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Title / Naslov General Procedure for Eddy Current Inspection of Steam Generator Tubes				
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Affected Procedure Steps / Sporni razdelki postopka 2.0 Reference				
Description / Text of Change (Attach PCN Sheets as Needed) / Opis / Spremenjeno besedilo (priloži strani PCN-ja po potrebi) Točke 2.2 in 2.3 revidirane in nova stran priložena				
SES Required?/Je SES potreben? <input type="checkbox"/> Yes/Da <input checked="" type="checkbox"/> No/Ne If "YES" : / Če je odgovor "Da" : Safety Evaluation Required?/Je Varnostna ocena potrebna? <input type="checkbox"/> Yes/Da <input type="checkbox"/> No/Ne		Submitter/Predlagatelj K. Gudek		Date / Datum 13.09.2013
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		Approved / Odobril P. Škrlat		Date / Datum 3.10.13
OFF-HOURS SUBMITTAL / PREDLAGATELJI SPREMEMB, KI DELAJO IZVEN REDNEGA DELOVNEGA ČASA : • submit to Shift Engineer for concurrence / predati inženirju izmene zaradi pregleda SHIFT ENGINEER / INŽENIR IZMENE: • determine if Safety Evaluation Screening is required / pregled potrebnosti ocene varnosti (SES) • forward to Shift Supervisor or Procedure Owner for approval / poslati vodji izmene ali nosilcu postopka v odobritev COPYHOLDER / PREJEMNIK KOPIJE POSTOPKA : • retain and attach this sheet to the cover of the procedure affected / ta obrazec priložiti naslovnici zadevnega postopka				

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NUKLEARNA ELEKTRARNA KRŠKO

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GENERAL PROCEDURE FOR EDDY CURRENT INSPECTION
OF STEAM GENERATOR TUBES

Written by : Kosinar Jurek
(K. Gudek)

Date: 20/01/2010

Reviewed by : dr. A. Vučajić
(A. Vučajić)

Date: 10/02/2

Reviewed by : F. Androjna
(F. Androjna)

Date: 24/03/2010

Approved by : P. Širola
(P. Širola)

Date: 12/04/2010

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TABLE OF CONTENTS

1.0 PURPOSE AND SCOPE	3
2.0 REFERENCES	3
3.0 PREREQUISITES	4
4.0 PRECAUTIONS AND LIMITATIONS	4
5.0 REQUIREMENTS	5
6.0 FREQUENCY OF EXAMINATION	7
7.0 INSTRUCTIONS	8
8.0 ACCEPTANCE CRITERIA	12
9.0 APPENDICES	12

Procedure No. ISI-4.301	GENERAL PROCEDURE FOR EDDY CURRENT INSPECTION OF STEAM GENERATOR TUBES	NEK/T0.VZ
Revision - 3		Page 3 od 12

1.0 PURPOSE AND SCOPE

1.1 The purpose of this procedure is to define requirements for Eddy Current Examination of Steam Generator (S-F 72W-D4/2) tubes, of Inconel 690, 0.75 in. diameter x 0.043 in. wall thickness by utilizing Bobbin and MRPC probes.

Scope and frequency of examination and acceptance criteria shall be in accordance with the requirements of NEK TS SR 3.4.5.0.

1.2 This procedure covers requirements for personnel, equipment, calibration, acquisition, analysis, reporting, specific procedures are acceptance criteria.

2.0 REFERENCES

2.1 NEK Tech. Spec. SR 3.4.5.0

2.2 ASME Section V, 2007 Edition

2.3 ASME Section XI, 2007/A08 Edition

2.4 ASNT CP-189, 1995 Edition

2.5 Industry Database (IDB) - QDA Training Program, Eddy Current Steam Generator Data Analysis - Review Material, EPRI NDE Centre, latest edition

2.6 ADP-1.1.033, Varnost in zdravje pri delu v Nuklearni elektrarni Krško

2.7 EPRI – Pressurized Water Reactor Steam Generator Examination Guidelines, latest revision

2.8 TD-OH, Program uparjalnikov

2.9 ADP-1.0.020, Uporaba korektivnega programa

PCN 1, str. 2/2

naslednja str. 4

3.0 PREREQUISITES

3.1 ET Contractor

ET contractor shall be qualified, educated and experienced organization with:

- a. administrative and specific procedures (QAM)
- b. qualified and experienced ET personnel
- c. certified equipment
- d. ability to perform ET of SG tubes according to applicable technical standards, specifications and world wide accepted guide lines.

4.0 PRECAUTIONS AND LIMITATIONS

During any manipulation with the equipment the provisions of ALARA and Ref. 2.6 shall be respected.

5.0 REQUIREMENTS

ET Steam Generator inspection (data acquisition, data analysis, CDS – computerized data screening, inspection planning and data management) as well as overall system performance including techniques, analysis and human performance, process controls and field analysis feedback shall be performed in accordance with requirements of the EPRI – Pressurized Water Reactor Steam Generator Examination Guidelines, (Ref. 2.7).

5.1 ET Personnel

ET personnel shall be qualified and certified to level I, II, IIA and/or III for ET method per requirements of CP-189, (Ref. 2.4).

Organization shall assure the following as minimum:

- a. operators for ET data acquisition - level I
- b. ET data acquisition team leader - level II
- c. ET data analyst - level II A
- d. IMS operator - II A
- e. lead analyst - level III
- f. maintenance, calibration and repair of equipment can be performed only by manufactures authorized personnel or specially trained persons.
- g. ET team leader and coordinator - level II A

For all II A analysis personnel it is necessary to pass plant specific training/test program, except for analysts which have completed EPRI QDA program, (Ref. 2.5).

5.2 Equipment

5.2.1 Tester and Manipulator

Only modern generation of equipment shall be used, with mechanized probe drive and remote controlled fixture.

The eddy current tester shall be capable of operation in the differential, or absolute mode, or both, in the frequency range from 10 kHz to 999 kHz.

The tester shall be multifrequency, with 8 channels, and 3 mixers as a minimum. Also, test sample rate shall be variable in range of 200 to 1000 samples/sec.

The tester shall be calibrated at least once a year or whenever the equipment has been overhauled or repaired as a result of malfunction or damage.

5.2.2 Computer and Softwares

The computers and softwares shall assure interpretation of collected data (on optical disks) by ZETEC's MIZ-18 and MIZ-30 analysis system or similar to this.

5.2.3 ET Probes

a. Bobbin 0.630" dia. for all tubes, except low row tubes where 0.610, 0.590 and/or 0.540" dia. probes can be used. Probes shall be designed for use in the range of high frequency. Other probe dimensions and frequency may be used for special application when and where is necessary.

b. MRPC 0.600 or max. 0.620" dia. can be used for testing of straight tube length and 0.580 or 0.560" dia. for low row "U-bands".

5.2.4 ET Calibration Standards

Only calibration standards provided by NEK can be used. Those standards shall be manufactured from a length of tubing of the same nominal size and material type as that to be examined in SG. Standards shall contain calibration discontinuities as described in ref. 2.2, ASME sec. V. Additional types of discontinuities are allowed to get more information for analyses.

5.3 **Materials**

N/A

5.4 **Concurrence**

It is the contractor obligation to develop the general and specific procedures, instructions, and check lists which shall assure high quality work related to all ET activities such as:

- training and qualification
- equipment installation
- data collection for bobbin and MRPC
- data analysis for bobbin and MRPC
- inspection management system
- data resolution
- data flow and storage during data collection and analysis.

All developed or revised procedures, instructions and check lists shall be submitted to NEK ISI engineer in charge of ET and SKV.QA for acceptance. |

6.0 FREQUENCY OF EXAMINATION

Frequency of examination of SG tubes is defined by NEK Tech. Spec. 3.4.5.0 (Ref. 2.1)

7.0 INSTRUCTIONS

7.1 Preparatory Activities

For all personnel involved in ET it is necessary to perform training, before start of inspection, especially for operators and platform workers. Contractor has to make schedule for data acquisition and submit it to NEK responsible person for approval.

Before equipment installation, all systems shall be checked functionally.

7.2 Equipment Calibration

Prior data acquisition start, equipment shall be checked and calibrated using NEK's calibration standards at the beginning, after each four hour during acquisition, at the end of each production run and any time that malfunctioning is suspected.

7.3 Data Acquisition

Data acquisition shall be performed using contractors procedures mentioned in 5.4 including forward listed important items.

Data shall be recorded on optical disks. In the case that data are going to be recorded only in this way, it is necessary to make a copy of each disk.

Bobbin data collection shall be performed as much as possible in one probe pass from one side to the other.

The bobbin probe speed during data collection shall not exceed 18 in./sec. with sampling rate 600/sec.

The MRPC probe speed shall be 0.2 in./sec. with sampling rate about 65/revolution and rotation 260 RPM.

System configuration shall assure selection of frequencies as a minimum:

- a. prime frequency for optimized phase and amplitude information about the tube wall
- b. subtraction frequency for TSP subtraction
- c. TSP locator frequency
- e. mix of a. and b. frequencies used to suppress tube bundle structure signals (TSP, AVB).

7.4 Data Analysis

7.4.1 Generally

All indications recorded during data collecting shall be evaluated. Data analysis shall include:

- a. primary
- b. secondary
- c. resolution.

The reporting of indications shall include following information:

- a. location
- b. voltage
- c. phase angle
- d. percent wall loss, or appropriate abbreviation for certain type of indication
- e. reporting channel
- f. extent of examined tubes.

7.4.2 Bobbin Probe Data Reporting Criteria

All indications $\geq 20\%$ shall be recorded with amplitudes $> 0.5\text{ V}$ (if signal to noise ratio has acceptable level it may be less), in accordance with Ref. 2.5.

7.4.3 MRPC Reporting

Based on "C"-scan presentation, MRPC indications shall be reported as follows:

- a. SAI - single axial indication
- b. MAI - multiple axial indication
- c. SCI - single circumferentially oriented indication.
- d. MCI - multiple circumferentially oriented indication

All tubes with bobbin calls $> 40\%$ in TSP intersections as well as in TTS region shall be subjected to MRPC inspection for indication confirmation. Based on this additional inspection, MRPC results shall be:

- a. if MRPC result is SAI, MAI, SCI, MCI and/or RI combination of bobbin and MRPC results shall be used to characterize final result
- b. if MRPC result is INF or NRI that shall be final result for that indication (taking care to use high signal amplifications to be the most conservative in such case)
- c. if MRPC result is SAI, MAI, SCI, MCI and/or RI on location where bobbin result is NRI, INF, NDD; MRPC result shall be used as final except for free span indications, where the following criteria shall be used:
 - if bobbin data reevaluation shows reportable indication, MRPC call shall be accepted as real
 - if bobbin reevaluation shows INF, NDD and/or NRI, MRPC call shall be considered as nonrelevant.

MRPC data collected in areas where bobbin inspection is not possible or is not adequate, (R1 & R2 "U"-band) shall be used as

final after P/S resolution.

7.5 Reports of Examination

7.5.1 Inspection Report

The content of the Inspection Report are following as minimum:

- list of all tube inspection results (bobbin + MRPC, this is valid also for all of the following sorts)
- list of all $\geq 20\%$ indications
- list of indications $> 40\%$ (Plugging list)
- list of any additional ET inspection result as part of extended scope and per request of NEK
- personnel qualification records
- equipment calibration records
- list of all applied ET procedures.

7.5.2 Final Report

In addition to the content specified in 7.5.1 the Final Report shall include the following as the minimum:

- updated NEK SG ET history
- list of all plugged tubes with their all reports
- statistic related to the list of indications in 7.5.1
- comments and conclusions based on ET results

8.0 ACCEPTANCE CRITERIA

For single or multiple flaws of cracks, wastage, or intergranular corrosion, the depth of an allowable O.D. flaw shall not exceed 40% of the tube wall thickness.

In case of any nonconformity, deviations or exceeding of acceptance criteria a ZKP shall be initiated according to ADP-1.0.020 (Ref. 2.9).

9.0 APPENDICES

9.1 Abbreviations

AVB - antivibration bar
CL - cold leg
ET - eddy current testing
HL - hot leg
IMS - inspection management system
INF - indication not found
ISI - in service inspection
MRPC - motorized rotating pancake coil
NDD - non detectable degradation
NRI - non reportable indication
QAM - quality assurance manual
QDA - quality data analysis
SKV.QA - quality assurance department
RI - reportable indication
RPM - round per minute
SG - steam generator
TSP - tube support plate
TTS - top of the tube sheet
V - volt
ZKP - zahtevak za korektivni program