# SPECIAL REPORT

# ON

# SPARE CRDM WELD

# REFURBISHMENTS

Public Service Electric & Gas

Salem Generating Station

September 1988

CRDM LEAK REPAIR/REFURBISHMENT REPORT
SALEM - 1

## TABLE OF CONTENTS

## 1.0 EXECUTIVE SUMMARY

On January 7, 1988, Salem Unit 1 was being returned to service after its seventh refueling outage. RCS inservice hydrostatic testing was being conducted at 2300 psi with the Unit in Mode 3 (heatup) as a part of the recently installed bottom mounted instrumentation design modification. Reactor head area inspection through the lower shroud inspection doors revealed the presence of pin hole leaks on three canopy weld locations of spares or the reactor vessel head adapters. The leaks were characterized by fine sprays of steam/water from the pinholes on the head penetrations E5, E7 and G7 (Attachment 2).

The Unit was returned to Mode 5 (cold shutdown) for repairs and additional inspection. With the reactor shroud removed, a visual inspection was made on all Control Rod Drive Mechanism (CRDM) housings. Three additional spare CRDM adapters (J5, J7 and J9) were found to have boron buildup indicating them as potential candidates for leakage. No defects were found on the other penetrations including the full length CRDMs.

Based on these findings, management made a decision to repair or refurbish all the 13 spare adapters.

A number of repair/refurbishment methods for leaking canopies were considered. These included mechanical seals, spot repairs on the leaking canopy, replacement of canopies, cutting and capping the adapters below the canopy, split canopy, and weld buildup. The two candidates that could be implemented based on considerations of repair effectiveness, required development time and ALARA considerations were the cut and cap repair and weld buildup.

Since access to interior penetration locations is difficult and radiation fields are high, both the available options were reviewed carefully with respect to these concerns. Automatic, remotely operated cutting equipment was not yet developed for this geometry. Therefore radiation exposure for the cut and cap method would be excessive (total job 302 man-REM) compared to the buildup method for which no cutting is required and automated welding equipment is available (total job 55 man-REM). Further, a four pass overlay technique was recently implemented successfully at Indian Point 2 on spare CRDM penetration adapters and the equipment was available. Therefore, from an ALARA and experience standpoint, the buildup option was chosen. Welding Services, Inc. of Atlanta, Ga. was chosen to perform weld buildup based on their preparedness, experience at Indian Point 2, and their overall experience (Attachment 9).

The method of repair/refurbishment used for the spare penetration canopies is weld buildup, except for the use of split canopy repair at the peripheral penetration El. This was done to preserve that peripheral spare canopy seal for future root cause analysis. The buildup/overlay method, and its precedence, both from a historical and regulatory standpoint, are discussed in the safety evaluation along with considerations of the technical adequacy in the special circumstances at Salem.

Apart from the repair/refurbishment modifications described above, boron was cleaned from the affected reactor head areas, the penetration counterbores and from the nine reactor vessel studs. All boric acid traces were removed using scotch brite and damp rags with demineralized water. All surfaces were dried immediately after wet cleaning to minimize resultant corrosion or rusting. No material damage was found or caused.

The evaluation regarding the feasibility of installing a CRDM leak detection system as proposed during the Salem Unit 2 instrument column leak event was ongoing. To detect any leak in the area of the reactor head penetrations in a expedious way, the design of an experimental leak detection system was finalized and its installation was completed along with the canopy repair/refurbishment.

The method of refurbishment chosen for the leak mitigation was reviewed with both the Region 1 of USNRC and NRR on January 28, 1988 and February 4, 1988, respectively. This special report for the CRDM leak repair/refurbishment performed is developed as per PSE&G's commitment to the NRC.

## 2.0 REVIEW OF EXPERIENCE AT OTHER UTILITIES

A review of canopy seal weld failures in the industry revealed that these failures had been occurring since the early 1970s. However, only a few utilities had considered these failures reportable.

### Consolidated Edison - Indian Point 2

During the 1986 refueling outage at Indian Point 2, leaks were observed during cooldown. The RCS pressure was approximately 300 psig. The leakage was from the canopy seal weld on four of the spare penetrations. The same problem had been discovered during a previous outage. In all cases, the leakage was only a few pounds of boric acid with a minimal spread of radioactivity.

Indian Point did not consider this leakage as pressure boundary leakage. They contracted Welding Services of Atlanta to perform a remote weld overlay.

Northern States Power - Prairie Island

Prairie Island had several canopy seal weld leaks starting in the mid-1970's. All of the leaks occurred in spare CRDM or instrument locations. Prairie Island used manual local weld repairs to fix their initial leaks and these CRDMs have not leaked since. Prairie Island has also used a split ring canopy weld in more recent repairs. Preliminary findings of its spare canopy being evaluated by Westinghouse indicates that the leak was caused by transgranular stress corrosion cracking initiated at the areas of lack of penetration on the inside diameter (ID).

Pacific Gas and Electric - Diablo Canyon

During March 1988, leaks at 4 canopy seals at Diablo Canyon Unit 1 on the spare penetrations were located. Over the next few weeks, these spare adapters were cut and a cap welded on using full penetration butt weld. Inspection access doors in the head shroud panels were also installed. Westinghouse analysis has indicated that the leaks were caused by transgranular stress corrosion cracking. Cracks initiated at lack of penetration, weld ID corrosion, fused areas and at base metal ID surfaces.

Carolina Power & Light - Robinson

A leak was discovered at Robinson during an outage in 1984 while performing surveillance of the vessel head. The leak was on a spare canopy seal location. Westinghouse performed a cut and cap weld repair. Robinson also had some canopy seal leaks in the 1970s.

Florida Power & Light - Turkey Point

In May 1987, Turkey Point 3 experienced leaks in the canopy seal welds at spare locations D-7 and D-9. More recently a leak was observed at location D-8, a full length control rod location. FP&L repaired the D-7 and D-9 locations by cutting the head adapters below the weld and welding a new cap in place. In the case of D-8, a full length drive, a split ring canopy was installed using a manual welding process. Westinghouse performed these repairs.

Florida Power & Light conducted the metallurgical evaluation of a failed weld. The results of their root cause investigation indicated that the degradation had occurred at the location of a weld repair from the inside of the weld outward, and that it was related to incomplete weld fusion. A contributing factor was believed to be the presence of a crevice (stagnant region) allowing the concentration of aggressive elements. Turkey Point installed a radiation monitor and new shroud inspection access doors to better facilitate identification of these leaks in the future.

WOG Survey & Westinghouse

In summarizing the industry experience, it is clear that these leaks are most likely to occur in canopy seal welds at spare locations. Westinghouse is currently in the process of compiling data on these failures through the Westinghouse Owners Group (WOG). Of the utilities that have responded to them, the data shows that spares are roughly 50 times as likely to fail as full length CRDMs (with instruments columns approximately 20 times as likely).

Westinghouse provided the results of their domestic plant seal weld leakage survey. No plant names were provided. Nine plants reported leaks, twenty-three reported no leaks, and the rest did not report. Of the plants reporting, including Salem, the data can be broken down as follows:

| Head Adapter | Leaks | No. of Seal Welds | % Leakers | No. of Plants |
|---|---|---|---|---|
| Spares | 24 | 374 | 6.42 | 8 |
| T/C | 5 | 142 | 3.52 | 3 |
| PLCRDM | 2 | 136 | 1.47 | 2 |
| FLCRDM | 3 | 1574 | 0.19 | 2 |
| Total | 34 | 2226 | 1.48 | 9 |

WOG and/or Westinghouse are investigating the generic root cause analysis. Westinghouse is also working on development of remote welding technique using split canopies and NDE to determine incipient leakage from the seal welds.

## 3.0 REPAIR/REFURBISHMENT OPTIONS

Six options were available to repair/refurbish canopy seals. A brief description of each method is provided here below.

Local Manual Repairs

In this method, the defective area is removed by grinding and a manual through wall weld repair is made. It is most effective when the defective area in the weld is narrow. The difficulties of this method include poor access for welders, removal of the moisture from the back side of the weld, reestablishing an effective inert gas purge, and high radiation exposures. The disadvantage of this method is that it treats only the area that is leaking. Other areas in the weld which may be defective, but not yet leaking, are not addressed. The main advantage is that it can be done quickly and inexpensively and requires no specialized equipment. With adequate mock-up training this method can be effective.

Weld Metal Buildup/Overlay

With this method, one or more layers of new weld metal are deposited over the top of the canopy seal weld. The weld metal is deposited with a remotely operated orbital welding machine, therefore, radiation exposures are low. Although all of the buildups to date have been made at spare locations, buildups can be made on full length drives at any location while the head is on the vessel. For this reason it is the most versatile refurbishment method available today. Overlays can be designed to meet the original design requirments for full 40 year service.

Cut and Cap

With this method the upper end of the head adapter and entire plug is cut off. A pipe cap is then butt welded to the remaining portion of the head adapter. This is a permanent repair and is the preferred repair for spare head adapter locations when the head is removed from the vessel. The disadvantages are that it is time consuming, expensive, involves a relatively high radiation dose, and it cannot be used to repair a full length drive.

Split Canopy

This is a repair that Westinghouse states is a permanent repair method for either a spare or full length drive location. A split ring is placed around the original canopy and circumferentially seal welded above and below the original canopy. The two longitudinal seams in the split ring are then welded. This forms a second canopy to contain any leakage through the first canopy. Presently, this method is only applicable to peripheral CRDM locations because it is be welded manually and access is not possible in interior locations. If tooling were developed to make the welds remotely, it could be applied at any CRDM location.

Seal Weld Replacement

Westinghouse originally intended that the canopy seals could be cut and rewelded to allow removal and replacement or service of the CRDM. Although the seal welds have been cut and rewelded prior to the reactor going critical, there are no known instances where a lower canopy seal has been removed and replaced on an operating commercial reactor. Cutting and rewelding appears to be feasible using existing remote welding systems.

Mechanical Seal

The mechanical seal uses clamps. The sealing is accomplished by a grafoil seal that is fabricated to conform to the seal when compressed. The compression is accomplished by a split clamp to draw the seal tight against the seal weld. The CRDM mechanical seal clamp compresses the grafoil seal over the canopy weld area of the spare penetration. The seal is compressed to a higher pressure than the fluid it is sealing (Attachment 10). This prevents the fluid from penetrating the seal material or migrating past the seal and leaking out. Installation can be accomplished remotely by using long handled tools. Mechanical seals for Salem 1 were ruled out because of the developmental work still required. However, use of the mechanical seals is contemplated for Salem Unit 2 during the upcoming outage scheduled to start in September 1988. Salem Unit 2 has no leaks at any of the four spare CRDMs but these mechanical seals will be installed to prevent any RCS pressure boundary leak in case of any future through the wall defect occurrence. The seals are designed by Combustion Engineering and will be installed by them using remote tooling.

## 4.0 WELD REPAIR/REFURBISHMENT PERFORMED AT SALEM 1

The weld buildup/weld overlay work was performed by Welding Services, Inc. under the PSE&G Q.A. program on a total of 12 spare penetrations. The thirteenth penetration was repaired using a split canopy to preserve that spare penetration for future root cause analysis. The weld buildup consisted of 4 passes of approximately 0.070" each (Attachment 5). Both the weld buildup and weld overlay terms are used synonymously in this report. The work performed is briefly described hereunder.

The canopy joint and vicinity was heated for a period of 12 hours through resistance coil before the weld buildup. Temperature of 500°F to 800°F was maintained over a period of 12 hours and was read on strip charts. Its purpose was to drive moisture out from the joint. After initial few canopies weld refurbishment, the heating method to drive out the trapped fluid was enhanced by grinding a 3/16" slot in the canopy prior to drying.

Next the canopy and the vicinity were thoroughly cleaned of any boron on the surface or the oxidation from heating. This was performed by buffing wheels/fine grit flapper wheels. This buffing was done by remote manipulation of the buffing equipment through Welding Services, Inc. (WSI) Smart Track System.

The weld buildup was performed using weld procedure qualified by WSI and witnessed by PSE&G in Atlanta. Weld acceptance criteria were also developed prior to actual welding. This criteria included parameters based on actual full scale mock-up welding performed. Thus the required number of weld layers, weld beads in each weld layer, weld interpass temperature and the required thickness of weld buildup were validated. Welding operators were qualified at the site using the established welding parameters.

After the buffing operation, the weld surface was video taped during the initial weld buildup pass. The weld buildups were applied using Welding Service's remote automatic gas tungston arc welding system. The welding using this orbital device was performed to meet the minimum weld buildup requirement. Several video taping cycles from different angles were performed and reviewed by both WSI and PSE&G personnel before the weld buildup device was removed from the spare CRDM column.

After completion of the weld buildup and before final visual and liquid penetrant (L.P.) inspection, the weld buildup surface was prepared with buffing wheel.

An informational L.P. inspection was then performed using the WSI inspection head. This L.P. inspection technique was qualified on the site mock up. The L.P. inspection was performed using a video display and the joint was thoroughly wiped/washed subsequent to completion of L.P. inspection.

A peripherally located spare penetration at El location was repaired using Westinghouse supplied split canopy (Attachment 7). This split canopy was welded by Salem Maintenance Dept. using PSE&G procedure and QA program. This penetration will be cut and capped at the next refueling outage and the canopy weld will be sent to Westinghouse for investigation.

After completion of the weld buildup and weld repair, an in service hydrostatic testing of the RCS was performed during heatup at a pressure of 2300 psi, i.e. 1.02 x operating pressure at >500°F for a duration of 60 minutes. Inspection of the weld buildup, split canopy repair and all the other penetrations was performed through the three access doors in the lower shroud.

The total exposure for the complete repair/refurbishment of the thirteen spare penetrations including the reactor head disassembly and reassembly was 58 man-REM with the detailed breakdown provided in the Attachment 11.

## 5.0 LEAK DETECTION SYSTEM INSTALLED

As a result of the Salem 1 CRDM leak, a new experimental reactor head main coolant system leakage air particulate monitor (MCSLAPM) was installed during the outage.

MCSLAPM is an air particulate monitor developed to identify RCS leakage from the reactor head area. MCSLAPM takes an air sample from all four CRDM vent fans and detects the Rb88 activity as it decays from Kr88, a noble gas, which is extremely abundent in the RCS. Kr88 decays with a 2.8 hour half life to a highly charged particulate daughter Rb88 which has a 17.8 minute half life. The air samples from these four locations are transported via stainless steel tubing into a receiver vessel (Attachment 8). This vessel is used as a hold up/decay tank to optimize the system response to Kr88. The Rb88 particulate is collected on a moveable filter paper and dominates the detector response due to its very high beta energy. The detector, a beta scintillator, has been fine tuned to optimize its sensitivity to Rb88. The detector assembly is located on 100' elevation in the containment. An analog output from the rate meter is transmitted to a recorder in the control equipment room.

The detector was calibrated using RCS chemistry samples from the Unit 1 primary sample room and a high purity germanium detector (HPGE) traceable to the National Bureau of Standards. With the reactor at 100% power and no RCS leakage, the detector registers 35-50 cpm. The reactor head MCSLAPM is estimated to be capable of detecting RCS leakage of approximately 0.05 gpm. Based on a mathematical model, this should correspond to 90 cpm. Comparatively an RCS leak of 1 gpm should correspond to 1800 cpm.

The reactor head MCSLAPM in conjunction with the general area MCSLAPM contributes to an overall RCS leak detection system. The reactor head MCSLAPM will respond to a leak in the reactor vessel head area. The general containment MCSLAPM monitors the overall Kr88 air activity and is sensitive to leakage as low as 0.01 gpm. By analyzing the responses (rate of increases) of the two MCSLAPMS for a reactor head and general RCS leak (e.g. pressurizer) a determination can be made as to whether an unknown leak is from the reactor head area or some other location.

The reactor head MCSLAPM is not safety related. Once enough data has been obtained and analyzed, a set of criteria based on action levels will be developed and provided to operations department personnel to enhance their ability to quickly act in the event of a RCS reactor head area leakage.

## 6.0 ROOT CAUSE EVALUATION:

The root cause of the leakage is currently unknown. A number of possible causes have been postulated, it is believed that canopy weld corrosion, possibly in conjunction with weld defects, is the most likely cause of failure. The reasons for this hypothesis are discussed below.

We speculate that air trapped in the adapter on reactor fill is forced into the canopy area on spare adapters and into the control rod drive mechanism penetrations. The oxygenated environment is conducive to pitting in stainless steels at elevated temperatures, and the unique geometry of the spare adapters, which trap air in the canopies, may explain why the problem is worse on spares.

Visual examination of the Salem 1 defects indicates that they are pinhole leaks, in some cases multiple pinholes, located in or near the seal weld crown on the canopies. In no cases were linear, or crack-like indications found.

Similar pinhole defects were observed in 1987 at Turkey Point 3 in two leaking canopies on spare CRDM adapters. Detailed metallographic examinations performed by

Westinghouse, showed that the pinholes were due to corrosion and pitting in the vicinity of a defective weld repair in the canopy weld. Westinghouse attributed the corrosion to an aggressive water environment in the canopy.

Destructive examinations recently performed for Diablo Canyon Unit 1 indicate that the leaks were caused by transgranular stress corrosion cracking. Cracks initiated at lack-of-penetration, weld ID corrosion, fused areas, and at base metal ID surfaces.

Five thermocouple columns removed from Salem 1 in October 1987 have similar canopies and were recently metallographically examined at Westinghouse. The chemistry evaluation of the top and bottom of each canopy seal indicated variance in the sulphur content of the materials. Westinghouse postulates that when a low sulphur material is joined to a high sulphur material, weld pool preferentially melts the low sulphur side which might have resulted in unacceptable weld puddle shift and lack of fusion. We believe that although the sulphur variance in the materials may be a contributor, inadequate heat input was the principal contributor to the lack of fusion of the consumable insert. This lack of fusion in conjunction with the aggressive environment in the canopy could be the cause for eventual failure, if it were to occur in any of these five thermocouple columns.

PSE&G plans to remove the spare CRDM adapter with the split canopy for analysis at the next refueling outage at Salem Unit 1. This perepheral penetration was repaired through the use of split canopy over the current canopy seal. It is hoped that detailed metallographic analysis of the removed spare adapter canopy will shed further light on the root cause of leaks at Salem 1.

## 7.0 DESIGN HISTORY

There are 79 penetrations on the Salem Unit 1 reactor vessel head. Of these, 53 contain full length control rods, 8 contain part lengths, 5 are for instruments and 13 are spares (Attachment 2). The spares were designed to accommodate possible changes in control rod patterns that were anticipated in the late 1960s when it was thought that plants would convert to plutonium recycle. The five instrument columns were cut and capped during this 1987-88 refueling outage as part of the bottom mounted core exit thermocouple modification.

The four inch diameter inconel reactor vessel head penetrations each have a stainless steel adapter welded on the end. The adapter has a male ACME thread and integral canopy as shown in Attachment 4. Full or part length CRDMs and spare adapter plugs have a matching female thread and a small appurtenance to match up to the canopy on the adapter. The CRDM pressure housing, spare adpater plug, and instrument pressure housings are threaded into the adapter and the canopy is seal welded.

The canopy seal welds on Salem were made by United Engineers under the supervision of Westinghouse. Westinghouse also provided the special orbital welding head, the power supply, and the qualified welding procedure specification. The weld was performed using a square butt weld with a "J" type consumable insert. The insert was tack welded to the upper assembly threaded onto the head adapter and then Tungston Inert Gas (TIG) welded. In order to protect the root side of the weld from oxidation during welding, an argon gas purge was used. Argon was introduced into the annulus behind the canopy seal via a needle inserted through a gap between the insert ends.

The canopy seal weld and ACME thread design was developed to provide the required structural integrity (via the threaded connection) and leak tightness (via the canopy seal weld) while providing for relatively simple removal of the housing. This could be accomplished by cutting the thin canopy and un-screwing the housing. The canopy design also accommodates fatigue considerations relative to the bell-mouthing at the end of the housing or adapter plug due to the pressure cycles/transients and thermal expansion. The ACME threads do not provide for a leak tight seal and the canopy annulus is designed to withstand RCS pressure. The canopy seal and weld are subject to primary system pressure that leaks past the threads and corresponding thermal and pressure displacements that exist between the reactor vessel head adapters and the head adapter plugs.

Four CRDM fans pull air into the CRDM area and then out through four ducts in the shroud panels. These ducts exhaust to containment above the missile shield area (Attachment 6). The fans are located near the duct exhaust. The spare adapters have dummy cans above them to provide equal air flow distribution to all locations. These four foot long dummy cans are bolted to the spare adapter cap but remain unsupported at an upper elevation.

## 8.0 SAFETY EVALUATION:

The weld buildup method was selected at Salem to refurbish six leaking canopy seals and to reinforce the other six canopy seals on the non-leaking spare penetrations. The weld buildup consisted of 4 layers of approximately 0.28" (0.070" x 4) of weld overlaying. One peripheral spare penetration was repaired through the use of split canopy seals in a way similar to that done on the Salem Unit 2 repair of a thermocouple column conoseal leak. Thus this safety evaluation addresses the spare penetrations refurbished through weld buildup/weld overlaying.

Structural Adequacy - The head adapter plugs (spares) are attached to the corresponding head penetrations through ACME threads and are sealed using the canopy seal. The resistance to the primary system pressure hydrostatic end forces acting on the head adapter is provided by the ACME threads. These threads, therefore, act as the pressure retaining boundary. The canopy seal and associated seal weld is exactly what the name suggest, i.e. it is a "seal".

The Salem Unit 1 Technical Specifications define a pressure boundary leakage to be leakage (except steam generator tube leakage) through a non-isolable fault in a Reactor Coolant System component body, pipe wall or vessel wall. The definition is further clarified in the Bases for Salem Unit 1 Technical Specification 3.4.6.2. The Bases state that pressure boundary leakage of any magnitude is unacceptable since it may be indicative of an "impending gross failure of the pressure boundary". Leakage from a canopy seal weld on a CRDM is not indicative of impending gross failure. Westinghouse has reviewed this conclusion and concurred.

In accordance with the ASME Code interpretation Xl-1-83-28, repairs on the canopy seal is not considered repair or replacement under the rules of ASME Section XI. This does not imply that the Salem refurbishments are not done meeting the intent of the ASME Section XI.

The stress evaluation of the weld buildup on the conoseals with weld overlay was performed using a finite element technique in accordance with 1983 ASME Section III. The stress intensities and the cumulative fatigue damage meet the code requirements. To meet any field variances in the actual profile or condition of weld buildup, the analysis was also run simulating no credit for the first layer and/or additional fifth layer of weld overlay.

Use of Weld Overlay - Although not specificially addressed in Section XI of the ASME Code, the overlay method has been extensively used on primary coolant pressure boundaries in the U.S. nuclear industry. Its use has been primarily in

BWR recirculation and RHR piping to refurbish butt welds with intergranular stress corrosion cracking. The method used in BWR involves a weld buildup on the pipe exterior surface to seal potential or actual leaks and to reinforce the cracked weld joint. This technique is similar to the one being used at Salem on adapter canopies.

Weld overlay was first used in BWR's at Monticello in 1982. Since then, most operating BWR's have found it necessary to overlay recirculation piping, and hundreds of overlays are currently in service on primary coolant pressure boundaries. Attachment 1 lists those BWR's which installed overlays as of September, 1985 (since the list was compiled, more have been installed). The longest in-service use of overlays is at Hatch 1, where they are now entering the fourth fuel cycle.

Regulatory Position on Overlays - The use of weld overlays was formally authorized by the U.S. NRC for repair of IGSCC damage in BWR piping in Generic Letter 84-11, "Inspections of BWR Stainless Steel Piping." In this letter, overlay sizing rules based on stress margins are given as "Staff Acceptance Criterion" for overlay repair, since the repair/refurbishment method does not explicitly appear in the Code. Current rules for overlay repair in BWRs are given in NUREG-0313, Revison 2, "Technical Report on Material Selection and Processing Guidelines for BWR Coolant Pressure Boundary Piping," September 1985, and are similar to rules for overlay sizing given in the Generic Letter.

Thus the overlay repair/refurbishment has a firm historical and regulatory basis for the coolant boundary use and is applicable to the spare CRDM canopy refurbishment at Salem Unit 1. The intent of the regulatory requirements is met since cumulative fatigue damage and stress intensities requirements of the ASME Section III are satisfied.

Overlay Life - The current expected life for overlays in BWR service is unknown. However, as noted above, the oldest overlays in service are in their fourth fuel cycle. The lifetime of overlays at Salem, like that in BWR's, is determined by the time it takes for continuing defect propagation, probably by a corrosion mechanism, to penetrate the overlay. Evidence in BWR's suggests that stress corrosion cracks in the underlying pipe stop in the overlay weld metal.

The situation at Salem differs in that the root cause of the defects is unknown and defects appear to propagate in weld metal. However, it appears that they propagate slowly. The existing canopies are approximately 100 mils thick (at the weld head) and leaks have appeared only after 13 years of service. The Salem four-pass overlays are significantly greater than 100 mils thick, even discounting the first pass. Therefore, the overlay life will easily exceed several years of service.

It is planned to destructively examine a spare adapter canopy removed from Salem Unit 1 during the next refueling outage. Pending results of that examination, an attempt will be made to establish the root cause of the leaks and to determine whether, or how much, further operation with overlays is warranted.

Gross leakage - Although all the spare canopies will be refurbished/repaired and leaks eliminated, as a bounding analysis a calculation was made to estimate the leak rate through ACME threads presuming that no seal weld exists. The results indicate that the maximum flow rate from a totally degraded seal weld will be approximately 3.5 gpm and this constitutes a small leak, not a small LOCA. Thus its our judgement that there would be no credible catastrophic failure mechanism with the head penetration canopies.

The real life leak flow rate from a repaired or any original canopy will not be significant as experienced at Salem and at other affected U.S. plants. The leakage could not be quantified by the RCS mass balance performed to meet the requirements of technical specification 3.4.6.2. The RCS mass balance is considered to have an accuracy of 0.1 gpm. Since the leakage rate will be less than 1 gpm as allowed by Technical Specification 3.4.6.2, the condition is bounded by the accident analysis.

Borated Water Concern - Even though there is no unanalyzed concern from the plants safety point of view, concern exists from borated water wastage of the reactor vessel head and the reactor vessel studs. Westinghouse has performed laboratory studies indicating that in a worst case, boric acid could result in corrosion of carbon steel at rates up to 400 mils/month.

PSE&G has not operated with any known leaks from the CRDM canopy seals. Three reactor head lower shroud doors have been installed for the leak detection purpose and station performs inspection through these doors during heatup and forced shutdowns. The containment has a general area radiation monitor (R11A) which detects radioactivity as a function of leak rate. This is used for analysis in addition to leak rate calculations.

Although the Salem Units have state of the art leak detection/inspection capabilities, concern of undetected carbon steel wastage from boric acid attack remains. To detect any leak in the area of the reactor vessel head penetations during power operation in an expedious and positive way, a new experimental system for the detection of any leak was designed and installed along with the canopy repair.

The new system utilizes a Beta scintilator detector which samples the lower shroud air as it exits from the CRDM ventilation fans. The leak detection is done by analyzing for Krypton 88 and Rubedium 88 emanating from the reactor coolant system leakage. This additional leak detection system in conjunction with the R11A radiation monitor for the containment radiation alarm, will adequately detect any head penetration leaks.

PSE&G intends to operate with no known reactor head area leak and to closely monitor the head area leak. Thus potential of any significant undetected wastage of carbon steel surfaces as a result of any reactor head penetration leak is precluded. It also provides the justification of continued operation against any potential failure of the repaired or the remaining other head penetrations.

Conclusion - The use of weld overlays to refurbish the spare CRDM penetration canopy seals has extensive historical precedence and a regulatory basis. Although the root cause of leaks at Salem is unknown, it appears that the defects propagate slowly, and that overlay life will exceed several fuel cycles. Further, since there are no safety issues involved with the failures of the canopies, continued operation of Salem Unit 1 with overlay refurbishment is justified.

## 9.0 FUTURE ACTIONS

The following is the list of future actions the PSE&G plans to implement:

1. Install inspection doors in the lower reactor vessel head cooling shroud on Salem Unit 2 during the September 1988 refueling outage (DCR 2SM-442).

2. Install reactor vessel head penetration area leak detection system on Salem Unit 2 during the September 1988 refueling outage (DCR 2SC-1607). The system will be principally similar to the one installed for Salem Unit 1.

3. Cut and cap all five thermocouple columns on Salem Unit 2 during the September 1988 refueling outage as part of the bottom mounted instrumentation system (DCR 2EC-2232 PKG.2).

4. Send the five thermocouple columns (T/C) to be removed from Salem Unit 2 for metallographic evaluation. This includes the one previously leaking T/C column with a split canopy repair.

5. Cut and cap the one peripheral spilt canopy repaired spare penetration during the April 1989 outage of Salem Unit 1. This penetration will be sent out to Westinghouse for metallographic evaluation to establish the root cause for the spare CRDM leaks. The analysis would also include both internal and external surface examination, fractographic analysis, surface deposit, chemical evaluation and bulk chemical analyses of weld deposit and base materials.

6. Install Mechanical seals on the four adapter type Salem Unit 2 spare penetrations during the September 1988 outage. These seals should be able to contain any future leak that might develop on these spare penetrations (DCR 2EC-2232 PKG.3).

7. Pursue through Westinghouse a remote split canopy installation technique so as to be able to repair any full length CRDM leak in future as an alternate to weld overlaying.

## 10.0 REFERENCES:

10.1 WCAP 11744 Salem Unit 1 seal weld repair stress analysis and fatigue evaluation report.

10.2 Westinghouse Report MT-MNA-105 (88) Metallurgical investigation of five instrument canopy welds from Salem Unit 1.

10.3 WCAP 11590 Metallurgical investigation of leakage of the CRDM housing canopy seal welds at the Turkey Point 3 Station.

10.4 Combustion Engineering reports CENC-1791 and CENC-1797 Analytical evaluation of control rod housing cap weld repair, Salem Unit No. 1 reactor vessel.

10.5 Design Change Request 1EC-2298 for weld overlaying 12 spare penetration canopy seals (2EC-2232 PKG. 2 for Unit 2).

10.6 Design Change Request 1SM-585 for split canopy repair for one peripheral spare penetration canopy seal.

10.7 Design Change Request 1EC-2299 installing the experimental reactor head penetration leak detection system (2SC-1067 for Unit 2).

10.8 PSE&G internal memorandum MEC-88-0595 dated June 15, 1988, from Greg Ruane to Harold Trenka, Review of Westinghouse metallurgical investigation of five instrument port canopy welds from Salem Unit 1.

10.9 PG&E internal investigation report for Diablo Canyon Unit 1 CRDM leak event dated May 6, 1988.

10.10 Notes of Westinghouse/Industry discussion on seal weld problems S-C-A900-MNM-0525 dated February 26, 1988.

10.11 Notes of January 28, 1988 meeting with NRC Region 1 concerning spare CRDM weld leaks on Salem Unit 1, NLR I88035 dated February 2, 1988, from G. Roggio to B. Preston.

10.12 MPR Associates, Inc. letters dated January 11, January 18, January 29 and their draft report on Repair of Spare CRDM Penetration Canopies, Salem Unit 1.

10.13 Station deficiency reports SSP-88-014 and SSP-88-044 on the subjects of original leak finding and removal of head vent line.

10.14 Field Questions SMDM-88001 through SMDM-88008 on implementation of the DCR 1EC-2298.

10.15 NUREG 0313 Rev. 2, Technical Report on Material Selection and Processing Guidelines for BWR coolant pressure boundary piping dated June 1986.

10.16 NRC Generic Letter 84-11, Inspection of BWR stainless steel piping.

10.17 PSE&G Salem Unit 2 thermocouple column leaks report to NRC, NLR-N87202 dated October 26, 1987.

10.18 PSE&G presentation to NRR on February 4, 1988 and to Region 1 of NRC on January 28, 1988.

10.19 Summary of Westinghouse materials subcommittee meeting held on August 4 in Pittsburgh, Pa.

## 11.0 ATTACHMENTS

1. List of weld overlay repairs in US BWR's.
2. Salem Unit 1 head penetation layout.
3. Head Penetrations
4. Spare canopy seal weld detail (original).
5. Weld metal overlay at Salem 1.
6. CRDM Ventilation System
7. Split ring canopy
8. Schematic of leak detection system
9. Summary of Welding Services, Inc. experience
10. Schematic of mechanical clamp method of sealing
11. Major Job Dose Performance Report 1988 Unit 1 CRDM leak Outage.
12. Nine pictures illustrating the leak, general area and the equipment for refurbishment.

ATTACHMENT 1:

## Weld Overlay Repairs in US BWR's

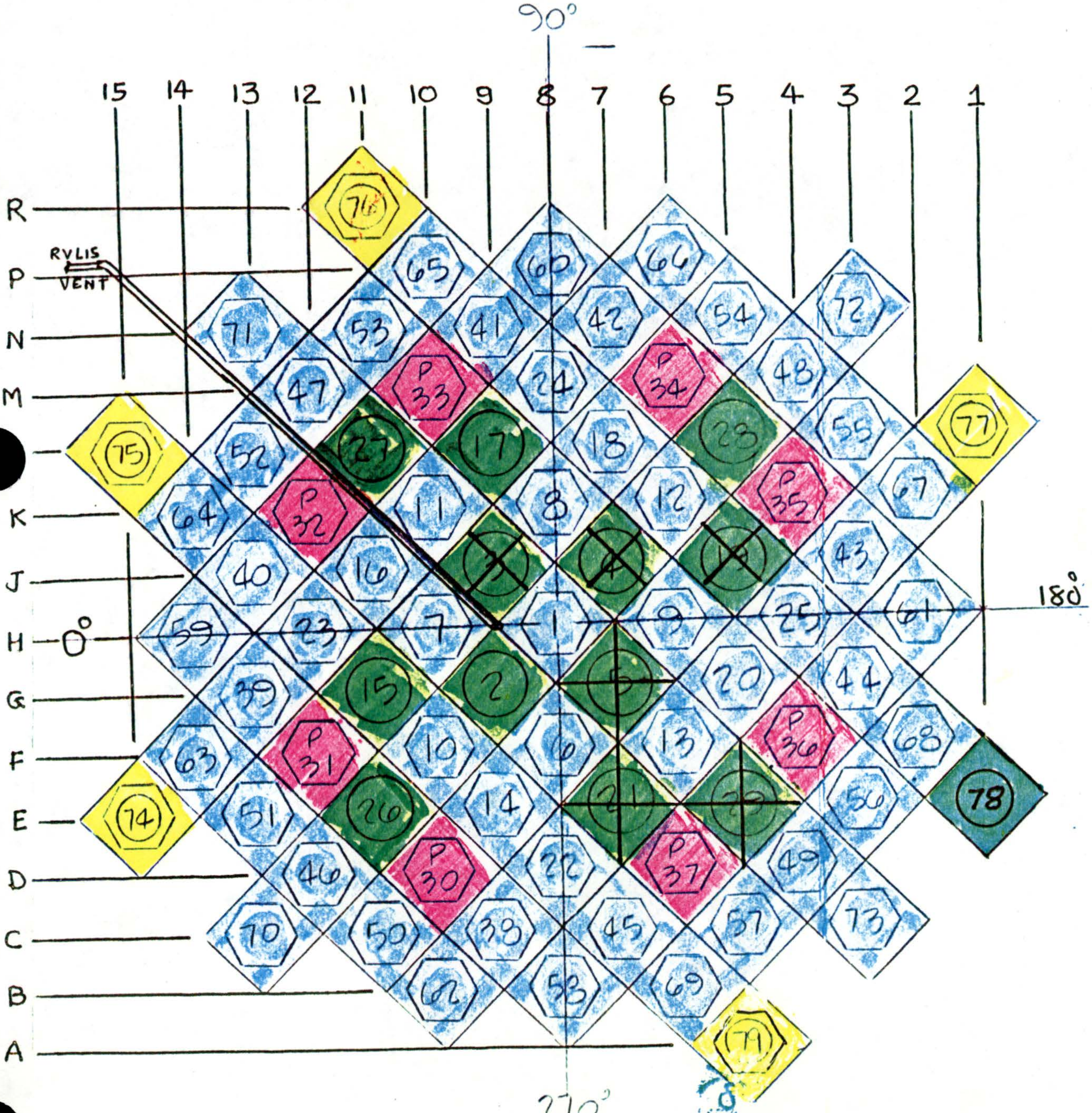
| Plant | Overlay Date (Outage Start) | Number of Overlays* | Current Piping Status |
|---|---|---|---|
| Monticello | 10/82 | 6 Recirc<br>1RHR | Replaced<br>01/84 |
| Hatch 1 | 10/82<br>09/84 | 6 Recirc<br>17 Recirc | In Service |
| Dresden 2 | 01/83 | 7 Recirc | In Service |
| Browns Ferry 2 | 06/84 | 7 Recirc | In Service |
| Brunswick 1 | 01/83<br>03/85 | 3 Recirc<br>22 Recirc | In Service |
| Quad Cities 1 | 09/83 | 16 Recirc | In Service |
| Millstone 1 | 04/84 | 7 Recirc | In Service |
| Brunswick 2 | 11/83 | 8 Recirc | In Service |
| Vermont Yankee | 03/83<br>07/84 | 22 Recirc<br>2 Recirc | Replaced<br>09/85 |
| Duane Arnold | 03/85 | 16 Recirc | In Service |
| Fitzpatrick | 09/84 | 6 Recirc | In Service |
| Peach Bottom 2 | 10/83 | 21 Recirc | Replaced<br>04/84 |
| Peach Bottom 3 | 04/83 | 15 Recirc | Replaced<br>09/87 |
| Browns Ferry 1 | 05/83 | 42 Recirc | In Service |

*Overlays installed as of September 1985, when this tabulation was complied. Actual number in service today is greater.

| Plant | Overlay Date (Outage Start) | Number of Overlays* | Current Piping Status |
|---|---|---|---|
| Cooper | 04/83 | 13 Recirc | Replaced 09/84 |
| Quad Cities 2 | 12/83<br>04/85 | 9 Recirc<br>5 Recirc | In Service |
| Dresden 3 | 09/83 | 61 Recirc | Replaced 09/85 |
| Oyster Creek | 03/83<br>09/83 | 12 Iso Condenser<br>1 Recirc | In Service |
| Browns Ferry 3 | 08/84 | 2 Recirc | In Service |
| Hatch 2 | 04/83 | 2 Recirc | Replaced 01/84 |

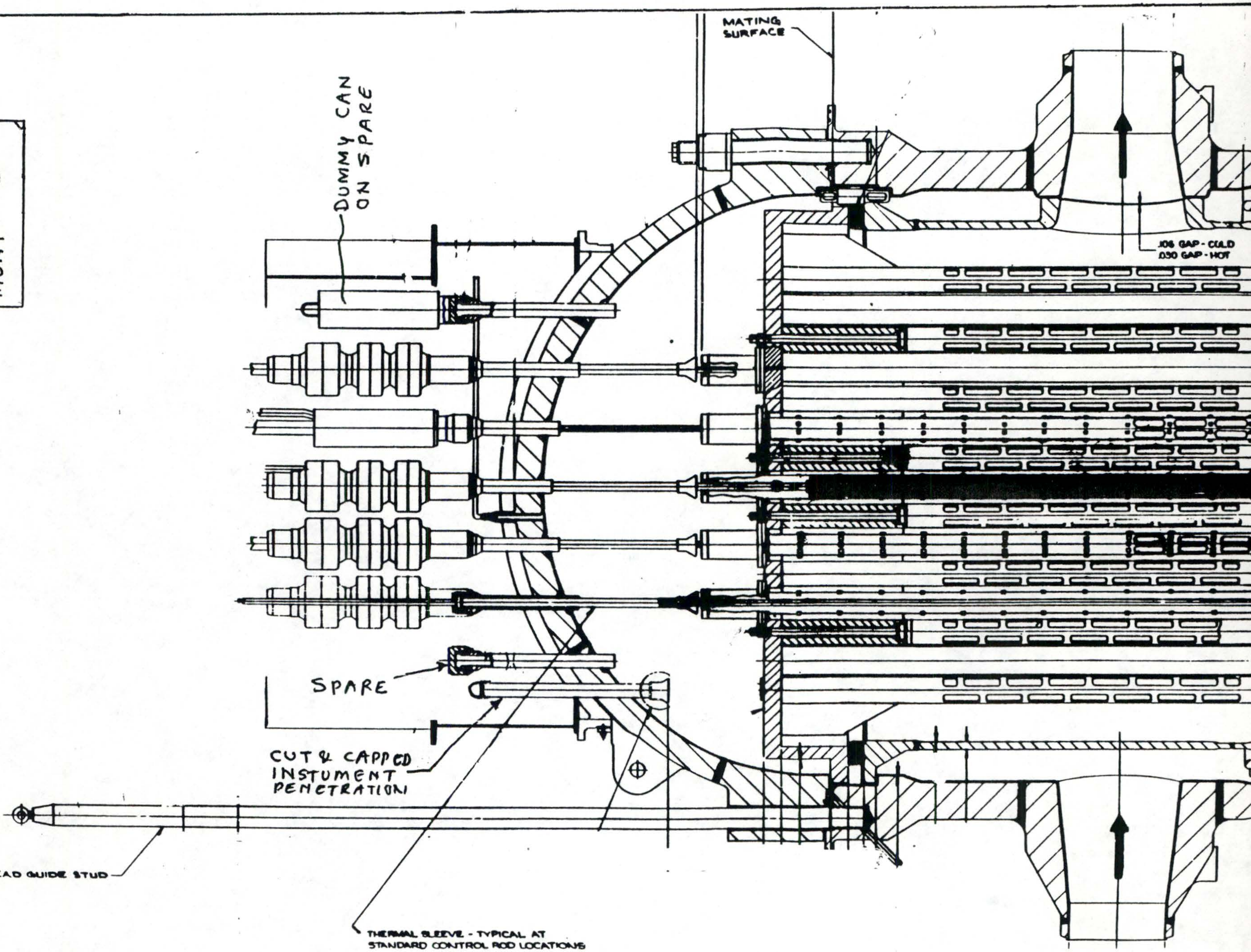
| SYMBOL | DESCRIPTION | QUANTITY |
|---|---|---|
| | STANDARD CRDM | 53 |
| P | PART LENGTH CRDM | 8 |
| | INSTRUMENTATION COLUMN | 5 |
| | ADAPTOR PLUG (SPARE) | 13 |

ATACHMENT 2

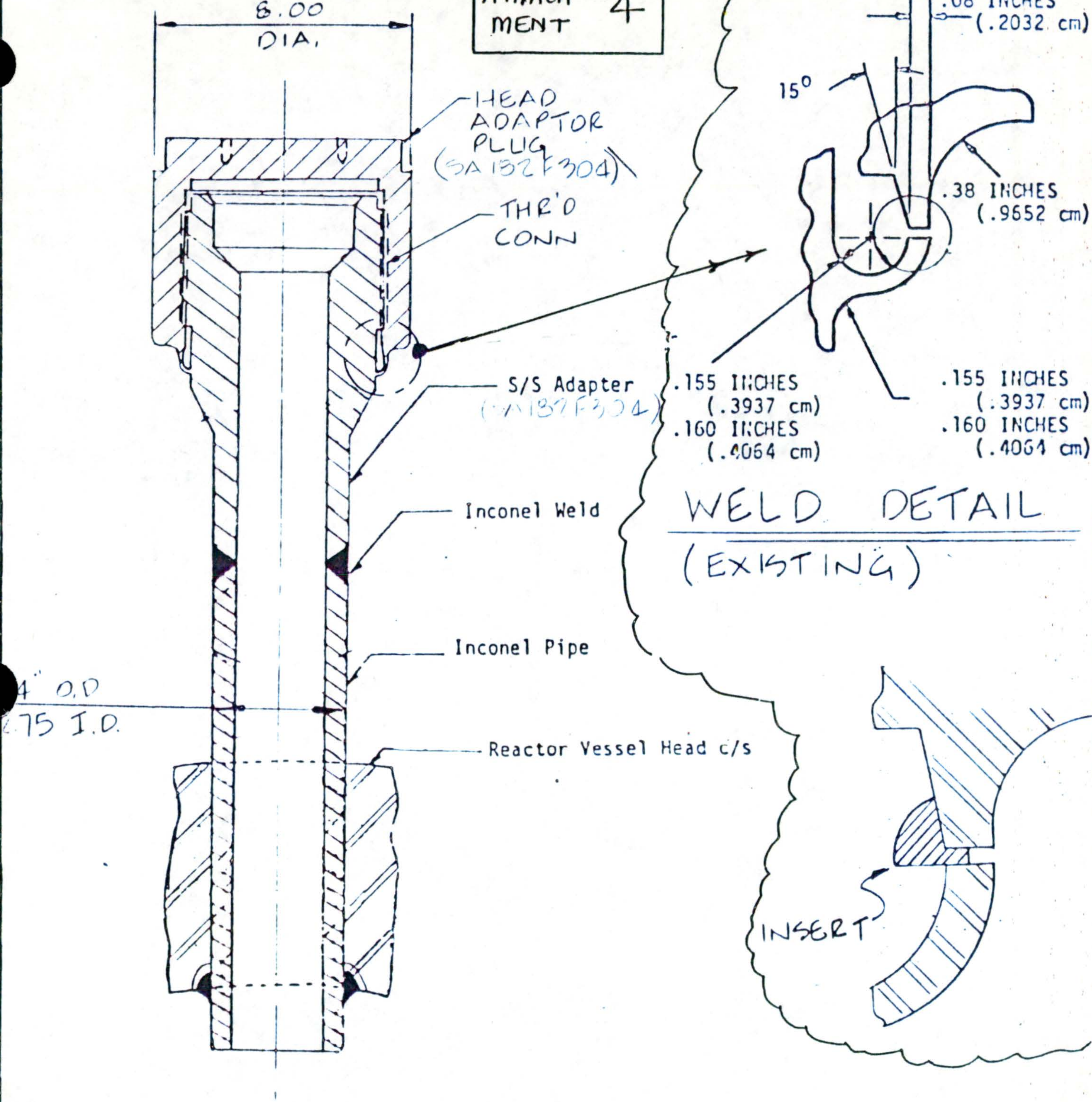



PENETRATION IDENTIFICATION NUMBERS SALEM-1

ATTACH
MENT 3

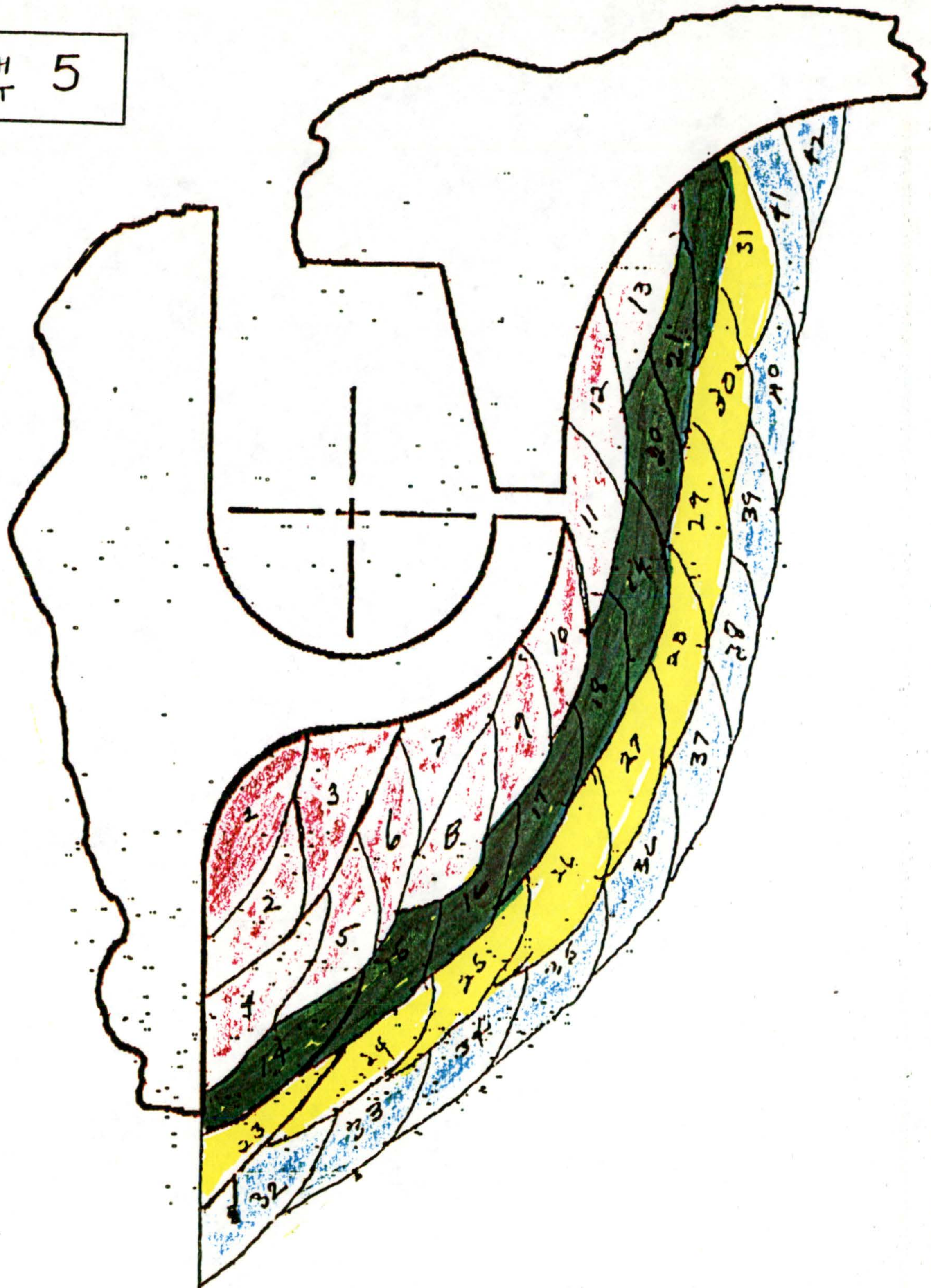


ATTACHMENT 4



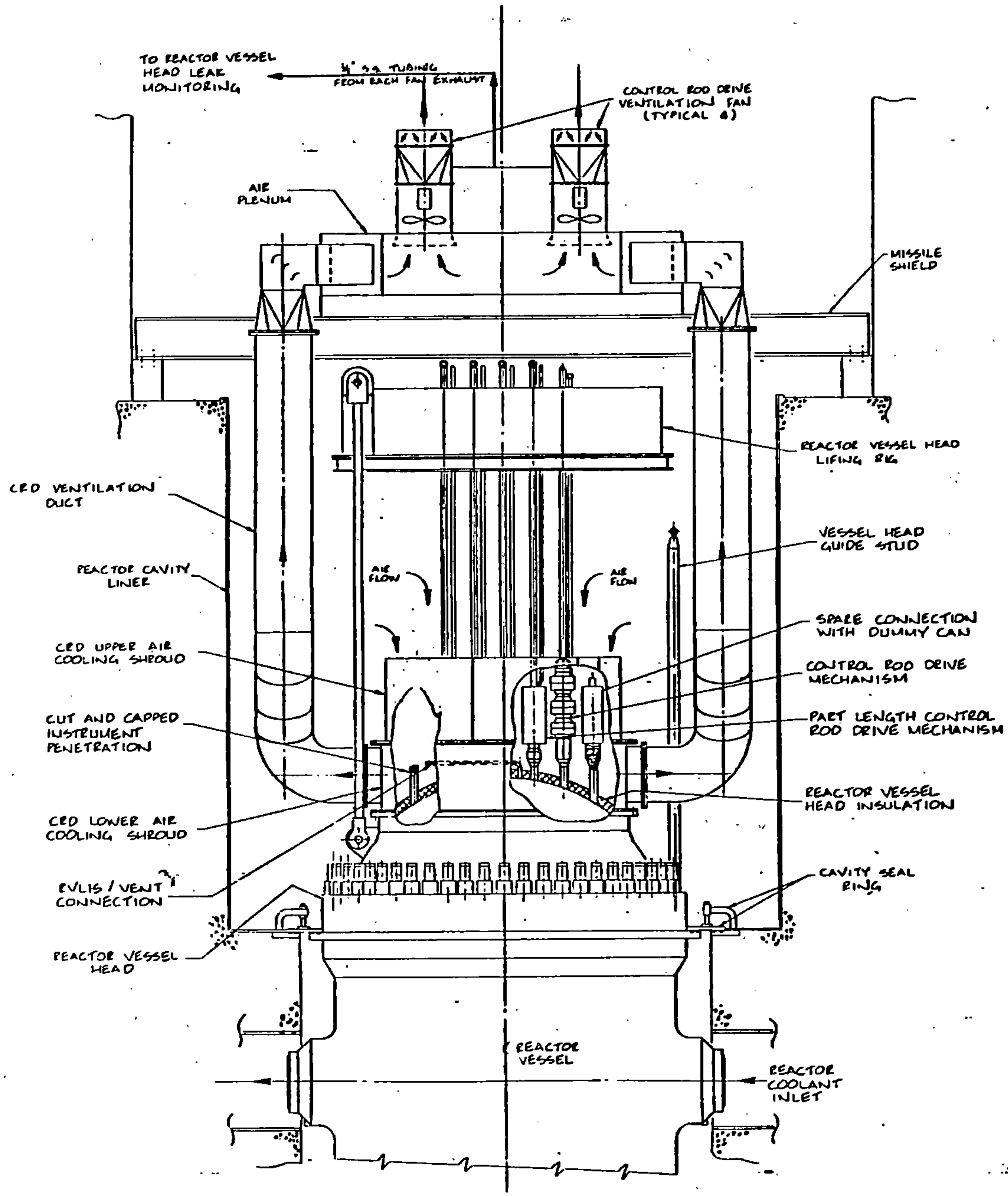

SPARE CRD DETAIL (EXISTING)

ATTACHMENT 5



CANOPY WELD BUILD-UP DETAIL

SALEM - 1



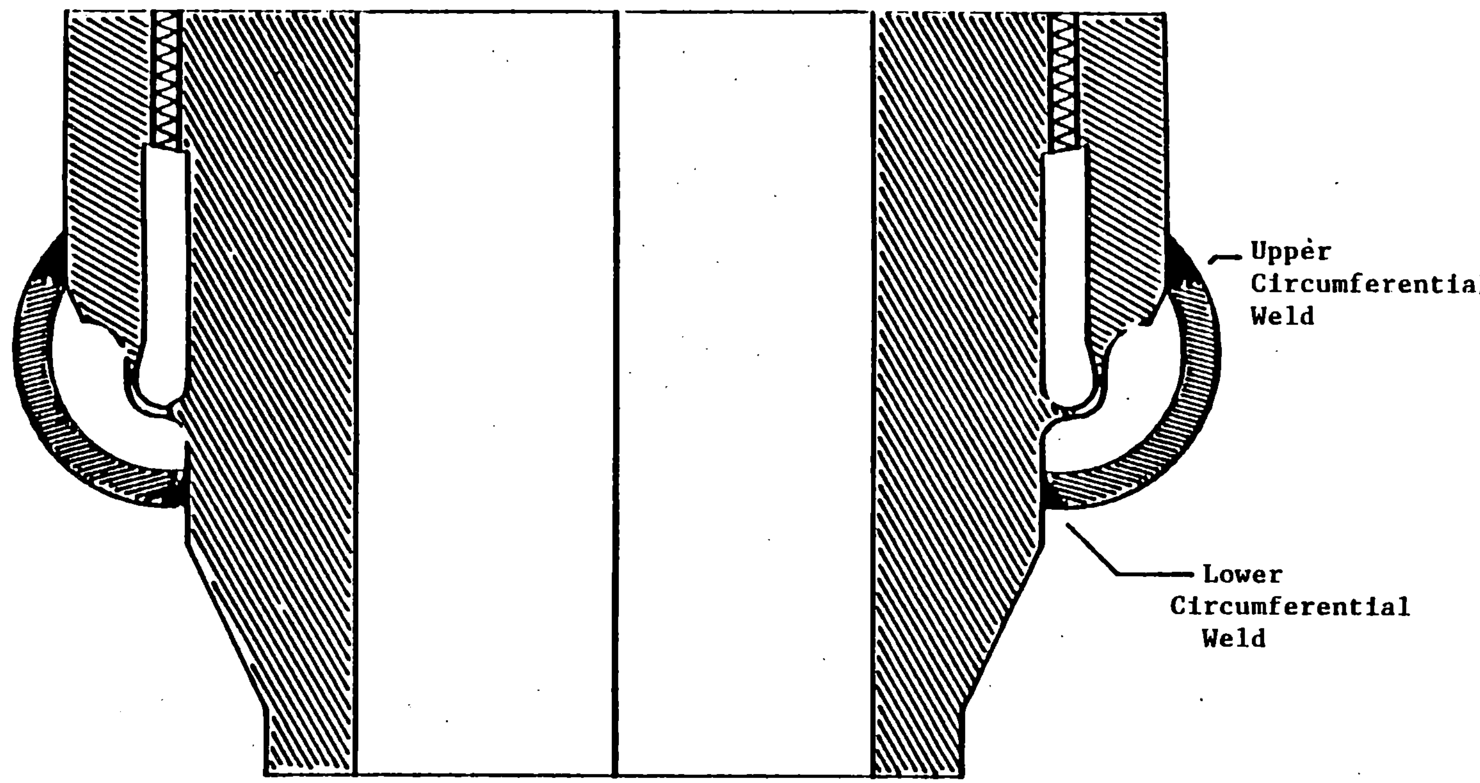

ATTACHMENT 6

REVISION

SALEM NUCLEAR GENERATING STATION UNIT NO. 1 - REACTOR CONT. CONTROL ROD DRIVE VENTILATION SCHEMATIC

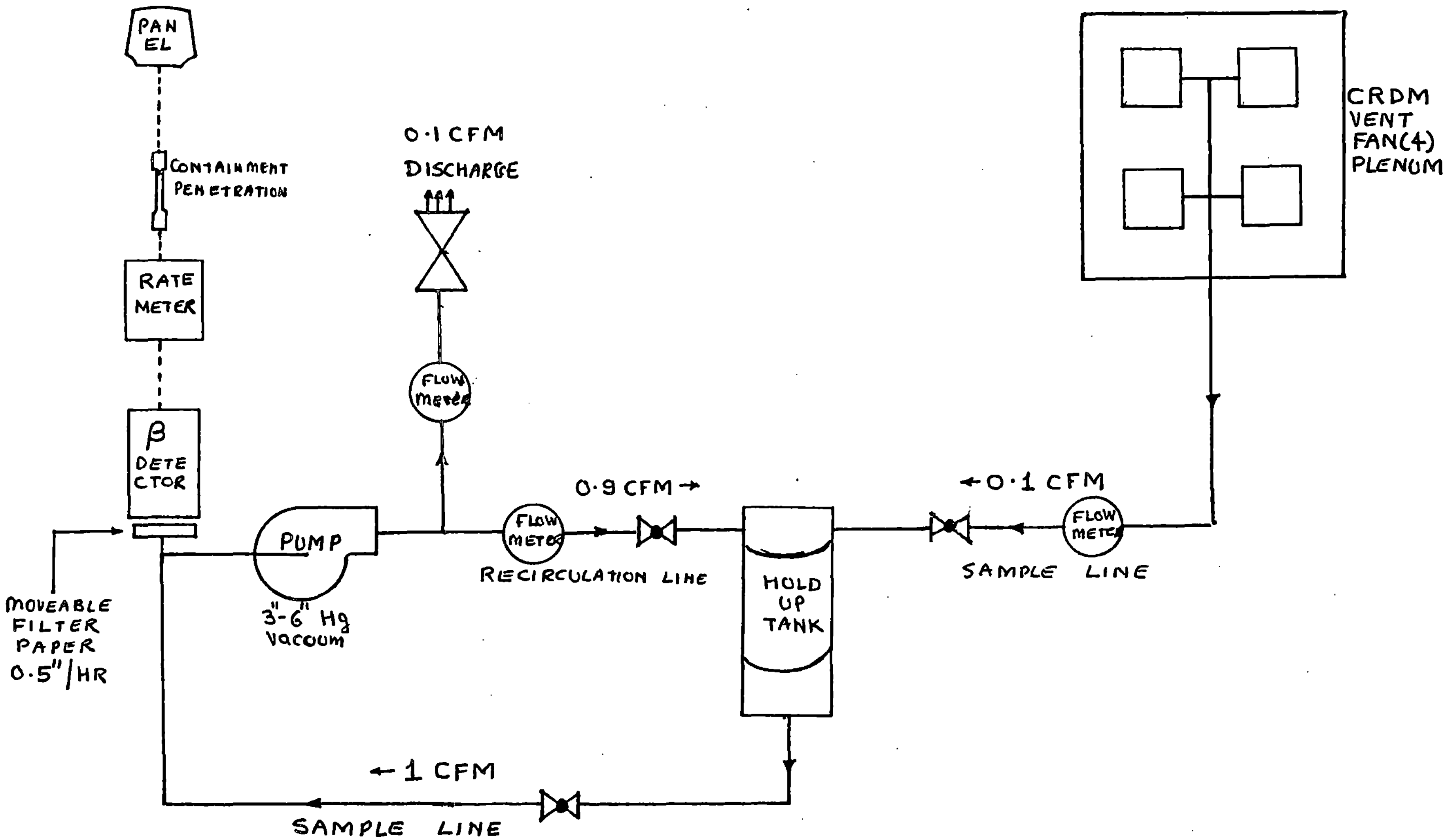
PUBLIC SERVICE ELECTRIC AND GAS COMPANY
NUCLEAR DEPARTMENT
NEWARK, N.J.

A




Split Ring Canopy

ATTACHMENT 7




## SALEM

REACTOR HEAD MAIN COOLANT SYSTEM LEAKAGE AIR PARTICULATE MONITOR SYSTEM RH-MCSLAPM

ATTACHMENT 8

ATTACHMENT 9

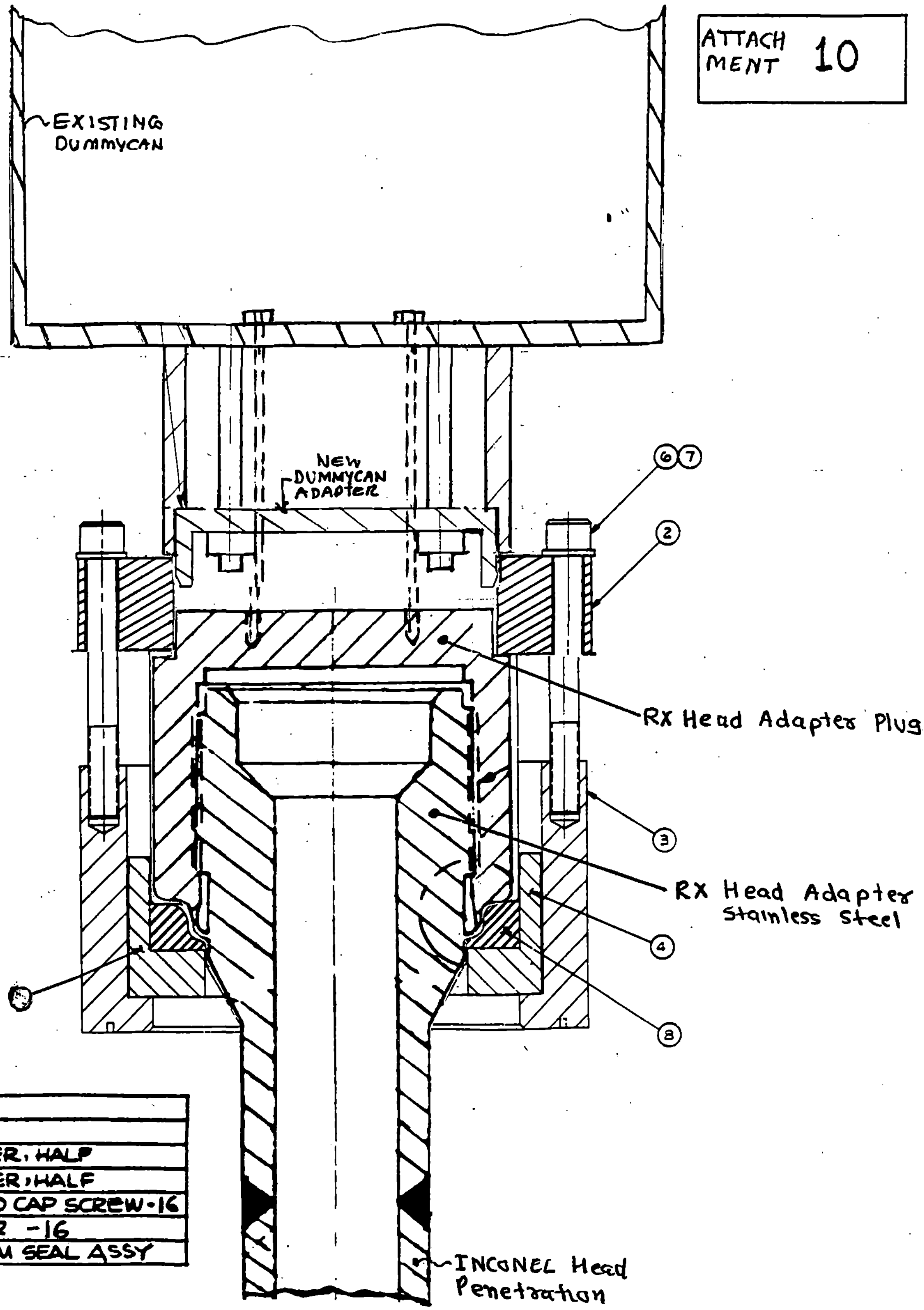
WSI EXPERIENCE DATA SHEET

| PLANT SERVICED | DATE OF SERVICE | TYPE OF SERVICE |
|---|---|---|
| BABCOCK & WILCOX<br>LAWRENCE, MASS. | 7-85 | BOILER TUBE OVERLAY |
| BABCOCK & WILCOX<br>BARBERTON, OH. | 1-87 | OVERLAY BOILER TUBE PANELS WITH INCONEL |
| BROWNS FERRY NUCLEAR PLANT UNIT I<br>TENNESSEE VALLEY AUTHORITY | 1982 | WELD REPAIRS ON RECIRCULATION PIPING SYSTEM |
| BROWNS FERRY NUCLEAR PLANT UNIT I TVA | 1983 | OVERLAY SWEEPOLET TO HEADER AND FRACTURE MECHANICS |
| BROWN FERRY NUCLEAR PLANT UNIT II TVA | 1984-85 | WELD OVERLAY REPAIR AND FRACTURE MECHANICS |
| BROWNS FERRY NUCLEAR PLANT UNIT II TVA | 5-85 | OVERLAY PIPING SYSTEM |
| CALVERT CLIFFS UNIT I<br>BALTIMORE GAS & ELECTRIC CO.<br>LUSBY, MD.<br>(TWO JOBS) | 11-85 | TWO (2) OMEGA SEAL WELDS |
| CONNECTICUT YANKEE POWER PLANT | WINTER-85 | DEVELOPMENT OF SPECIAL REMOTE OMEGA SEAL WELD HEAD |
| CONNECTICUT YANKEE POWER PLANT | SPRING-86 | OMEGA SEAL WELDS |
| JAMES A. FITZPATRICK NUCLEAR POWER STATION<br>NEW YORK POWER AUTHORITY<br>OSWEGO, NY | 1984 | (2) WELD OVERLAY OF RECIRCULATION PIPING |
| JAMES A. FITZPATRICK NUCLEAR POWER STATION<br>NEW YORK POWER AUTHORITY | 4-85 | WELD OVERLAY SERVICES |
| JAMES A FITZPATRICK NUCLEAR POWER PLANT<br>NEW YORK PLANT AUTHORITY | 3-87 | CORE SPRAY REPLACEMENT AND WELD OVERLAY |

WSI EXPERIENCE (CONTINUED)

| PLANT SERVICED | DATE OF SERVICE | TYPE OF SERVICE |
|---|---|---|
| GILBERTON PLANT<br>FRACKVILLE, PA | 8-87 | HARDFACE WELD OVERLAY OF TWO FLUIDIZED BED BOILERS |
| EDWIN I, HATCH<br>NUCLEAR POWER PLANT<br>GEORGIA POWER CO. | 1984 | 28" WELD OVERLAY TEST PROGRAM |
| EDWIN I, HATCH UNIT I<br>NUCLEAR POWER PLANT<br>GEORGIA POWER CO. | 1984 | WELD OVERLAY REPAIRS |
| EDWIN I, HATCH UNIT I<br>NUCLEAR POWER PLANT<br>GEORGIA POWER CO.<br>BAXLEY, GA. | 85-86 | OVERLAY WELD REPAIRS |
| INDIAN POINT<br>NUCLEAR STATION UNIT #2<br>BUCHANAN, NY | 10-87 | OVERLAY CANOPY SEAL WELDS |
| MERCER GENERATING STATION<br>PUBLIC SERVICE ELECTRIC & GAS CO.<br>TRENTON, NJ | 1984 | BOILER TUBE OVERLAY |
| MERCER GENERATING STATION<br>PUBLIC SERVICE ELECTIRC & GAS, CO.<br>TRENTON, NJ | 10-85 | BOILER TUBE OVERLAY |
| MILLSTONE II<br>NORTHEAST UTILITIES<br>WATERFORD, CT. | 3-85 | 2 OMEGA SEAL WELDS |
| SHEARON HARRIS I<br>CAROLINA POWER & LIGHT CO. | 8-82 | C.R.D.M. INSTALLATION WELDING/CUTTING |

ATTACHMENT 10




| | |
|---|---|
| 2 | TOP PLATE |
| 3 | HOUSING |
| 4 | SEAL CARRIER, HALF |
| 5 | SEAL CARRIER, HALF |
| 6 | SOCKET HEAD CAP SCREW-16 |
| 7 | LOCKWASHER -16 |
| 8 | GRAFOIL CRDM SEAL ASSY |

CRDM SEAL CLAMP ASSEMBLY - MECHANICAL SEAL

SALEM NUCLEAR STATION
MAJOR JOB DOSE PERFORMANCE
1988 UNIT 1 CRDM LEAK OUTAGE

ATTACHMENT 11



REACTOR HEAD REPAIR

| RWP | JOB / AREA DESCRIPTION | ENTRIES | TIME (Person-Hours) PROJECTED | ACTUAL | % OF TOTAL | CHG TIME | DOSE (Millirem) PROJECTED | ACTUAL | % OF TOTAL | CHG DOSE | STATUS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 88-1-0038 | MODE 3 INSPECTION<br>U/1 CTMT ALL AREAS EXCEPT LOWER CAVITY | 32 | 50.0 | 41.9 | 84% | | 500 | 877 | 175% | | T |
| 88-1-0050 | VISUAL INSPECTION OF OUT OF SCOPE CRD LEAKS<br>UNIT ONE 100' CAVITY ON REACTOR HEAD | 9 | 40.0 | 14.4 | 36% | | 4500 | 1418 | 31% | | T |
| 88-1-0081 | 1RCE1-CRDMLEAK-REMOVE RX STUDS.INSP.& CLEAN.<br>U/1 RX CAVITY & 130 ELEV. | 66 | 80.0 | 153.7 | 192% | | 1700 | 2573 | 151% | | T |
| 88-1-0102 | 1RCE1-PERFORM WELD REPAIR OF CRDM I.A.W.ENG.INST<br>U/1 REACTOR HEAD | 979 | 1000.0 | 2843.9 | 284% | | 24000 | 17661 | 73% | | T |
| 88-1-0104 | INITIAL SET UP OF W.S.I. SUPPORT EQUIPMENT<br>UNIT 1 CONTAINMENT 130' REACTOR HEAD | 14 | 1.4 | 35.0 | 2499% | | 160 | 43 | 26% | | T |
| 88-1-0106 | VIDEO TAPE NEAR RX HEAD PLATFORM.<br>U/1 CTMT 130EL RX HEAD PLATFORM AREA. | 8 | 24.0 | 33.7 | 140% | | 50 | 67 | 134% | | T |
| 88-1-0120 | 1RCE1 PERFORM NDE TEST ON CRDM<br>U/1 RX. HEAD | 2 | 4.0 | 1.7 | 44% | | 500 | 521 | 104% | | T |
| 88-1-0122 | CLEAN-UP OF REACTOR HEAD AND CAVITY<br>UNIT ONE CONTAINMENT IN CAVITY & ON REACTOR HEAD | 39 | 25.0 | 87.6 | 350% | | 800 | 2685 | 335% | | T |
| 88-1-0136 | 1RCE1 PERFORM NDE TEST ON CRDM<br>U/1 CTMT. RX HEAD | 2 | 1.0 | 2.0 | 205% | | 800 | 203 | 25% | | T |
| 88-1-0138 | 1RCE1-CRDM REPAIRS/CUT WELD FROM RX HEAD VENT<br>U/1 RX HEAD | 2 | 24.0 | 4.4 | 19% | | 200 | 52 | 26% | | T |
| [illegible]1 | 1RCE1-PERFORM WELD REPAIR OF CRDM I.A.W.ENG.INST<br>UNIT ONE CONTAINMENT CRDM **** CAVITY ONLY **** | 36 | 600.0 | 25.8 | 4% | | 1500 | 1592 | 106% | | T |
| [illegible]-1-0142 | ECECT SCAFFOLDING FOR REPAIR OF PENETRATION #78<br>U/1 CTMT 100'UPPER RX CAVITY | 14 | 12.0 | 20.0 | 167% | | 750 | 558 | 74% | | T |
| 88-1-0149 | SHIELDING INSTALLATION/REMOVAL FOR CANOPY REPAIR<br>UNIT ONE CONTAINMENT 100' REACTOR CAVITY | 36 | 144.0 | 51.6 | 36% | | 2100 | 1431 | 68% | | T |
| 88-1-0150 | WELDING OF SPARE CRDM AND REPAIR OF CANOPY<br>UNIT ONE CONTAINMENT 100' REACTOR CAVITY | 18 | 144.0 | 37.5 | 26% | | 4100 | 1527 | 37% | | T |
| 88-2-0131 | 2CV435, DIAPHRAGM LEAKS, MARK NO M-61<br>23 CHARGING PUMP AREA AUX 2 | 1 | 4.0 | 0.4 | 10% | | 20 | 3 | 15% | | T |
| 88-2-0143 | 12MS14/LEAKS THRU/REWORK F-12<br>UNIT ONE SOUTH PIPING PENS 100' OUTSIDE PEN AREA | 10 | 144.0 | 31.5 | 22% | | 10 | 1 | 10% | | T |
| | TOTALS FOR MAJOR JOB | 1268 | 2297.4 | 3385.3 | 147% | | 41690 | 31212 | 74% | | |

NOTE: 'CHG TIME' & 'CHG DOSE' COLUMNS REFLECT CHANGES IN RWP TIME & DOSE SINCE LAST REPORT RUN (00:15 3/1/88).

THE PROJECTED DOSE COLUMN HAS BEEN READJUSTED I.A.W. ALARA REVIEW

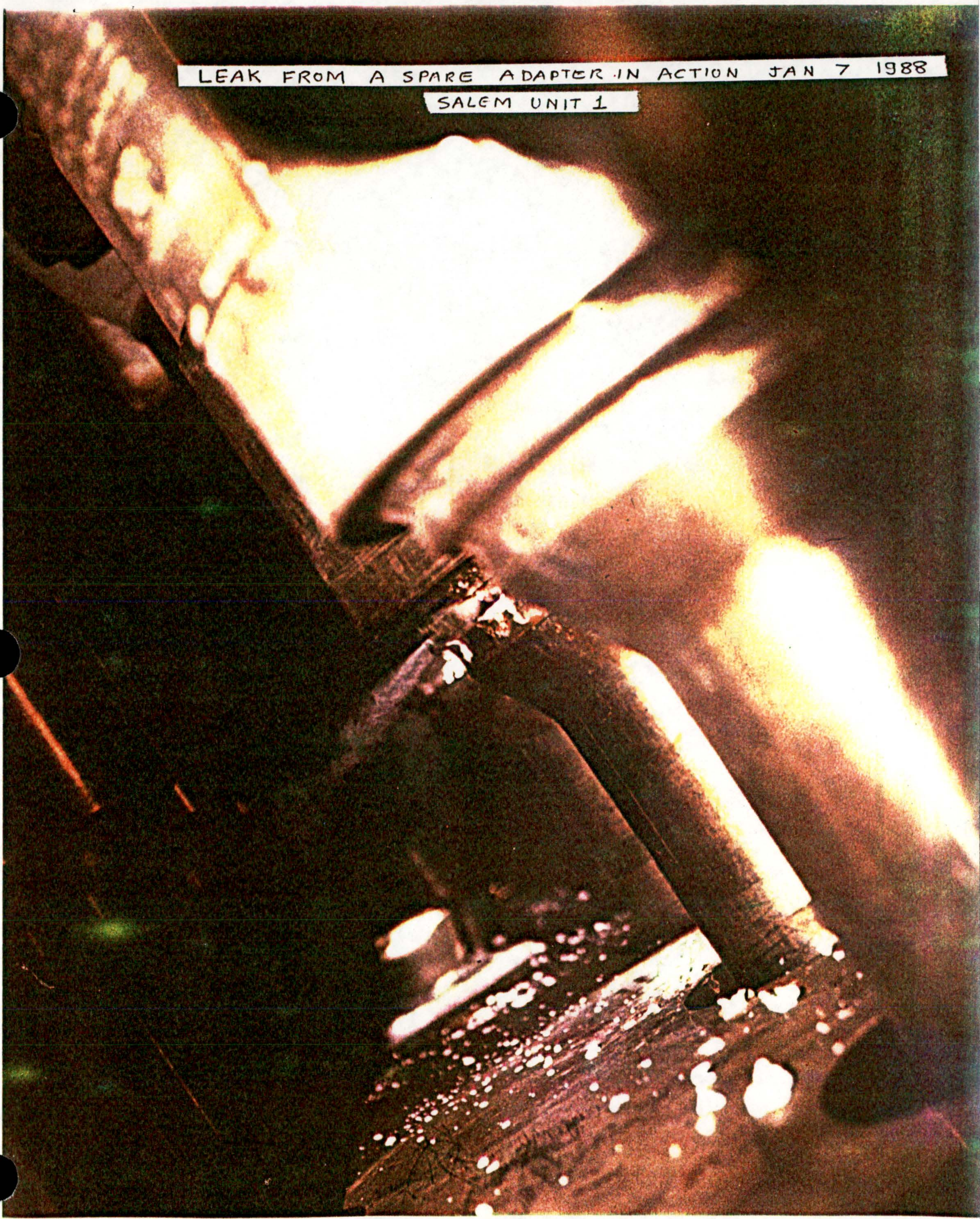
SALEM NUCLEAR STATION
MAJOR JOB DOSE PERFORMANCE
1988 UNIT 1 CRDM LEAK OUTAGE

REACTOR HEAD DISASSEMBLY (Including Prep)

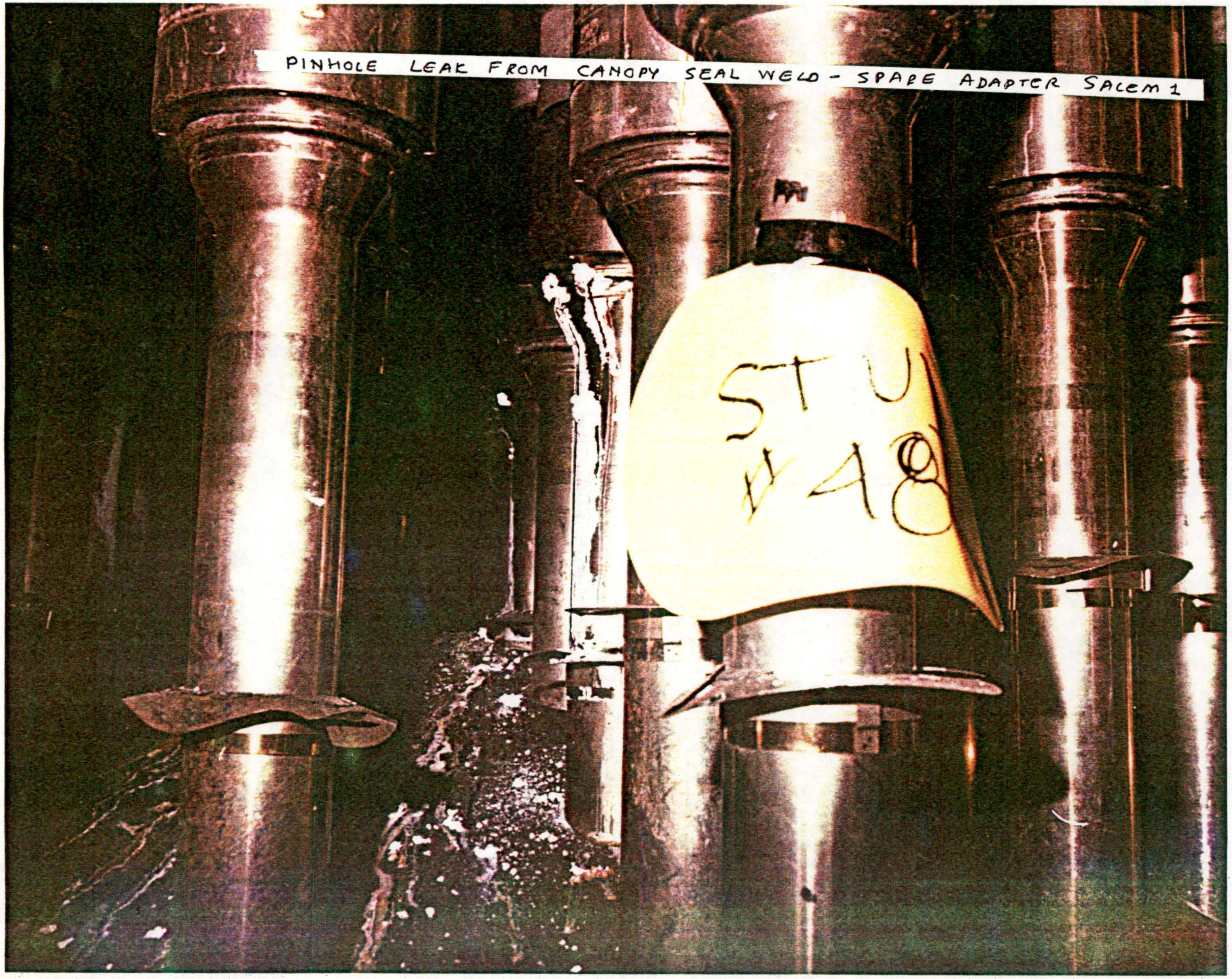
| RWP | JOB / AREA DESCRIPTION | ENTRIES | TIME (Person-Hours) PROJECTED | ACTUAL | % OF TOTAL | CHG TIME | DOSE (Millirem) PROJECTED | ACTUAL | % OF TOTAL | CHG DOSE | STATUS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| -1-0054 | 1RCE1-CRDM WELD LEAK-REMOVE INSUL/DUCTS/SHROUDS U/1 RX CAVITY CTMT | 18 | 192.0 | 29.9 | 16% | | 1100 | 284 | 25% | | T |
| -1-0055 | 1RCE1-CRDM WELD LEAK SUPPORT.DISCONNECT ELECTRIC U/1 REACTOR CAVITY TOP OF HEAD/AND CAVITY | 50 | 96.0 | 96.0 | 100% | | 2000 | 1345 | 67% | | T |
| -1-0058 | 1RCE1-CRDM WELD LEAK-SET UP TO MAKE COR.REPAIRS U/1 CAVITY RX HEAD. | 123 | 192.0 | 246.4 | 128% | | 6500 | 6320 | 97% | | T |
| -1-0062 | 1RCE1-INSTALL LEAD SHIELDING ON RX HEAD UNIT 1 REACTOR HEAD UPPER CAVITY | 8 | 48.0 | 12.7 | 27% | | 1300 | 612. | 47% | | T |
| -1-0072 | PREP RX HEAD FOR DECONING AND HYDRO LANCING. U/1 CTMT RX HEAD UPPER CAVITY | 13 | 192.0 | 13.8 | 7% | | 2500 | 1446 | 57% | | T |
| -1-0088 | CLEAN C.R.D. COUNTER-BORE WELD AREA ON RX HEAD U/1 RX HEAD IN CAVITY | 12 | 4.0 | 10.7 | 268% | | 800 | 619 | 77% | | T |
| -1-0099 | ASSEMBLE / DISASSEMBLE RX HEAD SHIELD PLATFORM UNIT ONE CONTAINMENT; 130'EL, RX CAVITY, RX HEAD | 8 | 32.0 | 12.3 | 38% | | 100 | 77 | 77% | | T |
| 3-1-0119 | 1RCE1-REMOVE COIL STACKS/MAG JACKS U/1 RX HEAD | 39 | 80.0 | 111.6 | 139% | | 2000 | 1897 | 94% | | T |
| 8-1-0123 | REMOVE PB SHIELDING UNIT ONE CONTAINMENT ON TOP OF REACTOR HEAD | 9 | 20.0 | 7.2 | 36% | | 100 | 41 | 41% | | T |
| | TOTALS FOR MAJOR JOB | 280 | 856.0 | 540.5 | 63% | | 16400 | 12641 | 77% | | |

REACTOR HEAD REASSEMBLY

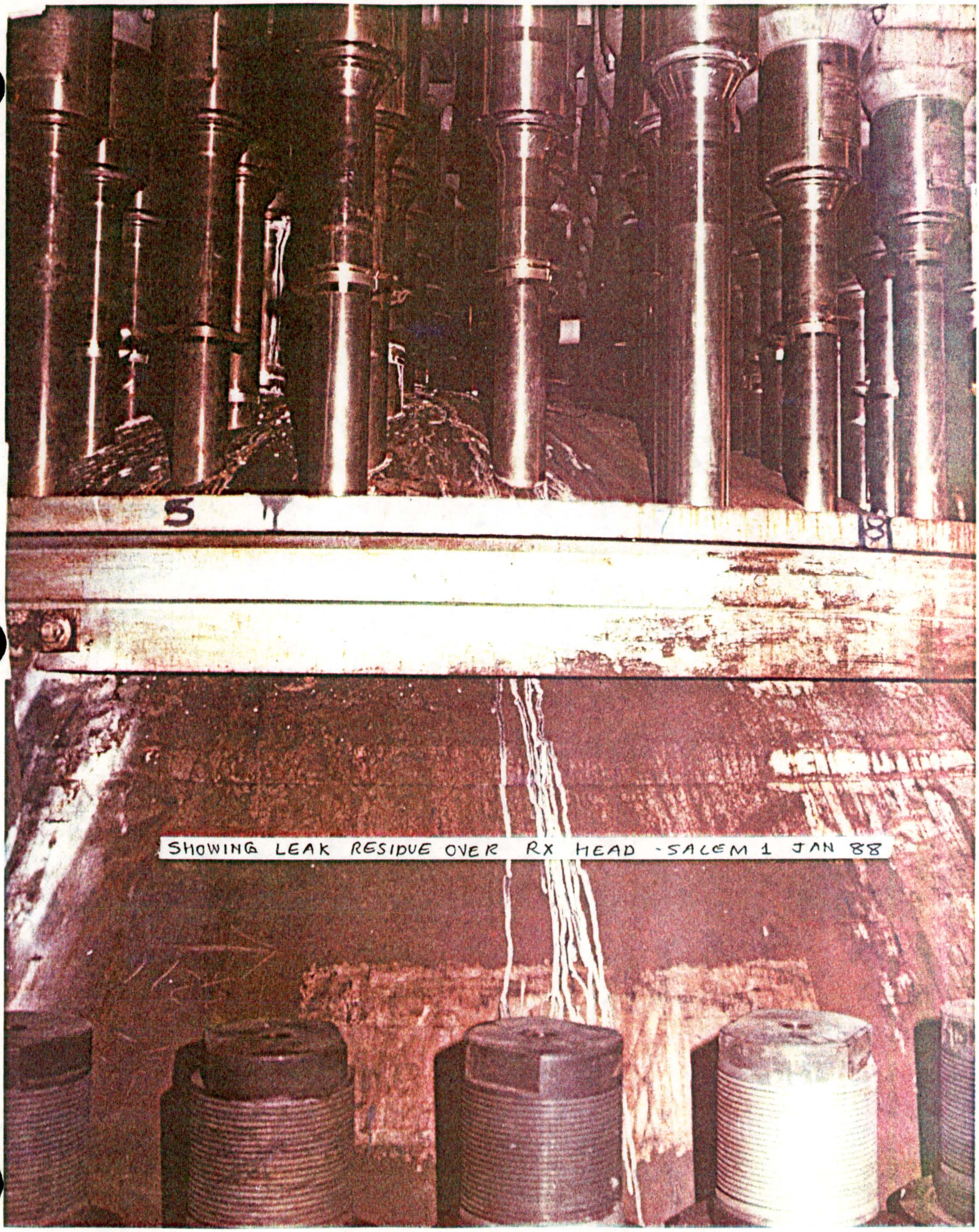
| RWP | JOB / AREA DESCRIPTION | ENTRIES | TIME (Person-Hours) PROJECTED | ACTUAL | % OF TOTAL | CHG TIME | DOSE (Millirem) PROJECTED | ACTUAL | % OF TOTAL | CHG DOSE | STATUS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 88-1-0124 | REINSTALL MAG JACKS/DUMMY CANS/RPI STACK COILS UNIT ONE REACTOR HEAD 100' CONTAINMENT BLDG. | 28 | 80.0 | 58.1 | 73% | | 1500 | 1372 | 91% | | T |
| 88-1-0125 | REMOVAL OF REACTOR HEAD LEAD SHIELDING UNIT ONE CONTAINMENT 100' ON HEAD AND IN CAVITY | 3 | 15.0 | 5.1 | 34% | | 800 | 57 | 7% | | T |
| 88-1-0126 | REINSTALL CRDM INSULATION ON REACTOR HEAD UNIT ONE REACTOR CAVITY AND REACTOR HEAD. | 24 | 48.0 | 41.5 | 87% | | 3300 | 5922 | 179% | | T |
| 88-1-0127 | RE-INSTALL SHROUDS/DUCTS/RX HEAD MIRROR INSLTION UNIT ONE CONTAINMENT 100' REACTOR CAVITY AND REACTOR HEAD | 34 | 40.0 | 70.4 | 176% | | 1650 | 3040 | 184% | | T |
| 88-1-0128 | RE-INSTALL BOXBEAM/HEAD VENT/RVLIS/RPI CABLES UNIT ONE CONTAINMENT 100' REACTOR CAVITY AND HEAD. | 41 | 40.0 | 84.2 | 211% | | 1650 | 1205 | 73% | | T |
| 88-1-0140 | 1RCE1-CRDM REPAIRS/REWELD HEAD VENT LINE BACK U/1 RX HEAD | 9 | 10.0 | 11.4 | 114% | | 300 | 207 | 69% | | T |
| 88-1-0175 | 1RCE1-RAD.AIR MON.INSTALLATION.DCR 1-EC-2299 UNIT 1 CONTAINMENT REACTOR TOP OF REACTOR HEAD | 91 | 120.0 | 143.4 | 120% | | 500 | 253 | 50% | | T |
| 88-1-0180 | INSPECT FLUX RING WIRES ON AREA OF STUCK MAGJACK U/1 CTMT 100' ON TOP RX HEAD D-12 MAGJACK AREA. | 3 | 0.5 | 2.5 | 493% | | 150 | 275 | 183% | | T |
| 88-1-0182 | 1RCE1-REPLACE CRDM COIL STACKS AND MAG JACKS. REACTOR VESSEL HEAD AREA | 25 | 80.0 | 63.0 | 79% | | 1500 | 1803 | 120% | | T |
| 88-1-[illegible] | INSPECTION OF SYSTEMS AT 1K AND OPERATING PRESS UNIT ONE CTMT: PZR, BIOSHIELD(RTDS), RX HEAD FOR CRDMS | 35 | 10.0 | 34.9 | 349% | | 1000 | 354 | 35% | | T |
| 88-1-0202 | RODS 1C2 AND 1SA2/LOW MEGGER READINGS/REPAIR. UNIT ONE CONTAINMENT; RX HEAD J-BOXES, ON RX HEAD, & 78' EL. | 15 | 8.0 | 20.1 | 251% | | 200 | 102 | 51% | | T |
| | TOTALS FOR MAJOR JOB | 308 | 451.5 | 534.6 | 118% | | 12550 | 14590 | 116% | | |

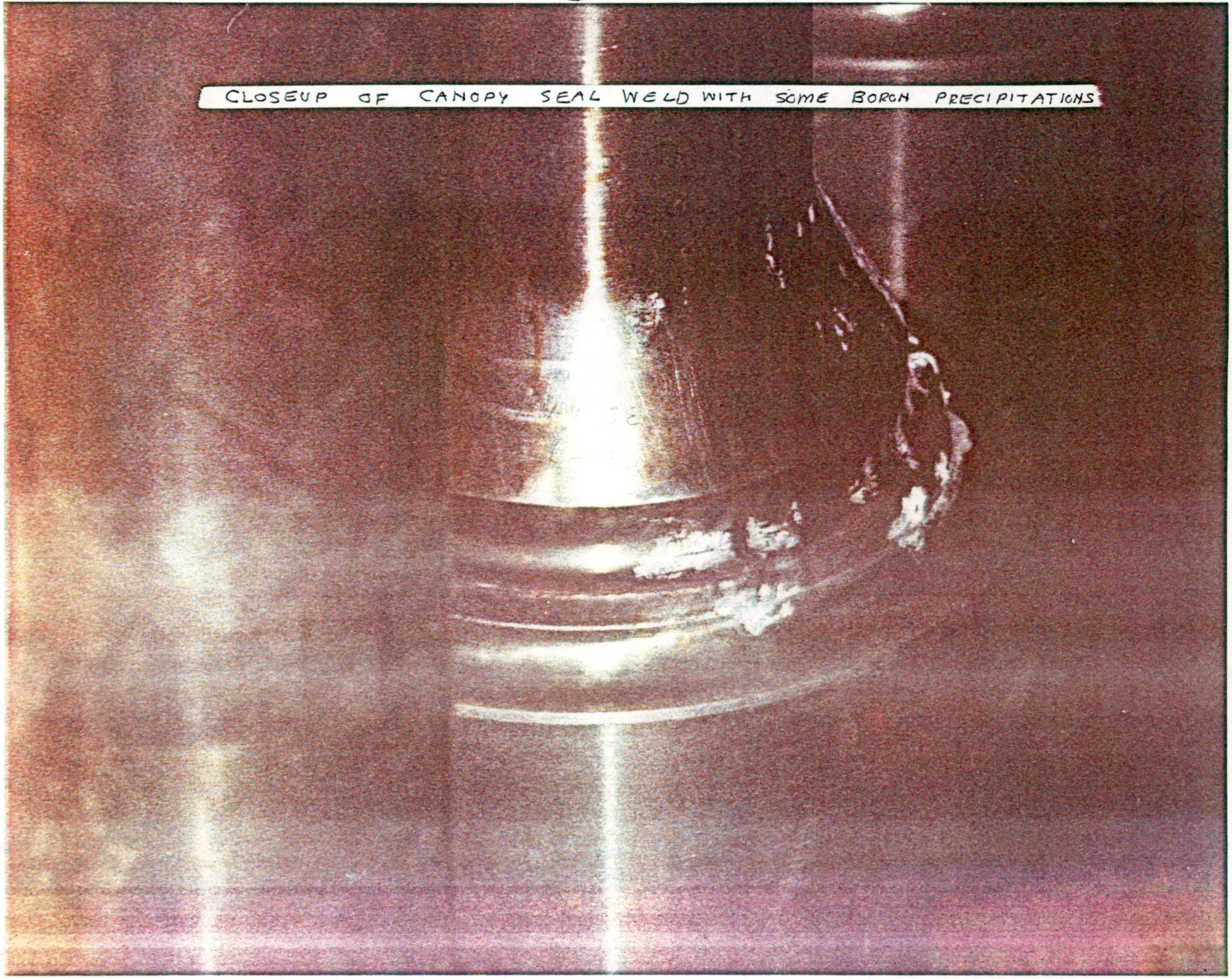


LEAK FROM A SPARE ADAPTER IN ACTION JAN 7 1988
SALEM UNIT 1

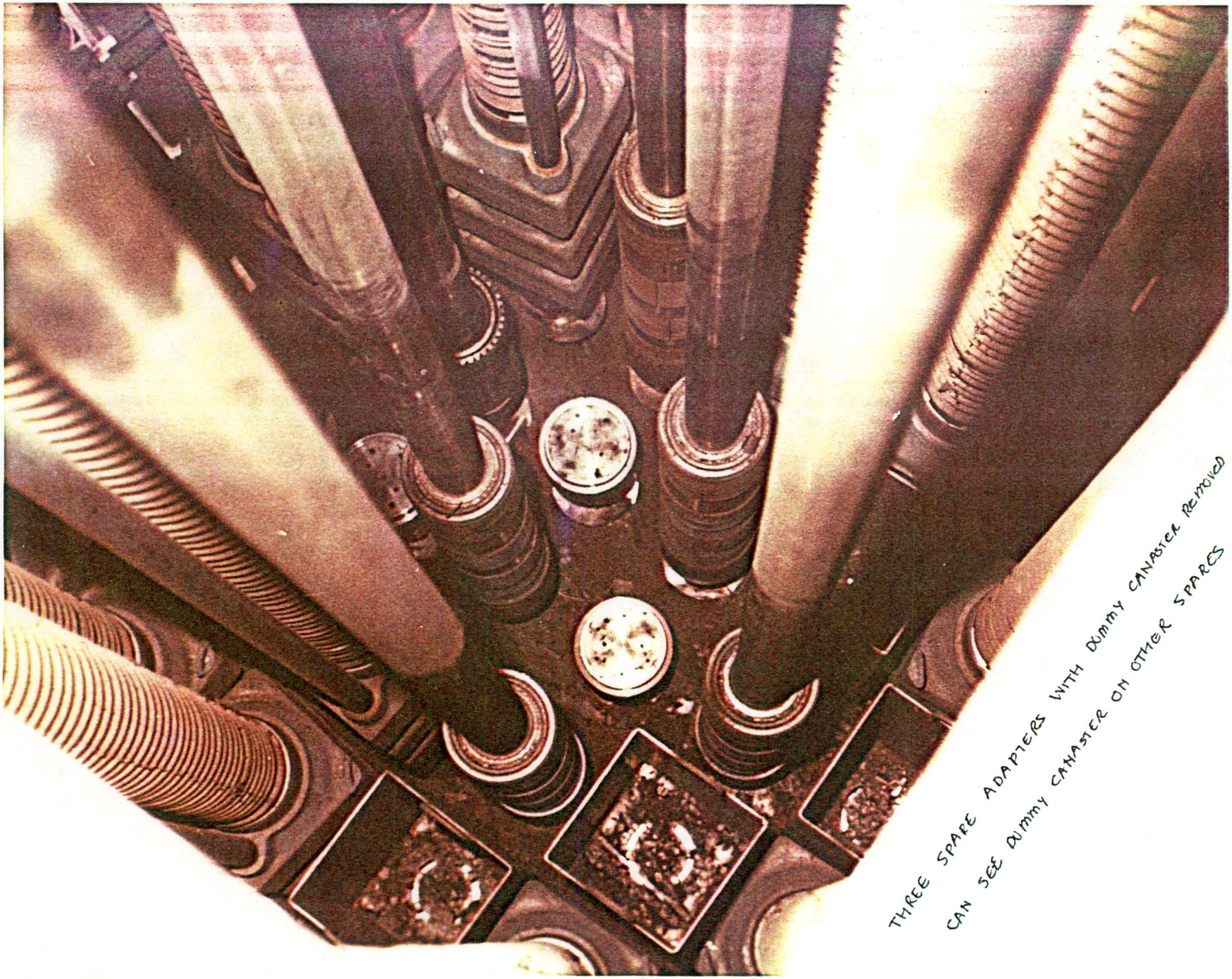



PINHOLE LEAK FROM CANOPY SEAL WELD - SPARE ADAPTER SALEM 1


SHOWING LEAK RESIDUE OVER RX HEAD - SALEM 1 JAN 88
5
8



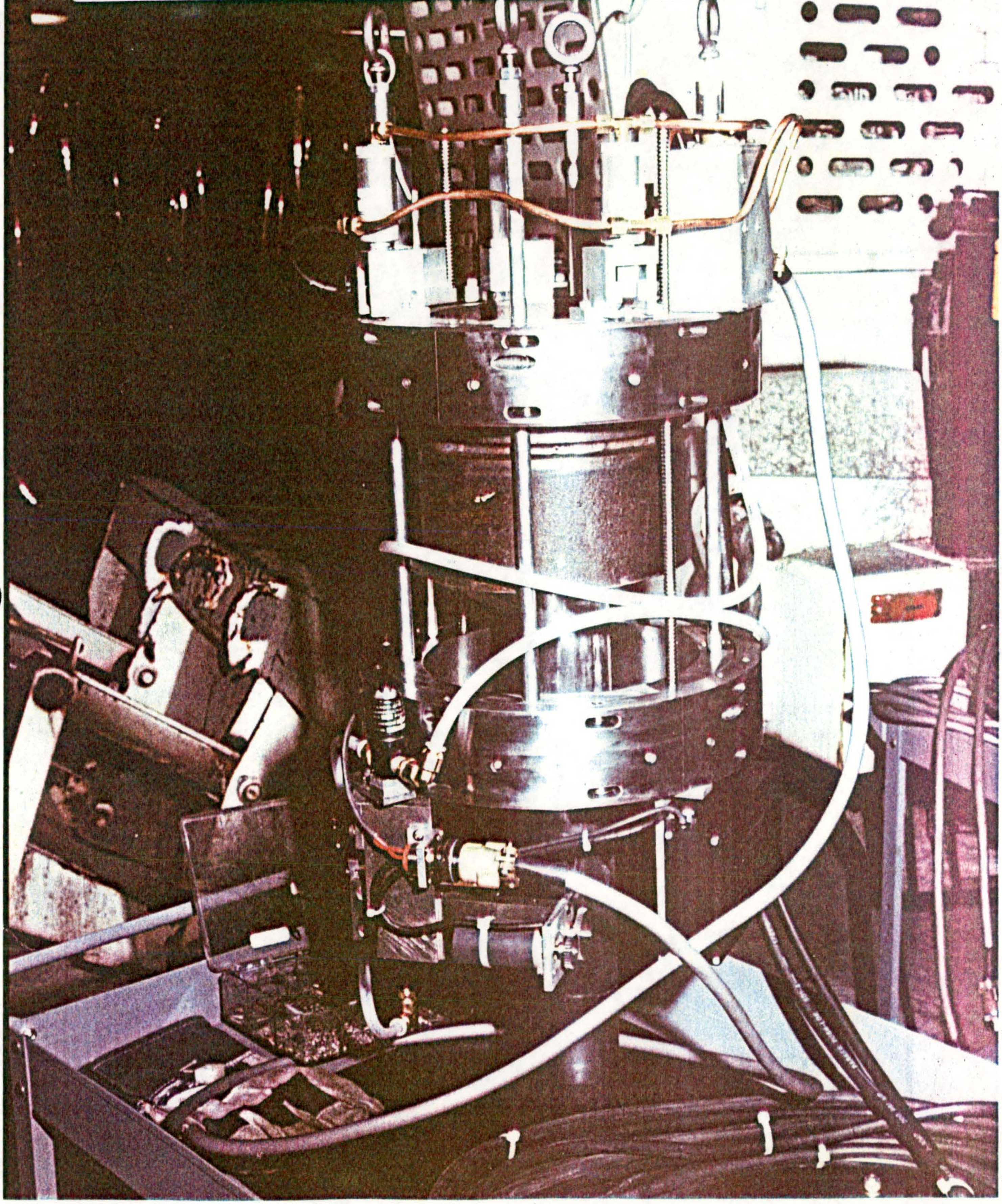
CLOSEUP OF CANOPY SEAL WELD WITH SOME BORON PRECIPITATIONS



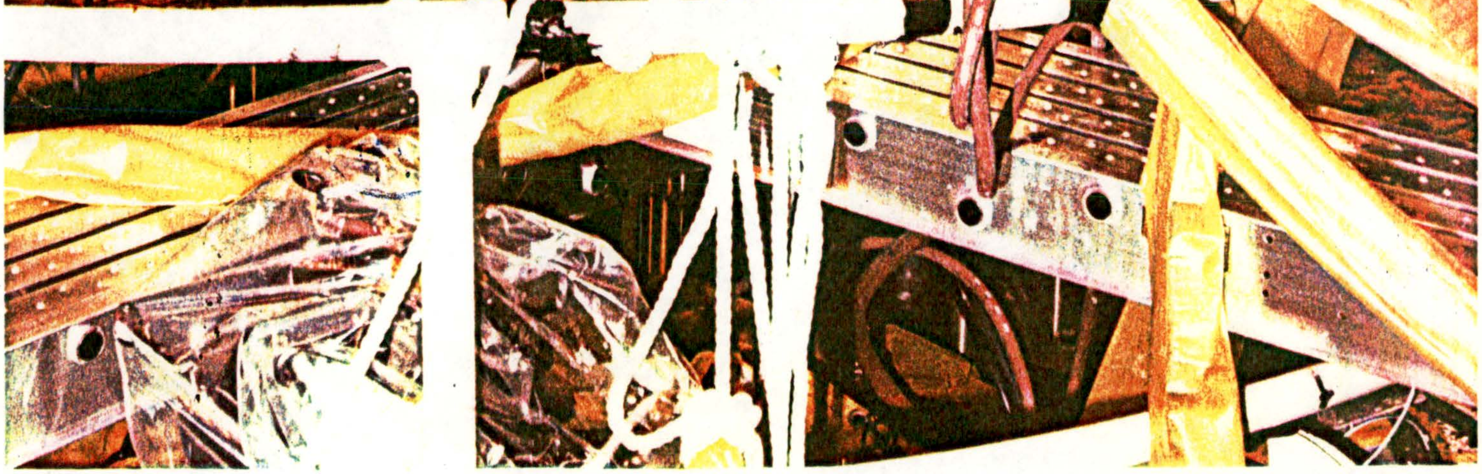
THREE SPARE ADAPTERS WITH DUMMY CANASTER REMOVED
CAN SEE DUMMY CANASTER ON OTHER SPARES


WSI FULL SCALE MOCKUP OF A SPARE PENETRATION - SALEM

WSI WELDING HEAD IN SALEM SHOP



LOWERING OF WSI SMARTTRACK SYSTEM OVER RX - SALEM 1



WSI CONTROL PANEL & DISPLAY MONITORS FOR OVERLAY REPAIR