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# U.S. DEPARTMENT OF ENERGY

# WASTE ISOLATION PILOT PLATN

# COMPRESSED AIR (CA00)

# SYSTEM DESIGN DESCRIPTION (SDD)

# **SDD CA00**


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For

U.S. Department of Energy

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| REV. NO. | REV. DATE | PAGES/SECTIONS AFFECTED | APPROVED BY |
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| 0 | 11/91 | Sections 1.0, 2.0, 3.0, 3.3 | ECP 1-CA91-170<br>ECO No. 5822 |
| 1 | 3/92 | Added Section 2.12 | ECP 1-CA92-54<br>ECO No. 6085 |
| 2 | 8/93 | Revised Section 1.0, 2.0, 3.3, & App.<br>Added Section 3.0, 4.0, 5.0, 6.0, 7.0 | ECP 1-CA91-170<br>ECO No. 6841 |
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| 3 | 8/96 | Page: 5-4<br>Section: Table 5.1-2 | ECO No. 8190 |
| 4 | 3/99 | Revised sections 1.0, 2.0, 3.0, 6.0, 7.0, and Tables | ECP 1-CA97-049<br>ECO No. 8618<br>ECP 1-GP97-111<br>ECO No. 8907<br>ECO No. 9263 |
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| 7 | 10/03 | Pages i, 3, 7, & 20 | ECO No. 10883 |

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| 8 | 05/04 | Sections 1.0, 2.1.4, 2.1.7, 3.1<br>Appendices B, C, H<br>Figure 3.2-1 | ECO No. 11008 |
| 8 | 05/04 | Appendices B, H | ECO No. 11008<br>Add. 1 |
| 9 | 01/06 | Sections 1.0 and 2.0 | ECO No. 11320 |
| 10 | 01/08 | Summary<br>Page 4 CA05 Bullet<br>Steps 2.1.4 (E), 2.1.5, 2.1.14, Table 2-1 | ECO No. 11425 |

# COMPRESSED AIR SYSTEM
# SDD CA00

## SUMMARY

The Compressed Air system consists of the equipment required to generate and distribute compressed air throughout the WIPP site. Compressed air is used for operation of various pneumatic devices on the surface and underground. Compressed air which has had additional drying and filtering is supplied in surface facilities for use as instrument air. The system also consists of a high pressure compressed air system for breathing air systems, local, high pressure compressed gas distribution systems and a cooling system for the reciprocating compressors.

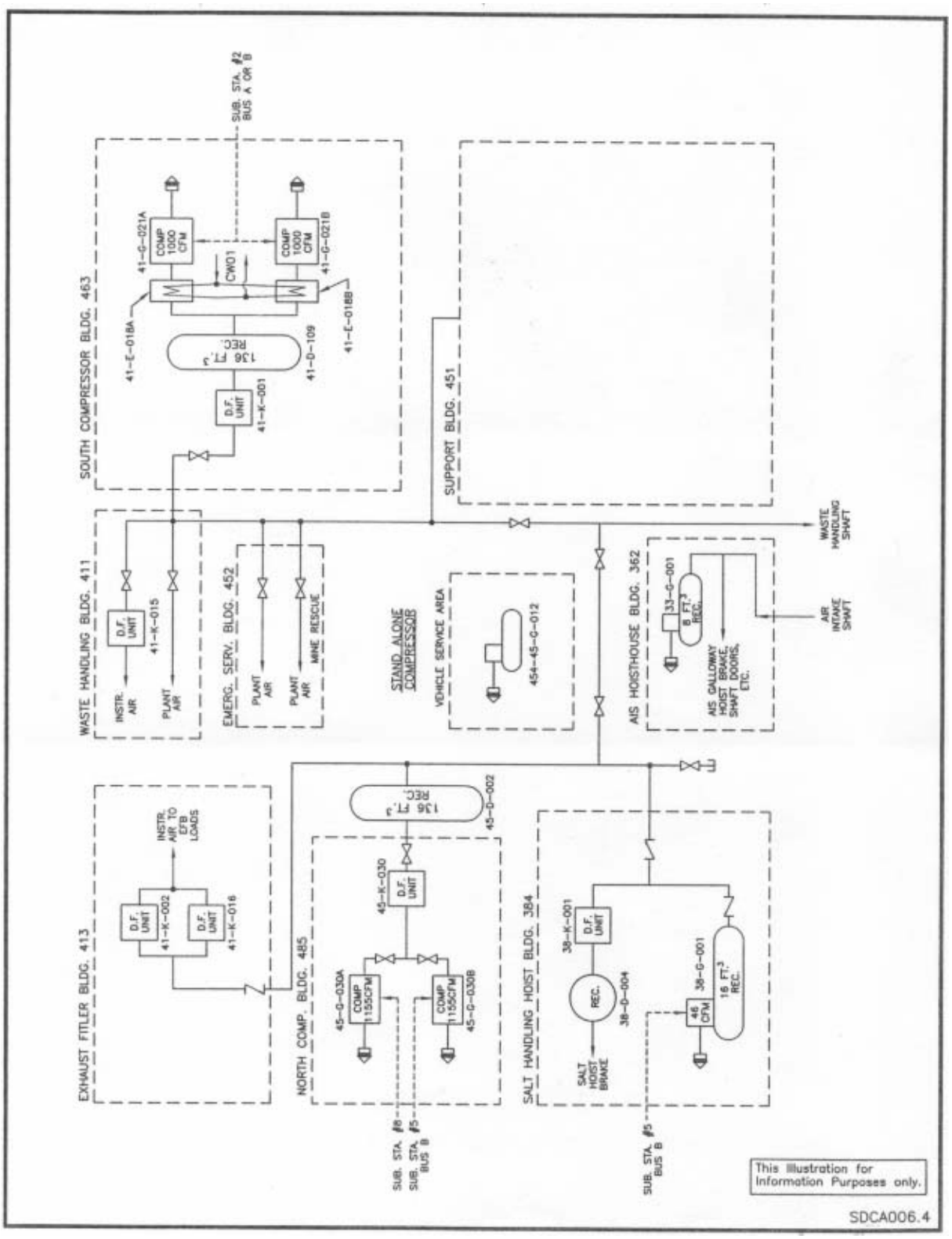


Figure 1 – Surface Compressed Air Supply and Interconnection Diagram

COMPRESSED AIR (CA00)
SYSTEM DESIGN DESCRIPTIO (SDD)

## 1.0 SYSTEM DESCRIPTION

The following is a general narrative of the overall system. Detailed information concerning system configuration and specific components is provided in the equipment and instrument registers maintained in the Engineering File Room. A functional diagram of the system is shown in Figure 1.

The system CA00 is made up of the following subsystems:

- CA01, the surface plant air distribution and compression subsystem, deals with generating compressed air and distributing it throughout surface facilities. This air is used to operate various pneumatic devices and is defined as plant air. The main (north) compressor station is located in building 485 and is composed of two 1155 scfm air cooled, screw type units, connected to a common dryer/filter unit and receiver tank. The backup (south) compressor station is located in building 463 and is composed of two 1000 cfm piston type units with a dryer/filter unit and receiver tank. The south station employs a water cooling system (CW01) to remove heat from the piston type compressors. In the event that both the main and backup systems fail to supply enough compressed air, smaller supplemental compressor units are located in the Salt Hoist Building, and AIS Hoist house Building. These are linked together and valved such that failure of one source will allow air to be supplied from other sources. These compressors are all driven by electric motors. Each receiving tank has a pressure relief valve installed, as do each of the compressors.

- There is one compressor system which is physically isolated from the main plant system. It is located adjacent to Building 455 where it is used for pneumatic tool operation, vehicle service, and other uses as required.

- CA02, the instrument air subsystem, cleanses the air further of moisture and oil and distributes it for instrument use. This is accomplished via dryer/filter units located in the Waste Handling Building and the Exhaust Filter Building. The dividing points between CA01 and CA02 are the inlet valves to the dryer package.

- CA03, the underground air distribution system, distributes plant air to the underground via air line in the waste shaft. A backup diesel powered screw-type compressor (System AU04) is available underground should the CA01 compressors fail to provide adequate

air. The dividing point between CA01 and CA03 is the isolation valve at the collar of the shaft.

- CA04, the breathing air cylinder recharging system, is a stand-alone system used to recharge the self contained breathing apparatus bottles. It is located in building 463 and is comprised of a four stage high pressure compressor, an air cleaning station, a bottle fill station, and a bottle storage station. Air is compressed to 5000+ psig, cleaned of oil, carbon monoxide and other impurities, and then directed to the storage bottles. Storage bottle pressure is nominally 4500 psig.

- CA05, the compressed gases subsystem, is comprised of four stand alone distribution systems for bottled gases:

  Bldg. 452 Nitrogen is used by the counting lab for processing dosimetry.

  Oxygen is used for refilling breathing air packs used by the Mine Rescue Team(s).

  Bldg. 453 Nitrogen, argon, and helium are used by Quality Assurance to test TRUPACT O-rings.

  Bldg. 459 Caron monoxide, nitrogen, oxygen, methane, hydrogen sulfite, and nitrous oxide gases are used for calibrating gas monitors.

- CW01, the cooling water subsystem, is used to remove heat from the Ingersoll-Rand large piston type compressors (System CA01). An ethylene glycol and water mixture is used as the coolant. Ethylene glycol is used in the coolant to protect against freezing. Heat is removed from the coolant via a forced air heat exchanger. The dividing points between this system and the rest of the water distribution system (WD00) are the pipe connections to the coolant pumps. The dividing points between CW01 and CA01 are the piping connections to the compressors.

## 2.0 DESIGN REQUIREMENTS

The functional classifications are defined in the Documented Safety Analysis and the General Plant Design Description.

The system will be capable of delivering compressed air in accordance with the parameters specified in Appendix C. This appendix identifies the specific quantities, pressures, and qualities of compressed air needed at various locations throughout the site.

2.1 Summary

The following requirements must be maintained during any design modification and reestablished following any maintenance performed on the system.

2.1.1 The design of mechanical equipment and pressure circuits shall be in conformance with ANSI, ASME and other related standards listed in Codes and Standards Section of this SDD.

Air receivers shall be designed, fabricated and stamped to the ASME Pressure Vessel Code, Section VIII, Division I.

Air receiver tanks shall be equipped with one or more automatic pressure relief valves. The total pressure relieving capacity of the relief valves should prevent the pressure rising more than 10% above the rated operating value.

Wall thickness of piping system components shall be increased over that required by loading criteria, to allow for corrosion consistent with the specified service life of the piping. Piping smaller than ½" nominal size shall not be used except in instrument services and in auxiliary services, such as compressor pump trim piping or compressed gas uses. Pipe supports shall be provided as needed for the support and flexibility of the overall piping system. Such supports shall conform to applicable design codes.

2.1.2 The design of the electrical systems and equipment shall be in conformance with the National Electric Code, NFPA 70, and the other electrical standards listed in Codes and Standards Section of this SDD.

2.1.3 The operation of breathing air cylinder recharging equipment shall be per WIPP Operations Procedure WP 12-ES1124, Operation of Breathing Air Compressor.

2.1.4 The Compressed Air System (CA01) shall meet the following overall functional design requirements:

A. UTILIZE ambient air, where necessary filtered for radioactive particulate to the standards required by 10 CFR 835.

B. Receive electrical power from the terminals of the electrical system distribution boards and motor control centers. Electrical supplies to the various compressors in the facility shall be taken from different substations so that loss of a single substation or bus will not result in loss of compressed air in the facility.

C. Provide compressors, dryers, receivers, filters, valves, cooling systems, piping, and related control and instrumentation systems as needed to deliver compressed air to the users listed in the Secondary Interface Section of this document. Where air receivers form part of modular air compressor unit's interconnections shall be provided between the air receivers on those units and the interconnecting plant air lines so that the dryers can be operated when their associated compressors are inoperative.

D. Provide compressed air at conditions and quantities in accordance with the parameters listed in Appendix C of this SDD.

The Plant Air Subsystem (CA01) shall meet the following overall functional design requirements:

E. The main plant compressed air supply shall be provided by a single major pumping station. This station shall be equipped with two compressor units sized so that under normal conditions only one will be operating. An additional air compressor station shall be available equipped with two units either of which shall be capable of meeting total plant compressed air requirements in the event of the unavailability of the main pumping station described above. Modular air dryer units shall be provided in the Exhaust Filter Building and Waste Handling Building, capable of meeting compressed air requirements for instrument air in those buildings.

F. The connection between the modular units described and the interconnected plant air system shall be by way of check valves. The function of these valves will be to ensure that, in the event of the unavailability or failure of the main and backup air supply systems previously described, these units can start up and supply loads in the building in which they are located without being overloaded by the remainder of the facility air demand.

G. The Instrument Air Subsystem (CA02) shall meet the following overall functional design requirements:

- Air dryers providing instrument air may be either separately supplied from the interconnecting plant air piping or may be associated with individual air compressors.

- See Paragraph 2.1.9 for specific requirements for compressed air dryers.

The following specific requirements apply to Compressed Air system equipment. Design of Balance of Plant equipment shall conform to normal

commercial/industrial practice for fabricating air compressors and shall utilize manufacturers accepted product specifications.

2.1.5 The compressed gas systems shall meet the applicable requirements of the USCGA and OSHA. Tubing, piping and fittings used in the compressed gas system shall comply with Section 2 of ASME Code B31.9. No cast iron shall be used for handling compressed gases.

2.1.6 Compressed air to the underground mine shall be transmitted from the surface by pipes in at least one shaft which connect to the interconnected Plant Air System described above. An air line shall connect the Air Intake Shaft Hoist house with the underground air distribution system. A compressor shall be provided at both the Salt Handling and the Air Intake Shaft Hoist houses to ensure additional backup compressed air supplies for the hoist brakes at all times.

2.1.7 Air Compressor Essential Features

The types of compressors and the number of stages shall be determined based on design air flow, pressure and temperature requirements.

Air compressors and their attendant accessories shall be factory installed on single base plates, either individually (simplex units) or in pairs mounted on air receivers (duplex units).

Compressors shall be heavy-duty units with electric motor drives. Each compressor shall be equipped with an air intake filter/silencer, an inter-cooler and after-cooler (if required), and the associated interconnecting piping.

Compressors supplying the main plant work areas shall be located indoors.

Oil-free compressors shall meet the air quality standards required in ISA 57.3.

The intake air filter/silencer on each compressor shall reduce the near field noise to 95 db on the A weighted scale at a distance of 5 ft from the unit.

Modular Compressors and compressors in the main pumping station shall be equipped for completely automatic operation. Air delivery shall be checked by air receiver pressures. Pressure shall be sensed by regulating valves which activate loading and unloading mechanisms to maintain plant pressure. These compressors shall automatically restart when air pressure in the receiver drops to a predetermined level. The compressors shall stop and start unloaded. The connection between the modular units described and the interconnected plant air system shall be by way of check valves. The function of these valves will be to ensure that in the event of the unavailability or failure of the main and backup air supply systems previously described, these

units can start up and supply loads in the buildings in which they are located without being overloaded by the remainder of the facility air demand. Compressed air systems serving potentially contaminated areas shall be provided with double check valves to minimize the potential for system contamination during emergencies.

Compressors in the backup (south) compressed air station may be equipped for manual start-up and shutdown of the individual units.

Compressors in the main pumping station shall be equipped with automatic dual control. For normal air demands, one compressor shall run at either full load or no load. For peak load demands both compressors shall operate.

The backup compressor in the Salt Handling Hoist house shall be equipped with an automatic start-up system which is initiated when the pressure at the Hoist air brake compressed air supply falls to less than a predetermined value.

In accordance with MSHA requirements all reciprocating type air compressors rated over 10 HP shall be equipped with automatic temperature-actuated shut-off mechanisms. These mechanisms shall be set to operate when the normal operating temperature is exceeded by more than 25 percent.

A compressor shall be provided at the Air Intake Hoist house to ensure compressed air is available for hoist brakes.

### 2.1.8 Plant Air Filter/Dryer Essential Features

Dryer/Filter units shall be provided in conjunction with the compressors in the Main Compressor Station and in the Backup Station.

The units shall be capable of processing the entire output in each of their respective Stations.

Equipment provided shall include pre-filters, after-filters, interconnecting piping, instrumentation and controls.

The mode of operation shall make use of desiccant dryers.

Desiccant dryers shall be of the dual tower type with automatic and sequential cycling of the dual chambers. This will successively operate each tower as a dry air generator while the second tower is in the desiccant regenerative cycle.

Dryer towers shall be of welded construction conforming to the requirements of the ASME Boiler and Pressure Vessel Code, Section VIII, Division I, and shall be code stamped. Corrosion allowances shall be at least 1/8 inch.

The desiccant regeneration cycle shall be accomplished by using dry air from the operating (duty) tower to regenerate the desiccant in the tower undergoing purge without the use of internal or external heaters.

Refrigerant dryers shall be designed for continuous operation and shall not be cycled on and off in conjunction with associated air compressors as they respond to meet changing demand.

Control of the refrigeration system shall be designed to provide a constant coolant/refrigerant temperature drop in the refrigeration evaporator.

Input air shall be pre-cooled by the use of refrigerated outgoing air in a suitable air/air heat exchanger.

2.1.9 Instrument Air Filter/Dryer Design Criteria

Air dryers shall be the dual tower desiccant type designed for heatless regeneration and mounted in completely self-contained units. These units shall include pre-filters, after-filters, interconnecting piping, instrumentation and controls.

Dryer towers shall be of welded construction conforming to the requirements of the ASME Boiler and Pressure Vessel Code, Section VIII, Division I, and shall be code-stamped. Corrosion allowance shall be at least 1/8 inch.

On dual filter units pre-filters and after-filters shall be arranged with piping and manual isolating valves to allow continuous filtering while replacing one set of filter cartridges.

Each prefilter shall be the disposable cartridge type, capable of removing 99 percent of the incident entrained water and oil droplets without damage to filter media. The filter shall be equipped with automatic drain trap assembly.

Each after-filter shall be the disposable cartridge type, capable of preventing any carryover of granular desiccant into the air system. The filter case shall include a drain connection. The filter shall retain 100 percent of particles 0.9 microns and larger at the specified rated flow.

The desiccant regeneration cycle shall be accomplished by using dry air from the operating (duty) tower to regenerate the desiccant in the tower undergoing purge without the use of internal or external heaters.

Air dryers shall be provided with automatic and sequential cycling of the dual chambers. This will successively operate each tower as a dry air generator while the second tower is in the desiccant regenerative cycle.

Air dryers shall be designed to fail with inlet valves open to permit air to pass through both towers and continue to supply air for a minimum of 4 hours in the event of failure of electrical power.

2.1.10 Underground Air Distribution Essential Features

An additional air-line is installed in the Air Intake Shaft (AIS) to supply compressed air underground.

A mobile diesel driven air compressor will be provided to supply air to areas of the mine where compressed air distribution piping is not available.

In the event that all normal air supplies from the surface are lost, this emergency diesel compressor may be connected to the mine underground distribution system as a backup supply.

2.1.11 Breathing Air Essential Features

A compressor shall be supplied for recharging commercial compressed air cylinders at a nominal pressure of 5000 psig (cylinders are filled to 4500 psig).

The capacity of the recharging compressor shall be based on a requirement to supply 4 persons engaged at moderate work level requiring 1.5 scfm per person for a period of 4 hours.

The rated service life for each cylinder under the conditions described in the previous section shall be 30 minutes.

The quality of the breathing air shall be grade D or better, as specified in the Compressed Gas Association Common Specification for Air, G-7.1, ANSI 286.1.

2.1.12 Essential Features of Compressed Gas Equipment

Gas bottles shall be supported in permanent racks in such a manner that each bottle is held vertical and is locked in place by a chain or by steel bottle straps. No straps shall be used which could fail to support the bottles in case of a fire.

Tubing, if used for compressed gases, shall be bent around corners and obstructions using a minimum radius of five diameters.

The gas within the tubing or piping shall be identified by permanent labels attached to the tubing or piping spaced every four to six feet along the tubing or piping.

Gas bottles shall be transported, stored, and used in the vertical position only except for momentary periods used for handling or lifting the bottles. The protective caps which cover the valve at the top of the bottle shall be in place at all times except when the bottle is in use.

When a gas bottle is connected to a system or is in use, the valves on the gas bottle shall be opened and shall be protected against tampering.

Before use or connection to a system, a gas bottle shall be inspected visually and shall be determined to be safe for use insofar as this is possible with a visual inspection.

2.1.13 Cooling Water Equipment Essential Features

Design of this equipment shall be based on the use of ethylene glycol/water coolant.

Water cooling systems shall be closed loop with circulating pumps, fans, and finned radiators for air cooling of the cooling water. Outdoor location is permissible.

Pumps shall be horizontal, single stage, centrifugal type, directly coupled, and complete with non-overloading Totally Enclosed Fan Cooled (TEFC) motors.

Pumps shall be rated, constructed and certified in accordance with HI standards as noted in Codes and Standards Section of this SDD.

The air cooled exchanger shall be a self contained packaged unit designed to cool a 35 percent ethylene glycol solution to within 15°F of ambient air temperature.

A fan or fans shall be provided to draw air through the coils. The fans shall be equipped with direct drives and TEFC motors.

A surge tank shall be provided on the air cooled exchanger. The tank shall be of heavy gauge steel construction and equipped with a sight glass.

A thermal mixing valve shall be included in the cooling circuit to prevent thermal shock to the compressors.

2.1.14 Piping Design Criteria

Design of the Compressed Air piping system shall be in accordance with the American National Standard Code for Pressure Piping ASME B31.9, "Building Services Piping."

Piping components including valves shall be designed to be suitable for operation under the external service conditions applicable to the WIPP site specified in Appendix F, and also included in the technical specs in Appendix G.

The following general design features shall apply to the design of the Compressed Air piping system.

Piping shall be arranged for ease of operation accessibility, maintenance, economy and appearance.

Piping shall be arranged to provide low point drains and high point vents and shall have protection against the possibility of moisture traps freezing in cold weather.

Sizing of piping shall be based on process or utility design basis parameters, such as flow rates, temperatures, pressures, and distances, taken in conjunction with allowable pressure drop and loading.

TABLE 2-1 – Applicable Codes and Standards

| SUBJECT | NUMBER | TITLE |
|---|---|---|
| American National Standard Institute (ANSI) | C37.20 | Switchgear Assemblies Incl. Metal Bus |
| ANSI | Z55-1 | Gray Finishes for Indus. Apparatus |
| ANSI | Z86.1 | Commodity Specification for Air (CGA G-7.1) |
| ASHRAE | 52-76 | Method of Testing Air Cleaning Devices |
| American Society Of Mechanical Engineers. (ASME) | Section II | ASME Boiler and Pressure Vessel Code, Material Specification |
| ASME | B2.1 | Pipe Threads (except Dryseal) |
| ASME | B16.5 | Steel Pipe Flanges and Fittings |
| ASME | B31.1 | Power Piping, 1983 |
| ASME | B31.9 | Building Services Piping |
| ASME | B73.1 | Horizontal End Suction Centrifugal Pumps for Chem. Process |
| ASME | N509 | Nuclear Power Plant Air cleaning Units |

| SUBJECT | NUMBER | TITLE |
|---|---|---|
| ASME | N510 | Testing for Nuclear Air Cleaning System |
| ASME | Section V | ASME Boiler and Pressure Vessel Code, Nondestructive Examination |
| ASME | Section VIII | Boiler and Pressure Vessel Code, Pressure Vessels |
| ASME | Section IX | Boiler and Pressure Vessel Code, Welder Qualification |
| ASME | PTC 9 | ASME Performance Tesst Codes |
| ASME | SA 53 | Welded and Seamless Pipe |
| ASME | SA 285 | Lo and Inter. Tens. Plates for Press Vessel |
| ASME | SA 372 | Carbon Steel Forgings for Pressure Vessels |
| ASME | SA 516 | Carbon Steel Plates for Pressure Vessels |
| ASME | SFA-5.1 | Arc Weld Electrodes |
| ASME | SFA-5.5 | Lo Alloy Weld Electrodes |
| ASME | SFA-5.11 | Nickel and Nickel-Alloy Covered Welding electrodes |
| ASME | SFA-5.14 | Nickel and Nickel-Alloy Bare Welding Rods and Electrodes |
| American Society for Testing and Materials (ASTM) | A 6 | General Requirements for Rolled Steel Plates, Shapes, Sheet Piling and Bars for Structural Use |
| ASTM | A 29 | Steel Bars, Carbon and Alloy, Hot-Rolled and Cold-Finished |
| ASTM | A 36 | Structural Steel |
| ASTM | A 48 | Gray Iron Castings |
| ASTM | A 276 | Stainless and Heat-Resisting Steel Bars and Shapes |
| ASTM | A 283 | Low and Intermediate Tensile strength Carbon Steel Plates, Shapes and Bars |
| ASTM | D 1056 | Flexible Cellular Materials – Sponge or Expanded Rubber |
| American Welding Society (AWS) | A 5.12 | Tungsten Arc-Welding Electrodes |
| AWS | D 1.1 | Structural Welding Code-Steel |
| Anti-Friction Bearing Manufacturer's Association (AFBMA) | Std. 8.2 | Ball and Roller Bearings Mounting Accessories |
| AFBMA | Std. 9 | Load Ratings and Fatigue Life for Ball Bearings |

| SUBJECT | NUMBER | TITLE |
|---|---|---|
| AFBMA | Std. 11 | Load Ratings and Fatigue Life for Roller Bearings |
| Compressed Air & Gas Institute (CAGI) | PNEUROP-69 | Test Code for the Measurement of Sound |
| Hydraulic Institute (HI) | 14th Ed-83 | Standards for Centrifugal, Rotary and Reciprocating Pumps |
| Instrument Society of America (ISA) | RP 7<br>1 | Pneumatic Control Circuit Pressure Test |
| ISA | 57.3-75 | Quality Standard for Instrument Air |
| Insulated Power Cable engineers Association (IPCEA) | S-58-516 | Standards for Ethylene – Propylene – Rubber Insulated Wire and Cable for the Transmission and Distribution of Electric Energy |
| National Electrical Manufacturers Association (NEMA) | CC 1 | Electrical Power Connectors for Substations |
| NEMA | ICS 1 | General Standards for Industrial Controls and Systems |
| NEMA | ICS 4 | Terminal Blocks for Industrial Control Equipment and Systems |
| NEMA | ICS 6 | Enclosures for Industrial Controls and Systems |
| NEMA | MG 1 | Motors and Generators |
| NEMA | MG 2 | Safety Standards for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators |
| Steel Structures Painting Council (SSPC) | PA 1 | Shop, Field and Maintenance Painting |
| SSPC | PA 2 | Measurement of Dry Paint Thickness with Magnetic Gauges |
| SSPC | PS 8.01 | Rust Preventive Compounds (Thick Film) |
| SSPC | SP 1 | Solvent Cleaning |
| SSPC | SP 2 | Hand Tool Cleaning |
| SSPC | SP 3 | Power Tool Cleaning |
| SSPC | SP 6 | Commercial Blast Cleaning |
| SSPC | SP 10 | Near-White Blast Cleaning |
| SSPC | Vis 1 | Pictorial Surface Preparation Standards for Painting Steel Surfaces |
| Tubular Exchange Manufacturers Association | Class C-78 | Tubular Exchange Manufacturers Association Standards |
| Underwriters Lab | UL 900-82 | Test Performance of Air Filter Units |

| SUBJECT | NUMBER | TITLE |
|---|---|---|
| U.S. Depart of Labor, Occupational Safety and health Administration (OSHA) | | The Compressed Air System will be designed in accordance with the applicable standards contained in 29 CFR 1910 and 29 CFR 1926 (commonly called OSHA). |
| U.S. Department of Energy (DOE) | Order 5480.1B | Environmental, Safety and Health Program for DOE Operations |
| DOE | Order 420.1B | Facility Safety |
| DOE | Order 430.1B | Real Property Asset Management |
| DOE | DOE/CAO-94-1012 | Quality Assurance program Document |
| DOE | ERDA 76-21 | Nuclear Air Cleaning handbook |
| Nuclear Safety Management Quality Assurance Requirements | 10 CFR 830.120 | Quality Assurance Requirements |
| U.S. Mine Safety and Health Administration (MSHA) | 30 CFR Part 29 | Portable Coal Dust/Rock Dust Analyzers and Continuous Duty, Warning Light, Portable Methane Detectors for Use in Coal Mines |
| MSHA | 30 CFR Part 57 | Safety and Health Standards – Underground Metal and Nonmetal Mines |
| MSHA | 30 CFR Part 75 | Mandatory Safety Standards - Underground Coal Mines |

## 3.0 SYSTEM OPERATION AND PRECAUTIONS

### 3.1 Operation

The system is operated from control panels located on the individual components and by isolation valves located throughout the system. The control panels have all necessary controls for starting, stopping, and running the compressors, dryers, and other components. The control panels include displays of system parameters and alarms. Key system parameters and alarms are also displayed in the Central Monitoring Room (CMR). Additionally, the main compressors can be remotely stopped from the CMR.

Operation of the compressors is controlled by the individual control panels located on the compressor units. The main north compressors (Building 485) operate on a pressure/demand scheme. When pressure drops to a preset level the compressor(s) go to a full load condition. As pressure rises to a preset level, the compressor(s) unload and run in an unloaded scheme until the pressure once again drops and compression is needed. If one compressor is not able to keep up with demand, the alternate compressor of the pair will start and run. The backup main (south) compressors operate in a

similar manner except that as there is a demand for air, the compressors step from zero load through half load to full load depending on system pressure. The separate individual compressors operate similar to the main compressors. Reference the Operating Procedures for each compressor for further details and for detailed operation of these units.

The dryers in the Instrument air system are completely automatic and dry the air to -40 degree dew point using a dual tower desiccant drying arrangement. The control of these dryers is either by sensors in the dryer or by programmed timed cycle. Additionally, there is one refrigeration type air dryer at Salt Handling Shaft Hoist house. This unit is also completely automatic and dries to a 32 degree dew point.

Relief valves are installed on all compressors, all receivers (integral to compressors and separate), and all compressed air dryers. All reciprocating compressors over 10 horsepower have hi-temperature shutdown switches installed.

Operation of the diesel powered compressor underground shall be per vendor's operation and maintenance manual and per operating procedures.

The cooling system (CW01) is an integral part of the south compressor system to provide cooling for the reciprocating compressors. The cooling system is interlocked with the compressors via a flow switch. Loss of coolant flow will cause the compressor(s) to shut down. A thermal mixing valve is included in the circuit.

This valve allows for the bypassing of the heat exchanger until the coolant has warmed up to preclude thermal shock to the compressors.

## 3.2 Normal Operations

Normal operation consists of operation in such a way that the needs for compressed air are satisfied. This will require alignment of the valves in accordance with the needs of the users and the start-up of the compressor of choice to supply those needs. The LEAD compressor is started; the other compressor is placed in LAG (where two or more compressors are in the system); and the valves are aligned as needed by the users of the compressed air. After the start-up tests and observations have been completed allow the compressor to continue to operate. During the period of normal operation, perform the required periodic and recurring checks and maintenance as required for proper operation.

## 3.3 Precautions

Besides the normal electrical precautions, the following precautions are unique to the compressed air system.

- Do not attempt to service any compressed gas system part or tighten gas system fittings without first relieving the compressed air from the section of the system involved such that the maintenance may be conducted on an unpressurized component.

- An operable pressure relief valve must always be on the compressor side of any isolation valve or possible blockages (dryers, coolers, filters, etc.).

- Most compressors are belt driven. There are OSHA requirements for belt, sheave, and shaft guards to be in place to protect personnel.

- One of the most common causes of lubrication troubles is dirty intake air. Special attention must be paid to intake air filters.

- On the diesel engine driven compressor, never leave air pressure in the receiver when the engine has been shut down.

- Follow vendor recommendations on the use of cleaning solvents. Volatiles, high temperature, and/or compression can result in an explosion and fire.

- The diesel engine on the U/G compressor should only be cranked for starting 30 seconds in every 2.5 minutes.

- After any removal and replacement of the three phase electrical connections to a compressor drive motor, the direction of rotation should be observed on restart.

- Vendor recommendation must be followed for adding or removing ethylene glycol coolant. Any spills or releases of coolant materials are to be managed per site spill response procedures.

# APPENDIX A
# EQUIPMENT LIST

A complete listing of Equipment for Systems CA01, CA02, CA03, CA04, and CA05 are located in the Equipment Register which is located in the Engineering File Room. The equipment list contains the following information on equipment for the above systems: Equipment Status (Active or Inactive)

- Equipment Identification Number
- Superseded Number (if equipment has been superseded)
- Deleted Number (if equipment has been deleted)
- Description of the equipment
- System No.
- Functional Classification
- Capacity of the equipment
- Rating of the equipment
- Voltage of the equipment
- Facility Number (site location of the equipment)
- Room Number (specific location in a facility)
- Location (further detail on location)
- CH, RH, TRU-waste related
- Sub Equipment (Equipment related to item)
- Engineering Change Order Number (tracking mechanism for changes)
- Ops Category (Category which relates equipment to specific site documents)
- Fed from (Source of power for equipment)
- Manufacturer (Manufacturer of the specific equipment)

- Model Number
- Serial Number
- Loop Number (Instrumentation Loop number)
- Drawing Numbers (Other, P&ID, Location, Electrical, Panel)
- PO Number (Original Purchase Oder Number)
- Work Order Number (Work order number that installed or modified equipment)
- O&M on file (shows if O&M is on file in file room)
- OMM Spec. (WID Specification number for equipment)
- Comments section
- Purchase Date
- Property Tag Number

There are also equipment registers available for the following items in this system: valves, pipe lines, electrical panels, and conduits.

APPENDIX B
SYSTEM INTERFACES

| System Providing Service | Services to be Provided to CA00 |
|---|---|
| CM00 | Provide status monitoring of main plant compressors in System CA01and also provide monitoring of system pressure. CM00 also provides shutdown capability for main compressors 45-K-030-A & B. |
| ED00 | Provide normal electric power, lighting, safety grounding and cabling for system CA00 equipment comprising:<br><br>2 Ingersoll-Rand air compressor motors, 200 HP (each)<br>2 Atlas-Copco air compressor motors, 250 HP (each)<br>1 S.H. standby air compressor, 15 HP<br>2 Local facility air compressor units, 25 & 15 HP<br>2 Cooling water pumps for Ingersoll-Rand compressors, 5 HP (each)<br>5 Water cooling fans, 1 HP ea<br>2 Atlas-Copco Luboil Cooler Fans, 7.5 HP (each)<br><br>All above motors to be supplied at 480 V, 3-phase, 60 Hz.<br>Provide backup diesel power for one air compressor motor, 250 HP.<br><br>The interface between System CA00 equipment and interfacing electrical distribution systems will be at the electrical terminals of the supplying distribution boards of circuit breakers. Cabling between System CA00 components will also be supplied by System ED00. |
| FP00 | Provide protection from the consequence of a fire in System CA00 equipment identified in Appendix A of this SDD. |
| GC00 | Provide space, support, and embedment for System CA equipment as specified in Appendix A and for the associated piping and fixtures described in drawings for system CA00. Provide accessibility for inspection, maintenance and equipment removal. |
| HV00 | Provide environmental conditions for the operation of System CA equipment in surface facilities. |
| UH00 | Provide space and support for one 6-inch air pipe and its pipe hangers the full length of the Air Intake Shaft and for a 4-inch air pipe and its hangers the full length of the Waste Handling Shaft.<br><br>Provide a platform for use in performing maintenance and inspections of the air pipe and equipment in the Air Intake Shaft, and the Waste Handling Shaft. |
| WD00 | Provide makeup cooling water from the plant domestic water distribution system as needed to operate the Ingersoll-Rand compressor glycol/water cooling system. |

| System Providing Service | Services to be Provided to CA00 |
|---|---|
| AU00 | Provide plant air distribution system and a supply of plant air at a nominal pressure of 100 psig for use in underground storage and experimental operations.<br><br>Supply should be arranged so that loss of power from either of the two buses in the plant sub will not result in a loss of underground air supply. |
| GC00 | Provide a plant air distribution system which interconnects the following buildings and areas:<br><br>● Waste Handling Building<br>● Exhaust Filter Building<br>● S. H. Hoist Building<br>● Underground Facility<br>● AIS Hoist Building<br><br>Dimensions and control features of this system as required to coordinate the needs of individual systems described elsewhere in this Appendix.<br><br>Provide individual air compressor units as required to supply plant air to other Support Facilities, i.e.<br><br>● Vehicle Service |
| HV00 | Provide a supply of dry filtered instrument air at a nominal pressure of 100 psig to operate HV00 dampers and controls in the following buildings:<br><br>● Exhaust Filter Building<br>● Waste Handling Building |
| UH00 | Provide plant air to the Salt Handling Hoist Building and to the Air Intake Shaft Hoist.<br><br>Provide instrument air to the Waste Hoist.<br><br>A plant air compressor shall be provided at the Air Intake Shaft to provide the normal requirements for compressed air for operation of the brakes on the Galloway winch and to open the collar doors.<br><br>A backup plant air compressor unit shall be provided at the Salt Handling Hoist Building to ensure air supply required by the hoist brake system in the event of the failure of the main plant air supply system. |

| System Providing Service | Services to be Provided to CA00 |
|---|---|
| VU00 | Provide a supply of dry filtered instrument air at a nominal pressure of 100 psig to operate dampers and controls required for the operation of the main exhaust fans, the filtration exhaust fans, and the HEPA filters.<br><br>An alternate backup source of air should be provided so that failure of a single air compressor system will not result in loss of air supplied to this equipment |
| WH00 | Provide supplies of instrument and plant air as required to support the operation of WH00 equipment. |

APPENDIX C
OPERATING LIMITS

| System | Flow Limits cfm | Pressure Limits psig | Other |
|---|---|---|---|
| Plant Air Total | 2000 | 95-120 | |
| Waste Handling Building Instrument Air | 50 | 60-120 | -40° Dew Point |
| Atlas-Copco Compressors | 2000 | 90-125 | |
| Ingersoll Rand Compressors | 2000 | 90-120 | |
| Exhaust Filter Building Instrument Air | 100 | 80*-120 | -40° Dew Point |
| Salt Handling Shaft Hoist house | 46 | 95-120 | |
| Air Intake Shaft Area | Delivers 6 | 120 | |
| Vehicle Service Area | Delivers 50 | 120 ✺ | |
| Underground Compressor | 250 | 100 | |
| Salt Hoist Dryer | 50 cfm | 150 | 32° Dew Point |
| Atlas Copco Desiccant Dryer | 2000 cfm | 150 psig | 0° Dew Point |
| Ingersoll Compressor Desiccant Dryer | 2000 cfm | 150 psig | 0° Dew Point |
| Breathing Air | 18.7 | 5,000 – 5,025✺ | -40° Dew Point and 0 ppm of CO |

Note * To provide adequate pressure for proper damper operation
✺ There is no real lower limit.

# APPENDIX D
# PREVENTIVE MAINTENANCE SCHEDULES

Preventive Maintenance Schedules are controlled by the site Computer History and Maintenance Planning System (CHAMPS) which contains a listing of equipment for the system, a list of Preventive Maintenance Instructions (PMI), and a schedule for conducting these PMI's on a regular periodic basis. Listings of equipment PM's and schedules are available from the Work Control Center.

# APPENDIX E
# INSTRUMENTATION

A complete listing of Instrumentation for Systems CA01, CA02, CA03, CA04, CA05, and CW01 are located in the Equipment Register which is located in the Engineering File Room. The Instrument List contains the same type of information for the system instruments as the Equipment List does for system equipment. Additionally the Instrument List contains Alarm/Shutdown Setpoints for above equipment.

# APPENDIX F
# PARAMETER LIST

Listed herein are the significant parameters which relate to the design of the Compressed Air System Equipment.

Equipment Parameters are listed for the buildings or areas in which the equipment is located and according to the relevant subsystem.

**Ambient Conditions for Surface Compressed Air System Equipment**

| | |
|---|---|
| **Location** | **Indoors *** |
| **Atmosphere** | **Air** |
| **Elevation above Sea Level, ft.** | **3,410** |
| **Pressure psia** | **14.7** |
| **Indoor Temperature Range** | **65 To 95** |
| **Humidity Range, %** | **20 To 70** |
| **Outdoor Temperature Range,** | **19 To 110** |
| ***Unless noted otherwise** | |

# APPENDIX G
# ORIGINAL EQUIPMENT SPECIFICATIONS

| SPECIFICATION NUMBER | TITLE |
|---|---|
| 15058-014 | Fabrication and Installation of Piping |
| 15150-014 | Compressed Air Systems |
| 15155-014 | HEPA Inlet Filter Unit |
| 15157-014 | Compressed Air System Testing |
| E-L-315 | Compressed Air Piping |
| D-0060 | Piping Material Requirements |
| D-0061 | Fabrication and Installation of Piping Systems |

APPENDIX H
EQUIPMENT MANUALS AND PROCEDURES

| **System CA01**<br><br>**Equipment Number** | **Item** | **Operation Procedure** | **Maintenance Manual** | **Location** |
|---|---|---|---|---|
| 41-G-021A & B | Compressor | WP04-CA1001<br>WP04-CA4001 | O & M Manual and Drawings | Engr Files |
| 45-G-030A<br>45-G-030B | Compressor | WP04-CA1202<br>WP04-CA4001 | O & M Manual and Drawings | Engr Files |
| System CA02<br>41-K-002, 015, 016 | Dryers | WP04-CA1101 | O & M Manual and Drawings | Engr Files |
| System AU04<br>74-G-089 | Underground Compressor | WP04-CA2001 | O & M Manual and Drawings | Engr Files |