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Bolting Degradation and NDE-ASME Section XI Code VS Applied NDE Technique Qualifications

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Abstract

Applied NDE for bolting degradation such as stress corrosion cracking (SCC) and wastage mandate improved methodology and a new approach to flaw acceptance standards. Current Code Acceptance Standards are based on a single bolt or stud installation. In a major turn about, a basis for new Acceptance Standards is being established which will take advantage of the redundancy in bolted closure design and establish criteria based on the entire closure integrity. This change will relax single stud/bolt maximum allowable flaw size making NDE qualification for SCC detection very realistic. This paper discusses new Code rules which mandate qualification based on flaws of interest vs impact if SCC is treated apart from current Code Acceptance Standards.

1. Introduction

A performance demonstration of an ultrasonics (UT) technique for detection of service induced stress corrosion cracking (SCC) requires that a meaningful threshold or allowable flaw depth be established. Current Code acceptance standards are based on a single bolt or stud installation. However when SCC is a concern, analysts tend to identify initiation as the required detection threshold for SCC. Detection of SCC at initiation is impracticable; it is also in conflict with current Code philosophy which provides a "threshold" or allowable flaw size and it conflicts with recently published rules for examination of bolting. Appendix VI of Section XI B&PV Code published in the Winter 1983 Addenda, 1983 Edition was the first mandatory NDE Code document to require a performance demonstration, or qualification, of the applied technique. Appendix VI states that "the purpose of the examination procedure (EP) qualification is to determine that the proposed examination technique is capable of detecting the specified flaw and to assure that its capabilities and limitations will be listed and recognized". A UT technique for SCC cannot be demonstrated unless a threshold or maximum allowable flaw size is provided. Failure to acceptably demonstrate an in-place UT technique may require periodic disassembly of SCC service sensitive bolted connections for surface examination. Dissassembly of a bolted connection for the sole purpose of NDE is not an acceptable option. The AIF/MPC Task Group on Bolting is committed to providing the methodology and approach to safety and service oriented in-place examinations. An Acceptable in-place UT technique can be demonstrated if meaningful Acceptance

Standards are provided by Section XI. Augmented visual examinations specific to leakage and corrosion detection will be key to the service sensitive approach. Redundancy inherent in the design of bolted connections should permit a change in Code philosophy for Acceptance Standards. The change will shift from a single bolt or stud to the leak tight integrity of the enclosure as a whole. This paper discusses Code rules for performance demonstration of UT techniques for bolting examinations; the application of acceptance standards for qualification; considerations for a service sensitive approach; and impact on the user where SCC and wastage of bolting are a concern.

2. Background

Appendix VI, Section XI titled, "Ultrasonic Examination of Bolts and Studs" provides rules for qualification of equipment, personnel, and procedures for UT examination to detect nonaxial indications in Class 1 (Category B-G-1) and Class 2 (Category C-D) bolts and studs. This Appendix simply requires that if you claim to have a UT technique for detection of SCC, you must demonstrate that technique and document its capabilities and limitations (if any). Appendix VI does not specify or endorse any specific techniques, it provides that any technique which demonstrates a capability to detect the "specified flaw", or flaw of interest, is qualified for use. This appendix represents a major change in Code philosophy where NDE is concerned. Techniques are identified by reference to the referenced Code (Section V); or a User developed technique may be applied. In another Code "first", Appendix VI requires that personnel successfully complete a performance qualification test specific to the examination procedure to be used. This performance qualification is in addition to the qualifications required in IWA-2300. The performance demonstration verifies the ability to detect and locate <u>all</u> test part reflectors <u>within the detectability and accuracy limits</u> specified in the examination procedure. Those of you familiar with the Code would probably find "detectability and accuracy limits" new Code phraseology. This phraseology is new, however, Code intent that maximum allowable flaw sizes be detected is inherent in the Acceptance Standards as published. The Code generic maximum allowable flaw size experiences a subtle change for SCC sensitive bolting when Appendix VI is applied and a fracture analyst assumes the position that SCC must be detected at initiation. Detection at initiation eliminates the threshold or maximum allowable flaw size, it also eliminates essential criteria for evaluating the examination procedure "detectability and accuracy limits" against a performance standard. The Code maximum allowable flaw size philosophy must remain for SCC and wastage and it must be established at meaningful levels without sacrificing safety considerations. Initiation of SCC is not detectable by UT, a threshold can be demonstrated. Redundancy in bolted closure design should provide the basis for the leak before break criteria[1] and provide meaningful allowable flaw size. Existing Code rules for bolting inservice inspection (ISI) would better address service induced degradation like SCC and wastage, and I believe ISI intent, if a service sensitive approach was utilized to determine scope, extent, and method of examinations. Existing Code examination criteria is a carry-over from the fabrication Code which requires a full length examination including unloaded portions.

3. Service Sensitive Approach

A service sensitive approach to bolting inservice inspection is described as follows:

- o apply combinations of NDE methodology eg. visual and/or monitoring for leakage using UT for assessment,
- o perform augmented volumetric examinations of any bolted closure with observed or detected leakage,
- o increase examination frequency for service sensitive bolting,
- o decrease examination frequency for non-service sensitive bolting,
- o specify required examinations to those areas which degradation is known or postulated to occur,
- o assume that no evidence of leakage is indicative of "no problem" provided, corrosion from another source is verified not to exist.

The service sensitive approach could utilize the Bolting Database[2] to establish when/where NDE is performed.

4. Conclusions

Section XI provides rules for performance demonstration or qualification of UT techniques for examination of bolting. The acceptance standards used can have major impact on qualification results. Compliance to Section XI is not practicable when initiation is established as the detection threshold for SCC. Acceptance standards for bolting based on the entire joint integrity should be used when they are developed. Current Code Acceptance Standards which are based on a single bolt or stud installation are too conservative and may preclude UT qualification for SCC and wastage. UT response characteristics inherent in bolting degradation like SCC and wastage must be considered in the technique evaluation. The UT qualification specimens should contain suitable representatives or simulations of these failure modes. A service sensitive approach is recommended for detection of bolting degradation like SCC and wastage.

5. References

1. SMIRT 8 Paper D 6/3 APTEC/The Use of Leak-Before-Break Criteria and Assessment of Margins in Addressing Closure Integrity Issues/Nickell, Cipolla, Merrick

2. SMIRT 8 Paper D 6/4 Materials Research and Computer Simulation/The Bolting Database: An Example of Numeric Application in the Nuclear Power Industry/ W. Oldfield, K. Nix, C. Cantrell, E. Merrick