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Hanford EPICS Vacuum Controls Vacuum Gauge Pair (Pirani and Cold Cathode) Test Specifications

Christine Patton, Dave Barker

Distribution of this draft:

Hanford CDS, Operators, Vacuum and PSI

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California Institute of Technology
LIGO Project - MS 51-33
Pasadena CA 91125
Phone (818) 395-2129
Fax (818) 304-9834
E-mail: info@ligo.caltech.edu

Massachusetts Institute of Technology
LIGO Project - MS 20B-145
Cambridge, MA 01239
Phone (617) 253-4824
Fax (617) 253-7014
E-mail: info@ligo.mit.edu

WWW: http://www.ligo.caltech.edu/

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Hanford EPICS Vacuum Controls Test Specifications

SYSTEM TESTED: _____

SOFTWARE TESTED: _____

HARDWARE CONFIGURATION:

Equipment List	Date	Revision	Serial Number

TESTED BY:

Name	Title	Date

TESTS COMPLETED:

Test Name	Sign Off	Date

APPROVED BY:

Signature	Date

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1 INTRODUCTION

The LIGO beam tube vacuum is measured by pairs of Pirani and Cold Cathode gauges which cover the vacuum range 760 to 1.0e-11 torr. The Pirani gauge has an operational range of 760 torr (atmosphere) to 1.0e-3 torr. The Cold Cathode gauge has an operational range of 1.0e-3 to 1.0e-11 torr.

The EPICS system has a database for each pair of vacuum gauges. Both gauges are physically close to each other and measure the same vacuum.

The Cold Cathode gauge may be operated on a poor vacuum (pressure > 1.0e-3), but to do so will shorten its operational life. Therefore the EPICS system allows the user to switch the Cold Cathode gauge off.

1.1. Signal Conversions

Each gauge provides a DC voltage in the range 0 - 10V.

The gauge pair voltage is used to calculate the vacuum in Torr. The voltage must be within the domain of the equations or an incorrect pressure reading will result. The voltage to vacuum conversion equations are:

Cold Cathode (EPICS calculation record) -

$$P = 10^{(V-K)}$$

where,

P is in Torr

V is in volts for $1.5 \leq V \leq 8.7$

K = 11.000 for Torr

Pirani (EPICS subroutine record) -

where,

P is in Torr, V is in volts for $0 \leq V \leq 6$

a = 3.29, b = 24.98, c = 0.98, V_0 = 0.3752,

d = 4.929, f = 1.6 x $10^{-6,}$ g = -225,

h = 2.0253, k = 0.52703,

$$P = \left[\frac{a}{\frac{b}{V^2 - V_0^2} - 1}\right]^{1/c}$$

Domain: 0.38<V<4.85

$$P = \sqrt{\frac{(V-d) + \sqrt{(V-d)^2 - 4fg}}{2f}}$$

Domain: 4.85<V<5.18

$$P = \exp\left[\frac{V-h}{k}\right]$$

Domain: V>5.18

1.2. Purpose

This document is the test specification for the EPICS controls of the Vacuum Gauge Pair. With the EPICS system running in simulation mode, this test spec. allows the user to fully test the controls system functionality with no impact on PSI. In non-simulation mode, both the EPICS controls, the PSI interface and the Gauge Pairs can be tested.

1.3. Test Description

The Gauge Pair (GP) database will be tested in three phases:

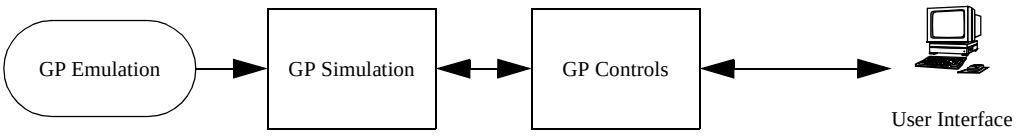
- Simulation mode.
- Non-simulation mode, not connected to PSI wiring.
- Non-simulation mode, fully connected to PSI wiring and hardware.

THE TEST MAY ONLY BE RUN FULLY CONNECTED TO PSI WIRING WHEN PSI AND CALTECH VACUUM MANAGEMENT HAVE GIVEN EXPRESS PERMISSION TO DO SO. Ignorning this warning may cause damage to the gauges and/or vacuum system.

In simulation mode the user can test the basics of database execution. In non-simulation mode the user will inject voltages to emulate the PSI wiring. Output voltages and/or currents will be measured.

When running directly to the PSI vacuum system, the actual operation of the Gauges will be tested. These tests will be performed with the Hanford Vacuum team and PSI.

In simulation mode, all input and output from/to hardware are simulated by an additional EPICS database. Also, the behaviour of the Gauges can be emulated by an additional sequencer which drives the simulation records in such a manner as to emulate a changing vacuum.



This document will show testing of the Right Mid Station..

1.4. Test Initialization

The user must have booted the IOC with the correct EPICS database for the system to be tested. It is assumed throughout this document that the user is familiar with EPICS configuration and operation.

The gauge pair uses a subroutine record whose procedure is defined in VE_GP_PIRANI_CVT_TORR.o. This object provides code to convert the Pirani vacuum gauge DC voltage into a vacuum measured in torr.

The vacuum emulation system (HVE-MX:X1E.db, HVE_MX_X1ERRE.st, and HVE-MX:X1EE.adl) allows the user to enter a starting vacuum, a final vacuum and a delta vacuum for both the Pirani and Cold Cathode gauges. The emulation then changes the simulation input records (HVE-MX:X1_PT343[A-B]_S) to the voltage values relating to the vacuums entered. The vacuum will then be changed by <delta vacuum> at 1Hz. This allows the user to test the HVE_MX_X1RR.st, the Rate of Rise sequencer software.

1.4.1. Simulation Mode

The following database files must be loaded and initialised:

HVE-MX:X1.db

HVE-MX:X1S.db

HVE-MX:X1E.db

HVE-MX:GV13.db

The following sequencers must be loaded and running:

HVE_MX_X1RR.st

HVE_MX_X1ERRE.st

HVE_MX_GV13OPEN.st

The following MEDM screens must be running. All widgets must be connected to the database:

HVE-MX:X1.adl

HVE-MX:X1S.adl

HVE-MX:X1EE.adl

HVE-MX:GV13.adl

The following Alarm Handler file must be running:

MX.alhConfig

1.4.2. Non-Simulation Mode, Not Connected to PSI Wiring

Ensure all signals are disconnected to PSI. The user is required to inject DC voltages into the gauge pair controls (0 - 10V range), emulate a relay contact closure and measure output voltage in the 0 - 24V range.

(QT) Tests marked with this symbol and are underlined define a Quick Test. Quick Tests allow the user to just test the hardware interface to the EPICS controls, and not test the control logic itself.

1.4.3. Non-Simulation Mode, Full Connection to PSI Wiring

These tests will be performed with Hanford Operators, Hanford Vacuum management and PSI. They will be fully coordinated with these teams and will only proceed with the express permission of all parties. Full lock and tag-out procedures will be followed.

THIS TEST WILL ONLY PROCEED WHEN IT IS DEEMED SAFE TO DO SO.

All PSI wiring will be attached to the PSI interface wiring block.

THESE TEST SPECS ARE TO BE DETERMINED.

1.4.4. Data Tables

Attached to this Test Spec are two data tables:

PSI Signal Matrix for Hanford Gauge Pairs. This specifies the PSI interface connectors used by all the Gauge Pairs at the Hanford site.

Signal Data Matrix for Hanford Gauge Pairs. This specifies Gauge Pair input and output signal limits, units, engineering conversions and alarm limits.

	PASS	FAIL	COMMENTS

2 Testing in Simulation Mode

2.1. Test Setup

On all of the simulation screens, switch the databases into simulation mode by pushing the Sim On buttons. Check that the simulations are on, and the simulated signals have entered the SIMULATION (foreground yellow, MINOR) alarm state. All simulation values are zero or set to a predefined default value (see Table 2: Hanford Vacuum Gauge Pair Signal Ranges).

Run the Alarm Handler with the alarm configuration file appropriate for the Gauge Pair being tested. Acknowledge all outstanding alarms (e.g. Interlocks or out of range inputs).

2.2. Test Pirani Gauge

2.2.1. Test conversion of Pirani gauge volts to torr in low range.

2.2.1.a During this test you will check the following.

- Confirm the Pirani gauge voltage on the GP main screen change to 3.00.
- Verify the Pirani gauge vacuum change to ~ 1.83 torr on the main screen.
- Verify that the Active Gauge widget on the gauge pair main screen changes from “Gauges out of range” to “Pirani”.

2.2.1.b Run the test by typing 3.0 in the Pirani Voltage on the GP simulation screen.

2.2.2. Test conversion of gauge volts to torr in mid range.

2.2.2.a During this test you will check the following.

- Confirm the Pirani gauge voltage on the GP main screen change to 5.00.
- Verify the Pirani gauge vacuum change to 218 torr on the following screens.

2.2.2.b Run the test by typing 5.0 in the Pirani Voltage on the GP simulation screen.

2.2.3. Test conversion of gauge volts to torr in high range.

2.2.3.a During this test you will check the following.

- Confirm Pirani gauge voltage on all the GP main screen change to 5.5.
- Verify the Pirani gauge vacuum change to 730 torr on the main screen.

2.2.3.b Run the test by typing 5.5 in the Pirani Voltage on the GP simulation screen.

2.2.4. Test changing Pirani acceptable low limit. This test is in two parts, in the first the Pirani is out of the new range. In the second the Pirani is brought into the new range.

	PASS	FAIL	COMMENTS

2.2.4.a During this test you will check the following.

- In the first part, verify that the Active Gauge on the gauge pair main screen changes within 5 seconds from “Pirani” to “Gauges out of range”.

- In the second part confirm that the Active Gauge on the main screen changes within 5 seconds from “Gauges out of range” to “Pirani”.

2.2.4.b To setup the test, on the gauge pair simulation screen, change the Pirani Low End from .002 to 0.1 .

2.2.4.c To run the first part of the test, on the gauge pair simulation screen, type in 0.5 in the Pirani voltage.

2.2.4.d To run the second part of the test, on the gauge pair simulation screen, type in 1.0 in the Pirani voltage.

2.2.4.e Return the Pirani Low End to .002.

2.2.5. Test Pirani voltage alarms.

2.2.5.a Test of Pirani voltage above normal operating range. During this test you will check the following.

- Verify that on the main screen and on the alarm handler screen this signal goes into a MAJOR alarm state.

2.2.5.b To run the test, on the simulation screen, type 6.0 in the Pirani voltage.

2.2.5.c Test of Pirani voltage at upper end of normal operating range. During this test you will check the following.

- Verify that on the main screen and on the alarm handler this signal goes into a SIMULATION alarm state.

2.2.5.d To run the test, on the simulation screen, type 4.0 in the Pirani voltage.

2.2.5.e Test of Pirani voltage below normal operating range. During this test you will check the following.

- Verify that on the main screen and on the alarm handler screen this signal goes into a MAJOR alarm state.

2.2.5.f To run the test, on the simulation screen, type a .381 in the Pirani voltage.

2.2.5.g Test of Pirani voltage at low end of normal operating range. During this test you will check the following.

- Verify that on the main screen and on the alarm handler this signal goes into a SIMULATION alarm state.

2.2.5.h To run the test, on the simulation screen, type a 0.4 in the Pirani voltage.

2.2.6. Test invalid Pirani voltage. During this test you will check the following.

	PASS	FAIL	COMMENTS

- Verify the main screen displays a voltage and vacuum of 0.0

- Verify that within five seconds the Active Gauge widget returns to "Gauges out of range" and the MAJOR alarm state is shown on the main screen and the alarm handler.

2.2.7. To run the test, on the simulation screen, type 0.0 in the Pirani voltage.

2.3. Test Cold Cathode Gauge On/Off

On initialization the cold cathode on/off button on the main screen is in the on position. After turning the simulation on, the cold cathode button on the main screen must be switched to off and then to on and finally back to off again in order for the simulation screen to read the state of the button.

2.3.1. Test of switching the Cold Cathode gauge on. Assumes an initial state of Cold Cathode OFF. During this test you will check the following.

- Verify the Cold Cathode on/off color block on the gauge pair simulation screen turns from red to green.

2.3.2. To run the test, on the gauge pair main screen, switch the cold cathode gauge ON.

2.4. Test Cold Cathode Gauge Conversion and Alarms.

2.4.1. Test conversion of gauge volts to torr and alarms above normal operating range.

2.4.1.a During this test you will check the following.

- Confirm the Cold Cathode voltage on the main screen changes to 8.0 within one second and show the signal in the MAJOR alarm state.

- Verify the Cold Cathode vacuum on the main screen changes to 1.0e-03 torr and shows the signal in the MAJOR alarm state.

- Verify that the Active Gauge on the gauge pair main screen changes from "Gauges out of range" to "Cold Cathode".

- Verify the alarm handler shows this signal in the MAJOR alarm state.

2.4.1.b To run the test, on the gauge pair simulation screen, type in 8.0 in the Cold Cathode voltage.

2.4.2. Test conversion of gauge volts to torr and alarms at upper end of the normal operating range.

2.4.2.a During this test you will check the following.

- Confirm the Cold Cathode gauge voltage on the main screen changes to 5.0 within one second and shows the signal in the SIMULATION alarm state.

- Verify the Cold Cathode gauge vacuum on the main screen changes to 1.0e-06 torr and shows the signal in the SIMULATION alarm state.

	PASS	FAIL	COMMENTS

- Verify the alarm handler shows this signal in the SIMULATION alarm state.

2.4.2.b To run the test, on the simulation screen, type in 5.0 in the Cold Cathode voltage.

2.4.3. Test conversion of gauge volts to torr and alarms at lower end of the normal operating range.

2.4.3.a During this test you will check the following.

- Confirm Cold Cathode gauge voltage on the main screen changes to 2.0 within one second and shows the signal in the SIMULATION alarm state.
- Verify the Cold Cathode gauge vacuum on the main screen changes to 1.0e-09 torr and shows the signal in the SIMULATION alarm state
- Verify the alarm handler shows this signal in the SIMULATION alarm state.

2.4.3.b To run the test, on the simulation screen, type in 2.0 in the Cold Cathode voltage.

2.4.4. Test conversion of gauge volts to torr and alarms below the normal operating range.

2.4.4.a During this test you will check the following.

- Confirm Cold Cathode gauge voltage on the main screen changes to 0.5 within one second and shows the signal in the MAJOR alarm state.
- Verify the Cold Cathode gauge vacuum on the main screen changes to 3.2e-11 torr and shows the signal in the MAJOR alarm state
- Verify the alarm handler shows this signal in the MAJOR alarm state.

2.4.4.b To run the test, on the simulation screen, type in 0.5 in the Cold Cathode voltage.

2.5. Test Gauge Pair Interlock

2.5.1. Test interlock when Pirani gauge is reading.

2.5.1.a During this test, for each Pirani voltage value you will check the following.

- For each value, verify that the interlock value on the gauge pair main screen remains at zero.
- For each value, verify that the interlock block on the main screen remains “Bad”, red.

2.5.1.b To run the test, type in, one at a time, the following voltage values into the Pirani voltage on the gauge pair simulation screen.

- 1.0

	PASS	FAIL	COMMENTS

- 2.0
- 3.0
- 4.0
- 5.0
- 6.0

2.5.1.c Return the Pirani voltage on the simulation screen to 0.39.

2.5.2. Test interlock when Cold Cathode gauge is reading. Cold Cathode transition from above normal operating range into normal operating range.

2.5.2.a During this test, for each Cold Cathode voltage value you will check the following.

- Verify that the interlock value on the gauge pair main screen equals 1 for each value below 6.0.
- Verify that the interlock block on the main screen changes to “Good”, green, for each value below 6.0.

2.5.2.b To run the test, type in, one at a time, the following voltage values into the Cold Cathode voltage on the simulation screen.

- 6.0
- 5.0
- 4.0
- 3.0
- 2.0
- 1.0

2.5.3. Test interlock when Cold Cathode gauge is reading. Cold Cathode transition from normal operating range to below normal operating range.

2.5.3.a During this test, for each Cold Cathode voltage value you will check the following.

- Verify the interlock shows “Bad”, zero or red on the main screen.
- Verify the Active Gauge returns to “Gauges out of range”.

2.5.3.b To run the test, type in, one at a time, the following voltage values into the Cold Cathode voltage on the simulation screen.

- 0.5
- 0.0

	PASS	FAIL	COMMENTS

2.5.4. Test changing acceptable interlock vacuum range. In this test the upper interlock level for the Cold Cathode is raised such that an 8V signal corresponds to a good interlock.

2.5.4.a Test setup. On the simulation screen, change the Interlock Vacuum to .001.

2.5.4.b During this test, for each value you will check the following.

- For each value, verify that the interlock value on the gauge pair main screen is one.
- For each value, verify that the interlock block on the main screen changes to “Good”, green.

2.5.4.c To run the test ,type in, one at a time, the following voltage values into the Cold Cathode voltage on the simulation screen.

- 8.0
- 7.0
- 6.0
- 5.0
- 4.0

2.5.4.d Return the Cold Cathode gauge voltage on the simulation screen to 0.0.

2.5.4.e Return the Interlock Vacuum on the simulation screen to .00001.

2.6. Test Pirani Rate of Rise

2.6.1. The following tests use the Gauge Pair rate of rise emulation system to change the Pirani vacuum at the required rate. Test Vacuum drop from 700 to 500 torr at 5 torr/sec. Test that the Rate of Rise is shown correctly in units of torr/sec, torr/min and torr/hour.

2.6.1.a Test Setup. On X1EE screen; select Pirani Gauge for control, type in 700 as the initial vacuum, type in 500 as the final vacuum, type in 5 as the change. It is assumed that the rate of rise displays units are initially torr/sec.

2.6.1.b During this test you will check the following.

- Verify on the main screen the Pirani starts at 700 torr and reduces by 5 torr/sec.
- After 15 seconds, verify that on the main screen the rate of rise is correctly shown as -5.0 torr/sec.
- When the rate of rise units are changed to torr/min, then within 5 seconds, verify that on the main screen the rate of rise is correctly shown as -300 torr/minutes.

	PASS	FAIL	COMMENTS

- When the rate of rise units are changed to torr/hour, then within 5 seconds, verify that on the main screen the rate of rise is correctly shown as -18000 torr/hour.

- When the rate of rise units are changed back to torr/sec, then within 5 seconds, verify that on the main screen the rate of rise is correctly shown as -5.0 torr/sec.

- After 40 seconds run time, verify the Pirani vacuum stops decreasing on the main screen.

2.6.1.c To run the test, on X1EE screen, press Go button (see next three items).

2.6.1.d During the test at the appropriate time press the torr/minute button on the main screen.

2.6.1.e During the test at the appropriate time press the torr/hour button on the main screen.

2.6.1.f During the test at the appropriate time press the torr/sec button on the main screen.

2.6.2. Test Vacuum increase from 500 to 700 torr at 5 torr/sec.

2.6.2.a Test setup. On the X1EE screen; select the Pirani Gauge for control, type in 500 as the initial vacuum, type in 700 as the final vacuum, type in 5 as the change.

2.6.2.b During this test you will check.

- Verify on the main screen that the Pirani starts at 500 torr and increases by 5.0 torr/sec.

- After 15 seconds, verify that on the main screen the rate of rise is correctly shown as +5 torr/sec.

- After 40 seconds, verify the Pirani vacuum stops increasing on the main screen.

2.6.2.c To start the test, on the X1EE screen, press the Go button.

2.6.2.d Return the Pirani voltage on the simulation screen to 0.0.

- Verify the Pirani gauge on the main screen returns to a voltage and vacuum of 0.0.

2.7. Test Cold Cathode Rate of Rise

2.7.1. Test Vacuum drop from 1.0e-5 to 1.0e-6 torr at 1.0e-7 torr/sec. Test that the Rate of Rise is shown correctly in units of torr/sec, torr/min and torr/hour.

2.7.1.a Test setup. On the X1EE screen; select the Cold Cathode Gauge for control, type in 1.0e-5 as the initial vacuum, type in 1.0e-6 as the final vacuum, type in 1.0e-7 as the change.

2.7.1.b During this test you will check the following.

	PASS	FAIL	COMMENTS

- Verify on the main screen that the Cold Cathode is starting at 1.0e-5 torr and reducing by 1.0e-7 torr/sec.
- After 15 seconds, verify that on the main screen the rate of rise is correctly shown as -1.0e-7 torr/sec.
- When the rate of rise units are changed to torr/min, then within 5 seconds, verify that on the main screen the rate of rise is correctly shown as - 6.0e-6 torr/minutes.
- When the rate of rise units are changed to torr/hour, then within 5 seconds, verify that on the main screen the rate of rise is correctly shown as -3.6e-4 torr/hour.
- When the rate of rise units are changed back to torr/sec, then within 5 seconds, verify that on the main screen the rate of rise is correctly shown as -1.0e-7 torr/sec.
- After 100 seconds, verify the Cold Cathode vacuum stops decreasing on the main screen.

2.7.1.c To run the test, on X1EE screen, press Go button (see next three items).

2.7.1.d During the test at the appropriate time press the torr/minute button on the main screen.

2.7.1.e During the test at the appropriate time press the torr/hour button on the main screen.

2.7.1.f During the test at the appropriate time press the torr/sec button on the main screen.

2.7.2. Test Vacuum increase from 1.0e-6 to 1.0e-5 torr at 1.0e-7 torr/sec.

2.7.2.a On the X1EE screen; select the Cold Cathode Gauge for control, type in 1.0e-6 as the initial vacuum, type in 1.0e-5 as the final vacuum, type in 1.0e-7 as the change.

2.7.2.b During the test you will check the following.

- Verify on the main screen the Cold Cathodestarts at 1.0e-6 torr and increases by 1.0e-7 torr/sec.
- After 15 seconds, verify that on the main screen the rate of rise is correctly shown as +1.0e-7 torr/sec.
- After 100 seconds, verify the Cold Cathode vacuum stops increasing on the main screen.

2.7.2.c To run the test, on the X1EE screen, press the Go button.

2.7.2.d Return the Cold Cathode voltage on the simulation screen to 0.0.

- Verify the Cold Cathode gauge on the main screen returns to a voltage and vacuum of 0.0.

	PASS	FAIL	COMMENTS

2.8. Test "Cross-over" Rate of Rise

Test Vacuum "cross-over" from Pirani range to Cold Cathode range.

2.8.1. Test Pirani active range.

2.8.1.a During the test you will check the following.

- Verify on the main screen that the Pirani vacuum is ~ 1.1e-1 torr, ~ 1.3e-2 and ~ 1.3e-3 torr.
- Verify the Active Gauge is "Pirani" except for 0.39V when there is no active gauge.

2.8.1.b To run the test, type in, one at a time, the following voltage values into the Pirani voltage on the simulation screen.

- 1.0
- 0.5
- 0.39

2.8.2. Test Cold Cathode active range.

2.8.2.a During this test you will test the following.

- Verify on the main screen that the Cold Cathode vacuum is 1.0e-6 torr, 10e-8 and 1.0e-10 torr.
- Verify the Active Gauge is "Cold Cathode".

2.8.2.b Type in, one at a time, the following voltage values into the Cold Cathode voltage on the simulation screen.

- 5.0
- 3.0
- 1.0

2.8.2.c Return the Cold Cathode and Pirani voltages on the simulation screen to 0.0.

- Verify the gauges on the main screen returns to a voltage and vacuum of 0.0.

	PASS	FAIL	COMMENTS

3 Testing in non-simulation mode, not connected to PSI

Items needed to perform these tests; 2 DC voltage sources with range 0.00 to 10.00 V (resolution 2 decimal places), 1 DVM, cables necessary to connect to PSI DIN-rail connectors, shorting cables.

These tests will check not only the wiring between the PSI connectors and the ADC channels, but also the wiring between the PSI connectors and the Interlock Board. When the gauge voltage exceeds the interlock board threshold, the interlock will be asserted. These thresold voltages are about 0.6V for the Pirani channels and about 6.0V for the Cold Cathode channels.

To verify the appropriate Interlock Relay has opened, the operator must open the relevant Gate Valve screen(s) for the gauge pair being tested. A table of the gate valve screens which must be viewed while changing the gauge pair voltages is provided.

3.1. Test Pirani Gauge

For these tests, connect one DC voltage source to the PSI connectors for the Pirani, and the other DC voltage source to the PSI connectors for the Cold Cathode. Ensure the Cold Cathode gauge is switched OFF.

(QT) 3.1.1. Test conversion of Pirani gauge volts to torr in low range.

3.1.1.a During this test you will check the following.

- Confirm Pirani gauge voltage on main screen changed to 3.0 (+/- 0.1).
- Confirm Pirani gauge vacuum on all main screens changed to 1.83 torr (+/ - 0.06).
- Verify that the Active Gauge changes from “Gauges out of range” to “Pirani”.
- Verify that the VME Interlock signal on all relevant interlock channels (viewed on the main Gate Valve screens) show an interlocked (Red) condition.

3.1.1.b To start the test, inject a 3.0 voltage into the PSI connectors for the Pirani gauge Voltage.

3.1.2. Test conversion of Pirani gauge volts to torr in mid range.

3.1.2.a During this test you will check the following.

- Confirm Pirani gauge voltage on main screen changed to 5.0 (+/- 0.1).
- Verify the Pirani gauge vacuum changed to 245 torr (+/- 5).

3.1.2.b To start the test, inject a 5.0 voltage into the PSI connectors for the Pirani gauge Voltage.

3.1.3. Test conversion of Pirani gauge volts to torr in high range.

3.1.3.a During this test you will check the following.

	PASS	FAIL	COMMENTS

- Confirm Pirani gauge voltage on main screen changed to 5.5 (+/-0.1).
- Verify the Pirani gauge vacuum changed to 760 torr (+/- 10).

3.1.3.b To start the test, inject a 5.5 voltage into the PSI connectors for the Pirani gauge Voltage.

3.1.4. Test changing Pirani acceptable low limit.

3.1.4.a On the simulation screen, change the Pirani Low End from .002 to 0.1.

3.1.4.b Test Pirani below new limit. During this test you will check the following.

- Verify that the Active Gauge on the main screen changes from “Pirani” to “Gauges out of range”.

3.1.4.c To start the test, inject a 0.5 voltage into the PSI connectors for the Pirani gauge Voltage

3.1.4.d Test Pirani above new limit. During this test you will check the following.

- Confirm that the Active Gauge on the main screen changes from “Gauges out of range” to “Pirani”.

3.1.4.e To start the test, inject a 1.0 voltage into the PSI connectors for the Pirani gauge Voltage.

3.1.5. Test Pirani voltage alarms.

3.1.5.a Test Pirani voltage above normal operating range. During this test you will check the following.

- Verify that on the main screen and on the alarm handler screen this signal goes into a MAJOR alarm state.

3.1.5.b To run the test, inject a 6.1 voltage into the PSI connectors for the Pirani gauge Voltage.

3.1.5.c Test Pirani voltage in normal operating range. During this test you will check the following.

- Verify that on the main screen and on the alarm handler this signal leaves the MAJOR alarm state and returns to MINOR alarm state.

3.1.5.d To run the test, inject a 5.7 voltage into the PSI connectors for the Pirani gauge Voltage.

3.1.5.e Test Pirani alarms below normal operating range. During this test you will check the following.

- Verify that on the main screen and on the alarm handler screen this signal goes into a MAJOR alarm state.

3.1.5.f To run the test, inject a 0.3 voltage into the PSI connectors for the Pirani gauge Voltage.

	PASS	FAIL	COMMENTS

3.1.5.g Inject a 0.45 V voltage into the PSI connectors for the Pirani gauge Voltage.

- Verify that on the main screen and on the alarm handler this signal leaves the MAJOR alarm state and shows NO_ALARM state.

3.2. Test Cold Cathode Gauge On/Off

For this test you need a DVM to be used on the DC Voltage 24V range. Connect the DVM to the Cold Cathode On/Off line at the PSI interface. It is assumed the Cold Cathode is initially OFF.

(QT) 3.2.1. Cold Cathode gauge switch ON test.

3.2.1.a During this test you will check the following.

- Verify the output immediately goes to 24 volts and remains at 24 volts.

3.2.1.b To start the test, on the main screen, switch the cold cathode gauge ON.

3.2.2. Cold Cathode gauge switch OFF test.

3.2.2.a During this test you will check the following.

- Verify the off output immediately goes to 0 volts and remains at 0 volts.

3.2.2.b To start the test, on the main screen, switch the cold cathode gauge OFF.

3.2.2.c Switch the Cold Cathode ON.

3.3. Test Cold Cathode Gauge

(QT) 3.3.1. Test conversion of Cold Cathode gauge volts to torr in high range (assumes CC is ON).

3.3.1.a During this test you will check the following.

- Confirm the Cold Cathode voltage on main screen changes to 8.0 (+/-0.1) within one second.
- Verify the Cold Cathode gauge vacuum changes to 1.2e-03 torr (+/-0.1).
- Verify that the Active Gauge widget on the main screen changes from “Pirani” to “Cold Cathode”.
- Verify that the VME Interlock signal on all relevant interlock channels (viewed on the main Gate Valve screens) show an interlocked (Red) condition.

3.3.1.b To run the test, inject an 8.0 voltage into the PSI connectors for the Cold Cathode voltage.

3.3.2. Test conversion of gauge volts to torr in mid range.

3.3.2.a During this test you will check the following.

- Confirm Cold Cathode gauge voltage on main screen changed to 5.0 (+/-

	PASS	FAIL	COMMENTS

0.05) within one second.

- Verify the Cold Cathode gauge vacuum changed to 1.0e-06 torr (+/- 0.1).

3.3.2.b To start the test, inject a 5.0 voltage into the PSI connectors for the Cold Cathode voltage.

3.3.3. Test conversion of gauge volts to torr in low range.

3.3.3.a During this test you will check the following.

- Confirm Cold Cathode gauge voltage on main screen changed to 2.0 (+/- 0.1) within one second.

- Verify the Cold Cathode gauge vacuum changed to 1.0e-09 torr (+/-0.1).

3.3.3.b To run the test, inject a 2.0 voltage into the PSI connectors for the Cold Cathode voltage.

3.3.4. Test Cold Cathode voltage alarms.

3.3.4.a Test Cold Cathode alarm above normal operating range. During this test you will check the following.

- Verify that on the main screen and on the alarm handler screen this signal goes into a MAJOR alarm state.

3.3.4.b To start the test, inject an 8.3 V voltage into the PSI connectors for the Cold Cathode voltage.

3.3.4.c Test Cold Cathode alarm within normal operating range. During this test you will check the following.

- Verify that on the main screen and on the alarm handler this signal leaves the MAJOR alarm state and shows the NO-ALARM alarm state.

3.3.4.d To run the test, inject 5.0 Volts into the PSI connectors for the Cold Cathode voltage.

3.3.4.e Test Cold Cathode alarm below normal operating range. During this test you will check the following

- Verify that on the main screen and on the alarm handler screen this signal goes into a MAJOR alarm state.

3.3.4.f To run the test, inject 0.3 Volts into the PSI connectors for the Cold Cathode voltage.

3.3.4.g Inject 2.0 volts into the PSI connectors for the Cold Cathode voltage.

- Verify that on the main screen and on the alarm handler this signal leaves the MAJOR alarm state and enters the NO_ALARM alarm state.

3.4. Test Gauge Pair Interlock

For this test you will need two sources of power to inject voltages between .38 and 7.0 volts. The Cold Cathode must be OFF.

	PASS	FAIL	COMMENTS

3.4.1. Test interlock when Pirani gauge is reading.

3.4.1.a During this test you will confirm the following.

- For each value, verify that the interlock value on the main screen remains zero.

3.4.1.b Inject the following voltages into the PSI connectors for the Pirani voltage

- 0.40
- 5.00
- 7.00

3.4.1.c Inject 0.39 volts into the PSI connectors for the Pirani gauge.

3.4.2. Test interlock when Cold Cathode gauge is reading.

3.4.2.a Turn the Cold Cathode ON.

3.4.2.b During this test you will check the following.

- Verify that the interlock value on the main screen changes reads one when the voltages 5.0 and 1.0 are injected.
- Verify that the interlock reads zero when the 0.5 voltage is injected.

3.4.2.c Inject the following voltages into the PSI connectors for the Cold Cathode voltage,

- 7.0
- 5.0
- 1.0
- 0.45

3.4.2.d Turn the Cold Cathode off on the main screen.

- Verify that the interlock changes to zero.

	PASS	FAIL	COMMENTS

4 Testing fully connected to PSI mode

To Be Determined.

Table 1: PSI Signal Matrix for Hanford Vacuum Gauge Pairs.

Location	ID	PIRANI A		COLD CATHODE B				Location	ID	PIRANI A		COLD CATHODE B			
		Voltage		Voltage		On/Off				Voltage		Voltage		On/Off	
		+	-	+	-	+	-			+	-	+	-	+	-
LVEA Y								Right Mid Station							
WCP1:	PT114	067	068	072	073	074	076	WBSC5:	PT310	068	069	073	074	075	077
WBSC2:	PT120	079	080	084	085	086	088	Beam Tube:	PT343	080	081	085	086	087	089
WBSC8:	PT180	103	104	108	109	110	112	WCP5:	PT344	092	093	097	098	099	101
LVEA X								WCP6:	PT345	104	105	109	110	111	113
WCP2:	PT134	067	068	072	073	074	076	Beam Tube:	PT346	116	117	121	122	123	125
WBSC4:	PT104	079	080	084	085	086	088	Left End Station							
WBSC7:	PT170	103	104	108	109	110	112	WBSC10:	PT410	040	041	045	046	047	050
Left Mid Station								WCP7:	PT424	064	065	069	070	071	073
WBSC6:	PT210	068	069	073	074	075	077	Right End Station							
Beam Tube:	PT243	080	081	085	086	087	089	WBSC9:	PT510	040	041	045	046	047	049
WCP3:	PT244	092	093	097	098	099	101	WCP8:	PT524	064	065	069	070	071	073
WCP4:	PT245	104	105	109	110	111	113								
Beam Tube:	PT246	116	117	121	122	123	125								

Table 2: Signal Data Matrix for Hanford Gauge Pair

Signal	Type	Signal Value Limits					Engineering Value Limits.				Alarm Limits				
		OFF/ Invalid	Low/ OFF	High/ ON	Tolerance	Units	Low/ OFF	High/ON	Units	Tolerance	Src	LO-LO/ ZSV	LOW/ ZSV	HIGH\ OSV	HIHI/ OSV
Pirani	ai	<0.38	0.38	6.0	+/- 0.1	V	1.3e-3	1.9e+03	Torr	NA	Eng	0.381	0.4	5.6	6.0
Cold Cath-ode	ai	<0.5	0.50	8.0	+/- 0.1	V	3.2e-11	1.0e-03	Torr	NA	Eng	0.5	1.5	6.0	8.0

Note: Gate Valves marked by parentheses are controlled by a different IOC.

Table 3: Relation Between Gauge Pairs and Gate Valve Interlock Channels.

Left End Station Interlock Testing.

Gauge Pair	Gate Valve
Y1	17
Y2	17,18
Y3	18

Left Mid Station Interlock Testing.

Gauge Pair	Gate Valve
Y1	9
Y2	9,10
Y3	10,11
Y4	11,12
Y5	12

LVEA-Y Interlock Testing.

Gauge Pair	Gate Valve
Y1	1,(2)
Y2	1,3,5
Y3	5,6
Y4	6

LVEA-X Interlock Testing.

Gauge Pair	Gate Valve
X1	4,(3)
X2	2,4
X3	7,8
X4	8

Right Mid Station Interlock Testing.

Gauge Pair	Gate Valve
X1	13
X2	13,14
X3	14,15
X4	15,16
X5	16

Right End Station Interlock Testing.

Gauge Pair	Gate Valve
X1	19
X2	19,20
X3	20

Hanford LIGO EPICS Test Specification Comments Sheet.

Comment ID: | Sheet | of

Raised By: | Test Spec ID:

Date: | Change Request Raised:

☐ **Hardware related** ☐ **Software related**

☐ **High priority, no work around exists** ☐ **Low priority**

☐ **High priority, work around exists** ☐ **For information only.**