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Analyzing the ASME BPV Code of Construction Professional Engineer Accreditation Requirements and their impact in Central, South America and Mexico

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Abstract– ***Central, South America and Mexico have about 36 ASME Section VIII U2 certificate holders [1] while their vast majority of engineering degree programmes are not recognized by international engineering accreditation organizations.***

Current international code practices for Boiler, Pressure Vessel and Nuclear Construction are moving towards mandating the presence of Certifying Engineers who are in responsible charge for both equipment User Design Specifications (UDS) and Manufacturer's Design Reports (MDR), in order to guarantee that the design and construction of the pressure-retaining component adhere to the ASME Boiler and Pressure Vessel Code design margin philosophies. However, the lack of international engineering degree programme accreditation within the vast majority of countries located in Central and South America is a barrier that cannot be easily surpassed without the engineers having to undergo a thorough revalidation process within the jurisdiction of a foreign country that has accredited their engineering degree programmes to the Washington Accord or the EUR-ACE label, in order to comply with the present-day rules.

Therefore, pressure vessels and components construction to ASME Section VIII, Divisions 1 to 3 and ASME Section III in Central, South America and Mexico will go through design, construction and installation. If the application requires a Certifying Engineer to be in responsible charge, subcontracting costs of at least two Certifying Engineers need to be considered to certify the UDS and MDR of the vessel. This requires contacting and contracting professional engineers outside of their own jurisdictions for vessels that would be specified, constructed, and put into service inside their own jurisdiction.

This paper presents the recently approved ASME Section VIII, Divisions 1 and 2 CodeCase 3036 that the authors developed with substantial help from manufacturers, authorized inspection agencies and other interested parties within Central, South America and Mexico; to attempt to close the gap in these jurisdictions while international engineering degree programme accreditation is achieved in the region, although not without placing substantial restrictions to locally-registered engineers.

Keywords—ASME, Certifying Engineer, IEA, Professional Engineer, Engineers Europe

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I. Introduction

The American Society of Mechanical Engineers (ASME) established the Boiler & Pressure Vessel Code (BPVC) in 1911 in order to improve the safety of pressure vessels and boilers, and published the first BPVC Edition in 1915. Before legal construction codes were introduced, there had been numerous boiler explosions throughout the 19th century. One of the most catastrophic incidents was the Grover Shoe Factory Disaster in Brockton, Massachusets on March 10, 1905 where a boiler exploded, resulting in 58 deaths and 117 injuries [2].

Thus, the need for a minimum safety margin was recognized to provide human lives and industrial installations adequate protection. It is recognized that pressure vessel integrity is supported on the following four pillars:

1. Examination and Inspection
2. Welders
3. Materials
4. Design

Prior to following the ASME Code of Construction, none of these pillars had minimum technical requirements established and allowed designers, material manufacturers, equipment construction, welding, examination and inspection personnel to follow their own judgement for equipment that would be installed in public spaces.

All four pillars have minimum qualification requirements incorporated into the Code, and while Examination and Inspection personnel and Welders need to be qualified to be involved in pressure vessel construction; the qualification and certification of designers has not been required for all applications. In the ASME Section VIII, Division 1 2019 Edition the Mandatory Appendix 47 "Requirements for Pressure Vessel Designers" was introduced, launching the Certifying Engineer figure for Pressure Vessels constructed to ASME Section VIII, Division 1.

One of the current requirements in ASME Section VIII, Division 1, Mandatory Appendix 47, section 47-2(a)(1) [3] and Section VIII, Division 2, Annex 2-J, section 2-J.3.2(b) [4] states that the engineer in responsible charge [5] shall be Chartered, Registered, or Licensed in accordance with one or more of the following:

- As a Registered Professional Engineer in at least one state of the United States or at least one province of Canada
- With the International Register of Professional Engineers by an authorized member of the International Professional Engineers Agreement (IPEA)
- With an Authorized Member of the Asia Pacific Economic Cooperation (APEC)
- With an authorized member of the European Federation of National Engineering Associations (Engineers Europe)

Central, South America and Mexico have historically followed regional accreditation in lieu of international accreditation [6] and thus, are lagging behind attaining international recognition of their engineering degree programmes. Although significant effort has been made to accredit the engineering degree programmes from Central and South American countries [7] these are not internationally recognized due to the programmes not adhering to the Washington Acccord or obtaining an EUR-ACE label, rendering them uneligible to join one of the international professional engineer accords part of the International Engineering Alliance or Engineers Europe.

The ASME Section VIII, Division 2 prior 2017 Edition allowed locally-registered engineers as an acceptable substitution for Certifying Engineers that were not able to join an international engineering accord [8]. This removal left the Central and South American locally-registered engineers without a way to comply with the Section VIII, Division 2 Certifying Engineer requirements in the 2019 Edition of the Code.

II. International Engineering Accreditation Accords

In order for a Latin American engineer who is chartered, registered or licensed locally within any of the countries within Central and South America to meet the ASME Section VIII, Division 1, Mandatory Appendix 47, section 47-2(a)(1) or Section VIII, Division 2, Annex 2-J, 2-J.3.2.(d) they would have to join one of the International Engineering Alliance (IEA) professional engineering accords or become a member of the European Federation of National Engineering Associations.

The purpose of these International Professional Engineering agreements is to establish an international benchmark of competence for independent practice as a professional engineer and a framework for the recognition of substantial equivalence of standards and quality assurance systems [9].

Each accord defines the benchmark competence standard which shall be demonstrated by each candidate in order to successfully achieve membership. In general, each candidate shall demonstrate acceptable competence in the following areas detailed below:

A. Academic achievement
B. Professional engineering competence for independent practice
C. A minimum period of practical experience since graduation
D. A minimum period in responsible charge of significant engineering work

A. Academic Achievement

IPEA and APEC both require that the engineering degree programme has been either:

- Accredited in a jurisdiction holding signatory status of the Washington Accord.
- Delivered and accredited in accordance with the best practice guidelines developed by the Federation of Engineering Institutions of Asia and the Pacific.
- Listed in the Index compiled by the Engineers Europe (formally known as FEANI).

Engineering degree programmes not able to comply with the requirements detailed above may be validated by one of the following:

- The Engineering-in-Training examination set by the Institution of Professional Engineers Japan (formerly: the Japan Consulting Engineers Associations).
- The combined Fundamentals of Engineering and Principles and Practices of Engineering examinations set by the United States National Council of Examiners in Engineering and Surveying.
- A structured programme of engineering education accredited by an agency independent of the education provider, and/or one or more written examinations set by an authorized body within a jurisdiction, provided that the accreditation procedures and criteria and/or the examination standards have been endorsed by all Authorized Members.

Engineers Europe requires that the engineering degree programmes possess an EUR-ACE seal to be eligible, though each individual member may also provide a way for other engineering degree programmes to prove that their programme is equivalent.

B. Professional Engineering Competence for Independent Practice

Each economy assesses the candidates as eligible for independent practice through a competency based assessment acceptable to the Authorized Members that confirms that they

have developed the necessary level of practice skills and professional maturity to meet the IEA exemplar competency criteria.

The range and level of the competencies required are normally expected to include competence to:

- Apply engineering knowledge to the analysis and solution of engineering problems; and
- Provide technical and managerial leadership; and
- Use effective communication and interpersonal skills.

C. Experience

While the exact definition of practical experience will be at the discretion of each member evaluating the candidate for membership of an accord; generally IPEA and APEC require 7 years of experience and Engineers Europe evaluates the required years of experience depending on the European Qualification Framework (EQF) varying typically between 2 to 10 years of experience. [10]

D. Responsible Charge

The National Society of Professional Engineers in the Position Statement No. 10-1778 define Responsible Charge as detailed below:

> *"Position Statement: It is the position of the National Society of Professional Engineers (NSPE) that engineering should be performed by a professional engineer in responsible charge of the work.*
>
> *Background: The NCEES model law defines "Responsible Charge" as the direct control and personal supervision of engineering work. The Board of Ethical Review has reinforced this definition throughout their case evaluations. The professional engineer in Responsible Charge is actively engaged in the engineering process, from conception to completion. Engineering decisions must be personally made by the professional engineer or by others over which the professional engineer provides supervisory direction and control authority. Reviewing drawings or documents after preparation without involvement in the design and development process does not satisfy the definition of Responsible Charge."* [5]

Responsible Charge of Significant Engineering Work is deemed satisfied per the IEA agreement Section B: General Rules and Procedures when the applicant has:

- Applied in the required standards
- Planned, designed, coordinated and executed a small project; or
- Undertaken part of a larger project based on an understanding of the whole project; or
- Undertaken novel, complex and/or multi-disciplinary work.

IPEA and APEC both require a minimum period of two years in responsible charge of significant engineering work.[9]

III. The United States and Canada Registered Professional Engineer system

The United States and Canada have their own professional engineer registration system that is managed independently by each state. For a foreign engineer whose engineering degree programme is not ABET-accredited for the US or CEAB-accredited for Canada, the path forward is to go through an extensive revalidation process including a number of exams to be determined individually.

Aspiring Professional Engineers in the US and Canada need to first go through an Engineer-In-Training period before achieving full Professional Engineer status. In the case of the U.S. they also need to pass the combined Fundamentals of Engineering, and Principles and Practices of Engineering examinations set by the United States National Council of Examiners in Engineering and Surveying. Additional examination may be necessary in the case of Canada, where engineers are also required to pass the National Professional Practice Examination (NPPE).

The main roadblock for international applicants, provided that they have their engineering degree programmes revalidated through evaluation and passing the required tests specified; is providing evidence of Canadian experience (which they cannot provide if they have never worked in Canada nor have plans to) or providing three (or five in order to waive the Fundamentals of Engineering exam) references from licensed, chartered, or registered professional engineers recognized by the US state, since most international applicants have never worked in the US.

Therefore, becoming a Registered Professional Engineer (RPE) in the US or Canada is nearly impossible to achieve for international applicants living outside of these countries.

IV. ASME Section VIII, Divisions 1 and 2 CodeCase 3036

A new CodeCase was developed and approved through the ASME Boiler & Pressure Vessel Section VIII Committee to close the gap of Certifying Engineer requirements for regions where licensure according to International Engineering Alliance, US/CAN Registered Professional Engineers and/or Engineers Europe is not currently available.

The main intent is to allow jurisdictions to design and construct ASME Section VIII, Division 2, Class 2 pressure vessels inside their own jurisdictions, by engineers authorized for work by local jurisdictions, while providing a way to comply with ASME Section VIII, Division 1, Mandatory Appendix 47 recently incorporated Certifying Engineer figure.

The CodeCase 3036 is presented below [11]:

"Case 3036

Alternative Requirements for Certifying Engineer Qualification, Section VIII, Division 1; Section VIII, Division 2

Inquiry: As an alternative to the requirements of Section VIII, Division 1, Mandatory Appendix 47, 47-2(a)(1) or Section VIII, Division 2, Annex 2-J, 2-J.3.2(c), under what conditions may an engineer chartered, registered, or licensed within the jurisdictions where the vessel design and manufacturing take place and the jurisdiction of the location of the installation, be qualified as a Certifying Engineer?

Reply: It is the opinion of the Committee that in lieu of the requirements of Section VIII, Division 1, Mandatory Appendix 47, 47-2(a)(1) or Section VIII, Division 2, Annex 2-J, 2-J.3.2(c), an engineer chartered, registered, or licensed within the jurisdictions where the vessel design and manufacturing take place and the jurisdiction of the location of the installation, shall comply with the following requirements to be qualified as a Certifying Engineer:

a) The engineer shall have met all required qualification requirements given in Section VIII, Division 1, Mandatory Appendix 47, 47-2(a)(2), or Section VIII, Division 2, Annex 2-J, 2-J.3.2(b), except that the engineer shall have a minimum of 8 yr of experience in the design of pressure vessels and any supplemental requirements stipulated by the user. For Division 2 applications, the person shall attest in writing that they understand and meet the requirements of the ASME Code of Ethics.

b) The engineer shall have received authority to perform engineering work from licensing or registering authorities.

c) The engineer shall identify the locations and the licensing or registering authorities under which they have received the authority to perform engineering work.

d) The engineer shall comply with the requirements of the locations to practice engineering where the vessel design and manufacturing take place, and the requirements of location of the installation.

e) The engineer shall provide evidence showing that engineers in the jurisdictions where the vessel design and manufacturing take place, and the jurisdiction of the location of the installation, are not currently able to be chartered, registered, or licensed in accordance with Section VIII, Division 1, Mandatory Appendix 47, 47-2(a)(1), or Section VIII, Division 2, Annex 2-J, 2-J.3.2(c), to the satisfaction of the Authorized Inspector.

f) The jurisdictions where the vessel design and manufacturing take place and the jurisdiction of the location of the installation shall be within Central and South America.

g) This Case number shall be shown on the Manufacturer's Data Report"

CodeCase 3036 item a) requires a minimum number of 8 years of experience in the design of pressure vessels, which is above the 4 years of experience required in ASME Section VIII, Division 1, Mandatory Appendix 47, section 47-2(a)(2) and Section VIII, Division 2, Annex 2-J, section 2-J.3.2(b).

Item d) requires that the practising engineer is chartered, registered, or licensed in the locations where the vessel design and manufacturing take place, and in the location of the installation.

Item e) requires that the jurisdictions where the vessel design and manufacturing take place, and the jurisdiction of the location of the installation are outside US, Canada and outside IEA and Engineers Europe application.

Item f) requires that where the vessel design and manufacturing take place, and the jurisdiction of the location of the installation shall be within Central and South America, placing a strict geographical limitation.

V. Analysis

The lack of international engineering degree accreditation in Central, South America, and Mexico places an enormous barrier for Latin American engineers looking to apply international codes of construction even within their own jurisdictions, which only requires local registration of the engineer in order to enable professional engineering practice.

International engineering degree programme accreditation is a fundamental step of the process of becoming a Professional Engineer. If an engineer desires to join one of the international engineering accords, their engineering degree programme must first be recognized as qualified according to international standards and all cases where they are not; need to be evaluated on an individual basis by an international accreditation agency in order to determine whether the engineering degree programme and the engineer individual qualifications are considered equivalent, or if they have to go through a revalidation process.

It is recognized that when an engineer submits an application to revalidate their engineering degree programme and succeeds all the required additional tests and courses (as determined applicable), other engineers that possess the same engineering degree programme and submit another application are not automatically exempted from further examination or coursework: that is usually subject to the evaluation of the international accreditation agency. Therefore, the revalidation process is very time consuming and inefficient. Thus, it is recommended for countries to directly submit an organization to become signatories of the Washington Accord or EUR-ACE label holders.

Once an engineer desiring to become certified as a Professional Engineer, has achieved international recognition of their engineering degree programme, that is, it has been deemed equivalent to the Washington Accord or the EUR-

ACE label benchmark, the engineer may now apply to an international engineering accord to become a Certifying Engineer in responsible charge of pressure vessel construction.

The ASME BPV Code requires evidence of engineer qualification for Certifying Engineers in order to ensure that the specified design margin is satisfied. In Pressure Technology application (Section VIII) this change was driven by numerous design flaws detected by inspection agencies and regulatory boards related to deficient engineering practice. In the Nuclear Industry, being the consequence of equipment failure even more significant, the ASME BPV Code Section III, Mandatory Appendix XXIII, section XXIII-1223(b)(1) defines similar requirements to ASME Section VIII, Divisions 1 and 2, except that Section III, Mandatory Appendix XXIII, XXIII-1223(b)(2) allows engineers chartered, registered, or licensed by a country or entity recognized by the Washington Accord as a full signatory member, to comply with the necessary qualifications.

It is important to recognize that only the engineering degree programmes are certified to the Washington Accord, not engineers. Thus, when this requirement is compared to the other International Engineering Accords qualification benchmarks, only the Academic Achievement would have been satisfied when ASME Section III, Mandatory Appendix XXIII, section XXIII-1223(b)(2) is complied with.

Section XXIII-1223(c) also requires a minimum of 4 years of experience, at least 2 of which have been in each specialty field for which they perform certifying or review activities as delineated in sections XXIII-1230 through XXIII-1270, which may be used to comply with the Experience and Responsible Charge benchmark defined by the International Engineering Alliance. [12]

When the Certifying Engineer qualifications requirements from ASME Sections III and VIII are compared, it is important to note that although both sections require a minimum number of years of experience; the Washington Accord alone may be used to satisfy the professional engineer qualifications for Section III use, but it may not be used to satisfy the qualifications for Section VIII use.

Allowing use of the Washington Accord as replacement for an International Professional Engineer Accord membership such as IPEA, APEC or Engineers Europe, places the burden of qualifying the ability of the Professional Engineer in responsible charge of the pressure vessel construction in the Certificate Holder, subject to the Authorized Inspector approval and the User's acceptance. An engineer's ability to be in responsible charge does not depend solely on the quality of their engineering degree programme: the quality and relevance of their experience is critical to guarantee adherence to the ASME Code margin of design and philosophy.

On the other hand, CodeCase 3036 leverages local registration as a possible substitution to membership of an International Professional Engineering Accord within the Central and South America region, provided that a number of substantial limitations are met:

CodeCase 3036 Item d) requires that the engineer is chartered, registered, or licensed in three locations that may be distinct: where the vessel design takes place, where the manufacturing takes place, and in the location of the installation. As a consequence, international vessel procurement will be significantly impacted: As an example, Argentina purchases many pressure vessels for Section VIII use from Brazil and thus, this item will severely restrict international application even within the boundaries of Central and South America, considering that the Certifying Engineer will have to provide evidence to the Authorized Inspector that they are chartered, registered, or licensed within both Brazil and Argentina for the User Design Specification or Manufacturer Design Report certification, whichever is applicable.

CodeCase 3036 Item e) aims to limit the applicability of this CodeCase to jurisdictions where membership of an International Engineering Accord or US/CAN Professional Engineer Registration is not currently possible. However, the drawback of this item is that it currently renders jurisdictions becoming provisional or full signatory members of the Washington Accord unable to use this CodeCase.

Once a country becomes a provisional signatory of the Washington Accord, they are recognized as having their accreditation procedures being under supervision and thus do not yet enjoy full rights under the Washington Accord agreements. However, in order to become a provisional signatory, they must have started the process with an authority, agency, body or institution that is independent of the academic institution delivering accredited programmes within their jurisdiction.

As a consequence, a local (or regional) engineering accreditation body must have been formed and this body is being trained to perform all engineering degree programme accreditations within their jurisdictions. This renders the jurisdiction unable to comply with Item e) of the CodeCase 3036, since the Authorized Inspector may challenge the jurisdiction's inability to join an international engineering accord, as the local accreditation body could potentially provide assitance to the engineering programmes in achieving international recognition.

Another obstacle becomes apparent for jurisdictions becoming full signatories of the Washington Accord or holding a EUR-ACE label. After this feat, all future engineering degree programmes automatically become certified, but those that were received by actively practising engineers do not automatically become Washington Accord or EUR-ACE certified. Subsequently, more work needs to be done by both the Engineering Accreditation Body and the Engineer in order to being eligible to join an International Engineering Accord, see section II.A above.

Mexico has been recently approved as a full signatory of the Washington Accord, represented by the Consejo de Acreditación de la Enseñanza de la Ingeniería (CACEI) in 2022, although it is noted that this approval is subject to conditions set out by the Washington Accord meeting at

IEAM 2022. Thus, Mexico may not use CodeCase 3036 along with other Central and South America countries that are full or provisional signatories of the Washington Accord (Peru, Costa Rica and Chile).

The international application of CodeCase 3036 is restricted by its Item f), rendering all other jurisdictions outside Central and South America unable to use this CodeCase. It is understood that there are several other jurisdictions that may not yet join an International Engineering Accord, and may not be in compliance with the current ASME Section VIII and Section III Certifying Engineer qualification requirements. These jurisdictions would also benefit greatly from application of this CodeCase, should item f) be removed or modified in the future.

RECOMMENDATIONS

- The ASME BPVC Committee should review the Certifying Engineer qualification requirements, taking into consideration the significant barriers to achieving international engineering degree recognition for jurisdictions that are outside the International Engineering Alliance (IPEA) and the European Federation of National Engineering Associations (Engineers Europe).
- The ASME BPVC Committee should consider modifying the existing CodeCase 3036 in order to improve its applicability not only to Central and South America, but also to other jurisdictions that may not currently comply with ASME Section VIII, Division 1, Mandatory Appendix 47, 47-2(a)(1), or ASME Section VIII, Division 2, Annex 2-J, 2-J.3.2(c).
- Each individual country in Central and South America should move towards achieving international engineering degree accreditation recognition through either the Washington Accord or the EUR-ACE label, a need that becomes even more necessary as the world becomes increasingly globalized.
- Starting an international Engineering Association in Central, South America and Mexico may be considered in order to achieve global engineering degree programme accreditation for all countries, similar to Engineers Europe in Europe.
- Each individual university should also consider applying to become a Washington Accord full signatory or to hold a EUR-ACE label, conductive to providing their future engineers with more opportunities for professional engineering practice.
- The revalidation process of engineering degree programmes for jurisdictions that have not yet achieved international recognition should be improved in order to enable practising engineers to qualify as future Professional Engineers in a more efficient manner.

CONCLUSION

The qualification of Certifying Engineers in ASME Boiler and Pressure Vessel Code (BPVC) application is paramount to achieving the desired design margin leading to guaranteeing public safety. Engineers in responsible charge of pressure vessel construction are required to join an International Engineering Accord such as the International Professional Engineers Agreement (IPEA), the Asia Pacific Economic Cooperation (APEC) or the European Federation of National Engineering Associations (Engineers Europe).

Central and South America's lack of international engineering degree programme accreditation is becoming an obstacle to comply with the latest editions of the ASME BPVC. As a result, CodeCase 3036 was designed and implemented in order to attempt to close the gap for this region.

Nonetheless, CodeCase 3036 currently places substantial limitations and restrictions to professional engineering practice that makes it impractical for international exercise within Central and South America, prohibits all application outside this region and disallows use once a jurisdiction becomes a full or provisional signatory of the Washington Accord, or becomes a EUR-ACE label holder.

Therefore, Central and South America are encouraged to join the international engineering degree programme accreditation standard that is a product of the globalization of the engineer. The ASME BPVC Committee are also encouraged to improve CodeCase 3036 in order to lead the way for jurisdictions that are currently lacking international engineering degree programme recognition, and for those that are in the process of gaining international recognition.

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