 N·m) to 2369 in-lb (268 N·m)	1455 in-lb (164 N·m) to 1545 in-lb (175 N·m)	1601 in-lb (181 N·m) to 1700 in-lb (192 N·m)
0.7500-16	3686 in-lb (416 N·m) to 3914 in-lb (442 N·m)	4171 in-lb (471 N·m) to 4429 in-lb (500 N·m)	2959 in-lb (334 N·m) to 3142 in-lb (355 N·m)	3201 in-lb (362 N·m) to 3399 in-lb (384 N·m)
0.8750-14	5723 in-lb (647 N·m) to 6077 in-lb (687 N·m)	6499 in-lb (734 N·m) to 6901 in-lb (780 N·m)	4074 in-lb (460 N·m) to 4326 in-lb (489 N·m)	4365 in-lb (493 N·m) to 4635 in-lb (524 N·m)
1.0000-12 OR 1.0000-14	8682 in-lb (981 N·m) to 9219 in-lb (1042 N·m)	10,573 in-lb (1195 N·m) to 11,227 in-lb (1268 N·m)	6402 in-lb (723 N·m) to 6798 in-lb (768 N·m)	6790 in-lb (767 N·m) to 7210 in-lb (815 N·m)
1.1250-12	10,961 in-lb (1238 N·m) to 11,639 in-lb (1315 N·m)	12,610 in-lb (1425 N·m) to 13,390 in-lb (1513 N·m)	8585 in-lb (970 N·m) to 9116 in-lb (1030 N·m)	9118 in-lb (1030 N·m) to 9682 in-lb (1094 N·m)
1.2500-12	16,975 in-lb (1918 N·m) to 18,025 in-lb (2037 N·m)	18,624 in-lb (2104 N·m) to 19,776 in-lb (2234 N·m)	11,155 in-lb (1260 N·m) to 11,845 in-lb (1338 N·m)	11,640 in-lb (1315 N·m) to 12,360 in-lb (1396 N·m)

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Table 201/20-50-11-993-801 220 KSI TENSION FASTENERS AND NUTS (EXCEPT BACB31G) (Continued)

FASTENER CLASS	220 KSI			
1.3750-12	21,340 in-lb (2411 N·m) to 22,660 in-lb (2560 N·m)	23,280 in-lb (2630 N·m) to 24,720 in-lb (2793 N·m)	16,005 in-lb (1808 N·m) to 16,995 in-lb (1920 N·m)	16,490 in-lb (1863 N·m) to 17,510 in-lb (1978 N·m)

Table 202/20-50-11-993-802 BACB31G

FASTENER CLASS	220 KSI			
FASTENER PART NUMBER OR STYLE	BACB31G			
NOMINAL THREAD SIZE	DRY FASTENER		LUBED FASTENER	
	TURN THE NUT AND NO FAY SEAL	TURN THE FASTENER HEAD OR FAY SEAL	TURN THE NUT AND NO FAY SEAL	TURN THE FASTENER HEAD OR FAY SEAL
0.1900-32	82 in-lb (9 N·m) to 88 in-lb (10 N·m)	97 in-lb (11 N·m) to 103 in-lb (12 N·m)	53 in-lb (6 N·m) to 57 in-lb (6 N·m)	58 in-lb (7 N·m) to 62 in-lb (7 N·m)
0.2500-28	107 in-lb (12 N·m) to 113 in-lb (13 N·m)	121 in-lb (14 N·m) to 129 in-lb (15 N·m)	73 in-lb (8 N·m) to 77 in-lb (9 N·m)	78 in-lb (9 N·m) to 82 in-lb (9 N·m)
0.3125-24	204 in-lb (23 N·m) to 216 in-lb (24 N·m)	243 in-lb (27 N·m) to 258 in-lb (29 N·m)	155 in-lb (18 N·m) to 165 in-lb (19 N·m)	175 in-lb (20 N·m) to 185 in-lb (21 N·m)
0.3750-24	388 in-lb (44 N·m) to 412 in-lb (47 N·m)	485 in-lb (55 N·m) to 515 in-lb (58 N·m)	291 in-lb (33 N·m) to 309 in-lb (35 N·m)	320 in-lb (36 N·m) to 340 in-lb (38 N·m)
0.4375-20	514 in-lb (58 N·m) to 546 in-lb (62 N·m)	669 in-lb (76 N·m) to 711 in-lb (80 N·m)	340 in-lb (38 N·m) to 361 in-lb (41 N·m)	412 in-lb (47 N·m) to 438 in-lb (49 N·m)
0.5000-20	825 in-lb (93 N·m) to 876 in-lb (99 N·m)	1038 in-lb (117 N·m) to 1102 in-lb (125 N·m)	529 in-lb (60 N·m) to 561 in-lb (63 N·m)	631 in-lb (71 N·m) to 670 in-lb (76 N·m)
0.5625-18	1213 in-lb (137 N·m) to 1288 in-lb (146 N·m)	1426 in-lb (161 N·m) to 1514 in-lb (171 N·m)	786 in-lb (89 N·m) to 834 in-lb (94 N·m)	892 in-lb (101 N·m) to 948 in-lb (107 N·m)
0.6250-18	1601 in-lb (181 N·m) to 1700 in-lb (192 N·m)	1843 in-lb (208 N·m) to 1957 in-lb (221 N·m)	1067 in-lb (121 N·m) to 1133 in-lb (128 N·m)	1164 in-lb (132 N·m) to 1236 in-lb (140 N·m)
0.7500-16	2862 in-lb (323 N·m) to 3039 in-lb (343 N·m)	3395 in-lb (384 N·m) to 3605 in-lb (407 N·m)	1892 in-lb (214 N·m) to 2009 in-lb (227 N·m)	2086 in-lb (236 N·m) to 2215 in-lb (250 N·m)

Table 203/20-50-11-993-803 160-200 KSI TENSION FASTENERS, NUTS, NUTPLATES

FASTENER CLASS	160-200 KSI
FASTENER MATERIAL	STEEL/CRES
FASTENER PART NUMBER	BACB30EM, BACB30FD, BACB30LE, BACB30LM, BACB30LN, BACB30LP, BACB30LR, BACB30LU, BACB30NE, BACB30PN, BACB30UG, BACB30ZF, MS20004-MS20024, NAS1216, NAS6603-NAS6620, NAS6703-NAS6720
NUT PART NUMBER	AS3485, AS3486, BACN10B, BACN10GW, BACN10JA, BACN10JB, BACN10RM, BACN11W, BACN11Z, BACN10ZC, NAS1804, NAS1805, NAS577

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Table 203/20-50-11-993-803 160-200 KSI TENSION FASTENERS, NUTS, NUTPLATES (Continued)

FASTENER CLASS	160-200 KSI			
NOMINAL THREAD SIZE	DRY FASTENERS		LUBED FASTENERS	
	TURN THE NUT AND NO FAY SEAL	TURN THE FASTENER HEAD AND/OR FAY SEAL	TURN THE NUT AND NO FAY SEAL	TURN THE FASTENER HEAD AND/OR FAY SEAL
0.1120-40 OR 0.1120-48	8 in-lb (1 N·m)	8 in-lb (1 N·m)	6 in-lb (1 N·m)	6 in-lb (1 N·m)
0.1380-32 OR 0.1380-40	15 in-lb (2 N·m)	15 in-lb (2 N·m)	12 in-lb (1 N·m)	12 in-lb (1 N·m)
0.1640-32 OR 0.1640-36	19 in-lb (2 N·m) to 21 in-lb (2 N·m)	19 in-lb (2 N·m) to 21 in-lb (2 N·m)	15 in-lb (2 N·m)	15 in-lb (2 N·m)
0.1900-32	34 in-lb (4 N·m) to 36 in-lb (4 N·m)	34 in-lb (4 N·m) to 36 in-lb (4 N·m)	24 in-lb (3 N·m) to 26 in-lb (3 N·m)	24 in-lb (3 N·m) to 26 in-lb (3 N·m)
0.2500-28	82 in-lb (9 N·m) to 88 in-lb (10 N·m)	97 in-lb (11 N·m) to 103 in-lb (12 N·m)	63 in-lb (7 N·m) to 67 in-lb (8 N·m)	73 in-lb (8 N·m) to 77 in-lb (9 N·m)
0.3125-24	165 in-lb (19 N·m) to 175 in-lb (20 N·m)	194 in-lb (22 N·m) to 206 in-lb (23 N·m)	107 in-lb (12 N·m) to 113 in-lb (13 N·m)	121 in-lb (14 N·m) to 129 in-lb (15 N·m)
0.3750-24	310 in-lb (35 N·m) to 330 in-lb (37 N·m)	398 in-lb (45 N·m) to 422 in-lb (48 N·m)	194 in-lb (22 N·m) to 206 in-lb (23 N·m)	243 in-lb (27 N·m) to 258 in-lb (29 N·m)
0.4375-20	514 in-lb (58 N·m) to 546 in-lb (62 N·m)	669 in-lb (76 N·m) to 711 in-lb (80 N·m)	340 in-lb (38 N·m) to 361 in-lb (41 N·m)	412 in-lb (47 N·m) to 438 in-lb (49 N·m)
0.5000-20	825 in-lb (93 N·m) to 876 in-lb (99 N·m)	1038 in-lb (117 N·m) to 1102 in-lb (125 N·m)	529 in-lb (60 N·m) to 561 in-lb (63 N·m)	631 in-lb (71 N·m) to 670 in-lb (76 N·m)
0.5625-18	1213 in-lb (137 N·m) to 1288 in-lb (146 N·m)	1426 in-lb (161 N·m) to 1514 in-lb (171 N·m)	786 in-lb (89 N·m) to 834 in-lb (94 N·m)	892 in-lb (101 N·m) to 948 in-lb (107 N·m)
0.6250-18	1601 in-lb (181 N·m) to 1700 in-lb (192 N·m)	1843 in-lb (208 N·m) to 1957 in-lb (221 N·m)	1067 in-lb (121 N·m) to 1133 in-lb (128 N·m)	1164 in-lb (132 N·m) to 1236 in-lb (140 N·m)
0.7500-16	2862 in-lb (323 N·m) to 3039 in-lb (343 N·m)	3395 in-lb (384 N·m) to 3605 in-lb (407 N·m)	1892 in-lb (214 N·m) to 2009 in-lb (227 N·m)	2086 in-lb (236 N·m) to 2215 in-lb (250 N·m)
0.8750-14	4462 in-lb (504 N·m) to 4738 in-lb (535 N·m)	5335 in-lb (603 N·m) to 5665 in-lb (640 N·m)	2910 in-lb (329 N·m) to 3090 in-lb (349 N·m)	3298 in-lb (373 N·m) to 3502 in-lb (396 N·m)
1.0000-12 OR 1.0000-14	6790 in-lb (767 N·m) to 7210 in-lb (815 N·m)	8633 in-lb (975 N·m) to 9167 in-lb (1036 N·m)	4414 in-lb (499 N·m) to 4687 in-lb (530 N·m)	5335 in-lb (603 N·m) to 5665 in-lb (640 N·m)
1.1250-12	8536 in-lb (964 N·m) to 9064 in-lb (1024 N·m)	10,379 in-lb (1173 N·m) to 11,021 in-lb (1245 N·m)	5626 in-lb (636 N·m) to 5974 in-lb (675 N·m)	6499 in-lb (734 N·m) to 6901 in-lb (780 N·m)
1.2500-12	12,222 in-lb (1381 N·m) to 12,978 in-lb (1466 N·m)	15,229 in-lb (1721 N·m) to 16,171 in-lb (1827 N·m)	8342 in-lb (943 N·m) to 8858 in-lb (1001 N·m)	9409 in-lb (1063 N·m) to 9991 in-lb (1129 N·m)

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Table 204/20-50-11-993-804 160-200 KSI TITANIUM TENSION FASTENERS, NUTS, NUTPLATES

FASTENER CLASS	160-200 KSI			
FASTENER MATERIAL	TITANIUM			
FASTENER PART NUMBER	BACB30MR, BACB30MS, BACB30NM, BACB30NN, BACB30NS, BACB30XJ, BACB30XK, BACB30XL, BACB30XM, BACS21EJ, NAS1189, NAS6803-NAS6820			
NUT PART NUMBER	AS3485, AS3486, BACN10B, BACN10GW, BACN10JA, BACN10JB, BACN10RM, BACN11W, BACN11Z, BACN10ZC, NAS1804, NAS1805, NAS577			
NOMINAL THREAD SIZE	DRY FASTENERS		LUBED FASTENERS	
	TURN THE NUT AND NO FAY SEAL	TURN THE FASTENER HEAD AND/OR FAY SEAL	TURN THE NUT AND NO FAY SEAL	TURN THE FASTENER HEAD AND/OR FAY SEAL
0.1120-40 or 0.1120-48	8 in-lb (1 N·m)	8 in-lb (1 N·m)	6 in-lb (1 N·m)	6 in-lb (1 N·m)
0.1380-32 or 0.1380-40	15 in-lb (2 N·m)	15 in-lb (2 N·m)	12 in-lb (1 N·m)	12 in-lb (1 N·m)
0.1640-32 or 0.1640-36	19 in-lb (2 N·m) to 21 in-lb (2 N·m)	19 in-lb (2 N·m) to 21 in-lb (2 N·m)	15 in-lb (2 N·m)	15 in-lb (2 N·m)
0.1900-32	34 in-lb (4 N·m) to 36 in-lb (4 N·m)	34 in-lb (4 N·m) to 36 in-lb (4 N·m)	24 in-lb (3 N·m) to 26 in-lb (3 N·m)	24 in-lb (3 N·m) to 26 in-lb (3 N·m)
0.2500-28	82 in-lb (9 N·m) to 88 in-lb (10 N·m)	97 in-lb (11 N·m) to 103 in-lb (12 N·m)	63 in-lb (7 N·m) to 67 in-lb (8 N·m)	73 in-lb (8 N·m) to 77 in-lb (9 N·m)
0.3125-24	165 in-lb (19 N·m) to 175 in-lb (20 N·m)	194 in-lb (22 N·m) to 206 in-lb (23 N·m)	107 in-lb (12 N·m) to 113 in-lb (13 N·m)	121 in-lb (14 N·m) to 129 in-lb (15 N·m)
0.3750-24	310 in-lb (35 N·m) to 330 in-lb (37 N·m)	398 in-lb (45 N·m) to 422 in-lb (48 N·m)	194 in-lb (22 N·m) to 206 in-lb (23 N·m)	243 in-lb (27 N·m) to 258 in-lb (29 N·m)
0.4375-20	514 in-lb (58 N·m) to 546 in-lb (62 N·m)	669 in-lb (76 N·m) to 711 in-lb (80 N·m)	340 in-lb (38 N·m) to 361 in-lb (41 N·m)	412 in-lb (47 N·m) to 438 in-lb (49 N·m)
0.5000-20	825 in-lb (93 N·m) to 876 in-lb (99 N·m)	1038 in-lb (117 N·m) to 1102 in-lb (125 N·m)	529 in-lb (60 N·m) to 561 in-lb (63 N·m)	825 in-lb (93 N·m) to 876 in-lb (99 N·m)
0.5625-18	1213 in-lb (137 N·m) to 1288 in-lb (146 N·m)	1426 in-lb (161 N·m) to 1514 in-lb (171 N·m)	786 in-lb (89 N·m) to 834 in-lb (94 N·m)	892 in-lb (101 N·m) to 948 in-lb (107 N·m)
0.6250-18	1601 in-lb (181 N·m) to 1700 in-lb (192 N·m)	1843 in-lb (208 N·m) to 1957 in-lb (221 N·m)	1067 in-lb (121 N·m) to 1133 in-lb (128 N·m)	1164 in-lb (132 N·m) to 1236 in-lb (140 N·m)
0.7500-16	1843 in-lb (208 N·m) to 1957 in-lb (221 N·m)	2134 in-lb (241 N·m) to 2266 in-lb (256 N·m)	1892 in-lb (214 N·m) to 2009 in-lb (227 N·m)	2086 in-lb (236 N·m) to 2215 in-lb (250 N·m)

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Table 205/20-50-11-993-805 95-156 KSI SHEAR FASTENERS (EXCEPT BACB31V)

FASTENER CLASS	95-156 KSI			
FASTENER PART NUMBER OR STYLE	BACB30LH, BACB30LJ, BACB30LK, BACB30LT, BACB30NF, BACB30NJ, BACB30NL, BACB30NR, BACB30NT, BACB30PC, BACB30PF ^[1] , BACB30PU ^[1] , BACB30PW ^[1] , BACB30SW, BACB30TP, BACB30UU, BACB30WP, BACB30XN, BACB30ZC, BACB30ZG, BACS12BE()(no 'C' codes), BACS12BF()(no 'C' codes), BACS12BG()(no 'C' codes), BACS12BP()(no 'C' codes), BACS12CB, BACS12CK, BACS12ER, BACS12FA, BACS12GM, BACS12GP, BACS12GR, BACS12GU, BACS12GX, BACS12HC, BACS12HJ, BACS12HK, BACS12HL, BACS12HM, BACS12HN, BACS12HP, BACS12HU, BACS12HV, BACS12HW, BACS12HY, BACS12JA, BACS12JB, BACS12JD, BACS12JE, BACS12JL, BACS12N, MS21262, MS24678, MS24694-S(), NAS1217, NAS1218, NAS1351, NAS1352, NAS1801, NAS1802, NAS220-() ^[2] , NAS220C() ^[2] , NAS221-() ^[2] , NAS221C() ^[2] , NAS428, NAS514, NAS517, NAS563-NAS572, NAS600-NAS606, NAS623, NAS6203-NAS6220, NAS7600-NAS7616, NAS8200-NAS8206, THREADED ROD (STEEL, CRES, NICKEL ALLOY)			
NUT PART NUMBER OR STYLE	BACN10JC04-BACN10JC7 ONLY, BACN10R, BACN10YR, BACN11AG, MS21042, MS21043, MS21045, NAS679: ALL NUT PLATES EXCEPT BACN10JA AND BACN10JB, CLIPNUTS, METAL STANDOFFS, INSERTS IN METAL, TAPPED HOLES, METAL CHANNELS AND GANG CHANNELS			
NOMINAL THREAD SIZE	DRY FASTENER		LUBED FASTENER	
	TURN THE NUT AND NO FAY SEAL	TURN THE FASTENER HEAD AND/OR FAY SEAL	TURN THE NUT AND NO FAY SEAL	TURN THE FASTENER HEAD AND/OR FAY SEAL
0.0860-56 or 0.0860-64	3 in-lb (0 N·m)	3 in-lb (0 N·m)	3 in-lb (0 N·m)	3 in-lb (0 N·m)
0.1120-40 or 0.1120-48	8 in-lb (1 N·m)	8 in-lb (1 N·m)	6 in-lb (1 N·m)	6 in-lb (1 N·m)
0.1380-32 or 0.1380-40	15 in-lb (2 N·m)	15 in-lb (2 N·m)	12 in-lb (1 N·m)	12 in-lb (1 N·m)
0.1640-32 or 0.1640-36	20 in-lb (2 N·m)	20 in-lb (2 N·m)	15 in-lb (2 N·m)	15 in-lb (2 N·m)
0.1900-32	35 in-lb (4 N·m)	35 in-lb (4 N·m)	25 in-lb (3 N·m)	25 in-lb (3 N·m)
0.2500-28	65 in-lb (7 N·m)	80 in-lb (9 N·m)	65 in-lb (7 N·m)	75 in-lb (8 N·m)
0.3125-24	125 in-lb (14 N·m)	150 in-lb (17 N·m)	110 in-lb (12 N·m)	125 in-lb (14 N·m)
0.3750-24	200 in-lb (23 N·m)	240 in-lb (27 N·m)	175 in-lb (20 N·m)	200 in-lb (23 N·m)
0.4375-20	300 in-lb (34 N·m)	350 in-lb (40 N·m)	270 in-lb (31 N·m)	300 in-lb (34 N·m)
0.5000-20	635 in-lb (72 N·m)	790 in-lb (89 N·m)	545 in-lb (62 N·m)	650 in-lb (73 N·m)
0.5625-18	975 in-lb (110 N·m)	1150 in-lb (130 N·m)	810 in-lb (92 N·m)	920 in-lb (104 N·m)
0.6250-18	1300 in-lb (147 N·m)	1500 in-lb (169 N·m)	1100 in-lb (124 N·m)	1200 in-lb (136 N·m)
0.7500-16	2650 in-lb (299 N·m)	3000 in-lb (339 N·m)	1925 in-lb (217 N·m)	2150 in-lb (243 N·m)
0.8750-14	3500 in-lb (395 N·m)	4500 in-lb (508 N·m)	3000 in-lb (339 N·m)	3400 in-lb (384 N·m)
1.0000-12 or 1.0000-14	5600 in-lb (633 N·m)	7500 in-lb (847 N·m)	4550 in-lb (514 N·m)	5500 in-lb (621 N·m)
1.1250-12	7000 in-lb (791 N·m)	9000 in-lb (1017 N·m)	5800 in-lb (655 N·m)	6700 in-lb (757 N·m)

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Table 205/20-50-11-993-805 95-156 KSI SHEAR FASTENERS (EXCEPT BACB31V) (Continued)

FASTENER CLASS	95-156 KSI			
1.2500-12	11,000 in-lb (1243 N·m)	13,000 in-lb (1469 N·m)	8600 in-lb (972 N·m)	9700 in-lb (1096 N·m)

*[1] Use the thread diameter of the nut to find the applicable torque value. Do not use the nominal fastener diameter.

*[2] No BZ, BZP, or DD material codes are covered for the NAS220-NAS221.

Table 206/20-50-11-993-806 BACB31U, BACB31V

FASTENER CLASS	160 KSI				95 KSI	
FASTENER PART NUMBER OR STYLE	BACB31U				BACB31V	
NOMINAL THREAD SIZE	DRY FASTENER		LUBED FASTENER		DRY FASTENER	LUBED FASTENER
	TURN THE NUT AND NO FAY SEAL	TURN THE FASTENER HEAD AND/OR FAY SEAL	TURN THE NUT AND NO FAY SEAL	TURN THE FASTENER HEAD AND/OR FAY SEAL	TURN THE NUT OR FASTENER HEAD	TURN THE NUT OR FASTENER HEAD
	FAY SEAL OR NO FAY SEAL					
0.1900-32	29 in-lb (3 N·m) to 31 in-lb (4 N·m)	29 in-lb (3 N·m) to 31 in-lb (4 N·m)	29 in-lb (3 N·m) to 31 in-lb (4 N·m)	29 in-lb (3 N·m) to 31 in-lb (4 N·m)	29 in-lb (3 N·m) to 31 in-lb (4 N·m)	29 in-lb (3 N·m) to 31 in-lb (4 N·m)
0.2500-28	107 in-lb (12 N·m) to 113 in-lb (13 N·m)	121 in-lb (14 N·m) to 129 in-lb (15 N·m)	63 in-lb (7 N·m) to 67 in-lb (8 N·m)	73 in-lb (8 N·m) to 77 in-lb (9 N·m)	39 in-lb (4 N·m) to 41 in-lb (5 N·m)	29 in-lb (3 N·m) to 31 in-lb (4 N·m)
0.3125-24	204 in-lb (23 N·m) to 216 in-lb (24 N·m)	243 in-lb (27 N·m) to 258 in-lb (29 N·m)	107 in-lb (12 N·m) to 113 in-lb (13 N·m)	121 in-lb (14 N·m) to 129 in-lb (15 N·m)	—	—
0.3750-24	388 in-lb (44 N·m) to 412 in-lb (47 N·m)	485 in-lb (55 N·m) to 515 in-lb (58 N·m)	170 in-lb (19 N·m) to 180 in-lb (20 N·m)	243 in-lb (27 N·m) to 258 in-lb (29 N·m)	—	—

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Table 207/20-50-11-993-807 160 KSI CASTELLATED NUTS

NUT CLASS	160 KSI			
NUT PART NUMBER OR STYLE	BACN10JD7-BACN10JD20 ONLY			
NOMINAL THREAD SIZE	DRY FASTENER		LUBED FASTENER	
	TURN THE NUT AND NO FAY SEAL	TURN THE FASTENER HEAD AND/OR FAY SEAL	TURN THE NUT AND NO FAY SEAL	TURN THE FASTENER HEAD AND/OR FAY SEAL
0.4375-20	360 in-lb (41 N·m) to 690 in-lb (78 N·m)	620 in-lb (70 N·m) to 760 in-lb (86 N·m)	260 in-lb (29 N·m) to 425 in-lb (48 N·m)	383 in-lb (43 N·m) to 468 in-lb (53 N·m)
0.5000-20	630 in-lb (71 N·m) to 1070 in-lb (121 N·m)	963 in-lb (109 N·m) to 1170 in-lb (132 N·m)	440 in-lb (50 N·m) to 650 in-lb (73 N·m)	585 in-lb (66 N·m) to 715 in-lb (81 N·m)
0.5625-18	1000 in-lb (113 N·m) to 1470 in-lb (166 N·m)	1320 in-lb (149 N·m) to 1610 in-lb (182 N·m)	700 in-lb (79 N·m) to 920 in-lb (104 N·m)	828 in-lb (94 N·m) to 1010 in-lb (114 N·m)
0.6250-18	1400 in-lb (158 N·m) to 1900 in-lb (215 N·m)	1710 in-lb (193 N·m) to 2090 in-lb (236 N·m)	1000 in-lb (113 N·m) to 1200 in-lb (136 N·m)	1080 in-lb (122 N·m) to 1320 in-lb (149 N·m)
0.7500-16	2400 in-lb (271 N·m) to 3500 in-lb (395 N·m)	3150 in-lb (356 N·m) to 3850 in-lb (435 N·m)	1700 in-lb (192 N·m) to 2150 in-lb (243 N·m)	1930 in-lb (218 N·m) to 2360 in-lb (267 N·m)
0.8750-14	3700 in-lb (418 N·m) to 5500 in-lb (621 N·m)	4950 in-lb (559 N·m) to 6050 in-lb (684 N·m)	2600 in-lb (294 N·m) to 3400 in-lb (384 N·m)	3060 in-lb (346 N·m) to 3740 in-lb (423 N·m)
1.0000-12 or 1.0000-14	5100 in-lb (576 N·m) to 8900 in-lb (1006 N·m)	8010 in-lb (905 N·m) to 9790 in-lb (1106 N·m)	3600 in-lb (407 N·m) to 5500 in-lb (621 N·m)	4950 in-lb (559 N·m) to 6050 in-lb (684 N·m)
1.1250-12	6900 in-lb (780 N·m) to 10,700 in-lb (1209 N·m)	9630 in-lb (1088 N·m) to 11,700 in-lb (1322 N·m)	4900 in-lb (554 N·m) to 6700 in-lb (757 N·m)	6030 in-lb (681 N·m) to 7370 in-lb (833 N·m)
1.2500-12	11,500 in-lb (1299 N·m) to 15,700 in-lb (1774 N·m)	14,100 in-lb (1593 N·m) to 17,200 in-lb (1943 N·m)	7500 in-lb (847 N·m) to 9700 in-lb (1096 N·m)	8730 in-lb (986 N·m) to 10,600 in-lb (1198 N·m)

Table 208/20-50-11-993-808 125 KSI - NUTS, NUT PLATES, CLIP NUTS, STANDOFFS, INSERTS IN METAL, TAPPED HOLES

NUT CLASS	125 KSI	
NUT PART NUMBER OR STYLE	AS3479, AS3481, BACN10DW, BACN10DY, BACN10DZ, BACN10FX, BACN10GH, BACN10JC04-BACN10JC7 ONLY, BACN10JN, BACN10JP, BACN10JQ, BACN10JR, BACN10JS, BACN10JT, BACN10JY, BACN10JZ, BACN10KA, BACN10KB, BACN10KE, BACN10KF, BACN10KH, BACN10KJ, BACN10MS, BACN10MX, BACN10NW, BACN10TL, BACN10TM, BACN10VR, BACN10YC, BACN10YD, BACN10YF, BACN10YK, BACN10YR, BACN11P, MS21042, MS21043, NAS1474, NAS679, NAS686, INSERTS IN METAL, TAPPED HOLES	
NOMINAL THREAD SIZE	DRY FASTENERS	LUBED FASTENERS
	FAY SEAL OR NO FAY SEAL	
0.0860-56 or 0.0860-64	3 in-lb (0 N·m)	3 in-lb (0 N·m)

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Table 208/20-50-11-993-808 125 KSI - NUTS, NUT PLATES, CLIP NUTS, STANDOFFS, INSERTS IN METAL, TAPPED HOLES (Continued)

NUT CLASS	125 KSI	
0.1120-40 or 0.1120-48	8 in-lb (1 N·m)	6 in-lb (1 N·m)
0.1380-32 or 0.1380-40	15 in-lb (2 N·m)	12 in-lb (1 N·m)
0.1640-32 or 0.1640-36	19 in-lb (2 N·m) to 21 in-lb (2 N·m)	15 in-lb (2 N·m)
0.1900-32	34 in-lb (4 N·m) to 36 in-lb (4 N·m)	24 in-lb (3 N·m) to 26 in-lb (3 N·m)
0.2500-28	78 in-lb (9 N·m) to 82 in-lb (9 N·m)	73 in-lb (8 N·m) to 77 in-lb (9 N·m)
0.3125-24	146 in-lb (16 N·m) to 155 in-lb (18 N·m)	121 in-lb (14 N·m) to 129 in-lb (15 N·m)
0.3750-24	233 in-lb (26 N·m) to 247 in-lb (28 N·m)	194 in-lb (22 N·m) to 206 in-lb (23 N·m)
0.4375-20	340 in-lb (38 N·m) to 361 in-lb (41 N·m)	291 in-lb (33 N·m) to 309 in-lb (35 N·m)
0.5000-20	766 in-lb (87 N·m) to 814 in-lb (92 N·m)	631 in-lb (71 N·m) to 670 in-lb (76 N·m)
0.5625-18	1116 in-lb (126 N·m) to 1185 in-lb (134 N·m)	892 in-lb (101 N·m) to 948 in-lb (107 N·m)
0.6250-18	1455 in-lb (164 N·m) to 1545 in-lb (175 N·m)	1164 in-lb (132 N·m) to 1236 in-lb (140 N·m)
0.7500-16	2910 in-lb (329 N·m) to 3090 in-lb (349 N·m)	2086 in-lb (236 N·m) to 2215 in-lb (250 N·m)
0.8750-14	4365 in-lb (493 N·m) to 4635 in-lb (524 N·m)	3298 in-lb (373 N·m) to 3502 in-lb (396 N·m)

Table 209/20-50-11-993-809 80-125 KSI CASTELLATED NUTS

NUT CLASS	80 KSI		125 KSI			
NUT PART NUMBER	BACN10JD103-BACN10JD120 BACN11N103-BACN11N120 MS14145		BACN10JD3-BACN10JD6 ONLY BACN11N3-BACN11N20 ONLY MS14144			
NOMINAL THREAD SIZE	DRY OR LUBED FASTENERS		DRY FASTENERS		LUBED FASTENERS	
	TURN THE NUT AND NO FAY SEAL	TURN THE FASTENER HEAD AND/OR FAY SEAL	TURN THE NUT AND NO FAY SEAL	TURN THE FASTENER HEAD AND/OR FAY SEAL	TURN THE NUT AND NO FAY SEAL	TURN THE FASTENER HEAD AND/OR FAY SEAL
0.1900-32	18 in-lb (2 N·m) to 25 in-lb (3 N·m)	18 in-lb (2 N·m) to 25 in-lb (3 N·m)	25 in-lb (3 N·m) to 35 in-lb (4 N·m)	31 in-lb (4 N·m) to 38 in-lb (4 N·m)	25 in-lb (3 N·m) to 35 in-lb (4 N·m)	25 in-lb (3 N·m) to 35 in-lb (4 N·m)
0.2500-28	30 in-lb (3 N·m) 50 in-lb (6 N·m)	45 in-lb (5 N·m) to 55 in-lb (6 N·m)	50 in-lb (6 N·m) to 80 in-lb (9 N·m)	72 in-lb (8 N·m) to 88 in-lb (10 N·m)	50 in-lb (6 N·m) to 75 in-lb (8 N·m)	68 in-lb (8 N·m) to 83 in-lb (9 N·m)
0.3125-24	60 in-lb (7 N·m) to 90 in-lb (10 N·m)	80 in-lb (9 N·m) to 100 in-lb (11 N·m)	100 in-lb (11 N·m) to 150 in-lb (17 N·m)	135 in-lb (15 N·m) to 165 in-lb (19 N·m)	90 in-lb (10 N·m) to 125 in-lb (14 N·m)	113 in-lb (13 N·m) to 137 in-lb (15 N·m)

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Table 209/20-50-11-993-809 80-125 KSI CASTELLATED NUTS (Continued)

NUT CLASS	80 KSI		125 KSI			
0.3750-24	95 in-lb (11 N·m) to 160 in-lb (18 N·m)	144 in-lb (16 N·m) to 176 in-lb (20 N·m)	160 in-lb (18 N·m) to 240 in-lb (27 N·m)	216 in-lb (24 N·m) to 264 in-lb (30 N·m)	150 in-lb (17 N·m) to 200 in-lb (23 N·m)	180 in-lb (20 N·m) to 220 in-lb (25 N·m)
0.4375-20	220 in-lb (25 N·m) to 280 in-lb (32 N·m)	252 in-lb (28 N·m) to 308 in-lb (35 N·m)	250 in-lb (28 N·m) to 350 in-lb (40 N·m)	315 in-lb (36 N·m) to 385 in-lb (43 N·m)	240 in-lb (27 N·m) to 300 in-lb (34 N·m)	270 in-lb (31 N·m) to 330 in-lb (37 N·m)
0.5000-20	290 in-lb (33 N·m) to 510 in-lb (58 N·m)	459 in-lb (52 N·m) to 561 in-lb (63 N·m)	480 in-lb (54 N·m) to 790 in-lb (89 N·m)	710 in-lb (80 N·m) to 870 in-lb (98 N·m)	440 in-lb (50 N·m) to 650 in-lb (73 N·m)	585 in-lb (66 N·m) to 715 in-lb (81 N·m)
0.5625-18	480 in-lb (54 N·m) to 850 in-lb (96 N·m)	765 in-lb (86 N·m) to 935 in-lb (106 N·m)	800 in-lb (90 N·m) to 1150 in-lb (130 N·m)	1035 in-lb (117 N·m) to 1265 in-lb (143 N·m)	700 in-lb (79 N·m) to 920 in-lb (104 N·m)	828 in-lb (94 N·m) to 1010 in-lb (114 N·m)
0.6250-18	660 in-lb (75 N·m) to 980 in-lb (111 N·m)	882 in-lb (100 N·m) to 1080 in-lb (122 N·m)	1100 in-lb (124 N·m) to 1500 in-lb (169 N·m)	1350 in-lb (153 N·m) to 1650 in-lb (186 N·m)	1000 in-lb (113 N·m) to 1200 in-lb (136 N·m)	1080 in-lb (122 N·m) to 1320 in-lb (149 N·m)
0.7500-16	1300 in-lb (147 N·m) to 2000 in-lb (226 N·m)	1800 in-lb (203 N·m) to 2200 in-lb (249 N·m)	2300 in-lb (260 N·m) to 3000 in-lb (339 N·m)	2700 in-lb (305 N·m) to 3300 in-lb (373 N·m)	1700 in-lb (192 N·m) to 2150 in-lb (243 N·m)	1940 in-lb (219 N·m) to 2360 in-lb (267 N·m)
0.8750-14	1500 in-lb (169 N·m) to 3300 in-lb (373 N·m)	2970 in-lb (336 N·m) to 3630 in-lb (410 N·m)	2500 in-lb (282 N·m) to 4500 in-lb (508 N·m)	4050 in-lb (458 N·m) to 4950 in-lb (559 N·m)	2600 in-lb (294 N·m) to 3400 in-lb (384 N·m)	3060 in-lb (346 N·m) to 3740 in-lb (423 N·m)
1.0000-12 or 1.0000-14	2200 in-lb (249 N·m) to 5300 in-lb (599 N·m)	4770 in-lb (539 N·m) to 5830 in-lb (659 N·m)	3700 in-lb (418 N·m) to 7500 in-lb (847 N·m)	6750 in-lb (763 N·m) to 8250 in-lb (932 N·m)	3600 in-lb (407 N·m) to 5500 in-lb (621 N·m)	4950 in-lb (559 N·m) to 6050 in-lb (684 N·m)
1.1250-12	3000 in-lb (339 N·m) to 6200 in-lb (701 N·m)	5580 in-lb (630 N·m) to 6820 in-lb (771 N·m)	5000 in-lb (565 N·m) to 9000 in-lb (1017 N·m)	8100 in-lb (915 N·m) to 9900 in-lb (1119 N·m)	4900 in-lb (554 N·m) to 6700 in-lb (757 N·m)	6080 in-lb (687 N·m) to 7370 in-lb (833 N·m)
1.2500-12	5400 in-lb (610 N·m) to 8600 in-lb (972 N·m)	7740 in-lb (874 N·m) to 9460 in-lb (1069 N·m)	9000 in-lb (1017 N·m) to 13,000 in-lb (1469 N·m)	11,700 in-lb (1322 N·m) to 14,300 in-lb (1616 N·m)	7500 in-lb (847 N·m) to 9700 in-lb (1096 N·m)	8730 in-lb (986 N·m) to 10,600 in-lb (1198 N·m)

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Table 210/20-50-11-993-810 REDUCED SHEAR HEAD FASTENERS

FASTENER CLASS	95 KSI	
FASTENER PART NUMBER	BACB30DP, BACB30EL, BACB30FB, BACB30LL, BACB30NU, BACB30RF, BACB30UR, BACB30UW, BACB30VF, BACB30XD, BACB30YE, BACB30ZE, BACB31A, BACS12HB, BACS12HE, BACS12JC, NAS1992, NAS1993-NAS2000, NAS8704-NAS8716	
NUT PART NUMBER OR STYLE	ALL NON-CASTELLATED NUTS, NUT PLATES, CLIP NUTS, METALLIC STANDOFFS, INSERTS, TAPPED HOLES	ALL CASTELLATED NUTS
NOMINAL THREAD SIZE	DRY AND CETYL ALCOHOL LUBED FASTENERS ^{*[1]*[2]}	
	TURN THE HEAD OR THE NUT -FAY SEAL OR NO FAY SEAL	
0.1640-32 or 0.1640-36	15 in-lb (2 N·m)	10 in-lb (1 N·m) to 18 in-lb (2 N·m)
0.1900-32	29 in-lb (3 N·m) to 31 in-lb (4 N·m)	18 in-lb (2 N·m) to 25 in-lb (3 N·m)
0.2500-28	39 in-lb (4 N·m) to 41 in-lb (5 N·m)	30 in-lb (3 N·m) to 40 in-lb (5 N·m)
0.3125-24	92 in-lb (10 N·m) to 98 in-lb (11 N·m)	90 in-lb (10 N·m) to 100 in-lb (11 N·m)
0.3750-24	97 in-lb (11 N·m) to 103 in-lb (12 N·m)	95 in-lb (11 N·m) to 105 in-lb (12 N·m)
0.4375-20	155 in-lb (18 N·m) to 165 in-lb (19 N·m)	150 in-lb (17 N·m) to 170 in-lb (19 N·m)
0.5000-20	223 in-lb (25 N·m) to 237 in-lb (27 N·m)	220 in-lb (25 N·m) to 245 in-lb (28 N·m)
0.5625-18	301 in-lb (34 N·m) to 319 in-lb (36 N·m)	290 in-lb (33 N·m) 325 in-lb (37 N·m)
0.6250-18	407 in-lb (46 N·m) to 433 in-lb (49 N·m)	395 in-lb (45 N·m) to 435 in-lb (49 N·m)
0.7500-16	660 in-lb (75 N·m) to 700 in-lb (79 N·m)	645 in-lb (73 N·m) to 720 in-lb (81 N·m)
0.8750-14	1067 in-lb (121 N·m) to 1133 in-lb (128 N·m)	1040 in-lb (118 N·m) to 1150 in-lb (130 N·m)
1.0000-12 or 1.0000-14	1601 in-lb (181 N·m) to 1700 in-lb (192 N·m)	1560 in-lb (176 N·m) to 1730 in-lb (195 N·m)

*[1] This table only gives the torque value for dry fasteners or fasteners that are lubricated with cetyl alcohol. The applicable torque value must be specified in the AMM procedure for fasteners that are installed with other lubricants (including solid film lubricants).

*[2] An 'S' in the part number code may indicate solid film lubricant.

Table 211/20-50-11-993-811 60-80 KSI SCREWS AND NUTS, NYLON NUTS

FASTENER CLASS	60-80 KSI	NYLON NUTS
FASTENER PART NUMBER OR STYLE	BACS12BP()(all codes that contain 'C')(), , BACS12BE()C(), BACS12BF()C(), BACS12BG()C(), MS24693-C(), MS24693-S(), MS24694-C(), MS51957, MS51958	ALL FASTENERS

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Table 211/20-50-11-993-811 60-80 KSI SCREWS AND NUTS, NYLON NUTS (Continued)

FASTENER CLASS	60-80 KSI	NYLON NUTS	
NUT PART NUMBER OR STYLE	BACN10JC8-BACN10JC28 ONLY, MS21245	BACN10YJ08-BACN10YJ3 ONLY	
NOMINAL THREAD SIZE	DRY OR LUBED FASTENER	DRY OR LUBED FASTENER	
	TURN THE NUT OR THE FASTENER HEAD	TURN THE NUT AND NO FAY SEAL	TURN THE FASTENER HEAD AND FAY SEAL
0.0860-56 or 0.0860-64	3 in-lb (0 N·m)	-	-
0.1120-40 or 0.1120-48	6 in-lb (1 N·m)	-	-
0.1380-32 or 0.1380-40	12 in-lb (1 N·m)	-	-
0.1640-32 or 0.1640-36	15 in-lb (2 N·m)	5 in-lb (1 N·m)	6 in-lb (1 N·m)
0.1900-32	19 in-lb (2 N·m) to 21 in-lb (2 N·m)	7 in-lb (1 N·m)	8 in-lb (1 N·m)
0.2500-28	39 in-lb (4 N·m) to 41 in-lb (5 N·m)	-	-
0.3125-24	76 in-lb (9 N·m) to 80 in-lb (9 N·m)	-	-
0.3750-24	126 in-lb (14 N·m) to 134 in-lb (15 N·m)	-	-

Table 212/20-50-11-993-812 STAKE SCREWS

FASTENER CLASS		60-80 KSI		95-160 KSI	
STAKE SCREW PART NUMBERS		FCM(***)(*)CP(**); FH(***)(*)CP(**); PS(***)(*)CP(**); C(***)(*)CP(**); S(***)(*)CP(**); SFSW(***)(*)CP(**); PS(***)(*)CS(**); S10(***)(*)CP(**); SFSW(***)(*)CS(**); FHC(***)(*)CP(**)		CPS(***)(*)D(**); FCM(***)(*)D(**); FH(***)(*)D(**); PS(***)(*)D(**); S(***)(*)D(**); SFS(***)(*)D(**); SFSW(***)(*)D(**); WHS(***)(*)TPS(**)	
NOMINAL THREAD SIZE	STAKE DASH NUMBER	TORQUE TOOL SETPOINT			
		DRY SCREWS	LUBED SCREWS	DRY SCREWS	LUBED SCREWS
0.0860-56 or 0.0860-65	2C	3 in-lb (0 N·m)	3 in-lb (0 N·m)	3 in-lb (0 N·m)	3 in-lb (0 N·m)
0.1120-40 or 0.1120-48	4C	6 in-lb (1 N·m)	5 in-lb (1 N·m)	8 in-lb (1 N·m)	6 in-lb (1 N·m)
0.1380-32 or 0.1380-40	6C	12 in-lb (1 N·m)	8 in-lb (1 N·m)	15 in-lb (2 N·m)	12 in-lb (1 N·m)
0.1640-32 or 0.1640-36	8C	16 in-lb (2 N·m)	12 in-lb (1 N·m)	19 in-lb (2 N·m) to 21 in-lb (2 N·m)	15 in-lb (2 N·m)
0.1900-32	10C	19 in-lb (2 N·m) to 21 in-lb (2 N·m)	15 in-lb (2 N·m)	34 in-lb (4 N·m) to 36 in-lb (4 N·m)	24 in-lb (3 N·m) to 26 in-lb (3 N·m)

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Table 213/20-50-11-993-813 JAM NUTS

NUT STYLE	LOCKWIRE HOLES	NO LOCKWIRE HOLES
NUT PART NUMBER	BACN11U(), NAS1423, NAS509	AN315, AN316, BACN11U()N, MS35649, MS35650, MS3591
NOMINAL THREAD SIZE		
0.1900-32	15 in-lb (2 N·m)	19 in-lb (2 N·m) to 21 in-lb (2 N·m)
0.2500-28	19 in-lb (2 N·m) to 21 in-lb (2 N·m)	24 in-lb (3 N·m) to 26 in-lb (3 N·m)
0.3125-24	34 in-lb (4 N·m) to 36 in-lb (4 N·m)	49 in-lb (6 N·m) to 52 in-lb (6 N·m)
0.3750-24	44 in-lb (5 N·m) to 46 in-lb (5 N·m)	63 in-lb (7 N·m) to 67 in-lb (8 N·m)
0.4375-20	63 in-lb (7 N·m) to 67 in-lb (8 N·m)	97 in-lb (11 N·m) to 103 in-lb (12 N·m)
0.5000-20	78 in-lb (9 N·m) to 82 in-lb (9 N·m)	112 in-lb (13 N·m) to 118 in-lb (13 N·m)
0.5625-18	87 in-lb (10 N·m) to 93 in-lb (11 N·m)	131 in-lb (15 N·m) to 139 in-lb (16 N·m)
0.6250-18	97 in-lb (11 N·m) to 103 in-lb (12 N·m)	146 in-lb (16 N·m) to 155 in-lb (18 N·m)
0.7500-16	155 in-lb (18 N·m) to 165 in-lb (19 N·m)	233 in-lb (26 N·m) to 247 in-lb (28 N·m)
0.8750-14	213 in-lb (24 N·m) to 227 in-lb (26 N·m)	320 in-lb (36 N·m) to 340 in-lb (38 N·m)
1.0000-12 or 1.0000-14	272 in-lb (31 N·m) to 288 in-lb (33 N·m)	407 in-lb (46 N·m) to 433 in-lb (49 N·m)
1.1250-12	359 in-lb (41 N·m) to 381 in-lb (43 N·m)	534 in-lb (60 N·m) to 567 in-lb (64 N·m)
1.2500-12	437 in-lb (49 N·m) to 464 in-lb (52 N·m)	655 in-lb (74 N·m) to 695 in-lb (79 N·m)

Table 214/20-50-11-993-814 COARSE THREAD FASTENERS AND NUTS

FASTENER PART NUMBER	ALL COARSE THREAD FASTENERS (DESIGNATED BY UNC OR UNJC)		
NUT PART NUMBER OR STYLE	ALL COARSE THREAD NUTS, INSERTS, AND TAPPED HOLES (DESIGNATED BY UNC OR UNJC)		
NOMINAL THREAD SIZE	DRY FASTENERS ONLY		
	TURN THE NUT AND NO FAY SEAL	TURN THE FASTENER HEAD AND/OR FAY SEAL	MAXIMUM TORQUE ALLOWED TO ALIGN THE COTTER PIN AND THE HOLE
0.1900-24	14 in-lb (2 N·m)	15 in-lb (2 N·m)	20 in-lb (2 N·m)
0.2500-20	29 in-lb (3 N·m) to 31 in-lb (4 N·m)	29 in-lb (3 N·m) to 31 in-lb (4 N·m)	45 in-lb (5 N·m)
0.3125-18	49 in-lb (6 N·m) to 52 in-lb (6 N·m)	53 in-lb (6 N·m) to 57 in-lb (6 N·m)	100 in-lb (11 N·m)
0.3750-16	97 in-lb (11 N·m) to 103 in-lb (12 N·m)	107 in-lb (12 N·m) to 113 in-lb (13 N·m)	170 in-lb (19 N·m)
0.4375-14	146 in-lb (16 N·m) to 155 in-lb (18 N·m)	155 in-lb (18 N·m) to 165 in-lb (19 N·m)	280 in-lb (32 N·m)
0.5000-13	262 in-lb (30 N·m) to 278 in-lb (31 N·m)	281 in-lb (32 N·m) to 299 in-lb (34 N·m)	520 in-lb (59 N·m)
0.5625-12	349 in-lb (39 N·m) to 371 in-lb (42 N·m)	407 in-lb (46 N·m) to 433 in-lb (49 N·m)	650 in-lb (73 N·m)

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Table 214/20-50-11-993-814 COARSE THREAD FASTENERS AND NUTS (Continued)

FASTENER PART NUMBER	ALL COARSE THREAD FASTENERS (DESIGNATED BY UNC OR UNJC)		
0.6250-11	466 in-lb (53 N·m) to 494 in-lb (56 N·m)	524 in-lb (59 N·m) to 556 in-lb (63 N·m)	900 in-lb (102 N·m)
0.7500-10	800 in-lb (90 N·m) to 850 in-lb (96 N·m)	907 in-lb (102 N·m) to 963 in-lb (109 N·m)	1500 in-lb (169 N·m)
0.8750-9	1499 in-lb (169 N·m) to 1591 in-lb (180 N·m)	1746 in-lb (197 N·m) to 1854 in-lb (209 N·m)	2700 in-lb (305 N·m)
1.0000-8	2566 in-lb (290 N·m) to 2724 in-lb (308 N·m)	2910 in-lb (329 N·m) to 3090 in-lb (349 N·m)	4500 in-lb (508 N·m)
1.1250-7	3541 in-lb (400 N·m) to 3760 in-lb (425 N·m)	3880 in-lb (438 N·m) to 4120 in-lb (465 N·m)	7200 in-lb (813 N·m)
1.2500-7	4360 in-lb (493 N·m) to 4630 in-lb (523 N·m)	4850 in-lb (548 N·m) to 5150 in-lb (582 N·m)	10,000 in-lb (1130 N·m)

(c) Self-Locking Nuts, Table 215, Table 216.

Table 215/20-50-11-993-815 Locking Torques for Self-Locking Nuts

SIZE	TORQUE	
	MINIMUM BREAKAWAY	MAXIMUM LOCKING
0.1120-40	0.5 in-lb (0.1 N·m)	5 in-lb (0.6 N·m)
0.1380-32	1.0 in-lb (0.1 N·m)	10.0 in-lb (1.1 N·m)
0.1640-32	1.5 in-lb (0.2 N·m)	15.0 in-lb (1.7 N·m)
0.1900-32	2.0 in-lb (0.2 N·m)	18.0 in-lb (2.0 N·m)
0.2500-28	3.5 in-lb (0.4 N·m)	30.0 in-lb (3.4 N·m)
0.3125-24	6.5 in-lb (0.7 N·m)	60.0 in-lb (6.8 N·m)
0.3750-24	9.5 in-lb (1.1 N·m)	80.0 in-lb (9.0 N·m)
0.4375-20	14.0 in-lb (1.6 N·m)	100.0 in-lb (11.3 N·m)
0.5000-20	18.0 in-lb (2.0 N·m)	150.0 in-lb (16.9 N·m)
0.5625-18	24.0 in-lb (2.7 N·m)	200.0 in-lb (22.6 N·m)
0.6250-18	32.0 in-lb (3.6 N·m)	300.0 in-lb (33.9 N·m)
0.7500-16	50.0 in-lb (5.6 N·m)	400.0 in-lb (45.2 N·m)
0.8750-14	70.0 in-lb (7.9 N·m)	600.0 in-lb (67.8 N·m)
1.0000-14	90.0 in-lb (10.2 N·m)	800.0 in-lb (90.4 N·m)
1.0000-12	90.0 in-lb (10.2 N·m)	800.0 in-lb (90.4 N·m)
1.1250-12	117.0 in-lb (13.2 N·m)	900.0 in-lb (101.7 N·m)
1.2500-12	143.0 in-lb (16.2 N·m)	1000.0 in-lb (113.0 N·m)
1.3750-12	165.0 in-lb (18.6 N·m)	1100.0 in-lb (124.3 N·m)
1.5000-12	195.0 in-lb (22.0 N·m)	1250.0 in-lb (141.2 N·m)
1.7500-12	245.0 in-lb (27.7 N·m)	1450.0 in-lb (163.8 N·m)

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Table 215/20-50-11-993-815 Locking Torques for Self-Locking Nuts (Continued)

SIZE	TORQUE	
	300.0 in-lb (33.9 N·m)	1700.0 in-lb (192.1 N·m)
2.0000-12		

Table 216/20-50-11-993-816 Locking Torques for Self-Locking Nuts (Coarse Threads)

SIZE	TORQUE	
	MINIMUM BREAKAWAY	MAXIMUM LOCKING
0.086-56	0.2 in-lb (0.0 N·m)	2.0 in-lb (0.2 N·m)
0.112-40	0.5 in-lb (0.1 N·m)	5 in-lb (1 N·m)
0.138-32	1.0 in-lb (0.1 N·m)	10 in-lb (1 N·m)
0.164-32	1.5 in-lb (0.2 N·m)	15 in-lb (2 N·m)
0.190-24	2.0 in-lb (0.2 N·m)	18 in-lb (2 N·m)
0.250-20	4.5 in-lb (0.5 N·m)	30 in-lb (3 N·m)
0.312-18	7.5 in-lb (0.8 N·m)	60 in-lb (7 N·m)
0.375-16	12.0 in-lb (1.4 N·m)	80 in-lb (9 N·m)
0.437-14	16.5 in-lb (1.9 N·m)	100 in-lb (11 N·m)
0.500-13	24.0 in-lb (2.7 N·m)	150 in-lb (17 N·m)
0.562-12	30.0 in-lb (3.4 N·m)	200 in-lb (23 N·m)
0.625-11	40.0 in-lb (4.5 N·m)	300 in-lb (34 N·m)
0.750-10	60.0 in-lb (6.8 N·m)	400 in-lb (45 N·m)
0.875-9	82.0 in-lb (9.3 N·m)	600 in-lb (68 N·m)
1.000-8	110.0 in-lb (12.4 N·m)	800 in-lb (90 N·m)
1.125-7	137.0 in-lb (15.5 N·m)	900 in-lb (102 N·m)
1.250-7	165.0 in-lb (18.6 N·m)	1000 in-lb (113 N·m)
1.375-6	200.0 in-lb (22.6 N·m)	1200 in-lb (136 N·m)
1.500-6	230.0 in-lb (26.0 N·m)	1400 in-lb (158 N·m)
1.750-5	300.0 in-lb (33.9 N·m)	1800 in-lb (203 N·m)
2.000-4.5	360.0 in-lb (40.7 N·m)	2200 in-lb (249 N·m)
2.250-4.5	430.0 in-lb (48.6 N·m)	2600 in-lb (294 N·m)
2.500-4	500.0 in-lb (56.5 N·m)	3000 in-lb (339 N·m)

(d) Reduced-Head Bolts, Figure 202.

(e) Rigid Tube Coupling Connections, Table 217 and Figure 203.

Table 217/20-50-11-993-817 Standard Torque Values for Rigid Tube Coupling Connectors

TUBE OD (INCHES)	TORQUE VALUE			
	ALUMINUM ALLOY FITTINGS NAS591- NAS593		STAINLESS STEEL FITTINGS NAS594, NAS596, BACN10HX COUPLING	
	MINIMUM	MAXIMUM	MINIMUM	MAXIMUM

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Table 217/20-50-11-993-817 Standard Torque Values for Rigid Tube Coupling Connectors (Continued)

1	TORQUE VALUE			
	480 in-lb (54 N·m)	720 in-lb (81 N·m)	480 in-lb (54 N·m)	720 in-lb (81 N·m)
1-1/4	600 in-lb (68 N·m)	900 in-lb (102 N·m)	600 in-lb (68 N·m)	900 in-lb (102 N·m)
1-1/2	600 in-lb (68 N·m)	900 in-lb (102 N·m)	600 in-lb (68 N·m)	900 in-lb (102 N·m)
2	900 in-lb (102 N·m)	1200 in-lb (136 N·m)	900 in-lb (102 N·m)	1200 in-lb (136 N·m)
2-1/2	1500 in-lb (169 N·m)	1800 in-lb (203 N·m)	1800 in-lb (203 N·m)	2100 in-lb (237 N·m)
3	--	--	1800 in-lb (203 N·m)	2100 in-lb (237 N·m)
4	--	--	2400 in-lb (271 N·m)	2700 in-lb (305 N·m)

(f) Pipe Thread Fittings, Table 218.

Table 218/20-50-11-993-818 Standard Torque Values for Pipe Thread Fittings

MATING PIPE FITTING MATERIAL COMBINATIONS	SIZE (INCHES)	TORQUE	
		MINIMUM	MAXIMUM
All Except CRES-to-CRES	1/8	100 in-lb (11 N·m)	175 in-lb (20 N·m)
	1/4	150 in-lb (17 N·m)	300 in-lb (34 N·m)
	3/8	225 in-lb (25 N·m)	450 in-lb (51 N·m)
CRES-to-CRES	1/8	100 in-lb (11 N·m)	150 in-lb (17 N·m)
	1/4	100 in-lb (11 N·m)	275 in-lb (31 N·m)
	3/8	100 in-lb (11 N·m)	400 in-lb (45 N·m)
	1/2	100 in-lb (11 N·m)	500 in-lb (56 N·m)
	3/4	150 in-lb (17 N·m)	600 in-lb (68 N·m)
	1	200 in-lb (23 N·m)	800 in-lb (90 N·m)

(g) Low Pressure and Return Line Fittings, Table 219.

Table 219/20-50-11-993-819 Standard Torque Values for Low Pressure and Return Line Fittings

TUBE SIZE		FLARED AND FLARELESS COMPONENTS TORQUE	
		TUBE MATERIAL/END CONFIGURATION	
OUTER DIAMETER (INCHES)	SIZE	ALUMINUM FLARED TUBE ENDS ALUMINUM TUBE ENDS WITH BACS13BD AND BACS13BX SWAGED SLEEVES FLARELESS TYPE HOSE END FITTINGS WITH ALUMINUM INSERTS TORQUE	FLARED HOSE END FITTINGS WITH ALUMINUM INSERTS
3/16	03	80 in-lb (9 N·m)	35 in-lb (4 N·m)

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**Table 219/20-50-11-993-819 Standard Torque Values for Low Pressure and Return Line Fittings
(Continued)**

TUBE SIZE		FLARED AND FLARELESS COMPONENTS TORQUE	
1/4	04	110 in-lb (12 N·m)	65 in-lb (7 N·m)
5/16	05	140 in-lb (16 N·m)	90 in-lb (10 N·m)
3/8	06	170 in-lb (19 N·m)	130 in-lb (15 N·m)
1/2	08	280 in-lb (32 N·m)	260 in-lb (29 N·m)
5/8	10	360 in-lb (41 N·m)	360 in-lb (41 N·m)
3/4	12	450 in-lb (51 N·m)	500 in-lb (56 N·m)
7/8	14	--	--
1	16	750 in-lb (85 N·m)	700 in-lb (79 N·m)
1-1/4	20	900 in-lb (102 N·m)	900 in-lb (102 N·m)
1-1/2	24	900 in-lb (102 N·m)	900 in-lb (102 N·m)
1-3/4	28	--	--
2	32	--	2000 in-lb (226 N·m)

(h) Flareless Tube Fittings, Table 220, Table 221, Table 222.

Table 220/20-50-11-993-820 Installation Torques for Flared, Flareless, and Short Flareless Fittings with Lubricated Threads on Aluminum and Annealed CRES Tube In-Line Fittings and Hose Ends

TUBE SIZE*[1]		FLARED AND FLARELESS COMPONENTS TORQUE						
		TUBE MATERIAL/END CONFIGURATION*[2]*[3]*[4]*[5]*[6]*[7]						
OUTER DIAMETER (INCHES)	SIZE	ALUMINUM FLARED TUBE ENDS	6061T ALUMINUM AND ANNEALED CRES TUBE WITH BACS13AP SLEEVES					
		ALUMINUM TUBE ENDS WITH BACS13BD AND BACS13BX SWAGED SLEEVES						
		FLARELESS TYPE HOSE END FITTINGS WITH ALUMINUM INSERTS						
	TORQUE*[8]*[9]*[10]*[11]		MINIMUM TUBE WALL THICKNESS: ALUMINUM AND ANNEALED CRES (INCHES)	TORQUE	SPECIAL THIN WALL ANNEALED CRES WALL THICKNESS (INCHES)	TORQUE	SPECIAL HEAVY WALL ANNEALED CRES WALL THICKNESS (INCHES)	TORQUE (IN-LB ± 5%)
1/8	02	--	--	--	--	--	--	--
3/16	03	80 ±4 in-lb (9 ±0 N·m)	0.028	80 ±4 in-lb (9 ±0 N·m)	--	--	--	--

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Table 220/20-50-11-993-820 Installation Torques for Flared, Flareless, and Short Flareless Fittings with Lubricated Threads on Aluminum and Annealed CRES Tube In-Line Fittings and Hose Ends (Continued)

TUBE SIZE ^{*[1]}		FLARED AND FLARELESS COMPONENTS TORQUE						
1/4	04	110 ±6 in-lb (12 ±1 N·m)	0.028	110 ±6 in-lb (12 ±1 N·m)	--	--	--	--
5/16	05	140 ±7 in-lb (16 ±1 N·m)	0.028	140 ±7 in-lb (16 ±1 N·m)	--	--	--	--
3/8	06	170 ±9 in-lb (19 ±1 N·m)	0.028	170 ±9 in-lb (19 ±1 N·m)	0.020	160 ±8 in-lb (18 ±1 N·m)	--	--
1/2	08	280 ±14 in-lb (32 ±2 N·m)	0.028	280 ±14 in-lb (32 ±2 N·m)	--	--	0.035	550 ±28 in-lb (62 ±3 N·m)
5/8	10	360 ±18 in-lb (41 ±2 N·m)	0.028	360 ±18 in-lb (41 ±2 N·m)	0.020	250 ±13 in-lb (28 ±2 N·m)	0.049	450 ±23 in-lb (51 ±3 N·m)
							0.035	450 ±23 in-lb (51 ±3 N·m)
3/4	12	450 ±23 in-lb (51 ±3 N·m)	0.028	450 ±23 in-lb (51 ±3 N·m)	0.020	325 ±16 in-lb (37 ±2 N·m)	--	--
7/8	14	--	--	--	--	--	--	--
1	16	750 ±38 in-lb (85 ±5 N·m)	0.035	750 ±38 in-lb (85 ±5 N·m)	--	--	--	--
1-1/4	20	900 ±45 in-lb (102 ±5 N·m)	--	--	--	--	--	--
1-1/2	24	900 ±45 in-lb (102 ±5 N·m)	--	--	--	--	--	--
1-3/4	28	--	--	--	--	--	--	--
2	32	--	--	--	--	--	--	--

*[1] For fittings and hoses with ends of more than one size, select the torque value for each end that matches its size. Compare the fitting or hose part number to the part standard to determine the part size and material.

NOTE: The end fitting size for standard BAC, AS and NAS fittings and hoses is determined by reference to the appropriate part standard. Table: "Standard End Fitting Size and Thread Size" (check the table for each model) may be used to determine the end fitting size for non-standard fittings and hoses that must be tightened in accordance with BAC5001.

*[2] Controlled Tooling: ST 2599A, Torque Wrench for Tube Fittings or ST 2599B, Torque Wrench for Tube Components shall be used where possible to connect fittings. Equivalent micrometer style torque wrenches, adapters, and extensions are permitted only when the installation prohibits the use of the Controlled Tooling. When torque tool adapters or extensions are used, torque indicator reading correction factors may be required. Instructions for adapter/extension use and methods for obtaining the correction factor are given in BSS7083.

*[3] Use aluminum fitting torque values for aluminum, steel, or titanium fittings installed in aluminum bosses.

*[4] Use aluminum fitting torque values for aluminum jamnuts installed on aluminum, titanium, or steel bulkhead fittings.

*[5] Use steel fitting torque values for steel or titanium fittings installed in steel or titanium bosses.

*[6] Use steel fitting torque values for steel or titanium jamnuts installed on steel or titanium bulkhead fittings.

*[7] The boss or bulkhead fitting size determines the torque value for reducer fittings.

*[8] Tube material specifications: 6061-T6 Aluminum - MIL-T-7081, WW-T-700/6; Annealed CRES - MIL-T-8504, MIL-T-8606, MIL-T-8808; 1/8 Hard CRES - MIL-T-6845; 21-6-9 CRES - BMS7-185; TI-3AL-2.5V - AS5620 and AMS4946.

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- *[9] Aluminum flared tube ends, aluminum tube ends with BAC13BD and BAC13BX swaged sleeves, flareless type hose end fittings with aluminum inserts, aluminum swivel nuts and externally threaded ends on flareless elbow, tee and cross fittings, and flareless aluminum union fittings.
- *[10] Unless otherwise specified on the Engineering Drawing, tighten the following items to each other using the torque values on the table:
- Tube assemblies with aluminum coupling nuts;
 - In-line fittings made of aluminum. In-line fittings such as tube-to-tube union, elbow, tee or cross fittings, adapter or reducer fittings, or in-line components with flareless ends such as BAC check valves that the Engineering Drawing requires shall be installed in accordance with BAC5001-10.
 - Hoses made with flareless aluminum end fittings;
- *[11] If an item on Table: "Installation Torques for Flared, Flareless, and Short Flareless Fittings with Lubricated Threads Used on Aluminum and Annealed CRES Tube In-Line Fittings and Hose Ends" is mated to an item on Table: "Installation Torques for Flared, Flareless, and Short Flareless Fittings with Lubricated Threads Used on CRES and Titanium Tube Fittings and Hose Ends", then tighten these mixed items using the torque values on Table: "Installation Torques for Flared, Flareless, and Short Flareless Fittings with Lubricated Threads Used on Aluminum and Annealed CRES Tube In-Line Fittings and Hose Ends", unless otherwise specified on the Engineering Drawing.

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Table 221/20-50-11-993-821 Installation Torques for Flared, Flareless, and Short Flareless Fittings with Lubricated Threads Used on CRES and Titanium Tube Fittings and Hose Ends

TUBE SIZE ^{*[1]}		FLARED AND FLARELESS COMPONENTS TORQUE				
		TUBE MATERIAL/END CONFIGURATION ^{*[2]*[3]*[4]*[5]*[6]*[7]}				
OUTER DIAMETER (INCHES)	SIZE	21-6-9 (BMS7-185) AND OTHER CRES ENDS WITH BACS13BD AND BACS13BX SWAGED SLEEVES 1/8 HARD (MIL-T-6845) AND ANNEALED CRES (MIL-T-8504, MIL-T-8808) FLARED TUBE ENDS HOSE END FITTINGS WITH CRES TUBE INSERTS ALL 3AL-2.5V (AS5620 and AMS4946) TITANIUM ENDS ^{*[8]}	1/8 HARD (MIL-T-6845) CRES TUBE ENDS WITH BACS13AP PRESET SLEEVES			
		TORQUE (IN-LB ±5%)	MINIMUM WALL THICKNESS (INCHES)	TORQUE	SPECIAL THIN- WALL TUBE WALL THICKNESS (INCHES)	TORQUE (IN-LB ±5%)
1/8	02	--	--	--	--	--
3/16	03	100 ±5 in-lb (11 ±1 N·m)	0.016 in. (0.406 mm)	100 ±5 in-lb (11 ±1 N·m)	--	--
1/4	04	140 ±7 in-lb (16 ±1 N·m)	0.020 in. (0.508 mm)	140 ±7 in-lb (16 ±1 N·m)	--	--
5/16	05	190 ±10 in-lb (21 ±2 N·m)	0.020 in. (0.508 mm)	190 ±10 in-lb (21 ±2 N·m)	--	--
3/8	06	270 ±14 in-lb (31 ±2 N·m)	0.028 in. (0.711 mm)	270 ±14 in-lb (31 ±2 N·m)	--	--
1/2	08	500 ±25 in-lb (56 ±3 N·m)	0.034 in. (0.864 mm)	500 ±25 in-lb (56 ±3 N·m)	0.028 in. (0.711 mm)	375 ±19 in-lb (42 ±3 N·m)

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Table 221/20-50-11-993-821 Installation Torques for Flared, Flareless, and Short Flareless Fittings with Lubricated Threads Used on CRES and Titanium Tube Fittings and Hose Ends (Continued)

TUBE SIZE ^{*[1]}		FLARED AND FLARELESS COMPONENTS TORQUE				
		TUBE MATERIAL/END CONFIGURATION ^{[2]*[3]*[4]*[5]*[6]*[7]}				
5/8	10	700 ±35 in-lb (79 ±4 N·m)	0.049 in. (1.245 mm)	700 ±35 in-lb (79 ±4 N·m)	0.035 in. (0.889 mm)	575 ±29 in-lb (65 ±3 N·m)
3/4	12	900 ±45 in-lb (102 ±5 N·m)	0.049 in. (1.245 mm)	900 ±45 in-lb (102 ±5 N·m)	0.042 in. (1.067 mm)	725 ±36 in-lb (82 ±4 N·m)
7/8	14	--	--	--	--	--
1	16	1200 ±60 in-lb (136 ±7 N·m)	--	--	--	--
1-1/4	20	1600 ±80 in-lb (181 ±9 N·m)	--	--	--	--
1-1/2	24	2000 ±100 in-lb (226 ±11 N·m)	--	--	--	--
1-3/4	28	--	--	--	--	--
2	32	2000 ±100 in-lb (226 ±11 N·m)	--	--	--	--

*[1] For fittings and hoses with ends of more than one size, select the torque value for each end that matches its size. Compare the fitting or hose part number to the part standard to determine the part size and material.

NOTE: The end fitting size for standard BAC, AS and NAS fittings and hoses is determined by reference to the appropriate part standard. Table: "Standard End Fitting Size and Thread Size" (check the table for each model) may be used to determine the end fitting size for non-standard fittings and hoses that must be tightened in accordance with BAC5001.

*[2] Controlled Tooling: ST 2599A, Torque Wrench for Tube Fittings or ST 2599B, Torque Wrench for Tube Components shall be used where possible to connect fittings. Equivalent micrometer style torque wrenches, adapters, and extensions are permitted only when the installation prohibits the use of the Controlled Tooling. When torque tool adapters or extensions are used, torque indicator reading correction factors may be required. Instructions for adapter/extension use and methods for obtaining the correction factor are given in BSS7083.

*[3] Use aluminum fitting torque values for aluminum, steel, or titanium fittings installed in aluminum bosses.

*[4] Use aluminum fitting torque values for aluminum jamnuts installed on aluminum, titanium, or steel bulkhead fittings.

*[5] Use steel fitting torque values for steel or titanium fittings installed on steel or titanium bosses.

*[6] Use steel fitting torque values for steel or titanium jamnuts installed on steel or titanium bulkhead fittings.

*[7] The boss or bulkhead fitting size determines the torque value for reducer fittings.

*[8] Unless otherwise specified on the Engineering Drawing, tighten these items to each other using the torque values on the table:

-Tube assemblies made with Titanium 3AL-2.5V tubing with material specifications: AS5620 and AMS4946;

-Tube assemblies made with 21-6-9 CRES or Alloy 304, 1/8 Hard CRES tubing (for example BMS7-185 (alloy 21-6-9), MIL-T-6845, AMS-T-6845 or AMS5566 (alloy 304, 1/8 Hard));

-Flared tube assemblies made with annealed CRES tubing with material specifications: MIL-T-8504 (alloy 304), MIL-T-8808 (alloy 321 or 347), AMS5556 (alloy 347), AMS5557 (alloy 321), or AMS5567 (alloy 304);

-In-line fittings made of titanium, CRES or steel. In-line fittings such as tube-to-tube union, elbow, tee or cross fittings, adapter or reducer fittings, or in-line components with flareless ends such as BAC check valves that the Engineering Drawing requires shall be installed in accordance with BAC5001-10.

-Hoses made with titanium or CRES end fittings.

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Table 222/20-50-11-993-822 Installation Torques for Flared Hose End Fittings with Aluminum Inserts

TUBE SIZE		TUBE MATERIAL/END CONFIGURATION * ^[1] * ^[2] * ^[3] * ^[4] * ^[5] * ^[6] * ^[7]
		FLARED AND FLARELESS COMPONENTS TORQUE (IN-LB ±5%)
OUTER DIAMETER (INCHES)	SIZE	FLARED HOSE END FITTINGS WITH ALUMINUM INSERTS
1/8	02	--
3/16	03	35 ±2 in-lb (3.95 ±0.20 N·m)
1/4	04	65 ±3 in-lb (7 ±1 N·m)
5/16	05	90 ±5 in-lb (10 ±1 N·m)
3/8	06	130 ±7 in-lb (15 ±1 N·m)
1/2	08	260 ±13 in-lb (29 ±2 N·m)
5/8	10	360 ±18 in-lb (41 ±2 N·m)
3/4	12	500 ±25 in-lb (56 ±3 N·m)
7/8	14	--
1	16	700 ±35 in-lb (79 ±4 N·m)
1-1/4	20	900 ±45 in-lb (102 ±5 N·m)
1-1/2	24	900 ±45 in-lb (102 ±5 N·m)
1-3/4	28	--
2	32	2000 ±100 in-lb (226 ±11 N·m)

*^[1] Controlled Tooling: ST 2599A, Torque Wrench for Tube Fittings or ST 2599B, Torque Wrench for Tube Components shall be used where possible to connect fittings. Equivalent micrometer style torque wrenches, adapters, and extensions are permitted only when the installation prohibits the use of the Controlled Tooling. When torque tool adapters or extensions are used, torque indicator reading correction factors may be required. Instructions for adapter/extension use and methods for obtaining the correction factor are given in BSS7083.

*^[2] Use aluminum fitting torque values for aluminum, steel, or titanium fittings installed in aluminum bosses.

*^[3] Use aluminum fitting torque values for aluminum jamnuts installed on aluminum, titanium, or steel bulkhead fittings.

*^[4] Use steel fitting torque values for steel or titanium fittings installed in steel or titanium bosses.

*^[5] Use steel fitting torque values for steel or titanium jamnuts installed on steel or titanium bulkhead fittings.

*^[6] The boss or bulkhead fitting size determines the torque value for reducer fittings.

*^[7] Tube material specifications: 6061-T6 Aluminum - MIL-T-7081, WW-T-700/6; Annealed CRES - MIL-T-8504, MIL-T-8606, MIL-T-8808; 1/8 Hard CRES - MIL-T-6845; 21-6-9 CRES - BMS7-185; TI-3AL-2.5V - AS5620 and AMS4946.

(i) Clamps, V-Band, and Channel-Band, Table 223, Table 224, Table 225, Table 226.

Table 223/20-50-11-993-823 Standard Torque Values for Coupling Clamps, V-Band, and Channel-Band

BOEING PART NUMBER	NOTES	DASH NUMBER ()	TORQUE
BACC10AU()	--	250-275	70 +5 / -0 in-lb (8 +1 / -0 N·m)
		300-500	100 +5 / -0 in-lb (11 +1 / -0 N·m)

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**Table 223/20-50-11-993-823 Standard Torque Values for Coupling Clamps, V-Band, and Channel-Band
(Continued)**

BOEING PART NUMBER	NOTES	DASH NUMBER ()	TORQUE
BACC10BR8()	*[1]	100-900	100 +5 / -0 in-lb (11 +1 / -0 N·m)
BACC10CT2-()	*[1]	100-600	100 +5 / -0 in-lb (11 +1 / -0 N·m)
BACC10DP()A	--	150-250	50 +5 / -0 in-lb (6 +1 / -0 N·m)
	--	350-400	50 +5 / -0 in-lb (6 +1 / -0 N·m)
	--	45-600	70 +5 / -0 in-lb (8 +1 / -0 N·m)
BACC10DP()B	--	300	50 +5 / -0 in-lb (6 +1 / -0 N·m)
BACC10DP()AB	--	350-400	50 +5 / -0 in-lb (6 +1 / -0 N·m)
		450-600	70 +5 / -0 in-lb (8 +1 / -0 N·m)
BACC10DU()AB	--	100-175	50 +5 / -0 in-lb (6 +1 / -0 N·m)
		200-275	55 +5 / -0 in-lb (6 +1 / -0 N·m)
		300-450	60 +5 / -0 in-lb (7 +1 / -0 N·m)
		500-600	65 +5 / -0 in-lb (7 +1 / -0 N·m)
		700-1000	75 +5 / -0 in-lb (8 +1 / -0 N·m)
BACC10EY()B	--	150-800	105 +5 / -0 in-lb (12 +1 / -0 N·m)
		150-400	75 +5 / -0 in-lb (8 +1 / -0 N·m)
		425-800	105 +5 / -0 in-lb (12 +1 / -0 N·m)
BACC10EZ()B	--	125-275	75 +5 / -0 in-lb (8 +1 / -0 N·m)
		300	105 in-lb (12 N·m)

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**Table 223/20-50-11-993-823 Standard Torque Values for Coupling Clamps, V-Band, and Channel-Band
(Continued)**

BOEING PART NUMBER	NOTES	DASH NUMBER ()	TORQUE
BACC10GY()	--	150-175	40 +5 / -0 in-lb (5 +1 / -0 N·m)
		200-275	45 +5 / -0 in-lb (5 +1 / -0 N·m)
		300-450	50 +5 / -0 in-lb (6 +1 / -0 N·m)
		475-600	55 +5 / -0 in-lb (6 +1 / -0 N·m)
		650-900	65 +5 / -0 in-lb (7 +1 / -0 N·m)
BACC10HX()	*[2]	100-300	10 +5 / -0 in-lb (1 +1 / -0 N·m)
		325-500	15 +5 / -0 in-lb (2 +1 / -0 N·m)
		550-800	20 +5 / -0 in-lb (2 +1 / -0 N·m)
BACC10KH	--	200-275	45 +5 / -0 in-lb (5 +1 / -0 N·m)
		300-475	55 +5 / -0 in-lb (6 +1 / -0 N·m)
		500-550	60 +5 / -0 in-lb (7 +1 / -0 N·m)
		600-650	65 +5 / -0 in-lb (7 +1 / -0 N·m)
		700	70 +5 / -0 in-lb (8 +1 / -0 N·m)
BACC10LE()	--	500-600	55 +5 / -0 in-lb (6 +1 / -0 N·m)
		650-900	65 +5 / -0 in-lb (7 +1 / -0 N·m)
BACC10NU()	--	500-600	55 +5 / -0 in-lb (6 +1 / -0 N·m)
		650-900	65 +5 / -0 in-lb (7 +1 / -0 N·m)

*[1] Inside of coupling not lubricated.

*[2] Inside of coupling and T-bolt threads not lubricated.

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Table 224/20-50-11-993-824 Installation Torques for BACR12H Roylyn Couplings

NOMINAL DUCT OUTER DIAMETER (INCHES)	DUCT MATERIAL	TORQUE	
		MINIMUM	MAXIMUM
1.50	5052-0	600 in-lb (68 N·m)	1000 in-lb (113 N·m)
	Stainless Steel	900 in-lb (102 N·m)	1200 in-lb (136 N·m)
1.75	5052-0	900 in-lb (102 N·m)	1200 in-lb (136 N·m)
2.00	5052-0	1300 in-lb (147 N·m)	2500 in-lb (282 N·m)
2.50	5052-0	2000 in-lb (226 N·m)	3000 in-lb (339 N·m)

Table 225/20-50-11-993-825 Duct Support Clamp Installation Torques

BOEING PART NUMBER	DASH NUMBER	RECOMMENDED TORQUE
BACC10Q	ALL	25 ±5 in-lb (3 ±1 N·m)
BACC10GW	ALL	40 in-lb (5 N·m) maximum ^{*[1]}
BACC10HN	ALL	40 in-lb (5 N·m) maximum ^{*[1]}

*[1] The torque value may depend on the duct material and size. See AMM procedure for specific torque value.

Table 226/20-50-11-993-826 Installation Torques for True Circle Machine Screw Type Clamps

HOSE DUCT OR CAP PART NUMBER SERIES	TORQUE	
	BACC10BN	
	MINIMUM	MAXIMUM
AS1501 Series	13 in-lb (1 N·m)	17 in-lb (2 N·m)
Rubber/Silicone Fiberglass Duct/ Sleeves		
BACC14AU (10.25 to 12.00 inches in diameter)		
BACD40 Series (except BACD40AF)		
BACD40AF (10.25 to 13.00 inches in diameter)	22 in-lb (2 N·m)	28 in-lb (3 N·m)
MIL-DTL-6000		
MIL-H-7938		
MIL-PRF-7061	13 in-lb (1 N·m)	17 in-lb (2 N·m)
S417N802	22 in-lb (2 N·m)	28 in-lb (3 N·m)
10-20353	13 in-lb (1 N·m)	17 in-lb (2 N·m)

- (j) Fasteners in all fiber/resin composite and/or thermoplastic/thermoset materials and structures, and their combinations with metal structures (Table 227, Table 228, Table 229, Table 230, Table 231, Table 232, Table 233, Table 234, Table 235, Table 236, Table 237).

NOTE: The torque values for plastic parts are given by part type, not part number.

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Table 227/20-50-11-993-827 220 KSI TENSION FASTENERS AND NUTS

FASTENER CLASS	220 KSI	
FASTENER PART NUMBER	BACB30US, BACS21EK, BACS21EM, MS14163, MS21297, MS14181	
NUT PART NUMBER OR STYLE	BACN10HC, BACN10HR, BACN11B, BACN11BU, MS14164, MS14182, MS21084, MS21085	
NOMINAL THREAD SIZE	TURN THE NUT AND NO FAY SEAL	TURN THE FASTENER HEAD AND/OR FAY SEAL
0.1900-32	60 in-lb (7 N·m)	70 in-lb (8 N·m)
0.2500-28	110 in-lb (12 N·m)	125 in-lb (14 N·m)
0.3125-24	210 in-lb (24 N·m)	250 in-lb (28 N·m)
0.3750-24	400 in-lb (45 N·m)	500 in-lb (56 N·m)
0.4375-20	675 in-lb (76 N·m)	840 in-lb (95 N·m)
0.5000-20	1100 in-lb (124 N·m)	1300 in-lb (147 N·m)
0.5625-18	1550 in-lb (175 N·m)	1800 in-lb (203 N·m)
0.6250-18	2110 in-lb (238 N·m)	2300 in-lb (260 N·m)
0.7500-16	3800 in-lb (429 N·m)	4300 in-lb (486 N·m)
0.8750-14	5900 in-lb (667 N·m)	6700 in-lb (757 N·m)
1.0000-12 or 14	8950 in-lb (1011 N·m)	10,900 in-lb (1232 N·m)
1.1250-12	11,300 in-lb (1277 N·m)	13,000 in-lb (1469 N·m)
1.2500-12	17,500 in-lb (1977 N·m)	19,200 in-lb (2169 N·m)
1.3750-12	22,000 in-lb (2486 N·m)	24,000 in-lb (2712 N·m)

Table 228/20-50-11-993-828 220 KSI BACB31G

CLASS	220 KSI	
FASTENER PART NUMBER	BACB31G	
NOMINAL THREAD SIZE	TURN THE NUT AND NO FAY SEAL	TURN THE FASTENER HEAD AND/OR FAY SEAL
0.1900-32	85 in-lb (10 N·m)	100 in-lb (11 N·m)
0.2500-28	110 in-lb (12 N·m)	125 in-lb (14 N·m)
0.3125-24	210 in-lb (24 N·m)	250 in-lb (28 N·m)
0.3750-24	400 in-lb (45 N·m)	500 in-lb (56 N·m)
0.4375-20	530 in-lb (60 N·m)	690 in-lb (78 N·m)
0.5000-20	850 in-lb (96 N·m)	1070 in-lb (121 N·m)
0.5625-18	1250 in-lb (141 N·m)	1470 in-lb (166 N·m)
0.6250-18	1650 in-lb (186 N·m)	1900 in-lb (215 N·m)
0.7500-16	2950 in-lb (333 N·m)	3500 in-lb (395 N·m)

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Table 229/20-50-11-993-829 150 - 200 KSI TENSION FASTENERS, NUTS, NUTPLATES

CLASS	160 - 200 KSI		150 - 160 KSI	
	STEEL / CRES FASTENERS		TITANIUM FASTENERS	
FASTENER PART NUMBER	BACB30EM, BACB30FD, BACB30LE, BACB30LM, BACB30NE, BACB30LP, BACB30LR, BACB30LU, BACB30PN, BACB30ZF, BACS12GP, MS14157, MS21134, MS21250, MS27576, NAS1101, NAS1102, NAS1121-NAS1128, NAS1131-NAS1138, NAS1151-NAS1158, NAS1216-NAS1218, NAS1790, NAS5314, NAS6303-NAS6320, NAS6603- NAS6620, NAS6703- NAS6720, NAS8602-NAS8616, NAS9103-NAS9106		BACB30MR, BACB30MS, BACB30NM, BACB30NN, BACB30XJ, BACB30XK, BACB30XL, BACB30XM, BACS21EJ, NAS1101, NAS1102, NAS1121-NAS1128, NAS1131-NAS1138, NAS1151-NAS1158, NAS1189, NAS1190, NAS1790, NAS6803 - NAS6820, NAS7900-NAS7906	
NUT PART NUMBER	BACN10JA, BACN10JB, BACN10ZC, BACN11Z, MS14156, MS21133, NAS1804, NAS1805, NAS577		BACN10JA, BACN10JB, BACN10ZC, BACN11Z, MS14156, MS21133, NAS1804, NAS1805, NAS577	
NOMINAL THREAD SIZE	TURN THE NUT AND NO FAY SEAL	TURN THE FASTENER HEAD AND/OR FAY SEAL	TURN THE NUT AND NO FAY SEAL	TURN THE FASTENER HEAD AND/OR FAY SEAL
0.0860 2-56 or 2-64	3 in-lb (0.3 N·m)	3 in-lb (0.3 N·m)	3 in-lb (0.3 N·m)	3 in-lb (0.3 N·m)
0.1120-40 or 48	8 in-lb (0.9 N·m)	8 in-lb (0.9 N·m)	8 in-lb (0.9 N·m)	8 in-lb (0.9 N·m)
0.1380-32 or 40	15 in-lb (1.7 N·m)	15 in-lb (1.7 N·m)	15 in-lb (1.7 N·m)	15 in-lb (1.7 N·m)
0.1640-32 or 36	20 in-lb (2 N·m)	20 in-lb (2 N·m)	20 in-lb (2 N·m)	20 in-lb (2 N·m)
0.1900-32	30 in-lb (3 N·m)	30 in-lb (3 N·m)	30 in-lb (3 N·m)	30 in-lb (3 N·m)
0.2500-28	85 in-lb (10 N·m)	100 in-lb (11 N·m)	85 in-lb (10 N·m)	100 in-lb (11 N·m)
0.3125-24	170 in-lb (19 N·m)	200 in-lb (23 N·m)	170 in-lb (19 N·m)	200 in-lb (23 N·m)
0.3750-24	320 in-lb (36 N·m)	410 in-lb (46 N·m)	320 in-lb (36 N·m)	410 in-lb (46 N·m)
0.4375-20	530 in-lb (60 N·m)	690 in-lb (78 N·m)	530 in-lb (60 N·m)	690 in-lb (78 N·m)
0.5000-20	850 in-lb (96 N·m)	1070 in-lb (121 N·m)	850 in-lb (96 N·m)	1070 in-lb (121 N·m)
0.5625-18	1250 in-lb (141 N·m)	1470 in-lb (166 N·m)	1250 in-lb (141 N·m)	1470 in-lb (166 N·m)
0.6250-18	1650 in-lb (186 N·m)	1900 in-lb (215 N·m)	1650 in-lb (186 N·m)	1900 in-lb (215 N·m)
0.7500-16	2950 in-lb (333 N·m)	3500 in-lb (395 N·m)	1900 in-lb (215 N·m)	2200 in-lb (249 N·m)
0.8750-14	4600 in-lb (520 N·m)	5500 in-lb (621 N·m)	-	-
1.0000-12 or 14	7000 in-lb (791 N·m)	8900 in-lb (1006 N·m)	-	-
1.1250-12	8800 in-lb (994 N·m)	10,700 in-lb (1209 N·m)	-	-
1.1250-12	13,600 in-lb (1537 N·m)	15,700 in-lb (1774 N·m)	-	-

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Table 230/20-50-11-993-830 95-156 KSI SHEAR FASTENERS (EXCEPT BACB31V), NUTS, NUTPLATES, CLIP NUTS, STANDOFFS, INSERTS IN METAL, TAPPED HOLES (FOR NON-METAL STACK-UP)

CLASS	95-156 KSI	
FASTENER PART NUMBER OR STYLE	BACB30LH, BACB30LK, BACB30LJ, BACB30LT, BACB30NF, BACB30NJ, BACB30NL, BACB30NR, BACB30NT, BACB30PC, BACB30PF ^{*[1]} , BACB30PU ^{*[1]} , BACB30PW ^{*[1]} , BACB30SW, BACB30TP, BACB30UU, BACB30WP, BACB30XN, BACB30ZC, BACB30ZG, BACN10JR3CFD, BACS12BE(no 'C' codes), BACS12BF(no 'C' codes), BACS12BG(no 'C' codes), BACS12BP(no 'C' codes), BACS12CB, BACS12CK, BACS12ER, BACS12FA, BACS12GM, BACS12GR, BACS12GU, BACS12GX, BACS12HJ, BACS12HL, BACS12HM, BACS12HN, BACS12HP, BACS12HU, BACS12HV, BACS12HW, BACS12HY, BACS12JA, BACS12JB, BACS12JD, BACS12JE, BACS12JK, BACS12JL, BACS12JM, BACS12N, MS21262, MS24678, MS24694-S(), MS27039, NAS1297 ^{*[1]} , NAS1351, NAS1352, NAS1580, NAS1801, NAS1802, NAS428, NAS514, NAS517, NAS563 - NAS572, NAS600 - NAS606, NAS623, NAS6203 - NAS6220, NAS8200 - NAS8206, THREADED ROD (STEEL, CRES, NICKEL ALLOY)	
NUT PART NUMBER	AN315, BACN10JC04 - BACN10JC7 ONLY, BACN10R, BACN10YR, BACN11AG, MS20500, MS21042 - MS21045, NAS1291, NAS679	
	ALL NUT PLATES EXCEPT BACN10JA, BACN10JB	
	ALL CLIP NUTS, METALLIC STANDOFFS	
	ALL INSERTS IN METAL AND TAPPED HOLES	
NOMINAL THREAD SIZE	ALL METAL CHANNELS, GANG CHANNELS	
	TURN THE NUT AND NO FAY SEAL	TURN THE FASTENER HEAD AND/OR FAY SEAL
0.0860-56 or 64	3 in-lb (0.3 N·m)	3 in-lb (0.3 N·m)
0.1120-40 or 48	8 in-lb (0.9 N·m)	8 in-lb (0.9 N·m)
0.1380-32 or 40	15 in-lb (1.7 N·m)	15 in-lb (1.7 N·m)
0.1640-32 or 36	20 in-lb (2 N·m)	20 in-lb (2 N·m)
0.1900-32	30 in-lb (3 N·m)	30 in-lb (3 N·m)
0.2500-28	65 in-lb (7 N·m)	80 in-lb (9.0 N·m)
0.3125-24	125 in-lb (14.1 N·m)	150 in-lb (17 N·m)
0.3750-24	200 in-lb (23 N·m)	240 in-lb (27 N·m)
0.4375-20	300 in-lb (34 N·m)	350 in-lb (40 N·m)
0.5000-20	635 in-lb (72 N·m)	790 in-lb (89 N·m)
0.5625-18	975 in-lb (110 N·m)	1150 in-lb (130 N·m)
0.6250-18	1300 in-lb (147 N·m)	1500 in-lb (169 N·m)
0.7500-16	2650 in-lb (299 N·m)	3000 in-lb (339 N·m)
0.8750-14	3500 in-lb (395 N·m)	4500 in-lb (508 N·m)
1.0000-12 or 14	5600 in-lb (633 N·m)	7500 in-lb (847 N·m)
1.1250-12	7000 in-lb (791 N·m)	9000 in-lb (1016.9 N·m)
1.2500-12	11,000 in-lb (1243 N·m)	13,000 in-lb (1469 N·m)

*[1] Use the thread diameter of the nut to find the applicable torque value. Do not use the nominal fastener diameter.

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Table 231/20-50-11-993-831 80-125 KSI CASTELLATED NUTS

NUT CLASS	80 KSI		125 KSI	
NUT PART NUMBER	AN320, BACN10JD103 - BACN10JD120 BACN11N103 - BACN11N120, MS14145, MS17826, MS21224		AN310, BACN10JD3 - BACN10JD6 ONLY BACN11N3 - BACN11N20 ONLY MS14144, MS17825	
NOMINAL THREAD SIZE	TURN THE NUT AND NO FAY SEAL	TURN THE FASTENER HEAD AND/OR FAY SEAL	TURN THE NUT AND NO FAY SEAL	TURN THE FASTENER HEAD AND/OR FAY SEAL
0.1900-32	18 in-lb (2 N·m) - 25 in-lb (3 N·m)	18 in-lb (2 N·m) - 25 in-lb (3 N·m)	25 in-lb (3 N·m) - 35 in-lb (4 N·m)	38 in-lb (4 N·m) - 38 in-lb (4 N·m)
0.2500-28	30 in-lb (3 N·m) - 50 in-lb (6 N·m)	45 in-lb (5 N·m) - 55 in-lb (6 N·m)	50 in-lb (6 N·m) - 80 in-lb (9 N·m)	72 in-lb (8 N·m) - 88 in-lb (10 N·m)
0.3125-24	60 in-lb (7 N·m) - 90 in-lb (10 N·m)	80 in-lb (9 N·m) - 100 in-lb (11 N·m)	100 in-lb (11 N·m) - 150 in-lb (17 N·m)	135 in-lb (15 N·m) - 165 in-lb (19 N·m)
0.3750-24	95 in-lb (11 N·m) - 160 in-lb (18 N·m)	144 in-lb (16 N·m) - 176 in-lb (20 N·m)	160 in-lb (18 N·m) - 240 in-lb (27 N·m)	216 in-lb (24 N·m) - 264 in-lb (30 N·m)
0.4375-20	220 in-lb (25 N·m) - 280 in-lb (32 N·m)	252 in-lb (28 N·m) - 308 in-lb (35 N·m)	250 in-lb (28 N·m) - 350 in-lb (40 N·m)	315 in-lb (36 N·m) - 385 in-lb (43 N·m)
0.5000-20	290 in-lb (33 N·m) - 510 in-lb (58 N·m)	459 in-lb (52 N·m) - 561 in-lb (63 N·m)	480 in-lb (54 N·m) - 790 in-lb (89 N·m)	710 in-lb (80 N·m) - 870 in-lb (98 N·m)
0.5625-18	480 in-lb (54 N·m) - 850 in-lb (96 N·m)	765 in-lb (86 N·m) - 935 in-lb (106 N·m)	800 in-lb (90 N·m) - 1150 in-lb (130 N·m)	1035 in-lb (117 N·m) - 1265 in-lb (143 N·m)
0.6250-18	660 in-lb (75 N·m) - 980 in-lb (111 N·m)	882 in-lb (100 N·m) - 1080 in-lb (122 N·m)	1100 in-lb (124 N·m) - 1500 in-lb (169 N·m)	1350 in-lb (153 N·m) - 1650 in-lb (186 N·m)
0.7500-16	1300 in-lb (147 N·m) - 2200 in-lb (249 N·m)	1800 in-lb (203 N·m) - 2200 in-lb (249 N·m)	2300 in-lb (260 N·m) - 3000 in-lb (339 N·m)	2700 in-lb (305 N·m) - 3300 in-lb (373 N·m)
0.8750-14	1500 in-lb (169 N·m) - 3300 in-lb (373 N·m)	2970 in-lb (336 N·m) - 3630 in-lb (410 N·m)	2500 in-lb (282 N·m) - 4500 in-lb (508 N·m)	4050 in-lb (458 N·m) - 4950 in-lb (559 N·m)
1.0000-12 or 14	2200 in-lb (249 N·m) - 5300 in-lb (599 N·m)	4770 in-lb (539 N·m) - 5830 in-lb (659 N·m)	3700 in-lb (418 N·m) - 7500 in-lb (847 N·m)	6750 in-lb (763 N·m) - 8250 in-lb (932 N·m)
1.1250-12	3000 in-lb (339 N·m) - 6200 in-lb (701 N·m)	5580 in-lb (630 N·m) - 6820 in-lb (771 N·m)	5000 in-lb (565 N·m) - 9000 in-lb (1017 N·m)	8100 in-lb (915 N·m) - 9000 in-lb (1017 N·m)
1.2500-12	5400 in-lb (610 N·m) - 8600 in-lb (972 N·m)	7740 in-lb (874 N·m) - 9460 in-lb (1069 N·m)	9000 in-lb (1017 N·m) - 13,000 in-lb (1469 N·m)	11,700 in-lb (1322 N·m) - 14,300 in-lb (1616 N·m)

Table 232/20-50-11-993-832 160 KSI CASTELLATED NUTS

NUT CLASS	160 KSI	
NUT PART NUMBER OR STYLE	BACN10JD7 - BACN10JD20 ONLY	
NOMINAL THREAD SIZE	TURN THE NUT AND NO FAY SEAL	TURN THE FASTENER HEAD AND/OR FAY SEAL
0.4375-20	370 in-lb (42 N·m) - 690 in-lb (78 N·m)	620 in-lb (70 N·m) - 760 in-lb (86 N·m)

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Table 232/20-50-11-993-832 160 KSI CASTELLATED NUTS (Continued)

NUT CLASS	160 KSI	
0.5000-20	630 in-lb (71 N·m) - 1070 in-lb (121 N·m)	963 in-lb (109 N·m) - 1170 in-lb (132 N·m)
0.5625-18	1000 in-lb (113 N·m) - 1470 in-lb (166 N·m)	1320 in-lb (149 N·m) - 1610 in-lb (182 N·m)
0.6250-18	1400 in-lb (158 N·m) - 1900 in-lb (215 N·m)	1710 in-lb (193 N·m) - 2090 in-lb (236 N·m)
0.7500-16	2400 in-lb (271 N·m) - 3500 in-lb (395 N·m)	3150 in-lb (356 N·m) - 3850 in-lb (435 N·m)
0.8750-14	3700 in-lb (418 N·m) - 5500 in-lb (621 N·m)	4950 in-lb (559 N·m) - 6050 in-lb (684 N·m)
1.0000-12 or 14	5100 in-lb (576 N·m) - 8900 in-lb (1006 N·m)	8010 in-lb (905 N·m) - 9790 in-lb (1106 N·m)
1.1250-12	6900 in-lb (780 N·m) - 10,700 in-lb (1209 N·m)	9630 in-lb (1088 N·m) - 11,700 in-lb (1322 N·m)
1.2500-12	11,500 in-lb (1299 N·m) - 15,700 in-lb (1774 N·m)	14,100 in-lb (1593 N·m) - 17,200 in-lb (1943 N·m)

Table 233/20-50-11-993-833 REDUCED SHEAR HEAD FASTENERS AND NUTS

FASTENER CLASS	95 KSI	
NUT PART NUMBER OR STYLE	BACB30DP, BACB30EL, BACB30FB, BACB30LL, BACB30NU, BACB30RF, BACB30UR, BACB30UW, BACB30VF, BACB30XD, BACB30YE, BACB30ZE, BACB31A, BACS12HB, BACS12HE, BACS12JC, NAS1581, NAS1992-NAS2000, NAS8703-NAS8716	
NUT PART NUMBER OR STYLE	ALL NON-CASTELLATED NUTS, NUT PLATES, CLIP NUTS, METALLIC STANDOFFS, INSERTS, TAPPED HOLES	ALL CASTELLATED NUTS
NOMINAL THREAD SIZE	DRY AND CETYL ALCOHOL LUBED FASTENERS	
	TURN THE HEAD OR THE NUT - FAY SEAL OR NO FAY SEAL	
NOTE: This table only gives the torque values for dry fasteners or fasteners that are lubricated with cetyl alcohol. The applicable torque value must be specified on the Engineering drawing for fasteners that are installed with other lubricants (including solid film lubricant). An “S” in the part number code indicates solid film lubricant.		
0.1640-32 or 36	15 in-lb (1.7 N·m)	10 in-lb (1.1 N·m) - 18 in-lb (2 N·m)
0.1900-32	30 in-lb (3 N·m)	18 in-lb (2 N·m) - 25 in-lb (3 N·m)
0.2500-28	40 in-lb (5 N·m)	30 in-lb (3 N·m) - 40 in-lb (5 N·m)
0.3125-24	95 in-lb (11 N·m)	90 in-lb (10 N·m) - 100 in-lb (11 N·m)
0.3750-24	100 in-lb (11 N·m)	95 in-lb (11 N·m) - 105 in-lb (12 N·m)
0.4375-20	160 in-lb (18 N·m)	150 in-lb (17 N·m) - 245 in-lb (28 N·m)
0.5000-20	230 in-lb (26 N·m)	220 in-lb (25 N·m) - 15 in-lb (1.7 N·m)

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Table 233/20-50-11-993-833 REDUCED SHEAR HEAD FASTENERS AND NUTS (Continued)

FASTENER CLASS	95 KSI	
0.5625-18	310 in-lb (35 N·m)	290 in-lb (33 N·m) - 325 in-lb (37 N·m)
0.6250-18	420 in-lb (47 N·m)	395 in-lb (45 N·m) - 435 in-lb (49 N·m)
0.7500-16	680 in-lb (77 N·m)	645 in-lb (73 N·m) - 15 in-lb (1.7 N·m)
0.8750-14	1100 in-lb (124 N·m)	1040 in-lb (118 N·m) - 1150 in-lb (130 N·m)
1.0000-12 or 14	1650 in-lb (186 N·m)	1560 in-lb (176 N·m) - 1730 in-lb (195 N·m)

Table 234/20-50-11-993-834 60-80 KSI SCREWS AND NUTS

CLASS	60 - 80 KSI	
FASTENER PART NUMBER	BACS12BP() (any combination of codes containing 'C')(), BACS12BE()C(), BACS12BF()C(), BACS12BG()C(), MS24693-C(), MS24693-S(), MS24694-C(), MS35207, MS51957, MS51958	
NUT PART NUMBER	BACN10JC8 - BACN10JC24 ONLY, MS21083, MS21245	
NOMINAL THREAD SIZE	TURN THE NUT AND NO FAY SEAL	TURN THE FASTENER HEAD AND/OR FAY SEAL
0.0860-2-56 or 2-64	3 in-lb (0.3 N·m)	3 in-lb (0.3 N·m)
0.1120-40 or 48	6 in-lb (0.7 N·m)	6 in-lb (0.7 N·m)
0.1380-32 or 40	12 in-lb (1.4 N·m)	12 in-lb (1.4 N·m)
0.1640-32 or 36	15 in-lb (1.7 N·m)	15 in-lb (1.7 N·m)
0.1900-32	20 in-lb (2 N·m)	20 in-lb (2 N·m)
0.2500-28	40 in-lb (5 N·m)	50 in-lb (6 N·m)
0.3125-24	80 in-lb (9 N·m)	95 in-lb (11 N·m)
0.3750-24	130 in-lb (15 N·m)	160 in-lb (18 N·m)
0.4375-20	250 in-lb (28 N·m)	280 in-lb (32 N·m)
0.5000-20	400 in-lb (45 N·m)	510 in-lb (58 N·m)
0.5625-18	670 in-lb (76 N·m)	850 in-lb (96 N·m)
0.6250-18	820 in-lb (93 N·m)	980 in-lb (111 N·m)
0.7500-16	1650 in-lb (186 N·m)	2000 in-lb (226 N·m)
0.8750-14	2400 in-lb (271 N·m)	3300 in-lb (373 N·m)
1.0000-12 or 14	3750 in-lb (424 N·m)	5300 in-lb (599 N·m)
1.1250-12	4600 in-lb (520 N·m)	6200 in-lb (701 N·m)
1.2500-12	7000 in-lb (791 N·m)	8600 in-lb (972 N·m)
1.3750-12	8000 in-lb (904 N·m)	9000 in-lb (1017 N·m)
1.5000-12	11,000 in-lb (1243 N·m)	12,000 in-lb (1356 N·m)

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Table 235/20-50-11-993-835 STAKE SCREWS

CLASS		60 - 80 KSI	95 - 160 KSI
FASTENER PART NUMBER		FCM(***)(*)CP(**) FH(***)(*)CP(**) PS(***)(*)CP(**) C(***)(*)CP(**) S(***)(*)CP(**) SFSW(***)(*)CP(**) PS(***)(*)CS(**) S10(***)(*)CP(**) SFSW(***)(*)CS(**) FHC(***)(*)CP(**)	CPS(***)(*)D(**) FCM(***)(*)D(**) FH(***)(*)D(**) PS(***)(*)D(**) S(***)(*)D(**) SFS(***)(*)D(**) SFSW(***)(*)D(**) WHS(***)(*)TPS(**)
NOMINAL THREAD SIZE	STAKE DASH NUMBER	DRY SCREWS	DRY SCREWS
0.0860-56 or 64	2C	3 in-lb (0.3 N·m)	3 in-lb (0.3 N·m)
0.1120-40 or 48	4C	6 in-lb (0.7 N·m)	8 in-lb (0.9 N·m)
0.1380-32 or 40	6C	12 in-lb (1.4 N·m)	12 in-lb (1.4 N·m)
0.1640-32 or 36	8C	16 in-lb (1.8 N·m)	20 in-lb (2 N·m)
0.1900-32	10F	20 in-lb (2 N·m)	35 in-lb (4 N·m)

Table 236/20-50-11-993-836 PLASTIC PARTS AND POTTED INSERTS

PART TYPE	POTTED INSERTS	PLASTIC PARTS	
		STANDARD PARTS	OTHER PLASTIC PARTS
PART STYLE	ALL INSERTS IN POTTING COMPOUNDS OR OTHER NON-METALLIC MATERIALS	STUDS OR THREADED INSERTS/ NUTS MOLDED INTO PLASTIC PARTS SUCH AS STANDOFFS, BONDED STUDS, ETC. THRU-HOLE PLASTIC PARTS SUCH AS BRACKETS, SUPPORTS, CLAMPS, SPACERS, WASHERS, AND GROMMETS	INTERIOR PARTS SUCH AS DECORATIVE TRIM, PLACARDS, SHROUDS, CEILINGS, LININGS, ETC.
NOMINAL THREAD SIZE	TURN THE FASTENER HEAD OR NUT	TURN THE FASTENER HEAD OR NUT	TURN THE FASTENER HEAD OR NUT
	DRY OR LUBED FASTENER	DRY OR LUBED FASTENER	DRY OR LUBED FASTENER

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Table 236/20-50-11-993-836 PLASTIC PARTS AND POTTED INSERTS (Continued)

PART TYPE	POTTED INSERTS	PLASTIC PARTS	
		STANDARD PARTS	OTHER PLASTIC PARTS
0.0860-56 or 64	3 in-lb (0.3 N·m)	-	APPLY INSTALLATION TORQUE AS REQUIRED TO HOLD THE MATING PARTS TOGETHER AT THE FAYING SURFACES AND ELIMINATE THE RELATIVE MOTION BETWEEN THE PARTS.
0.1120-40 or 48	6 in-lb (0.7 N·m)	5 in-lb (0.6 N·m) - 10 in-lb (1.1 N·m)	
0.1380-32 or 40	12 in-lb (1.4 N·m)	10 in-lb (1.1 N·m) - 15 in-lb (1.7 N·m)	
0.1640-32 or 36	15 in-lb (1.7 N·m)	15 in-lb (1.7 N·m) - 20 in-lb (2 N·m)	
0.1900-32	20 in-lb (2 N·m)	20 in-lb (2 N·m) - 25 in-lb (3 N·m)	
0.2500-28	40 in-lb (5 N·m)	30 in-lb (3 N·m) - 35 in-lb (4 N·m)	
0.3125-24	80 in-lb (9 N·m)	60 in-lb (7 N·m) - 65 in-lb (7 N·m)	
0.3750-24	130 in-lb (15 N·m)	-	

Table 237/20-50-11-993-837 JAM NUTS

NUT PART NUMBER	AN316, MS35649, MS35650, MS35691 OTHER JAM NUTS WITHOUT LOCKWIRE HOLES		NAS1423, NAS509, OTHER JAM NUTS WITH LOCKWIRE HOLES	
	TURN THE NUT AND NO FAY SEAL	TURN THE FASTENER HEAD AND/OR FAY SEAL	TURN THE NUT AND NO FAY SEAL	TURN THE FASTENER HEAD AND/OR FAY SEAL
0.1900-32	20 in-lb (2 N·m)	20 in-lb (2 N·m)	15 in-lb (1.7 N·m)	15 in-lb (1.7 N·m)
0.2500-28	25 in-lb (3 N·m)	30 in-lb (3 N·m)	20 in-lb (2 N·m)	20 in-lb (2 N·m)
0.3125-24	50 in-lb (6 N·m)	50 in-lb (6 N·m)	35 in-lb (4 N·m)	35 in-lb (4 N·m)
0.3750-24	65 in-lb (7 N·m)	70 in-lb (8 N·m)	45 in-lb (5 N·m)	45 in-lb (5 N·m)
0.4375-20	100 in-lb (11 N·m)	105 in-lb (12 N·m)	65 in-lb (7 N·m)	70 in-lb (8 N·m)
0.5000-20	115 in-lb (13 N·m)	125 in-lb (14 N·m)	80 in-lb (9 N·m)	85 in-lb (10 N·m)
0.5625-18	135 in-lb (15 N·m)	145 in-lb (16 N·m)	90 in-lb (10 N·m)	95 in-lb (11 N·m)
0.6250-18	150 in-lb (17 N·m)	160 in-lb (18 N·m)	100 in-lb (11 N·m)	105 in-lb (12 N·m)
0.7500-16	240 in-lb (27 N·m)	250 in-lb (28 N·m)	155 in-lb (18 N·m)	165 in-lb (19 N·m)
0.8750-14	330 in-lb (37 N·m)	345 in-lb (39 N·m)	220 in-lb (25 N·m)	230 in-lb (26 N·m)
1.0000-12 or 14	420 in-lb (47 N·m)	440 in-lb (50 N·m)	280 in-lb (32 N·m)	290 in-lb (33 N·m)
1.1250-12	550 in-lb (62 N·m)	575 in-lb (65 N·m)	365 in-lb (41 N·m)	380 in-lb (43 N·m)
1.2500-12	675 in-lb (76 N·m)	705 in-lb (80 N·m)	450 in-lb (51 N·m)	470 in-lb (53 N·m)

————— **END OF TASK** —————

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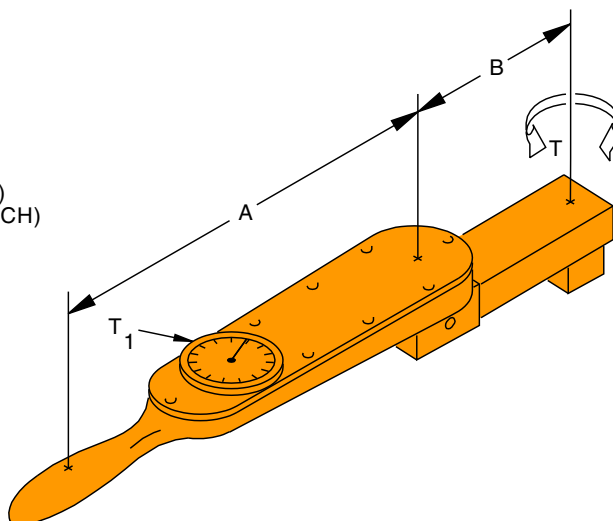
$$T_1 = \frac{TA}{A+B}$$

A = LENGTH OF THE TORQUE WRENCH
B = EFFECTIVE LENGTH OF THE ADAPTER
T = APPROVED TORQUE (SHOWN IN TORQUE TABLE)
T₁ = ADJUSTED TORQUE (SHOWN ON TORQUE WRENCH)

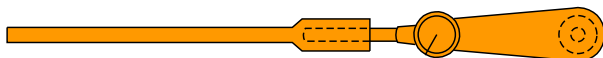
EXAMPLE: A = 12 INCHES
B = 3 INCHES
T = 160 POUND -INCHES

$$T_1 = \frac{160 \times 12}{12+3}$$

T₁ = 128 POUND -INCHES

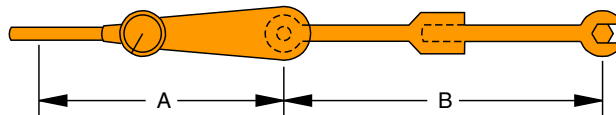


METHOD 1



HANDLE EXTENSION ONLY.
NO CORRECTION NECESSARY.

METHOD 2



ADAPTER WITH THE EXTENSION BETWEEN THE
ADAPTER AND THE WRENCH. BOTH ARE IN LINE
WITH THE WRENCH. INDICATED TORQUE T₁:

$$T_1 = \frac{TA}{A+B}$$

METHOD 3

2411227 S00061527277_V1

Finding Torque Values for a Torque Wrench with an Adapter
Figure 201/20-50-11-990-801 (Sheet 1 of 2)

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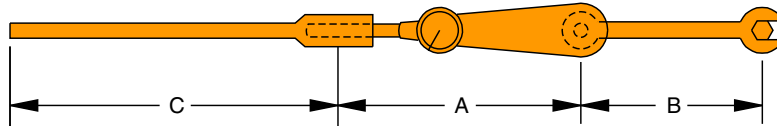
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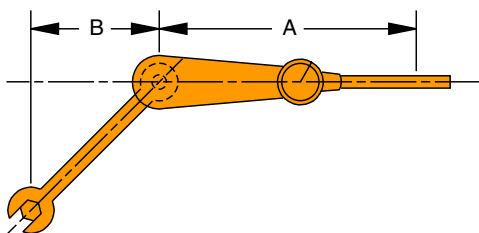
BOTH HANDLE EXTENSION AND ADAPTER,
INDICATED TORQUE T_1 :

$$T_1 = \frac{T \times (A+C)}{A+B+C}$$

METHOD 4

IF POSSIBLE, METHODS 5 AND 6 SHOULD NOT BE USED. WHEN IT IS NECESSARY TO USE THESE METHODS, THE FOLLOWING CONDITIONS MUST BE APPLICABLE:

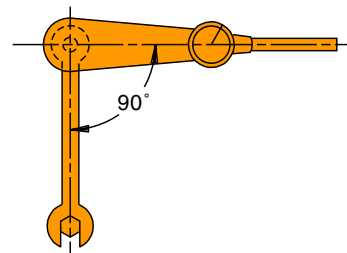
1. THE ADAPTER PLUS ANY EXTENSIONS USED BETWEEN THE WRENCH AND THE ADAPTER MUST NOT BE MORE THAN THE LENGTH OF THE WRENCH.
2. WHEN A FORCE IS APPLIED AT $90 \pm 3^\circ$ TO THE HANDLE OF THE WRENCH, IT IS RECOMMENDED THAT A STIRRUP-TYPE HANDLE WITH A POINTER (INDICATING ANGLE OF LOADING) BE USED TO MAKE SURE LOADING IS AT THE CORRECT ANGLE.



ADAPTER AT ANGLE OTHER THAN
 90° . INDICATED TORQUE T_1 :

$$T_1 = \frac{TA}{A+B}$$

METHOD 5



ADAPTER AT RIGHT ANGLE TO THE
WRENCH. NO CORRECTION NECESSARY.

METHOD 6

2411228 S00061527278_V1

Finding Torque Values for a Torque Wrench with an Adapter
Figure 201/20-50-11-990-801 (Sheet 2 of 2)

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BACB30DP (CRES)
BACB30EL (STEEL)



BACB30NU
(TITANIUM)



BACB30LL
(CRES)



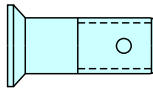
BACB30FB (STEEL)
BACB30RF (STEEL)
BACB30UW (STEEL)



BACB30UR (TITANIUM)



BACB30VF (TITANIUM)
BACB30XD (TITANIUM)



NAS1992 THRU NAS2000



NAS8702 THRU
NAS8716



BACB30ZE (CRES)



BACB30YE (TITANIUM)
BACB31A (CRES)



BACS12HB (CRES)



BACS12HE (TITANIUM)



BACS12JC

BOLT PART NUMBERS AND STYLES

2411229 S00061527279_V1

Torque Values for Reduced-Head Bolts
Figure 202/20-50-11-990-802

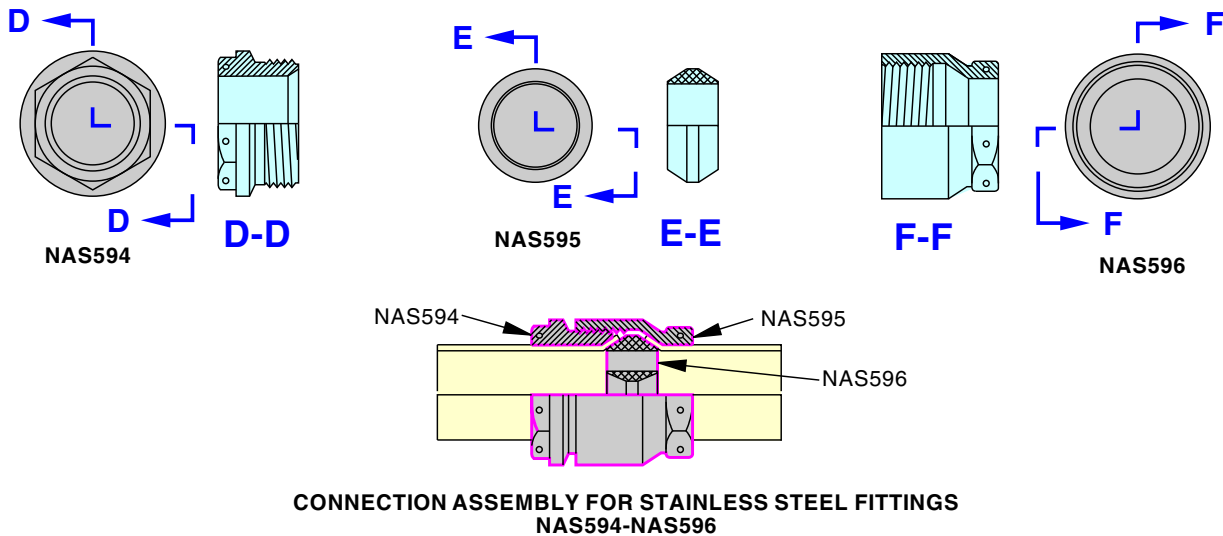
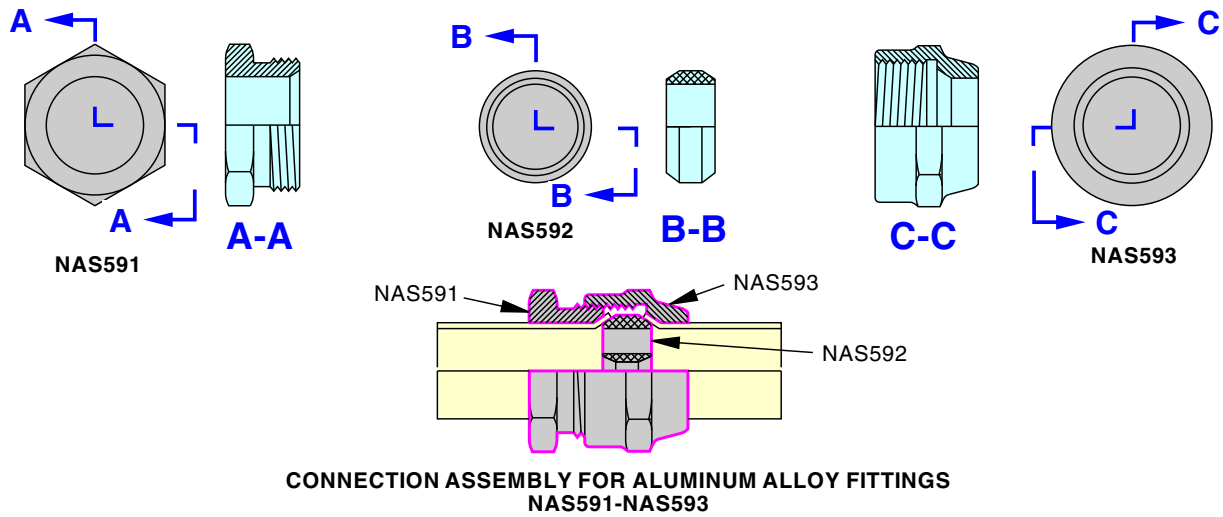
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Connection Assemblies for Rigid Tube Couplings
Figure 203/20-50-11-990-803

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CIRCUIT BREAKER RESET - MAINTENANCE PRACTICES

1. General

- A. This procedure has one task:
(1) Circuit Breaker Reset.

TASK 20-60-01-860-801

2. Circuit Breaker Reset

A. **General**

- (1) This procedure is for on-the-ground maintenance.
- (a) Circuit breakers open when there is an electrical overload in the airplane system. A circuit breaker that opens because of an electrical overload is known as a "tripped" circuit breaker.
 - (b) You must use the FIM for troubleshooting open fuel pump circuit breakers.
 - 1) You can not use this procedure to reset a tripped fuel pump circuit breaker.
 - (c) If there are currently specific instructions for the reset of a tripped circuit breaker in maintenance and troubleshooting procedures, follow those instructions.
 - (d) A defective circuit breaker can cause the circuit breaker to open. Make sure that the circuit breaker is serviceable.
 - (e) Use your judgement and airline policy to reset a tripped circuit breaker.
 - (f) Monitor the airplane to see if a tripped circuit breaker occurs again on subsequent flights.
 - (g) Do not reset a tripped circuit breaker until you know the cause for the tripped circuit breaker and that the circuit breaker can be safely reset. Fires have occurred in which the tripped circuit breakers were reset without an examination of the cause.
 - (h) Use this procedure to reset a tripped circuit breaker:
 - 1) If you know that the circuit breaker is serviceable.
 - 2) If this procedure is in agreement with your airline policy.
 - 3) If you cannot find the cause for the tripped circuit breaker.
 - 4) If you cannot find whether it is safe to reset the circuit breaker.

B. **References**

Reference	Title
FIM	Fault Isolation Manual
SWPM 20-02-10	Airplane Flammable Leakage Zones
WDM	

C. **Tools/Equipment**

Reference	Description
STD-576	Lock - Circuit Breaker (Commercially available - per SWPM 20-00-10 or equivalent)

D. **Location Zones**

Zone	Area
100	Lower Half of Fuselage
200	Upper Half of Fuselage

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E. Circuit Breaker Reset

SUBTASK 20-60-01-860-001

- (1) Attach a DO-NOT-CLOSE tag to the tripped circuit breaker.

SUBTASK 20-60-01-860-002

- (2) Install a circuit breaker lock, STD-576, on the tripped circuit breaker.

SUBTASK 20-60-01-860-003

- (3) If the tripped circuit breaker is one of three circuit breakers protecting a 3-phase circuit:
- (a) Open the other two circuit breakers.
 - (b) Attach DO-NOT-CLOSE tags.
 - (c) Install circuit breaker locks, STD-576.

SUBTASK 20-60-01-860-004

- (4) Look in the aircraft logbook to find if there is recorded data about a "tripped" circuit breaker, such as:
- (a) The condition existing when the circuit breaker trip occurred.
 - (b) The conditions existing when the circuit breaker was reset.
 - (c) The results of resetting the circuit breaker.

SUBTASK 20-60-01-860-005

- (5) Do a visual check for damage to electrical wiring and system components related to the tripped circuit breaker.
- (a) If it is necessary, refer to the WDM .
 - (b) Look for these types of damage:
 - 1) Electrical shorting
 - 2) Electrical arcing
 - 3) Corrosion on the contacts of the electrical wiring and system components
 - 4) Abrasion of the electrical wiring and system components
 - 5) Cracks on the insulation of the electrical wiring
 - 6) Split wires

NOTE: A split wire is when you can see the conductor through the crack in the insulation of the electrical wiring.

 - 7) Broken wires
 - 8) Discoloration of the insulation of the electrical wiring
 - 9) Fluid or dust contamination of electrical wiring and system components

NOTE: Contamination can be a fuel source during electrical arcing.

 - 10) Metal shavings.
- NOTE: Metal shavings can cause electrical shorting.

SUBTASK 20-60-01-860-006

- (6) Make sure that there are no loose terminal connections.
- NOTE: Loose terminal connections can be a source of electrical arcing.

SUBTASK 20-60-01-860-007

- (7) If you find damage to the electrical wiring, refer to the Standard Wiring Practices Manual (SWPM) and repair the electrical wiring.

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SUBTASK 20-60-01-860-008

- (8) If you find damage to a system component, refer to the applicable Aircraft Maintenance Manual (AMM) procedure and replace the component.

SUBTASK 20-60-01-860-009

- (9) Remove contamination and metal shavings, if it is necessary.

SUBTASK 20-60-01-860-010

- (10) Remove the DO-NOT-CLOSE tag(s).

SUBTASK 20-60-01-860-011

- (11) Remove the circuit breaker locks, STD-576.

SUBTASK 20-60-01-860-012



BEFORE YOU CLOSE A FUEL PUMP CIRCUIT BREAKER THAT OPENED DURING PUMP OPERATION, DO THE APPLICABLE FIM PROCEDURE. A DAMAGED PUMP, OR A PROBLEM WITH THE PUMP WIRING CAN CAUSE THE CIRCUIT BREAKER TO OPEN. THIS CONDITION CAN CAUSE A FIRE, OR AN EXPLOSION.



KEEP PERSONS AND EQUIPMENT CLEAR OF THE SYSTEM RELATED TO THE TRIPPED CIRCUIT BREAKER. MAKE SURE THAT THERE IS NO DAMAGE TO THE ELECTRICAL WIRING AND SYSTEM COMPONENTS. MAKE SURE THAT ALL TERMINAL CONNECTIONS ARE TIGHT. DAMAGED ELECTRICAL WIRING, DAMAGED SYSTEM COMPONENTS AND LOOSE TERMINAL CONNECTIONS CAN CAUSE ELECTRICAL ARCING AND A FIRE WHEN THE CIRCUIT BREAKER IS CLOSED.

MAKE SURE THROUGH SWPM 20-02-10 THAT THE OPEN CIRCUIT BREAKER DOES NOT HAVE AN EFFECT ON FLAMMABLE LEAKAGE ZONES. IF THE CIRCUIT BREAKER IS CLOSED WITHOUT FLAMMABLE LEAKAGE ZONE VERIFICATION, SPARKS CAN CAUSE A FIRE OR EXPLOSION.

- (12) Close the circuit breaker(s).

SUBTASK 20-60-01-860-013

- (13) After you close the circuit breaker(s), make sure that there is no electrical arcing or other damage to the system.

SUBTASK 20-60-01-860-014

- (14) To make sure that the airplane system operates correctly, refer to the applicable procedure in the Aircraft Maintenance Manual (AMM).

————— **END OF TASK** —————

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ELECTRICAL WIRING INTERCONNECTION SYSTEM - MAINTENANCE PRACTICES

1. General

- A. This procedure contains scheduled maintenance task data.

 EWIS

TASK 20-60-02-100-801

2. General Visual Inspection of EWIS

NOTE: This procedure is a scheduled maintenance task.

A. General

- (1) This procedure is an Enhanced Zonal Analysis Procedure (EZAP) task.
- (2) This procedure performs a general visual inspection of Electrical Wiring Interconnection System (EWIS).

B. Definitions:

- (1) Electrical Wiring Interconnection System (EWIS): means any wire, power feeder, wiring device, or combination of these, including termination devices, installed in any area of the airplane for the purpose of transmitting electrical energy, including data and signals, between two or more intended termination points. EWIS is defined in full by 14 CFR section 25.1701.
- (2) General Visual Inspection (GVI) — A visual examination of an interior or exterior area, installation, or assembly to detect obvious damage, failure, or irregularity. This level of inspection is made from within touching distance unless otherwise specified. A mirror may be necessary to enhance visual access to all exposed surfaces in the inspection area. This level of inspection is made under normally available lighting conditions such as daylight, hangar lighting, flashlight, or droplight and may require removal or opening of access panels or doors. Stands, ladders, or platforms may be required to gain proximity to the area being checked.

C. References

Reference	Title
20-40-11-910-801	Static Grounding (P/B 201)
20-60-02-100-803	Cleaning to Remove Combustible Material (P/B 701)
20-60-07-910-801	Protection of the EWIS During Maintenance (P/B 201)
SWPM 20, Standard Wiring Practices	Standard Wiring Practices
SWPM 20-10-20	Standard Wiring Practices Manual

D. General Visual Inspection of EWIS

SUBTASK 20-60-02-210-001

- (1) Do this task: Static Grounding, TASK 20-40-11-910-801.

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SUBTASK 20-60-02-860-001



WARNING

BE CAREFUL WHEN YOU DO WORK AROUND ENERGIZED PANELS. HIGH VOLTAGES CAN KILL YOU.

- (2) If it is necessary to touch the EWIS, it is recommended to remove electrical power from the EWIS to be inspected:

NOTE: You can remove all electrical power from the airplane if the removal from one or more systems is not possible. Complete electrical power removal will additionally require disconnecting the main (and auxiliary, if installed) aircraft batteries, otherwise there will still be energized EWIS systems. The battery removal task removes the battery connector/s from the aircraft.

- (a) Identify the applicable electrical system(s) for the EWIS to be inspected.
- (b) Open circuit breakers and switches for the EWIS to be inspected.
- (c) Put a collar/warning tag on the applicable circuit breaker(s), and warning tag on the applicable switch(s) for the EWIS to be inspected.

SUBTASK 20-60-02-010-003

- (3) Remove panels as necessary to gain access to the EWIS.

SUBTASK 20-60-02-210-003

- (4) Do these steps to perform a general inspection of the EWIS:

NOTE: You do not need to pull on the wire bundles, shake the wire bundles, or disconnect the connectors to perform this inspection.

- (a) Protect all EWIS during the inspection:



CAUTION

KEEP TOOLS, TOOL TRAYS, AND OTHER WORK ITEMS OFF OF THE WIRES. OBJECTS PUT ON THE WIRE BUNDLES OR THEIR RELATED COMPONENTS CAN CAUSE DAMAGE TO THE WIRES, INSULATION, AND CONNECTORS.



CAUTION

DO NOT PUT PRESSURE ON THE WIRE BUNDLES, ELECTRONIC SYSTEMS, OR STRUCTURES IN THE COMPARTMENT. PRESSURE CAN CAUSE DAMAGE TO WIRE BUNDLES AND ELECTRICAL CONNECTIONS.



CAUTION

DO NOT CUT, CAUSE NICKS, OR CAUSE OTHER DAMAGE TO THE CABLES, WIRES, METAL-BRAIDED SHIELD, OR OVERBRAID. DAMAGE TO THESE COMPONENTS CAN CAUSE MALFUNCTIONS, OR DAMAGE TO OTHER EQUIPMENT.

- 1) EWIS that are undisturbed and kept free of contamination will provide trouble-free service without the need for unscheduled maintenance.



CAUTION

DO NOT USE WIRE BUNDLES, TUBING, DUCTS, OR OTHER ENGINE COMPONENTS AS A STEP OR HAND-HOLD. DAMAGE TO EQUIPMENT CAN OCCUR.

- 2) EWIS can be easily damaged during the inspection if they are used as a handhold or support for personal equipment.

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- (b) Check the EWIS and the area around them for combustible material such as dust, lint and other surface contamination.
 - 1) If combustible material is found, do this task: Cleaning to Remove Combustible Material, TASK 20-60-02-100-803.
- (c) Check the EWIS for: contact, chafing, sagging, security, visible damage, lacing tape/ties installation, sheath / conduit deformity or installation, end of sheath rubbing on end attachment, missing or damaged grommets, dust and lint accumulation, surface contamination, deterioration of previous repairs.
- (d) Check connectors for: external corrosion, backshell tail, rubber pad/packing on backshell, backshell wire securing device, missing or broken safety wire, discoloration or evidence of overheat on terminal lugs or blocks, torque stripe misalignment.
- (e) Check switches for rear protection cap damage.
- (f) Check ground points for: corrosion, bonding braid/bonding jumper, broken or disconnected braid, multiple strands corroded or broken.
- (g) Check EWIS clamps or brackets for: presence, corrosion, condition, bends or twists, attachment, protection/cushion.
- (h) Check EWIS supports such as rails, racks, shelves, or tubes/conduits for: breaks, deformity, missing fasteners, missing edge protection on rims of feed through holes, race track cushion damage.
- (i) If damage is found on any EWIS, do the following:
 - 1) Do this task: Protection of the EWIS During Maintenance, TASK 20-60-07-910-801.
 - 2) Repair or replace per the applicable task: SWPM 20, Standard Wiring Practices.
- (j) If damage is found with the pressure seals, replace the component: SWPM 20-10-20.

E. Put the Airplane Back to Its Usual Condition

SUBTASK 20-60-02-410-001



MAKE SURE THAT YOU REMOVE ALL TOOLS, LOOSE PARTS AND UNWANTED MATERIAL FROM THE AREA WHEN YOU COMPLETE MAINTENANCE. DAMAGE TO EQUIPMENT COULD OCCUR.

- (1) Install all panels removed for access.

SUBTASK 20-60-02-860-002

- (2) Restore electrical power in the area(s) and/or from the item(s) that had the electrical power removed.
 - (a) Remove the collar/warning tag on the applicable circuit breaker(s), and warning tag on the applicable switch(s) for the area(s) and/or from the item(s) that had the electrical power removed.

————— **END OF TASK** —————

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ELECTRICAL WIRING INTERCONNECTION SYSTEM - INSPECTION/CHECK

1. General

- A. This procedure contains scheduled maintenance task data.

 EWIS

TASK 20-60-02-100-802

2. Detailed Inspection of EWIS

NOTE: This procedure is a scheduled maintenance task.

A. General

- (1) This procedure is an Enhanced Zonal Analysis Procedure (EZAP) task.
- (2) This procedure performs a detailed inspection of Electrical Wiring Interconnection System (EWIS).

B. Definitions:

- (1) Electrical Wiring Interconnection System (EWIS): means any wire, power feeder, wiring device, or combination of these, including termination devices, installed in any area of the airplane for the purpose of transmitting electrical energy, including data and signals, between two or more intended termination points. EWIS is defined in full by 14 CFR section 25.1701.
- (2) Detailed Inspection (DET) — An intensive examination of a specific item, installation, or assembly to detect damage, failure, or irregularity. Available lighting is normally supplemented with a direct source of good lighting at an intensity deemed appropriate. Inspection aids such as mirrors, magnifying lenses, or other means may be necessary. Surface cleaning and elaborate access procedures may be required. A DET can be more than just a visual inspection, since it may include tactile assessment in which a component or assembly is checked for tightness/security. It may require the removal of items such as access panels and drip shields, or the moving of components.

C. References

Reference	Title
20-40-11-910-801	Static Grounding (P/B 201)
20-60-02-100-803	Cleaning to Remove Combustible Material (P/B 701)
20-60-07-910-801	Protection of the EWIS During Maintenance (P/B 201)
SWPM 20, Standard Wiring Practices	Standard Wiring Practices
SWPM 20-10-20	Standard Wiring Practices Manual

D. Detailed Inspection of EWIS

SUBTASK 20-60-02-100-001

- (1) Do this task: Static Grounding, TASK 20-40-11-910-801.

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SUBTASK 20-60-02-860-005



WARNING

BE CAREFUL WHEN YOU DO WORK AROUND ENERGIZED PANELS. HIGH VOLTAGES CAN KILL YOU.

- (2) If it is necessary to touch the EWIS, it is recommended to remove electrical power from the EWIS to be inspected:

NOTE: You can remove all electrical power from the airplane if the removal from one or more systems is not possible. Complete electrical power removal will additionally require disconnecting the main (and auxiliary, if installed) aircraft batteries, otherwise there will still be energized EWIS systems. The battery removal task removes the battery connector/s from the aircraft.

- (a) Identify the applicable electrical system(s) for the EWIS to be inspected.
- (b) Open circuit breakers and switches for the EWIS to be inspected.
- (c) Put a collar/warning tag on the applicable circuit breaker(s), and warning tag on the applicable switch(s) for the EWIS to be inspected.

SUBTASK 20-60-02-010-005

- (3) Remove panels as necessary to gain access to the EWIS.

SUBTASK 20-60-02-210-004

- (4) Do these steps to perform a detailed inspection of the EWIS:

NOTE: You do not need to pull on the wire bundles, shake the wire bundles, or disconnect the connectors to perform this inspection.

- (a) Protect all EWIS during the inspection:



CAUTION

KEEP TOOLS, TOOL TRAYS, AND OTHER WORK ITEMS OFF OF THE WIRES. OBJECTS PUT ON THE WIRE BUNDLES OR THEIR RELATED COMPONENTS CAN CAUSE DAMAGE TO THE WIRES, INSULATION, AND CONNECTORS.



CAUTION

DO NOT PUT PRESSURE ON THE WIRE BUNDLES, ELECTRONIC SYSTEMS, OR STRUCTURES IN THE COMPARTMENT. PRESSURE CAN CAUSE DAMAGE TO WIRE BUNDLES AND ELECTRICAL CONNECTIONS.



CAUTION

DO NOT CUT, CAUSE NICKS, OR CAUSE OTHER DAMAGE TO THE CABLES, WIRES, METAL-BRAIDED SHIELD, OR OVERBRAID. DAMAGE TO THESE COMPONENTS CAN CAUSE MALFUNCTIONS, OR DAMAGE TO OTHER EQUIPMENT.

- 1) EWIS that are undisturbed and kept free of contamination will provide trouble-free service without the need for unscheduled maintenance.



CAUTION

DO NOT USE WIRE BUNDLES, TUBING, DUCTS, OR OTHER ENGINE COMPONENTS AS A STEP OR HAND-HOLD. DAMAGE TO EQUIPMENT CAN OCCUR.

- 2) EWIS can be easily damaged during the inspection if they are used as a handhold or support for personal equipment.

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- (b) Check the EWIS and the area around them for combustible material such as dust, lint and other surface contamination.
 - 1) If combustible material is found, do this task: Cleaning to Remove Combustible Material, TASK 20-60-02-100-803.
- (c) Check the EWIS for: contact, chafing, sagging, security, visible damage, lacing tape/ties installation, sheath / conduit deformity or installation, end of sheath rubbing on end attachment, missing or damaged grommets, dust and lint accumulation, surface contamination, deterioration of previous repairs.
- (d) Check connectors for: external corrosion, backshell tail, rubber pad/packing on backshell, backshell wire securing device, missing or broken safety wire, discoloration or evidence of overheat on terminal lugs or blocks, torque stripe misalignment.
- (e) Check switches for rear protection cap damage.
- (f) Check ground points for: corrosion, bonding braid/bonding jumper, broken or disconnected braid, multiple strands corroded or broken.
- (g) Check EWIS clamps or brackets for: presence, corrosion, condition, bends or twists, attachment, protection/cushion.
- (h) Check EWIS supports such as rails, racks, shelves, or tubes/conduits for: breaks, deformity, missing fasteners, missing edge protection on rims of feed through holes, race track cushion damage.
- (i) If damage is found on any EWIS, do the following:
 - 1) Do this task: Protection of the EWIS During Maintenance, TASK 20-60-07-910-801.
 - 2) Repair or replace per the applicable task: SWPM 20, Standard Wiring Practices.
- (j) If damage is found with the pressure seals, replace the component: SWPM 20-10-20.

E. Put the Airplane Back to Its Usual Condition

SUBTASK 20-60-02-410-002



MAKE SURE THAT YOU REMOVE ALL TOOLS, LOOSE PARTS AND UNWANTED MATERIAL FROM THE AREA WHEN YOU COMPLETE MAINTENANCE. DAMAGE TO EQUIPMENT COULD OCCUR.

- (1) Install all panels removed for access.

SUBTASK 20-60-02-860-006

- (2) Restore electrical power in the area(s) and/or from the item(s) that had the electrical power removed.
 - (a) Remove the collar/warning tag on the applicable circuit breaker(s), and warning tag on the applicable switch(s) for the area(s) and/or from the item(s) that had the electrical power removed.

————— **END OF TASK** —————

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ELECTRICAL WIRING INTERCONNECTION SYSTEM - CLEANING/PAINTING

1. General

A. This procedure contains scheduled maintenance task data.



EWIS

TASK 20-60-02-100-803

2. Cleaning to Remove Combustible Material

NOTE: This procedure is a scheduled maintenance task.

A. General

- (1) This procedure is an enhanced zonal analysis procedure (EZAP) task.
- (2) This procedure cleans the area(s) and/or items(s) to significantly reduce the accumulation of combustible material.

B. Definition:

- (1) A combustible material is any solid, liquid, or gaseous material that has the ability to cause a fire to be sustained after removal of the ignition source. Refer to Advisory Circular AC 25-27 for additional information regarding combustible materials and wiring contamination.

C. References

Reference	Title
20-40-11-910-801	Static Grounding (P/B 201)
20-60-07-910-801	Protection of the EWIS During Maintenance (P/B 201)
51-00	STANDARD PRACTICES AND STRUCTURES
SWPM 20-10-04	Cleaning of Wire Harnesses

D. Tools/Equipment

Reference	Description
STD-126	Brush - Soft-bristle, Non-metallic
STD-10711	Shop Vacuum (400Hz if using aircraft power)

E. Cleaning to Remove Combustible Material

SUBTASK 20-60-02-010-001

- (1) Do this task: Static Grounding, TASK 20-40-11-910-801.

SUBTASK 20-60-02-860-003



EXERCISE EXTREME CAUTION WHEN WORKING AROUND ENERGIZED PANELS. HIGH VOLTAGES PRESENT CAN BE FATAL.

- (2) If it is necessary to touch the EWIS, it is recommended to remove electrical power in the area(s) or from the item(s) to be cleaned:

NOTE: You can remove all electrical power from the airplane if the removal from one or more systems is not possible. Complete electrical power removal will additionally require disconnecting the main (and auxiliary, if installed) aircraft batteries, otherwise there will still be energized EWIS systems. The battery removal task removes the battery connector/s from the aircraft.

- (a) Identify the applicable electrical system(s) in the area(s) and/or from the item(s) to be cleaned.

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- (b) Open circuit breakers and switches for the applicable area(s) and/or from the item(s) to be cleaned.
- (c) Put a collar/warning tag on the applicable circuit breaker(s), and warning tag on the applicable switch(s) for the area(s) and/or from the item(s) to be cleaned.

SUBTASK 20-60-02-010-004

- (3) Remove panels as necessary to gain access to the area(s)/item(s).

SUBTASK 20-60-02-100-002

- (4) Do these steps to clean the area(s)/item(s):

NOTE: This procedure cleans the area(s)/item(s) where significant combustible material accumulates.

- (a) Do this task: Protection of the EWIS During Maintenance, TASK 20-60-07-910-801.



CAUTION

DO NOT CUT, CAUSE NICKS, OR CAUSE OTHER DAMAGE TO THE CABLES, WIRES, METAL-BRAIDED SHIELD, OR OVERBRAID. DAMAGE TO THESE COMPONENTS CAN CAUSE MALFUNCTIONS, OR DAMAGE TO OTHER EQUIPMENT.

- (b) Remove loose contamination by hand.
- (c) Use a vacuum, STD-10711, with a soft bristle brush head to remove accumulations of combustible materials.
NOTE: The vacuum cleaner head should be made of plastic or non-conductive material.
- (d) Use a soft-bristle non-metallic brush, STD-126, to loosen accumulations of combustible materials that remain and vacuum the area(s)/item(s) again.
- (e) For contamination in the area(s) that can not be removed with a brush and vacuum, do the applicable procedure(s): STANDARD PRACTICES AND STRUCTURES, SECTION 51-00.
- (f) For contamination on wiring harnesses that you can not remove with a brush and vacuum, do this procedure: SWPM 20-10-04.

F. Put the Airplane Back to Its Usual Condition

SUBTASK 20-60-02-410-003



CAUTION

MAKE SURE THAT YOU REMOVE ALL TOOLS, LOOSE PARTS AND UNWANTED MATERIAL FROM THE AREA WHEN YOU COMPLETE MAINTENANCE. DAMAGE TO EQUIPMENT COULD OCCUR.

- (1) Install all panels removed for access.

SUBTASK 20-60-02-860-004

- (2) Restore electrical power in the area(s) and/or from the item(s) that had the electrical power removed.
 - (a) Remove the collar/warning tag on the applicable circuit breaker(s), and warning tag on the applicable switch(s) for the area(s) and/or from the item(s) that had the electrical power removed.

————— **END OF TASK** —————

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CIRCUIT BREAKER CYCLE - MAINTENANCE PRACTICES

1. General

- A. This procedure has this task:
- (1) Circuit Breaker Cycle
- B. This procedure is for on-the-ground maintenance.
- (1) This procedure is for on-the-ground maintenance and is preventative maintenance for those circuit breakers that are less frequently used. It is not necessary to do this procedure for frequently used circuit breakers. Because each airline operates differently, it is an airline decision as to which circuit breakers are frequently used and which circuit breakers are less frequently used.
 - (2) Research has shown that the cycling of less frequently used circuit breakers can help to improve operational system reliability. If a circuit breaker has not been operated for some time, it is possible that the circuit breaker may not open when an electrical fault occurs.
 - (3) Circuit breakers are located in all areas of the airplane such as the flight compartment, electrical equipment bays, cargo compartments, passenger compartment, and other areas.
 - (4) Too much repeated use of a circuit breaker can result in premature failure of the circuit breaker.

TASK 20-60-05-800-801

2. Circuit Breaker Cycle

A. **References**

Reference	Title
24-22-00-860-802	Remove Electrical Power (P/B 201)

B. **Circuit Breaker Cycle**

SUBTASK 20-60-05-020-001

- (1) Do this task: Remove Electrical Power, TASK 24-22-00-860-802.

NOTE: Electrical power must be off so that subsequent incorrect fault indications or nuisance messages are prevented.

SUBTASK 20-60-05-860-001

- (2) Do these steps to cycle a circuit breaker on the airplane:
 - (a) Open the circuit breaker.
 - (b) Do a visual check of the circuit breaker area for damage.
 - 1) Look for these types of damage:
 - a) Electrical shorting
 - b) Electrical arcing
 - c) Discoloration of the circuit breaker
 - d) Contamination of the circuit breaker.
 - 2) If you find damage to the circuit breaker, replace the circuit breaker.
 - (c) Close the circuit breaker.

NOTE: After you open and close the circuit breaker, you can possibly find contamination.
 - (d) Remove all contamination, if it is necessary.
 - (e) If you find that the circuit breaker is unserviceable after you open and close it, replace the circuit breaker.

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SUBTASK 20-60-05-860-002

- (3) If it is necessary, do this procedure again to cycle another circuit breaker.

————— **END OF TASK** —————

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ELECTRONIC LINE REPLACEABLE UNIT - CLEANING/PAINTING

1. General

- A. This procedure cleans the electronic line replaceable units (LRU) and the area around it where dust can accumulate and obstruct filters and cooling systems.

TASK 20-60-06-100-801

2. Electronic LRU Cleaning

A. Tools/Equipment

Reference	Description
STD-123	Brush - Soft Bristle
STD-10711	Shop Vacuum (400Hz if using aircraft power)

B. Consumable Materials

Reference	Description	Specification
B00130	Alcohol - Isopropyl	TT-I-735
B00184	Solvent - Presealing, Cleaning Solvent	BMS11-7

C. Procedure

SUBTASK 20-60-06-010-001

- (1) Remove panels as necessary to gain access to the LRUs and the area around them.

SUBTASK 20-60-06-140-001

- (2) Do the steps that follow to clean the LRUs and the area around them:
- (a) Remove any contamination by hand.
 - (b) Use a vacuum, STD-10711 to remove any loose dirt or debris.
NOTE: The vacuum cleaner head should be made of plastic or non-conductive material.
 - (c) Use a soft bristle brush, STD-123 to loosen any dust on or around the LRU and vacuum the area again.
 - (d) Do the following steps to clean the LRU filters if applicable:
 - 1) Replace fiberglass and paper filters if contaminated.
 - 2) Clean metallic screens and filters with alcohol, B00130 or solvent, B00184, if contaminated.

SUBTASK 20-60-06-410-001

- (3) Install all panels removed for access.

————— **END OF TASK** —————

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PROTECTION OF EWIS (EZAP) - MAINTENANCE PRACTICES

1. General

- A. This procedure has two tasks.
- (1) Instructions for protections and caution information that will minimize contamination and accidental damage to EWIS, as applicable, during performance of maintenance, alteration, or repairs.
 - (2) Instructions for inspection, cleaning and sealing of electrical connectors.

 EWIS

TASK 20-60-07-910-801

2. Protection of the EWIS During Maintenance

A. General

- (1) Definition:
 - (a) Electrical Wiring Interconnection System (EWIS): means any wire, power feeder, wiring device, or combination of these, including termination devices, installed in any area of the airplane for the purpose of transmitting electrical energy, including data and signals, between two or more intended termination points. EWIS is defined in full by 14 CFR section 25.1701.
- (2) This procedure gives instructions for the installation of temporary protection for EWIS during maintenance work when contamination or mechanical damage can occur.
- (3) Protect all airplane EWIS, regardless of the gauge or insulation material, during airplane maintenance to prevent or significantly decrease the potential for damage from contamination and debris.
 - (a) Protection of EWIS starts with identification of the potential for contamination or mechanical damage.
 - (b) The protection ends with making sure that EWIS is free of all sources of contamination.
 - (c) Prevention and frequent removal of contamination during all maintenance work is necessary to maintain EWIS in an airworthy condition.
 - (d) EWIS can be easily damaged during removal of airplane equipment, or if it is used as a handhold or support for personal equipment.
 - (e) In general, EWIS that is undisturbed and kept free of contamination will provide trouble-free service without the need for unscheduled maintenance.
- (4) To maintain necessary properties of EWIS, it must be kept free of chemicals and debris.
 - (a) Hydraulic fluid is a common cause of wire bundle and wire component degradation. Hydraulic fluid is very damaging to connector grommets, wire bundle clamps, and to wire insulation when exposed over a long time. This can cause indirect damage such as arcing and chafing, and break down of the insulation.
- (5) Make sure that EWIS is protected from the accumulation of contamination before you start maintenance work such as servicing, repairing, cleaning, or modifying.

B. References

Reference	Title
20-60-02-100-803	Cleaning to Remove Combustible Material (P/B 701)
SWPM 20, Standard Wiring Practices	Standard Wiring Practices

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C. Procedure

SUBTASK 20-60-07-910-001



KEEP THESE MATERIALS AWAY FROM WIRES. THESE MATERIALS WILL DECREASE THE LIFE OF WIRES. IF YOU SPILL THESE MATERIALS, OR LET LEAKAGE GET ON THE WIRES, INJURY TO PERSONNEL AND DAMAGE TO EQUIPMENT CAN OCCUR.

- (1) Make sure that chemicals such as, but not limited to the following, are kept away from the EWIS:

- (a) Hydraulic fluid
- (b) Battery electrolytes
- (c) Fuel
- (d) Corrosion-inhibiting compounds

NOTE: Avoid overspray of CIC on wire bundles and joined electrical connectors. Light overspray to an adjacent area is acceptable.

- (e) Waste system chemicals
- (f) Cleaning agents
- (g) Deicing fluids
- (h) Paint
- (i) Sealants
- (j) Potting compounds.

SUBTASK 20-60-07-910-002



KEEP TOOLS, TOOL TRAYS, AND OTHER WORK ITEMS OFF OF THE WIRES. OBJECTS PUT ON THE WIRE BUNDLES OR THEIR RELATED COMPONENTS CAN CAUSE DAMAGE TO THE WIRES, INSULATION, AND CONNECTORS.



DO NOT PUT PRESSURE ON THE WIRE BUNDLES, ELECTRONIC SYSTEMS, OR STRUCTURES IN THE COMPARTMENT. PRESSURE CAN CAUSE DAMAGE TO WIRE BUNDLES AND ELECTRICAL CONNECTIONS.



DO NOT CUT, CAUSE NICKS, OR CAUSE OTHER DAMAGE TO THE CABLES, WIRES, METAL-BRAIDED SHIELD, OR OVERBRAID. DAMAGE TO THESE COMPONENTS CAN CAUSE MALFUNCTIONS, OR DAMAGE TO OTHER EQUIPMENT.



DO NOT USE WIRE BUNDLES, TUBING, DUCTS, OR OTHER ENGINE COMPONENTS AS A STEP OR HAND-HOLD. DAMAGE TO EQUIPMENT CAN OCCUR.

- (2) Install temporary protective covers on the areas below and adjacent to the maintenance area.

- (a) Use a cover that is applicable to protect components from the specific contaminant.
 - 1) Examples of covers are as follows:
 - a) Plastic sheeting for liquid

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- b) Canvas sheeting for liquid or debris
 - c) Paper for debris
 - d) Cardboard for debris.
- (b) Use tape to attach the cover to the aircraft structure.
- 1) Examples of tapes are:
 - a) Masking tape for debris
 - b) Vinyl tape for liquids.
 - 2) Make sure that the cover is in a shape to collect and contain fluids and debris.
 - 3) Install the tape carefully to prevent damage to the structure and hold the shape of the cover to collect and contain fluids and debris.
 - 4) Make sure that you do not tape the cover to any EWIS.
- (c) Make sure that the cover is attached in place.
- 1) Make sure that EWIS stay covered during all of the maintenance work.

D. Put the Airplane Back to Its Usual Condition

SUBTASK 20-60-07-010-001

- (1) Carefully remove the temporary protective covers.
- (a) Make sure that the contaminants are contained and do not spill.

SUBTASK 20-60-07-210-002

- (2) Examine the area to make sure that no contaminants were spilled.
- (a) If there is contamination on the EWIS, do this procedure: Cleaning to Remove Combustible Material, TASK 20-60-02-100-803.
- (3) Make sure the EWIS was not damaged during the maintenance.
- (a) If any of the EWIS was damaged during maintenance, repair or replace per the applicable task: SWPM 20, Standard Wiring Practices.

————— END OF TASK —————

TASK 20-60-07-910-802

3. Inspection, Cleaning and Sealing of Electrical Connectors

A. References

Reference	Title
SWPM 20-60-01	CLEANING OF ELECTRICAL CONNECTORS
SWPM 20-60-03	SPECIAL PROTECTION OF ELECTRICAL CONNECTORS
SWPM 20-60-06	INSTALLATION OF ELECTRICAL CIRCULAR CONNECTORS
SWPM 20-60-08	SEALING OF ELECTRICAL CONNECTORS

B. Procedure

SUBTASK 20-60-07-210-001

- (1) To inspect the electrical connectors for corrosion, do the task in SWPM 20-60-03.

SUBTASK 20-60-07-160-001

- (2) To clean the electrical connectors, do the task in SWPM 20-60-01.

SUBTASK 20-60-07-420-001

- (3) To tighten the electrical connectors, do the task in SWPM 20-60-06.

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SUBTASK 20-60-07-760-001

(4) To seal of electrical connectors, do the task in SWPM 20-60-08.

———— **END OF TASK** ————

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INSTRUMENT PANEL - CLEANING/PAINTING

1. General

- A. This procedure cleans the forward instrument panels located in the flight compartment.

TASK 20-60-08-100-801

2. Instrument Panel Cleaning

A. General

- (1) This procedure cleans the forward instrument panels area where dust can accumulate.

B. Consumable Materials

Reference	Description	Specification
B00130	Alcohol - Isopropyl	TT-I-735
G01043	Cloth - Lint-free	

C. Location Zones

Zone	Area
211	Flight Compartment - Left
212	Flight Compartment - Right

D. Instrument Panel Cleaning



DO NOT USE ABRASIVE MATERIALS WHEN YOU CLEAN THE DISPLAY SURFACE. ABRASIVE MATERIALS WILL CAUSE SCRATCHES IN THE DISPLAY SURFACE.

SUBTASK 20-60-08-160-001

- (1) Blow off the instrument panel with dry, filtered air to remove the large dust and dirt particles.

SUBTASK 20-60-08-160-002



DO NOT APPLY CLEANER DIRECTLY ON THE DISPLAY SURFACE OR THE UNIT. ALWAYS APPLY CLEANER TO THE CLOTH. THIS WILL HELP PREVENT DAMAGE TO THE DISPLAY SURFACE OR THE UNIT.

- (2) Soak a clean lint-free cloth, G01043 with alcohol, B00130.

SUBTASK 20-60-08-160-003



DO NOT USE TOO MUCH FORCE WHEN YOU CLEAN THE DISPLAY SURFACE. TOO MUCH FORCE WILL CAUSE DAMAGE TO THE DISPLAY SURFACE.

- (3) Clean the instrument panel with the moist lint-free cloth, G01043.

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- (4) Dry the instrument panel fully with a clean dry lint-free cloth, G01043.

———— **END OF TASK** ————

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INTERMITTENT WIRING - INSPECTION/CHECK

1. **General**

- A. This procedure outlines a method to inspect aircraft wiring for degradation which could cause intermittent system behavior. The tasks below are listed in the most logical order considering access required, time to accomplish the inspection, and potential findings, however these steps may be accomplished in any order, in whole or in part, as required, to eliminate aircraft wiring as the source of an intermittent fault. It may not be necessary or desirable to accomplish all steps within these procedures depending on the nature of the fault experienced and the system in which the fault occurred.
- B. This procedure contains the following task:
- (1) Intermittent Wiring Inspection and Check - Special Detailed Inspection.

TASK 20-70-24-200-801

2. **Intermittent Wiring Inspection and Check - Special Detailed Inspection**

(Figure 201, Figure 202, Figure 203, Figure 204, Figure 205, Figure 206, Figure 207)

A. General

- (1) This procedure outlines a method to inspect aircraft wiring for degradation which could cause intermittent system behavior. The steps below are listed in the most logical order considering access required, time to accomplish the inspection, and potential findings, however, these steps may be accomplished in any order, in whole or in part, as necessary, to eliminate aircraft wiring as the source of an intermittent fault. It may not be necessary or desirable to accomplish all steps within this procedure depending on the nature of the fault experienced and the system in which the fault occurred.
- (2) This task contains the following procedures:
- (a) Electrical Load Test
 - (b) Electrical Current Test
 - (c) Insulation Resistance Test
 - (d) Ultrasonic Short Circuit Detection Test
 - (e) Electrical Connection Inspection
 - (f) Wire Shake Test
 - (g) Voltage Drop Inspection
 - (h) Reflectometry Inspection
 - (i) Automated Intermittent Fault Detection & Integrity Test

B. References

Reference	Title
20-10-39-700-801	Insulation Resistance Testing - Special Detail Inspection (P/B 501)
SOPM SWPM 20-20-00	Standard Overhaul Practices Manual

C. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt.", which stands for Optional.

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Reference	Description
COM-1793	Multimeter - Digital/Analog (or equivalent meter meets task requirements) Part #: 117 Supplier: 89536 Part #: 260-8XPI Supplier: 55026 Part #: 287 Supplier: 89536 Part #: 289 Supplier: 89536 Part #: 87V Supplier: 89536 Part #: FLUKE 27 II Supplier: 89536 Part #: FLUKE-77-4 Supplier: 89536 Opt Part #: 187 Supplier: 89536 Opt Part #: 189 Supplier: 89536 Opt Part #: 21 Supplier: 89536 Opt Part #: 27 Supplier: 89536 Opt Part #: 77 SERIES III Supplier: 89536 Opt Part #: 87 Supplier: 89536 Opt Part #: FLUKE 27 Supplier: 89536 Opt Part #: MODEL 27 Supplier: 89536
COM-2531	Clamp-On- Current Meter Part #: 324 Supplier: 89536 Part #: 374 Supplier: 89536 Part #: LH41A Supplier: 0JV05 Opt Part #: 321 Supplier: 89536 Opt Part #: 322 Supplier: 89536 Opt Part #: MODEL 33 Supplier: 89536 Opt Part #: MODEL 36 Supplier: 89536
COM-13811	Multimeter (Analog / Digital with Low/ High Z Impedance functions or equivalent) Part #: 117 Supplier: 89536 Part #: FLUKE 289 Supplier: 89536 Opt Part #: MODEL 8 MK7 Supplier: 00426
COM-13988	Clamp-on - Current, AC/DC (used with Fluke multimeters or other manufacturer's meter) Part #: i30 Supplier: 89536
COM-17798	Multimeter - Digital, Insulation Resistance Part #: 1004-745 Supplier: U0146 Part #: 1507 Supplier: 4U744 Part #: 1587 Supplier: 89536 Part #: 1587 FC Supplier: 4U744 Part #: MIT2500 Supplier: U0146 Part #: MIT410/2 Supplier: U0146
COM-18702	Digital Camera - Acoustic Part #: FLK-ii900 Supplier: 4U744 Part #: FLK-ii910 Supplier: 4U744
COM-19603	Reflectometer - Time Domain, Spread Spectrum (SSTDOR) Part #: LWF-1001 Supplier: \$1337
COM-19604	Set - Test Lead, Multimeter Part #: TL80A-1 Supplier: 4U744
COM-19606	Power Supply - DC, Portable Part #: 72-13095 Supplier: 02929 Part #: TP3016M Supplier: \$1338

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Reference	Description
COM-19843	Kit, Contact Retention Part #: DMC95 Supplier: 11851
COM-20952	Detector - Intermittent Fault Part #: USC-IFD-512 Supplier: 350J1
COM-20963	Kit - Tone Generator and Probe Part #: 26000900 Supplier: 1UQL0 Part #: 33-866 Supplier: 30119 Part #: VDV500-063 Supplier: 75347
SPL-1473	Probe - Kit, Ultrasonic Leak Part #: B00033 Supplier: 62373 Part #: ST6760A-1 Supplier: 81205
SPL-17763	Reflectometer - Multi Carrier Time Domain (MCTDR) Part #: W1101 Supplier: FB3T5
SPL-19679	Test Set - Voltage Drop Part #: C24010-1 Supplier: 88277

D. Inspection Method

SUBTASK 20-70-24-700-001

- (1) Make sure that adequate voltage is supplied through the circuit using one of the following methods.
 - (a) Electrical load test (Preferred) or Current draw test (Alternate).
 - 1) If no voltage or current is supplied, a hard short or open is present in the circuit:
 - a) Find the short or open using continuity, voltage drop, and/or reflectometry testing.
 - 2) If voltage or current supplied is low, high resistance is present in the circuit:
 - a) Find the source of the voltage loss using voltage drop testing.
 - 3) If the current supplied is high, binding or a partial short is present in the component being driven by the circuit:
 - a) Examine the component for binding, drag, or a partial internal short.

SUBTASK 20-70-24-700-002

- (2) Make sure that no partial shorts exist in the circuit using an insulation resistance test.
 - (a) If partial shorts exist, isolate the location by dividing the circuit.

SUBTASK 20-70-24-700-003

- (3) Make sure that all the connections in the circuit are engaged correctly by doing a general visual inspections, pin engagement checks, or a torque checks as required.
 - (a) If connection damage or looseness exists, repair circuit connections as required.

SUBTASK 20-70-24-700-004

- (4) Do a wire shake test to find intermittent opens or shorts.
 - (a) If intermittent faults are found, repair as required.

SUBTASK 20-70-24-700-005

- (5) If all tests pass, the wiring is good and can be ruled out as the source of an intermittent issue.

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E. Electrical Load Test

SUBTASK 20-70-24-700-006

- (1) Make sure that adequate voltage is supplied through the circuit by doing one of the following methods.

- (a) Electrical Load Testing Using Aircraft Power (Preferred)

- 1) Install a digital/analog multimeter, COM-1793, across the component, with the electrical leads as close to the component as possible. Refer to the Component Load Testing example (Figure 201).

NOTE: Any connections which occur between the two leads of the Digital Multi Meter (DMM) will have some amount of voltage drop. If a poor connection is included in this measurement (such as a bad ground), it will show as though the proper voltage is being dropped across the component when in reality a large portion of that voltage is dropping across the poor connection. To prevent accidentally overlooking a potential fault, it is critical that no unnecessary connections be included in this measurement.

NOTE: While measuring from exposed terminals is ideal, backprobing into the component connector may be necessary. Use caution when installing backprobes so that the connector, wire, pins, or sockets are not damaged. A multimeter test lead set, COM-19604, may be used to help this step.

- a) Connect the positive probe of the DMM as close as possible to the component on the upstream side of the circuit.
 - b) Connect the negative probe of the DMM as close as possible to the component on the downstream side of the circuit.
 - 2) Set the digital/analog multimeter, COM-1793, to measure AC or DC voltage as necessary.
 - 3) Measure the voltage drop across the component. Apply power to actuate the component if necessary.

NOTE: For most 28VDC systems, the voltage measured across the component should be >25VDC. A more accurate expected drop may be calculated using the applicable wiring specification

NOTE: For most 115VAC systems the voltage measured across the component should be >109VAC. A more accurate expected drop may be calculated using the applicable wiring specification.

- 4) If the voltage measured is <0.005V, no voltage is present at the component:
 - a) An open or short exists in the circuit.
 - <1> Test the circuit using voltage drop or continuity testing as necessary to find where the open or short is located.
 - <2> If the open or short occurs in a wire, do the reflectometry test to find the location of the fault.
 - 5) If the voltage drop measured is below the appropriate value listed above:
 - a) High resistance may be present in the circuit:
 - <1> Compare the measurement with a similar circuit or review the circuit design to make sure that the voltage is not meant to be at this low level.
 - <2> Find the voltage loss in the circuit if the voltage drop is low (Refer to Voltage Drop Inspection).

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- 6) If the voltage drop across the component is above the applicable value listed above:
 - a) The circuit is supplying sufficient power to the component.
- (b) Electrical Load Testing Using A DC Power Supply (Alternate)

NOTE: This procedure is used to load test individual wires including isolated wiring shields such as audio wiring shields and PERG grounds.

NOTE: While low current multimeter resistance tests normally measure a "good" reading with an intermittent connection, the load tests normally measure a "bad" reading with a low current, intermittent, connection. This test will help identify recessed pins, poor connections when shaking the wire harness.

- 1) Remove power from the circuit to be inspected.
- 2) Review the wiring diagram and then disconnect all ends of the circuit to be tested.
 - a) Make sure that all branch circuits are identified and isolated from the aircraft.
- 3) Connect a portable dc power supply, COM-19606, to the upstream end of the circuit to be tested (where the circuit was disconnected from the aircraft power source). Refer to the Load Testing Using a Power Supply Example (Figure 202).
 - a) Make sure that the power supply is OFF.
 - b) Connect the positive terminal of the power supply to the circuit to be tested.
 - c) Connect the negative terminal of the power supply to aircraft ground.
- 4) Connect the test set, SPL-19679, to the downstream end of the circuit to be tested (where the circuit was disconnected from the component). Refer to the Load Testing Using a Power Supply Example (Figure 202).
 - a) Connect the circuit to be tested to the positive terminal of the test set, SPL-19679.
 - b) Connect the negative terminal of the test set, SPL-19679, to aircraft ground.
- 5) Connect a digital/analog multimeter, COM-1793, across the test set, SPL-19679. Refer to Load Testing Using a Power Supply Example (Figure 202).
 - a) Connect the positive lead of the digital/analog multimeter, COM-1793, to the positive terminal of the test set, SPL-19679.
 - b) Connect the negative lead of the digital/analog multimeter, COM-1793, to the negative terminal of the test set, SPL-19679.
 - c) Set the meter to read volts DC.
- 6) Turn on the portable dc power supply, COM-19606, and set it for 28.0VDC at 1.0 Amps.



DO NOT APPLY HIGH LEVELS OF CURRENT (>0.040A) FOR AN EXTENDED TIME. A CURRENT SETTING ABOVE THAT LEVEL CAN CAUSE DAMAGE TO THE LOAD TEST-BOX EQUIPMENT.

- 7) Adjust the test set, SPL-19679, to apply a 0.040A load to the circuit.
- 8) Make sure that the voltage drop across the load is >25.0 VDC.

NOTE: Limit the duration of current application >0.040A to only that which is required to take the voltage drop measurement(s).

- a) If the voltage drop measured is <0.005V, no voltage is present at the component:

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- <1> An open or short exists in the circuit.
 - <a> Test the circuit using voltage drop or continuity testing as necessary to find where the open or short is located.
 - If the open or short occurs in a wire, do the reflectometry test to find the location of the fault.



DO NOT APPLY HIGH LEVELS OF CURRENT ($>0.040A$) FOR AN EXTENDED TIME. A CURRENT SETTING ABOVE THAT LEVEL CAN CAUSE DAMAGE TO THE LOAD TEST-BOX EQUIPMENT.

- 9) Adjust the test set, SPL-19679, to apply a load to the circuit which is similar to the normal operating load of the system.

NOTE: If the normal load of the system exceeds the capability of the test set, SPL-19679, voltage drop across the load may be calculated using Ohm's Law (Refer to Figure 205).
- 10) Make sure that the voltage drop across the load remains $>25.0VDC$.
 - a) If the voltage drop across the load is $<25.0VDC$, there is a voltage loss in the circuit. Refer to Voltage Drop Inspection to find the source of voltage loss.
 - b) If the voltage drop across the load is $>25.0VDC$, the circuit is delivering adequate power to the load.
- 11) Turn OFF the portable dc power supply, COM-19606, and disconnect it from the circuit.
- 12) Disconnect the test set, SPL-19679, from the circuit.
- 13) Connect the circuit to the aircraft (Refer to the appropriate WDM).
- 14) Do an operational check of the system(s) which was/were disturbed.

F. Electrical Current Test

SUBTASK 20-70-24-700-007

- (1) This method requires that the expected current through the circuit to be known. This can be done through one of the following methods.
 - (a) Most common method is by comparison with equivalent systems.
 - 1) Current draw data may be collected from similar circuits on the same aircraft (ex. left and right), or other aircraft (ex. same circuit different aircraft) for comparison.
 - 2) Each data point collected using this method increases the level of confidence in what a "good" circuit should measure.
 - 3) If no similar circuits are available as a reference this method cannot be used.
 - (b) By comparison to Component Maintenance Manual (CMM) values.
 - 1) Most CMMs provide a maximum current draw limit and some CMMs also provide a normal expected current.
 - a) The upper limit is provided when the maximum current draw is given in the CMM, but the normal operating current is not available at this time. If measured current draw is reaching the maximum limit, it may be cause for further investigation.
- (2) Make sure adequate power is flowing through the circuit as follows.

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- (a) Get access to the circuit to be tested at the most convenient location.

NOTE: This is often at the circuit breaker panel, however, any point along the circuit is acceptable.



WARNING

MAKE SURE THAT YOU ARE CAREFUL WHEN YOU ARE NEAR ENERGIZED CIRCUITS. AN ELECTRICAL SHOCK CAN CAUSE AN INJURY.

- (b) Connect an appropriately rated current clamp to the circuit to be tested. Refer to the tool manufacturer's operating manual.

NOTE: The AC/DC current clamp, COM-13988, is recommended for DC current or when the expected current is less than 2 amps, otherwise clamp-on current meter, COM-2531, is recommended.

- (c) Energize the circuit to be tested.
- (d) Measure single phase circuit current.
- (e) Compare the measured current to established limits or a similar system.
- 1) If current draw is found to be >10% low, there is a restriction in the circuit. To locate the source of restriction refer to the Voltage Drop Inspection.
 - 2) If current draw is found to be >10% high, inspect the component for signs of binding and/or resistance to actuation.
 - a) If no signs of binding exist, do an insulation resistance test of the component (Refer to Insulation Resistance Test).
 - 3) If current draw is found to be in-range, the circuit is delivering sufficient power to the component.
- (f) Remove the AC/DC current clamp, COM-13988, or clamp-on current meter, COM-2531.
- (g) Put back any necessary access which was opened to do this test.

G. Insulation Resistance Test

SUBTASK 20-70-24-700-008

- (1) Make sure that no partial short circuits exist by doing the following insulation resistance tests.
- (a) Remove power from the circuit under test.
 - (b) Disconnect the wires to be tested from the aircraft at each end.
 - (c) Examine the wiring diagram to make sure that no branch circuits exist and that the circuit to be tested is isolated from the aircraft.
 - (d) If a load test was not done previously, do the following:
 - 1) Measure the continuity of each wire to be tested from end to end using a digital/analog multimeter, COM-1793, to make sure that no opens exist.
 - a) If an open exists, test the circuit using the voltage drop or continuity testing to find the location of the open.

<1> If the open is found in a wire, do the reflectometry test to find the location of the open.
 - 2) Measure the resistance between each wire to be tested and aircraft ground using a digital/analog multimeter, COM-1793, to make sure that no direct shorts exist.
 - a) If a direct short exists, test the circuit using voltage drop or continuity testing to find the location of the short.

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- <1> If the short is found in a wire, do the reflectometry test to find the location of the short.
- (e) Setup the insulation resistance multimeter, COM-17798, as follows:
- 1) Perform circuit isolation test to prevent damage at higher voltages by setting the test voltage to lowest setting - 50VDC.
 - a) Set the test voltage to 50VDC.
 - b) Test circuit to ground.
 - c) Press and Hold the test button for at least 5 seconds.
 - d) Make sure that each measurement is >50MΩ.
 - <1> If an insulation resistance value <50MΩ is recorded, review Wiring Diagram Manual (WDM) and connections to ensure circuit is isolated.
 - <2> Repeat test until assured isolation. If circuit isolation is confirmed, disconnect sections as applicable to further isolate.
 - 2) Set the test voltage to 500VDC.
- (f) Test each wire in the a damaged system to ground.
- NOTE:** If a connector is disconnected to open the circuit for testing and is now free from any structure, the backshell has lost its path to ground. In this case you may not detect a short to the backshell while performing this test. To prevent this oversight, connect the backshell to an adequate ground on the aircraft structure using a jumper wire.
- 1) Make sure that each measurement is >550MΩ.
 - 2) If an insulation resistance value <550MΩ is recorded, divide the circuit into smaller pieces and repeat the test to locate the partial short.
- (g) Do a test on each wire in the damaged system to each other wire in the same wiring harness.
- 1) Make sure that each measurement is >550MΩ
 - 2) If an insulation resistance value <550MΩ is recorded, divide the circuit into smaller pieces and repeat the test to locate the partial short.
- (h) If wires are shielded, test each wire to its shield.
- 1) Make sure that each measurement is >550MΩ .
 - 2) If an insulation resistance value <550MΩ is recorded, divide the circuit into smaller pieces and repeat the test to locate the partial short.
- (i) If all insulation resistance measurements are 550MΩ or greater at 500VDC the circuit insulation is in good condition.
- (j) Connect the circuit to the aircraft (Refer to the appropriate WDM).
- (k) Do an operational check of the system(s) that was/were disturbed.



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H. Ultrasonic Short Circuit Detection Test

SUBTASK 20-70-24-700-009

- (1) Do an Insulation Resistance Testing (IRT) using any of the following method.

NOTE: Since most intermittent faults randomly occur with engines running and/or inflight, and are not occurred during ground testing, it is probable that the fault is due to a wiring being subjected to cold/wet, heavy vibration, and stretching due to the aircraft pressurization. Do the steps below using an insulation resistance multimeter, COM-17798 or an equivalent to do the dry test, Method 1, and if no faults are found, follow up with the wet test, Method 2 to help locate the fault on the ground.



WARNING

MAKE SURE THAT YOU DO NOT USE A POSSIBLE IGNITION SOURCE AROUND OPEN FUEL TASKS, FUEL VENTS OR SPILLED FUEL. 500V DC TESTERS CAN BE AN IGNITION SOURCE. FUEL FUMES CAN BE NOT STABLE AND CAUSE POSSIBLE IGNITION. IF YOU DO NOT OBEY, INJURY TO PERSONNEL AND DAMAGE TO EQUIPMENT CAN OCCUR.

- (a) Intermittent Insulation Resistance Test With Audio – Visual Detection - Dry (Method 1)
- 1) Prepare for testing by following: Insulation Resistance Testing - Special Detail Inspection, TASK 20-10-39-700-801.
 - 2) Review the WDM to make sure that sensitive components are isolated from high voltage.
 - a) Give a special attention to all terminal blocks and splices for circuit under test.
 - 3) Examine electrical connectors for bent or broken pins/sockets, dirt, moisture and damage.
 - 4) On the applicable Line Replaceable Unit (LRU), install a conductive dust cap and a connector cover.
 - 5) Technician A - Setup the insulation resistance multimeter, COM-17798, as follows:
 - a) Connect the insulation resistance multimeter, COM-17798, to circuit under test.

NOTE: If a connector is disconnected to open the circuit for testing and is now free from any structure, the backshell has lost its path to the ground. In this case, you may not detect a short to the backshell while performing this test. To prevent this oversight, connect the backshell to a sufficient ground on the aircraft structure using a jumper wire.
 - b) Perform circuit isolation test to prevent damage at higher voltages by setting the test voltage to 50VDC, which is the lowest setting.
 - <1> Set the test voltage to 50VDC.
 - <2> Test circuit to ground.
 - <3> Press and Hold the test button for at least 5 seconds.
 - <4> Make sure that each measurement is >50MΩ.
 - <a> If an insulation resistance value <50MΩ is recorded, review the WDM and connections to make sure that the circuit is isolated.
 - Repeat the test to Isolate and if circuit isolation is confirmed, disconnect sections as applicable to further isolate.

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- 6) Technician B - Follow the acoustic digital camera, COM-18702, operator's instruction to turn on the device and monitor for ultrasonic wave created during any insulation resistance breakdown (Figure 206).
- 7) Technician C - Follow the ultrasonic leak probe, SPL-1473, operator's instructions to turn on device and connect the non-conductive hollow probe (Figure 207).
- 8) Technician A - Set the test voltage to 500VDC when the circuit is isolated at 50VDC.
 - a) Do not apply more than 500VDC to aircraft wiring or components.

NOTE: Any wiring or components tested at 1000VDC or greater shall be re-tested at 500VDC to make sure that the insulation resistance health is good before return them to service.
- 9) Test circuit(s) to ground as follows:
 - a) Press and Hold the test button for at least 5 seconds but up to 2 minutes.
 - b) Make sure that each measurement is $>2M\Omega$.
 - $<1>$ If an insulation resistance value $<2M\Omega$ is recorded, notify Technicians B and C to listen and watch for an ultrasonic wave (arcing).
 - $<2>$ If an audible or visual signature is not found, divide the circuit into smaller pieces and repeat the test to find the short.
 - c) Do a test on each wire in the damaged system to each other wire in the same wiring harness.
 - d) Make sure that each measurement is $>2M\Omega$.
 - $<1>$ If an insulation resistance value $<2M\Omega$ is recorded, notify Technicians B and C to listen and watch for an ultrasonic wave (arcing).
 - $<2>$ If an audible or visual signature is not found, divide the circuit into smaller pieces and repeat the test to find the partial short.
 - e) If wires are shielded, test each wire to its shield.
 - f) Make sure that each measurement is $>2M\Omega$.
 - $<1>$ If an insulation resistance value $<2M\Omega$ is recorded, notify Technicians B and C to listen and watch for an ultrasonic wave (arcing).
 - $<2>$ If an audible or visual signature is not found, divide the circuit into smaller pieces and repeat the test to find the partial short.
- 10) If all insulation resistance measurements are $2M\Omega$ or greater at 500VDC, then the circuit insulation is OK.
 - a) Reinstall all disconnected connectors (Refer to applicable WDM).
- 11) Do an operational check of the systems that were disconnected.
- (b) Intermittent Insulation Resistance Test With Audio – Visual Detection - Wet (Method 2)
 - 1) Perform a detailed inspection of the insulation resistance testing, do this task: Insulation Resistance Testing - Special Detail Inspection, TASK 20-10-39-700-801.
 - 2) Review the WDM to make sure that sensitive components are isolated from high voltage.
 - a) Give a special attention to all terminal blocks and splices for circuit under test.
 - 3) Disconnect all connectors related to the wire being tested.
 - 4) Examine the electrical connectors for bent or broken pins/sockets, dirt, moisture and damage.

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- 5) On the applicable LRUs, install conductive dust cap and connector cover.
- 6) Technician A - Setup the insulation resistance multimeter, COM-17798, as follows:
 - a) Connect the insulation resistance multimeter, COM-17798, to circuit under test.

NOTE: If a connector is disconnected to open the circuit for testing and is now free from any structure, the backshell has lost its path to the ground. In this case, you may not detect a short to the backshell while performing this test. To prevent this oversight, connect the backshell to a sufficient ground on the aircraft structure using a jumper wire.
- 7) Technician B- Follow ultrasonic leak probe, SPL-1473, operator's instructions to turn on device and connect the non-conductive hollow probe.
 - a) While wearing insulated gloves, listen for static noise when shake wiring harness and spraying a fine water mist (Figure 207).
- 8) Technician C- Follow the acoustic digital camera, COM-18702, operator's instruction to turn on device and monitor for ultrasonic wave created during any insulation resistance breakdown (Figure 206).
- 9) Technician A - Set the test voltage to 500VDC.
 - a) Do not apply more than 500VDC to aircraft wiring or components.

NOTE: Any wiring or components tested at 1000VDC or greater shall be re-tested at 500VDC to make sure that the insulation resistance health is good before to return to service.
- 10) Test circuit(s) to ground.
 - a) Press and Hold the test button for at least 5 seconds, but up to 2 minutes while Technician B shakes the harness.
- 11) Make sure that each measurement is $>2M\Omega$.
 - a) If an insulation resistance value $<2M\Omega$ is recorded, notify Technicians B and C to listen and watch for an ultrasonic wave (arcing).
 - b) If an audible or visual signature is not found, divide the circuit into smaller pieces and repeat the test to find the partial short.
- 12) Do a test on each wire in the damaged system to each other wire in the same wiring harness.
- 13) Make sure that each measurement is $>2M\Omega$.
 - a) If an insulation resistance value $<2M\Omega$ is recorded, notify Technicians B and C to listen and watch for an ultrasonic wave (arcing).
 - b) If an audible or visual signature is not found, divide the circuit into smaller pieces and repeat the test to find the partial short.
- 14) If wires are shielded, test each wire to its shield.
- 15) Make sure that each measurement is $>2M\Omega$.
 - a) If an insulation resistance value $<2M\Omega$ is recorded, notify Technicians B and C to listen and watch for an ultrasonic wave (arcing).
 - b) If an audible or visual signature is not found, divide the circuit into smaller pieces and repeat the test to find the partial short.
- 16) If all insulation resistance measurements are $2M\Omega$ or greater at 500VDC the circuit insulation is OK.

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- a) Reinstall all disconnected connectors (Refer to the appropriate WDM).
- 17) Do an operational check of the system systems that were disconnected.

I. Electrical Connection Inspection

SUBTASK 20-70-24-700-010

- (1) Make sure that proper engagement of all connections are within the circuit by doing the following.

NOTE: This inspection contains steps to access all connections in the circuit. Some connections may be more difficult to get to than others, such as potted connectors or connections behind lavatories, etc. Where desired, connections may be temporarily skipped during this inspection to allow the inspection to fit airline operational requirements. Any connection omitted in this way cannot be ruled out as a potential cause of the intermittent issue. To ensure potential causes are not overlooked, any missed connection should be properly noted for future evaluation.

- (a) Remove power from the circuit under test.
- (b) For each connector in the circuit:
 - 1) Get access to the connector.
 - 2) Disconnect the connector.
 - 3) Do a visual inspection of the mating surfaces of the connector for contamination, corrosion, signs of arcing, or other damage.
 - 4) Do a connector lock retention check for each pin and socket in the circuit under investigation using one of the following methods:

NOTE: The proper retention of pins and sockets cannot be given by doing a visual inspection only. The manual check is necessary to find if correct retention is provided.

- a) Pull on each wire behind the connector or press on each pin or socket from the front side of the connector with an appropriate tool.
- b) Press on each pin and socket using the applicable retention test tool from the contact retention kit, COM-19843, and make sure that the contact lock resists the appropriate pressure.

NOTE: Refer to the connector specification for required contact locking strength. Refer to the contact retention kit manufacturer's instructions for tool selection.

- c) Repair any connections which are not properly retained.
- 5) Reassemble the connector backshells.
- 6) Reconnect the connector using the appropriate torquing procedure.
- 7) Put back any necessary access which was opened to do this inspection
- (c) For each terminal connection:
 - 1) Get access to the connection.
 - 2) Do a visual inspection of the wire insulation, terminal, and terminal lug for any signs of damage, contamination, or corrosion.
 - 3) Do a torque-check of the connection.
 - 4) Make sure that the wire is properly retained in the terminal.
 - 5) Put back any necessary access which was opened to do this inspection.

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- (d) For each terminal block or relay base:
 - 1) Get access to the terminal block or relay base.
 - 2) Do a visual inspection of the terminal block or relay base for contamination, corrosion, signs of arcing, or other damage.
 - 3) Do a pin retention check for each pin in the circuit under inspection.
 - a) Pull on each wire at the terminal block or relay base to ensure all wires are properly retained.
 - b) Repair any connections which are not properly retained.
 - 4) Put back any necessary access which was opened to do this inspection.

J. Wire Shake Test

SUBTASK 20-70-24-700-011

- (1) Make sure that no intermittent shorts or opens exist by doing a wire shake test using one of the following methods:

- (a) Reflectometry:

- 1) Do a reflectometry inspection of the circuit for intermittent faults (Refer to Reflectometry Inspection).

NOTE: Use a TDR capable of intermittent fault analysis such as multi carrier time domain reflectometer, SPL-17763.

- (b) Continuity:

NOTE: This intermittent continuity test uses the "Lo Ohm" function of the or equivalent, which applies up to 10mA of current to capture low resistance changes and records the measurement. When using the record function, the user may review the trend results on the meter to quickly identify intermittent connections. An analog multimeter with Low/ High Z Impedance functions, COM-13811, Simpson 260 or equivalent, may also be used, but only on the Rx1 scale which will apply up to 10mA of current.

- 1) Remove power from the circuit under test.
 - 2) Disconnect the wires to be tested from the aircraft at each end.
 - 3) Examine the wiring diagram to make sure that no branch circuits exist and that the circuit to be tested is isolated from the aircraft.
 - 4) Test each wire in the circuit for intermittent opens as follows:
 - a) Connect the positive lead of the multimeter with Low/ High Z Impedance functions, COM-13811, to the "Lo Ohm" function, to one end of the wire under test.
 - b) Connect the negative lead of the multimeter with Low/ High Z Impedance functions, COM-13811, to the "Lo Ohm" function, to the other end of the wire under test.

NOTE: Use a jumper wire to aircraft ground or a spare wire to complete the circuit as necessary.

- c) Set the meter to record continuity and begin data collection.

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CAUTION

DO NOT USE TOO MUCH FORCE ON THE WIRE. TOO MUCH FORCE CAN CAUSE DAMAGE TO THE WIRE.

- d) Work from one end of the wire under test to the other manually disturbing (shaking) the harness as you go.
 - e) Make sure there is continuity between both ends of the wire under test throughout the entire test.
 - <1> Review the meter "trend" recording for dips and spikes. If continuity is lost at any point (resistance goes to OL or very high) an intermittent open is present.
 - f) Do the test again in the suspect area until the location of the intermittent open is found.
 - g) Repair any wire damage that you find.
- 5) Test each wire in the circuit for intermittent shorts to ground as follows:
- a) Connect the positive lead of the multimeter with Low/ High Z Impedance functions, COM-13811, to the "Lo Ohm" function, to one end of the wire under test.
 - b) Connect the negative lead of the multimeter with Low/ High Z Impedance functions, COM-13811, to the "Lo Ohm" function, to aircraft ground.
 - c) Set the meter to record continuity and begin data collection.



CAUTION

DO NOT USE TOO MUCH FORCE ON THE WIRE. TOO MUCH FORCE CAN CAUSE DAMAGE TO THE WIRE.

- d) Work from one end of the wire under test to the other manually disturbing (shaking) the harness as you go.
 - e) Make sure that there is no continuity between the wire under test and aircraft ground throughout the entire test.
 - <1> Review the meter "trend" recording for dips and spikes. If any amount of continuity exists at any point during the test, an intermittent short is present.
 - f) Do the test again in the suspect area until the location of the intermittent open is found.
 - g) Repair any wire damage that you find.
- 6) Test each wire in the circuit for intermittent shorts to other wires in the circuit as follows:
- a) Connect the positive lead of the multimeter with Low/ High Z Impedance functions, COM-13811, to the "Lo Ohm" function, to one end of the wire under test.
 - b) Jumper each other wire in the circuit together at either end of the circuit
 - c) Connect the negative lead of the multimeter with Low/ High Z Impedance functions, COM-13811, to the "Lo Ohm" function, to any of the other wires in the circuit which were jumpered together in the previous step.
 - d) Set the meter to record continuity and begin data collection.

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CAUTION

DO NOT USE TOO MUCH FORCE ON THE WIRE. TOO MUCH FORCE CAN CAUSE DAMAGE TO THE WIRE.

- e) Work from one end of the wire under test to the other manually disturbing (shaking) the harness as you go.
 - f) Make sure there is no continuity between the wire under test and any other wire in the circuit throughout the entire test.
 - <1> Review the meter "trend" recording for dips and spikes. If any amount of continuity exists at any point during the test an intermittent short is present.
 - g) Do the test again in the suspect area until the location of the intermittent short is found.
 - h) Repair any wire damage that you find.
- 7) If wires in the circuit are shielded, test each wire in the circuit for intermittent shorts to shield as follows:
- a) Connect the positive lead of the multimeter with Low/ High Z Impedance functions, COM-13811, to the "Lo Ohm" function, to one end of the wire under test.
 - b) Connect the negative lead of the multimeter with Low/ High Z Impedance functions, COM-13811, to the "Lo Ohm" function, to the shield.
 - c) Set the meter to record continuity and begin data collection.



CAUTION

DO NOT USE TOO MUCH FORCE ON THE WIRE. TOO MUCH FORCE CAN CAUSE DAMAGE TO THE WIRE.

- d) Work from one end of the wire under test to the other manually disturbing (shaking) the harness as you go.
 - e) Make sure there is no continuity between the wire under test and its shield throughout the entire test.
 - <1> Review the meter "trend" recording for dips and spikes. If any amount of continuity exists at any point during the test an intermittent short is present.
 - f) Do the test again in the suspect area until the location of the intermittent short is found.
 - g) Repair any wire damage that you find.
- 8) Reconnect the circuit to the aircraft (Refer to the appropriate WDM).
- 9) Do an operational check of the system(s) which was/were disturbed.

K. Voltage Drop Inspection

SUBTASK 20-70-24-700-012

- (1) Make sure that the condition of connections throughout the circuit as follows:

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WARNING

MAKE SURE THAT YOU ARE CAREFUL WHEN YOU ARE NEAR ENERGIZED CIRCUITS. AN ELECTRICAL SHOCK CAN CAUSE AN INJURY.

(a) Testing voltage drop across a component:

- 1) Install a digital/analog multimeter, COM-1793 across the component with the electrical leads as close to the component as possible. Refer to Component Load Testing Example (Figure 201).

NOTE: Any connections which occur between the two leads of the DMM will have some amount of voltage drop. If a poor connection is included in this measurement (such as a bad ground) it will appear as though the proper voltage is being dropped across the component when in reality a large portion of that voltage is dropping across the poor connection. To prevent accidentally overlooking a potential fault it is critical that no unnecessary connections be included in this measurement.

NOTE: While measuring from exposed terminals is ideal, backprobing into the component connector may be necessary. Use caution when installing backprobes so that the connector, wire, pins, or sockets are not damaged. A multimeter test lead set, COM-19604 may be used to facilitate this step.

- a) Connect the positive probe of the digital/analog multimeter, COM-1793 as close as possible to the component on the upstream side of the circuit.
 - b) Connect the negative probe of the digital/analog multimeter, COM-1793 as close as possible to the component on the downstream side of the circuit.
- 2) Set the digital/analog multimeter, COM-1793 to measure AC or DC voltage as required.
 - 3) Measure the voltage drop across the component. Apply power to actuate the component if necessary.
 - a) For most 28VDC systems the voltage drop across the component should be >25VDC.
 - b) For most 115VAC systems the voltage drop across the component should be >11VAC.
 - 4) If the voltage drop measured is <0.005V no voltage is present at the component:
 - a) An open or short exists in the circuit.
 - <1> Test the circuit using voltage drop or continuity testing as necessary to find where the open or short is located.
 - <2> If the open or short occurs in a wire, do the reflectometry testing to find the location of the fault.
 - 5) If the voltage drop measured is below the appropriate value listed above:
 - a) High resistance may be present in the circuit.
 - <1> Compare the measurement with a similar circuit or review the circuit design to make sure that the voltage is not intended to be at this low level.
 - <2> If the voltage drop is indeed low locate the voltage loss in the circuit.
 - 6) If the voltage drop across the component is above the applicable value listed above:
 - a) The circuit is delivering adequate power to the component.

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(b) Testing voltage drop across a fixed connection.

- 1) Install a digital/analog multimeter, COM-1793 across the fixed connection (connection to ground, splice, electrical connector, etc.) with the electrical leads as close to the connection as possible. Refer to Voltage Drop Across Connections Example (Figure 203).

NOTE: Any connections which occur between the two leads of the DMM will have some amount of voltage drop. For example, in a ground connection if the positive meter probe is placed on the wire going in to the ring terminal and the negative meter probe is placed on the aircraft structure, the voltage drop measurement will include the resistance of the wire to ring terminal connection and the resistance of the ring terminal to ground connection. Move the meter leads as necessary to evaluate each connection if needed

NOTE: While measuring from exposed terminals is ideal, backprobing into the component connector may be necessary. Use caution when installing backprobes so that the connector, wire, pins, or sockets are not damaged. A multimeter test lead set, COM-19604 may be used to facilitate this step.

- a) Connect the positive probe of the digital/analog multimeter, COM-1793 as close as possible to the component on the upstream side of the circuit.
 - b) Connect the negative probe of the digital/analog multimeter, COM-1793 as close as possible to the component on the downstream side of the circuit.
- 2) Set the digital/analog multimeter, COM-1793 to measure AC or DC voltage as required.
 - 3) Measure the voltage drop across the component. Apply power to actuate the component if necessary.
 - 4) If the voltage drop across the connection exceeds 0.100V for AC or DC circuits:
 - a) High resistance is present in the connection.

NOTE: If desired, high resistance can also be confirmed using an appropriately sized bonding meter. Refer to SOPM SWPM 20-20-00. For wires larger than AWG 8 the Amptec 620LK or the T477W bonding meters are preferred. Smaller bonding meters lack an adequate power output for testing larger ground bonds.

- 5) If the voltage drop across the connection is less than 0.100V for AC or DC circuits the connection is in good condition
- 6) Disconnect the digital/analog multimeter, COM-1793 from the circuit.
- 7) Repair any damaged connections that you find.

(c) Testing voltage drop across relay contacts.

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- 1) Install a digital/analog multimeter, COM-1793 across the relay connection under test with the electrical leads as close to the connection as possible. Refer to Voltage Drop Across Connections Example (Figure 203).

NOTE: If the measurement cannot be taken directly at the relay base due to access, any connections which occur between the two leads of the DMM will have some amount of voltage drop. For example, the voltage drop measurement will include the resistance of any wire to pin connections, any pin to pin connections, and the resistance relay contacts themselves. Move the meter leads as necessary to evaluate each connection if needed.

NOTE: While measuring from exposed terminals is ideal, backprobing into the component connector may be necessary. Use caution when installing backprobes so that the connector, wire, pins, or sockets are not damaged. A multimeter test lead set, COM-19604 may be used to facilitate this step.

- a) Connect the positive probe of the digital/analog multimeter, COM-1793 as close as possible to the component on the upstream side of the circuit.
 - b) Connect the negative probe of the digital/analog multimeter, COM-1793 as close as possible to the component on the downstream side of the circuit.
- 2) Set the digital/analog multimeter, COM-1793 to measure AC or DC voltage as required.
 - 3) Measure the voltage drop across the component. Apply power to actuate the component if necessary.

NOTE: In order to do this test the relay contacts under test must be closed and at or near the designed operating current should be flowing through the contacts.

- 4) If the voltage drop across the relay contacts exceeds 0.100V for AC or DC circuits, high resistance is present in the connection.
- 5) If the voltage drop across the connection is less than 0.100V for AC or DC circuits the connection is in good condition.
- 6) Disconnect the digital/analog multimeter, COM-1793 from the circuit.
- 7) Repair any damaged connections that you find.

L. Reflectometry Inspection

SUBTASK 20-70-24-700-013

NOTE: The multi carrier time domain reflectometer, SPL-17763 is used on de-energized circuits and it provides highly accurate distance-to-fault, for even minor impedance changes. The spread spectrum time domain reflectometer, COM-19603 is not as accurate but is a simplified TDR that displays complete opens/shorts on both de-energized & energized circuits. The Tone Probe included in the kit, COM-20963 is a hand held Tone Probe attachment that traces individual wires and identifies fault locations. This is helpful when identifying the exact location of an open wire, failed open relay contacts or limit switches, especially on series spliced switches. Example; Cargo door circuits.

- (1) Make sure that no shorts or opens exist in the circuit as follows:
 - (a) Remove power from the circuit under test.
 - (b) Disconnect the wires to be tested from the aircraft at each end.
 - (c) Review the wiring diagram to ensure no branch circuits exist and that the circuit to be tested is isolated from the aircraft.

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- (d) Set up the multi carrier time domain reflectometer, SPL-17763 or spread spectrum time domain reflectometer, COM-19603 as follows:

- 1) Select or enter the wire impedance which most closely matches the wire type to be tested.

NOTE: If the impedance of the wire to be tested is unknown select the most similar wire type from the list. Differences between the expected impedance and actual impedance will affect the resolution of test (ie. The height of spikes or dips in the signal) but will only prevent you from doing the test in extreme cases. As long as the impedance selected is within 25% of the actual wire impedance you may progress with the test.

- 2) Select or enter the wire VoP (Velocity of propagation) which most closely matches the wire type to be tested.

NOTE: If the VoP (Velocity of propagation) value of the wire to be tested is unknown select the most similar wire type from the list. Differences between the expected VoP and actual VoP will only affect the accuracy of the distance-to-fault function of the test, not the tests ability to detect the presence of a fault. The error in the distance to fault calculation will be directly proportional to the error in the VoP estimate. If you are off by 10% VoP the distance to fault will also be off by 10%. Significant time should not be lost trying to attain the exact VoP value as even wires produced by the same manufacturer under the same product specification can have minor variations.

- (e) Test each wire in the circuit for opens or shorts as follows:

- 1) Note the approximate length of the wire under test.
- 2) Connect the positive lead of the multi carrier time domain reflectometer, SPL-17763 or spread spectrum time domain reflectometer, COM-19603 to the wire under test.
- 3) Connect the negative lead of the multi carrier time domain reflectometer, SPL-17763 or spread spectrum time domain reflectometer, COM-19603 to any parallel return path such as the wire's shield, another wire in the same bundle, or in some cases aircraft ground.

NOTE: The return path selected needs to be the same length as the wire under test and remain within 3 inches from the wire under test along the entire run. If the return path is shorter or longer than the wire under test a jumper wire may be used to match the two lengths so long as the jumper wire observes the 3 inch separation requirement above. When separation exceeds 3 inches the TDR signal is significantly attenuated (weakened) decreasing the resolution of the test and limiting the maximum length of wire which can be tested. Greater separation may be possible for short wires with the above effect in mind.

- 4) Start the test on the multi carrier time domain reflectometer, SPL-17763 or spread spectrum time domain reflectometer, COM-19603.



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- 5) Evaluate the TDR scan as follows (Refer to Figure 204):

NOTE: Simplified TDR tools such as the spread spectrum time domain reflectometer, COM-19603 may only display “OPEN” or “SHORT” and distance to fault rather than the full graphical display described in this step. The spread spectrum time domain reflectometer, COM-19603 may also be used on energized circuits to show distance to opening/closing relay or limit switch contacts during system operation. This is helpful to find the location of series connected relays and switches. Example; Cargo door circuits.

- a) Note the spike where the wire under test connects to the test cable.

NOTE: Refer to the tool manufacturer’s manual to determine if the tool automatically accounts for the length of the test lead when making distance to fault calculations. It may be necessary to subtract out the length of the test cable from the distance to fault.

- b) If the wire is shielded, note the dip where the shielding starts.

NOTE: If the shielding is cut back, this dip will be moved to the right a corresponding distance.

- 6) Start the intermittent fault test on the multi carrier time domain reflectometer, SPL-17763 or spread spectrum time domain reflectometer, COM-19603.
- 7) Work from one end of the wire under test to the other manually disturbing (shaking) the harness as you go.
- 8) Review the recorded continuity data.
- a) There should be no intermittent faults recorded during the test.
- b) If a fault is found, continue disturbing the wire under test in the area shown by the distance-to-fault function until the fault is located.

NOTE: Use the Tone Probe included in the kit, COM-20963 to further isolate the exact wire and location. The Tone Probe will detect the end of the open wire, relay contact or switch; but an intermittent short circuit is not detected while hard shorted. It will identify the short circuit location only when shaking the circuit open. Go to distance-to-fault location identified on TDR, then use the tone and probe in this area while shaking. The tone will appear when the open wire, relay contact or switch is detected.

- 9) Repair any faults that you find.
- 10) Disconnect the multi carrier time domain reflectometer, SPL-17763 or spread spectrum time domain reflectometer, COM-19603 from the circuit.
- 11) Reconnect the circuit to the aircraft (Refer to the appropriate WDM).
- 12) Do an operational check of the system(s) which was/were disturbed.



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M. Automated Intermittent Fault Detection & Integrity Test

SUBTASK 20-70-24-700-015

- (1) Do an Automated Intermittent Fault Detection using Voyager FC.

NOTE: Since most intermittent faults randomly occur with engines running in-flight and are not repeated during ground testing, it is probable that your fault is due to wiring being opened to cold/wet, heavy vibration, and stretching due to the aircraft pressurization. To help locate the fault on the ground, this automated tester self-maps circuit when connected and performs simultaneous and continuous intermittency tests on multiple points, up to 512 test points (e.g. connector pins). The unit tests wiring, relays, circuit breakers, connectors, terminal blocks, and passive components. The unit detects permanent and intermittent shorts, opens, instability and Electro-Magnetic Interference (EMI) events occurring down to 50 nS.

- (a) Prepare for testing by de-energizing the applicable circuit to be tested.
- (b) Review the WDM to ensure the intermittent fault detector, COM-20952 is isolated from any voltage.
 - 1) Pay special attention to all terminal blocks and splices for circuit under test.
- (c) Examine the electrical connectors for bent or broken pins/sockets, dirt, moisture and damage.
- (d) Install conductive dust cap and connector cover on the applicable LRUs.
- (e) Connect the intermittent fault detector, COM-20952 to the aircraft wiring under test as follows:
 - 1) Follow the intermittent fault detector, COM-20952 operator's manual to setup for testing.
 - 2) Follow power on procedures for the intermittent fault detector, COM-20952 and prepare to perform automapping.
- (f) Do the Voyager Automap procedure and verify automap matches current aircraft circuit configuration.
- (g) Examine passive LRUs (e.g. relay & actuator coils) resistance readings to AMM/FIM/CMM specifications.
- (h) If all readings are ok, shake or stress applicable aircraft wiring by:
 - 1) Manually shaking harness
 - 2) Pressurizing airplane
 - 3) Operating Flight Control
- (i) If all measurements are good, the circuit(s) is OK.
- (j) Disconnect the intermittent fault detector, COM-20952 from the aircraft.
- (k) Install all disconnected connectors (Refer to the appropriate WDM).
- (l) Do an operational check of the system(s) that were disconnected.

———— **END OF TASK** ————

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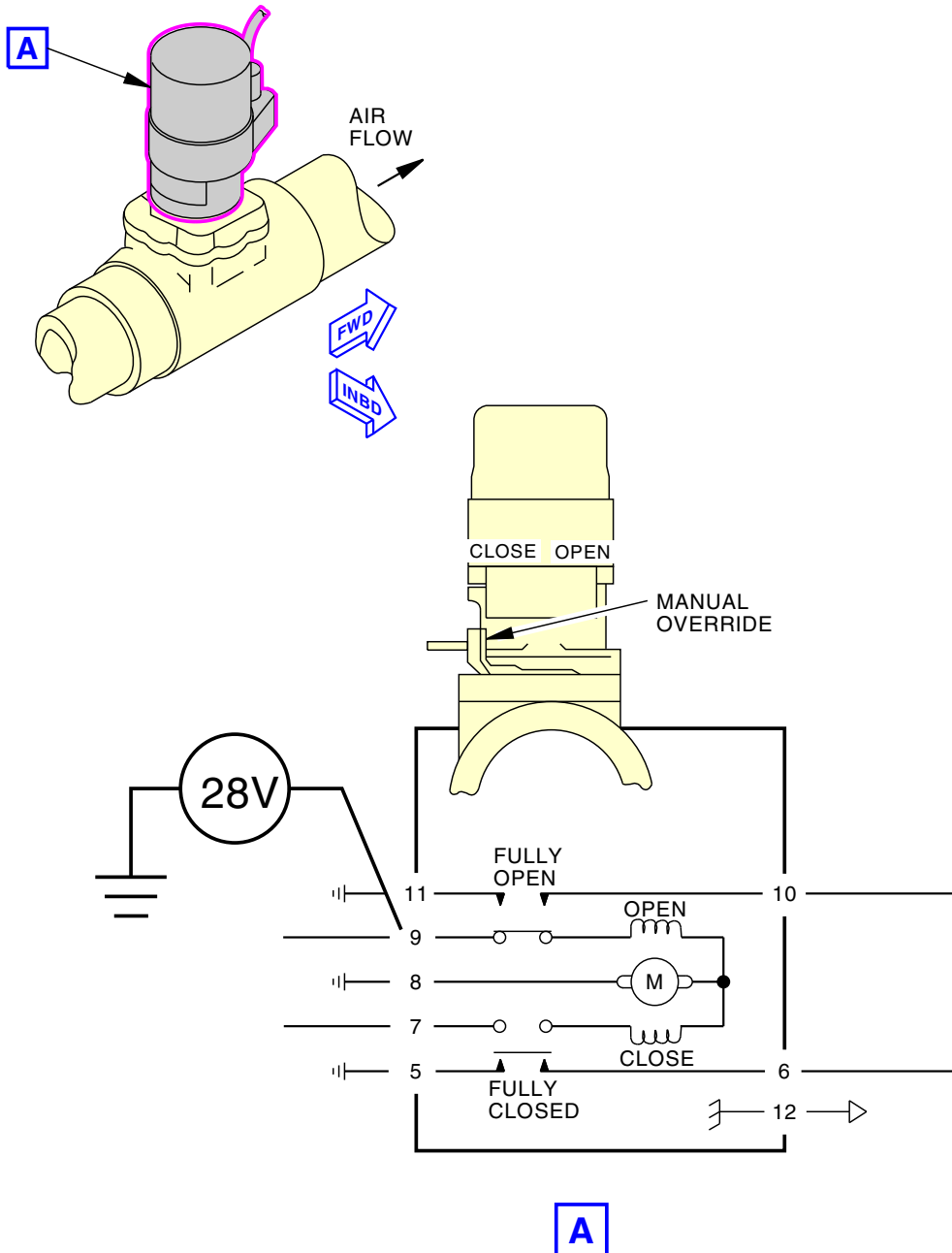
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INTERMITTENT FUNCTION OF AN AIR SHUTOFF VALVE IS REPORTED. UPON INSPECTION IT'S FOUND THAT THE VALVE INTERMITTENTLY FAILS TO GET TO THE COMMANDED POSITION. IF VOLTAGE DROP ACROSS THE VALVE ACTUATOR IS MEASURED FROM PIN 9 TO AIRCRAFT GROUND, THE DMM INDICATES 28 VDC.



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Component Load Testing (Example)
Figure 201/20-70-24-990-801 (Sheet 1 of 2)

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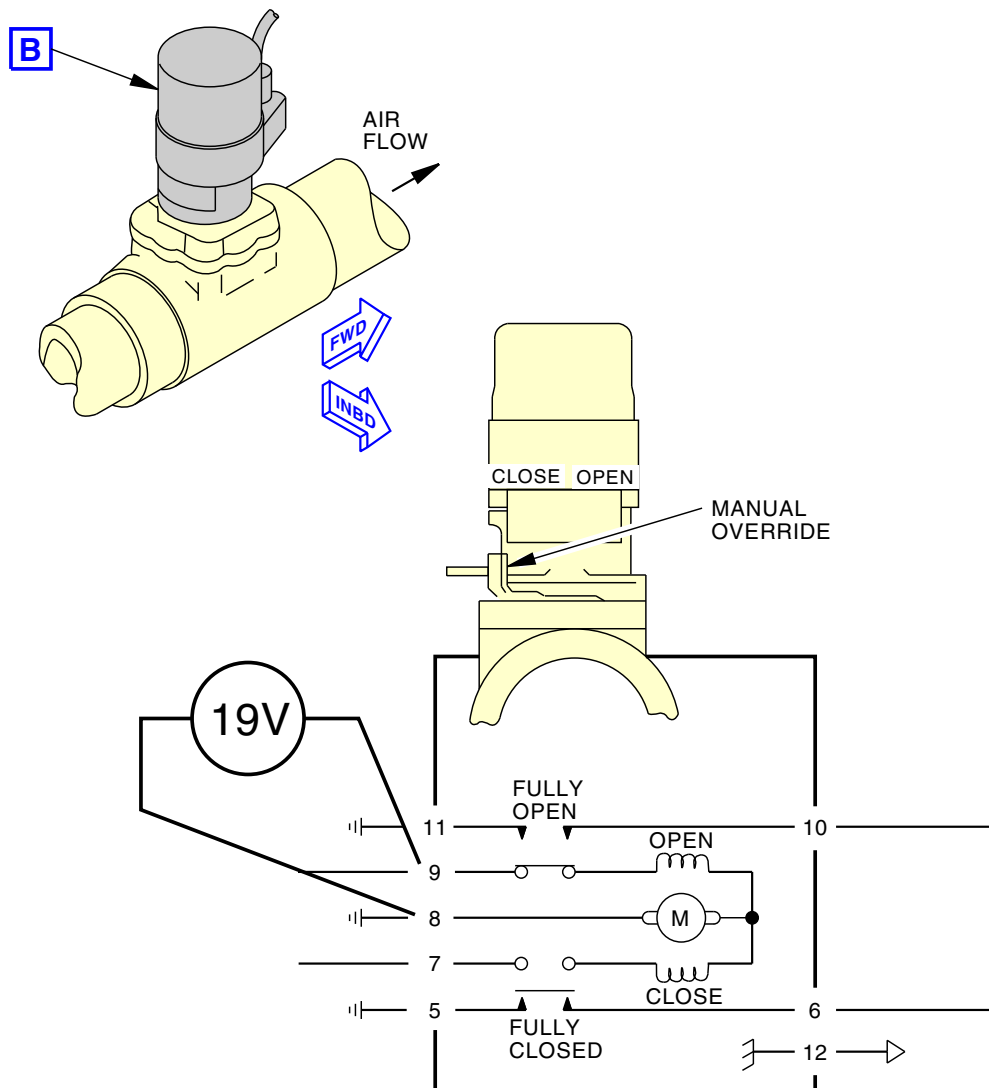
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THIS MEASUREMENT INCLUDES ANY VOLTAGE DROPPED ACROSS THE CONNECTION FROM PIN 8 TO AIRCRAFT GROUND INCLUDING THE GROUNDING CONNECTION. IF VOLTAGE DROP IS MEASURED DIRECTLY ACROSS THE ACTUATOR FROM PIN 9 TO PIN 8, THE DMM INDICATES ONLY 19 VDC. THIS LOW VOLTAGE DROP ACROSS THE ACTUATOR EXPLAINS THE INTERMITTENT FUNCTION OF VALVE.



IF THE VOLTAGE DROP IS MEASURED FROM PIN 8 TO AIRCRAFT GROUND, THE DMM WILL SHOW THAT 9 VDC IS BEING LOST ACROSS THE GROUND WIRE AND ITS CONNECTION TO THE AIRCRAFT. THE EXPECTED VOLTAGE DROP ACROSS THE GROUND CONNECTION IS ONLY 0.100 VDC. A DEGRADED GROUND WIRE OR GROUND CONNECTION IS THE CAUSE OF THE FAULT IN THIS CASE.

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Component Load Testing (Example)
Figure 201/20-70-24-990-801 (Sheet 2 of 2)

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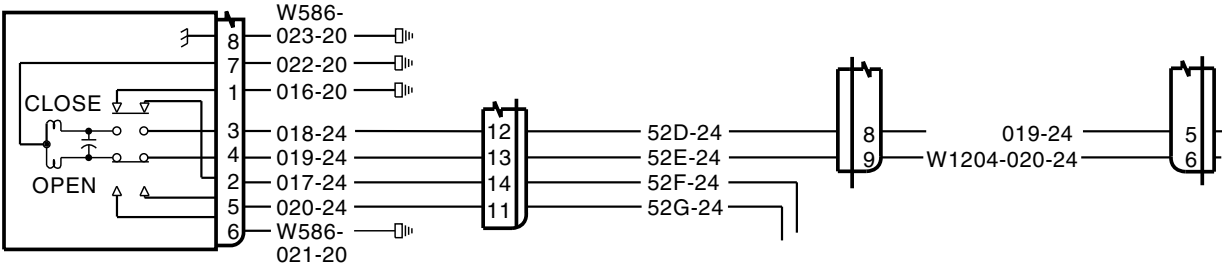
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INTERMITTENT FUNCTION OF AN AIR SHUTOFF VALVE IS REPORTED. UPON INSPECTION IT IS FOUND THAT THE VALVE INTERMITTENTLY FAILS TO ACHIEVE THE COMMANDED POSITION. FOR THIS EXAMPLE ASSUME IT IS IMPRACTICAL TO LOAD TEST THE CIRCUIT USING AIRCRAFT POWER. AS AN ALTERNATE TO AIRCRAFT POWER THE CIRCUIT CAN BE LOAD TESTED USING A POWER SUPPLY AND VOLTAGE DROP TEST SET FOLLOWING THE STEPS OUTLINED IN THIS PROCEDURE.

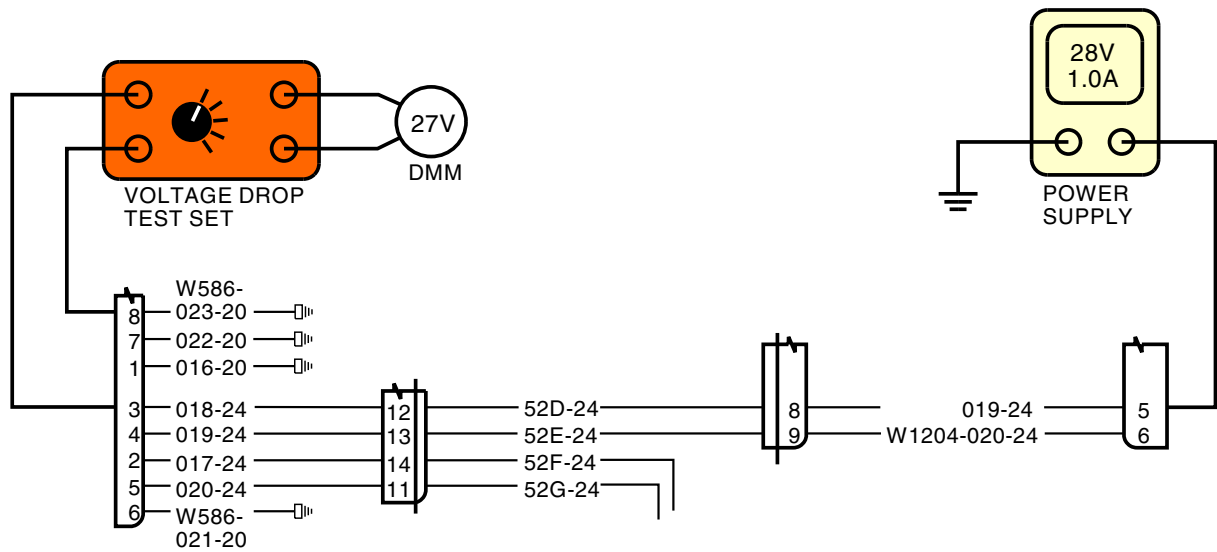
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Load Testing Using a Power Supply (Example)
Figure 202/20-70-24-990-802 (Sheet 1 of 2)

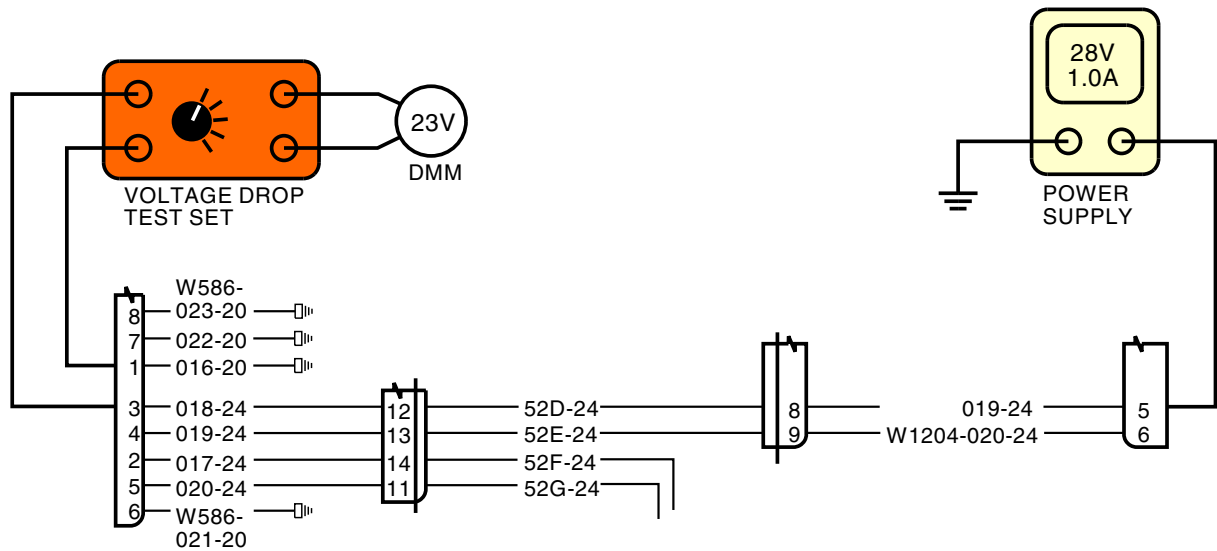
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WHEN THE LOAD IS CONNECTED TO THE GROUND AT PIN 8 ABOVE, 27 VDC IS MEASURED ACROSS THE LOAD INDICATING THAT THE CIRCUIT BETWEEN THE POWER SUPPLY AND THE GROUND AT PIN 8 IS IN GOOD CONDITION. HOWEVER, WHEN THE LOAD IS CONNECTED TO THE GROUND AT PIN 1 BELOW, ONLY 23 VDC IS MEASURED ACROSS THE LOAD INDICATING THAT 4 VDC IS BEING LOST SOMEWHERE IN THE CIRCUIT BETWEEN THE POWER SUPPLY AND THE GROUND AT PIN 1.



SINCE WE KNOW THE CIRCUIT BETWEEN THE POWER SUPPLY AND THE VOLTAGE DROP TEST SET IS GOOD FROM THE FIRST TEST ABOVE, WE CAN CONCLUDE THE 4 VDC LOSS IS OCCURRING SOMEWHERE BETWEEN PIN 1 AND ITS ASSOCIATED GROUND CONNECTION. IN THIS EXAMPLE, DOING A VOLTAGE DROP INSPECTION OF THE CONNECTIONS FOUND THAT PIN 1 HAD BEEN POORLY CRIMPED TO THE GROUND WIRE RESULTING IN HIGH RESISTANCE.

2980284 S0000758198_V1

Load Testing Using a Power Supply (Example)
Figure 202/20-70-24-990-802 (Sheet 2 of 2)

EFFECTIVITY
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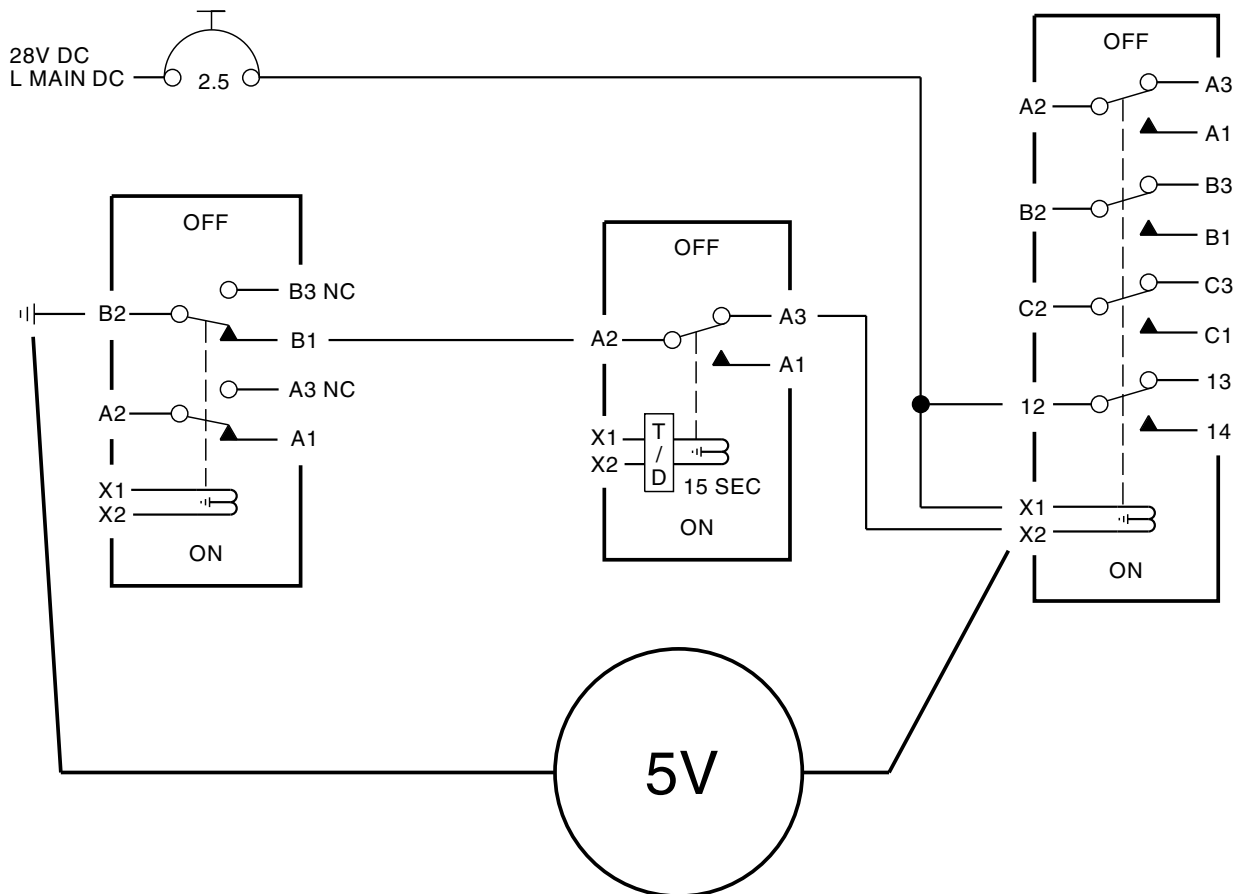
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INTERMITTENT LOW FUEL PRESSURE WARNINGS REPORTED ON A FUEL JETTISON PUMP. UPON INSPECTION THE PUMP IS FOUND TO INTERMITTENTLY CUT OUT.



WHEN VOLTAGE DROP FOR THE ENTIRE GROUND CIRCUIT OF THE 3-PHASE CONTROL RELAY IS MEASURED IT IS FOUND TO BE 5 VDC. THIS INCLUDES THE VOLTAGE DROP ACROSS ALL CONNECTIONS BETWEEN THE DMM LEADS.

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Voltage Drop Across Connections (Example)
Figure 203/20-70-24-990-803 (Sheet 1 of 3)

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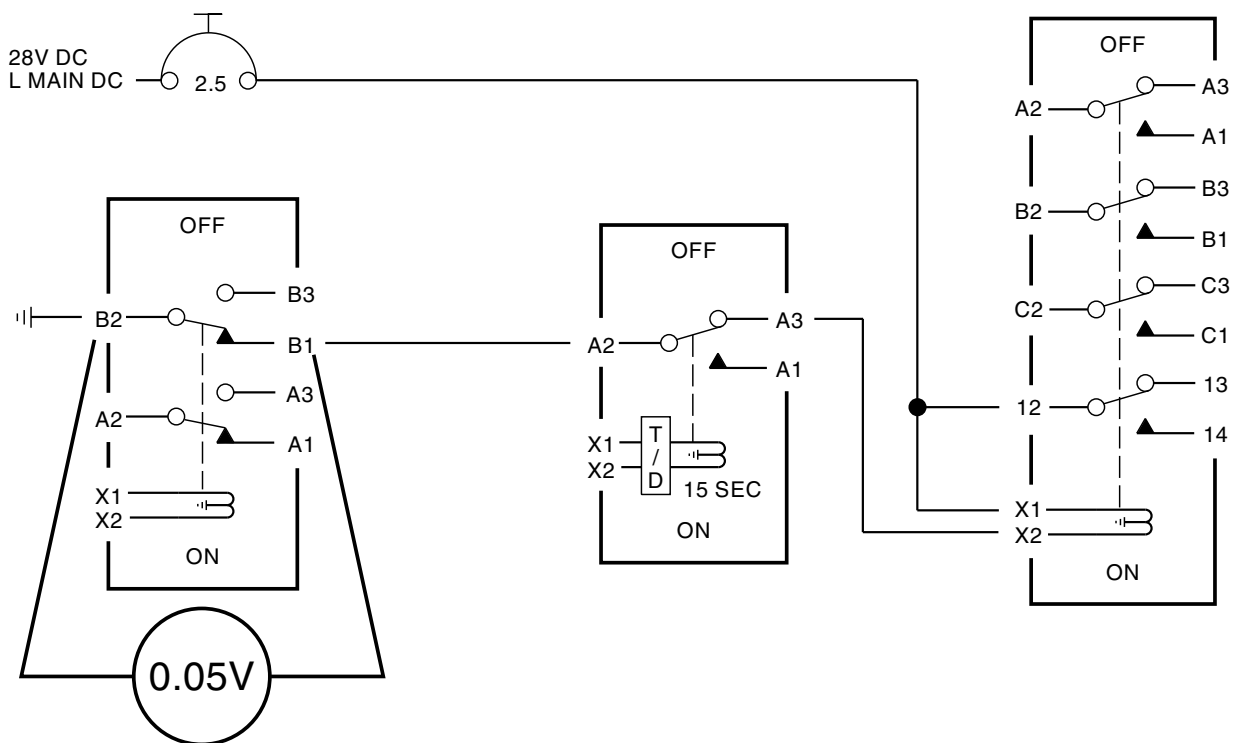
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WHEN THE LEADS ARE BROUGHT CLOSER TOGETHER TO EVALUATE EACH COMPONENT INDIVIDUALLY
THE RELAY BELOW MEASURES 0.05 VDC OF VOLTAGE DROP (A GOOD VALUE).



2980289 S0000758203_V1

Voltage Drop Across Connections (Example)
Figure 203/20-70-24-990-803 (Sheet 2 of 3)

EFFECTIVITY
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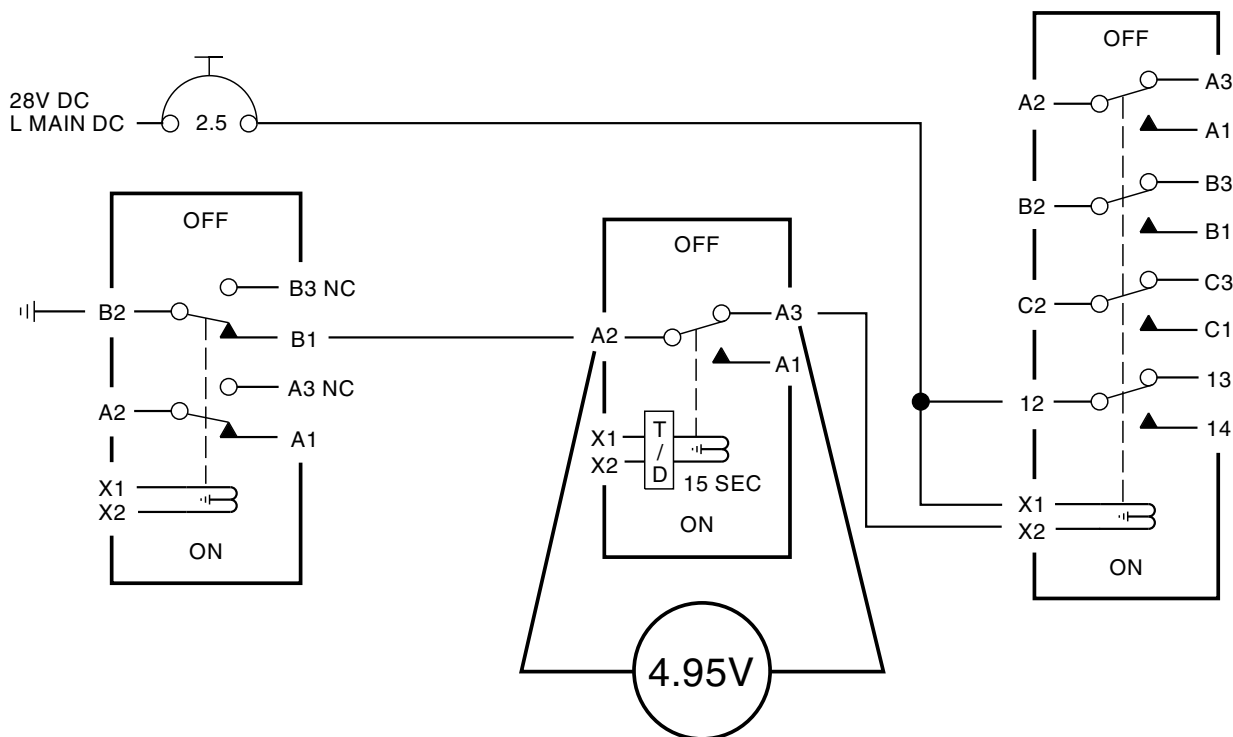
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THE RELAY ABOVE MEASURES 4.95 VDC (A BAD VALUE). IN THIS EXAMPLE, DAMAGED RELAY CONTACTS WERE CAUSING AN EXCESSIVE VOLTAGE DROP ACROSS THE RELAY. THIS EXCESSIVE DROP ACROSS THE RELAY REDUCED THE AMOUNT OF VOLTAGE AVAILABLE TO ENERGIZE THE COIL OF THE 3-PHASE RELAY ALLOWING IT TO INTERMITTENTLY RELAX.

NOTE:

IF THE VOLTAGE DROP ACROSS A RELAY IS MEASURED BY BACKPROBING, THIS VOLTAGE DROP INCLUDES THE DROP ACROSS THE RELAY CONTACTS BUT ALSO THE VOLTAGE DROP ASSOCIATED WITH ANY PIN CONNECTIONS IN THE BASE ITSELF. BY REPLACING THE RELAY AND RETESTING IT CAN BE VERIFIED THAT THE VOLTAGE DROP WAS DUE TO THE RELAY AND NOT THE BASE.

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Voltage Drop Across Connections (Example)
Figure 203/20-70-24-990-803 (Sheet 3 of 3)

EFFECTIVITY
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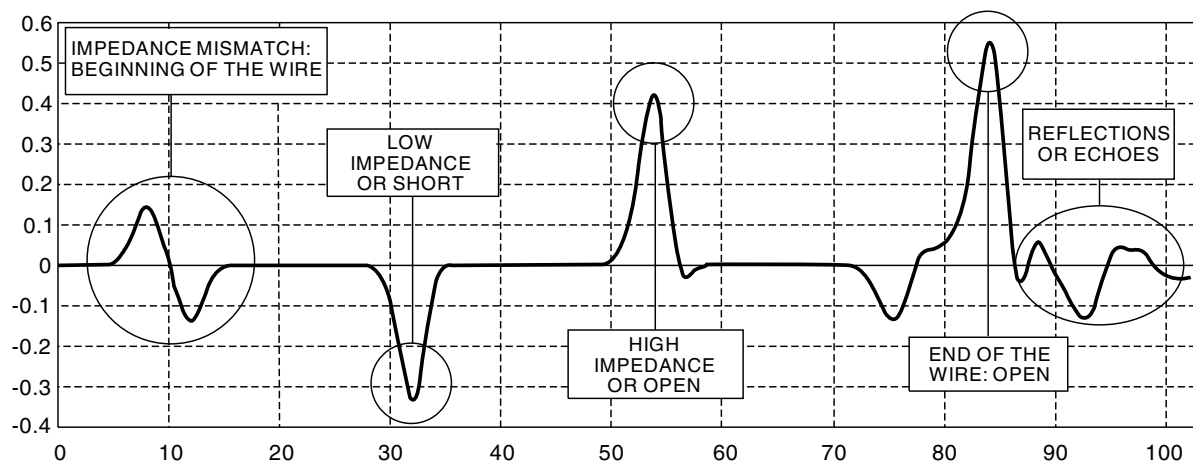
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TDR Scan (Example)
Figure 204/20-70-24-990-804

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EXAMPLE:

USING A POWER SUPPLY SET TO SUPPLY 28 VDC AT 1 AMP AND A VOLTAGE DROP TEST SET SET TO A 1 AMP LOAD THE MEASURED VOLTAGE DROP ACROSS THE LOAD IS FOUND TO BE 27 VDC. THIS MEANS THAT 1 VDC IS LOST IN THE CIRCUIT. IF THE NORMAL OPERATING CURRENT FOR THE CIRCUIT IS 10 AMPS THE VOLTAGE LOSS UNDER OPERATING CONDITIONS CAN BE CALCULATED AS FOLLOWS:

USING OHMS LAW IT CAN BE SHOWN THAT A 1 VDC LOSS AT 1 AMP EQUATES TO AN EQUIVALENT RESISTANCE OF 1 OHM IN THE CIRCUIT. THIS RESISTANCE COULD BE PRIMARILY LOCATED AT A SINGLE CONNECTION OR SPREAD OUT OVER MULTIPLE CONNECTIONS.

$$V = IR \rightarrow R = \frac{V}{I}$$
$$R = \frac{1 \text{ VDC}}{1 \text{ AMP}} = 1 \text{ OHM}$$

IF WE THEN MULTIPLY THE RESISTANCE WE CALCULATED FOR THE CIRCUIT BY THE OPERATING CURRENT OF THE CIRCUIT THE LOSS UNDER OPERATING LOAD IS FOUND TO BE 10 VDC! THIS IS A SIGNIFICANT LOSS WHICH WILL ALMOST CERTAINLY CAUSE INTERMITTENT OPERATION OF THE SYSTEM. ADDITION TROUBLESHOOTING SHOULD BE ACCOMPLISHED TO DETERMINE THE SOURCE OF THIS VOLTAGE LOSS.

$$V = IR$$
$$V = 10 \text{ AMPS} \times 1 \text{ OHM} = 10 \text{ VDC}$$

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Calculating Voltage Drop (Example)
Figure 205/20-70-24-990-805

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SHORT CIRCUIT
VISUAL DETECTION



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Insulating Resistance check with Acoustic Digital Camera
Figure 206/20-70-24-990-806

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BOEING
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NON-CONDUCTIVE
ACOUSTIC PROBE

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Insulating Resistance check with Ultrasonic Leak Probe
Figure 207/20-70-24-990-807

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