NUCLEAR GENERATION SITE UNITS 2 AND 3 EFFECTIVE DATEJUL 0 9 1987

.

# STEAM EXTRACTION LINE EROSION

### MONITORING PROGRAM

# TABLE OF CONTENTS

SECTI	ON	PAGE	
1.0	OBJECTIVE(S)	2	
2.0	REFERENCE(S)	2	
3.0	PREREQUISITE(S)	2	
4.0	PRECAUTION(S)	.3	
5.0	CHECKLIST(S)	3	
6.0	<pre>PROCEDURE(S) 6.1 Surveillance Scope 6.2 Surveillance Frequency 6.3 Surveillance Method 6.4 Nondestructive Examination (NDE) 6.5 Evaluation of NDE Data Evaluation for Repair or Replacement</pre>	3 3 4 5 5 6	
7.0	RECORD(S)	7	
ΑΤΤΑΟ	HMENTS 1 Surveillance Areas 2 Surveillance Isometric Drawings 3 Examination Areas	3 3 3 4 5 5 5 8 7 7 8 11 35	

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### STEAM EXTRACTION LINE EROSION MONITORING PROGRAM

### 1.0 OBJECTIVE

1.1 This procedure defines the periodic surveillance requirements for monitoring steam line erosion at San Onofre Nuclear Generating Station, Units 2 and 3. The program details those lines, and the locations on the selected lines which are to be inspected, the frequency of the surveillances required, and the criteria for determining if repairs or replacements are required.

#### 2.0 REFERENCES

- 2.1 Other
  - 2.1.1 Institute of Nuclear Power Operations (INPO) Significant Event Report (SER) 41-82
  - 2.1.2 INPO Significant Operating Experience Report (SOER) 82-11
  - 2.1.3 "Tackling Erosion Corrosion in Nuclear Steam Generating Plants," Nuclear Engineering International Magazine, June 1981
  - 2.1.4 Institute of Nuclear Power Operations Significant Operating Experience Report 87-3, dated March 20, 1987.
  - 2.1.5 Electric Power Research Institute Report NP-3944, <u>Erosion/Corrosion in Nuclear Plant Steam Piping:</u> <u>Causes and Inspection Program Guidelines</u>, dated April 1985.

### 3.0 PREREQUISITES

- 3.1 Prior to use of a user-controlled (pink) copy of this Procedure, it is the user's responsibility to verify that the revision and any TCNs are current by utilizing one of the following methods:
  - 3.1.1 Check it against a controlled copy and any TCNs;
  - 3.1.2 Access an SCE Document Configuration System (SDCS);
  - 3.1.3 Contact CDM by telephone or through counter inquiry;
  - 3.1.4 Obtain a user-controlled (pink) copy of this procedure from CDM;
  - 3.1.5 Reference a current (within one week) Destination Configuration Control Log and associated daily update.

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#### 4.0 PRECAUTIONS

- 4.1 The person or persons conducting work under this procedure must take the necessary steps to protect themselves from contact with any piping, valves, heaters or other components from which thermal insulation has been removed as severe burns may result. Should steam or high pressure water leakage be detected, immediately leave the area and notify the Control Room.
- 5.0 CHECKLIST

5.1 None

- 6.0 PROCEDURE
  - 6.1 Surveillance Scope
    - 6.1.1 Identification of Lines and Areas to be Inspected
      - .1 The extraction steam lines to the first, second and fourth point heaters, and the bleed steam line from the first point extraction line to the Moisture Separator Reheater will be inspected. A total of 106 areas (i.e., c bends, tees, reducers and areas downstream of control valves, check valves, and flow orifices) per Unit will be inspected. The line numbers are listed in Attachment: 1. The points on these lines to be inspected are identified in Attachment 2.
      - .2 For <u>bends</u>, the entire area of the bend will be inspected. For <u>tees</u>, an area the length of two pipe diameters on each side of the tee will be inspected. An area three pipe diameters in length will be inspected downstream of <u>reducers</u>, <u>control valves</u>, <u>check valves</u>, and <u>flow orifices</u> whereever possible.

# 6.1.2 Basis for Selection

.1 Experience in the erosion surveillance program of several nuclear utilities (Reference 2.1.3) indicates that erosion occurs almost exclusively in the high pressure extraction lines with little or no erosion in the low pressure extraction lines.

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In accordance with reference 2.1.4, this program was revised to include additional areas susceptible to erosion corrosion. These areas included downstream of control valves, check valves and flow orifices in accordance with the recommendations of references 2.1.4 and 2.1.5.

#### 6.0 PROCEDURE (Continued)

- 6.1.3 Calculating Erosion Susceptibility
  - .1 Two calculational methods are used to identify the lines most susceptible to erosion. The first is the correlation between steam velocity and moisture content. The second is the product of pressure, velocity and moisture content (PVX). For carbon-steel lines with a moisture content greater than 5% and a velocity greater than 150 ft/sec or with a PVX product of greater than 1.0 x 10<sup>5</sup>, erosion can be expected.
  - .2 The first point extraction lines, the bleed steam lines and the second point extraction lines all have calculated PVX products of over 1.0 x 10<sup>5</sup> and have moisture contents of over 5% although only the second point extraction lines have a calculated steam velocity of 150 ft/sec. This, in connection with what was learned from other plants, gives a clear indication that erosion should be expected in these lines.
  - .3 Experience in other plants has also shown that erosion is far more likely to occur at the second of two consecutive bends than at a single bend following a straight run of pipe.
- 6.1.4 For the above reasons and the man hours required for inspecting the large number of bends in each line, not all bends will be surveyed at each inspection interval.
  - .1 If significant amounts of erosion are seen in the bends inspected, then all remaining bends in the line will be added to the Erosion Surveillance<sup>o</sup> Program.
- 6.1.5 The fourth point extraction lines have a calculated PVX of under  $1.0 \times 10^5$  and a moisture content of under 5%, but have a calculated steam velocity of over 150 ft/sec.
  - .1 Although no significant erosion may be expected in <u>low</u> pressure extraction lines, and the calculated PVX value is low, <u>two points in each line determined to be the</u> most susceptible to erosion will be inspected. This is due to the high steam velocity (181 ft/sec) and the relatively high moisture content (3.9%).
    - .2 If any significant erosion is monitored, other bends in the lines will be added to the program.

# 6.2 Surveillance Frequency

Surveillances will be performed every refueling outage for all inspection points. Due to the nonlinearity of erosion rates, additional inspections may be performed between refuelings for areas showing erosion in previous inspections.

#### 6.0 PROCEDURE (Continued)

6.2.1 If, after a review of data, it can be determined that no erosion is occurring at some inspection locations, the determination may be made to decrease the frequency of inspection at these points.

#### 6.3 Surveillance Method

- 6.3.1 Piping wall thickness shall be measured using longitudinal wave ("straight beam") ultrasonic techniques. Digital ultrasonic thickness gauges, calibrated "A-scan" instruments, or the equivalent, may be used.
- 6.3.2 A rectilinear scan pattern shall be used to examine the entire area of concern, as shown in Attachment 3.
  - .1 Scanning over circumferential welds should be avoided since grinding of the weld surface would be required in most cases.
  - .2 Scanning should be performed in such a manner as to identify localized thinning of the wall from the inside surface.
  - .3 The ultrasonic test report shall record the exact location and actual wall thickness found over the scan area at each inspection point.
  - .4 Special rotation shall be made for areas of localized thinning in order to monitor potential further degradation of wall thickness.
- 6.3.3 Areas where "straight beam" UT indicates wall thinning shall be evaluated using other techniques such as "angle beam" UT examination or radiography since the presence of laminar inclusions in the piping parent material can give spurious indications of erosion.

# 6.4 Nondestructive Examination (NDE)

6.4.1 Monitoring of steam extraction lines in accordance with this procedure shall be performed using nondestructive examination (NDE) methods and techniques in accordance with procedures which have been approved by a Southern California Edison Level III in the applicable NDE method.

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6.4.2 The personnel performing the nondestructive examinations shall demonstrate their proficiency to the satisfaction of a Southern California Edison Level III. Surveillance of the work by the Level III is sufficient to satisfy this requirement.

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### 6.0 PROCEDURE (Continued)

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- 6.4.3 Ultrasonic and/or radiographic examination methods may be used to determine the wall thickness in piping systems at the locations selected.
- 6.4.4 The Radiographic method shall not be used as the primary examination method for piping having a Nominal Pipe Size greater than 8.

# 6.5 Evaluation of NDE Data/Evaluation for Repair or Replacement

- 6.5.1 When an area is identified on a pipe or fitting which is below the minimum wall thickness specified for that size schedule, it shall be subject to engineering evaluation.
- 6.5.2 The engineering evaluation shall consist of three parts: (1) determination of the minimum design wall thickness. (2) estimation of the material loss rate and (3)estimation of the remaining service life of the pipe segment or fitting.
- The minimum design wall thickness shall be calculated in 6.5.3 accordance with the edition and addenda of American National Standard (ANSI) B31.1, Power Piping, applicable to the installation of the pipe or fitting. Later editions and/or addenda of ANSI B31.1 may be used.
- The material loss rate shall be estimated based on 6.5.4 previous examination (thickness measurement) results, or if previous examination results are not available, may be calculated using methods such as those described in reference 2.1.9.

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- The remaining service life shall be defined as that 6.5.5 period of time during which, based on the material loss rate of 6.5.4, the pipe or fitting shall remain at or above the minimum design wall thickness calculated in 6.5.3, plus 5 percent. The 5 percent factor is a margin of safety added to compensate for, any inaccuracies in the NDE measurements.
- 6.5.6 The pipe or fitting shall not remain in service beyond its remaining service life as determined in 6.5.5. unless the material loss rate is shown by subsequent examination to be less than originally estimated.
  - Where the material loss rate is shown by a single subsequent examination to be less than that estimated in 6.5.5, subsequent examinations shall be performed to compensate for inaccuracies in the NDE measurements. The number and frequency of the subsequent examinations shall be determined on a case-by-case basis by the engineer cognizant of this program with the concurrence of an SCE Level III in the applicable examination method.

# 6.0 PROCEDURE (Continued)

6.5.7 Where the pipe segment is replaced or repaired, 6.2.4, 6.5.6 and 6.5.6.1 above do not apply.

# 7.0 RECORDS

7.1 Copies of all examination results generated under this procedure shall be maintained in CDM for the life of the applicable Unit.

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# SURVEILLANCE AREAS

Line No.	Description
1301 ML 041	1st Pt. Htr. Extraction Line
1301 ML 042	lst Pt. Htr. Extraction Line
1301 ML 043	2nd Pt. Htr. Extraction Line
1301 ML 044	2nd Pt. Htr. Extraction Line
1301 ML 287	Bleed Steam from the 1st Pt. Htr. Ext. line to MSR E-113
1301 ML 318 1301 ML 319 1301 ML 320	Bleed Steam from 1301ML287 to MSR E-113
1301 ML 288	Bleed Steam from the 1st Pt. Htr. Ext. line to MSR E-112
1301 ML 326 1301 ML 327 1301 ML 328	Bleed Steam from 1301ML288 to MSR E-112
1301 ML 095	Connection between cross under piping and 1301 ML 043
1301 ML 104	Connection between cross under piping and 1301 ML 044
1301 ML 047	4th Pt. Htr. Extraction Line
1301 ML 048	4th Pt. Htr. Extraction Line

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O&M SUPPORT	PROCEDURE	S023-	-X\	/11-	-4
REVISION 2		PAGE	9	0F	36
ATTACHMENT	1				

System 1301		Nominal Wall	Manufacturers Mini Wall	Calculated Design t <sub>min</sub>				
Line No.	Schedule	(inches)	(inches)	(inches)				
041-36"-R-KK1	-	-	.722	.565				
-18"-	40	. 562	. 492	.314				
042-18"-R-KK1	40	. 562	. 492	.314				
287-20"-R-KK1	40	. 594	. 520	.341				
-12"-	40	. 406	.355	.240				
- 6"-	40	. 280	.245	.154				
288-12"-R-KK1	40	. 406	. 355	.240				
- 6"-	40	. 280	. 245	. 154				
318- 6"-R-KK1	40	. 280	.245	. 154				
319- 6"- <del>R-</del> KK1	40	. 280	. 245	. 154				
320- 6"-R-KK1	40	. 280	. 245	. 154				
326- 6"-R-KK1	40	. 280	.245	.154				
327- 6"-R-KK1	40	. 280	. 245	. 154				
328- 6"-R-KK1	40	. 280	.245	.154				
043-24"-R-KK2	Std.	. 375	. 328	.200				
-20**-	Std.	. 375	. 328	.177				
044-24"-R-KK2	Std.		. 328	.200				
-20 <sup>m</sup> -	Std.	·.375	.328	.177				
047-36"-R-LL1	Std.	. 375	. 328	.084*				
048-36"-R-LL1	Std.	. 375	. 328	.084*				
104-20"-R-KK2	Std.	. 375	. 328	.177				
095-20 <sup>#</sup> -R-KK2	Std.	. 375	. 328	.177				

.150 inches will be used for the repair/replacement criteria to ensure adequate protection against damage from external forces.

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PAGE 2 OF 3

#### Areas for Surveillance

The following areas as numbered on the attached marked up isometric drawings (Attachment 2) will be inspected in the Erosion Surveillance Program.

The configuration of these lines are mirror images for Units 2 and 3. For this reason, marked up isometrics for Unit 2 only have been attached. The same areas for Unit 3 will be inspected.

<u>    Li</u>	ne l	10.					Area	<u>a s</u>												<u> </u>
1301	ML	041	-	01,	02,	03,	04,	05,	11,	13,	14,	15,	16							
1301	ML	042	-	01,	02,	04,	05,	08,	10,	12,	13,	14								
1301	ML	043	-	01,	02,	03.	04,	* 07	, 10	, 11	, 13	14.	, 15							
1301	ML	044	-	01,	02,	03,	05,	07,	08,	11,	12,	14,	15							
1301	ML	287	-	01,	03,	04,	05,	09,	11,	13,	14,	15,	<u>16</u> ,	18,	20,	21,	22,	23,	24,	25
1301	ML	318	-	02,	04,	0 <del>5</del>														
1301	ML	319	-	02,	01,	04														
1301	ML	320	-	02,	01,	04														•
1301	ML	288	-	01,	02,	04,	09,	11,	13,	14,	15,	16,	18,	20,	21,	22,	23,	24,	25	
1301	ML	326	-	02,	05,	06														
1301	ML	327	-	02,	01,	04								a .						
1301	ML	328	-	02,	01,	04					·				••					
1301	ML	0 <del>95</del>	-	01,	02,	03														
1301	ML	104	-	01,	02,	03														
1301	ML	047	-	03,	02,	07,	08							*						
1301	ML	048	-	03,	02,	07,	08													

 This inspection point is shown on the extension of line 043 found on 1301 ML 095 (page 30 of 35). K-

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O&M SUPPORT PROCEDURE SO23-XVII-4 REVISION 2 PAGE 11 OF 36 ATTACHMENT 2

HP TURBINE K-001, SYS 1301 1 ST POINT HEATER E-037 SYS 1301 S2-1301-ML-041-36-R-KKI



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ATTACHMENT 2

PAGE 1 OF 24

O&M SUPPORT PROCEDURE SO23-XVII-4 REVISION 2 PAGE 12 OF 36 ATTACHMENT 2

HP TURBINE K-001, SYS 1301 1 ST POINT HEATER E-037 SYS 1301 S2-1301-(ST)-041-18"-R-KK1- (32C\*)



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# ATTACHMENT 2

PAGE 2 OF 24

O&M SUPPORT PROCEDURE SO23-XVII-4 REVISION 2 PAGE 13 OF 36 ATTACHMENT 2

LINE 041 HP TURBINE KO01, SYS 1301 1 ST POINT HEAT(S) E-036 SYS 1301 S2-1301-(ST)-ML-042-18"-R-KK1 (32C\*)



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ATTACHMENT 2

PAGE 3 OF 24

O&M SUPPORT PROCEDURE SO23-XVII-4 REVISION 2 PAGE 14 OF 36 ATTACHMENT 2

LINE 041 HP TURBINE KOO1, SYS 1301 1 ST POINT HEAT(S) E-036 SYS 1301 S2-1301-(ST)-ML-042-18"-R-KK1- (32C\*)



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ATTACHMENT 2

U&M SUPPORT PROCEDURE SO23-XVII-4 REVISION 2 PAGE 15 OF 36 ATTACHMENT 2

COLD REHEAT STEAM HDRS, SYS 1301 2ND POINT HEATER E038 SYS 1301 S2-1301-ML-043-20"-R-KK2



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PAGE 5 OF 24

O&M SUPPORT PROCEDURE SO23-XVII-4 REVISION 2 PAGE 16 OF 36 ATTACHMENT 2

COLD REHEAT STEAM HDRS, SYS 1301 2ND POINT HEATER E038 SYS 1301 S2-1301-ML-043-20"-R-KK2



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ATTACHMENT 2 PAGE 6 OF 24

O&M SUPPORT PROCEDURE SO23-XVII-4 REVISION 2 PAGE 17 OF 36 ATTACHMENT 2

COLD REHEAT STEAM HDRS, SYS 1301 2ND POINT HEATER E039 SYS 1301 S2-1301-ML-044-20"-R-KK2



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ATTACHMENT 2 PA

PAGE 7 OF 24

O&M SUPPORT PROCEDURE SO23-XVII-4 REVISION 2 PAGE 18 OF 36 ATTACHMENT 2

COLD REHEAT STEAM HDRS, SYS 1301 2ND POINT HEATER E039 SYS 1301 S2-1301-ML-044-20"-R-KK2



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PAGE 8 OF 24

O&M SUPPORT PROCEDURE SO23-XVII-4 REVISION 2 PAGE 19 OF 36 ATTACHMENT 2

LINE 041 M/S SUP HDR TURBINE KO01, SYS 1301 MOISTURE SEPARATOR (W) E113 SYS 1301 S2-1301-(ST)-ML-287-12"-R-KK1 (32C\*)



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ATTACHMENT 2

PAGE 9 OF 24

O&M SUPPORT PROCEDURE SO23-XVII-4 REVISION 2 PAGE 20 OF 36 ATTACHMENT 2

LINE 041 M/S SUP HDR TURBINE KO01, SYS 1301 MOISTURE SEPARATOR W HEAT E113 SYS 1301 S2-1301-ML-287-12"-R-KK1



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LINE 041 M/S SUP HDR TURBINE KOO1, SYS 1301 MOISTURE SEPARATOR W HEAT E113 SYS 1301 S2-1301-ML-287-6"-R-KK1



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ATTACHMENT 2

O&M SUPPORT PROCEDURE SO23-XVII-4 REVISION 2 PAGE 22 OF 36 ATTACHMENT 2

LINE 287 BLED STEAM TURBINE KOO1, SYS 1301 MOISTURE SEPARATOR HEAT E113 SYS 1301 S2-1301-ML-318-6"-R-KK1



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ATTACHMENT 2 PAGE 12 OF 24

O&M SUPPORT PROCEDURE SO23-XVII-4 REVISION 2 PAGE 23 OF 36 ATTACHMENT 2

LINE 287 BLED STEAM TURBINE KOO1, SYS 1301 MOISTURE SEPARATOR E113 SYS 1301 S2-1301-ML-319-6"-R-KK1



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ATTACHMENT 2

O&M SUPPORT PROCEDURE SO23-XVII-4 REVISION 2 PAGE 24 OF 36 ATTACHMENT 2

LINE 287 BLED STEAM TURBINE KOO1, SYS 1301 MOISTURE SEPARATOR HEAT E113 SYS 1301 S2-1301-ML-320-6"-R-KK1



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ATTACHMENT 2

O&M SUPPORT PROCEDURE SO23-XVII-4 REVISION 2 PAGE 25 OF 36 ATTACHMENT 2

LINE 287 M/S SUP HOR TURBINE KOO1, SYS 1301 MOISTURE SEPARATOR (E) HEAT E113 SYS 1301 S2-1301 (ST)-ML-288-12"-R-KK1 (32C\*)



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ATTACHMENT 2

PAGE 15 OF 24

O&M SUPPORT PROCEDURE SO23-XVII-4 REVISION 2 PAGE 26 OF 36 ATTACHMENT 2

LINE 287 M/S SUP HDR TURBINE KOO1, SYS 1301 MOISTURE SEPARATOR E HEAT E113 SYS 1301 S2-1301-ML-288-12"-R-KK1



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ATTACHMENT 2

PAGE 16 OF 24

O&M SUPPORT PROCEDURE SO23-XVII-4 REVISION 2 PAGE 27 OF 36 ATTACHMENT 2

LINE 287 M/S SUP HDR TURBINE KOO1, SYS 1301 MOISTURE SEPARATOR E HEAT E112 SYS 1301 S2-1301-ML-288-6"-R-KK1



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ATTACHMENT 2

PAGE 17 OF 24

O&M SUPPORT PROCEDURE SO23-XVII-4 REVISION 2 PAGE 28 OF 36 ATTACHMENT 2

LINE 288 HP TURBINE KOO1, SYS 1301 MOISTURE SEPARATOR HEAT E112 SYS 1301 S-2-1301-ML-326-6"-R-KK1



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PAGE 18 OF 24

O&M SUPPORT PROCEDURE SO23-XVII-4 REVISION 2 PAGE 29 OF 36 ATTACHMENT 2

LINE 288 HP TURBINE KOO1, SYS 1301 MOISTURE SEPARATOR HEAT E112 SYS 1301 S2-1301-ML-327-6"-R-KK1



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ATTACHMENT 2

PAGE 19 OF 24

O&M SUPPORT PROCEDURE SO23-XVII-4 REVISION 2 PAGE 30 OF 36 ATTACHMENT 2

LINE 288 HP TURBINE KOO1 SYS 1301 MOISTURE SEPARATOR HEAT E112 SYS 1301 S2-1301-ML-328-6"-R-KK1



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ATTACHMENT 2

PAGE 20 OF 24

O&M SUPPORT PROCEDURE SO23-XVII-4 REVISION 2 PAGE 31 OF 36 ATTACHMENT 2

COLD REHEAT STEAM LINE (W) SYS 1301 LINE 043 SYS 1301 S2-1301-ML-095-20"-R-KK2



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ATTACHMENT 2

PAGE 21 OF 24

O&M SUPPORT PROCEDURE S023-XVII-4 REVISION 2 PAGE 32 OF 36 ATTACHMENT 2

COLD REHEAT STEAM HDRS SYS 1301 LINE 044 SYS 1301 S2-1301-ML-104-20"-R-KK2



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ATTACHMENT 2

PAGE 22 OF 24

O&M SUPPORT PROCEDURE SO23-XVII-4 REVISION 2 PAGE 33 OF 36 ATTACHMENT 2

EXTRACTION STEAM IN CONDENSER NECK LINE S-2-1301-ML-047



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ATTACHMENT 2

PAGE 23 OF 24

EXTRACTION STEAM IN CONDENSER NECK LINE S-2-1301-ML-048



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ATTACHMENT 2 PAGE 24 OF 24

O&M SUPPORT PROCEDURE SO23-XVII-4 REVISION 2 PAGE 35 OF 36 ATTACHMENT 3

EXAMINATION AREAS





INSPECTION POINT "B" (CAPPED TEE OR LATERAL)



ATTACHMENT 3

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O&M SUPPORT PROCEDURE SO23-XVII-4 REVISION 2 PAGE 36 OF 36 ATTACHMENT 3

NOZZLE (CONDENSER OR ELATER)

# EXAMINATION AREAS

U.T. SCAN AREA

PIPE OR REDUCER

INSPECTION POINT "C"





INSPECTION POINT "B" (STANDARD ELBOW)

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ATTACHMENT 3

PAGE 2 OF 2