Attachment 1

383HA617 Rev. 0

Evaluation of CRD Scram Characteristics
Under Simulated Earthquake Conditions

GENERAL ELECTRIC

NUCLEAR ENERGY DIVISION

CLASS II MCSR-262

FOR G.E. EMPLOYEES & SELECTED EXTERNAL ADDRESSEES

MCSR 262

Document No. 383HA617 Rev. 0

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PROJECT "D" Lattice Core - 0.750 nom. gap

DOCUMENT TITLE Evaluation of CRD Scram Characteristics Under Simulated Earthquake Conditions

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RESPONSIBLE ENGINEER P. G. Rentz ISSUED BY B. L. Smith DATE DEC - 8 1971

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NUCLEAR ENERGY DIVISION
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San Jose, California

MCSR 262
DOCUMENT NO. 383HA617 REV. 0

APPLICATION ____________

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REVISION STATUS SHEET

NED 605 (3-69)

TITLE
Evaluation of CRD Scram Characteristics Under Simulated Earthquake Conditions

REFERENCE:

1). 1970 PEP Q0002, RC10 CRD Scram Capability with Earthquake Induced Misalignment of Core Components.

2) 1971 PEP Q0062, CE-12, RC-3.

3) Letter to S. W. Smith from F. E. Cooke July 28, 1970 (attached).

4) Letter to J. Fritz from R. J. Murkowski May 12, 1970.

5) 731E849 Control Rod Clearance Study.

6) TRA-378 Earthquake Core Misalignment Test (attached).

1.0 INTRODUCTION:

In order to evaluate the scram characteristics of the control rod drive during an earthquake, a three phase test program was drafted and executed. Each phase was designed to simulate one of the core conditions resulting from an earthquake as defined in ref. 3. The program was authorized and funded as a PEP (see ref. 1&2).

The testing consisted of determining CRD scram performance under the following conditions:

Phase 1 - 500 pound constant friction load simulated by adding 500 pounds to the present drive line weight,

Phase 2 - maximum core misalignment due to allowable drawing tolerances, and

Phase 3 - additional misalignment due to earthquake, and finally with an aligned core, fuel channels bowed to a maximum of 1.5 inches.

2.0 RESULTS AND CONCLUSIONS:

2.1 Phase 1

A. At 1030 psig, vessel pressure with 500 pounds added to an aligned driveline, the 90% scram increases from an expected valve of 2.5 seconds to 5.3 seconds.

B. At zero vessel pressure, the 90% scram times were only increased by approximately 10%.

C. At vessel pressures between 800 and 925 psig, the CRD will not full insert.

2.2 Phase 2

At maximum misalignment conditions due to drawing and installation tolerances, there was no significant effect on CRD performance.

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2.3 Phase 3

A. Additional static misalignment to simulate a possible earthquake condition when superimposed upon the maximum misalignment condition of Phase 2 had no significant effect on CRD performance.

B. With an aligned core, the first significant degradation of scram times occurs at channel bows of 0.6". At channel bows of 0.9" through 1.5" the CRD does not fully insert. At .9" bow and 1030 psi vessel pressure, the CRD stopped at 07 or 85%. At 1.5" bow and 1030 psi the CRD stopped at 42 or 17%. All scram tests were conducted with a static bow.

C. Channel bows at 0.9" at temperatures up to 546°F and 1.5" at ambient conditions do not produce channel yielding.

D. The misalignments to simulate earthquake displacements of the core supports and the channel bowing tests produced wear on the control rod and channels. This wear generated metal chips which get into the CRD and will effect its maintenance life.

3.0 TEST PROCEDURE:

3.1 Phase 1

Phase 1 testing was intended to simulate friction in the driveline caused by lateral loading during an earthquake. The amount of friction was set at 500 pounds per ref. 3. This friction was simulated by adding 500 pounds to a control rod blade. Square bars were added to two sides of the control rod as shown in Figure 1. A fuel support was modified to allow these weights to pass, and a spacer was used at the top grid to hold the two remaining fuel bundles in proper position.

Testing consisted of running drive traces and scrams. A drive trace consists of recording drive pressures, position and time, while continuously inserting and withdrawing the CRD. The drive system was adjusted to provide a slower than normal drive insert and withdraw speed of approximately one inch per second. The scrams were performed from the fully withdrawn position with an accumulator gas precharge of 575 psi and a final water charge of 1510 psi. The order and number of drive traces and scrams were as follows:

Vessel Pressure (psi)	Testing
23	2 drive traces, 2 scrams & 2 drive traces
1030 (cold hydro)	1 drive trace, 5 accumulator scrams, 1 drive trace, 2 vessel scrams, 1 drive trace
800 " "	1 drive trace, 2 accum. scram, 1 drive trace 1 vessel scram, 1 drive trace
900 " "	1 accum. scram, & 1 vessel scram
950 " "	1 accum. scram, & 1 vessel scram
925 " "	1 accum. scram, 1 vessel scram & 1 drive trace
23	1 drive trace, 2 scrams, & 1 drive trace

3.2 Phase 2

The second phase was intended to test the scram performance of the CRD under maximum expected core misalignment due to fabrication and installation tolerances.

The lower core plate was misaligned with respect to the CRD housing centerline.

0.136 in. as defined in 731E849 (ref.5) plus
0.030 in. hole position for a total of
0.166 in. The top grid was misaligned
0.124 in. as defined in ref. 4.

These dimensions were target misalignments. An optical alignment fixture was used to establish the target points and measure the actual misalignments obtained. The accuracy of the alignment system is estimated at ± .020.

The direction in which the misalignment was made is shown in Fig. 2. The actual dimensions obtained are listed in Table 1.

Testing was similar to phase 1 with the addition of jog traces and settle friction test. Jog traces consist of measuring driving pressures, position and time as the drive was jogged in and out one notch at a time over the full stroke. Settle friction testing consists of measuring the pressure under the drive piston as the drive settles back into each notch.

Testing consisted of two drive traces, one jog trace, one settle friction, two scrams and one settle friction performed with no core misalignment. Then, after the core plate and top grid had been moved to the misaligned position, this test was repeated. No testing was performed at higher vessel pressures since no effects of misalignment were observed on CRD performance at ambient conditions.

3.3 Phase 3

The final phase was divided into two tests. The first was with earthquake induced lateral core misalignments and the second was with earthquake induced channel or core bow. The amount of misalignment and bow were defined in ref. 3. The misalignment for part 1 was in addition to and in a plane 90° to the phase 2 misalignment. Fig. 2 defines this condition where the target displacements were "A"=.166, "B"=.042 (.166-.124=.042), "C"=.20 and "D"=.60.

With this misalignment established in the core plate and top grid respectively the following tests were performed:

Vessel Pressure (psi)	Tests
23 (ambient)	2 drive traces, 1 jog trace, 1 settle friction, 2 scrams & 1 settle friction
800 cold Hydro	3 accum. scrams & 2 vessel scrams
500 & 800 Hot	1 drive trace, 1 settle friction, 2 accum.scrams, 2 vessel scrams, 1 settle friction, 1 drive trace

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Vessel Pressure (psi)	Tests
1030 Hot	1 drive trace, 1 settle friction, 5 accum. scrams, 2 vessel scrams, 1 settle friction and 1 drive trace
23 (ambient)	1 settle friction, 2 scrams, 2 drive traces, & 1 jog trace

The 800 psi cold hydro was run in order to determine if the effects seen during ambient testing warranted hot testing. The answer was yes and hot testing commenced.

Part 2 testing was performed with varying amounts of bow in the channels. The core was aligned prior to bowing. The bowing was accomplished by first articulating the center bars of the Building G fuel bundles with a ball joint. A spacer block was installed and the channels drilled to line up with tapped holes in the block (see Fig. 4, 5 and 6). The four bundles were then held together in their proper orientation while a plate was bolted, through the channels, to the spacer blocks. A scissors jack arrangement was installed to the plate as shown in Fig. 7. This assembly was lifted (see Fig. 8) and lowered into the 30" vessel. The scissors jack slipped onto two pins on one of the "T" bars which are welded to the inside of the vessel. The top grid was then installed using 1/2" pins to take the side loads (see Fig. 9).

Before the fuel assembly was lowered into place, an optical target scale was clamped to the plate. The alignment scope was used to view the scale. The scope in its mount is shown in Fig. 10, and the view of the scale through the scope is shown in Fig. 11. The cross hairs of the scope were lined up on a number, then after jacking the plate over the amount of bow could be determined by subtracting the original number from the final. The maximum bow reached was 1.5 inches. The effects on the channels of this 1.5 inch bow can be seen in Fig. 12, while Fig. 13 shows an overall sketch of this set-up.

In terms of testing, one new type of test was introduced in this part. The CRD was driven in using cooling water at elevated pressures rather than using the normal drive insert system. The results of this test were traces of pressure which indicate driveline friction in the insert direction.

To facilitate the writing of the test request and the running of the test, a basic test was defined as follows:

A. Two cooling water driving traces.
B. One settle friction trace.
C. Two drive traces.
D. Two accum. scrams (1510/575).

The test sequence is shown in Table 2. Referring then to this table, the following comments are in order. First, increased vessel pressure testing started as soon as the effects of bowing were deemed significant, i.e. 0.9 inch bow. Second, after 1.3 and 1.5 inch bow the jack was backed off to 0 bow to verify that the channels were still in the elastic range. Then, the bow was increased to 0.6 to determine if any damage had occurred due to testing.

The next point is that the 0.9 inch bow hot tests were run to verify that the cold hydro tests yield results which arevery close to the hot condition. It should be noted that the optical scale was removed prior to going hot.

After hot testing, an attempt to return to zero bow failed. A galled thread on the jacking screw caused the mechanism to bind up at about 0.7 bow. The bundles were removed, disassembled and inspected at this point. The control rod and fuel support were also removed and inspected.

The fuel bundles were reassembled with some new cables (see cable in Fig. 4 & 5) and reinstalled in the vessel. Testing continued as shown in Table 2. The remaining tests were performed in order to demonstrate high energy scram effects (N_2 precharge increased from 575 to 710 to 875 psig) and to determine if CRD housing deflections had any effect on scraming.

One other dimensional check was made in conjunction with returning the channels to zero bow after the final 1.5 inch bow tests. The dimensions between the top grid and the T-bars on the vessel wall were determined under both loaded and unloaded conditions. This was to ascertain if any movement of the top grid occurred due to loading which would invalidate the amount of bow which was measured on the scale.

4.0 TEST RESULTS:

4.1 Phase 1

The primary piece of data from phase 1 is scram times. At zero vessel pressure, the times to 90% stroke were between 1.725 and 1.741 sec. which is slightly slower than the 1.6 second normal; however, at 800 psi vessel pressure the drive stopped after 2.2 seconds at position 22. At 900 psi, the drive stopped after 0.6 seconds at position 26. In addition, at both vessel pressures the CRD did not move ~~during a~~ fifteen second vessel scram signal (accumulator valved out).

Fig. 14 plots the results of 925, 950 and 1030 psi testing. At the normal operating pressures of 1030 psig and normal accumulator charge, the 90% scram time was approximately five seconds which is about twice the time for a normal scram. The conclusion is that if the CRD sees an additional friction load of 500 pounds, there will be reduced speeds at normal operating pressures, and within some pressure spread less than 925 psi, full stroke will not be achieved. The additional possibility exists that no CRD motion will occur at these lower vessel pressures.

4.2 Phase 2

The results of phase 2 testing were that there was no detected change in CRD performance due to expected fabrication and installation misalignment. Scram times were 1.548 sec. aligned and 1.558 misaligned. Both times were within the normal 90% scram time spread for CRD #880 (Engineering test CRD).

Settle friction ranged from 40 to 45 psi aligned and 39 to 46 psi misaligned. Both ranges are normal.

The drive trace data was likewise similar between aligned and misaligned. This data is presented in the attached phase 2 test data section.

4.3 Phase 3

During initial testing of part 1 of this phase, the data (see attached phase 3 part 1 test data section) indicated a decrease in settle pressures of approximately 5 psi. This can be and was interpreted as increased friction. Scram times and drive performance were normal.

In order to determine if the increased friction would effect scram times at elevated vessel pressure, scram testing at a cold hydro of 800 psi was performed. The accumulator scram times were normal but the vessel scram times were about 15% slow. To verify this slowing, and to determine temperature effects, a hot test was performed. At 500 and 800 psi vessel pressure, accumulator and vessel scram times were normal. At 1030 psi, some slowing was observed, approximately 15% both in accumulator and vessel scram times. Fig. 15 presents the normal scram speed profile for drive 880 with the new data plotted.

Settle friction and drive data at all vessel pressures tested showed normal performance. The post pressurized settle friction indicated a decrease in friction of approximately 10 psi. Since the alignment did not change during the test, a wearing-in action is the most likely explanation for the reduced friction.

During the first part of testing, the channels were coated with blueing so the rub marks would be very evident. Fig. 16 shows a typical resultsof this technique. Actual metal removal could be detected but no heavy wear marks were visible.

Since little or no effects on drive performance were found, it is concluded that under static conditions the lateral deplacement used in this test will have no effect on scram capability.

Part 2 of this testing phase was channel bowing. As the amount of bow was increased incrementally to 1.5 inches, and primarily between 0.6 and 1.5 inch, the distance of the control rod would travel decreased. Fig. 17 shows that accum. (1510/575) scram travel is a function of vessel pressure and bow. That is as the amount of bow increased the amount of travel decreased. Also, at elevated vessel pressures the amount of travel decreased. In Figure 17, the travel is shown to be more at 1030 psi than at 800 psi vessel pressure. This effect of vessel pressure can be predicted and explained from the scram profile (see Fig. 15). The other variable, bow, was predicted as the results of the friction observed during the cooling water drive test (see Fig. 18). As can be seen, the cooling water pressure and therefore the friction, increased greatly as bow increased. Once 0.9 in. bow tests were run and the stopping point, position 07 at 1030 psi was observed and the corresponding cooling pressure, about 250 psi, was determined, then it could be anticipated that at 1.2 inch bow and 1030 psi the drive would stop near position 12. Likewise, at 1.5 inch bow and 1030 psi

position 40 could be predicted. The horizontal line on Fig. ~~17~~ 15 at 255 psi is the evidence of the repeatability of the stopping point.

In addition to Fig. 17, Fig. 19 is presented to indicate the times associated with the various amounts of travel at zero and 1030 vessel pressure. Only accumulator scram data is presented on this figure.

The significant fact of this data and figures is that at some point between 0.6 and 0.9" bow, drive line friction was not high enough to keep the CRD from completing its full stroke. It must be kept in mind that these scram tests at the specified channel bows were all performed at static conditions. If a seismic oscillation occurred which produced channel bows up to 1.5" and no yielding of the channels occurred at this deflection, then it is possible that if the driveline has stopped because of deflections > 0.9 inch, it will continue on in as the deflections swing back through approximately 0.6" back to zero and then to 0.6". The channels were shown to be elastic when the jack was backed off from 1.2 inch and 1.5 inch bow. Note, however, that no hot tests were run at 1.2 or 1.5 inch bow. In each case, cold, the bundles moved back to within .03 inches of the original zero. The .03 inch can be explained since each time a test was run after a given bow was set the bundles moved back about .03. At 1.2 and 1.5, the scope had to be reinstalled after cold pressure tests. The .03 was not taken into account when reinstalling the scope. Therefore, when backed off the final position is 0.03 above 0.

If yielding were to occur at 1.5 inch bow and 1030 psi, 546°F vessel conditions, due to a lower yield strength at elevated temperatures, then the scram would not be accomplished as stated above. Under yielded fuel channel conditions of 1.5 inch deflection, a full insertion of the control rod blade would only occur if, as the blade experiences increased friction, due to bow, the fuel channels are deflected back towards zero bow by the control rod. If this deflection reduces bow to that point between 0.6 inch and 0.9 inch bow, discussed above, the blade will continue movement to full insertion. During this test, the jack mechanism did not allow any verification of this theory.

During testing, it was found that settle friction results (Fig. 20) showed similar characteristics as cooling water results(Fig. 18). This can best be seen in the plot for 0.9 inch bow. Cooling pressure increased, decreased then increased to its high of 300 psi. Settle friction pressures, which decrease with increased friction, decreased until the drive would not settle, then increased and decreased to zero again as the cooling pressure changed. This correlation supports the shape of the cooling curve.

The explanation of this shape can be seen in Fig. 21. During the first half of the stroke, the loading is as shown in 21A. High friction occurs at the bottom of the fuel channels. In 21B, the roller has gone past halfway and is unloaded to some degree, thus, decreasing load and friction at the bottom. Friction increases again as the roller picks up the other side in 21C and contact occurs at the middle and bottom.

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The results of the inspection of internals are pictured in Figures 22 through 31 with Figure 22 provided to aid in interpretation.

Referring to Figure 21C and 22, it would be expected that wear marks would be found on the upper and lower areas of the north and west channels as well as in the middle of the south and east channels. Figure 23 shows the north and west channels with wear marks at the bottom and the upper one-third. Note the wear on the north channel being close to the inside corner. Figure 24 shows the south and east channel wear as covering the middle one-third of the length. Again, the inner edge is worn. Note that at the center, where the spacer blocks were, a wider spot of wear occurred. Such a mark indicates some distortion of the channel shape at that location.

Figure 25 and 26 show the corresponding wear on the control rod. Also, rub marks were found on both sides of the handle on the top of the control rod. The side which faced the north and west channels is pictured in Figure 27.

The unpredicted rubbing which was discovered upon inspection and was the cause of much friction, was between the northwest edge of the control rod and the fuel support. The entire length of the fuel support was galled (see Figure 28). The resulting groove was the width of the control rod and about .06 inch deep at the top of the fuel support. The control rod was galled and torn over 90% of its length from the velocity limiter (Fig. 29) to near the top. Fig. 30 shows the resulting edge of the control rod. The material which was removed by galling and tearing was found in the CRD inner filter (see Fig. 31). Such materials in the CRD would significantly reduce seal life.

An explanation of how this rubbing occurs is presently in Fig. 32. During the lower half of the stroke, the rollers are loaded as in A with the loading at the bottom of the channels shown in B. Note the bending of the wings which allows contact with the fuel support as in C. Above the halfway point, the loading of the rollers is as in D. The loading in the middle is as in E, and the bottom is again as in B. The result is the same with rubbing occurring as in C. The wear marks near the inner edge on the channels verify this explanation.

The results of the high energy scrams at 1.5 inch bow were that the drive went in an additional 15% for a total of 30% with 1320/710 charge, and 40% more for a total of 55% with 1510/875 charge. These were at 800 psi with similar results at 900 and 1030 psi vessel pressure.

The deflecting of the CRD housing 0.5 inches and .625 inch, in addition to the 1.5 inch bow, had no effect on the scrams. Quick releasing the housing and hand exciting the housing had also no effect on scramming.

The results of the loaded-unloaded top grid measurements are shown in Fig. 33. The maximum difference was .016 inch which was not considered significant.

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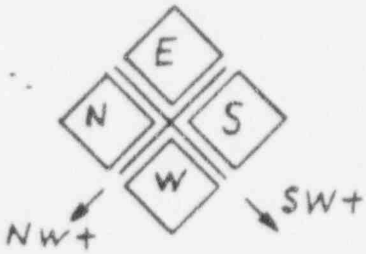

TABLE 1

Alingment ± .02

Test	Core Plate NW ("A") Actual	Core Plate NW ("A") Target	Core Plate SW ("C") Actual	Core Plate SW ("C") Target	Top Grid NW ("B") Actual	Top Grid NW ("B") Target	Top Grid SW ("D") Actual	Top Grid SW ("D") Target
Phase 1	*	0	*	0	*	0	*	0
Phase 2 Pre-test Alignment	*	0	*	0	*	0	*	0
Initial Misalignment	.184	.166	-.053	0	.029	** .042	-.029	0
Pre-Test Check	.184	.166	-.034	0	.029	.042	-.019	0
Phase 3 Part 1	.155	.166	.195	.2	.024	.042	.611	.6
Post Test Check	.150	.166	.180	.2	.028	.042	.611	.6
Part 2	.010	0	-.003	0	.008	0	-.004	0
Post Test Check	.078	0	.003	0	.008	0	-.004	0

* Tight wire system used; actuals unknown

** .166-.124 = .042

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TABLE 2
TEST SEQUENCE

Amount of Bow	Vessel Pressure (PSI)	Basic Test	Other Tests
0	23 (ambient)	X	None
.3	23 (ambient)	X	None
.6	23 (ambient)	X	None
.9	23 (ambient)	X	None
	1030 cold Hydro		2 accum scrams
			2 vessel scrams
	800 & 900		1 accum scram
1.2	23 (ambient)	Parts A,B & D	None
	800, 900 and 1030 cold Hydro		1 accum scram
.6	23 (ambient)	X	None
1.5	800		1 accum scram
			2 vessel scrams
	900		1 accum scram
	and 1030		1 vessel scram
	23 (ambient)	Part B	1 cooling trace
			1 accum scram
.6	23 (ambient)	X	None
.9	23 (ambient)	X	
	800 & 900) Hot	Part D	2 vessel scrams
	1030)	Parts A, B and D	1 drave trace
	23	X	
0	23 (ambient)	X	None
1.5	800, 900 and 1030 cold Hydro		2 accum scrams (1320/710)
			2 scrams (1510/875)
	1030		2 scrams (1510/575)

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TABLE 2 (cont.)

1.5 with .5 CRD housing displacement	1030 cold Hydro		1 accum scram (1510/575)
1.5 with osolating CRD housing	1030 cold Hydro		3 scrams (1510/575)
1.5 with .625 CRD housing displacement			2 accum scrams 1 dynamic 1 static
1.5		Part D	

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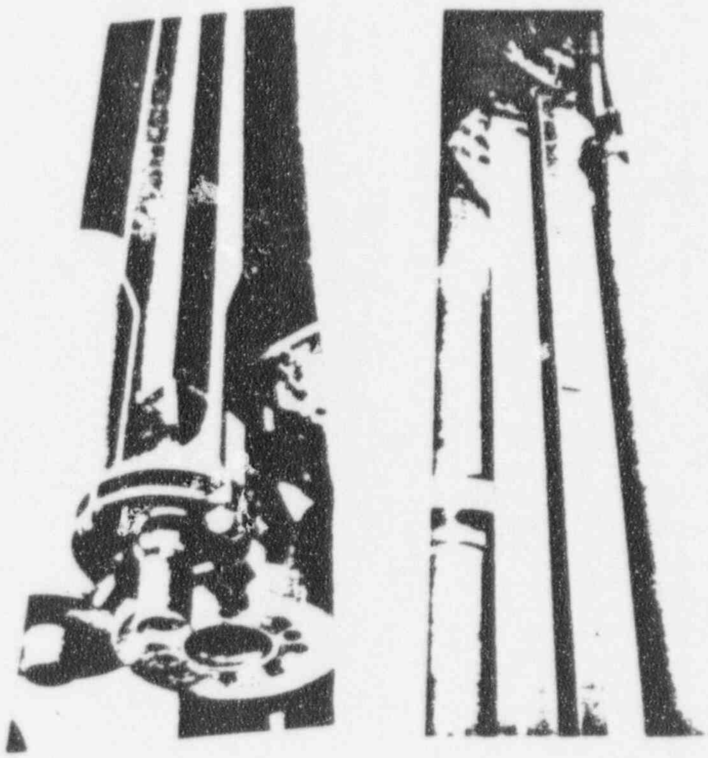

FIGURE 1

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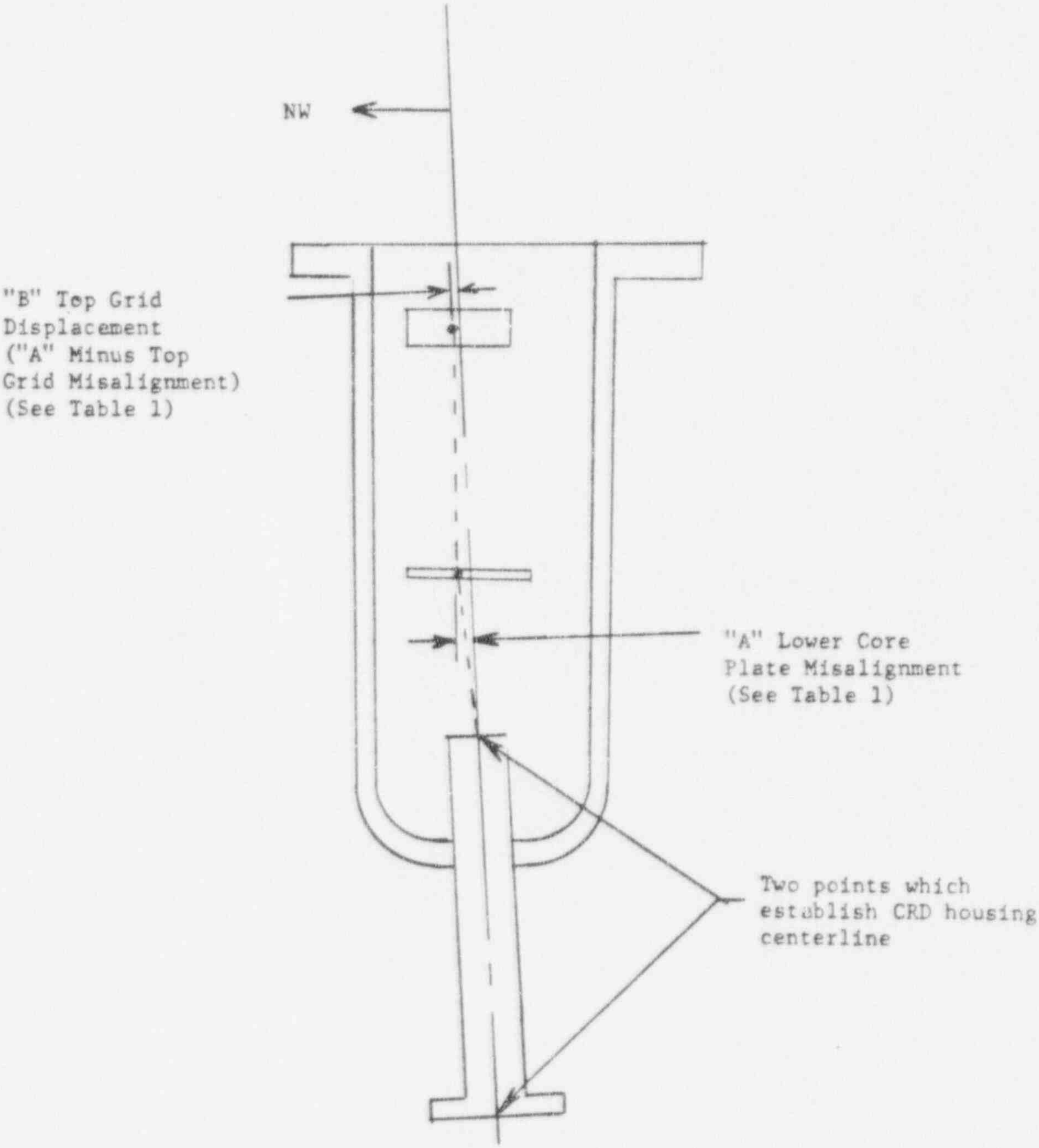

FIGURE 2

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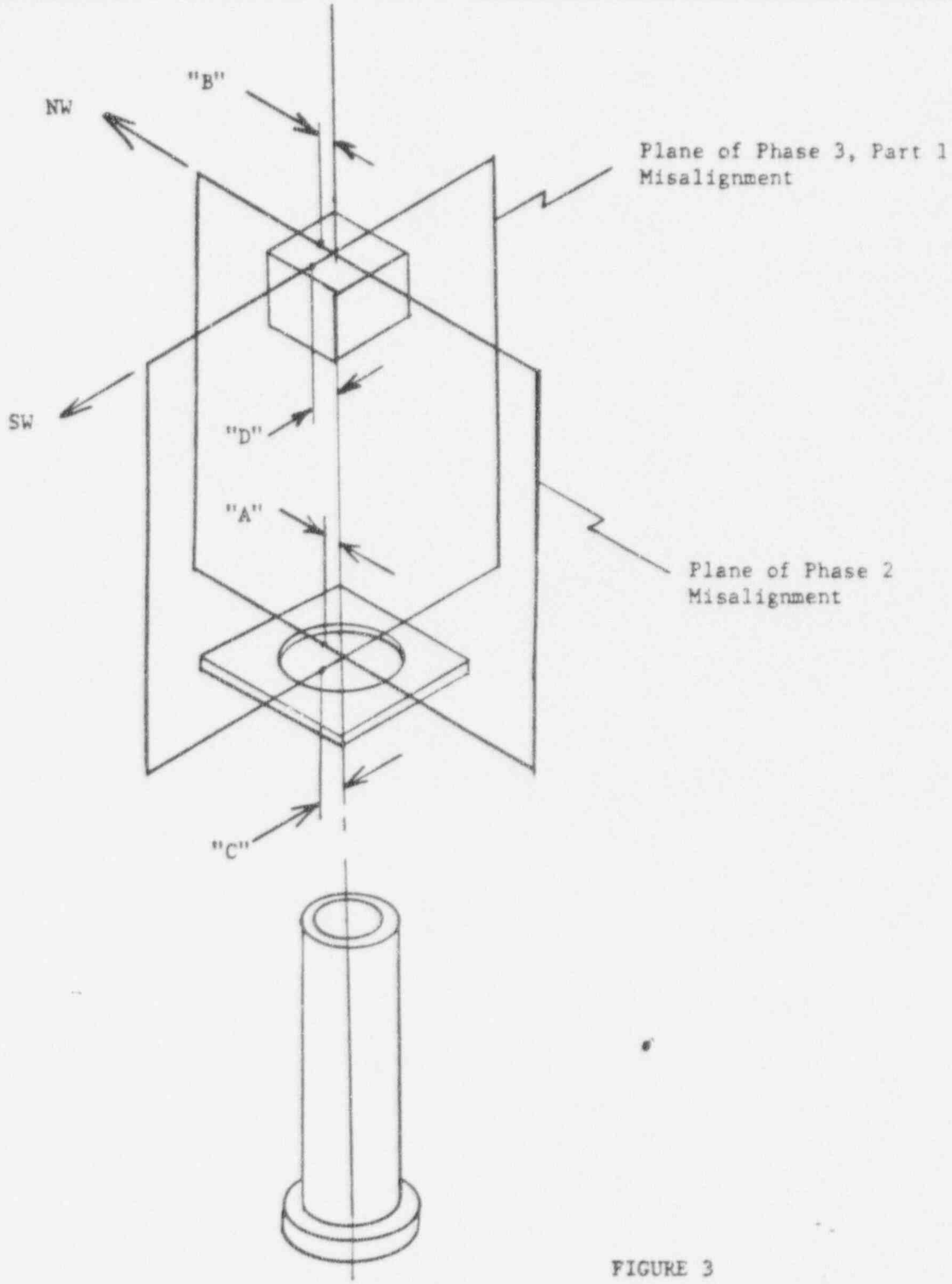

FIGURE 3

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FIGURE 4

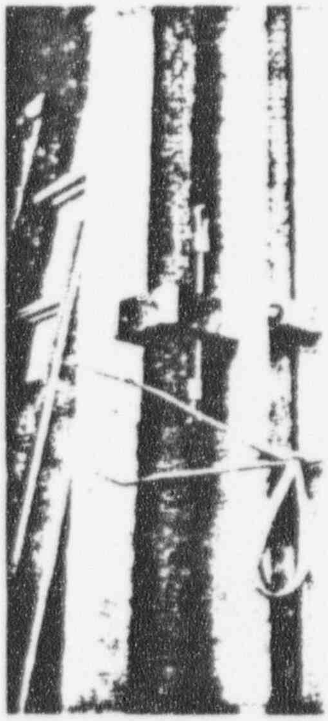

FIGURE 5

FIGURE 6

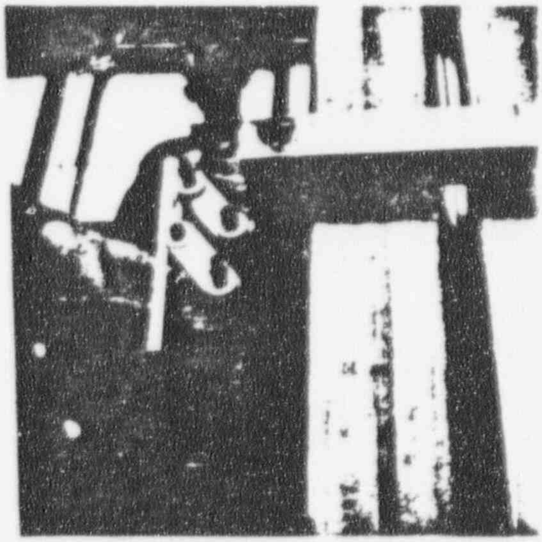

FIGURE 7

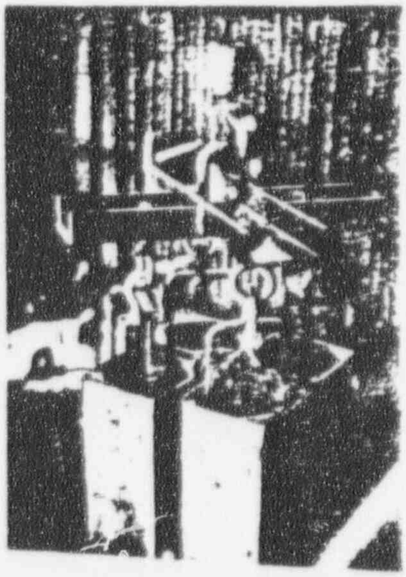

FIGURE 8

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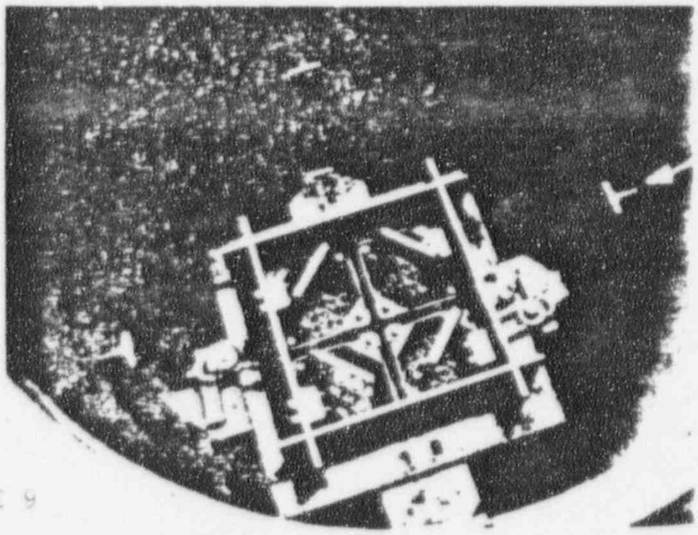


"T" BAR

FIGURE 9

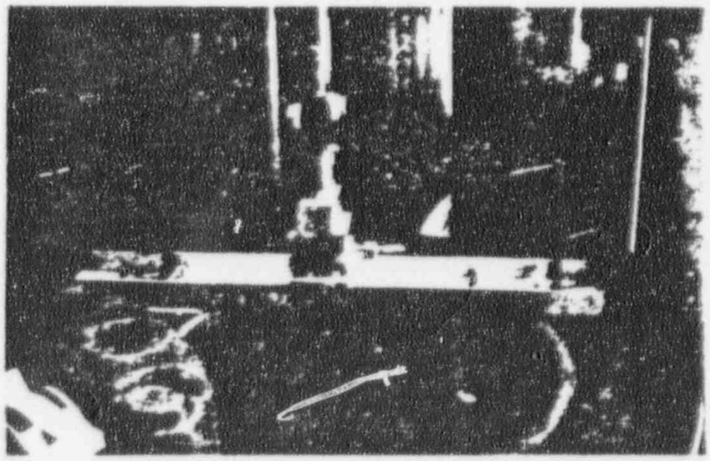
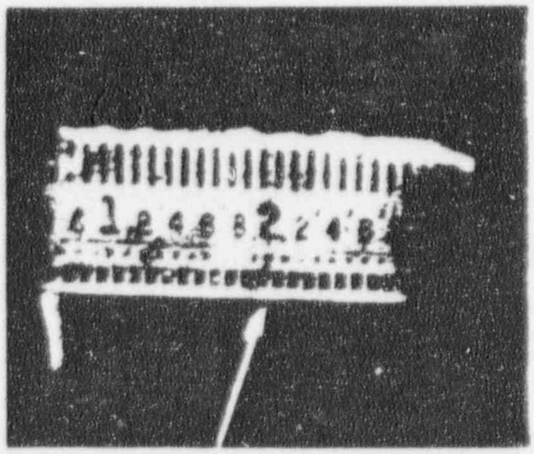


FIGURE 10



HAIR LINE

FIGURE 11

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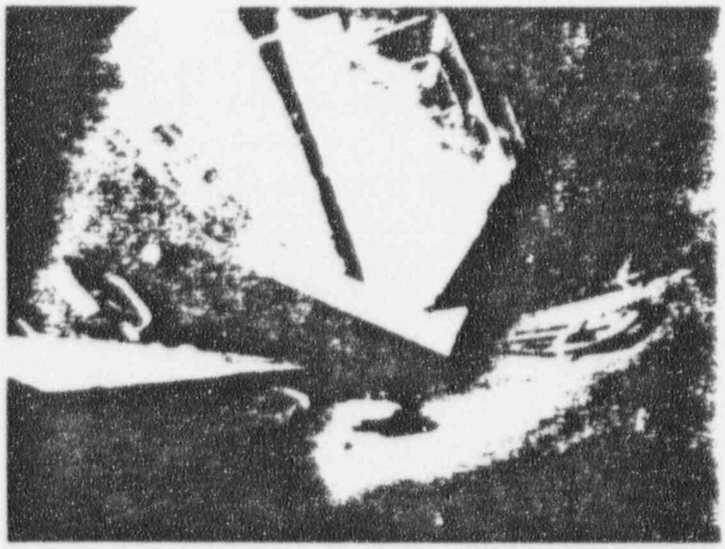

FIGURE 12

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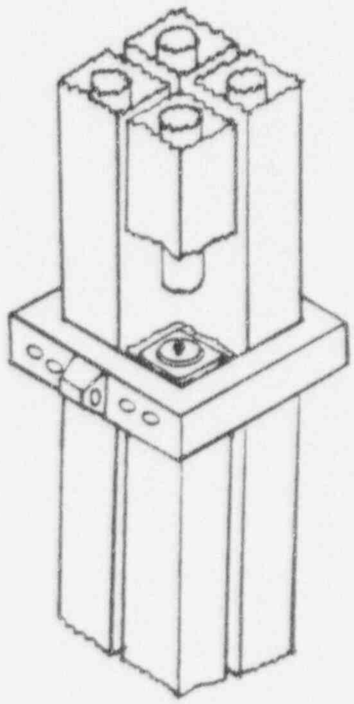
Evaluation of CRD Scram Characteristics Under Simulated Earthquake Conditions



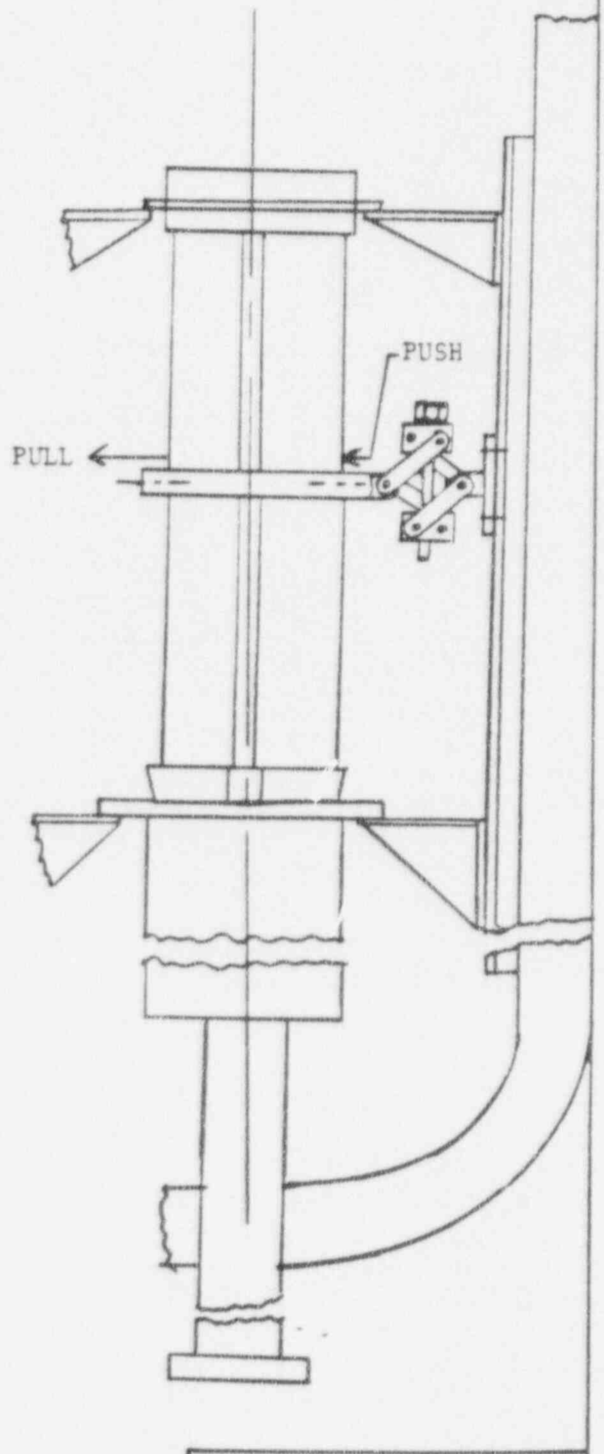


FIGURE 13

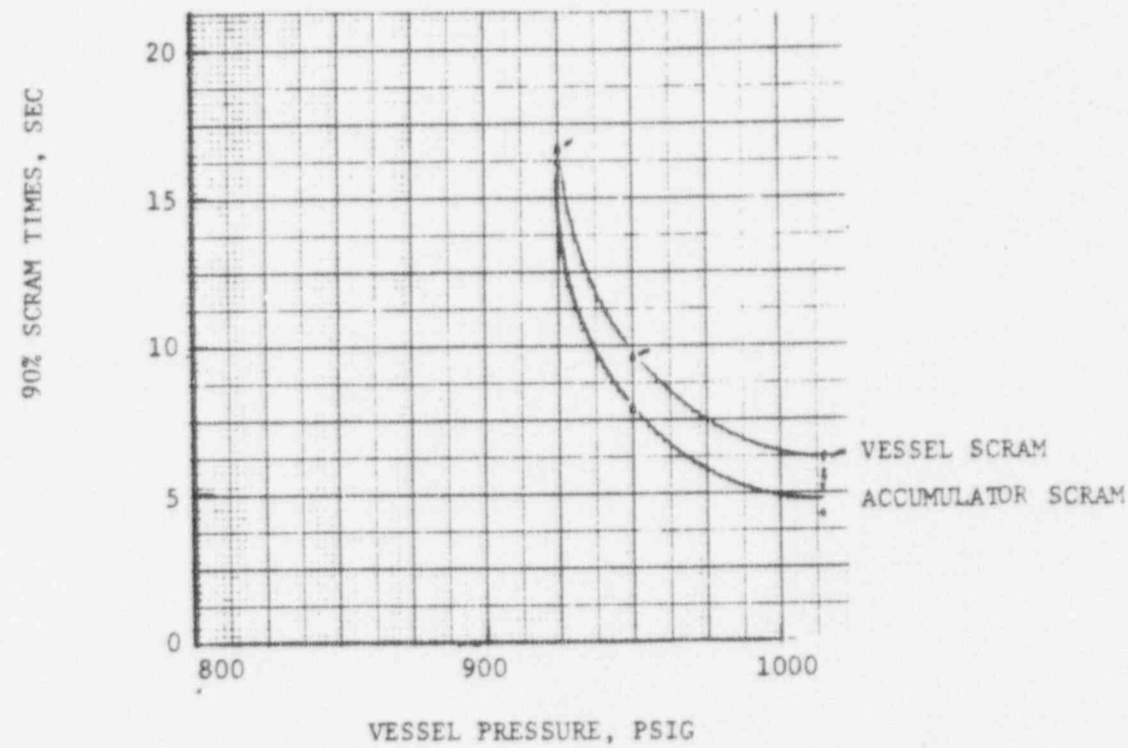

20
15
10
5
0
90% SCRAM TIMES, SEC
800
900
1000
VESSEL PRESSURE, PSIG
VESSEL SCRAM
ACCUMULATOR SCRAM

FIGURE 14

GENERAL ELECTRIC
ATOMIC POWER EQUIPMENT DEPARTMENT

MCSR 262

ENGINEERING FORM

TITLE Evaluation of CRD Scram Characteristics Under Simulated Earthquake Conditions

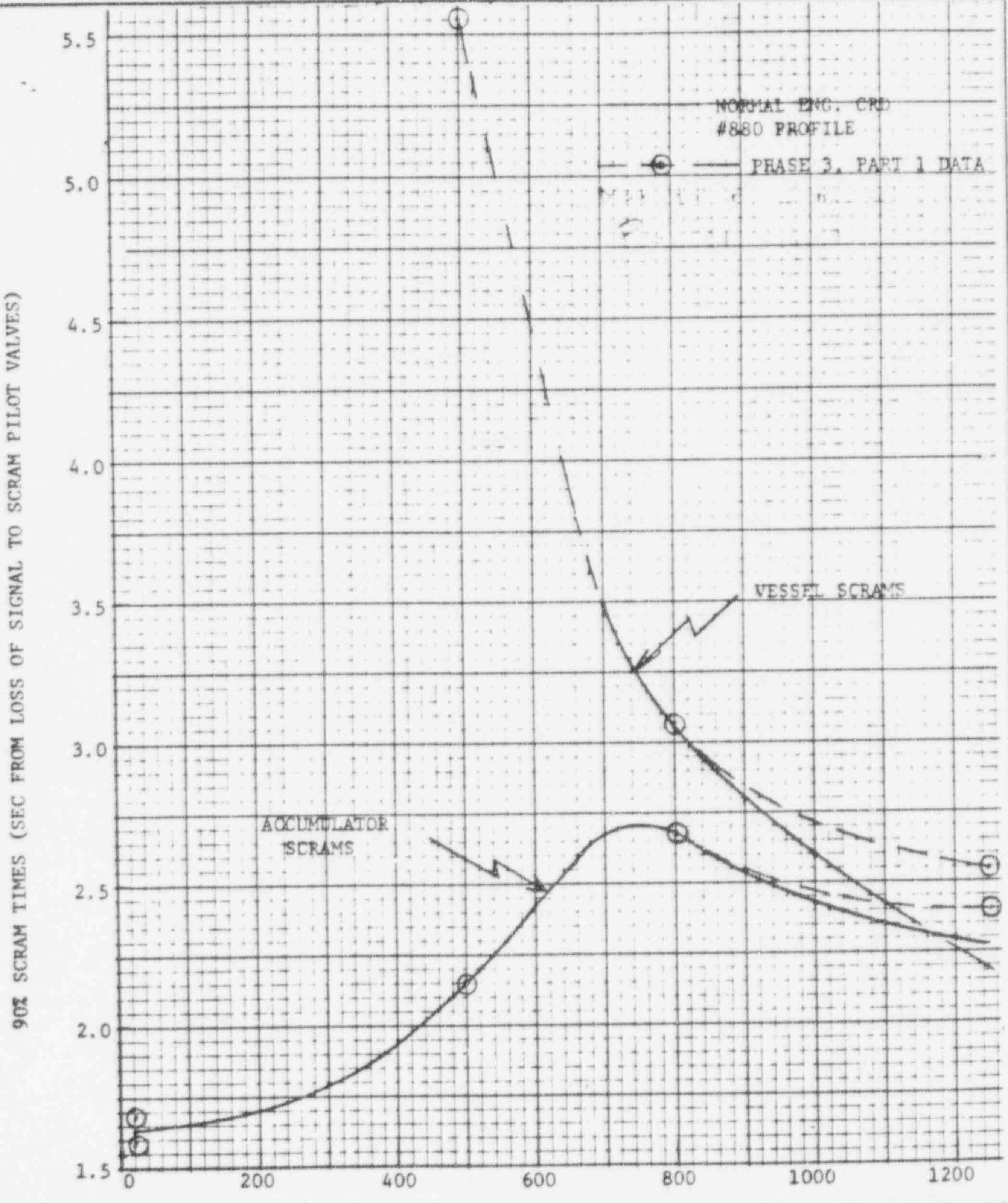


FIGURE 15

REV NO. 0

BY	APPROVALS	383HA617
ISSUED DEC - 8 1971		CONT ON SHEET 22 SH NO. 21

MED - 749

TITLE
Evaluation of CRD Scram Characteristics Under Simulated Earthquake Conditions

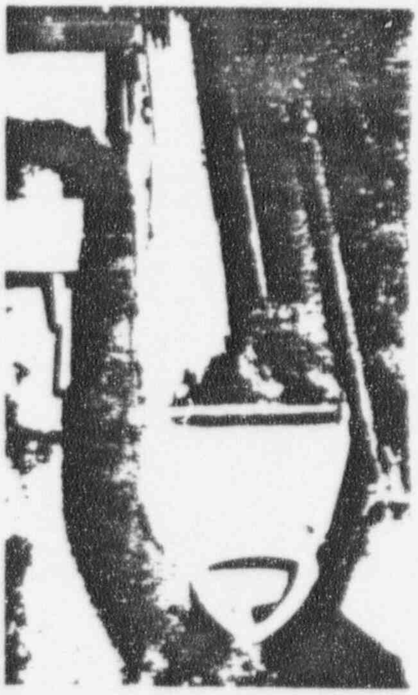


FIGURE 16

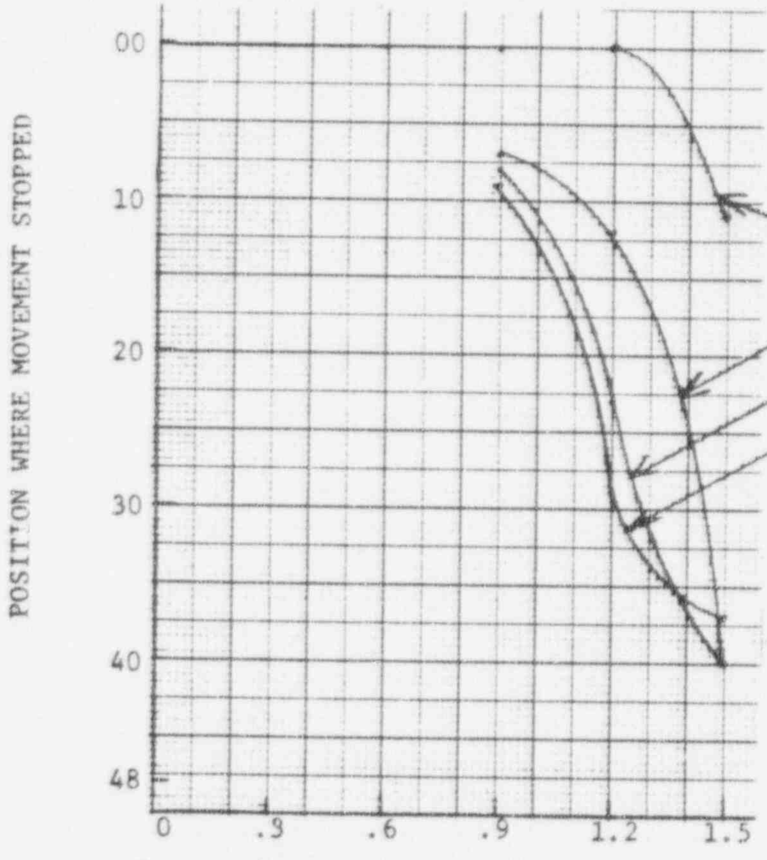


FIGURE 17

TITLE Evaluation of CRD Scram Characteristics Under Simulated Earthquake Conditions

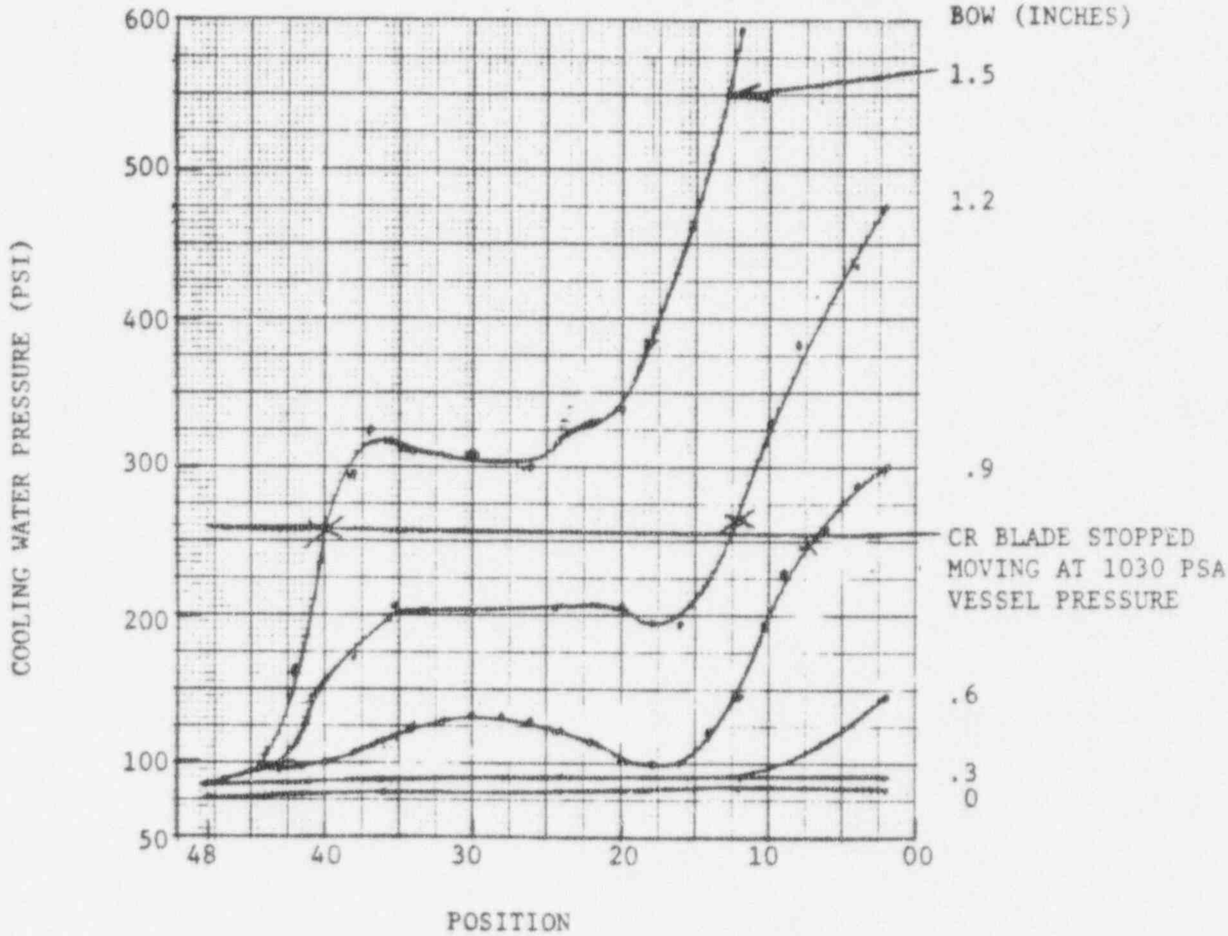


FIGURE 18

GENERAL ELECTRIC
ATOMIC POWER EQUIPMENT DEPARTMENT

MCSR 262

ENGINEERING FORM

TITLE
Evaluation of CRD Scram Characteristics Under Simulated Earthquake Conditions

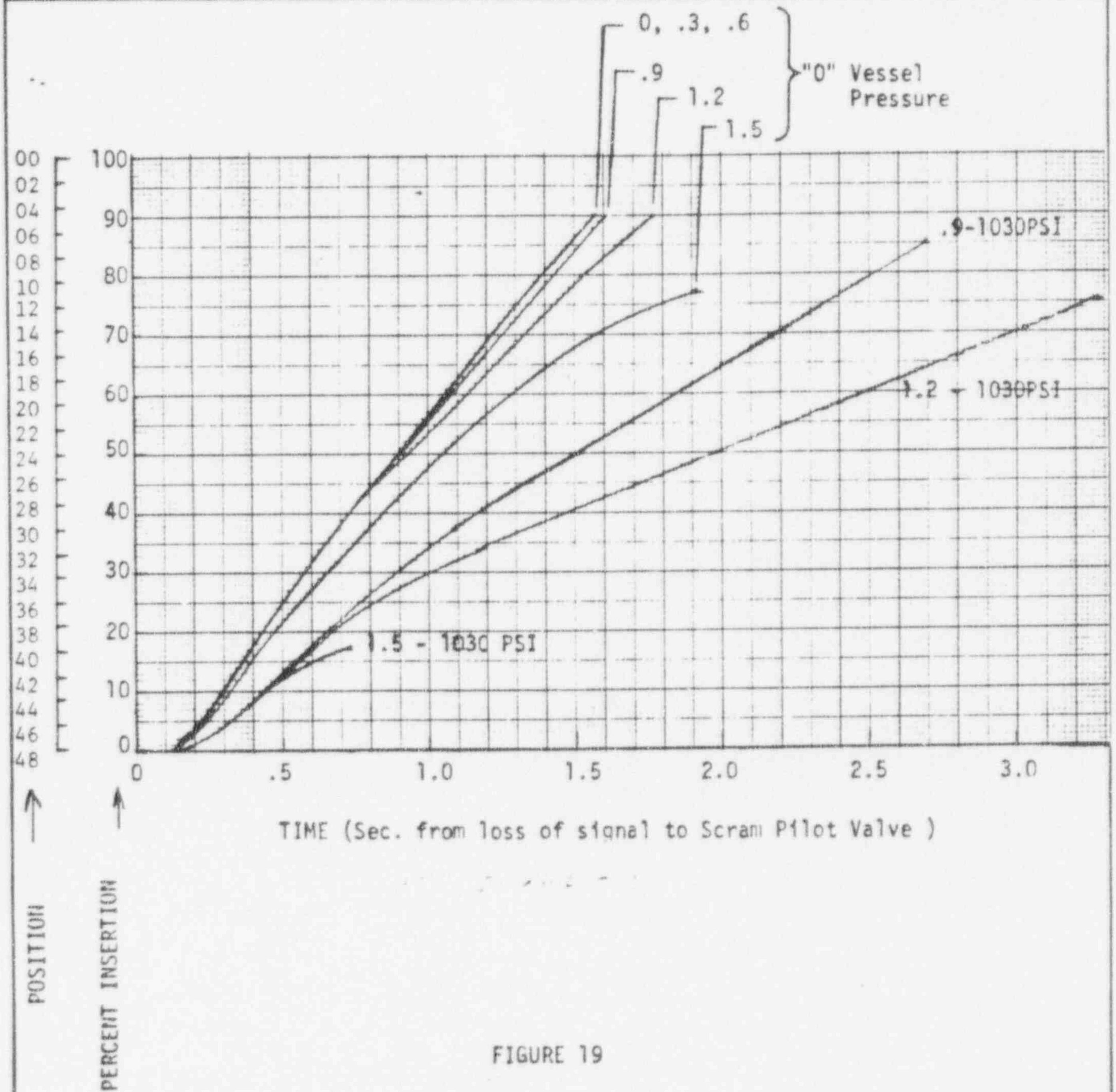


FIGURE 19

REV NO.	0
BY	APPROVALS	383HA617
ISSUED DEC - 8 1971		CONT ON SHEET 25 SH NO. 24

MED - 749

TITLE
Evaluation of CRD Scram Characteristics Under Simulated Earthquake Conditions

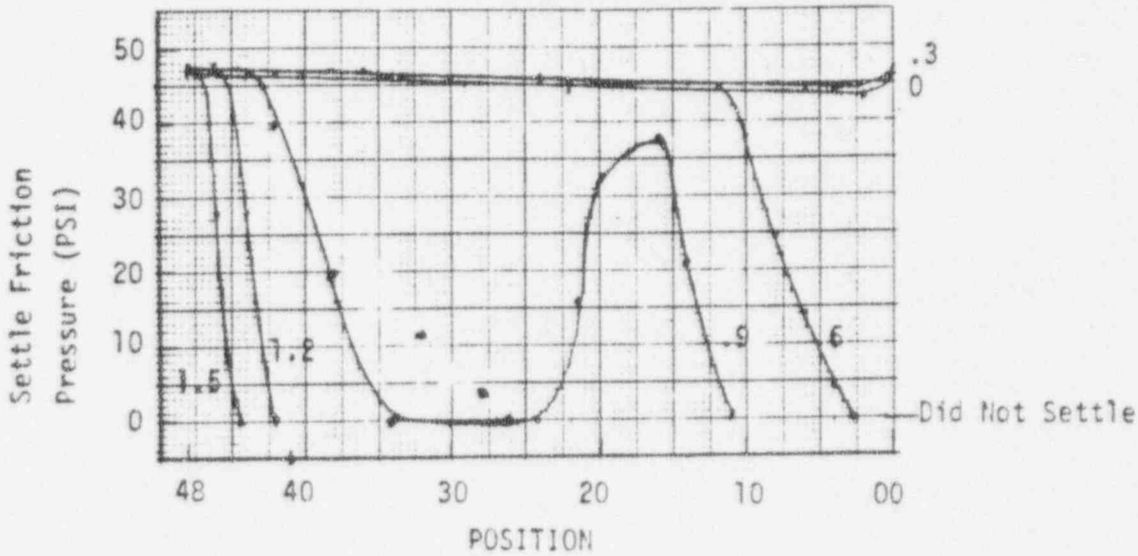


FIGURE 20

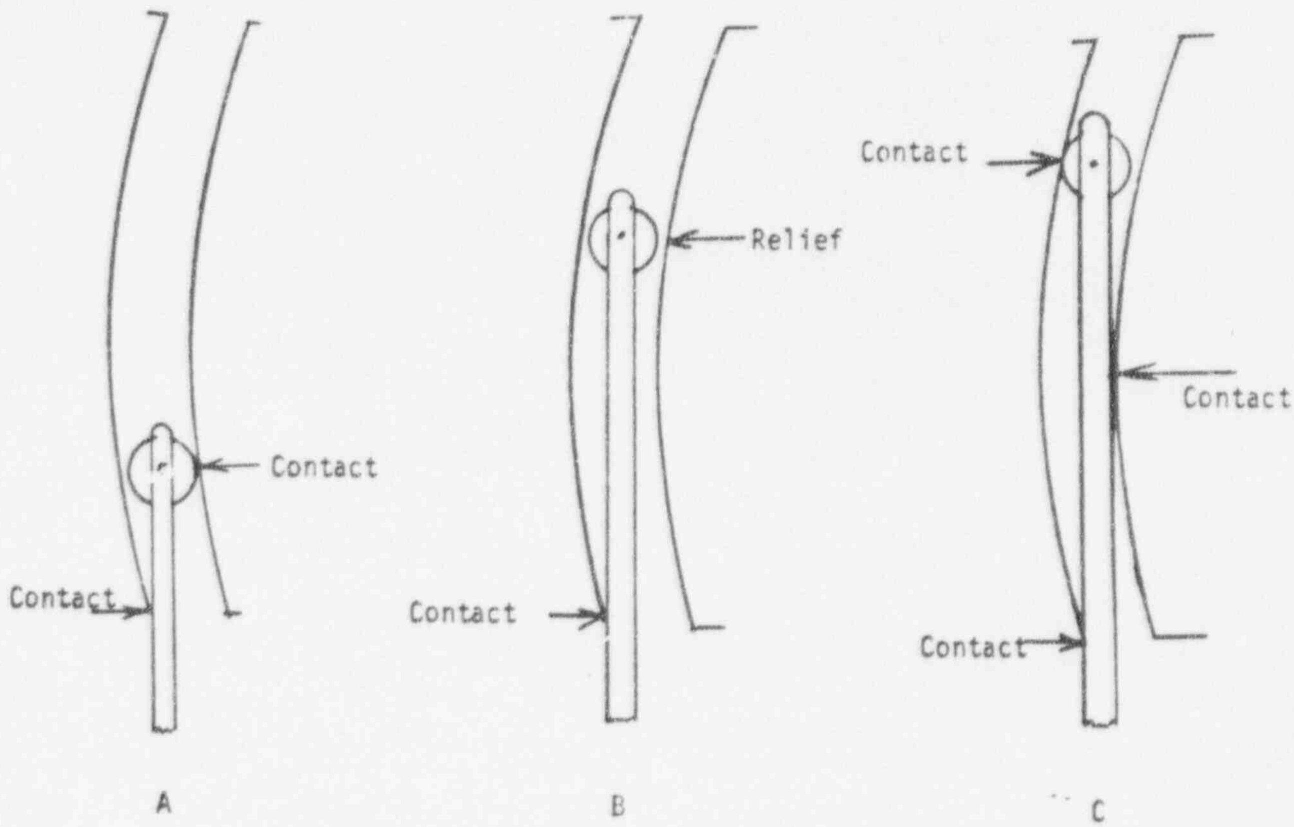


FIGURE 21

TITLE
Evaluation of CRD Scram Characteristics Under Simulated Earthquake Conditions

FIGURE 22

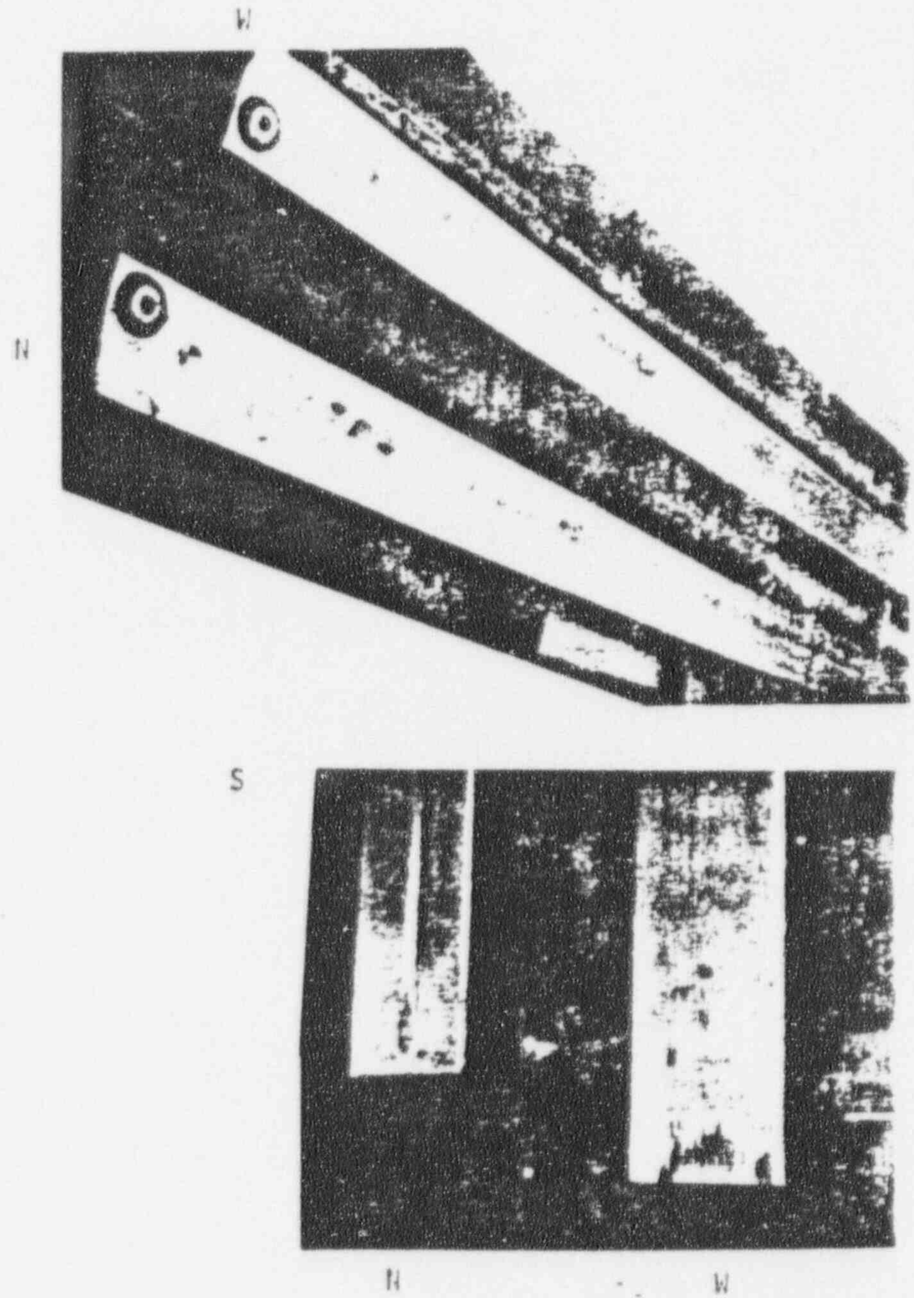


FIGURE 23

GENERAL ELECTRIC

ATOMIC POWER EQUIPMENT DEPARTMENT

ENGINEERING FORM

MCSR 262

TITLE
Evaluation of CRD Scram Characteristics Under Simulated Earthquake Conditions

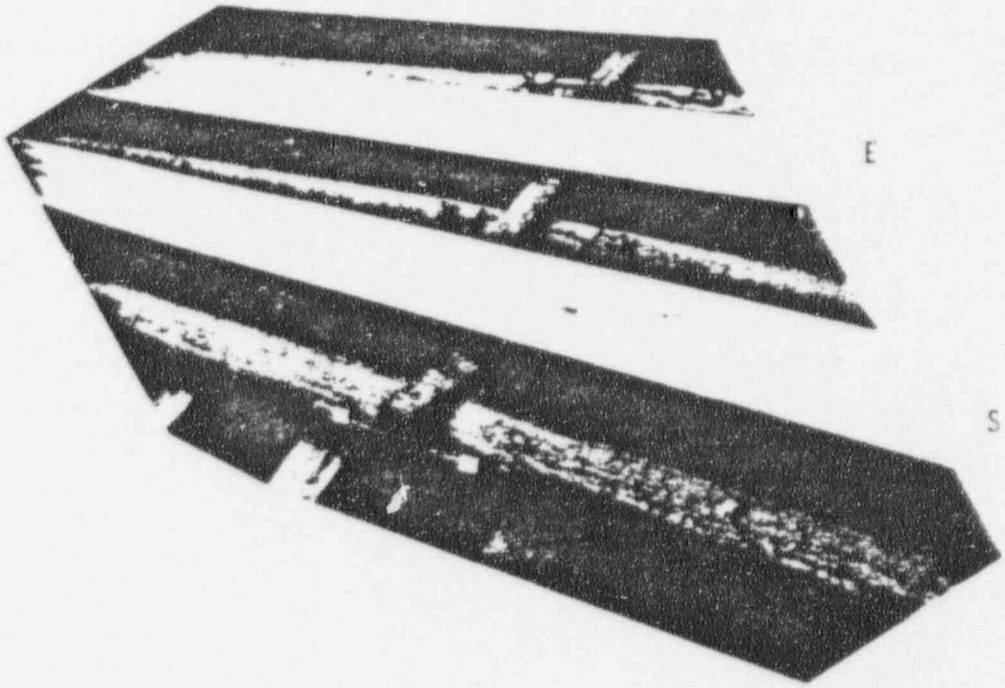
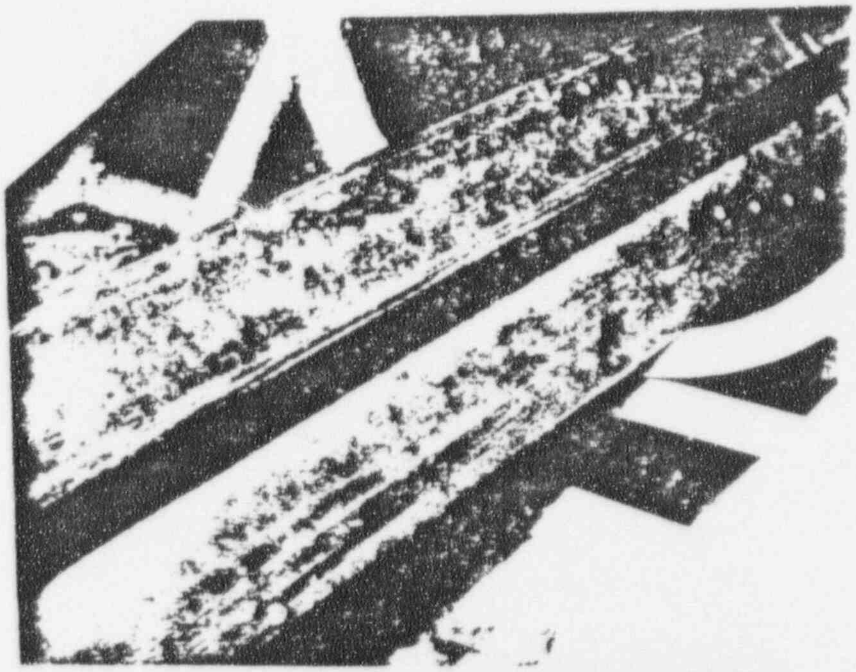


FIGURE 24

REV NO.	0
BY	
APPROVALS	
ISSUED	[illegible] 1974
	383HA617
CONT ON SHEET	28
SH NO.	27

NED - 749

TITLE
Evaluation of CRD Scram Characteristics Under Simulated Earthquake Conditions



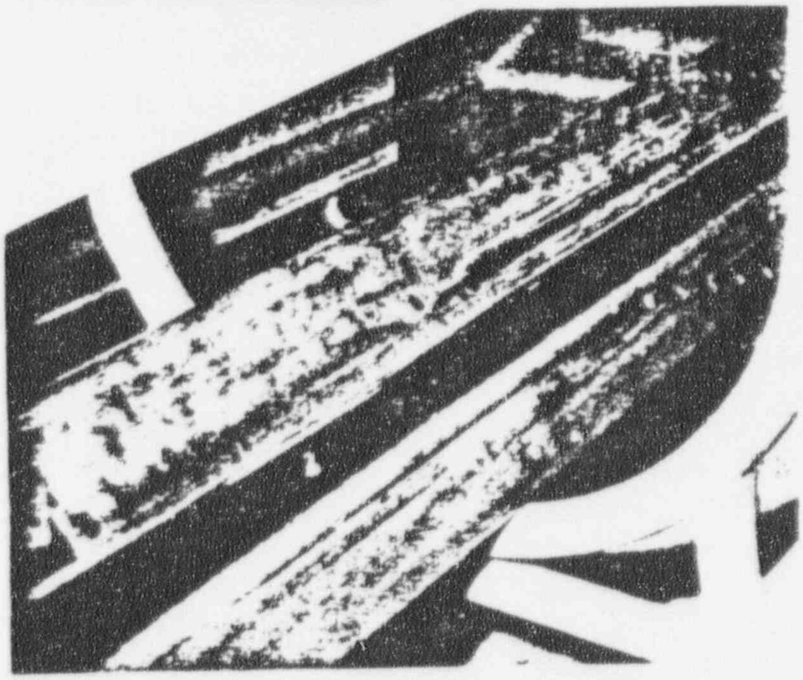
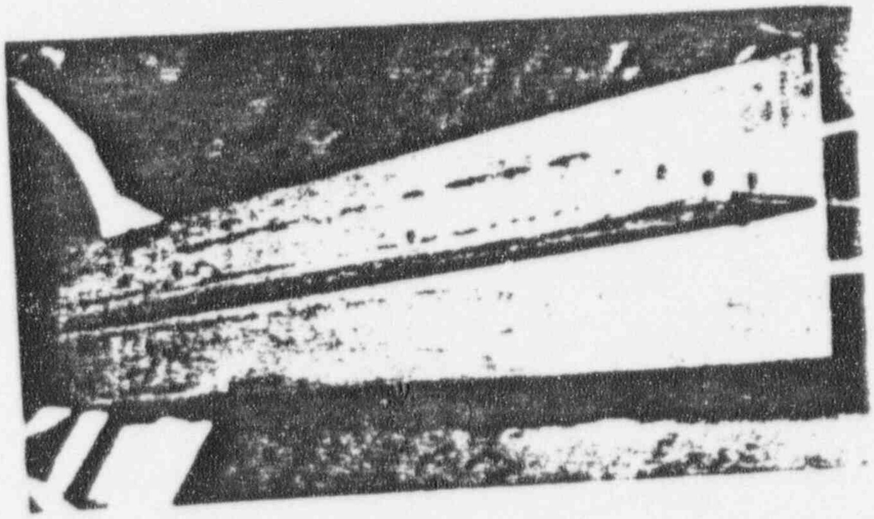
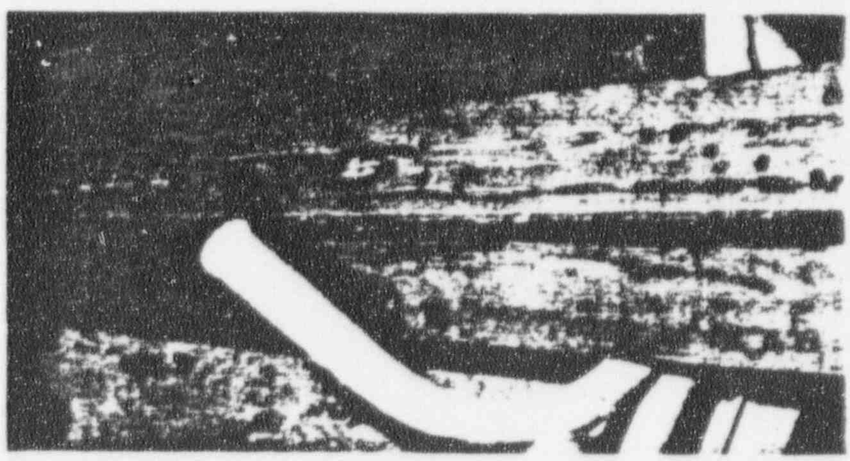


FIGURE 25



S

E

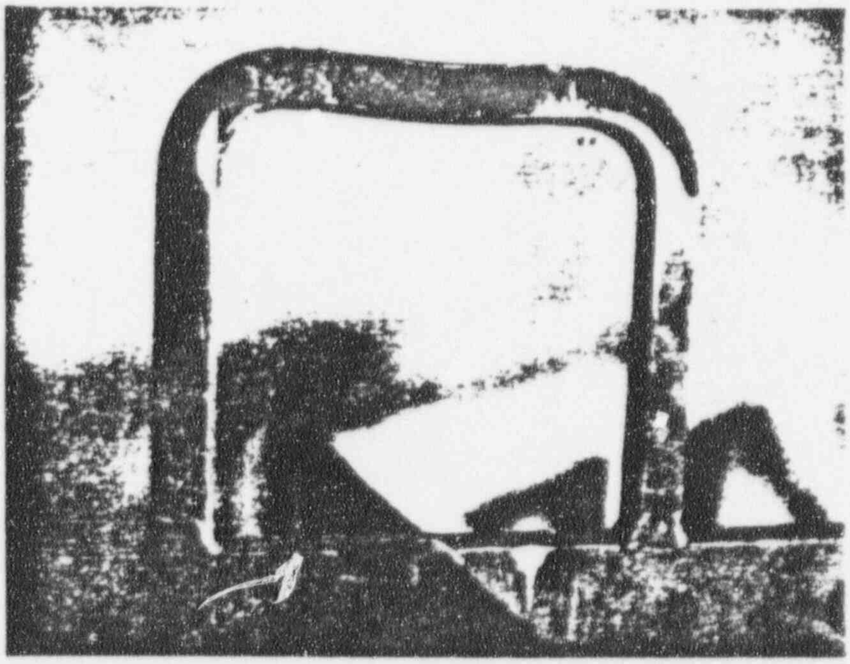


S

E

FIGURE 26

TITLE
Evaluation of CRD Scram Characteristics Under Simulated Earthquake Conditions



N-W SIDE

FIGURE 27

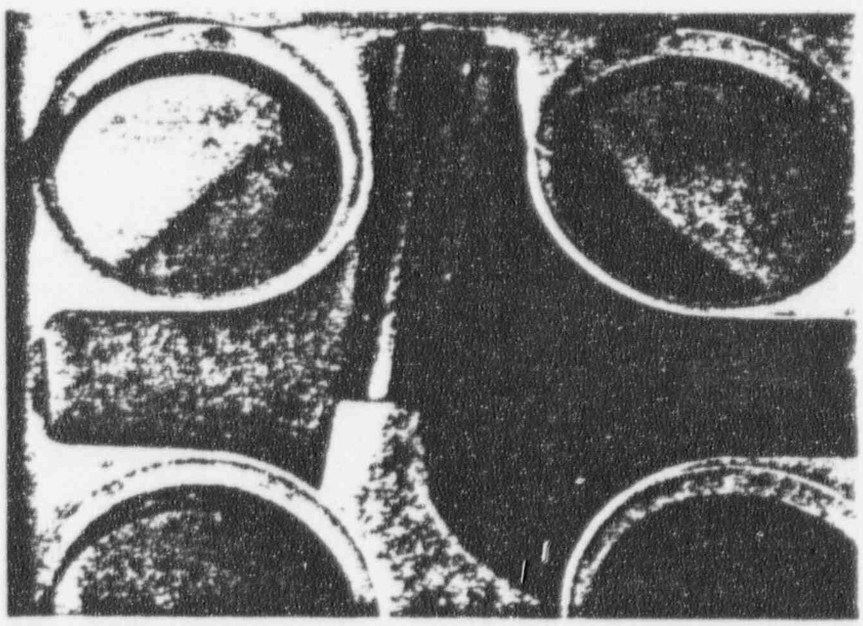


FIGURE 28

TITLE Evaluation of CRD Scram Characteristics Under Simulated Earthquake Conditions

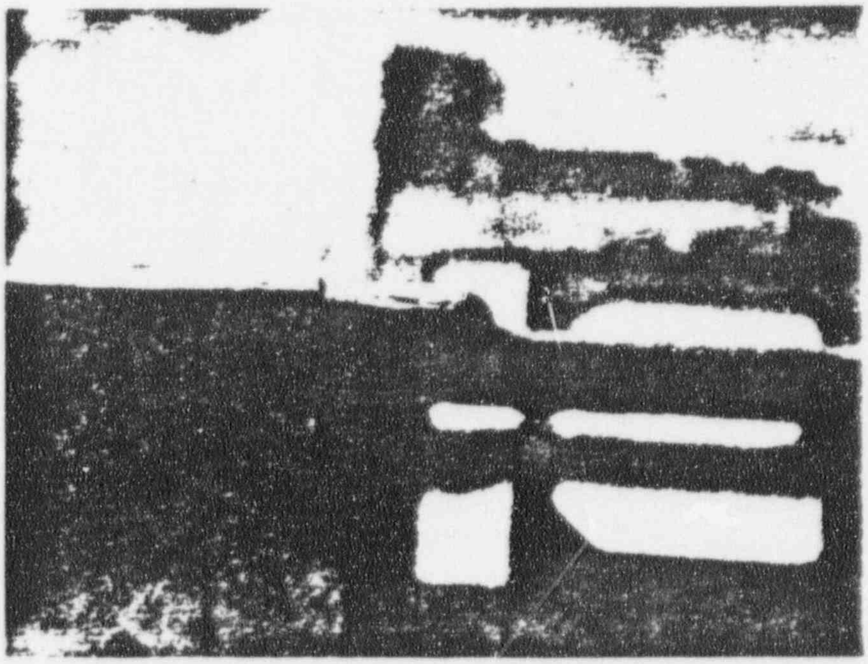


FIGURE 29

GENERAL ELECTRIC
ATOMIC POWER EQUIPMENT DEPARTMENT

ENGINEERING FORM

MCSR 262

TITLE
Evaluation of CRD Scram Characteristics Under Simulated Earthquake Conditions

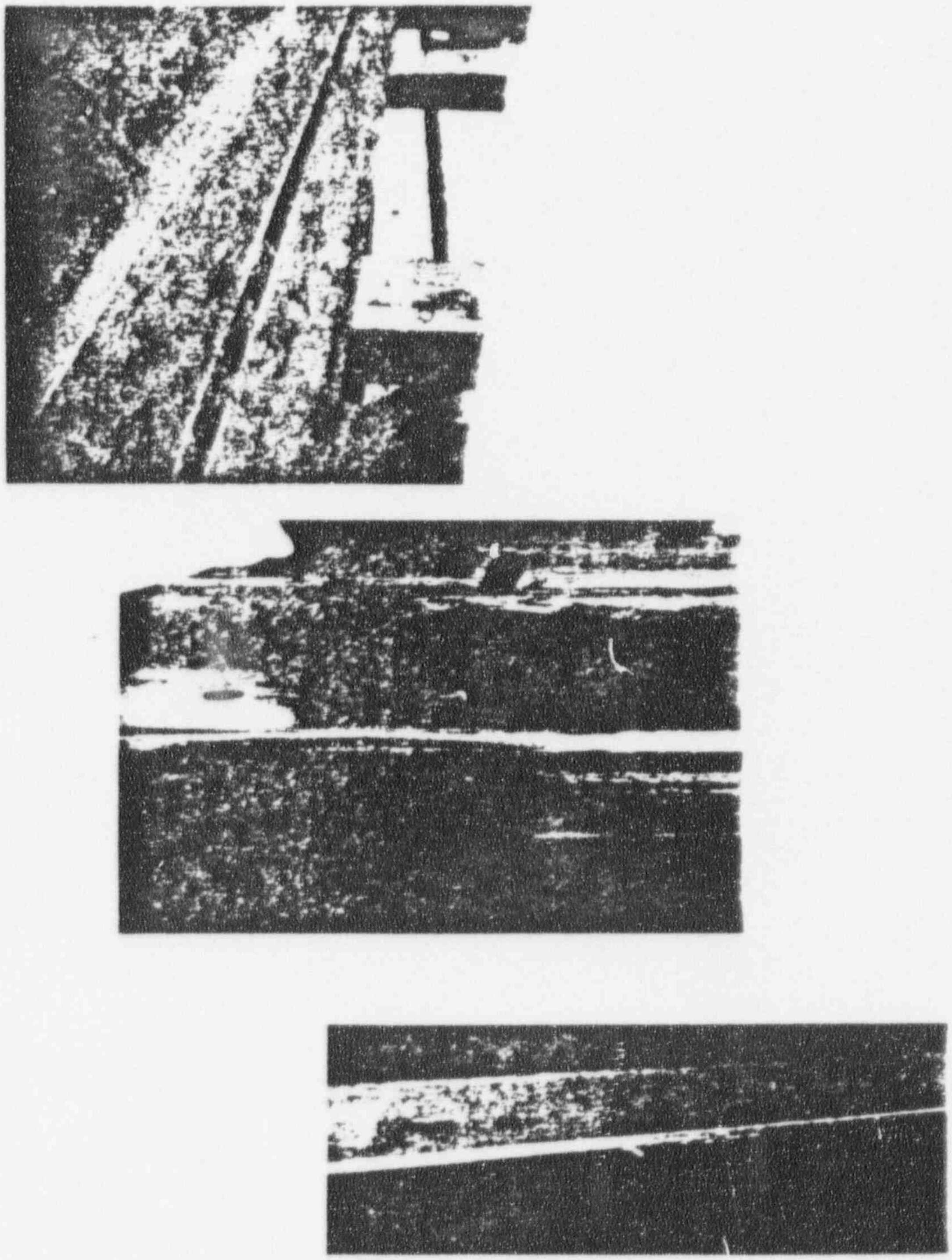


FIGURE 30

REV NO.	0
	383HA617
CONT ON SHEET 33	SH NO. 32

BY

APPROVALS

ISSUED

NED - 749

TITLE
Evaluation of CRD Scram Characteristics Under Simulated Earthquake Conditions

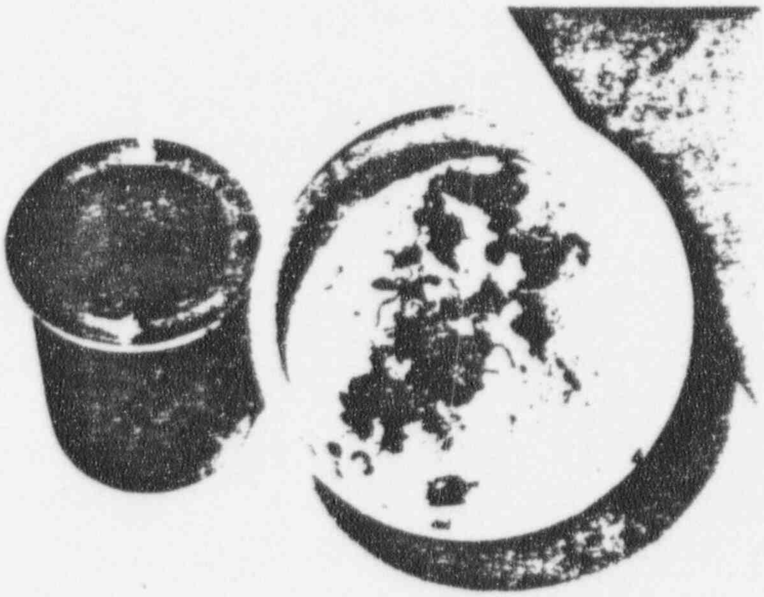


FIGURE 31

GENERAL ELECTRIC
ATOMIC POWER EQUIPMENT DEPARTMENT

ENGINEERING FORM

MCSR 262

TITLE
Evaluation of CRD Scram Characteristics Under Simulated Earthquake Conditions

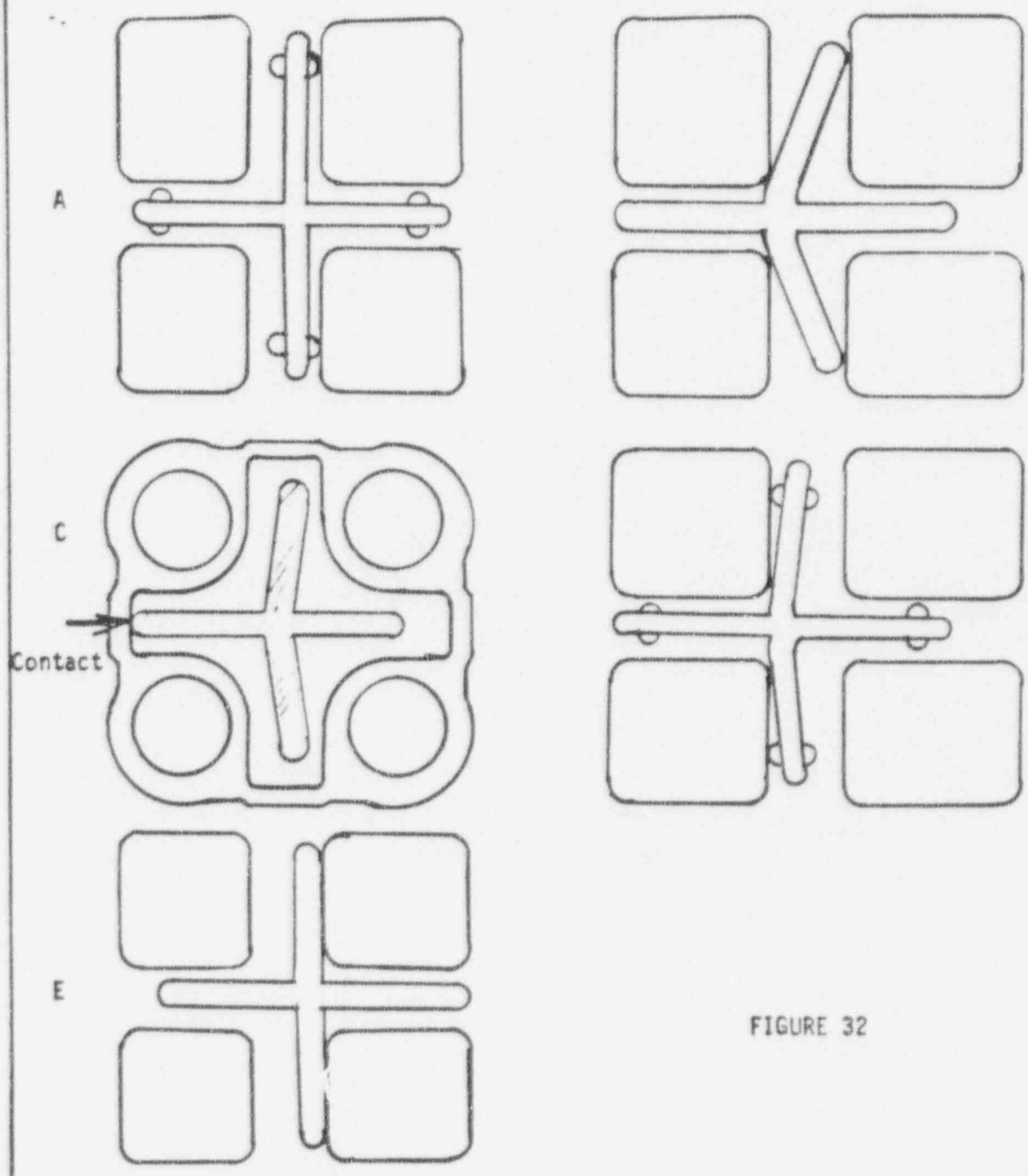
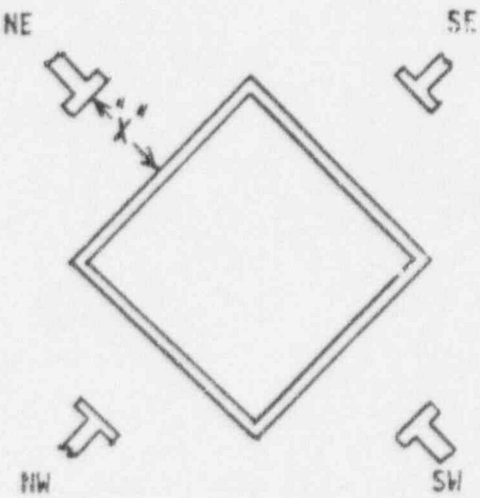


FIGURE 32

BY	APPROVALS	REV NO. 0
		383HA617
ISSUED DEC - 8 1971		CONT ON SHEET 35 SH NO. 34

- 749

TITLE Evaluation of CRD Scram Characteristics Under Simulated Earthquake Conditions



"X"	LOADED	UNLOADED
SE	6.725	6.734
SW	7.208	7.192
NE	6.494	6. 488
NW	7.004	6.999

FIGURE 33

TITLE
Evaluation of CRD Scram Characteristics Under Simulated Earthquake Conditions

PHASE 1

TEST DATA

TABLE SCRAM DATA

TITL EARTHQUAKE CORE MISALIGNMENT TEST REQUEST , 378 PHASE

DRIVE MODEL ENG. S/N 880 ROD WT. (lb) 756

COOLING PRESS (PSIG) 15 TEST SYSTEM 30" 15 GPM AT 1500 PSIG

DATE 9-29-70

PAGE

R Hollowell / Bubniak
TECHNICIAN

DATE	CUMULATIVE SCRAM (#)	VESSEL PRESSURE (PSIG)	ACCUMULATOR CHARGE (PSIG)	STEAM SPACE TEMPERATURE (°F)	VESSEL BOTTOM TEMPERATURE (°F)	PROBE TEMPERATURE (°F)	START OF MOTION SCRAM SIG. LOSS TO DO-46 (sec)	5% STROKE-SCRAM SIG. LOSS TO DO-45 (sec)	50% STROKE-SCRAM SIG. LOSS TO DO-24 (sec)	90% STROKE-SCRAM SIG. LOSS TO DO-05 (sec)	BUFFER TIME DO-05 TO 00 (sec)	10% STROKE-SCRAM SIG LOSS TO DO-43 (sec)	PO/PR POSITION 24	PU/PR POSITION 24	PIU/PIOT POSITION 24	N2/PR POSITION 24	REMARKS
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	⊗ USED START of motion from SCRAM #2
9-29-70	1	23	1510/581	72	72	72	⊗ .207	.348	1.020	1.726	.290	.396	250	550	220		
↓	2	23	1510/581	72	72	72	.207	.352	1.015	1.725	.288	.417	250	575	210		
9-30-70	3	1030	1510/581	544	544	90	.242	.620	3.195	5.428		.820	945	7	10	1000	
	4	1030	1510/581	544	544	96	.220	.590	2.530	4.420	1.321	.770	900	15	28	940	
	5	1030	1510/581	544	544	100	.224	.590	2.997	5.195	1.776	.796	950	5	28	1000	
	6	1030	1510/581	544	544	129	.230	.619	3.082	5.265	1.291	.830	960	0	23	1007	
	7	1030	1510/581	544	544	121	.239	.624	3.275	5.630	1.310	.832	960	10	25	1000	
	8	1030	VESSEL	543	543	106	.403	.985	3.717	6.142	1.117	1.250	380	950			
	9	1030	VESSEL	544	544	116	.399	.917	3.517	6.184	1.183	1.180	955	920			
	10	800	1510/585	513	513	102	.250	.440	2.172			.565	760	40	9	830	Stopped @ 22 pos.
	11	800	1510/585	513	512	102	.250	.410	2.112			.562	750	60	0	820	Stopped @ 22 pos
	12	800	VESSEL	513	513	107											DID NOT MOVE HELD Sig 13 sec
	13	900	1510/588	525	523	200	.260	.450	.612								Stopped @ 26 pos.
	14	900	VESSEL	523	524	182											DID NOT MOVE HELD Sig 15 sec.
	15	950	1510/588	530	531	198	.235	.506	3.822	8.109	2.046	.642	900	5	18	960	
	16	950	VESSEL	532	532	112	.450	1.131	4.996	9.610	2.630	1.490	895	900			
	17	925	1510/592	529	529	116	.220	.475	3.518	16.200	5.138	.605	880	8	15	940	
	18	925	VESSEL	528	528	116	.529	1.295	5.898	16.624	3.684	1.722	880	875			
10-1-70	19	23	1510/592	178	74	74	.225	.368	1.030	1.741	.262	.421	250	560	215	850	
}	20	23	1510/592	178	74	74	.215	.353	1.038	1.732	.260	.428	240	560	220	850	

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TABLE DRIVE DATA

TITLE EARTHQUAKE CORE MISALIGNMENT TEST REQUEST A-378 PHASE 1
DRIVE MODEL ENG. S/N 880 ROD WT. (lb) 750 (wet)
COOLING PRESS (PSIG) 15 TEST SYSTEM 30", 15 GPM AT 1500 PSIG

DATE 1970	VESSEL PRESSURE (PSIG)	STEAM SPACE TEMP. (°F)	VESSEL BOTTOM TEMP. (°F)	PROBE TEMP. (°F)	HCU SUPPLY PRESS. UP P11/PR ΔP (psi)	PRESSURE UNDER PISTON DRIVING UP-P13/PR ΔP (psi)	PRESSURE OVER PISTON DRIVING UP-P12/PR ΔP (psi)	SPEED DRIVING UP (in/sec) U.O. 39 D.O. 19 (60")	HCU SUPPLY PRESS. DOWN - P11 PR ΔP (psi)	PRESSURE OVER PISTON DRIVING DOWN-P12/PR ΔP (psi)	PRESSURE UNDER PISTON DRIVING DOWN-P13/PR ΔP (psi)	SPEED DRIVING DOWN (in./sec) U.O. 39 - DO 19 (60")	DRIVE UP FLOW (GPM) / DRIVE DOWN FLOW (GPM)	BREAKAWAY PRESSURE DRIVE UP	BREAKAWAY PRESSURE DRIVE DOWN
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
9/29	23	72	72	72	430	380	430	.926	210	205	210	1.4	2.5 / .6	355	235
9/29	23	72	72	72	420	375	410	1.11	212	208	210	1.39	2.3 / .3	360	230
9/29	23	72	72	72	440	390	430	1.43	210	205	210	1.27	2.7 / .3	340	230
9/29	23	72	72	72					210	203	208	1.39	/ .3		230
9/29	23	70	72	72	460	390	450	1.68	212	210	210	1.25	/ .4	320	230
9/30	1030	545	544	73	460	380	440	1.3	215	200	215	1.13	3.0 / .8	360	250
9/30	1030	542	543	162	460	370	440	1.58	205	190	210	1.07	3.5 / 1.0	350	240
9/30	1030	548	544	143	460	360	440	1.44	205	195	200	1.18	3.4 / 1.1	350	240
9/30	800	514	514	117	460	380	450	1.48	210	200	225	1.18	3.8 / 1.7	340	250
9/30	800	513	513	160	465	380	450	1.48	210	200	220	1.23	3.8 / 1.6	340	260
9/30	800	513	512	96	460	370	450	1.36	208	195	220	1.23	3.9 / 1.2	340	260
9/30	925	528	528	112	460	380	450	1.39	210	200	220	.904	3.4 / .8	340	245
10/1	23	178	74	74	440	385	435	1.41	210	205	215	1.1	3.6 / 1.1	350	240
10/1	23	178	74	74	440	360	440	1.53	205	205	220	1.12	3.5 / .8	330	250

DATE 9-29-70
PAGE

TECHNICIAN
Hollowell
Bogniak

REMARKS

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ATPF 774A

LEAKAGE & FRICTION DATA PRE-TEST

SEAL LEAKAGE TEST PAR. 7.0

INDEX TUBE	APPLIED PRESSURE (PSIG) SPEC.	APPLIED PRESSURE (PSIG) ACTUAL	P.O. PORT (ML/MIN) SPEC.	P.O. PORT (ML/MIN) ACTUAL	COLLET (ML/MIN) SPEC.	COLLET (ML/MIN) ACTUAL	SPUD (ML/MIN) SPEC.	SPUD (ML/MIN) ACTUAL	VESSEL PORTS (ML/MIN) SPEC.	VESSEL PORTS (ML/MIN) ACTUAL	TOTAL LEAKAGE (ML/MIN) SPEC.	TOTAL LEAKAGE (ML/MIN) ACTUAL
EXTENDED	200 AT P.O.	200	N.A.	0	2650	825	1138	805	758*	200	4160	1830
RETRACTED	200 AT P.U.	200	758	0	1705	410	189	0	567	60	2460	470

(P.O. PORT, COLLET, SPUD and VESSEL PORTS are grouped under LEAK POINT.)

* VESSEL PORTS + P.U. PORT

NOTE: PLUG COOLING WATER ORIFICE DURING LEAK TEST

LEAKAGE & FRICTION DATA POST TEST (10-1-70)

SEAL LEAKAGE TEST PAR. 7.0

INDEX TUBE	APPLIED PRESSURE (PSIG) SPEC.	APPLIED PRESSURE (PSIG) ACTUAL	P.O. PORT (ML/MIN) SPEC.	P.O. PORT (ML/MIN) ACTUAL	COLLET (ML/MIN) SPEC.	COLLET (ML/MIN) ACTUAL	SPUD (ML/MIN) SPEC.	SPUD (ML/MIN) ACTUAL	VESSEL PORTS (ML/MIN) SPEC.	VESSEL PORTS (ML/MIN) ACTUAL	TOTAL LEAKAGE (ML/MIN) SPEC.	TOTAL LEAKAGE (ML/MIN) ACTUAL
EXTENDED	200 AT P.O.	200	N.A.	0	2650	1670	1138	1495	758*	660	4160	3825
RETRACTED	200 AT P.U.	200	758	55	1705	1345	189	0	567	85	2460	1485

(P.O. PORT, COLLET, SPUD and VESSEL PORTS are grouped under LEAK POINT.)

* VESSEL PORTS + P.U. PORT

NOTE: PLUG COOLING WATER ORIFICE DURING LEAK TEST

TABLE LEAKAGE & FRICTION DATA

TITLE EARTHQUAKE CORE MISALIGNMENT TEST REQUEST A 378

DRIVE MODEL ENG S/N 880 DATE 9-28-70

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CONT ON SHEET 40 SH NO. 39

TITLE
Evaluation of CRD Scram Characteristics Under Simulated Earthquake Conditions

PHASE 2

TEST DATA

TABLE **SCRAM DATA** *PHASE 2*

TITLE *EARTHQUAKE CORE MISALIGNMENT (PRE-TEST)* TEST REQUEST *A-376-1*

DRIVE MODEL ________ S/N *880* ROD WT. (lb) ________

COOLING PRESS (PSIG) ________ TEST SYSTEM *30°* *15* GPM AT ________ PSIG

SCRAM COUNTER ________

PAGE ________

DATE *2 ?-1971*

BUBNIAK/PARDO
TECHNICIAN

CUMULATIVE SCRAM (#)	VESSEL PRESSURE (PSIG)	TIME	STEAM SPACE TEMPERATURE (°F)	VESSEL BOTTOM TEMPERATURE (°F)	PROBE TEMPERATURE (°F)	START OF MOTION SCRAM SIG. LOSS TO DO-48 (sec)	5% STROKE-SCRAM SIG. LOSS TO DO-45 (sec)	10% STROKE-SCRAM SIG. LOSS TO DO-43 (sec)	20% STROKE-SCRAM SIG. LOSS TO PU-38 (sec)	50% STROKE-SCRAM SIG. LOSS TO DO-24 (sec)	90% STROKE-SCRAM SIG LOSS TO DO-05 (sec)	BUFFER TIME (sec) DO-03 TO DO-GG	PU/PR ΔP MIDSTROKE (PSI)	PO/PR ΔP MIDSTROKE (PSI)	VESSEL WATER CONDUCTIVITY-(MEGOHM)	REMARKS
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
1.	22	1540	63	63	63	.132	.240	.293	.430	.884	1.550	.224	450	230		PRE-TEST (ALIGNED)
2	22	1550	63	63	63	.117	.235	.293	.425	.887	1.545	.217	465	255		
1	21	1330	63	63	63	.125	.245	.298	.420	.890	1.566	.222	460	240		TEST 2-9-71 (MISALIGNED)
2	21	1335	63	63	63	.110	.220	.290	.420	.870	1.550	.223	445	240		

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TABLE LEAKAGE & FRICTION DATA

TITLE *Earthquake Core Misalignment (Pre-Test)* TEST REQUEST *A 378-1*

DRIVE MODEL *ENG* S/N *880* DATE *2-2-71*

LEAKAGE & FRICTION DATA

SEAL LEAKAGE TEST PAR. 7.0

INDEX TUBE	APPLIED PRESSURE psig SPEC.	APPLIED PRESSURE psig ACTUAL	LEAK POINT: P.O. PORT ML/MIN SPEC.	P.O. PORT ML/MIN ACTUAL	COLLET ML/MIN SPEC.	COLLET ML/MIN ACTUAL	SPUD ML/MIN SPEC.	SPUD ML/MIN ACTUAL	VESSEL PORTS ML/MIN SPEC.	VESSEL PORTS ML/MIN ACTUAL	TOTAL LEAKAGE ML/MIN SPEC.	TOTAL LEAKAGE ML/MIN ACTUAL
EXTENDED	200 AT P.O.	200	N.A.	0	2650	2260	1138	1120	758*	200	4160	3580
RETRACTED	200 AT P.U.	200	758	0	1705	420	189	0	567	40	2460	660

*VESSEL PORTS P. U. PORT

NOTE: PLUG COOLING WATER ORIFICE DURING LEAK TEST COOLING ORIFICE LEAKAGE ML/MIN

30 psig APPLIED @ P. U. RETRACTED, 1060/1703 ML/MIN SPEC.

COLLET FRICTION PAR. 8.1.

VESSEL PRESSURE psig	SPEC. MIN. psig	TRIAL 1 P. O. MIN. psig	2 P. O. MIN. psig	3 P. O. MIN. psig	4 P. O. MIN. psig	5 P. O. MIN. psig
	70					

SETTLE FRICTION

PAR. 8.2.1

40 PSID MIN. W/10 psig MAX. VARIANCE

PHASE 2 - PRE-TEST (ALIGNED)

NOTCH	VESSEL psig 20	22			
48	42	44			
46	43	45			
44	43	44			
42	43	44			
40	43	43			
38	43	44			
36	43	43			
34	43	42			
32	43	43			
30	43	43			
28	43	42			
26	42	42			
24	42	41			
22	42	42			
20	42	42			
18	42	42			
16	41	41			
14	42	42			
12	42	42			
10	41	41			
08	42	42			
06	42	42			
04	41	41			
02	40	42			
00	44	43			

REV. NO. 0

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CONT ON SHEET 43 SH NO. 42

TABLE LEAKAGE & FRICTION DATA

TITLE: Earthquake Core Misalignment TEST REQUEST: A-378-1

DRIVE MODEL: Eng 880 S/N: 880 DATE: 2-9-71

LEAKAGE & FRICTION DATA

SEAL LEAKAGE TEST PAR. 7.0

INDEX TUBE	APPLIED PRESSURE psig SPEC.	APPLIED PRESSURE psig ACTUAL	LEAK POINT: P.O. PORT ML/MIN SPEC.	P.O. PORT ML/MIN ACTUAL	COLLET ML/MIN SPEC.	COLLET ML/MIN ACTUAL	SPUD ML/MIN SPEC.	SPUD ML/MIN ACTUAL	VESSEL PORTS ML/MIN SPEC.	VESSEL PORTS ML/MIN ACTUAL	TOTAL LEAKAGE ML/MIN SPEC.	TOTAL LEAKAGE ML/MIN ACTUAL
EXTENDED	200 AT P. O.	200	N.A.	0	2650	1340	1138	1200	758*	310	4160	2850
RETRACTED	200 AT P.U.	200	758	90	1705	680	189	0	567	70	2460	810

*VESSEL PORTS P. U. PORT

NOTE: PLUG COOLING WATER ORIFICE DURING LEAK TEST

COOLING ORIFICE LEAKAGE ML/MIN

30 psig APPLIED @ P. U. RETRACTED, 1060/1703 ML/MIN SPEC.

COLLET FRICTION PAR. 8.1.

VESSEL PRESSURE psig	SPEC. MIN. psig	TRIAL 1 P. O. MIN. psig	TRIAL 2 P. O. MIN. psig	TRIAL 3 P. O. MIN. psig	TRIAL 4 P. O. MIN. psig	TRIAL 5 P. O. MIN. psig
	70					

SETTLE FRICTION

PAR. 8.2.1

40 PSID MIN. W/10 psig MAX. VARIANCE

PHASE 2 - TEST (MISALIGNED)

NOTCH	VESSEL psig 21	VESSEL psig 22			
48	44	45			
46	46	46			
44	44	45			
42	44	44			
40	44	45			
38	44	45			
36	44	45			
34	43	44			
32	44	44			
30	43	44			
28	43	44			
26	41	42			
24	42	42			
22	40	41			
20	41	42			
18	40	41			
16	39	40			
14	40	40			
12	41	40			
10	40	40			
08	41	41			
06	41	42			
04	42	42			
02	41	41			
00	44	44			

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CONT ON SHEET 44 BK NO. 43

TABLE DRIVE DATA

TITLE EARTHQUAKE CORE MISALIGNMENT TEST REQUEST A-378-1

DRIVE MODEL ENG S/N 880 ROD WT. (lb) ______

COOLING PRESS (psig) ______ TEST SYSTEM 30" , 15 GPM AT ______ psig

DATE 2-2-1971

PAGE ______

TECHNICIAN vic/mike

1 DATE	2 VESSEL PRESSURE (psig)	3 STEAM SPACE TEMPERATURE (°F)	4 VESSEL BOTTOM TEMPERATURE (°F)	5 PROBE TEMPERATURE (°F)	6 HCU SUPPLY PRESSURE UP P11/PR ΔP (psi)	7 PRESSURE UNDER PISTON DRIVING UP–P13/PR ΔP (psi)	8 PRESSURE OVER PISTON DRIVING UP–P12/PR ΔP (psi)	9 SPEED DRIVING UP (in/sec)	10 HCU SUPPLY PRESSURE DOWN –P11/PR ΔP (psi)	11 PRESSURE OVER PISTON DRIVING DOWN–P12/PR ΔP (psi)	12 PRESSURE UNDER PISTON DRIVING DOWN–P13/PR ΔP (psi)	13 SPEED DRIVING DOWN (in./sec)	14 DRIVE UP FLOW (GPM) / DRIVE DOWN FLOW (GPM)	15 STALL UP FLOW (GPM) / STALL DOWN FLOW (GPM)	16 TIME	REMARKS
2-2-1971	22	amb	amb.	amb	247	80	10	4740	240	232	95	43.20	3.9 / 2	1.7 / 1.2	1445	PRE-TEST (ALIGNED)
2-2-1971	22	"	"	"	240	75	10.5	47.50	243	232	95	43.10	3.8 / 2.1	1.6 / 1.3	1450	
2-9-1971	22	63	63	63	253	80	10.5	49.50	250	228	97	43.90	3.8 / 2.1	1.6 / 1.3	1105	TEST -2-9-71 (MISALIGNED)
2-9-1971	22	63	63	63	257	80	10.5	49.76	250	225	96	43.90	3.8 / 2.1	1.1 / 1.3	1110	

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REV NO 0

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CONT ON SHEET 45 SH NO. 44

ATPE 774A

TITLE
Evaluation of CRD Scram Characteristics Under Simulated Earthquake Conditions

PHASE 3 PART 1

TEST DATA

2-16

TABLE SCRAM DATA

TITLE EARTHQUAKE CORE MISALIGNMENT TEST REQUEST A-378-2

DRIVE MODEL ENG. S/N 880 ROD WT. (lb)

COOLING PRESS (PSIG) TEST SYSTEM 30° 1.5 GPM AT PSI SCRAM COUNTER

PAGE

DATE 2-12-1971

BUBNIAK/PARDO
TECHNICIAN

REMARKS

CUMULATIVE SCRAM (#)	VESSEL PRESSURE (PSIG)	TIME	STEAM SPACE TEMPERATURE (°F)	VESSEL BOTTOM TEMPERATURE (°F)	PROBC TEMPERATURE (°F)	START OF MOTION SCRAM SIG. LOSS TO DO-48 (sec)	5% STROKE-SCRAM SIG. LOSS TO DO-45 (sec)	10% STROKE-SCRAM SIG. LOSS TO DO-43 (sec)	20% STROKE-SCRAM SIG. LOSS TO PU-38 (sec)	50% STROKE-SCRAM SIG. LOSS TO DO-24 (sec)	90% STROKE-SCRAM SIG. LOSS TO DO-05 (sec)	BUFFER TIME (sec) DO-03 TO DO-GG	PU/PR ΔP MIDSTROKE (PSI)	PO/PR ΔP MIDSTROKE (PSI)	ACC. CHARGE (PSIG)	REMARKS
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
1	22	1535	70	70	70	.147	.247	.300	.428	.870	1.538	.247	500	190	1570/571	
2	22	1545	70	70	70	.127	.238	.297	.416	.867	1.518	.226	510	188	1510/571	
3	800	1540	61	65	61	.130	.295	.390	.620	1.460	2.658	.440	20	720	1510/564	*COLD HYDRO
4	800	1555	61	65	61	.132	.298	.380	.615	1.462	2.672	.442	20	700	1570/564	↕
5	800	1605	61	65	61	.135	.290	.400	.620	1.472	2.700	.450	20	700	1510/564	
6	800	1610	61	65	61	.152	.387	.528	.852	1.880	3.324	.512	230	650	Vessel	
7	800	1625	61	65	61	.158	.384	.532	.866	1.900	3.340	.520	225	650	Vessel	COLD HYDRO
8	500	1230	466	466	83	.130	.266	.326	.497	1.120	2.136	.360	160	320	1570/555	HOT
9	500	1245	466	466	95	.130	.266	.335	.503	1.132	2.170	.365	140	340	1510/555	
10	500	1250	465	465	128	.180	.550	.790	1.325	3.085	5.580	.850	100	460	Vessel	
11	500	1300	465	465	129	.165	.550	.790	1.310	3.075	5.550	.830	100	460	Vessel	
12	800	1250	510	510	100	.135	.295	.388	.615	1.485	2.665	.447	0	695	526/1570	
13	800	1300	510	510	115	.140	.300	.397	.613	1.450	2.644	.443	0	680	1570/556	
14	800	1305	510	510	145	.156	.400	.530	.845	1.870	3.175	.445	490	700	Vessel	
15	800	1315	570	570	165	.153	.390	.530	.815	1.786	3.013	.440	400	690	Vessel	
16	1030	1505	540	540	159	.135	.307	.410	.620	1.322	2.447	.370	0	360	1570/556	
17	1030	1510	540	540	147	.138	.308	.410	.610	1.380	2.448	.372	0	350	1570/556	

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CONT ON SHEET 47 SH NO. 46

REV NO. 0

TABLE SCRAM DATA

TITLE EARTHQUAKE CORE MISALIGNMENT TEST REQUEST A-378-2

DRIVE MODEL ENG S/N 880 ROD WT. (lb)

COOLING PRESS (PSIG) TEST SYSTEM 30" 15 GPM AT ~~[illegible]~~ PSIG SCRAM COUNTER

PAGE

DATE 2-17-71

TECHNICIAN

CUMULATIVE SCRAM (#)	VESSEL PRESSURE (PSIG)	TIME	STEAM SPACE TEMPERATURE (°F)	VESSEL BOTTOM TEMPERATURE (°F)	PROBE TEMPERATURE (°F)	START OF MOTION SCRAM SIG LOSS TO DO-48 (sec)	5% STROKE-SCRAM SIG. LOSS TO DO-45 (sec)	10% STROKE-SCRAM SIG LOSS TO DO-43 (sec)	20% STROKE-SCRAM SIG. LOSS TO PU-38 (sec)	50% STROKE-SCRAM SIG. LOSS TO DO-24 (sec)	90% STROKE-SCRAM SIG LOSS TO DO-05 (sec)	BUFFER TIME (sec) DO-03 TO DO-GG	PU/PR ΔP MIDSTROKE (PSI)	PO/PR ΔP MIDSTROKE (PSI)	ACCUM. CHARGE (PSIG)	REMARKS
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	HOT
18	1030	1515	540	540	174	.148	.337	.460	.700	1.510	2.570	.368	200	900	Vessel	
19	1030	1525	540	540	200	.144	.325	.438	.685	1.475	2.538	.360	400	850	Vessel	2-17-1971
20	1030	1530	540	540	200	.130	.303	.400	.610	1.350	2.390	.372	0	875	1510/550	water Sample @ 0930 = .25
21	1030	1540	540	540	195	.134	.310	.412	.616	1.352	2.390	.368	0	875	1510/550	" " 1030 = .20 " " 1130 = .20
22	1030	1545	540	540	207	.142	.314	.406	.615	1.353	2.386	.356	0	875	1510/550	
2-19 23	24	1016	192	120	70	.150	.260	.310	.460	.930	1.632	.228	570	250	1500/550	2-18-1971
2-19 24	24	1015	192	120	70	.130	.240	.300	.445	.920	1.610	.232	575	255	1500/550	water sample @ 0830 = .16 " " 0930 = .18 " " 1230 = .28 " " 1330 = .26 " " 1430 = .23 " " 1530 = .28
																2-19-1971 water sample @ 0930 = .25 " " 1030 = .23 " " 1130 = .25

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...- 8 1971

CONT ON SHEET 48 BK NO. 47

* MISSALIGNED .600
.200

TABLE LEAKAGE & FRICTION DATA

TITLE EARTHQUAKE CORE MISSALIGNMENT TEST REQUEST R-378-2

DRIVE MODEL ENG S/N #880 DATE 2-12-71

PRE-TEST VIC & MIKE

LEAKAGE & FRICTION DATA

SEAL LEAKAGE TEST PAR. 7.0

INDEX TUBE	APPLIED PRESSURE psig SPEC.	APPLIED PRESSURE psig ACTUAL	P.O. PORT ML/MIN SPEC.	P.O. PORT ML/MIN ACTUAL	LEAK POINT COLLET ML/MIN SPEC.	LEAK POINT COLLET ML/MIN ACTUAL	LEAK POINT SPUD ML/MIN SPEC.	LEAK POINT SPUD ML/MIN ACTUAL	VESSEL PORTS ML/MIN SPEC.	VESSEL PORTS ML/MIN ACTUAL	TOTAL LEAKAGE ML/MIN SPEC.	TOTAL LEAKAGE ML/MIN ACTUAL
EXTENDED	200 AT P.O.	200	N.A.	0	2650	740	1138	1040	758*	100	4160	1880
RETRACTED	200 AT P.U.	200	758	50	1705	850	189	0	567	150	2460	1050

*VESSEL PORTS P. U. PORT

NOTE: PLUG COOLING WATER ORIFICE DURING LEAK TEST

COOLING ORIFICE LEAKAGE ML/MIN

30 psig APPLIED @ P. U. RETRACTED, 1060/1703 ML/MIN SPEC.

COLLET FRICTION PAR. 8.1.

VESSEL PRESSURE psig	SPEC. MIN. psig	TRIAL 1 P. O. MIN. psig	TRIAL 2 P. O. MIN. psig	TRIAL 3 P. O. MIN. psig	TRIAL 4 P. O. MIN. psig	TRIAL 5 P. O. MIN. psig
	70					

REQ NO. 0

383HAL17

CONT ON SHEET 49 SH NO. 48

SETTLE FRICTION

PAR. 8.2.1

40 PSID MIN. W/10 psig MAX. VARIANCE

NOTCH	VESSEL psig * 22	22	500	500	500
48	47	44	45	49	50
46	47	46	46	50	50
44	45	43	45	48	49
42	45	42	44	48	48
40	44	44	44	48	49
38	44	42	44	48	49
36	44	42	44	48	48
34	42	41	44	48	48
32	43	42	43	48	48
30	43	43	42	48	48
28	42	42	42	48	48
26	42	42	42	49	48
24	42	42	42	48	48
22	42	42	42	48	48
20	40	42	42	47	47
18	40	41	43	47	47
16	40	41	43	48	48
14	40	42	42	48	48
12	40	42	42	47	48
10	40	42	42	47	48
08	41	42	43	48	48
06	42	42	44	47	48
04	42	42	44	47	48
02	41	43	42	46	49
00	44	45	46	50	50

* Col. off @ PU

TABLE LEAKAGE & FRICTION DATA

TITLE *EARTHQUAKE CORE MISALIGNMENT* TEST REQUEST *A-378-2*

DRIVE MODEL *ENG* S/N *880* DATE *2-18-1971*

LEAKAGE & FRICTION DATA

SEAL LEAKAGE TEST PAR. 7.0

INDEX TUBE	APPLIED PRESSURE psig SPEC.	APPLIED PRESSURE psig ACTUAL	LEAK POINT: P.O. PORT ML/MIN SPEC.	P.O. PORT ACTUAL	COLLET ML/MIN SPEC.	COLLET ACTUAL	SPUD ML/MIN SPEC.	SPUD ACTUAL	VESSEL PORTS ML/MIN SPEC.	VESSEL PORTS ACTUAL	TOTAL LEAKAGE ML/MIN SPEC.	TOTAL LEAKAGE ACTUAL
EXTENDED	200 AT P.O.		N.A.		2650		1138		758*		4160	
RETRACTED	200 AT P.U.		758		1705		189		567		2460	

*VESSEL PORTS P.U. PORT

NOTE: PLUG COOLING WATER ORIFICE DURING LEAK TEST. COOLING ORIFICE LEAKAGE ML/MIN

30 psig APPLIED @ P.U. RETRACTED, 1060/1703 ML/MIN SPEC.

COLLET FRICTION PAR. 8.1.

VESSEL PRESSURE psig	SPEC. MIN. psig	TRIAL 1 P.O. MIN. psig	2 P.O. MIN. psig	3 P.O. MIN. psig	4 P.O. MIN. psig	5 P.O. MIN. psig
0	70					

SETTLE FRICTION

PAR. 8.2.1

40 PSID MIN. W/10 psig MAX. VARIANCE

NOTCH	VESSEL psig 800	800	1030	1030	POST TEST 24
48	45	42	42	41	52
46	44	42	44	43	53
44	44	42	43	42	53
42	43	42	43	42	52
40	43	42	43	42	52
38	44	42	42	41	52
36	44	41	42	42	52
34	44	41	42	41	52
32	44	41	42	41	52
30	44	41	42	41	51
28	43	41	42	41	52
26	43	41	42	42	52
24	43	41	42	42	52
22	43	41	42	41	51
20	43	41	42	41	51
18	43	41	42	41	50
16	43	41	42	41	50
14	43	41	42	41	60
12	43	41	42	41	60
10	43	42	42	42	50
08	43	42	42	43	50
06	43	42	43	43	50
04	43	42	43	43	50
02	43	42	42	43	50
00	46	44	43	45	52

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CONT ON SHEET 50 SH NO. 49

MAY - 3 1971

TABLE DRIVE DATA

TITLE *EARTHQUAKE CORE MISALIGNMENT* TEST REQUEST *A-378-2*

DRIVE MODEL *ENG* S N *880* ROD WT. (lb) ______

COOLING PRESS (psig) ______ TEST SYSTEM *30"* , *15* GPM AT ______ psig

DATE *2-12-1971*

PAGE ______

TECHNICIAN *Bubniak / Pardo*

REMARKS

	DATE	VESSEL PRESSURE (psig)	STEAM SPACE TEMPERATURE (°F)	VESSEL BOTTOM TEMPERATURE (°F)	PROBE TEMPERATURE (°F)	HCU SUPPLY PRESSURE UP P11/PR ΔP (psi)	PRESSURE UNDER PISTON DRIVING UP–P13/PR ΔP (psi)	PRESSURE OVER PISTON DRIVING UP–P12/PR ΔP (psi)	SPEED DRIVING UP (in/sec)	HCU SUPPLY PRESSURE DOWN –P11/PR ΔP (psi)	PRESSURE OVER PISTON DRIVING DOWN–P12/PR ΔP (psi)	PRESSURE UNDER PISTON DRIVING DOWN–P13/PR ΔP (psi)	SPEED DRIVING DOWN (in./sec)	DRIVE UP FLOW (GPM) / DRIVE DOWN FLOW (GPM)	STALL UP FLOW (GPM) / STALL DOWN FLOW (GPM)	TIME
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	2-11-71	22	70	70	70	250	82	10	50.00	253	230	98	43.20	3.7/2.1	1.7/1.1	1430
	2-11-71	22	70	70	70	250	80	9.5	49.90	258	230	98	43.00	3.8/2.1	1.7/1.2	1435
HOT →	2-17-71	500	460	463	105	250	80	8	48.80	240	230	102	41.54	3.8/2.5	2/1.6	0920
"	2-17-71	500	466	465	133	250	80	7.5	50.78	256	240	103	41.20	3.9/2.2	2.2/1.3	1315
"	2-18-71	800	509	509	140	250	65	6	48.60	253	248	97	39.40	4.1/2.8	2.4/1.9	1120
"	2-18-71	800	510	510	178	253	93	7	50.40	270	240	112	40.20	4/2.8	2.2/1.6	1340
"	2-18-71	1030	539	539	126	263	65	7.5	50.50	275	245	95	39.26	4/2.7	2.4/1.9	1425
"	2-18-71	1030	539	539	126	260	65	7.5	51.73	263	240	95	39.85	3.9/2.6	2.4/1.6	1430
"	2-18-71	1030	540	540	150	260	60	7	51.90	268	240	93	39.78	4/2.6	2.3/1.7	1600
COLD	2-19-71	23	121	177	68	250	83	7	52.20	250	230	107	42.50	3.7/2	1.6/1.2	1020
	2-19-71	23	121	177	68	250	83	7	51.85	250	225	115	42.60	3.7/2.1	1.7/1.2	1030

ATPE 774A

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CONT ON SHEET 51 SH NO. 50 REV 0

After hot Test

TABLE LEAKAGE & FRICTION DATA

TITLE EARTHQUAKE CORE MISALIGNMET TEST REQUEST A 378-2

DRIVE MODEL ENG S/N 880 DATE 2-19-1971

LEAKAGE & FRICTION DATA

SEAL LEAKAGE TEST PAR. 7.0

INDEX TUBE	APPLIED PRESSURE psig SPEC.	APPLIED PRESSURE psig ACTUAL	LEAK POINT P.O. PORT ML/MIN SPEC.	P.O. PORT ML/MIN ACTUAL	COLLET ML/MIN SPEC.	COLLET ML/MIN ACTUAL	SPUD ML/MIN SPEC.	SPUD ML/MIN ACTUAL	VESSEL PORTS ML/MIN SPEC.	VESSEL PORTS ML/MIN ACTUAL	TOTAL LEAKAGE ML/MIN SPEC.	TOTAL LEAKAGE ML/MIN ACTUAL
EXTENDED	200 AT P.O.	200	N.A.	0	2650	1860	1138	1400	758*	150	4160	3410
RETRACTED	200 AT P.U.	200	758	20	1705	1100	189	0	567	130	2460	1260

*VESSEL PORTS P. U. PORT NOTE: PLUG COOLING WATER ORIFICE DURING LEAK TEST COOLING ORIFICE LEAKAGE ML/MIN

30 psig APPLIED @ P. U. RETRACTED, 1060/1703 ML/MIN SPEC.

COLLET FRICTION PAR. 8.1.

VESSEL PRESSURE psig	SPEC. MIN. psig	TRIAL 1 P. O. MIN. psig	2 P. O. MIN. psig	3 P. O. MIN. psig	4 P. O. MIN. psig	5 P. O. MIN. psig
0	70					

SETTLE FRICTION

PAR. 8.2.1

40 PSID MIN. W/10 psig MAX. VARIANCE

NOTCH	VESSEL psig				
48					
46					
44					
42					
40					
38					
36					
34					
32					
30					
28					
26					
24					
22					
20					
18					
16					
14					
12					
10					
08					
06					
04					
02					
00					

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CONT ON SHEET 52 SH NO. 51

TITLE
Evaluation of CRD Scram Characteristics Under Simulated Earthquake Conditions

PHASE 3 PART 2

TEST DATA

TABLE **SCRAM DATA**

TITLE *EARTHQUAKE CORE MISALIGNMENT* TEST REQUEST *A-378-3* *01*

DRIVE MODEL *ENG* S/N *880* ROD WT. (lb) ______

COOLING PRESS (PSIG) *2-15-30* TEST SYSTEM *30"* ______ *15* GPM AT *WORKING* PSIG

SCRAM COUNTER ______

PAGE *1*

DATE *5-16-71*

HOLLOWELL / BUBNIAK
TECHNICIAN

CUMULATIVE SCRAM (#)	VESSEL PRESSURE (PSIG)	TIME	STEAM SPACE TEMPERATURE (°F) 8	VESSEL BOTTOM TEMPERATURE (°F) 6	PROBE TEMPERATURE (°F) 5	START OF MOTION SCRAM SIG LOSS TO DO-48 (sec)	5% STROKE-SCRAM SIG. LOSS TO DO-45 (sec)	10% STROKE-SCRAM SIG. LOSS TO DO-43 (sec)	20% STROKE-SCRAM SIG. LOSS TO PU-38 (sec)	50% STROKE-SCRAM SIG. LOSS TO DO-24 (sec)	90% STROKE-SCRAM SIG. LOSS TO DO-05 (sec)	BUFFER TIME (sec) DO-03 TO DO-GG	PU/PR ΔP MIDSTROKE (PSI)	PO/PR ΔP MIDSTROKE (PSI)	VESSEL WATER CONDUCTIVITY—MEGOHM)	REMARKS
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	DISP.
1	23	1420	69	69	69	.128	.232	.299	.432	.908	1.578	.250	480	270	.420	0.0
2	23	1426	69	69	69	.128	238	.295	.430	.899	1.562	.260	480	270	.420	0.0
3	23	1618	69	69	69	.128	.230	.290	.424	.878	1.540	.260	500	270	.420	0.3
4	23	1625	69	69	69	.130	.230	.290	.430	.880	1.560	.260	500	270	.420	0.3
5	23	1030	69	69	69	.128	238	.298	.425	.885	1.558	.275	480	260	.420	0.6
6	23	1036	69	69	69	.130	.240	.300	.480	.892	1.580	.280	480	265	.420	0.6
7	23	15.15	69	69	69	.122	.225	.281	.427	.910	1.604	327	490	260	.420	0.9
8	23	15.22	69	69	69	.127	230	291	.492	.908	1.605	.312	.490	260	.420	0.9
9	HYDRO 1030	1050	69	69	69	.130	.310	.413	.650	1.548	2.742 ⊗	—	30	900	.420	0.9 ⊗ LAST DO 07
10	HYDRO 1030	1105	69	69	69	.138	.308	.415	.648	1.535	2.692 ⊗	—	30	900	.420	0.9 ⊗ DO-07
11	HYDRO 1030	1112	69	69	69	.130	.330	.442	.712	1.680	2.960 ⊗	—	VESS	850	.420	0.9 ⊗ DO-07 VESS
12	HYDRO 1030	1115	69	69	69	.130	.330	.445	.708	1.680	2.808	—	VESS	850	.420	0.9 ⊗ DO-07 VESS
13	HYDRO 900	1125	69	69	69	.145	.320	.423	.670	1.586	2.712 ⊗	—	20	810	.420	0.9 ⊗ DO 08
14	HYDRO 800	1130	69	69	69	.148	.300	.395	.642	1.621	2.689 ⊗	—	20	730	.420	0.9 ⊗ DO 09
15	23	16.10	69	69	69	132	230	.289	.480	.934	1.768	437	540	215	.420	1.2
16	23	1615	69	69	69	.133	.236	.294	.440	.936	1.768	.430	550	210	.420	1.2
17	Hydro 800	09.25	68	68	68	.140	.299	.404	.688		1816 ⊗				.420	1.2 ⊗ DO 29

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CONT ON SHEET 54 SH NO 53

TABLE SCRAM DATA

TITLE *EARTHQUAKE CORE MISALIGNMENT* TEST REQUEST *A - 378 . 3*

DRIVE MODEL *ENG* S/N *880* ROD WT. (lb) ______

COOLING PRESS (PSIG) ______ TEST SYSTEM *30"* *15* GPM AT ______ PSIG

SCRAM COUNTER ______

PAGE *2*

DATE *5-17-71 +*

TECHNICIAN ______

CUMULATIVE SCRAM (#)	VESSEL PRESSURE (PSIG)	TIME	STEAM SPACE TEMPERATURE (°F)	VESSEL BOTTOM TEMPERATURE (°F)	PROBE TEMPERATURE (°F)	START OF MOTION SCRAM SIG LOSS TO DO-48 (sec)	5% STROKE-SCRAM SIG. LOSS TO DO-45 (sec)	10% STROKE-SCRAM SIG. LOSS TO DO-43 (sec)	20% STROKE-SCRAM SIG. LOSS TO PU-38 (sec)	50% STROKE-SCRAM SIG. LOSS TO DO-24 (sec)	90% STROKE-SCRAM SIG LOSS TO DO-05 (sec)	BUFFER TIME (sec) DO-03 TO DO-GG	PU/PR ΔP MIDSTROKE (PSI)	PO/PR ΔP MIDSTROKE (PSI)	VESSEL WATER CONDUCTIVITY (MEGOHM)	REMARKS
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
18	Hydro 900	09.35	69	69	69	.141	.311	.430	749	2.469	2.648		5	880	.420	1.2 @ D.O. #23
19	Hydro 1050	09.38	69	69	69	.140	.305	.419	.688	1.996	3.264		5	945	.420	1.2 @ D.O. #12
20	23	14.12	69	69	69	.150	.242	.300	.438	.905	1580	272	480	260	.420	0.6 First Repeat
21	23	14.15	69	69	69	140	.240	.305	432	.892	1.570	240	480	270	.420	0.6 First Repeat
22	Hydro 800	1605	69	69	69	.150	.308	.413	.783		.957				420	1.5 @ D.O. -37
23	H_2O 900	1610	69	69	69	.148	.326	.452			.732				430	1.5 @ D.O. -40
24	Hydro 1080	1615	69	69	69	.139	.316	.439			.736				430	1.5 @ D.O. -40
25	Hydro 800	1617	69	69	69	.143	.303	.404	.770		.970		Vessel		.430	1.5 @ D.O. -37
26	800	1620	69	69	69	.153	.400	.628					Vessel		.430	1.5 D.O. -43
27	900	1622	69	69	69	.151	.362	.531			.648		Vessel		.430	1.5 @ D.O. -42
28	1030	1625	69	69	69	.139	.339	.488			.684		Vessel		.430	1.5 @ D.O. -41
29	23	09:35	69	69	69	.143	.252	.308	.467	1.048	1.907		560	145	.430	1.5 @ D.O. #11
30	23	13.15	69	69	69	.128	.236	.296	.433	.897	1.573	.280	460	265	.440	.6 Second Repeat
31	23	13.20	69	69	69	.132	.241	.299	.433	.893	1.578	284	460	260	.448	.6 Second Repeat
32	23	15.45	69	69	69	.132	.237	.296	.423	.885	1.591	326	485	260	.420	.9 First Repeat
33	23	15.55	69	69	69	132	.236	.293	.433	.902	1.614	.340	470	265	420	.9 First Repeat
34	800	12.30	509	511	89	.142	.300	.396	.624	1.641	2.740		6	700	.410	.9 *DO-09

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CONT ON SHEET 55 SH NO 54

383HA617

REV NO 0

TABLE SCRAM DATA

TITLE EARTHQUAKE CORE MISALIGNMENT TEST REQUEST A-378-4

DRIVE MODEL ENG S/N 880 ROD WT. (lb) ______

COOLING PRESS (PSIG) ______ TEST SYSTEM 30'' 15 GPM AT ______ PSIG

SCRAM COUNTER ______

PAGE 3

DATE 5-18-71 +

TECHNICIAN ______

CUMULATIVE SCRAM (#)	VESSEL PRESSURE (PSIG)	TIME	STEAM SPACE TEMPERATURE (°F)	VESSEL BOTTOM TEMPERATURE (°F)	PROBE TEMPERATURE (°F)	START OF MOTION SCRAM SIG. LOSS TO DO-48 (sec)	5% STROKE-SCRAM SIG LOSS TO DO-45 (sec)	10% STROKE-SCRAM SIG. LOSS TO DO-43 (sec)	20% STROKE-SCRAM SIG. LOSS TO PU-38 (sec)	50% STROKE-SCRAM SIG. LOSS TO DO-24 (sec)	90% STROKE-SCRAM SIG LOSS TO DO-05 (sec)	BUFFER TIME (sec) DO-03 TO DO-GG	PU/PR MIDSTROKE ΔP (PSI)	PO/PR MIDSTROKE ΔP (PSI)	VESSEL WATER CONDUCTIVITY-MEGOHM)		REMARKS
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16		
35	800	12:35	509	511	120	.138	.291	.389	.615	1.618	2.786⊗		10	690	.410	.9	*DO.09
36	800	12:40	509	511	117	.146	.393	.539	.869	2.056	3.321⊗		VESSEL	710	.410	.9	*DO 09
37	800	1245	509	511	160	.152	.379	.529	.846	2.045	3.411⊗		VESSEL	710	.410	.9	*PU .08
38	900	13:05	523	526	85	.132	.307	.405	.653	1.536	2.765⊗		10	750	.410	.9	*PU 07
39	900	13:10	523	526	103	.135	.308	.406	.661	1.561	2.834⊗		50	790	.410	.9	*PU 07
40	900	13:15	523	525	126	.141	.356	.483	.782	1.819	3.094⊗		VESSEL	800	.410	.9	*PU 07
41	900	13:20	523	525	142	.139	.346	.471	.761	1.798	3.036⊗		VESSEL	800	.410	.9	*PU 07
42	1030	13.35	545	545	109	.123	.307	.402	.630	1.451	2.732⊗		30	875	.410	.9	⊗ DO *06
43	1030	13.40	545	545	148	.132	.308	.403	.634	1.463	2.693⊗		30	875	.410	.9	⊗ DO *06
44	1030	13:45	545	546	162	.142	.331	.445	.704	1.570	2.911⊗		VESSEL	900	.410	.9	⊗ PU 05
45	1030	13:50	545	546	172	.126	.323	.433	.685	1.562	2.769⊗		VESSEL	875	.410	.9	⊗ DO *06
46	23	13:40	157	98	73	.148	.252	.308	.443	.923	1.643	.320	5.0	300	.410	.9	
47	23	13:50	157	98	73	.129	.243	.300	.452	.948	1.682	.318	5.0	340	.410	.9	
48																	

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CONT ON SHEET 57 / 56

TABLE SCRAM DATA

TITLE EARTHQUAKE CORE MISALIGNMENT TEST REQUEST A-378-5

DRIVE MODEL ENG S/N 880 ROD WT. (lb)

COOLING PRESS (PSIG) TEST SYSTEM 30" GPM AT PSIG

SCRAM COUNTER

PAGE 4

DATE 6-3-71

TECHNICIAN

CUMULATIVE SCRAM (#)	VESSEL PRESSURE (PSIG)	TIME	STEAM SPACE TEMPERATURE (°F)	VESSEL BOTTOM TEMPERATURE (°F)	PROBE TEMPERATURE (°F)	START OF MOTION SCRAM SIG. LOSS TO DO-48 (sec)	5% STROKE-SCRAM SIG. LOSS TO DO-45 (sec)	10% STROKE-SCRAM SIG. LOSS TO DO-43 (sec)	20% STROKE-SCRAM SIG. LOSS TO PU-38 (sec)	50% STROKE-SCRAM SIG. LOSS TO DO-24 (sec)	90% STROKE-SCRAM SIG. LOSS TO DO-05 (sec)	BUFFER TIME (sec) DO-03 TO DO-00	PU/PR MIDSTROKE ΔP (PSI)	PO/PR MIDSTROKE ΔP (PSI)	N2 Precharged / H2O charged	REMARKS
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
48	23	1357	67	67	67	.149	.251	.312	.439	.914	1.600	.295	500	280	563/1510	0 BOW
49	23	1404	67	67	67	.132	.238	.293	.433	.914	1.596	.278	500	280	563/1510	0 BOW
50	800	08:55	69	69	69	.143	.277	.357	.588	1.994	2.142 ⊗		110	850	710/1320	1.5 Bow ⊗ P.U of #23
51	800	09:05	69	69	69	.148	.271	.353	.582	2.099			110	860	710/1320	1.5 Bow
52	900	0915	69	69	69	.151	.281	.373	.624		1.993 ⊗				710/1320	1.5 Bow ⊗ P.U of #27
53	900	09.20	69	69	69	.141	.278	.371	.618		1.912 ⊗				710/1320	1.5 Bow ⊗ P.U of #27
54	1030	09:25	69	69	69	.134	.295	.397	.712		1.320 ⊗				710/1320	1.5 Bow ⊗ P.U of #34
55	1030	09.30	69	69	69	.142	.292	.384	.668		1.510 ⊗				710/1320	1.5 Bow ⊗ P.U of #32
56	800	09.48	69	69	69	.148	.261	.326	.510	1.340	1.995 ⊗		180	790	875/1510	1.5 Bow ⊗ D.O. of #18
57	800	09.54	69	69	69	.144	.259	.323	.513	1.352	2.081 ⊗		200	820	875/1510	1.5 Bow ⊗ D.O. of #18
58	900	1000	69	69	69	.138	.258	.335	.523	1.508	1.956 ⊗		125	950	875/1510	1.5 Bow ⊗ PU of #21
59	900	10.05	69	69	69	.141	.261	.336	.525	1.535	2.035 ⊗		120	950	875/1510	1.5 Bow ⊗ PU of #21
60	1030	13.00	68	68	68	.142	.265	.349	.564		1.713 ⊗				875/1510	1.5 Bow ⊗ P.U of #25
61	1030	13.05	68	68	68	.140	.267	.348	.561		1.730 ⊗				875/1510	1.5 Bow ⊗ D.O of #25
62	1030	13.20	68	68	68	.138	.314	.438	.941						564/1510	1.5 Bow
63	1030	13.25	68	68	69	.144	.317	.456	1.006						564/1510	1.5 Bow
64	1030	08.45	68	68	68	Position indicator Disconnected									561/1510	1.5 Bow

.5 Deflection

TABLE SCRAM DATA

TITLE EARTAQUAKE CORE MISALIGNMENT TEST REQUEST A-378-5

DRIVE MODEL ENG S/N 880 ROD WT. (lb) ______

COOLING PRESS (PSIG) ______ TEST SYSTEM 30" 15 GPM AT ______ PSIG

SCRAM COUNTER ______

PAGE 5

DATE 6-3-71 +

TECHNICIAN ______

	CUMULATIVE SCRAM (#)	VESSEL PRESSURE (PSIG)	TIME	STEAM SPACE TEMPERATURE (°F)	VESSEL BOTTOM TEMPERATURE (°F)	PROBE TEMPERATURE (°F)	START OF MOTION SCRAM SIG LOSS TO DO-48 (sec)	5% STROKE-SCRAM SIG. LOSS TO DO-45 (sec)	10% STROKE-SCRAM SIG. LOSS TO DO-43 (sec)	20% STROKE-SCRAM SIG. LOSS TO PU-38 (sec)	50% STROKE-SCRAM SIG. LOSS TO DO-24 (sec)	90% STROKE-SCRAM SIG. LOSS TO DO-05 (sec)	BUFFER TIME (sec) DO-03 TO DO-GG	PU/PR MIDSTROKE ΔP (PSI)	PO/PR MIDSTROKE ΔP (PSI)	N_2 PRECHARGE / H_2O CHARGE	REMARKS
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
	65	1030	08.52	68	68	68										561/1510	1.5 Bow .5 Deflection
	66	1030	08.58	68	68	68										561/1510	1.5 Bow .5 Deflection
Dynamic	67	1030	09.05	68	68	68	.140	.323	.396	.971		1.113				561/1510	1.5 Bow @ D.O. of #38 .5 Deflection
Dynamic	68	1030	09.10	68	68	68	.138	.312	.448	.970		1.173				561/1510	1.5 Bow @ D.O. of 38 .5 Deflection
Excited	69	1030	0920	68	68	68	.140	.321	.443	1.010		1.116				561/1510	1.5 Bow @ D.O. of #38 .5 Deflection
	70	1030	09.25	68	68	68	.139	.313	.442	.973						561/1510	1.5 Bow D.O. of #38 .625 Deflection
Dynamic	71	1030	09.30	68	68	68	.140	.320	.449	.964		1.100				561/1510	1.5 Bow D.O. of #38 .625 Deflect
	72	1030	09.35	68	68	68	.139	.312	.446	.939		1.068				561/1510	1.5 Bow D.O. of #38 .5 Deflection
	73	1030	09.45	68	68	68	.139	.314	.437	.905		1.017				561/1510	1.5 Bow D.O. of #38 .5 Deflection
	74	1030	09.50	68	68	68	.134	.308	.439	.973		1.100				561/1510	1.5 Bow D.O. of #38 (0) Deflection
	75	1030	09.55	68	68	68	.140	.316	.445	.968		1.089				561/1510	1.5 Bow D.O. of #38 (0) Deflection

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TEST REMARKS SHEET

PAGE 1 OF ___

PROJECT EARTHQUAKE CORE MISALIGNMENT SPECIFICATION NO. ___ SPEC. SECTION NO. ___

TR NO. A-378-3 SUPPLEMENT NO. 3 TEST LOCATION 30"

EQUIPMENT ___ S/N #880

MODIFICATIONS: ___

COOLING WATER DRIVING TESTS

PURPOSE: TO DETERMINE PSIG REQUIRED TO MOVE CRD

REMARKS:

RUN#	POS	48R	48	36	24	12	02	DISP
1	PRESS	78	78	80	80	84	82	0.0
2		78	78	80	80	82	80	0.0
1		84	85	92	94	93	92	0.3
2		97	97	90	90	89	90	0.3
1		75	77	85	85	88	145	0.6
2		73	75	85	83	87	142	0.6
1		75	78	112	117	150	290	0.9
2		75	79	120	130	140	310	0.9
1		75	74	75	76	79	125	0.6 REPEAT
2		74	76	79	77	78	125	0.6 REPEAT
1		74	74	80	77	80	130	0.6 2nd REPEAT
2		70	70	78	77	80	129	0.6 2nd REPEAT

REV NO 0

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TEST OPERATOR HOLLOWELL DATE 5/16-71

APPROVED ___ DATE ___

TABLE — LEAKAGE & FRICTION DATA

TITLE: *EARTH QUAKE CORE MISALIGNMENT* — TEST REQUEST: *378-5*

DRIVE MODEL: *ENG.* — S/N: *880* — DATE: *6-3-71*

PAR. 8.2.1

40 PSID MIN. W/10 psig MAX. VARIANCE

COOLING TEST

NOTCH	1.2 DISPLACEMENT VESSEL psig 1 PSI	2 PSI	1.5 Bow PSI	.9	.9
48	76	88	75	74	78
46	78	78	95	76	78
44	95	87	105	78	80
42	115	145	160	78	83
40	150	160	260	85	86
38	175	185	295	95	95
36	195	220	325	100	100
34	195	225	310	110	105
32	192	225	310	110	105
30	195	210	310	110	110
28	190	210	300	110	110
26	190	210	300	105	110
24	210	200	330	105	107
22	225	205	330	103	100
20	205	205	340	92	90
18	190	200	360	90	88
16	210	180	415	85	84
14	245	290	505	100	98
12	265	265	585	135	130
10	340	320		175	168
08	380	385		215	200
06	415	440		260	230
04	440	430		275	260
02	470	480		345	285
00	—	—		255	250

PAR. 8.2.1 — PAR. 8.2.1

COOLING WATER DRIVING TESTS

40 PSID MIN. W/10 psig MAX. VARIANCE — 40 PSID MIN. W/10 psig MAX. VARIANCE

Cooling Test

NOTCH	VESSEL psig .9 PSI	.9 PSI	.9 PSI	.9 PSI	DATE 6-3 DISPLACEMENT 0.0	0.0		EXPANDED FROM SH. 1 1st .9 1	2
48	82	78	80	78	82	83		78	79
46	80	78	82	81	83	83		80	85
44	83	82	83	83	85	84		80	85
42	83	82	82	83	86	87		85	95
40	85	85	87	92	86	87		95	100
38	92	91	99	110	85	86		105	110
36	98	96	105	116	85	86		112	120
34	110	105	107	115	85	85		120	125
32	120	118	116	115	85	85		120	130
30	118	112	111	110	84	86		130	125
28	128	120	119	112	85	86		125	130
26	118	115	108	114	85	86		120	130
24	110	105	105	112	86	86		117	130
22	103	98	101	102	85	86		115	115
20	95	91	85	99	85	86		100	105
18	88	91	83	90	86	87		95	100
16	85	86	83	82	86	87		95	100
14	97	90	93	88	86	87		120	130
12	130	115	104	125	87	87		150	140
10	145	135	140	160	87	87		200	190
08	215	200	202	212	87	87		230	230
06	245	235	230	250	87	88		255	260
04	290	250	265	265	89	89		285	290
02	280	270	260	265	87	87		290	310
00					86	89			

NO. 0

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TABLE LEAKAGE & FRICTION DATA

TITLE *EARTHQUAKE MISALIGNMENT* TEST REQUEST *A 3783445*

DRIVE MODEL *ENG* S/N *880* DATE *5-25-71 THRU 6-2-7*

	SETTLE FRICTION PAR. 8.2.1 40 PSID MIN. W/10 psig MAX. VARIANCE					SETTLE FRICTION PAR. 8.2.1 40 PSID MIN. W/10 psig MAX. VARIANCE					SE 40 ps	SETTLE FRICTION PAR. 8.2.1 40 PSID MIN. W/10 psig MAX. VARIANCE DATE
NOTCH	VESSEL psig DISP 0.0	DISP 0.3	0.6	0.9	1.2	REPEAT 0.6	DISP 1.5	VESSEL psig 2nd REPEAT 0.6	0.9	0.9	0.9	VESSEL psig 6-3 DISPLACEMENT
	23	23	23	23	23	23	23	23	23	1030	23 PSI	0.0
48	47	47	49	47	49	48	49	47	48	52	50	46
46	47	48	49	48	48	48	28	47	48	53	51	46
44	46	47	48	47	28	46	DID NOT SETTLE	47	47	53	51	45
42	46	46	48	38	DID NOT SETTLE	46	↓	47	47	52	46	46
40	46	46	48	28	↓	46	↓	47	43	46	38	45
38	46	47	48	20	↓	46	↓	47	33	38	30	46
36	46	47	46	18	↓	44	↓	46	27	28	21	46
34	46	46	46	DID NOT SETTLE	↓	44	↓	46	24	23	16	46
32	46	46	47	12	↓	44	↓	46	23	19	18	45
30	46	46	47	DID NOT SETTLE	↓	44	↓	46	20	18	12	46
28	45	46	47	4	↓	45	↓	46	21	14	19	46
26	45	46	47	DID NOT SETTLE	↓	44	↓	46	21	20	16	45
24	45	46	47	DID NOT SETTLE	↓	45	↓	46	23	27	23	45
22	44	45	46	16	↓	44	↓	46	28	33	30	45
20	44	45	47	32	↓	45	↓	45	35	40	48	46
18	44	45	46	36	↓	44	↓	45	38	44	49	44
16	44	45	46	38	↓	44	↓	45	42	50	50	43
14	44	45	46	21	↓	44	↓	45	30	40	37	43
12	44	44	44	DID NOT SETTLE	↓	43	↓	44	8	10	9	42
10	44	45	38	↓	↓	42	↓	36	—	—	—	43
08	44	45	24	↓	↓	34	↓	24				44
06	44	44	13	↓	↓	26	↓	14				44
04	44	44	5	↓	↓	18	↓	4				44
02	43	43	WOULDN'T SETTLE @ 83	↓	↓	08	↓	WOULD NOT SET				44
00	46	47	—	↓	↓	DID NOT SETTLE	↓	W.N.S				47

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TABLE DRIVE DATA

TITLE *EARTHQUAKE CORE MISALIGNMENT* TEST REQUEST *A-378-3*

DRIVE MODEL *# ENG* S/N *# 880* ROD WT. (lb) ______

COOLING PRESS (psig) *15 ≈ 30* TEST SYSTEM *30"* , *15* GPM AT ______ psig

DATE *5-16-71*

PAGE *1*

TECHNICIAN *HOLLOWELL / BUBNIAK*

DATE	VESSEL PRESSURE (psig)	STEAM SPACE TEMPERATURE (°F)	VESSEL BOTTOM TEMPERATURE (°F)	PROBE TEMPERATURE (°F)	HCU SUPPLY PRESSURE UP P11/PR ΔP (psi)	PRESSURE UNDER PISTON DRIVING UP–P13/PR ΔP (psi)	PRESSURE OVER PISTON DRIVING UP–P12/PR ΔP (psi)	SPEED DRIVING UP (in./sec)	HCU SUPPLY PRESSURE DOWN –P11/PR ΔP (psi)	PRESSURE OVER PISTON DRIVING DOWN–P12/PR ΔP (psi)	PRESSURE UNDER PISTON DRIVING DOWN–P13/PR ΔP (psi)	SPEED DRIVING DOWN (in./sec)	DRIVE UP FLOW (GPM) / DRIVE DOWN FLOW (GPM)	STALL UP FLOW (GPM) / STALL DOWN FLOW (GPM)	TIME	REMARKS
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	DISP.
5-16	23	69	69	69	247	77	11.0	47.0	250	235	105	41.2	3.8 / 1.5	1.5 / 0.5	1405	0.0
5-16	23	69	69	69	248	76	11.0	47.0	250	235	105	41.2	3.8 / 1.5	1.5 / 0.5	1410	0.0
5-16	23	69	69	69	250	80	11.0	46.6	250	240	105	41.2	3.9 / 1.4	1.4 / 0.5	1610	0.3
5-16	23	69	69	69	250	80	11.0	46.8	250	240	105	41.2	3.8 / 1.4	1.4 / 0.5	1615	0.3
5-17	23	69	69	69	248	80	12.0	48.7	250	240	105	45.0	3.9 / 1.5	1.5 / 0.6	1015	0.6 ⊗
* CHANGE IN DRIVE PRESS AND FLOW OCCURRED DURING DRIVE TRACES					250-278	80-165	12-8	CHANGES TOOK PLACE FROM POS	262-350	253-240 13 TO 00	40-105 AND	02-12	27-23 / 1.1-1.5			
5-17	23	69	69	69	248	77	11.0	49.0	242	230	103	44.2	3.8 / 1.4	1.4 / 0.0	1020	0.6
	Range from #48 to 00			min max	248 270	77 153	8.5 11.0		242 258	230 242	40 103		32-38 / 1.0-1.9			
5-18	23	69	69	69	263	125	10.0	83.6	268	260	65	from Pos 11 38.4	3.6 / 1.0	1.4 / 0.3		0.9
	Range from #48 to 00			min max	250 360	77 340	0.5 10		258 280	250 260	65 110		1.6-4.0 / 0.4-1.3			0.9
5-18	23	69	69	69	270	122	10	71.0	272	265	70	from Pos 10 39.6	3.6 / 1.1	1.4 / 0.3	⊗	pressure started Driving for (01) 800 psi
	Range from #48 to 00			min max	280 370	76 340	0.5 11.0		260 280	260 265	40 100		1.6-4.0 / 0.9-1.3			
NO DRIVE TRACES AT 1.2 OR 1.5																
5-20	23	69	69	69	260	75	11.0	45.4	240	230	102	46.9	3.8 / 1.9	1.9 / 0.6	1340	0.6 REPEAT
RANGE					260 280	75 190	9 11		235 250	225 240	55 102		3.3 3.8 / 1.2 1.9			0.6
5-20	23	69	69	69	258	75	11.0	45.8	240	230	101	45.0	3.8 / 1.3	1.3 / 0.9		0.6
RANGE					258 280	75 190	8 11		240 250	225 245	55 101		3.3 3.8 / 1.0 1.3			

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TABLE DRIVE DATA

TITLE EARTHQUAKE CORE MISALIGNMENT TEST REQUEST A-378-3 + 4
DRIVE MODEL ENG S/N BBO ROD WT. (lb) ______
COOLING PRESS (psig) ______ TEST SYSTEM 30" , 15 GPM AT ______ psig

DATE 5-21-71
PAGE ______
TECHNICIAN HOLLOWELL / BUBNIAK

DATE 71	VESSEL PRESSURE (psig)	STEAM SPACE TEMPERATURE (°F)	VESSEL BOTTOM TEMPERATURE (°F)	PROBE TEMPERATURE (°F)	HCU SUPPLY PRESSURE UP P1L/PR ΔP (psi)	PRESSURE UNDER PISTON DRIVING UP–P13/PR ΔP (psi)	PRESSURE OVER PISTON DRIVING UP–P12/PR ΔP (psi)	SPEED DRIVING UP (in./sec)	HCU SUPPLY PRESSURE DOWN –P1L/PR ΔP (psi)	PRESSURE OVER PISTON DRIVING DOWN–P12/PR ΔP (psi)	PRESSURE UNDER PISTON DRIVING DOWN–P13/PR ΔP (psi)	SPEED DRIVING DOWN (in./sec)	DRIVE UP FLOW (GPM) / DRIVE DOWN FLOW (GPM)	STALL UP FLOW (GPM) / STALL DOWN FLOW (GPM)	TIME	REMARKS
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
5-21	23	69	69	69	260	75	11.0	47.1	250	230	100	44.8	3.9 / 1.3	1.8 / 0.4	1305	REPEAT 0.6 2nd TIME
				MIN MAX	260 286	75 185	8.0 11.0		250 260	230 245	50 100		[illegible]	[illegible]		
5-21	23	69	69	69	260	75	11.0	47.8	250	230	100	45.0	3.7 / 1.3	4.4 / 0.4	1310	REPEAT 0.6 2nd TIME
				MIN MAX	260 285	75 195	8.0 11.0		250 265	230 245	50 100		3.3 3.7 / 0.5 1.3			
5-21	23	69	69	69	270	110	9.0	71.16	250	250	75	FROM POS #8 47.09	3.4 / 1.2	1.3 / 0.4	15:30	0.9
				MIN MAX	250 355	75 310	2.0 10.0		245 275	220 260	3 105		3.7 3.6 / 6.5 1.2			
5-21	23	69	69	69	270	107	9.0	69.06	250	230	70	FROM POS #8 49.15	3.4 / 1.2	1.4 / 0.4	15:40	0.9
				MIN MAX	250 350	76 300	2.0 10.6		240 270	225 260	10 105		4.8 / 0.6 1.3			
5-24	1030	544	544	150	270	105	2.0	TO POS 10 41.68	280	260	90	FROM POS #9 32.20	3.6 / 1.9	/ 1.0	1610	0.9 HOT TEST
				MIN MAX	240 305	78 175	0.0 4.0		260 320	240 270	20 120		3.7 3.8 / 2.6 2.0			
5-25	23	154	98	72	260	112	8.5	TO POS 3 44.02	245	235	78	FROM POS #10 46.41	3.25 / 1.3	/ 0.5	13 25	0.9
				MIN MAX	245 275	74 165	7.0 10		240 250	225 248	33 170		3.2 3.5 / 0.9 1.4			
5-25	23	158	98	72	258	108	8.5		245	235	78	FROM POS #9 37.48	3.2 / 1.2	/ 0.5	13:35	0.9
				MIN MAX	245 270	78 155	7.5 10		240 255	225 250	33 118		3.9 3.5 / 0.9 1.45			
6-3	23	67°	67°	67°	257	83	12.5	45.76	252	247	109	41.84	3.45 / 1.3	1.3 / 0.3	13.40	} 0.0 5.5
6-3	23	67°	67°	67°	257	83	11.5	45.72	250	245	106	41.90	3.45 / 1.3	1.3 / 0.3	13.45	

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LEAKAGE & FRICTION DATA

TABLE LEAKAGE & FRICTION DATA

TITLE Earth Quake

DRIVE MODEL Eng. S/N 880

TEST REQUEST A-378-3 DATE 5-14-71

PRE-TEST 00 0150

DEC-8 1971

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PRE-TEST

SEAL LEAKAGE TEST PAR. 7.0

INDEX TUBE	APPLIED PRESSURE psig SPEC.	APPLIED PRESSURE psig ACTUAL	P.O. PORT ML/MIN SPEC.	P.O. PORT ML/MIN ACTUAL	COLLET ML/MIN SPEC.	COLLET ML/MIN ACTUAL	SPUD ML/MIN SPEC.	SPUD ML/MIN ACTUAL	VESSEL PORTS ML/MIN SPEC.	VESSEL PORTS ML/MIN ACTUAL	TOTAL LEAKAGE ML/MIN SPEC.	TOTAL LEAKAGE ML/MIN ACTUAL
EXTENDED	200 AT P. O.	200	N. A.	0	2650	970	1138	320	758*	300	4160	1590
RETRACTED	200 AT P.U.	200	758	0	1705	820	189	0	567	215	2460	1035

*VESSEL PORTS P. U. PORT NOTE: PLUG COOLING WATER ORIFICE DURING LEAK TEST COOLING ORIFICE LEAKAGE ML/MIN

30 psig APPLIED @ P. U. RETRACTED, 1060/1703 ML/MIN SPEC.

3-27-71 POST TEST

SEAL LEAKAGE TEST PAR. 7.0

INDEX TUBE	APPLIED PRESSURE psig SPEC.	APPLIED PRESSURE psig ACTUAL	P.O. PORT ML/MIN SPEC.	P.O. PORT ML/MIN ACTUAL	COLLET ML/MIN SPEC.	COLLET ML/MIN ACTUAL	SPUD ML/MIN SPEC.	SPUD ML/MIN ACTUAL	VESSEL PORTS ML/MIN SPEC.	VESSEL PORTS ML/MIN ACTUAL	TOTAL LEAKAGE ML/MIN SPEC.	TOTAL LEAKAGE ML/MIN ACTUAL
EXTENDED	200 AT P. O.	200	N. A.	0	2650	2860	1138	440	758*	4200	4160	7500
RETRACTED	200 AT P.U.	200	758	80	1705	2240	189	0	567	240	2460	2560

*VESSEL PORTS P. U. PORT NOTE: PLUG COOLING WATER ORIFICE DURING LEAK TEST COOLING ORIFICE LEAKAGE ML/MIN

30 psig APPLIED @ P. U. RETRACTED, 1060/1703 ML/MIN SPEC.

6-17-71 POST TEST

SEAL LEAKAGE TEST PAR. 7.0

INDEX TUBE	APPLIED PRESSURE psig SPEC.	APPLIED PRESSURE psig ACTUAL	P.O. PORT ML/MIN SPEC.	P.O. PORT ML/MIN ACTUAL	COLLET ML/MIN SPEC.	COLLET ML/MIN ACTUAL	SPUD ML/MIN SPEC.	SPUD ML/MIN ACTUAL	VESSEL PORTS ML/MIN SPEC.	VESSEL PORTS ML/MIN ACTUAL	TOTAL LEAKAGE ML/MIN SPEC.	TOTAL LEAKAGE ML/MIN ACTUAL
CEW 540												
EXTENDED	200 AT P. O.	200	N. A.	0	2650	920	1138	740	758*	150	4160	1810
RETRACTED	200 AT P.U.	200	758	0	1705	1800	189	0	567	200	2460	2000

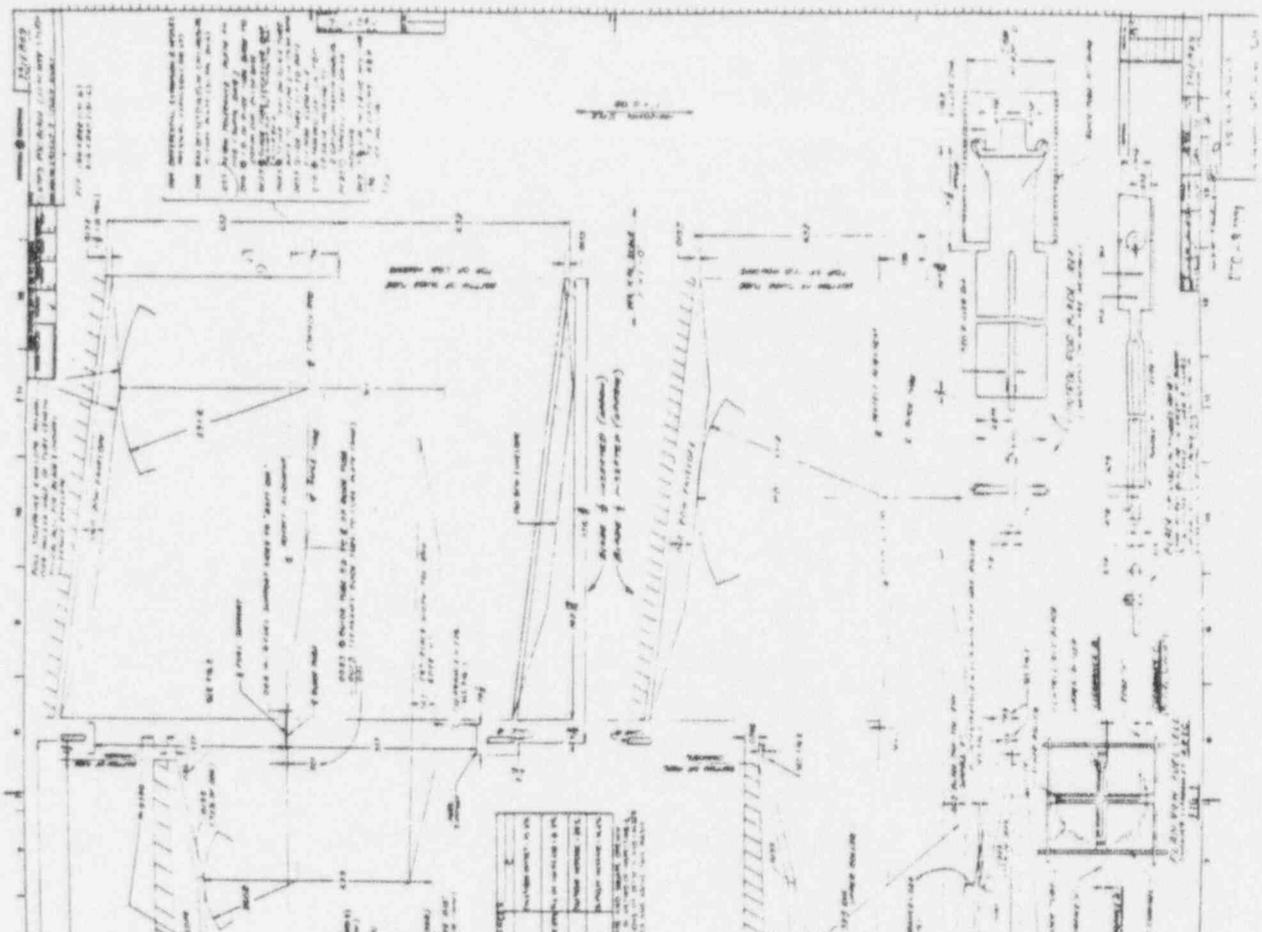
*VESSEL PORTS P. U. PORT NOTE: PLUG COOLING WATER ORIFICE DURING LEAK TEST COOLING ORIFICE LEAKAGE ML MIN

30 psig APPLIED @ P. U. RETRACTED, 1060/1703 ML MIN SPEC.

RETRACTED - exercised collet. leakage = 1620

COLLET FRICTION PAR. 8.1.

VESSEL PRESSURE	SPEC. MIN.	TRIAL 1	TRIAL 2	TRIAL 3	TRIAL 4	TRIAL 5



cc: N. J. Biglieri
J. F. Cage, Jr.
J. J. Gallagher
K. J. Jamrus
L. K. Liu
P. E. Moore
F. F. Smith, Jr.
L. E. Suggs
S. W. Tagart
D. A. Venier
R. E. Williams
H. E. Williamson

July 28, 1970

Subject: Test Procedure for Core Misalignment Test PEP RC-10,1970

To: S. W. Smith
M/C 711

Ref. Above subject test procedure, S. W. Smith, July 14, 1970.

This letter provides the basic core misalignment information required for the above reference testing.

REF LETTER TO J.S WILEY FROM F.E. COOKE APR. 17, 1970

During the first scram testing phase, the blade should have 500 lb. excess weight above normal. This is to demonstrate that the blade can be inserted without stalling during quake lateral loading. For this first phase, scram speed should be determined with the core plate, upper guide and fuel channels displaced relative to the upper end of the control drive housing by the maximum amounts shown on Drawing 731E849. This drawing shows the possible misalignment effects due to component and installation tolerances combined with reactor assembly differential thermal expansion and pressure effects.

The next testing phase should simulate the effects of shroud rotation about its supports during quake loading conditions together with the effects of control drive housing dynamic behavior during quake loading conditions. For this phase, scram speeds should be determined with normal blade weight and with the core plate and upper guides displaced horizontally an additional 0.2 and 0.6 inch respectively to that shown on Drawing 731E849. The core plate and upper guide move together in the same direction.

The effect on scram speed should be checked by initially deflecting the flange end of the control drive housing and releasing it to simulate quake dynamic effects (this is similar to the tests reported in APED-4853).

The final testing phase should include scram speed determinations with normal misalignment and blade weight but with the midpoint of the fuel channel bowed in progressive increments to a limit of 1 1/2 inches (with the ends simply supported). The four channels surrounding the blade should be uniformly deflected together by jacking or tensioning them. This test is to simulate fuel channel loadings up to the channel yield collapse strength limit at operating temperature.

F. E. Cooke

F. E. Cooke
Reactor Assembly
M/C 743

REF LETTER TO I.R KOBSA FROM F.E. COOKE MARCH 6, 1970

dw

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May 12, 1970

cc: I.R. Kobsa
R.E. Williams
F.E. Cooke

J. Fritz
M/C 135

Replying to your question about misalignment of top guide and core support plates for use in your test program, I have the following comments:

Recent vendors deviations have caused us to establish what is the maximum amount of variance from true position that we will accept. This study has shown that the total amount of offset between top guide and core support plate will be limited to .093 inch. Further offsets can be expected as shown below.

	.008	Top Guide master hole selection tolerance
	.008	Core Plate master hole selection tolerance
	.015	Field alignment tolerance of top guide to core plate.
Total	.031	

Therefore, the total offset between the top guide and the core support plate due to manufacturing deviations and field installation tolerances could be 0.124 inch.

Misalignment due to C.R.D. penetrations deviating from true position could cause an additional .060" misalignment.

I further suggest that for a more detailed criteria on misalignments, refer to APED 4835, titled "Locking Piston Control Rod Drive Design Evaluation Tests", in particular, Page A-9 which shows the resulting drive friction on pounds resulting from various misalignments. For this test, the offset was as high as 133% of design criteria, which resulted in a misalignment of the guide tube from true vertical position of 7/8" over a 17 foot length, or an angle of offset of the guide tube equal to 0° 15'. This should be applicable to your test, and would serve as a comparison of the old design and the new design.

R. J. Murkowski
Reactor Assembly
M/C 743

/bh

DEC - 8 1971

REV NO. 0
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CONT ON SHEET 67 SH NO. 66

CHECK ONE:

XX Test Request

☐ Supplement

TEST REQUEST

Test Request Number A-378 Supplement Number ____

Equipment EARTHQUAKE CORE MISALIGNMENT P/N ____ S/N ____

Specification No. ____ Spec. Sect. No. ____ W.O. No. 05475

PURPOSE:

To determine scram characteristics under different conditions of core misaligment and earthquake induced deflections.

[redacted] TEST EQUIPMENT:

1) Drive - - - - - - S/N 880
2) Index Tube - - - S/N 540
3) Piston Tube - - S/N 442
4) Collet - - - - -

TEST PROCEDURE:

NOTES: 1) The cognizant engineer must be present during all testing.

2) Record all data during testing.

PHASE I

1) Additional Equipment Required:

A) Modified control blade (750 lb total weight)
B) Modified fuel support casting
C) Retaining plate for fuel bundles

2) Test Facility Modifications:

A) Remove fuel bundles, fuel support casting and the control blade.
B) Install the modified control blade. (Use extreme caution when handling this blade; it weighs 750 lbs.)
C) Install the modified fuel support casting oriented such that the open rods are in line with the square weights on the modified control blade.
D) Install two fuel assemblies and attach the retaining plate.

3) Inspect Drive:

A) Carefully inspect the collet, noting the condition prior to testing. Pay particular attention to the collet fingers.
B) Inspect the notches on the index tube and note any chipped notches. Measure the bow of the index tube.
C) Inspect all inner surfaces that can come into contact with the index tube and verify that the surfaces are clean and free of defects. Pay particular attention to the type of defect which could be caused by rubbing against the index tube.

Requestor S. Smith Date 2/22/76 Approved [signature] Date 2/22/76

No. D

383HA617

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CHECK ONE:

☒ Test Request

☐ Supplement

TEST REQUEST

Test Request Number A-378 Supplement Number

Equipment EARTHQUAKE CORE MISALIGNMENT P/N S/N

Specification No. Spec. Sect. No. W.O. No. 05475

PURPOSE:

MODIFICATIONS:

TEST PROCEDURE:

D) Inspect the spud being sure the fingers are straight and not damaged.

4) Assemble and leak check the drive.

5) Install the Drive in the Vessel:

A) When coupling the drive, be very careful so the spud doesn't hit the heavy blade too hard.
B) Be sure no interferences exist in the drive line -- the weights on the blade must clear during the entire stroke.
C) The settle circuit should be set so the drive will settle very slowly.

6) Do 2 (two) full stroke drive traces (drive in only).

NOTE: For all scram testing the system will be set up as follows:

A) Accumulator charge = 575/1510
B) Inlet line loss = 350 psi @ 108 GPM (cold)
C) Discharge line loss = 248 psi @ 29.6 GPM (cold)
D) Scram valve dome pressure = 100 psi
E) All vessel temperatures are the saturation temperatures at the specified pressure.

7) Do 2 (two) full stroke scrams at ambient pressure.

8) Do 1 (one) drive in trace at ambient pressure.

9) Do 1 (one) drive in trace at 1030 psi

10) Do 5 (five) full stroke scrams at 1030 psi.

11) Do 1 (one) drive in trace at 1030 psi.

Requestor Date Approved

REV NO 0 Date

383HA617

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CHECK ONE:

- [x] Test Request
- [ ] Supplement

TEST REQUEST

Test Request Number A-378 Supplement Number

Equipment EARTHQUAKE CORE MISALIGNMENT P/N S/N

Specification No. Spec. Sect. No. W.O. No. 05475

PURPOSE:

MODIFICATIONS:

TEST PROCEDURE:

12) Do 2 (two) vessel scrams at 1030 psi (full stroke).

13) Do 1 (one) drive in trace at 1030 psi.

14) Do 1 (one) drive in trace at 800 psi.

15) Do 2 (two) full stroke scrams at 800 psi.

16) Do 1 (one) drive in trace at 800 psi.

17) Do 1 (one) drive in trace at ambient pressure.

18) Do 2 (two) full stroke scrams at ambient pressure.

19) Do 1 (one) drive in trace at ambient pressure.

20) Remove drive and leak check.

21) Disassemble and inspect drive.

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Requestor Date Approved Date

CHECK ONE:

TEST REQUEST

☐ Test Request

☒ Supplement

Test Request Number A-378 Supplement Number 1

Equipment Earthquake Core Misalignment P/N S/N

Specification No. Spec. Sect. No. W.O. No. 05475

PURPOSE:

To determine any effects on scram of maximum expected core misalignment due to fabrication and installation tolerances.

MODIFICATIONS:

Misalign 30" vessel per attached sketch.

TEST PROCEDURE:

TEST EQUIPMENT

1) Drive
2) Index Tube
3) Piston Tube
4) Blade
5) Guide Tube
6) Dummy Bundles

NOTES:

1) The cognizant Engineer must be present during all testing.
2) The data to be recorded are the normal parameters related to shim, drive and scram functions. There are no special parameters to be recorded. Record all data during testing.

PHASE II

1) Inspect components paying particular attention to any defects that may have been caused by rubbing of the moving components.

    A) Inspect guide tube.
    B) Inspect Fuel bundles.
    C) Inspect blade.

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Requestor ______ Date ______ Approved ______ Date ______

2) Inspect drive.

A) Inspect the index tube paying particular attention to any condition that could be caused by rubbing during operation.

B) Inspect all inner surfaces of the drive that can come into contact with the index tube and verify that the surfaces are clean and free of defects, paying particular attention to the type of defect which could by caused by rubbing against the index tube.

3) Assemble and leak check the drive.

4) Install the drive in the vessel and set up the 30" system for normal drive operation.

NOTE:

For all scram testing, the system will be set up as follows unless otherwise indicated:

A) Accumulator Charge = 1510/575
B) Inlet line loss = 350 psi @ 108 GPM (cold)
C) Discharge line loss = 248 psi @ 29.6 GPM (cold)
D) Scram valve dome pressure = 100 psi
E) All vessel temperatures are the saturation temperatures at the specified pressure.

PERFORM TESTING AS LISTED BELOW

Ambient Pressure

1) Two full stroke drive traces (in and out)
2) One jog trace (in and out)
3) One settle friction trace
4) Two full stroke scrams
5) One settle friction trace

500 psi

6) One drive trace (in and out)
7) One settle friction trace
8) Two full stroke scrams
9) Two full stroke vessel scrams
10) One settle friction trace
11) One drive trace (in and out)

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<u>800 psi</u>

12) One drive trace (in and out)
13) One settle friction trace
14) Two full stroke scrams
15) Two full stroke vessel scrams
16) One settle friction trace
17) One drive trace (in and out)

<u>1030 psi</u>

18) One drive trace (in and out)
19) One settle friction trace
20) Five full stroke scrams
21) Two full stroke vessel scrams
22) One settle friction trace
23) One drive trace (in and out)

<u>Ambient Pressure</u>

24) One settle friction trace
25) Two full stroke scrams
26) Two full stroke drive trace (in and out)
27) One full stroke jog trace (in and out)
28) Remove and leak check drive
29) Disassemble and inspect drive noting any conditions different from that at the beginning of the test. Refer. Steps 1 and 2.
30) Remove and inspect fuel bundles
31) Remove and inspect blade

NOTE: 500, 800 and 1030 psi testing may be deleted if no significant affects are seen at ambient pressure.

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Nuclear Energy Division

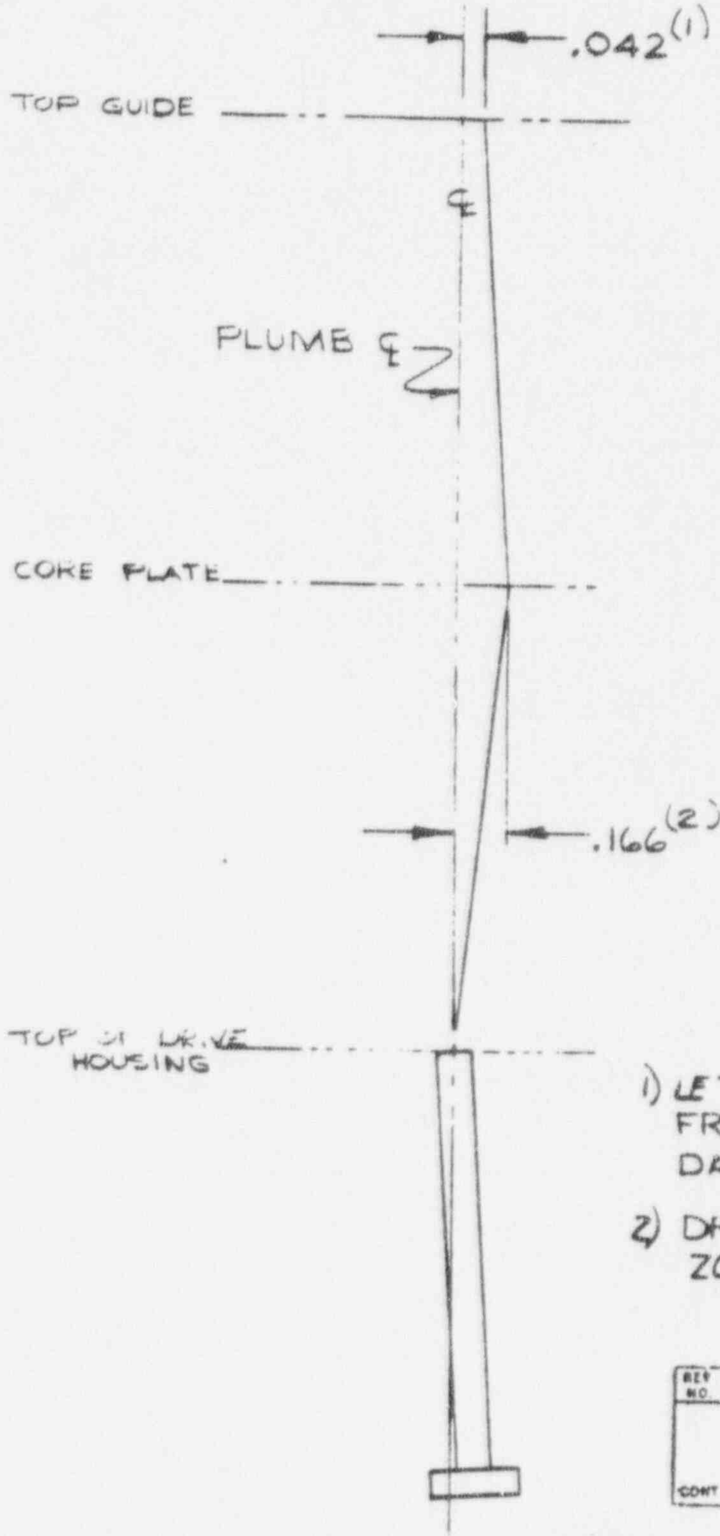
ENGINEERING CALCULATION SHEET

DATE

SHOP ORDER NO. CORE MISALIGNMENT - TRA-378

SUBJECT ______ BY S. SMITH SHEET 1 OF 1

MAXIMUM CORE MISALIGNMENT DUE TO INSTALLATION AND FABRICATION TOLERANCES



1) LETTER TO J. FRITZ FROM R.J. MURKOWSKI DATED 5/12/1970.

2) DRAWING 731E849 ZONE C-13

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383HA617	
CONT ON SHEET 74	SH NO. 73

Form No ATPE 87

CHECK ONE:

☐ Test Request

☒ Supplement

TEST REQUEST

Test Request Number A-378 Supplement Number 2

Equipment Earthquake Core Misalignment P/N S/N

Specification No. Spec. Sect. No. W.O. No. 05475

PURPOSE:

To determine any effects on scram of maximum expected core misalignment due to fabrication and installation tolerances plus earthquake induced deflections of the core plate and top guide.

MODIFICATIONS:

Misalign the 30" vessel per attached sketch.

TEST PROCEDURE:

TEST EQUIPMENT

1) Drive
2) Index Tube
3) Piston Tube
4) Blade
5) Guide Tube
6) Dummy Bundles

NOTES:

1) The cognizant Engineer must be present during all testing.
2) The data to be recorded are the normal parameters related to shim, drive and scram functions. There are no special parameters to be recorded. Record all data during testing.

PHASE III

1) Inspect components paying particular attention to any defects that may have been caused by rubbing of the moving components.

   A) Inspect guide tube.
   B) Inspect fuel bundles.
   C) Inspect blade.

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Requestor Date Approved Date

2) Inspect drive.

A) Inspect the index tube paying particular attention to any condition that could be caused by rubbing during operation.

B) Inspect all inner surfaces of the drive that can come into contact with the index tube and verify that the surfaces are clean and free of defects, paying particular attention to the type of defect which could by caused by rubbing against the index tube.

3) Assemble and leak check the drive.

4) Install the drive in the vessel and set up the 30" system for normal drive operation.

NOTE:

For all scram testing, the system will be set up as follows unless otherwise indicated:

A) Accumulator Charge = 1510/575
B) Inlet line loss = 350 psi @ 108 GPM (cold)
C) Discharge line loss = 248 psi @ 29.6 GPM (cold)
D) Scram valve dome pressure = 100 psi
E) All vessel temperatures are the saturation temperatures at the specified pressure.

PERFORM TESTING AS LISTED BELOW

Ambient Pressure

1) Two full stroke drive traces (in and out)
2) One jog trace (in and out)
3) One settle friction trace
4) Two full stroke scrams
5) One settle friction trace

500 psi

6) One drive trace (in and out)
7) One settle friction trace
8) Two full stroke scrams
9) Two full stroke vessel scrams
10) One settle friction trace
11) One drive trace (in and out)

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800 psi

12) One drive trace (in and out)
13) One settle friction trace
14) Two full stroke scrams
15) Two full stroke vessel scrams
16) One settle friction trace
17) One drive trace (in and out)

1030 psi

18) One drive trace (in and out)
19) One settle friction trace
20) Five full stroke scrams
21) Two full stroke vessel scrams
22) One settle friction trace
23) One drive trace (in and out)

Ambient Pressure

24) One settle friction trace
25) Two full stroke scrams
26) Two full stroke drive trace (in and out)
27) One full stroke jog trace (in and out)
28) Remove and leak check drive
29) Disassemble and inspect drive noting any conditions different from that at the beginning of the test. Refer. Steps 1 and 2.
30) Remove and inspect fuel bundles
31) Remove and inspect blade

NOTE: 500, 800 and 1030 psi testing may be deleted if no significant affects are seen at ambient pressure.

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Nuclear Energy Division

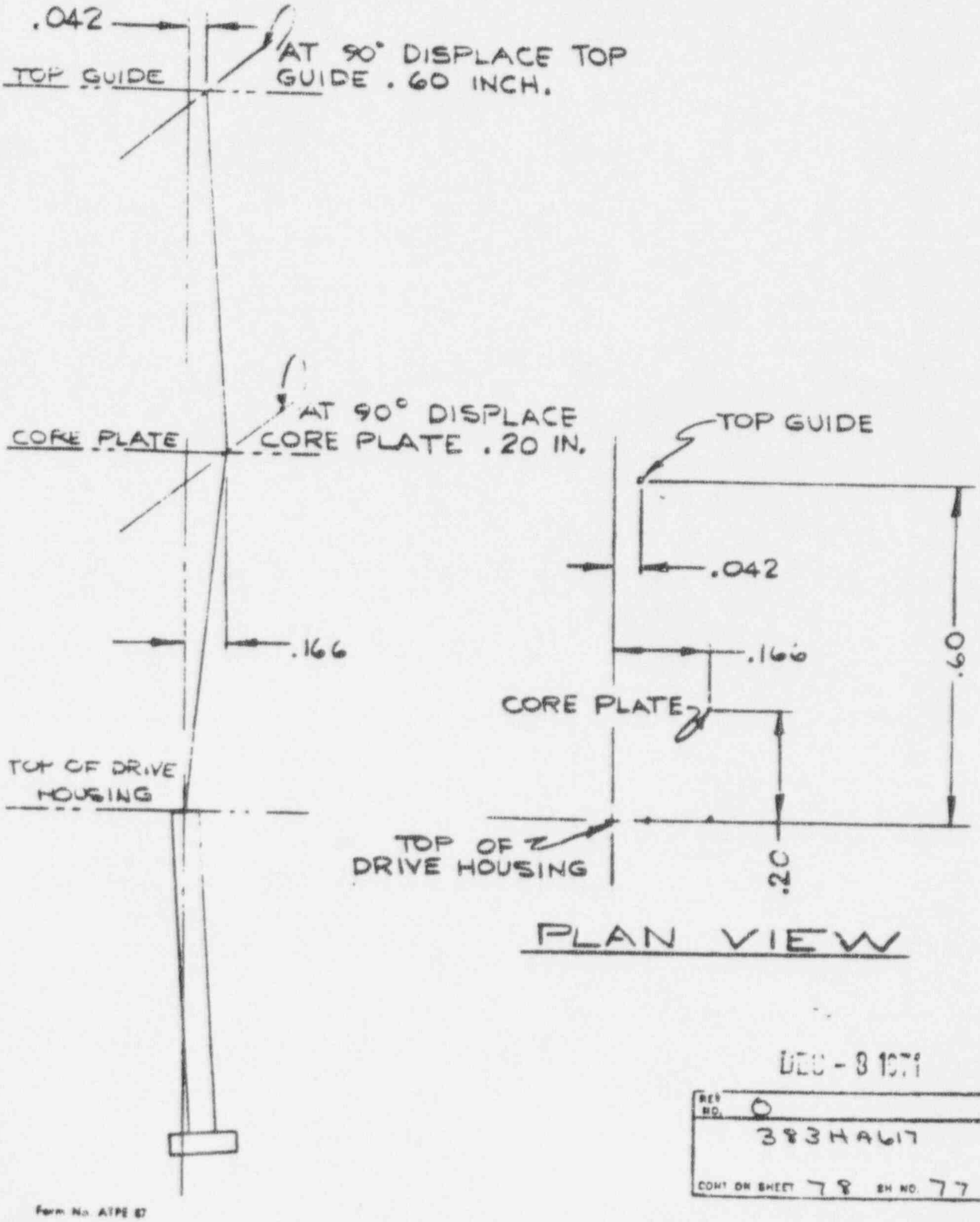
ENGINEERING CALCULATION SHEET

DATE

SHOP ORDER NO. CORE MISALIGNMENT - TRA-378

SUBJECT ______ BY S. SMITH SHEET 1 OF 1

MAXIMUM CORE MISALIGNMENT DUE TO INSTALLATION AND FABRICATION TOLERANCES PLUS MAXIMUM EARTHQUAKE DISPLACEMENT



Form No. ATPE 87

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CHECK ONE:

- ☐ Test Request
- ☒ Supplement

TEST REQUEST

Test Request Number A-378 Supplement Number 3

Equipment EARTHQUAKE CORE MISALIGNMENT P/N ______ S/N ______

Specification No. ______ Spec. Sect. No. ______ W.O. No. [redacted] U3727

PURPOSE:

To determine effect of bowing the channels on drive performance.

MODIFICATIONS:

Install channel bow equipment.

TEST PROCEDURE:

1) Basic Test
   - A) Drive the CRD in using cooling water (twice).
   - B) Perform settle friction test.
   - C) Obtain two-drive traces
   - D) Perform two scrams (1310/575).

2) Displacements of bowing plate at which basic test is to be repeated; 0, .3, .6, .9, 1.2, 1.5.

3) All testing is to have engineering coverage, and [redacted] approval prior to each step of each test.

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Requestor P. D. Renty Date 5/12/71 Approved ______ Date ______

CHECK ONE:

☐ Test Request

☒ Supplement

TEST REQUEST

Test Request Number A-378 Supplement Number 4

Equipment Earthquake Core Misalignment P/N S/N

Specification No. Spec. Sect. No. W.O. No. U3727

PURPOSE:

Continue channel bow tests of Supplement 3.

MODIFICATIONS:

TEST PROCEDURE:

A) After 1.2 and 1.5, back off to 0 then set displacement at .6. Repeat Para. 1 of Supplement 3.

B) Cold Hydro

1) At .9 displacement, run 2 accumulator (1510/575) m scrams, and two vessel scrams at 1030 psi. Also one accumulator scram at 900 and 800 psi vessel pressure.

2) At 1.2 and 1.5, run one accumulator scram at 800, 900 and 1030 psi.

C) Reset to .9 after .6 after 1.5 and repeat Para. 1 of Supplement 3.

D) Hot Test at .9.

1) Run 2 accumulator and 2 vessel scrams at 800, 900 and 1030 psi.

2) Repeat Para. 1, A., B., and C. of Supplement 3 at 1030 psi.

E) Repeat Para. 1 of Supplement 3 at 0 vessel pressure after the hot test at .9 displacement.

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Requestor P.D. Reutz Date 5/25/71 Approved Date DEC - 8 1971

CHECK ONE:

☐ Test Request

☒ Supplement

TEST REQUEST

Test Request Number A-378 Supplement Number 5

Equipment Earthquake Core Misalignment P/N S/N

Specification No. Spec. Sect. No. W.O. No. U-3727

PURPOSE:

MODIFICATIONS:

TEST PROCEDURE:

1. Repeat 0 displacement tests per Supp. 3
2. At 1.5 displacement and 800,900 and 1030 psi cold hydro, perform two accumulator scrams (1320/710).
3. Repeat 2. with 1510/875 accumulator.
4. Repeat 2. at 1030 psi with 1510/575 accumulator.
5. Deflect CRD housing .3 inches and repeat 4.
6. With a quick release, release CRD housing and at the same time, repeat 4.

REV NO. 0

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Requestor P. B. Renty Date 6/2/71 Approved Date