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Flight Set 360L007 (STS-33R) Case and Seal Final Report Volume II

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1.0 INTRODUCTION

This report assess the performance of the 3607007, Seventh Flight, Redesigned Solid Rocket Motors (RSRM) with respect to case hardware and joint sealing issues as seen from post-flight assessment of the case and seals. In addition, the potential anomalies have been classified and are summarized in section 5.0.

Figure 1 illustrates the RSRM, consisting of the igniter joint, the case field joint with the capture feature and the J-joint insulation configuration, the nozzle-to-case joint with the 100, 7/8-inch radial bolts in conjunction with a wiper O-ring and modified insulation design, and the forward-to-aft exit cone joint (see Figure 2). Figure 3 shows the configuration of all the internal nozzle joints. Figure 4 shows a cross section of the S&A with the Barrier Booster assembly and rotor shaft and SII seal system.

2.0 SUMMARY AND CONCLUSIONS

2.1 Post-Flight Case Assessment Summary

The post-flight assessment of both motors showed the case segments to be in good condition. Field joint fretting indications on this flight set ranged from none on one joint through light (<0.003 inch deep) on most of the joints to locally medium (>0.003, <0.005 inch deep) on two joints. Figure 5 visually summarizes the fretting on all the field joints. No new fretting was found in old fretting locations. All fretting was mapped from the inner clevis leg. The capture feature fretting was not mapped due to the difficulty of measuring the fretting in the capture feature region, but it is assumed that the capture feature had similar damage as the inner clevis leg. Listed below is a summary of fretting for each joint:

FIELD JOINT FRETTING SUMMARY

LH/FWD	Light fretting (0.000 to 0.003 inch deep) at 37, 50 degrees. Intermittently light from 112 to·142, 157 through 165, and from 223 through 0 through 3 degrees.
LH/CTR	Light fretting at 38, 112 through 119, 126, 146, and 158 degrees. Intermittent light fretting from 216 through 270 degrees. A moderate fret of 0.004 inch deep was observed at 221 degrees.
LH/AFT	Light fretting at 125 through 129, 140, 161, 166, 195 through 197, 218, 244 through 246, 256 through 258, 308 though 312, and 327 degrees. This joint had fretting from a previous flight from 185 through 220 degrees.
RH/FWD	Intermittent light fretting around entire circumference of joint. A moderate fret at 341 degrees, and no heavy frets.
RH/CTR	No light, moderate, or heavy frets.
RH/AFT	Light fretting at 32 through 41, 49, 104, 124, 130, 173, 184, 260 to 283, 312 to 318 degrees. No moderate or heavy frets.

The factory joint weather seals were removed at KSC to prevent corrosion of the outer clevis leg under the M-clip hat band. Light corrosion was found under the weather seal on the RH forward dome-to-cylinder joint and medium-to-heavy corrosion was observed on the LH aft stiffener-to-stiffener joint. This corrosion was due to weather seal unbonds (Reference 1). Many of the factory joints had light corrosion observed on the tang OD and outer clevis ID intermittently over the entire circumference of the joint between the M-clip locations. Investigating the cause of the corrosion revealed that following joint mating in the vertical assembly stand, the crews wiped any observed grease out of the joint with solvent dampened polywipe wrapped around a shop aid. This wiping was done to clean and prepare the outer joint surface for weatherseal bonding. This wiping allowed solvent to drip into the outer clevis ID and tang OD region diluting the grease, allowing light corrosion to build up. Table I summarizes the corrosion seen in the factory joints. The factory joint fretting and M-clip fretting is summarized in table II.

The in-situ assessment of all of the factory joint O-rings showed nominal condition. The detailed assessment of the O-rings also showed nominal condition.

The Stiffener rings and case stubs had no apparent water impact damage. No cracks or warpage was found. No deformed bolt holes were observed. No web cracks were noted. No bolts were missing or elongated.

Based on missing instafoam, the cavity collapse load centerline on the RH motor was estimated to be at 340 degrees. The cavity collapse load centerline on the LH motor was estimated to be at 100 degrees.

The Case Component Post-Flight Assessment Team identified 8 observations, made during disassembly assessments, as "potential anomalies" ,and were further classified as "minor anomalies".

2.2 Post-Flight Seals Assessment Summary

The post-flight assessment of both motors showed the seal components to be in good condition. There was no evidence of hot gas or soot past the J-flap on the six field joints or past the polysulfide on the two nozzle-to-case joints. The igniter joints showed no hot gas or soot past the primary seals.

The Seal Component Post-Flight Assessment Team has identified 13 observations, made during disassembly assessments, as "potential anomalies" , 2 remained as observations and 11 were further classified as "minor anomalies".

3.0 POST-FLIGHT INSPECTION OBJECTIVES

Post-flight assessment objectives are addressed in reference 2.

4.0 CASE AND SEALS POST-FLIGHT ASSESSMENT RESULTS

Design Engineering performed post-flight evaluations of Flight 360L007 forward, center, and aft field joints, aft exit cone field joints, nozzle-to-case joints, the igniter, and safe and arm joints at Hanger AF. The safe and arm internal joints, internal nozzle joints, and factory joints were disassembled and evaluated at the refurbishment facilities in Clearfield, Utah. This section documents the post-fire condition of Flight 360L007 case hardware, sealing surfaces, and seals as noted during disassembly, and discusses all observations assessed by the respective Component Program Team (CPT).

In an attempt to standardize and document the evaluation of flight motors, a standard evaluation plan has been written (Reference 3 and 4). Appropriate procedures contained in this plan were used to evaluate the case and seal in the RSRM. The intent of this plan is to ensure that all pertinent evaluation points of Flight 360L007 were examined and documented in a consistent and complete manner. Also, to accurately document the magnitude of the types of damage that are seen, definitions are presented below.

DEFINITIONS

CUT:	Width, essentially zero (having to open up to find the damage), and depth greater than 0.005 inch.
SCRATCH:	Width less than 0.005 inch and depth less than 0.005 inch.
NICK:	Width less than 0.020 inch, but greater than 0.005 inch; and depth less than 0.010 inch, but greater than 0.005 inch.
GOUGE:	Width greater than 0.020 inch and depth greater than 0.010 inch.
CIRCUMFERENTIAL OR RADIAL FLOWLINE:	Visible evidence of incomplete flow or knit if the material.
(i) closed:	Tightly adhered, not separable, does not open when lightly probed.
(ii) separable:	Visually appears closed. Separates when lightly probed.
(iii) Open:	Obvious separation or gap.
HARD INCLUSION:	Foreign material enclosed in the seal material.
POROSITY OF SOFT INCLUSIONS:	An air pocket enclosed in the seal material.
EXTRUSION DAMAGE:	Seal material pinched and/or cut due to an overfill condition.

HEAT EFFECT:	Glossy and/or hardened seal surface due to hot gas impingement.
EROSION:	Seal material missing due to hot gas impingement or blow by.
LIGHT CORROSION:	Can be wiped off by hand. Surface discoloration.
MEDIUM CORROSION:	Can not be wiped off by hand without the use of a Scotch-Brite material, methyl chloroform, or grease soaked rag.
HEAVY CORROSION:	Staring to penetrate into the metal surface such that pitting and/or metal material is significantly eroded.
LIGHT FRETTING:	Pits less than or equal to 0.003 inch deep.
MEDIUM FRETTING:	Pits greater than 0.003 inch deep and less than or equal to 0.005 inch deep.
HEAVY FRETTING:	Pits greater than 0.005 deep.

The left motor will be discussed first, then the right motor. The evaluation will start at the igniter and proceed down the motors to the aft exit cones.

4.1 LEFT HAND MOTOR DISASSEMBLY EVALUATION

4.1.1 External Walk Around

The external walk around assessment revealed no signs of hot gas leakage past any joints. There was missing instafoam on all three stiffener rings at approximately 100 degrees. There was no K5NA cracked on any of the stiffener rings.

4.1.2 Safe and Arm Joint

There was medium to heavy soot on both faces of the gasket up to but not past the primary seal on the S & A gasket. There was medium corrosion observed on the gasket ID. No other damage was observed to the joint or gasket seals at the time of disassembly.

4.1.2.1 Safe and Arm Device Internal Joints

Assessment of the safe and arm device found the following:

0 Light corrosion on the outer circumference of the B-B pyrotechnic basket due to water between the basket and B-B.

0 Deformations in the sealing washer of both SII's.

0 A radial scratch across the bottom of the B-B 198 degree SII port secondary O-ring groove seal surface.

0 Circumferential scratches on both B-B housing bore leak check port holes.

0 The rotor shaft environmental O-ring (#5) was covered with an excessive amount of grease.

0 A closed radial flowline on the A & M to B-B environmental O-ring.

No evidence of soot of blow-by was found past any of the SII O-rings. No evidence of soot was observed to the rotor shaft primary O-rings. No damage to the rotor shaft or housing bore seal surfaces were observed.

4.1.3 Outer Igniter Joint (Adapter-to-Forward Dome)

A blow hole through the zinc chromate putty was observed at 332 degrees. Soot was observed on the entire circumference of the gasket ID. Soot to the primary seal but not past the primary seal was observed on the forward face from 330 though 0 degrees. Soot to the primary seal but not past the primary seal was also observed on the aft face from 270 though 279 degrees. Two very small dimples (less than 0.003 inch in diameter) were observed on the forward face. One was on the primary seal at 235 degrees and the other was on the secondary seal at 144 degrees. Also, traces of touch up paint were observed on the environmental seal outer edge.

4.1.3.1 Igniter and Case Hardware

No damage was found on the forward dome igniter boss, igniter adapter, igniter chamber or the igniter through hole.

4.1.4 Inner Igniter Joint (Adapter-to-Chamber)

Soot was observed on the OD and the aft gasket face from 210 through 0 though 130 degrees. Soot did not reach the outer primary seal. No soot was observed on the forward face. Putty was observed on the ID from 20 through 65 degrees. No putty was observed on the forward or aft gasket face.

4.1.5 Forward Field Joint

There was no sign of hot gas or soot past the J-leg. The grease coverage was per design and no corrosion was found on any of the sealing surfaces. The joint was slightly contaminated with debris and water from the hydrolase operations which remove the joint protection system.

No seal damage was observed at the time of disassembly, and the V-2 filler was properly installed with no damage. Detailed assessment of the O-rings revealed no damage.

4.1.5.1 Forward Field Joint Case Hardware

Assessment of the metal components found light fretting at 37, 50, 112 intermittently through 142, 157 though 165, and 223 intermittently through 0 though 3 degrees. Figure 6 gives a detailed view of the fretting.

4.1.6 Center Field Joint

There was no sign of hot gas or soot past the J-leg. The grease coverage was per design and no corrosion was found on any of the sealing surfaces. The joint was slightly contaminated with debris and water from the hydrolase operations which remove the joint protection system.

No seal damage was observed at the time of disassembly, and the V-2 filler was properly installed with no damage. Detailed assessment of the O-rings revealed no damage.

4.1.6.1 Center Field Joint Case Hardware

Assessment of the metal components found light fretting at 38, 112 though 119, 126, 146, 158, and intermittently from 216 through 270 degrees. A moderate fret of 0.004 inch deep was observed at 221 degrees. Figure 7 gives a detailed view of the fretting.

4.1.7 Aft Field Joint

There was no sign of hot gas or soot past the J-leg. The grease coverage was per design and no corrosion was found on any of the sealing surfaces. The joint was slightly contaminated with debris and water from the hydrolase operations which remove the joint protection system.

No seal damage was observed at the time of disassembly, and the V-2 filler was properly installed with no damage. Detailed assessment of the O-rings revealed no damage.

4.1.7.1 Aft Field Joint Case Hardware

Assessment of the metal components found light fretting at 125 though 129, 140, 161, 166, 195 though 197, 218, 244 though 246, 256 though 258, 308 though 312, and 327 degrees. This joint had fretting from a previous flight from 185 though 220 degrees. Figure 8 gives a detailed view of the fretting. All fretting was mapped on the clevis and it is assumed that the tang has similar damage to it.

4.1.8 Nozzle-to-Case Joint

There was no evidence of hot gas or soot past the polysulfide. The grease application was per specification. There was no corrosion found on either the fixed housing of the aft dome. No polysulfide extruded past the wiper O-ring. No radial bolt holes disassembly plugs were damaged during the disassembly process.

Detailed assessment of the O-rings found no damage to the primary or secondary O-rings. The wiper O-ring had 2 gouges and 1 nick. One gouge was 0.350 in. long by 0.040 in. wide by 0.010 in. deep. The other gouge was 0.180 in. long by 0.100 wide by 0.030 in. deep. The nick was 0.030 long by 0.010 in. wide by 0.005 in. deep. This is disassembly damage from the radial bolt hole plugs.

4.1.9 Aft Exit Cone Joint (Joint 1)

At splashdown, the glass carbon phenolic (GCP) delaminated in the primary O-ring groove from 292 through 0 though 4 degrees. This delamination damaged both O-rings. The metal surfaces had intermittent medium corrosion on the outer edge of the forward face and between the O-ring grooves.

Detailed assessment of the O-rings found that the primary O-ring had approximately thirty inches missing. The secondary O-ring had splash down damage with several area of scratches and gouges.

4.1.10 Forward End Ring-to-Nose Inlet Housing (Joint 2)

Assessment of the joint did not revealed any obvious pressure paths through the RTV/adhesive of the joint interface. Typical scalloped shaped sooting of the grease was observed around the full circumference of the joint about half way between the edge of the aluminum housing and the primary O-ring groove situated between bolt holes. Heavy sooting was observed at 96 through 138, and 228 through 318 degrees. No soot or evidence of blowby was observed up to or past the primary O-ring. No apparent damage to the primary or secondary O-rings was found during preliminary inspection and the sealing surfaces suffered no assembly or disassembly damage. Detailed assessment of the O-rings observed no damage.

4.1.11 Nose Inlet Housing-to-Throat Support Housing (Joint 3)

Assessment of the joint revealed a pressure path through the RTV at 140 degrees. No soot or evidence of blowby was present past the primary O-ring. No apparent damage was found during preliminary assessment of the primary or secondary O-rings. Assessment of the sealing surfaces revealed no signs of damage. Typical light corrosion was found intermittently on the nose inlet housing at the adhesive-to metal interface at 90 through 140 degrees. Detailed assessment of the O-rings observed no damage.

4.1.12 Forward Exit Cone-to-Throat Support Housing (Joint 4)

Assessment of the joint revealed no pressure paths through the RTV backfill. No apparent damage to the primary or secondary O-rings was found during preliminary assessment. The sealing surfaces had no anomalous observations. No corrosion was found on any of the joint sealing surfaces. Detailed assessment of the O-rings observed no damage.

4.1.13 Fixed Housing-to-Aft End Ring (Joint 5)

Assessment of the joint revealed no pressure paths through the RTV. RTV was observed up to the land forward of the primary O-ring at 40 through 127.5 degrees. No damage was found during preliminary assessment of the primary or secondary

O-rings. Assessment of the sealing surface revealed no signs of damage. Typical light corrosion was observed on the inside diameter lip of the aft end ring.

Detailed assessment of the O-rings observed no damage to the primary O-ring and intermittent scratches on the secondary O-ring between 176 and 302 degrees with the worst case at 230 degrees. The worst case measured 0.175 in. long by 0.002 in. wide by 0.002 in. deep.

4.1.14 Factory Joints

4.1.14.1 Forward Dome-to-Cylinder Factory Joint

Light corrosion was observed on the tang OD and outer clevis leg ID, intermittently over the entire circumference of the joint between the M-clips. No corrosion was observed in the internal joint areas. The overall grease coverage was nominal and applied per STW7-2999 with the exception of the previously mentioned region.

Light fretting was observed on the inner surface of inner clevis leg land forward of the primary O-ring groove at 244, 246, 271 intermittently through 292, and 310 degrees, on the land between the O-ring grooves at 292 intermittently through 310 degrees, and on the land aft of the secondary O-ring groove at 232 intermittently through 248, 264 intermittently through 274, 288, 294 intermittently through 318 degrees. Corresponding fretting was also observed on the tang ID aft of the sealing surface at 226 intermittently through 320 degrees. M-clip fretting was observed in the tang OD at 238 intermittently through 320 degrees.

4.1.14.2 Forward Cylinder-to-Cylinder Factory Joint

Light corrosion was observed on the tang OD and outer clevis leg ID intermittently over the entire circumference of the joint between M-clips. The overall grease coverage was nominal and applied per STW7-2999 with exception to the previously mention region.

Fretting was observed on the tang ID aft of the sealing surface at 205, 212, 215, 216, 218, 220, 221, 224, 228, and 358 degrees. Typical M-clip fretting was observed on the tang OD intermittently over the entire circumference of the joint.

4.1.14.3 Center Forward Cylinder-to-Cylinder Factory Joint

Light corrosion was observed on the tang OD and outer clevis leg ID intermittently the entire circumference of the joint between M-clip locations. The overall grease coverage was nominal and applied per STW7-2999 with exception to the previously mentioned region.

Light fretting was observed on the ID of the inner clevis leg on the land aft of the secondary O-ring groove at 2, 184 intermittently through 214, 336 intermittently through 350, and 258 degrees. Corresponding fretting was observed on the tang OD aft of the sealing surface at 158, 170 intermittently through 350, and 358 degrees. Typical M-clip fretting was observed on the tang OD intermittently for approximately fifty three percent of the joint circumference.

4.1.14.4 Center Aft Cylinder-to-Cylinder Factory Joint

The center aft factory joint was clean with no notable corrosion. The overall grease coverage was nominal and applied per STW7-2999. Insulation flashing and Chemlok were on the land forward of the primary O-ring groove for about 30 percent around the circumference of the joint.

A small fret was found at 350 degrees on the tang ID just downstream of the sealing surface with a corresponding pit on the land aft of the secondary O-ring groove on the inner clevis leg. M-clip fretting with its associated scratches were observed intermittently at 86, 100, 104, 112, 196, 204, 238, and 324 through 358 degrees.

A light scratch or impression was noted on the tang OD at 14 degrees. This defect appeared to be a circular impression centered around the pin hole with a radius approximately .2 inch greater than the pin hole.

4.1.14.5 ET-to-Stiffener Factory Joint

Light to moderate corrosion was observed on the inner surface of the outer clevis leg the entire circumference. The overall grease coverage was nominal and applied per STW7-2999.

Fretting was observed at 2, 106, 116, 120, 142, 150, 238, 314, 338, and 354 degrees. M-clip fretting was observed intermittently the entire circumference of the tang outer surface.

Insulation Flashing and Chemlok were on the land forward of the primary O-ring groove intermittently around circumference of the clevis joint.

4.1.14.6 Stiffener-to-Stiffener Factory Joint

Heavy, spotty corrosion was observed in clevis root at 128 through 145, 268, and 346 through 356 degrees. Heavy, spotty corrosion was observed on inner surface of the tang downstream of the pinholes at 188, 190, 334 through 339, 346 through 356 degrees. The weather seal on this joint had partially debonded at splash down and allowed sea water to enter the joint. The overall grease coverage was nominal and applied per STW7-2999.

Fretting was observed at 246 degrees. M-clip fretting was observed intermittently on the tang OD.

Insulation Flashing and Chemlok were on the land forward of the primary O-ring groove intermittently approximately 20 percent around the circumference of the clevis leg.

The leak check port plug was initially remove at KSC as part of the postflight evaluation at KSC. One of the FRR issues that needed to be assessed KSC was the condition of the port at 45 degrees. The port condition was in nominal condition.

4.1.14.7 Aft Dome-to-Stiffener Factory Joint

Heavy corrosion was observed on the inner surface of the outer clevis leg and on the root of the clevis at 110 through 118, 126, 164, 182, 189, 234, and 252 degrees. The overall grease coverage was light as compared to STW7-2999 requirements.

Fretting was observed intermittently around the entire joint. The heaviest frets were at 106, 114, 156, 160, 226, 230 and 234 degrees. M-clip fretting was observed on the outer tang surface intermittently between 214 and 348 degrees. A light scratch was observed across the tang sealing surface at 222 degrees.

Insulation Flashing and Chemlok were on the land forward of the primary O-ring groove intermittently for about 20 percent of the circumference of the joint.

4.1.15 Miscellaneous Hardware

Corrosion pits were found on case segments at GEI spot bond locations because of galvanic action between the silver-filled epoxy (Ecobond 56C) and the D6AC steel. All GEI was removed at Hanger AF. Light to medium corrosion with light pits were observed on various spot bond locations.

4.2 RIGHT MOTOR DISASSEMBLY EVALUATION

4.2.1 External Walk Around

The external walk around assessment revealed no signs of hot gas leakage past any joints. There was missing instafoam on the center and aft stiffener rings at approximately 340 degrees. There was no K5NA cracked on any of the stiffener rings.

4.2.2 Safe and Arm Joint

There was medium to heavy soot on both sides of the gasket up to but not past the primary seal on the S & A gasket for approximately two-thirds of the circumference. There was no corrosion or damage observed to the joint or gasket seals at the time of disassembly.

4.1.2.1 Safe and Arm Device Internal Joints

Assessment of the safe and arm device found the following:

0 Light corrosion on the outer circumference of the B-B basket mounting surface due to water between the basket and B-B.

0 An axial scratch was found on the A & M to B-B bore environmental O-ring seal surface.

0 Deformations in the sealing washer of both SII's.

0 A radial scratch was found across the sealing washer of the 18 degree SII.

0 Circumferential scratches were found on the 126 degree leak check port housing bore.

0 The rotor shaft environmental O-ring (#5) was covered with an excessive amount of grease.

No evidence of soot of blow-by was found past any of the SII O-rings. No evidence of soot was observed to the rotor shaft primary O-rings. No damage to the rotor shaft or housing bore seal surfaces were damaged.

4.2.3 Outer Igniter Joint (Adapter-to-Forward Dome)

The was no blowhole observed in the zinc chromate putty. Putty was on the outer gasket ID at 18 through 101 and 207 through 270 degrees. No putty was observed on either the forward or aft gasket face.

4.2.3.1 Igniter and Case Hardware

No damage was found on the forward dome igniter boss, igniter adapter, igniter chamber or the igniter through hole.

4.2.4 Inner Igniter Joint (Adapter-to-Chamber)

A terminated blowhole was observed in the zinc chromate putty at 340 degrees. No soot reached the gasket. A small depression was observed on the outer seal aft face crown at 10 degrees and was approximately 0.002 inch deep by 0.004 inch wide. Putty was on the gasket OD intermittently around the entire circumference. Putty appeared on the aft face in several locations. Putty did not reach the outer primary seal and was 0.05 in. maximum from the edge of the retainer.

4.2.5 Forward Field Joint

There was no sign of hot gas or soot past the J-leg. The grease coverage was per design and no corrosion was found on any of the sealing surfaces. The joint was slightly contaminated with debris and water from the hydrolase operations which remove the joint protection system. Light intermittent corrosion was observed on the tang OD and inner clevis ID.

No seal damage was observed at the time of disassembly, and the V-2 filler was properly installed with no damage. Detailed assessment of the O-rings revealed a nick on the primary O-ring at 70.6 degrees. It was 0.070 in. long by 0.010 in. wide by 0.005 in. deep. This nick is believe to have occurred at disassembly. No damage was observed on the other two O-rings.

4.2.5.1 Forward Field Joint Case Hardware

Assessment of the metal components found light fretting intermittently the entire circumference of the joint. Figure 9 gives a detailed view of the fretting, all fretting was mapped on the clevis and it is assumed that the tang has similar damage to it.

4.2.6 Center Field Joint

There was no sign of hot gas or soot past the J-leg. The grease coverage was per design and no corrosion was found on any of the sealing surfaces. The joint was slightly contaminated with debris and water from the hydrolase operations which remove the joint protection system. Light intermittent corrosion was observed on the tang OD at the shim locations.

No seal damage was observed at the time of disassembly, and the V-2 filler was properly installed with no damage. Detailed assessment of the O-rings revealed no damage.

4.2.6.1 Center Field Joint Case Hardware

Assessment of the metal components found no fretting.

4.2.7 Aft Field Joint

There was no sign of hot gas or soot past the J-leg. The grease coverage was per design and no corrosion was found on any of the sealing surfaces. The joint was slightly contaminated with debris and water from the hydrolase operations which remove the joint protection system. Light intermittent corrosion was observed on the tang OD surface.

No seal damage was observed at the time of disassembly, and the V-2 filler was properly installed with no damage. Detailed assessment of the O-rings revealed no damage.

4.2.7.1 Aft Field Joint Case Hardware

Assessment of the metal components found light fretting at 32 to 41, 49, 104, 124, 130, 173, 184, 260 to 283, and 312 to 318 degrees. Figure 10 gives a detailed view of the fretting.

4.2.8 Nozzle-to-Case Joint

There was no evidence of hot gas or soot past the polysulfide. The grease application was light to none on the fixed housing and the primary O-ring was dry. The grease application on the aft dome was per specification. There was no corrosion found on either the fixed housing or the aft dome. No polysulfide extruded past the wiper O-ring. Five radial bolt holes disassembly plugs were damaged during the disassembly process at 52.2, 73.8 88.2, 318.6 and 354.6 degrees.

Detailed assessment of the O-rings found no damage to the wiper or secondary O-rings. The primary O-ring had scratches at 86 and 354 degrees which are related to radial bolt hole plug damage. A cut was observed at 52.6 degrees that measured 0.200 in. long by 0.002 in. wide by 0.100 in. The initial assessment revealed a silicone rubber inclusion. The preliminary investigation tried to evaluate how a silicone inclusion could have made it through the baselined manufactured process and quality control inspection steps. This initial investigate did not find a plausible scenario to explain the presence of the inclusion. After further investigation and correlation with the nozzle-to-case assessment produced a plausible scenario for the cut and silicone inclusion. The silicone inclusion was from the radial bolt hole plug which uses silicone foam rubber to hold the plug in place. During disassembly of the nozzle-to-case joint, the plug was damaged, cutting the O-ring and imbedding a particle of silicone foam rubber into the O-ring.

4.2.9 Aft Exit Cone Joint (Joint 1)

The assessment team was not notified of exit cone disassembly so the in-situ inspection of O-rings and joint area was not done. Intermittent medium corrosion was observed on the outer edge of the forward face and between the O-ring grooves at 115 through 155 degrees.

Detailed assessment of the O-rings found that the primary O-ring had no damage. The secondary O-ring had several areas of scratches and gouges from O-ring retainer clips at 82.5, 105, 137, and 337 degrees. The worst case was at 82.5 degrees and was 0.100 in. long by 0.050 in. wide by 0.010 in. deep.

4.2.10 Forward End Ring-to-Nose Inlet Housing (Joint 2)

Assessment of the joint did not revealed any obvious pressure paths through the RTV/adhesive of the joint interface. Typical scalloped shaped sooting of the grease was observed around the full circumference of the joint about half way between the edge of the aluminum housing and the primary O-ring groove situated between bolt holes. Heavy sooting was observed at 334 through 0 through 18 and 120 through 150 degrees. Light soot was observed to the primary O-ring at 126 through 162 and 198 through 258 degrees. No soot or evidence of blowby was observed past the primary O-ring. Typical light corrosion was observed intermittently on the secondary O-ring sealing surface. No apparent damage to the primary or secondary O-rings was found during preliminary inspection and the sealing surfaces suffered no assembly or disassembly damage. The detailed O-ring assessment found no damage to the O-rings.

4.2.11 Nose Inlet Housing-to-Throat Support Housing (Joint 3)

Detailed assessment revealed a terminated void in the RTV at 100 degrees. No soot or evidence of blowby was observed up to or past the primary O-ring. Assessment of the sealing surfaces revealed no signs of damage. Typical light corrosion was found intermittently on the nose inlet housing at the adhesive to metal interface at 95 through 105 and 228 through 318 degrees. No apparent damage was found during preliminary assessment of the O-rings. The detailed O-ring assessment found no damage to the O-rings.

4.2.12 Forward Exit Cone-to-Throat Support Housing (Joint 4)

Assessment of the joint revealed no pressure paths through the RTV backfill. No corrosion was found on any of the joint sealing surfaces. Typical light corrosion was found on the bevel of the throat from 2.5 through 5 degrees. This corrosion coincides with the bondline separations on the forward exit cone. No apparent damage to the O-rings was found during preliminary assessment, and the sealing surfaces suffered no assembly or disassembly damage. The detailed O-ring assessment found no damage to the O-rings.

4.2.13 Fixed Housing-to-Aft End Ring (Joint 5)

Assessment of the joint revealed no pressure paths through the RTV. RTV was observed up to the primary O-ring at 103 through 133, 145 through 165, and 245 through 310 degrees. Assessment of the sealing surface revealed no signs of damage. Typical light corrosion was observed intermittently on the inside diameter lip of the aft end ring. No damage was found during preliminary assessment of the O-rings. The detailed O-ring assessment found no damage to the O-rings.

4.2.14 Factory Joints

The in-situ assessment of all of the factory joint O-rings showed nominal condition. The detailed assessment of the O-rings also showed nominal condition.

4.2.14.1 Forward Dome-to-Cylinder Factory Joint

Light corrosion was observed on the tang OD and outer clevis leg ID intermittently over the entire circumference between the M-clips. The overall grease coverage was nominal and applied per SWT7-2999 except for the region previously noted.

Light fretting was observed on the inner clevis leg ID on the land between the O-ring grooves intermittently for approximately thirty three percent of the joint circumference, and on the land aft of the secondary O-ring groove at 166, 172, and 174 degrees. Corresponding fretting was observed on the tang ID aft of the sealing surface intermittent for approximately thirty five percent of the joint circumference. M-clip fretting was observed on the tang OD at 16, 50, 120, 172, and 200 intermittently through 352 degrees.

Light scratches were observed on the tang ID aft of the sealing surface at 37, 61, 85, 91, 92, 93, 115, 135, 136, 137, 158, 173, 183, 184, 191, 199, 249, 250, 251, 252, 254, 336, 344, 347, 353, and 353 degrees. Raised metal was observed on the tang OD M-clip at 324 and 328 degrees. Metal slivers were found in pin holes at 152, 216, and 324 degrees.

4.2.14.2 Forward Cylinder-to-Cylinder Factory Joint

Light corrosion was observed on the tang OD and outer clevis leg ID intermittently over the entire circumference between the M-clips. The overall grease coverage was nominal and applied per STW7-2999 except for the previously mentioned region.

Light fretting was observed on the inner clevis leg ID on the land aft of the secondary O-ring groove at 2, 6, 8, 10, 14, 30, 50, 70, 74, 182, 186, 190, 194, 198, 224, 234, 258, 334, 338, 342, 346, 350, 354, and 358 degrees. Associated fretting was observed on the tang ID aft of the sealing surface intermittently for approximately thirty seven percent of the joint circumference.

4.2.14.3 Center Forward Cylinder-to-Cylinder Factory Joint

No corrosion was observed in the internal joint areas. The overall grease coverage was nominal.

A shallow fretting pit was observed on the inner clevis leg on the land between the O-ring grooves at 197 degrees. An associated pit on the tang sealing surface at 197 degrees was also observed. Another fret was observed on the tang sealing surface at 357 degrees. M-clip fretting was observed on the outer tang surface intermittently for about 30 percent of the circumference of the joint. No other anomalous conditions were observed in the joint.

The usual insulation flashing and Chemlok were on the land forward of the primary O-ring groove for about 70 percent around the circumference of the joint.

4.2.14.4 Center Aft Cylinder-to-Cylinder Factory Joint

Light to moderate corrosion was observed on the outer clevis leg ID and corresponding tang OD between the M-clip locations over the entire circumference of the joint. The overall grease coverage was nominal and applied per STW7-2999 except where previously mentioned.

Insulation flashing and Chemlok were on the land forward of the primary O-ring groove for about fifty percent around the circumference of the joint. The worst case noted was at 146 through 156 degrees where insulation flashing and Chemlok had been deposited on the primary O-ring.

No fretting was observed in the inner joint regions. M-clip fretting was observed at 2, 40 through 46, 56, 68, 78, 106, 110, 180, 194, 210, 212, 226, 238, 242, 270, 272, 300, 306 and 322 degrees.

4.2.14.5 ET-to-Stiffener Factory Joint

Light to moderate corrosion was observed on the tang OD and outer clevis leg ID intermittently over the entire circumference between the M-clips. The overall grease coverage was nominal and applied per STW7-2999 except for the previously mentioned region.

Fretting was found on the inner clevis leg land forward of the primary O-ring groove at 10, 28, 30, and 190 degrees, and on the land between the O-ring grooves at 10, 28, 30, 190, 194, 198, and 220 degrees. Fretting was also found on the tang ID aft of the sealing surface corresponding to the above locations. No M-clip fretting was observed.

4.2.14.6 Stiffener-to-Stiffener Factory Joint

Light to moderate corrosion was observed on the tang OD and outer clevis leg ID intermittently over entire circumference between the M-clips. The overall grease coverage was nominal and applied per STW7-2999 except for the previously mentioned region.

Fretting was found on the inner clevis leg land between the O-ring grooves at 10, 16, and 242 degrees, and on the land aft of the secondary O-ring groove at 10, 16, 238, and 242 degrees. Associated fretting was found on the tang ID aft of the sealing surface at 10, 16, 86, 238 and 242 degrees. M-clip fretting was observed on the tang OD at 2 through 6, 10, 14, 18, 20, 24, 30, 32, 90, 92, 124, 136, 166, 174-178, 182, 186, 208, 238, 246, 250, 254, 260, 298, 300, 320, 336, 348, 350 and 352 degrees.

4.2.14.7 Aft Dome-to-Stiffener Factory Joint

Light corrosion was observed on the tang OD and outer clevis leg ID intermittently over the entire circumference between the M-clips. The overall grease coverage was nominal and applied per STW7-2999 except for the previously mentioned region. No corrosion was observed on the internal joint areas.

Fretting was found on the inner clevis leg land forward of the primary O-ring groove at 350 degrees, on the land between the O-ring grooves at 238, 242, 244, 246, 258, 298, 302, 306, 314, 322, 324, and 350 degrees, and on the land aft of the secondary O-ring groove at 2, 94, 98, 126, 226, 250, 252, 258, 264, 268, 274-278, 282, 314, 322, 330, 346, 350, 356, and 358 degrees. Associated fretting was found on the tang ID aft of the sealing surface corresponding to the above degree locations. M-clip fretting was observed on the tang OD at 81, 83, 85, 86, 87, 92, 94, 98, 100, 104, 256, 262, 266, 272, 288, 302, 308, 314, 328, 338, 346, and 350 degrees. Metal slivers were found in pin holes at 294, 310, 314, and 318 degrees.

4.2.15 Miscellaneous Hardware

Corrosion pits were found on case segments at GEI spot bond locations because of galvanic action between the silver-filled epoxy (Ecobond 56C) and the D6AC steel. All GEI was removed at Hanger AF. Light to medium corrosion with light pits were observed on various spot bond locations.

4.3 Port plug and small O-ring Post-Fire Evaluations

The evaluation of the port plugs after flight use consisted of adding to the port plug torque database, visual assessment of the port plug for damage, and visual assessment of the port plug O-rings for anomalies.

Port plugs in the field joints, igniter, and nozzle-to-case joints were removed during disassembly operations at KSC. Port plugs in the S&A, factory joints and internal nozzle joints were removed at Clearfield. The initial assessment of the port plugs occurred at the time of removal. Closure plugs were removed from the custom vent port plugs by the O-ring Assessment Team. All port plugs and O-rings were then assessed by the O-ring assessment Team as a final assessment.

During the assessment at KSC several observations were reported which were OD extrusion damage to the adjustable vent port plug primary O-ring and ID circumferential cut to the field joint leak check port plug O-ring. The extrusion damage occurred during the installation of the vent port plug in to the port. This damage is an acceptable condition because of the design of the primary seal. The primary O-ring is used as a packing seal. When the adjustable vent port plug is fully installed in the vent port, the primary O-ring extrudes out of the gland area and is damaged. The damage is inherent to the design. The ID circumferential cut occurs when the leak check port plug is removed from the port. The last thread turns into the O-ring and cuts it. This is an acceptable condition.

Both S&A 126 degree leak check port plugs had circumferential galling on the plug sealing surfaces, a circumferential scratch on the plug sealing surface, and the LH plug had a chipped first thread. Both S&A 306 degree leak check port plugs had circumferential galling on the port plug sealing surface and the LH plug and a circumferential scratch on the sealing surface. All eight vent port plug primary O-rings had OD extrusion damage on both motors. The leak check port plug O-rings that had ID circumferential cuts were the LH igniter inner joint, forward field joint, forward dome-to-cylinder factory joint, center aft factory joint, ET-to-stiffener factory joint, aft dome-to-stiffener factory joint, nozzle-to-case joint, RH center field joint, center aft factory joint, ET-to-stiffener factory joint, stiffener-to-stiffener factory joint, and aft dome-to-stiffener factory joint. The RH 180 degree transducer primary O-ring and 115 degree IPT plug primary O-ring had an ID circumferential cut. The LH nozzle-to-case leak check port plug had two radial scratches on the sealing surface.

4.4 Post-Fire Team Assessments

The Seals Component Post-Fire Assessment Team, the Case Component Post-Fire Assessment Team, and the RPRB has reviewed all observations presented in this document and has determined that 21 observations were potential anomalies, classified as critical, major, minor or remains observation, as defined under Table III criteria. The Post Fire Anomaly Record (PFAR) number is referenced after each potential anomaly.

4.4.1 Remains Observations

1. Contamination in primary seal area of the SRM Ignition Initiator (SII) ports (360L007B-21).
2. Rolled last thread/burr on leak check port plug (360L007A-28).

4.4.2 Minor Anomalies

1. Unbonded paint (FWD CLY-CLY Factory Joint) (360L007B-02).
2. Debonded/missing paint (aft dome Y joint) (360L007A-08).
3. Field joint fretting (360L007A-09).
4. Field joint fretting (360L007B-10).
5. No dovetail in pin removed from aft field joint (360L007B-11).
6. Lack of grease on fixed housing between primary and secondary O-rings (360L007B-12).
7. Missing paint (forward dome Y joint) (360L007A-13).

8. Deformations in the sealing washer of the SRM Ignition Initiator (SII) (360L007A-15).

9. Deformations in the sealing washer of the SRM Ignition Initiator (SII) (360L007B-16).

10. Radial scratch across SRM Ignition Initiator (SII) port secondary O-ring groove (360L007A-17).

11. Radial scratch across the sealing washer of the SRM Ignition Initiator (SII) (360L007B-18).

12. Galling on shoulder seal surface of MS9902-01 leak test port plug (360L007A-19).

13. Galling on shoulder seal surface of MS9902-01 leak test port plug (360L007B-20).

14. Circumferential scratch on Safe and Arm (S&A) device leak test port sealing surface (360L007A-22).

15. Circumferential scratch on Safe and Arm (S&A) device leak test port sealing surface (360L007B-23).

16. Radial scratches on the secondary seal surface of the leak check plug (360L007A-27).

17. Factory joint fretting (360L007A-29).

18. Disassembly cut in primary O-ring from nozzle-to-case joint (also contamination present) (360L007B-30).

19. Factory joint fretting (360L007B-31).

4.4.3 Major Anomalies

There were no major anomalies.

4.4.4 Critical Anomalies

There were no critical anomalies.

5.0 References

1. L. E. MacCauley, TWR-17432, "KSC Ten-Day Postflight Hardware Evaluation Report 360L007 (RSRM-7, STS-33R)", Thiokol Corporation, 18 December 1989.

2. D. M. Garecht, TWR-17546, Vol. I, "Flight Motor Set 360L007 (STS-33R) Final Report", Thiokol Corporation, June 1990.

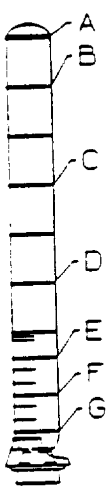
3. W. D. Starrett, TWR-50050, "KSC Post-Flight Engineering Evaluation Plan (Case, Seals, and Joints)", Thiokol Corporation,

4. Performance and Advanced Design, et. al., TWR-16475, Book 2, Volumes. 1-9, "Clearfield Post-Flight Engineering Evaluation Plan", Morton Thiokol, Inc., 7 October 1988 (Vol. 4, Seals Component).

Thiokol CORPORATION
SPACE OPERATIONS

TABLE I

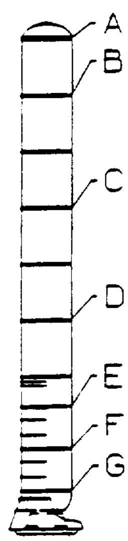
RSRM-7 FACTORY JOINT CORROSION SUMMARY



JOINT	A	B
A	OUTER CLEVIS LEG: LOCALLY LIGHT INSIDE JOINT: NONE	OUTER CLEVIS LEG: LOCALLY LIGHT INSIDE JOINT: NONE
B	OUTER CLEVIS LEG: LOCALLY LIGHT INSIDE JOINT: NONE	OUTER CLEVIS LEG: LOCALLY LIGHT INSIDE JOINT: NONE
C	OUTER CLEVIS LEG: LOCALLY LIGHT INSIDE JOINT: NONE	OUTER CLEVIS LEG: NONE INSIDE JOINT: NONE
D	OUTER CLEVIS LEG: NONE INSIDEJOINT: NONE	OUTER CLEVIS LEG: LOCALLY LIGHT INSIDE JOINT: NONE
E	OUTER CLEVIS LEG: LOCALLY LIGHT INSIDE JOINT: NONE	OUTER CLEVIS LEG: LOCALLY LIGHT INSIDE JOINT: NONE
F	OUTER CLEVIS LEG: LOCALLY HEAVY INSIDE JOINT: LOCALLY HEAVY	OUTER CLEVIS LEG: LOCALLY LIGHT INSIDE JOINT: NONE
G	OUTER CLEVIS LEG: LOCALLY HEAVY INSIDE JOINT: LOCALLY HEAVY	OUTER CLEVIS LEG: LOCALLY LIGHT INSIDE JOINT: NONE

TABLE II

RSRM-7 FACTORY JOINT AND M-CLIP FRETTING SUMMARY

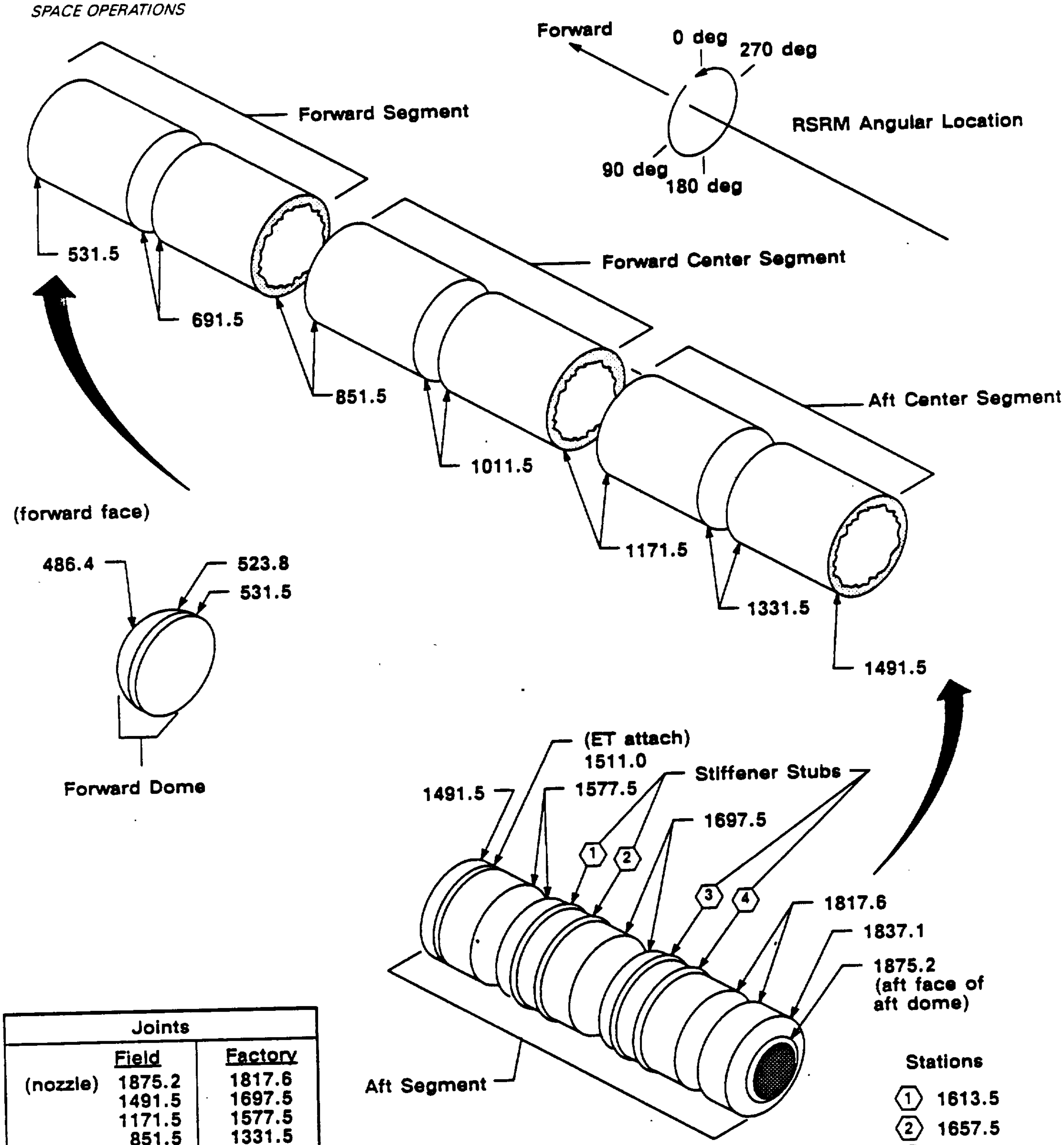


JOINT	A	B
A	JOINT: INTERMITTENT M-CLIP: LOCAL	JOINT: INTERMITTENT M-CLIP: LOCAL
B	JOINT: LOCAL M-CLIP: INTERMITTENT	JOINT: INTERMITTENT M-CLIP: NONE
C	JOINT: LOCAL M-CLIP: INTERMITTENT	JOINT: LOCAL M-CLIP: INTERMITTENT
D	JOINT: LOCAL M-CLIP: LOCAL	JOINT: NONE M-CLIP: LOCAL
E	JOINT: LOCAL M-CLIP: INTERMITTENT	JOINT: LOCAL M-CLIP: NONE
F	JOINT: LOCAL M-CLIP: INTERMITTENT	JOINT: LOCAL M-CLIP: INTERMITTENT
G	JOINT: INTERMITTENT M-CLIP: INTERMITTENT	JOINT: INTERMITTENT M-CLIP: INTERMITTENT

Table III

Criteria for Classifying "Potential Anomalies"

	REMAINS OBSERVATION	ANOMALY		
		MINOR	MAJOR	CRITICAL
JUSTIFICATION	A. Requires no specific action	A. Requires corrective action, but has no impact on: - Motor performance - Program schedule B. Does not reduce usability of part for its intended function C. Could cause damage preventing reuse of hardware in combination with other anomaly D. Significant departure from the historical data base	A. Could cause failure in combination with other anomaly B. Could cause damage preventing reuse of hardware C. Program acceptance of cause, corrective action and risk assessment required before subsequent static test or flight	A. Violates CEI spec requirements B. Could cause failure and possible loss of mission or life C. Mandatory resolution before subsequent static test or flight



Joints	
Field	Factory
(nozzle) 1875.2	1817.6
1491.5	1697.5
1171.5	1577.5
851.5	1331.5
(igniter) 486.4	1011.5
	691.5
	531.5

Stations

1 1613.5
2 1657.5
3 1733.6
4 1777.6

Figure 1. RSRM Case Segments and Relationships

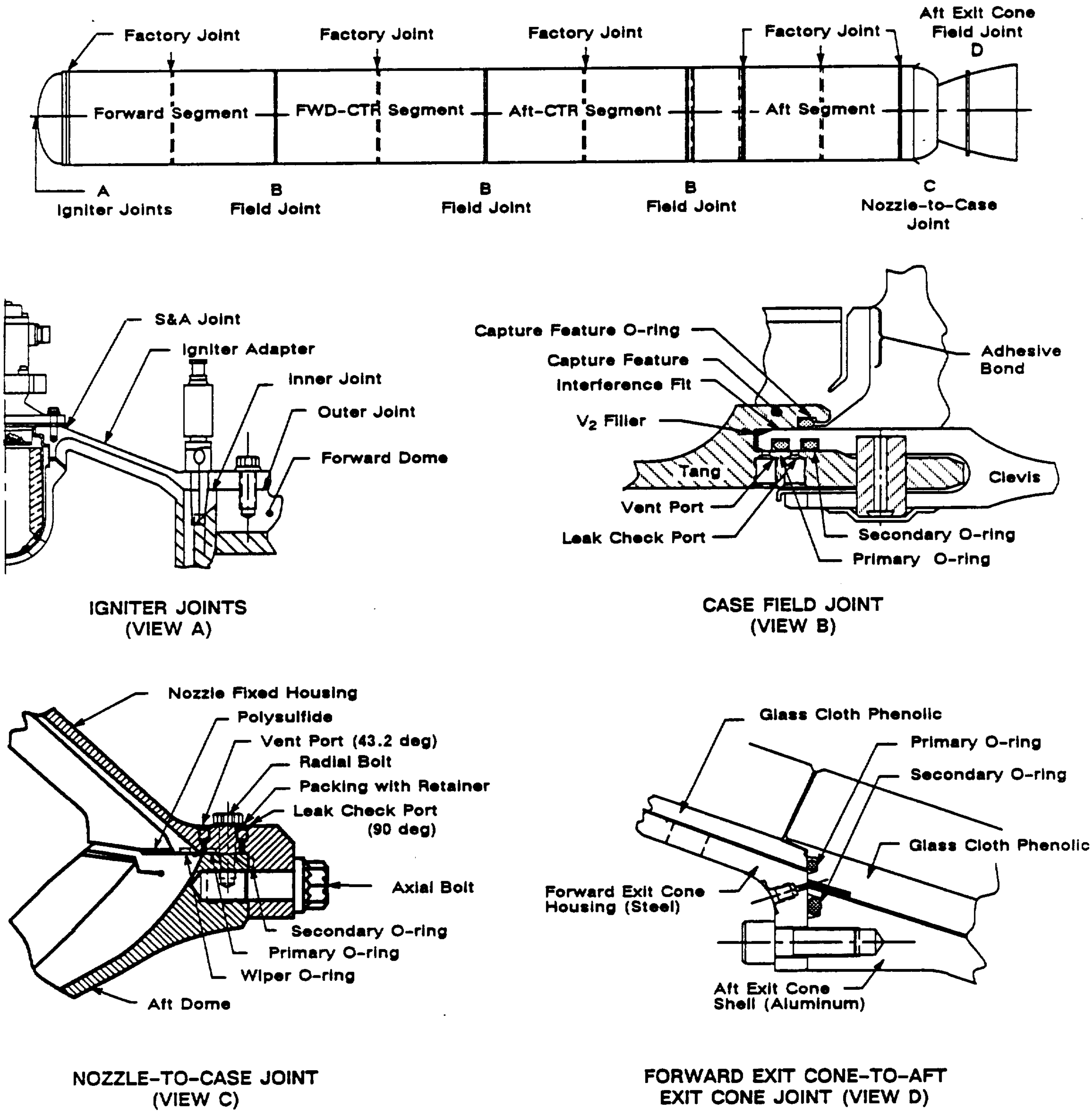


Figure 2. RSRM Joint Configuration

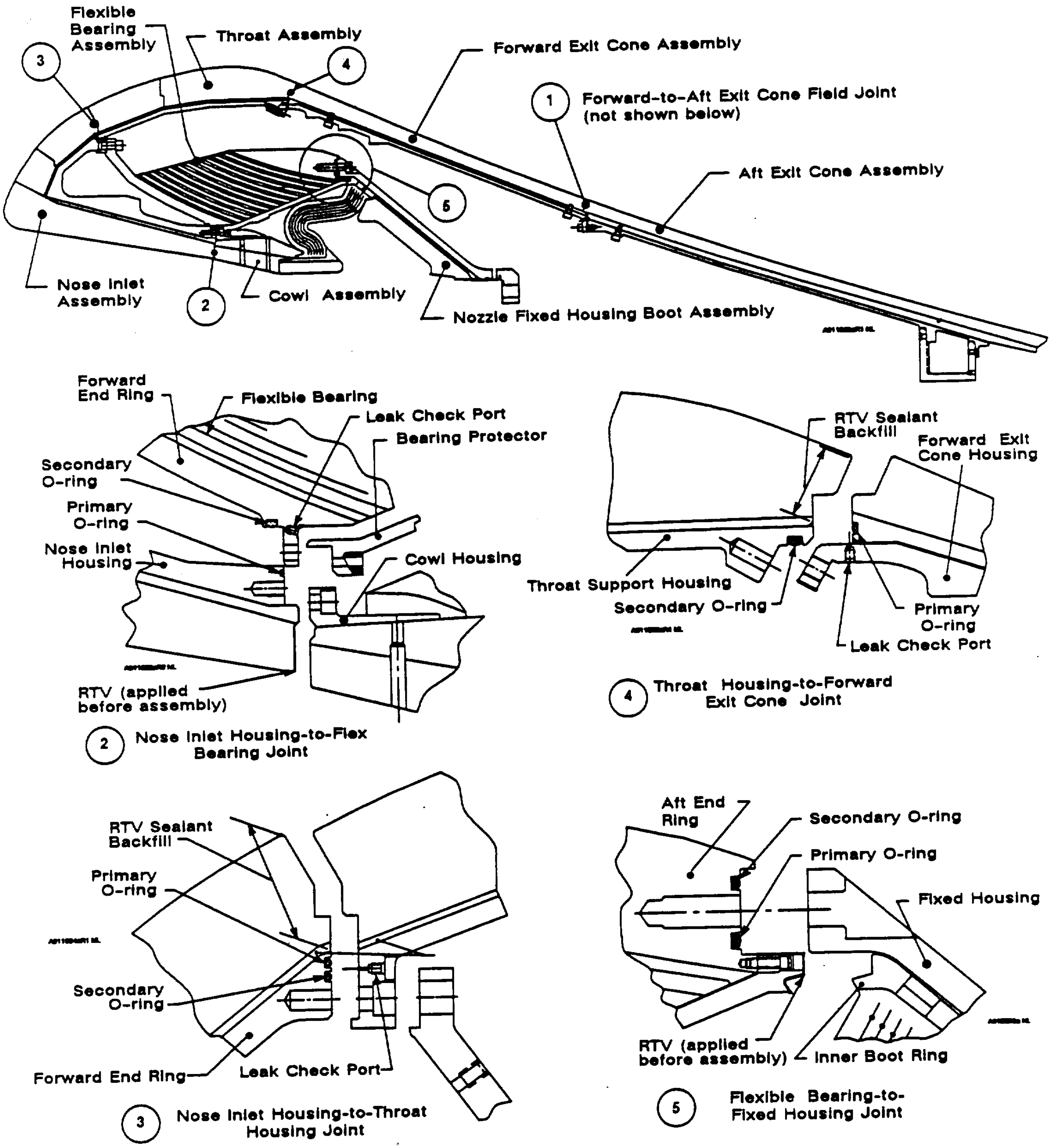


Figure 3. RSRM Nozzle Internal Joints

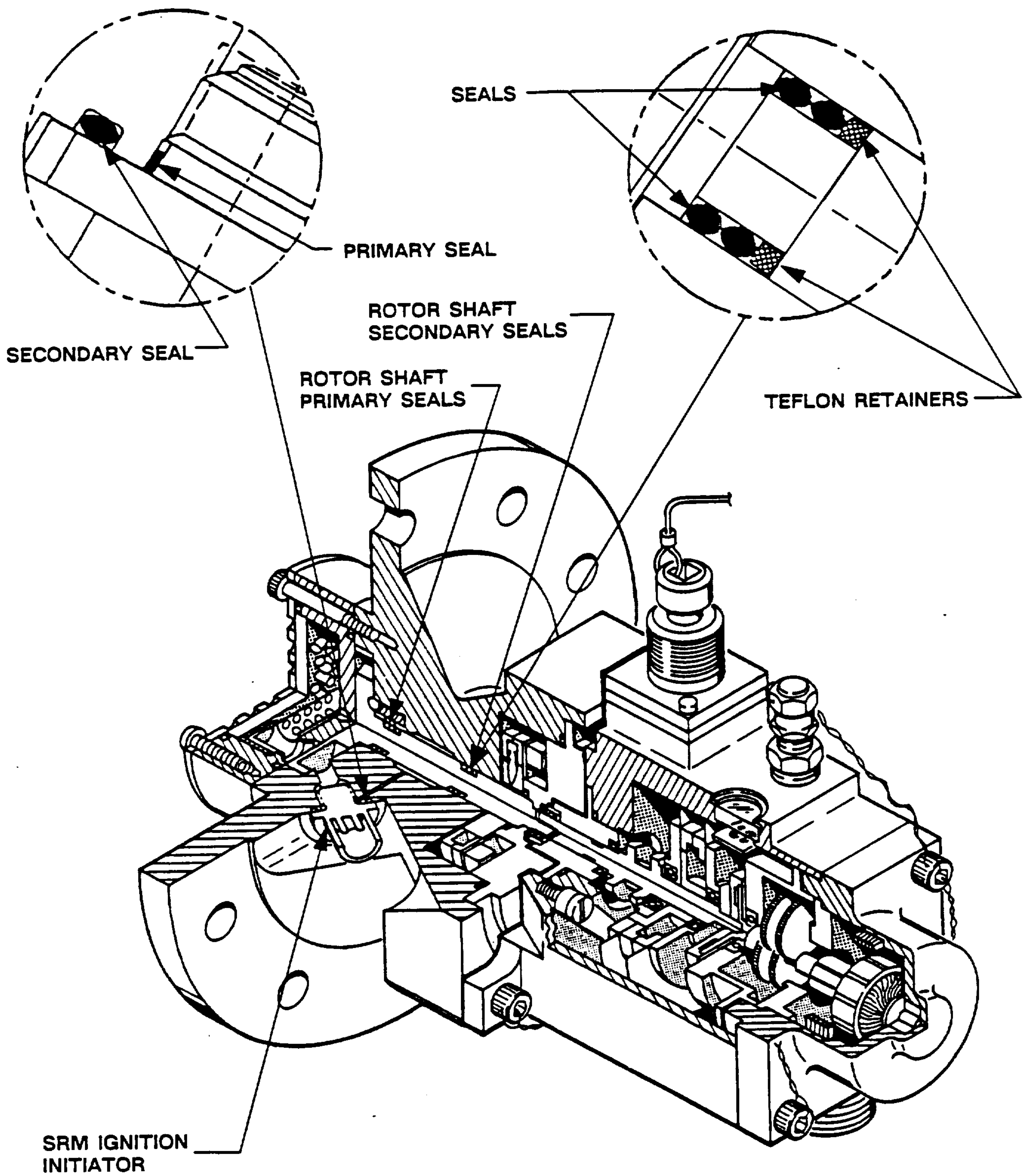


Figure 4. Safe and Arm Device Seals

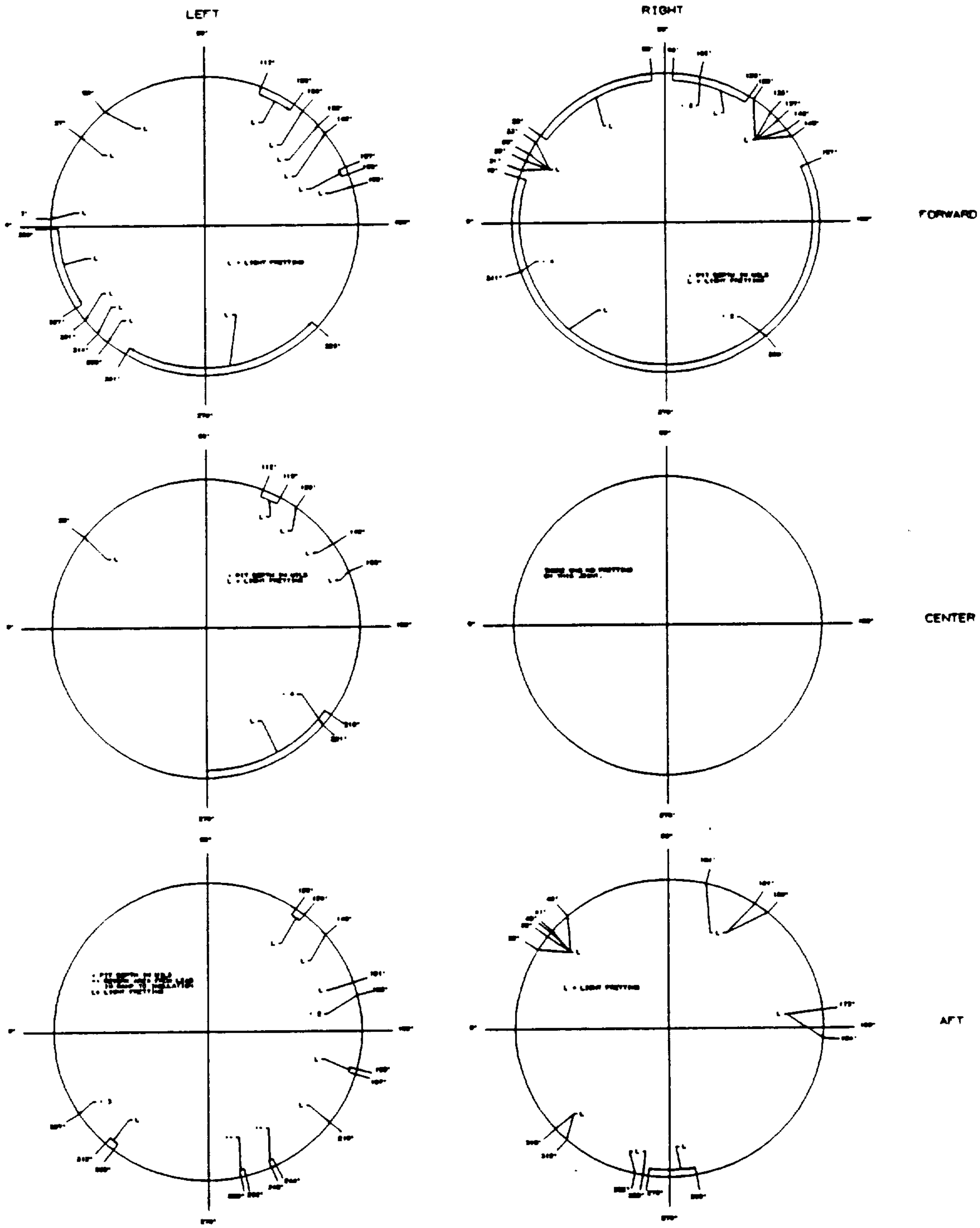


Figure 5. Field Joint Fretting Summary

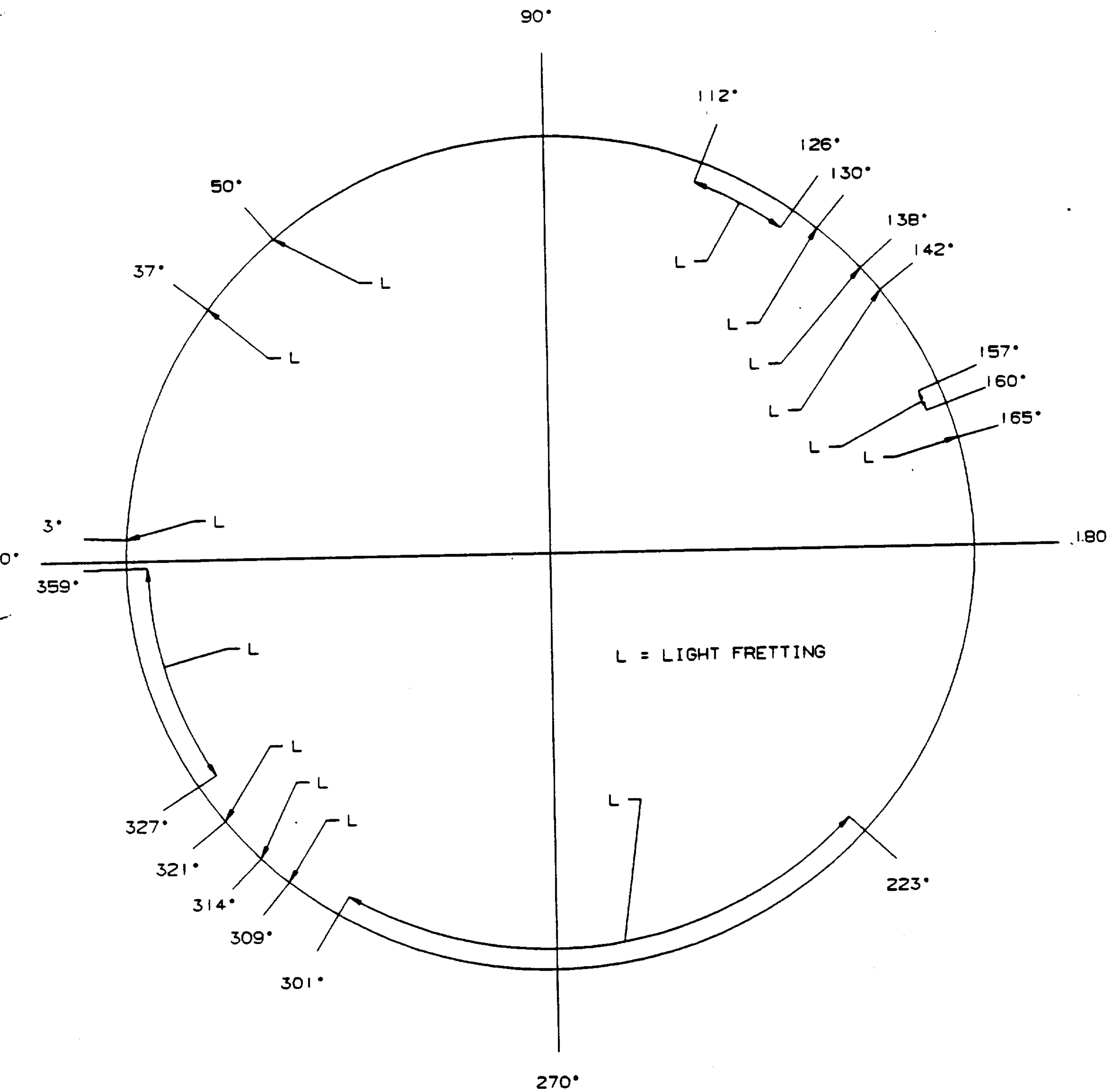


Figure 6. LH Forward Field Joint Fretting

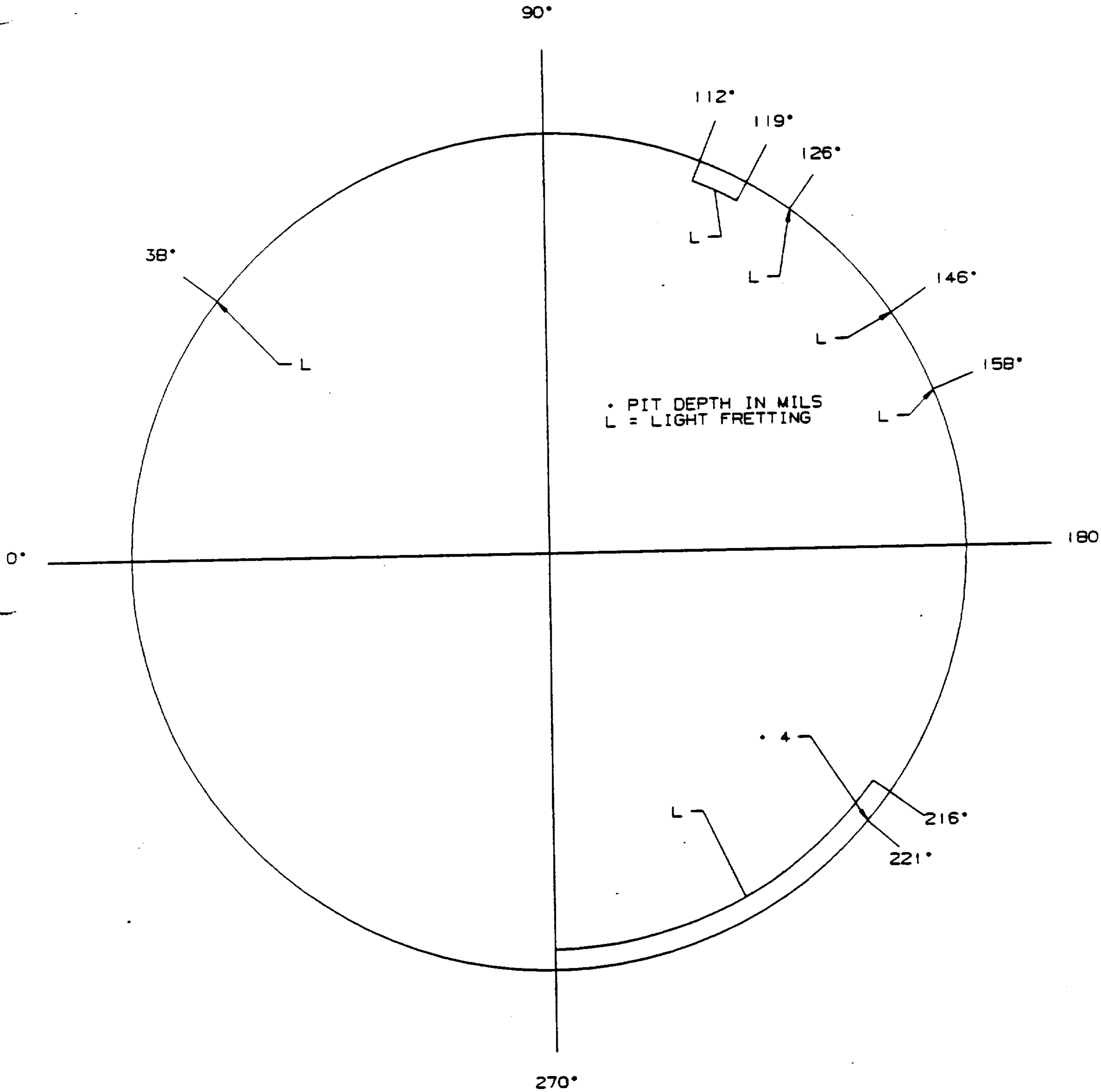


Figure 7. LH Center Field Joint Fretting

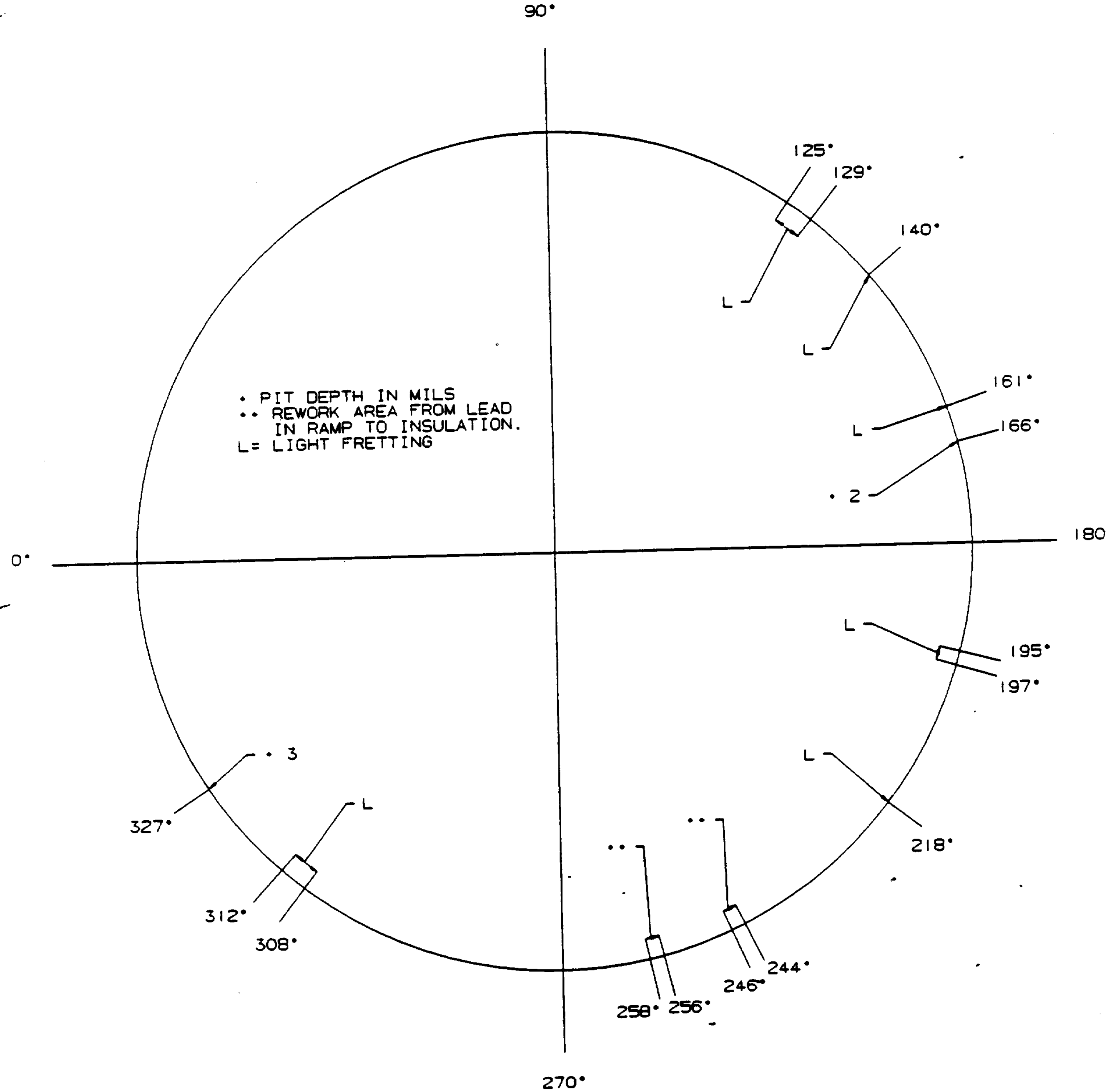


Figure 8. LH Aft Field Joint Fretting

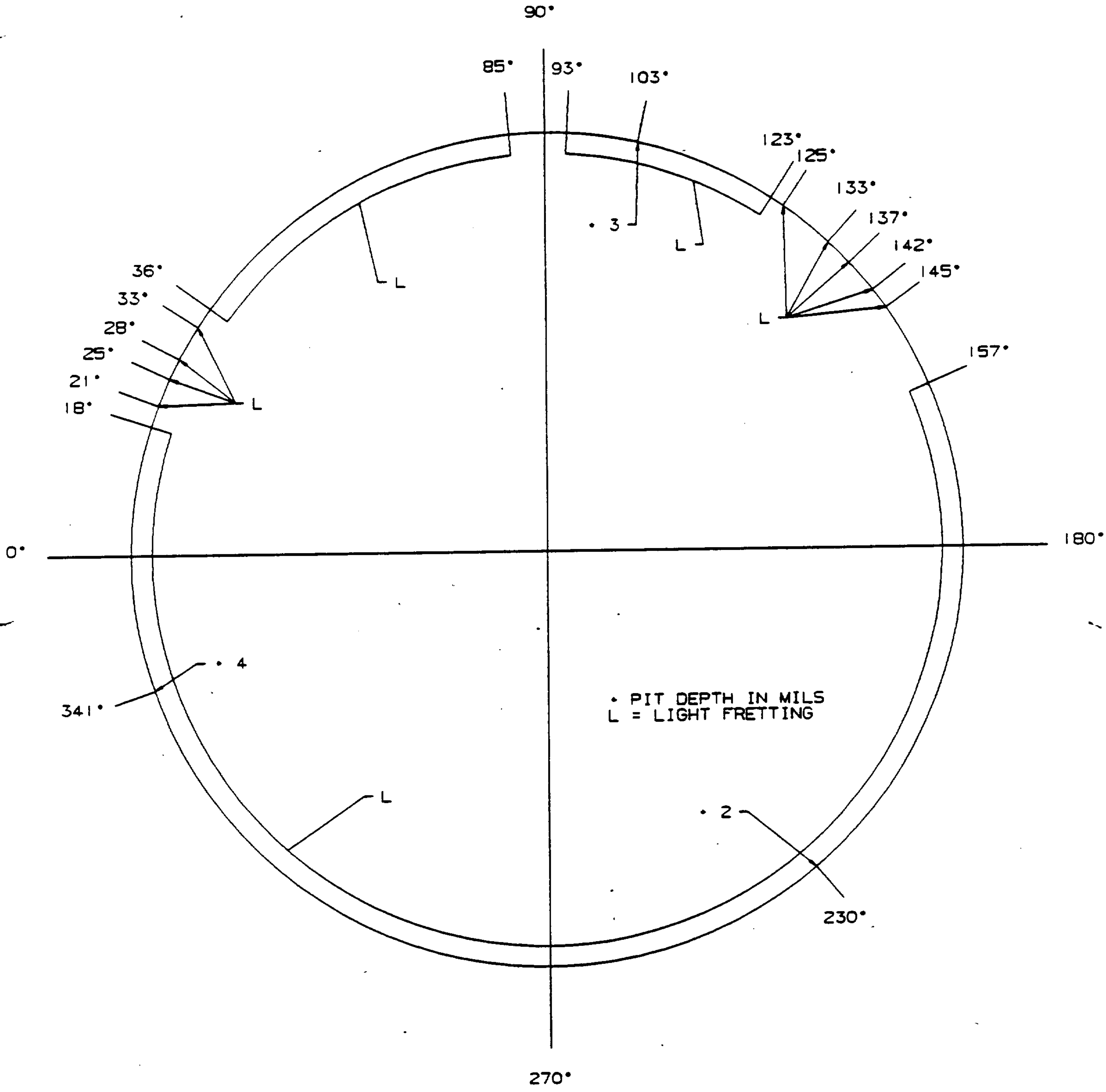
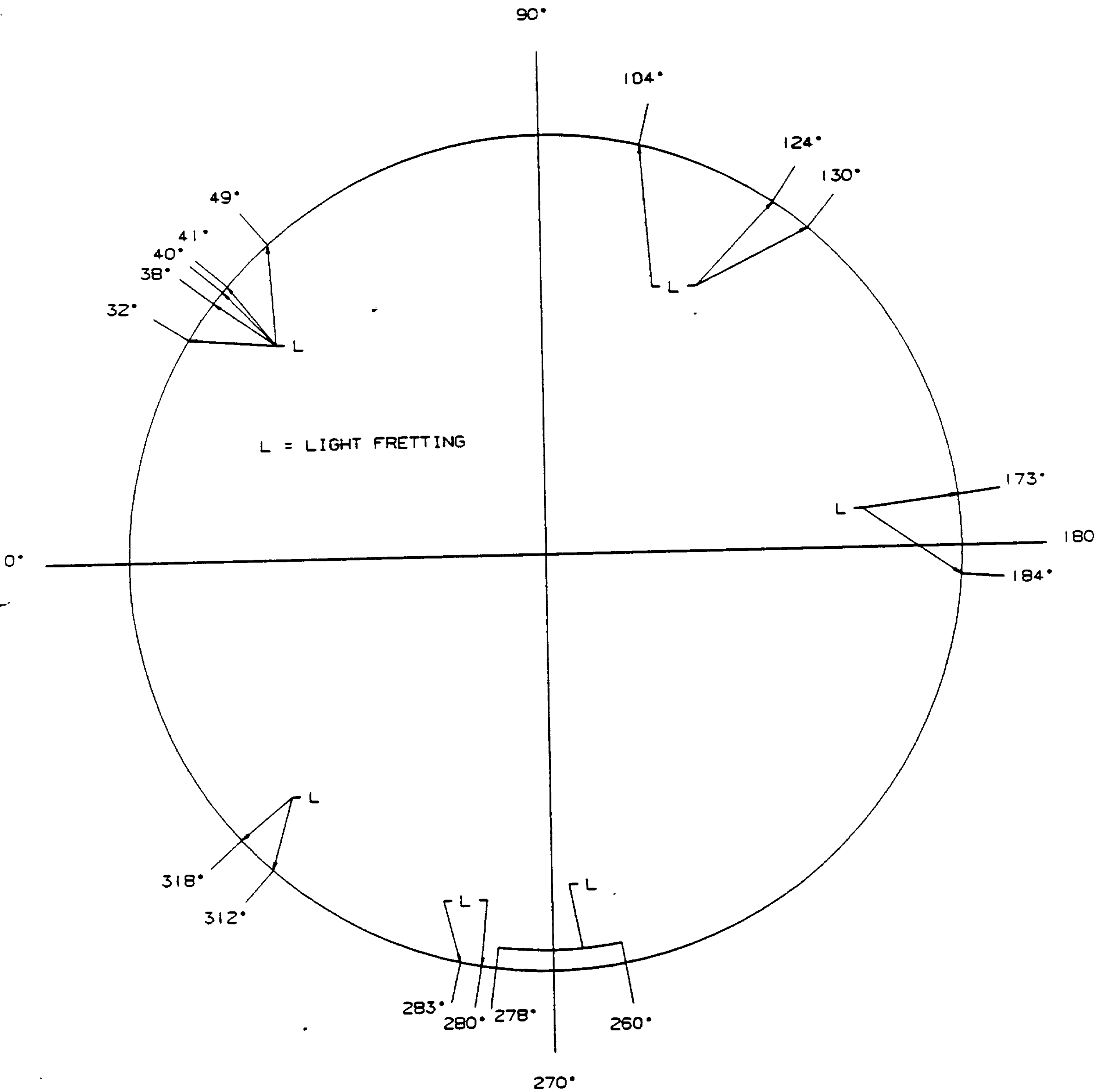


Figure 9. RH Forward Field Joint Fretting



Figrue 10. RH Aft Field Joint Fretting

APPENDIX A

RPRB PRESENTATIONS

2.0 CASE / SEALS

2.1 Case	**Presenter: L. Nelsen**
2.2 Seals	**Presenter: L. Nelsen**

2.1 Case

- PM: G. Kotter
  SI: J. Seller
  PFE:
  DE: R. Mackley, J. Miller, L. Nelsen, A. Carlisle
  ME: B. Nelson
  QE: D. Bartelt, K. Shupe
  Rel: S. Rogers

Case
Non-dovetail Pin Installed

- PFARs: 360L007B–11
- DESCRIPTION: Inspection of the 360L007B aft field joint revealed that the pin installed at 22° was missing the dovetail of the removal hole
- REFERENCE: PV6–146675
- DISCUSSION: Currently all pins are 100% dimensionally inspected at refurbishment only. When they are first received by Receiving Inspection, they are sample inspected. They are also sample inspected at the vendor. This pin had been through refurbishment. Dimensional inspection does not include inspection for dovetailed holes
- RECOMMENDATIONS:
  - TEAM CLASSIFICATION: Minor Anomaly
  - JUSTIFICATION: The pin was easily removed and functioned as normal; however, corrective action is required
  - CORRECTIVE ACTION/OTHER RECOMMENDATIONS:
    - Quality to review current acceptance and refurb specifications to determine why this pin was accepted
    - 100 percent visual inspection for dovetail removal section at vendor and Receiving Inspection

Case / Seals

- ACTIONEE: Quality Assurance
- REPORT BACK TO RPRB?: No. PM to verify completion of corrective action

Peeling Case Primer and Paint

- PFARs: 360L007A–13, 360L007A–08, 360L007B–02
- DESCRIPTION: Inspection of the 360L007 hardware revealed several areas of peeling primer and paint on the case
- REFERENCE: PV6–146673, PV6–146420, PV6–146112
- DISCUSSION: Peeling paint and primer was found forward of the RH forward factory joint at 160°, in the LH aft dome Y-joint the full circumference, and the LH forward dome Y-joint intermittently. Light–to–medium corrosion was observed on the exposed metal surfaces. No pitting was observed
- RECOMMENDATIONS:
  - TEAM CLASSIFICATION: Minor Anomaly
  - JUSTIFICATION: Corrosion can affect hardware reuse
  - CORRECTIVE ACTION/OTHER RECOMMENDATIONS:
    - The paint and chemlok anomaly team is investigating cause
    - The above mentioned team is monitoring the current flight set in production to determine possible corrective action
  - ACTIONEE: The paint and chemlok anomaly team
  - REPORT BACK TO RPRB?: Yes

Field Joint Fretting

- PFARs: 360L007A–09, 360L007B–10
- DESCRIPTION: Fretting was observed on all 360L007 field joints except the RH center
- HISTORY: 360L001 through 360L006
- REFERENCE: PV6–146670, PV6–146674
- DISCUSSION: Light–to–medium fretting was measured on all 360L007 field joints, except the RH center. The maximum pit depths found were 0.004 inches on both the LH center and RH forward field joints. All other field joints had light fretting (pits less than 0.003 inch deep). The LH ET attach cylinder, which had a refurbished region of fretting from 180 to 220 degrees only, had two new locations of fretting in this regions at 197 and 218 degrees. These frets were light measuring 0.002 inches or less. The new frets were not on previous fretting locations
- RECOMMENDATIONS:
  - TEAM CLASSIFICATION: Minor Anomaly
  - JUSTIFICATION: Fretting not acceptable per the PEEL (TWR–50050, Vol II)
  - CORRECTIVE ACTION/OTHER RECOMMENDATIONS: Reference PFARs for previous motors
  - ACTIONEE: Fretting anomaly investigation team
  - REPORT BACK TO RPRB?: Yes

2.2 Seals

- PM: J. Walters → Nozzle-to-case Team
  SI: S. Morris
  PFE: D. Starrett
  DE: D. Pulleyn
  ME: J. Faust
  QE: D. Cozlar, D. Dayton
  Rel: G. Conover

Seals
Nozzle-to-Case Joint Grease Application

- PFARs: 360L007B–12
- DESCRIPTION: The 360L007B nozzle fixed housing appeared to have improper grease coverage
- HISTORY: None
- REFERENCE: PV6–146676
- DISCUSSION: The metal surface on the 360L007B nozzle fixed housing appeared very dry and lacking proper grease coverage at intermittent locations on the metal surface between the primary and secondary O–ring grooves. No corrosion or O–ring damage was observed. The aft dome metal surface had adequate grease coverage. The primary O–ring had less grease than the wiper O–ring or the secondary O–ring; however, the grease coverage on the primary O–ring was acceptable

Case / Seals

- RECOMMENDATIONS:
  - TEAM CLASSIFICATION: Minor Anomaly
  - JUSTIFICATION: This was the first time that lack of grease on nozzle hardware has been reported. This condition posed no impact to hardware reuse or schedule
  - CORRECTIVE ACTION/OTHER RECOMMENDATIONS:
    - Work Center to ensure TRACS class for nozzle-to-case assembly/grease application is in place
    - Update PEEL to clarify grease application limits for metal hardware, joints, and O-rings. Make lack of grease on metal joint surfaces acceptable as long as no corrosion results

Re address

Not sure

  - ACTIONEES: Work Center, Postfire Hardware Evaluation
  - REPORT BACK TO RPRB?: No, PM to ensure completion of action items

S&A DISASSEMBLY REPORT

- PFARs: 360T004B-25, 360L006A-31, 360L006B-32, 360L007A-19, 360L007B-20, TEM04-06, LAT41-03

- DESCRIPTION:

  - Circumferential galling was found on the shoulder seal surface of the S&A-to-adapter and B-B bore leak test (MS9902-01) plugs. The width and length of the galled region varies.

- HISTORY: Not previously reported.

- DISCUSSION:

  - Galling on the plug occurs during the machining process of the seal surface on the plug.

  - The leak test plugs are inspected and installed into the B-B at E-VAD. They are removed prior to leak test and re-installed on plant (B-B bore) and at KSC (flange).

  - Thiokol assembly planning does not call out inspection of the B-B bore leak test plug prior to re-installation.

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S&A DISASSEMBLY REPORT

- RECOMMENDATIONS:
  - TEAM CLASSIFICATION: Minor Anomaly
  - JUSTIFICATION:
    - Violates surface finish and requires corrective action.
    - Shoulder seal is a packing rather than a face seal.
    - Galled surface does not extend across the full O-ring footprint.
    - No O-ring damage has been found due to galled shoulder seal surface of leak test plug.
  - CORRECTIVE ACTION:
    - Short Term: Inspect all MS9902-01 plugs in Stores and at E-VAD per MS9902 specification and reject those that are unacceptable. Effective: 19 January 1990.

S&A DISASSEMBLY REPORT

- CORRECTIVE ACTION (cont.):
  - Long Term: Replace MS9902-01 plug with 1U50159 leak test plug; 1U50159 plugs are 100 percent inspected and controlled in-house.
- REPORT BACK TO RPRB? No
- ACTIONEE: Quality Engineering for short term and S&A Component Team for long term.

S&A DISASSEMBLY REPORT

- PFARs: 360L007A-22, 360L007B-23
- DESCRIPTION:
    - A single circumferential scratch was found on the shoulder seal area of the S&A-to-adapter and B-B bore leak test ports.
- HISTORY: Not previously reported.
- DISCUSSION:
    - The scratch occurred prior to leak test plug installation. The scratch is visible with good lighting and should have been found during inspection.
    - Thiokol assembly planning does not call out an inspection point for the B-B bore leak test plug port seal surfaces.
    - The Barrier Booster refurbishment specification (STW7-3133) does not allow any seal surface defects.

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S&A DISASSEMBLY REPORT

- RECOMMENDATIONS:
  - TEAM CLASSIFICATION: Minor Anomaly
  - JUSTIFICATION:
    - Violates engineering and requires corrective action.
    - The scratch is in the circumferential direction and does not cross the O-ring footprint.
    - The shoulder O-ring is a packing seal.
    - No O-ring damage has been found due to scratch in leak test port.
  - CORRECTIVE ACTION:
    - Short Term: Update Thiokol assembly planning and vendor refurb planning to perform detailed inspection of all port seal surfaces. Effective: 19 January 1990.

S&A DISASSEMBLY REPORT

- CORRECTIVE ACTION (cont.):
  - Long Term: Modify refurbishment specification, STW7-3133, to incorporate better seal surface definitions and inspection points.
- REPORT BACK TO RPRB? No
- ACTIONEE: S&A Component Team and Joints and Seals Design.

S&A DISASSEMBLY REPORT

- PFARs: 360L006A-31, 360L007B-21
- DESCRIPTION:
  - A black substance was found in the grease on the primary seal surface of the SII port.
- HISTORY: Not previously reported.
- DISCUSSION:
  - Lab analysis identified black substance as combustion products from SII.
  - Source of contamination was found to be introduced during removal of the SII at disassembly.
    - Combustion products in the sooted tip of the SII rubbed off into the grease as the SII was removed.

S&A DISASSEMBLY REPORT

- RECOMMENDATIONS:
  - TEAM CLASSIFICATION: Remains observation.
  - JUSTIFICATION:
    - Non-problem and does not require corrective action.
  - RECOMMENDATIONS:
    - Close PFARs.

S&A DISASSEMBLY REPORT

- PFARs: 360L006A-27, 360L006B-28
- DESCRIPTION:
  - A single radial scratch was found across the primary (shoulder) seal surface of the SII port.
- HISTORY: Not previously reported.
- DISCUSSION:
  - The scratch occurred prior to SII installation. The scratch is visible with good lighting and should have been found during inspection.
  - Thiokol assembly planning does not call out an inspection point for the SII port seal surfaces.
  - The Barrier Booster refurbishment specification (STW7-3133) does not allow primary seal surface defects.
- RECOMMENDATIONS:
  - TEAM CLASSIFICATION: Minor Anomaly

S&A DISASSEMBLY REPORT

- JUSTIFICATION:
  - Violates engineering and requires corrective action.
  - The SII's are low pressure leak tested; no leaks were detected.
  - The primary O-ring is a packing seal.
  - Evidence of soot to the primary O-ring has not been reported.
  - No O-ring damage has been found due to scratch in port.
- CORRECTIVE ACTION:
  - Short Term: Update Thiokol assembly planning and vendor refurb planning to include detailed inspection of all port seal surfaces. Effective: 19 January 1990.

S&A DISASSEMBLY REPORT

- CORRECTIVE ACTION (cont.):
  - Long Term: Update refurbishment specification, STW7-3133, to incorporate better seal surface definitions and inspection points.
  - Incorporate test plan to evaluate the SII leak test.
- REPORT BACK TO RPRB? No
- ACTIONEE: S&A Component Team and Joints and Seals Design.

S&A DISASSEMBLY REPORT

- PFARs: 360H005A-22, 360H005A-23, 360H005B-24, 360H005B-25, 360L006A-17, 360L006B-18, 360L007A-15, 360L007B-16, TEM04-07, TEM04-08

- DESCRIPTION:

  - Several deformations were found in the sealing washer on the SII's. The deformations are circumferential and follow the pattern of the NSI. The largest deformations, located over the wrench slots, are approximately 3 mils deep.

- HISTORY: Previously found at post-fire inspection since TEM-04. Deformations have been noticed since SII Lot HWD and subsequent.

- DISCUSSION:

  - The NSI/SII is a government furnished part.

    - The SII is created by welding a back-up ring to the NSI which provides a secondary seal surface. A sealing washer is then welded on to provide the actual seal surface and to compensate for irregularity in the NSI/back-up ring interface.

  - The washer is deformed during manufacturing process.

S&A DISASSEMBLY REPORT

- RECOMMENDATIONS:
  - TEAM CLASSIFICATION: Minor Anomaly
  - JUSTIFICATION:
    - Potential to violate O-ring squeeze and requires corrective action.
    - Deformation does not completely compromise secondary O-ring footprint.
    - The SII's are low pressure leak tested; no leaks were detected.
  - CORRECTIVE ACTION:
    - Short Term: Investigate engineering accept/reject criteria of deformations.
    - Add inspection point during acceptance to screen out-of-tolerance deformations. Effective: 19 January 1990.

S&A DISASSEMBLY REPORT

- CORRECTIVE ACTION (cont.):
  - Long Term: Recommend and submit engineering changes to NASA for a unibody construction for the SII.
  - Add PEEL limits stating that deformations in sealing washer are reportable.
  - Evaluate new design for larger secondary O-ring and groove for higher squeeze.
  - Incorporate test plan to evaluate the SII leak test.
- REPORT BACK TO RPRB? Yes
- ACTIONEE: NASA, S&A Component Team, and Joints and Seals Design.

S&A DISASSEMBLY REPORT

- PFARs: 360L006A-25, 360L007B-18
- DESCRIPTION:
  - A single radial scratch was found across the sealing washer of the SII. The maximum depth of the worst case scratch was less than 1.0 mil.
- HISTORY: Not previously reported.
- DISCUSSION:
  - Thiokol assembly planning has an inspection point to verify no damage to the SII's: no scratches, nicks, dings, etc.
  - The scratches occur prior to SII assembly; source is unknown.
- RECOMMENDATIONS:
  - TEAM CLASSIFICATION: Minor Anomaly

S&A DISASSEMBLY REPORT

- JUSTIFICATION:
  - First time occurrence, is reportable, and requires corrective action.
  - The SII's are low pressure leak tested; no leaks were detected.
  - No secondary O-ring damage has been found due to the scratch across the seal washer.
- CORRECTIVE ACTION:
  - Short Term: Update Thiokol assembly log to include detailed inspection of SII seal surfaces; replace those that are unacceptable. Effective: 19 January 1990.
  - Long Term: Recommend and submit engineering changes to NASA for unibody SII.
  - Incorporate test plan to evaluate the SII leak test.
- REPORT BACK TO RPRB? No
- ACTIONEE: S&A Component Team, Joints and Seals Design, and NASA.

S&A DISASSEMBLY REPORT

- PFARs: 360L006A-26, 360L007A-17
- DESCRIPTION:
  - A single radial scratch was found across the bottom of the SII secondary O-ring groove.
- HISTORY: Not previously reported.
- DISCUSSION:
  - The scratch occurred prior to SII installation. The scratch is visible in good lighting and should not have been missed during inspection.
  - Thiokol assembly planning does not call out an inspection point for the SII port seal surfaces.
  - The Barrier Booster refurbishment specification (STW7-3133) does not allow secondary seal surface defects in ports.

S&A DISASSEMBLY REPORT

- RECOMMENDATIONS:
  - TEAM CLASSIFICATION: Minor Anomaly
  - JUSTIFICATION:
    - Violates engineering and requires corrective action.
    - The SII's are low pressure leak tested; no leaks were detected.
    - No primary O-ring damage has been found due to scratch in shoulder seal surface of port.
  - CORRECTIVE ACTION:
    - Short Term: Update Thiokol assembly planning and vendor refurb planning to perform detailed inspection of all port seal surfaces. Effective: 19 January 1990.

S&A DISASSEMBLY REPORT

- CORRECTIVE ACTION (cont.):
  - Long Term: Update refurbishment specification, STW7-3133, to incorporate better seal surface definitions and inspection points.
  - Incorporate test plan to evaluate the SII leak test.
- REPORT BACK TO RPRB? No
- ACTIONEE: S&A Component Team and Joints and Seals Design.