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June 12, 2001

Re: Indian Point Unit No. 2
Docket No. 50-247
NL-01-075

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Mail Station O-P1-17
Washington, DC 20555-0001

Subject: Supplemental Information Regarding Relief Request to Allow Use of ASME Code Case N-597 (Relief Request No. 58)

Reference: 1) June 1, 2001 Conference Call between NRC and Con Edison
2) Con Edison Letter to USNRC dated March 22, 2001

On June 1, 2001 a conference call was held between Consolidated Edison Company of New York, Inc. and the Nuclear Regulatory Commission to discuss a request for relief from certain requirements of the American Society of Mechanical Engineers (ASME) Boiler & Pressure Vessel Code for Indian Point Unit 2. Specifically, relief was requested to allow the use of ASME Code Case N-597 for evaluations to determine the structural capability of components degraded by non-uniform localized pipe wall thinning. To facilitate the staff's review of the subject relief request, enclosed is procedure SE-SQ-12.318, Revision 0, "Flow Accelerated Corrosion Program Plan," and supplement document dated July 4, 2000.

No new regulatory commitments are being made by Con Edison in this correspondence.

Should you or your staff have any questions regarding this matter, please contact Mr. John McCann, Manager, Nuclear Safety & Licensing at (914) 734-5074.

Sincerely,

A. Alan Blind

Enclosure

A047

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SE-SQ-12.318
REV. 0

FLOW ACCELERATED CORROSION PROGRAM PLAN

Prepared by:	9/8/00 (Date)	Technical Reviewer:	10-3-00 (Date)
Reviewer:	Date	Reviewer:	Date
Reviewer:	Date	Reviewer:	Date
Reviewer:	Date	Reviewer:	Date
SNSC Review:	#2781 10/24/00 (Meeting No. Date)	Reviewer:	Date
Approval:	Programs MGR (Signature/Title) 10-24-00 (Date)		10-24-00 (Effective Date)

Biennial Review:

Reviewer/Date

Reviewer/Date

Temporary Procedure Changes:

Change No. Date

FLOW ACCELERATED CORROSION PROGRAM PLAN

1.0 PURPOSE

1.1 To implement the existing inspection program cited in the Updated Final Safety Analysis Report (UFSAR) Section 10.4, "Tests and Inspections" under an administrative procedure.

1.2 To provide necessary instructions to meet specified calculation control requirements.

2.0 DISCUSSION

2.1 Background

The Flow Accelerated Corrosion Program Plan (FACPP) was established in 1989 to consolidate information and plans concerning wet steam corrosion issues in a single umbrella document. The document included extensive historical discussions, explanatory material concerning the basis parameters of the CHECWORKS computer program, and other material that does not require formal control in an administrative or implementing procedure. The purpose of the present effort is to provide appropriate administrative controls to ensure that the intent of the UFSAR program will continue to be met. Information that does not require administrative control will continue to be provided in an information document.

Reference 6.1 specifies and defines the types of calculations requiring control and establishes the methods for ensuring control. One option is to use the methods specified in the Engineering Operations Manual (EOM). An alternative is to perform calculations under the control of an intent-specific approved procedure provided that the calculation method and practice are documented.

As an example, the FACPP contains calculations regarding Component Structural Evaluations. These evaluations are necessary based on as-found pipe conditions in a particular inspection period. The purpose is to verify that the pipe can be relied on to remain intact at least until the next scheduled outage based on predicted wear. This evaluation justifies existing conditions. Justifications of this type are an impact identified in Reference 6.1 (step 1.1.1.b) and must be controlled in accordance with Reference 6.1 requirements.

Therefore, the two purposes of this procedure are to establish administrative controls for the FACPP and to provide controls for program specific calculations.

3.0 PRECAUTIONS AND LIMITATIONS

3.1 NONE

4.0 EQUIPMENT AND MATERIALS

4.1 NONE

5.0 INSTRUCTIONS

5.1 Responsibilities

The responsibilities specific to this procedure are:

5.1.1 FAC Program Engineer (FACPE) - Shall be responsible to ensure that program control requirements are maintained for the program.

5.1.2 FAC Project Manager (FACPM) - Shall be responsible to ensure that necessary actions are taken with respect to required program inspections and mitigating actions as specified in this procedure during or in association with plant outages. The FACPE may perform part or all of the duties ascribed to the FACPM in this procedure.

5.2 Identification of Susceptible Systems

5.2.1 The FACPE shall maintain a list (Attachment 7.1) to identify the current marked-up plant drawings by mark-up revision number for the purpose of susceptible system identification.

5.2.2 For the purposes of gross identification, the Consolidated Edison drawing revision number is not critical to the task and should be a revision current at the time of mark-up.

5.2.3 The drawings shall be maintained in two sets. One set shall identify applicable small bore piping (piping of 2 inches diameter or less) and the other shall identify applicable large bore piping (piping of greater than 2 inches diameter).

5.2.4 The drawings may also bear other markings and information deemed pertinent by the FACPE such as references to large bore or small bore evaluations.

5.2.5 A basis discussion for the original susceptibility study is contained in reference 6.2. The feedback loop for cyclic review of system susceptibility consists of identifying systems that have become susceptible/not susceptible by reason of operation, replacement, or other mechanism and revising the mark-up accordingly. These feedback operations are contained in this procedure.

5.2.6 The FACPE shall ensure that cyclic reviews are completed and mark-up drawings updated accordingly.

5.3 Inspection Plan - CHECWORKS Modeled Systems

5.3.1 The FACPE shall ensure that the CHECWORKS computer model is used for pipe wear prediction to the extent applicable and is maintained current with respect to program sub-models (Heat Balance Diagram, Chemistry, etc) as discussed in reference 6.3.

5.3.2 The FACPE shall ensure adequate monitoring and model calibration by requiring the appropriate level of inspection for CHECWORKS applicable systems.

5.3.3 The FACPE shall ensure that the CHECWORKS computer model is updated as necessary for plant changes (such as Chemistry, Operating hours, etc.) or CHECKWORKS software changes.

5.3.4 The output of the Inspection Plan for CHECWORKS Modeled Systems should be compiled in a summary report and should contain "CHECWORKS Analysis" in the title. This analysis normally presents the entire "CHECWORKS Wear Rate Analysis" in a "Combined Summary Report". A list of possible inspection points is derived from this list.

5.3.5 The resulting list forms part of the total number of inspection points considered for the Master Inspection List (Section 5.9).

5.4 Inspection Plan - Large Bore NON-CHECWORKS Systems

5.4.1 The FACPE shall ensure that Large Bore NON-CHECWORKS systems are grouped into sub-systems similar to CHECWORKS systems.

5.4.2 The FACPE shall ensure that summary sheets are established for each sub-system, identified by a numerical designation, and updated once per cycle.

5.4.3 The summary should contain plant configuration information and the results of any previous inspections.

5.4.4 The FACPE shall ensure that each summary sheet is reviewed to plan inspections for the most susceptible, not previously inspected, components within the sub-system if the existing inspection coverage is inadequate.

5.4.5 The output of the Inspection Plan for Large Bore NON-CHECWORKS systems should be compiled in a summary report and should contain "Large bore NON-CHECWORKS Review" in the title. The resulting list forms part of the total number of inspection points considered for the Master Inspection List (Section 5.9).

5.5 Inspection Plan - Small Bore Systems

5.5.1 The FACPE shall ensure that Small Bore systems are grouped into sub-systems similar to CHECWORKS systems. Piping less than 2 inches in diameter is not modeled in CHECWORKS.

5.5.2 The FACPE shall ensure that summary sheets are established for each sub-system, identified by a letter designation, and updated once per cycle.

5.5.3 The summary should contain plant configuration information and the results of any previous inspections.

5.5.4 The FACPE shall ensure that each summary sheet is reviewed to plan inspections for the most susceptible, not previously inspected, components within the sub-system if the existing inspection coverage is inadequate.

5.5.5 The output of the Inspection Plan for Small Bore systems should be compiled in a summary report and should contain "Small Bore Review" in the title. The resulting list forms part of the total number of inspection points considered for the Master Inspection List (Section 5.9).

5.6 Inspection Plan - Component Reinspection - UT Trending

5.6.1 The FACPE shall ensure that a trending file is created and updated each cycle for the purpose of listing each previously inspected individual component and the critical inspection results for that component.

5.6.2 The trending file shall provide the remaining Effective Full Power Years (EFPY) for that component.

5.6.3 The trending file shall indicate the Refueling Outage Cycle date when that component is required to be reinspected. This date shall be established at a point prior to the time when the minimum acceptable wall thickness will be reached.

5.6.4 The trending file should be a spreadsheet containing the word "TREND" in the title. This file is component and empirically based which is a supplement to the model and evaluation based system approaches described in 5.3, 5.4 and 5.5.

5.6.5 The trending file shall contain the embedded mathematical operations necessary to determine EFPY and the date of reinspection. The selected wear rate shall have a safety factor of 1.1 and the minimum thickness allowed shall not be less than three tenths of the nominal thickness. These factors are explained in detail in reference 6.2.

5.6.6 The output of the Inspection Plan for Component Reinspections should be compiled in a summary report and should contain "Trending of UT Inspection Data" in the title. The resulting list forms part of the total number of inspection points considered for the Master Inspection List (Section 5.9).

5.7 Inspection Plan - Closed and Low Usage Boundary Valves

5.7.1 The FACPE shall ensure that a list of boundary valves that could have leakage problems resulting in FAC deterioration is updated each cycle as necessary.

5.7.2 The valves should be large bore valves within or on the susceptibility boundary.

5.7.3 The FACPE shall identify work orders written against the valves for seat leakage on a cycle basis.

5.7.4 The FACPE shall ensure inspections are scheduled downstream of leaking closed and low usage boundary valves on a priority basis.

5.7.5 The output of the Inspection Plan for Closed and Low Usage Boundary valves should be compiled in a summary report and should contain "Closed and Low Usage Boundary Valves" in the title. The resulting list forms part of the total number of inspection points considered for the Master Inspection List (Section 5.9).

5.8 Inspection Plan - Plant and Industry Experience

5.8.1 FAC related events enter the evaluation process though Condition Reports, CHUG (CHECWORKS Users Group) notifications, INPO notifications, or other means. The FACPE is responsible to search for these events, in the unlikely situation they are not sent directly to the FACPE, and evaluate them with respect to the FAC program.

5.8.2 Attachment 7.2 shall be used to log the results of major evaluations of plant and industry experience.

5.8.3 Changes to the FAC program can be discovered through interviews with personnel in maintenance, engineering and operations. Changes in configuration, material, or operating lineups can affect the program by changing susceptibility conditions or the degree of damage experienced at a susceptible location.

5.8.4 Attachment 7.2 shall be used to log the results of interview processes where significant FAC program changes are found.

5.8.5 All completed Attachment 7.2 forms shall be maintained in a binder and should be numbered with the year and sequential number (e.g. 00-001).

5.8.6 The FACPE shall review all Attachment 7.2 forms annually to ensure closure or work-in-process for each evaluation. Evaluation form information can result in changes to the inspection program and shall be considered for input to the Master Inspection List (Section 5.9).

5.8.7 Evaluation form action statements should not remain open as a means of ensuring continued inspections in overlapping cycles. Components requiring continued inspections shall be made part of the appropriate process 5.3, 5.4, 5.5, 5.6 or 5.7.

5.8.8 The binder and completed forms are not controlled documents. These documents are worksheets intended to focus subject matter and evaluation processes on current events. Associated Condition Reports, where applicable, are the controlled documents with respect to any important issues raised.

5.9 Master Inspection List

5.9.1 The inspection points derived from the evaluation processes identified in 5.3 through 5.8 are combined to form a list of potential inspection candidates. This draft list may be further refined to remove or add inspection points. (A component may have been replaced after the need for inspection was identified and may no longer require inspection, etc.).

5.9.2 The final list of inspection points for a particular inspection period is compiled in a document bearing the words "Master Inspection List" in the title.

5.9.3 The FACPM shall ensure that all points in the Master Inspection List are inspected in the particular inspection period.

5.9.4 Where the inspection can not be made, a request to exempt the location or provide an alternate location is generated by the FACPM using Attachment 7.3. Completed Attachment 7.3 documents are compiled in an Outage Summary.

5.9.5 The Outage Summary provides an overview document for inspection and mitigation efforts conducted in a particular cycle.

5.10 Engineering Evaluation of the Inspection Data - Basis

5.10.1 Structural evaluations must be checked and reviewed in accordance with the applicable ANSI, B31.1 Code. Indian Point Station UFSAR cites the use of the American Standard Code for Pressure Piping ASA B31.1-1955 as the evaluation code. This edition of the code does not address seismic loading. Therefore, the B31.1 1973 edition shall be utilized to evaluate components. The 1973 version of the code requires a more detailed analysis than the 1955 code and is in accordance with current analytical standards. However, the allowable stress values for piping materials shall be obtained from the 1955 edition of the code.

5.10.2 The requirements of ASME, Section III and ANSI, B31.1, 1973 for branch reinforcements shall be met.

5.11 Engineering Evaluation of the Inspection Data - Minimum Wall Thickness

5.11.1 Minimum Wall Thickness is the greater of either the thickness required for pressure stress (i.e. hoop stress) or the thickness required for bending stress. The calculation is controlled and documented on a form containing the information of the type specified in Attachment 7.4, and in accordance with step 5.15, for each inspection.

5.11.2 An example Minimum Wall Thickness calculation methodology is provided in reference 6.2.

5.12 Engineering Evaluation of the Inspection Data - Predicted Thickness

5.12.1 The Predicted Thickness refers to the calculated thickness at the end of the next operating cycle. This Predicted Thickness depends on the Wear Rate.

5.12.2 The Wear Rate is normally the larger of the CHECWORKS analysis wear rate (Wr1 for CHECWORKS applicable components) or the Trended wear rate (Wr2).

5.12.3 Obtain Wr1 from CHECWORKS. (The following is one method to obtain the information.)

a. Select Tasks.
b. Select Wear Rate Analysis.
c. Select Analysis.
d. Select Result.
e. Select Run Definition for the applicable analysis group.
f. Select Combined to generate report.
g. The "current wear rate" (Wr1) is listed in mils/year on the resulting report.

5.12.4 Obtain Wr2 calculated from the ultrasonic test data using CHECWORKS as described in the reference 6.3. The methods considered for use are Band, Area, Moving Blanket, Point-to-Point, and User Defined. The analyst shall list the method used and, if the method is "User Defined", then the methodology used to calculate wear shall be documented. (The following is one method to obtain the information.)

a. Select Tasks.
b. Select UT Analysis.
c. Select Line, Component and Period for the component.
d. Select Summary.
e. The summary contains "Calculated Total Life Wear" and "Total Service Hours". Divide the service hours by 8760 hours per year to obtain EFPY (Eff Full Power Years). Divide the lifetime wear by EFPY to obtain wear rate (Wr2) in mils/year.

5.12.5 The predicted thickness at the next refueling outage is equal to the currently measured thickness after subtracting the product of wear rate (larger of Wr1 or Wr2), EFPY expected until next outage and a safety factor of 1.1.

5.13 Engineering Evaluation of the Inspection Data - Action Statements

5.13.1 If the Measured Thickness is 70% or less of the Nominal Thickness as a result of the Initial Examination of a component, it is required that the process for Sample Expansion be initiated using Attachment 7.5.

5.13.2 If either the Measured Thickness or the Predicted Thickness is less than the Minimum Thickness the component is unacceptable for continued service.

a. A Sample Expansion shall be initiated using Attachment 7.5.
b. A Condition Report shall be generated.
c. A work order shall be generated.
d. A deficiency tag shall be generated.

5.13.3 If it is necessary to justify continued operation with a component found unacceptable in step 5.13.2, then the Condition Report shall provide analysis in accordance with ASME Code Case N-597 or other acceptable Code Analysis.

5.13.4 If the Measured Thickness is 87.5% or less of the Nominal Thickness for either the Main or Branch run on a Tee, then reduced area reinforcement shall be considered for the branch connections. This evaluation shall be based on ASME Code Paragraph NC-3643.3 "Reinforcement for Openings" and ANSI B31.1 Code Paragraph 104.3, "Intersections". Use Attachment 7.6 or similar form to document this evaluation.

5.14 Engineering Evaluation of the Inspection Data - Sample Expansion

5.14.1 The expansion shall include the next two susceptible components (NTSC) in the same line or system and the equivalent components in all parallel trains (ECPT).

5.14.2 If the component that generated the expansion is in a CHECWORKS analyzed system, then the NTSC shall be taken from the same analysis-line or set. Susceptibility is based on the predicted "Time to Tcrit" ranking list in CHECWORKS, where "Tcrit" is the critical wall thickness. Reliance on the ranking may be tempered with inspection history and local flow conditions.

5.14.3 If the component that generated the expansion is not in a CHECWORKS analyzed system, then the NTSC shall be determined similar to the process used for inspection determinations in steps 5.4 and 5.5.

5.14.4 The ECPT is chosen from a functionally similar piping system with nearly identical conditions and usage. The critical characteristics (e.g. component type, proximity to flow disturbance from flow control valve or similar, and proximity to line termination) should be considered in the selection.

5.14.5 If no functionally similar piping exists, then select a suitable alternate based on engineering experience.

5.14.6 Expansion within a parallel line to the next most susceptible components in that parallel line is not necessary if the initial parallel train examinations are acceptable and do not require expansions.

5.14.7 Historical data should be evaluated to determine if sufficient UT data exists on the subject line to preclude a sample expansion.

5.15 <u>Engineering Evaluation of the Inspection Data - Calculation Control</u>

5.15.1 The following controls apply to Attachments 7.4, 7.5 and 7.6 or calculations supporting these attachments.

a. The specified calculation results are controlled by signature of the Preparer who performs standardized calculations and the Checker who independently verifies the results of the standardized calculation.

b. The calculation results shall be reviewed and, if acceptable, approved by the FACPM by signature as Reviewer. This action may, but is not required to, coincide with the duty of Preparer or Checker.

c. The signature of the FACPM confirms that the form used contains all the required information.

d. Each Calculation shall be uniquely identified. The identifier shall be a combination of the cycle and the component identifier (e.g. 14-4EXB-14P which means cycle 14 for component 4EXB-14P). (Attachment 7.5, 7.7 and other calculations shall always be attached to, and controlled as part of, attachment 7.4.)

e. The original calculations shall be filed with Records Management at the end of each inspection period.

5.16 Program Update Information

5.16.1 Update the UT data fields in CHECKWORKS using the UT data obtained during or in association with an outage.

5.16.2 Update the Susceptibility Drawings to show any changes due to pipe replacement or other changes noted during the cycle. These changes are normally codified in the Outage Summary Report.

5.16.3 Update the UT Trending file with required UT data.

5.16.4 Update the Isometric Sketches. New Isometric sketches are normally contained in the Outage Summary Report.

5.17 Evaluation Review for Vendor Supplied Compilations

5.17.1 Vendor supplied compilations should be reviewed by the FACPE and Attachment 7.7 should be used to document the review.

5.17.2 The review is termed "open" if there are any outstanding review issues. Otherwise, the compilation is accepted and the review is "closed". The status of open item resolution should be recorded on or attached to Attachment 7.7 until all issues are resolved.

5.17.3 The following documents are candidates for compilation review:

a. Small Bore Review
b. Trending of UT Inspection Data
c. Closed and Low Usage Boundary Valve Review
d. CHECWORKS Analysis
e. Large Bore Non-CHECWORKS Review
f. Master Inspection List
g. Outage Summary

6.0 REFERENCES

6.1 SAO-451, Verification, Documentation and Traceability of Calculations

6.2 Flow Accelerated Corrosion Program Plan Supplement (FACPPS)

6.3 CHECWORKS Users Guide

6.4 SAO-100, Indian Point Station Procedure Policy

6.5 AD-SQ-2.002, "Preparation, Review, Revision, Approval, Control and Distribution of Procedures and Control and Distribution of Manuals"

7.0 ATTACHMENTS

7.1 Revision Status for Susceptibility Drawings

7.2 Plant and Industry Experience Report

7.3 Request for Inspection Exemption or Alternate Inspection Location

7.4 Component Structural Evaluation

7.5 Sample Expansion

7.6 Reinforcement of Openings

7.7 Review and Acceptance of Vendor Compilations

8.0 ADDENDA

NONE

ATTACHMENT 7.1
Revision Status for Susceptibility Drawings

Large Bore Drawings			Small Bore Drawings	
Drawing No.	Revision *		Drawing No.	Revision *

*Refers to the Outage Update Revision

ATTACHMENT 7.2
Plant and Industry Experience Report

Report No.__________

I. Source Document ______________________________ Date _______

Comments ____
____
____

Originator ________________ Date ____________

II. Action Required Yes No

Action Specified/Comments ____
____
____
____
____
____
____
____
____

FAC Engineer ______________________________ Date ____________

III.This report is closed with the following conclusion or programmatic action.
____
____
____

FAC Engineer ______________________________ Date ____________

ATTACHMENT 7.3

Request for Inspection Exemption or Alternate Inspection Location

I. REQUEST

Review of the following identified item is requested.

Item Identifier: ____________________

Basis for Request: ____________________

____

____
Signature/Date

II. RESOLUTION

A. Inspection of specified location required. Yes ____ No ____

Basis for above determination. ____________________

____

B. Other Options _ If Other Options is checked, please select one of the following:

1. Alternate Inspection locations selected. Yes ___ No ____

   Location: ____________________

   Basis for Selection: ____________________

2. Consequences Tolerable, inspection to be deferred. Yes ___ No ____

   Basis for Determination: ____________________

   ____

3. Waiver with Compensatory Measures, inspection to be deferred. Yes __ No ____

   Compensatory Measures being taken: ____________________

   ____

4. A More Rigorous Engineering Review justifies deferment. Yes___ No ___

   Method: ____________________

   ____

Prepared By: ____________________ Approved By: ____________________

ATTACHMENT 7.4
Component Structural Evaluation Format

IP2 Flow Accelerated Corrosion Program
Structural Evaluation

EVAL. No.________________ Rev.______________
Sheet No. __ of __

COMPONENT DESCRIPTION

Plant________________ MIL Item No.______________ System______________________
Component Type________ Component I.D. ______________ Line No.__________________

SUMMARY REPORT

ACTION: Accept ____ Repair/Replace______ (Mark Selection)
PROJECTED TIME TO Tmin: PREDICTED LIFE:_________(EFPY)
Sample Expansion: Required____ Not Required_____ (Mark Selection) Comments:_______________
Preparer: (Sig/Date)______Checker: (Sig/Date)_______Reviewer: (Signature/date) (If Required) ____________

COMPONENT DESIGN STRESS DATA

Pipe O.D. _______ Nominal Thickness:________ Material: _________ Design Temperature:___________
Design Pressure:_________ Operating Temperature:__________ Material Allowable Stress:__________
Comp. Allowable Sh:__________ Sustained Stress:___________ Sustained Allowable:_____________
Upset Stress:________ Upset Allowable:_________ Faulted Stress:____________ Faulted Allowable:_______

MEASUREMENT DATA

Minimum Measured Thickness:______________ Location:_______________ Report Date:______________
Band/Blanket (Method):____________________ Per Cent of Nominal:_____________________________

OPERATING TIMES USED IN EVALUATION

Time of Component Installation:_____________ System Service at Most Recent Inspection:_____________
Component Service at Most Recent Inspection:____
110% Est. Time Until Next RFO (1.1*Oc):____

WEAR RATE DATA

Current CHECWORKS Rate: (Wr1) _________________ Trended Rate: (Wr2) _______________
Wear Rate Used in Evaluation: (Larger of Wr1 or Wr2)___________________________________

PREDICTED MINIMUM WALL

Predicted Minimum Wall at next RFO:____

EVALUATION SUMMARY

(Provide relation between 0.875Tnom, 0.3Tnom, Tpredicted, and any applicable Action Statement)

STRUCTURAL EVALUATION CRITERIA

Tminh= (P*D)/(2*(S+0.4*P)) = _____________, Tmins = (sustained stress ratio*Tnom) =______________
Tminu= (Occ. (OBE) stress ratio*Tnom)= _____________ Tminf= (Occ. (SSE) stress ratio*Tnom)=__________
Tmin = Greater of Tminh, Tmins, Tminu, Tminf, or 0.3Tnom=_____________________________________

STRUCTURAL EVALUATION RESULTS SUMMARY

(Provide relation between Tpred and Tmin , Tmeas and 0.7Tnom, and Accept/Reject)

COMPONENT TIME TO Tmin CALCULATON

(Predicted Life in EFPY):____

ATTACHMENT 7.5
SAMPLE EXPANSION

SAMPLE EXP REQ # ____________

The listed component requires sample expansion based on examination results and the component structural evaluation.

Drawing Number: ____________________

Component: ________________________

Additional Items for Inspection

1) Parallel line ___ Next most susceptible item ______
Item: ____
____

2) Parallel line ___ Next most susceptible item ______
Item: ____
____

3) Parallel line ___ Next most susceptible item ______
Item: ____
____

4) Parallel line ___ Next most susceptible item ______
Item: ____
____

5) Parallel line ___ Next most susceptible item ______
Item: ____
____

Total number of sample expansion points ______

Signature Block

By: ________________ Date: ____________

Checked By: ________________ Date: ____________

ATTACHMENT 7.6

REINFORCEMENT FOR OPENINGS

COMPONENT NUMBER: ________

The IP2 FAC Program requires that reduced area reinforcement be considered for inspected branch connections. If the inspection indicates that the actual main run (header) wall and the branch thickness is greater than 0,875 t_{nom}, no further evaluation is required. The pipe wall is within the manufacturers' tolerance. However, if the wall is below 0.875 t_{nom}, consideration of available area for reinforcement is necessary.

The calculation provides the required area for reinforcement and the available (total) area for reinforcement based on user input. The calculation is based on ASME Code Paragraph NC-3643.3, "Reinforcement for Openings" and ANSI B31.1 Code Paragraph 104.3, "Intersections".

USER INPUT SECTION

Angle between axes of branch and run:	a = ________ deg
Outside diameter of pipe:	Do_h = _______ in
Outside diameter of branch:	Do_b = _______ in
Predicted thickness of pipe:	T_h = _______ in
Predicted thickness of branch:	T_b = _______ in
Nominal Thickness of branch:	te = ________ in
Width of reinforcement:	we = ________ in
Design Pressure:	P = ________ psi
Allowable Stress:	S = ________ psi
Fillet weld size between branch and run:	F_w = _______ in

CALCULATIONS

NOMENCLATURE

Required minimum wall thickness (for pressure): $tm_h = \frac{P(Do_h)}{2(S+0.4P)}$ $tm_b = \frac{P(Do_b)}{2(S+0.4P)}$

Adjusted inside diameter for branch pipe: $d_1 = \frac{Do_b - 2(T_b)}{\text{Sin}(a)}$ d_1 = ________ in

Half width of reinforcing zone: $d_0 = T_b + T_h + d_1/2$ d_0 = _______ in

d_2 = if (max (d) < do_b , max (d), Do_b) d_2 = _______ in

Diameter of reinforcement: De = if[we> 0 in, (2we) + Do_b , 0 in]   De = _______ in

Altitude of reinforcement zone outside of run or reinforcement: L=2.5(T)   L = ________ in

ATTACHMENT 7.6
REINFORCEMENT FOR OPENINGS
COMPONENT NUMBER: ________

REINFORCEMENT AREA

Required reinforcement area: $A_{required} = 1.07\ [tm_h\ (d_1\ (2 - \sin(a)))]$

CONTRIBUTING AREAS

Area provided by excess pipe wall in the run: $A_1 = d_2\ (T_h - tm_h)$ $A_1 =$ ________ in^2

Area provided by excess pipe wall in the Branch for distance L above the run: $A_2 = 2\ [L\ (T_b - tm_b)$ $A_2 =$ ________ in^2

Area provided by deposited weld metal:

$W_1 = \text{if}\ [De > 2d_2,\ 0in,\ \text{if}\ [De + 2(F_W) < 2(d_2),\ F_W,\ (2d_2 - De)1/2]]$ $W_1 =$ ________ in

$W_2 = \text{if}\ (De > 2d_2,\ 0in,\ \text{if}\ (L > F_W,\ F_W,\ L))$ $W_h =$ ________ in

$A_3 = \text{if}\ [W_h + W_1 < F_W,\ 2(W_1)(W_h),\ F_W^2 - (F_W - W_1)^2 - (F_W - W_h)^2$ $A_3 =$ ________ in^2

Area provided by reinforcement: $A_4 = IF\ (De > 2d_2,\ 2d_2 - Do_b,\ De - Do_b)\ \text{if}\ (te > L,\ L,\ te)$

$A_4 =$ ________ in^2

Available reinforcement area: $A_{available} = A_1 + A_2 + A_3 + A_4$

SUMMARY OF RESULTS $A_{available} =$ ________ in^2 $A_{required} =$ ________ in^2

The total area available for reinforcement is greater than or equal to the required reinforcement area. The component is acceptable. ________

The total area available for reinforcement is less than the required reinforcement area. The component fails. ________

REFERENCES:

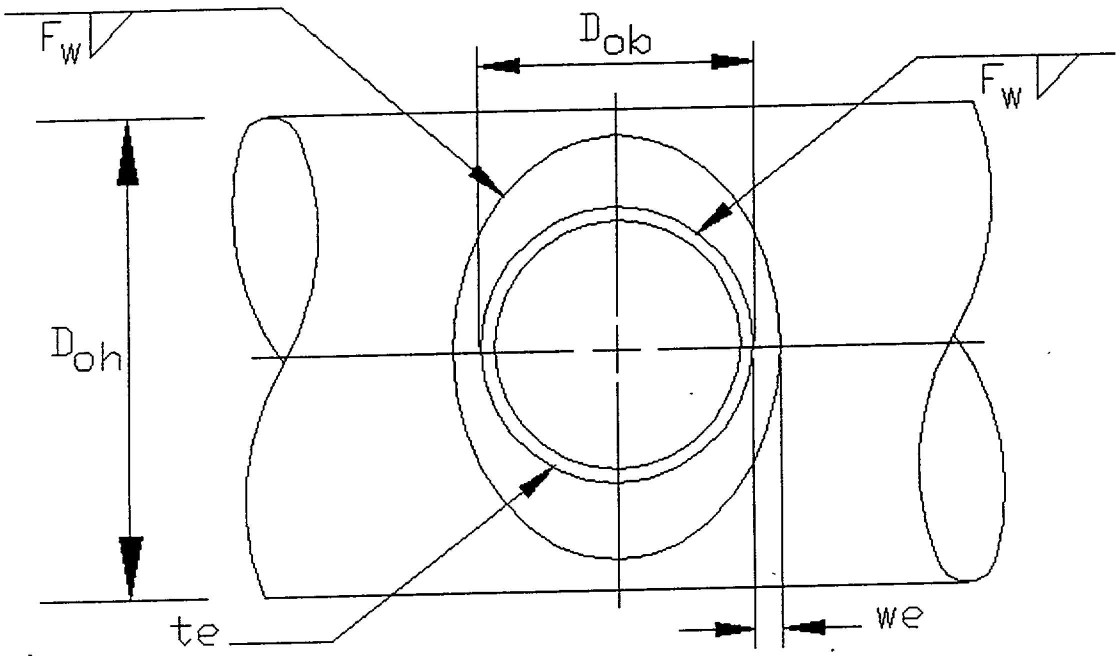
ASME BPVC, Division 1, Section III, Subsection NC, 1971 Edition with Addenda through Summer 1973.

ANSI B31.1, "Power Piping", 1973 Edition with Addenda through Summer 1973.

By:________________ Date__________

Chkd:________________ Date__________

ATTACHMENT 7.6
REINFORCEMENT FOR OPENINGS
COMPONENT NUMBER: ________



ATTACHMENT 7.7
Review and Acceptance of Vendor Compilations

Document Title:____

Document Number:______________________________________

Company:____

Purpose of Document:____

Method of Document Compilation:____

Affect on IP2 FAC Program:____

Document is Accepted: ____________________/______________ (FAC Program Manager/Date)

If not signed above, then significant Open Items are attached, the vendor is informed and working toward resolution, and the document under review is not yet acceptable.

Safety Evaluation No. N/A Rev. No. N/A

SAFETY EVALUATION SCREENING DETERMINATION

NOTE: 1. If the change is a Procedure, then this form shall not be used for SIL V.
2. For all other changes (non-Procedure) this form shall not be used for SIL IV or V.

Implementing Document (e.g., Mod No., Procedure No.) SE-SQ 12.318

Title: FLOW ACCELERATED CORROSION PROGRAM PLAN

SAFETY IMPACT LEVEL (SIL) NONE Tag No(s). VARIOUS

Plant Mode Restriction: NONE

SIQ Attached? (SIQ Part I required for SIL II, III or IV, EXCEPT non-intent procedure changes; Part II required for digital changes) Yes___ No X

Description of Change: (use additional space as needed) NEW ADMIN PROCEDURE TO CONTROL EXISTING PROGRAM

NOTE: IF the answer to question 1, 2, 3, 4, 5 OR 6 is "YES," then a Safety Evaluation (ATTACHMENT V) is required for the proposed activity, and this form cannot be used.

1) Does the proposed change involve a change to the IP1 UFSAR, IP1 Decommissioning Plan or IP2 UFSAR text, tables or figures (temporary or permanent)?
YES_______ NO X Administrative Only (Addendum I, § 1.4)____

2) Are there any changes to procedures as described in the UFSAR (See Addendum I, § 1.5.4)?
YES______ NO X Administrative Only (Addendum I, § 1.4)______

3) Does the proposed change require the addition of new information to the UFSAR to remain consistent with the current level of detail?
YES _______ NO X

4) Does the change involve a test or experiment which might affect nuclear safety in a manner not previously evaluated in the IP1 UFSAR, IP1 Decommissioning Plan or IP2 UFSAR (e.g., a one-of a kind test used to measure the effectiveness of new techniques or a new system configuration)?
YES ____ NO X

5) Are there any changes to the NRC approved Fire Protection Program?
YES _____ NO X Administrative Only (Addendum I, § 1.4)________

6) Are there any changes to the snubber list in TP-SQ-11.035?
YES______ NO X Administrative Only (Addendum I, § 1.4)______

Safety Evaluation No. N/A

Rev. No. N/A

NOTE: If the answer to question 7 is "YES," then a Safety Evaluation or prior NRC approval may required. Refer to Addendum I, Section 1.6 for guidance.

7) Does the change affect other documents considered to be part of the licensing basis as defined in SAO-460, 3.4? See Addendum I, § 1.6 for guidance.
YES ____ NO X Administrative Only (Addendum I, § 1.4)______

NOTE: Changes to the Technical Specifications require prior NRC approval.

8) Are the Technical Specifications affected?
YES ____ NO X

9) Provide an overall justification for concluding that the proposed activity does not require a safety evaluation (use additional space as needed): NO SAFETY IMPACT PRODUCED BY ADMINISTRATIVE CONTROLS APPLIED TO EXISTING PROGRAMS

NOTE: If the change under consideration is a Temporary Facility Change, the Preparer shall be on the Qualified Safety Reviewers List if implementation is to be permitted prior to NS&L review.

Preparer: CHRIS BERGREN [signature] Date: 9/30/00
Print AND Sign

Approver*: PATRICK O'BRIEN [signature] Date: 10-18-00
Print AND Sign

IF documentation of SNSC approval of the Screening Determination is required by the implementing document process requirements (e.g., SAO-206 for TFCs), THEN complete the following:

Dana Lyne	#2781	10/24/00
SNSC Approval	Meeting No.	Date

*Approver is Manager, NS&L, or designee, for non-procedure changes. Approval authority for new procedures and procedure changes is per SAO-100.

PROCEDURE REQUEST FORM

SECTION I

Procedure Number: SE-SQ-12.318 Revision Number: 0

Procedure Title: FLOW ACCELERATED CORROSION PROGRAM PLAN

Type of Change: X New ___ Cancel ___ Revision

Reason for Change: PROCEDURE TO IMPLEMENT & CONTROL EXISTING FSAR REQUIRED PROGRAM

Intent Change: ___ Yes X No

Prepared by: [signature] Date: 9/8/00

SECTION II

Incorporated Regulatory Commitments: ___ YES X NO

Commitment Identification #: ___

Sections Affected: ___

SECTION III

Training Required: ___ YES ___ NO

Section Responsible ___

Personnel To Be Trained: ___

Method of Training: ☐ Read Procedure ☐ Memo

☐ Work Through ☐ Formal Class

☐ Other ___

Approved by: [signature] Date: 10-18-00

Signature /Title

PROCEDURE BASIS RECORD

Procedure No. SE-SQ-12.318 Reviewer: 0

Title: FLOW ACCELERATED CORROSION PROGRAM PLAN

1. Interpretation of Requirements: FSAR 10.4 "AN INSPECTION PROGRAM HAS BEEN ESTABLISHED ... TO EVALUATE WALL THICKNESS AT LOCATIONS CONSIDERED TO BE MOST SUSCEPTIBLE TO EROSION/CORROSION."

2. How procedure meets these requirements: DEFINES PROGRAM PLAN TO CONTROL PROCESSES AND STRUCTURAL EVALUATIONS FOR PIPING.

3. Preparer's Notes: SEE CR's 199908974 & 8975

[signature]
Prepared By

FAC ENG
Title

9/8/00
Date

[signature]
Approved By

Site Engr. Programs
Section Head

10-18-00
Date

CON EDISON
INDIAN POINT STATION
SS, ENG, NQA, MJ,CAG, RP, SGRP

ATTACHMENT 7.2
Page 1 of 2

TECHNICAL REVIEW

Procedure No. SE-SQ-12.318 Revision: 0

Title: Flow Accelerated Corrosion Program Plan

Prepared by: [signature] C. Bergren

Assigned Reviewer: Mike Cheskis Due Date: 10/1/00

1. Is procedure content current, accurate and adequately addressed?

 ✓ Yes ______ No If No, Comments: ______

Resolution: ______

2. Are the appropriate types of instrumentation and equipment designated and properly utilized?

 ✓ Yes ______ No If No, Comments: ______

3. Can the procedure be performed as written ?

 ✓ Yes ______ No If No, Comments: ______

Resolution: ______

4. Does the procedure conflict with or duplicate other station procedures?

 ______ Yes ✓ No If No, Comments: "NO" is the required response. Procedures are NOT in conflict or duplicated.

Resolution: ______

5. If any acceptance criteria is provided or developed, the derivation of formulas, tolerances, assumptions, etc., should be complete, accurate and adequately presented. Verify the results are correct. Explain: CALCULATIONS ARE IN ACCORD WITH EPRI CHECKWORKS

6. Does the procedure comply with Technical Specifications?

✓ Yes ______ No If No, Comments: ______

Resolution: ______

7. Does the procedure require a Safety Evaluation per SAO-460?

______ Yes ✓ No If No, Comments: SAFETY EVAL NOT REQUIRED BECAUSE THERE IS NO CHANGE TO THE LICENSE BASIS

Resolution: ______

8. Does the procedure comply with the Security and Fire Protection Plan and with applicable federal, state and local regulations?

✓ Yes ______ No If No, Comments: ______

Resolution: ______

9. Does the procedue increase the unavailability time (i.e. the use of "Test in Bypass') beyond approved Maintenance Rule performance criteria?

______ Yes X No If Yes, have the Performance Criteria been re-evaluated?

Comments: ______

Verified Technically Correct: [signature] Syst. ENG. 10-3-00
Title Date

Approved By: Patrick O'Brien [signature] 10-18-00
Section Head Date

FLOW ACCELERATED CORROSION PROGRAM PLAN SUPPLEMENT

A RESOURCE DOCUMENT FOR THE INSPECTION PROGRAM TO DETECT AND MONITOR FLOW ACCELERATED CORROSION IN PIPING SYSTEMS AT INDIAN POINT UNIT NO. 2

Edited by: Chris Bergren
FAC Program Engineer
July 4, 2000

PREFACE

This document is intended to be a resource for those responsible for, or interested in, the FAC program and, as such, the document is not controlled. Updates are made at the discretion of the FAC Program Engineer and the only "current" copy is maintained in a Company computer. The purpose of the document is to provide supplemental material for the controlled program plan specified in Reference B. This document is an edited, updated, version of existing material originally provided by the following individuals: Dean Shah (Con Ed), John Lamb (formerly Con Ed), William Kessler (Con Ed) and Scot Blodgett (Altran Corp.).

INDEX

1.0 INTRODUCTION

Several power plants have experienced piping failure caused by severe pipe wall thinning. This thinning results from Flow Accelerated Corrosion (FAC) of carbon steel piping. The United States Nuclear Regulatory Commission (NRC) and the Institute of Nuclear Power Operations (INPO) have identified many of these incidents and have suggested that each utility review the effects of FAC at their operating facilities. The Electric Power Research Institute (EPRI) has made extensive efforts to understand the specific causes of wall thinning and has developed guidelines for assessing this problem. (References 1-13, 21, 25-28, 35, 40.)

Some of the conditions which lead to FAC damage are the use of susceptible pipe material (i.e., carbon steel), piping geometry, moisture content of steam, oxygen level, and other variables such as water chemistry, operating temperature and velocity in piping systems. Flow Accelerated Corrosion damage due to these conditions has occurred in single-phase (water) and two-phase (wet steam) systems.

Injuries and fatalities to plant personnel have been the most serious consequences of FAC pipe failures. Other consequences include major equipment damage and multiple equipment failures due to steam and water damage. In addition, FAC damage and resultant pipe failures could lead or contribute to severe reactor plant transients.

Con Edison is determined to ensure personnel safety and minimize unnecessary plant challenges resulting from potential failures of any piping system. An inspection program for the Extraction Steam System was established in 1984. As a result of a feedwater pipe failure at Surry Unit No. 2, determined to be caused by the effects of flow accelerated corrosion, Con Edison has augmented the Indian Point Unit 2 inspection program to include single-phase systems. Due to an extensive addition of inspection locations, a need to develop a long-term systematic program was realized in order to provide a reliable and cost-effective inspection plan.

The core requirement for Indian Point Unit 2 is derived form Section 10.4 of the Updated Final Safety Analysis Report (UFSAR) where the following statement is made:

> *In response to NRC IE Bulletin 87-01, an inspection program has been established for piping and fittings in the extraction steam, turbine crossunder, heater drain pump discharge, condensate, feedwater and auxiliary feedwater systems. UT inspections are utilized to evaluate wall thickness at locations considered to be most susceptible to erosion/corrosion.*

The inspection program is implemented under Reference B, the Flow Accelerated Corrosion Program Plan (FACPP). The enhanced program will ensure all station objectives are achieved and maintained. Consolidated Edison recognizes the need for an adequately staffed and funded FAC program to support these necessary objectives. This program is designed to consolidate and address the work done by the NRC, EPRI, INPO, and NUMARC , as well as meeting the objectives described in the following sections.

2.0 OBJECTIVES

The primary objective of this program is to maintain the long-term process of FAC detection and monitoring in piping systems so that pipe wall thinning can be mitigated or reduced to prevent pipe failures. These detection, monitoring, and mitigation processes require that the program demonstrate the best elements of:

- Early planning

  Planning for the next outage can not begin soon enough after completion of an outage. The current inspection results need to be evaluated and incorporated in the program without delay. These evaluations form the basis for the next round of pipe inspections and replacements.

- Clear methodology

  Authorities responsible for future planning must understand the basic principles associated with FAC. The industry and Indian Point 2 follow well-established policies and practices when making determinations of future activities.

- Consistent technique

  The pattern and process of data collection must be repeatable in order to provide meaningful wear rate information. Experienced technicians following approved procedures are key elements.

- Process control

  Engineering evaluations of the obtained data require controls due to the number of inspection points and the many computer-based systems required to hold and process the data. Mitigation efforts in the form of planned piping replacements require long-lead times for purchase order and planning efforts.

- Schedule control

  Inspection and replacement efforts need to be tightly integrated into the plant schedule with a view to inspecting and replacing pipe with the Unit online if possible. Where online work is not possible, then the outage schedule must be managed with respect to scaffold, insulation removal, UT inspections, pipe replacement, insulation reinstallation and in consideration of other work in the area.

- Reliability and cost effective results

  The number of FAC incidents should be reduced to as low as fiscally and managerially achievable and the achievement of this goal should be demonstrable through plant history and through inspections by outside agencies. Program results are communicated to plant personnel to ensure continued understanding and support of stated objectives.

3.0 RESPONSIBILITIES

The Site Engineering Manager has the overall responsibility for managing Site Engineering which includes a Section responsible for Engineering Programs. One of those defined programs is the FAC program. Therefore, the Site Engineering Manager has overall responsibility for implementation of the FAC program.

The Programs Section Manager has responsibility under the Site Engineering Manager for implementation of several defined programs. One of those defined programs is the FAC program. Therefore, the Programs Section Manger has chain-of-command responsibility for implementation of the FAC program. The Programs Section Manager would normally be the approval authority for the administrative procedure implementing the FAC Program Plan (FACPP).

The Flow Accelerated Corrosion Program Engineer (FACPE) is responsible for:

- Ensuring all FAC activities and documents meet the requirements of the FACPP.

- Performing self-assessments or other reports of the FAC Program on schedule.

- Specific implementation and maintenance of the FAC program which includes:

    - Identification of specific locations to be inspected,
    - Scheduling of inspection activities,
    - Evaluation of inspection result,
    - Documenting the evaluation results,
    - Maintaining CHECWORKS sub-programs such as Heat Balance, and Chemistry,
    - Maintaining CHECWORKS current with respect to upgrades,
    - Maintaining the Susceptibility drawings,
    - Ensuring adequate Design Engineering support for designing mitigation efforts such as pipe replacement or pipe overlay,
    - Ensuring adequate Construction (or Maintenance) support for implementing inspection and replacement plans including scaffold, pipe insulation, asbestos handling, welding and control of these processes,
    - Ensuring adequate Quality Assurance support for UT or other inspection management,
    - Maintaining the FACPP administrative procedure and FACPP supplement,
    - Maintaining the Isometric Sketches and other support sketches,
    - Analyzing leakage in susceptible systems for evidence of FAC or, for seat leakage, for contribution to FAC damage, and
    - Evaluating events in the industry for impact on the IP2 FACPP.

- Maintaining contact with industry sources such as the CHECWORKS Users Group (CHUG) through the web-site or through meeting attendance.

4.0 CAUSE OF FLOW ACCELERATED CORROSION

FAC in general terms can be considered as an accelerated form of corrosion induced by flow which causes the dissolution of the protective oxide film on the surface of piping components. FAC in nuclear and fossil power plants has occurred in both single and two phase (wet steam) lines, but never in dry steam lines.

Basically two forms of FAC degradation occur. A general localized form of FAC occurring at local flow discontinuities, and a form of FAC which results in more general wall thinning. FAC damage is exhibited in a wide range of surface damage including scallops, smooth wear and tiger striping. Tiger striping is characterized by a mapping or striping of a pipes' inside diameter. (Ref 40)

In a number of laboratory investigations and site engineering evaluations, both in the United States and overseas, the major variables affecting the FAC process have been identified (References 11,13,24,40) as follows:

- Flow Path Geometry
- Material Composition
- Fluid Temperature
- Flow Velocity and Flow Restrictions
- pH and Oxygen
- Moisture Content in Steam Systems

4.1 Flow Path Geometry

During investigations conducted by EPRI as part of root cause research work, it became evident that one of the major contributing factors in flow accelerated corrosion degradation was poor piping geometry. Severe flow accelerated corrosion degradation was found to be in the vicinity of system discontinuities such as branch connections, elbows, and in the areas of shop and field welds, particularly where backing rings were used. The area where the closeness between changes in direction and other discontinuities does not allow the turbulence to dissipate is expected to have a higher rate of FAC. Usually a length equivalent to 15 diameters of straight pipe is required for flow to stabilize. (Ref 11)

4.2 Material Composition

Carbon steel is more susceptible to high rates of FAC. Alloying elements such as chromium, copper, and molybdenum can improve the FAC resistance of carbon steels. Various tests using different alloy compositions have shown that FAC rates can be reduced by approximately three times with carbon molybdenum steel and more than 10 times with chromium molybdenum steel when compared to carbon steel. Austenitic stainless steels essentially are immune to FAC. (Ref 13,29)

4.3 Fluid Temperature

FAC is strongly temperature dependent, with well defined maximum rates based on test data. The FAC rate increases and then decreases as temperature is increased. For water, the maximum rate appears to occur at about 280°F. For wet steam, the corresponding maximum is about 355°F. (Ref 11,30,40)

4.4 Flow Velocities and Flow Restrictions

Turbulence is created as a result of inherently high fluid velocities, or due to the presence of flow-restricting devices such as an orifice or control valve. Severe fluid turbulence adjacent to the pipe surface is known to increase the FAC rates. (Ref 11,13 40)

4.5 pH and Oxygen

The effects of pH and Oxygen on the rate of FAC is documented both in the research literature and the site inspection data. Results show that the rate of FAC is lower as the pH and oxygen levels are increased. (Ref 11,13, 31, 32, 40)

4.6 Moisture Content

It has been determined that moisture causes FAC in wet steam piping. In wet steam systems, water droplets entrained in the steam cause FAC. Inspection reports from operating domestic power plants indicate that piping systems with higher moisture content suffered higher rates of FAC. (Ref 11,40)

5.0 SCOPE

The scope of the FAC program includes all carbon steel systems exposed to single-phase (water) flow at a temperature above 200°F and all systems subject to two-phase (wet steam) flow. This includes all tanks and valves located within a susceptible system. Specific susceptibility criteria are detailed in Section 7.0 of this document.

The scope of this program does not include intergranular stress corrosion, corrosion due to Boric Acid solution, corrosion due to sediments or suspended solids, microbiologically induced corrosion (MIC), pipe wall degradation due to cavitation, or other degradation mechanisms other than FAC.

6.0 PROGRAM DEVELOPMENT AND APPROACH

The approach of this program is based on a comprehensive and continual engineering review of the plant design, available technical information, and experience at Indian Point 2 and other plants. This program was developed consistent with the guidelines provided by INPO, NRC, and EPRI and includes the following:

- Establish which systems have piping that is potentially susceptible to flow accelerated corrosion. (Section 7.0)

- For piping which can be modeled using CHECWORKS, provide information for the necessary sub-programs (heat balance, chemistry, etc) to analytically identify trouble areas for inspection. (Section 8.0)

- Calibrate the CHECWORKS model output by comparing and compensating actual inspection data to obtain line correction. (Section 8.0)

- For piping systems that can not be modeled in CHECWORKS, establish an evaluation methodology for Large Bore (Non-CHECWORKS) and Small Bore piping. (Section 8.0)

- For all systems whether CHECWORKS or not, establish a trending program based on actual inspection data independent of the analytical models. (Section 8.0)

- Establish a program to evaluate leakage at susceptibility boundary valves to monitor downstream piping for potential FAC damage. (Section 8.0)

- Establish a mechanism to examine industry issues, plant issues and personnel experience to determine whether any change to the program is needed. (Section 8.0)

- Evaluate the results of all models, trends and evaluations above to produce a Master Inspection List for the next refueling outage. (Section 9.0)

- Evaluate the inspection results to determine piping condition, provide feedback data for CHECWORKS calibration and for susceptibility analysis. (Section 10.0)

- Take appropriate action where deficiencies are identified (sample expansion, pipe replacement, etc.). (Section 10.0)

- Establish methods for FAC mitigation. (Section 11.0).

- Establish mechanisms to (1) easily track and monitor outage preparation and lessons learned (2) provide Isometric Sketches of inspection locations, (3) maintain hard-copy files of inspection data, and (4) keep track of training. (Sections 12.0 and 13.0)

7.0 IDENTIFICATION OF SUSCEPTIBLE SYSTEMS

A detailed engineering review was performed to identify all FAC susceptible piping systems. Table 7.1 lists each system and its appropriate disposition at the conclusion of that review. The table is applicable to both the Large Bore and Small Bore reviews. The specific screening boundaries are shown and maintained current on the Large Bore and Small Bore Screening Drawings. These drawings are updated in accordance with the FACPP.

The following criteria were used to exclude non-susceptible piping segments from further FAC analysis. The letter designations following each heading can be found adjacent to the appropriate line on both small bore and large bore screening drawings.

7.1 Low Temperature (TW)

Single phase systems in which the normal operating temperature at 100% power level is 200°F or less were excluded. Research data has shown that FAC is insignificant below this temperature (Reference 11). Also, this exclusion criteria is in compliance with INPO (Reference 4) and EPRI (Reference D). There is no temperature exclusion for two-phase systems. If measurable wear is identified in related systems operating above 200°F, it is recommended that the parts of the system under 200°F be checked for susceptibility.

7.2 Piping Material Other Than Carbon Steel (M)

Piping systems constructed of material other than carbon steels can be excluded (Reference D). FAC occurs most readily in plain carbon steels. In ferritic steels, alloying elements such as chromium, at levels greater than or equal to 1¼%, can greatly improve the FAC resistance. As such, chromium lines are not readily susceptible to FAC. Lines constructed of chromium can be monitored on a limited basis to ensure other degradation mechanisms are not present. Essentially, austenitic stainless steel is immune to FAC. As a result, inspection of stainless steels is not included in this program. It should be noted that carbon steel components such as valves and nozzles must be monitored even if the balance of the system is constructed of a non-susceptible material.

7.3 Systems Other Than Water Or Wet Steam (N, D)

FAC does not occur in piping containing fluids other than water or wet steam. Thus, all other systems (such as gas, dry [superheated] steam and oil systems) have been excluded. However, inspection sampling is recommended on the main steam system between the steam generator and high pressure turbine on a periodic basis to confirm non-susceptibility as the system contains some moisture content.

7.4 Raw Water Systems (R)

Raw water systems, such as service water and city water, have high dissolved oxygen content and are not susceptible to flow accelerated corrosion. Therefore, all raw water systems have been excluded (Reference D).

7.5 Systems with No Flow or Operate Less Than 2% of Operating Time (U)

Systems with no flow or those systems which operate less than 2% of the plant operating time can be excluded from further evaluation due to relatively low level of susceptibility (Reference 36). Systems which operate less than 2% of the plant operating time but see severe service (i.e. flashing flow, high velocities, etc.) shall be considered for inclusion as industry experience has shown such lines to be susceptible.

Low usage systems should be reviewed prior to each refueling outage with operators and system engineers to determine any changes in operation or function that may affect system susceptibility screening. Seat leakage past low usage boundary valves must be considered as a potential source of susceptibility on low usage systems.

TABLE 7.1

DRAWING NO.	TITLE	SYSTEM DESIGNATOR	SUSCEPTIBLE? Y/N	REASON FOR EXCLUSION (See Legend)	NOTES
9321-F-2017	Main Steam	MS	Y	N/A	
9321-F-2018	Condensate & Boiler Feed Pump Suction	CS, CD	Y	N/A	
9321-F-2019	Boiler Feedwater	BFD	Y	N/A	6" Bypass Lines Replaced With SS Clad Piping
9321-F-2020	Extraction Steam	3EX, 4EX, 5EX, 6EX	Y	N/A	6EX Lines Replaced With SS Clad Piping, Except for Nozzles and Valves
9321-F-2022	Heater Drains & Vents	CD, 5EX, 6EX, HD	Y	N/A	
9321-F-2023	Moisture Separator and Reheater Drains & Vents	5EX, MS	Y	N/A	
9321-H-2024	Blr. Feed Pump Turbine Stm. Lines, Drains & Vents	3EX, CT	Y	N/A	
9321-F-2025	Condenser Air Removal	CA	N	N	
9321-F-2026	Circulating Water	CW	N	R	
9321-F-2027	Steam Supply & Condensate Return System	UH	Y	N/A	
9321-F-2028	Jacket Water to Diesel Generator	CC	N	R	
9321-H-2029	Starting Air to Diesel Generators	DA	N	N	
9321-F-2030	Fuel Oil to Diesel Generator	DF	N	N	
9321-F-2031	Extraction Steam Trap System	3EX, 4EX, 5EX, 6EX	Y	N/A	
9321-F-2033	Service & Cooling Water - River and Fresh	SWT	N	R	
9321-F-2035	Station Air	SA	N	N	
9321-F-2036	Instrument Air	IA	N	N	
9321-F-2037	Lube Oil	LO	N	N	
9321-F-2038	Chemical Feed	CF	N	N	
9321-F-2039	Chlorination	CL	N	N	

DRAWING NO.	TITLE	SYSTEM DESIGNATOR	SUSCEPTIBLE? Y/N	REASON FOR EXCLUSION (See Legend)	NOTES
9321-F-2040	Hydrogen and CO_2	HS, CO	N	N	
9321-F-2041	Main Steam Traps, Sht. No. 1	MS	Y	N/A	
9321-F-2042	Main Steam Traps, Sht. No. 2	MS	Y	N/A	
9321-F-2120	Superheater Building Service Boilers	FO, AS, WP, AF	Y	N/A	
9321-F-2719	Waste Disposal System	WD	N	M, N	
9321-F-2720	Auxiliary Coolant System	AC	N	M, TW	
9321-F-2721	Air Cooling System for Hot Penetrations	PCA	N	N	
9321-F-2722	Service Water Supply Sht. 1	CC	N	R	
9321-F-2723	Nitrogen to Nuclear Equipment	SGN	N	N	
9321-F-2724	Make-up Water System Nuclear Steam Supply Plant	PW	N	M, TW	
9321-F-2725	Automatic Gas Analyzer System	WD	N	N	
9321-F-2726	Penetration and Liner Weld Joint Channel Pressurization System	WCP	N	N	
9321-F-2727	Hydrogen Recombiner	M	N	N	
9321-F-2728	Nuclear Equipment Drains	WD	N	M	
9321-F-2729	Steam Generator Blowdown & Blowdown Sample System	MS	Y	N/A	
9321-F-2730	Waste Disposal System, Sht. 2	WD	N	M, N	
9321-F-2734	Piping at Reactor Coolant Pumps	AC, RC, CH	N	M, TW	
9321-F-2735	Safety Injection System	SI	N	M	
9321-F-2736	Chemical & Volume Control System	CH	N	M	
9321-F-2737	Chemical & Volume Control System Sht. No. 2	CH	N	M	
9321-F-2738	Reactor Coolant System	RC	N	M	
9321-F-2745	Sampling System	SL	N	M	
9321-F-2746	Isolation Valve Seal Water System	IV	N	M	

DRAWING NO.	TITLE	SYSTEM DESIGNATOR	SUSCEPTIBLE? Y/N	REASON FOR EXCLUSION (See Legend)	NOTES
9321-F-4006	Yard Fire Protection Piping	FP	N	R	
9321-F-4022	Ventilation System for Containment, PAB and Fuel Storage Building		N	N	
9321-F-7020	Steam & Water Analysis System Sampling	CS	N	M	
188851	Integrated Liquid Waste Sht. No. 1		N	M	
188852	Integrated Liquid Waste Units 1 & 2		N	M	
B207653	High Temperature Filter System for Boiler Feed Water	BFD	N	U	
207698	Lube Oil Diesel Generators 21, 22, 23		N	N	
208168	Chemical and Volume Control System	CH	N	M	
208368	Laval Separator Flush Water Piping - SW Pumps		N	R	
208479	Containment Building Post Accident System		N	N	
208487	Noble Gas Radiation Detection System R-27		N	N	
208798	Reactor Vessel Level Instrument System		N	M	
208879	Post Accident Cont. Venting System		N	N	
209762	Service Water System Sht. No. 2		N	R	
A209775	Auxiliary Steam Supply and Condensate Return System	UH	Y	N/A	
A209847	Moisture Separator Reheaters Vent Chamber Discharge	MS, VCD	Y	N/A	
B226935	Reheater Drain Tanks Level Control Schematic Diagram	MS, IA	N	N, U	
227178	Sampling System		N	M, U	
A227551	Fire Protection System Diagram Details Sht. #1	FP	N	R	
A227552	Fire Protection System Diagram Details Sht. #2	FP	N	R	
A227553	Fire Protection System Diagram Details Sht. #3	FP	N	R	
A227554	Fire Protection System Diagram Details Sht. #4	FP	N	R	
A227780	Main Steam	MS	Y	N/A	

DRAWING NO.	TITLE	SYSTEM DESIGNATOR	SUSCEPTIBLE? Y/N	REASON FOR EXCLUSION (See Legend)	NOTES
A227781	Auxiliary Coolant System	AC	N	TW	
A228272	Moisture Preseparator System	MPS	Y	N/A	
228363	Stator Winding Cooling Water System		N	TW	
228365	Hydrogen Seal Oil System		N	N	
234191	Closed Cooling Water System		N	TW	
235296	Safety Injection System	SI	N	M	
A235304	Heater Drains and Vents	1EX, 2EX, 3EX, 4EX	Y	N/A	
235306	Nitrogen to Nuclear Equipment		N	N	
A235307	Condensate & Boiler Feed Pump Suction	CD, CT	Y	N/A	
A235308	Main Steam	MS, 5EX	Y	N/A	Crossunder Pipe inspected 100% visually and partially clad with SS
235309	Chemical and Volume Control System	CH	N	M	
236427	Water Treatment Plant Prefilter		N	R	
A240128	Boiler Feedwater Level & Flow Instrumentation S/G. 21 - 24	BFD	N	U	
240901	Hydrogen and CO_2		N	N	
A241161	Steam Generator Blowdown Sampling Panels		N	M	
242656	Wht. Pit I/A - D/G BA Evap. Bldg. Nuc Tnk Pad	IA	N	N	
A242688	Instrument Air Containment Bldg. & Auxiliary Blr. Feed Pump Bldg.	IA	N	N	
A242753	Instrumentation Diagram Fan Cooler Filter Units		N	N	
A244603	Chemical Process Liquid Waste Disposal Sht. #2	LW	N	TW	
251783	Auxiliary Cooling System RHR Pumps	AC	N	TW	

Legend:

Code	Reason for Exclusion
D	Dry Steam
TW	Temperature (Water)
U	Usage
N	Not Water
M	Pipe Material
R	Raw Water

NOTES: 1) The basis for the exclusion criteria is presented in Sections 7.1 through 7.5.

8.0 INSPECTION PLAN

The objective of this section is to discuss the development of an inspection plan as specified in the FACPP.

8.1 CHECWORKS Modeling

This discussion provides general information on the development of CHECWORKS models to be used in the FAC program for Indian Point Unit 2. For detailed information, consult the CHECWORKS Users Guide (Ref. C) as specified in the FACPP.

The CHECWORKS models or database are maintained under the direction of the Consolidated Edison FAC Program Engineer using the FACPP and the CHECWORKS Users Guide. Specific information required to create a CHECWORKS database will include but is not be limited to:

- The Heat Balance Diagram
- Water Chemistry Reports
- Pant Operated and Design Conditions
- Plant Operating History
- Piping and Instrument Drawings
- Piping Isometric Drawings
- Plant Piping Specification
- Material Information

8.1.1 Heat Balance Diagram

The Heat Balance Diagram (HBD) must be constructed before CHECWORKS can be used to perform Wear Rate or Chemistry Analysis. It is not required if the database is only used to store and evaluate UT data. The HBD is a schematic representation of the plants thermodynamic operating conditions. The HBD must define a complete circuit from the Steam Generator through the HP and LP Turbines to the Condenser including the Moisture Separator Reheater, Drain Tanks, Feed Train and Feed Pumps. Significant mixing and splitting of flows must be defined to ensure proper modeling. Complete instructions are provided in the CHECWORKS Users Guide, Section 4.0.

8.1.2 Steam Cycle Data

The CHECWORKS code has the capability of performing analysis at various power levels. While this may provide a more accurate analysis, it is acceptable to input all thermodynamic conditions for each major component in the steam cycle at 100% power. Any extensive periods of low power operation in the future shall be considered for modeling at the lower power level. These conditions include Flow Rate (lbs/hour), Enthalpy (BTU/lbm), and Operating Pressure (psig) or Temperature (°F). This data is available on the heat balance diagram.

8.1.3 Water Chemistry

The historic water chemistry data is obtained from the Chemistry Section. In general, the average cycle data should be used. However, in the event of a significant mid-cycle chemistry change such as the introduction of an alternate amine (e.g., ETA), then the total operating hours at each condition should be used.

CHECWORKS has the capability of unlimited cycle history. The weighted average chemistry for older cycles that was used in CHECMATE can continue to be used since breaking this data into discrete cycles will have little effect on the accuracy of the current wear rate analysis.

8.1.4 Plant Periods

In CHECWORKS each plant period must be defined including both operating and maintenance (scheduled or prolonged unscheduled) periods. Each operating period includes the total time in effective full power hours (EFPH), water chemistry, and power level, typically 100% for operating and 0% for maintenance periods.

8.1.5 Plant Piping

Instructions for the addition of line data to CHECWORKS are included in Section 7.0 of the CHECWORKS Users Guide. In addition to storing line data, CHECWORKS also has the optional capability of storing and viewing isometric drawings.

8.1.6 Component Data

Standard pipe material and component data are included in the libraries in the CHECWORKS code. These libraries can be edited to add or change data when necessary.

A. Piping Materials

The material type for the components modeled in CHECWORKS are to be taken from the IP2 piping specification. When components are replaced, the CHECWORKS database must be updated to show the replacement date and the material, especially when improved materials are used.

B. Diameter/Wall Thickness

The diameter and nominal wall thickness values for pipe and fittings modeled in CHECWORKS are to be taken from the plant piping specification for a class consistent with the line shown on the P&ID. Additional information may be obtained from piping fabrication drawings or other sources as necessary.

For valves and orifices, drawings of the individual components shall be used as a basis for the wall thickness and orifice size input. Orifice size shall be selected based on seat inside diameter. As vendor drawings are not always available, valve orifice size can be taken as the pipe ID until more specific information becomes available.

8.1.7 Wear Rate Analysis

In CHECWORKS, any number of lines can be grouped for wear rate analysis. However, as a minimum, each plant system (e.g., Feedwater (FW), Condensate, Moisture Separator Reheater (MSR) Drains, Feedwater Heater Drains, Steam Generator, Blowdown, etc.) shall constitute an analysis line. Where more inspection data is available or when the fluid conditions change (i.e., MSR drains to drain tank the line may be partially full and from the drain tank to the FW heater the line is likely to be full) a more detailed breakdown of the lines should be performed. Areas where fluid mixing and chemistry changes occur should also be separated into different analysis lines.

As each analysis group has a single correction factor to correlate the predicted wall loss to the actual inspection data, analysis groups consisting of fewer lines will provide more accurate correlation over those lines. For example, each stage of extraction steam shall be analyzed as a separate line. If poor model correlation is noted within an analysis line section when compared with UT data, separate analysis lines will result in better correlation provided a sufficient number of examinations exist. Any component(s) having a poor correlation should be evaluated to assure that fluid conditions in the component(s) are being correctly modeled.

Lines with questionable usage, flow conditions or which see intermittent use shall be analyzed as a separate analysis line. This is necessary to avoid line correction factors which are incorrectly utilized by CHECWORKS which in turn may provide misleading results.

A "Pass 1" or "Pass 2" wear rate analysis is based upon whether or not UT inspection data have been incorporated into the CHECWORKS wear rate analysis. The Pass 1 analysis is performed without the consideration of UT data. The Pass 2 analysis utilizes a line correction factor that normalizes the differences between the CHECWORKS Pass 1 predicted wear and that measured from UT inspection.

The CHECWORKS computer code has the capability of excluding UT wear data (Pass 1) or including the UT wear data (Pass 2) by selecting the appropriate option on the wear rate analysis run definition form (CHECWORKS Users Guide, Section 12.1.1). The measured wear rate for a component is obtained by performing an analysis of the UT data using the UT analysis feature of CHECWORKS as described in the CHECWORKS Users Guide, Section 13.0. Specific consideration must be given as to which wear data is to be included in the wear rate analysis, as a small number of accurate wear determinations will give far better results than a large number which are not reflective of actual wear.

Once a system is adequately represented in CHECWORKS with inspection results, a Pass 2 analysis is performed to refine predicted FAC rates and calculated life expectancies of uninspected components.

8.1.8 Inspection Location Selection - CHECWORKS Modeled Systems

The inspection location selection process for CHECWORKS analyzed systems consists of the initial inspection, second inspection and follow-on inspections. Each step has an important function in CHECWORKS model calibration and system susceptibility monitoring.

A. Initial Inspection

The initial inspection sample is selected to determine the level of FAC susceptibility, to identify components with FAC damage and to provide data for analytical model calibration. The inspection sample shall include the following:

- All industry and plant experience locations (see section 8.6 - i.e. downstream of control valves, orifices etc.) in all trains. Areas with past replacements should also be considered.

- Components with the highest pass 1 predicted wear. The sample shall include components from as many different geometry types as is reasonable based on relative predicted susceptibility. At least one similar component in each parallel train should also be selected for comparison purposes.

- Components with the lowest pass 1 predicted service life.

- At least one component in each two-phase line of piping.

- Unusual geometry including field fabricated tees and locations known to have backing rings.

- At least 3-5 components per CHECWORKS analysis line.

B. Second Inspection

The second inspection interval is used to confirm the results of the initial inspections, obtain data for analytical model refinement and to ensure components predicted to be approaching minimum wall are suitable for continued service. Engineering judgment taking into consideration past inspection history, CHECWORKS predictions and trending of component wall thinning should be used to determine at what outage the second inspection is performed. The inspection sample shall include the following:

- At least three components from the initial inspection sample that exhibited the most wear.

- Components predicted to have a service life less than the time to the next inspection interval. This includes components identified for reinspection (see following "Component Reinspection - UT Trending" Section), as well as components with a negative "time to t_{crit}" ranking in the CHECWORKS pass 2 analysis.

- New industry experience locations.

- Systems with particularly high wear rates or low structural margins will in general require second inspections sooner than other systems. Second inspections should occur within 1 to 3 operating cycles depending on the system.

C. Follow-On Inspections

Inspections performed after the second inspection interval are used to monitor system susceptibility, changes in plant operation and water chemistry and components approaching the end of their predicted service life. Follow-on inspections shall be performed for the life of the plant. Inspection locations should be comprised of the following:

- Components predicted to have a service life less than the time to the next inspection interval. This includes components identified for reinspection in Section 8.4 "Component Reinspection - UT Trending", as well as components with a negative "time to t_{crit}" ranking in the CHECWORKS pass 2 analysis.

- At least one of the highest wear components inspected during the previous inspection interval.

- Any new industry experience locations.

- Piping within two diameters of a previously replaced component if not already inspected under the sample expansion process.

- Previously replaced components not constructed of a FAC resistant material.

- Piping downstream of control valves or orifices that exhibited wear during previous inspection intervals.

- Additional high wear components predicted by CHECWORKS.

Follow-on inspection results should be compared to predicted results to ensure accurate model calibration. Results that do not fall within specified limits as per the CHECWORKS user guide should be investigated as to the reason and to determine if an updated FAC analysis should be performed and/or additional inspection locations specified. Components with highly over-predicted wear rates may contain trace chromium concentrations that can significantly lower FAC rates. Studies have shown that trace chromium concentrations as low as 0.1% can greatly reduce carbon steel susceptibility to FAC. If the reason for disagreement between the predicted and measured wear rates for a component cannot be determined it is recommended that a material composition analysis be performed.

8.1.9 Analysis Document

The result of all the preceding wear rate work is normally compiled in a "CHECWORKS Analysis" document. This document includes a full wear rate analysis in a combined summary report, a demonstration and evaluation of each LCF (line correction factor), and the input data and assumptions used to maintain or change the CHECWORKS model up the point of the analysis. From this work, the various inspection points are selected for possible inclusion in the next cycle inspection list.

8.2 Large Bore Non-CHECWORKS Systems

8.2.1 Scope

This discussion concerns the analyses of large bore (>2") FAC susceptible systems where CHECWORKS can not adequately model system degradation. Also, the selection of inspection locations for large bore Non-CHECWORKS (LBNCW) piping is presented. Non-CHECWORKS FAC susceptible systems are determined through the screening effort detailed in Section 7.0 and maintained up-to-date on the Large Bore Screening Drawings. The intent of the applied methodology is to ensure adequate inspection coverage of LBNCW FAC susceptible systems and assure the structural adequacy of uninspected components.

The scope includes all large bore plant systems identified as FAC susceptible and not suitable for CHECWORKS modeling (i.e. vent lines, gland steam, aux. steam, recirculation lines, high level dump lines, bypass lines etc.). In general, these systems have usage and flow rates which cannot be accurately quantified because demand and operating conditions greatly vary or are controlled by a remote level, pressure, or temperature signal.

8.2.2 Process Considerations

A. Review the list of susceptible LBNCW systems in Section 7.0 and Large Bore Screening Drawings.

B. Group susceptible systems into sub-systems for review based on similar flow and operating conditions. Give the sub-system a numerical designation. The boundaries of the sub-systems should be defined similarly to the CHECWORKS analysis line grouping (see Section 8.1.7). For example, each stage of the feedwater heater drain high level condenser dumps should be an individual sub-system.

C. A summary sheet for each large bore sub-system is developed and updated after each inspection interval. The summary sheet for each sub-system contains the following information:

- Large Bore Review Number
- Description of the system
- Flow Diagram Number(s)
- FAC Isometric Number(s) if available
- A listing of all previous inspections indicating the components nominal thickness, measured minimum thickness, time of inspection, and percent wall loss from nominal
- Phase (single or 2-phase)
- Potential for Susceptibility (High, Low) based on FAC judgment, plant experience and industry experience. It should be noted that all susceptibility rankings should be on the conservative side.

D. Inspection point determination:

- A review of historical inspection and replacement data is performed to ensure that the most susceptible components within each sub-system have been inspected. Typically the most susceptible components include, but are not limited to:
  - Control Valves
  - Discharge Nozzles
  - Orifices
  - Areas with Concentrated Geometry Changes (i.e. fitting bound elbows, etc.)
  - Drain Tanks, Shells of MSR's, Feedwater Heaters, etc.
  - Normally closed valves with a potential for leakage. If the most susceptible component(s) has not been inspected it should be added to the inspection list.

- If the most susceptible component(s) has been previously inspected, select the next highest ranked component for inspection. Table 8.1 summarizes the relative FAC wall thinning rates for all different piping components for both single and two-phase conditions. These rankings are provided for information. Relative susceptibility as determined by the FAC engineer normally includes materials, operational, plant experience, industry experience, and FAC judgment considerations.

- Additional locations should be considered for inspection on sub-segments where it is determined that there is an insufficient number of inspections to adequately identify susceptibility or if there have been a number of replacements on the segment.

- Discuss with the operations/systems/maintenance personnel the susceptible systems to determine current operational/functional parameters. This may identify specific locations that are highly susceptible which should be added as inspection points.

- Determine whether the line or similar lines in a parallel train have had any historical component operational failures such as oscillating control valves or eroded orifices. This may greatly influence flow velocities and conditions and should be considered in the selection of inspection locations.

- Reinspection of previously inspected components shall be in accordance with Section 8.4.

- Components inspected during the current RFO are structurally analyzed as discussed in Section 10.0.

8.2.3 Prior to each refueling outage all inspection data taken during the current RFO should be incorporated into the Large Bore Non-CHECWORKS reviews and new inspection locations specified as necessary. This is normally compiled in a "Large Bore Non-CHECWORKS Review" document.

TABLE 8.1

CHECWORKS Parametric Influences
RELATIVE FAC WALL THINNING RATE

2-PHASE FLOW			SINGLE PHASE FLOW		
COMPONENT TYPE	GEOMETRY CODE	RELATIVE RANKING	COMPONENT TYPE	GEOMETRY CODE	RELATIVE RANKING
CONTROL VALVE	24	1.000	RED TEE	11	1.000
RED TEE	11	0.966	RED TEE	10	0.810
GLOBE VALVE	21	0.962	90-DEG EXP ELBOW	19	0.810
RED TEE	14	0.742	180-DEG ELBOW	5	0.714
RED TEE 1-LEG	12	0.701	REDUCER 7	7	0.667
TEE	13	0.674	RED TEE 1-LEG	12	0.667
RED TEE	10	0.644	RED TEE	14	0.667
TEE 1-LEG	12	0.633	90-DEG ELBOW	102	0.667
TEE	11	0.580	ORIFICE	6	VARIES
EXIT NOZZLE	31	0.580	GENERIC VALVE	8	0.619
PIPE DS 69	69	0. 580	TEE	11	0.619
REDUCER 7	7	0.538	TEE	13	0.619
90-DEG ELBOW	102	0.530	90-DEG RED ELBOW	16	0.619
90-DEG EXP ELBOW	19	0.515	ANGLE VALVE	20	0.619
PIPE DS 57	57	0.485	GLOBE VALVE	21	0.619
RED TEE	12	0.477	GATE VALVE	22	0.619
180-DEG ELBOW	5	0.462	BUTTERFLY VALVE	23	0.619
CHECK VALVE	25	0.462	CONTROL VALVE	24	0.619
45-DEG ELBOW	101	0.455	CHECK VALVE	25	0.619
PIPE DS 67	67	0.451	EXIT NOZZLE	31	0.619
GATE VALVE	22	0.424	PIPE DS 70	70	0.619
PIPE DS 61	61	0.417	45-DEG ELBOW	101	0.619
GENERIC VALVE	8	0.405	EXPANDER	18	0.571
90-DEG RED ELBOW	16	0.402	PIPE DS 57	57	0.524
EXPANDER	18	0.398	TEE	10	0.476
TEE	10	0.386	RED TEE	12	0.476
INLET NOZZLE	30	0.386	INLET NOZZLE	30	0.476
PIPE DS 54	54	0.371	90-DEG ELBOW	2	0.429
PIPE DS 9	9	0.364	45-DEG ELBOW	3	0.429
90-DEG ELBOW	2	0.356	90-DEG ELBOW	4	0.429
90-DEG ELBOW	4	0.356	TEE 1-LEG	12	0.429
TEE	12	0. 356	PIPE DS 55	55	0.429
90-DEG ELBOW	104	0.356	PIPE DS 66	66	0.429
45-DEG ELBOW	3	0.322	PIPE DS 67	67	0.429
45-DEG ELBOW	103	0.322	45-DEG ELBOW	103	0.429
45-DEG ELBOW	1	0.303	90-DEG ELBOW	104	0.429
PIPE DS 55	55	0.295	45-DEG ELBOW	1	0.381
ORIFICE	6	VARIES	TEE NO-BRANCH	15	0.381
TEE NO-BRANCH	15	0.288	RED TEE NO-BR	15	0.381
RED TEE NO-BR	15	0.288	REDUCER 17	17	0.381
ANGLE VALVE	20	0.288	PIPE DS 54	54	0.381
BUTTERFLY VALVE	23	0.288	PIPE DS 61	61	0.333
PIPE DS 53	53	0.288	TEE	12	0.286
PIPE DS 70	70	0.288	PIPE DS 51	51	0.286
PIPE DS 65	65	0.284	PIPE DS 52	52	0.286
REDUCER 17	17	0.254	PIPE DS 53	53	0.286
PIPE DS 52	52	0.242	PIPE DS 58	58	0.286
PIPE DS 66	66	0.220	PIPE DS 68	68	0.286
PIPE DS 51	51	0.212	PIPE DS 69	69	0.286
PIPE DS 68	68	0.193	PIPE DS 60	60	0.238
PIPE DS 58	58	0.170	PIPE DS 62	62	0.238
PIPE DS 60	60	0.117	PIPE DS 65	65	0.238
PIPE DS 62	62	0.117	PIPE DS 9	9	0.143
PIPE DS 64	64	0.106	PIPE DS 56	56	0.143
PIPE DS 63	63	0.080	PIPE DS 63	63	0.143
PIPE DS 56	58	0.076	PIPE DS 64	64	0.143

\Notes: ONE: Components are sorted from highest to lowest relative susceptibility
TWO: Two phase flow results are based on a quality of ninety percent (90%)
THREE Study performed using CHECWORKS Version 1.0D

8.3 Small Bore Non-CHECWORKS Analysis

8.3.1 Scope

This discussion concerns methods for the analysis of small bore (</= 2") FAC susceptible piping and provides the requirements for small bore inspection location selection. Small bore FAC Non-CHECWORKS (SBNCW) susceptible systems were determined through the screening effort detailed in Section 7.0 and maintained up-to-date on the Small Bore Screening Drawings. The intent of this section is to ensure adequate inspection coverage of SBNCW FAC susceptible systems to enable the FAC engineer to make an informed decision as to susceptibility

Small bore socket welded piping cannot be accurately modeled using CHECWORKS due to the many uncertainties associated with it. Factors such as a lack of understanding of operating conditions, percent of usage and fit-up gaps between the piping and the sockets (which vary significantly) lead to uncertainties that cannot be modeled with any degree of confidence. All FAC susceptible small bore piping shall be analyzed using these considerations.

8.3.2 Process Considerations

A. Review the list of FAC susceptible small bore piping determined in Section 7.0 and the Small Bore Screening Drawings.

B. A summary sheet for each individual susceptible FAC small bore system is developed and updated after each inspection interval. A system is defined as all piping with similar flow and operating conditions. The summary sheet for each system normally contains the following items:

- Small Bore Review Letter Designation
- Description of the system
- Flow Diagram Number(s)
- FAC Isometric Number(s) if available
- A listing of all previous inspections indicating the components nominal thickness, measured minimum thickness, time of inspection, and percent wall loss from nominal
- Phase (single or 2-phase)
- Flashing Potential
- Potential for Susceptibility (High or Low) based on FAC judgment and experience.

C. Review the isometric drawing(s) and flow diagrams for each small bore system to ensure adequate coverage of highly susceptible areas. Highly susceptible areas include, but are not limited to:

- Control Valves
- Discharge Nozzles

- Orifices
- Steam Traps
- Areas with Concentrated Geometry Changes
- Normally closed valves with leakage potential

D. Based on the amount of piping, the operating conditions, the extent of coverage of susceptible areas and previous inspection results, make a judgment as to the adequacy of inspection coverage.

E. On lines with adequate inspection coverage, make a judgment as to the susceptibility of the line as either high or low. Repeat inspection of several components may be required before an accurate judgment of susceptibility can be made.

F. Systems that lack coverage of highly susceptible components should have additional locations specified to determine the level of susceptibility. The inspection sample should include the areas listed in step D above and as many other locations as necessary to adequately judge the susceptibility of the system.

G. Systems determined to be high wear should be considered for complete replacement with a FAC resistant material as soon as reasonably possible. If replacement cannot be performed before the unit is returned to service, inspection shall be expanded to quantify the extent of wear in the system. Additional inspection should be performed in future outages until replacement can be completed.

H. Systems determined to be low wear require minimal future monitoring of the highest ranked components to ensure the level of susceptibility does not change. If significant wear is found during future inspections, the system should be reclassified as high wear and the procedure outlined in step G should be followed.

I. Prior to each inspection interval, discuss the susceptible systems with representatives from operations, maintenance and system engineering to determine current operational/functional parameters. The discussions may identify specific locations that are highly susceptible which should be added as inspection points. Consideration should also be given to areas where industry experience has demonstrated a potential for susceptibility.

J. Reinspection of components shall be in accordance with Section 8.4.

8.3.3 Prior to each refueling outage all inspection data taken during the current RFO should be incorporated into the Small Bore Non-CHECWORKS reviews and new inspection locations specified as necessary. This is normally compiled in a "Small Bore Non-CHECWORKS Review" document.

8.4 Reinspection - UT Trending

8.4.1 Scope

The purpose of this section is to discuss tracking component specific UT data and specifying components for reinspection. All components that have been inspected under the FAC program are addressed in this discussion

8.4.2 Reinspection Considerations

Components may be scheduled for reinspection for several reasons:

- Suspect or questionable inspection results which require confirmation.
- The predicted life is less than the time to the next RFO (i.e., prior to replacement).
- Baseline inspection after component repair or replacement.
- Monitoring of component wear at a specified time interval.

8.4.3 Component Monitoring

Components that have been inspected shall be re-examined at a frequency consistent with the calculated component life based on the inspection results. Re-examination shall be scheduled for the RFO preceding the predicted time when the minimum acceptable wall thickness t_{min}, will be reached. A subsequent inspection may also be scheduled if the calculated wear rate appears to be inconsistent with other components judged to be of similar susceptibility. The following steps shall be taken to determine the reinspection schedule:

A. Component Life Calculation

Using the selected wear rate (W_r), the minimum measured wall thickness (t_{meas}), the minimum accepted component wall thickness (t_{min}), and a safety factor of 1.1, the remaining component service life shall be calculated in EFPY. For this calculation, t_{min} shall not be less than 0.3 tnom.

$$Remaining\ Service\ Life\ (T_{life}) = \frac{t_{meas} - t_{min}}{(1.1)Wr}$$

B. Determining Reinspection Schedule

A component shall be scheduled for reinspection based on the time of component inspection in total EFPY (T_{meas}), the calculated remaining component service life (T_{life}), and the refueling outage (RFO) schedule for the unit.

The time of reinspection in total Effective Full Power Years (EFPY) shall be calculated as follows:

$$T_{reinsp} = T_{meas} + T_{life}$$

A component shall be reinspected prior to the calculated $T_{reinsp.}$

8.4.4 <u>Component Tracking</u>

A computerized database, in addition to the CHECWORKS database, should be utilized to record historical component inspection data, help schedule components for reinspection, and record other important component information. The database shall be maintained current as the program is implemented over the operating life of the unit.

Prior to each refueling outage all inspection data taken during the current RFO should be incorporated into a "Trending of UT Inspection Data" document with new inspection locations specified as necessary. This is normally compiled in a spreadsheet document containing all the import and mathematical computation information for each column of the spreadsheet.

8.5 Closed and Low Usage Boundary Valves

8.5.1 Scope

Industry experience has identified seat leakage problems with valves that are closed or see very low usage during normal operation. The leakage can cause FAC in lines that are screened out of scope due to low usage per Section 7.0.

A review was performed to identify all valves that are closed during normal operation and which act as a FAC susceptibility boundary. The list of valves was then screened against the following criteria to develop the final closed and low usage boundary list.

- All valve types except safety relief and check valves shall be reviewed.
- Only closed valves on lines >2'' shall be included on the list.
- Valves on dry steam lines shall be included on the list because of potential changes in steam quality.
- Valves on lines that are capped need not be included on the list.
- Valves on low energy lines (< 200°F and 275 psig) shall not be included on the list unless there is a potential for flashing flow.
- Valves on the heating steam, auxiliary steam and auxiliary condensate systems shall not be included on the list due to a low consequence of failure.
- Valves on the auxiliary feedwater system shall not be included on the list as the system operates less than 2% of the total operating time.
- Valves on lines constructed of stainless steel or chrome-moly shall not be included on the list.
- Double isolation valve configurations shall not be included on the list.

8.5.2 Trouble Report Evaluation

A trouble report search was performed on all valves included on the final closed and low usage boundary list to identify all valves with past leakage problems. The piping downstream of all valves with a history of seat leakage was inspected at the following inspection interval to identify potential FAC damage.

The closed and low usage boundary valve list is normally reviewed before each refueling outage with representatives from operations, maintenance and system engineering to determine potential problems which may have an impact on FAC susceptibility.

Prior to each refueling outage, a trouble report search encompassing the previous operating cycle is performed to identify seat leakage on all valves on the closed and low usage boundary list. All valves identified with seat leakage should be considered for inspection during the next refueling outage. The final list is normally compiled in "Closed and Low Usage Boundary Valve" report.

8.6 Plant and Industry Experience

8.6.1 Scope

This discussion concerns the incorporation of plant and industry experience into the process of identifying susceptible components for inspection. This section applies to all plant systems and is not limited to those currently included in the scope of the FAC program. The intent is to develop an historical evaluation basis in a hands-on format as a supplement to those same issues as identified in formal corrective action systems.

8.6.2 Plant Experience

Plant specific experience is normally taken into consideration in the identification of susceptible systems and components. Part of this process is contained in the basis segments previously discussed as reiterated in the following:

A. Review and Tabulation of historical UT Data

Historical UT data was summarized, tabulated, and considered in the selection of susceptible systems and components (Section 8.3.3).

B. Review of Plant History Data

A maintenance request research effort and summary of repairs potentially attributed to FAC was performed during Cycle 13 and considered in the selection of susceptible systems and components.

C. Accumulated UT Data and Repair/Replacements

The evaluation and documentation of UT data and the recording of required repair/replacements is maintained for each outage. This represents the effort going forward necessary to accumulate plant specific experience.

D. Interviews

Interviews with plant personnel are intended to solicit specific operational and maintenance information from personnel who deal with the operation of plant systems on a regular basis. Formal interviews are documented in the same manner as any plant or industry issue. It is necessary that these issues focus on field force personnel with day-to-day plant responsibilities for components within the susceptibility boundaries.

Formal interviews with plant operators should make use of flow diagrams and walkdowns. Areas to be discussed include:

- Flow rates and flow control
- Operating pressure

- Operating temperature
- Steam quality
- Time of system operation with particular attention to low usage systems
- Duration of any non-standard operating modes
- Lines that have experienced high vibrations or velocities
- Lines that are difficult to balance
- Valves that are difficult to operate or seat

The intent of the interviews with maintenance and system engineering personnel is to confirm the historical basis for decisions about FAC susceptible systems whenever the basis may be called into question. Interview questions should be aimed at determining any problems with equipment or systems in the past or present that may have an effect on or be an indicator of the presence of FAC.

8.6.3 Industry Experience

Industry experience can arrive directly from an industry source (such as CHUG or INPO) or could arrive from industry sources through the formal corrective action system (condition report) or could be discovered in a discussion of issues with peer engineers at a nearby nuclear facility. It is necessary that these issues be thoroughly examined if there is a potential program impact suspected. The intent of this section is to ensure that such a process continues as part of the FACPP..

Documents of the type that normally inaugurate industry reviews are:

- USNRC Information Notices
- EPRI Reports
- NUMARC Reports
- NUREG Reports
- INPO Reports
- Nuclear Network Reports
- Nuclear Power Industry Periodicals

The nature and method for any particular review can not be codified in advance. The form discussed in the following should be used as necessary to provide a framework for discussion and any follow-up actions for the FACPP.

8.6.4 Integration of Plant and Industry Experience into the FAC Program

The FACPP provides a "Plant and Industry Experience" review form to maintain a consistent process. Various actions may be required as a result of the evaluation process on any given topic. The following are some examples:

A. Inspection Plan Modification

A specific location identified as a potential problem area may be added to the inspection list for the next refueling outage to determine FAC susceptibility. The results of the inspection will determine the need for future inspection consideration. There is also the possibility that the inspection plan would be modified in other ways based on new information.

B. CHECWORKS Model Modification

The CHECWORKS model for a system or portion of a system determined to be operated differently than currently modeled should be updated to determine the potential effects on FAC. Additional inspection locations should be specified as necessary per Section 8.1.8.

C. Non-CHECWORKS Large or Small Bore Review Update

Information relevant to system reviews shall be noted on the worksheets for future consideration.

D. Susceptibility Screening Update

A system or portion of a system currently screened out of scope that is identified as having an operational change which may affect FAC potential shall be considered for inclusion to the FAC program. Selected inspection locations may be identified on these systems during the next refueling outage to determine FAC susceptibility. The inspection locations may be monitored over two or more cycles to determine if a line is susceptible and should be added to the scope of the program. All lines required to be added to the FAC program should be evaluated using the same methods as discussed in the FACPP and this supplement. There is also the potential that the scope would be reduced based on the new information (retired lines etc.).

9.0 MASTER INSPECTION LIST

This Instruction describes the method for generating a Master Inspection List (MIL) comprised of the inspections required for an FAC inspection interval (typically each RFO). The MIL shall contain as a minimum the component name, line number, component type (i.e. pipe, elbow, tee, etc.), and the reason for inspection (i.e. CHECWORKS analysis, trending, Non-CHECWORKS analysis, industry/plant experience etc.).

This Instruction shall apply to all required inspection locations developed as a result of the implementation of the requirements detailed in Section 8.

9.1 Inspection Locations

The inspection locations identified from the implementation of Program Document Section 8 shall be merged into a common total listing of required inspections. This total listing will be the Master Inspection List. The initial Master Inspection List shall be established approximately six months prior to each RFO and revised as required.

The items listed below are consistent with the objectives of the program and are to be addressed in the preparation of the list.

- All susceptible systems have been reviewed for initial sampling requirements.
- All systems identified as susceptible, have been reviewed in accordance with the methods presented in Sections 8.1, 8.2 and 8.3.
- All previously inspected components which require reinspection have been specified in accordance with Section 8.4.
- All Boundary Valves and Plant and Industry Experience locations have been specified in accordance with Section 8.5 and 8.6.

9.2 Request for Exemption

Points which the plant recommends to exempt from inspection shall be identified on Request for Exemption Form 9.1 or equivalent. Components which are requested for exemption and for which prior data or an equivalent alternate inspection location does not exist shall require an evaluation based on the consequences of component failure to determine one of the following:

- The consequences are tolerable. No inspection need be performed.
- A more rigorous engineering review justifies postponing the inspection or the selection of an alternate location for inspection.
- The inspection is waived with compensatory measures to avoid plant damage or personnel injury.

- The original scheduled inspection should be performed.

Points which have not previously been inspected and are selected due to CHECWORKS or non-CHECWORKS evaluation shall not be exempted unless the FAC engineer selects an equivalent alternate location to satisfy CHECWORKS or non-CHECWORKS requirements or a more rigorous engineering review justifies an exemption.

Components scheduled for reinspection due to the component's remaining life calculation shall not be exempted unless further methods can be applied to qualify the component structurally for a longer duration. Such methods include evidence of reduced wear rates, detailed local wall evaluations, etc.

9.3 Baseline Examination of Replacement Components Prior to Installation

A baseline examination should be considered for all one-for-one carbon steel replacement components. A baseline examination is not required on replaced components with a projected life greater than the remaining life of the plant. Reasons for not performing baseline examinations should be documented.

10.0 ENGINEERING EVALUATION OF THE INSPECTION DATA

This section presents the process for evaluating the results of ultrasonic wall thickness measurements obtained from piping and fitting examinations. The inspections are used to determine component acceptability for continued service based on measured wear rates and to provide the necessary input to run a Pass 2 analysis which will be used to determine system acceptability.

Structural evaluations must be checked and reviewed in accordance with the applicable ANSI, B31.1 Code. Indian Point Station UFSAR cites the use of the American Standard Code for Pressure Piping ASA B31.1-1955 as the evaluation code. This edition of the code does not address seismic loading. Therefore, the B31.1 1973 edition shall be utilized to evaluate components. The 1973 version of the code requires a more detailed analysis than the 1955 code and is in accordance with current analytical standards. However, the allowable stress values for piping materials shall be obtained form the 1955 edition of the code. The requirements of ASME, Section III and ANSI, B31.1, for branch reinforcements shall be met. The FACPP provides formats for structural evaluations and branch reinforcement evaluations and the methods for controlling these documents and any necessary supporting documents.

Sample expansion may be required based on the results of these qualifications. Sample expansion criteria are discussed in Section 10.3 and specified in the FACPP.

Structural evaluation of baseline measurements need not be performed unless the minimum measured thickness is found to be below the manufacturers' tolerance.

10.1 <u>Calculation of Predicted Thickness</u>

10.1.1 <u>Calculation Input</u>

Upon receipt of the inspection results (UT thickness data); the Outside Diameter (Do), nominal wall thickness (t_{nom}), material type, design pressure (P), and design temperature (T) can be determined using the line designation appearing on the flow diagrams and the plant piping specification or other appropriate documentation. These values should be specified on a component structural evaluation form. (See FACPP for format guidance). The following items should be input and verified in the CHECWORKS database or structural evaluation form:

- The allowable stress (S_h) provided in the B31.1 Code; corresponding to the material and design temperature.
- The current <u>minimum</u> measured thickness (t_{meas}) in inches. Include the grid reference band and circumferential location, if available.
- If t_{meas} is less than or equal to 70% of t_{nom}, the FACPP requires a sample expansion. A form is provided in the FACPP for this purpose
- The total Effective Full Power Years (EFPY) for the component (O_t). The total EFPY for the component shall consider the replacement history of the component.

- The EFPY of operation until the next RFO (O_c).

- The wear calculated from the UT Data using CHECWORKS as described in the CHECWORKS Users Guide, Paragraph 13.8. The methods to be considered include:

  - Band
  - Area
  - Moving Blanket
  - Point-to-Point
  - User Defined

10.1.2 <u>Calculation Method</u>

The methodology used to calculate the "User Defined " wear needs to be documented. The CHECWORKS Users Guide provides a discussion on which method provides the most accurate wear analysis based upon the type of component. The types of "as manufactured" wall thickness variation that can exist should also be considered to assure that effective engineering judgment can be used in calculating a correct wear value. Fabricated components typically have the following "as manufactured" wall thickness variation:

- Elbows -- Thinner at the mid point of the extrados and correspondingly thicker at the intrados.

- Concentric expanders/reducers -- Thinner at the large diameter

- Eccentric expanders/ reducers -- May have wall thickness variation that are not predictable unless the actual manufacturing process is known.

10.1.3 <u>Calculation</u>

Using the wear calculated from the methods and guidelines provided above, the calculated rate of FAC wall thinning (Wr) is determined.

$$Wr = \frac{Wear}{Ot} \quad \text{in/EFPY}$$

- If the wear is determined by the Point-to-Point method then the operating time (O_t) is the time (EFPY) between the two inspection periods. Engineering judgment is essential since in certain cases, the component wear rate may be over predicted due to component manufacturing variations, analytical limitations, or insufficient operating time for accurate point to point wear calculation. In these instances, the cognizant FAC engineer may use a lower wear rate, but only after providing technical justification.

- The predicted thickness at the end of the next operating cycle is to be calculated as follows: (using a safety factor of 1.1 per NUMARC guidelines.)

$$t_{pred} = t_{meas} - 1.1\, W_r O_c \text{ (in)}$$

10.2 Calculation of Code Min Allowable

The intent of the structural evaluation is to assure the structural adequacy of inspected components through the next operating cycle. A specific methodology for the qualification of degraded components has not been mandated by specific code requirement. The approach outlined in the FACPP is intended to be consistent with the requirements of Code Case N-597 and will assure that material stresses remain below code "allowables" by meeting the intent of the original construction code.

10.2.1 Pressure Stress

The minimum code allowable wall thickness ($t_{min\ p}$) based on the design pressure (P) and outside diameter (D_o) and the code allowable stress (S) is calculated as follows:

$$t_{min\ p} = \frac{PD_o}{2(S + 0.4P)}$$

10.2.2 Bending Stress

The minimum allowable wall thickness based on the longitudinal pressure stress plus mechanical bending loads ($t_{min\ b}$) is calculated using the "stress ratio" method which ratios the stress provided from the pipe design analysis which assumes no wear.

If stress analysis for a component is available enter the maximum sustained (Sust) or occasional (Occ) stress as follows:

$$\text{SR}(Sust \text{ or } Occ) = \frac{Stress\ provided}{Allowable\ stress}$$

If stress analysis is not available for the component, the stress ratio is calculated as follows:

$$SR(Sust) = \frac{\frac{PDo}{4t_{nom}} + 5000}{S_h}$$

The maximum Stress Ratio (SR) is equal to the greater of the stress ratio from the sustained and occasional loads.

The minimum required thickness based on pressure plus mechanical bending loading ($t_{min\ b}$) is calculated as follows:

$$t_{min\ b} = t_{nom} \times SR$$

10.2.3 Minimum Acceptable Wall Thickness

The minimum acceptable wall thickness (t_{min}) is equal to the greater of $t_{min\ p}$ or $t_{min\ b}$.

If the predicted thickness previously calculated is greater than t_{min} the component is acceptable and the evaluation is complete. If the predicted thickness is less than t_{min} the component requires repair/replacement or code justification for continued service as specified in the FACPP. A local wall thinning evaluation using the methodology contained in ASME Code Case N-597 or other Code acceptable analysis methodology may be performed to qualify a component that does not meet the requirements above. All components that require replacement or local wall thinning evaluation require a sample expansion in accordance with the FACPP.

10.2.4 Local Wall Thinning Analysis - Code Case N-597

The allowable local wall thickness is determined as a function of the depth and the extent of the affected area at the next RFO based on the appropriate corrosion rate (W_r). NOTE: A UT area profile and thickness scan of the locally thinned area is normally required.

Before proceeding to a local thinning evaluation or a conclusion of repair/replacement, analysis refinements should be investigated which may qualify the component. This may include a refined wear rate calculation or a refined pipe bending stress calculation for determination of stress from sustained loading.

If the local wall thinning evaluation indicates that t_{pred} is less than the local required wall thickness (t_{aloc}), the component is rejected and must be either repaired or replaced.

If t_{pred} is greater than t_{aloc} (as a result of a local thinning evaluation), the component is acceptable for continued service.

10.2.5 Format

Various formats and computer-assisted solutions are acceptable provided that the methodologies are consistent and the required documentation and applicable Quality Assurance requirements are satisfied. Review and acceptance of any final evaluation or calculation by the FAC Engineer, and control of that calculation or evaluation in accordance with the FACPP, assures compliance.

10.3 Sample Expansion

Sample expansion is the process by which additional components are selected for inspection due to the detection of flow accelerated corrosion related wall thinning exceeding specified limits. This instruction defines the process for conducting sample expansion as a result of component UT examinations and evaluation.

All components examined under the IP2 FAC Program shall be within the scope of this instruction. This includes both systems which have and do not have CHECWORKS analyses.

10.3.1 Sample Expansion

As required in the FACPP, sample expansion is required if:

- the minimum measured wall thickness (t_{meas}) is less than 70% of the nominal wall thickness (t_{nom})or;
- the predicted wall thickness (t_{pred}) at the next RFO is less than the calculated minimum acceptable wall thickness (t_{min}).

Sample expansion is only required during the initial examination of a component. Baseline inspections of new components or reinspection of existing components that previously generated a sample expansion do not require sample expansion.

10.3.2 Component Selection

Samples are expanded to include the next two susceptible components in the same line or system and the equivalent components in all parallel trains. Parallel components and the next two susceptible components shall be determined as specified below:

- Determination of Equivalent Components on Parallel Train
  - Parallel trains are identified as functionally similar piping systems that are subjected to nearly identical operating conditions and usage. The lines are typically similar geometrically but not necessarily identical.
  - An equivalent component on a parallel train shall be determined based on the following parameters.
    - Type of component.
    - Proximity to flow disturbing devices.
    - Proximity to flow control valves and other devices which could cause flashing or alter 2-phase flow conditions.
    - Proximity to line termination point in 2-phase systems (e.g., lines approaching the condenser).

- The objective is to identify a component of equivalent FAC susceptibility both in wall thinning rate and predicted life. If no equivalent component is identified, FAC experience judgment shall be utilized to select the closest alternative.

- Expansion within a parallel line to the next most susceptible components in that parallel line is not necessary if the initial parallel train examinations are acceptable and do not require expansions.

- Determination of Next Two Susceptible Components for CHECWORKS Analyzed Systems

  - The next two susceptible components on CHECWORKS analyzed lines shall be from the same set or analysis line from which the initial selections were taken. Susceptibility is based on the predicted time to t_{crit} ranking list in CHECWORKS. Some experience judgment is required based on inspection history and local flow conditions in the line.

- Determination of Next Two Susceptible Components Non-CHECWORKS Analyzed Locations

  - For non-CHECWORKS analyzed systems, the next two most susceptible components are selected for UT examination based on FAC experience using the guidelines provided in Section 8.2.

10.3.3 Historical Inspections

Historical UT data should be evaluated to determine if sufficient UT data exists on the subject line to preclude a sample expansion. The FAC engineer shall review these cases in order to assure that the extent of UT coverage on the subject lines is adequate to represent the most susceptible areas. Should coverage not be adequate, the sample is required to be expanded.

10.3.4 Documentation

Sample expansion is documented on the FACPP form provided and signed by the originator and checker.

10.4 <u>Glossary of Terms</u>

The following is a definition of the terms used in this instruction and the attached structural evaluation forms:

D_o	Outside Diameter
M_A	Deadweight Moment
M_B	Seismic Moment
O_t	Total Effective Full Power Years (EFPY) of Operation (For Point-to-Point Wear this is the time in (EFPY) between the two inspection periods.)
O_c	Estimated Effective Full Power Years (EFPY) of Operation to next RFO.
P	Design Pressure
t_{aloc}	Local Required Wall Thickness
t_{meas}	Minimum Measured Wall Thickness
$t_{min\ p}$	Minimum Required Wall Thickness Based on Pressure Stress
$t_{min\ b}$	Minimum Required Wall Thickness Based on Bending Stresses
t_{min}	Minimum Required Wall Thickness
t_{nom}	Nominal Wall Thickness
t_{pred}	Predicted Wall Thickness
T	Design Temperature
S	Allowable Stress
S_h	Allowable Stress at Temperature
S_{SUST}	Stress Due to Sustained Loads
S_{OCCA}	Stress Due to Occasional Loads
W_{r1}	CHECWORKS Current Wear Rate
W_{r2}	Calculated Rate of Wall Thinning

11.0 MITIGATING AND REMEDIAL ACTIONS

A variety of mitigating measures and remedial actions are available for dealing with FAC problems including:

- Replacement with FAC resistant material
- Design/layout changes to improve flow path geometry
- Modification of water chemistry to minimize factors which promote FAC.

The selection process must include appropriate technical and economic considerations to ensure effective repair or replacement of damaged components and to minimize future FAC problems.

11.1 Replacement with FAC Resistant Material

As discussed earlier, FAC is a problem confined primarily to carbon steel material components. Damage can usually be prevented by replacement with a more FAC resistant material. Chrome-moly or stainless steel can be used to minimize or eliminate FAC . In many cases, it may be necessary to join replacement components to existing, undamaged carbon steel components. Choosing a ferritic steel replacement material simplifies welding and minimizes thermal mismatch problems. Availability of the needed components is likely to be a key factor in determining which of the candidate material to choose.

In evaluating the suitability of a material's FAC resistance, material specification tolerances on chemical composition should be considered. Chrome-moly materials have been installed in power plant piping systems for many years with satisfactory results. Chrome-moly P11, P22 and P5 grade alloy steels have shown good resistance to FAC.

The P11, P22, and P5 material has almost the same mechanical properties as carbon steel. Replacement piping of this material can be installed with the same general geometry and unit weight. Due to similarity of its coefficient of thermal expansion, the thermal stresses and nozzle loadings are not considered to be significant. These materials require special considerations for welding including pre and post-weld heat treatment.

Austenitic steel such as TP304 and TP316 have excellent resistance to FAC. They are readily available and do not require pre and post-weld heat treatment. If austenitic steel is used as a replacement material, susceptibility to chloride stress corrosion cracking should be considered (see Reference 15). Stainless steel also has a larger thermal expansion coefficient, approximately 1.4 times that of carbon steel, which will require piping analysis evaluation and possible support modifications.

Recently, carbon steel piping clad with 304L stainless steel has been made available. The clad is approximately 80 mils thick with the sole purpose of flow accelerated corrosion resistance. The carbon steel is the pressure boundary. This piping weighs approximately the same as carbon steel, so the piping supports do not have to be altered. The coefficient of thermal expansion for the clad piping is approximately the same as carbon steel; therefore, a section of piping can be replaced and connected to the existing piping. In addition, this piping does not require pre and post-weld heat treatment.

When repairing, cladding, or replacing components, wall thickness measurement can be taken to document baseline readings.

11.2 Design/Layout Changes to Improve Flow Path Geometry

During the FAC root cause research investigations conducted by INPO (Reference 1) and EPRI (Reference 11), it became evident that poor piping geometry was one of the major contributing factors in extreme FAC degradation and failure. The benefits of good geometry are twofold, as it not only mitigates degradation due to FAC, but also improves energy flow efficiency at the same time, which is a long-term advantage.

The following is a list of cases where improved flow path geometry may be of benefit:

- Piping configurations where closeness between changes in direction and other discontinuities do not allow turbulence to dissipate. These configurations are expected to have a higher rate of FAC. A length equivalent to 15 pipe diameters will enable flow to stabilize significantly. Reducing the number of closely located fittings shall be considered when major portions of a system are being replaced.

- Short radius elbows are more susceptible to FAC than long radius elbows and long radius elbows are more susceptible than five diameter bends. When replacing short radius elbows damaged by FAC, consider replacing them with long radius elbows or 5D bends if possible.

- Branch connections of 90° generally have a higher FAC rate than bends, elbows, and lateral type connections.

- FAC can be minimized in the areas adjacent to shop and field welds by ensuring the transition area between the two materials is as smooth as possible. For example, permanent backing rings should not be allowed when butt welding.

- Branch connections off the side and bottom of a steam line are expected to contain a higher amount of moisture, and consequently have a higher FAC rate than branch connections located on the top of the run pipe. Branch connections in horizontal pipe runs should be on the top when possible.

- Where wet steam piping is directed down into a vessel with two inlet connections, the second connection is expected to contain a higher moisture content, and consequently a higher FAC rate. Modifying the inlet piping at the second nozzle can create the same moisture separation condition that exists at the first nozzle. One approach would be to extend the horizontal run of pipe at the second nozzle and install an impulse trap (see Reference 11).

- Consider installing a moisture removal device in the system where desirable and assure their proper function.

- When replacing a high velocity system, consider replacing it with a larger pipe diameter, which will reduce the velocity and FAC rate.

11.3 Modify Water Chemistry

Water chemistry changes are attractive in that they offer a means of prolonging the life of existing piping. Dissolved oxygen content and pH have strong effects on the rate of FAC. Increase of oxygen dosing and pH, reduces FAC rate. Increasing oxygen dosing is not recommended due to its adverse impact on steam generator tubing performance. Increasing the pH to a value as high as practical should be considered. EPRI (Reference 11) recommends a pH of 9.3 to 9.6 for secondary systems comprised of all steel materials and a pH of 8.8 to 9.2 for secondary systems containing copper alloy materials.

At Indian Point Unit 2, all Feedwater Heaters have been replaced with stainless steel tubes and all six condenser boxes have been retubed.

12.0 LONG TERM PLANNING

The development of a long-term strategy should focus on reducing the plant flow accelerated corrosion susceptibility. Optimizing the inspection planning process is important, but the reduction of flow accelerated corrosion wear rates is needed if both the number of inspections and the probability of failure are to be reduced.

In order to achieve the long term goals of both reduced cost and increased safety, a strategy which will provide a more systematic reduction of flow accelerated corrosion rates must be adopted. The following three options are available to reduce flow accelerated corrosion wear rates:

- Improvements in materials.
- Improvements in water chemistry.
- Local design changes.

These three options were discussed in detail in the previous section.

Currently, the IP2 long-term strategy is to replace susceptible piping with upgraded or improved materials and to modify the secondary water chemistry. During the 1991 Refueling Outage, "Corronix" piping (carbon steel clad with stainless steel) was tested in a portion of the 26 Extraction line with excellent results. Therefore, the remainder of the 26 Extraction line was replaced with "Corronix" piping during the 1993 Refueling Outage as well as the Feedwater Bypass Lines (four 6" Low Flow Lines). In addition, over 1200 square feet of the Crossunder piping was clad with stainless steel using automatic welding machines during the 1993 and 1995 refueling outages. Additional replacements performed during the 1995 refueling outage are provided in the 1995 RFO summary report.

The Chemistry Department with the help of Nuclear Power Engineering has completed a review to determine the impact of changing the water chemistry, such as raising the pH and changing the amine to ETA. After careful consideration with respect to the Steam Generators and other possible impacts it was decided to adopt the new water chemistry.

Replacements and inspections continued through the 2000 refueling outage. These are reported in the outage summary documents for the 1997 and 2000 refueling outage.

13.0 TRAINING CONSIDERATIONS

An important element of the FAC program is training. Proper training will help plant personnel develop a better understanding of the factors which influence FAC, which will in turn provide the FAC engineer with more useful information. The following topics shall be discussed:

- Factors influencing wall loss
- Examples of pipe failures
- Overview of the FAC program
- Maintenance contributions
- System Engineer contributions
- Operations Department contributions
- Communication

Training should encourage open communication between plant personnel and the FAC engineer. Communication has proven to be the key to a successful FAC program. Given the proper training, the information from plant personnel will be focused and reliable.

The following examples demonstrate the current state of FAC training.

Training courses CT-203 "Corrosion and Corrosion Prevention" and CT-106 "Power Plant Water Chemistry", provide necessary training for Chemistry personnel.

Lesson Plan R-71-C-020 discussed with Operations personnel in 1987 covered the Surry pipe failure event. These case study techniques are used to train Operations and Maintenance personnel.

Con Edison personnel have participated in the EPRI seminars for FAC evaluation, as well as CHECWORKS users training and shall continue to attend the semi-annual CHECWORKS Users Group (CHUG) meetings.

Lesson Plan 9602 EC was given during operator licensing requalification training. The training was performed during cycle 2 of the training and was completed in the first quarter of 1996. The plant operators have successfully completed the objectives of this lesson plan.

As part of Engineering Support Personnel (ESP) continuing training (course no. NTS 9601), an introduction to the Flow Accelerated Corrosion Program was provided.

As part of Maintenance Personnel continuing training (course no. NMM 9602), an introduction to the Flow Accelerated Corrosion Program was provided. The training focused on the methods to recognize the visual characteristics of FAC.

14.0 REFERENCES

The references listed below have been reviewed during the course of this study and have contributed to the preparation and content of this document. Major day-to-day basis or working references are listed in Section 14.1. Historical or background references are listed in Section 14.2. Additional reference material can be found attached or discussed in the Plant and Industry Experience Binders.

1.1 <u>Basis References</u>

A. Updated Final Safety Analysis Report, Section 10.4

B. SE-SQ-12.402, Flow Accelerated Corrosion Program Plan

C. CHECWORKS Flow Accelerated Corrosion Version 1.0F User Guide, TR-103198-P1, Final Report, June 1998.

D. EPRI "Recommendations for an Effective Flow-Accelerated Corrosion Program", NSAC 202L, Revision 2, April 1999.

E. CHUG Position Paper No. 4 "Recommendations for Inspecting Feedwater Heater Shells for Flow Accelerated Corrosion Damage", February 2000.

F. The Code: ANSI/ASME B31.1 "ASME Code for Pressure Piping"

G. The Piping Spec: United Engineers and Constructors Specification 9321-01-248-18, "Specification for Fabrication of Piping Systems".

H. Altran Calculation for Consolidated Edison, Indian Point Unit 2, "Small Bore Erosion/Corrosion Susceptibility Screening," 93192-C-01, Rev. 0, April 1994.

I. QAP 17.309 "Ultrasonic Examination - Thickness Measurements for Flow Accelerated Corrosion and General Erosion and Corrosion".

14.2 Historical References

1. INPO SOER 82-11 "Erosion and Subsequent Failure of Steam Piping Sections", November 17,1982.

2. INPO SOER 23-85 "Water Pipe Wall Erosion Downstream of Flow Restricting Devices", May 16,1985.

3. INPO SER 01-87 "Erosion/Corrosion Induced Failure of Main Feedwater Pump Suction Piping", January 7, 1987.

4. INPO SOER 87-3 "Pipe Failures in High Energy Systems Due to Erosion/Corrosion", March 20, 1987.

5. NRC Information Notice No. 86-106 "Feedwater Line Break", December 16, 1986.

6. NRC Information Notice No. 86-106, Supplement 1 "Feedwater Line Break", February 13, 1987.

7. NRC Information Notice No. 86-106, Supplement 2 "Feedwater Line Break", March 18,1987.

8. NRC Information Notice No. 86-106, Supplement 3 "Feedwater Line Break", November 10, 1988.

9. NRC Information Notice No. 82-22 "Failure in Turbine Exhaust Lines", July 9, 1982.

10. NRC Bulletin No. 87-01 "Thinning of Pipe Walls in Nuclear Power Plants", July 9, 1987.

11. EPRI NP-3944 "Erosion/Corrosion in Nuclear Plant Steam Piping: Causes and Inspection Program Guidelines", April 1985.

12. EPRI Report "Practical Considerations for the Repair of Piping Systems Damaged by Erosion/Corrosion", October 5, 1987.

13. EPRI Report "Single-Phase Erosion/Corrosion of Carbon Steel Piping", February 19, 1987.

14. Heat Balance (Stretch Power) for Con Edison Indian Point Unit 2 Station, Engineering Sketch No. 559-100-052491.

15. Reg. Guide 1.36 "Non-Metallic Thermal Insulation of Austenitic Stainless Steel".

16. Con Edison Indian Point Unit 2 Report for 3" Rupture Drain Line to 26C Feedwater Heater, April 3, 1987.

17. Selman (Con Edison) to Russell (NRC) "Response to NRC Bulletin No. 87-1", September 11, 1987.

18. Ebasco Study "Technical Report Erosion/Corrosion Study in Select BOP Systems", August 1987.

19. (moved)

20. Con Edison internal memo from Mullin to Curry "1987 Refueling Outage High Energy Piping Inspection Summary Report", April 14, 1988.

21. EPRI NP-5911M "Acceptance Criteria for Structural Evaluation of Erosion/Corrosion Thinning in Carbon Steel Piping", April 1988.

22. Central Electricity Research Board Notice No. RD/L/N 197/80 "Erosion/Corrosion: The Calculation of Mass Transfer Coefficients", November 12, 1980.

23. Central Electricity Research Board Paper TPRD/L/2349/N82 "Thermal-Hydraulic Effects on Mass-Transfer Behavior and on Erosion/Corrosion Metal Loss Rates", January 1983.

24. Central Electricity Research Board Paper TPRD/3114/R87 "Erosion/Corrosion in PWR Secondary Circuits", March 1985.

25. NRC Information Notice No. 87-36 "Significant Unexpected Erosion of Feedwater Lines", August 4, 1987.

26. NRC Information Notice No. 88-14 "Summary of Responses to NRC Bulletin 87-01", April 22, 1988.

27. INPO SER 41-82 "Erosion of Steam Piping and Resulting Failure", July 15,1982.

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29. E. Kunze and J. Novak "Erosion/Corrosion in a Wet Steam Loop", Werksoffe and Korrosion 33, pp 14-24, 1982.

30. M.J. Moore and C.H. Sieverding "Two-Phase Steam Flow in Turbines and Separators", Hemisphere Publishing Corporation, 1976.

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32. I.S.Woolsey, G.J. Bignold, C.M. De Whalley, and E.K. Garbett "The Influence of Oxygen and Hydrazine on the Erosion/Corrosion Behavior and Electrochemical Potentials of Carbon Steel Under Boiler Feedwater Conditions", C.E.G.B., Central Electricity Research Laboratories, U.K.

33. (moved)

34. Westinghouse Steam System Manual for Series 44 Steam Generators.

35. EPRI NP-6066 "Utility Response to NRC Bulletin 87-01, "Thinning of Pipe Walls in Nuclear Power Plants", October 1988.

36. (moved)

37. (moved)

38. ASME Code Case N-480.

39. (moved)

40. EPRI, *Flow Accelerated Corrosion in Power Plants*, TR-106611, 1996

41. USNRC "Erosion / Corrosion-Induced Pipe Wall Thinning in U.S. Nuclear Power Plants", NUREG-1344, April 1989.

Appendix I

Index of Isometric Sketches

SK-	Rev	P&ID	Prefix	Title
1	C	2020	3 EX A	EXTRACTION STM FROM LP TURBINE TO FWHTR 23A
2	D	2020	3 EX B	EXTRACTION STM FROM LP TURBINE TO FWHTR 23B
3	C	2020	3 EX C	EXTRACTION STM FROM LP TURBINE TO FWHTR 23C
4	C	2020	4 EX A	EXTRACTION STM FROM LP TURBINE TO FWHTR 24A
5	D	2020	4 EX B	EXTRACTION STM FROM LP TURBINE TO FWHTR 24B
6	D	2020	4 EX C	EXTRACTION STM FROM LP TURBINE TO FWHTR 24C
7	C	2020	5 EX	EXTRACTION STM FROM SEPAR TK TO FWHTRS 25 A,B,C
7A	B	A2282272	MOPS	PRESEPERATOR TANK VENT TO 25 A,B,C FWHTRS
8	D	2020	6 EX	EXTRACTION STM FROM HP TURBINE TO FWHTR 26 A,B,C
9	D	2020	5 EX D	DRAINS FROM FWHTRS 25 A,B,C TO HTR DRN TK
10	N/A	N/A	N/A	NOT USED
11	N/A	N/A	N/A	NOT USED
12	D	2020	6 EX D	DRAINS FROM FWHTRS 25 A,B,C TO HTR DRN TK
13	N/A	N/A	N/A	NOT USED
14	N/A	N/A	N/A	NOT USED
15	C	2020	5 EX V	VENTS FROM HTR DRAIN TANK TO FWHTRS 25 A,B,C
16	N/A	N/A	N/A	NOT USED
17	N/A	N/A	N/A	NOT USED
18	C	2020	5 EX C	DRAINS FROM HTR DRAIN TANK TO COND 21,22,23
19	C	2020	5 EX C	HTR DRN FROM HTR DRM TK TO PUMPS & RECIRC LINES
20	D	2020	HD	HTR DRAIN DISCHARGE FROM PUMPS TO FW HEADER
21A	C	A235304	4 EX D	DRAIN FROM HTR 24A TO 23A & DRAIN TO CONDENSER 23
21B	C	A235304	4 EX D	DRAIN FROM HTR 24A TO 23A & DRAIN TO CONDENSER 23
22A	C	A235304	4 EX D	DRAIN FROM HTR 24B TO 23B & DRAIN TO CONDENSER 22
22B	C	A235304	4 EX D	DRAIN FROM HTR 24B TO 23B & DRAIN TO CONDENSER 22
23A	C	A235304	4 EX D	DRAIN FROM HTR 24C TO 23C & DRAIN TO CONDENSER 21
23B	C	A235304	4 EX D	DRAIN FROM HTR 24C TO 23C & DRAIN TO CONDENSER 21
24A	B	A235304	3 EX D	DRAIN FROM HTR 23A TO 22A & DRAIN TO CONDENSER 23
24B	C	A235304	3 EX D	DRAIN FROM HTR 23A TO 22A & DRAIN TO CONDENSER 23
25A	B	A235304	3 EX D	DRAIN FROM HTR 23B TO 22B & DRAIN TO CONDENSER 22
25B	C	A235304	3 EX D	DRAIN FROM HTR 23B TO 22B & DRAIN TO CONDENSER 22
26A	B	A235304	3 EX D	DRAIN FROM HTR 23C TO 22C & DRAIN TO CONDENSER 21
26B	C	A235304	3 EX D	DRAIN FROM HTR 23C TO 22C & DRAIN TO CONDENSER 21
27	C	2023	1A	DRAINS FROM MOISTURE SEPERATOR 21A TO MSDT 21A
28	C	2023	2A	DRAINS FROM MOISTURE SEPERATOR 22A TO MSDT 22A
29	C	2023	3A	DRAINS FROM MOISTURE SEPERATOR 23A TO MSDT 23A
30	C	2023	1B	DRAINS FROM MOISTURE SEPERATOR 21B TO MSDT 21B
31	C	2023	2B	DRAINS FROM MOISTURE SEPERATOR 22B TO MSDT 22B
32	C	2023	3B	DRAINS FROM MOISTURE SEPERATOR 23B TO MSDT 23B
33A	C	2023	1A	MSDT 21A TO HTR DRAIN TK & DRAIN COLLECTOR TK
33B	C	2023	1A	MSDT 21A TO HTR DRAIN TK & DRAIN COLLECTOR TK
34A	C	2023	2A	MSDT 22A TO HTR DRAIN TK & DRAIN COLLECTOR TK
34B	C	2023	2A	MSDT 22A TO HTR DRAIN TK & DRAIN COLLECTOR TK
35A	C	2023	3A	MSDT 23A TO HTR DRAIN TK & DRAIN COLLECTOR TK
35B	C	2023	3A	MSDT 23A TO HTR DRAIN TK & DRAIN COLLECTOR TK
36A	C	2023	1B	MSDT 21B TO HTR DRAIN TK & DRAIN COLLECTOR TK
36B	C	2023	1B	MSDT 21B TO HTR DRAIN TK & DRAIN COLLECTOR TK
37A	C	2023	2B	MSDT 22B TO HTR DRAIN TK & DRAIN COLLECTOR TK

SK	Rev	P&ID	Prefix	Title
37B	C	2023	2B	MSDT 22B TO HTR DRAIN TK & DRAIN COLLECTOR TK
38A	C	2023	3B	MSDT 23B TO HTR DRAIN TK & DRAIN COLLECTOR TK
38B	D	2023	3B	MSDT 23B TO HTR DRAIN TK & DRAIN COLLECTOR TK
39	B	2023	MS-1A	MSRHTR 21A DRN TO & VENT FROM RHTR DRN TK 21A
40	B	2023	MS-2A	MSRHTR 22A DRN TO & VENT FROM RHTR DRN TK 22A
41	B	2023	MS-3A	MSRHTR 23A DRN TO & VENT FROM RHTR DRN TK 23A
42	B	2023	MS-1B	MSRHTR 21B DRN TO & VENT FROM RHTR DRN TK 21B
43	B	2023	MS-2B	MSRHTR 22B DRN TO & VENT FROM RHTR DRN TK 22B
44	B	2023	MS-3B	MSRHTR 23B DRN TO & VENT FROM RHTR DRN TK 23B
45A	C	2023	MS-1A	DR FROM RHTR DR TK 21A TO FWHTR 26 & BYPAS TO COND
45B	B	2023	MS-1A	DR FROM RHTR DR TK 21A TO FWHTR 26 & BYPAS TO COND
45C	B	2023	MS-1A	DR FROM RHTR DR TK 21A TO FWHTR 26 & BYPAS TO COND
45D	B	2023	MS-1A	DR FROM RHTR DR TK 21A TO FWHTR 26 & BYPAS TO COND
46A	C	2023	MS-2A	MSR DR FROM RDT 22A TO FWHTR 26A,B,C & BYPAS
46B	C	2023	MS-2A	MSR DR FROM RDT 22A TO FWHTR 26A,B,C & BYPAS
47	B	2023	MS-3A	MSR DR FROM RDT 23A TO FWHTR 26A,B,C & BYPAS
48A	B	2023	MS-1B	MSR DR FROM RDT 21B TO FWHTR 26A,B,C & BYPAS
48B	C	2023	MS-1B	MSR DR FROM RDT 21B TO FWHTR 26A,B,C & BYPAS
49A	C	2023	MS-2B	MSR DR FROM RDT 22B TO FWHTR 26A,B,C & BYPAS
49B	B	2023	MS-2B	MSR DR FROM RDT 22B TO FWHTR 26A,B,C & BYPAS
49C	C	2023	MS-2B	MSR DR FROM RDT 22B TO FWHTR 26A,B,C & BYPAS
50A	C	2023	MS-3B	MSR DR FROM RDT 23B TO FWHTR 26A,B,C & BYPAS
50B	C	2023	MS-3B	MSR DR FROM RDT 23B TO FWHTR 26A,B,C & BYPAS
50C	C	2023	MS-3B	MSR DR FROM RDT 23B TO FWHTR 26A,B,C & BYPAS
51	C	2729	MS-46	SG BLOWDN FROM CONTAIN PEN TO FLASH TANK (MS-46)
52	C	2729	MS-45	SG BLOWDN FROM CONTAIN PEN TO FLASH TANK (MS-45)
53	C	2729	MS-47	SG BLOWDN FROM CONTAIN PEN TO FLASH TANK (MS-47)
54	C	2729	MS-48	SG BLOWDN FROM CONTAIN PEN TO FLASH TANK (MS-48)
55	B	2729	BD3	SECONDARY BLOWDN FROM UNIT 2 TO UNIT 1 BLWDN TK
56	C	A235308	5EX	MAINSTM FROM PRESEPARTRS A&C TO MSR 21A,22A,23A
57	C	A235308	5EX	MAINSTM FROM PRESEPARTRS B&D TO MSR 21B,22B,23B
58	N/A	N/A	N/A	NOT USED
59	N/A	N/A	N/A	NOT USED
60	N/A	N/A	N/A	NOT USED
61	N/A	N/A	N/A	NOT USED
62	N/A	N/A	N/A	NOT USED
63	N/A	N/A	N/A	NOT USED
64	N/A	N/A	N/A	NOT USED
65A	C	A209847	VCD	MSR 21A TO HP HTR 26 CONTROL SECT LINE 827
65B	B	A209847	VCD	MSR 21A TO HP HTR 26 CONTROL SECT LINE 827
66A	B	A209847	VCD	MSR 22A TO HP HTR 26 CONTROL SECT LINE 828
66B	B	A209847	VCD	MSR 22A TO HP HTR 26 CONTROL SECT LINE 828
67A	C	A209847	VCD	MSR 23A TO HP HTR 26 CONTROL SECT LINE 829
67B	C	A209847	VCD	MSR 23A TO HP HTR 26 CONTROL SECT LINE 829
68A	C	A209847	VCD	MSR 21B TO HP HTR 26 CONTROL SECT LINE 818
68B	C	A209847	VCD	MSR 21B TO HP HTR 26 CONTROL SECT LINE 818
69A	C	A209847	VCD	MSR 22B TO HP HTR 26 CONTROL SECT LINE 819
69B	C	A209847	VCD	MSR 22B TO HP HTR 26 CONTROL SECT LINE 819
70A	C	A209847	VCD	MSR 23B TO HP HTR 26 CONTROL SECT LINE 820
70B	B	A209847	VCD	MSR 23B TO HP HTR 26 CONTROL SECT LINE 820
71	B	2019	BFD	BOILER FEED PUMP 21 DISCHARGE TO HEADER
72	B	2019	BFD	BOILER FEED PUMP 21 DISCHARGE TO HEADER

SK	Rev	P&ID	Prefix	Title
73	C	2019	BFD	BLR FEED PUMPS DISCHARGE HDR TO HP HTRS 26A,B,C
74	C	2019	BFD	FDWTR FROM HP HTRS 26A,B,C TO HTR DISCHARGE HDR
75	C	2019	BFD	FDWTR FROM HP HTRS 26 OUTLET HDR TO CONT PEN E
76	C	2019	BFD	FDWTR FROM HP HTRS 26 OUTLET HDR TO CONT PEN F
77	C	2019	BFD	FDWTR FROM HP HTRS 26 OUTLET HDR TO CONT PEN G
78	C	2019	BFD	FDWTR FROM HP HTRS 26 OUTLET HDR TO CONT PEN H
79A	C	2024	3 EX-TELO	FROM BF PUMP TRB 21,22 TO MAIN TRB GLAND STM COND
79B	B	2024	3 EX-TELO	FROM BF PUMP TRB 21,22 TO MAIN TRB GLAND STM COND
80	B	A235307	CD	COND SUPPLY PIPING FROM HTRS 23A,B,C TO 24A,B,C
81	B	A235307	CD	COND SUPPLY PIPING FROM HTRS 24A,B,C TO 25A,B,C
82	C	A235307	CD	COND SUPPLY PIPING FROM HTRS 25A,B,C TO BFP SCT HDR
83	C	A235307	CD	BFP SCT HDR & FROM SCT HDR TO BFP 21
84	C	A235307	CD	BF PUMP SUCTION HDR TO BF PUMP 22
85	C	2018	GCD	GLAND STEAM COND FROM FCV-1113 TO COND 22 & 23
86	B	A209775	UH	AUX COND RETURN FROM UN1 DEART TO UN3 DEARATOR
87	B	2041	MST	MS TRAP DRAIN HDR TO DR COLLECTION TK
88	B	2041	MST	MS TRAP DRAIN HDR FROM COLUMN 20 TO COLUMN 15
89	C	2041	MST	MS TRAP DRAIN HDR TO COLUMN 20
90	C	2031	EST	EXTRACTION STEAM DRAIN HEADER
91	B	2031	EST	EXTRACTION STEAM DRAIN HEADER
92	C	2019	BFD	BOILER FEED FROM PENETRATION F TO STM GEN #22
93	B	2019	BFD	BOILER FEED FROM PENETRATION F TO STM GEN #21
94	B	2019	BFD	BOILER FEED FROM PENETRATION F TO STM GEN #23
95	B	2019	BFD	BOILER FEED FROM PENETRATION F TO STM GEN #24
96	N/A	N/A	N/A	NOT USED
97	N/A	N/A	N/A	NOT USED
98	N/A	N/A	N/A	NOT USED
200	A	A227780	200	MAIN STEAM DUMPS TO CONDENSER- PCV-1122,23
201	A	A227780	201	MAIN STEAM DUMPS TO CONDENSER- PCV-1126,27
202	A	A227780	202	MAIN STEAM DUMPS TO CONDENSER- PCV-1130,31
203	A	A227780	203	MAIN STEAM DUMPS TO CONDENSER- PCV-1124,25
204	A	A227780	204	MAIN STEAM DUMPS TO CONDENSER- PCV-1128,29
205	A	A235304	205	HEATER DRAIN TANK HIGH LEVEL DUMP TO CONDENSER
206	A	A227780	206	MAIN STEAM DUMPS TO CONDENSER- PCV-1120,21
207	A	2022	207	CONDENSATE INJECTION TO HTR DRAIN PUMP SUCTION
208	A	A235304	208	FDWTR HTR 21A,B,C NORM LV & HIGH LV DRN TO COND
209	A	A235304	209	FDWTR HTR 22A,B,C NORM LV & HIGH LV DRN TO COND
210	A	2042	210	MAIN STEAM TRAPS DRAIN TO DISCHARGE TUNNEL
211	A	A209847	211	REHEAT STEAM CONTROL LEAKOFF TO COND 21
212	A	A235304	212	FDWTR HTR 21A,B,C HIGH LV DUMPS TO COND
213	A	2019	213	BOILER FDWTR RECIRC DWNSTRM OF FLOW CONTROL
214	A	A209847	214	REHEAT STEAM CONTROL LEAKOFF TO COND 21
215	A	2024	215	BOILER FP TURBINE CYLINDER DRN TO BFTDT & 3" VENT
216	A	2042	216	MAIN STEAM TRAP HEADER
217	A	A227780	217	CROSSUNDER DUMP LINE TO CONDENSER 21(W)
218	A	A227780	218	CROSSUNDER DUMP LINE TO CONDENSER 21(E)
219	A	A227780	219	CROSSUNDER DUMP LINE TO CONDENSER 21(E)
220	A	A227780	220	CROSSUNDER DUMP LINE TO CONDENSER 21(E)
221	A	A235304	221	HEATER 21A VENT TO CONDENSER
222	A	A235304	222	HEATER 21A VENT TO CONDENSER
223	A	A235304	223	HEATER 21A VENT TO CONDENSER
224	A	A235304	224	HEATER 22A,B,C DUMPS TO CONDENSER

SK	Rev	P&ID	Prefix	Title
225	A	A227780	225	CROSSUNDER DUMP TO CONDENSER 23(W)
226	A	A227780	226	CROSSUNDER DUMP TO CONDENSER 22(W)
227	A	A235308	227	CROSSUNDER DRAIN LINE TO HEATER DRAIN TANK
228	A	A209847	228	REHEATER STEAM CONTROL LEAKOFF TO COND 21
229	A	A235304	229	HEATER 22C VENT TO CONDENSER
230	A	2018	230	3" GLAND STEAM CONDENSER DRAIN TO CONDENSER
231	A	2023	231	MS DRAIN TANK 21B VENT TO MS 21B
232	A	2018	232	CROSSUNDER DRAIN TAP TO HEATER DRAIN TANK
233	A	2018	233	DC TANK TO CONDENSER
234	A	A235304	234	HEATER 22B DRAIN TO 21B
235	A	A235308	235	#3 STOP VALVE LEAKOFF (TO COND 23)
236	A	A235308	236	FCV TO COND 23 (E)
237	A	A235308	237	FCV TO COND 23 (W)
238	A	A235304	238	HEATER 23C VENT TO HEADER
239	A	A235304	239	HEATER 23B VENT TO HEADER
240	A	A235304	240	HEATER 23A VENT TO HEADER
241	A	A235308	241	CROSSUNDER DRAIN TANK TO HEATER DRAIN TANK
242	A	A235304	242	FWH 23A DRN TO FWH 22A
243	A	A235304	243	FWH 23B DRN TO FWH 22B
244	A	A235304	244	FWH 23C DRN TO FWH 22C
245	A	2019	245	SG CHEM FEED LINES 21,22,23,24
246	A	A235304	246	HTR 22B VENT TO CONDENSER
247	A	A235304	247	FWH 21B VENT TO CONDENSER
248	A	A227780	248	MS SUPPLY TO 22 BFPT
249	A	A228272	249	SEPERATING TANK B DRN TO HTR DRN TANK
250	A	A227780	250	HP CYLINDER STEAM HEATING (OFF 21 SG SUPPLY)
251	A	A227780	251	MS SUPPLY TO REHEATERS
252	A	A227780	252	MS SUPPLY TO SJAE
253	A	2729	253	BLOWDOWN TANK DRAIN LINE
254	A	A235308	254	MS STOP VALVE BYPASS NO. 1 & 2 BYPASS
255	A	A227780	255	HP CYLINDER STEAM HEATING (WEST SIDE)
256	A	2729	256	BLOWDOWN LINE 48 INSIDE CONTAINMENT
257	A	2017	257	MS SUPPLY TO AUX FW TURBINE
258	A	B237145	258	GLAND STEAM RETURN HP TURBINE EXIT NOZZLE
259	A	A235308	259	MS STOP VALVE BYPASS NO. 3 & 4 BYPASS
260	A	2017	260	MS ATMOSPHERIC DUMP
261	A	2018	261	CST SUPPLY TO CONDENSER
262	A	2024	262	GLAND STEAM SUPPLY TO BFPT
263	A	A235308	263	GLAND SEAL STEAM SUPPLY & REG VALVE BYPASS
264	A	A227780	264	CONDENSATE DRAIN LINE MS SUPPLY TO REHEATER
265	A	A227780	265	CONDENSATE DRAIN – MS SUPPLY TO REHEATER
266	A	A227780	266	CONDENSATE DRAIN – MS SUPPLY TO REHEATER
267	A	B237145	267	LOW PRESSURE CV STEM LEAKOFF
268	B	A227780	268	CONDENSATE DRAIN MAIN STEAM SUPPLY TO REHEATER
269	B	A227780	269	CONDENSATE DRAIN MAIN STEAM SUPPLY TO REHEATER
270	B	A227780	270	CONDENSATE DRAIN MAIN STEAM SUPPLY TO REHEATER
271	B	A228272	271	SEPERATOR TANK A TO HEATER DRAIN TANK
272	B	A235308	272	TAKEOFF FROM PROCESS LINE
273	B	A209847	MS	MSR #22B VCD DUMP TO CONDENSER 21
274	B	A235304	4EX	FEEDWATER HEATER 24A VENT PIPING
275	B	A235308	MS	#1 STOP VALVE LEAKOFF RETURN TO CONDENSER 23
276	B	2022	5EX	FEEDWATER HEATER 25A VENT PIPING

SK	Rev	P&ID	Prefix	Title
277	B	2022	5EX	FDWTR HTR 25A,B,C VENT PIPING TO CONDENSER 23
278	B	2022	6EX	FEEDWATER HEATER 26A VENT PIPING
279	B	2120	AF	AUX BOILER FEEDWATER SUPPLY
280	B	2120	AS	AUX STEAM LINE FROM BOILER
281	B	A209775	UH	AUX STEAM CONDENSATE RECEIVER 22 RETURN LINE
282	B	A209775	UH	UNIT HEATER SUPPLY AUX STM EAST SIDE TURBINE HALL
283	B	A209775	UH	AUX STM SUPPLY TO UNIT HDRS WEST SIDE OF TRBN HALL
284	B	A209775	SB	AUX STEAM TO UNIT HEATER SUPPLY

Appendix II

SPECIFICATION OF SUPPORT WORK

1.0 RESPONSIBILITY

1.1 As stated in Section 3.0, the Manager, Maintenance Department (or other designated PMA), or his designee is responsible for:

- Repair or replacement of the components identified by Plant Engineering.
- Preparation of support work, including permits, required lighting, scaffolding, removal of insulation, cleaning of fitting surfaces, and restoration of insulation.

2.0 SCAFFOLDING

2.1 Scaffolding shall be constructed for inspection areas as needed. Areas requiring scaffolding shall be identified in the listing of locations to be inspected.

3.0 INSULATION

3.1 Insulation shall be removed from the areas to be inspected as identified below:

3.1.1 ELBOWS – Remove elbow insulation and at least three pipe diameters from each side of elbow inspection locations (minimum eight inches).

3.1.2 STRAIGHT PIPE – Remove all insulation for a distance at least three pipe diameters downstream from the upstream component (minimum eight inches).

3.1.3 TEE – Remove tee insulation and at least three pipe diameters on each of three tee legs (minimum eight inches).

3.1.4 EXPANDER/REDUCER – Remove expander/reducer insulation and at least three pipe diameters from each side of inspection location (minimum eight inches).

3.1.5 END CAP – Remove cap insulation and at lest three pipe diameters from each end cap weld connection (minimum eight inches).

NOTE: Scaffolding erection and insulation removal, in some cases, need not be completed for all locations before proceeding to ultrasonic thickness testing.

Appendix III

Plant Specific History

Indian Point Unit 2 has experienced fifteen failures attributed to flow accelerated corrosion in High Energy Piping since 1987.

The first event occurred on the afternoon of April 3, 1987. The reactor was operating at 100% power. Average coolant temperature was 549°F and pressurizer level was 25%. The Unit was generating 860 MWe. At 12:30 P.M., a 3" break occurred in a 6" spool piece approximately 10" downstream of the 26C level control valve. At the time of the event, operators were preparing to place 22 heater drain tank pump in service. The suction and discharge valves had been open and operators were racking in the electrical breaker when the drain line from 26C feedwater heater to the heater drain tank developed a 3" diameter fishmouth break. The leak was isolated in approximately 30 minutes. The Unit was de-rated 2% reactor power.

The failure was attributed to erosion/corrosion which was amplified by the piping configuration, the throttling which occurred downstream of the level control valve. The metallurgical analysis from the Chemical section determined that the wrong material was installed for this application. The material installed was plain carbon steel; the proper material was chrome-moly steel. The spool piece was installed during the 26 feedwater heater replacement modification in 1984. See SAO-132 Report 87-12 for details.

The second event occurred on the evening of November 7, 1987. The Unit was shutdown for a Refueling Outage. At 5:00 P.M., an 18" elbow failed during the hydrostatic test of 25A feedwater heater. A new feedwater heater was installed on October 14, 1987. According to procedure, the heater was hydrostatically tested to 375 psig. Approximately 2 minutes into the hydro, the 18" elbow 5EX-1 failed in the 10 o'clock position looking south to north. Ultrasonic thickness measurements were taken in the vicinity and were approximately 0.09 inches. the failure was attributed to erosion/corrosion. Elbow 5EX-1 was replaced during the 1987 Outage. See Con Edison Memorandum November 16, 1987 from Pete Skulte to Samuel Rothstein for details.

The third event occurred on the evening of March 5, 1989. The reactor was operating at 100% power. Average coolant system temperature was 549°F and the reactor coolant system pressure was 2235 psig. The pressurizer level was 25%. The Unit was generating 910 MWe. At 7:45 P.M., a 6" elbow (3B-1) upstream of check valve 5EX-29-6 failed in the 9 o'clock position looking south to north. The failure was on 6" elbow 3B-1 on 23B MSR drain line to the heater drain tank; it was approximately 1" long in the vertical direction. The Unit reduced load to approximately 350 MWe.

On March 7, 1989, Leak Repair Inc. put a clamp around the elbow and pumped it with ferminite to stop the leak. The Unit was brought back to 100% power at 11:30 A.M.. See SOR 89-128 for details.

During the 1989 Refueling Outage, the clamp was removed and elbow 3B-1 was cut out. The ferminite clamp caused the elbow to fishmouth rupture inward, because the wall thickness in the vicinity of the failure was approximately 0.05 inches. A new elbow was installed during the 1989 outage.

The fourth event occurred on the afternoon of July 1, 1989. The Unit was at 547°F, hot shutdown. performing physics testing coming back from a Refueling Outage. A 4" 45° elbow (MST-17) failed in the 10 o'clock position looking south to north. The failure was on 4" elbow MST-17 on the Main Steam Trap Header to the Drains Collection Tank; it is located in the Turbine-Generator Building west side, northeast of 22 MBFP at approximately 31' elevation. A temporary weld repair was made shortly after the failure. On or about July 25, 1989, MST-17 failed in the 3 o'clock and 9 o'clock positions looking south to north. Leak Repair, Inc installed a temporary clamp on July 28, 1989.

The fifth event occurred on the morning of September 26, 1989 at 10:45 A.M.. The Unit was at 100% power and 905 MWe gross generation. A 4" 45° elbow (MST-18) failed in the 3 o'clock position looking south to north. The failure was on 4" 45° elbow MST-18 on the Main Steam Trap Header to the Drains collection Tank; it is located in the Turbine-Generator Building west side, northeast of 22 MBFP at approximately 31' elevation about 1' upstream of the previous temporary repair. At the time of the event, MS-95 (Main Steam Trap Drain Stop) was closed due to the air leakage test taking place. This caused the line to pressurize rupturing MST-18 fitting.

The sixth event occurred on July 13, 1990. The Unit was being started up after the Mid-Cycle Outage. A 27.5" cross-under pipe to 21A MSR failed in an area approximately 0.25" by 0.25". This failure occurred on the north side of the pipe approximately 9" above the expansion joint area and approximately 8" below the elbow weld. Inside the pipe in the vicinity of the failure, there exists a link (see Drawing # B227139). This link is welded to the inner wall of the pipe. The purpose of the link is to prevent axial movement. Ultrasonic Thickness readings were taken in a 1" grid pattern around the failure for 6" in each direction. The nominal wall thickness is 0.5". The UT readings were approximately nominal; the lowest reading was 0.331" (see QA Inspection Report # 90-IR-130). The minimum wall thickness by B31.1 is 0.22" and by Central Engineering is 0.30". At 10:00 P.M. on July 27,1990, the Unit was shutdown. A temporary repair was performed under NP -90-50799 using MP-11.61 and Safety Evaluation 90-227-TR. The temporary repair consisted of welding a 4" by 4", curved, 27.5" I.D. plate 0.5" thick to the 27.5" O.D. pipe in the area of the failure. The repair began at 2:00 A.M. and was completed at 3:00 A.M. on July 28, 1990. This pipe will be permanently repaired during the 1991 Refueling Outage.

The seventh event occurred on January 18, 1991. The Unit was at 96.3 % power and 985 MWe. An elbow on the main steam trap header developed a pinhole leak. The elbow was located in the Turbine-Generator Building 15' elevation, in the overhead near MCC 24. An elbow clamp was installed and injected with sealant to stop the leak under work order NP-91-53008. A permanent repair was performed under NP-91-53075, which replaced the elbow during the 1991 Refueling Outage.

The eighth event occurred on November 1, 1991. The Unit was at 99.2% and 985 MWe. A leak was discovered at the saddle vent hole of the southeast crossunder drip pot. This is located on the 33' elevation of the Turbine-Generator Building under the HP Turbine. The leak at the vent hole indicates a weld leak at the 32" crossunder pipe to 8" drip pot weld. A temporary repair was performed under work order NP-91-56614 to stop the leak. A permanent repair will be performed under work order NP-91-57034.

The ninth event occurred on February 27, 1992. The Unit was at 100% power and 998 MWe. A leak was observed at the thermowell weld to the 32" crossunder. The leak was located on the northwest lead on the 33' elevation of the Turbine-Generator Building under the HP Turbine. A temporary repair was performed under work order NP-92-58760 to stop the leak and a permanent repair was performed under NP-92-58953.

The tenth event occurred on July 27, 1993. The Unit was at 100 % power and 928 MWe. A leak was observed at the crossunder northeast lead at the toe of the weld on the west expansion joint. The leak was located on the northeast lead on the east side of the expansion joint at the 6 o'clock position on the 33' elevation of the Turbine-Generator Building under the HP Turbine. A temporary repair was performed under work order NP-93-65837 to stop the leak and a permanent repair will be performed under NP-93-66083.

The eleventh event occurred on December 3, 1993. The Unit was at 100 % power and 990 MWe. A leak was observed at the crossunder northeast lead at the weld-o-let for the temperature probe. The leak was located on the northwest lead on the weld-o-let at the 9 o'clock position looking north on the 33' elevation of the Turbine-Generator Building under the HP Turbine. A temporary repair was performed under work order NP-93-68461 to stop the leak and a permanent repair will be performed under NP-93-6.

The twelfth event occurred on December 8, 1993 and December 9, 1993. The Unit was at 100 % power and 990 MWe. An elbow on the main steam trap header developed a pinhole leak on December 8. The elbow was located in the Turbine-Generator Building 15' elevation, in the overhead near MCC 24. On December 9, 1993 at approximately 10:30 A.M., the main steam trap header was aligned from the drains collection tank to the river in order to trouble shoot for air leakage. A main steam trap header rupture occurred during the valving process back to the drains collection tank. This valving process was not in accordance with an accepted operating procedure. The rupture occurred adjacent to the pinhole leak on the 90 degree socket weld elbow. The rupture was approximately 1.5 " in length and approximately 0.5" in width starting at the 9 o'clock position. An elbow clamp was installed and injected with sealant to stop the leak under work order NP-93-68461. A permanent repair will be performed under NP-93-68549, which will replace the elbow during the 1995 Refueling Outage. For further information on this event, see Equipment Analysis Report 93-644 and SOR # 93-644.

The thirteenth event occurred on approximately 8/8/95, a small amount of steam was noted leaking from the crossunder piping tee to 23A MSR on the West side of Turbine Hall. After reviewing 95 RFO inspection data, it was noted that this area was well within its nominal value range for pipe wall thickness on the 26 2@ ID pipe. The larger portion of the tee 46 2" ID pipe was stainless steel weld clad during the past refueling outage and was not considered as susceptible to a leak. After the unit was decreased in power on 8/11/95, the asbestos insulation was removed around the weld of the branch connection tee to determine the location of the leak. The UT results revealed that there was no major wall thinning around the pinhole leak located on the 26 2" pipe just above the toe of the weld (in the heat affected zone) facing due west. Expanding the UT examination further from the leak, a thinned area about 1" x 1" was detected approximately 3" away from the pinhole leak. The thinned 1" x 1" area had a low wall thickness reading of approximately .175" with the average reading about .2" thick. The entire branch tee connection was abated of asbestos insulation and a detailed UT analysis was performed using a conservative 1" grid size to ensure pipe integrity. Another thinned area was discovered symmetrically from the previously thinned area and was approximately 1" x 1" in size. The thinned areas are most likely caused by flow discontinuity by the turning vanes.

An engineered clamp to cover both the thinned areas and the pinhole steam leak were installed under work order NP-95-79535. The follow up corrective action to prevent reoccurrence of this event include an immediate inspection of three location areas with similar pipe configuration (See OIR 95-08-0777 and 95-08-779). This will ensure this local thinning area and pinhole are an isolated case. The long term corrective action will examine the repair options available, such as, replacing the affected section of pipe, internal weld repair, or an external weld repair. Each of the options will be technically reviewed and an acceptable engineered solution will be implemented. The permanent repair will be completed during the 1997 RFO under work order NP-95-79781.

The fourteenth event occurred at 4:40am on 12/13/95, a steam leak occurred on 26A FWH in the vicinity of the FWH extraction steam nozzle. The steam line was isolated and there were no personnel injuries. After the insulation was removed, an inspection determined the leak was on the extraction steam nozzle in the heat affected zone of the weld (nozzle to saddle on the FWH shell)on the south side. At 12:15pm the unit was manually taken off the line as a safety precaution to ensure the other FWHs could be safely isolated and inspected for similar damage. The insulation was removed around all the 26 and 25 FWH nozzles and a UT inspection was performed. The results were reviewed and showed no major wall thinning in these locations and in the area of the upstream elbow weld, except for 26B FWH. 26B FWH had a thinned area similar to 26A FWH. The 26C FWH had a nozzle greater than 1.1" thick and showed minimal flow accelerated corrosion as compared to 26A and B FWHs. The 26A and 26B FWH nozzles were replaced with a thicker nozzle clad with stainless steel in the counterbore region by work orders NP-95-81746 and NP-95-81776, respectively.

The following corrective action to prevent recurrence of this event included an immediate inspection of 18 location areas with a similar pipe configuration. In addition to this initial inspection list an immediate in depth review of our flow accelerated corrosion program was performed, and an evaluation all of our systems susceptible to FAC was conducted. An inspection plan was developed and UT inspections were performed during the PORV(interim 13) outage (2/96). In addition to the aforementioned corrective actions, Indian Point notified the industry of this event via the INPO Network (OE 7609), EPRI=s CHUG Bulletin board, and our sister plant IP3 immediately upon identification. Con Edison is taking action to improve its FAC program at Indian Point 2 (see 1996 Nuclear Power Goals III.A.1.k.1-8) to ensure this wall

thinning is an isolated case. See SAO-132A report 95-32 and Altran Technical Report 96119-TR-01 for a detailed root cause analysis and the corrective actions required.
The fifteenth event occurred on December 18, 1995. A 90 degree elbow (MST-39) on the main steam trap header developed a leak. The elbow was located in the Auxiliary Feedwater Building 50' elevation, near the stairwell. A permanent repair was performed under NP-95-81865, which replaced the elbow during the 1996 PORV Outage.

1996 - No FAC events identified.

1997 - No FAC events identified.

1998 - No FAC events identified.

1999 - No FAC events identified.

2000 (to date) - No FAC events identified.

The lack of event occurrences is attributable to a monumental amount of time spent offline during this period. Also, the inspection and mitigation efforts have made an impact.

Appendix IV

Additional Work for Component Cooling Water

The Component Cooling Water system has a 200 degF design temperature. This does not constitute high energy piping according to Section 7. Therefore, this system was originally excluded from inspection. However, Westinghouse performed a study to assist Indian Point Unit #2 in increasing the design basis inlet temperature of the Service Water System. As a result of this study, Con Edison submitted to the NRC on July 13, 1990 an "Application for License Amendment to Increase the Design Basis Inlet Temperature of the Service Water System". In this submittal, WE committed to monitor the 8" supply and return piping to the Spent Fuel Heat Exchanger and the 10" Component cooling Water Pump discharge piping. The CCW areas to be inspected were the result of the Westinghouse recommendations contained in the "Ultimate Heatsink Project" WCAP 12312 pages 5-10, 5-11 and 6-1. Additional material on this subject are located in the "E/C Basis Documents and Supporting Information", Volume 2 (i.e. Sketch SK-96, SK-97, SK-98 and Table T-96).

Appendix V

Status and Planning Aides

1. Update Files

   A. Hard Copy Files

   B. Susceptibility Drawings

   C. Isometric Drawings

   D. FACPP/FACPPS

   E. Plant and Industry Experience

1. Cycle Milestones

1. Outage Preparation and Implementation

1. Inspection History and Plan

1. Replacement History and Plan

1.A Update Files - Hard Copy Files

- The hard copy files are maintained in a file cabinet on 72' elevation TSC.
- The hard copy files do not contain documents of the type that are considered as Plant Records. These files are information only type files.
- The files are divided in two main sections: "Historical through 1996" and "Historical since 1996". In both of these sections, the files are in SKETCH NUMBER ORDER.
- The files "Historical through 1996" contain copies of UT data as a minimum. This UT data have been entered in CHECWORKS and are controlled in CHECWORKS.
- The files "Historical since 1996" follow the latest file organization and control pattern. Stapled to the left side of the individual file is the copy of the UT data, the UT calibration and a photograph (normal minimum information). Stapled to the right side are copies of the evaluations. The originals of these evaluations are carefully indexed and sent to Iron Mountain. A list of BATCH numbers is maintained to allow retrieval of the Plant Records. The UT data from these files have been entered in CHECWORKS and are controlled in CHECWORKS.
- Normally, the files are prepared and ready to be filed at the end of the outage. The FACPE/FACPM signs the original evaluation in accordance with the FACPP. Then copies of the evaluation are stapled to the right side of the individual folder. All forms supplementary to the structural evaluation, such as sample expansion or component reinforcement, are attached behind the structural evaluation. A single evaluation number, consisting of the Cycle Number followed by the Component ID, applies to all the evaluations connected to a single structural evaluation.
- Each folder can contain more than one component. Where there are more than one, they are normally contiguous components captured in a single UT effort.

I.B Update Files - Susceptibility Drawings

- Susceptibility Drawings are controlled by the FACPP.
- The drawings are marked-up P&ID type drawings which show the areas of susceptible/ non-susceptible piping.
- The revision of the actual P&ID is not critical and should be a revision current at the time of mark-up.
- Mark-up normally occurs after a refueling outage to show any change in the boundary brought about by pipe replacement or for any other reason.

- A stamp is normally applied to the markup showing the person responsible for the change and the mark-up revision number.

- The FACPP has an attachment which is required to be updated by the FACPE showing the latest mark-up revision number of the drawing.

- Therefore, the latest mark-up revision number is controlled by this process.

1.C - Update Files - Isometric Sketches

- The Isometric Sketches used for the FAC Program are controlled through the FACPPS, Appendix I, where the current revision of the sketch is listed.

- Isometric sketches are information-type documents used to assist in planning and execution of NDE.

- It is important to remember that the sketches are ACAD sketches and currently they can not be viewed on the NT machines. Windows 95/98 can view and edit the sketches. One copy of the drawings is in the C drive of a Windows machine. They are also copied on disks.

- Isometrics are updated after a refueling outage. Sketches developed during a refueling outage are normally presented in an outage summary. These hand sketches must be translated into ACAD by an ACAD expert. Also, sketches may be marked up during an outage and presented directly to the FACPE for update.

1.D - Update Files - FACPP/FACPPS

- The FACPP is a site procedure and is revised in accordance with site procedure requirements.

- The FACPPS is a supplementary reference document and can be changed by the FACPE as needed.

1.E - Update Files - Plant and Industry Experience

- Plant and Industry Experience Forms are managed in accordance with the FACPP.

- Weld Leaks are also captured in the same Binder as the P&IE forms.

2 - Cycle Milestones

- End of Refueling Outage
    - Ensure update of Hard Copy Files
    - Ensure original evaluations to Records (Iron Mountain) and obtain batch numbers
    - Ensure update of Isometric Sketches
    - Ensure update of Susceptibility Drawings.

- Initiate Effort to produce the following plans for the next refueling outage
    - CHECWORKS Analysis
    - Large Bore Non-CHECWORKS Review
    - Small Bore Review
    - Trending of UT Data
    - Closed and Low Usage Boundary Valve Review
    - Master Inspection List (preliminary - based on the above five documents)

- Establish a Specification to have each identified point inspected.
    - Discussion - in this respect, the "specification" is an informal document that ensures that all parties to the effort are aware of the plan.
    - In the recent past, the primary parties to the inspection effort are Quality Assurance, Construction, and the FACPM.
    - Quality Assurance is responsible for the procedure that is used to perform the UT inspections. Also, Quality Assurance has been funding and managing the contract resources to perform the inspections. Therefore, this funding is not controlled by the FACPM although the FACPM will be contacted for input.
    - Construction has been organizing the effort to construct and remove scaffold. This effort is funded to Construction from Outage Management. The FACPM will be required to submit scaffold requests for each inspection. The FACPM will be asked by Outage Management to estimate the funding needed for this effort.
    - Construction has been organizing the effort to remove and reinstall insulation. This effort is funded to Construction from Outage Management. The FACPM to submit lists of inspection points with each point designated as Bare Pipe, Pad, or Possible ACM.
    - The FACPM initiates a Work Order to accomplish the inspections. In the past, basically one work order is used for all inspections. See work order 99-11332 as an example.

- Establish a Specification to implement any pipe replacement (mitigation) effort.
    - Discussion - in this respect, the "specification" is an informal document that ensures that all parties to the effort are aware of the plan.

- At some point when the preliminary Master Inspection List is being reviewed, the piping with the most overall damage - the pipe which could benefit the most from replacement - should be easily identifiable. This identified pipe should coincide with the Planned Replacement schedule (see following "Replacement History/Plan").
- The FACPM determines from the available information the best replacement plan.
- The FACPM normally discusses this plan with Design Engineering in order to REVISE the PIPING SPECIFICATION 9321-01-248-18 to allow the replacement to proceed using FAC resistant material. Alternately, the FACPM could submit an Engineering Services Request (ESR or RES) to obtain a modification or DOE/MSAP to replace the pipe independent from a piping specification change allowance.
- Con Edison maintains an OPEN Project Number 01813-88 to capture, budget and plan all changes under this program. If the Piping Specification change method of pipe replacement is used then there is NO Modification and NO ROI. The replacement is done simply as a Maintenance-type work order.
- As an example, in November, 1999, revision 12 to the Piping Specification was issued which allowed the use of Stainless Steel replacement piping for the 25 Extraction Steam line. This pipe was changed to SS during the 2000 Refueling Outage under Project 01813-88.
- The FACPM develops and issues a specification to Construction at least 10 months prior to the outage. This specification must contain a parts list developed in conjunction with the Construction Planner and Design Engineering so that long-lead pipe and fittings can be ordered. This specification must contain a set of marked-up drawings so the Construction Planner and Estimator will know the extent of replacement and can estimate scaffold, insulation, and other needs. Remember to include Fittings and Flanges in the Piping Specification Change. Normally, valves are not changed.

- Plant and Industry Experience Update

  - Investigate Industry Reports of problems which could impact the FAC program.
  - Investigate steam leaks and seat leakage on or near susceptible systems to determine if problems could impact the FAC program.
  - Maintain the Plant and Industry Experience with the results of the above evaluations.
  - Ensure that significant issues are brought out in the Condition Reporting system for upper management awareness or additional resolution.

- 10 month prior to outage checklist

  - FACPP, Attachment 7.1 list of current susceptibility drawings is up to date ________
  - FACPP, CHECWORKS contains all latest data CHECWORKS Analysis reviewed _____
  - FACPP, Large Bore NON-CHECWORKS Review is complete_______
  - FACPP, Small Bore Review is complete _________
  - FACPP, Trending of UT data is complete_________
  - FACPP, the Trouble Report evaluation for the Closed and Low Usage Boundary Valves is complete__________
  - The Closed and Low Usage Boundary Valve Review is complete________
  - FACPP, Plant and Industry Experience Binder up to date _________

- FACPP, Master Inspection List (preliminary) is complete _________
- FACPP, Structural and other evaluations from previous outage have been controlled and originals sent to RMC_______
- FACPP, The Isometric Sketches up to date_______
- FACPP, The hard copy files up to date_______
- The Inspection Specification issued to Quality Assurance and Construction or alternate PMA. Each MIL inspection point identified by Isometric and Pipe Plan drawing. Preliminary discussions with these groups complete and outage obstacles identified if any. __________
- The Replacement Specification issued to Construction or alternate PMA. Each replacement identified by Isometric and Pipe Plan drawings. Preliminary discussions complete and outage obstacles identified if any________
- Changes to Piping Specification being pursued by Design Engineering or alternate modification being pursued by Design Engineering_________
- Estimate for Replacement complete____________
- Parts for Replacement on order_________
- No obstacles identified with FUNDING from Quality Assurance, Outage Management, or with Project 01813-88 for the upcoming outage________
- Preliminary work on identification of outage facilities started.
  - Trailer for Inspection Personnel (QA)________
  - Trailer for Engineering Personnel (Usually with Inspection personnel)_______
  - Camera to record inspections____________
  - Printer to print pictures and evaluations for files________
  - Computers that can work ACAD (Windows 95/98) for Isometrics________
  - Computers that can work MathCad for evaluations_________
  - Telephones_________

- Final Outage Checklist

  - Operations meeting scheduled to update any changes to how the plant is operated which could impact the susceptibility drawings and change the MIL_______
  - MIL is Final________
  - Parts are ON-SITE or CLOSE_______
  - Outage Management appoints a Project Manager for the Inspection effort_______
  - Outage Management appoints a Project Manager for the Replacement effort_______
  - Facilities arranged for Engineering and Inspection personnel________
  - Plans are finalized to arrange as much PRE-OUTAGE work as possible - Erecting Scaffold, Removing Insulation and including possible Pipe Replacement_________
  - Plans are finalized and coordinated through Outage Management_________

END Cycle Milestones -

3 - Inspection History / Plan

Flow Accelerated Corrosion (FAC) Program Inspections

Historical FAC Inspections - Planned Number of Inspections

Outage	Number of Inspections
1986	9
1987	125
1989	197
1991	190
1993	450
1995	550
1996	100
1997	356
2000	117

Note that the number of planned inspections indicates one inspection for each MIL designated inspection point. In reality, each MIL designated point normally results in the inspection of several nearby components. In 1997, the actual final number of inspected components was 825 and in 2000 the final total number of inspected components was 244.

The number of MIL designated components decreases based on the number and extent of mitigation (pipe replacement) efforts and the number of previous inspections. The number of MIL designated inspections for 2002 is expected to be approximately 80.

4 - Replacement History / Plan

Wet Steam Project Work Scopes
Historical and Future Planned Piping Replacements

This document presents an overview of the Wet Steam Project both historically and as a long-term planning guide and is an update of the list dated February 1, 1997 (Wet Steam Scope Original.doc). The listing has been reviewed to verify that identified major replacements coincide with the current revisions of the Large and Small Bore Screening Drawings which are updated after each refueling outage.

RFO	Piping Description	Pipe Size	Pipe Length	New Material	Drawing
1993	26 Extraction Line	18" 12"	200 ft 100 ft	CS clad w/SS	9321-F-2020
	Feedwater Bypass	6"	200 ft	CS clad w/SS	9321-F-2019
1995	21A MSR Drain	8" 6"	20 ft 160 ft	CS clad w/SS	9321-F-2023
	22A MSR Drain	8" 6"	20 ft 160 ft	CS clad w/SS	9321-F-2023
	23A MSR Drain	8" 6"	20 ft 160 ft	CS clad w/SS	9321-F-2023
	23B MSR Drain	8" 6"	20 ft 320 ft	CS clad w/SS	9321-F-2023
	East Main Steam Trap	2"	140 ft	Chrome-Moly	9321-F-2042
Note 1	26 FWH Operating Vent	2"	160 ft	Chrome-Moly	9321-F-2022
Note 1	25 FWH Operating Vent	1.5"	160 ft	Chrome-Moly	9321-F-2022
Note 1	24 FWH Operating Vent	2"	160 ft	Chrome-Moly	235304
1997	Main Steam Trap Note 2	6" 4" 3"	60 ft 220 ft 260 ft	Stainless Steel	9321-F-2041 9321-F-2042
	25 FWH Ext Inlet Lines	18"	40 ft	Stainless Steel	9321-F-2020
	MOPS A&B to 25 FWH	20"	40 ft	Stainless Steel	228272
	21B MSR Drain	8" 6"	20 ft 320 ft	Stainless Steel	9321-F-2023
	22B MSR Drain	8" 6"	20 ft 320 ft	Stainless Steel	9321-F-2023
	Extraction Steam Trap Note 3	6" 4"	60 ft 220 ft	Stainless Steel	9321-F-2031
	26 FWH – Short sections after RHTR Drain LCV's	6" 4"	10 ft 10 ft	Stainless Steel	9321-F-2023
	Cross-Under Piping Note 4	-	-	CS Clad w/SS	235308 227780

RFO	Piping Description	Pipe Size	Pipe Length	New Material	Drawing
2000 Note 5	MSR Vent Chamber Drain (VCD) Piping	3"	1700 ft	Stainless Steel	209847
	25 FWHExt Steam	28" 18"	115 ft 15 ft	Stainless Steel	9321-F-2020
	Reducers at PCV-1161 for 23 FWHExt Steam	28" x 24"	10 ft	Stainless Steel	9321-F-2020
	22 FWH Operating Vents	2.5"	80 ft	Stainless Steel	235304
	HDT to Cond at LCV's	14" 10"	8 ft 16 ft	Stainless Steel	235304
2002	Reheater Drains to 26 FWH's after LCV's	8" 6"	80 ft 200 ft	Stainless Steel	9321-F-2023
	23A FWHExt Steam	28" 20"	220 ft 60 ft	Stainless Steel	9321-F-2020
2004	23B FWHExt Steam	28" 20"	220 ft 60 ft	Stainless Steel	9321-F-2020
	23 FWH Operating Vent	2"	160 ft	Stainless Steel	235304
	Misc. Steam Traps	1"	750 ft	Stainless Steel	9321-F-2041
2006	23C FWHExt Steam	28" 20"	220 ft 60 ft	Stainless Steel	9321-F-2020
	Misc. Steam Traps	1"	750 ft	Stainless Steel	9321-F-2041

Note 1: Identified discrepancy between Screening Drawings, calculations and original list. Lines were replaced, drawings require update.
Note 2: Original list identified 8" Main Steam Trap lines. Drawings do not indicate this work was done. Will be added to Miscellaneous Steam Traps in 2004, 2006.
Note 3: Original list identified 8" Extraction Steam Trap lines. Drawings do not indicate this work was done. Will be added to Miscellaneous Steam Traps in 2004, 2006.
Note 4: Added completion of Cross-Under piping SS weld overlay to 1997 work accomplished.
Note 5: Planned Replacements for 2000 RFO changes: added VCD lines, 22 FWH operating vents and HDT to Condensers D/S LCV's. Moved up portion of 23 Extraction Steam from later outages. Deferred work on 26 FWH Reheater drain lines based on 1997 UT examination evaluations. All Planned replacements for the 2000 RFO were completed.