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PART UCL
REQUIREMENTS FOR WELDED PRESSURE VESSELS CONSTRUCTED OF MATERIAL WITH CORROSION RESISTANT INTEGRAL CLADDING, WELD METAL OVERLAY CLADDING, OR WITH APPLIED LININGS

GENERAL

UCL-1 SCOPE

The rules in Part UCL are applicable to pressure vessels or vessel parts that are constructed of base material with corrosion resistant integral or weld metal overlay cladding and to vessels and vessel parts that are fully or partially lined inside or outside with corrosion resistant plate, sheet, or strip, attached by welding to the base plates before or after forming or to the shell, heads, and other parts during or after assembly into the completed vessel.[1] These rules shall be used in conjunction with the general requirements in Subsection A and with the specific requirements in the applicable Parts of Subsection B.

UCL-2 METHODS OF FABRICATION

Vessels and vessel parts of base material with corrosion resistant integral or weld metal overlay cladding construction shall be fabricated by welding. Corrosion resistant linings may be attached by welding to vessels fabricated by any method of construction permitted under the rules of this section.

UCL-3 CONDITIONS OF SERVICE

Specific chemical compositions, heat treatment procedures, fabrication requirements, and supplementary tests may be required to assure that the vessel will be suitable for the intended service. This is particularly true for vessels subject to severe corrosive conditions, and also those vessels operating in a cyclic temperature service. These rules do not indicate the selection of an alloy suitable for the intended service or the amount of the corrosion allowance to be provided. See also informative and nonmandatory guidance regarding metallurgical phenomena in Appendix 6 of Section II, Part D.

It is recommended that users assure themselves by appropriate tests, or otherwise, that the alloy material selected and its heat treatment during fabrication will be suitable for the intended service.

NOTE: Attention is called to the difficulties that have been experienced in welding materials differing greatly in chemical composition. Mixtures of uncertain chemical composition and physical properties are produced at the line of fusion. Some of these mixtures are brittle and may give rise to cracks during solidification or afterward. To avoid weld embrittlement, special care is required in the selection of lining material and welding electrodes, and in the application of controls over the welding process and other fabrication procedures.

MATERIALS

UCL-10 GENERAL

The base materials used in the construction of clad vessels and of those having applied corrosion linings shall comply with the requirements for materials given in UCS-5, UF-5, UHT-5, or ULW-5.

UCL-11 INTEGRAL AND WELD METAL OVERLAY CLAD MATERIAL

(a) Clad material used in constructions in which the design calculations are based on the total thickness including cladding [see UCL-23(c)] shall conform to one of the following specifications:

SA-263, Corrosion-Resisting Chromium–Steel Clad Plate, Sheet and Strip

[1] See 3-2 Definition of Terms.

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SA-264, Corrosion-Resisting Chromium–Nickel Steel Clad Plate, Sheet and Strip

SA-265, Nickel and Nickel–Base Alloy Clad Steel Plate.

In addition to the above, weld metal overlay cladding may be used as defined in this Part.

(b) Base material with corrosion resistant integral or weld metal overlay cladding used in constructions in which the design calculations are based on the base material thickness, exclusive of the thickness of the cladding material, may consist of any base material satisfying the requirements of UCL-10 and any metallic corrosion resistant integral or weld metal overlay cladding material of weldable quality that in the judgment of the user is suitable for the intended service.

(c) Base material with corrosion resistant integral cladding in which any part of the cladding is included in the design calculations, as permitted in UCL-23(c), shall show a minimum shear strength of 20,000 psi (138 MPa) when tested in the manner described in the clad plate specification. One shear test shall be made on each such clad plate as rolled, and the results shall be reported on the certified material test report.

When the composite thickness of the clad material is $\frac{3}{4}$ in. (19 mm) or less, and/or when the cladding metal thickness is nominally 0.075 in. (1.9 mm) or less, the "Bond Strength" test, as described in SA-263, SA-264, or SA-265, may be used in lieu of the bond "Shear Strength" test to fulfill the criteria for acceptable minimum shear strength, except that the bend test specimen shall be $1\frac{1}{2}$ in. (38 mm) wide by not more than $\frac{3}{4}$ in. (19 mm) in thickness and shall be bent, at room temperature, through an angle of 180 deg. to the bend diameter provided for in the material specifications applicable to the backing metal. The results of the "Bond Strength" test shall be reported on the certified material test report.

(d) A shear or bond strength test is not required for weld metal overlay cladding.

(e) When any part of the cladding thickness is specified as an allowance for corrosion, such added thickness shall be removed before mill tension tests are made. When corrosion of the cladding is not expected, no part of the cladding need be removed before testing, even though excess thickness seems to have been provided or is available as corrosion allowance.

UCL-12 LINING

Material used for applied corrosion resistant lining may be any metallic material of weldable quality that in the judgment of the user is suitable for the intended purpose.

DESIGN

UCL-20 GENERAL

(a) The rules in the following paragraphs apply specifically to pressure vessels and vessel parts constructed of base material with corrosion resistant integral or weld metal overlay cladding and those having applied corrosion resistant linings and shall be used in conjunction with the general requirements for *Design* in Subsection A, and with the specific requirements for *Design* in Subsection B that pertain to the method of fabrication used.

(b) Minimum Thickness of Shells and Heads. The minimum thickness specified in UG-16(b) shall be the total thickness for clad material with corrosion resistant integral or weld metal overlay cladding and the base-material thickness for applied-lining construction.

UCL-23 MAXIMUM ALLOWABLE STRESS VALUES

(a) Applied Corrosion Resistant Linings. The thickness of material used for applied lining shall not be included in the computation for the required thickness of any lined vessel. The maximum allowable stress value shall be that given for the base material in Table UCS-23, or UNF-23.

(b) Integrally Clad Material Without Credit for Full Cladding Thickness. Except as permitted in (c) below, design calculations shall be based on the total thickness of the clad material less the specified nominal minimum thickness of cladding. A reasonable excess thickness either of the actual cladding or of the same thickness of corrosion resistant weld metal may be included in the design calculations as an equal thickness of base material. The maximum allowable stress value shall be that given for the base material referenced in Table UCS-23, UF-6, or UHT-23 and listed in Table 1A of Section II, Part D.

(c) Base Material with Corrosion Resistant Integral or Weld Metal Overlay Cladding With Credit for Cladding Thickness. When the base material with corrosion resistant integral cladding conforms to one of the specifications listed in UCL-11(a), or consists of an acceptable base material with corrosion resistant weld metal overlay and the joints are completed by depositing corrosion resisting weld metal over the weld in the base material to restore the cladding, the design calcula-

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tions may be based on a thickness equal to the nominal thickness of the base material plus S_c/S_b times the nominal thickness of the cladding after any allowance provided for corrosion has been deducted, where

S_c = maximum allowable stress value for the integral cladding at the design temperature, or for corrosion resistant weld metal overlay cladding, that of the wrought material whose chemistry most closely approximates that of the cladding, at the design temperature, psi

S_b = maximum allowable stress value for the base material at the design temperature, psi

Where S_c is greater than S_b, the multiplier S_c/S_b shall be taken equal to unity. The maximum allowable stress value shall be that given for the base material referenced in Table UCS-23, UF-6, or UHT-23 and listed in Table 1A of Section II, Part D. Vessels in which the cladding is included in the computation of required thickness shall not be constructed for internal pressure under the provisions of Table UW-12, column (c).

The thickness of the corrosion resistant weld metal overlay cladding deposited by manual processes shall be verified by electrical or mechanical means. One examination shall be made for every head, shell course, or any other pressure retaining component for each welding process used. The location of examinations shall be chosen by the Inspector except that, when the Inspector has been duly notified in advance and cannot be present or otherwise make the selection, the fabricator may exercise his own judgment in selecting the locations.

UCL-24 MAXIMUM ALLOWABLE WORKING TEMPERATURE

(a) When the design calculations are based on the thickness of base material exclusive of lining or cladding thickness, the maximum service metal temperature of the vessel shall be that allowed for the base material.

(b) When the design calculations are based on the full thickness of base material with corrosion resistant integral or weld metal overlay cladding as permitted in UCL-23(c), the maximum service metal temperature shall be the lower of the values allowed for the base material referenced in Table UCS-23, UF-6, or UHT-23 and listed in Table 1A of Section II, Part D, or refer to UCL-23(c) for corrosion resistant weld metal overlay cladding and the cladding material referenced in Table UHA-23 or UNF-23.

(c) The use of corrosion resistant integral or weld metal overlay cladding or lining material of chromium-alloy stainless steel with a chromium content of over 14% is not recommended for service metal temperatures above 800°F.

UCL-25 CORROSION OF CLADDING OR LINING MATERIAL

(a) When corrosion or erosion of the cladding or lining material is expected, the cladding or lining thickness shall be increased by an amount that in the judgment of the user will provide the desired service life.

(b) Telltale Holes. The requirements of UG-25(e) and UG-46(b) shall apply when telltale holes are used in clad or lined vessels, except that such holes may extend to the cladding or lining.

UCL-26 THICKNESS OF SHELLS AND HEADS UNDER EXTERNAL PRESSURE

The thickness of shells or heads under external pressure shall satisfy the requirements of the Part of Subsection C applicable to the base material. The cladding may be included in the design calculations for clad material to the extent provided in UCL-23(b) and (c).

UCL-27 LOW TEMPERATURE OPERATIONS

The base materials used in the construction of vessels shall satisfy the requirements of UCS-66, UCS-67, UCS-68, Part UF, or UHT-5.

FABRICATION

UCL-30 GENERAL

The rules in the following paragraphs apply specifically to pressure vessels and vessel parts constructed of base material with corrosion resistant integral or weld metal overlay cladding and those having applied corrosion resistant linings, and shall be used in conjunction with the general requirements for *Fabrication* in Subsection A, and with the specific requirements for *Fabrication* in Subsection B that pertain to the method of fabrication used.

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UCL-31 JOINTS IN INTEGRAL OR WELD METAL OVERLAY CLADDING AND APPLIED LININGS

(a) The types of joints and welding procedure used shall be such as to minimize the formation of brittle weld composition by the mixture of metals of corrosion resistant alloy and the base material.

(b) When a shell, head, or other pressure part is welded to form a corner joint, as in Fig. UW-13.2, the weld shall be made between the base materials either by removing the clad material prior to welding the joint or by using weld procedures that will assure the base materials are fused. The corrosion resistance of the joint may be provided by using corrosion resistant and compatible weld filler material or may be restored by any other appropriate means.

NOTE: Because of the different thermal coefficients of expansion of dissimilar metals, caution should be exercised in design and construction under the provisions of these paragraphs in order to avoid difficulties in service under extreme temperature conditions, or with unusual restraint of parts such as may occur at points of stress concentration.

UCL-32 WELD METAL COMPOSITION

Welds that are exposed to the corrosive action of the contents of the vessel should have a resistance to corrosion that is not substantially less than that of the corrosion resistant integral or weld metal overlay cladding or lining. The use of filler metal that will deposit weld metal with practically the same composition as the material joined is recommended. Weld metal of different composition may be used provided it has better mechanical properties in the opinion of the manufacturer, and the user is satisfied that its resistance to corrosion is satisfactory for the intended service. The columbium content of columbium-stabilized austenitic stainless steel weld metal shall not exceed 1.00%, except when a higher columbium content is permitted in the material being welded.

UCL-33 INSERTED STRIPS IN CLAD MATERIAL

The thickness of inserted strips used to restore cladding at joints shall be equal to that of the nominal minimum thickness of cladding specified for the material backed, if necessary, with corrosion resistant weld metal deposited in the groove to bring the insert flush with the surface of the adjacent cladding.

UCL-34 POSTWELD HEAT TREATMENT

CAUTION: Postweld heat treatment may be in the carbide-precipitation range for unstabilized austenitic chromium–nickel steels, as well as within the range where a sigma phase may form, and if used indiscriminately could result in material of inferior physical properties and inferior corrosion resistance, which ultimately could result in failure of the vessel.

(a) Vessels or parts of vessels constructed of base material with corrosion resistant integral or weld metal overlay cladding or applied corrosion resistant lining material shall be postweld heat treated when the base material is required to be postweld heat treated. In applying these rules, the determining thickness shall be the total thickness of the base material.

When the thickness of the base material requires postweld heat treatment, it shall be performed after the application of corrosion resistant weld metal overlay cladding or applied corrosion resistant lining unless exempted by the Notes of Table UCS-56.

(b) Vessels or parts of vessels constructed of chromium stainless steel integral or weld metal overlay cladding and those lined with chromium stainless steel applied linings shall be postweld heat treated in all thicknesses, except vessels that are integrally clad or lined with Type 405 or Type 410S and welded with an austenitic electrode or non-air-hardening nickel–chromium–iron electrode need not be postweld heat treated unless required by (a) above.

UCL-35 RADIOGRAPHIC EXAMINATION 01

(a) General. Vessels or parts of vessels constructed of base material with corrosion resistant integral or weld metal overlay cladding and those having applied corrosion resistant linings shall be radiographed when required by the rules in UW-11(a), UCS-57, UHT-57, and UCL-36. The material thickness specified under these rules shall be the total material thickness for clad construction and the base material thickness for applied-lining construction, except as provided in (c) below.

(b) Base Material Weld Protected by a Strip Covering. When the base material weld in clad or lined construction is protected by a covering strip or sheet of corrosion resistant material applied over the weld in the base material to complete the cladding or lining, any radiographic examination required by the rules of UW-11(a), UHT-57, and UCS-57 may be made on the completed weld in the base material before the covering is attached.

(c) Base Material Weld Protected by an Alloy Weld. The radiographic examination required by the rules in UW-11(a), UHT-57, and UCS-57 shall be made after

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the joint, including the corrosion resistant layer, is complete, except that the radiographic examination may be made on the weld in the base material before the alloy cover weld is deposited, provided the following requirements are met.

(1) The thickness of the base material at the welded joint is not less than required by the design calculation.

(2) The corrosion resistant alloy weld deposit is non-air-hardening.

(3) The completed alloy weld deposit is spot examined by any method that will detect cracks.

01 *(4)* The thickness of the base material shall be used in determining the radiography requirement in (a) above.

UCL-36 EXAMINATION OF CHROMIUM STAINLESS STEEL CLADDING OR LINING

The alloy weld joints between the edges of adjacent chromium stainless steel cladding layers or liner sheets shall be examined for cracks as follows.

(a) Joints welded with straight chromium stainless steel filler metal shall be examined throughout their full length. The examination shall be by radiographic methods when the chromium stainless steel welds are in continuous contact with the welds in the base metal. Liner welds that are attached to the base metal, but merely cross the seams in the base metal, may be examined by any method that will disclose surface cracks.

(b) Joints welded with austenitic chromium–nickel steel filler metal or non-air-hardening nickel–chromium–iron filler metal shall be given a radiographic spot examination in accordance with UW-52. For lined construction, at least one spot examination shall include a portion of the liner weld that contacts weld metal in the base material.

01 UCL-40 WELDING PROCEDURES

Welding procedures for corrosion resistant weld overlay, composite (clad) metals, and attachment of applied linings shall be prepared and qualified in accordance with the requirements of Section IX.

UCL-42 ALLOY WELDS IN BASE METAL

Groove joints in base material and parts may be made with corrosion resistant alloy-steel filler metal, or groove joints may be made between corrosion resistant alloy steel and carbon or low alloy steel, provided the welding procedure and the welders have been qualified in accordance with the requirements of Section IX for the combination of materials used. Some applications of this rule are base metal welded with alloy-steel electrodes, and alloy nozzles welded to steel shells.

UCL-46 FILLET WELDS

Fillet welds of corrosion resistant metal deposited in contact with two materials of dissimilar composition may be used for shell joints under the limitations of UW-12, for connection attachments under the limitations of UW-15 and UW-16, and for any other uses permitted by this Division. The qualification of the welding procedures and welders to be used on fillet welds for a given combination of materials and alloy weld metal shall be made in accordance with the rules prescribed in Section IX.

INSPECTION AND TESTS

UCL-50 GENERAL

The rules in the following paragraphs apply specifically to the inspection and testing of pressure vessels and vessel parts constructed of base material with corrosion resistant integral or weld metal overlay cladding and those having applied corrosion resistant linings, and shall be used in conjunction with the general requirements for *Inspection and Tests* in Subsection A, and with the specific requirements for *Inspection and Tests* in Subsection B that pertain to the method of fabrication used.

UCL-51 TIGHTNESS OF APPLIED LINING

A test for tightness of the applied lining that will be appropriate for the intended service is recommended, but the details of the test shall be a matter for agreement between the user and the manufacturer. The test should be such as to assure freedom from damage to the load carrying base material. When rapid corrosion of the base material is to be expected from contact with the contents of the vessel, particular care should be taken in devising and executing the tightness test.

Following the hydrostatic pressure test, the interior of the vessel shall be inspected to determine if there is any seepage of the test fluid through the lining.

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Seepage of the test fluid behind the applied lining may cause serious damage to the liner when the vessel is put in service. When seepage occurs, F-4 of Appendix F shall be considered and the lining shall be repaired by welding. Repetition of the radiography, and heat treatment, or the hydrostatic test of the vessel after lining repairs is not required except when there is reason to suspect that the repair welds may have defects that penetrate into the base material, in which case the Inspector shall decide which one or more shall be repeated.

UCL-52 HYDROSTATIC TEST

The requirements for standard hydrostatic test in UG-99 shall apply to pressure vessels fabricated in accordance with the rules of Part UCL.

MARKING AND REPORTS

UCL-55 GENERAL

The provisions for marking and reports in UG-115 through UG-120 shall apply to vessels that are constructed of base material with corrosion resistant integral or weld metal overlay cladding and those having applied corrosion resistant linings, with the following supplements to the Data Reports.

(a) Include specification and type of lining material.

(b) Include applicable paragraph in UCL-23 under which the shell and heads were designed.

PRESSURE RELIEF DEVICES

UCL-60 GENERAL

The provisions for pressure relief devices given in UG-125 through UG-136 shall apply without supplement to welded vessels that are constructed of base material with corrosion resistant integral or weld metal overlay cladding and those having applied corrosion resistant linings.

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