VOLUME III

DOCUMENT NUMBER

QTR-2191-001

REV. N/C

TITLE

QUALIFICATION TEST REPORT FOR 450 GALLON CRASHWORTHY FUEL TANK FOR U.S. AIR FORCE H-53 HELICOPTER

TEST PERFORMED BY

FIBER SCIENCE DIVISION

CONTRACT NUMBER

F09603-79-C-1642-P20002

PREPARED BY

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APRIL 2, 1982

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APPENDIX A

QUALIFICATION TEST PROCEDURES

QTR-2191

SECTIONS K THRU T

DOCUMENT NUMBER

QTP-2191 SECTION "K"

TITLE

QUALIFICATION TEST PROCEDURE

H-53 TANK

REQUIREMENTS FOR ENVIRONMENTAL TESTS

REVISIONS

LTR.	DATE	PREPARED	APPROVED	DESCRIPTION

PREPARED BY: Richard Lyman DATE: 1/27/81

CHECKED BY: R. Stone DATE: 2-10-81

APPROVED BY: C. A. Patrick Jr DATE: 2/10/81

FIBER SCIENCE, INC.
SALT LAKE CITY, UTAH

NO. QTP-2191 Section "K"

DATE: 1/27/81

SCOPE

This procedure covers the requirements for Environmental Testing of the 450 Gallon Filament Wound External Fuel Tank for the H-53 Helicopter. This document shall only cover environmental requirements for qualification testing for high and low temperature exposure. All other environmental qualification test requirements, humidity exposure, salt spray and dust exposure, are qualified by similarity to the construction of the 650 gallon tank for the CH-53E Helicopter. The 650 gallon tank was qualified by Lear Siegler under contract to the U.S. Navy, Contract No. N00019-78-C-0137.

2.0 APPLICABLE DOCUMENTS

2.1 MILITARY SPECIFICATIONS

MIL-STD-831	Preparation of test reports.

2.2 FEDERAL SPECIFICATION

TT-S-735	Standard Test Fluid; Hydrocarbon.

2.3 TECHNICAL EXHIBIT

ASD/ENFEA-78	Tank - 450 gallon external fuel, filament wound lightweight explosion proof.

2.4 DRAWINGS

FIBER SCIENCE, INC.

2191-001	Tank - installation, 450 Gallon H-53

SARGENT FLETCHER

27-450-4400	Pylon assembly 450 gallon fuel tank.

3.0 REQUIREMENTS

3.1 TEST ARTICLE

One dried tank assembly (2191-001) mounted to a pylon (27-450-4400) which in turn is mounted in a test chamber shall be fueled to a full tank condition with Type II test fluid per TT-S-735 and then subjected to the Environmental Qualification Tests of Paragraph 4.6.17 as described in Technical Exhibit ASD/ENFEA-78.

3.2 TEST ARRANGEMENT

The test arrangement shown in Figure 1 shall be such as to take all reasonable precautions to simulate the actual environmental conditions of the tank and pylon while mounted on the helicopter.

3.3 TEST METHOD

The tank after drying for one day at 160^{o} F $\pm$ 5^{o} F shall be filled with Type II test fluid per TT-S-735 and suspended in a 2^{o} nose down position in a test chamber. The tank shall then be pressurized to 15 psi and subjected for three (3) days to the low temperature exposure of -65^{o} F $\pm$ 5^{o} F, drained, examined, refilled, pressurized and subjected to the high temperature exposure of 160^{o} F $\pm$ 10^{o} F for three (3) days. There shall be no evidence of leakage.

3.4 TEST INSTRUMENTATION

A staining agent of fluorescent dye shall be mixed in the Type II test fluid to aid in the detection of any fluid leakage during the test. A soap solution shall be used above the test fluid level as shown in Figure 1 to detect leakage. Pressure and temperature shall be monitored continuously during the test by a continuous recording device or round the clock manning of the test.

3.4.1 INSTRUMENTATION CALIBRATION

All instrumentation shall be calibrated and capable of reading or recording data within $\pm$ 2% of its full scale value. No instrument shall be used that has not been calibrated within the previous calibration period.

3.5 TEST PRODECURES

The test procedures shall be in accordance with Paragraph 4 of this document.

3.6 DOCUMENTATION

At the conclusion of testing a test report will be prepared for submission to the contractor.

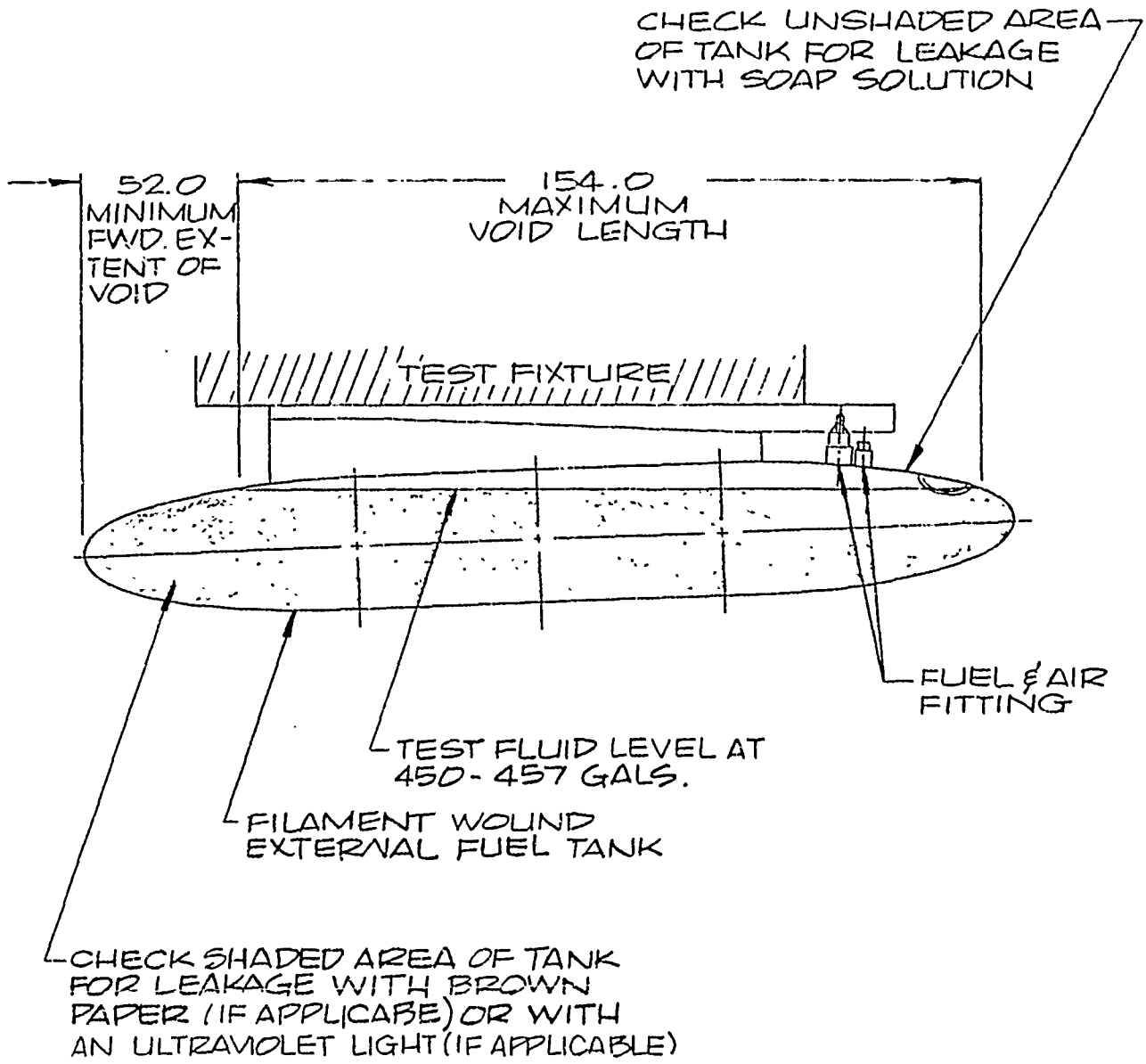


FIGURE 1

ENVIROMENTAL TEST ARRANGEMENT

4.0 QUALIFICATION TEST PROVISIONS

4.1 EXAMINATION OF PRODUCT

The tank and pylon shall be fully examined prior to mounting to the environmental test fixture for shipping damage to the test site. This examination shall include a visual inspection and a tap test for delaminations. The results of this inspection shall be recorded by the testing activity in the presence of an authorized Fiber Science Test Engineer.

4.2 MOUNTING

The tank shall then be mounted in an environmental test chamber by means of the simulated airframe adaptor and examined for proper attachment and assimilation to the actual aircraft installation. Any significant variations or deviations shall be recorded.

4.3 ARRANGEMENT

The test arrangement shall be examined for compliance with this procedure or shall be deemed to be in compliance with this procedure and the applicable paragraphs of ASD/ENFEA-78 Technical Exhibit and approved by an F.S.I. authorized Test Engineer and an authorized Government representative.

4.4 INSTRUMENTATION AND TEST EQUIPMENT

4.4.1 INSTRUMENTATION CALIBRATION

All instrumentation shall be inspected to verify that each instrument has had a calibration check within the last calibration period.

4.4.2 INSTALLATION

All instruments and test equipment: pressure gauges, temperature gauges or recorders shall be installed and leads properly tethered so as to have little or no affect on the test. Temperature sensing devices shall be located to best establish the mean temperature of the test chamber and test article.

4.4.3 OPERATION

All instrumentation and test equipment shall be checked for proper operation. Any defects in instrumentation or equipment shall be recorded and the test shall not proceed until the defect is removed or deemed not critical for the test required by the testing activity and approved by an authorized Fiber Science Test Engineer.

4.5 TEST ARTICLE DRYING

Dry empty tank and integral pylon for 24 hours at 160° F ± 5° F. All access openings shall be open during the drying process. Temperature shall be continuously monitored (manned) or recorded) during the drying time.

4.6 FUELING

The tank shall be filled with 450 to 457 gallons of Type II test fluid per TT-S-735 through the filler cap opening. A satisfactory staining agent, for brown paper leak detection, or a fluorescent dye, for ultra-violet light leak detection shall be added to the test fluid. The amount of leak detection agent to be added to the test fluid shall be determined.

4.7 ENVIRONMENTAL TEST

Upon completion of the drying of the test article per Paragraph 4.5 and fueling per Paragraph 4.6, perform the following tests:

4.7.1 LOW TEMPERATURE TEST

The tank mounted in the test chamber, filled with the test fluid and properly prepared for leak detection (cover entire tank with brown paper for leak detection if a staining agent is used in the fluid) shall be pressurized to 15 ± 2 psi cooled to -65° F ± 5° F. The tank shall be held at the -65° F ± 5° F temperature for 72 hours.

4.7.1.1 LOW TEMPERATURE TEST EXAMINATION

Upon completion of the 72 hour low temperature test, examine the tank for any sign of leakage. Any leakage shall be considered as a tank failure. Empty tank and visually inspect for any unsatisfactory condition including a tap test for delaminations.

4.7.2 HIGH TEMPERATURE TEST

Refuel the tank to the requirements of Paragraph 4.6, secure all access and fuel line openings and pressurize the tank to 15 ± 2 psi. Increase chamber temperature to 160° F ± 10° F and maintain for 72 hours.

4.7.2.1 HIGH TEMPERATURE TEST EXAMINATION

Upon completion of the 72 hour high temperature test, examine the tank for any sign of leakage. Any leakage shall be considered as a tank failure. Empty tank and visually inspect for any unsatisfactory condition including a tap test for delaminations.

5.0 QUALIFICATION TEST REPORT

A formal qualification test report shall be submitted per MIL-STD-831 within 30 days after the testing is complete. This report is to include all recorded temperature and pressure data sheets, if such were continuously recorded, and inspection data sheets. The test tank shall be returned to Fiber Science for further testing in the same shipping container it was received in.

APPENDIX "A"

TEST DATA SHEETS

TEST DATA SHEET

QTR-2191 SECTION "K"

Testing Activity _____ Activity Test Engr. _____

Tank Serial No. _____ F.S.I. Test Engr. _____

Test Date _____ Government Rep. _____

EXAMINATION OF PRODUCT

Ref. Para. 4.1: Visual Inspection _____

_____

_____

_____

_____

Delaminations (Tap Test) _____

_____

_____

_____

_____

MOUNTING

Ref. Para. 4.2: Aircraft Simulated Attachment

Deviations If Any _____

_____

_____

_____

_____

ARRANGEMENT

Ref. Para. 4.3: APPROVED TEST ARRANGEMENT (REF. FIGURE 1 AND ASD/ENFEA-78 TECHNICAL EXHIBIT)

Testing Activity Approval

Approved By _____ Date _____

F.S.I. Test Engineer Approval

Approved By _____ Date _____

Government Approval

Approved By _____ Date _____

Minimum of two signatures required.

INSTRUMENTATION

Ref. Para. 4.4.1: CHECK INSTRUMENTATION CALIBRATION

ITEM	CALIBRATION DATE
Test Chamber (If Applicable)	
Temperature Recorder (If Applicable)	
Temperature Gauge	
Pressure Recorders (If Applicable)	
Pressure Gauges	
Other Instruments:	
1.	
2.	
3.	

Ref. Para. 4.4.2: CHECK PROPER INSTALLATION

ITEM	REMARKS
Tank	
Simulated Aircraft Adaptor	
Cooling Source	
Heating Source	
Recorders (If Applicable)	
Gauges	
Other Instruments:	
1.	
2.	
3.	
4.	

Ref. Para. 4.4.3: CHECK PROPER OPERATION

ITEM	REMARKS
Cooling Source	
Heating Source	
Gauges	
Recorders (If Applicable)	
Other Instruments:	
1.	
2.	
3.	
4.	

DRYING

Ref. Para. 4.5: DRY EMPTY TANK AND PYLON

ITEM	REMARKS
Tank Condition (Empty)	
Access Ports (Open)	
Temperature (160^{o} F $\pm$ 5^{o} F)	
Time at Temperature (24 Hrs)	
Temperature Monitoring (Manned or Recorded)	

FUELING

Ref. Para. 4.6: FUEL TANK AT PROPER ATTITUDE

ITEM	REMARKS
Attitude (2^{o} Nose Down)	
Fill with 450 to 457 Gal. Type II Test Fuel	
Type of Leak Detecting Additive	
Amount of Leak Detecting Additive	
Secure All Openings	

ENVIRONMENTAL TEST

LOW TEMPERATURE TEST

Ref. Para. 4.7.1: WITH ALL EQUIPMENT AND INSTRUMENTATION WORKING PROPERLY, PRESSURIZE TANK, CLOSE CHAMBER AND START COOL DOWN.

ITEM	OPERATION REMARKS
Chamber Closed (Time)	
Start Cool Down (Time)	
Cooling Rate (^{O}F/Hr.)	
Test Temperature (-65^{O}F ± 5^{O}F)	
Time Achieved (Chamber)	
Time Achieved (Tank)	
Elapsed Time (72 Hrs.)	
Open Chamber (Time)	
Removed Test Article (Time)	
Temperature Recorder	
Pressure Recorder	
Temperature Gauge	
Pressure Gauge	
Other Instruments:	
1._____	
2._____	
3._____	
4._____	

LOW TEMPERATURE EXAMINATION

Ref. Para. 4.7.1.1: CHECK LEAKAGE, DAMAGE AND APPEARANCE

Brown Paper Dye Stain Examination for Leakage (If Applicable): _____

Ultra Violet Light Dye Detection for Leakage (If Applicable): _____

Soap Solution Test Void Area for Leakage (See Figure 1): _____

Ref. Para. 4.7.1.1: DRAIN TANK, RELIEVE PRESSURE AND OPEN ACCESS PORTS

Visual Examination

Condition of Outside Surface _____

Condition of Liner _____

Condition of Fittings _____

Condition of Seals _____

Delaminations (Tap Test) _____

HIGH TEMPERATURE TEST

Ref. Para. 4.7.2: REFUEL TANK, RESET INSTRUMENTATION, PRESSURIZE TANK, CLOSE CHAMBER AND START WARM UP:

ITEM	OPERATION REMARKS
Chamber Closed (Time)	
Start Warm Up (Time)	
Warm Up Rate (^{O}F/Hr.)	
Test Temperature (160^{O}F $\pm$ 10^{O}F)	
Time Achieved (Chamber)	
Time Achieved (Tank)	
Elapsed Time (72 Hrs.)	
Open Chamber (Time)	
Removed Test Article (Time)	
Temperature Recorder	
Pressure Recorder	
Temperature Gauge	
Pressure Gauge	
Other Instruments:	
1.	
2.	
3.	
4.	

HIGH TEMPERATURE EXAMINATION

Ref. Para. 4.7.2.1: CHECK LEAKAGE, DAMAGE AND APPEARANCE

Brown Paper Dye Stain Examination for Leakage (If Applicable): _____

Ultra Violet Light Dye Detection for Leakage (If Applicable): _____

Soap Solution Test Void Area for Leakage (See Figure 1): _____

Ref. Para. 4.7.2.1: DRAIN TANK, RELIEVE PRESSURE AND OPEN ACCESS PORTS

Visual Examination

Condition of Outside Surface _____

_____

_____

_____

Condition of Liner _____

_____

_____

_____

Condition of Fittings _____

_____

_____

_____

Condition of Seals _____

_____

_____

_____

Delaminations (Tap Test) _____

_____

_____

_____

EVALUATION OF DATA

LOW TEMPERATURE TEST: _____

HIGH TEMPERATURE TEST: _____

GENERAL CONDITION OF TANK: _____

RECORDER READING: _____

DOCUMENT NUMBER

QTP-2191 SECTION "L"

TITLE

QUALIFICATION TEST PROCEDURE

H-53 TANK

REQUIREMENTS FOR STATIC LOADS

REVISIONS

LTR.	DATE	PREPARED	APPROVED	DESCRIPTION

PREPARED BY: Richard Lyman DATE: 1/20/81

CHECKED BY: Randy Stowe DATE: 1-28-80

APPROVED BY: C. A. Patrick Jr DATE: 1/29/80

FIBER SCIENCE, INC.
SALT LAKE CITY, UTAH

NO. QTP-2191 Section "L"

DATE: 1/20/81

1.0 SCOPE

This procedure covers the requirements for Static Loads Testing of the 450 Gallon Filament Wound External Fuel Tank for the H-53 Helicopter.

2.0 APPLICABLE DOCUMENTS

2.1 MILITARY SPECIFICATIONS

MIL-A-8591	Airborne stores and associated suspension equipment, criteria for.
MIL-A-8868	Airplane strength and Rigidity, data and reports.
MIL-STD-831	Test reports, preparation of.

2.2 TECHNICAL EXHIBIT

ASD/ENFEA-78	Tank - 450 gallon external fuel, filament wound light-weight explosion proof.

2.3 TECHNICAL REPORT

SR-2191-001	Structural Analysis Report 450 Gallon Tank

2.4 DRAWINGS

FIBER SCIENCE

2191-001	Tank - Installation, 450 gallon H-53

SARGENT FLETCHER

27-450-4400	Pylon Assembly - 450 gallon fuel tank.

3.0 REQUIREMENTS

3.1 TEST ARTICLE

One tank assembly (2191-001) shall be securely fastened to a pylon (27-450-4400) which in turn is mounted to a structural test fixture by means of a simulated airframe adaptor. The tank shall then be fueled to a full tank condition and subjected to the static loads testing conditions of Technical Exhibit ASD/ENFEA-78, Paragraph 4 6.18.

3.2 TEST ARRANGEMENT

The test arrangement shall be similar to that shown in Figure 1 with all reasonable precautions taken to simulate the actual mounting of the tank and pylon to the helicopter.

3.3 TEST METHOD

The tank secured to the pylon by the pylon support points shall be suspended from the structural test fixture in a 2° nose down position. High tensil fabric strapping connected to a whippletree arrangement shall be placed around the tank at location indicated in Figure 2. The whippletrees shall be connected to load applying devices which shall as near as practical apply the loads to the tank in a simultaneous manner. The tank shall then be filled with water to a full tank condition pressurized to the 15 psi working pressure and the static structural loads applied as follows:

3.3.1. DESIGN LIMIT LOADS

The tank shall be subjected to three (3) critical static limit load conditions (115% of the design loads) as determined by the 450 gallon tank structural analysis report SR-2191 prepared to the requirements of MIL-A-8868 using the loading parameters set forth in the Technical Exhibit ASD/ENFEA-78 from MIL-A-8591 Rev E. One condition of the three selected shall be a crash or hard landing condition. At the conclusion of the test there shall be no evidence of rupture, leakage or structural damage.

3.3.2 DESIGN ULTIMATE LOADS

The tank upon completion of the design limit loads test of Paragraph 3.3.1 shall be subjected to the same three (3) load conditions at the ultimate load conditions (150% of the design loads). At the conclusion of the test there shall be no evidence of rupture, leakage or structural damage.

3.3.3 DESTRUCTION TEST

The tank upon completion of the design ultimate loads test of Paragraph 3.3.2 shall be subjected to a static loads destruction test using the loading condition considered most critical in the ultimate loads testing. The actual destructive load values shall be recorded.

3.4 TEST INSTRUMENTATION

Ten (10) biaxial strain gauges as shown in Figure 3, shall be attached to the tank to record structural loading during the test. All applied load measuring devices shall have the capability of recording or establishing the exact applied load at the time of any failure. A full color 16 MM movie shall be taken at various significant conditions during the test. Twelve (12) color still photos shall also be taken of the test setup and various aspects of the test of which at least one third (4) of the still photographs shall be taken of the structural damage caused by the static loads destruction test.

3.4.1 INSTRUMENTATION CALIBRATION

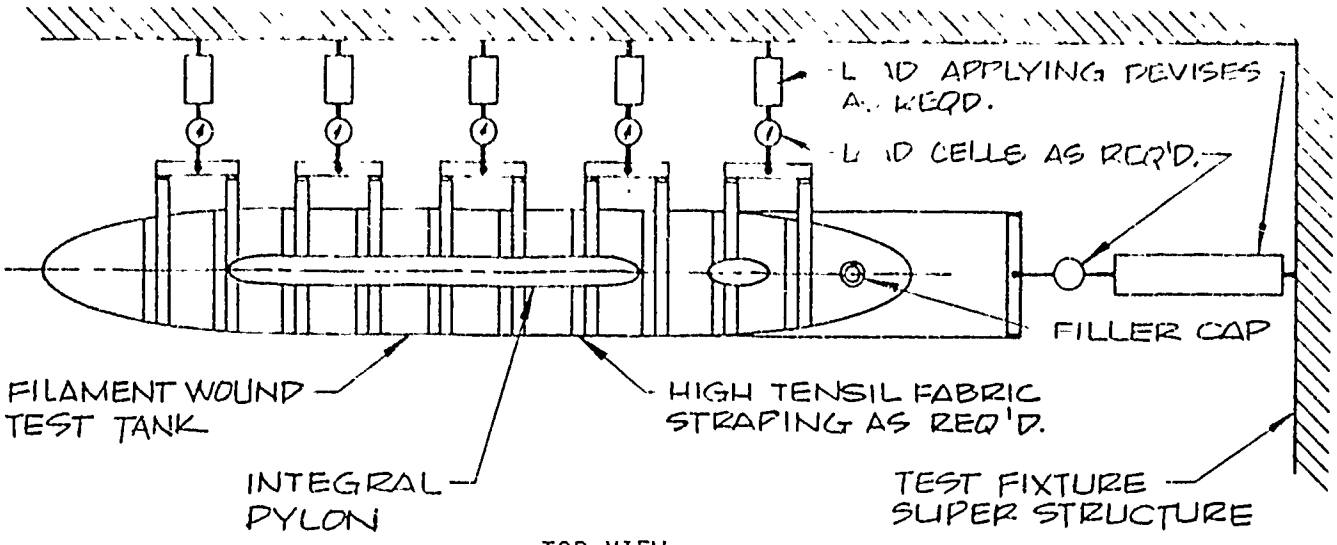
All instrumentation shall be calibrated and capable of reading or recording data within ± 2% of its full scale value. No instrument shall be used that has not been calibrated within the previous calibration period.

3.5 TEST PROCEDURES

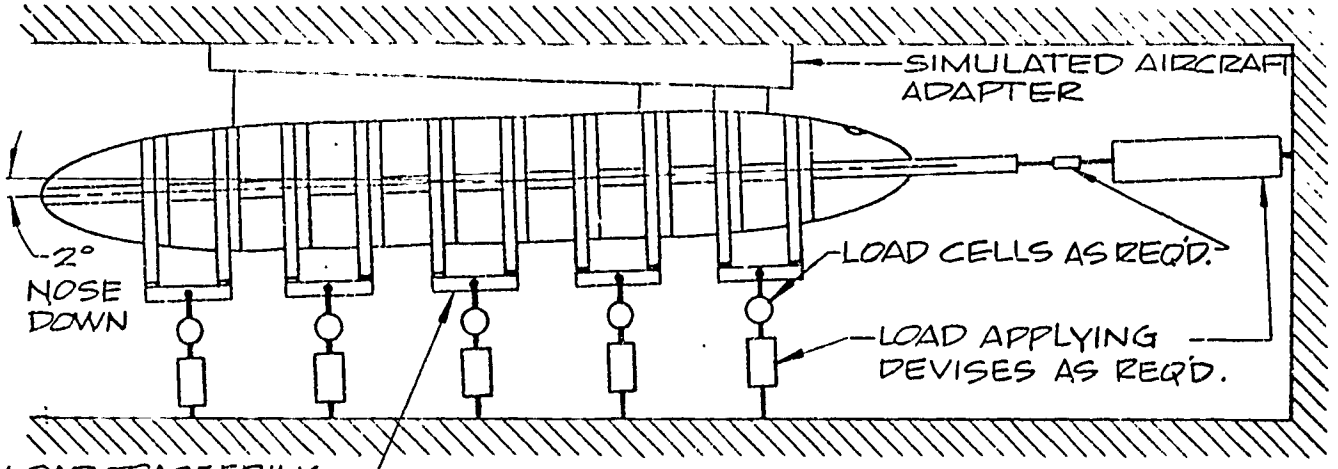
The test procedures shall be in accordance with Paragraph 4 of this document.

3.6 DOCUMENTATION

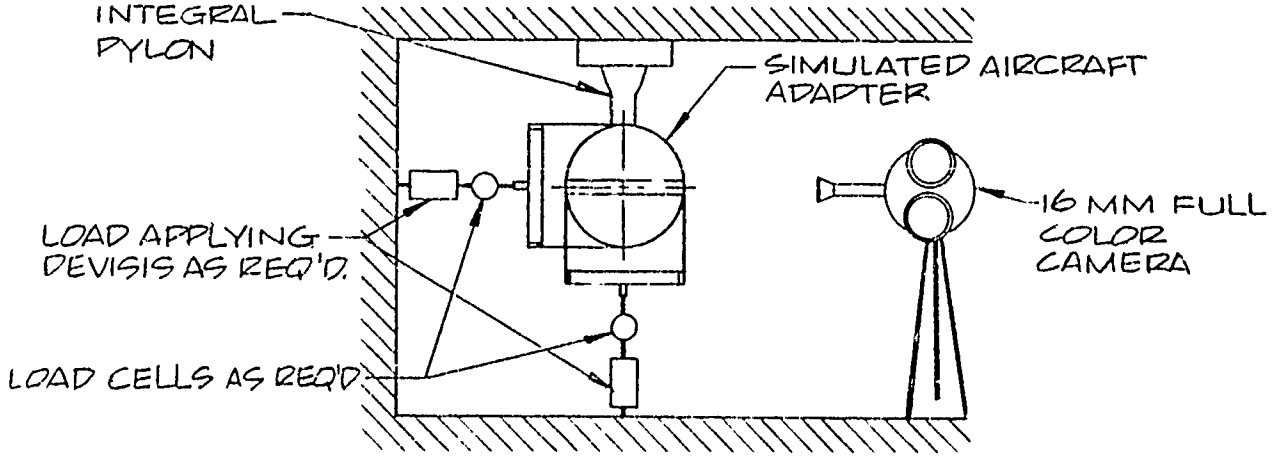
At the conclusion of testing a test report will be prepared for submission to the contractor.



TOP VIEW

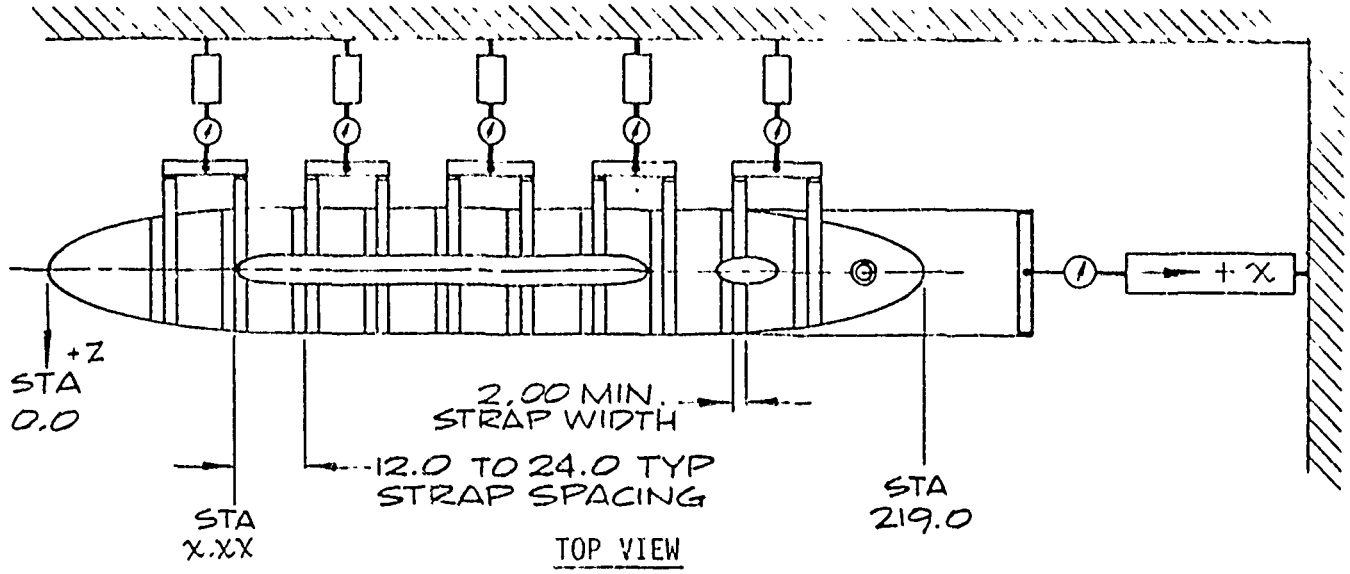


FRONT VIEW

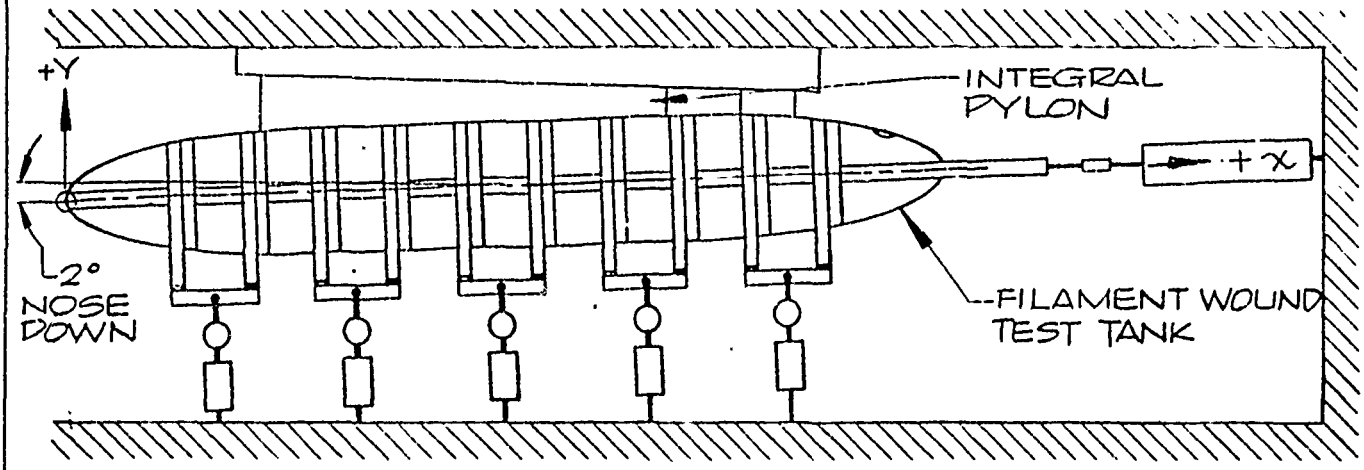


END VIEW

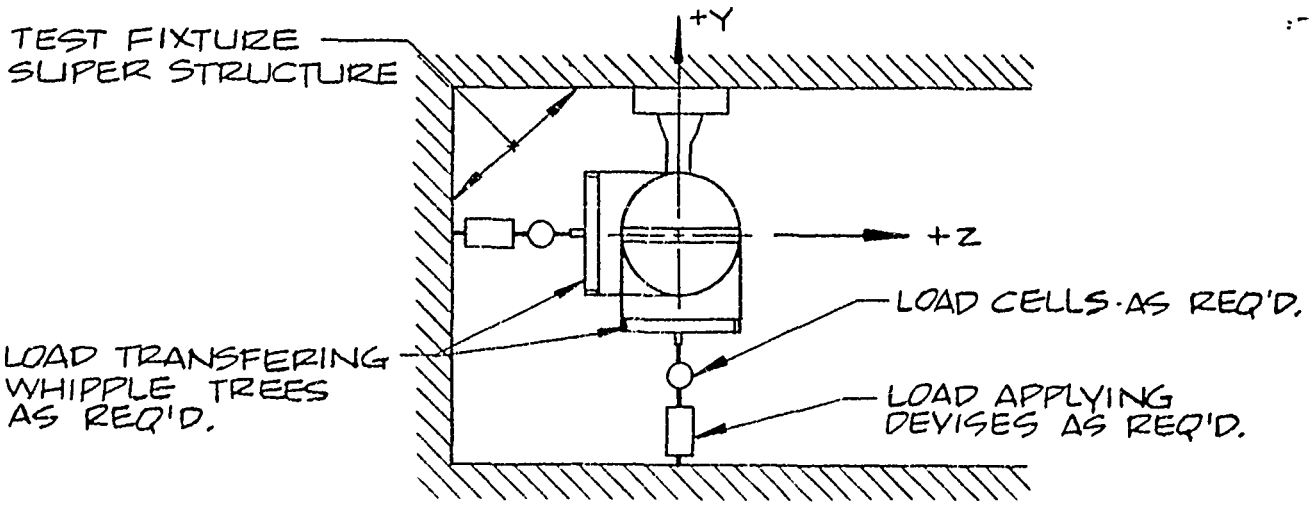
FIGURE 1
STATIC LOADS TEST ARRANGEMENT



TOP VIEW



FRONT VIEW



END VIEW

FIGURE 2

STATIC LOADS COORDINATE SYSTEM

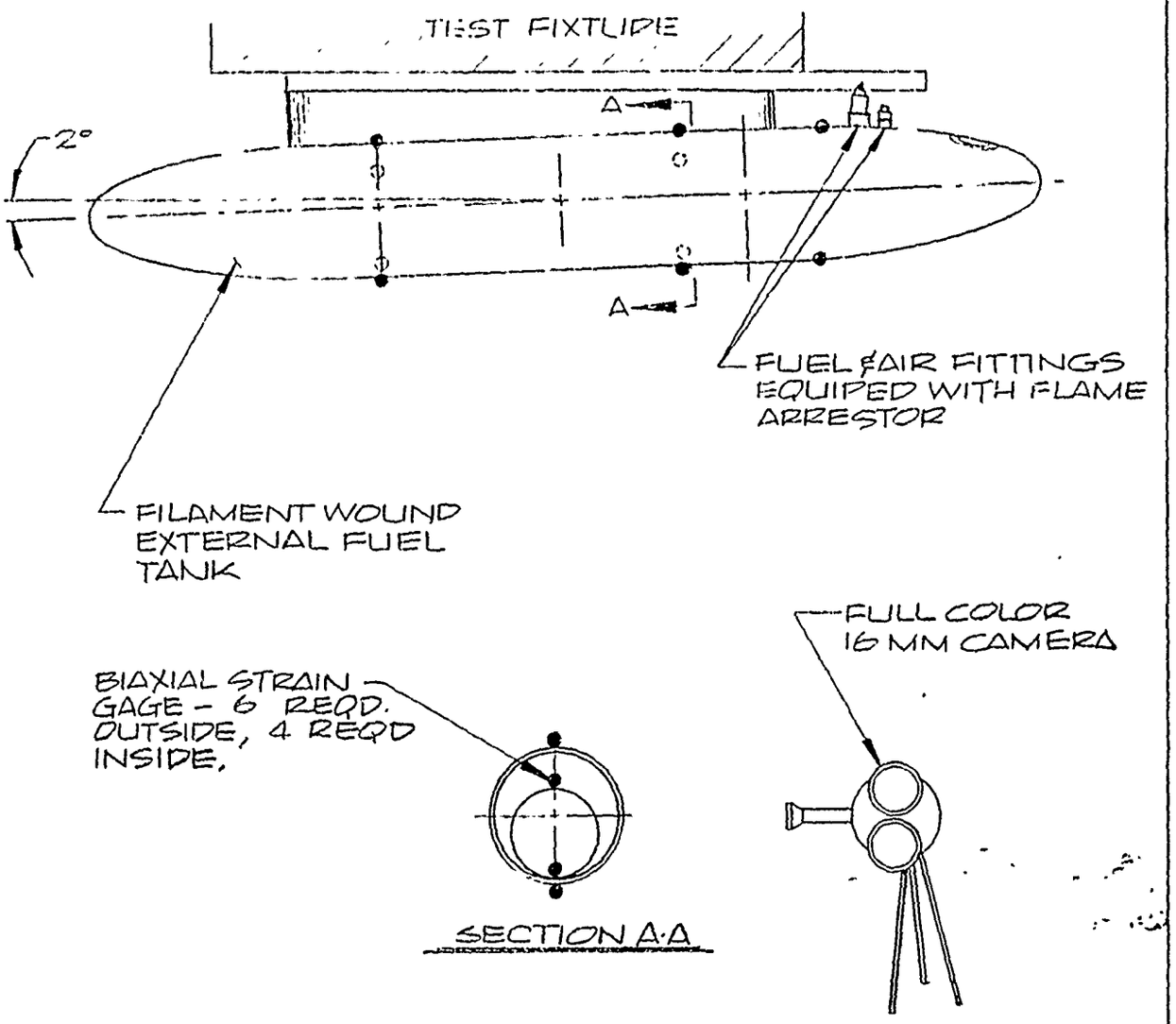


FIGURE 3

STRAIN SENSOR ARRANGEMENT

4.0 QUALIFICATION TEST PROVISIONS

4.1 EXAMINATION OF PRODUCT

The tank and pylon shall be fully examined prior to mounting to the structural test fixture for shipping damage to the test site. This examination shall include a visual inspection and a tap test for delaminations. The results of this inspection shall be recorded by the testing activity in the presence of an authorized Fiber Science Test Engineer.

4.2 MOUNTING

The tank shall then be mounted to the structural test fixture by means of the simulated airframe adaptor and examined for proper attachment and assimilation to the actual aircraft installation. Any signigicant variations or deviations shall be recorded.

4.3 ARRANGEMENT

The test arrangement shall be examined for compliance with Figure 1, 2, and Figure 3 of this procedure or shall be deemed to be in compliance with the applicable paragraphs of ASD/ENFEA-78 Technical Exhibit and approved by an F.S.I. authorized Test Engineer and an authorized Government representative.

4.4 INSTRUMENTATION AND TEST EQUIPMENT

4.4.1 INSTRUMENTATION CALIBRATION

All instrumentation shall be inspected to verify that each instrument has had a calibration check within the last calibration period.

4.4.2 INSTALLATION

All instruments and test equipment: cameras, load cells, strain gauges and recorders shall be installed and leads properly tethered so as to have little or no affect on the test. High tensile fabric strapping and connecting whippletrees shall be inspected per Figure 3 for proper location. Strain sensor readings shall be taken at locations indicated in Figure 3 of this procedure.

4.4.3 OPERATION

All instrumentation, test equipment and load cells shall be checked for proper operation. Any defects in instrumentation or equipment shall be recorded and the test shall not proceed until the defect is removed or deemed not critical for the test required by the testing activity and approved by an authorized Fiber Scicne Test Engineer.

4.5 FUELING

The tank shall be filled with 450 to 457 gallons of water through the filler cap opening. The tank properly mounted (2^{0} nose down) during filling will contain the proper amount when the water begins to overflow out the filler cap opening.

4.6 STATIC STRUCTURAL LOADS TESTING

Pressurize tank to 15 psi and apply the structural loads as follows:

4.6.1 LIMIT LOADS TEST

Apply the three (3) limit load conditions determined by the structural analysis report SR-2191 to be the most critical. One loading condition must be a crash or hard landing condition. At the completion of each of the three test conditions, the tank shall be examined for any evidence of rupture, leakage or structural damage. The entire tank surface shall receive a tap test to determine if any delaminations occurred due to the applied static loads. A sketch shall be made showing approximate size and shape of the delamination.

4.6.2 ULTIMATE LOADS TEST

Reapply the three (3) load conditions of Paragraph 4.6.1 to the ultimate load values determined by the structural analysis report SR-2191. At the completion of each of the three test conditions the tank shall be examined for any evidence of rupture, leakage or structural damage. The entire tank surface shall receive a tap test to determine if any delaminations occurred due to the applied static loads. A sketch shall be made showing approximate size and shape of the delamination..

4.6.3 DESTRUCTION TEST

The fiber Science Test Engineer, with the concurrence and approval of the testing activity and the Government representative, shall determine after analyzing the test results from the ultimate loads test, which of the three (3) test conditions shall be used to static test the tank to destruction. The tank shall then be tested to destruction. The location of destructive failure shall be recorded along with the corresponding maximum load values at the initial point of failure. The entire tank surface shall receive a tap test to determine the extent of the failure. A sketch shall be made showing approximate size and shape of the delamination caused by the failure.

4.7 PHOTOGRAPHS

Eight (8) color photographs shall be taken of the test setup and any damage resulting from the limit and ultimate loads test. In addition, four (4) color photographs shall be taken of location where the destructive failure initiated.

4.8 DISSECTION

At the discretion of the authorized Fiber Science Test Engineer, the tank may be cross sectioned to determine the internal extent of the destructive static loads damage.

5.0 QUALIFICATION TEST REPORT

A formal qualification test report shall be submitted per MIL-STD-831 within 30 days after the testing is complete. This report is to include all recorded strain data sheets, 16 MM color film, photographs and expended tank. The expended tank shall be returned to Fiber Science for post evaluation in the same shipping container it was received in.

APPENDIX "A"

TEST DATA SHEETS

TEST DATA SHEET

QTP-2191 SECTION "L"

Testing Activity _____ Activity Test Engr. _____

Tank Serial No. _____ F.S.I. Test Engr. _____

Test Date _____ Government Rep. _____

EXAMINATION OF PRODUCT

Ref. Para 4.1: Visual Inspection _____

_____

_____

_____

_____

Delaminations (Tap Test) _____

_____

_____

_____

_____

MOUNTING

Ref. Para. 4.2: Aircraft Simulated Attachment

Deviations If Any _____

_____

_____

_____

_____

ARRANGEMENT

Ref. Para. 4.3: Approved Test Arrangement (Ref. Figure 1,2, and Figure 3 and ASD/ENFEA-78 Technical Exhibit).

Testing Activity Approval

Approved By _____ Date _____

F.S.I. Test Engineer Approval

Approved By _____ Date _____

Government Approval

Approved By _____ Date _____

Minimum of two signatures required.

INSTRUMENTATION

Ref. Pafa. 4.4.1: CHECK INSTRUMENTATION CALIBRATION

ITEM	CALIBRATION DATE
Load Cells	_____
Cameras (If Applicable)	_____
Pressure Gauges	_____
Strain Gauge Recorders	_____
Other Instruments:	_____
1. _____	_____
2. _____	_____
3. _____	_____
4. _____	_____

Ref. Para. 4.4.2: CHECK PROPER INSTALLATION

ITEM	REMARKS
Tank	
Simulated Aircraft Adaptor	
Load Cells	
Whippletrees	
Cameras	
Strain Gauges	
Recorders	
Other Instruments:	
1. _____	
2. _____	
3. _____	
4. _____	

Ref. Para. 4.4.3: CHECK PROPER OPERATION

ITEM	REMARKS
Load Cells	
Pressure Gauges	
Cameras	
Recorders	
Other Instruments:	
1. _____	
2. _____	
3. _____	
4. _____	

TUFLING

Ref. Para 4.5 FUEL TANK AT PROPER ATTITUDE

ITEM	REMARKS
Attitude (2^{o} nose down)	
Fill With 450 to 457 Gal. Water	
Secure Filler Cap	

STATIC STRUCTURAL LOADS

Ref. Para 4.6 PRESSURIZE TANK TO 15 $\pm$ 2 PSIG

ACTUAL PRESSURE _____

LIMIT LOADS

Ref. Para. 4.6.1 APPLY LIMIT LOADS PER SR-2191

See Figure 3 For Coordinates

ITEM	APPLIED LOAD STRAP LOCATION (STATION)	CONDITION I		CONDITION II		CONDITION III	
		Y LOAD	Z LOAD	Y LOAD	Z LOAD	Y LOAD	Z LOAD
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
TOTAL							

TOTAL X LOAD			

Ref. Para. 4.6.1 APPLY LIMIT LOADS PER SR-2191 - (continued)

POST TEST EXAMINATION

VISUAL INSPECTION _____

DELAMINATIONS (TAP TEST) _____

FAILURE IF ANY (LOCATION, TYPE, EXTENT) _____

ULTIMATE LOADS

Ref. Para. 4.6.2 APPLY ULTIMATE LOADS PER SR-2191

See Figure 3 For Coordinates

ITEM	APPLIED LOAD STRAP LOCATION (STATION)	CONDITION I		CONDITION II		CONDITION III	
		Y LOAD	Z LOAD	Y LOAD	Z LOAD	Y LOAD	Z LOAD
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
	TOTAL						
	TOTAL X LOAD						

Ref. Para. 4.6.2 APPLY ULTIMATE LOADS PER SR-2191 - (continued)

POST TEST EXAMINATION

VISUAL INSPECTION

DELAMINATIONS (TAP TEST)

FAILURE IF ANY (LOCATION, TYPE, EXTENT)

DESTRUCTIVE LOADS TEST

Ref. Para. 4.6.3

Test condition to which tank shall be subjected for destructive testing.

DESTRUCTIVE CONDITION: _____

_____

_____

F.S.I. Test Engineer Approval

Approved By _____ Date _____

Testing Activity Approval

Approved By _____ Date _____

Government Approval

Approved By _____ Date _____

Ref. Para. 4.6.3 DESTRUCTIVE LOADS TEST (continued)

ITEM	APPLIED LOAD STRAP LOCATION (STATION)	DESTRUCTIVE LOAD CONDITION 125% OF ULTIMATE		150% OF ULTIMATE		175% OF ULTIMATE	
		Y LOAD	Z LOAD	Y LOAD	Z LOAD	Y LOAD	Z LOAD
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
TOTAL							
TOTAL X LOAD							

Ref. Para. 4.6.3

DISTRUCTIVE LOADS TEST - (continued)

DESTRUCTIVE FAILURE

LOCATION _____

TYPE OF FAILURE _____

EXTENT OF VISUAL FAILURE _____

EXTENT OF DELAMINATION FAILURE (TAP TEST) _____

PROVIDE SCALED SKETCH OF DELAMINATED AREA (SIZE, LOCATION AND APPROXIMATE SHAPE)

Ref. Para. 4.7 PHOTOGRAPHS

Number Photographs and Identify Locations

PHOTO	LOCATION	PHOTO	LOCATION
1.	_____	7.	_____
2.	_____	8.	_____
3.	_____	9.	_____
4.	_____	10.	_____
5.	_____	11.	_____
6.	_____	12.	_____

Ref. Para. 4.8 DISSECTION OF THE TANK

Approved By _____ Date _____

Condition of Tank Wall Constructions

_____

_____

Condition of Frames

_____

_____

Condition of Reinforcements

_____

_____

_____

EVALUATION OF DATA

GENERAL APPEARANCE:

DYNAMIC LOADS SIMULATED BY STATIC LOADS:

APPARENT DESIGN LOAD MARGIN OF SAFETY:

EVALUATION OF DATA (continued)

STRUCTURAL BOND OF SANDWICH CORE FACES:

CAMERA DATA:

STRAIN RECORDINGS:

DOCUMENT NUMBER

QTP-2191 SECTION "M"

TITLE

QUALIFICATION TEST PROCEDURE

H-53 TANK

REQUIREMENTS FOR FORCED EJECTION

REVISIONS

LTR.	DATE	PREPARED	APPROVED	DESCRIPTION

PREPARED BY: Richard Lyman DATE: 11/29/80

CHECKED BY: Randy Stone DATE: 12-5-80

APPROVED BY: C. A. Patnode Jr. DATE: 12/6/80

FIBER SCIENCE, INC.
SALT LAKE CITY, UTAH

NO. QTP-2191 Section "M"

DATE: 11/29/80 PAGE 1 OF 20

1.0 SCOPE

This procedure covers the requirements for Forced Ejection Testing of the 450 Gallon Filament Wound External Fuel Tank for the H-53 helicopter.

2.0 APPLICABLE DOCUMENTS

2.1 MILITARY SPECIFICATIONS

MID-STD-831	Test reports, preparation of.

2.2 TECHNICAL EXHIBIT

ASD/ENFEA-78	Tank - 450 gallon external fuel, filament wound lightweight explosion proof.

2.3 DRAWINGS

FIBER SCIENCE 2191-001	Tank - Installation, 450 gallon H-53
SARGENT FLETCHER 27-450-4400	Pylon Assembly - 450 gallon fuel tank.

3.0 REQUIREMENTS

3.1 TEST ARTICLE

One tank assembly (2191-001) shall be fueled to a full tank condition and mounted to a pylon (27-450-4400) which in turn is mounted to a functional test fixture by means of the TF-261-178 adaptor. The tank shall be subjected to the impact of a forced ejection of the tank and pylon onto a concrete surface as described in the T chnical Exhibit ASD/ENFEA-78 Paragraph 3.4.1.3.3, Paragraph 3.4.1.6, and Paragraph 3.4.1.7.1.

3.2 TEST ARRANGEMENT

The test arrangement shall be similar to that shown in Figure 1 with all reasonable precautions taken to simulate the actual mounting of the tank and pylon to the helicopter including forced ejection release capabilities.

3.3 TEST METHOD

The tank secured to the pylon by the pylon support points shall be suspended from the functional test fixture by means of a TF-261-178 adaptor in a 2^{0} nose down position. The tank shall then be filled with water to a full tank condition with the tank center point (see Figure 1) being 37.3 $\pm$ 1.5 inches (48 $\pm$ 2" for JP-4 or JP-5 fuel) above a horizontal concrete impact surface. The tank shall be ejected from the functional test stand by means of the pylon ejection system. There shall be no rupture or leakage from impact of the tank with the concrete test surface.

3.4 TEST INSTRUMENTATION

High speed movies positioned so that they are photographing continuously the full length of the tank shall be taken with a 15 mm. full color camera capable of photographing 2000 frames per second minimum at the time of impact. A grided reference plane shall be placed directly behind the tank as shown in Figure 1. The reference plane and tank shall be painted white with black grid lines as shown in Figure 2. Pressure in the tank during the time interval of the impact transient shall be measured and recorded at four points as shwon in Figure 3. Ten (10) biaxial strain gauges, as shown in Figure 3, shall also be attached to record tank structural loading during the test. Twelve (12) color still photos shall be taken of the

impact damaged areas and any other highly stressed or failed areas after the test.

3.4.1 INSTRUMENTATION CALIBRATION

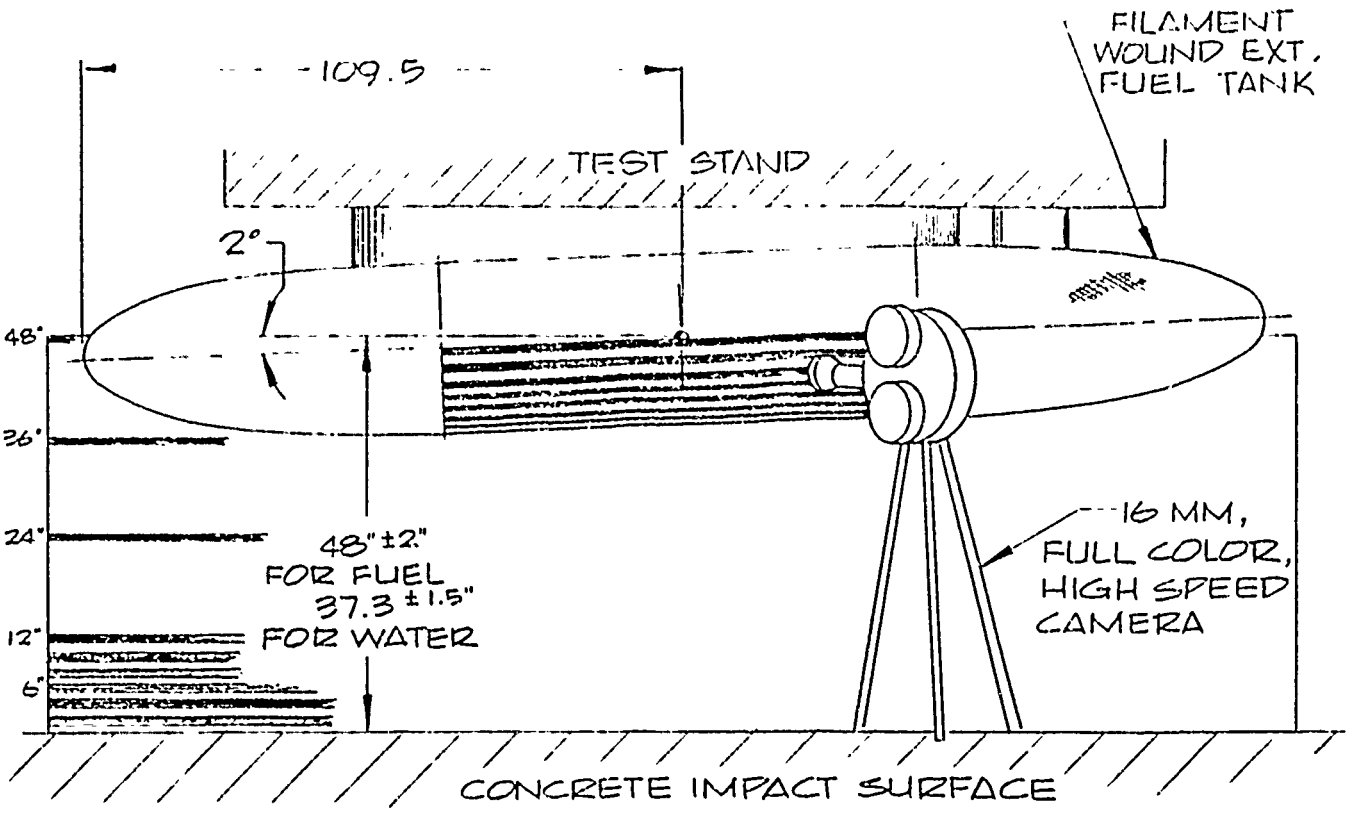
All instrumentation shall be calibrated and capable of reading or recording data within ± 2% of its full scale value. No instrument shall be used that has not been calibrated within the previous calibration period.

3.5 TEST PROCEDURES

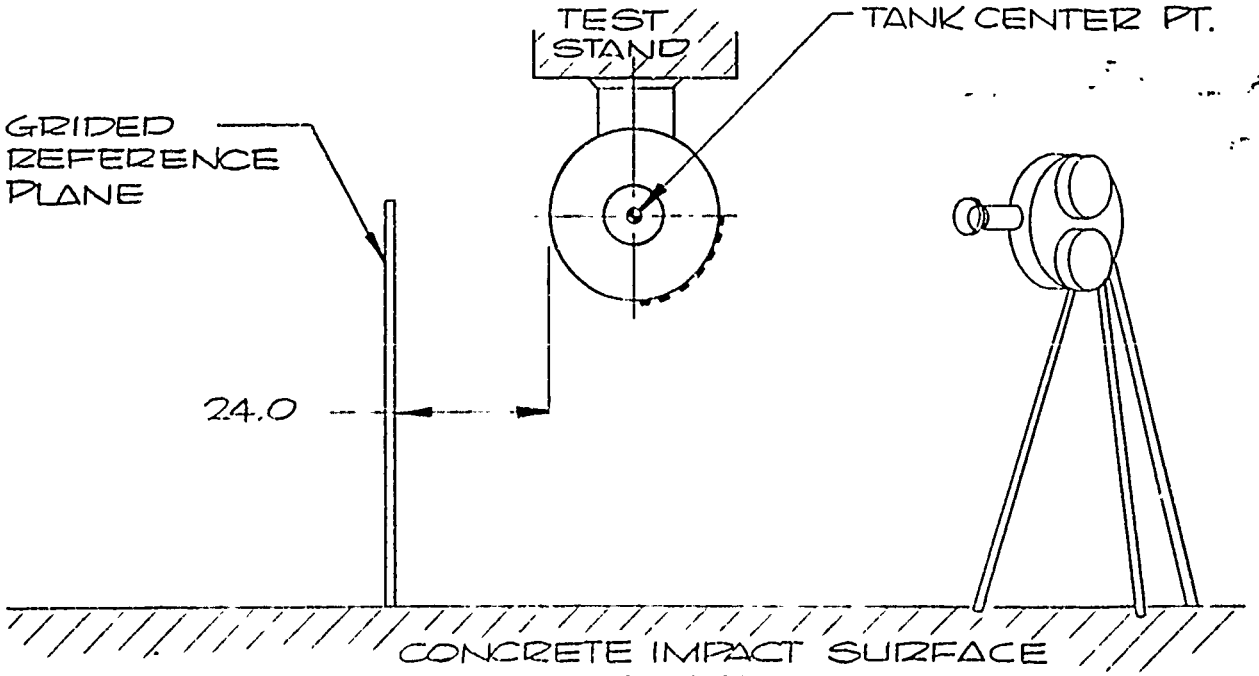
The test procedures shall be in accordance with Paragraph 4 of this document.

3.6 DOCUMENTATION

At the conclusion of testing a test report will be prepared for submission to the contractor.



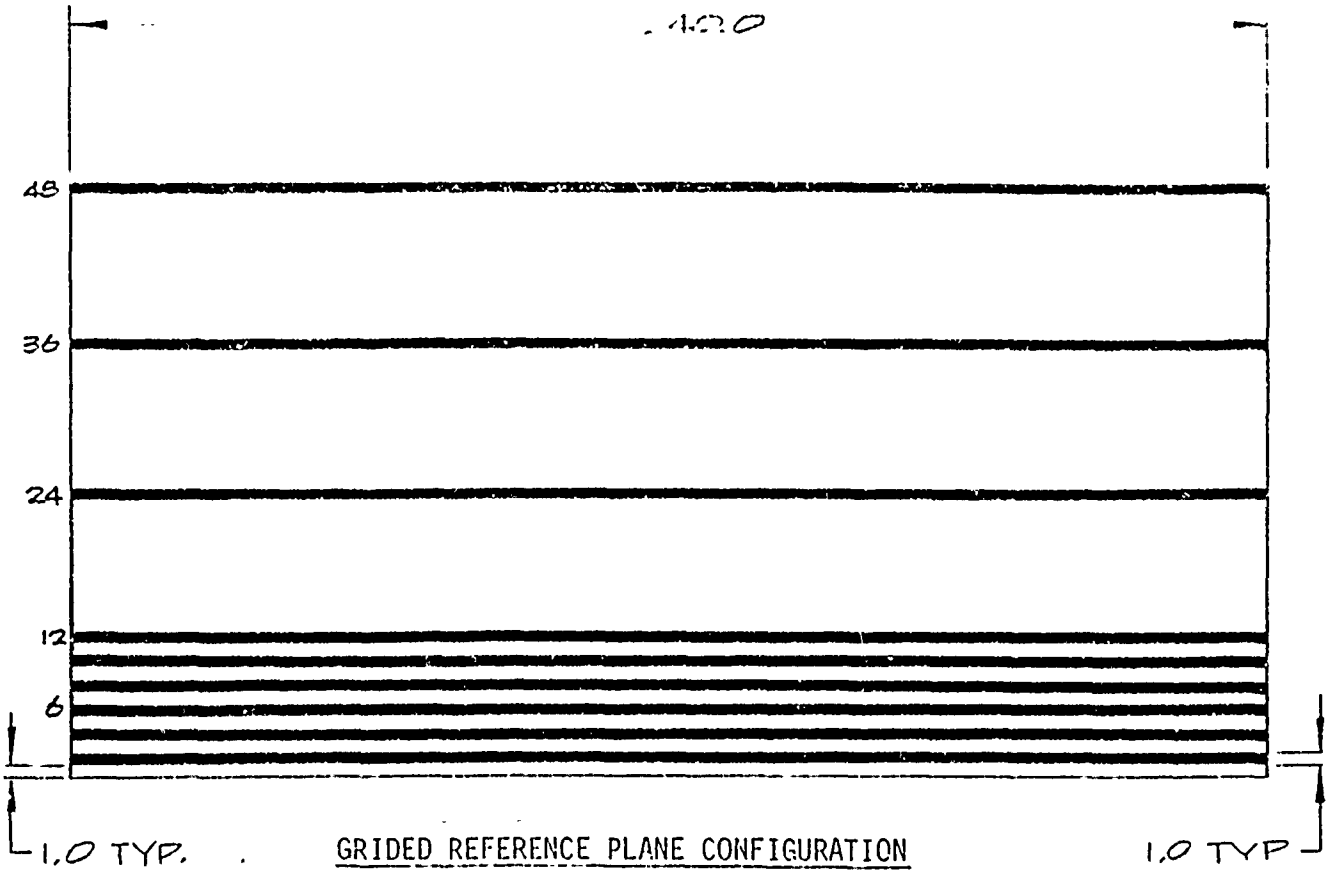
SIDE VIEW



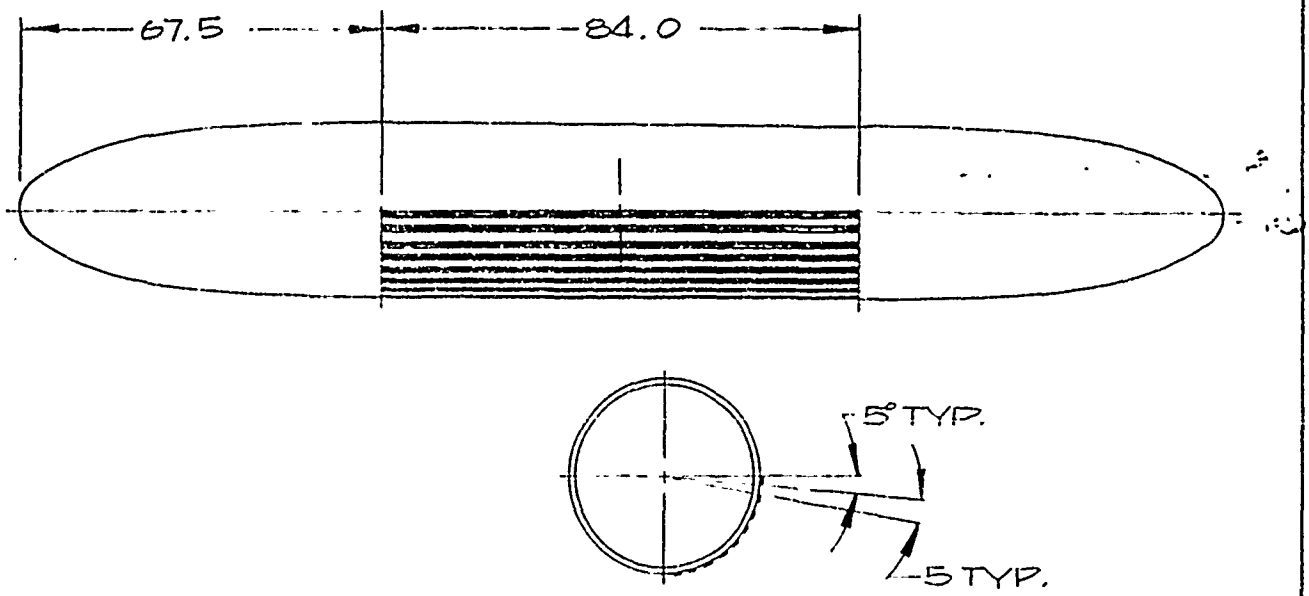
END VIEW

FIGURE 1

TEST ARRANGEMENT



GRIDED REFERENCE PLANE CONFIGURATION

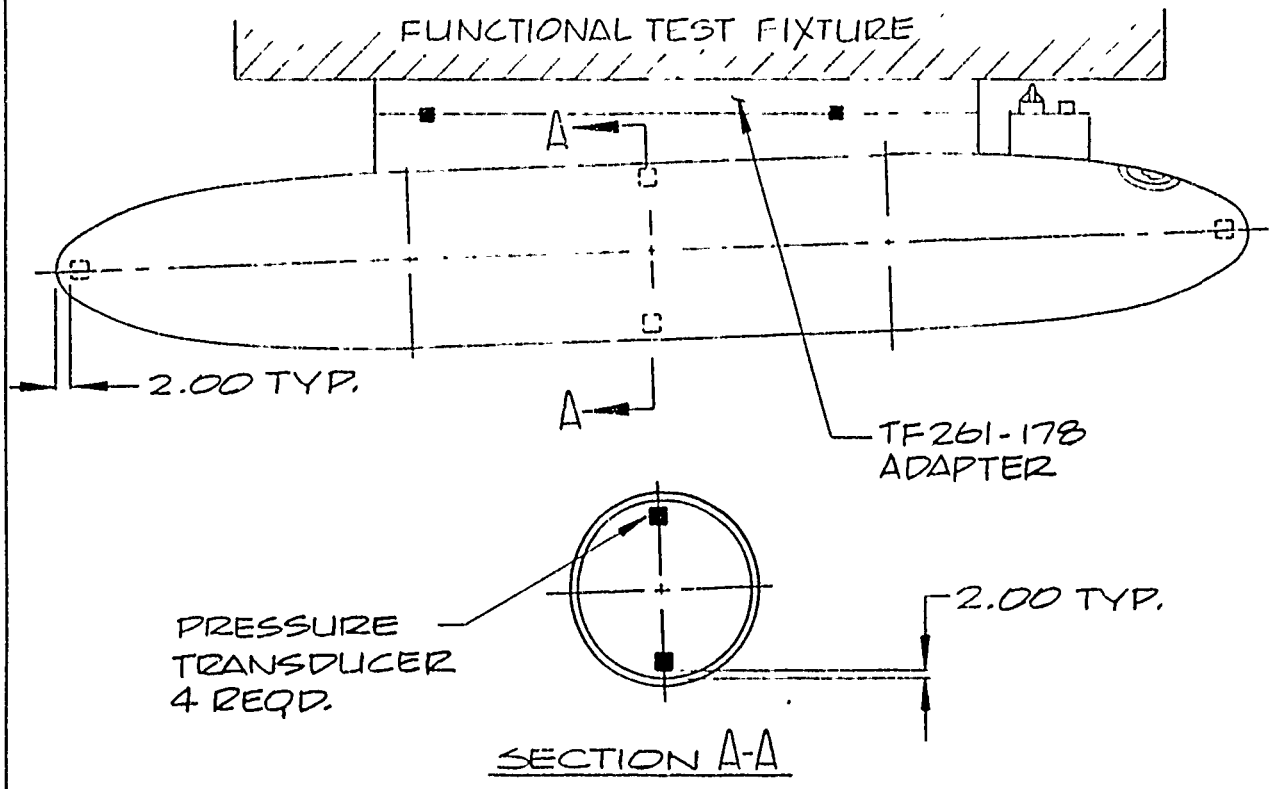


SECTION A-A

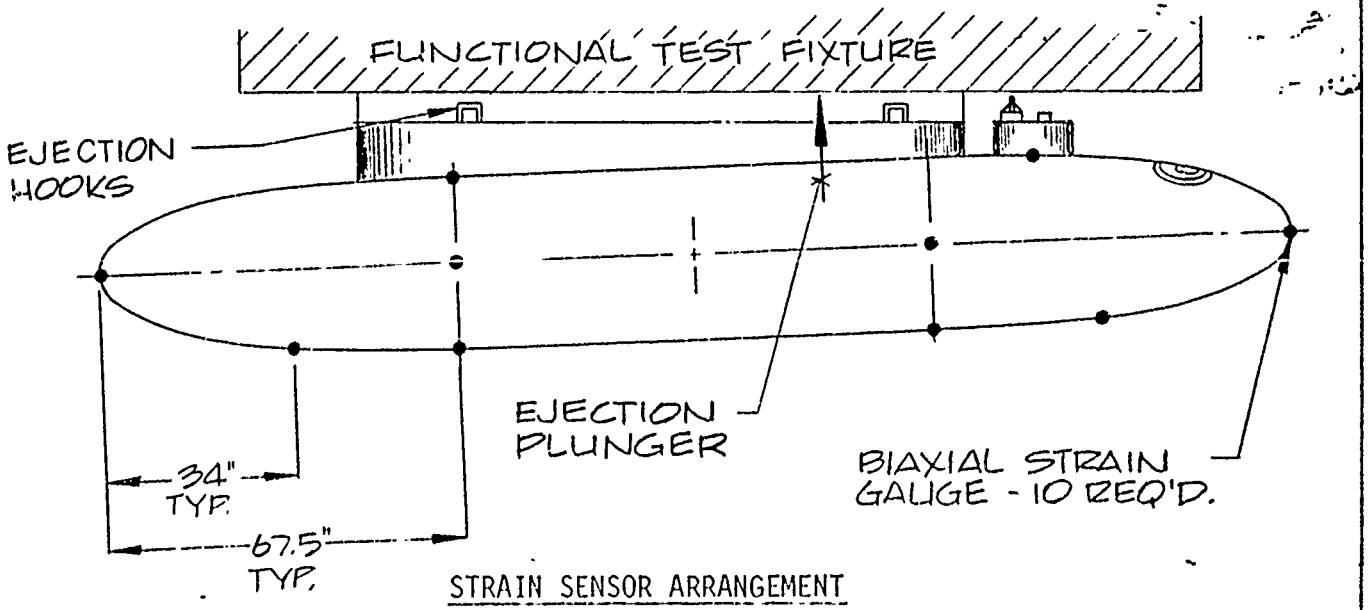
GRIDED TANK SURFACE CONFIGURATION

Figure 2

REFERENCE MARKING ARRANGEMENT



PRESSURE SENSOR ARRANGEMENT



STRAIN SENSOR ARRANGEMENT

FIGURE 3

SENSOR ARRANGEMENT

4.0 QUALIFICATION TEST PROVISIONS

4.1 EXAMINATION OF PRODUCT

The tank and pylon shall be fully examined prior to mounting to the functional test fixture for shipping damage to the test site. This examination shall include a visual inspection and a tap test for delaminations. The results of this inspection shall be recorded by the testing activity in the presence of an authorized Fiber Science Test Engineer.

4.2 MOUNTING

The tank shall then be mounted to the functional test fixture by means of the TF-216-178 adaptor and examined for proper attachment and assimilation tc the actual aircraft installation. Any significant variations or deviations shall be recorded.

4.3 ARRANGEMENT

The test arrangement shall be examined for compliance with Figure 1 and Figure 2 of this procedure or shall be deemed to be in compliance with the applicable paragraphs of ASD/ENFEA-78 Technical Exhibit and approved by an F.S.I. authorized test engineer and an authorized Government representative.

4.4 INSTRUMENTATION AND TEST EQUIPMENT

4.4.1 INSTRUMENTATION CALIBRATION

All instrumentation shall be inspected to verify that each instrument has had a calibration check within the last calibration period.

4.4.2 INSTALLATION

All instruments and test equipment: cameras, grid reference planes, pressure transducers, strain gauges and recorders shall be installed and leads properly tethered so as to have little or no affect on the test. Pressure and strain readings shall be taken at locations indicated in Figure 3 of this procedure.

4.4.3 OPERATION

All instrumentation, test equipment and ejection gun shall be checked for proper operation. Any defects in instrumentation or equipment shall be recorded and the test shall not proceed until the defect is removed or deemed not critical for the test required by the testing activity and approved by an authorized Fiber Science Test Engineer.

4.5 FUELING

The tank shall be filled with 450 to 457 gallons of water through the filler cap opening. The tank properly mounted (2^{o} nose down) during filling will contain the proper amount when the water begins to overflow out the filler cap opening.

4.6 GUN LOADING

The ejection gun cartridge chamber shall be loaded with 2 cartridges using a standard load. Safety precautions should be taken to insure load is properly installed and that the breach is properly closed and locked.

4.7 FORCED EJECTION IMPACT

With all instrumentation synchronized and ready for operation, the ejection gun shall be discharged forcing the tank downward to impact the concrete surface.

4.8 POST FORCED EJECTION IMPACT EXAMINATION

4.8.1 LEAKAGE

There shall be no leakage from the tank caused by the forced ejection.

4.8.2 DELAMINATIONS

The entire tank surface shall receive a tap test to determine if any delaminations occurred outside the impact area. A sketch shall be made showing approximate size and shape.

4.8.3 FORCED EJECTION IMPACT IMPRINT

The tank impact surface imprint configuration shall be graphically sketched and dimensioned.

4.8.4 PHOTOGRAPHS

Twelve (12) color photographs of the damaged areas at locations determined by the testing activity and the Fiber Science Test Engineer.

4.8.5 DISSECTION

At the discretion of the authorized Fiber Science Test Engineer, the tank may be cross sectioned to determine the internal extent of the crash impact damage.

5.0 QUALIFICATION TEST REPORT

A formal qualification test report shall be submitted per MIL-STD-831 within 30 days after the testing is complete. This report is to include all recorded pressure and strain data sheets, high speed film, photographs and expended tanks. Expended tanks shall be returned to Fiber Science for post evaluation in the same shipping containers they were received in.

APPENDIX "A"

TEST DATA SHEETS

TEST DATA SHEET

QTP-2191 SECTION "M"

Testing Activity_____ Activity Test Engr._____

Tank Serial No. _____ F.S.I. Test Engr. _____

Test Date _____ Government Rep. _____

EXAMINATION OF PRODUCT

Ref. Para. 4.1 Visual Inspection_____

Delaminations (Tap Test)_____

MOUNTING

Ref. Para 4.2 Aircraft Simulated Attachment

Deviations If Any_____

ARRANGLMENT

Ref. Para. 4.3: Approved Test Arrangement (Ref. Figure 1, Figure 2 & ASD/ENFEA-78 Technical Exhibit.)

Testing Activity Approval

Approved By_____ Date _____

F.S.I. Test Engineer Approval

Approved By_____ Date _____

Government Approval

Approved By_____ Date _____

Minimum of two signatures required.

INSTRUMENTATION

Ref. Para. 4.4.1: CHECK INSTRUMENTATION CALIBRATION

ITEM	CALIBRATION DATE
Firing Device (If Applicable)	_____
Cameras (If Applicable)	_____
Pressure Transducer Recorder	_____
Strain Gauge Recorders	_____
Other Instruments:	_____
1._____	_____
2._____	_____
3._____	_____
4._____	_____

Ref. Para. 4.4.2 CHECK PROPER INSTALLATION

ITEM	REMARKS
Tank	
TF-261-178 Adaptor	
Cartridges	
Cameras	
Grided Reference Plane	
Pressure Transducers	
Strain Gauges	
Recorders	
Other Instruments:	
1. _____	
2. _____	
3. _____	

Ref. Para. 4.4.3 CHECK PROPER OPERATION

ITEM	REMARKS
Ejection Gun	
Hook Mechanisms	
Cameras	
Recorders	
Other Instruments:	
1. _____	
2. _____	
3. _____	

ITEM	REMARKS
Ref. Para. 4.7 (continued)	Other Instruments:
	1. _____ _____
	2. _____ _____
	3. _____ _____
	4. _____ _____

POST FORCED EJECTION IMPACT EXAMINATION

Ref. Para 4.8 General Appearance _____

_____

_____

Ref. Para. 4.8.1 LEAKAGE (There shall be no leakage)

Remarks _____

_____

Ref. Para. 4.8.2 DELAMINATIONS

Results of Tap Test for Delaminations

_____

_____

_____

(Supply scaled sketch of size, location and approximate shape).

Ref. Para. 4.8.3 FORCED EJECTION IMPACT IMPRINT

Describe Damaged Condition of Impacted Imprint Area of the Tank

_____

_____

_____

(Supply a scaled sketch of the size and approximate shape of impact area.)

Ref. Para. 4.8.4 PHOTOGRAPHS

Number Photographs and Identify Locations

PHOTO	LOCATION	PHOTO	LOCATION
1.	_____	7.	_____
2.	_____	8.	_____
3.	_____	9.	_____
4.	_____	10.	_____
5.	_____	11.	_____
6.	_____	12.	_____

Ref. Para. 4.8.5 DISSECTION OF THE TANK

Approved By _____ Date _____

Condition of Frames

_____

_____

Condition of Plumbing

_____

_____

Condition of Probe

Condition of Float Switches

EVALUATION OF DATA
CONTINUED

DELAMINATIONS:

EJECTION IMPACT IMPRINT:

INTERNAL PLUMBING CONDITION:

EVALUATION OF DATA

CAMERAS:

PRESSURE RECORDINGS:

STRAIN RECORDINGS:

DOCUMENT NUMBER

QTP-2191 SECTION "N"

TITLE

QUALIFICATION TEST PROCEDURE

H-53 TANK

REQUIREMENTS FOR FUEL VAPOR IGNITION TEST

REVISIONS

LTR.	DATE	PREPARED	APPROVED	DESCRIPTION

PREPARED BY: Richard Lyman DATE: 11/18/80

CHECKED BY: Randy Stone DATE: 12/5/80

APPROVED BY: C. G. Patrick Jr. DATE: 12/6/80

FIBER SCIENCE, INC.
SALT LAKE CITY, UTAH

NO. QTP-2191 Section "N"

DATE: 11/18/80

1.0 SCOPE

This procedure covers the requirements for fuel vapor explosion testing of the 450 Gallon Filament Wound External Fuel Tank for the H-53 helicopter.

2.0 APPLICABLE DOCUMENTS

2.1 MILITARY SPECIFICATIONS

MIL-STD-831	Test Reports, Preparation of.

2.2 TECHNICAL EXHIBIT

ASD/ENFEA-78	Tank - 450 gallon external fuel, filament wound lightweight explosion proof.

2.3 DRAWINGS

FIBER SCIENCE 2191-001	Tank - Installation, 450-gallon H-53
SARGENT FLETCHER 27-450-4400	Pylon Assembly - 450 gallon fuel tank.

3.0 REQUIREMENTS

3.1 TEST ARTICLE

One tank assembly (2191-001) equipped with an approved ignition device and mounted to a pylon (27-450-4400) which in turn is mounted to a suitable test fixture shall be subjected to a fuel vapor ignition of N-Pentane/air mixture of the proper fuel/air ratio as described in Technical Exhibit ASD/ENFEA-78, Paragraph 3.4.1.7.3.

3.2 TEST ARRANGEMENT

The test arrangement shall be similar to that shown in Figure 1 with all reasonable precautions taken to simulate the actual mounting of the tank and pylon to the helicopter.

3.3 TEST METHOD

The tank shall be suspended at the pylon attach points, in a 2^{0} nose down position, from a suitable test fixture. The aft access opening shall be replaced with a suitable fixture incorporating a spark plug or other ignition device. The tank shall be dry and free of fuel. A N-Pentane/air mixture of the proper fuel/air ratio shall be introduced into the tank at atmospheric pressure to provide an energy source. The fuel/air mixture must be such that the pressure rises to at least 6.5 atm in 60 milliseconds or less. This mixture will then be ignited by the ignition device and the effect on the tank observed.

The tank fuel and air connections, equipped with flame arrestors, shall be observed to determine whether a flame propagates through these connections during the test.

3.4 TEST INSTRUMENTATION

A high speed 16 mm color movie shall be taken with a Fast-X camera capable of photographing 2000 frames per minute minimum. Pressure in the tank during the time interval of the vapor ignition transient shall be measured and recorded at four points as shown in Figure 1. Four color still photos shall be taken of any external damage areas after the test.

3.4.1 INSTRUMENTATION CALIBRATION

All instrumentation shall be calibrated and capable of reading or recording data within ± 2% of its full scale value. No instrument shall be used that has not been calibrated within the previous calibration period.

3.5 TEST PROCEDURES

The test procedures shall be in accordance with paragraph 4 of this document.

3.6 DOCUMENTATION

At the conclusion of testing a test report will be prepared for submission to the contractor.

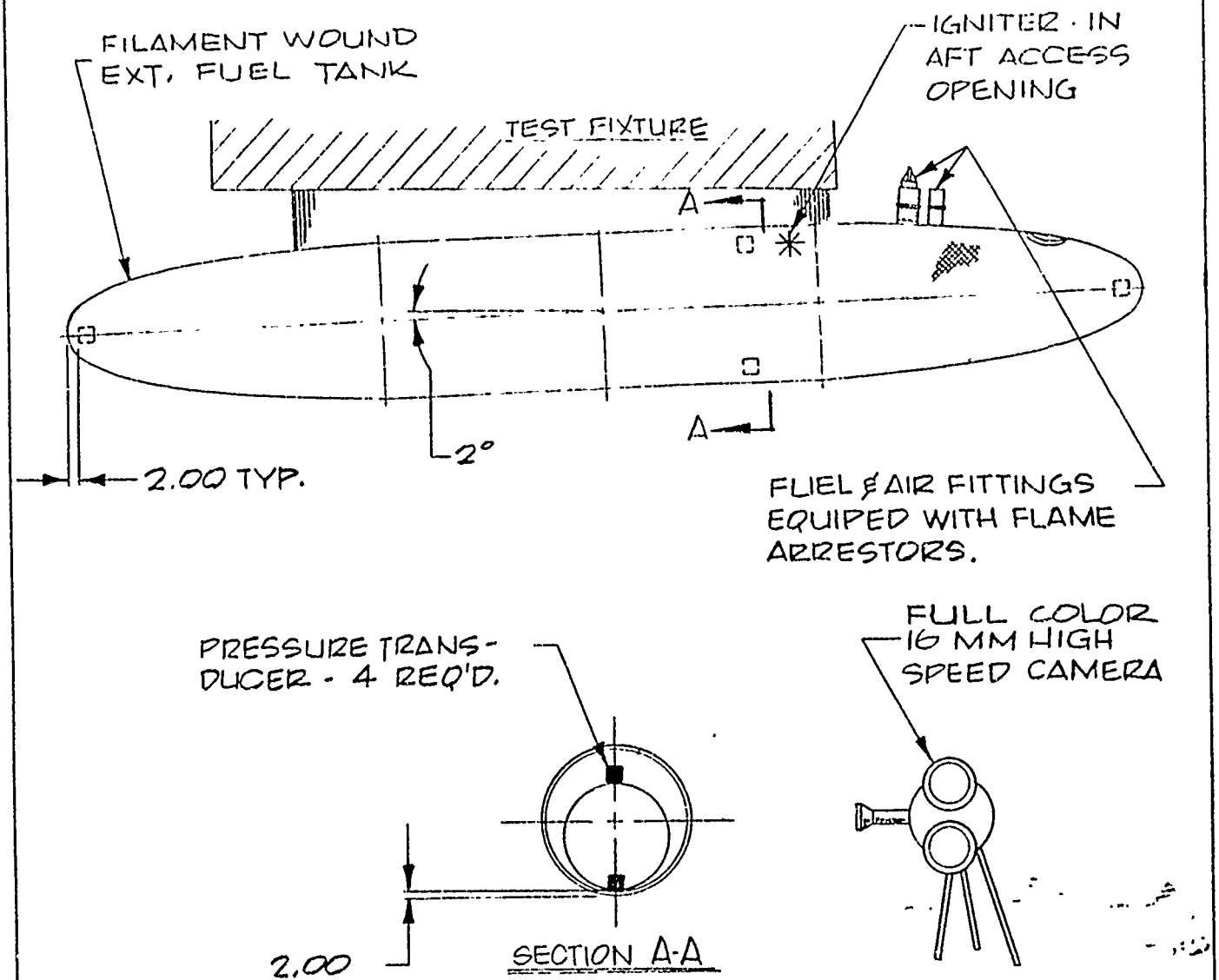


FIGURE 1

VAPOR IGNITION ARRANGEMENT

4.0 QUALIFICATION TEST PROVISIONS

4.1 EXAMINATION OF PRODUCT

The tank and pylon shall be fully examined prior to mounting to the test fixture for shipping damage to the test site. This examination shall include a visual inspection and a tap test for delaminations. The results of this inspection shall be recorded by the testing activity in the presence of an authorized Fiber Science Test Engineer.

4.2 MOUNTING

The tank shall then be mounted to the test fixture and examined for proper attachment and assimilation to the actual aircraft installation. Any significant variations or deviations shall be recorded.

4.3 ARRANGEMENT

The test arrangement shall be examined for compliance with Figure 1 of this procedure and applicable paragraphs of ASD/ ENFEA-78 Technical Exhibit.

4.4 INSTRUMENTATION AND TEST EQUIPMENT

4.4.1 INSTRUMENTATION CALIBRATION

All instrumentation shall be inspected to verify that each instrument has had a calibration check within the last calibration period.

4.4.2 INSTALLATION

All instruments and test equipment: igniter, camera, pressure transducers, and recorders shall be installed in such a way as to best satisfy the intent of the test. Pressure and strain readings shall be taken at locations indicated in Figure 1 of this procedure.

4.4.3 OPERATION

All instrumentation and test equipment shall be checked for proper operation. Any defects in instrumentation shall be recorded and the test shall not proceed until the defect is removed or deemed not critical for the test required by the testing activity and approved by an authorized Fiber Science Test Engineer.

4.5 PRIMING TANK

The tank shall be dry and free of fuel. A N-Pentane/air mixture of the proper fuel/air ratio shall be introduced into the tank at atmospheric pressure at the forward access opening or the filler cap, to provide the proper fuel/air ratio for ignition.

4.6 FUEL VAPOR IGNITION TEST

Remove or lock in a depressed (open) position the fuel and air spill valves. With all instrumentation synchronized and ready for operation, the N-Pentane/air mixture shall be ignited and the reaction recorded.

4.7 POST FUEL VAPOR IGNITION EXAMINATION

Visually inspect and tap test entire surface of tank for delaminations. Record all external damage if any to the outside surface of tank. Remove both access openings and filler cap and visually inspect the interior of the tank. Record all internal damage to the tank shell, frames, baffles, fittings or tubing. Photograph all internal and external, if any, damage. Identify photographs by number and location.

5.0 QUALIFICATION REPORT

A formal qualification test report shall be submitted per MIL-STD-831 within 30 days after the testing is complete. This report is to include all recorder pressure data sheets, high speed film and photographs. The test tank shall be returned to Fiber Science for further testing in the same shipping container it was received in.

APPENDIX "A"

TEST DATA SHEETS

TEST DATA SHEET

QTR-2191 SECTION "N"

Testing Activity_____ Activity Test Engr._____

Tank Serial No. _____ F.S.I. Test Engr. _____

Test Date _____ Government Rep. _____

EXAMINATION OF PRODUCT

Ref. Para. 4.1: Visual Inspection_____

Delaminations (Tap Test)_____

MOUNTING

Ref. Para. 4.2 Aircraft Simulated Attachment

Deviations If Any_____

ARRANGEMENT

Ref. Para. 4.3: Approved Test Arrangement Including Ignition Device (Ref. Figure 1 & ASD/ENFEA-78 Technical Exhibit.)

Testing Activity Approval

Approved By_____ Date _____

F.S.I. Test Engineer Approval

Approved By_____ Date _____

Government Approval

Approved By_____ Date _____

Minimum of two signatures required.

INSTRUMENTATION

Ref. Para. 4.4.1 CHECK INSTRUMENTATION CALIBRATION

ITEM	CALIBRATION DATE
Igniter (If Applicable)	
Cameras (If Applicable)	
Pressure Transducer Recorder	
Timing Devices	
Other Instruments:	
1._____	
2._____	
3._____	
4._____	

Ref. Para 4.4.2: CHECK PROPER INSTALLATION

ITEM	REMARKS
Igniter	
Cameras	
Pressure Transducers	
Recorders	
Other Instruments:	
1.	
2.	
3.	
4.	

Ref. Para 4.4.3: CHECK PROPER OPERATION

ITEM	REMARKS
Igniter	
Cameras	
Pressure Transducers	
Recorders	
Other Instruments:	
1.	
2.	
3.	
4.	

PRIMING TANK

Ref. Para. 4.5: PRIME TANK WITH PROPER MIXTURE

ITEM	REMARKS
Access opening in which primer was introduced to the tank.	
N-Pentane/air ratio used to achieve 6.5 atmospheres (95 to 100 psi) in 60 milliseconds.	
1.	
2.	
3.	
4.	
5.	
Secure Access Opening.	

FUEL VAPOR IGNITION TEST

Ref. Para. 4.6: INGITE FUEL VAPORS WITH ALL INSTRUMENTATION SYNCHRONIZED

ITEM	OPERATION REMARKS
Igniter	
Pressure Achieved	
Camera	
Pressure Transducers	
Recorders	
Other Instruments:	
1.	
2.	
3.	
4.	

POST FUEL VAPOR IGNITION EXAMINATION

Ref. Para. 4.7: EXAMINE TANK FOR THE FOLLOWING:

Visual Inspection _____

Delaminations (Tap Test) _____

Internal Damage

Tank Shell _____

Frames _____

Baffles _____

Fittings _____

Tubing _____

EVALUATION OF DATA

CAMERAS:

PRESSURE RECORDINGS:

INTERNAL DAMAGE:

DOCUMENT NUMBER

QTP-2191 SECTION "0"

TITLE

QUALIFICATION TEST PROCEDURE

H-53 TANK

REQUIREMENTS FOR GUNFIRE TEST

REVISIONS

LTR.	DATE	PREPARED	APPROVED	DESCRIPTION

PREPARED BY: RICHARD LYMAN DATE: 11/18/80

CHECKED BY: Randy Stone DATE: 12-5-80

APPROVED BY: C. G. Patrick Jr. DATE: 12/6/80

FIBER SCIENCE, INC.
SALT LAKE CITY, UTAH

NO. QTP-2191 Section "0"

DATE: 11/18/80

1.0 SCOPE

This procedure covers the requirements for ballistic testing of the 450 Gallon Filament Wound External Fuel Tank for the H-53 helicopter.

2.0 APPLICABLE DOCUMENTS

2.1 MILITARY SPECIFICATIONS

MIL-STD-831	Test Reports, Preparation of.

2.2 TECHNICAL EXHIBIT

ASD/ENFEA-78	Tank - 450 gallon external fuel, filament wound lightweight explosion proof.

2.3 DRAWINGS

FIBER SCIENCE

2191-001	Tank - Installation, 450 gallon H-53

SARGENT FLETCHER

27-450-4400	Pylon Assembly - 450 gallon fuel tank.

3.0 REQUIREMENTS

3.1 TEST ARTICLES

Two tank assemblies (2191-001) fueled to a full tank condition and mounted to a pylon (27-450-4400) which in turn is mounted to a test stand shall be subjected individually to the impact of a single projectile as described in Technical Exhibit ASD/ENFEA-78, paragraph 3.4.1.7.2.

3.2 TEST ARRANGEMENT

The test arrangement shall be similar to that shown in Figure 1 with all reasonable precautions taken to simulate the actual mounting of the tank and pylon to the helicopter.

3.3 TEST METHOD

The tanks shall be suspended in a 2^{0} nose down position by the pylon supports attached to a suitable test fixture and filled to the normal full condition with water. The tank shall be impacted by a 14.5 mm armor piercing projectile at an impact velocity of 3200 ft. per sec. from a distance of 75 feet. The projectile trajectory shall be in the horizontal plane and intersect the tank center, and be approximately perpendicular to the longitudinal centerline. Refer to Figure 1.

3.4 TEST INSTRUMENTATION

High speed color movies shall be taken with a Fast-X camera capable of photographing 2000 frames per second minimum, of the projectile entrance and exit areas. Pressure in the tank during the time interval of the impact transient shall be measured and recorded at four points as shown in Figure 2. Four color still photos shall be taken of the entrance and exit areas and any other damaged areas after the test.

3.4.1 INSTRUMENTATION CALIBRATION

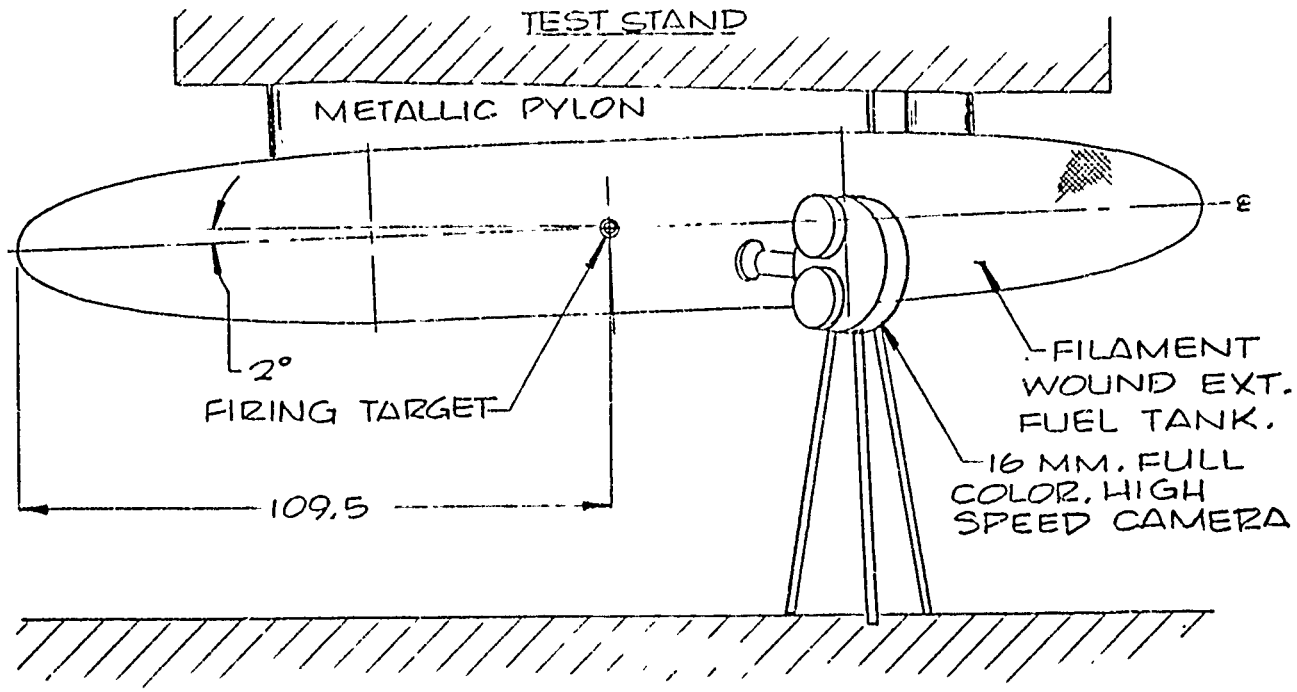
All instrumentation shall be calibrated and capable of reading or recording data within ±2% of its full scale value. No instrument shall be used that has not been calibrated within the previous calibration period.

3.5 TEST PROCEDURES

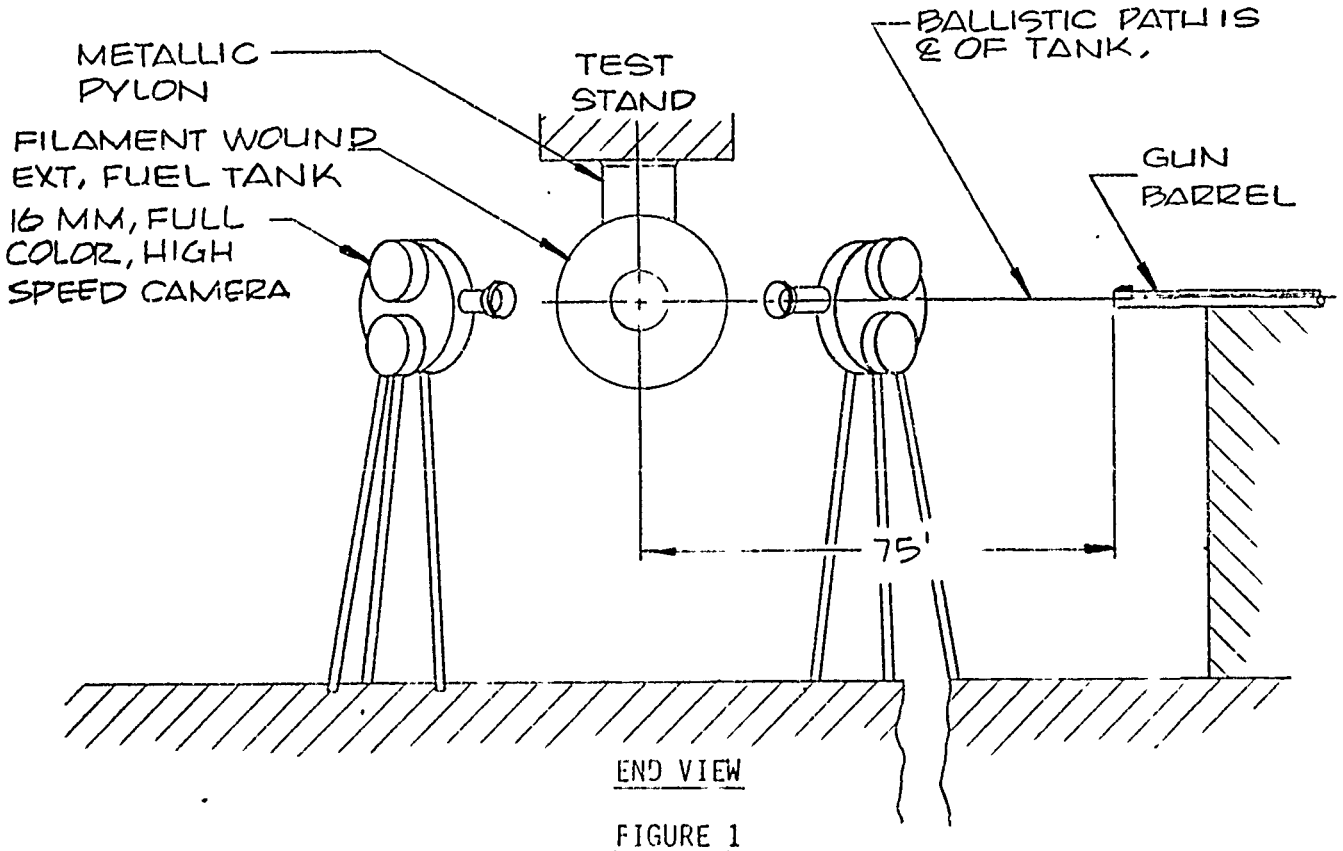
The test procedures shall be in accordance with paragraph 4 of this document.

3.6 DOCUMENTATION

At the conclusion of testing a test report will be prepared for submission to the contractor.



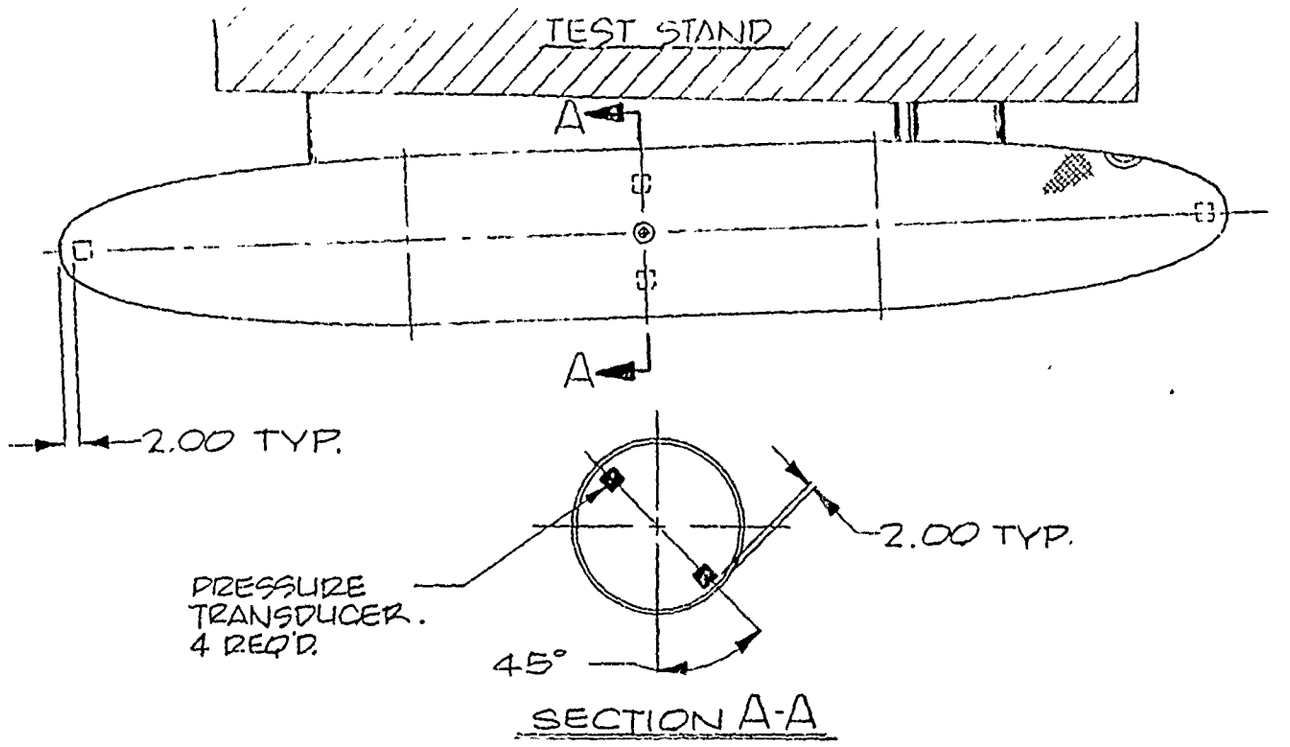
SIDE VIEW



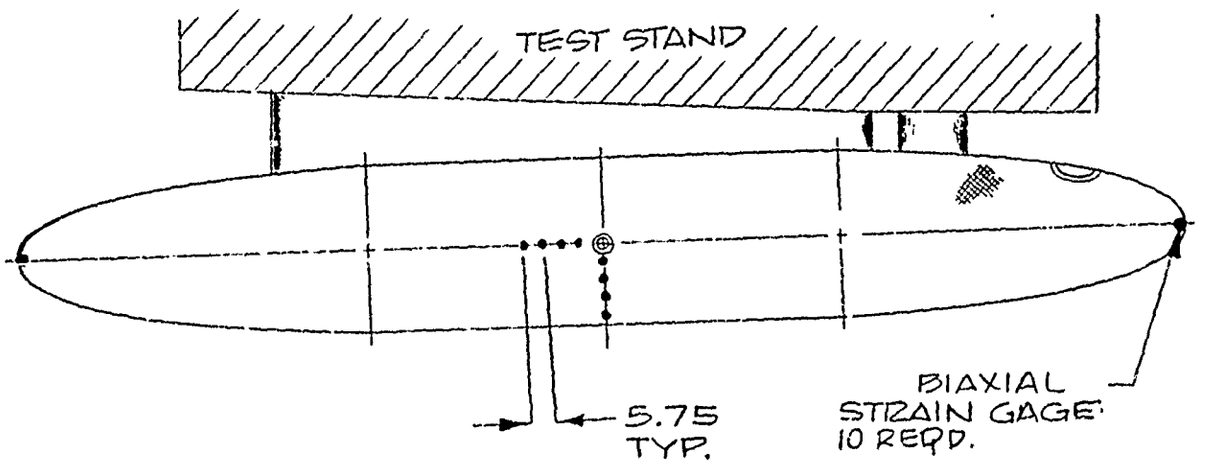
END VIEW

FIGURE 1

TEST ARRANGEMENT



PRESSURE SENSOR ARRANGEMENT



STRAIN SENSOR ARRANGEMENT

FIGURE 2

SENSOR ARRANGEMENT

4.0 QUAILIFICATION TEST PROVISIONS

4.1 EXAMINATION OF PRODUCT

The tank and pylon shall be fully examined prior to mounting to the test stand for shipping damage to the test site. This examination shall include a visual inspection and a tap test for delaminations. The results of this inspection shall be recorded by the testing activity in the presence of an authorized Fiber Science Test Engineer.

4.2 MOUNTING

The tank shall then be mounted to the test fixture and examined for proper attachment and assimilation to the actual aircraft installation. Any significant variations or deviations shall be recorded.

4.3 ARRANGEMENT

The test arrangement shall be examined for compliance with Figure 1 of this procedure and applicable paragraphs of ASD/ ENFEA-78 Technical Exhibit.

4.4 INSTRUMENTATION AND TEST EQUIPMENT

4.4.1 INSTRUMENTATION CALIBRATION

All instrumentation shall be inspected to verify that each instrument has had a calibration check within the last calibration period.

4.4.2 INSTALLATION

All instruments and test equipment: gun, cameras, pressure transducers, strain gauges and recorders shall be installed in such a way as to best satisfy the intent of the test. Pressure reading shall be taken at locations indicated in Figure 2 of this procedure.

4.4.3 OPERATION

All instrumentation and test equipment shall be checked for proper operation. Any defects in instrumentation shall be recorded and the test shall not proceed until the defect is removed or deemed not critical for the test required by the testing activity and approved by an authorized Fiber Science Test Engineer.

4.5 FUELING

The tank shall be filled with 450 to 457 gallons of water through the filler cap opening. If the tank is properly mounted (2^{o} nose down) the tank will contain the proper amount when the water begins to overflow out the filler cap opening.

4.6 GUNFIRE TEST

With all instrumentation synchronized and ready for operation, the gun shall be loaded with one 14.5 mm. round and fired and the effects recorded.

4.7 POST GUNFIRE EXAMINATION

Examine projectile created orifice in tank wall at entrance and exit. The orifice area shall not be larger than the projected area of the projectile as it entered or exited the tank. Record measurements on the data sheet. Examination of entire tank surface should be made to determine visual appearance, fractured or broken rovings. In addition, the entire tank surface should receive a tap test to determine if any delaminations occurred. Record all pertinent information including four still photographs each of round entrance and exit orifice.

5.0 QUALIFICATION TEST REPORT

A formal qualification testreport shall be submitted per MIL-STD-831 within 30 days after the testing is complete. This report is to include all recorder pressure and strain data sheets, high speed film, photographs and expended tanks. The expended tanks shall be returned to Fiber Science for post evaluation in the same shipping containers they were received in.

APPENDIX "A"

TEST DATA SHEETS

TEST DATA SHEET

QTR-2191 SECTION "0"

Testing Activity_____ Activity Test Engr._____

Tank Serial No. _____ F.S.I. Test Engr. _____

Test Date _____ Government Rep. _____

EXAMINATION OF PRODUCT

Ref. Para. 4.1: Visual Inspection_____

Delaminations (Tap Test)_____

MOUNTING

Ref. Para 4.2: Aircraft Simulated Attachment

Deviations If Any_____

ARRANGEMENT

Ref. Para. 4.3: Approved Test Arrangement (Ref. Figure 2 & ASD/ENTEA-78 Technical Exhibit.)

Testing Activity Approval

Approved By_____ Date_____

F.S.I. Test Engineer Approval

Approved By_____ Date_____

Government Approval

Approved By_____ Date_____

Minimum of two signatures required.

INSTRUMENTATION

Ref. Para. 4.4.1: CHECK INSTRUMENTATION CALIBRATION

ITEM	CALIBRATION DATE
Gun (If Applicable)	_____
Cameras (If Applicable)	_____
Pressure Transducer Recorder	_____
Strain Gauge Recorder	_____
Timing Devices	_____
Other Instruments:	_____
1._____	_____
2._____	_____
3._____	_____
4._____	_____

Ref. Para 4.4.2: CHECK PROPER INSTALLATION

ITEM	REMARKS
Gun	
Cameras	
Pressure Transducers	
Strain Gauges	
Recorders	
Other Instruments	
1.	
2.	
3.	
4.	

Ref. Para 4.4.3: CHECK PROPER OPERATION

ITEM	REMARKS
Gun	
Cameras	
Pressure Transducers	
Strain Gauges	
Recorders	
Other Instruments	
1.	
2.	
3.	
4.	

FUELING

Ref. Para 4.5: FUEL TANK AT PROPER ATTITUDE

ITEM	REMARKS
Attitude (20° Nosedown)	
Fill With 450 Gal. Water	
Secure Filler Cap	

GUNFIRE TEST

Ref. Para 4.6: FIRE GUN WITH ALL INSTRUMENTATION SYNCHRONIZED

ITEM	OPERATION REMARKS
Gun	
Cameras	
Pressure Transducers	
Strain Gauges	
Recorders	
Other Instruments	
1.	
2.	
3.	
4.	

POST GUNFIRE EXAMINATION

Ref. Para. 4.7: EXAMINE TANK FOR THE FOLLOWING:

ITEM	REMARKS
Initial Round Area	
Round Entrance Orifice Area	
Exit Round Area (If round can be retrieved unmodified.)	
Round Exit Orifice Area	
Visual Inspection	
Delaminations (Tap Test)	

Ref. Para. 4.7: Color Photographs

LOCATION	PHOTO NO.
Entrance	(__) (__) (__) (__)
Exit	(__) (__) (__) (__)
Other Damage	

LOCATION	PHOTO NO.

EVALUATION OF DATA

CAMERAS:

PRESSURE RECORDINGS:

STRAIN RECORDINGS:

DOCUMENT NUMBER

QTP-2191 SECTION "P"

TITLE

QUALIFICATION TEST PROCEDURE

H-53 TANK

REQUIREMENTS FOR FUEL FIRE TEST

REVISIONS

LTR.	DATE	PREPARED	APPROVED	DESCRIPTION

PREPARED BY: Richard Lyman DATE: 11/20/80

CHECKED BY: Randy Stone DATE: 12/5/80

APPROVED BY: Clarence A Patinkin Jr DATE: 12/6/80

FIBER SCIENCE, INC.
SALT LAKE CITY, UTAH

NO. QTP-2191 Section "P"

DATE: 11/20/80

1.0 SCOPE

This procedure covers the requirements for Fuel Fire Testing of the 450 Gallon Filament Wound External Fuel Tank for the H-53 helicopter.

2.0 APPLICABLE DOCUMENTS

2.1 MILITARY SPECIFICATIONS

MIL-T-5629	Turbine fuel, aviation, Grades JP-4 and JP-5.
MIL-STD-831	Preparation of test reports.

2.2 TECHNICAL EXHIBIT

ASD/ENFEA-78	Tank - 450 gallon external fuel, filament wound lightweight explosion proof.

2.3 DRAWINGS

FIBER SCIENCE, INC.

2191-001	Tank - installation, 450 Gallon H-53

SARGENT FLETCHER

27-450-4400	Pylon assembly 450 gallon fuel tank.

3.0 REQUIREMENTS

3.1 TEST ARTICLE

One tank assembly (2191-001) mounted to a pylon (27-450-4400) which in turn is mounted to a test stand shall be fueled to a full tank condition with JP-5 and subjected to a JP-4 fuel fire for 10 minutes as described in Technical Exhibit ASD/ENFEA-78 Paragraph 3.4.1.7.4.

3.2 TEST ARRANGEMENT

The test arrangement shall be similar to that shown in Figure 1, with all reasonable precautions taken to simulate the actual mounting of the tank and pylon to the helicopter.

3.3 TEST METHOD

The tank shall then be filled to the normal full position with JP-5 fuel, suspended in a 2^{0} nose down position by the pylon support points with a suitable test fixture. The tank shall be suspended 48 $\pm$ 2 inches at its center point above a reservoir of JP-4 fuel. This reservoir when ignited shall have sufficient fuel to entirely engulf the tank in flames at a minimum temperature of 1750^{0} F. for a minimum of 10 minutes. A 16 mm. full color movie shall be taken of the entire burn test sequence. Refer to Figure 1.

3.4 TEST INSTRUMENTATION

Full color 16 mm movies shall be taken of the burn test from automatic ignition through extinguishing of all flames. The camera shall be positioned so that a side view can be seen and in such a way as to photograph well the extinguishing process without blocking the view of the process. Refer to Figure 2. Continuous temperature reading shall be monitored during the test by 20 thermocouples positioned approximately as shown in Figure 3. Twelve (12) color still photos shall be taken after the fire has been extinguished at select locations as determined by the testing activity and the Fiber Science Test Engineer.

3.4.1 INSTRUMENTATION CALIBRATION

All instrumentation shall be calibrated and capable of reading or recording data within ± 2% of its full scale value. No instrument shall be used that has not been calibrated within the previous calibration period.

3.5 TEST PROCEDURES

The test procedures shall be in accordance with Paragraph 4 of this document.

3.6 DOCUMENTATION

At the conclusion of testing a test report shall be prepared for submission to the contractor.

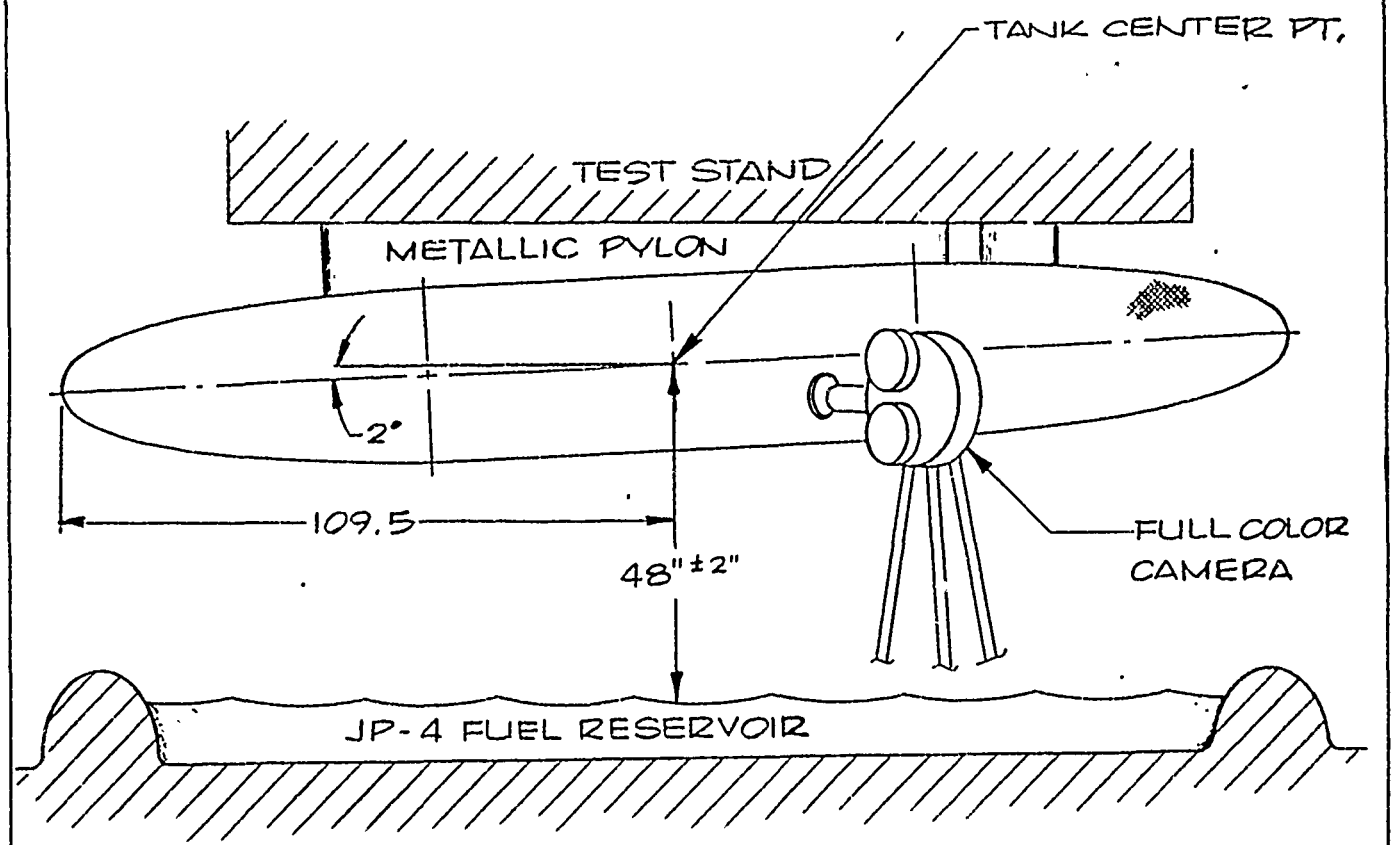


FIGURE 1

BASIC TEST ARRANGEMENT

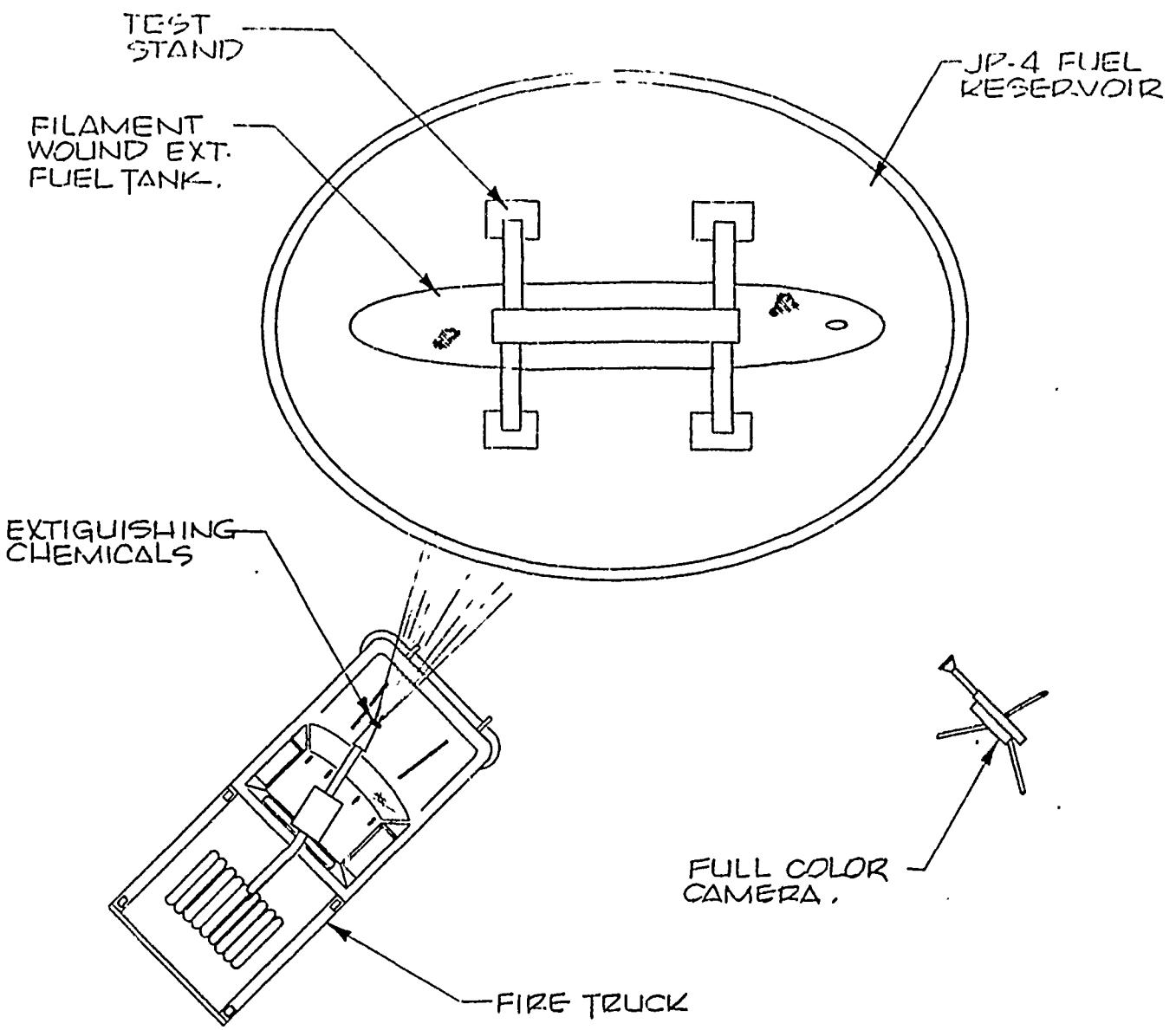
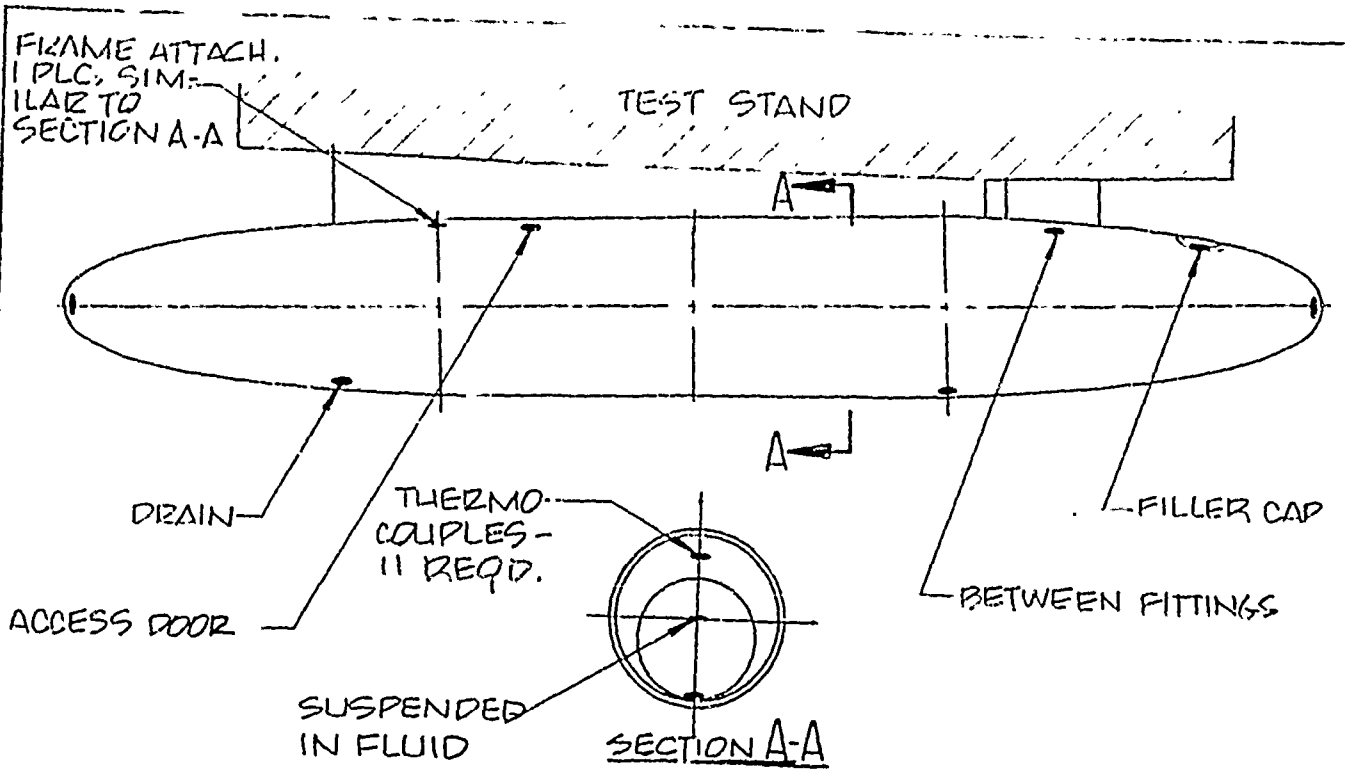
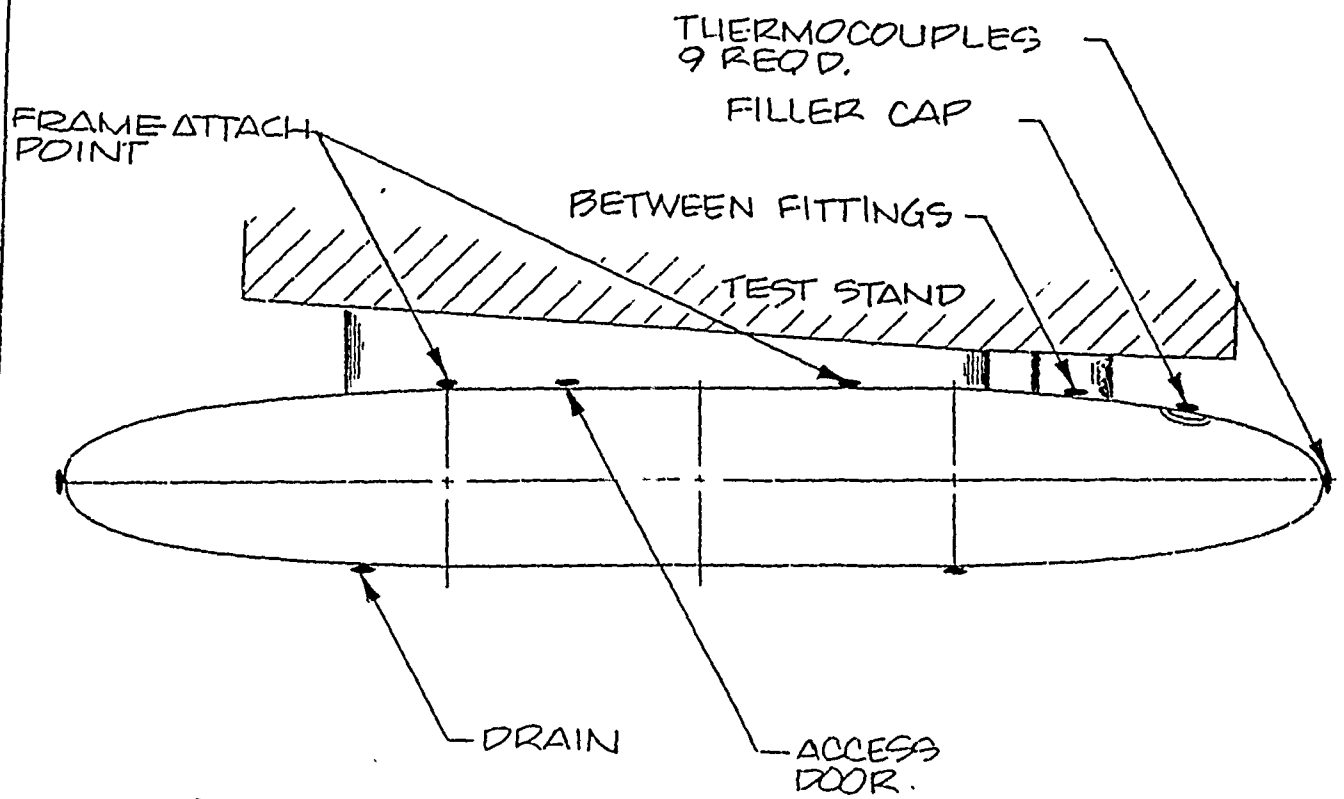


FIGURE 2

EXTINGUISHING FUEL FIRE ARRANGEMENT



INTERNAL THERMOCOUPLE ARRANGEMENT



EXTERNAL THERMOCOUPLE ARRANGEMENT

FIGURE 3

THERMOCOUPLE ARRANGEMENT

4.0 QUALIFICATION TEST PROCEDURE

4.1 EXAMINATION OF PRODUCT

The tank and pylon shall be fully examined prior to mounting to the test stand for shipping damage to the test site. This examination shall include a visual inspection and a tap test for delaminations. The results of this inspection shall be recorded by the testing activity in the presence of an authorized Fiber Science Test Engineer.

4.2 MOUNTING

The tank shall then be mounted to the test fixture and examined for proper attachment and assimilation to the actual aircraft installation. Any significant variations or deviations shall be recorded.

4.3 ARRANGEMENT

The test arrangement shall be examined for compliance with Figure 1 and Figure 2 of this procedure and applicable paragraphs of ASD/ENFEA-78 Technical Exhibit.

4.4 INSTRUMENTATION

4.4.1 INSTRUMENTATION CALIBRATION

All instrumentation shall be inspected to verify that each instrument has had a calibration check within the last calibration period.

4.4.2 INSTALLATION

All instrumentation, test equipment, cameras, thermocouples and recorders shall be installed and leads to sensors properly insulated for the test. Temperature readings shall be taken at locations indicated in Figure 3 of this procedure.

4.4.3 OPERATION

All instrumentation and test equipment shall be checked for proper operation. Any defects in instrumentation shall be recorded and the test shall not proceed until the defect is removed or deemed not critical for the test required by the testing activity and approved by an authorized Fiber Science Test Engineer.

4.5 FUELING

The tank shall be filled with 450 to 457 gallons of JP-5 fuel through the filler cap opening. The tank if properly mounted (2^{0} nose down) will contain the proper amount of fuel when the fuel begins to overflow at the filler cap opening.

4.6 FUEL FIRE TEST

With all instrumentation synchronized and ready for operation the reservoir shall be filled with JP-4 fuel to the desired level to complete the test. The fuel shall be remotely ignited and the documentation recorded. The burn time shall be 10 to 10.5 minutes after complete ignition of the reservoir. The extinguishing time shall be recorded and shall be as rapid as is practical but not more than 10 minutes.

4.7 POST FUEL FIRE EXAMINATION

The tank shall complete this test without rupture. Examine entire surface of the tank with special care taken to examine the following:

a. Void volume area of the tank.

b. The various fittings on the tank.

c. The mounting bolt locations.

d. Access openings.

e. Nose and tail caps.

Examine and record the condition of the pylon. Twelve (12) color photographs shall be taken of the tank condition at locations determined by the testing activity and Fiber Science Test Engineer. At the discretion of the authorized Fiber Science Test Engineer the tank may be cross sectioned to determine the extent of degradation or damage to inside filament winding on the tank.

5.0 QUALIFICATION TEST REPORT

A formal qualification test report shall be submitted per MIL-STD-831 within thirty days after the testing is complete. This report is to include all recorder temperature data sheets, 16 mm. color movie film, 12 color photographs and the expended tank. The expended tank shall be returned to Fiber Science for postevaluation in the same shipping container it was received in.

APPENDIX "A"

TEST DATA SHEETS

TEST DATA SHEET

QTR-2191 SECTION "P"

Testing Activity_____ Activity Test Engr._____

Tank Serial No. _____ F.S.I. Test Engr. _____

Test Date _____ Government Rep. _____

EXAMINATION OF PRODUCT

Ref. Para. 4.1 Visual Inspection_____

_____

_____

_____

_____

Delaminations (Tap Test)_____

_____

_____

_____

_____

MOUNTING

Ref. Para 4.2: Aircraft Simulated Attachment

Deviations If Any_____

_____

_____

_____

_____

ARRANGEMENT

Ref. Para. 4.3

Approved Test Arrangement (Ref. Figure 2 & ASD/ENFEA-78 Technical Exhibit.)

Testing Activity Approval

Approved By_____ Date_____

F.S.I. Test Engineer Approval

Approved By_____ Date_____

Government Approval

Approved By_____ Date_____

Minimum of two signatures required.

INSTRUMENTATION

Ref. Para. 4.4.1:

CHECK INSTRUMENTATION CALIBRATION

ITEM	CALIBRATION DATE
Igniter If Applicable	
Cameras If Applicable	
Thermocouple Recorder	
Timing Devices	
Other Instruments:	
1.	
2.	
3.	
4.	

ARRANGEMENT

Ref. Para. 4.3

Approved Test Arrangement (Ref. Figure 2 & ASD/ENFEA-78 Technical Exhibit.)

Testing Activity Approval

Approved By_____ Date_____

F.S.I. Test Engineer Approval

Approved By_____ Date_____

Government Approval

Approved By_____ Date_____

Minimum of two signatures required.

INSTRUMENTATION

Ref. Para. 4.4.1:

CHECK INSTRUMENTATION CALIBRATION

ITEM	CALIBRATION DATE
Igniter If Applicable	_____
Cameras If Applicable	_____
Thermocouple Recorder	_____
Timing Devices	_____
Other Instruments:	_____
1._____	_____
2._____	_____
3._____	_____
4._____	_____

Ref. Para. 4.4.2

CHECK PROPER INSTALLATION

ITEM	REMARKS
Tank/Reservoir	
Camera	
Thermocouples	
Recorders	
Other Instruments:	
1.	
2.	
3.	
4.	

Ref. Para. 4.4.3

CHECK PROPER OPERATION

ITEM	REMARKS
Igniter	
Cameras	
Thermocouples	
Recorders	
Fire Extinguishing Equipment	
Other Instruments:	
1.	
2.	
3.	
4.	

FUELING

Ref. Para. 4.5: FUEL TANK AT PROPER ATTITUDE

ITEM	REMARKS
Attitude (2^{o} nose down)	
Fill With 450 Gal. JP-5	
Secure Filler Cap	
Reservoir Filled With	
Gallons of JP-4	

FUEL FIRE TEST

Ref. Para. 4.6 IGNITE JP-4 FUEL FIRE WITH ALL INSTRUMENTATION SYNCHRONIZED

ITEM	OPERATION REMARKS
Igniter	
Cameras	
Thermocouples	
Recorders	
Fire Extinguishers	
Timers	
Other Instruments	
1. _____	
2. _____	
3. _____	
4. _____	

Ref. Para. 4.6 BURN TIME.

ITEM	TIME
Initial Ignition	
Complete Reservoir Ignition	
Begin Extinguishing	
Extinguishing Complete	

POST FUEL FIRE EXAMINATION

Ref. Para. 4.7: EXAMINE TANK FOR THE FOLLOWING:

GENERAL APPEARANCE

VOID VOLUME REGION

FITTING REGION

a. Fuel & Air Fittings

b. Drain Fitting

MOUNTING BOLT LOCATIONS

a. Forward

b. Aft

ACCESS OPENINGS

a. Forward

b. Aft

END CLOSURES

Nose

Tail

PYLON CONDITION

Ref. Para. 4.8.4

PHOTOGRAPHS

Number Photographs and Identify Locations

PHOTO	LOCATION	PHOTO	LOCATION
1.		7.	
2.		8.	
3.		9.	
4.		10.	
5.		11.	
6.		12.	

DISSECTION OF TANK

Approved By _____ Date _____

GENERAL INTERIOR CONDITION

CONDITION OF INNER WINDING

CONDITION OF LINER

EVALUATION OF DATA

CAMERAS:

THERMOCOUPLE RECORDINGS:

GENERAL CONDITION:

DOCUMENT NUMBER

QTP-2191 SECTION "Q"

TITLE

QUALIFICATION TEST PROCEDURE

H-53 TANK

REQUIREMENTS FOR ELECTROSTATIC TEST

REVISIONS

LTR.	DATE	PREPARED	APPROVED	DESCRIPTION

PREPARED BY: RICHARD LYMAN DATE: 1/21/81

CHECKED BY: K. Stone DATE: 1-30-81

APPROVED BY: C. A. Patmore Jr. DATE: 1/30/81

FIBER SCIENCE, INC.
SALT LAKE CITY, UTAH

NO. QTP-2191 Section "Q"

DATE: 1/21/81

1.0 SCOPE

This procedure covers the requirements for Electrostatic Testing of the 450 Gallon Filament Wound External Fuel Tank for the H-53 Helicopter.

2.0 APPLICABLE DOCUMENTS

2.1 MILITARY SPECIFICATIONS

MIL-STD-831	Test Reports, Preparation of.

2.2 FEDERAL SPECIFICATIONS

FED. TEST METHOD STD. 101B	Preservation, Packaging and Packing Materials; Test Procedures for.
(METHOD 4046)	(Electrostatic Properties of Materials)

2.3 TECHNICAL EXHIBIT

ASD/ENFEA-78	Tank - 450 gallon external fuel, filament wound light-weight explosion proof.

2.4 DRAWINGS

FIBER SCIENCE

2191-001	Tank - Installation, 450 gallon H-53

3.0 REQUIREMENTS

3.1 TEST ARTICLE

One (1) expended tank assembly shall be dissected to remove a minimum of nine (9) structurally sound representative samples for electrostatic discharge testing to the requirements of Paragraph 4.6.23 of the Technical Exhibit ASD/ENFEA-78.

3.2 TEST ARRANGEMENT

The test arrangement shall be similar to that shown in Figure 1 with all reasonable precautions taken to simulate an actual condition.

3.3 TEST SAMPLES

A minimum of nine (9) structurally sound samples five (5) inches by three (3) inches free from defects such as holes, cracks, or tears shall be prepared for testing. The exterior paint coating must be continuous.

3.4 CONDITIONING

Prior to testing, a minimum of three (3) or one third (1/3) of the samples shall be dried in an oven for twelve (12) days at $160^{0} \pm 5^{0}$ F. A minimum of three (3) other samples shall be placed in a horizontal position under a continuous water shower for 24 hours. The remaining samples (minimum of 3) shall be placed in a $50 \pm 5\%$ relative humidity atmosphere uniformly maintained at $73^{0} \pm 5^{0}$ F for twelve (12) days. Upon completion of the individual sample conditioning, all samples shall be dried in a desiccating chamber for a minimum of 24 hours before testing.

3.5 TEST METHOD

The representative test samples properly conditioned shall be electrostatically discharge tested to the requirements of Federal Test Method Standard 101B Method 4046. The maximum decay time for a full charge shall not exceed two (2) seconds.

3.6 TEST INSTRUMENTATION

The electrostatic discharge test shall be conducted in a test chamber similar to that shown in Figure 1 using 0 to 15 KV positive and negative power source. Additional instrumentation shall include an electrometer for measuring volts, amperes and ohms from .01 to 100, a single channel recorder capable of recording up to eight (8) inches per second and a still camera for recording at least one color photograph of each test.

3.6.1 INSTRUMENTATION CALIBRATION

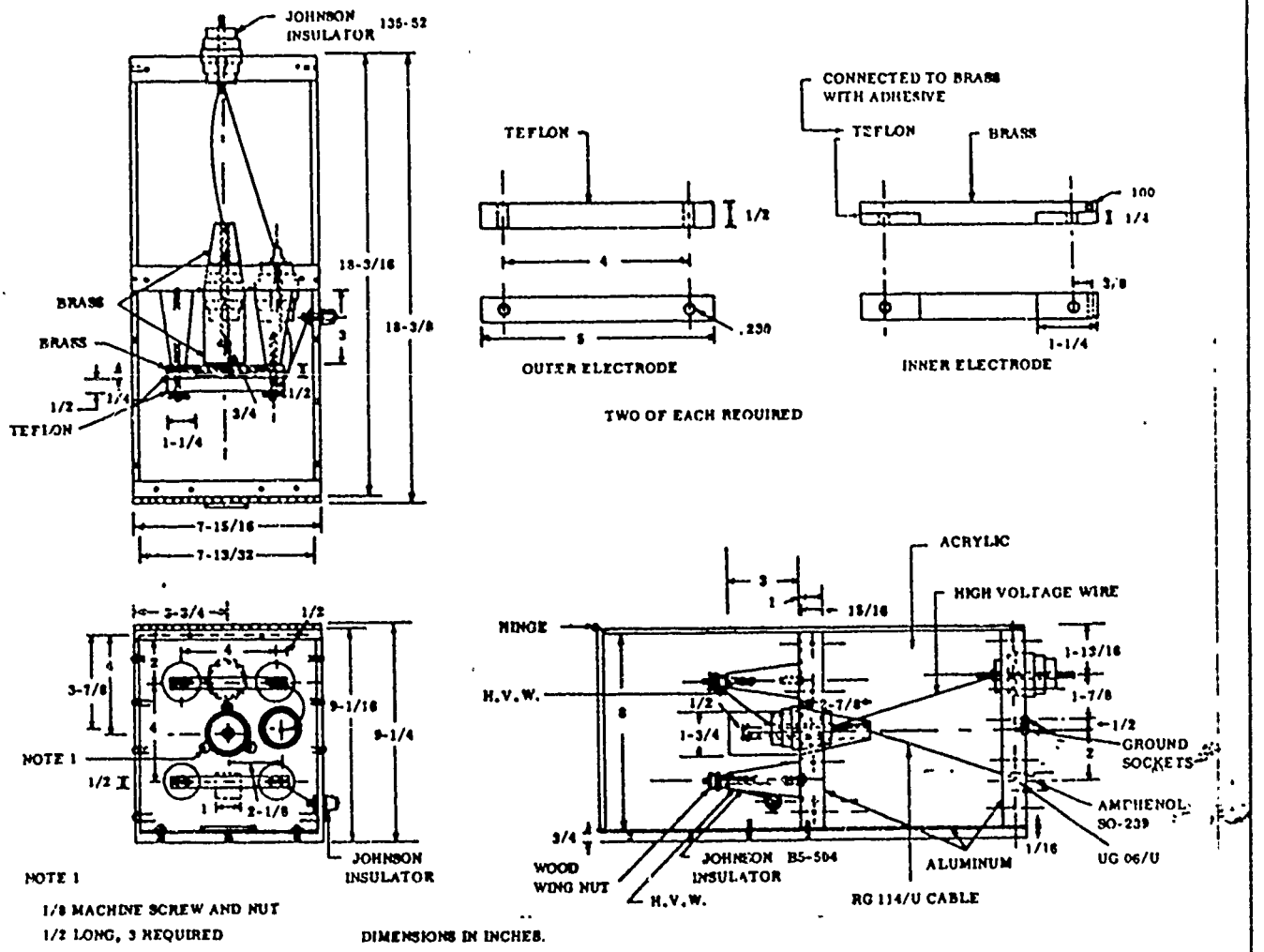
All instrumentation shall be calibrated and capable of reading or recording data within ± 2% of its full scale value. No instrument shall be used that has not been calibrated within the previous calibration period.

3.7 TEST PROCEDURES

The test procedures shall be in accordance with Paragraph 4 of this document.

3.8 DOCUMENTATION

At the conclusion of testing a test report will be prepared for submission to the contractor.



Note: Drawing taken from Federal Test Method Standard 101B Method 4046

FIGURE 1

ELECTROSTATIC TEST CHAMBER MECHANISM

4.0 QUALIFICATION TEST PROVISIONS

4.1 EXAMINATION OF SAMPLES

The test samples prepared to the requirements of Paragraph 3.3 by Fiber Science, Inc., shall be fully examined prior to conditioning for use in the test chamber for shipping damage to the test facility. This examination shall include a visual inspection per Paragraph 3.3 and a tap test for delaminations. The results of this inspection shall be recorded by the testing activity in the presence of an authorized Fiber Science Test Engineer.

4.2 CONDITIONING OF SAMPLES

Condition the test samples to the requirements of Paragraph 3.4 and Federal Test Method Standard 101B Method 4046. The time sequence of the conditioning shall be such that upon completion of the conditioning all samples will be ready to test on the same day.

4.3 ARRANGEMENT

The test arrangement shall be examined for compliance with Figure 1 of this procedure, applicable paragraphs of ASD/ ENFEA-78 Technical Exhibit and Federal Test Method Standard 101B Method 4046.

4.4 INSTRUMENTATION AND TEST EQUIPMENT

4.4.1 INSTRUMENTATION CALIBRATION

All instrumentation shall be inspected to verify that each instrument has had a calibration check within the last calibration period.

4.4.2 INSTALLATION

All instruments and test equipment: electrostatic discharge device, electrometers, recorders and camera shall be installed and synchronized in such a way as to best satisfy the intent of the test.

4.4 OPERATION

All instrumentation and test equipment shall be checked for proper operation. Any defects in instrumentation shall be recorded and the test shall not proceed until the defect is removed or deemed not critical for the test required by the testing activity and approved by an authorized Fiber Science Test Engineer.

4.5 ELECTROSTATIC DISCHARGE TEST

With all samples properly conditioned and all instrumentation synchronized and ready for operation, insert individually each sample into the electrostatic discharge chamber and apply a static discharge per Paragraph 6 of Federal Test Method Standard 101B Method 4046. The maximum electrostatic discharge decay time shall not exceed two (2) seconds on any of the sample tests.

5.0 QUALIFICATION REPORT

A formal qualification test report shall be submitted per MIL-STD-831 within 30 days after the testing is complete. This report is to include all electrostatic discharge decay time recorder data sheets, applied static discharge voltages and photographs. The test samples shall be returned to Fiber Science in the same shipping container it was received in.

APPENDIX "A"

TEST DATA SHEETS

TEST DATA SHEET

QTR-2191 SECTION "Q"

Testing Activity_____ Activity Test Engr._____

Tank Serial No._____ F.S.I. Test Engr. _____

Test Date _____ Government Rep. _____

EXAMINATION OF SAMPLES

Ref. Para 4.1: Visual Inspection _____

_____

_____

_____

_____

Delaminations (Tap Test)_____

_____

_____

_____

_____

CONDITIONING OF SAMPLES

Ref. Para. 4.2: CONDITION SAMPLES FOR ELECTROSTATIC DISCHARGE TESTING

Samples oven dried at $160^{0} \pm 5^{0}$ F for twelve (12) days. Three (3) samples minimum required.

ITEM	REMARKS
Number of Samples	
Date and Time in Oven	
Date and Time out of Oven	
Visual Inspection of Condition	
Delaminations (Tap Test)	

Ref. Para. 4.2: CONDITION SAMPLES FOR ELECTROSTATIC DISCHARGE TESTING - (continued)

Samples placed in water shower for 24 hours. Three (3) samples minimum required.

ITEM	REMARKS
Number of Samples	
Date and Time in Shower	
Date and Time out of Shower	
Visual Inspection of Condition	
Delaminations (Tap Test)	

Samples placed in 50 ± 5% relative humidity at 73° ± 5° F for twelve (12) days.

ITEM	REMARKS
Number of Samples	
Date and Time in 50% Humidity	
Date and Time out of 50% Humidity	

Ref. Para. 4.2: CONDITION SAMPLES FOR ELECTROSTATIC DISCHARGE TESTING - (continued)

Visual Inspection of Condition _____

_____

_____

_____

Delaminations (Tap Test)_____

_____

_____

_____

All samples (after conditioning) placed in desiccating chamber for 24 hours before testing.

ITEM	REMARKS
Number of Samples	_____
Date and Time in Chamber	_____
Chamber Condition	_____
Date and Time Out of Chamber	_____

Visual Inspection of Condition _____

_____

_____

_____

Delaminations (Tap Test)_____

_____

_____

_____

ARRANGEMENT

Ref. Para. 4.3: APPROVED TEST ARRANGEMENT (REF. FIGURE 1, ASD/ENFEA-78 TECHNICAL EXHIBIT AND FED. TEST METHOD STD. 101B METHOD 4046).

Testing Activity Approval

Approved By _____ Date _____

F.S.I. Test Engineer Approval

Approved By _____ Date _____

Government Approval

Approved By _____ Date _____

Minimum of two signatures required.

INSTRUMENTATION

Ref. Para. 4.4.1: CHECK INSTRUMENTATION CALIBRATION

ITEM	CALIBRATION DATE
Electrostatic Discharge Mech. (If Applicable)	
Cameras (If Applicable)	
Electrometers	
Discharge Decay Recorder	
Other Instruments:	
1.	
2.	
3.	
4.	

Ref. Para. 4.4.2: CHECK PROPER INSTALLATION

ITEM	REMARKS
Electrostatic Discharge Mechanism	
Cameras	
Electrometer	
Discharge Delay Recorders	
Other Instruments:	
1.	
2.	
3.	
4.	

Ref. Para. 4.4.3: CHECK PROPER OPERATION

ITEM	REMARKS
Electrostatic Discharge Mechanism	
Cameras	
Electrometer	
Discharge Delay Recorders	
Other Instruments	
1.	
2.	
3.	
4.	

ELECTROSTATIC DISCHARGE TEST

Ref. Para. 4.5: CALIBRATION

5 KV Positive charged voltage applied to Aluminum Calibration Panel

ITEM	REMARKS
Electrometer Multiplier Switch at 10	
Discharge Mechanism Operate Switch at 0	
Recorder Chart Speed at one (1) inch/second	
Close High Voltage (5 KV) Positive Switch	
Adjust Multiplier Switch to Maximum	
Multiplier Charge equal to Recorder Chart Reading	
Close Discharge Mechanism Ground Switch	
Stop Chart Recorder at zero Electrometer Reading	
Electrometer Zero Check Position	
Measure Discharge Decay Time	

EVALUATION: _____

Ref. Para. 4.5: CALIBRATION - (continued)

5 KV Negative charged voltage applied to Aluminum Calibration Panel

ITEM	REMARKS
Electrometer Multiplier Switch at 10	
Discharge Mechanism Operate Switch at 0	
Recorder Chart Speed at one (1) inch/second	
Close High Voltage (5 KV) Negative Switch	
Adjust Multiplier Switch to Maximum	
Multiplier Charge equal to Recorder Chart Reading	
Close Discharge Mechamism Ground Switch	
Stop Chart Recorder at zero Electrometer Reading	
Electrometer Zero Check Position	
Measure Discharge Decay Time	

EVALUATION: _____

Ref. Para. 4.5: SAMPLE DISCHARGE TEST

5 KV Positive and Negative charged voltages applied to the test samples.

ITEM	REMARKS
Electrometer Multiplier Switch at 10	
Operate Switch at 0	
Recorder Chart Speed at one half (1/2) inch/second	
Vertical Sample Between Electrodes	
Close High Voltage Switch (5 KV Positive 5 KV Negative)	
Adjust Multiplier Switch to Maximum	
Close Grounding Switch	
Measure Discharge Decay Time	

EVALUATION OF DATA

GENERAL APPEARANCE OF TESTED SAMPLES: _____

ELECTROSTATIC DISCHARGE DECAY TIME: _____

ELECTROSTATIC CHARGE OF SAMPLES RELATIVE TO OTHER SIMILAR USE MATERIALS: _____

PHOTOGRAPHS: _____

DOCUMENT NUMBER

QTP-2191 SECTION "R"

TITLE

QUALIFICATION TEST PROCEDURE

H-53 TANK

REQUIREMENTS FOR LIGHTNING TEST

REVISIONS

LTR.	DATE	PREPARED	APPROVED	DESCRIPTION

PREPARED BY: Richard Lyman DATE: 11/29/80

CHECKED BY: Randy Stowe DATE: 12/5/80

APPROVED BY: C. G. Palmer Jr. DATE: 1/8/81

FIBER SCIENCE, INC.
SALT LAKE CITY, UTAH

NO. QTP - 2191 Section "R"

DATE: 11/29/80

1.0 SCOPE

This procedure covers the requirements for Lightning Testing of the 450 Gallon Filament Wound External Fuel Tank for the H-53 helicopter.

2.0 APPLICABLE DOCUMENTS

2.1 MILITARY SPECIFICATIONS

MIL-B-5087	Electrical bonding and lightning protection for aerospace systems.
MIL-STD-831	Preparation of test reports.

2.2 FEDERAL SPECIFICATIONS

FAA-Circular 20-53	Prevention of fire and explosion from lightning strike.

2.3 TECHNICAL EXHIBIT

ASD/ENFEA-78	Tank - 450 gallon external fuel, filament wound lightweight explosion proof.

2.4 TECHNICAL REPORTS

SAE Committee AE4L	Lightning Test Waveforms and Techniques for Aerospace Vehicles and Hardware.

2.5 DRAWINGS

FIBER SCIENCE

2191-001	Tank - installation, 450 gallon H-53

SARGENT FLETCHER

27-450-4400	Pylon assembly 450 gallon fuel tank.

3.0 REQUIREMENTS

3.1 TEST ARTICLE

Two (2) test articles, one sub scale and one full scale, shall be subjected to a simulated lightning strike as described in Technical Exhibit ASD/ENFEA-78 Paragraph 3.8.6 and verified in accordance with the requirements of MIL-B-5087 to the extent applicable.

3.1.1 SUB SCALE TEST ARTICLE

One (1) test article shall be a scale model of the full scale test tank and shall be used in simulated lightning tests to establish lightning characteristics relative to possible attachment points for Zone 1A areas (direct attachment areas) and Zone 1B areas (channel hang-on areas).

3.1.2 FULL SCALE TEST ARTICLE

One (1) full scale pre-production tank assembly (2191-001) mounted to a pylon (27-450-4400) which in turn is mounted to a test fixture shall be placed in a high current lightning test area. The tank shall then be subjected to simulated lightning strikes in the areas determined by the simulated testing of the scale model of paragraph 3.1.1.

3.2 TEST ARRANGEMENT

The test arrangement shall be similar to that shown in Figure 2 and Figure 3 for the sub scale and full scale tests respectively. All reasonable precautions shall be taken to simulate the actual mounting of the tank and pylon to the helicopter.

3.3 TEST METHOD

An initial paper study shall be made of the composite tank design (see Drawing 2191-001) taking particular note of the proper grounding of any concentration of metallic or conductive parts to the tank pylon and aircraft. In addition the tank shape and location on the H-53 helicopter shall be made to determine the most likely areas (Zone 1A) for direct lightning strike attachment (see Figure 1). Secondary, channel hang-on areas (Zone 1B) shall also be determined

prior to testing. This study shall be made by a qualified lightning research authority who is to be selected by the testing activity and approved by the Fiber Science Test Engineer and a Government representative.

3.3.1 SUB SCALE TEST METHOD

The sub scale test article of Paragraph 3.1.1 shall be placed in a high current lightning test area. An adequate current ground path and return to generator path shall be established as part of the test setup. The sub scale test article shall be struck with a simulated direct lightning strike of 200,000 amperes at all points determined to be possible direct attachment points from the paper study of Paragraph 3.3. The sub scale test article shall be empty, dry and loaded with a spark detecting device, preferably an open lense camera.

3.3.2 FULL SCALE TEST METHOD

One empty and dry tank assembly (2191-001) mounted to a pylon (27-450-4400) which in turn is mounted to a functional test fixture by means of a TF-261-178 adaptor shall be placed in a high current lightning test area. An adequate current ground path and return to generator path shall be established as part of the test setup. The pylon ejection gun shall be loaded with 2 cartridges, the breach shall be closed and the triggering mechanism shall be placed in a normal flight position. The tank shall then be struck with a simulated direct lightning strike of 200,000 amperes at all points determined to be possible direct attachment points from studies and tests performed in Paragraphs 3.3 and 3.3.1.

3.4 TEST INSTRUMENTATION

High speed full color movies shall be taken with a Fast-X camera capable of photographing 4000 frames per second minimum at the time the tank is struck with the simulated lightning strike. Pressure in the tank during the time interval of the impact transient shall be measured and recorded at four points as shown in Figure 3. One color still photo shall be taken of each simulated lightning strike point and any areas damaged by channel hang-on effects.

3.4.1 INSTRUMENTATION CALIBRATION

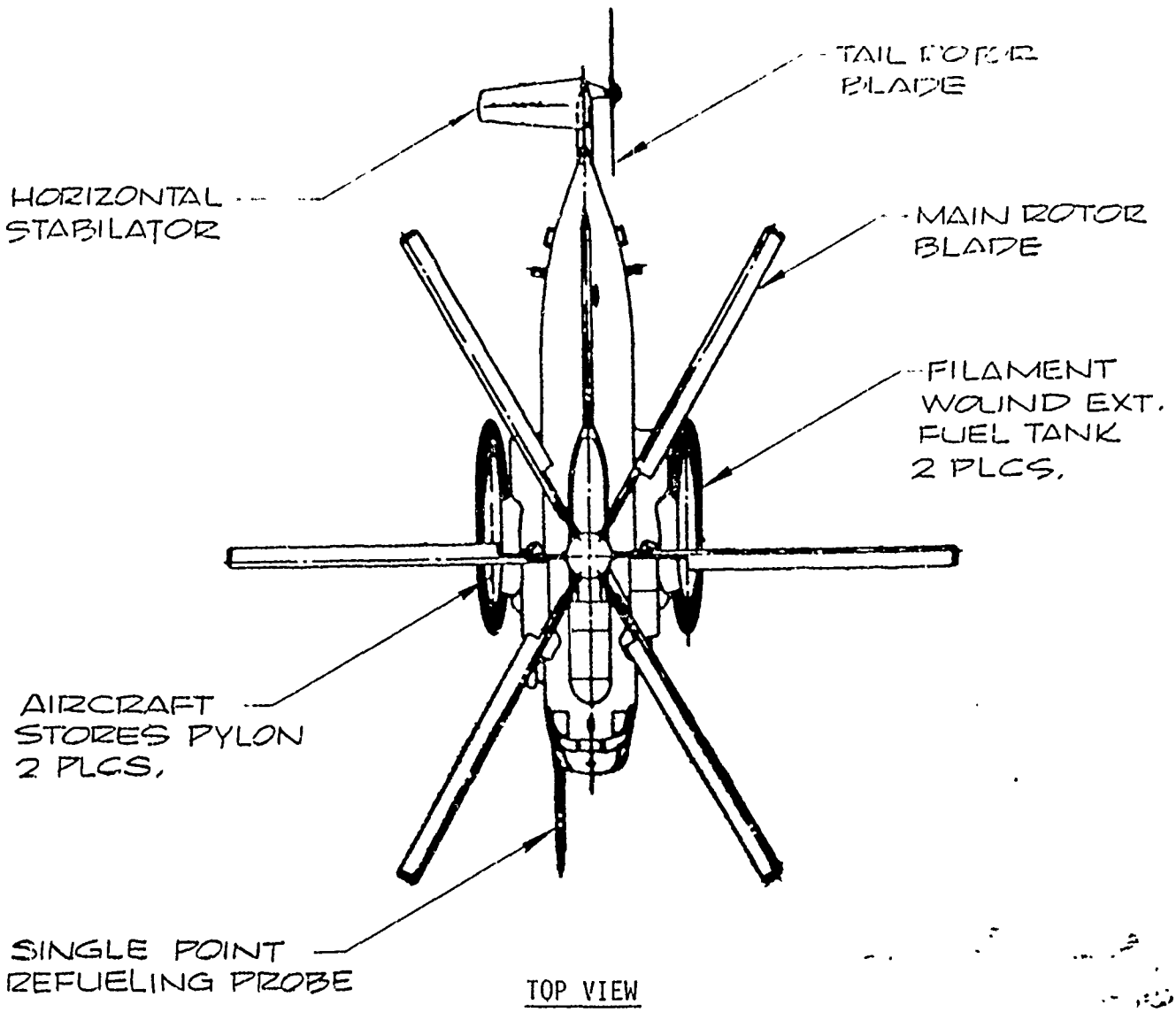
All instrumentation shall be calibrated and capable of reading or recording data within ± 2% of its full scale value. No instrument shall be used that has not been calibrated within the previous calibration period.

3.5 TEST PROCEDURES

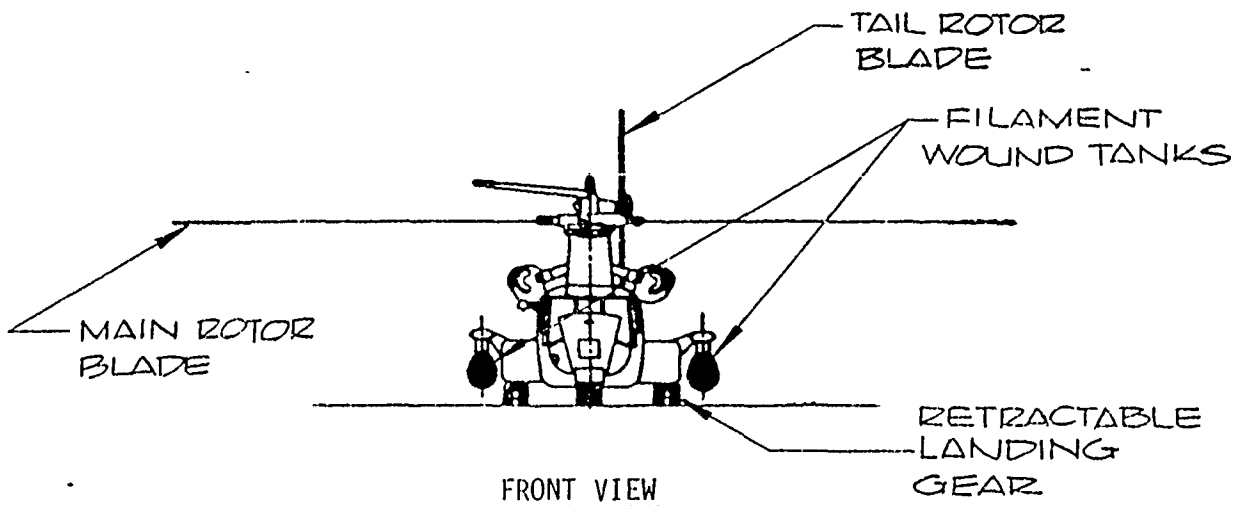
The test procedures shall be in accordance with Paragraph 4 of this document.

3.6 DOCUMENTATION

At the conclusion of testing a test report will be prepared for submission to the contractor.



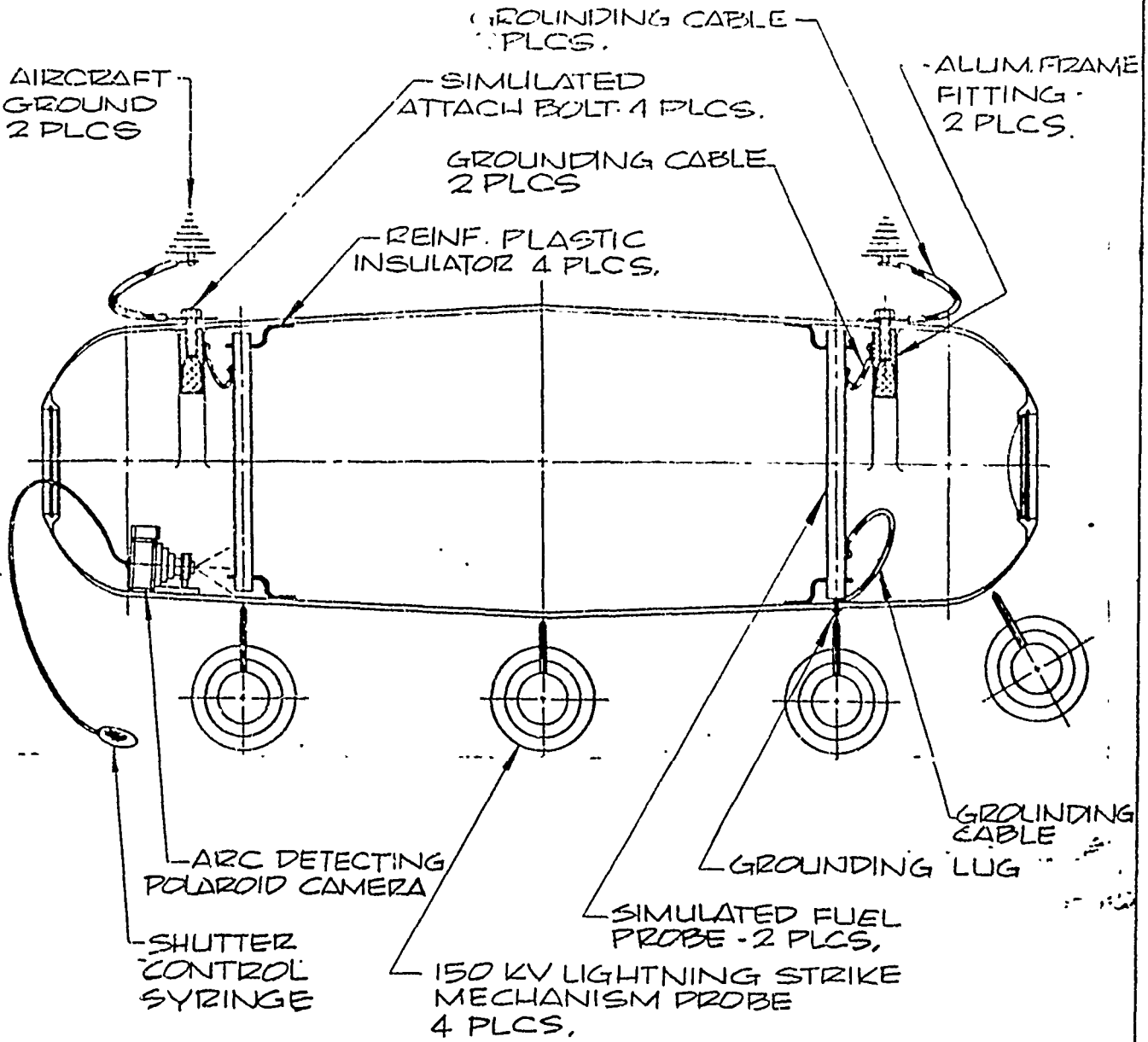
TOP VIEW



FRONT VIEW

FIGURE 1

FUEL TANK LOCATION ON H-53 HELICOPTER

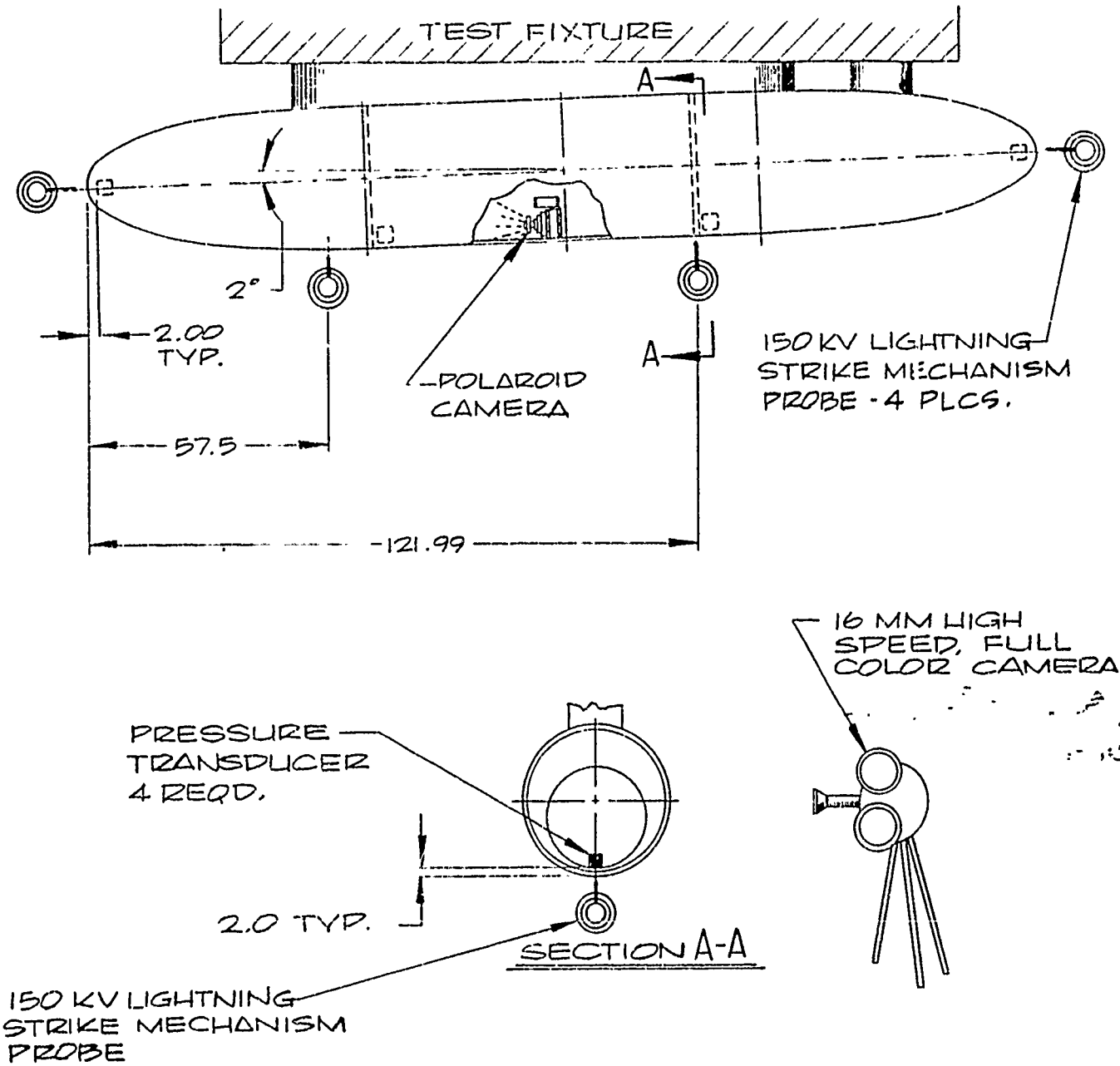


FUEL TANK CENTER SECTION

3/4 SCALE MODEL

FIGURE 2

SUBSCALE SIMULATED LIGHTNING TEST



LIGHTNING PROBE ARRANGEMENT

FIGURE 3

FULLSCALE SIMULATED LIGHTNING TEST

4.0 QUALIFICATION TEST PROVISIONS

4.1 EXAMINATION OF PRODUCT

The sub scale test article and the pre-production test tank and pylon shall be fully examined prior to mounting to the test stand for shipping damage to the test site. This examination shall include a visual inspection and a tap test for delaminations. The results of this inspection shall be recorded by the testing activity in the presence of an authorized Fiber Science Test Engineer.

4.2 MOUNTING

The sub scale test article and the pre-production test tank shall then be mounted to the test fixture and examined for proper attachment and assimilation to the actual aircraft installation. Any significant variations or deviations shall be recorded.

4.3 ARRANGEMENT

The test arrangement shall be examined for compliance with Figure 2 (sub scale test article) and Figure 3 (pre-production test tank) of this procedure and applicable paragraphs of ASD/ENFEA-78 Technical Exhibit and MIL-B-5087.

4.4 INSTRUMENTATION AND TEST EQUIPMENT

4.4.1 INSTRUMENTATION CALIBRATION

All instrumentation shall be inspected to verify that each instrument has had a calibration check within the last three months.

4.4.2 INSTALLATION

All instruments and test equipment: current generators, lightning strike mechanism, volt meters, amp meters, cameras, pressure transducers, and recorders shall be installed in such a way as to best satisfy the intent of the test. Pressure readings shall be taken at locations indicated in Figure 3 of this procedure.

NOTE: Pressure readings or 16 mm. movie camera shall not be required on sub scale lightning test.

4.4.3 OPERATION

All instrumentation and test equipment shall be checked for proper operation. Any defects in instrumentation shall be recorded and the test shall not proceed until the defect is removed or deemed not critical for the test required by the testing activity and approved by an authorized Fiber Science Test Engineer.

4.5 STRIKE LOCATIONS

The lightning strike attachment locations for the sub scale test article shall be determined by the Fiber Science Test Engineer after a thorough review of the paper study required per Paragraph 3.3 (Test Method), in consultation with the testing activity test engineer, and approved by an authorized Government representative. The lightning strike locations for the full scale pre-production tank and pylon shall be determined in the same manner as the sub scale test article except the test report and test data of the sub scale test article testing shall be reviewed to best establish the lightning strike attachment locations.

4.6 GUN LOADING

The ejection gun cartridge chamber shall be loaded with 2 cartridges using a standard load. Safety precautions should taken to insure load is properly installed and that the breach is properly closed and locked.

NOTE: The sub scale test tank shall not be mounted to a pylon and therefore is not affected by this test condition.

4.7 SIMULATED LIGHTNING STRIKE

With all instrumentation synchronized and ready for operation, and the tank pressurized to the operating pressure of 15 psi per Paragraph 3.4.1.3.4 of the Technical Exhibit ASD/ENFEA-78, a simulated lightning strike of 200,000 amps shall be discharged at a pre determined location per Paragraph 4.5. The test shall be repeated for all Zone 1A attachment areas with a post examination per Paragraph 4.8 after each simulated lightning strike.

NOTE: The sub scale test article shall not be pressurized for this test.

4.8 POST SIMULATED LIGHTING STRIKE EXAMINATION

The test article shall be examined after each simulated lighting strike for punctures through the composite wall, delaminations to the composite structure, and/or arching inside the test article cavity. As part of the check for delaminations, a tap test shall be made after each test of the entire outside surface of the test article and all delaminations if any shall be accurately located and a sketch made of their approximate size and shape.

5.0 QUALIFICATION TEST REPORT

A formal qualification test report of the lightening tests, shall be submitted per MIL-STD-831 within thirty days after the testing is complete. This report is to include all recorder amprage (if applicable) voltage (if applicable) and pressure data sheets, high speed film, photographs and expended tanks. Expended tanks shall be returned to Fiber Science for post evaluation in the same shipping containers they were received in.

4.8 POST SIMULATED LIGHTNING STRIKE EXAMINATION

The test article shall be examined after each simulated lightning strike for punctures through the composite wall, delaminations to the composite structure, and/or arching inside the test article cavity. As part of the check for delaminations, a tap test shall be made of the entire outside surface of the test article and all delaminations shall be accurately located and a sketch made of their approximate size and shape.

5.0 QUALIFICATION TEST REPORT

A formal qualification test report shall be submitted per MIL-STD-831 within thirty days after the testing is complete. This report is to include all recorder pressure data sheets, high speed film, photographs and expended tanks. Expended tanks shall be returned to Fiber Science for post evaluation in the same shipping containers they were received in.

APPENDIX "A"

TEST DATA SHEETS

TEST DATA SHEET

QTR-2191 SECTION "R"

Testing Activity_____ Activity Test Engr._____

Tank Serial No. _____ F.S.I. Test Engr. _____

Test Date _____ Government Rep. _____

EXAMINATION OF PRODUCT

Ref. Para. 4.1 Visual Inspection_____

Delaminations (Tap Test)_____

MOUNTING

Ref. Para 4.2 Aircraft Simulated Attachment

Deviations If Any_____

ARRANGEMENT

Ref. Para. 4.3

Approved Test Arrangement (Ref. Figure 1 & ASD/ENFEA-78 Technical Exhibit).

Testing Activity Approval

Approved By_____ Date _____

F.S.I. Test Engineer Approval

Approved By_____ Date _____

Government Approval

Approved By_____ Date _____

Minimum of two signatures required.

INSTRUMENTATION

Ref. Para. 4.4.1

CHECK INSTRUMENTATION CALIBRATION

ITEM	CALIBRATION DATE
Lightning Strike Mechanism (If Applicable)	_____
Cameras (If Applicable)	_____
Volt Meters	_____
Amp Meters	_____
Pressure Transducer Recorder	_____
Current Recorder	_____
Other Instruments:	_____
1. _____	_____
2. _____	_____
3. _____	_____
4.	

Ref. Para. 4.4.2 CHECK PROPER INSTALLATION

ITEM	REMARKS
Lightning Strike Mechanism	
Cameras	
Volt Meters	
Amp Meters	
Pressure Transducers	
Recorders	
Other Instruments:	
1. _____	
2. _____	
3. _____	
4. _____	

Ref. Para 4.4.3 CHECK PROPER OPERATION

ITEM	REMARKS
Lightning Strike Mechanism	
Cameras	
Volt Meter	
Amp Meter	
Pressure Transducers	
Recorders	
Other Instruments:	
1. _____	
2. _____	
3. _____	
4. _____	

STRIKE LOCATIONS

Ref. Para. 4.5: SELECT LIGHTNING STRIKE ATTACHMENT LOCATIONS

STRIKE NUMBER	LOCATIONS
1.	
2.	
3.	
4.	
5.	
6.	

GOVERNMENT APPROVAL OF STRIKE LOCATIONS

APPROVED BY _____ Date _____

GUN LOADING

Ref. Para. 4.6: LOAD EJECTION GUN WITH 2 STANDARD LOAD CARTRIDGES

ITEM	REMARKS
Cartridge Load	
Install Cartridges	
Check Installation	
Close and lock Breach	

SIMULATED LIGHTNING STRIKE

Ref. Para. 4.7: SIMULATE LIGHTNING STRIKE WITH ALL INSTRUMENTATION SYNCHRONIZED AND TANK PRESSURIZED TO 15 P.S.I.

ITEM	OPERATION REMARKS
Lightning Strike Mechanism	
Ejection Gun (Shall not discharge)	
Cameras	
Volt Meters	
Amp Meters	
Pressure Transducers	
Recorders	
Other Instruments:	
1.	
2.	
3.	
4.	

POST SIMULATED LIGHTNING STRIKE EXAMINATION

Ref. Para. 4.8 EXAMINE TANK FOR THE FOLLOWING:

EJECTION DAMAGE (IF EJECTED)

PUNCTURES (IF ANY)
State size, appearance and location

DELAMINATIONS
Results of Tap Test for delaminations

_____

_____

(Supply scaled sketch of size, location and approximate shape).

PHOTOGRAPHS
Number photographs and identify location

PHOTO	LOCATION
1. _____	_____
2. _____	_____
3. _____	_____
4. _____	_____
5. _____	_____
6. _____	_____

EVALUATION OF DATA

CAMERAS:

PRESSURE RECORDINGS:

STRAIN RECORDINGS:

DOCUMENT NUMBER

QTP-2191 SECTION "S"

TITLE

QUALIFICATION TEST PROCEDURE

H-53 TANK

REQUIREMENTS FOR CRASH IMPACT TEST

REVISIONS

LTR.	DATE	PREPARED	APPROVED	DESCRIPTION

PREPARED BY: Richard Lyman DATE: 11/20/80

CHECKED BY: Randy Stone DATE: 12/5/80

APPROVED BY: C.G. Patnode Jr. DATE: 12/6/80

FIBER SCIENCE, INC.
SALT LAKE CITY, UTAH

NO. QTP-2191 Section "S"

DATE: 11/20/80

1.0 SCOPE

This procedure covers the requirements for crash impact testing of the 450 Gallon Filament Wound External Fuel Tank for the H-53 helicopter.

2.0 APPLICABLE DOCUMENTS

2.1 MILITARY SPECIFICATIONS

MIL-STD-831	Test Reports, Preparation of.

2.2 TECHNICAL EXHIBIT

ASD/ENFEA-78	Tank - 450 gallon external fuel, filament wound lightweight explosion proof.

2.3 DRAWINGS

FIBER SCIENCE

2191-001	Tank - Installation, 450 gallon H-53

SARGENT FLETCHER

27-450-4400	Pylon Assembly - 450 gallon fuel tank.

3.0 REQUIREMENTS

3.1 TEST ARTICLES

Two tank assemblies (2191-001) fueled to a full tank condition and mounted to a pylon (27-450-4400) which in turn is mounted to a portable rig shall be subjected to the impact of an aerial drop as described in Technical Exhibit ASD/ENFEA-78. Paragraph 3.4.1.7.5.

3.2 TEST ARRANGEMENT

The test arrangement shall be similar to that shown in Concept A or B of Figure 1 with all reasonable precautions taken to simulate the actual mounting of the tank and pylon to the helicopter. Other concepts of dropping the tank may be recommended but must be approved before use.

3.3 TEST METHOD

The tanks shall be filled to the normal full position with water and suspended in a 2^{0} nose down position by the pylon support points and secured to the portable test fixture. The tank shall then be dropped for ground impact testing with a forward impact velocity of 39.2 ± 2 feet per second (45 ± 2 feet per second with fuel) and a vertical velocity of 35.3 ± 2 feet per second (40 ± 2 feet per second with fuel), see Figure 2. The impact angle of the tank with respect to the ground shall be between 0^{0} and 15^{0} nose up. Refer to Figure 2. Total allowable leakage is .25 gallons per minute maximum for this test.

3.4 TEST INSTRUMENTATION

High speed full color movies shall be taken with a 16 mm. camera capable of photographing 1000 frames per second minimum at the time of impact. Pressure in the tank during the time interval of the impact transient shall be measured and recorded at four points as shown in Figure 3. Ten (10) biaxial strain gauges, as shown in Figure 3, shall also be attached to record tank structural loading during the test. Twelve (12) color still photos shall be taken of the impact damaged areas and any other highly stressed or failed areas after the test.

3.4.1 INSTRUMENTATION CALIBRATION

All instrumentation shall be calibrated and capable of reading or recording data within ± 2% of its full scale value. No instrument shall be used that has not been calibrated within the previous calibration period.

3.5 TEST PROCEDURES

The test procedures shall be in accordance with paragraph 4 of this document.

3.6 DOCUMENTATION

At the conclusion of testing a test report will be prepared for submission to the contractor.

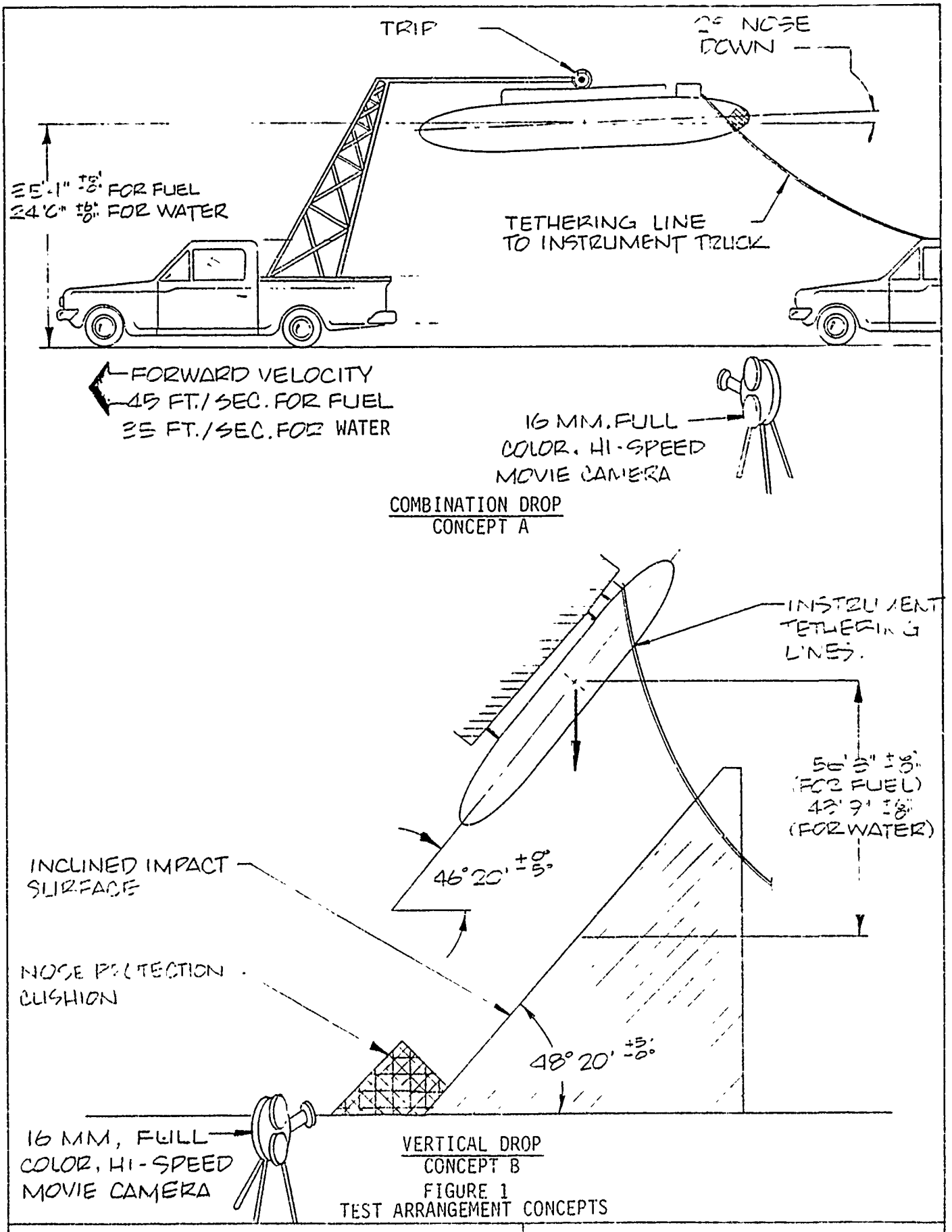
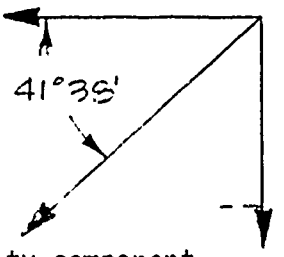


FIGURE 1
TEST ARRANGEMENT CONCEPTS

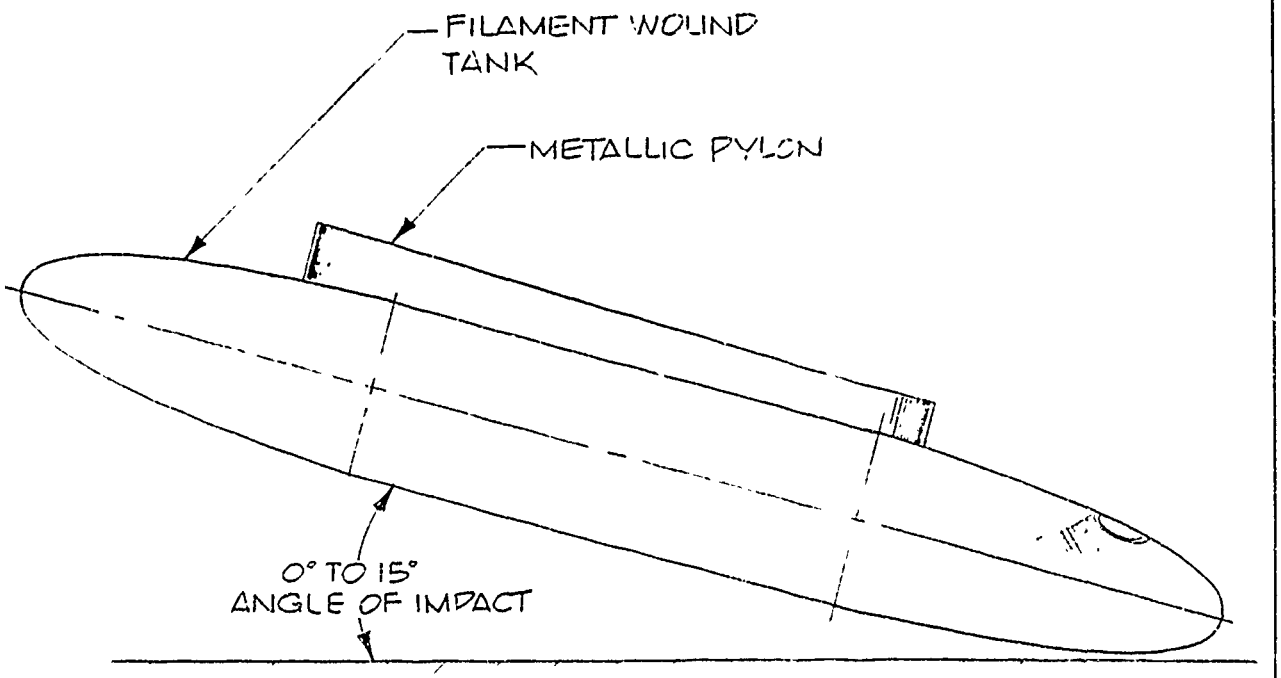
Forward tank velocity component with fuel 45 ± 2 feet per second. Equivalent forward tank velocity component with water 39.6 ± 2 feet per second



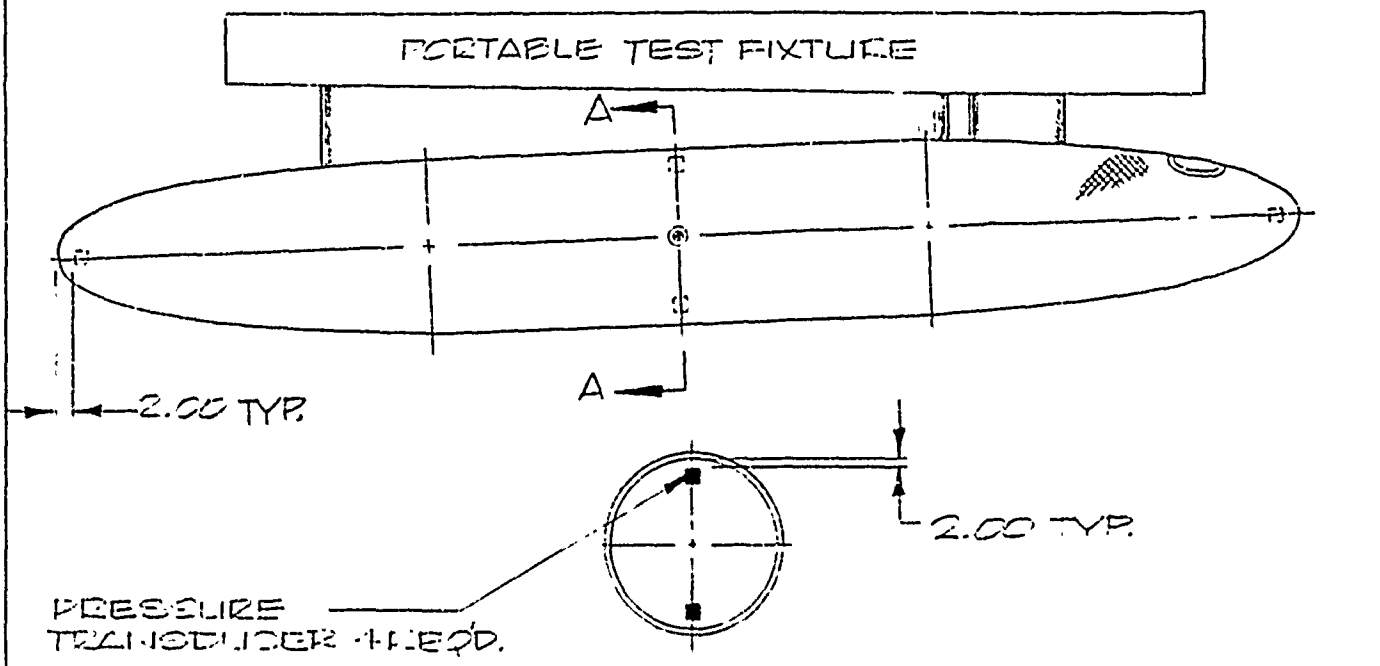
Vertical tank velocity component with fuel 40 ± 2 feet per second. Equivalent vertical tank velocity component with water 35.3 ± 2 feet per second.

Resultant tank velocity component with fuel 60.2 ± 2 feet per second. Equivalent resultant tank velocity component with water 53.1 ± 2 feet per second.

VECTOR DIAGRAM OF
TANK IMPACT VELOCITY

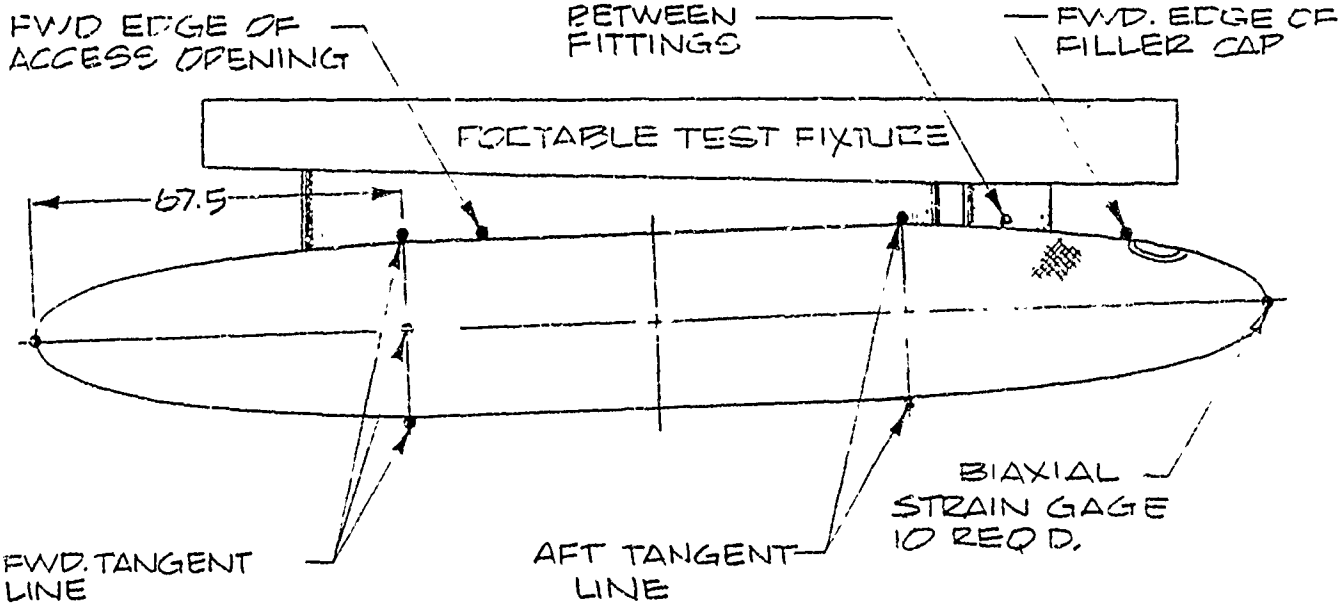


POSITION OF TANK ON IMPACT
FIGURE 2
CRASH IMPACT CONDITIONS



SECTION A-A

PRESSURE SENSOR ARRANGEMENT



STRAIN SENSOR ARRANGEMENT

FIGURE 3

SENSOR ARRANGEMENT

4.0 QUALIFICATION TEST PROVISIONS

4.1 EXAMINATION OF PRODUCT

The tank and pylon shall be fully examined prior to mounting to the portable test rig for shipping damage to the test site. This examination shall include a visual inspection and a tap test for delaminations. The results of this inspection shall be recorded by the testing activity in the presence of an authorized Fiber Science Test Engineer.

4.2 MOUNTING

The tank shall then be mounted to the portable test fixture and examined for proper attachment and assimilation to the actual aircraft installation. Any significant variations or deviations shall be recorded.

4.3 ARRANGEMENT

The test arrangement shall be examined for compliance with Figure I of this procedure or shall be deemed to be in compliance with the applicable paragraphs of ASD/ENFEA-78 Technical Exhibit and approved by an F.S.I. authorized test engineer and an authorized Government representative.

4.4 INSTRUMENTATION AND TEST EQUIPMENT

4.4.1 INSTRUMENTATION CALIBRATION

All instrumentation shall be inspected to verify that each instrumentation has had a calibration check within the last calibration period.

4.4.2 INSTALLATION

All instruments and test equipment: velocity meters, cameras, pressure transducers, strain gauges and recorders shall be installed and leads properly tethered so as to have little or no affect on the test. Pressure and strain readings shall be taken at locations indicated in Figure 3 of this procedure.

4.4.3 OPERATION

All instrumentation and test equipment shall be checked for proper operation. Any defects in instrumentation shall be recorded and the test shall not proceed until the defect is removed or deemed not critical for the test required by the testing activity and approved by an authorized Fiber Science Test Engineer.

4.5 FUELING

The tank shall be filled with 450 to 457 gallons of water through the filler cap opening. The tank properly mounted (2^{o} nose down) during filling will contain the proper amount when the water begins to overflow out the filler cap opening.

4.6 CRASH IMPACT

With all instrumentation synchronized and ready for operation, the tank shall be dropped at the proper speed and angle.

4.7 POST CRASH IMPACT EXAMINATION

4.7.1 LEAKAGE

All leakage from the tank shall be measured where practical. The combined leakage from all ruptures shall not exceed .25 gallons per minute maximum.

4.7.2 RUPTURES

All tank ruptures shall be properly described and accurately located on the tank surface. The exact size of the rupture (width, length and depth where applicable) shall be noted.

4.7.3 NON-RUPTURE DAMAGE

All other damage to the tank surface or fittings shall be recorded including exact location and size.

4.7.4 DELAMINATIONS

The entire tank surface shall receive a tap test to determine if any delaminations occurred outside the impact area. A sketch shall be made showing approximate size and shape.

4.7.5 CRASH IMPACT IMPRINT

The tank impact surface imprint configuration shall be graphically sketched and dimensioned.

4.7.6 PHOTOGRAPHS

At least twelve (12) color photographs of the damaged areas at locations determined by the testing activity and the Fiber Science Test Engineer shall be taken.

4.7.7 DISSECTION

At the discretion of the authorized Fiber Science Test Engineer, the tank may be cross sectioned to determine the internal extent of the crash impact damage.

5.0 QUALIFICATION TEST REPORT

A formal qualification test report shall be submitted per MIL-STD-831 within 30 days after the testing is complete. This report is to include all recorded pressure and strain data sheets, high speed film, photographs and expended tanks. Expended tanks shall be returned to Fiber Science for post evaluation in the same shipping containers they were received in.

APPENDIX "A"

TEST DATA SHEETS

TEST DATA SHEET

QTR-2191 SECTION "S"

Testing Activity_____ Activity Test Engr._____

Tank Serial No. _____ F.S.I. Test Engr. _____

Test Date _____ Government Rep. _____

EXAMINATION OF PRODUCT

Ref. Para. 4.1: Visual Inspection _____

_____

_____

_____

_____

Delaminations (Tap Test)_____

_____

_____

_____

_____

MOUNTING

Ref. Para. 4.2: Aircraft Simulated Attachment

Deviations If Any_____

_____

_____

_____

_____

ARRANGEMENT

Ref. Para. 4.3: Approved Test Arrangement (Ref. Figure 1 & ASD/ENFEA-78 Technical Exhibit.)

Testing Activity Approval

Approved By_____ Date_____

F.S.I. Test Engineer Approval

Approved By_____ Date_____

Government Approval

Approved By_____ Date_____

Minimum of two signatures required.

INSTRUMENTATION

Ref. Para. 4.4.1: CHECK INSTRUMENTATION CALIBRATION

ITEM	CALIBRATION DATE
Speedometer (If applicable)	_____
Cameras (If applicable)	_____
Pressure Transducer Recorder	_____
Strain Gauge Recorder	_____
Other Instruments	_____
1._____	_____
2._____	_____
3._____	_____
4._____	_____

Ref. Para. 4.4.2: CHECK PROPER INSTALLATION

ITEM	REMARKS
Tank	
Speedometers	
Cameras	
Pressure Transducers	
Strain Gauges	
Recorders	
Other Instruments	
1. _____	
2. _____	
3. _____	
4. _____	

Ref. Para 4.4.3: CHECK PROPER OPERATION

ITEM	REMARKS
Speedometers	
Trip Mechanism	
Cameras	
Pressure Transducers	
Recorders	
Other Instruments	
1. _____	
2. _____	
3. _____	
4. _____	

FUELING

Ref. Para 4.5: FUEL TANK AT PROPER ATTITUDE

ITEM	REMARKS
Attitude (2^0 Nose Down)	
Fill with 450 Gal. Water	
Secure Filler Cap	

CRASH IMPACT TEST

Ref. Para. 4.6: DROP TANK WITH ALL INSTRUMENTATION SYNCHRONIZED

ITEM	OPERATION REMARKS
Speedometers	
Trip Mechanism	
Cameras	
Pressure Transducers	
Strain Gauges	
Recorders	
Other Instruments	
1. _____	
2. _____	
3. _____	
4. _____	

POST CRASH IMPACT EXAMINATION

Ref. Para. 4.7: General Appearance

_____

_____

_____

_____

Ref. Para. 4.7.1: LEAKAGE

Amount At Each Location

1. _____
2. _____
3. _____
4. _____

Ref. Para. 4.7.2: RUPTURES

Locations

1. _____
2. _____
3. _____
4. _____

Extent of Damage

1. _____
2. _____
3. _____
4. _____

Ref. Para. 4.7.3 NON-RUPTURE DAMAGE

Final Distortion of Cross Sectional Shape

END CLOSURES

Nose Cap

Tail Cap

PYLON CONDITION

FUEL & AIR FITTING CONDITION

Ref. Para. 4.7.4: DELAMINATIONS

Results of Tap Test for Delaminations

(Supply scaled sketch of size, location and approximate shape).

Ref. Para. 4.7.5: CRASH IMPACT IMPRINT

Describe Damaged Condition of Impacted Area of the Tank

_____

_____

_____

(Supply a scaled sketch of the size and approximate shape of impact area.)

Ref. Para 4.7.6: PHOTOGRAPHS

Number Photographs and Identify Locations

PHOTO	LOCATION	PHOTO	LOCATION
1.	_____	7.	_____
2.	_____	8.	_____
3.	_____	9.	_____
4.	_____	10.	_____
5.	_____	11.	_____
6.	_____	12.	_____

Ref. Para. 4.7.7 DISSECTION OF THE TANK

Approved By_____ Date_____

Condition of Frames

_____

_____

Condition of Probe

_____

_____

Condition of Float Switches

Condition of Fuel Line

EVALUATION OF DATA

CAMERAS:

PRESSURE RECORDINGS:

STRAIN RECORDINGS:

DOCUMENT NUMBER

QTP-2191 SECTION "T"

TITLE

QUALIFICATION TEST PROCEDURE

H-53 TANK

REQUIREMENTS FOR STATIC JETTISON TEST

REVISIONS

LTR.	DATE	PREPARED	APPROVED	DESCRIPTION

PREPARED BY: Richard Lyman DATE: 9/11/81

CHECKED BY: [signature] DATE: 9-16-81

APPROVED BY: [signature] DATE: 9/17/81

FIBER SCIENCE, INC.
SALT LAKE CITY, UTAH

NO QTP-2191 Section "T"

DATE. 9/11/81

1.0 SCOPE

This procedure covers the requirements for static Jettison testing of the 450 Gallon Filament Wound External Fuel Tank for the H-53 helicopter.

2.0 APPLICABLE DOCUMENTS

2.1 MILITARY SPECIFICATIONS

MIL-STD-831	Test Reports, Preparation of.

2.2 ENGINEERING EXHIBIT

WR-ALC/MMSRCB 450-1	Tank - H-53 Crash Survivable--450 gallon external fuel.

2.3 DRAWINGS

FIBER SCIENCE

2191-001	Tank - Installation, 450 gallon H-53.

SARGENT FLETCHER

27-450-4400	Pylon Assembly - 450 gallon fuel tank.
27-450-48022	Tank Assembly - Fuselage 450 Gallon fuel.

3.0 REQUIREMENTS

3.1 TEST ARTICLES

Two empty tank assemblies (2191-001) and (27-450-48022) shall be mounted to two pylon (27-450-4400) assemblies which in turn is mounted separately to a test rig. Each tank and pylon assembly shall be subjected to a jettisoned drop test from an elevated static position as described in Engineering Exhibit WR-ALC/ MMSRCB 450-1.

3.2 TEST ARRANGEMENT

The test arrangement shall be similar to that shown in Concept A or Concept B Figure 1 with all reasonable precautions taken to simulate the actual mounting of the tank and pylon to the helicopter. Other concepts of dropping the tank may be recommended but must be approved before use.

3.3 TEST METHOD

The tanks shall be empty and suspended in a 2^{0} nose down position by the pylon support points and secured to the static test rig at least 64 feet above the ground.

The tank shall then be force ejected (jettison) from the static test rig using the ejection mechanism contained within the tank pylon 27-450-4400. The 2190-001 tank shall have a jettison characteristic equal to or better than the 27-450-48022 tank, that is less or equivalent roll, less or equivalent pitch and less or equivalent yaw.

3.4 TEST INSTRUMENTATION

Two high speed 16 mm movie cameras shall be used to record the jettison characteristics. Each camera shall be capable of photographing 200 frames per second minimum. One camera shall photograph the side view of the jettison characteristic and the other an end view. The cameras shall be sychronized with a timing device so that jettison characteristics can be compared relative to time and distance after the test is complete.

3.4.1 INSTRUMENTATION CALIBRATION

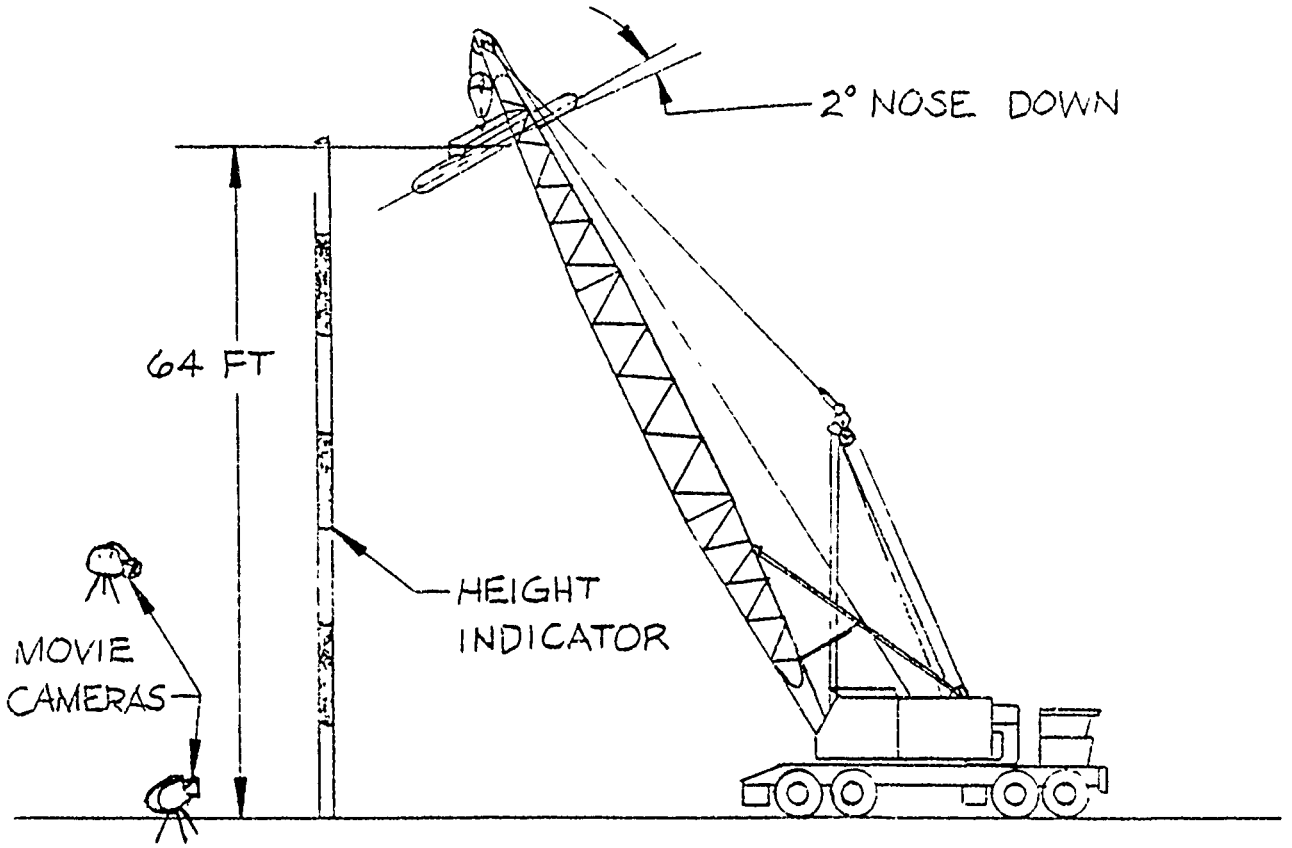
All instrumentation shall be calibrated and capable of reading or recording data within ± 2% of its full scale value. No instrument shall be used that has not been calibrated within the previous calibration period.

3.5 TEST PROCEDURES

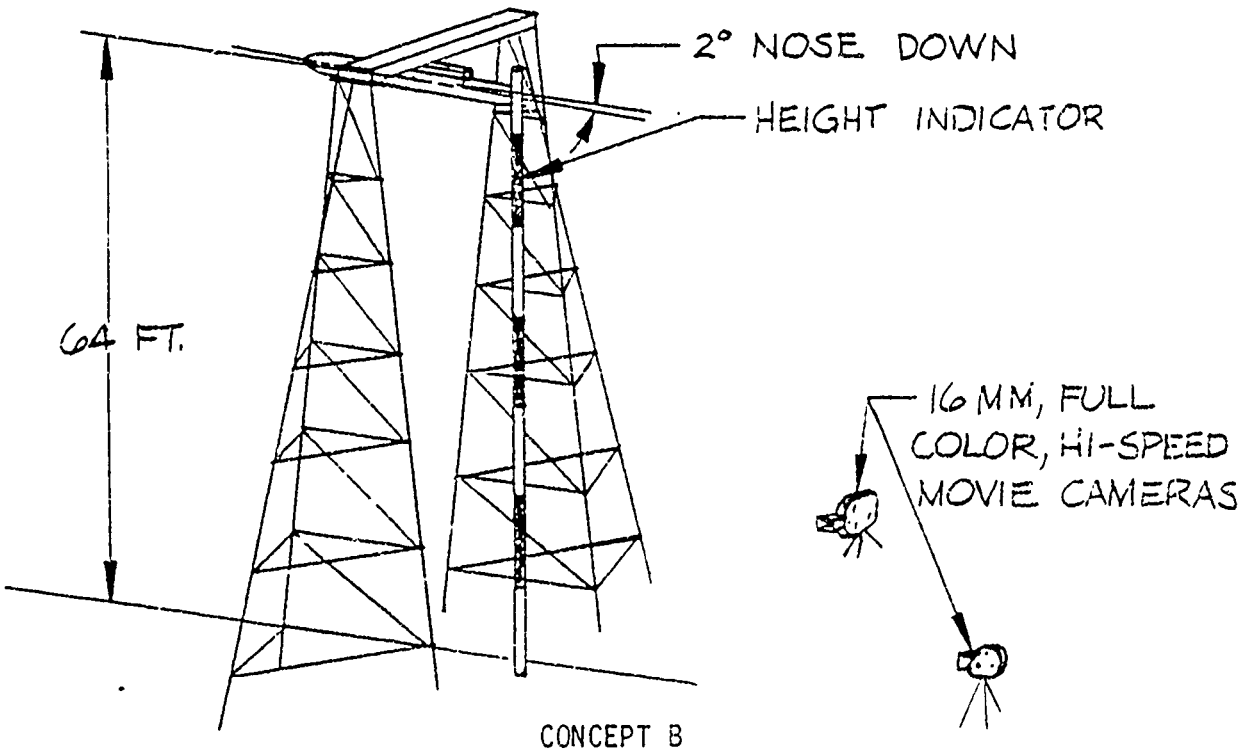
The test procedures shall be in accordance with paragraph 4 of this document.

3.6 DOCUMENTATION

At the conclusion of testing a test report will be prepared for submission to the contractor.



CONCEPT A



CONCEPT B
FIGURE 1.

4.0 QUALIFICATION TEST PROVISIONS

4.1 EXAMINATION OF PRODUCT

The tank and pylon shall be fully examined prior to mounting to the test rig for shipping damage to the test site. The results of this examination shall be recorded by the testing activity in the presence of an authorized Fiber Science Test Engineer.

4.2 MOUNTING

The tank should be empty of all fuel or other liquids and shall then be mounted to the test rig and examined for proper attachment and assimilation to the actual aircraft installation. Any significant variations or deviation shall be recorded.

4.3 ARRANGEMENT

The test arrangement shall be examined for compliance with Figure 1 of this procedure or shall be deemed to be in compliance with the applicable paragraphs of WR-ALC/MMSRCB 450-1 Engineering Exhibit and approved by an F.S.I. authorized test engineer and an authorized Government representative.

4.4 INSTRUMENTATION AND TEST EQUIPMENT

4.4.1 INSTRUMENTATION CALIBRATION

All instrumentation shall be inspected to verify that each instrumentation has had a calibration check within the last calibration period.

4.4.2 INSTALLATION

All instruments and test equipment: Timing devices, cameras, and recorders shall be installed and positioned to adequately record the jettison characteristics until the tank impacts the ground.

4.4.3 OPERATION

All instrumentation and test equipment including the ejection (jettisoning) gun shall be checked for proper operation. Any defects in instrumentation shall be recorded and the test shall not proceed until the defect is removed or deemed not critical for the test required by the testing activity and approved by an authorized Fiber Science Test Engineer.

4.4.4 PHOTOGRAPHS

At least six (6) color photographs shall be taken of each test arrangement and the condition of the tank after it has impacted the ground.

4.5 GUN LOADING

The ejection gun cartridge chamber shall be loaded with 2 cartridges using a standard load. Safety precautions should be taken to insure load is properly installed and that the breech is properly closed and locked.

4.6 STATIC JETTISON

With all instrumentation synchronized and ready for operation, the tank shall be jettisoned from a 2^{0} nose down position at the height requirements of paragraph 3.3.

4.7 POST JETTISON EXAMINATION

4.7.1 CRASH IMPACT

Each tank shall be examined after the test for crash impact damage. The data recorded shall be for information purposes only.

4.7.2 JETTISON CHARACTERISTICS

The 16 mm movies from each test shall be developed and examined. Each tank shall be compared for Jettison characteristics relative to roll, pitch and yaw at corresponding time intervals after jettisoning. Evaluation of the jettisoning characteristics shall be to the requirements of paragraph 3.3.

5.0 QUALIFICATION TEST REPORT

A formal qualification test report shall be submitted per MIL-STD-831 within 30 days after the testing is complete. This report is to include all high speed film, photographs and expended tanks. Expended tanks shall be returned to Fiber Science for post evaluation in the same shipping containers they were received in.

APPENDIX "A"

TEST DATA SHEETS

TEST DATA SHEET

QTR-2191 SECTION "T"

Testing Activity_____ Activity Test Engr._____

Tank Serial No. _____ F.S.I. Test Engr. _____

Test Date _____ Government Rep. _____

EXAMINATION OF PRODUCT

Ref. Para. 4.1: Visual Inspection_____

_____

_____

_____

_____

MOUNTING

Ref. Para. 4.2: Aircraft Simulated Attachment

Deviations If Any_____

_____

_____

_____

_____

ARRANGEMENT

Ref. Para. 4.3: Approved Test Arrangement (Ref. Figure 1 WR-ALC/ MMSRCB 450-1 Engineering Exhibit.)

Testing Activity Approval

Approved By_____ Date_____

F.S.I. Test Engineer Approval

Approved By_____ Date_____

Government Approval

Approved By_____ Date_____

Minimum of two signatures required.

INSTRUMENTATION

Ref. Para. 4.4.1: CHECK INSTRUMENTATION CALIBRATION

ITEM	CALIBRATION DATE
Cameras (if applicable)	_____
Timing Devices	_____
Recorders	_____
Other Instruments	
1._____	_____
2._____	_____
3._____	_____
4._____	_____

Ref. Para. 4.4.2: CHECK PROPER INSTALLATION

ITEM	REMARKS
Tank	
Cartridges	
Cameras	
Timing Devices	
Recorders	
Other Instruments	
1. _____	
2. _____	
3. _____	
4. _____	

Ref. Para. 4.4.3: CHECK PROPER OPERATION

ITEM	REMARKS
Ejection Gun	
Hook Mechanism	
Cameras	
Timing Devices	
Recorders	
Other Instruments	
1. _____	
2. _____	
3. _____	
4. _____	

Ref. Para. 4.4.4 PHOTOGRAPHS

Number Photographs and Identify Locations

PHOTO	LOCATION	PHOTO	LOCATION
1.	_____	4.	_____
2.	_____	5.	_____
3.	_____	6.	_____

GUN LOADING

Ref. Para. 4.5 LOAD EJECTION GUN WITH 2 STANDARD LOAD CARTRIDGES

ITEM	REMARKS
Cartridge Load	_____
Install Cartridges	_____
Check Installation	_____
Close and lock Breach	_____

STATIC JETTISON

Ref. Para. 4.6 JETTISON TANK WITH ALL INSTRUMENTATION SYNCHRONIZED

ITEM	OPERATION REMARKS
Ejection Gun	_____
Hook Mechanism	_____
Cameras	_____
Timing Devices	_____
Recorders	_____
Other Instruments	
1.	_____
2.	_____

POST JETTISON EXAMINATION

CRASH IMPACT

Ref. Para. 4.7.1 GENERAL APPEARANCE

_____

_____

_____

_____

RUPTURES

Locations

1. _____
2. _____
3. _____
4. _____

Extent of Damage

1. _____
2. _____
3. _____
4. _____

JETTISON CHARACTERISTICS

4.7.2 COMPARE JETTISON CHARACTERISTICS OF 2191-001 TANK ASSEMBLY TO 27-450-48022 TANK ASSEMBLY PER PARAGRAPH 3.3.

ROLL CHARACTERISTICS		ELAPSED TIME
27-450-48022	2191-001	
		JETTISON
		.2 Sec.
		.4 Sec.
		.8 Sec.
		1.4 Sec.
		AT IMPACT

PITCH CHARACTERISTICS		ELAPSED TIME
27-450-48022	2191-001	
		JETTISON
		.2 Sec.
		.4 Sec.
		.8 Sec.
		1.4 Sec.
		AT IMPACT

YAW CHARACTERISTICS		ELAPSED TIME
27-450-48022	2191-001	
		JETTISON
		.2 Sec.
		.4 Sec.
		.8 Sec.
		1.4 Sec.
		AT IMPACT

EVALUATION OF DATA

CAMERAS: _____

TIMING DEVICES: _____

RECORDERS: _____

EVALUATION OF DATA

CONTINUED

JETTISON CHARACTERISTICS: _____

CRASH IMPACT DAMAGE: _____