TEST PLAN FOR THE BOLT/JOINT STIFFNESS FOR THE ALPHA MAGNETIC SPECTROMETER (AMS)-02

TWP MHECSMBSX

Prepared by

Lockheed Martin Space Operations
Houston, TX

For

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center

October 19, 2001

Test Plan for the Bolt Joint Stiffness

Prepared by:

_____
Phil Mott, Certification & Test Lead
LMSO

Reviewed by:

_____
Chittur Balasubramanian, Stress Analysis Lead
LMSO

Approval:

_____
Trent Martin, Structural Analysis Lead
LMSO

_____
Mike Trznadel, Manager
Structural Analysis Section
LMSO

_____
Kenneth Bollweg
Project Manager, AMS-02
LMSO

CONTENTS

Section ..... Page
1.0 Test Objectives 1
2.0 Test Article 1
3.0 Test Sample Setup 3
3.1 Case 1A, 2A, 3A 3
3.2 Case 1B, 2B, 3B 4
3.3 Case 1C, 2C, 3C 4
3.4 Case 1D, 2D, 3D 5
3.5 Instrumentation 5
4.0 Data Requirements 8
5.0 Test Procedures 8
6.0 Test Support 11

TABLES

Table		Page
2-1	Test Configurations	1
3.5.1-1	Material Properties for Strain Gage Setup	5
6-1	Test Personnel	11

FIGURES

Figure		Page
2-1	Test Setup – Case 1	2
2-2	Test Setup – Case 2	2
2-3	Test Setup – Case 3	3
3.5.2-1	Instrumentation Layout – Case 1	6
3.5.2-2	Instrumentation Layout – Case 2	6
3.5.2-3	Instrumentation Layout – Case 3	7
5.1-1	Test Setup – Case 1	8
5.1-2	Test Setup – Case 2	9
5.1-3	Test Setup – Case 3	9

ACRONYMS AND ABBREVIATIONS

AMS	Alpha Magnetic Spectrometer
FEM	Finite Element Model
JSC	Johnson Space Center
LMSO	Lockheed Martin Space Operations
MSDS	Material Safety Data Sheet
P/N	Part Number
QA	Quality Assurance
STL	Structural Testing Laboratory
TPS	Task Preparation Sheet
TRR	Test Readiness Review

1. Test Objectives

1.1. Each set up will determine the bolt/joint stiffness for that configuration.

1.2. The data taken will be used to verify the FEM of the Vacuum Case.

1.3. Each set up will be tested to failure.

2. Test Article

The test articles will consist of 12 setups, each a different configuration as shown in Table 2-1. The test articles for each of the three cases are shown in Figures 2-1 through 2-3.

Table 2-1: Test Configurations

CASE	BOLT GAP	JOINT
1A	With Liquid Shim	Dry
1B	Without Liquid Shim	Dry
1C	With Liquid Shim	Grease
1D	Without Liquid Shim	Grease
2A	With Liquid Shim	Dry
2B	Without Liquid Shim	Dry
2C	With Liquid Shim	Grease
2D	Without Liquid Shim	Grease
3A	With Liquid Shim	Dry
3B	Without Liquid Shim	Dry
3C	With Liquid Shim	Grease
3D	Without Liquid Shim	Grease

Case 1: Conical Flange to Support Ring (Insert)
Case 2: Outer Cylinder to Support Ring (Insert)
Case 3: Outer Cylinder to Support Ring (Thru Hole)

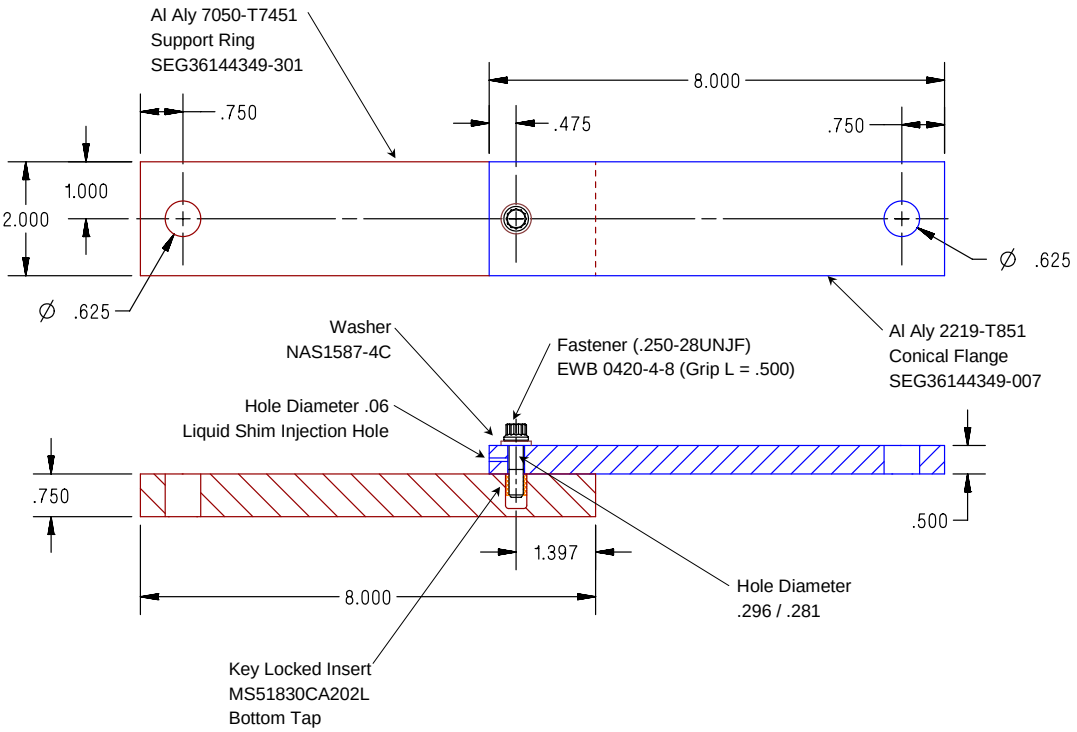

Figure 2-1: Test Setup – Case 1

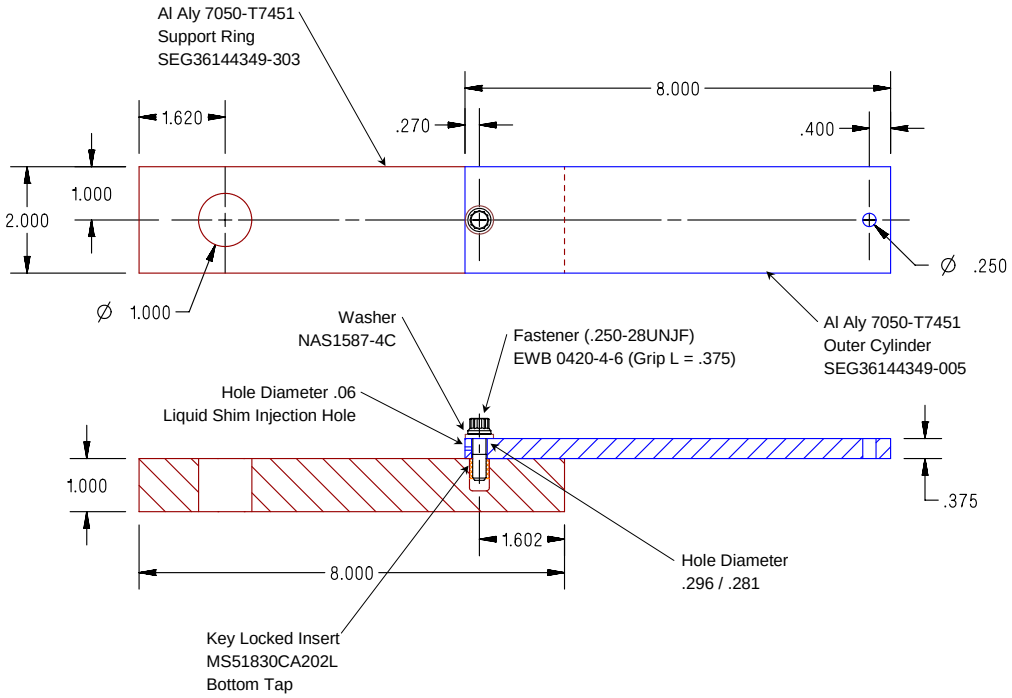

Figure 2-2: Test Setup – Case 2

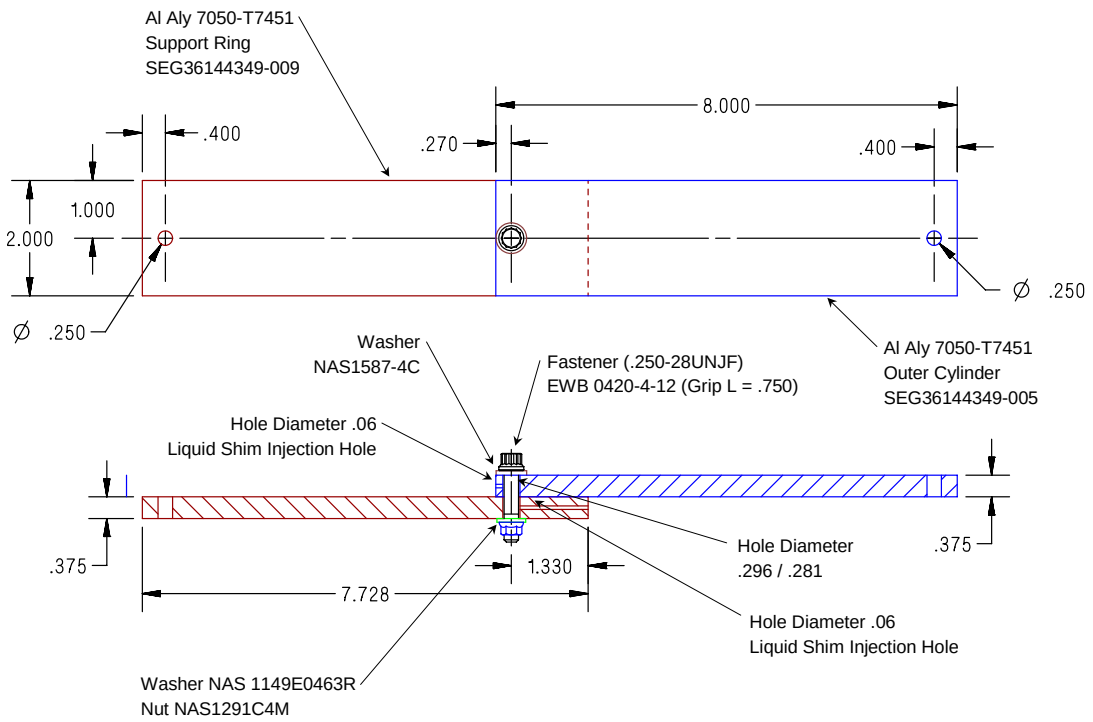

Figure 2-3: Test Setup – Case 3

3. Test Sample Setup

3.1. Case 1A, 2A, 3A

3.1.1. Refer to Figures 2-1, 2-2 or 2-3 for part numbers.

3.1.2. Apply PTFE Release Agent, MS122DF, to the entire length of the fastener per the manufacturer's directions.

3.1.3. Install fastener and measure running torque. Do not tighten fastener but leave it protruding about .125 inches above the plate.

3.1.4. Mix liquid shim per the manufacturer's direction.

3.1.5. Using syringe, inject liquid shim into the .060 diameter injection hole on the plate while slowing turning fastener until the liquid shim is oozing out of the top of the hole. Clean off excess liquid shim at the top of the hole and measure running torque to check if it has increased due to the liquid shim.

3.1.6. Torque fastener to:

Case 1: 146-172 ft-lbs
Case 2: 146-172 ft-lbs
Case 3: 146-172 ft-lbs

3.1.7. Allow liquid shim to cure for 24 hours per the manufacturer's instructions before testing.

3.2. Case 1B, 2B, 3B

3.2.1. Refer to Figures 2-1, 2-2 or 2-3 for part numbers

3.2.2. Install fastener and measure running torque.

3.2.3. Torque fastener to:

Case 1: 146-172 ft-lbs
Case 2: 146-172 ft-lbs
Case 3: 146-172 ft-lbs

3.3. Case 1C, 2C, 3C

3.3.1. Refer to Figures 2-1, 2-2 or 2-3 for part numbers.

3.3.2. Apply PTFE Release Agent, MS122DF, to the entire length of the fastener per the manufacturer's directions.

3.3.3. Apply a thin film of High Vacuum Grease to the overlapping plate surfaces (mating surface).

3.3.4. Install fastener and measure running torque. Do not tighten fastener but leave it protruding about .125 inches above the plate.

3.3.5. Mix liquid shim per the manufacturer's direction.

3.3.6. Using syringe, inject liquid shim into the .060 diameter injection hole on the plate while slowing turning fastener until the liquid shim is oozing out of the top of the hole. Clean off excess liquid shim at the top of the hole and measure running torque to check if it has increased due to the liquid shim.

3.3.7. Torque fastener to:

Case 1: 146-172 ft-lbs
Case 2: 146-172 ft-lbs
Case 3: 146-172 ft-lbs

3.3.8. Allow liquid shim to cure for 24 hours per the manufacturer's instructions before testing.

3.4. Case 1D, 2D, 3D

3.4.1. Refer to Figures 2-1, 2-2 or 2-3 for part numbers

3.4.2. Apply a thin film of High Vacuum Grease to the overlapping plate surfaces (mating surface).

3.4.3. Install fastener and measure running torque.

3.4.4. Torque fastener to:

Case 1: 146-172 ft-lbs
Case 2: 146-172 ft-lbs
Case 3: 146-172 ft-lbs

3.5. Instrumentation

3.5.1. For gage setup, use material properties shown in Table 3.5.1-1.

Table 3.5.1-1 Material Properties for Strain Gage Setup

Location	Material	E x 10^6 psi		ν
		Tension	Compression	
Conical Flange	Aluminum 2219-T851 Plate	10.5	10.8	.33
Support Ring	Aluminum 7050-T7451 Plate	10.3	10.6	.33
Outer Cylinder	Aluminum 7050-T7451 Plate	10.3	10.6	.33

3.5.2. See Figures 3.5.2-1 through 3.5.2-3 for triaxial strain and deflection gage setups. Note that one leg of the triaxial gage should be aligned with the direction of the loading.

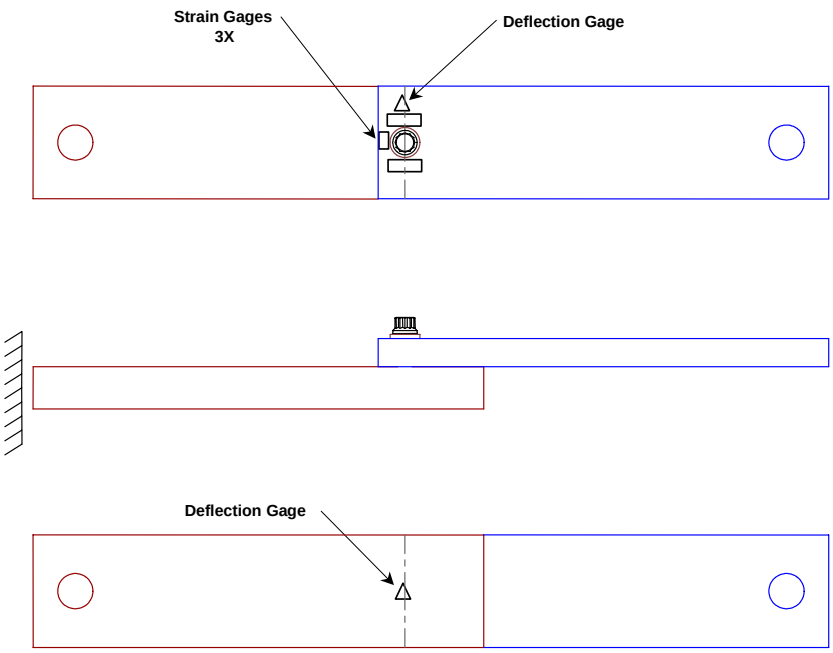

Figure 3.5.2-1: Instrumentation Layout – Case 1

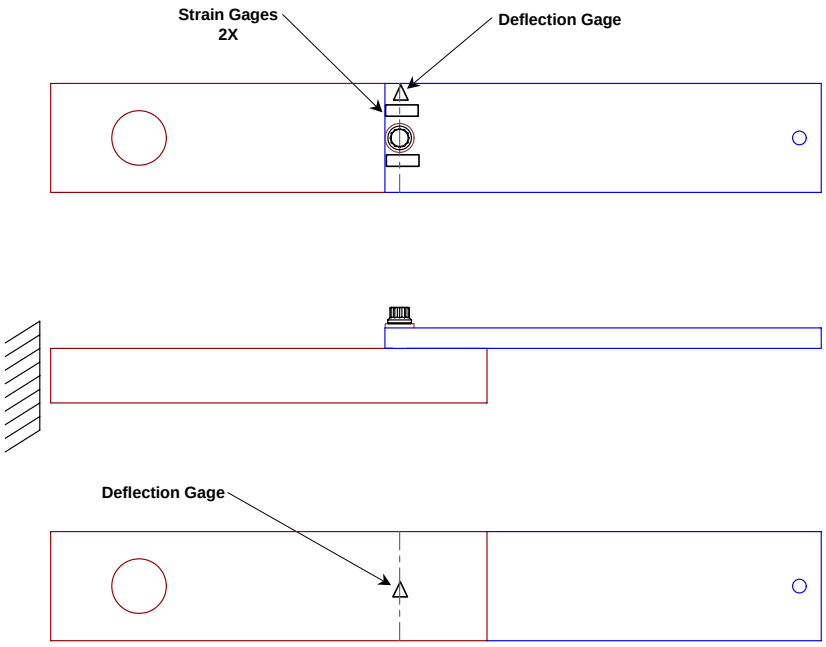

Figure 3.5.2-2: Instrumentation Layout – Case 2

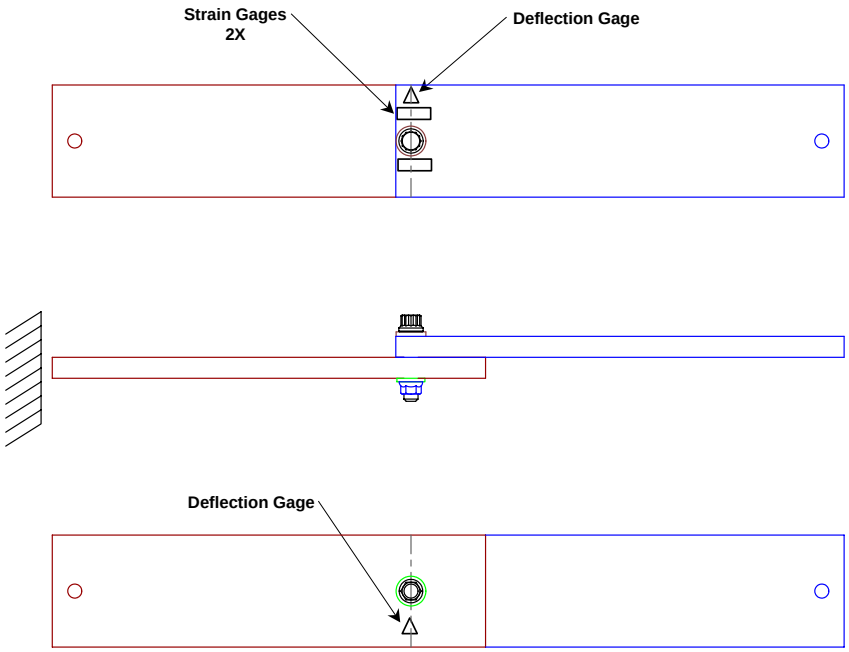

Figure 3.5.2-3: Instrumentation Layout – Case 3

4. Data Requirements

4.1. These tests require the support of the JSC Building 13 STL. The following output will be coordinated and delivered by the test lab.

Load in Anti-Rotation Supports versus Applied Load
Delta Deflection (in direction of applied load) versus Applied Load
Strain versus Applied Load

4.2. Real time readouts of all gages provided on a display monitor for the Test Engineer and Stress Analyst during all of the tests. Once the data has been obtained, further monitoring is not necessary.

4.3. Test Data Package including test notes, control documentation, instrumentation, test data and other applicable data.

5. Test Procedures

5.1. These procedures apply to all cases. See the following figures for test setups.

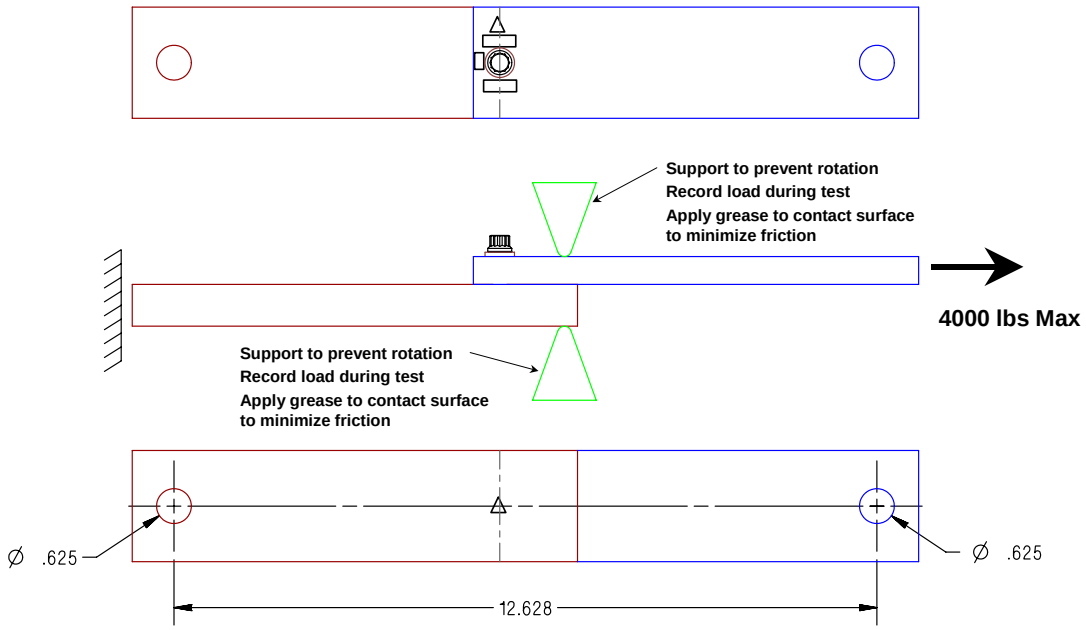

Figure 5.1-1: Test Set Up – Case 1

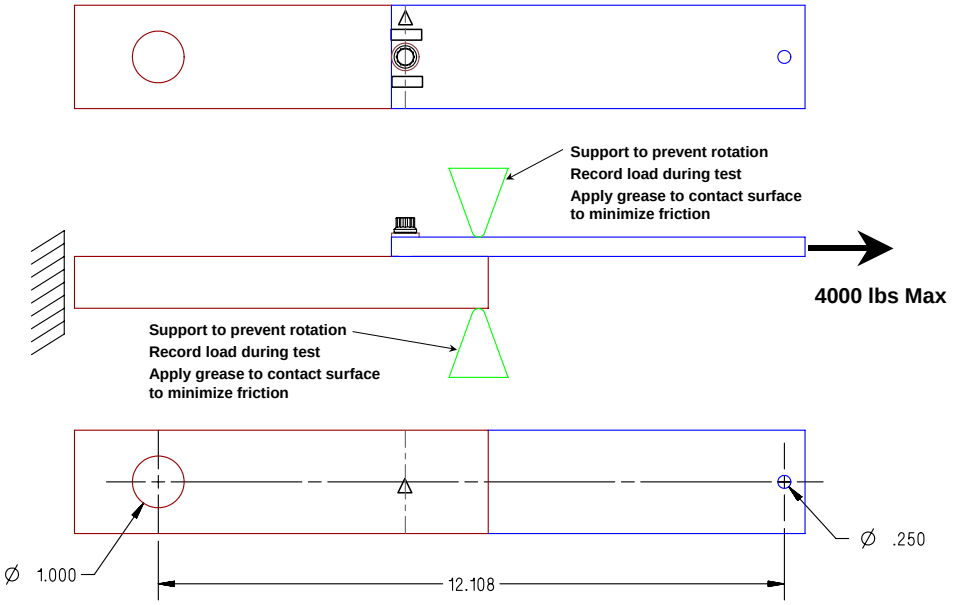

Figure 5.1-2: Test Set Up – Case 2

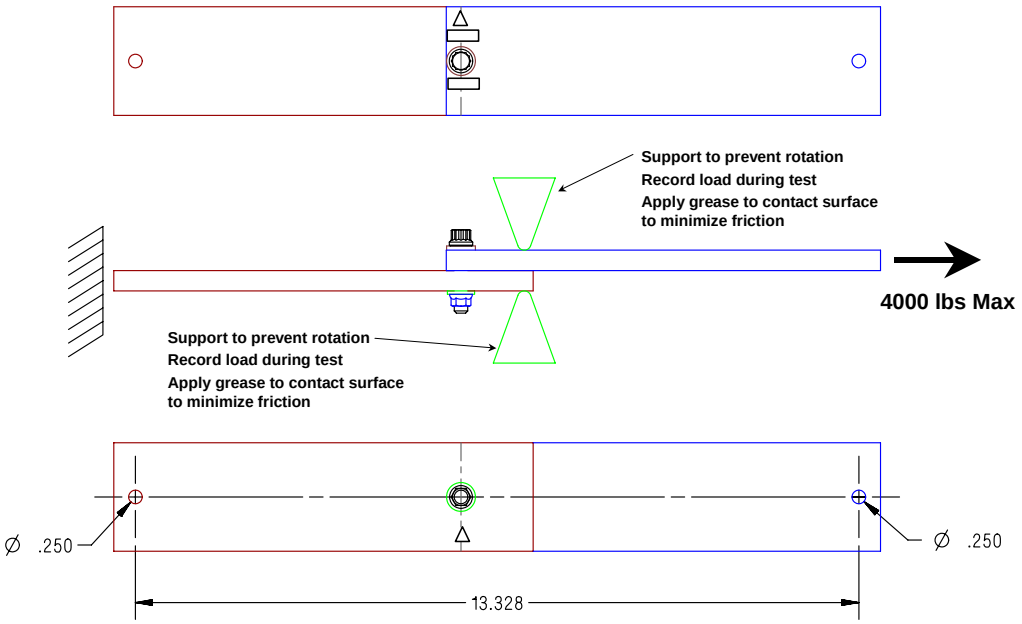

Figure 5.1-3: Test Set Up – Case 3

5.2. Position anti-rotation supports within .25 inches of location shown in the previous figures.

5.3. Apply a thin film of High Vacuum Grease to the contact area of the supports to minimize friction.

5.4. Clear the test area of all unnecessary personnel.

5.5. Zero strain and deflection gages

5.6. Begin recording strain and deflection data.

5.7. Start actuator at 800 lbs per minute.

5.8. Pull test article to failure. Maximum applied will be less than 4000 lbs.

5.9. Repeat procedure for all test samples.

6. Test Support

6.1. This test will be used for FEM verification and strength determination. Full Quality Assurance (Q.A.) coverage is not required. Test readiness will be determined by the Test Director. Table 6-1 defines the personnel responsible for this test.

Table 6-1. Test Personnel

Responsibility	Representative	Contact
Test Engineer	Hsing Ju / LMSO	281-333-7494
AMS-02 Test Lead Engineer	Phil Mott / LMSO	281-333-6451
Project Manager	Kenneth Bollweg / LMSO	281-335-2714
Structural Lead	Trent Martin / LMSO	281-335-2139
Stress Lead	Chittur Balasubramanian / LMSO	281-333-7518
Stress Analyst	Howard Carter / LMSO	281-333-7339
Safety	Robert Seiwell/Hernadez	483-6348
Q.E.	David Fretz	281-483-6375 281-763-7853
Facility Personnel	Don Wilbanks / LMSO	281-483-8819