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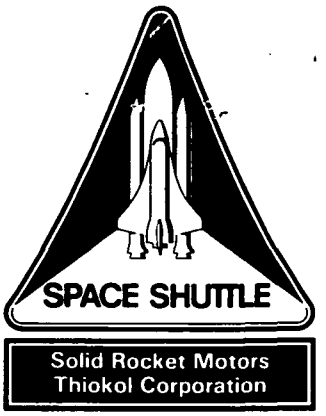


TWR-17548 Volume II

# FLIGHT SET 360L009 (STS-36)
# CASE AND SEALS COMPONENT FINAL REPORT

NOVEMBER 1990

**Prepared for:**

**NATIONAL AERONAUTICS AND SPACE ADMINISTRATION**
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# Case and Seals Component Final Report

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### APPENDICES

## 1.0 INTRODUCTION

This report assesses the performance of the 360L009, Ninth Flight, Redesigned Solid Rocket Motors (RSRM) in respect to case hardware and joint sealing issues as seen from post-fire assessment of the case and seals. In addition, all 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

### 2.1 Post-Fire Case Assessment Summary

The post fire assessment of both motors showed the case segments to be in good condition. Field joint fretting on this flight set ranged from light (<0.003 inch deep) on most of the joints to locally heavy (>0.005 inch deep) on three of the joints, figure 5 visually summarizes the fretting on all the joints. The LH aft field joint is the most heavily fretted joint to date, this joint had previously fretted areas from STS-27. No new fretting was found in old fretting locations; however new frets were found at the edges of repaired areas on both the LH center and aft field joints. All fretting was mapped from the inner clevis leg. The capture feature fretting was not mapped due 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 field joint:

Field Joint Fretting

LH/FWD — Light fretting from 43 to 63, 110 to 129, 172, 187, 207, 243, and 244 degrees.

LH/CTR Intermittent light fretting around most of the joint with concentrations of moderate (0.003 to 0.005 inch deep) and heavy (>0.005 inch deep) fretting between 180 and 300 degrees. A 0.008 inch deep fret was found at 225 degrees.

LH/AFT Intermittent light fretting around most of the joint with concentrations of moderate (0.003 to 0.005 inch deep) and heavy (>0.005 inch deep) fretting from 135 through 0 to 9 degrees. Two 0.009 inch deep frets were found at 195, and 350 degrees and a 0.011 inch deep fret at 278 degrees.

RH/FWD Light frets at 44 and 45 degrees and a 0.004 inch deep fret at 180 degrees.

RH/CTR Light fretting from 156 to 187, 256 to 280, 298 to 315, and 338 through 0 to 1 degrees. Moderate (0.003 to 0.005 inch deep) fretting at 118, 305, and 340 degrees. A 0.009 inch deep fret was found at 350 degrees.

RH/AFT Light fretting at 30, 35, 42, and 55 degrees.

Heavy corrosion was found on the RH forward dome igniter inside diameter and igniter chamber at the location of the blow hole in the outer joint putty lay up. The factory joint weather seals were removed at KSC to prevent rusting of the outer clevis leg under the pin retainer hat band. Medium corrosion was found under the LH center aft factory joint weather seal, this weather seal had six unbonds (Reference 1). Light corrosion was found on one additional joint that did not have any unbonds in the weather seal. The factory joint corrosion is summarized in Table 1. The factory joint fretting and M-clip fretting is summarized in Table 2.

The stiffener rings and stiffener stubs suffered typical water impact damage. The RH center stiffener stub suffered an outer ligament crack. The LH center, LH aft, RH center, and the RH aft stiffener rings were cracked. Based on the missing instafoam the cavity collapse load center line was estimated to be 190 degrees for both motors.

The Case Component Post Fire Assessment Team has identified six observations, made during disassembly assessments, as "potential anomalies". The six potential anomalies were further classified as two "remains observation" and four as "minor anomalies".

## 2.2 Postflight Seals Assessment Summary

The post-fire assessment of both motors showed the seals component to be in good condition. There was no evidence of hot gas or soot past the J-seal on the six field joints or past the polysulfide on the two nozzle-to-case joints. The LH igniter joints showed no hot gas or soot too the primary seals, while the RH igniter had a blow hole in the inner and outer putty lay ups. The cadmium plating was corroded on the O.D. edge of the RH inner gasket because the outer joint blow hole allowed hot combustion gases to come in contact with the gasket retainer. There was no soot to the aft exit cone primaries and there was no evidence of soot or hot gas past the primary seals on any of the internal nozzle joints. Intermittent aluminum oxidation ($Al_2O_3$) was found between the primary and secondary seals on both aft exit cones. Overall the grease application to all field and nozzle-to-case joints was nominal.

The Seals Component Post Fire Assessment Team has identified twelve observations, made during disassembly assessments, as "potential anomalies". The twelve potential anomalies were further classified as three "remains observation", and nine as "minor anomalies".

## 3.0 POSTFLIGHT ASSESSMENT OBJECTIVES

Post fire assessment objectives are addressed in Reference 2.

## 4.0 CASE/SEALS POSTFLIGHT ASSESSMENT RESULTS

Design Engineering performed post fire evaluations of Flight 360L009 forward, center, and aft field joints, aft exit cone field joints, nozzle-to-case joints, the igniter, and safe and arm joints at Hangar AF. The safe and arm internal joints, internal nozzles, and factory joints were disassembled and evaluated at the refurbishment facilities in Clearfield, Utah. This section documents the postflight condition of Flight 360L009 case hardware, sealing surfaces, and seals as noted during disassembly, and discusses all observations assessed by the respective Component Program Teams (CPT).

In an attempt to standardize and document the evaluation of flight motors, a standard evaluation plan has been written (see References 3, 4, 5, and 6). Appropriate procedures contained in this plan were used to evaluate the case and seals in the RSRM. The intent of this plan is to ensure that all pertinent evaluation points of

Flight 360L009 were examined and documented in a consistent and complete manner. Also, to accurately document the magnitude of the types of damage that are seen, postfire assessment definitions are as follows:

Postfire Assessment Definitions

Cut: Width, essentially zero (have 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 of 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 or Soft Inclusion: An air pocket enclosed in the seal material.

Extrusion Damage: Seal material pinched and/or cut due to an over fill 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: Starting to penetrate into the metal surface such that pitting and/or metal material is significantly eroded.

Light Fretting: Pits less than or equal too 0.003 inch deep.

Medium Fretting: Pits less than or equal too 0.005 inch deep but greater then 0.003 inch deep.

Heavy Fretting: Pits greater than 0.005 inch 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 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 the center and forward stiffener rings and the ETA ring at approximately 190 degrees and the K5NA was cracked on the center and aft rings at this same location.

### 4.1.2 Safe and Arm Joint

There was soot on the I.D. edge of the retainer but not on either face of the gasket. There was no signs of blow by past the primary seal. There was no corrosion or damage found to the joint or the seals at the time of disassembly.

#### 4.1.2.1 Safe and Arm Device Internal Joints

Assessment of the safe and arm device found raised metal on the primary seal surface and the lead-in thread of the 198 degree SII port. Circumferential galling was found on the land between the primary and secondary seal surfaces of both SII ports. Also, deformations of the sealing washer of both SII's were found. The leak test pressure path for the 18 degree SII port was blocked with grease. Copper particles were found in the grease on the high pressure side of the rotor shaft secondary O-rings, this contamination is introduced into the cavity between the primary and secondary O-rings during the leak test of the rotor shaft seals. A small nick was present in the rotor housing bore primary seal

surface, the nick is located approximately 0.120 inch into the bore.

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

No blow paths through the zinc chromate putty were present and there was no evidence of hot gas leakage past the primary seal or damage observed on the joint or gasket seals. A 0.005 inch diameter by 0.002 inch high raised area was found on the outboard primary seal cushion of the forward face at 173 degrees. The 115 degree Igniter Pressure Transducer (IPT) dual seal plug secondary O-ring (Figure 6) had an I.D. circumferential cut that was caused by excessive grease in the dove tail groove (Reference 7).

#### 4.1.3.1 Igniter/Case Hardware

No damage was found on the forward dome igniter boss, igniter adapter, igniter chamber. Two areas of medium corrosion were present in the igniter through hole at 285 and 324 degrees.

### 4.1.4 Inner Igniter Joint (Adapter-to-Chamber)

No blow paths through the zinc chromate putty were present and there was no evidence of hot gas leakage past the primary seal. The inner bolts were removed before the igniter was removed from the forward dome, this allowed the chamber to fall into the forward segment. When the chamber fell it pivoted about the 270 degree location and sheared metal of the aft face of the gasket retainer at this location. No damage observed on the gasket seals. Twenty two of the Packing with Retainers from the inner joint bolts were damaged during disassembly. There was soot on the tips and up to the primary seal on all special transducer bolts.

### 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 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 visible 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 43, 57, 62, 110 to 129, 172, 187, 207, 243, and 244 degrees. No medium

or heavy fretting was found. Figure 7 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 sealing surfaces. The joint was slightly contaminated with debris from hydrolaze 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 visible 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 intermittent light fretting from 10 to 300 degrees. Concentrations of medium and heavy fretting were found from 180 to 300 degrees. One 0.008 inch deep fret was located at 225 degrees. Figure 8 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-joint. The grease coverage was per design and no corrosion was found on any sealing surfaces. The joint was slightly contaminated with debris and water from hydrolaze 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 visible damage. No damage was observed on the three O-rings during detailed assessment.

#### 4.1.7.1 Aft Field Joint Case Hardware

Assessment of the metal components found light fretting around the entire circumference except between 9 to 46, and 56 to 116 degrees. Medium and heavy fretting was present from 135 through zero to nine degrees. Two heavy frets of 0.009 inch deep fret are located at 195 and 350 degrees. Also, a 0.011 inch deep fret was found at 278 degrees. Figure 9 gives a detailed view of the fretting. This joint, both clevis and tang had flown on RSRM-2 (STS-27), had been previously fretted and repaired. Fretting was found at the edges of repaired areas but not in any areas were metal was removed.

#### 4.1.7.2 ET Attach Stubs

No damage was found on the ET attach forward or aft stubs or bolt holes.

#### 4.1.7.3 Stiffener Rings

No damage was found on the forward stiffener ring.

The center stiffener ring had 12 bolts missing from 172 to 194 degrees when it was still installed on the motor. Post-removal assessment found the web buckled at 182 degrees, cracked at 196 degrees, and a deformed bolt hole at 180 degrees.

The aft stiffener ring had four missing bolts from 202 to 208 degrees, four missing between 212 and 218 degrees, seven missing between 182 and 194, and one each at 176 and 178 degrees when it was still installed on the motor. Post-removal assessment found the web cracked at 194 degrees, web buckled and missing material at 181 degrees, and a web buckle at 219 degrees.

#### 4.1.7.4 Stiffener Stubs

The forward stiffener stub, forward stiffener ring stub, and center stiffener ring stub were not damaged.

The aft stiffener ring stub showed deformed bolt holes from 174 to 180 degrees and from 190 to 202 degrees.

### 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 or the aft dome. No polysulfide extruded past the wiper O-ring. No radial bolt hole disassembly plugs were damaged during the disassembly process.

Detailed assessment of the O-rings found no damage to any of them. Detailed assessment of the Packing with Retainers found one with disassembly damage.

#### 4.1.8.1 Nozzle-to-Case Joint Hardware

The aft dome nozzle boss and the fixed housing showed no signs of metal damage or corrosion on the mating or sealing surfaces.

### 4.1.9 Aft Exit Cone Joint (Joint 1)

No pressure paths were found through the RTV, therefore no pressure or soot reached the primary O-ring. Light corrosion was found on the aft exit cone flange between 112 and 117 degrees on the O.D. of the flange. Medium corrosion was found on the I.D. of the flange between 26 and 49 degrees.

No damage to the primary or secondary O-rings were observed at the time of disassembly. Detailed assessment of the O-rings found no damage on the primary O-ring. The secondary had two nicked areas at 111 and 190 degrees. This damage was caused by the disassembly clips that keep the O-ring from falling out of the groove during joint separation.

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

Scalloped shaped sooting 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. Typical light sooting was observed up to the primary O-ring at 24 through 36, 72 through 78, 96 through 114, 186 through 192, 204 through 246, 276 through 282, 288 through 318, and 330 through 336 degrees. No soot or evidence of blowby was observed past the primary O-ring. Typical light corrosion was observed on both mating surfaces. No damage to the primary or secondary O-rings was found during detailed assessment and the sealing surfaces suffered no assembly or disassembly damage. No port plug, O-ring, or port hole damage was observed. The port hole had nominal grease coverage.

### 4.1.11 Nose Inlet Housing-To-Throat Support Housing (Joint 3)

No pressure paths through the RTV were observed. No damage was found on the primary O-ring, the secondary O-ring, or sealing surfaces during the initial assessment. No corrosion was observed on the mating surfaces. No damage to the primary or secondary O-rings was found during detailed assessment. No port plug, O-ring, or port hole damage was observed. The port hole had nominal grease coverage.

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

Assessment of the joint revealed no pressure paths through the RTV backfill. The primary O-ring had a gouged area at 175 degrees, which measured 0.190 in. long by 0.140 in. wide by 0.010 in. deep. This gouge was caused during disassembly of the joint. The secondary O-ring was not damaged, and the sealing surfaces suffered no assembly/disassembly damage. No corrosion was found on the joint sealing surfaces. No port plug, O-ring, or port hole damage was observed.

### 4.1.13 Fixed Housing-To-Aft End Ring (Joint 5)

Detailed assessment revealed no anomalies to the joint. No damage was found during assessment of the primary or secondary O-rings, assessment of the sealing surface revealed no signs of damage. There was typical intermittent light corrosion of the I.D. lip of

the aft end ring. No port plug, O-ring, or port hole damage was observed. All Packing with Retainers had typical disassembly damage.

### 4.1.14 Factory Joints

#### 4.1.14.1 Forward Dome-to-Cylinder Factory Joint

No heavy corrosion was observed. Fretting was observed intermittently over the entire circumference of the joint. No M-clip fretting was observed. No O-ring damage was observed. No port plug, O-ring, or port hole damage was observed. The port hole had grease in it from assembly.

#### 4.1.14.2 Forward Cylinder-to-Cylinder Factory Joint

Heavy corrosion was observed intermittently the entire circumference of the joint. No joint fretting was observed. M-clip fretting was observed intermittently the entire O.D. of the tang. No O-ring damage was observed. No port plug, O-ring, or port hole damage was observed. The port hole had grease in it from assembly.

#### 4.1.14.3 Center Forward Cylinder-to-Cylinder Factory Joint

No heavy corrosion was observed. Fretting was observed at 1 and at 210 degrees. No M-clip fretting was observed. No O-ring damage was observed. No port plug, O-ring, or port hole damage was observed. The port hole had grease in it from assembly.

#### 4.1.14.4 Center Aft Cylinder-to-Cylinder Factory Joint

Medium to heavy corrosion was observed downstream of the tang sealing surface at 191 intermittently through 231, 322, 326 through 337, and 345 through 0 through 45 degrees. Heavy corrosion was also observed on the tang inside chamfer at 36 intermittently through 79 degrees and on the outside chamfer at 8 and 14 degrees. No joint fretting was observed. M-clip fretting was observed intermittently the entire circumference of the outer tang surface. No O-ring damage was observed. No port plug, O-ring, or port hole damage was observed.

#### 4.1.14.5 ET-to-Stiffener Factory Joint.

Heavy corrosion was observed intermittently on the tang O.D. and on the inner surface of the outer clevis leg the entire circumference of the joint. Fretting was observed at 82, 130, 138, and at 150 degrees. M-clip fretting was observed at 162, 166, 168, 198, 232, 238, 244, 258, 302, 310, 312, 246, and 250 degrees. No O-ring damage was observed. No port plug, O-ring, or port hole

damage was observed. Nominal grease coverage was observed in the port plug hole.

#### 4.1.14.6 Stiffener-to-Stiffener Factory Joint.

Heavy corrosion was observed intermittently on the tang O.D. and on the inner surface of the outer clevis leg the entire circumference of the joint. Fretting was observed at 6, 222, 244, 346, 348, and 358 degrees. M-clip fretting was observed at 174 and 208 degrees. No O-ring damage was observed. No port plug, O-ring, or port hole damage was observed. Nominal grease coverage was observed in the port plug hole.

#### 4.1.14.7 Aft Dome-to-Stiffener Factory Joint.

Heavy corrosion was observed at 168 through 170 degrees on the tang sealing surface. Fretting was observed at 14, 190, 194, 224, 230, 234, 238, 250, 254, 282, and 294 degrees. M-clip fretting was observed intermittently the entire circumference of the tang O.D. No O-ring damage was observed. No port plug, O-ring, or port hole damage was observed.

### 4.1.15 Miscellaneous Hardware

Corrosion pits were being found on case segments at GEI spot bond locations because of galvanic action between the silver-filled epoxy (Ecobond 56C) and the D6AC. All GEI was removed at Hanger AF, light surface corrosion was found on all the spot bond locations due to removal operations.

## 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 all three stiffener rings and on the ETA rings at approximately 190 degrees and the K5NA was cracked on the forward, center, and aft rings at this same location.

### 4.2.2 Safe and Arm Joint (Adapter-to-Barrier Booster)

There was soot on the I.D. edge of the retainer but not on either face of the gasket. There were no signs of blow by past the primary seal. A rework area was found on the inner side of the forward face primary seal at 207 degrees. The environmental seal was torn at 100 and 288 degrees on the forward face of the gasket. There was no corrosion or damage found to the joint or the seals at the time of disassembly.

#### 4.2.2.1 Safe and Arm Device Internal Joints

Assessment of the safe and arm device found deformations of the sealing washer of the 18 degree SII. A radial scratch across seal washer of the 18 degree SII was also found. Raised metal was present on the primary seal surface and the lead-in thread of the 198 degree SII port. Circumferential galling was found on the land between the primary and secondary seal surfaces of both SII ports. A closed radial flow line was found on the I.D. of the B-B leak test port plug O-ring. Circumferential galling was found on the seal surface of the Barrier Booster (B-B) and S&A leak check port plugs. Also, three deformations were present on the underside of the S&A leak check port plug, the largest deformation extended into the O-ring footprint.

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

A blow hole through the zinc chromate putty was present at 175 degrees. Soot was found on the I.D. edge of the retainer from 18 to 342 degrees . No anomalies were found on the primary or secondary seals of the gasket.

#### 4.2.3.1 Igniter/Case Hardware

Heavy corrosion was found on the I.D. edge of the igniter through hole and igniter chamber at 175 degrees, the corrosion pit in the through hole measured 0.001 to 0.002 inch deep. No other damage was found on the igniter adapter, igniter chamber or the igniter through hole.

### 4.2.4 Inner Igniter Joint (Adapter-to-Chamber)

A blow hole through the zinc chromate putty was found at 90 degrees, soot was present on the I.D. edge from 88 to 96 degrees. The outer joint blow hole allowed combustion products to come in-contact with the O.D. edge of the inner gasket. The combustion products corroded the cadmium plating off the retainer at the 175 degree location, dimensions are 1.5 inches circumferential by 0.15 inch radial (see Reference 8, Appendix A). Soot was found on the O.D. edge of the retainer from 60 to 340 degrees. No seal damage was found on either primary or secondary seals. Eleven Packing with Retainers from the inner joint bolts were damaged during disassembly. All the transducer bolts had soot up to the primary O-ring.

### 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

from the hydrolaze operations which removed the joint protection system.

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

#### 4.2.5.1 Forward Field Joint Case Hardware

Assessment of the metal components found light fretting at 44 and 45 degrees and a 0.004 inch deep fret at 180 degrees. Figure 10 gives a detailed view of the fretting.

### 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 except for as noted below. The joint was slightly contaminated with debris from the hydrolaze operations which removed the joint protection system.

No seal damage was observed at the time of disassembly and the V-2 filler was properly installed with no visible 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 light fretting from 156 to 187, 256 to 280, 298 to 315, and 338 through 0 to 1 degrees. Moderate (0.003 to 0.005 inch deep) fretting at 118, 305, and 340 degrees. A 0.009 inch fret was found at 350 degrees. Figure 11 gives a detailed view of the fretting. Also, medium corrosion was present on the O.D. of the clevis from 86 to 92 degrees.

### 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 from the hydrolaze operations which removed the joint protection system.

No seal damage was observed at the time of disassembly and the V-2 filler was properly installed with no visible 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 30, 35, 42, and 55 degrees. Figure 12 gives a detailed view of the fretting.

#### 4.2.7.2 External Attach Stubs

No damage was found on the ET attach forward or aft stubs or bolt holes.

#### 4.2.7.3 Stiffener Rings

No damage was found on the forward stiffener ring.

The center stiffener ring had 25 bolts missing from 160 to 208 degrees when it was still installed on the motor. Post-removal assessment found the web cracked between 178 and 188 degrees at the web to flange interface. The web was buckled at 159 degrees.

The aft stiffener ring had nine bolts missing from 162 to 178 degrees and 10 missing from 190 to 208 degrees when it was still installed on the motor. Post-removal assessment found the web cracked at 180 and 188 degrees. The web was buckled at 162 and 208 degrees and there were numerous deformed holes between 188 and 204 degrees.

#### 4.2.7.4 Stiffener Stubs

The forward stiffener stub, forward stiffener ring stub, and aft stiffener ring stub were not damaged.

The center stiffener ring stub had an outer ligament crack at 210 degrees.

### 4.2.8 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 or the aft dome. No polysulfide extruded past the wiper O-ring. No radial bolt hole disassembly plugs were damaged during the disassembly process.

Detailed assessment of the O-rings and Packing with Retainers found no damage.

#### 4.2.8.1 Nozzle-to-Case Joint Hardware

The aft dome nozzle boss and the fixed housing showed no signs of metal damage or corrosion on the mating or sealing surfaces.

### 4.2.9 Aft Exit Cone Joint (Joint 1)

No pressure paths were found through the RTV, therefore no pressure or soot reached the primary O-ring. Light corrosion was found on the I.D. of the flange from 135 to 153 degrees and medium corrosion from 97 to 130, and 265 to 300 degrees.

No damage was found on the O-ring during detailed assessment.

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

Scalloped shaped sooting 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. No soot appeared to have reached the primary O-ring. Typical light corrosion was observed on both mating surfaces. No damage was observed to the primary O-ring, the secondary O-ring, or sealing surfaces. No port plug, O-ring, or port hole damage was observed. The port hole had nominal grease coverage.

### 4.2.11 Nose Inlet Housing-To-Throat Support Housing (Joint 3)

Detailed assessment revealed no anomalies to the joint. No damage was found during assessment of the primary or secondary O-rings, and the sealing surfaces had no signs of damage. No corrosion was observed on the mating surfaces. No port plug, O-ring, or port hole damage was observed. The port hole had nominal grease coverage.

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

No pressure paths were observed through the RTV backfill. No damage to the primary O-ring, the secondary O-ring, or sealing surfaces were observed. No corrosion was found on any of the joint sealing surfaces. Dark colored grease on the area between the primary and secondary O-ring grooves was observed at 90 through 95, 105 through 115, and 195 through 200 degrees. No port plug, O-ring, or port hole damage was observed.

### 4.2.13 Housing-To-Aft End Ring (Joint 5)

Detailed assessment revealed no anomalies to the joint. No damage was found during assessment of the primary or secondary O-rings, and the sealing surface revealed no signs of damage. There was intermittent very light corrosion of the I.D. lip of the aft end ring. No port plug, O-ring, or port hole damage was observed. All Packing with Retainers had typical disassembly damage.

### 4.2.14 Factory Joints

#### 4.2.14.1 Forward Dome-to-Cylinder Factory Joint.

Heavy corrosion was observed in the primary O-ring groove at 222 through 230, and 272 through 292 degrees and the secondary O-ring groove at 12 through 18, 238 through 264, 268 through 272, and 294 through 326 degrees. Heavy corrosion was observed on the tang sealing surface at 224 and 314 degrees. No joint fretting or M-clip fretting was observed. Water knife damage was observed on the primary O-ring but this is an expected condition. No damage to the secondary O-ring was observed. No port plug, O-ring, or port hole damage was observed.

#### 4.2.14.2 Forward Cylinder-to-Cylinder Factory Joint.

No heavy corrosion was observed. Joint fretting was observed at 174, 241, 243, 273.5 through 285, 336 and 340 degrees. M-clip fretting was observed at 236 and at 238 degrees on the outer tang surface. No O-ring damage was observed. No port plug, O-ring, or port hole damage was observed. The port hole had nominal grease coverage.

#### 4.2.14.3 Center Forward Cylinder-to-Cylinder Factory Joint.

No heavy corrosion was observed. No joint fretting or M-clip fretting was observed. No O-ring damage was observed. No port plug, O-ring, or port hole damage was observed.

#### 4.2.14.4 Center Aft Cylinder-to-Cylinder Factory Joint.

No heavy corrosion was observed. No joint fretting or M-clip fretting was observed. No O-ring damage was observed. No port plug, O-ring, or port hole damage was observed. The port hole did not have grease in it.

#### 4.2.14.5 ET-to-Stiffener Factory Joint.

No corrosion was observed in the joint. Fretting was observed at 12, 18, 22, 26, 34, 46, 50, 52, 54, 116, 178, 186, 192, 198, 202, 226, 234, 242, 246, 258, 316, 336, 338, and 344 degrees. M-clip fretting was observed at 2, 26, 38, 294, 296, and 358 degrees. No O-ring damage was observed. No port plug, O-ring, or port hole damage was observed. Nominal grease coverage was observed in the port hole.

#### 4.2.14.6 Stiffener-to-Stiffener Factory Joint.

No corrosion was observed in the joint. Fretting was observed intermittently from 162 through 0 through 30 degrees. M-clip

fretting was observed intermittently the entire circumference of the outer tang surface. No O-ring damage was observed. No port plug, O-ring, or port hole damage was observed. Nominal grease coverage was observed in the port hole.

#### 4.2.14.7 Aft Dome-to-Stiffener Factory Joint.

No corrosion was observed in the joint. No fretting was observed in the joint. M-clip fretting was observed intermittently the entire circumference of the outer tang surface. No O-ring damage was observed. No port plug, O-ring, or port hole damage was observed. Nominal grease coverage was observed in the port hole.

### 4.2.15 Miscellaneous Hardware

Corrosion pits were being found on case segments at GEI spot bond locations because of galvanic action between the silver-filled epoxy (Ecobond 56C) and the D6AC. All GEI was removed at Hanger AF, light surface corrosion was found on all the spot bond locations due to removal operations.

## 4.3 Leak Check and Vent Port Plug Post Flight Evaluations

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

The port plugs had breakaway torques recorded. This exercise was done to add to the port plug torque database so evaluation of installation torque levels and locking devices can be made on each port plug.

A summary of the postflight evaluations of the port plugs and port plug O-rings is contained in Table 3. Port plugs in the igniters, field joints, and nozzle-to-case joints were removed and assessed during the disassembly operations at KSC. Port plugs in the internal nozzle joints and factory joints were removed and assessed at Clearfield. Closure screws were removed from the vent port plugs at KSC and assessed there.

During the assessment at KSC several observations were reported which were O.D. extrusion damage to the adjustable vent port plug primary O-ring and I.D. 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 I.D. 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. The only other condition observed was the separation on the I.D. mold line of the IPT secondary O-ring which is addressed in section 5.2.

## 5.0 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 eighteen observations were potential anomalies, classified as critical, major, minor or remains observation, as defined under Table 5 criteria. The Post Fire Anomaly Record (PFAR) number is referenced after each potential anomaly.

## 5.1 Remains Observation

There were four potential anomalies that were classified as "remains observation", they are:

1. Sheared metal on inner gasket retainer (360L009A-05)

2. Deformations on underside of S & A leak check port plug (360L009A-20)

3. Outer ligament crack on center stiffener stub (360L009B-02)

4. Pitting on forward dome boss (360L009B-04)

## 5.2 Minor Anomalies

Fourteen potential anomalies were classified as "minor anomalies", they are:

1. Missing cadmium plating on igniter gasket retainer (360L009B-07)

2. I.D. circumferential cut on the secondary O-ring of the IPT plug (360L009A-09)

3. Field joint fretting (360L009A-08, 360L009B-06)

4. Factory joint fretting (360L009 , 360L009

5. Deformations in the sealing washer of the SII's (360L009A-11, 360L009B-12)

6. Copper particles in Barrier Booster rotor shaft grease (360L009A-13)

7. Radial scratch across the sealing washer of the SII (360L009B-14)

8. Galling on shoulder seal surface of MS9902-01 leak test port plug (360L009B-15)

9. SII leak test port through-hole filled with grease (360L009A-16)

10. Raised metal on shoulder seal surface of SII port (360L009B-18)

11. Nick on primary sealing surface of Barrier Booster bore (360L009A-20)

### 5.3 Major Anomalies

There were no major anomalies

### 5.4 Critical Anomalies

There were no critical anomalies

## 6.0 REFERENCES

1. J. Durtschi, TWR-17436, "KSC Ten-Day Postflight Hardware Evaluation Report 360L009 (RSRM-9, STS-36)", Thiokol Corporation, pg. 14, 16 March 1990.

2. D. M. Garecht, TWR-17548, Vol. I, "Flight Motor Set 360L009 (STS-36R) Final Report", Thiokol Corporation, September 1990.

3. W. D. Starrett, TWR-50050, Vol. II, Rev. B, "KSC Postflight Engineering Evaluation Plan (Case, Seals, and Joints)", Thiokol Corporation, December 1989.

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).

5. R. L. Hyer, TWR-60162, Rev. A, "Postflight Hardware Special Issues (STS-36) Clearfield", Thiokol Corporation, 1 May 1990.

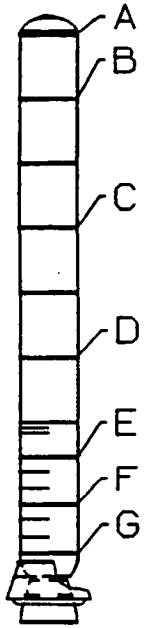
6. R. L. Hyer, TWR-60161, "Postflight Hardware Special Issues (STS-36) KSC", 20 February 1990.

7. D. S. Gurney, TWR-60300, "RSRM-9A IPT Plug Secondary O-ring Anomaly Investigation Test Results", Thiokol Corporation, March 1990.

8. A. K. Bhambri, Interoffice Memo 2421-FY90-M079, "Trip Report of STS-36 Igniter Chamber/Dome Joint Pitting Investigation on 8 & 9 March at KSC", Thiokol Corporation, 14 March 1990.

# TABLE I

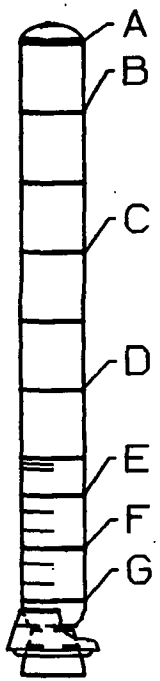
## RSRM-9 FACTORY JOINT CORROSION SUMMARY




| JOINT | A | B |
|---|---|---|
| A | OUTER CLEVIS LEG: NONE<br>INSIDE JOINT: NONE | OUTER CLEVIS LEG: NONE<br>INSIDE JOINT: LOCALLY HEAVY |
| B | OUTER CLEVIS LEG: NONE<br>INSIDE JOINT: HEAVY | OUTER CLEVIS LEG: NONE<br>INSIDE JOINT: NONE |
| C | OUTER CLEVIS LEG: NONE<br>INSIDE JOINT: NONE | OUTER CLEVIS LEG: NONE<br>INSIDE JOINT: NONE |
| D | OUTER CLEVIS LEG: NONE<br>INSIDE JOINT: LOCALLY HEAVY | OUTER CLEVIS LEG: NONE<br>INSIDE JOINT: NONE |
| E | OUTER CLEVIS LEG: NONE<br>INSIDE JOINT: HEAVY | OUTER CLEVIS LEG: NONE<br>INSIDE JOINT: NONE |
| F | OUTER CLEVIS LEG: NONE<br>INSIDE JOINT: HEAVY | OUTER CLEVIS LEG: NONE<br>INSIDE JOINT: NONE |
| G | OUTER CLEVIS LEG: NONE<br>INSIDE JOINT: LOCALLY HEAVY | OUTER CLEVIS LEG: NONE<br>INSIDE JOINT: NONE |

# TABLE 2

## RSRM-9 FACTORY JOINT AND M-CLIP FRETTING SUMMARY




| JOINT | A | B |
|---|---|---|
| A | JOINT: INTERMITTENT<br>M-CLIP: NONE | JOINT: NONE<br>M-CLIP: NONE |
| B | JOINT: NONE<br>M-CLIP: INTERMITTENT | JOINT: LOCAL<br>M-CLIP: LOCAL |
| C | JOINT: LOCAL<br>M-CLIP: NONE | JOINT: NONE<br>M-CLIP: NONE |
| D | JOINT: NONE<br>M-CLIP: INTERMITTENT | JOINT: NONE<br>M-CLIP: NONE |
| E | JOINT: LOCAL<br>M-CLIP: LOCAL | JOINT: LOCAL<br>M-CLIP: LOCAL |
| F | JOINT: LOCAL<br>M-CLIP: LOCAL | JOINT: INTERMITTENT<br>M-CLIP: INTERMITTENT |
| G | JOINT: LOCAL<br>M-CLIP: INTERMITTENT | JOINT: NONE<br>M-CLIP: INTERMITTENT |

TABLE 3
360L009 LEAK CHECK AND VENT PORT
PLUG POST FLIGHT ASSESSMENT RESULTS

| JOINT LOCATION | PART ASSESSED | LEFT HAND (9A) RESULTS | RIGHT HAND (9B) RESULTS |
|---|---|---|---|
| Forward Field | Adjust. Vent Port Plug | No Damage | No Damage |
| | Primary O-ring | O.D. Extrusion Damage | O.D. Extrusion Damage |
| | Secondary O-ring | No Damage | No Damage |
| | Closure Plug | No Damage | No Damage |
| | O-ring | No Damage | No Damage |
| | Leak Check Plug | No Damage | No Damage |
| | O-ring | No Damage | I.D. Circum-ferential Cut |
| Center Field | Adjust. Vent Port Plug | Medium Condition on spotface outboard of seal surface | No Damage |
| | Primary O-ring | O.D. Extrusion Damage | O.D. Extrusion Damage |
| | Secondary O-ring | No Damage | No Damage |
| | Closure Plug | No Damage | No Damage |
| | O-ring | No Damage | No Damage |
| | Leak Check Plug | No Damage | No Damage |

TABLE 3 (cont.)

| | | | |
|---|---|---|---|
| | O-ring | No Damage | No Damage |
| Aft Field | Adjust. Vent Port Plug | No Damage | No Damage |
| | Primary O-ring | O.D. Extrusion Damage | No Damage |
| | Secondary O-ring | No Damage | No Damage |
| | Closure Plug | No Damage | No Damage |
| | O-ring | No Damage | No Damage |
| | Leak Check Plug | No Damage | No Damage |
| | O-ring | No Damage | No Damage |
| Nozzle-to-Case | Adjust. Vent Port Plug | No Damage | No Damage |
| | Primary O-ring | O.D. Extrusion Damage | O.D. Extrusion Damage |
| | Secondary O-ring | No Damage | No Damage |
| | Closure Plug | No Damage | No Damage |
| | O-ring | No Damage | No Damage |
| | Leak Check Plug | No Damage | No Damage |
| | O-ring | I.D. Circum-ferential Cut | No Damage |
| Internal Nozzle Joints | | | |
| No. 1 | Leak Check Plug | No Damage | No Damage |

TABLE 3 (cont.)

| | | | |
|---|---|---|---|
| | O-ring | No Damage | No Damage |
| No. 2 | Leak Check Plug | No Damage | No Damage |
| | O-ring | No Damage | No Damage |
| No. 3 | Leak Check Plug | No Damage | No Damage |
| | O-ring | No Damage | No Damage |
| No. 4 | Leak Check Plug | No Damage | No Damage |
| | O-ring | No Damage | No Damage |
| No. 5 | Leak Check Plug | No Damage | Small spot of medium corrosion on spot face outside of plug mating surface |
| | O-ring | No Damage | No Damage |
| Factory Joints | | | |
| Forward Dome | Leak Check Plug | No Damage | No Damage |
| | O-ring | No Damage | No Damage |
| Forward Segment | Leak Check Plug | No Damage | No Damage |
| | O-ring | No Damage | No Damage |
| Forward Center Segment | Leak Check Plug | No Damage | No Damage |
| | O-ring | No Damage | No Damage |

TABLE 3 (cont.)

| | | | |
|---|---|---|---|
| Aft Center Segment | Leak Check Plug | Disassembly Damage on plug head | No Damage |
| | O-ring | No Damage | No Damage |
| Attach-to-Stiffener | Leak Check Plug | No Damage | No Damage |
| | O-ring | No Damage | No Damage |
| Stiffener-to-Stiffener | Leak Check Plug | No Damage | No Damage |
| | O-ring | No Damage | No Damage |
| Aft Dome | Leak Check Plug | No Damage | No Damage |
| | O-ring | No Damage | No Damage |
| Igniter | | | |
| IPT | Transducer Primary O-ring | No Damage | No Damage |
| | Secondary O-ring | Separation on I.D. mold line | No Damage |
| Outer Joint | Leak Check Plug | No Damage | No Damage |
| | O-ring | I.D. Circum-ferential Cut | I.D. Circum-ferential Cut |
| Inner Joint | Leak Check Plug | No Damage | No Damage |
| | O-ring | I.D. Circum-ferential Cut | No Damage |

TABLE 3 (cont.)

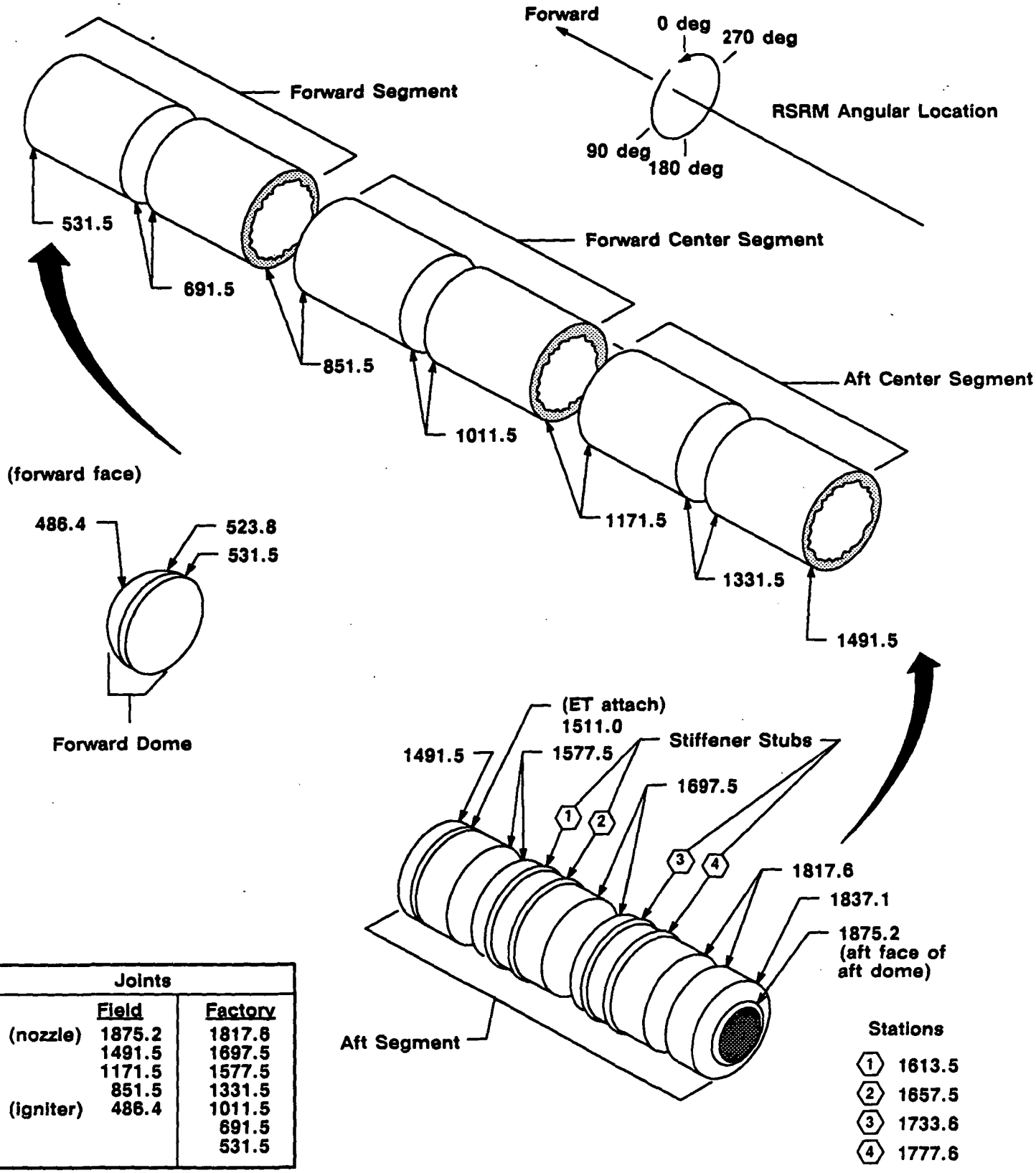
| | | | |
|---|---|---|---|
| Transducer (40 Deg.) | Primary O-ring | No Damage | No Damage |
| | Secondary O-ring | No Damage | No Damage |
| Transducer (100 Deg.) | Primary O-ring | No Damage | No Damage |
| | Secondary O-ring | No Damage | No Damage |
| Transducer (180 Deg.) | Primary O-ring | No Damage | No Damage |
| | Secondary O-ring | No Damage | No Damage |
| Transducer (270 Deg.) | Primary O-ring | No Damage | No Damage |
| | Secondary O-ring | No Damage | No Damage |
| Special Bolt (40 Deg.) | Primary O-ring | No Damage | No Damage |
| | Packing with Retainer | No Damage | No Damage |
| Special Bolt (100 Deg.) | Primary O-ring | No Damage | No Damage |
| | Packing with Retainer | No Damage | No Damage |
| Special Bolt (180 Deg.) | Primary O-ring | No Damage | No Damage |

TABLE 3 (cont.)

| | | | |
|---|---|---|---|
| | Packing with Retainer | No Damage | No Damage |
| Special Bolt (270 Deg.) | Primary O-ring | No Damage | No Damage |
| | Packing with Retainer | No Damage | No Damage |

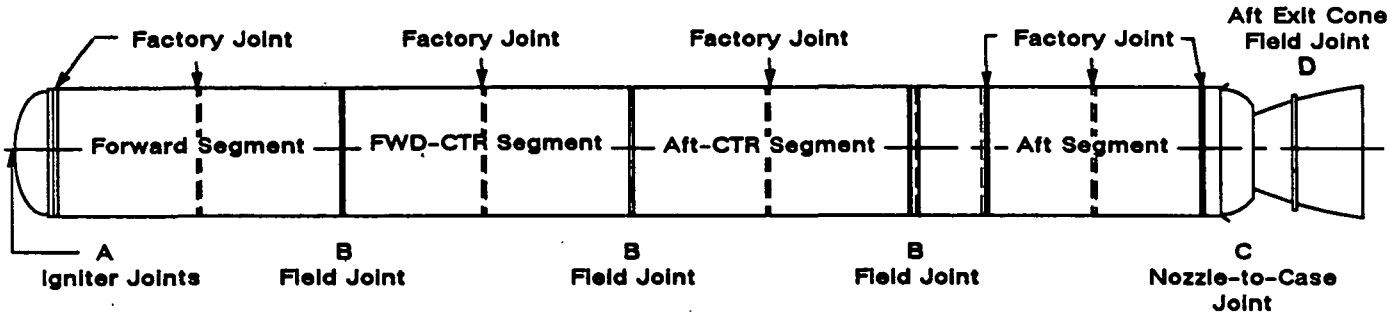
TABLE 4
CRITERIA FOR CLASSIFYING "POTENTIAL ANOMALIES"

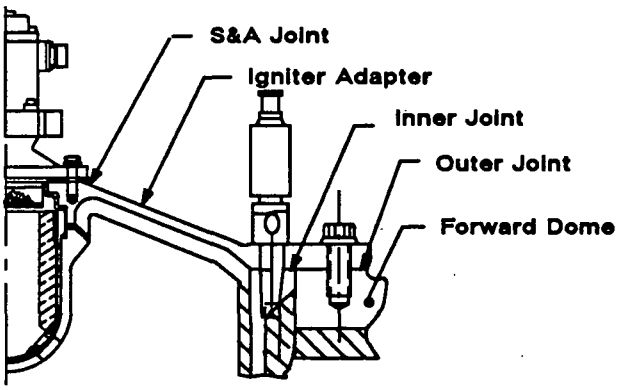
| Remains Observation | Anomaly | | |
|---|---|---|---|
| | Minor | Major | Critical |
| Requires no Specific Action | Requires corrective action, but has no impact on:<br><br>- Motor Performance<br>- Program Schedule<br><br>Does not reduce usability of part for its intended function<br><br>Could cause damage preventing reuse of hardware in combination with other anomaly<br><br>Significant departure from the historical database | Could cause failure in combination w/ other anomaly<br><br>Could cause damage preventing reuse of hardware<br><br>Program acceptance of cause, corrective action, and risk assessment required before subsequent static test or flight | Violates CEI Spec. requirements<br><br>Could cause failure and possible loss of mission/life<br><br>Mandatory resolution before subsequent static test/flight |
| Note: These criteria to be applied to the specific observed "potential anomaly" as it relates to the observed article and as it relates to subsequent articles. | | | |



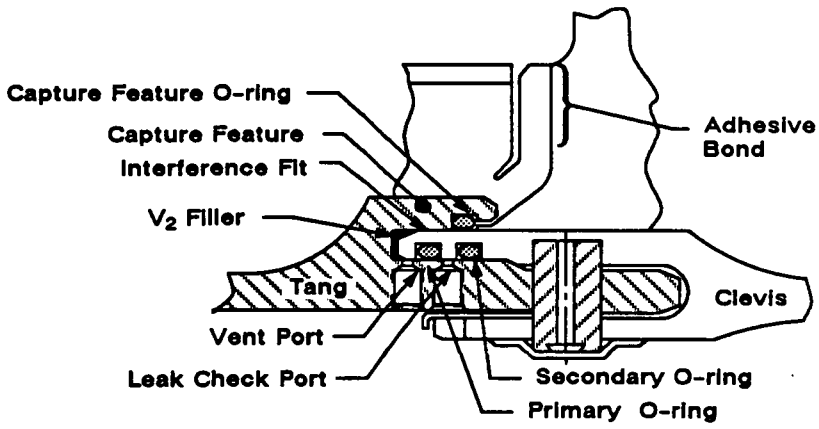

| Joints | | |
|---|---|---|
| | Field | Factory |
| (nozzle) | 1875.2 | 1817.6 |
| | 1491.5 | 1697.5 |
| | 1171.5 | 1577.5 |
| | 851.5 | 1331.5 |
| (igniter) | 486.4 | 1011.5 |
| | | 691.5 |
| | | 531.5 |

Figure 1 RSRM Case Segments and Relationships

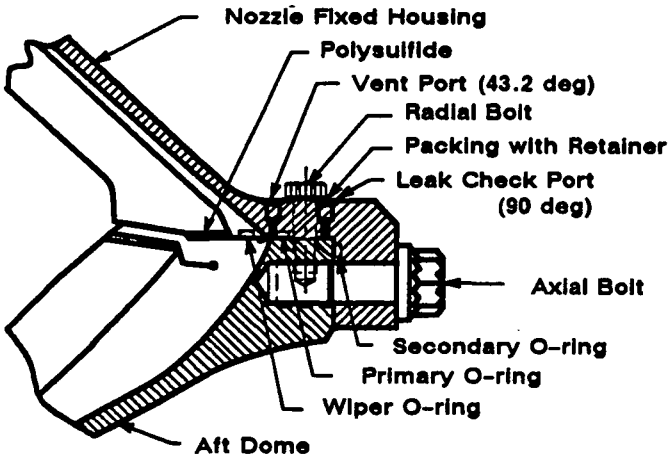


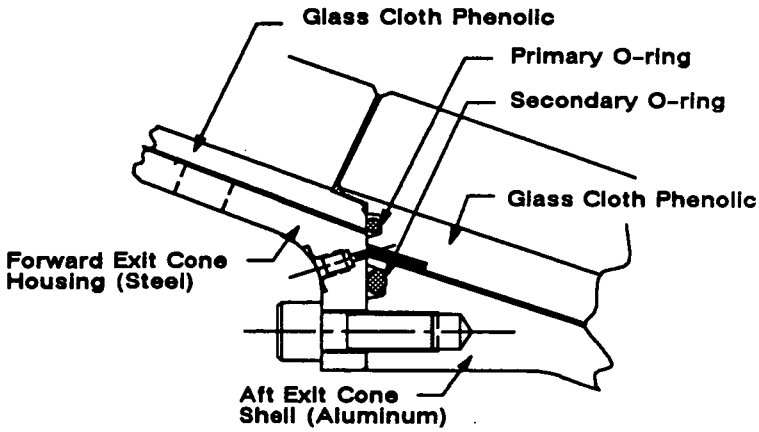

IGNITER JOINTS
(VIEW A)




CASE FIELD JOINT
(VIEW B)




NOZZLE-TO-CASE JOINT
(VIEW C)




FORWARD EXIT CONE-TO-AFT
EXIT CONE JOINT (VIEW D)

**Figure 2. RSRM Joint Configuration**

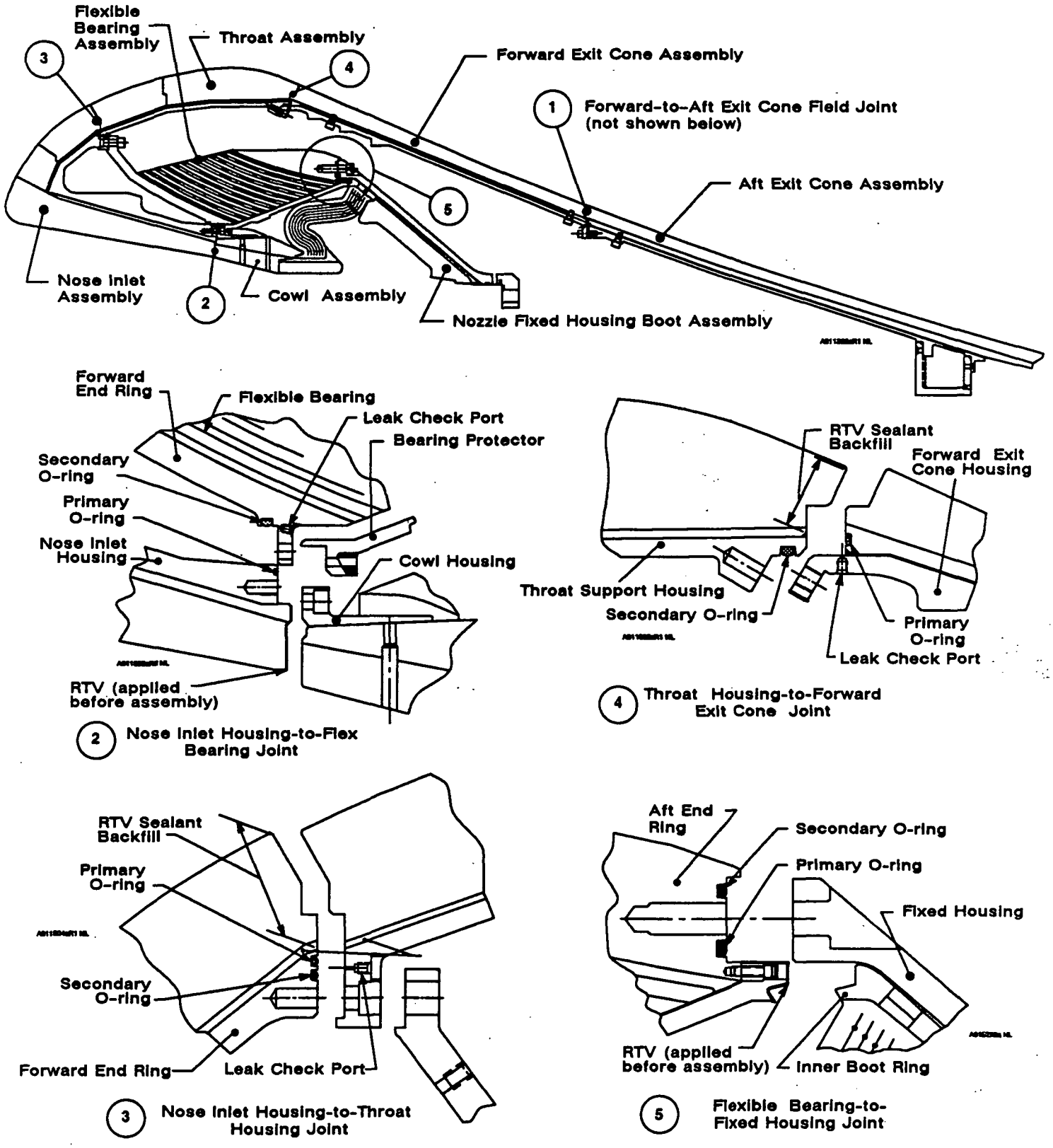



**Figure 3. RSRM Nozzle Internal Joints**

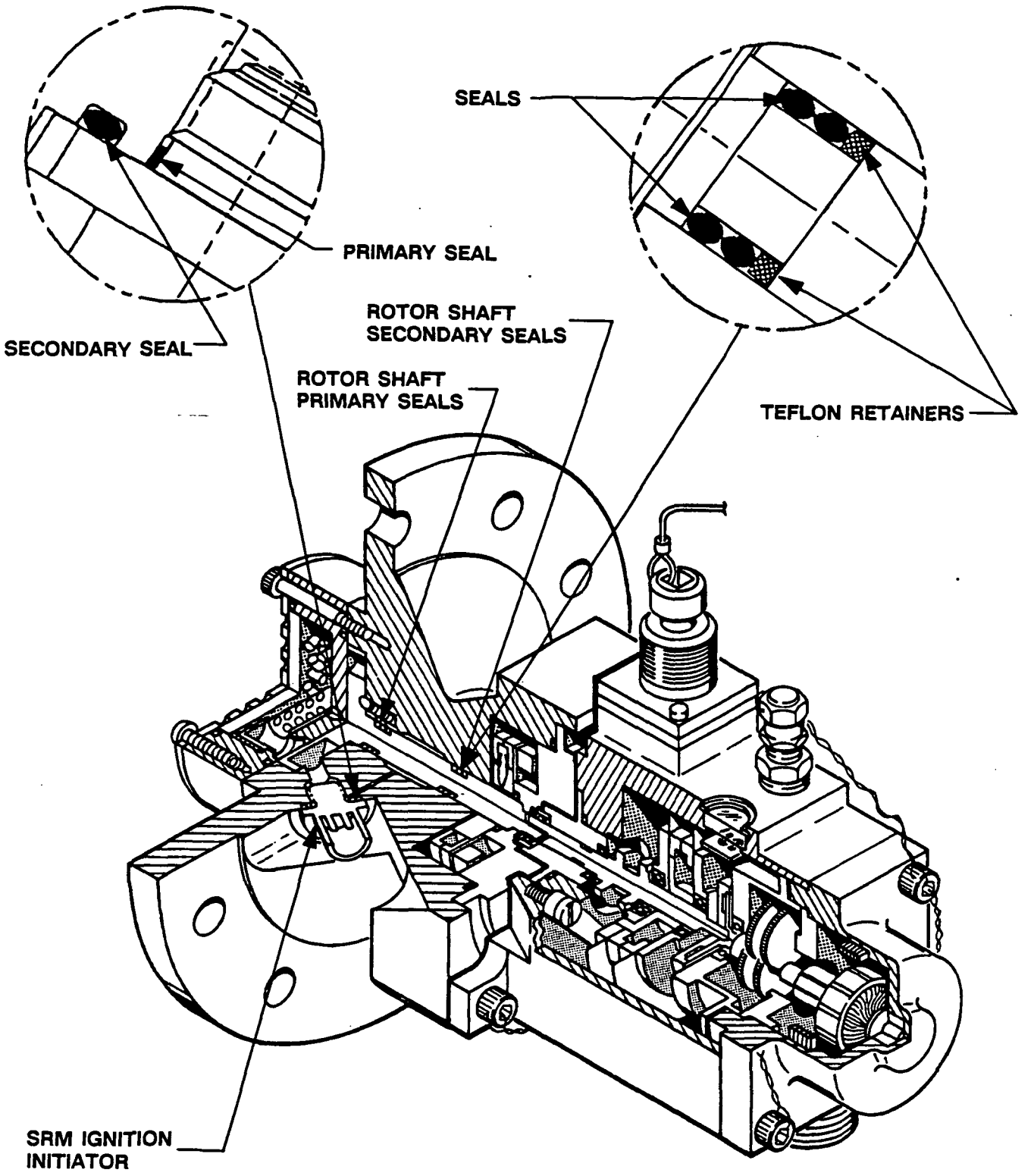



**Figure 4. Safe and Arm Device Seals**

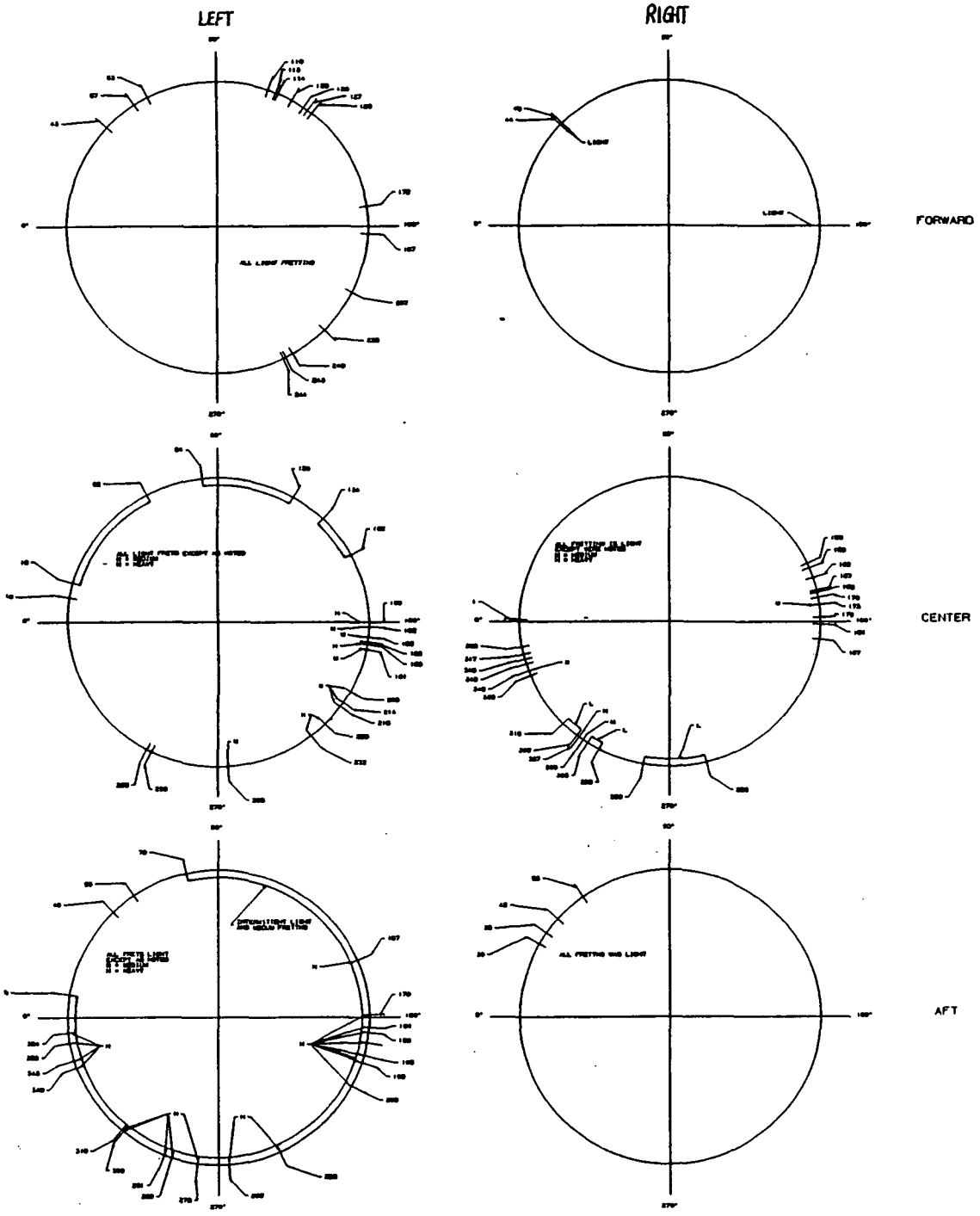
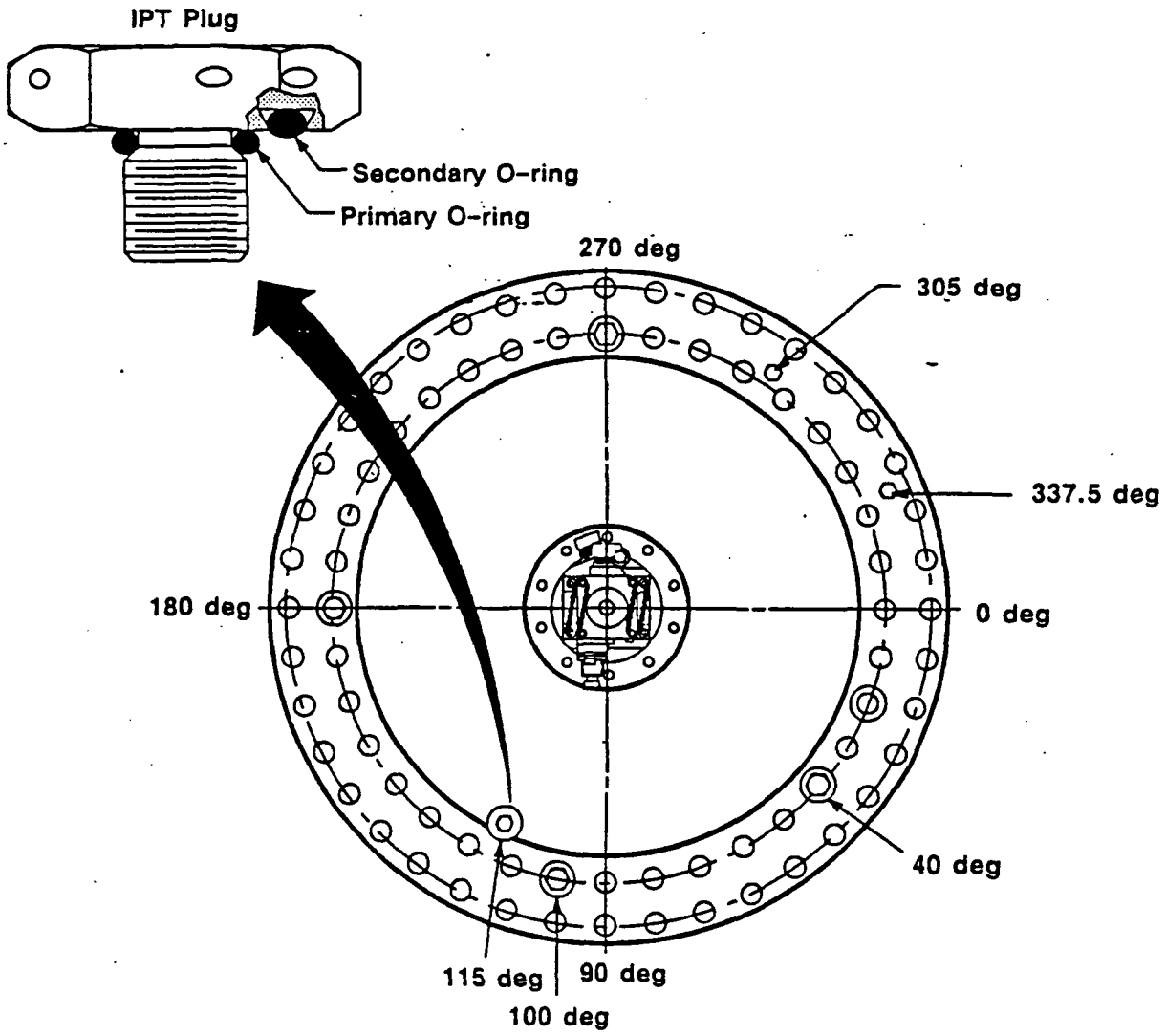



Figure 5 Field Joint Fretting Summary




Igniter Adapter (top view)

Figure 6 Igniter TPT Plug

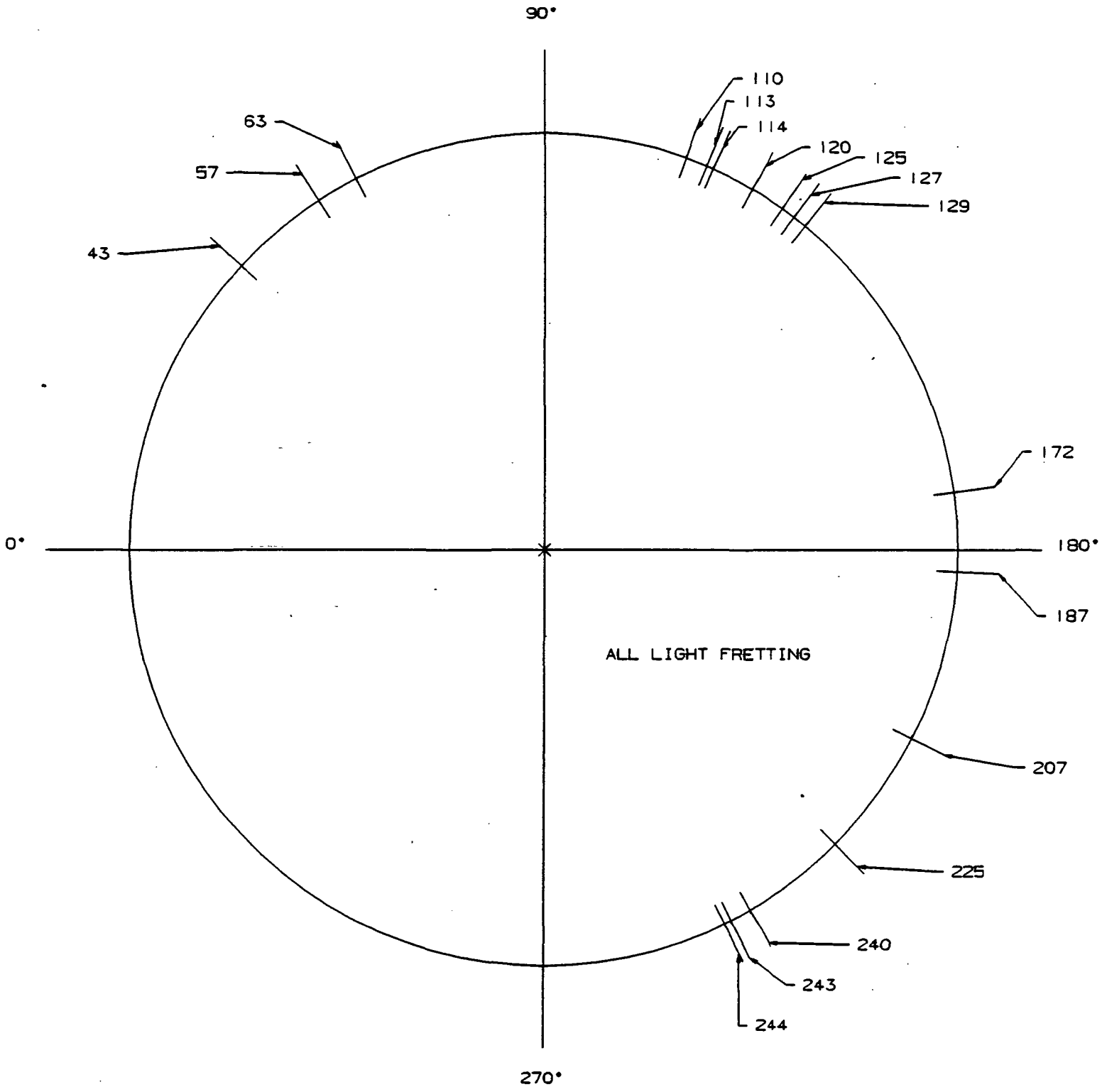



Figure 7 LH Forward Field Joint Fretting

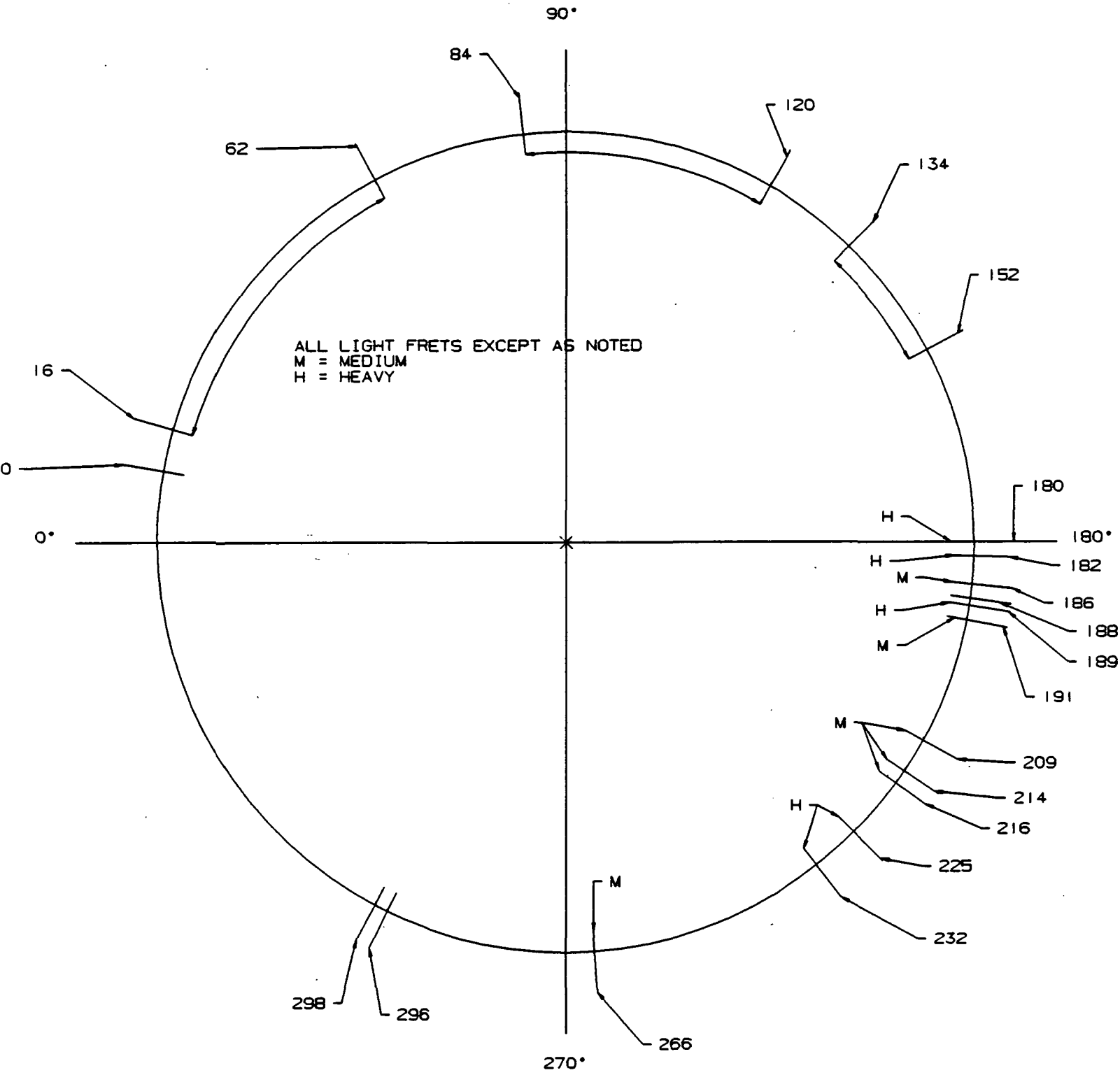



Figure 8 LH Center Field Joint Fretting

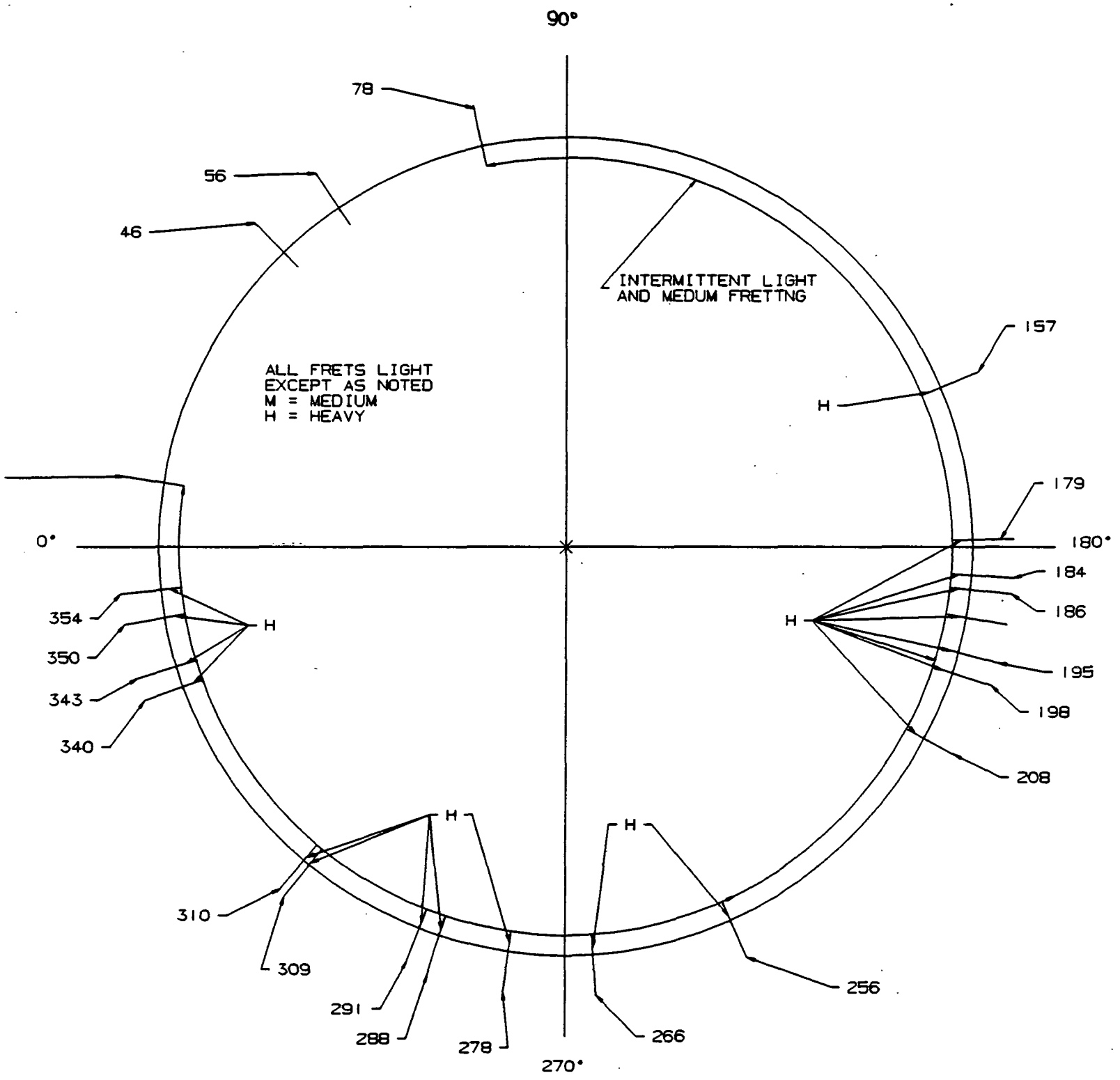



Figure 9 LH Aft Field Joint Fretting

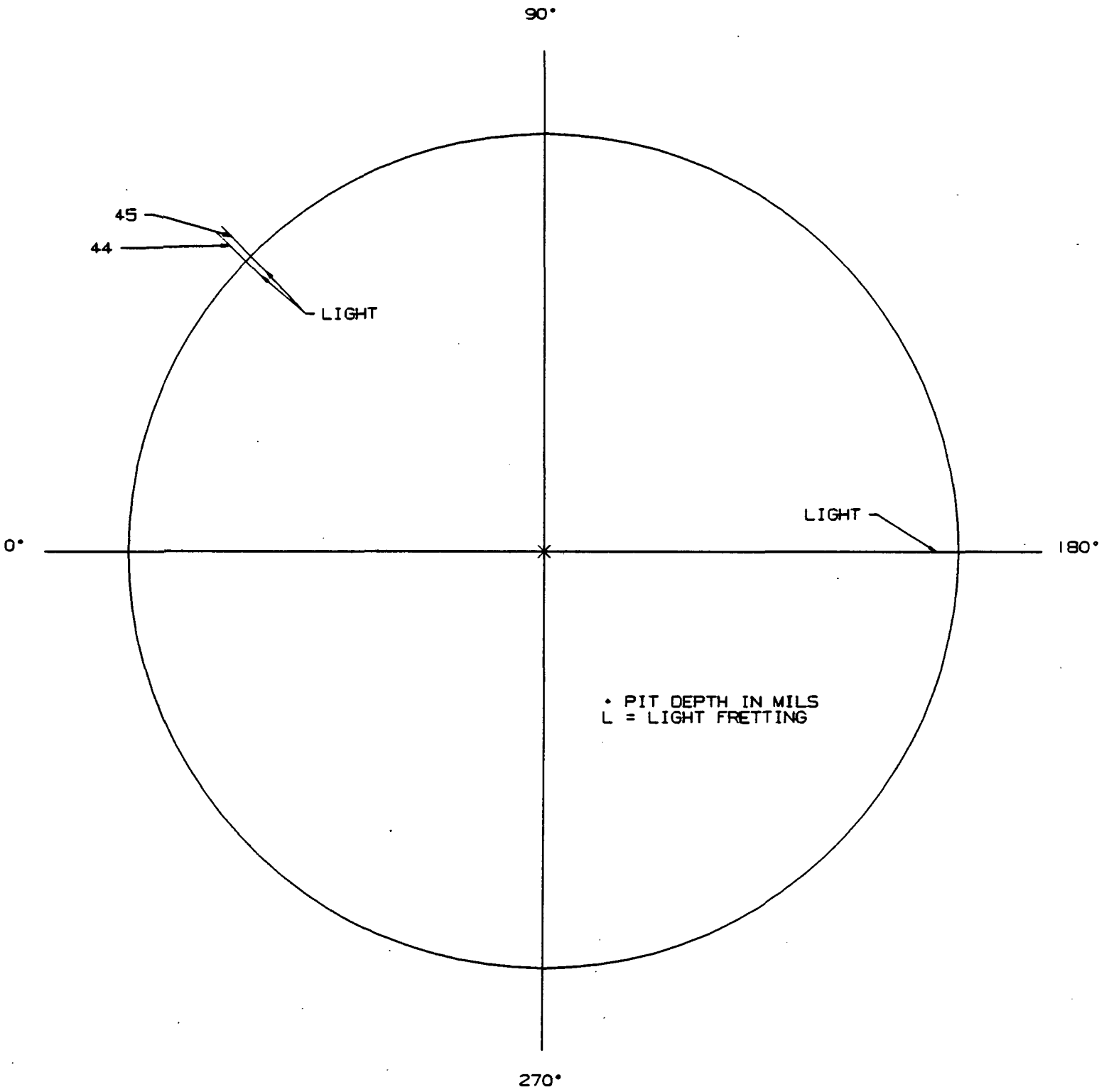



Figure 10 RH Forward Field Joint Fretting

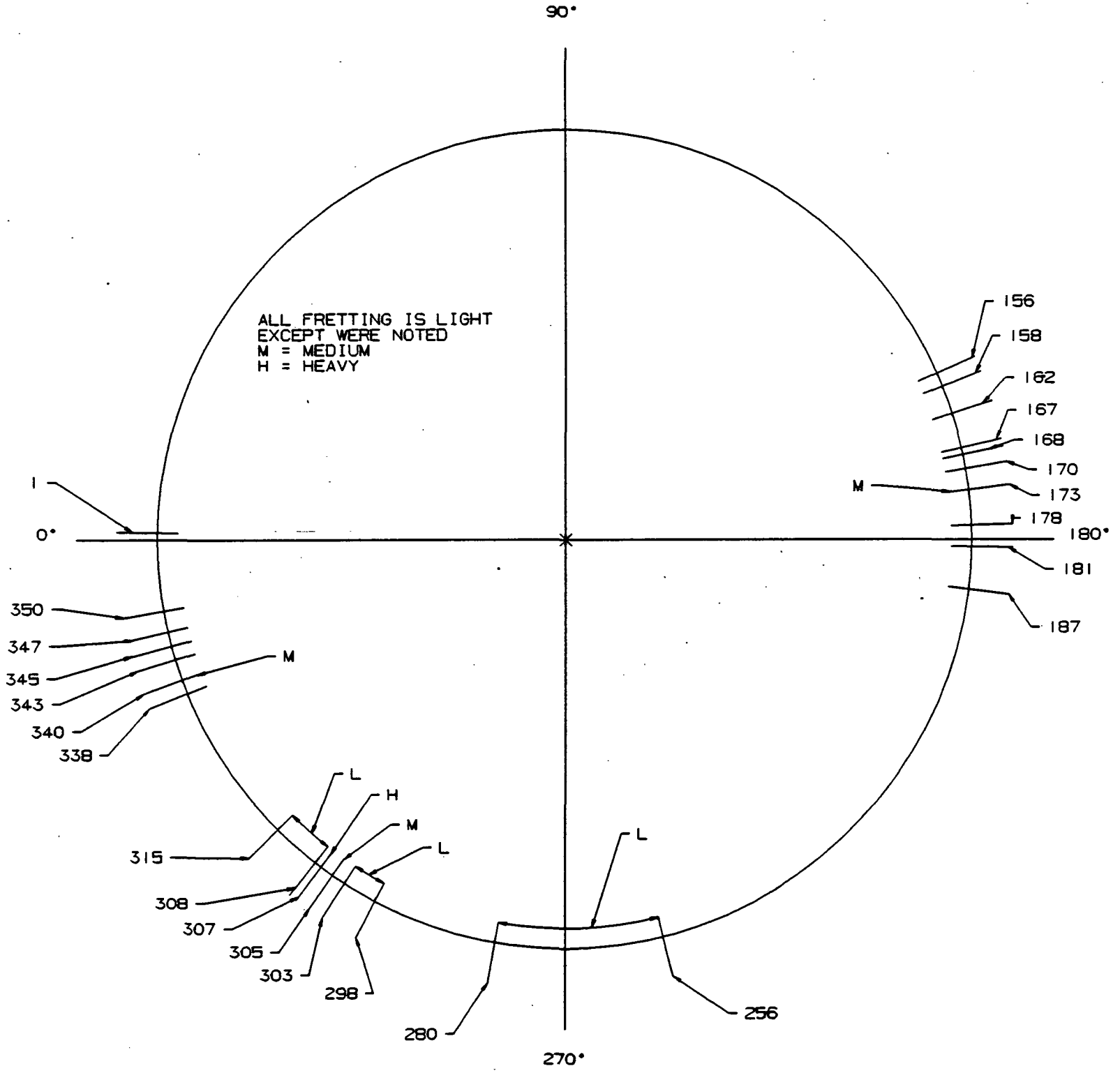



Figure 11 RH Center Field Joint Fretting

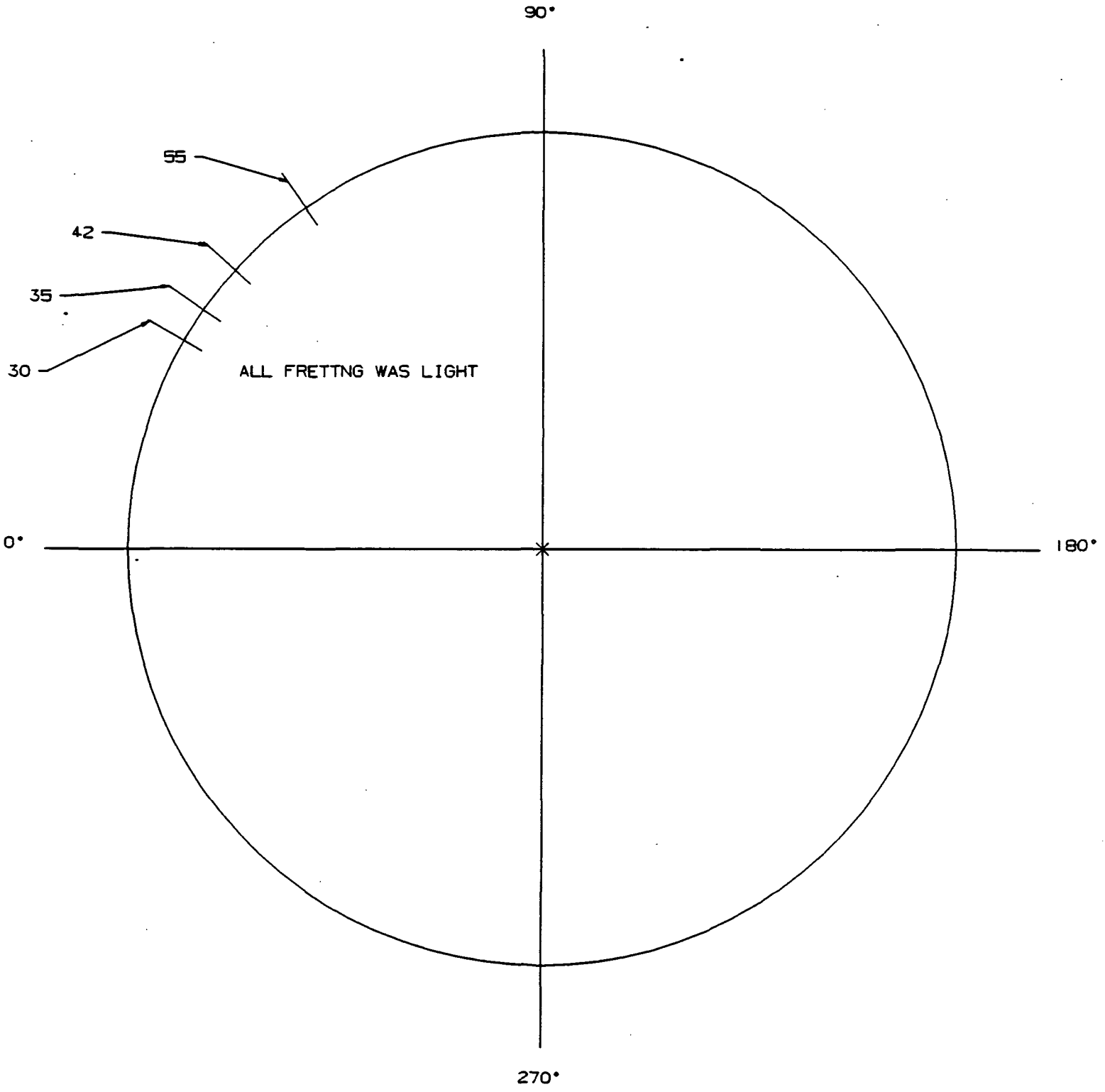



Figure 12 RH Aft Field Joint Fretting

# APPENDIX A

# RPRB PRESENTATIONS

# RSRM Hardware Assessment at KSC

## Presented by Post-Fire Engineering Team

*Team Presentation:*
*360L009 Post-Flight Anomaly Review (PFARs)*
*21 March 1990*

# AGENDA



| Para. | Section | Presenter |
|---|---|---|
| 1.0 | Overview | J. Durtschi |
| 2.0 | Case/Seals/Case Hardware | |
| | Case | R. Mackley |
| | Igniter | P. McCluskey |
| | Seals | K. Baker/D. Gurney |
| 3.0 | Insulation | N. Eddy |
| | External Insulation | |

# 1.0 OVERVIEW

## 1.1 Hardware Status Presenter: J. Durtschi

Special Issues Summary

Team Classifications

PFAR Summary/Status

# OVERVIEW



## Hardware Status

- Disassembly/Evaluation at KSC Hangar AF completed 9 March (L+9 Days)
  - LH igniter removed improperly
    - Removed inner bolts before outer
    - Chamber fell into forward segment
    - PR written against SPC (processing)
- S&A disassembly/evaluation planned for 21 March
- Nozzles disassembled/evaluated at Clearfield planned for 23 March
- Aft center and aft segments shipped
  - Forward and forward center segments shipped on 20 and 21 March

## Special Issues:

**Condition:** Class I Hardware change increased rubber insulation thickness on forward stiffener segment forward stub.

**Reference:** TWR-50367, pg. 009-FRRM A89

**Assessment:** No problems were identified with increase of insulation thickness over the stub on the LH motor. Three separations were identified in the stub insulation of the RH motor near 210 degrees. The noted separations were located 0.060 inch from the top of the stub to a depth of 0.20 inch and ranged from 0.2-to-0.4 inch in length. No heat affects were identified in the separations. Missing material from the top of the stub was identified at 200 degrees and measured 0.06 inch deep by 3.0 inches circumferentially over the width of the stub (~0.6 inch). No heat affects were identified.

**Condition:** 360L009 had dual-sided fretting (clevis and capture feature) on three field joints—LH Center, LH Aft, and RH Center.

**Reference:** TWR-50367, pg. 009-FRRM 71

**Assessment:** Evaluation of the three field joints revealed no new fretting in old fretting locations; however new frets were found at the edge of repair areas on the LH aft joint.

**Condition:** DR 112679 was written on the RH forward segment (1U50131-10, S/N 37) for a thin wall condition.

**Reference:** TWR-60059, pg. 009-FRRK 29

**Assessment:** No evidence of damage due to thin wall condition.

**Condition:** DR was written against the igniter outer gasket (RH) for a low crown height on the secondary seal. Low spot is located at 90 degrees and measures 0.020 inch from the crown of the seal to the metal retainer. Note: DR shows location at 63 degrees. Photo shows location at 90 degrees. DR will be changed.

**Reference:** TWR-50367, pgs. 009-FRRM A126 and A127, DR 170986

**Assessment:** There was no evidence of pressure to this seal.

**Condition:** IFA STS-32-M-1 written against 360L008 RH S&A gasket secondary seal for an impression on the seal crown.

**Reference:** pgs. 009-FRRK 6-9

**Assessment:** No impressions were found on the gasket seals.

**Condition:** Helicoils pulled out of compliance ring on the 360L007 and 360L008 LH and RH motors. Thermal curtain attach brackets on compliance ring were not inspected for evidence of compliance ring thread damage, such as bent or pulled out bolts .

**Reference:** pgs. 009-FRRK 93-94, PFARs 360L007A-06 and B-07, 360L008B-04 and A-05

**Assessment:** No bolt or bracket damage was observed prior to disassembly. The bolts were removed by hand on the LH nozzle and no helical coils were backed out and no damage was observed. The bolts were removed with an air ratchet on the RH nozzle and four helical coils were backed out approximately one turn. No thread damage was observed.

## PFAR SUMMARY (360L009)

- TOTAL NUMBER OF NEW PFARS: 9
  - KSC PRs: 9
  - IFA/SPR: 2

| COMPONENT | PFAR | TITLE |
|---|---|---|
| CASE | 360L009B-02 | Outer ligament crack in RH center stiffener stub |
| | **360L009B-04 | Pitting on boss of igniter chamber |
| | 360L009B-06 | Fretting on RH interference fit of field joint |
| | 360L009A-08 | Fretting on LH interference fit of field joint |
| SEALS | 360L009A-05 | Sheared metal from LH inner gasket |
| | **360L009B-07 | Cadmium plating pealing off RH inner gasket |
| | *360L009A-09 | LH IPT secondary O-ring separation |
| IGNITER | **360L009B-03 | Pitting on boss of igniter chamber |

| | | |
|---|---|---|
| INSULATION | 360L009A-01 | Unbonds on factory joint weatherseal extending to pin retainer band |
| JPS | | No problems |
| NOZZLE | | No problems |

* IFA

** These three PFARs result from the blowhole in the RH igniter putty and are combined on a single IFA

## Team Classifications

### Team Classification of Observations

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

**PFAR Status**

- **318 Total PFARS**
- **156 Open PFARS**
    - **Less Than 70 Different Problems Open (Because of Reoccurring Problems)**

# 2.0 CASE / SEALS

| | |
|---|---|
| **Case** | **Presenter: R. Mackley** |
| **Igniter** | **Presenter: P. McCluskey** |
| **Seals** | **Presenter: K. Baker/D. Gurney** |

COMPONENT: CASE
PFAR NUMBER: 360L009B-06

---

REFERENCE: SQUAWK=36-044 PR=PV6-154648 IFA=N/A SPR=N/A

TITLE: FIELD JOINT FRETTING

DESCRIPTION:
Fretting was observed in the interference fit region of the field joints. The worst case measured 0.009 inch deep and was located at 348 degrees on the center field joint.

HISTORY:
All redesign flights have had fretting on at least one joint of each motor (360L001 through 360L008).

CAUSE:
Corrosion occuring at interference surface while under load and subject to vibration and slip. Condition manifests as a pit and causes a gouge upon disassembly. Mechanisms of the phenomena are wear-oxidation and/or oxidation-wear.

CLASSIFICATION: MINOR ANOMALY

JUSTIFICATION:
Capture feature and clevis interference surfaces are not expected to deviate from their as-manufactured condition during flight and recovery.

COMPONENT: CASE
CONTINUATION OF PFAR NUMBER: 360L009B-06

---

CORRECTIVE ACTION:

1. Complete confidence tests on glass beading/Molykote samples. (Action: Fretting Team)

2. Complete Molykote compatibility tests. (Action: D. Mason, Fretting Team)

3. Assure virgin glass beaded surfaces. (Action: Case Design - Reo Mackley)
3a. Reduce or eliminate mold ring corrosion/ fretting (Action: J. Miller; PCA Task Force, D. Mason; Fretting Team)

4. Burnishing/ cold roll testing. (Action: J. Daines)

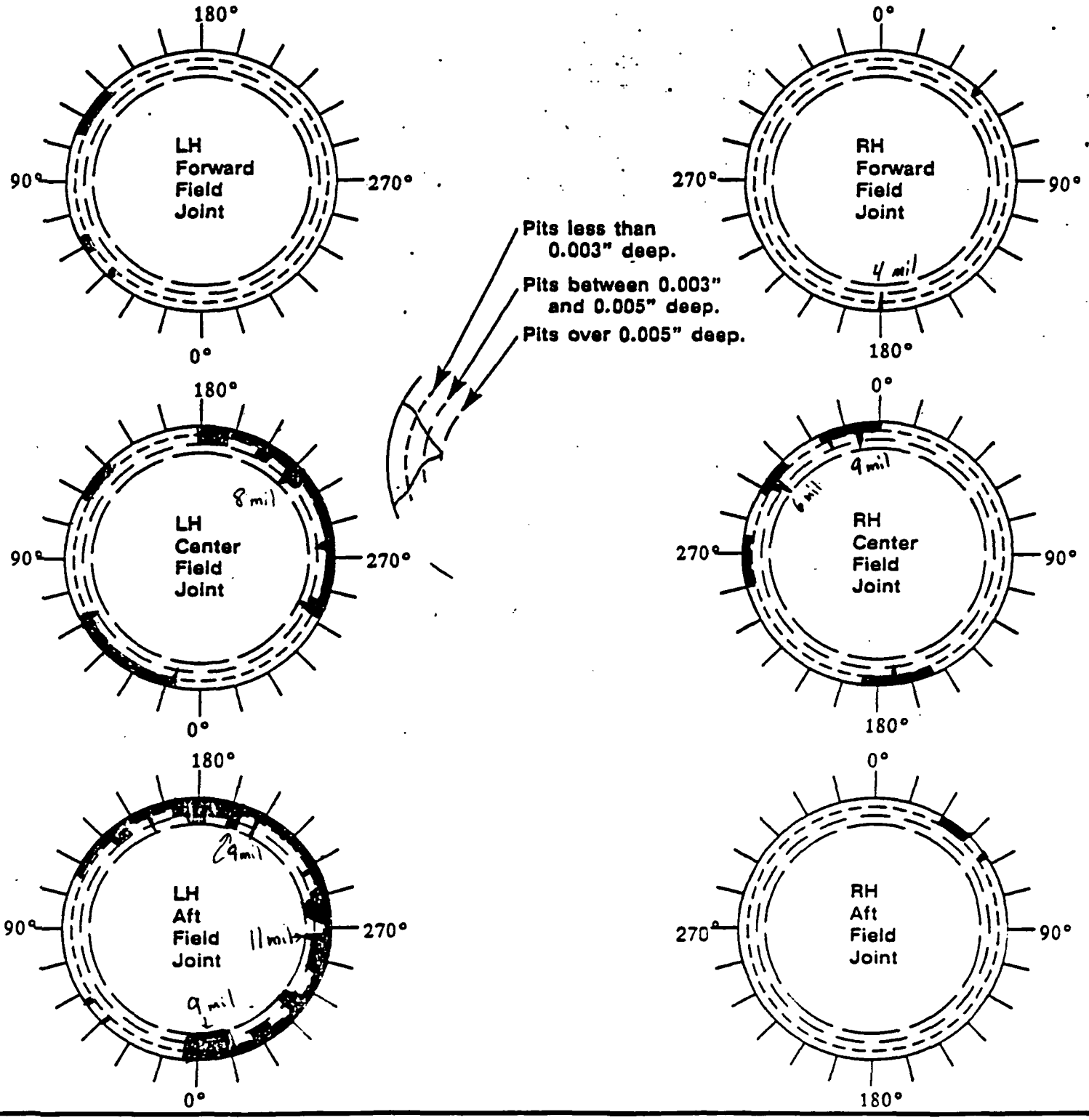
REPORT BACK TO RPRB?: YES

## Overall Field Joint Fretting Clarification Form

| Motor No.: 360L009 | Date: 3-8-90 |
|---|---|

Assessment Engineer(s): K. Baker, L. Hyer, A. Carlisle, D. Holt, D. Starrett

Sketch Overall Field Joint Fretting Observations Below:




Clarification Number: B-46B

Corresponding Comment Number(s): _____

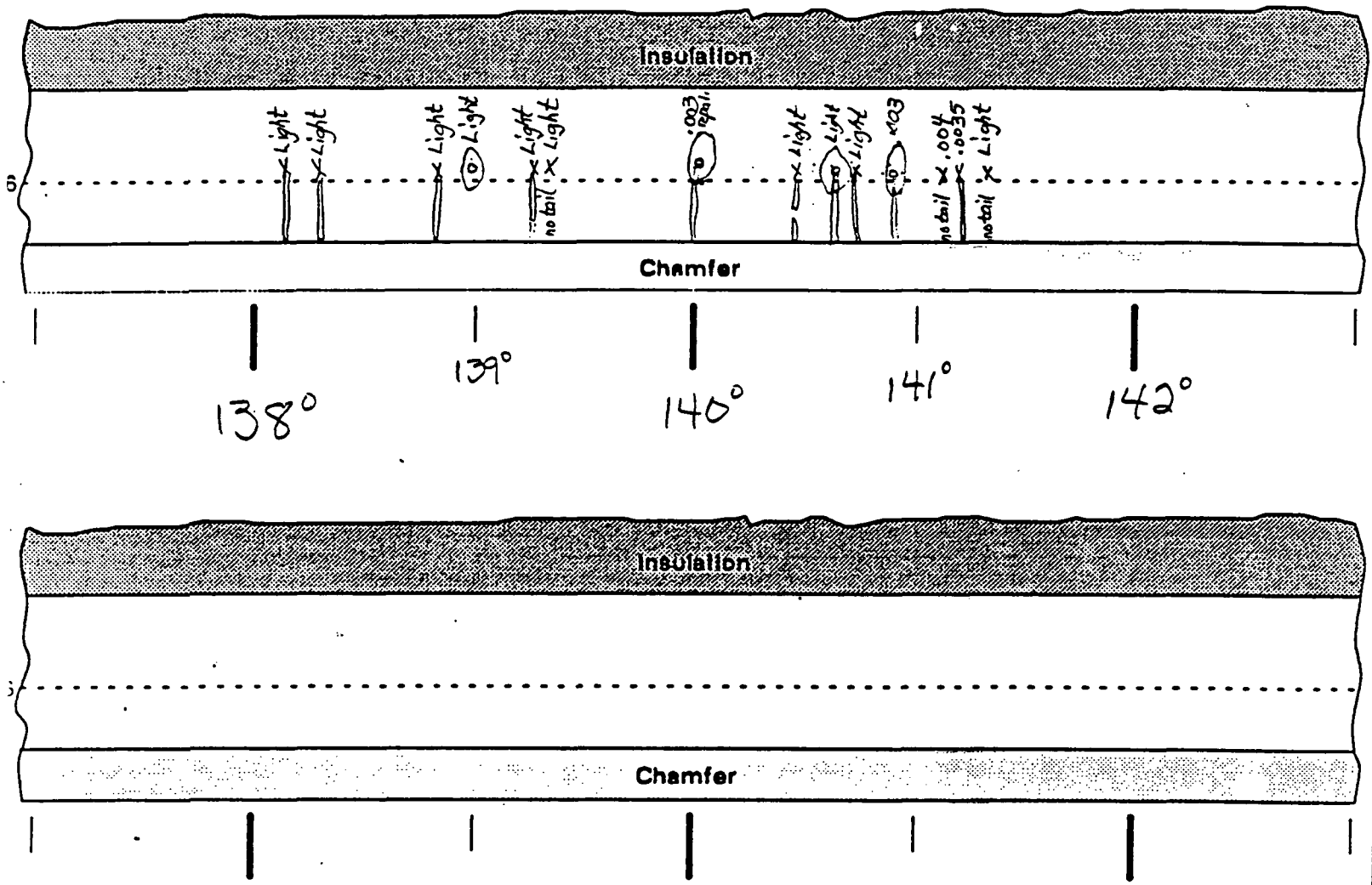
## Field Joint Mapping of Fretting Clarification Form

| Motor No.: 360L009 | Side: ☒ Left (A) ☐ Right (B) | Date: 3/9/90 |
|---|---|---|

Assessment Engineer(s): K. Baker, L. Hyer.

Field Joint: ☐ Forward ( Sta. = 851.5) ☐ Center (Sta. = 1171.5) ☒ Aft (Sta. = 1491.5)

Sketch Individual Field Joint Fretting Observations Below:




x New Fret

o Old Fret/Repair/Blend Region

| Pinhole Centerline

Clarification Number: F--8b

Corresponding Comment Number(s): 1

COMPONENT: CASE
PFAR NUMBER: 360L009A-08

---

REFERENCE: SQUAWK=36-046 PR=PV6-154635 IFA=N/A SPR=N/A

TITLE: FIELD JOINT FRETTING

DESCRIPTION:

Fretting was observed in the interference fit region of the field joints. The worst case measured 0.011 inch deep and was located at 278 degrees on the aft field joint. (Note: This joint has been considered the worst overall fretted joint to date.)

HISTORY:

All redesign flights have had fretting on at least one joint of each motor (360L001 through 360L008).

CAUSE:

Corrosion occuring at interference surface while under load and subject to vibration and slip. Condition manifests as a pit and causes a gouge upon disassembly. Mechanisms of the phenomena are wear-oxidation and/or oxidation-wear.

CLASSIFICATION: MINOR ANOMALY

JUSTIFICATION:

Capture feature and clevis interference surfaces are not expected to deviate from their as-manufactured condition during flight and recovery.

**COMPONENT: CASE**
**CONTINUATION OF PFAR NUMBER: 360L009A-08**

---

**CORRECTIVE ACTION:**

1. Complete confidence tests on glass beading/Molykote samples. (Action: Fretting Team)

2. Complete Molykote compatibility tests. (Action: D. Mason; Fretting Team)

3. Assure virgin glass beaded surfaces. (Action: T. Swauger )
3a. Eliminate mold ring corrosion/ fretting. (Action: D. Mason; Fretting Team)

4. Burnishing/ Cold Roll testing (Action: T. Swauger)

**REPORT BACK TO RPRB?: YES**

**RESULTS:**

1. Testing completed. No positive results reported.

COMPONENT: CASE
PFAR NUMBER: 360L009B-02

---

REFERENCE: SQUAWK=36-037 PR=PV6154371 IFA=N/A SPR=N/A

TITLE: OUTER LIGAMENT CRACK ON CENTER STIFFENER STUB

DESCRIPTION:
An outer ligament crack occurred as part of the result of splash down. The crack is located on the R.H. center stiffener stub at 210 degrees.

HISTORY:
RSRM 1B, 2B, 3B(2), 4A(2), 5A. 32 total stiffeners from SRM/RSRM fight history had ligament cracks.

CAUSE:
Damage is the result of splash down. 25 missing bolts from 160 to 208 degrees.

CLASSIFICATION: OBSERVATION

JUSTIFICATION:
Existing condition is acceptable per the PEEP limits. Stiffeners with outer ligament cracks will not be reused. No corrective action is planned. Management has accepted a 25 percent attrition rate due to ligament cracks.

CORRECTIVE ACTION:
Update the PEEP to make outer ligament cracks reportable.

ACTIONEE:

REPORT BACK TO RPRB?: NO

RESULTS:
Included in 10th Flight special issues document. PEEP will be revised from the special issues document.

COMPONENT: CASE
PFAR NUMBER: 360L009B-04

---

REFERENCE: SQUAWK=36-041 PR=PV6154634 IFA=N/A SPR=N/A

TITLE: PITTING ON FORWARD DOME BOSS

DESCRIPTION:
Pitting 0.001 to 0.002 inch deep located on the forward boss in the igniter through hole region at 175 degrees. Heavy corrosion also noted on the O.D. face of the chamber and missing

HISTORY:
None previously reported in the same region.

CAUSE:
Pitting is the result of heavy corrosion. A blow hole through the putty at 175 degrees contributed to the corrosion. Reference PFARs 360L009B-03, 360L009B-07.

CLASSIFICATION: OBSERVATION

JUSTIFICATION:
Heavy corrosion with pits less than 0.010 inch deep is acceptable per the PEEP.

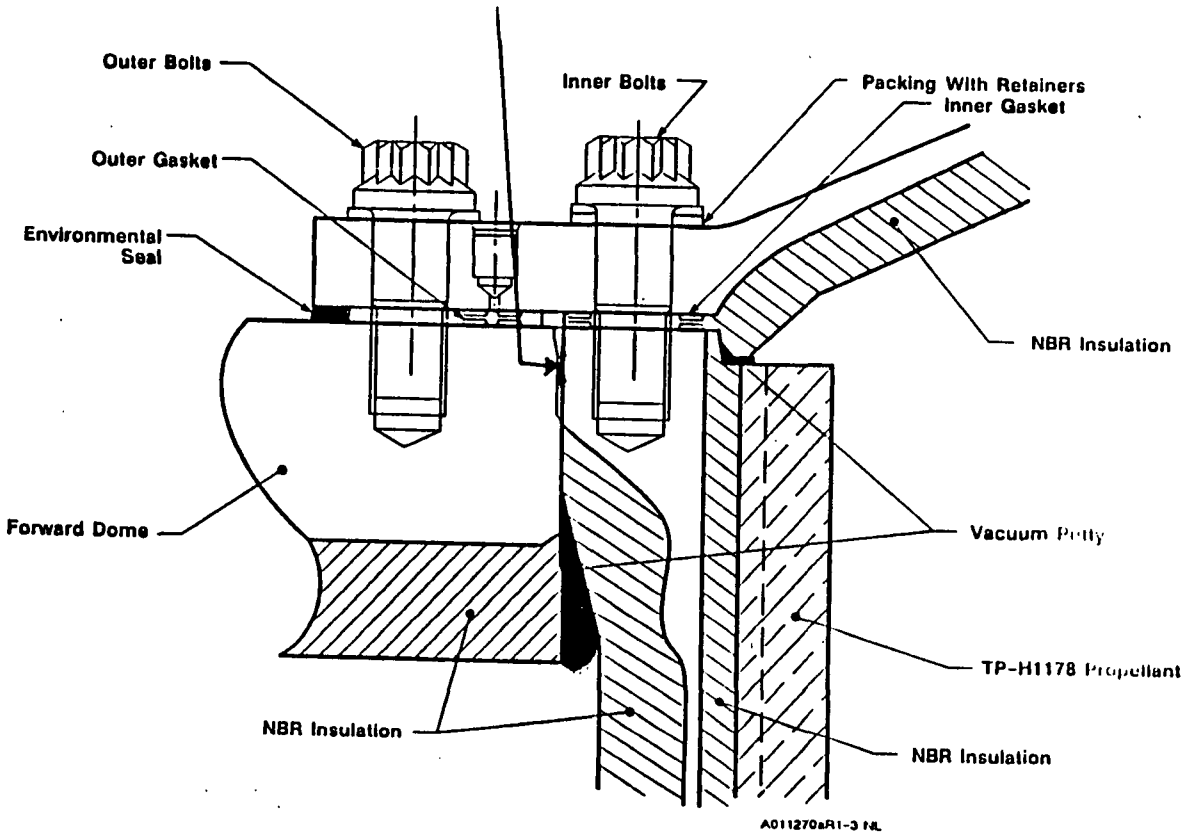
CORRECTIVE ACTION:
None

ACTIONEE: N/A

REPORT BACK TO RPRB?: NO

RESULTS:
None

Pitting on Dome
(.0015" deep)



COMPONENT: IGNITER
PFAR NUMBER: 360L009B-03

---

REFERENCE: SQUAWK=36-040 PR=PV6-154632 IFA=N/A SPR=N/A

TITLE: PITTING ON IGNITER CHAMBER BOSS

DESCRIPTION:
Pitting was noted on the RH igniter chamber flange OD at 175 degrees. The pitting, which did not have a measurable depth, coincided with a putty blow path that measured from 0.3-to-2.5 inches circumferentially. This was the first motor using the new horizontal putty lay-up.

HISTORY:
Pitting on the igniter chamber has not been seen before.

CAUSE:
The pitting resulted from corrosion due to the putty blow path.

CLASSIFICATION: MINOR ANOMALY

JUSTIFICATION:
This condition represents a significant departure from the historical database but has no impact on motor performance or program schedule. It also has no impact on reuse of hardware.

CORRECTIVE ACTION:
The long-term corrective action for this problem is to redesign the igniter chamber-to-forward dome joint.

ACTIONEE: P. M. MCCLUSKEY

REPORT BACK TO RPRB?: NO

COMPONENT: SEALS
PFAR NUMBER: 360L009B-07

---

REFERENCE: SQUAWK=36-045 PR=PV6-154631 IFA=STS-36-M-1 SPR=DR4-5/191

TITLE: MISSING CADMIUM PLATING ON IGNITER GASKET RETAINER

DESCRIPTION:
Cadmium plating was corroded on the O.D. of the inner gasket retainer aft face at 175 degrees. Pits were also noted in the 4130 steel retainer. The affected area measured 1.5 inches circumferential by 0.15 inch radial. This area corresponds to a blowhole in the outer joint putty layup.

HISTORY:
RSRM 1A, 1B, 2B, 5B.

CAUSE:
Putty blowhole allowed hot, corrosive combustion gases to come in contact with the gasket retainer resulting in corrosion.(Ref. 2421-FY90-M079)

CLASSIFICATION: MINOR ANOMALY

JUSTIFICATION:
Significant departure from the historical database. This condition has been seen before but not to the extent. Five members of the Igniter/ Seals teams were in nonconcurrence. Dissenters felt it was not a significant departure.

CORRECTIVE ACTION:
Redesign igniter joint to eliminate putty blowholes.

ACTIONEE: S. B. MEDRANO

REPORT BACK TO RPRB?: NO

COMPONENT: SEALS
PFAR NUMBER: 360L009A-05

---

REFERENCE: SQUAWK=36-043 PR=PV6154637 IFA=N/A SPR=N/A

TITLE: SHEARED METAL ON INNER GASKET RETAINER

DESCRIPTION:
A small amount of metal was sheared off the retainer of the inner gasket on the aft face at 270 degrees.

HISTORY:
None previously reported.

CAUSE:
At disassembly, the inner circle of igniter bolts was removed prior to removal of the igniter from the forward dome. This caused the igniter chamber to fall in to the forward segment. As the chamber fell, it hinged on the inner gasket at 270 degrees causing the metal to shear on the gasket.

CLASSIFICATION: OBSERVATION

JUSTIFICATION:
Damage occurred at disassembly. The decision has been made not to refurbish any gasket retainers. The damage is acceptable per the reuse criteria.

CORRECTIVE ACTION:
No corrective actions for Thiokol. SPC was given action to review igniter removal procedures, and correct if required. (Squawk 36-043)

ACTIONEE: N/A

REPORT BACK TO RPRB?: NO

COMPONENT: SEALS
PFAR NUMBER: 360L009A-09

REFERENCE: SQUAWK=36-047 PR=PV6-154643 IFA=STS-36-M-2 SPR=DR4-5/193

TITLE: I.D. CIRCUMFERENTIAL CUT ON THE SECONDARY O-RING OF THE IPT PLUG

DESCRIPTION:
Cut on the I.D. of the igniter adapter plug secondary O-ring. Cut is not on the mold line. Cut extends approximately half way around the circumference and is approximately 0.60 inch deep.

HISTORY:
360L006B-32; previously reported but not classified. Corrective action will be the same for both PFARs.

CAUSE:
I.D. cut caused by an overfill condition created by excessive grease. Extrusion of the O-ring occurs.

CLASSIFICATION: MINOR ANOMALY

JUSTIFICATION:
The I.D. cut is a significant departure from the historical database. Testing has confirmed the cut would not have affected seal performance.

CORRECTIVE ACTION:
1) Complete testing to duplicate damage and verify sealing of the damaged O-ring. (D. Gurney, ETP-0688)

2) Implement Engineering requirements for plug head flushness. (D. Gurney, B. Baugh)

3) Update planning to incorporate proper grease application and plug head flushness. (R. Nielsen; M.E.)

REPORT BACK TO RPRB?: NO

**COMPONENT: SEALS**
**CONTINUATION OF PFAR NUMBER: 360L009A-09**

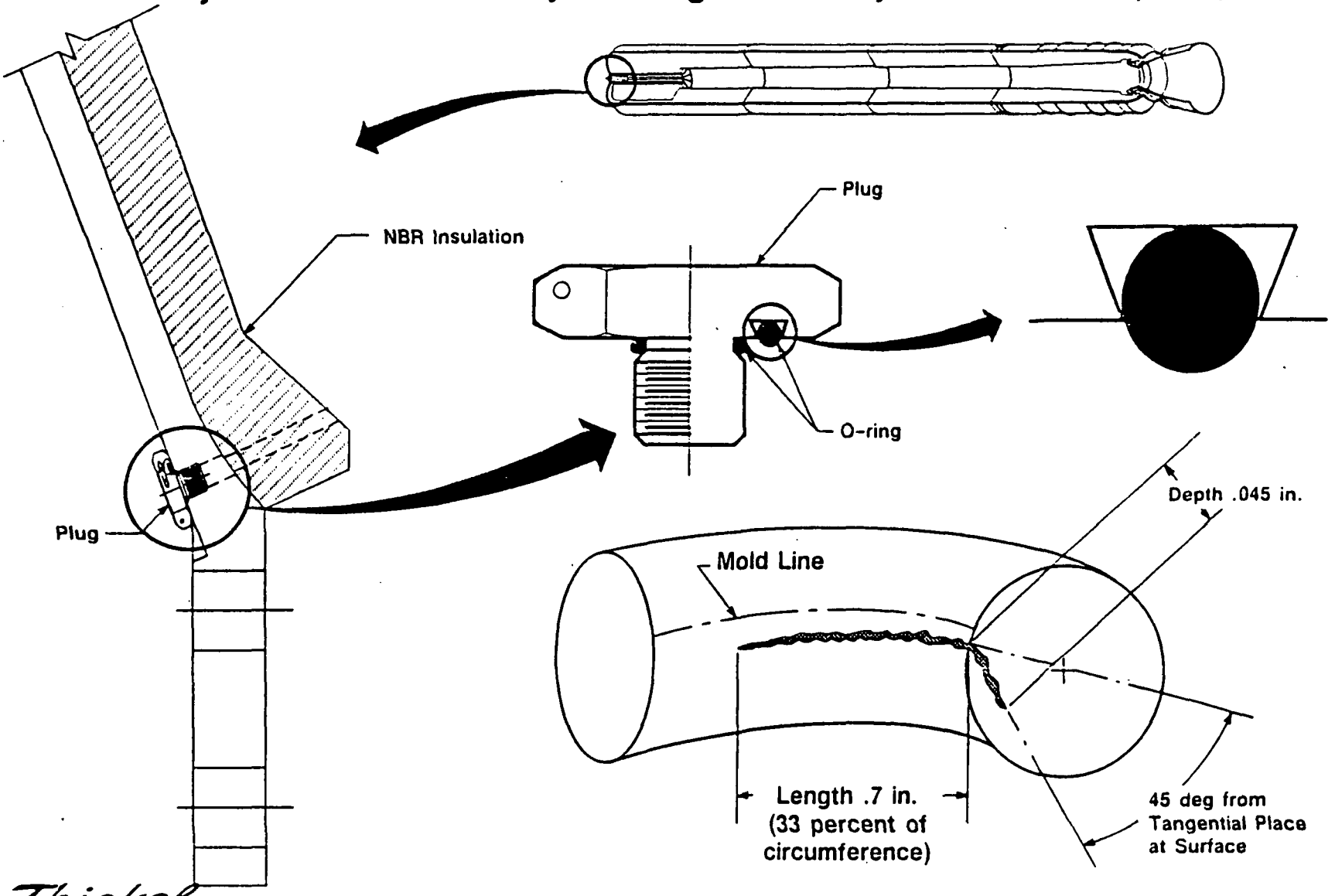
---

**RESULTS:**

**1) Testing was completed. Results indicate damage was caused by an overfill condition. Pressure tests confirm the damage O-rings maintained a seal. (TWR-60300)**

# Previous Flight Assessment—360L009 (STS-36)

## Disassembly Evaluation Summary—In-Flight Anomaly STS-36-M-2 (Cont)




Thiokol CORPORATION
SPACE OPERATIONS

# RPRB PRESENTATION

# 360L009 S&A DISASSEMBLY REPORT

2 MAY 1990

G. S. EDEN
JOINTS AND SEALS DESIGN

PM: S. MEDRANO
SIE: T. GREGORY
PFE: L. MACCAULEY
DE: S. EDEN, D. BULLARD
QE: D. LARSON
Rel: G. CONOVER
SS: S. SOFFE

Thiokol CORPORATION
SPACE OPERATIONS

# 360L009 S&A DISASSEMBLY REPORT

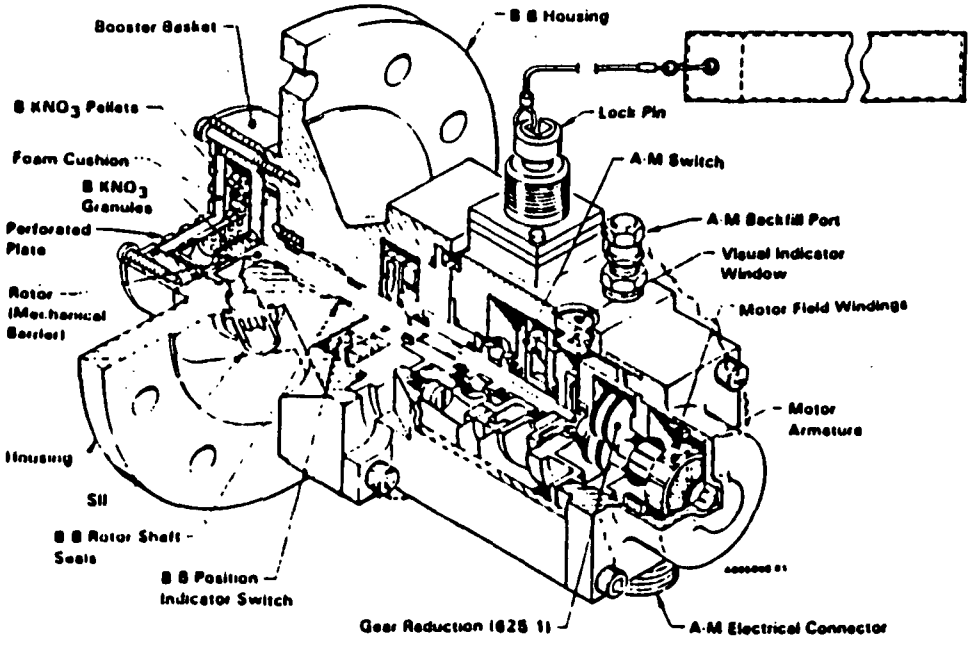



Figure 4 5 1 Safety and Arming Device Configuration

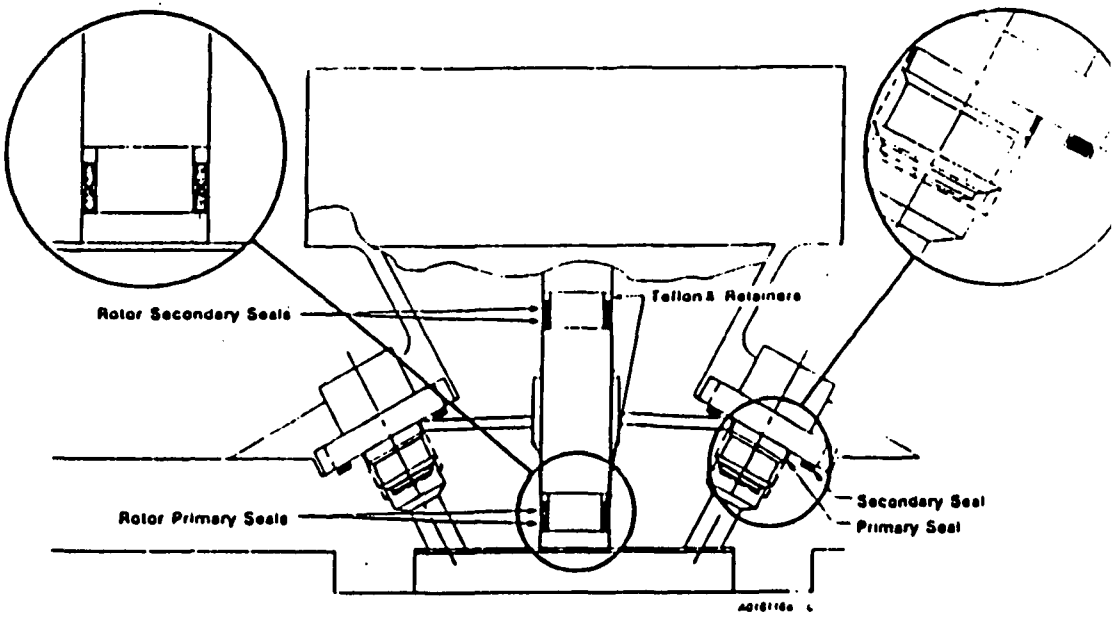



Figure 4.6-6. S&A Device Rotor and SII Port Sealing System

ORIGINAL PAGE IS
OF POOR QUALITY

*Thiokol* CORPORATION
*SPACE OPERATIONS*

INFORMATION ON THIS PAGE WAS PREPARED TO SUPPORT AN ORAL PRESENTATION AND CANNOT BE CONSIDERED COMPLETE WITHOUT THE ORAL DISCUSSION

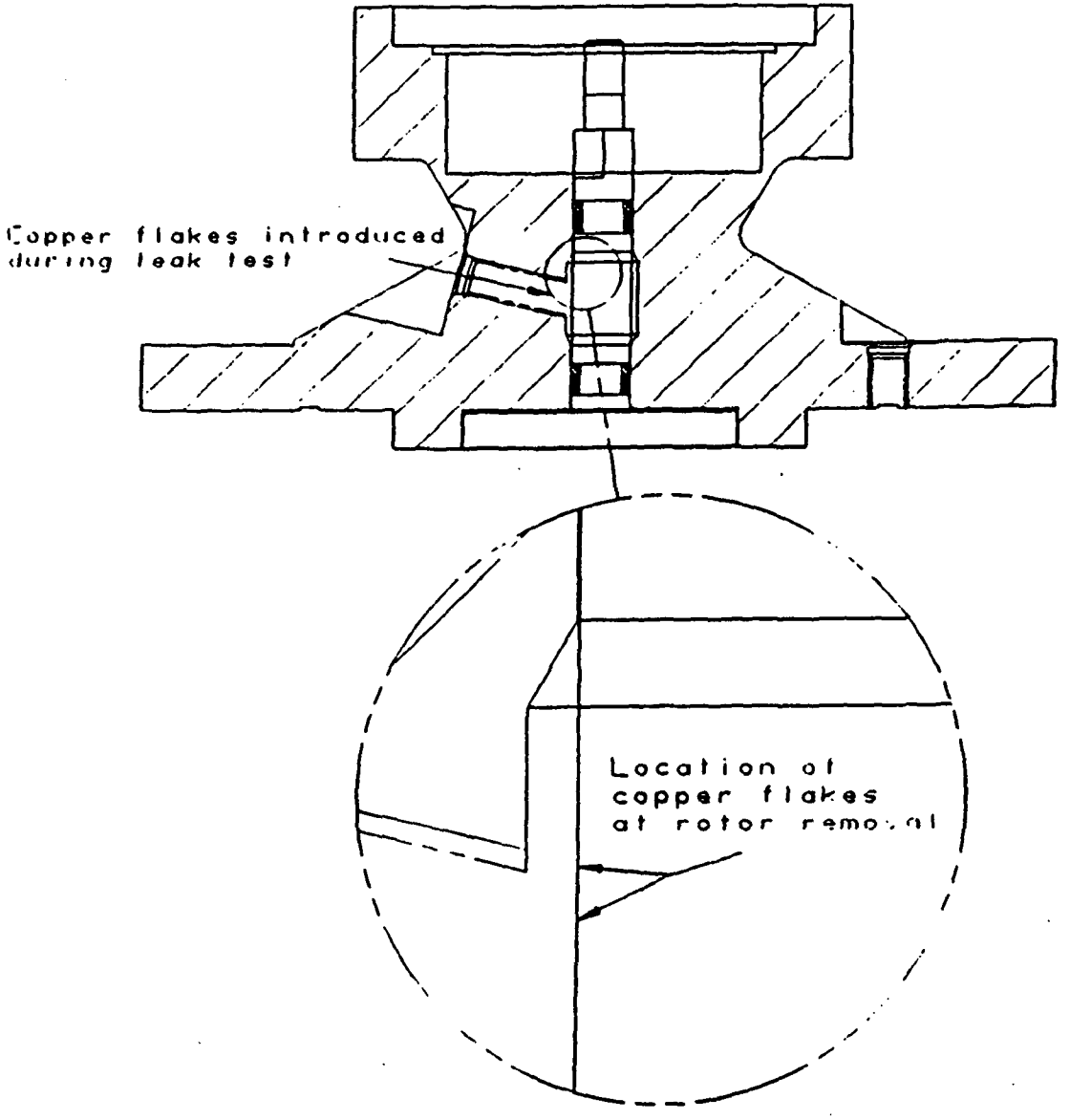
# OVERVIEW

| ITEM | PAGE | OBSERVATION | LOCATION | CLASSIFICATION |
|---|---|---|---|---|
| 1 | 3 | Copper particles | Rotor secondary O-rings | Minor Anomaly |
| 2 | 6 | Nick | Housing bore seal surface | Minor anomaly |
| 3 | 8 | Deformations | SII sealing washer | Minor Anomaly |
| 4 | 12 | Scratch | SII sealing washer | Minor Anomaly |
| 5 | 14 | Raised metal | SII port primary seal surface | Minor Anomaly |
| 6 | 16 | Blocked leak path | SII port leak test path | Minor Anomaly |
| 7 | 19 | Galling | Leak test plug seal surface | Minor Anomaly |
| 8 | 22 | Deformations | Leak test plug head | Remains Observation |

# 360L009 S&A DISASSEMBLY REPORT

- PFARs: 360L009A-13
- DESCRIPTION (ITEM 1):
  - Small copper particles were found on the 360L009A rotor shaft between the primary and secondary O-rings. No copper was found on the O-rings.
- HISTORY: Previously found on 360H005B, 360L006A, 360L006B, and 360L008A. This is the first occurrence of copper found on the rotor and not on the O-rings.
- DISCUSSION:
  - The copper is introduced into the rotor housing bore leak test cavity during the high pressure leak test at Eaton Valve and Actuator Division (E-VAD).
    - The 8U leak test equipment uses a copper "Conoseal" in the connection between the pressure line and leak test port adapter. Conoseals from the line were inspected and found to be flaking under use.
  - Small diameter of particles would not effect B-B rotor torque.
  - Violates engineering and requires corrective action.
  - Twenty eight B-B's were leak tested prior to incorporation of in-line filter. Copper is expected to be in every unit.
  - In-line filter was in place for Flight 14 and subsequent B-B's.

# 360L009 S&A DISASSEMBLY REPORT



# 360L009 S&A DISASSEMBLY REPORT

- RECOMMENDATIONS:
  - TEAM CLASSIFICATION: *Minor Anomaly*
  - JUSTIFICATION:
  - Rotor is installed into housing bore before leak test is performed.
  - Particles were not in contact with the O-rings.
  - Rotor seals passed two high pressure and one low pressure leak test.
  - CORRECTIVE ACTION:
    - Short term: Modify E-VAD planning to blow pressure line clean prior to each use. Implement an in-line filter in the 8U leak test equipment to prevent contamination from entering the bore.
      - Completed: 16 February 1990, Effective: Flight 14
    - Long term: Replace all copper fittings in leak test equipment.
      - (Actionee: J. Heman, S. Eden, DE) Effective: Flight 20
  - REPORT BACK TO RPRB? No

# 360L009 S&A DISASSEMBLY REPORT

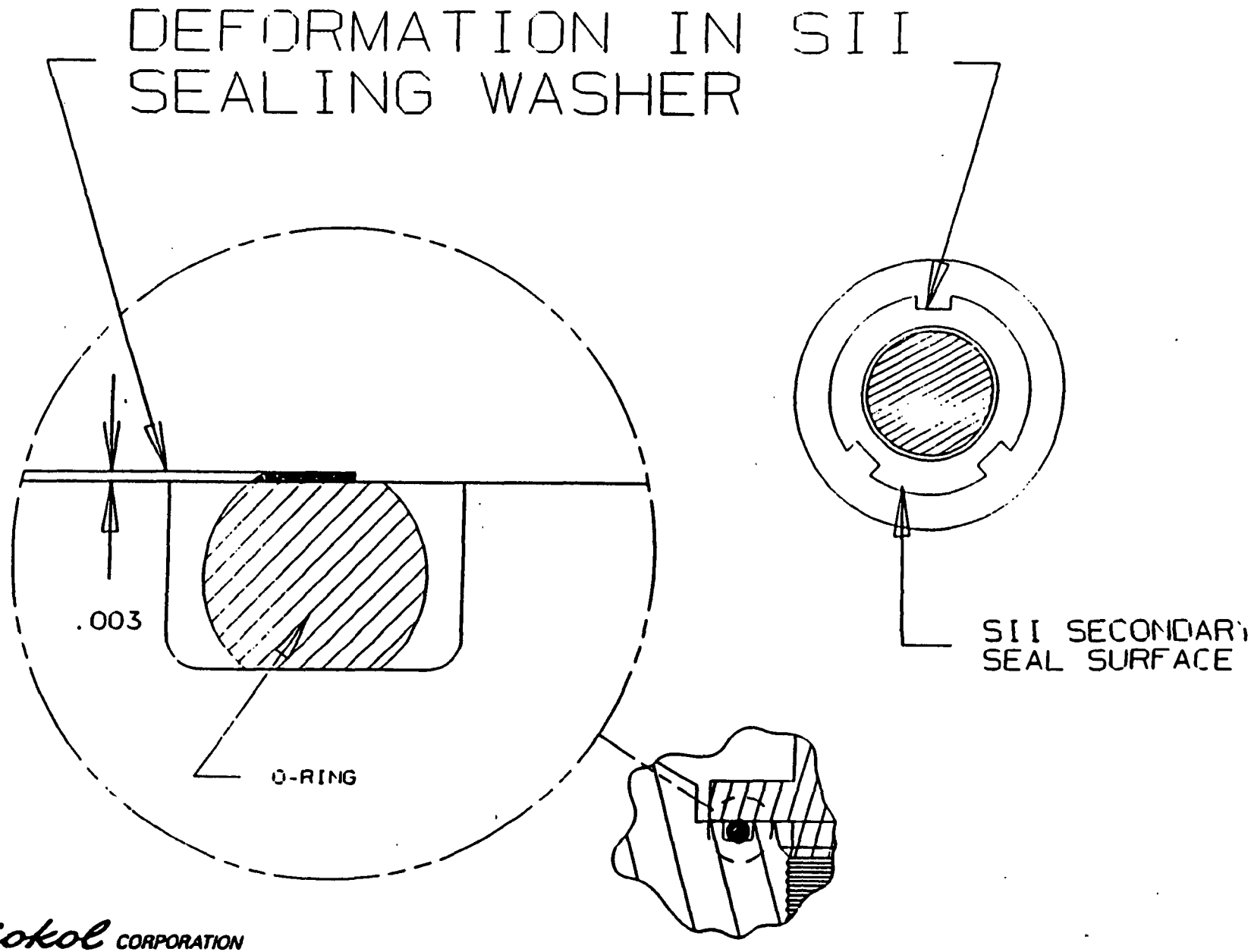
- PFARs: 360L009A-16
- DESCRIPTION (ITEM 2):
  - A small nick was found on the 360L009A rotor housing bore primary seal surface. There was no raised metal.
- HISTORY: A similar nick was found on the 360L006B rotor housing bore secondary seal surface.
- DISCUSSION:
  - Cause of nick unknown; occurred prior to B-B assembly.
    - The B-B rotor housing bore is made of 304 Stainless and easily damaged.
  - The B-B refurbishment specification (STW7-3133) does not specifically call out inspection point for the housing bore.
    - An OCR to inspect the bore for damage after bore measurement was implemented with effectivity of Flight 8.
  - Violates engineering and requires corrective action.

# 360L009 S&A DISASSEMBLY REPORT

- RECOMMENDATIONS:
  - TEAM CLASSIFICATION: Minor Anomaly
  - JUSTIFICATION:
    - B-B passed high and low pressure leak tests.
    - Nick does not violate the O-ring footprint.
    - Post-fire inspection found no damage to the rotor shaft O-rings.
- CORRECTIVE ACTION:
  - Short Term: Modify vendor planning to clean inspection tool prior to each use.
    - (Actionee: D. Larson,QE) Effective: Flight 16
  - Long Term: Replace bore measurement inspection tool with air micrometer.
    - (Actionee: D. Larson, QE) Effective: Flight 19
    - Update B-B refurbishment specification, STW7-3133, to incorporate better seal surface definitions and inspection points.
    - (Actionee: D. Bullard, S. Eden, DE) Effective: August 1990
- REPORT BACK TO RPRB? No

# 360L009 S&A DISASSEMBLY REPORT

- PFARs: 360L009A-11, 360L009B-12
- DESCRIPTION (ITEM 3):
  - Several deformations found in sealing washer on both the 360L009A 18 and 198 degree SII's as well as the 360L009B 18 degree SII. Deformations are circumferential, they follow pattern of NSI, and are located over wrench slots.
- HISTORY: Previously found at post-fire inspection since TEM-04. Deformations noticed since SII Lot HWD and subsequent. Largest deformations approximately 3 mils deep.
- DISCUSSION:
  - The NSI/SII is a government furnished part.
  - SII created by welding a back-up ring to NSI. A sealing washer is welded on to provide the actual seal surface.
  - Sealing washer deforms during manufacturing process.
  - Potential to violate O-ring squeeze and requires corrective action.
- RECOMMENDATIONS:
  - TEAM CLASSIFICATION: Minor Anomaly


DEFORMATION IN SII
SEALING WASHER
.003
O-RING
SII SECONDARY
SEAL SURFACE

# 360L009 S&A DISASSEMBLY REPORT

- RECOMMENDATIONS (cont.):
  - JUSTIFICATION:
    - Deformation does not completely compromise secondary O-ring footprint.
    - Each SII is pressure tested to 3460 psi at the vendor.
    - SII's are low pressure leak tested; no leaks were detected.
  - CORRECTIVE ACTION:
    - Short Term:
      - Investigate engineering accept/reject criteria of deformations. 4 mil TIR established and submitted to QE.
        - Completed: 2 March 1990
      - Inspect all available SII's in Stores to engineering recommendations and screen out-of-recommendation deformations. 4 out of 147 SII's met engineering recommendations.
        - Completed: 23 March 1990
      - Obtain dimensions of all SII secondary O-rings in Stores and available secondary O-ring grooves to determine feasibility of using out-of-recommendation SII's.
        - Completed: 1 May 1990

# 360L009 S&A DISASSEMBLY REPORT

- CORRECTIVE ACTION (cont.):
  - Long Term:
    - Recommend and submit engineering changes to NASA for unibody SII construction.
      - (Actionee: S. Eden, D. Bullard, DE) Effective: 18 May 1990
    - Add limits to PEEP stating that deformations in sealing washer are reportable.
      - (Actionee: L. MacCauley, PFE) Effective: Flight 14
    - Evaluate new design of larger secondary O-ring and groove for higher squeeze.
      - Completed: 27 April 1990
      - Wider groove and larger cross-section O-ring will ensure higher squeeze.
    - Evaluate SII leak test and incorporate results.
      - (Actionee: J. Heman, S. Eden, DE) February 1991
    - Get relief from NASA for SII's in Stores that do not meet recommended criteria. Define scope of "relief" required.
      - Completed: 2 April 1990
      - Industry shortage of NSI's; 3 month lead time for new SII's; no relief from NASA.
- REPORT BACK TO RPRB? Yes

# 360L009 S&A DISASSEMBLY REPORT

- PFARs: 360L009B-14
- DESCRIPTION (ITEM 4):
  - A radial/circumferential scratch was found across the sealing washer of the 18 degree SII on 360L009B. The scratch was approximately 0.100 inches in length and less than 0.001 deep.
- HISTORY: Radial scratches have been previously seen on 360L006A, 360L007B, and 360L008A.
- 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 installation; source is unknown.
    - The aluminum shipping plate is being evaluated as a possible cause of the scratch.
  - Reportable and requires corrective action.

# 360L009 S&A DISASSEMBLY REPORT

- RECOMMENDATIONS:
  - TEAM CLASSIFICATION: Minor Anomaly
  - JUSTIFICATION:
    - SII's are low pressure leak tested; no leaks were detected.
    - No secondary O-ring damage found due to a scratch on the seal washer.
  - CORRECTIVE ACTION:
    - Short Term: Update Thiokol assembly planning to clarify inspection of SII seal surfaces.
      - (Actionee: N. Hess, QE) Effective: Flight 16
    - Long Term: Recommend and submit engineering changes to NASA for unibody SII.
      - (Actionee: S. Eden, D. Bullard, DE) Effective: 18 May 1990
    - Evaluate SII leak test and incorporate results.
      - (Actionee: J. Heman, S. Eden, DE) February 1991
- REPORT BACK TO RPRB? No

# 360L009 S&A DISASSEMBLY REPORT

- PFARs: 360L009B-19
- DESCRIPTION (ITEM 5):
  - Raised metal was found on the 198 degree SII shoulder seal surface.
- HISTORY: No previous record of this anomaly.
- DISCUSSION:
  - The raised metal was caused prior to SII installation. The raised metal 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.
  - Violates engineering and requires corrective action.
- RECOMMENDATIONS:
  - TEAM CLASSIFICATION: Minor Anomaly

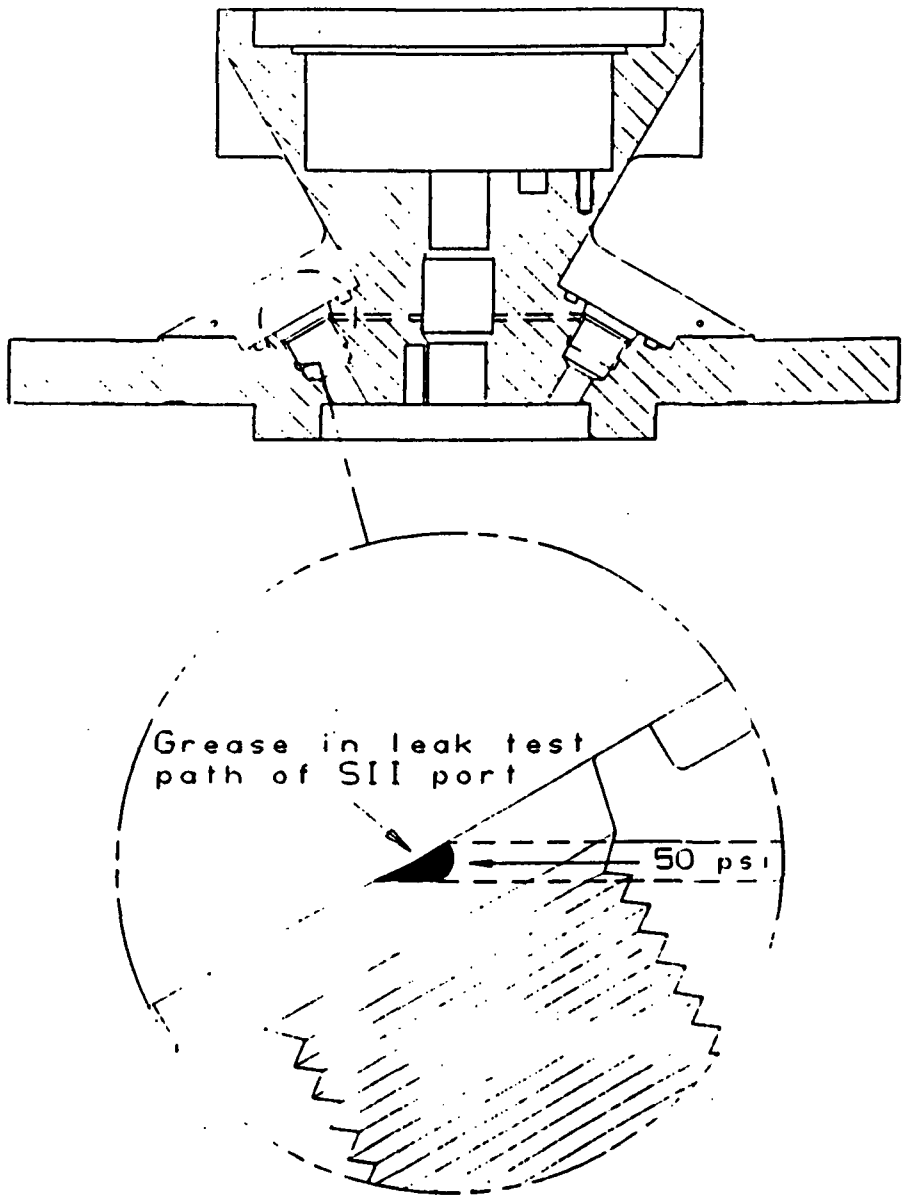
# 360L009 S&A DISASSEMBLY REPORT

- JUSTIFICATION:
  - No evidence of soot to the primary O-ring has been reported.
  - The primary O-ring is a packing seal.
  - Primary O-ring was not damaged due to raised metal in port.
- CORRECTIVE ACTION:
  - Short Term: Update Thiokol assembly planning and vendor refurb planning to include detailed inspection of all port seal surfaces.
    - (Actionee: N. Hess, D. Larson, QE) Effective: Flight 20
  - Long Term: Update refurbishment specification, STW7-3133, to incorporate better seal surface definitions and inspection points.
    - (Actionee: D. Bullard, S. Eden, DE) Effective: August 1990
    - Evaluate SII leak test and incorporate results.
      - (Actionee: J. Heman, S. Eden, DE) February 1991
- REPORT BACK TO RPRB? No

# 360L009 S&A DISASSEMBLY REPORT

- PFARs: 360L009A-16
- DESCRIPTION (ITEM 6):
  - *The leak test path between the O-rings in the 18 degree SII port of was filled with grease.*
- HISTORY: Previously found on 360L001A, 360L001B, 360L002A, 360L002B, 360L003A, 360L003B, 360T004A, and 360T004B.
- DISCUSSION:
  - Grease in the leak test path could possibly mask the 50 psi leak test of the SII primary and secondary O-rings.
  - Excess O-ring grease extrudes into the leak test path during SII installation.
  - Requires corrective action.
- RECOMMENDATIONS:
  - TEAM CLASSIFICATION: Minor Anomaly

# 360L009 S&A DISASSEMBLY REPORT



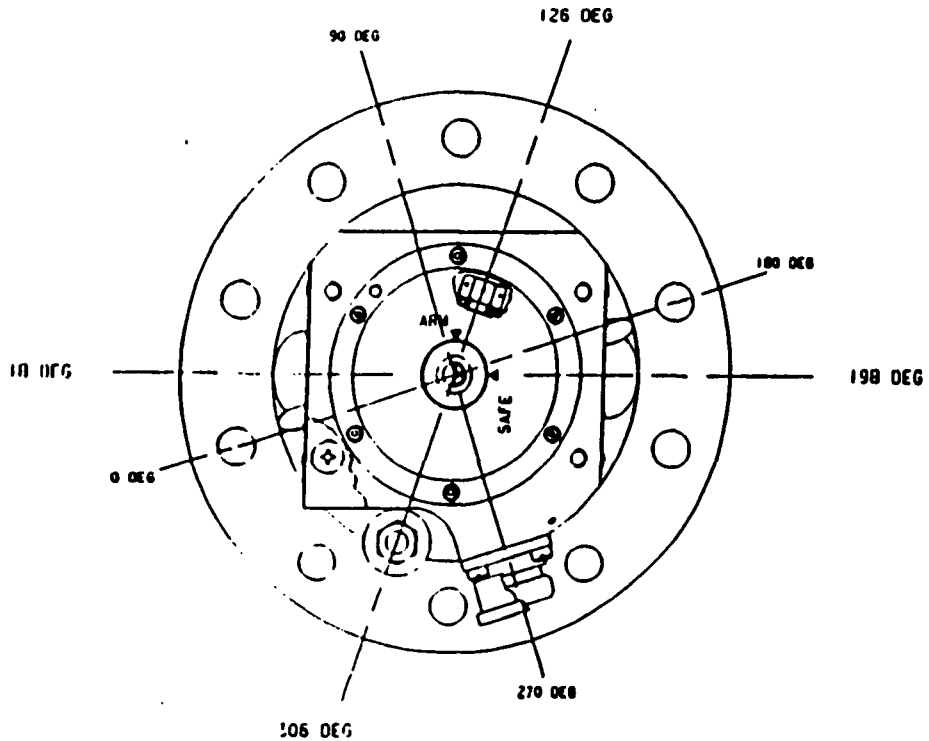
# 360L009 S&A DISASSEMBLY REPORT

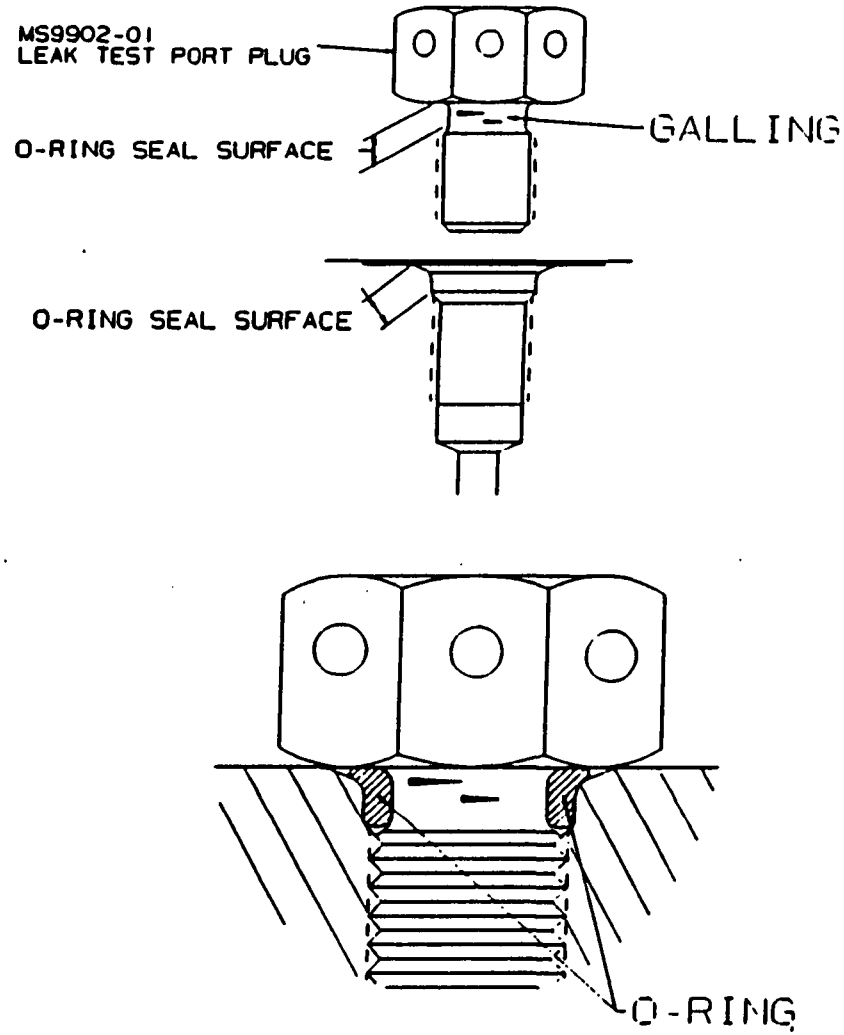
- RECOMMENDATIONS (cont.):
  - JUSTIFICATION:
    - No history of soot past the SII primary O-ring.
    - Metal-to-metal contact exits between SII and port spotface.
    - No damage found on primary or secondary O-ring.
  - CORRECTIVE ACTION:
    - Short Term:
      - Modify Thiokol assembly planning to limit O-ring grease application to a thin film, install O-rings, and verify that leak test path is free from obstruction prior to SII installation.
        - (Actionee: A. Jones, N. Hess) Effective: Flight 17
    - Long Term:
      - Evaluate SII leak test and incorporate results.
        - (Actionee: J. Heman, S. Eden, DE) February 1991
- REPORT BACK TO RPRB? No

# 360L009 S&A DISASSEMBLY REPORT

- PFARs: 360L009B-15
- DESCRIPTION (ITEM 7):
  - Circumferential galling found on shoulder seal surface of 360L009B B-B bore and B-B flange leak test plugs (MS9902-01). Width and length of galled regions varied.
- HISTORY: Previously found on 360T004, 360L006, 360L007, TEM-04, TEM-05, and LAT-41.
- DISCUSSION:
  - Violates surface finish and requires corrective action.
  - Galling occurs during machining process of leak test plug seal surface.
  - Leak test plugs inspected and installed into B-B at vendor, Eaton-Valve and Actuator Division (E-VAD). Plugs are removed prior to leak test and re-installed.
  - KSC planning calls out inspection for 306 degree leak test plug prior to re-installation; Thiokol planning does not call out inspection for 126 degree leak test plug.
- RECOMMENDATIONS:
  - TEAM CLASSIFICATION: Minor Anomaly

# 360L009 S&A DISASSEMBLY REPORT



- JUSTIFICATION:
  - Galled surface does not extend across full O-ring footprint.
  - Shoulder seal is packing seal; top and side surfaces would seal.
  - No O-ring damage found due to galled shoulder seal surface.
- CORRECTIVE ACTION:
  - Short Term:
    - Inspect all MS9902-01 leak test plugs in Stores and at E-VAD per MS9902 specification and reject those that are unacceptable.
      - Stores inspection completed: 19 January 1990
      - (Actionee: D. Larson, QE) Effective: Flight 20
    - Update Thiokol assembly planning to perform visual inspection of leak test plugs just prior to re-installation.
      - (Actionee: N. Hess, QE) Effective: Flight 17
  - Long Term:
    - Replace MS9902-01 plug with 1U50159 leak test plug; 1U50159 plugs are 100 percent inspected and controlled in-house.
      - (Actionee: D. Bullard, S. Eden, DE) Effective: Flight 20
- REPORT BACK TO RPRB? No

# 360L009 S&A DISASSEMBLY REPORT

- PFARs: 360L009A-20
- DESCRIPTION (ITEM 8):
  - Three deformations were found on the underside of the head of the 306 degree leak test port plug (MS9902-01). The largest deformation, approximately 0.0017 inches deep, extended into the O-ring footprint.
- HISTORY: No previous record of this anomaly.
- DISCUSSION:
  - Source of deformations unknown; possibly caused during manufacture of leak test plug.
  - Leak test plugs inspected and installed into B-B at vendor, Eaton-Valve and Actuator Division (E-VAD). Plugs are removed prior to in-house and KSC leak test and re-installed.
  - KSC assembly planning calls out inspection for 306 degree leak test plug prior to re-installation.

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# 360L009 S&A DISASSEMBLY REPORT

- RECOMMENDATIONS:
  - TEAM CLASSIFICATION: Remains observation.
  - JUSTIFICATION:
    - Downstream location of deformations would not affect the sealability of the shoulder O-ring.
  - RECOMMENDATION:
    - Close PFAR.
- REPORT BACK TO RPRB? No

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