CHAPTER

20

STANDARD PRACTICES

CHAPTER 20
STANDARD PRACTICES

Subject/Page	Date	COC
20-EFFECTIVE PAGES		
1 thru 9	Feb 15/2025	
10	BLANK	
20-CONTENTS		
1	Feb 15/2023	
2	Jun 15/2023	
O 3	Feb 15/2025	
4	Feb 15/2021	
5	Oct 15/2022	
6	Oct 15/2022	
7	Oct 15/2022	
8	Oct 15/2024	
9	Oct 15/2022	
O 10	Feb 15/2025	
O 11	Feb 15/2025	
O 12	Feb 15/2025	
O 13	Feb 15/2025	
O 14	Feb 15/2025	
O 15	Feb 15/2025	
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O 18	Feb 15/2025	
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202	BLANK	
20-10-02		
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404	Feb 15/2015	
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20-10-07		
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220	Jun 15/2023	
221	Jun 15/2023	
222	Jun 15/2023	
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227	Jun 15/2023	C
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229	Jun 15/2023	C
20-10-07 (cont)		
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20-10-10		
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402	Jun 15/2022	
403	Oct 15/2015	
404	Jun 15/2022	
20-10-11		
401	Oct 15/2020	
R 402	Feb 15/2025	
403	Feb 15/2022	
R 404	Feb 15/2025	
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20-10-11		
801	Oct 15/2017	
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20-10-14		
R 401	Feb 15/2025	
O 402	Feb 15/2025	
O 403	Feb 15/2025	
404	Oct 15/2024	

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20-10-15		
401	Oct 15/2017	
402	Oct 15/2017	
20-10-17		
R 401	Feb 15/2025	
R 402	Feb 15/2025	
R 403	Feb 15/2025	
R 404	Feb 15/2025	
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202	Oct 15/2017	
20-10-21		
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20-10-24		
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412	Oct 15/2015	
413	Oct 15/2015	
414	Oct 15/2015	
20-10-27		
201	Jun 15/2024	
202	Jun 15/2024	
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201	Oct 15/2018	
202	Oct 15/2018	
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202	Oct 15/2022	
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206	Jun 15/2023	
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402	Oct 15/2015	
20-10-33		
401	Oct 15/2022	
402	Feb 15/2022	
403	Oct 15/2022	
404	Feb 15/2022	
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405	Oct 15/2017	
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407	Feb 15/2021	
408	Feb 15/2024	
409	Oct 15/2017	

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Subject/Page	Date	COC
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409	Jun 15/2023	
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808	Oct 15/2015	
809	Oct 15/2015	
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814	Oct 15/2015	
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839	Oct 15/2020	
840	Feb 15/2024	
841	Oct 15/2020	
842	Feb 15/2024	
843	Oct 15/2020	
844	Oct 15/2020	
845	Oct 15/2020	

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846	Oct 15/2020	
847	Jun 15/2022	
848	Oct 15/2020	
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879	Oct 15/2020	
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881	Oct 15/2020	
20-10-51 (cont)		
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886	Feb 15/2024	
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890	Oct 15/2020	
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892	Oct 15/2020	
893	Feb 15/2021	
894	Oct 15/2020	
895	Oct 15/2020	
896	Oct 15/2020	
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898.24	Oct 15/2020	
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898.51	Oct 15/2020	
898.52	Oct 15/2020	
898.53	Oct 15/2020	
898.54	Oct 15/2020	

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204	Oct 15/2015	
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404	Oct 15/2015	
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222	Feb 15/2022	
223	Feb 15/2024	
224	Feb 15/2022	
225	Feb 15/2022	

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R 204	Feb 15/2025	
R 205	Feb 15/2025	
R 206	Feb 15/2025	
R 207	Feb 15/2025	
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O 211	Feb 15/2025	
R 212	Feb 15/2025	
R 213	Feb 15/2025	
R 214	Feb 15/2025	
R 215	Feb 15/2025	
R 216	Feb 15/2025	
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R 403	Feb 15/2025	
R 404	Feb 15/2025	
R 405	Feb 15/2025	
R 406	Feb 15/2025	
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R 207	Feb 15/2025	
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602	Oct 15/2017	
603	Oct 15/2014	
604	Feb 15/2016	
20-20-31		
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602	Feb 15/2024	
603	Jun 15/2024	
604	Feb 15/2022	
605	Jun 15/2016	

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608	Oct 15/2024	
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610	Oct 15/2024	
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20-30-11		
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O 202	Feb 15/2025	
R 203	Feb 15/2025	
R 204	Feb 15/2025	
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201	Oct 15/2014	
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201	Oct 15/2023	
202	Oct 15/2023	
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206	Oct 15/2017	
20-40-12		
201	Oct 15/2022	
202	Oct 15/2017	
R 203	Feb 15/2025	
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205	Oct 15/2022	
R 206	Feb 15/2025	
R 207	Feb 15/2025	
208	Jun 15/2020	
209	Oct 15/2015	
210	Oct 15/2017	
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R 201	Feb 15/2025	
R 202	Feb 15/2025	
203	Oct 15/2024	
204	Oct 15/2024	
205	Oct 15/2024	
206	Oct 15/2024	
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227	Oct 15/2024	
20-50-11 (cont)		
228	Oct 15/2024	
229	Oct 15/2024	
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240	Oct 15/2024	
20-60-01		
201	Oct 15/2014	
202	Oct 15/2014	
203	Oct 15/2017	
204	BLANK	
20-60-02		
201	Feb 15/2024	
202	Feb 15/2024	
203	Feb 15/2024	
204	BLANK	
20-60-03		
201	Feb 15/2024	
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203	Feb 15/2024	
204	BLANK	
20-60-04		
201	Feb 15/2024	
202	Jun 15/2024	
203	Jun 15/2024	
204	BLANK	
20-60-05		
201	Jun 15/2015	
202	Oct 15/2014	
20-60-06		
201	Feb 15/2021	
202	BLANK	
20-60-07		
201	Jun 15/2024	
202	Jun 15/2024	
203	Jun 15/2024	
204	BLANK	
20-60-08		
201	Oct 15/2017	
202	BLANK	
20-70-24		
201	Oct 15/2024	
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225	Oct 15/2024	
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229	Oct 15/2024							
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232	Oct 15/2024							
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243	Oct 15/2024							
244	Oct 15/2024							

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STANDARD PRACTICES - MAINTENANCE PRACTICES	20-00-00		201	LOM ALL
Airworthiness Limitation Precautions TASK 20-00-00-910-801			201	LOM ALL
Enhanced Zonal Inspection Program (EZAP) Precautions TASK 20-00-00-910-802			202	LOM ALL
FLOOR PANEL PROTECTION - MAINTENANCE PRACTICES	20-09-01		201	LOM ALL
Floor Panel Damage Prevention During Maintenance TASK 20-09-01-610-801			201	LOM ALL
BEARINGS AND BUSHINGS - REMOVAL/INSTALLATION	20-10-02		401	LOM ALL
Bearings and Bushings - Removal/Installation TASK 20-10-02-900-801			401	LOM ALL
CONTROL CABLE AIR AND PRESSURE SEALS - REMOVAL/INSTALLATION	20-10-04		401	LOM ALL
Control Cable Air Seal Removal TASK 20-10-04-000-802			401	LOM ALL
Control Cable Air Seal Installation TASK 20-10-04-400-802			404	LOM ALL
Control Cable Half Ball Pressure Seal Removal TASK 20-10-04-000-801			405	LOM ALL
Control Cable Half Ball Pressure Seal Installation TASK 20-10-04-400-801			407	LOM ALL
VELCRO - MAINTENANCE PRACTICES	20-10-06		201	LOM ALL
Velcro Removal TASK 20-10-06-000-801			201	LOM ALL
Velcro Installation TASK 20-10-06-400-801			202	LOM ALL
E/E RACK-MOUNTED COMPONENTS AND PRINTED CIRCUIT CARD - REMOVAL/INSTALLATION	20-10-07		201	LOM ALL
E/E Box Removal TASK 20-10-07-000-801			201	LOM ALL

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E/E Box Installation TASK 20-10-07-400-801			213	LOM ALL
Lever Latch Fork Adjustment TASK 20-10-07-820-801			220	LOM ALL
Printed Circuit Card Removal TASK 20-10-07-000-802			221	LOM ALL
Printed Circuit Card Installation TASK 20-10-07-400-802			224	LOM ALL
E/E Shelf Assembly Removal TASK 20-10-07-020-802			224	LOM 461-463
E/E Shelf Assembly Installation TASK 20-10-07-400-804			230	LOM 461-463
CONTROL CABLE STOPS - REMOVAL/INSTALLATION	20-10-08		401	LOM ALL
Control Cable Stops Removal TASK 20-10-08-960-801			401	LOM ALL
Control Cable Stops Installation TASK 20-10-08-420-801			401	LOM ALL
CONTROL CABLE PULLEYS - REMOVAL/INSTALLATION	20-10-09		401	LOM ALL
Control Cable Pulleys Removal TASK 20-10-09-000-801			401	LOM ALL
Control Cable Pulleys Installation TASK 20-10-09-400-801			403	LOM ALL
TURNBUCKLE LOCK - REMOVAL/INSTALLATION	20-10-10		401	LOM ALL
Turnbuckle Locking Clips Removal TASK 20-10-10-000-801			401	LOM ALL
Turnbuckle Lock Installation TASK 20-10-10-400-801			401	LOM ALL
PRESSURE-SENSITIVE DECALS - REMOVAL/INSTALLATION	20-10-11		401	LOM ALL
Pressure-Sensitive Decal Removal TASK 20-10-11-000-802			401	LOM ALL
Pressure-Sensitive Decal Installation TASK 20-10-11-400-801			403	LOM ALL

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PRESSURE-SENSITIVE DECALS - REPAIRS	20-10-11		801	LOM ALL
Repair External Pressure Sensitive Decals TASK 20-10-11-000-801			801	LOM ALL
PRESSURE SENSITIVE PLACARDS - REMOVAL/INSTALLATION	20-10-14		401	LOM ALL
Pressure Sensitive Placard - Removal TASK 20-10-14-000-801			401	LOM ALL
Pressure Sensitive Placard - Installation TASK 20-10-14-400-801			402	LOM ALL
RECESSED BOSS SEAL FITTINGS - REMOVAL/INSTALLATION	20-10-15		401	LOM ALL
Boss Fitting Removal TASK 20-10-15-000-801			401	LOM ALL
Adapter (Straight) Fitting Installation TASK 20-10-15-400-801			401	LOM ALL
Positioning (Elbow Type) Fitting Installation TASK 20-10-15-400-802			401	LOM ALL
O-RINGS - REMOVAL/INSTALLATION	20-10-17		401	LOM ALL
O-Rings Removal TASK 20-10-17-000-801			401	LOM ALL
O-Rings Installation TASK 20-10-17-400-801			403	LOM ALL
THREADED INSERTS - MAINTENANCE PRACTICES	20-10-18		201	LOM ALL
Maintenance Practices TASK 20-10-18-900-801			201	LOM ALL
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Cap and Plug Hydraulic Fittings TASK 20-10-20-800-801			201	LOM ALL
ALUMINUM FOIL MARKERS - REMOVAL/INSTALLATION	20-10-21		401	LOM ALL
Aluminum Foil Markers Removal TASK 20-10-21-000-801			401	LOM ALL
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LUBRICATION FITTINGS - REMOVAL/INSTALLATION	20-10-24		401	LOM ALL
Lubrication Fitting Removal TASK 20-10-24-000-801			401	LOM ALL
Lubrication Fitting Installation TASK 20-10-24-420-801			403	LOM ALL
RIG PINS - MAINTENANCE PRACTICES	20-10-25		201	LOM ALL
Rig Pin Maintenance Practices TASK 20-10-25-910-801			201	LOM ALL
CAPTIVE SCREWS - REMOVAL/INSTALLATION	20-10-26		401	LOM ALL
Captive Screws Removal TASK 20-10-26-000-801			401	LOM ALL
Captive Screws Installation TASK 20-10-26-400-801			409	LOM ALL
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TEFLON BACKUP RINGS - REMOVAL/INSTALLATION	20-10-31		401	LOM ALL
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Remove Paint from Metal Surfaces with Lacquer Thinner or Solvent TASK 20-10-34-110-801			703	LOM ALL
Clean Bare, Clad, or Plated Metal with Solvent TASK 20-10-34-110-802			704	LOM ALL
ELECTRICAL BONDING - INSPECTION/CHECK	20-10-37		601	LOM ALL
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Insulation Resistance Testing - Special Detail Inspection TASK 20-10-39-700-801			501	LOM ALL

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Control Cable Grommet Removal TASK 20-10-41-000-801			401	LOM ALL
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Lockwire, Cotter Pins, and Lockrings - Installation TASK 20-10-44-400-801			401	LOM ALL
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FLARELESS TUBING ASSEMBLY - REMOVAL/INSTALLATION	20-10-51		401	LOM ALL
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Flareless Tubing Assembly Installation TASK 20-10-51-400-804			403	LOM ALL

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Swage the BACS13BX Flareless Sleeves with the Internal Elastomer Swage Equipment TASK 20-10-51-300-806			880	LOM ALL
BACS13BX Flareless Sleeve Swaging on Stainless Steel and Titanium Hydraulic Tubing TASK 20-10-51-300-807			885	LOM ALL
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Correct Torque Value Determination for a Hydraulic Hose Assembly TASK 20-10-52-910-801			210	LOM ALL
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Flexible Hose Removal TASK 20-10-52-000-801			402	LOM ALL

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LE Flap/Slat Sensor Resistance Check - Check III TASK 20-10-76-700-803			208	LOM ALL
LE Flap/Slat Proximity Sensor Check - Check IV TASK 20-10-76-700-804			213	LOM ALL
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TE Flap Indication System Insulation Resistance Check - Check II TASK 20-10-76-700-806			222	LOM ALL
TE Flap Indication System Resistance Check - Check III TASK 20-10-76-700-807			227	LOM ALL
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STRIPPERS - MAINTENANCE PRACTICES	20-30-71		201	LOM ALL
Strippers TASK 20-30-71-910-801			201	LOM ALL
AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 80) - MAINTENANCE PRACTICES	20-30-80		201	LOM ALL
General Cleaning of Metal (Series 80) TASK 20-30-80-910-801			201	LOM ALL
AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 81) - MAINTENANCE PRACTICES	20-30-81		201	LOM ALL
General Cleaning of Solvent Sensitive Organic Coatings (Series 81) TASK 20-30-81-910-801			201	LOM ALL

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General Cleaning of Solvent Resistant Organic Coatings (Series 82) TASK 20-30-82-910-801			201	LOM ALL
AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 83) - MAINTENANCE PRACTICES	20-30-83		201	LOM ALL
General Cleaning of Composites (Series 83) TASK 20-30-83-910-801			201	LOM ALL
AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 84) - MAINTENANCE PRACTICES	20-30-84		201	LOM ALL
Final Cleaning of Metal Prior to Painting (Series 84) TASK 20-30-84-910-801			201	LOM ALL
AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 85) - MAINTENANCE PRACTICES	20-30-85		201	LOM ALL
Final Cleaning of All Organic Coatings Prior to Painting (Series 85) TASK 20-30-85-910-801			201	LOM ALL
AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 86) - MAINTENANCE PRACTICES	20-30-86		201	LOM ALL
Final Cleaning of Solvent Resistant Coatings Prior to Painting (Series 86) TASK 20-30-86-910-801			201	LOM ALL
AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 87) - MAINTENANCE PRACTICES	20-30-87		201	LOM ALL
Final Cleaning of Composites Prior to Painting (Series 87) TASK 20-30-87-910-801			201	LOM ALL
AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 88) - MAINTENANCE PRACTICES	20-30-88		201	LOM ALL
Final Cleaning of Metal Prior to Non-structural Bonding (Series 88) TASK 20-30-88-910-801			201	LOM ALL

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AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 89) - MAINTENANCE PRACTICES	20-30-89		201	LOM ALL
Final Cleaning of Solvent Sensitive Organic Coatings Prior to Non-structural Bonding (Series 89) TASK 20-30-89-910-801			201	LOM ALL
AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 90) - MAINTENANCE PRACTICES	20-30-90		201	LOM ALL
Final Cleaning of Solvent Resistant Organic Coatings Prior to Non-structural Bonding (Series 90) TASK 20-30-90-910-801			201	LOM ALL
AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 91) - MAINTENANCE PRACTICES	20-30-91		201	LOM ALL
Final Cleaning of Composites Prior to Non-structural Bonding (Series 91) TASK 20-30-91-910-801			201	LOM ALL
AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 92) - MAINTENANCE PRACTICES	20-30-92		201	LOM ALL
Final Cleaning Prior to General Sealing (Series 92) TASK 20-30-92-910-801			201	LOM ALL
AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 93) - MAINTENANCE PRACTICES	20-30-93		201	LOM ALL
Final Cleaning Prior to Fuel Tank Sealing (Series 93) TASK 20-30-93-910-801			201	LOM ALL
AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 94) - MAINTENANCE PRACTICES	20-30-94		201	LOM ALL
Final Cleaning Prior to Application of Rain Erosion Resistant Coating (Series 94) TASK 20-30-94-910-801			201	LOM ALL
AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 95) - MAINTENANCE PRACTICES	20-30-95		201	LOM ALL
Final Cleaning Prior to Aerodynamic Smoothing and Fairing (Series 95) TASK 20-30-95-910-801			201	LOM ALL

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STANDARD PRACTICES

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AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 96) - MAINTENANCE PRACTICES	20-30-96		201	LOM ALL
Final Cleaning of Oxygen Components Exposed to Oxygen (Series 96) TASK 20-30-96-910-801			201	LOM ALL
AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 97) - MAINTENANCE PRACTICES	20-30-97		201	LOM ALL
Final Cleaning Prior to Structural Bonding (Series 97) TASK 20-30-97-910-801			201	LOM ALL
AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 98 & 98-1) - MAINTENANCE PRACTICES	20-30-98		201	LOM ALL
Cleaning of Specific Polymerics (Series 98) TASK 20-30-98-910-801			201	LOM ALL
Cleaning of Phenolics or Nylon (Series 98-1) TASK 20-30-98-910-802			203	LOM ALL
AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 99) - MAINTENANCE PRACTICES	20-30-99		201	LOM ALL
Final Cleaning of Composites Prior to Structural Bonding (Series 99) TASK 20-30-99-910-801			201	LOM ALL
AIRPLANE GROUNDING - MAINTENANCE PRACTICES	20-40-11		201	LOM ALL
Static Grounding TASK 20-40-11-910-801			201	LOM ALL
Electrical Bonding TASK 20-40-11-760-801			203	LOM ALL
Measurement of Airplane Electrical Resistance to Ground TASK 20-40-11-760-802			203	LOM ALL
ELECTROSTATIC DISCHARGE SENSITIVE (ESDS) DEVICES - MAINTENANCE PRACTICES	20-40-12		201	LOM ALL
Wrist Strap Continuity Test TASK 20-40-12-820-801			201	LOM ALL
ESDS Handling for Printed Circuit Board Removal TASK 20-40-12-000-801			202	LOM ALL

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ESDS Handling for Metal Encased Unit Removal TASK 20-40-12-000-802			205	LOM ALL
ESDS Handling for Metal Encased Unit Installation TASK 20-40-12-400-802			207	LOM ALL
Conductive Dust Cap and Connector Cover Removal TASK 20-40-12-000-804			208	LOM ALL
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CLEANING TO REMOVE COMBUSTIBLE MATERIAL (EZAP) - MAINTENANCE PRACTICES	20-60-02		201	LOM ALL
Cleaning to Remove Combustible Material TASK 20-60-02-100-801			201	LOM ALL
DETAILED INSPECTION OF EWIS (EZAP) - MAINTENANCE PRACTICES	20-60-03		201	LOM ALL
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INTERMITTENT WIRING - INSPECTION/CHECK	20-70-24		201	LOM ALL
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TASK 20-00-00-910-801

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 Section 9 of the Maintenance Planning Data (MPD) 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 Oversight Office that is responsible for the airplane model Type Certificate. 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 Oversight Office that is responsible for the airplane model Type Certificate.

(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 Section 9 of the Maintenance Planning Data (MPD) 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 Oversight Office that is responsible for the airplane model Type Certificate. 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 Oversight Office that is responsible for the airplane model Type Certificate.

B. Location Zones

Zone	Area
100	Lower Half of Fuselage
200	Upper Half of Fuselage
500	Left Wing
600	Right Wing

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C. Critical Design Configuration Control Limitations (CDCCLs)

SUBTASK 20-00-00-910-001

WARNING	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.

D. Airworthiness Limitation Instructions (ALIs)

SUBTASK 20-00-00-910-002

WARNING	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

EWIS

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

WARNING	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 and1 ft^2 (0.1 m^2) 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 in^2 (51.6 cm^2) for each leg.

——— END OF TASK ———

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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 20-10-04-000-802

2. Control Cable Air Seal Removal

Figure 401

A. General

(1) This task includes the steps to remove the nose landing gear manual extension release mechanism control cable air seal [1].

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 rings and one large ring from the ends of the control cable air seal [1].

SUBTASK 20-10-04-000-002

(2) Remove the seal [1] from the nose wheel well panel.

SUBTASK 20-10-04-000-003

(3) Remove the seal [1] from the cable.

END OF TASK

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

2381808 S0000546147_V1

Control Cable Air Seal Installation
Figure 401/20-10-04-990-802 (Sheet 1 of 2)

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A-A

2383631 S0000547030_V1

Control Cable Air Seal Installation
Figure 401/20-10-04-990-802 (Sheet 2 of 2)

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TASK 20-10-04-400-802

3. Control Cable Air Seal Installation

A. General

(1) This task includes the steps to install the nose landing gear manual extension release mechanism control cable air seal [1].

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 20-10-04-640-003

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

F. Control Cable Air Seal Installation

SUBTASK 20-10-04-420-012

(1) Install the control cable air seal [1] per Boeing Specification BAC5502, but do not fill the seal [1] with lubricant.

NOTE: The seal [1] will receive lubricant during cable movement.

SUBTASK 20-10-04-350-001

(2) Break sharp edges of the seal hole with a chamfer or radius of approximately 0.01 inch. This will prevent seal [1] damage during and after installation.

SUBTASK 20-10-04-420-013

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

SUBTASK 20-10-04-420-014

(4) Put the seal [1] through the panel hole.

(a) Make sure that the retaining groove of the seal [1] attached correctly with the panel.

(b) Make sure that the small end of the seal [1] is in the pressurized side of the panel.

SUBTASK 20-10-04-420-015

(5) Install two small rings into the grooves of the small end of the seal [1] in the pressurized side of the panel.

SUBTASK 20-10-04-420-016

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

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SUBTASK 20-10-04-211-001

(7) Make sure to install the correct part number and dimensions for the seal [1] installation. Refer to Table 1.

Table 1. Control Cable Air Seal Installation

SEAL PART NUMBER	CABLE DIAMETER (INCH)	INSTALLATION HOLE SIZE (+0.00 TO -0.06) (INCH)	LARGE RESTRAINING RING	SMALL RESTRAINING RING
BACS11T3A*[1]	0.094	0.59	BACS11L132C	BACS11L131C

*[1] BACS11T= basic seal part number
3= for specific cable diameter and installation hole size.
A= for elastomeric compound 1546 material requirement for the seal.

G. Control Cable Air Seal Installation Test

SUBTASK 20-10-04-480-001

(1) Make sure that the control cable and air seal [1] is correctly installed. Refer to Table 1.
  (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) For the mechanism installation and test with the seal [1] refer to: Nose Gear Manual Extension Release Mechanism Installation, TASK 32-35-11-400-801.

——— END OF TASK ———

TASK 20-10-04-000-801

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 [2].

B. Control Cable Half Ball Pressure Seal Removal

SUBTASK 20-10-04-020-003

(1) Remove the two screws [6] and washers [5], or the two nuts [7], washers [5], washers [8], and two screws [6].

SUBTASK 20-10-04-020-005

(2) Remove the seal cover [4] from the seal plate [3].

SUBTASK 20-10-04-020-004

(3) Remove the two half ball pressure seals [2] from the seal cover [4].

SUBTASK 20-10-04-020-001

(4) If it is necessary, replace the seal plate [3] and the seal cover [4].

——— END OF TASK ———

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3020889 S0000793269_V2

Control Cable Half Ball Pressure Seal Installation
Figure 402/20-10-04-990-803

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TASK 20-10-04-400-801

5. Control Cable Half Ball Pressure Seal Installation

(Figure 402)

A. General

(1) This task includes the steps to install the control cable half ball pressure seals [2].

B. References

Reference	Title
12-26-00-600-801	Control Cable Lubrication (P/B 301)

C. Consumable Materials

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

D. 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 half ball pressure seals [2], do this task: Control Cable Lubrication, TASK 12-26-00-600-801.

SUBTASK 20-10-04-420-001

(2) If you removed the seal plate [3] or the seal cover [4], do these steps:

(a) Install the seal plate [3] and the seal cover [4] to the non-pressurized side of the pressure bulkhead.

(b) Make sure that the cable goes through the center hole of the seal plate [3] and seal cover [4] after installation.

(c) If necessary, refer to the specified system rigging instructions to adjust the control cable.

E. Control Cable Half Ball Pressure Seal Installation

SUBTASK 20-10-04-420-004

(1) Connect the two half ball pressure seals [2] on the cable and put in the center hole of the seal cover [4] and seal plate [3].

(a) Put the seal cover [4], seal plate [3], and half ball pressure seals [2] in its position on the pressure bulkhead.

SUBTASK 20-10-04-420-005

(2) Loosely install the two screws [6] and washers [5], or the two nuts [7], washers [5], washers [8] and two screws [6].

SUBTASK 20-10-04-420-006

(3) Adjust the half ball pressure seals [2] to attain minimum cable deflection.

(a) If necessary, refer to the specified system rigging instructions to adjust the control cable.

NOTE: Be careful to make sure minimum cable friction after seal installation.

SUBTASK 20-10-04-420-017

(4) Tighten the two screws [6], or the two screws [6] and two nuts [7].

F. Control Cable Half Ball Pressure Seal Installation Test

SUBTASK 20-10-04-200-001

(1) Make sure that the cable and half ball pressure seals [2] 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.

END OF TASK

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VELCRO - MAINTENANCE PRACTICES

1. General

A. This procedure has these tasks:

(1) The removal of Velcro.

(2) The installation of Velcro.

TASK 20-10-06-000-801

2. Velcro Removal

A. General

(1) This task includes the steps to remove Velcro.

B. Tools/Equipment

Reference	Description
STD-8416	Cutter - Wire, Diagonal or Side, 6 in. (150 mm)

C. Consumable Materials

Reference	Description	Specification
B00062	Solvent - Acetone (99.5% Grade)	ASTM D 329 (Supersedes O-A-51)
B00148	Solvent - Methyl Ethyl Ketone (MEK)	ASTM D740
G00034	Cotton Wiper - Process Cleaning Absorbent Wiper (Cheesecloth, Gauze)	AMS3819 Class 1 Grade A or B Form 1 (Supersede BMS15-5 CL A)
G00040	Cord - Nylon Thread	A-A-59826 (Supersedes V-T-295)

D. Velcro Removal

SUBTASK 20-10-06-010-001

(1) Remove Velcro from surface.

(a) If necessary, apply moderate pressure.

(2) Check surface for any dust, marks or adhesive residue.

(a) Clean surface with a clean cotton wiper, G00034 that is moist with solvent, B00148, solvent, B00062, or alcohol.

E. Optional Removal

SUBTASK 20-10-06-020-001

(1) Remove nylon cord, G00040 using diagonal or side wire cutter, STD-8416.

(2) Remove Velcro from Surface.

(3) Check surface for any dust, marks or adhesive residue.

(a) Clean surface with a clean cotton wiper, G00034 that is moist with solvent, B00148, solvent, B00062, or alcohol.

END OF TASK

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TASK 20-10-06-400-801

3. Velcro Installation

A. General

(1) This task includes the steps to install Velcro.

B. Consumable Materials

Reference	Description	Specification
A00028	Adhesive - Modified Epoxy For Rigid PVC, Foam Cored Sandwiches	BAC5010 Type 70 (BMS5-92 Type 1)
B00062	Solvent - Acetone (99.5% Grade)	ASTM D 329 (Supersedes O-A-51)
B00148	Solvent - Methyl Ethyl Ketone (MEK)	ASTM D740
G00034	Cotton Wiper - Process Cleaning Absorbent Wiper (Cheesecloth, Gauze)	AMS3819 Class 1 Grade A or B Form 1 (Supersede BMS15-5 CL A)
G00040	Cord - Nylon Thread	A-A-59826 (Supersedes V-T-295)

C. Velcro Installation.

SUBTASK 20-10-06-820-001

(1) Cut Velcro-tape to necessary length.

SUBTASK 20-10-06-400-001

(2) Clean the surface with a clean cotton wiper, G00034 that is moist with solvent, B00148, solvent, B00062, or alcohol before application.

SUBTASK 20-10-06-910-001

(3) Apply adhesive, A00028 to surface and Velcro tape.

SUBTASK 20-10-06-910-002

(4) Apply Velcro to surface.

(a) If necessary, apply moderate pressure.

(b) Allow adhesive to cure before use.

D. Optional Installation

SUBTASK 20-10-06-400-003

(1) Cut tape to necessary length.

SUBTASK 20-10-06-400-004

(2) Stitch around edges with nylon cord, G00040.

——— END OF TASK ———

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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) Adjustment of the lever latch fork.

(3) The installation of the E/E box.

(4) The removal of a printed circuit card.

(5) The installation of a printed circuit card.

LOM 461-463

LOM LOM LOM LOM LOM

> **CAUTION**
> DUE TO THE CRITICAL ALIGNMENT OF THE AIR-DATA INERTIAL-REFERENCE UNITS, DISTURBANCE OR REMOVAL OF THE E5-2 SHELF REQUIRES RE-ALIGNMENT. THIS CAN ONLY BE ACCOMPLISHED BY BOEING AOG PERSONNEL USING SPECIALIZED ALIGNMENT TOOLING. CONTACT BOEING BEFORE DISTURBING THE MOUNTING SHELVES.

LOM (6) The removal of an E/E shelf assembly.

LOM (7) The installation of an E/E shelf assembly.

LOM **LOM ALL**

TASK 20-10-07-000-801

2. E/E Box Removal

(Figure 201)

A. References

Reference	Title
20-40-12-000-802	ESDS Handling for Metal Encased Unit Removal (P/B 201)
20-40-12-400-804	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

LOM ALL; AIRPLANES WITH REXNORD AEROSPACE MECHANISMS 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 E/E BOX BEFORE YOU DO THE PROCEDURE FOR DEVICES THAT ARE SENSITIVE TO ELECTROSTATIC DISCHARGE. ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE E/E BOX.

(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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

LOM ALL; AIRPLANES WITH REXNORD AEROSPACE MECHANISMS EXTRACTOR (Continued)

SUBTASK 20-10-07-020-001

> **CAUTION** DO NOT TOUCH THE CONDUCTOR PINS OR OTHER CONDUCTORS ON THE E/E BOX. IF YOU TOUCH THESE CONDUCTORS, ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE E/E BOX.

(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.

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

> **CAUTION** DO NOT TOUCH THE CONDUCTOR PINS OR OTHER CONDUCTORS ON THE E/E BOX. IF YOU TOUCH THESE CONDUCTORS, ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE E/E BOX.

(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 ⅛ 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 20-40-12-400-804.

LOM 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

> **CAUTION** DO NOT TOUCH THE E/E BOX BEFORE YOU DO THE PROCEDURE FOR DEVICES THAT ARE SENSITIVE TO ELECTROSTATIC DISCHARGE. ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE E/E BOX.

(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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

LOM ALL; AIRPLANES WITH HOLLINGSEAD EXTRACTOR (Continued)

SUBTASK 20-10-07-020-005

> **CAUTION** DO NOT TOUCH THE CONDUCTOR PINS OR OTHER CONDUCTORS ON THE E/E BOX. IF YOU TOUCH THESE CONDUCTORS, ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE E/E BOX.

(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.

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

> **CAUTION** DO NOT TOUCH THE CONDUCTOR PINS OR OTHER CONDUCTORS ON THE E/E BOX. IF YOU TOUCH THESE CONDUCTORS, ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE E/E BOX.

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

NOTE: Shake the front of the E/E box from side to side approximately ⅛ in. (3 mm) to help disconnect the E/E box from the electrical connector.

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 20-40-12-400-804.

LOM 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

> **CAUTION** DO NOT TOUCH THE E/E BOX BEFORE YOU DO THE PROCEDURE FOR DEVICES THAT ARE SENSITIVE TO ELECTROSTATIC DISCHARGE. ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE E/E BOX.

(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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

LOM ALL; AIRPLANES WITH HARTWELL EXTRACTOR (Continued)

SUBTASK 20-10-07-020-009

> **CAUTION** DO NOT TOUCH THE CONDUCTOR PINS OR OTHER CONDUCTORS ON THE E/E BOX. IF YOU TOUCH THESE CONDUCTORS, ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE E/E BOX.

(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.

(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 CONDUCTOR PINS OR OTHER CONDUCTORS ON THE E/E BOX. IF YOU TOUCH THESE CONDUCTORS, ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE E/E BOX.

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

NOTE: Shake the front of the E/E box from side to side approximately ⅛ in. (3 mm) to help disconnect the E/E box from the electrical connector.

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 20-40-12-400-804.

LOM ALL; AIRPLANES WITH LEVER LATCH HANDLES

F. E/E Box Removal Procedure

SUBTASK 20-10-07-860-012

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

SUBTASK 20-10-07-910-009

> **CAUTION** DO NOT TOUCH THE E/E BOX BEFORE YOU DO THE PROCEDURE FOR DEVICES THAT ARE SENSITIVE TO ELECTROSTATIC DISCHARGE. ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE E/E BOX.

(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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

LOM ALL; AIRPLANES WITH LEVER LATCH HANDLES (Continued)

SUBTASK 20-10-07-020-017

> **CAUTION** DO NOT TOUCH THE CONDUCTOR PINS OR OTHER CONDUCTORS ON THE E/E BOX. IF YOU TOUCH THESE CONDUCTORS, ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE E/E BOX.

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

SUBTASK 20-10-07-020-018

(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.

SUBTASK 20-10-07-020-019

> **CAUTION** DO NOT TOUCH THE CONDUCTOR PINS OR OTHER CONDUCTORS ON THE E/E BOX. IF YOU TOUCH THESE CONDUCTORS, ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE E/E BOX.

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

NOTE: Shake the front of the E/E box from side to side approximately ⅛ in. (3 mm) to help disconnect the E/E box from the electrical connector.

SUBTASK 20-10-07-420-027

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

SUBTASK 20-10-07-420-028

(7) If the E/E box is sensitive to electrostatic discharge, do this task: Conductive Dust Cap and Connector Cover Installation, TASK 20-40-12-400-804.

LOM ALL; AIRPLANES WITH BARRY-TYPE RETAINING FASTENERS

G. E/E Box Removal Procedure

SUBTASK 20-10-07-040-002

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

SUBTASK 20-10-07-580-002

> **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 20-10-07-020-030

> **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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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

SUBTASK 20-10-07-020-031

(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 20-10-07-020-032

CAUTION	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.

NOTE: Shake the front of the E/E box from side to side approximately ⅛ in. (3 mm) to help disconnect the E/E box from the electrical connector.

SUBTASK 20-10-07-420-048

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

SUBTASK 20-10-07-580-003

(7) If the E/E box is sensitive to electrostatic discharge, do this task: Conductive Dust Cap and Connector Cover Installation, TASK 20-40-12-400-804.

LOM ALL

——— END OF TASK ———

ECCN 9E991 BOEING PROPRIETARY - See title page for details

REXNORD AEROSPACE MECHANISMS EXTRACTOR

F24337 S0006561811_V2

E/E Box Installation
Figure 201/20-10-07-990-801 (Sheet 1 of 6)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

E/E Box Installation
Figure 201/20-10-07-990-801 (Sheet 2 of 6)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

E/E Box Installation
Figure 201/20-10-07-990-801 (Sheet 3 of 6)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

LEVER LATCH TYPE (EXAMPLE)

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.

M12304 S0006561814_V2

E/E Box Installation
Figure 201/20-10-07-990-801 (Sheet 4 of 6)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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)

M12346 S0006561815_V2

E/E Box Installation
Figure 201/20-10-07-990-801 (Sheet 5 of 6)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

BARRY-TYPE RETAINING FASTENER

3027600 S0000798746_V1

E/E Box Installation
Figure 201/20-10-07-990-801 (Sheet 6 of 6)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

TASK 20-10-07-400-801

3. E/E Box Installation

(Figure 201)

A. References

Reference	Title
20-40-12-000-804	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

LOM ALL; AIRPLANES WITH REXNORD AEROSPACE MECHANISMS EXTRACTOR

C. E/E Box Installation Procedure

SUBTASK 20-10-07-860-004

(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 20-10-07-910-004

(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 20-40-12-000-804.

SUBTASK 20-10-07-020-013

(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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

LOM ALL; AIRPLANES WITH REXNORD AEROSPACE MECHANISMS EXTRACTOR (Continued)

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

SUBTASK 20-10-07-420-008

(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 ⅛ in. (3 mm) above the tray surface.

SUBTASK 20-10-07-420-009

(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.

NOTE: The E/E box will engage with the electrical connector easier if you move the front of the E/E box from side to side approximately ⅛ in. (3 mm). While you shake the box, apply a strong and steady horizontal force to the front of the E/E box.

SUBTASK 20-10-07-210-018

(8) Make sure the electrical connector is engaged.

SUBTASK 20-10-07-210-019

(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 20-10-07-420-019

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

SUBTASK 20-10-07-420-020

(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 20-10-07-420-010

(13) Tighten the extractor.

SUBTASK 20-10-07-420-041

(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 20-10-07-420-021

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

SUBTASK 20-10-07-860-005

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

LOM ALL; AIRPLANES WITH HOLLINGSEAD EXTRACTOR

D. E/E Box Installation Procedure

SUBTASK 20-10-07-860-006

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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

LOM 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 20-10-07-910-005

(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 20-40-12-000-804.

SUBTASK 20-10-07-020-014

(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.

SUBTASK 20-10-07-420-011

(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 ⅛ in. (3 mm) above the tray surface.

SUBTASK 20-10-07-420-012

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

NOTE: The E/E box will engage with the electrical connector easier if you shake the front of the E/E box from side to side approximately ⅛ in. (3 mm). While you shake the box, apply a light horizontal force to the front of the E/E box.

SUBTASK 20-10-07-820-002

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

SUBTASK 20-10-07-420-022

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

SUBTASK 20-10-07-420-023

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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

LOM ALL; AIRPLANES WITH HOLLINGSEAD EXTRACTOR (Continued)

SUBTASK 20-10-07-210-007

(11) Shake the E/E box to make sure of a tight fit.

SUBTASK 20-10-07-420-013

(12) Tighten the extractor.

SUBTASK 20-10-07-420-042

(13) 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

(14) Make sure the electrical connector is engaged.

SUBTASK 20-10-07-420-024

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

SUBTASK 20-10-07-860-007

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

LOM ALL; AIRPLANES WITH HARTWELL EXTRACTOR

E. E/E Box Installation

SUBTASK 20-10-07-860-008

(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 20-10-07-910-006

(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 20-40-12-000-804.

SUBTASK 20-10-07-020-015

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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

LOM ALL; AIRPLANES WITH HARTWELL EXTRACTOR (Continued)

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.

(a) Replace components if they are damaged.

SUBTASK 20-10-07-420-014

(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 ⅛ in. (3 mm) above the tray surface.

SUBTASK 20-10-07-420-015

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

NOTE: The E/E box will engage with the electrical connector easier if you shake the front of the E/E box from side to side approximately ⅛ in. (3 mm). While you shake the box, apply a light horizontal force to the front of the E/E box.

SUBTASK 20-10-07-820-003

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

SUBTASK 20-10-07-420-025

(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 20-10-07-420-016

(11) Tighten the extractor.

SUBTASK 20-10-07-420-043

(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 20-10-07-420-026

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

SUBTASK 20-10-07-860-009

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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

LOM ALL; AIRPLANES WITH LEVER LATCH HANDLES

F. E/E Box Installation

SUBTASK 20-10-07-860-013

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

SUBTASK 20-10-07-210-015

(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 20-10-07-910-010

(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 20-40-12-000-804.

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 20-10-07-210-016

> **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.

SUBTASK 20-10-07-420-029

(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 ⅛ in. (3 mm) above the tray surface.

SUBTASK 20-10-07-420-030

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

NOTE: The E/E box will engage with the electrical connector easier if you shake the front of the E/E box from side to side approximately ⅛ in. (3 mm). While you shake the box, apply a light horizontal force to the front of the E/E box.

SUBTASK 20-10-07-820-004

(8) Move lever latch to its locked position and verify proper adjustment.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

LOM ALL; AIRPLANES WITH LEVER LATCH HANDLES (Continued)

(a) To adjust the lever latch fork, do this task: Lever Latch Fork Adjustment, TASK 20-10-07-820-801.

SUBTASK 20-10-07-210-017

(9) Make sure the electrical connector is engaged.

SUBTASK 20-10-07-210-020

(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 20-10-07-420-031

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

SUBTASK 20-10-07-860-014

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

LOM ALL; AIRPLANES WITH BARRY-TYPE RETAINING FASTENERS

G. E/E Box Installation Procedure

SUBTASK 20-10-07-040-001

(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 20-10-07-580-001

(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 20-40-12-000-804.

SUBTASK 20-10-07-020-029

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

SUBTASK 20-10-07-200-002

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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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

SUBTASK 20-10-07-420-044

(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 ⅛ in. (3 mm) above the tray surface.

SUBTASK 20-10-07-420-045

(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.

NOTE: The E/E box will engage with the electrical connector easier if you move the front of the E/E box from side to side approximately ⅛ in. (3 mm). While you shake the box, apply a strong and steady horizontal force to the front of the E/E box.

SUBTASK 20-10-07-200-003

(8) Make sure the electrical connector is engaged.

SUBTASK 20-10-07-420-046

(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 20-10-07-420-047

(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.

LOM ALL

——— END OF TASK ———

TASK 20-10-07-820-801

4. Lever Latch Fork Adjustment

(Figure 201)

A. Prepare For Adjustment

SUBTASK 20-10-07-020-021

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

SUBTASK 20-10-07-020-022

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

SUBTASK 20-10-07-010-002

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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

B. Adjust Lever Latch Fork

SUBTASK 20-10-07-420-032

(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 20-10-07-420-033

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

SUBTASK 20-10-07-420-034

(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.

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 201.

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 20-10-07-420-035

(6) Tighten jamnut to snug fit.

END OF TASK

TASK 20-10-07-000-802

5. Printed Circuit Card Removal

(Figure 202)

A. References

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

B. Procedure

SUBTASK 20-10-07-860-010

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

SUBTASK 20-10-07-910-007

> **CAUTION** 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 Removal, TASK 20-40-12-000-801.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SUBTASK 20-10-07-010-001

(3) Open the cardfile door.

SUBTASK 20-10-07-020-016

(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.

(e) Remove the printed-circuit card assembly.

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

**SYSTEMS CARDFILE
(EXAMPLE)**

F24340 S0006561819_V2

**Printed Circuit Card Installation
Figure 202/20-10-07-990-802**

ECCN 9E991 BOEING PROPRIETARY - See title page for details

TASK 20-10-07-400-802

6. Printed Circuit Card Installation

(Figure 202)

A. References

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

B. Procedure

SUBTASK 20-10-07-860-011

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

SUBTASK 20-10-07-910-008

> **CAUTION**
> 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 20-10-07-210-013

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

SUBTASK 20-10-07-420-017

(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 ———

LOM 461-463

LOM **TASK 20-10-07-020-802**

LOM **7. E/E Shelf Assembly Removal**

LOM (Figure 203)

LOM
LOM
LOM
LOM
LOM

> **CAUTION**
> DUE TO THE CRITICAL ALIGNMENT OF THE AIR-DATA INERTIAL-REFERENCE UNITS, DISTURBANCE OR REMOVAL OF THE E5-2 SHELF REQUIRES RE-ALIGNMENT. THIS CAN ONLY BE ACCOMPLISHED BY BOEING AOG PERSONNEL USING SPECIALIZED ALIGNMENT TOOLING. CONTACT BOEING BEFORE DISTURBING THE MOUNTING SHELVES.

LOM **A. Location Zones**

LOM

Zone	Area
117	Electrical and Electronics Compartment - Left

LOM

ECCN 9E991 BOEING PROPRIETARY - See title page for details

LOM **LOM 461-463 (Continued)**
LOM

LOM **B. Procedure**

LOM SUBTASK 20-10-07-020-033

LOM (1) Remove each Line Replaceable Unit (LRU) from the applicable rack-mounted shelf. To do this,
LOM refer to each applicable LRU removal procedure.

LOM SUBTASK 20-10-07-020-034

LOM (2) Remove the electrical connector receptacles from the electronic equipment shelf assembly as
LOM required.

LOM (a) Remove the grounding wires as required.

LOM SUBTASK 20-10-07-020-035

LOM (3) Disconnect the grounding wire from the electronic equipment rack.

LOM SUBTASK 20-10-07-020-036

LOM (4) Disconnect the electronic equipment cooling hoses as required.

LOM SUBTASK 20-10-07-020-037

LOM (5) Remove the shelf assembly attach bolts, washers, and nuts.

LOM SUBTASK 20-10-07-020-038

LOM (6) Remove the shelf assembly.

LOM **END OF TASK**

ECCN 9E991 BOEING PROPRIETARY - See title page for details

ELECTRONIC EQUIPMENT RACK, E5

A

M27923 S0006561822_V2

LOM
LOM

Electronic Equipment Shelf
Figure 203/20-10-07-990-804 (Sheet 1 of 4)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

**TOP-MOUNTED ELECTRONIC EQUIPMENT SHELF
(EXAMPLE)**

B

M27936 S0006561823_V2

LOM
LOM

**Electronic Equipment Shelf
Figure 203/20-10-07-990-804 (Sheet 2 of 4)**

ECCN 9E991 BOEING PROPRIETARY - See title page for details

ELECTRONIC EQUIPMENT RACK, E4

C

M28356 S0006561824_V2

LOM
LOM

Electronic Equipment Shelf
Figure 203/20-10-07-990-804 (Sheet 3 of 4)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SIDE-MOUNTED ELECTRONIC EQUIPMENT SHELF
(EXAMPLE)

D

M28358 S0006561825_V2

LOM
LOM

Electronic Equipment Shelf
Figure 203/20-10-07-990-804 (Sheet 4 of 4)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

LOM TASK 20-10-07-400-804

LOM 8. E/E Shelf Assembly Installation

LOM (Figure 203)

LOM A. References

LOM

Reference	Title
SWPM 20-00-00	Standard Wiring Practices Manual

LOM B. Tools/Equipment

LOM 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.

LOM

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

LOM C. Location Zones

LOM

Zone	Area
117	Electrical and Electronics Compartment - Left

LOM D. Procedure

LOM SUBTASK 20-10-07-420-049

LOM (1) Install the shelf assembly in the electronic equipment rack with the attach bolts, washers, and nuts.

LOM SUBTASK 20-10-07-420-050

LOM (2) Install the equipment cooling hoses as required.

LOM SUBTASK 20-10-07-420-051

LOM (3) Install the shelf assembly grounding wire to the electronic equipment rack.

LOM (a) Use an intrinsically safe approved bonding meter, COM-1550 to make sure that the resistance between the electronic equipment rack and the electronic equipment shelf is less than or equal to 0.0025 ohms (SWPM 20-00-00).

LOM SUBTASK 20-10-07-420-052

LOM (4) Install the electrical receptacles in the electronic equipment shelf, as applicable.

LOM (a) Connect the electrical connector grounding wires, as applicable.

LOM (b) Use an intrinsically safe approved bonding meter, COM-1550 to make sure that the resistance between each connector grounding wire and the electronic equipment shelf is less than or equal to 0.0010 ohms (SWPM 20-00-00).

LOM (c) If any connectors on an E/E shelf were disconnected during the removal of the shelf, do these steps:

ECCN 9E991 BOEING PROPRIETARY - See title page for details

LOM **LOM 461-463 (Continued)**

1) Perform a general visual inspection that all connectors are fully engaged and locked.

SUBTASK 20-10-07-420-053

(5) Install each applicable Line Replaceable Unit (LRU). To do this, refer to each applicable LRU installation procedure.

(a) Make sure that you do the LRU replacement test for each LRU installed.

(b) Do the functional tests for critical systems as determined by the operator, industry standards, and/or local regulatory body to make sure that the disturbed systems are back to original aircraft configuration.

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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

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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

F15948 S0006561831_V2

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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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. 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

B. Control Cable Pulleys Removal

SUBTASK 20-10-09-020-002

(1) Install a 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 cable will not move out of the pulley guides.

SUBTASK 20-10-09-020-003

(2) Loosen the turnbuckle nearest to the control cable pulley to release tension.

SUBTASK 20-10-09-020-004

(3) Remove the bolt from the pulley disk.

SUBTASK 20-10-09-020-001

(4) Remove the pulley disk.

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

Control Cable Pulleys Installation
Figure 401/20-10-09-990-802

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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 20-10-09-020-007

(3) Remove the control cable clamp, SPL-1569 from the control cable.

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) Do this task on all turnbuckles that were adjusted: Turnbuckle Lock Installation, TASK 20-10-10-400-801.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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 Locking Clips Removal

(Figure 401, Figure 402)

A. Turnbuckle Locking Clips Removal

SUBTASK 20-10-10-860-001

(1) Twist the turnbuckle locking clip.

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.

END OF TASK

TASK 20-10-10-400-801

3. Turnbuckle Lock Installation

(Figure 401, Figure 402)

A. References

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

B. Consumable Materials

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

C. Locking Clip Installation

SUBTASK 20-10-10-420-001

CAUTION

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 20-10-10-420-006

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

SUBTASK 20-10-10-420-002

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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SUBTASK 20-10-10-420-003

(5) Engage the hook into the hole.

SUBTASK 20-10-10-420-004

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

SUBTASK 20-10-10-420-005

(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.

D. 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 and turn barrel until not more than three threads are exposed outside the barrel and the proper cable tension is reached.

SUBTASK 20-10-10-420-008

(3) Insert correct diameter lockwire (safety wire) (TASK 20-10-44-400-801).

SUBTASK 20-10-10-420-009

CAUTION

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 ⅝ 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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

F07591 S0006561841_V2

Turnbuckle Locking Clip
Figure 401/20-10-10-990-801

ECCN 9E991 BOEING PROPRIETARY - See title page for details

2990126 S0000767337_V1

Turnbuckle Lockwire Installation
Figure 402/20-10-10-990-802

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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 20-10-11-000-802

2. **Pressure-Sensitive Decal Removal**

(Figure 401)

A. References

Reference	Title
20-30-89-910-801	Final Cleaning of Solvent Sensitive Organic Coatings Prior to Non-structural Bonding (Series 89) (P/B 201)
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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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 #: PT6529-S Supplier: 81205 Part #: SCD5019 Supplier: 7RKH2 Part #: ST982LF-9 Supplier: 81205 Part #: TS1275-4 Supplier: 22975
COM-2615	Light - Work Part #: 9610C Supplier: 0A748 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 Opt Part #: EP326-25S-25 Supplier: 15664 Opt Part #: EP326-25S-50 Supplier: 15664
STD-3925	Heater - Blower, Explosion Proof, Electric

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C. Consumable Materials

Reference	Description	Specification
B01009	Solvent - Final Cleaning Of All Organic Ctgs Before Non-Structural Bonding (AMM 20-30-89) - Series 89	
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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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 solvent.

> **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 Series 89 solvent, B01009 (TASK 20-30-89-910-801) to the decal with a brush or cloth.

2) When the decal has wrinkles (after approximately two minutes), apply solvent 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 Series 89 solvent, B01009 (TASK 20-30-89-910-801).

END OF TASK

TASK 20-10-11-400-801

3. Pressure-Sensitive Decal Installation

(Figure 401)

A. References

Reference	Title
20-30-89-910-801	Final Cleaning of Solvent Sensitive Organic Coatings Prior to Non-structural Bonding (Series 89) (P/B 201)
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)
51-31-00 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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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 #: PT6529-S Supplier: 81205 Part #: SCD5019 Supplier: 7RKH2 Part #: ST982LF-9 Supplier: 81205 Part #: TS1275-4 Supplier: 22975

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C. 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
B00137	Abrasive - Garnet Coated Paper	
B01009	Solvent - Final Cleaning Of All Organic Ctgs Before Non-Structural Bonding (AMM 20-30-89) - Series 89	
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)

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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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, cleaner 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.

SUBTASK 20-10-11-110-005

> **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.

(5) Clean all other surfaces thoroughly with solvent, B00083, and cotton wiper, G00034, except in preparation for application of the Refuel Panel Placard (BAC27NSF223) which requires the use of Series 89 solvent, B01009 (TASK 20-30-89-910-801), a clean dry cloth 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 20-10-11-800-002

(1) On decals with an area less than 1 ft^2 (0.093 m^2), 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 ft^2 (0.093 m^2), 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. (102 mm) 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 in. (51 mm) to 3 in. (76 mm) beyond the decal edge.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(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 20-10-11-800-003

(3) On strip decals, remove about 1 ft (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 ft^2 (0.093 m^2) 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.

(b) For decals with an area greater than 1 ft^2 (0.093 m^2), 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. (76.2 mm) of strip decals to the receiving surface.

1) Use the applied section as a joint and strip up to 3 ft (91.4 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 decal a minimum of 0.5 in. (12.70 mm) and maximum of 2 in. (50.8 mm).

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 51-31-00/201) 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:

ECCN 9E991 BOEING PROPRIETARY - See title page for details

1) For distances of 0.100 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 0.100 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 20-10-11-420-005

(3) To apply decals over surfaces with raised or recessed rivets and fasteners, 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 51-31-00/201) and the applicable structural repair manual.

(b) Use tool ST732 to cut decals, except pressure-sensitive Polyester, around the heads of fasteners or rivets.

(c) Cut and remove an area of film, of pressure-sensitive polyester decals, and approximate the size of a nonflush rivet or fastener, with a Scotchcal cutter.

(d) Push the decal firmly in position around the rivet or fastener.

(e) 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 20-10-11-800-005

(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 20-10-11-390-002

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

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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 20-10-11-000-801

2. Repair External Pressure Sensitive Decals

A. References

Reference	Title
51-31-00 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 20-10-11-800-001

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 1/4 inch 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 51-31-00/201) and the applicable structural repair manual.

SUBTASK 20-10-11-420-004

(3) Apply the patch.

SUBTASK 20-10-11-390-001

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

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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 #: PT6529-S Supplier: 81205 Part #: SCD5019 Supplier: 7RKH2 Part #: ST982LF-9 Supplier: 81205 Part #: TS1275-4 Supplier: 22975

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B. Consumable Materials

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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(Continued)

Reference	Description	Specification
B00130	Alcohol - Isopropyl	TT-I-735
B00143	Solvent - Trichlorotrifluorethane (Freon)	MIL-C-81302

C. Pressure Sensitive Placard Removal

SUBTASK 20-10-14-210-001

(1) Do a check of the placard to see if it is sufficiently bonded.

NOTE: If the placard is bonded firmly and the new placard is the same size, you can install the new placard over the used placard.

SUBTASK 20-10-14-020-001

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 placard with a sealant removal tool, COM-2481.

SUBTASK 20-10-14-110-001

(3) 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
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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SUBTASK 20-10-14-840-001

(2) If the placard has no backing adhesive, prepare placard as follows:

(a) Make the rear surface of the placard rough with abrasive, B00137.

(b) Clean the placard with solvent, B00083.

(c) Remove the release paper from one side of the adhesive, A00016.

(d) Apply the adhesive, A00016, to the rear of placard.

(e) Cut the unwanted adhesive, A00016.

(f) Laminate the adhesive, A00016, to the placard with one of these steps:

1) Roll placard on hot roll laminator heated to 140°F (60°C).

2) 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 the 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 cotton wiper, G00034, moist in solvent, B00143, or alcohol, B00130, or solvent, B00083.

SUBTASK 20-10-14-800-002

(2) Dry fully with clean cotton wiper, G00034.

SUBTASK 20-10-14-420-001

(3) Install the placard.

NOTE: You can install the new placard immediately if you did not remove the old 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.

CAUTION 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.

(a) Mask an area approximately 1/16 in. (2 mm) smaller than the placard with Scotch Flatback Masking Tape 250, G00270, or attach a mask of necessary size.

(b) Do these steps steps to bond the vinyl placard with adhesive, A00119:

1) Use a brush to apply adhesive, A00119, to the contact area.

2) Remove the Scotch Flatback Masking Tape 250, G00270, or mask.

3) Let the adhesive, A00119, dry approximately 15 minutes.

4) Remove the release paper from the placard.

5) Install the placard to the surface.

6) Rub the placard with firm hand pressure and a cheesecloth pad.

7) If it is necessary, remove unwanted adhesive with solvent, B00083.

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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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 ———

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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 20-10-15-020-002

(1) Loosen the jamnut.

SUBTASK 20-10-15-020-003

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

SUBTASK 20-10-15-020-001

(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 20-10-15-420-004

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

SUBTASK 20-10-15-420-001

CAUTION

IF YOU DO NOT INSTALL THE BACK-UP RING CORRECTLY, YOU CAN CAUSE DAMAGE TO EQUIPMENT.

(3) Install the fitting into the boss and tighten to the correct torque for the size of the fitting, (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)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

B. Procedure

SUBTASK 20-10-15-420-005

(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 20-10-15-420-006

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

SUBTASK 20-10-15-420-002

CAUTION

INSTALL THE BACK-UP RING CORRECTLY. IF YOU DO NOT INSTALL THE BACK-UP RING CORRECTLY, YOU CAN 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 20-10-15-420-003

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

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

O-RINGS - REMOVAL/INSTALLATION

1. General

A. This procedure has these tasks:

(1) A removal of the O-rings

(2) An installation of the O-rings.

B. It is possible to install the 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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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O-Ring Installation
Figure 401/20-10-17-990-802

ECCN 9E991 BOEING PROPRIETARY - See title page for details

TASK 20-10-17-400-801

3. O-Rings 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-1575	Kit - O-Ring Tool Part #: SP-0786 Supplier: 62209 Part #: ST848 Supplier: 81205 Part #: ST848R Supplier: 81205 Opt Part #: PSAT-KIT Supplier: 1V757

B. O-Rings Installation

SUBTASK 20-10-17-800-001

(1) Use one of the installation tools (Table 401) in the O-ring toolkit, SPL-1575:

Table 401/20-10-17-993-802 Installation tools

TOOL NO.	TUBE OR HOSE FITTING SIZE
ST848 -187	3/16
-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

CAUTION: 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 20-10-17-420-003

CAUTION: 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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SUBTASK 20-10-17-420-001

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

SUBTASK 20-10-17-420-002

(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

CAUTION DO NOT PINCH THE O-RINGS. MAKE SURE THAT YOU CORRECTLY INSTALL AND TIGHTEN THE COMPONENTS. IF NOT, IT CAN CAUSE FAILURE.

(8) Examine the O-ring for twists and pinches caused by installation.

(a) Make sure that you align the O-ring with no twists before you close the gland.

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

THREADED INSERTS - MAINTENANCE PRACTICES

1. General

A. This task gives maintenance practices for threaded inserts.

TASK 20-10-18-900-801

2. Maintenance Practices

A. References

Reference	Title
SOPM 20-50-22	How to Install Threaded Inserts

B. Threaded Inserts Maintenance Practices

SUBTASK 20-10-18-960-001

(1) For the installation of threaded inserts, refer to SOPM 20-50-22.

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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

> **WARNING** 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	MATERIAL	USAGE INFORMATION
PLUG	20, 24	SHORT FLARELESS	AS4662	TITANIUM, CRES, ALUMINIUM	600–3000 PSI SYSTEMS
CAP, FITTING ASSEMBLY	20, 24	SHORT FLARELESS	AS4694	TITANIUM, CRES, ALUMINIUM	600–3000 PSI SYSTEMS
PLUG	02 thru 32	FLARELESS	AS21913	CARBON STEEL, CRES, ALUMINIUM, TITANIUM	USE WITH TUBING ONLY
CAP ASSEMBLY	04 thru 24	FLARELESS	BACC14AD*[1]*[2]	CARBON STEEL, CRES, ALUMINIUM	0–3000 PSI SYSTEMS
PLUG	02 thru 12	FLARELESS	BACP20AU	CARBON STEEL, CRES, ALUMINIUM	USE WITH TUBING ONLY

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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

CAPS/PLUGS	TUBE SIZE	FLARELESS/ SHORT FLARELESS	PART NUMBER	MATERIAL	USAGE INFORMATION
PLUG	02 thru 32	FLARELESS	AS5169	CARBON STEEL, CRES, ALUMINIUM, TITANIUM	USE IN BOSSES ONLY

*[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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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. References

Reference	Title
20-30-88-910-801	Final Cleaning of Metal Prior to Non-structural Bonding (Series 88) (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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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 #: PT6529-S Supplier: 81205 Part #: SCD5019 Supplier: 7RKH2 Part #: ST982LF-9 Supplier: 81205 Part #: TS1275-4 Supplier: 22975
COM-4746	Handle - Sealant Removal Tool Part #: 310/1 (for SkyScraper) Supplier: F6892 Part #: SHR0272-T (for PnJ scraper) Supplier: 7RKH2 Part #: ST982LH-F-3 (for ST982LF) Supplier: 81205 Opt Part #: SHW0215 (for PnJ scraper) Supplier: 7RKH2

C. Consumable Materials

Reference	Description	Specification
B00344	Solvent - Xylene, Nitration Grade	ASTM D843
B01008	Solvent - Final Cleaning Of Metal Prior To Non-Structural Bonding (AMM 20-30-88) - Series 88	
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 20-10-21-020-001

(1) Use a sealant removal tool, COM-2481 and sealant removal tool handle, COM-4746 to remove the adhesive.

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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SUBTASK 20-10-21-110-002

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) On metal surfaces, use a cotton wiper, G00034 that is wet with Series 88 solvent, B01008 (TASK 20-30-88-910-801)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 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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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.

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.

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 OR CAUSE DAMAGE TO THE ENVIRONMENT. REFER TO THE MATERIAL SAFETY DATA SHEETS (MSDS) AND THE LOCAL SAFETY PRECAUTIONS.

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, xylene 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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SUBTASK 20-10-21-800-003

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

NOTE: Do not use this procedure on external surfaces open to the weather.

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

1) If you use the 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.

NOTE: The adhesive must be tacky but will not bond to a clean finger when lightly touched.

C. Install the Aluminum Foil Marker

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 20-10-21-420-006

(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 20-10-21-420-001

(7) To install a cellophane-backed aluminum foil marker, do these steps:

(a) Put the aluminum foil marker in water (50°F (10°C) to 120°F (49°C)) 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 20-10-21-420-002

(8) To install a paper-backed aluminum foil marker, do these steps:

(a) Remove the paper backing from the aluminum foil marker, but be careful not to touch the adhesive coating.

1) Where the paper backing has a cut, bend the paper backing lightly along the cut line. Hold the backing and move it slowly away from the aluminum foil marker to prevent damage to the marker.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

2) 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 20-10-21-420-003

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

(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 20-10-21-420-004

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

SUBTASK 20-10-21-420-005

(11) Use a roller and start at one end of the marker and roll the marker into position. Be careful to prevent air bubbles. 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

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 OR CAUSE DAMAGE TO THE ENVIRONMENT. REFER TO THE MATERIAL SAFETY DATA SHEETS (MSDS) AND THE LOCAL SAFETY PRECAUTIONS.

(13) If it is necessary, remove unwanted adhesive.

(a) Use solvent, B00148, for adhesive, A00134, and adhesive, A00870, or solvent, B00083, for adhesive, A00119.

NOTE: Do not use the Methyl Ethyl Ketone (MEK) 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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SUBTASK 20-10-21-210-001

(15) Make sure that there is a good bond on the edge of the aluminum foil marker.

NOTE: Be careful not to lift the edge.

SUBTASK 20-10-21-390-001

(16) For protection of markers from fuel, hydraulic fluid, or outdoor weather do the following

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

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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.

(2) 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.

(a) This procedure is only a temporary and should only be used until the fitting can be conveniently repaired or replaced.

B. References

Reference	Title
20-30-21-910-801	Lubricants (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-7616	Adapter - Rubber Tipped Part #: LX-1418 Supplier: 7MZE3 Opt Part #: B411 Supplier: 0FKM1
STD-438	Gun - Grease

D. 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.

(a) Refer to Lubricants, TASK 20-30-21-910-801 for a list of appropriate lubricants for the area.

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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SUBTASK 20-10-24-410-001

(6) Close any panels opened for access.

SUBTASK 20-10-24-840-003

(7) Return the aircraft to normal.

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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)

1 INSTALL WITH ADHESIVE

2 INSTALLATION WITH ADHESIVE OPTIONAL

F15873 S0006561873_V2

Lubrication Fitting Modification and Installation
Figure 401/20-10-24-990-802

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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. References

Reference	Title
20-30-89-910-801	Final Cleaning of Solvent Sensitive Organic Coatings Prior to Non-structural Bonding (Series 89) (P/B 201)

C. Consumable Materials

Reference	Description	Specification
A00026	Compound - Sealing, Locking And Retaining, Single Component	ASTM D5363
A50086	Primer - Loctite 7471 Primer T Activator	
B01009	Solvent - Final Cleaning Of All Organic Ctgs Before Non-Structural Bonding (AMM 20-30-89) - Series 89	
G00262	Nitrogen - Liquid	A-A-59503 Type II, MIL-PRF-27401 Type II
G01659	Swab - Cotton Or Rayon, (Disposable)	

D. Lubrication Fitting Installation

SUBTASK 20-10-24-840-001

(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 Series 89 solvent, B01009, on a clean cotton swab (TASK 20-30-89-910-801).

(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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

E. Blown-Out Fittings Lubrication

SUBTASK 20-10-24-840-002

(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:

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

> **CAUTION** 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 Series 89 solvent, B01009, with a clean swab, G01659 (TASK 20-30-89-910-801).

(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 primer 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 retainer compound, A00026.

1) Apply the retainer compound to a depth of 0.25 in. (6.35 mm) to 0.40 in. (10.16 mm).

SUBTASK 20-10-24-420-002

> **CAUTION** 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 apply the retainer compound, A00026, and install the lubrication fitting:

(a) Use swab, G01659, to apply a thin layer of retainer 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 that the fitting is fully cool.

> **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.

(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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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 gives a list of rig pin sets with a list of the rig pins contained in each set.

(2) The list gives:

(a) Rig pin number.

(b) Rig pin part number (P/N).

(c) ATA location.

B. Procedure

SUBTASK 20-10-25-480-001

(1) Use the correct rig pin for the application.

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

F70207 Assembly Number	AMM Rig Pin Prefix	ATA No.
-4	ST-4	27–41–51
-7	A/S-1, E-4, LGE1, NS4, LGP2	27–11–00, 27–61–00, 27–31–00, 32–51–00, 32–31–00, 32–44–00
-8	R-5	27–21–00, 27–81–00
-9	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
-10	A/S-14	27–61–00
-14	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	S/B-1, S/B-3, NS2, NS5, NS10	27–62–00, 32–51–00
-88	A/S-3, NS1, NS2, NS10, LGB3, LGB4	27–11–00, 27–61–00, 27–51–22, 32–51–00, 32–41–00
-101	S/B-2	27–61–00, 27–62–00
-113	A/S-8, A/S-9, A/S-10, A/S-11	27–51–14, 27–61–00
-115	R-3, R-4	27–21–00, 32–51–00
-117	A/S-1A	27–11–00, 27–61–00

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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

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) Removal adapter component part numbers are in accordance with 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. See Figure 401 (Sheet 1).

(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. See Figure 402 (Sheet 1). 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. See Figure 403 (Sheet 1).

(6) Place Removal Tool slot around the head of screw to be removed. Inner stud slot shall push against the head. See Figure 404 (Sheet 1).

(7) Squeeze handle of the Hand Tool fully to unflare captive screw sleeve by pulling sleeve out of the hole. See Figure 405 (Sheet 1).

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(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. See Figure 406 (Sheet 1).

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

**CAPTIVE SCREW
(DETERMINATION OF DISTANCE A)
(EXAMPLE)**

2323955 S0000526822_V2

**Captive Screw Installation
Figure 401/20-10-26-990-801**

ECCN 9E991 BOEING PROPRIETARY - See title page for details

2323969 S0000526821_V2

Flush Head Removal Adaptor
Figure 402/20-10-26-990-802

ECCN 9E991 BOEING PROPRIETARY - See title page for details

2323985 S0000526823_V2

Removal Sleeve Engagement
Figure 403/20-10-26-990-803

ECCN 9E991 BOEING PROPRIETARY - See title page for details

2324017 S0000527045_V2

Remove Tool Installation
Figure 404/20-10-26-990-804

ECCN 9E991 BOEING PROPRIETARY - See title page for details

2324034 S0000526825_V2

Unflaring Sleeve
Figure 405/20-10-26-990-805

ECCN 9E991 BOEING PROPRIETARY - See title page for details

2324095 S0000526826_V2

Removal of Extra Long Screws
Figure 406/20-10-26-990-806

ECCN 9E991 BOEING PROPRIETARY - See title page for details

TASK 20-10-26-400-801

3. Captive Screws Installation

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) Recommended installation tooling is in accordance with 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

(2) Hand Installation.

(a) Hand Tool is in accordance with Figure 407 (Sheet 1).

(b) Recommended components part numbers for the hand tool are in accordance with Table 403.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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

(c) Place screw assembly into prepared hole in panel.

(d) 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).

(e) Squeeze handles of tool together to flare sleeve, excessive force is not required.

(f) Remove tool from fastener by unscrewing.

(g) Should flare require additional tightening, repeat procedure, exerting additional squeezing force.

(3) Air Hydraulic Installation

(a) Air Hydraulic tool is in accordance with Figure 408 (Sheet 1).

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 and Figure 409 (Sheet 1).

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 in accordance with 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)
G	0.376 in. (9.55 mm) to 0.437 in. (11.10 mm)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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

GRIP CODE	TOP PANEL GRIP THICKNESS
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 to40 psi (276 kPa) to50 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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

**HAND TOOL ASSEMBLY
(EXAMPLE)**

2324210 S0000527025_V2

**Hand Tool
Figure 407/20-10-26-990-807**

ECCN 9E991 BOEING PROPRIETARY - See title page for details

2324402 S0000527024_V2

Air Hydraulic Tool P/N DTP3000
Figure 408/20-10-26-990-808

ECCN 9E991 BOEING PROPRIETARY - See title page for details

ADAPTER

SPLINE DRIVER

NOSE PIECE FOR
CAPTIVE SCREW

PULLER

THRUST WASHER

2324559 S0000527026_V2

Puller Assembly Components
Figure 409/20-10-26-990-809

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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 the heat guns, soldering guns, and soldering irons are referred to as heat devices.

(4) It is recommended to use the crimped splices and sleeves with nylon ties or heat shrinkable covering in the areas that could have flammable fumes.

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-267	Detector Unit - Combustible Gas, Detects 0-100% LEL Combustible Gas And 0-10,000 PPM Organic Vapors Part #: MX6-K103R211 Supplier: 65147 Part #: ppbRAE 3000 Supplier: 27914 Opt Part #: 72-0026-49 Supplier: 0HTS3 Opt Part #: MX6-K003R211 Supplier: 65147

C. Precautions

SUBTASK 20-10-27-880-001

WARNING

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

(1) Use the heat devices only in the safe areas.

(a) Do not use the heat devices in the 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 the heat devices in the areas where smoking is not permitted.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

D. How to Measure Fume Levels

SUBTASK 20-10-27-750-001

> **WARNING** 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 combustible gas detector unit, COM-267, to measure the fume level.

NOTE: The following conditions can occur.

- A liquid fuel or fume source is near.
- The local fuel fume level is high or the ventilation is not sufficient.

(b) Make sure that 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 the open fuel tanks, fuel vents, or fuel leaks where fume concentrations can not be known or controlled.

(b) Make sure that 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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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**

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

> **CAUTION**
> 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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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".

2844221 S0000664397_V1

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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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 ———

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 ———

ECCN 9E991 BOEING PROPRIETARY - See title page for details

F15883 S0006561881_V2

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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

PERSONNEL EQUIPMENT SAFETY HARNESS RECEPTACLES - MAINTENANCE PRACTICES

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 surfaces of the wing and 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.

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 20-10-30-420-001

(1) Install the vacuum pad lifeline kit, COM-12523, or vacuum pad flightline kit, COM-12524.

(a) Install the vacuum pads in the area defined 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.

4) Make sure that 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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(3) Attach the hook end of the vacuum pad assembly to the body harness.

——— END OF TASK ———

ECCN 9E991 BOEING PROPRIETARY - See title page for details

LEFT WING
(RIGHT WING IS OPPOSITE)

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.)

3012800 S0000785776_V1

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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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 20-10-30-420-002

(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 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 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 ore 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 harness.

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

3012824 S0000785774_V1

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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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 20-10-30-420-003

(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 vacuum pads are not placed over splice joints or access panels.

NOTE: This is to maintain vacuum integrity.

(2) Put on the body safety harness

(3) Attach the hook end of the vacuum pad assembly to the body harness.

——— END OF TASK ———

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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)
24-22-00-860-812	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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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 24-22-00-860-812.

(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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

TASK 20-10-33-400-801

3. Power Device Cartridge (Squib) Installation

A. References

Reference	Title
24-22-00-860-812	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 24-22-00-860-812.

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

> **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.

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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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 CL A)

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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

TASK 20-10-34-140-801

3. Clean Metal Surfaces with a Rotary Bonding Brush

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	
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 20-10-34-930-001

(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 COULD 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.

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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(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 ———

TASK 20-10-34-120-802

4. Clean with a Rotary Abrasive Disk

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

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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

B. References

Reference	Title
20-30-81-910-801	General Cleaning of Solvent Sensitive Organic Coatings (Series 81) (P/B 201)

C. Consumable Materials

Reference	Description	Specification
B00139	Solvent - Lacquer Thinner	A-A-857
B01001	Solvent - General Cleaning Of All Organic Coatings (AMM 20-30-81) - Series 81	
G00034	Cotton Wiper - Process Cleaning Absorbent Wiper (Cheesecloth, Gauze)	AMS3819 Class 1 Grade A or B Form 1 (Supersede BMS15-5 CL A)

D. Remove Paint

SUBTASK 20-10-34-110-001

WARNING DO NOT GET SOLVENTS IN YOUR MOUTH, OR YOUR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM SOLVENTS. SOLVENTS ARE HAZARDOUS MATERIALS. SOLVENTS MAY BE FLAMMABLE OR HARMFUL TO THE ENVIRONMENT. REFER TO PRODUCT MATERIAL SAFETY DATA SHEETS (MSDS) AND LOCAL REQUIREMENTS FOR PROPER HANDLING PROCEDURES.

(1) Apply solvent, B00139 or Series 81 solvent, B01001 (TASK 20-30-81-910-801) 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, CRES, steel, 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)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(Continued)

Reference	Description	Specification
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.

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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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**

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
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

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(Continued)

Reference	Description
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

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

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(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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LEGEND:

FIRE ZONES

2089664 S0000441046_V2

Fire Zone Locations
Figure 601/20-10-37-990-801

ECCN 9E991 BOEING PROPRIETARY - See title page for details

LEGEND:

FLAMMABLE ZONES

2089678 S0000441047_V2

Flammable Zone Locations
Figure 602/20-10-37-990-802

ECCN 9E991 BOEING PROPRIETARY - See title page for details

LEGEND:

FLAMMABLE LEAKAGE ZONES

2089704 S0000441049_V2

Flammable Leakage Zone Locations
Figure 603/20-10-37-990-803

ECCN 9E991 BOEING PROPRIETARY - See title page for details

Hazardous Locations - Open Fuel Tank(s)
Figure 604/20-10-37-990-804

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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
24-22-00-860-812	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 FC Supplier: 4U744 Part #: MIT2500 Supplier: U0146 Part #: MIT410/2 Supplier: U0146 Opt Part #: 1587 Supplier: 89536

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 24-22-00-860-812).

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

WARNING

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.

CAUTION

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 20-10-39-000-001

(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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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, do these steps:

1) Set the resistance tester to 500 VDC range.

2) Connect the probes to the circuit to be measured.

3) 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 less 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

WARNING	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 20-10-39-020-001

(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 vaules 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 megohms 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

WARNING	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 20-10-39-020-002

(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 20-10-39-420-003

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) Ensure 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 20-10-39-420-004

(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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Dielectric Absorption Rate – Passive Components Testing (Example)
Figure 501/20-10-39-990-801

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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 3/4, 1, and 1-1/4 inch (19.05, 25.4, 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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Control Cable Grommets Installation
Figure 401/20-10-41-990-802

ECCN 9E991 BOEING PROPRIETARY - See title page for details

TASK 20-10-41-400-801

3. Control Cable Grommet Installation

(Figure 401)

A. References

Reference	Title
20-30-98-910-802	Cleaning of Phenolics or Nylon (Series 98-1) (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
SPL-1549	Set - Installation, NAS 1368 Grommets Part #: A20006-32 Supplier: 81205 Opt Part #: ST1065C Supplier: 81205

C. 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
B01051	Solvent - Cleaning Of Phenolics Or Nylon (AMM 20-30-98) - Series 98-1	

D. Install the Grommet with the Control Cable Removed

SUBTASK 20-10-41-110-001

WARNING

DO NOT GET SOLVENTS IN YOUR MOUTH, OR YOUR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM SOLVENTS. SOLVENTS ARE HAZARDOUS MATERIALS. SOLVENTS MAY BE FLAMMABLE OR HARMFUL TO THE ENVIRONMENT. REFER TO PRODUCT MATERIAL SAFETY DATA SHEETS (MSDS) AND LOCAL REQUIREMENTS FOR PROPER HANDLING PROCEDURES.

(1) Clean the bulkhead area that will touch the grommet with Series 98-1 solvent, B01051 (TASK 20-30-98-910-802).

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.

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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.

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.

E. Install the Grommet with the Control Cable Installed

SUBTASK 20-10-41-110-002

WARNING	DO NOT GET SOLVENTS IN YOUR MOUTH, OR YOUR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM SOLVENTS. SOLVENTS ARE HAZARDOUS MATERIALS. SOLVENTS MAY BE FLAMMABLE OR HARMFUL TO THE ENVIRONMENT. REFER TO PRODUCT MATERIAL SAFETY DATA SHEETS (MSDS) AND LOCAL REQUIREMENTS FOR PROPER HANDLING PROCEDURES.

(1) Clean the bulkhead area that will touch the grommet with Series 98-1 solvent, B01051 (TASK 20-30-98-910-802).

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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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

TASK 20-10-44-400-801

3. **Lockwire, Cotter Pins, and Lockrings - Installation**

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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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 it's 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. One twist of a pair of wires is a 180-degree angle change in the position of one wire relative to the other, when the wires are twisted through half a revolution.

(d) Use the double twist procedure for all lockwire unless a single wire procedure is specified.

(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 safely 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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

Lockwire Material Specification

NASM20995( )	
CRES	C
MONEL	NC
INCONEL	N
Copper	CY

B. References

Reference	Title
SOPM 20-50-01	Bolt and Nut Installation

C. 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) 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.

(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):

(a) On all fittings where you install lockwire, attach the fitting to the mating part or an adjacent part.

(b) Install lockwire for right threads as shown in (Figure 401, Figure 402, Figure 403).

(c) Install lockwire for left threads opposite to that shown in (Figure 401, Figure 402, Figure 403).

(d) Make sure that the loop of double wire goes around, not above, the head of the bolt or screw.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

CAUTION

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).

(a) 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:

(a) To install cotter pins in castellated nuts, install the pin with the head parallel to the slot in the nut.

1) Bend the cotter pin ends to the bolt end or to the castellated nut's slit adjacent to the pin end.

2) Cotter pins in castellated nuts must not extend more than one-half of the cotter pin diameter above the top of the slot.

NOTE: If necessary, use the grip length of a bolt or washers to adjust the hole of the cotter pin. The bolt can be adjusted to be longer or shorter by one or two lengths per SOPM 20-50-01.

(b) 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.

(c) 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:

(a) Put the bent hook of the lockring into an aligned locking hole in the shaft and nut but do not spring the ring.

(b) Move the lockring over the flange into the groove with minimum expansion of the lockring.

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

Lockwire Installation
Figure 401/20-10-44-990-801

ECCN 9E991 BOEING PROPRIETARY - See title page for details

Connector Lockwire Installation
Figure 402/20-10-44-990-802

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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Locking Pins Installation
Figure 403/20-10-44-990-803

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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.

(2) A maximum of 3 fasteners can be safety–cabled together in series.

(a) A maximum of 2 fasteners can be safety-cabled together with a single cable on the sleeve type torque tube couplings.

(3) The maximum space between fasteners to be safety–cabled together must not exceed 6 inches.

(4) Nicks, frays, kinks and other mutilations of the safety cable between tension points are not acceptable. The safety cable shall be installed so that the only tension imposed on the cable is from the safety cable installation tool, COM-2048,safety cable installation tool, COM-2046.

(5) Maximum hole diameter shall be in accordance with this table.

Maximum Cable Hole Diameters

CABLE DIAMETER	MAX HOLE DIAMETER
0.020 in. (0.508 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)

(6) Safety cable must meet the flex requirements of this table.

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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)

(7) Correctly crimped ferrules have a general triangular shape. The die indentation must extend a minimum length from the outer end of the ferrule as specified in this table.

Minimum Die Indentation Length

Cable Diameter	Minimum Extension
0.032 in. (0.813 mm), 0.040 in. (1.016 mm)	0.10 in. (2.54 mm)
0.020 in. (0.508 mm)	0.075 in. (1.905 mm)

(a) The cut cable shall extend a maximum of .06 inch beyond the installed ferrule.

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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 CL A)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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

CAUTION	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 (Figure 201).

——— END OF TASK ———

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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Sealant Installation on Ring Tongue Terminals
Figure 201/20-10-47-990-802

ECCN 9E991 BOEING PROPRIETARY - See title page for details

DETERMINE INSTALLATION TORQUE FOR TUBES/FITTINGS/HOSES

TASK 20-10-51-910-801

1. Tube Material and End Fitting Determination for Hydraulic Tube Assembly

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 (see Table 201).

Table 201/20-10-51-993-935 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 20-10-51-910-002

(1) Use the Boeing drawing system to determine tube material and end fittings. Do the following:

(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 202/20-10-51-993-926 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
1	16	-16	16	1.3125–12

ECCN 9E991 BOEING PROPRIETARY - See title page for details

Table 202/20-10-51-993-926 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
1–1/4	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 20-10-51-800-015

(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 203/20-10-51-993-927 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
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 20-10-51-800-016

(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 204/20-10-51-993-928

Models	Location in AMM
737–300/400/500	20–10–51/801
737–600/700/800/900	20–10–51/801
747–100/200	20–11–05/801
747–400	20–11–05/801

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Table 204/20-10-51-993-928 (Continued)

Models	Location in AMM
747–8	20–11–05/801
757	20–10–09/801
767	20–10–09/801
777	20–10–09/801

SUBTASK 20-10-51-800-017

(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 205/20-10-51-993-929 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 20-10-51-200-005

(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 206/20-10-51-993-930 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)
“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)

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Table 206/20-10-51-993-930 Hydraulic Fitting Material Codes (Continued)

Codes	Material
“S”	347 CRES (now cancelled)
“T”	6AL-4V Titanium - usually Gray from Fluride 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 20-10-51-910-003

(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 207/20-10-51-993-931 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
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 208/20-10-51-993-937 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
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

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

TASK 20-10-51-910-802

2. Torque Values for Tubes, Hoses or Fittings installed to Components Determination

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 (see Table 209).

Table 209/20-10-51-993-933 Service Letter for All Models

Models
737–SL-29–119
747–SL-29–078
757–SL-29–054
767–SL-29–067
777–SL-29–041

B. References

Reference	Title
20-10-52-990-812	Figure: Hydraulic Hose Identification (P/B 201)

C. Procedure

SUBTASK 20-10-51-200-006

(1) Determine torque for Hydraulic Tube or Hose End with seal (e.g. Union P/N MS21902) installed in Component Boss Port (see Figure 201). Do the following:

(a) Determine the materials. Do one of the following:

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 20-10-52-990-812).

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 210).

Table 210/20-10-51-993-934 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)

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Table 210/20-10-51-993-934 Selecting Torque for Tube or Hose Assembly on Mating Union or Component (Continued)

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

CAUTION 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 20-10-51-200-007

(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) (See Figure 201). Do the following:

(a) Determine the materials. Do one of the following:

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 20-10-52-990-812).

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 210).

CAUTION 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.

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SUBTASK 20-10-51-200-008

(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 (see Figure 201). Do the following:

(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 210).

CAUTION	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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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 201/20-10-51-990-926

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Hydraulic Fitting Identification Information
Figure 202/20-10-51-990-927 (Sheet 1 of 25)

SLEEVE AND B-NUT FITTINGS							
			MATERIAL DATA				
FITTING TYPE	ILLUSTRATION	PARMT NUMBER	AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA	EXAMPLE OF P/N
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 = 6AI-4V	NATURAL SILVERY COLOR		AS1581T06
NUT, TUBE COUPLING, LIGHTWEIGHT, REDUCED CROSS SECTION		BACN10YA	TITANIUM	NONE (BASE P/N = 6AI-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 = 6AI-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 FINIFH (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 = 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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UNION FITTINGS							
			MATERIAL DATA				
FITTING TYPE	ILLUSTRATION	PART NUMBER	AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA	EXAMPLE OF P/N
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	MS21902V4P
			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 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	MS21916V8-4P
			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		
		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.

2324579 S0000527693_V2

Hydraulic Fitting Identification Information
Figure 202/20-10-51-990-927 (Sheet 2 of 25)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

UNION FITTINGS (CONTINUED)

FITTING TYPE	ILLUSTRATION	PART NUMBER	MATERIAL DATA: AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA	EXAMPLE OF P/N
LIGHTWEIGHT FLARELESS SWAGE UNION		BACU24AB (ONE SWAGED END)	CRES	H (15-5PH)	NATURAL SILVERY COLOR		BACU24AB10HP
				HP (15-5PH WITH CADMIUM PLATE FINISH - ON Al TUBE ONLY)	YELLOWISH BROWN		
			ALUMINUM	W = 7075	BROWN		
LIGHTWEIGHT FLARELESS WELD UNION		AS1582 (ONE WELDED END)	TITANIUM	T (6Al-4V)	NATURAL SILVERY COLOR		AS1582T08
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.

2336828 S0000533495_V2

Hydraulic Fitting Identification Information
Figure 202/20-10-51-990-927 (Sheet 3 of 25)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

EXTERNALLY SWAGED (PERMASWAGE TYPE) ADAPTER UNION FITTINGS

FITTING TYPE	ILLUSTRATION	PART NUMBER	MATERIAL DATA				EXAMPLE OF P/N
			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		BACA14BP1212J
			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	BACA14BM0606JA
			ALUMINUM	D (6061-T6, OVERAGED)	GREEN, EXCEPT FOR BULKHEAD END (GOLDISH ANODIZE)		

NOTE:
NOT KEPT UP TO DATE - ALWAYS CONSULT LATEST REVISION OF FITTING STANDARD FOR P/N AND SUPERSESSION DATA.

2324604 S0000527694_V2

Hydraulic Fitting Identification Information
Figure 202/20-10-51-990-927 (Sheet 4 of 25)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

FLARELESS FITTINGS WITH BOEING RECESSED SEAL BOSS END							
FITTING TYPE	ILLUSTRATION	PART NUMBER	MATERIAL DATA				EXAMPLE OF P/N
			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"	BACA14AZ8A10J
			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	BACA14BA12BJ
			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	BACA14BB8BJ
			CRES	J (304), K (316), R (321)	NATURAL SILVERY COLOR		
			ALUMINUM	W (7075)	BROWN		

Hydraulic Fitting Identification Information
Figure 202/20-10-51-990-927 (Sheet 5 of 25)

NOTE:
NOT KEPT UP TO DATE - ALWAYS CONSULT LATEST REVISION OF FITTING STANDARD FOR P/N AND SUPERSESSION DATA.

2324705 S0000527695_V2

ECCN 9E991 BOEING PROPRIETARY - See title page for details

FITTING SHAPES WITH FLARELESS ENDS							
			MATERIAL DATA				
FITTING TYPE	ILLUSTRATION	PART NUMBER	AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA	EXAMPLE OF P/N
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	BACE21BR1208JN
				P (15-5PH WITH CADMIUM PLATE FINISH)	YELLOWISH BROWN		
			TITANIUM	T (6Al-4V)	DARK GRAY		
		AS4137	CRES	J (304), DRY FILM ON NUT ID	NATURAL SILVERY COLOR		AS4137V0806P **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 (6Al-4V), DRY FILM ON NUT ID	DARK GRAY		

NOTE:

NOT KEPT UP TO DATE - ALWAYS CONSULT LATEST REVISION OF FITTING STANDARD FOR P/N AND SUPERSESSION DATA.

2325229 S0000527696_V2

Hydraulic Fitting Identification Information
Figure 202/20-10-51-990-927 (Sheet 6 of 25)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

FITTING SHAPES WITH FLARELESS ENDS (CONTINUED)							
			MATERIAL DATA				
FITTING TYPE	ILLUSTRATION	PART NUMBER	AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA	EXAMPLE OF P/N
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 "-", W, J, K, S, RESPECTIVELY; **NOTE:** BACE21BR IN CODES JN, P, T NOW SUPERSEDED BY AS4137J, P, T RESPECTIVELY	BACE21AU1208W
			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	NAS1761J0812
			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.

2336924 S0000533496_V2

Hydraulic Fitting Identification Information
Figure 202/20-10-51-990-927 (Sheet 7 of 25)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

FITTING SHAPES WITH FLARELESS ENDS (CONTINUED)

FITTING TYPE	ILLUSTRATION	PART NUMBER	MATERIAL DATA: AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA	EXAMPLE OF P/N
ELBOW, 45 DEGREE, BULKHEAD, REDUCER (LIGHTWEIGHT REDUCED BODY)		BACE21BM	CRES	J (304)	NATURAL SILVERY COLOR	CODES J, P, T - SEE AS413OV--P, J, T, RESPECTIVELY	BACE21BM1208T
				P (15-5PH WITH CADMIUM PLATE FINISH)	YELLOWISH BROWN		
			TITANIUM	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.

2325488 S0000527697_V2

Hydraulic Fitting Identification Information
Figure 202/20-10-51-990-927 (Sheet 8 of 25)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

FITTING SHAPES WITH FLARELESS ENDS (CONTINUED)							
			MATERIAL DATA				
FITTING TYPE	ILLUSTRATION	PART NUMBER	AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA	EXAMPLE OF P/N
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 AS413OT;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 T - 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 (6AI-4V)	DULL GRAY		
			ALUMINUM	W (2024-T6)	GREEN		
				W (7075)	BROWN		
ELBOW, 90 DEGREE, SWIVEL, REDUCER, (LIGHTWEIGHT, REDUCED BODY)		BACE21BT	CRES	JN (304) WITH DRY FILM LUBE ON SWIVEL NUT	NATURAL SILVERY COLOR	CODES JN, P, T - SEE AS4138 IN CODES J, V--P, T, RESPECTIVELY	BACE21BT1208T
				P (15-5PH WITH CADMIUM PLATE FINISH)	YELLOWISH BROWN		
			TITANIUM	T (6AI-4V)	DULL GRAY		
		AS4138	CRES	J (304) DRY FILM ON NUT ID	NATURAL SILVERY COLOR		AS4138V0806P **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		

NOTE:

NOT KEPT UP TO DATE - ALWAYS CONSULT LATEST REVISION OF FITTING STANDARD FOR P/N AND SUPERSESSION DATA.

2325784 S0000527698_V2

Hydraulic Fitting Identification Information
Figure 202/20-10-51-990-927 (Sheet 9 of 25)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

FITTING SHAPES WITH FLARELESS ENDS (CONTINUED)							
			MATERIAL DATA				
FITTING TYPE	ILLUSTRATION	PART NUMBER	AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA	EXAMPLE OF P/N
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.	BACE21AW1208W
			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.	NAS1762J0812
			CRES	J (304), K (316), S (347)	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.

2325934 S0000527699_V2

Hydraulic Fitting Identification Information
Figure 202/20-10-51-990-927 (Sheet 10 of 25)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

FITTING SHAPES WITH FLARELESS ENDS (CONTINUED)							
			MATERIAL DATA				
FITTING TYPE	ILLUSTRATION	PART NUMBER	AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA	EXAMPLE OF P/N
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.	BACE21BN1208T
				P (15-5PH WITH CADMIUM PLATE FINISH)	YELLOWISH BROWN		
			TITANIUM	T (6Al-4V)	DULL GRAY		
		AS4132	CRES	J (304)	NATURAL SILVERY COLOR		AS4132V0806P **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 (6Al-4V), DRY FILM ON NUT ID	DARK GRAY		
ELBOW, 90 DEGREE, FLARELESS, STANDARD WEIGHT		BACE21AS (REDUCER ONLY)	CARBON STEEL	"-" OR NO CODE	YELLOWISH BROWN	"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.	BACE21AS1008W
			CRES	J (304), K (316), R (321), S (347)	NATURAL SILVERY COLOR		
			ALUMINUM	W (7075)	BROWN		
			TITANIUM	T (6Al-4V)	DULL GRAY		

Hydraulic Fitting Identification Information
Figure 202/20-10-51-990-927 (Sheet 11 of 25)

NOTE:

NOT KEPT UP TO DATE - ALWAYS CONSULT LATEST REVISION OF FITTING STANDARD FOR P/N AND SUPERSESSION DATA.

2327295 S0000527700_V2

ECCN 9E991 BOEING PROPRIETARY - See title page for details

FITTING SHAPES WITH FLARELESS ENDS (CONTINUED)							
			MATERIAL DATA				
FITTING TYPE	ILLUSTRATION	PART NUMBER	AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA	EXAMPLE OF P/N
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.	MS21908V4P
				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 (6AI-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	AS1008W0808 **NOTE:** PHASE-IN TO AIRPLANE PRODUCTION UNDERWAY
			CRES	J (304), K (316), R (321), S (347)	NATURAL SILVERY COLOR		
			TITANIUM	T (6AI-4V)	DULL GRAY		
			ALUMINUM	D (2024-T6)	GREEN		
				W (7075)	BROWN		

NOTE:

NOT KEPT UP TO DATE - ALWAYS CONSULT LATEST REVISION OF FITTING STANDARD FOR P/N AND SUPERSESSION DATA.

2326190 S0000527701_V2

Hydraulic Fitting Identification Information
Figure 202/20-10-51-990-927 (Sheet 12 of 25)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

FITTING SHAPES WITH FLARELESS ENDS (CONTINUED)							
			MATERIAL DATA				
FITTING TYPE	ILLUSTRATION	PART NUMBER	AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA	EXAMPLE OF P/N
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	BACE21BL1208T
				P (15-5PH WITH CADMIUM PLATE FINISH)	YELLOWISH BROWN		
			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		
				V--P (15-5PH WITH CADMIUM PLATE FINISH)	YELLOWISH BROWN		
			TITANIUM	T (6Al-4V), DRY FILM ON NUT ID	DARK GRAY		
ELBOW, 90 DEGREE, REDUCER		BACE21AR (STANDARD WEIGHT)	CARBON STEEL	"-" OR NO CODE	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.	BACE21AR1008W
			CRES	J (304)	NATURAL SILVERY COLOR		
			ALUMINUM	W (7075)	BROWN		
			TITANIUM	T (6Al-4V)	DULL GRAY		
		AS1004	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.	AS1004VW0808 **NOTE:** PHASE-IN TO AIRPLANE PRODUCTION UNDERWAY
				W (7075)	BROWN		
			CRES	J (304), K (316), R (321), S (347)	NATURAL SILVERY COLOR		
			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.

2326932 S0000527702_V2

Hydraulic Fitting Identification Information
Figure 202/20-10-51-990-927 (Sheet 13 of 25)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

FITTING SHAPES WITH FLARELESS ENDS (CONTINUED)							
			MATERIAL DATA				
FITTING TYPE	ILLUSTRATION	PART NUMBER	AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA	EXAMPLE OF P/N
TEE, FLARELESS, REDUCER, LIGHTWEIGHT		BACT16BL	CRES	J (304)	NATURAL SILVERY COLOR	CODES J, P, T - SEE AS4133 IN CODES J, V-P, T RESPECTIVELY.	BACT16BL120810T
				P (15-5PH WITH CADMIUM PLATE FINISH)	YELLOWISH BROWN		
			TITANIUM	T (6Al-4V)	DULL GRAY		
		AS4133	CRES	J (304)	NATURAL SILVERY COLOR		AS4133V080606P **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	DARK GRAY		
TEE, FLARELESS, REDUCER, STANDARD WEIGHT		BACT16AS	CARBON STEEL	"-" OR NO CODE	YELLOWISH BROWN	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.	BACT16AS120810J
			CRES	J (304), K (316), R (321), S (347)	NATURAL SILVERY COLOR		
			ALUMINUM	W (7075)	BROWN		
			TITANIUM	T (6Al-4V)	DULL GRAY		

Hydraulic Fitting Identification Information
Figure 202/20-10-51-990-927 (Sheet 14 of 25)

NOTE:
NOT KEPT UP TO DATE - ALWAYS CONSULT LATEST REVISION OF FITTING STANDARD FOR P/N AND SUPERSESSION DATA.

2327234 S0000527703_V2

ECCN 9E991 BOEING PROPRIETARY - See title page for details

Hydraulic Fitting Identification Information
Figure 202/20-10-51-990-927 (Sheet 15 of 25)

FITTING SHAPES WITH FLARELESS ENDS (CONTINUED)

FITTING TYPE	ILLUSTRATION	PART NUMBER	MATERIAL DATA: AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA	EXAMPLE OF P/N
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 CODE P; CODE W - SEE AS1005 CODE W; CODES J, K - SEE SUPERSEDED BACT16BL CODE J; CODE S - SEE AS4133 CODE J; CODE V - SEE AS4133V.	MS21905V4P
			CRES	J (304)	NATURAL SILVERY COLOR		
			ALUMINUM	W (7075)	BROWN		
			TITANIUM	T (6AI-4V)	DULL GRAY		
		AS1005	ALUMINUM (ONLY MATERIAL CODE USED BY BOEING)	W (7075)	BROWN	USE AS4133 FOR ALL MATERIAL APPLICATIONS EXCEPT ALUMINUM.	AS1005W0808 NOTE: PHASE-IN TO AIRPLANE PRODUCTION UNDERWAY.
TEE, BULKHEAD-ON-SIDE, LIGHTWEIGHT, REDUCER		BACE16BM	CRES	J (304)	NATURAL SILVERY COLOR	CODES J, P, T - SEE AS4135 IN CODES J, V-P AND T RESPECTIVELY.	BACT16BM060410T
				P (15-5PH WITH CADMIUM PLATE FINISH)	YELLOWISH BROWN		
			TITANIUM	T (6AI-4V)	DULL GRAY		
		AS4135	CRES	J (304)	NATURAL SILVERY COLOR		AS4135V080608P 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 (6AI-4V), DRY FILM ON NUT ID	DULL GRAY		

NOTE: NOT KEPT UP TO DATE - ALWAYS CONSULT LATEST REVISION OF FITTING STANDARD FOR P/N AND SUPERSESSION DATA.

2327232 S0000527704_V1

ECCN 9E991 BOEING PROPRIETARY - See title page for details

FITTING SHAPES WITH FLARELESS ENDS (CONTINUED)							
			MATERIAL DATA				
FITTING TYPE	ILLUSTRATION	PART NUMBER	AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA	EXAMPLE OF P/N
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.	BACT16A 120810J
			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.	MS21909V4P
				V--P	YELLOWISH BROWN		
			ALUMINUM	W (7075)	BROWN		
			TITANIUM	T (6Al-4V)	DULL GRAY		

Hydraulic Fitting Identification Information
Figure 202/20-10-51-990-927 (Sheet 16 of 25)

NOTE:

NOT KEPT UP TO DATE - ALWAYS CONSULT LATEST REVISION OF FITTING STANDARD FOR P/N AND SUPERSESSION DATA.

2327557 S0000527705_V2

ECCN 9E991 BOEING PROPRIETARY - See title page for details

FITTING SHAPES WITH FLARELESS ENDS (CONTINUED)							
			MATERIAL DATA				
FITTING TYPE	ILLUSTRATION	PART NUMBER	AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA	EXAMPLE OF P/N
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 **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.	AS1009W080806 **NOTE:** (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).
			CRES	J (304), K (316), R (321), 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.

2338516 S0000533497_V2

Hydraulic Fitting Identification Information
Figure 202/20-10-51-990-927 (Sheet 17 of 25)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

FITTING SHAPES WITH FLARELESS ENDS (CONTINUED)							
			MATERIAL DATA				
FITTING TYPE	ILLUSTRATION	PART NUMBER	AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA	EXAMPLE OF P/N
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		
				V--P (15-5PH WITH CADMIUM PLATE FINISH)	YELLOWISH BROWN		
			TITANIUM	T (6Al-4V), DRY FILM ON NUT ID	DARK GRAY		
TEE, BULKHEAD-ON-RUN, STANDARD WEIGHT, REDUCER		BACT16AX	CRES	V--P	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
				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.

2327589 S0000527706_V2

Hydraulic Fitting Identification Information
Figure 202/20-10-51-990-927 (Sheet 18 of 25)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

FITTING SHAPES WITH FLARELESS ENDS (CONTINUED)							
			MATERIAL DATA				
FITTING TYPE	ILLUSTRATION	PART NUMBER	AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA	EXAMPLE OF P/N
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. **NOTE:** BACT16BN SUPERSEDED BY AS4134; BACT16BN CODES J, P, T NOW SUPERSEDED BY AS4134 CODES J, V-P AND T, RESPECTIVELY.	MS21912V4P
			CRES	J	NATURAL SILVERY COLOR		
			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; G - (NO CODE) D, F, J, K, R, S, T, W - SEE G (CODES D, F, J, K, R, S, T, W, RESPECTIVELY. **NOTE:** "-" IS REMOVED FROM P/N; GD -USE GW GF - SEE AS4134V--P; G (CODES J, K, R, S) - SEE AS4134J; GT - SEE AS4135T.	AS1003W080806 **NOTE:** (1) PHASE-IN TO AIRPLANE PRODUCTION UNDERWAY. (2) SUFFIX "G" FOLLOWING BASIC P/N IS FOR PARTS WITH AS4377 STYLE G FITTING END AND ARE NOT FOR USE IN PORTS (SEE AS1003 STANDARD FOR DETAILS).
			CRES	J (304), K (316), R (321), 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.

2327611 S0000527707_V2

Hydraulic Fitting Identification Information
Figure 202/20-10-51-990-927 (Sheet 19 of 25)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

FITTING SHAPES WITH FLARELESS ENDS (CONTINUED)							
			MATERIAL DATA				
FITTING TYPE	ILLUSTRATION	PART NUMBER	AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA	EXAMPLE OF P/N
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.	BACT16BR120810T
				P (15-5PH WITH CADMIUM PLATE FINISH)	YELLOWISH BROWN		
			TITANIUM	T (6AI-4V)	DULL GRAY		
TEE, SWIVEL-ON-RUN, LIGHTWEIGHT, REDUCER		AS4139	CRES	JN (304), DRY FILM ON NUT ID	NATURAL SILVERY COLOR		AS4139V0806O8P **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 (6AI-4V)	DULL GRAY		
TEE, SWIVEL-ON-RUN, STANDARD WEIGHT, REDUCER		BACT16AY	CARBON STEEL	N (CARBON STEEL WITH DRY FILM ON SWIVEL NUT)	YELLOWISH BROWN	CODES M, N - SEE BACT16BR CODES J, P RESPECTIVELY; W CODE STILL ACTIVE.	BACT16AY120810J
			CRES	K (316), M (304, S (347)	NATURAL SILVERY COLOR		
			ALUMINUM	W (7075-T73)	BROWN		
TEE, SWIVEL-ON-RUN, STANDARD WEIGHT, NON-REDUCER		NAS1763	CARBON STEEL	"-" WITH CADMIUM PLATE FINISH	YELLOWISH BROWN	CODES "-", J, K, S, T - SEE BACT16BR CODES J, P, T RESPECTIVELY; CODE W - SEE BACT16AY IN CODE W.	NAS1763J040608
			CRES	J (304), K (316), S (347)	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.

2327669 S0000527708_V2

Hydraulic Fitting Identification Information
Figure 202/20-10-51-990-927 (Sheet 20 of 25)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

FITTING SHAPES WITH FLARELESS ENDS (CONTINUED)							
			MATERIAL DATA				
FITTING TYPE	ILLUSTRATION	PART NUMBER	AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA	EXAMPLE OF P/N
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.	BACT16BT120810T
				P (15-5PH WITH CADMIUM PLATE FINISH)	YELLOWISH BROWN		
			TITANIUM	T (6Al-4V)	DULL GRAY		
TEE, SWIVEL-ON-SIDE, LIGHTWEIGHT, REDUCER		AS4140	CRES	JN (304), DRY FILM ON NUT ID	NATURAL SILVERY COLOR		AS4140V0808O6P **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.	BACT16AZ120810J
			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.	NAS1764J040608
			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.

2328567 S0000527709_V2

Hydraulic Fitting Identification Information
Figure 202/20-10-51-990-927 (Sheet 21 of 25)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

FITTING SHAPES WITH FLARELESS ENDS (CONTINUED)							
			MATERIAL DATA				
FITTING TYPE	ILLUSTRATION	PART NUMBER	AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA	EXAMPLE OF P/N
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 (6AI-4V)	DULL GRAY		
CROSS, REDUCER AND N0N-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		
			TITANIUM	T (6AI-4V), DRY FILM ON NUT ID	DARK GRAY		
CROSS, N0N-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 (6AI-4V)	DULL GRAY		

NOTE:

NOT KEPT UP TO DATE - ALWAYS CONSULT LATEST REVISION OF FITTING STANDARD FOR P/N AND SUPERSESSION DATA.

2328570 S0000527710_V2

Hydraulic Fitting Identification Information
Figure 202/20-10-51-990-927 (Sheet 22 of 25)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

FITTING SHAPES WITH FLARELESS ENDS (CONTINUED)							
			MATERIAL DATA				
FITTING TYPE	ILLUSTRATION	PART NUMBER	AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA	EXAMPLE OF P/N
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		

Hydraulic Fitting Identification Information
Figure 202/20-10-51-990-927 (Sheet 23 of 25)

NOTE:
NOT KEPT UP TO DATE - ALWAYS CONSULT LATEST REVISION OF FITTING STANDARD FOR P/N AND SUPERSESSION DATA.

2328688 S0000527711_V2

ECCN 9E991 BOEING PROPRIETARY - See title page for details

AXIAL SWAGE FITTING CONFIGURATIONS WITH ONE OR MORE FLARELESS ENDS							
			MATERIAL DATA				
FITTING TYPE	ILLUSTRATION	PART NUMBER	AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA	EXAMPLE OF P/N
STRAIGHT, FEMALE FLARELESS ADAPTER		AS5792	TITANIUM	T (6Al-4V)	DULL GRAY WITH BLUE STRIPE ON SWAGE ENDS		AS5792T0806
STRAIGHT, MALE FLARELESS ADAPTER		AS5793	TITANIUM	T (6Al-4V)	DULL GRAY WITH BLUE STRIPE ON SWAGE ENDS		AS5793T0806
ELBOW, 90 DEGREE, FEMALE FLARELESS		AS5801	TITANIUM	T (6Al-4V)	DULL GRAY WITH BLUE STRIPE ON SWAGE ENDS		AS5801T0806
ELBOW, 45 DEGREE, FEMALE FLARELESS		AS5803	TITANIUM	T (6Al-4V)	DULL GRAY WITH BLUE STRIPE ON SWAGE ENDS		AS5803T0806

NOTE:

NOT KEPT UP TO DATE - ALWAYS CONSULT LATEST REVISION OF FITTING STANDARD FOR P/N AND SUPERSESSION DATA.

2339164 S0000533498_V2

Hydraulic Fitting Identification Information
Figure 202/20-10-51-990-927 (Sheet 24 of 25)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

AXIAL SWAGE FITTING CONFIGURATIONS WITH ONE OR MORE FLARELESS ENDS (CONTINUED)							
			MATERIAL DATA				
FITTING TYPE	ILLUSTRATION	PART NUMBER	AVAILABLE MATERIALS	MATERIAL CODE LETTER	COLOR IDENTIFICATION	MATERIAL CODE SUPERSESSION DATA	EXAMPLE OF P/N
TEE, FEMALE FLARELESS ON RUN		AS5804	TITANIUM	T (6Al-4V)	DULL GRAY WITH BLUE STRIPE ON SWAGE ENDS		AS5804T080808
TEE, FEMALE FLARELESS ON BRANCH		AS5806	TITANIUM	T (6Al-4V)	DULL GRAY WITH BLUE STRIPE ON SWAGE ENDS		AS5806T080606
TEE, MALE FLARELESS ON BRANCH		AS5807	TITANIUM	T (6Al-4V)	DULL GRAY WITH BLUE STRIPE ON SWAGE ENDS		AS5807T080808
TEE, FEMALE FLARELESS ON RUN		AS5809	TITANIUM	T (6Al-4V)	DULL GRAY WITH BLUE STRIPE ON SWAGE ENDS		AS5809T080808
TEE, MALE FLARELESS ON RUN		AS5810	TITANIUM	T (6Al-4V)	DULL GRAY WITH BLUE STRIPE ON SWAGE ENDS		AS5810T080606

NOTE:

NOT KEPT UP TO DATE - ALWAYS CONSULT LATEST REVISION OF FITTING STANDARD FOR P/N AND SUPERSESSION DATA.

2328851 S0000527712_V2

Hydraulic Fitting Identification Information
Figure 202/20-10-51-990-927 (Sheet 25 of 25)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

FLARELESS TUBING ASSEMBLY - REMOVAL/INSTALLATION

1. General

A. You must consult with Boeing before conducting any repairs to oxygen system tubing.

B. 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.

WARNING DO NOT USE THIS PROCEDURE ON OXYGEN TUBING. GREASE, DIRT, OR OTHER FLAMMABLE MATERIALS IN THE OXYGEN TUBING CAN CAUSE A FIRE OR EXPLOSION.

C. 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.

D. You must identify the tubing assembly configuration and the tubing material before removal.

E. 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.

F. 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 12-40-00-100-803.

G. 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.

H. 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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I. 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.

J. 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 401/20-10-51-993-903

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 OR 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).

(4) FLARELESS TUBING ASSEMBLY - REPAIRS, PAGEBLOCK 20-10-51/801.

TASK 20-10-51-000-801

2. Flareless Tubing Assembly Removal

A. References

Reference	Title
20-10-51-300-805	Tube Repair (P/B 801)
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 20-10-51-020-008

(2) Get access to the tube assembly fittings.

SUBTASK 20-10-51-020-002

(3) Remove the support clamps on the tubing that will be removed.

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SUBTASK 20-10-51-020-004

> **WARNING**
> 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 the 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 20-10-51-020-001

(6) Remove the tubing assembly from the airplane.

SUBTASK 20-10-51-420-015

(7) Install the caps on the ports and hydraulic lines to prevent leakage and contamination.

SUBTASK 20-10-51-160-001

> **CAUTION**
> QUICKLY CLEAN THE INSTALLATION AREA OF ALL HYDRAULIC FLUID. THE HYDRAULIC FLUID CAN CAUSE DAMAGE TO THE AIRPLANE EQUIPMENT.

(8) Clean all hydraulic fluid from the area.

(a) Do this task: Tube Repair, TASK 20-10-51-300-805.

END OF TASK

TASK 20-10-51-400-804

3. Flareless Tubing Assembly Installation

(Figure 402, Figure 403)

A. References

Reference	Title
12-40-00-100-801	Clean (Wet Wash) the External Surfaces of the Airplane (P/B 201)
12-40-00-100-803	Clean (Waterless Wash) the External Surfaces of the Airplane (P/B 201)

B. Flareless Tubing Assembly Installation

SUBTASK 20-10-51-160-002

> **CAUTION**
> COLLECT THE HYDRAULIC FLUID IN A CONTAINER. IF IT GETS ON THE AIRPLANE, IMMEDIATELY CLEAN IT FROM ALL SURFACES. HYDRAULIC FLUID CAN CAUSE DAMAGE TO STRUCTURE AND EQUIPMENT.

(1) 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 12-40-00-100-803.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SUBTASK 20-10-51-210-015

(2) 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 20-10-51-210-016

(3) Look for worn areas or dents on the tube.

(a) If it is necessary, replace the tube.

SUBTASK 20-10-51-640-002

(4) Apply the thread compound applicable to your system Table 402 immediately before installation as follows (Figure 402):

(a) Apply the thread compound to the outer diameter of the external threads, the shoulder, and the 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 the inner surface of the bore of the fitting.

Table 402/20-10-51-993-842 Thread Compounds

SYSTEM	BULK CODE	APPROVED THREAD COMPOUND (Straight Thread Fittings)
Compressed Gas (Not Oxygen)	D50004	Antiseize Compound BMS3-28
Deicing or Anti-icing	D50004	Antiseize Compound BMS3-28
Instrument Air	D50004	Antiseize Compound BMS3-28
Pneumatic	D50004 D00062	Antiseize Compound BMS3-28 or Pneumatic Grease AMS-G-4343
Air Conditioning	D50004 D01062 D00062	Antiseize Compound BMS3-28 or Never-Seez Pure Nickel Special or Pneumatic Grease AMS-G-4343
Fire Protection	D50004	Antiseize Compound BMS3-28
Coolant	D00070 D00467	Hydraulic Fluid MIL-PRF-5606 or Shock Strut Fluid BMS 3-32 Type II
Water Injection	D50004	Antiseize Compound BMS3-28
Fuel	D00070 D00467	Hydraulic Fluid MIL-PRF-5606 or Shock Strut Fluid BMS 3-32 Type II
Lubrication	D00070 D00467	Hydraulic Fluid MIL-PRF-5606 or Shock Strut Fluid BMS 3-32 Type II
Hydraulic MIL-PRF-5606	D00070 D00467	Hydraulic Fluid MIL-PRF-5606 or Shock Strut Fluid BMS 3-32 Type II
Hydraulic BMS3-11	D00054 D00153 D50269	Skydrol Assy Lube MCS 352B or Hydraulic Fluid BMS3-11 Type IV or Hydraulic Fluid BMS3-11 Type V
Hydraulic MIL-PRF-6083	D00070 D00106 D00467	Hydraulic Fluid MIL-PRF-5606 or Hydraulic Fluid MIL-PRF-6083 or Shock Strut Fluid BMS 3-32 Type II

ECCN 9E991 BOEING PROPRIETARY - See title page for details

Table 402/20-10-51-993-842 Thread Compounds (Continued)

SYSTEM	BULK CODE	APPROVED THREAD COMPOUND (Straight Thread Fittings)
Miscellaneous Tubing	D50004 D00053	Antiseize Compound BMS3-28 or Grease AMS-G-6032

SUBTASK 20-10-51-420-008

(5) 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 20-10-51-820-003

(6) Align the tube and fitting by hand and make the tube end touch the bottom of the fitting.

SUBTASK 20-10-51-210-017

(7) Look at the tags to make sure the tubes are aligned with the correct port fittings.

SUBTASK 20-10-51-420-016

(8) 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 20-10-51-420-009

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.

(9) Tighten the flareless tubing assembly with a torque wrench to the installation torque in (Table 405), if it is one of the following types:

(a) Steel, Titanium, and Cres Tubes:

1) 21-6-9 Cres and all other Cres tube ends with BACS13BX swaged sleeves

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 (Table 403):

Table 403/20-10-51-993-843 Minimum Wall Thickness

Tube Dash No.	Wall Thickness Inches (mm)
-4	0.020 (.508)
-5	0.020 (.508)
-6	0.028 (.711)
-8	0.035 (.889)
-10	0.049 (1.245)
-12	0.049 (1.245)
-16	0.065 (1.651)

4) Hose end fittings with steel inserts (nipples)

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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 Table 404:

Table 404/20-10-51-993-844 Minimum Wall Thickness

Tube Dash No.	Wall Thickness Inches (mm)
-3	0.028 (.711)
-4	0.028 (.711)
-5	0.028 (.711)
-6	0.028 (.711)
-8	0.028 (.711)
-10	0.028 (.711)
-12	0.028 (.711)
-16	0.035 (.889)
-20	0.049 (1.245)
-24	0.049 (1.245)

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.

Table 405/20-10-51-993-845 Installation Torque

NOMINAL TUBE DIAMETER Inch (mm)	TUBE DASH NO.	STEEL, TITANIUM, AND CRES TUBES TORQUE Pound-Inches +/- 5% (N-m)	ALUMINUM & ANNEALED CRES TUBES TORQUE Pound-Inches +/- 5% (N-m)
3/16 (4.76)	-3	100 (11.3)	80 (9.03)
1/4 (6.35)	-4	140 (15.8)	110 (12.4)
5/16 (7.94)	-5	190 (21.5)	140 (15.8)
3/8 (9.53)	-6	270 (30.5)	170 (19.2)
1/2 (12.7)	-8	500 (56.5)	280 (31.6)
5/8 (15.88)	-10	700 (79.1)	360 (40.7)
3/4 (19.05)	-12	900 (101.7)	450 (50.8)

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Table 405/20-10-51-993-845 Installation Torque (Continued)

NOMINAL TUBE DIAMETER Inch (mm)	TUBE DASH NO.	STEEL, TITANIUM, AND CRES TUBES TORQUE Pound-Inches +/- 5% (N-m)	ALUMINUM & ANNEALED CRES TUBES TORQUE Pound-Inches +/- 5% (N-m)
1 (25.4)	-16	1200 (135.6)	750 (84.7)
1-1/4 (31.75)	-20	1600 (180.8)	900 (101.7)
1-1/2 (38.1)	-24	2000 (226)	900 (101.7)
2 (50.8)	-32	2000 (226)	--

SUBTASK 20-10-51-420-010

(10) If the flareless tubing assembly is a reducer fitting, use the boss or bulkhead dimension to get the correct torque and tighten the assembly.

SUBTASK 20-10-51-420-011

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.

(11) Tighten the flareless tubing assembly with a torque wrench to the installation torques in Table 405 if it is an assembly that follows:

(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 Table 406:

Table 406/20-10-51-993-846 Wall Thickness

Tube Dash No.	Wall Thickness Inch (mm)	Torque Pound-Inches (Newton-Meters)
-8	0.028 (.7112)	375 (42.37)
-10	0.035 (.889)	575 (64.97)
-12	0.042 (1.0668)	725 (81.91)

(b) Aluminum and Annealed Cres Tubes:

1) 6061-T6 aluminum and annealed Cres with BACS13AP sleeves with a wall thickness shown in Table 407:

Table 407/20-10-51-993-847 Wall Thickness

Tube Dash No.	Wall Thickness Inches (mm)	Torque Pound-Inches (Newton-Meters)
-6	0.020 (.508)	160 (18.08)
-10	0.020 (.508)	250 (28.25)
-12	0.020 (.508)	325 (36.72)

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SUBTASK 20-10-51-420-012

(12) Tighten the flareless tubing assembly with a torque wrench to the installation torque (Table 405) if it is a material listed above as follows:

(a) Hold the union with a wrench and tighten the B-nut to the installation torque value.

NOTE: If you have a leak, you can loosen and tighten the B-nut 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 20-10-51-420-013

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.

(13) 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) (Figure 403).

1) Make sure that the maximum reduction in the internal diameter is not more than 0.015 in. (0.381 mm) after you tighten the BACS13AP.

SUBTASK 20-10-51-420-014

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.

(14) 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

(15) 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 20-10-51-710-002

(16) 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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

TASK 20-10-51-760-801

4. Electrical Resistance Specifications in the Fuel Tank Check

(Figure 401, Figure 405)

A. General

(1) This task has steps to measure the electrical bonding resistance of hydraulic tubes in the fuel tank.

(2) 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 20-00-00-910-801.

NOTE: This is applicable to Airworthiness Limitation 28-AWL-10.

(3) Refer to BULKHEAD FITTINGS - REMOVAL/INSTALLATION, PAGEBLOCK 29-11-55/401, to replace the bulkhead fittings for the hydraulic tubes in the fuel tank.

B. References

Reference	Title
20-00-00-910-801	Airworthiness Limitation Precautions (P/B 201)
28-11-00-910-802	Fuel Tank - Purging and 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. Procedure

SUBTASK 20-10-51-910-001

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: Fuel Tank - Purging and Tank Entry, TASK 28-11-00-910-802.

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SUBTASK 20-10-51-760-003

WARNING	MAKE SURE THE METER YOU USE WILL NOT CAUSE AN EXPLOSION. IF NOT, MAKE SURE THE AMOUNT OF DANGEROUS GAS, AS MEASURED BY A GAS DETECTOR, IS LESS THAN 10 PERCENT OF THE LOWER EXPLOSIVE LIMIT. IF NOT, AN EXPLOSION CAN OCCUR THAT CAN CAUSE INJURIES TO PERSONS AND DAMAGE TO EQUIPMENT.

(2) Do a check of the electrical bonding resistance with the intrinsically safe approved bonding meter, COM-1550.

SUBTASK 20-10-51-760-006

28-AWL-10: CDCCL

(3) Measure the electrical bonding resistance across the in-line union/tee fittings (tube-to-tube) that you replaced (Figure 401), (Figure 405).

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).

NOTE: This is applicable to Airworthiness Limitation 28-AWL-10.

28-AWL-10: CDCCL

(a) Make sure the electrical bonding resistance is 0.00095 ohm (0.95 milliohm) or less.

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).

NOTE: This is applicable to Airworthiness Limitation 28-AWL-10.

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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Resistance Measurement Across Tee/Union Fittings
Figure 401/20-10-51-990-904

ECCN 9E991 BOEING PROPRIETARY - See title page for details

TASK 20-10-51-000-802

5. Flareless Fittings in Pressurized, Strut, Fuel Tank, and Cargo Areas Installation

A. References

Reference	Title
20-10-51-300-805	Tube Repair (P/B 801)

B. Procedure

SUBTASK 20-10-51-300-001

(1) Make the necessary repairs to the flareless tubing assembly.

(a) Do this task: Tube Repair, TASK 20-10-51-300-805.

SUBTASK 20-10-51-420-017

> **CAUTION** USE TWO WRENCHES TO TIGHTEN THE TUBE COUPLING NUTS. USE ONE TO HOLD THE NIPPLE, AND THE OTHER TO TIGHTEN THE COUPLING NUT. IF YOU DO NOT USE TWO WRENCHES, DAMAGE TO THE TUBES AND NIPPLES CAN OCCUR.

(2) 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 the fittings.

SUBTASK 20-10-51-420-018

(3) 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 408/20-10-51-993-850 Installation Torques

Tube Size	Titanium Cres Tube Pound-Inches (Newton-meters)	Aluminum Pound-Inches (Newton-meters)
0.250	140 (15.82)	110 (12.43)
0.375	270 (30.51)	170 (19.21)
0.500	500 (56.49)	280 (31.64)
0.625	700 (79.09)	360 (40.67)
0.750	900 (101.7)	450 (50.84)
1.000	1200 (135.6)	750 (84.74)
1.250	1600 (180.8)	900 (101.7)
1.500	2000 (226)	900 (101.7)

SUBTASK 20-10-51-760-007

(4) 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 20-10-51-790-002

(5) Do a leak test on the repair installations of the flareless fittings in pressurized areas as follows:

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(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.

SUBTASK 20-10-51-710-003

(6) 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

(7) 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

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 20-10-51-220-032

(1) For hydraulic system tubing, do the checks that follow.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(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.

(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 406).

<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 in Figure 406.

(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 20-10-51-220-033

(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).

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(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.

SUBTASK 20-10-51-220-034

(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 20-10-51-220-035

(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 20-10-51-220-036

(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 20-10-51-220-037

(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 20-10-51-220-038

(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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

TASK 20-10-51-200-802

7. Space Between Tubing Clamps Check

A. Procedure

SUBTASK 20-10-51-220-019

(1) Make sure the space between the tubing clamps is within the limits shown in (Table 409), unless it is specified differently.

Table 409/20-10-51-993-851 Maximum Space Between Tubing Clamps

TUBE OD Inch (mm)	MATERIAL	CLAMP SPACE - VISUAL Inches (cm)	CLAMP SPACE - SPECIAL *[1]
1/4 (6.35)	Steel, Titanium	16.0 (40.6)	12.0 (30.4)
3/8 (9.53)	Steel, Titanium	20.0 (50.8)	15.0 (38.1)
3/8 (9.53)	Aluminum	16.5 (41.9)	12.0 (30.5)
1/2 (12.7)	Steel, Titanium	23.0 (58.4)	17.0 (43.2)
1/2 (12.7)	Aluminum	19.0 (48.3)	14.0 (35.6)
5/8 (15.88)	Steel, Titanium	22.0 (55.9)	18.5 (47.0)
5/8 (15.88)	Aluminum	22.0 (55.9)	16.5 (41.9)
3/4 (19.05)	Steel, Titanium	27.5 (69.9)	20.5 (52.1)
3/4 (19.05)	Aluminum	24.0 (61.0)	18.0 (45.7)
1.0 (25.4)	Steel, Titanium	30.0 (76.2)	22.5 (57.2)
1.0 (25.4)	Aluminum	26.5 (67.3)	19.5 (49.5)
1-1/4 (31.75)	Steel, Titanium	31.5 (80.0)	23.5 (59.7)
1-1/4 (31.75)	Aluminum	28.5 (72.4)	21.0 (53.3)

*[1] Special: Wing Rear Spar, Engine Strut, Engine Aft Fairing.

——— END OF TASK ———

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LUBRICATION POINTS

F15920 S0006561930_V2

Flareless Tubing Assembly Lubrication Points
Figure 402/20-10-51-990-838

ECCN 9E991 BOEING PROPRIETARY - See title page for details

1 MAKE SURE THAT THE MAXIMUM REDUCTION IN THE INTERNAL DIAMETER IS NOT MORE THAN 0.015 INCH (0.381 mm) AFTER YOU TIGHTEN THE BACS13AP.

F15923 S0006561931_V3

Maximum Collapse of Preset Flareless Sleeve
Figure 403/20-10-51-990-839

ECCN 9E991 BOEING PROPRIETARY - See title page for details

ELECTRICAL BONDING PROCESSES

TEST POINTS FOR A PERMASWAGE BULKHEAD FITTING AND BASIC STRUCTURE

SCREW TOGETHER WELD-ON BULKHEAD FITTING

1 MICRO-OHMMETER

F15926 S0006561932_V3

Bulkhead Fittings
Figure 404/20-10-51-990-840

ECCN 9E991 BOEING PROPRIETARY - See title page for details

1 MICRO-OHMMETER

F15929 S0006561933_V2

Union/Tee Fittings
Figure 405/20-10-51-990-841

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SIDE-BY-SIDE CLAMP

BACK-TO-BACK CLAMP

BUTTERFLY CLAMP

LOOP CLAMP

CLAMPING TO MAINTAIN CLEARANCES

2032766 S0000407445_V4

Tubing Clearances Check Clamps
Figure 406/20-10-51-990-868

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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

LOM 422-434, 437-447, 450-999

(14) Axial Swage Fitting Installation (5,000 psi rated - Shape, Elbow, Tee)

LOM ALL

(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 737NG 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.

LOM 422-434, 437-447, 450-999

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 20-10-51-400-811).

ECCN 9E991 BOEING PROPRIETARY - See title page for details

LOM ALL

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.

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.)

CAUTION

USE CADMIUM PLATED STEEL FITTINGS WHEN REPLACING ALUMINUM LINES WITH CORROSION RESISTANT STEEL LINES. GALVANIC CORROSION MAY 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.

LOM 422-434, 437-447, 450-999

(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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

LOM ALL

(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.

(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.

CAUTION

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.

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(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.

(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 801/20-10-51-993-902

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).

CAUTION

DO NOT ALLOW PUMPS, VALVES, ACTUATORS OR OTHER COMPONENTS TO HANG FROM KEVLAR HOSES. KEVLAR HYDRAULIC HOSES KINK EASILY AND MAY CAUSE LEAKAGE.

W. When you do repairs to Kevlar hydraulic hoses, remember Kevlar hoses kink more easily than CRES (steel) wire braided hoses.

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TASK 20-10-51-360-802

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.

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
20-10-51-400-804	Flareless Tubing Assembly Installation (P/B 401)

C. Procedure

SUBTASK 20-10-51-790-006

(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 20-10-51-860-013

(2) Depressurize the system.

SUBTASK 20-10-51-211-003

(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.

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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 20-10-51-300-805.

(c) Correct the cause of the chafing if present and replace any worn or missing clamps.

SUBTASK 20-10-51-211-004

(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 20-10-51-400-804

b) Retightening of Fitting Joints with Persistent Hydraulic Leaks, TASK 20-10-51-360-803

c) FLARELESS TUBING ASSEMBLY - REPAIRS, 20-10-51/801 for improperly swaged connections for specific permanently swaged fitting joints.

NOTE: It can be necessary to replace parts if the leak can not be corrected by swage.

(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 20-10-51-400-804.

(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, mismated 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 20-10-51-360-803.

(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.

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SUBTASK 20-10-51-211-005

(5) If the leak is at a threaded 'boss' joint [See Figure 801, sheet 7] that uses o-rings this most commonly occurs due to mistakes during assembly, check for the following:

(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.

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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

PRESSURIZED TUBE LEAK

NOTE:

EXAMPLE OF LEAK FROM FATIGUE CRACK ADJACENT TO WELD SLEEVE (TUBE SIDE OF WELD) ON TITANIUM HYDRAULIC TUBE ASSEMBLY.

2324214 S0000527013_V2

Tube and Fitting Leakage Identification
Figure 801/20-10-51-990-925 (Sheet 1 of 7)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

ALUMINUM TUBE CORROSION

2324211 S0000527014_V2

Tube and Fitting Leakage Identification
Figure 801/20-10-51-990-925 (Sheet 2 of 7)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

CRACKED FITTINGS

2324326 S0000527015_V2

Tube and Fitting Leakage Identification
Figure 801/20-10-51-990-925 (Sheet 3 of 7)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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).

2324353 S0000527017_V2

Tube and Fitting Leakage Identification
Figure 801/20-10-51-990-925 (Sheet 4 of 7)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

GALLING DAMAGE

2324433 S0000527018_V2

Tube and Fitting Leakage Identification
Figure 801/20-10-51-990-925 (Sheet 5 of 7)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

STRESS CORROSION CRACKING

2324455 S0000527019_V2

Tube and Fitting Leakage Identification
Figure 801/20-10-51-990-925 (Sheet 6 of 7)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

MS33649
SINGLE SEAL BOSS STRAIGHT
THREADED "BOSS" JOINT

2324602 S0000527020_V2

Tube and Fitting Leakage Identification
Figure 801/20-10-51-990-925 (Sheet 7 of 7)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

TASK 20-10-51-360-803

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, Strut, Fuel Tank, and Cargo Areas Installation, TASK 20-10-51-000-802.

(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
20-10-51-000-802	Flareless Fittings in Pressurized, Strut, Fuel Tank, and Cargo Areas Installation (P/B 401)
20-10-51-200-802	Space Between Tubing Clamps Check (P/B 401)
20-10-51-400-804	Flareless Tubing Assembly Installation (P/B 401)
20-10-51-993-842	Table: Thread Compounds (P/B 401)
20-10-51-993-845	Table: Installation Torque (P/B 401)
20-10-51-993-850	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 20-10-51-211-001

(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 20-10-51-400-804.

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SUBTASK 20-10-51-030-001

(4) Loosen the flareless fittings to check for preload on the tube assembly.

(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 20-10-51-400-804.

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 20-10-51-400-804.

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 20-10-51-993-842.

(b) Tighten the flareless fittings with BACS13AP sleeves two times (tighten, loosen, and tighten again) to nominal torque shown in Table 20-10-51-993-845

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 20-10-51-993-842.

(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 20-10-51-993-845.

2) Loosen the fitting to release the torque.

3) Tighten the fitting to the torque value specified in Table 20-10-51-993-850.

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.

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1) Use a clean white cloth to find hydraulic leakage.
2) If you find leakage, do the steps that follow.
   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.
         <b> Galling or scratches.
         <c> Dimples.
         <d> Cracks.
      <2> If damage is found, replace any damaged assemblies.
         <a> Use this procedure:Flareless Tubing Assembly Installation, TASK 20-10-51-400-804.
   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 20-10-51-993-842.
      <2> Tighten the fittings two times (tighten, loosen, and tighten) to nominal torque shown in Table 20-10-51-993-845.
      <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 20-10-51-400-804.
   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 20-10-51-993-842.
      <2> Tighten the fitting to the torque shown in Table 20-10-51-993-845.
      <3> Loosen the fitting to release the torque.
      <4> Tighten the fitting to the torque value specified in Table 20-10-51-993-850.
      <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. Use this procedure: Flareless Tubing Assembly Installation, TASK 20-10-51-400-804.

END OF TASK

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1847483 S0000328861_V2

BACS13AP Flareless Preset Sleeve
Figure 802/20-10-51-990-861

ECCN 9E991 BOEING PROPRIETARY - See title page for details

1847485 S0000328863_V2

BACS13BX/BACS13BD Flareless Internally Swaged Sleeve
Figure 803/20-10-51-990-862

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1847486 S0000328865_V2

NAS1760 Flareless Weld Sleeve
Figure 804/20-10-51-990-863

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TASK 20-10-51-300-805

4. Tube Repair

(Figure 805, Figure 806, Figure 807, Figure 808, Figure 809, Figure 810, Figure 811, Figure 812, Figure 813, Figure 814, Figure 815)

A. General

> **CAUTION** 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. We recommend that you use a bend block or tool equivalent to the Parker G-824 hand bender. Make sure the bend block supports the tube bend beyond the neutral axis of the bend, as shown in Figure 805 and Table 802, and that the bend-ovality allowables are not exceeded.

Table 802/20-10-51-993-905 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]
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

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Table 802/20-10-51-993-905 Permitted Ovality and Wrinkle of Hydraulic Tube Bends (Continued)

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 Max - OD Min]/OD Specified) x 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 803/20-10-51-993-906 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)
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).

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(e) Any damage having a sharp point or small radius not smooth bottomed can cause a stress point in the tube that could lead to fatigue cracking. Service limits found in Table 803 apply only to damage having a smooth bottom. Service damage located on or near the tube ends, welded areas, fittings, and formed transitions is not allowed.

(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 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 814, Table 805)

Table 804/20-10-51-993-907 Smooth Dent Damage Limits for Electrical Rigid Conduits

CONDUIT SIZE (OD)	MAXIMUM DENT DEPTH
0.25 in. (6.35 mm)	0.050 in. (1.270 mm)
0.31 in. (7.87 mm)	0.063 in. (1.600 mm)
0.38 in. (9.65 mm)	0.075 in. (1.905 mm)
0.50 in. (12.70 mm)	0.100 in. (2.540 mm)
0.63 in. (16.00 mm)	0.125 in. (3.175 mm)
0.75 in. (19.05 mm)	0.150 in. (3.810 mm)
0.88 in. (22.35 mm)	0.175 in. (4.445 mm)
1.00 in. (25.40 mm)	0.200 in. (5.080 mm)
1.25 in. (31.75 mm)	0.250 in. (6.350 mm)
1.50 in. (38.10 mm)	0.300 in. (7.620 mm)
1.75 in. (44.45 mm)	0.350 in. (8.890 mm)
2.00 in. (50.80 mm)	0.400 in. (10.160 mm)

Table 805/20-10-51-993-908 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. (1.016 mm)	10
	ALUMINUM ALLOY	0.020 in. (0.508 mm)	10
OVER 1.0	STAINLESS STEEL	0.060 in. (1.524 mm)	10
	ALUMINUM ALLOY	0.030 in. (0.762 mm)	10

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(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 or D10203 fitting on the new tube section, use this procedure: Flareless Fittings in Pressurized, Strut, Fuel Tank, and Cargo Areas Installation, TASK 20-10-51-000-802 and Externally Swaged (Permaswage) Fittings Installation, TASK 20-10-51-400-808. Refer to Electrical Resistance Specifications in the Fuel Tank Check, TASK 20-10-51-760-801 for verifying electrical resistance where required.

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, BACS13AP sleeve or BACS13BX 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, using the procedures in Figure 810, Table 806.

Table 806/20-10-51-993-909 Procedure to Replace a 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 (Fig. 810)	1.562	1.705	1.886	2.100	2.341	2.319	N/A	N/A
35211	Harrison Swage Machine 6777	MS21924	A (Fig. 810)	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 (Fig. 810)	0.487	1.612	1.791	1.965	2.199	2.122	2.119	2.049
BACS13AP	Hand or Machine Preset	MS21924	C (Fig. 810)	1.422	1.547	1.726	1.900	2.134	N/A	N/A	N/A
CRYOIVE Assembly	N/A	MS21924	B (Fig. 810)	1.487	1.612	1.791	1.965	2.100	2.122	N/A	N/A

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(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. You can make splice a repair of 21-6-9 and Ti-3AL-2.5V tube with 304-1/8 Hard tube of the wall thickness shown in Table 822, Table 823, Table 826. You can also make a splice repair of a Ti-3AL-2.5V tube with 21-6-9 tube of the wall thickness shown in Table 822, Table 823, Table 826.

Table 807/20-10-51-993-868 Tool 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 - Refer to Table 824 for individual tool numbers - 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 807/20-10-51-993-868 Tool 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 RCLK5C01S002 (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 808/20-10-51-993-869 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 808/20-10-51-993-869 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 809/20-10-51-993-870 Tube Material and Fitting Selection Table

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	.051	.074	
6061-t6	.035	.035	.035	.035	.035	.035	.035	.049	.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 810/20-10-51-993-871 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	F-17.25
			Optional:	
			Passivate + Primer (green)	F-17.25 + F-20.02 or F-20.49
			Passivate + Primer (green) + Paint (white)	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 (see NOTE)	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)
		Outside Only	+ Primer (green)	+ F-20.02 or F-20.49
			Optional:	
			+ Primer (green)	+ F-20.02 or F-20.49
			+ Paint (white)	+ F-21.30

NOTE: Some earlier airplane models were delivered with aluminum tubes having anodize finish (F-17.19 - now an inactive finish) in combination with primer (F-20.02). Current airplane models are delivered with aluminum tubes having alodine finish, some in combination with primer and paint, as shown.

Table 811/20-10-51-993-895 Approved Fitting/Tube Material Combinations for Repair with Permaswage Unions

DMC PART NO.	FITTING MATERIAL	FOR USE WITH TUBE MATERIAL	APPROVED TUBE SIZES OD/WALL						
			04	06	08	10	12	16	20

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Table 811/20-10-51-993-895 Approved Fitting/Tube Material Combinations for Repair with Permaswage Unions (Continued)

DMC PART NO.	FITTING MATERIAL	FOR USE WITH TUBE MATERIAL	APPROVED TUBE SIZES OD/WALL						
D10282-()*[1]*[2]	21–6-9 CRES	21-6-9 CRES	.016	.020	.026	.033	.039	.052	--
		3AL-2.5V Ti	.016	.019	.026	.032	.039	.051	.070
		304-1/8 Hard CRES (MIL-T-6845)	.020	.028	.035	.049	.058	.065	--
D10282D() *[1]*[2]	6061T6	6061T6 Al (MIL-T-7081)	.035	.035	.035	.035	.035	.035	.049
BOEING PART NO.	FITTING MATERIAL	FOR USE WITH TUBE MATERIAL	APPROVED TUBE SIZES OD/WALL						
			04	06	08	10	12	16	20
BACU24BS (SIZE)(SIZE) J *[1]*[2]	21-6-9 CRES	21-6-9 CRES	.016	.020	.026	.033	.039	.052	--
		3AL-2.5V	.016	.019	.026	.032	.039	.051	.070
		304-1/8 Hard CRES (MIL-T-6845)	.020	.028	.035	.049	.058	.065	--
BACU24BS (SIZE)(SIZE) D *[1]*[2]	6061T6 Al	6061T6Al (MIL-T-7081)	.035	.035	.035	.035	.035	.035	.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 Boeing or DMC part number indicates 6061T6 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 D10282-(SIZE) and aluminum D10282D(SIZE) permaswage unions are improved replacements for the standard corrosion resistant steel D10036D (SIZE) and aluminum D10036D (SIZE) unions, respectively. The D10036 unions are functionally interchangeable with the D10282 unions.

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BACU24BS (SIZE)(SIZE) J - (both sizes the same), BACU24BS (SIZE)(SIZE) D - (both sizes the same), D10282-(SIZE) and D10282D (SIZE) unions 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.

(8) The permitted limits of hydraulic line tubing damage caused by dents, chafes, or the corrosion removal process per the Corrosion Prevention Manual, are shown in Table 803.

(9) 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:

(a) 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 809).

(b) 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 808 and Table 812).

Table 812/20-10-51-993-910 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
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

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Table 812/20-10-51-993-910 Tube Cutout Lengths (Inches) (Continued)

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 (5,000 psi rated)	None Necessary	1.000	N/A	1.000	1.000	1.000	1.000	1.000	1.000	N/A
Extended Length Axial Swage Union, AS6322E (5,000 psi rated)	None Necessary	2.306	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 813/20-10-51-993-911 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

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Table 813/20-10-51-993-911 Tube Cutout Dimensions for Installing DAS5792T/DAS5793T Adapter Fittings (Continued)

”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.

(c) Replace a tube center section that has very much damage with an assembled tube and fitting assembly, or axially swaged adapter fittings and a tube assembly (Figure 811).

(10) 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.

(11) 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.

B. References

Reference	Title
20-10-51-000-802	Flareless Fittings in Pressurized, Strut, Fuel Tank, and Cargo Areas Installation (P/B 401)
20-10-51-760-801	Electrical Resistance Specifications in the Fuel Tank Check (P/B 401)
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.

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 #: 6633K-01 Supplier: 08199

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D. Tube Repair

SUBTASK 20-10-51-350-009

(1) For hydraulic tubing specifications and wall thicknesses, see Table 814.

NOTE: Table 801 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 814/20-10-51-993-861 Tubing Specifications and Wall Thickness for 737 Hydraulic Tubes

	-4	-6	-8	-10	-12	-16	-20	-24
Aluminum 6061-T6 AMS 4083 (R)*[1]	NU*[1]	0.035 (.889)	0.035 (.889)	0.035 (.889	0.035 (.889)	0.035 (.889)	0.049 (1.245)	0.049 (1.245)
CRES 21-6-9 BMS 7-185 (P,R)*[1]	0.016 (.4064)	0.020 (.508)	0.026 (.6604)	0.033 (.8382)	0.039 (.9906)	0.052 (1.321)	NU	NU
TITANIUM 3AL-2.5V AS5620/ AMS 4946 (P,R)*[1]	0.016 (.4046)	0.019 (.4826)	0.026 (.6604)	0.032 (.8128)	0.039 (.9906)	0.051 (1.295)	0.074 (1.880)	NU
CRES 304 1/8 HARD MIL-T-6845 (P,R)*[1]	0.020 (.508)	0.028 (.7112)	0.035 (.889)	0.049 (1.245)	0.058 (1.473)	0.065 (1.651)	NU	NU

*[1] Inches, (millimeters) 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 20-10-51-800-007

(2) Use the tube materials shown in Table 815.

Table 815/20-10-51-993-862 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
ANNEALED CRES 304	---	T-8504	AMS 5567
ANNEALED CRES 321	---	T-8808	AMS 5556 AMS 5557
TITANIUM 3AL-2.5V	---	---	AS5620 AMS 4946

*[1] Low Pressure, Non-Hydraulic Systems Only

SUBTASK 20-10-51-800-008

(3) Use the Hydraulic System Design Pressure shown in (Table 816) during the repairs.

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Table 816/20-10-51-993-863 Hydraulic System Design Pressures

COMPONENT	Maximum Working Pressure Psi (kPa)	Proof Pressure Psi (kPa)	Burst Pressure Psi (kPa)
Pressure lines (including hoses and fittings) and units with air under full system pressure (such as accumulators).	3000 (20684.3)	6000 (41368.5)	12000 (82737.1)
Return and case drain lines, fittings and units	600 (4136.9)	900 (6205.3)	1500 (10342.1)
Return line hoses	600 (4136.9)	1500 (10342.1)	3000 (20684.3)
Pump Supply Reservoirs, units, lines, and fittings	65 (448.2)	100 (689.5)	200 (1378.9)
Airbleed Line (Upstream of the regulator)	250 (1723.7)	500 (3447.4)	1000 (6894.8)
Drains and vents open to the atmosphere	15 (103.4)	50 (344.7)	75 (517.1)

SUBTASK 20-10-51-940-016

(4) Make a decision about the type of repair necessary.

(a) Use Figure 806, Table 807,Table 808, Table 809, and Table 810 to make a decision about the group the repair is in.

SUBTASK 20-10-51-940-017

(5) Refer to Figure 808 and Table 812 and Table 813 to 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.

SUBTASK 20-10-51-420-025

(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 809, 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.

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) To assemble the tool refer to 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.

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13) Remove the tool with the plug expanded

NOTE: The expanded plug should remove metal particles from the inside of the tube. Make sure no metal particles fall inside the tube.

(c) Install the necessary flareless sleeves or alternate end fittings to the repair tube as told in the following applicable tasks:

1) (Install the CRYOLIVE Flareless Sleeve Assembly, TASK 20-10-51-400-805)

2) (Swage the BACS13BX Flareless Sleeves with the Internal Elastomer Swage Equipment, TASK 20-10-51-300-806)

3) (BACS13BX Flareless Sleeve Swaging on Stainless Steel and Titanium Hydraulic Tubing, TASK 20-10-51-300-807)

4) (BACS13AP Flareless Sleeve Preset, TASK 20-10-51-300-808)

5) (Axial Swage Fitting Installation (5,000 psi rated - Union) or Male/Female Adapter Fittings, TASK 20-10-51-400-810)

(d) Assemble and tighten the flareless fittings which are part of the repair section.

(e) Measure all of the tube assembly length (L1) (Figure 809, Figure 811).

(f) To find the necessary cutout length (L2) as shown in Figure 809, Figure 810, use the procedure given in Figure 811, Table 817, Figure 818.

Table 817/20-10-51-993-912 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	MS21902or equivalent	L1 minus 2P	L1 minus 2P
BACS13BX	Harrison Roller Swage Kit 6633K01	MS21902 or equivalent	L1 minus 2[Z1]	L1 minus 2[Z2[
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 2[Z2]	L1 minus 2[Z2]
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 (Z1+0.10)	N/A
BACS13AP	Hand or Hacmine Preset	Permswage Cryofit H-Fitting	L1 minus (H+0.10)	N/A

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Table 817/20-10-51-993-912 Procedure to Find the Tube Cutout Length L2 (Continued)

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 2[Z2]	L1 minus 2{Z2]
N/A	N/A	Rynglok Permaswage Cryofit H-Coupling		L1 plus 0.20

*[1] See the Figure for Flareless Sleeve Tube End Values in the procedure to Install the CRYOLIVE Flareless Sleeve Assembly 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 as shown in 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 20-10-51-300-806.

a) Make sure that the correct P dimension (position of the BACS13BX sleeve on the tube) is used.

NOTE: The different value applies to Size 20 and 24 sleeves when used with short flareless fittings.

2) To use the tube swage kit, COM-1794, for installation of BACS13BX flareless sleeves, do this task: BACS13BX Flareless Sleeve Swaging on Stainless Steel and Titanium Hydraulic Tubing, TASK 20-10-51-300-807.

3) To use the Harrison 6777 Roller Swage Machine for installing 35211 sleeves or 35212 unions, refer to "Swage Harrison 35211 sleeves and 35212 unions with the Harrison 6777 Roller Swage Machine."

4) To install the Cryolive flareless sleeve assembly, do this task: Install the CRYOLIVE Flareless Sleeve Assembly, TASK 20-10-51-400-805.

5) To install the BACS13AP flareless sleeves, do this task: BACS13AP Flareless Sleeve Preset, TASK 20-10-51-300-808.

6) To install H-couplings (BACC42W), do this task: BACC42W H-Coupling Installation, TASK 20-10-51-400-806.

7) To install Cryofit unions (3P02111) or (3PHS111), do this task: 3P02111/3PHS111 Cryofit Coupling Installation, TASK 20-10-51-400-807.

8) For installation of Permaswage fittings (BACU24BS), do this task: Externally Swaged (Permaswage) Fittings Installation, TASK 20-10-51-400-808.

9) For installation of Axial Swage unions (8,000 psi rated - Rynglok), do this task: Axial Swage Fitting Union Installation (8,000 psi rated - Rynglok), TASK 20-10-51-400-809.

10) For installation of Axial Swage unions (5,000 psi rated - DAS5969T) 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 20-10-51-400-810.

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LOM 422-434, 437-447, 450-999

11) For installation of Axial Swage shape fittings (5,000 psi rated), do this task: Axial Swage Fitting Installation (5,000 psi rated - Shape, Elbow and Tee), TASK 20-10-51-400-811.

LOM ALL

(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 you keep the minimum straight length specifications for all fittings (Figure 812).

(o) To install the Cryolive flareless sleeve assembly, do this task: Install the CRYOLIVE Flareless Sleeve Assembly, TASK 20-10-51-400-805.

1) 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.

2) See Table 818 for approved Cryolive sleeve, coupling nut, and plastic cap combinations.

Table 818/20-10-51-993-913 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 7075-T73 Al 6AL-4V Ti	921721J04 921721W04 921721T04
06	304 CRES 7075-T73 Al 6AL-4V Ti	921721J06 921721W06 921721T06
08	304 CRES 7075-T73 Al 6AL-4V Ti	921721J08 921721W08 921721T08
10	304 CRES 7075-T73 Al 6AL-4V Ti	921721J10 921721W10 921721T10
12	304 CRES 7075-T73 Al 6AL-4V Ti	921721J12 921721W12 921721T12
16	304 CRES 7075-T73 Al 6AL-4V Ti	921721J16 (Combination not Approved) 921721T16

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*[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.

(p) 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.

(q) To install the Axial Swage union (8,000 psi rated - Rynglok), do this task: Axial Swage Fitting Union Installation (8,000 psi rated - Rynglok), TASK 20-10-51-400-809.

(r) To install the Axial Swage union (5,000 psi rated - DAS5969T) 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 20-10-51-400-810.

LOM 422-434, 437-447, 450-999

(s) To install the Axial Swage tee and elbow fittings (5,000 psi rated), do this task: Axial Swage Fitting Installation (5,000 psi rated - Shape, Elbow and Tee), TASK 20-10-51-400-811.

LOM ALL

SUBTASK 20-10-51-710-007

(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.

END OF TASK

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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

WRINKLE MEASUREMENTS

L19628 S0006402386_V2

Permitted Ovality and Wrinkle of Hydraulic Tube Bends
Figure 805/20-10-51-990-869

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CAUTION: DO NOT USE CADMIUM PLATED PARTS ON TITANIUM TUBES. CORROSION WILL OCCUR IF YOU USE CADMIUM PLATED PARTS ON TITANIUM TUBES.

TUBE JOINING		TUBE MATERIAL 8	REF TABLE C FOR TOOLS REQUIRED	APPROVED SIZES
ILLUSTRATION	PART NUMBER*			
BACS13AP (BITE-TYPE)	BACS13AP( ) 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 (ELASTOMERIC SWAGE)	BACS13BX( )HP 2 3	6061T6	A	06, 08, 10, 12, 16, 20 4 24 4
	USE BACS13BX( )H FOR MATING WITH CRES PARTS; USE BACS13BX( )HP FOR MATING WITH ALUMINUM PARTS	304 ANN.	A	16, 20
		304 1/8 Hard	A	06, 08, 10, 12, 16, 20 4, 24 4
		21-6-9	A	04, 06, 08, 10, 12, 16
BACS13BX (ROLLER SWAGE)	BACS13BX()H 2	21-6-9	D	04, 06, 08, 10, 12, 16
		Ti-3Al-2.5V	D	04, 06, 08, 10, 12, 16

REPAIR METHOD - RECONNECTABLE WITH FLARELESS FITTING SLEEVES
TABLE A

L19633 S0006402388_V4

Tube Material and Fitting Selection Tables
Figure 806/20-10-51-990-870 (Sheet 1 of 8)

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CAUTION: DO NOT USE CADMIUM PLATED PARTS ON TITANIUM TUBES. CORROSION WILL OCCUR IF YOU USE CADMIUM PLATED PARTS ON TITANIUM TUBES.

TUBE JOINING		TUBE MATERIAL 8	REF TABLE C FOR 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
	AXIALLY SWAGED HYDRAULIC DAS5792T	21-6-9 CRES	I	04, 06, 08, 10, 12, 16
		3AL-2.5V Titanium	I	04, 06, 08, 10, 12, 16, 20
	AXIAL SWAGE TO MALE FLARELESS ADAPTER DAS5793T	21-6-9 CRES	I	04, 06, 08, 10, 12, 16
		3AL-2.5V Titanium	I	04, 06, 08, 10, 12, 16, 20

* SEE TABLE D FOR ASSOCIATED APPROVED FITTINGS.

REPAIR METHOD - RECONNECTABLE WITH FLARELESS FITTING SLEEVES
TABLE A

L19634 S0006402389_V4

Tube Material and Fitting Selection Tables
Figure 806/20-10-51-990-870 (Sheet 2 of 8)

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TUBE JOINING		TUBE MATERIAL 8	REF TABLE C FOR 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, 20
	Permaswage D10282 - (Cres)	Ti-3Al-2.5V	E	04, 06, 08, 10, 12, 16 20
		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
	DAS5969T TUBE-TO-TUBE UNION	21-6-9 CRES	I	04, 06, 08, 10, 12, 16
		3AL-2.5V Titanium	I	04, 06, 08, 10, 12, 16

REPAIR METHOD - PERMANENT UNIONS, TUBE-TO-TUBE
TABLE B

L19640 S0006402390_V6

Tube Material and Fitting Selection Tables
Figure 806/20-10-51-990-870 (Sheet 3 of 8)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

REF LETTER FOR TABLES A AND B	TOOL REQUIRED
A	Harrison Portable Swagers No. 5175 and 5720 or equivalent stationary Swager No. 5570
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 - Refer to Table 824 for individual tool numbers - 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: # TS3P02111
G	None necessary - hand tools only.
H	Aeroquip Rynglok Kit RTS8-02-006 for sizes 04, 06, 08, 10, 12, 16, 20.
I	Eaton Aeroquip Tool Kit P/N RTLK5-01S-007

TOOL REQUIRED FOR REPAIR METHOD
TABLE C

2872531 S0000677871_V1

Tube Material and Fitting Selection Tables
Figure 806/20-10-51-990-870 (Sheet 4 of 8)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

PART NUMBER	ASSOCIATED APPROVED FITTINGS	
	FITTING NUTS 5 7	UNIONS 6
BACS13AP (BITE-Type) BACS13BX (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 size 20, use: • MS21902-Alum or Steel • M21924-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, 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, Cre • 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
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

ASSOCIATED APPROVED FITTINGS
TABLE D

L19645 S0006402392_V3

Tube Material and Fitting Selection Tables
Figure 806/20-10-51-990-870 (Sheet 5 of 8)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

MATERIAL	TUBE SIZES								
	04	05	06	08	10	12	16	20	24
	0.250	0.312	0.375	0.500	0.625	0.750	1.000	1.250	1.500
21-6-9	0.016	0.020	0.020	0.026	0.033	0.039	0.052		
3A1-2.5V	0.016		0.019	0.026	0.032	0.039	0.052	0.070	
6061-T6	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.049	0.049
304 1/8 H	0.020	0.020	0.028	0.035	0.049	0.058	0.065*	0.035*	0.049*
304/321 ANNEALED CRES	0.035*		0.035*	0.035*	0.035*	0.035*	0.035*	0.035*	0.035*

* NOT QUALIFIED FOR 3000 PSI SYSTEMS, LOWER PRESSURES ONLY.

TABLE E

NOTE:

ALTERNATIVE WALL THICKNESSES FOR TUBE REPAIRS OF 3000 PSI AND LOWER SYSTEM PRESSURE APPLICATIONS PER FLAGNOTE 8

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.

L19647 S0006402393_V5

Tube Material and Fitting Selection Tables
Figure 806/20-10-51-990-870 (Sheet 6 of 8)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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 (See NOTE)	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)
		Outside Only	+ Primer (Green) Optional: + Primer (Green) + Paint (White)	+ F-20.02 or F-20.49 + F-20.02 or F-20.49 + F-21.30
NOTE: Some earlier airplane models were delivered with aluminum tubes having anodize finish (F-17.19 - now an inactive finish) in combination with primer (F-20.02). Current airplane models are delivered with aluminum tubes having alodine finish, some in combination with primer and paint, as shown.				

TYPICAL FINISHES FOR HYDRAULIC TUBING
TABLE F

L08177 S0006604335_V4

Tube Material and Fitting Selection Tables
Figure 806/20-10-51-990-870 (Sheet 7 of 8)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

NOTE:

REFER TO FIG. 824 TO MAKE AN ORDER FOR PARTS.

1. STANDARD CADMIUM-PLATED SLEEVE BACS13AP (SIZE).
2. STANDARD CADMIUM-PLATED SLEEVE:
   BACS13BX (SIZE) HP.
3. BACS13BD20H/HP AND BACS13BD24H/HP HAVE BEEN SUPERSEDED BY BAC13BX20H/HP AND BAC13BX24H/HP.
4. THE BACSBBX 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. MAKE SURE YOU DETERMINE THE APPLICATION BEFORE SWAGING. SHORT FLARELESS FITTINGS REQUIRE A SHORTER "Z " DIMENSION (FIG. 811).
5. DO NOT USE ALUMINUM NUTS OR UNIONS ON TUBE MATERIALS OTHER THAN ALUMINUM.
6. 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 AS465 FITTING ENDS.
7. 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.
8. WHEN PERFORMING A HYDRAULIC TUBE REPAIR WITH THE SAME TUBE MATERIAL, THE ALTERNATE TUBE WALL THICKNESSES LISTED IN FIG. 806 (SHEET 6) 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.
9. IF THE PART NUMBER ENDS WITH CODE LETTER "D" IT CAN BE USED ON TITANIUM, CRES, OR ALUMINIUM TUBING.

3005749 S0000780573_V1

Tube Material and Fitting Selection Tables
Figure 806/20-10-51-990-870 (Sheet 8 of 8)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

CUTTER TOOL

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

L19653 S0006402397_V3

DMC Tools
Figure 807/20-10-51-990-871 (Sheet 1 of 2)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

DEBURRING TOOL ASSEMBLY

CHAMFER DIMENSIONS

DEBURRING TOOL INSERTION

DEBURRING TOOL EXTRACTION

TUBE SIZE	TUBE WALL THICKESS (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

L19654 S0006402398_V3

DMC Tools
Figure 807/20-10-51-990-871 (Sheet 2 of 2)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

NOTE:

FITTING NUTS NOT SHOWN.

L19655 S0006402399_V3

Tubing Repair with Unions - Short Damage
Figure 808/20-10-51-990-872

ECCN 9E991 BOEING PROPRIETARY - See title page for details

NOTE:

REFER TO FIG. 810 (SHEET 1) FOR THE MINIMUM LENGTHS L1 AND L2.

L19665 S0006402401_V3

Tubing Repair by End Replacement
Figure 809/20-10-51-990-873 (Sheet 1 of 2)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

NOTE:

REFER TO TABLE 817 FOR THE LENGTHS L1 AND L2.

2069547 S0000430357_V3

Tubing Repair by End Replacement
Figure 809/20-10-51-990-873 (Sheet 2 of 2)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

A

NOTE:

REFER TO TABLE 806 FOR THE LENGTHS A, B AND C.
COUPLING NUTS NOT SHOWN.

F15978 S0006561969_V4

Tube Cutout Lengths for Replacement of Damaged BACU24AB Swage Unions
Figure 810/20-10-51-990-874 (Sheet 1 of 3)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

B

C

NOTE:

REFER TO TABLE 806 FOR THE LENGTHS A, B, AND C.
COUPLING NUTS NOT SHOWN.

F15979 S0006561970_V4

Tube Cutout Lengths for Replacement of Damaged BACU24AB Swage Unions
Figure 810/20-10-51-990-874 (Sheet 2 of 3)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

2070625 S0000430370_V4

Tube Cutout Lengths for Replacement of Damaged BACU24AB Swage Unions
Figure 810/20-10-51-990-874 (Sheet 3 of 3)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

NOTE:

REFER TO TABLE 817 FOR MINIMUM LENGTHS L1 AND L2.

F15981 S0006561972_V6

Tubing Repair by Section Replacement, Straight or Bend - Extensive Damage
Figure 811/20-10-51-990-876 (Sheet 1 of 2)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

REPAIR ASSEMBLY TOTAL LENGTH = 2 X TUBE CUTOUT LENGTHS FOR DAS5792T FROM TABLE 812 + 2 X TUBE CUTOUT LENGTHS FOR DAS5793T FROM TABLE 812 + REMAINING FREE TUBE LENGTH. OBSERVE MINIMUM TUBE LENGTHS REQUIRED FOR AXIALLY SWAGED FITTINGS FROM FIGURE 810.

REPAIR ASSEMBLY TOTAL LENGTH = 2 TUBE CUTOUT LENGTHS FOR DAS5792T FROM TABLE 812 + 2 TWO "P" DIMENSION VALVES FOR BACS13BX SLEEVE FROM FIGURE 809 + TWO DIMENSION "D" FOR MS21902 FLARELESS UNION FROM TABLE 805 + FREE TUBE LENGTH. OBSERVE MINIMUM TUBE LENGTHS REQUIRED FOR AXIALLY SWAGED FITTINGS FROM FIGURE 810.

NOTE:

REFER TO TABLE 817 FOR THE LENGTHS L1 AND L2.

2069883 S0000430477_V4

Tubing Repair by Section Replacement, Straight or Bend - Extensive Damage
Figure 811/20-10-51-990-876 (Sheet 2 of 2)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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

F15988 S0006561976_V6

Minimum Straight Length Specifications for Repair Fitting Installations Adjacent to Tube Bends
Figure 812/20-10-51-990-878

ECCN 9E991 BOEING PROPRIETARY - See title page for details

TORQUE WRENCH DIAL - PROCEDURE TO READ TORQUE

TUBE SIZE	MATERIAL WALL THICKNESS - INCHES		SWAGE TORQUE (POUNDS-INCH)	
	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 AS5620/AMS4946

2 AS SPECIFIED IN SPECIFICATION BMS 7-185

F16045 S0006561986_V4

Swage Torques, Sleeve Dimensions, and Wall Thicknesses for Roller Swaging
Figure 813/20-10-51-990-883 (Sheet 1 of 3)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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)

F16046 S0006561987_V2

Swage Torques, Sleeve Dimensions, and Wall Thicknesses for Roller Swaging
Figure 813/20-10-51-990-883 (Sheet 2 of 3)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SECTION OF ROLLER SWAGED JOINT

TUBE SIZE	TUBE DIMENSIONS "NOMINAL" WALL THICKNESS - INCHES 2		SWAGED JOINT WALL THICKNESS FOR "NOMINAL" TUBE WALLS - INCHES 1	
	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 2

1 "NOMINAL" WALL THICKNESS DEFINITION: TUBE WALL THICKNESS WITHOUT TOLERANCES AS SPECIFIED BY TUBE SPECIFICATION: AS5620/AMS4946 FOR Ti-3AL-2.5V AND BMS 7-185 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

F16047 S0006561988_V4

Swage Torques, Sleeve Dimensions, and Wall Thicknesses for Roller Swaging
Figure 813/20-10-51-990-883 (Sheet 3 of 3)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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

L97117 S0006402450_V2

Permitted Forming Limits for Electrical Rigid Conduits
Figure 814/20-10-51-990-899

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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.

1931831 S0000365197_V4

Tube Material and Fitting Selection Tables
Figure 815/20-10-51-990-900 (Sheet 1 of 2)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SEQ. NUMBER	DMC PART NUMBER	DESCRIPTION	PART DEFINITION	
			CONFIGURATION (CROSS-HATCHING INDICATES AXIAL SWAGE ENDS)	POST DESIGNATIONS
7	DAS5970T /AS5970T	FITTING ASSEMBLY, ELBOW 90 DEGREE, AXIALLY SWAGED, HYDRAULIC, 5080 psi		PORT NO. 1 = AXIAL SWAGE. PORT NO. 2 = AXIAL SWAGE.
8	DAS5792T /AS5792T	FITTING ASSEMBLY, STRAIGHT, FEMALE FLARELESS AXIALLY SWAGED, HYDRAULIC, 3000 psi		PORT NO. 1 = FEMALE FLARELESS END. PORT NO. 2 = AXIAL SWAGE END.
9	DAS5793T /AS5793T	FITTING ASSEMBLY, STRAIGHT, MALE FLARELESS AXIALLY SWAGED, HYDRAULIC, 3000 psi		PORT NO. 1 = MALE FLARELESS END. PORT NO. 2 = AXIAL SWAGE END.

2946818 S0000723356_V1

Tube Material and Fitting Selection Tables
Figure 815/20-10-51-990-900 (Sheet 2 of 2)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

TASK 20-10-51-300-809

5. Titanium Hydraulic Tubing, 3000 psi - Roll swaging Harrison 53211 Sleeves and 35212 Unions using the Harrison 6777 Swage Machine

A. General

(1) The sleeves, unions, and nuts used for this repair are listed in Figure 806, Table 807, Table 808, Table 809, Table 810, Figure 808, and Table 812.

(2) Get the necessary tools and dies as listed in the operating manual with the Harrison 6777 Swage Machine.

NOTE: This procedure does not apply to repair of aluminum and CRES tubing.

B. Procedure

SUBTASK 20-10-51-300-002

(1) Do the repair:

(a) Cut and chamfer tubes as shown in Figure 807. Length requirements are shown in Figure 808, Table 812, Figure 809, Figure 810, Table 806, Figure 811, Table 817 as applicable. 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 as illustrated in Figure 816.

(d) Use Swage Torques as shown in Figure 817.

(e) After swaging the tube ends, inspect the after-swage inside diameter of the tube end to the values specified in (Figure 816, Sheet 5). Also, 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 6000psi.

3) There shall be no leakage in proof testing.

4) If there is leakage, loosen and retighten the fitting. If leakage persists, remove the tube and inspect tube end and test fittings for defects.

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

Harrison Portable Swagers for BACS13BX Sleeves
Figure 816/20-10-51-990-905 (Sheet 1 of 5)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SIZE	EXPANDER ASSEMBLY	MANDREL (1)	ROLLERS (2)	CAGE (3)
-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 3AI-2.5V TITANIUM TUBING

TUBE O.D.	SET LENGTH "L" (INCHES) ±.005
-04	1.010
-06	1.205
-08	1.310
-10	1.382
-12	1.474
-16	1.600

TOOL ADJUSTMENT

HARRISON 6777 MACHINE

L19678 S0006402411_V2

Harrison Portable Swagers for BACS13BX Sleeves
Figure 816/20-10-51-990-905 (Sheet 2 of 5)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

TUBE AND SLEEVE DIA. INCHES	TWO HALF JAWS (4)	RETAINER (5)
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

L19679 S0006402412_V2

Harrison Portable Swagers for BACS13BX Sleeves
Figure 816/20-10-51-990-905 (Sheet 3 of 5)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

TUBE AND UNION DIA. INCHES	TWO HALF JAWS (6)
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

L19680 S0006402413_V2

Harrison Portable Swagers for BACS13BX Sleeves
Figure 816/20-10-51-990-905 (Sheet 4 of 5)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

NOTE:

I.D. AFTER SWAGE REQUIREMENTS-MEASURING METHOD FOR 35211 SLEEVE AND 35212 UNION

TUBE O.D./DASH NO.	TUBE WALL	TORQUE	I.D. AFTER SWAGE
TUBE MATERIAL: 3AI-2.5V TITANIUM PER AS5620/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

L19681 S0006402414_V4

Harrison Portable Swagers for BACS13BX Sleeves
Figure 816/20-10-51-990-905 (Sheet 5 of 5)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

TORQUE WRENCH DIAL - PROCEDURE TO READ TORQUE

TUBE SIZE	MATERIAL WALL THICKNESS - INCHES		SWAGE TORQUE (POUNDS-INCH)	
	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 AS5620/AMS4946
2 AS SPECIFIED IN SPECIFICATION BMS 7-185

L19690 S0006402419_V4

Swage Torques, Sleeve Dimensions, and Wall Thicknesses for Roller Swaging
Figure 817/20-10-51-990-906 (Sheet 1 of 3)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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)

L19691 S0006402420_V2

Swage Torques, Sleeve Dimensions, and Wall Thicknesses for Roller Swaging
Figure 817/20-10-51-990-906 (Sheet 2 of 3)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SECTION OF ROLLER SWAGED JOINT

TUBE SIZE	TUBE DIMENSIONS "NOMINAL" WALL THICKNESS - INCHES 2		SWAGED JOINT WALL THICKNESS FOR "NOMINAL" TUBE WALLS - INCHES 1	
	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 2

1 "NOMINAL" WALL THICKNESS DEFINITION: TUBE WALL THICKNESS WITHOUT TOLERANCES AS SPECIFIED BY TUBE SPECIFICATION: AS5620/AMS4946 FOR Ti-3AL-2.5V AND BMS 7-185 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

L19692 S0006402421_V4

Swage Torques, Sleeve Dimensions, and Wall Thicknesses for Roller Swaging
Figure 817/20-10-51-990-906 (Sheet 3 of 3)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

TASK 20-10-51-400-805

6. Install the CRYOLIVE Flareless Sleeve Assembly

A. General

WARNING	USE EXTREME CAUTION WHEN USING LIQUID NITROGEN. THE TEMPERATURE OF LIQUID NITROGEN IS 320 DEGREES BELOW ZERO (-195.5°C). PROVIDE PROPER VENTILATION AS LIQUID NITROGEN VAPORS CAN DISPLACE OXYGEN IN CONFINED AREAS. USE SAFETY GLASSES AND A FACE SHIELD WHEN USING LIQUID NITROGEN. MISUSE OF LIQUID NITROGEN CAN CAUSE INJURY TO PERSONS.

WARNING	SLOWLY AND CAREFULLY SUBMERGE WARM ITEMS IN LIQUID NITROGEN TO PREVENT RAPID BOILING OFF AND SPLASHING. MISUSE OF LIQUID NITROGEN CAN CAUSE INJURY TO PERSONS.

(1) The CRYOLIVE flareless sleeve, shown in Figure 806, Table 807, Table 808, Table 809, and Table 810 and Figure 819, is 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 in 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 cryolive flareless sleeve/coupling nut/protective cap assembly, STD-1353 can be used, as shown in Figure 806, Table 807, Table 808, Table 809, and Table 810 and Figure 819, with 304 1/8 hard CRES, Ti-3Al-2.5V and 21-6-9 CRES tube and 6061-T6 aluminum tube. 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 tube. 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 819 for approved Cryolive sleeve, coupling nut and plastic cap combinations.

Table 819/20-10-51-993-914 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 7075-T73 Al 6AL-4V Ti	921721J04 921721W04 921721T04

ECCN 9E991 BOEING PROPRIETARY - See title page for details

Table 819/20-10-51-993-914 CRYOLIVE Flareless Sleeve/Coupling Nut/Plastic Cap Combinations (Continued)

06	304 CRES 7075-T73 Al 6AL-4V Ti	921721J06 921721W06 921721T06
08	304 CRES 7075-T73 Al 6AL-4V Ti	921721J08 921721W08 921721T08
10	304 CRES 7075-T73 Al 6AL-4V Ti	921721J10 921721W10 921721T10
12	304 CRES 7075-T73 Al 6AL-4V Ti	921721J12 921721W12 921721T12
16	304 CRES 7075-T73 Al 6AL-4V Ti	921721J16 (Combination not Approved) 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.

(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
20-30-80-910-801	General Cleaning of Metal (Series 80) (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-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
B01000	Solvent - General Cleaning Of Metal (AMM 20-30-80) - Series 80	

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(Continued)

Reference	Description	Specification
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 20-10-51-800-009

(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 20-10-51-110-011

WARNING DO NOT GET SOLVENTS IN YOUR MOUTH, OR YOUR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM SOLVENTS. SOLVENTS ARE HAZARDOUS MATERIALS. SOLVENTS MAY BE FLAMMABLE OR HARMFUL TO THE ENVIRONMENT. REFER TO PRODUCT MATERIAL SAFETY DATA SHEETS (MSDS) AND LOCAL REQUIREMENTS FOR PROPER HANDLING PROCEDURES.

(3) Use Series 80 solvent, B01000 (TASK 20-30-80-910-801) to clean the tube in the area where you will install the cryolive flareless sleeve/coupling nut/protective cap assembly, STD-1353.

SUBTASK 20-10-51-800-010

(4) Put on the insulated gloves, COM-1355.

SUBTASK 20-10-51-880-001

WARNING USE EXTREME CAUTION WHEN USING LIQUID NITROGEN. THE TEMPERATURE OF LIQUID NITROGEN IS 320 DEGREES BELOW ZERO (-195.5°C). PROVIDE PROPER VENTILATION AS LIQUID NITROGEN VAPORS CAN DISPLACE OXYGEN IN CONFINED AREAS. USE SAFETY GLASSES AND A FACE SHIELD WHEN USING LIQUID NITROGEN. MISUSE OF LIQUID NITROGEN CAN CAUSE INJURY TO PERSONS.

WARNING SLOWLY AND CAREFULLY SUBMERGE WARM ITEMS IN LIQUID NITROGEN TO PREVENT RAPID BOILING OFF AND SPLASHING. MISUSE OF LIQUID NITROGEN CAN CAUSE INJURY TO PERSONS.

(5) Put nitrogen, G00262, into a small, insulated work box, COM-1356.

(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 20-10-51-420-026

(8) Install the cryolive flareless sleeve/coupling nut/protective cap assembly, STD-1353:

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(a) Using tongs, STD-1354, remove the CRYOLIVE flareless sleeve cryolive flareless sleeve/coupling nut/protective cap assembly, STD-1353 from the liquid nitrogen and allow the excess liquid nitrogen to run off.

WARNING DO NOT PUT GLOVED HAND IN LIQUID NITROGEN. THE LIQUID NITROGEN CAN "WICK" INTO THE GLOVE MATERIAL AND CAUSE INJURY TO YOUR HAND.

(b) Grasp the CRYOLIVE flareless sleeve 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 to warm and shrink on to the tube.

SUBTASK 20-10-51-540-001

CAUTION 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 PROTRUSION PER THE "P" DIMENSION REQUIREMENT OF (FIGURE 818). IF THE "P" DIMENSION IS INCORRECT, THE INSTALLATION MUST BE REPLACED.

(10) When ready to complete final joining/torquing of the coupling nut/CRYOLIVE flareless sleeve to the mating fitting, remove and discard the plastic cap by unscrewing the coupling nut. Refer to Table 819.

NOTE: The plastic caps are manufactured from polycarbonate material and can be recycled.

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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

[1] ALL EXCEPT SHORT FLARELESS
[2] SHORT FLARELESS

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Flareless Sleeve Tube End Values
Figure 818/20-10-51-990-907

ECCN 9E991 BOEING PROPRIETARY - See title page for details

NOTE:

REMOVAL OF PLASTIC CAP AFTER INSTALLATION.

L19732 S0006402440_V2

CRYOLIVE Flareless Sleeve Assembly
Figure 819/20-10-51-990-908

ECCN 9E991 BOEING PROPRIETARY - See title page for details

TASK 20-10-51-300-806

7. Swage the BACS13BX Flareless Sleeves with the Internal Elastomer Swage Equipment
(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-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. 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 20-10-51-940-022

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 20-10-51-640-003

(3) Apply a light layer of antiscoring lubricant 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.

(a) Make sure the tube and sleeve are clean and dry.

SUBTASK 20-10-51-340-002

(4) Apply the necessary swage pressure, shown in Figure 820, and hold the pressure for a minimum of two seconds.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

Table 820/20-10-51-993-915

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 Pressure (PSI)*[1] BACS13BX	Wall (in.)	Swage Pressure (PSI) ±5% BACS13BX	Wall (in.)	Swage Pressure (PSI) ±5% BACS13BX	Wall (in.)	Swage Pressure (PSI)*[1] BACS13BX	Wall (in.)	Swage Pressure (PSI)*[1] 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 portable and stationary swager.

*[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.

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SUBTASK 20-10-51-220-020

(5) Do a check of the groove depth with a Tiplar or Mueller bore gage (Figure 821).

SUBTASK 20-10-51-220-021

(6) Do a check on the external dimensions of the swaged fitting (Figure 820).

SUBTASK 20-10-51-220-022

(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 20-10-51-210-018

(8) Make sure the seal areas of the sleeves and unions are not scratched or damaged during fabrication.

SUBTASK 20-10-51-210-019

(9) Make sure each seal area keeps the usual finish specifications.

SUBTASK 20-10-51-220-023

(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. (0.051 mm) in height.

SUBTASK 20-10-51-220-024

(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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

DIMENSION	SIZE								
	04	05	06	08	10	12	16	20	24
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

DIMENSIONS OF FLARELESS TUBE ENDS AND BACS13BX SLEEVES AFTER ELASTOMERIC SWAGING

NOTE:

ALL DIMENSIONS ARE IN INCHES.

[1] ALL EXCEPT SHORT FLARELESS

[2] SHORT FLARELESS

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BACS13BX Flareless Sleeve Dimensions After Elastomeric Swaging
Figure 820/20-10-51-990-909

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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

NOTE:
ALL DIMENSIONS ARE IN INCHES (mm).

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Groove Depth Measurement for BACS13BX Sleeves
Figure 821/20-10-51-990-910

ECCN 9E991 BOEING PROPRIETARY - See title page for details

TASK 20-10-51-300-807

8. BACS13BX Flareless Sleeve Swaging on Stainless Steel and Titanium Hydraulic Tubing

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 #: 6633K-01 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 20-10-51-940-023

(2) Get the necessary tools as told in the operating instruction manual supplied with the tube swage kit, COM-1794.

SUBTASK 20-10-51-350-010

(3) Apply the necessary torque, shown in Figure 813, to the expander mandrel.

SUBTASK 20-10-51-220-025

(4) After you swage, make sure the BACS13BX sleeve and tube agree with the specifications of Figure 813.

(a) Do not trim the tube after you roller swage.

(b) If it is necessary, remove the burrs with an approved deburring tool.

SUBTASK 20-10-51-210-020

(5) Make sure the seal areas of the sleeves are not scratched or damaged during fabrication.

SUBTASK 20-10-51-210-021

(6) Make sure each seal area keeps the 63 RHR (no annular tool marks) finish specifications of its standard.

SUBTASK 20-10-51-220-026

(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.

SUBTASK 20-10-51-220-027

(8) Make sure the die marks on the external skirt and shoulder areas of the sleeves do not touch the nut.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SUBTASK 20-10-51-210-022

(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 20-10-51-300-808

9. BACS13AP Flareless Sleeve Preset

A. General

(1) We recommend you pressure preset and do not preset by hand. If you must preset by hand, we recommend 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 20-10-51-350-011

(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 822, Table 821).

ECCN 9E991 BOEING PROPRIETARY - See title page for details

Table 821/20-10-51-993-916 Preset Pressures for Cherry G-85 Lockbolt Gun with ST878D Presetting Tool Assembly

TUBE SIZE	WALL THICKNESS	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 822, Table 821).

(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 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 20-10-51-350-012

(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 823).

(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 822 and Table 823.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(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 822 and Table 823.

Table 822/20-10-51-993-917 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] Pound- Inches	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 823/20-10-51-993-918 Displacement Turns and Torque Values for Hand Preset of Flareless Sleeves - Aluminum Tubing

TUBE DIAMETER*[1]		1/4	4/16	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] Pound- Inches	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 20-10-51-220-028

(4) After you preset, make sure the BACS13AP sleeve and tube joint have the properties that follow (Figure 824):

(a) Corrosion resistant steel tubing (MIL-T-6845):

1) Make sure the sleeves have a maximum of 0.005 in. (0.127 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. (0.381 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. (0.127 mm) (Figure 824).

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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

ST878D TOOL ASSEMBLY

A

L19694 S0006402422_V2

Preset Pressures (PSI) for the Cherry G-85 Lockbolt Gun with ST878D Presetting Tool Assembly (BACS13AP Sleeves)
Figure 822/20-10-51-990-911

ECCN 9E991 BOEING PROPRIETARY - See title page for details

BEFORE PRESET BY HAND

AFTER PRESET BY HAND

L19696 S0006402424_V2

Preset by Hand with Preset Tool ST879A
Figure 823/20-10-51-990-912

ECCN 9E991 BOEING PROPRIETARY - See title page for details

ASSEMBLED AND PRESET SLEEVE

TUBE END DEFORMATION

1 MAKE SURE THE ID DOES NOT DECREASE MORE THAN 0.005 INCH AFTER PRESET OR 0.015 INCH AFTER YOU TIGHTEN MANY TIMES.

L19697 S0006402425_V2

Properties of Preset BACS13AP Flareless Sleeve/Tube End
Figure 824/20-10-51-990-913

ECCN 9E991 BOEING PROPRIETARY - See title page for details

TASK 20-10-51-400-806

10. BACC42W H-Coupling Installation

A. General

WARNING DO NOT USE BACC42W H-COUPLINGS ON ANY OXYGEN LINES OR ON FLUID LINES IN THE FIRE ZONES OF THE ENGINES OR APU'S. DAMAGE TO EQUIPMENT OR INJURY TO PERSONS 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 809).

B. References

Reference	Title
20-30-80-910-801	General Cleaning of Metal (Series 80) (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)
STD-1357	Assembly - Tube Coupling

D. Consumable Materials

Reference	Description	Specification
B01000	Solvent - General Cleaning Of Metal (AMM 20-30-80) - Series 80	

E. Procedure

CAUTION DO NOT TIGHTEN THE COUPLING ASSEMBLY BY HAND AFTER YOU REMOVE IT FROM THE SHIPPING CONTAINER OR BEFORE YOU INSTALL IT ON THE TUBE. THE COUPLING ASSEMBLY HAS NO MORE THAN ONE THREAD ENGAGED. YOU CAN COMPRESS THE UNION AND MAKE THE COUPLING ASSEMBLY DIFFICULT TO PUT IN POSITION.

SUBTASK 20-10-51-860-006

(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).

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SUBTASK 20-10-51-110-012

> **WARNING**
> DO NOT GET SOLVENTS IN YOUR MOUTH, OR YOUR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM SOLVENTS. SOLVENTS ARE HAZARDOUS MATERIALS. SOLVENTS MAY BE FLAMMABLE OR HARMFUL TO THE ENVIRONMENT. REFER TO PRODUCT MATERIAL SAFETY DATA SHEETS (MSDS) AND LOCAL REQUIREMENTS FOR PROPER HANDLING PROCEDURES.

(2) Use Series 80 solvent, B01000 (TASK 20-30-80-910-801) 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.

SUBTASK 20-10-51-350-013

(3) Cut the tube.

SUBTASK 20-10-51-110-013

(4) Chamfer and remove the burrs from the inside diameter and outside diameter edges..

SUBTASK 20-10-51-110-014

> **WARNING**
> DO NOT GET SOLVENTS IN YOUR MOUTH, OR YOUR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM SOLVENTS. SOLVENTS ARE HAZARDOUS MATERIALS. SOLVENTS MAY BE FLAMMABLE OR HARMFUL TO THE ENVIRONMENT. REFER TO PRODUCT MATERIAL SAFETY DATA SHEETS (MSDS) AND LOCAL REQUIREMENTS FOR PROPER HANDLING PROCEDURES.

(5) Clean the edges with Series 80 solvent, B01000 (TASK 20-30-80-910-801).

SUBTASK 20-10-51-940-024

(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 825).

SUBTASK 20-10-51-940-025

(7) Use the same measurements to make a mark (index line) on the coupling side of the tube.

SUBTASK 20-10-51-940-026

(8) Find and make a mark (marking dots) on the nut and coupling side of the tube (Figure 825).

NOTE: These marks will be used for the last inspection check (dimension "C").

SUBTASK 20-10-51-420-027

(9) Install the tube coupling assembly, STD-1357 over the coupling side of the tube.

SUBTASK 20-10-51-210-023

(10) Make sure the large radius and the large diameter end of the sleeve are toward the center of the union.

SUBTASK 20-10-51-420-028

(11) Install the nut and sleeve over the tape on the nut side of the tube.

SUBTASK 20-10-51-210-024

(12) Make sure the sleeve large bore is toward the clearance.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SUBTASK 20-10-51-820-012

(13) Align the tubes and move the union until it touches the tape on the nut side on the tube.

SUBTASK 20-10-51-210-025

(14) Make sure the union meets or cover the index line on the coupling side of the tube.

SUBTASK 20-10-51-940-027

(15) Install tape on the coupling side of the tube, with the tape edge even with the end of the union.

SUBTASK 20-10-51-420-029

(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 20-10-51-420-030

(17) Engage the threads of the nut with the coupling body and tighten the nut handtight.

SUBTASK 20-10-51-420-031

(18) Hold the coupling body with a wrench and tighten the coupling assembly nut to the stop.

SUBTASK 20-10-51-210-026

(19) Examine the completed repair to make sure you can see the two marking dots (Figure 825).

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 20-10-51-210-027

(20) Make sure dimension "C" did not increase.

SUBTASK 20-10-51-200-003

(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 (Figure 825).

(e) Install the nut again and tighten the nut. See BACC42W Standard.

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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

H-COUPLING (BEFORE INSTALLATION)

H-COUPLING (INSTALLED, TIGHTENED)

TUBE SIZE	DIMENSION A
04 THRU 10	1.440
12 THRU 16	1.740

NOTE:

USE THESE DIMENSIONS TO FINDDIMENSION C.

ALL DIMENSIONS ARE IN INCHES.

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H-Coupling Installation
Figure 825/20-10-51-990-919

ECCN 9E991 BOEING PROPRIETARY - See title page for details

TASK 20-10-51-400-807

11. 3P02111/3PHS111 Cryofit Coupling Installation

(Figure 826)

A. General

> **WARNING** DO NOT USE CRYOFIT COUPLINGS ON ANY OXYGEN LINES OR ON FLUID LINES INSIDE THE FIRE ZONES OF ENGINES OR APU'S. DAMAGE TO EQUIPMENT OR INJURY TO PERSONS CAN OCCUR.

> **WARNING** USE EXTREME CAUTION WHEN USING LIQUID NITROGEN. THE TEMPERATURE OF LIQUID NITROGEN IS 320 DEGREES BELOW ZERO (-195.5°C). PROVIDE PROPER VENTILATION AS LIQUID NITROGEN VAPORS CAN DISPLACE OXYGEN IN CONFINED AREAS. USE SAFETY GLASSES AND A FACE SHIELD WHEN USING LIQUID NITROGEN. MISUSE OF LIQUID NITROGEN CAN CAUSE INJURY TO PERSONS.

> **WARNING** SLOWLY AND CAREFULLY SUBMERGE WARM ITEMS IN LIQUID NITROGEN TO PREVENT RAPID BOILING OFF AND SPLASHING. MISUSE OF LIQUID NITROGEN CAN CAUSE INJURY TO PERSONS.

(1) The Cryofit coupling is a fitting which you can use to repair Ti-3AL-2.5V tubing as shown in (Figure 806, Table 807, Table 808, Table 809, and Table 810). To install the fitting in a straight section, shrink fit it in it's position.

B. References

Reference	Title
20-30-80-910-801	General Cleaning of Metal (Series 80) (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-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
B01000	Solvent - General Cleaning Of Metal (AMM 20-30-80) - Series 80	
G00262	Nitrogen - Liquid	A-A-59503 Type II, MIL-PRF-27401 Type II

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(Continued)

Reference	Description	Specification
G00270	Tape - Scotch Flatback Masking 250	ASTM D6123 (Supersedes A-A-883)

E. Procedure

SUBTASK 20-10-51-860-007

(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 20-10-51-110-015

WARNING

DO NOT GET SOLVENTS IN YOUR MOUTH, OR YOUR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM SOLVENTS. SOLVENTS ARE HAZARDOUS MATERIALS. SOLVENTS MAY BE FLAMMABLE OR HARMFUL TO THE ENVIRONMENT. REFER TO PRODUCT MATERIAL SAFETY DATA SHEETS (MSDS) AND LOCAL REQUIREMENTS FOR PROPER HANDLING PROCEDURES.

(2) Use Series 80 solvent, B01000 (TASK 20-30-80-910-801) to clean the tube in the area where you will install the Cryofit coupling cryofit repair kit, STD-4058.

SUBTASK 20-10-51-420-032

(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 20-10-51-320-002

(4) Cut the tube.

SUBTASK 20-10-51-350-014

(5) Chamfer and remove burrs from the inside diameter and outside diameter edges.

SUBTASK 20-10-51-110-016

(6) Clean the edges with Series 80 solvent, B01000 (TASK 20-30-80-910-801).

SUBTASK 20-10-51-110-017

(7) Apply a thin layer (one to two drops) of Loctite 290 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 20-10-51-110-018

WARNING

USE EXTREME CAUTION WHEN USING LIQUID NITROGEN. THE TEMPERATURE OF LIQUID NITROGEN IS 320 DEGREES BELOW ZERO (-195.55°C). PROVIDE PROPER VENTILATION AS LIQUID NITROGEN VAPORS CAN DISPLACE OXYGEN IN CONFINED AREAS. USE SAFETY GLASSES AND A FACE SHIELD WHEN USING LIQUID NITROGEN. MISUSE OF LIQUID NITROGEN CAN CAUSE INJURY TO PERSONS.

(9) Put nitrogen, G00262 into a small, insulated work box, COM-1356.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SUBTASK 20-10-51-110-019

> **WARNING** SLOWLY AND CAREFULLY SUBMERGE WARM ITEMS IN LIQUID NITROGEN TO PREVENT RAPID BOILING OFF AND SPLASHING. MISUSE OF LIQUID NITROGEN CAN CAUSE INJURY TO PERSONS.

(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 20-10-51-940-028

(11) Move the Cryofit coupling in the nitrogen, G00262 (-320° F) (-195.55°C) to the repair location.

SUBTASK 20-10-51-420-033

(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.

SUBTASK 20-10-51-480-004

(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. (3.048 mm) exists between the tube ends.

(b) For 3PHS111 couplings, make sure that the gap is less than 0.300 in. (7.620 mm).

SUBTASK 20-10-51-080-002

(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 20-10-51-480-005

(15) Place an installation stop ("O" ring) or SNAP-ON coupling in the middle of the mark on one of the tube ends.

SUBTASK 20-10-51-480-006

(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 20-10-51-820-013

(17) Adjust the tubes and installation stop as necessary.

(18) Remove the test coupling.

SUBTASK 20-10-51-420-034

(19) Make sure that the tube ends within half the coupling length of the end are free of scratches.

SUBTASK 20-10-51-840-005

(20) If a fitting must be installed over a tube end containing a scratch, apply a thin layer (one to two drops) of Loctite 290 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 20-10-51-840-006

(21) For a 3PO2111, remove a Cryofit coupling from the liquid nitrogen and immediately place it into a pre-chilled, extended time tool.

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(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 20-10-51-840-007

(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 20-10-51-420-035

(24) Install the coupling and following the steps below in rapid sequence:

(a) Remove the chiller.

(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 20-10-51-200-004

(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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SNAP-ON
INSTALLATION STOP

EXTENDED TIME TOOL

TONGS

O-RINGS INSTALLATION
STOP

CRYOFIT COUPLING INSTALLATION

NOTE:

CRYOFIT KITS INCLUDE ADDITIONAL ITEMS.

L19700 S0006402428_V2

Cryofit Coupling 3P02111 and 3PH5111 Repair
Figure 826/20-10-51-990-914 (Sheet 1 of 2)

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APPLICATION OF INSTALLATION MARK

INSTALLATION STOP

TUBE CHILLER APPLICATION

CORRECT POSITIONING OF CRYOFIT FITTING ON TUBE

ACCEPTABLE

UNACCEPTABLE

POSITION OF INSTALLED FITTING ON TUBE

NOTE:

CRYOFIT KITS INCLUDE ADDITIONAL ITEMS.

L19709 S0006402429_V3

Cryofit Coupling 3P02111 and 3PH5111 Repair
Figure 826/20-10-51-990-914 (Sheet 2 of 2)

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TASK 20-10-51-400-808

12. Externally Swaged (Permaswage) Fittings Installation

A. General

(1) To do the externally swaged fitting (Permaswage) repair procedure, use the DLT series swaging tool and one the following parts:

(a) BACU24BS or D10282 in-line tube unions (sizes 04, 06, 08, 10, 12, 16 and 20).

(b) BACA14BP or D10203 in-line tube unions (sizes 04, 06, 08, 10, 12, 16 and 20).

NOTE: BACA14BP or D10203 has both an swaged end and a flareless fitting end, to install the flareless fitting end, use this procedure: Flareless Fittings in Pressurized, Strut, Fuel Tank, and Cargo Areas Installation, TASK 20-10-51-000-802.

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) You can use CRES externally swaged (Permaswage) fittings, as shown in Figure 806, Table 807, Table 808, Table 809, and Table 810, with 304-1/8 hard CRES tube to repair Ti-3AL-2.5V and 21-6-9 CRES. You can make splice a repair of 21-6-9 and Ti-3AL-2.5V tube with 304-1/8 Hard tube of the wall thickness shown in Table 822, Table 823, Table 826. You can also make a splice repair of a Ti-3AL-2.5V tube with 21-6-9 tube of the wall thickness shown in Table 822, Table 823, Table 826. Repair 6061T6 aluminum tubing with aluminum fittings with D suffix in the basic part number.

(3) 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 Table 826 and Table 827.

(4) 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 829 (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 828.

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.

(5) DMC Permaswage Lightweight series (DLT Series) - Tool numbers are listed in Table 824. 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 824 (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 824/20-10-51-993-919 Swage and Inspection Tool Part Numbers

TUBE SIZE	SWAGE TOOL ASSEMBLY	SWAGE HEAD ASSEMBLY	POWER UNIT*[1]	INSPECTION GAGE

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Table 824/20-10-51-993-919 Swage and Inspection Tool Part Numbers (Continued)

04	DLTFRPSKT3300	DLT05PSHA3004	DLT05MAPW0000	D12-9892-04
06	DLTFRPSKT3300	DLT10PSHA3006	DLT10MAPW0000	D12-9892-06
08	DLTFRPSKT3300	DLT20PSHA3008	DLT20MAPW0000	D12-9892-08
10	DLTFRPSKT3300	DLT20PSHA3010	DLT20MAPW0000	D12-09892-10
12	DLTFRPSKT3300	DLT30PSHA3012	DLT30MAPW0000	D12-09892-12
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.

B. References

Reference	Title
20-10-51-000-802	Flareless Fittings in Pressurized, Strut, Fuel Tank, and Cargo Areas Installation (P/B 401)
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	Radial Swaged Tube Repair Kit, 3000 PSI, Permaswage Part #: DLTFRPSKT3300 (04 - 24 Tube) 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	
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 (3.81 l) oil resistant container, STD-203).

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SUBTASK 20-10-51-940-029

WARNING DO NOT USE PERMASWAGE FITTINGS ON OXYGEN LINES OR ON FLUID LINES IN FIRE ZONES OF ENGINES OR APU'S. DAMAGE TO EQUIPMENT OR INJURY TO PERSONS CAN OCCUR.

WARNING 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.

SUBTASK 20-10-51-940-035

(3) Use the tools, 3000 psi tube repair kit, SPL-541, shown in (Table 824).

SUBTASK 20-10-51-940-030

(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 827.

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. (12.7 mm)) or longer than 0.150 in. (3.81 mm), use a tube splice and two fittings to make the repair (Figure 827).

SUBTASK 20-10-51-940-031

(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 20-10-51-110-020

(6) Clean the tube in the swage area:

(a) Use an applicable solvent (for example, ethyl alcohol) 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 827.

(c) Remove paint and anodize from the tubes in an area equal to the values shown in Figure 827.

1) Use the methods shown in Table 825.

Table 825/20-10-51-993-920 Cleaning and Paint Removal Procedures for Aluminum Tubes

MATERIAL SURFACE	PROCEDURE TO CLEAN TUBE

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Table 825/20-10-51-993-920 Cleaning and Paint Removal Procedures for Aluminum Tubes (Continued)

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 20-10-51-940-032

(7) Remove the burrs from the tube ends:

(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 20-10-51-940-033

(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 829.

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 829.

(c) Swage fittings to the marks.

SUBTASK 20-10-51-370-004

(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 20-10-51-370-005

(10) Apply coating, C00064 to open areas of aluminum and primer, C00259 to all other tubes and fittings.

F. Procedure

SUBTASK 20-10-51-860-008

(1) Remove pressure from the system where you will do repairs, do this task: Hydraulic Reservoirs Depressurization, TASK 29-09-00-860-802.

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(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 20-10-51-940-034

(2) Use a union and a tube.

(a) For BACU24BS or D10282 reference Table 826.

Table 826/20-10-51-993-921 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
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.

(b) For BACA14BP or D10203 reference Table 827.

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Table 827/20-10-51-993-936 BACA14BP(D10203) 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
D10203-()*[2]	21-6-9 CRES	21-6-9 CRES	0.016	0.020	0.026	0.033	0.039	0.052	--
D10203-()*[2]	21-6-9 CRES	3AL-2.5V Ti	0.016	0.019	0.026	0.032	0.039	0.051	0.070
D10203-()*[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	--
D10203D()*[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
BACA14BP (SIZE)(SIZE)J*[2]	21-6-9	21-6-9 CRES	0.016	0.020	0.026	0.033	0.039	0.052	--
BACA14BP (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
BACA14BP (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	--
BACA14BP (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 BACA14BP (SIZE)(SIZE) J union (both sizes the same) and the D10203-(SIZE) union are interchangeable. In addition, the BACA14BP (SIZE)(SIZE) D union (both sizes the same) and D10203D (SIZE) D union are interchangeable.

NOTE: Keep the Permaswage fittings in their container until you are ready to install them.

SUBTASK 20-10-51-350-015

(3) Make sure the tube is sufficiently long to do the repair (Figure 827).

SUBTASK 20-10-51-110-021

(4) Clean the tube as shown in Table 825.

(5) Cut the tube.

(a) If you do not join the tube immediately, seal the tube ends with a cap.

SUBTASK 20-10-51-210-028

(6) Examine the unions for silicone seals (Table 826).

SUBTASK 20-10-51-420-036

(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 20-10-51-350-016

WARNING	DO NOT MAKE PUMP ADJUSTMENT THAT CAN CAUSE THE SWAGE-TOOL HYDRAULIC-PRESSURE TO BE MORE THAN RECOMMENDED BY MANUFACTURE. DLT SERIES TOOLS OPERATE AT 9750 PSI TO 10250 PSI MAXIMUM. IF PRESSURE IS MORE THAN ABOVE MAXIMUM AND MINIMUM VALUES, INJURY TO PERSONNEL OR DAMAGE CAN OCCUR.

(8) Swage the union to the tube as shown in the manufacturer's recommended procedures.

SUBTASK 20-10-51-350-017

(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 20-10-51-110-022

(10) Lubricate the head and lower die block regularly.

SUBTASK 20-10-51-210-029

(11) Examine the end plates for loose retaining screws.

SUBTASK 20-10-51-220-029

(12) Examine the finished swage as shown in the manufacturer's recommended procedure or measure with Vernier caliper for dimensions as shown in (Figure 830).

SUBTASK 20-10-51-760-008

(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 20-10-51-760-009

(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 20-10-51-210-030

(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 20-10-51-370-006

(17) Apply primer, C00259 to the Alodine areas of the finished tube joint where the bare metal is open.

SUBTASK 20-10-51-820-014

(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 20-10-51-820-015

(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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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 (mm).

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Minimum Straight Length for Permaswage Fitting Installation
Figure 827/20-10-51-990-915

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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 FIG. 829.

L19716 S0006402434_V2

Tube Splice Repair
Figure 828/20-10-51-990-916

ECCN 9E991 BOEING PROPRIETARY - See title page for details

DIMENSION (FIG. 827)	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

L19718 S0006402436_V2

Witness Mark Location and Usual Marking Procedures
Figure 829/20-10-51-990-917

ECCN 9E991 BOEING PROPRIETARY - See title page for details

TUBE DIAMETER (INCHES)	SWAGED DIAMETER MAX A DIMENSIONS (INCHES)	SWAGED LENGTH MIN B DIMENSIONS (INCHES)
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.

L19721 S0006402437_V3

Final Swage Dimensions
Figure 830/20-10-51-990-918

ECCN 9E991 BOEING PROPRIETARY - See title page for details

TASK 20-10-51-400-809

13. Axial Swage Fitting Union Installation (8,000 psi rated - Rynglok)

(Figure 831, Figure 832, Figure 833, Figure 834)

A. General

> **WARNING** DO NOT USE AXIAL SWAGE FITTINGS ON OXYGEN LINES. IF YOU USE AXIAL SWAGE FITTINGS ON OXYGEN LINES, DAMAGE TO EQUIPMENT AND INJURY TO PERSONNEL CAN OCCUR.

> **WARNING** 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 831), 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 808 and Table 812, 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 812, 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 829. Fittings and tubing material sizes are shown in Table 828.

Table 828/20-10-51-993-922 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						
		04	06	08	10	12	16	20

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Table 828/20-10-51-993-922 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 829/20-10-51-993-923 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)
29-09-00-860-802	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-1803	Swager - Rynglok Hydraulic Fitting Part #: RCSK8-02-004 Supplier: 00624 Part #: RCSK8-02-006 Supplier: 00624 Part #: RTSK8-02-006 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. Axial Swage Fitting Union Installation (8,000 psi rated - Rynglok)

SUBTASK 20-10-51-860-009

(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 that the section you cut out of the tube is a straight section with a minimum straight length as shown in Figure 812.

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 808 and Table 812.

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 812.

SUBTASK 20-10-51-110-023

(5) Clean the non-painted tube sections that you will repair with alcohol, B00068.

SUBTASK 20-10-51-370-007

(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 832, Figure 833, Figure 834).

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 833.

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

WARNING	MAKE SURE THAT THERE IS NO PUMP ADJUSTMENT THAT CAN CAUSE THE SWAGE TOOL TO BE MORE THAN WHAT THE MANUFACTURER RECOMMENDS. THE AEROQUIP RECOMMENDS THAT ITS TOOL OPERATE AT 8000 PSI TO 8500 PSI MAXIMUM. IF THE PRESSURE IS MORE THAN THIS VALUE, INJURY AND DAMAGE 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 sown in Figure 834 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.

SUBTASK 20-10-51-790-004

(14) Examine the tube-to-union interface for hydraulic leakage.

(a) If leakage is found, cut out the union and repair the tube by section replacement.

SUBTASK 20-10-51-370-008

(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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H79286 S0006562009_V2

Axial Swage Tube to Tube Union (5,000 psi Rated and 8,000 psi Rated)
Figure 831/20-10-51-990-920

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H79298 S0006562013_V4

Mark Location During Rynglok Fitting Installation
Figure 832/20-10-51-990-921

ECCN 9E991 BOEING PROPRIETARY - See title page for details

H79310 S0006562014_V3

Fitting Position for Tube Insertion
Figure 833/20-10-51-990-922

ECCN 9E991 BOEING PROPRIETARY - See title page for details

MINIMUM INSPECTION MARK AFTER SWAGING

MAXIMUM INSPECTION MARK AFTER SWAGING

H79312 S0006562015_V3

Use of Inspection Gage After Swage of Axial Swage Fittings (5,000 psi Rated or 8,000 psi Rated - Rynglok)
Figure 834/20-10-51-990-923

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TASK 20-10-51-400-810

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 AXIAL SWAGE FITTINGS ON OXYGEN LINES. IF YOU USE AXIAL SWAGE FITTINGS ON OXYGEN LINES, 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 (Figure 831), 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.

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 less than the tube cutout length dimension illustrated in Figure 808 and listed in Table 812, use one Axial Swage union fitting for repair.

(8) If the tube damage is longer than the tube cutout length dimension illustrated in Figure 808 and listed in Table 812, 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).

(a) The splice must be equal to or slightly shorter than the removed tube section.

(b) The minimum length of tubing to be removed is shown in Table 829.

(9) Fittings and tubing material sizes are shown in Table 830.

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Table 830/20-10-51-993-924

DMC PART NUMBER	FOR USE WITH TUBE MATERIALS	APPROVED TUBE SIZES OD/WALL (IN.)					
		04	06	08	10	12	16
Titanium Material: AS5969T()()BD Tube-to-Tube Union. AS5792T()()BD Female Adapter. AS5793T()()BD Male Adapter. AS6322T()()BD and AS6322T()()EBD Tube-to-Tube Union.	21-6-9 CRES	0.016 in. (0.406 mm)	0.020 in. (0.508 mm)	0.026 in. (0.660 mm)	0.032 in. (0.813 mm)	0.039 in. (0.991 mm)	0.052 in. (1.321 mm)
	3AL-2.5V Titanium	0.016 in. (0.406 mm)	0.019 in. (0.483 mm)	0.026 in. (0.660 mm)	0.033 in. (0.838 mm)	0.039 in. (0.991 mm)	0.051 in. (1.295 mm)
	6061–T6 Aluminum	0.028 in. (0.711 mm)	0.035 in. (0.889 mm)	0.035 in. (0.889 mm)	0.035 in. (0.889 mm)	0.035 in. (0.889 mm)	0.049 in. (1.245 mm)

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 - Tube Repair, Axial Swage, w/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)

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E. Procedure

SUBTASK 20-10-51-860-012

(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.

1) An example of a suitable container is a 1 U.S.-gal (3.81 l) oil resistant container, STD-203.

SUBTASK 20-10-51-800-011

(2) Use the tools contained in axial tube repair kit, COM-8946.

NOTE: The COM-8946 tool kit contains sizes 04 through 20. However, only sizes 04, 06, 08, 10, and 12 are applicable to 737NG 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 as shown in Figure 812.

NOTE: This will make sure the fitting and the swage tool will fit.

(b) If the damage is shorter than the dimensions listed in Figure 808, Table 812, use one Axial Swage union (5,000 psi rated) for the repair.

(c) If the damage is within the dimensions listed in Figure 808, Table 812, the cut can be through the center of the damaged section.

SUBTASK 20-10-51-150-002

(4) Remove the paint and the anodize from the tubes to the dimensions shown in Figure 812.

SUBTASK 20-10-51-100-001

(5) Clean the non-painted tube sections that you will repair with alcohol, B00068.

SUBTASK 20-10-51-800-012

(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 20-10-51-930-004

(8) Apply positioning and inspection marks on the tube to be repaired using the appropriate gage from the axial tube repair kit, COM-8946 and a Sanford Sharpie (or equivalent) felt tip pen with a fine or extra-fine point.

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) See Figure 832, Figure 833, and Figure 834.

(b) 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.

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SUBTASK 20-10-51-400-002

(10) Put the edge of the fitting ring over the center of the positioning mark (nominal tube insertion) as shown in Figure 833.

(a) Make sure that the edge of the fitting ring is anywhere along the length of the positioning mark.

NOTE: Nominal position is recommended.

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 20-10-51-211-002

(13) Examine the finished installation for correct ring advancement.

(a) Use the appropriate size inspection gage from the axial tube repair kit, COM-8946.

1) The inspection gage should fit over the ring area as shown in Figure 834.

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 (Hydraulic Reservoirs Pressurization, TASK 29-09-00-860-801).

END OF TASK

LOM 422-434, 437-447, 450-999

TASK 20-10-51-400-811

15. Axial Swage Fitting Installation (5,000 psi rated - Shape, Elbow and Tee)

(Figure 808, Figure 831, Figure 832, Figure 833, Figure 834)

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.

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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 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.

(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 830 and illustrated in Figure 815, in sizes 04, 06, 08, 10, and 12 are used with 3Al-2.5V titanium tubing and 21-6-9 CRES tubing.

NOTE: The axial tube repair kit, COM-8946, tool kit contains sizes 04 through 20. However, only sizes 04, 06, 08, 10, and 12 are applicable to 737NG 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.

WARNING DO NOT USE AXIAL SWAGE FITTINGS ON OXYGEN LINES. IF YOU USE AXIAL SWAGE FITTINGS ON OXYGEN LINES, 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.

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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 - Tube Repair, Axial Swage, w/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. Axial Swage Fitting Installation (5,000 psi rated - Shape, Elbow and Tee)

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 20-10-51-350-019

(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 812.

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 (Figure 808, Figure 831).

SUBTASK 20-10-51-020-007

(4) Remove the fittings, the tube assembly, and the cut tube section as an assembly.

SUBTASK 20-10-51-800-013

(5) Discard the fittings, the tube assembly, and the cut tube section.

SUBTASK 20-10-51-800-014

(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 20-10-51-420-039

(7) Tighten the swivel nuts hand-tight.

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LOM 422-434, 437-447, 450-999 (Continued)

SUBTASK 20-10-51-420-040

(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 20-10-51-420-041

(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.

(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.

LOM ALL

——— END OF TASK ———

TASK 20-10-51-350-802

16. Hydraulic Tubing Repair with Flexible Hoses

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 at the earliest practical maintenance opportunity.

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
20-10-52-400-801	Flexible Hose Installation (P/B 401)
29-09-00-860-802	Hydraulic Reservoirs Depressurization (P/B 201)

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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 Opt Part #: 65-92528-1 (Spares Kit) Supplier: 81205

D. Install the Flexible Hose

(Figure 835)

CAUTION DO NOT LET PUMPS, VALVES, ACTUATORS OR OTHER COMPONENTS HANG FROM KEVLAR HOSES. KEVLAR HYDRAULIC HOSES KINK EASILY AND CAN CAUSE LEAKAGE.

NOTE: Kevlar hydraulic hoses kink more easily than Corrosion Resistant Steel (CRES) 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 (1 ¼ in. (31.75 mm)).

SUBTASK 20-10-51-220-030

(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 (Table 831) 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 835).

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.

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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 831).

Table 831/20-10-51-993-864 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	⅜ in. (9.52 mm)	2.50 in. (63.5 mm)
AS115-08	½ in. (12.7 mm)	2.88 in. (73.15 mm)
AS115-10	⅝ in. (15.88 mm)	3.25 in. (82.55 mm)
AS115-12	¾ in. (19.05 mm)	4.00 in. (101.6 mm)
AS4568-16	1 in. (25.4 mm)	7.50 in. (190.5 mm)
AS4568-20	1¾ in. (44.45 mm)	15.00 in. (381 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 832).

Table 832/20-10-51-993-865 Minimum Hose Bend Clearance

HOSE CLEARANCE TO	MINIMUM CLEARANCE
Control Cables and Linkages	1 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 20-10-51-860-010

(2) For the hydraulic system where you will do the repair, do this task: Hydraulic Reservoirs Depressurization, TASK 29-09-00-860-802.

SUBTASK 20-10-51-960-003

(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 20-10-51-300-805.

SUBTASK 20-10-51-960-004

(4) If the damaged tube is too long to replace by a flexible hose, do the steps that follow:

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(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 20-10-51-420-037

(5) Do this task: Flexible Hose Installation, TASK 20-10-52-400-801.

SUBTASK 20-10-51-860-011

(6) Supply the usual operating pressure to the repaired tube.

SUBTASK 20-10-51-210-031

(7) Examine the hose and connections for leaks.

SUBTASK 20-10-51-220-031

(8) Make sure the repair agrees with all specifications for slack, flex, twisting, bending, clearance, and support.

END OF TASK

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SLACK

FLEX

TWISTING

L19726 S0006402438_V2

Hydraulic Tubing Repair with Flexible Hose
Figure 835/20-10-51-990-924 (Sheet 1 of 2)

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BENDING

CLEARANCE

L19731 S0006402439_V2

Hydraulic Tubing Repair with Flexible Hose
Figure 835/20-10-51-990-924 (Sheet 2 of 2)

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TASK 20-10-51-300-810

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

> **WARNING** 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
20-10-09-400-801	Control Cable Pulleys Installation (P/B 401)
20-50-11-910-801	Standard Torque Values (P/B 201)

C. Procedure

SUBTASK 20-10-51-300-003

(1) Do the repair:

(a) 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.

(b) Refer to Figure 808 and Table 812 to find the necessary tube cutout length when you use a single flareless MS21902 union to replace a damaged tube area.

(c) To use assembled tube ends or a center section to do a repair, find the cutout length and install as follows:

1) Make an estimate of the total length (L1) of the 6061–T6 aluminum tube repair section necessary to replace the damaged tube (Figure 809, Figure 811).

2) Cut and trim the repair tube as follows: (Figure 807)

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.

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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.

3) Swage the necessary flareless BACS13BX sleeves to the repair tube using the applicable section: Swage BACS13BX Flareless Sleeves with the Harrison Elastomer Swagers 5175, 5570, 5720.

4) Assemble and tighten the flareless fittings which are part of the repair section (TASK 20-10-09-400-801).

5) Measure all of the tube assembly length with BACS13BX sleeves (L1) (Figure 809, Figure 811).

6) To find the necessary cutout length (L2) as shown in Figure 809, Figure 811, use the procedure given in Table 817 for BACS13BX sleeves and Harrison Portable Swagers with MS21902 unions.

7) Remove the pressure from the systems where you will do the repairs.

8) Cut out the damaged tube (L2). Trim the tube ends as shown in Figure 807.

9) When you make the installation, refer to the section: "Swage the BACS13BX flareless sleeves with the Harrison Elastomer Swagers 5175, 5570, 5720".

10) Install the repair section and tighten the nuts, do this task: Standard Torque Values, TASK 20-50-11-910-801.

END OF TASK

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)

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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 20-10-51-930-001

(1) Rubber Stamp Method

(a) Clean the tube surface with solvent, B50095.

1) Remove oxide from the tubing surface with abrasive mat, G00251.

(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 a stamp pad, G50410.

3) Apply the part number to the tube surface with the stamp.

(d) Apply a clear coating, C00033.

SUBTASK 20-10-51-930-002

(2) Hand letter 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) Use a 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 locations that follow.

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 20-10-51-930-003

> **CAUTION** 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 the 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 the adhesive tape, G50393.

(c) Attach the 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.

> **CAUTION** 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 837

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.

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B. Possible Scenario 1 (Tube-to-Tube Splice)

(1) Repair Damage on Tube Near Aileron Centering Mechanism on the Rear Spar

(a) Prepare for the Repair

1) Identify the damaged tube and the parts necessary to do the repair.

a) Locate the damaged area.

b) 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).

c) Follow the tube in both directions to determine where you can make a splice using AS5969T/DAS5969T axial swage fittings.

<1> 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.

<2> 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.

<3> See Figure 836 for the splice locations.

d) Determine where to cut the 272A4451-1009 tube.

e) Determine what parts and tooling are needed to do the repair.

<1> Required Fittings (New)

<a> AS5969T0606/DAS5969T0606 Tube-to-Tube Union (two)

<2> Required Tubes (New)

<a> 272A4451-1009 (one)

<3> Required Tools

<a> See Table 807 for the required tooling.

(b) Remove the Damaged Tube Section

1) Remove pressure from the hydraulic system.

2) Cut the 272A4451-1009 tube.

a) Loosen or remove tube support clamps, as necessary, to cut the tube for splicing.

b) Cut the tube in two places, approximately halfway between the bends.

3) Remove the cut portion of the tube.

a) Loosen or remove tube support clamps (as necessary).

b) Keep the damaged tube for reference.

4) Deburr and chamfer the tube ends that are still connected to the airplane structure.

5) 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).

6) Cut the new 272A4451-1009 tube.

a) Use the damaged 272A4451-1009 tube that was removed from the airplane as a template.

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b) Deburr and chamfer the new 272A4451-1009 tube.

c) Make witness marks on the new tube (see FLARELESS TUBING ASSEMBLY - REPAIRS, 20-10-51/801 and the fitting manufacturer's instructions).

(c) Do the Repair

1) Slide the AS5969T0606/DAS5969T0606 union fittings on the ends of the 272A4451-1009 tubes that are attached to the airplane structure.

2) Slide the new 272A4451-1009 tube section into the AS5969T0606/DAS5969T0606 union fittings.

3) Reinstall and tighten any support clamps that were removed from 272A4451-1009.

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.

b) Make sure that there is no preload on the new 272A4451-1009 tube when the support clamps are tightened.

c) Make sure that there is enough clearance to the adjacent tubes or the structure.

4) 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.

5) 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.

6) Swage the AS5969T0606/DAS5969T0606 union fitting to the 272A4451-1009 tube that is attached to the airplane structure and the new 272A4451-1009 tube.

a) Swage one fitting end at a time.

b) Use FLARELESS TUBING ASSEMBLY - REPAIRS, 20-10-51/801 and the tool manufacturer's instructions.

c) Make sure that fitting is centered on the tube ends at both sides of the joint.

d) Make sure that the tube and fitting remain in position to the witness marks and the clocking marks.

7) 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.

8) 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.

a) Swage one fitting end at a time.

b) Use FLARELESS TUBING ASSEMBLY - REPAIRS, 20-10-51/801 and the tool manufacturer's instructions.

c) Make sure that fitting is centered on the tube ends at both sides of the joint.

d) Make sure that the tube and fitting remain in position to the witness marks and the clocking marks.

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9) After the swaging is complete, do the steps that follow.

a) Make sure that the fittings are correctly installed.

<1> 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.

b) Reinstall any loose support clamps.

<1> Make sure that all support clamps are in place and secure at each location on the tube.

<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.

10) Pressurize the hydraulic system.

11) Do a leak check.

C. Possible Scenario 2 (Replacement of Elbow, Tee Adapter, and Two Tube Sections)

(1) Repair Damage at Bend in Tube of P/N 272A4453–1007

(a) Prepare for the Repair

1) Required Tooling

a) DMC Tooling for Axially Swaged 5,000 psi rated fittings, sizes 04 and 06.

2) Required Fittings (New)

a) AS5801T0404/DAS5801T0404 Elbow, Axial Swage to flareless swivel.

b) AS5806T060406/DAS5806T060406 Tee, Axial Swage on run to flareless swivel.

c) AS5969T0606/DAS5969T0606 Union, Axial Swage, tube-to-tube.

3) Required Tubes (New)

a) Tube P/N 272A4453–1007 (no end fittings)

b) Tube P/N 272A4453–1001 (no end fittings)

(b) Procedure

1) Remove pressure on the hydraulic system.

2) Remove the old components.

a) Back off swivel nuts on AS5801T0404/DAS5801T0404 and AS5806T060406DAS5806T060406 fittings.

b) Cut tube P/N 272A4453–1001 in a straight section.

c) Remove, as an assembly, the fittings, the -1007 tube, and the cut section of the -1001 tube.

d) Discard the fittings, the -1007 tube, and the cut section of the -1001 tube.

3) Install the new components.

a) Put the new fittings, the -1007 tube, and the support clamps in place.

<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.

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b) Hand-tighten the swivel nuts.

c) Cut an appropriate section of new -1001 tube to replace the cut section.

d) Put the new section of the -1001 tube in place.

e) Splice the tube with AS5969T tube-to-tube union.

f) Torque the swivel nuts on the fittings.

<1> Use a backup wrench on the fitting wrench pad.

g) Secure the tube support clamps.

<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.

h) Swage the parts using the tool manufacturer's instructions.

(c) Pressurize the system.

(d) Do a leak check of the system.

D. Possible Scenario 3 (Replacement of Permanent Tee Fitting and Three Tube Sections)

(1) Repair Damage in Main Landing Gear Wheel Well Pressure Deck

(a) Prepare for the Repair

1) Identify the damaged tube, the parts, and the tooling necessary to do the repair.

a) Locate the damaged area.

b) Identify the tube as part number 272A4452-1029 (0.375 in. (10 mm) diameter and 0.019 in. (0.483 mm) diameter).

c) Follow the tube in both directions to determine where you can make a splice.

NOTE: 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 812 and Figure 816).

<1> 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.

<2> 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 812 and Figure 816). Replace the tee fitting and portions of tubes 272A4452-1001, 272A4452-1026, and 272A4452-1029 using splice repairs in straight sections of each tube.

d) Determine where to cut each tube that will be replaced.

<1> The 272A4452-1001 tube: cut approximately halfway (forward to aft direction) along the straight length before the bend.

<2> The 272A4452-1026 tube: cut approximately halfway between the support clamps that hold the 272A4452-1026 and 272A4452-1029 tubes.

<3> 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.

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e) Determine the parts and tools that will be required to replace the tubes and fittings.

<1> Required Tooling

<a> See Table 807 for required tooling.

<2> Required Fittings (New)

<a> AS5972T060606/DAS5972T060606 Tee (one)

<b> AS5969T0606/DAS5969T0606 Tube-to-Tube Union (three)

<3> Required Tubes (New)

<a> 272A4452-1001 (no end fittings)

<b> 272A4452-1026 (no end fittings)

<c> 272A4452-1029 (no end fittings)

(b) Remove the Damaged Tube Section

1) Remove pressure from the hydraulic system.

2) Tag each tube run outside of the sections that will be removed.

3) Loosen or remove tube support clamps (as necessary).

a) For 272A4452-1026 Tube:

<1> Remove and retain the support clamps along the portion of the tube to the left.

<2> 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.

b) For 272A4452-1029 Tube:

<1> Remove and retain the support clamps along the portion of the tube to the left.

<2> 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.

4) Cut each tube that you will replace.

a) Cut one tube at a time.

b) Tag each tube run after you remove each tube section.

c) 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.

(c) Do the Repair

1) Remove the 272A4452-1026 tube.

NOTE: Remove this tube first. This will allow access to the 272A4452-1029 tube.

a) Remove the support clamps (as necessary).

b) Move the tube away from the structure.

c) Cut the tube approximately halfway between the support clamp locations.

d) 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.

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e) Remove the cut portion of the tube.

<1> Save this section of tube for reference.

f) Deburr and chamfer the part of the 272A4452-1026 tube that is still attached to the airplane structure.

g) Make witness marks (see FLARELESS TUBING ASSEMBLY - REPAIRS, 20-10-51/801 and the fitting manufacturer's instructions).

h) Mark and cut a new section of 272A4452-1026 tubing.

<1> Use the cut section of tubing that was removed from the airplane to determine where the new tube should be cut.

<2> Use the Axial Swage Fitting Installation (5,000 psi rated - Union) or Male/Female Adapter Fittings, TASK 20-10-51-400-810 for making a splice repair with a AS5969T0606/DAS5969T0606 union.

<3> Deburr and chamfer both ends of the new tube section.

<4> 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).

2) Remove the 272A4452-1029 tube.

a) Remove the support clamps (as necessary).

b) Move the tube away from the structure.

c) Cut the tube approximately halfway between the support clamp locations.

d) 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.

e) Remove the cut portion of the tube.

<1> Save this section of tube for reference.

f) Deburr and chamfer the part of the 272A4452-1029 tube that is still attached to the airplane structure.

g) Make witness marks (see FLARELESS TUBING ASSEMBLY - REPAIRS, 20-10-51/801 and the fitting manufacturer's instructions).

h) Mark and cut a new section of 272A4452-1029 tubing.

<1> Use the cut section of tubing that was removed from the airplane to determine where the new tube should be cut.

<2> Use the Axial Swage Fitting Installation (5,000 psi rated - Union) or Male/Female Adapter Fittings, TASK 20-10-51-400-810 for making a splice repair with a AS5969T0606/DAS5969T0606 union.

<3> Deburr and chamfer both ends of the new tube.

<4> 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).

3) Remove the 272A4452-1001 tube.

a) Remove the support clamps (as necessary).

b) Move the tube away from the structure.

c) Cut the tube at the locations shown in FIGURE.

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d) Remove the AS5972T060606/DAS5972T060606 tee fitting and the cut portion of the tube.

<1> Save this section of tube for reference.

e) Deburr and chamfer the part of the 272A4452-1001 tube that is still attached to the airplane structure.

f) Make witness marks (see FLARELESS TUBING ASSEMBLY - REPAIRS, 20-10-51/801 and the fitting manufacturer's instructions).

g) Mark and cut a new section of 272A4452-1001 tubing.

<1> Use the cut section of tubing that was removed from the airplane to determine where the new tube should be cut.

<2> Use the Axial Swage Fitting Installation (5,000 psi rated - Union) or Male/Female Adapter Fittings, TASK 20-10-51-400-810 for making a splice repair with a AS5969T0606/DAS5969T0606 union.

<3> Deburr and chamfer both ends of the new tube section.

<4> 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).

(d) Pre-assemble the tubes and fittings.

1) 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.

2) Slide the replacement 272A4452-1029 tube section into the AS5969T06060/DAS5969T0606 union that is on the remaining section of 272A4452-1029 section that is attached to the airplane structure.

3) 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.

4) Slide the side leg of the new AS5972T060606/DAS5972T060606 tee fitting on the end of the new 272A4452-1026 tube.

5) Slide the free end of the new 272A4452-1029 tube into one run leg of the new AS5972T060606/DAS5972T060606 tee fitting.

6) Slide the forward end of the new 272A4452-1001 tube into the AS5972T060606/DAS5972T060606 tee fitting.

7) Reinstall and tighten the support clamps on the 272A4452-1001, 272A4452-1026, and 272A4452-1029 tubes.

a) Make sure the AS5972T060606/DAS5972T060606 tee fitting stays in position.

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.

8) On the new 272A4452-1001, 272A4452-1026, and 272A4452-1029 tubes, mark the position of the AS5969T0606/DAS5969T0606 union.

a) Make a felt tip mark across each fitting and tube.

NOTE: This will indicate the correct clocking during final installation.

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b) Make sure that the new AS5972T060606/DAS5972T060606 tee fitting, AS5969T0606/DAS5969T0606 union fittings, and the replacement tubes are in the correct position.

<1> Make sure that they are correctly routed with no clearance issues and with no preload introduced.

9) Mark the position of the AS5972T060606/DAS5972T060606 tee fitting on the 272A4452-1001, 272A4452-1026, and 272A4452-1029 tubes.

a) Make a felt tip mark across each fitting and tube.

NOTE: This will indicate the correct clocking during final installation.

(e) Do the final installation of the tubes and fittings.

1) Remove the 272A4452-1026 and 272A4452-1029 tube sections.

a) Loosen and remove the clamps on the 272A4452-1026 and 272A4452-1029 tubes (as necessary).

<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.

b) Remove the end of the 272A4452-1026 tube from the AS5972T060606/DAS5972T060606 tee fitting.

<1> Swing the 272A4452-1026 tube to allow access to the 272A4452-1029 tube for swaging.

c) Remove the end of 272A4452-1029 tube from the AS5972T060606/DAS5972T060606 tee fitting.

<1> Move the tube away from the stringer far enough to allow for access to swage the tube to the AS5969T0606/DAS5969T0606 union fitting.

2) Swage the fittings to 272A4452-1029 tube section.

a) 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.

<1> Make sure that the fitting is centered on the tube ends at both sides of the joint.

b) Swage the fitting using Axial Swage Fitting Installation (5,000 psi rated - Union) or Male/Female Adapter Fittings, TASK 20-10-51-400-810 and the fitting manufacturer's instructions.

c) Position the AS5969T0606/DAS5969T0606 union fitting to the witness marks and to the clocking mark on the end of the new 272A4452-1029 tube.

<1> Make sure that the fitting is centered on the tube ends at both sides of the joint.

d) Swage the fitting using Axial Swage Fitting Installation (5,000 psi rated - Union) or Male/Female Adapter Fittings, TASK 20-10-51-400-810 and the fitting manufacturer's instructions.

e) Position the end of the 272A4452-1029 tube into the forward end of the AS5972T060606/DAS5972T060606 tee fitting.

f) Reposition the AS5972T060606/DAS5972T060606 tee and the 272A4452-1026 and the 272A4452-1029 tubes.

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g) Reposition and tighten the support clamps on the straight portions to the left on the 272A4452-1026 and 272A4452-1029 tubes.

<1> Make sure that you do not tighten the forward support clamp on the 272A4452-1029 tube.

<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.

3) Swage the fittings to the 272A4452-1026 tube section.

a) Reposition the end of the 272A4452-1026 tube into the side leg of the AS5972T060606/DAS5972T060606 tee fitting.

b) 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.

c) Swage the DAS5969T0606 union and 272A4452-1026 tube.

<1> Move the 272A4452-1026 tube away from the airplane structure if necessary for access.

<2> Use Axial Swage Fitting Installation (5,000 psi rated - Union) or Male/Female Adapter Fittings, TASK 20-10-51-400-810 and the fitting manufacturer's instructions.

d) Position the AS5969T0606/DAS5969T0606 union fitting to the witness marks and the clocking mark on the end of the new 272A4452-1026 tube.

<1> Make sure that the AS5972T060606/DAS5972T060606 tee fitting is in the correct position at the end of the 272A4452-1026 tube.

e) Swage the AS5969T0606/DAS5969T0606 union and 272A4452-1026 tube.

<1> Use Axial Swage Fitting Installation (5,000 psi rated - Union) or Male/Female Adapter Fittings, TASK 20-10-51-400-810 and the fitting manufacturer's instructions.

4) Swage the fittings to the 272A4452-1001 tube section.

a) Position the AS5972T060606/DAS5972T060606 tee fitting to the witness marks and clock position mark on the 272A4452-1029 tube.

b) Position the AS5972T060606/DAS5972T060606 tee fitting to the witness marks and clock position mark on the 272A4452-1026 tube.

c) 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.

d) Make sure that the opposite end of the 272A4452-1001 tube is correctly positioned in the AS5972T060606/DAS5972T060606 tee fitting.

e) Swage the AS5969T0606/DAS5969T0606 union fitting and the 272A4452-1001 tube that is attached to the airplane structure.

<1> Use Axial Swage Fitting Installation (5,000 psi rated - Union) or Male/Female Adapter Fittings, TASK 20-10-51-400-810 and the fitting manufacturer's instructions.

f) Position the new 272A4452-1001 tube to the clocking mark on the AS5972T060606/DAS5972T060606 tee fitting.

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g) Position the new AS5969T0606/DAS5969T0606 union fitting to the witness marks and the clocking mark on the new 272A4452-1001 tube.

h) Swage the AS5969T0606/DAS5969T0606 union fitting and the new 272A4452-1001 tube.

<1> Use Axial Swage Fitting Installation (5,000 psi rated - Union) or Male/Female Adapter Fittings, TASK 20-10-51-400-810 and the fitting manufacturer's instructions.

i) Position the AS5972T060606/DAS5972T060606 tee fitting to the fitting marks and the clocking position mark on the 272A4452-1001 tube.

j) Swage the AS5972T060606/DAS5972T060606 tee fitting and the 272A4452-1001 tube.

<1> Use Axial Swage Fitting Installation (5,000 psi rated - Union) or Male/Female Adapter Fittings, TASK 20-10-51-400-810 and the fitting manufacturer's instructions.

5) After the swaging is complete, do the steps that follow.

a) Make sure that the fittings are correctly installed.

<1> 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.

b) Reinstall any loose support clamps.

<1> Make sure that all support clamps are in place and secure at each location on each tube.

<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.

c) Remove any tagging used for marking the tubes for installation.

6) Pressurize the hydraulic system.

7) Do a leak check.

END OF TASK

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Scenario 1
Figure 836/20-10-51-990-866 (Sheet 1 of 2)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

Scenario 1
Figure 836/20-10-51-990-866 (Sheet 2 of 2)

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1931675 S0000365353_V5

Scenario 2
Figure 837/20-10-51-990-865

ECCN 9E991 BOEING PROPRIETARY - See title page for details

Scenario 3
Figure 838/20-10-51-990-867

ECCN 9E991 BOEING PROPRIETARY - See title page for details

FLEXIBLE HOSE - MAINTENANCE PRACTICES

1. General

A. This task gives maintenance practices for hydraulic hoses.

TASK 20-10-52-211-801

2. CRES Hydraulic Hose - Examination

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.

SUBTASK 20-10-52-960-001

(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 use the procedure FLEXIBLE HOSE - REMOVAL/INSTALLATION, PAGEBLOCK 20-10-52/401.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SUBTASK 20-10-52-960-002

(3) Replace hoses if two or more wires in one plait are broken, or if several wires are broken in the same area. [See 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 use the procedure FLEXIBLE HOSE - REMOVAL/INSTALLATION, PAGEBLOCK 20-10-52/401.

SUBTASK 20-10-52-210-004

(4) Special attention must be given to examine the sleeve and wire braid for damage at the hose end (hose-to-fitting transition). Any hose end sleeve damage such as chafing, cracking, bird caging, etc. is subject for hose replacement.

(a) To replace the hose use the procedure FLEXIBLE HOSE - REMOVAL/INSTALLATION, PAGEBLOCK 20-10-52/401.

SUBTASK 20-10-52-960-003

(5) Replace hoses that have damaged fire sleeves (installed in high temperature areas) using procedure FLEXIBLE HOSE - REMOVAL/INSTALLATION, PAGEBLOCK 20-10-52/401.

SUBTASK 20-10-52-210-005

(6) Do a detailed visual inspection of the hose for bird-caging. [See 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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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.

2324213 S0000527021_V2

Hose Leakage Identification
Figure 201/20-10-52-990-811

ECCN 9E991 BOEING PROPRIETARY - See title page for details

EXAMPLE OF BIRD-CAGING

2020925 S0000401446_V1

Hose Wear
Figure 202/20-10-52-990-810

ECCN 9E991 BOEING PROPRIETARY - See title page for details

TASK 20-10-52-800-801

3. Spiral Sleeving - Installation

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 201/20-10-52-993-804

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 20-10-52-420-005

(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 20-10-52-420-006

(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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

Table 202/20-10-52-993-806

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 203/20-10-52-993-805

NAME	SPECIFICATION	RECOMMENDED MATERIAL
Silicone Tape		Permacel 2650, V99742
		Scotch 70, V76381

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

1971078 S0000378685_V2

CRES Spiral Sleeving
Figure 203/20-10-52-990-805

ECCN 9E991 BOEING PROPRIETARY - See title page for details

TASK 20-10-52-400-802

4. Protective Lacing - Installation

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), steps 1 through 3, except 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), steps 1 through 3.

(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 ———

ECCN 9E991 BOEING PROPRIETARY - See title page for details

STEP 1

STEP 2

STEP 3

FOR TWO OR MORE HOSES

NOTE:

ALL DIMENSIONS ARE IN INCHES.

K12749 S0006562037_V3

Protective Lacing Installation
Figure 204/20-10-52-990-806

ECCN 9E991 BOEING PROPRIETARY - See title page for details

TASK 20-10-52-910-801

5. Correct Torque Value Determination for a Hydraulic Hose Assembly

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 204/20-10-52-993-812 Service Letter for All Models

Models
737–SL-29–119
747–SL-29–078
757–SL-29–054
767–SL-29–067
777–SL-29–041

B. References

Reference	Title
20-10-51-993-930	Table: Hydraulic Fitting Material Codes (P/B 201)

C. Procedure

SUBTASK 20-10-52-200-003

(1) Evaluate the hose part number to verify the fitting end sizes and materials on the hose. See example namesplates Table 205, Table 206, Table 207 and Figure 205 for additional data.

Table 205/20-10-52-993-813 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 206/20-10-52-993-815 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.)
K	Integral Braided Polyester Abrasion Sleeve (Blue Color)

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Table 206/20-10-52-993-815 Example Hose Definition 2: Hydraulic Hose P/N AS115-06K0344 (Continued)

Breakdown	Definition
034	Length in Whole Inches 034 X 1.0 = 34.0 Inches
4	Fractional Length in Eighths of an Inch Increments 4 X 0.125 = 0.500 Inch

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 207/20-10-52-993-816 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 Inches
4	Fractional Length in Eighths of an Inch Increments 4 x 0.125 = 0.500 Inch
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 20-10-52-200-004

(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 20-10-51-993-930 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 208/20-10-52-993-817 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
747–400	20–51–01/201
747–8	20–51–01/201
757	20–11–00/201
767	20–11–00/201

ECCN 9E991 BOEING PROPRIETARY - See title page for details

Table 208/20-10-52-993-817 Installation Torque for Flareless Tubing Fittings Table for all Models (Continued)

Models	Location in AMM
777	20–11–00/201

——— END OF TASK ———

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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	MATERIAL AND RATING DATA: 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)
- K = INTEGRAL BLUE POLYESTER ABRASION SLEEVE
- FRACTION OF HOSE LENGTH IN EIGHTHS OF AN INCH (0.25 INCH)
- HOSE LENGTH IN WHOLE INCHES

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.

NOTE:
NOT KEPT UP TO DATE - ALWAYS CONSULT LATEST REVISION OF FITTING STANDARD FOR P/N AND SUPERSESSION DATA.

2331246 S0000527957_V2

Hydraulic Hose Identification
Figure 205/20-10-52-990-812 (Sheet 1 of 5)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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:

BACH8A 08 ER 020 4 B

- BASIC P/N
- HOSE SIZE (08) (SEE STANDARD)
- FITTING ENDS (SEE STANDARD): NO. 1 END - SIZE 10, STRAIGHT; NO. 2 END - SIZE 06, STRAIGHT
- HOSE LENGTH IN WHOLE INCHES
- FRACTION OF HOSE LENGTH IN EIGHTHS OF AN INCH (0.5 INCH)
- B = BLUE POLYESTER ABRASION SLEEVE

E = EXPANDER
N = NORMAL (SAME AS HOSE SIZE)
R = REDUCER

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.

Hydraulic Hose Identification
Figure 205/20-10-52-990-812 (Sheet 2 of 5)

NOTE:

NOT KEPT UP TO DATE - ALWAYS CONSULT LATEST REVISION OF FITTING STANDARD FOR P/N AND SUPERSESSION DATA.

2331321 S0000527959_V2

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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	MATERIAL AND RATING DATA: PRESSURE RATING
A. STRAIGHT-TO-STRAIGHT, EXPANDER/REDUCER B. STRAIGHT-TO-45 DEGREE, EXPANDER/REDUCER C. STRAIGHT-TO-90 DEGREE, EXPANDER/REDUCER	A. B. C. **NOTE:** SEE BOEING STANDARD BACH6MTHRUH6V.	BACH6M	04	04	06	MULTI-LAYER CRES/CRES	3,000 PSI
		BACH6P	06	04	08	MULTI-LAYER CRES/CRES	3,000 PSI
		BACH6R	08	06	10	MULTI-LAYER CRES/CRES	3,000 PSI
		BACH6S	10	08	12	MULTI-LAYER CRES/CRES	3,000 PSI
A. STRAIGHT-TO-STRAIGHT, EXPANDER/REDUCER B. STRAIGHT-TO-45 DEGREE, EXPANDER/REDUCER C. STRAIGHT-TO-90 DEGREE, EXPANDER/REDUCER	A. B. C. **NOTE:** SEE BOEING STANDARD BACH6MTHRUH6V.	BACH6T	12	10	16	MULTI-LAYER CRES/CRES	3,000 PSI
		BACH6V	16	12	16	MULTI-LAYER CRES/CRES	3,000 PSI

EXAMPLE OF PART NUMBER:

BACH6 P 035 4 AT N

- BACH6 — BASIC P/N
- P — HOSE SIZE (06)
- 035 — HOSE LENGTH IN WHOLE INCHES
- 4 — FRACTION OF HOSE LENGTH IN EIGHTHS OF AN INCH (0.50 INCH)
- AT — CRES FITTINGS END NO. 1: SIZE O6, 90 DEGREE ELBOW END NO. 2: SIZE 04, STRAIGHT FITTING
- N — N = PTFE ABRASION SLEEVE PURPLE BMS3-11 BAND

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.

2331963 S0000527960_V2

Hydraulic Hose Identification
Figure 205/20-10-52-990-812 (Sheet 3 of 5)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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	MATERIAL AND RATING DATA: PRESSURE RATING
A. STRAIGHT-TO-STRAIGHT, EXPANDER/REDUCER	A.	BACH5M	04	04	06	CRES/304 CRES OR ALUM*	1,500 PSI
B. STRAIGHT-TO-45 DEGREE, EXPANDER/REDUCER	B.	BACH5P	06	04	08	CRES/304 CRES OR ALUM*	1,500 PSI
C. STRAIGHT-TO-90 DEGREE, EXPANDER/REDUCER	C. *NOTE: SEE BOEING STANDARD BACH5MTHRUH5X.	BACH5R	08	06	10	CRES/304 CRES OR ALUM*	1,500 PSI
		BACH5S	10	08	12	CRES/304 CRES OR ALUM*	1,500 PSI
A. STRAIGHT-TO-STRAIGHT, EXPANDER/REDUCER	A.	BACH5T	12	10	16	CRES/304 CRES OR ALUM*	1,000 PSI
B. STRAIGHT-TO-45 DEGREE, EXPANDER/REDUCER	B.	BACH5V	16	12	20	CRES/304 CRES OR ALUM*	1,000 PSI
C. STRAIGHT-TO-90 DEGREE, EXPANDER/REDUCER	C. *NOTE: SEE BOEING STANDARD BACH5MTHRUH5X.	BACH5W	20	16	20	CRES/304 CRES OR ALUM*	1,000 PSI
		BACH5X	16	20 (SHORT FLARELESS)	20 (SHORT FLARELESS)	CRES/304 CRES OR ALUM*	1,000 PSI

EXAMPLE OF PART NUMBER: BACH5 P 040 6 AT T

- BASIC P/N
- HOSE SIZE (06)
- HOSE LENGTH IN WHOLE INCHES
- FRACTION OF HOSE LENGTH IN EIGHTHS OF AN INCH (0.75 INCH)
- CRES FITTINGS END NO. 1: SIZE O4 STRAIGHT END NO. 2: SIZE 06 90 DEGREE ELBOW
- T = TFE ABRASION SLEEVE

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.

2332071 S0000527961_V2

Hydraulic Hose Identification
Figure 205/20-10-52-990-812 (Sheet 4 of 5)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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	MATERIAL AND RATING DATA: 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
- HOSE SIZE (08)
- HOSE LENGTH IN WHOLE INCHES
- FRACTION OF HOSE LENGTH IN EIGHTHS OF AN INCH (0.25 INCH)
- H = INTEGRAL FIRESLEEVE
- ANGULAR ORIENTATION OF END FITTINGS IN 1 DEGREE INCREMENTS (270 DEGREES)
- HOSE CLASS CODE (A = CLASS I, B = CLASS 2)

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.

2332206 S0000527962_V2

Hydraulic Hose Identification
Figure 205/20-10-52-990-812 (Sheet 5 of 5)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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.
   E. Before you do maintenance on oxygen system flexible hoses, read the oxygen system safety precautions and general maintenance instructions, Crew Oxygen System: CREW OXYGEN SYSTEM - MAINTENANCE PRACTICES, PAGEBLOCK 35-12-00/201, or the applicable Passenger Oxygen System maintenance practices.
   F. Use thread compounds from Table 401.

Table 401/20-10-52-993-818 Flexible Hose Assembly Thread Compounds

TYPE OF SYSTEM	BULK CODE	APPROVED THREAD COMPOUNDS (STRAIGHT THREAD FITTINGS)
Compressed Gas	D50004	Antiseize Compound BMS 3–28
Deicing or (Anti-icing)	D50004	Antiseize Compound BMS 3–28
Instrument Air	D50004	Antiseize Compound BMS 3–28
Pneumatic	D50004 D50062	Antiseize Compound BMS 3–28 or Pneumatic Grease AMS-G-4343
Air Conditioning	D50004 D01062 D00062	Antiseize Compound BMS3-28 or Never-Seez Pure Nickel Special or Pneumatic Grease AMS-G-4343
Fire Protection	D50004	Antiseize Compound BMS 3–28
Coolant	D00070 D00467	Hydraulic Fluid MIL-PRF-5606 or Shock Strut Fluid BMS 3-32 Type II
Water Injection	D50004	Antiseize Compound BMS3-28
Fuel	D00070 D00467	Hydraulic Fluid MIL-PRF-5606 or Shock Strut Fluid BMS 3-32 Type II
Lubrication	D00070 D00467	Hydraulic Fluid MIL-PRF-5606 or Shock Strut Fluid BMS 3-32 Type II
Hydraulic MIL-PRF-5606	D00070 D00467	Hydraulic Fluid MIL-PRF-5606 or Shock Strut Fluid BMS 3-32 Type II
Hydraulic BMS 3-11	D00054 D00153 D50269	Skydrol Assy Lube MCS 352B or Hydraulic Fluid BMS3-11 Type IV or Hydraulic Fluid BMS3-11 Type V
Hydraulic Tubing MIL-PRF-6083	D00070 D00106 D00467	Hydraulic Fluid MIL-PRF-5606 or Hydraulic Fluid MIL-PRF-6083 or Shock Strut Fluid BMS 3-32 Type II

ECCN 9E991 BOEING PROPRIETARY - See title page for details

Table 401/20-10-52-993-818 Flexible Hose Assembly Thread Compounds (Continued)

TYPE OF SYSTEM	BULK CODE	APPROVED THREAD COMPOUNDS (STRAIGHT THREAD FITTINGS)
Misc Tubing	D50004 D00053	Antiseize Compound BMS3-28 or Grease AMS-G-6032

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. UNWANTED MATERIAL CAN CAUSE CONTAMINATION OF HOSES, DAMAGE TO SYSTEM COMPONENTS, AND LEAKAGE OF FLUID. SOME FLUID CAN CAUSE CORROSION OR OTHER DAMAGE.

(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.

(3) If it is necessary, remove the clamps.

END OF TASK

TASK 20-10-52-400-801

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) Prior to hose installation do a visual check of the hose assembly to determine its condition.

(a) Look at the hose, fittings, sealing surfaces, and outer coverings for damage.

(b) Do the following if you find broken wires in the outer covering:

1) Put a tag on the hoses that have isolated or random broken wires.

NOTE: This is to identify the hose for future inspections.

2) 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.

(2) Make sure all the hose fittings are clean and free of defects.

NOTE: Hoses that look like they have been kinked must be replaced.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SUBTASK 20-10-52-640-001

(3) Lubricate the external threads as necessary with the correct lubricant.

SUBTASK 20-10-52-420-001

(4) Put the hose in position and tighten the fitting by hand.

SUBTASK 20-10-52-210-002

(5) Examine the installation for the correct alignment and length.

SUBTASK 20-10-52-420-003

CAUTION	USE THE INDEX LINE ON THE SIDE OF THE HOSE TO MAKE SURE THE HOSE IS NOT TWISTED. IF THE HOSE IS TWISTED, HOSE FAILURE OR HOSE COUPLING LEAKAGE CAN OCCUR.

(6) Tighten the B-nut to the correct torque, do this task: Standard Torque Values, TASK 20-50-11-910-801.

SUBTASK 20-10-52-420-004

(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.

SUBTASK 20-10-52-420-002

CAUTION	MAKE SURE THAT THE FLEXIBLE HOSE AND TUBE HAVE SUFFICIENT CLEARANCE FROM THE ADJACENT COMPONENTS. IF THE FLEXIBLE HOSE OR TUBE RUB ON THE COMPONENTS, DAMAGE TO THEM CAN OCCUR.

(8) Clamp the hose when it is necessary and adjust the slack.

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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Flexible Hose Installation
Figure 401/20-10-52-990-801

ECCN 9E991 BOEING PROPRIETARY - See title page for details

FLEXIBLE HOSE - REPAIRS

1. General

A. This procedure contains a task for the replacement of unserviceable hydraulic rigid tubes with flexible hoses as a temporary repair.

B. This procedure contains a task for the temporary repair of flexible hydraulic hoses.

CAUTION	PUT CAPS ON HOSES AND FITTINGS WHEN THEY ARE NOT CONNECTED. IF YOU DO NOT USE CAPS, CONTAMINATION OF THE HOSES, AND DAMAGE TO THE SYSTEM COMPONENTS AND LEAKAGE OF HYDRAULIC FLUID COULD OCCUR. YOU MUST REMOVE ALL HYDRAULIC FLUID THAT CAME OUT OF THE HOSE AND FELL ON THE AIRPLANE. HYDRAULIC FLUID CAN CAUSE CORROSION AND DAMAGE TO THE AIRPLANE.

C. 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
20-10-51-000-802	Flareless Fittings in Pressurized, Strut, Fuel Tank, and Cargo Areas Installation (P/B 401)
29-09-00-860-802	Hydraulic Reservoirs Depressurization (P/B 201)

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 20-10-52-200-001

(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.

(c) The length of the hose must be sufficient to keep the slack, flex, twisting, bending, clearance, and support acceptable, see (Figure 801).

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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 from (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 801/20-10-52-993-802 Minimum Hose Bend Radius

AS 115 HOSE	HOSE INSIDE DIAMETER INCHES (mm)	MINIMUM HOSE BEND RADIUS MEASURED INSIDE OF BEND INCHES (mm)
-04	1/4 (6.350)	1.50 (38.1)
-06	3/8 (9.53)	2.50 (63.5)
-08	1/2 (12.7)	2.88 (73.2)
-10	5/8 (15.9)	3.25 (82.6)
-12	3/4 (19.1)	4.00 (101.6)

Table 802/20-10-52-993-803 Minimum Clearance

HOSE CLEARANCE TO	MINIMUM CLEARANCE INCH (mm)
CONTROL CABLE LINKAGES	1.0 *[1] (25.4)
CABLE AT PULLEYS	0.5 (12.7)
CABLE AT MIDSPAN	2.0 (50.8)
ELECTRICAL WIRING	0.5 (12.7)
HYDRAULIC TUBES OR LINES	0.2 (5.08)

*[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. To remove the pressure, 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, Strut, Fuel Tank, and Cargo Areas Installation, TASK 20-10-51-000-802.

SUBTASK 20-10-52-300-002

(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, Strut, Fuel Tank, and Cargo Areas Installation, TASK 20-10-51-000-802.

(c) Install the tubing on the fittings.

SUBTASK 20-10-52-860-003

(8) Supply the usual pressure to the line.

SUBTASK 20-10-52-210-003

(9) Do a check of the hose and the connections for leaks.

SUBTASK 20-10-52-200-002

(10) Do a check to make sure the slack, flex, twisting, bending, clearance, and support is correct.

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SLACK

FLEX

TWISTING

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Hydraulic Tubing Repair
Figure 801/20-10-52-990-804 (Sheet 1 of 2)

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BENDING

CLEARANCE

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Hydraulic Tubing Repair
Figure 801/20-10-52-990-804 (Sheet 2 of 2)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

TASK 20-10-52-300-803

3. Temporary Repair of Flexible Hydraulic Hoses

(Figure 802 and Figure 803)

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 condition 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 cowls.

(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
29-00-00 P/B 201	HYDRAULIC POWER - MAINTENANCE PRACTICES

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 Opt Part #: 65-92528-1 (Spares Kit) Supplier: 81205

D. Prepare for the Installation

SUBTASK 20-10-52-300-003

(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.

(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).

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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 803):
   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 (Table 803).

         NOTE: This will help prevent sharp bends in the hose assembly.

Table 803/20-10-52-993-810

AS 115 HOSE	HOSE INNER DIAMETER (INCH)	MINIMUM HOSE BEND RADIUS MEASURED AT INNER BEND (INCH)
-04	1/4	1.50
-06	3/8	2.50
-08	1/2	2.88
-10	5/8	3.25
-12	3/4	4.00

<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).

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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 in Table 804.

Table 804/20-10-52-993-819 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 a relative 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 (PAGEBLOCK 29-00-00/201).

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 in 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.

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(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.

SUBTASK 20-10-52-440-001

(5) Supply hydraulic pressure to the system on which you did the temporary repair (PAGEBLOCK 29-00-00/201).

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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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

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.

2141300 S0000464997_V1

Possible Repair of Flexible Hydraulic Hoses
Figure 802/20-10-52-990-807 (Sheet 1 of 2)

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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.

2141302 S0000464998_V1

Possible Repair of Flexible Hydraulic Hoses
Figure 802/20-10-52-990-807 (Sheet 2 of 2)

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SLACK

FLEX

TWISTING

2141561 S0000464999_V1

Replacement Flexible Hose Requirements
Figure 803/20-10-52-990-808 (Sheet 1 of 2)

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BENDING

CLEARANCE

2141563 S0000465000_V1

Replacement Flexible Hose Requirements
Figure 803/20-10-52-990-808 (Sheet 2 of 2)

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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) A 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 20-10-53-960-801

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 20-10-53-420-007

(2) Put the tubes in the applicable notches in one-half of the block clamp assembly.

SUBTASK 20-10-53-420-003

(3) Put the other half of the block clamp assembly in position.

SUBTASK 20-10-53-420-008

(4) Put the channel over the half of the block clamp assembly that the bolthead will touch.

SUBTASK 20-10-53-420-009

(5) Put the washers on the bolts and put the bolts through the holes in the block clamp assembly.

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SUBTASK 20-10-53-420-010

(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 bolthead and the nut so the bolthead does not wear into the block clamp channel.

——— END OF TASK ———

TASK 20-10-53-000-801

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 20-10-53-420-004

(1) Put the P-clamp on the tube.

SUBTASK 20-10-53-420-005

(2) Put the pan dirt strap in the hole of the clamp.

SUBTASK 20-10-53-420-006

(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
20-30	SPECIFICATIONS AND MATERIALS
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	Chemical Reactivator Application (P/B 701)
51-21-73-370-803	BMS10-60 Topcoat Application (P/B 701)
51-21-73-370-804	BMS10-11 Topcoat 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	MAKE SURE YOU DO NOT SPRAY SOLVENTS OR KEEP THEM IN OPEN CONTAINERS. DO NOT USE FLAMMABLE SOLVENTS IN THE AIRPLANE. SOLVENTS AND CLEANERS CONTAIN TOXIC INGREDIENTS. WEAR PROTECTIVE GLOVES, AND DO NOT GET SOLVENT OR CLEANER ON SKIN OR EYES. MAKE SURE YOU HAVE SUFFICIENT VENTILATION OR USE RESPIRATOR MASKS. INJURY TO PERSONNEL OR DAMAGE TO EQUIPMENT CAN OCCUR.

CAUTION	MAKE SURE YOU DO NOT USE SOLVENTS OTHER THAN THOSE SPECIFIED. THEY CAN CAUSE DAMAGE TO THE FINISH.

(a) Use the applicable solvent (SPECIFICATIONS AND MATERIALS, SECTION 20-30).

(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 20-10-61-120-002

(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.

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(e) Solvent clean the area to remove sanding dust.

(f) Wipe the surface with a clean, dry wiper, G50262.

(g) Prepare the surface for paint (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 51-21-73-370-802).

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 20-10-61-370-002

(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		FINSIH
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.

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*[2] Interior applications.

*[3] Exterior applications.

SUBTASK 20-10-61-370-003

(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

WARNING	MAKE SURE YOU DO NOT BREATHE THE FUMES OF FINISHES AND SOLVENTS. DO WORK IN A WELL-VENTILATED AREA. USE APPROVED RESPIRATORY PROTECTION AS NECESSARY. DO NOT GET FINISHES AND SOLVENTS IN EYES OR ON SKIN AND CLOTHING. KEEP MATERIALS AWAY FROM SOURCE OF IGNITION. FINISHES AND SOLVENTS ARE TOXIC AND FLAMMABLE. THEY CAN CAUSE INJURY TO PERSONNEL OR DAMAGE TO EQUIPMENT.

(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 51-21-73-370-803.

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 51-21-73-370-804.

(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 20-10-61-370-004

(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 51-21-73-370-803.

(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 51-21-73-370-804.

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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.

(b) For BMS10-60 dry film thicknesses, see BMS10-60 Topcoat Application, TASK 51-21-73-370-803.

(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 51-21-73-370-804

SUBTASK 20-10-61-370-005

(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 51-21-73-370-803).

(a) Cure the BMS10-60 topcoat (BMS10-60 Topcoat Application, TASK 51-21-73-370-803).

(b) Measure the dry film thickness of the stencil paint (BMS10-60 Topcoat Application, TASK 51-21-73-370-803).

SUBTASK 20-10-61-370-006

(6) If you applied BMS10-11, Type I primer, C00259, apply BMS10-11, Type II topcoat coating, C00260 (BMS10-11 Topcoat Application, TASK 51-21-73-370-804).

(a) Cure the BMS10-11, Type II topcoat (BMS10-11 Topcoat Application, TASK 51-21-73-370-804).

(b) Measure the dry film thickness of the stencil paint (BMS10-11 Topcoat Application, TASK 51-21-73-370-804).

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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1. General

A. Time Domain Reflectometer (TDR)

(1) Use a time domain reflectometer (TDR) to examine coaxial cables. The TDR can locate opens, shorts, crimps and other defects in coaxial cables of lengths up to 1,200 feet 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

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 #: 6021-5154 Supplier: 1UW81 Part #: W1101 Supplier: FB3T5 Opt Part #: 1205 Supplier: 93929 Opt Part #: 1205CXA Supplier: 93929 Opt Part #: 1270 Supplier: 93929 Opt Part #: 1270A Supplier: 93929 Opt Part #: 1502C Supplier: 80009 Opt Part #: 900AST Supplier: 53387
SPL-17763	Reflectometer - Multi Carrier Time Domain (MCTDR) Part #: W1101 Supplier: FB3T5

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

TASK 20-10-72-200-801

3. Coaxial Cable and Antenna System Inspection with a Frequency Domain Reflectometer
(Figure 201)

A. General

(1) This procedure has 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 to locate opens, shorts, incorrect crimps, bends, moisture, loose connectors, and defective antenna elements that lead to weak or intermittent RF operation. You can also use the Frequency Domain Reflectometer (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 Voltage Standing Wave Ratio (VSWR) 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 Electronic Equipment (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 Universal Serial Bus (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 (RL) 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 RL fault without disconnecting.

B. References

Reference	Title
20-10-07 P/B 201	E/E RACK-MOUNTED COMPONENTS AND PRINTED CIRCUIT CARD - REMOVAL/INSTALLATION
20-10-07-000-801	E/E Box Removal (P/B 201)
20-10-07-400-801	E/E Box Installation (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-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: $1365
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 20-10-72-860-002

(1) Do these steps to prepare the applicable cable, antenna system, and the 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 Standing Wave Ratio (SWR) 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 Satellite Communications System (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 softkey.

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 of 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. 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.

Table 201/20-10-72-993-805 737 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)

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Table 201/20-10-72-993-805 737 RF SYSTEM FREQUENCY RANGE CHART (Continued)

Cable and Antenna System	System Operating Frequency	Maximum Voltage Standing Wave Ratio and (Return Loss)
TCAS	1030 to 1090 MHz	2.0 (9.54 dB)
VHF	116/156 MHz	2.0 (9.54 dB)
VOR	108 to 118 MHz	6.1 (2.87 dB)
ATC/DME	960 to 1215 MHz	1.8
ILS (Localizer)	108 to 113 MHz	5.2
ILS (Glideslope)	327 to 337 MHz	2.0 (9.54 dB)
Rad Alt (LRRA)	4275 to 4325 MHz	1.7 (11.73 dB)
*[2]HF	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)
*[4]GPS *[5](STC-S613Z001/956-0027-001/AT575-143H)	1575 to 1585 MHz	2.0 (9.54 dB)
*[4]GPS *[5](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] Bias Tee is needed.

*[5] 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.

*[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 to 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 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 201).

(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 20-10-07/201

(2) Do the active GPS 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-15185 test coaxial cable to the Biass 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 Bias Tee (BNC female connector).

(e) Connect the BNC Male to single banana plugs adapter, COM-9903 to 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 12 volts DC and max amperage of 500 mA (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 12VDC 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 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.

(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 Line Replaceable Unit (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 20-10-07/201.

(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 20-10-72-860-003

(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 Wiring Diagram Manual (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 202/20-10-72-993-804 Cable Probable Velocity of Propogation (Vp)

TYPE OF CABLE	PROBABLE Vp
Jelly Filled	.64
Polyethylene (PIC, PE, or SPE)	.66
PTFE (Teflon) or TFE	.70
Pulp Insulation	.72
BMS13-65-OE/OF and PN 82210AA	.74
BMS13-65-OG/OH	.76
BMS13-65-OJ/OK	.766
Foam or Cellular PE (FPE)	.78
PTFE Lightweight (BMS13-65-OK)	.79
Semi-solid PE (SSPE)	.84
ePTFE (SAT-X-X-7LC01C01-XX.XX)	.85
Air (Helical spacers)	.98

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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 or remove cables.

(h) Calibrate the frequency domain reflectometer, COM-15185. Refer to Calibration steps above.

(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 the press TOP and enter 0 to adjust the scale.

2) Press BOTTOM and enter -70.

SUBTASK 20-10-72-970-002

(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 20-10-72-970-003

(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 let the user to 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 20-10-72-970-004

(1) Select the Fault Location Mode:

(a) Push trace measurement field to display Measurement Mode menu.

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(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).

(d) Set Start/Stop Frequencies to 5GHz and 6GHz.

(e) Set Start/Stop Distance:

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.

1) Make sure that the stop distance is at least 20% longer than correct length.

NOTE: The correct length of the cable is found in the applicable system's WDM.

(f) Select Units and set to m (meters) or ft (feet).

(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 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 or 20.83 dB for RL.

(d) Select Fail Flag (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:

(a) Push velocity and enter the cable velocity (Table 201).

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.

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(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.

(8) Interpreting the Fault Location Measurement (Figure 1, Typical Fault Location Measurement for an Antenna System):

(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.

(9) Make sure of 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 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 20-10-72-080-004

(1) Disconnect the Time Domain Reflectometry (TDR) adapter cable from the EE Rack Bench Plug.

SUBTASK 20-10-72-080-005

(2) Remove the 50 ohm terminator from the other end of the applicable cable if used for troubleshooting.

SUBTASK 20-10-72-410-002

(3) To install the applicable black box, do this task: E/E Box Installation, TASK 20-10-07-400-801.

SUBTASK 20-10-72-420-002

(4) Connect any cables previously disconnected for troubleshooting.

END OF TASK

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**FREQUENCY DOMAIN REFLECTOMETER
(EXAMPLE)**

2811321 S0000647418_V1

**Frequency Domain Reflectometer
Figure 201/20-10-72-990-803**

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TYPICAL FAULT LOCATION MEASUREMENT FOR AN ANTENNA SYSTEM (EXAMPLE)

3019049 S0000791075_V1

TYPICAL FAULT LOCATION MEASUREMENT FOR AN ANTENNA SYSTEM (EXAMPLE)
Figure 202/20-10-72-990-804 (Sheet 1 of 2)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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)

3019048 S0000791496_V1

TYPICAL FAULT LOCATION MEASUREMENT FOR AN ANTENNA SYSTEM (EXAMPLE)
Figure 202/20-10-72-990-804 (Sheet 2 of 2)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

THERMAL IMAGING - MAINTENANCE PRACTICES

1. General

A. This procedure contains this task:

(1) Thermal Imaging Checks

TASK 20-10-75-700-801

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 an infrared camera, COM-15040 with a high temperature range and low thermal sensitivity (also known as Noise Equivalent Temperature Difference (NETD)) of ≤ 32°F at 86°F (≤ 0.05°C at 30°C). It is also recommended 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. Procedure

SUBTASK 20-10-75-750-001

(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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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.

WARNING	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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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. Make sure 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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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. 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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

ELECTRICAL
- EVALUATION

ELECTRICAL SYSTEM

HYDRAULIC (SPRINKLER) SYSTEM

2535598 S0000600840_V1

Electrical Evaluation
Figure 201/20-10-75-990-801

ECCN 9E991 BOEING PROPRIETARY - See title page for details

2535599 S0000600849_V1

Improperly Crimped Terminal
Figure 202/20-10-75-990-802

ECCN 9E991 BOEING PROPRIETARY - See title page for details

2535601 S0000600854_V1

Blown Fuse
Figure 203/20-10-75-990-803

ECCN 9E991 BOEING PROPRIETARY - See title page for details

2535602 S0000600855_V1

Loose Bus Bar / Relay Phase B Hot Spot / Relay Contacts Worn with Carbon Buildup
Figure 204/20-10-75-990-804

ECCN 9E991 BOEING PROPRIETARY - See title page for details

2535605 S0000600858_V1

3-Phase Inspection
Figure 205/20-10-75-990-805

ECCN 9E991 BOEING PROPRIETARY - See title page for details

2535606 S0000600859_V1

Pitot Static Probe and AOA Sensor
Figure 206/20-10-75-990-806

ECCN 9E991 BOEING PROPRIETARY - See title page for details

2535607 S0000600865_V1

Leak from Fairing Due to Ruptured Pressure Seal
Figure 207/20-10-75-990-807

ECCN 9E991 BOEING PROPRIETARY - See title page for details

2535609 S0000600867_V1

Too Hot of Air Exiting Turbine - Leaking Heat Exchanger
Figure 208/20-10-75-990-808

ECCN 9E991 BOEING PROPRIETARY - See title page for details

2535610 S0000600869_V1

Bleed Air Leak Tests - Airplane Belly View
Figure 209/20-10-75-990-809

ECCN 9E991 BOEING PROPRIETARY - See title page for details

HEAT EXCHANGER PROPER OPERATION

FILTER BYPASS

ACTUATOR BYPASS

RESERVOIR CONTAMINATION

2535611 S0000600870_V1

Filter Bypass, Actuator Bypass, Accumulator Pre-Charge, Reservoir Contamination
Figure 210/20-10-75-990-810

ECCN 9E991 BOEING PROPRIETARY - See title page for details

2535612 S0000600872_V1

Water/Mold Detection
Figure 211/20-10-75-990-811

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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 212/20-10-75-990-812

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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 213/20-10-75-990-813

ECCN 9E991 BOEING PROPRIETARY - See title page for details

FLAP/SLAT INDICATION PREVENTATIVE MEASURES - MAINTENANCE PRACTICES

1. General

A. This procedure has these tasks

(1) LE Slat Retract Magnetic Target Check - Check I

(2) LE Slat Retract Indication System Insulation Resistance Check - Check II

(3) LE Flap/Slat Sensor Resistance Check - Check III

(4) LE Flap Slat Proximity Sensor Check - Check IV

(5) TE Flap Position Indication Excitation Check - Check I

(6) TE Flap Indication System Insulation Resistance Check - Check II

(7) TE Flap Indication System Resistance Check - Check III

B. The objective of these test procedures are to perform a health checks on the 737NG Leading Edge Flap/Slat and Trailing Edge Indication system comprising the position sensors, transmitter, targets, and related airplane wiring.

TASK 20-10-76-700-801

2. LE Slat Retract Magnetic Target Check I

A. General

(1) The LE Slats utilize six each two-wire cylindrical proximity sensors (P/N 8-788-02) and magnetic target for sensors S1094 through S1099. The sensor's impedance rapidly changes as the magnetic target approaches and retracts. This check ensures a minimum gauss level from the center of the target in order to eliminate intermittent transient lights due to low target magnetism when the slats are retracted.

B. References

Reference	Title
27-81-00-040-801	Leading Edge Flaps and Slats Deactivation (P/B 201)
27-81-00-440-801	Leading Edge Flaps and Slats - Activation (P/B 201)
27-81-00-860-803	Leading Edge Flaps and Slats Extension (P/B 201)
27-81-00-860-804	Leading Edge Flaps and Slats Retraction (P/B 201)

C. Tools/Equipment

Reference	Description
STD-6151	Gaussmeter
STD-12053	Magnetometer (Capable of measuring 65-75 gauss)

D. Location Zones

Zone	Area
211	Flight Compartment - Left
212	Flight Compartment - Right
500	Left Wing
600	Right Wing

ECCN 9E991 BOEING PROPRIETARY - See title page for details

E. Procedure

WARNING

MAKE SURE THAT PERSONS AND EQUIPMENT ARE CLEAR OF THE LEADING EDGE FLAPS AND SLATS AND THE TRAILING EDGE FLAPS. THE FLAPS AND SLATS WILL EXTEND. THIS CAN CAUSE INJURY TO PERSONS AND DAMAGE TO EQUIPMENT.

CAUTION

MAKE SURE THE INBOARD FAN DUCT COWL AND THE INBOARD AND OUTBOARD THRUST REVERSERS ARE CLOSED OR REMOVED BEFORE YOU EXTEND THE LEADING EDGE FLAPS AND SLATS IN THIS TEST. THERE IS NOT SUFFICIENT CLEARANCE FOR THE FLAPS AND SLATS TO EXTEND IF THE INBOARD FAN DUCT COWL AND THE THRUST REVERSERS ARE IN THE OPEN POSITION. THIS CAN CAUSE DAMAGE TO EQUIPMENT.

SUBTASK 20-10-76-860-001

(1) Make sure the inboard fan duct cowl and the inboard and outboard thrust reversers are closed or removed before extending the leading edge flaps and slats.

SUBTASK 20-10-76-860-002

(2) Extend the leading edge slats to the 30-unit position with primary control, do this task: Leading Edge Flaps and Slats Extension, TASK 27-81-00-860-803.

SUBTASK 20-10-76-040-001

WARNING

MAKE SURE THAT YOU DEACTIVATE THE LEADING-EDGE SLAT BEFORE YOU WORK ON THE SLAT SYSTEM. THE SLATS CAN MOVE QUICKLY WHEN YOU ACTIVATE THEM. IT CAN CAUSE INJURIES TO PERSONS AND DAMAGE TO THE EQUIPMENT.

(3) To deactivate the leading edge flaps and slats in the full extend position, do this task: Leading Edge Flaps and Slats Deactivation, TASK 27-81-00-040-801,

SUBTASK 20-10-76-700-002

(4) Use gaussmeter, STD-6151 or magnetometer, STD-12053 to test each slat retract sensor magnetic target, S1094 through S1099, and complete Table 201.

(a) Obtain readings with gaussmeter, STD-6151 or magnetometer, STD-12053 by:

1) Selecting “Max” to retain the maximum value, the display will keep updating as higher value is recorded while moving the meter to and from the target; at least 3 times.

2) Position the meter to measure the electromagnetic waves. Try to change the measurement angle or position to obtain the highest reading value. (Figure 201).

3) Make sure that a minimum of 600mG per target.

Table 201/20-10-76-993-815 Slat retract Sensor Magnetic Gauss Level

TEST	TARGET	MINIMUM GAUSS REQUIREMENT	GAUSS READING	SENSOR
1	S1094	600mG		LE Slat 2 Retract Sensor
2	S1095	600mG		LE Slat 3 Retract Sensor
3	S1096	600mG		LE Slat 4 Retract Sensor
4	S1097	600mG		LE Slat 5 Retract Sensor

ECCN 9E991 BOEING PROPRIETARY - See title page for details

Table 201/20-10-76-993-815 Slat retract Sensor Magnetic Gauss Level (Continued)

TEST	TARGET	MINIMUM GAUSS REQUIREMENT	GAUSS READING	SENSOR
5	S1098	600mG		LE Slat 6 Retract Sensor
6	S1099	600mG		LE Slat 7 Retract Sensor

SUBTASK 20-10-76-440-003

> **WARNING** MAKE SURE THAT PERSONS AND EQUIPMENT ARE CLEAR OF THE LEADING EDGE FLAPS AND SLATS AND THE TRAILING EDGE FLAPS. THE FLAPS AND SLATS WILL EXTEND. THIS CAN CAUSE INJURY TO PERSONS AND DAMAGE TO EQUIPMENT.

(5) Re-activate the leading edge flaps and slats, do this task: Leading Edge Flaps and Slats - Activation, TASK 27-81-00-440-801.

SUBTASK 20-10-76-860-003

> **WARNING** MAKE SURE THAT YOU DEACTIVATE THE LEADING-EDGE SLAT BEFORE YOU WORK ON THE SLAT SYSTEM. THE SLATS CAN MOVE QUICKLY WHEN YOU ACTIVATE THEM. IT CAN CAUSE INJURIES TO PERSONS AND DAMAGE TO THE EQUIPMENT.

(6) Retract the flaps from 30 to 0 degrees, do this task: Leading Edge Flaps and Slats Retraction, TASK 27-81-00-860-804.

F. Evaluation of Results

SUBTASK 20-10-76-700-003

(1) Review the recorded readings in Table 201 and make sure that all magnetic targets meet minimum Gauss level.

(a) If value is below or do not meet the minimum recommend level, consider replacing defective target during next maintenance opportunity.

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

INDICATE THE CORRECT MEASUREMENT DIRECTION OF THE ELECTROMAGNETIC WAVE.

INDICATE THE INCORRECT MEASUREMENT DIRECTION OF THE ELECTROMAGNETIC WAVE.

NOTE:

ARROW POINTING DIRECTION INDICATES THE DIRECTION OF THE ELECTROMAGNETIC.

2916509 S0000700591_V1

The Measurement Direction of the Electromagnetic Wave
Figure 201/20-10-76-990-801

ECCN 9E991 BOEING PROPRIETARY - See title page for details

TASK 20-10-76-700-802

3. LE Slat Retract indication System Insulation Resistance Check - Check II

A. General

(1) This task contains the procedure for performing LE Slat Sensor and interface wiring insulation Resistance Predictive Health Check.

(2) The test will determine the condition of the electrical sub-components of the applicable Retract Sensor system by comparing the Insulation Resistance (IR) and Dielectric Absorption Rate (DAR).

B. References

Reference	Title
27-51-01-000-801	Flap/Slat Electronics Unit Removal (P/B 401)
27-51-01-400-801	Flap/Slat Electronics Unit 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 FC Supplier: 4U744 Part #: MIT2500 Supplier: U0146 Part #: MIT410/2 Supplier: U0146 Opt Part #: 1587 Supplier: 89536
SPL-18771	Breakout Box - 66 Pin Electrical/Insulation Resistance Part #: A22002-72 Supplier: 81205
SPL-18772	Cable Set - 737NG LE/TE Flap/Slats Test Part #: A22002-73 Supplier: 81205

D. Location Zones

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

E. Access Panels

Number	Name/Location
117A	Electronic Equipment Access Door

F. Procedure

SUBTASK 20-10-76-860-004

(1) Open these circuit breakers and install safety tags:

CAPT Electrical System Panel, P18-2

Row	Col	Number	Name
C	10	C00468	FLIGHT RECORDER DC

ECCN 9E991 BOEING PROPRIETARY - See title page for details

F/O Electrical System Panel, P6-2

Row	Col	Number	Name
A	6	C00566	FLIGHT CONTROL FLAP LOAD RELIEF
A	7	C00210	FLIGHT CONTROL FLAP SHUTOFF VALVES
A	8	C00211	FLIGHT CONTROL FSEU DC 1
A	11	C01443	FC TE FLAP POS/SKEW SNSR & IND RIGHT
A	12	C00213	FC TE FLAP POS/SKEW SNSR & IND LEFT

SUBTASK 20-10-76-010-001

(2) Open this access panel:

Number	Name/Location
117A	Electronic Equipment Access Door

SUBTASK 20-10-76-000-001

(3) Remove Flap/Slat Electronic unit, do this task: Flap/Slat Electronics Unit Removal, TASK 27-51-01-000-801.

SUBTASK 20-10-76-480-001

(4) Install the cable set, SPL-18772, Insulation Resistance Adapter Cable Assembly “D” on to the FSEU mount.

SUBTASK 20-10-76-480-002

(5) Connect cable set, SPL-18772, Insulation Resistance Adapter Cable Assembly “D” to the 66 pin resistance breakout box, SPL-18771.

SUBTASK 20-10-76-080-001

(6) Install insulation resistance multimeter, COM-17798 leads to the 66 pin resistance breakout box, SPL-18771 per Table 202, Test 1. Example:

(a) Meter positive lead 66 pin resistance breakout box, SPL-18771 - TP 49.

(b) Meter negative lead to 66 pin resistance breakout box, SPL-18771 - TP 61.

SUBTASK 20-10-76-700-004

WARNING

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.

(7) Set up the insulation resistance multimeter, COM-17798 as follows:

(a) Press the PI/DAR button until DAR is displayed on the meter's display.

(b) Press the RANGE button until 500V is displayed on the meter's display.

SUBTASK 20-10-76-700-005

(8) Press the release the INSULATION RESISTANCE button to start the 60 second 500VDC test.

(a) During the test, the high voltage symbol will display in the upper left corner and the TEST icon will show in the lower portion of the meter's screen until the test is finished.

(b) The primary display will show the measured Insulation Resistance (IR) and upon test completion, the Dielectric Absorption Ratio (DAR)

1) During testing, observe and record the highest IR value displayed in Table 202.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

2) Upon test completion, record the DAR value at the end of the test (EX. 0.9, 1.0,..1.6, ERR).

NOTE: ERR ≥ 1.6

SUBTASK 20-10-76-700-006

(9) Repeat steps 6, 7, and 8 for each test of Table 202 (Test #2 to #6) and record the IR and DAR observed for each test performed.

Table 202/20-10-76-993-806 Insulation Resistance and Dielectric Absorption Rate Test Table

TEST	POSITIVE LEAD TEST POINT	NEGATIVE LEAD TEST POINT	INSULATION RESISTANCE REQUIREMENT (MEGAOHMS)	INSULATION RESISTANCE (IR)*[1]	DIELECTRIC ABSORPTION RATIO (DAR) REQUIREMENT >1.0*[1]	FAULT ISOLATION/REMARKS
1	TP49	TP61	≥ 100			LE Slat 2 Retract Sensor (S1094)
2	TP51	TP61	≥ 100			LE Slat 3 Retract Sensor (S1095)
3	TP53	TP61	≥ 100			LE Slat 4 Retract Sensor (S1096)
4	TP55	TP61	≥ 100			LE Slat 5 Retract Sensor (S1097)
5	TP57	TP61	≥ 100			LE Slat 6 Retract Sensor (S1098)
6	TP59	TP61	≥ 100			LE Slat 7 Retract Sensor (S1099)

*[1] If outside range, recommend fault isolation per Fault Isolation Manual for maintenance messages 27-81225 thru 27-81236 within 6 months or first maintenance opportunity.

G. Test Evaluation

SUBTASK 20-10-76-700-007

(1) Evaluate each of the test results of IR/DAR tests recorded in Table 202.

(a) If any of test where the IR/DAR result value is equal or less than the IR/DAR requirements, it is recommended to further fault isolate the fault.

1) Fault isolate by disconnecting applicable LRU and do the IR test insulation resistance test to isolate between LRU and wiring.

(b) If all of tests where the IR/DAR result values meet the required readings then no further action is required.

H. Put the Airplane Back to Its Usual Condition

SUBTASK 20-10-76-860-005

(1) Disconnect the electrical leads of the insulation resistance multimeter, COM-17798 from the 66 pin resistance breakout box, SPL-18771.

SUBTASK 20-10-76-080-002

(2) Remove the cable set, SPL-18772, Insulation Resistance Adapter Cable Assembly “D” from the FSEU mount.

SUBTASK 20-10-76-400-001

(3) Install the FSEU, do this task: Flap/Slat Electronics Unit Installation, TASK 27-51-01-400-801.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SUBTASK 20-10-76-410-001

(4) Close this access panel:

Number	Name/Location
117A	Electronic Equipment Access Door

SUBTASK 20-10-76-860-006

(5) Remove the safety tags and close these circuit breakers:

CAPT Electrical System Panel, P18-2

Row	Col	Number	Name
C	10	C00468	FLIGHT RECORDER DC

F/O Electrical System Panel, P6-2

Row	Col	Number	Name
A	6	C00566	FLIGHT CONTROL FLAP LOAD RELIEF
A	7	C00210	FLIGHT CONTROL FLAP SHUTOFF VALVES
A	8	C00211	FLIGHT CONTROL FSEU DC 1
A	11	C01443	FC TE FLAP POS/SKEW SNSR & IND RIGHT
A	12	C00213	FC TE FLAP POS/SKEW SNSR & IND LEFT

END OF TASK

TASK 20-10-76-700-803

4. LE Flap/Slat Sensor Resistance Check - Check III

A. General

(1) This task contains the procedure for resistance testing the LE flap & slat sensors and interface wiring.

(2) The test will determine the condition of the electrical sub-components of the LE Flap & Slat Position Sensor System by comparing the resistance against reference.

B. References

Reference	Title
27-51-01-000-801	Flap/Slat Electronics Unit Removal (P/B 401)
27-51-01-400-801	Flap/Slat Electronics Unit 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-1741	Meter - LCR (Inductance, Capacitance, Resistance; Use COM-20443 for OH bleed loop testing) Part #: 878B Supplier: 08098 Part #: 879B Supplier: 08098 Part #: 880 Supplier: 08098 Part #: U1733P Supplier: 1LQK8 Opt Part #: 875B Supplier: 08098 Opt Part #: 878A Supplier: 08098 Opt Part #: 879 Supplier: 08098

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(Continued)

Reference	Description
SPL-18771	Breakout Box - 66 Pin Electrical/Insulation Resistance Part #: A22002-72 Supplier: 81205
SPL-18772	Cable Set - 737NG LE/TE Flap/Slats Test Part #: A22002-73 Supplier: 81205

D. Location Zones

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

E. Access Panels

Number	Name/Location
117A	Electronic Equipment Access Door

F. LE Flap/Slat Sensor Resistance Check - Check III

SUBTASK 20-10-76-860-007

(1) Make sure that the flaps are in the UP position.

SUBTASK 20-10-76-860-008

(2) Open these circuit breakers and install safety tags:

CAPT Electrical System Panel, P18-2

Row	Col	Number	Name
C	10	C00468	FLIGHT RECORDER DC

F/O Electrical System Panel, P6-2

Row	Col	Number	Name
A	6	C00566	FLIGHT CONTROL FLAP LOAD RELIEF
A	7	C00210	FLIGHT CONTROL FLAP SHUTOFF VALVES
A	8	C00211	FLIGHT CONTROL FSEU DC 1
A	11	C01443	FC TE FLAP POS/SKEW SNSR & IND RIGHT
A	12	C00213	FC TE FLAP POS/SKEW SNSR & IND LEFT

SUBTASK 20-10-76-010-002

(3) Open this access panel:

Number	Name/Location
117A	Electronic Equipment Access Door

SUBTASK 20-10-76-020-001

(4) Remove Flap/Slat Electronics Unit (FSEU) (TASK 27-51-01-000-801).

SUBTASK 20-10-76-480-003

(5) Install the cable set, SPL-18772, insulation resistance adapter cable assembly “D” on to the FSEU mount.

SUBTASK 20-10-76-480-004

(6) Connect cable set, SPL-18772, insulation resistance adapter cable assembly “D” to the 66 pin resistance breakout box, SPL-18771.

SUBTASK 20-10-76-480-005

(7) Install LCR meter (Inductance, Capacitance, Resistance), COM-1741, leads to the 66 pin resistance breakout box, SPL-18771 (as example Test 1, Table 203):

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(a) Install LCR meter (Inductance, Capacitance, Resistance), COM-1741, positive lead to 66 pin resistance breakout box, SPL-18771 - TP 1.

(b) Install LCR meter (Inductance, Capacitance, Resistance), COM-1741, negative lead to 66 pin resistance breakout box, SPL-18771 - TP 61.

SUBTASK 20-10-76-700-008

WARNING	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.

(8) Set up the LCR meter (Inductance, Capacitance, Resistance), COM-1741 as follows:

(a) Push the L/C/R mode switch to set to R (resistance mode).

(b) Push the 1 kHz/120Hz button to select the 120Hz excitation frequency.

(c) Push the DATA HOLD button once.

(d) Push and hold the L/C/R button until the meter changes to the series mode.

NOTE: “Ser” appears in the upper right corner of the display to indicate that the meter is in the series mode.

SUBTASK 20-10-76-700-009

(9) Read and record the resistance value on the LCR meter (Inductance, Capacitance, Resistance), COM-1741.

NOTE: The Nominal Resistance reading at normal room temperature (CMM DC resistance, bench test condition) referred to as L1. L1 should be 27 to 33 ohms (+2 ohms for wiring = 29 to 35 ohms). The permitted resistance reading for in-service sensors exposed to varying conditions is 24 to 38 ohms. The Nominal Resistance reading at normal room temperature (CMM DC resistance, bench test condition) referred to as R1. R1 should be 344.5 to 351.5 ohms (+2 ohms for wiring = 346.5 to 353.5 ohms). The permitted resistance reading for in-service sensors exposed to varying conditions is 338 to 361 ohms. The Nominal Resistance reading at normal room temperature (CMM DC resistance, bench test condition) referred to as C1. C1 should be approximately 32 ohms. The permitted resistance reading for in-service sensors exposed to varying conditions is 20 to 100 ohms.

On wing resistance readings will vary with the temperature of the proximity sensor. The resistance values can be outside the permitted limits and the proximity sensor can still be serviceable. The copper metal has a temperature coefficient of resistance that is approximately 0.40 ohm/°C. The deviation of the coil circuit (generally the yellow-red circuit can be calculated at the rate of 0.40 ohm/°C from the Standard Temperature (77°F (25°C)).

SUBTASK 20-10-76-700-010

(10) Move test leads of the LCR meter (Inductance, Capacitance, Resistance), COM-1741, for each test (Test 2 to 54 in Table 203).

(a) Make sure to record the resistance for evaluation.

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Table 203/20-10-76-993-807-001 LE Flap/Slat Sensor Resistance Check

TEST	POSITIVE LEAD TEST POINT	NEGATIVE LEAD TEST POINT	RESISTANCE REQUIREMENT (OHMS)	RESISTANCE MEASUREMENT	REMARKS
1	TP1	TP61	24 - 38		S994
2	TP2	TP61	338 - 361		S994
3	TP3	TP61	24 - 38		S995
4	TP4	TP61	338 - 361		S995
5	TP5	TP61	24 - 38		S996
6	TP6	TP61	338 - 361		S996
7	TP7	TP61	24 - 38		S997
8	TP8	TP61	338 - 361		S997
9	TP9	TP61	24 - 38		S998
10	TP10	TP61	338 - 361		S998
11	TP11	TP61	24 - 38		S999
12	TP12	TP61	338 - 361		S999
13	TP13	TP61	24 - 38		S1000
14	TP14	TP61	338 - 361		S1000
15	TP15	TP61	24 - 38		S1001
16	TP16	TP61	338 - 361		S1001
17	TP17	TP61	24 - 38		S168
18	TP18	TP61	338 - 361		S168
19	TP19	TP61	24 - 38		S169
20	TP20	TP61	338 - 361		S169
21	TP21	TP61	24 - 38		S170
22	TP22	TP61	338 - 361		S170
23	TP23	TP61	24 - 38		S171
24	TP24	TP61	338 - 361		S171
25	TP25	TP61	24 - 38		S1008
26	TP26	TP61	338 - 361		S1008
27	TP27	TP61	24 - 38		S1009
28	TP28	TP61	338 - 361		S1009
29	TP29	TP61	24 - 38		S1006
30	TP30	TP61	338 - 361		S1006
31	TP31	TP61	24 - 38		S1007
32	TP32	TP61	338 - 361		S1007
33	TP33	TP61	24 - 38		S1004

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Table 203/20-10-76-993-807-001 LE Flap/Slat Sensor Resistance Check (Continued)

TEST	POSITIVE LEAD TEST POINT	NEGATIVE LEAD TEST POINT	RESISTANCE REQUIREMENT (OHMS)	RESISTANCE MEASUREMENT	REMARKS
34	TP34	TP61	338 - 361		S1004
35	TP35	TP61	24 - 38		S1005
36	TP36	TP61	338 - 361		S1005
37	TP37	TP61	24 - 38		S1002
38	TP38	TP61	338 - 361		S1002
39	TP39	TP61	24 - 38		S1003
40	TP40	TP61	338 - 361		S1003
41	TP41	TP61	24 - 38		S174
42	TP42	TP61	338 - 361		S174
43	TP43	TP61	24 - 38		S175
44	TP44	TP61	338 - 361		S175
45	TP45	TP61	24 - 38		S172
46	TP46	TP61	338 - 361		S172
47	TP47	TP61	24 - 38		S173
48	TP48	TP61	338 - 361		S173
49	TP49	TP50	20 - 100		S1094
50	TP51	TP52	20 - 100		S1095
51	TP53	TP54	20 - 100		S1096
52	TP55	TP56	20 - 100		S1097
53	TP57	TP58	20 - 100		S1098
54	TP59	TP60	20 - 100		S1099

G. Test Evaluation

SUBTASK 20-10-76-700-011

(1) Evaluate each of the test results of resistance tests recorded in Table 203.

(a) If any of test where the resistance result value is equal or less than the resistance requirements, it is recommended to further fault isolate the fault.

1) Fault isolate by disconnecting applicable Line Replaceable Unit (LRU) and do the resistance test to isolate between LRU and wiring.

(b) If all of tests where the resistance result values meet the required readings then no further action is required.

H. Put the Airplane Back to Its Usual Condition

SUBTASK 20-10-76-080-003

(1) Disconnect the electrical leads of the LCR meter (Inductance, Capacitance, Resistance), COM-1741, from the 66 pin resistance breakout box, SPL-18771.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SUBTASK 20-10-76-080-004

(2) Remove the cable set, SPL-18772, insulation resistance adapter cable assembly “D” from the FSEU mount.

SUBTASK 20-10-76-420-001

(3) Install the FSEU, do this task: Flap/Slat Electronics Unit Installation, TASK 27-51-01-400-801.

SUBTASK 20-10-76-410-002

(4) Close this access panel:

Number	Name/Location
117A	Electronic Equipment Access Door

SUBTASK 20-10-76-860-009

(5) Remove the safety tags and close these circuit breakers:

CAPT Electrical System Panel, P18-2

Row	Col	Number	Name
C	10	C00468	FLIGHT RECORDER DC

F/O Electrical System Panel, P6-2

Row	Col	Number	Name
A	6	C00566	FLIGHT CONTROL FLAP LOAD RELIEF
A	7	C00210	FLIGHT CONTROL FLAP SHUTOFF VALVES
A	8	C00211	FLIGHT CONTROL FSEU DC 1
A	11	C01443	FC TE FLAP POS/SKEW SNSR & IND RIGHT
A	12	C00213	FC TE FLAP POS/SKEW SNSR & IND LEFT

END OF TASK

TASK 20-10-76-700-804

5. LE Flap/Slat Proximity Sensor Check - Check IV

A. General

(1) This procedure checks the health of the proximity sensors system for the leading edge flaps and slats in UP, EXTEND and FULLY EXTENDED positions.

(2) The data collected on the proximity sensors can be used to troubleshoot failing sensors.

B. References

Reference	Title
29-11-00-860-801	Hydraulic System A or B Pressurization (P/B 201)
29-11-00-860-805	Hydraulic System A or B Power Removal (P/B 201)

C. Location Zones

Zone	Area
117	Electrical and Electronics Compartment - Left
118	Electrical and Electronics Compartment - Right
211	Flight Compartment - Left
212	Flight Compartment - Right
500	Left Wing
600	Right Wing

ECCN 9E991 BOEING PROPRIETARY - See title page for details

D. Access Panels

Number	Name/Location
117A	Electronic Equipment Access Door

E. Procedure

SUBTASK 20-10-76-860-010

> **WARNING**
> MAKE SURE PERSONS AND EQUIPMENT ARE CLEAR OF THE LEADING EDGE AND TRAILING EDGE CONTROL SURFACES. THE LEADING EDGE AND TRAILING EDGE CONTROL SURFACES CAN EXTEND AND RETRACT QUICKLY. THIS CAN CAUSE INJURY TO PERSONS AND DAMAGE TO EQUIPMENT.

> **CAUTION**
> MAKE SURE THE INBOARD FAN DUCT COWL AND THE INBOARD AND OUTBOARD THRUST REVERSERS ARE CLOSED OR REMOVED BEFORE YOU EXTEND THE LEADING EDGE FLAPS AND SLATS IN THIS TEST. THERE IS NOT SUFFICIENT CLEARANCE FOR THE FLAPS AND SLATS TO EXTEND IF THE INBOARD FAN DUCT COWL AND THE THRUST REVERSERS ARE IN THE OPEN POSITION. THIS CAN CAUSE DAMAGE TO EQUIPMENT.

(1) Make sure the inboard fan duct cowl and the inboard and outboard thrust reversers are closed before extending the leading edge flaps and slats.

SUBTASK 20-10-76-010-003

(2) Open this access panel:

Number	Name/Location
117A	Electronic Equipment Access Door

SUBTASK 20-10-76-860-011

> **WARNING**
> KEEP PERSONS AND EQUIPMENT CLEAR OF THE FLIGHT CONTROL SURFACES, THE THRUST REVERSERS, AND THE LANDING GEAR. THESE COMPONENTS CAN MOVE SUDDENLY WHEN YOU SUPPLY HYDRAULIC POWER. THIS CAN CAUSE INJURIES TO PERSONS AND DAMAGE TO EQUIPMENT.

(3) Do this task: Hydraulic System A or B Pressurization, TASK 29-11-00-860-801.

SUBTASK 20-10-76-860-012

(4) Make sure the flap control lever is in the FLAP UP detent position with the leading edge (LE) flaps and slats in the retract position.

SUBTASK 20-10-76-720-001

(5) Do a test of the leading edge flap and slat proximity sensors:

(a) Push the ON/OFF button on the front panel of the Flap/Slat Electronics Unit (FSEU) to turn on the display.

1) EXISTING FAULTS? is displayed in front of FSEU.

(b) Push the down arrow until OTHER FUNCTNS? is displayed.

(c) Push the YES button to select OTHER FUNCTNS?.

(d) Push the down arrow until I/O MONITOR? is displayed.

(e) Push the YES button to select PROX SENSORS? from the I/O MONITOR? menu.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(f) Push the down arrow to step through the proximity sensor states at the leading edge flaps and slats UP position.

1) Record the reported position displayed on the FSEU for each test point and sensor using Table 204.

Table 204/20-10-76-993-808-001 Flaps Up Position Sensor Readings

TEST POINT	SENSOR	REQUIRED POSITION	REPORTED POSITION	REMARKS	SENSOR
1	S1 OUTBD	GAP NEAR			S994
2	S1 INBD	GAP NEAR			S995
3	S2 OUTBD	GAP FAR			S996
4	S2 INBD	GAP FAR			S997
5	S2 RETR	GAP NEAR			S1094
6	S3 OUTBD	GAP FAR			S998
7	S3 INBD	GAP FAR			S999
8	S3 RETR	GAP NEAR			S1095
9	S4 OUTBD	GAP FAR			S1000
10	S4 INBD	GAP FAR			S1001
11	S4 RETR	GAP NEAR			S1096
12	S5 OUTBD	GAP FAR			S1002
13	S5 INBD	GAP FAR			S1003
14	S5 RETR	GAP NEAR			S1097
15	S6 OUTBD	GAP FAR			S1004
16	S6 INBD	GAP FAR			S1005
17	S6 RETR	GAP NEAR			S1098
18	S7 OUTBD	GAP FAR			S1006
19	S7 INBD	GAP FAR			S1007
20	S7 RETR	GAP NEAR			S1099
21	S8 OUTBD	GAP NEAR			S1008
22	S8 INBD	GAP NEAR			S1009
23	F1 RETR	GAP NEAR			S168
24	F1 EXT	GAP FAR			S169
25	F2 RETR	GAP NEAR			S170
26	F2 EXT	GAP FAR			S171
27	F3 RETR	GAP NEAR			S172
28	F3 EXT	GAP FAR			S173
29	F4 RETR	GAP NEAR			S174
30	F4 EXT	GAP FAR			S175

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SUBTASK 20-10-76-860-013

WARNING MAKE SURE PERSONS AND EQUIPMENT ARE CLEAR OF THE LEADING EDGE AND TRAILING EDGE CONTROL SURFACES. THE LEADING EDGE AND TRAILING EDGE CONTROL SURFACES CAN EXTEND AND RETRACT QUICKLY. THIS CAN CAUSE INJURY TO PERSONS AND DAMAGE TO EQUIPMENT.

(6) Move the flap control lever to the 1-unit detent position.

(a) Make sure these lights come on during the flaps and slats extension and go off after extension;

1) The LE FLAPS TRANSIT light on the center instrument panel, P2-2.

2) All the LE flaps and slats TRANSIT lights on the aft overhead panel, P5-12.

SUBTASK 20-10-76-720-002

(7) Push the down arrow on the FSEU to step through the proximity sensor states.

(a) Record the reported position displayed on the FSEU for each test point and sensor using Table 205.

Table 205/20-10-76-993-809-001 Flaps 1 Detent Position Sensor Readings

TEST POINT	SENSOR	REQUIRED POSITION	REPORTED POSITION	REMARKS	SENSOR
1	S1 OUTBD	GAP FAR			S994
2	S1 INBD	GAP NEAR			S995
3	S2 OUTBD	GAP FAR			S996
4	S2 INBD	GAP NEAR			S997
5	S2 RETR	GAP FAR			S1094
6	S3 OUTBD	GAP FAR			S998
7	S3 INBD	GAP NEAR			S999
8	S3 RETR	GAP FAR			S1095
9	S4 OUTBD	GAP FAR			S1000
10	S4 INBD	GAP NEAR			S1001
11	S4 RETR	GAP FAR			S1096
12	S5 OUTBD	GAP FAR			S1002
13	S5 INBD	GAP NEAR			S1003
14	S5 RETR	GAP FAR			S1097
15	S6 OUTBD	GAP FAR			S1004
16	S6 INBD	GAP NEAR			S1005
17	S6 RETR	GAP FAR			S1098
18	S7 OUTBD	GAP FAR			S1006
19	S7 INBD	GAP NEAR			S1007
20	S7 RETR	GAP FAR			S1099

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Table 205/20-10-76-993-809-001 Flaps 1 Detent Position Sensor Readings (Continued)

TEST POINT	SENSOR	REQUIRED POSITION	REPORTED POSITION	REMARKS	SENSOR
21	S8 OUTBD	GAP FAR			S1008
22	S8 INBD	GAP NEAR			S1009
23	F1 RETR	GAP FAR			S168
24	F1 EXT	GAP NEAR			S169
25	F2 RETR	GAP FAR			S170
26	F2 EXT	GAP NEAR			S171
27	F3 RETR	GAP FAR			S172
28	F3 EXT	GAP NEAR			S173
29	F4 RETR	GAP FAR			S174
30	F4 EXT	GAP NEAR			S175

SUBTASK 20-10-76-860-014

WARNING MAKE SURE PERSONS AND EQUIPMENT ARE CLEAR OF THE LEADING EDGE AND TRAILING EDGE CONTROL SURFACES. THE LEADING EDGE AND TRAILING EDGE CONTROL SURFACES CAN EXTEND AND RETRACT QUICKLY. THIS CAN CAUSE INJURY TO PERSONS AND DAMAGE TO EQUIPMENT.

(8) Move the flap control lever to the 30-unit detent position.

(a) Make sure these lights come on during the flaps and slats extension and go off after extension:

1) The LE FLAPS TRANSIT light on the center instrument panel, P2-2.

2) All the LE flaps and slats TRANSIT lights on the aft overhead panel, P5-12.

SUBTASK 20-10-76-720-003

(9) Push the down arrow on the FSEU to step through the proximity sensor states.

(a) Record the reported position displayed on the FSEU for each test point and sensor using Table 206.

Table 206/20-10-76-993-810-001 Flaps 30 Detent Position Sensor Readings

TEST POINT	SENSOR	REQUIRED POSITION	REPORTED POSITION	REMARKS	SENSOR
1	S1 OUTBD	GAP NEAR			S994
2	S1 INBD	GAP FAR			S995
3	S2 OUTBD	GAP NEAR			S996
4	S2 INBD	GAP FAR			S997
5	S2 RETR	GAP FAR			S1094
6	S3 OUTBD	GAP NEAR			S998
7	S3 INBD	GAP FAR			S999
8	S3 RETR	GAP FAR			S1095

ECCN 9E991 BOEING PROPRIETARY - See title page for details

Table 206/20-10-76-993-810-001 Flaps 30 Detent Position Sensor Readings (Continued)

TEST POINT	SENSOR	REQUIRED POSITION	REPORTED POSITION	REMARKS	SENSOR
9	S4 OUTBD	GAP NEAR			S1000
10	S4 INBD	GAP FAR			S1001
11	S4 RETR	GAP FAR			S1096
12	S5 OUTBD	GAP NEAR			S1002
13	S5 INBD	GAP FAR			S1003
14	S5 RETR	GAP FAR			S1097
15	S6 OUTBD	GAP NEAR			S1004
16	S6 INBD	GAP FAR			S1005
17	S6 RETR	GAP FAR			S1098
18	S7 OUTBD	GAP NEAR			S1006
19	S7 INBD	GAP FAR			S1007
20	S7 RETR	GAP FAR			S1099
21	S8 OUTBD	GAP NEAR			S1008
22	S8 INBD	GAP FAR			S1009
23	F1 RETR	GAP FAR			S168
24	F1 EXT	GAP NEAR			S169
25	F2 RETR	GAP FAR			S170
26	F2 EXT	GAP NEAR			S171
27	F3 RETR	GAP FAR			S172
28	F3 EXT	GAP NEAR			S173
29	F4 RETR	GAP FAR			S174
30	F4 EXT	GAP NEAR			S175

F. Put the Airplane Back to Its Usual Condition

SUBTASK 20-10-76-860-015

(1) Push the ON/OFF button on the front panel of the FSEU to turn off the display.

SUBTASK 20-10-76-860-016

WARNING

MAKE SURE PERSONS AND EQUIPMENT ARE CLEAR OF THE LEADING EDGE AND TRAILING EDGE CONTROL SURFACES. THE LEADING EDGE AND TRAILING EDGE CONTROL SURFACES CAN EXTEND AND RETRACT QUICKLY. THIS CAN CAUSE INJURY TO PERSONS AND DAMAGE TO EQUIPMENT.

(2) Move the flap control lever to the FLAP UP detent to retract the leading edge flaps and slats.

SUBTASK 20-10-76-860-017

(3) Do this task: Hydraulic System A or B Power Removal, TASK 29-11-00-860-805.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SUBTASK 20-10-76-410-003

(4) Close this access panel:

Number	Name/Location
117A	Electronic Equipment Access Door

END OF TASK

TASK 20-10-76-700-805

6. TE Flap position Indication Excitation Check - Check I

A. General

(1) This check monitors the TE Flap Position Indication and Skew Sensor systems for excitation transients by monitoring current draw and voltage drop.

B. References

Reference	Title
27-51-00-860-801	Trailing Edge Flap System Operation With Primary Control (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-9509	Probe, Clamp-on - Current, AC/DC Part #: 80I-600 Supplier: 89536 Part #: I410 Supplier: 89536 Part #: I800 Supplier: 89536 Part #: i30 Supplier: 89536 Opt Part #: 80I-600A Supplier: 89536
COM-18639	Oscilloscope - Portable Part #: 124B Supplier: 1USX4

D. Location Zones

Zone	Area
211	Flight Compartment - Left
212	Flight Compartment - Right

E. Procedure

SUBTASK 20-10-76-860-018

(1) Open this circuit breaker and install safety tag:

F/O Electrical System Panel, P6-2

Row	Col	Number	Name
A	11	C01443	FC TE FLAP POS/SKEW SNSR & IND RIGHT

SUBTASK 20-10-76-860-019

WARNING BE CAREFUL WHEN YOU OPEN THE P6-2 CIRCUIT BREAKER PANEL. THE P6-2 CIRCUIT BREAKER PANEL CONTAINS HIGH VOLTAGES AND CURRENTS THAT CAN CAUSE INJURY TO PERSONS AND DAMAGE TO EQUIPMENT.

(2) Open P6-2 Right circuit breaker panel.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SUBTASK 20-10-76-480-006

(3) Locate the circuit breaker C01443 on P6-2 panel.

(a) Connect oscilloscope, COM-18639 to either of the circuit breaker's terminals and aircraft ground.

(b) Connect clamp-on probe, COM-9509 around wire W2103-0015-24.

SUBTASK 20-10-76-860-020

(4) Remove the safety tag and close this circuit breaker:

F/O Electrical System Panel, P6-2

Row	Col	Number	Name
A	11	C01443	FC TE FLAP POS/SKEW SNSR & IND RIGHT

SUBTASK 20-10-76-700-012

(5) Prepare to measure voltage and amperage while moving the TE Flaps from UP to 40 and back to UP.

(a) Begin recording voltage and amperage to capture spikes, or dropouts or deviation >20% while flaps are in transit through full range of movement.

(b) Monitor flap position indicator for evidence of lagging, sticking, or leap frogging behavior in either of the flap position indicator needles.

SUBTASK 20-10-76-860-021

(6) Extend the flaps from 0 to 40 degrees using hydraulic power. Do this task: Trailing Edge Flap System Operation With Primary Control, TASK 27-51-00-860-801.

(a) Record the highest and lowest voltage and current values through the flaps down cycle.

SUBTASK 20-10-76-860-022

(7) Retract the flaps from 40 to 0 degrees using hydraulic power. Do this task: Trailing Edge Flap System Operation With Primary Control, TASK 27-51-00-860-801.

(a) Record the highest and lowest voltage and current values through the flaps up cycle.

SUBTASK 20-10-76-700-013

(8) Evaluate the following:

(a) Make sure the recorded voltage and current values through the flaps down/up cycle are within the following readings:

1) Nominal voltage throughout cycle.

a) Voltage = 75VPP to 85VPP or 26VAC to 30VAC.

2) Nominal Amperage throughout cycle.

a) Amperage = 1.0A to 2.0A.

(b) Make sure voltage and current is within nominal range and does not spike or dropout. Also, ensure voltage and amperage does not deviate (gradually increase or decrease) from stationary value >20% during transition.

1) Deviation example:

a) Stationary Value = 1.5A

b) In transit deviation must be <20% = 1.5 X 0.2 = deviation range 1.2A to 1.8A

(c) If values exceeds above, or needles were lagging, sticking or leap frogging, recommend isolating root cause at next maintenance opportunity by performing Trailing Edge (TE) flap indication fault isolation procedure for faults 27-52259 and 27-52260.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SUBTASK 20-10-76-860-023

(9) Open this circuit breaker and install safety tag:

F/O Electrical System Panel, P6-2

Row	Col	Number	Name
A	11	C01443	FC TE FLAP POS/SKEW SNSR & IND RIGHT

SUBTASK 20-10-76-080-005

(10) Remove oscilloscope, COM-18639 and clamp-on probe, COM-9509.

SUBTASK 20-10-76-860-024

(11) Remove the safety tag and close this circuit breaker:

F/O Electrical System Panel, P6-2

Row	Col	Number	Name
A	11	C01443	FC TE FLAP POS/SKEW SNSR & IND RIGHT

SUBTASK 20-10-76-860-025

(12) Open this circuit breaker and install safety tag:

F/O Electrical System Panel, P6-2

Row	Col	Number	Name
A	12	C00213	FC TE FLAP POS/SKEW SNSR & IND LEFT

SUBTASK 20-10-76-480-007

(13) Locate the circuit breaker C00213 on P6-2 circuit breaker panel.

(a) Connect oscilloscope, COM-18639 to either of the circuit breaker's terminals and aircraft ground.

(b) Connect clamp-on probe, COM-9509 around wire W2103-0014-24.

SUBTASK 20-10-76-860-026

(14) Remove the safety tag and close this circuit breaker:

F/O Electrical System Panel, P6-2

Row	Col	Number	Name
A	12	C00213	FC TE FLAP POS/SKEW SNSR & IND LEFT

SUBTASK 20-10-76-700-014

(15) Prepare to measure voltage and amperage while moving the TE Flaps from UP to 40 and back to UP.

(a) Begin recording voltage and amperage to capture spikes, or dropouts or deviation >20% while flaps are in transit through full range of movement.

(b) Monitor flap position indicator for evidence of lagging, sticking, or leap frogging behavior in either of the flap position indicator needles.

SUBTASK 20-10-76-860-027

(16) Extend the flaps from 0 to 40 degrees using hydraulic power. Do this task: Trailing Edge Flap System Operation With Primary Control, TASK 27-51-00-860-801.

(a) Record the highest and lowest voltage and current values through the flaps down cycle.

SUBTASK 20-10-76-700-015

(17) Retract the flaps from 40 to 0 degrees using hydraulic power. Do this task: Trailing Edge Flap System Operation With Primary Control, TASK 27-51-00-860-801.

(a) Record the highest and lowest voltage and current values through the flaps up cycle.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SUBTASK 20-10-76-700-016

(18) Evaluate the following:

(a) Make sure the recorded voltage and current values through the flaps down/up cycle are within the following readings:

1) Nominal voltage throughout cycle.

a) Voltage = 75VPP to 85VPP or 26VAC to 30VAC.

2) Nominal Amperage throughout cycle.

a) Amperage = 1.0A to 2.0A.

(b) Make sure voltage and current is within nominal range and does not spike or dropout. Also, ensure voltage and amperage does not deviate (gradually increase or decrease) from stationary value >20% during transition.

1) Deviation example:

a) Stationary Value = 1.5A

b) In transit deviation must be <20% = 1.5 X 0.2 = deviation range 1.2A to 1.8A

(c) If values exceeds above, or needles were lagging, sticking or leap frogging, recommend isolating root cause at next maintenance opportunity by performing TE flap indication fault isolation procedure for faults 27-52259 and 27-52260.

SUBTASK 20-10-76-860-028

(19) Open this circuit breaker and install safety tag:

F/O Electrical System Panel, P6-2

Row	Col	Number	Name
A	12	C00213	FC TE FLAP POS/SKEW SNSR & IND LEFT

SUBTASK 20-10-76-080-006

(20) Remove oscilloscope, COM-18639 and clamp-on probe, COM-9509.

SUBTASK 20-10-76-410-004

(21) Close P6-2 right circuit breaker panel.

SUBTASK 20-10-76-860-029

(22) Remove the safety tag and close this circuit breaker:

F/O Electrical System Panel, P6-2

Row	Col	Number	Name
A	12	C00213	FC TE FLAP POS/SKEW SNSR & IND LEFT

——— END OF TASK ———

TASK 20-10-76-700-806

7. TE Flap Indication System Insulation Resistance Check - Check II

A. General

(1) This task contains the procedure for performing Flap Position Indicator, Flap Position Transmitters, Flap Skew Sensors and interface wiring Insulation Resistance Predictive health Check.

(2) The test will determine the condition of the electrical sub-components of the Flap Position and Skew Sensor system by comparing the Insulation Resistance (IR) and Dielectric Absorption Rate (DAR).

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(3) Review Insulation Resistance Testing - Special Detail Inspection, TASK 20-10-39-700-801 prior to performing this procedure.

B. References

Reference	Title
20-10-39-700-801	Insulation Resistance Testing - Special Detail Inspection (P/B 501)
22-11-00-740-802	Digital Flight Control System (DFCS) - System Test (P/B 501)
27-51-00-740-801	FSEU Display and Existing Faults Test (P/B 501)
27-51-00-740-802	Trailing Edge Flap Asymmetry Skew System BITE Test (P/B 501)
27-51-00-740-803	Trailing Edge Flap Load Relief System BITE Test (P/B 501)
32-31-00-730-802	System Test - Landing Gear Control System (P/B 501)
34-45-01-400-801	TCAS Computer Installation (P/B 401)
34-61-00-710-801	Flight Management Computer System - Operational 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-17798	Multimeter - Digital, Insulation Resistance Part #: 1004-745 Supplier: U0146 Part #: 1507 Supplier: 4U744 Part #: 1587 FC Supplier: 4U744 Part #: MIT2500 Supplier: U0146 Part #: MIT410/2 Supplier: U0146 Opt Part #: 1587 Supplier: 89536
SPL-18771	Breakout Box - 66 Pin Electrical/Insulation Resistance Part #: A22002-72 Supplier: 81205
SPL-18772	Cable Set - 737NG LE/TE Flap/Slats Test Part #: A22002-73 Supplier: 81205

D. Location Zones

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

E. Access Panels

Number	Name/Location
117A	Electronic Equipment Access Door

F. Procedure

SUBTASK 20-10-76-860-030

(1) Open these circuit breakers and install safety tags:

F/O Electrical System Panel, P6-2

Row	Col	Number	Name
A	11	C01443	FC TE FLAP POS/SKEW SNSR & IND RIGHT
A	12	C00213	FC TE FLAP POS/SKEW SNSR & IND LEFT

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SUBTASK 20-10-76-010-004

(2) Open this access panel:

Number	Name/Location
117A	Electronic Equipment Access Door

SUBTASK 20-10-76-480-008

(3) Connect cable set, SPL-18772, Insulation Resistance Adapter Cable Assy “B” to 66 pin resistance breakout box, SPL-18771.

SUBTASK 20-10-76-480-009

(4) Connect cable set, SPL-18772, cable assembly “A” to cable set, SPL-18772 Insulation Resistance Adapter cable assembly “B”.

SUBTASK 20-10-76-020-002

(5) Disconnect connectors D40162P (Position 15), D40180P (Position 16), and D40019P (Position 30) located at the AE0101A EE bay bracket connectors disconnect on the left-hand side of the E1 rack.

SUBTASK 20-10-76-480-010

(6) Connect feed through cable set, SPL-18772, cable assembly “A” connectors to AE0101A connectors.

(a) Connect cable set, SPL-18772, cable assembly “A” J1 to connector D40162P (AE0101A - Position 15).

(b) Connect cable set, SPL-18772, cable assembly “A” J2 to connector D40180P (AE0101A - Position 16).

(c) Connect cable set, SPL-18772, cable assembly “A” J3 to connector D40019P (AE0101A - Position 30).

(d) Connect cable set, SPL-18772, cable assembly “A” ground Clamp J4 to airplane chassis ground.

SUBTASK 20-10-76-480-011

(7) Install insulation resistance multimeter, COM-17798 leads to 66 pin resistance breakout box, SPL-18771 per Table 207, Test 1. Example:

- Meter positive lead to 66 pin resistance breakout box, SPL-18771 - TP1.
- Meter negative lead to 66 pin resistance breakout box, SPL-18771 - TP14.

SUBTASK 20-10-76-700-017

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.

(8) Set up theinsulation resistance multimeter, COM-17798 as follows:

(a) Press the PI/DAR button until DAR is displayed on the meter's display.

(b) Press the RANGE button until 500V is displayed on the meter's display.

SUBTASK 20-10-76-700-018

(9) Press the release the INSULATION RESISTANCE button to start the 60 second 500VDC test.

(a) During the test, the high voltage symbol will display in the upper left corner and the TEST icon will show in the lower portion of the meter's screen until the test is finished.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(b) The primary display will show the measured Insulation Resistance (IR) and upon test completion, the Dielectric Absorption Ratio (DAR).

1) During testing, observe and record the lowest IR value displayed in Table 207.

2) Upon test completion, record the DAR value at the end of the test (EX. 0.9, 1.0,..1.6, ERR).

NOTE: ERR ≥ 1.6

SUBTASK 20-10-76-700-019

(10) Repeat steps 7, 8, and 9 for each test in Table 207 (Test #2 to #13) and record the IR and DAR observed for each test performed.

Table 207/20-10-76-993-811 Insulation Resistance and Dielectric Absorption Rate Test Table

TEST	POSITIVE LEAD TEST POINT	NEGATIVE LEAD TEST POINT	INSULATION RESISTANCE REQUIREMENT (MEGOHMS)	INSULATION RESISTANCE (IR)*[1]	DIELECTRIC ABSORPTION RATIO (DAR) REQUIREMENT > 1.0*[1]	FAULT ISOLATION/REMARKS
1	TP1	TP14	≥ 20			Left Flap Position Transmitter
2	TP2	TP14	≥ 20			28 VAC Excitation on the Left Wing TE Flap Skew Sensors
3	TP3	TP14	≥ 20			T528 TE Flap Skew Sensor 4 Left Wing LBL 65
4	TP4	TP14	≥ 20			T527 TE Flap Skew Sensor 3 Left Wing LBL 164
5	TP5	TP14	≥ 20			T526 TE Flap Skew Sensor 2 Left Wing LBL 254
6	TP6	TP14	≥ 20			T525 TE Flap Skew Sensor 1 Left Wing LBL 357
7	TP7	TP14	≥ 20			Right flap Postion Transmitter
8	TP8	TP14	≥ 20			28 VAC Excitation on the Right Wing TE Flap Skew Sensors
9	TP9	TP14	≥ 20			T532 TE Flap Skew Sensor 8 Right wing LBL 357
10	TP10	TP14	≥ 20			T531 TE Flap Skew Sensor 7 Right wing LBL 254
11	TP11	TP14	≥ 20			T530 TE Flap Skew Sensor 6 Right wing LBL 164

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Table 207/20-10-76-993-811 Insulation Resistance and Dielectric Absorption Rate Test Table (Continued)

TEST	POSITIVE LEAD TEST POINT	NEGATIVE LEAD TEST POINT	INSULATION RESISTANCE REQUIREMENT (MEGOHMS)	INSULATION RESISTANCE (IR)*[1]	DIELECTRIC ABSORPTION RATIO (DAR) REQUIREMENT > 1.0*[1]	FAULT ISOLATION/REMARKS
12	TP12	TP14	≥ 20			T529 TE Flap Skew Sensor 5 Right wing LBL 65
13	TP13	TP14	≥ 20			Flap Position Indicator

*[1] If outside range, recommend fault isolation per Fault Isolation Manual for maintenance messages 27-52259 and 27-52260 within 6 months or prior to busy the season.

G. Test Evaluation

SUBTASK 20-10-76-700-020

(1) Evaluate each of the test results of IR/DAR tests recorded in Table 207.

(a) If any of test where the IR/DAR result value is equal or less than the IR/DAR requirements, it is recommended to further fault isolate the fault.

1) Fault isolate by disconnecting applicable LRU and do the IR test insulation resistance test to isolate between LRU and wiring.

(b) If all of tests where the IR/DAR result values meet the required readings then no further action is required.

H. Put the Airplane Back to Its Usual Condition

SUBTASK 20-10-76-080-007

(1) Disconnect insulation resistance multimeter, COM-17798 leads from the 66 pin resistance breakout box, SPL-18771.

SUBTASK 20-10-76-080-008

(2) Disconnect feed through cable set, SPL-18772, cable assembly “A” connectors from AE0101A connectors.

(a) Disconnect cable set, SPL-18772, cable assembly “A” J1 from connector D40162P (AE0101A - Position 15).

(b) Disconnect cable set, SPL-18772, cable assembly “A” J2 from connector D40180P (AE0101A - Position 16).

(c) Disconnect cable set, SPL-18772, cable assembly “A” J3 from connector D40019P (AE0101A - Position 30).

(d) Disconnect cable set, SPL-18772, cable assembly “A” ground Clamp J4 from airplane chassis ground.

SUBTASK 20-10-76-420-002

(3) Connect connectors D40162P (Position 15), D40180P (Position 16), and D40019P (Position 30) located at the AE0101A EE bay bracket connectors disconnect on the left-hand side of the E1 rack.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SUBTASK 20-10-76-860-031

(4) Remove the safety tags and close these circuit breakers:

F/O Electrical System Panel, P6-2

Row	Col	Number	Name
A	11	C01443	FC TE FLAP POS/SKEW SNSR & IND RIGHT
A	12	C00213	FC TE FLAP POS/SKEW SNSR & IND LEFT

SUBTASK 20-10-76-700-030

(5) Do this task: FSEU Display and Existing Faults Test, TASK 27-51-00-740-801.

SUBTASK 20-10-76-740-003

(6) Do this task: Trailing Edge Flap Asymmetry Skew System BITE Test, TASK 27-51-00-740-802.

SUBTASK 20-10-76-740-004

(7) Do this task: Trailing Edge Flap Load Relief System BITE Test, TASK 27-51-00-740-803.

SUBTASK 20-10-76-730-003

(8) Do this task: Digital Flight Control System (DFCS) - System Test, TASK 22-11-00-740-802.

SUBTASK 20-10-76-700-031

(9) Do this task: System Test - Landing Gear Control System, TASK 32-31-00-730-802.

SUBTASK 20-10-76-700-032

(10) Do this task: TCAS Computer Installation, TASK 34-45-01-400-801.

SUBTASK 20-10-76-710-002

(11) Do this task: Flight Management Computer System - Operational Test, TASK 34-61-00-710-801.

SUBTASK 20-10-76-410-006

(12) Close this access panel:

Number	Name/Location
117A	Electronic Equipment Access Door

END OF TASK

TASK 20-10-76-700-807

8. TE Flap Indication System Resistance Check - Check III

A. General

(1) This task contains the procedure for resistance testing Flap Position Indicator, Flap Position Transmitters Flap Skew Sensors and interface wiring.

(2) The test will determine the condition of the electrical sub-components of the Flap Position and Skew Sensor system by comparing the resistance against a reference.

B. References

Reference	Title
22-11-00-740-802	Digital Flight Control System (DFCS) - System Test (P/B 501)
27-51-00-740-801	FSEU Display and Existing Faults Test (P/B 501)
27-51-00-740-802	Trailing Edge Flap Asymmetry Skew System BITE Test (P/B 501)
27-51-00-740-803	Trailing Edge Flap Load Relief System BITE Test (P/B 501)
32-31-00-730-802	System Test - Landing Gear Control System (P/B 501)
34-45-01-400-801	TCAS Computer Installation (P/B 401)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(Continued)

Reference	Title
34-61-00-710-801	Flight Management Computer System - Operational 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-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-18771	Breakout Box - 66 Pin Electrical/Insulation Resistance Part #: A22002-72 Supplier: 81205
SPL-18772	Cable Set - 737NG LE/TE Flap/Slats Test Part #: A22002-73 Supplier: 81205

D. Location Zones

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

E. Access Panels

Number	Name/Location
117A	Electronic Equipment Access Door

F. Procedure

SUBTASK 20-10-76-860-032

(1) Open these circuit breakers and install safety tags:

F/O Electrical System Panel, P6-2

Row	Col	Number	Name
A	11	C01443	FC TE FLAP POS/SKEW SNSR & IND RIGHT
A	12	C00213	FC TE FLAP POS/SKEW SNSR & IND LEFT

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SUBTASK 20-10-76-010-005

(2) Open this access panel:

Number	Name/Location
117A	Electronic Equipment Access Door

SUBTASK 20-10-76-480-012

(3) Connect cable set, SPL-18772, cable assembly “A” to 66 pin resistance breakout box, SPL-18771.

SUBTASK 20-10-76-020-003

(4) Disconnect connectors D40162P (Position 15), D40180P (Position 16), and D40019P (Position 30) located at the AE0101A disconnect on the left-hand side of the E1 rack.

SUBTASK 20-10-76-480-013

(5) Connect cable set, SPL-18772, cable assembly “A” connectors to AE0101A connectors.

(a) Connect cable set, SPL-18772, cable assembly “A” J1 to connector D40162P (AE0101A - Position 15).

(b) Connect cable set, SPL-18772, cable assembly “A” J2 to connector D40180P (AE0101A - Position 16).

(c) Connect cable set, SPL-18772, cable assembly “A” J3 to connector D40019P (AE0101A - Position 30).

(d) Connect cable set, SPL-18772, cable assembly “A” ground Clamp J4 to airplane chassis ground.

SUBTASK 20-10-76-700-021

(6) Install digital/analog multimeter, COM-1793, leads to 66 pin resistance breakout box, SPL-18771, per Table 208, Test 1. Example:

- Meter positive lead to 66 pin resistance breakout box, SPL-18771 - TP5.
- Meter negative lead to 66 pin resistance breakout box, SPL-18771 - TP6.

SUBTASK 20-10-76-700-022

(7) Measure and record the resistance of the left wing flap position transmitter and skew sensors per Table 208.

Table 208/20-10-76-993-812 Left Wing Sensors

TEST POINT	POSITIVE LEAD CONNECTION	NEGATIVE LEAD CONNECTION	RESISTANCE REQUIREMENT	REMARKS
1	TP5	TP6	6.0 - 7.4	Left Skew Rotor
2	TP16	TP17	8.0 - 9.8	Skew 1 Stator XY
3	TP17	TP18	8.0 - 9.8	Skew 1 Stator YZ
4	TP16	TP18	8.0 - 9.8	Skew 1 Stator ZX
5	TP13	TP14	7.8 - 9.4	Skew 2 Stator XY
6	TP14	TP15	7.8 - 9.4	Skew 2 Stator YZ
7	TP13	TP15	7.8 - 9.4	Skew 2 Stator ZX
8	TP10	TP11	7.5 - 9.1	Skew 3 Stator XY
9	TP11	TP12	7.5 - 9.1	Skew 3 Stator YZ
10	TP10	TP12	7.5 - 9.1	Skew 3 Stator ZX

ECCN 9E991 BOEING PROPRIETARY - See title page for details

Table 208/20-10-76-993-812 Left Wing Sensors (Continued)

TEST POINT	POSITIVE LEAD CONNECTION	NEGATIVE LEAD CONNECTION	RESISTANCE REQUIREMENT	REMARKS
11	TP7	TP8	7.4 - 9.0	Skew 4 Stator XY
12	TP8	TP9	7.4 - 9.0	Skew 4 Stator YZ
13	TP7	TP9	7.4 - 9.0	Skew 4 Stator ZX
14	TP1	TP3	8.0 - 9.8	Left Position Stator YZ
15	TP1	TP4	8.0 - 9.8	Left Position Stator XZ
16	TP3	TP4	8.0 - 9.8	Left Position Stator XY
17	TP1	TP2	15.3 - 18.7	Left Position Rotor

SUBTASK 20-10-76-700-023

(8) Remove test leads and move them to Test Points per Table 208 to measure and record the left wing sensors resistance for all test points.

SUBTASK 20-10-76-700-024

(9) Measure and record the resistance of the right wing flap position transmitter and skew sensors per Table 209.

Table 209/20-10-76-993-813 Right Wing Sensors

TEST POINT	POSITIVE LEAD CONNECTION	NEGATIVE LEAD CONNECTION	RESISTANCE REQUIREMENT	REMARKS
1	TP23	TP24	6.0 - 7.4	Right Skew Rotor
2	TP25	TP26	7.5 - 9.1	Skew 5 Stator XY
3	TP26	TP27	7.5 - 9.1	Skew 5 Stator YZ
4	TP25	TP27	7.5 - 9.1	Skew 5 Stator ZX
5	TP28	TP29	7.7 - 9.3	Skew 6 Stator XY
6	TP29	TP30	7.7 - 9.3	Skew 6 Stator YZ
7	TP28	TP30	7.7 - 9.3	Skew 6 Stator ZX
8	TP31	TP32	8.0 - 9.6	Skew 7 Stator XY
9	TP32	TP33	8.0 - 9.6	Skew 7 Stator YZ
10	TP31	TP33	8.0 - 9.6	Skew 7 Stator ZX
11	TP34	TP35	8.2 - 10.0	Skew 8 Stator XY
12	TP35	TP36	8.2 - 10.0	Skew 8 Stator YZ
13	TP34	TP36	8.2 - 10.0	Skew 8 Stator ZX
14	TP19	TP21	8.3 - 10.1	Right Position YZ
15	TP19	TP22	8.3 - 10.1	Right Position XZ
16	TP21	TP22	8.3 - 10.1	Right Position XY
17	TP19	TP20	15.5 - 18.9	Right Position Rotor

SUBTASK 20-10-76-700-025

(10) Remove test leads and move them to Test Points per Table 209 to measure and record the right wing flap position transmitters and skew sensors resistance for all test points.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SUBTASK 20-10-76-700-026

(11) Measure and record the resistance of the flap position indicator per Table 210.

Table 210/20-10-76-993-814 Flap Position Indicator

TEST POINT	POSITIVE LEAD CONNECTION	NEGATIVE LEAD CONNECTION	RESISTANCE REQUIREMENT	REMARKS
1	TP37	TP39	4.9 - 6.0	Left Rotor
2	TP38	TP39	4.9 - 6.0	Right Rotor
3	TP40	TP41	12.3 - 14.0	Left Stator XY
4	TP41	TP39	9.5 - 11.5	Left Stator YZ
5	TP40	TP39	10.2 - 12.4	Left Stator ZX
6	TP42	TP43	12.3 - 14.0	Right Stator XY
7	TP43	TP39	9.5 - 11.5	Right Stator YZ
8	TP42	TP39	10.2 - 12.4	Right Stator ZX

SUBTASK 20-10-76-700-027

(12) Remove test leads and move them to Test Points per Table 210 to measure and record the flap position indicator resistance for all test points.

G. Test Evaluation

SUBTASK 20-10-76-700-028

(1) Evaluate each of the test results of resistance tests recorded in Table 208, Table 209 and Table 210.

(a) For Table 210: If the measured value is outside the resistance requirement range for any test point and there is no active fault, it is acceptable to not perform any additional maintenance or component replacement. The airplane can be dispatched without further maintenance.

(b) If one of the tests does not meet the resistance requirements, it is recommended to do a fault isolation.

1) Disconnect the applicable LRU.

2) Do the resistance test to isolate between LRU and wiring.

(c) If all of the tests meet the resistance requirements, no more action is necessary.

H. Put the Airplane Back to Its Usual Condition

SUBTASK 20-10-76-080-009

(1) Disconnect digital/analog multimeter, COM-1793, leads from the 66 pin resistance breakout box, SPL-18771.

SUBTASK 20-10-76-080-010

(2) Disconnect cable set, SPL-18772, cable assembly “A” connectors from AE0101A connectors.

(a) Disconnect cable set, SPL-18772, cable assembly “A” J1 from connector D40162P (AE0101A - Position 15).

(b) Disconnect cable set, SPL-18772, cable assembly “A” J2 from connector D40180P (AE0101A - Position 16).

(c) Disconnect cable set, SPL-18772, cable assembly “A” J3 from connector D40019P (AE0101A - Position 30).

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(d) Disconnect cable set, SPL-18772, cable assembly “A” ground Clamp J4 from airplane chassis ground.

SUBTASK 20-10-76-420-003

(3) Connect connectors D40162P (Position 15), D40180P (Position 16), and D40019P (Position 30) located at the AE0101A EE bay bracket connectors disconnect on the left-hand side of the E1 rack.

SUBTASK 20-10-76-860-033

(4) Remove the safety tags and close these circuit breakers:

F/O Electrical System Panel, P6-2

Row	Col	Number	Name
A	11	C01443	FC TE FLAP POS/SKEW SNSR & IND RIGHT
A	12	C00213	FC TE FLAP POS/SKEW SNSR & IND LEFT

SUBTASK 20-10-76-700-029

(5) Do this task: FSEU Display and Existing Faults Test, TASK 27-51-00-740-801.

SUBTASK 20-10-76-740-001

(6) Do this task: Trailing Edge Flap Asymmetry Skew System BITE Test, TASK 27-51-00-740-802.

SUBTASK 20-10-76-740-002

(7) Do this task: Trailing Edge Flap Load Relief System BITE Test, TASK 27-51-00-740-803.

SUBTASK 20-10-76-730-002

(8) Do this task: Digital Flight Control System (DFCS) - System Test, TASK 22-11-00-740-802.

SUBTASK 20-10-76-730-001

(9) Do this task: System Test - Landing Gear Control System, TASK 32-31-00-730-802.

SUBTASK 20-10-76-720-004

(10) Do this task: TCAS Computer Installation, TASK 34-45-01-400-801.

SUBTASK 20-10-76-710-001

(11) Do this task: Flight Management Computer System - Operational Test, TASK 34-61-00-710-801.

SUBTASK 20-10-76-410-008

(12) Close this access panel:

Number	Name/Location
117A	Electronic Equipment Access Door

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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

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
24-22-00-860-811	Supply Electrical Power (P/B 201)
24-22-00-860-812	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 20-10-77-860-040

(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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SUBTASK 20-10-77-860-001

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.

SUBTASK 20-10-77-860-003

(3) Do this task: Remove Electrical Power, TASK 24-22-00-860-812.

(a) Make sure that the external electrical cable is disconnected from the airplane.

(b) Make sure that the GRD POWER AVAILABLE light on the P5-4 panel is OFF.

SUBTASK 20-10-77-860-005

(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 20-10-77-860-006

(5) Set the PROBE HEAT A and B switches on the P5-9 panel to ON.

SUBTASK 20-10-77-700-001

(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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SUBTASK 20-10-77-860-007

(7) Set the PROBE HEAT A and B switches on the P5-9 panel to AUTO.

SUBTASK 20-10-77-860-008

(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 20-10-77-860-039

(9) Do this task: Supply Electrical Power, TASK 24-22-00-860-811.

SUBTASK 20-10-77-700-006

(10) Do a check of the recorded data as follows:

(a) Make sure that all resistance values in Table 201 are between 45 to 65 ohms.

(b) If the resistance values are not in range, isolate the root cause at the next maintenance opportunity as follows:

1) Disconnect the applicable pitot probe connector.

2) Make sure that the heater resistance is 45 to 65 ohms.

Table 201/20-10-77-993-804 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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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 test 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 test 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. 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

C. Prepare for the Check

SUBTASK 20-10-77-860-002

(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 an hour.

SUBTASK 20-10-77-860-041

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.

SUBTASK 20-10-77-860-043

(3) Make sure that the PROBE HEAT A and B switches, on the P5-9 panel, are in the AUTO position.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SUBTASK 20-10-77-860-010

(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 20-10-77-860-011

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.

D. Pitot Probe Heater Power Consumption Check - Check II

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.

SUBTASK 20-10-77-860-013

(2) Remove the safety tag and close this circuit breaker:

CAPT Electrical System Panel, P18-3

Row	Col	Number	Name
C	1	C00523	HEATERS CAPT PITOT

SUBTASK 20-10-77-760-002

CAUTION 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 the ON position.

(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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SUBTASK 20-10-77-860-014

(4) Set the PROBE HEAT A switch, on the P5-9 panel, to the AUTO position.

SUBTASK 20-10-77-860-015

(5) Open this circuit breaker and install safety tag:

CAPT Electrical System Panel, P18-3

Row	Col	Number	Name
C	1	C00523	HEATERS CAPT PITOT

SUBTASK 20-10-77-760-003

(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

Row	Col	Number	Name
C	4	C00236	HEATERS ELEV PITOT LEFT

(b) Put the AC/DC current clamp, COM-13988, around the wire for terminal =L.

SUBTASK 20-10-77-860-016

(7) Remove the safety tag and close this circuit breaker:

CAPT Electrical System Panel, P18-3

Row	Col	Number	Name
C	4	C00236	HEATERS ELEV PITOT LEFT

SUBTASK 20-10-77-760-004

CAUTION

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 the ON position.

(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 20-10-77-860-017

(9) Set the PROBE HEAT A switch, on the P5-9 panel, to the AUTO position.

SUBTASK 20-10-77-860-018

(10) Open this circuit breaker and install safety tag:

CAPT Electrical System Panel, P18-3

Row	Col	Number	Name
C	4	C00236	HEATERS ELEV PITOT LEFT

SUBTASK 20-10-77-760-005

(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

Row	Col	Number	Name
D	6	C00524	HEATERS AUX PITOT

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(b) Put the AC/DC current clamp, COM-13988, around the wire for terminal =L.

SUBTASK 20-10-77-860-019

(12) Remove the safety tag and close this circuit breaker:

CAPT Electrical System Panel, P18-3

Row	Col	Number	Name
D	6	C00524	HEATERS AUX PITOT

SUBTASK 20-10-77-760-006

CAUTION

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 the ON position.

(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 20-10-77-860-020

(14) Set the PROBE HEAT B switch, on the P5-9 panel, to the AUTO position.

SUBTASK 20-10-77-860-021

(15) Open this circuit breaker and install safety tag:

CAPT Electrical System Panel, P18-3

Row	Col	Number	Name
D	6	C00524	HEATERS AUX PITOT

SUBTASK 20-10-77-760-007

(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

Row	Col	Number	Name
D	5	C00525	HEATERS F/O PITOT

(b) Put the AC/DC current clamp, COM-13988, around the wire for terminal =L.

SUBTASK 20-10-77-860-022

(17) Remove the safety tag and close this circuit breaker:

CAPT Electrical System Panel, P18-3

Row	Col	Number	Name
D	5	C00525	HEATERS F/O PITOT

SUBTASK 20-10-77-760-008

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 the ON position.

(a) Measure and record the AC voltage at the circuit breaker in Table 202.

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(b) Measure and record the AC amperage in Table 202, for each minute, up to a maximum of 5 minutes.

SUBTASK 20-10-77-860-024

(19) Set the PROBE HEAT B switch, on the P5-9 panel, to the AUTO position.

SUBTASK 20-10-77-860-025

(20) Open this circuit breaker and install safety tag:

CAPT Electrical System Panel, P18-3

Row	Col	Number	Name
D	5	C00525	HEATERS F/O PITOT

SUBTASK 20-10-77-760-009

(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

Row	Col	Number	Name
D	4	C00237	HEATERS ELEV PITOT RIGHT

(b) Put the AC/DC current clamp, COM-13988, around the wire for terminal =L.

SUBTASK 20-10-77-860-026

(22) Remove the safety tag and close this circuit breaker:

CAPT Electrical System Panel, P18-3

Row	Col	Number	Name
D	4	C00237	HEATERS ELEV PITOT RIGHT

SUBTASK 20-10-77-760-010

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 the ON position.

(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 20-10-77-860-027

(24) Set the PROBE HEAT B switch, on the P5-9 panel, to the AUTO position.

SUBTASK 20-10-77-860-029

(25) Remove the AC/DC current clamp, COM-13988.

SUBTASK 20-10-77-860-030

(26) 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

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(Continued)

CAPT Electrical System Panel, P18-3

Row	Col	Number	Name
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 20-10-77-730-004

(27) 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___

(b) If NO was checked, the system meets performance requirements and no further action is required.

(c) If YES was checked, it is recommended to replace the applicable pitot probe at the next maintenance opportunity.

Table 202/20-10-77-993-806 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 ———

TASK 20-10-77-200-803

4. Pitot Probe Heater Insulation Resistance Check - Check III

A. General

(1) This task includes the steps to perform an Insulation Resistance (IR) Predictive Health Check on the Pitot Probe, P5-9 Panel and the interface wiring.

(2) Insulation tests should only be performed on de-energized circuits.

(3) The Pitot Probe IR Check requires access to the rear of the probe to disconnect the negative wires, 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.

(4) The test will determine the condition of the electrical sub-components of the Pitot system by measuring the IR Dielectric Absorption Rate (DAR).

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(a) The DAR test is particularly valuable for uncovering moisture, oil, contaminant ingress that have a flattening effect on the DAR curve, causing leakage current and eventually shorted windings. The DAR is the ratio of two time-resistance readings: one is taken after 60 seconds and the other is taken after 30 seconds. With good insulation, the IR will start low and then increase as the capacitive leakage current and absorption current get smaller. Results are obtained by dividing the 60 sec test value by the 30 sec test value. A low DAR index usually indicates problems with the insulation. The recommended insulation resistance multimeter, COM-17798 or an equivalent, provides an automated timed test providing a ratio of 60s/30s, to identify moisture or contamination in connectors, heater windings, and aircraft wiring installations.

(b) Follow instructions to properly evaluate using Reference Not Currently Available.

(5) Review INSULATION RESISTANCE TESTING - INSPECTION/CHECK, PAGEBLOCK 20-10-39/501, prior to performing this procedure.

(6) Obey all WARNINGS and Cautions during the task.

(7) An insulation resistance multimeter, COM-17798 or an equivalent tool is required for this task.

B. References

Reference	Title
20-10-39 P/B 501	INSULATION RESISTANCE TESTING - INSPECTION/CHECK
24-22-00-860-812	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 FC Supplier: 4U744 Part #: MIT2500 Supplier: U0146 Part #: MIT410/2 Supplier: U0146 Opt Part #: 1587 Supplier: 89536

D. Pitot Probe Heater Insulation Resistance Check

SUBTASK 20-10-77-860-031

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.

NOTE: Make sure the probe is at ambient temperature during testing. The preferred method for probe temperature is to use infrared thermometer or thermal imager. If this is not possible the ambient air temperature may be assumed provided the pitot probe heaters have been turned off for more than an hour.

(1) Remove all covers from the pitot, angle of attack, and total air temperature probes.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SUBTASK 20-10-77-860-032

(2) Remove aircraft electrical power (TASK 24-22-00-860-812).

(a) Make sure that the external electrical power cord is disconnected from the airplane.

(b) Make sure that the GRD POWER AVAILABLE light, on the P5-4 panel, is OFF.

SUBTASK 20-10-77-860-033

NOTE: The following circuit breakers on the P18-3 panel must be open even with power removed from the aircraft. These circuit breakers must be open to eliminate parallel electrical paths to ensure proper measurements.

(3) 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 20-10-77-860-034

(4) Make sure the aircraft remains de-energized, place the P5 window and Pitot heat panel probe heat switches system A and B to ON.

SUBTASK 20-10-77-010-002

(5) Open P18-3 circuit breaker panel.

SUBTASK 20-10-77-700-010

(6) Check CAPT PITOT PROBE HEATER.

(a) Connect the insulation resistance multimeter, COM-17798 leads to the HEATERS CAPT PITOT circuit breaker on the P18-3 as follows:

1) Red probe to the lower terminal of the circuit breaker with wire W0717-22 attached.

2) Black probe to aircraft ground.

(b) Disconnect the pitot probe ground connection at the probe or at the structure.

NOTE: This is to prevent false, bad readings due to pitot heater element being connected to ground.

NOTE: Access requires removal of the probe (TASK 34-11-01-000-801 or TASK 27-31-94-000-801) or by removing flight deck access panels.

1) Make sure that the disconnected negative connection is isolated from the aircraft structure. It will be energized during the following testing.

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.

(c) Do the IR check with an insulation resistance multimeter, COM-17798, as follows:

ECCN 9E991 BOEING PROPRIETARY - See title page for details

1) Follow the tester instructions to install test probes.
2) Set the test voltage to 500 VDC.
3) Set the test mode to DAR.
4) Start the DAR test.

   NOTE: The primary display shows the resistance in megaohms.

5) Record the IR value at 1 minute and the DAR value in Reference Not Currently Available.

   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 20-10-77-700-011

(7) Check ELEV PITOT LEFT PROBE HEATER.

(a) Connect the insulation resistance multimeter, COM-17798 leads to the HEATERS ELEV PITOT LEFT circuit breaker on the P18-3 as follows:

1) Red probe to the lower terminal of the circuit breaker with wire W0715-22 attached.
2) Black probe to aircraft ground.

(b) Disconnect the pitot probe ground connection at the probe or at the structure.

NOTE: This is to prevent false, bad readings due to pitot heater element being connected to ground.

NOTE: Access requires removal of the probe (TASK 34-11-01-000-801 or TASK 27-31-94-000-801) or by removing flight deck access panels.

1) Make sure that the disconnected negative connection is isolated from the aircraft structure. It will be energized during the following testing.

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.

(c) Do the IR check with an insulation resistance multimeter, COM-17798, as follows:

1) Follow the tester instructions to install test probes.
2) Set the test voltage to 500 VDC.
3) Set the test mode to DAR.
4) Start the DAR test.

   NOTE: The primary display shows the resistance in megaohms.

5) Record the IR value at 1 minute and the DAR values in Reference Not Currently Available.

   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 20-10-77-700-012

(8) Check AUX PITOT PROBE HEATER.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(a) Connect the insulation resistance multimeter, COM-17798 leads to the HEATERS AUX PITOT circuit breaker on the P18-3 as follows:

1) Red probe to the lower terminal of the circuit breaker with wire W0720-22 attached.

2) Black probe to aircraft ground.

(b) Disconnect the pitot probe ground connection at the probe or at the structure.

NOTE: This is to prevent false, bad readings due to pitot heater element being connected to ground.

NOTE: Access requires removal of the probe (TASK 34-11-01-000-801 or TASK 27-31-94-000-801) or by removing flight deck access panels.

1) Make sure that the disconnected negative connection is isolated from the aircraft structure. It will be energized during the following testing.

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.

(c) Do the IR check with an insulation resistance multimeter, COM-17798, as follows:

1) Follow the tester instructions to install test probes.

2) Set the test voltage to 500 VDC.

3) Set the test mode to DAR.

4) Start the DAR test

NOTE: The primary display shows the resistance in megaohms.

5) Record the IR value at 1 minute and the DAR values in Reference Not Currently Available.

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 20-10-77-700-013

(9) Check F/O PITOT PROBE HEATER.

(a) Connect the insulation resistance multimeter, COM-17798 leads to the HEATERS F/O PITOT circuit breaker on the P18-3 as follows:

1) Red probe to the lower terminal of the circuit breaker with wire W0721-22 attached.

2) Black probe to aircraft ground.

(b) Disconnect the pitot probe ground connection at the probe or at the structure.

NOTE: This is to prevent false, bad readings due to pitot heater element being connected to ground.

NOTE: Access requires removal of the probe (TASK 34-11-01-000-801 or TASK 27-31-94-000-801) or by removing flight deck access panels.

1) Make sure that the disconnected negative connection is isolated from the aircraft structure. It will be energized during the following testing.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

> **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.

(c) Do the IR check with an insulation resistance multimeter, COM-17798, as follows:

1) Follow the tester instructions to install test probes.
2) Set the test voltage to 500 VDC.
3) Set the test mode to DAR.
4) Start the DAR test.

   NOTE: The primary display shows the resistance in megaohms.

5) Record the IR value at 1 minute and the DAR values in Reference Not Currently Available.

   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 20-10-77-700-014

(10) Check ELEV PITOT RIGHT PROBE HEATER.

(a) Connect the insulation resistance multimeter, COM-17798 leads to the HEATERS ELEV PITOT RIGHT circuit breaker on the P18-3 as follows:

1) Red probe to the lower terminal of the circuit breaker with wire W0719-22 attached.
2) Black probe to aircraft ground.

(b) Disconnect the pitot probe ground connection at the probe or at the structure.

NOTE: This is to prevent false, bad readings due to pitot heater element being connected to ground.

NOTE: Access requires removal of the probe (TASK 34-11-01-000-801 or TASK 27-31-94-000-801) or by removing flight deck access panels.

1) Make sure that the disconnected negative connection is isolated from the aircraft structure. It will be energized during the following testing.

> **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.

(c) Do the IR check with an insulation resistance multimeter, COM-17798, as follows:

1) Follow the tester instructions to install test probes.
2) Set the test voltage to 500 VDC.
3) Set the test mode to DAR.
4) Start the DAR test.

   NOTE: The primary display shows the resistance in megaohms.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

5) Record the IR value at 1 minute and the DAR values in Reference Not Currently Available.

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 20-10-77-860-037

(11) Reconnect all pitot probe ground wires that were disconnected for this test.

(a) If applicable, follow instructions in TASK 34-11-01-400-801 or TASK 27-31-94-400-801 to install the pitot probe.

SUBTASK 20-10-77-860-035

(12) Put the PROBE HEAT switches in the AUTO position.

SUBTASK 20-10-77-860-036

(13) 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

(14) Do the pitot probe installation test (TASK 34-11-01-400-801).

NOTE: Pitot system leak tests are only required if the hose fittings were disconnected to accomplish this test.

E. Test Evaluation

SUBTASK 20-10-77-700-015

(1) Evaluate the results of the IR/DAR tests Reference Not Currently Available.

(a) Is any value measured, less than or equal to 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.

LOM ALL; AIRPLANES WITH PITOT PROBE PART NUMBER 0851HT-2

(b) Is IR less than 100 megaohm?

YES___ NO___

1) If NO was checked, recommend review of data at the next test interval to determine if the IR decreases more.

2) If YES was checked, recommend to disconnect the applicable probe and re-perform the IR test to isolate the fault between the probe and wiring.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

LOM ALL; AIRPLANES WITH PITOT PROBE PART NUMBER 0851HT-2 (Continued)

Table 203/20-10-77-993-807 IR/DAR DATA TABLE

	Positive Lead Connection	Negative Lead Connection	Insulation Resistance (IR) > 100 Megaohms	Dielectric Absorption Rate (DAR) ≥ 1.0	Remarks
1	HEATERS CAPT PITOT	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

LOM ALL; AIRPLANES WITHOUT PITOT PROBE PART NUMBER 0851HT-2

(c) Is IR less than 1 megaohm?

YES___ NO___

1) If NO was checked, recommend review of data at the next test interval to determine if the IR decreases more.

2) If YES was checked, recommend to disconnect the applicable probe and re-perform the IR test to isolate the fault between the probe and wiring.

Table 204/20-10-77-993-808 IR/DAR DATA TABLE

	Positive Lead Connection	Negative Lead Connection	Insulation Resistance (IR) > 1 Megaohms	Dielectric Absorption Rate (DAR) ≥ 1.0	Remarks
1	HEATERS CAPT PITOT	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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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) Equipment Recommendation

(a) Fluke 437-II 400 Hz power quality analyzer, COM-15045 or equivalent.

(2) Usage

(a) Enables user to identify the presence of intermittent, transient and unbalanced power conditions in aircraft systems; i.e. Power sources (Auxiliary Power Unit (APU),Ground Power Unit (GPU) and ENG GEN (Engine Generator)) 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. 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 #: HDPQ XPLORER 400 Plus Supplier: 23207 Part #: PQ3198 Supplier: 1ZJQ1 Opt Part #: FLUKE-437-II Supplier: 89536 Opt Part #: PW3198-01/500 PRO Supplier: 1ZJQ1

C. Procedure

SUBTASK 20-10-78-860-001

(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 analyzer 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.

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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

b) The voltage clips [2] should be attached to an exposed connection (i.e. terminal block).

c) 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, APU or ENG GEN) at a time.

(d) Place system under load. Follow the corresponding AMM procedure 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. The APU is 235VAC/400Hz see SSM/WDM for 115VAC/400Hz connections.

2) Select Scope Button to view waveforms.

a) Make sure the correct waveform for each phase, voltage and frequency.

b) Note any obvious distortion.

3) Select “Phasor” function to ensure correct current clamp hookup to match phase rotation and note correct phase shift.

a) Voltage is the heavy arrow and current is the thin arrow. Phase current and volts should be nearly in phase if 180 out of phase, make sure 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 20-10-78-700-001

(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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(a) If a fault exists when using only one of the generating systems (GPU, APU or ENG GEN):

1) Fault may exist

a) Internal to the generating source.

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:

a) Cycle individual loads one at a time, hydraulic pumps, fuel pumps, etc. Until the unbalanced load circuit is identified.

2) See troubleshooting section to isolate faulty components.

SUBTASK 20-10-78-700-002

(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 procedure.

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 20-10-78-700-003

(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) by:

a) Thermal Imaging - Infrared (IR) camera easily identifies current imbalance, voltage imbalance (drop) via heat signature.

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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

CONNECTION OF ANALYZER TO 3-PHASE DISTRIBUTION SYSTEM (EXAMPLE)

2557686 S0000610023_V1

Power Quality Check
Figure 201/20-10-78-990-801 (Sheet 1 of 2)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

VECTOR DIAGRAM FOR CORRECTLY CONNECTED ANALYZER (EXAMPLE)

2557699 S0000610073_V1

Power Quality Check
Figure 201/20-10-78-990-801 (Sheet 2 of 2)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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) 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)
36-00-00-860-805	Supply Pressure Upstream of the PRSOV (P/B 201)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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 #: 9050 Supplier: 4MJL8 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

WARNING 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.

WARNING 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.

WARNING 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.

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).

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(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.

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).

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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 20-10-79-790-005

(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 20-10-79-790-006

(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 20-10-79-790-007

(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.

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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

AIR CONDITIONING CHECK
(EXAMPLE)

HYDRAULIC BYPASSING CHECK
(EXAMPLE)

2923432 S0000705107_V1

Ultrasonic Leak Probe
Figure 201/20-10-79-990-801

ECCN 9E991 BOEING PROPRIETARY - See title page for details

AIR CONDITIONING CHECK
(EXAMPLE)

(EXAMPLE)

A

2923434 S0000705108_V1

Acoustic Digital Camera
Figure 202/20-10-79-990-802

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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
20-40-12-000-804	Conductive Dust Cap and Connector Cover Removal (P/B 201)
20-40-12-400-804	Conductive Dust Cap and Connector Cover Installation (P/B 201)
24-22-00-860-811	Supply Electrical Power (P/B 201)
24-22-00-860-812	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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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 Unit (LRU) 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 20-10-80-860-001

(3) Do this task: Remove Electrical Power, TASK 24-22-00-860-812.

NOTE: Electrical power must be off to prevent incorrect fault indications or fault messages from occurring.

SUBTASK 20-10-80-300-003

(4) Get access to the applicable wire bundles and LRUs.

SUBTASK 20-10-80-300-004

(5) Select the applicable troubleshooting configuration:

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(a) Circuits Containing One Wire

(b) Circuits Containing Two Wires

(c) ARINC 429 Data Bus Wires.

SUBTASK 20-10-80-300-005

(6) Continue to the steps for the applicable troubleshooting configuration.

E. Circuits Containing One Wire

(Figure 201)

CAUTION	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 20-40-12-400-804.

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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

F. Circuits Containing Two Wires

(Figure 202)

> **CAUTION** 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 20-40-12-400-804.

SUBTASK 20-10-80-760-011

(4) Do these steps to connect two multimeters M1 and M2 (two digital/analog multimeters, 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 20-40-12-400-804.

(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)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

CAUTION 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 20-40-12-400-804.

SUBTASK 20-10-80-760-017

(4) Do these steps to connect two multimeters M1 and M2 (two digital/analog multimeters, 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 20-40-12-400-804.

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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

H. Procedure for the Wire Shake Inspection

CAUTION	DO NOT PUT TOOLS, TOOL TRAYS, AND OTHER WORK ITEMS ON THE WIRES. OBJECTS THAT YOU 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, NICK, OR CAUSE DAMAGE TO THE CABLES, THE WIRES, THE METAL-BRAID SHIELD, OR THE OVER-BRAID. DAMAGE TO THESE COMPONENTS CAN CAUSE MALFUNCTIONS, OR DAMAGE TO OTHER EQUIPMENT.

SUBTASK 20-10-80-211-001

(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 20-40-12-000-804.

2) Reconnect the applicable electrical connector(s) to the applicable LRU(s).

I. Put the Airplane Back to Its Usual Condition

SUBTASK 20-10-80-860-002

(1) If necessary, do this task: Supply Electrical Power, TASK 24-22-00-860-811.

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

CIRCUITS CONTAINING ONE WIRE

CIRCUITS WITH MULTIMETER AND METER-LEAD KIT CONNECTED USING LOAD RESISTOR

2806838 S0000645138_V1

Circuits Containing One Wire (Example)
Figure 201/20-10-80-990-801 (Sheet 1 of 3)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

WIRE SHAKE INSPECTION ASSEMBLY WITH MULTIMETER

A

WIRE SHAKE INSPECTION ASSEMBLY WITH LOAD RESISTOR

B

2806839 S0000645139_V1

Circuits Containing One Wire (Example)
Figure 201/20-10-80-990-801 (Sheet 2 of 3)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

WIRE SHAKE INSPECTION ASSEMBLY WITH MULTIMETER

A

WIRE SHAKE INSPECTION ASSEMBLY WITH JUMPER ADAPTER

B

2806840 S0000645140_V1

Circuits Containing One Wire (Example)
Figure 201/20-10-80-990-801 (Sheet 3 of 3)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

CIRCUITS CONTAINING TWO WIRES

CIRCUITS WITH MULTIMETER AND METER-LEAD KIT CONNECTED USING LOAD RESISTOR

2806841 S0000645141_V1

Circuits Containing Two Wires (Example)
Figure 202/20-10-80-990-802 (Sheet 1 of 2)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

Circuits Containing Two Wires (Example)
Figure 202/20-10-80-990-802 (Sheet 2 of 2)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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

2806843 S0000645143_V1

ARINC 429 Data Bus Wires (Example)
Figure 203/20-10-80-990-803 (Sheet 1 of 2)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

ARINC 429 Data Bus Wires (Example)
Figure 203/20-10-80-990-803 (Sheet 2 of 2)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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 non-prefabricated cables for easier installation when portable swaging machines are available.

C. It is recommended but not required that the cable assemblies on each side of a cable loop be replaced at the same time. This helps the system stay in correct rig as new and used cables stretch at different rates.

TASK 20-10-91-000-801

2. Control Cables Removal

(Figure 401), (Figure 402) and (Figure 403)

A. Equipment

(1) Tension Regulator Tool

B. References

Reference	Title
20-10-04-000-801	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 Locking Clips Removal (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
SPL-1569	Clamp - Control Cable Part #: A20005-9 Supplier: 81205

D. Consumable Materials

Reference	Description	Specification
G00270	Tape - Scotch Flatback Masking 250	ASTM D6123 (Supersedes A-A-883)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

E. Procedure

CAUTION

IF YOU WILL INSTALL A NEW CABLE, USE THE INSTALLED CABLE TO PULL IT THROUGH INTO ITS POSITION. IF YOU DO NOT OBEY, YOU CAN HAVE A PROBLEM ROUTING THE NEW CABLE.

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 Locking Clips Removal, TASK 20-10-10-000-801.

SUBTASK 20-10-91-020-002

(3) If necessary, do this task: Control Cable Half Ball Pressure Seal Removal, TASK 20-10-04-000-801.

SUBTASK 20-10-91-420-001

(4) If necessary, 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 the cables do not move out of the pulley guides.

SUBTASK 20-10-91-480-002

(5) If necessary, install the tension regulator tool on the elevator control cables to keep light tension on the cables.

NOTE: The tension regulator tool is for use on the elevator control cables only.

SUBTASK 20-10-91-480-001

(6) 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

(7) Do these steps to remove the cable:

(a) If necessary, do this task: Control Cable Pulleys Removal, TASK 20-10-09-000-801.

(b) Remove the cable.

(c) Install the new cable at the same time you remove the old cable. Use the old cable to pull the new cable into its position.

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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

3077621 S0000834814_V1

Control Cables Installation
Figure 401/20-10-91-990-802 (Sheet 1 of 2)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

3077623 S0000834815_V1

Control Cables Installation
Figure 401/20-10-91-990-802 (Sheet 2 of 2)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(EXAMPLE)

3077624 S0000834817_V1

Typical Fairlead Installation
Figure 402/20-10-91-990-803

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(EXAMPLE)

3077629 S0000833974_V1

Typical Rubstrip Installation
Figure 403/20-10-91-990-804

ECCN 9E991 BOEING PROPRIETARY - See title page for details

TASK 20-10-91-400-801

3. Control Cables Installation

(Figure 401), (Figure 402) and (Figure 403)

A. General

(1) If this procedure does not agree with a specified maintenance procedure, use the specified maintenance procedure.

(2) Detailed data is in Chapter 27 for flight control cables and Chapter 32 for Landing Gear Control Cables.

(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
20-10-04-400-801	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)
27-09-14-860-801	Control Cables Identification and Assembly Specifications (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-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 CL A)
G00270	Tape - Scotch Flatback Masking 250	ASTM D6123 (Supersedes A-A-883)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

E. Prefabricated Cable Installation

SUBTASK 20-10-91-420-003

(1) Install the cable.

(a) 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.

(b) 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.

(c) Pull the old cable out, which pulls the new cable through at the same time.

(d) Keep light tension on the new cable.

(e) Remove the control cable clamp, SPL-1569, and rigging pins (if applicable).

SUBTASK 20-10-91-410-001

(2) Do this task: Control Cable Pulleys Installation, TASK 20-10-09-400-801.

SUBTASK 20-10-91-410-004

(3) Do this task: Control Cable Half Ball Pressure Seal Installation, TASK 20-10-04-400-801.

F. Non-prefabricated 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.

I (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).

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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:

(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 the 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)	⅛ 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)	¼ in. (6.350 mm)	9/32 in. (7.144 mm)	5/16 in. (7.938 mm)	⅜ 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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(e) The swaged terminal must have no pits, die marks, or 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 as shown in Figure 401.

(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 (Table 403 or Table 404) to the installed fittings.

NOTE: Applying the proof load to the full length of the cable will check the swaging and also stretch the cable to help reduce tension fall off.

NOTE: If you use a pre-stretched cable, you do not have to apply a proof load to the full length of the cable. You can apply a proof load to each fitting independently.

NOTE: The proof load for stabilizer trim cables shall be 900 ±25 lb (408 ±12 kg).

(a) Make sure that the cable has not been installed and is in a straight line if the proof load is applied to the full length of the cable.

(b) Apply the proof load evenly in not less than 3 seconds and hold the load for a minimum of 5 seconds.

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)	⅛ 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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

Table 404/20-10-91-993-804 Proof Loads For Cable Assemblies

WIRE ROPE TYPE		CABLE DIAMETER *[1]				
		7/32 in. (5.556 mm)	¼ in. (6.350 mm)	9/32 in. (7.144 mm)	5/16 in. (7.938 mm)	⅜ in. (9.525 mm)
		PROOF LOAD				
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 a 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 help with control cable installation, have them remove retainer pins and fairleads when the new cable goes through the pulley. Connect retainer pins and fairleads when the new cable is in its position. Continue with the next pulley until you complete the procedure.

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.

(a) Use the portable cable swager kit, COM-1583, to install the remaining fittings.

(b) Use the terminal pull tester, COM-4837, to apply a proof load to each remaining fitting independently.

1) Make sure that the proof load is not applied to pulleys, fairleads, quadrants, or associated structure.

2) 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

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.

(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 20-10-91-860-001

(14) Do this task: Control Cables Identification and Assembly Specifications, TASK 27-09-14-860-801.

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SUBTASK 20-10-91-420-006

(15) 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

(16) Remove the cable clamps and rigging pins from the control cable and drums.

SUBTASK 20-10-91-080-001

(17) If applicable, remove the tension regulator tool from the elevator control cable.

SUBTASK 20-10-91-410-005

(18) Do this task: Control Cable Pulleys Installation, TASK 20-10-09-400-801.

SUBTASK 20-10-91-210-001

(19) If necessary, do this task: Control Cable Half Ball Pressure Seal Installation, TASK 20-10-04-400-801.

NOTE: Correctly adjusted seals stop deflection of the cable and make sure that the cable is free to move.

SUBTASK 20-10-91-420-007

(20) 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

(21) 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

(22) Make the last rigging adjustments.

NOTE: Refer to the applicable chapter for rigging load.

SUBTASK 20-10-91-220-001

(23) 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) Through a fairlead - 0.50 in. (12.70 mm) (Figure 402).

2) By a rubstrip - 0.10 in. (2.54 mm) (Figure 403).

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.

(d) Make sure that control cables do not touch fairleads, rubstrips, or grommets after rigging in the usual position for operation.

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SUBTASK 20-10-91-420-008

(24) Do this task on all the adjusted turnbuckles: Turnbuckle Lock Installation, TASK 20-10-10-400-801.

SUBTASK 20-10-91-020-006

(25) Remove Scotch Flatback Masking Tape 250, G00270 marked on the cable and fittings.

SUBTASK 20-10-91-710-002

(26) Operate controls through full travel to make sure that cables move freely with minimum force.

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

CONTROL CABLE END RETAINING PLATES - REMOVAL/INSTALLATION

1. General

A. This procedure has these tasks:

(1) A removal of control cable end retaining plates.

(2) An installation of control cable end retaining plates.

TASK 20-10-96-000-801

2. Control Cable End Retaining Plate - Removal

(Figure 401)

A. General

(1) This task includes the steps to remove the control cable end retaining plate.

B. Control Cable End Retaining Plate - Removal

SUBTASK 20-10-96-000-001

(1) Remove the nut [6], the washer [4] (if applicable), washer [5], and the bolt [3] from the retaining plate [2] and the quadrant [7].

SUBTASK 20-10-96-000-002

(2) Move the retaining plate [2] until the cable end [1] is through the larger hole at the other end of the channel in the retaining plate [2].

SUBTASK 20-10-96-000-003

(3) Remove the retaining plate [2] from the cable end [1].

END OF TASK

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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

2977223 S0000752680_V1

**Control Cable End Retaining Plate Installation
Figure 401/20-10-96-990-801**

ECCN 9E991 BOEING PROPRIETARY - See title page for details

TASK 20-10-96-400-801

3. **Control Cable End Retaining Plate - Installation**
(Figure 401)

A. General

(1) This task includes the steps to install the control cable end retaining plate.

B. Control Cable End Retaining Plate - Installation

SUBTASK 20-10-96-400-001

(1) Push the cable end [1] through the larger hole in the channel in the retaining plate [2].

SUBTASK 20-10-96-400-002

(2) Move the retaining plate [2] until the cable end [1] is at the other end of the channel in the retaining plate [2].

SUBTASK 20-10-96-400-003

(3) Turn the retaining plate [2] until the larger hole in the channel aligns with the bolt hole in the quadrant [7].

SUBTASK 20-10-96-400-004

(4) Install the bolt [3], the washer [4] (if applicable), the washer [5], and the nut [6] in the larger hole in the channel in the retaining plate [2] and quadrant [7].

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

AUTOMATED SMALL UNMANNED AERIAL SYSTEM (sUAS) ASSISTED EXTERNAL ZONAL GENERAL VISUAL INSPECTION - MAINTENANCE PRACTICES

1. General

A. This procedure has these tasks to use an automated small Unmanned Aerial System, sUAS, as an alternate method to complete an External Zonal General Visual Inspection (GVI) equivalency.

(1) Automated sUAS Assisted External Zonal GVI Flight Operation.

(2) Inspect the Automated sUAS Assisted Zonal GVI Images.

TASK 20-10-94-210-801

2. Automated sUAS Assisted External Zonal GVI Flight Operation

A. References

Reference	Title
28-11-00-910-801	Purging and Fuel Tank Entry Precautions (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
SPL-21125	sUAS - small Unmanned Aircraft System Part #: DCL90-00002 Supplier: FBEM2 Part #: MB-HW-001 Supplier: H2P60

C. General

SUBTASK 20-10-94-210-001

(1) This automated small Unmanned Aerial System, sUAS, Assisted External Zonal GVI flight operation must be done in accordance with local regulations.

D. Procedure

SUBTASK 20-10-94-210-006

WARNING DO NOT OPERATE THE SMALL UNMANNED-AERIAL-SYSTEM DIRECTLY ABOVE PERSONNEL. IF YOU DO NOT OBEY, DAMAGE TO EQUIPMENT OR INJURY TO PERSONNEL CAN OCCUR.

WARNING DO NOT OPERATE THE SMALL UNMANNED-AERIAL-SYSTEM IN CLASS I, DIVISION 1 OR DIVISION 2 LOCATIONS. IF YOU DO NOT OBEY, DAMAGE TO EQUIPMENT OR INJURY TO PERSONNEL CAN OCCUR.

(1) Follow the automated sUAS manufacturer's instructions to prepare the sUAS, SPL-21125, for flight operation.

NOTE: Refer to the task: Purging and Fuel Tank Entry Precautions, TASK 28-11-00-910-801, for information about Class I, Division 1 or Division 2 locations.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SUBTASK 20-10-94-210-007

(2) Follow the automated sUAS manufacturer's instructions to operate the sUAS, SPL-21125.

NOTE: The automated sUAS will collect inspection images during flight.

NOTE: The small Unmanned Aerial Vehicle, sUAV, will land automatically when the flight operation is complete.

(a) Abort operation of the sUAS, SPL-21125, if necessary.

(b) Do a GVI without a sUAS for areas where the sUAS does not fly, and for areas where the sUAS cannot get a clear image.

——— END OF TASK ———

TASK 20-10-94-210-802

3. Inspect the Automated sUAS Assisted External Zonal GVI Images

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-21125	sUAS - small Unmanned Aircraft System Part #: DCL90-00002 Supplier: FBEM2 Part #: MB-HW-001 Supplier: H2P60

B. Procedure

SUBTASK 20-10-94-210-005

(1) Use the sUAS, SPL-21125 viewer system, to inspect the captured GVI images.

——— END OF TASK ———

ECCN 9E991 BOEING PROPRIETARY - See title page for details

OFF-AIRPLANE DATA LOADING - MAINTENANCE PRACTICES

1. General

A. On-board software loadable LRUs can be loaded with software on the airplane using the AMM Software Installation procedures for each software loadable LRU or off the airplane using these off-airplane loading procedures. The AMM on-airplane Software Installation procedure for each software loadable LRU is contained within the respective ATA chapter for the LRU. This procedure provides details for the software loading of an LRU off the airplane.

TASK 20-15-01-410-801

2. Off-Airplane Software Installation

A. General

(1) Off-airplane data loading equipment may have the capability to support various interfaces: ie ARINC 429, ARINC 629, RS232, and PC cards. Off-airplane data loading equipment may be used to load several software loadable LRUs. Reference the airlines off-airplane data loading policy to determine which LRUs can be off-airplane loaded with the following equipment. For off-airplane data loading equipment information contact an off-airplane data loading equipment vendor directly. Equipment information for the shop data loader, COM-1407 follows.

(2) Modern software loaders that meet the security requirements defined in ARINC 645 are recommended to be used now. The procedures for modern software loaders will be marked as preferred for now and will be the only procedures available after removing floppy disk loaders procedures in the future. Please check with your Software Loader Supplier for current capabilities since this is still maturing across current and future software loaders.

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-1407	Loader - Data, Shop Part #: QSL7X7 Supplier: 0D4J3 Opt Part #: 615 FDS Supplier: 0D4J3

C. Additional Alternative Equipment

SUBTASK 20-15-01-860-001

(1) Data Loader - Shop, Pentar Avionics Headquarters, 19820 North Creek Parkway Suite 102, Bothell, WA 98011

D. Procedures

SUBTASK 20-15-01-410-001

(1) Off-airplane data loading is accomplished on software loadable LRUs that are removed from the airplane or are taken out of stores.

SUBTASK 20-15-01-410-002

(2) An LRU which is removed from the airplane for the purpose of off-airplane loading must be installed using the AMM Removal and Installation procedures. The R & I procedures will require that you make sure that the correct software is installed in the LRU.

SUBTASK 20-15-01-410-003

(3) Refer to the appropriate airline's documentation for the correct software part number or numbers for each software loadable LRU prior to performing this software loading procedure.

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SUBTASK 20-15-01-410-004

(4) The procedures for software loading using off-airplane data loading equipment are documented in the respective supplier's off-airplane data loading equipment user's manual.

SUBTASK 20-15-01-410-005

(5) Refer to the airline's off-airplane data loading policy for additional off-airplane loading equipment and procedures information.

——— END OF TASK ———

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TASK 20-15-11-400-801

1. **On-Airplane Software - Installation**
(Figure 201)

A. General

(1) This task provides the common instructions on how to install software on-airplane.

(a) The complete software installation procedure can be found in the AMM chapter of the component.

(2) Software Installation Times

(a) The time required to install software in a component is variable and is dependent on several factors which include:

1) Retrieval of the correct software media, applicable equipment and Maintenance Manual procedure.

2) Setup procedures.

3) Data transfer time.

4) Software configuration check.

5) Return to usual airplane configuration.

6) Airline completion procedures.

(3) Data Transfer Times - Modern Loaders

(a) As floppy disks are going obsolete, modern airborne and portable loaders are being developed which use many forms of media and often have a mass storage device that stores airplane software locally for software loading. These loaders typically have a user interface to start and status the software load operation.

1) The data transfer time is the time from a “Start Load” entry until a “Load Complete” message is displayed.

2) The data transfer time depends on the total size of the software.

3) Typical software transfer times are about 15 minutes per 2 Mbytes for analyzer, COM-1562, Line Replaceable Unit (LRU)s.

(4) Modern software loaders that meet the security requirements defined in ARINC 645-1 or newer are recommended to use. The procedures for modern software loaders will be marked as preferred for now and will be the only procedures available after removing floppy disk loaders procedures in the future. Please check with your Software Loader Supplier for current capabilities since this is still maturing across current and future software loaders.

(5) Data Transfer Times - Floppy Disk Loaders

(a) The data transfer time is the time from disk or disks insertion into the data loader until the data transfer is complete.

(b) The data transfer time depends on:

1) The number of disks.

2) The type and size of software files on each disk.

3) The unique protocols and processors of the data loader.

4) The unique internal protocols and processors of the component.

5) Disks inserted in a timely manner.

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(c) Typical data transfer times are:

1) Operational Program Software (OPS): approximately 5 to 16 minutes for each disk. For example, if the OPS has four disks, then the complete installation can take as long as 64 minutes.

2) Operational Program Configuration (OPC): approximately 1 to 3 minutes for each disk.

3) Databases (DB): approximately 3 to 15 minutes for each disk.

(d) Short Load

1) Some components can do a short load.

2) During a short load, only pieces of software that are different from what is already in the component are installed during data transfer. This can cause a data transfer time that is much shorter than the time given in Table 201. It is possible that some disks will not be used during software installation.

3) You know that the correct software is installed when the correct software part number shows for the software configuration check.

4) The display electronic unit (DEU) for the Common Display System is an example of a component that can do a short load.

(6) Table 201 - Data Transfer Times

(a) Table 201 shows data transfer 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 given 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.

(c) Data transfer times are approximate times in minutes for software installed with a data loader. Data transfers can fail, and failure of the data transfer will increase the total time necessary for software installation. Data transfer times are supplied only as an aid to help you schedule work.

(d) The times given 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.

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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.

Table 201/20-15-11-993-801 Table 201

AMM CHAPTER	COMPONENT	SOFTWARE	DATA TRANSFER TIME (MINUTES)
22-11	Flight Control Computer (FCC)	OPS	5 to 16
23-15	Satellite Data Unit (Rockwell Collins)	OPS ORT (DB)	15 to 48 1 to 5
23-15	Satellite Data Unit (Honeywell)	USER ORT (DB) SECURED ORT (DB)	1 to 5 1 to 5
23-15	Satellite Data Unit (Thales)	OPS ORT (DB)	15 to 48 1 to 5
23-27 23-27	ACARS Management Unit (AlliedSignal)	CORE & App (OPS) Airplane Database (DB)	5 to 16 1 to 15
23-27 23-27	ACARS Management Unit (Rockwell Collins)	CORE (OPS) AOC (DB)	2 to 16 3 to 15
23-27 23-27	ACARS Management Unit (Teledyne)	Application (OPS)	5 to 16
23-27	ACARS Multi-Purpose Display Unit (MIDU) (AlliedSignal)	OPS *[1]	5 to 6
23-32	Digital Interface Unit (Passenger Flight Information Display System)	Airshow DB *[2]	3 to 15
LOM 427-434, 437-447, 450-999			
23-42	Attendant Control Panel APC Lighting	OPS ACP(DB)	5 to 10 5 to 10
LOM ALL			
31-31	Digital Flight Data Acquisition Unit	DFDAU Mandatory (OPS) *[3] ACMS Monitoring (OPS) *[3]	5 to 32 3 to 20
31-31	Optical Quick Access Recorder (Teledyne)	OPS *[5]	30
31-62	Display Electronic Unit (Common Display System)	OPS OPC DB	35 to 128 1 to 3 2 to 15
34-46	Enhanced Ground Proximity Warning Computer (EGPWC)	DB *[1]	5 to 45

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Table 201/20-15-11-993-801 Table 201 (Continued)

AMM CHAPTER	COMPONENT	SOFTWARE	DATA TRANSFER TIME (MINUTES)
34-61	Flight Management Computer (FMCS)	OPS OPC MEDB NAV DB ACARS Datalink DB*[4] Perf Defaults DB *[4]	10 to 32 1 to 3 3 to 15 3 to 75 3 to 15 3 to 15
34-61	LCD Control Display Unit	OPS	5 to 16
49-61	APU Electronic Control Unit	OPS	5 to 16

*[1] Software installed from PCMCIA card
*[2] Software installed from disk or CD-ROM
*[3] Software installed from disk or PCMCIA card
*[4] Optional software
*[5] Software installed from disk drive at component front panel

(7) Software Loaders

(a) Modern software loaders that meet the security requirements defined in ARINC 645-1 or newer are recommended to use. The procedures for modern software loaders will be marked as preferred for now and will be the only procedures available after removing floppy disk loaders procedures in the future. Please check with your Software Loader Supplier for current capabilities since this is still maturing across current and future software loaders.

(b) A software loader is a LRU or a Ground Support Equipment (GSE) device that connects to software loadable airplane components through interface wiring and can transfer the files of a software part to loadable components.

(c) These are the types of data loaders:

1) Airborne Data Loader (ADL)

a) An airborne data loader is a data loader that is installed in the flight compartment on the P61 panel.

2) Portable Data Loader (PDL)

a) A portable data loader (PDL) is equipment that is moved to the airplane to install software. The PDL is removed from the airplane when the task is complete.

LOM 429-431, 440, 442-447, 450-460, 464-999

3) Enhanced Airborne Data Loader (eADL)

a) An enhanced airborne data loader is a data loader that is installed in the flight compartment on the P61 panel. For detailed instructions on the eADL see the supplier eADL Operations Guide.

b) The eADL software installation:

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LOM 429-431, 440, 442-447, 450-460, 464, 465

<1> Floppy Disk Software Installation

LOM 429-431, 440, 442-447, 450-460, 464-999

<2> USB Flash Drive Software Installation

<a> This procedure uses the USB port on the front panel of the eADL to install software from a valid USB flash drive to the Mass Storage Device (MSD). Once the software is installed on the MSD, the software is loaded to the component.

<b> The USB flash drive must be configured correctly using the USB tool defined in the eADL Operations Guide.

LOM ALL

(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. The control panel has a switch position for each applicable component. There are INOP labels on switch positions that are not available for software installation.

(e) There is an airborne data loader (ADL) or a connector for a portable data loader (PDL) on the P61 panel.

1) A P61 panel with a ADL and PDL switching function, there will only be one data load source at a time.

a) When a PDL is connected to the PDL connector, then the PDL will be the primary data source for data loading.

b) The ADL will be the primary data source for data loading when the PDL is not connected to the PDL connector.

(f) Figure 201 shows examples of data loader control panels, airborne data loaders, and the connector panel for a portable data loader.

(8) Alternative Software Installation

(a) Usually software is installed with a data loader in the flight compartment. But some components have an interface connector, disk drive, CD-ROM drive, or PCMCIA (personal computer memory card international association) interface for software installation at the front of the component.

(9) Airborne Data Loaders (ADL)

(a) This procedure supplies generic procedures for modern and examples for operation of these older floppy-disk based ADLs:

1) AlliedSignal (Sundstrand)

2) Teledyne

3) SFIM

(10) Portable Data Loaders (PDL)

(a) A PDL has an interface cable that is connected to the DATA TRANSFER UNIT RECEPTACLE connector on the P61 panel. The circuit breaker that supplies power for the PDL must be open when a PDL is connected or disconnected.

(b) PDLs are not Boeing supplied tools. Refer to the data loader supplier for instructions for PDL operation.

LOM 429-431, 440, 442-447, 450-460, 464-999

(11) Enhanced Airborne Data Loader (eADL)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(a) Teledyne

LOM ALL

(12) 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.

B. References

Reference	Title
24-22-00-860-811	Supply Electrical Power (P/B 201)
24-22-00-860-812	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-261	Data Loader - ARINC 615 (without ARINC 645-1 Compliant) Part #: 11615-50 Supplier: 0D4J3 Part #: CEI-715-DL-2 Supplier: 0BPH5 Part #: PXS-LDS-10 Supplier: 98571 Opt Part #: 11615-20 Supplier: 0D4J3 Opt Part #: 30100 Supplier: 0BAW0 Opt Part #: 80000-05 Supplier: 0BAW0 Opt Part #: 964-0400-020 Supplier: 97896 Opt Part #: 964-0400-025 Supplier: 97896 Opt Part #: 964-0400-030 Supplier: 97896 Opt Part #: 964-0400-055 Supplier: 97896 Opt Part #: 964-0400-060 Supplier: 97896 Opt Part #: 964-0400-064 Supplier: 97896 Opt Part #: 964-0400-065 Supplier: 97896 Opt Part #: P2K-615A-06 Supplier: 0BAW0

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(Continued)

Reference	Description
COM-1562	Analyzer - Data Bus, ARINC 429 Part #: 01-1001-05 Supplier: 0Z3C6 Part #: 01-1001-12 Supplier: 0Z3C6 Part #: 403557 Supplier: CG603 Part #: 800-0630 Supplier: 1JSZ6 Part #: DT400H-01 Supplier: 0Z3C6 Part #: UA1410 Supplier: 0H231 Opt Part #: 01-1001-10 Supplier: 0Z3C6 Opt Part #: 01-1404-00 Supplier: 41364 Opt Part #: 1116-4000-21 Supplier: A0197 Opt Part #: 429EBP Supplier: 41364 Opt Part #: 429EX Supplier: 41364 Opt Part #: 702125-01 Supplier: CG603 Opt Part #: DT400H Supplier: 0Z3C6 Opt Part #: MODEL 429HBA Supplier: 5J927 Opt Part #: TYPE 030/026 Supplier: $0494
COM-21223	Data Loader - ARINC 615 (with ARINC 645-1 Compliant) Part #: 403474 Supplier: CG603 Part #: 403562 Supplier: CG603 Part #: AE-615-MPDL Supplier: CD624 Part #: PDL-615-XT Supplier: 89Q20

D. Generic Load Procedure for use of modern PDLs - (Preferred)

SUBTASK 20-15-11-860-019

(1) Software may be transferred to the hard drive of the PDL via various modern forms of media. Software may be transferred electronically over a secure network the PDL hard drive.

(2) Use of ARINC 645 or ARINC 645-1 PDLs will require that all software is signed with digital signature for transfer to the PDL.

(3) Connect the PDL to the ARINC 615 data loader, COM-261, or ARINC 645-1 compliant portable data loader, COM-21223, connector on the P11 panel.

(4) Select the target LRU to load via the 20x3 switch.

(5) Select the software part number and target LRU to load via the PDL user interface.

(6) Start the load process and monitor status. Refer to the PDL user guide for details on starting and monitoring load status.

(7) Receive a load complete message or failure message.

(8) If a failure occurs, resolve issue and re-start the load.

(9) Repeat for each software part to be loaded.

E. Generic Load Procedure for use of modern ADLs - (Preferred)

SUBTASK 20-15-11-860-020

(1) Software may be transferred to the hard drive of the ADL via a built-in media drive (e.g. USB port). In some cases, software may be transferred electronically over a secure network via a wireless LRU to the ADL hard drive.

(2) Use of ARINC 645 or ARINC 645-1 ADLs will require that all software is signed with digital signature for transfer to the ADL.

(3) Select the target LRU to load via the 20x3 switch.

(4) Select the software part number and target LRU to load via the ADL user interface.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(5) Start the load process and monitor status. Refer to the PDL user guide for details on starting and monitoring load status.

(6) Receive a load complete message or failure message.

(7) If a failure occurs, resolve issue and re-start the load.

(8) Repeat for each software part to be loaded.

F. AlliedSignal (Sundstrand) Airborne Data Loader Installaition - (Non-Preferred)

SUBTASK 20-15-11-860-002

(1) The AlliedSignal ADL has these status lights:

(a) PROG (In Progress) - shows as software installation occurs.

(b) CHNG (Change) - shows when it is time to install the subsequent disk.

(c) COMP (Complete) - shows when the software installation is completed.

(d) RDY (Ready) - shows when the disk is in the disk drive and the ADL is ready to install the software in the component.

1) If the RDY indication flashes, then the data loader is in standby mode while it waits for the component to validate the data.

(e) XFER (Transfer Fail) - shows the software installation is not completed. Open and close the circuit breaker for the component, and start the installation again.

(f) R/W (Read/Write) - shows when the ADL cannot read or write the data on the disk. Open and close the circuit breaker for the component, and start the installation again. If the problem continues, then replace the disk.

(g) HRDW (Hardware) - shows when the ADL fails the self test.

SUBTASK 20-15-11-860-003

(2) Do these steps to prepare for the software installation:

(a) Do this task: Supply Electrical Power, TASK 24-22-00-860-811.

1) Make sure that the power is not removed while you install software.

NOTE: A power interruption will cause a failure of the software installation.

(b) Make sure that the system select switch on the data loader control panel (P61) is set to NORM or NORMAL.

(c) Open this circuit breaker:

CAPT Electrical System Panel, P18-2

Row	Col	Number	Name
A	9	C00923	DATA LOADER

(d) To open the ADL front cover, pull at the top edge.

(e) Push the eject button on the ADL.

1) If a plastic protective disk is ejected from the disk drive, then remove it.

(f) Close this circuit breaker:

CAPT Electrical System Panel, P18-2

Row	Col	Number	Name
A	9	C00923	DATA LOADER

(g) Wait until all the status lights are off.

NOTE: The status lights will flash on and off while the ADL does a self test.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(h) Make sure that the circuit breakers are closed for the applicable component or system that will receive the new software.

SUBTASK 20-15-11-420-001

(3) Do these steps at the ADL to install the software:

NOTE: You must know the correct software part numbers for the component. For the component to be an approved installation, software with the correct part numbers must be installed.

NOTE: This is a general procedure for software installation. Some components have other steps that are necessary. The software installation task for the component will include all necessary steps.

(a) Set the switch or switches on the data loader control panel to the applicable position for your component or system.

(b) Carefully push the first disk (label up) into the disk drive.

NOTE: If the destination component is active, the installation sequence will begin and the RDY light will come on. When the data transfer begins, the PROG light will come on. The RDY light can flash when the component validates the data. If the software is on more than one disk, the CHNG light will come on when it is time to put in the subsequent disk.

(c) If the CHNG light comes on, wait approximately 10 seconds and then push the eject button.

NOTE: The installation can fail if you wait too long before you remove and install disks.

1) Remove the disk from the disk drive.

2) Put the subsequent disk into the disk drive.

3) If there are more than two disks for the software installation, then remove and install disks until the COMP light shows.

(d) When the COMP light comes on, wait approximately 10 seconds and then push the eject button.

(e) Remove the disk from the disk drive.

(f) If there was a plastic protective disk in the disk drive before you installed software, then put it back into the disk drive.

SUBTASK 20-15-11-860-004

(4) Set the system select switch on the data loader control panel to NORM or NORMAL.

SUBTASK 20-15-11-410-001

(5) Close the front cover on the ADL.

SUBTASK 20-15-11-740-001

(6) Make sure that the correct software part numbers are installed in the component.

NOTE: The software installation task for the component has the steps to do a software configuration check.

SUBTASK 20-15-11-860-005

(7) Do this task: Remove Electrical Power, TASK 24-22-00-860-812.

G. Teledyne Airborne Data Loader Installation - (Non-Preferred)

SUBTASK 20-15-11-860-006

(1) Do these steps to prepare for the software installation:

(a) Do this task: Supply Electrical Power, TASK 24-22-00-860-811.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

1) Make sure that the power is not removed while you install software.

NOTE: A power interruption will cause a failure of the software installation.

(b) Make sure that the system select switch on the data loader control panel (P61) is set to NORM or NORMAL.

(c) Open this circuit breaker:

CAPT Electrical System Panel, P18-2

Row	Col	Number	Name
A	9	C00923	DATA LOADER

(d) To open the ADL front cover, turn the cover knob clockwise and pull.

(e) Push the eject button on the ADL.

1) If a plastic protective disk is ejected from the disk drive, then remove it.

(f) Close this circuit breaker:

CAPT Electrical System Panel, P18-2

Row	Col	Number	Name
A	9	C00923	DATA LOADER

(g) Wait until the display shows INSERT DISK #1.

NOTE: The display lights and the ADL FAIL light will go on and off while the ADL does a self test. When the self test is complete, the display will show INSERT DISK #1.

(h) Make sure that the circuit breakers are closed for the applicable component or system that will receive the new software.

SUBTASK 20-15-11-420-002

(2) Do these steps at the ADL to install the software:

NOTE: You must know the correct software part numbers for the component. For the component to be an approved installation, software with the correct part numbers must be installed.

NOTE: This is a general procedure for software installation. Some components have other steps that are necessary. The software installation task for the component will include all necessary steps.

(a) Set the switch or switches on the data loader control panel to the applicable position for your component or system.

(b) Carefully push the first disk (label up) into the disk drive.

NOTE: The display will show DISK INSERTED and then VOL:. If the destination component is active, the display will then show the file, extension and the percent of the file transfer completed. If there is more than one file, the ADL will install the next file until all files are completed. If the software is on more than one disk, then the display will show CHANGE DISK or INSERT DISK when it is time to put in the subsequent disk.

NOTE: If TRANSFER FAIL shows, then the installation is not completed. Open and close the circuit breaker for the component, and start the installation again. If READ/WRITE FAIL shows, then there is a problem with the disk. Open and close the circuit breaker for the component, and start the installation again. If the problem continues, then replace the disk.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(c) If CHANGE DISK or INSERT DISK shows on the display, wait approximately 10 seconds and then push the eject button.

NOTE: The installation can fail if you wait too long before you remove and install disks.

1) Remove the disk from the disk drive.

2) Put the subsequent disk into the disk drive.

3) If there are more than two disks for the software installation, then remove and install disks until LOAD COMPLETE shows on the display.

(d) When LOAD COMPLETE shows on the display, wait approximately 10 seconds and then push and eject button.

(e) Remove the disk from the disk drive.

(f) If there was a plastic protective disk in the disk drive before you installed software, then put it back in the disk drive.

SUBTASK 20-15-11-860-007

(3) Set the system select switch on the data loader control panel to NORM or NORMAL.

SUBTASK 20-15-11-410-002

(4) Close the front cover on the ADL.

SUBTASK 20-15-11-740-002

(5) Make sure that the correct software part numbers are installed in the component.

NOTE: The software installation task for the component has the steps to do a software configuration check.

SUBTASK 20-15-11-860-008

(6) Do this task: Remove Electrical Power, TASK 24-22-00-860-812.

H. SFIM Airborne Data Loader Installation - (Non-Preferred)

SUBTASK 20-15-11-860-009

(1) Do these steps to prepare for the software installation:

(a) Do this task: Supply Electrical Power, TASK 24-22-00-860-811.

1) Make sure that the power is not removed while you install software.

NOTE: A power interruption will cause a failure of the software installation.

(b) Make sure that the system select switch on the data loader control panel (P61) is set to NORM or NORMAL.

(c) Open this circuit breaker:

CAPT Electrical System Panel, P18-2

Row	Col	Number	Name
A	9	C00923	DATA LOADER

(d) To open the ADL front cover, pull at the top edge.

(e) Push the eject button on the ADL.

1) If a plastic protective disk is ejected from the disk drive, then remove it.

(f) Close this circuit breaker:

CAPT Electrical System Panel, P18-2

Row	Col	Number	Name
A	9	C00923	DATA LOADER

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(g) Wait until the display shows UNIT READY.

NOTE: While the ADL does a self test, the display indicators can flash on and off. TEST IN PROG, TEST COMPLETE and then UNIT READY will show on the display.

(h) Make sure that the circuit breakers are closed for the applicable component or system that will receive the new software.

SUBTASK 20-15-11-420-003

(2) Do these steps at the ADL to install the software:

NOTE: You must know the correct software part numbers for the component. For the component to be an approved installation, software with the correct part numbers must be installed.

NOTE: This is a general procedure for software installation. Some components have other steps that are necessary. The software installation task for the component will include all necessary steps.

(a) Set the switch or switches on the data loader control panel to the applicable position for your component or system.

(b) Carefully push the first disk (label up) into the disk drive.

NOTE: If the destination component is active, the installation sequence will begin. READY and then TRANSF IN PROG will show on the display. Then the display will show the data bus transmitter number and the amount of data. If there is more than one file, the ADL will install the next file until all files are completed. If the software is on more than one disk, the display will show DISK CHANGE or INSERT DISK when it is time to put in the subsequent disk.

NOTE: If TRANSF FAIL shows, then the installation is not completed. Open and close the circuit breaker for the component, and start the installation again. If DISK ERROR shows, then there is a problem with the disk. Open and close the circuit breaker for the component, and start the installation again. If the problem continues, then replace the disk.

(c) If DISK CHANGE or INSERT DISK shows in the display, wait approximately 10 seconds and then push the eject button.

NOTE: The installation can fail if you wait too long before you remove and install disks.

1) Remove the disk from the disk drive.

2) Put the subsequent disk into the disk drive.

3) If there are more than two disks for the software installation, then remove and install disks until the display shows TRANSF COMPLETE.

(d) When TRANSF COMPLETE shows on the display, wait approximately 10 seconds and then push the eject button.

(e) Remove the disk from the disk drive.

(f) If there was a plastic protective disk in the disk drive before you installed software, then put it back into the disk drive.

SUBTASK 20-15-11-860-010

(3) Set the system select switch on the data loader control panel to NORM or NORMAL.

SUBTASK 20-15-11-410-003

(4) Close the front cover on the ADL.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SUBTASK 20-15-11-740-003

(5) Make sure that the correct software part numbers are installed in the component.

NOTE: The software installation task for the component has the steps to do a software configuration check.

SUBTASK 20-15-11-860-011

(6) Do this task: Remove Electrical Power, TASK 24-22-00-860-812.

LOM 429-431, 440, 442-447, 450-460, 464-999

I. Teledyne Enhanced Airborne Data Loader (eADL) Installation - (Non-Preferred)

SUBTASK 20-15-11-860-017

(1) Do these steps to prepare for the installation:

(a) Do this task: Supply Electrical Power, TASK 24-22-00-860-811.

(b) Make sure that the power is not removed while you install software.

NOTE: A power interruption will cause a failure of the software installation.

(2) Make sure that this circuit breaker is closed:

CAPT Electrical System Panel, P18-2

Row	Col	Number	Name
A	9	C00923	DATA LOADER

(a) Make sure that the circuit breakers are closed for the applicable component or system that will receive the new software.

(b) Set the switch or switches on the data loader control panel to the applicable position for the component or system to receive the new software.

(c) Open the eADL front cover by releasing the two screws and lifting up on the cover.

LOM 429-431, 440, 442-447, 450-460, 464, 465

SUBTASK 20-15-11-470-005

(3) Do these steps to install software from a floppy disk:

(a) Wait until the display shows the eADL Main Menu.

NOTE: To navigate UP or DOWN and make a selection on the eADL screen, use the appropriate buttons on the eADL front panel.

1) If the eADL Main Menu does not show, select MAIN or GO BACK until the eADL shows the Main Menu.

(b) Select “Target Page.”

1) The eADL will show the Select Target System screen.

(c) Select “Floppy Drive.”

1) The eADL will show a Load Confirmation screen.

(d) Carefully push the first disk (label up) into the disk drive.

(e) Select “CONFIRM.”

1) The eADL will show “LOADING” on the Transfer In Progress screen.

NOTE: It may take one to two minutes for the installation to start.

NOTE: If the disk set has more than one disk and the data of the current disk is completely transferred, the eADL will prompt you to insert the next diskette. Eject the current diskette, insert the next diskette and select “CONTINUE.”

ECCN 9E991 BOEING PROPRIETARY - See title page for details

2) The “TRANSFER” annunciator will change to “LOADING” and turn yellow during the installation procedure.

3) The “LOADING” annunciator will change to “COMPLETE” and turn green when the installation procedure is completed.

(f) Select “MAIN” or “GO BACK” to go back to the main menu.

(g) Eject the disk from the disk drive when the software installation is completed.

LOM 429-431, 440, 442-447, 450-460, 464-999

SUBTASK 20-15-11-470-006

(4) Do these steps to install software from a USB flash drive to the eADL MSD:

(a) Put the USB flash drive into the eADL USB port.

NOTE: The USB flash drive must be configured correctly as specified in the eADL Operations Guide.

(b) Make sure that the “eADL Main Menu” is shown.

NOTE: To navigate UP or DOWN and make a selection on the eADL screen, use the appropriate buttons on the eADL front panel.

1) If the eADL Main Menu does not show, select MAIN or GO BACK until the eADL shows the Main Menu.

(c) Select “Maintenance Page.”

1) This will show the “Maintenance Menu” screen.

(d) Select “Transfer Parts From USB.”

1) If the error message “USB Is Not Mounted Or Is Not A Valid USB” is shown, select “GO BACK” and do the steps again.

2) Make sure that the USB flash drive is configured correctly by the USB tool as specified in the eADL Operations Guide.

3) The eADL screen will show “CONFIRM TO BEGIN TRANSFERRING.”

4) Select “CONFIRM.”

NOTE: The USB and MSD annunciators will turn yellow during the transfer procedure.

NOTE: If the software is already on the eADL MSD, this message will show: “This part name already exists.”

(e) Make sure that USB and MSB annunciators turn green and the message shows "Part Transfer Complete".

NOTE: This means that software transfer is complete.

NOTE: The annunciators will turn red if the transfer procedure is aborted or if there is a failure.

(f) Select “MAIN” or “GO BACK” to go back to the main menu.

(g) Remove the USB flash drive from the eADL USB port.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(h) Following the successful load of the software perform these steps to remove previous versions from the MSD:

NOTE: This procedure allows the operator to remove an LSP from the MSD. This will also delete any downloaded files associated with the LSP that may have been added to the LSP. This action cannot be undone.

NOTE: It is recommended to remove the older LSP on the MSD, but it is not required.

1) On the eADL use the Up and Down keys and select the following:
   a) Select the Maintenance page.
   b) Select delete Software part option.

      NOTE: The listed LSP may or may not appear as a part number. It will appear as it was originally saved using eADL Part Builder.
   c) Select the desired LSP.
   d) The eADL screen will display, Part Selected for Deletion is <Desired LSP>.
   e) Press the CONFIRM softkey to initiate the deletion process.

      NOTE: If you want to cancel the operation, use the Go Back key.
2) The MSD annunciator will turn yellow while the delete operation is taking place.
3) The MSD annunciator will turn back to green and scree will display:
   a) Part Deleted.
4) Press the GO BACK key to return to the Main Menu.

SUBTASK 20-15-11-470-007

(5) Do these steps to install the software from the eADL MSD to the LRU:

(a) Make sure that the “eADL Main Menu” is shown.

NOTE: To navigate UP or DOWN and make a selection on the eADL screen, use the appropriate buttons on the eADL front panel.

1) If the eADL Main Menu does not show, select MAIN or GO BACK until the eADL shows the Main Menu.

(b) Select “Target Page.”

NOTE: This will show the “Select Target System” screen.

(c) Select the software received by the LRU.

NOTE: This will show the “Select Software Part” screen.

(d) Push the “SELECT” button for the desired software.

NOTE: The listed software will appear as it was originally configured in the USB tool. See the supplier eADL Operations Guide.

(e) Make sure that the “Load Confirmation” screen shows.

(f) Select “CONFIRM”.

NOTE: This will show the “Transfer In Progress” screen.

NOTE: The “TRANSFER” annunciator will change to “LOADING” and turn yellow during the installation procedure.

NOTE: The “LOADING” annunciator will change to “COMPLETE” and turn green when the installation procedure is completed.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(g) Select “MAIN” or “GO BACK” to go back to the main menu.

SUBTASK 20-15-11-470-002

(6) Make sure that the correct software part numbers are installed in the component.

NOTE: The software installation task for the component has the steps to do a software configuration check.

SUBTASK 20-15-11-860-018

(7) Do these steps to put the airplane back to its usual condition:

(a) Close the eADL cover and tighten screws.

(b) Set the system select switch on the data loader control panel (P61) to NORM or NORMAL.

(c) Do this task: Remove Electrical Power, TASK 24-22-00-860-812.

LOM ALL

J. Optional Loading Methods

NOTE: Use this procedure when an airplane is configured for an ADL, but a PDL is the only type of loader available.

SUBTASK 20-15-11-860-012

(1) Make an adapter cable to attach the PDL to an ADL connector.

(a) Use the PDL supplier's manual to find the pins on these connectors to assemble an adapter cable:

1) The MS27473T18A53S connector connects with the PDL connection.

2) The MS27508E18A53P connector connects with the airplane connection.

SUBTASK 20-15-11-860-013

(2) Make sure that the ADL is not energized and the select switch is in the NORMAL position.

SUBTASK 20-15-11-020-001

(3) Turn four mounting screws to the left to remove the ADL.

SUBTASK 20-15-11-020-002

(4) Remove the ADL.

SUBTASK 20-15-11-860-014

(5) Disconnect the airplane connector from the rear of the ADL.

SUBTASK 20-15-11-860-015

(6) Connect the adapter cable as follows:

(a) The MS27473T18A53S connector connects with the PDL connection.

(b) The MS27508E18A53P connector connects with the airplane connection.

SUBTASK 20-15-11-860-016

(7) Use one of the PDL procedures to install the LRU software.

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

DATA LOADER CONTROL PANEL
A
P61 PANEL
AIRBORNE DATA LOADER
B
OR
CONNECTOR PANEL FOR PORTABLE DATA LOADER
C 1

FWD
INBD

FLIGHT COMPARTMENT (EXAMPLE)

CONNECTOR PANEL FOR PORTABLE DATA LOADER
C 2

SYSTEM SELECT SWITCH

DATA LOADER CONTROL PANEL (EXAMPLE)
A

SYSTEM SELECT SWITCH

DATA LOADER CONTROL PANEL (EXAMPLE)
A

1 AIRPLANES WITH THE CONNECTOR PANEL FOR PORTABLE DATA LOADER INSTALLED ON THE UPPER PART OF P61 PANEL.

2 AIRPLANES WITH THE CONNECTOR PANEL FOR PORTABLE DATA LOADER INSTALLED ON THE LOWER PART OF P61 PANEL.

L03683 S0006562063_V3

On-Airplane Software Installation
Figure 201/20-15-11-990-801 (Sheet 1 of 2)

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AIRBORNE DATA LOADER (TELEDYNE)

B

AIRBORNE DATA LOADER (SFIM)

B

ENHANCED AIRBORNE DATA LOADER (EADL) (TELEDYNE)

B 3

AIRBORNE DATA LOADER (ALLIED SIGNAL (SUNDSTRAND))

B

CONNECTOR PANEL FOR PORTABLE DATA LOADER

C

3 EARLIER EADL'S INCLUDED A DISK DRIVE

L03682 S0006562064_V4

On-Airplane Software Installation
Figure 201/20-15-11-990-801 (Sheet 2 of 2)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SELF-LUBRICATING BEARINGS AND BUSHINGS - INSPECTION/CHECK

1. General

A. This procedure contains three tasks:

(1) The first task has two inspection/check procedures of bearings and bushings. One procedure is for bearings and bushings that are installed on the airplane. The other procedure is when the bearings and bushing are on the bench.

(2) The second is an inspection/check of special bushing and bearing configurations. Special bushings and bearings are those with holes, keyways, flanges, threads, or other special properties.

(3) The third is an inspection/check of bushings and bearings (bench check). Do this task after you have done the bench test instructions from the first task. This task gives steps to do a check of the breakaway torques of spherical bearings.

B. You can examine the self-lubricated (teflon-cloth lining) bearings and bushings on the airplane or removed (bench check). The recommended procedure is the bench check. During the bench check you fully examine the parts for signs of damage from corrosion or cracks. Also, you can do a torque check of the bearing inner race.

TASK 20-20-21-210-801

2. Bearing and Bushings - Inspection/Check

A. Procedure - Check of Self-Lubricated Bearings and Bushings (Installed on the Airplane)

SUBTASK 20-20-21-210-001

> **CAUTION**: DO NOT LUBRICATE TEFLON BEARINGS. TEFLON BEARINGS ARE SELF-LUBRICATED. GREASE OR OTHER LUBRICANTS CAN CAUSE LINING DETERIORATION.

(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 inch 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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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.

B. Procedure - Check of Self-Lubricated Bearing and Bushing (Bench Check)

SUBTASK 20-20-21-210-004

CAUTION	DO NOT LUBRICATE TEFLON BEARINGS. TEFLON BEARINGS ARE SELF-LUBRICATED. GREASE OR OTHER LUBRICANTS CAN CAUSE LINING DETERIORATION.

(1) Examine the bearing and bushing for physical damage, cracks, or corrosion.

SUBTASK 20-20-21-210-005

(2) Examine the bearing or bushing to see if it turns in the housing or for fretting on the surfaces without the lining.

NOTE: If the bearing or bushing turns in the housing, you must measure the dimension to make sure it is not too worn.

SUBTASK 20-20-21-210-006

(3) Manually turn the bearing and feel for signs that it is too rough, too loose, has too much drag or unusual drag.

SUBTASK 20-20-21-210-007

(4) Do a check of the bearing lining:

NOTE: On most spherical bearings, you can turn the ball and look at the lining through the bearing bore.

(a) Examine the lining for worn areas.

1) Usually, reject bearings and bushings that have internal diametrical play of 0.010 inch. But, use service experience and the applicable permitted wear limits to know if the part is serviceable.

(b) Examine the lining load pattern.

1) Examine the surface where the lining and ball/pin touch. Make sure all of the surface has an equal load.

NOTE: Incorrect swaging during manufacture or installation can cause the edges of the lining to wear too much. These bearings and bushings are not serviceable.

(c) Examine the lining for unwanted material.

1) Examine the lining to make sure that no unwanted material becomes attached.

(d) Examine the lining for chemical deterioration.

1) Examine the lining and lining bond for signs of chemical damage.

SUBTASK 20-20-21-210-008

(5) Do the Bearings and Bushings (Bench Check) - Inspection/Check, TASK 20-20-21-220-801 task.

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

TASK 20-20-21-210-802

3. Special Bearing and Bushing Configuration - Inspection/Check

A. Procedure - Special Bearing and Bushing Configurations - Check

SUBTASK 20-20-21-210-009

(1) Examine aluminum bearing races for serviceable surface treatment or plating, and for corrosion and cracks.

SUBTASK 20-20-21-210-010

(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 20-20-21-210-011

(3) Do the Bearing/Bushing - Inspection/Check (Bench Check) task.

END OF TASK

TASK 20-20-21-220-801

4. Bearings and Bushings (Bench Check) - Inspection/Check

A. General

(1) Before you do this task, do the Procedure Bearing and Bushings - Inspection/Check, TASK 20-20-21-210-801 (Bench Check) in the first task.

B. Procedure - Wear Check

SUBTASK 20-20-21-220-001

(1) To determine the amount of bearing wear, manually apply a reversing load to bearing in a simple holding fixture and measure play with a dial indicator. Radial wear should be measured by applying a reversing radial load of 10 to 15 pounds and total diametrical play measured. A reversing load of the same magnitude should then be applied in a axial (thrust) direction and axial play measured.

NOTE: When measuring play in the radial direction, several points should be checked by rotating the outer race relative to the inner race to establish the point where maximum play exists before attempting to make an accurate wear reading.

C. Procedure - Bearing Breakaway Torque on Spherical Bearing Check

SUBTASK 20-20-21-220-002

(1) To do the breakaway preload torque checks, measure the torque necessary to turn one race with the other race held.

NOTE: The bearing must not have lubricants or other contaminants. The breakaway torque must not be more than twice the permitted rotational preload torque as listed in the applicable drawing for the specific bearing.

NOTE: Measure the breakaway torque before you do the rotational torque checks. Do the test at room temperature.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

D. Procedure - Bearing Rotational Torque on Spherical Bearing Check

SUBTASK 20-20-21-220-003

(1) To do the rotational preload torques checks, measure the torque necessary to turn one race with the other race held.

NOTE: The bearing must not have lubricants or other contaminants. The permitted rotational preload torques values are listed in the applicable drawing for the specific bearing.

NOTE: Measure the breakaway torque before you do the rotational torque checks. For rotational torque tests, you must turn the bearing through two or three full turns immediately before you measure the torque. Do the tests at room temperature.

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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 cables fittings

(3) An inspection of the pulleys

(4) An inspection of the nose wheel well control cable wire rope.

B. These 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. These procedures 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. Control Cable Wire Rope - Inspection

(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. Consumable Materials

Reference	Description	Specification
G00034	Cotton Wiper - Process Cleaning Absorbent Wiper (Cheesecloth, Gauze)	AMS3819 Class 1 Grade A or B Form 1 (Supersede BMS15-5 CL A)

C. Location Zones

Zone	Area
100	Lower Half of Fuselage
300	Empennage

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(Continued)

Zone	Area
400	Powerplant and Nacelle Struts
500	Left Wing
600	Right Wing

D. Prepare for the Inspection

SUBTASK 20-20-31-100-001

> **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.

> **CAUTION** DO NOT USE SOLVENT OR HEAT TO THIN GREASE. DO NOT USE SOLVENT TO CLEAN CABLES, SINCE SOLVENT DILUTES AND REMOVES GREASE FROM INSIDE CABLE STRANDS. DO NOT APPLY OR SPRAY BMS 3-23 ON CONTROL CABLES.

(1) If it is necessary, clean the control cables with lint-free cotton wiper, G00034, that is clean and dry.

(a) Remove the old grease and dirt from the surface of the control cable.

(b) Clean the control cable for the full length of the cable for the full length of travel through fairleads, air pressure seals, over pulleys, quadrants, and drums.

SUBTASK 20-20-31-200-003

(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 0.2 in. (5.1 mm), except 0.1 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.

E. Control Cable Wire Rope Inspection

SUBTASK 20-20-31-200-015

(1) Ignore this step if it is not applicable to your work:

(a) Make sure that the flight control cables are displaced full travel in each direction for the complete inspection at seals, pulleys, and fairlead areas.

SUBTASK 20-20-31-200-013

(2) Perform a detailed visual inspection of the cable runs for incorrect routing, kinks in the wire rope, or other damage.

(a) Replace the cable assembly if:

1) 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).

2) A kink is found.

3) Corrosion is found.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SUBTASK 20-20-31-200-014

(3) Perform a detailed visual inspection of the cable.

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.

(a) Rub a cloth along the cable to find the broken wires.

NOTE: The cloth will catch on broken wires.

(b) Replace the 7X7 cable assembly if:

1) There are two or more broken wires in 12 in. (305 mm) of cable.

2) There are three or more broken wires anywhere in the total cable assembly.

(c) Replace the 7X19 cable assembly if:

1) There are four or more broken wires in 12 in. (305 mm) of cable.

2) There are six or more broken wires anywhere in the total cable assembly.

(d) Inspect the carbon steel control cable lubrication.

1) Make sure that there is sufficient lubrication on the control cable.

2) 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

TASK 20-20-31-200-802

3. Inspection of the Control Cable Fittings

NOTE: This procedure is a scheduled maintenance task.

A. Location Zones

Zone	Area
100	Lower Half of Fuselage
300	Empennage
400	Powerplant and Nacelle Struts
500	Left Wing
600	Right Wing

B. Procedure

SUBTASK 20-20-31-200-007

(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 20-20-31-200-008

(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 20-20-31-200-009

(3) Perform a detailed visual inspection of the unswaged portion of the end fitting.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(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 20-20-31-200-010

(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 20-20-31-200-805

4. Inspection of Pulleys

NOTE: This procedure is a scheduled maintenance task.

A. Location Zones

Zone	Area
100	Lower Half of Fuselage
300	Empennage
400	Powerplant and Nacelle Struts
500	Left Wing
600	Right Wing

B. Procedure

SUBTASK 20-20-31-200-011

(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 20-20-31-200-012

(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 ———

ECCN 9E991 BOEING PROPRIETARY - See title page for details

7x7 CABLE

EACH OUTER WIRE WORN LESS THAN 40%
(WORN AREAS NOT BLENDED)

7x19 CABLE

EACH OUTER WIRE WORN 40-50%
(WORN AREAS ARE BLENDED)

EACH WIRE IS WORN MORE THAN 50%

EXAMPLE OF INTERNAL WEAR

1 VISIBLE SPACE BETWEEN WIRES.

2 WEAR CONDITION RESULTING IN BLENDED SURFACES BETWEEN WIRES.

3 THE OUTER WIRE WEAR AREA ON CABLE STRAND. A VISIBLE SPACE BETWEEN WIRES 1 OR A FULLY BLENDED SURFACE. 2

4 CABLE WEAR MAY OCCUR ON ONE SIDE ONLY OR ON FULL CIRCUMFERENCE. CABLE WEAR CAN EXTEND ALONG THE CABLE FOR A DISTANCE EQUAL TO USUAL CABLE TRAVEL.

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Cable Wear Patterns
Figure 601/20-20-31-990-801

ECCN 9E991 BOEING PROPRIETARY - See title page for details

F25724 S0006562077_V3

Pulley Wear Patterns
Figure 602/20-20-31-990-802

ECCN 9E991 BOEING PROPRIETARY - See title page for details

TASK 20-20-31-200-806

5. **Nose Wheel Well Control Cable Wire Rope - Inspection**

(Figure 603, Figure 604)

NOTE: This procedure is a scheduled maintenance task.

A. References

Reference	Title
12-26-00-600-801	Control Cable Lubrication (P/B 301)
32-00-01-480-801	Landing Gear Downlock Pins Installation (P/B 201)
32-33-00-710-801	Operational Test for the Nose Landing Gear (P/B 501)
32-35-00-730-802	Nose Gear Manual Extension System Test - Airplane Not on Jacks (P/B 501)
32-51-00-700-801	Nose Wheel Steering System Test (P/B 501)

B. Consumable Materials

Reference	Description	Specification
G00034	Cotton Wiper - Process Cleaning Absorbent Wiper (Cheesecloth, Gauze)	AMS3819 Class 1 Grade A or B Form 1 (Supersede BMS15-5 CL A)

C. Location Zones

Zone	Area
100	Lower Half of Fuselage
300	Empennage
400	Powerplant and Nacelle Struts
500	Left Wing
600	Right Wing

D. Prepare for the Inspection

SUBTASK 20-20-31-200-016

(1) Prepare the control cable system for full travel, do this task: Nose Wheel Steering System Test, TASK 32-51-00-700-801.

SUBTASK 20-20-31-200-017

(2) Make sure that the control cable system is displaced full travel in each direction (full nose cable steering to the left and then full nose cable steering to the right) for complete inspection at seals, pulleys, and fairlead areas.

SUBTASK 20-20-31-200-018

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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(CAUTION PRECEDES)

CAUTION	DO NOT USE SOLVENT OR HEAT TO THIN GREASE. DO NOT USE SOLVENT TO CLEAN CABLES, SINCE SOLVENT DILUTES AND REMOVES GREASE FROM INSIDE CABLE STRANDS. DO NOT APPLY OR SPRAY BMS 3-23 ON CONTROL CABLES.

(3) If it is necessary, clean the control cables with lint-free cotton wiper, G00034, that is clean and dry.

(a) Remove the old grease and dirt from the surface of the control cable.

(b) Clean the control cable for the full length of the cable for the full length of travel through fairleads, air pressure seals, over pulleys, quadrants, and drums.

SUBTASK 20-20-31-200-019

(4) Do a detailed visual inspection to make sure that the cable does not touch parts other than pulleys, quadrants, cable seals, or grommets installed to control cable routing.

NOTE: The minimum cable clearance from other parts is 0.2 in. (5.1 mm), except 0.1 in. (2.5 mm) within 10 in. (254 mm) of a pulley or quadrant.

(a) Look for evidence of contact with other parts and correct the condition if evidence of contact is found.

E. Control Cable Wire Rope Inspection

SUBTASK 20-20-31-200-020

(1) Do a detailed visual inspection of the cable runs for incorrect routing, kinks in the wire rope, or other damage.

(a) Replace the cable assembly if:

1) A wear pattern exists where the individual wires in a strand appear to blend together (outer wires worn by more than 40 percent) (Figure 603).

2) A kink is found.

3) Corrosion is found.

SUBTASK 20-20-31-200-021

(2) Do a detailed visual inspection of the cable.

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.

(a) Rub a cloth along the cable to find the broken wires.

NOTE: The cloth will catch on broken wires.

(b) Replace the 7X7 cable assembly if:

1) There are two or more broken wires in 12 in. (305 mm) of cable.

2) There are three or more broken wires anywhere in the total cable assembly.

(c) Replace the 7X19 cable assembly if:

1) There are four or more broken wires in 12 in. (305 mm) of cable.

2) There are six or more broken wires anywhere in the total cable assembly.

(d) Inspect the carbon steel control cable lubrication.

1) Make sure that there is sufficient lubrication on the control cable.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

2) 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.

F. Control Cable Fittings Inspection

SUBTASK 20-20-31-200-022

(1) Do 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 20-20-31-200-023

(2) Do 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 20-20-31-200-024

(3) Do 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 20-20-31-200-025

(4) Do a detailed visual inspection of the turnbuckle.

(a) Replace the turnbuckle if a crack is visible or if corrosion is present.

G. Pulleys Inspection

SUBTASK 20-20-31-200-026

(1) Do a detailed visual inspection to make sure that pulleys are free to rotate.

(a) Replace pulleys which are not free to rotate.

SUBTASK 20-20-31-200-027

(2) Do a detailed visual inspection of the pulleys for conditions shown in Figure 604.

(a) Replace pulleys which are not in a normal condition.

SUBTASK 20-20-31-200-028

(3) For the airplane on jacks, do these steps to monitor that the manual extension mechanism release roller correctly sets to its retracted position:

(a) Do this task: Operational Test for the Nose Landing Gear, TASK 32-33-00-710-801.

NOTE: Normal operation of the nose landing gear mechanism confirms that the release roller of the nose gear manual extension system has correctly reset to its retracted position.

(b) As an alternative, do these steps to make sure that the release roller of nose landing gear manual extension system has set to its retracted position:

1) Do this task: Landing Gear Downlock Pins Installation, TASK 32-00-01-480-801.

2) Open the access door to the manual extension T-handles.

3) Pull the manual extension handle for the nose gear.

NOTE: One person needs to be stationed in the nose landing gear wheel well.

4) Release the manual extension handle for the nose gear.

NOTE: Observe the manual extension mechanism to make sure that the release roller correctly sets to its retracted position.

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5) Make sure that the handle returns to the stowed position without hesitation or binding.

6) Close the access door to the manual extension T-handles.

SUBTASK 20-20-31-200-029

(4) For the airplane not on jacks, do this step to monitor that the manual extension mechanism release roller correctly sets to its retracted position:

(a) Do this task: Nose Gear Manual Extension System Test - Airplane Not on Jacks, TASK 32-35-00-730-802.

——— END OF TASK ———

ECCN 9E991 BOEING PROPRIETARY - See title page for details

7x7 CABLE

EACH OUTER WIRE WORN LESS THAN 40%
(WORN AREAS NOT BLENDED)

7x19 CABLE

EACH OUTER WIRE WORN 40-50%
(WORN AREAS ARE BLENDED)

EACH WIRE IS WORN MORE THAN 50%

EXAMPLE OF INTERNAL WEAR

1 VISIBLE SPACE BETWEEN WIRES.

2 WEAR CONDITION RESULTING IN BLENDED SURFACES BETWEEN WIRES.

3 THE OUTER WIRE WEAR AREA ON CABLE STRAND. A VISIBLE SPACE BETWEEN WIRES 1 OR A FULLY BLENDED SURFACE. 2

4 CABLE WEAR MAY OCCUR ON ONE SIDE ONLY OR ON FULL CIRCUMFERENCE. CABLE WEAR CAN EXTEND ALONG THE CABLE FOR A DISTANCE EQUAL TO USUAL CABLE TRAVEL.

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Cable Wear Patterns
Figure 603/20-20-31-990-803

ECCN 9E991 BOEING PROPRIETARY - See title page for details

F25724 S0006562077_V3

Pulley Wear Patterns
Figure 604/20-20-31-990-804

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SPECIFICATIONS AND MATERIALS - MAINTENANCE PRACTICES

1. **General**
   A. This procedure contains one 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 BSS7432, Evaluation 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)
20-30-21-910-801	Lubricants (P/B 201)
20-30-31-910-801	Cleaners and Polishes (P/B 201)
20-30-41-910-801	Finishing Materials (P/B 201)
20-30-51-910-801	Miscellaneous Materials (P/B 201)
20-30-61-910-801	Welding Materials (P/B 201)
20-30-71-910-801	Strippers (P/B 201)
70-30-11-910-801-F00	Adhesives, Cements, and Sealants (P/B 201)
70-30-21-910-801-F00	Lubricants (P/B 201)
70-30-31-910-801-F00	Cleaners and Polishes (P/B 201)
70-30-41-910-801-F00	Finishing Materials (P/B 201)
70-30-51-910-801-F00	Miscellaneous Materials (P/B 201)

C. Procedure

SUBTASK 20-30-00-800-002

(1) Use these tasks for information on airframe consumable materials:

(a) Adhesives, Cements, and Sealers (Adhesives, Cements, and Sealants, TASK 20-30-11-910-801)

(b) Cleaners and Polishes (Cleaners and Polishes, TASK 20-30-31-910-801)

(c) Finishing Materials (Finishing Materials, TASK 20-30-41-910-801)

(d) Lubricants (Lubricants, TASK 20-30-21-910-801)

(e) Strippers (Strippers, TASK 20-30-71-910-801)

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(f) Welding Materials (Welding Materials, TASK 20-30-61-910-801)

(g) Miscellaneous Materials (Miscellaneous Materials, TASK 20-30-51-910-801)

SUBTASK 20-30-00-800-001

(2) Use these tasks for information on General Electric/CFMI engine consumable materials:

(a) Adhesives, Cements, and Sealers (Adhesives, Cements, and Sealants, TASK 70-30-11-910-801-F00)

(b) Cleaners and Polishes (Cleaners and Polishes, TASK 70-30-31-910-801-F00)

(c) Finishing Materials (Finishing Materials, TASK 70-30-41-910-801-F00)

(d) Lubricants (Lubricants, TASK 70-30-21-910-801-F00)

(e) Miscellaneous Materials (Miscellaneous Materials, TASK 70-30-51-910-801-F00)

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

ADHESIVES, CEMENTS, AND SEALANTS - MAINTENANCE PRACTICES

1. **General**
   A. This procedure has these tasks:
      (1) Adhesives, Cements, and Sealants
      (2) Sealant Cure Time
   B. This procedure lists adhesives, cements, sealants, and sealant cure times 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 201/20-30-11-993-806 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]*[1]*[3]	PR-1828*[1]*[3]	BMS 5–150	BMS 5-168*[4]
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*[5]	No	---	Yes	Yes	Yes	Yes (class B-2 only)	Yes*[5]
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, faying surface seal, pre-pack sealing, wet fastener and wet bushing or bearing installation procedures.

*[2] This sealant has a primer that must also be used.

*[3] This sealant cannot be used on or near acrylic windows or other acrylic components.

*[4] See Table 205.

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*[5] 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.

Table 202/20-30-11-993-807 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 203/20-30-11-993-808 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 Availablity 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))).

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Table 204/20-30-11-993-804 BMS 5-95 Availablity and Uses (Continued)

BMS 5–95, Types, Classes	Availability, Uses
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.
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

TASK 20-30-11-910-802

3. Sealant Cure Time

A. General

(1) This task has information for sealant cure times.

(2) The general rules in this task are a start point to find the effect of temperature and humidity on sealant properties. The actual effect can be different than is specified by the general rules and can only be made sure through experience or a test.

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(3) If the temperature or humidity increases, it will decrease sealant tack-free and cure times. If the temperature or humidity decreases, it will increase sealant tack-free and cure times. At standard test conditions (approximately 77°F (25°C) and 50% relative humidity), changes in temperature and humidity will change the sealant properties as follows:

(a) Each time that the ambient temperature increases by 20°F or 11°C, it decreases sealant tack-free and cure times by approximately 1/2.

(b) Each time that the relative humidity increases by 15%, it decreases sealant tack-free and cure times by approximately 1/3 to 1/2. Humidity will have an effect on polysulfide sealants more than polythioether sealants.

B. Sealant Cure Time

SUBTASK 20-30-11-800-004

(1) In the Table 206, find the applicable sealant cure time.

NOTE: The table that follows will give you the approximate cure times. Follow the manufacturers instruction for the applicable cure times.

Table 206/20-30-11-993-814 Sealant Cure Time

Sealant Cure Time	
Sealant	**Cure Time*[1]**
BMS5-63, Type I, Class B-4	48 Hours
BMS5-63, Type II, Class B-1/2	4 Hours
BMS5-63, Type II, Class B-4	48 Hours
BMS5-95, Class B-1/2	20 Hours
BMS5-95, Class B-2	48 Hours
BMS5-142, Type II, Class B1	8 Hours
BMS5-142, Type II, Class B2	24 Hours

*[1] This is the cure time to get an ASTM D2240, Type A durometer hardness of 30. Cure times are approximate only.

END OF TASK

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LUBRICANTS - MAINTENANCE PRACTICES

1. **General**

   A. This procedure contains a list of lubricants for airplane maintenance. There are no procedural steps in this procedure.

TASK 20-30-21-910-801

2. **Lubricants**

   A. General

   (1) The data contained in this task has been moved to the Introduction section of the AMM.

——— END OF TASK ———

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CLEANERS AND POLISHES - MAINTENANCE PRACTICES

1. **General**

   A. This procedure contains a list of cleaners and polishes for airplane maintenance. There are no procedural steps in this procedure.

TASK 20-30-31-910-801

2. **Cleaners and Polishes**

   A. General

   (1) The data contained in this task has been moved to the Introduction section of the AMM.

——— END OF TASK ———

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FINISHING MATERIALS - MAINTENANCE PRACTICES

1. **General**

   A. This procedure lists finishing materials for airplane maintenance. There are no procedural steps in this procedure.

TASK 20-30-41-910-801

2. **Finishing Materials**

   A. General

   (1) The data contained in this task has been moved to the Introduction section of the AMM.

——— END OF TASK ———

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MISCELLANEOUS MATERIALS - MAINTENANCE PRACTICES

1. **General**

   A. This procedure lists miscellaneous consumable materials for airplane maintenance. There are no procedural steps in this procedure.

TASK 20-30-51-910-801

2. **Miscellaneous Materials**

   A. General

   (1) The data contained in this task has been moved to the Introduction section of the AMM.

——— END OF TASK ———

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WELDING MATERIALS - MAINTENANCE PRACTICES

1. **General**

   A. This procedure lists the consumable materials which are necessary for welding and soldering. There are no procedural steps in this procedure.

TASK 20-30-61-910-801

2. **Welding Materials**

   A. General

   (1) The data contained in this task has been moved to the Introduction section of the AMM.

——— END OF TASK ———

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STRIPPERS - MAINTENANCE PRACTICES

1. **General**

   A. This procedure lists the consumable materials which are necessary for stripping organic and inorganic coatings. There are no procedural steps in this procedure.

TASK 20-30-71-910-801

2. **Strippers**

   A. General

   (1) The data contained in this task has been moved to the Introduction section of the AMM.

——— END OF TASK ———

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AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 80) - MAINTENANCE PRACTICES

1. General

A. This subject contains a list of solvents for general cleaning of metals as listed in BAC5750. This subject gives only the list of solvents. It does not tell you which solvent to use or how to use the solvents.

TASK 20-30-80-910-801

2. General Cleaning of Metal (Series 80)

A. General

(1) This selection of solvents uses BAC5750 as a guide. This list of solvents has the Series Bulk Code of B01000, but this code is only for reference to identify this complete group. In your orders to get the solvents of this list, you must identify each individual solvent by its name, bulk code, or other specification, as shown.

Do not use the Series Bulk Code. Refer to the U-File for the applicable vendors. Mixture ratios are given by volume with a tolerance of plus or minus 2%.

B. Procedure

SUBTASK 20-30-80-800-001

(1) In Table 201, find the applicable solvent.

Table 201/20-30-80-993-801 General Cleaning of Metal (Series 80)

Material Name	Material Bulk Code	Other Specifications
70% Isopropyl Alcohol (Balance Deionized Water)		
Acetone	B00062	ASTM D 329
Aqua Solvent SP-20		
Ardrox 5529		
Aviation Cleaning Gasoline		
Barsol A-2926		
BIOACT 108		BMS11-14 Type 1
Bonderite C-SO 2382-BK Aero		
Bonderite C-SO 6709 Aero		
CDG-110 or Naptha:IPA 1:1		
CDG-211 or Naptha:IPA:DNA 2:1:1		
CEE-BEE A-954		
Citra Safe	B50226	
Citra Safe, Deodorized	B50225	
Citra Safe, Ultra-deodorized		
Degreasing Solvent (Mineral Spirits)	B00074	MIL-PRF-680 Type I, II or III
DesoClean 45		
Diestone DLS		
Diestone HFP		

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Table 201/20-30-80-993-801 General Cleaning of Metal (Series 80) (Continued)

Material Name	Material Bulk Code	Other Specifications
DS-108	B50230	
EP-921	B50229	
Ethyl 3-Ethoxy Propionate (EEP)	B50228	
Ethyl Alcohol		
Ethyl Alcohol, Denatured	B00068	AMS 3002, ASTM E 1145 Type II
FCC-55 or Naptha:MPK 1:1	B01026	
FD Cleaner		
H201		
HFE-7100	B50002	
HFE71DE	B50003	
Isopar H Fluid		
Isopropyl Alcohol (IPA)	B00130	TT-I-735 Grade A or B, ASTM D 770
Isopropyl Alcohol:Toluene 1:1		
Lenium FHD		
Limonene Cleaner	B00634	BMS11-10 Types 1, 2 and 3
MEK:sec-Butyl Alcohol 42:58 percent		
MEK:Toluene 1:1		
Methyl Ethyl Ketone (MEK)	B00148	ASTM D740 Type I
Methyl Isobutyl Ketone (MIBK)	B00151	ASTM D1153
Methyl Propyl Ketone (MPK)	B00666	BMS11-9 Grades 1 and 2
MIBK:MEK 3:2		
MOK, or MOK*		
MPK:MEK 70:30 percent		
Naphtha, Aliphatic	B00083	TT-N-95, Type II or ASTM D 3735, Type III
n-Butyl Alcohol	B00342	ASTM D304
Novec 72FL Engineered Fluid		
NS Clean 100		
Pre-sealing Cleaning Solvent	B00184	BMS11-7 or A-A-59281, Type I
Re-Entry Prepsolv		
SAAB 176911		
Shopmaster RTU		
SkyKleen 1000	B50085	

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Table 201/20-30-80-993-801 General Cleaning of Metal (Series 80) (Continued)

Material Name	Material Bulk Code	Other Specifications
Teruclean PGE-01		
Toluene	B00094	A-A-59107
Trichloroethylene		
Vertrel MCA	B50005	
Vertrel XF	B50004	
Wedco 3500		
Xylene		

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 81) - MAINTENANCE PRACTICES

1. General

A. This subject contains a list of solvents for general cleaning of solvent sensitive organic coatings as listed in BAC5750. This subject gives only the list of solvents. It does not tell you which solvent to use or how to use the solvents.

TASK 20-30-81-910-801

2. General Cleaning of Solvent Sensitive Organic Coatings (Series 81)

A. General

(1) This selection of solvents uses BAC5750 as a guide. This list of solvents has the Series Bulk Code of B01001, but this code is only for reference to identify this complete group. In your orders to get the solvents of this list, you must identify each individual solvent by its name, bulk code, or other specification, as shown.

Do not use the Series Bulk Code. Refer to the U-File for the applicable vendors. Mixture ratios are given by volume with a tolerance of plus or minus 2%.

B. Procedure

SUBTASK 20-30-81-800-001

(1) In Table 201, find the applicable solvent.

Table 201/20-30-81-993-801 General Cleaning of Solvent Sensitive Organic Coatings (Series 81)

Material Name	Material Bulk Code	Other Specifications
70% Isopropyl Alcohol (Balance Deionized Water)		
BIOACT 108		BMS11-14 Type 1
CDG-110 or Naptha:IPA 1:1		
CDG-211 or Naptha:IPA:DNA 2:1:1		
CEE-BEE A-954		
Degreasing Solvent (Mineral Spirits)	B00074	MIL-PRF-680 Type I, II or III
Ethyl Alcohol, Denatured	B00068	AMS 3002, ASTM E 1145 Type II
FD Cleaner		
H201		
HFE-7100	B50002	
HFE71DE	B50003	
Isopar H Fluid		
Isopropyl Alcohol (IPA)	B00130	TT-I-735 Grade A or B, ASTM D 770
Lenium FHD		
Naphtha, Aliphatic	B00083	TT-N-95, Type II or ASTM D 3735, Type III
Novec 72FL Engineered Fluid		
SAAB 176911		

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Table 201/20-30-81-993-801 General Cleaning of Solvent Sensitive Organic Coatings (Series 81) (Continued)

Material Name	Material Bulk Code	Other Specifications
Shopmaster RTU		
Vertrel MCA	B50005	
Vertrel XF	B50004	

END OF TASK

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AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 82) - MAINTENANCE PRACTICES

1. General

A. This subject contains a list of solvents for general cleaning of solvent resistant organic coatings as listed in BAC5750. This subject gives only the list of solvents. It does not tell you which solvent to use or how to use the solvents.

TASK 20-30-82-910-801

2. General Cleaning of Solvent Resistant Organic Coatings (Series 82)

A. General

(1) This selection of solvents uses BAC5750 as a guide. This list of solvents has the Series Bulk Code of B01002, but this code is only for reference to identify this complete group. In your orders to get the solvents of this list, you must identify each individual solvent by its name, bulk code, or other specification, as shown.

Do not use the Series Bulk code. Refer to the U-File for this applicable vendors. Mixture ratios are given by volume with a tolerance of plus or minus 2%.

B. Procedure

SUBTASK 20-30-82-800-001

(1) In Table 201, find the applicable solvent.

Table 201/20-30-82-993-801 General Cleaning of Solvent Resistant Organic Coatings (Series 82)

Material Name	Material Bulk Code	Other Specifications
70% Isopropyl Alcohol (Balance Deionized Water)		
Acetone	B00062	ASTM D 329
Aqua Solvent SP-20		
Ardrox 5529		
Aviation Cleaning Gasoline		
BIOACT 108		BMS11-14 Type 1
Bonderite C-SO 2382-BK Aero		
Bonderite C-SO 6709 Aero		
CDG-110 or Naptha:IPA 1:1		
CDG-211 or Naptha:IPA:DNA 2:1:1		
CEE-BEE A-954		
Citra Safe	B50226	
Citra Safe, Deodorized	B50225	
Citra Safe, Ultra-deodorized		
Degreasing Solvent (Mineral Spirits)	B00074	MIL-PRF-680 Type I, II or III
DesoClean 45		
Diestone DLS		
Diestone HFP		
DS-108	B50230	

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Table 201/20-30-82-993-801 General Cleaning of Solvent Resistant Organic Coatings (Series 82) (Continued)

Material Name	Material Bulk Code	Other Specifications
EP-921	B50229	
Ethyl 3-Ethoxy Propionate (EEP)	B50228	
Ethyl Alcohol		
Ethyl Alcohol, Denatured	B00068	AMS 3002, ASTM E 1145 Type II
FCC-55 or Naptha:MPK 1:1	B01026	
FD Cleaner		
H201		
HFE-7100	B50002	
HFE71DE	B50003	
Isopropyl Alcohol (IPA)	B00130	TT-I-735 Grade A or B, ASTM D 770
Lenium FHD		
Limonene Cleaner	B00634	BMS11-10 Types 1, 2 and 3
MEK:sec-Butyl Alcohol 42:58 percent		
MEK:Toluene 1:1		
Methyl Ethyl Ketone (MEK)	B00148	ASTM D740 Type I
Methyl Isobutyl Ketone (MIBK)	B00151	ASTM D1153
Methyl Propyl Ketone (MPK)	B00666	BMS11-9 Grades 1 and 2
MIBK:MEK 3:2		
MOK, or MOK*		
MPK:MEK 70:30 percent		
Naphtha, Aliphatic	B00083	TT-N-95, Type II or ASTM D 3735, Type III
n-Butyl Alcohol	B00342	ASTM D304
Novec 72FL Engineered Fluid		
Pre-sealing Cleaning Solvent	B00184	BMS11-7 or A-A-59281, Type I
Re-Entry Prepsolv		
Shopmaster RTU		
SkyKleen 1000	B50085	
Teruclean PGE-01		
Toluene	B00094	A-A-59107
Trichloroethylene		
Vertrel MCA	B50005	
Vertrel XF	B50004	

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Table 201/20-30-82-993-801 General Cleaning of Solvent Resistant Organic Coatings (Series 82) (Continued)

Material Name	Material Bulk Code	Other Specifications
Wedco 3500		
Xylene		

END OF TASK

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AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 83) - MAINTENANCE PRACTICES

1. General

A. This subject contains a list of solvents for general cleaning of composites as given in BAC5750. This subject gives only the list of solvents. It does not tell you which solvent to use or how to use the solvents.

TASK 20-30-83-910-801

2. General Cleaning of Composites (Series 83)

A. General

(1) This selection of solvents uses BAC5750 as a guide. This list of solvents has the Series Bulk code of B01003, but this code is only for reference to identify this complete group. In your orders to get the solvents of this list, you must identify each individual solvent by its name, bulk code, or other specification, as shown.

Do not use the Series Bulk Code. Refer to the U-File for the applicable vendors. Mixture ratios are given by volume with a tolerance of plus or minus 2%.

B. Procedure

SUBTASK 20-30-83-800-001

(1) In Table 201, find the applicable solvent.

Table 201/20-30-83-993-801 General Cleaning of Composites (Series 83)

Material Name	Material Bulk Code	Other Specifications
70% Isopropyl Alcohol (Balance Deionized Water)		
Acetone	B00062	ASTM D 329
Aqua Solvent SP-20		
Ardrox 5529		
Bonderite C-SO 2382-BK Aero		
Bonderite C-SO 6709 Aero		
CDG-110 or Naptha:IPA 1:1		
CDG-211 or Naptha:IPA:DNA 2:1:1		
Citra Safe	B50226	
Citra Safe, Deodorized	B50225	
Citra Safe, Ultra-deodorized		
Diestone DLS		
Diestone HFP		
Ethyl Alcohol, Denatured	B00068	AMS 3002, ASTM E 1145 Type II
FCC-55 or Naptha:MPK 1:1	B01026	
FD Cleaner		
H201		
Isopropyl Alcohol (IPA)	B00130	TT-I-735 Grade A or B, ASTM D 770

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Table 201/20-30-83-993-801 General Cleaning of Composites (Series 83) (Continued)

Material Name	Material Bulk Code	Other Specifications
Limonene Cleaner	B00634	BMS11-10 Types 1, 2 and 3
MEK:sec-Butyl Alcohol 42:58 percent		
MEK:Toluene 1:1		
Methyl Ethyl Ketone (MEK)	B00148	ASTM D740 Type I
Methyl Propyl Ketone (MPK)	B00666	BMS11-9 Grades 1 and 2
MIBK:MEK 3:2		
MPK:MEK 70:30 percent		
Naphtha, Aliphatic	B00083	TT-N-95, Type II or ASTM D 3735, Type III
Pre-sealing Cleaning Solvent	B00184	BMS11-7 or A-A-59281, Type I
Re-Entry Prepsolv		
SkyKleen 1000	B50085	
Teruclean PGE-01		

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 84) - MAINTENANCE PRACTICES

1. General

A. This subject contains a list of solvents for final cleaning of metal before painting as given in BAC5750. This subject gives only the list of solvents. It does not tell you which solvent to use or how to use the solvents.

TASK 20-30-84-910-801

2. Final Cleaning of Metal Prior to Painting (Series 84)

A. General

(1) This selection of solvents uses BAC5750 as a guide. This list of solvents has the Series Bulk Code of B01004, but this code is only for reference to identify this complete group. In your orders to get the solvents of this list, you must identify each individual solvent by its name, bulk code, or other specification, as shown.

Do not use the Series Bulk code. Refer to the U-File for the applicable vendors. Mixture ratios are given by volume with a tolerance of plus or minus 2%.

B. Procedure

SUBTASK 20-30-84-800-001

(1) In Table 201, find the applicable solvent.

Table 201/20-30-84-993-801 Final Cleaning of Metal Prior to Painting (Series 84)

Material Name	Material Bulk Code	Other Specifications
Acetone	B00062	ASTM D 329
Bonderite C-SO 2382-BK Aero		
Bonderite C-SO 6709 Aero		
CDG-110 or Naptha:IPA 1:1		
CDG-211 or Naptha:IPA:DNA 2:1:1		
Citra Safe	B50226	
Citra Safe, Deodorized	B50225	
Citra Safe, Ultra-deodorized		
DesoClean 45		
Diestone DLS		
Diestone HFP		
DS-108	B50230	
FCC-55 or Naptha:MPK 1:1	B01026	
FD Cleaner		
Isopropyl Alcohol (IPA)	B00130	TT-I-735 Grade A or B, ASTM D 770
Limonene Cleaner	B00634	BMS11-10 Types 1, 2 and 3
MEK:sec-Butyl Alcohol 42:58 percent		
MEK:Toluene 1:1		

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Table 201/20-30-84-993-801 Final Cleaning of Metal Prior to Painting (Series 84) (Continued)

Material Name	Material Bulk Code	Other Specifications
Methyl Ethyl Ketone (MEK)	B00148	ASTM D740 Type I
Methyl Propyl Ketone (MPK)	B00666	BMS11-9 Grades 1 and 2
MIBK:MEK 3:2		
MPK:MEK 70:30 percent		
Pre-sealing Cleaning Solvent	B00184	BMS11-7 or A-A-59281, Type I
Re-Entry Prepsolv		
SkyKleen 1000	B50085	
Toluene	B00094	A-A-59107

END OF TASK

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AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 85) - MAINTENANCE PRACTICES

1. General

A. This subject contains a list of solvents for final cleaning of solvent sensitive organic coatings before painting as given in BAC5750. This subject gives only the list of solvents. It does not tell you which solvent to use or how to use the solvents.

TASK 20-30-85-910-801

2. Final Cleaning of All Organic Coatings Prior to Painting (Series 85)

A. General

(1) This selection of solvents uses BAC5750 as a guide. This list of solvents has the Series Bulk Code of B01005, but this code is only for reference to identify this complete group. In your orders to get the solvents of this list, you must identify each individual solvent by its name, bulk code, or other specification, as shown.

Do not use the Series Bulk Code. Refer to the U-File for the applicable vendors. Mixture ratios are given by volume with a tolerance of plus or minus 2%.

B. Procedure

SUBTASK 20-30-85-800-001

(1) In Table 201, find the applicable solvent.

Table 201/20-30-85-993-801 Final Cleaning of Solvent Sensitive Organic Coatings Prior to Painting (Series 85)

Material Name	Material Bulk Code	Other Specifications
Bonderite C-SO 2382-BK Aero		
Bonderite C-SO 6709 Aero		
CDG-110 or Naptha:IPA 1:1		
CDG-211 or Naptha:IPA:DNA 2:1:1		
Diestone DLS		
Diestone HFP		
DS-108	B50230	
FCC-55 or Naptha:MPK 1:1	B01026	
FD Cleaner		
Isopropyl Alcohol (IPA)	B00130	TT-I-735 Grade A or B, ASTM D 770
MEK:sec-Butyl Alcohol 42:58 percent		
MEK:Toluene 1:1		
Methyl Ethyl Ketone (MEK)	B00148	ASTM D740 Type I
Methyl Propyl Ketone (MPK)	B00666	BMS11-9 Grades 1 and 2
MIBK:MEK 3:2		
MPK:MEK 70:30 percent		
Pre-sealing Cleaning Solvent	B00184	BMS11-7 or A-A-59281, Type I

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Table 201/20-30-85-993-801 Final Cleaning of Solvent Sensitive Organic Coatings Prior to Painting (Series 85) (Continued)

Material Name	Material Bulk Code	Other Specifications
Toluene	B00094	A-A-59107

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 86) - MAINTENANCE PRACTICES

1. General

A. This subject contains a list of solvents for final cleaning of solvent resistant organic coatings before painting as given in BAC5750. This subject gives only the list of solvents. It does not tell you which solvent to use or how to use the solvents.

TASK 20-30-86-910-801

2. Final Cleaning of Solvent Resistant Coatings Prior to Painting (Series 86)

A. General

(1) This selection of solvents uses BAC5750 as a guide. This list of solvents has the Series Bulk Code of B01006, but this code is only for reference to identify this complete group. In your orders to get the solvents of this list, you must identify each individual solvent by its name, bulk code, or other specification, as shown.

Do not use the Series Bulk Code. Refer to the U-File for the applicable vendors. Mixture ratios are given by volume with a tolerance of plus or minus 2%.

B. Procedure

SUBTASK 20-30-86-800-001

(1) In Table 201, find the applicable solvent.

Table 201/20-30-86-993-802 Final Cleaning of Solvent Resistant Organic Coatings Prior to Painting (Series 86)

Material Name	Material Bulk Code	Other Specifications
Acetone	B00062	ASTM D 329
Bonderite C-SO 2382-BK Aero		
Bonderite C-SO 6709 Aero		
CDG-110 or Naptha:IPA 1:1		
CDG-211 or Naptha:IPA:DNA 2:1:1		
Citra Safe	B50226	
Citra Safe, Deodorized	B50225	
Citra Safe, Ultra-deodorized		
DesoClean 45		
Diestone DLS		
Diestone HFP		
DS-108*[1]	B50230	
FCC-55 or Naptha:MPK 1:1	B01026	
FD Cleaner		
Isopropyl Alcohol (IPA)	B00130	TT-I-735 Grade A or B, ASTM D 770
Limonene Cleaner	B00634	BMS11-10 Types 1, 2 and 3
MEK:sec-Butyl Alcohol 42:58 percent		
MEK:Toluene 1:1		

ECCN 9E991 BOEING PROPRIETARY - See title page for details

Table 201/20-30-86-993-802 Final Cleaning of Solvent Resistant Organic Coatings Prior to Painting (Series 86) (Continued)

Material Name	Material Bulk Code	Other Specifications
Methyl Ethyl Ketone (MEK)	B00148	ASTM D740 Type I
Methyl Propyl Ketone (MPK)	B00666	BMS11-9 Grades 1 and 2
MIBK:MEK 3:2		
MPK:MEK 70:30 percent		
Pre-sealing Cleaning Solvent	B00184	BMS11-7 or A-A-59281, Type I
Re-Entry Prepsolv		
SkyKleen 1000	B50085	
Toluene	B00094	A-A-59107

*[1] DS-108 shall be completely dried prior to application of paint. Use only on organic coatings applied to metal substrates.

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 87) - MAINTENANCE PRACTICES

1. General

A. This subject contains a list of solvents for final cleaning of composites before painting as given in BAC5750. This subject gives only the list of solvents. It does not tell you which solvent to use or how to use the solvents.

TASK 20-30-87-910-801

2. Final Cleaning of Composites Prior to Painting (Series 87)

A. General

(1) This selection of solvents uses BAC5750 as a guide. This list of solvents has the Series Bulk Code of B01007, but this code is only for reference to identify this complete group. In your orders to get the solvents of this list, you must identify each individual solvent by its name, bulk code, or other specification, as shown.

Do not use the Series Bulk Code. Refer to the U-File for the applicable vendors. Mixture ratios are given by volume with a tolerance of plus or minus 2%.

B. Procedure

SUBTASK 20-30-87-800-001

(1) In Table 201, find the applicable solvent.

Table 201/20-30-87-993-801 Final Cleaning of Composites Prior to Painting (Series 87)

Material Name	Material Bulk Code	Other Specifications
Acetone	B00062	ASTM D 329
Bonderite C-SO 2382-BK Aero		
Bonderite C-SO 6709 Aero		
CDG-110 or Naptha:IPA 1:1		
CDG-211 or Naptha:IPA:DNA 2:1:1		
Citra Safe	B50226	
Citra Safe, Deodorized	B50225	
Citra Safe, Ultra-deodorized		
Diestone DLS		
Diestone HFP		
FCC-55 or Naptha:MPK 1:1	B01026	
FD Cleaner		
Isopropyl Alcohol (IPA)	B00130	TT-I-735 Grade A or B, ASTM D 770
Limonene Cleaner	B00634	BMS11-10 Types 1, 2 and 3
MEK:sec-Butyl Alcohol 42:58 percent		
MEK:Toluene 1:1		
Methyl Ethyl Ketone (MEK)	B00148	ASTM D740 Type I
Methyl Propyl Ketone (MPK)	B00666	BMS11-9 Grades 1 and 2

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Table 201/20-30-87-993-801 Final Cleaning of Composites Prior to Painting (Series 87) (Continued)

Material Name	Material Bulk Code	Other Specifications
MIBK:MEK 3:2		
MPK:MEK 70:30 percent		
Pre-sealing Cleaning Solvent	B00184	BMS11-7 or A-A-59281, Type I
Re-Entry Prepsolv		
SkyKleen 1000	B50085	

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 88) - MAINTENANCE PRACTICES

1. General

A. This subject contains a list of solvents for final cleaning of metal before non-structural bonding as given in BAC5750. This subject gives only the list of solvents. It does not tell you which solvent to use or how to use the solvents.

TASK 20-30-88-910-801

2. Final Cleaning of Metal Prior to Non-structural Bonding (Series 88)

A. General

(1) This selection of solvents uses BAC5750 as a guide. This list of solvents has the Series Bulk Code of B01008, but this code is only for reference to identify this complete group. In your orders to get the solvents of this list, you must identify each individual solvent by its name, bulk code, or other specification, as shown.

Do not use the Series Bulk Code. Refer to the U-File for the applicable vendors. Mixture ratios are given by volume with a tolerance of plus or minus 2%.

B. Procedure

SUBTASK 20-30-88-800-001

(1) In Table 201, find the applicable solvent.

Table 201/20-30-88-993-801 Final Cleaning of Metal Prior to Non-structural Bonding (Series 88)

Material Name	Material Bulk Code	Other Specifications
Acetone	B00062	ASTM D 329
Bonderite C-SO 6709 Aero		
CDG-110 or Naptha:IPA 1:1		
CDG-211 or Naptha:IPA:DNA 2:1:1		
Diestone DLS		
Diestone HFP		
Ethyl alcohol, denatured	B00068	AMS 3002, ASTM E 1145 Type II
FCC-55 or Naptha:MPK 1:1	B01026	
Isopropyl alcohol (IPA)	B00130	TT-I-735 Grade A or B, ASTM D 770
MEK:sec-Butyl alcohol 42:58 percent		
Methyl ethyl ketone (MEK)	B00148	ASTM D740 Type I
Methyl propyl ketone (MPK)	B00666	BMS11-9 Grades 1 and 2
MIBK:MEK 3:2		
MPK:MEK 70:30 percent		
Pre-sealing Cleaning Solvent	B00184	BMS11-7 or A-A-59281, Type I
SkyKleen 1000	B50085	

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 89) - MAINTENANCE PRACTICES

1. General

A. This subject contains a list of solvents for final cleaning of solvent sensitive organic coatings before non-structural bonding as given in BAC5750. This subject gives only the list of solvents. It does not tell you which solvent to use or how to use the solvents.

TASK 20-30-89-910-801

2. Final Cleaning of Solvent Sensitive Organic Coatings Prior to Non-structural Bonding (Series 89)

A. General

(1) This selection of solvents uses BAC5750 as a guide. This list of solvents has the Series Bulk Code of B01009, but this code is only for reference to identify this complete group. In your orders to get the solvents of this list, you must identify each individual solvent by its name, bulk code, or other specification, as shown.

Do not use the Series Bulk Code. Refer to the U-File for the applicable vendors. Mixture ratios are given by volume with a tolerance of plus or minus 2%.

B. Procedure

SUBTASK 20-30-89-800-001

(1) In Table 201, find the applicable solvent.

Table 201/20-30-89-993-801 Final Cleaning of Solvent Sensitive Organic Coatings Prior to Non-structural Bonding (Series 89)

Material Name	Material Bulk Code	Other Specifications
CDG-110 or Naptha:IPA 1:1		
CDG-211 or Naptha:IPA:DNA 2:1:1		
Ethyl alcohol, denatured	B00068	AMS 3002, ASTM E 1145 Type II
Isopropyl alcohol (IPA)	B00130	TT-I-735 Grade A or B, ASTM D 770

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 90) - MAINTENANCE PRACTICES

1. General

A. This subject contains a list of solvents for final cleaning of solvent resistant organic coatings before non-structural bonding as given in BAC5750. This subject gives only the list of solvents. It does not tell you which solvent to use or how to use the solvents.

TASK 20-30-90-910-801

2. Final Cleaning of Solvent Resistant Organic Coatings Prior to Non-structural Bonding (Series 90)

A. General

(1) This selection of solvents uses BAC5750 as a guide. This list of solvents has the Series Bulk Code of B01010, but this code is only for reference to identify this complete group. In your orders to get the solvents of this list, you must identify each individual solvent by its name, bulk code, or other specification, as shown.

Do not use the Series Bulk Code. Refer to the U-File for the applicable vendors. Mixture ratios are given by volume with a tolerance of plus or minus 2%.

B. Procedure

SUBTASK 20-30-90-800-001

(1) In Table 201, find the applicable solvent.

Table 201/20-30-90-993-801 Final Cleaning of Solvent Resistant Organic Coatings Prior to Non-structural Bonding (Series 90)

Material Name	Material Bulk Code	Other Specifications
Bonderite C-SO 6709 Aero		
CDG-110 or Naptha:IPA 1:1		
CDG-211 or Naptha:IPA:DNA 2:1:1		
Diestone DLS		
Diestone HFP		
Ethyl alcohol, denatured	B00068	AMS 3002, ASTM E 1145 Type II
FCC-55 or Naptha:MPK 1:1	B01026	
Isopropyl alcohol (IPA)	B00130	TT-I-735 Grade A or B, ASTM D 770
MEK:sec-Butyl alcohol 42:58 percent		
Methyl ethyl ketone (MEK)	B00148	ASTM D740 Type I
Methyl propyl ketone (MPK)	B00666	BMS11-9 Grades 1 and 2
MIBK:MEK 3:2		
MPK:MEK 70:30 percent		
Pre-sealing Cleaning Solvent	B00184	BMS11-7 or A-A-59281, Type I
SkyKleen 1000	B50085	

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 91) - MAINTENANCE PRACTICES

1. General

A. This subject contains a list of solvents for final cleaning of composites before non-structural bonding as given in BAC5750. This subject gives only the list of solvents. It does not tell you which solvent to use or how to use the solvents.

TASK 20-30-91-910-801

2. Final Cleaning of Composites Prior to Non-structural Bonding (Series 91)

A. General

(1) This selection of solvents uses BAC5750 as a guide. This list of solvents has the Series Bulk code of B01011, but this code is only for reference to identify this complete group. In your orders to get the solvents of this list, you must identify each individual solvent by its name, bulk code, or other specification, as shown.

Do not use the Series Bulk code. Refer to the U-File for the applicable vendors. Mixture ratios are given by volume with a tolerance of plus or minus 2%.

B. Procedure

SUBTASK 20-30-91-800-001

(1) In Table 201, find the applicable solvent.

Table 201/20-30-91-993-801 Final Cleaning of Composites Prior to Non-structural Bonding (Series 91)

Material Name	Material Bulk Code	Other Specifications
Acetone	B00062	ASTM D 329
Bonderite C-SO 6709 Aero		
CDG-110 or Naptha:IPA 1:1		
CDG-211 or Naptha:IPA:DNA 2:1:1		
Diestone DLS		
Diestone HFP		
Ethyl alcohol, denatured	B00068	AMS 3002, ASTM E 1145 Type II
FCC-55 or Naptha:MPK 1:1	B01026	
Isopropyl alcohol (IPA)	B00130	TT-I-735 Grade A or B, ASTM D 770
MEK:sec-Butyl alcohol 42:58 percent		
Methyl ethyl ketone (MEK)	B00148	ASTM D740 Type I
Methyl propyl ketone (MPK)	B00666	BMS11-9 Grades 1 and 2
MIBK:MEK 3:2		
MPK:MEK 70:30 percent		
Pre-sealing Cleaning Solvent	B00184	BMS11-7 or A-A-59281, Type I
SkyKleen 1000	B50085	

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 92) - MAINTENANCE PRACTICES

1. General

A. This subject contains a list of solvents for final cleaning before general sealing as given in BAC5000. This subject gives only the list of solvents. It does not tell you which solvent to use or how to use the solvents.

TASK 20-30-92-910-801

2. Final Cleaning Prior to General Sealing (Series 92)

A. General

(1) This selection of solvents uses BAC5000 as a guide and may be used on all surfaces except unpainted composite laminated surfaces. This list of solvents has the Series Bulk Code of B01012, but his code is only for reference to identify this complete group. In your orders to get the solvents of this list, you must identify each individual solvent by its name, bulk code, or other specification, as shown. Do not use the Series Bulk code. Refer to the U-File for the applicable vendors.

B. Procedure

SUBTASK 20-30-92-800-001

(1) In Table 201, find the applicable solvent.

Table 201/20-30-92-993-801 Final Cleaning Prior to General Sealing (Series 92)

Material Name	Material Bulk Code	Other Specifications
MEK:sec-Butyl alcohol 42:58 percent		
Methyl ethyl ketone (MEK)	B00148	ASTM D740 Type I
Methyl propyl ketone (MPK)	B00666	BMS11-9
Naphtha, aliphatic (for acrylic surfaces only)	B00083	TT-N-95, Type II or ASTM D 3735, Type III
Pre-sealing Cleaning Solvent	B00184	BMS11-7 or A-A-59281, Type I

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 93) - MAINTENANCE PRACTICES

1. General

A. This subject contains a list of solvents for final cleaning before fuel tank sealing as given in BAC5504. This subject gives only the list of solvents. It does not tell you which solvent to use or how to use the solvents.

TASK 20-30-93-910-801

2. Final Cleaning Prior to Fuel Tank Sealing (Series 93)

A. General

(1) This selection of solvents uses BAC5504 as a guide. This list of solvents has the Series Bulk Code of B01013, but this code is only for reference to identify this complete group. In your orders to get the solvents of this list, you must identify each individual solvent by its name, bulk code, or other specification, as shown.

Do not use the Series Bulk Code. Refer to the U-File for the applicable vendors.

B. Procedure

SUBTASK 20-30-93-800-001

(1) In Table 201, find the applicable solvent.

Table 201/20-30-93-993-801 Final Cleaning Prior to Fuel Tank Sealing (Series 93)

Material Name	Material Bulk Code	Other Specifications
MEK:sec-Butyl Alcohol 42:58 percent		
Methyl Ethyl Ketone (MEK)	B00148	ASTM D 740 Type I
Methyl Propyl Ketone (MPK)	B00666	BMS11-9 Grades 1 and 2
Pre-sealing Cleaning Solvent	B00184	BMS11-7 or A-A-59281, Type I

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 94) - MAINTENANCE PRACTICES

1. General

A. This subject contains a list of solvents for final cleaning before application of rain erosion coating before painting as given in BAC5880. This subject gives only the list of solvents. It does not tell you which solvent to use or how to use the solvents.

TASK 20-30-94-910-801

2. Final Cleaning Prior to Application of Rain Erosion Resistant Coating (Series 94)

A. General

(1) This selection of solvents uses BAC5880 as a guide. This list of solvents has the Series Bulk Code of B01014, but this code is only for reference, to identify this complete group. In your orders to get the solvents of this list, you must identify each individual solvent by its name, bulk code, or other specification, as shown.

Do not use the Series Bulk Code. Refer to the U-File for the applicable vendors.

B. Procedure

SUBTASK 20-30-94-800-001

(1) In Table 201, find the applicable solvent.

Table 201/20-30-94-993-801 Final Cleaning Prior to Application of Rain Erosion Resistant Coating (Series 94)

Material Name	Material Bulk Code	Other Specifications
Methyl ethyl ketone (MEK)	B00148	ASTM D740 Type I
Toluene (for 8200 ASTROCOAT Primer surfaces only)	B00094	A-A-59107
Xylene (for 8200 ASTROCOAT Primer surfaces only)		

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 95) - MAINTENANCE PRACTICES

1. General

A. This subject contains a list of solvents for final cleaning before aerodynamic smoothing and fairing as given in BAC5030. This subject gives only the list of solvents. It does not tell you which solvent to use or how to use the solvents.

TASK 20-30-95-910-801

2. Final Cleaning Prior to Aerodynamic Smoothing and Fairing (Series 95)

A. General

(1) This selection of solvents uses BAC5030 as a guide. This list of solvents has the Series Bulk Code of B01015, but this code is only for reference to identify this complete group. In your orders to get the solvents of this list, you must identify each individual solvent by its name, bulk code, or other specification, as shown.

Do not use the Series Bulk Code. Refer to the U-File for the applicable vendors.

B. Procedure

SUBTASK 20-30-95-800-001

(1) In Table 201, find the applicable solvent.

Table 201/20-30-95-993-801 Final Cleaning Prior to Aerodynamic Smoothing and Fairing (Series 95)

Material Name	Material Bulk Code	Other Specifications
FCC-55 or Naptha:MPK 1:1	B01026	
MEK:sec-Butyl Alcohol 42:58 percent		
Methyl Ethyl Ketone (MEK)	B00148	ASTM D740 Type I
Methyl Propyl Ketone (MPK)	B00666	BMS11-9 Grades 1 and 2
Pre-sealing Cleaning Solvent	B00184	BMS11-7 or A-A-59281, Type I

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 96) - MAINTENANCE PRACTICES

1. General

A. This subject contains a list of solvents for final cleaning of oxygen components exposed to oxygen as given in BAC5402. This subject gives only the list of solvents. It does not tell you which solvent to use or how to use the solvents.

TASK 20-30-96-910-801

2. Final Cleaning of Oxygen Components Exposed to Oxygen (Series 96)

A. General

(1) This selection of solvents uses BAC5402 as a guide. This list of solvents has the Series Bulk code of B01016, but this code is only for reference to identify this complete group. In your orders to get the solvents of this list, you must identify each individual solvent by its name, bulk code, or other specification, as shown.

Do not use the Series Bulk Code. Refer to the U-File for the applicable vendors.

B. Procedure

SUBTASK 20-30-96-800-001

(1) In Table 201, find the applicable solvent.

Table 201/20-30-96-993-801 Final Cleaning of Oxygen Components Exposed to Oxygen (Series 96)

Material Name	Material Bulk Code	Other Specifications
1,1,1 Trichloroethane	B50135	
Acetone/Ethyl Acetate 1:1		
AK-225G		
Cyclohexane/Ethyl Acetate 1:1		
Ethyl Acetate	B50153	TT-E-751
HFE-7100	B50002	
HFE71DE	B50003	
Isopropyl Alcohol (IPA)	B00130	TT-I-735 Grade A or B, ASTM D 770
Solstice PF-HP		
Tetrachloroethylene	B00093	ASTM D4081
Trichloroethylene		
Trichlorotrifluoroethane		
Vertrel MCA	B50005	
Vertrel XF	B50004	

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 97) - MAINTENANCE PRACTICES

1. General

A. This procedure contains a list of solvents for final cleaning before stru ctural bonding as given in BAC5514. This procedure gives only the list of solvents. It does not tell you which solvent to use or how to use the solvents.

TASK 20-30-97-910-801

2. Final Cleaning Prior to Structural Bonding (Series 97)

A. General

(1) This selection of solvents uses BAC5514 as a guide. This list of solvents has the Series Bulk Code of B01017, but this code is only for reference to identify this complete group. In your orders to get the solvents of this list, you must identify each individual solvent by its name, bulk code, or other specification, as shown. Do not use the Series Bulk Code. Refer to the U-File for the applicable vendors.

B. Procedure

SUBTASK 20-30-97-800-001

(1) When your procedure refers to this subject (Table 201), use a solvent from this list.

Table 201/20-30-97-993-801 Final Cleaning Prior to Structural Bonding (Series 97)

Material Name	Material Bulk Code	Other Specifications
MEK:sec-Butyl alcohol 42:58 percent		
Methyl ethyl ketone (MEK)	B00148	ASTM D740 Type I
Methyl propyl ketone (MPK)	B00666	BMS11-9
MIBK:MEK 3:2		

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 98 & 98-1) - MAINTENANCE PRACTICES

1. General

A. This procedure contains a list of solvents for general cleaning of various polymerics as given in BAC5750. This procedure gives only the list of solvents. It does not tell you which solvent to use or how to use the solvents. This procedure contains two tasks:

(1) Cleaning of specific polymerics (Series 98).

(2) Cleaning of phenolics or nylon (Series 98-1).

TASK 20-30-98-910-801

2. Cleaning of Specific Polymerics (Series 98)

A. General

(1) This selection of solvents uses BAC5750 as a guide. This procedure contains a list of solvents for general cleaning of specific polymerics as given in BAC5750. This list of solvents has the Series Bulk Code of B01018, but this code is only for reference to identify this complete group. In your orders to get the solvents of this list, you must identify each individual solvent by its name, bulk code, or other specification, as shown. Do not use the Series Bulk Code. Refer to the U-File for the applicable vendors.

(2) The solvents in this list may be used for:

(a) The general cleaning of:

1) Polyester (Vibrin, Mylar, Dacron)

2) Polytetrafluoroethylene (Teflon)

3) Polyvinyl fluoride (Tedlar).

(b) OR, the final cleaning of the following prior to painting:

1) Polyester (Vibrin, Mylar, Dacron)

2) Polytetrafluorethylene (Teflon)

3) Polyvinyl fluoride (Tedlar).

(c) OR, the final cleaning of the following prior to non-structural bonding:

1) Polyester (Vibrin, Mylar, Dacron)

2) Polytetrafluorethylene (Teflon)

3) Polyvinyl fluoride (Tedlar).

B. Procedure

SUBTASK 20-30-98-910-001

(1) When your procedure refers to this subject (Table 201), use a solvent from this list.

Table 201/20-30-98-993-803 Cleaning of Specific Polymerics (Series 98)

Material Name	Material Bulk Code	Other Specifications	tedlar	mylar	teflon
70% Isopropyl Alcohol (Balance Deionized Water)			x	x	x
Acetone	B00062	ASTM D 329	x	x	x
BIOACT 108		BMS11-14 Type 1	x		

ECCN 9E991 BOEING PROPRIETARY - See title page for details

Table 201/20-30-98-993-803 Cleaning of Specific Polymerics (Series 98) (Continued)

Material Name	Material Bulk Code	Other Specifications	tedlar	mylar	teflon
Bonderite C-SO 6709 Aero			x	x	
CDG-110 or Naptha:IPA 1:1			x	x	
CDG-211 or Naptha:IPA:DNA 2:1:1			x	x	
Ethyl 3-Ethoxy Propionate (EEP)	B50228		x	x	x
Ethyl Alcohol			x	x	x
Ethyl Alcohol, Denatured	B00068	AMS 3002, ASTM E 1145 Type II	x	x	x
FCC-55 or Naptha:MPK 1:1	B01026		x	x	
HFE-7100	B50002		x		x
HFE71DE	B50003		x		x
MEK:sec-Butyl Alcohol 42:58 percent			x	x	
Methyl Ethyl Ketone (MEK)	B00148	ASTM D740 Type I	x	x	x
Methyl Isobutyl Ketone (MIBK)	B00151	ASTM D 1153	x	x	x
Methyl Propyl Ketone (MPK)	B00666	BMS11-9 Grades 1 and 2	x	x	x
MOK or MOK*			x	x	x
Naphtha, Aliphatic	B00083	TT-N-95, Type II or ASTM D 3735, Type III	x	x	x
n-Butyl Alcohol	B00342	ASTM D304	x	x	x
Pre-sealing Cleaning Solvent	B00184	BMS11-7 or AA- 59281, Type I	x	x	x
Shopmaster RTU			x		
SkyKleen 1000	B50085		x	x	x
Vertrel MCA	B50005		x		x

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

TASK 20-30-98-910-802

3. Cleaning of Phenolics or Nylon (Series 98-1)

A. General

(1) This selection of solvents uses BAC5750 as a guide. This procedure contains a list of solvents for general cleaning of phenolics or nylon as given in BAC5750. This list of solvents has the Series Bulk Code of B01051, but this code is only for reference to identify this complete group. In your orders to get the solvents of this list, you must identify each individual solvent by its name, bulk code, or other specification, as shown. Do not use the Series Bulk Code. Refer to the U-File for the applicable vendors.

B. Procedure

SUBTASK 20-30-98-800-002

(1) When your procedure refers to this subject (Table 202), use a solvent from this list.

Table 202/20-30-98-993-802 Cleaning of Phenolics or Nylon (Series 98-1)

Material Name	Material Bulk Code	Other Specifications	Phenolics	Polyamide
70% Isopropyl Alcohol (Balance Deionized Water)			x	x
Acetone	B00062	ASTM D 329	x	
Bonderite C-SO 6709 Aero				x
CDG-110 or Naptha:IPA 1:1				x
CDG-211 or Naptha:IPA:DNA 2:1:1				x
Ethyl 3-Ethoxy Propionate (EEP)	B50228		x	
Ethyl Alcohol			x	x
Ethyl Alcohol, Denatured	B00068	AMS 3002, ASTM E 1145 Type II	x	x
FCC-55 or Naptha:MPK 1:1	B01026			x
HFE-7100	B50002			x
HFE71DE	B50003			x
MEK:sec-Butyl Alcohol 42:58 percent				x
Methyl Ethyl Ketone (MEK)	B00148	ASTM D740 Type I	x	
Methyl Isobutyl Ketone (MIBK)	B00151	ASTM D 1153	x	
Methyl Propyl Ketone (MPK)	B00666	BMS11-9 Grades 1 and 2	x	
MOK or MOK*			x	
Naphtha, Aliphatic	B00083	TT-N-95, Type II or ASTM D 3735, Type III	x	x
n-Butyl Alcohol	B00342	ASTM D304	x	x
Pre-sealing Cleaning Solvent	B00184	BMS11-7 or A-A-59281, Type I	x	
Shopmaster RTU				x
SkyKleen 1000	B50085		x	

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Table 202/20-30-98-993-802 Cleaning of Phenolics or Nylon (Series 98-1) (Continued)

Material Name	Material Bulk Code	Other Specifications	Phenolics	Polyamide
Toluene	B00094	A-A-59107		x
Vertrel MCA	B50005			x

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 99) - MAINTENANCE PRACTICES

1. General

A. This procedure contains a list of solvents for final cleaning of composites prior to structural bonding as given in BAC5578. This procedure gives only the list of solvents. It does not tell you which solvent to use or how to use the solvents.

TASK 20-30-99-910-801

2. Final Cleaning of Composites Prior to Structural Bonding (Series 99)

A. General

(1) This selection of solvents uses BAC5578, D6-83908, and D6-83909 as a guide. This list of solvents has the Series Bulk Code of B01019, but this code is only for reference to identify this complete group. In your orders to get the solvents of this list, you must identify each individual solvent by its name, bulk code, or other specification, as shown. Do not use the Series Bulk Code. Refer to the U-File for the applicable vendors.

B. Procedure

SUBTASK 20-30-99-800-001

(1) When your procedure refers to this subject (Table 201), use a solvent from this list.

Table 201/20-30-99-993-801 Final Cleaning of Composites Prior to Structural Bonding (Series 99)

Material Name	Material Bulk Code	Other Specifications
1,1,1 Trichloroethane (for nonmetallic core only)	B50135	
70% Isopropyl Alcohol (Balance Deionized Water)		
Acetone	B00062	ASTM D 329
Isopropyl Alcohol (IPA)	B00130	TT-I-735 Grade A or B, ASTM D 770
MEK:sec-Butyl Alcohol 42:58 percent		
MEK:Toluene 1:1		
Methyl Ethyl Ketone (MEK)	B00148	ASTM D740 Type I
Methyl Propyl Ketone (MPK)	B00666	BMS11-9 Grades 1 and 2
Pre-sealing Cleaning Solvent (for nonmetallic core only)	B00184	BMS11-7 or A-A-59281, Type I

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(WARNING PRECEDES)

> **WARNING** DO NOT WEAR HEADSET OR HANDLE ANY UMBILICAL CONNECTIONS TO AIRPLANE DURING ATMOSPHERIC ELECTRICAL DISTURBANCES. LIGHTNING STRIKE CAN CAUSE SEVERE INJURY.

(6) Stop ground servicing operations, external to the airplane, during electrical storms.

(7) The airplane is normally electrostatically grounded through conductive tires (Refer to the task, Measure Electrical Resistance to Ground). 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 AND DO NOT TOUCH CONNECTIONS TO THE AIRPLANE DURING ATMOSPHERIC ELECTRICAL ACTIVITY OR IN STRONG ELECTROMAGNETIC FIELDS. LIGHTNING STRIKE AND HIGH DISCHARGE CURRENTS CAN CAUSE SEVERE INJURY.

> **WARNING** ALWAYS ATTACH THE GROUNDING CABLE TO THE GROUND CONNECTION FIRST. NEVER ATTACH THE CABLE TO THE AIRPLANE AND THEN TO THE GROUND CONNECTION.

> **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. GROUND WIRES ATTACHED TO DOORS OR FAIRINGS MADE FROM COMPOSITE MATERIALS DO NOT PROVIDE A GROUND.

(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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

TASK 20-40-11-760-801

3. Electrical Bonding

A. Procedure:

SUBTASK 20-40-11-420-001

WARNING	DO NOT CONNECT A HEADSET AND DO NOT TOUCH CONNECTIONS TO THE AIRPLANE DURING ATMOSPHERIC ELECTRICAL ACTIVITY OR IN STRONG ELECTROMAGNETIC FIELDS. LIGHTNING STRIKE AND HIGH DISCHARGE CURRENTS CAN CAUSE SEVERE INJURY.

CAUTION	ATTACH BONDING CABLES ONLY TO SPECIFIED POINTS ON THE AIRPLANE. INCORRECTLY ATTACHED BONDING CABLES CAN CAUSE SCRATCHES WHICH CAN CAUSE CORROSION AND CRACKS ON STRESSED PARTS. BOND WIRES ATTACHED TO DOORS OR FAIRINGS MADE FROM COMPOSITE MATERIALS DO NOT PROVIDE A BOND.

(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. Measurement of Airplane Electrical Resistance to Ground

A. References

Reference	Title
24-22-00-860-812	Remove Electrical Power (P/B 201)
24-41-11-200-803	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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

C. Prepare to Check

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 24-41-11-200-803.

SUBTASK 20-40-11-000-001

(3) Do this task: Remove Electrical Power, TASK 24-22-00-860-812.

SUBTASK 20-40-11-080-001

(4) Disconnect the airplane static ground cables if connected (TASK 20-40-11-910-801).

SUBTASK 20-40-11-940-001

WARNING 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.

(5) Use these precautions for possible fuel vapors when you use a megohmmeter to measure the discharger resistance.

(a) Use a 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 below a wing fuel tank vent, 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) The area is well ventilated.

2) The metal workstands are grounded.

3) The megohmmeter is plugged into a grounded receptacle.

4) The megohmmeter is insulated from the metal work stand.

5) The measurement is taken from outside the main wheel well and the flammable leakage zone.

SUBTASK 20-40-11-480-003

(6) Connect a insulation meter, COM-6457, or equivalent, to a known bonding/grounding point in the main wheel well.

SUBTASK 20-40-11-480-004

(7) 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

(8) Set the insulation meter, COM-6457, or equivalent, to the 50 Vdc range.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SUBTASK 20-40-11-970-001

(9) Measure the resistance to ground and record the resistance in the maintenance log.

NOTE: The resistance should be less than 1.0 megohms. If the resistance is more than 1.0 megohms this may be the result of a bad grounding location. There may be a very high surface resistance on the airplane.

(a) If the resistance is more than 1.0 megohms, 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

(10) Make sure that the airplane is not parked on a painted surface.

(a) Make sure that the tires have sufficient conductivity.

SUBTASK 20-40-11-970-003

(11) Repeat the measurement at other parking site locations where successful measurements have been made.

NOTE: This will make sure that the airplane has sufficient conductivity.

SUBTASK 20-40-11-080-002

(12) Disconnect the insulation meter, COM-6457 from the airplane and the ramp.

SUBTASK 20-40-11-480-005

(13) Connect the airplane static ground cables if necessary (TASK 20-40-11-910-801).

SUBTASK 20-40-11-860-002

(14) Put the Airplane Back to Its Usual Condition.

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

MAIN WHEEL WELL GROUND STUD LOCATION

A

G26187 S0006562205_V2

Static Ground Point Location
Figure 201/20-40-11-990-801

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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 (Figure 201). 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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(Continued)

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. Procedure

SUBTASK 20-40-12-700-001

(1) Plug 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 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. The acceptable range is 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. The acceptable range is less than 10 megohms.

SUBTASK 20-40-12-090-001

(6) Discard static control wrist strap, COM-1565 if it does not operate in the acceptable range.

——— END OF TASK ———

TASK 20-40-12-000-801

3. ESDS Handling for Printed Circuit Board Removal

(Figure 201)

A. References

Reference	Title
SWPM 20-41-01	ELECTROSTATIC SENSITIVE DEVICE IDENTIFICATION

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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: 6Y703 Part #: 13670 Supplier: 6Y703 Part #: SCS 2301211 Supplier: 6Y703 Part #: SCS 23067 Supplier: 6Y703 Opt Part #: 2100RX4X6 Supplier: 55203 Opt Part #: 2120R Supplier: 55203 Opt Part #: 2120R6X7 Supplier: 55203 Opt Part #: SCS 2121211 Supplier: 6Y703
COM-1567	Container - Conductive, Antistatic Part #: PCC-700-ADE Supplier: 62049 Opt Part #: 2217-12 Supplier: 9A807

C. Handling Procedure

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. (SWPM 20-41-01)

SUBTASK 20-40-12-020-001

(3) Remove the printed circuit board with the applicable removal task.

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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SUBTASK 20-40-12-860-003

> **CAUTION** DO NOT USE STAPLES OR ADHESIVE TAPES TO CLOSE THE BAG OR CONTAINER. FAILURE TO CLOSE CORRECTLY CAN CAUSE DAMAGE TO THE PRINTED CIRCUIT BOARD.

(5) Use 100% cotton twine or ESDS/antistatic tape 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. References

Reference	Title
SWPM 20-41-01	ELECTROSTATIC SENSITIVE DEVICE IDENTIFICATION

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: 6Y703 Part #: 13670 Supplier: 6Y703 Part #: SCS 2301211 Supplier: 6Y703 Part #: SCS 23067 Supplier: 6Y703 Opt Part #: 2100RX4X6 Supplier: 55203 Opt Part #: 2120R Supplier: 55203 Opt Part #: 2120R6X7 Supplier: 55203 Opt Part #: SCS 2121211 Supplier: 6Y703
COM-1567	Container - Conductive, Antistatic Part #: PCC-700-ADE Supplier: 62049 Opt Part #: 2217-12 Supplier: 9A807

C. Handling Procedure

SUBTASK 20-40-12-860-005

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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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. (SWPM 20-41-01)

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 provides instructions to touch an ESDS metal encased unit during removal.

B. References

Reference	Title
SWPM 20-41-01	ELECTROSTATIC SENSITIVE DEVICE IDENTIFICATION

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-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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(Continued)

Reference	Description
COM-1566	Bags - Conductive, Static Shielding Part #: 13020 Supplier: 6Y703 Part #: 13670 Supplier: 6Y703 Part #: SCS 2301211 Supplier: 6Y703 Part #: SCS 23067 Supplier: 6Y703 Opt Part #: 2100RX4X6 Supplier: 55203 Opt Part #: 2120R Supplier: 55203 Opt Part #: 2120R6X7 Supplier: 55203 Opt Part #: SCS 2121211 Supplier: 6Y703
COM-1567	Container - Conductive, Antistatic Part #: PCC-700-ADE Supplier: 62049 Opt Part #: 2217-12 Supplier: 9A807

I

D. ESDS Metal Encased Units 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

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:

WARNING 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.

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.

(b) Connect the static control wrist strap, COM-1565, to an electrostatic ground jack on the E/E rack, to a nearest ground stud, or to an unpainted surface of the primary structure. (SWPM 20-41-01)

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 20-40-12-400-804.

SUBTASK 20-40-12-860-020

(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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> **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.

(a) Use 100% cotton twine or ESDS/antistatic tape to close the antistatic bag or container.

SUBTASK 20-40-12-860-013

(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 provides instructions to touch an ESDS metal encased unit during installation.

B. References

Reference	Title
SWPM 20-41-01	ELECTROSTATIC SENSITIVE DEVICE IDENTIFICATION

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-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: 6Y703 Part #: 13670 Supplier: 6Y703 Part #: SCS 2301211 Supplier: 6Y703 Part #: SCS 23067 Supplier: 6Y703 Opt Part #: 2100RX4X6 Supplier: 55203 Opt Part #: 2120R Supplier: 55203 Opt Part #: 2120R6X7 Supplier: 55203 Opt Part #: SCS 2121211 Supplier: 6Y703
COM-1567	Container - Conductive, Antistatic Part #: PCC-700-ADE Supplier: 62049 Opt Part #: 2217-12 Supplier: 9A807

D. ESDS Metal Encased Unit Installation

SUBTASK 20-40-12-860-014

(1) Make sure electrical power is removed from the metal encased unit.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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, to a nearest ground stud, or to an unpainted surface of the primary structure. (SWPM 20-41-01)

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 20-40-12-420-003

(4) Do this task: Conductive Dust Cap and Connector Cover Removal, TASK 20-40-12-000-804.

SUBTASK 20-40-12-860-016

(5) Install the ESDS unit with the applicable installation task.

SUBTASK 20-40-12-860-017

(6) Remove the static control wrist strap, COM-1565.

——— END OF TASK ———

TASK 20-40-12-000-804

7. Conductive Dust Cap and Connector Cover Removal

(Figure 201)

A. Conductive Dust Cap and Connector Cover Removal

SUBTASK 20-40-12-020-005

> **CAUTION** DO NOT TOUCH THE CONDUCTOR PINS OR OTHER CONDUCTORS ON THE UNIT. IF YOU TOUCH THESE CONDUCTORS, ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE UNIT.

(1) Remove all of the conductive dust caps and the connector covers from the unit to be installed.

SUBTASK 20-40-12-020-006

(2) Install the ESDS unit with the applicable installation task.

——— END OF TASK ———

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COMMERCIAL

GOVERNMENT

INTERNATIONAL
(BOEING)

TYPES OF ESDS SYMBOLS

BOEING ESDS DECALS (EXAMPLE)

F77521 S0006562216_V2

Static Discharge Sensitive Devices Identifiers
Figure 201/20-40-12-990-801

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TASK 20-40-12-400-804

8. **Conductive Dust Cap and Connector Cover Installation**

(Figure 201)

(Table 201Table 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 201/20-40-12-993-804

Table 1 ITT CANON		
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 202/20-40-12-993-805

TABLE 2 SOURIAU		
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 20-40-12-420-005

CAUTION DO NOT TOUCH THE CONDUCTOR PINS OR OTHER CONDUCTORS ON THE UNIT. IF YOU TOUCH THESE CONDUCTORS, ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE UNIT.

(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).

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SUBTASK 20-40-12-420-006

(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.

SUBTASK 20-40-12-860-019

(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 nut torque value are different, use the torque range that has the lowest maximum value.

NOTE: Boeing specification SOPM 20-50-01 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, D00013
4) MIL-PRF-46010 lubricant, D00110
5) Bostik Never Seez Pure Nickel Special Pure Nickel Special compound, 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, 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, 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, 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-8N/-16N	BAC5008
G50136	Compound - Corrosion Inhibiting, Non-drying Paste	BMS3-38

C. Standard Fastener Installation

SUBTASK 20-50-11-420-003

(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 20-50-11-420-004

(2) Tighten the nut or fastener that installs composite and plastic materials and structures, and their combinations with metal structures (Table 228, Table 229, Table 230, Table 231, Table 232, Table 233, Table 234, Table 235, Table 236, Table 237, Table 238, Table 239, Table 240, Table 241).

(a) Impact tools are not allowed to insert, seat, apply torque, or remove fasteners.

(b) Make sure that all structural members and/or barrel nuts and holes are aligned prior to fastener installation to prevent scraping the fastener threads or damage to the hole.

(c) Fastener insertion must be performed using normal hand pressure or light tapping using a non-metallic mallet.

1) The mallet weight must not exceed 12 oz (0.34 kg).

2) Use of metal hammers, rivet guns, or similar impact tools is not allowed.

(d) Drawing the fastener into the hole by torquing the nut is not allowed.

(e) Nuts are lubricated by the manufacturer.

1) Do not degrease or lubricate fasteners or nuts unless specified on the Engineering Drawing.

(f) Nuts must not engage the first incomplete thread next to the bolt shank.

(g) All nut threads must be engaged.

1) The complete chamfer on the end of the fastener must protrude above the nut.

(h) Installed bolt heads and nuts must be free of burrs and sharp edges.

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D. Torque Tables

SUBTASK 20-50-11-580-002

(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, Table 214,.

NOTE: These tables are applicable to install fasteners and nuts in a metal structure.

Table 201/20-50-11-993-844 220 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)

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Table 201/20-50-11-993-844 220 KSI TENSION FASTENERS AND NUTS (EXCEPT BACB31G) (Continued)

FASTENER CLASS	220 KSI			
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)
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 202/20-50-11-993-845 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)

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Table 203/20-50-11-993-846 160-200 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			
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)

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Table 203/20-50-11-993-846 160-200 KSI TENSION FASTENERS, NUTS, NUTPLATES (Continued)

FASTENER CLASS	160-200 KSI			
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)

Table 204/20-50-11-993-847 160-200 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)	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)

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Table 204/20-50-11-993-847 160-200 KSI TITANIUM TENSION FASTENERS, NUTS, NUTPLATES (Continued)

FASTENER CLASS	160-200 KSI			
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)

Table 205/20-50-11-993-848 95-156 KSI SHEAR FASTENERS IN METAL STRUCTURE (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)

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Table 205/20-50-11-993-848 95-156 KSI SHEAR FASTENERS IN METAL STRUCTURE (EXCEPT BACB31V) (Continued)

FASTENER CLASS	95-156 KSI			
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)
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 206/20-50-11-993-849 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 207/20-50-11-993-850 160 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*[1]	TURN THE FASTENER HEAD AND/OR FAY SEAL*[1]	TURN THE NUT AND NO FAY SEAL*[1]	TURN THE FASTENER HEAD AND/OR FAY SEAL*[1]
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) 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)

*[1] Change the fastener grip length or add washers to align the nut slot to the cotter pin hole in the specified torque range.

Table 208/20-50-11-993-851 125 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	

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Table 208/20-50-11-993-851 125 KSI - NUTS, NUT PLATES, CLIP NUTS, STANDOFFS, INSERTS IN METAL, TAPPED HOLES (Continued)

NUT CLASS	125 KSI	
0.0860-56 or 0.0860-64	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)	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 209/20-50-11-993-852 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 209/20-50-11-993-852 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 210/20-50-11-993-853 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 211/20-50-11-993-854 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
NUT PART NUMBER OR STYLE	BACN10JC8-BACN10JC24 ONLY, BACN11BN, MS21245	BACN10YJ08, BACN10YJ3

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Table 211/20-50-11-993-854 60-80 KSI SCREWS AND NUTS, NYLON NUTS (Continued)

FASTENER CLASS	60-80 KSI		NYLON NUTS	
NOMINAL THREAD SIZE	DRY OR LUBED FASTENER		DRY OR 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 OR FAY SEAL
0.0860-56 or 0.0860-64	3 in-lb (0 N·m)	3 in-lb (0 N·m)	-	-
0.1120-40 or 0.1120-48	6 in-lb (1 N·m)	6 in-lb (1 N·m)	-	-
0.1380-32 or 0.1380-40	12 in-lb (1 N·m)	12 in-lb (1 N·m)	-	-
0.1640-32 or 0.1640-36	15 in-lb (2 N·m)	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)	24 in-lb (3 N·m) to 26 in-lb (3 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)	49 in-lb (6 N·m) to 52 in-lb (6 N·m)	-	-
0.3125-24	78 in-lb (9 N·m) to 82 in-lb (9 N·m)	92 in-lb (10 N·m) to 98 in-lb (11 N·m)	-	-
0.3750-24	126 in-lb (14 N·m) to 134 in-lb (15 N·m)	155 in-lb (18 N·m) to 165 in-lb (19 N·m)	-	-
0.4375–20	243 in-lb (27 N·m) to 258 in-lb (29 N·m)	272 in-lb (31 N·m) to 288 in-lb (33 N·m)	-	-
0.5000–20	388 in-lb (44 N·m) to 412 in-lb (47 N·m)	495 in-lb (56 N·m) to 525 in-lb (59 N·m)	-	-
0.5625–18	650 in-lb (73 N·m) to 690 in-lb (78 N·m)	825 in-lb (93 N·m) to 876 in-lb (99 N·m)	-	-
0.6250–18	795 in-lb (90 N·m) to 845 in-lb (95 N·m)	951 in-lb (107 N·m) to 1009 in-lb (114 N·m)	-	-
0.7500–16	1601 in-lb (181 N·m) to 1700 in-lb (192 N·m)	1940 in-lb (219 N·m) to 2060 in-lb (233 N·m)	-	-
0.8750–14	2328 in-lb (263 N·m) to 2472 in-lb (279 N·m)	3201 in-lb (362 N·m) to 3399 in-lb (384 N·m)	-	-
1.0000–12 or 1.0000–14	3638 in-lb (411 N·m) to 3863 in-lb (436 N·m)	5141 in-lb (581 N·m) to 5459 in-lb (617 N·m)	-	-
1.1250–12	4462 in-lb (504 N·m) to 4738 in-lb (535 N·m)	6014 in-lb (679 N·m) to 6386 in-lb (722 N·m)	-	-

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Table 211/20-50-11-993-854 60-80 KSI SCREWS AND NUTS, NYLON NUTS (Continued)

FASTENER CLASS	60-80 KSI		NYLON NUTS	
1.2500–12	6790 in-lb (767 N·m) to 7210 in-lb (815 N·m)	8342 in-lb (943 N·m) to 8858 in-lb (1001 N·m)	-	-
1.3750–12	7760 in-lb (877 N·m) to 8240 in-lb (931 N·m)	8730 in-lb (986 N·m) to 9270 in-lb (1047 N·m)	-	-
1.5000–12	10,670 in-lb (1206 N·m) to 11,330 in-lb (1280 N·m)	11,640 in-lb (1315 N·m) to 12,360 in-lb (1396 N·m)	-	-

Table 212/20-50-11-993-855 STAKE SCREWS

FASTENER CLASS		60-80 KSI		95-160 KSI	
STAKE SCREW PART NUMBERS*[1]		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*[2]			
		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)

*[1] (***) = screw diameter; (*) = length (dash number); (**) = color code (glossiness and color).

*[2] Use the torque values for dry screws unless the AMM procedure specifies additional lubricant.

Table 213/20-50-11-993-856 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)

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Table 213/20-50-11-993-856 JAM NUTS (Continued)

NUT STYLE	LOCKWIRE HOLES	NO LOCKWIRE HOLES
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 214/20-50-11-993-857 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)
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)

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Table 214/20-50-11-993-857 COARSE THREAD FASTENERS AND NUTS (Continued)

FASTENER PART NUMBER	ALL COARSE THREAD FASTENERS (DESIGNATED BY UNC OR UNJC)		
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 215/20-50-11-993-858 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)
2.0000-12	300.0 in-lb (33.9 N·m)	1700.0 in-lb (192.1 N·m)

Table 216/20-50-11-993-859 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)	2.5 in-lb (0.3 N·m)

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Table 216/20-50-11-993-859 Locking Torques for Self-Locking Nuts (Coarse Threads) (Continued)

SIZE	TORQUE	
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 217/20-50-11-993-860 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
1	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)

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Table 217/20-50-11-993-860 Standard Torque Values for Rigid Tube Coupling Connectors (Continued)

	TORQUE VALUE			
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 218/20-50-11-993-861 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 219/20-50-11-993-862 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)
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)

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Table 219/20-50-11-993-862 Standard Torque Values for Low Pressure and Return Line Fittings (Continued)

TUBE SIZE		FLARED AND FLARELESS COMPONENTS TORQUE	
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) Flared, Flareless, and Short Flareless Fittings, Table 220, Table 221, Table 222, Table 223.

Table 220/20-50-11-993-863 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

TUBE SIZE; FITTING END SIZE, HOSE END SIZE*[1]		TUBE MATERIAL/END CONFIGURATION*[2]*[3]*[4]*[5]*[6]*[7]						
NOMINAL TUBE DIAMETER (INCH)	SIZE	TUBING ENDS; FITTING ENDS; HOSE ENDS *[8]*[9]*[10]	BACS13AP BITE TYPE SLEEVES WITH 6061T ALUMINUM MIL-T-7081 OR ANNEALED CRES (MIL-T-8504, MIL-T-8606, MIL-T-8808) TUBE					
		TORQUE (IN-LB ± 5%)	MINIMUM TUBE WALL THICKNESS ALUMINUM AND ANNEALED CRES (INCH)	TORQUE (IN-LB ± 5%)	SPECIAL THIN WALL ANNEALED CRES WALL THICKNESS (INCH)	TORQUE (IN-LB ± 5%)	SPECIAL HEAVY WALL ANNEALED CRES WALL THICKNESS (INCH)	TORQUE (IN-LB ± 5%)
1/8 (0.125)	02	--	--	--	--	--	--	--
3/16 (0.188)	03	80 ±4 in-lb (9 ±0 N·m)	0.028	80 ±4 in-lb (9 ±0 N·m)	--	--	--	--
1/4 (0.250)	04	110 ±6 in-lb (12 ±1 N·m)	0.028	110 ±6 in-lb (12 ±1 N·m)	--	--	--	--
5/16 (0.313)	05	140 ±7 in-lb (16 ±1 N·m)	0.028	140 ±7 in-lb (16 ±1 N·m)	--	--	--	--
3/8 (0.375)	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 (0.500)	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)

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Table 220/20-50-11-993-863 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 (Continued)

TUBE SIZE; FITTING END SIZE, HOSE END SIZE*[1]		TUBE MATERIAL/END CONFIGURATION*[2]*[3]*[4]*[5]*[6]*[7]						
NOMINAL TUBE DIAMETER (INCH)	SIZE	TUBING ENDS; FITTING ENDS; HOSE ENDS *[8]*[9]*[10]	BACS13AP BITE TYPE SLEEVES WITH 6061T ALUMINUM MIL-T-7081 OR ANNEALED CRES (MIL-T-8504, MIL-T-8606, MIL-T-8808) TUBE					
		TORQUE (IN-LB ± 5%)	MINIMUM TUBE WALL THICKNESS ALUMINUM AND ANNEALED CRES (INCH)	TORQUE (IN-LB ± 5%)	SPECIAL THIN WALL ANNEALED CRES WALL THICKNESS (INCH)	TORQUE (IN-LB ± 5%)	SPECIAL HEAVY WALL ANNEALED CRES WALL THICKNESS (INCH)	TORQUE (IN-LB ± 5%)
5/8 (0.625)	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 (0.750)	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 (0.875)	14	--	--	--	--	--	--	--
1 (1.000)	16	750 ±38 in-lb (85 ±5 N·m)	0.035	750 ±38 in-lb (85 ±5 N·m)	--	--	--	--
1-1/4 (1.250)	20	900 ±45 in-lb (102 ±5 N·m)	--	--	--	--	--	--
1-1/2 (1.500)	24	900 ±45 in-lb (102 ±5 N·m)	--	--	--	--	--	--
1-3/4 (1.750)	28	--	--	--	--	--	--	--
2 (2.000)	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.

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*[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] 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.

*[9] Unless otherwise specified on the Engineering Drawing, tighten the following items to each other using the torque values on the table:

-Tube assemblies made with material specifications: 6061-T4 or -T6 aluminum tubing - MIL-T-7081, AMS-T-7081, AMS4081, AMS4083, AMS-WW-T-700/6 or BMS7-328;

-Flareless tube assemblies made with annealed CRES tubing with material specifications: MIL-T-8504 (alloy 304), MIL-T-8606 (alloys 321 or 347), MIL-T-8808 (alloys 321 or 347), AMS556 (alloy 347), AMS5557 (alloy 321), or AMS5567 (alloy 304);

-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;

*[10] 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.

Table 221/20-50-11-993-864 Installation Torques for Flared, Flareless, and Short Flareless Fittings with Lubricated Threads Used on CRES and Titanium Tube Fittings and Hose Ends

TUBE SIZE; FITTING END SIZE; HOSE END SIZE*[1]		TUBE MATERIAL/END CONFIGURATION *[2]*[3]*[4]*[5]*[6]*[7]				
NOMINAL TUBE DIAMETER (INCH)	SIZE	TUBING ENDS; FITTING ENDS; HOSE ENDS *[8]	BACS13AP BITE TYPE SLEEVES WITH 1/8 HARD (MIL-T-6845, AMS-T-6842 OR AMS5566) CRES TUBE			
		TORQUE (IN-LB ±5%)	MINIMUM WALL THICKNESS (INCH)	TORQUE (IN-LB ±5%)	SPECIAL THIN-WALL TUBE WALL THICKNESS (INCH)	TORQUE (IN-LB ±5%)
1/8 (0.125)	02	--	--	--	--	--
3/16 (0.188)	03	100 ±5 in-lb (11 ±1 N·m)	0.016	100 ±5 in-lb (11 ±1 N·m)	--	--
1/4 (0.250)	04	140 ±7 in-lb (16 ±1 N·m)	0.020	140 ±7 in-lb (16 ±1 N·m)	--	--

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Table 221/20-50-11-993-864 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; FITTING END SIZE; HOSE END SIZE*[1]		TUBE MATERIAL/END CONFIGURATION *[2]*[3]*[4]*[5]*[6]*[7]				
NOMINAL TUBE DIAMETER (INCH)	SIZE	TUBING ENDS; FITTING ENDS; HOSE ENDS *[8]	BACS13AP BITE TYPE SLEEVES WITH 1/8 HARD (MIL-T-6845, AMS-T-6842 OR AMS5566) CRES TUBE			
		TORQUE (IN-LB ±5%)	MINIMUM WALL THICKNESS (INCH)	TORQUE (IN-LB ±5%)	SPECIAL THIN-WALL TUBE WALL THICKNESS (INCH)	TORQUE (IN-LB ±5%)
5/16 (0.313)	05	190 ±10 in-lb (21 ±2 N·m)	0.020	190 ±10 in-lb (21 ±2 N·m)	--	--
3/8 (0.375)	06	270 ±14 in-lb (31 ±2 N·m)	0.028	270 ±14 in-lb (31 ±2 N·m)	--	--
1/2 (0.500)	08	500 ±25 in-lb (56 ±3 N·m)	0.034	500 ±25 in-lb (56 ±3 N·m)	0.028	375 ±19 in-lb (42 ±3 N·m)
5/8 (0.625)	10	700 ±35 in-lb (79 ±4 N·m)	0.049	700 ±35 in-lb (79 ±4 N·m)	0.035	575 ±29 in-lb (65 ±3 N·m)
3/4 (0.750)	12	900 ±45 in-lb (102 ±5 N·m)	0.049	900 ±45 in-lb (102 ±5 N·m)	0.042	725 ±36 in-lb (82 ±4 N·m)
7/8 (0.875)	14	--	--	--	--	--
1 (1.000)	16	1200 ±60 in-lb (136 ±7 N·m)	--	--	--	--
1-1/4 (1.250)	20	1600 ±80 in-lb (181 ±9 N·m)	--	--	--	--
1-1/2 (1.500)	24	2000 ±100 in-lb (226 ±11 N·m)	--	--	--	--
1-3/4 (1.750)	28	--	--	--	--	--
2 (2.000)	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 in steel or titanium bosses.

*[6] Use steel fitting torque values for steel or titanium jamnuts installed on steel or titanium bulkhead fittings.

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*[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 ASM4946;

-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.

Table 222/20-50-11-993-865 Installation Torques for Flared Hose End Fittings with Aluminum Inserts

TUBE SIZE		TUBE MATERIAL/END CONFIGURATION *[1]*[2]*[3]*[4]*[5]*[6]*[7]
		FLARED HOSE END FITTINGS WITH ALUMINUM INSERTS
NOMINAL DIAMETER (INCH)	SIZE	TORQUE (IN-LB ±5%)
1/8 (0.125)	02	--
3/16 (0.188)	03	35 ±2 in-lb (3.95 ±0.20 N·m)
1/4 (0.250)	04	65 ±3 in-lb (7 ±1 N·m)
5/16 (0.313)	05	90 ±5 in-lb (10 ±1 N·m)
3/8 (0.375)	06	130 ±7 in-lb (15 ±1 N·m)
1/2 (0.500)	08	260 ±13 in-lb (29 ±2 N·m)
5/8 (0.625)	10	360 ±18 in-lb (41 ±2 N·m)
3/4 (0.750)	12	500 ±25 in-lb (56 ±3 N·m)
7/8 (0.875)	14	--
1 (1.000)	16	700 ±35 in-lb (79 ±4 N·m)
1-1/4 (1.250)	20	900 ±45 in-lb (102 ±5 N·m)
1-1/2 (1.500)	24	900 ±45 in-lb (102 ±5 N·m)
1-3/4 (1.750)	28	--
2 (2.000)	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.

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*[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.

Table 223/20-50-11-993-866 Standard End Fitting Size and Thread Size

END FITTING SIZE*[1]	THREAD SIZE ALL OTHER PRESSURE RATINGS (MAJOR DIAMETER - TPI)
04	.4375 - 20
05	.5000 - 20
06	.5625 - 18
08	.7500 - 16
10	.8750 - 14
12	1.0625 - 12
16	1.3125 - 12
20	1.6250 - 12
24	1.8750 - 12
32	2.5000 - 12

*[1] To use the table, measure the major diameter and number of threads per inch (TPI) of the external thread, find thread size on the table and follow the row to the left for the end fitting size.

(i) Clamps, V-Band, Channel-Band and Couplings, Table 224, Table 225, Table 226, Table 227.

Table 224/20-50-11-993-867 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)
		550-600	100 +5 / -0 in-lb (11 +1 / -0 N·m)
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)
	--	450-600	70 +5 / -0 in-lb (8 +1 / -0 N·m)
BACC10DP()B	--	300	50 +5 / -0 in-lb (6 +1 / -0 N·m)

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Table 224/20-50-11-993-867 Standard Torque Values for Coupling Clamps, V-Band, and Channel-Band (Continued)

BOEING PART NUMBER	NOTES	DASH NUMBER ()	TORQUE
BACC10DU()ABE	--	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	Supplier part number: MVT68675-()	150-800	105 +5 / -0 in-lb (12 +1 / -0 N·m)
	Supplier part number: 14J53-()	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 +5 / -0 in-lb (12 +1 / -0 N·m)
		125-300	105 +5 / -0 in-lb (12 +1 / -0 N·m)
BACC10FY()()()	-	All	30 +5 / -0 in-lb (3 +1 / -0 N·m)
BACC10GY()	--	150-175	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)
		475-600	65 +5 / -0 in-lb (7 +1 / -0 N·m)
		650-900	85 +5 / -0 in-lb (10 +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)

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Table 224/20-50-11-993-867 Standard Torque Values for Coupling Clamps, V-Band, and Channel-Band (Continued)

BOEING PART NUMBER	NOTES	DASH NUMBER ()	TORQUE
BACC10JB()		014–396	21.5 ±3.5 in-lb (2.4 ±0.4 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()	--	250-275	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)

*[1] Inside of coupling not lubricated.

*[2] Inside of coupling and T-bolt threads not lubricated.

Table 225/20-50-11-993-868 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 226/20-50-11-993-869 Duct Support Clamp Installation Torques

BOEING PART NUMBER	DASH NUMBER	RECOMMENDED TORQUE
BACC10Q	ALL	25 ±5 in-lb (3 ±1 N·m)

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Table 226/20-50-11-993-869 Duct Support Clamp Installation Torques (Continued)

BOEING PART NUMBER	DASH NUMBER	RECOMMENDED TORQUE
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 227/20-50-11-993-870 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)		
MIL-DTL-6000	22 in-lb (2 N·m)	28 in-lb (3 N·m)
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 228, Table 229, Table 230, Table 231, Table 232, Table 233, Table 234, Table 235, Table 236, Table 237, Table 238, Table 239, Table 240, Table 241).

NOTE: The torque values for plastic parts are given by part type, not part number.

Table 228/20-50-11-993-871 220 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)

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Table 228/20-50-11-993-871 220 KSI TENSION FASTENERS AND NUTS (Continued)

FASTENER CLASS	220 KSI	
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	2100 in-lb (237 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 229/20-50-11-993-872 220 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)

Table 230/20-50-11-993-873 150 - 200 KSI TENSIONS 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

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Table 230/20-50-11-993-873 150 - 200 KSI TENSIONS FASTENERS, NUTS, NUTPLATES (Continued)

CLASS	160 — 200 KSI		150 — 160 KSI	
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 (2.3 N·m)	20 in-lb (2.3 N·m)	20 in-lb (2.3 N·m)	20 in-lb (2.3 N·m)
0.1900-32	30 in-lb (3.4 N·m)	30 in-lb (3.4 N·m)	30 in-lb (3.4 N·m)	30 in-lb (3.4 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)	- - -	- - -
1.2500-12	13,600 in-lb (1537 N·m)	15,700 in-lb (1774 N·m)	- - -	- - -

Table 231/20-50-11-993-874 BACB31U

BOLT STYLE: BACB31U used with 160–200 KSI nuts (EXAMPLES: BACN10JA, BACN10JB, BACN11Z)					
		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	10–32	30 in-lb (3.4 N·m)	30 in-lb (3.4 N·m)	30 in-lb (3.4 N·m)	30 in-lb (3.4 N·m)
0.25	1/4–28	85 in-lb (10 N·m)	100 in-lb (11 N·m)	65 in-lb (7 N·m)	75 in-lb (8 N·m)
0.3125	5/16–24	170 in-lb (19 N·m)	200 in-lb (23 N·m)	110 in-lb (12 N·m)	125 in-lb (14 N·m)
0.3750	3/8–24	320 in-lb (36 N·m)	410 in-lb (46 N·m)	200 in-lb (23 N·m)	250 in-lb (28 N·m)

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Table 232/20-50-11-993-875 BACB31U

BOLT STYLE: BACB31U used with 125 KSI nuts (EXAMPLES: BACN10KE, BACN11G, BACN10YR)					
		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	10–32	30 in-lb (3.4 N·m)	30 in-lb (3.4 N·m)	30 in-lb (3.4 N·m)	30 in-lb (3.4 N·m)
0.25	1/4–28	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	5/16–24	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	3/8–24	200 in-lb (23 N·m)	240 in-lb (27 N·m)	175 in-lb (20 N·m)	200 in-lb (23 N·m)

Table 233/20-50-11-993-876 BACB31V

BOLT STYLE: BACB31V used with 125 KSI nuts (EXAMPLES: BACN10KE, BACN11G, BACN10YR)					
		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	10–32	30 in-lb (3.4 N·m)	30 in-lb (3.4 N·m)	30 in-lb (3.4 N·m)	30 in-lb (3.4 N·m)
0.2500	1/4–28	40 in-lb (5 N·m)	40 in-lb (5 N·m)	30 in-lb (3.4 N·m)	30 in-lb (3.4 N·m)

Table 234/20-50-11-993-877 95-156 KSI SHEAR FASTENERS (EXCEPT BACB31V), NUTS, NUTPLATES, CLIP NUTS, STANDOFFS, INSERTS IN METAL, TAPPED HOLES

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, 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
	ALL METAL CHANNELS, GANG CHANNELS

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Table 234/20-50-11-993-877 95-156 KSI SHEAR FASTENERS (EXCEPT BACB31V), NUTS, NUTPLATES, CLIP NUTS, STANDOFFS, INSERTS IN METAL, TAPPED HOLES (Continued)

CLASS	95-156 KSI	
NOMINAL THREAD SIZE	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 (0.3 N·m)	3 in-lb (0.3 N·m)
0.1120-40 or 0.1120-48	8 in-lb (0.9 N·m)	8 in-lb (0.9 N·m)
0.1380–32 or 0.1380-40	15 in-lb (1.7 N·m)	15 in-lb (1.7 N·m)
0.1640-32 or 0.1640-36	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 N·m)
0.3125-24	125 in-lb (14 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 1.0000-14	5600 in-lb (633 N·m)	7500 in-lb (847 N·m)
1.1250-12	7000 in-lb (791 N·m)	9000 in-lb (1017 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.

Table 235/20-50-11-993-878 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)	31 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)

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Table 235/20-50-11-993-878 80-125 KSI CASTELLATED NUTS (Continued)

NUT CLASS	80 KSI		125 KSI	
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) - 2000 in-lb (226 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) - 9900 in-lb (1119 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 236/20-50-11-993-879 160 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)
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)

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Table 236/20-50-11-993-879 160 KSI CASTELLATED NUTS (Continued)

NUT CLASS	160 KSI	
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 237/20-50-11-993-880 REDUCED SHEAR HEAD FASTENERS AND NUTS

FASTENER CLASS	95 KSI	
FASTENER PART NUMBER	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	
0.1640–32 or 36	15 in-lb (1.7 N·m)	10 in-lb (1.1 N·m) - 18 in-lb (2.0 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) - 170 in-lb (19 N·m)
0.5000–20	230 in-lb (26 N·m)	220 in-lb (25 N·m) - 245 in-lb (28 N·m)
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) - 720 in-lb (81 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 238/20-50-11-993-881 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)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

Table 238/20-50-11-993-881 60-80 KSI SCREWS AND NUTS (Continued)

CLASS	60 - 80 KSI	
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 (2.3 N·m)	20 in-lb (2.3 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)

Table 239/20-50-11-993-882 STAKE SCREWS

CLASS		60 - 80 KSI	95 - 160 KSI
FASTENER PART NUMBER*[1]		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(***)(*)TPK(**)
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 (1 N·m)
0.1380–32 or 40	6C	12 in-lb (1.4 N·m)	15 in-lb (1.7 N·m)
0.1640–32 or 36	8C	16 in-lb (2 N·m)	20 in-lb (2.3 N·m)
0.1900–32	10F	20 in-lb (2.3 N·m)	35 in-lb (4 N·m)

*[1] (***) = screw diameter (*) = length (dash number) (**) = color code (glossiness and color)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

Table 240/20-50-11-993-883 PLASTIC PARTS AND POTTED INSERTS

PART TYPE	POTTED INSERTS*[5]*[6]	PLASTIC PARTS*[2]*[3]*[6]	
		STANDARD PARTS*[4]	OTHER PLASTIC PARTS*[1]
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.	INTERIOR PARTS SUCH AS DECORATIVE TRIM, PLACARDS, SHROUDS, CEILINGS, LININGS, ETC.
		THRU-HOLE PLASTIC PARTS SUCH AS BRACKETS, SUPPORTS, CLAMPS, SPACERS, WASHERS, AND GROMMETS	
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
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 (1 N·m) - 10 in-lb (1 N·m)	
0.1380–32 or 40	12 in-lb (1.4 N·m)	10 in-lb (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 (2.3 N·m)	
0.1900–32	20 in-lb (2.3 N·m)	20 in-lb (2.3 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)	- - -	

*[1] These parts are not used to attach systems to the airplane. This requirement does not apply to the plastic standard parts given in the middle column of this table.

*[2] Contact Liaison Engineering if there are questions about the applicability of this requirement.

*[3] Do not damage plastic parts during installation. Examples of damage include cuts, crushing, or bulged edges around the fastener.

*[4] Standard parts are used to attach systems such as wiring, ducts, tubes, etc., to the airplane. Plastic standard parts include BAC and vendor standard parts, and engineering parts. Example part numbers include: BACS38Y, BACS21DZ, BACN10TS, BACB20AV, BACC15AT, 411A4902-7, 287T0011-1, etc.

*[5] Potted inserts are installed in panels or other parts with wet potting compounds or other non-metallic materials. These parts are not mechanically fastened. Example insert part numbers include: BACI12AG, BACI12AH, NAS1834, NAS1836, etc.

*[6] If potted inserts, standard parts or other plastic parts are used together, use the lowest torque value given in the torque tables. Find the lowest torque value for a range and a set point value by this procedure. Compare the midpoint value from the range to the set point value and apply the lowest torque value.

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Table 241/20-50-11-993-884 JAM NUTS

NUT PART NUMBER	AN316, MS35649, MS35650, MS35691 OTHER JAM NUTS WITHOUT LOCKWIRE HOLES		NAS1423, NAS509, OTHER JAM NUTS WITH LOCKWIRE HOLES	
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	20 in-lb (2.3 N·m)	20 in-lb (2.3 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 (2.3 N·m)	20 in-lb (2.3 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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

$$T_1 = \frac{TA}{A+B}$$

A = LENGTH OF THE TORQUE WRENCH
B = EFFECTIVE LENGTH OF THE ADAPTER
T = APPROVED TORQUE (SHOWN IN TORQUE TABLE)
T_1 = ADJUSTED TORQUE (SHOWN ON TORQUE WRENCH)

EXAMPLE: A = 12 INCHES
B = 3 INCHES
T = 160 POUND -INCHES

$$T_1 = \frac{160 \times 12}{12+3}$$

T_1 = 128 POUND -INCHES

METHOD 1

HANDLE EXTENSION ONLY.
NO CORRECTION NECESSARY. 1

METHOD 2

ADAPTER WITH THE EXTENSION BETWEEN THE ADAPTER AND THE WRENCH. BOTH ARE IN LINE WITH THE WRENCH. INDICATED TORQUE T_1:

$$T_1 = \frac{TA}{A+B}$$

METHOD 3

1 HANDLE EXTENSIONS MAY ONLY BE USED ON RIGID FRAME TORQUE TOOLS SUCH AS DIAL INDICATORS, ELECTRONIC WRENCHES, AND OTHER DIRECT INDICATING TOOLS. THE HANDLE IS EITHER INTEGRALTO OR RIGIDLY ATTACHED TO THE BODY OF THE TOOL. CLICKER-TYPE TORQUE TOOLS ARE NOT ALLOWED FOR USE WITH A HANDLE EXTENSION.

F15915 S0006562221_V3

Finding Torque Values for a Torque Wrench with an Adapter
Figure 201/20-50-11-990-810 (Sheet 1 of 2)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

BOTH HANDLE EXTENSION AND ADAPTER,
INDICATED TORQUE T_1: 1

$$T_1 = \frac{Tx(A+C)}{A+B+C}$$

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 APPLICABL-E:

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 ±3˚ 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

F44268 S0006562222_V4

Finding Torque Values for a Torque Wrench with an Adapter
Figure 201/20-50-11-990-810 (Sheet 2 of 2)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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

F15953 S0006562234_V5

Torque Values for Reduced-Head Bolts
Figure 202/20-50-11-990-811

ECCN 9E991 BOEING PROPRIETARY - See title page for details

CONNECTION ASSEMBLY FOR ALUMINUM ALLOY FITTINGS
NAS591-NAS593

CONNECTION ASSEMBLY FOR STAINLESS STEEL FITTINGS
NAS594-NAS596

F15954 S0006562235_V4

Connection Assemblies for Rigid Tube Couplings
Figure 203/20-50-11-990-812

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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 Fault Isolation Manual (FIM) for troubleshooting open fuel pump circuit breakers.

1) You can not use this procedure to reset a tripped fuel pump circuit breaker.

NOTE: Reset of the fuel pump circuit breakers is a Critical Design Configuration Control Limitation (CDCCL) item.

(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 determine the cause for the tripped circuit breaker.

4) If you cannot determine whether it is safe to reset the circuit breaker.

B. References

Reference	Title
SWPM 20-02-10	Airplane Flammable Leakage Zones

C. Location Zones

Zone	Area
100	Lower Half of Fuselage
200	Upper Half of Fuselage

D. Procedure

SUBTASK 20-60-01-860-001

(1) Attach a DO-NOT-CLOSE tag to the tripped circuit breaker.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SUBTASK 20-60-01-860-002

(2) Install a circuit breaker lock 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.

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. If necessary, refer to the Wiring Diagram Manual (WDM). Look for these types of damage:

(a) Electrical shorting

(b) Electrical arcing

(c) Corrosion on the contacts of the electrical wiring and system components

(d) Abrasion of the electrical wiring and system components

(e) Cracks on the insulation of the electrical wiring

(f) Split wires

NOTE: A split wire is when you can see the conductor through the crack in the insulation of the electrical wiring.

(g) Broken wires

(h) Discoloration of the insulation of the electrical wiring

(i) Fluid or dust contamination of electrical wiring and system components

NOTE: Contamination can be a fuel source during electrical arcing.

(j) 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.

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 necessary.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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 lock(s).

SUBTASK 20-60-01-860-012

WARNING	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.

WARNING	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).

NOTE: Reset of the fuel pump circuit breakers is a Critical Design Configuration Control Limitation (CDCCL) item.

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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

CLEANING TO REMOVE COMBUSTIBLE MATERIAL (EZAP) - MAINTENANCE PRACTICES

1. General

A. This procedure has this task:

(1) Cleaning to Remove Combustible Material.

EWIS

TASK 20-60-02-100-801

2. Cleaning to Remove Combustible Material

NOTE: This procedure is a scheduled maintenance task.

A. General

(1) This task is an Enhanced Zonal Analysis Procedure (EZAP) task.

(2) This task 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)
20-60-07-913-801	Protection of the EWIS During Maintenance (P/B 201)
24-22-00-860-811	Supply Electrical Power (P/B 201)
24-22-00-860-812	Remove Electrical Power (P/B 201)
51-00	CORROSION PREVENTION
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 20-60-02-860-001

WARNING

EXERCISE EXTREME CAUTION WHEN WORKING AROUND ENERGIZED PANELS. HIGH VOLTAGES PRESENT CAN BE FATAL.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(WARNING PRECEDES)

> **WARNING** REMOVE THE AIRPLANE ELECTRICAL POWER WHEN YOU DO AN INSPECTION OR CLEAN THE ELECTRICAL-WIRING INTERCONNECT-SYSTEMS (EWIS). IF YOU DO NOT OBEY, A FIRE CAN OCCUR AND CAUSE INJURY TO PERSONS AND DAMAGE TO EQUIPMENT.

(2) If it is necessary to touch the EWIS, remove electrical power in the area(s) or from the item(s) to be cleaned (TASK 24-22-00-860-812):

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.

(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 20-60-02-010-002

(3) Remove panels as necessary to gain access to the area(s)/item(s).

SUBTASK 20-60-02-100-001

(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 20-60-07-913-801.

> **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): CORROSION PREVENTION, 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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SUBTASK 20-60-02-410-001

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.

(5) Install all panels removed for access.

SUBTASK 20-60-02-860-002

(6) Restore electrical power in the area(s) and/or from the item(s) that had the electrical power removed (TASK 24-22-00-860-811).

(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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

DETAILED INSPECTION OF EWIS (EZAP) - MAINTENANCE PRACTICES

1. General

A. This procedure has this task:

(1) A detailed inspection of EWIS.

EWIS

TASK 20-60-03-100-801

2. Detailed Inspection of EWIS

NOTE: This procedure is a scheduled maintenance task.

A. General

(1) This task is an Enhanced Zonal Analysis Procedure (EZAP) task.

(2) This task performs a detailed inspection of Electrical Wiring Interconnect Systems (EWIS).

B. References

Reference	Title
20-40-11-910-801	Static Grounding (P/B 201)
20-60-02-100-801	Cleaning to Remove Combustible Material (P/B 201)
20-60-07-913-801	Protection of the EWIS During Maintenance (P/B 201)
24-22-00-860-811	Supply Electrical Power (P/B 201)
24-22-00-860-812	Remove Electrical Power (P/B 201)
SWPM 20, Standard Wiring Practices	Standard Wiring Practices
SWPM 20-10-20	Standard Wiring Practices Manual

C. Detailed Inspection of EWIS

SUBTASK 20-60-03-100-001

(1) Do this task: Static Grounding, TASK 20-40-11-910-801.

SUBTASK 20-60-03-860-001

WARNING

BE CAREFUL WHEN YOU DO WORK AROUND ENERGIZED PANELS. HIGH VOLTAGES CAN KILL YOU.

WARNING

REMOVE THE AIRPLANE ELECTRICAL POWER WHEN YOU DO AN INSPECTION OR CLEAN THE ELECTRICAL-WIRING INTERCONNECT-SYSTEMS (EWIS). IF YOU DO NOT OBEY, A FIRE CAN OCCUR AND CAUSE INJURY TO PERSONS AND DAMAGE TO EQUIPMENT.

(2) If it is necessary to touch the EWIS, remove electrical power from the EWIS to be inspected (TASK 24-22-00-860-812):

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 the circuit breakers and switches for the EWIS to be inspected.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(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 20-60-03-010-003

(3) Remove the panels as necessary to gain access to the EWIS.

SUBTASK 20-60-03-211-001

(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:

1) EWIS that are undisturbed and kept free of contamination will provide trouble-free service without the need for unscheduled maintenance.

2) EWIS can be easily damaged during the inspection if they are used as a handhold or support for personal equipment.

(b) Check the EWIS and 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 20-60-02-100-801.

(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 the 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 the switches for rear protection cap damage.

(f) Check the ground points for: corrosion, bonding braid/bonding jumper, broken or disconnected braid, multiple strands corroded or broken.

(g) Check the EWIS clamps or brackets for: presence, corrosion, condition, bends or twists, attachment, protection/cushion.

(h) Check the 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 20-60-07-913-801.

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.

SUBTASK 20-60-03-940-001

(5) Remove all tools, loose parts, and unwanted material from the area.

SUBTASK 20-60-03-410-001

(6) Install all panels removed for access.

SUBTASK 20-60-03-860-002

(7) Restore the electrical power in the area(s) and/or from the item(s) that had the electrical power removed (TASK 24-22-00-860-811).

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

GENERAL VISUAL INSPECTION OF EWIS (EZAP) - MAINTENANCE PRACTICES

1. General

A. This procedure has this task:

(1) General Visual Inspection of EWIS.

EWIS

TASK 20-60-04-100-801

2. General Visual Inspection of EWIS

NOTE: This procedure is a scheduled maintenance task.

A. General

(1) This task is an Enhanced Zonal Analysis Procedure (EZAP) task.

(2) This task performs a general visual inspection of Electrical Wiring Interconnect Systems (EWIS).

B. References

Reference	Title
20-40-11-910-801	Static Grounding (P/B 201)
20-60-02-100-801	Cleaning to Remove Combustible Material (P/B 201)
20-60-07-913-801	Protection of the EWIS During Maintenance (P/B 201)
24-22-00-860-811	Supply Electrical Power (P/B 201)
24-22-00-860-812	Remove Electrical Power (P/B 201)
SWPM 20, Standard Wiring Practices	Standard Wiring Practices
SWPM 20-10-20	Standard Wiring Practices Manual

C. General Visual Inspection of EWIS

SUBTASK 20-60-04-210-001

(1) Do this task: Static Grounding, TASK 20-40-11-910-801.

SUBTASK 20-60-04-860-001

WARNING BE CAREFUL WHEN YOU DO WORK AROUND ENERGIZED PANELS. HIGH VOLTAGES CAN KILL YOU.

WARNING REMOVE THE AIRPLANE ELECTRICAL POWER WHEN YOU DO AN INSPECTION OR CLEAN THE ELECTRICAL-WIRING INTERCONNECT-SYSTEMS (EWIS). IF YOU DO NOT OBEY, A FIRE CAN OCCUR AND CAUSE INJURY TO PERSONS AND DAMAGE TO EQUIPMENT.

(2) If it is necessary to touch the EWIS, remove electrical power from the EWIS to be inspected (TASK 24-22-00-860-812):

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. 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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(b) Open the 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 20-60-04-010-002

(3) Remove the panels as necessary to gain access to the EWIS.

SUBTASK 20-60-04-210-002

(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:

1) EWIS that are undisturbed and kept free of contamination will provide trouble-free service without the need for unscheduled maintenance.

2) EWIS can be easily damaged during the inspection if they are used as a handhold or support for personal equipment.

(b) Check the EWIS and 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 20-60-02-100-801.

(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 the 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 the switches for rear protection cap damage.

(f) Check the ground points for: corrosion, bonding braid/bonding jumper, broken or disconnected braid, multiple strands corroded or broken.

(g) Check the EWIS clamps or brackets for: presence, corrosion, condition, bends or twists, attachment, protection/cushion.

(h) Check the 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 20-60-07-913-801.

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).

SUBTASK 20-60-04-410-002

(5) Install all panels removed for access.

SUBTASK 20-60-04-860-002

(6) Restore electrical power in the area(s) and/or from the item(s) that had the electrical power removed (TASK 24-22-00-860-811).

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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
24-22-00-860-812	Remove Electrical Power (P/B 201)

B. Procedure

SUBTASK 20-60-05-020-001

(1) Do this task: Remove Electrical Power, TASK 24-22-00-860-812

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. Look for these types of damage:

1) Electrical shorting

2) Electrical arcing

3) Discoloration of the circuit breaker

4) Contamination of the circuit breaker

(c) If you find damage to the circuit breaker, replace the circuit breaker.

(d) Close the circuit breaker.

NOTE: After you open and close the circuit breaker, you can possibly find contamination.

(e) Remove contamination, if necessary.

(f) If you find that the circuit breaker is unserviceable after you open and close it, replace the circuit breaker.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

SUBTASK 20-60-05-860-002

(3) If necessary, do this procedure again to cycle another circuit breaker.

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

ELECTRONIC LRU CLEANING - MAINTENANCE PRACTICES

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
B01000	Solvent - General Cleaning Of Metal (AMM 20-30-80) - Series 80	

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.

(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 Series 80 solvent, B01000 if contaminated.

SUBTASK 20-60-06-410-001

(3) Install all panels removed for access.

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

WIRE BUNDLE PROTECTION (EZAP) - PROTECTION OF EWIS (EZAP) - MAINTENANCE PRACTICES

1. General

A. This procedure has one task.

(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.

B. This procedure is an Enhanced Zonal Analysis Procedure (EZAP) task.

EWIS

TASK 20-60-07-913-801

2. Protection of the EWIS During Maintenance

A. General

(1) This procedure gives instructions for the installation of temporary protection for Electrical Wiring Interconnect Systems (EWIS) during maintenance work when contamination or mechanical damage can occur.

(2) 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.

(3) 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.

(4) 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
20-60-02-100-801	Cleaning to Remove Combustible Material (P/B 201)
SWPM 20, Standard Wiring Practices	Standard Wiring Practices

ECCN 9E991 BOEING PROPRIETARY - See title page for details

C. Protection of the EWIS During Maintenance

SUBTASK 20-60-07-913-001

WARNING	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 (CIC)

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 20-60-07-913-002

(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

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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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 20-60-07-211-001

(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 20-60-02-100-801.

(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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

INSTRUMENT PANEL CLEANING

1. General

A. This procedure cleans all instrument panels located in the flight compartment.

TASK 20-60-08-100-801

2. Instrument Panel Cleaning

A. General

(1) This procedure cleans the flight compartment 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

> **CAUTION** 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

> **CAUTION** 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 20-60-08-160-004

> **CAUTION** 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.

SUBTASK 20-60-08-160-003

(4) Dry the instrument panel fully with a clean dry lint-free cloth, G01043.

END OF TASK

ECCN 9E991 BOEING PROPRIETARY - See title page for details

INTERMITTENT WIRING - INSPECTION/CHECK

1. **General**
   A. 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**

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) Low Resistance Test
   (f) MOHR Time Domain Reflectometry (TDR) Masking
   (g) Electrical Connection Inspection
   (h) Wire Shake Test
   (i) Voltage Drop Inspection
   (j) Reflectometry Inspection
   (k) Automated Intermittent Fault Detection & Integrity Test

B. References

Reference	Title
20-10-39-700-801	Insulation Resistance Testing - Special Detail Inspection (P/B 501)
20-10-78-760-801	Power Quality Checks (P/B 201)
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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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 FC Supplier: 89536 Part #: LH41A Supplier: 0JV05 Opt Part #: 321 Supplier: 89536 Opt Part #: 322 Supplier: 89536 Opt Part #: 374 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 #: 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 FC Supplier: 4U744 Part #: MIT2500 Supplier: U0146 Part #: MIT410/2 Supplier: U0146 Opt Part #: 1587 Supplier: 89536
COM-18702	Digital Camera - Acoustic Part #: 9050 Supplier: 4MJL8 Part #: FLK-ii900 Supplier: 4U744 Part #: FLK-ii910 Supplier: 4U744
COM-19603	Reflectometer - Time Domain, Spread Spectrum (SSTDR) Part #: LWF-1001 Supplier: $1337
COM-19604	Set - Test Lead, Multimeter Part #: TL80A-1 Supplier: 4U744

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(Continued)

Reference	Description
COM-19606	Power Supply - DC, Portable Part #: 72-13095 Supplier: 02929 Part #: TP3016M Supplier: $1365
COM-19843	Tool Kit - Contact Retention Part #: DMC95 Supplier: 11851
COM-20583	Adapter - Stray Voltage Part #: SV225 Supplier: 4U744
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
COM-23670	Cable Analyzer - TDR (CT100B) Part #: CT100B Supplier: $1360
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.

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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.

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) In-Circuit Electrical Load Test - Backspoon

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, electronic backspooning into the component connector may be necessary. Use caution when installing electronic backspoons 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 28 VDC systems, the voltage measured across the component should be >25 VDC. A more accurate expected drop may be calculated using the applicable wiring specification

NOTE: For most 115 VAC systems the voltage measured across the component should be >109 VAC. 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.

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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).
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) Low Current Load Test
1) Remove power from the circuit to be inspected.
2) Disconnect the electrical connector or Line Replaceable Unit (LRU).
3) Set the multimeter with Low/ High Z Impedance functions, COM-13811, to measure AC or DC voltage as necessary.
4) Connect the positive lead to the multimeter with Low/ High Z Impedance functions, COM-13811, positive voltage connection.
5) Connect the negative lead to the multimeter with Low/ High Z Impedance functions, COM-13811, negative voltage connection (ground connection).
6) Apply power to the circuit to be inspected.
7) Measure the voltage drop across the component (unloaded measurement).
   a) If the voltage drop measured is <0.005 V no voltage is present at the component:
      <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.
         <b> If the open or short occurs in a wire, do the reflectometry test to find the location of the fault.
8) After 10 seconds to stabilize, use the REL % mode to set the measured voltage value as a reference value.

   NOTE: Refer to the multimeter with Low/ High Z Impedance functions, COM-13811, operator's manual for operating instructions.

   NOTE: The measurement value at the time that relative percent mode is enabled, is stored as the reference value. The reference value and real-time measurement will be shown on the display. A relative percentage measurement which indicates the difference between the real-time and reference value will also be shown on the display.

   a) Make sure that the display shows a stable relative percentage measurement of 0.0% and a stable reference voltage measurement.
9) Remove electrical power from the circuit to be inspected.
10) Attach the adapter, COM-20583, to the multimeter with Low/ High Z Impedance functions, COM-13811 (Figure 208).
   a) Connect the positive lead to the adapter, COM-20583, positive voltage connection.
   b) Connect the negative lead to the adapter, COM-20583, negative voltage connection (ground connection).

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11) Apply power to the circuit to be inspected.

12) Measure the voltage drop across the component with the adapter, COM-20583, attached to the multimeter with Low/ High Z Impedance functions, COM-13811 (loaded measurement).

a) After 10 seconds, make sure that the relative percentage measurement is <1% and is stable.

b) If the relative percentage measurement is <1%:

<1> It is possible that there are broken wire strands or bad circuit connections. Shake the harness to find the location of the fault.

<a> Monitor the voltage on the multimeter with Low/ High Z Impedance functions, COM-13811, with the adapter, COM-20583, attached while another technician shakes the harness.

13) If necessary, do the loaded and unloaded measurement test again on a similar system.

NOTE: For example, left to right, forward to aft or a on similar airplane.

a) On the similar system, make sure that loaded relative percentage measurement is <10%.

<1> If the loaded measurement is >10%, this is possibly due to an output issue, either LRU or interconnected wiring.

<2> Refer to the engineering document such as Component Maintenance Manual (CMM) or Specification Control Drawing (SCD) to identify the correct output of the specific LRU.

(c) 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, or default to a "good" reading with an intermittent connection, the load tests normally measure, or default to a "bad" reading with a low current, intermittent, connection. This test will help to 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.

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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 28.0 VDC at 1.0 Amps.

CAUTION 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 <0.005 V, no voltage is present at the component:

<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.

<b> If the open or short occurs in a wire, do the reflectometry test to find the location of the fault.

CAUTION 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 >25.0 VDC.

a) If the voltage drop across the load is <25.0 VDC, 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 >25.0 VDC, 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 Wiring Diagram Manual (WDM)).

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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 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.

SUBTASK 20-70-24-700-015

(2) Make sure that adequate power is flowing through the circuit as follows.

(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 1 amps, otherwise clamp-on current meter, COM-2531, is recommended.

(c) Energize the circuit to be tested.

(d) Measure single phase circuit current.

1) Refer to Power Quality Checks, TASK 20-10-78-760-801 for 3-phase circuits. Use the power quality analyzer to make sure that simultaneous calibrated measurements are taken to prevent misdiagnosis, when you measure 3-phase current using a single ammeter or three individual ammeters.

(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.

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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.

<1> If the short is found in a wire, do the reflectometry test to find the location of the short.

WARNING DO NOT APPLY MORE THAN 2500 VDC TO AIRCRAFT WIRING OR COMPONENTS. IF YOU DO TESTS AT 3000 VDC OR MORE, YOU CAN CAUSE ARCING BETWEEN AIRCRAFT CONNECTOR PINS IN HIGH HUMIDITY. IF YOU DO NOT FOLLOW INSTRUCTION, DAMAGE TO THE AIRPLANE AND INJURY TO PERSONNEL CAN OCCUR.

(e) Setup the insulation resistance multimeter, COM-17798, as follows:

NOTE: Any wiring or components that have been tested at 1000 VDC or more could be damaged by arcing. Upon test completion at more than 600 VDC, we recommend those tested at more than 600 VDC be retested at 500 VDC to check for degraded insulation.

NOTE: The test more than 500 VDC must only be used when there is a possibility of a intermittent short circuit in the aircraft wiring.

1) Perform circuit isolation test to prevent damage at higher voltages by setting the test voltage to lowest setting - 50 VDC.

a) Set the test voltage to 50 VDC.

b) Test circuit to ground.

c) Press and hold the test button for at least 5 seconds.

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d) Make sure that each measurement is >50 MΩ.

<1> If an insulation resistance value <50 MΩ is recorded, review 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 500 VDC.

(f) Test each wire in the a damaged system to ground.

NOTE: If you disconnect a connector, to open the circuit to do a test, there is no connection to the structure. Thus, there is not an electrical path from the backshell to ground. In this condition you will not find a short to the backshell when you do this test. To prevent this, use a jumper wire to connect the backshell to a sufficient ground on the airplane structure.

1) Make sure that each measurement is >50 MΩ.

2) If an insulation resistance value <50 MΩ 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 >50 MΩ.

2) If an insulation resistance value <50 MΩ 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 >50 MΩ.

2) If an insulation resistance value <50 MΩ is recorded, divide the circuit into smaller pieces and repeat the test to locate the partial short.

(i) If all insulation resistance measurements are 50 MΩ or more at 500 VDC set the test voltage to 1000 VDC.

NOTE: The test more than 500 VDC must only be used when there is a possibility of a intermittent short circuit in the aircraft wiring.

1) Repeat the above steps "Test each wire in the a damaged system to ground" through "If wires are shielded, test each wire to its shield".

2) Make sure that each measurement is > 100 MΩ.

CAUTION	MAKE SURE THAT YOU ISOLATE THE AIRCRAFT WIRING FROM ALL COMPONENTS BEFORE YOU APPLY THE 2500 VDC IN TIGHT AREAS. THIS CAN BE AIR CLEARANCES OF LESS THAN 2 MM, FOUND IN RELAYS, SWITCHES OR LIGHT BULBS. A VOLTAGE OF 2500 VDC CAN CAUSE AN ARC THROUGH THE CLEARANCE OF APPROXIMATELY 0.059 INCH (1.5 MM). TOO MUCH ARCING INTO THESE COMPONENTS CAN CAUSE DAMAGE TO THE COMPONENT SURFACE.

(j) If all insulation resistance measurements are 100 MΩ or more at 1000 VDC, set the test voltage to 2500 VDC.

1) Repeat the steps “Test each wire in the a damaged system to ground" through "If wires are shielded, test each wire to its shield".

2) Make sure that each measurement is > 250 MΩ.

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(k) If all insulation resistance measurements are 250 MΩ or more at 2500 VDC the circuit insulation is in good condition.

(l) Connect the circuit to the airplane (Refer to the appropriate WDM).

(m) Do an operational check of the system(s) that was/were changed.

H. Ultrasonic Short Circuit Detection Test

SUBTASK 20-70-24-700-009

(1) Do an Insulation Resistance (IR) test.

NOTE: Most intermittent faults randomly occur during engine operation or in-flight and do not occur during a ground test. Thus, if wet, cold of heavy vibration conditions applied to a wire bundle are too much, a fault can occur. A wire bundle that has damage because of airplane pressurization can also give a fault condition.

NOTE: If you do the Method 1 test and do not find a fault, then do the Method 2 test.

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 doing the 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 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 you disconnect a connector, to open the circuit to do a test, there is no connection to the structure. Thus, there is not an electrical path from the backshell to ground. In this condition you will not find a short to the backshell when you do this test. To prevent this, use a jumper wire to connect the backshell to a sufficient ground on the airplane structure.

b) Perform circuit isolation test to prevent damage at higher voltages by setting the test voltage to 50 VDC, which is the lowest setting.

<1> Set the test voltage to 50 VDC.

<2> Test circuit to ground.

<3> Press and hold the test button for at least 5 seconds.

<4> Make sure that each measurement is >50 MΩ.

<a> If an insulation resistance value <50 MΩ is recorded, review the WDM and connections to make sure that the circuit is isolated.

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<b> Repeat the test to Isolate and if circuit isolation is confirmed, disconnect sections as applicable to further isolate.

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 500 VDC when the circuit is isolated at 50 VDC.

a) Do not apply more than 500 VDC to aircraft wiring or components.

NOTE: Any wiring or components tested at 1000 VDC or greater shall be re-tested at 500 VDC 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 >50 MΩ.

<1> If an insulation resistance value <50 MΩ 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 >50 MΩ.

<1> If an insulation resistance value <50 MΩ 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 >50 MΩ.

<1> If an insulation resistance value <50 MΩ 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 50 MΩ or greater at 500 VDC, then the circuit insulation is good.

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.

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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.
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 you disconnect a connector, to open the circuit to do a test, there is no connection to the structure. Thus, there is not an electrical path from the backshell to ground. In this condition you will not find a short to the backshell when you do this test. To prevent this, use a jumper wire to connect the backshell to a sufficient ground on the airplane structure.
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 500 VDC.
   a) Do not apply more than 500 VDC to aircraft wiring or components.

      NOTE: Any wiring or components tested at 1000 VDC or greater shall be re-tested at 500 VDC to make sure that the insulation resistance health is good before a 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 >50 MΩ.
   a) If an insulation resistance value <50 MΩ 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 >50 MΩ.
   a) If an insulation resistance value <50 MΩ 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 >50 MΩ.
   a) If an insulation resistance value <50 MΩ is recorded, notify Technicians B and C to listen and watch for an ultrasonic wave (arcing).

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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 50 MΩ or greater at 500 VDC the circuit insulation is OK.

a) Reinstall all disconnected connectors (Refer to the appropriate WDM).

17) Do an operational check of the system systems that were disconnected.

I. Low Resistance Test

SUBTASK 20-70-24-700-016

CAUTION	MAKE SURE THAT YOU ISOLATE SENSITIVE COMPONENTS IN THE CIRCUIT. THE TEST EQUIPMENT USES 10 MILLIAMP CURRENT AT AN OPEN CIRCUIT VOLTAGE OF 20 VOLTS. IF YOU DO NOT OBEY, DAMAGE TO THE CIRCUIT CAN OCCUR.

(1) Do a Low Resistance Test using one of the following methods.

(a) Low Resistance Test - Wiring and Connections (Method 1).

NOTE: This method uses the multimeter with Low/ High Z Impedance functions, COM-13811, 50-ohm application to measure low resistances. The meter amplifies defects by using 10mA and up to 20V at 0.001-ohm resolution. In this test the multimeter with Low/ High Z Impedance functions, COM-13811, meter is zero calibrated across a known “good” circuit which is then compared to a suspected “defective” circuit.

NOTE: When testing a circuit with less than approximately 20 ft of wiring, e.g. a switch or switch panel, then you must use a 0.5 ohm resistor in series with the measurement to prevent unstable readings.

1) Prepare for testing:

a) Examine the WDM to make sure that sensitive devices in the circuit are isolated from the high power low ohm test (20V/10mA).

<1> Make sure that branch circuits are not connected to sensitive devices.

b) Make sure that “good” wiring and suspected “defective” wiring under test are the same type and length.

c) Disconnect the wires to be tested from LRUs as necessary.

d) On the applicable LRU install a conductive dust cap and a connector cover.

e) Examine the electrical connectors for bent or broken pins/sockets, dirt, moisture and damage.

f) Select the 50-Ohm low resistance function.

NOTE: Refer to the multimeter with Low/ High Z Impedance functions, COM-13811, operator’s manual for operating instructions.

2) Do the low resistance test:

a) Measure the resistance of the known “good” circuit.

<1> Connect the positive lead of the multimeter with Low/ High Z Impedance functions, COM-13811, to one end of the circuit.

<a> When testing a circuit with less than approximately 20 ft of wiring, use a 0.5 ohm resistor in series with the measurement to prevent unstable readings.

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<2> For the negative lead of the multimeter with Low/ High Z Impedance functions, COM-13811:

<a> If the circuit is short, connect the negative lead to the other end of the circuit.

<b> If the circuit is long, connect the negative lead to aircraft ground and then connect the other end of circuit to aircraft ground with a jumper wire.

<3> Wait 10 seconds to make sure that resistance value is stable.

NOTE: It may be necessary to repeat the measurement more than one time to make sure that the real-time resistance value is stable. If the measurement remains unstable, this is a sign of a bad connection.

<4> Use the REL % mode to set the measured resistance value of the known “good” circuit as a reference value.

NOTE: Refer to the multimeter with Low/ High Z Impedance functions, COM-13811, operator’s manual for operating instructions.

NOTE: The measurement value at the time that relative percent mode is enabled, is stored as the reference value . The reference value and real-time measurement will be shown on the display. A relative percentage measurement which indicates the difference between the real-time and reference value will also be shown on the display.

<a> Make sure that the display shows a stable relative percentage measurement of 0.0% and a stable reference resistance measurement.

b) Measure the resistance of the suspected “defective” circuit (Figure 209).

<1> Connect the positive lead of the multimeter with Low/ High Z Impedance functions, COM-13811, to one end of the circuit.

<a> When testing a circuit with less than approximately 20 ft of wiring, use a 0.5 ohm resistor in series with the measurement to prevent unstable readings.

<2> For the negative lead of the multimeter with Low/ High Z Impedance functions, COM-13811:

<a> If the circuit is short, connect the negative lead to the other end of the circuit.

<b> If the circuit is long, connect the negative lead to aircraft ground and then connect the other end of circuit to aircraft ground with a jumper wire.

<3> Compare the real-time resistance measurement of the suspected “defective” circuit with reference measurement of the “good” circuit.

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<a> Make sure that the relative percentage measurement is <2% and is stable in <10 seconds.

NOTE: NOTE: The real-time resistance measurement of the suspected “defective” circuit should stabilize near the reference measurement in <10 Seconds. Typical low resistance measurements result in a rapid decrease in resistance followed by a final slow decrease to the final measurement; For example, a 63.2% drop in first time constant (t) and then a slower, yet gradual decrease to final resistance in 5 time constants (5t).

c) If the relative percentage measurement is >2% difference or there is unstable real-time resistance measurement between the two circuits, do one of the following:

<1> Do the MOHR TDR masking procedure to find the exact location of the deviation (preferred).

<2> If the TDR is not available, then shake the harness to simulate flight vibration, pressurization and temperature changes to locate the fault:

NOTE: For circuits <10ft, expect large fluctuations of >25% when shaking the wiring. Pay special attention to the reference and real-time resistance measurements as you shake the wiring on small circuits.

<a> Technician B - Shake harness wiring, focusing on connections and feed-thrus.

<b> Technician A - Make sure that the relative percentage measurement does not fluctuate while technician B is shaking the harness.

<3> Review the WDM and do the same test on individual branches to isolate the degraded circuit section in the suspected “defective” circuit.

3) Connect the circuit to the aircraft (refer to the appropriate WDM).

4) Do an operational check of the system(s) which was/were disturbed.

(b) Low Resistance Test - Contacts (Method 2).

NOTE: This test is a repeatability test for low ohm connections such as relays and switches.

1) Prepare for testing:

a) Examine the wiring diagram to make sure that sensitive devices in the circuit are isolated from high power low ohm test (20V/10mA).

<1> Make sure that branch circuits are not connected to sensitive devices.

b) Disconnect the contacts to be tested from LRUs as necessary.

c) On the applicable LRU install a conductive dust cap and a connector cover.

d) Examine the electrical connectors for bent or broken pins/sockets, dirt, moisture and damage.

e) Select the 50-Ohm Low Resistance function.

NOTE: Refer to the multimeter with Low/ High Z Impedance functions, COM-13811, operator’s manual for operating instructions.

2) Do the Low Resistance test:

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a) Connect the positive lead of the multimeter with Low/ High Z Impedance functions, COM-13811, to one end of the contact.

<1> When testing a circuit with less than approximately 20 ft of wiring, use a 0.5 ohm resistor in series with the measurement to prevent unstable readings.

b) Connect the negative lead of the multimeter with Low/ High Z Impedance functions, COM-13811, to the other end of the contact.

c) Close the contact by energizing the relay or valve coil or by toggling a switch, or manually rotating a valve.

d) Measure the resistance in the circuit.

<1> Wait 10 seconds to make sure that the resistance value is stable.

NOTE: It may be necessary to repeat the measurement more than once to make sure that the real-time resistance value is stable. If the measurement remains unstable, this is a sign of a bad connection.

<a> A typical measurement directly across a contact (not including wiring) is <200 milli-ohms (0.200 ohms).

<2> Use the REL % mode to set the measured resistance value as a reference value.

NOTE: Refer to the multimeter with Low/ High Z Impedance functions, COM-13811, operator's manual for operating instructions.

NOTE: The measurement value at the time that relative percent mode is enabled, is stored as the reference value. The reference value and real-time measurement will be shown on the display. A relative percentage measurement which indicates the difference between the real-time and reference value will also be shown on the display.

<a> Make sure that the display shows a stable relative percentage measurement of 000.00% and a stable reference resistance measurement.

e) Open the contact.

<1> The multimeter with Low/ High Z Impedance functions, COM-13811, will show a high reading.

f) Close the contact.

<1> Make sure that the relative percentage measurement is <1% and is stable in <10 seconds.

g) Cycle the contact at least 3 times and measure the resistance.

<1> Make sure that the relative percentage measurement is <1% and is stable in <10 seconds.

3) Connect the circuit to the aircraft (refer to the appropriate WDM).

4) Do an operational check of the system(s) which was/were disturbed.

J. MOHR TDR Masking

NOTE: This procedure is used to compare similar wiring and identify areas of degradation that lead to intermittent opens and shorts in-flight.

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SUBTASK 20-70-24-700-017

(1) Prepare for testing:

(a) Follow the TDR, COM-23670, operator's manual to setup for testing and power on.

(b) Connect MOHR reference cable (Blue 50 ohm cable with Bayonet Neill-Concelman (BNC) connectors) to the TDR, COM-23670.

(c) Select an adapter from the pin and socket probe kit.

1) Connect the adapter to the reference cable.

(d) Review the WDM to identify similar wiring, type and length, and then disconnect these wires from LRUs as necessary.

(e) De-energize the applicable circuit to be tested.

SUBTASK 20-70-24-700-018

(2) Setup the trace.

(a) Connect the TDR, COM-23670, to the known "good" wire circuit.

(b) Press the "Blue" menu button:

1) Change cable length to short (<300ft) or as applicable.

2) Change Resolution to NORMAL.

NOTE: Refer to the tool manufacturer`s operating manual.

(c) Select the Velocity of Propagation (VOP) of the wire type to be tested.

NOTE: If the VOP value of the wire to be tested is unknown select a generic 0.68 VOP. An accurate VOP is necessary for accurate cable length and Distance-to-Fault calculations.

(d) Use the "AUTOFIT" button to show entire circuit on the TDR, COM-23670, display.

(e) Measure the beginning and end of the wire circuit where the impedance starts to change:

1) Put the forward cursor at the beginning of the circuit:

NOTE: This is the initial connection where the impedance starts to increase. This can be confirmed by temporarily disconnecting TDR adapter from the circuit.

2) Move the aft cursor to the end of the circuit.

NOTE: The end of the circuit is the next spike in the circuit where the impedance start to change again.

3) Measure the distance measured between the two cursors.

NOTE: The distance between the two cursors represents entire circuit. This will show as a "Δft(M)" value.

SUBTASK 20-70-24-700-019

(3) Follow the TDR, COM-23670, operator's manual to create a mask from the trace (Figure 210):

NOTE: The mask creates an area around a scanned trace that functions as a test limit for the live TDR trace. Any point of the trace that extends into the masked area will cause the background to turn red. This can be used for creating acceptance criteria for wires and connectors. If the live TDR trace fits within the mask, it will appear with a green background.

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(a) Do a scan of the live trace.

NOTE: To create a mask of the entire circuit displayed on the screen, make sure that "Snapshot" is displayed on bottom of screen. To create mask of only the wiring run between both forward and aft cursors, make sure that "Cursor" is displayed on bottom of screen.

NOTE: The scanned trace will turn red.

(b) Create a mask from the trace.

NOTE: Refer to the TDR, COM-23670, operator's manual for operating instructions.

NOTE: The screen will turn green to show that the live TDR trace fits within the mask.

(c) Use the Change Vertical Margin button to adjust the mask boundaries around the trace.

1) Make sure that the vertical margin is 25mp.

NOTE: Normally the TDR mask stabilizes between 25mp to 50mp.

SUBTASK 20-70-24-700-020

(4) Connect the TDR, COM-23670, to the defective circuit and wait 10 seconds for the measurement to stabilize.

(a) If the mask is green, the original and comparison measurements are within the recommended 25mp to 50mp margin.

(b) If the mask is red, the measurements are not within the recommended margin. Do the distance-to-fault evaluation procedure:

1) Position the aft cursor on the reflection caused by the cable fault.

NOTE: This is the start of the change separation between the "good" and "defective" measurements.

2) Measure the distance to fault or impedance mismatch.

NOTE: Distance to fault or impedance mismatch is displayed by the ΔFt(M) indication. Higher impedance is displayed by a rise in value; more "open" connection. Low impedance is displayed by a decrease in value; more "shorted" connection.

3) Do this step to make the fault larger to get a more accurate measurement of Distance-to-Fault (DTF).

a) Increase the vertical margin of both the "good" (red) and the suspected "defective" (white) trace to 200mp/div.

4) Move the aft cursor to show the rise or fall in impedance.

a) Distance to fault, or impedance change, is indicated by the ΔFt(M) display.

(c) Connect the circuit to the aircraft (refer to the appropriate WDM).

(d) Do an operational check of the system(s) which was/were disturbed.

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K. 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.

(d) For each terminal block or relay base:

1) Get access to the terminal block or relay base.

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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.

L. Wire Shake Test

NOTE: Because of the increased voltage between the test wire and negative meter connection, more capacitance will be made. This will cause the IR value to continue to increase a long period of time until it becomes stable. It is not necessary to apply voltage until the value becomes stable. As long as the value is more than the expected MΩ value for the applied test voltage and continues to increase continuously after 5 seconds, the value can be considered good and test voltage can be removed. If there value increases and then decreases, this means that an arcing event occurred. This can be considered an unsuccessful test and the source of the defect must be isolated.

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 Reflectrometry Inspection).

NOTE: Use a TDR capable of intermittent fault analysis such as multi carrier time domain reflectometer, SPL-17763, or TDR, COM-23670.

(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.

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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 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 (Overload) 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.

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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.

> **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.

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M. Voltage Drop Inspection

SUBTASK 20-70-24-700-012

(1) Make sure that the condition of connections throughout the circuit are as follows:

> **WARNING** MAKE SURE THAT YOU ARE CAREFUL WHEN YOU ARE NEAR ENERGIZED CIRCUITS. AN ELECTRICAL SHOCK CAN CAUSE AN INJURY.

(a) Spoon Probe Voltage Drop Test:

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, electronic backspooning into the component connector may be necessary. Use caution when installing electronic backspoons 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 thedigital/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 28 VDC systems the voltage drop across the component should be >25 VDC.

b) For most 115 VAC systems the voltage drop across the component should be >109 VAC.

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.

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<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.

(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, electronic backspooning into the component connector may be necessary. Use caution when installing electronic backspoons 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 American Wire Gauge (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, electronic backspooning into the component connector may be necessary. Use caution when installing electronic backspoons 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 is not stable within 10 seconds, or does not repeat the same measurement within 1% after each cycle of the relay contacts, then the connection is poor or degraded.

5) If the voltage drop across the connection is stable within <10 seconds, and repeats within 1% with each cycle of the relay contacts, then 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.

N. Reflectometry Inspection

SUBTASK 20-70-24-700-013

NOTE: The multi carrier time domain reflectometer, SPL-17763, and TDR, COM-23670, is used on de-energized circuits only and provides highly accurate distance-to-fault for even minor impedance changes. The spread spectrum time domain reflectometer, COM-19603, while not as accurate, is a simplified TDR simply displaying complete opens or 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 identify fault locations. This is helpful when identifying the exact location of an open wire or failed open relay contacts or limit switches, especially on series spliced switches. For an example, cargo Door circuits.

NOTE: Use the TDR Masking procedure to compare like wiring and identify areas of degradation, such as recessed pins, broken wiring strands, loose connections, that lead to intermittent opens and shorts in-flight.

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(1) Make sure that no shorts or opens exist in the circuit as follows:

(a) Prior to using the multi carrier time domain reflectometer, SPL-17763, remove power from the circuit under test and disconnect the wires to be tested from the aircraft at each end.

1) Review the wiring diagram to ensure no branch circuits exist and that the circuit to be tested is isolated from the aircraft.

(b) Set up the multi carrier time domain reflectometer, SPL-17763, or spread spectrum time domain reflectometer, COM-19603, or TDR, COM-23670, 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 which most closely matches the wire type to be tested.

NOTE: If the VOP 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.

(c) 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, or TDR, COM-23670, 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, or TDR, COM-23670, to any parallel return path. For an example, the wire's shield, another wire in the same bundle, or in the case of a short to structure, you may use aircraft ground.

NOTE: To ensure the most accurate fault location and to prevent false opens or shorts near the start of the measurement, ensure the TDR test leads are wrapped together and/or not separated by more than 3 inches. 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.

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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. For an 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 have another technician monitor SSTDR.

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-short 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, from the circuit.

11) Reconnect the circuit to the airplane (Refer to the appropriate WDM).

12) Do an operational check of the system(s) which was/were disturbed.

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O. Automated Intermittent Fault Detection & Integrity Test

SUBTASK 20-70-24-700-014

(1) Do an Automated Intermittent Fault Detection using Voyager FC.

NOTE: Most intermittent faults randomly occur during engine operation or in-flight and do not occur during a ground test. Thus, if wet, cold or heavy vibration conditions applied to a wire bundle are too much, a fault can occur. A wire bundle that has damage because of airplane pressurization can also give a fault condition.

NOTE: To help locate the fault on the ground, this automated tester self-maps the circuit when connected. It will do simultaneous and continuous intermittency tests on a maximum of 512 test points, which can include 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 and actuator coils) resistance readings to Aircraft Maintenance Manual (AMM)/Fault Isolation Manual (FIM)/CMM specifications.

(h) If all indications are good, shake or stress applicable airplane wiring by:

1) Manually shaking harness

2) Pressurizing airplane

3) Operating Flight Control.

(i) If all indications are good, the circuit(s) is correct.

(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

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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.

2981579 S0000759823_V1

Component Load Testing (Example)
Figure 201/20-70-24-990-801 (Sheet 1 of 2)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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 IN ONLY 0.100 VDC. A DEGRADED GROUND WIRE OR GROUND CONNECTION IS THE CAUSE OF THE FAULT IN THIS CASE.

B

2981580 S0000759824_V1

Component Load Testing (Example)
Figure 201/20-70-24-990-801 (Sheet 2 of 2)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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.

2981581 S0000759825_V1

Load Testing Using a Power Supply (Example)
Figure 202/20-70-24-990-802 (Sheet 1 of 2)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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.

2981582 S0000759827_V1

Load Testing Using a Power Supply (Example)
Figure 202/20-70-24-990-802 (Sheet 2 of 2)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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.

2981585 S0000759828_V1

Voltage Drop Across Connections (Example)
Figure 203/20-70-24-990-803 (Sheet 1 of 3)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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).

2981586 S0000759829_V1

Voltage Drop Across Connections (Example)
Figure 203/20-70-24-990-803 (Sheet 2 of 3)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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.

2981588 S0000759830_V1

Voltage Drop Across Connections (Example)
Figure 203/20-70-24-990-803 (Sheet 3 of 3)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

2981590 S0000759831_V1

TDR Scan (Example)
Figure 204/20-70-24-990-804

ECCN 9E991 BOEING PROPRIETARY - See title page for details

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.

$$V = IR$$

$$V = 10\ \text{AMPS} \times 1\ \text{OHM} = 10\ \text{VDC}$$

2981591 S0000759833_V1

Calculating Voltage Drop (Example)
Figure 205/20-70-24-990-805

ECCN 9E991 BOEING PROPRIETARY - See title page for details

2981592 S0000759834_V1

Insulation Resistance Check with Acoustic Digital Camera
Figure 206/20-70-24-990-806

ECCN 9E991 BOEING PROPRIETARY - See title page for details

2981593 S0000759835_V1

Insulation Resistance check with Ultrasonic Leak Probe
Figure 207/20-70-24-990-807

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(EXAMPLE)

3060949 S0000824274_V1

Stray Voltage Eliminator
Figure 208/20-70-24-990-808

ECCN 9E991 BOEING PROPRIETARY - See title page for details

(EXAMPLE)

3060950 S0000824275_V1

Low Resistance Test
Figure 209/20-70-24-990-809 (Sheet 1 of 2)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

Typical low resistance measurements result in a rapid decrease in resistance followed by a final slow decrease to the final measurement; e.g. 63.2% drop in first time constant (t) and then a slower, yet gradual decrease to final resistance. Final resistance, as well as the total time to reach 5t, is compared to the reference measurement; e.g. if system #1 (blue) is .051 ohms in 5 seconds, then system #2 (red) would be suspect due to the abnormal decrease and fluctuation as it neared final resistance.

(EXAMPLE)

3060951 S0000824276_V1

Low Resistance Test
Figure 209/20-70-24-990-809 (Sheet 2 of 2)

ECCN 9E991 BOEING PROPRIETARY - See title page for details

A TRACE THAT FAILS THE MASK TEST.
(EXAMPLE)

A TRACE THAT PASSES THE MASK TEST.
(EXAMPLE)

3060952 S0000824277_V1

MOHR TDR Mask
Figure 210/20-70-24-990-810

ECCN 9E991 BOEING PROPRIETARY - See title page for details