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C-A OPERATIONS PROCEDURES MANUAL

7.1.6 Compressor Room - First Stage Compressor Operation

Text Pages 2 through 12

Hand Processed Changes

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Collider-Accelerator Department Chairman Date

E. Quimby

7.1.6 Compressor Room - First Stage Compressor Operation

1. Purpose

This procedure covers the operation of a first stage compressor skid. Evacuation and purging operations are strictly manual and must be carried out at the compressor skid. Other operations can be performed either manually at the local control panel or via the Cryogenic Control Computer. This OPM contains the following procedures relating to the operation of the compressor skid:

Sections:
- 5.1 Emergency Shutdown
- 5.2 Skid Initialization
- 5.3 Startup
- 5.4 Shutdown
- 5.5 Evacuation
- 5.6 Purge
- 5.7 Safety Interlocks

2. Responsibilities

2.1 The Shift Supervisor, or an Operator designated by the Shift Supervisor, is responsible for conducting this procedure and providing documentation in the Cryogenic Control Room Log.

2.2 Should a problem arise during the completion of this procedure, the Shift Supervisor shall contact the Technical Supervisor for instructions before continuing.

3. Prerequisites

3.1 Operator shall become familiar with the first stage helium compressor P&ID 3A995019, the electrical schematic 3A985003, and the physical location of components on the skids.

3.2 The skid is prepared as follows:

3.2.1 The compressor and oil pump have been checked for alignment and rotation, the skid has been leak checked, all instrument gas supply valves have been opened, and all electrical disconnects have been energized.

4. Precautions

4.1 Hearing protection shall be worn in Bldg. 1005H whenever any compressor is operating.

5. Procedure

5.1 Emergency Shutdown

The first stage compressor skid is outfitted with several safety interlocks and an emergency shutdown button mounted on the local control panel. When any of these devices are activated, the compressors and oil pump will automatically shut down, and the suction valve will close. If the system shuts down automatically, the local annunciator panel will light and identify which safety interlock activated the shut down.

[1] In the event of an emergency depress the emergency shutdown button.

[2] Immediately report to the shift supervisor for direction. Do not attempt to restart the compressor until all problems have been rectified. If the system has shut down because of a safety interlock, see section 5.7 for corrective action.

5.2 Skid Initialization

This procedure is to configure and check out the first stage compressor skid prior to being operated.

_____ [1] Switch hand switch HS2099 into the "LOCAL" position.

_____ [2] CONFIRM that all valves are in their initial positions according to C-A-OPM-ATT 7.1.6.a "Initial Valve Settings".

_____ [3] CONFIRM that the system has been properly evacuated and backfilled with helium. If the system has not yet been evacuated, perform the evacuation procedures in accordance with section 5.5 of this OPM before proceeding.

_____ [4] CONFIRM that the helium pressure in the skid is 30 psi (PI2081). If not, backfill the skid using the purge supply valve H2083M.

_____ [5] CONFIRM both cooling water inlet and outlet valves are OPEN and adjusted for the proper flow. See C-A-OPM 7.1.5. (Compressor Room - Water System Operation) for instructions on adjusting the flow rate. If the "COOLING WATER FLOW LOW" indicator light does not extinguish, there is a problem with the cooling water system and a supervisor should be informed. Do not continue until the problem is rectified.

_____ [6] Confirm that all lights on the local annunciator panel are off, this indicates that none of the safety interlocks are tripped.

_____ [7] PRESS the skid "RESET" button (HS2061). The blue "SKID RESET" light should light and/or remain lit.

_____ [8] CONFIRM that the skid's oil is reading at least 50% on LI2091E when the compressors and oil pump are not operating. If not, manually increase the oil level to 50% using HS2091 (oil make up valve E2087A).

_____ [9] Switch the "OIL MAKE UP" local hand switch (HS2091) to the AUTO position.

_____ [10] START the oil pump using the local hand switch HS2095. Allow the oil to circulate through the cooler, filter and compressor. Check that 30 psi is established between PI2088E and PI2081H. If not, adjust E2091P. Observe the pressure loss between PI2088E and PI2098E. This should be less than 15 psi. If not, change the oil filter element. Oil level will gradually decrease while the oil pump is operating and the compressor is not.

_____ [11] Completely UNLOAD both compressors' slide valves using the hand switches HS2063 and HS2064 on the local control panel. The green "UNLOADED" indicator lights should be lit and the visual indicator on the front face of the compressors should be in the UNLOADED position.

_____ [12] OPEN the skid's main process discharge valve H2075M.

_____ [13] If the compressor is not going to be started within the next 5 minutes, STOP the oil pump.

_____ [14] RECORD in the Cryogenics Control Room Log Book that the compressor skid has been initialized.

5.3 Startup

This procedure is for starting up a first stage compressor skid. All operations in this section can be performed either at the compressor's local control panel or by the Cryogenic Control Computer. In the computer mode, the control room can load and unload the slide valves, start and stop the compressor and oil pump motors, and open and close the suction valve. The discharge valve must be opened manually. It is assumed that the skid has been evacuated and purged according to Sections 5.5 and 5.6.

_____ [1] CONFIRM that the Compressor skid has been initialized according to section 5.2.

_____ [2] Mode selector switch HS2099 must be in the "LOCAL" position to operate the compressors from the local control panel. The switch must be in the "COMPUTER" position to operate the compressors from the main control room.

_____ [3] START the oil pump. Allow the oil pump to run for 1 minute prior to starting a compressor.

_____ [4] OPEN the skid's main process inlet valve H2076A.

_____ [5] UNLOAD both of the compressors' slide valves until they are at the "UNLOADED" limit. The compressors' will not start unless the slide valve is in the fully unloaded position

_____ [6] START one of the compressors. Once a compressor is started a restart lock-out is activated. This lock-out keeps the compressor from being restarted for 1 hour.

_____ [7] After 1 minute of normal operation, the second compressor can be STARTED as required.

_____ [8] After 1 minute of normal operation, a compressor's slide valve can be loaded as required.

Note:
The compressor skid can be switched from local to computer controlled mode and visa versa at any time. Switching modes will not change the state of any of the components on the skid. The Cryogenic Control Room shall be informed prior to changing the compressor skids control mode

5.4 Shutdown

This procedure is for shutting down a compressor skid after a period of normal operation. All operations in this section can be performed either at the compressor's local control panel or by the Cryogenic Control Computer.

_____ [1] NOTIFY the main control that a compressor is going to be shutdown.

_____ [2] Mode selector switch HS2099 must be in the "LOCAL" position to operate the compressor from the local control panel. The switch must be in the "COMPUTER" position to operate the compressor from the main control room.

_____ [3] Completely UNLOAD each compressor's slide valve.

_____ [4] STOP both compressors.

_____ [5] After 1 minute, STOP the oil pump.

_____ [6] CLOSE the main process inlet valve H2076A.

_____ [7] RECORD in the Cryogenics Control Room Logbook that the compressor skid has been shut down.

5.5 Evacuation

This procedure is for evacuating and backfilling an individual first stage compressor skid. It shall be performed anytime the skid internals have been exposed to the atmosphere.

_____ [1] Switch hand switch HS2099 into the "LOCAL" position.

_____ [2] CONFIRM that the following valves are CLOSED; H2075M, H2076A, H2083M, and H2090M

_____ [3] CLOSE valves E2089M and E2095M.

_____ [4] OPEN the evacuation header valve V2089M and EVACUATE the skid to approximately 500 microns as measure at the vacuum skid.

_____ [5] CLOSE the evacuation header valve H2089M.

_____ [6] Using the purge supply valve H2083M, slowly BACKFILL the helium lines to 30 psi at PI2081.

_____ [7] Repeat steps 4 through 6 for two more evacuate/backfill cycles.

_____ [8] OPEN valves E2089M and E2095M.

_____ [9] When finished, the skids internals should be at approximately 30 psi at PI2081.

_____ [10] RECORD in the Cryogenics Control Room Logbook that the compressor skid has been evacuated and backfilled.

5.6 Purge

Before operating on line, a compressor skid must be purged to remove impurities from the skid internals. This can be done by either using the compressors themselves or the utility compressor in conjunction with the purifier.

5.6.1 Purge Using the Utility Compressor and Cryogenic Purifier

This procedure utilizes the utility compressor and the cryogenic purifier to clean up the gas within the compressor skid. It is assumed that the skid has been initialized and evacuated according to sections 5.2 and 5.5 of this OPM. It is also assumed that the purifier and utility compressor have been configured according to C-A-OPM 7.1.9 section 5.9 (Compressor Room - Utility Compressor Operation, Configuring for Purging with Cryogenic Purifier).

_____ [1] CONFIRM all valves are configured according to the initial valve configuration C-A-OPM-ATT 7.1.6.a.

_____ [2] Switch hand switch HS2099 into the "LOCAL" position.

_____ [3] START the oil pump.

_____ [4] Slowly OPEN the purge supply valve H2083M.

_____ [5] Slowly OPEN the purge return valve H2090M.

_____ [6] RUN the purifier in this mode until the gas at the purifier reaches an acceptable level of purity.

_____ [7] CLOSE valves H2083M and H2090M.

_____ [8] DEPRESSURIZE the compressor skid to 30 psi using the purge return valve H2090M.

_____ [9] STOP the oil pump.

_____ [10] RECORD in the Cryogenics Control Room Logbook that the compressor skid has been purged.

5.6.2 Purging Using the Skid's Compressors

This procedure utilizes the compressors on the skid being purged and the cryogenic purifier to clean up the gas within the compressor skid. It is assumed that the skid has been initialized and evacuated according to sections 5.2 and 5.5 of this OPM. It is also assumed that the purifier has been configured according to C-A-OPM 7.1.28 "Compressor Room – Cryogenic Purifier Operation".

_____ [1] CONFIRM all valves are configured according to the initial valve configuration in C-A-OPM-ATT 7.1.6.a.

_____ [2] Switch hand switch HS2099 into the "PURGE" position.

_____ [3] OPEN the purge supply valve H2083M.

_____ [4] OPEN the purge return valve H2090M.

> **Note:**
> While purging a compressor skid in this configuration, the slide valves shall always be in the fully unloaded position

_____ [5] START the compressor according to section 5.3.

_____ [6] Maintain purge supply and return pressures using the purifier controls.

_____ [7] RUN the purifier in this mode until the gas at the purifier reaches an acceptable level of purity.

_____ [8] STOP the compressors according to section 5.4.

_____ [9] Switch hand switch HS2099 into the "LOCAL" or "COMPUTER" position.

_____ [10] CLOSE valves H2083M and H2090M.

_____ [11] DEPRESSURIZE the compressor skid to 30 psi using the purge return valve H2090M.

_____ [12] RECORD in the Cryogenics Control Room Logbook that the compressor skid has been purged.

5.7 Equipment Protective Interlocks

The following is a list of interlocks which will stop the compressors from operating.

5.7.1 Gas Management Panel Master Shut Down

This interlock will shut down every compressor and pump motor in the RHIC compressor room. When activated, every compressor will stop and the blue "SKID RESET" lights will extinguish. Operators shall immediately notify the shift supervisor when this interlock is activated.

5.7.2 Differential Oil Pressure Low

This interlock activates if the differential pressure on DPSI2088E is less than 30 psi. When activated, both compressors and the oil pump on a first stage compressor skid will not run. When activated the Operator should do the following:

> **Note:**
> This interlock will not activate for 1 minute after the oil pump has been started. This is to give the oil system a short time to balance.

_____ [1] CONFIRM that the bulk oil separator has the proper amount of oil in it. If not, manually increase the oil level to using the local hand switch HS2091.

_____ [2] RESTART the oil pump using the local hand switch HS2095. Allow the oil to circulate through the cooler, filter and compressor. Check that 30 psi is established between PI 2088E and PI2081H. If not, adjust E2091P. Observe the pressure loss between PI2088E and PI2098E. This should be less than 15 psi. If not, change the oil filter element. Oil level will gradually decrease while the oil pump is operating and the compressor is not.

_____ [3] If neither step 1 and 2 will remedy the problem, the Operator shall inform the Shift Supervisor.

5.7.3 Cooling Water Flow Low

This interlock activates when the cooling water flow through the oil cooler is insufficient. When activated, both compressors on a first stage compressor skid will not run. When activated the Operator should do the following:

> **Note:**
> This interlock is temporarily jumped. It will activate its annunciator light but it will not shut down the compressors.

_____ [1] CONFIRM that both cooling water inlet and outlet valves are OPEN

_____ [2] CONFIRM that the main cooling water system is running.

_____ [3] If neither step 1 and 2 will remedy the problem, the Operator shall inform the Shift Supervisor.

5.7.4 Motor Temp High

This interlock activates if the temperature in the compressor motors windings or bearings is over set limits. When activated, both compressors on a first stage compressor skid will not run. The Operator shall inform the Shift Supervisor if this interlock activates. Under no circumstances shall the operator try to restart a compressor which trips off on this interlock, without the Shift Supervisor's approval.

5.7.5 Bulk Oil Separator Level High

This interlock activates if the oil level in the bulk oil separator is over set limits. When activated, both compressors on a first stage compressor skid will not run. The Operator shall notify the Shift Supervisor if the compressors trips off on this interlock.

Note:
When first started, the compressor will run for 9 minutes with this interlock activated. This is to allow the compressors to discharge oil out of the separator and hence lower the level.

5.7.6 Bulk Oil Separator Level Low

This interlock activates if the oil level in the bulk oil separator is under set limits. When activated, both compressors and the oil pump on a first stage compressor skid will not run.

_____ [1] CONFIRM that the "OIL MAKE-UP" hand switch (HS2091) is in the AUTO position. If it is, try filling the separator by switching the switch to "MANUAL".

_____ [2] CONFIRM that the oil make-up system is running.

_____ [3] If neither step 1 and 2 will remedy the problem, the Operator shall inform the Shift Supervisor.

5.7.7 Suction Pressure Low

This interlock activates if the compressor's suction pressure is under set limits. When activated, both compressors on a first stage compressor skid will not run. The Operator shall notify the Shift Supervisor if the compressors trips off on this interlock.

5.7.8 Vibration High

This interlock activates if a compressor motor's vibration is excessive. When activated, both compressors on a first stage compressor skid will not run. The Operator shall notify the Shift Supervisor if the compressors trips off on this interlock. Under no circumstances shall the operator try to restart a compressor which trips off on this interlock without Shift Supervisor approval.

5.7.9 Discharge Pressure High

This interlock activates if the compressor's discharge pressure is over set limits. When activated, both compressors on a first stage compressor skid will not run. The Operator shall notify the Shift Supervisor if the compressors trips off on this interlock.

5.7.10 Discharge Temperature High

This interlock activates if the compressor's discharge temperature is over set limits. When activated, both compressors on a first stage compressor skid will not run. The Operator shall notify the Shift Supervisor if the compressors trips off on this interlock.

5.7.11 Restart Lockout

Starting a compressor will initiate a restart lockout which will prevent restarting the motor in the event of a shutdown for a period of 60 minutes. Each compressor has its own Restart Lockout.

5.7.12 Valve Configuration Interlock

Besides the interlocks on the local skid annunciator panel, the compressors will not start unless either of the following conditions are met:

_____ [1] Both the skid Inlet and Outlet valves (H2076A and H2075M) must be OPEN.

_____ [2] Both the skid Inlet and Outlet valves (H2076A and H2075M) must be CLOSED, and the skid mode hand switch (HS2099) must be switched to "PURGE".

6. Documentation

6.1 The check-off lines on the procedure are for place-keeping only. The procedure is not to be initialed or signed, it is not a record.

6.2 The Shift Supervisor, or designee, shall document the completion of the procedure in the Cryogenics Control Room Log

7. References

7.1 P&ID drawing 3A995019 and electrical schematic 3A985003.
7.2 BNL Compressor Station Operating Manual Volume I as supplied by Koch Process Systems Inc.
7.3 C-A-OPM 7.1.5 "Compressor Room – Water System Operation".
7.4 C-A-OPM 7.1.9 "Compressor Room – Utility Compressor Operation".
7.5 C-A-OPM 7.1.28 "Compressor Room – Cryogenic Purifier Operation".

8. Attachments

8.1 C-A-OPM-ATT 7.1.6.a "Initial Valve Configuration"