

December 2, 1985

Docket No. 50-220

LICENSEE: Niagara Mohawk Power Corporation  
FACILITY: Nine Mile Point Nuclear Station Unit No. 1  
SUBJECT: SUMMARY OF NOVEMBER 18, 1985 MEETING WITH NIAGRA MOHAWK  
POWER CORPORATION

A meeting was held on November 18, 1985 in Bethesda, Maryland between representatives of Niagara Mohawk Power Corporation (NMPC), the licensee, and the NRC staff to discuss plans for inspection of an potential repair methods for furnace sensitized stub tubes. A list of the attendees is attached as Enclosure 1. A copy of the slides used by the as apart of its presentation is also attached as Enclosure 2.

Issues discussed included:

1. The inspections and work performed at the 1984 refueling outage, development work and analysis, and experience gained from other Boiling Water Reactors.
2. Inspection plans for the Spring 1986 refueling outage.
3. Preparations for any repairs found necessary for any of the stub tubes at the Spring 1986 outage.
4. The development of long-term repair methods for cracked stub tubes.

The licensee intends to formally submit their guidelines for the repair of leaking control rod drive penetrations for staff review and approval.

Original signed by  
Robert A. Hermann, Sr. Project Manager  
BWR Project Directorate #1  
Division of BWR Licensing

Enclosure:  
As stated

cc w/enclosure:  
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UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
WASHINGTON, D. C. 20555

December 2, 1985

Docket No. 50-220

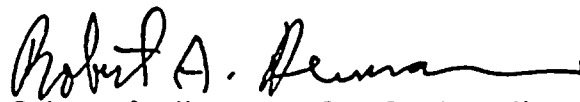
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ATTENDANCE LIST - STUB TUBES

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Brian Lipford	MPR	
William R. Schmidt	MPR	
Lee A. klosowski	NMPC	
B. D. Liaw	NRC/DE	
C. D. Seller	NRC/DE/MTEB	
R. A. Hermann	NRC/DBL/BWD#1	
W. A. Koo	NRC/DE/MTEB	
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W. S. Hazelton	NRC/DE/MTEB	





NIAGARA MOHAWK POWER CORPORATION  
NINE MILE POINT UNIT 1  
CONTROL ROD DRIVE PENETRATION  
REPAIR PROGRAM

NOVEMBER 18, 1985



OUTLINE OF PRESENTATION  
NMP-1 CRD PENETRATION REPAIR PROGRAM

I. INTRODUCTION/BACKGROUND

- A. NMP-1 1984 SPRING OUTAGE - ROLLED JOINT REPAIRS
- B. COMPLETED EFFORTS IN SUPPORT OF ROLLED JOINT REPAIR METHOD
  - 1. MOCK-UP TESTS
  - 2. STRESS ANALYSIS - LONG-TERM EFFECTIVENESS OF ROLLED JOINT
  - 3. EXPERIENCE AT OTHER BWRS
  - 4. EVALUATION OF COLD WORK/IGSCC RESISTANCE
  - 5. SAFETY EVALUATION OF ROLLED JOINT REPAIR

II. INSPECTION PLANS FOR SPRING 1986 REFUELING OUTAGE

- A. HYDROTEST
- B. VISUAL EXAMS
- C. ULTRASONIC EXAMS

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III. PREPARATION FOR SPRING 1986 OUTAGE REPAIRS

A. VERIFICATION OF ACCEPTABILITY OF ROLLING PROCESS -  
EPRI METALLURGICAL/MGCL<sub>2</sub> TESTS

B. DEVELOPMENT OF ROLL REPAIR IMPROVEMENTS

1. PROCUREMENT OF IMPROVED ROLLING EQUIPMENT,  
MOCKUPS

2. MOCK-UP TESTS OF METHODS FOR RE-ROLLING  
PREVIOUSLY ROLLED HOUSINGS

3. EVALUATION OF CRD THERMAL SLEEVE EFFECTIVENESS

4. JUSTIFICATION FOR SECURING COOLING

C. GUIDELINES FOR THE REPAIR OF LEAKING PENETRATIONS

IV. DEVELOPMENT OF LONG-TERM REPAIR METHODS

A. REVIEW OF DEVELOPMENT WORK BY OTHERS

B. NMP-1 SEAL ASSEMBLY DESIGN CONCEPT

1. CRD HOUSING IS RETAINED

2. CRD HOUSING IS REPLACED



C. NMP-1 SEAL ASSEMBLY DEVELOPMENT

1. DEMONSTRATION OF STUB TUBE AND HOUSING MACHINING - PCI
2. MECHANICAL SEAL ASSEMBLY DESIGN
3. INSTALLATION TOOL DESIGN
4. SEAL ASSEMBLY STRESS ANALYSIS
5. SEAL ASSEMBLY PROTOTYPE DEVELOPMENT TESTING
6. CONTINGENCY PLANNING FOR IMPLEMENTATION OF LONG-TERM REPAIR

D. SAFETY ANALYSIS OF NMP-1 SEAL ASSEMBLY AND VESSEL MODIFICATION.

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NINE MILE POINT UNIT 1  
STUB TUBE/CONTROL ROD DRIVE  
PENETRATION REPAIR PROGRAM

I. INTRODUCTION

A. SPRING 1984 OUTAGE

1. INSPECTION

- A. CRD PENETRATION 46-27 FOUND LEAKING AT 15 DROPS PER MINUTE
- B. CRD PENETRATION 14-11 SHOWED SIGNS OF WETNESS
- C. SEVEN ADDITIONAL HOUSINGS SHOWED POSSIBLE EVIDENCE OF PRIOR LEAKAGE
- D. CLOSED CIRCUIT TV INSPECTION OF 12 PENETRATIONS REVEALED SIGNIFICANT CRACKING OF SIX STUB TUBES

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## 2. REPAIR

- A. INITIALLY, NINE CRD HOUSINGS WERE ROLL EXPANDED TO SUBSTANTIALLY REDUCE LEAKAGE
  - (1) PENETRATIONS WHICH LEAKED OR EXHIBITED POSSIBLE SIGNS OF PREVIOUS LEAKAGE
  - (2) ONE PENETRATION WITH OBSERVED STUB TUBE CRACKING, BUT NO SIGNS OF LEAKAGE, WAS NOT REPAIRED (31-10)
- B. DURING ISI HYDROTEST, AN ADDITIONAL PENETRATION (50-19) WAS FOUND LEAKING AND WAS SUCCESSFULLY REPAIRED BY ROLLING
- C. TOTAL OF TEN PENETRATIONS REPAIRED BY ROLLING OF CRD HOUSING

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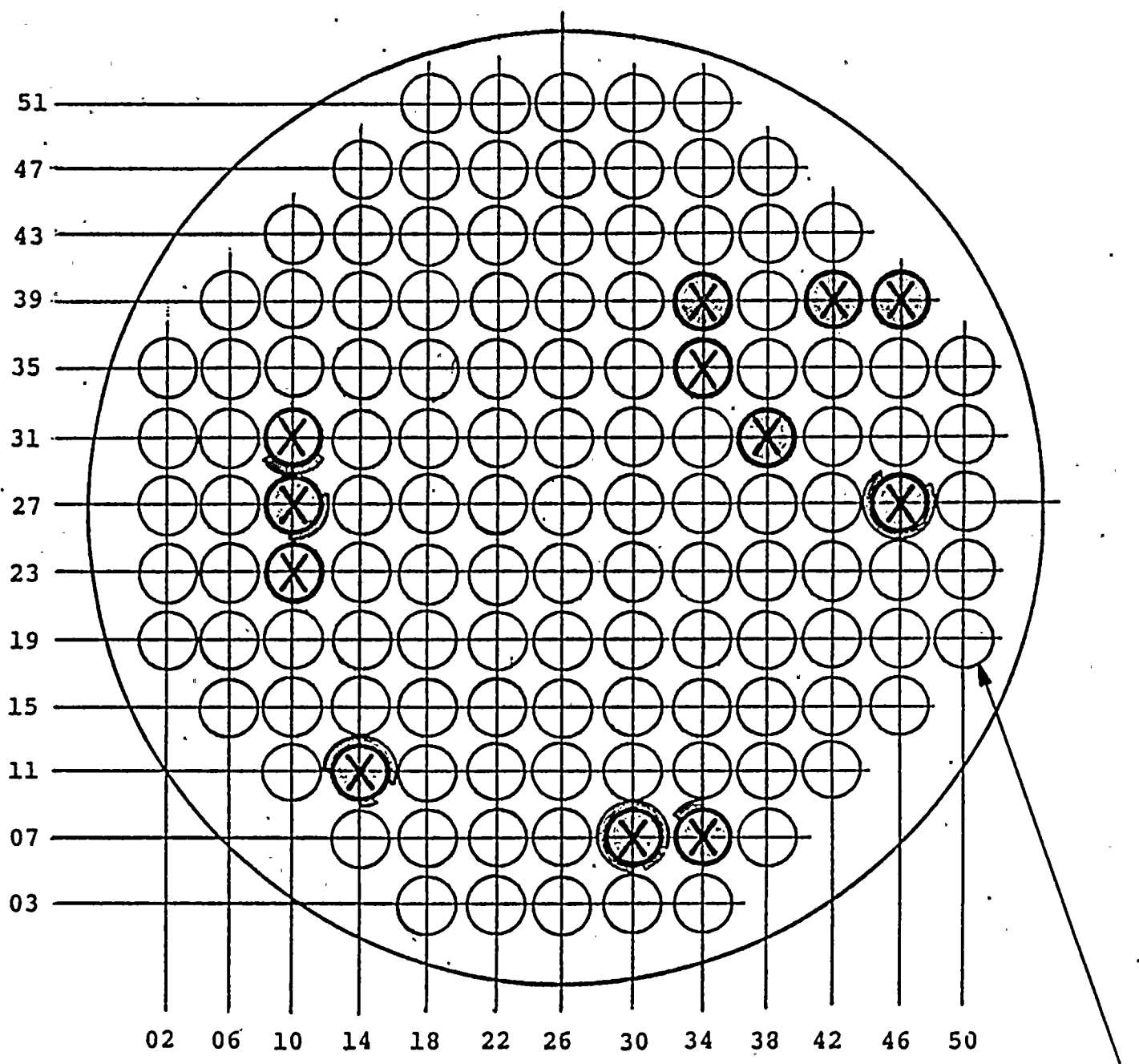
D. REPAIR SEQUENCE

- (1) PERFORM U.T. INSPECTION TO VERIFY:
  - 0 INTEGRITY OF STUB TUBE-TO-CRD HOUSING J-WELD
  - 0 INTEGRITY OF CRD HOUSING MATERIAL IN THE AREA TO BE ROLLED
- (2) ROLL EXPAND CRD HOUSING INTO TIGHT CONTACT WITH VESSEL WALL TO LIMIT LEAKAGE
  - 0 ACHIEVE 3-4% WALL THINNING OF CRD HOUSING
  - 0 ROLL BAND 3" LONG

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# INSPECTION RESULTS



Rolled After Post Repair-Hydrostatic Test

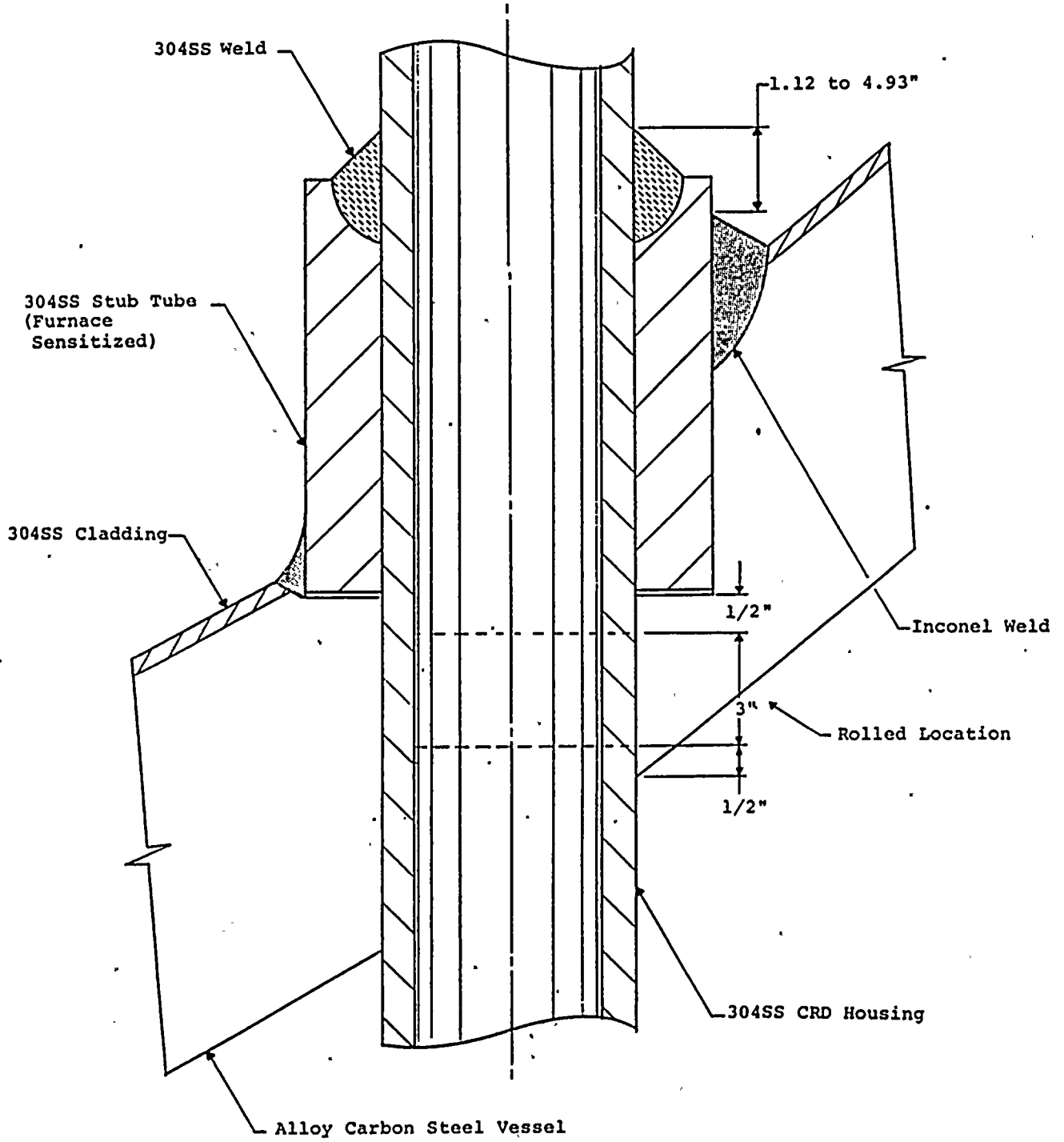
**Legend:**

-  Inspected By CCTV
-  Possible Evidence Of Prior Leak
-  Visible Leak
-  Crack Visible By CCTV





MPR ASSOCIATES  
F-85-43-40  
3/26/85



ROLLED AREA  
OF NMP-1 CRD HOUSING



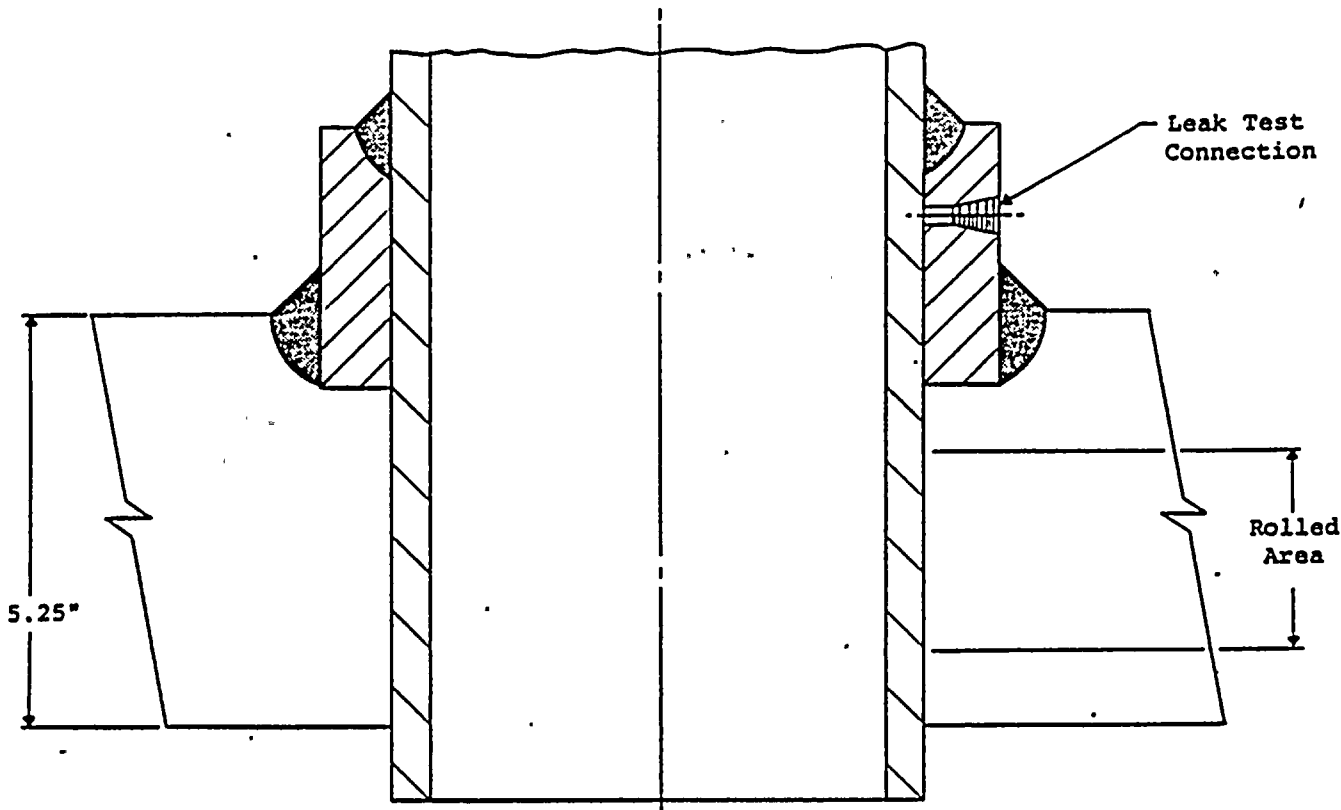
MOCK-UP TESTS:

QUALIFICATION PROCEDURES -

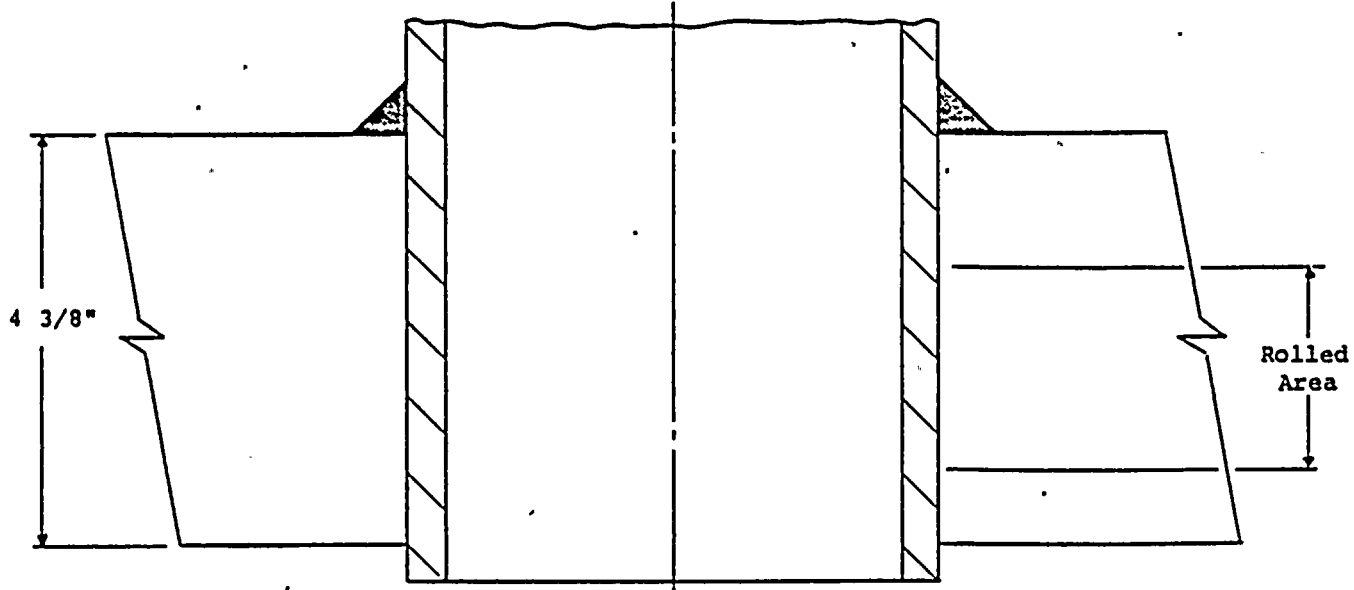
- 0 TWO MOCK-UP TYPES TESTED; TYPE A AND TYPE B
- 0 10 MOCK-UPS ROLLED; 4 MOCK-UPS WERE ROLLED TO DEVELOP AND QUALIFY ROLLING EQUIPMENT AND PROCEDURES, 6 MOCK-UPS WERE ROLLED FOR PERSONNEL TRAINING AND ADDITIONAL EQUIPMENT QUALIFICATION.
- 0 QUALIFICATION TESTS AFTER ROLLING INCLUDED:
  1. PRELIMINARY LEAK TEST - 1875 PSIG; MOCK-UP TYPE A.
  2. THERMAL CYCLING TEST - HEATED AT RATE OF 50°F/HR TO 550°F. SOAKED FOR 1 HOUR AND COOLED AT RATE OF 50°F/HR.
  3. FINAL LEAK TEST - 1875 PSIG.
  4. DIMENSIONAL EXAMINATIONS - 0.065 TO 0.075 INCH DIAMETRAL EXPANSION WAS MEASURED (4 TO 5.4% WALL THINNING). RESULTED IN INSIGNIFICANT BORE DIAMETER INCREASE (0.001" ON RADIUS).

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Type A Mock-Up



Type B Mock-Up

MOCK-UPS



## STRESS ANALYSIS - EFFECTIVENESS OF ROLLED JOINT

PURPOSE - TO DETERMINE THE CONTACT PRESSURE BETWEEN THE CRD HOUSING AND REACTOR VESSEL DURING VARIOUS OPERATING CONDITIONS FOLLOWING ROLLING OF THE HOUSING

- 0 A CRD HOUSING AND VESSEL MODEL WAS DEVELOPED USING ELASTIC-PLASTIC MATERIAL PROPERTIES.
- 0 FOLLOWING A SIMULATED ROLLING PROCESS ON THE MODEL, A REPEATING SERIES OF THERMAL CYCLES WERE APPLIED. EACH CYCLE CONSISTED OF:
  1. ISOTHERMAL HEAT UP FROM 70°F TO 550°F TO CONSIDER PLANT HEAT UP AND NORMAL OPERATION
  2. RESET SCRAM TRANSIENT, HOUSING AT 470°F, VESSEL AT 550°F ( T = 80°F)\*
  3. ISOTHERMAL COOL DOWN TO 75°F TO CONSIDER PLANT COLD SHUTDOWN
- 0 CONTACT PRESSURE BETWEEN THE HOUSING AND VESSEL WAS RECORDED. CONTACT PRESSURE VARIED OVER THE TRANSIENT FROM APPROXIMATE 3000 TO 7000 PSI.

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\* NOTE, THIS THERMAL CONDITION IS EQUIVALENT TO NORMAL OPERATION WITH COOLING FLOW TO CRD

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## RESULTS OF ANALYSES

CONDITION	CONTACT PRESSURE (PSI)	
	BEST ESTIMATE (2)	MINIMUM (3)
COLD SHUTDOWN AFTER INITIAL ROLL	6,500	5,200
STEADY STATE OPERATION AT 550°F		
o WITH COOLING FLOW	4,200	3,000
o WITHOUT COOLING FLOW	7,400	6,400
RESET SCRAM TRANSIENT/ NORMAL COOLING FLOW	4,200	3,000
COOL SHUTDOWN AFTER INITIAL HEATUP AND COOLDOWN	4,600	3,200

### NOTES

1. CYCLIC ANALYSIS AFTER 12 SIMULATED LOAD STEPS SHOWS NO RATCHETING.
2. BEST ESTIMATE BASED ON TYPICAL MATERIAL PROPERTIES.
3. MINIMUM BASED ON MINIMUM MATERIAL PROPERTIES.

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## RELATED EXPERIENCE AT OTHER BWR PLANTS

### INCORE PENETRATION LEAKS

#### 0 GARIGLIANO IN 1966

- ONE OUTER INCORE PENETRATION STUB TUBE LEAKED
- HOUSING WAS ROLLED; NO FURTHER LEAKS

#### 0 OYSTER CREEK IN 1974

- ONE OUTER INCORE PENETRATION LEAKED THROUGH THE WELD ATTACHING THE INCORE HOUSING TO THE VESSEL BOTTOM HEAD
- HOUSING WAS ROLLED; NO FURTHER LEAKS

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## RELATED EXPERIENCE AT OTHER BWR PLANTS

### CRD STUB TUBE/HOUSING LEAKS AFTER PLANT STARTUP

- 0 BIG ROCK IN APRIL 1979
  - ONE OF THE OUTSIDE CRD STUB TUBES OUT OF 32 LEAKED
  - ROLL REPAIRED STUB TUBE IN 1979. ROLLED JOINT STILL EFFECTIVE AS OF DECEMBER 1983.
  
- 0 SANTA MARIA DE GARONIA (NUCLENOR) IN 1981
  - ONE STUB TUBE IN THE SECOND ROW WAS FOUND LEAKING AS A RESULT OF A STUB TUBE CRACK 1/4 INCH BELOW THE ROOT OF THE STUB TUBE-TO-HOUSING WELD
  - A SECOND STUB TUBE WAS FOUND TO BE LEAKING IN SEPTEMBER 1983 DURING A HYDROTEST
  - TO DATE 55 STUB TUBES OUT OF 97 HAVE BEEN EXAMINED AND 42 CONTAIN DEFECTS. ONLY THE TWO LEAKERS HAVE BEEN REPAIRED TO MINIMIZE LEAKAGE
  - REPAIR WAS COMPLETED INITIALLY USING ROLL REPAIR. LEAKAGE WAS OBSERVED FROM ROLLED PENETRATION AND A MECHANICAL SEAL WAS INSTALLED. (MECHANICAL SEAL DISCUSSED LATER IN MEETING)

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## EVALUATION OF COLD WORK/IGSCC RESISTANCE

- 0 LABORATORY TESTS HAVE SHOWN THAT EXCESSIVE AMOUNTS OF COLD WORK CAN INCREASE THE POTENTIAL OF IGSCC IN 304 STAINLESS STEELS.
- 0 USING TEST DATA, GE ESTABLISHED A CORRELATION BETWEEN EXPECTED IGSCC RESISTANCE OF COLD WORKED MATERIAL WITH SURFACE HARDNESS.
- 0 SURFACE HARDNESS NOT EXCEEDING ROCKWELL B 95 IS NOT EXPECTED TO SIGNIFICANTLY LOWER RESISTANCE OF HOUSING MATERIAL TO IGSCC.
- 0 HARDNESS IN ROLLED REGION IS NOT A CONCERN. (PLACED IN NET COMPRESSION BY ROLLING.)
- 0 TRANSITION REGIONS AT END OF ROLLS ARE AREAS OF CONCERN FOR IGSCC - TENSILE STRESS STATE.
- 0 HARDNESS TESTS OF MOCK-UPS INDICATE TRANSITION REGION TO BE IN RANGE OF 87 TO 93 ROCKWELL B.
- 0 ABSENCE OF ANY IGSCC ATTACK IN SIMILAR ROLL JOINTS AT OTHER BWRs CONFIRMS HARDNESS RESULTS:
  - 10 YEARS SATISFACTORY EXPERIENCE AT OYSTER CREEK
  - 5 YEARS SATISFACTORY EXPERIENCE AT BIG ROCK POINT

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SAFETY ASSESSMENT OF NMP-1  
STUB TUBE CRACKS

- 0 PREVIOUS SAFETY ASSESSMENTS OF CRD STUB TUBE CRACKS ARE APPLICABLE TO NMP-1 AND REMAIN VALID
  - LEAKAGE LIMITED
  - CRD HOUSING EJECTION NOT POSSIBLE
  - STRUCTURAL INTEGRITY OF RCS BOUNDARY NOT AFFECTED
  - NO EFFECT ON CRD OPERATION/SCRAM
- 0 TUBE ROLLING OPERATION FURTHER MINIMIZES ANY LEAKAGE AND PROVIDES ADDITIONAL HOUSING SUPPORT; DOES NOT CHANGE SAFETY ASSESSMENT
- 0 EXISTING DRYWELL LEAKAGE MONITORING CAPABILITY IS EXCELLENT AND ADEQUATE TO MONITOR PENETRATION LEAKAGE IN SERVICE
  - LEVEL RATE-OF-RISE IN DRYWELL FLOOR DRAIN TANK (CR ALARM AND RECORDER, 1/4 GPM SENSITIVITY)
  - PUMP-OUT TIMER (CR ALARM AND RATE, SENSITIVITY 5 GPM IN 18 MIN., 0.5 GPM IN 180 MIN., ETC.)
  - INTEGRATED FLOW TO WASTE DISPOSAL IS MONITORED

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II. INSPECTION PLANS FOR SPRING 1986 REFUELING OUTAGE

A. HYDROTEST

B. VISUAL EXAMS

C. ULTRASONIC EXAMS

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II. INSPECTION PLAN FOR SPRING 1986 REFUELING OUTAGE

A. INSERVICE INSPECTION PLAN SUBMITTED TO NRC  
SEPTEMBER 1984

B. THE FOLLOWING INSPECTIONS ARE PLANNED:

1. HYDROTEST

- A. INSPECT FOR EVIDENCE OF LEAKAGE SUCH  
AS WATER DROPS AT CRD HOUSING FLANGE
- B. IF LEAKAGE IS OBSERVED, CONFIRM THE  
SOURCE OF LEAKAGE BY EXAMINING  
VICINITY OF LOWER VESSEL HEAD, I.E.,  
WATER STREAKS, DISCOLORATION OR  
CORROSION PRODUCTS
- C. PERFORM INSPECTION DURING EACH SYSTEM  
LEAKAGE OR SYSTEM HYDROSTATIC TEST
- D. EVALUATE ANY OBSERVED LEAKAGE ON CASE  
BASIS (GUIDELINES FOR REPAIR HAVE  
BEEN DEVELOPED)

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2. VISUAL EXAMINATION FROM INSIDE THE REACTOR VESSEL

- A. INSPECT FOR CRACKING WHICH COULD RESULT IN FUTURE LEAKAGE
- B. UTILIZE CLOSED CIRCUIT TV
- C. EXAMINE THE FOLLOWING:
  - (1) WELD AND HEAT AFFECTED ZONES (HAZ) OF STUB TUBE-TO-VESSEL WELD AND ADJACENT AREAS
  - (2) WELD AND HAZ OF STUB TUBE-TO-CRD HOUSING J-WELD AND ADJACENT AREAS.
  - (3) ALL ACCESSIBLE SURFACES OF STUB TUBES
- D. EXAMINE WHENEVER ACCESSIBLE DURING EACH 10 YEAR INSPECTION INTERVAL (ASME SECTION XI, TABLE IWB-2500-1)
- E. EVALUATE CRACKS ON A CASE BASIS.





### 3. ULTRASONIC EXAMINATION

- A. INSPECT FOR CRACKS OR DEFECTS IN CRD HOUSING AND FUSION ZONE OF THE CRD HOUSING TO STUB TUBE WELD.
- B. EXAMINE THE FOLLOWING:
  - (1) ENTIRE INTERIOR SURFACE OF CRD HOUSING FROM OUTSIDE EDGE OF VESSEL BOTTOM HEAD THROUGH AND INCLUDING ROLLED AREA TO APPROXIMATELY 2 INCHES ABOVE THE J-WELD
  - (2) ROLLED AREA INSPECTION TO INCLUDE TRANSITION FROM ROLLED TO UNROLLED AREAS FOR EVIDENCE OF DEFECTS
- C. EXAMINE AT LEAST ONE PREVIOUSLY ROLLED HOUSING EACH REFUEL OUTAGE. EXAMINE DIFFERENT HOUSINGS EACH OUTAGE AS PRACTICAL
- D. IF NO DEFECTS ARE FOUND DURING THE FIRST THREE REFUEL OUTAGES, REDUCE FREQUENCY OF INSPECTION TO ONE PENETRATION EVERY THIRD REFUEL OUTAGE
- E. EVALUATE RESULTS ON A CASE BASIS

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### III. PREPARATION FOR SPRING 1986 OUTAGE REPAIRS

- A. VERIFICATION OF ACCEPTABILITY OF ROLLING PROCESS - EPRI METALLURGICAL/MGCL<sub>2</sub> TESTS
- B. DEVELOPMENT OF ROLL REPAIR IMPROVEMENTS
  - 1. PROCUREMENT OF IMPROVED ROLLING EQUIPMENT, MOCKUPS
  - 2. MOCK-UP TESTS OF METHODS FOR RE-ROLLING PREVIOUSLY ROLLED HOUSINGS
  - 3. EVALUATION OF CRD THERMAL SLEEVE EFFECTIVENESS
  - 4. JUSTIFICATION FOR SECURING COOLING
- C. GUIDELINES FOR REPAIR OF LEAKING CRD PENETRATIONS

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## VERIFICATION OF ACCEPTABILITY OF ROLLING PROCESS

- 0 AS DISCUSSED, EVALUATIONS WERE COMPLETED TO DETERMINE COLD WORK EFFECTS ON IGSCC RESISTANCE PRIOR TO ROLL REPAIR IN 1984 OUTAGE
- 0 IGSCC RESISTANCE WAS FOUND TO BE UNAFFECTED BASED ON SERVICE EXPERIENCE AND CORRELATIONS USING HARDNESS LEVELS
- 0 FURTHER INVESTIGATIONS UNDERWAY AT EPRI-CHARLOTTE:
  - EVALUATION OF STRAIN-INDUCED MARTENSITE
  - STUDY OF RESIDUAL STRESSES
- 0 PRELIMINARY RESULTS
  - MARTENSITE IS PRESENT, BUT ONLY IN ROLLED REGIONS OF HOUSING I.D.
  - NET STRESSES IN ROLLED REGION ARE COMPRESSIVE AND WILL ARREST ANY CRACKING
  - ROLLING DOES NOT AFFECT IGSCC RESISTANCE OF ROLLED HOUSING

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## DEVELOPMENT OF ROLL REPAIR IMPROVEMENTS

### ADDITIONAL MOCK-UP TESTS

0 PURPOSE - TO EVALUATE AND BETTER UNDERSTAND THE EFFECTIVENESS OF ROLL REPAIR APPROACHES.

0 THREE ADDITIONAL TESTS

- RE-ROLLING TEST - CONSISTS OF ROLLING TWO ADDITIONAL EXPANSION ROLLS ON A PREVIOUSLY ROLLED HOUSING. THIS TEST WILL PROVIDE:

-- ROLLING PROCEDURES FOR REPAIR OF PREVIOUSLY ROLLED HOUSINGS FOUND TO BE LEAKING

-- DATA ON EFFECT OF RE-ROLLING

- PULL-OUT STRENGTH TEST - CONSISTS OF PULLING A HOUSING OUT OF ITS ROLLED JOINT. THIS TEST WILL DETERMINE THE EFFECTIVENESS OF THE ROLLED JOINT IN RETAINING THE CRD HOUSING AGAINST STEADY-STATE AND TRANSIENT LOADS.

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- ROLL TEST OF A NUCLEAR GRADE HOUSING MATERIAL -  
CONSISTS OF ROLLING A HOUSING FABRICATED FROM  
NUCLEAR GRADE MATERIAL. THIS TEST DETERMINES  
THE EFFECTIVENESS OF THE ROLLED SEAL AND  
ADEQUACY OF EXISTING TOOLS AND PROCEDURES WHEN  
USING A NUCLEAR GRADE MATERIAL. (FOR EVALUA-  
TION OF POSSIBLE LONG-TERM REPAIR APPROACH -  
DISCUSSED LATER.)
  
- TEST PLANNED, AT SITE IN DECEMBER 1985 -  
JANUARY 1986

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## EVALUATION OF CRD THERMAL SLEEVE

- 0 CONCERN - IS EXCESS COOLING WATER BYPASSING THE THERMAL SLEEVE, THEREBY DECREASING THE EFFECTIVENESS OF THE ROLLED JOINT?
- A FRACTION OF THE NORMAL COOLING WATER FLOW CAN PASS THROUGH THE GAP BETWEEN THE CRD HOUSING AND THE THERMAL SLEEVE
  - THIS FLOW IS LIMITED BY CLOSE FIT CLEARANCES BETWEEN THE LOWER PORTION OF THE THERMAL SLEEVE AND THE HOUSING
  - EVALUATIONS SHOW THAT THE THERMAL SLEEVE BYPASS FLOW IS ACCEPTABLY LOW.

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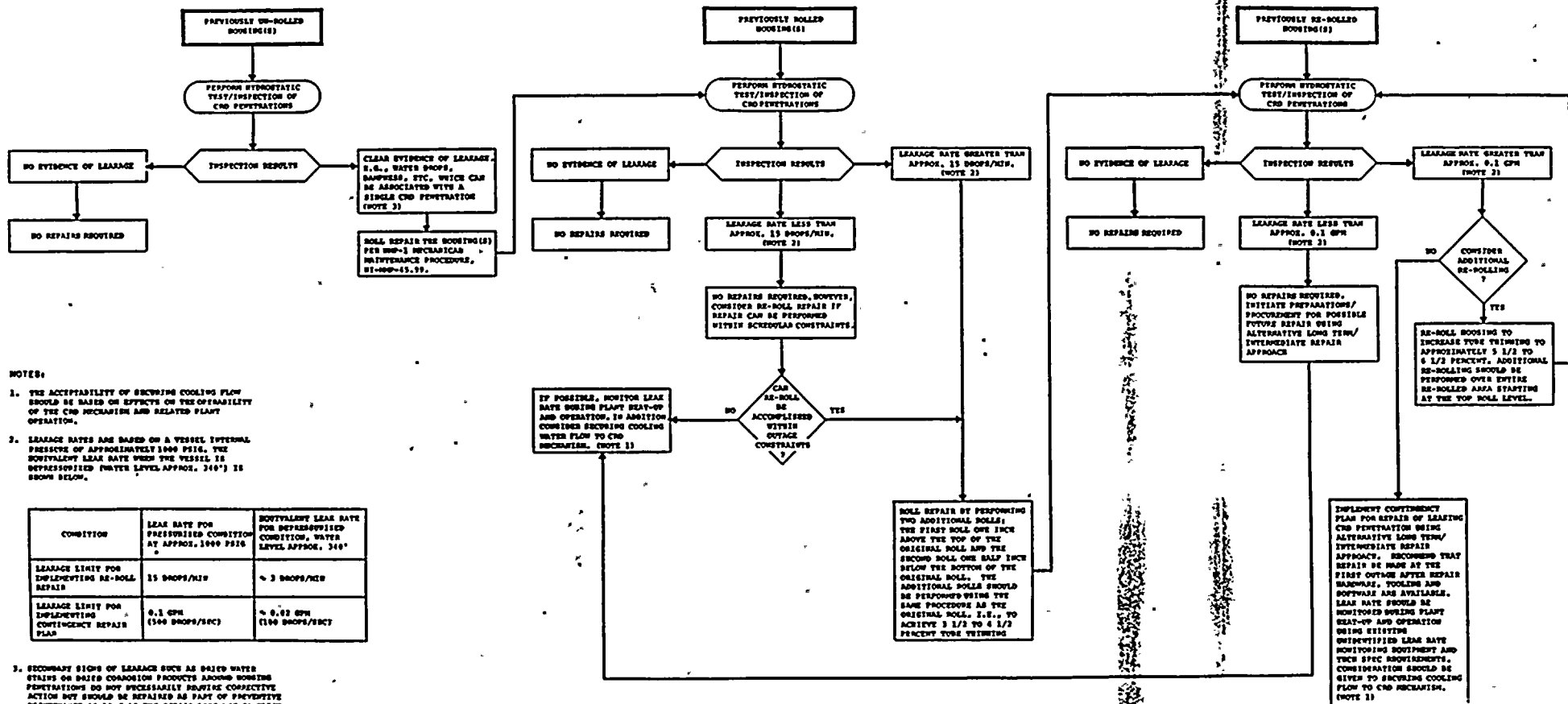


## EFFECT OF CRD COOLING WATER FLOW

- 0 EXPERIENCE AND ANALYSIS INDICATE COOLING WATER FLOW REDUCES ROLLED JOINT EFFECTIVENESS.
- 0 AT LEAST ONE BWR HAS OPERATED WITHOUT COOLING WATER TO SELECTED DRIVES WITH NO SIGNIFICANT EFFECT ON DRIVE OPERATION OR LIFETIME. SECURING COOLING FLOW WAS EFFECTIVE IN REDUCING LEAKAGE.
- 0 NMPC IS EVALUATING ACCEPTABILITY OF SECURING COOLING TO SELECTED DRIVES WHICH LEAK IN SERVICE. AREAS BEING EVALUATED:
  - CRD OPERATION
  - LIFETIME OF NON-METALLICS
  - TECH SPEC LIMITS

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- NOTES:
1. THE ACCEPTABILITY OF SECURING COOLING FLOW SHOULD BE BASED ON EFFECTS ON THE OPERABILITY OF THE CRD MECHANISM AND RELATED PLANT OPERATION.
  2. LEAKAGE RATES ARE BASED ON A VESSEL INTERNAL PRESSURE OF APPROXIMATELY 1000 PSIG. THE EQUIVALENT LEAK RATE WHEN THE VESSEL IS DEPRESSURIZED WATER LEVEL APPROX. 316" IS SHOWN BELOW.

CONDITION	LEAK RATE FOR PRESSURIZED CONDITION AT APPROX. 1000 PSIG	EQUIVALENT LEAK RATE FOR DEPRESSURIZED CONDITION, WATER LEVEL APPROX. 316"
LEAKAGE LIMIT FOR IMPLEMENTING RE-ROLL REPAIR	15 DROPS/HR	~ 3 DROPS/HR
LEAKAGE LIMIT FOR IMPLEMENTING CONTINGENCY REPAIR PLAN	0.1 GPM (100 DROPS/SEC)	~ 0.02 GPM (100 DROPS/SEC)

3. SECONDARY SIGNS OF LEAKAGE SUCH AS SAILED WATER STAINS OR SAILED CORROSION PRODUCTS AROUND HOUSING PENETRATIONS DO NOT NECESSARILY DEMAND CORRECTIVE ACTION BUT SHOULD BE REPAIRED AS PART OF PREVENTIVE MAINTENANCE AS LONG AS THE REPAIR DOES NOT CONFLICT WITH OUTAGE CONSTRAINTS.

TABLE I  
NMP-1  
GUIDELINES FOR REPAIR OF LEAKING  
CONTROL ROD DRIVE (CRD)  
PENETRATIONS





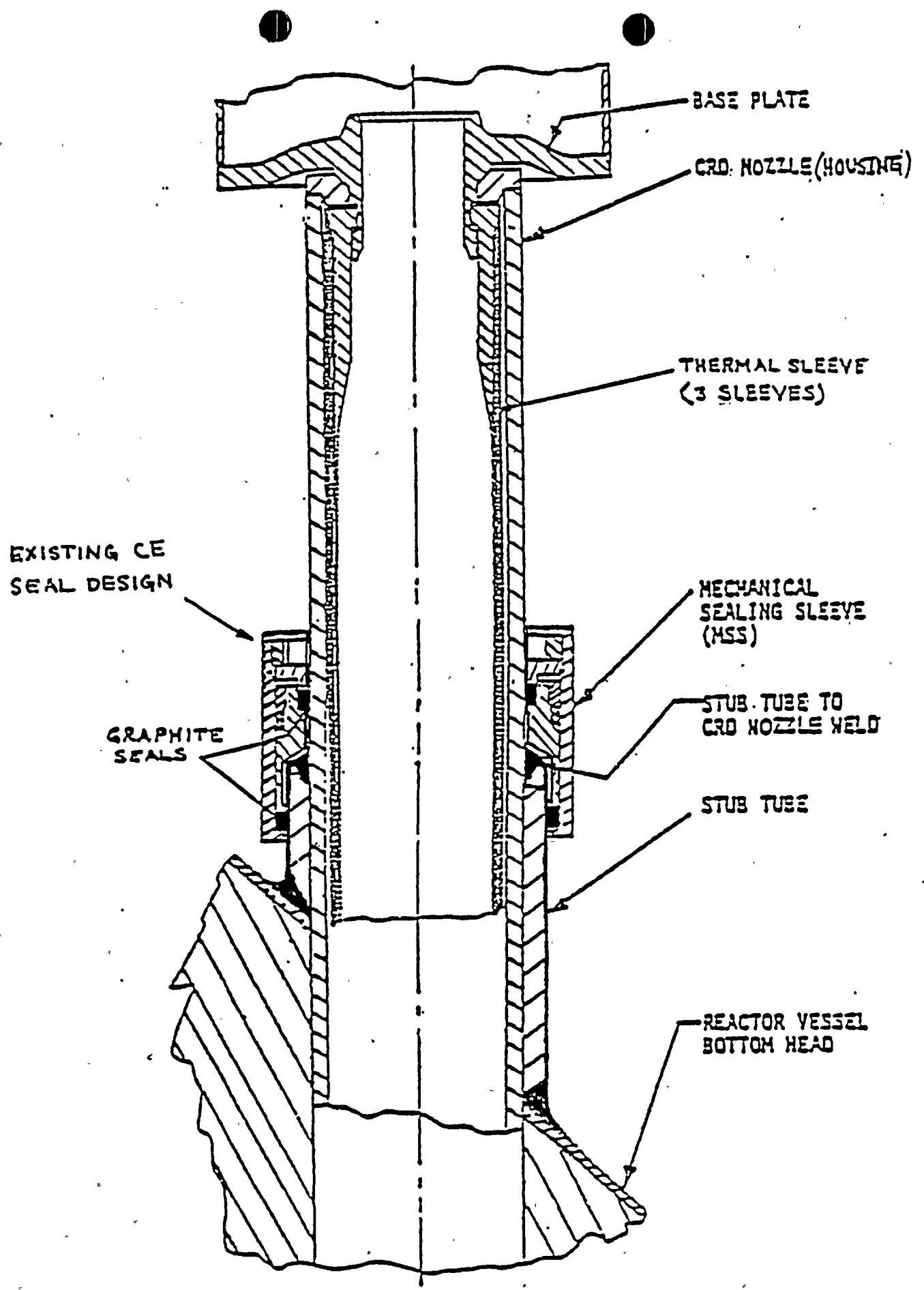
IV. DEVELOPMENT OF LONG-TERM REPAIR METHODS

A. REVIEW OF DEVELOPMENT BY OTHERS

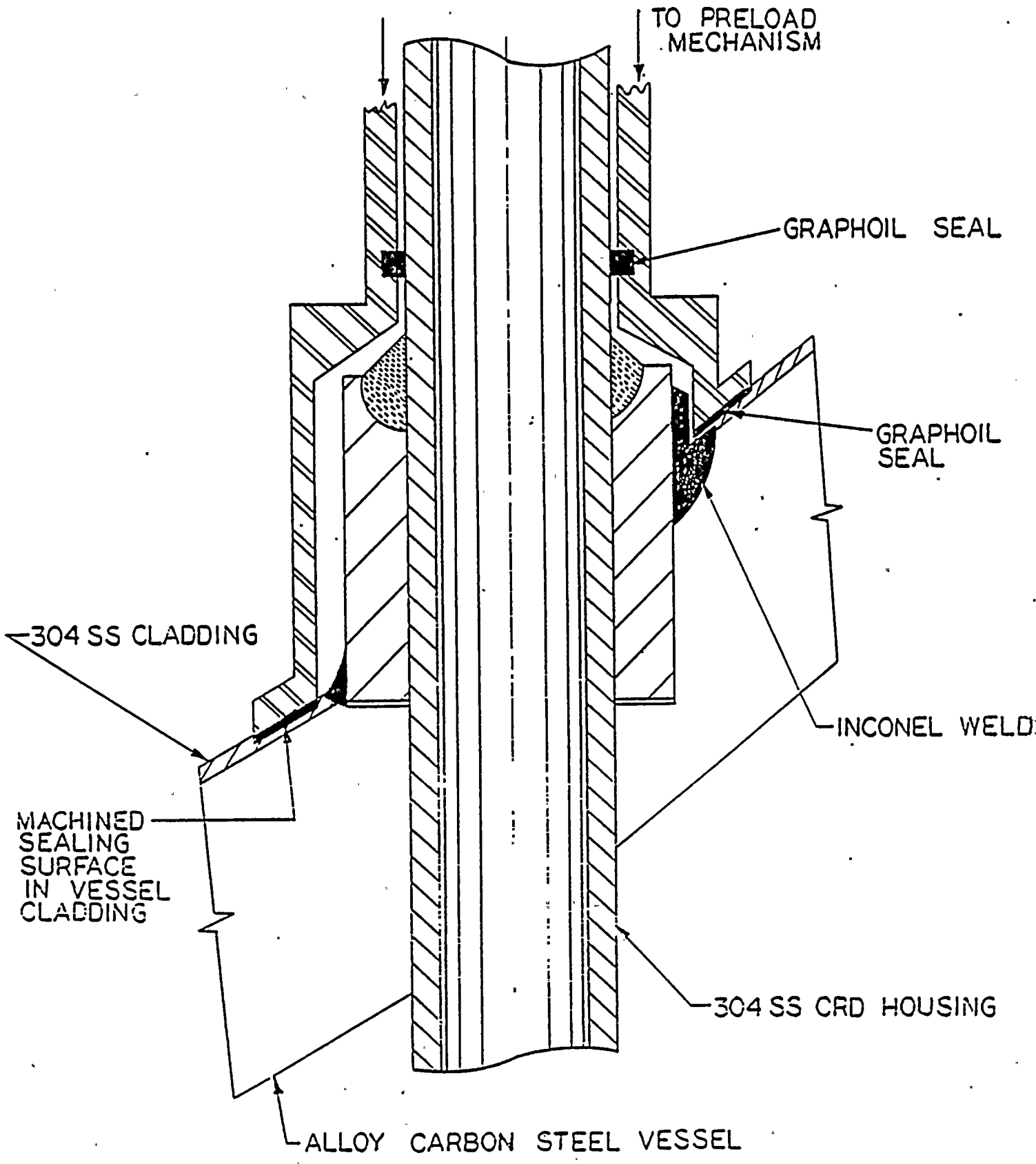
- o GE AND JAPANESE WELDED REPAIRS
- o CE/NUCLENOR MECHANICAL SEAL
  - EXISTING DESIGN
  - BOTTOM MOUNTED HEAD DESIGN

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COMBUSTION ENGINEERING BOTTOM HEAD SEAL CONCEPTUAL DESIGN



MPR MECHANICAL SEAL ASSEMBLY

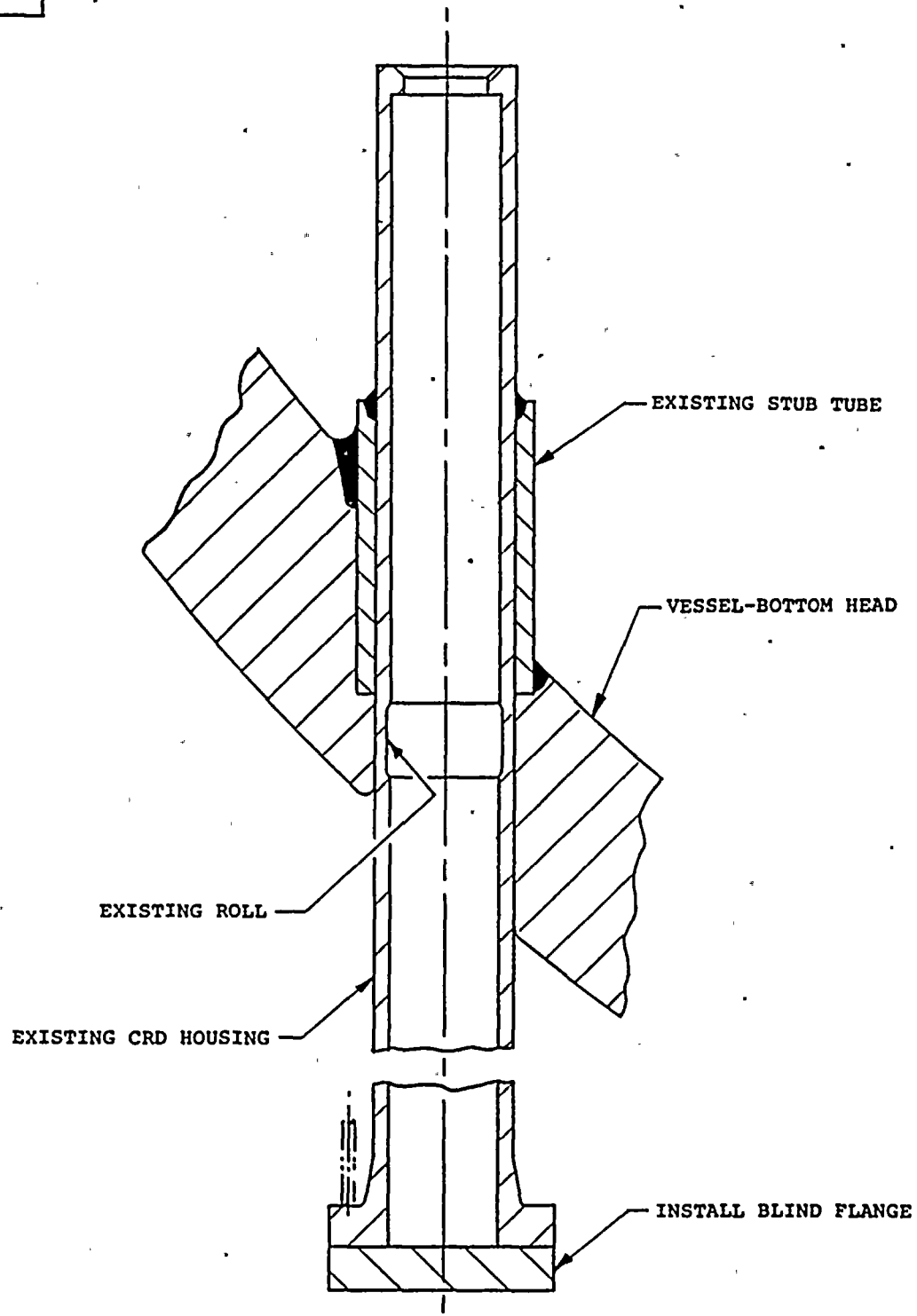
RETAIN CRD HOUSING/REMOVE STUB TUBE; USE EXISTING  
ROLLED JOINT AND MECHANICAL BACKUP SEAL

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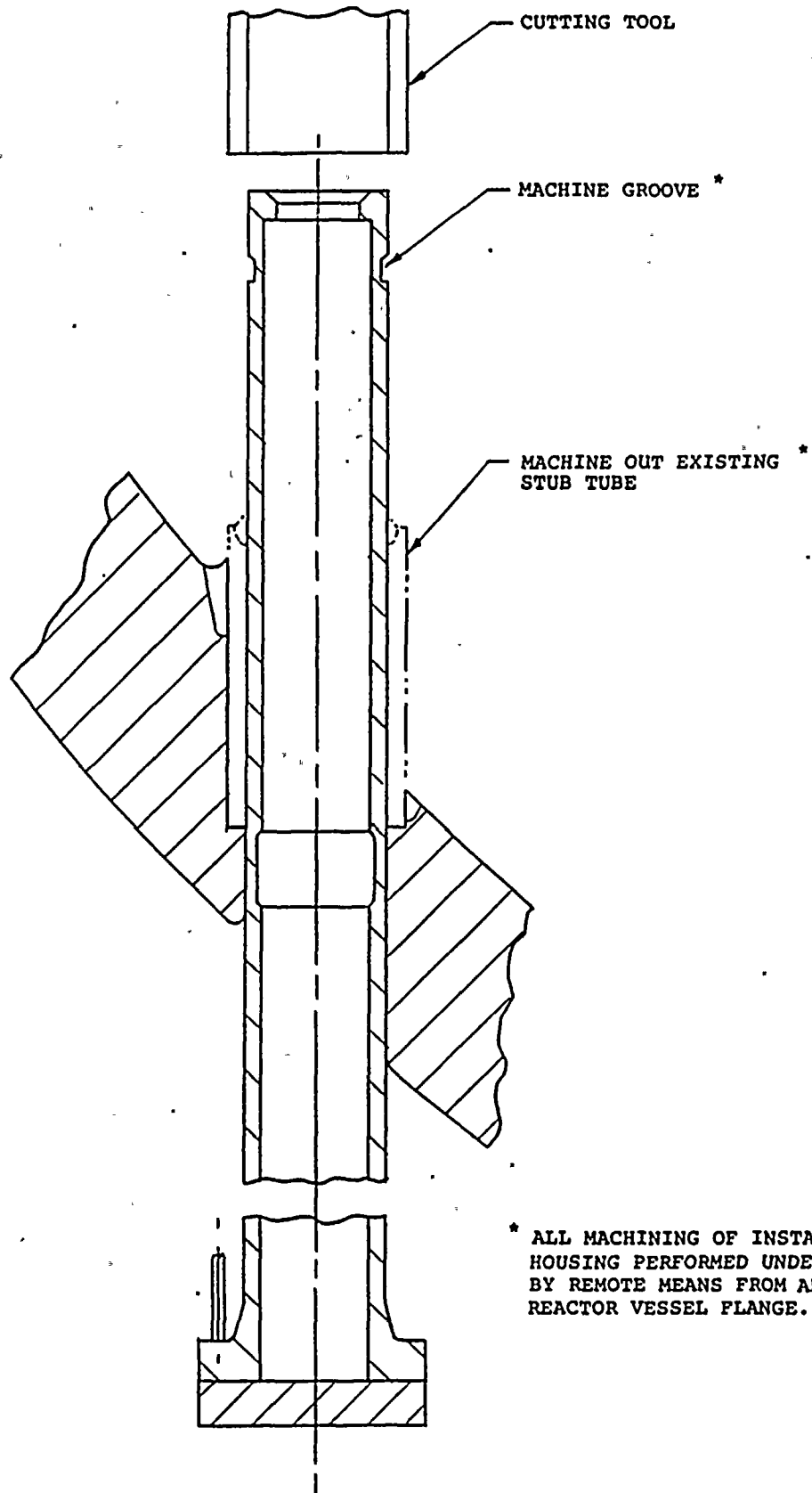
MPR ASSOCIATES  
F-85-43-55  
4/24/85



STEP 1 - REMOVE CRD MECHANISM, INSTALL BLIND  
FLANGE, REMOVE CONTROL ROD & GUIDE TUBE



MPR ASSOCIATES  
F-85-43-56  
4/24/85

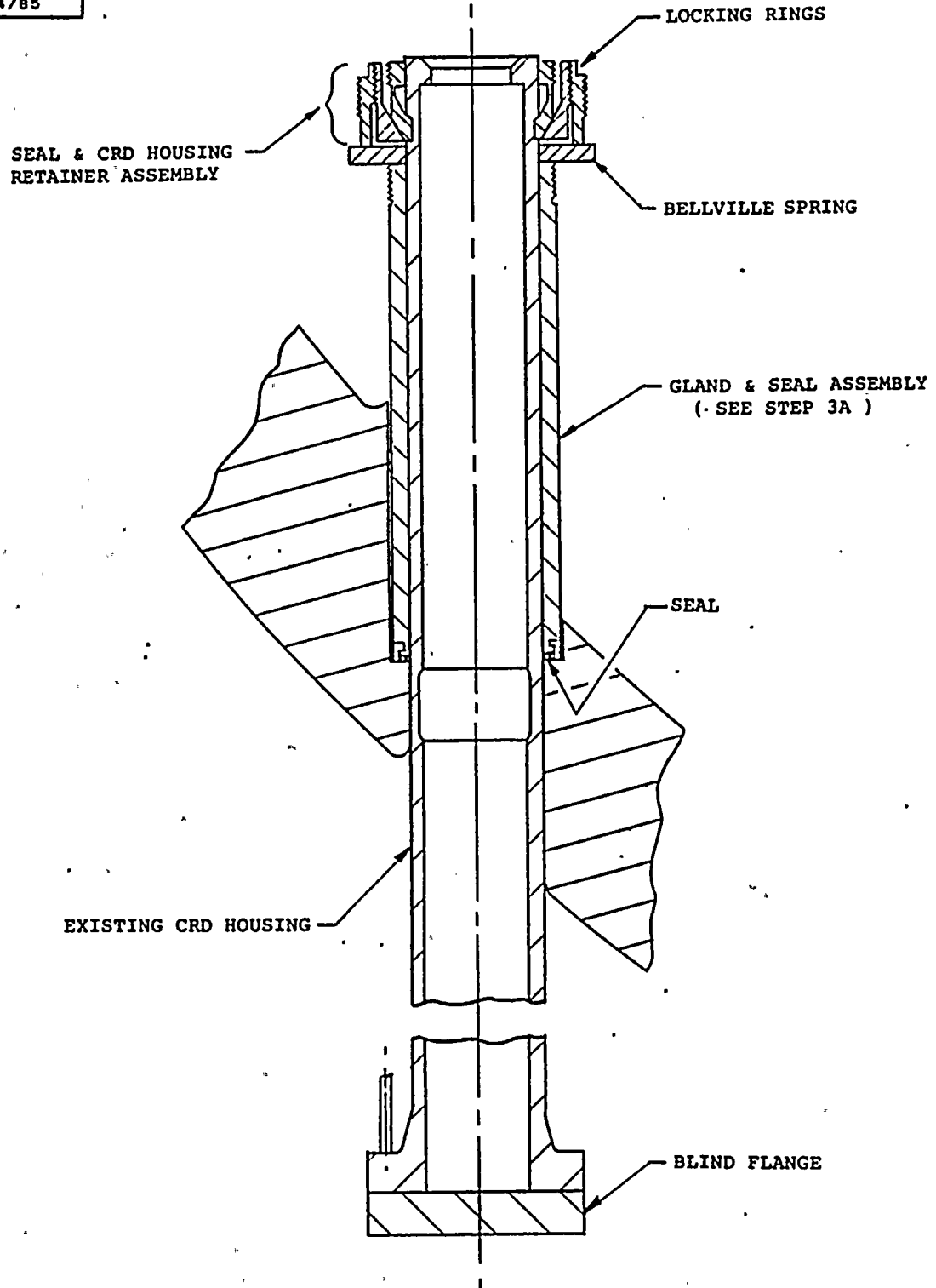


\* ALL MACHINING OF INSTALLED CRD HOUSING PERFORMED UNDERWATER BY REMOTE MEANS FROM ABOVE REACTOR VESSEL FLANGE.

STEP 2 - MACHINE OUT EXISTING STUB TUBE & MACHINE GROOVE AT TOP OF CRD HOUSING



MPR ASSOCIATES  
F-85-43-87  
4/24/85



STEP 3 - INSTALL SEAL, GLAND, & LOCKING RINGS



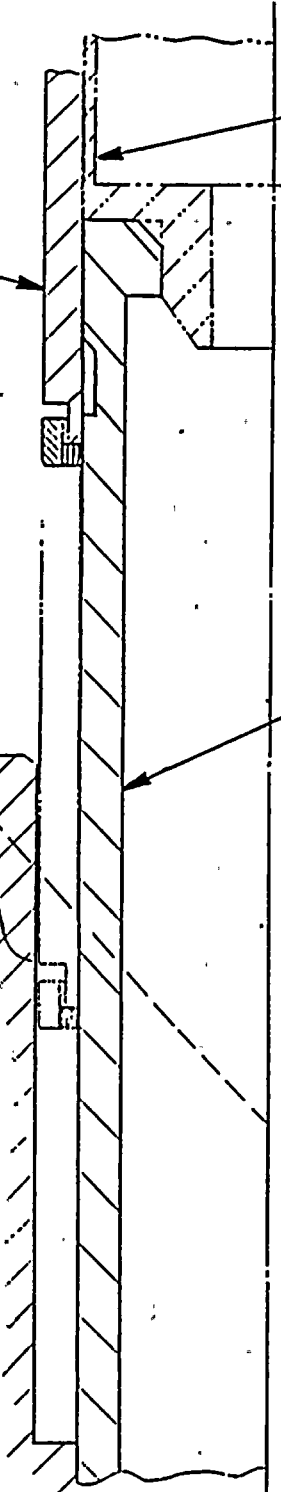
MPR ASSOCIATES  
F-85-43-58  
4/24/85,

GLAND WITH GLAND RING,  
AND PACKING SEAL,  
ATTACHED

SLEEVE PORTION OF  
GLAND INSTALLATION TOOL

EXISTING CRD HOUSING

VESSEL BOTTOM HEAD



STEP 3A - LOWERING OF GLAND INTO BOTTOM HEAD CAVITY  
WITH GLAND RING & PACKING SEAL ATTACHED





MPR MECHANICAL SEAL REPAIR OPTION

- 0 REPLACE CRD HOUSING; USE ROLLED JOINT AND MECHANICAL SEAL FOR SEALING
- 0 CONCEPTUAL DESIGN AND INSTALLATION PROCEDURE DEVELOPED

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C. NMP-1 MECHANICAL SEAL DEVELOPMENT

1. DEMONSTRATION OF STUB TUBE AND HOUSING MACHINING - PCI
  - o EXPLORATORY TESTS COMPLETE
  - o FULL SCALE MOCKUP TO BE FABRICATED
  - o FULL SCALE MACHINING DEMONSTRATION PLANNED FOR LATE 1985, EARLY 1986
2. MECHANICAL SEAL ASSEMBLY DESIGN - DETAIL DESIGN COMPLETE
3. INSTALLATION TOOLING - CONCEPTUAL DESIGNS COMPLETE
4. STRESS ANALYSIS - COMPLETE

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A technical cross-sectional drawing of a mechanical seal assembly. The central component is a vertical shaft with a central bore. At the top, the shaft is secured by a nut and washer. The shaft is surrounded by a seal assembly consisting of a rotating ring and a stationary ring. The stationary ring is mounted on a housing. The housing is shown in cross-section with diagonal hatching. The lower part of the housing is labeled 'CRD HOUSING'. On the left side, a cavity is labeled 'LOWER VESSEL HEAD CAVITY'. The drawing uses solid lines for visible surfaces and dashed lines for hidden internal features. Two circular punch holes are visible at the top of the page.

LOWER VESSEL  
HEAD CAVITY

CRD HOUSING

NMP-1  
PROTOTYPE MECHANICAL SEAL ASSEMBLY



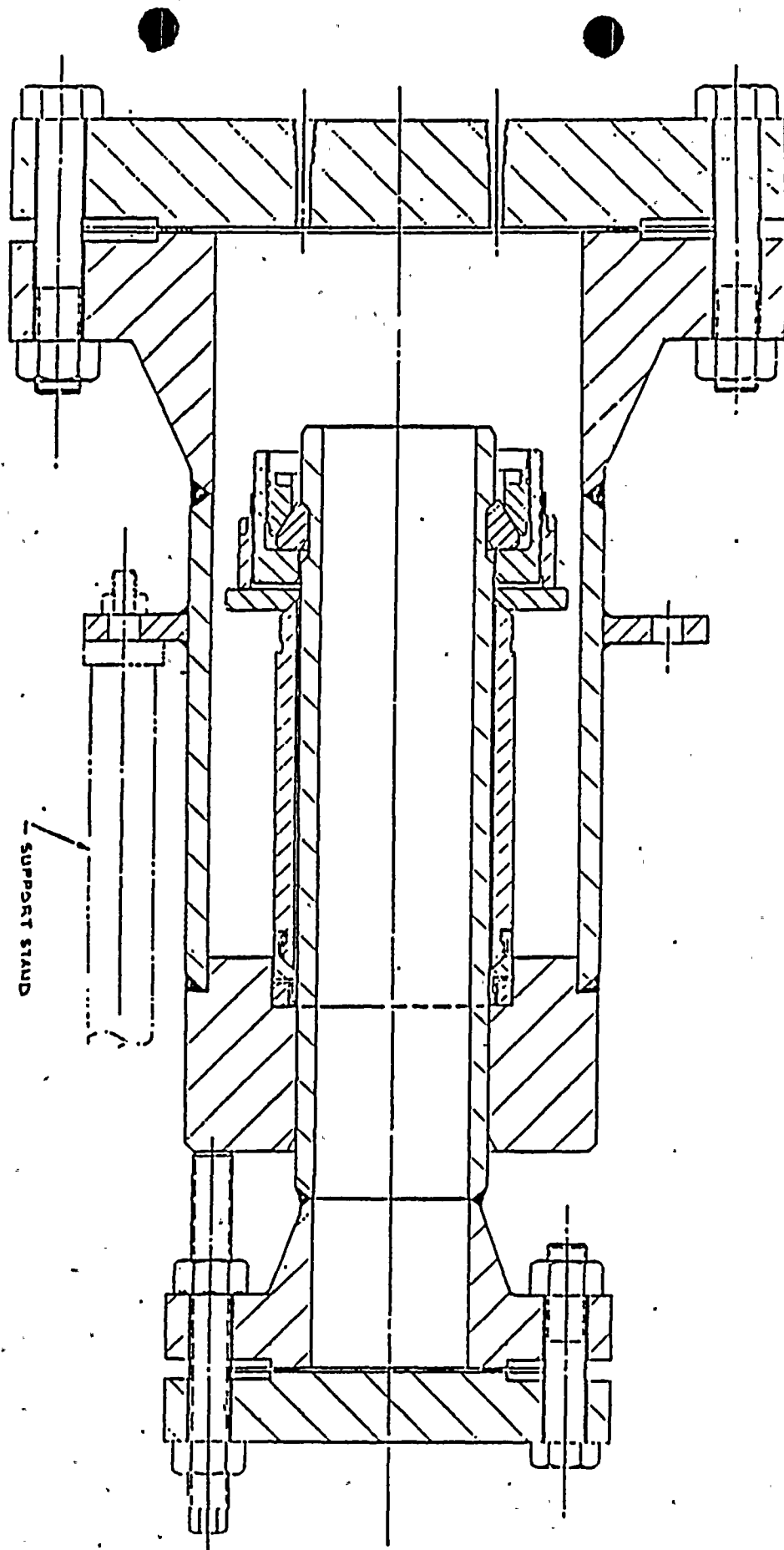
5. SEAL ASSEMBLY PROTOTYPE DEVELOPMENT TESTING

- 0 PROTOTYPE SEAL FABRICATION - OUT FOR BIDS,  
FABRICATION LATE 1985, EARLY 1986
- 0 TEST FIXTURE DESIGN - OUT FOR BIDS,  
FABRICATION LATE 1985, EARLY 1986
- 0 TEST PLAN
  - SEAL LEAKAGE TESTS, AMBIENT CONDITIONS
  - NORMAL CONDITIONS
  - DIFFERENT SEAL MATERIALS
  - WITH AND WITHOUT PRELOAD
  - ROUGHENED, RUSTED SEAL SURFACES

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NMP-1  
PROTOTYPE MECHANICAL SEAL ASSEMBLY  
TEST FIXTURE



1  
2  
3

6. CONTINGENCY PLANNING FOR IMPLEMENTATION OF  
LONG-TERM REPAIR

- 0 PROCUREMENT SPEC FOR NG MATERIALS - COMPLETE
- 0 INSTALLATION SPEC
- 0 PROCUREMENT SPEC FOR PRODUCTION TOOLING
- 0 PROCUREMENT OF SELECTED LONG LEAD MATERIALS

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