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| **طرح نگهداشت و افزایش تولید 27 مخزن** |
| **CONTROL PHILOSOPHY****نگهداشت و افزایش تولید میدان نفتی بینک** |
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**REVISION RECORD SHEET**

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1. **INTRODUCTION**

Binak oilfield in Bushehr province is a part of the southern oilfields of Iran, is located 20 km northwest of Genaveh city.

With the aim of increasing production of oil from Binak oilfield, an EPC/EPD Project has been defined by NIOC/NISOC and awarded to Petro Iran Development Company (PEDCO). Also, PEDCO (as General Contractor) has assigned the EPC-packages of the Project to "Hirgan Energy - Design and Inspection" JV.

As a part of the Project, a New Gas Compressor Station (adjacent to existing Binak GCS) shall be constructed to gather of 15 MMSCFD (approx.) associated gases and compress & transfer them to Siahmakan GIS.

1. **GENERAL DEFINITION**

The following terms shall be used in this document.

|  |  |
| --- | --- |
| CLIENT:  | National Iranian South Oilfields Company (NISOC)  |
| PROJECT: | Binak Oilfield Development – General Facilities |
| EPD/EPC CONTRACTOR (GC): | Petro Iran Development Company (PEDCO) |
| OWNER:  | OWNER is collectively referring to National Iranian South Oil Company (NISOC) and Petro Iran Development Company (PEDCO) |
| EPC CONTRACTOR: | Joint Venture of: Hirgan Energy – Design & Inspection (D&I) Companies |
| VENDOR: | HAVAYAR Company |
| EXECUTOR:  | Executor is the party which carries out all or part of construction and/or commissioning for the project. |
| THIRD PARTY INSPECTOR (TPI): | The firm appointed by EPD/EPC CONTRACTOR (GC) and approved by CLIENT (in writing) for the inspection of goods. |
| SHALL: | Is used where a provision is mandatory. |
| SHOULD: | Is used where a provision is advisory only. |
| WILL:  | Is normally used in connection with the action by Client rather than by an EPC/EPD Contractor, supplier or Vendor. |
| MAY:  | Is used where a provision is completely discretionary. |

1. **ABBREVIATIONS AND ACRONYMS**

PLC Programmable Logic Controller

UCP Unit Control Panel

P&ID Piping and Instrumentation Diagram

DCS Distributed Control System

LCP Local Control Panel

HMI Human Machine Interface

AOP Auxiliary Oil Pump

1. **PURPOSE OF THIS DOCUMENT**
* The present document outlines the Operating and Control Philosophy (Logics and Sequences) of Hydrocarbon Reciprocating Compressor in the “BINAK Oil Field”.
* The purpose of this document is to describe the start/stop, shutdown and operational sequences in normal and emergency conditions of Hydrocarbon Reciprocating Compressor (C-2101/02 A/B/C).
1. **REFERENCE DOCUMENTS**
* This document has to be read with the latest revision of the following documents:
* Piping & Instruments Diagrams (BK-GCS-HY-120-PR-PI-0001)
* I/O List (BK-GCS-HY-120-IN-LI-0005)
* Cause & Effect Charts List (BK-GCS-HY-120-IN-LI-0001)
1. **BACKGROUND PROCESS INFORMATION**

The project has three trains of compressor with the arrangement of 2+1. The process gas with the pressure and temperature of 4.9 barg and 36.8 °C comes out from Compressor Suction Drums V-2101 A/B/C after collecting any likely entrained liquid droplet and prevent them entering the compressors.

The pressure of process gas is then increased to 18 barg in the first stage of compressor cylinder (C-2101-C1 A/B/C). The hot pressurized gas enters to interstage coolers AE-2101 A/B/C to be cooled from 129 °C to 60 °C. Afterwards, the cooled gas enters to interstage K.O. Drums V-2102 A/B/C to separate condensates. Then the gas enters to second stage of compressor cylinder C-2102-C2 A/B/C and the pressure reaches to 54.8 barg. The pressurized gas cooled down from 148 to 60 °C through after coolers AE-2102 A/B/C and then the probable condensate is separated by discharge K.O. Drum V-2103.

1. **CONTROL COMPONENTS**

**7.1 Unit Control Panel (UCP):**

The Unit Control Panel (UCP) with PLC-based control system provided by compressor Vendor is used for the operation of the compressor package.

The primary control device for the compressor train in this system is a PLC configured for Control Logic Sequencing, and Alarm/Shutdown Protection. Shut down relay base system has been considered in UCP panel as per configuration document.

The PLC is designed to provide for Condition Monitoring, Start/Stop Sequencing, Loading & Unloading, Alarm monitoring, and Shutdown protection for the Compressor trains.

The following main functions are considered as Control Functions in the UCP:

* Measurement data, Normal and Alarm Status Display
* Manual Reset for Maintenance and Restart-up after Abnormal Shut-down
* Display of Alarm and Trip Setpoints on Display Screen
* Adjustment of Alarm and Trip Setpoints on Display Screen
* Individual Start/Stop Functions of the Motors
* Permissive Start Conditions

**7.2 Display Screen (HMI):**

The display screen is an HMI mounted on UCP cabinet front door that shows following operating parameters of the compressor:

* Process Measurement Signal
* Running Status of Each Motor
* Alarm Set Points
* Trip Set Points
* Permissive Start Conditions

**7.3 Local Control Panel (LCP):**

The LCP is a machine mounted panel located on the main compressor skid consisting of the following main operating functions (Pushbuttons, Indicating Lights, Selector Switch) (The details are in P&ID).

**Pushbuttons:**

* Emergency Shut down (ESD-2230 A/B/C)
* Main Motor Start (HST-2234 A/B/C)
* Main Motor STOP (HSP-2234 A/B/C)
* Auxiliary Oil Pump Start (HST-2231 A/B/C)
* Auxiliary Oil Pump STOP (HSP-2231 A/B/C)
* Oil Heater ON (HST-2230 A/B/C)
* Oil Heater OFF (HSP-2230 A/B/C)
* Lubricator Heater ON (HST-2232 A/B/C)
* Lubricator Heater OFF (HSP-2232 A/B/C)
* Oil Cooler Motor A Start (HST-2235 A/B/C)
* Oil Cooler Motor A Stop (HSP-2235 A/B/C)
* Oil Cooler Motor B Start (HST-2242 A/B/C)
* Oil Cooler Motor B Stop (HSP-2242 A/B/C)
* Lubricator Motor Start (HST-2233 A/B/C)
* Lubricator Motor Stop (HSP-2233 A/B/C)
* Main Water Pump Motor Strat (HST-2236 A/B/C)
* Main Water Pump Motor Stop (HSP-2236 A/B/C)
* Auxiliary Water Pump Motor Start (HST-2237 A/B/C)
* Auxiliary Water Pump Motor Stop (HSP-2237 A/B/C)
* Water Heater ON (HST-2238 A/B/C)
* Water Heater OFF (HSP-2238 A/B/C)
* Water Cooler Start (HST-2239 A/B/C)
* Water Cooler Stop (HSP-2239 A/B/C)
* Barring Motor Start (HST-2240 A/B/C)
* Barring Motor Stop (HSP-2240 A/B/C)
* Reset (HSR-2243 A/B/C)
* Lamp Test (HST-2241 A/B/C)

**Indicators (Lamps):**

* Common Alarm (XF-2230 A/B/C)
* Common Shutdown (ESDL-2230 A/B/C)
* Comp. Start Permission (XSP-2230 A/B/C)
* Main Motor Running (XR-2234 A/B/C)
* Auxiliary Oil Pump Motor Running (XR-2231 A/B/C)
* Lubricator Heater Running (XR-2232 A/B/C)
* Oil Heater Running (XR-2230 A/B/C)
* Lubricator Motor Running (XR-2233 A/B/C)
* Oil Cooler Motor A Running (XR-2235 A/B/C)
* Oil Cooler Motor B Running (XR-2242 A/B/C)
* Main Water Pump Motor Running (XR-2236 A/B/C)
* Auxiliary Water Pump Motor Running (XR-2237 A/B/C)
* Water Heater Running (XR-2238 A/B/C)
* Water Cooler Running (XR-2239 A/B/C)
* Barring Motor Running (XR-2240 A/B/C)
* Main Motor Ammeter (II-2234 A/B/C)

**Key Selector Switch:**

* Comp Local/Remote (HSL/R-2241 A/B/C)
* Main Motor L-O-R (HSL/R-2234 A/B/C)
* Aux. Oil Pump L-O-R (HSL/R-2231 A/B/C)
* Aux. Water Pump L-O-R (HSL/R-2237 A/B/C)
* Main Water Pump L-O-R (HSL/R-2236 A/B/C)
* Oil Cooler Motor A L-O-R (HSL/R-2235 A/B/C)
* Oil Cooler Motor B L-O-R (HSL/R-2242 A/B/C)
* Oil Heater L-O-R (HSL/R-2230 A/B/C)
* Lubricator Heater L-O-R (HSL/R-2232 A/B/C)
* Lubricator Motor L-O-R (HSL/R-2233 A/B/C)
* Water Cooler L-O-R (HSL/R-2239 A/B/C)
* Water Heater L-O-R (HSL/R-2238 A/B/C)
* Baring Motor L-O-R (HSL/R-2240 A/B/C)
1. **MODES OF OPERATIONS**

This section describes the modes of operation of the compressors. The compressor would be intended to be operated from the UCP and Local switch board. Unit operational mode selection shall be performed by means of KEY SELECTOR SWITCH (HSL/R 2241 A/B/C) on the LCP.

**LOCAL MODE (LCP):**

The device would be operated from controls in the field such as mounted local switch board. Local mode would be for giving access to the LCP and would be the normal operating mode.

**REMOTE MODE (PLC/UCP):**

In this mode the device would be operated from the UCP. If the operation be in local mode, the control of all equipment except emergency shutdown will be inactive from UCP.

**8.1 L-O-R OPERATION MODES**

**MAIN MOTOR:**

The main motor start/stop has three operation modes L-O-R. Selection of the Operation Method shall be made before the operation.

* Local MODE:

At “Local” mode, the main motor would be start or stop by operator from LCP.

* Remote MODE:

At “Remote” mode, the main motor would be started/stopped from UCP.

* OFF MODE:

OFF Mode is default mode. If the Master Selector is in OFF mode, no kind of starting sequence can be run, because the machine is not ready to start and any kind of start command is ignored. OFF mode will be use in maintenance case.

**Oil heater:**

The oil heater has three operation modes L-O-R. Selection of the operation method shall be made before the operation.

* Local MODE:

At “local” mode, the oil heater can be started and stopped by related push buttons on LCP.

* Remote MODE:

At “Remote” mode, the oil heater would be controlled from UCP and logic. If the compressor is running, the oil heater will be ON / OFF by crank case lube oil temperature transmitter (TT-2203 A/B/C).

If the lube oil temperature is lower than the setpoint value (15 °C), the Oil Heater will be ON automatically. If the lube oil temperature is higher than the setpoint value (35 °C), the Oil Heater will be OFF automatically.

* OFF MODE:

OFF Mode is default mode prior to the compressor start-up. If the Master Selector is in OFF mode, no kind of starting sequence can be run, and any kind of start command is ignored. OFF mode will be use in maintenance case.

**AUX. OIL PUMP:**

The auxiliary oil pump has three operation modes L-O-R. Selection of the Operation Method shall be made before the operation.

* Local MODE:

At “Local” mode, operator can start & stop oil pump by related P.B located on LCP. Please note the critical interlock is active in local mode.

* Remote MODE:

At “Remote” mode, the auxiliary oil pump would be controlled by UCP and logic. If the compressor is running, the Aux. oil pump is started / stopped by lube oil pressure transmitter (PT-2204 A/B/C).

If the lube oil pressure is lower than the setpoint value (1.5 barg), the Auxiliary Oil Pump will be started automatically. If the lube oil pressure is higher than the setpoint value (5 barg), the Auxiliary Oil Pump will be stopped automatically.

* OFF MODE:

OFF Mode is default mode prior to the compressor start-up. If the Master Selector is in OFF mode, no kind of starting sequence can be run, because the machine is not ready to start and any kind of start command is ignored. OFF mode will be use in maintenance case.

**AUXILIARY WATER PUMP:**

The auxiliary water pump has three operation modes L-O-R. Selection of the Operation Method shall be made before the operation.

* Local MODE:

At “Local” mode, operator can start & stop oil pump by related P.B located on LCP. Please note the critical interlock is active in local mode.

* Remote MODE:

At “Remote” mode, the auxiliary water pump would be controlled by UCP and logic. If the compressor is running, the pump is start / stopped by cooling water pressure transmitter (PT-2220 A/B/C).

If the cooling water pressure is lower than the setpoint value (2.5 barg), the Auxiliary Water Pump will be started automatically. If the cooling water pressure is higher than the setpoint value (3 barg), the Auxiliary Water Pump will be stopped automatically.

* OFF MODE:

OFF Mode is default mode prior to the compressor start-up. If the Master Selector is in OFF mode, no kind of starting sequence can be run, because the machine is not ready to start and any kind of start command is ignored. OFF mode will be use in maintenance case.

**MAIN WATER PUMP:**

The main water pump has three operation modes L-O-R. Selection of the Operation Method shall be made before the operation.

* Local MODE:

At “Local” mode, operator can start & stop oil pump by related P.B located on LCP. Please note the critical interlock is active in local mode.

* Remote MODE:

At “Remote” mode, the main water pump would be started from UCP.

* OFF MODE:

OFF Mode is default mode prior to the compressor start-up. If the Master Selector is in OFF mode, no kind of starting sequence can be run, because the machine is not ready to start and any kind of start command is ignored. OFF mode will be use in maintenance case.

**OIL COOLER:**

The oil cooler has three operation modes L-O-R. Selection of the Operation Method shall be made before the operation.

* Local MODE:

At “Local” mode, operator can start & stop oil pump by related P.B located on LCP. Please note the critical interlock is active in local mode.

* Remote MODE:

At “Remote” mode, the oil cooler would be started from UCP.

* OFF MODE:

OFF Mode is default mode prior to the compressor start-up. If the Master Selector is in OFF mode, no kind of starting sequence can be run, because the machine is not ready to start and any kind of start command is ignored. OFF mode will be use in maintenance case.

**LUBRICATOR HEATER:**

The lubricator heater has three operation modes L-O-R. Selection of the Operation Method shall be made before the operation.

* Local MODE:

At “Local” mode, operator can start & stop oil pump by related P.B located on LCP. Please note the critical interlock is active in local mode.

* Remote MODE:

At “Remote” mode, the lubricator heater would be started from UCP.

* OFF MODE: OFF mode will be use in maintenance case.

OFF Mode is default mode prior to the compressor start-up. If the Master Selector is in OFF mode, no kind of starting sequence can be run, because the machine is not ready to start and any kind of start command is ignored.

**LUBRICATOR Motor:**

The lubricator motor has three operation modes L-O-R. Selection of the Operation Method shall be made before the operation.

* Local MODE:

At “Local” mode, operator can start & stop oil pump by related P.B located on LCP. Please note the critical interlock is active in local mode.

* Remote MODE:

At “Remote” mode, the lubricator motor would be started/stopped from UCP.

* OFF MODE: OFF mode will be use in maintenance case.

OFF Mode is default mode prior to the compressor start-up. If the Master Selector is in OFF mode, no kind of starting sequence can be run, because the machine is not ready to start and any kind of start command is ignored.

**Water Cooler:**

The water cooler has three operation modes L-O-R. Selection of the operation method shall be made before the operation.

* Local MODE:

At “Local” mode, operator can start & stop oil pump by related P.B located on LCP. Please note the critical interlock is active in local mode.

* Remote MODE:

At “Remote” mode, the water cooler would be controlled from UCP.

* OFF MODE:

OFF Mode is default mode prior to the compressor start-up. If the Master Selector is in OFF mode, no kind of starting sequence can be run, because the machine is not ready to start and any kind of start command is ignored. OFF mode will be use in maintenance case.

**WATER HEATER:**

The water heater has three operation modes L-O-R. Selection of the Operation Method shall be made before the operation.

* Local MODE:

At “Local” mode, operator can start & stop oil pump by related P.B located on LCP. Please note the critical interlock is active in local mode.

Remote MODE:

At “Remote” mode, the water heater would be controlled by UCP and logic. If the compressor is running, the water heater is start / stopped by cooling water reservoir temperature transmitter (TT-2213 A/B/C).

If the cooling water temperature is lower than the setpoint value (60 °C), the water heater will be started automatically. If the cooling water temperature is higher than the setpoint value (63 °C), the water heater will be stopped automatically.

* OFF MODE:

OFF Mode is default mode prior to the compressor start-up. If the Master Selector is in OFF mode, no kind of starting sequence can be run, because the machine is not ready to start and any kind of start command is ignored.

**BARING MOTOR:**

The baring device is used in maintenance conditions and has three operation modes L-O-R. Selection of the Operation Method shall be made before the operation.

* Local MODE:

At “Local” mode, operator can start & stop oil pump by related P.B located on LCP. Please note the critical interlock is active in local mode.

Remote MODE:

At “Remote” mode, the baring motor would be controlled from UCP.

* OFF MODE:

OFF Mode is default mode prior to the compressor start-up. If the Master Selector is in OFF mode, no kind of starting sequence can be run, because the machine is not ready to start and any kind of start command is ignored.

1. **START / STOP SEQUENCE**

**9.1 PREPARATIONS FOR START**

After completion of compressor installation, overhaul, or long stop, and before starting the compressor, the inspections and preparations should be performed based on the instruction specified in the operation manual. The crank case heater and water reservoir heater shall be checked to warm the lubrication oil and cooling water to the minimum temperatures for obtaining permission to start the compressor. As a rule, all start permissions shall be checked. In addition, the water and oil circulation routs shall be checked.

**9.2 PREHEATING & PRELUBRICATION**

A preheating phase has to be carried out for the cylinder water to prevent gas condensation during operation. This is due to the saturation condition of the process gas.

In addition, two electrical heaters are installed in the crankcase reservoir and lubricator tank. These heaters shall be energized during standstill and operating periods. Lube oil and Lubricator oil Pre-heating phase can be started from LCP or UCP’s start command.

Pre-lubrication of the cylinder lubricator is done through manual rotating of the lubricator’s handwheel. For the pre-lubrication of the lube oil system, the auxiliary oil pump shall be started. In the case that there is no trip, alarm and emergency stop, the pre-heating and pre-lubrication phase will be completed.

**9.3 START PERMISSIONS**

The compressor start can be initiated whenever all permissions to start have been satisfied. The status of each compressor start permissions will be indicated on HMI or start permission lamp on LCP (XSP-2230 A/B/C). The requirements for start permission are as follows:

Min. oil temperature (TT-2204 A/B/C) – 36 °C

Min. oil pressure (PT-2204 A/B/C) – 5 barg

Min. packing N2 pressure (PT-2210 A/B/C) – 1.2 barg

Min. distance piece N2 pressure (PT-2211 A/B/C) – 0.2 barg

Min. cooling water pressure (PT-2220 A/B/C)- 3 barg

Auxiliary oil pump start permission (TT-2203 A/B/C)- 15 °C

Min. lube oil level in crank case (LT-2200 A/B/C) – 32.25 mm

Min cooling water temperature (TT-2221 A/B/C) – 66 °C

Open status of spill-back valve

Start permission from DCS (section 9.4).

**9.4 START SEQUENCE (MAIN DRIVE)**

All conditions as described in section 9.1, 9.2 & 9.3 have to be fulfilled to initiate the start sequence. From the Selector Switch (Local / Remote) on local control panel (LCP), the mode of operation can be selected. The compressor main drive motor could be started manually by operator via Main Motor Start Pushbutton on the LCP (HST 2234 A/B/C) or from PLC (HMI) depending on the selected mode of operation in the LCP.

The sequence for start the compressor shall be done to give the start permission. Minimum oil pressure and minimum oil temperature will be reached by starting crank case oil heater and aux. oil pump. Minimum packing and distance piece N2 pressure shall be checked and be equal to the set point of PCV 2205 A/B/C and PCV 2206 A/B/C. Main water pump should be started for supplying minimum pressure of cooling water. In addition, Min lube oil level in crank case shall be checked by operator. There are some requirements that shall be checked in DCS. Before starting the compressor, a start permission request (HSS-2126 A/B/C) will be sent from UCP to DCS. If the requirements from DCS be available and there is not any alarm, a signal will be sent from DCS to UCP as start permission. This signal with start permission of UCP are essential for starting the main motor. The requirements that shall be checked in DCS for sending this signal could be explained as follows. There are two conditions for starting the compressor. One condition is normal and another is after trip of shutdown. As mentioned in related documents, normal condition of gas is the pressure of 4.9 barg (36.8 °C) and 18 barg (60 °C) for first and second stages, respectively. It should be mentioned that the compressor can be started in settle-out pressure (20 barg) after a trip or shutdown. These requirements alongside the open status of compression streams (XV-2121 A/B/C and XV-2133 A/B/C) are items that shall be checked for sending start permission signal from DCS. If there is any problem for sending this signal, it shall be resolved by checking the plant. In addition, if there is any alarm or ESD cause in plant, they must be resolved.

Afterwards, when all permission requirements are obtained, the compressor start permission lamp on LCP will be ON. In addition, running status lamps of all mentioned equipment are on LCP for checking. The lubricator heater and lubricator oil pump motor shall be started at the same time with the main compressor motor. At the time of starting the main motor, compressor will be in unload (0%) mode. The capacity steps of this compressor are 0%, 25%, 50%, 75%, and 100%. Loading procedure of compressor shall be stepwise as explained in section 9.5.

**9.5 COMPRESSOR IN OPERATION**

After the main motor has been started and a time delay of 20 seconds has been elapsed, the feedback from the MCC “main motor running” is given.

After the main motor startup is finished, the compressor is in operation and ready to be loaded.

**9.5.1 SWITCH TO LOAD MODE**

The compressor can be loaded up through capacity control in UCP. Compressor can work fully unload for 20 minutes, after 20 minutes the motor shall be off. Suction valve unloaders are fitted on both ends of the cylinders (0%-25%-50%-75%-100%; 5 Steps).

Suction valve unloaders are Pneumatic (Air-To-Load Type / Fail Safe). At the starting time, solenoid valve is de-energized, so air is unavailable on the unloader to load the compressor. After running the compressor in operation mode, the compressor can be loaded from 0% to 100% in 5 steps.

In case of 50% which change between CE and HE is possible, compressor could work maximum 7 days and interval to be done. Compressor in 25% shall not be worked more than 7 days and using spill-back is recommended (interval between head end and crank end shall not be done and just head end to be loaded) as mentioned in section 10.5.

**9.5.2 STOP AUXILIARY LUBE OIL PUMP**

After startup, the auxiliary oil pump should be at remote mode. The AOP would be controlled via UCP and logic at “Remote” mode. If the compressor is running, the pump is started / stopped by lube oil pressure transmitter (PT-2204 A/B/C). 5 barg is the set point for stop AOP.

**9.6 COMPRESSOR NORMAL STOP**

In Normal Stop Sequence the compressor is unloaded prior to stopping the Main Drive Motor. From 100% to 0% in 5 steps.

**9.6.1 NORMAL STOP SEQUENCE**

Before normal stop initiation, the compressor shall be fully unloaded, e.g., from 100% to 75%, 75% to 50%, 50% to 25%, and then from 25% to 0%. The interval time for change between each step shall not be less than 15 seconds.

Stop sequence could be initiated after the compressor is unloaded as follows:

* Manually, by the operator from the LCP with Main Motor Stop Push Button
* By Compressor Stop Push Button signal from PLC (HMI)

When the Main Drive Motor Stop command is sent, the shaft driven oil pump no longer can cover the required pressure in the lube oil system. At this condition, the Auxiliary Oil Pump (AOP) Start Command will be automatically energized to start the AOP.

The lubricator oil pump motor shall be automatically stopped after the main compressor motor is stopped. The spill-back valve (PCV-2123 A/B/C) will receive the open command to be open in compressor stop sequence. The auxiliary lube oil pump and all electrical heaters are kept in operation.

The Normal Stop Sequence is now completed. Afterward, it is possible to start the Compressor if the ‘READY TO START’ is established as described earlier in this document.

**9.7 COMPRESSOR SHUTDOWN / TRIP**

A Shutdown is an abnormal condition that requires an immediate trip of the compressor train without delay of unloading. When a Shutdown condition is detected, the following actions will be occurred:

* 1. The PLC will initiate a Shutdown and display the “Common Shutdown” message on the HMI.
	2. At the same time, the Main Drive Motor Stop signal to the Switchgear is deenergized to open the circuit breaker and stop the Motor.
	3. When the Main Drive Motor Stop command is sent, if the AOP selector switch is in Auto position, the AOP Start Command will be energized (based on the logic defined above) to start the AOP. If the switch is in Manual mode, the pump will continue to run until the operator switches the switch to the OFF position.
	4. Cylinder lubrication pump is stopped with time delay. The time will be adjusted during commissioning.
	5. The spill-back valve will open the spill-back line.
	6. The unloader valves will be open immediately.
	7. The Shutdown Sequence is now completed.
	8. The condition which caused the Shutdown should be investigated and corrective action taken as required.

The trip signals of package are as follows:

* Client ESD signal (ESD-01 A, ESD-02, ESD-02A)
* LCP Push button (ESD-2230 A/B/C)
* UCP Push button (ESD-2231 A/B/C)
* 1st stage discharge temperature High High (TS-2191 A/B/C)
* 2nd stage discharge temperature High High (TS-2194 A/B/C)
* 2nd stage discharge line pressure High High (PS-2195 A/B/C)
* Lube oil pressure Low Low (PS-2204 A/B/C)
* Cooling water line pressure Low Low (PS-2220 A/B/C)
* Compressor frame vibration High High (VT-2200 A/B/C, VT-2201 A/B/C, VT-2202 A/B/C)
* Bearing temperature High High (TT-2216 A/B/C, TT-2218 A/B/C)
* Packing temperature High High (TT-2217 A/B/C, TT-2219 A/B/C)
* Main motor bearing temperature High High (TT-2214 A/B/C, TT-2215 A/B/C)
* Cooling water temperature High High (TT-2221 A/B/C)

**9.8 Bare-Block Depressurizing**

While the compressor train is off, depressurizing sequence could be commenced. In this step, XV-2121 A/B/C and XV-2133 A/B/C are in closed position. According to shutdown sequence, spill-back valve (PV-2123 A/B/C) is in open position at this time and the pressure of whole compressor train is in settle-out pressure. BDV-2134 A/B/C and BDV-2132 A/B/C will open the stream line toward flare network. It should be mentioned that differential pressure can open or close the suction and discharge valves of cylinders. Therefore, the gas can be released through suction side of bare block to the discharge side even if the main motor of compressor is OFF. The purging of the bare-block can be used through this rout. While the gas pressure in cylinder is higher than out of cylinder, discharge valves will be open and suction valves are close. Accordingly, while the gas pressure inside the cylinder is less than out of cylinder, suction valves are open and discharge valves will be closed. In other words, the gas in discharge side of C-2101 A/B/C, AE-2101 A/B/C, V-2102 A/B/C, and suction side of C-2102 A/B/C will be released through BDV-2134 A/B/C. The gas inside the pipe of discharge side of C-2102 A/B/C and inside AE-2102 A/B/C will be released to flare network over BDV-2133 A/B/C. The spill-back line could connect the two sides of each train for equalization the pressure in whole train.

1. **COMPRESSOR CONTROL**

The purpose of the Compressor control system is to pressurize the hydrocarbon while protecting the compressor from low suction and extreme conditions in discharge of each stage.

There is the controller associated with the compressor control scheme, as follows:

First Stage Suction Pressure Transmitter –PT-2122 A/B/C (from DCS)

First Stage Suction Pressure Transmitter –PT-2121 A/B/C (from DCS)

First Stage Discharge Pressure Transmitter –PT-2125 A/B/C (from DCS)

Second Stage Suction Pressure Transmitter –PT-2131 A/B/C (from DCS)

Second Stage Discharge Pressure Transmitter –PT-21234 A/B/C (from DCS)

Second Stage Discharge Pressure Switch – PS-2133 A/B/C (from UCP)

First Stage Discharge Temperature Switch – TS-2191 A/B/C (from UCP)

First Stage Discharge Temperature Transmitter – TT-2124 A/B/C (from DCS)

Second Stage Discharge Temperature Switch – TS-2194 A/B/C (from UCP)

Second Stage Discharge Temperature Transmitter – TT-2134 A/B/C (from DCS)

Open Status of the First Stage Suction line – XV-2121 A/B/C (from DCS)

Open Status of the Second Stage Discharge line – XV-2133 A/B/C (from DCS)

The output of the PT-2121 A/B/C (from DCS) is sent to spill-back valve PCV-2123 A/B/C. Spill back will be controlled by UCP. The purpose of the suction pressure controller, PT-2121 A/B/C, is to protect the compressor from abnormally low suction pressure. For a low suction pressure condition, the suction pressure controller will open the spillback valve to maintain the compressor suction pressure. The set point of this pressure controller is set lower than the normal suction pressure.

The purpose of controlling the compressor discharge pressure, PS-2133 A/B/C, is to protect the compressor from an abnormally high discharge pressure. For a high discharge pressure condition, the discharge pressure transmitters PT-2133 A/B/C and PT-2124 A/B/C will send alarm signal to UCP. If the operating pressure reaches to the PS-2133 A/B/C set point (57 barg), the switch will trip the compressor. The set point of this pressure switch is higher than the highest expected normal operating pressure. As long as the discharge pressure is normal, it will be lower than the pressure switch set point.

The purpose of controlling the compressor discharge temperature, TS-2191 A/B/C and TS-2194 A/B/C, is to protect the compressor from an abnormally high discharge temperature. For a high discharge temperature condition, the discharge temperature transmitters TT-2191 A/B/C and TT-2194 A/B/C will send alarm signal to UCP. If the discharge temperature of each stage reaches to the set point of temperature switches TS-2191 A/B/C (159 °C) or TS-2194 A/B/C (178 °C), the corresponding switch will trip the compressor. The set point of this temperature switch is higher than the highest expected normal operating temperature. As long as the discharge temperature is normal, it will be lower than the temperature switch set point.

**10.1 CAPACITY CONTROL**

Depending on operating conditions, step-up or step-down of the compressor capacity through unloading valves shall be done manually by operator through UCP (See 9.5.1).

The following items shall be considered in capacity control system:

* After 15 seconds of starting motor, compressor could be loaded
* In fully unload condition, compressor could work for maximum 20 min and after 20 min motor shall be off
* In case of 50%, compressor could work maximum 7 days. Change between crank end and head end to be done no more than 7 days interval.

0% capacity mode is only used for start-up of the compressor. By selecting each step of Capacity Control on the UCP (0% to 25%, 25% to 50%, 50% to 75%, and 75% to 100%) the load step would change to a higher level. It is done in reverse as well.

There should be at least 15 seconds delay following any change in load steps in either direction before any subsequent load steps. This will allow the motor current and the process gas flow to stabilize. The concept of interval changes in each step has been shown in following table.



# ALARM & SHUTDOWN (C-2101 / 2102 A/B/C)

* + - * + All common alarm (XF-2230 A/B/C) & common shutdown (ESDL-2230 A/B/C) can be monitored in UCP and LCP. Common shutdown can made normal status return by system reset push button (HSR-2242 A/B/C). If any of the following conditions apply, the common alarm & common shutdown will be activated and the alarm lamp will be lit. Then detail alarm signals can check in UCP and LCP. When common shutdown occurs, capacity load control becomes 0% of loading.
	1. **Suction Line Pressure**
		1. Common alarm
			+ - First stage

By instrument tag No. PT-2123 A/B/C, signal tag No. PAL-2123 A/B/C occurs when suction line pressure is lower than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 4.4 barg (for Normal Operation), and signal tag No. PAH-2123 A/B/C occurs when suction line pressure is higher than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 6 barg (for Normal Operation).

* + - * + Second Stage

By instrument tag No. PT-2132 A/B/C, signal tag No. PAL-2132 A/B/C occurs when suction line pressure is lower than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 14.7 barg (for Normal Operation).

* + 1. Low suction pressure
			- * By instrument tag No. PT-2121 A/B/C, when suction line pressure is lower than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 4.7 barg (for Normal Operation) this PT would open the spill-back valve (PV-2123 A/B/C) to compensate the reduction of pressure in suction line. Consequently, while the suction pressure is in normal condition, PT-2121 A/B/C will send signal to PV-2123 A/B/C to be closed.
	1. **Discharge Line Pressure**
		1. Common alarm
			+ - First stage

Instrument tag No. PT-2124 A/B/C, signal tag No. PAH-2124 A/B/C occurs when discharge line pressure is higher than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 21.5 barg.

* + - * + Second stage

Instrument tag No. PT-2133 A/B/C, signal tag No. PAH-2133 A/B/C occurs when discharge line pressure is higher than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 56 barg.

* + 1. Common shutdown
			- * Second stage

Instrument tag No. PS-2133 A/B/C, signal tag No. PSHH-2133 A/B/C occurs when discharge line pressure is higher than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 57 barg.

* 1. **Discharge Line Temperature**
		1. Common alarm
			+ - First stage

Instrument tag No. TT-2191 A/B/C, signal tag No. TAH-2191 A/B/C occur when discharge line temperature is higher than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 140 °C.

* + - * + Second stage

Instrument tag No. TT-2194 A/B/C, signal tag No. TAH-2194 A/B/C occur when discharge line temperature is higher than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 160 °C.

* + 1. Common shutdown
			- * First stage

Instrument tag No. TS-2191 A/B/C, signal tag No. TSHH-2191 A/B/C occur when discharge line temperature is higher than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 150 °C.

* + - * + Second stage

Instrument tag No. TS-2194 A/B/C, signal tag No. TSHH-2194 A/B/C occur when discharge line temperature is higher than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 170 °C.

* 1. **Lube Oil Pressure**
		1. Common alarm
			+ - Instrument tag No. PT-2204 A/B/C, signal tag No. PAL-2204 A/B/C occurs when lube oil pressure is lower than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 1.5 barg.
		2. Common shutdown
			+ - Instrument tag No. PS-2204 A/B/C, signal tag No. PSLL-2204 A/B/C occurs when lube oil pressure is lower than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 1.2 barg.
	2. **Lubricator Pressure**
		1. Common alarm
			+ - Instrument tag No. PT-2200 A/B/C, signal tag No. PAL-2200 A/B/C occurs when lube oil pressure is lower than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 4 barg.
	3. **Outboard N2 Purge Pressure**
		1. Common alarm
			+ - Instrument tag No. PT-2210 A/B/C, signal tag No. PAL-2210 A/B/C occurs when outboard N2 purge pressure is lower than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 1.8 barg.
	4. **Inboard N2 Purge Pressure**
		1. Common alarm
			+ - Instrument tag No. PT-2211 A/B/C, signal tag No. PAL-2211 A/B/C occurs when inboard N2 purge pressure is lower than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 0.2 barg.
	5. **Distance Piece N2 Purge Outlet Pressure**
		1. Common alarm
			+ - Instrument tag No. PT-2212 A/B/C, signal tag No. PAH-2212 A/B/C occurs when N2 purge pressure is higher than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 4 barg.
	6. **Lube Oil Filter Diff. Pressure**
		1. Common alarm
			+ - Instrument tag No. PDT-2204 A/B/C, signal tag No. PDAH-2204 A/B/C occurs when lube oil filter diff. pressure is higher than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 0.7 bar.
	7. **Crank Case Lube Oil Level**
		1. Common alarm
			+ - Instrument tag No. LT-2200 A/B/C, signal tag No. LAL-2200 A/B/C occurs when crank case lube oil level is lower than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 32.25 mm.
	8. **Lube Oil Temperature**
		1. Common alarm
			+ - Instrument tag No. TT-2204 A/B/C, signal tag No. TAH-2204 A/B/C occurs when lube oil temperature is higher than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 65℃.
				- Instrument tag No. TT-2204 A/B/C, signal tag No. TAL-2204 A/B/C occurs when lube oil temperature is lower than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 5℃.
	9. **Cooling Water Temperature**
		1. Common alarm
			+ - Instrument tag No. TT-2221 A/B/C, signal tag No. TAH-2221 A/B/C occurs when cooling water temperature is higher than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 66 ℃.
				- Instrument tag No. TT-2221 A/B/C, signal tag No. TAL-2221 A/B/C occurs when cooling water temperature is lower than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 60 ℃.
		2. Common shutdown
			+ - Instrument tag No. TT-2221 A/B/C, signal tag No. TAHH-2221 A/B/C occurs when cooling water temperature is higher than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 70 ℃.
	10. **Cooling Water Pressure**
		1. Common alarm
			+ - Instrument tag No. PT-2220 A/B/C, signal tag No. PAL-2220 A/B/C occurs when cooling water pressure is lower than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 2.5 barg.
		2. Common shutdown
			+ - Instrument tag No. PS-2220 A/B/C, signal tag No. PSLL-2220 A/B/C occurs when cooling water pressure is lower than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 2 barg.
	11. **Cooling Water Reservoir Level**
		1. Common alarm
			+ - Instrument tag No. LT-2213 A/B/C, signal tag No. LAL-2213 A/B/C occurs when cooling water reservoir level is lower than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 600 mm.
	12. **Compressor Front Bearing (DE) Temperature**
		1. Common alarm
			+ 1. Instrument tag No TT-2216 A/B/C, Signal tag No. TAH-2216 A/B/C Occurs when compressor front bearing temperature is higher than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 95℃.
		2. Common shutdown
			+ 1. Instrument tag No. TT-2216 A/B/C, signal tag No. TAHH-2216 A/B/C occurs when compressor front bearing temperature is higher than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 105 ℃.
	13. **Compressor Mid Bearing Temperature**
		1. Common alarm
			+ 1. Instrument tag No TT-2220 A/B/C, Signal tag No. TAH-2220 A/B/C Occurs when compressor front bearing temperature is higher than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 95℃.
		2. Common shutdown
			+ 1. Instrument tag No. TT-2220 A/B/C, signal tag No. TAHH-2220 A/B/C occurs when compressor front bearing temperature is higher than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 105 ℃.
	14. **Compressor End Bearing (NDE) Temperature**
		1. Common alarm
			+ 1. Instrument tag No TT-2218 A/B/C, Signal tag No. TAH-2218 A/B/C Occurs when compressor front bearing temperature is higher than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 95℃.
		2. Common shutdown
			+ 1. Instrument tag No. TT-2218 A/B/C, signal tag No. TAHH-2218 A/B/C occurs when compressor front bearing temperature is higher than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 105 ℃.
	15. **First Stage Packing Temperature**
		1. Common alarm
			+ 1. Instrument tag No. TT-2217 A/B/C, signal tag No. TAH-2217 occurs when first stage cylinder packing temperature is higher than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 120 ℃.
		2. Common shutdown
			+ 1. Instrument tag No. TT-2217, signal tag No. TAHH-2217 occurs when first stage cylinder packing temperature is higher than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 130 ℃.
	16. **Second Stage Packing Temperature**
		1. Common alarm
			+ 1. Instrument tag No. TT-2219 A/B/C, signal tag No. TAH-2219 occurs when second stage cylinder packing temperature is higher than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 120 ℃.
		2. Common shutdown
			+ 1. Instrument tag No. TT-2219, signal tag No. TAHH-2219 occurs when second stage cylinder packing temperature is higher than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 130 ℃.
	17. **Compressor Frame-1 Vibration**
		1. Common alarm
			+ 1. Instrument tag No. VE-2200 A/B/C, signal tag No. VEH-2200 A/B/C occurs when compressor frame-1 vibration is higher than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 8 mm/sec RMS.
		2. Common shutdown
			+ 1. Instrument tag No. VE-2200 A/B/C, signal tag No. VEHH-2200 A/B/C occurs when compressor frame-1 vibration is higher than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 12 mm/sec RMS.
	18. **Compressor Frame-2 Vibration**
		1. Common alarm
			+ 1. Instrument tag No. VE-2201 A/B/C, signal tag No. VEH-2201 A/B/C occurs when compressor frame-2 vibration is higher than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 8 mm/sec RMS.
		2. Common shutdown
			+ 1. Instrument tag No. VE-2201 A/B/C, signal tag No. VEHH-2201 A/B/C occurs when compressor frame-2 vibration is higher than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 12 mm/sec RMS.
	19. **Compressor Frame-3 Vibration**
		1. Common alarm
			+ 1. Instrument tag No. VE-2202 A/B/C, signal tag No. VEH-2202 A/B/C occurs when compressor frame-2 vibration is higher than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 8 mm/sec RMS.
		2. Common shutdown
			+ 1. Instrument tag No. VE-2202 A/B/C, signal tag No. VEHH-2202 A/B/C occurs when compressor frame-2 vibration is higher than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 12 mm/sec RMS.
	20. **Key phasor**
		1. Common alarm
			+ 1. Instrument tag No. XE-2200 A/B/C, signal tag No. XEH-2200 A/B/C occurs the value is higher than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 430 rpm.
	21. **First Stage Rod Position**
		1. Common alarm
			+ 1. Instrument tag No. ZE-2201 A/B/C, signal tag No. ZEH-2201 A/B/C occurs first stage rod position is higher than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 0.69 mm.
	22. **Second Stage Rod Position**
		1. Common alarm
			+ 1. Instrument tag No. ZE-2200 A/B/C, signal tag No. ZEH-2200 A/B/C occurs when second stage rod position is higher than [or equal to](https://en.dict.naver.com/#/entry/enko/fbb6e974defa4d7f9335efcfb2dedc36) 0.6 mm.
	23. **Compressor Main Motor MCC Fault**
		1. Common shutdown
			+ 1. Signal tag No. XF-2224 A/B/C occurs when compressor motor MCC Fault.
	24. **Aux. Oil Pump Motor MCC Fault**
		1. Common alarm
			+ 1. Signal tag No. XF-2202 A/B/C occurs when aux oil pump motor MCC Fault.
	25. **Frame Electrical Heater Motor MCC Fault**
		1. Common alarm
			+ 1. Signal tag No. XF-2203 A/B/C occurs when frame electrical heater motor MCC Fault.
	26. **Oil Cooler Motor MCC Fault**
		1. Common alarm
			+ 1. Signal tag No. XF-2205 / 2206 A/B/C occurs when oil cooler motor MCC Fault.
	27. **Lubricator Pump Motor MCC Fault**
		1. Common alarm
			+ 1. Signal tag No. XF-2201 A/B/C occurs when lubricator pump motor MCC Fault.
	28. **Lubricator Heater MCC Fault**
		1. Common alarm
			+ 1. Signal tag No. XF-2200 A/B/C occurs when lubricator heater MCC Fault.
	29. **Cooling Water Heater MCC Fault**
		1. Common alarm
			+ 1. Signal tag No. XF-2223 A/B/C occurs when cooling water heater MCC Fault.
	30. **Main / Aux Water Pump Motor MCC Fault**
		1. Common alarm
			+ 1. Signal tag No. XF-2222 / 2221 A/B/C occurs when Main / Aux water pump motor MCC Fault.
	31. **Cooling Water Cooler Motor MCC Fault**
		1. Common alarm
			+ 1. Signal tag No. XF-2220 A/B/C occurs when cooling water cooler motor MCC Fault.