WESTINGHOUSE POSITION

ON

USNRC REGULATORY GUIDE 1.150

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WESTINGHOUSE POSITION
ON
USNRC REGULATORY GUIDE 1.150
APPLICABILITY

INTRODUCTION

The following position has been adopted by Westinghouse with respect to implementation of USNRC Regulatory Guide 1.150, "Ultrasonic Testing of Reactor Vessels During Preservice and Inservice Inspection". The basis for this position is Appendix A to USNRC Regulatory Guide 1.150, Revision 1 where the Electric Power Research Institute Ad Hoc Committee recommendations are adopted as an acceptable approach to the positions recommended in the base document. The Westinghouse position is applicable to full penetration reactor vessel welds that are subject to volumetric examination as required by Section XI of the ASME Boiler and Pressure Vessel Code. Examination requirements for all welds as defined in ASME Section XI categories B-A, B-B, B-C, and B-D are augmented with emphasis placed on those welds considered important from a neutron embrittlement and pressurized thermal shock point of view.

Category B-A -- Longitudinal and circumferential shell welds in the vessel beltline region.

Category B-B -- Longitudinal and circumferential shell welds other than those in categories B-A and B-C.

-- Meridional and circumferential welds in the bottom head and closure head.

Category B-C -- Vessel-to-flange and closure head-to-flange welds.

Category B-D -- Nozzle-to-vessel welds and nozzle inside radii.

DESCRIPTION OF THE AUGMENTED EXAMINATION PROGRAM

The scope of a typical augmented program, is described below. The Westinghouse Technical Position on USNRC Regulatory Guide 1.150 is found as Attachment A, Implementation.

Period 1 and 2 Vessel Examinations

During 40-month and 80-month examination periods, areas of the reactor vessel typically accessible for examinations include the vessel flange-to-shell weld from the seal surface, outlet nozzle-to-shell welds from the nozzle bores, welds in the closure head, outlet nozzle-to-safe end welds and ligaments around threaded stud holes in the vessel flange.

Examinations of the vessel flange-to-shell weld from the seal surface and outlet nozzle-to-shell welds from the nozzle bores are conducted with angles which provide normal or near-normal incidence to the plane of the weld. This method of examination generally establishes a favorable relationship between the interrogating sound beam and planar reflectors which might exist parallel to the weld and provides examination coverage of the volumes of material near the vessel inside and outside diameter surfaces with no limitations due to gating, near field effects, etc. For these examinations, Westinghouse plans to augment Section XI requirements in the areas of instrument performance checks, calibration, examination, recording and sizing and reporting of results per Attachment A, Implementation.

Welds in the closure head are located sufficiently far from the reactor core so as to be relatively unaffected by the concerns of neutron damage or pressurized thermal shock. Where access permits, these welds will be examined using contact ultrasonic techniques from the outside surface. These techniques provide coverage of the volumes of material near the vessel head inside diameter surface with no limitations due to gating, near field effects, etc. For examinations of these welds Westinghouse plans to augment Section XI requirements in the areas of instrument performance checks, calibration, examination, and reporting of results per Attachment A, Implementation.

Examinations of the vessel flange ligaments and outlet nozzle-to-safe end welds fall outside the scope of the augmented examination program and will be examined per Section XI.

Preservice or Period 3 Vessel Examination

During a preservice or ten year examination, areas of the reactor vessel accessible for examination include all those listed for period 1 and 2 examinations and all reactor vessel circumferential and longitudinal shell welds, inlet nozzle-to-shell welds, bottom head meridional and circumferential welds, and inlet nozzle-to-safe end welds.

Welds in the reactor vessel beltline region are associated with neutron embrittlement and pressurized thermal shock considerations. For examinations of welds in this region Westinghouse plans to augment Section XI requirements in the areas of instrument performance checks, calibration, examination, recording and sizing, and reporting of results per the Attachment A, Implementation.

Vertical and circumferential welds outside the vessel beltline region and welds in the bottom head are located sufficiently far from the reactor core so as to be relatively unaffected by the concerns of neutron damage or pressurized thermal shock. Examinations of these welds will be augmented in the areas of instrument performance checks, calibration, examination, recording and sizing, and reporting of results per the Technical Position, Attachment A. Examinations of welds in the bottom head where instrument tubes and penetrations tend to interfere with remote test results are typically supplemented via contact examinations from the outside surface, where access permits. These techniques provide coverage of the volumes of material near the head inside diameter surface with no limitations due to gating, near field effects, etc. Westinghouse plans to augment Section XI examinations of these welds in the areas of instrument performance checks, calibration, examination, and reporting of results per Attachment A, Implementation.

The reactor vessel inlet nozzle-to-shell welds are important from a structural integrity standpoint because of the high stress concentration present. Examinations of these welds are performed from the nozzle bores with angles which provide normal or near-normal incidence to the plane of the weld. This method of examination generally establishes a favorable relationship between the interrogating sound beam and planar reflectors which might exist parallel to the weld and provides examination coverage of the volumes of material near the vessel inside and outside diameter surfaces with no limitations due to gating, near field effects, etc. For these examinations, Westinghouse plans to augment Section XI requirements in the areas of instrument performance checks, calibration, examination, recording and sizing, and reporting of results per Attachment A, Implementation.

Examinations of inlet nozzle-to-safe end welds fall outside the scope of the augmented examination program and will be examined per Section XI requirements.

ATTACHMENT A
WESTINGHOUSE POSITION
ON
USNRC REGULATORY GUIDE 1.150
IMPLEMENTATION

INTRODUCTION

USNRC Regulatory Guide 1.150, Revision 1, "Ultrasonic Testing of Reactor Vessel Welds During Preservice and Inservice Examination", has been issued with the intent of increasing reliability for detection and characterization of service induced defects. The guide recommends supplementing current ASME XI requirements in the areas of:

1. Instrument performance
2. System calibration
3. Near surface resolution
4. Beam profile
5. Scanning weld-metal interface
6. Sizing, and
7. Reporting of results.

Westinghouse has evaluated Revision 1 of the Regulatory Guide which, in Appendix A, adopts the Electric Power Research Institute (EPRI) Ad Hoc Committee's recommendations as an acceptable approach to the positions stated in the base document. As a result of this review, Westinghouse has developed a plan for augmenting ASME XI examinations of reactor vessels. The technical position for this augmented program, based on Appendix A to Revision 1 of Regulatory Guide 1.150, is described herein.

1.0 INSTRUMENT PERFORMANCE CHECKS

1.1 PRE-EXAM PERFORMANCE CHECKS

Performance checks recommended by this particular sub-paragraph are addressed via implementation of those checks recommended in 1.2.

1.2 FIELD PERFORMANCE CHECKS

1.2a Frequency of Checks

Performance checks recommended in 1.2c, 1.2d, and 1.2e are conducted before and after examining all vessel welds that need be examined during the outage. Those specified per 1.2f are conducted prior to examinations, during the calibration sequence.

1.2b Instrument linearity checks will include the range of instrument settings intended for use during the examinations.

1.2c RF Waveform

Photographic records of the RF pulse waveforms are obtained before and after each reactor vessel examination for each transducer used for mechanized scanning.

1.2d Screen Height Linearity

Screen height linearity is determined prior to calibration and before and after each series of reactor vessel examinations during one outage.

1.2e Amplitude Control Linearity

Amplitude control linearity is determined prior to calibration and before and after each series of reactor vessel examinations during the outage.

1.2f Angle Beam Profile Characterization

Vertical beam profile measurements are conducted for each transducer used during mechanized examinations as part of the calibration sequence. These measurements are specified at 20 percent of the distance-amplitude-curve as well as at 50 percent of the distance-amplitude-curve and all measurement data are included in the calibration data package.

2.0 CALIBRATION

System calibration is established on the appropriate basic calibration block(s) in accordance with the applicable Edition of Section XI of the ASME Boiler and Pressure Vessel Code.

2.1 CALIBRATION FOR MANUAL SCANNING

Procedures used for manual scanning of reactor vessel welds specify investigation of all indications which exceed 20 percent DAC. Indications which exceed 50 percent DAC are considered recordable. In addition, scanning is performed at two times the calibration sensitivity to provide additional conservatism from a detection standpoint.

2.2 CALIBRATION FOR MECHANIZED SCANNING

2.2a Distance-amplitude-curves are developed with transducers mounted on the array plate planned for use during the specific reactor vessel examination when possible.

2.2b Distance-amplitude-curves are developed statically per the applicable Edition of Section XI of the ASME Boiler and Pressure Vessel Code and verified dynamically at or higher than the specified scanning speed.

2.2c The scanning motion of the reactor vessel inspection tool is such that transducers scan forward during one scan increment and backward on the next successive increment. Experience indicates the difference in scan motion has no significant effect on detection.

2.2d Calibration is verified dynamically thus development of correction factors is not appropriate.

2.3 CALIBRATION CONFIRMATION

System calibration is confirmed, as a minimum, before and after each series of vessel examinations with a particular array plate. In addition, instrument stability is verified every four hours using an Electronic Block Simulator (EBS).

2.3a Complete ultrasonic system performance is confirmed using an array of cylindrical reflectors called a Mechanical Calibration Transfer Standard (MTS). Responses from reflectors in the array are referenced to the distance-amplitude-curves generated with the basic calibration block(s) per the applicable Edition of Section XI of the ASME Boiler and Pressure Vessel Code. The design of the array allows at least a two point check of sweep and sensitivity. Reflectors selected for calibration verification appear at transit times representative of those of the primary reflectors in the basic calibration block where practical.

2.3b Written records are maintained for both the target reflector responses and the distance-amplitude-curves for each transducer/inspection channel combination.

2.3c The entire ultrasonic system is protected from temperature, vibration, and shock via a trailer mounted control center with controlled environment.

2.4 CALIBRATION BLOCKS

Basic calibration blocks are designed per the applicable Edition of Section XI of the ASME Boiler and Pressure Vessel Code. Surfaces of reference reflectors will be protected from the environment by a suitable plugging method.

3.0 EXAMINATION

The scope and extent of the ultrasonic examinations are per IWA-2000 of the applicable Edition of the ASME Boiler and Pressure Vessel Code.

The ultrasonic system used for these examinations is capable of recording of multiple indications appearing simultaneously and all examinations are conducted with a minimum of 25 percent scan overlap based on the transducer element size.

3.1 INTERNAL SURFACE

Examination procedures provide for supplementing code required examinations with techniques specifically intended to interrogate volumes of material near the vessel ID surface when scanning vessel shell beltline region welds and access and geometry permit. Procedures provide for implementation of near surface examination methods as described in either 3.1a or 3.1b.

3.1a Forty-five degree full node examinations demonstrated capable of identifying the near surface, 2 percent, 90 degree corner reflector, or

3.1b Shallow angle techniques demonstrated capable of identifying the near surface, 2 percent, 90 degree corner reflector or other appropriate reference defect(s).

3.1c The near surface examination technique selected, either 3.1a or 3.1b, will be conducted to provide coverage of one inch of material near the vessel ID, as a minimum.

3.2 SCANNING WELD-METAL INTERFACE

Beam angles are selected for examinations of nozzle-to-shell welds from the nozzle bores and the vessel flange-to-shell weld from the flange seal

surface based on their ability to provide complete coverage of the weld and specified adjacent base material and provide normal or near-normal incidence to the weld/base metal interface. Ability to adhere to the ± 15 degree tolerance suggested is dependent upon component geometry.

4.0 BEAM PROFILE

The Westinghouse position on this item is stated in 1.2f.

5.0 SCANNING WELD-METAL INTERFACE

The Westinghouse position on this item is stated in 3.2.

6.0 RECORDING AND SIZING

The recording and sizing criteria recommended in 6.2 and 6.3 will be applied to augment Section XI recording requirements for remote mechanized examinations of welds in the reactor vessel.

6.1 GEOMETRIC INDICATIONS

All indications which exceed the appropriate recording level are listed on the remote inspection tool data printout in terms of amplitude, sweep position, and location in the vessel.

Procedures specify that all indications on the data printout be investigated to determine whether they are valid (i.e., cracks, lack of penetration, inclusions, slag, etc.) or not valid (i.e., geometry, beam redirection, loss of interface gating, etc.). This interpretation is noted on the data printout.

6.2 INDICATIONS WITH CHANGING METAL PATH

6.2a Valid indications detected via Section XI angle beam techniques will be recorded per the augmented criteria specified in 6.2b and 6.2c.

6.2b Valid angle beam indications at metal paths representing 25 percent and greater of the through-wall thickness of the vessel wall measured from the inner surface will be recorded at 50 percent DAC.

6.2c Valid angle beam indications which are within the inner 25 percent of the vessel through-wall thickness measured from the vessel inner surface will be recorded at 20 percent DAC. If the indication exceeds 50 percent DAC it will be recorded to 50 percent DAC limits as well.

6.3 INDICATIONS WITHOUT CHANGING METAL PATH

Valid indications detected via Section XI angle beam techniques will be recorded per the augmented criteria specified in 6.3a and 6.3b.

6.3a Valid angle beam indications at metal paths representing 25 percent and greater of the through-wall thickness of the vessel wall measured from the inner surface will be recorded at 50 percent DAC.

6.3b Valid angle beam indications which are within the inner 25 percent of the vessel through-wall thickness measured from the vessel inner surface will be recorded at 20 percent DAC. If the indication exceeds 50 percent DAC it will be recorded to 50 percent DAC limits as well.

6.4 ADDITIONAL RECORDING CRITERIA

6.4a Approprite scan intervals for recorrding of indications depend on indication length, beam spread, etc., and are determined on a case-by-case basis.

6.4b Recorded information includes the sweep position and transducer position for the peak amplitude point and 100 percent, 50 percent, and 20 percent DAC points where appropriate.

6.4c Information presented on the data printout includes the indication amplitude, sweep position, and location in the vessel. The system is capable of recording multiple indications which may appear simultaneously.

7.0 REPORTING OF RESULTS

The reactor vessel examination final report will include all records obtained per implementation of items 1, 2, 3, and 6 as described herein.

7a. An estimate of the error band for sizing flaws cannot be provided at this time. Estimates of this type are subjective in nature and not readily substantiated with quantitative data. The industry is currently assessing procedures and equipment for reflector sizing with the intent of providing a quantitative data base for such estimates and identifying improved methods, where appropriate.

7b. Descriptions of the calibration procedures will be included in the reactor vessel examination final report.

7c. Estimates of examination limitations due to geometry, access, gating, etc., will be provided in the reactor vessel examination final report.

7d. Descriptions and sketches of the remote examination system which explain its operation will be provided in the reactor vessel examination final report.

7e. Alternative volumetric techniques, if applied, will be described in the final report.