XH5D/XH5D-HE
USER’S MANUAL

SELF-CONTAINED, DUAL PUMP
WELLHEAD CONTROL PANEL
GENERAL
The XH5D self-contained system is a device designed and built for protecting oil and gas production wells. It includes a switch-gage to detect high and low pressures as well as hydraulic interface for fire detection and manual ESD.

The XH5D is self-sufficient and doesn’t need external sources of energy or supply pressure for keeping a wellhead open and protected. It uses hydraulic fluid for driving the surface and subsurface valves and it has two separate hand pumps and dump valves for independent control of the SSV and SCSSV.

The detection of High and Low pressures is done by a switch-gage with adjustable contacts for detecting when the monitored pressure is out of acceptable limits. The switch-gage connects to an electronic module that indicates High and Low pressure conditions as well as initiates the shutdown when a pressure alarm is detected. The electronic circuits are fed by a battery module capable of keeping the system operating for five (5) years.

The XH5D is built to operate exposed to the elements as all hydraulic components are enclosed in a stainless steel box while the electronic circuits and battery module are enclosed in a separate compartment inside the stainless steel box. The front of the panel includes the gages and controls as shown in Fig.1 while the inside components are shown in Fig. 2. The –HE version also includes additional sealing and a chemical seal to protect the sensing gauge from process fluids.

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**Fig. 1 XH5 Interface & Controls**

- **“Reset” – “Test” Switch**
- **LED Indicators:**
  - High Press. Alarm
  - Low Press. Alarm
  - Low Battery Alarm
  - Auxiliary Alarm
  - Telemetry Stdn
  - “Heart Beat” (System OK)
- **Hydraulic Pump SCSSV**
- **Hydraulic Pump “SSV – Pilot”**
- **Flow Pressure w/ High and Low Pressure Alarm**
- **“Pilot” Pressure**
- **SSV Actuator Pressure.**
- **SCSSSV Pressure**
- **“SSV – Pilot” Pumping Selector Valve**
- **“In Service – ESD” Selector Valve (Manual Shutdown)**
Fig. 2 – XH5D-HE Enclosure’s Interior

INSTALLATION – PRELIMINARY STEPS AND TESTS
The XH5D is typically sent with the battery module mounted backwards or in a separate package for preventing the system from operating while in transit. Also, as needed for meeting shipping regulations, the device is typically shipped without hydraulic fluid in the reservoir and without Nitrogen pre-charge in the SSV hydraulic piston accumulator. (The pilot pressure accumulator uses only 60 psi of Nitrogen pre-charge and considered safe for air transport.)

Before installing, the system is to be inspected to confirm that there is no external damage or indication of rough handling during shipment.

In case of overseas shipments it is recommended that the XH5D-HE is tested in a work shop near the final destination to facilitate the commissioning and allow the operators to become familiar with the unit.

NOTE
It is recommended that the operator becomes familiar with the Hydraulic Schematic (Appendix “B”) and have a copy handy during the tests described below to better understand the system’s behavior.
To commission the system follow with the steps listed below:

i. Pre-charge 16 CU IN piston accumulator with about 1,000 psi of Nitrogen

ii. Confirm the pre-charge of about with 60 psi of Nitrogen on the 20 CU IN diaphragm accumulator.

iii. Add hydraulic fluid to the reservoir. Filling is to exceed over 75% full using the high level mark on the level indicator as 100% reference. (In factory the units are tested with “Megaflow”™ AW Hydraulic Oil 32, however, any quality hydraulic fluid with an AW32 viscosity will operate well.)

iv. Open Electronic Compartment inside the stainless steel box and install battery module as shown in Appendix “A”. By doing this the electronic circuit becomes energized and the green LED blinks every second (Heartbeat) to indicate the electronic circuit is operating without problem.

v. Before pressurizing the hydraulic circuits is recommended that hydraulic fluid is circulated throughout the system to flush any particle and contaminants that could be present within the hydraulic lines. With this purpose proceed as follows:

   a) Set valve “In Service – ESD” to “ESD”.
   b) Set valve “SSV - Pilot” to “Pilot”
   c) Pump “Pilot/ SSV” (right side pump) in a fast mode for approximately one minute while observing the “Pilot” pressure gauge (right side of the panel). This gauge should display “0” psi but the needle oscillates with each pump strike.
   d) Set valve “SSV – Pilot” to “SSV”
   e) Again, pump “Pilot/ SSV” (right side pump) in a fast mode for approximately one minute while observing the “SSV” pressure gauge (center of the panel). This gauge should stay in “0” psi
   f) Pump “SCSSV” (left side pump) in a fast mode for approximately one minute while observing the “SCSSV” pressure gauge (left side of the panel). This gauge should stay in “0” psi.

vi. Confirm that the plugs on the bulkhead connectors are tight before proceeding with the following steps.

vii. Set valve “In Service – ESD” to “In Service”.

viii. Set valve “SSV - Pilot” to “Pilot”

ix. Press “Reset” on switch “Test – Reset”.

x. Pump “Pilot/ SSV” (right side pump) while observing the “Pilot” pressure gauge. Pump until reaching 100 psi. Inspect hydraulic lines to confirm that there is no leakage.

xi. Pump “SCSSV” pump (left side pump) while observing the “SCSSV” pressure gauge. Pump until reaching about 10,000 psi. Inspect hydraulic lines to confirm that there is no leakage. As this test is being done with the SCSSV output blocked the pressure will rise quickly and the pressure will decrease in about 20 to 30% in a few seconds after the pumping stops. However, after the initial pressure decrease the pressure should remain stable except for the effects of temperature changes.

xii. Set valve “SSV - Pilot” into “SSV”

xiii. Pump “SSV - Pilot” pump (right side pump) while observing the “SSV” pressure gauge. Pump until reaching 3,000 psi. Inspect hydraulic lines to confirm that
there is no leakage. It is normal for the pressure to fall about 15% after finishing
the pumping.

xiv. Set valve “In Service – ESD” to “ESD” to return all pressures to zero before
moving the XH5D to the field for installation.

FIELD INSTALLATION

Typically the XH5D is mounted on one or two poles made of 3” pipe. Using two poles is
preferred as it would insure safe mounting even if one of the pipe brackets used for fastening the
panel to the poles would fail. The two poles should have a separation of 10” to 15” (25cm to
38cm) center to center. The pipe brackets connect to the strut channel mounted on the left side
of the panel.

Fig. 3 – XH5D Mounting

With the panel firmly mounted, proceed to connect the field devices as shown on Fig. 4.
The connection to the ESD station (Connection No. 4) can be also connected to a fire plug (Included). If the fire plug used does not have a return line, some means are to be used to prevent hydraulic fluid from reaching the ground. A small amount of hydraulic fluid (approximately 10 CU IN or 164 CC) will be released in the event of a fire.

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**Fig. 4 – Rear view, hydraulic lines connections.**

<table>
<thead>
<tr>
<th>Connection No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Flow-line Sensing Pressure (3/8” Tubing)</td>
</tr>
<tr>
<td>2</td>
<td>Hydraulic pressure to SSV (3/8” Tubing)</td>
</tr>
<tr>
<td>3</td>
<td>Hydraulic pressure to SCSSV (1/4” Tubing)</td>
</tr>
<tr>
<td>4</td>
<td>Hydraulic pressure to Manual ESD/Fire Sensor (1/4” Tubing)</td>
</tr>
<tr>
<td>5</td>
<td>Hydraulic return from Manual ESD (3/8” Tubing)</td>
</tr>
</tbody>
</table>
OPERATION AND ADJUSTMENTS

The operation of the installed panel is as follows:

Starting Production:

1- Set valve “In Service – ESD” to “In Service”
2- Set valve “SSV - Pilot” to “Pilot”.
3- Press “Reset” on switch “Test – Reset”.
4- Pump “Pilot/ SSV” (right side pump) while observing the “Pilot” pressure gauge until reaching 90 to 100 psi.
5- Pump “SCSSV” (left side pump) while observing the “SCSSV” pressure gauge. Pump until reaching the pressure necessary to open SCSSV. Do not exceed 12,000 psi.
6- Set valve “SSV - Pilot” into “SSV”.
7- Pump “SSV - Pilot” pump (right side pump) while observing the “SSV” pressure gauge. Pump until SSV is fully opened plus about 500 psi but no less than 1,500 psi. Do not exceed actuator’s pressure rating. It is normal for the pressure to fall about 10% after finishing the pumping.
8- Check all hydraulic connections (internal and external to the panel) to confirm that there is no leakage.
9- Adjust High and Low Alarm set point on switch-gage.

Closing SSV:

10- Move High or Low Alarm Set-Point until it touches the gage’s needle. The system responds closing the SSV. The corresponding LED (High or Low Pressure Alarm) blinks and the green LED stops blinking. There is no change on pilot pressure but the SSV pressure goes to zero.

Re-opening the SSV:

11- Press “Reset”. The Alarm LED stops blinking while the green LED (Heartbeat) blinks for a few seconds and then returns to one flash per second. The pilot pressure goes down a couple of psi.
12- Pump “Pilot/ SSV” (right side pump) while observing the “Pilot” pressure gauge until reaching 100 psi.
13- Set valve “SSV - Pilot” into “SSV”.
14- Pump “SSV - Pilot” pump (right side pump) while observing the “SSV” pressure gauge. Pump until reaching 1,500 psi. It is normal for the pressure to fall about 10% after finishing the pumping. Do not exceed 3,000 psi.

Initiating ESD (Clothing of the SSV and then SCSSV):

15- Set valve “In Service – ESD” to “ESD”.

Shutdown Delay adjustment for SCSSV:

16- The SCSSV closes only in case of manual ESD and/or by the activation of the fusible plug.
17- When an ESD is initiated, the “Pilot Pressure” and “SSV Pressure” shown on the front of the panel go to zero psi in the first one or two seconds. Then after some time delay, the SCSSV pressure slowly goes down to zero.
18- The time lapsing between the activation of the manual ESD can be adjusted by adjusting the “Flow Control Valve” (shown on Fig.2, page 3 of this manual).
19- Turn knob of “Flow Control Valve” a fraction of a turn in the direction of the clock pointers to increase time delay and in the opposite direction to reduce it.

20- For initial setting close the “Flow Control Valve” by turning knob clockwise all the way and then turning it back four turns.

Re-opening the well after ESD:

21- Repeat steps 1 through 9 of this list. **When re-opening the well after ESD, it is critical the pumping is done in the correct order of PILOT – SCSSV – SSV. The SCSSV is to be always opened before the SSV**

Adjusting High and Low Pressure Alarms:

22- Turn red knob to adjust High pressure Alarm to the desired High Pressure Alarm. Repeat the same with the black knob to set the Low Pressure Alarm.

HYDRAULIC CIRCUITS

The hydraulic circuits are shown on appendix “B”.

ELECTRONIC SYSTEM

By replacing most of the hydraulic logic with electronic circuits, the most failure prone components are removed and the hydraulic circuit greatly simplified to a few reliable components. In this way, by having self-diagnostic in the electronics and a simplified hydraulic system, the XH5D-HE offers a reliability level not seen on any of the typical self-contained wellhead control panel. Furthermore, if a failure would occur, the diagnostic and correction of the problem is much simpler because of the simplicity of the hydraulics.
When operating under normal conditions (no alarms) the electronic system flashes the green LED every second (heartbeat) to indicate that the electronic system is “alive” operating without problems.

If any alarm is detected the green LED stops flashing and the solenoid valve is tripped to initiate shutdown of the SSV only. The red LED corresponding to the detected alarm starts flashing and it is latched in such way that even if the alarm condition would go away or a new alarm would be detected; the first detected alarm only will flash, holding the information for the operator to see the actual cause of the shutdown. For example, if a High Pressure Alarm would occur, the corresponding High Pressure Alarm LED will flash and keep on flashing even if the high pressure alarm goes away and now the needle is touching the Low Pressure contact. The first detected alarm will keep displaying until the operator presses “Reset”.

A total shutdown or “ESD” (closing of the SSV and SCSSV) would be executed only in the case of Fire Alarm (fuseable plug) and/or Manual Shutdown. The Manual ESD and Fire alarms are executed bypassing the electronics to maximize reliability.

Once the operator presses “Reset” while the alarm still present, the system resets the solenoid valve to allow the re-opening of the well and alternatively flashes the green LED and corresponding alarm red LED, if the alarm still present. The system tolerates the existing alarm for 30 minutes before re-initiating the shutdown and prevents the system from being left in

Fig. 4 – External Alarm Termination Box
production while operating in an abnormal condition. Once the pressure alarm clears, only the green LED remain flashing.

The “Test” function allows the operator to see the last alarm and also confirm that all the indicator LEDs are working properly. This is, when pressing “Test”, the system respond by flashing the last detected alarm for about two seconds and then flashes the red LEDs in sequence.

The Telemetry and Auxiliary alarm signals are monitored by the XH5D-HE which is continually verifying that the End Of Line Zeners (EOL) are connected. If the EOL is no longer connected, either in the junction box itself or at the end of the cable connecting it to the external alarm, then the XH5D-HE initiates shutdown and the corresponding LED shows a double blink to indicate the alarm was caused by a wiring failure and not by an actual alarm. See Appendix “C” for field wiring detail.

The battery module provides two separate voltages, 3.6 VDC to feed the microcontroller circuits and 14.4 VDC to operate the solenoid valve. Both voltages are periodically monitored to confirm the system has the proper battery supply to operate reliably.

If the system detects a low voltage, the green LED and the “Low Battery” red LED alternates flashing but the system remains in operation. However, if a voltage falls too far down to insure reliable operation, a shutdown is executed and only the “Low Battery” red LED flashes.

Given the low power consumption of the system it is expected that the operator will be able to detect the warning signs of low battery and should be able to replace the battery module before it gets to the point where the system causes shutdown because low battery.

The battery module is to be replaced as soon as the system shows signs of low voltage to insure the system continues operating reliably. The battery module has an expected life of five years.

WARNING!

Do not attempt to recharge the batteries on the battery module as this may cause an instable condition that may result in a violent explosion.

Return the spent battery modules to Axiom Technologies or to any lithium battery recycling facility.

See the instructions shown on Appendix “A” for replacing the battery module.
WIRING INTEGRITY
Given the safety requirements associated with the XH5, enhanced self-diagnostics have been added to insure the integrity of the system and the reliability of the operation.

To this effect, the XH5 monitors the wiring integrity of all alarms circuits including the High/Low Pressure alarm gauge and the loop integrity to the remote alarms located external to the XH5 enclosure.

As shown on Fig. 4, the XH5 is shipped with the End of Line Zener connected at the external alarms input points. When connecting the XH5 to an external alarm device, the End of Line Zener is to be removed from the Operator Interface Module and connected in parallel with the external alarm device.

Please note that, when connecting the End of Line Zener, polarity is important for proper operation. If the End of Line Zener is connected backwards it will cause the corresponding alarm channel to go into and remain on alarm condition.

If the End of Line Zener is disconnected or the wiring to the external alarm signal would fail, then the XH5 will read a “wiring failure” where the corresponding alarm LED would double flash and XH5 shutdown is initiated.

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**CAUTION!**

*TO REDUCE THE RISK OF IGNITION OF HAZARDOUS ATMOSPHERES:*

Do not open this enclosure unless the area is known free of ignitable mixture of gases.

Keep tightly closed when in operation.

Battery Module is to be replaced only with Axiom Part No. AT00000001 (Former AT-LBP-36144) battery module
XH5 - ENVIRONMENTAL SPECIFICATIONS
Temperature range : -40 to +85°C
Humidity range : 0 To 95% max., non-condensing
Altitude : 2,000 m. max.
Hazardous Area Classification : Suitable for Class I, Division 2, Groups C & D, Hazardous Locations.
Temp. Code T3C

XH5D - PRESSURE RATINGS
Sensing Pressure : Ranges of up to 20,000 psi max
Solenoid Valve Pressure : 100 psi max. (standard)

XH5D - ELECTRICAL RATINGS
Electrical Source : Dual voltage lithium battery module3.6 & 14.4 VDC
Current consumption : 20 mA max. on 3.6VDC Circuits
0.5 mA (3 A max. pulse) on 14.4VDC Circuits

THIS APPARATUS IS SUITABLE FOR USE IN A CLASS 1, DIVISION 2, GROUP C, D OR UNCLASSIFIED LOCATIONS
Confirm the area is free of ignitable mixture of gases and remove cover of electronic compartment.

Align battery module with the four mounting bolts and insert pushing gently. Confirm the battery module is positioned with the resistors to the left as shown in the picture. Tighten spacers by hand only.

Appendix A - Battery Module Installation
Appendix "C" - XH5D Installation Notes

1- The XH5 operates with normally open contact and contact closure indicates that an alarm is present.

2- For supervising field wiring, each input channel is provided with a 7.5V "End Of line Zener" (EOZ) at the XH5's input terminals. At the time of installation, the EOZ is to be connected to the end of the loop and connected in parallel with the alarm switch. If more than one switch are daisy-chained, then the EOZ is to be installed at the very last switch. The EOZ at the end of the alarm wiring allows the XP7 to confirm the wiring's integrity.

3- The EOZ must be connected in the correct polarity, Blue wire to "Signal" and White wire to "Common". Connecting the EOZ on a reverse polarity will cause the corresponding channel to stay on alarm.

4- The alarm switch may be located at 3,000 FT or more from the XH5

5- Each input sends a pulse of 14VDC to the alarm switch. If the EOZ is connected (as it should), then the voltage is cut down to 7.4VDC (+/- 0.3VDC) and the XH5 accepts this voltage as a normal condition. If the EOZ would be missing or the wiring to the alarm switch disconnected, then the voltage may rise up to about 14VDC which is considered a "Wiring Failure" and cause shutdown.

6- Multiple XH5s may share a single alarm switch such as a tank level, ESD station or any "dry contact" alarm switch.

WARNING - ELECTRICAL INSTALLATION REQUIREMENTS

1- This apparatus is suitable for use in a Class 1, Division 2, Groups C & D or unclassified locations.

2- Electrical parameters to permit selection of apparatus for interconnection:
   - Vmax = 16.8 Volts DC
   - Imax = 20mA on 3.6Volts DC Circuits
   - La = 100.0 mH (maximum value of inductance that can be connected to the apparatus intrinisically safe input circuit.)
   - Ca = 12.6 uF (maximum value of capacitance that can be connected to the apparatus intrinisically safe input circuit.)

3- Use the following formulas to calculate the allowed capacitance (Ca') and inductance values (La') for field wiring used in the non-incendive field wiring circuit (Belden 8451 use for Example*):
   - Note: symbol " < " means less than (3 < 7)
   - Ca' = C pF/ft X length of wiring loop (ft) < Ca
   - Example*: Ca' = 33.45 pF/ft X 800 ft = 0.0268 uF < 12.6 uF
   - La' = L uH/ft X length of wiring loop (ft) < La
   - Example*: La' = 0.17uH/ft X 800 ft = 136.0 uH < 100.0 mH

4- The associated non-incendive field wiring apparatus shall not be connected in parallel unless this is permitted by the associated non-incendive field wiring apparatus approval.

5- This apparatus is approved for connection to simple apparatus, two wire applications such as "dry" contacts, transistor open collector that would "pull signal to ground", etc. Polarity requirements: TB2-1 and TB2-2 are positive voltage (3.6 VDC); TB2-3 and TB2-4 are return or ground connection.

Axiom Technologies

XH5D Wiring Diagram

Monitored inputs for Safety Shutdown System