UNITED STATES
NUCLEAR REGULATORY COMMISSION
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

NINE MINE POINT NUCLEAR STATION, UNIT 1

CONTROL ROD DRIVE PENTRATION LEAKAGE FROM STUB TUBE CRACKING

INTRODUCTION

On March 27, 1984, during a refueling outage, an inspection was performed in the control rod drive (CRD) housings (Figure 1); at location 46-27, a small leak (see Figure 2) (approximately 15 drops per minute) was observed at the CRD housing flange. At location 14-11, water bead marks were observed at the top of the CRD housing flange. Additionally, there was either slight corrosion or film on the CRD housing at locations 30-07, 38-31, 42-39, 10-27 and 46-39. Because of these observations, additional examinations, visual (TV) and ultrasonic were scheduled. The visual (TV) examinations were performed on the stub tubes from the exterior of those tubes within the vessel and cracks were observed (see Table). The ultrasonic (UT) examinations were performed from the inside diameter of the control rod drive housing tubes both before and after the rolling repair. In neither UT examination were any reportable indications observed.

Upon completing a visual examination from under the reactor pressure vessel of the CRD housing to reactor pressure vessel interface, a total of nine (9) suspect stub tube/CRD housing assemblies were chosen for underwater closed circuit television inspection from inside the reactor pressure vessel. The areas of inspection for each of the nine (9) assemblies consisted of the heat-affected zone and weld areas of the CRD stub tube to CRD housing and CRD stub tube to reactor pressure vessel. The ultrasonic examinations were performed in both the areas to be rolled to verify that the seal area was free of indications before and after rolling and that the area of "J" weld joining the CRD stub tube to CRD mechanism weld was sound. During the visual examination of the nine (9) assemblies, an additional three (3) assemblies were chosen for closed circuit television examination based on a "pan" of adjacent assemblies. Of these three (3) additional assemblies, the closed circuit television inspection indicated that only one (1) assembly contained an indication (see Table). The CRD housing material, from two inches above the "J" weld (CRD stub tube to CRD housing weld) through and including two inches below the "J" weld, was inspected with 0° and 45° axial ultrasonics. No indications were reported. (Note: The ultrasonic testing was performed from the inside diameter of the CRD housings).

Subsequent to the rolling operation of the nine (9) assemblies, a reactor vessel hydrostatic test was performed. No leakage was observed from the nine (9) rolled penetrations. However, leakage was observed from another CRD penetration (location 50-19). The leak rate was approximately six (6)

drops per minute. That stub tube/CRD housing assembly was rolled utilizing similar methods to those which were implemented for the other nine (9) assemblies. An ultrasonic examination on the tenth assembly was also performed. A visual examination inside the reactor vessel of the tenth assembly was not performed on this tube. It had been noted in the visual examinations that the observed cracks were generally horizontally oriented and approximately 1/2 to 1 inch below the elevation of the CRD housing to stub tube field weld. (See Table) This indicates that a sufficient protuberance exists above the potential failure area that would preclude ejection of that portion of the assembly above the stub tube even in the event of a full 360° crack.

Niagara Mohawk Power Corporation (NMPC) gave a status report to the staff on NMP-1 CRD stub tube inspection and repair on April 10, 1984. The CRD housing leak was also documented in Licensee Event Report 84-002 dated April 26, 1984. By letter dated May 11, 1984 NMPC submitted a safety assessment performed by GE regarding the stub-tube repair. By letter dated May 25, 1984 NMPC reported the leakage of CRD penetration 50-19 (discussed previously) and stated it was evaluating plans for future examinations. By letter dated May 31, 1984 NMPC committed to perform the examinations at its next refueling outage and reiterated its intentions to provide details of its plans by October 1, 1984. By letter dated June 8, 1984 NMPC provided an updated analysis on the leakage rate that could occur from a postulated CRD mechanism ejection.

EVALUATION

SYSTEM CONSIDERATIONS

The effects of cracks postulated to grow 360° around the circumference of the stub tube were evaluated by General Electric.

According to the licensee, the CRD housing cannot be ejected from the reactor vessel. Further the licensee stated that the stub tube is adequate for support of the CRD housing since the stub tube is loaded in compression and cannot be forced through the vessel head penetration. A mechanical restraint system is provided underneath the vessel to prevent ejection of the CRD mechanism or housing. Moreover the stub tube-to-housing weld remains intact. Results of visual and UT examinations of these welds show no cracks at present. Therefore, the probability of a CRP ejection due to stub tube cracks is very minimal.

The intergranular stress corrosion cracking (IGSCC) of the CRD penetration stub tubes has occurred at several older BWRs with furance sensitized stub tubes. CRD stub tube cracks were found in Oyster Creek, Big Rock Point and other foreign BWR plants. Based on related experience at other BWR plants, any future leakage rate from a stub tube crack at NMP-1 would be small and could be monitored during plant operation. The licensee states that existing NMP-1 drywell leakage monitoring capability is adequate to monitor penetration leakage in service; drywell floor drain tank level rise is

alarmed in the control room and the pump-out timer and intergrated flow monitor are used for a close watch of any leakage in the drywell. Plant Technical Specifications require the plant to be shutdown if the leakage exceeds the limit given in the current Technical Specification. Further, in a letter dated June 6, 1984 the staff has requested NMPC to provide a more restrictive leakage detection Technical Specification requirement in accordance with the guidelines recommended in NUREG-0313, Rev. 1. within 30 days of receipt of the letter. If the welding between the stub tube and the housing completely fails, there is a remote possibility that the housing may be displaced. If the housing is free to move radially, the horizontal motion would be limited by 0.015 inch maximum radial clearance between the drive housing's outer diameter and the bore through the stub tube and vessel bottom head. The maximum leak that could be postulated for such a remote event is approximately 150 gpm which can be detected easily by the drywell floor drain system described earlier. Since the leakage is higher than the allowable identified leakage in the drywell given in the Technical Specifications the plant would shutdown.

The excess capacity of the feedwater system will try to compensate for the loss in vessel inventory due to the leak. The second CRD pump which is not normally running can also be used to supplement the feedwater system if the operator sees a need.

The operator is expected to depressurize the vessel to minimize the leak and allow injection by the low pressure system (core spray system). Since NMP-1 does not have any HPCI or RCIC systems, emergency cooling system (isolation conderser) or the ADS actuation is required to reduce the primary system pressure to allow core cooling by the core spray system. The NMP-1 core spray system consists of two separate and independent systems. Each system contains two sets of pumps. One core spray system (3400 gpm) is sufficient to maintain the reactor water level. Most likely the operator will start the emergency cooling system manually. The initial cold inventory from the isolation condenser causes a steep rise in reactor water level and a decrease in pressure. The operator proceeds with the shutdown using the emergency cooling system and the CRD pump for maintaining the reactor level. When the reactor pressure reaches about 135 psig, the operator places the reactor shutdown system in service.

The consequence of a maximum leak of 150 gpm from the CRD housing does not result in any temperature or pressure in excess of the criteria for which the fuel, pressure vessel or containment are designed.

The effect of misalignment of the drive housing, with respect to the core was evaluated in a series of tests conducted by GE. Tests at GE have shown that there is no significant increase in scram time for a one-inch displacement of the housing from the center. The maximum displacement possible for the NMP-1 housing is only 0.35 inch. Therefore the functional

requirement of the CRD to insert the control blades will not be adversely affected.

REPAIR CONSIDERATIONS

The licensee, after reviewing several alternatives, selected to repair any CRD penetration which leaked or showed evidence of previous leakage by rolling the CRD housing to the reactor vessel lower head to seal the leakage path. This repair method was selected since it had been utilized and was successful at other operating reactors with similiar problems. The process was developed by the licensee's contractor (Combustion Engineering) and qualified using several mock-ups. Qualification of the mock-up consisted of hydro-testing after rolling, thermal-cycling and re-hydrotesting. The mock-up roll was considered successful, since only a one drop leak was observed after a one hour pressure test following thermal cycling. The criteria applied to CRD housing rolling were:

(1) Achieve 3 to 3 1/2 % wall reduction as minimum.
(2) Limit well reduction to a maximum 5 to 6%.
(3) Have a roll band of at least 3 inches in height.

We find the repair method acceptable for the following reasons:

(1) The repair method was adequately demonstrated to be effective using mock-ups.

(2) The repair process has been shown to be effective in limiting leakage at other operating reactors. The success of the rolling repair in similar applications as early as 1966 provides additional confidence in the durability of the fix.

(3) The cold reduction of the housing wall is limited to 5-6%. Cold worked stainless steel has been used for reactor internals bolting and for control rod cladding and fuel cladding in early reactors with no apparent enhancement of IGSCC.

(4) The licensse has stated that the stub tubes will be closely monitored for leakage. The licensee has committed to inservice inspection at the next refueling outage and will provide final plans for the inpections by October 1, 1984.

CONCLUSION

We have evaluated the effects of cracking in stub tubes and the repair method used to limit leakage from the CRD penetrations with stub cracks and conclude the facility can be operated safely for the reasons stated above. In particular, the following factors are considered significant in supporting our conclusion:

(1) CRD housings that showed evidence of leaking have been rolled and successfully ultrasonically and hydrostatically tested.

(2) The licensee will monitor the stub tubes closely for leakage and will perform inservice inspections at the next refueling outage.

(3) The "J" weld to the CRD mechanism has been ultrasonically inspected and no indications were reported.

(4) The location of the cracking identified is such that it would not lead to a CRD mechanism ejection.

(5) The system design includes "shoot-out-steel" to prevent a control ejection.

(6) The postulated CRD dislocation by failure of the "J" weld attaching the mechanism has been evaluated and its failure would not present a significant safety hazard because the maximum potential leakage is limited (150 pgm) and is readily detectable.

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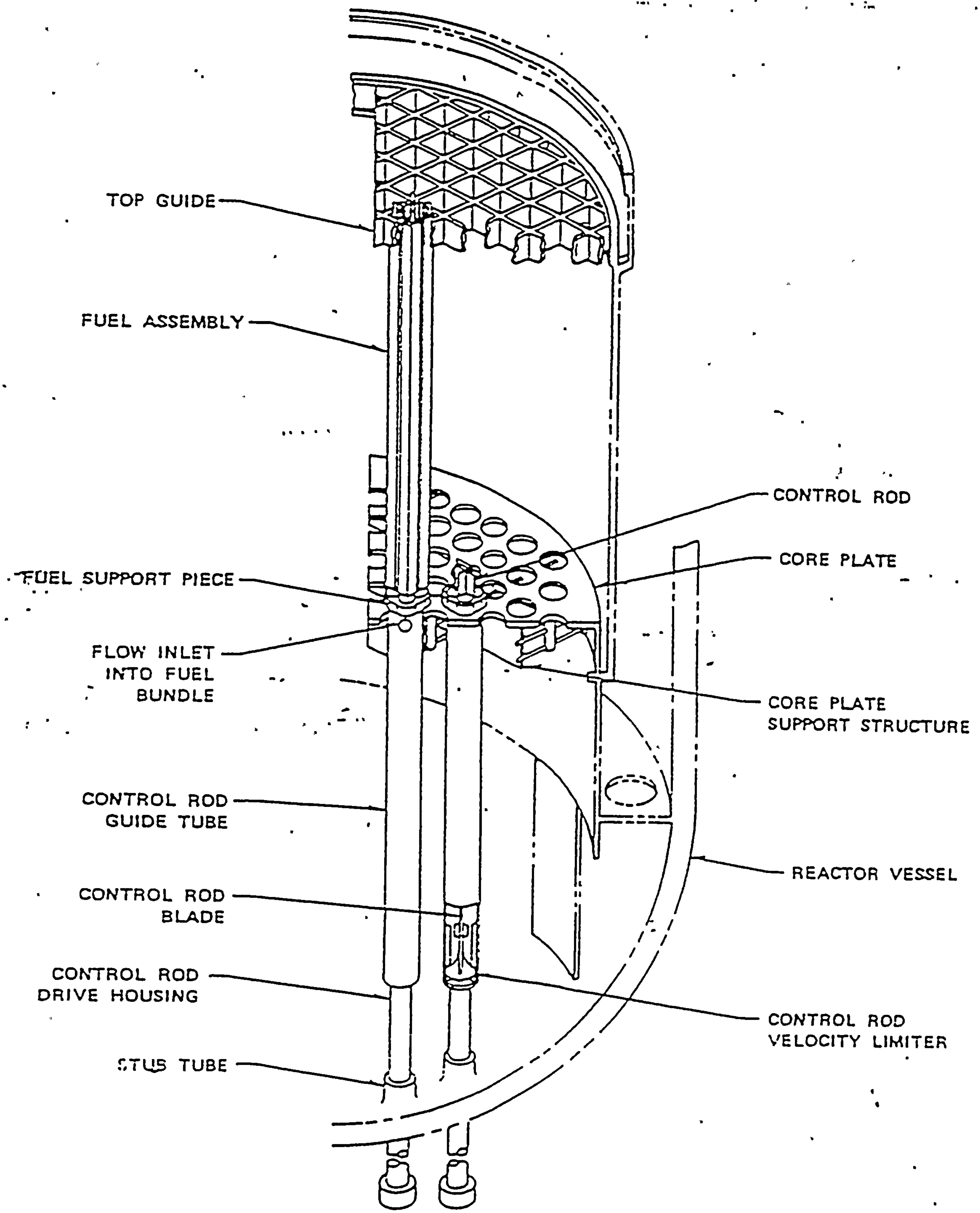
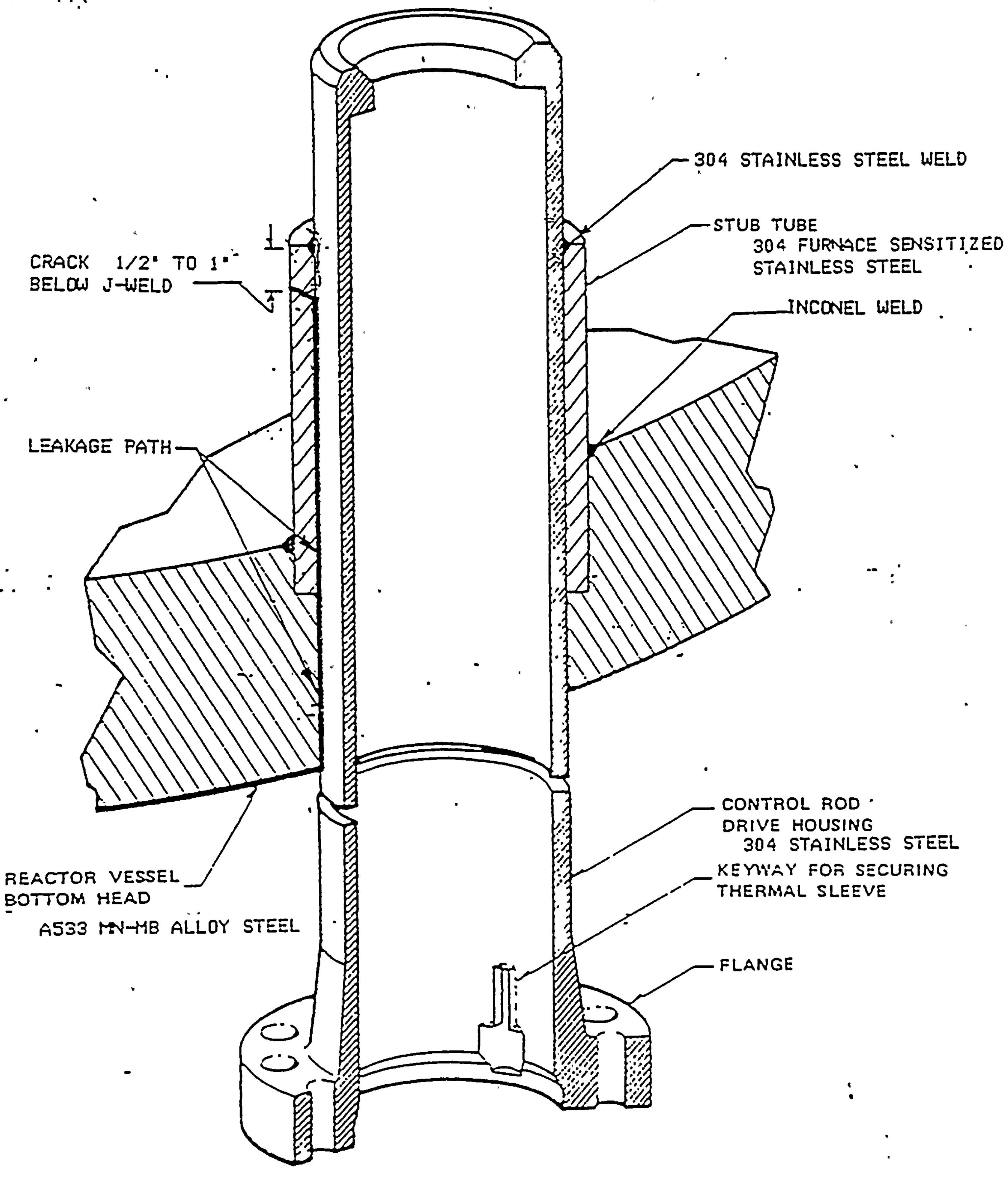
FIGURE-1



Relationship Between Stub Tube, Reactor Pressure Vessel, and

FIGURE-2


304 STAINLESS STEEL WELD
STUB TUBE
304 FURNACE SENSITIZED
STAINLESS STEEL
CRACK 1/2" TO 1"
BELOW J-WELD
INCONEL WELD
LEAKAGE PATH
CONTROL ROD
DRIVE HOUSING
304 STAINLESS STEEL
KEYWAY FOR SECURING
THERMAL SLEEVE
REACTOR VESSEL
BOTTOM HEAD
A533 MN-MB ALLOY STEEL
FLANGE

TABLE

RESULTS OF INSPECTIONS

HOUSING NO.	PRESENCE OF LEAKAGE	RESULTS OF TV INSPECTIONS
46-27	15 drops per minute leakage	Significant crack, 270° long
14-11	Evidence of leakage (wetness) around housing-head annulus	Significant crack 200°+ long
30-07	Suspected of prior leakage	Tight crack, 330° long
34-07	Suspected of prior leakage	Tight crack 35° long
42-39	Suspected of prior leakage	No evidence of cracks
38-31	Suspected of prior leakage	No evidence of cracks
34-39	Suspected of prior leakage	No evidence of cracks
10-27	Suspected of prior leakage	Tight crack approximately 100° long
46-39	Suspected of prior leakage	No evidence of cracks
34-35	No evidence of leakage	No evidence of cracks
10-23	No evidence of leakage	No evidence of cracks
10-31	No evidence of leakage	Tight crack, approximately 100° long
50-19	6 drops per minute leakage	Not performed