Bruce Power's Nuclear Pressure Boundary Quality Assurance Program Requirements, Implementation and Transition

John Charles Krane, P Eng.

Bruce Power Inc., P.O. Box 1540, B10, Tiverton, Ontario, Canada, N0G 2T0
john.krane@brucepower.com

Abstract

The development of a full scope nuclear pressure boundary quality assurance program in Canada requires extensive knowledge of the structure and detailed requirements of codes and standards published by the Canadian Standards Association (CSA) and American Society of Mechanical Engineers (ASME). Incorporation into company governance documents and implementation of these requirements while managing the transition to more recent revisions of these codes and standards represents a significant challenge for Bruce Power, Canada's largest independent nuclear operator. This paper explores the key developments and innovative changes that are used to ensure successful regulatory compliance and effective implementation of the Bruce Power Pressure Boundary Quality Assurance Program. Challenges and mitigating strategies to sustain this large compliance based program at Bruce Power's 8 unit nuclear power plant site will also be detailed.
Keywords: Bruce Power, pressure boundary, certification, quality assurance, nuclear

1. Introduction

Bruce Power, Canada's largest independently-owned nuclear power producer has developed, implemented and independently certified a full scope nuclear pressure boundary quality assurance program. This paper will discuss some of the regulatory basis and requirements applied to the program. The relationships and application of the fundamental standards and codes that were used in the creation and certification of the program will also be explored. Key developments and innovations needed for successful control and compliance of pressure boundary related activities will be reviewed in detail. The continuing challenges and mitigating strategies needed to sustain this large compliance based program will also be summarized.

2. Regulation and Standards

Bruce Power has several regulatory conditions related to the control of pressure boundary work specified in its Power Reactor Operating License (PROL). The Canadian Nuclear Safety Commission (CNSC) is responsible to the government of Canada to provide regulation of pressure boundary activities at the Bruce Power 8 unit nuclear power reactor site. As part of the provision of these regulatory duties, the CNSC have appointed the Technical Standards and Safety Authority (TSSA) to act as their agent for the purposes of:

- Certifying the Bruce Power Pressure Boundary Quality Assurance Program and;
- Performing Authorized Inspection Agency (AIA) duties.

The TSSA is a company situated in Ontario Canada and is accredited to ASME QAI-1, Qualification for Authorized Inspection. As Bruce Power considers expansion plans for Alberta and Saskatchewan it is possible that further ASME QAI-1 accredited companies acceptable to the CNSC will be needed to fulfill future certification and AIA duties.

The PROL requires Bruce Power to: design, manufacture, fabricate, procure, install, modify, repair, test, examine and inspect or otherwise perform work to vessels, boilers, systems, piping, fittings, parts, components and supports according to the requirements of N285.0-95, etc. This enacts the requirements of a National Standard of Canada, CAN/CSA- N285.0-95, General Requirements for Pressure-Retaining Systems and Components in CANDU Nuclear Power Plants. The PROL also states that, where indicated by the Standard(s), the licensee shall obtain regulatory approvals for registered designs, accepted overpressure protection reports, standards and code classifications, registered welding and brazing procedures, qualified welders and brazers and examination personnel, quality assurance (QA) programs, etc.. It is the TSSA, acting as an agent of the CNSC who provides these approvals and regulates ongoing pressure boundary activities by acting as the AIA. The approval of the pressure boundary QA program is done by TSSA survey and issuance of TSSA certificates of authorization.

2.1 Classification

The relationship between the PROL, CSA N285.0 standard and ASME code is primarily developed through the classification process which is described in CSA N285.0. Classification definition can be simply summarized as follows:

- Class 1 systems remove heat directly from the nuclear fuel;
- Class 2 systems penetrate the containment structure and;
- Class 3 systems contain radioactivity and are not Class 1 or 2;
- Class 4 are containment system components.

In Canada, we also have a unique Class 6 designation for design and fabrication/installation of non radioactive system/components in nuclear power plants. Class 6 system/components will not be discussed in this paper as many of the controls and requirements are described in a different standard CSA B51, Boiler, pressure vessel and pressure piping code. CSA N285.0 defines the code class of the system and ASME Section III provides the requirements for the components of these systems as they take on the same classification. As specified in CSA N285.0, the CNSC regulator is required to approve classification designations for all new or modified systems.

2.2 Registration

CSA N285.0 also contains the detailed administrative requirements specific to Canadian regulators and the AIA. One of the key administrative requirements is registration of designs and use of Canadian Registration Numbers (CRN's). Application, approval and assignment of CRN's are the responsibility of the Canadian province of installation. In the case of Bruce Power in Ontario, this is the TSSA. Component and system designs require registration and submittals must be approved by the TSSA. This requirement is factored into the Bruce Power design control process.

3. Pressure Boundary Quality Assurance Manual

To successfully implement and control activities associated with the PROL, N285.0 and ASME requirements, a suitable Pressure Boundary Quality Assurance Manual (PBQAM) is required. The Bruce Power PBQAM was structured to and meets the requirements of:

- ASME Section III, Article NCA-4000, Quality Assurance and;
- The Basic Requirements and Supplements of ASME NQA-1, (Nuclear) Quality Assurance Requirements for Nuclear Facility Applications.

Specific controls and requirements were also included in the PBQAM to cover the use of additional QA standards CSA N286.1 & CSA N286.2 and CSA Z299 as well as ISO (the International Organization for Standardization) 9001. The amalgamation of these standards into a single workable PBQAM formed the key component and was the catalyst for Bruce Power's successful pressure boundary program certification.

The definition and structure of the controls in the PBQAM required major effort by a certification project team of key individuals assigned to provide input to every section of the PBQAM. Although Bruce Power had many elements of a pressure boundary program in place and functioning during the design, construction and operation of the 8 reactors site and large centre of site conventional steam supply system, there were gaps that were identified by a full scale comprehensive gap analysis performed by the project team with the assistance of an ASME code expert. Gaps identified resulted from evolution of code requirements, inadequate strict compliance (specific compliance was not satisfied as staff thought meeting intent of code was sufficient), and removal of code concessions by the regulator. All gaps were identified; analyzed and corrective action plans were prepared and independently verified for adequacy.

It was recognized early in the certification project that staff members assigned to the project required training in the codes and standards. Training was provided on Codes and Jurisdictions, ASME NQA-1 and other specific code sections applicable to assigned areas. Strong executive team support was also provided for setting expectations and assigning resources. Once the corrective action plans were approved, actions were tracked and regular project management meetings were held with the project team. This was important as there were many areas of the pressure boundary program where collateral support and handoffs were essential to success. Strong team communications assisted in driving the project success.

4. Key Developments and Innovations

As the gap analysis was performed, several areas of significant concerned were identified such as:

- identification and control of items;
- material code effective date reconciliation;
- control of non conforming items and;
- staff qualification and certification.

Each of these areas will be explored below.

4.1 Identification and control of items

Bruce Power was formed in May 2001. It took control of assets from Ontario Power Generation (OPG). OPG is owned by the provincial government of Ontario. Before the formation of Bruce Power; OPG designed, constructed and operated all nuclear power plants at 3 different sites in Ontario. Over the past 30+ years, quantities of pressure boundary items were purchased and warehoused at various OPG sites. When Bruce Power took control of these assets non- compliances existed with respect to the identification and control of these pressure boundary items. In some instances, history docket records were missing and not traceable back to the items. In other instances, item markings were degraded or missing or item material condition had degraded. There were also issues with respect to the identification of pressure boundary vs. non pressure boundary items in the master material catalogue. The corrective action that was initiated by Bruce Power was broad in scope and very comprehensive. The entire master material catalogue (75,000 items) was reviewed and 25,000 catalogue identifications (CID's) were put into a warehouse hold (QCPEND) until re-inspection cleared the items by satisfying the following requirements:

1) identified as a pressure boundary item;
2) technical and quality requirements were met;
3) the item was clearly identified using an orange Bruce Power CID label (see Figure 1).

Eventually, after further review, approximately 14,000 CID's were flagged as pressure boundary items. Items with high demand were given priority and have been inspected and released from QCPEND or scrapped and re-ordered. The remaining CID's will stay under control in QCPEND until demand triggers an inspection prior to use. Staff was trained and now recognizes that only items with orange CID labels are suitable for use in pressure boundary systems. This acts as another barrier to inadvertent use of non pressure boundary items. An example of an orange pressure boundary CID label is shown below in figure 1.

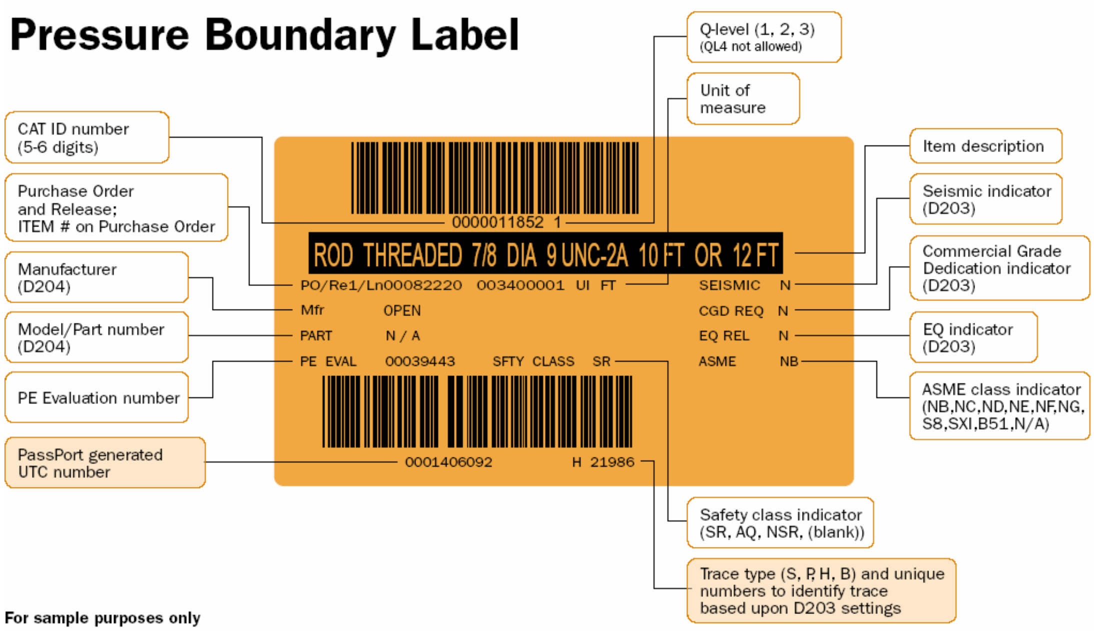

Figure 1 Example of an Orange Pressure Boundary CID Label

4.2 Material code effective date reconciliation

CSA N285.0 called for the most recent code editions/addenda be used for modifications. This caused many materials with different ASME code effective dates (CED's) to be specified, assigned separate CIDs and potentially stocked in the warehouse. In order to stay compliant with requirements and keep material inventory at reasonable levels, material with different code effective dates were evaluated and grouped under single CIDs when the material had the same technical and quality properties, i.e. no changes were found when the material was evaluated and reconciled over a range of code effective dates. This allowed for a marked reduction in the number of CIDs. All of these material CIDs with multiple CED's receive an annual review to ensure no impact from code changes.

4.3 Control of non conforming items

To improve the use of the control of non conforming items process, Bruce Power amalgamated 6 different individual processes that were being used on site into a single Control of Non-Conforming Items process. The new non conformance reporting process allows any staff member to report suspected non conformances. Inspection and test qualified personnel are responsible to ensure that the item is tagged and segregated. The non conformance report is entered into existing company wide corrective action process database which can store information and is used for tracking purposes. Non Conformance Verifiers are identified by procedure and are contacted to confirm that the item in question is truly non conforming and is being controlled. Evaluators are then assigned based on the nature of the non conformance (i.e. PB Specialists for Fabrication and Installation Non Conformances) and complete the disposition and assign actions. This information is then entered into a Non conformance Report and attached to the Corrective Action Report where disposition actions are tracked to completion.

4.4 Staff qualification and certification

Approximately 2400 Bruce Power staff are identified as having the ability to work on pressure boundary activities. Staff in these functions are attached to a minimum Pressure Boundary Indoctrination qualification and are required to complete a computer based course and exam. This information is controlled and tracked in a company wide training database (TIMSII). Other staff are similarly attached to additional qualifications needed to perform their assigned roles. Inspection and Test staff (i.e. Source Surveillance Technicians, Non Destructive Evaluation Technicians, Pressure Boundary Specialists, Inspection and Test Planners and In Process Inspectors, etc.) are all linked to specific training requirements that were identified after completion of a rigorous evaluation using a systematic approach to training process. Staff filling these positions are required to take all necessary training to become qualified. Once qualification is obtained and the training results entered into TIMSII, a standardized format certificate is generated from the TIMSII database listing all of the required pressure boundary training for the role being performed and the allowed scope of activities. These certificates are updated and reissued annually.

5. Pressure Boundary Program Certification Survey

Many other processes were changed and aligned to the requirements of the CSA standard and ASME code. When the project manager was satisfied that these processes were close to being fully compliant a third party code expert was used to evaluate and provide feedback on the implementation. This proved to be a worthwhile exercise as some additional gaps were uncovered and corrected. An additional third party code expert review was also performed on the certification survey demonstration job. Two non conformances were identified during the review and were controlled as per the non conformance process. This control was used to demonstrate the non conformance process during the survey.

The pressure boundary certification survey was performed by the TSSA. The TSSA are accredited by ASME to QAI-1 and were approved by the CNSC to act as the Bruce Power pressure boundary quality assurance program accreditor. The CNSC also acted as an observer on the survey. The pressure boundary processes were primarily demonstrated by the use of a class 1 feed and bleed modification demonstration job constructed to the most recent code effective date. One minor finding was identified during the survey and was corrected immediately to the satisfaction of the survey team. Following the survey, 10 Certificates of Authorization were issued to Bruce Power from the TSSA, covering the full scope of work identified in the PBQAM.

6. Sustaining the Pressure Boundary Program

In many ways this is the start of the challenge for Bruce Power. A large scope pressure boundary program, being implemented across a large 8 nuclear reactor site presents it own set of challenges. Bruce Power has set up an oversight program that observes and evaluates implementation and control of the PBQAM. Changes to the PBQAM, pressure boundary related procedures and organization manuals are routed through and controlled by the Pressure Boundary Specialist. Assignment of full time AIA staff stationed directly at the Bruce Power site adds to the consistency of knowledge of the Bruce Power processes and staff involved in key functions (i.e. Inspection and Test, etc.). Regular dialogue between Bruce Power oversight staff and the AIA staff help to identify any developing issues and have them corrected quickly. Experienced Inspection and Test staff also perform a key role in identifying and reporting non conformances. This is helping preserve program compliance and safety at a time when new staff are coming into the company in increasing numbers. Results from oversight reports are reported and communicated to the Bruce Power management team semi annually during the Business Health Evaluation report. Corrective actions are assigned and the results are continually tracked and trended. Additionally, Bruce Power has an active focus area self assessment program. Certification efforts were greatly assisted by a full and rigorous self assessment of all PBQAM sections and implementing documentation and activities prior to the certification survey. These focus area self assessments continue annually and form an input to the Business Health Evaluation report.

7. Transition to Newer Codes and Standards

As codes and standards change, Bruce Power will be required to adopt the changes (as specified in changes to our PROL) by integrating them into our PBQAM and implementing them across site. The anticipated 2009 revision of our PROL, calling out new revision requirements from N285.0, will require Bruce Power to adopt changes that will affect our classification and registration processes Changes to inspection and test planning, operational pressure test, use of Licensee Verifiers, ASME code effective date for modifications and requirements for in-service plugging by fusion welding of nuclear class heat exchangers are some of the other changes that will require more consequential revisions to our processes. Also, a new PROL requirement will require Bruce Power to directly contract with an AIA service provider acceptable to the CNSC. Bruce Power are committed to ensure that these and future changes are rigorously evaluated and implemented to ensure ongoing compliance.

8. Conclusion

The Bruce Power Pressure Boundary Program is a full scope nuclear pressure boundary quality assurance program that meets the requirements of the PROL, CSA N285.0 and applicable ASME code requirements. A significant effort was expended to fully incorporate the requirements into company governance, standardize and improve processes, fully implement and complete assessment evaluations of effectiveness. Challenges remain and will be ongoing as Bruce Power continues to maintain and improve processes and make necessary changes while hiring and bringing new staff into roles that affect the program. Strong oversight and continued evaluation while working with our AIA will provide assurance that compliance will continue and will be sustainable.