Applicability Assessment Guidance for POD Curves

Background:

MRP-262 Rev. 3 documents the development of POD curves, derived from Performance Demonstration Initiative (PDI) inspection qualification data, for several dissimilar metal weld generic configurations of interest as reflected in Table 1 below. Section 9 of that report addresses *Applicability of Results* with both quantitative and qualitative criteria that should be assessed when applying these results to a specific location. The report cautions the reader that model parameter sets applied to simulate inspections that fall outside of the stated criteria must be technically justified by the user. Although similar analyses could be performed for other configurations, the necessary data is limited, data applicability to a specific weld design or field condition must be considered, and the data analysis time and cost may be prohibitive.

Table 1 - Dimensions and Predominant Inspection Approach for Qualification Specimens Used in POD Assessment [MRP-262 R3, Table 3-1]

Category	Mockup Series	Application	Outside Diameter Range	Thickness Range†	Inspection Surface	Scan Mode
A	705-710	Pressurizer Surge	12-14in 305-356mm	1.2-2.3in 30-58mm	Outside	Non-encoded & Encoded
B1	601-604	Reactor Vessel Nozzle	27-31in 686-787mm	2.5-3.0in 64-76mm	Inside	Encoded
C††	315	Weld Overlay	2.7-29.4in††† 69-747mm†††	0.3-2.3in 8mm-58mm	Outside	Non-encoded & Encoded

† For categories A and B1, this column refers to the pipe thickness; for category C, it refers to the total thickness (pipe thickness plus weld overlay thickness).

†† The maximum inspection depth for category C is 1.5in (38.1mm).

††† This is the outside diameter with the weld overlay.

This white paper presents pragmatic guidance for performing an assessment of the potential applicability of an MRP-262 R3 POD curve to any given location in support of an xLPR analysis. The result of such an assessment though will not be a definitive POD curve for the subject location and must be considered an input assumption within the xLPR analysis case to be appropriately documented for its contribution to the cumulative output uncertainty.

Assessment Factors:

MRP-262 R3 discusses the following as attributes to be considered when assessing applicability of PWSCC POD parameters to additional locations. They generally characterize the degree of difficulty in conducting the exam and an applicability assessment should be a relative comparison of these attributes between the new location and that of the mockup set underlying the established POD parameters. Descriptive details and relevant factors have been provided to inform such an assessment.

Applicability Assessment Guidance for POD Curves

- **Examination surface** *(ID/OD)*
  - Scan surface must match for POD parameters to be relevant
- **OD**
  - Modest adverse effect on circumferential POD as diameter decreases
  - Greater adverse effect on axial POD as diameter decreases
- **Wall thickness**
  - Uniform scan surface necessary to fully interrogate the volume of interest for circumferential indications increases extending away from the weld with increasing wall thickness
  - The detection of axial flaws is more difficult when the wall thickness increases because the ultrasonic beam is required to propagate through a larger volume to weld material and axial flaws are generally located in the weld material.
- **Materials adjacent to weld**
  - Wrought LAS and austenitic SS materials are well represented in mockup set the POD data was derived from
  - CASS was less represented in POD input data and may have a modest adverse impact on extent of coverage and only a secondary impact on POD
- **General weld configuration** *(single/double vee, ID surface complexity, etc.)*
  - The mockup set the POD data was derived from reflects a diverse range of weld prep angles and configurations as well as a fully representative set of ID surface geometries. Barring a highly atypical physical configuration, adverse impact on POD is unlikely
- **Tapers or obstructions adjacent to weld**
  - Relative to mockup set the POD data was derived from:
    - Minor effect from shallow uniform extended tapers
    - Greater adverse effect from transitions and steeper slopes within the scan surface needed to fully interrogate the volume of interest
  - Obstructions that limit scanning may directly limit exam coverage
- **Local surface contour** *(probe liftoff / contact conditions)*
  - Qualification mockup set local surface contours satisfy prevailing scan surface expectations designed to minimize probe lift-off
  - Welds subject to recurring qualified exams should satisfy minimum PDI surface contour requirements within intended scan zones as specified in the qualified examination procedures
  - Actual or postulated local surface contours that fail to satisfy surface condition requirements of the qualified examination procedure will result in loss of coverage as opposed to directly affecting POD.

<u>Assessment Approach:</u>

There is no framework for quantitatively assessing such attributes and determining their impact individually or collectively on POD curve applicability to an alternate location. Although

conservative POD assumptions might also be made, such a solution should be approached with caution and is potentially at odds with the "best-estimate" focus of the probabilistic xLPR code.

However, PDI-qualified exams are rigorously planned and implemented including carefully developed scan plans to optimize coverage of the required exam zone and actions to ensure the topography of the scan surfaces is suitable for satisfactory transducer contact. If these actions have been completed and satisfactory exam zone coverage can be demonstrated, variations in the above listed exam attributes may be dispositioned as having been satisfactorily resolved. Therefore, the MRP-262 R3 POD curve most aligned with the subject configuration and applicable PDI examination procedures can be assumed as suitably representative of the expected POD if a rigorous statistical basis were to be developed for that location.

The xLPR code includes a user input "effectiveness factor" on POD that varies from zero to 1 and can be applied to facilitate specific analysis objectives and to assess whether results are sensitive to the POD inputs. For locations with a predicted exam zone coverage of 100%, no effectiveness factor penalty on POD is warranted. In cases where the predicted coverage is less than 100%, the lack of coverage percentage may be applied at the analyst's discretion as a POD effectiveness penalty.

This discussion is summarized in the following assessment approach:

Recommended Assessment Approach:

1. Examination Surface mismatch is disqualifying.

2. If a competent detailed exam scan plan that demonstrates suitable exam zone coverage is in place *(or can be reasonably assumed for analysis purposes)* that accounts for the attributes listed above, the MRP-262 R3 POD curve most closely aligned with the subject configuration and applicable PDI examination procedures can be assumed as suitably representative.

3. In cases where exam zone coverage of less than 100% is predicted, the missed coverage percentage may be applied as a POD effectiveness penalty at the analyst's discretion.

4. To assess situations not covered here or with other extenuating circumstances, consult an NDE professional to characterize scanning effectiveness disparities, inform POD curve selection, and address whether a POD effectiveness penalty may be warranted.

Assessment Results for Specific LBB DM Weld Locations of Interest

Location	Recommendation	OD	Wall Thickness	Adjacent Materials	Weld Config.	Tapers & Obstructions	Exam Surface	Local Contours	Explanatory Notes
Category A PZR Surge	**MRP-262 R3**	12-14 in 305-356 mm	1.2-2.3 in 30-58 mm	LAS - SS	Single Vee	Minimal	OD	Modest	Reference Case
Category B2 RV In/Out	**MRP-262 R3**	27-31 in 686-787 mm	2.5-3.0 in 64-76 mm	LAS - SS	Single Vee		ID	Minimal	ID Reference Case
HL Surge	Apply Cat A	12.75 – 14 in	1.3 – 1.7 in	LAS – CASS?	Single vee	ID/OD Taper (Ref. MRP-216, Fig. A-34)	OD	Assume PDI-acceptable	Cat. A already included HL Surge and features are consistent
HL Shutdown Cooling Outlet	Apply Cat A	12.75 – 14 in	1.25 – 1.5 in	LAS – CASS?	Single vee	~45° uphill taper ~2" from weld CtrLine	OD	Assume PDI-acceptable	See Ref. 1 for expected coverage assessment
CL Shutdown Cooling & SI	Apply Cat A	~12 – 14 in	1.5 – 2 in	LAS - SS	Single vee	ID/OD Taper (Ref. MRP-216, Fig. A-34)	OD	Assume PDI-acceptable	See Ref. 1 for expected coverage assessment
RCP Inlet (CE)	Apply Cat A	~35 in	2.5 in	LAS - SS	Single vee	Elbow?	OD	Assume PDI-acceptable	See Ref. 1 for expected coverage assessment
RCP Outlet (CE)	Apply Cat A	~35 in	2.5 in	LAS - SS	Single vee	Minimal	OD	Assume PDI-acceptable	See Ref. 1 for expected coverage assessment
RCP Inlet (B&W)	Apply Cat A	33.5 in	2.5 - 3 in	LAS - SS	Single vee	Minimal	OD	Assume PDI-acceptable	See R. 1 for expected coverage assessment
RCP Outlet (B&W)	Apply Cat A	33.5 in	2.5 - 3 in	LAS - SS	Single vee	Elbow	OD	Assume PDI-acceptable	See Ref. 1 for expected coverage assessment
SG Nozzles	Apply Cat A	33.5 in to 50"	2.5 – 5.2"	LAS - SS	Single or Double Vee	OD tapers	OD	Assume PDI-acceptable	Procedures are qualified up to 5.2" thickness using same techniques demonstrated on thinner components.

References

1. ML18108A086 - NRC Public Meeting - Overview of CC N-770 Exam Issues – addresses examination capabilities and expected extent of coverage for the CC N-770 population of welds