

TERBY CORPORATION

LAMBERTON ROAD • WINDSOR, CONNECTICUT U.S.A.
A SUBSIDIARY OF INGERSOLL-RAND

REPORT NO.

019

REPORT OF POTENTIAL SAFETY HAZARD, 10CFR21
(PART 21 OF TITLE 10 OF THE CODE OF FEDERAL REGULATION)

TO: DIR. OF ENG. D. R. Morrow FILE NO. F41411A
ENG. MGR.-NUCL. K. Wheeler SER. NO. T41411A
PROD. MGR.-NUCL. R. Hebert TYPE GS-2N
VP-QUAL. ASSUR. R. Neeld REF. TM-188
SERVICE MGR. R. Theroux DATED _____

PREPARED BY K. Wheeler DATE 1/15/82

PIECE NO. 90076D DRAWING NO. 90076D REV. J

PART NAME Plug, Valve QUAN. ---

DESCRIPTION OF "DEFECT":
During shop testing in Japan an axial vibration of the valve plug assembly was observed resulting in damage to the valve stem packing and steam leakage to the atmosphere.
ENGINEERING EVALUATION & RECOMMENDATION: The vibration does not occur in the normal operating envelope of the turbopump unit and results in no loss of control function or system availability. Testing and inspection indicate that the stem packing damage was due to dimensional errors made in metric conversion for Japanese manufacture and material discrepancies in the Japanese sourced carbon packing. Therefore, this does not constitute a reportable safety hazard.
APPROVED BY DIR. OF ENG.: <u>Daniel R. Morrow</u> DATE: <u>1-15-82</u>
THIS "DEFECT OR NON-COMPLIANCE" -
_____ CONSTITUTES A SAFETY HAZARD AND REQUIRES THAT A REPORT BE PREPARED BY NAME: _____ DATE: _____
<input checked="" type="checkbox"/> DOES NOT CONSTITUTE A SAFETY HAZARD AND DOES NOT REQUIRE ANY FURTHER REPORTING.
APPROVED BY/TITLE: <u>J.M. Nathan Pres.</u> DATE: <u>Jan 15, 1982</u>
RETURN TO DIRECTOR OF ENG. _____ ERING: _____

Part of worldwide Ingersoll-Rand

Copy No. _____

TECHNICAL MEMORANDUM

PREPARED AND CONDUCTED BY TERRY
BY MUTUAL AGREEMENT WITH SHIN
NIPPON ZOKI AND TERRY HIRO-ZOKI
FOR HITACHI, LTD.

TM- 188

Title: GS-2N CONTROL VALVE STABILITY ANALYSIS,
TESTING AND DEVELOPMENT PROGRAM.

<u>Distribution:</u>	<u>Control Copy No.</u>		
D. R. Morrow	1		
R. A. Neeld	2		
W. L. Wathen	3		
K. Wheeler	4		
R. Hebert	5-13	for:	
		SNM - Mr. Kawaguchi	1
		Mr. Okada	1
		THKK - Mr. Blanchfield	1
		Mr. Igata	1
		Hitachi as required	2
		MARUBENI - Mr. Tono	1

Written By: K. A. Wheeler Date: 11/11/81
Manager, Nuclear Engineering Services

APPROVED BY: David R. Morrow DATE: 11/13/81
DIRECTOR OF ENGINEERING

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RECOMMENDATIONS

- 1) The original valve design configuration is satisfactory for the intended service and no modifications are required.
- 2) Short term operation outside of the normal operating envelope causes no loss of control function or system availability and no modifications are required.
- 3) Continuous operation in certain areas outside the normal operating envelope can result in damage to the valve stem packing which could lead to excessive steam leakage to the room atmosphere. Control function is not compromised.

The modified valve plug configuration described in this report is recommended for such operation outside the normal envelope.

BACKGROUND

The GS-2N, File 41411A turbine manufactured by Shin Nippon Machinery Company, Ltd. (SNM) was undergoing testing coupled to the driven pump at the Hitachi factory when valve stem steam leakage suddenly increased after 8 days of operation. Upon inspection of the valve bonnet, the snap ring, the lower guide bushing and all the carbon rings were found missing.

The valve was reassembled with new parts and testing resumed with close attention to the valve. During this testing it was discovered that, at certain speeds, the valve had a high axial vibration and after approximately 2 hours of tests with and without the vibration present the stem leakage again increased. This time only the snap ring and carbon rings were gone. The vibration amplitude, acceleration and frequency was measured during this testing and several spectrum plots were made.

At this point in time, Terry Corporation (TST) was first notified of the problem.

Due to pressure and time constraints imposed by Hitachi, SNM proceeded to make and test several modifications to the valve design in an attempt to eliminate the vibration. A tabulation of these changes and tests is attached as Appendix I.

The last test at Hitachi was on 24 February with a modified valve plug having a contoured nose cone and was judged satisfactory by SNM and Hitachi. The turbine was then returned to SNM for repair of a steam leak at the gland case, replacement of the Airpax tach and fitting of permanently modified valve and stem packing components.

At this point, it was decided that an engineer from TST would be needed to review and approve the changes that had been made before the turbine could be released for shipment to the end user Tokyo Electric Power Co. (TEPCO)

I arrived at Kure, March 3, 1981, and reviewed all of the test data and the various design changes that had been made. Inspection of the original valve bonnet, sleeve, plug, seat and stem found all to be per drawing dimensionally. No looseness was found in any of the governor linkage pivots or connections.

BACKGROUND (continued)

The test data showed an excessive pressure unbalance with the "final" valve design which, when extrapolated to the rated inlet pressure, would have required more force than the available governor servo force. In addition, all of the testing which had been done was over a narrow range of inlet pressure and flow. For these reasons the modified valve design could not be approved by TST and was rejected.

Any changes to the valve or valve seat would require extensive testing prior to approval so it was decided to reassemble using the original valve.

Hitachi had questioned the suitability of snap rings in steam service and had made suggestions for a revised design during the testing in their plant. SNM had suggested replacing the snap rings with screwed in plugs per SNM sketch attached. Since this change would not affect the function or dynamics of the valve, it was approved. Both snap rings were eliminated.

The reassembled turbine, with the original valve and modified stem packing, was spin tested March 5, 1981, and run on March 6, 1981, under load. SNM did not have sufficient steam flow capacity to duplicate the conditions where the vibration occurred and the test was run without incident. A post test inspection of the valve stem carbon rings found no broken or damaged parts. All testing was witnessed by Hitachi Quality Assurance.

A meeting was held at Hitachi on March 10, 1981, to discuss the program and further action to be taken.

After a general discussion of the problem and inspection results, the following points were made,

- 1) TST would not approve the modified valve design due to excessive pressure unbalance and insufficient testing.
- 2) It was not known at that time what the source of the severe vibration was.
- 3) The vibration may have been evident only due to the extreme test condition which is not a normal operating point for the RCIC system.
- 4) Changing the snap rings to screwed in plugs is acceptable to TST., although not deemed necessary at this time.

BACKGROUND (continued)

- 5) The vibration itself may not be a problem as long as it does not damage other components and thus affect the function of the system.
- 6) TST will investigate the problem further and issue a report of the findings including a definition of what, if any, changes are necessary.
- 7) This report will be issued no later than October, 1981, so as not to delay start-up schedule.
- 8) Hitachi requested that TST participate in the presentation to the customer if significant changes are required.
- 9) Hitachi requested that the screwed plugs replacing the snap rings be considered as original design for this turbine in terms of any further changes that may be required.

INVESTIGATION

Investigation of this problem included review of original design analysis and testing, baseline testing of equipment similar to that used on T41411A, analysis of test results, modification of hardware, retesting and comparison of results to system operating parameters for the turbo pump unit.

Based on the analysis and test results, a theory was developed as to the cause of excitation. This theory was then tested and confirmed as the cause.

TEST PROGRAM

A test program was undertaken by TST to attempt to duplicate the vibration experienced at Hitachi and identify the cause and possible solutions. The testing was conducted generally in accordance with the test agenda REV. 1, 3/27/81 for test No. 1238 attached in Appendix II.

Baseline testing was done utilizing valve and linkage components the same as those supplied on T-41411A tested at Hitachi in February, 1981. All testing was done with 0.004 inches diametral clearance on the valve plug and clearance "C" on KT 764 Appendix II, of 0.003 to 0.004 inches. A high amplitude axial vibration of the valve/valve stem assembly was found when operating with a valve lift of 0.15 to 0.250 inches and a pressure ratio of approximately 2:1. The principal frequency of vibration was measured at 340 Hz with harmonics of 3X and 5X present. No even harmonics were present. A spectrum plot showing the principal frequency is attached (figure 1).

The relatively low principal frequency, the presence of only ODD harmonics and the configuration of the valve plug suggested that the source of excitation might be the high velocity (acoustic) steam flow across the valve nose generating an "ORGAN PIPE" resonance similar to blowing across an empty bottle.

To test this theory, various configurations of baffles in the inside bore of the valve plug were tested, the intent being to interrupt the sound waves at their points of tangency with the plug bore.

These modifications resulted in a reduction of the amplitude of the principal frequency to 1/3 of the original design and almost complete elimination of the 3X and 5X components. A spectrum plot of the final modification is shown in figure 2, KT832., showing small peaks at 1X, 5X, + 9X but none at 3X or 7X and very low amplitudes.

In addition to the reduction in amplitude the vibration was now of a transient nature and could not be tuned in to a steady state buzz as could be done with the original configuration.

Testing was conducted over a range of inlet pressures from 300 PSIG to 600 PSIG inlet, valve travel (lift) from 0.100 to 0.300 inches and pressure ratios across the valve of 1.35:1 to 3.2:1

TEST PROGRAM (continued)

All vibrations were experienced at inlet pressures of 350 PSIG or higher at valve travels of 0.150 to 0.250 inches and pressure ratios of 1.8:1 to 2.1:1. A total of four different modified configurations were tested, the difference being the number and location of the baffles. The final configuration is shown in figure 4.

DISCUSSION

Testing at both Hitachi and TST revealed a potentially damaging high amplitude axial vibration of the valve/valve stem assembly under certain specific operating conditions. Analysis of test data from TST testing revealed several factors:

- 1) Principal frequency and only odd harmonics were present.
- 2) Vibration occurred over a relatively narrow range of operating parameters such as inlet pressure, valve travel and pressure ratio across the valve.
- 3) When excited, the vibration was a clean, narrow, high amplitude peak which could be tuned in and would essentially be self sustaining.

The above factors indicated that the basic exciting force was an acoustic organ pipe vibration being excited by steam flow across the open end of the valve plug.

The presence of only odd harmonics is indicative of a closed end organ pipe resonance and the principal frequency measured while not exactly that which would be predicted was close to that which would be predicted from basic physics texts. A simplified representation of the wave forms for displacement is shown in figure 3.

The exciting force in this case is thought to be the variation in pressure on the closed end of the organ pipe (valve plug) which varies from minimum to maximum at the fundamental frequency of the organ pipe.

To test this theory an obstruction to the sound waves was inserted in the valve plug to break up the resonance. As noted in the test discussion dramatic reductions in the amplitude were realized by this modification indicating that the original hypothesis of the exciting force was correct.

In addition to the presence of obstructions to the sound waves in the valve plug reducing the amplitude of the vibration, it was also noted that the vibrations became transient in nature, that is they were no longer tuneable and could only be excited in short term transients where as the original configuration could be tuned and would self sustain or continue with no changes in operating parameters.

DISCUSSION

Since many turbines with this valve configuration are presently in service in nuclear power plants worldwide, including Japan, with no reported field operating problems of this nature, a comparison of the turbo pump unit characteristics with the system operating performance characteristics was made.

Using the specified power, speed, steam condition specification requirements for T41411A, the predicted performance curve for T41411A, and GE specified constant flow, constant system differential pressure parameters for Boiling Water Reactors a predicted turbine operating line was generated for T41411A. This curve, figure 5, was plotted for turbine inlet pressure vs. the pressure ratio across the control valve. In addition the range of operational parameters where vibration was observed at Hitachi and TST is indicated by the cross hatched area and the testing envelope is indicated.

Comparison of the System Operating Line with the tested valve instability area clearly indicates a conservative margin between the two allowing for normal margins in turbine, pump and system operation.

CONCLUSIONS

- 1) The vibration experienced during testing was duplicated on test at TST using similar hardware and test conditions.
- 2) This vibration is attributed to an "ORGAN PIPE" type resonance occurring within the valve plug cavity due to the high velocity steam flow across the open end of the valve plug.
- 3) This resonance only occurs at a specific pressure ratio across the valve and then, only when the inlet pressure is approx. 350 PSIG to 600 PSIG or greater.
- 4) The acoustic resonance caused vibration can be controlled to acceptable limits by design modifications to the valve plug cavity alone.
- 5) Operation for two hours at maximum vibration amplitudes resulted in NO damage to valve or valve stem seal components.
- 6) Comparison of specific operating conditions where vibrations were present both at Hitachi and TST with the actual operating system performance curve shows adequate margin between areas where vibration is present and actual "real life" system operating parameters.
- 7) No changes to the valve design are deemed necessary for operation in the actual installed turbo pump environment. If steady state operation in the off design range of parameters is required, a design modification is available which performs satisfactorily under these conditions without compromising performance under intended operating conditions.

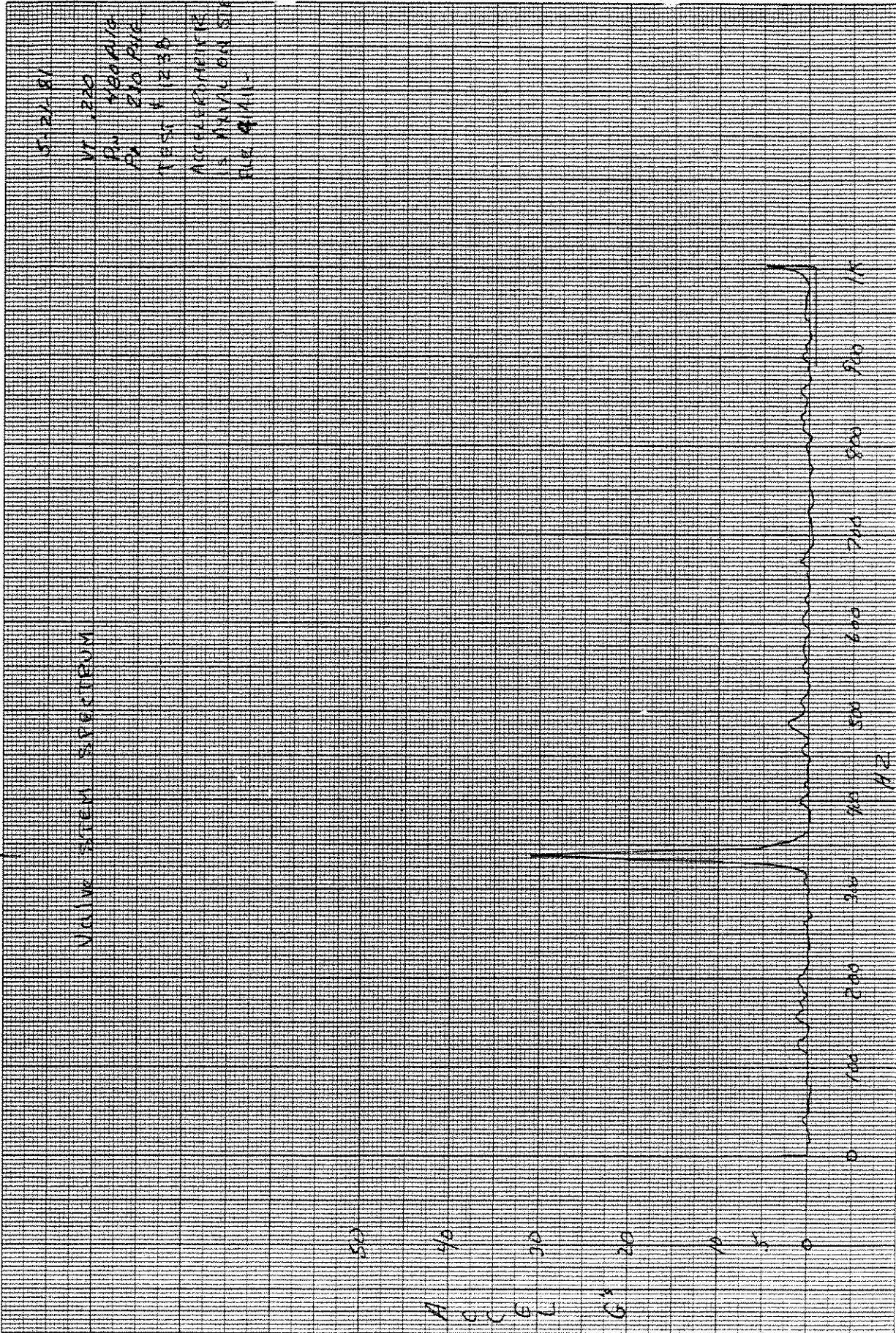


FIGURE 1

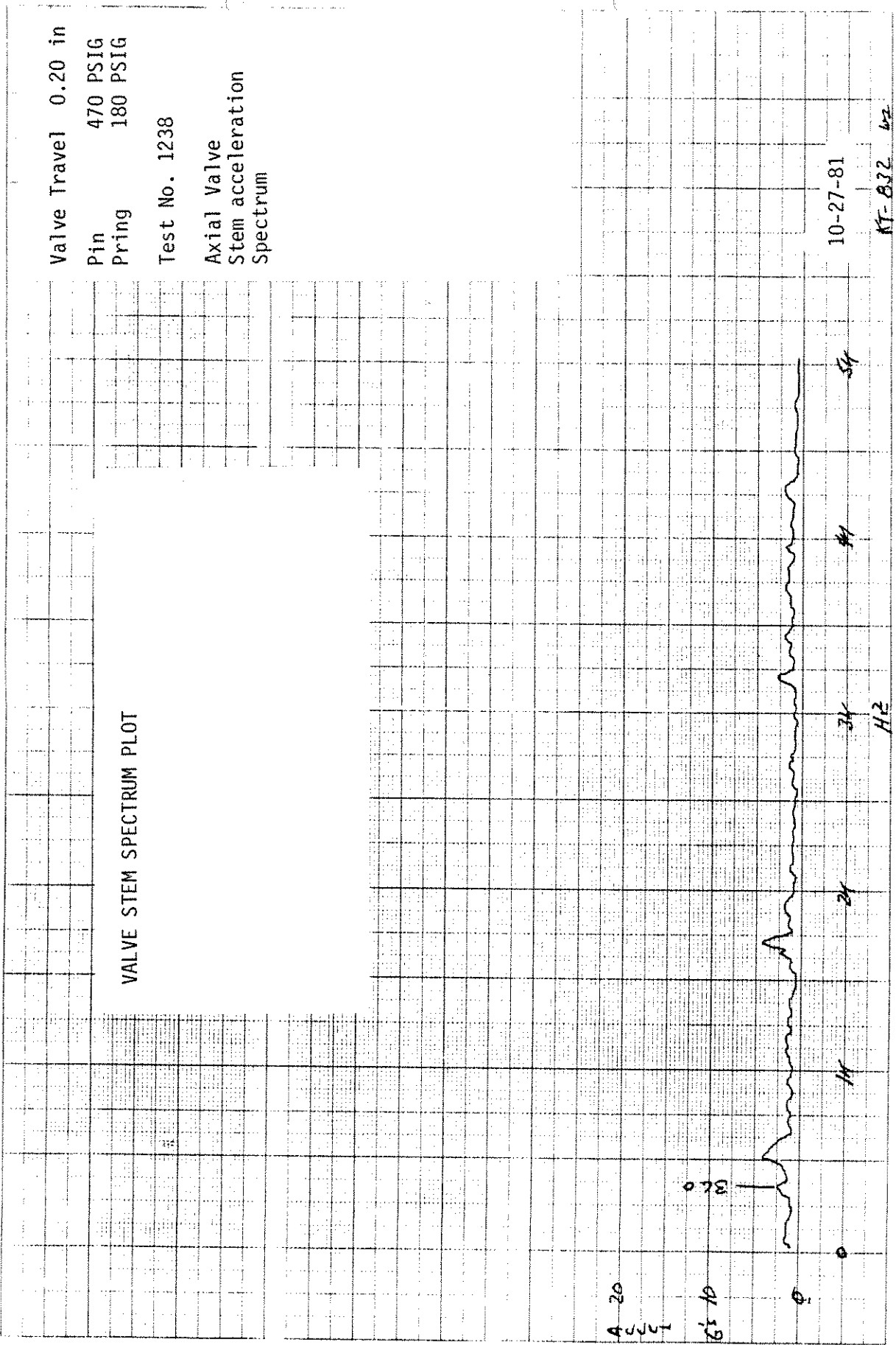


Figure 2

BY: _____ DATE: _____ SUBJECT: _____ PAGE _____
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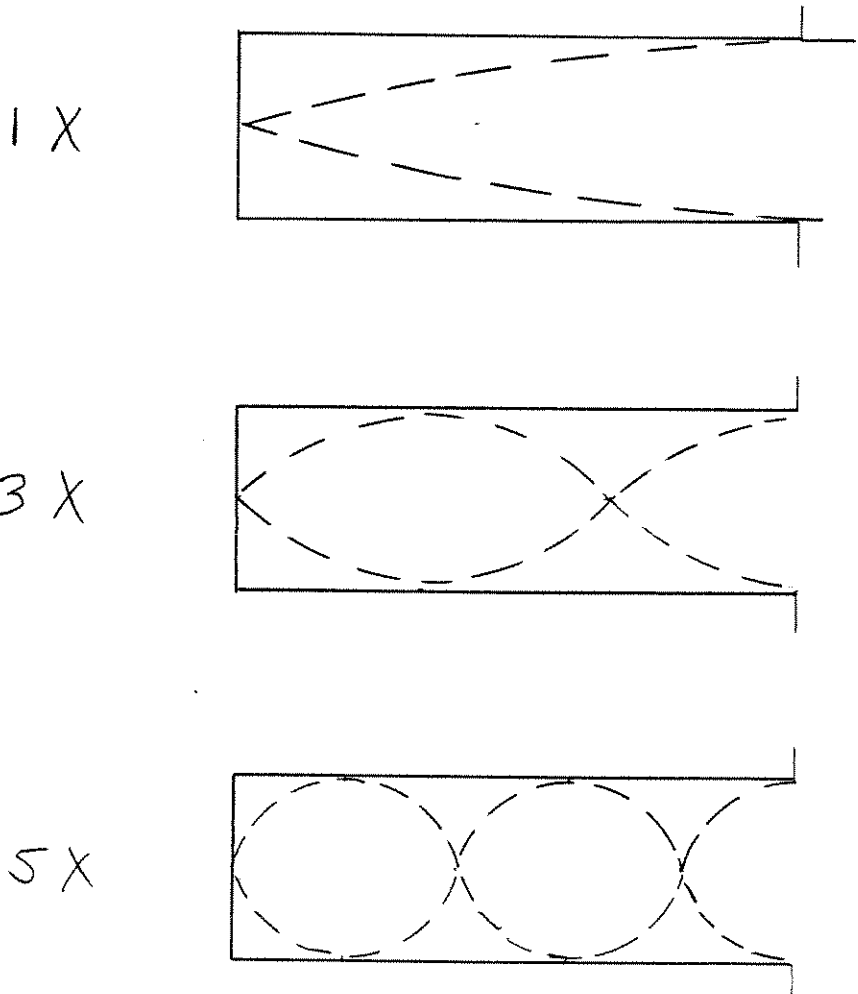


Fig 3

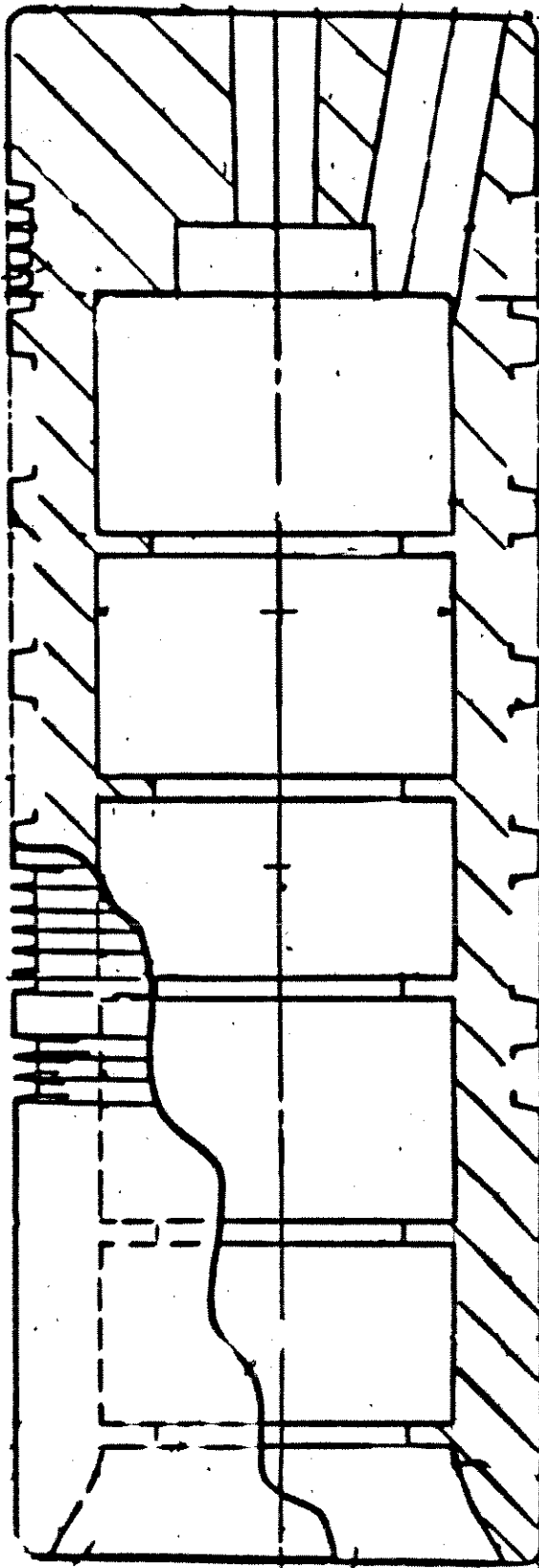


Figure 4

K-14312

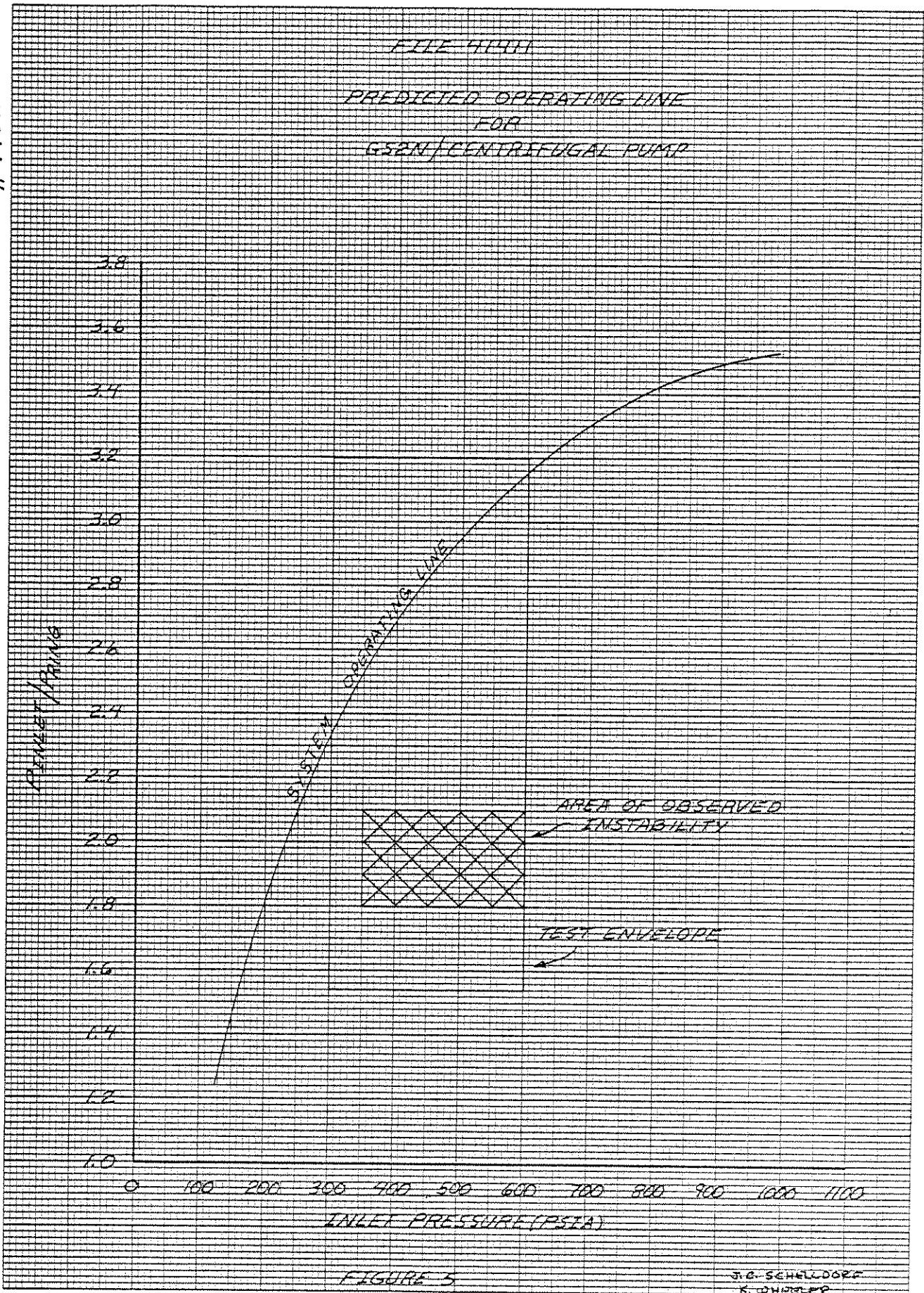


FIGURE 5

J.G. SCHELDORF
K. WHEELER

APPENDIX I

SUMMARY OF TESTS RUN AT HITACHI

<u>DATE</u>	<u>DESCRIPTION</u>
1/27 - 2/14	Original design with 0.004 inch clearance on valve plug. Problems first noticed on 2/14.
2/16	Valve clearance reduced to 0.0015 inches, stem runout at 0.002 inches. Flat disk about 1 inch thick with two 0.6 inch diameter balance holes inserted inside valve plug. Test acceptable.
2/17	Original design with 0.0015 inch clearance. Pressure tap in balance chamber added for this test. Test acceptable.
2/18 - 2/20	Original valve for customer witness tests. Did not operate in area where vibration is evident. Tests acceptable
2/21	Original design with 0.0025 inch clearance. Some vibration noted.
2/23	Contoured nose cone with one 0.39 inch diameter hole in center added to valve with 0.0025 inch clearance. See sketch in test data. No vibration noted, however, large pressure differential between balance chamber and steam ring.
2/24	Contoured nose cone with five holes. One 0.55 inch diameter in center and four 0.3 inch diameter around it. Valve clearance at 0.004 inches. Pressure differential reduced to approximately 45 PSI at 600 PSI inlet. No vibration - test deemed acceptable.

APPENDIX II

REV. 1
3/27/81

TEST #1238

3" Nuclear Governor Valve Test Agenda

PURPOSE: To explore valve and stem vibrations of a Terry GS-2N Turbine. Field reports from Japan indicate that these vibrations are of high magnitude and frequency such that the stem gland has been severely damaged.

REFERENCE: (1) Mr. Ken Wheeler's field trip to Japan in March. (2) Mr. Neeld's telex of 3/21/81 from Japan advising that a special test be conducted at the Terry Test Lab under simulated field conditions.

PROCEDURE: A GS-2N nuclear valve assembly will be setup in Navy Test so that field conditions can be simulated where the problem parameters have been reported. Other than the valve assembly, the levers, linkage and Servo will be setup identical to field conditions. Some means of positioning the governor valve through the Servo will be provided. An accelerometer will be mounted on the valve stem to measure the severity of vibration during this test.

Steam will flow through the valve to an exhaust header. A throttle valve will be used downstream of the governor valve body to simulate ring pressure. A PRV station and desuperheater will be used to set steam pressures and temperatures to 850 psi and 600^o maximum. The moisture region can be explored with this system. The governor valve position and transient

continued.....

TEST #1238
PAGE 2

motions will be monitored by two linear potentiometers attached directly to the governor valve and lever then displayed on a strip chart recorder. A hand held seismic probe can be used to also explore the valve stem vibration at different locations once the system becomes unstable.

Lever to guide clearance shall be varied as necessary during test and recorded dimension "C" on KT-764.

Once accelerometers are mounted, natural frequencies will be explored by ringing the mechanism.

Steam flow can be measured with the steam condensate weighting system. Measure valve steam leakoff flows throughout the test.

Test Parameters

Inlet steam pressure 500 to 800 psi.

Inlet steam temperature saturated to 25° SH.

Steam flow 25,000 - 30,000 #/HR.

Downstream pressure - 0-500 psi.

Valve travel 0-200 mils.

Test Duration - Minimum two hours in the maximum vibration mode. Monitor gland leakage during this period.

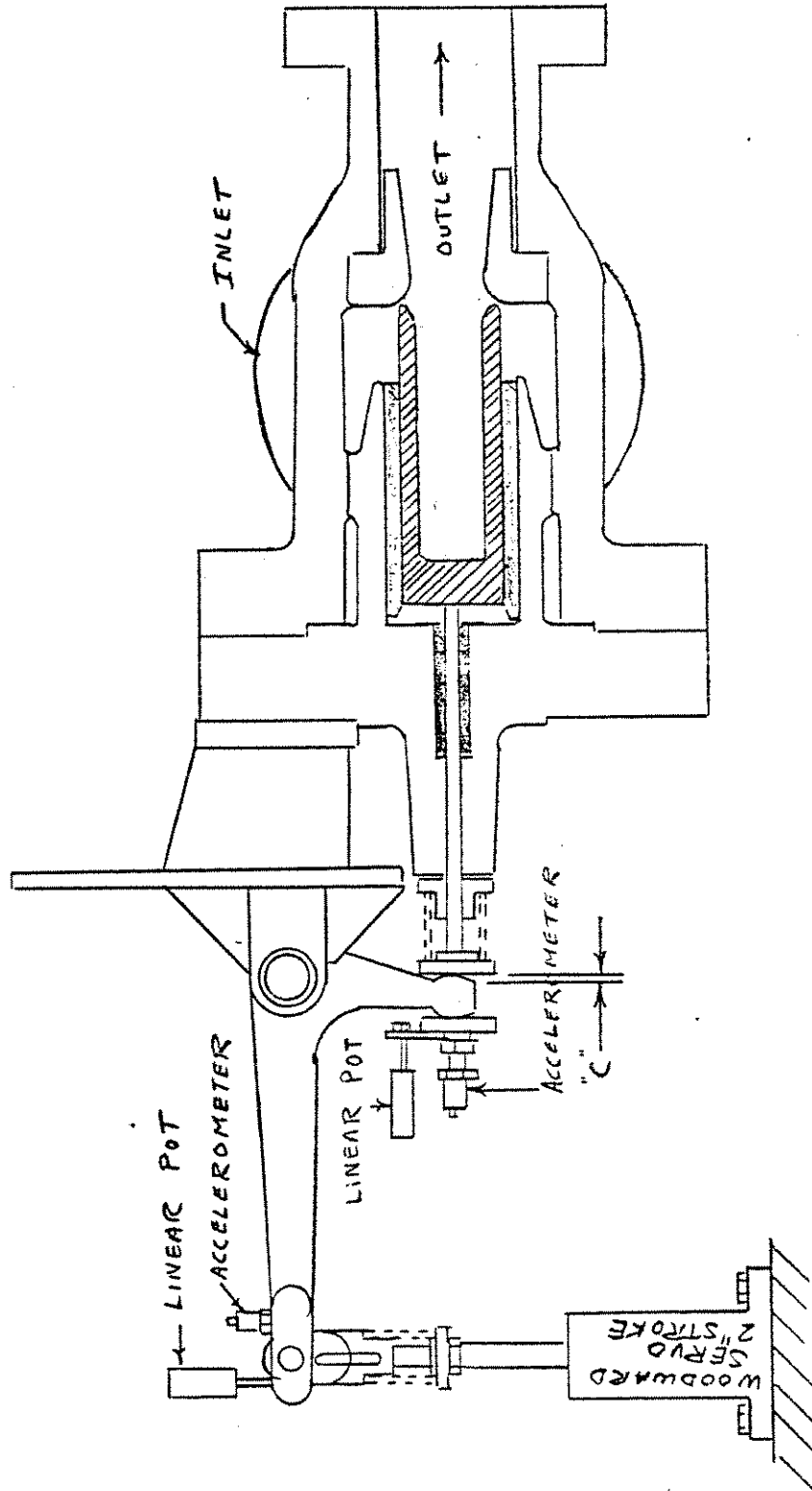
Post Test Inspection - Dismantle assembly for inspection of all components.

Analyze test results and make changes as necessary. Should this be required, retest after redesign.

This test agenda has been reviewed and approved by Mr. K. Okada, Director Deputy General Manager of Shin Nippon Machinery Company LTD on 3/27/81.

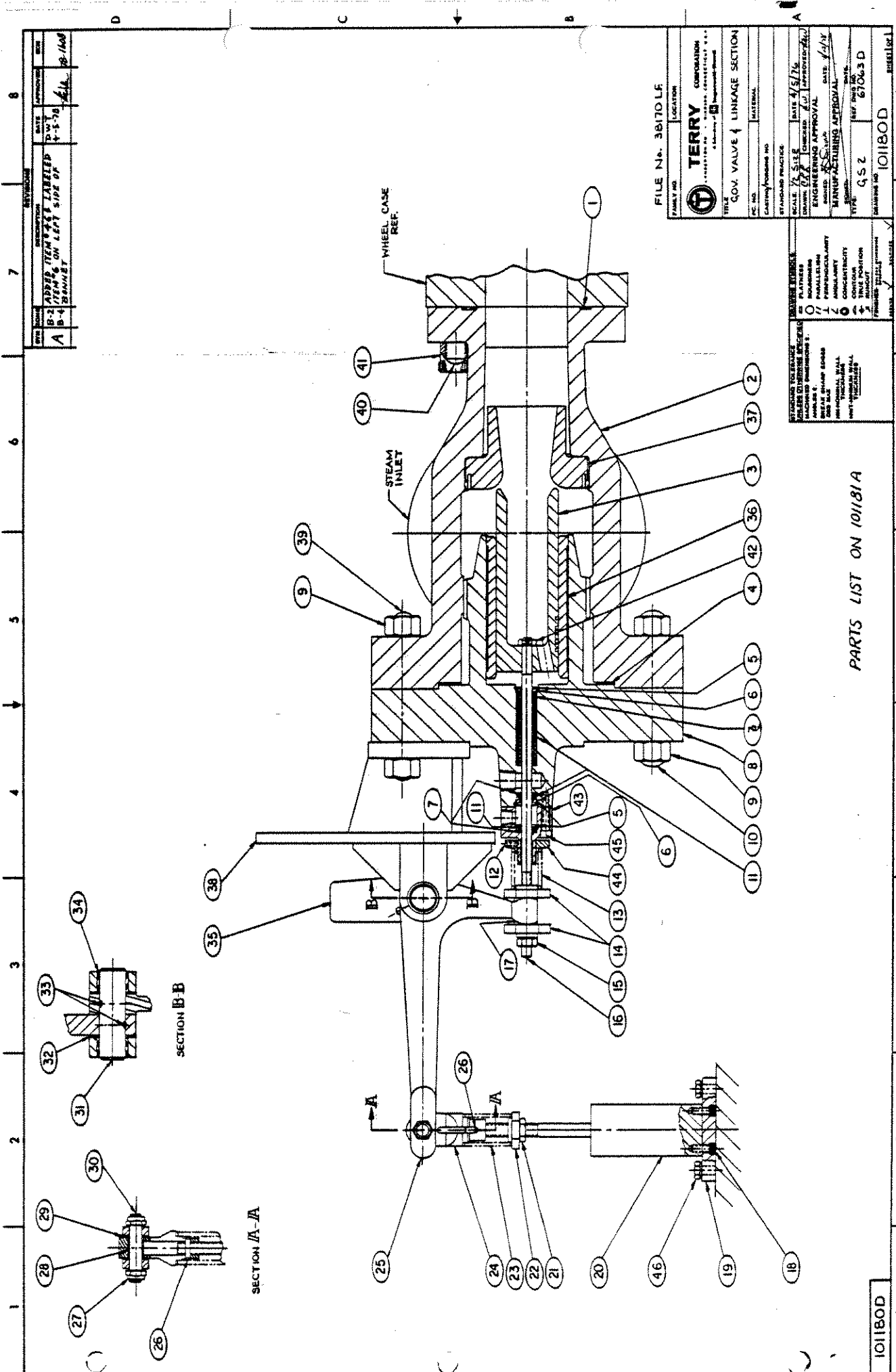
J. Raymond
Ch. Test Engr.

TEST # 123B
GOVERNOR VALVE DYNAMICS



KT-76A
TMR 3-24-81

APPENDIX III



REV	DESCRIPTION	DATE	APPROVED BY
A	ADD'D ITEMS TO LABELS	4-5-78	AL
B-1	ITEM #6 ON LEFT SIDE OF		
B-4	BRACKET		
			10-1/68

FILE No. 3817D L5

LOCATION

TERRY CORPORATION
 A Division of TERRY INDUSTRIES, INC.
 10000 W. 10th Street, Tulsa, Oklahoma 74117

TYPE: GLOB. VALVE LINKAGE SECTION

REV. NO. 1

DATE: 4/5/78

DESIGNED BY: [Signature]

CHECKED BY: [Signature]

APPROVED BY: [Signature]

MANUFACTURING APPROVAL

DATE: 4/1/78

TYPE: G.S. 2

REV. NO. 1

DATE: 6/26/83 D

1011BOD

STANDARD PRACTICE	SCALE: 1/2" = 1"
UNLESS OTHERWISE SPECIFIED:	
1. FINISHES: AS SHOWN	
2. MATERIALS: AS SHOWN	
3. DIMENSIONS: AS SHOWN	
4. TOLERANCES: AS SHOWN	
5. SURFACE FINISH: AS SHOWN	
6. THREADS: AS SHOWN	
7. HOLE FINISH: AS SHOWN	
8. SPACINGS: AS SHOWN	
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PARTS LIST ON 1011B1A

1011BOD

PARTS LIST: TYPE GS-2
 FILE 38170LF SECTION DRAWING NO. 101180D

DWG NO. 101181A SH. 2 OF 2

ITEM NO.	NAME OF PART	TERRY PIECE NO.	MATERIAL			NO. PER UNIT
			TERRY SPEC	TYPE	GRADE	
26	DOWEL, 1/4 x 1" LG	75143A19	COMM			1
27	FLEXLOC LOCKNUT 31FK813	75232A07	COMM			2
28	GARLOCK BUSHING 10DU14	75201A21	COMM			1
29	GARLOCK THRUST WASHER DU08	75201A54	COMM			2
30	PIN	44530	EM-31	ASTM A276	S41000	1
31	PIN	67300	EM-31	ASTM A276	S41000	1
32	GARLOCK THRUST WASHER DU18	75201A62	COMM			2
33	PIN, #6 P&W TAPER 2 1/4 LG	75108A31	COMM			2
34	GARLOCK BUSHING #20DU16	75201A40	COMM			2
35	LEVER, MICRO SWITCH	73103B	EM-81	ASTM A36	AISI 1010-1025	1
36	SLEEVE, VALVE	79180C01	EM-59	ASTM A276	S41000	1
37	SEAT, VENTURI	79181C	EM-59	ASTM A276	S41000	1
38	SUPPORT, FULCRUM	67158D	EM-81	ASTM A36	AISI 1010-1025	1
39	STUD, BOLT 1 1/8-7	102524	EM-13	ASTM A193	B7	2
40	STUD, 1"-8	13472	EM-13	ASTM A193	B7	8
41	ALLENUT, 1"-8	75776A11	EM-87	COMM	AISI 4140	8
42	NUT, 3/8-24UNF	105564A	EM-31	ASTM A276	S41000	1
43	CASE, VALVE STEM	89324C	EM-77	ASTM A473	AISI 403	1
44	SEAT, VALVE SPG	89325B	EM-31	ASTM A276	S41000	1
45	SCR, 5/16-18 SOC HD CAP	75362A11	EM-87	COMM	AISI 4037	3
46	SCR, 3/8-16 HEX HD CAP	75181A08	COMM		SAE GRADE 2	4

REV & ECN	A	SE 1/12/78	MF2	78-138	REV & ECN		
	B	DWT 4/5/78	MF2	78-1609			

INTER-OFFICE MEMORANDUM

DATE: January 13, 1982

FROM: G.L.Kniep

TO: K.A.Wheeler (A)
R.F.Johnson (C)
E.Lichtsteiner (C)
D.R.Morrow (C)

OFFICE: Product Engineering

FILE:

SUBJECT: Valve Stem Spacer
Terry Pc. No. 54843
Dwg. No. A10231
Matl. Source: Japan

Ref.: Letter to Pure Carbon Co.
dtd. 12/14/81 (attached)

The following test results were reported by Pure Carbon Company as a courtesy to us:

	<u>TERRY EM-092</u>	<u>Actuals</u>
• Hardness, Scleroscope	72, min.	1. 75-80 2. 71-73 3. 75-78
• Transverse Breaking Strength, psi	7500, min.	1. 5200 (69%) 2. 5393 (72%) 3. 3852 (51%)
• Apparent Density, gm/cc	1.72, min.	1. 1.67 2. 1.62 3. 1.65

It would be reasonable to say that hardness and apparent density are acceptable, however, the essential property of TBS (nearly half the specified value in one case) falls far short of a desirable value.

We would suggest that the vendor source be advised to investigate their material processing, possibly in the areas of molding and tempering practices.

G.L.K
G.L.Kniep

/dah
cc: File EM-092
attachment

TERRY

Part of worldwide Ingersoll-Rand

Steam Turbine Division

Terry Corporation
P.O. Box 555 Lamberton Road
Windsor, Ct. 06095
(203) 688-6211 Telex 99-4495
Cable Terrysteam

December 14, 1981

Pure Carbon Co., Inc.
St. Marys, PA 15857

ATTN.: R.W.Pontzer
Q.C.Manager

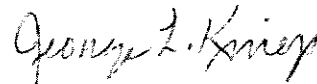
SUBJECT: Valve Stem Spacer - Terry Pc.#54843
Drawing #A-10231; Material Source:
Japan.

Gentlemen:

Enclosed you will find six (6) valve stem spacers showing radial cracks, plus fragments from approximately three (3) other spacers. These spacers came from a nuclear auxiliary (stand-by) steam turbine designed for 1250 psig steam pressure, maximum at the inlet. The spacers obviously have seen some service of an undeterminable amount of time, however, service is not of a continuous nature.

Please examine this material and tell us if you can conclude whether or not it meets our spec. Enclosed please find one copy of Terry material specification EM-092, Rev. 2 and drawing A-10231, Rev. B.

Sincerely,



George L. Kniep
Senior Engineer

/dah

cc: K.A.Wheeler
E.Lichtsteiner
D.R.Morrow
S.Beta

enclosures

INTER-OFFICE MEMORANDUM

DATE: January 19, 1982

FROM: G.L. Kniep

TO: K.A. Wheeler (A)
R.F. Johnson (C)
E. Lichtsteiner (C)
D.R. Morrow (C)

OFFICE: Product Engineering

FILE:

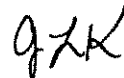
SUBJECT: Valve Stem Spacer
Terry Pc. No. 54843
Dwg. No. A10231
Matl. Source: JapanRef.: Letter to Pure Carbon Co.
dtd. 12/14/81 (attached)

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G.L. Kniep

/mwh

cc: File EM-092

attachment

TERRY

Part of worldwide Ingersoll-Rand

Steam Turbine Division

Terry Corporation
P.O. Box 555 Lambert Road
Windsor, Ct. 06095
(203) 688-6211 Telex 99-4495
Cable Terrysteam

December 14, 1981

Pure Carbon Co., Inc.
St. Marys, PA 15857

ATTN.: R.W. Pontzer
Q.C. Manager

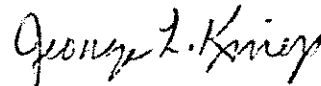
SUBJECT: Valve Stem Spacer - Terry Pc.#54843
Drawing #A-10231; Material Source:
Japan.

Gentlemen:

Enclosed you will find six (6) valve stem spacers showing radial cracks, plus fragments from approximately three (3) other spacers. These spacers came from a nuclear auxiliary (stand-by) steam turbine designed for 1250 psig steam pressure, maximum at the inlet. The spacers obviously have seen some service of an undeterminable amount of time, however, service is not of a continuous nature.

Please examine this material and tell us if you can conclude whether or not it meets our spec. Enclosed please find one copy of Terry material specification EM-092, Rev. 2 and drawing A-10231, Rev. B.

Sincerely,



George L. Kniep
Senior Engineer

/dah

cc: K.A. Wheeler
E. Lichtsteiner
D.R. Morrow
S. Beta

enclosures