Standard Procedure for:

Validating Proton Exchange Membrane Cell Hardware Ability to Seal according to ASME B31.3

Original Version

June 27, 2023

Description:

This document provides the detailed standard sequence of steps used at the National Renewable Energy Laboratory (NREL) to validate the ability of proton exchange membrane cell hardware to seal at up to 30 bar-absolute (bar_a) according to ASME B31.3.

Successful completion of this test (zero leakage at test pressure and temperature for 3 hours) is required before proceeding with cell operation if the internal pressure of the cell will be 2.0 bar or greater than the external pressure and the cell hardware design has not been previously validated.

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1.1 Equipment

E 1 Test Equipment

Equipment	Notes
PEM Electrolysis Cell Hardware	Designed for at least 30 bar_a
Helium or Forming Gas Cylinder	
Helium or Forming Gas Regulator	At least 35 bar_a
Pressure Relief Valve	33 bar_a > Cracking Pressure ≥ 36 bar_a
Pressure Transducer/Dial Display	At least 36 bar_a
Thermometer	For temperature recording during Leak Test
Temperature Control Box	For Cell Heaters (with overtempt. protection)

1.2 Test Parameters

P 1 Test Parameters

Design Pressure, bar_a	30
Test Pressure, bar_a	33
Test: Design Pressure ratio	1.1
Pressure Relief Valve, bar_a	36
Pressure Relief, Relief:Design ratio	1.2
Test Temperature, °C	At intended cell operation temperature.

1.3 Test Procedure

Proc 1 Leak Test

Step	Action	Status
1	Assemble cell according to the procedure outlined in the "NREL 25cm2 High Pressure LTE Cell Overview" document using the FuGeMEA architecture (i.e., Nafion 115 catalyst coated membrane) and prepare the leak test apparatus according to Schematic A3 in Appendices.	
2	Cap the anode outlet.	
3	Cap the cathode outlet.	
4	Connect the anode inlet to the apparatus.	
5	Connect the cathode inlet to the apparatus.	
6	Connect the cell heaters to the Temperature Control Box.	
7	Set the Temperature Control Box Overtemperature Protection to 15% above the Test Temperature.	
8	Set the Temperature Control Set Point equal to the Test Temperature.	
9	Wait until the Process Value is within 1 % of the Test Temperature.	
10	Hold cell at Test Temperature for at least 15 minutes before proceeding.	
11	Close blocking valves BV-1 and BV-4.	
12	Close needle valves NV-1 and NV-3	
13	Increase the pressure to 1.7 bar_a using the pressure regulator.	
14	Close blocking valve BV-2 and observe pressure.	
15	If pressure is stable proceed to step 18. If pressure is decreasing, use a gas detector capable of detecting the test gas to determine the source(s) of the leak(s).	
17	If a leak is found, resolve the leak and repeat steps 1-15 until no leak is detected.	
18	Open blocking valve BV-2.	
19	Increase pressure in 1 bar increments until the Test Pressure holding for at least 30 seconds at each pressure.	
20	Hold cell at Test Pressure for 5 minutes.	
21	Open exhaust blocking valve BV-1.	
22	Adjust needle valve NV-1 on the exhaust to decrease pressure to the Design Pressure.	
23	Close needle valve NV-1 and blocking valve BV-1	
24	Close blocking valve BV-2 and observe pressure.	
25	Record Date:Time , Temperature, and Pressure in Table R1 Test Record.	
26	If pressure at 3 hours is equal to the initial pressure (temperature corrected) complete testing and go to step 30. If pressure at any point in the test is less than the initial pressure, proceed to next step.	
27	Use a gas detector capable of detecting the test gas to determine the source(s) of the leak(s).	
28	Resolve the sources of the leak.	
29	Repeat steps 1-26 until no pressure loss is detected after 3 hours at the Design Pressure.	
30	Follow the Safing Procedure in the Appendices to bring the testing to a safe state.	

1.4 Test Record

R 1 Test Record

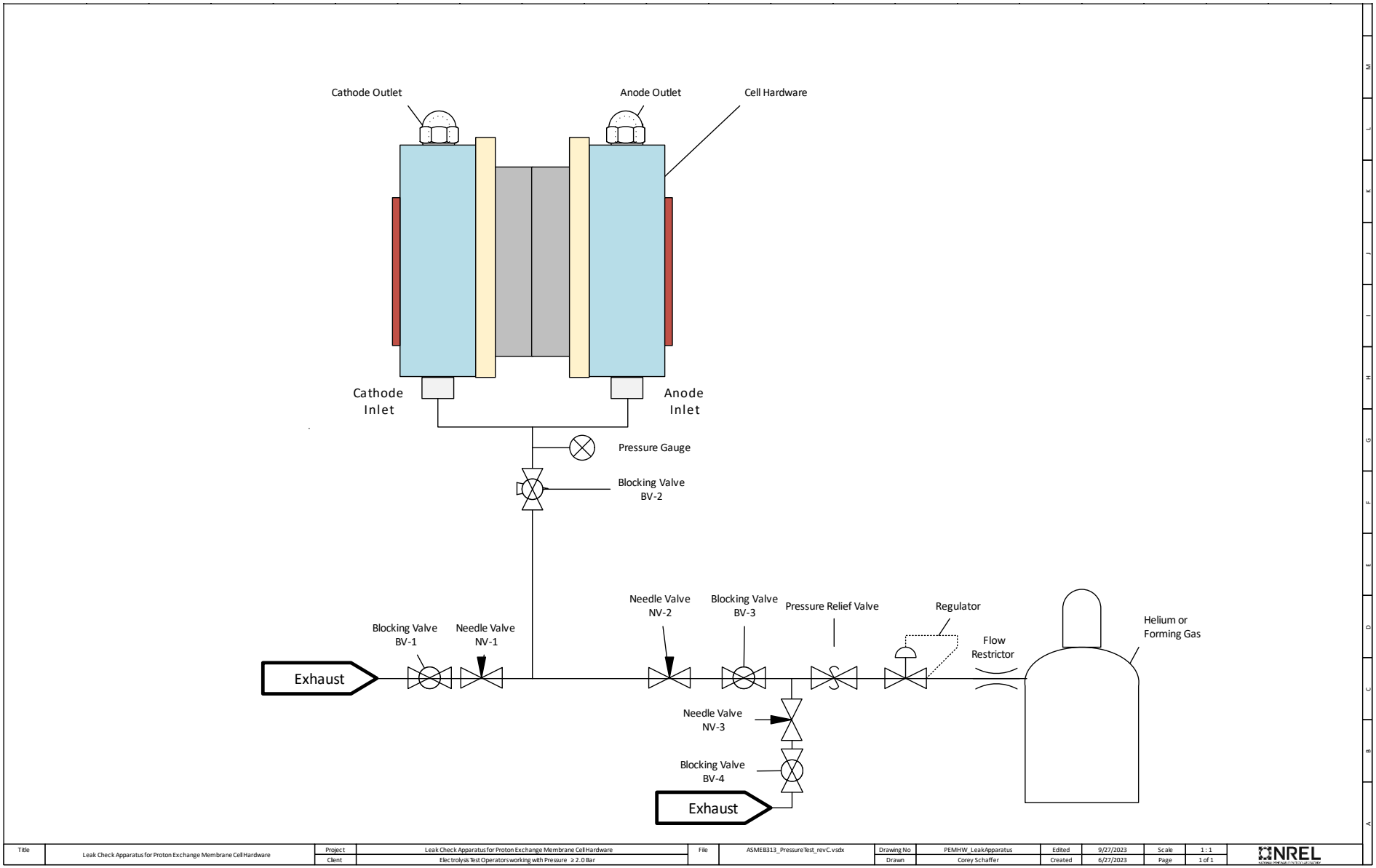
Elapsed Time, Minutes	Pressure, Bar-A	Temperature, °C	Date:Time
0			
30			
60			
90			
120			
150			
180			

1.5 Appendices

A 1 Links

Item	Link
Process Piping: The Complete Guide to ASME B31.3, Fourth Edition	https://asmedigitalcollection.asme.org/ebooks/book/280/Process-Piping-The-Complete-Guide-to-ASME-B31-3

A 2 Safing Procedure

Step	Action	Status
1	Turn off the Temperature Control Box.	
2	Turn the regulator to 0. If the regulator outlet is equipped with a valve, turn off the valve.	
3	Open blocking valve BV-2.	
4	Close the needle valve NV-1 e on the exhaust.	
5	Open blocking valve BV-1 on the exhaust.	
6	Slowly open the needle valve NV-1 on the exhaust.	
7	Wait until the pressure gauge reads atmospheric pressure.	
8	Confirm that cell temperature is less than 60 °C.	
9	Apparatus is safe to be worked on.	

A 3 Apparatus Schematic