Agrium

Kenai Nitrogen Operations

Plants 1&4 Process Air Compression Systems: 21/71
Process Hazards Analysis Revalidation

Final Report

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Project No.: K00S50R1

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1.0 ABOUT THIS STUDY

The Process Hazards Analysis, K00S0050 conducted between October 1, 1996 to October 31, 1996 was revalidated at Agrium's Kenai Nitrogen Operations on October 9, 2001 to October 12, 2001. The original PHA, as well as the revalidation, focused on the plants Process Air Compression Systems: 21 and 71.

EPA RMP 40 CFR Part 68 Section 112 (7) and OSHA Rule 1910.119, "Process Safety Management of Highly Hazardous Chemicals" requires that the initial Process Hazard Analysis (PHA) for a covered process be updated and revalidated by a knowledgeable team at least every five years. The objective of PHA revalidation is to assure that the PHA is consistent with the current process. The PHA is revalidated, by evaluating and addressing the following questions:

- Have significant new hazards been created or introduced into the process?
- Has the possible occurrence of a catastrophic release in the process unit become significantly more likely?
- Have consequences of previously identified toxic or flammable material releases become more severe?
- Have consequences that could go "off-site" been identified?
- Have previously identified safeguards become compromised or challenged?

METHODOLOGIES

Baseline PHA

The original, or baseline, PHA was conducted primarily using the "HAZOP" technique.

HAZOP Technique

The guidewords, in conjunction with key process parameters, prompt the Process Hazards Analysis team to brainstorm possible causes and potential consequences of deviations from expected operation. For example, the deviation of "NO FLOW" would prompt the leader to ask the team, "What could cause no flow in this section or line segment?" The "Possible Cause/Potential Consequence" scenarios were documented in the report worksheets along with "Existing Systems and Safeguards," that either reduce the likelihood of the cause occurring or reduce the potential consequences. For scenarios involving significant risk, "Recommendations," which the team believed, may further reduce the risk or improve the operability of the facility were also documented.

The specific steps of the HAZOP methodology used in the baseline PHA were:

Choose study node
Apply a deviation (parameter + guideword)
Brainstorm causes of the deviation
For each cause, identify ultimate global consequences
Identify existing safeguards
Qualitatively assess the risk of the scenario

If warranted, make recommendation(s) to reduce risk and/or improve the operability of the facility

This process is repeated for each deviation and node until the entire process has been analyzed.

Revalidation

The PHA procedure used to revalidate Plant Instrument and Utility Air System was the Guideword/Checklist PHA Revalidation Method. This methodology was organized into the following tasks, and are described below:

1. Collection of Information
2. Information Review
3. Revalidation Study Sessions (with PHA Team)

Collection of Information

The following information was collected prior to the Revalidation Study Sessions:

1. Baseline PHA, including worksheets, Action Item list, P&IDs reviewed, and status of recommendations.
2. Documented changes to the design or operation of the process since the baseline PHA (including MOCs).
3. Documented incident reports from this unit.
4. Latest revision of Piping and Instrument Diagrams (P&IDs) that describe the process.
5. Other Process Safety Information, such as PRV design basis and data and Standard Operating Conditions and Limits (SOCLs).

Information Review

The collected information was reviewed by the Revalidation Team Leader and Agrium Kenai Nitrogen Operations representatives on April 3, 2001 to September 13, 2001. The purpose of the Information Review is to screen the baseline PHA for content and quality, and to identify concerns and issues that need to be reviewed by the Revalidation Team during the study sessions. This resulted in the generation of an agenda or work plan for the sessions. The Information Review included the following tasks required to identify items for discussion with the team:

1. Review the baseline PHA and complete the Initial PHA Content Checklist, see Attachment 2, and the Baseline PHA Screening Checklist, see Attachment 3. Evaluate the baseline PHA to ensure that off-site consequences were adequately discussed and addressed.
2. Review and verify the documented status of recommendations from the baseline PHA and any project PHAs affecting this unit.
3. Review all incidents occurring in the system since the baseline PHA, and develop a list of those pertinent to the revalidation process.
4. Develop a list of all changes that have occurred to the design or operation of the process

since the baseline PHA, see Attachment 5. This is done by comparing the latest P&IDs with the P&IDs reviewed during the baseline PHA, and by reviewing those changes to the design or operation of the process that have been analyzed by the MOC process.

5. Develop an agenda, or work plan for the study sessions, see Attachment 1.

Revalidation Study Sessions (with PHA Team)

The revalidation study was discussed and prepared by a multi-disciplined team knowledgeable in the process and in the PHA method used. At the beginning of the session, the Team Leader reviewed the PHA revalidation scope and purpose, and reviewed the completion of the Initial PHA Content Checklist and the Baseline PHA Screening Checklist. The group was then lead through the revalidation procedure, which included:

1. General discussion regarding the status of open recommendations from the baseline PHA, see Attachment 4;
2. Work through the Change Evaluation Checklist to identify undocumented changes, see Attachment 5;
3. Work through the Operations Change Evaluation and Wrap-up Checklist Issues, see Attachment 6;
4. Work through the Maintenance Change Evaluation and Wrap-up Checklist Issues, see Attachment 7;
5. Work through the Engineering Change Evaluation and Wrap-up Checklist Issues, see Attachment 8;
6. Work through the Inspection Change Evaluation and Wrap-up Checklist Issues, see Attachment 9;
7. Work through the Emergency Response Change Evaluation and Wrap-up Checklist Issues, see Attachment 10;
8. Work through the Safety Group Change Evaluation and Wrap-up Checklist Issues, see Attachment 11;
9. Work through the General Change and Wrap-up Checklist Issues, see Attachment 12;
10. Review Human Factors Issues/Checklist, see Attachment 13;
11. Discuss Previous Incident Reports, see Attachment 14;
12. Evaluate Potential Off-Site Consequences, see Attachment 15;
13. Discuss Additional Areas "What-If" Worksheets, see Attachment 16;
14. Review Revalidation Guideword Checklist, see Attachment 17;
15. Review Risk Ranking Matrix, see Attachment 18.

"What-If" - The team utilized the "What-If" technique to identify potential hazards and areas of concern when it was determined that those hazards or concerns were not adequately addressed by the baseline PHA, such as potential off-site consequences. The "What-If" technique was also utilized to evaluate potential hazards caused by new or modified equipment as the review team deemed appropriate. OSHA recognizes the "What-If" as an acceptable method of evaluating process hazards. Those scenarios evaluated using the "What-If" technique can be found in Attachments 15 and 16.

The "What-If" technique involves asking questions that require the team to analyze deviations from the design intent. An example is: "What-If...the drying step were left out of the procedure?" The team then develops consequences of this action (or inaction) and documents the safeguards in a manner similar to HAZOP. The "What-If" scenario is then ranked for risk, and recommendations are made if appropriate, similar to the HAZOP technique. Attachment 18 shows the criteria for applying risk rankings to various scenarios.

Other Issues

Facility Siting – Agrium Kenai Nitrogen Operations has completed a plant-wide facility siting study, which adequately addresses those issues; therefore, the Facility/Plant Siting Issues checklist was not utilized.

Compliance with OSHA Rule 1910.119 and EPA RMP Rule

This study complies with OSHA rule 1910.119, "Process Safety Management of Highly Hazardous Chemicals" and EPA 40CFR Part 68 Section 112, "Risk Management Program."

In particular, this study complies with paragraph (e,6) of the OSHA rule that states; "At least every five years after the completion of the initial process hazard analysis. The process hazard analysis shall be updated and revalidated by a team, meeting the requirements in paragraph (e)(4) of this section to assure that the process hazard analysis is consistent with the current process." The study also complies with Subpart D (68.67) of the RMP Rule covering the same requirements as OSHA 1910.119 and potential off-site consequences.

The study was completed within five years of the baseline PHA. A multi-disciplined team, including at least one person with knowledge and experience in the process, discussed and prepared the study in a manner to ensure that the baseline PHA is consistent with the current process.

Process Hazards Analysis Team (e, 4)

The PHA Revalidation was discussed and prepared by a team with expertise in engineering and operations, with at least one employee having specific expertise in the process being evaluated. The Process Hazards Analysis Revalidation was conducted on October 9, 2001 to October 12, 2001 at Agrium Kenai Nitrogen Operations in Kenai, Alaska.

The study team consisted of the following people:

Name	Title	Years of Experience
Richard E. Warren	Emergency Response	30
Russell R. Peterson	P&C Engineering Supervisor	26
Edward J. Aisenbrey	PHA Facilitator/PSM Coordinator	24
Chuck Bergonzini	Safety Specialist	20
Steve Donnelly	Plant #4 A Operator	20
David Saltenberger	Plant #1 B Operator	17
Robert A. Ross	Reliability Engineer	10
Michele Grzybowski	Environmental Specialist	6
America Dukowitz	PSM Administrative Assistant/Scribe	3
Forrest A. Pipkin	Mechanical Engineer	2

Process Description

Plant 1

Atmospheric air is taken through the air intake and is compressed in the first stage of the compressor. The air is then cooled in the First Stage Air Compressor Cooler where any condensed water is removed and sent to the GES from the First Stage Air Separator. Compression is continued in the second and third stages, and the air is cooled in the Second and Third Air Compressor Coolers, respectively.

The Condensate from the coolers is separated in the Second and Third Stage Air Separators and sent to the GES.

The outlet of the Third Stage Air Separator enters the fourth and final stage of the compressor where it is compressed to the required pressure to be delivered to the 1D100 Secondary Reformer via 1B108A and B Primary and Secondary Process Air Heaters in the Primary Reformer auxiliary section.

Inlet conditions to the Process Air Compressor are set by ambient conditions. The Process Air Compressor speed is controlled by FRC100 located on the #1 Control Room Board.

The Process Air Compressor discharge pressure will vary as required to maintain the flow. When the required flow reaches the capacity of the compressor, no further increase in flow will be possible.

Surging of the Process Air compressor is prevented by FCV606 venting to atmosphere to maintain the necessary minimum flow through the compressor at surge conditions.

A small portion of air from the compressor is sent to the carbon dioxide (CO_2) compressor for the Urea Plant. Make-up to the instrument air header can also be taken from the process air compressor using PIC637.

The compressor is driven by a multi-stage total condensing steam turbine which directly drives the low case of the compressor (first and second stages) and through a speed increaser, the high case (third and fourth stages).

The turbine operates with 550 psig steam and 50 psig admission steam, exhausting to 20" to 26" of mercury (Hg) (vacuum). The controls are set up to take all the 50 psig steam available and control the speed by use of 550 psig steam.

The system has auxiliary equipment, which includes the Steam Condenser, Condensate Return Pumps, Steam Air Jet Ejectors, and the necessary instrumentation and controls.

The Process Air Compressor is supplied with a package oil system which provides lubricating oil for the bearings in the compressor and steam driver, and governor oil for the steam driver. No seal oil is required.

EQUIPMENT:

1E123A/B ***1ST STAGE AIR COMPRESSOR COOLER*** SYSTEM 21

This fin fan air cooled exchanger is located on the east side of the Compressor Building north of the 1E124 Syngas Steam Condensers. 1E123A/B cools the 1st stage discharge of the air machine, low case, to condense water and to keep the 2nd stage suction cool. Air enters the 1E123A/B at 25 psig and 300°F and is cooled to about 60°F (depending on ambient conditions). The outlet temperature is controlled by automatic louvers. The air leaving 1E123A/B goes to 1F122, 1st Stage Air Compressor Separator, where condensed water is removed. The 1E123A/B outlet temperature should not be allowed to run below freezing or ice will form in the tubes.

1E127A/B ***2ND STAGE AIR COMPRESSOR COOLER*** SYSTEM 21

This fin fan air cooled exchanger is located on the east side of the Compressor Building north of the 1E124 Syngas Steam Condensers. The 1E127A/B cools the 2nd stage discharge of the air machine, 1G123B, to condense water and to keep the 3rd stage suction cool. Air enters 1E127s at 70 psig and 275° F. It is cooled to about 60°F (depending on ambient conditions). The outlet temperature is controlled by manual louvers. The air leaving 1E127A/B goes to 1F124, 2nd Stage Air Separator, where condensed water is removed. The 1E127A/B outlet temperature should not be allowed to run below freezing or ice will form in the tubes.

1E129A/B ***3RD STAGE AIR COMPRESSOR COOLER*** SYSTEM 21

This fin fan air cooled exchanger is located on the east side of the Compressor Building north of the 1E127 Syngas Steam Condensers. The 1E129A/B cools the 3rd stage discharge of the air machine, high case 1GC123A, to condense water and to keep the 4th stage suction cool. Air enters 1E129A/B at 190 psig and 250°F and is cooled to about 60°F (depending on ambient conditions). The outlet temperature is controlled by automatic and manual louvers. The air leaving 1E129A/B goes to 1F125, 3rd Stage Air Compressor Separator, where condensed water is removed. The 1E129A/B outlet temperature should not be allowed to run below freezing or ice will form in the tubes.

1E147A/B ***PROCESS AIR COMPRESSOR LUBE OIL COOLERS*** SYSTEM 21

These horizontal tube exchangers are located south of the Air Machine Lube Oil Reservoir. 1E148A/B are used to cool the lube oil going to the Process Air Compressor bearings by transferring the heat to the cooling water on the tube side of the 1E148A/B. The oil picks up heat from the bearings and returns to 1F182, the Oil Reservoir, where the 1G134A/B Lube Oil Pumps pump it back to the 1E148A/B.

Note: Care should be taken to bleed all air from the oil side before putting lube oil coolers and filters in service.

1E149 ***LUBE OIL STEAM COIL*** SYSTEM 21

The 1E149 is a steam coil located under the 1F182 Air Machine Lube Oil Reservoir. The 1E149 uses 50 psig steam to warm the lube oil up in the air machine lube oil reservoir prior to starting the 1GC123 air compressor. Once the lube oil temperature reaches 100 to 110°, the steam to the 1E149 should be blocked in.

1E167 ***GLAND CONDENSER*** SYSTEM 21
1GJ107 ***GLAND CONDENSER AIR EJECTOR***

1GJ107 is located on the west side of the 1G123, Process Air Compressor. Its purpose is to produce a low pressure zone between the Labyrinth Seals on the turbine by educting leak-off steam through the Gland Condenser, 1E167. This low pressure zone prevents steam leak off from entering the bearing housing, causing contamination of the oil with water, thus avoiding damage to the bearings. The low pressure zone also draws off any air leakage past the outer labyrinth seal.

1F120 ***DRAIN POT*** SYSTEM 21

Located under the Compressor Deck on the east side of the Air Compressor Turbine 1GCT123. Any steam condensing in 1GCT123 turbine case drains into 1F120. Because it operates under a vacuum, draining 1F120 requires isolating it from the turbine and breaking the vacuum. DO NOT open any bleeds or drains on the drain pot unless it is isolated from the turbine, as this will allow air to be pulled into the exhaust trunk and could effect vacuum on the condensers which in turn will cause an increase in exhaust temperature. 1F120 is drained as needed.

1F122 ***1ST STAGE AIR SEPARATOR*** SYSTEM 21
1F124 ***2ND STAGE AIR SEPARATOR***
1F125 ***3RD STAGE AIR SEPARATOR***

The separators are located outside on the northeast side of the Compressor Building by the air machine door. Each time air is compressed in the air machine and cooled in the intercoolers, the water in the air is condensed. This water has to be removed or it will carry over and damage the air compressor. After each of the first three stages of compression, the air is cooled in air cooled exchangers 1E123, 1E127, and 1E129. Water and air are separated in the separators after each exchanger. The levels in the separators are drained to the General Effluent Sewer (GES). The separators are equipped with high and high high level alarms. Each separator is drained through a drain trap to the GES.

1F129 ***INTAKE AIR SCREEN*** SYSTEM 21

The intake air screen sits on the north end of the 1J101 Ammonia Plant Compressor Building, about 40' in the air. The intake has a screen mesh cover to keep flying debris from being sucked into the air compressor.

1F140A/B ***LUBE OIL FILTERS*** SYSTEM 21

The 10 micron oil filters are located at the south end on the Lube Oil Reservoir, 1F182. They filter any contaminants larger than 10 microns out of the lube oil. The pressure drop, across the filter, can be monitored on PDI6061/6062. If this differential is rising rapidly, it may be due to water in the oil. This may be caused by loss of vacuum in the gland condenser. When switching filters/exchangers, be sure to bleed all air off the filter and the exchanger you are switching to.

1F149 ***AIR VENT SILENCER*** SYSTEM 21

This silencer is located outside on the west wall of the Compressor Building at the roof level. FCV606 is the anti surge valve for the Air Compressor, 1G123. When starting up the Compressor, 1FCV606 is open to prevent surging and vents to the atmosphere, 1F149 has been installed for personal protection. At very low rates or during plant upsets, air is vented to atmosphere.

1F152 ***COUPLING OIL FILTER*** SYSTEM 21

The .5 micron filter is located on the northwest side of the 1G123A, Low Case Process Air Compressor. It filters impurities larger than .5 microns out of the lube oil going to the three couplings on the Process Air Compressor. The filter should be bypassed and changed when PDI6063 reaches 8 psig.

Note: Dry type couplings are now being used on the air compressor, and this filter is no longer in service at this time.

1F159 ***MUFFLER*** SYSTEM 21

This silencer, 1F159, is located on the first stage suction line of the Process Air Compressor, 1G123. While compressing the air, a great deal of noise is produced. These silencers have been installed for personnel protection.

1F182 ***LUBE OIL RESERVOIR*** SYSTEM 21

The reservoir is located west of 1G123, Process Air Compressor, in the Compressor Building. The reservoir holds approximately 1930 gallons or 35 drums of Union Turbine Oil ISO VG-32. It is equipped with a sight glass, temperature gauge, and an external 50 psig steam heater (1E149). The oil is circulated through the bearings and controls the chest valves as governor oil. The Steam Heater, 1E149, is used to keep the reservoir warm when the compressor is shut down. The steam to this heater is controlled manually.

1G134A/B ***MAIN AND AUXILIARY LUBE OIL PUMPS*** SYSTEM 21
1GT134 ***TURBINE***

The pumps are located on top of 1F182 Process Air Compressor Lube Oil Reservoir. The pumps are submerged in the reservoir and supplies oil to the governor and the bearings. 1G134A is powered by a 40 horse 550 psig steam driven turbine, which exhausts to the air compressor steam condenser. 1G134B is powered by a 50 horsepower electric motor, which is normally in an auto standby mode. When PSL6066, on the discharge of the pumps, reaches 85 psig, 1G134B will start if the switch is in AUTO. When starting the compressor in freezing conditions use the 1G134B (electric pump) to avoid freezing the 1E125 Condensers. Switch to 1G134A after the turbine is up and running. During normal conditions the start switch for 1G134B should always be kept in the auto mode.

1GC123A/B ***HIGH AND LOW CASE COMPRESSOR*** SYSTEM 21
1GCT123 ***TURBINE***

1GC123 is located in the Compressor Building on the north end. Its purpose is to supply process air to the secondary reformer 1D100. This is accomplished by taking air from the atmosphere and compressing it in two stages of the 1GC123B, Low Case. This air at 70 psig then goes to the 1GC123A, High Case, where it goes through two more stages of compression. The air now at 540 psig is sent to the Primary Reformer for preheating. The compressor is driven by 1GCT123, a 14,270 horsepower turbine, that uses 550 psig and 50 psig steam (the majority of it being 50 psig). This is one turbine that has two T&T valves and two chest valves, each with their own actuator driven by the governor. The 550 psig steam drives the first three wheels of the turbine then mixes with 50 psig steam and drives the second half of the turbine exhausting into a vacuum to the 1E125 Condensers. This turbine drives the low case, which through 1GC123 speed increaser drives the high case at about twice the speed of the low case. Emergency make-up to the instrument air header comes off the fourth stage suction of the air compressor.

Plant 4

Atmospheric air is taken through the intake air filter and is compressed in the first stage of the compressor. The air is then cooled in the First Stage Air Compressor Cooler and the condensed water is removed and sent to the sewer in the First Stage Air Separator. Compression is continued in the second and third stages. The gas is cooled in the Second and Third Air Compressor Coolers respectively.

The Condensate from these coolers is separated in the Second and Third Stage Air Separators and sent to the sewer.

The outlet of the Third Stage Air Separator enters the fourth and final stage of the compressor where it is compressed to the required pressure to be delivered to the Reforming Section.

Inlet conditions to the Process Air Compressor are set by ambient conditions. The Process Air Compressor speed is controlled by the air flow to the secondary reformer. This is accomplished by a signal from the differential pressure across the air flow transmitter orifice.

The Process Air Compressor discharge pressure will vary as required to maintain the flow set for the secondary reformer. When the flow required reaches the capacity of the compressor, no further increase in flow will be possible.

Surging of the Process Air compressor is prevented by blowing off enough air to the atmosphere to maintain the necessary minimum flow through the compressor.

A small portion of the output of the air compressor is sent to the carbon dioxide (CO_2) compressor for the Urea Plant. Make-up to the instrument air header can also be taken from the process air compressor.

The compressor is driven by a multi-stage total condensing steam turbine which directly drives the low case of the compressor (first and second stages) and, through a speed increaser, the high case (third and fourth stages).

The turbine operates with 550 psig steam and 50 psig induction steam, exhausting to a vacuum of 25" mercury (Hg) absolute. The controls are normally set up to take all the 50 psig steam available and control the speed by use of 550 psig steam.

The system is complemented with the Steam Condenser, Condensate Return Pumps, Steam Air Jet Ejectors, and the necessary instrumentation and controls.

The Process Air Compressor is supplied with a package oil system which provides lubricating oil for the compressor and driver, and governor control oil for the driver. No seal oil is required.

EQUIPMENT:

4E223 ***1ST STAGE AIR COMPRESSOR COOLER*** SYSTEM 71

This fin fan air cooled exchanger is located above the Pipe Alley on the west side of the Compressor Building north of the 4E272, process condensate coolers. 4E223 cools the 1st stage discharge of the air machine, low case, to condense water and to keep the 2nd stage suction cool. Air enters 4E223 at 25 psig and 300°F. It is cooled to 60°F (depending on ambient conditions). The outlet temperature is controlled by 4TIC1501 which controls the louvers. The air leaving 4E223 goes to 4F222, 1st Stage Air Compressor Separator, where condensed water is removed. The 4E223 outlet temperature should not be allowed to run below freezing or ice will form in the tubes.

4E227 ***2ND STAGE AIR COMPRESSOR COOLER*** SYSTEM 71

This fin fan air cooled exchanger is located above the Pipe Alley on the west side of the Compressor Building north of 4E272, process condensate cooler. 4E227 cools the 2nd stage discharge of the air machine, G4C223B, to condense water and to keep the 3rd stage suction cool. Air enters 4E227 at 80 psig and 310°F. It is cooled to 60°F (depending on ambient conditions). The outlet temperature is controlled by 4TIC1504 which controls the louvers. The air leaving 4E227 goes to 4F224, 2nd stage air separator, where condensed water is removed. The 4E227 outlet temperature should not be allowed to run below freezing or ice will form in the tubes.

4E229 ***3RD STAGE AIR COMPRESSOR COOLER*** SYSTEM 71

This fin fan air cooled exchanger is located above the Pipe Alley on the west side of the Compressor Building north of the 4E272, process condensate coolers. 4E229 cools the 3rd stage discharge of the air machine, low case 4GC223A, to condense water and to keep the 2nd stage suction cool. Air enters 4E229 at 190 psig and 314°F. It is cooled to 60°F (depending on ambient conditions). The outlet temperature is controlled by 4TIC1507 which controls the louvers. The air leaving 4E229 goes to 4F225, 3rd Stage Air Compressor Separator, where condensed water is removed. The 4E229 outlet temperature should not be allowed to run below freezing or ice will form in the tubes.

4E248A/B ***PROCESS AIR COMPRESSOR LUBE OIL COOLERS*** SYSTEM 71

These horizontal tube exchangers are located on top of the 4F271, Air Machine Lube Oil Reservoir. 4E248A/B are used to cool the lube oil going to the Process Air Compressor, 4G223, bearings by transferring the heat to the cooling water on the tube side of 4E248s. The oil picks up heat from the bearings and returns to 4F271, the oil reservoir, where the 4G234 lube oil pumps it back to the 4E248s.

Note: Care should be taken to bleed all air from the oil side before putting 4E248s in service.

4E249 ***PROCESS AIR COMPRESSOR STEAM COIL*** SYSTEM 71

See 4F271 Process Air Compressor Lube Oil Reservoir.

4E267 ***PROCESS AIR COMPRESSOR TURBINE GLAND CONDENSER*** SYSTEM 71
4E285 ***PROCESS AIR COMPRESSOR TURBINE GLAND CONDENSER EJECTOR***
4H271 ***PROCESS AIR COMPRESSOR GLAND EJECTOR SILENCER***

4E285 is located on the southwest side of the 4G223, Process Air Compressor. Its purpose is to produce a low pressure zone between the labyrinth seals on the turbine by educting leak-off steam through the gland condenser, 4E267. This low pressure zone prevents steam leak-off from entering the bearing housing, thus avoiding damage to the bearings and contamination of the oil with water. The ejector 4E285 is equipped with silencer 4H271 to reduce noise produced by jet ejector.

4F220 ***PROCESS AIR COMPRESSOR TURBINE DRAIN POT*** SYSTEM 71

This vessel is located under the Compressor Deck on the east side of the air compressor 4G223. Any steam condensing in 4GT223 turbine case drains into 4F220. Because it operates under a vacuum draining, 4F220 requires isolating it from the turbine and breaking the vacuum. DO NOT open any bleeds or drains on the drain pot unless it is isolated from the turbine, as this will allow air to be pulled into the exhaust trunk and could effect vacuum on the condensers, which in turn will cause an increase in exhaust temperature. 4F220 is drained once every 12 hours under normal operation.

4F222 ***1ST STAGE AIR SEPARATOR*** SYSTEM 71
4F224 ***2ND STAGE AIR SEPARATOR***
4F225 ***3RD STAGE AIR SEPARATOR***

These separators are located outside on the west side of the Compressor Building by the air machine door. Each time air is compressed in the air machine and cooled in the intercoolers, the water in the air is condensed. This water has to be removed or it will damage the air compressor. After each of the first three stages of compression the air is cooled in air cooled exchangers 4E223, 4E227, and 4E229. Water and air are separated in the separators after each cooler. The levels in the separators are controlled by 4LIC807, 4LIC810, and 4LIC813. The water goes to the General Effluent Sewer (GES). These separators are equipped with high and high high level alarms. If the separator carries over water, it will damage the air compressor. Each separator can be drained manually.

4F240A/B ***PROCESS AIR COMPRESSOR LUBE OIL FILTERS*** SYSTEM 71

These 10 micron oil filters are located at the south end on the Lube Oil Reservoir, 4F271. They filter any contaminants larger than 10 microns out of the lube oil. The pressure drop across the filter can be monitored on 4PDI1443 and will alarm when the differential pressure is high. If this differential is rising rapidly, it may be due to water in the oil. This may be caused by loss of vacuum in the gland condenser. The loss of vacuum is usually caused by turbine steam warm-up lines being left open on one of the four compressors in the Compressor Building. When switching filters/exchangers, be sure to bleed all air off the filter and the exchanger you are switching to.

4F252 ***PROCESS AIR COMPRESSOR COUPLING OIL FILTER*** SYSTEM 71

The .5 micron filter is located on the south east side of the 4G223A, Low Case Process Air Compressor. It filters impurities larger than .5 microns out of the lube oil going to the three couplings on the Process Air Compressor, 4G223. The filter should be bypassed and changed when 4PDI1445 reaches a high pressure.

Note: The couplings on all major compressors have now been changed to a "dry" system. The coupling oil system has been drained, blocked, and tagged. The coupling oil will be placed in service if a coupling becomes hot and/or by Maintenance direction.

4F271 ***PROCESS AIR COMPRESSOR LUBE OIL RESERVOIR*** SYSTEM 71

The reservoir is located west of 4G223, Process Air Compressor, in the Compressor Building. The reservoir holds approximately 2600 gallons or 50 drums of Union Turbine Oil ISO VG-32. It is equipped with a sight glass, steam heater, and a low level alarm, 4LSL1803. The oil is circulated through the bearings, controls the governors, and lubricates the couplings of the air compressor, 4G223. The steam heater, 4E249, is used to keep the reservoir warm when the compressor is shut down. The steam is controlled manually.

4F279 ***PROCESS AIR COMPRESSOR GOVERNOR LUBE OIL FILTER*** SYSTEM 71

Located on the south side of the Air Compressor Lube Oil Skid, this is a 25 micron filter equipped with a high differential pressure alarm, 4PDSH2419. This unit filters oil for the Governor System, which is used as part of the trip system holding the T&T in the open position. See MSDS for Turbine 32 Oil.

4GC223A ***PROCESS AIR COMPRESSOR HIGH PRESSURE CASE*** SYSTEM 71
4GC223B ***PROCESS AIR COMPRESSOR LOW PRESSURE CASE***
4GCT223 ***PROCESS AIR COMPRESSOR TURBINE***

4GC223 is located in the Compressor Building on the south end. Its purpose is to supply 540 psig process air to the secondary reformer (4D200). This is accomplished by taking air from the atmosphere and compressing in two stages of the 4GC223B, low case. This air at 92 psig then goes to the 4GC223A, high case, where it goes through two more stages of compression. The air now at 540 psig is sent to the reformer for preheating. The compressor is driven by 4GCT223, a 13,000 horse power turbine, that uses 550 psig and 50 psig steam (the majority of it being 50 psig). This turbine has two T&T valves and two chest valves, each with their own actuator, driven by the governor. The 550 psig steam drives the first three wheels of the turbine, then mixes with 50 psig steam and drives the second half of the turbine exhausting into a vacuum in the 4E225 condensers. This turbine drives the low case, which through 4GC223 speed increases gear drives the high case. This gear speed increaser almost doubles the speed of the high case. In winter operations hot gas must sometimes be circulated back to the first stage suction to prevent freezing of the suction line screen. Emergency make-up to the instrument air header comes off the FOURTH stage suction of the air compressor.

4GG223 ***PROCESS AIR COMPRESSOR GEAR (SPEED INCREASER)*** SYSTEM 71

Located between the low case and high case of the air compressor, this gear speed increaser takes the low case shaft speed and multiplies it by a factor of 1.9 times. The high case input shaft is coupled to the output shaft of the gear speed increaser. Because the gear increaser generates considerable heat during normal operation, a large flow of lubricating oil is directed through the unit. The four local TIs should be monitored, as well as the return oil line sight glass, for adequate lubrication and cooling.

4G234A/B ***PROCESS AIR COMPRESSOR MAIN & AUXILIARY LUBE OIL PUMPS*** SYSTEM 71
4GT234A ***PROCESS AIR COMPRESSOR MAIN LUBE OIL PUMP TURBINE***

These pumps are located on top of 4F271 Process Air Compressor Lube Oil Reservoir. The pump is submerged in the reservoir and supplies oil to the governor, the bearings, and the couplings of the air machine. 4G234A is powered by a 40 horse, 550 psig steam driven turbine, 4GT234A, which exhausts to the air compressor steam condenser. 4G234B is powered by a 50 horse electric motor which is normally in an auto standby mode. When 4PSL1442 on the discharge of the pumps is tripped, 4G234B will start if the switch is in AUTO. When starting the compressor in freezing conditions, use the 4G234B to avoid freezing the 4E225 condensers. Switch to 4G234A after the turbine is up and running. During normal conditions the start switch for 4G234B should always be kept in the auto mode.

4H249 ***AIR VENT SILENCER*** SYSTEM 71

This silencer is located outside on the southwest end of the Compressor Building at the roof level. 4FV186 is the anti-surge valve for the air compressor, 4G223. When starting up the compressor, 4FV186 is open to prevent surge; it vents to the atmosphere. 4H249 has been installed for personal protection. Air is also vented when we are at very low rates or during plant upsets.

4H259 ***PROCESS AIR SILENCER*** SYSTEM 71
4H263 ***BALANCE DRUM VENT SILENCER***
4H264 ***1ST STAGE IN-LINE DISCHARGE SILENCER***

4H265 ***2ND STAGE IN-LINE DISCHARGE SILENCER***
4H266 ***3RD STAGE IN-LINE DISCHARGE SILENCER***

These silencers are located on the suction (4H259), on the first stage balance line (4H263), on the first stage discharge (4H264), on the second stage discharge (4H265), and on the third stage discharge (4H266) of the Process Air Compressor, 4G223. While compressing the air, a great deal of noise is produced. These silencers have been installed for personal protection.

Study P&IDs

The following Process & Instrument Diagrams (P&IDs) were studied during the PHA:

P&ID	DESCRIPTION	LATEST REVISION
R1I-1050	Process Air Compression	Rev. 10
R1I-1051	Process Air Compression and Turbine	Rev. 10
R4I-4100	Process Air Compression	Rev. 7
R4I-4110	Air Compressor Steam Condensers	Rev. 5
R4I-4130	Air Compressor Steam Condensers	Rev. 5

Due to the size of the P&IDs used for this study, the actual drawings will not be included in this report. The P&IDs used during the study have been retained by Agrium Kenai Nitrogen Operations, PSM Group, and will be maintained in the PHA Revalidation P&ID file drawer.

Other Available PSI

Operating Procedures, Standard Operating Conditions and Limits (SOCLs), and Material Safety Data Sheets were available for review by the revalidation team as needed. Included in the SOCLs are the consequences of deviating from established safe operating limits. Design criteria and maintenance history for relief devices in this system were available for review as necessary.

2.0 RECOMMENDATIONS

Along with appearing in the revalidation study sheets, suggested recommendations identified by the study team are documented below.

The recommendations are numbered based on the attachment/worksheet in Section 3.0 where the cause/consequence scenario and the recommendations are documented. If there is more than one recommendation per worksheet, they are numbered chronologically. This list is to be used by management to resolve and document resolution of the suggested actions by the Process Hazards Analysis Revalidation team.

RECOMMENDATION: 5-1

Correct R4I-4100 to show 2”AP2021-A tying into 18”AP2010-A downstream of 4H265.

(Reference: Attachment 5)

RECOMMENDATION: 5-2

Correct R4I-4130 to show 4PSV5926 instead of 4PSV4926.

(Reference: Attachment 5)

RECOMMENDATION: 6-1

Team discussed the addition of the 3rd Air Compressor and determined that there are some issues with it that were unknown at the time of the initial project PHA for Big Blue. Armed with the operating experience we have now, the Team feels that it would be prudent to perform a new PHA on Big Blue.

(Reference: Attachment 6)

RECOMMENDATION: 6-2

Update Plant 1 Training Plan for board operators to reflect installation of DCS.

(Reference: Attachment 6)

RECOMMENDATION: 6-3

Plant 1 Operations to develop a specific list of DCS issues and DCS group to resolve Plant 1 DCS issues.

(Reference: Attachment 6)

RECOMMENDATION: 6-4

P&ID’s in both Plants 1 & 4 need to be updated to remove all reference to high level air machine separator trips.

(Reference: Attachment 6)

RECOMMENDATION: 6-5

Need to get SOCL alarm points more in line with actual limits that were set up on old alarms. Example: absorber bottoms SOCL low limit is 0% and high is 100%. Note from JAT: Review all SOCL alarm settings and change HH or LL as appropriate. After SOCL review & changes, consider adding a menu button to give operator the option of silencing all ‘operator settable’ alarms.

(Reference: Attachment 6)

RECOMMENDATION: 8-1

PSM Coordinator to review strategy of headers/footers with Technical Services Superintendent.

(Reference: Attachment 8)

RECOMMENDATION: 10-1

Emergency Response Coordinator to check to see if there is a requirement to periodically change out breathing air bottles or hydrostatic testing and to check and see if existing supply has ever been changed.

(Reference: Attachment 10)

RECOMMENDATION: 11-1

ART to review safety meeting records and identify areas for improvement.

(Reference: Attachment 11)

RECOMMENDATION: 13-1

Add platform by Plant 1 50# T & T.

(Reference: Attachment 13)

RECOMMENDATION: 13-2

Develop and implement a plan to resolve the long outstanding problems with the heating and cooling system in the Plant 4/5 Control Room.

(Reference: Attachment 13)

3.0 STUDY WORKSHEETS & ATTACHMENTS

The following attachments were used throughout the PHA Revalidation and may be found on the following pages:

Attachment 1	Revalidation Agenda
Attachment 2	Initial PHA Content Checklist
Attachment 3	Baseline PHA Screening Checklist
Attachment 4	Discussion of Recommendations from Baseline PHA
Attachment 5	Change Evaluation Checklist to Identify Undocumented Changes
Attachment 6	Operations Change Evaluation and Wrap-up Checklist
Attachment 7	Maintenance Change Evaluation and Wrap-up Checklist
Attachment 8	Engineering Change Evaluation and Wrap-up Checklist
Attachment 9	Inspection Change Evaluation and Wrap-up Checklist
Attachment 10	Emergency Response Change Evaluation and Wrap-up Checklist
Attachment 11	Safety Group Change Evaluation and Wrap-up Checklist
Attachment 12	General Change Evaluation and Wrap-up Checklist
Attachment 13	Human Factors Issues/Checklist
Attachment 14	Previous Incident Reports Checklist
Attachment 15	Evaluate Potential Off-Site Consequences Worksheet
Attachment 16	Additional Areas "What-If" Worksheets
Attachment 17	Revalidation Guideword Checklist
Attachment 18	Risk Ranking Matrix