

Report
on
ISO 16528
“Boiler and Pressure Vessel Standard”
Submitted to
ABSA

K. Lau, Ph.D., P.Eng., Life Fellow ASME
Advisor – Codes, Standards and Policies
ABSA the pressure equipment safety authority
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EXECUTIVE SUMMARY

This report provides a review of ISO, ISO/TC, EU and PED in relation to boiler and pressure vessel standards. Some details are given on the historic development of ISO 16528, intent and the content of the standard, as well as how the ISO 16528 Parts 1 and 2 are applied. The relationship of CSA B51 to ISO 16528 and how ISO 16528-1 is adopted for use in the Province of Alberta, Canada are detailed.

(I) ISO and ISO/TC

ISO

The International Organization for Standardization (see www.iso.org) – “a world federation of national standards bodies first established in 1946 now consists of 164 national standards bodies”

ISO/TC

Technical Committees are formed, and the main task of the committees is to develop “International Standards”. There are now a total of 329 Technical Committees (with additional 457 subcommittees making a total of 786 Technical Committees and subcommittees).

ISO Member Bodies

Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. As well, international organizations and NGOs, in liaison with ISO, may also take part in the work. Each ISO Member, for the work in the ISO/TC, would have its “Advisory Committee” which represents the member body in the ISO/TC and votes on all ISO/TC proposals and resolutions.

ISO/TC11 Boilers and Pressure Vessels

ISO/TC11 was one of the first Technical Committees established. It now consists of 25 participating member countries (including Canada) and 33 observer countries (see <https://www.iso.org/committee/46156.html?view=participation>). Two standards are published under ISO/TC11.

Currently, the Secretariat of ISO/TC11 is ANSI and the Committee Manager is Mike Burns of the National Board of the Boiler and Pressure Vessel Inspectors. The ISO/TC11 is on “Standby” currently.

The American National Standards Institute (ANSI is a private, not-for-profit organization dedicated to supporting the United States voluntary standards and conformity assessment system and strengthening its impact, both domestically and internationally) and represents the US in ISO. The ASME Technical Oversight Management Committee (TOMC) is the US Advisory Committee that

participates in the developmental work of ISO/TC11 and votes on all proposals and resolutions.

Canada is represented in ISO by Standards Council of Canada and the ISO/TC11 Canadian Advisory Committee/Council (ISO/TC11 CAC) participates in the developmental work of ISO/TC11 and votes on all ISO/TC11 proposals and resolutions.

ISO 16528-1 and ISO 16528-2

Under the direct responsibility of ISO/TC11, ISO 16528 Boilers and pressure vessel standard was first published in 2002.

The ISO 16528 was restructured and published in 2007 as:

ISO 16528-1:2007 — Part 1: Performance requirements; and
ISO 16528-2:2007 — Part 2: Procedures for fulfilling the requirements of
ISO 16528-1

In accordance with ISO website information, both ISO 16528-1 and ISO 16528-2 were last reviewed and confirmed in 2016, therefore both standards remain current.

(II)

Boiler and Pressure Vessel Standards and Regulatory Requirements

Boilers and pressure vessels have been in use for eons and have been the most important mechanical equipment since the industrial revolution. With the increased use of boilers and pressure vessels starting late 1700's, numerous incidents occurred with, unfortunately, a huge number of fatalities. Because of the very significant public safety concerns, pressure equipment laws were promulgated by almost all governments around the world.

Since that time, many pressure equipment standards were developed and published by government-sponsored bodies, learned organizations and/or industrial organizations. *"The design of pressure vessels can be regarded as one of the oldest topics for mechanical engineering science investigation"*¹

There is a proliferation of regional and national standards in boilers and pressure vessels with *"differing approaches historically taken by regulatory authorities, and differences in the underlying design and construction philosophies in the various national and regional product standards"*. As well *"up to now, codes, standards, certification systems and regulations have together formed a set of interlocking requirements to assure that equipment is safe to operate"*²

¹ "Boiler Explosion at Dudley" by W. Smith, 1st paper published in the Institution of Mechanical Engineers, UK., Vol.1, 1848.

² Performance-based innovation for boilers and pressure vessels by S. Cameron – ISO Focus June 2008

(III) EU (European Union) and PED (Pressure Equipment Directive)

PED 97/23/EC (now PED 2014/68/EU)

The Pressure Equipment Directive was first issued by the European Commission in 1997, with the aim *“to guarantee free movement of the products in its scope while ensuring a high level of safety”*³.

Quoting directly from ABSA Pressure News Vol. 4, Issue 4 (December 1999):

“Directives” as issued by the European Parliament and the Council of the European Union are “laws” which each member state is obliged to translate into their national laws within a specific period of time. The PED is effective November 29, 1999 and between November 29, 1999 and May 29, 2002, pressure equipment may comply with the PED or existing national requirements. However, after May 29, 2002, the PED will be mandatory in the European Community member states.

The PED provides for essential safety requirements. Proof of conformity will necessitate different modules of conformity assessment procedures depending on different categories (levels of risk) of equipment. The PED will impact on pressure equipment of 0.5 bar (approx. 7.5 psig or 52 kpa) pressure. In addition, only “Notified Bodies” will be allowed to perform the necessary third party inspection, verification, and accreditation and certification services when such services are required as part of the conformity assessment procedures. Also, only materials acceptable to the PED will be allowed for use in pressure equipment construction.

A new pressure equipment design and construction standard is being prepared by CEN and is expected to provide for extensively different requirements from the international standards currently in use. It is expected that the PED will greatly affect pressure equipment exports to the European Community. Companies exporting pressure equipment to European Union countries should be prepared before the PED becomes mandatory.

Thus, the EU PED 2014/68/EU (formerly 97/23/EC) sets out the requirements *“for the design and fabrication of pressure equipment (pressure equipment means steam boilers, pressure vessels, piping, safety valves and other components and assemblies subject to pressure loading) generally over one litre in volume and having a maximum pressure more than 0.5 bar gauge. It also sets the administrative procedures requirements for the “conformity assessment” of pressure equipment, for the free placing on the European market without local legislative barriers. It has been mandatory throughout the EU since 30 May 2002”, with 2014 revision fully effective as of 19 July*

³ European Commission website information on Pressure Equipment Directive – see: https://ec.europa.eu/growth/sectors/pressure-gas/pressure-equipment/directive_en

2016. This is enacted in the UK as the Pressure Equipment Regulations (PER). The set out standards and regulations regarding pressure vessels and boilers safety is also very close to the US standards defined by the American Society of Mechanical Engineers (ASME). This enables most international inspection agencies to provide both verification and certification services to assess compliance to the different pressure equipment directives.”⁴

To satisfy and comply with the EU PED first issued in 1997 and enforceable 2002, there was a strong drive to develop EN and ISO standards on boilers and pressure vessels.

European Standards (EN) are documents that have been ratified by one of the 3 European Standards Organizations, CEN, CENELEC or ETSI. They are designed and created by all interested parties through a transparent, open, consensus process. A number of EN standards are now available (EN 13445 ‘Unfired Pressure Vessel’; EN 12952 Water tube boilers; and EN 12853 Shell boilers, all became available in the beginning of the 21st century)

⁴ Pressure Equipment Directive – Wikipedia

(IV) ISO 16528

The renewed energy of ISO/TC11 in the development of an ISO standard on pressure equipment at the end of last century was partly driven by increase globalization, international/free trade and movement of pressure equipment. At the same time, the increased effort was also driven by a proposal by the European Commission for common legislation on pressure equipment to be enforced across all member nations among the European Union. The European Pressure Equipment Directive (PED) as noted in (III) above was released - 97/23/EC - now Pressure Equipment Directive (PED) 2014/68/EU.

However, with the large number of existing regional and national standards and significant regulatory and cultural differences among jurisdictions around the world, an ISO standard providing sufficient descriptive base provisions and ensuring a proper level of pressure equipment safety was quickly realized as an insurmountable task. Indeed, this could be the reason why ISO/TC11, being one of the first Technical Committees (No. 11) established, did not manage to release a standard for decades.

To quote directly from ISO/TC11 “Business Plan” which is also similarly (but not quite identical) stated in “Introduction” of ISO 16528-1: 2007(E):

“There are significant differences among countries in regulating the supply and operation of pressure equipment. These differences include compliance with a specific national standard(s), limiting source or specification of materials, use of specific inspection bodies, and discriminatory certification systems or import licenses. Development of a performance based International Standard is the best realistic approach to facilitating world trade by enhancing recognition of national and regional standards. These standards have a proven history of supporting public safety and good commercial operating experience. An international performance-based standard will enable these standards to co-exist providing an approach that can accommodate technical innovations, existing regulatory frameworks and market needs.

The main objective is to produce and encourage the use of an ISO performance standard that can be used by the member bodies of ISO to accommodate the needs of their markets – both users and regulatory bodies.”^{5,6}

It was with the above plan that the Technical Specification ISO/TS 16528 was published in 2002 on registration of codes and standards, and subsequently, with the restructuring of ISO/TS 16528, the release of the following standards in 2007:

ISO 16528-1 Boilers and Pressure Vessels –
Part 1: Performance requirements; and
ISO 16528-2 Boilers and Pressure Vessels –

⁵ Executive Summary - ISO/TC11 Business Plan – July 9, 2004

⁶ Introduction, ISO 16528-1: 2007(E) - ISO

Part 2: Procedures for fulfilling the requirements of ISO 16528-1.

While the standards were first released in 2007, both were reviewed and reaffirmed in 2016 and accordingly, both standards are still current.

It is not believed that there should be much discussion needed on ISO 16528-2 which simply “*provides a procedure to identify existing prescriptive standards that fulfil the requirements of ISO 16528-1*”)⁶ following which a standard may then be assessed.

With the above understanding, it may be obvious that ISO 16528-1 is not a boiler and pressure vessel standard per se, as typically the case in existing regional or national pressure equipment standards. Rather, ISO 16528-1 provides the essential elements and provisions which existing regional and national pressure equipment standards must properly address prior to their publishers applying to ISO through the process of ISO 16528-2 for recognition and acceptance as in compliance with ISO 16528-1.

ISO 16528-1: Boilers and Pressure Vessels – Part 1: Performance requirements;

A review of ISO 16528-1 must bear in mind of the fact this standard provides only the essential elements and provisions a regional/national pressure equipment standard must address prior to the standard’s application and acceptance as one in compliance with ISO 16528-1.

As stated in the Introduction to ISO 16528 Part 1, “*This part of ISO 16528, which is performance-based, enables these standards to co-exist, providing an approach that can accommodate technical innovations, existing regulatory frameworks and market needs. Compliance with the requirements of this part of ISO 16528 does not relieve parties from obligations under local, national or international laws or regulations*”

Accordingly, when almost all existing standards cover basic requirements or comprehensive requirements or a combination of both, ISO 16528-1 only gives broad provisions of what must be covered. This includes all common elements such as Scope; Units of Measurements; Duties and Responsibilities of Users, Manufacturers, Third-party Inspectors; Technical Requirements (including Materials, Design loading and methods...etc., Manufacturing methods and welding...etc., Inspection); and Conformity Assessment.

With the above, the ISO 16528-1 is a relative short document and would not take long for a quick review. There are however, two significant features of ISO 16528-1 that merit special discussion:

a) ISO 16528-1 Clause 6 Failure Mode

One significant and interesting provision in ISO 16528-1 is the requirement for pressure equipment standards to consider different mandatory failure modes and

the designer to document the reason for not having to address one or more of the failure modes.

It is specifically stated in Clause 6.1 of ISO 16528-1 that *“The design shall consider the following failure modes and specifically address those listed in 6.2. This requirement does not mandate detailed analysis of the failure modes listed in 6.2 if the design parameters for the boilers and pressure vessels do not require such an analysis, e.g. it is not necessary to analyse creep rupture for boilers and pressure vessels operating at essentially ambient temperatures. In such cases, the designer shall document the reason for not addressing one or more of the failure modes listed in 6.2.”*

As well, Annex A provides a list of some common failure modes and limit states for clarification of Clause 6 provisions.

This is not a common feature in existing pressure equipment standards. Pressure equipment standards around the world cover a variety of failure modes through design rules and often, the modes of failure would be built into the design equations or implied. This includes common failure modes such as elastic instability and buckling which would typically be built into design-by-rule equations, but not specifically mentioned. There are situations most standards would make specific provisions for failure modes such as fatigue and creep. For convenience of the standards publishing organizations applying for ISO 16528 registration and acceptance, Table 1 and Table 2 of ISO 16528-2 provide guidance for the Standard-issuing body to indicate their standard conforms with these ISO 16528-1 provisions.

b) ISO 16528-1 Annex B “Guidance on selection of standards”

As note earlier, *“There are significant differences among countries in regulating the supply and operation of pressure equipment” and “These standards have a proven history of supporting public safety....”*

There are a number of standards that have applied to and been recognized by ISO as in meeting *“the requirements of ISO 16528 Part 1: Performance Requirements”*. Annex B provides a process in selecting the use of a pressure equipment standard in full or in part; even though that standard has been assessed and recognized by ISO for compliance with ISO 16528. Clause B1 of this Annex however, notes that *“It is not the purpose of the annex to define how to select a particular standard, but to give an understanding of the issues to be considered when making a selection.”* and *“It is also not the intent to recommend any specific standard for any particular application.”*

(V) Use of ISO 16528-1 in Alberta

In 2011, shortly following CSA's application to and acceptance by ISO for CSA B51 as having fulfilled the requirements of ISO 16528-1 in 2010, the Pressure Equipment Safety Regulation (PESR) was amended through Alberta Regulation AR138/2011 whereby ISO 16528 was adopted as part of the Regulation with specific conditions.

ABSA Information Bulletin IB16-019⁷ provides the full details relative to the use of ISO 16528-1 in Alberta. In essence, ISO 16528-1 has been adopted for use in Alberta by Section 6(l) of the Pressure Equipment Safety Regulation which states: *"ISO 16528 Boilers and Pressure Vessels Part 1, 1st Edition, 2007 for construction not addressed in the above codes and standards provided the same engineering philosophy, safety margins and administrative requirements in CSA B51 are followed"*.

Thus, *"for construction of boilers and pressure vessels (and components forming parts thereof) that is addressed by one or more of the adopted codes and standards listed under Sections 6(a) to 6(k) of the Pressure Equipment Safety Regulation, the applicable listed adopted code(s)/standard(s) must be used"*. It is important to highlight that, when ISO 16528-1 is used, *"the same engineering philosophy, safety margins and administrative requirements in CSA B51"* must be followed.

⁷ IB16-019 "Use of ISO 16528 in Alberta" - see <https://www.absa.ca/media/1893/ib16-019.pdf>

(VI) CSA B51 and ISO 16528

The Canadian Advisory Committee (CAC) of ISO/TC11 was formed in 2000 through Standards Council Canada (SCC) with support of CSA, and the CAC membership consisted of seven volunteer CSA B51 TC members. Activities of ISO/TC11 and the CAC of ISO/TC11 were discussed in CSA B51 in many of the annual meetings of the CSA B51 TC.

Following the release of ISO 16528 in 2007 and the beginning of applications to ISO for recognition of standards under the ISO 16528 process in 2008, the matter of having CSA B51 recognized as a standard under ISO 16528-1 was discussed under Agenda #59.7.2 during the 2008 CSA B51 TC annual meeting in Winnipeg, Manitoba. It was recognized that this would be a CSA issue with SCC, and CSA together with CAC of ISO/TC11 would be taking the leadership on this matter. The minutes of the meeting noted the possible benefits of the proposal and recorded that “*Members of CSA B51 TC supported the registration of B51 to the ISO standard....*”⁸.

In 2009, CSA had gone through the process of applying to ISO for the recognition of CSA B51 under ISO 16528. And in 2010, “*CSA B51 Boiler, Pressure Vessel and Pressure Piping Code was recognized by International Standards Organization (ISO) as meeting the requirements of ISO Standard ISO-16528 Boilers and Pressure Vessels Part 1: Performance requirements*” (as stated in the news releases of CSA and ABSA’s “The Pressure News”⁹).

⁸ Annual Meeting Minutes CSA B51 59th Annual Meeting, August 21, 2008 The Fort Garry Hotel, Winnipeg

⁹ Page 5, Volume 15 Issue 2 ABSA The Pressure News <https://www.absa.ca/media/1709/2010-v15-iss2.pdf>