



PDI Site Specific Mock-up Criteria

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Objective

- Provide an overview of the current site specific mock-up process, including some historical background
- This presentation **will not** describe in detail all of the industry actions that are underway to address lessons learned and NRC concerns

Background

- Site specific mock-up criteria developed at the start of the PDI Appendix VIII, Supplement 10 program
 - Reviewed with NRC during numerous public meetings between 2000 and 2005
 - First official revision published in June 2004
 - Part of MRP-139 (NEI-03-08 Implementation)
 - Revised in June 2011 to address weld overlays (Supplement 11) and to incorporate lessons learned
 - No examinations performed using criteria developed for weld overlays
 - Procedure was not capable of satisfying criteria
 - Design changed to allow examination with previously qualified techniques

Why is it needed?

- Numerous variations of dissimilar metal welds 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 exam weld and cover examination volume
 - As-built contours vary from plant to plant and may be different than design
 - Scanning obstructions may force modifications to configurations

Why is it needed?

- Repairs may result in unique configurations that need to be accounted for during examination
- Site specific mock-ups allows examiner to become familiar with unique examination requirements and provides provisions to assure adequate examination
 - Search unit selection
 - Proper angle
 - Correct size
 - Adjustments in scan pattern
 - Familiarization with signals associated with weld geometric profile

Present Code Requirements

- The specimen set shall include examples of the following fabrication conditions:
- (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.*

Present Code Requirements

- Industry test sets include all of the above conditions
- However, industry realized that criteria was needed to address unique configurations and included site specific mock-ups as part of their technical basis

Criteria

When can it be used?

- Configuration Specific Mockups **shall** be used for:
 - Selection of alternative angles, sizes, focal depths, and contours for the search unit(s).
 - Selection of compound angles to accommodate unique configurations
 - Adjusting the scan pattern to compensate for limited access
 - Allowing examination personnel to become familiar with ultrasonic responses associated with the configuration's metallurgical and geometric conditions and other unique examination requirements.

Criteria

When can it be used?

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

Criteria

When must it be used?

- Configuration specific mockups shall be required when the configuration being examined was not included in the PDI test set that may require modification or customization of the examination techniques (Examples)
 - Reducers/expanders with tapered surfaces
 - Tapers that act as a transition between 2 different diameters
 - Geometric conditions such as nozzle bosses, or fittings that reduce the available coverage of the examination volume under the overlay
 - Other surface discontinuities that could adversely affect contact or limit access to the weld and buttering within the examination volume

Criteria

Mock-up Requirements

- Configuration specific mock-ups shall meet the following general requirements:
 - The mock-up shall be fabricated from the same material type and product form as the component to be examined
 - Typical grades of stainless steel, inconel and ferritic material are acceptable
 - Wrought product forms, i.e., plate piping and forgings, are acceptable representations of piping and forgings of that material
 - The welding method and position shall simulate that which was used to fabricate the in-service component

Criteria

Mock-up Requirements

- When the actual plant configuration requires scanning from internal or external tapers, the mock-up shall contain that geometry
 - Several different similar configurations can be covered by the use of one mock-up as long as the mock-up demonstrates the worst-case scenario
 - The justification for this approach shall be covered in the technical basis for the mock-up
 - The mock-up shall contain all physical limitations present in the in-service component. These limitations may be simulated by “masking” off areas or by limiting the amount of scanning allowed
 - The mock up shall contain any geometric condition(s) that require discrimination between geometry and flaw indications

Criteria

Quality Requirements for Mock-ups

- Mock-ups shall be manufactured in accordance with Quality Assurance programs that at a minimum contain the following attributes:
 - Design Control
 - Procurement
 - Procedures and Drawings
 - Material Control
 - Welding
 - Controls for special processes (HIP, CIP)
 - Control of Measurement and Test Equipment
 - Inspection Procedures
 - Non-conformance program
 - Document control procedures

Criteria

Number of Flaws

- The quantity of flaws is based on the complexity of the configuration and the limiting conditions that will challenge the techniques
 - Geometric conditions such as tapers
 - Weld configuration
 - Access
 - Other limiting factors

Criteria

Flaw Sizes

- For dissimilar metal welds the flaw size shall be based on IWB-3500
- Flaw depths between 10% and 20% of nominal wall thickness are acceptable
 - Less than the smallest flaw size range defined by Supplement 10
- Flaw heights greater than 20% of the nominal wall thickness may be used provided they are justified in the technical basis document
 - May be needed to bound capability and evaluate sizing techniques

Criteria

Flaw Types

- Alternative flaws (e.g., HIP, CIP), cracks, or a combination may be used
- Other reflectors such as notches may be used to aid in determining sound beam path etc., but shall not be used as part of the demonstration
- Alternative flaws, if used, shall provide crack-like reflective characteristics.
- Alternative flaws shall be manufactured in a fashion that will ensure a final tip width of less than or equal to 0.002 in

Criteria

Flaw Locations

- The flaws shall be placed within the examination volume at locations that are known to be susceptible to cracking (e.g. weld, nozzle/ pipe butter or heat affected zone of the safe end base material)
- Axial and circumferential flaw orientations shall be include
- The flaw placement shall demonstrate acceptability over the volume to be examined, with special emphasis in covering the susceptible weld and butter material

Criteria

Technical Basis Document Content

- The Technical Basis Document shall include:
 - A drawing of the Configuration Specific mockup and the configuration of the joint to be examined
 - Justification for the flaw size distribution, placement, and orientation of mockup flaws
 - The demonstrated coverage map
 - Full documentation for search units that have not been previously demonstrated for use with the qualified procedure
 - Any exceptions or changes required to the qualified procedure such as, search unit angle, metal path focal point, contouring, beam skewing (electronic or mechanical) and scan pattern shall be noted

Criteria

Demonstration Requirements

- The licensee shall ensure that the examination personnel are familiar with the data collection and analysis processes established during the configuration specific demonstration
 - Configuration specific demonstrations may be conducted in a non-blind format
- The licensee should arrange for an Authorized Nuclear Inservice Inspector to witness the demonstration
- The licensee shall ensure that a Level III individual, either employed by the licensee or the licensee's representative, witnesses the demonstration
- Changes required to the essential variables defined in the qualified procedure shall be documented and included in the Technical Basis Document for the examination of the specific configuration

Criteria

Acceptance Criteria

- The procedure shall be considered qualified if it can be demonstrated that the flaws are discernible by specific criteria identified in the examination procedure (e.g., signal to noise ratio ≥ 2 to 1 can be obtained from the flaws).
 - The Authorized Nuclear Inservice Inspector should document their review and acceptance of the modified procedure and the Technical Basis Document.

Criteria

Limitations

- Areas within the examination volume that cannot be examined reliably shall be documented as a limitation

Criteria

Reporting

- A demonstration report shall be generated to include the same procedurally defined detail as that required for an actual examination. If automated techniques are used, images showing the responses should be included in the report.
 - The demonstration report should include the technical basis document, which includes the technical basis for the number and location of flaws in the configuration specific mock-up
 - The licensee should include specific examination requirements or examination scan plan, as applicable for the specific configuration, into their examination procedure
 - The licensee shall maintain the technical basis document for future reference

Future Actions

- Site specific criteria will be evaluated and strengthened where necessary in an effort to address NRC concerns and incorporate lessons learned from recent industry events
 - Working group has been assigned
 - Many items being considered
 - Aggressive implementation schedule

Summary

- The need for site specific mock-up criteria is clear
 - Allows for customization of techniques for specific complex components
 - Avoids force fitting techniques onto configurations that they were not designed to examine
 - Allows examiner to become familiar with expected responses
- Industry will incorporate lessons learned into the process and strengthen the criteria where needed