# H.A.F.A. INTERNATIONAL INCORPORATED

# IIT®

## INSTRUMENTED INSPECTION TECHNIQUE

AS AN ALTERNATIVE TO THE

HYDROSTATIC TESTING REQUIREMENTS FOR

ASME CLASS 1, 2 AND 3 SYSTEMS AND COMPONENTS

Topical Report HAFA 135 (NP-A)

December 1985



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Topical Report HAFA 135 (NP-A) Transmittal Form

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TITLE ______________________ COMPANY ______________________

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Fay H Askwith
Fay H. Askwith, President

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ATTENTION: Fay H. Askwith

# IIT

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Topical Report HAFA 135 (NP-A)

December 1985

CONTROLLED COPY NUMBER 9

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

November 7, 1985

Mr. H. H. Askwith, Vice President
H.A.F.A. International, Inc.
7545 Central Industrial Drive
Riviera Beach, Florida 33404

Dear Mr. Askwith:

SUBJECT: ACCEPTANCE FOR REFERENCING OF LICENSING TOPICAL REPORT HAFA 135(P), "INSTRUMENTED INSPECTION TECHNIQUE AS AN ALTERNATIVE TO THE HYDROSTATIC TESTING REQUIREMENTS FOR ASME CLASS 1, 2 AND 3 SYSTEMS AND COMPONENTS"

We have completed our review of the subject topical report submitted by H.A.F.A. International, Inc. (H.A.F.A.) by letter dated April 2, 1985. We find the report to be acceptable for referencing in license applications to the extent specified and under the limitations delineated in the report and the associated NRC proprietary and non-proprietary evaluations, which are enclosed. The evaluations define the basis for acceptance of the report.

We do not intend to repeat our review of the matters described in the report and found acceptable when the report appears as a reference in license applications, except to assure that the material presented is applicable to the specific plant involved. Our acceptance applies only to the matters described in the report.

In accordance with procedures established in NUREG-0390, it is requested that H.A.F.A. publish accepted versions of this report, proprietary and non-proprietary, within three months of receipt of this letter. The accepted versions shall incorporate this letter and the enclosed evaluations between the title page and the abstract. The accepted versions shall include an -A (designating accepted) following the report identification symbol.

Should our criteria or regulations change such that our conclusions as to the acceptability of the report are invalidated, H.A.F.A. and/or the applicants referencing the topical report will be expected to revise and resubmit their respective documentation, or submit justification for the continued effective applicability of the topical report without revision of their respective documentation.

Sincerely,

Cecil O. Thomas

Cecil O. Thomas, Chief
Standardization and Special
Projects Branch
Division of Licensing

Enclosure:
As stated

TOPICAL REPORT EVALUATION

INSTRUMENTED INSPECTION TECHNIQUE AS AN ALTERNATIVE TO THE HYDROSTATIC TESTING REQUIREMENTS FOR ASME CLASS 1, 2, AND 3 SYSTEMS AND COMPONENTS

SUBMITTED BY H.A.F.A. INTERNATIONAL INCORPORATED
TOPICAL REPORT HAFA 135 (N)
APRIL 1985

## 1.0 BACKGROUND

Pressure tests of nuclear power plant systems and components are performed primarily to determine their preoperational and continued inservice structural integrity and leak tightness. 10 CFR 50.55a states in part that pressure tests of systems and components of boiling and pressurized water-cooled nuclear power facilities shall be performed in accordance with the requirements of Section XI of the ASME Boiler and Pressure Vessel Code. The owners of the facilities are required to update the testing programs to later approved editions and addenda of Section XI at ten-year intervals and, in many instances, compliance with the newer requirements is impractical because of the existing system or component design. In such cases, the Regulation allows relief to be granted by the Commission if the necessary findings can be made. The Regulation also allows proposed alternatives to the requirements to be used when authorized by the Director of the Office of Nuclear Reactor Regulation if the alternatives would provide an acceptable level of quality and safety or compliance with the specified requirements would result in hardship or unusual difficulties without a compensating increase in the level of quality and safety.

As an alternative method for pressure testing systems and components, H.A.F.A. International Incorporated submitted to the staff for review the topical report, "Instrumented Inspection Technique as an alternative to the Hydrostatic Testing Requirements for ASME Class 1, 2, and 3 Systems and Components." This report is evaluated for application of the alternative method to pressure tests required by Section XI.

## 2.0 SCOPE AND SUMMARY OF REVIEW

The information and data contained in the topical report were presented to demonstrate that the Instrumented Inspection Technique is capable of detecting and locating external system leakage, intersystem valve leakage, reducing personnel exposure to radiation, detecting small leaks, eliminating overpressurization of lower pressure rated piping and components, and is therefore a suitable alternative to Section XI requirements for hydrostatic tests. The staff's review considers the Code requirements and the impracticalities associated with implementation of the requirements, and application of the Instrumented Inspection Technique as an alternative. Although the Topical report refers to hydrostatic testing, its intent is to apply to pressure testing in general, i.e., system leakage tests, system functional tests, system hydrostatic tests, and system pneumatic tests. The staff's review therefore encompasses pressure tests in general.

Based on our review and evaluation, we have concluded that sufficient information has been presented to support the conclusion that the Instrumented Inspection Technique is a suitable alternative for the pressure test requirements of Section XI. Application of the alternative method provides added assurance of system and component structural integrity and leak tightness when compared to conventional pressure testing methods. Implementation of the Instrumented Inspection Technique is not intended to circumvent Section XI Code requirements for pressure tests but to provide an added margin of reliability of the test results. The staff finds that the Code requirements, where practical to meet, will be complied with and in situations where the requirements are impractical, the regulations will be followed prior to implementation of the alternative testing method. However, the Code requirement for the four-hour hold time prior to visual examination of insulated systems and components may be reduced to two hours if the alternative method is utilized.

The remainder of this safety evaluation includes summaries of Section XI Code requirements for pressure tests and the topical report, and the bases for our conclusions.

## 3.0 CODE REQUIREMENTS

The Section XI Code requirements for pressure tests given below are a summary of those from the 1980 Edition through Winter 1981 Addenda. These requirements are cited for explanatory purposes only and are not cited to limit the alternative testing method to the requirements in this edition and addenda.

## 3.1 SYSTEM TEST REQUIREMENTS

The Code requires that pressure retaining components within each system boundary be subjected to system pressure tests under which conditions visual examination, VT-2[1], is performed. The required system pressure tests are defined as:

(a) Systems Leakage Test - A pressure test conducted following opening and reclosing of a component in the system after pressurization to nominal operating pressure.

(b) System Functional Test - A pressure test conducted to verify operability of systems (or components) not required to operate during normal plant operation while under system operating pressure.

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[1] A VT-2 is a visual examination that is conducted to locate evidence of leakage from pressure retaining components or abnormal leakage from components with or without leakage collection systems as required during conduct of system pressure or functional tests.

(c) System Inservice Test - A pressure test conducted to perform visual examination VT-2 while the system is in service under operating pressure.

(d) System Hydrostatic Test - A pressure test conducted during a plant shutdown at a pressure above nominal operating pressure or system pressure for which overpressure protection is provided.

(e) System Pneumatic Test - A pressure test conducted in lieu of a hydrostatic pressure test.

Pressure and temperature requirements are defined for the type of test being performed and the system or component Code Class. System boundaries are located at the intersection of Code Class changes and the pressure test hold time depends on whether or not the system or component is insulated.

For Class 1 systems and components, all pressure tests except the hydrostatic test are required to be performed at not less than the nominal operating pressure associated with 100% rated reactor power. The hydrostatic test is required to be performed at not less than 1.10 times the nominal operating pressure at 100°F or less. However, the pressure can be lowered incrementally with increasing temperature to 1.02 times the operating pressure at a temperature of 500°F provided limiting conditions specified in the Technical Specifications are not violated.

For Class 2 systems and components, all pressure tests are required to be performed at nominal operating pressure except the hydrostatic test pressure is required to be at least 1.10 times the lowest pressure setting of safety or relief valves provided for overpressure protection for systems with a design temperature of 200°F (93°C) or less and 1.25 times this pressure for systems with a design temperature above 200°F (93°C).

The system inservice test and system functional test of Class 3 systems are required to be performed at nominal operating pressure. The test pressure requirements for hydrostatic tests are the same as those for Class 2 systems, i.e., 1.10 times the lowest setting of safety or relief valves provided for overpressure protection for systems with a design temperature of 200°F (93°C) or less and at least 1.25 times this pressure for systems with a design temperature above 200°F. For systems not provided with safety or relief valves, the system design pressure is required to be used during the hydrostatic test.

Test temperature for Class 1, 2 & 3 systems and components constructed of ferritic steel is required to meet the criteria specified for fracture prevention. For systems constructed of austenitic steel, test temperature limitations are not required to meet fracture prevention criteria. The pressure test hold time is required to be ten (10) minutes for systems that are not insulated and four (4) hours for insulated systems.

The accuracy of test gages used in pressure testing is required to provide results accurate to within 0.5% of full scale. The test gages are required to be calibrated against a standard dead weight tester or a calibrated master gage. The test gages are required to be calibrated before each test or series of tests, where a series of tests is a group of tests that use the same pressure test gage or gages and that are conducted within a period not exceeding two (2) weeks.

## 4.0 SUMMARY OF TOPICAL REPORT

The information contained in the topical report included (1) rationale for the alternative testing, (2) a description of the Instrumented Inspection Technique, and (3) the results of tests performed on systems at four facilities. A summary of these aspects is given below.

## 4.1 TESTING RATIONALE

Section XI Code requirements for pressure tests fail to address the problem of intersystem leakage or adequately address small external leakage since small leakages may not penetrate insulation or appear at breaks in the insulation. To implement the requirements of the Code, in many instances, involves system preparations which could entail removal of valve internals, blanking safety or relief valves, pin blocking spring hangers, shutting down both units of a two-unit site when testing shared systems, and exposing testing personnel to accumulated doses of radiation which could be lowered in keeping with the aims of ALARA (As Low As Reasonably Achievable).

The Instrumented Inspection Technique is capable of eliminating or reducing many of the problems associated with implementing the Code requirements for pressure tests while meeting the intent of the Code and addressing problems that are potentially safety significant.

## 4.2 DESCRIPTION OF THE INSTRUMENTED INSPECTION TECHNIQUE

( PROPRIETARY INFORMATION )

## 4.3 TEST RESULTS OF IIT APPLICATION ON SYSTEMS AT SEVEN PLANTS

( PROPRIETARY INFORMATION )

## 5.0 EVALUATION

### 5.1 APPLICATION OF IIT AS AN ALTERNATIVE PRESSURE TESTING METHOD

The Instrumented Inspection Technique (IIT) is a pressure testing method that is performed in accordance with the rules of Section XI and the Regulation, 10 CFR 50.55a. The equipment employed enables testing personnel to locate leaks faster, detect smaller leaks, and detect intersystem leaks. The IIT is therefore an alternative pressure testing method that provides superior quality and safety over conventional testing and is thus an acceptable alternative.

### 5.2 APPLICATION OF IIT AS AN ALTERNATIVE TO IMPRACTICAL CODE REQUIREMENTS

#### 5.2.1 Test Pressure Requirement

Attaining and holding t e Code required test pressures in portions of Class 1, 2, and 3 systems have been cited in many instances by a number of licensees to be impractical to perform at their facilities. Supporting information justifying their determinations was provided to the Commission and relief from performing these tests at Code required test pressures was granted after review and evaluation. Sufficient data on small leaks in water-filled systems have been taken and the results analyzed to demonstrate that small leaks can be detected by IIT and that the changes in the leakage rates between normal operating pressures and the Code required pressures are relatively small. Based on the leak detection

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capabilities of IIT, the staff finds that its application in situations where the Code required test pressures are impractical to attain and hold, and the tests are performed at normal operating pressure, will provide added assurance that small leaks at the lower pressures will be detected. We therefore find IIT to be an acceptable alternative method to be used for impractical Code test pressure requirements.

5.2.2 Test Hold Time

The Code requirement for pressure test hold time of four (4) hours prior to visual examination of insulated systems is based on allowing sufficient time to elapse for a leaking fluid to penetrate the insulation and be detected by the VT-2 (visual) inspection. Since small leaks can be detected by IIT, it is not necessary to require the four-hour hold time. Leakage detected by IIT can be located prior to or after achieving the required pressure. The staff finds that a two-hour hold time is adequate for insulated systems prior to the VT-2 inspection when using IIT as the alternative testing method.

## 6.0 CONCLUSIONS AND RECOMMENDATIONS

(1) Based on our review and evaluation of the information and data presented in the topical report, we conclude that the IIT will provide added assurance of the structural integrity and leak tightness of systems and components subjected to pressure tests and that the testing method provides an increase in the level of quality and safety, and is therefore an acceptable alternative testing method.

(2) Application of IIT where Code requirements are impractical to meet also increases the level of quality and safety because of the leak detection capabilities of the method employed.

(3) The four-hour hold time requirement for insulated systems may be reduced to two-hours because of the small leak detection and location capabilities of IIT. Visual (VT-2) examination of the systems as required by Section XI should be performed after the two-hour hold time.

(4) Prior to implementation of IIT, a system safety and operational review should be performed and testing procedures approved as described in the topical report. Impractical Code requirements and supporting information to justify the impracticalities should be submitted to the Commission for evaluation as required by Regulations.

## NOTICE

This report was prepared by the organization named below as an account of work sponsored by Philadelphia Electric Company, Public Service Electric and Gas Company, Tennessee Valley Authority, and Toledo Edison Company. Neither the utilities named above, members of the utilities named above, the organization named below, nor any persons acting on behalf of any of them; (a) makes any warranty, expressed or implied, with respect to the use of any information, apparatus, method or process disclosed in this report or that such use may not infringe privately owned rights, or (b) assumes any liabilities with respect to the use of, or for damages resulting from the use of, any information, apparatus, method or process disclosed in this report.

Prepared by

H.A.F.A. International, Incorporated

## ABSTRACT

An evaluation and demonstration program has been conducted by H.A.F.A. International, Incorporated (HAFA) to determine the effectiveness of its Instrumented Inspection Technique (IIT) using the HAFA-patented Multi-Media Leak Detection Apparatus and Leak Measuring Devices (Patent Number 4364261). These were used in conjunction with Acoustic Leak Sensing Equipment (ALSE) to locate and quantify internal and external leakages at both normal system operating pressures (NOP), and at (or above) the ASME Section XI Code requirements Light Water Reactor (LWR) piping systems hydrostatic test pressures.

Theoretical and actual field testing data are presented in support to a claim of the applicability of the IIT method as an acceptable alternative to ASME Section XI Code hydrostatic testing requirements. The IIT procedures are shown to be highly effective in identifying intersystem leakage, pressure isolation leakage and external leakage, with the accompanying ability to quantify leakage in check valves in the reverse direction. The IIT, at NOP, identifies and quantifies leakage to a higher degree of accuracy, lower cost, and a reduction of radiation exposure than is normally achievable using standard procedures to meet current Code requirements.

CONTENTS

# I. INTRODUCTION

It is a requirement of the Code of Federal Regulations (CFR) Title 10 that testing or inspection of a specified nuclear plant system or component is to the maximum extent practical in accordance with generally recognized codes and standards.(1) Piping, pumps and valves which are classified as ASME Code Class 1, 2 and 3 are required to be designed to enable the performance of inservice inspection and testing as set forth in Section XI of the Boiler and Pressure Vessel Code.(2)

The regulations have a built in flexibility in their applications and permit alternative requirements on the grounds of impracticality or proposed alternative methods which provide an acceptable level of quality and safety! In the course of developing and applying inservice inspection (ISI) programs to light water reactor (LWR) systems, many test methods used (which are not defined)* tested specific components of a system but did not test that system as a whole, or in its interaction with other systems with respect to internal or external leakage. Added instrumentation such as local flow and pressure measuring devices coupled with acoustic emission monitoring in specific applications was integrated into proprietary standard inspection routines to avoid anomalies such as obscured test surfaces of the coolant boundaries, etc. The methodology was defined as Instrumented Inspection Techniques (IIT) and was successfully applied in an ad hoc manner. Other forms of testing in which alternatives to the required test pressures were acceptable to the Nuclear Regulatory Commission (NRC) also gave insights to the sometimes limitations and practical restrictions on proving a systems leak tightness to the Code requirements.(3)

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*One of the basic tenents of the Code is that it is not a "how to" document. i.e., It does not define test method!

Appropriate to the above therefore a test program was conducted to determine:

. The applicable procedures and systems in LWRs to which meaningful IIT can be substituted for present ASME Code requirements such as hydrostatic testing, system leakage tests, system functional tests and system pneumatic tests.

. Whether testing using IIT can be performed on systems and components in LWRs while in "operation."

. If techniques to enhance the present visual inspection of systems that may contain insulated piping can be defined.

. The cost savings and improvements in ALARA using IIT.

. What systems to be tested could be removed as a critical path item during plant outages.

The efficacy of the methodology relies heavily upon systems analysis and in-plant coordination which in many instances requires plant operations cooperation. It also requires licensing interface declarations and the practical support of the test instruments. The combination of these items and the know-how of their applicability is considered to be a restriction on their use and may result in questionable safety assessments without the endorsement of this corporation.

In developing data to produce a resolution of many of the above issues the cooperation and support of the following LWR utilities were obtained and are gratefully acknowledged.

Public Service Electric and Gas Company (PWR)

Philadelphia Electric Company (BWR)

The Tennessee Valley Authority (PWR)

The Toledo Edison Company (PWR)

## II. TESTING RATIONALE

A review of ASME Boiler and Pressure Vessel Codes, for example, shows that the 1980 Edition thru 1981 Addenda of Section XI requires that ASME Class 2 systems and components be tested to Articles IWA-5000 and IWC-5000. The hydrostatic test pressure is required to be 1.25 times the system pressure if its design temperature is greater than 200 F. For systems having a design temperature of 200 F and below, the hydrostatic test pressure is 1.1 times the system pressure. Where a system is provided with overpressure protection by safety or relief valves, system test pressure is defined as the lowest set pressure of safety or relief valves in the system. Where there is no safety or relief valve in the section of the system under test, the system design pressure is the basis for the hydrostatic test pressure.

ASME Class 3 requirements for hydrostatic pressure testing are listed in Articles IWA-5000 and IWD-5000. Test pressures are applied to the above rationale as for ASME Class 2 systems.

Article IWA-5211 of Section XI of the Code defines the conditions under which pressure retaining components within each LWR system shall be tested. It also delineates visual examination requirements in accordance with IWA-5421 (Leakage).

Article IWA-5212 requires that the system test conditions be maintained essentially constant during the period of visual examination.

Article IWA-5213 requires the hydrostatic test pressure to be held for four hours on insulated systems and ten minutes on noninsulated systems and components.

The requirements of IWA-5212 fail to address the problem of intersystem or boundary leaks which are potentially safety-significant. The intent of IWA-5213 obviously can only address visible external leakages! It was demonstrated (Section V and Appendix I) that leakage areas important to safety may be difficult or impossible to find as per the visual examination (VT-2) method even during test periods, which last as long as nine hours.[4] Since small leakages may not penetrate the insulation or be designed to be conducted away, the IWA-5213 four-hour hold time gives only a minimal validity to a test.

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H.A.F.A. International, Incorporated inspection techniques are generally non-intrusive to plant operations and use proprietary techniques and instruments. The procedures used meet the intent of the present Codes and Regulations.

Practical experience gained by HAFA in the development of hydrostatic testing programs has revealed the following problems caused by the restraints of Conventional ASME Section XI Testing:

1. Secondary hydrostatic pressure testing of the Davis-Besse 1 Main Steam System (PWR) requires a test temperature in the range of 130 F to 200 F to accommodate brittle fracture prevention criteria. Temperature control throughout the length of the system over the testing period of four hours, plus inspection time, is not easily achieved. A test pressure of 1313 psig within the temperature range must be maintained for a test duration of seven to nine hours.

2. Other problems in testing the steam line such as at Davis Besse 1 and Salem include:

   a. Blanking of nine Code safety valves and an atmospheric dump valve in each of two loops.

   b. Testing requires removal of bonnets and internals from check valves MS726, 727, 734, 735, and 274.* Reassembly of these valves following testing requires retesting of the system to ensure leak tightness of the components. The Code does not address this concern, but such a requirement tends to negate the results of any preceding test.

   c. Due to the weight of liquid water in a system designed for steam, all spring hangers in the system must be pin blocked.

   d. Temporary piping and connections between the hydrostatic test pump and several locations in the system must be routed through high radiation and high contamination control areas. This requires cleaning and decontamination of pumps and piping equipment before and after testing and imposes an estimated 50mR/man additional radiation exposure.

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*See Davis-Besse 1 Piping and Instrumentation Diagram M-003.

e. To meet the aims of ALARA, an estimated dose of 1734mR is received by personnel in completing this test per Code. IIT imposes an estimated 196mR dose.(5) (See Appendix 2, pages 1 and 2.)

f. Test time requires an estimated total of 2540 man-hours versus 103 man-hours for IIT.(6)

g. A delay in startup of approximately 4.5 days, as the test is an outage critical path item.(7) IIT is arranged so as not to affect a plant's outage critical path.

3. Testing of the Pressurizer Relief Discharge System at Salem 1 & 2 carries an estimated at 712mR dose per unit and 411 man-hours. IIT testing requires 122 man-hours with exposure estimated at 214mR.(8)

4. Testing of Residual Heat Removal (RHR) system pump suction piping at Peach Bottom 2 & 3 is estimated to incur a dose of 2750mR per pump test per unit and 626 man-hours, whereas estimates show IIT requires 148 man-hours with exposures of 665mR.(9)

5. Testing of Emergency Service Water and Emergency Cooling Water at Peach Bottom 2 & 3 is estimated at 1940mR per unit and 458 man-hours. IIT will require 148 man-hours with exposure estimated at 705mR.(10)

6. Testing of RHR system pump discharge piping system at Peach Bottom 2 & 3 is estimated at 3190mR per unit and 698 man-hours. IIT will require 139 man-hours with exposure estimated at 665mR.[11]

7. Testing the Essential Raw Cooling Water system at Sequoyah 1 & 2 will require shutdown of both units due to system commonality, at a cost in excess of $6 Million in replacement power. In addition, leakage in interloop crossties within the system may well prohibit loop "isolation," preventing any local identification of intersystem leakage.

# III. INSTRUMENTED INSPECTION TECHNIQUE

This section prescribes, defines, and illustrates H.A.F.A. International, Incorporated techniques of instrumented inspection.

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## B. PERSONNEL QUALIFICATIONS

All personnel utilizing this equipment are certified to the HAFA Quality Assurance Procedure 9.2 (Appendix III). Personnel are required to pass written examinations, demonstrate hands-on proficiency, and to meet minimum educational requirements. This personnel testing qualifications program meets the intent of ANSI 45.2.6. All testing is performed in accordance with written procedures developed under the HAFA/Utility Quality Assurance Programs, which meet the pertinent portions of 10 CFR 50 Appendix B.

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## IV. SYSTEM SAFETY AND OPERATIONAL TEST AND REVIEW

This section describes the procedures developed by H.A.F.A. International, Incorporated to develop and conduct a full test program.

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## V. DISCUSSION

The discussion is initially based upon the various systems offered by the cooperating utilities. Regulatory recognition and acceptance is still in process. It would not be appropriate to enlarge on the details of the preliminary discussion at this time. However, the systems tested are defined and test conclusions given.

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TEST NUMBER 1 - BELLEFONTE PLANT, MAKEUP AND PURIFICATION SYSTEM

Tests were performed on the suction side piping and valves of three makeup pumps at Bellefonte Plant. This test was required to verify the leaktight integrity of the piping and valves in the system caused by an inadvertent overpressurization during the flushing operation. The system was tested at the design pressure 675 psig x 1.25 = 844 psig, and at incremental pressures of 20, 450, 650 psig. Hold times of 10 minutes were imposed at the different pressure levels.[12]

The system leak rate was determined to be less than 0.1 gpm. Analysis of the test data identified:

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TEST 1 CONCLUSION

1. There were no apparent significant increases in leak rates from NOP increases from 625 psig to 844 psig (ASME Section III hydrostatic pressure requirements for this system).

2. IIT permits the identification of valve leakage (as stated above) that conventional hydrostatic pressure testing has the inability to identify.

TEST NUMBER 2 - SALEM NUCLEAR GENERATING STATION
DIESEL GENERATOR COOLING WATER SYSTEM

A demonstration test was performed whereby two check valves in the Diesel Generator Cooling Water System were tested for reverse flow. The purpose of this test was to determine the reliability of the LMD 10 and the ALSE to locate and quantify valve leakages.

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TEST 2 CONCLUSION

The results demonstrated a change in the intra-system leak rate of approximately 4% with a pressure increase of 400%. The ALSE also confirmed the check valves were leaking. IIT accomplished this test in a manner obviating the need for a request for relief.(13)

TEST NUMBER 3 - DAVIS-BESSE UNIT 1, COMPONENT COOLING WATER SYSTEM

Prior to performing the pressure testing of the Component Cooling Water Essential Loop 1, an acoustic audit was performed to identify background noise in the system. This audio audit was conducted because the system was to be subsequently tested when the plant was in normal operating mode. Conventional testing of this system would require plant shutdown. The CCW Essential Loop 1 was tested in the following manner:

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TEST 3 CONCLUSION

The testing that was performed on the CCW demonstrates the following:

1. Testing can be performed on systems of this type during normal operation.

2. There was no significant measurable changes in leak rates during the different pressures.

3. Reverse flow verification of check valves can be performed at NOP without requesting Code relief.

TEST NUMBER 4 - SEQUOYAH UNITS 1 & 2, ESSENTIAL RAW COOLING WATER (ERCW)

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TEST 4 CONCLUSION

Based upon the results of the acoustic measurement task, a determination was made that IIT could test the system with both units in operation. Conventional testing would require shutdown of both units at an estimated cost in excess of six million dollars.(14) It should be noted that the conventional method of hydrostatic pressure testing would fail to identify interloop leakage through butterfly valves.

TEST NUMBER 5 - PEACH BOTTOM UNIT 3, HIGH PRESSURE SERVICE WATER SYSTEM

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TEST 5 CONCLUSION

Based upon the data presented above, one can conclude that:

1. Selected walkdowns in conjunction with IIT would enhance the validity of the system pressure tests (e.g., wrong pressure setting of relief valve),

2. IIT locates leakage not found by normal VT-2 walkdowns, and

3. There is no significant difference in leakage rates between NOP and hydrostatic test pressures.

TEST NUMBER 6 - PRELIMINARY TESTING OF STEAM LINES AT RIVIERA BEACH STEAM PLANT AND EDDYSTONE STEAM PLANT UNIT 3

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TEST 6 CONCLUSION

At present, insufficient data has been acquired upon which to base a conclusion leading to establishing a set of acoustic emission testing parameters. Additional testing is scheduled to be performed on the Davis-Besse Unit 1 steam lines.

TEST NUMBER 7 - DAVIS-BESSE UNIT 1, HIGH PRESSURE INJECTION SYSTEM (HPI) AND MAKEUP AND PURIFICATION SYSTEM (MU&P)

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TEST 7 CONCLUSION

The leak rate decrease in check valves under increasing reverse flow pressure was found, as expected, to be due to the improvement in the valve seating with pressure. IIT proved capable of quantifying both total system leak rate and leakage through individual selected boundary valves. The IIT showed itself capable of testing this system without recourse to system modification or relief request, during startup mode. Testing time for the first series, consisting of eight separate testing segments, required a total actual test time of less than seven hours. The second series, of fourteen test segments, required less than eight hours of actual testing.

TEST NUMBER 8 - AUXILIARY SPRAY LINE

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TEST 8 CONCLUSION

The setup of equipment, acquisition of data, and removal of the equipment in less than thirty minutes (approximately 4 man-hours of work) demonstrates the advantages with regard to ALARA and also the versatility of the IIT.[15]

TEST NUMBER 9 - DAVIS-BESSE UNIT 1 MAIN STEAM SYSTEM

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TEST 9 CONCLUSION

The acoustic emission data that was taken on the main steam line was inconclusive due to the incompatibility of equipment. Additional data will be acquired during further transition phases from mode 3 to 5.

## VI. CONCLUSIONS

The application of Instrumented Inspection Techniques (IIT) has been sufficiently demonstrated to be a suitable alternative to the current ASME Section XI requirements for pressure testing, system leakage tests, system functional tests, system hydrostatic tests, and system pneumatic tests of Nuclear Plant Class 1, 2 and 3 systems and components. The techniques used require a preliminary systems analysis and the use of special equipment in applying optimum operational, technical and economical methods to locate external and intersystem boundary leaks.

The test results contained in this Topical Report demonstrate that the IIT provides results equivalent or superior to the conventional method of hydrostatic pressure testing in the areas of sensitivity and reliability. In addition, the use of IIT eliminates the following problems associated with conventional hydrostatic pressure testing to the present ASME Code requirements.

a. The need to blank flanges and gag or remove pressure relief devices

b. The need to remove valve internals and bonnets

c. The need to pin piping support hangers

d. The possibility of overpressurizing piping and components rated at lower pressures due to unidentified intersystem leakage, thus potentially damaging plant systems and components.

e. Inability to find internal leaks in a system.

The IIT identifies system leakages and in many instances the specific leak rate through individual boundary valves. It is, in most cases, nonintrusive on plant operations, more cost- and time-effective and, in keeping with ALARA considerations, results in radiation doses considerably lower than those taken during conventional testing.

## VII. REFERENCES

1. Code of Federal Regulations (10 CFR 50.55a)

2. "Rules for Inservice Inspection of Nuclear Power Plant Components." American Society of Mechanical Engineers, Boiler and Pressure Vessel Code. 345 East Forty-Seventh Street, NY, NY 10017

3. Feedwater ring header modifications, Davis-Besse 1, Toledo Edison Company; circa June 1982

4. H. H. Askwith, HAFA International, Inc., to M. J. Kelly, Peach Bottom 3, Philadelphia Electric Company, Private Communication, circa November 1984

5. H. H. Askwith, HAFA International, Inc., to Davis-Besse 1 and Salem (PSE&G) Test Staff, Private Communication

6. Ibid

7. Ibid

8. Ibid

9. M. J. Kelly, Peach Bottom 3, Philadelphia Electric Co. to H. H. Askwith, HAFA International, Inc., Private Communication, circa December 1984

10. Ibid

11. Ibid

12. "Hydrostatic Testing of the Makeup and Purification System Suction Side of Pumps 001A, 002A and 003A, Bellefonte Nuclear Power Plant" HAFA Test Procedure, D. Hirsch 3-2-83

13. PSE&G, Salem, NJ, Demonstration Test, Recorded R. P. Milke, C. G. Duffy, HAFA; Jan 9-13-84

14. Peach Bottom APS Unit 3 Test Data on High Pressure Service Water System, R. P. Milke, C. G. Duffy, HAFA October 12, 84

15. System Pressure/Leak Test, D. Abbuehl and C. G. Duffy, 1-10-85

# APPENDIX I

## TEST PROCEDURES AND RECORDS

PROPRIETARY

# APPENDIX I. TEST PROCEDURES & RECORDS

## CONTENTS

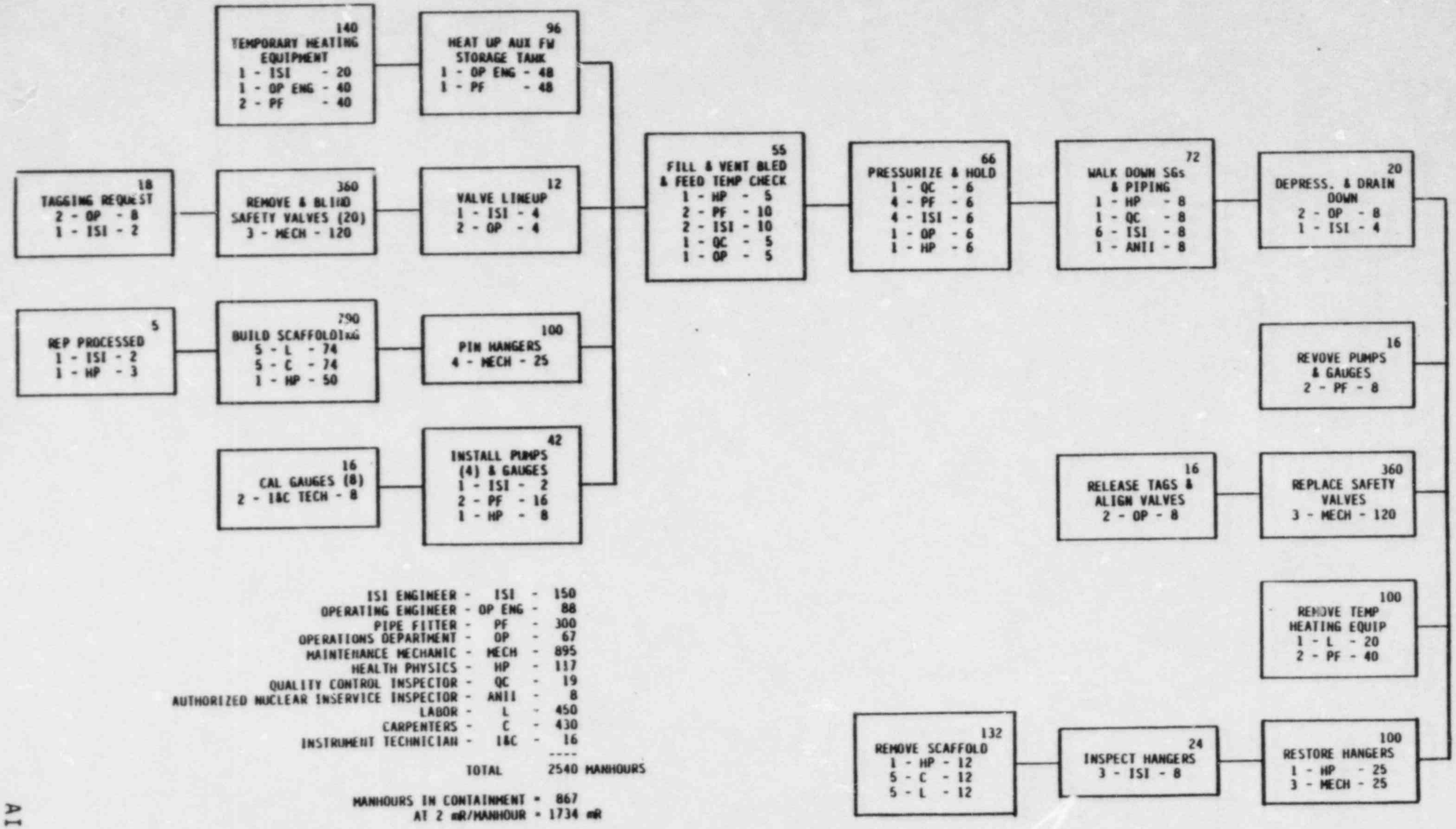
# APPENDIX II

# TEST IMPACT DIAGRAMS

# DAVIS-BESSE UNIT 1/SALEM UNIT 1 & 2 MAIN STEAM SYSTEM

## (CONVENTIONAL)

## CRITICAL PATH 4.5 DAYS



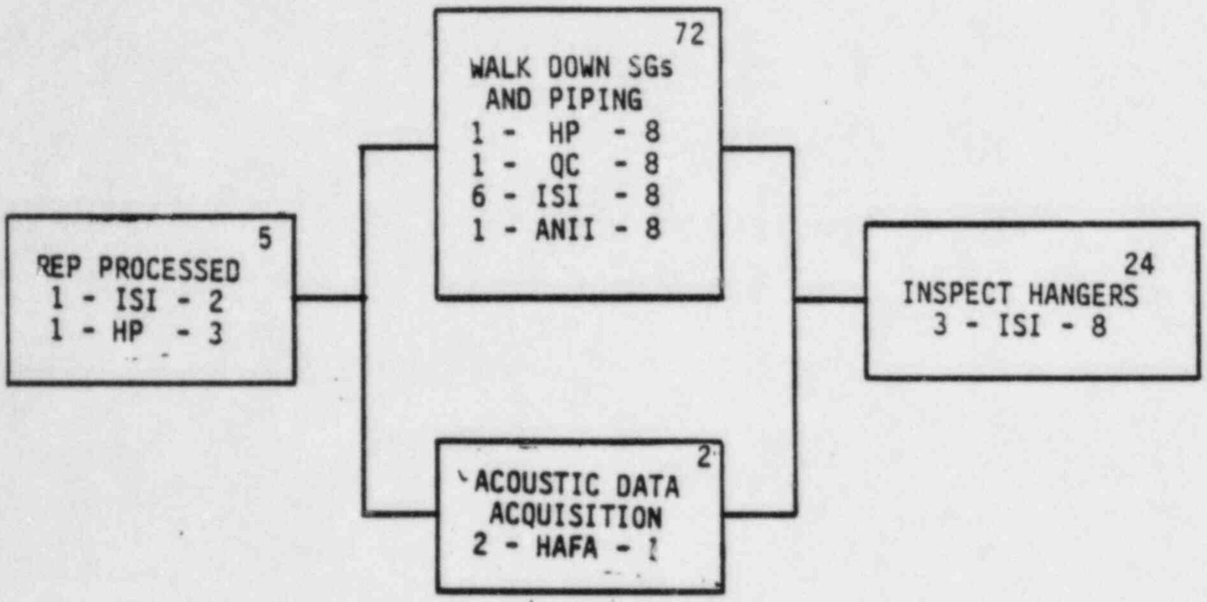

| | | | |
|---|---|---|---|
| ISI ENGINEER | - ISI | - | 150 |
| OPERATING ENGINEER | - OP ENG | - | 88 |
| PIPE FITTER | - PF | - | 300 |
| OPERATIONS DEPARTMENT | - OP | - | 67 |
| MAINTENANCE MECHANIC | - MECH | - | 895 |
| HEALTH PHYSICS | - HP | - | 117 |
| QUALITY CONTROL INSPECTOR | - QC | - | 19 |
| AUTHORIZED NUCLEAR INSERVICE INSPECTOR | - ANII | - | 8 |
| LABOR | - L | - | 450 |
| CARPENTERS | - C | - | 430 |
| INSTRUMENT TECHNICIAN | - I&C | - | 16 |
| | | | ---- |
| TOTAL | | | 2540 MANHOURS |

MANHOURS IN CONTAINMENT = 867
AT 2 mR/MANHOUR = 1734 mR

DAVIS-BESSE UNIT 1/SALEM UNIT 1 & 2 MAIN STEAM SYSTEM

(IIT)

NO CRITICAL PATH HOURS



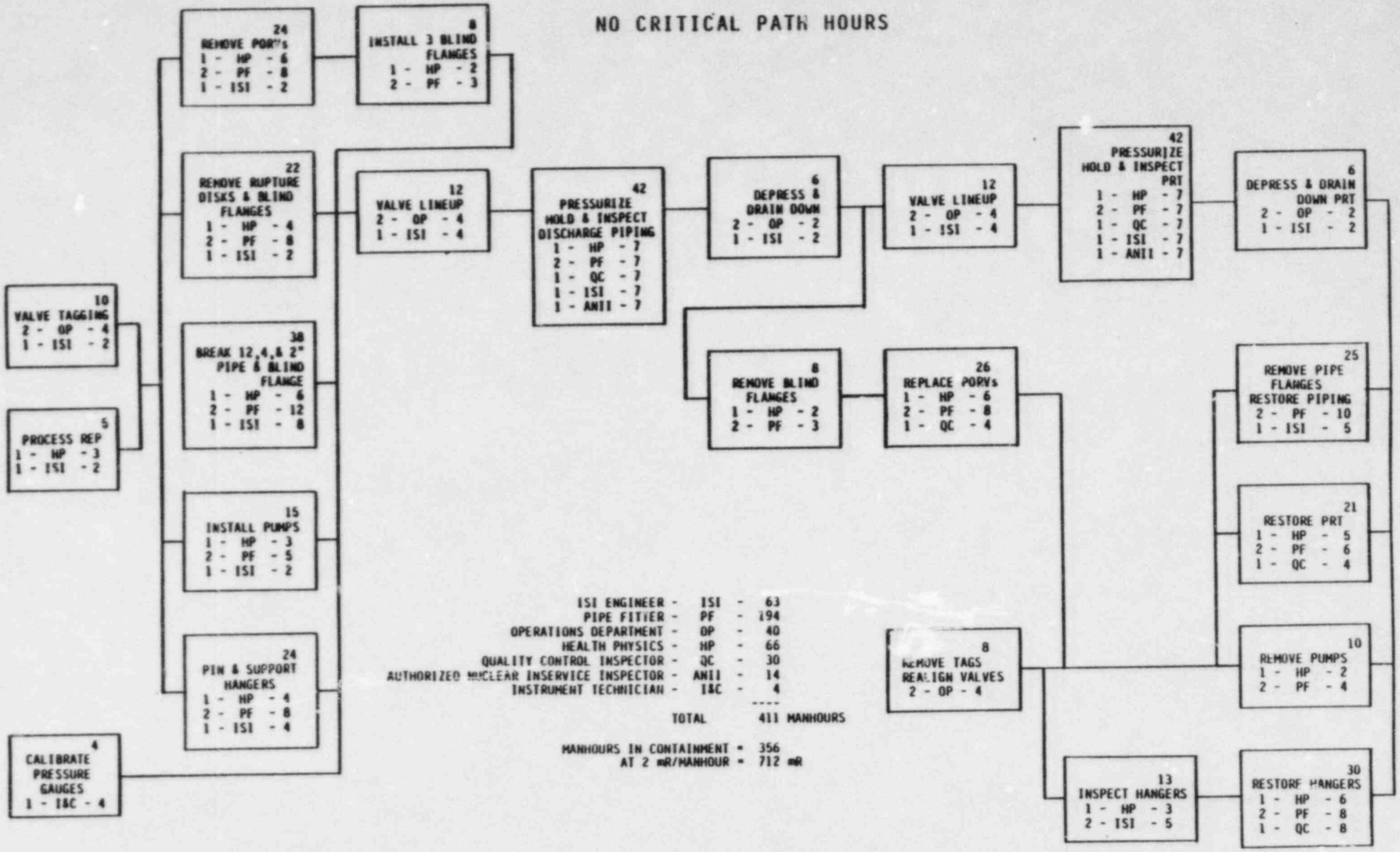

| | | | |
|---|---|---|---|
| HAFA PERSONNEL | HAFA | 2 | |
| ISI ENGINEER | ISI | 74 | |
| HEALTH PHYSICS | HP | 11 | |
| QUALITY CONTROL INSPECTOR | QC | 8 | |
| AUTHORIZED NUCLEAR INSERVICE INSPECTOR | ANII | 8 | |
| | | --- | |
| TOTAL | | 103 | MANHOURS |

MANHOURS IN CONTAINMENT = 98
AT 2mR/MANHOUR = 196

# SALEM 1 & 2 PRESSURIZER RELIEF DISCHARGE SYSTEM

## (CONVENTIONAL)

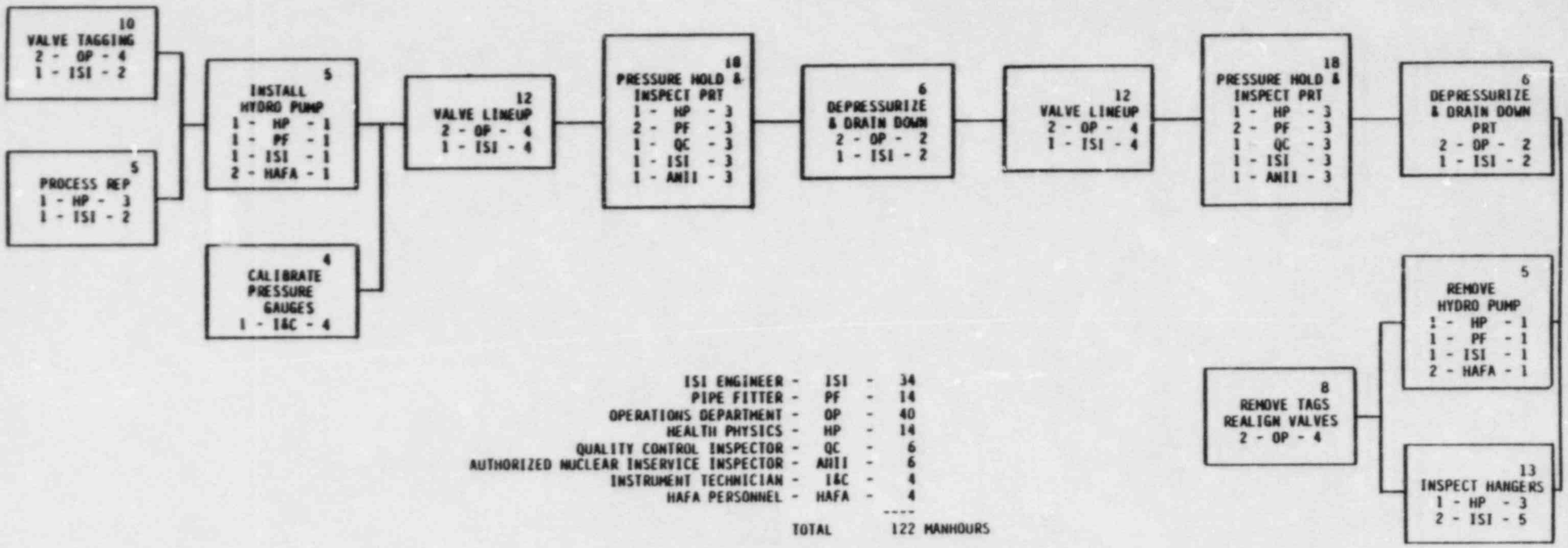
## NO CRITICAL PATH HOURS



# SALEM 1 & 2 PRESSURIZER RELIEF DISCHARGE SYSTEM

## (IIT)

## NO CRITICAL PATH HOURS



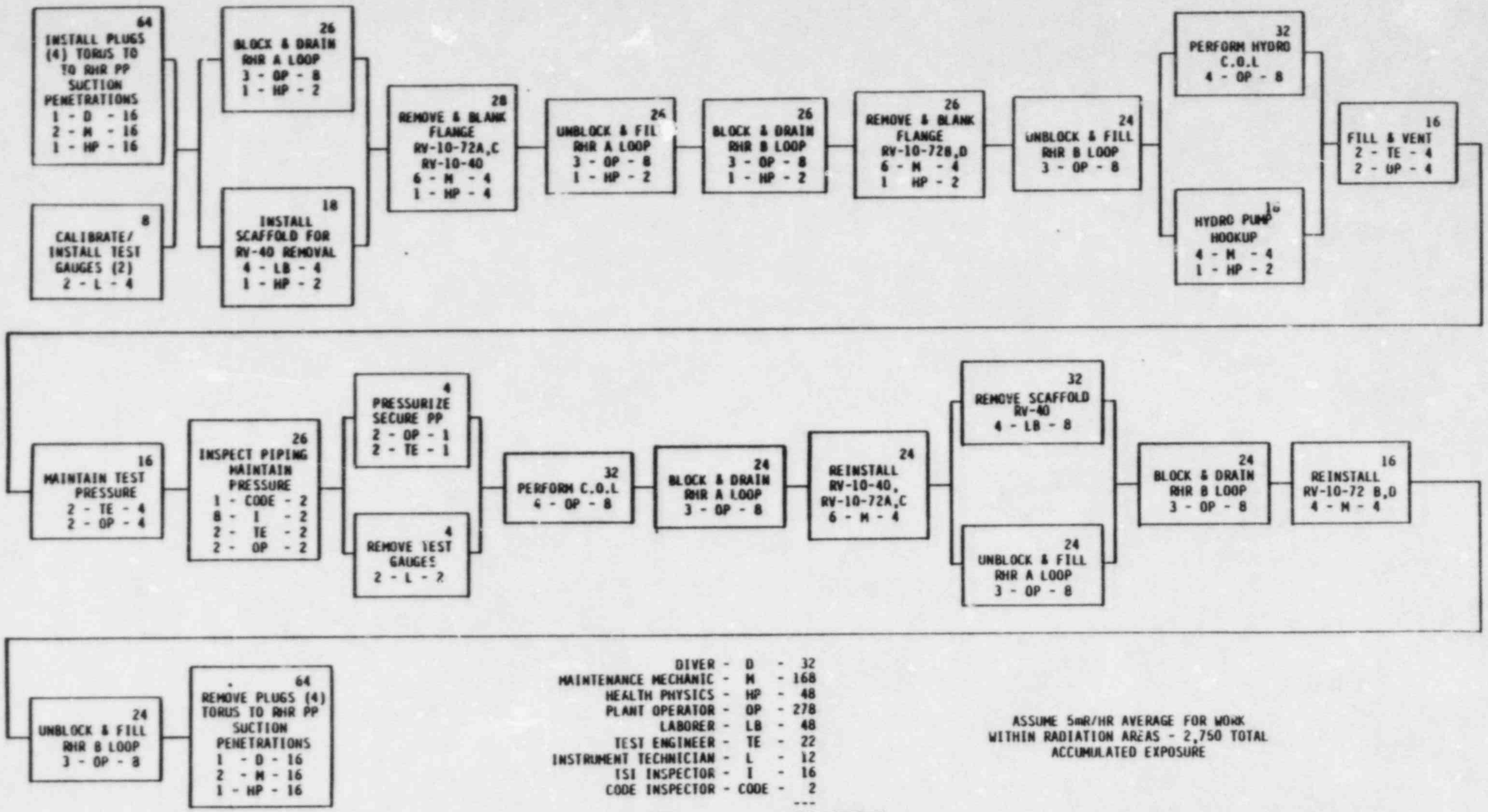

| | | |
|---|---|---|
| ISI ENGINEER - | ISI - | 34 |
| PIPE FITTER - | PF - | 14 |
| OPERATIONS DEPARTMENT - | OP - | 40 |
| HEALTH PHYSICS - | HP - | 14 |
| QUALITY CONTROL INSPECTOR - | QC - | 6 |
| AUTHORIZED NUCLEAR INSERVICE INSPECTOR - | ANII - | 6 |
| INSTRUMENT TECHNICIAN - | I&C - | 4 |
| HAFA PERSONNEL - | HAFA - | 4 |
| | | ---- |
| TOTAL | | 122 MANHOURS |

MANHOURS IN CONTAINMENT = 107
AT 2 mR/MANHOUR = 214 mR

## PEACH BOTTOM 2 & 3 RHR SYSTEM PUMP SUCTION PIPING

### (CONVENTIONAL)

### NO CRITICAL PATH HOURS



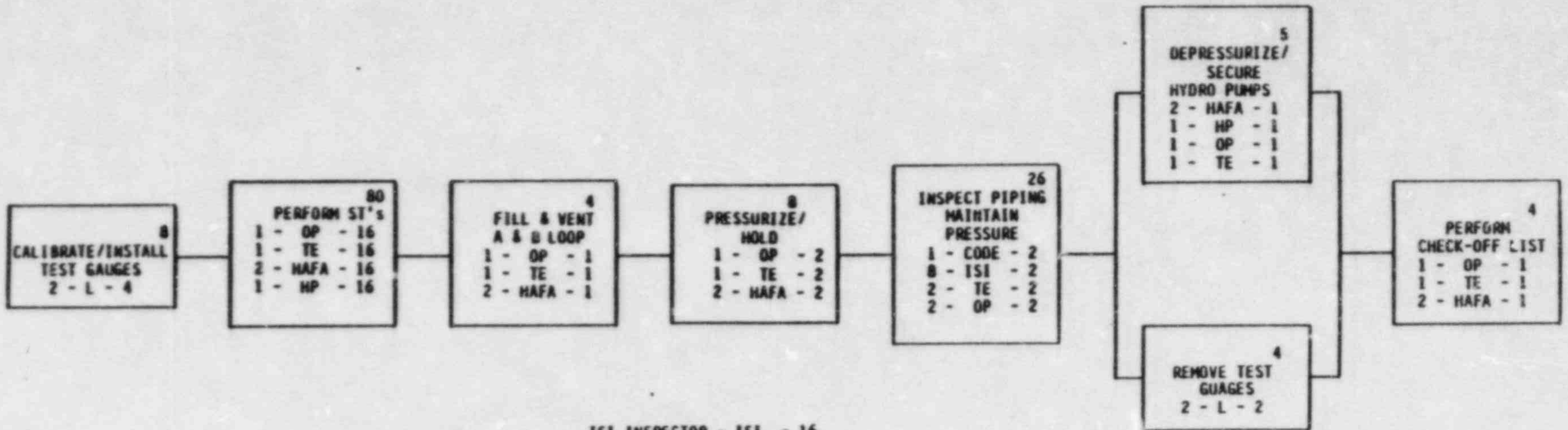

| | | |
|---|---|---|
| DIVER | D | 32 |
| MAINTENANCE MECHANIC | M | 168 |
| HEALTH PHYSICS | HP | 48 |
| PLANT OPERATOR | OP | 278 |
| LABORER | LB | 48 |
| TEST ENGINEER | TE | 22 |
| INSTRUMENT TECHNICIAN | L | 12 |
| ISI INSPECTOR | I | 16 |
| CODE INSPECTOR | CODE | 2 |
| TOTAL | | 626 MANHOURS |

ASSUME 5mR/HR AVERAGE FOR WORK WITHIN RADIATION AREAS - 2,750 TOTAL ACCUMULATED EXPOSURE

PEACH BOTTTOM 2 & 3 RHR SYSTEM PUMP SUCTION PIPING

(IIT)

NO CRITICAL PATH HOURS



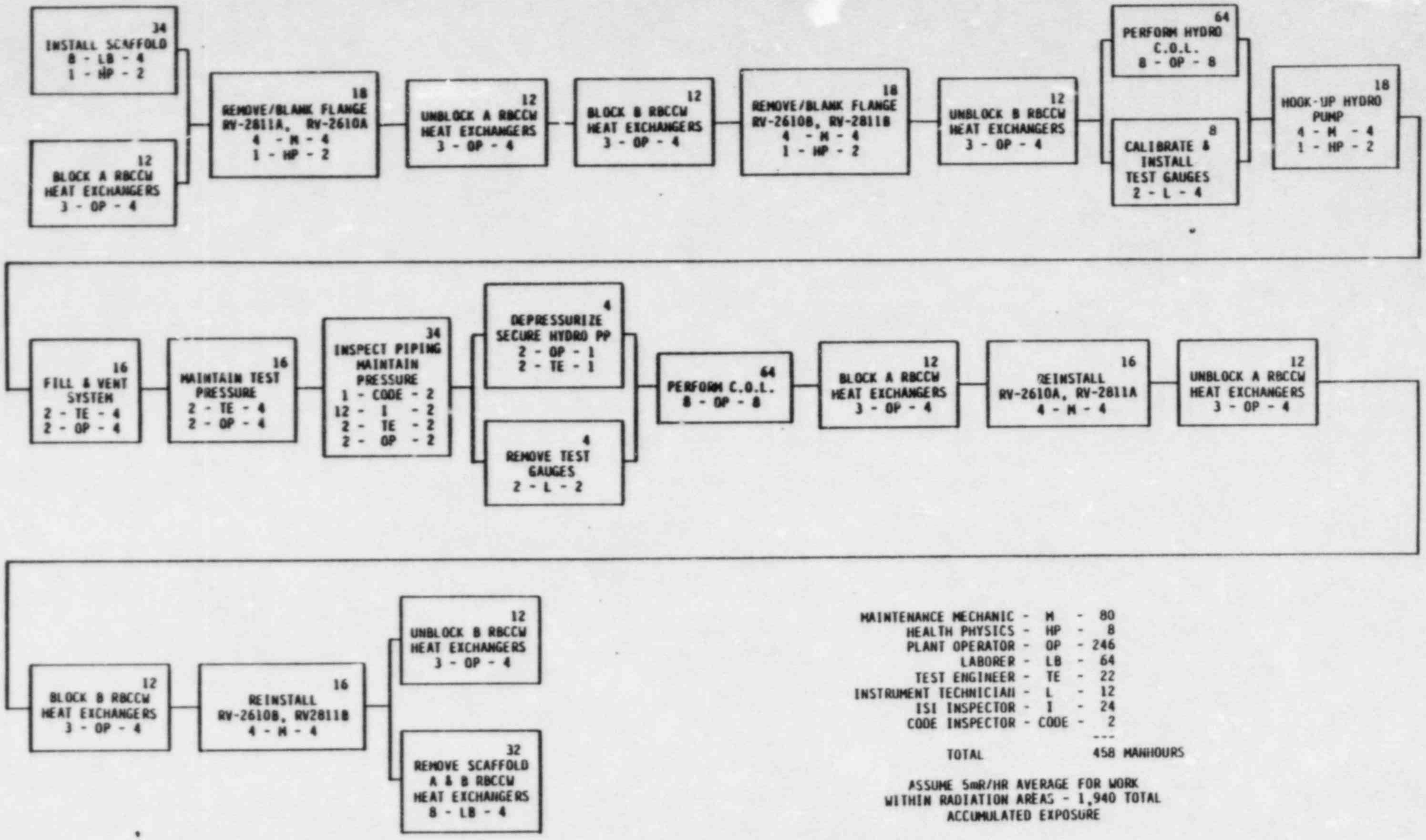

| | | |
|---|---|---|
| ISI INSPECTOR | ISI | 16 |
| HEALTH PHYSICS | HP | 17 |
| PLANT OPERATOR | OP | 25 |
| TEST ENGINEER | TE | 25 |
| INSTRUMENT TECHNICIAN | L | 12 |
| CODE INSPECTOR | CODE | 2 |
| HAFA PERSONNEL | HAFA | 42 |
| TOTAL | | 139 MANHOURS |

ASSUME 5mR/HR AVERAGE FOR WORK WITHIN RADIATION AREAS - 665 TOTAL ACCUMULATED EXPOSURE

# PEACH BOTTOM 2 & 3 EMERGENCY SERVICE WATER/EMERGENCY COCLING WATER

## (CONVENTIONAL)

## 48 CRITICAL PATH HOURS



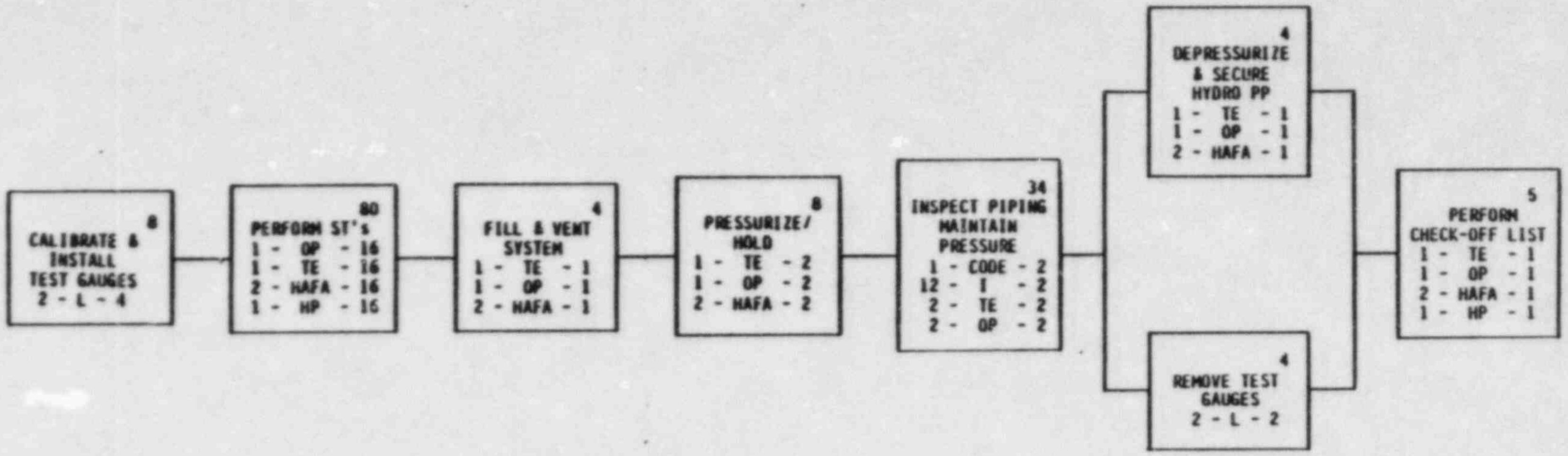

| | | | |
|---|---|---|---|
| MAINTENANCE MECHANIC | M | - | 80 |
| HEALTH PHYSICS | HP | - | 8 |
| PLANT OPERATOR | OP | - | 246 |
| LABORER | LB | - | 64 |
| TEST ENGINEER | TE | - | 22 |
| INSTRUMENT TECHNICIAN | L | - | 12 |
| ISI INSPECTOR | I | - | 24 |
| CODE INSPECTOR | CODE | - | 2 |
| TOTAL | | | 458 MANHOURS |

ASSUME 5mR/HR AVERAGE FOR WORK WITHIN RADIATION AREAS - 1,940 TOTAL ACCUMULATED EXPOSURE

# PEACH BOTTOM 2 & 3 EMERGENCY SERVICE WATER/EMERGENCY COOLING WATER

## (IIT)

## NO CRITICAL PATH HOURS



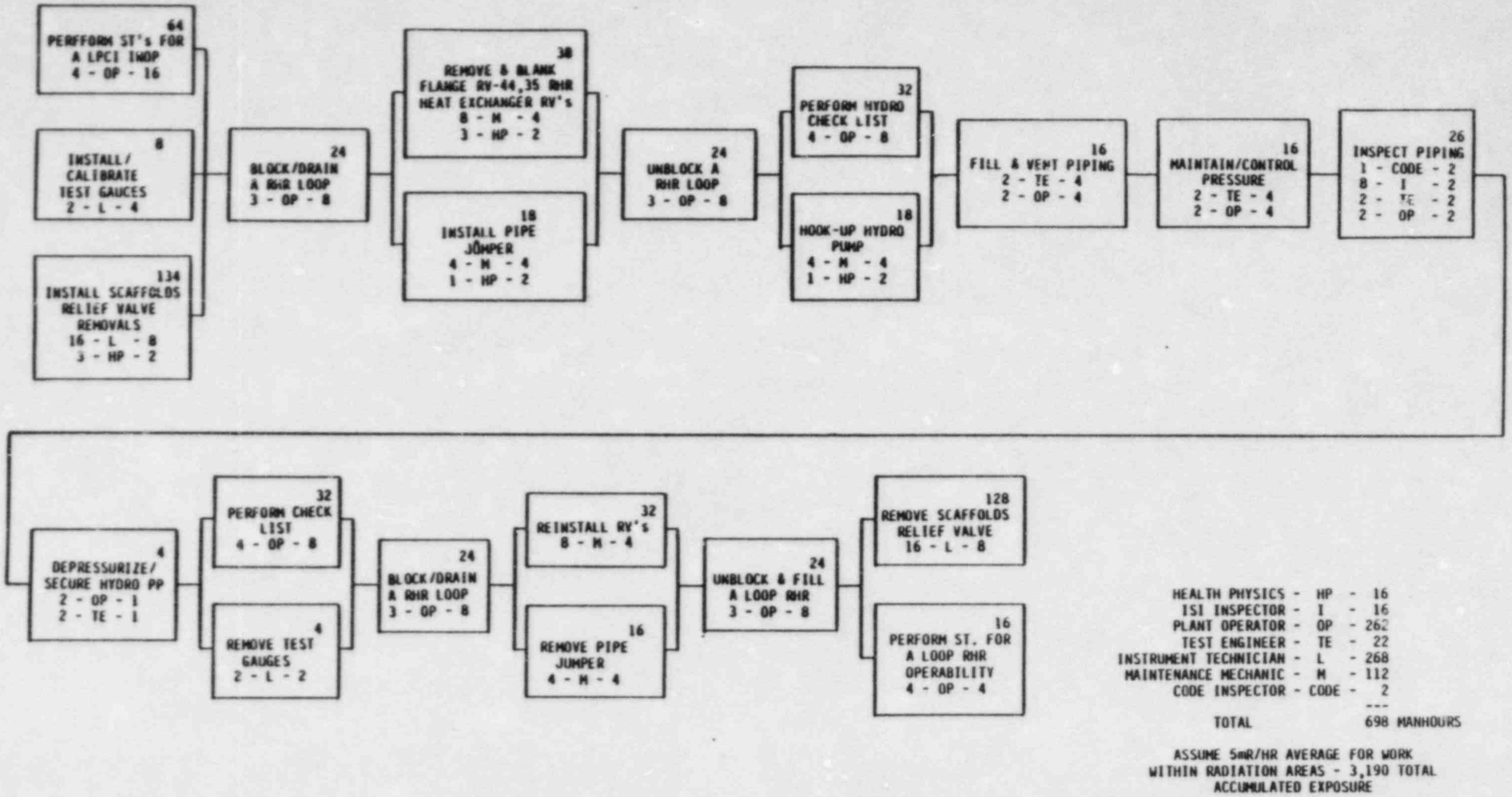

| | | |
|---|---|---|
| HEALTH PHYSICS - | HP - | 17 |
| ISI INSPECTOR - | I - | 24 |
| PLANT OPERATOR - | OP - | 25 |
| TEST ENGINEER - | TE - | 25 |
| INSTRUMENT TECHNICIAN - | L - | 12 |
| CODE INSPECTOR - | CODE - | 2 |
| HAFA PERSONNEL - | HAFA - | 42 |
| | | --- |
| TOTAL | | 147 MANHOURS |

ASSUME 5mR/HR AVERAGE FOR WORK WITHIN RADIATION AREAS - 705 TOTAL ACCUMULATED EXPOSURE

# PEACH BOTTOM 2 & 3 RHR SYSTEM PUMP DISCHARGE PIPING

## (CONVENTIONAL)

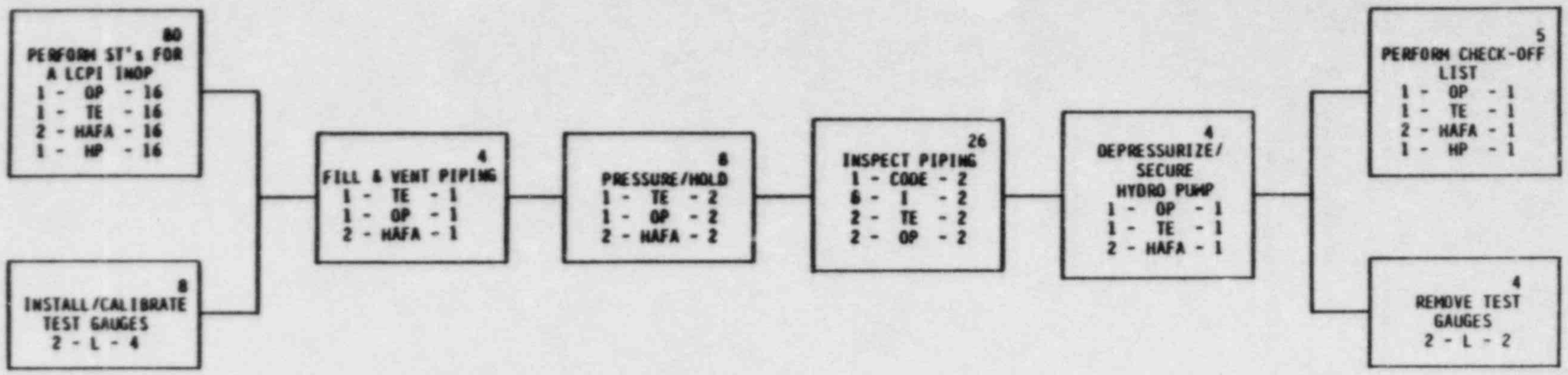
## NO CRITICAL PATH HOURS



# PEACH BOTTOM 2 & 3 RHR SYSTEM PUMP DISCHARGE PIPING

## (IIT)

## NO CRITICAL PATH HOURS



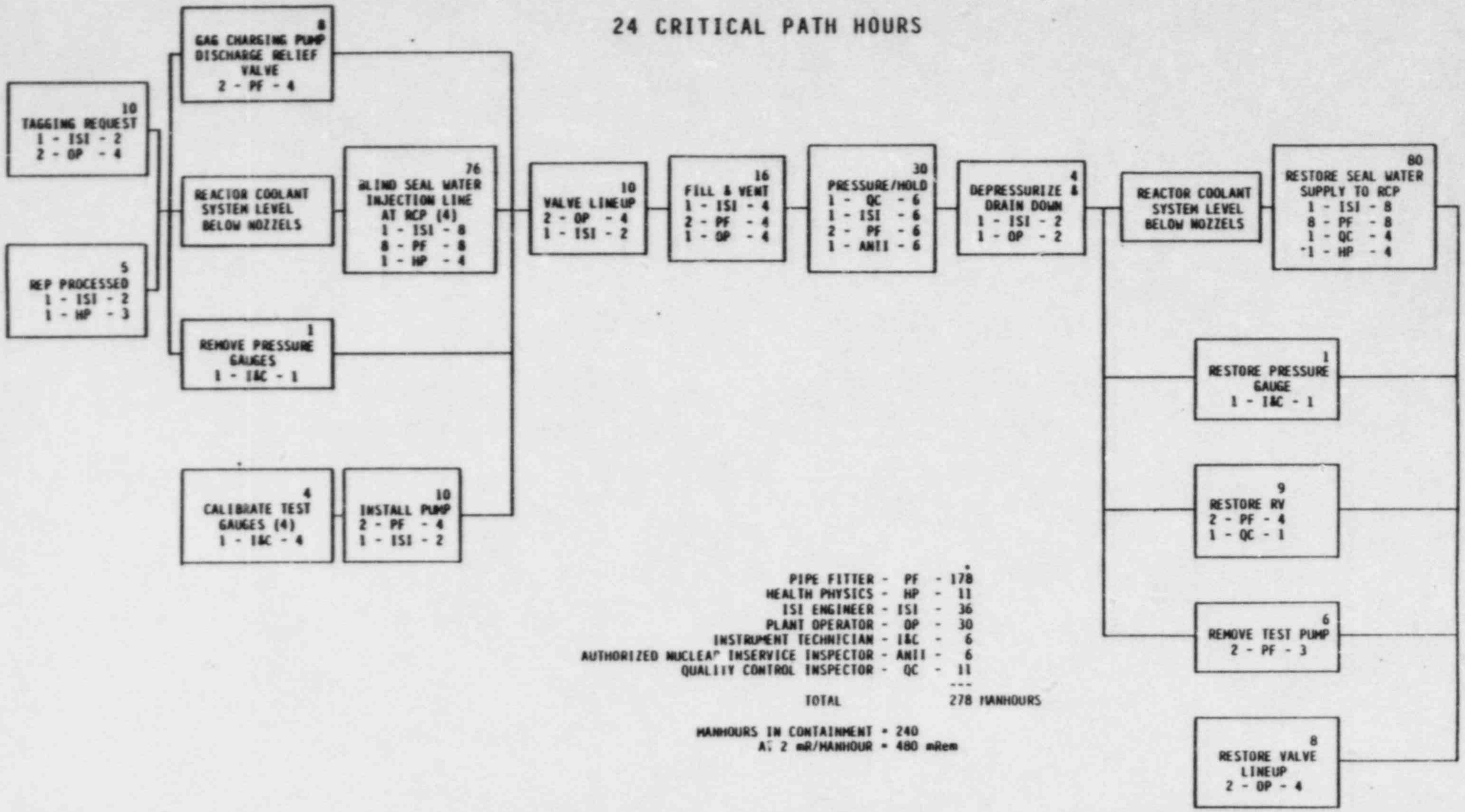

| | | |
|---|---|---|
| HEALTH PHYSICS - | HP - | 17 |
| ISI INSPECTOR - | I - | 16 |
| PLANT OPERATOR - | OP - | 25 |
| TEST ENGINEER - | TE - | 25 |
| INSTRUMENT TECHNICIAN - | L - | 12 |
| CODE INSPECTOR - | CODE - | 2 |
| HAFA PERSONNEL - | HAFA - | 42 |
| | | --- |
| TOTAL | | 139 MANHOURS |

ASSUME 5mR/HR AVERAGE FOR WORK WITHIN RADIATION AREAS - 665 TOTAL ACCUMULATED EXPOSURE

## SALEM 1 & 2 CVS - CHARGING PUMP TO RCP SEAL

## (CONVENTIONAL)

## 24 CRITICAL PATH HOURS



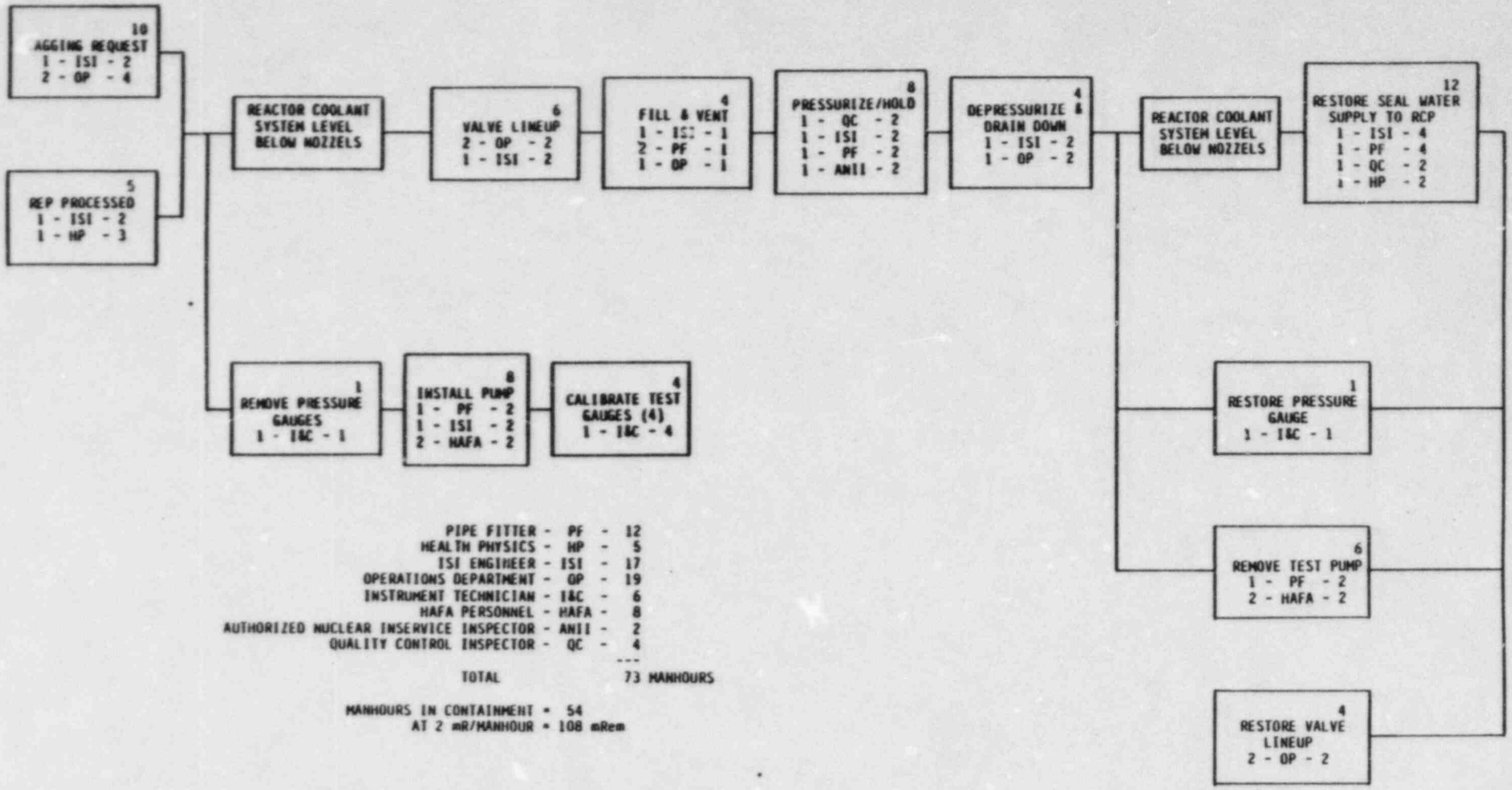

| | | |
|---|---|---|
| PIPE FITTER | PF | 178 |
| HEALTH PHYSICS | HP | 11 |
| ISI ENGINEER | ISI | 36 |
| PLANT OPERATOR | OP | 30 |
| INSTRUMENT TECHNICIAN | I&C | 6 |
| AUTHORIZED NUCLEAR INSERVICE INSPECTOR | ANII | 6 |
| QUALITY CONTROL INSPECTOR | QC | 11 |
| TOTAL | | 278 MANHOURS |

MANHOURS IN CONTAINMENT = 240
AT 2 mR/MANHOUR = 480 mRem

# SALEM 1 & 2 CVS - CHARGING PUMPS TO RCP SEAL

## (IIT)

## NO CRITICAL PATH HOURS




| | | |
|---|---|---|
| PIPE FITTER - | PF - | 12 |
| HEALTH PHYSICS - | HP - | 5 |
| ISI ENGINEER - | ISI - | 17 |
| OPERATIONS DEPARTMENT - | OP - | 19 |
| INSTRUMENT TECHNICIAN - | I&C - | 6 |
| HAFA PERSONNEL - | HAFA - | 8 |
| AUTHORIZED NUCLEAR INSERVICE INSPECTOR - | ANII - | 2 |
| QUALITY CONTROL INSPECTOR - | QC - | 4 |
| TOTAL | | 73 MANHOURS |

MANHOURS IN CONTAINMENT = 54
AT 2 mR/MANHOUR = 108 mRem

APPENDIX III

HAFA QUALITY ASSURANCE PROCEDURE 9.2

SUBJECT: CERTIFICATION OF INSPECTION & TEST PERSONNEL

1.0 PURPOSE

The purpose of this procedure is to establish the requirements for the qualification and certification of personnel performing inspection, examination and testing other than N.D.E.

2.0 SCOPE

This QAP is applicable to those inspections, examinations and tests performed on nuclear safety related systems, structures and components.

3.0 RESPONSIBILITY

The HAFA Director of Quality Assurance is responsible for the development, control and implementation of this QAP.

4.0 REFERENCES

4.1 QAP 9.0, Control of Special Processes

4.2 ANSI N45.2.6, Qualification of Inspection, Examination and Testing Personnel for Nuclear Power Plants.

5.0 ATTACHMENTS

A. HAFA Form 170, Training Record

B. HAFA Form 171, Personnel Qualification Record

C. HAFA Form 172, Personnel Certification

6.0 GENERAL

This procedure establishes the necessary prerequisities for the various levels of task performance.

7.0 PROCEDURE

7.1 Qualifications

Personnel performing inspections, examinations or tests shall be qualified to one of three qualification levels for that task. The qualification level shall be determined by the individuals physical abilities, education, experience and the scope of the task.

The required personnel capabilities associated with each level are as follows:

7.1.1 Level One (I)

a. Perform inspections, examinations or tests in accordance with written procedures or instructions and recognize the approval status of same.

b. Be familiar with tools and equipment to be employed and shall have demonstrated proficiency in their use.

c. Be able to determine the calibration status of inspection and measuring equipment.

7.1.2 Level Two (II)

Same capabilities as Level I plus:

a. Demonstrated ability to plan, set up, supervise and report results of inspections, examinations or tests.

b. Certify Level I personnel.

c. Evaluate validity and acceptability of inspection, examination or test results.

7.1.3 Level Three (III)

Same capabilities as Level II plus:

a. Ability to evaluate the adequacy of programs used to train and test inspection, examination and test personnel whose qualifications are covered by this QAP.

b. Certify Levels I, II, & III personnel

7.2 Education and Experience

The following is the recommended personnel education and experience for each level. These should be used as a guide to perform each task. Other factors which the certifying authority may consider as substitutes for education or experience are previous experience in a similar job or a capability demonstrated by testing.

7.2.1 Level I

a. Two years of related experience in equivalent inspection, examination, or testing activities, or

b. High school graduation and six months of related experience in equivalent inspection, examination, or testing activities, or

c. Completion of college level work leading to an Associate Degree in a related discipline plus three months of related experience in equivalent inspection, examination, or testing activities.

7.2.2 Level II

a. One year of satisfactory performance as Level I in the corresponding inspection, examination or test category or class, or

b. High school graduation plus three years of related experience in equivalent inspection, examination, or testing activities, or

c. Completion of college level work leading to an Associate Degree in a related discipline plus one year related experience in equivalent inspection, examination, or testing activities, or

d. Four-year college graduation plus six months of related experience in equivalent inspection, examination, or testing activities.

7.2.3 Level III

a. Six years of satisfactory performance as a Level II in the corresponding inspection, examination or test category or class, or

b. High school graduation plus ten years of related experience in equivalent inspection, examination, or testing activities; or high school graduation plus eight years experience in equivalent inspection, examination, or testing activities, with at least two years as Level II, and with at least two years associated with nuclear facilities—or if not, at least sufficient training to be acquainted with the relevant quality assurance aspects of a nuclear facility, or

c. Completion of college level work leading to an Associate Degree and seven years of related experience in equivalent inspection, examination, or testing activities, with at least two years of this experience associated with nuclear

facilities-or if not, at least sufficient training to be acquainted with the relevant quality assurance aspects of a nuclear facility, or

d. Four-year college graduation plus five years of related experience in equivalent inspection, examination, or testing activities, with at least two yers of this experience associated with nuclear facilities-or if not, at least sufficient training to be acquainted with the relevant quality assurance aspects of a nuclear facility.

7.3 Physical

The certifying organization shall identify any physical characteristics required in the performance of each activity.. Personnel requiring these characteristics shall have them verified by examination at intervals not exceeding one year. Records of physical qualifications will be maintained as Quality Records.

7.4 Training

Formal training programs shall be conducted as required to qualify personnel who perform inspections, examinations and tests. Training shall be recorded on Training Record form (Attachment "A") and maintained as Quality Records.

7.5 Personnel Qualification Record

A Personnel Qualification Record shall be maintained on each individual and shall reflect his/her qualification status for each task. It shall indicate physical qualifications, training received and dates, test scores and any other data to support certifications and recertifications (Attachment "B").

7.6 Certification

Qualification of personnel shall be certified in writing on an appropriate form (Attachment "C"). Certifications are effective for one year from date of issue.

7.7 Re-evaluation

Anytime it is determined by the certifying organization that the capabilities of an individual are not in accordance with the qualifications specified for the task, that person shall be removed from the activity until such a time as the required capability has been demonstrated.

ATTACHMENT 'A'
QAP 9.2

H.A.F.A. International, Inc.

# TRAINING RECORD

SUBJECT: ______________________________

INSTRUCTOR: ______________________________

DURATION: ______________ DATE: ______________

ATTENDEES

| NAME (PRINT) | SIGNATURE | TITLE |
| --- | --- | --- |
| | | |
| | | |
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HAFA FORM 170

ATTACHMENT 'B'
QAP 9.2

H.A.F.A. International, Inc.

# PERSONNEL QUALIFICATION RECORD

NAME: ______________________ JOB TITLE: ______________________

## EDUCATION

| SCHOOL | COMP. | DURATION |
| --- | --- | --- |
| | | |
| | | |
| | | |

## ACQUIRED EXPERIENCE AS

| ACQUIRED EXPERIENCE AS | COMPANY | DATES |
| --- | --- | --- |
| | | |
| | | |
| | | |
| | | |
| | | |

## TRAINING

| COURSE | DATE | DURATION | SCORE |
| --- | --- | --- | --- |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

## PHYSICAL

| EYE EXAM: | Method | Results |
| --- | --- | --- |
| Acuity | | |
| Color | | |

Restrictions or Comments

______________________

______________________

______________________

HAFA FORM 171

H.A.F.A. International, Inc.

# PERSONNEL CERTIFICATION

H.A.F.A. INTERNATIONAL, INC.
7545 Central Industrial Drive
Riviera Beach, Florida 33404

CERTIFICATION

______________________

has fulfilled all prerequisities and is qualified to perform the task of:

______________________

Level ________

This certificate expires ____________
Date

______________________ ____________
Certified by: Date

H.A.F.A. INTERNATIONAL, INC.
7545 Central Industrial Drive
Riviera Beach, Florida 33404

CERTIFICATION

______________________

has fulfilled all prerequisities and is qualified to perform the task of:

______________________

Level ________

This certificate expires ____________
Date

______________________ ____________
Certified by: Date

H.A.F.A. INTERNATIONAL, INC.
7545 Central Industrial Drive
Riviera Beach, Florida 33404

CERTIFICATION

______________________

has fulfilled all prerequisities and is qualified to perform the task of:

______________________

Level ________

This certificate expires ____________
Date

______________________ ____________
Certified by: Date

H.A.F.A. INTERNATIONAL, INC.
7545 Central Industrial Drive
Riviera Beach, Florida 33404

CERTIFICATION

______________________

has fulfilled all prerequisities and is qualified to perform the task of:

______________________

Level ________

This certificate expires ____________
Date

______________________ ____________
Certified by: Date