

TEST REPORT

Wyle

LABORATORIES

128 MARYLAND STREET • P. O. BOX 195 • EL SEGUNDO, CALIFORNIA

PHONE: EASTGATE 2-1763
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REPORT NO. 6867

OUR JOB NO. 5389

YOUR P. O. NO. 32786

CONTRACT

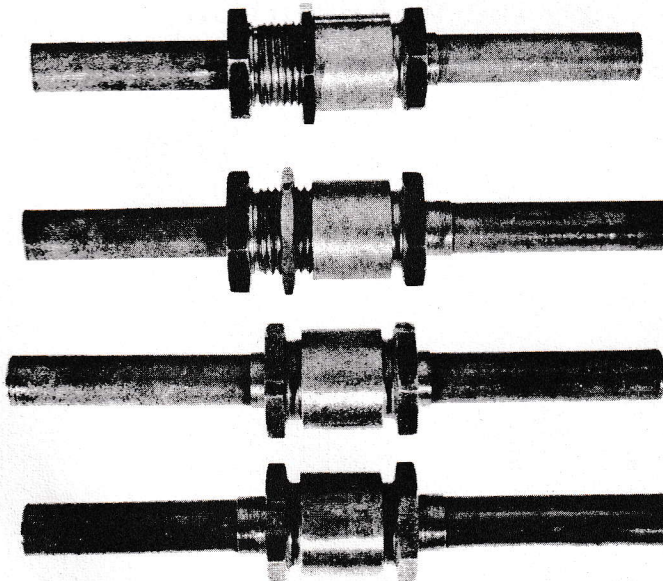
15 Page Report

DATE

March 31, 1959

Voi-Shan Mfg. Company
8463 Higuera Street
Culver City, California

REPEATED ASSEMBLY, IMPULSE
AND VIBRATION IMPULSE TESTS
ON
VOI-SHAN MFG. COMPANY
FLARED AND FLARELESS CONNECTORS
1/2" SIZE



STATE OF CALIFORNIA }
COUNTY OF LOS ANGELES } ss.

John R. Herring

being duly sworn,
deposes and says: That the information contained in this report is the result of complete
and carefully conducted tests and is to the best of his knowledge true and correct in
all respects.

SUBSCRIBED and sworn to before me this 31 day of March, 1959

Notary Public in and for the County of Los Angeles, State of California.

My Commission expires Feb. 12, 1960

TEST BY Hydraulic Branch

TEST WITNESS

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1.0 REFERENCES

- 1.1 MILITARY SPECIFICATION MIL-F-18280A (ASG), TITLE: "FITTINGS, FLARELESS, FLUID CONNECTION", DATED 24 APRIL 1956.
- 1.2 VOI-SHAN MANUFACTURING COMPANY DRAWING NO. VSF-2000-8DD, TITLE: "UNION ASSEMBLY - FLARELESS".
- 1.3 VOI-SHAN MANUFACTURING COMPANY DRAWING NO. VSF-2001-8DD, TITLE: "UNION ASSEMBLY - FLARED".
- 1.4 VOI-SHAN MANUFACTURING COMPANY DRAWING NO. VSF-2002-8DD, TITLE: "UNION ASSEMBLY - BULKHEAD, FLARELESS".
- 1.5 VOI-SHAN MANUFACTURING COMPANY DRAWING NO. VSF-2003-8DD, TITLE: "UNION ASSEMBLY - BULKHEAD FLARED".
- 1.6 VOI-SHAN MANUFACTURING COMPANY PURCHASE ORDER NUMBER 32786.

2.0 PURPOSE

- 2.1 THE PURPOSE OF THIS REPORT IS TO PRESENT THE METHODS USED AND THE RESULTS OBTAINED DURING THE QUALIFICATION TEST PROGRAM TO WHICH 20 UNION ASSEMBLIES, FLARED; 20 UNION ASSEMBLIES, FLARELESS; 12 UNION ASSEMBLIES BULKHEAD, FLARED; AND 12 UNION ASSEMBLIES BULKHEAD, FLARELESS, WERE SUBJECTED.
- 2.2 REFERENCE 1.1 WAS USED AS THE GOVERNING SPECIFICATION DURING THIS TEST PROGRAM.

3.0 SUMMARY

- 3.1 TWENTY (20) UNION ASSEMBLIES, FLARED; TWENTY (20) UNION ASSEMBLIES, FLARELESS; TWELVE (12) UNION ASSEMBLIES, FLARELESS, BULKHEAD; AND 12 UNION ASSEMBLIES, FLARED, BULKHEAD, WERE SUBJECTED TO THE QUALIFICATION TEST AS OUTLINED IN PARAGRAPH 5.0 BELOW.
- 3.2 THE SPECIMENS CONFORMED TO THE REQUIREMENTS OF THE SPECIFICATION EXCEPT AS NOTED IN TABLES 1 AND 2, "SUMMARY OF VIBRATION - IMPULSE RESULTS".

4.0 DESCRIPTION OF TEST SPECIMEN

- 4.1 THE UNION ASSEMBLIES, FLARED, SUBMITTED TO THIS LABORATORY FOR TESTING CONSISTED OF ONE (1) NUT, ONE (1) COUPLING, ONE (1) INSERT, AND TWO (2) SLEEVES. THE UNIT IS A LIGHT-WEIGHT ASSEMBLY TO

4.0 DESCRIPTION OF TEST SPECIMEN (CONTINUED)

BE USED IN PLACE OF AN AN815 UNION, TWO (2) AN818 NUTS, AND TWO (2) AN819 SLEEVES. THE UNION ASSEMBLIES, FLARELESS, CONSISTED OF ONE (1) NUT, ONE (1) COUPLING, AND ONE (1) INSERT, WHICH ARE USED WITH THE STANDARD MS-21922 SLEEVES. THIS ASSEMBLY IS A LIGHT-WEIGHT REPLACEMENT FOR AN MS-21902 UNION AND TWO (2) MS-21921 NUTS. (SEE PHOTOGRAPH NUMBER 3).

4.2 THE MANUFACTURER IS: VOI-SHAN MANUFACTURING CO.
8463 HIGUERA STREET
CULVER CITY, CALIFORNIA

4.3 THE UNITS SUBMITTED FOR TESTING WERE 2024T6 ALUMINUM FOR 1/2-INCH O.D. .065 WALL ALUMINUM TUBING PER MIL-T-7081. THE UNION ASSEMBLIES WILL BE REFERRED TO HEREAFTER AS THE TEST SPECIMEN.

5.0 TEST REQUIREMENTS

5.1 THE NOTED NUMBER OF UNITS WILL BE SUBJECTED TO TESTS AS OUTLINED IN THE SEQUENCE BELOW:

| | | |
|---------|------------------------|--|
| 5.1.1 | EXAMINATION OF PRODUCT | ALL UNITS |
| 5.1.2 | REPEATED ASSEMBLY | REF. 1.1, PARA. 4.3.3.1 |
| 5.1.2.1 | MINIMUM TIGHTENING | 4 FLARED, 4 FLARELESS REF. 1.1, PARA. 4.3.3.1.1 |
| 5.1.2.2 | MAXIMUM TIGHTENING | 4 FLARED, 4 FLARELESS REF. 1.1, PARA. 4.3.3.1.2 |
| 5.1.2.3 | OVERTIGHTENED TORQUE | 4 FLARED, 4 FLARELESS REF. 1.1, PARA. 4.3.3.1.3 |
| 5.1.3 | IMPULSE TEST | 8 FLARED, 8 FLARELESS REF. 1.1, PARA. 4.3.3.2 |
| 5.1.4 | VIBRATION-IMPULSE TEST | 12 FLARED, BULKHEAD 12 FLARELESS, BULKHEAD REF. 1.1, PARA. 4.3.3.3 |

6.0 TEST CONDITIONS AND TEST EQUIPMENT

6.1 AMBIENT CONDITIONS: UNLESS OTHERWISE SPECIFIED HEREIN, ALL TESTS REQUIRED BY THIS SPECIFICATION WERE PERFORMED AT ATMOSPHERIC PRESSURE OF 760 ± 15 MILLIMETERS OF MERCURY, A TEMPERATURE OF $70 \pm 20^{\circ}\text{F}$, AND A RELATIVE HUMIDITY OF APPROXIMATELY 50%. WHERE TESTS WERE PERFORMED WITH ATMOSPHERIC CONDITIONS SUBSTANTIALLY DIFFERENT FROM THESE SPECIFIED VALUES, PROPER ALLOWANCES FOR CHANGES IN INSTRUMENT READINGS WERE MADE TO COMPENSATE FOR THE DEVIATIONS FROM THE SPECIFIED CONDITIONS.

6.2 INSTRUMENTATION AND EQUIPMENT:

- 6.2.1 HAND PUMP, BLACK HAWK, 0 - 10,000 PSIG.
- 6.2.2 PRESSURE PUMP, SPRAGUE ENGINEERING, 0 - 30,000 PSIG.
- 6.2.3 PRESSURE GAUGE, ASHCROFT GAUGE COMPANY, 0 - 5,000 PSIG, $\pm 0.5\%$ OF FULL SCALE ACCURACY.
- 6.2.4 PRESSURE GAUGE, ASHCROFT GAUGE COMPANY, 0 - 10,000 PSIG, $\pm 0.5\%$ OF FULL SCALE ACCURACY.
- 6.2.5 PRESSURE GAUGE, ASHCROFT GAUGE COMPANY, 0 - 20,000 PSIG, $\pm 0.5\%$ OF FULL SCALE ACCURACY.
- 6.2.6 TRANSDUCER, STATHAM, 0 - 10,000 PSIG.
- 6.2.7 OSCILLOSCOPE, TEKTRONIX.
- 6.2.8 PUMP, HYDRAULIC, DENISON, 10 GPM CAPACITY.
- 6.2.9 TIMER, WITH CYCLE COUNTER, WYLE LABORATORIES.
- 6.2.10 TORQUE WRENCH, SNAP-ON TOOL COMPANY.
- 6.2.11 VIBRATION FIXTURE, WYLE LABORATORIES.
- 6.2.12 THERMOCOUPLE BRIDGE, MINNEAPOLIS-HONEYWELL, MODEL 126W2, RANGE -100 TO $+200^{\circ}\text{F}$, SYSTEM ACCURACY $\pm 3.6^{\circ}\text{F}$, USING COPPER CONSTANTAN THERMOCOUPLE.

7.0 TEST PROCEDURE AND RESULTS

7.1 EXAMINATION OF PRODUCT

7.1.1 THE TEST SPECIMENS WERE EXAMINED AND THE FOLLOWING NOTED: THE INDIVIDUAL WEIGHT WAS APPROXIMATELY ONE (1) OUNCE; THE WORKMANSHIP AND CLEANLINESS WERE SATISFACTORY.

7.2 REPEATED ASSEMBLY TEST

TWELVE (12) FLARED AND TWELVE (12) FLARELESS SPECIMENS WERE SUBJECTED TO THE FOLLOWING REPEATED ASSEMBLY TESTS:

7.2.1 FOUR (4) FLARED AND FOUR (4) FLARELESS SPECIMENS WERE TIGHTENED 15 SUCCESSIVE TIMES USING THE MINIMUM TIGHTENING VALUES OF ONE-SIXTH TURN PAST THE POINT OF SHARP TORQUE RISE. EACH TIGHTENING OPERATION INCLUDED A COMPLETE REMOVAL OF THE TUBE FROM THE FITTING BODY. AFTER EACH THIRD TIGHTENING OPERATION, THE FITTING ASSEMBLY WAS SUBJECTED TO A FLUID PRESSURE OF 6000 PSIG, WHICH WAS HELD FOR FIVE (5) MINUTES. AFTER THE FIFTEENTH TIGHTENING OPERATION, THE SPECIMENS WERE PRESSURIZED TO 12,000 PSIG. THERE WAS NO SIGN OF LEAKAGE OR PERMANENT DEFORMATION NOR AT ANY TIME DURING THE TIGHTENING OPERATIONS WERE THE ASSEMBLIES DIFFICULT TO ASSEMBLE OR DISASSEMBLE.

7.2.2 FOUR (4) FLARED AND FOUR (4) FLARELESS SPECIMENS WERE SUBJECTED TO THE SAME REPEATED ASSEMBLY TEST AS OUTLINED ABOVE, EXCEPT THAT THE TIGHTENING VALUE WAS THE MAXIMUM TIGHTENING VALUE, OR ONE-THIRD TURN PAST THE POINT OF SHARP TORQUE RISE. DURING AND AFTER THE TEST, NO LEAKAGE OR BLOW-OFF OF FITTING ASSEMBLIES WAS NOTED. AT NO TIME DURING THE FIFTEEN TIGHTENING OPERATIONS WERE THE ASSEMBLIES DIFFICULT TO ASSEMBLE OR DISASSEMBLE.

7.2.3 FOUR (4) FLARED AND FOUR (4) FLARELESS SPECIMENS WERE SUBJECTED TO THE REPEATED ASSEMBLY TEST AS OUTLINED ABOVE, EXCEPT THAT THE SPECIMENS WERE TORQUED TO 440 INCH POUNDS. DURING AND AFTER THE TEST, NO PERMANENT DEFORMATION OR LEAKAGE WAS NOTED.

7.0 TEST PROCEDURE AND RESULTS (CONTINUED)

7.2.4 DURING THE FIRST TIGHTENING TO MINIMUM TORQUE, THE TENDENCY FOR THE TUBE TO TURN DURING ASSEMBLY WAS MEASURED AND THE RESTRAINING FORCES FOR THE FOUR EACH FLARELESS AND FLARED TUBE ASSEMBLIES WERE AS FOLLOWS:

FLARELESS TUBE ASSEMBLIES: 15, 5, 15 AND 2 INCH POUNDS
FLARED TUBE ASSEMBLIES: 22, 28, 32 AND 32 INCH POUNDS

7.3 IMPULSE TEST

7.3.1 FOUR (4) FLARED SPECIMENS, TIGHTENED TO MINIMUM TIGHT, FOUR (4) FLARED SPECIMENS, TIGHTENED TO OVERTIGHT TORQUE, FOUR (4) FLARELESS SPECIMENS, TIGHTENED TO MINIMUM TIGHT, AND FOUR (4) FLARELESS SPECIMENS, TIGHTENED TO OVERTIGHT TORQUE WERE SUBJECTED TO 200,000 IMPULSE CYCLES. AN IMPULSE CYCLE CONSISTED OF A RISE FROM ZERO PSI TO A SURGE PRESSURE BETWEEN 4,300 PSI AND 4,700 PSI; THEN DROPPING TO 3,000 PSI FOR APPROXIMATELY ONE-HALF THE CYCLE, THEN DROPPING BACK TO THE ZERO PSI PRESSURE FOR THE REMAINDER OF THE CYCLE. THE CYCLES WERE CONDUCTED AT A RATE OF 35 ± 5 CYCLES PER MINUTE. THE FIRST 175,000 IMPULSE CYCLES WERE CONDUCTED AT ROOM TEMPERATURE, FOLLOWED BY A SOAK AT -65°F AT A PRESSURE OF TWO (2) TO 10 PSI STATIC PRESSURE FOR 24 HOURS. SUBSEQUENT TO THIS COLD-SOAK PERIOD, THE REMAINING 25,000 IMPULSE CYCLES WERE RUN AT -65°F . BEFORE AND AFTER THE IMPULSE CYCLES AT ROOM TEMPERATURE AND AT -65°F , THE FITTING ASSEMBLIES WERE PRESSURIZED TO 6,000 PSI AND HELD FOR FIVE (5) MINUTES. DURING THE IMPULSE TEST AND THE SUBSEQUENT PRESSURE TEST, A SLIGHT LEAKAGE (SEEPAGE) WAS NOTED FROM TWO (2) OF THE FLARED SPECIMENS THAT HAD BEEN TIGHTENED TO MINIMUM TIGHT TORQUE. (SEE PHOTOGRAPH NUMBER 1 FOR LOW TEMPERATURE TEST SETUP.)

7.4 VIBRATION IMPULSE TEST

7.4.1 TWELVE (12) FLARED, BULKHEAD SPECIMENS AND TWELVE (12) FLARELESS, BULKHEAD SPECIMENS WERE INSTALLED IN A VIBRATION FIXTURE AS SHOWN IN PHOTOGRAPH NUMBER 2 AND SUBJECTED TO THE FOLLOWING VIBRATION IMPULSE TEST. THE CENTER SPECIMEN WAS RIGIDLY MOUNTED IN THE CROSS BAR, WHILE THE TAIL STOCK END WAS FREE TO MOVE IN AND OUT SO AS TO PRODUCE CANTILEVER BENDING IN THE TUBING.

7.0 TEST PROCEDURE AND RESULTS (CONTINUED)

7.4.1 USING THE FORMULA: $D = \frac{FL^3}{3EI}$ AS GIVEN IN REFERENCE 1.1, ABOVE, AN ORIGINAL SINGLE DISPLACEMENT OF 0.365 INCH WAS USED. SUBSEQUENT TO CHANGING TO TAIL-STOCK FITTINGS AS NOTED BELOW AND THEREBY CHANGING THE EFFECTIVE BENDING LENGTH OF THE TUBE, THIS DISPLACEMENT WAS REDUCED TO 0.338 INCH. THE SPECIMENS WERE VIBRATED BY DISPLACING FROM ZERO THROUGH THIS NOTED AMPLITUDE AND BACK TO ZERO AT THE RATE OF 1750 ± 50 CYCLES PER MINUTE. A TOTAL OF 10,000,000 VIBRATION CYCLES WERE RUN ON THE SPECIMENS. (FOR RESULTS OF THIS TEST, SEE TABLES NUMBER 1 AND 2). SIMULTANEOUS WITH THE VIBRATION, THE SPECIMENS WERE IMPULSED AS DESCRIBED IN PARAGRAPH 7.3 OF THIS REPORT.

7.4.2 THE TEST SPECIMEN TUBING WAS ORIGINALLY FITTED WITH AN-818 NUTS AND AN-819 SLEEVES ON THE TAIL-STOCK END. DUE TO FREQUENT CRACKING AT THE BASE OF THE FLARE, THIS ARRANGEMENT WAS CHANGED TO MS-21921 NUTS AND MS-21922 SLEEVES AT THE END OF 2,997,000 CYCLES. FOR CALCULATIONS OF DEFLECTION, SEE FIGURES 1 AND 2.

8.0 CONCLUSION

8.1 TWENTY CONNECTORS, FLARED, 20 CONNECTORS, FLARELESS, 12 CONNECTORS, FLARED, BULKHEAD, AND 12 CONNECTORS, FLARELESS, BULKHEAD, WERE SUBJECTED TO THE QUALIFICATION TESTS AS OUTLINED IN MILITARY SPECIFICATION MIL-F-18280A AND VOI-SHAN MANUFACTURING COMPANY PURCHASE ORDER NUMBER 32786. THE FITTINGS CONFORMED TO THE SPECIFICATION REQUIREMENTS. FOR RESULTS OF THE VIBRATION IMPULSE TESTS, SEE TABLES 1 AND 2.

TABLE NUMBER 1
RESULTS OF VIBRATION - IMPULSE TEST
VOI-SHAN MANUFACTURING COMPANY
FLARELESS TUBE CONNECTORS

| <u>SERIAL NUMBER</u> | <u>NUMBER OF CYCLES COMPLETED</u> | <u>DESCRIPTION OF FAILURE</u> |
|--------------------------|---------------------------------------|-----------------------------------|
| 54 | 5,733,000 | TUBING CRACKED INSIDE MS SLEEVE |
| 52 | 10,000,000 | |
| 64 | 3,429,000 | TUBING CRACKED INSIDE MS SLEEVE |
| 63 | 10,000,000 | |
| 53 | 10,000,000 | |
| 58 | 10,000,000 | |
| 55 | 5,031,000 * | TUBING CRACKED INSIDE MS SLEEVE |
| 46 | 7,686,000 | TUBING CRACKED INSIDE MS SLEEVE |
| 57 | 5,607,000 | TUBING CRACKED INSIDE MS SLEEVE |
| 50 | 10,000,000 | |
| 56 | 10,000,000 | |
| 42 | 5,283,000 | TUBING CRACKED INSIDE MS SLEEVE |

AVERAGE NUMBER OF CYCLES PER SPECIMEN - 7,730,750

*THIS SPECIMEN WAS LEFT IN THE VIBRATION FIXTURE UNTIL THE TUBING
BROKE COMPLETELY IN THE AREA OF THE "BITE" OF THE SLEEVE.

TABLE NUMBER 2
RESULTS OF VIBRATION - IMPULSE TEST
VOI-SHAN MANUFACTURING COMPANY
FLARED TUBE CONNECTORS

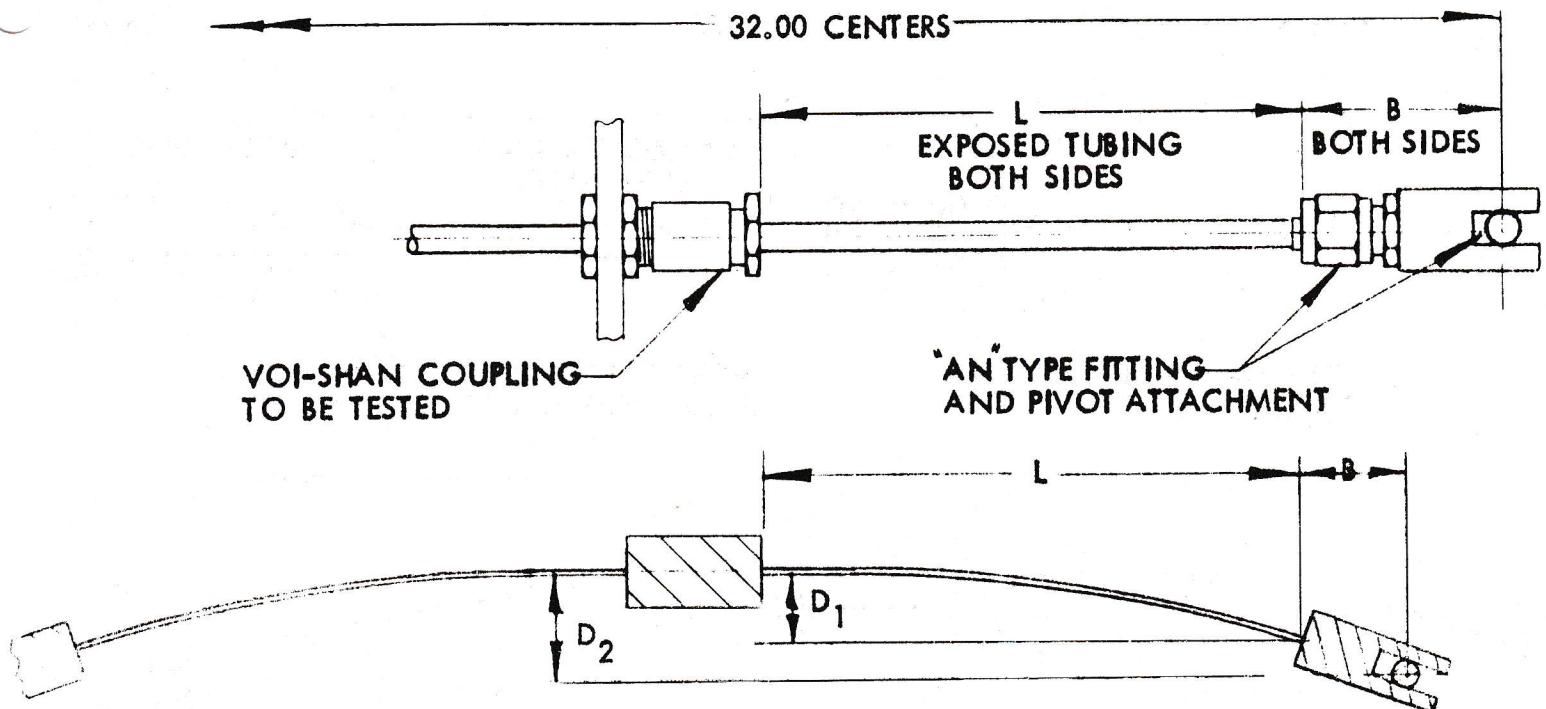
| <u>SERIAL NUMBER</u> | <u>NUMBER OF CYCLES COMPLETED</u> | <u>DESCRIPTION OF FAILURE</u> |
|--------------------------|---------------------------------------|-----------------------------------|
| 45 | 9,126,000 | CRACK AT BASE OF FLARE |
| 49 | 8,352,000 | CRACK AT BASE OF FLARE |
| 61 | 1,251,000 | CRACK AT BASE OF FLARE |
| 62 | 3,915,000 | CRACK AT BASE OF FLARE |
| 59 | 2,385,000 | CRACK AT BASE OF FLARE |
| 41 | 2,034,000 | CRACK AT BASE OF FLARE |
| 47 | 2,844,000 | CRACK AT BASE OF FLARE |
| 51 | 3,384,000 | CRACK AT BASE OF FLARE |
| 43 | 1,881,000 | CRACK AT BASE OF FLARE |
| 60 | 4,536,000 | CRACK AT BASE OF FLARE |
| 48 | 4,500,000 | CRACK AT BASE OF FLARE |
| 44 | 1,566,000 | CRACK AT BASE OF FLARE |

AVERAGE NUMBER OF CYCLES PER SPECIMEN - 3,814,500

FIGURE NUMBER 1
VIBRATION - IMPULSE TEST

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SET-UP #1



$$D_1 = \frac{FL^3}{3EI}$$

$$D_2 = \frac{WL^2}{6EI} (2L + 3B)$$

$$S = \frac{WL}{Z}, \quad Z = \frac{I}{C} \quad \therefore \quad W = \frac{SI}{LC}$$

$$D_2 = \frac{SIL^2}{LC6EI} (2L + 3B) \quad \therefore \quad D_2 = \frac{SL}{6EC} (2L + 3B)$$

$$D_1 = \text{Tube Deflection}$$

$$D_2 = \text{Total Deflection Required on Vibration Test Machine}$$

$$S = \text{Bending Stress} = 13,300 \text{ psi}$$

$$L = 12.257 \text{ -inch}$$

$$B = 3.037 \text{ -inch}$$

$$E = 10,000,000$$

$$D_2 = \frac{13,300(12.257)}{6 \times 10^6 \times .250} (24.514 + 9.111)$$

$$D_2 = .367 \text{ inches}$$

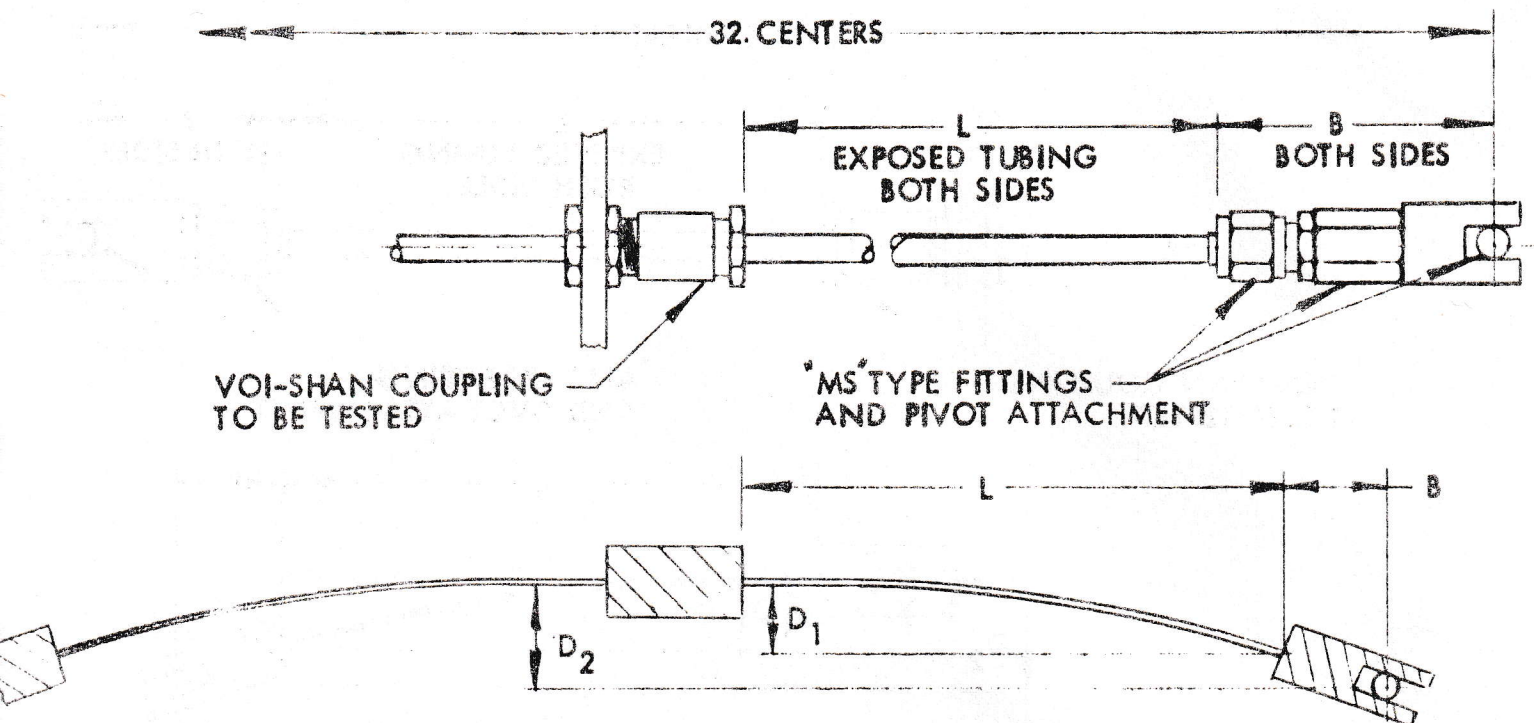
$$C = \frac{\text{Tube Dia.}}{2} = .250 \text{ -inch}$$

Submitted by Voi-Shan Manufacturing Company

FIGURE NUMBER 2
VIBRATION - IMPULSE TEST

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SET-UP #2



$$D_1 = \frac{FL^3}{3EI}$$

$$D_2 = \frac{WL^2}{6EI} (2L + 3B)$$

$$S = \frac{WL}{Z}, \quad Z = \frac{I}{C} \quad \therefore \quad S = \frac{WLC}{I} \quad \therefore \quad W = \frac{SI}{LC}$$

$$\therefore D_2 = \frac{SI L^2}{LC 6EI} (2L + 3B) \quad \therefore \quad D_2 = \frac{SL}{6EC} (2L + 3B)$$

$$D_1 = \text{Tube Deflection}$$

$$D_2 = \text{Total Deflection Required on Vibration Test Machine}$$

$$S = \text{Bending Stress} = 13,300 \text{ psi}$$

$$L = 11.124\text{-inch}$$

$$B = 4.170\text{-inch}$$

$$E = 10,000,000$$

$$C = .250\text{-inch}$$

$$D_2 = \frac{13,300 (11.124)}{6 \times 10^6 \times .250} (22.248 + 12.510)$$

$$D_2 = .338\text{-inches}$$

Submitted by Voi-Shan Manufacturing Company

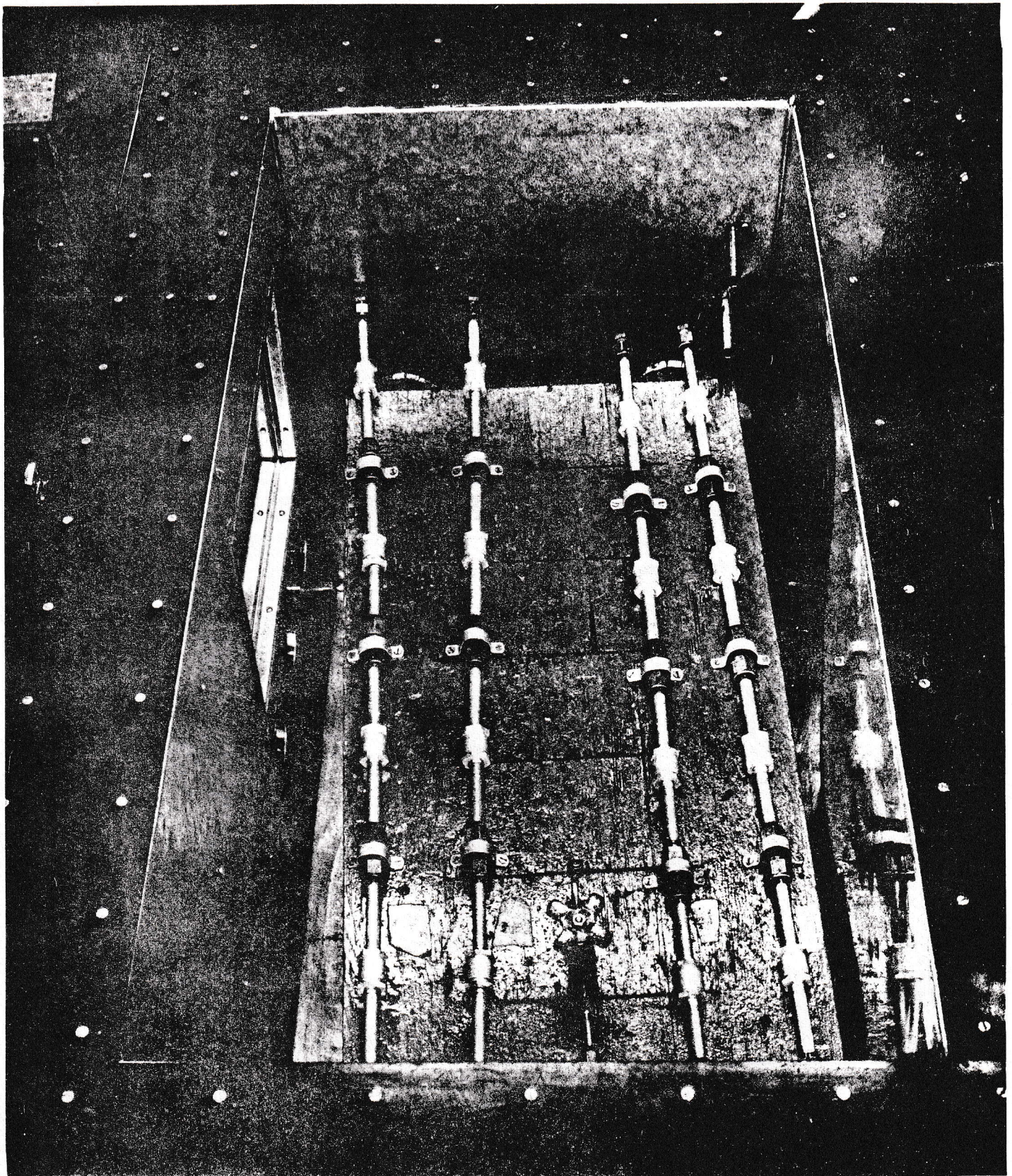
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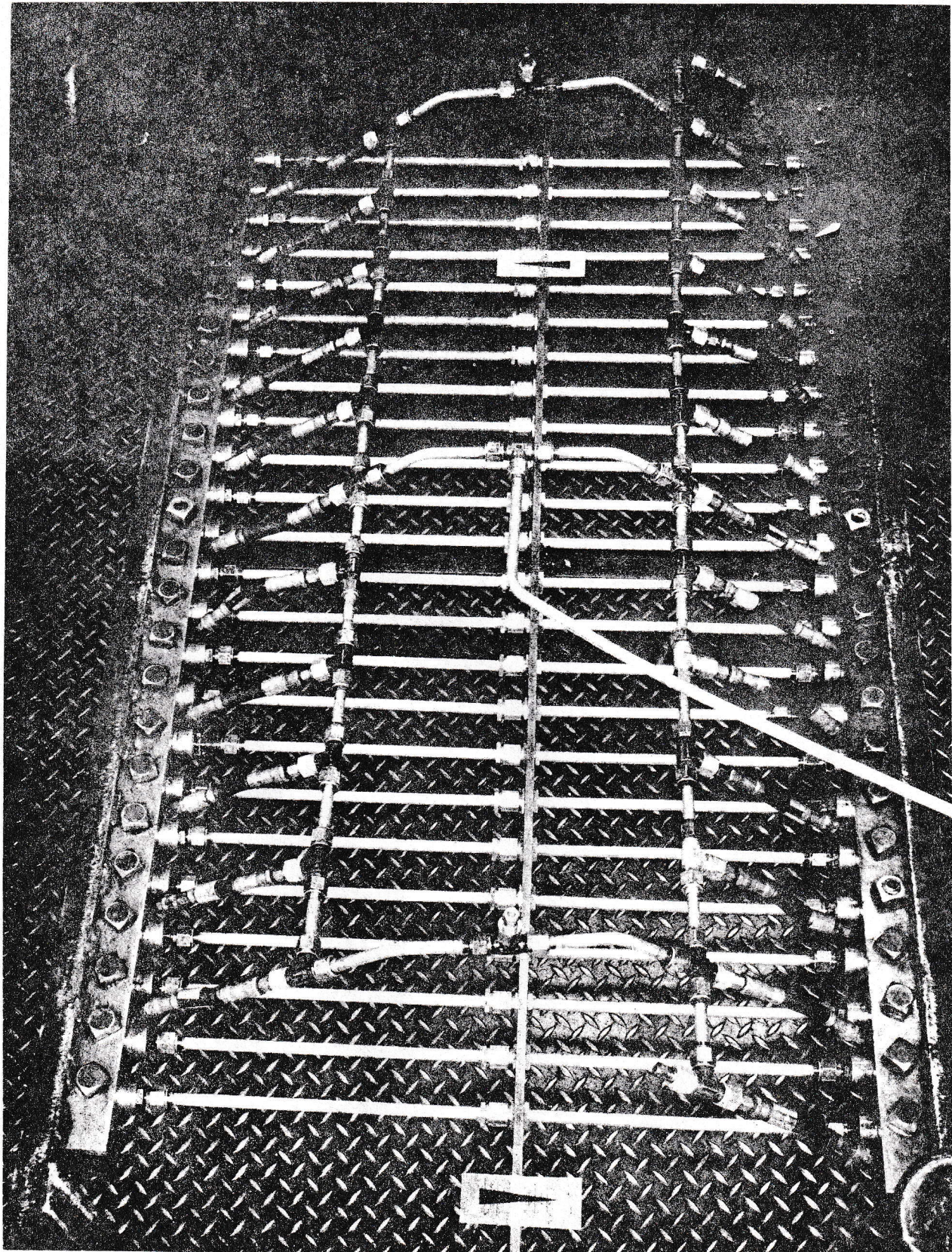
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Low Temperature Test Set-up



PHOTOGRAPH NUMBER 1

Vibration-Impulse Test
Set-Up



PHOTOGRAPH NUMBER 2

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Exploded View of
Test Specimen

