Case XXXX

Rules for Gasketed Electrochemical Cell Stacks for Electrolysis

Section VIII, Division 1

Inquiry: In the absence of rules covering gasketed electrochemical cell stacks in Section VIII, Division 1, what rules may be used to fabricate gasketed electrochemical cell stacks in compliance with Section VIII, Division 1?

Reply: It is the opinion of the Committee that the following rules may be used to fabricate gasketed electrochemical cell stacks in compliance with Section VIII, Division 1.

1. INTRODUCTION

Electrochemical cell stacks (ECS) are commonly used within electrochemical systems to either generate electric currents as in fuel cells when supplied with reactant and an oxidant (for example, hydrogen and oxygen) or to carry out chemical reactions when supplied with electrical current and reactants as in electrolysis (for example, splitting water into hydrogen and oxygen gases).

2. SCOPE

The rules in this Code Case cover the minimum requirements for design, fabrication, assembly, inspection, testing, and documentation of planar geometry gasketed electrochemical cell stacks (ECS) within the Scope described in U-1 for electrolysis, stationary fuel cell or other electrochemical applications.

These rules cover the gasketed ECS and their components but are not intended to limit the configurations or details to those illustrated or otherwise described herein. Designs that differ from those covered in this Code Case, as well as other types of ECS, shall be in accordance with the provisions in U-2(g)(1)(-b) or (-c).

ECS that are contained in an external enclosure are exempted from the rules in this Code Case, provided that the external enclosure is subject to applicable rules of this Division unless exempted under U-1. The MAWP of external closure shall be no less than the design pressure of internal ECS.

This Code Case does not address the process and electrical safety requirements of ECS. These requirements are commonly found in other applicable safety standards such as CSA/ANSI B22734 and CSA/ANSI FC 1, CSA/ANSI FC 6, ISO 22734 and IEC 62282-2-100.

3. MATERIALS

All pressure-containing parts shall be constructed using materials permitted by this Division except for dielectric materials, membrane materials and other internal ECS component materials used for the purpose of electrochemical process provided that when used in ECS, they meet the type test requirements in other applicable safety standards such as CSA/ANSI B22734 or CSA/ANSI FC 1, CSA/ANSI FC 6, ISO 22734 or IEC 62282-2-100.
4. TERMINOLOGY

Membrane electrochemical cell: a common type of electrochemical cell with individual planar geometry assembly of electrodes, fluid containment, fluid flow means, seals, and electrical current conduction means that include cell separation membranes.

Gasketed cell plate pack: a collection of all membrane electrochemical cells arranged as a pack. The gaskets provide periphery sealing between electrochemical cells and between anode and cathode cell compartments.

Gasketed electrochemical cell stack (ECS): an assembly of components including gasketed cell plate pack held in compression between endplates to establish gasketed fluid seals and minimize electrical resistance between cells. The compression loads may be accomplished by bolts, springs, hydraulics or other means, see Figure 1.

Other internal ECS components: electrochemical cell internal components, such as bipolar foils, meshes, seals, and porous structures, that are used to collect and distribute electric current, collect and distribute fluids, and provide structural support to the cell membrane/separator; ECS electrical terminal plates and dielectric insulator plates are also considered as internal ECS components.

Dielectric material: nonmetallic material with very low electrical conductivity (electrical insulator) that is essential for ECS construction. Planar electrical insulators interposed between internal cell stack, electrical terminal plate, and endplate are typically constructed of dielectric materials.

Membrane/separator: material that provides selective fluid isolation between anode and cathode cell compartments, while allowing ionic transport via electrolyte within its structure.

Electrical terminal plate: planar current conductor located at one or both terminal ends of the cell stack to conduct electrical current through the electrochemical cell stack. Electrical current connections are typically located on the endplate; see Figure 1.

Endplate: planar structural support at either end of the cell stack used with bolts, springs, or other means to provide pressure containment and locations for the nozzles or connectors, and to minimize electrical resistance between cells.

Compression bolt: a bolt assembly used to compress the endplates, electrochemical cell pack and other internal components to affect a pressure seal.

gasket: a sealing element between electrochemical cell plates.

Electrolyte: ion transport medium held within electrochemical cells.

Ion: electrically charged atom or group of atoms that transports through cell electrolyte during electrochemical reaction, for example: proton H⁺, hydroxyl OH⁻, and others. Cations are positively charged ions, anions are negatively charged ions.
5. APPLICABILITY

The design aspects covered in this Code Case apply to the metallic pressure-retaining components that are considered in the calculation of the MAWP as described in Paragraph 6. Metallic or nonmetallic components that provide electrical insulation and electrical current distribution, and facilitate ion conduction and separation are not addressed in this Code Case.

6. DESIGN CONSIDERATIONS

(a) Endplates: See Paragraph 7.

(b) Gasketed Cell Plate Pack. Gasketed cell plate pack shall be designed to contain pressurized fluid without leaking to a pressure of at least 1.5 times the MAWP. The MAWP of gasketed cell plate pack may be determined without performing proof testing or design calculations for the gasketed cell plate pack and other internal ECS components, provided the following requirements are met:

1. The MAWP for gasketed ECS shall be determined considering all metallic pressure-retaining parts, including the endplates, bolting, and nozzles.
2. Other pressure retaining components in gasketed cell plate pack and other internal ECS components are structurally supported by endplates.

7. CALCULATION PROCEDURES

Design of endplates, nozzle reinforcement and compression bolts in ECS shall follow the requirements of this Division. Rectangular endplates shall be designed in accordance with 45-6 in Mandatory Appendix 45.

8. PRESSURE TEST REQUIREMENTS

Hydrostatic or pneumatic tests shall be conducted on all assembled ECS in accordance with the following requirements: the anode and cathode sides of ECS shall be tested simultaneously with a common pressure source without visible external leakage. The common pressure test shall be performed in accordance with UG-99 or UG-100, except that the test pressure shall be at least 1.5 times MAWP for a minimum of 2 minutes. When hydrostatic pressure testing cannot be performed, pneumatic testing may be performed. Reasons for pneumatic testing shall be recorded in the Remarks Section of Manufacturer's Data Report. Pneumatic testing should be performed in accordance with ASME PCC-2, Article 501.

9. OVERPRESSURE PROTECTION

Overpressure protection shall comply with UG-150 through UG-156.

10. MARKING AND CERTIFICATION

This Case number shall be shown in the Manufacturer’s Data Report. Additionally, the Manufacturer shall indicate in the Remarks section of the Manufacturer's Data Report that this vessel is compliant with the applicable CSA/ANSI B22734 or, ISO 22734 and IEC standards as shown in Paragraph 3.
Form U-1E as shown in Appendix 1 shall be used for Manufacturer’s Data Report. Alternatively, Form U-3E as shown in Appendix 1 shall be used for ECS that meet the requirements of U-1(j).

1. endplates
2. nozzles
3. cell plate pack that contains stacked and gasketed electrochemical cells
4. compression bolts with springs
5. electrical current connections
6. dielectric insulator plate
7. electrical terminal plate

Figure 1 Typical Electrochemical Cell Stack (ECS)
APPENDIX 1

GUIDE FOR PREPARING MANUFACTURER’S DATA REPORT FORMS U-1E AND U-3E

1-1 The instructions contained in this Appendix are to provide general guidance for the Manufacturer in preparing Data Reports as required in UG-120.

1-2 Manufacturer’s Data Reports required by ASME Code rules are not intended for pressure vessels that do not meet the provisions of the Code, including those of special design or construction that require and receive approval by jurisdictional authorities under the laws, rules, and regulations of the respective State or municipality in which the vessel is to be installed.

1-3 The instructions for the Data Reports are identified by parenthesized numbers corresponding to circled numbers on the sample Forms in this Appendix. The number items that have a blank content in Instructions are reserved for other Forms.

1-4 Where more space than has been provided for on the Form is needed for any item, indicate in the space, “See remarks”, or “See attached Form U-4” as appropriate.

1-5 Any quantity to which units apply shall be entered on the Manufacturer’s Data Report with the chosen units.

1-6 Manufacturer’s Data Report Forms may be preprinted or computer generated. Forms shall be identical in size, arrangement, and content, as shown in this Appendix, or Form U-4 may be used.

When using forms that result in multiple pages, each page shall be marked to be traceable to the first page of the form. For Form U-1E, each page shall contain, at the top of the page, as a minimum, the Manufacturer’s name, Manufacturer’s serial number, CRN (as applicable), and National Board number (as applicable), as shown on the first page of the form.

Additionally, each sheet shall contain the page number of that page and the total number of pages that compose the complete form.
Instructions

(1) Name, street address, city, state or province (as applicable), and country of Manufacturer as listed on ASME Certificate of Authorization.
(2) Name and address of purchaser.
(3) Name of user, and address where vessel is to be installed. If not known, so indicate (e.g., "not known" or “built for stock”).
(4) 
(5) 
(6) Indicate vessel capacity. See U-1(j).
(7) 
(8) Manufacturer’s serial number. See UG-116(a)(5).
(9) Canadian registration number, where applicable.
(10) Indicate drawing number(s), including applicable revision number, that cover general assembly and list of materials. For Canadian registered vessels, the number of the drawing approved by the provincial authorities.
(11) 
(12) Where applicable, the National Board number from the Manufacturer’s Series of National Board numbers sequentially without skips or gaps.
(13) ASME Code, Section VIII, Division 1, Edition (e.g., 1989) and Addenda (e.g., A89, A90, etc.), if applicable, used for construction.
(14) All Code Case numbers and revisions used for construction must be listed. Where more space is needed use “Remarks” section or list on a supplemental page.
(15) Note any special service by Code paragraph as specified in UG-120(d) (e.g., lethal, low temperature, unfired steam boiler, direct fired).
(16) 
(17) 
(18) 
(19) 
(20) Show the complete ASME specification number and grade of the actual material used in the vessel. Material is to be as designated in Section VIII, Division 1 (e.g., “SA-285C”). Exceptions: A specification number for a material not identical to an ASME specification may be shown only if such material meets the criteria in the Code in conjunction with the Foreword of this Section. When material is accepted through a Code Case, the applicable Case number shall be shown.
(21) Thickness is the nominal thickness of the material used in the fabrication of the vessel shell. It includes corrosion allowance.
(22) State corrosion allowance (see UG-25).
(23) 
(24) 
(25) 
(26) 
(27) 
(28) 
(29) 
(30) 
(31) 
(32) Bolts used to secure removable head or heads of vessel. Indicate the number, size, material specification (grade/type).
(33)
(34) Show maximum allowable working pressure (internal or external) for which vessel is constructed. See UG-118.
(35) Show maximum temperature permitted for vessel at MAWP. See (35).
(36) Indicate the minimum design metal temperature (MDMT).
(37) Indicate if impact testing was conducted (yes or no) and the component(s) that were impact tested and the impact test temperature. Where more space is needed, use “Remarks” section or list on a supplement page. If no, indicate applicable paragraph(s) [such as UG-20(f), UCS-66(a), UCS-66(b), or UCS-66(c), and UHA-51 or UHT-6].
(38) Indicate the type of test used (pneumatic, hydrostatic, or combination test, as applicable) and specify test pressure at the top of the vessel in the test position. Indicate under “Remarks” if the vessel was tested in the vertical position.
(39) Nozzles, inspection, and safety valve openings; list all openings, regardless of size and use. Where more space is needed, list them on a supplemental page.
(40) Indicate nozzles by size (NPS) and inspection openings by inside dimensions.
(41) Data entries with description acceptable to the Inspector. For all types of nozzles an abbreviation may be used to define any generic name. Some typical abbreviations:
  - Flanged fabricated nozzle Cl. 150 flg.
  - Long weld neck flange Cl. 300 lw.
  - Weld end fabricated nozzle w.e.
  - Lap joint flange Cl. 150 lap jnt.
  - Socket weld nozzle Cl. 3000 sw.
(42) Show the material for the nozzle neck.
(43) Show the material for the flange.
(44) Nominal thickness applies to nozzle neck thickness.
(45) Data entries with description acceptable to the Inspector. A code identification of Figure UW-16.1 (sketch no.) may be used to define the type of attachment.
(46) Category C and D welds — Identify degree of examination (radiographic or if applicable ultrasonic) employed: full, spot, or none (see UW-11). Also identify the joint efficiency associated with the weld from Table UW-12. When more space is needed, use “Remarks” section supplemental page or RT map, as applicable.
(47) "Location" applies to inspection openings only.
(48) Describe:
  - (a) type of support (skirt, lugs, etc.);
  - (b) location of support (top, bottom, side, etc.);
  - (c) method of attachment (bolted, welded, etc.).
(49) To be completed when one or more parts of the vessel are furnished by others and certified on Data Report U-2 or U-2A. The part Manufacturer’s name and serial number required by UG-116 should be indicated.
(50) Space for additional comments including any Code restrictions on the vessel, or any unusual requirements that have been met, such as those in U-2(g), UG-11, UG-19(a)(2), UG-19(a)(3), UG-46, UG-53, UG-79, UG-90(c)(2), UG-99(e)(2), UG-115, UG-119(g), UG-120(b), UG-120(d), and UG-120(f), or in other notes to this Table. Indicate stiffening rings when used. See W-1(d) or W-1(e) when additional space is needed. List any pressure-retaining covers and their attaching bolting and nuts. The minimum information shall include the material specification, material grade, size, and thread designation.
(51)
(52)
(53)
(54)
(55)
(56)
(57) The name of the Manufacturer as shown on his ASME Code Certificate of Authorization.
(59) Manufacturer’s authorization number to use the Certification Mark with the UM Designator from his Certificate of Authorization.
(60) Certificate of Shop Inspection block is to be completed by the Manufacturer and signed by the Authorized Inspector who performs the inspection.
(61) The National Board Authorized Inspector Commission number must be shown.
(65) Signature of Certified Individual indicates Certification Mark with the appropriate Designator has been applied in accordance with the requirements of Section VIII, Division 1.
(71) Indicate whether the cell plates are gasketed, or other construction.
(72) Indicate end plate geometry and dimensions:
   (a) Circular: diameter
   (b) Rectangle: length and width
   (c) Other: provide detail descriptions and dimensions, if more space is needed, use “Remarks” section or list on a supplement page.
(73) Describe: quantity of cell plates installed at time of pressure test.
FORM U-1P  MANUFACTURER’S DATA REPORT FOR PLATE HEAT EXCHANGERS
As Required by the Provisions of the ASME Boiler and Pressure Vessel Code Rules, Section VIII, Division 1

1. Manufactured and certified by __________________________
   (Name and address of Manufacturer)
   (Manufacturer’s serial no.)
   (Drawing no.)
   (Code Case no.)
   (Special service per UG-120(d))

2. Manufactured for __________________________
   (Name and address of Purchaser)

3. Location of installation __________________________
   (Name and address)

4. Type (Horizontal or vertical) (Gasketed, semiweld, brazed)

5. ASME Code, Section VIII, Div. 1 (Edition (year)]
   (Fixed material) (Movable material) (Other material)

   (Year built) (National Board no.)

7. Frame compression bolts and nuts
   (Quantity, diameter, material specification, and grade)
   (Indicate yes or no and the component(s) impact tested)

8. Impact test __________________________
   (Indicate yes or no and the component(s) impact tested)

9. Heat transfer plates
   (Plate model) (Material specification and grade) (Thickness) (Minimum/maximum quantity of plates for frame)
   (Minimum/maximum pressure tested) (Minimum piping dimension) (Maximum piping dimension)

10. Chamber 1, MAWP _______ at max. temp _______ MDMT at _______ Hydro/pneu. test press. _______

11. Chamber 2, MAWP _______ at max. temp _______ MDMT at _______ Hydro/pneu. test press. _______

12. Nozzles, connections, inspections, and safety valve openings:

13. Supports: Lugs _______ Legs Feet _______ Others _______ Attached _______

14. Manufacturer’s Partial Data Reports properly identifying and signed by Commissioned Inspectors have been furnished for the following items of the report (list the name of the part, item number, and Manufacturer’s name and identifying number):

15. Remarks: __________________________

(07/21)
CERTIFICATE OF SHOP COMPLIANCE

We certify that the statements in this report are correct and that all details of design, material, construction, and workmanship of this plate and frame heat exchanger conform to the ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1.

Date

Date

(Manufacturer)

(Representative)

CERTIFICATE OF SHOP INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by ___________________________, have inspected the plate and frame heat exchanger described in this Manufacturer's Data Report on ___________ of ____________, and state that, to the best of my knowledge and belief, the Manufacturer has constructed this plate and frame heat exchanger in accordance with ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. By signing this certificate neither the Inspector nor his/her employer makes any warranty, expressed or implied, concerning the plate and frame heat exchanger described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his/her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date

Name

Signed

Commissions

(National Board Authorized Inspector Commission number)

CERTIFICATE OF FIELD ASSEMBLY COMPLIANCE

We certify that the statements in this report are correct and that all parts of this vessel conforms with the requirements of ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1.

Date

Name

Signed

Commissions

(National Board Authorized Inspector Commission number)

CERTIFICATE OF FIELD ASSEMBLY INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by ___________________________, have compared the statements in the Manufacturer's Data Report with the described plate and frame heat exchanger and state that parts referred to as data items ____________, not included in the certificate of shop inspection, have been inspected by me and to the best of my knowledge and belief, the Manufacturer has constructed this plate and frame heat exchanger in accordance with the ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. By signing this certificate neither the Inspector nor his/her employer makes any warranty, expressed or implied, concerning the plate and frame heat exchanger described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his/her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date

Name

Signed

Commissions

(National Board Authorized Inspector Commission number)
FORM U-3P  MANUFACTURER’S CERTIFICATE OF COMPLIANCE
FOR PLATE HEAT EXCHANGERS
COVERING PRESSURE VESSELS TO BE STAMPED WITH THE UM DESIGNATOR [SEE U-1(j)]
As Required by the Provisions of the ASME Boiler and Pressure Vessel Code Rules, Section VIII, Division 1

1. Manufactured and certified by
   (Name and address of Manufacturer)

2. Manufactured for
   (Name and address of Purchaser)

3. Location of installation
   (Name and address)

4. Type
   (Horizontal or vertical) (Gasketed, semi-weld, brazed)

5. ASME Code, Section VIII, Div. 1
   [Edition (year)]
   (Fixed material) (Movable material) (Other material)

6. Endplates: (a) (b) (c)
   
   (Plate material) (Material specification and grade) (Thickness) (Minimum/maximum quantity of plates for frame)

7. Frame compression bolts and nuts
   (Quantity, diameter, material specification, and grade)

8. Impact test
   (Indicate yes or no and the component(s) impact tested)

9. Heat transfer plates
   (Plate model) (Material specification and grade) (Thickness) (Minimum/maximum quantity of plates for frame)

10. Chamber 1, MAWP
    at max. temp
    MDMT at
    Hydro/pneu. test press

11. Chamber 2, MAWP
    at max. temp
    MDMT
    Hydro/pneu. test press

12. Nozzles, connections, inspections, and safety valve openings:

<table>
<thead>
<tr>
<th>Purpose (Inlet, Outlet, Drain, etc.)</th>
<th>Qty.</th>
<th>Dia. or Size</th>
<th>Type</th>
<th>Material</th>
<th>Flange Rating</th>
<th>Nozzle Thickness</th>
<th>How Attached</th>
<th>Location (Insp./Open.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

13. Supports:
   Lugs (Quantity)
   Legs Feet (Quantity)
   Others (Describe)
   Attached
   (Where and how)

4. Manufacturer’s Partial Data Reports properly identifying and signed by Commissioned Inspectors have been furnished for the following items of the report (list the name of the part, item number, and Manufacturer’s name and identifying number):
   

15. Remarks:
   
   
   
   
   
   
   

(07/21)

FOR ASME COMMITTEE USE ONLY
CERTIFICATE OF SHOP COMPLIANCE

We certify that the statements in this report are correct and that all details of design, material, construction, and workmanship of this vessel conform to the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

UM Certificate of Authorization Number:  
Expires: 

Date:  
Name:  
Signed:  
(Manufacturer)

Signed:  
(Certified Individual)

(07/17)