



Update of NIFG Action to Strengthen the Site Specific Mockup Process

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Background

- Section XI requires demonstrating the minimum and maximum diameter and thickness for each of the types of component and examples of geometric conditions that normally requires discrimination from flaws.
 - *(1) geometric and material conditions that normally require discrimination from flaws (e.g., counterbore or weld root conditions, cladding, weld buttering, remnants of previous welds, adjacent welds in close proximity, and weld repair areas);*
 - *(2) typical limited scanning surface conditions (e.g., weld crowns, diametrical shrink, single-side access due to nozzle and safe end external tapers for outside surface examinations; and internal tapers, exposed weld roots, and cladding conditions for inside surface examinations). Qualification requirements shall be satisfied separately for each examination surface.*

Background

- PDI determined that when field configurations for DM welds differ from those contained within the PDI inventory, the optimization of the Appendix VIII demonstrated techniques through the use of site specific mockups would provide a better examination process.
 - Site specific mock-up criteria were developed at the start of the PDI Appendix VIII, Supplement 10 program
 - Reviewed with NRC during public meetings
 - First official revision published in June 2004
 - Part of MRP-139 (NEI-03-08 Implementation)

Why is the Site Specific Mockup Process Needed?

- Numerous variations of dissimilar metal weld configurations exist in the industry and many are not included in test sets
 - Geometry varies from one weld to another
 - Search unit angle and focal depth may need to be changed in order to properly examine the weld and cover the required examination volume with an optimized technique
 - As-built contours vary from plant to plant and may be different than design
 - Scanning obstructions may force modifications to configurations

Why is the Site Specific Mockup Process Needed?

- Site specific mock-ups allows examiner to become familiar with unique examination requirements and provides provisions to assure optimized examination
 - Search unit selection
 - Proper angle
 - Correct size
 - Focusing
 - Adjustments in scan pattern
 - Familiarization with signals associated with weld configuration and flaw responses

NIFG action: Strengthen Site Specific Mockup Process

- Purpose
 - Strengthen the Site Specific Mockup process due to recent industry issues and NRC concerns
 - Mockup Quality
 - Blind vs. Non-Blind Demonstration
 - Use of Computer Modeling
 - Examiner Training/Practice on Mockups
 - Controls for Validation of Search Unit Parameters

Strengthen Site Specific Mockup Process

- Status

- Draft revision of the Site Specific Mockup Requirements has been prepared for PDI review and approval

Site Specific Mockup Requirements

When must a site-specific mockup be used?

- Site specific configuration mockups shall be required when the configuration being examined is not included in the procedure performance demonstration sample inventory
 - The outside surface contains external tapers or conditions that preclude coverage of the examination volume with the qualified examination techniques(s). For example:
 - Components with tapered scan surfaces greater than +3 degrees from the procedure demonstration set
 - Tapered weld crowns that act as a transition between two different diameters that requires modification to the examination parameters to obtain coverage of the examination volume
 - Other surface discontinuities that could adversely affect contact or limit access to the weld and buttering within the examination volume

Site Specific Mockup Requirements

What are the proper uses of the site-specific mockup?

- Site Specific Configuration mockups **shall not** be used for:
 - Altering or changing a previously qualified technique or essential parameter for a configuration covered within the PDI sample inventory
 - Expanding qualified thickness or diameter range

Site Specific Mockup Requirements

What are the proper uses of the site-specific mockup?

- Site Specific Configuration Mockups are the means to:
 - Select alternative angles or focal laws, sizes, focal depths, and contours for the search unit(s);
 - Select specialized search units or focal laws to accommodate unique configurations;
 - Establish maximum increment and scan speed required for adequate detection and sizing of flaws;
 - Adjust the scan pattern to compensate for the site specific configuration; and
 - Assure examination personnel are familiar with ultrasonic responses associated with the configuration's metallurgical/geometric conditions as compared to flaw responses and other unique examination requirements

Site Specific Mockup Requirements

Areas of Enhancements

- Focused on DM welds
- Flaws
 - Quantity
 - Size
 - Types
 - Locations and Aspect Ratios
- Technical Basis Document
- Demonstration Requirements
- Implementation
- Acceptance Criteria

Site Specific Mockup Requirements

Areas of Enhancements

- Focused on DM welds
 - Deleted weld overlays (Supplement 11) from the scope of the site specific mockup requirements document
 - Weld overlays were incorporated in June 2011 revision to support a unique weld overlay design
 - Never implemented due examination procedure not capable of satisfying the criteria

Site Specific Mockup Requirements

Areas of Enhancements

- Flaws
 - Quantity
 - Quantity of flaws based on the component configuration and scanning/examination limitations
 - Sufficient number of flaws to demonstrate detectability over the entire examination volume
 - A minimum of one axial and one circumferential oriented flaw shall be required
 - The number of flaws used for the site specific demonstration shall be addressed in the site specific demonstration technical basis document

Site Specific Mockup Requirements

Areas of Enhancements

- Flaw Size (no change)
 - Shall include at least one axial and one circumferential flaw with depths between 10% and 20% of nominal wall thickness
 - Flaw depths greater than 20% of the nominal wall thickness may be used to bound the capability of the technique or to evaluate flaw sizing capability

Site Specific Mockup Requirements

Areas of Enhancements

– Flaw Types

- Alternative flaws (e.g., HIP, CIP), cracks, or a combination may be used
- Alternative flaws, if used, shall provide crack-like reflective characteristics that will ensure a final tip width of less than or equal to 0.002 inch
- (New) The profiles of the circumferential flaws in the mockup specimens should vary in height along the length of the flaw
- (New) The shape of axial flaws located in the weld and buttering material will be determined by the shape and width of the weld

Site Specific Mockup Requirements

Areas of Enhancements

- Flaw Locations and Aspect Ratios
 - Placed within the examination volume at locations that are known to be susceptible to cracking (e.g. weld and buttering material)
 - (New) Length of axial flaws is dictated by the width of the susceptible weld and butter material
 - (New) Circumferential flaws should have length to depth aspect ratios ranging from 2:1 to 4:1.
 - Based on review of field data from actual detected flaws

Site Specific Mockup Requirements

Areas of Enhancements

- Technical Basis Document
 - Written report that supports the modifications to the qualified procedure - Includes:
 - Drawing of the site specific mockup and component to be examined (added detail)
 - All geometric conditions of the component such as inside and outside surface geometry, taper angles, specifications for all base, buttering and weld material, and any access restrictions
 - A discussion of the difference from the procedure qualification samples
 - Justification for the number of flaws, flaw size distribution, shape, placement, and orientation (added detail)

Site Specific Mockup Requirements

Areas of Enhancements

- Technical Basis Document (continued)
 - Any examination parameter modifications required to the qualified procedure such as:
 - search unit angle
 - focusing
 - contouring
 - beam skewing (electronic or mechanical)
 - scan pattern
 - The technical basis for any examination parameter modification shall be included

Site Specific Mockup Requirements

Areas of Enhancements

- Technical Basis Document (continued)
 - (New) If the search units selected do not fall within the configuration, size and focusing requirements defined by the qualified procedure computer modeling shall be used to validate the search unit selection
 - (New) Search unit validation process for complex examination techniques using compound wedges or focal laws that require beam skewing or angle compensation
 - Shall include provisions to verify search unit refracted angle, exit point, focal depth and skew angle
 - Computer modeling (e.g. Beam simulation, defect response evaluations, 3D CAD, ray tracing)
 - Specialized reference or calibration blocks

Site Specific Mockup Requirements

Areas of Enhancements

- Technical Basis Document (continued)
 - The maximum scan increment and maximum scan speed demonstrated to successfully detect, characterize and size the flaws as applicable
 - (New) These parameters may not exceed the qualified procedure values
 - Demonstrated coverage map including any limitations
 - Documentation for search units selected for use
 - (New) Screen prints or images of each flaw in the mockup(s) documenting the flaw responses
 - (New) Component specific analysis processes

Site Specific Mockup Requirements

Areas of Enhancements

- Technical Basis Document (continued)
 - (New) Geometric ray tracing or ultrasonic modeling/simulation results related to the mock-up and the field component used to support the demonstration
 - Drawings of calibration or reference blocks used to verify ultrasonic transducer characteristics or sensitivity
 - (New) Modifications of the qualified procedure examination parameters shall be documented in a side-by-side comparison format

Site Specific Mockup Requirements

Areas of Enhancements

- Demonstration Requirements
 - (New) The demonstration shall exercise the entire examination process of the procedure (e.g. search unit verification, calibration, examination, analysis/interpretation and reporting)
 - Site specific configuration demonstrations may be conducted in a blind or non-blind format
 - (New) If a non-blind demonstration process is used for non-encoded procedures, computer modeling shall be used as an additional validation of the demonstration results

Site Specific Mockup Requirements

Areas of Enhancements

- Implementation (New)
 - Prior to performing the weld examinations, the licensee shall ensure the following:
 - Examination personnel are familiar with the examination requirements of the procedure and the technical basis document
 - Examiners have received sufficient training/practice to demonstrate the ability to detect, characterize and size each flaw, as applicable, using processes consistent with the field application (e.g. equipment, examination parameters, setup, etc.)
 - Additional factors of field implementation; such as time constraints from radiation levels, temperature, noise, and physical access, shall be considered when performing the mock-up training/practice

Site Specific Mockup Requirements

Areas of Enhancements

- Acceptance Criteria

- The qualified procedure as modified by the technical basis document shall be considered acceptable for use if:

- (New) Flaws are discernible using the specific criteria contained in the qualified examination procedure, including any additional guidance defined in the technical basis document
- (New) If the procedure is applicable to depth or length sizing the techniques must be able to size the flaw(s) within the Supplement 10 criteria applied to each flaw separately
- (New) If the results of the demonstration do not meet the above criteria the licensee shall consider alternative examination processes or methods

Site Specific Mockup Requirements

- Summary

- Site specific mockup process is necessary to optimize qualified techniques for unique configurations within the Appendix VIII demonstrated procedure ranges
- Enhancements address recent industry issues and NRC concerns
 - Incorporates the use of computer modeling to assist in technique optimization and validation of non-blind demonstration results
 - Provides requirements for verification of complex search unit parameters
 - Provides requirements for examiner training/practice on site specific configuration mockups prior to site examination to ensure proficiency with weld and flaw responses

Strengthen the Site Specific Mockup Process

- Follow-on Actions
 - PDI approval
 - NRC engagement
 - Incorporate process into Code

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