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SECTION VIII

Rules for Construction of Pressure Vessels

2025 ASME Boiler and Pressure Vessel Code

An International Code

Division 3

Alternative Rules for Construction of High Pressure Vessels

ASME
SETTING THE STANDARD

AN INTERNATIONAL CODE

2025 ASME Boiler & Pressure Vessel Code

2025 Edition July 1, 2025

VIII

RULES FOR CONSTRUCTION OF PRESSURE VESSELS

Division 3

Alternative Rules for Construction of High Pressure Vessels

ASME Boiler and Pressure Vessel Committee
on Pressure Vessels

The American Society of Mechanical Engineers
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FOREWORD*

In 1911, The American Society of Mechanical Engineers established the Boiler and Pressure Vessel Committee to formulate standard rules for the construction of steam boilers and other pressure vessels. In 2009, the Boiler and Pressure Vessel Committee was superseded by the following committees:

(a) Committee on Power Boilers (I)
(b) Committee on Materials (II)
(c) Committee on Construction of Nuclear Facility Components (III)
(d) Committee on Heating Boilers (IV)
(e) Committee on Nondestructive Examination (V)
(f) Committee on Pressure Vessels (VIII)
(g) Committee on Welding, Brazing, and Fusing (IX)
(h) Committee on Fiber-Reinforced Plastic Pressure Vessels (X)
(i) Committee on Nuclear Inservice Inspection (XI)
(j) Committee on Transport Tanks (XII)
(k) Committee on Overpressure Protection (XIII)
(l) Technical Oversight Management Committee (TOMC)

Where reference is made to "the Committee" in this Foreword, each of these committees is included individually and collectively.

The Committee's function is to establish rules of safety relating to pressure integrity. The rules govern the construction** of boilers, pressure vessels, transport tanks, and nuclear components, and the inservice inspection of nuclear components and transport tanks. For nuclear items other than pressure-retaining components, the Committee also establishes rules of safety related to structural integrity. The Committee also interprets these rules when questions arise regarding their intent. The technical consistency of the Sections of the Code and coordination of standards development activities of the Committees is supported and guided by the Technical Oversight Management Committee. The Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks, or nuclear components, or the inservice inspection of nuclear components or transport tanks. Users of the Code should refer to the pertinent codes, standards, laws, regulations, or other relevant documents for safety issues other than those relating to pressure integrity and, for nuclear items other than pressure-retaining components, structural integrity. Except for Sections XI and XII, and with a few other exceptions, the rules do not, of practical necessity, reflect the likelihood and consequences of deterioration in service related to specific service fluids or external operating environments. In formulating the rules, the Committee considers the needs of users, manufacturers, and inspectors of components addressed by the Code. The objective of the rules is to afford reasonably certain protection of life and property, and to provide a margin for deterioration in service to give a reasonably long, safe period of usefulness. Advancements in design and materials and evidence of experience have been recognized.

The Code contains mandatory requirements, specific prohibitions, and nonmandatory guidance for construction activities and inservice inspection and testing activities. The Code does not address all aspects of these activities and those aspects that are not specifically addressed should not be considered prohibited. The Code is not a handbook and cannot replace education, experience, and the use of engineering judgment. The phrase *engineering judgment* refers to technical judgments made by knowledgeable engineers experienced in the application of the Code. Engineering judgments must be consistent with Code philosophy, and such judgments must never be used to overrule mandatory requirements or specific prohibitions of the Code.

The Committee recognizes that tools and techniques used for design and analysis change as technology progresses and expects engineers to use good judgment in the application of these tools. The designer is responsible for complying with Code rules and demonstrating compliance with Code equations when such equations are mandatory. The Code neither requires nor prohibits the use of computers for the design or analysis of components constructed to the requirements of the Code. However, designers and engineers using computer programs for design or analysis are cautioned that they are

* The information contained in this Foreword is not part of this American National Standard (ANS) and has not been processed in accordance with ANSI's requirements for an ANS. Therefore, this Foreword may contain material that has not been subjected to public review or a consensus process. In addition, it does not contain requirements necessary for conformance to the Code.

** *Construction*, as used in this Foreword, is an all-inclusive term comprising materials, design, fabrication, examination, inspection, testing, certification, and overpressure protection.

responsible for all technical assumptions inherent in the programs they use and the application of these programs to their design.

The rules established by the Committee are not to be interpreted as approving, recommending, or endorsing any proprietary or specific design, or as limiting in any way the manufacturer's freedom to choose any method of design or any form of construction that conforms to the Code rules.

The Committee meets regularly to consider revisions of the rules, new rules as dictated by technological development, Code cases, and requests for interpretations. Only the Committee has the authority to provide official interpretations of the Code. Requests for revisions, new rules, Code cases, or interpretations shall be addressed to the staff secretary in writing and shall give full particulars in order to receive consideration and action (see the Correspondence With the Committee page). Proposed revisions to the Code resulting from inquiries will be presented to the Committee for appropriate action. The action of the Committee becomes effective only after confirmation by ballot of the Committee and approval by ASME. Proposed revisions to the Code approved by the Committee are submitted to the American National Standards Institute (ANSI) and published at http://go.asme.org/BPVCPublicReview to invite comments from all interested persons. After public review and final approval by ASME, revisions are published at regular intervals in Editions of the Code.

The Committee does not rule on whether a component shall or shall not be constructed to the provisions of the Code. The scope of each Section has been established to identify the components and parameters considered by the Committee in formulating the Code rules.

Questions or issues regarding compliance of a specific component with the Code rules are to be directed to the ASME Certificate Holder (Manufacturer). Inquiries concerning the interpretation of the Code are to be directed to the Committee. ASME is to be notified should questions arise concerning improper use of the ASME Single Certification Mark.

When required by context in the Code, the singular shall be interpreted as the plural, and vice versa.

The words "shall," "should," and "may" are used in the Code as follows:

- *Shall* is used to denote a requirement.
- *Should* is used to denote a recommendation.
- *May* is used to denote permission, neither a requirement nor a recommendation.

STATEMENT OF POLICY ON THE USE OF THE ASME SINGLE CERTIFICATION MARK AND CODE AUTHORIZATION IN ADVERTISING

ASME has established procedures to authorize qualified organizations to perform various activities in accordance with the requirements of the ASME Boiler and Pressure Vessel Code. It is the aim of the Society to provide recognition of organizations so authorized. An organization holding authorization to perform various activities in accordance with the requirements of the Code may state this capability in its advertising literature.

Organizations that are authorized to use the ASME Single Certification Mark for marking items or constructions that have been constructed and inspected in compliance with the ASME Boiler and Pressure Vessel Code are issued Certificates of Authorization. It is the aim of the Society to maintain the standing of the ASME Single Certification Mark for the benefit of the users, the enforcement jurisdictions, and the holders of the ASME Single Certification Mark who comply with all requirements.

Based on these objectives, the following policy has been established on the usage in advertising of facsimiles of the ASME Single Certification Mark, Certificates of Authorization, and reference to Code construction. The American Society of Mechanical Engineers does not "approve," "certify," "rate," or "endorse" any item, construction, or activity and there shall be no statements or implications that might so indicate. An organization holding the ASME Single Certification Mark and/or a Certificate of Authorization may state in advertising literature that items, constructions, or activities "are built (produced or performed) or activities conducted in accordance with the requirements of the ASME Boiler and Pressure Vessel Code," or "meet the requirements of the ASME Boiler and Pressure Vessel Code." An ASME corporate logo shall not be used by any organization other than ASME.

The ASME Single Certification Mark shall be used only for stamping and nameplates as specifically provided in the Code. However, facsimiles may be used for the purpose of fostering the use of such construction. Such usage may be by an association or a society, or by a holder of the ASME Single Certification Mark who may also use the facsimile in advertising to show that clearly specified items will carry the ASME Single Certification Mark.

STATEMENT OF POLICY ON THE USE OF ASME MARKING TO IDENTIFY MANUFACTURED ITEMS

The ASME Boiler and Pressure Vessel Code provides rules for the construction of boilers, pressure vessels, and nuclear components. This includes requirements for materials, design, fabrication, examination, inspection, and stamping. Items constructed in accordance with all of the applicable rules of the Code are identified with the ASME Single Certification Mark described in the governing Section of the Code.

Markings such as "ASME," "ASME Standard," or any other marking including "ASME" or the ASME Single Certification Mark shall not be used on any item that is not constructed in accordance with all of the applicable requirements of the Code.

Items shall not be described on ASME Data Report Forms nor on similar forms referring to ASME that tend to imply that all Code requirements have been met when, in fact, they have not been. Data Report Forms covering items not fully complying with ASME requirements should not refer to ASME or they should clearly identify all exceptions to the ASME requirements.

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General

ASME codes and standards are developed and maintained by committees with the intent to represent the consensus of concerned interests. Users of ASME codes and standards may correspond with the committees to propose revisions or cases, report errata, or request interpretations. Correspondence for this Section of the ASME Boiler and Pressure Vessel Code (BPVC) should be sent to the staff secretary noted on the Section's committee web page, accessible at https://go.asme.org/CSCommittees.

NOTE: See ASME BPVC Section II, Part D for guidelines on requesting approval of new materials. See Section II, Part C for guidelines on requesting approval of new welding and brazing materials ("consumables").

Revisions and Errata

The committee processes revisions to this Code on a continuous basis to incorporate changes that appear necessary or desirable as demonstrated by the experience gained from the application of the Code. Approved revisions will be published in the next edition of the Code.

In addition, the committee may post errata and Special Notices at http://go.asme.org/BPVCerrata. Errata and Special Notices become effective on the date posted. Users can register on the committee web page to receive email notifications of posted errata and Special Notices.

This Code is always open for comment, and the committee welcomes proposals for revisions. Such proposals should be as specific as possible, citing the paragraph number, the proposed wording, and a detailed description of the reasons for the proposal, including any pertinent background information and supporting documentation.

Cases

(a) The most common applications for cases are

(1) to permit early implementation of a revision based on an urgent need

(2) to provide alternative requirements

(3) to allow users to gain experience with alternative or potential additional requirements prior to incorporation directly into the Code

(4) to permit use of a new material or process

(b) Users are cautioned that not all jurisdictions or owners automatically accept cases. Cases are not to be considered as approving, recommending, certifying, or endorsing any proprietary or specific design, or as limiting in any way the freedom of manufacturers, constructors, or owners to choose any method of design or any form of construction that conforms to the Code.

(c) The committee will consider proposed cases concerning the following topics only:

(1) equipment to be marked with the ASME Single Certification Mark, or

(2) equipment to be constructed as a repair/replacement activity under the requirements of Section XI

(d) A proposed case shall be written as a question and reply in the same format as existing cases. The proposal shall also include the following information:

(1) a statement of need and background information

(2) the urgency of the case (e.g., the case concerns a project that is underway or imminent)

(3) the Code Section and the paragraph, figure, or table number to which the proposed case applies

(4) the editions of the Code to which the proposed case applies

(e) A case is effective for use when the public review process has been completed and it is approved by the cognizant supervisory board. Cases that have been approved will appear in the next edition or supplement of the Code Cases books, "Boilers and Pressure Vessels" or "Nuclear Components." Each Code Cases book is updated with seven Supplements.

Supplements will be sent or made available automatically to the purchasers of the Code Cases books until the next edition of the Code. Annulments of Code Cases become effective six months after the first announcement of the annulment in a Code Case Supplement or Edition of the appropriate Code Case book. The status of any case is available at http://go.asme.org/BPVCCDatabase. An index of the complete list of Boiler and Pressure Vessel Code Cases and Nuclear Code Cases is available at http://go.asme.org/BPVCC.

Interpretations

(a) Interpretations clarify existing Code requirements and are written as a question and reply. Interpretations do not introduce new requirements. If a revision to resolve conflicting or incorrect wording is required to support the interpretation, the committee will issue an intent interpretation in parallel with a revision to the Code.

(b) Upon request, the committee will render an interpretation of any requirement of the Code. An interpretation can be rendered only in response to a request submitted through the online Inquiry Submittal Form at http://go.asme.org/InterpretationRequest. Upon submitting the form, the inquirer will receive an automatic email confirming receipt.

(c) ASME does not act as a consultant for specific engineering problems or for the general application or understanding of the Code requirements. If, based on the information submitted, it is the opinion of the committee that the inquirer should seek assistance, the request will be returned with the recommendation that such assistance be obtained. Inquirers may track the status of their requests at http://go.asme.org/Interpretations.

(d) ASME procedures provide for reconsideration of any interpretation when or if additional information that might affect an interpretation is available. Further, persons aggrieved by an interpretation may appeal to the cognizant ASME committee or subcommittee. ASME does not "approve," "certify," "rate," or "endorse" any item, construction, proprietary device, or activity.

(e) Interpretations are published in the ASME Interpretations Database at http://go.asme.org/Interpretations as they are issued.

Committee Meetings

The ASME BPVC committees regularly hold meetings that are open to the public. Persons wishing to attend any meeting should contact the secretary of the applicable committee. Information on future committee meetings can be found at http://go.asme.org/BCW.

SUMMARY OF CHANGES

Changes listed below are identified on the pages by a margin note, **(25)**, placed next to the affected area.

Page	*Location*	*Change*
xvii	List of Sections	Title of Section XI, Division 1 revised
xviii	Foreword	Third, fourth, seventh, tenth, and eleventh paragraphs editorially revised
xxi	Personnel	Updated
2	KG-130	Subparagraph (c) revised
5	Table KG-141	Updated
6	Table KG-150	Under "U.S. Customary Units," all instances of "lb" revised to "lbf"
8	KG-300	Last sentence revised
8	KG-310	First sentence revised
9	KG-311.7	Subparagraph (c) revised
9	KG-311.11	First paragraph revised
10	KG-311.14	Endnote 1 and subpara. (b) revised
11	KG-311.15	Subparagraphs (b) and (e) revised
12	KG-323	First paragraph and subparas. (f) and (h) revised
12	KG-324	Subparagraph (b) revised
13	KG-324.1	Subparagraphs (b) and (e) revised
13	KG-330	Editorially revised
15	KG-412	Revised
15	KG-413.2	Revised
16	KG-420	Subparagraphs (d) and (d)(2) revised
16	KG-440	First paragraph and subpara. (l) revised
20	KG-613	Revised
25	KM-211.2	Subparagraph (b) revised
26	KM-211.3	Subparagraph (b) revised
26	KM-211.5	Added
26	KM-212.2	Title revised
30	Table KM-234.2(a)	General Note revised
31	KM-250	(1) First paragraph revised (2) Second through fourth paragraphs designated (a) through (d) and previously designated subparas. redesignated
32	KM-254	First sentence revised
32	KM-261	First paragraph revised
33	KM-270	In subpara. (c), definition of *P* revised
34	Figure KM-270.1M	Corrected by errata to the graphic displaying metric units
39	KM-400	In subpara. (a), second paragraph revised
40	Table KM-400-1	(1) Carbon steel, SA-354; 0.7Cr–1.5Si; 3½Ni–1½ Cr–½ Mo–½ Mn; and Notes (25) and (26) added (2) For 2¼Cr–1Mo, reference to Note (15) added (3) General Note (b) and Notes (3), (4), (8), (9), (11), (12), (14), (18), and (23) revised
48	Table KM-400-1M	(1) Carbon steel, SA-354; 0.7Cr–1.5Si; 3½Ni–1½ Cr–½ Mo–½ Mn; and Notes (25) and (26) added (2) For 2¼Cr–1Mo, reference to Note (15) added (3) General Note (b) and Notes (3), (4), (8), (9), (11), (12), (14), (18), and (23) revised

Page	Location	Change
57	Table KM-400-2	(1) For 15Cr–5Ni–3Cu, SA-564 and SA-705, conditions H1150M and H1150, Max. Design Temp. revised
		(2) General Note and Notes (3), (5), (6), and (10) revised
62	Table KM-400-2M	(1) For 15Cr–5Ni–3Cu, SA-564 and SA-705, conditions H1150M and H1150, Max. Design Temp. revised
		(2) General Note and Notes (3), (5), (6), and (10) revised
67	Table KM-400-3	General Note (b) revised
69	Table KM-400-3M	General Note (b) revised
71	Table KM-400-4	In Note (2), metric units deleted
72	Table KM-400-4M	In Note (2), U.S. customary units deleted
74	KM-610	First sentence editorially revised
82	Article KM-8	Added
84	KD-120	Subparagraph (c) revised
89	KD-221.1	Definition of K_{ut} revised
89	KD-221.2	Definition of K_{utj} revised
93	Table KD-230.4	In General Note (c), definitions of K_{ut} and K_{utj} revised
95	KD-236	Revised in its entirety
96	KD-240	Subparagraphs (d) and (e) revised
112	Table KD-320.1	In General Note (e)(4), second equation for N revised
116	Table KD-320.1M	In General Note (e)(4), second equation for N revised
135	KD-401	(1) In subpara. (a), last sentence deleted
		(2) Subparagraph (d) deleted
135	KD-411	Subparagraph (a) revised
136	KD-420	Subparagraphs (a) and (b) revised
136	KD-430	Subparagraph (a) revised
138	Table KD-430	(1) Row for cast high strength alloy steels added
		(2) Note (1) revised
138	Table KD-430M	(1) Row for cast high strength alloy steels added
		(2) Note (1) revised
139	Table KD-431	Former Table D-500 redesignated and moved
137	KD-450	Added
137	KD-451	Added
144	KD-620	Subparagraph (b) revised
169	KD-1043	Subparagraphs (a) and (d) revised
169	KD-1045	Subparagraph (d) deleted
170	KD-1048	Subparagraph designator (a) removed and subpara. (b) deleted
170	KD-1049	First sentence revised
188	KF-121.1	In subpara. (b), first sentence revised
190	KF-211	Second paragraph added
191	KF-216	Revised
192	KF-222.1	In sixth sentence, reference to Section IX revised
192	KF-226	Subparagraph (b) revised
193	KF-233	In subpara. (a), penultimate sentence revised
193	KF-236	First sentence revised
193	KF-238	Subparagraph (a) revised
204	KF-613.1	Last sentence revised
205	KF-615	Revised in its entirety
205	KF-620	In subpara. (b), second sentence revised
205	KF-630	Subparagraph (f) added
212	KF-825.2	Subparagraph (a) revised
212	KF-825.3	Subparagraphs (a) and (b) revised
213	KF-825.6	Revised

Page	Location	Change
213	KF-825.7	Subparagraph (a) revised
213	KF-825.8	First paragraph and subpara. (a) revised
217	KF-912	Second paragraph revised
220	KF-1130	Subparagraph (c) revised
221	KF-1160	Revised
224	KOP-100	(1) Subparagraph (a) revised
		(2) Subparagraph (c) deleted and subsequent subparagraph redesignated
224	KOP-120	Subparagraphs (a), (c), and (e) revised
225	KOP-130	Subparagraph (a) revised
225	KOP-140	First sentence revised
225	KOP-151	Revised
225	KOP-153	In subpara. (a), reference to Section XIII, Part 4 revised to Section XIII, Part 3
226	KOP-156	Revised in its entirety
228	KOP-200	Revised
228	KOP-210	Subparagraph (b) revised and subpara. (h) added
230	KOP-300	First paragraph and subparas. (a) and (b)(4) revised
231	KE-105	Added
231	KE-106	Former KE-105 redesignated
232	KE-112.1	First paragraph revised
233	KE-114	Revised
233	KE-115	Cross-reference updated
234	KE-211	Subparagraphs (a)(3) and (a)(4) revised
234	KE-212.1	Last sentence revised
234	KE-212.4	First sentence revised
235	KE-213	Subparagraphs (b) and (c) revised
235	KE-221	Subparagraph (c) revised
235	KE-230	Subparagraph (a) revised
235	KE-231	Subparagraph (c) revised
236	KE-233	Revised in its entirety
236	KE-233.1	Subparagraph (c) added and subsequent subparagraph redesignated
237	KE-241	Subparagraphs (b) and (c) revised
239	KE-251	Subparagraph (a) revised
239	KE-252	Subparagraph (c) revised
239	KE-263	First paragraph revised
240	KE-270	Added
241	KE-300	Subparagraphs (b), (c), (d), and (e) revised
241	KE-301	(1) Subparagraphs (c), (i)(2)(-a)(-2), and (i)(3)(-d) revised
		(2) Subparagraph (i)(3)(-e) added
244	KE-302	Subparagraphs (b) and (e) revised
253	KE-310	First paragraph revised
254	KE-322	Last sentence revised
254	KE-324	Revised
254	KE-325	Revised
254	KE-333	First paragraph and subparas. (a) and (a)(3) revised
255	KE-334	Revised in its entirety
261	KT-304	Added
261	KT-305	Added
261	KT-311	Revised
262	KT-312.1	Definition of K_{ut} revised
262	KT-312.2	Last paragraphs revised
262	KT-312.3	Subparagraph (b) revised

Page	*Location*	*Change*
268	KS-140	Revised
269	KS-250	Subparagraph (b) revised
269	KS-260	Revised
270	KS-300	Subparagraph (a)(2)(-b) revised
270	KS-301	Subparagraph (a) revised
270	KS-302	Revised
271	KS-320	Subparagraphs (d)(6) and (d)(10) revised
272	1-100	Definitions of a, K_{ub}, and K_{utj} revised
280	2-100	In second paragraph, first sentence revised
280	2-112	Second sentence revised
281	2-119	Second sentence revised
281	2-123	Subparagraph (d) revised
282	5-200	Subparagraph (c)(2) revised
297	9-400	Subparagraph (e) revised
299	Form K-1	On second page, “Certificate of Shop Inspection” and “Certificate of Field Assembly Inspection” revised
301	Form K-2	On second page, “Certificate of Shop Inspection” and “Certificate of Field Assembly Inspection” revised
306	Form CRPV-1A	On second page, “Certificate of Shop Inspection” revised
310	Form CRPV-2A	On second page, “Certification by Shop Inspector of Qualification ...” revised
313	Nonmandatory Appendix D	Deleted
339	I-300	In first column of in-text table, all instances of “lb” revised to “lbf”

CROSS-REFERENCING IN THE ASME BPVC

Paragraphs within the ASME BPVC may include subparagraph breakdowns, i.e., nested lists. The following is a guide to the designation and cross-referencing of subparagraph breakdowns:

(a) Hierarchy of Subparagraph Breakdowns

(1) First-level breakdowns are designated as (a), (b), (c), etc.

(2) Second-level breakdowns are designated as (1), (2), (3), etc.

(3) Third-level breakdowns are designated as (-a), (-b), (-c), etc.

(4) Fourth-level breakdowns are designated as (-1), (-2), (-3), etc.

(5) Fifth-level breakdowns are designated as (+a), (+b), (+c), etc.

(6) Sixth-level breakdowns are designated as (+1), (+2), etc.

(b) Cross-References to Subparagraph Breakdowns. Cross-references within an alphanumerically designated paragraph (e.g., PG-1, UIG-56.1, NCD-3223) do not include the alphanumerical designator of that paragraph. The cross-references to subparagraph breakdowns follow the hierarchy of the designators under which the breakdown appears. The following examples show the format:

(1) If X.1(c)(1)(-a) is referenced in X.1(c)(1), it will be referenced as (-a).

(2) If X.1(c)(1)(-a) is referenced in X.1(c)(2), it will be referenced as (1)(-a).

(3) If X.1(c)(1)(-a) is referenced in X.1(e)(1), it will be referenced as (c)(1)(-a).

(4) If X.1(c)(1)(-a) is referenced in X.2(c)(2), it will be referenced as X.1(c)(1)(-a).

PART KG
GENERAL REQUIREMENTS

ARTICLE KG-1
SCOPE AND JURISDICTION

KG-100 SCOPE

KG-101 INTENT

The rules of this Division constitute requirements for the design, construction, inspection, and overpressure protection of metallic pressure vessels with design pressures generally above 10 ksi (70 MPa). However, it is not the intent of this Division to establish maximum pressure limits for either Section VIII, Division 1 or 2, nor minimum pressure limits for this Division. Specific pressure limitations for vessels constructed to the rules of this Division may be imposed elsewhere in this Division for various types of fabrication. Whenever *Construction* appears in this document, it may be considered an all-inclusive term comprising materials, design, fabrication, examination, inspection, testing, certification, and pressure relief.

KG-102 DESCRIPTION

Pressure vessels within the scope of this Division are pressure containers for the retainment of fluids, gaseous or liquid, under pressure, either internal or external.

This pressure may be generated by

(a) an external source

(b) the application of heat from

(1) direct source

(2) indirect source

(c) a process reaction

(d) any combination thereof

KG-103 LAWS OR REGULATIONS

The scope of this Division has been established to identify components and parameters considered in formulating the rules given in this Division. Laws or regulations issued by municipal, state, provincial, federal, or other enforcement or regulatory bodies having jurisdiction at the location of an installation establish the mandatory applicability of the Code rules, in whole or in part, within the jurisdiction. Those laws or regulations may require the use of this Division for vessels or components not considered to be within its scope. These laws or regulations should be reviewed to determine size or service limitations of the coverage, which may be different or more restrictive than those of this Division.

KG-104 LOCATION

KG-104.1 Fixed Location. Except as provided in KG-104.2, these rules cover vessels to be installed at a fixed (stationary) location for a specific service where operation and maintenance control are maintained in conformance with the User's Design Specification and records retained during the life of the vessel by the User.

KG-104.2 Mobile Vessels. These rules also apply to pressure vessels that are relocated from work site to work site between pressurizations, and where operation and maintenance control are maintained in conformance with the User's Design Specification and records retained during the life of the vessel by the User.

KG-110 GEOMETRIC SCOPE OF THIS DIVISION

The scope of this Division includes only the vessel and integral communicating chambers and shall include the requirements specified in KG-111 through KG-117.

KG-111 EXTERNAL PIPING AND JACKETS

Where external piping is to be connected to the vessel (see Article KD-6):

(a) the first threaded joint for screwed connections

(b) the face of the first flange for flanged connections

(c) the first sealing surface for proprietary connections or fittings

(d) the welding end connection for the first circumferential joint for welded connections to external piping, valves, instruments, and the like

(e) the welding pad for attachment of an external jacket

KG-112 INTERNAL PRESSURE PIPING

Internal pressure piping, when failure of such piping will affect the integrity of the pressure boundary.

KG-113 NONPRESSURE PARTS

Nonpressure parts that are welded directly to the internal or external surface of a pressure vessel. For parts beyond this, and for stud-bolted attachments, see Articles KD-6 and KD-7.

KG-114 COVERS AND CLOSURES

Pressure-retaining permanent covers or closures, including seals and bolting, or other mechanical retainers, used in service for vessel openings (see Article KD-6).

KG-115 INSTRUMENT CONNECTIONS

The first sealing surface for small proprietary fittings or instrumentation, such as gages and instruments, for which rules are not provided by this Division (see Article KD-6).

KG-116 OVERPRESSURE PROTECTION

Overpressure protection shall satisfy the requirements of Part KOP.

KG-117 COMBINATION UNITS

When a pressure vessel unit consists of more than one independent pressure chamber, only the parts of chambers which are within the scope of this Division need to be constructed in compliance with its provisions (see Articles KD-1 and KG-3).

KG-120 CLASSIFICATIONS OUTSIDE THE SCOPE OF THIS DIVISION

The following pressure-containing components are not included in the scope of this Division:

(a) vessels and components exclusively within the scope of other Sections of the ASME Boiler and Pressure Vessel Code

(b) fired process tubular heaters and components (see API STD 560 or ISO 13705)

(c) pressure-containing equipment that is an integral part or component of a rotating or reciprocating mechanical device, such as

(1) pumps
(2) compressors
(3) turbines
(4) generators
(5) engines
(6) hydraulic or pneumatic cylinders

where the primary design considerations and/or stresses are derived from the functional requirements of the device

(d) piping and piping components covered in the scope of the ASME B31 Piping Codes

(e) components covered in the scope of other applicable ASME Codes and Standards

KG-121 STAMPING OF PRESSURE-CONTAINING COMPONENTS OUTSIDE THE SCOPE OF THIS DIVISION

Any pressure-containing component, with the exception of components that follow the rules of KG-120(a), which meets all applicable requirements of this Division may be stamped with the Certification Mark with U3 Designator.

The Certification Mark is an ASME symbol identifying a product as meeting Code requirements. The Designator is a symbol used in conjunction with the Certification Mark for the scope of activity described in a Manufacturer's Certificate of Authorization.

KG-130 ASSEMBLY AND TESTING OF VESSELS AT FIELD OR INTERMEDIATE SITES (25)

A field site is a location of final permanent installation of the pressure equipment. An intermediate site is a temporary location under the control of the Certificate Holder. The location of an intermediate site is other than that listed on the Certificate of Authorization and other than a field site. All Code activities may be performed at intermediate or field sites by the Certificate Holder provided they comply with all Code requirements, and control of those activities is described in the Certificate Holder's Quality Control System. Assembly and testing of vessels constructed to this Division at intermediate or field sites shall be performed using one of the following three alternatives:

(a) The Manufacturer of the vessel completes the vessel in the field or at an intermediate site.

(b) The Manufacturer of parts of a vessel to be completed in the field or at an intermediate site by some other party stamps these parts in accordance with Code rules and supplies the Manufacturer's Data Report Form K-2 to the other party. The other party, who shall also hold a valid U3 Certificate of Authorization, makes the final assembly, required nondestructive examination (NDE), and final pressure test; completes the Manufacturer's Data Report Form K-1; and stamps the vessel. The Certificate of Authorization is a document issued by the Society that authorizes the use of the ASME Certification Mark and appropriate Designator for a specified time and for a specified scope of activity.

(c) Code work at field or intermediate sites is completed by a Certificate Holder of a valid U3 Certificate of Authorization other than the Manufacturer. The Certificate Holder performing the work is required to supply a Manufacturer's Data Report Form K-2 covering the portion of the work completed by the Certificate Holder's organization (including data on the pressure test if conducted by the Certificate Holder performing the fieldwork) to the Manufacturer responsible for the Code vessel. The Manufacturer applies the ASME Certification Mark with U3 Designator in the presence of a representative

from the Manufacturer's Inspection Agency and completes the Manufacturer's Data Report Form K-1 with the Inspector.

In all three alternatives, the party completing and signing the Manufacturer's Data Report Form K-1 assumes full Code responsibility for the vessel. In all three cases, each Manufacturer's Quality Control System shall describe the controls to assure compliance for each Certificate holder.

KG-140 STANDARDS REFERENCED BY THIS DIVISION

KG-141 SECTIONS OF THE ASME CODE

(a) Sections of the ASME Boiler and Pressure Vessel Code referenced in this Division are

- Section I, Rules for Construction of Power Boilers
- Section II, Materials
  - Part A — Ferrous Material Specifications
  - Part B — Nonferrous Material Specifications
  - Part C — Specifications for Welding Rods, Electrodes, and Filler Metals
  - Part D — Properties
- Section V, Nondestructive Examination
- Section VIII, Division 1, Rules for Construction of Pressure Vessels
- Section VIII, Division 2, Alternative Rules for Construction of Pressure Vessels
- Section IX, Welding, Brazing, and Fusing Qualifications
- Section X, Fiber-Reinforced Plastic Pressure Vessels
- Section XIII, Rules for Overpressure Protection

(b) Throughout this Division references are made to various standards, such as ASME standards, that cover pressure–temperature rating, dimensional, or procedural standards for pressure vessel parts. Specific editions of standards referenced in this Division are shown in Table KG-141.

KG-142 STANDARD PARTS

Standard pressure parts which comply with an ASME product standard shall be made of materials permitted by this Division (see Part KM).

KG-150 UNITS OF MEASUREMENT

(a) Either U.S. Customary, SI, or any local customary units may be used to demonstrate compliance with requirements of this edition related to materials, fabrication, examination, inspection, testing, certification, and overpressure protection.

(b) A single system of units shall be used for all aspects of design except where otherwise permitted by this Division. When components are manufactured at different locations where local customary units are different than those used for the general design, the local units may be used for the design and documentation of that component, within the limitations given in (c). Similarly, for proprietary components or those uniquely associated with a system of units different than that used for the general design, the alternate units may be used for the design and documentation of that component, within the limitations given in (c).

(c) For any single equation, all variables shall be expressed in a single system of units. Calculations using any material data published in this Division or Section II, Part D (e.g., allowable stresses, physical properties, external pressure design factor B, etc.) shall be carried out in one of the standard units given in Table KG-150. When separate equations are provided for U.S. Customary and SI units, those equations must be executed using variables in the units associated with the specific equation. Data expressed in other units shall be converted to U.S. Customary or SI units for use in these equations. The result obtained from execution of these equations or any other calculations carried out in either U.S. Customary or SI units may be converted to other units.

(d) Production, measurement, and test equipment, drawings, welding procedure specifications, welding procedure and performance qualifications, and other fabrication documents may be in U.S. Customary, SI, or local customary units in accordance with the fabricator's practice. When values shown in calculations and analysis, fabrication documents, or measurement and test equipment are in different units, any conversions necessary for verification of Code compliance and to ensure that dimensional consistency is maintained shall be in accordance with the following:

(1) Conversion factors shall be accurate to at least four significant figures.

(2) The results of conversions of units shall be expressed to a minimum of three significant figures.

(e) Conversion of units, using the precision specified previously, shall be performed to ensure that dimensional consistency is maintained. Conversion factors between U.S. Customary and SI units may be found in the Nonmandatory Appendix I, Guidance for the Use of U.S. Customary and SI Units, in the ASME Boiler and Pressure Vessel Code. Whenever local customary units are used, the Manufacturer shall provide the source of the conversion factors which shall be subject to verification and acceptance by the Authorized Inspector.

(f) Dimensions shown in the text, tables, and figures, whether given as a decimal or a fraction, may be taken as a decimal or a fraction and do not imply any manufacturing precision or tolerance on the dimension.

(g) Material that has been manufactured and certified to either the U.S. Customary or SI material specification (e.g., SA-516M) may be used regardless of the unit system used in design. Standard fittings (e.g., flanges and elbows)

that have been certified to either U.S. Customary or SI units may be used regardless of the equations or any other calculations carried out in either U.S. Customary or SI units system used in design.

(h) All entries on a Manufacturer's Data Report and data for Code-required nameplate marking shall be in units consistent with the fabrication drawings for the component using U.S. Customary, SI, or local customary units. Units may be shown parenthetically (either primary or alternative). Users of this Code are cautioned that the receiving jurisdiction should be contacted to ensure the units are acceptable.

KG-160 TOLERANCES

The Code does not fully address tolerances. When dimensions, sizes, or other parameters are not specified with tolerances, the values of these parameters are considered nominal and allowable tolerances or local variances may be considered acceptable when based on engineering judgment and standard practices as determined by the designer.

Table KG-141
Referenced Standards in This Division and Year of Acceptable Edition

(25)

Title	Number	Year
Fitness-For-Service	API 579-1/ASME FFS-1	2021
Steels for Hydrogen Service at Elevated Temperatures and Pressures in Petroleum Refineries and Chemical Plants	API RP 941	2016, Addendum 1: 2020
Fired Heaters for General Refinery Service	API Standard 560	Latest Edition
Minimum Design Loads for Buildings and Other Structures	ASCE/SEI 7	2022
Unified Inch Screw Threads (UN and UNR Thread Form)	ASME B1.1	Latest edition
Pipe Flanges and Flanged Fittings, NPS ½ Through NPS 24 Metric/Inch Standard	ASME B16.5	2025 [Note (2)]
Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)	ASME B18.2.2	Latest edition
Metric Fasteners for Use in Structural Applications	ASME B18.2.6M	Latest edition
Process Piping	ASME B31.3	Latest edition
Surface Texture (Surface Roughness, Waviness and Lay)	ASME B46.1	Latest edition
Conformity Assessment Requirements	ASME CA-1	Latest edition
Inspection Planning Using Risk-Based Methods	ASME PCC-3	Latest edition
Qualifications for Authorized Inspection	ASME QAI-1	Latest edition [Note (1)]
Standard Test Method for Apparent Hoop Tensile Strength of Plastic or Reinforced Plastic Pipe	ASTM D2290	2019a
Standard Test Methods for Tension Testing of Metallic Materials	ASTM E8	Latest edition
Standard Test Methods for Notched Bar Impact Testing of Metallic Materials	ASTM E23	Latest edition
Standard Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, and Scleroscope Hardness	ASTM E140	Latest edition
Standard Method for Linear-Elastic Plane-Strain Fracture Toughness of Metallic Materials	ASTM E399	2023
Standard Test Methods for Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products	ASTM B557	Latest Edition
Standard Test Method for Measurement of Fatigue Crack Growth Rates	ASTM E647	2024
Standard Practices for Cycle Counting in Fatigue Analysis	ASTM E1049	Latest edition
Standard Test Method for Determining Threshold Stress Intensity Factor for Environment-Assisted Cracking of Metallic Materials	ASTM E1681	2023ε1
Standard Test Method for Measurement of Fracture Toughness	ASTM E1820	2024
Standard Terminology Relating to Fatigue and Fracture Testing	ASTM E1823	2024a
Standard Test Method for Determination of Reference Temperature, T_o, for Ferritic Steels in the Transition Range	ASTM E1921	Latest edition
Marking and Labeling Systems	ANSI/UL-969	Latest edition
Guide to Methods for Assessing the Acceptability of Flaws in Metallic Structures	BS-7910	2019
Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections	CGA V-1	2021
Gas cylinders — 17E and 25E taper threads for connection of valves to gas cylinders — Part 1: Specifications	ISO 11363-1	2018
Petroleum, petrochemical and natural gas industries — Fired heaters for general refinery service	ISO 13705	Latest edition

GENERAL NOTE: For product standards, pressure–temperature ratings and cyclic analysis may limit application (see Part KD).

NOTES:
(1) See KG-411.
(2) The use of a flange or flanged fitting that relies on and meets the requirements of a B16 Case is not permitted.

(25)

Table KG-150
Standard Units for Use in Equations

Quantity	U.S. Customary Units	SI Units
Linear dimensions (e.g., length, height, thickness, radius, diameter)	inches (in.)	millimeters (mm)
Area	square inches (in.^{2})	square millimeters (mm^2)
Volume	cubic inches (in.^{3})	cubic millimeters (mm^3)
Section modulus	cubic inches (in.^{3})	cubic millimeters (mm^3)
Moment of inertia of section	inches^4 (in.^{4})	millimeters^4 (mm^4)
Mass (weight)	pounds mass (lbm)	kilograms (kg)
Force (load)	pounds force (lbf)	newtons (N)
Bending moment	inch-pounds (in.-lbf)	newton-millimeters (N-mm)
Pressure, stress, stress intensity, and modulus of elasticity	pounds per square inch (psi)	megapascals (MPa)
Energy (e.g., Charpy impact values)	foot-pounds (ft-lbf)	joules (J)
Temperature	degrees Fahrenheit (°F)	degrees Celsius (°C)
Absolute temperature	Rankine (°R)	kelvin (K)
Fracture toughness	ksi square root inches (ksi$\sqrt{\text{in.}}$)	MPa square root meters (MPa$\sqrt{\text{m}}$)
Angle	degrees or radians	degrees or radians
Boiler capacity	Btu/hr	watts (W)

ARTICLE KG-2
ORGANIZATION OF THIS DIVISION

KG-200 ORGANIZATION

KG-210 PARTS OF THIS DIVISION

This Division is divided into eight parts.

(a) Part KG contains the scope of the Division, establishes the extent of its coverage, and sets forth the responsibilities of the User and Manufacturer and the duties of the Inspectors of vessels constructed under these rules.

(b) Part KM contains

(1) the materials which may be utilized

(2) the permissible material specification identification numbers, special requirements, and limitations

(3) mechanical and physical properties upon which the design is based, and other necessary information concerning material properties (see Section II, Part D)

(c) Part KD contains requirements for the design of vessels and vessel parts.

(d) Part KF contains requirements for the fabrication of vessels and vessel parts.

(e) Part KOP contains rules for overpressure protection.

(f) Part KE contains requirements for nondestructive examination and repair of materials, vessels, and vessel parts.

(g) Part KT contains testing requirements and procedures.

(h) Part KS contains requirements for stamping and certifying vessels and vessel parts. It also gives requirements for Manufacturer's Data Reports and Records to be furnished to the User.

KG-220 APPENDICES

KG-221 Mandatory. The Mandatory Appendices address specific subjects not covered elsewhere in this Division. Their requirements are mandatory when applicable.

KG-222 Nonmandatory. The Nonmandatory Appendices provide information and suggested good practices.

KG-230 ARTICLES AND PARAGRAPHS

KG-231 Articles. The main divisions of the Parts of this Division are designated Articles. These are given numbers and titles such as Article KG-1, Scope and Jurisdiction.

KG-232 Paragraphs and Subparagraphs. The Articles are divided into paragraphs and subparagraphs which are given three-digit numbers, the first of which corresponds to the Article number. Each such paragraph or subparagraph number is prefixed with letters which, with the first digit (hundreds), indicate the Part and Article of this Division in which it is found, such as KD-140, which is a subparagraph of KD-100 in Article KD-1 of Part KD.

(a) Major subdivisions of paragraphs or subparagraphs are indicated by the basic paragraph number followed by a decimal point and one or two digits. Each of these subdivisions are titled and appear in the table of contents.

(b) Minor subdivisions of paragraphs are designated (a), (b), etc.

(c) Where further subdivisions are needed, they are designated by numbers in parentheses [e.g., KG-311.8(b)(1)].

KG-240 REFERENCES

When a Part, Article, or paragraph is referenced in this Division, the reference shall be taken to include all subdivisions under that Part, Article, or paragraph, including subparagraphs.

KG-250 TERMS AND DEFINITIONS

Terms and symbols used in this Division are defined in the various Parts, Articles, or paragraphs where they first apply or are of primary interest. A list of symbols is given in Mandatory Appendix 1.

ARTICLE KG-3
RESPONSIBILITIES AND DUTIES

(25) KG-300 GENERAL

The User, Manufacturer, and Inspector involved in the production and certification of vessels according to this Division have definite responsibilities and duties in meeting the requirements of this Division. The responsibilities and duties set forth in the following relate only to compliance with this Division, and are not to be construed as involving contractual relations or legal liabilities. Whenever *User* appears in this document, it may be considered to apply also to an agent (e.g., designee or licensor) acting on the User's behalf.

(25) KG-310 USER'S RESPONSIBILITY

It is the responsibility of the User or an agent acting on behalf of the User to provide a User's Design Specification for each pressure vessel to be constructed in accordance with this Division. The User's Design Specification shall contain sufficient detail to provide a complete basis for design and construction in accordance with this Division. It is the User's responsibility to specify, or cause to be specified, the effective Code Edition to be used for construction.

A single User's Design Specification may be prepared to support the design of more than one pressure vessel when all details of the construction are identical for each pressure vessel. The installation location for all vessels supported by a single User's Design Specification shall be defined in sufficient detail such that any jurisdictional, technical, and environmental requirements for the vessel are defined. The User's Design Specification shall include the most conservative state jurisdictional, technical, and environmental requirements to be considered during the design.

(a) The designated agent may be

(1) a design agency specifically engaged by the User

(2) the Manufacturer of a system for a specific service that includes a pressure vessel as a component that is purchased by the User, or

(3) an organization that offers pressure vessels for sale or lease for specific services

(b) The User may select more than one designated agent to obtain the most experience-based advice in several areas of expertise when needed (e.g., design, metallurgy, fabrication, pressure relief).

(c) A designated agent may be self-appointed as such by accepting certain responsibilities of a designated agent, as in the case of vessels designed, manufactured (built) for stock, and intended for operation in a specific application.

(d) The Design Specification shall contain sufficient detail to provide a complete basis for Division 3 design and construction. Such requirements shall not result in design or construction that fails to conform with the rules of this Division.

(e) Multiple Duplicate. A single User's Design Specification may be prepared to support the design of more than one pressure vessel that is to be located in a single, specific jurisdiction, provided that the environmental requirements and jurisdictional regulatory authority applied for each installation location are clearly specified and are the same or more conservative than required.

KG-311 USER'S DESIGN SPECIFICATION

The User's Design Specification shall include the specifications described in KG-311.1 through KG-311.15

KG-311.1 Vessel Identification.

(a) unique vessel serial number. However, the User may specify that the unique vessel serial number may be assigned by the Manufacturer for each vessel.

(b) name, function, purpose

(c) service fluid

KG-311.2 Vessel Configuration.

(a) shape

(b) vertical or horizontal

(c) nominal size or volume capacity

(d) support method and location, including the foundation type and allowable loading, if applicable (see KD-110 and Article KD-7). When the support method is unknown at the time of vessel manufacture, the User's Design Specification shall state that the Manufacturer is not responsible for the design of any supports or attachments not welded to the vessel (see Article KD-7) and that the User assumes the responsibility.

(e) construction type

(f) functions and boundaries of the items covered in KG-110

(g) items furnished by Manufacturer

(h) items furnished by User

KG-311.3 Controlling Dimensions.

(a) outline drawings
(b) openings, connections, closures
  (1) quantity of each
  (2) type and size
  (3) purpose
  (4) location, elevation, and orientation

KG-311.4 Design Criteria.

(a) Design Pressure. Design pressure is the pressure at the top of the vessel and which, together with the applicable coincident (metal) temperature, is stamped on the nameplate. The pressure at the top of the vessel is also the basis for the pressure setting of the pressure relief devices protecting the vessel.

(b) Design Temperature. The maximum mean metal temperature specified by the User, at design pressure. See KD-112. This is the design temperature that is to be stamped on the vessel.

(c) More than one combination of design pressure and temperature may be specified.

(d) Minimum Design Metal Temperature (MDMT). The MDMT is the lowest temperature to which the vessel will be exposed when the primary stresses at any location in the vessel are greater than 6 ksi (40 MPa)(see KM-234). This temperature shall be determined considering the lowest process temperature to which the vessel will normally be exposed in service, including process upsets, dumps, jet impingement, etc. Also, see KD-112 and KD-113.

(e) Thermal gradients across the vessel sections.

KG-311.5 Operating Conditions.

(a) operating pressure at coincident fluid temperature. The *operating pressure* is the maximum sustained process pressure that is expected in service. The operating pressure shall not exceed the design pressure. This pressure is expressed as a positive value, and may be internal or external to the vessel.

(b) upset and other combinations of operating pressures and coincident fluid temperature in sufficient detail to constitute an adequate basis for selecting materials

(c) proposed methods of heating and cooling, as well as those upset conditions that could lead to rapid heating or cooling of the vessel surfaces

(d) cyclic operating data and conditions

KG-311.6 Contained Fluid Data.

(a) phase (liquid, gaseous, dual)
(b) density
(c) unusual thermodynamic properties
(d) inlet and outlet fluid temperatures
(e) flow rates
(f) jet impingement streams
(g) statement if noxious, hazardous, or flammable

KG-311.7 Materials Selection. (25)

(a) appropriate materials for resistance to process corrosion (specific or generic).

(b) corrosion/erosion allowance.

(c) any information relating to possible deterioration of the selected construction materials due to environmental exposure. Examples of such concerns may be found in, but are not limited to, Section II, Part D, Nonmandatory Appendix A.

(d) if materials of construction include steels with a minimum specified yield strength greater than 120 ksi (827 MPa), state whether the material, when loaded, will be in contact with water or an aqueous environment at any time.

When additional requirements are appropriate for the intended service, see KG-311.12.

KG-311.8 Loadings.

(a) The User shall specify all expected combinations of coincident loading conditions as listed in KD-110. These shall include reaction load vectors.

(b) This loading data may be established by
  (1) calculation
  (2) experimental methods
  (3) actual measurement for similar conditions
  (4) computer analysis
  (5) published data

(c) For mobile vessels, loading conditions imposed by handling, transportation, or motion of the structure to which the vessel is fastened, including credible accidental loadings, shall be considered according to Article KD-1.

KG-311.9 Useful Operating Life Expected. State years, cycles, or both. It is permissible to state that the life is to be determined analytically during design.

KG-311.10 Fatigue Analysis.

(a) Fatigue analysis is mandatory for Division 3 vessels. It is the User's responsibility to provide, or cause to be provided, information in sufficient detail so an analysis for cyclic operation can be carried out in accordance with Articles KD-3 and KD-4.

(b) The User shall state if leak-before-burst can be established based on documented experience with similar designs, size, material properties, and operating conditions (see KD-141) or if leak-before-burst is to be established analytically. The number of design cycles shall be calculated by Article KD-4 if leak-before-burst cannot be established.

(c) The User shall state whether through-thickness leaks can be tolerated as a failure mode for protective liners and inner layers. See KD-103, KD-810(f), and KD-931.

KG-311.11 Overpressure Protection. The User or the (25)
User's designated agent shall be responsible for the design, construction, and installation of the overpressure

protection system. This system shall meet the requirements of Part KOP. Calculations, test reports, and all other information used to justify the size, location, connection details, and flow capacity for the overpressure protection system shall be documented in the User Design Specification (see KOP-120). For a vessel built for stock by a Manufacturer, the Manufacturer shall fulfill all User's responsibilities as the User's designated agent in preparing the User's Design Specification's overpressure protection requirement. The only exception is that the Manufacturer shall not be required to document the relief system, if the relief system is provided by other than the vessel Manufacturer. The User's Design Specification shall state that the relief system is to be determined by others and state that the requirements of Part KOP are to be met prior to installation.

For vessels using power-actuated pressure relief systems following the rules of Article KOP-2, the User's Design Specification shall follow the requirements of KOP-201.

KG-311.12 Additional Requirements. The User shall state in the User's Design Specification what additional requirements are appropriate for the intended vessel service (see Part KE).

(a) For those services in which laminar discontinuities may be harmful, additional examination of materials prior to fabrication shall be specified by the User; for example, ultrasonic examination of plate in Section V, SA-435 and forgings in Section V, SA-388.

(b) State additional requirements such as nondestructive examinations, restricted chemistry, or heat treatments.

(c) The User shall state any nonmandatory or optional requirements of this Division that are considered to be mandatory for this vessel.

(d) The User shall state whether U.S. Customary or SI units are to be used in all certified documents, and on all marking and stamping required by this Division. The User shall also state if duplicate nameplates and certified documents in a second language are required, and if there are any other special requirements for markings and their locations. See also KG-150 and KS-130.

(e) The User shall state requirements for seals and bolting for closures and covers (see KD-660).

(f) Specific additional requirements relating to pressure testing shall be listed in the User's Design Specification, such as

(1) fluid and temperature range
(2) position of vessel
(3) location, Manufacturer's facility or on-site
(4) cleaning and drying

(g) The User shall state in the User's Design Specification what construction reports, records, or certifications, in addition to those listed in KS-320, the Manufacturer is required to provide to the User.

(h) See below.

(1) The User shall state in the User's Design Specification when the special requirements of Article KD-10 for vessels in high pressure hydrogen service shall be met.

(2) The User shall ensure that the requirements of KD-1001 are met.

(i) The User shall state considerations for limiting the potential for unsatisfactory performance when subjected to service or test loads, if applicable. Examples of such considerations may be found in, but are not limited to, KD-231.2(b).

KG-311.13 Installation Site.

(a) location

(b) jurisdictional authority (the User shall state the name and address of the jurisdictional authority that has jurisdiction at the site of installation of the vessel, and state any additional requirements or restrictions of that authority that pertain to the design, construction, or registration of this vessel). When preparing a User's Design Specification for a vessel design intended to be acceptable in multiple jurisdictions, the design shall be based on the most conservative requirements, including all technical, environmental, and jurisdictional requirements. The following information shall be provided:

(1) a listing of all jurisdictions considered in the design

(2) the governing parameters for all design inputs based on the stated installation locations

(c) environmental conditions

KG-311.14 Certification of User's Design Specification. (25) One or a combination of methods shown below shall be used to certify the User's Design Specification.

(a) One or more Professional Engineers,[1] registered in one or more of the states of the United States of America or the provinces of Canada and experienced in pressure vessel design, shall certify that the User's Design Specification meets the requirements in KG-311, and shall apply the Professional Engineer seal in accordance with the required procedures. In addition, the Registered Professional Engineer(s) shall prepare a statement to be affixed to the document attesting to compliance with the applicable requirements of the Code; see KG-311.15(e). This Professional Engineer shall be other than the Professional Engineer who certifies the Manufacturer's Design Report, although both may be employed by or affiliated with the same organization.

(b) One or more individual(s) in responsible charge of the specification of the vessel and the required design conditions shall certify that the User's Design Specification meets the requirements in KG-311. Such certification requires the signature(s) of one or more Engineers with requisite technical and legal stature, and jurisdictional authority needed for such a document. One or more individuals shall sign the documentation based on the information reviewed, and the knowledge and belief that the objectives of this Division have been

Form KG-311.15
Typical Certification of Compliance of the User's Design Specification

CERTIFICATION OF COMPLIANCE OF
THE USER'S DESIGN SPECIFICATION

I (We), the undersigned, being experienced and competent in the applicable field of design related to pressure vessel requirements relative to this User's Design Specification, certify that to the best of my knowledge and belief it is correct and complete with respect to the Design and Service Conditions given and provides a complete basis for construction in accordance with KG-311 and other applicable requirements of the ASME Section VIII, Division 3 Pressure Vessel Code, _____ Edition and Code Cases(s) _____ . This certification is made on behalf of the organization that will operate these vessels.

_____
company name
_____

Certified by: _____
Title and areas of responsibility: _____
Date: _____

Certified by: _____
Title and areas of responsibility: _____
Date: _____

Professional Engineer Seal: _____
as required
_____
Date: _____

satisfied. In addition, these individuals shall prepare a statement to be affixed to the document attesting to compliance with the applicable requirements of the Code; see KG-311.15(e).

(25) **KG-311.15 Requirements for Engineers Who Sign and Certify a User's Design Specification.** Any Engineer who signs and certifies a User's Design Specification shall meet one of the criteria shown in (a), (b), or (c) below and shall comply with the requirements of (d) and (e) below.

(a) A Registered Professional Engineer who is registered in one or more of the states of the United States of America or the provinces of Canada and experienced in pressure vessel design.

(b) An Engineer experienced in pressure vessel design who meets all required qualifications to perform engineering work and any supplemental requirements stipulated by the user and the licensing or registering authorities. The Engineer shall identify the location and the licensing or registering authorities under which the Engineer has received the authority to perform engineering work.

(c) An Engineer experienced in pressure vessel design who meets all required qualifications to perform engineering work and any supplemental requirements stipulated by the user. The Engineer shall be registered in the International Register of Professional Engineers of the Engineers Mobility Forum.

(d) The Engineer certifying the User's Design Specification shall comply with the requirements of the location to practice engineering where that Specification is prepared unless the jurisdiction where the vessel will be installed has different certification requirements.

(e) When more than one Engineer certifies and signs the User's Design Specification, the area of expertise shall be noted next to the signature of each Engineer under "areas of responsibilities" (e.g., design, metallurgy, pressure relief, fabrication, etc.). In addition, one of the Engineers signing the User's Design Specification shall certify that all elements required by this Division are included in the Specification.

(f) An example of a typical User's Design Specification Certification Form is shown in Form KG-311.15.

KG-311.16 Additional User's Design Specification Requirements for Composite Reinforced Pressure Vessels (CRPV). The User shall state in the User's Design Specification any provisions required for protection of the structural laminate layer from damage due to impact, ultraviolet radiation, or other environmental exposure; fire or abrasive conditions; and inservice degradation of the laminate for the life of the CRPV under the service conditions specified shall be stated in the User's Design Specification (see KG-522).

KG-320 MANUFACTURER'S RESPONSIBILITY

KG-321 STRUCTURAL AND PRESSURE-RETAINING INTEGRITY

The Manufacturer is responsible for the structural and pressure-retaining integrity of a vessel or part thereof, as established by conformance with all rules of this Division which are required to meet the conditions in the User's Design Specification and shown in the Manufacturer's Design Report.

KG-322 CODE COMPLIANCE

(a) The Manufacturer completing any vessel or part to be marked with the Certification Mark with U3 Designator or Certification Mark with the word "PART" (see KS-120) in accordance with this Division has the responsibility to comply with all the applicable requirements of this Division and, through proper certification, to ensure that any work done by others also complies with all requirements of this Division.

(b) The Manufacturer shall certify compliance with these requirements by the completion of the appropriate Manufacturer's Data Report, as described in KS-300.

(25) KG-323 MANUFACTURER'S DESIGN REPORT

As part of the Manufacturer's responsibility, the Manufacturer shall provide a Manufacturer's Design Report that includes

(a) design calculations and analysis that establish that the design as shown on the drawings, including as-built changes, complies with the requirements of this Division for the design conditions that have been specified in the User's Design Specification.

(b) final and as-built drawings.

(c) a single Manufacturer's Design Report may be completed and certified to document more than one pressure vessel when all details of construction are identical for each pressure vessel. The location of installation shall be a single, specific jurisdiction, provided that all technical requirements of the User's Design Specification are identical. When preparing a Manufacturer's Design Report for a vessel design intended to be acceptable in multiple jurisdictions, the design shall be based on the most conservative requirements, including all technical, environmental, and jurisdictional requirements. The following information shall be provided:

(1) a listing of all jurisdictions considered in the design

(2) the governing parameters for all design inputs based on the stated installation locations

A separate Manufacturer's Data Report shall be issued for each vessel.

(d) the results of the fatigue analysis according to Articles KD-3 and KD-4, and KD-1260, if applicable.

(e) documentation of the consideration of the effects of heating, or heat treatments during manufacturing, and similarly, the maximum metal temperature specified, to show that the material properties or prestress used in the design are not adversely affected (see Parts KD and KF).

(f) statement of any openings for which the Manufacturer has not installed closures such as the service cover, or closure or other connections.

(g) the limiting thermal gradients across the vessel section.

(h) all design information required for the User or the User's designated agent to design the vessel's support to meet the requirements of Article KD-7, when the support method is unknown at the time of vessel manufacture. This may include as a minimum

(1) vessel weight

(2) vessel loading considered in design

(3) vessel natural frequency

(i) Certification of the Design Report as provided in KG-324, which shall not relieve the Manufacturer of the responsibility for the structural integrity of the completed item for the conditions stated in the User's Design Specification.

KG-324 CERTIFICATION OF MANUFACTURER'S DESIGN REPORT (25)

One or a combination of methods shown below shall be used to certify the Manufacturer's Design Report.

(a) One or more Professional Engineers,[1] registered in one or more of the states of the United States of America or the provinces of Canada and experienced in pressure vessel design, shall certify the Manufacturer's Design Report meets the requirements in KG-323. The Registered Professional Engineer(s) shall apply the Professional Engineer seal in accordance with the required procedures. In addition, the Registered Professional Engineer(s) shall prepare a statement to be affixed to the document attesting to compliance with the applicable requirements of the Code; see KG-324.1(h). This Professional Engineer shall be other than the Professional Engineer who certifies the User's Design Specification, although both may be employed by or affiliated with the same organization.

(b) One or more individual(s), experienced in pressure vessel design shall certify that the Manufacturer's Design Report meets the requirements in KG-323. Such

certification requires the signature(s) of one or more Engineers with requisite technical and legal stature, and corporate authority needed for such a document. These responsible individuals shall sign the documentation based on the information reviewed, and the knowledge and belief that the objectives of this Division have been satisfied. In addition, these individuals shall prepare a statement to be affixed to the document attesting to compliance with the applicable requirements of the Code; see KG-324.1(i).

(25) **KG-324.1 Requirements for Signing and Certifying a Manufacturer's Design Report.** Any Engineer who signs and certifies a Manufacturer's Design Report shall meet one of the criteria shown in (a), (b), or (c) below and shall comply with the requirements of (d), (e), and (f) below.

(a) A Registered Professional Engineer who is registered in one or more of the states of the United States of America or the provinces of Canada and experienced in pressure vessel design.

(b) An Engineer experienced in pressure vessel design who meets all required qualifications to perform engineering work and any supplemental requirements stipulated by the user. The Engineer shall identify the location and the licensing or registering authorities under which the Engineer has received the authority to perform engineering work stipulated by the user in the Design Specification.

(c) An Engineer experienced in pressure vessel design who meets all required qualifications to perform engineering work and any supplemental requirements stipulated by the user. The Engineer shall be registered in the International Register of Professional Engineers of the Engineers Mobility Forum.

(d) The Engineer certifying the Manufacturer's Design Report shall comply with the requirements of the location to practice engineering where that Report is prepared unless the jurisdiction where the vessel will be installed has different certification requirements.

(e) When more than one Engineer certifies and signs the Manufacturer's Design Report, the area of expertise shall be noted next to the signature of each Engineer under "areas of responsibilities" (e.g., design, metallurgy, pressure relief, fabrication, etc.). In addition, one of the Engineers signing the Manufacturer's Design Report shall certify that all elements required by this Division are included in the Report.

(f) The manufacturer's Design Report shall be certified only after

(1) all design requirements of this Division and the User's Design Specification have been met.

(2) the Manufacturer's Construction Records are reconciled with the Manufacturer's Design Report and with the User's Design Specification.

(g) Certification of the Design Report shall not relieve the Manufacturer of the responsibility for the structural integrity of the completed item for the conditions stated in the User's Design Specification.

(h) The inspector shall review the Manufacturer's Design Report and ensure that the requirements of KG-440 have been satisfied.

(i) An example of a typical Manufacturer's Design Report Certification Form is shown in Form KG-324.1.

KG-325 MANUFACTURER'S CONSTRUCTION RECORDS (MCR)

The Manufacturer shall prepare, collect, and maintain construction records and documentation of NDE reports, repairs, and deviations from drawings, as production progresses, to show compliance with the Manufacturer's Design Report. An index to the construction records file shall be maintained current. See KS-320.

KG-330 DESIGNER (25)

The Designer is the individual engineer, or group of engineers, experienced in high pressure vessel design, who performs the required analysis of the vessel. The Designer may be an employee of the Manufacturer, or an agent acting in the Manufacturer's behalf.

Form KG-324.1
Typical Certification of Compliance of the Manufacturer's Design Report

CERTIFICATION OF COMPLIANCE OF
THE MANUFACTURER'S DESIGN REPORT

I (We), the undersigned, being experienced and competent in the applicable field of design related to pressure vessel construction relative to the certified User's Design Specification, certify that to the best of my knowledge and belief the Manufacturer's Design Report is complete, accurate, and complies with the User's Design Specification and with all the other applicable construction requirements of the ASME Section VIII, Division 3 Pressure Vessel Code, _____ Edition and Code Case(s) _____ . This certification is made on behalf of the Manufacturer _____
company name
_____

Certified by: _____
Title and areas of responsibility: _____
Date: _____

Certified by: _____
Title and areas of responsibility: _____
Date: _____

Professional Engineer Seal: _____
as required
_____
Date: _____

Authorized Inspector review: _____
Date: _____

ARTICLE KG-4
GENERAL RULES FOR INSPECTION

KG-400 GENERAL REQUIREMENTS FOR INSPECTION AND EXAMINATION

The inspection and examination of pressure vessels stamped with the Certification Mark with U3 Designator shall conform to the general requirements for inspection and examination in this Article and, in addition, to the specific requirements for inspection and examination given in the applicable paragraphs.

KG-410 MANUFACTURER'S RESPONSIBILITIES

KG-411 INSPECTION CONTRACT

The Manufacturer shall have in force, at all times, a valid inspection contract or agreement with an accredited Authorized Inspection Agency, employing Authorized Inspectors as defined in KG-431. A valid inspection contract or agreement is a written agreement between the Manufacturer and the Authorized Inspection Agency in which the terms and conditions for furnishing the service are specified and in which the mutual responsibilities of the Manufacturer and the Inspector are stated.

(25) KG-412 CERTIFICATION

The Manufacturer who completes any vessel to be marked with the Certification Mark with U3 Designator has the responsibility of complying with all the requirements of this Division and, through proper certification, of ensuring that work done by others also complies with all requirements of this Division, as indicated by the Manufacturer's signature on the Manufacturer's Data Report.

KG-413 PROVISIONS FOR INSPECTION

KG-413.1 Access. The Manufacturer of the vessel or part thereof shall arrange for the Inspector to have free access to such parts of all plants as are concerned with the supply or manufacture of materials for the vessel, at all times while work on the vessel is being performed, and to the site of field erected vessels during the period of assembly and testing of the vessel.

(25) **KG-413.2 Progress.** The Manufacturer shall keep the Inspector informed of the progress of the work and shall notify the Inspector reasonably in advance when the vessel or materials will be ready for any required tests or inspections.

KG-414 DOCUMENTATION FURNISHED TO INSPECTOR

The Manufacturer shall provide documentation and records, with ready and timely access for the Inspector, and perform the other actions as required by this Division. Some typical required documents, which are defined in the applicable rules, are summarized as follows:

(a) the Certificate of Authorization to use the Certification Mark with U3 Designator from the ASME Boiler and Pressure Vessel Committee (see Article KS-2)

(b) the drawings and design calculations for the vessel or part (see KG-323)

(c) the mill test report or material certification for all material used in the fabrication of the vessel or part including welding materials (see KM-101), and sample test coupons (see KT-110) when required

(d) any Partial Data Reports when required by KS-301

(e) reports of examination of all materials (except welding materials) before fabrication

(1) to make certain they have the required thickness in accordance with the Design Specification

(2) for detection of unacceptable defects

(3) to make certain the materials are permitted by this Division (see KM-100)

(4) and to make certain that the identification traceable to the mill test report or material certification has been maintained (see KF-112)

(f) documentation of impact tests when such tests are required [see KM-212, KM-230(a), and Article KT-2]

(g) obtain concurrence of the Inspector prior to any repairs when required by KF-113, KF-710 and 2-116 of Mandatory Appendix 2

(h) reports of examination of head and shell sections to confirm they have been properly formed to the specified shapes within permissible tolerances (see KF-120 and KF-130)

(i) qualification of the welding procedures before they are used in fabrication (see KF-210, KF-822, and KT-220)

(j) qualification of all Welders and Welding Operators before using Welders in production work (see KF-210 and KF-823)

(k) reports of examination of all parts prior to joining to make certain they have been properly fitted for welding and that the surfaces to be joined have been cleaned and the alignment tolerances are maintained (see KF-230)

(l) reports of examination of parts as fabrication progresses for material identification (see KG-413 and KS-301) that surface defects are not evident, and that dimensional geometries are maintained

(m) provision of controls to assure that all required heat treatments are performed (see Part KF)

(n) providing records of nondestructive examinations performed on the vessel or vessel parts. This shall include retaining the radiographic film

(o) making the required hydrostatic or pneumatic test and having the required examination performed during such test (see Article KT-3)

(p) applying the required stamping and/or nameplate to the vessel and making certain it is applied to the proper vessel (see Article KS-1)

(q) preparing the required Manufacturer's Data Report with the supplement, and having them certified by the Inspector (see Article KS-1)

(r) maintenance of records (see KS-310 and KS-320)

KG-420 CERTIFICATION OF SUBCONTRACTED SERVICES (25)

(a) The Quality Control Manual shall describe the manner in which the Manufacturer (Certificate Holder) controls and accepts the responsibility for the subcontracted activities (see KG-322). The Manufacturer shall ensure that all subcontracted activities meet the requirements of this Division. This section of the manual will be reviewed with the Inspector together with the entire Quality Control Manual.

(b) Work such as forming, nondestructive examination, heat treating, etc., may be performed by others. It is the vessel Manufacturer's responsibility to ensure that all work performed complies with all the applicable requirements of this Division. After ensuring compliance, and obtaining permission of the Inspector, the vessel may be stamped with the Certification Mark.

(c) Subcontracts that involve welding on the pressure boundary components for construction under the rules of this Division, other than repair welds permitted by the ASME material specifications, shall be made only to subcontractors holding a valid Certificate of Authorization with U, U2, or U3 Designators.

(d) A Manufacturer may engage individuals by contract for services as Welders or Welding Operators, at shop or site locations shown on the Manufacturer's Certificate of Authorization, provided all of the following conditions are met:

(1) The work to be done by Welders or Welding Operators is within the scope of the Certificate of Authorization.

(2) The use of such Welders or Welding Operators is described in the Quality Control Manual of the Manufacturer.

(3) The Welding Procedures have been properly qualified by the Manufacturer, according to Section IX.

(4) The Welders and Welding Operators are qualified by the Manufacturer according to Section IX to perform these procedures.

(5) Code responsibility and control is retained by the Manufacturer.

KG-430 THE INSPECTOR

KG-431 IDENTIFICATION OF INSPECTOR

All references to Inspectors throughout this Division mean the Authorized Inspector as defined in this paragraph. All inspections required by this Division shall be by an Inspector qualified according to KG-432 and regularly employed by

(a) an ASME accredited Authorized Inspection Agency, as defined in ASME QAI-1, Qualifications for Authorized Inspection, or

(b) a company that manufactures pressure vessels exclusively for its own use and not for resale which is defined as a User–Manufacturer. This is the only instance in which an Inspector may be in the employ of the Manufacturer.

KG-432 INSPECTOR QUALIFICATION

All Inspectors shall have been qualified in accordance with ASME QAI-1, Qualifications for Authorized Inspection.

KG-433 MONITOR QUALITY CONTROL SYSTEM

In addition to the duties specified, the Inspector has the duty to monitor the Manufacturer's Quality Control System as required in Mandatory Appendix 2.

KG-434 MAINTENANCE OF RECORDS

The Inspector shall verify that the Manufacturer has a system in place to maintain the documentation for the Manufacturer's Construction Records current with production, and to reconcile any deviations from the Manufacturer's Design Report.

KG-440 INSPECTOR'S DUTIES (25)

The Inspector of vessels to be marked with the Certification Mark with U3 Designator has the duty of making all required inspections and such other inspections considered necessary in order to satisfy the Inspector that all requirements have been met. Some typical required inspections and verifications, which are defined in the applicable rules, are summarized as follows:

(a) to verify that the Manufacturer has a valid Certificate of Authorization and is working according to an approved Quality Control System

(b) to verify that applicable Design Report, User's Design Specification, drawings, and related documents are available (see KG-414)

(c) to verify that materials used in the construction of the vessel comply with the requirements of Part KM

(d) to verify that all Welding Procedures have been qualified

(e) to verify that all Welders and Welding Operators have been qualified

(f) to verify that the heat treatments, including postweld heat treatment (PWHT), have been performed [see KG-414(m)]

(g) to verify that material imperfections repaired by welding are acceptably repaired and reexamined

(h) to verify that the required nondestructive examinations, impact tests, and other tests have been performed and that the results are acceptable

(i) to make a visual inspection of the vessel to confirm that the material numbers have been properly transferred (see KF-112)

(j) to perform internal and external inspections where applicable, and to witness the hydrostatic or pneumatic tests (see Article KT-3)

(k) to verify that the required marking is provided, including stamping, and that the nameplate has been permanently attached to the proper vessel or vessel chamber (see Article KS-1)

(l) to sign the Certificate of Inspection on the Manufacturer's Data Report when the vessel, to the best of the Inspector's knowledge and belief, is complete and in compliance with all the provisions of this Division (see Article KS-3)

(m) to verify that the Manufacturer has maintained proper records (see KS-320 and KG-320)

ARTICLE KG-5
ADDITIONAL GENERAL REQUIREMENTS FOR COMPOSITE REINFORCED PRESSURE VESSELS (CRPV)

KG-500 GENERAL REQUIREMENTS

The following Article provides additional general requirements for the manufacture of Composite Reinforced Pressure Vessels (CRPV).

KG-510 SCOPE

This construction method uses a laminate of continuous unidirectional filaments of a specified glass or carbon fiber with a specified resin that is circumferentially wound in a systematic manner under controlled tension over a cylindrical metallic layer and cured in place. Openings are not permitted in the laminate. Metallic ends and nozzles complete the construction; see Section X, Mandatory Appendix 10, Figures 10-201-1, 10-201-2, and 10-201-3.

KG-511 METALLIC LAYER

The outside diameter of the metallic layer in the reinforced area shall not exceed 60 in. (1.52 m). The thickness of the metallic layer shall not be less than 0.25 in. (6 mm).

KG-512 SERVICE LIFE

Service life for CRPV constructed under the rules of this Division shall be limited to twenty years from the date of manufacture as noted on Form CRPV-1A.

KG-513 APPLICATION SPECIFIC TESTS AND OTHER REQUIREMENTS

This Division does not include requirements or rules for tests that may be appropriate for certain applications (e.g., fire tests, drop tests, projectile impact tests). For some applications, it may be necessary to consider additional conditions such as exposure to fire and projectile impact damage.

KG-514 UPPER LIMIT OF DESIGN PRESSURE

The internal design pressure for CRPV shall not be greater than 15,000 psi (103 MPa).

KG-515 SERVICE PRESSURE AND WORKING PRESSURE

In some standards and regulations used in ambient temperature compressed gas transport service, the term “service pressure” is used to indicate the pressure in the vessel at a temperature of 68°F (20°C). In other standards and regulations the term “working pressure” is used with the same definition. In these standards and regulations it is generally allowable for the service or working pressure to be exceeded as the gas is heated beyond 68°F (20°C) during filling or due to atmospheric heating. For pressure vessels to be used in transport service constructed to this Code, the service pressure and the working pressure shall be the maximum expected pressure at a temperature of 68°F (20°C). The service pressure or the working pressure or both shall be defined in the User’s Design Specification. The working pressure, service pressure, or the expected pressure due to heating during filling or atmospheric heating shall not exceed the design pressure of the vessel at the design temperature.

KG-516 PROTECTIVE LAYER

Additional requirements regarding specification of a protective layer for the CRPV in the User's Design Specification can be found in Section X, Mandatory Appendix 10, 10-202.

KG-517 REQUIREMENTS FOR CYCLIC PRESSURE QUALIFICATION TEST

In addition to the total number of operating cycles during the life of the CRPV, the User's Design Specification shall state if the temperature of the intended service will be controlled. If the intent is to control the temperature of service, the number of cycles colder than 30°F (0°C), the number of cycles between 30°F (0°C) and 110°F (45°C), and the number of cycles warmer than 110°F (45°C) shall be noted. If the service will be in ambient conditions with no intent to control the temperature, there is no requirement to report the number of cycles in the aforementioned temperature ranges.

KG-518 LAMINATE TENSILE STRENGTH AND ELASTIC MODULUS

The User's Design Specification shall state the required minimum tensile strength and the nominal elastic modulus for the laminate in the maximum property direction (parallel to the fiber direction).

KG-520 SUPPLEMENTAL GENERAL REQUIREMENTS FOR CRPV

KG-521 REQUIREMENTS FOR CRPV USED IN TRANSPORT SERVICE

(a) CRPV used in transport service shall conform to the regulatory requirements specific to the application in addition to this Division. Government regulatory agencies and other jurisdictions issue rules that may require compliance with additional Codes and Standards.)

(b) CRPV may be installed in ships, barges, container frames, rail cars, over-the-road trucks, and other craft, provided prior written agreement with the local jurisdictional authority is established covering operation and maintenance control for a specific service and where this operation and maintenance control is retained during the life of the CRPV by the User who prepares, or causes to be prepared, the User's Design Specification. See KG-310.

(c) CRPVs to be used in transport service as described above may be constructed and stamped within the scope of this Division as specified with the following additional provisions:

(1) The User's Design Specification shall include the requirements that provide for operation and maintenance control for the CRPV.

(2) For vessels to be used in transport service, the User's Design Specification shall specify the service pressure or the working pressure or both for the vessel (see KG-515).

(3) The Manufacturer's Data Report, as described in KS-300, shall include under "Remarks" one of the following statements:

(-a) "Constructed for transport service for use in (name of local jurisdictional authority in this space)."

(-b) "Constructed for service according to the requirements of (regulatory agency or additional code(s) in this space)."

(4) The loads on the CRPV imposed by the conditions of transport, including accident loads, relocation of the CRPV between sites, and cyclic loading and discharge shall be considered as part of KD-110.

(5) The CRPV shall not be used as structural support members in the transport vehicle or vessel structure.

KG-522 SUPPLEMENTARY MANUFACTURER'S RESPONSIBILITIES

Additional supplementary Manufacturer's requirements are found in Section X, Mandatory Appendix 10, 10-203.

ARTICLE KG-6
ADDITIONAL GENERAL REQUIREMENTS FOR IMPULSIVELY LOADED VESSELS

KG-600 GENERAL REQUIREMENTS

The following Article provides additional general requirements for the design and manufacture of impulsively loaded vessels.

KG-610 SCOPE

This Article applies to pressure vessels that are subjected to internal impulsive loadings that may consist of blast pressure from a detonation source and mechanical loadings caused by detonation fragments. Impulsive loading is defined in KD-210.

KG-611 CONSTRUCTION RULES

Each pressure vessel to which this Article applies shall comply with the existing rules of Section VIII, Division 3 and the additional requirements given in Article KM-7, KD-240, Article KOP-3, KT-350, and KS-102.

KG-612 MATERIALS AND COMBINATIONS OF MATERIALS

Each pressure vessel to which this Article applies shall comply with the requirements of KD-101, except as covered in Article KM-7.

KG-613 OVERPRESSURE PROTECTION (25)

In accordance with KG-311.11, the User or the User's designated agent shall be responsible for the provision in the Design Specification of the administrative or engineered controls that provide overpressure protection as specified in Article KOP-3.

KG-614 LOADINGS

The User's Design Specification (see KG-311) shall provide the following in addition to the required loadings specified in KG-311:

(a) the impulsive loading design basis.

(b) impulse source location within the vessel (i.e., vessel center, off-center, etc.).

(c) the basis for administrative controls limiting the impulse source.

(d) any protective liner requirements, such as for fragment shielding. For vessels without protective liners, such as single-use vessels, guidance for evaluation of postulated localized wall thinning from fragment partial penetration is provided in API-579-1/ASME FFS-1.

PART KM
MATERIAL REQUIREMENTS

ARTICLE KM-1
GENERAL REQUIREMENTS

KM-100 MATERIALS PERMITTED

(a) Materials that are to be used under the rules of this Division, except for integral cladding, welding filler metals, weld metal overlay, protective liner materials (see KD-103), laminate materials used for the wrapping of CRPV vessels (see Article KM-5), and inner layers of covers used on impulsively loaded vessels (see Article KM-7), shall conform to a material specification given in Section II, and shall be listed in Tables KM-400-1 through KM-400-4 (Tables KM-400-1M through KM-400-4M) The term *material specification* used in this Division shall be the referenced specification in Section II together with the supplemental requirements listed in the User's Design Specification (see KG-311.7).

(b) Materials that are outside the limits of size and/or thickness stipulated in the title or scope clause of the material specifications given in Section II and permitted by Part KM may be used if the materials are in compliance with the other requirements of the material specification and no size or thickness limitation is specified in this Division. In those specifications in which chemical composition or mechanical properties vary with size or thickness, materials outside the range shall be required to conform to the composition and mechanical properties shown for the nearest specified range.

(c) Except as provided in Articles KM-5, KM-7, and this paragraph, materials other than those allowed by this Division shall not be used for construction of the pressure-retaining component, including bolting and prestressed inner layer.

(1) Data on other materials may be submitted to and approved by the ASME Boiler and Pressure Vessel Committee in accordance with Section II, Part D, Mandatory Appendix 5.

(2) A vessel or part Manufacturer may certify materials identified with a specification not permitted by this Division, provided the following requirements are satisfied:

(-a) All requirements (including, but not limited to, melting method, melting practice, deoxidation, quality, and heat treatment) of a specification permitted by this Division to which the material is to be certified, including the requirements of this Division, have been demonstrated to have been met.

(-b) A certification that the material was manufactured and tested in accordance with the requirements of the specification to which the material is certified (a Certificate of Compliance), excluding the specific marking requirements, has been furnished to the vessel or part Manufacturer, together with copies of all documents and test reports pertinent to the demonstration of conformance to the requirements of the permitted specification.

(d) The bolt product form, as specified in Tables KM-400-1 through KM-400-3 (Tables KM-400-1M through KM-400-3M) shall not be used for applications other than bolting (see KM-300).

(e) Pressure vessel closure components, such as threaded bodies and main nuts, that have threaded sections for the purpose of engaging seals and/or retaining end loads may be manufactured from forging or bar product forms listed in Tables KM-400-1 through KM-400-3 (Tables KM-400-1M through KM-400-3M), provided that all other qualification and design requirements of this Division are met.

(f) The User shall confirm the coupling of dissimilar metals will have no harmful effect on the corrosion rate or life of the vessel for the service intended (see KG-311.7).

KM-101 CERTIFICATION BY MATERIALS MANUFACTURER

The Materials Manufacturer shall certify that all requirements of the applicable materials specifications in Section II (considering any exemptions allowed by KM-100), all special requirements of Part KM which are to be fulfilled by the Materials Manufacturer, and all supplementary material requirements specified by the User's Design Specification (see KG-311) have been complied with. The certification shall consist of a Materials Manufacturer's material test report showing numerical results of all required tests, and shall certify that all required examinations and repairs have been performed

on the materials. Also see KE-200. All conflicts between the materials specifications and the special requirements herein shall be noted and compliance with the special requirements stated (see KF-111).

KM-102 PREFABRICATED OR PREFORMED PRESSURE PARTS FURNISHED WITHOUT A CERTIFICATION MARK

(a) Prefabricated or preformed pressure parts for pressure vessels that are subject to stresses due to pressure and that are furnished by others or by the Manufacturer of the completed vessel shall conform to all applicable requirements of this Division except as permitted in (b), (c), (d), and (e) below. When the prefabricated or preformed parts are furnished with a nameplate that contains product-identifying marks and the nameplate interferes with further fabrication or service, and where stamping on the material is prohibited, the Manufacturer of the completed vessel, with the concurrence of the Authorized Inspector, may remove the nameplate. The removal of the nameplate shall be noted in the "Remarks" section of the vessel Manufacturer's Data Report. The nameplate shall be destroyed. The rules of (b), (c), (d), and (e) below shall not be applied to welded shells or heads.

Parts furnished under the provisions of (b), (c), and (d) need not be manufactured by a Certificate of Authorization Holder.

Prefabricated or preformed pressure parts may be supplied as follows:

(1) cast, forged, rolled, or die-formed nonstandard pressure parts

(2) cast, forged, rolled, or die-formed standard pressure parts that comply with an ASME product standard, either welded or nonwelded

(3) cast, forged, rolled, or die-formed standard pressure parts that comply with a standard other than an ASME product standard, either welded or nonwelded

(b) Cast, Forged, Rolled, or Die-Formed Nonstandard Pressure Parts. Pressure parts such as shells, heads, removable doors, and pipe coils that are wholly formed by casting, forging, rolling, or die forming may be supplied basically as materials. All such parts shall be made of materials permitted under this Division, and the Manufacturer of the part shall furnish identification in accordance with KM-101. Such parts shall be marked with the name or trademark of the parts manufacturer and with such other markings as will serve to identify the particular parts with accompanying material identification. The Manufacturer of the completed vessel shall be satisfied that the part is suitable for the design conditions specified for the completed vessel in accordance with the rules of this Division.

(c) Cast, Forged, Rolled, or Die-Formed Standard Pressure Parts That Comply With an ASME Product Standard, Either Welded or Nonwelded

(1) These are pressure parts that comply with an ASME product standard accepted by reference. The ASME product standard establishes the basis for the pressure–temperature rating and marking unless modified by this Division.

(2) Flanges and flanged fittings may be used at the pressure–temperature ratings specified in the appropriate standard listed in this Division.

(3) Materials for standard pressure parts shall be as permitted by this Division.

(4) Pressure parts such as welded standard pipe fittings, welding caps, and flanges that are fabricated by one of the welding processes recognized by this Division do not require inspection or identification in accordance with KM-101 except that certified reports of numerical results or certificates of compliance of the required Charpy V-notch impact testing of the parts shall be supplied to the Manufacturer of the completed vessel. Partial Data Reports are not required provided the requirements of KM-102(c) are met.

(5) If postweld heat treatment is required by the rules of this Division, it may be performed either in the location of the parts manufacturer or in the location of the Manufacturer of the vessel to be marked with the Certification Mark.

(6) If volumetric examination is required by the rules of this Division, it may be performed at one of the following locations:

(-a) the location of the Manufacturer of the completed vessel

(-b) the location of the pressure parts manufacturer

(7) Parts made to an ASME product standard shall be marked as required by the ASME product standard.

(8) The Manufacturer of the completed vessels shall have the following responsibilities when using standard pressure parts that comply with an ASME product standard:

(-a) ensure that all standard pressure parts comply with applicable rules of this Division

(-b) ensure that all standard pressure parts are suitable for the design conditions of the completed vessel

(-c) when volumetric examination is required by the rules of this Division, obtain the complete data set, properly identified, with an examination report, and any other applicable volumetric examination report

(9) The Manufacturer shall fulfill these responsibilities by obtaining, when necessary, documentation as provided below, providing for retention of this documentation, and having such documentation available for examination by the Inspector when requested. The documentation shall contain at a minimum

(-a) material used

(-b) the pressure–temperature rating of the part

(-c) the basis for establishing the pressure–temperature rating

(d) Cast, Forged, Rolled, or Die-Formed Standard Pressure Parts That Comply With a Standard Other Than an ASME Product Standard, Either Welded or Nonwelded

(1) Standard pressure parts that are either welded or nonwelded and comply with a manufacturer's proprietary standard or a standard other than an ASME product standard may be supplied by

(-a) a Certificate of Authorization holder

(-b) a pressure parts manufacturer

(2) Parts of small size falling within this category for which it is impossible to obtain identified material, or that may be stocked and for which identification in accordance with KM-101 cannot be obtained and are not customarily furnished, shall not be used.

(3) Materials for these parts shall be as permitted by this Division only.

(4) When welding is performed, it shall meet the requirements of this Division.

(5) Pressure parts such as welded standard pipe fittings, welding caps, and flanges that are fabricated by one of the welding processes recognized by this Division do not require inspection or identification in accordance with KM-101 except that certified reports of numerical results or certificates of compliance of the required Charpy V-notch impact testing of the parts shall be supplied to the Manufacturer of the completed vessel. Partial Data Reports are not required provided the requirements of KM-102(c) are met.

(6) If postweld heat treatment is required by the rules of this Division, it may be performed either in the location of the parts manufacturer or in the location of the Manufacturer of the completed vessel.

(7) If radiography or other volumetric examination is required by the rules of this Division, it may be performed at one of the following locations:

(-a) the location of the Manufacturer of the completed vessel

(-b) the location of the parts Manufacturer

(-c) the location of the pressure parts manufacturer

(8) Marking for these parts shall be as follows:

(-a) with the name or trademark of the Certificate Holder or the pressure part manufacturer and any other markings as required by the proprietary standard or other standard used for the pressure part

(-b) with a permanent or temporary marking that will serve to identify the part with the Certificate Holder or the pressure parts manufacturer's written documentation of the particular items, and that defines the pressure–temperature rating of the part

(9) The Manufacturer of the completed vessels shall have the following responsibilities when using standard pressure parts:

(-a) ensure that all standard pressure parts comply with applicable rules of this Division

(-b) ensure that all standard pressure parts are suitable for the design conditions of the completed vessel

(-c) when volumetric examination is required by the rules of this Division, obtain the complete data set, properly identified, with an examination report, and any other applicable volumetric examination report

(10) The Manufacturer of the completed vessel shall fulfill these responsibilities by one of the following methods:

(-a) Obtain, when necessary, documentation as described below, provide for retention of this documentation, and have such documentation available for examination by the Inspector when requested, or,

(-b) Perform an analysis of the pressure part in accordance with the rules of this Division. This analysis shall be included in the documentation and shall be made available for examination by the Inspector when requested.

(11) The documentation shall contain at a minimum

(-a) material used

(-b) the pressure–temperature rating of the part

(-c) the basis for establishing the pressure–temperature rating

(-d) a written certification by the pressure parts manufacturer that all welding complies with Code requirements

(e) The Code recognizes that a Certificate of Authorization Holder may fabricate parts in accordance with KM-102(d), and that are marked in accordance with KM-102(d)(8). In lieu of the requirements in KM-102(d)(4), the Certificate of Authorization Holder may subcontract to an individual or organization not holding an ASME Certificate of Authorization standard pressure parts that are fabricated to a standard other than an ASME product standard, provided all the following conditions are met:

(1) The activities to be performed by the subcontractor are included within the Certificate Holder's Quality Control System.

(2) The Certificate Holder's Quality Control System provides for the following activities associated with subcontracting of welding operations and these provisions shall be acceptable to the Manufacturer's Authorized Inspection Agency:

(-a) the welding processes permitted by this Division that are permitted to be subcontracted

(-b) welding operations

(-c) Authorized Inspection activities

(-d) placement of the Certificate of Authorization Holder's marking in accordance with KM-102(d)(8)

(3) The Certificate Holder's Quality Control System provides for the requirements of KG-413 to be met at the subcontractor's facility.

(4) The Certificate Holder shall be responsible for reviewing and accepting the Quality Control Programs of the subcontractor.

(5) The Certificate Holder shall ensure that the subcontractor uses written procedures and welding operations that have been qualified as required by this Division.

(6) The Certificate Holder shall ensure that the subcontractor uses personnel that have been qualified as required by this Division.

(7) The Certificate Holder and the subcontractor shall describe in their Quality Control Systems the operational control of procedure and personnel qualifications of the subcontracted welding operations.

(8) The Certificate Holder shall be responsible for controlling the quality and ensuring that all materials and parts that are welded by subcontractors and submitted to the Inspector for acceptance conform to all applicable requirements of this Division.

(9) The Certificate Holder shall describe in their Quality Control Systems the operational control for maintaining traceability of materials received from the subcontractor.

(10) The Certificate Holder shall receive approval for subcontracting from the Authorized Inspection Agency prior to the commencing of activities.

KM-103 BASE MATERIAL FOR INTEGRAL CLADDING, WELD METAL OVERLAY, AND OTHER PROTECTIVE LININGS

Base materials over which integral cladding or weld metal overlay materials are applied shall satisfy the requirements of Part KM. Base materials in which corrosion-resistant or abrasion-resistant liners are used shall also meet the requirements of Part KM.

KM-104 INTEGRAL CLADDING AND WELD METAL OVERLAY MATERIAL

Integral cladding and weld metal overlay materials may be any metallic material of weldable quality that meets the requirements of Article KF-3.

KM-105 PROTECTIVE LINER MATERIAL

Corrosion-resistant or abrasion-resistant liner materials may be any metallic or nonmetallic material suitable for the intended service conditions (see KG-311).

KM-106 REPETITION OF SPECIFIED EXAMINATIONS, TESTS, OR HEAT TREATMENTS

The requirements of Article KM-2 shall be met in addition to the examination, testing, and heat treating requirements for a given material that are stated in its material specification. No heat treatment need be repeated except in the case of quenched and tempered steel as required by KF-602.

ARTICLE KM-2
MECHANICAL PROPERTY TEST REQUIREMENTS FOR METALS

KM-200 GENERAL REQUIREMENTS

As permitted by KM-100, all forms of metal products may be used subject to meeting the requirements of the material specification as well as the mechanical test and examination requirements of this Division.

KM-201 DEFINITION OF THICKNESS

The requirements in this Article make reference to a thickness. For the purpose intended, the following definitions of thickness T at the time of heat treatment apply.

KM-201.1 Plates. The thickness is the dimension of the short transverse direction.

KM-201.2 Forgings. The thickness is the dimension defined as follows:

(a) for hollow forgings in which the axial length is greater than the radial thickness, the thickness is measured between the minimum inside and maximum outside surfaces (radial thickness), excluding flanges (protrusions) whose thicknesses are less than the wall thickness of the cylinder

(b) for disk forgings in which the axial length is less than or equal to outside diameter, the thickness is the axial length

(c) for ring forgings where the maximum axial length is less than the radial thickness, the maximum axial dimension is considered the thickness

(d) for rectangular solid forgings, the least rectangular dimension is the thickness

(e) for round, hexagonal, and octagonal solid forgings, the nominal thickness is the diameter or distance across the flats (axial length > diameter or distance across the flats)

KM-201.3 Bars and Bolting Materials. The thickness for bars and bolting material shall be the diameter for round bars, the lesser of the two cross-section dimensions for rectangular bars, and the distance across the flats for hexagonal bars; or the length of a given bar, whichever is less.

KM-201.4 Pipe. The thickness for pipe shall be the nominal wall thickness.

KM-210 PROCEDURE FOR OBTAINING TEST SPECIMENS AND COUPONS

For austenitic stainless steels and for nonferrous alloys, the procedure for obtaining test specimen coupons shall conform to the applicable material specification. These materials are exempt from the requirements of KM-211.

KM-211 PRODUCT FORMS

KM-211.1 Plates.

(a) For thicknesses less than 2 in. (50 mm), specimens shall be taken in accordance with the requirements of the applicable material specification.

(b) For thicknesses 2 in. (50 mm) and greater, the centerline of the test specimens shall be taken in accordance with the requirements of the applicable material specification, but not closer than T to any heat-treated edge and at a depth of $T/2$ from the plate surface.

(c) Where a separate test coupon is used to represent the vessel material, it shall be of sufficient size to ensure that the cooling rate of the region from which the test specimens are removed represents the cooling rate of the material at $T/2$ deep and at least T from any edge of the product. Unless cooling rates applicable to the bulk pieces or product are simulated in accordance with KM-220, the dimensions of the coupon shall be not less than $3T$ by $3T$ by T, where T is the maximum material thickness.

KM-211.2 Forgings. The datum point, defined as the midpoint of the gage length of tension test specimens or the area under the notch of impact test specimens, shall be located in accordance with one of the following methods. All testing shall be from integral prolongations of the forging, except as permitted in (d), and shall be performed after final heat treatment (see KT-111). In addition to the following, for quenched and tempered materials, the location of the datum point shall be equal to or farther from the nearest quenched surface than any pressurized surface or area of significant loading is from the quenched surface. The designer shall define the datum point locations within the forging relative to the rules of this Division. (25)

(a) For forgings having a maximum heat-treated thickness not exceeding 4 in. (100 mm), the datum points of the test specimens shall be located in the forging or test

forging at mid-thickness and at least $2T/3$ (T is the maximum heat-treated thickness) from the heat-treated end surface or nearest adjacent surfaces.

(b) For forgings having a maximum heat-treated thickness in excess of 4 in. (100 mm), the datum points of the test specimens shall be removed $T/4$ or deeper from the nearest heat-treated surface and at least $2T/3$ from the heat-treated end surface or nearest adjacent surfaces. $T/4$ from a heat-treated end or deeper may be used for precipitation hardening and age hardening materials listed in Table KM-400-2 (Table KM-400-2M) (UNS Nos. S13800, S15500, S17400, S17700, S45000, S45500, and S66286) that have been air cooled after aging.

(c) For forgings that are contour shaped or machined to essentially the finished product configuration prior to heat treatment, find the interior location that has the greatest distance to the nearest heat-treated surface. Designate this distance $t/2$. Test specimens shall be taken no closer to any heat-treated surface than one half of this distance ($\frac{1}{4}t$ location). The datum points of the specimen shall be a minimum of $t/2$ from any second heat-treated surface.

(d) With prior approval of the Manufacturer, test specimens may be taken from a separate test forging under the conditions described in KM-231(d), or removed from a location within the forging that has received substantially the same reduction and type of hot working as the main body of the forging for which the tests are being conducted, if permitted by the material specification. The dimensional requirements specified in (a), (b), (c), or (e) shall be met as applicable.

(e) For large forgings that require testing from each end in accordance with KM-231(b) or KM-231(c), test specimen locations according to (a), (b), (c), and (d) may be designated at each end independently based on the thickness at that end, provided at least one end represents the thickest dimension of the entire forging.

(25) **KM-211.3 Bars and Bolting Materials.**

(a) For diameters or thicknesses less than 2 in. (50 mm), the specimens shall be taken in accordance with the requirements of the applicable material specification.

(b) For diameters or thicknesses 2 in. (50 mm) and over, the datum point of the test specimen defined as the midpoint of the gage length of a tension test specimen or the area under the notch of the impact specimens shall be located at $T/4$ from the outside rolled surface or deeper and no closer than $2T/3$ from a heat-treated end. $T/4$ from a heat-treated end or deeper may be used for precipitation hardening and age hardening steels that have been air cooled after aging.

KM-211.4 Pipe.

(a) For thicknesses less than 2 in. (50 mm), specimens shall be taken in accordance with the requirements of the applicable material specification.

(b) For thicknesses 2 in. (50 mm) and over, specimens shall be taken in accordance with the requirements of the applicable material specification and at least $T/4$ from any heat-treated surface, where T is the maximum wall thickness of the pipe, and with the ends of the specimens no closer than T from a heat-treated end of the pipe. Test specimens shall be removed from integral prolongations from the pipe after completion of all heat treatment and forming operations.

KM-211.5 Castings. The datum point, defined as the midpoint of the gage length of tension test specimens or the area under the notch of impact test specimens, shall be located as defined in KM-211.2. Testing may be from prolongations or from cast test coupons. Where a single prolongation is required according to KM-231, it shall be taken from the feed-head end. Test coupons, cast with the vessel, shall be made from the same heat as the casting using a similar feed and head arrangement, shall be heat treated with the casting, and shall have a similar thickness to the casting at the time of heat treatment. The datum points of the test specimens for quenched and tempered materials shall be located at $T/4$ from the nearest quenched surface and T from the nearest quenched end. T is defined as twice the distance to the surface from the interior point that has the greatest distance to the test specimen's nearest quenched surface. (25)

KM-212 CHARPY IMPACT SPECIMENS

KM-212.1 Bolting Materials.

(a) Charpy V-notch impact test specimens shall be the standard 10 mm × 10 mm size and shall be oriented parallel to the axis of the bolt.

(b) Where Charpy V-notch impact testing is to be conducted and bolt diameter does not permit specimens in accordance with (a), subsize specimens may be used. Test temperature shall be reduced in accordance with Table KM-212.

(c) Where bolt diameter or length does not permit specimens in accordance with (a) or (b), impact testing is not required.

KM-212.2 Pressure-Retaining Component Materials, Other Than Bolting and Castings, Not Containing Welds. (25)

(a) The test coupons for Charpy specimens shall be oriented such that their major axes lie transverse to the direction of maximum elongation during rolling or to the direction of major working during forging. Examples of acceptable Charpy V-notch impact specimen orientations removed from plate and pipe are shown in

Table KM-212
Charpy Impact Test Temperature Reduction Below Minimum Design Metal Temperature

Actual Material Thickness or Charpy Impact Specimen Width Along the Notch, in. (mm) [Note (1)]	Temperature Reduction, °F (°C)
0.394 (10.00) (full-size standard bar)	0 (0)
0.354 (9.00)	0 (0)
0.315 (8.00)	0 (0)
0.295 (7.50) (3/4 size bar)	5 (3)
0.276 (7.00)	8 (4)
0.262 (6.67) (2/3 size bar)	10 (6)
0.236 (6.00)	15 (8)
0.197 (5.00) (1/2 size bar)	20 (11)
0.158 (4.00)	30 (17)
0.131 (3.33) (1/3 size bar)	35 (19)
0.118 (3.00)	40 (22)
0.098 (2.50) (1/4 size bar)	50 (28)

NOTE: (1) Straight line interpolation for intermediate values is permitted.

Figure KM-212 illustrations (a) and (b), respectively. Since the direction of major working in a forging can vary significantly depending upon its shape and the forging method used, a single, representative example of an acceptable Charpy specimen removed from such a forging cannot be shown. Corners of Charpy specimens parallel to and on the side opposite the notch may be as shown in Figure KM-212 illustration (b-2), if necessary, to maintain the standard 10 mm cross section at the notch.

(b) Where Charpy V-notch impact testing is to be conducted and material size or shape does not permit specimens in accordance with (a), longitudinal specimens with their major axes parallel to the direction of maximum elongation or major working may be used as shown in Figure KM-212 illustration (b-3).

(c) Where material size or shape does not permit Charpy V-notch specimens in accordance with (a) or (b), subsize longitudinal specimens may be used Test temperature shall be reduced in accordance with Table KM-212.

(d) Charpy V-notch impact testing is not required when the maximum obtainable subsize longitudinal specimen has a width along the notch of less than 0.099 in. (2.5 mm).

KM-212.3 Pressure-Retaining Component Materials Containing Welds.

(a) The test coupons for Charpy specimens shall be oriented such that their major axes lie transverse to the direction of the welded joint. Corners of Charpy specimens parallel to and on the side opposite the notch may be as shown in Figure KM-212, if necessary, to maintain the standard 10 mm cross section at the notch.

(b) Where Charpy V-notch impact testing is to be conducted and material size or shape does not permit specimens in accordance with (a), subsize specimens may be used. Test temperature shall be reduced in accordance with Table KM-212.

(c) Charpy V-notch impact testing is not required when the maximum obtainable subsize specimen has a width along the notch of less than 0.099 in. (2.5 mm).

KM-213 FRACTURE TOUGHNESS SPECIMENS

KM-213.1 Bolting Materials. If applicable, fracture toughness specimens shall be oriented such that the plane of the precrack is transverse to the axis of the bolt.

KM-213.2 Pressure-Retaining Component Materials, Other Than Bolting, Not Containing Welds. If applicable, fracture toughness specimens shall be oriented such that the plane of the precrack is parallel to the direction of maximum elongation during rolling or to the direction of major working during forging.

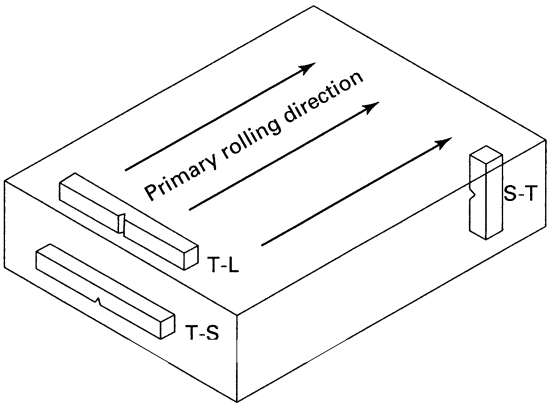
KM-213.3 Pressure-Retaining Component Materials Containing Welds. If applicable, fracture toughness specimens shall be oriented such that the plane of the precrack is parallel to the direction of the welded joint.

KM-220 PROCEDURE FOR HEAT TREATING SEPARATE TEST SPECIMENS

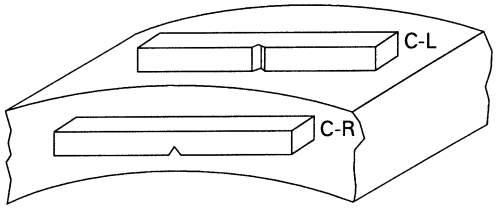
When metal products are to be heat treated and test specimens representing those products are removed prior to heat treatment, the test specimens shall be cooled at a rate similar to and no faster than the main body of the product. This rule shall apply for specimens taken directly from the product as well as those taken from separate test coupons representing the product. The following general techniques may be applied to all product forms, test specimens, or test coupons representing the product.

(a) Any procedure may be applied that can be demonstrated to produce a cooling rate in the test specimen that matches the cooling rate of the main body of the product at the region midway between mid-thickness and the surface ($T/4$) and no nearer to any heat-treated edge than a distance equal to the nominal thickness being cooled (T). The cooling rate of the test specimen shall replicate that of the actual part within a temperature of 25°F (14°C) at any given instant, and any given temperature shall be attained in both the actual part and test specimen within 20 sec at all temperatures after cooling begins from the heat treating temperature. Cooling rate can be determined by any method agreed upon between the manufacturer and purchaser, and can include, but is not limited to, theoretical calculations, experimental procedures, duplicate test forgings, or any combination thereof.

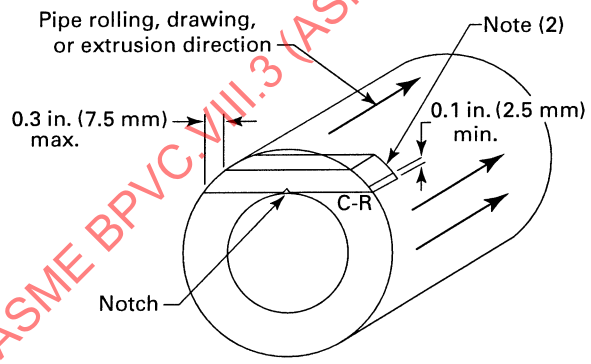
Figure KM-212
Examples of Acceptable Impact Test Specimens



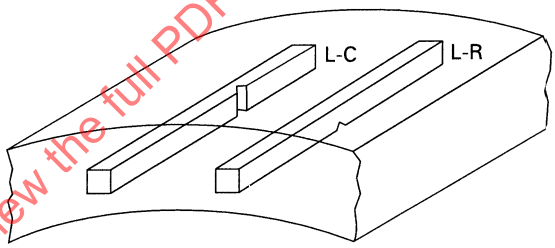
(a) Plate [Note (1)]



(b-1)



(b-2) [Note (3)]



(b-3)

(b) Charpy V-Notch Specimens From Pipe [Note (4)]

GENERAL NOTE: The Charpy impact specimen notch orientation codes shown are in accordance with ASTM E1823, Annex A2.

NOTES:

(1) For plate greater than 2.2 in. (55 mm) in thickness, short transverse (S-T orientation) Charpy V-notch impact specimens may also be used.

(2) Corners of the Charpy specimens may follow the contour of the component within the dimension limits shown.

(3) This Figure illustrates how an acceptable transverse Charpy specimen can be obtained from a cylindrical pipe too small for a full length standard specimen in accordance with ASME SA-370. The corners of longitudinal specimens parallel to and on the side opposite the notch may also be as shown.

(4) The transverse Charpy V-notch specimen orientation for pipe shall be as shown in illustration (b-1); either notch orientation (C-R or C-L) is acceptable. If the transverse orientation shown in illustration (b-1) cannot be accommodated by the pipe geometry, then the orientation shall be as shown in illustration (b-2). If the alternate transverse orientation shown in illustration (b-2) cannot be accommodated by the pipe geometry, then the orientation shall be as shown in illustration (b-3); either notch orientation (L-R or L-C) is acceptable.