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Hanford EPICS Vacuum Controls Electric Gate Valve Test Specifications

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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 GNB 112 cm Electric Gate Valves (GVE) are used in the Hanford Vacuum areas as 80K cryopump isolation valves, one gate valve on either side of each cryopump, and to isolate long sections of beam tube. Almost all Hanford Gate Valves are electric, except for four pneumatic gate valves located in the LVEA. The EPICS control system allows the operator to control each electric gate valve separately.

Each GVE supplies three digital signals. These are:

- Gate Valve Fault (1=Alarm, 0=OK)
- Gate Valve Open Limit Switch (1=OPEN state (switch close circuit), 0=NOT OPEN state (switch open circuit)).
- Gate Valve Close Limit Switch (1=CLOSED state (switch close circuit), 0=NOT CLOSED state (switch open circuit)).

The control system sends two digital signals to the GVE. These signals are:

- GVE Open Signal, 24V when enabled.
- GVE Close Signal, 24V when enabled.

The GVE will only open/close when the appropriate signal is continuously applied. Removing either signal stops movement.

In conjunction with the signals directly connected to the GVE, the GVE control system also uses the following input signals:

Additional analog input signal from hardware:

- Annulus Ion Pump current (0-10 volts representing 0-10 mA)

Additional digital input signal from hardware:

- VME Interlock board signal. (1= permissive granted, 0= permissive denied).

Additional analog signals from Gauge Pair EPICS control system:

- Gauge Pair Interlock signal from gauge pair downstream of Gate Valve.
- Gauge Pair Interlock signal form gauge pair upstream of Gate Valve.

1.1. Signal Conversions

The Annulus Ion Pump current is converted to vacuum (torr) by the equation:

$$P = 10^{(xref - ((yref - y)/slope)} \qquad \text{where,}$$

xref = $\log(7X10^{-7})$,

yref = $\log(10^{-7})$,

y = log(current in amps)

slope = 1.065

P is in torr

1.2. Purpose

This document is the test specification for the EPICS controls of this device. 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 Gate Valve itself can be tested.

1.3. Test Description

The Electric Gate Valve will be tested in three phases:

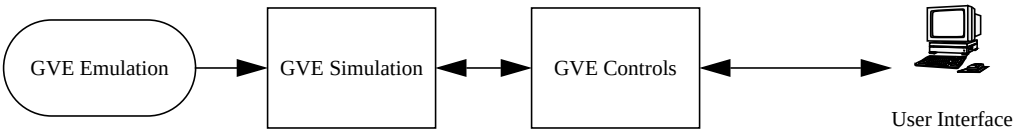
- Simulation mode.
- Non-simulation mode, not connected to PSI wiring.
- Non-simulation mode, fully connected to PSI wiring and hardware.

THE TEST MAY ONLY BE RUN FULLY CONNECTED TO PSI WIRING WHEN PSI AND CALTECH VACUUM MANAGEMENT HAVE GIVEN EXPRESS PERMISSION TO DO SO. Ignoring this warning may cause damage to the Gate Valve and the Vacuum System. **Remember, the gate valve is both an electrical and mechanical hazard to personnel in its vicinity.**

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 Gate Valve 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 Gate Valve itself is emulated by an additional sequencer which drives the simulation records in such a manner as to emulate a moving Gate Valve.



This document will show the testing of the Right Mid Station Gate Valve HVE-MX:GV13. Replace this name with the name of the gate valve you are testing.

1.4. Test Initialization

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

The gate valve uses the sequencer object code, HVE_MX_GV13OPEN.o, to control the opening and closing of the gate. The emulation system uses the HVE_MX_GV13GVEE.o to initialize the simulation input signals and to emulate setting the limit switches to control the open/close movement of the gate valve. The gate valve annulus ion pump uses a subroutine record whose procedure is defined in VE_GVE_AMPS_TO_TORR.o. This object provides code to convert the ion pump current into a vacuum measured in torr.

1.4.1. Simulation Mode

The following database files must be loaded and initialised:

HVE-MX:GV13.db and HVE-MX:GV13S.db

HVE-MX:X1S.db and HVE-MX:X2S.db

The following sequencers must be loaded and running:

HVE_MX_GV13OPEN.st and HVE_MX_GV13GVEE.st

HVE_MX_X1RR.st and HVE_MX_X2RR.st

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

HVE-MX:GV13.adl and HVE-MX:GV13E.adl

HVE-MX:X1S.adl and HVE-MX:X2S.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 gate valve controls (0 - 10V range), emulate three relay contact closures and measure output voltages 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 Gate Valves. This specifies the PSI interface connectors used by all the gate valves at the Hanford site.

Signal Data Matrix for Hanford Gate Valves. This specifies the gate valve input and output signal limits, units, engineering conversions and alarm limits.

	PASS	FAIL	COMMENTS

2 Testing in Simulation Mode

2.1. Test Setup

2.1.1. Run the Alarm Handler with the alarm configuration file appropriate for the gate valve being tested.

- Acknowledge all outstanding alarms (e.g. Interlocks or out of range inputs). Refer to Table 2: Signal Data Matrix for Hanford Gate Valves for a list of all signal levels.

2.1.2. On all the simulation screens, switch the databases into simulation mode by pushing the Sim On button.

- Verify the simulation is on and the simulated signals have entered the SIMULATION alarm state (foreground colours set to YELLOW and a MINOR alarm on the alarmhandler).

2.1.3. On the gate valve screens set the cold cathode gauges to ON.

2.1.3.0.a On the gauge pair simulation screens set the Pirani voltages to 0.39 and the Cold Cathode voltages to 5.0.

- Verify the gauge pair interlocks, on the gate valve main screens are in their "Good" (green) state.

2.1.3.0.b Iconize the gauge pair screens.

2.2. Test Annulus Ion Pump Current and Vacuum

2.2.1. Test Pump current, current to vacuum conversion, and alarms.

In the following tests the user will simulate the input of various voltages from PSI and check that the screens show the correct currents corresponding to these voltages.

Voltages representing pump current below 0.0V or above 10.0V are out of the operating range of the 25l/s Ion Pump and will be flagged by a major alarm.

2.2.2. Simulate invalid vacuum voltage from the Ion Pump (below valid range).

2.2.2.0.a You will check the following during this test:

- Verify the Pump Current reading on the main screen shows zero and a major alarm.

- Verify the Pump Vacuum reading on the main screen shows zero and a major alarm.

- Verify the Pump Current reading on the alarm handler shows a major alarm.

2.2.2.0.b Type in 0.0 into the Pump Current entry widget on the Simulation Screen.

2.2.3. Simulate invalid vacuum voltage from the Ion Pump (above valid range).

2.2.3.0.a You will check the following during this test:

	PASS	FAIL	COMMENTS

- Verify the Pump Current reading on the main screen shows 10.0 and a MAJOR alarm.

- Verify the Pump vacuum reading on the main screen shows 3.5e-05 and a MAJOR alarm.

- Verify the Pump Current signal on the alarm handler shows a MAJOR alarm

2.2.3.0.b Type in 10.0 into the Pump Current entry widget on the Simulation Screen.

2.2.4. Simulate valid pump current from the Ion Pump (middle of valid range).

2.2.4.0.a You will check the following during this test:

- Verify the Pump Current reading on the main screen shows 1.0 and a SIMULATION alarm.

- Verify the Pump vacuum reading on the main screen shows 4.0e-06 and a SIMULATION alarm.

- Verify the Pump current signal on the alarm handler shows a SIMULATION alarm.

2.2.4.0.b Type in 1.0 into the Pump Current entry widget on the Simulation Screen.

2.3. Test GVE Fault and VME Interlock

2.3.1. Test GVE Fault Indicator and alarm (**for Electric gate valves only**).

GVE fault values are; fault=0 or OK=1. These tests will check that a simulated GVE Fault/No-Fault changes the displays accordingly.

2.3.1.1 Test Fault reading and alarm.

2.3.1.1.a You will check the following during this test:

- Verify the GVE fault on the main screen changes from Normal (green) to fault (red) within one second.

- Verify on the alarm handler this signal is in a MAJOR alarm state.

2.3.1.1.b On the GVE simulation screen, type a 0.0 in the Gate Valve fault input widget.

2.3.1.2 Test No Fault reading and alarm.

2.3.1.2.a You will check the following during this test:

- Verify the GVE fault on the main screen changes from fault (red) to Normal (green) within one second.

- Verify on the alarm handler this signal goes into a SIMULATION alarm state.

	PASS	FAIL	COMMENTS

2.3.1.2.b On the GVE simulation screen, type a 1.0 in the Gate Valve fault input widget.

2.3.2. Test VME Interlock.

VME Interlock values are; 1= permissive granted, 0= permissive denied. These tests will check that a simulated VME Interlock changes the displays accordingly.

2.3.2.1 Test Permissive denied reading and alarm.

2.3.2.1.a You will check the following during this test:

- Verify the VME Interlock on the GV main screen changes from “good” (green) to “bad” (red) within one second.

2.3.2.1.b On the GV simulation screen, type a 0.0 in the VME Interlock input widget.

2.3.2.2 Test Permissive granted reading and alarm.

2.3.2.2.a You will check the following during this test:

- Verify the VME Interlock on the GV main screen changes from “bad” (red) to “good” (green) within one second.

2.3.2.2.b On the GV simulation screen, type a 1.0 in the VME Interlock input widget.

2.4. Test GVE Open

All Gate Valve Open tests assume an initial Closed position.

2.4.1. Test Gate Valve Open, all permissives “Good”.

Ensure all the Gate Valve permissives are “Good” (green).

2.4.1.0.a You will check the following during this test:

- The Valve Open Output on the GV simulation screen changes to Open GV.
- Verify the gate valve animation display shows the animated gate valve changing color from red to yellow to green and moving from the bottom of the gate to the middle and to the top.
- Verify the limit switch text on the bottom right side of the gate valve animation display changes from CLOSED to Not Closed and the text at the top changes from Not Open to Open.
- Verify an arrow pointing up appears on the top left side of the gate valve animation display.
- Verify the message box displays the text “Please wait, gate valve is opening.”
- Verify that after the animation goes to the top and changes to green the message box text displays “Gate open limit reached”.
- Verify the arrow pointing up disappears after the open limit is reached.

	PASS	FAIL	COMMENTS

2.4.1.0.b Press the OPEN button on the GV main screen.

2.4.2. Test GVE Open, opening an already opened GVE.

For this test the Gate Valve should be Open.

2.4.2.0.a You will check the following during this test:

- The gate valve doesn't move or change color and the message box text displays "Gate Valve is already Open." and "Gate Valve cannot be opened.".

2.4.2.0.b Press the OPEN button on the GV main screen.

2.4.2.0.c Close the Gate Valve.

2.4.3. Test GVE Open, stop during opening.

2.4.3.0.a You will check the following during this test:

- The message box text displays "Stop Request received." followed by "Open process stopping.", "Open Gate is Stopped" and flashing "Gate Valve Limit Switches not engaged.".
- The animation stops in the middle and is yellow.
- The limit switch text displays "Not Closed" and "Not Open".
- The Valve Open Output on the GV simulation screen goes blank.
- The arrow pointing up disappears.

2.4.3.0.b Press the OPEN button on the GV main screen. When the "Please wait, gate is opening." message appears in the message box, press the STOP button.

2.4.3.0.c Press the CLOSE button.

2.4.4. Test GVE Open, closing during opening.

2.4.4.0.a You will check the following during this test:

- The gate valve animation display stops in the middle and is yellow, then transitions to the bottom and turns red.
- The "Close Request received" message appears in the message box followed by "Open process stopping.", "Please wait, Gate Valve is Closing", and "Gate Close Limit reached".
- An arrow pointing down appears on the top left side of the animation display and the arrow pointing up has disappeared.
- The limit switch text on the right of the animation display changes from "Not Open" and "Not Closed" to "Not Open" and "CLOSED".

2.4.5. Press the OPEN button and when the "Please wait, gate opening." message appears in the message box, press the CLOSE button.

	PASS	FAIL	COMMENTS

2.4.6. Test GVE Open, gauge pair interlocks faulted.

2.4.6.1 Test GVE Open, one gauge pair faulted.

2.4.6.1.a You will check the following during this test:

- The message box text displays “Pressure out of range” and “Gate Valve cannot be opened”.
- The gate valve animation display does not move or change color, the limit switch text doesn’t change and no arrow appears.

2.4.6.1.b On the gauge pair simulation screen, set the gauge pair interlock to “Bad” (red) by entering 1.0 in the Pirani voltage widget. Press the OPEN button on the GV main screen.

2.4.6.2 Test GVE Open, both gauge pairs faulted.

2.4.6.2.a You will check the following during this test:

- Verify the message box text displays “Pressure out of range” and “Gate Valve cannot be opened”.
- Verify the gate valve animation display doesn’t move or change color, the limit switch text doesn’t change and no arrow appears.

2.4.6.2.b On the gauge pair simulation screens, set both gauge pair interlocks to “Bad” (red), press the OPEN button on the GV main screen.

2.4.6.2.c On the gauge pair simulation screens, set both gauge pair interlocks to “Good” (green) by typing .39 in the Pirani voltage widget.

2.4.7. Test GVE Open, GVE Faulted **(Electric Gate Valve Only)**.

2.4.7.0.a You will check the following during this test:

- The message box text displays “Gate Valve Drive Failure” and “Gate Valve cannot be opened”.
- The gate valve animation display does not move or change color.
- The limit switch text doesn’t change and no arrow appears.

2.4.7.0.b On the GV simulation screen type 0.0 in the Valve Fault input widget to set the Valve Fault Indicator to “Fault” (red). Press the OPEN button on the GV main screen.

2.4.7.0.c Return the Valve Fault Indicator to “Normal” (green).

2.4.8. Test GVE Open, VME Interlock Faulted.

2.4.8.0.a You will check the following during this test:

- The message box text displays “Hardware Lockout is in place” and “Gate Valve cannot be opened”.
- The gate valve animation display does not move or change color, the limit switch text does not change and no arrow appears.

	PASS	FAIL	COMMENTS

2.4.8.0.b On the GV simulation screen type a zero in the VME Interlock widget to set the VME Interlock to “Fault” (red), press the OPEN button on the GV main screen.

2.4.8.0.c Return the VME Interlock back to “Good” (green).

2.4.9. Test GVE Open, Annulus Ion Pump Interlock Faulted.

2.4.9.0.a You will check the following during this test:

- The message box text displays “Ion Pump below normal operation range.” and “Gate Valve cannot be opened”.
- That the gate valve animation display does not move or change color, the limit switch text does not change and no arrow appears.

2.4.9.0.b On the GV simulation screen, set the Annulus Ion Pump current to 0.0, press the OPEN button on the GV main screen.

2.4.10. Test GVE Open, all permissives “Bad”.

2.4.10.0.a You will check the following during this test:

- The message box text displays “Gate Valve Drive Failure”, “Pressure out of range”, “Hardware Lockout is in place”, “Ion Pump below normal operation range”, and “Gate Valve cannot be opened”.
- That the gate valve animation display does not move or change color, the limit switch text does not change and no arrow appears.

2.4.10.0.b On the gauge pair and GV simulation screens, set the gauges, the VME Interlock and GVE fault indicators, and the Annulus Ion Pump interlock to “Bad” (red). Press the OPEN button on the GV main screen.

2.4.10.0.c Return all permissives back to “Good” (green). Press the OPEN button.

2.5. Test GVE Close

Gate Valve CLOSE tests assume an Opened Gate Valve as the initial position.

2.5.1. Test GVE Close, all permissives “Good”.

Ensure all permissives are “Good” (green) and the Gate Valve is in the OPEN position.

2.5.1.0.a You will check the following during this test:

- The Valve Close output on the simulation screen changes to Close GV.
- The gate valve animation display shows the animated gate valve changing color from green to yellow to red and moving from the top eight blocks to the middle eight blocks to the bottom eight blocks.
- The limit switch text on the right side of the gate valve animation display changes from OPEN to Not Open and Not Closed to CLOSED.
- An arrow pointing down appears on the top left side of the gate valve ani-

	PASS	FAIL	COMMENTS

mation display.

- The message box displays the text “Please wait, gate valve is closing.” followed by “Gate close limit reached”.
- The arrow pointing down disappears after the close limit is reached.

2.5.1.0.b Press the CLOSE button on the GV main screen.

2.5.2. Test GVE Close, closing an already closed GVE.

2.5.2.0.a You will check the following during this test:

- The gate valve does not move or change color and the message box text displays “Gate Valve already closed” and “Gate Valve cannot be closed.”.

2.5.2.0.b Press the CLOSE button on the GV main screen.

2.5.2.0.c Press the OPEN button.

2.5.3. Test GVE Close, opening during closing.

2.5.3.0.a You will check the following during this test:

- The “Open Request Received” message appears in the message box followed by “Close gate is stopped”, “Please wait, Gate Valve is Opening”, and “Open limit reached”.
- The gate valve animation display stops in the middle and is yellow, then transitions to the open position and turns green.
- An arrow pointing up appears on the top left side of the animation display and the arrow pointing down has disappeared.
- The limit switch text on the right of the animation display changes from “Not Open” and “Not Closed” to “Not Closed” and “OPEN”.

2.5.3.0.b Press the CLOSE button and when the “Please wait, gate closing” message appears in the message box, press the OPEN button.

2.5.4. Test GVE Close, stop during closing.

2.5.4.0.a You will check the following during this test:

- The message box text displays “Stop Request Received” followed by “Gate Close is Stopping.” and “Gate Valve Limit Switches not engaged.”.
- The animation stops in the middle and is yellow.
- The limit switch text displays “Not Closed” and “Not Open”.
- The Valve Close Output on the GV simulation screen goes blank.
- The arrow pointing down disappears.

2.5.4.0.b Press the CLOSE button. When the “Please wait, gate is clos-

	PASS	FAIL	COMMENTS

ing." message appears in the message box, press the STOP button.

2.5.4.0.c Press the OPEN button.

2.5.5. Test GVE Close, downstream Gauge Pair Interlock faulted.

2.5.5.0.a You will check the following during this test:

- That the gate valve animation display transitions to the CLOSE position.

2.5.5.0.b On the gauge pair simulation screen, set the gauge interlock to "Bad" (red). Press the CLOSE button on the GV main screen.

2.5.5.0.c Return gauge pair interlock to "Good" and press the Open button.

2.5.6. Test GVE Close, GVE Faulted **(Electric Gate Valve Only)**.

2.5.6.0.a You will check the following during this test:

- The text "Gate Valve Drive failure" followed by "Gate Valve cannot be closed" appears in the message box.
- That the gate valve animation display does not move or change color.

2.5.6.0.b On the GV simulation screen, set the Valve Fault Indicator to "Fault" (red). Press the CLOSE button on the GV main screen.

2.5.6.0.c Return the Valve Fault Indicator to "Good" (green).

2.5.7. Test GVE Close, VME Interlock Faulted.

2.5.7.0.a You will check the following during this test:

- That the gate valve animation display transitions to the CLOSE position.

2.5.7.0.b On the GV simulation screen, set the VME Interlock to "Bad" (red). Press the CLOSE button on the GV main screen.

2.5.7.0.c Return VME Interlock to "Good" and press the Open button.

2.5.8. Test GVE Close, Annulus Ion Pump Interlock faulted.

2.5.8.0.a You will check the following during this test:

- That the gate valve animation display transitions to the CLOSE position.

2.5.8.0.b On the GV simulation screen, set the Annulus Ion Pump to "Bad" (red). Press the CLOSE button on the GV main screen.

2.5.8.0.c Return the Ion Pump to "Good" and press the Open button.

2.5.9. Test GVE Close, all permissives "Bad".

2.5.9.0.a You will check the following during this test:

- The text "Gate Valve Drive failure" followed by "Gate Valve cannot be closed" appears in the message box.
- That the gate valve animation display does not move or change color.

	PASS	FAIL	COMMENTS

2.5.9.0.b On the gauge pair and GV simulation screens, set the gauges, the VME Interlock and GVE fault indicators, and the Annulus Ion Pump interlock to “Bad” (red). Press the CLOSE button on the GV main screen.

2.5.9.0.c Return all the permissives to “Good”.

2.6. Test GVE Stop, Stop an already Stopped GVE

Ensure all permissives are in their “Good” state.

2.6.0.0.a You will check the following during this test:

- That the gate valve animation display stays in the middle and is yellow.
- The “Gate is already stopped” message appears in the message box.

2.6.0.0.b Press the CLOSE button. When the “Please wait, gate is closing.” message appears in the message box, press the STOP button. When the “Gate Valve Limit Switches not engaged.” message appears in the message box, then press the STOP button again.

2.6.0.0.c Press the Close button.

	PASS	FAIL	COMMENTS

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

3.1. Test Setup

3.1.1. Items needed to perform these tests:

stopwatch

GVE test jig

1 DC voltage source 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

Refer to Table 1: PSI Signal Matrix for Hanford Electric Gate Valves for the PSI DIN-rail connector numbers for each signal.

3.1.2. Complete test setup requires:

GVE test jig to be connected to the PSI connectors for the GV limit switches and GVE Fault

DC voltage source is connected to the PSI connectors for the Annulus Ion Pump

3.1.3. Ensure Gauge Pairs have been set up for simulation mode testing.

3.2. Test Annulus Ion Pump Current and Vacuum

3.2.1. Test Pump current, current to vacuum conversion, and alarms.

In the following tests the user will emulate the input of various voltages from PSI and check that the screens show the correct currents corresponding to these voltages.

Voltages representing pump current below 0.0V or above 10.0V are out of the operating range of the 25l/s Ion Pump and will be flagged by a major alarm.

3.2.2. Emulate invalid vacuum voltage from the Ion Pump (below valid range).

3.2.2.0.a You will check the following during this test:

- Verify the Annulus Ion Pump bar chart and torr value, on the main screen and on the alarm handler, change to a MAJOR alarm state and the Annulus Ion Pump interlock block is “Bad”, red.

- Verify on the main screen the vacuum in torr widget shows a pressure value of -0.0.

3.2.2.0.b Inject the voltage -1.0V (negative) into the PSI connectors for the Annulus Ion Pump Voltage.

3.2.3. Emulate invalid vacuum voltage from the Ion Pump (below valid range).

	PASS	FAIL	COMMENTS

3.2.3.0.a You will check the following during this test:

- Verify on the main screen and on the alarm handler this signal shows no alarms, however, the Annulus Ion Pump interlock is “Bad”, red.
- Verify on the main screen the vacuum in torr widget shows a pressure of $1x10^{-5}$ (+/-0.3).

3.2.3.0.b Inject the voltage 3.0V into the PSI connectors for the Annulus Ion Pump Voltage.

(QT) 3.2.4. Emulate valid vacuum voltage from the Ion Pump (middle valid range).

3.2.4.0.a You will check the following during this test:

- Verify the Annulus Ion Pump bar chart and torr value, on the main screen and on the alarm handler, shows no alarms.
- Verify the Annulus Ion Pump interlock block is “Good”, green.
- Verify on the main screen the vacuum in torr widget shows a pressure of ~ $4x10^{-6}$ (+/-0.3).

3.2.4.0.b Inject the voltage 1.0V into the PSI connectors for Annulus Ion Pump Voltage.

3.3. Test GVE Fault (for Electric gate valves only)

3.3.1. Test GVE Fault Indicator and alarm.

GVE fault values are; fault=0 or OK=1. These tests will check that a emulated GVE Fault/No-Fault changes the displays accordingly.

(QT) 3.3.1.1 Test Fault reading and alarm.

3.3.1.1.a You will check the following during this test:

- Verify the GVE fault on the main screen changed from Normal (green) to fault (red) within one second.
- Verify the alarm handler reports a MAJOR alarm on this signal.

3.3.1.1.b On the GVE Test Jig flip the switch for the GVE fault to “Bad”.

3.3.1.2 Test No Fault reading and alarm.

3.3.1.2.a You will check the following during this test:

- Verify the GVE fault on the main screen goes to Normal (green) and the alarm handler shows no alarm on this signal.

3.3.1.2.b On the GVE Test Jig flip the switch for the GVE fault to “Good”.

	PASS	FAIL	COMMENTS

3.4. Test Gate Valve Open

All Gate Valve Open tests assume an initial Closed position. These tests require the GV test jig be connected and power sources connected to the PSI connectors for the Annulus Ion Pump.

For testing, the output signal delays have been set to 5 seconds rather than the 1 second of normal operation.

(QT) 3.4.1. Test GVE Open, all permissives "Good"

To set the permissives to "good"; flip the switch on the GVE Test Jig for the GVE Fault to "Good", run the gauge pairs in simulation mode and inject 1.0 volts into the PSI connector for the Annulus Ion Pump.

You will need a stopwatch for this test.

3.4.1.0.a You will check the following during this test:

- Verify the open LED on the test jig stays on for 5 seconds following shorting the open limit switch connector then turns off.
- Verify the gate valve animation display shows the animated gate valve changing color from red to yellow to green and moving from the bottom of the gate to the middle and to the top.
- Verify the limit switch text on the bottom right side of the gate valve animation display changes from CLOSED to Not Closed and the text at the top changes from Not Open to Open.
- Verify an arrow pointing up appears on the top left side of the gate valve animation display.
- Verify the message box displays the text "Please wait, gate valve is opening.".
- Verify that after the animation goes to the top and changes to green the message box text displays "Gate open limit reached".
- Verify the arrow pointing up disappears after the open limit is reached.

3.4.1.0.b Press the OPEN button on the GV main screen. When the open LED on the GV Test Jig lights up, move the test jig lever from the close limit switch connector to the open limit switch connector, **you have two seconds to move the lever.**

3.4.2. Test GVE Open, opening an already opened GVE.

For this test the Gate Valve should be Open.

3.4.2.0.a You will check the following during this test:

- The gate valve doesn't move or change color and the message box text displays "Gate Valve is already Open." and "Gate Valve cannot be opened.".
- Verify the open LED on the test jig doesn't light up.

	PASS	FAIL	COMMENTS

3.4.2.0.b Press the OPEN button on the GV main screen.

3.4.2.0.c Close the Gate Valve.

3.4.3. Test GVE Open, stop during opening.

3.4.3.0.a You will check the following during this test:

- The message box text displays “Stop Request received.” followed by “Open process stopping.”, “Open Gate is Stopped” and flashing “Gate Valve Limit Switches not engaged.”.
- The animation stops in the middle and is yellow.
- The limit switch text displays “Not Closed” and “Not Open”.
- The Valve Open LED on the test jig turns off.
- The arrow pointing up disappears.

3.4.3.0.b Press the OPEN button on the GV main screen. When the “Please wait, gate is opening.” message appears in the message box, press the STOP button. When the open LED lights up move the test jig lever from the close limit switch connector and leave it up in the center between the open and close limit switches.

3.4.3.0.c Press the CLOSE button.

3.4.4. Test GVE Open, closing during opening

3.4.4.0.a You will check the following during this test:

- The gate valve animation display stops in the middle and is yellow, then transitions to the bottom and turns red.
- The “Close Request received” message appears in the message box followed by “Open process stopping.”, “Please wait, Gate Valve is Closing”, and “Gate Close Limit reached”.
- An arrow pointing down appears on the top left side of the animation display and the arrow pointing up has disappeared.
- The limit switch text on the right of the animation display changes from “Not Open” and “Not Closed” to “Not Open” and “CLOSED”.
- Verify the open LED was on prior to the close command, then turned off following the close command and the close LED turns on.

3.4.5. Press the OPEN button and when the “Please wait, gate opening.” message appears in the message box, press the CLOSE button. When the open LED lights up, move the test jig lever from the close limit switch connector and leave it up in the center between the open and close limit switches.

3.4.6. Test GVE Open, Timeout of opening GVE.

You will need a stopwatch for this test.

	PASS	FAIL	COMMENTS

3.4.6.0.a You will check the following during this test:

- Verify the open LED stays on for 12 seconds then turns off when the gate valve times out.
- Verify the gate valve animation stays in the middle and is yellow.
- Verify the status text messages are “Gate Valve open process has timed out.” followed by “Open Gate is Stopped.” and then “Gate Valve Limit Switches not engaged.”

3.4.6.0.b Press the OPEN button on the GV main screen. When the open LED lights up, remove the test jig lever from the close limit switch connector and leave it up in the center between the open and close limit switches.

3.4.6.0.c Return the gate valve to closed.

3.4.7. Test GVE Open, Open limit switch “Bounce”

3.4.7.0.a You will check the following during this test:

- The gate valve animation display jumps to the middle and turns yellow.
- Verify the open LED stays on for 2 seconds then turns off when the limit switch bounces.
- The limit switch text on the right of the animation display changes from “OPEN” and “Not Closed” to “Not Open” and “Not Closed”.
- The message box flashes the text “Gate Valve Limit Switches not engaged.”.

3.4.7.0.b Press the OPEN button on the GV main screen. When the open LED turns on, move the test jig lever from the close limit switch connector to the open limit switch then “bounce” the limit switch by removing the test jig lever from the open limit switch.

3.4.7.0.c Return the test jig lever to the open limit switch connector.

3.4.7.0.d Return the gate valve to closed.

3.4.8. Test GVE Open, downstream Gauge Pair Interlock faulted.

Set the gauge pair interlock to “Bad” by entering a voltage on the gauge pair simulation screens greater than .39 for the Pirani or greater than 5 for the Cold Cathode.

3.4.8.0.a You will check the following during this test:

- The message box text displays “Pressure out of range” and “Gate Valve cannot be opened”.
- The gate valve animation display doesn’t move or change color, the limit switch text doesn’t change and no arrow appears.
- Verify the open LED and the close LED don’t light up.

3.4.8.0.b Set the one of the gauge pair interlocks to “Bad” (red), press the

	PASS	FAIL	COMMENTS

OPEN button on the GV main screen.

3.4.8.0.c Return the gauge pair interlocks to “Good” (green).

3.4.8.0.d Press the CLOSE button.

3.4.9. Test GVE Open, GVE Faulted **(Electric Gate Valve only)**.

To set the GVE Fault to “Fault”, flip the switch on the test jig for the GVE Fault.

3.4.9.0.a You will check the following during this test:

- The message box text displays “Gate Valve Drive Failure” and “Gate Valve cannot be opened”.
- The gate valve animation display doesn’t change.
- The limit switch text doesn’t change and no arrow appears.
- Verify the open and close LEDs don’t light up.

3.4.9.0.b Set the Valve Fault Indicator to “Fault” (red), press the OPEN button on the GV main screen.

3.4.9.0.c Return the Valve Fault Indicator to “Normal” (green).

3.4.10. Test GVE Open, Annulus Ion Pump Interlock Faulted.

3.4.10.0.a You will check the following during this test:

- The message box text displays “Ion Pump below normal operation range” and “Gate Valve cannot be opened”.
- That the gate valve animation display does not change, the limit switch text does not change and no arrow appears.
- Verify the open and close LEDs don’t turn on.

3.4.10.0.b Set the voltage for the Annulus Ion Pump to -1.0, press the OPEN button on the GV main screen.

3.4.11. Test GVE Open, all permissives “Bad”.

3.4.11.0.a You will check the following during this test:

- The message box text displays “Gate Valve Drive Failure”, “Pressure out of range”, “Hardware Lockout is in place”, “Pump below normal operation range”, and “Gate Valve cannot be opened”.
- That the gate valve animation display does not move or change color, the limit switch text does not change and no arrow appears.
- Verify the open andclose LEDs don’t light up.

3.4.11.0.b Set all permissives to “Bad” (red), press the OPEN button on the GV main screen.

	PASS	FAIL	COMMENTS

3.4.11.0.c Return all permissives back to “Good” (green).

3.5. Test GVE Close

All Gate Valve Close tests assume an initial Open position. These tests require the GV test jig be connected and power sources connected to the PSI connectors for the Annulus Ion Pump.

For testing, the output signal delays have been set to 5 seconds rather than the 1 second of normal operation.

(QT) 3.5.1. Test GVE Close, all permissives “Good”

To set the permissives to “good”: flip the switch on the GVE Test Jig for the GVE Fault to “Good”, run the gauge pairs in simulation mode and inject 1.0 volts into the PSI connector for the Annulus Ion Pump.

You will need a stopwatch for this test.

3.5.1.0.a You will check the following during this test:

- Verify the close LED on the test jig stays on for 5 seconds following shorting the close limit switch connector then turns off.
- The gate valve animation display shows the animated gate valve changing color from green to yellow to red and moving from the top eight blocks to the middle eight blocks to the bottom eight blocks.
- The limit switch text on the right side of the gate valve animation display changes from OPEN to Not Open and Not Closed to CLOSED.
- An arrow pointing down appears on the top left side of the gate valve animation display.
- The message box displays the text “Please wait, gate valve is closing.” followed by “Gate close limit reached”.
- The arrow pointing down disappears after the close limit is reached.

3.5.1.0.b Press the CLOSE button on the GV main screen. When the close LED on the GV Test Jig lights up, move the test jig lever from the open limit switch connector to the close limit switch connector.

3.5.1.0.c Return the gate valve to open.

3.5.2. Test GVE Close, stop during closing.

3.5.2.0.a You will check the following during this test:

- The message box text displays “Stop Request Received” followed by “Gate Close is Stopping.”
- The animation stops in the middle and is still yellow.
- The limit switch text displays “Not Closed” and “Not Open”.
- The Valve Close LED turns off.

	PASS	FAIL	COMMENTS

- The arrow pointing down disappears.

3.5.2.0.b Press the CLOSE button on the GV main screen. When the "Please wait, gate is closing." message appears in the message box, press the STOP button. When the close LED lights up move the test jig lever from the open limit switch connector and leave it up in the center between the open and close limit switches.

3.5.2.0.c Return the gate valve to open.

3.5.3. Test GVE Close, opening during closing

3.5.3.0.a You will check the following during this test:

- The gate valve animation display stops in the middle and stays yellow, then transitions to the top and turns green.
- The "Open Request Received" message appears in the message box followed by "Close gate is stopped", "Please wait, Gate Valve is Opening", and "Open limit reached".
- First an arrow pointing down appears on the top left side of the animation display and then switches to an arrow pointing up.
- The limit switch text on the right of the animation display changes from "Not Open" and "Not Closed" to "Not Closed" and "OPEN".
- Verify the close LED was on prior to the open command, then turned off following the open command and the open LED turns on.

3.5.3.0.b Press the CLOSE button and when the "Please wait, gate closing." message appears in the message box, press the OPEN button. When the close LED lights up, move the test jig lever from the open limit switch connector and leave it up in the center between the open and close limit switches. When the open LED turns on, move the test jig lever to the open limit switch.

3.5.3.0.c Press the CLOSE button again.

3.5.4. Test GVE Close, Closing an already closed GVE.

To start this test, ensure the gate valve is closed and the test jig lever is on the close limit switch.

3.5.4.0.a You will check the following during this test:

- The gate valve doesn't move or change color and the message box text displays "Gate Valve already closed".
- Verify both the open and close LEDs remain off.

3.5.4.0.b Press the CLOSE button on the GV main screen.

3.5.4.0.c Press the OPEN button.

3.5.5. Test GVE Close, Timeout of closing GVE.

You will need a stopwatch for this test.

	PASS	FAIL	COMMENTS

3.5.5.0.a You will check the following during this test:

- Verify the close LED stays on for 12 seconds then turns off when the gate valve times out.
- Verify the gate valve animation stays in the middle and is yellow.
- Verify the status text messages are “Gate Valve close process has timed out.” followed by “Close Gate is Stopped.” and then “Gate Valve Limit Switches not engaged.”

3.5.5.0.b Press the CLOSE button on the GV main screen. When the close LED lights up, remove the test jig lever from the open limit switch connector and leave it up in the center between the open and close limit switches.

3.5.5.0.c Return the gate valve to open.

3.5.6. Test GVE Close, Close limit switch “Bounce”

3.5.6.0.a You will check the following during this test:

- The gate valve animation display jumps to the middle and turns yellow.
- The limit switch text on the right of the animation display changes from “CLOSED” and “Not Open” to “Not Open” and “Not Closed”.
- The message box flashes the text “Gate Valve Limit Switches not engaged.”.

3.5.6.0.b Press the CLOSE button on the GV main screen. When the close LED turns on, move the test jig lever from the open limit switch connector to the close limit switch then “bounce” the lever by removing the test jig lever from the close limit switch.

3.5.6.0.c Return the test jig lever to the close limit switch connector.

3.5.6.0.d Return the gate valve to open.

3.5.7. Test GVE Close, Gauge Pair Interlock faulted.

Set the gauge pair interlock to “Bad” by entering a voltage on the gauge pair simulation screens greater than .39 for the Pirani or greater than 5 for the Cold Cathode.

3.5.7.0.a You will check the following during this test:

- Verify the close LED turns on.
- Ensure the gate valve animation display transitions to the CLOSE position.

3.5.7.0.b Set one of the gauge pair interlocks to “Bad” (red), press the CLOSE button on the GV main screen. When the close LED lights up, move the test jig lever to the close limit switch.

3.5.7.0.c Return the gauge pair interlock to “Good” and press the Open button.

3.5.8. Test GVE Close, GVE Faulted **(Electric gate valve only)**.

	PASS	FAIL	COMMENTS

To set the GVE Fault to "Fault", flip the switch on the test jig for the GVE Fault.

3.5.8.0.a You will check the following during this test:

- The message box text displays "Gate Valve Drive Failure" and "Gate Valve cannot be closed".
- The gate valve animation display doesn't change.
- The limit switch text doesn't change and no arrow appears.
- Verify the open and close LEDs don't light up.

3.5.8.0.b Set the Valve Fault Indicator to "Fault" (red), press the CLOSE button on the GV main screen.

3.5.8.0.c Return the Valve Fault Indicator to "Normal" (green).

3.5.9. Test GVE Close, Annulus Ion Pump Interlock Faulted.

3.5.9.0.a You will check the following during this test:

- Verify the close LED turns on.
- Ensure the gate valve animation display transitions to the CLOSE position.

3.5.9.0.b Set the voltage for the Annulus Ion Pump to -1.0, press the CLOSE button on the GV main screen. When the close LED lights up, move the test jig lever to the close limit switch.

3.5.9.0.c Return the gate valve to open.

3.5.10. Test GVE Close, all permissives "Bad".

3.5.10.0.a You will check the following during this test:

- The message box text displays "Gate Valve Drive Failure" and "Gate Valve cannot be closed".
- That the gate valve animation display does not move or change color, the limit switch text does not change and no arrow appears.
- Verify the open and close LEDs don't light up.

3.5.10.0.b Set all permissives to "Bad" (red), press the CLOSE button on the GV main screen.

3.5.10.0.c Return all permissives back to "Good" (green).

3.6. Test GVE Stop

3.6.1. Test GVE Stop, Stop an already Stopped GVE.

Ensure all permissives are in their "Good" state.

3.6.1.0.a You will check the following during this test:

	PASS	FAIL	COMMENTS
• That the gate valve animation display stays in the middle and is yellow. • The “Gate is already stopped” message appears in the message box. • Neither the open or close LED lights up. 3.6.2. Press the CLOSE button. When the close LED lights up, remove the test jig lever from the open limit switch, but don’t short the close limit switch. Press the STOP button. When the close LED turns off, then press the STOP button again.			

	PASS	FAIL	COMMENTS

4 Testing fully connected to PSI

To Be Determined.

Table 1: PSI Signal Matrix for Hanford Electric Gate Valves.

Location	ID	INPUT								OUTPUT			
		Annulus Ion Pump Current		GVE Fault		Close Limit		Open Limit		Open Voltage		Close Voltage	
		+	-	+	-	+	-	+	-	+	-	+	-
LVEA Y	GVE3	001	002	141	142	143	144	145	146	180	182	183	185
	GVE1	199	200	135	136	137	138	139	140	174	176	177	179
LVEA X	GVE2	199	200	131	132	133	134	135	136	171	173	174	176
	GVE4	004	005	137	138	139	140	141	142	177	179	180	182
Left Mid Station	GVE9	001	002	169	170	171	172	173	174	215	217	218	220
	GVE10	007	008	175	176	177	178	179	180	221	223	224	226
	GVE11	010	011	181	182	183	184	185	186	227	229	230	232
	GVE12	013	014	187	188	189	190	191	192	233	235	236	238
Right Mid Station	GVE13	001	002	169	170	171	172	173	174	215	217	218	220
	GVE14	007	008	175	176	177	178	179	180	221	223	224	226
	GVE15	010	011	181	182	183	184	185	186	227	229	230	232
	GVE16	013	014	187	188	189	190	191	192	233	235	236	238
Left End Station	GVE17	001	002	109	110	111	112	113	114	133	135	136	138
	GVE18	007	008	115	116	117	118	119	120	139	141	142	144
Right End Station	GVE19	001	002	109	110	111	112	113	114	133	135	136	138
	GVE20	007	008	115	116	117	118	119	120	139	141	142	144

Table 2: Signal Data Matrix for Hanford Electric Gate Valves

Signal	Type	Input Value Limits					Engineering Value Limits.				Alarm Limits				
		OFF/ Invalid	Low/ OFF	High/ ON	Tolerance	Units	Low OFF	HighON	Units	Tolerance	Src	LO-LO/ ZSV	LOW/ ZSV	HIGH\ OSV	HIHI/ OSV
AIP Voltage	ai	<0.0	0	10		Volts	0.0	10	mA	+/- 0.3	Eng		.001	10	
AIP Vacuum	sub	< 0.0, >3.0	0.0	3.0	+/- 0.3	mA	1.0e-10	1.0e-4	Torr	N/A	Val		.001	10	
AIP Interlock	calc						FALSE	TRUE							
Fault	bi						TRUE	FALSE			Eng	YES			
Open Limit	bi						FALSE	TRUE							
Close Limit	bi						FALSE	TRUE							
VME Inter-lock	bi						TRUE	FALSE							
Gauge Pair Interlock	bi						TRUE	FALSE							
Open Cmd	bo						FALSE	TRUE							
Close Cmd	bo						FALSE	TRUE							

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.**