## EDOCS-120 TECHNICAL MANUAL

*Including*

**T.O. EDOCS-120-1 – OPERATION AND MAINTENANCE INSTRUCTION**

**T.O. EDOCS-120-3 – OVERHAUL INSTRUCTIONS**

**T.O. EDOCS-120-4 – ILLUSTRATED PARTS BREAKDOWN (IPB)**

# EXPEDITIONARY DEPLOYABLE OXYGEN CONCENTRATION SYSTEM 120 LITERS PER MINUTE

**MODEL EDOCS-120**

**PART NUMBER –793035-001**

PACIFIC CONSOLIDATED INDUSTRIES

3430 WEST CARRIAGE DRIVE

SANTA ANA, CALIFORNIA 92704

TELEPHONE 714-979-9200 TELEFAX 714-436-9150

## TECHNICAL MANUAL

## OPERATION AND MAINTENANCE INSTRUCTIONS

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## LIST OF EFFECTIVE PAGES

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## NUMERICAL INDEX OF EFFECTIVE WORK PACKAGES

**NOTE**

Only those work packages and subordinate work packages assigned to this manual are listed in this index, therefore, WP/WSP numbers may not be sequential.

# ACRONYMS USED IN THIS PUBLICATION

| Acronym | Shown In WP/WSP | Description |
|---|---|---|
| CGA | Safety Summary | Compressed Gas Association |
| CPU | WP 002 00; WP 006 00 | Central processing unit |
| DOT | Safety Summary | Department of Transportation |
| EEPROM | WP 002 00; WP 006 00 | Electronically erasable programmable read only memory chip |
| HOBS | WP 002 00; WP 004 00; WP 005 00 | Hospital Oxygen Backup System |
| NFPA | Safety Summary | National Fire Protection Agency |
| OSHA | Safety Summary | Occupational Safety and Hazards Administration |
| PLC | WP 002 00; WP 004 00; WP 005 00 | Programmable logic controller |
| PODS | WP 002 00; WP 004 00; WP 005 00 | Patient Oxygen Distribution System |
| SSODS | WP 002 00; WP 004 00; WP 005 00 | Surgical Suite Oxygen Distribution System |
| VSA | WP 002 00; WP 005 00; WP 006 00 | Vacuum swing adsorber |
| VSD | WP 002 00; WP 006 00 | Variable speed drive; also known as variable frequency drive (VFD) |

# SAFETY SUMMARY

The following are general safety precautions that are not related to any specific procedure and therefore do not appear elsewhere in this technical manual. These are general safety precautions and instructions that people must understand and apply during many phases of operation and maintenance to ensure personal safety and health and the protection of Government property.

Throughout this manual you will see three types of notations, which contain special information:

**NOTE**

Provides additional information that may be helpful in performing a specific task.

**CAUTION**

Provides information about conditions, which require special attention and precautions to avoid equipment damage.

**WARNING**

PROVIDES INFORMATION ABOUT CONDITIONS, WHICH REQUIRE SPECIAL ATTENTION AND PRECAUTIONS TO AVOID SERIOUS OR FATAL INJURIES.

Be sure to read the information in the notes, cautions, and warnings carefully, and consult someone experienced in handling oxygen equipment about any issues that are unclear. Additional safety guidelines related to specific components of the EDOCS-120 are described in the appropriate chapters.

## ELECTRICAL SAFETY AND LOCK-OUT/TAG-OUT PROCEDURES

While it may not be necessary to lock-out or tag-out the EDOCS-120 unit every time that service is required, certain electrical safety considerations must be observed and minimum procedures must be followed. Under certain conditions, danger may exist even when the power control is in the off position due to charges retained by capacitors. To avoid injuries, always remove power, discharge, and ground a circuit before touching it. Adhere to all lock out/tag out requirements. Additionally, when possible, work in pairs (preferably with someone BLS qualified) to ensure that help is available if needed.

## RESUSCITATION

Personnel working with or near dangerous voltage shall be trained in modern methods of resuscitation. Information and training sources may be obtained from the Director of Base Medical Services.

## FINGER RINGS/JEWELRY

Finger rings have caused many serious injuries. Remove rings, watches and other metallic objects, which may cause shock or burn hazards. Unless specifically allowed by shop safety procedures, remove finger rings during all maintenance activity.

## COMPRESSED AIR

Use of compressed air can create an environment of propelled particles. Do not direct air streams towards self or other personnel. Air pressure shall be reduced to less than 30 PSIG and used with effective chip guarding and personal protective equipment. Follow applicable AFOSH standards when using compressed air.

## DANGEROUS PRESSURES

Care must be taken during operation to ensure that all fittings are proper and tight. All system components must be compatible with pressure applied. Personnel must be protected by a safety shield or located at a distance sufficient to prevent injury.

## CLEANERS/CHEMICALS/PAINTS/ PRIMERS

Some cleaners, chemicals, paints, and primers have adverse effects on skin, eyes, and the respiratory tract. Observe manufacturer's Warning labels, Material Safety Data Sheets (MSDS) instructions for proper handling, storage, and disposal, and current safety directives. Use only in authorized areas. Consult the local Bioenvironmental Engineer and Base Safety Office for specific protection equipment and ventilation requirements. Follow applicable AFOSH standards.

## WORKING WITH OXYGEN

Oxygen is a powerful oxidizing agent that can cause a fire or explosion. A Material Safety Data Sheet is available at Pacific Consolidated Industries.

Oxygen systems must be properly cleaned and inspected, in accordance with Compressed Gas Association pamphlet G-4.1 prior to use to insure that no combustible materials remain in the connecting piping and fittings. If you are not familiar with oxygen cleaning procedures contact the Compressed Gas Association or Pacific Consolidate Industries prior to putting oxygen into your piping and distribution system. The Compressed Gas Association's web site is www.cganet.com.

Observe strict cleanliness procedures when fabricating and connecting the oxygen piping.

Only operate the oxygen generator in a well-ventilated area.

## GUIDELINES FOR HANDLING CYLINDERS

While the principal function of the EDOCS is to provide gaseous oxygen for medical use, conventional oxygen cylinders are still an integral part of the system for supplying backup oxygen and for mobile oxygen requirements (for example, on board ambulances, helicopters).

Oxygen cylinders are under extremely high pressure (as much as 2250 psi) and present a number of associated hazards as a result.

**WARNING**

THE SUDDEN RELEASE OF THIS PRESSURE, WHETHER BY PUNCTURE, DROPPING, OR LOSS OF A PRESSURE CAN EASILY TURN THE CYLINDER INTO A MISSILE HURTLING ACROSS THE GROUND AND THROUGH THE AIR. TAKE EXTREME CARE WHEN FILLING CYLINDERS AND WHEN HANDLING CHARGED CYLINDERS.

**WARNING**

DO NOT DRAG OR SLIDE CYLINDERS OR LIFT THEM BY THE PRESSURE CAP; THIS MAY DAMAGE THE CYLINDERS AND CAUSE THE SUDDEN RELEASE OF, CYLINDER PRESSURE. USE A SUITABLE HAND TRUCK, FORKLIFT, ROLL PLATFORM, OR SIMILAR DEVICE TO MOVE CYLINDERS.

**WARNING**

DO NOT DROP CYLINDERS OR PERMIT THEM TO STRIKE AGAINST EACH OTHER OR OTHER SURFACES; THIS MAY DAMAGE THE CYLINDERS AND CAUSE THE SUDDEN RELEASE OF CYLINDER PRESSURE. FIRMLY SECURE CYLINDERS DURING MOVING AND TRANSPORT.

**WARNING**

DO NOT FILL CYLINDERS TOO RAPIDLY (THAT IS, BY NOT HAVING ENOUGH CYLINDERS ON A CHARGING MANIFOLD); EXCESSIVE HEAT MAY BUILD UP IN THE GAS AND RESULT IN A FAILURE OF THE SEALS IN THE CYLINDER VALVES AND POSSIBLE IGNITION.

**WARNING**

PERIODICALLY CHECK THE SURFACE TEMPERATURE OF THE CYLINDERS DURING CHARGING OPERATIONS USING THE MAGNETICALLY MOUNTED TEMPERATURE INDICATORS PROVIDED WITH THE EQUIPMENT. ALLOWING EXCESSIVE HEAT TO BUILD UP IN THE GAS WILL RESULT IN A FAILURE OF THE SEALS IN THE CYLINDER VALVES AND POSSIBLE IGNITION.

**WARNING**

NEVER SHUT OFF A LINE WITHOUT VERIFYING THAT A SUITABLY RATED RELIEF VALVE OR BLEED OFF VALVE HAS BEEN INSTALLED BETWEEN THE TWO SHUTOFF VALVES. FAILURE TO DO SO CAN RESULT IN A RUPTURE OF THE LINE AND POSSIBLE IGNITION.

**WARNING**

NEVER CHARGE CYLINDERS WITH OXYGEN THAT ARE MARKED FOR OTHER GASES. ALWAYS CHECK THE CYLINDER MARKINGS AND ENSURE THAT ONLY CYLINDERS MARKED FOR OXYGEN ARE CHARGED WITH OXYGEN. FAILURE TO DO SO CAN RESULT IN CONTAMINATION OF THE PATIENT OXYGEN SUPPLY

## SAFE PRACTICES FOR HANDLING AND OPERATING OXYGEN EQUIPMENT

Oxygen used in the medical profession can be very hazardous. Although oxygen does not burn, it does support combustion. A material, which will not burn in air, may burn in high pressure pure oxygen - such as the metal in oxygen regulators or cylinders. Comprehensive guidelines and training on safe practices for handling oxygen are available from several sources listed at the end of this section. Some general guidelines for minimizing the chance of fire are provided below:

## STORAGE, MAINTENANCE AND HANDLING

- Do not allow smoking around oxygen.
- Store oxygen in clean, dry locations away from direct sunlight.
- Do not allow post valves, regulators, gauges, and fittings to come into contact with oils, greases, organic lubricants, rubber or any other combustible substance.
- Make sure that any cleaning, repair or transfilling of oxygen equipment is performed by qualified, properly trained personnel.
- Do not work on oxygen equipment with ordinary tools. Designate special tools, clean them and store them for Use With Oxygen Equipment Only.
- Ensure that any components added to the regulator, e.g., gauge guards, are installed so that they do not block the regulator vent holes.
- Use plugs, caps and plastic bags to protect "off duty" equipment from dust and dirt.
- Particulate migration from the cylinder can be minimized by the installation of a standoff tube (bayonet) at the inlet of the post valve.

## USE

- Make sure that staff using oxygen equipment are adequately trained in its operation and in oxygen safety and have knowledge of manufacturers instructions for using the equipment.
- Visually inspect the post valve gasket and regulator inlet prior to installation. If they are not visually clean they should not be used.
- Momentarily open and close ("Crack") the post valve to blow out debris prior to installing a regulator.
- Ensure that the regulator is set with the flow knob in the off position before attaching it to the cylinder.
- Position the equipment so that valve is pointed away from the user and any other persons.
- Open the cylinder valve slowly and completely to minimize the heat produced and achieve the desired flow conditions within the equipment.
- Do not look at the regulator pressure gauge until the cylinder valve is fully opened.

## REQUIRED PPE

IAW AFOSH and OSHA standards, air pressure shall be reduced to less than 30 PSIG (when possible) and used with effective chip guarding and personal protective equipment. OSHA requires wear of eye protection when working with compressed gases in excess of 30 psi. Almost all of the pressures in the EDOCS-120 are in excess of 30 psi, therefore the wear of eye protection is required for nearly every maintenance action involving fittings and tubing. For more specific guidance, the Compressed Gas Association has several pamphlets that are more detailed for handling compressed gases, and specifically, oxygen.

Especially exercise caution when evacuating cylinders to open air. Lodged debris can become dangerous projectiles when opening cylinder valves.

Additionally, the use of hearing protection is strongly recommended when evacuating cylinders because it produces a high decibel noise that can cause permanent hearing loss through prolonged exposure.

## COMPRESSED GAS CYLINDER SAFETY

Compressed gas cylinders are potential missiles and bombs if handled improperly. A fully charged "H" sized cylinder has flown through concrete walls and cinder block construction with minimal effort. Therefore it would be wise to follow all proper cylinder handling precautions to minimize risk to one's self, others and facilities.

Before filling any oxygen cylinder, ensure that it **IS** an oxygen cylinder (see Cylinder Color Codes below) and that the cylinder has a current hydrostatic test date. This can be verified by comparing the manufactured date (on the cylinder collar near the cylinder cap) with the most recent hydrostatic test date. Some common markings on cylinders are:

3AA, 3A or 3AL-3AA-heat-treated, high-strength steel; 3A- non-heat-treated, carbon steel; 3AL- aluminum alloys.

Service pressure - usually 2015 psig.

Manufacturer's mark- indicates who made cylinder.

Ownership mark- may be stamped on cylinder or on label.

Serial number- may start with cylinder size, usually a number that doesn't fit other description.

+ - Cylinder passed visual, leak and elastic expansion test.

☆ - Cylinder needs to be retested in 10 years rather than 5 years.

Inspector's mark - usually between month and year on test date, indicates who tested cylinder others – elastic expansion, construction method.

Cylinder labels should contain:

Contents, in language of country where cylinder will be used

Hazards of gas

Flammability of gas

Treatment for accidental exposure

Indication of high pressure

Should not conflict with DOT labeling

Additionally, cylinders charged from the EDOCS unit should be identified as 93% USP grade O.

Cylinder color codes:

Oxygen - green or white (international)

Nitrogen - black

Air - yellow, black and white, black and green

Carbon Dioxide - gray

Nitrous Oxide - light blue

Ethylene - red

Cyclopropane - orange

Helium - brown

Heliox - brown and green

Carbogen - gray and green

NFPA provides regulatory guidance and CGA provides additional recommendations for storing cylinders. (Standards for storing cylinders can be found in NFPA publication 56B.)

Cylinders are engineered to provide a large measure of safety and prevent unwanted (potential violent) off gassing. Fusible plugs (found mainly on E cylinders) are constructed of metal alloys that melt at high temperatures allowing gas to escape prior to cylinder rupture. This would typically happen during transfilling or other conditions that lead to rapid temperature increase.

Frangible disks (or rupture disks) are thin metal disks that rupture at high pressures allowing pressure to release. This can happen due to rapid over pressurization (also chiefly resulting from incorrect transfilling procedures).

## HYDROSTATIC TESTING OF CYLINDERS

Hydrostatic testing of cylinders is accomplished by filling cylinders with an inert gas (typically Nitrogen) while the cylinder is immersed in a bath to gauge displacement. Then the cylinder's expansion characteristics when filled to 5/3 its working pressure are measured. If permanent expansion of the cylinder is too much, it will fail the test. The cylinder will also fail the test if temporary displacement exceeds certain tolerances.

Prior to accepting a cylinder for filling, also check for visual anomalies: cracks, pits, bulges, corrosion. If any cylinder is questionable, do not use it. Refer to DOT and CGA guidance for condemning procedures.

## HIGH OXYGEN CONCENTRATION

Oxygen concentrations in excess of 25% significantly increase the hazard exposure to personnel and equipment. Those materials, which burn in air, will burn more violently and sometimes explosively in oxygen. Reducing the hazard requires meeting stringent guidelines for specifying equipment, materials of construction, and system cleanliness. Only those personnel familiar with the hazards of oxygen and safe practices for oxygen systems should be permitted to operate and maintain the system.

Substituting oxygen for compressed air is dangerous.

**Do Not Substitute Oxygen for Compressed Air!**

Oxygen used to clean off equipment or clothing could come in contact with a source of ignition (spark, flame, or other) and ignite. Enriched oxygen could also come into contact with hydrocarbons that will spontaneously combust in the presence of enriched oxygen. In some cases, the elevated oxygen levels could linger even after the source has been shut off. Clothing can even become saturated for extended periods of time with enriched oxygen and significantly increase the likelihood of ignition in the presence of sparks, heat or flame. Smokers who work with enriched oxygen beware!

Additionally, when working in an enriched oxygen atmosphere, it is important to ensure that the area is well ventilated. Otherwise personnel can begin to suffer from enriched oxygen-induced problems such as disorientation, chest pains, prolonged night vision adaptation and ultimately, death. DO NOT PLACE A TENT AROUND EDOCS UNIT! The EDOCS off gasses almost pure Nitrogen when concentrating Oxygen for use. Nitrogen, while inert, does not sustain life. If allowed to collect, it will cause hypoxia and asphyxiation of exposed personnel. If the generator is to be located indoors, additional ventilation must be considered. The best source of additional guidance would be the local Bio-Environmental Engineering office.

**OXYGEN CONCENTRATION LESS THAN 19% CAN CAUSE LOSS OF LIFE.**

Furthermore, all areas that are exposed to enriched-oxygen atmospheres should be continually monitored for fire loading practices. Fire loading is essentially good house keeping. If it is flammable, do not store it near enriched oxygen sources. Many materials will burn in the presence of pure (or near pure) oxygen that would not otherwise burn at all. Some materials will become self-igniting. (such as petroleum products and materials saturated with such products).

The best way to prevent unwanted combustion is to ensure adequate ventilation, prevent enriched oxygen component contamination, and avoid fire loading.

## HIGH TEMPERATURES

Certain areas of the generator can become hot to the touch. Some areas are the heat exchanger and interconnecting piping. The blower and silencer are another source of heat. Use caution when servicing the equipment.

WORK PACKAGE

ALPHABETICAL INDEX

# OPERATION AND MAINTENANCE INSTRUCTIONS

EFFECTIVITY: EXPEDITIONARY DEPLOYABLE OXYGEN CONCENTRATION SYSTEM- P/N 793035-001

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## ALPHABETICAL INDEX OF EFFECTIVE WORK PACKAGES

Only those work packages and subordinate work packages assigned to this manual are listed in this index.

WORK PACKAGE

FOREWORD

# OPERATION AND MAINTENANCE INSTRUCTIONS

EFFECTIVITY: EXPEDITIONARY DEPLOYABLE OXYGEN CONCENTRATION SYSTEM- P/N 793035-001

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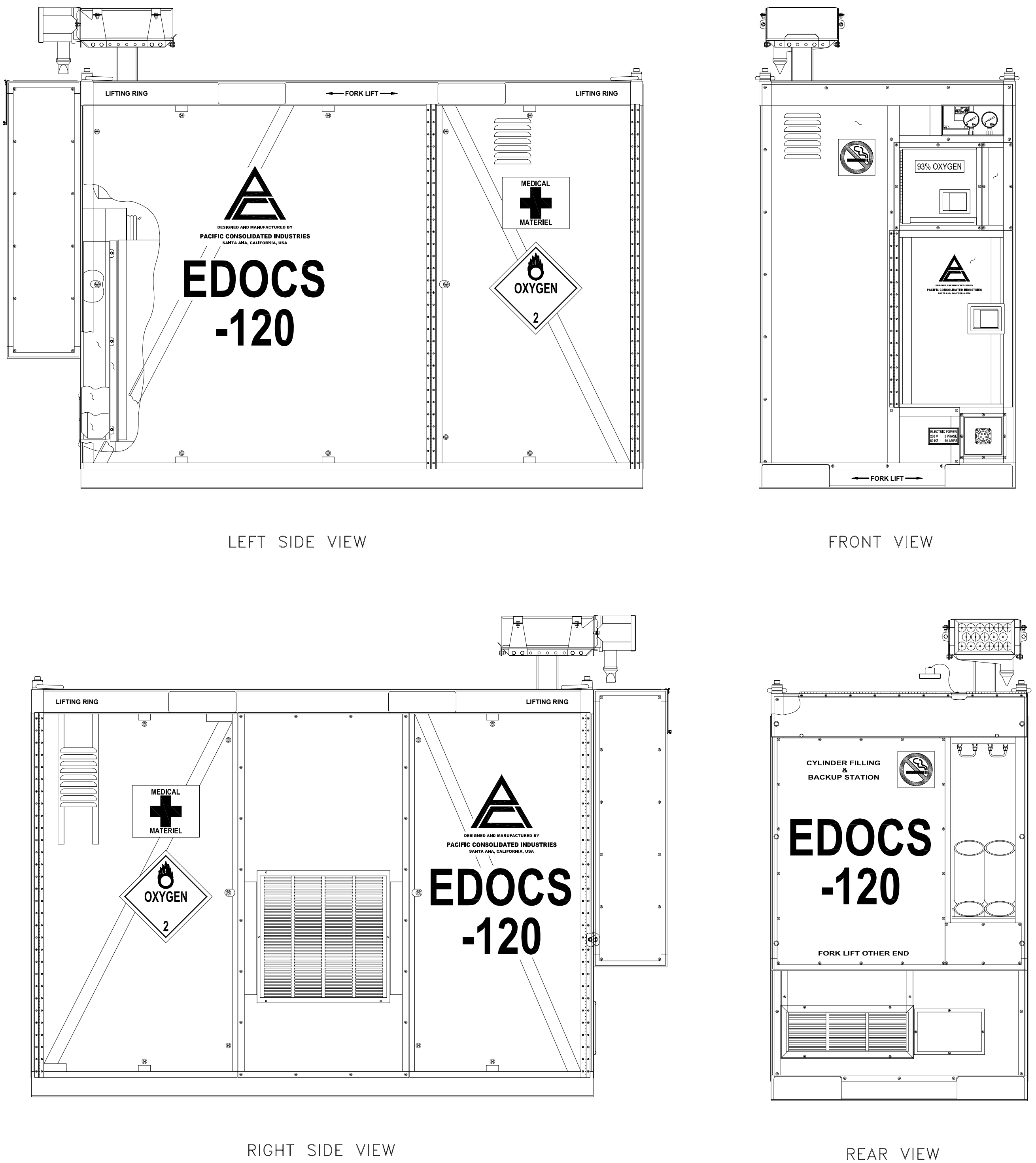



Figure 1. Expeditionary Deployable Oxygen Concentration System (EDOCS-120).

## 1. SCOPE

This technical manual contains instructions for the installation, operation and maintenance of the Expeditionary Deployable Oxygen Concentration System, PCI Model Number EDOCS-120. The part number is 793035-001. The unit is manufactured by Pacific Consolidated Industries, Santa Ana, California (see Figure 1).

## 2. PURPOSE

### 2.1 Background.

The availability of medical oxygen on the battlefield is a prime factor in saving the lives of wounded personnel.

In previous conflicts oxygen demand was met by use of high-pressure oxygen cylinders. Cylinders satisfied the demand for oxygen but created unacceptable logistical burdens associated with transportation, refill, and storage.

The introduction of liquid oxygen systems reduced the logistical problems associated with cylinders but created new problems. A central liquid oxygen generating plant was located in a rear area and cryogenic storage tanks were used to distribute the liquid to the field locations. The size and complexity of a liquid oxygen generating plant required extensive maintenance and highly trained operators.

Liquid oxygen cannot be stored nor stockpiled and transportation over long distances results in a high percentage of loss. The introduction of the modern lightweight, self contained, highly mobile military unit that can be deployed and operational with minimal logistical support meant that the old methods of supplying oxygen by cylinder or in liquid form were no longer acceptable.

The modern military medical unit required an oxygen generating system that could be stored and stockpiled, ready for immediate use, transported with the unit and totally self sufficient for as long as required in the filed. It also had to be easy to operate, dependable and as small and lightweight as possible.

### 2.2 System Overview.

The Expeditionary Deployable Oxygen Concentration System (EDOCS) is an innovative solution to the problem of generating oxygen at the point of use. This system, once deployed, totally eliminates any re-supply requirements, i.e., the logistical tail is not shortened, it is eliminated.

- The Expeditionary Deployable Oxygen Concentration System (EDOCS-120) generates the oxygen utilizing Vacuum Swing Adsorber (VSA) technology.
- The EDOCS-120 low-pressure system supplies 120 lpm of medical grade oxygen at 100 psi. The EDOCS high-pressure system, can also supply 30 lpm of the total 120 lpm at high pressure (2,250 psi) to refill cylinders. A vacuum pump is included with the EDOCS-120 to evacuate empty cylinders prior to filling.
- As an add-on accessory, a Hospital Oxygen Backup System (HOBS) consisting of eight customer-supplied “H” cylinders will automatically provide eight hours of oxygen backup flow at 120 liters per minute. A manifold system on the HOBS allows for recharging the cylinders when connected to an EDOCS-120. The HOBS can also provide emergency peak load demands of 200% of standard output, up to 240 liters per minute while maintaining a minimum of 80 psi.
- Another add-on accessory, the Patient Oxygen Distribution System (PODS), consists of a system of flow regulators to mount at patients’ bedside and multiple Teflon hoses with quick disconnect fittings to provide for the distribution of the oxygen throughout the patient ward.
- Yet another add-on accessory, the Surgical Suite Oxygen Distribution System (SSODS) provides regulated oxygen distribution to surgical equipment in the operating room.
- For field support of the PODS and SSODS, a Hospital Provisioning Kit is available to provide assorted quick disconnect fittings, various adapters, Fittings and lengths of Teflon and stainless steel hoses.

## 3. PRINCIPLE OF OPERATION

The air separation capability of the EDOCS-120 system is based upon the principle of adsorption. Adsorption is defined by Webster as “the adhesion in an extremely thin layer of molecules, as of gas, to the surface of solid bodies with which they are in contact”.

In this process, the solid bodies referred to are the surfaces of the molecular sieve material. The molecular sieve material is engineered to cause specific elements of the gas to adhere to its surface thereby separating the elements of that gas. In this application, elements other than oxygen contained in the air such as nitrogen, water vapor and carbon dioxide adhere to the molecular sieve while the oxygen passes through to be recovered.

The adhesion of the elements to the sieve is normally assisted by the addition of heat or pressure. Lowering the temperature or lowering the pressure will reduce this adhesion and the elements are then released.

Therefore, if air is forced through a molecular sieve at high pressure, the nitrogen, water vapor and other undesirable elements will adhere to the sieve while the oxygen passes through the sieve and is collected downstream of the sieve bed in high concentrations. At a certain point in time the molecular sieve will become saturated with the unwanted elements. The removal of the oxygen is stopped just prior to this saturation point. The direction of flow through the sieve bed is then reversed, and at the same time the pressure is lowered. The sieve releases the elements that adhered to the sieve and some of the concentrated oxygen is introduced in the reverse flow stream to blow these elements out through the waste vent and flood the adsorption vessel with high purity oxygen in preparation for the next adsorption cycle. This process is called desorption and purge.

When all the unwanted elements have been released from the sieve, it is again clean and ready to start the adsorption process over again. This process is called, for obvious reasons, a Pressure Swing Adsorber or PSA. When the pressure during this process goes to sub-atmospheric pressures the PSA process is called Vacuum Swing Adsorption (VSA).

Pacific Consolidated Industries utilizes a patented process that eliminates many of the design problems associated with PSA designs. The innovative Vacuum Swing Adsorber (VSA) system employed by PCI reduces the number of parts and the development of a patented molecular sieve material is the critical element that allowed the design of this VSA system.

This new sieve operates efficiently at very low pressure during the adsorption phase. During the desorption, phase a small vacuum is placed on the sieve which effectively removes the unwanted elements in the air that was adsorbed by the sieve and vents them to the atmosphere. The adsorption process will now efficiently operate at low pressures (8 to 10 psig).

The system utilizes a simple and reliable blower. The blower is a rotary device that does not require seals, valves or rings because the low pressures are easy to contain. The heat of compression is much less because the air is compressed less. Oil is not required due to the lack of friction and the low heat rise.

The low compression also means that the water vapor contained in the air (humidity) is not concentrated to a point that it will condense into a liquid. Therefore, collection and removal of liquid condensate is not necessary, as is the case with higher compression PSA systems.

The vacuum required for the desorption phase of the process is obtained from the input side of the same blower that produces the low pressure air for the absorption phase. This is accomplished with a 4-way valve on the inlet to the blower. The valve directs flow into the inlet of the blower either from the atmosphere (adsorption period) or from the adsorption vessel (desorption and purge period).

The low pressure air input into the adsorber vessel in combination with the high efficiency of the vacuum applied during the desorption stage means that a single absorption vessel may be used. The blower design uses a 4-way rotary valve. This valve slowly rotates in one constant direction, eliminating the rapid direction changes that cause excessive wear.

Figure 2 represents the process flow schematic of the EDOCS-120 system. Figure 3 represents the electrical schematics of the EDOCS-120 system and sub-systems. Tables 1 and 2 list the nomenclatures for each of the tag numbers on the diagrams.

## 4. SYSTEM CONFIGURATION

With all of the accessory components, the system configuration is comprised of four (4) subsystems that have been specifically design to avoid the hazards of handling oxygen. Special attention has been paid to material selections and adiabatic compression areas. This system offers a high degree of flexibility in how the system can be used, allowing the user to reconfigure and/or relocate subsystems depending upon the scenario (see Figure 4).

The four subsystems are:

- Expeditionary Deployable Oxygen Concentrator System (EDOCS-120)
- Hospital Oxygen Backup System (HOBS)
- Patient Oxygen Distribution System (PODS)
- Surgical Suite Oxygen Distribution System (SSODS)

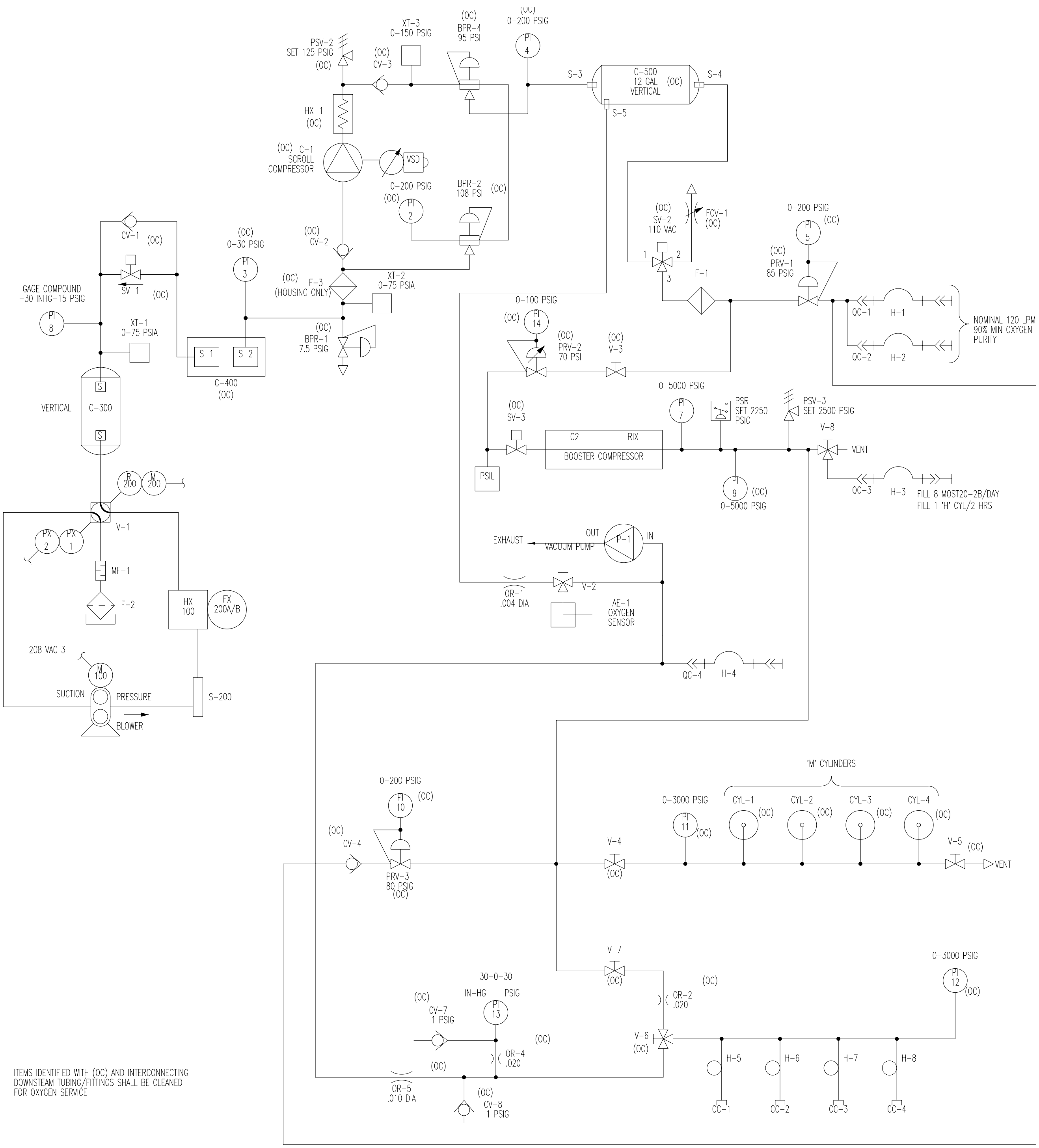



Figure 2. Flow Schematic With Backup System.

Table 1. Legends For Figure 2 Flow Schematic (Sh 1 of 2).

| Tag No. | Nomenclature |
|---|---|
| AE-1 | Oxygen sensor |
| BLOWER | VSA air supply and vacuum blower |
| BPR-1 | Buffer storage tank pressure limiting regulator |
| BPR-2 | Scroll compressor maximum pressure regulator |
| BPR-4 | Scroll compressor minimum pressure regulator |
| C-1 | Scroll compressor |
| C-2 | High pressure booster compressor |
| C-300 | Adsorber vessel |
| C-400 | Buffer storage tank |
| C-500 | Oxygen storage tank |
| CC-1 | Cylinder transfilling connector |
| CC-2 | Cylinder transfilling connector |
| CC-3 | Cylinder transfilling connector |
| CC-4 | Cylinder transfilling connector |
| CV-1 | Adsorber vessel discharge check valve |
| CV-2 | Scroll compressor inlet check valve |
| CV-3 | Scroll compressor outlet check valve |
| CV-4 | Backup system back flow check valve |
| CV-7 | Vacuum gauge protector check valve |
| CV-8 | Vacuum pump protector check valve |
| CYL-1 | Backup system cylinder |
| CYL-2 | Backup system cylinder |
| CYL-3 | Backup system cylinder |
| CYL-4 | Backup system cylinder |
| F-1 | Oxygen product particulate filter |
| F-2 | Blower inlet filter |
| F-3 | Scroll compressor inlet filter |
| FCV-1 | Oxygen off-specification vent flow control valve |
| FX-200 | Blower aftercooler cooling fan |
| H-1 | Low pressure oxygen product hose |
| H-2 | Low pressure oxygen product hose |
| H-3 | High pressure oxygen product hose |
| H-4 | Vacuum pump hose |
| H-5 | Cylinder transfilling hose |
| H-6 | Cylinder transfilling hose |
| H-7 | Cylinder transfilling hose |
| H-8 | Cylinder transfilling hose |
| HX-1 | Scroll compressor aftercooler heat exchanger |
| HX-100 | Blower aftercooler heat exchanger |
| M-100 | Blower motor |
| M-200 | VSA switching valve drive motor |

| Tag No. | Nomenclature |
|---|---|
| MF-1 | Blower inlet/vent muffler |
| OR-1 | Oxygen sensor sample flow orifice |
| OR-2 | Cylinder fill rate control orifice |
| OR-4 | Vacuum gauge snubber orifice |
| OR-5 | Vacuum pump protector orifice |
| P-1 | Vacuum pump |
| PI-2 | Scroll compressor outlet pressure gauge |
| PI-3 | Buffer storage tank pressure gauge |
| PI-4 | Oxygen storage tank pressure gauge |
| PI-5 | Oxygen pressure gauge |
| PI-6 | Booster compressor inlet pressure gauge |
| PI-7 | Booster compressor second stage pressure gauge |
| PI-8 | Adsorber vessel pressure gauge |
| PI-9 | Booster compressor outlet pressure gauge |
| PI-10 | Backup system supply pressure gauge |
| PI-11 | Backup cylinders pressure gauge |
| PI-12 | ‘D’/’E’ cylinders pressure gauge |
| PI-13 | Cylinder vacuum gauge |
| PRV-1 | Oxygen product pressure regulator |
| PRV-2 | Booster compressor inlet pressure regulator |
| PRV-3 | Backup system supply pressure regulator |
| PSIL | Booster compressor inlet pressure switch |
| PSR | Booster compressor outlet pressure switch |
| PSV-2 | Scroll compressor outlet pressure safety valve |
| PSV-3 | Booster compressor outlet pressure safety valve |
| PX-1 | VSA switching valve pressure position proximity switch |
| PX-2 | VSA switching valve vacuum position proximity switch |
| QC-1 | Low pressure oxygen quick connect fitting |
| QC-2 | Low pressure oxygen quick connect fitting |
| QC-3 | High pressure oxygen quick connect fitting |
| QC-4 | Vacuum pump quick connect fitting |
| R-200 | VSA switching valve gear reducer |
| S-1 | Buffer storage tank inlet strainer |
| S-2 | Buffer storage tank outlet strainer |
| S-200 | Blower discharge silencer |
| S-3 | Oxygen storage tank inlet strainer |
| S-4 | Oxygen storage tank outlet strainer |
| S-5 | Oxygen sample flow strainer |
| SV-1 | Adsorber purge solenoid valve |

Table 1. Legends For Figure 2 Flow Schematic. (cont.)

| Tag No. | Nomenclature |
|---|---|
| SV-2 | Oxygen off-specification control solenoid valve |
| SV-3 | Booster compressor inlet solenoid valve |
| V-1 | VSA pressure/vacuum switching valve |
| V-2 | Oxygen sensor sample flow selector valve |
| V-3 | Booster compressor supply shutoff valve |
| V-4 | Backup system shutoff valve |
| V-5 | Backup cylinders vent valve |
| V-6 | Cylinder fill/vacuum selector valve |
| V-7 | Cylinder shutoff valve |
| V-8 | High pressure quick connect fitting vent valve |
| VSD | Scroll compressor variable speed drive |
| XT-1 | Adsorber vessel pressure transducer |
| XT-2 | Buffer storage tank pressure transducer |
| XT-3 | Scroll compressor outlet pressure transducer |

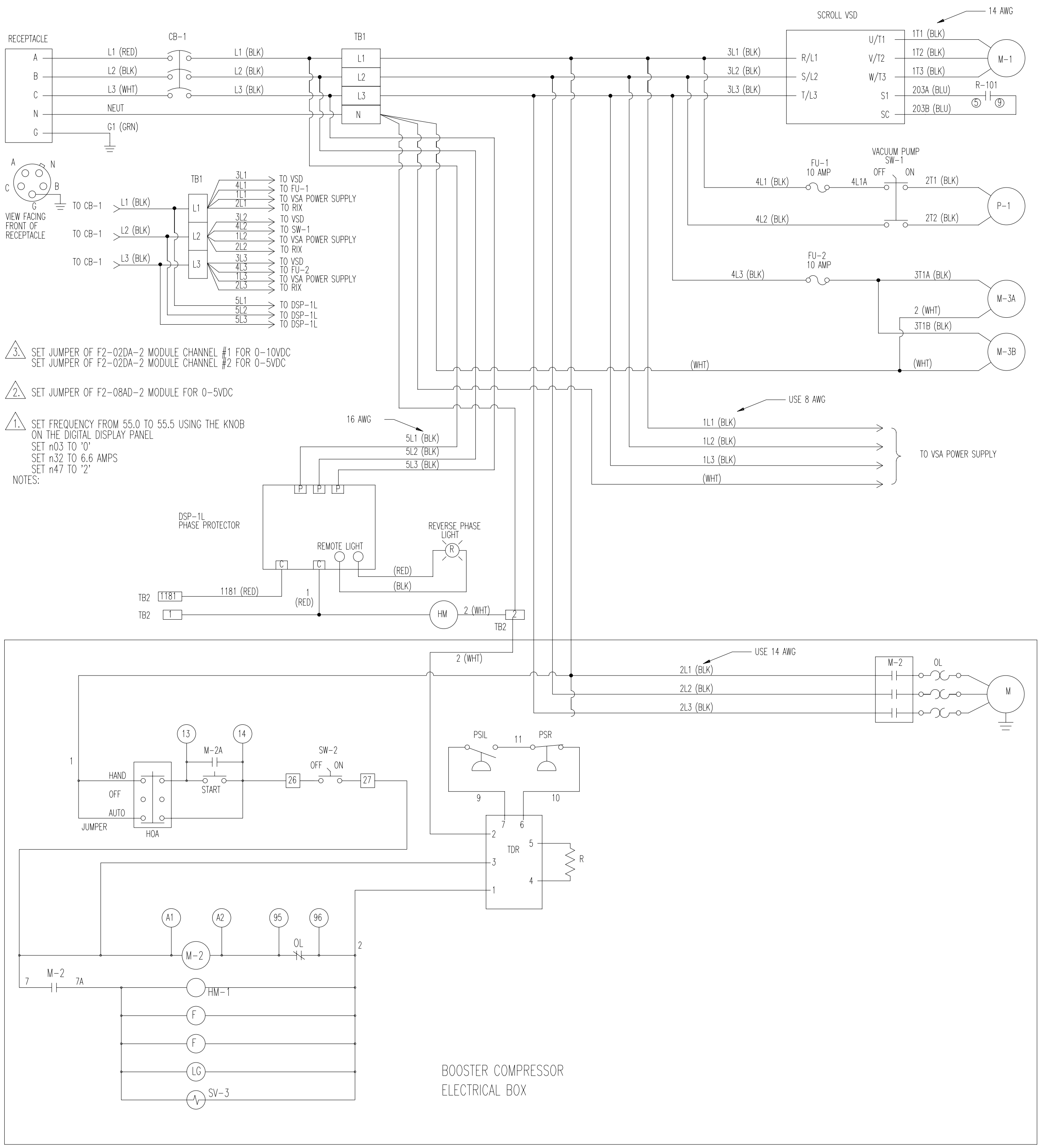



Figure 3. Electrical Schematics (Sh 1 of 4).

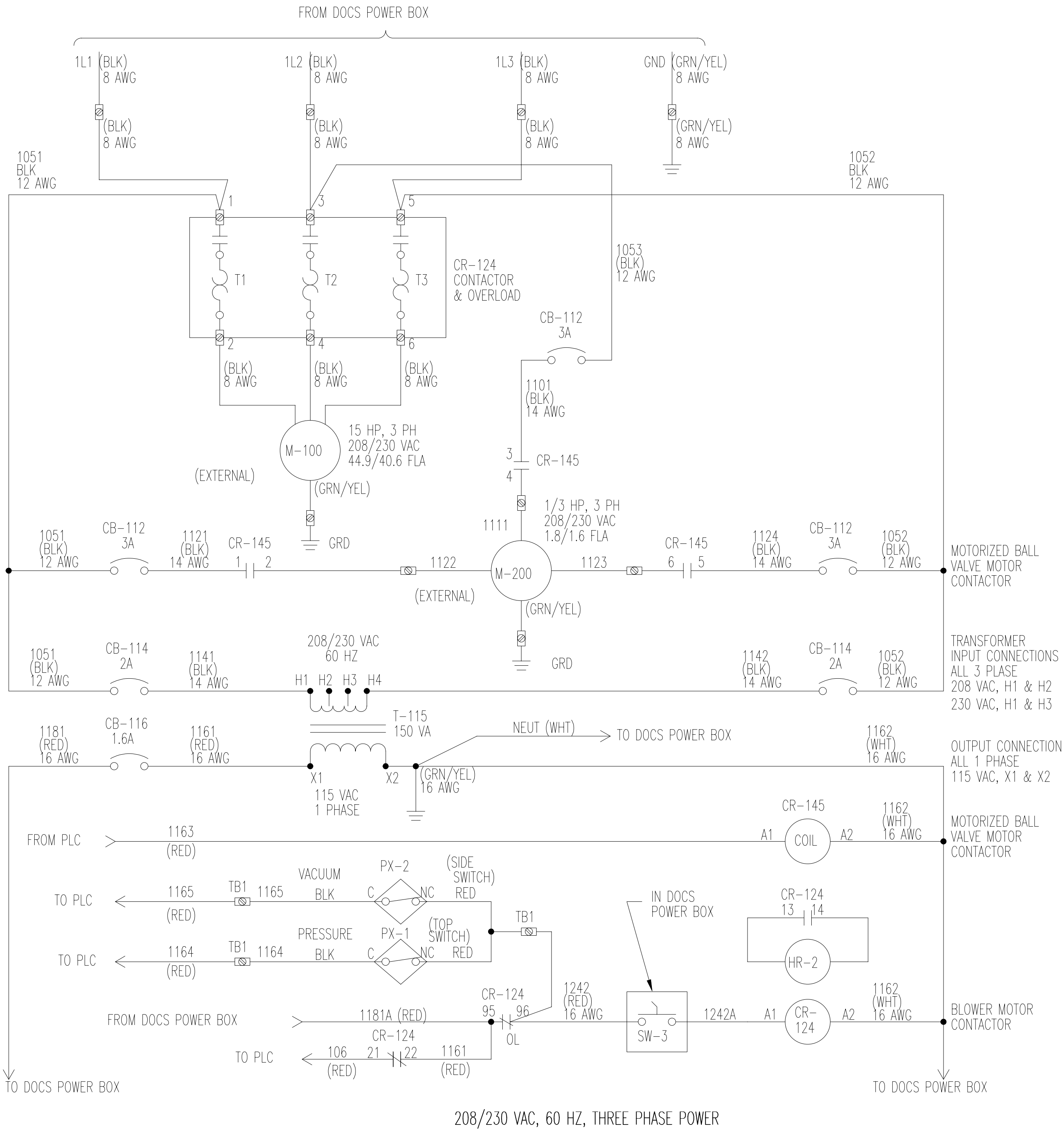



Figure 3. Electrical Schematics (Sh 2 of 4).

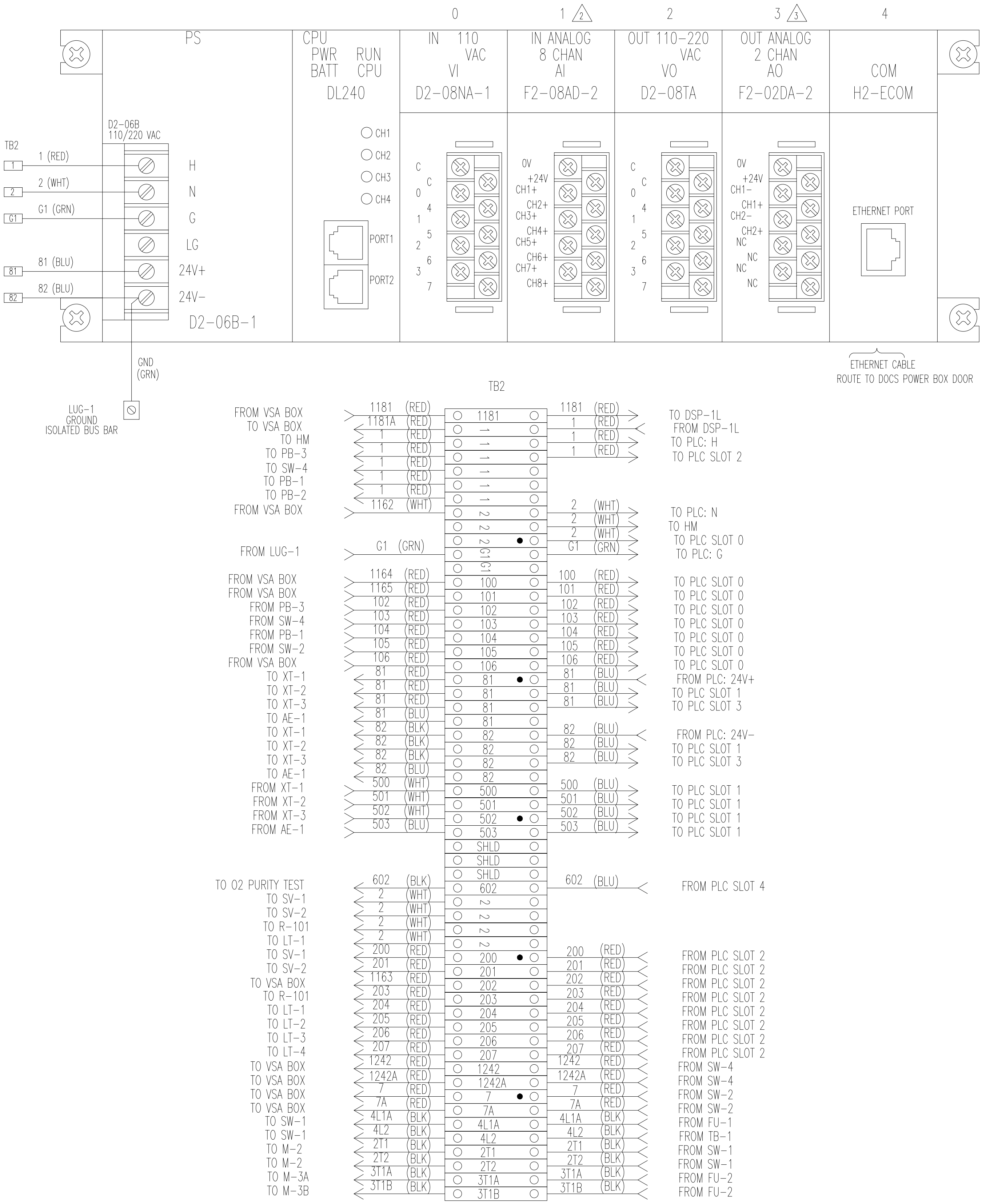



Figure 3. Electrical Schematics (Sh 3 of 4).

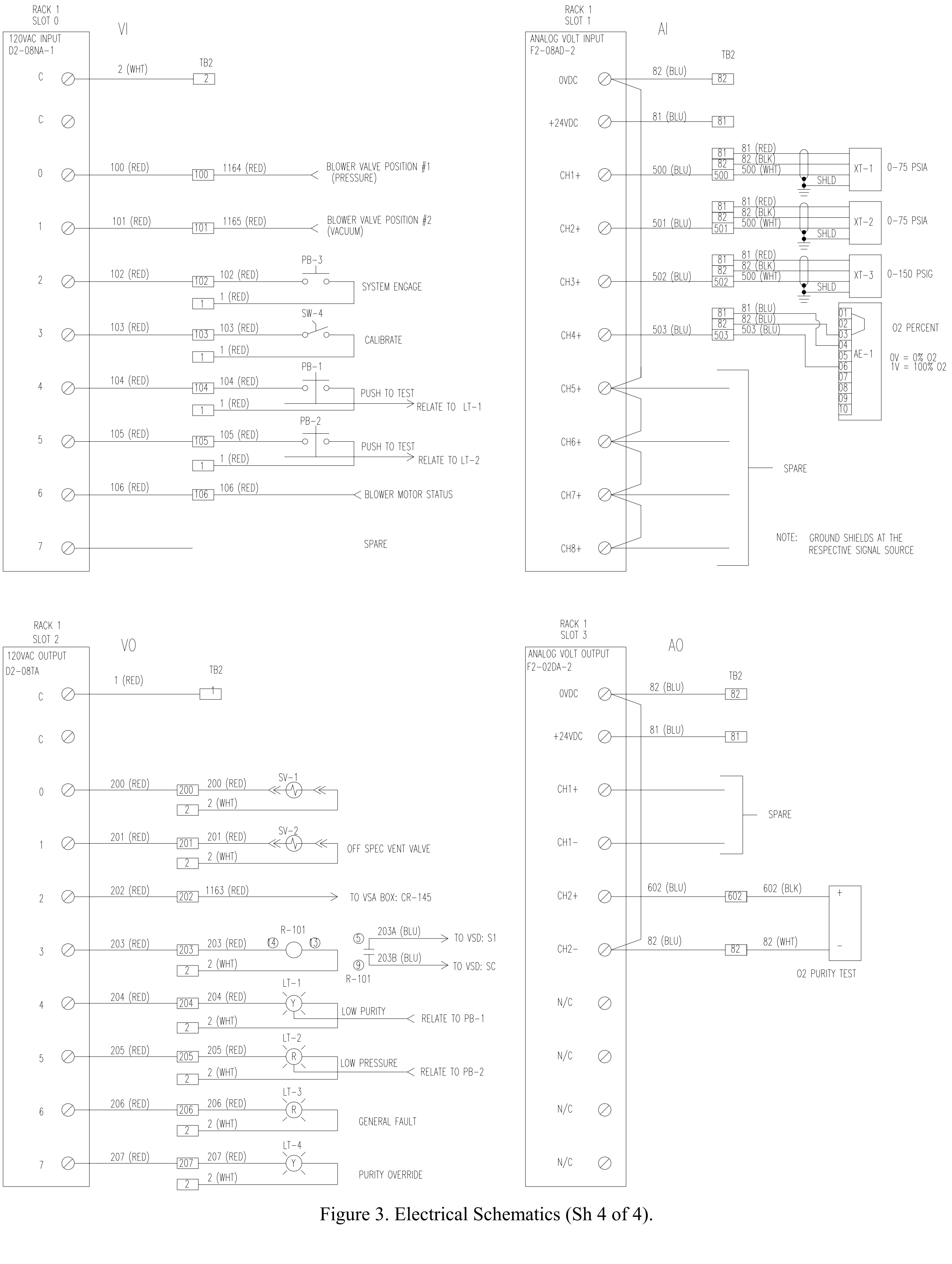



Figure 3. Electrical Schematics (Sh 4 of 4).

Table 2. Legends For Figure 3, Electrical Schematic.

| Tag No. | Nomenclature |
|---|---|
| AE-1 | Oxygen sensor |
| AI | Analog input module |
| AO | Analog output module |
| CB-1 | Circuit breaker- main |
| CB-112 | Circuit breaker- 4-way valve operator motor |
| CB-114 | Circuit breaker- control transformer |
| CB-116 | Circuit breaker- single phase control |
| COM | Ethernet communications module |
| CPU | Central processing unit- PLC |
| CR-124 | Contactor and overload relay- blower motor |
| CR-145 | Contactor- 4-way valve operator motor |
| DSP-1L | Out-of-phase protector |
| F | Cooling fans- booster compressor |
| FU-1 | Fuse- vacuum pump |
| FU-2 | Fuse- cooler motors |
| HM | Hourmeter- system run time |
| HM-1 | Hourmeter- booster compressor run time |
| HOA | Selector switch- booster compressor control |
| HR-2 | Hourmeter- blower run time |
| M-3A/B | Fan motors, scroll compressor aftercooler |
| LG | Run light- green- booster compressor |
| LT-1 | Light- yellow- low purity |
| LT-2 | Light- red- low output pressure |
| LT-3 | Light- red- general fault |
| LT-4 | Light- green- low purity override |
| M | Motor- booster compressor |
| M-1 | Motor- scroll compressor |
| M-100 | Blower motor |
| M-2 | Contactor- booster compressor motor |
| M-200 | VSA switching valve drive motor |
| OL | Relay- overload- booster compressor |
| P-1 | Vacuum pump motor |
| PB-1 | Push-to-test switch- low purity |
| PB-2 | Push-to-test switch- low pressure |
| PB-3 | Low purity override switch |
| PS | Power supply base- PLC |
| PSIL | Booster compressor inlet pressure switch |
| PSR | Booster compressor outlet pressure switch |
| PX-1 | VSA switching valve pressure position proximity switch |
| PX-2 | VSA switching valve vacuum position proximity switch |
| R-101 | Relay- scroll compressor control |
| RECPT | Receptacle- power connector |
| SV-1 | Adsorber purge solenoid valve |
| SV-2 | Oxygen off-specification control solenoid valve |
| SV-3 | Booster compressor inlet solenoid valve |
| SW-1 | Vacuum pump control switch |
| SW-2 | Booster compressor control switch |
| SW-3 | Blower control switch |
| SW-4 | Oxygen sensor calibration switch |
| T-115 | Control power transformer |
| TDR | Booster compressor start time delay relay |
| VI | Voltage input module- PLC |
| VO | Voltage output module- PLC |
| VSD | Scroll compressor variable speed drive |
| XT-1 | Adsorber vessel pressure transducer |
| XT-2 | Buffer storage tank pressure transducer |
| XT-3 | Scroll compressor outlet pressure transducer |

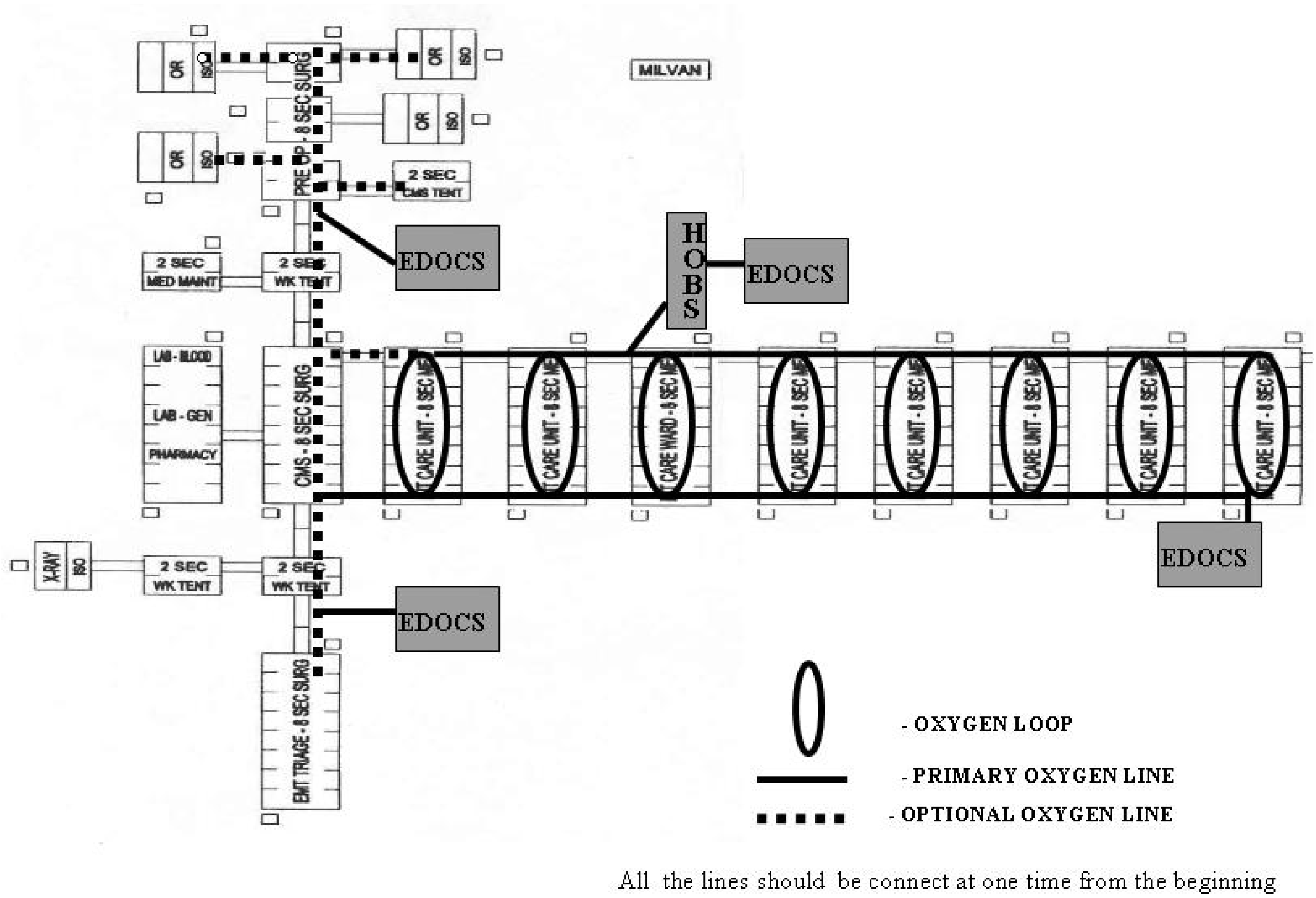



Figure 4. A Possible Hospital Layout.

## 4.1 Expeditionary Deployable Oxygen Concentrator System (EDOCS-120).

The primary function of the EDOCS-120 is the generation of oxygen utilizing the VSA principle. The EDOCS-120 unit is completely contained in a rugged aluminum case.

The cabinet measures 42” wide by 67” high by 102” long and weighs approximately 3,500 pounds.

The cabinet is fitted with forklift slots on the bottom for ground handling. Forklift slots are also provided on the top so that the unit can be loaded over the side of a trailer or truck. Lifting rings are provided at each corner to allow the unit to be sling loaded under a helicopter. Two EDOCS-120 units may be loaded on one 463-L standard aircraft pallet. One complete EDOCS system for the support of a 25 bed field hospital including, one EDOCS-120 unit, one HOBS unit, four PODS units, one SSODS unit and a Hospital Provisioning Kit may be loaded on one 463-L pallet.

## 4.2 EDOCS-120 Capabilities.

- Oxygen Purity – USP 93% monograph (93% ±3%); Oxygen purity is maintained by utilizing an oxygen sensor
- Pressure is maintained at 95 to 108 psig under variable usage (draw) conditions
- Purity and pressure are always the primary control points
- Production rate is 120 standard liters per minute (lpm) minimum flow
- Delivery pressure is regulated to 85 psig from the system regulator (PRV-1)
- Two low pressure supply connections (QC-1, QC-2)

- One vacuum connection (QC-4)
- One high pressure cylinder fill connections (QC-3)
- Can supply 120 lpm at 85 psig directly to the optional hospital distribution system (PODS, SSODS) without the back-up system, or operate through the optional HOBS to provide a back-up supply
- Pressure regulator at the low pressure supply connections regulates both supplies to the same pressure (PRV-1)
- High pressure compressor provides 60 lpm at 2250 psig- compressor will fill one “H” cylinder to 2250 psig in about 2 hours- one “H” cylinder = 7180 standard liters of oxygen
- Vacuum pump can evacuate one “H” cylinder from atmospheric pressure to 27 inches Mercury (Hg) in 4.5 minutes
- Four “M” cylinders integrated on the back of the EDOCS-120 provide a 2-hour back up supply of oxygen when the cylinders are full (“M” cylinders refill time is about 4 hours)
- “M” cylinders have the capability to refill auxiliary “D” and “E” cylinders using the rear charging station in conjunction with the booster compressor
- Capability to evacuate empty “D” and “E” cylinders from the rear charging station using the vacuum pump

**4.3 Cylinder Filling.**

Oxygen for filling cylinders is available from the EDOCS-120 at a maximum rate of 60 lpm to a pressure of 2250 psi.

When an EDOCS-120 is connected to the HOBS and cylinders are being filled, 60 lpm of flow will be utilized by the high-pressure booster compressor to fill cylinders and 60 lpm minimum will be available for hospital usage.

If during cylinder filling operations, the hospital usage increases beyond 60 lpm, the pressure supplied to the hospital will decrease as demand exceeds supply. When the pressure drops below 80 psig, the regulator on the HOBS will open allowing the flow being utilized to fill cylinders to be redirected through PRV-3 to supply the hospital demand and the pressure will stabilize at 80 psi. When the demand is reduced, the pressure supplied by the EDOCS-120 will increase above 80 psig causing the regulator (PRV-3) to close and the filling of cylinders will resume.

If the EDOCS-120 is not connected to a HOBS system, the backup system on the EDOCS-120 will be active. The backup system on the EDOCS-120 consists of 4 “M” cylinders with various valves and regulators (see Figure 5). When the pressure in the cylinders drop to approximately 1900 psig, the high pressure compressor will automatically start to refill the cylinders. When the cylinder pressure reaches 2250 psig, the compressor will automatically shut down. If the backup system pressure continues to drop while the compressor is operating, it is an indication of excessive oxygen flow (greater than 120 lpm) from the EDOCS-120.

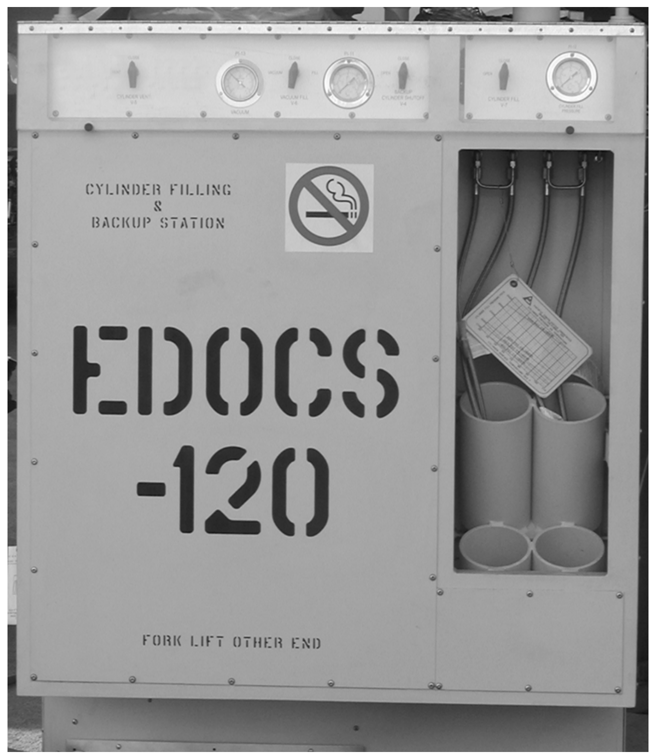



Figure 5. Integral Backup Supply System.

“D” cylinders can be transfilled from the “M” cylinders. Transfilling four “D” cylinders will reduce the oxygen stored in the four “M” cylinders from 14,360 liters by 1700 liters; this is only 11.8% of the capacity. That amount can then be replaced in about 30 minutes. The EDOCS-120 has been engineered and designed to safely fill “D” and “E” cylinders. It also provides a method of evacuating the cylinders to maintain purity. This is a field tested, proven, safe system. The supply of oxygen to the hospital will always have priority over cylinder filling.

## 5. FUNCTIONAL DESCRIPTION

### 5.1 General.

The following paragraphs describe the modules and the function of the modules and sub-assemblies that form the EDOCS-120. Individual component functions are discussed in the approximate order of operation. Unless otherwise indicated, refer to Figure 2 for the location of a given tag number in the system.

### 5.2 Vacuum Swing Adsorber (VSA).

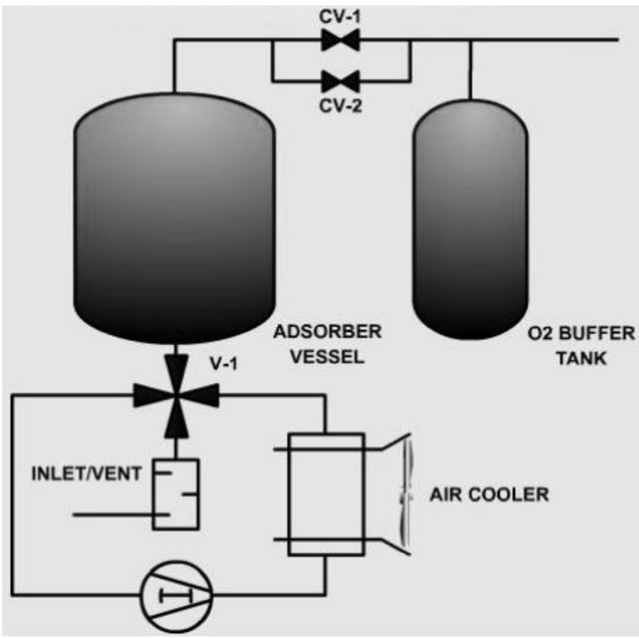



Figure 6. Simplified VSA Flow Scheme.

The patented S3 (Single blower, Single valve, Single bed) VSA operation is simple and very robust. The start of a cycle begins with the blower pushing air into the adsorber vessel (C-300). The molecular sieve material in the adsorber selectively adsorbs nitrogen while allowing oxygen and argon to pass through the bed. When the pressure in the adsorber vessel exceeds the pressure in the buffer tank (C-400), oxygen will flow into the buffer tank through a check valve (CV-1) until the pressure reaches the setpoint for the pressure cycle (about 9 psig). At this pressure, the programmable logic controller (PLC) commands the 4-way valve (V-1) operator motor (M-200) to start. Pressure transducer, XT-1, provides the pressure signal to the PLC for the pressure indication.) This causes the valve to rotate 90 degrees connecting the blower inlet to the adsorber vessel and the blower outlet to atmosphere. This causes the blower to begin pulling a vacuum on the adsorber vessel. Refer to Figure 6.

As a vacuum is pulled on the adsorber, adsorbed water vapor, carbon dioxide, hydrocarbon vapors, and nitrogen are desorbed and exhausted to the atmosphere. This deep vacuum step is the key design feature in the generator. By pulling a vacuum the adsorbent is cleaned each cycle. When the vacuum in the adsorber reaches the vacuum setpoint (about 15 inches Hg vacuum as indicated by XT-1), the purge solenoid valve (SV-1) is signaled to open to purge any remaining nitrogen and impurities from the bed. This purge continues for about 8 seconds after which the PLC signals the 4-way valve operator motor to start. This causes the valve to rotate 90 degrees and begin the pressure cycle again. About 1/2 second after the valve operator motor is signaled to begin the pressure cycle, the purge solenoid valve is signaled to close.

The means that restricts the 4-way valve to 90° rotational increments are two proximity switches (PX-1, PX-2) located 90° apart on the valve operator shaft. Pins protruding from the operator shaft interact with the proximity switches to signal the PLC in which position the valve is. Refer to Figure 7.

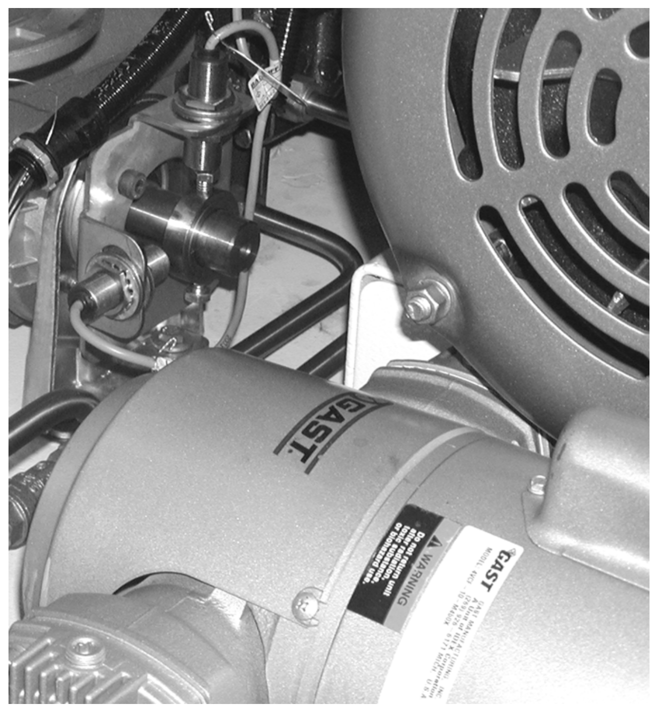



Figure 7. Proximity Switches (PX-1, PX-2).

#### 5.2.1 Adsorber Vessel (C-300).

The adsorber vessel (C-300) is a vertically mounted chamber filled with molecular sieve material (see Figure 8). As air enters the bottom of the vessel on the pressure cycle, the molecular sieve material in the adsorber selectively adsorbs nitrogen, water vapor, hydrocarbon vapors and $CO_2$ while allowing oxygen and argon to pass through the bed.

The nitrogen and impurities that are collected during the pressure cycle are exhausted out to atmosphere during the vacuum cycle and purge period to prepare the bed for the next pressure cycle. The molecular sieve material inside the adsorber vessel should last for the life of the unit.

5.2.2 Buffer Storage Tank (C-400).

The buffer storage tank (C-400) is filled with molecular sieve material as in the absorber vessel. The grade of the sieve material is different than the material in the adsorber vessel. It has the capability to adsorb oxygen instead of nitrogen. This provides a storage volume of oxygen that is greater than the actual volume of the tank because the oxygen molecules crowd together on the surfaces of the molecular sieve closer than would be the case if the vessel had no sieve inside. This storage of the concentrated oxygen is used for both the purge gas during the vacuum cycle and for the oxygen gas product output of the EDOCS-120 to the patient. The pressure of the buffer storage tank is limited to about 5.5 psig by the back pressure regulator (BPR-1). The pressure is monitored by the PLC via the pressure transducer (XT-2) output. Refer to Figure 9.

**5.3 Scroll Compressor (C-1).**

Refer to Figures 10 and 11. The scroll compressor (C-1) compression element consists of a fixed scroll-shaped housing and an orbiting scroll-shaped rotor. Oxygen enters the compressor element through the inlet opening (1). Once the oxygen is drawn in, the orbiting scroll (4) seals the inlet opening and forces the oxygen into a continuously decreasing space. As the scroll (4) keeps orbiting, this process of compression is constantly repeated; resulting in the discharging of oil-free compressed oxygen through the outlet opening (3).

Figure 8. Adsorber Vessel (C-300).

The speed of the scroll compressor is controlled by a variable speed drive (VSD). The frequency output of the variable speed drive is set for about 55 hertz (hz). The operation of the scroll compressor is controlled by the PLC. When initially starting the VSA blower, the PLC starts the scroll compressor after 5 complete pressure/vacuum cycles of the VSA. This ensures that the buffer storage tank has sufficient pressure for supplying oxygen to the scroll compressor inlet. To prevent the scroll from drawing air from the atmosphere (should there be a leak in the suction tubing to the compressor), the PLC monitors the inlet pressure to the scroll compressor via pressure transducer, XT-2, and stops the compressor if the inlet pressure drops below about 0.5 psig.


Figure 9. Buffer Storage Tank (C-400).

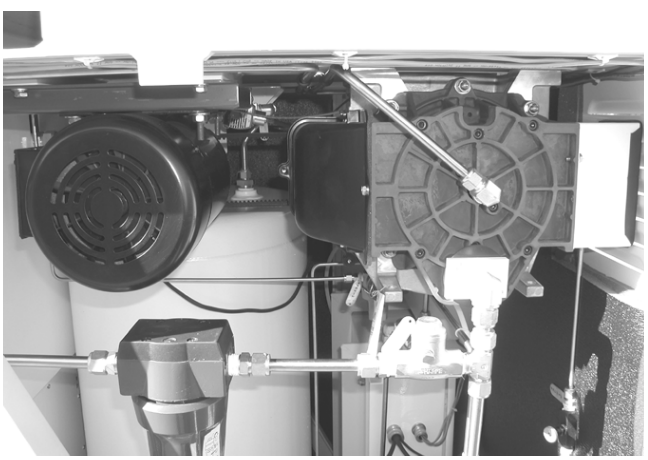
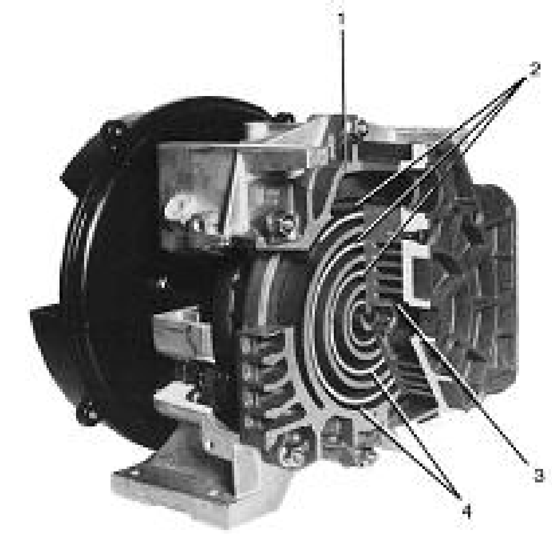


Figure 10. Scroll Compressor Installation.

The discharge pressure of the scroll compressor is monitored by the PLC via pressure transducer, XT-3. Whenever the discharge pressure exceeds 108 psig continuously for 10 minutes, the PLC stops the scroll compressor to conserve the life of the scroll seals. The scroll compressor resumes operation when the pressure reduces to about 103 psig. This condition will generally occur when the usage rate is substantially below 120 lpm.




1 Air Inlet
2 Fixed scroll
3 Compressed air outlet
4 Orbiting scroll

Figure 11. Scroll Compressor Design (C-1).

There are check valves on the inlet and outlet of the scroll compressor (CV-2, CV-3). The inlet check valve (CV-2) prevents the sudden back-flow of high pressure (100-108 psig) oxygen into the buffer tank when the compressor is stopped. The outlet check valve (CV-3) prevents the oxygen in the oxygen storage tank (C-500) from depleting due to leakage through the scroll seals. A pressure relief valve (PSV-2) on the discharge of the scroll compressor protects the system from being over-pressurized.

<u>5.3.1 Scroll Compressor Aftercooler (HX-1).</u>

A fan-cooled heat exchanger (HX-1) is installed in the discharge tubing of the scroll compressor. The heat exchanger removes the heat of compression in the oxygen that was generated by the scroll compressor. The oxygen is cooled to within about 15°F of the ambient temperature.

<u>5.3.2 Scroll Compressor Back Pressure Regulators.</u>

There are two (2) back pressure regulators in the discharge tubing of the scroll compressor. One back pressure regulator (BPR-2) regulates the maximum discharge pressure of the compressor. It is set for about 108 psig and allows any of the compressor output flow that is not being extracted from the EDOCS-120 as product to be returned to the inlet of the compressor. The other back pressure regulator (BPR-4) is set for about 95 psig and limits the output flow from the EDOCS-120. When the oxygen usage from the EDOCS-120 exceeds the production rate (120 lph), the discharge pressure of the scroll begins to fall. When the pressure falls below 95 psig, BPR-4 will begin to close causing a reduction in delivery pressure at the product output connections (QC-1, QC-2), thereby reducing the extraction rate to within the parameters that will maintain the proper purity (93±3%). This is a safety feature that ensures that the system cannot be overdrawn at unacceptably low oxygen purities.

## 5.4 Oxygen Storage Tank (C-500).

The oxygen storage tank (C-500) is a vertical 12-gallon storage tank that receives the 95 psig compressed oxygen from the scroll compressor (see Figure 12). It is filled with molecular sieve material as in the buffer storage tank. The grade of the sieve material is the same as the material in the buffer storage tank. It has the capability to adsorb oxygen instead of nitrogen. This provides a storage volume of oxygen that is greater than the actual volume of the tank because the oxygen molecules crowd together on the surfaces of the molecular sieve closer than would be the case if the vessel had no sieve inside. It provides a volume of oxygen that prevents wide pressure swings on the delivery pressure during widely varying oxygen usage rates.


Figure 12. Oxygen Storage Tank (C-500).

## 5.5 Oxygen Delivery System.

The oxygen delivery system consists of an off-specification solenoid valve, a particulate filter, and the product distribution box which houses a product delivery pressure regulator and product delivery quick connect fittings.

5.5.1 Off-Specification Solenoid Valve (SV-2).

The off-specification (off-spec) solenoid valve (SV-2) controls the delivery of the proper purity oxygen to the product delivery quick connect fittings (QC-1, QC-2). When the oxygen purity is below 90%, the PLC signals the off-spec solenoid valve to vent the impure oxygen to the atmosphere through the off-spec flow control valve (FCV-1). The off-spec flow control valve is adjusted to control the rate of flow to substantially less than the production rate (about 60-100 lpm) so the VSA system can “catch up” to bring the oxygen purity to 90% in a relative short period of time. Refer to Figure 13.

Figure 13. Off-Spec Solenoid Valve (SV-2).

When the purity reaches 90% and above, the PLC signals the off-spec solenoid valve to stop venting and begin delivering oxygen through the particulate filter (F-1) and to the product delivery pressure regulator (PRV-1) quick connect fittings in the distribution box (see Figure-14).

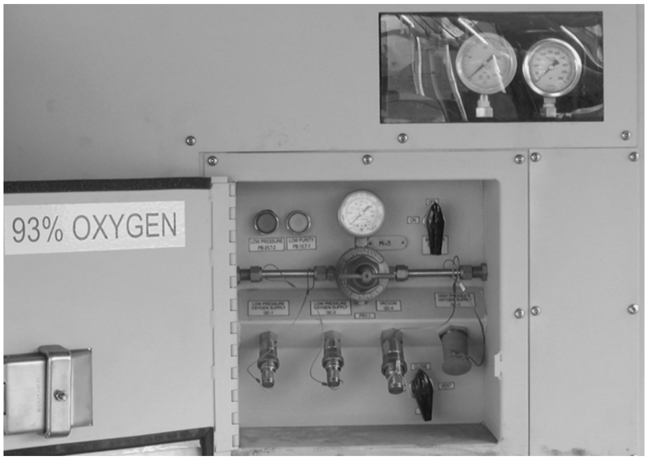



Figure 14. Product Distribution Box.

5.5.2 Product Distribution Box.

The product distribution box contains product quick connect fittings for low and high pressure oxygen (QC-1, QC-2, QC-3), a quick connect fitting for evacuating empty cylinders (QC-4), a warning light for low pressure (LT-2), a warning light for low purity (LT-1), a shutoff valve (V-3) for isolating the inlet to the high pressure compressor (C-2) and a vent valve (V-8) to vent the pressure from the high pressure quick connect fitting. Refer to Figure 14.

## 5.6 High Pressure Booster Compressor (C-2).

The high pressure booster compressor (C-2) is an air-cooled reciprocating, oil-less, two cylinder, two stage, single acting, opposed design. The two compression cylinders consist of a 1$^{st}$ stage piston of 1-1/4" diameter, and a 2$^{nd}$ stage piston of 1/2" diameter with a 2" piston stroke. The 1$^{st}$ stage piston assembly is the heart of the compressor. The piston assembly has the 1$^{st}$ stage on the bottom end and the 2$^{nd}$ stage on the top. Refer to Figure 15.

The pistons for these cylinders use rings of glass & $MoS_2$ filled Polytetrafluoroethylene (PTFE or Teflon plastic), which gives a good seal and is self-lubricating. Linear motion is imparted to the piston assembly from the rotary crankshaft by means of a connecting rod attached to the piston, which alternately compresses in its respective cylinder. The 1$^{st}$ stage rider rings guide one end of the assembly while the 1-3/4" diameter rider ring on the 2$^{nd}$ stage end guides the other. The main bearings and connecting rod bearings are all sealed, grease packed for life, and self-lubricating. The compressor valves are stainless steel reed type, normally closed and pressure-activated open.

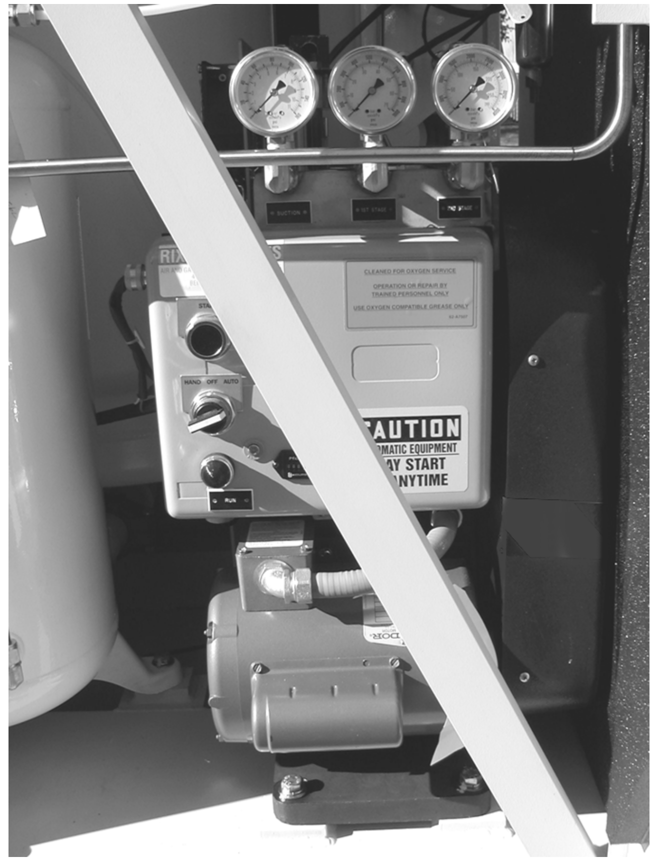


Figure 15. High Pressure Booster Compressor.

The compressor is activated by setting the switch on the compressor-mounted electrical box to "Automatic" position and the "High Pressure Booster" switch (SW-2) on the electrical box door (see Figure 17) to "On". Once the compressor is activated, it will maintain a discharge pressure between about 1900 psig and 2250 psig. The compressor inlet pressure must be above 30 psig for it to operate. If it is desired to disable the compressor, simply switch the "High Pressure Booster" switch (SW-2) on the electrical box door to "Off".

## 5.7 Cylinder Vacuum Pump (P-1).

The cylinder vacuum pump (P-1) is a dual piston, oil-less pump used to pull a negative pressure on cylinders connected to the EDOCS-120 or the optional HOBS units (see Figure 16). The vacuum pump is designed to remove residual gas pressure to 27 inches Hg vacuum. When cylinders have unknown gas or if the pressure has dropped to zero pressure, then the cylinder must be evacuated prior to re-pressurizing. To start the vacuum pump, turn the "Vacuum Pump" switch (SW-1) on the electrical box door to "On" (see Figure 17).

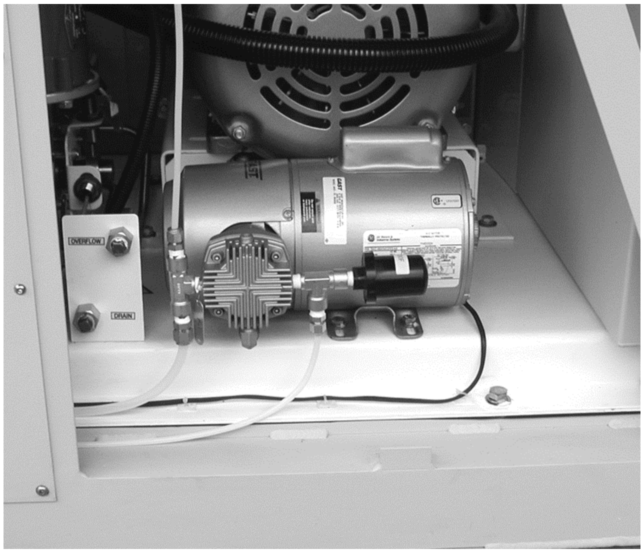



Figure 16. Cylinder Vacuum Pump (P1).

## 5.8 Electrical Boxes.

The electrical control box contains all of the controls for the EDOCS-120, with the exception of the VSA blower and valve motor controls. These are contained in the VSA electrical box located on the side of the VSA unit.

### 5.8.1 Electrical Control Box.

The electrical control box contains the controls necessary for controlling the operation of the EDOCS-120. The electrical control box door contains all of the control switches necessary to operate the EDOCS-120 (see Figure 17). The internal electrical sub-panel contains the PLC, the oxygen sensor, and control relays (see Figure 18).

### 5.8.2 VSA Electrical Box.

The VSA electrical box contains the motor contactor and overload relay (CR-124), for the blower motor (M-100), the motor contactor and circuit breaker (CR-145, CB-112) for the valve operator motor (M-200). Refer to Figure 19.

## 5.9 Programmable Logic Controller (PLC).

Refer to Figure 20. The programmable logic controller is a ladder logic device that has a program written to an electronically erasable programmable read only memory chip (EEPROM). It consists of a power supply base, a central processing unit (CPU), an AC volts input module (VI), an AC volts output module (VO), an analog input module (AI) an analog output module (AO), and an Ethernet communication module (COM). Each module is plugged into the power supply base and can be removed without disconnecting any wires or using any tools.

The CPU contains the EEPROM with the program and controls all of the actions of the plug-in modules. The AC volts input module monitors the state of the inputs (whether switches are on or off), which allows the PLC to take action according to the program instructions.


Figure 17. Electrical Control Box Door.

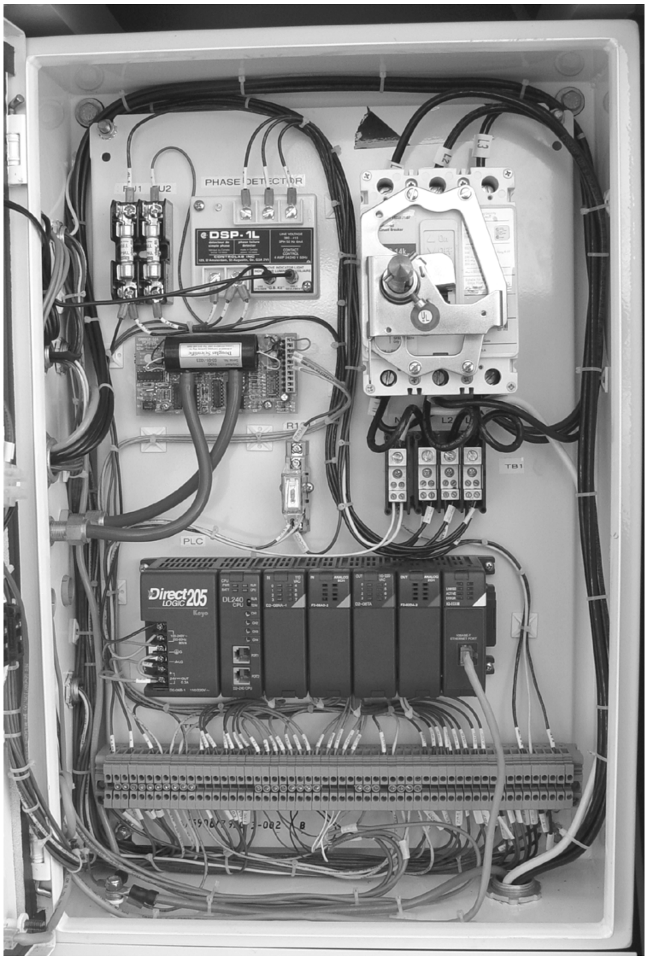


Figure 18. Electrical Controls.

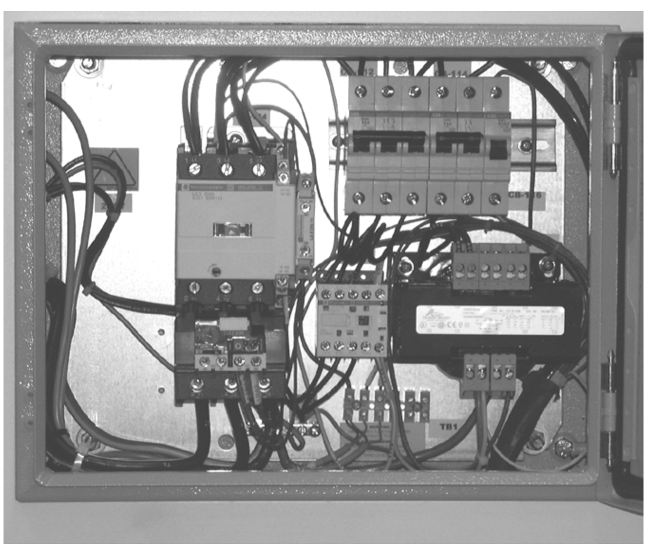


Figure 19. VSA Electrical Box.

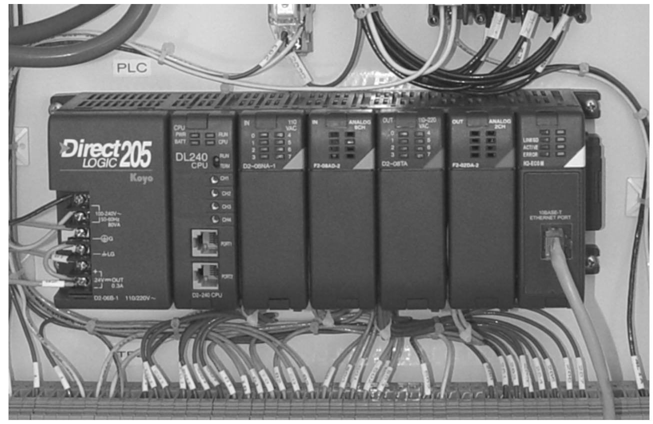


Figure 20. Programmable Logic Controller (PLC).

The AC volts output module provides voltage to operate components as directed by the PLC program. The analog input module receives voltage signals from the oxygen sensor and the pressure transducers and converts them to a digital signal for the PLC program to manipulate. The analog output module receives digital data from the PLC program, converts it to a voltage signal and sends the voltage signal to the components connected to the analog output module. The Ethernet communication module allows the operator to connect an external PC, with the proper software, to the PLC. This can be an extremely useful troubleshooting tool.

## 5.10 Oxygen Sensor. (AE-1)

Refer to Figure 21. The oxygen sensor measures the percentage of oxygen in the sample and outputs the value as a voltage to the PLC analog input module (the voltage is exactly proportional to the percent of oxygen in the sample. This value is sent to the test connector on the control box door through one channel of the PLC analog output module. It uses the purity to determine if the off-spec solenoid valve (SV-2) should be open to allow the required oxygen gas to flow to the patient or be vented to the atmosphere through the off-spec flow control valve (FCV-1). The sensing cell is non-depleting and never needs to be replaced.

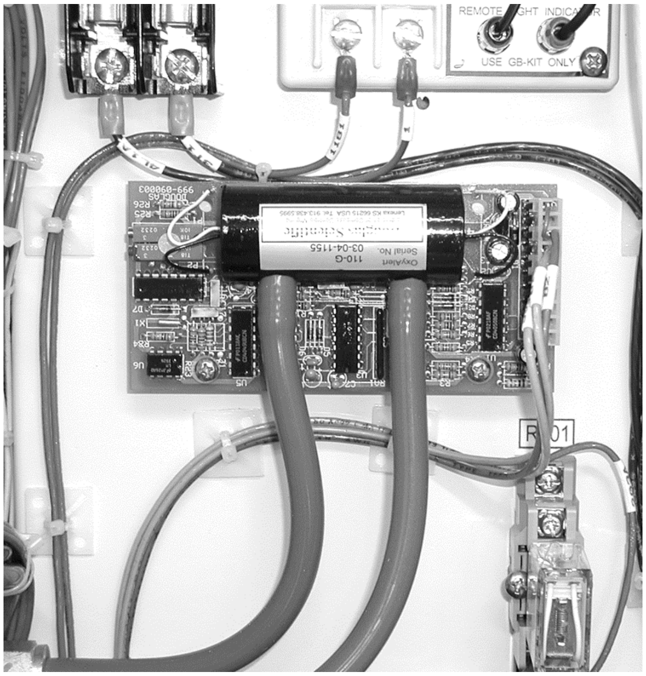


Figure 21. Oxygen Sensor (AE-1).

## 6. OXYGEN BACKUP SUPPLY SYSTEM

The integral oxygen backup supply system provides three functions,

- additional oxygen delivery capacity to the hospital during peak demand conditions,
- a supply of oxygen during periods that the EDOCS-120 is not in operation due to power outages, during maintenance activities, during repair operations, etc.,
- for filling “D” and “E” size medical oxygen cylinders.

The flow schematic of the oxygen backup supply system is found in Figure 2. See Figure 5 for the arrangement of the backup system.

The system consists of the following components,

- 4 “M” size cylinders (CYL-1, -2, -3, –4)
- System shutoff valve (V-4)
- Cylinder vent valve (V-5)
- Cylinder pressure gauge (PI-11)
- Backup supply staging regulator (PRV-3) with pressure gauge (PI-10)
- Backup system back flow check valve (CV-4)
- Small cylinders fill rack shutoff valve (V-7)
- Fill rate control restricting orifice (OR-2)
- Small cylinder fill/vacuum selector valve (V-6)
- Small cylinder fill rack pressure gauge (PI-12)
- Small cylinder fill hoses (H-5, -6, -7, -8)
- Small cylinder valve connectors, CGA870 (CC-1, -2, -3, -4)
- Small cylinder fill rack vacuum gauge (PI-13)
- Vacuum gauge over-pressure restrictor orifice (OR-4)
- Vacuum gauge over-pressure vent check valve (CV-7)
- Vacuum pump over-pressure restrictor orifice (OR-5)
- Vacuum pump over-pressure vent check valve (CV-8)

The backup cylinders are automatically filled to 2250 psig anytime the booster compressor control switch (SW-2) is at the ‘ON’ position and the pressure is about 1900 psig or less. Whenever the pressure downstream of the backup system back flow check valve (CV-4) is less than about 80 psig, oxygen will flow from the backup cylinders through the backup system supply pressure regulator (PRV-3) to the low pressure oxygen product quick connect fittings (QC-1, QC-2). When the pressure rises above 80 psig, the flow from the backup system stops.

## 7. PROCESS DESCRIPTION

All of the basic operations of the EDOCS-120 are controlled automatically. The PLC controls the operation of the VSA switching valve (V-1), the scroll compressor (C-1) and the oxygen off-spec purity control valve (SV-1).

After power is applied to the EDOCS-120, the PLC initializes and prepares for the blower to be started. When the blower control switch (SW-3) is switched on, the PLC signals the VSA switching valve motor contactor (CR-145) to turn on the switching valve motor (M-200) until the switching valve (V-1) is positioned in the vacuum position, as indicated by the proximity switch (PX-1) then removes the signal to stop the valve. The blower motor (M-100) is also signaled to start at this time. The PLC receives a signal from the blower motor contactor (CR-124) indicating that the blower is in operation. The PLC then waits until the adsorber vessel pressure transmitter (XT-1) indicates the vessel is at a vacuum of about 15.5 inches of mercury (in-Hg). When this vacuum is reached, the PLC signals the purge solenoid valve (SV-1) to open. This allows oxygen from the buffer tank (C-400) to flow into the adsorber vessel (C-300) to purge the vessel of impurities. After the purge solenoid valve has been open for 8 seconds, the PLC signals the switching valve motor to start. One half second later, the PLC removes the signal from the purge solenoid valve to close it. When the switching valve reaches the pressure position, as indicated by the proximity switch (PX-2), the PLC removes the signal from the switching valve motor contactor to stop the motor and stop the valve. The PLC then waits until the VSA vessel pressure transducer indicates that the pressure in the vessel is about 9 psig then signals the switching valve to move back to the vacuum position. After 5 vacuum/pressure cycles, the PLC signals the scroll compressor control relay (R-101) to start the scroll compressor.

The scroll compressor speed is controlled by the scroll compressor variable speed drive (VSD). It is preset to about 55 hertz so the scroll compressor can only deliver 120 lpm of oxygen. This reduces the possibility of over-drawing the system to the extent that the purity would fall below 90%. Once the pressure in the oxygen storage tank (C-500) begins to rise, oxygen from the storage tank begins to flow through the oxygen sensor (AE-1). The oxygen sensor sends a signal to the PLC indicating the purity of the sample. The oxygen sensor sends a signal of 0-1 volts dc that is proportional to an oxygen purity of 0-100%. If the purity is below about 90%, the off-spec solenoid valve remains in the vent to atmosphere mode (no electrical signal) and the low purity light (LT-1) is illuminated. When the purity rises above about 90%, the PLC signals the off-spec solenoid valve to stop venting and direct the oxygen to the oxygen product pressure regulator (PRV-1). At the same time, the low purity light turns off. The inlet pressure to the scroll compressor is continuously monitored by the buffer storage tank pressure transducer (XT-2). When the PLC senses (through XT-2) that the scroll compressor inlet pressure is equal to, or less than, 0.5 psig, it stops it until the pressure rises above 0.5 psig. This is a safety interlock to insure that, should there be any leaking fittings, ambient air will never be ingested by the compressor. A low inlet pressure on the scroll compressor is an indication that the product off-take is greater than the oxygen production rate.

The scroll compressor outlet pressure is also continuously monitored by the PLC through the scroll compressor outlet pressure transducer (XT-3). When the pressure is below 80 psig, the PLC signals the low output pressure light (LT-2) to illuminate. When the pressure rises above 80 psig, the light is turned off. A low output pressure is an indication that the product off-take is greater than the system production rate. Anytime the scroll compressor outlet pressure rises above 108 psig for at least 10 consecutive minutes, the PLC signals the scroll compressor to stop. Once the pressure falls below about 103 psig, the PLC signals the scroll compressor to start. This event is an indication that the product off-take is substantially less than the oxygen production rate. This function is intended to extend the life of the scroll compressor seals.

The scroll compressor outlet pressure is controlled by a pair of back pressure regulators. The scroll compressor maximum pressure regulator (BPR-2) limits the maximum outlet delivery pressure. This occurs when the product off-take is less than the delivery flow of the scroll compressor. The excess delivery flow is recycled to the inlet port of the compressor so that no oxygen is wasted (vented to atmosphere). The scroll compressor minimum pressure regulator (BPR-4) limits the minimum outlet pressure that the scroll compressor can produce. The purpose of setting a limit on the minimum outlet pressure is so the compressor, at its fixed speed, cannot deliver more flow than the VSA system can produce at the required purity. The scroll compressor can deliver a increasing flow rate at a fixed speed as the outlet pressure is reduced. Therefore, the scroll compressor speed is preset for the design flowrate with a 95 psig outlet pressure.

A low purity override pushbutton switch on the electrical control box allows the user to override the venting of oxygen that is below 90%. This gives the user the ability to use lower purity oxygen at higher delivery rates for emergency battlefield scenarios. The switch is a momentary pushbutton and resets automatically whenever power is recycled.

Whenever the oxygen sensor is calibrated, the PLC ignores any low purity signals until the calibration procedure is completed. During the calibration period, the low purity light flashes on and off. The calibration period is 2 minutes and is controlled by the PLC.

When in automatic mode the booster compressor is controlled by pressure switches. The inlet pressure switch (PSIL) prevents the compressor from operating whenever the inlet pressure is below 30 psig. Therefore, the booster supply shutoff valve (V-3) must be open and the VSA system must be operating for the booster compressor to function. The outlet pressure switch (PSR) causes the booster compressor to cycle on and off between about 1900 and 2250 psig. The control switch (HOA) on the booster compressor electrical control box must be set at “AUTO” position and the booster compressor control switch (SW-2) on the electrical control box must be set to “ON” for the booster compressor to fill cylinders automatically.

The vacuum pump can be operated independently of all other components by setting the vacuum pump control switch (SW-1) to “ON” to start the vacuum pump and to “OFF” when the vacuum on the cylinders reaches the desired vacuum (normally 25-27 in-Hg).

## 8. CONSUMABLE MATERIALS

Table 1 in WP 003 00 is a master list of the consumable materials required for the operation and support of the EDOCS-120, part number 793035-001.

## 9. TIME CHANGE COMPONENTS

Table 2 in WP 003 00 is a list of the time change components required for the operation and support of the EDOCS-120, part number 793035-001.

## 10. LEADING PARTICULARS

### 10.1 Physical Characteristics

Overall length ......................... 102 inches
Overall width ......................... 42 inches
Overall height ......................... 67 inches
Net weight ......................... 3500 pounds

### 10.2 Operating Characteristics

Flow rate (system) .................... 120 liters per minute
Oxygen purity........................... 93±3%
Pressure (oxygen product)........ 85 psig
Pressure (booster output).......... 2250 psig
Flow rate (booster) ................... 60 liters per minute
Operating voltage ..................... 208 volts, 3-phase, 60 hz
Power required ......................... 13.5 kw
Amperage (average) ................. 47 amps
Amperage (peak) ...................... 60 anps

### 10.3 Environmental Capabilities

Operating temperature ............. –20°F to 130°F
Storage temperature.................. –40°F to 145°F
Operating altitude ..................... 6000 feet

WORK PACKAGE

MASTER LIST OF SPECIAL TOOLS AND CONSUMABLES

# OPERATION AND MAINTENANCE INSTRUCTIONS

EFFECTIVITY: EXPEDITIONARY DEPLOYABLE OXYGEN CONCENTRATION SYSTEM- P/N 793035-001

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## LIST OF TABLES

## 1. SPECIAL TOOLS

There are no special tools required to maintain the EDOCS-120.

## 2. CONSUMABLE MATERIALS

Table 1 is a master list of the consumable items that are necessary for maintaining the operation of the EDOCS-120. Included in the list are lubricating oils, greases, solvents, and sealants. The frequency of use for the oils and greases are listed in WP 006 00, Table 4.

## 3. TIME CHANGE COMPONENTS

Table 2 lists the components of the EDOCS-120 that require changing at set time intervals. Included in the list are filter elements, seals and drive belts.

Table 1. Master List of Consumable Materials.

| Nomenclature | Specification/ Part No. | CAGE Code | Use | Reference |
|---|---|---|---|---|
| Bearing grease | W46040-777 | 75906 | Greasing the blower shaft bearings and scroll compressor bearings | WP 006 00, para. 4.4<br>WP 006 00, para 7.3 |
| Brulin solvent | Brulin 815GG, 1990GD, MP1793 | 94098 | Oxygen cleaning system components | General oxygen cleaning use |
| Gear oil | W49100-011 | 75906 | Lubricating the blower gears | WP 004 00, para. 3(g)<br>WP 006 00, para. 4.3 |
| General cleaning solvent (NSN 6850-01-383-3058 or equal) | 3-D Degreaser or equal | 0SPP4 | General parts cleaning and degreasing | General use |
| Lint-free cloth | N/A | | General parts cleaning | General use |
| Molybdenum-disulfide grease | 214290-001<br>MIL-G-21164 or equal | 75906<br>81349 | Thread lubricant | General use |
| Oxygen compatible grease | 582380-001 | 75906 | Greasing the high pressure booster compressor seals and bearings | General oxygen component use |
| Teflon pipe thread sealing tape | W14420-050<br>MIL-T-27730 or equal | 75906<br>81349 | Sealing pipe threads | General use |

Table 2. Time Change Components.

| Part Number | CAGE Code | Qty Reqd | Nomenclature | Replacement Period | Usage |
|---|---|---|---|---|---|
| 580863-005 | 75906 | 1 | Filter element | 1000 hours | F-2 – Blower inlet filter |
| 582184-001 | 75906 | 1 | V-belt | 1 year or as required | Scroll compressor drive belt |
| 582204-002 | 75906 | 1 | Filter element | 1000 hours | F-1 – Oxygen product particulate filter |
| 582250-001 | 75906 | 1 | Seal kit | 1000 hours | Scroll compressor seals |
| 582321-002 | 75906 | 3 | V-belt | 1 year or as required | Blower drive belt |
| 582327-001 | 75906 | 1 | V-belt | 1 year or as required | High pressure booster compressor drive belt |
| 582381-001 | 75906 | 2 | Filter | 2000 hours | High pressure booster compressor interstage and discharge filters |
| 792253-001 | 75906 | 1 | Filter element | 1000 hours | F-3 – Scroll compressor inlet filter |

WORK PACKAGE

PREPARATION FOR USE, STORAGE OR SHIPMENT

# OPERATION AND MAINTENANCE INSTRUCTIONS

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## LIST OF ILLUSTRATIONS

## 1. OPERATING LOCATION

When selecting the site to locate the EDOCS system, the operator and maintainer must ensure the following.

a. The area must be free of trash and debris that may cause a fire hazard or trip hazard.

b. No open flames or smoking within 50 feet of the equipment.

c. The area should be protected and free access limited to authorized personnel only.

d. The equipment should be located away from motor pools, fuel farms, and other similar hydrocarbon emitting areas.

e. The area should have sufficient space around the equipment to provide access for operation and maintenance tasks.

f. The unit should be shaded from direct sunlight if high temperatures are expected.

g. The area and any tarps, tents, or enclosures should not reduce the air circulation around the unit.

## 2. PREPARATION FOR USE

The EDOCS-120 is shipped with some of the functional components stowed inside the cabinet. Remove all tape, paper, wrappings, etc. Prior to setting up the unit for operation check the followings items.

a. Open the rear right door and remove the blower inlet filter assembly. It is normally wrapped with bubble wrap and is loosely stowed on top of the blower motor (M-100). Refer to Figure 1.

b. Remove the hoses that will be utilized in the setup (see Figure 1). The hoses supplied are, two low pressure oxygen product hoses (H-1, H-2), one high pressure oxygen product hose (H-3), and one vacuum hose (H-4).

c. Remove the protective plug from the inlet filter port on the roof of the EDOCS-120. Remove the wrap from the blower inlet filter and install it in the port on the roof. Refer to Figure 2.

### 2.1 Installing the EDOCS-120 Outside the Hospital.

The equipment should be placed outside the hospital in an area closest to the expected high demand requirement. This will ensure that the line pressure is maintained at the maximum pressure and minimize any pressure drops.

Figure 1. Hose Storage Rack.

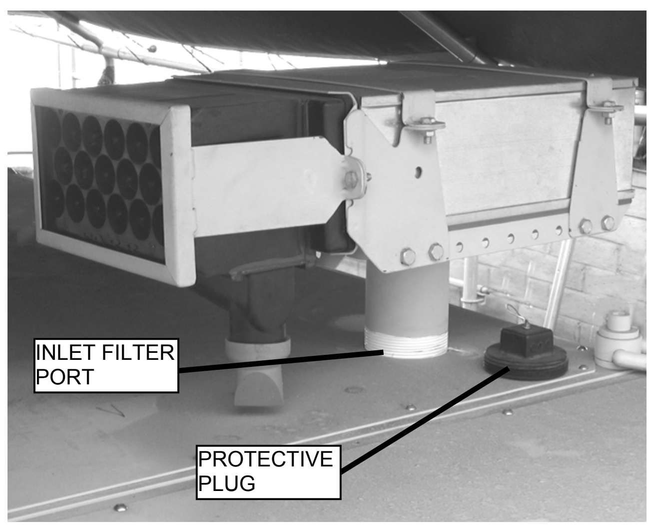


Figure 2. Filter Installed on Roof.

**WARNING**

Never activate the main power disconnect handle before connecting the electrical plug on the EDOCS-120 to the power source and ground. Doing so can cause arcing at the electrical connector, creating an ignition hazard.

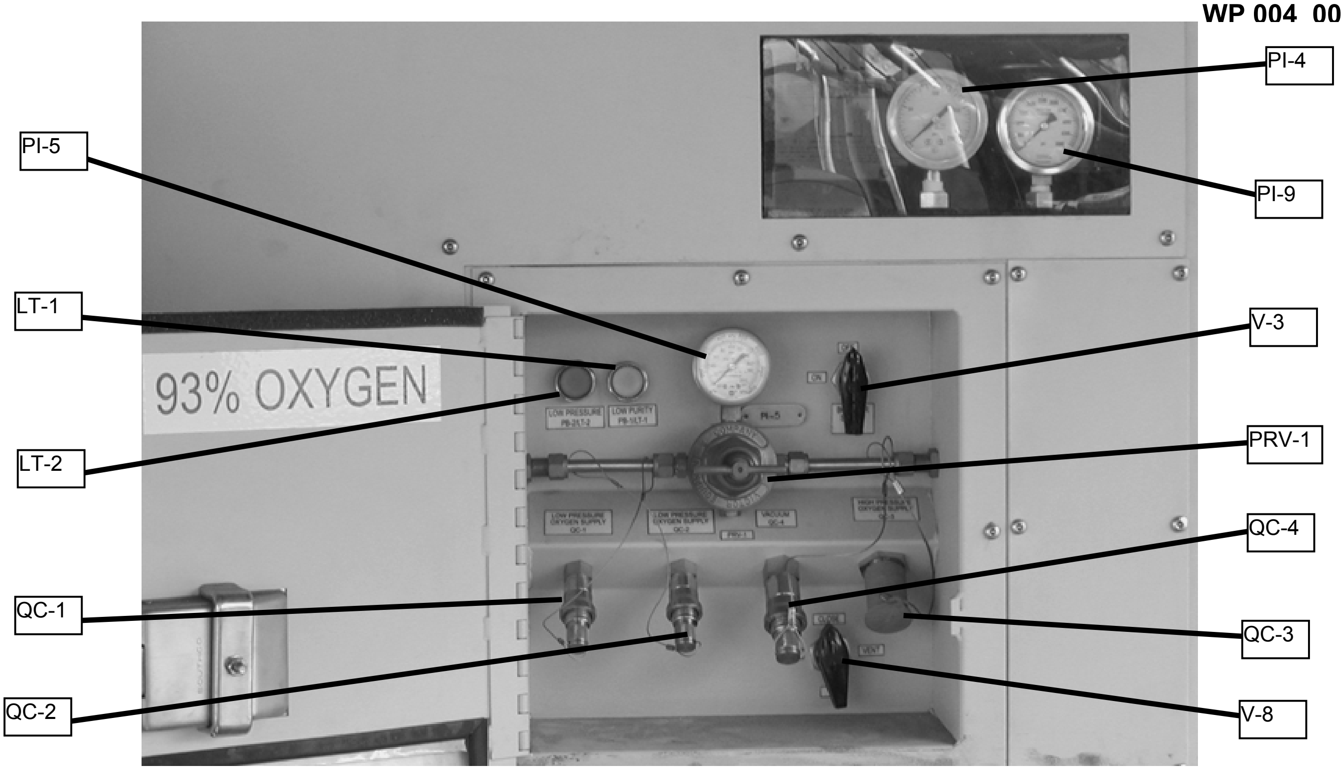


Figure 3. Product Distribution Box.

If a diesel-powered generator is used to power the EDOCS-120 it must be placed at least 25 feet away from the unit. Use disconnects and cabling rated at or above 208 VAC, 3-phase, 60-amp power, regardless of the power source used. The power cord itself must be at least 8 AWG, 4 wires plus a ground, and have a 5-pin electrical connector (MS90557, MIL-C-22992, Class L).

Ground the unit to the nearest electrical ground with no smaller than 12 AWG stranded or solid copper insulated (green insulation color) electrical wire. Verify the ground connection using an ohmmeter.

## 2.2 Positioning the EDOCS-120.

Position the EDOCS-120 no more than 15 feet from the hospital ward using a forklift, helicopter, or crane. Allow sufficient space between the units for the HOBS manifold and cylinders (when used) and to allow access to all associated lines and fittings. Ensure that the location of the EDOCS-120 permits truck access within 10 feet.

## 2.3 Connecting the EDOCS-120 to the Hospital

If the EDOCS-120 is to be connected directly to the hospital distribution system (PODS or SSODS), connect both low pressure oxygen product hoses (H-1, H-2) to the two low pressure oxygen product quick connect fittings (QC-1, QC-2) on the distribution box (see Figure 3).

If the EDOCS-120 is to be connected to a HOBS, connect one of the low pressure oxygen product hoses to a low pressure product quick connect fitting (QC-1 or QC-2) , the high pressure oxygen product hose (H-3) to the high pressure product quick connect fitting (QC-3) and the vacuum hose (H-4) the vacuum pump quick connect fitting (QC-4). Connect the other ends of the hoses to the corresponding quick connect fittings on the HOBS.

Figure 4 shows a possible hospital layout for the distribution of oxygen using the PODS and SSODS with the EDOCS-120 connected directly to the hospital and connected to a HOBS.

# 3. PREOPERATIONAL INSPECTION

Visually inspect the EDOCS for missing parts and any damage that may have occurred during loading, in transit, or during unloading. Prior to setting up the unit for service, inspect the following items.

a. Inspect for structural damage to the frame assembly, blower, buffer tanks, vacuum pump, tubing, and access doors. Damage includes rust, dents, and cracks.

b. Make sure all valves are operational.

c. Ensure that all valve handles are present and in good working order.

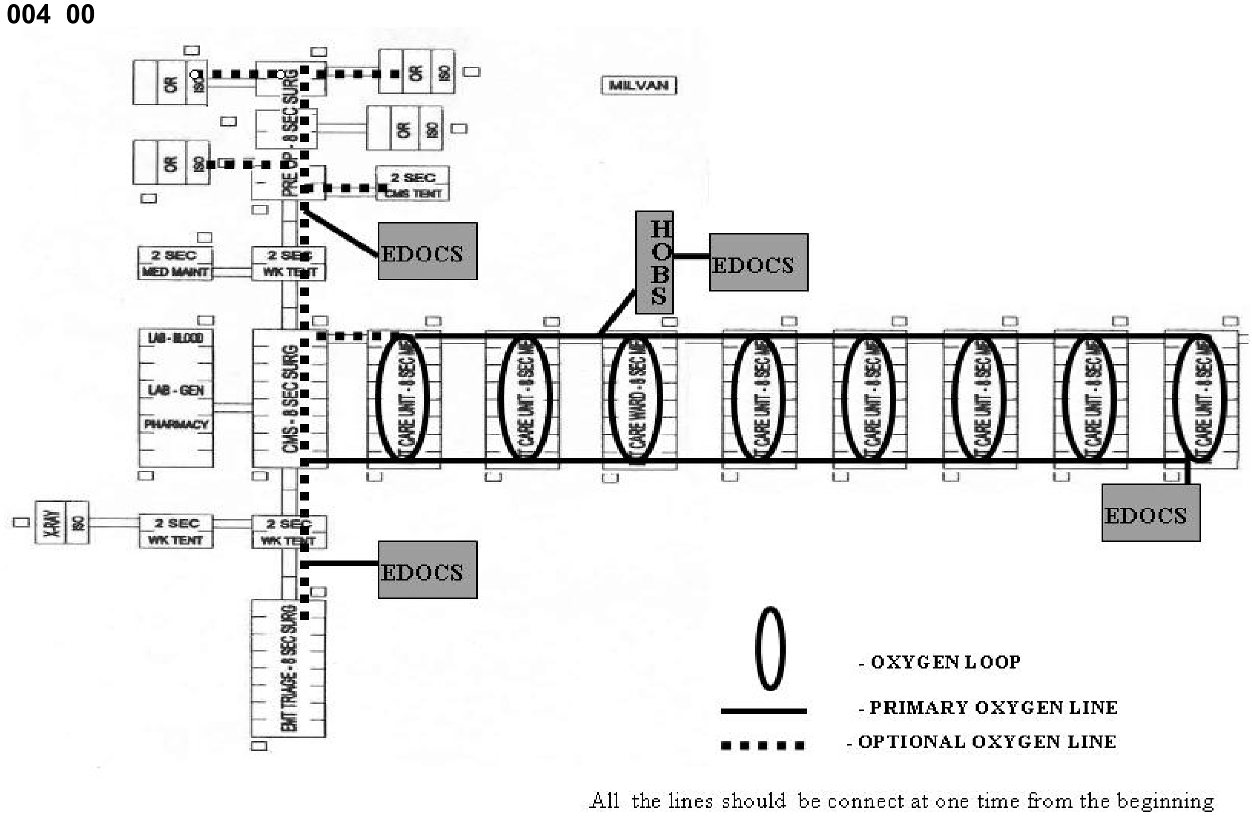


Figure 4. A Possible Hospital Layout.

d. Check all gauges to make sure the needles are intact and are at zero.

e. Check all mounting and tubing joints to determine that they are secure. Tighten where necessary.

f. Check all electrical connections for security. Tighten where necessary.

g. Check the oil level in the blower. This is done by removing the plugs on the fill port and the level port and pouring the proper oil (WP 003 00, Table 1) into the fill port until oil begins to trickle from the level port. Refer to Figure 5.

h. Check the belt tension on the scroll compressor. The proper tension and procedures for obtaining it are described in WP 006 00, paragraph 7.1.

i. Check the belt tension on the blower. The proper tension and procedures for obtaining it are described in WP 006 00, paragraph 4.1.

j. Check the switches on the electrical box door for ease of operation and freedom from binding.

## 3.1 Electrical System Pre-check.

After the EDOCS-120 is connected to a power supply, switch the main circuit breaker (CB-1) disconnect lever to ‘ON’ (rotate counter-clockwise) and check the following items.

a. Test the blower by turning it ON and then OFF. Ensure that the blower motor is rotating in the proper direction. If it isn’t, switch any two of the power cable wires (L1, L2 or L3) at the power source end of the cable.

b. Turn the vacuum pump ON and then OFF, listening for the sound of the pump working and for any unusual noises. Check the vacuum gauge (PI-13) on the oxygen backup supply system (see Figure 6) while the vacuum pump is running the be sure it is drawing a vacuum on the system.

c. Check the low pressure alarm and low purity alarm pilot lights by pressing their respective buttons (see Figure 3). The lights should illuminate when the buttons are pushed. Check the low purity override indicator light by depressing the button. It should illuminate. Depress the button again to turn it off.

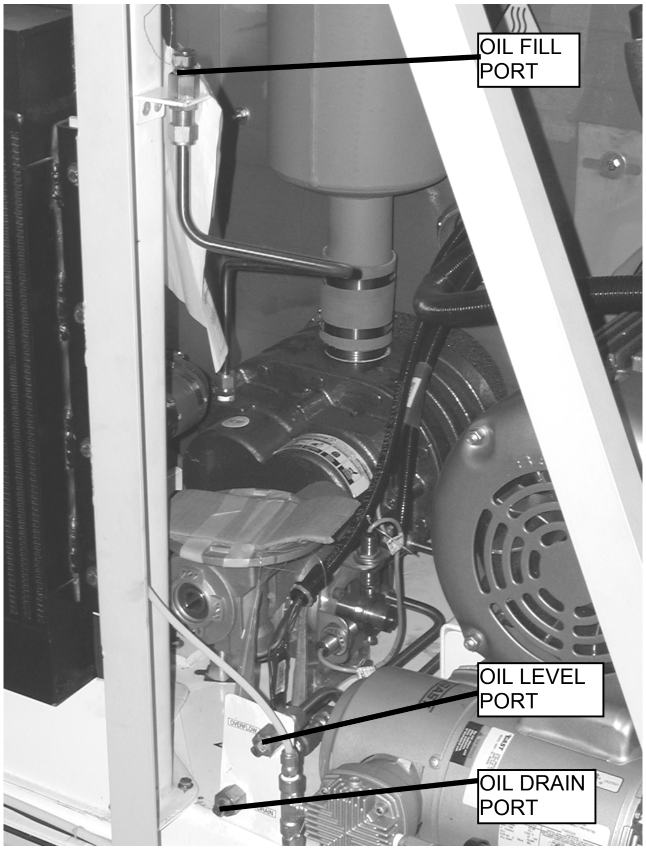


Figure 5. Blower Gear Case Oil Level Port.

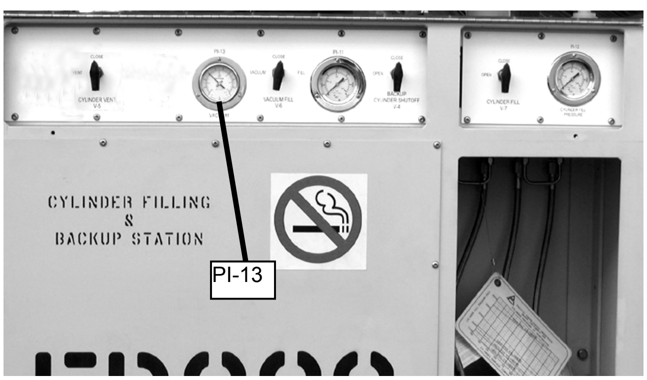


Figure 6. Oxygen Backup Supply System Panel.

## 4. STORAGE

### 4.1 Preparation For Short or Long Term Storage.

a. Disconnect the hoses from the quick disconnect fittings. Replace the protective covers on the quick connect fittings on the hoses and on the equipment.

b. Coil the hoses and place on the rack inside the EDOCS-120 cabinet (see Figure 1).

c. Remove the blower inlet filter and stow inside the cabinet. Replace the protective plug in the inlet filter port on the roof.

d. Ensure that all doors and panels are securely closed.

e. For long term storage (longer than six months) it would be a good idea to wrap the EDOCS-120 in plastic wrap to protect the surface finish from scratches.

## 5. PREPARATION FOR TRANSPORT

### 5.1 Transport By Ground Vehicles.

Forklift slots are provided on the bottom front end and top sides of the EDOCS-120 (see Figure 7). The slots are large enough to accommodate up to a ten (10) standard forklift. The EDOCS-120 must not be lifted with less than a two (2) ton forklift The bottom front slots allow the EDOCS-120 to be end loaded onto a truck or trailer bed. The top side slots allow the EDOCS-120 to be side loaded onto a high-sided truck or trailer bed. The width and length of the unit allows it to fit onto a standard 1.5 ton military trailer. The EDOCS-120 can be secured to the vehicle by strapping through the top forklift slots or using the tie-down rings on the top corners of the frame.

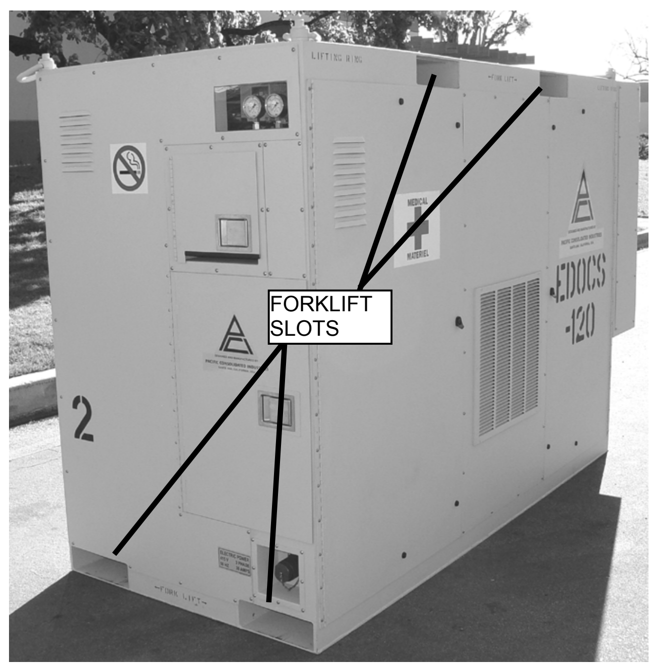


Figure 7. Forklift Slots.

**5.2 Transport By Aircraft.**

The EDOCS-120 footprint allows for two units to be placed on a standard 463-L pallet. The Loadmaster can secure the units to the 463-L pallet using netting or other suitable means as he/she deems appropriate.

**5.3 Helicopter Lift.**

Four swivel lifting rings are provided on the top corners of the EDOCS-120 frame (see Figure 8). They may be used for sling loading under a helicopter. The minimum distance between the top of the EDOCS-120 and the sling hook should be 8 feet.


Figure 8. Lifting Rings.

WORK PACKAGE

OPERATING INSTRUCTIONS

# OPERATION AND MAINTENANCE INSTRUCTIONS

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## LIST OF ILLUSTRATIONS



## LIST OF TABLES

## 1. GENERAL

The instructions in this work package are for information and guidance for the personnel responsible for operation of the EDOCS-120. The operator must know how to perform each function of which the EDOCS-120 is capable. This work package gives instructions on starting and stopping the EDOCS-120 and accomplishing the specific tasks for which the equipment was designed. The operator must be completely familiar with the function of all components of the EDOCS-120. The operator must also know the location and purpose of all operating controls and indicating instruments.

## 2. SAFETY PRECAUTIONS

### 2.1 General Safety.

The purpose of the EDOCS-120 is to separate oxygen from air and make the oxygen available at low and high pressures for medical uses. In doing so, the waste produce (purge exhaust) becomes depleted of oxygen (about 19% oxygen; air has 21% oxygen). If the purge exhaust is allowed to accumulate in a closed non-ventilated area, the air in the area could have the oxygen depleted sufficiently to produce unconsciousness or even death.

**WARNING**

OXYGEN CONCENTRATION LESS THAN 19% CAN CAUSE LOSS OF LIFE.

### 2.2 High Purity Oxygen.

Oxygen is a powerful oxidizing agent that can cause a fire or explosion. A Material Safety Data Sheet is available at Pacific Consolidated Industries.

Oxygen systems must be properly cleaned and inspected, in accordance with Compressed Gas Association pamphlet G-4.1; prior to use to insure that no combustible materials remain in the connecting piping and fittings. If you are not familiar with oxygen cleaning procedures contact the Compressed Gas Association or Pacific Consolidate Industries prior to putting oxygen into your piping and distribution system. The Compressed Gas Association's web site is www.cganet.com.

Oxygen used in the medical profession can be very hazardous. Although oxygen does not burn, it does support combustion. A material, which will not burn in air, may burn in high pressure pure oxygen - such as the metal in oxygen regulators or cylinders. Comprehensive guidelines and training on safe practices for handling oxygen are available from several sources. Some general guidelines for minimizing the chance of fire are provided below:

- Do not allow smoking around oxygen.
- Store oxygen in clean, dry locations away from direct sunlight.
- Do not allow post valves, regulators, gauges, and fittings to come into contact with oils, greases, organic lubricants, rubber or any other combustible substance.
- Make sure that any cleaning, repair or transfilling of oxygen equipment is performed by qualified, properly trained personnel.
- Do not work on oxygen equipment with ordinary tools. Designate special tools, clean them and store them as "For Use With Oxygen Equipment Only".
- Ensure that any components added to the regulator, e.g., gauge guards, are installed so that they do not block the regulator vent holes.
- Use plugs, caps and plastic bags to protect "off duty" equipment from dust and dirt.
- Particulate migration from the cylinder can be minimized by the installation of a standoff tube (bayonet) at the inlet of the post valve.

Oxygen concentrations in excess of 25% significantly increase the exposure to hazard for personnel and equipment. Those materials, which burn in air, will burn more violently and sometimes explosively in oxygen. Reducing the hazard requires meeting stringent guidelines for specifying equipment, materials of construction, and system cleanliness. Only those personnel familiar with the hazards of oxygen and safe practices for oxygen systems should be permitted to operate and maintain the system. Substituting oxygen for compressed air is dangerous.

**WARNING**

DO NOT SUBSTITUTE OXYGEN FOR COMPRESSED AIR. A CATASTROPHIC EXPLOSION COULD OCCUR.

Oxygen gas used to blow off equipment or clothing could come in contact with a source of ignition (spark, flame, or other) and ignite. Enriched oxygen could also come into contact with hydrocarbons that will spontaneously combust in the presence of enriched oxygen. In some cases, the elevated oxygen levels could linger even after the source has been shut off. Clothing can even become saturated for extended periods of time with enriched oxygen and significantly increase the likelihood of ignition in the presence of sparks, heat or flame.

All areas that are exposed to enriched-oxygen atmospheres should be continually monitored for fire loading practices. Fire loading is essentially good house keeping. If it is flammable, do not store it near enriched oxygen sources. Many materials will burn in the presence of pure (or near pure) oxygen that would not otherwise burn at all. Some materials will become self-igniting. (Such as petroleum products and materials saturated with such products). The best way to prevent unwanted combustion is to ensure adequate ventilation, prevent enriched oxygen component contamination, and avoid fire loading.

## 2.3 High Pressure Oxygen.

The cylinders and tubing may contain high pressure oxygen (up to 2250 psig). Care should be taken when attempting to loosen fittings or remove tubes or hoses. Always follow proper safety procedures when attempting to do so. Whenever it is necessary loosens fittings or remove tubes or hoses, always vent the pressure from that part of the system through the appropriate valve before attempting to do so.

Most rubber and plastic materials easily ignite and sustain combustion in the presence of high pressure oxygen. Some metals can ignite and sustain combustion in the presence of high pressure oxygen. For an example, aluminum can ignite and sustain combustion in the presence of 400 psig oxygen. Care must be taken to ensure no sparks or flames are created in the vicinity of high pressure oxygen.

## 2.4 Rotating Equipment.

The EDOCS-120 has two areas where rotating components present a hazard. One is at the blower motor shaft where the cooling fan is mounted on the motor shaft. The other is on the inside area of the scroll compressor and motor where the scroll compressor is driven by a drive belt. The EDOCS-120 should always be operated with the doors closed. If there is ever any need to operate the unit with any doors open, special precautions must be observed, such as placing a barrier, or other such positive means, in front of the rotating parts to prevent coming in contact with them.

## 3. CONTROLS AND INSTRUMENTS

The following paragraphs describe, locate, illustrate and furnish for the operator, crew or maintenance personnel sufficient information about the controls and instruments for the proper operation of the EDOCS-120. Controls and instruments have tag numbers that are identified code letters denoting their function, plus an arbitrarily assigned number. Table 1 lists the code letters used and their functions.

Table 1. Component Tag Symbols.

| SYMBOL | FUNCTION |
|---|---|
| BPR | Back pressure regulator |
| CC | Cylinder yoke connector |
| CV | Check valve |
| F | Filter |
| FCV | Flow control valve |
| H | Hose |
| PI | Pressure gauge |
| PRV | Pressure regulator |
| PSV | Pressure relief valve |
| QC | Quick connector |
| SV | Solenoid valve |
| V | Valve |
| XT | Pressure transducer |

## 3.1 Controls.

The EDOCS-120 has electrical controls, control valves, pressure relief valves, pressure switches and a programmable logic controller (PLC). These controls all function in unison as necessary to make the EDOCS-120 an automatic system.

## 3.2 Electrical Controls.

The EDOCS-120 contains electrical controls that may need to be operated during the operation of the system. The controls, their nomenclature, tag number, type and function are listed in Table 2. Figures 1 and 2 show the location of the electrical controls.

## 3.3 Control Valves.

The control valves are located in various locations on the EDOCS-120. Table 3 lists the valves, including their tag numbers, descriptions and the figure numbers where they are located.

Table 2. Electrical Controls.

| TAG NO. | EQUIPMENT NOMENCLATURE | TYPE | FUNCTION |
|---|---|---|---|
| CB1 | Main circuit breaker | Lever | Turns on power to the EDOCS-120 |
| HOA | Booster compressor control switch | 3-position selector | Controls booster compressor action |
| PB-1 | Low light purity push-to-test switch | Pushbutton | Tests status of low purity alarm light |
| PB-2 | Low pressure light push-to-test switch | Pushbutton | Tests status of low pressure alarm light |
| PB-3 | Low purity override switch | Pushbutton | Toggles low purity override function on and off |
| SW-1 | Vacuum pump control switch | 2-position selector | Controls power to the vacuum pump |
| SW-2 | Booster compressor control switch | 2-position selector | Controls power to the booster compressor |
| SW-3 | Blower control switch | 2-position selector | Controls power to the blower |
| SW-4 | Oxygen sensor calibration switch | Momentary toggle | Calibrates the oxygen sensor |

## 3.4 Manual Control Valves.

Frequent setting, resetting and adjustment of the manual control valves are required during startup, operation, shutdown or servicing (see Table 3).

Table 3. Control Valves.

| TAG NO. | DESCRIPTION | FIGURE |
|---|---|---|
| FCV-1 | Oxygen off-spec flow control valve | 6 |
| PRV-1 | Oxygen product pressure regulator | 3 |
| SV-1 | Adsorber purge solenoid valve | 5 |
| SV-2 | Oxygen off-spec solenoid valve | 6 |
| SV-3 | Booster compressor inlet solenoid valve | 24 |
| V-1 | VSA pressure/vacuum switching valve | 26 |
| V-2* | Oxygen sensor sample flow selector valve | 1 |
| V-3 | Booster compressor supply valve | 3 |
| V-4 | Backup system shutoff valve | 4 |
| V-5 | Backup cylinders vent valve | 4 |
| V-6* | Cylinder fill/vacuum selector valve | 4 |
| V-7* | Cylinder shutoff valve | 4 |
| V-8* | High pressure quick connect vent valve | 3 |

*Manual control valves that may require use during operation

## 3.5 Automatic Control Valves.

Although automatic control valves are not manually operable, they are directly related to proper operation of the EDOCS-120. Even though the operators do not directly control these valves, they must be familiar with each valve, its function and location. The automatic control valves include solenoid valves, motor operated valves and check valves (see Table 3).

## 3.6 Safety Relief Valves.

Pop safety relief valves are used throughout the EDOCS-120 to protect lines and vessels containing gases under pressurize. These valves pop open at a preset maximum safe pressure and vent the excess pressure to atmosphere. Table 4 lists these valves and their pressure setting.

Table 4. System Safety Relief Valves.

| TAG NO. | FUNCTION | SETTING | FIGURE |
|---|---|---|---|
| PSV-2 | Limits scroll compressor outlet pressure | 125 psig | 21 |
| PSV-3 | Limits booster compressor outlet pressure | 2500 psig | 6 |
| | Booster compressor inlet pressure relief valve; limits booster inlet pressure | 75 psig | 6 |
| | Booster compressor stage 1 pressure relief valve; limits stage 1 pressure | 700 psig | 6 |

### 3.7 Pressure Switches.

The pressure switches listed in Table 5 are automatic and preset to operate at predetermined pressures.

Table 5. Pressure Switches.

| TAG NO. | FUNCTION | SETTING | FIGURE |
|---|---|---|---|
| PSIL | Prevents booster compressor operation when inlet pressure is too low | 28 psig | 25 |
| PSR | Limits the pressure on the discharge of the booster compressor | 2250 psig | 25 |

### 3.8 Pressure Gauges.

Pressure gauges are provided for monitoring system pressures during operation. Table 6 lists the pressure gauges, their tag numbers, functions and figure number where they are located.

### 3.9 Pressure Regulators.

Several pressure regulators are used on the EDOCS-120. Some maintain a pressure on the particular system location. These are called back pressure regulators. Others take a higher pressure and reduce it to a lower pressure. These are called pressure regulators. Table 7 lists the back pressure regulators and pressure regulators, their tag numbers, functions and figure number where they are located.

### 3.10 Miscellaneous Indicators and Controls.

The EDOCS-120 contains miscellaneous indicators and controls that are not described in the previous paragraphs. However, it is very important that operators become familiar with these components. These components' tag numbers, description, function and figure number where they are located are listed in Table 8.

## 4. STARTING THE EDOCS-120

### 4.1 Pre-Start Up Check.

a. Perform the procedures described in WP 004 00, paragraphs 2 and 3.

b. Plug in the power cable into the receptacle at the lower right corner at the front of the EDOCS-120. Switch the main circuit breaker (CB-1) disconnect lever to 'ON' (rotate counter-clockwise). Refer to Figure 1. Check the phase reversal light to ensure proper phase direction. If the phase light is illuminated, turn power off and switch any two main power leads (L1, L2, L3) at the power source end of the power cable.

c. If the high pressure booster compressor (C-2) is to be used for maintaining pressure on the oxygen backup supply system or for filling high pressure cylinders, set the following controls in the indicated positions.

1. Set the booster compressor control selector switch (HOA) to 'AUTO'. Refer to Figure 2.

Table 6. Pressure Gauges.

| TAG NO. | FUNCTION | RANGE | FIGURE |
|---|---|---|---|
| PI-2 | Indicates scroll compressor discharge pressure | 0-200 psig | 21 |
| PI-3 | Indicates buffer storage tank and scroll compressor inlet pressures | 0-30 psig | 22 |
| PI-4 | Indicates oxygen storage tank pressure | 0-200 psig | 3 |
| PI-5 | Indicates regulated oxygen product output pressure | 0-200 psig | 3 |
| PI-6 | Booster compressor inlet pressure gauge | 0-100 psig | 7 |
| PI-7 | Indicates booster compressor stage 2 discharge pressure | 0-5000 psig | 6 |
| PI-8 | Indicates the pressure or vacuum on the adsorber vessel | 30 inches Hg-30 psig | 5 |
| PI-9 | Indicates booster compressor discharge pressure | 0-5000 psig | 3 |
| PI-10 | Indicates the backup system supply pressure | 0-200 psig | 7 |
| PI-11 | Indicates the pressure in the backup system cylinders | 0-2250 psig | 4 |
| PI-12 | Indicates the pressure on the cylinders being filled | 0-2250 psig | 4 |
| PI-13 | Indicates the vacuum on the cylinders in the charging rack | 30 inches Hg-30 psig | 4 |

Table 7. Pressure Regulators.

| TAG NO. | FUNCTION | SETTING | FIGURE |
|---|---|---|---|
| BPR-1 | Controls the maximum pressure in the buffer storage tank | 7.5 psig | 22 |
| BPR-2 | Limits the maximum discharge pressure on the scroll compressor | 108 psig | 21 |
| BPR-4 | Limits the minimum discharge pressure on the scroll compressor | 95 psig | 21 |
| PRV-1 | Regulates the oxygen product delivery pressure | 85 psig | 3 |
| PRV-1 | Regulates the pressure to the inlet of the booster compressor | 70 psig | 7 |
| PRV-3 | Regulates the pressure at which the backup system begins supplying oxygen to the hospital | 80 psig | 7 |

Table 8. Miscellaneous Indicators and Controls.

| TAG NO. | TYPE AND FUNCTION | FIGURE |
|---|---|---|
| AE-1 | Oxygen sensor. Sends an electrical signal to the PLC that is proportional to the percentage of oxygen in the sample gas. | 11 |
| AI | Analog input module. Converts an analog electrical signal to a digital signal for the PLC program to decipher. | 11 |
| AO | Analog output module. Converts a digital signal generated by the PLC program to an analog electrical output signal. | 11 |
| COM | Ethernet communication module. Allows communication with the PLC program through an Ethernet network. | 11 |
| CPU | Central processing unit for the PLC. Contains the control program on an electronically erasable read only memory (EEPROM) chip for controlling the system. | 11 |
| DSP-1L | Reverse phase detector relay. Prohibits the operation of the EDOCS-120 if the incoming power has reverse phase. | 11 |
| HM | System runtime hourmeter. Indicates the operational hours on the system. | 1 |
| HM-1 | Booster compressor runtime hourmeter. Indicates the operational hours of the booster. | 2 |
| HR-2 | Blower runtime hourmeter. Indicates the operational hours of the blower. | 17 |
| PX-1 | Proximity switch. Positions the VSA switching valve in the pressure position. | 18 |
| PX-2 | Proximity switch. Positions the VSA switching valve in the vacuum position. | 18 |
| R-200 | Worm gear reducer. Reduces the rotational speed of the switching valve. | 19 |
| VI | Voltage input module. Sends voltage signals from switches to the PLC program. | 11 |
| VO | Voltage output module. Sends voltage signals from the PLC program to devices. | 11 |
| VSD | Variable frequency drive. Controls the speed of the scroll compressor. | 3 |
| XT-1 | Pressure transducer. Sends an electrical signal to the PLC that is proportional to the pressure in the adsorber vessel. | 5 |
| XT-2 | Pressure transducer. Sends an electrical signal to the PLC that is proportional to the pressure in the buffer storage tank. | 20 |
| XT-3 | Pressure transducer. Sends an electrical signal to the PLC that is proportional to the scroll compressor discharge pressure. | 21 |

2. Set the booster compressor supply valve (V-3) to ‘ON’. If the booster compressor will not be used set the valve to ‘OFF’. Refer to Figure 3.

d. Calibrate the oxygen sensor system as described in paragraph 6.2. Be sure to set the oxygen sensor sample flow selector valve (V-2) to ‘SAMPLE’ when finished.

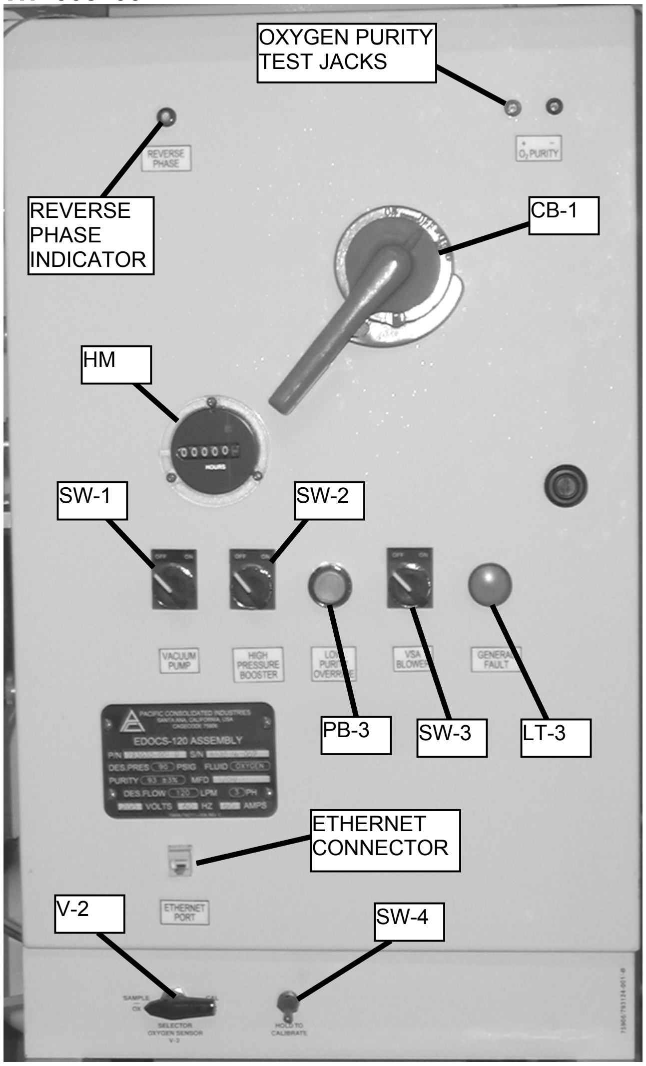


Figure 1. Electrical Control Panel.

e. Set the high pressure quick connect fitting vent valve (V-8) to ‘VENT’. Refer to Figure 3.

f. If the oxygen backup supply system is to be used in automatic mode, set the backup system shutoff valve (V-4) to ‘OPEN’, otherwise set the valve to ‘CLOSE’. Refer to Figure 4.

g. Set the backup cylinders vent valve (V-5) to ‘CLOSED’. Refer to Figure 4.

h. Set the cylinder fill/vacuum selector valve (V-6) to ‘CLOSE’. Refer to Figure 4.

i. Set the cylinder transfilling shutoff valve (V-7) to ‘CLOSE’. Refer to Figure 4.


Figure 2. Booster Compressor Electrical Control Box.

## 4.2 Starting the Blower.

a. Turn the main power circuit breaker (CB-1) disconnect lever on (see Figure 1).

b. Set the VSA blower control switch (SW-3) to ‘ON’. (see Figure 1) The VSA absorber pressure gauge (PI-8) should start-up in vacuum mode (see Figure 5).

c. The VSA vacuum/pressure switching valve (V-1) will automatically switch to the pressure position about 8 seconds after the vacuum reaches about 15 inches Hg. It stay in the pressure position until the pressure reaches about 9 psig after which it will switch back to the vacuum position. It will continue doing this as long as the blower control switch is set to ‘ON’.

d. After the switching valve has completed 5 vacuum/pressure cycles, the scroll compressor (C-1) will automatically start.

e. When the purity reaches 90% the oxygen off-spec solenoid valve (SV-2) will energize and stop venting the low purity oxygen to atmosphere (see Figure 6). At the same time, the proper purity oxygen will be delivered to the product distribution box (see Figure 3).

f. At this time oxygen is available for use.

g. The EDOCS-120 will continuously deliver oxygen at up to 120 lpm as long as the purity is 90% or greater.

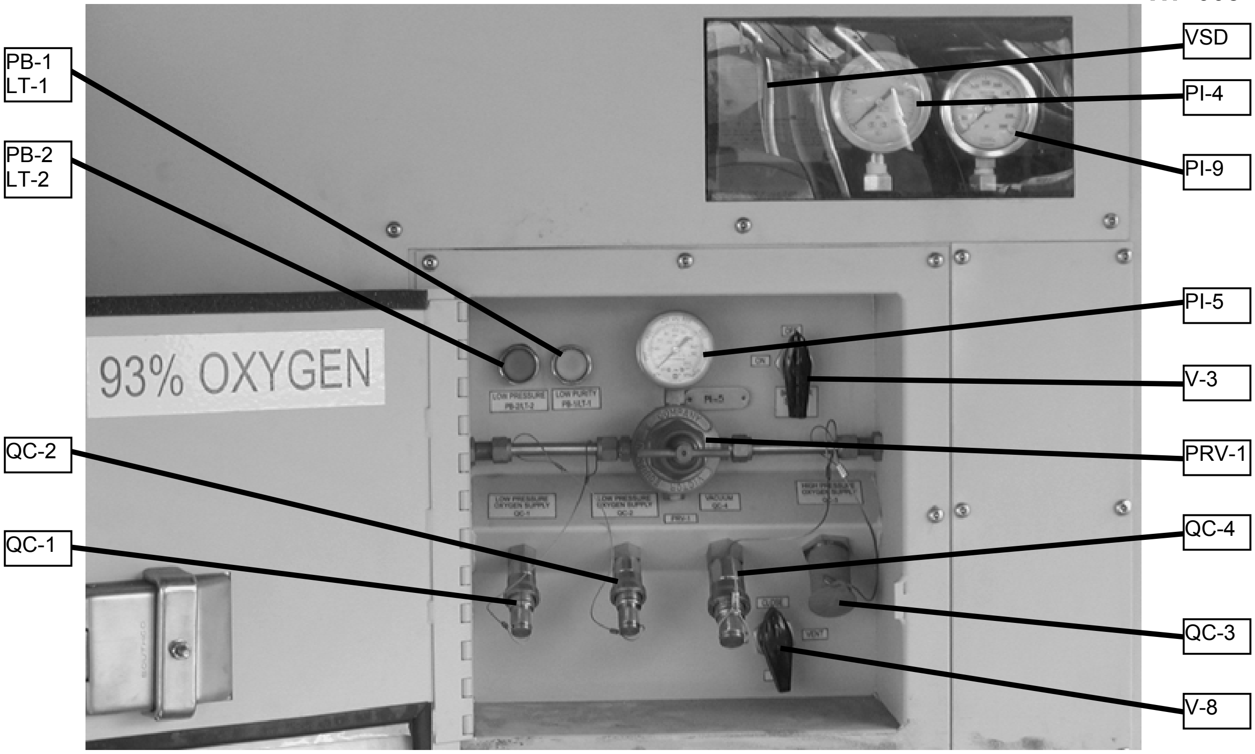


Figure 3. Product Distribution Box.

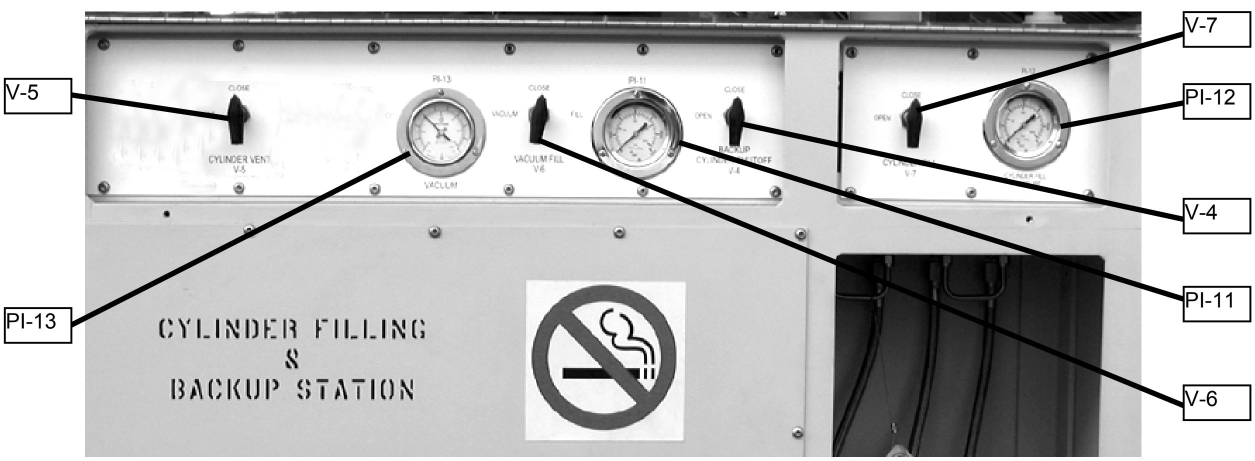


Figure 4. Oxygen Backup Supply System Panel.

If there are extreme surge usage conditions where the purity may fall below 90%, there is an override switch (PB-3) to allow delivery of oxygen at purities below 90% (see Figure 1).

**CAUTION**

Do not use the low purity override switch (PB-3) without express authorization from the Officer-in-Charge (OIC).

## 5. OPERATING THE EDOCS-120

### 5.1 Supplying Low Pressure Oxygen to the Hospital.

The EDOCS-120 is an interface and backup device for supplying oxygen to the hospital ward or surgical suite. Two low-pressure oxygen outputs (QC-1, QC-2) are provided for delivery of oxygen to the hospital (see Figure 3). Set the oxygen delivery pressure to 85 psig by adjusting the pressure regulator (PRV-1). Any time the oxygen pressure

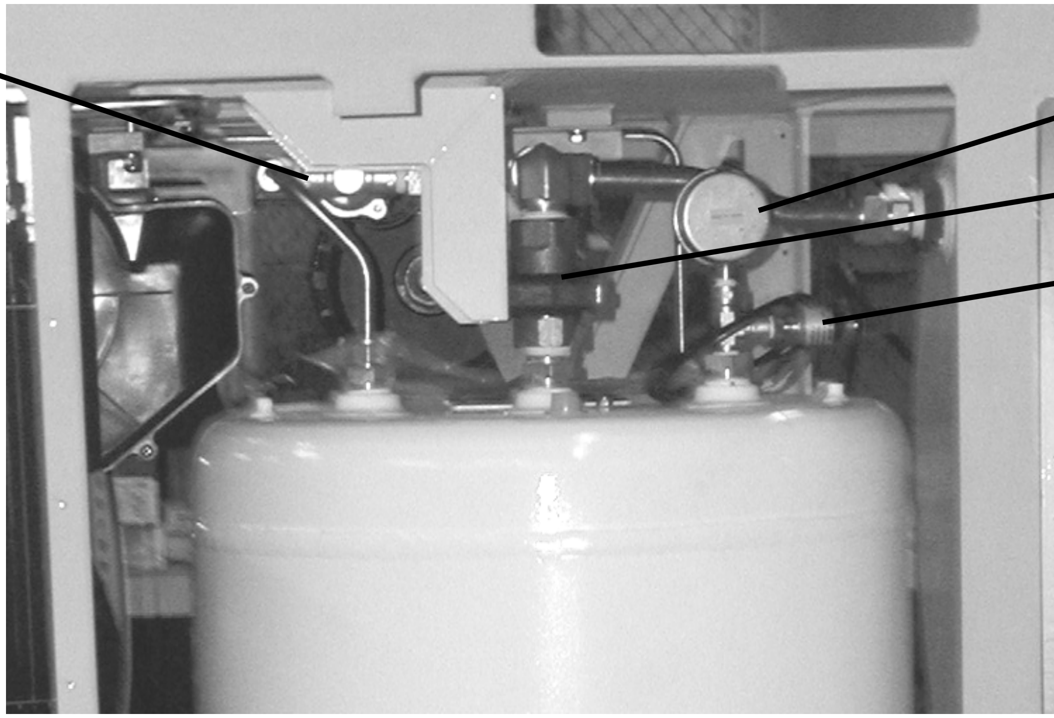


Figure 5. VSA Adsorber Controls.


Figure 6. Oxygen Off-Specification Solenoid Valve.

drops below 80 psi, the backup system supply regulator (PRV-3) will engage and automatically provide oxygen flow to the hospital, as long as the backup system cylinders are pressurized. When the oxygen pressure drops below 80 psi, an alarm inside the patient ward (part of the PODS) will sound. If the backup system shutoff valve (V-4) is closed, slowly rotate it to the 'OPEN' position (see Figure 4). If the system is in the automatic back-up mode (see paragraph 4.1(f.), the backup system supply regulator (PRV-3) will engage at 80 psi and provide the oxygen flow to the hospital automatically.

During operation, the adsorber pressure gauge (PI-8) should indicate 8-9 psig during the pressure cycle and 15-16 inches Hg during the vacuum cycle (see Figure 5). The scroll compressor outlet pressure gauge (PI-2) should indicate 95-108 psig (see Figure 3). The buffer storage tank pressure gauge (PI-3) should indicate 3.5 to 7.5 psig (see Figure 22).

**CAUTION**

Any time the PODS alarm sounds (even if momentarily); a Biomedical Equipment Technician (BMET) must be notified immediately. Also, alert all staff members of potential overdraw condition, use oxygen efficiently, and search for leaks. If in the automatic backup mode, the PODS alarm may only sound momentarily and may inadvertently be overlooked. This can present a problem because the PODS alarm is the only noticeable alert indicating backup oxygen is being used. In such case, complete loss of backup oxygen could occur before users are

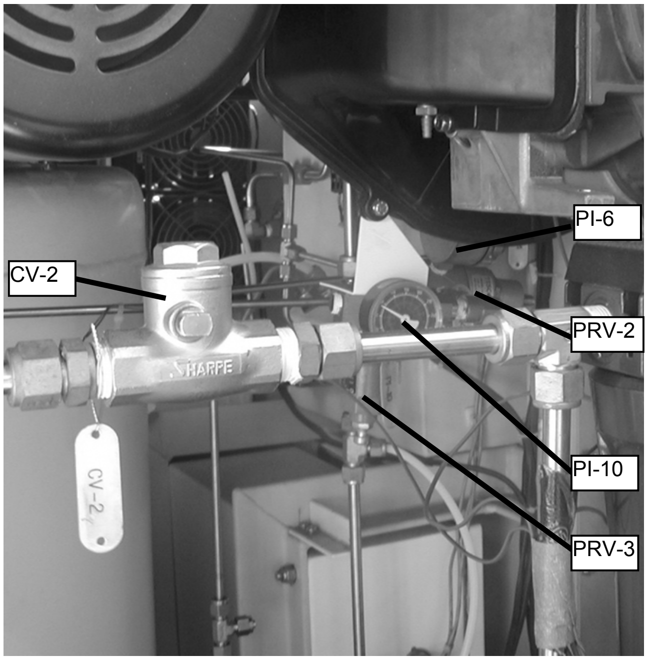


Figure 7. Oxygen Backup System Pressure Regulator.

aware of a problem. BMET must investigate each alarm occurrence thoroughly.

## 5.2 Operation of Oxygen Backup Supply System.

5.2.1 Evacuating Medical Oxygen 'D' and 'E' Cylinders.

Unless otherwise indicated, refer to Figures 4 and 8.

**WARNING**

ALWAYS VENT CYLINDERS TO ATMOSPHERIC PRESSURE BEFORE CONNECTING THE YOKE CONNECTORS TO THE CYLINDERS. SEVERE DAMAGE TO THE VACUUM GAUGE (PI-13) WITH HAZARDOUS FLYING SHRAPNEL CAN OCCUR.

**WARNING**

NEVER FILL LESS THAN FOUR CYLINDERS AT A TIME. FAILURE TO DO SO WILL RESULT IN EXCESS OXYGEN TEMPERATURE IN THE CYLINDER(S). THE RESULT OF WHICH COULD BE A CATASTROPHIC EXPLOSION OR FIRE.

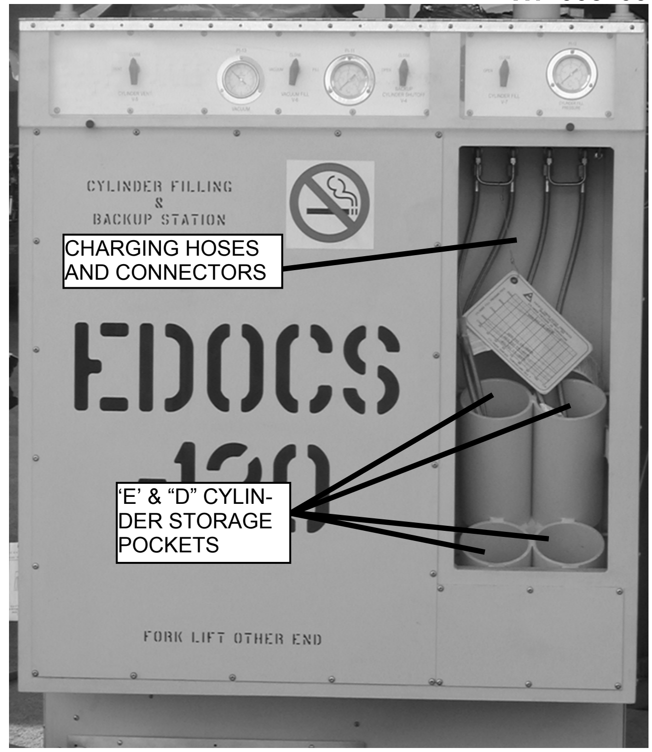


Figure 8. Oxygen Backup Supply System.

a. After ensuring that the cylinders contain no pressure, insert the cylinders in the pockets provided in the backup system frame.

b. Install the yoke connectors (CC-1, CC-2, CC-3, CC-4) to the cylinders. Make sure that the Teflon gaskets on the connectors are in place and not damaged prior to installation. Securely tighten the T-handle on each connector.

c. Close the backup system shutoff valve (V-4) and the cylinder filling shutoff valve (V-7).

d. Ensure that the cylinder fill/vacuum valve (V-6) is set to 'CLOSE'. Slowly open the valve on each cylinder to the fully open position. Observe the 'D'/'E' cylinders pressure gauge (PI-12).

e. If the gauge indicates any pressure, close the valve on each cylinder. Slowly loosen the T-handle on the yoke connector on one cylinder and remove it. Then slowly open the valve on all four cylinders until all of the pressure is vented. Reconnect the yoke connector to the cylinder and tighten it securely. Leave the valves on the cylinders fully open.

f. Set the cylinder fill/vacuum selector valve (V-6) to 'VACUUM' position.

g. Switch the vacuum pump control switch (SW-1) to 'ON' (see Figure 1). See Figure 9 for the location of the vacuum pump (P-1).

h. When the vacuum pressure (PI-13) reaches a vacuum of 25 in. Hg or moor, close the valves on the cylinders.

i. Turn off the vacuum pump.

j. Prepare the cylinders for filling in accordance with the procedures in paragraph 5.2.2 or 5.2.3.

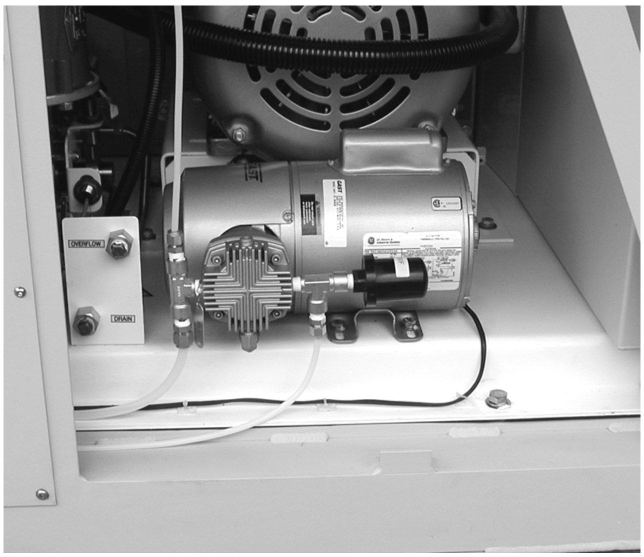


Figure 9. Vacuum Pump.

5.2.2 Recharging Medical Oxygen 'D' and 'E' Cylinders.

Unless otherwise indicated, refer to Figures 4 and 8.

**WARNING**

NEVER FILL LESS THAN FOUR CYLINDERS AT A TIME. FAILURE TO DO SO WILL RESULT IN EXCESS OXYGEN TEMPERATURE IN THE CYLINDER(S). THE RESULT OF WHICH COULD BE A CATASTROPHIC EXPLOSION OR FIRE.

a. Insert the cylinders to be filled in the pockets provided in the backup system frame.

b. Install the yoke connectors (CC-1, CC-2, CC-3, CC-4) to the cylinders. Make sure that the Teflon gaskets on the connectors are in place and not damaged prior to installation. Securely tighten the T-handle on each connector.

c. Ensure that the cylinder fill/vacuum valve (V-6) is set to 'CLOSE'. Slowly open the valve on each cylinder.

d. Close the backup system shutoff valve (V-4). Close the cylinder filling shutoff valve (V-7).

e. Set the cylinder fill/vacuum selector valve (V-6) to 'FILL' position.

f. Slowly open the cylinder shutoff valve (V-7). If the booster compressor is set for automatically recharging the backup cylinders (SW-2 set to 'ON'), the compressor will automatically start and begin recharging the cylinders. If the booster compressor control switch (SW-2) is set to 'OFF', switch it to 'ON' (see Figure 1).

g. When the pressure on the cylinders reaches about 2250 psig (PI-12), the booster compressor will automatically stop.

h. Close the valve on each cylinder. Close the cylinder filling shutoff valve (V-7).

**CAUTION**

The hoses contain oxygen at high pressure (up to 2250 psig) but it will deplete very quickly. However, extreme caution must be used when loosening the yoke connectors.

i. Slowly loosen the T-handle on each yoke connector to vent the small amount of oxygen under pressure from the fill hoses. After the pressure has vented, remove the yoke connectors from the cylinder valves. Remove the cylinders from the pockets.

j. Set the fill/vacuum selector valve (V-6) to 'CLOSE'.

k. Open the backup system shutoff valve (V-4). If the backup cylinder pressure (PI-11) is less than about 1900 psig, the booster compressor will automatically start. When the backup cylinder pressure reaches about 2250 psig, the booster compressor will automatically stop.

l. Set up the booster compressor and backup supply system to the desired configuration, automatic or manual (booster compressor off or on and V-4 closed or open).

5.2.3 Transfilling Medical Oxygen 'D' and 'E' Cylinders.

Unless otherwise indicated, refer to Figures 4 and 8.

**WARNING**

NEVER FILL LESS THAN FOUR CYLINDERS AT A TIME. FAILURE TO DO SO WILL RESULT IN EXCESS OXYGEN TEMPERATURE IN THE CYLINDER(S). THE RESULT OF WHICH COULD BE A CATASTROPHIC EXPLOSION OR FIRE.

a. Insert the cylinders to be transfilled in the pockets provided in the backup system frame.

b. Install the yoke connectors (CC-1, CC-2, CC-3, CC-4) to the cylinders. Make sure that the Teflon gaskets on the connectors are in place and not damaged prior to installation. Securely tighten the T-handle on each connector.

c. Ensure that the cylinder fill/vacuum valve (V-6) is set to 'CLOSE'. Slowly open the valve on each cylinder.

d. Open the backup system shutoff valve (V-4). Close the cylinder filling shutoff valve (V-7).

e. Set the cylinder fill/vacuum selector valve (V-6) to 'FILL' position.

f. Slowly open the cylinder shutoff valve (V-7). If the booster compressor is set for automatically recharging the backup cylinders (SW-2 set to 'ON'), the compressor will automatically start when the pressure (PI-11) reaches about 1900 psig and begin recharging the cylinders. If the booster compressor control switch (SW-2) is set to 'OFF', switch it to 'ON' (see Figure 1).

g. When the pressure on the cylinders being transfilled (PI-12) is approximately the same as the pressure on the backup cylinders (PI-11), close the backup system shutoff valve (V-4). This will speed the topping off (filled to 2250 psig) of the cylinders being transfilled from the booster compressor.

**Note**

If the booster compressor control switch is set to 'OFF' and the backup cylinders are filled to 2250 psig when the transfilling begins, the pressure will equalize at about 1990 psig on 'D' cylinders and about 1840 psig on 'E' cylinders.

h. When the pressure on the cylinders reaches about 2250 psig (PI-12), the booster compressor will automatically stop.

i. Close the valve on each cylinder. Close the cylinder filling shutoff valve (V-7).

**CAUTION**

The hoses contain oxygen at high pressure (up to 2250 psig) but it will deplete very quickly. However, extreme caution must be used when loosening the yoke connectors.

j. Slowly loosen the T-handle on each yoke connector to vent the small amount of oxygen under pressure from the fill hoses. After the pressure has vented, remove the yoke connectors from the cylinder valves. Remove the cylinders from the pockets.

k. Set the fill/vacuum selector valve (V-6) to 'CLOSE'.

l. Open the backup system shutoff valve (V-4). If the backup cylinder pressure (PI-11) is less than about 1900 psig, the booster compressor will automatically start. When the backup cylinder pressure reaches about 2250 psig, the booster compressor will automatically stop.

m. Set up the booster compressor and backup supply system to the desired configuration, automatic or manual (booster compressor off or on and V-4 closed or open).

5.2.4 Recharging Medical Oxygen 'H' Cylinders.

Unless otherwise indicated, refer to Figure 3.

a. Position the cylinder to be filled within 15 feet of the front of the EDOCS-120.

b. Connect the CGA540 cylinder adapter to the cylinder. Connect the high pressure oxygen product hose (H-3) to the adapter.

c. Ensure that the HOBS quick connect fitting vent valve (V-8) is set to 'VENT' position.

d. Connect the other end of the hose (H-3) to the HOBS quick connect fitting (QC-3) on the product distribution box.

e. Close the backup system shutoff valve (V-4) (see Figure 4). Slowly switch the HOBS quick connect fitting vent valve (V-8) to ‘CLOSE’ position.

f. Slowly open the shutoff valve on the cylinder. If the booster compressor is set for automatically recharging the backup cylinders (SW-2 set to ‘ON’), the compressor will automatically start when the pressure (PI-11) reaches about 1900 psig and begin recharging the cylinders. If the booster compressor control switch (SW-2) is set to ‘OFF’, switch it to ‘ON’ (see Figure 1).

g. When the booster compressor outlet pressure gauge (PI-9) reaches about 2250 psig (see Figure 3) the compressor will stop.

h. Close the shutoff valve on the cylinder. Slowly switch the HOBS quick connect fitting vent valve (V-9) to ‘VENT’ position.

i. Remove the hose from the HOBS quick connect fitting (QC-3) and the CGA540 adapter fitting. Stow the hose in the storage rack inside the EDOCS-120 cabinet.

j. Remove the CGA540 adapter fitting from ‘H’ cylinder shutoff valve.

k. Set up the booster compressor and backup supply system to the desired configuration, automatic or manual (booster compressor off or on and V-4 closed or open).

## 5.3 High Pressure Booster Compressor Operation.

The EDOCS-120 high pressure booster compressor (C-2) is utilized to replenish (fill) ‘H’, ‘D’, and ‘E’ size cylinders and the ‘M’ cylinders in the backup supply system with 93 ±3% oxygen gas product (see Figure 10).

**Note**

The booster compressor will start automatically when the back supply pressure drops below about 1900 psi. The booster discharge pressure can be monitored on gauge PI-9 on the front side of the unit (see Figure 3). The booster compressor will stop when the pressure reaches about 2250 psig.

a. Verify the booster compressor “Hand/Off/Auto” selector switch (HOA) is in the “AUTO” position before operating (see Figure 10).

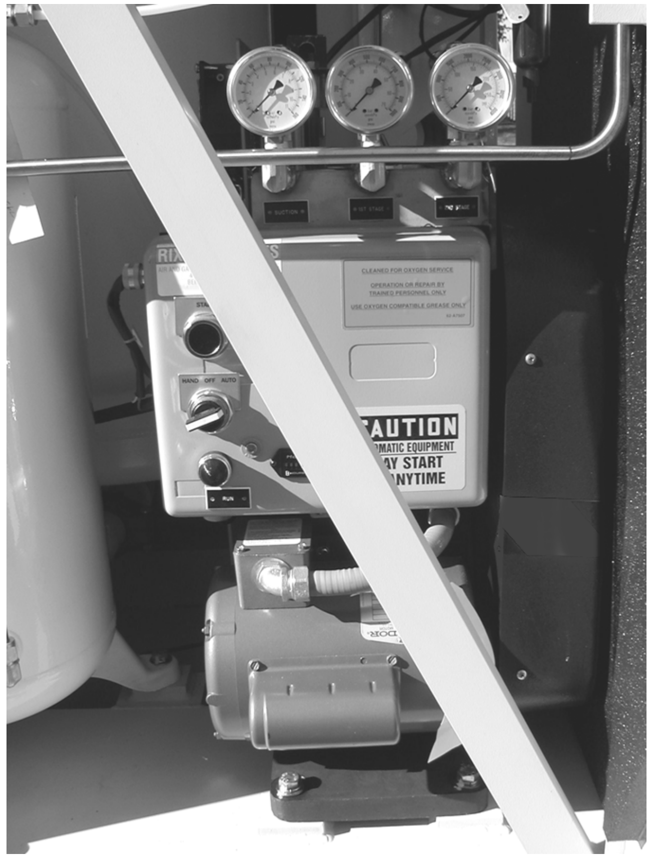

Figure 10. High Pressure Booster Compressor.

b. Turn the booster compressor control switch (SW-2) to the “ON” position (see Figure 1).

c. Slowly open the booster compressor supply shutoff valve (V-3) to provide 70 psig to the booster compressor inlet (see Figure 3). The compressor will start automatically if the discharge pressure is below about 1900 psig.

d. Slowly open valve V-4 on the back of the charging station to fill the backup supply system ‘M’ cylinders (see Figure 4).

e. Once the cylinder pressure reaches about 2250 psig, the booster compressor will shut down automatically and wait on standby until the pressure falls to about 1900 psig.

### 5.3.1 Booster Compressor Shut Down Procedure.

a. Close the backup system shutoff valve (V-4).

b. Close the booster compressor supply shutoff valve (V-3).

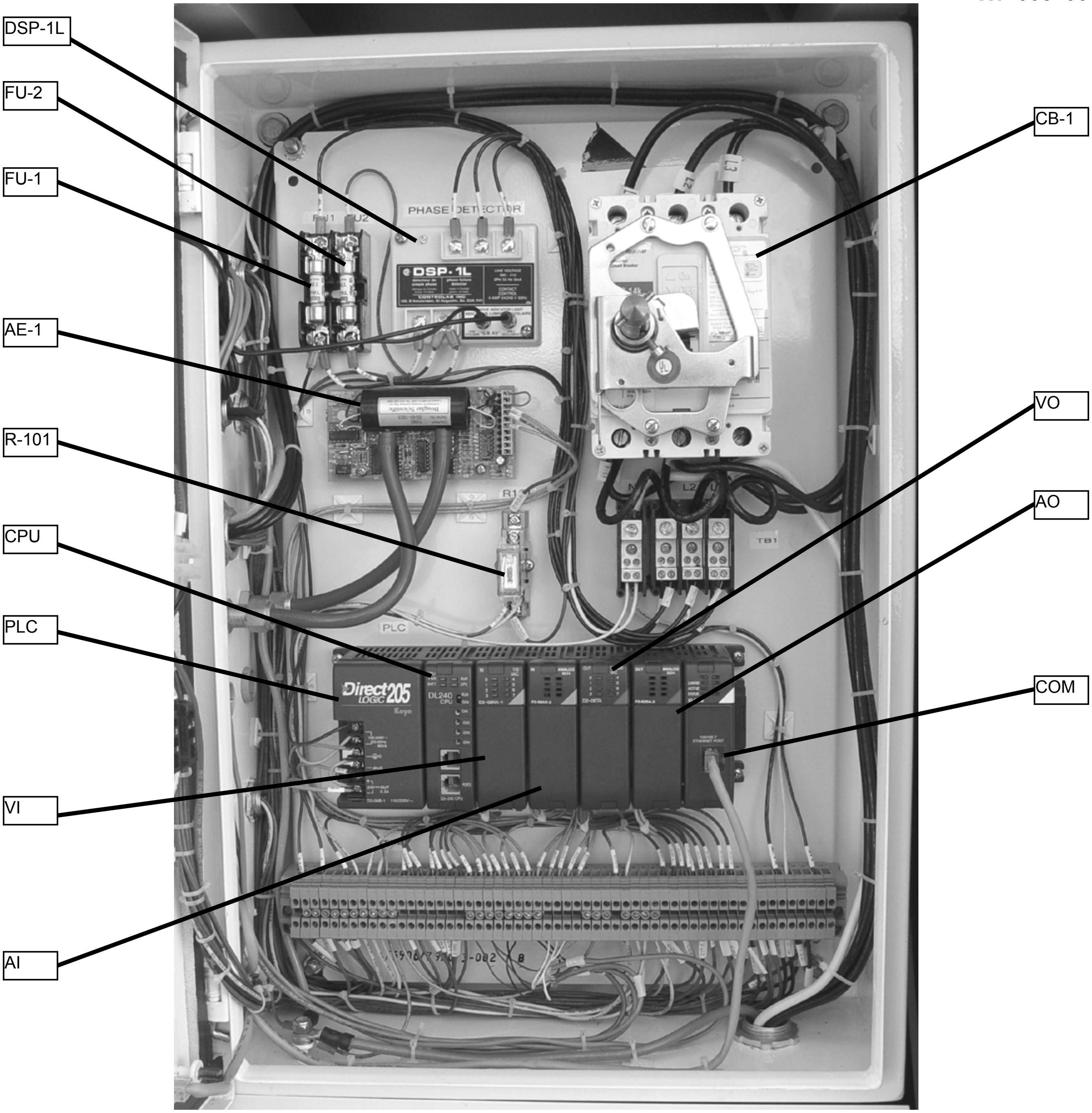


Figure 11. Electrical Control Box Panel.

c. Switch the booster compressor control switch (SW-2) to the ‘OFF’ position.

## 6. CHECKING OXYGEN PURITY

The oxygen purity is monitored by a non-depleting oxygen sensor (see Figure 11). The sensor never needs to be replenished and should last for the life of the EDOCS-120. Whenever power is recycled on the EDOCS-120, the sensing system must be calibrated in order for the programmable logic controller (PLC) to provide an accurate percentage of oxygen for system control.

### 6.1 Calibrating the Oxygen Sensor.

Anytime the oxygen sensor is replaced or there is a question whether the oxygen purity being reported by the EDOCS-120 system is correct, the oxygen sensor should be



Figure 12. Oxygen Sensor Calibration Kit.

calibrated. To calibrate the sensor, follow the procedures in WP 006 00, paragraph 14.

## 6.2 Calibrating the System.

A calibration kit is used for performing the following calibration procedures. The oxygen sensor calibration kit part number is 793600-001. The kit consists of the following components. Refer to Figure 12.

- Air pump.
- Hose with tube connection union.
- Electrical cord with plug.
- Potentiometer adjustment tool, P/N 793517-016.

The following tools are required to accomplish the tasks described in this procedure.

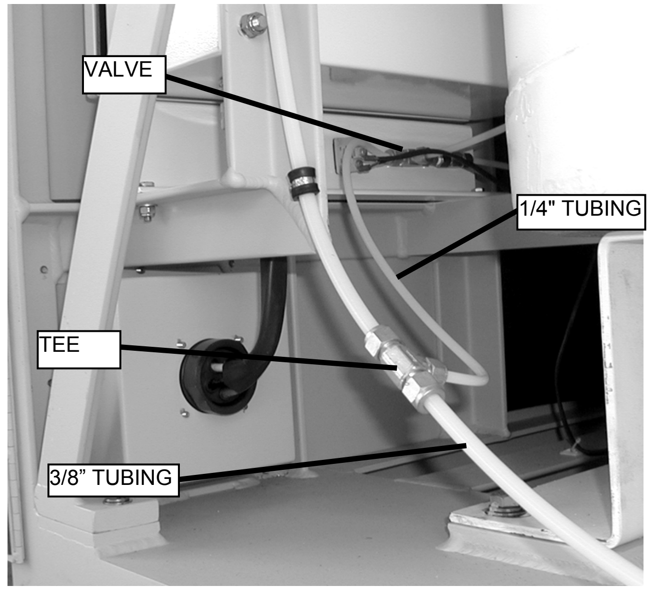


Figure 13. Sample/Calibration Selector Valve Tubing.

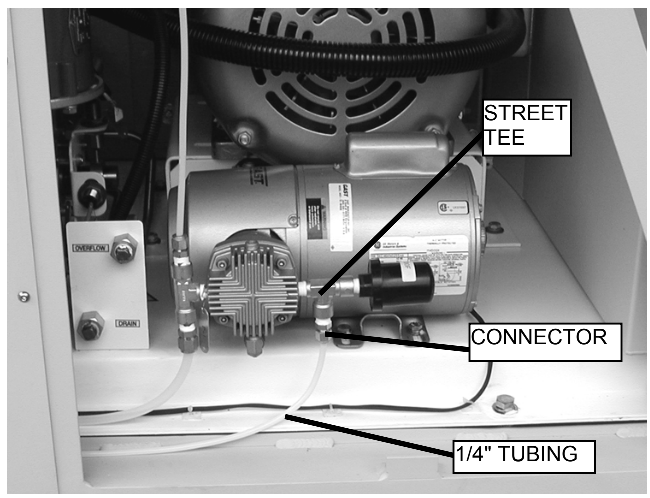


Figure 14. Alternate Calibration Tubing Connection.

**Note**

A small adjustable wrench (Crescent wrench) may be substituted for the wrenches.

- Two open-end wrenches, 9/16”
- A digital volt-ohm meter (DVM) that is capable of indicating at least 0.000 to 1.000 volts to a minimum of 3 decimal places.

**Note**

This calibration procedure must be performed anytime the power is initially applied to the system.

a. Open the access door on the right side of the EDOCS-120 unit.

b. Remove the 1/4” tube from the branch side of the tee (see Figure 13), or if there is no tee, remove the 1/4” tube from the street tee connector on the vacuum pump (see Figure 14).

c. Attach the hose to the fitting on the calibration kit hose (see Figure 12).

d. Plug the power cord into a single phase AC power outlet.

e. Push the calibration toggle switch (SW-4) up momentarily then release it (see Figure 15). The low purity light (LT-1) will begin flashing (see Figure 3).

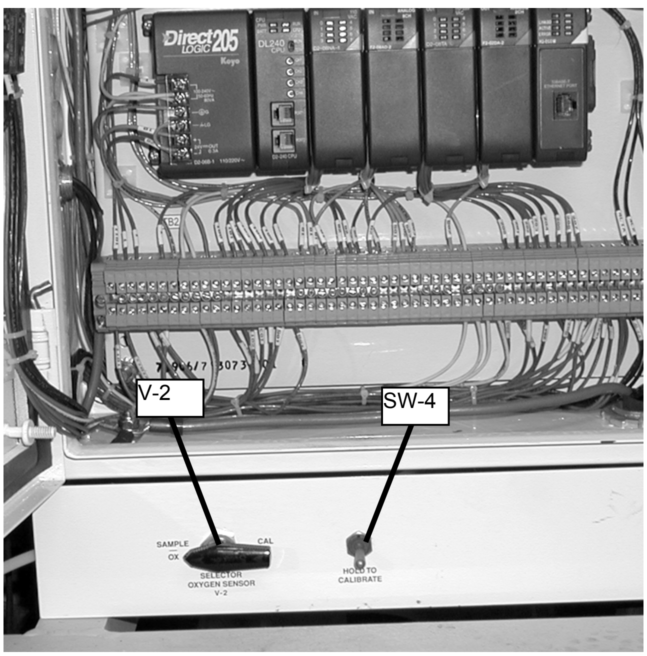


Figure 15. Oxygen Sensor Calibration Switch.

f. Switch the oxygen sensor flow selector valve (V-2) to ‘CAL’ position (see Figure 15).

g. When the low purity light stops flashing, check the voltage at the test sockets on the electrical box door (see Figure 16). Red is positive and black is negative.

h. The voltage should be between 0.208 and 0.210. If it is not, repeat steps (f.) through (h.).

i. Switch the oxygen sensor flow selector valve (V-2) to ‘SAMPLE’ position.


Figure 16. Electrical Control Box Door.

j. Remove the sensor calibration kit power cord from the outlet.

k. Remove the hose from the calibration kit hose-end fitting.

l. Install the hose on the tee (or vacuum pump fitting). Tighten the tube nut snugly.

m. Close the door.

n. Start the EDOCS-120 system according to the normal starting procedures (if not already in operation).

### 6.3 Using a Voltmeter to Check Oxygen Purity.

Check the voltage at the test sockets on the electrical box door using a digital voltmeter (DVM) (see Figure 16). Red is positive and black is negative. The voltmeter should be capable of indicating 0 to 1 volts DC with 3 decimal places. The value indicated should be multiplied by 100 to indicate the oxygen purity in percent (%) oxygen. For an example,

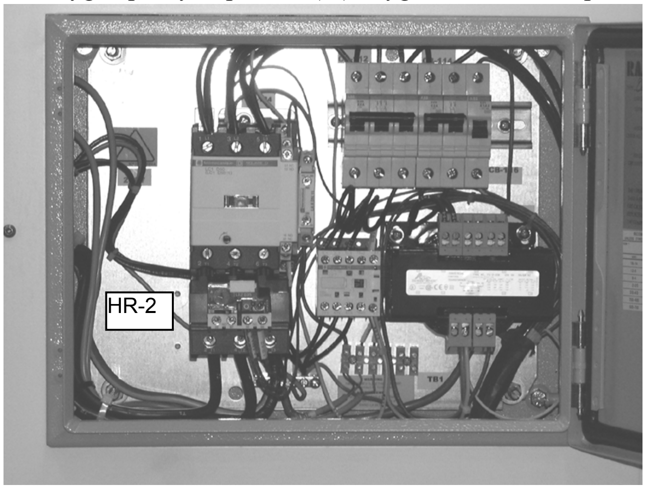


Figure 17. VSA Control Electrical Box.

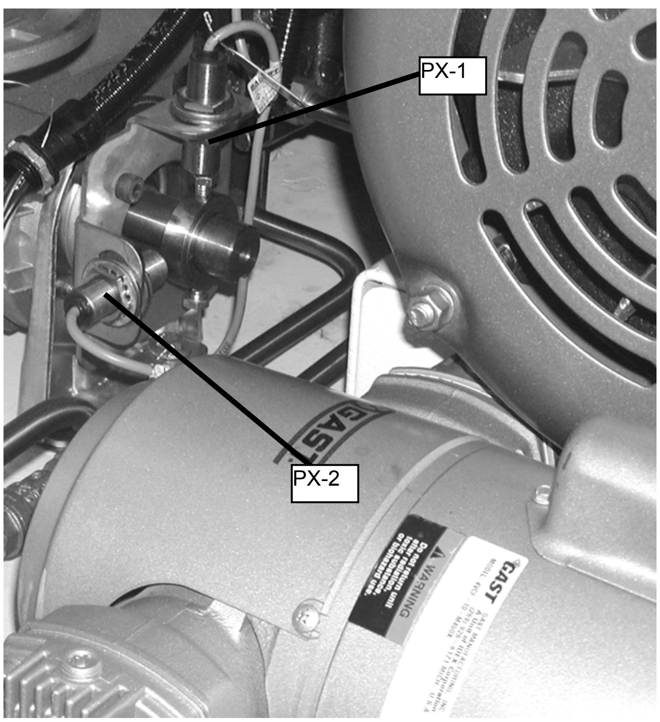


Figure 18. Proximity Switches.

if the DVM indicates .937, 100 X .937 = 93.7% oxygen purity.

## 7. OPERATION IN COLD CLIMATES

Operation of the EDOCS-120 in cold climates takes no special care. The time for the oxygen purity to be achieved from start up will take a longer period of time when operating in cold climates. If the unit is operating in extremely

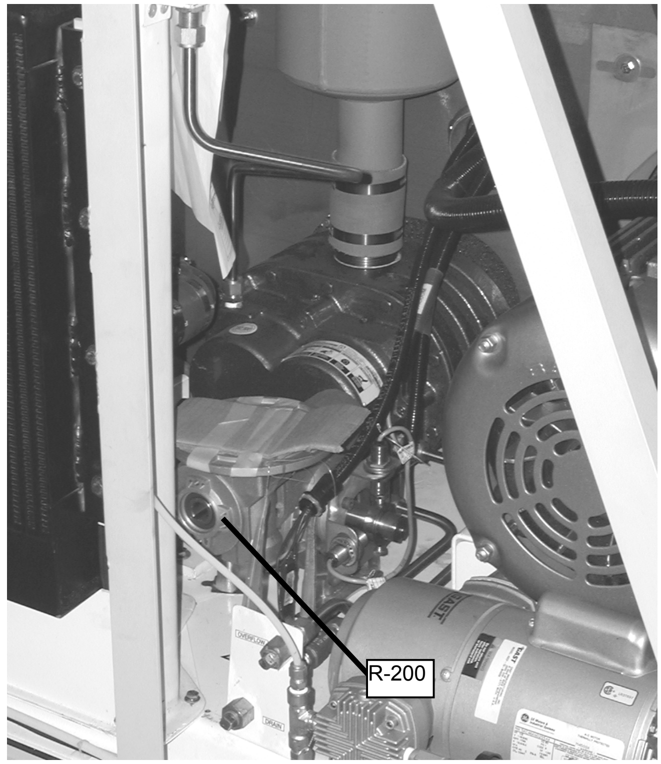


Figure 19. VSA Switching Valve Gear Reducer.

cold climates (below freezing temperatures), the aftercooler exhaust grill can be partially blocked to restrict the cooling air flow. This should be done whenever the internal temperature in the blower compartment is less than 60°F.

## 8. OPERATION IN HOT CLIMATES

When operating in hot climates (greater than 105°F), it is recommended to employ the optional Desert Cooling Package, part number 793590-001 (see Figure 23). To minimize the heating effects of solar radiation, the EDOCS-120 should be protected from direct sunlight by placing it under a tent or similar protective cover. Be careful not to restrict the free flow of the cooling air entering and exiting the cabinet.

## 9. OPERATION IN RAINY OR HUMID CLIMATES

Whenever operating in rainy or humid climates, periodically check the interior of the EDOCS-120 cabinet to ensure that standing water is not accumulating inside. Make sure the unit is not located in an area where puddles of water can accumulate and enter the interior of the cabinet. Orient the EDOCS-120 such that blowing rain cannot enter cavities or openings.

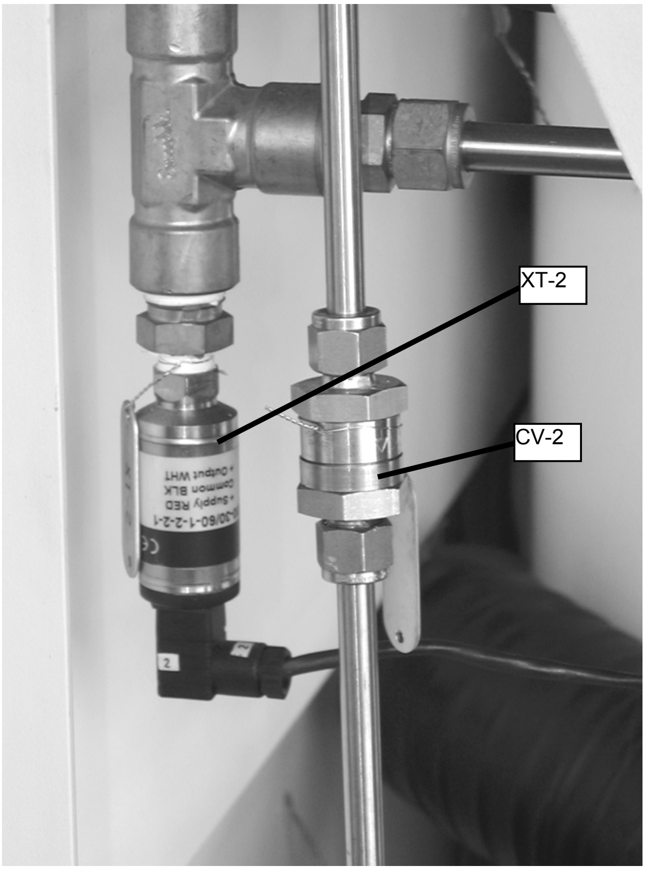


Figure 20. Buffer Storage Tank Pressure Transducer.

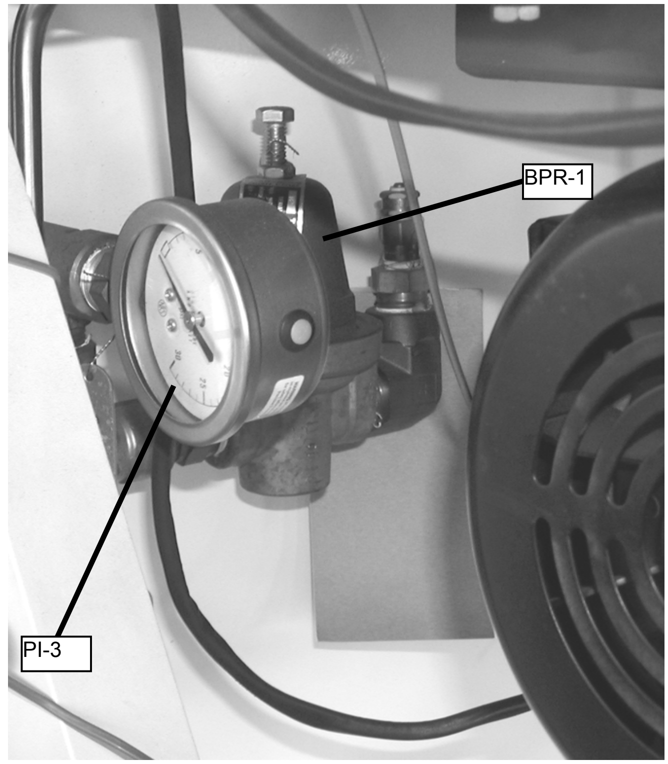


Figure 22. Buffer Storage Tank Back Pressure Regulator.

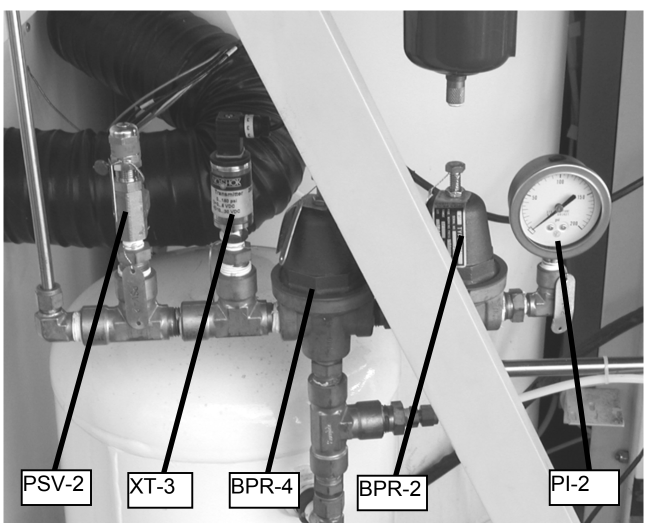


Figure 21. Scroll Compressor Controls.

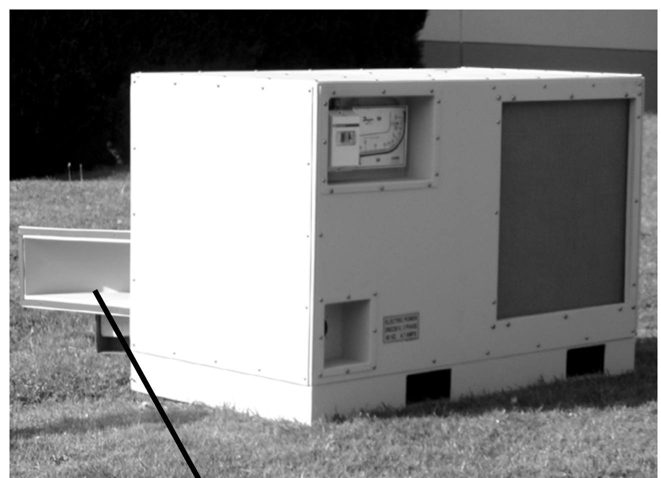


Figure 23. Desert Cooling Package.

## 11. OPERATION IN HIGH ALTITUDES

The EDOCS-120 will operate with no detrimental effects at high altitudes. There will be a reduction in the production rate of oxygen, but nothing significant. The pressure/vacuum cycle of the VSA will be a little longer than when operating at sea level.

## 12. SHUTTING DOWN THE EDOCS-120

To shut down the EDOCS-120, set the blower control switch (SW-3) to ‘OFF’ position. Switch the main circuit breaker (CB-1) disconnect lever to ‘OFF’ (rotate clockwise). Refer to Figure 1.

### 12.1 Emergency Shut Down Procedure.

Switch the main circuit breaker (CB-1) disconnect lever to ‘OFF’ (rotate clockwise). Refer to Figure 1.

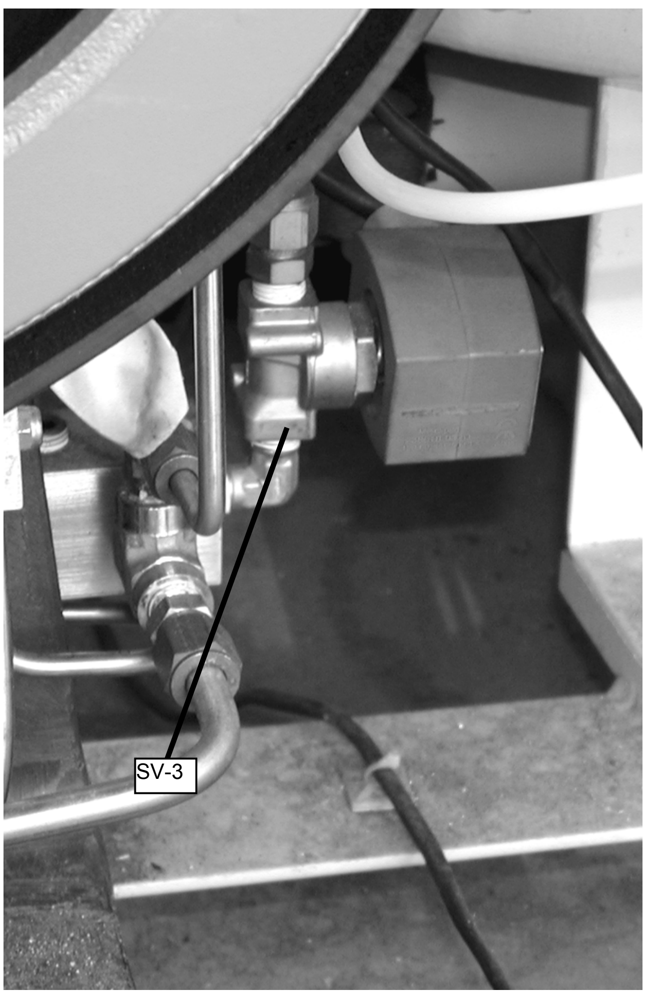


Figure 24. Booster Compressor Inlet Solenoid Valve.


Figure 25. Booster Compressor Pressure Switches.

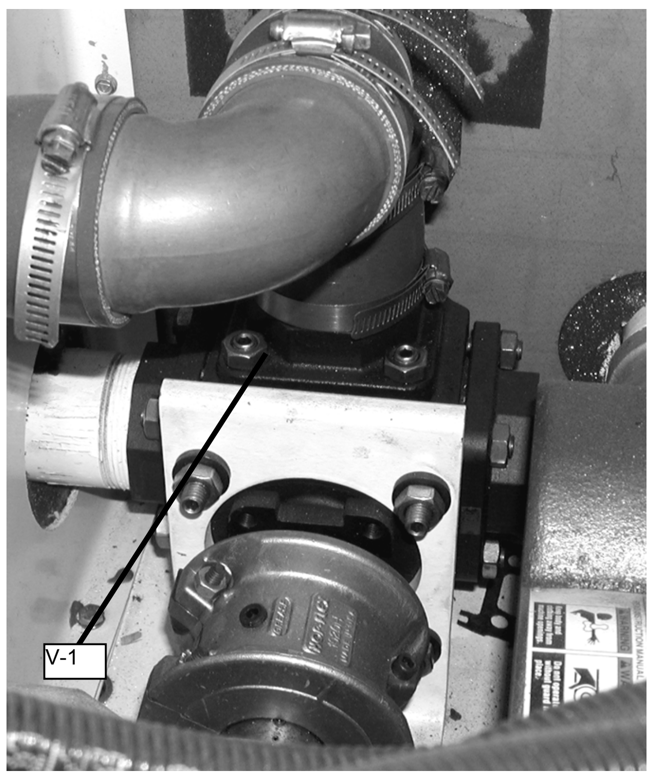


Figure 26. VSA Pressure/Vacuum Switching Valve.

WORK PACKAGE

PERIODIC INSPECTION, MAINTENANCE AND LUBRICATION

# OPERATION AND MAINTENANCE INSTRUCTIONS

EFFECTIVITY: EXPEDITIONARY DEPLOYABLE OXYGEN CONCENTRATION SYSTEM- P/N 793035-001

## LIST OF EFFECTIVE WP PAGES

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## TABLE OF CONTENTS

## TABLE OF CONTENTS (continued)



## LIST OF ILLUSTRATIONS



## LIST OF TABLES

## 1. GENERAL

The procedures in this work package cover only normal inspections, lubrication and maintenance necessary to keep the EDOCS-120 in good operating conditions. Extensive maintenance and overhaul activities are defined in T.O. EDOCS-120-3.

## 2. PRIOR TO USE INSPECTION

The inspections listed in Table 1 are to be accomplished on a regular basis prior to start-up at the time intervals shown in the table.

Table 1. Prior to Use Inspections For the EDOCS-120.

| OPERATION | PRIOR TO USE INSPECTION | | |
|---|---|---|---|
| | PRE-START | WEEKLY | MONTHLY |
| Inspect for structural damage. | X | | |
| Inspect all valves for proper operation. | X | | |
| Inspect all gauges for damage; ensure the needles are at ‘0’ position. | X | | |
| Calibrate the oxygen sensor IAW WP 005 00, paragraph 6.2 upon power-up. | X | | |
| Check blower drive belt for fraying and looseness. | | X | |
| Check scroll compressor drive belt for fraying and looseness. | | X | |
| Check blower gear case oil level. | | X | |
| Check blower inlet filter (F-2) for debris or clogging. | | | X |
| Check all fittings and tubing for leaks and looseness. | | | X |
| Check all fasteners for looseness. | | | X |
| Check the booster compressor drive belt for fraying or looseness. | | | X |

Table 2. Periodic Maintenance For the EDOCS-120.

| OPERATION | MAINTENANCE PERIOD | | | | |
|---|---|---|---|---|---|
| | 1000 hrs | 2000 hrs | 3000 hrs | 4000 hrs | 12 mos |
| Replace oxygen product filter (F-1). | X | | | | |
| Replace blower inlet filter element (F-2). | X | | | | |
| Replace scroll compressor inlet filter (F-3). | X | | | | |
| Replace scroll compressor scroll seals. | X | | | | |
| Grease blower shaft bearings | X (wkly) | | | | |
| Change the oil in the blower gear case. | X | | | | |
| Clean high pressure booster compressor interstage and discharge filters. | | X | | | |
| Adjust scroll compressor drive belt. | | X | | | |
| Adjust blower drive belt | | X | | | |
| Adjust high pressure booster compressor drive belt. | | X | | | |
| Check high pressure booster compressor piping and fittings for leaks. | | X | | | |
| Inspect high pressure booster compressor bearings. | | X | | | |
| Replace high pressure booster compressor stage 2 piston ring. | | X | | | |
| Clean scroll compressor fins. | | X | | | |
| Replace high pressure booster compressor stage 1 piston rings. | | | X | | |
| Inspect and recondition high pressure booster compressor valves. | | | | X | |
| Test high pressure booster compressor outlet pressure relief valve (PSV-3). | | | | X | |
| Grease scroll compressor bearings. | | | | | X |
| Replace blower drive belts (or as required). | | | | | X |
| Replace scroll compressor drive belt (or as required). | | | | | X |
| Replace high pressure booster drive belt (or as required). | | | | | X |

## 3. PREVENTIVE AND PERIODIC MAINTENANCE

In order to maintain peak performance of the EDOCS-120, preventive and periodic should be performed following any periodic inspections. By careful inspection and checking during the operation of the EDOCS-120 and at scheduled inspection periods, breakdowns and extensive maintenance can be avoided. The prior to use inspections in Table 1 and the periodic maintenance in Table 2 should be performed within the period of time listed in the tables.

## 4. GENERAL MAINTENANCE FOR THE BLOWER

### 4.1 Adjusting the Blower Drive Belt.

a. Open the rear left door and remove the drive belt cover panel on the side of the adsorber assembly. The panel is below the VSA control electrical box.

b. Remove the access panel below the backup supply system (see Figure 1).

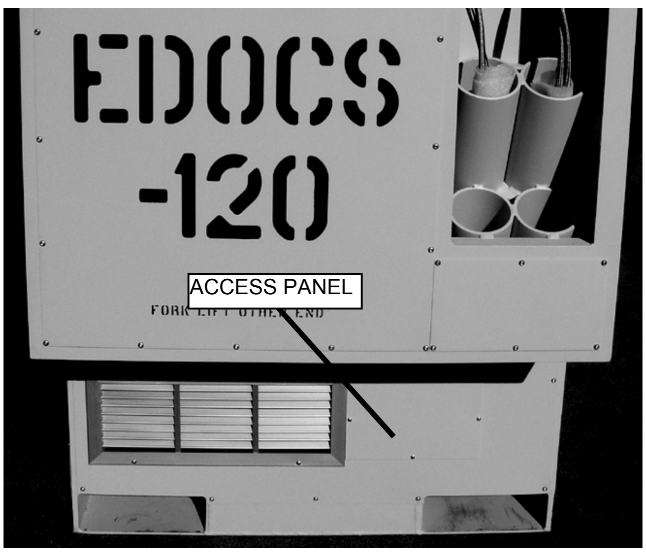


Figure 1. Motor Adjustment Access Panel.

c. Loosen the motor mounting bolts sufficiently to allow the motor to be moved with the adjusting bolts.

d. Check the belt tension by pressing one of the belts at the mid-point and measuring the force required to deflect the belt 0.30 inches. The force required should be 9-12 pounds for a used belt and 12-15 pounds for a new belt. Refer to Figure 2.

e. Adjust the tension adjusting bolts to achieve the required force at the 0.30 inch deflection. Tool kit p/n 793768-001 may be used to adjust the belts.

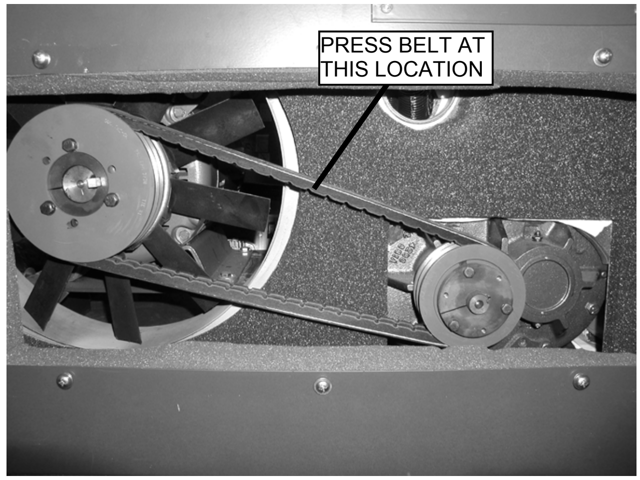


Figure 2. Blower Drive Belt Adjustment.

f. Tighten the motor mounting bolts.

g. Install the access panel. Tighten the panel attaching screws securely.

h. Install the drive belt cover panel. Tighten the attaching bolts securely. Close the door.

### 4.2 Replacing the Blower Drive Belt.

a. Open the rear left door and remove the lower panel on the side of the adsorber assembly.

b. Remove the access panel below the backup supply system (see Figure 1).

c. Loosen the motor mounting bolts sufficiently to allow the motor to be moved with the adjusting bolts.

d. Turn the adjusting bolts sufficiently to allow the belts to be removed from the pulleys (about 1.00 inch toward the blower). Remove the belts.

e. Install the new belts.

**Note**

Always replace all three belts when installing new belts, whether or not one or more of the belts may appear to be in good shape.

f. Adjust the belt tension following the procedures in paragraph 4.1(e.) through (f.).

g. Install the access panel. Tighten the panel attaching screws securely.

h. Install the drive belt cover panel. Tighten the attaching bolts securely. Close the door.

### 4.3 Maintaining the Blower Drive Gear Oil.

Check the oil level in the blower weekly. This is done by removing the plugs on the oil fill port and the oil level port and pouring the proper oil (Table 4 or WP 003 00, Table 1) into the fill port until oil begins to trickle from the oil level port. Refer to Figure 3.

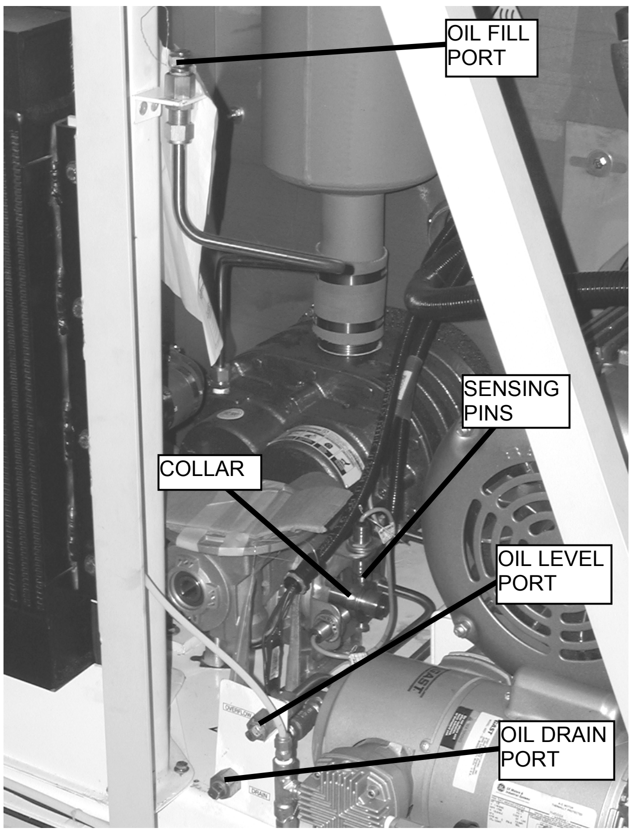


Figure 3. Blower Gear Case Oil Ports.

Drain the oil every 1000 hours of operation and refill with new oil. See Table 4 or WP 003 00, Table 1 for the proper grade of oil to use.

### 4.4 Greasing the Blower Shaft Bearings.

The drive end bearings should be greased weekly. Using a pressure grease gun, force grease into each bearing grease fitting until traces of clean grease come out of the relief fittings on the lower side of the bearing housing. Refer to Figure 4.

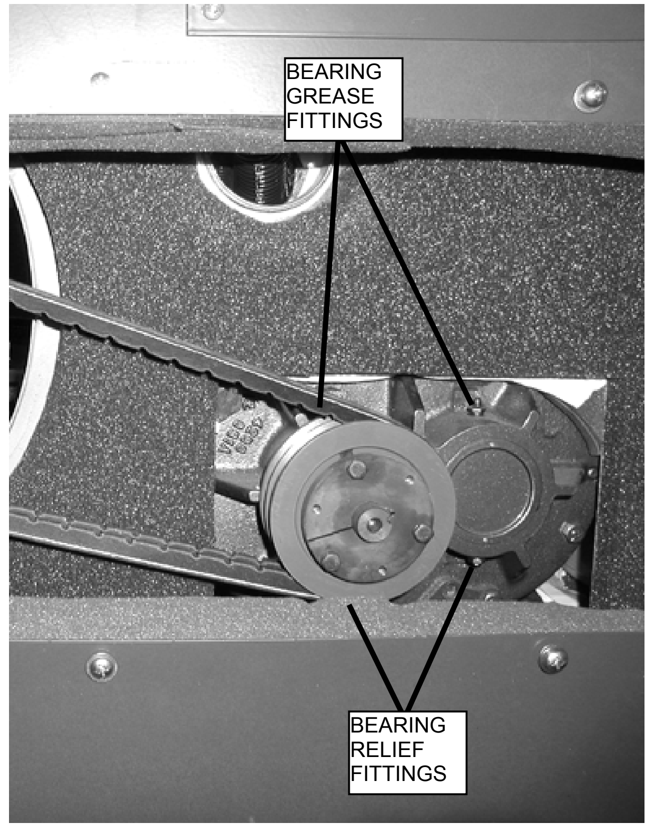


Figure 4. Blower Bearing Grease Fittings.

## 5. MAINTAINING THE VSA PRESSURE/VACUUM SWITCHING VALVE

Over a period of time, the frictional forces that the valve seals impose on the valve ball change due to seal wear. As a result of this, the ports in the rotating ball tend to misalign with the stationary ports in the valve body. This misalignment can cause a reduction in performance for the VSA system due to bypassing flow during the pressure cycle and ambient air intake during the vacuum cycle. To correct this condition, the sensing pins for the proximity switches (PX-1, PX-2) must be adjusted periodically. The following steps are used to adjust the positioning of the rotating ball.

**CAUTION**

The EDOCS-120 must not be operating during this procedure.

a. Remove the panel on the right side of the unit that has the louvered vent on it.

b. Remove the panel below the aftercooler radiator (HX-100). Refer to Figure 5.

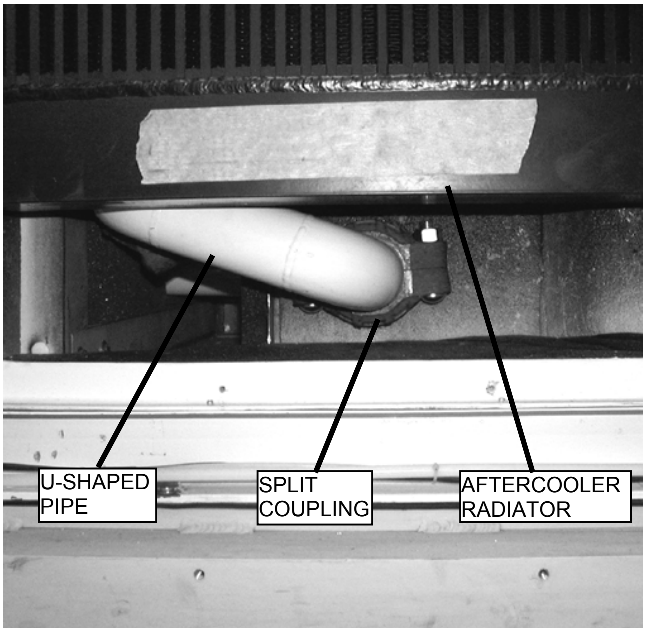


Figure 5. Valve Inlet Pipe.

c. Remove the split coupling attaching the U-shaped pipe to the valve inlet pipe (see Figure 5).

d. Push the rubber seal away from the joint between the two pipes. Swing the U-shaped pipe out of the way so the valve ball can be seen through the bore of the inlet pipe.

e. Using a flashlight, observe the position of the port in the valve ball relative to the inlet bore of the valve. If it is not aligned to within approximately 1/16", continue to the next step. Otherwise, skip to step (i) below.

**Note**

The 'L' port in the ball faces upward when the valve is in the vacuum position and faces downward when in the pressure position.

f. Loosen the setscrew on the collar with the sensing pins. Refer to Figure 3.

g. Rotate collar so the sensing pins are repositioned approximately the same distance as the mismatch in the bores. Rotate the collar clockwise if the bottom edge of the bore in the ball is above the valve body inlet bore. Rotate the ball counter-clockwise if the mismatch is at the top edge of the bore.

h. Tighten the setscrew snugly on the collar, taking care not to move the collar.

i. Align the U-shaped pipe with the valve inlet pipe. Center the rubber seal over the joint between the two pipes.

j. Install the split coupling halves over the rubber seal. Make sure the lips on the split coupling halves are seated in the grooves on the pipes. Tighten the coupling bolts securely.

k. Install the panel below the aftercooler radiator. Tighten the screws securely.

l. Install the side panel making sure the grill is inline with the aftercooler cooler. Tighten the screws securely.

## 6. MAINTAINING THE SYSTEM FILTERS

### 6.1 Replacing the Blower Inlet Filter Element.

**CAUTION**

Shut down the EDOCS-120 when replacing the filter. Failure to do so can allow debris to be ingested by the blower resulting with damage to the blower.

The filter element should be replaced every 1000 hours. Refer to Figure 6 when performing this procedure.

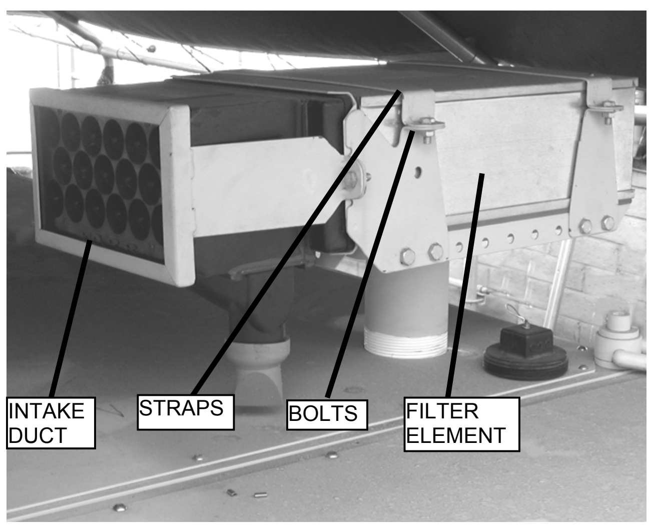


Figure 6. Replacing Blower Inlet Filter Element.

a. Remove the bolts securing the straps over the filter element. Remove the straps.

b. Remove the filter element. Discard the element.

c. Install the new filter element with the side openings facing the intake duct and the bottom openings facing down.

d. Place the straps over the element. Tighten the bolts securely.

## 6.2 Replacing the Scroll Compressor Inlet Filter Element.

**CAUTION**

Do not handle the new element by the outside foam cover. Handle by the bottom end cap only.

The scroll compressor inlet filter element should be changed every 1000 hours of operation. The replacement element can be identified by the blue foam cover. Use the following steps to replace the filter element. Refer to Figure 7.

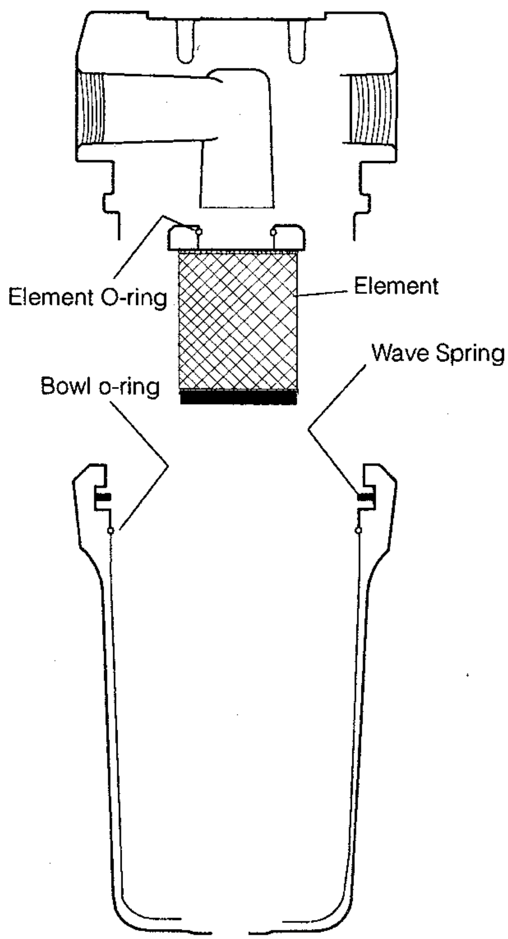


Figure 7. Replacing Scroll Compressor Inlet Filter Element.

a. Make sure that all pressure is removed from the filter housing. Open the manual drain valve on the bottom of the bowl by slowly turning it to the right (clockwise). Leave the valve open until there is no evidence of pressure remaining on the filter. Close the manual drain valve.

b. Remove the bowl by pushing the bowl straight up and rotating it 1/8$^{th}$ turn to the left (counterclockwise) until the bayonet latches are disengaged. Then pull the bowl straight down.

c. Pull the element straight down to disengage it from the filter head. Discard the old filter element.

d. Make certain the O-ring inside the top of the new replacement element is in place and push the element onto the filter head.

**Note**

Apply a small amount of oxygen compatible grease p/n 582380-001, or equivalent, to the O-rings.

e. Make certain the O-ring inside the top of the bowl and the wave spring are in place in the filter bowl. Align the bayonet tabs on the bowl with the bayonet notches on the filter head. Push the bowl firmly upward until it stops. Rotate the bowl to the right (clockwise) until it stops.

## 6.3 Replacing the Oxygen Product Particulate Filter Element.

The oxygen product particulate filter element should be replaced every 1000 hours. Use the following steps to replace the filter element. Refer to Figure 8.

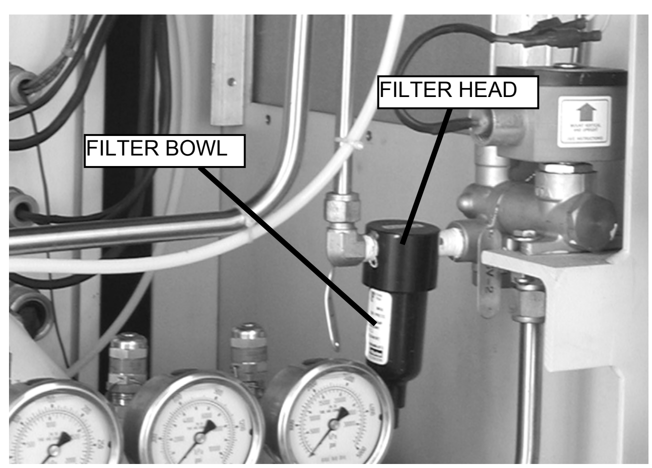


Figure 8. Replacing Oxygen Product Filter Element.

**WARNING**

THE FILTER MAY CONTAIN PRESSURIZED OXYGEN. REMOVE ALL PRESSURE FROM THE FILTER PRIOR TO REPLACING THE FILTER ELEMENT. FAILURE TO DO SO COULD RESULT IN SERIOUS INJURY TO PERSONNEL.

a. Remove the filter bowl by gripping it securely and rotating it counter-clockwise.

b. Remove the filter element by gently rotating it counter-clockwise until it is free of the filter head.

c. Install the new filter element by screwing it into the filter head. Gently turn the element clockwise until it stops. Tighten it snugly but take care not to over-tighten it.

d. Install the filter bowl by screwing it into the filter head. Turn the bowl clockwise until it stops. Grip the bowl firmly and tighten it as tight as possible with the hand.

## 7. SCROLL COMPRESSOR GENERAL MAINTENANCE

### 7.1 Adjusting the Scroll Compressor Drive Belt.

**WARNING**

NEVER ATTEMPT TO CHECK THE BELT TENSION WHILE THE SCROLL COMPRESSOR IS RUNNING. SERIOUS INJURY COULD RESULT.

The scroll compressor drive belt tension should be checked monthly to ensure optimum operation. Use the following steps to adjust the belt.

a. Open the door on the left side to gain access the scroll compressor.

b. Check the belt tension by pressing one of the belts at the mid-point and measuring the force required to deflect the belt 0.22 inches. The force required should be 3.6-4.8 pounds for a used belt and 5.1-6.5 pounds for a new belt. Refer to Figure 9.

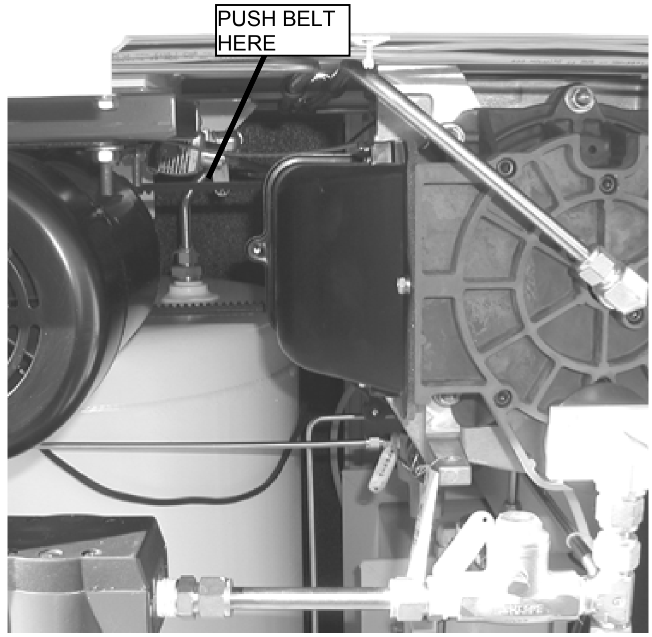


Figure 9. Checking Scroll Compressor Belt Tension.

c. Loosen the four (4) motor mounting bolts sufficiently to allow the motor to be moved with the tension adjusting bolt (see Figure 10).

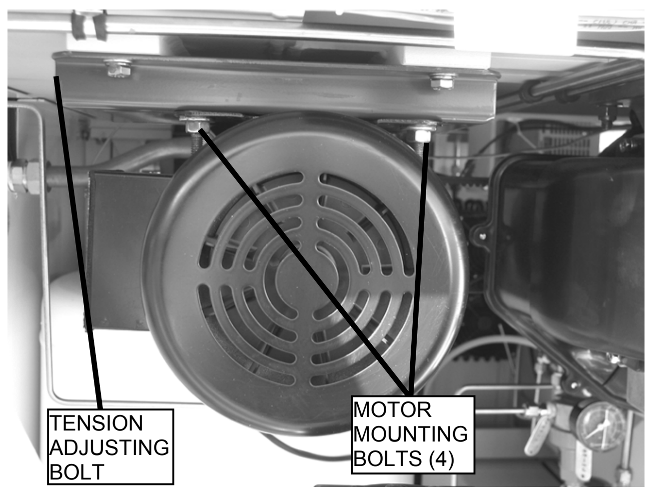


Figure 10. Scroll Compressor Motor Mount.

d. Adjust the tension adjusting bolt on the motor base to achieve the required force at the 0.22 inch deflection.

e. Tighten the motor mounting bolts.

f. Close the door.

## 7.2 Replacing the Scroll Compressor Drive Belt.

a. Open the door on the left side to gain access the scroll compressor.

b. Loosen the four (4) motor mounting bolts sufficiently to allow the motor to be moved with the tension adjusting bolt (see Figure 10).

c. Turn the tension adjusting bolt sufficiently to allow the belt to be removed from the pulleys (about 0.50 inch toward the scroll compressor). Remove the belt.

d. Install the new belt.

e. Adjust the belt tension in accordance with the applicable steps in paragraph 7.1.

f. Tighten the motor mounting bolts.

g. Close the door.

## 7.3 Greasing the Scroll Compressor Bearings.

The scroll compressor bearings should be greased once a year. Use the following steps to grease the bearings.

a. Remove the front panel to gain access to the scroll compressor.

b. Remove the plastic dust cap (see Figure 11).

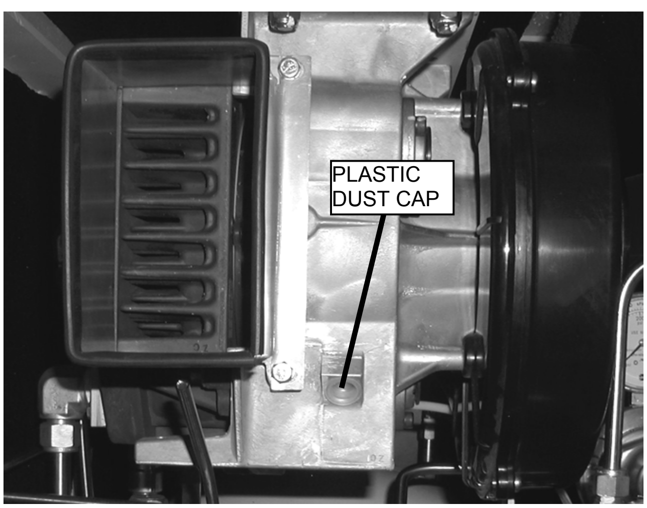


Figure 11. Scroll Compressor Grease Fitting.

c. Rotate the compressor pulley until the grease fitting is visible through the dust cap hole (see Figure 12). This will allow re-greasing of the main bearings.

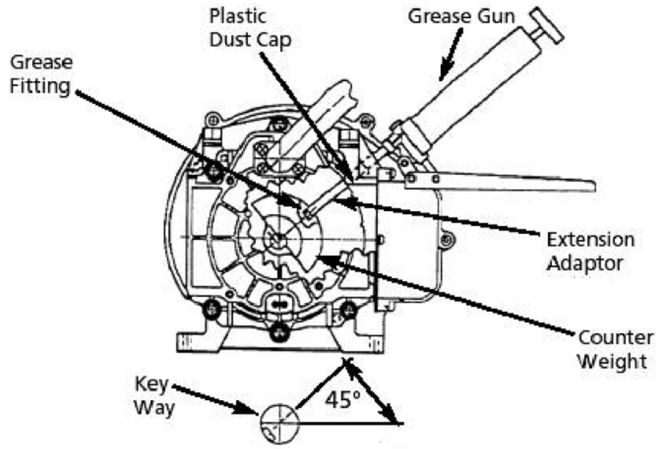


Figure 12. Greasing Scroll Compressor Bearings.

**Note**

See WP 003 00 for the approved bearing grease.

d. Use a grease gun extension adapter on the grease gun to engage the grease fitting.

**CAUTION**

Pump the grease gun before engaging the grease fitting to eliminate air from the grease passage on the extension adapter before engaging the grease fitting.

e. Engage the grease gun extension with the grease fitting. Pump the grease gun three (3) times if greasing existing bearings. If the bearings are newly installed bearings, pump the grease gun five (5) times.

**Note**

Each pump of the grease gun equals 0.65 grams of grease.

Additional bearings in the scroll compressor require greasing at 10,000 hour intervals. These bearings require some disassembly of the compressor. Therefore, the procedures for greasing these bearings are not included here. Instead, the procedures are included in the overhaul manual. See T.O. EDOCS-120-3, WP 005 00.

## 7.4 Checking Status of the Scroll Compressor Using the Variable Speed Drive.

The variable speed drive can be used to determine the status of the scroll compressor. The mode key is used to cycle the digital display through a variety of functions. The bar for the selected function illuminates when its value is in the digital display. Table 3 shows the function bar indication, its name, and its function. Refer to Figure 13.

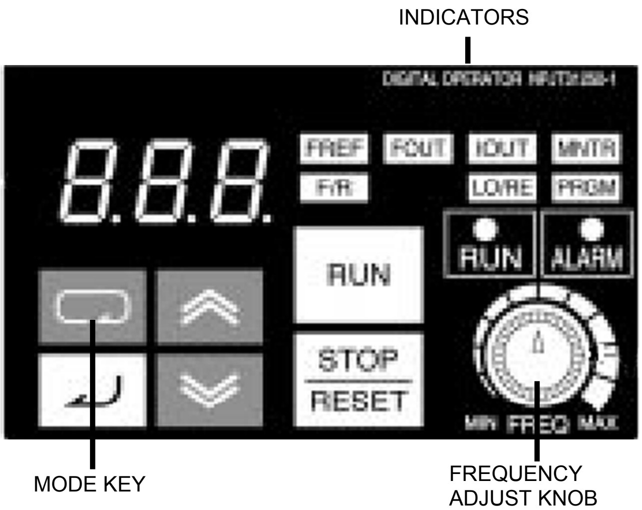


Figure 13. Variable Speed Drive Digital Operator.

Table 3. VSD Digital Operator Functions.

| Appearance | Function |
|---|---|
| FREF | The frequency set point (scroll compressor speed) can set or monitored when this indicator is lit. |
| FOUT | The output frequency (scroll compressor relative speed) can be monitored when this indicator is lit. |
| IOUT | The current draw of the scroll compressor can be monitored when this indicator is lit. |
| MNTR | The values set in U01 through U10 are monitored. These are program functions and are not to be used by operation personnel. |
| F/R | The direction of rotation can be set when this indicator is lit. This is not to be changed. |
| LO/RE | No useful information is displayed when this indicator is lit. This is used for basic setup of the VSD. |
| PRGM | The parameters of the VSD can be set when this indicator is lit. This is not to be changed. |

The frequency of the scroll compressor motor (scroll compressor speed) is adjusted using the frequency adjust knob (see Figure 13) while the FREF function indicator is lit. It should always be adjusted to 55.0.

## 8. ADJUSTING THE SYSTEM REGULATORS

### 8.1 Buffer Tank Pressure Regulator (BPR-1).

The buffer tank pressure regulator should be adjusted when the EDOCS-120 is in full operation and there is no oxygen product being taken from the system (0 product off-take). It should be adjusted to begin venting out the bottom port when the pressure reaches 7.5 psig. When it does not begin to vent at 7.5 psig, use the following steps to adjust the regulator. Refer to Figure 14.

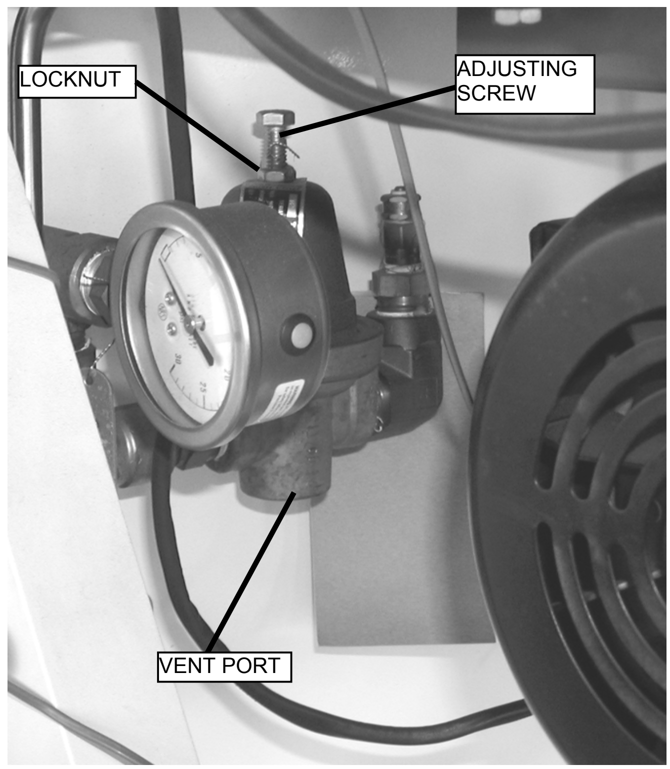


Figure 14. Buffer Tank Pressure Regulator (BPR-1).

a. Loosen the locknut on the adjusting screw.

b. Turn the adjusting screw until the regulator begins to vent at 7.5 psig. If it begins venting below 7.5 psig, turn the adjusting screw clockwise. If it begins venting above 7.5 psig, or doesn't vent at all above 7.5 psig, turn the screw counter-clockwise.

c. When the adjustment is complete, tighten the locknut.

## 8.2 Scroll Compressor Maximum Pressure Regulator (BPR-2).

The scroll compressor maximum pressure regulator (BPR-2) should be adjusted to limit the discharge pressure to 108 psig (as indicated on PI-2). Use the following steps to adjust the regulator. Refer to Figure 15.

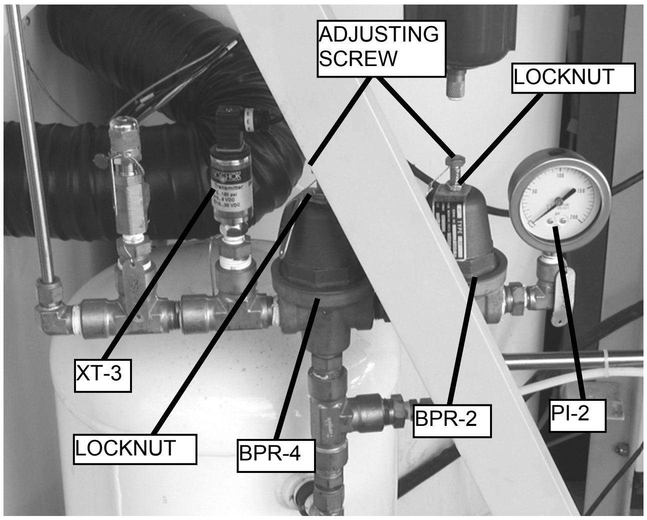


Figure 15. Scroll Compressor Pressure Regulators.

**Note**

The set point for the scroll compressor minimum pressure regulator (BPR-4) must be below 102 psig before adjusting the set point of the maximum pressure regulator.

a. The scroll compressor maximum pressure regulator should be adjusted when the EDOCS-120 is in full operation and there is no oxygen product being taken from the system (0 lpm product off-take).

b. Loosen the locknut on the adjusting screw of BPR-2.

c. Rotate the adjusting screw until the pressure indication on PI-2 stabilizes at 108 psig. If the pressure is below 108 psig, rotate the adjusting screw clockwise. If the pressure is above 108 psig, rotate the adjusting screw counter-clockwise.

d. After adjusting the pressure, tighten the locknut snugly.

## 8.3 Scroll Compressor Minimum Pressure Regulator (BPR-4).

The scroll compressor minimum pressure regulator (BPR-4) should be adjusted to limit the minimum discharge pressure to 95 psig as indicated on PI-4(see Figure 16). Use the following steps to adjust the regulator.

**Note**

The scroll compressor maximum pressure regulator (BPR-2) must be adjusted before attempting to adjust the scroll compressor minimum pressure regulator (BPR-4).

a. The scroll compressor minimum pressure regulator should be adjusted when the EDOCS-120 is in full operation and there is maximum oxygen product being taken from the system (120 lpm product off-take).

b. Loosen the locknut on the adjusting screw of BPR-4 (see Figure 15).

c. Rotate the adjusting screw until the pressure indication on PI-4 (see Figure 16) stabilizes at 95 psig. If the pressure is below 95 psig, rotate the adjusting screw clockwise. If the pressure is above 95 psig, rotate the adjusting screw counter-clockwise.

d. After adjusting the pressure, tighten the locknut snugly.

## 8.4 Oxygen Product Pressure Regulator (PRV-1).

The oxygen product pressure regulator (PRV-1) should be adjusted to 85 psig as indicated on PI-5 with 0 lpm product off-take. Refer to Figure 16. Rotate the T-handle on the regulator counter-clockwise to lower the pressure and clockwise to increase the pressure.

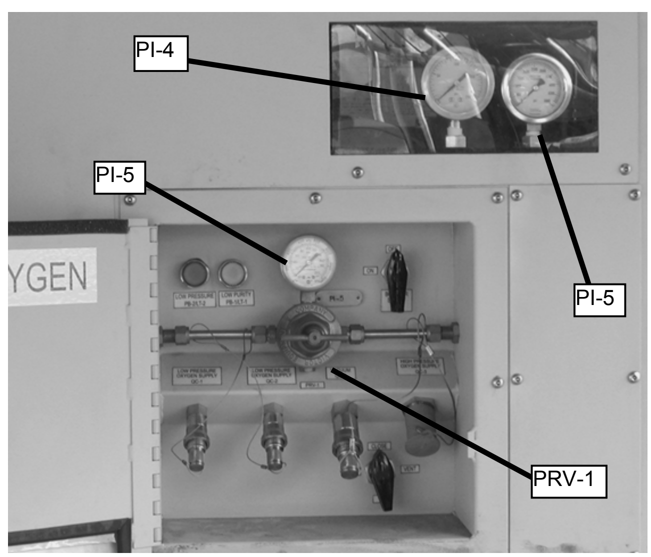


Figure 16. Oxygen Product Pressure Regulator (PRV-1).

## 8.5 Backup System Supply Pressure Regulator (PRV-3).

The backup system supply pressure regulator (PRV-3). Is pre-adjusted at the factory and should never require adjustment. However, if it becomes necessary to adjust it, the following steps should be used. Refer to Figure 17 for the location of the regulator and pressure gauge.

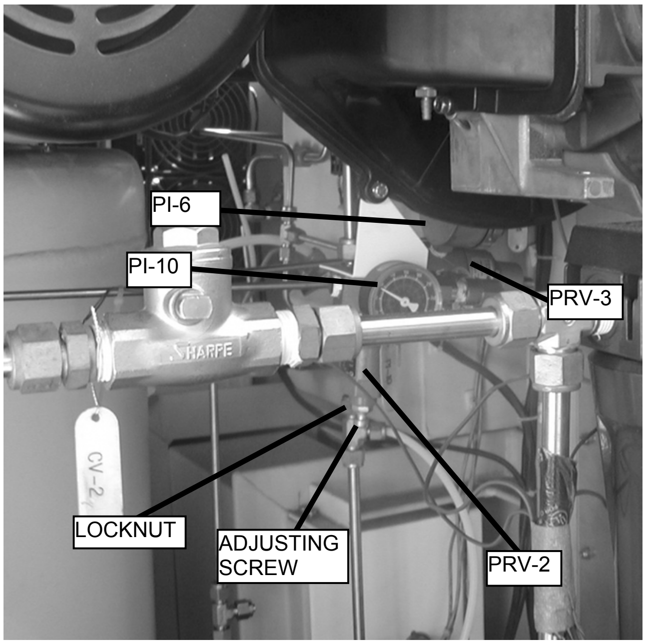


Figure 17. Backup System Pressure Regulators.

**Note**

The backup system cylinders must be filled before attempting to adjust the backup system pressure regulator (PRV-3). The EDOCS-120 should be in operation.

a. Close the backup system shutoff valve (V-4). Refer to WP 005 00, Figure 4.

b. Connect a low pressure oxygen product hose (H-1 or H-2) with a means of regulating the flow to one of the low pressure oxygen quick connect fittings (QC-1 or QC-2).

c. Adjust the oxygen flow rate through the hose to about 20-30 lpm.

d. Adjust the oxygen product pressure regulator (PRV-1) to about 70 psig. Shut off the oxygen product flow.

e. Loosen the locknut on the adjusting screw of PRV-3. Rotate the adjusting screw counter-clockwise 2 to 3 turns, using a screwdriver.

f. Slowly open the backup system shutoff valve (V-4).

g. Slowly rotate PRV-3 adjusting screw clockwise until 80 psig is indicated on PI-10.

h. Tighten the locknut securely.

**Note**

If the pressure is inadvertently adjusted to a pressure greater than 80 psig, back off the adjustment, allow flow to pass through the low pressure oxygen hose, stop the flow through the hose then repeat the adjustment steps.

## 8.6 Booster Compressor Inlet Pressure Regulator (PRV-2).

The booster compressor inlet pressure regulator (PRV-2) is pre-adjusted at the factory and should never require adjustment. However, if it becomes necessary to adjust it, the following steps should be used. Refer to Figure 17 for the location of the regulator and pressure gauge.

**Note**

The EDOCS-120 must be in operation before performing the following steps.

a. Open the backup system shutoff valve (V-4), if closed. Refer to WP 005 00, Figure 4.

b. Loosen the locknut on the adjusting screw of PRV-2. Rotate the adjusting screw counter-clockwise 2 to 3 turns, using a screwdriver.

c. Start the high pressure booster compressor (C-2) in accordance with WP 005 00, paragraph 5.3.

d. While the compressor is running, slowly rotate the adjusting screw on PRV-2 clockwise until the needle on the pressure gauge (PI-6) swings evenly on either side of 70 psig.

e. Tighten the locknut securely. If it is desired not to have the backup supply system operational, close V-4.

## 9. BOOSTER COMPRESSOR MAINTENANCE

### 9.1 Adjusting the Booster Compressor Discharge Pressure Switch (PSR).

The booster compressor discharge pressure switch (PSR) is adjusted at the factory and should never require adjustment. However, if it becomes necessary to adjust it, or it is desired to set the compressor shut down pressure to a lower pressure, the following steps should be used. The factory set point for the switch is 2250 psig. Refer to Figure 18.

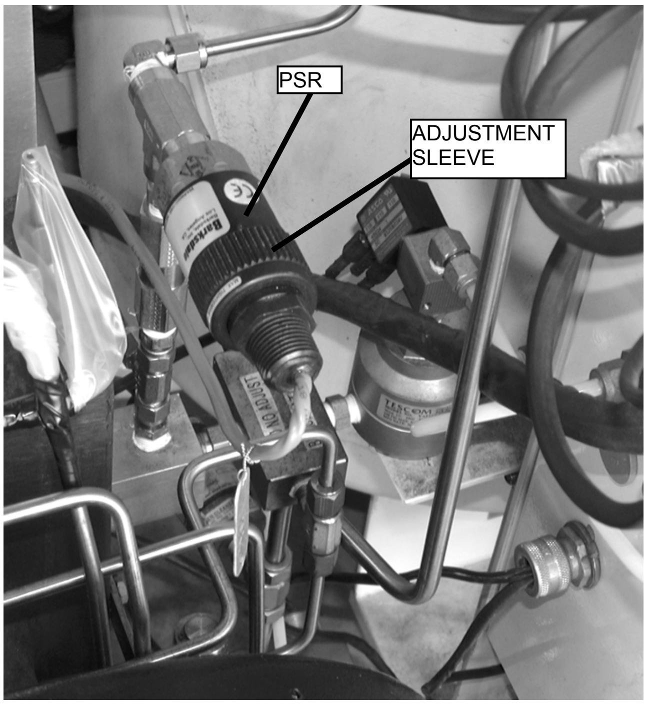


Figure 18. Booster Compressor Discharge Pressure Switch.

**Note**

The EDOCS-120 must be in operation before performing the following steps.

a. Close the backup system shutoff valve (V-4). Refer to WP 005 00, Figure 4.

**WARNING**

NEVER ADJUST THE BOOSTER COMPRESSOR SHUT DOWN SET POINT ABOVE 2250 psig. A FIRE OR EXPLOSION IN THE COMPRESSOR COULD OCCUR.

b. Start the high pressure booster compressor (C-2) in accordance with WP 005 00, paragraph 5.3.

c. Observe the pressure at which the compressor stops. The pressure can be viewed on PI-5 (see Figure 16).

d. If the compressor stops below the desired pressure set point, rotate the adjustment sleeve on PSR clockwise a small amount. If it stops above the desired pressure set point, rotate the adjustment sleeve counter-clockwise a small amount.

e. Slowly vent the pressure on the discharge of the compressor until it starts.

f. Observe the pressure at which the compressor stops. If it still isn't at the desired set point, repeat steps (d.) and (e.) until the desired shut down pressure set point is achieved.

g. If it is desired to have the backup supply system operational, open V-4.

### 9.2 Adjusting the Booster Compressor Drive Belt.

The booster compressor drive belt should be inspected monthly for fraying and looseness. It is recommended that the belt be replaced yearly.


Figure 19. Booster Compressor Belt Cover.

**WARNING**

THE COMPRESSOR MAY START AT ANY TIME WHEN AUTOMATIC MODE. BEFORE PERFORMING ANY MAINTENANCE, SET THE BOOSTER COMPRESSOR CONTROL SWITCH (HOA) TO OFF.

a. Set the booster compressor control selector switch (HOA) to OFF (see WP 005 00, Figure 20).

b. Remove the front panel next to the electrical control box.

c. Remove the drive belt cover (see Figures 19 and 20).

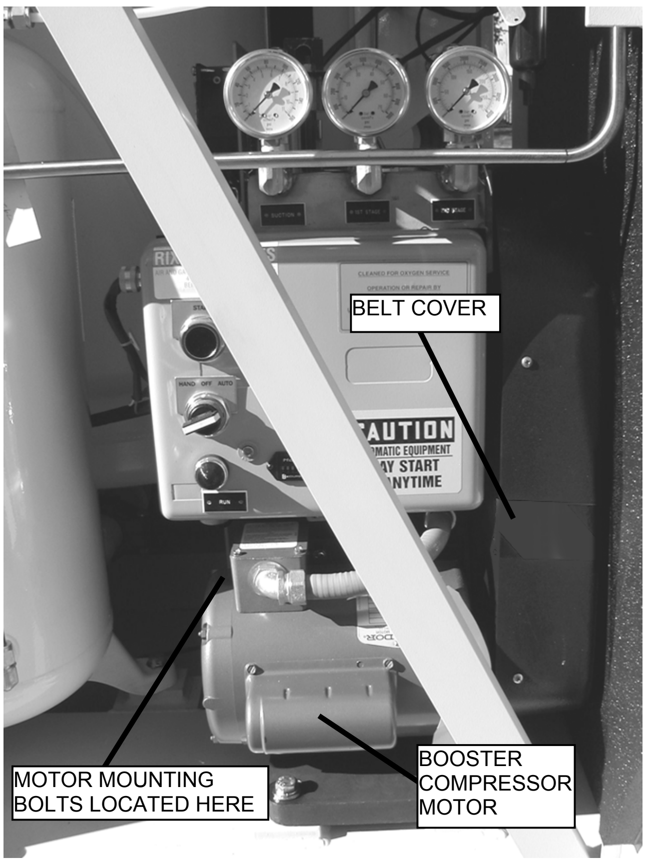


Figure 20. Booster Compressor Motor.

d. Loosen the motor mounting bolts (see Figure 20).

e. If the belt is being replaced, remove the old belt and install the new belt while the motor mounting bolts are loose.

f. Push down on the motor and tighten the motor mounting bolts securely. Take care to keep the motor sheave and flywheel sheave in alignment. The belt should deflect 1/2-3/4 inch at mid span with approximately 10 pounds force.

g. Install the belt cover. Tighten the screws snugly.

## 9.3 Cleaning the Booster Compressor Filters.

There are two filters in the booster compressor piping. One is located between the first stage discharge and the second stage inlet (interstage filter). The other one is located after the second stage cooling coil (second stage filter). Refer to Figure 21. The filters should be cleaned every 2000 hours of compressor operation. To clean the filters, use the following steps.

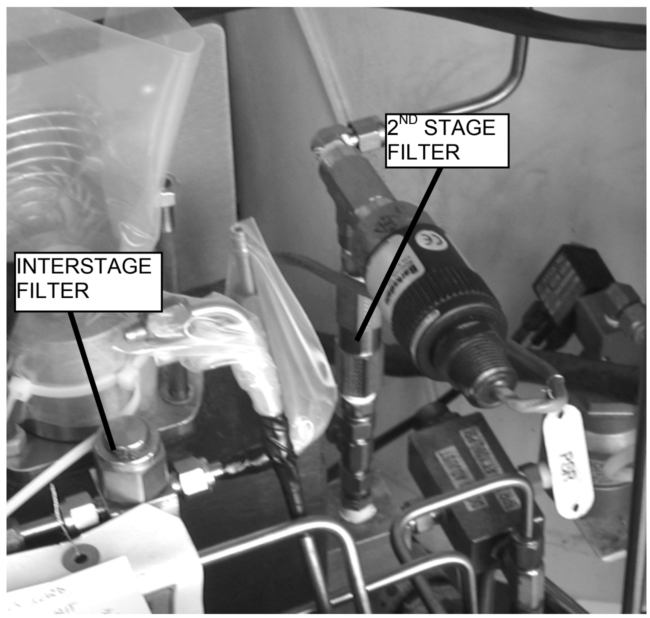


Figure 21. Location of Booster Compressor Filters.

**CAUTION**

Always cap the open ends of tubes to prevent any contamination from entering the tubes. Failure to do so could result in contamination damaging the compressor.

a. Remove all pressure from the compressor.

b. Remove filter to be cleaned. Refer to Figure 22. Note the direction of the flow arrow for proper orientation upon reinstallation. Place protective caps or bags over the tube open ends.

Figure 22. Booster Compressor Filter.

c. Clean and thoroughly dry the filter. Use the appropriate oxygen cleaning fluid (see WP 003 00, Table 1). Use an appropriate oxygen cleaning procedure.

d. Reinstall the filter with the flow arrow facing the proper direction. Tighten the fittings securely.

e. Start the booster compressor in accordance with WP 005 00, paragraph 5.3 and check the fittings for leakage. If any leaks are found, stop the compressor, remove all pressure and tighten the leaking fittings.

## 9.4 Maintaining the Booster Compressor Piping.

The booster compressor piping should be checked for leaks every 2000 hours of compressor operation, or whenever the piping has been disturbed, such as replacing or repairing components in the piping. The compressor must be in operation while checking for leaks.

**Note**

The leak check is simplified if the compressor is allowed to cool, then restarted, immediately prior to checking for leaks, since the hot discharge pipes can boil away the leak check soap solution, making detection of leaks difficult or impossible.

**WARNING**

HOT DISCHARGE LINES CAN CAUSE PAINFUL BURNS. BE CAREFUL TO AVOID COMING IN CONTACT WITH HOT SURFACES WHILE PERFORMING LEAK CHECKS OR MAKING REPAIRS. IF A LEAK IS DETECTED IT SHOULD BE NOTED OR CONSPICUOUSLY MARKED SO IT CAN BE REPAIRED AT THE NEXT CONVENIENT SHUT DOWN PERIOD.

A soapy solution in a squirt bottle works best for locating leaks in a gas system. Any gaskets and O-rings needed for the specific repair should be on hand prior to attempting to fix a leak.

a. Restart compressor after it has been allowed to cool down. Refer to WP 005 00, paragraph 5.3.

b. Systematically move from joint to joint and fitting to fitting in the gas system piping, spraying the leak test solution.

c. Observe for the formation of bubbles. Mark the location of any detected leaks. Large leaks may blow the soap solution away as quickly as it is applied. These may be detected by feel, again being careful of hot discharge lines.

d. Test relief valves by forming a bubble across the outlet opening and observing if the bubble grows.

e. Leaks at fitting joints may, in some cases, be corrected by tightening the joint.

f. O-ring joints cannot be corrected by additional tightening. In most every case, the leaking O-ring must be discarded and a new one installed. Always inspect the surfaces that seal against the O-ring for defects and correct them as required.

**CAUTION**

Avoid over-tightening as this can produce distortion and make the problem more severe. If the joint is tight and still leaks, the gasket must be replaced.

## 10. CHECKING THE PRESSURE TRANSDUCERS.

### 10.1 Adsorber Vessel Pressure Transducer (XT-1).

The adsorber vessel pressure transducer (XT-1) cannot be repaired. If it is found to be out of specification, it must be replaced. Use the following steps to check the operation and accuracy of the pressure transducer. Refer to Figure 23.

**WARNING**

HIGH VOLTAGE POWER EXISTS IN THE ELECTRICAL CONTROL BOX. THE FOLLOWING PROCEDURE MUST BE PERFORMED BY QUALIFIED PERSONNEL. PHYSICAL CONTACT WITH HIGH VOLTAGE WIRES COULD CAUSE SERIOS INJURY OR DEATH. EXTREME CAUTION MUST BE TAKEN.

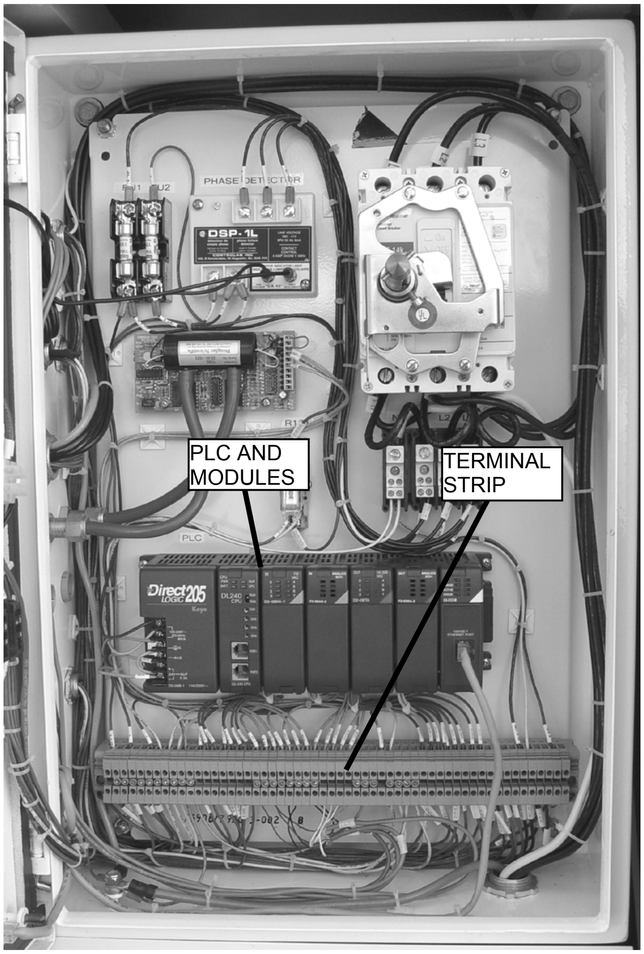


Figure 23. Electrical Control Box.

a. Open the electric box door. Apply power to the EDOCS-120. Switch the main circuit breaker (CB-1) on.

b. Locate terminals 500 and 82 on the terminal strip.

c. Use a digital volt meter (DVM) to check the DC voltage between terminals 500 and 82. The DVM plus (+) lead should be positioned on terminal and the (-) lead should be positioned on terminal 82.

d. The DC volts should be 0.98±0.05.

e. Start the blower in accordance with WP 005 00, paragraph 4.2.

f. Determine the peak pressure and the minimum vacuum on the adsorber vessel by viewing PI-8 (see WP 005 00, Figure 5) and comparing it with the maximum and minimum DC voltage on the DVM.

g. Take the peak pressure observed, add 14.7 to that and divide the sum by 15. The result should be within ±0.05 of the maximum DC voltage observed on the DVM.

h. Take the maximum vacuum observed, subtract this from 29.7 and divide the remainder by 30. The result should be within ±0.05 of the minimum DC voltage observed on the DVM.

i. If the results of the tests performed above are outside of the allowed ±0.05 DC volts, the pressure transducer should be replaced.

j. Close the electrical control box door.

## 10.2 Buffer Tank Pressure Transducer (XT-2).

The buffer tank pressure transducer (XT-2) cannot be repaired. If it is found to be out of specification, it must be replaced. Use the following steps to check the operation and accuracy of the pressure transducer. Refer to Figure 23.

**WARNING**

HIGH VOLTAGE POWER EXISTS IN THE ELECTRICAL CONTROL BOX. THE FOLLOWING PROCEDURE MUST BE PERFORMED BY QUALIFIED PERSONNEL. PHYSICAL CONTACT WITH HIGH VOLTAGE WIRES COULD CAUSE SERIOS INJURY OR DEATH. EXTREME CAUTION MUST BE TAKEN.

a. Open the electric box door. Apply power to the EDOCS-120. Switch the main circuit breaker (CB-1) on.

b. Locate terminals 501 and 82 on the terminal strip.

c. Use a digital volt meter (DVM) to check the DC voltage between terminals 501 and 82. The DVM plus (+) lead should be positioned on terminal and the (-) lead should be positioned on terminal 82.

d. The DC volts should be 0.98±0.05.

e. Start the blower in accordance with WP 005 00, paragraph 4.2.

f. Determine the peak pressure on the buffer tank by viewing PI-3 (see WP 005 00, Figure 22) and comparing it with the maximum voltage on the DVM.

g. Take the peak pressure observed, add 14.7 to that and divide the sum by 15. The result should be within ±0.05 of the maximum DC voltage observed on the DVM.

h. If the results of the tests performed above are outside of the allowed ±0.05 DC volts, the pressure transducer should be replaced.

i. Close the electrical control box door.

### 10.3 Scroll Compressor Outlet Pressure Transducer (XT-3).

The scroll compressor outlet pressure transducer (XT-3) cannot be repaired. If it is found to be out of specification, it must be replaced. Use the following steps to check the operation and accuracy of the pressure transducer. Refer to Figure 23.

**WARNING**

HIGH VOLTAGE POWER EXISTS IN THE ELECTRICAL CONTROL BOX. THE FOLLOWING PROCEDURE MUST BE PERFORMED BY QUALIFIED PERSONNEL. PHYSICAL CONTACT WITH HIGH VOLTAGE WIRES COULD CAUSE SERIOS INJURY OR DEATH. EXTREME CAUTION MUST BE TAKEN.

a. Open the electric box door. Apply power to the EDOCS-120. Switch the main circuit breaker (CB-1) on.

b. Locate terminals 502 and 82 on the terminal strip.

c. Use a digital volt meter (DVM) to check the DC voltage between terminals 502 and 82. The DVM plus (+) lead should be positioned on terminal and the (-) lead should be positioned on terminal 82.

d. The DC volts should be 0.00±0.03.

e. Start the blower in accordance with WP 005 00, paragraph 4.2. Allow the scroll compressor to build up full discharge pressure.

f. Determine the peak pressure on the scroll compressor discharge by viewing PI-2 (see WP 005 00, Figure 21) and comparing it with the maximum DC voltage on the DVM.

g. Take the peak pressure observed, and divide by 30. The result should be within ±0.05 of the maximum DC voltage observed on the DVM.

h. If the results of the tests performed above are outside of the allowed ±0.03 or ±0.05 DC volts, the pressure transducer should be replaced.

i. Close the electrical control box door.

## 11. ADJUSTING THE OFF-SPECIFICATION FLOW CONTROL VALVE (FCV-1).

The off-specification flow control valve (FCV-1) is preset at the factory. It is adjusted to flow approximately 80 lpm. If it becomes necessary to adjust the valve, a flow meter should be connected to the outlet of the valve. The valve can be adjusted only when the EDOCS-120 is producing oxygen at purities below 90%. The best time to adjust the valve is right after the scroll compressor builds pressure to 95 psig upon startup of the EDOCS-120. Refer to Figure 24. Tighten the locknut after the adjustment is complete.

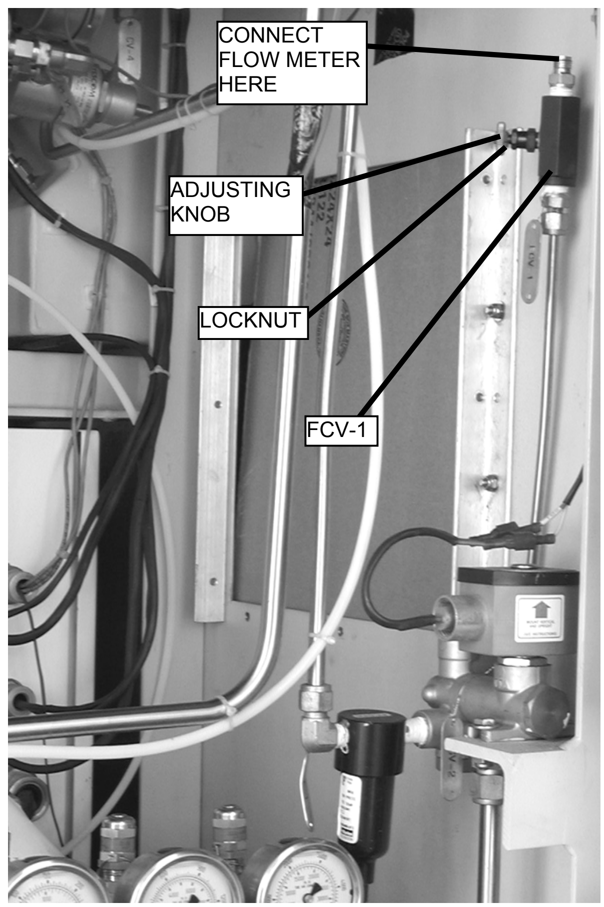


Figure 24. Off-Specification Flow Control Valve.

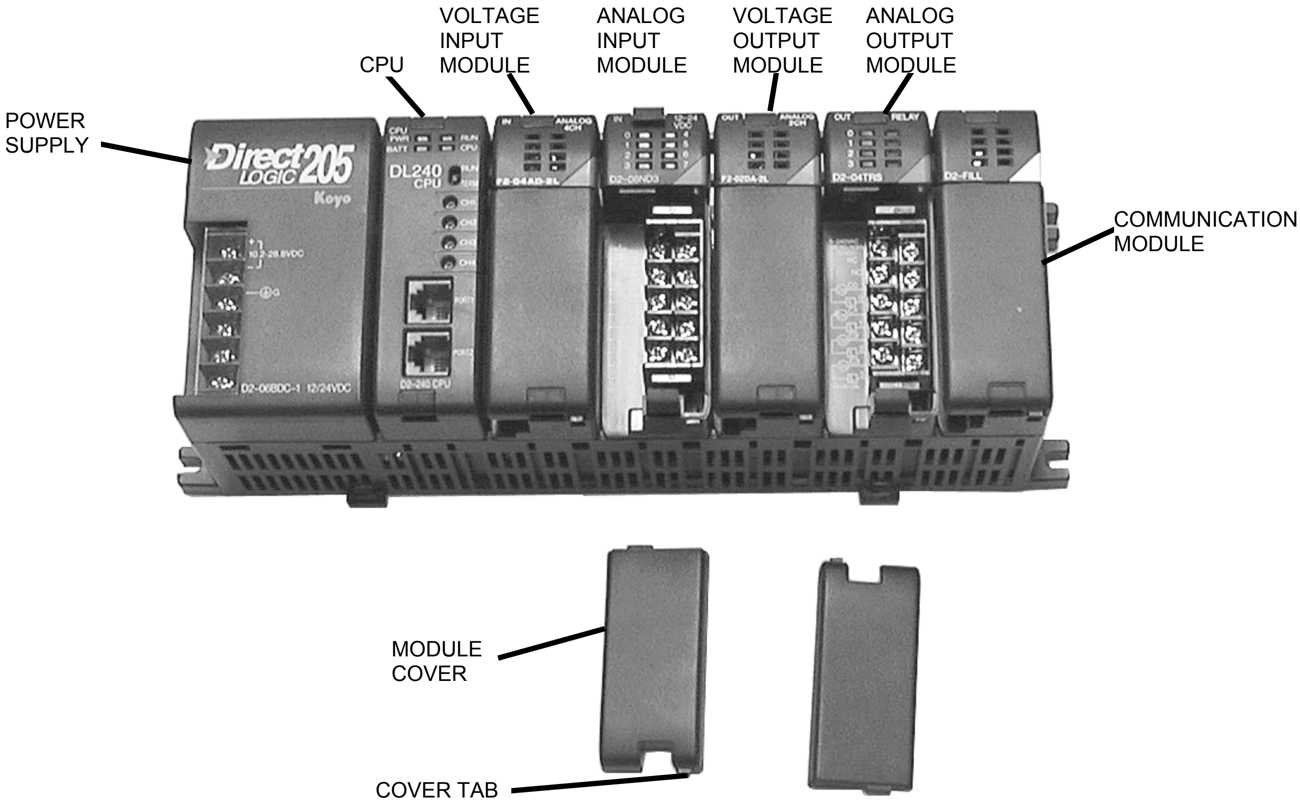


Figure 25. PLC and Modules.

## 12. PROGRAMMABLE LOGIC CONTROLLER (PLC)

The PLC contains a power supply and several plug-in modules (see Figure 25). If the power supply or any of the plug-in modules fails to function properly they must be replaced. However, the voltage output module has replaceable fuses and the central processing unit (CPU) has a replaceable, programmed EEPROM (see Figure 26). The terminal blocks on the input and output modules are removable without disconnecting any wires and all of the modules are simply plugged into the power supply base. To get access to the PLC, the electrical control box door must be opened (see Figure23).

**WARNING**

HIGH VOLTAGE POWER EXISTS IN THE ELECTRICAL CONTROL BOX.. ELECTRICAL MUST BE REMOVED FROM THE EDOCS-120 BEFORE PERFORMING ANY OF THE FOLLOWING TASKS. PHYSICAL CONTACT WITH HIGH VOLTAGE WIRES COULD CAUSE SERIOS INJURY OR DEATH. EXTREME CAUTION MUST BE TAKEN.

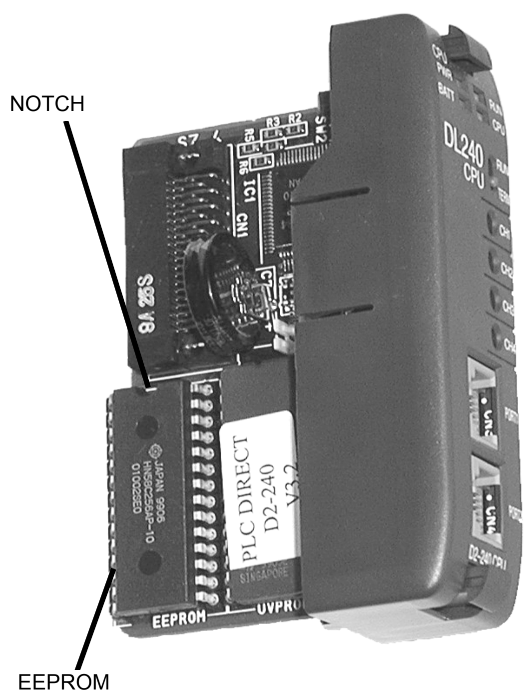


Figure 26. CPU Module and EEPROM.

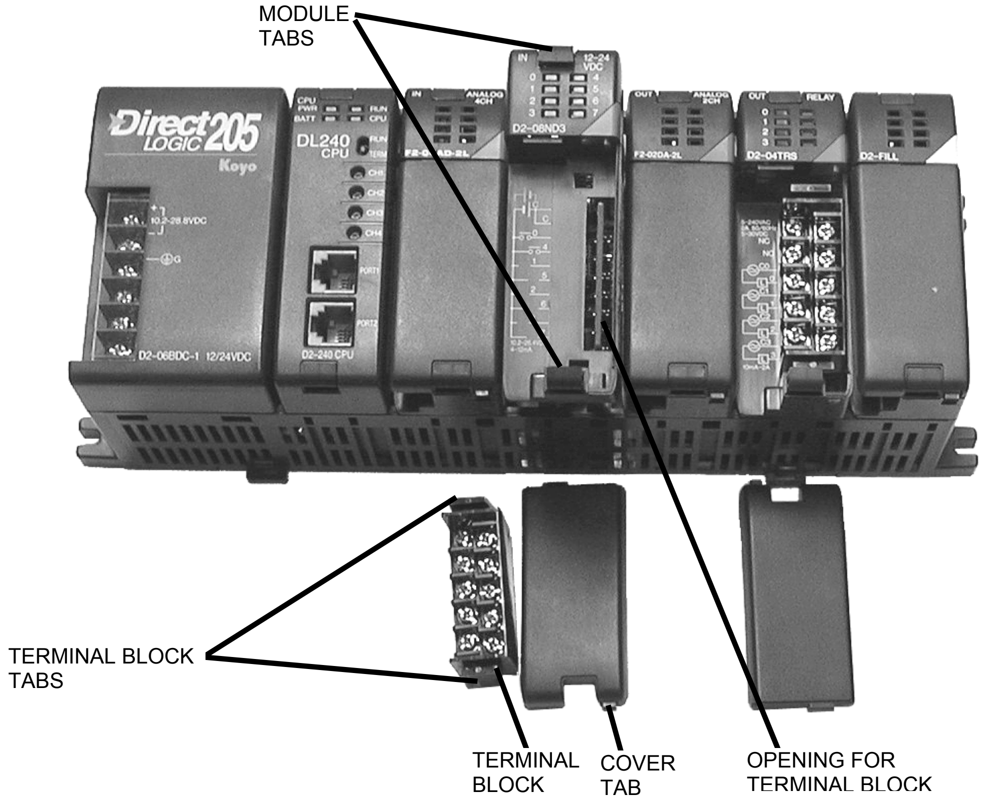


Figure 27. Removing a Module From the PLC.

## 12.1 Replacing the PLC Modules.

Follow the steps below to remove or replace any module. Refer to Figures 25 and 27 unless otherwise indicated.

a. Remove the cover on the module to be removed, unless it is the CPU that is being removed. The cover is removed by lifting up on the tab on the bottom of the cover.

b. Grab the top and bottom tabs on the terminal block, pinch together and remove the terminal block (see Figure 27), unless the CPU is the module being removed.

c. Pull the tabs up on the bottom and top of the module (see Figure 27). Pull the module straight out from the mounting base.

d. To install the module, align the circuit board with the slots at the top and bottom, inside surfaces of the mounting base. Make sure the tabs on the top and bottom of the module are pulled up then push the module straight in. Do not push against the tabs. When the module is firmly seated in the socket in the mounting base, push the tabs in.

e. Unless it is the CPU, install the terminal board on the module. Pinch the top and bottom tabs together and insert it into the opening in the module (see Figure 27). Install the cover by inserting the top tab into the upper opening on the module and push down on the bottom side until it snaps in.

## 12.2 Replacing the EEPROM Chip in the CPU.

a. Remove the CPU module as described in paragraph 12.1.

b. Carefully remove the EEPROM chip, taking care not to bend the pins on the chip (see Figure 26). Alternately pry it gently a small amount on each end until it can be grabbed with the fingers and pulled straight off the circuit board. A chip removal tool, available from any computer accessory store, makes it easy to remove and install the EEPROM chip.

c. Replace the defective EEPROM with a new one. Make sure it has a program on it. If it is identified with P/N 792109-007, it is programmed. Align the notched end of the EEPROM with the notch outline on the circuit board. Make sure all of the pins on the EEPROM are nested inside the corresponding sockets on the circuit board. If necessary, carefully bend the pins so they will all nest in the sockets. Gently push the EEPROM onto the circuit board.

d. Reinstall the CPU module as described in paragraph 12.1

## 12.3 Setting the Jumpers on the Analog Modules.

### 12.3.1 Analog Input Module Jumpers.

Whenever a new analog input module (AI) is installed, the voltage range setting for the module must be checked. The module that is installed at the factory is properly configured, however spare modules may not be properly configured. The voltage range must be configured for 5 volts for the EDOCS-120 to function properly. There is a smaller circuit board, which is on top of the motherboard. On this circuit board there is a jumper labeled "J3" (see Figure 28). If the jumper is not over the two pins, as shown in Figure 28, place it over the two pins, as shown. Install the module as described in paragraph 12.1.

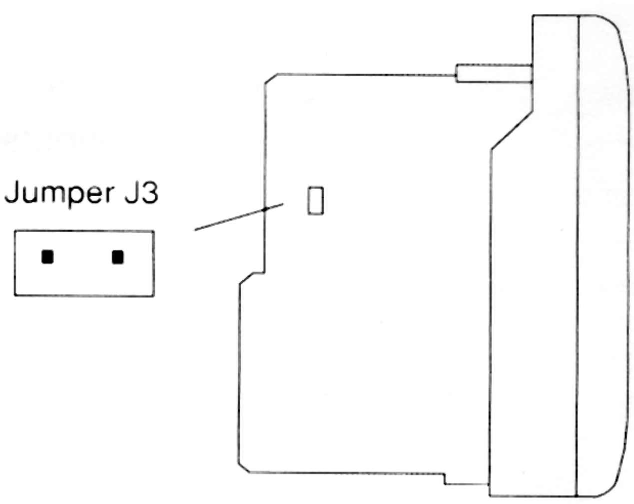


Figure 28. Analog Input Module Jumpers.

### 12.3.2 Analog Input Module Jumpers.

Whenever a new analog output module (AO) is installed, the voltage range setting for each of the output channels (CH1 and CH2) the module must be checked. The module that is installed at the factory is properly configured, however spare modules may not be properly configured. The voltage range for channel 1 (CH1) must be configured for 0-10 volts and channel 2 (CH2) must be configured for 0-5 volts for the EDOCS-120 to function properly. The jumpers of concern are on the top circuit board. On this circuit there are four jumpers labeled "UNI/±5, CH1", "CH2, UNI/±5", "BI-P, 0-5, CH1", and "BI-P, 0-5, CH2" (see Figure 29). The jumpers for the CH1 and CH2 UNI/±5 pins must be placed over the two pins and shown in Figure 29. The CH1 jumper for the BI-P/0-5 pins must be removed, as shown in the 3 position in Figure 29. The CH2 jumper for the BI-P/0-5 pins must be placed over the 0-5V pins as shown, as shown in the 2 position in Figure 29. Install the module as described in paragraph 12.1.

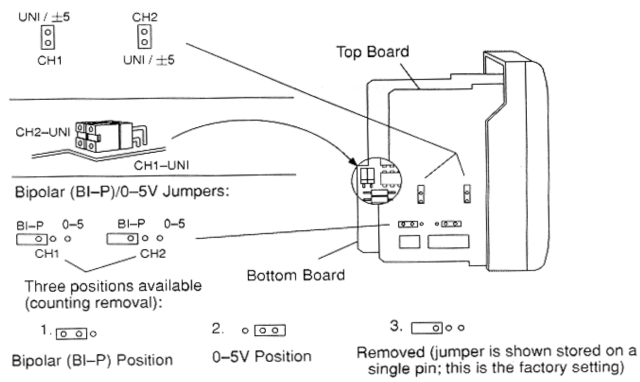


Figure 29. Analog Output Module Jumpers.

## 13. LUBRICATION REQUIREMENTS

### 13.1 Blower Lubrication.

The blower requires greasing of the bearings and maintaining the oil level in the gear case. Table 4 lists the requirements for the blower lubrication.

### 13.2 Scroll Compressor Lubrication.

The scroll compressor requires greasing of the bearings. Table 4 lists the requirements for the scroll compressor lubrication.

## 14. CALIBRATING THE OXYGEN SENSOR

**WARNING**

ELECTRICAL SHOCK HAZARD. SERIOUS INJURY OR DEATH COULD OCCUR. THE FOLLOWING PROCEDURES SHOULD ONLY BE PERFORMED BY QUALIFIED PERSONNEL KNOWLEDGEABLE WITH THE HAZARDS OF WORKING AROUND LIVE ELECTRICAL CIRCUITS.

Table 4. Lubrication Requirements For the EDOCS-120.

| COMPONENT | LUBRICANT | SERVICING INTERVAL | APPLICATION | FIGURE |
|---|---|---|---|---|
| Blower gear case. | W49100-011 | Check level weekly. Change every 2000 hours | Stop the blower. Fill the gear case until oil trickles from the oil level port. Refer to paragraph 4.3. | Figure 3. |
| Blower shaft bearings. | W46040-777 | For continuous operation, the bearings should be greased weekly. | Stop the blower. Apply grease to the grease fittings until traces of clean grease come out of the relief fittings. Refer to paragraph 4.4. | Figure 4. |
| Scroll compressor bearings. | W46040-777 | Grease the bearings yearly. | Stop the EDOCS-120. Pump the grease gun three times. If the bearings are newly installed, pump the grease gun five times. Refer to paragraph 7.3. | Figures 11 and 12. |

The following procedures should be performed initially.

a. Apply power to the unit.

b. Open the electrical box door. Set the circuit breaker switch on.

c. Locate the oxygen sensor. Refer to Figure 30.

d. Locate the offset adjustment potentiometer. It is the top potentiometer to the left of the black cylinder. Refer to Figure 30.

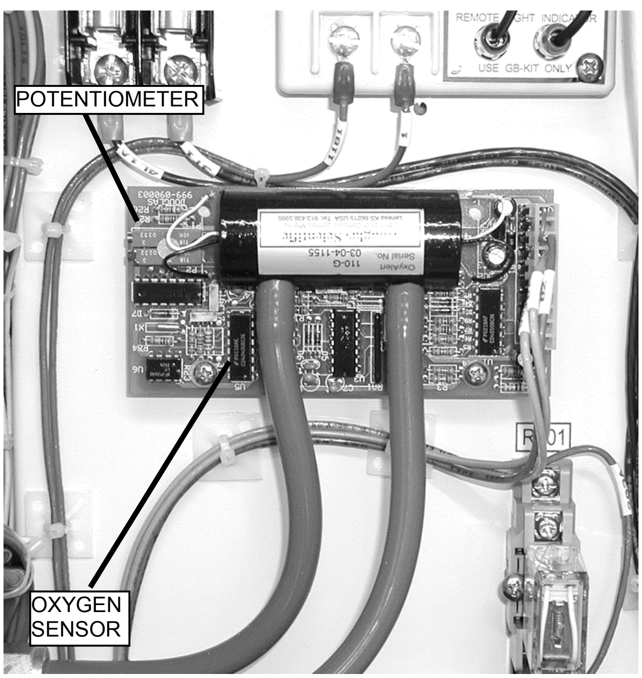


Figure 30. Oxygen Sensor.

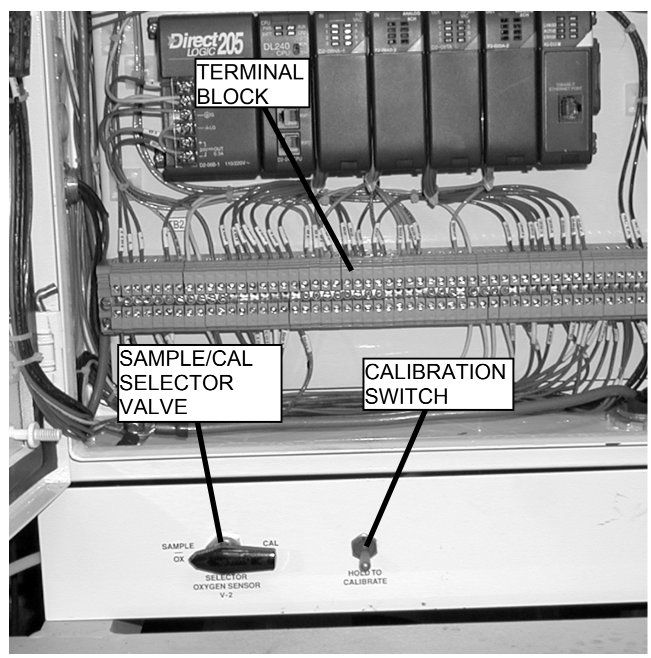


Figure 31. Sample/Cal Valve and Calibration Switch.

e. Locate terminals 503 and 82 on the modular terminal block at the bottom of the electrical panel. These terminals will be used to determine the voltage output of the oxygen sensor at any given oxygen concentration. The voltage is 0.000 to 1.000 volts dc proportional to 0-100% oxygen concentration. Refer to Figure 31.

f. Switch the Sample/Cal valve to Cal position. Refer to Figure 31.

g. Open the access door on the right side of the EDOCS-120 unit.

h. Remove the 1/4" tube from the branch side of the tee (see Figure 32), or if there is no tee, remove the 1/4" tube from the street tee connector on the vacuum pump (see Figure 33).

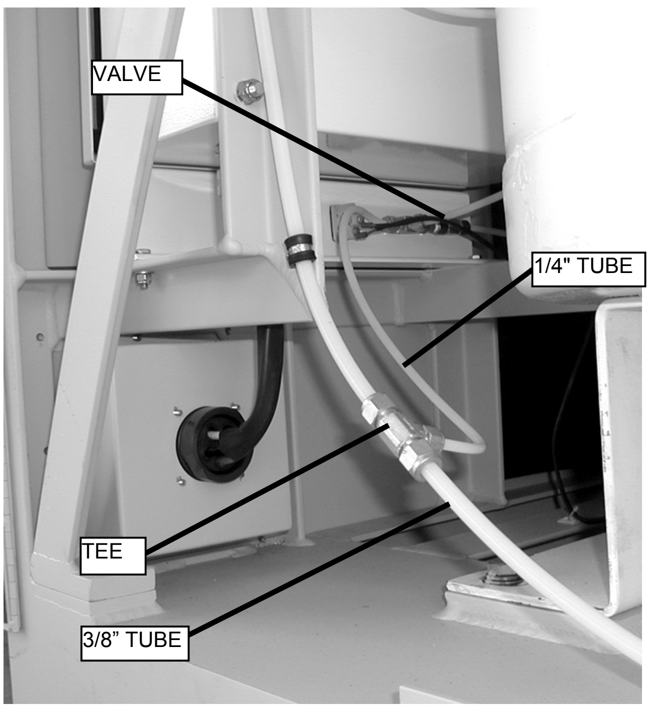


Figure 32. Sample/Cal Valve Tubing.

i. Attach the hose to the fitting on the calibration kit hose (see Figure 34).

k. Turn the DVM on and set the scale to a DC voltage range that will indicate 3 decimal places.

l. Place the positive probe from the DVM at the 503 terminal and the negative probe at the 82 terminal.

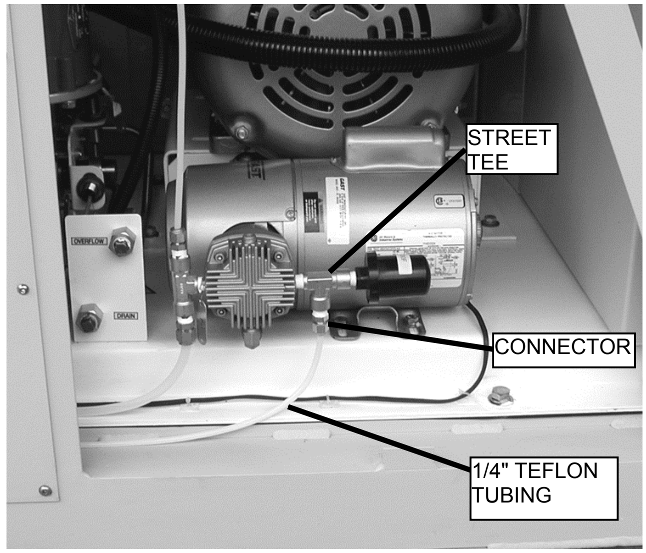


Figure 33. Sample/Cal Valve Tubing at Vacuum Pump.

m. Wait for the indication to stabilize (about 1 minute). If the voltage reading is not between 0.205 and 0.209 volts dc, the oxygen sensor requires adjusting.


Figure 34. Analyzer Calibration Kit.

### 14.1 Adjusting the Oxygen Sensor Output.

When the oxygen sensor output is not between 0.205 and 0.209 volts dc with the analyzer calibration kit connected and running, and the Sample/Cal valve in Cal position, the offset adjustment potentiometer must be adjusted. The following procedures are used to adjust the potentiometer.

a. When checking the voltage as described in Paragraph 14(l.), place the potentiometer adjustment tool on the adjusting screw at the left end of the top potentiometer. Gently rotate it until it is felt to have engaged with the slot in the adjusting screw. Refer to Figure 35.

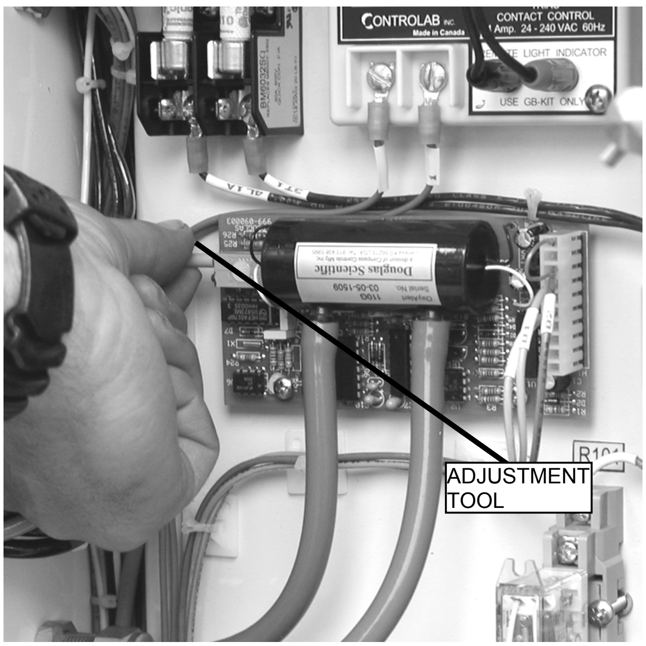


Figure 35. Adjusting the Offset Potentiometer.

b. Carefully rotate the tool in the direction that causes the output voltage to approach 0.205 to 0.209 volts dc.

c. Once the voltage has been adjusted to between 0.205 and 0.209 volts dc, the system is ready to be calibrated.

d. After the oxygen sensor has been calibrated per these procedures, the EDOCS-120 system must be calibrated. Refer to WP 005 00, paragraph 6.2 for the procedures.

## 15. COMPONENT SETPOINTS AND ADJUSTMENTS

Some components have predetermined setpoints that may never need resetting. However, they may need minor trim adjustments after the EDOCS-120 has been transported, and occasionally during operation. The following paragraphs show the setpoints of the various components on the EDOCS-120.

### 15.1 Pressure Regulators.

Table 5 shows the normal setpoints for all of the pressure regulators on the EDOCS-120.

Table 5. Pressure Regulator Setpoints.

| Tag No. | Description | Setpoint |
|---|---|---|
| BPR-1 | Buffer Storage Pressure Regulator | 7.5 psig |
| BPR-2 | Scroll Compressor Maximum Pressure Regulator | 108 psig |
| BPR-4 | Scroll Compressor Maximum Pressure Regulator | 95 psig |
| PRV-1 | Oxygen Pressure Regulator | 85 psig |
| PRV-2 | Booster Compressor Inlet Pressure Regulator | 70 psig |
| PRV-3 | Backup System Supply Pressure Regulator | 80 psig |

### 15.2 Relief Valves.

Table 6 shows the normal setpoints for all of the pressure relief valves on the EDOCS-120.

Table 6. Relief Valve Setpoints.

| Tag No. | Description | Setpoint |
|---|---|---|
| PSV-2 | Scroll Compressor Outlet Pressure Relief Valve | 125 psig |
| PSV-3 | Booster Compressor Outlet Pressure Relief Valve | 2500 psig |
| | Booster Compressor Inlet Pressure Relief Valve | 75 psig |
| | Booster Compressor Stage 1 Pressure Relief Valve | 700 psig |

## 15.3 Pressure Transducers.

The setpoint of the pressure transducers is controlled by the PLC program. The setpoints cannot be adjusted without reprogramming the EEPROM. However, if the setpoints appear to be different from the values listed in Table 7, the CPU or EEPROM must be replaced.

Table 7. Setpoints For Pressure Transducer Inputs.

| Tag No. | Description | Low Setpoint | High Setpoint |
|---|---|---|---|
| XT-1 | Adsorber Pressure Transducer | 15.5 In Hg vacuum | 9 psig |
| XT-2 | Buffer Storage Tank Pressure Transducer (stops the scroll compressor) | 1 psig | N/A |
| XT-3 | Scroll Compressor Outlet Pressure Transducer (stops the scroll compressor on high and starts it on low) | 103 psig | 108 psig |

## 15.4 Variable Speed Drive (VSD).

The variable speed drive has several internal function setpoints that must be set to values other than the VSD manufacturer's default values. The EDOCS-120 is supplied with the proper setpoints for these functions. However, if a new VSD must be configured, Table 8 shows the value that must be set for these functions.

Table 8. Variable Speed Drive Setpoints.

| Function | Description | Setpoint |
|---|---|---|
| FREF | Frequency (speed) of the scroll compressor. | 55.0-55.5 hz |
| n03 | Enable the frequency reference setpoint to be set from the digital panel control knob. | 0 |
| n32 | Setting for the maximum amperage for the scroll compressor motor. | 6.6 (amps) |
| n47 | Setting to allow for the VSD to restart anytime power is momentarily interrupted. | 2 |

## 15.5 PLC Input and Output Modules.

The analog input and output modules must have the proper jumpers set in order for the EDOCS-120 to function properly. The modules are properly configured at the factory. However, if new modules are being installed, it is important to verify that the jumpers are properly installed. Table 9 Shows the proper configuration of the jumpers. Instructions for configuring the modules are provided in paragraph 12.3.

Table 9. Proper Configuration of PLC Analog Modules.

| Tag No. | Description | Jumper | Setting |
|---|---|---|---|
| AI | Analog Input Module | J3 | Install jumper for 0-5 volts |
| AO | Analog Output Module | CH1 UNI/±5 | Install |
| | | CH1 BI-P/0-5 | Remove for 0-10 volts |
| | | CH2 UNI/±5 | Install |
| | | CH2 BI-P/0-5 | Install for 0-5 volts |

## 15.6 Pressure Switches.

Table 10 shows the pressure setpoints for the pressure switches in the EDOCS-120.

Table 10. Pressure Switch Setpoints.

| Tag No. | Description | Setpoint |
|---|---|---|
| PSIL | Booster compressor inlet pressure switch | 28 psig |
| PSR | Booster compressor outlet pressure switch | 2250 psig |

## 16. TROUBLESHOOTING.

The following troubleshooting tables list the possible malfunctions, their probable causes, and suggested remedies. If properly used, the tables will help eliminate much wasted time from "hit or miss" methods of locating and repairing problems in the EDOCS-120 component assemblies or subsystems. Refer to Tables 11 through 15 for the indicated trouble and the probable causes and remedies for the trouble.

Table 11. Troubleshooting the EDOCS-120 (Sh. 1 of 6).

| TROUBLE | PROBABLE CAUSE | REMEDY |
|---|---|---|
| BLOWER | | |
| Blower fails to start when control switch (SW-3) is turned on. | Main circuit breaker (CB-1) is off. | Switch circuit breaker on. |
| | Power input is out of phase. Reverse phase indicator is on. | Switch any two of the three power wires (L1, L2, L3) at the power source. |
| | Overload relay on CR-124 motor contactor is tripped or is defective. | Press reset button on relay or replace defective relay. |
| | Coil on motor contactor (CR-124) is defective. | Replace motor contactor. |
| Blower starts, but soon after it shuts down. | CR-124 overload set too low. | Set the overload amps to the blower motor (M-100) full load amps (FLA). |
| | Switching valve (V-1) is stuck in the pressure position. | Overload relay on the motor contactor (CR-145) is tripped or is faulty. Reset the relay or replace it if it is found to be defective.<br>Check the analog input module (AI) for proper operation. Replace it if it is found to be defective. (See paragraph 12.1.)<br>Check the pressure transducer (XT-1) for proper operation. Replace it if it is found to be defective. |
| | Blower motor (M-100) is shorted out | Replace the motor. |
| Loss of oil. | Gear housing not tightened properly. | Tighten gear housing bolts. (See T.O. EDOCS-120-3.) |
| | Lip seal failure. | Disassemble and replace lip seal. (See T.O. EDOCS-120-3.) |
| | Insufficient sealant. | Remove gear housing and replace sealant. (See T.O. EDOCS-120-3.) |
| Excessive bearing or gear wear. | Improper lubrication. | Correct oil level. Replace dirty oil. (See paragraph 4.3.) |
| | Excessive belt tension. | Check the belt for proper tension and adjust accordingly. (See paragraph 4.1.) |
| | Pulley misalignment. | Check carefully, realign if necessary. |
| Lack of sufficient output flow. | Slipping belts. | Check the belt for proper tension and adjust accordingly. (See paragraph 4.1.) |
| | Worn lobe clearances. | Check for proper clearances. (See T.O. EDOCS-120-3.) |

Table 11. Troubleshooting the EDOCS-120 (cont.).

| TROUBLE | PROBABLE CAUSE | REMEDY |
|---|---|---|
| Lack of sufficient output flow (continued). | Obstruction in piping. | Check system to assure an open flow path. |
| Knocking. | Unit out of time. | Re-time. (See T.O. EDOCS-120-3.) |
| | Distortion due to improper mounting pipe strains. | Check mounting alignment and relieve pipe strains. |
| | Excessive pressure differential. | Check for blockage in piping. Clear blockage if necessary. Examine storage tank pressure regulator (BPR-1) and reset if necessary. (See paragraph 8.1.) |
| | Worn gears. | Replace timing gears. (See T.O. EDOCS-120-3.) |
| Excessive blower temperature. | Too much or too little oil in gear reservoir. | Check oil level. (See paragraph 4.3.) |
| | Clogged filter or silencer. | Remove cause of obstruction. |
| | Excessive pressure differential. | Check for blockage in piping. Clear blockage if necessary. Examine storage tank pressure regulator (BPR-1) and reset if necessary. (See paragraph 8.1.) |
| | Elevated inlet temperature. | Reduce inlet temperature if possible. |
| | Worn lobe clearances. | Check for proper clearances. (See T.O. EDOCS-120-3.) |
| Rotor end or tip drag. | Insufficient assembled clearances. | Correct clearances. (See T.O. EDOCS-120-3.) |
| | Case or frame distortion. | Check mounting and pipe strain. |
| | Excessive operating pressure. | Check for blockage in piping. Clear blockage if necessary. Examine storage tank pressure regulator (BPR-1) and reset if necessary. (See paragraph 8.1.) |
| | Excessive operating temperature. | Reduce pressure differential or reduce inlet temperature. |
| Vibration. | Drive belt pulleys are misaligned. | Check carefully, realign if necessary. |
| | Blower lobes are rubbing. | Check the cylinder for hot spots. Then check for lobe contact at these points. Correct the clearances. (See T.O. EDOCS-120-3.) |
| | Worn bearings or gears. | Check condition of gears and bearings; replace if necessary. (See T.O. EDOCS-120-3.) |

Table 11. Troubleshooting the EDOCS-120 (cont.).

| TROUBLE | PROBABLE CAUSE | REMEDY |
|---|---|---|
| Vibration (continued). | Unbalanced or rubbing lobes. | Possible buildup of foreign material on the casing or lobes, or inside lobes. Remove buildup and restore clearances. (See T.O. EDOCS-120-3.) |
| | The motor or blower mounting bolts are loose. | Check mounting bolts and tighten if necessary. |
| | Piping resonance. | Check the pipe supports, check the resonance of nearby equipment, and check the foundation. |
| VACUUM SWING ADSORBER (VSA) | | |
| The pressure (PI-8) on the adsorber vessel does not reach the specified levels (15.5 in Hg vacuum and 9 psig). | Leaks in the piping. | Tighten the leaking piping and tubing joints. |
| | Analog input module operating voltage jumpers improperly set. | Set the jumpers for the proper voltage. (See paragraph 12.3.) |
| | Faulty adsorber vessel pressure transducer (XT-1). | Replace the pressure transducer. |
| | Faulty analog input module (AI). | Replace the analog input module. |
| | Faulty EEPROM program. | Replace the EEPROM or the CPU. |
| | The switching valve (V-1) is misaligned. | Align the valve plug. (See paragraph 5.) |
| Low oxygen purity. | Excessive oxygen product off-take. | Adjust the oxygen product flow rate so the average flow rate during any 10 minute period does not exceed 120 liters per minute (lpm). |
| | Blower drive belt is slipping. | Adjust the belt. (See paragraph 4.1.) |
| | Faulty voltage output module (VO). No voltage output to the adsorber purge solenoid valve (SV-1). | Replace the output voltage module. |
| | Malfunctioning adsorber purge solenoid valve (SV-1). | Replace the solenoid valve. |
| | The switching valve (V-1) is misaligned. | Align the valve plug. (See paragraph 5.) |
| SCROLL COMPRESSOR (C-1) | | |
| Scroll compressor starts and stops often. | Low oxygen product off-take. | This a normal condition. When the scroll discharge pressure is above 108 psig continuously for 10 minutes, the compressor will stop until the pressure falls to 103 psig. |

Table 11. Troubleshooting the EDOCS-120 (cont.).

| TROUBLE | PROBABLE CAUSE | REMEDY |
|---|---|---|
| The scroll compressor stops for no apparent reason. | The inlet pressure of the scroll pressure is below .5 psig. | This is a normal shut down condition to protect the system from the possibility of drawing ambient air into the oxygen system. |
| | Low inlet pressure (PI-3) on the scroll compressor. | Adjust the oxygen product flow rate so the average flow rate during any 10 minute period does not exceed 120 liters per minute (lpm). |
| | Flow and pressure problems with the blower, VSA and/or switching valve (V-1). | See the remedies listed above for the blower, VSA and switching valve. |
| | Excessive oxygen product off-take. | Adjust the oxygen product flow rate so the average flow rate during any 10 minute period does not exceed 120 liters per minute (lpm). |
| Low discharge pressure (PI-4) on the scroll compressor. | Excessive oxygen product off-take. | Adjust the oxygen product flow rate so the average flow rate during any 10 minute period does not exceed 120 liters per minute (lpm). |
| | Variable speed drive (VSD) is misadjusted | Adjust the frequency to 55.0-55.5 hz. (See paragraph 7.4.) |
| | Scroll compressor drive belt is slipping. | Adjust the belt tension. (See paragraph 7.1.) |
| | Defective or misadjusted maximum discharge pressure regulator (BPR-2). | Adjust the pressure regulator (see paragraph 8.2) or replace it if it is defective. |
| | Defective or misadjusted minimum discharge pressure regulator (BPR-4). | Adjust the pressure regulator (see paragraph 8.3) or replace it if it is defective. |
| | Flow and pressure problems with the blower, VSA and/or switching valve (V-1). | See the remedies listed above for the blower, VSA and switching valve. |
| | Worn scroll seals. | Replace the seals. (See T.O. EDOCS-120-3.) |
| HIGH PRESSURE BOOSTER COMPRESSOR (C-2) | | |
| Booster compressor fails to start when the control switch (SW-2) is switched on. | Discharge pressure is above the restart set point (approximately 1900 psig).. | This is a normal condition. The compressor will start automatically when the pressure falls below about 1900 psig |
| | The booster control selector switch (HOA) is switched off. | Position the switch to AUTO. |
| | Inlet pressure on the booster compressor is below 28 psig. | Increase the setting on PRV-2 to the proper pressure (70 psig). |

Table 11. Troubleshooting the EDOCS-120 (cont.).

| TROUBLE | PROBABLE CAUSE | REMEDY |
|---|---|---|
| Booster compressor fails to start when the control switch (SW-2) is switched on (continued). | Booster compressor inlet solenoid (SV-3) is malfunctioning. | Determine the reason for the malfunction (electrical or mechanical) and repair. If it is determined to be a defective solenoid valve, replace it. |
| | The motor contactor overload relay (OL) is tripped or defective. | Press reset button on relay or replace defective relay. |
| | Coil on motor contactor (M-2) is defective. | Replace the motor contactor. |
| | Booster motor (M) is shorted out | Replace the motor. |
| The motor overload relay (OL) tripped. | Voltage is too low. | Restore power and check the voltage. It should be 200-230 volts. |
| | Suction pressure to the compressor is too high. | Adjust the booster compressor inlet pressure regulator to the proper pressure (70 psig). (See paragraph 8.6.) |
| | Booster compressor motor (M) is shorted out. | Replace the motor. |
| High pressure on 1st stage | Defective suction or discharge valve on 2nd stage. | Remove, clean or replace suspect valves as necessary. |
| Relief valve on 1st stage is popping off. | Defective relief valve. | Reset or replace the relief valve. |
| High pressure on 2nd stage (PI-7, PI-9). | Pressure switch (PSR) is misadjusted or inoperative. | Reset or replace the switch. (See paragraph 9.1.) |
| Relief valve on 2nd stage is popping off. | Discharge lines or back pressure valve is restricted. | Clean back pressure valve and/or lines. |
| | Pressure switch (PSR) is misadjusted or inoperative. | Reset or replace the switch. (See paragraph 9.1.) |
| | Defective relief valve. | Reset or replace the relief valve. |
| Low pressure on 1st stage | Worn or broken rings in the 1st stage. | Replace piston rings and inspect cylinder for wear or scoring. (See T.O. EDOCS-120-3, WP 006 00.) |
| | Blown O-ring on the 1st stage valve. | Replace the O-ring. (See T.O. EDOCS-120-3, WP 006 00.) |
| | Suction or discharge valve on the 1st stage is leaking. | Clean, repair or replace the suspected valve as necessary. (See T.O. EDOCS-120-3, WP 006 00.) |
| | Piping leaks. | Repair the piping leaks. (See paragraph 9.4.) |
| Booster compressor overheats. | Fans are inoperative. | Repair or replace the fans. |

Table 11. Troubleshooting the EDOCS-120 (cont.).

| TROUBLE | PROBABLE CAUSE | REMEDY |
|---|---|---|
| Excessively high temperature on the heads or discharge lines. | Restriction in piping caused by damage. | Inspect the piping for kinks or other physical damage and repair as required. |
| | Faulty compressor valves. | Repair or replace the suspected valves. (See T.O. EDOCS-120-3, WP 006 00.) |
| | High ambient temperature. | Ventilate the area around the compressor or stop the compressor until the area cools down. |
| Compressor output is reduced. | Low inlet pressure. | Restore the inlet pressure to normal. |
| | Compressor drive belt is slipping. | Adjust the belt tension. (See paragraph 9.2.) |
| Longer than normal time to fill the backup system cylinders or ‘H’ cylinder. | Leaks in piping, cylinder heads, heat exchangers or seals. | Locate the leak and repair. |
| | Compressor drive belt is slipping. | Adjust the belt tension. (See paragraph 9.2.) |
| | The valves in the $1^{st}$ stage are leaking. | Check and repair the valves as necessary. (See T.O. EDOCS-120-3, WP 006 00.) |
| | Worn piston rings. | Replace the piston rings. (See T.O. EDOCS-120-3, WP 006 00.) |
| Loud metallic knock. | Worn connecting rod needle bearing. | Replace the bearing. (See T.O. EDOCS-120-3, WP 006 00.) |
| Clacking noises coming from one of the cylinder heads. | Worn or broken valves. | Remove the suspected valves and repair or replace them. (See T.O. EDOCS-120-3, WP 006 00.) |
| Flat, slapping sound when the compressor starts and stops. | Worn piston and/or cylinder liner. Worn rider rings. | Remove the suspect piston and cylinder liner and check for wear. Repair as necessary. Replace the rider rings. (See T.O. EDOCS-120-3, WP 006 00.) |
| Entire compressor vibrates. | Mounting bolts are loose. | Tighten the mounting bolts. |
| | Piston clearances not properly adjusted. | Readjust the piston clearance. (See T.O. EDOCS-120-3, WP 006 00.) |

Table 12. Startup Troubleshooting Flowchart.

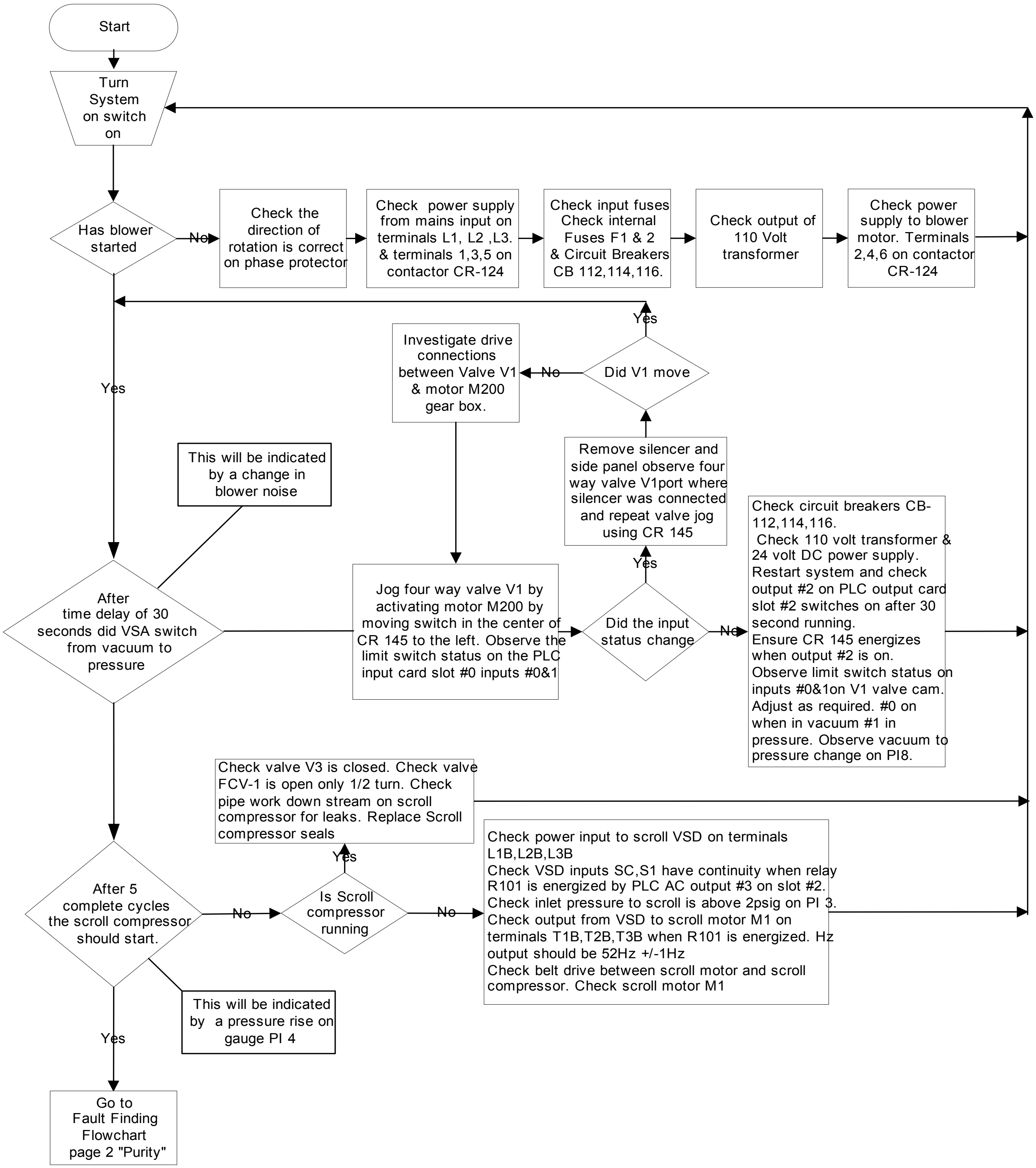

Table 13. Oxygen Purity Troubleshooting Flowchart.

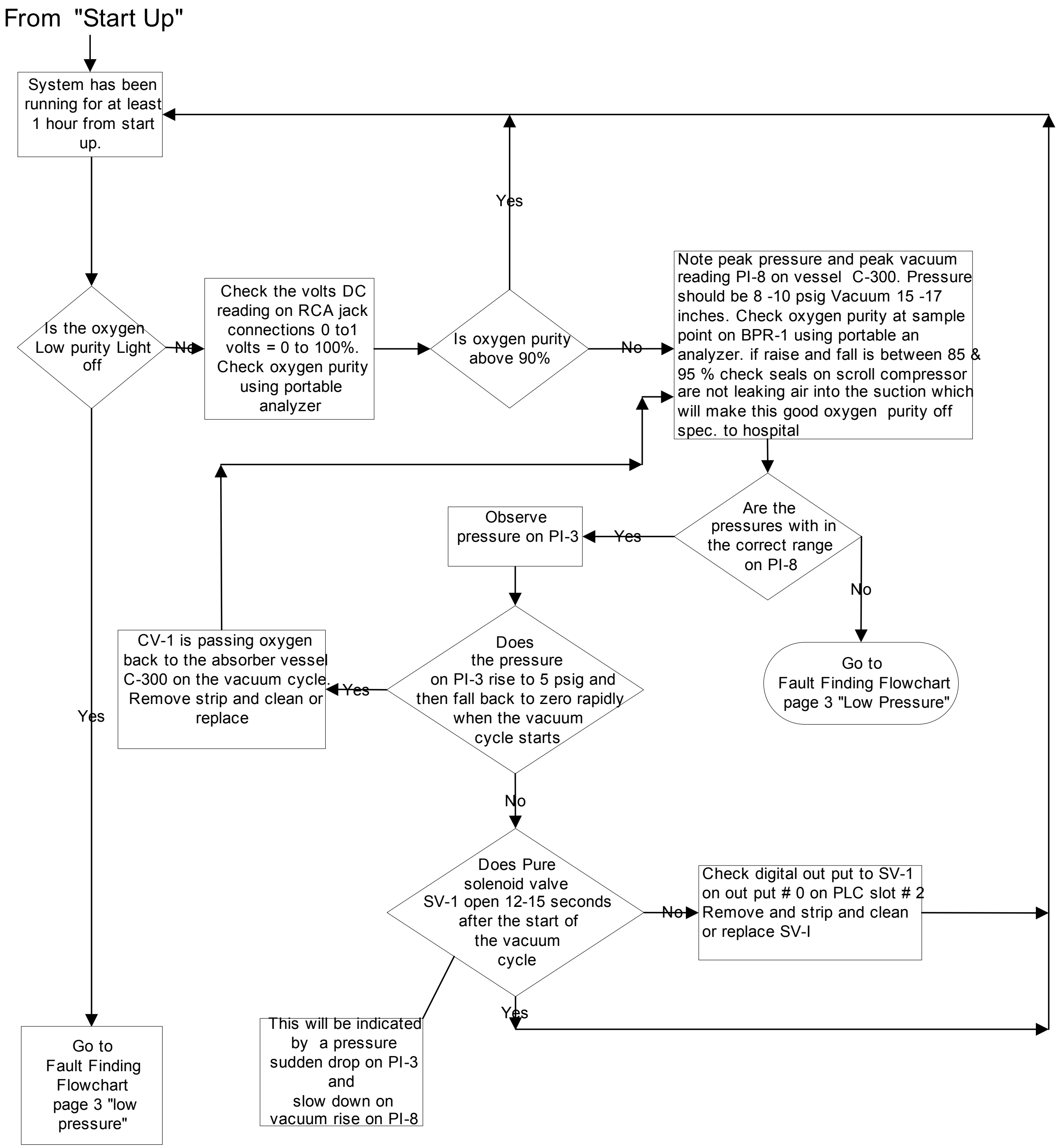

Table 14. System Pressures Troubleshooting Flowchart.

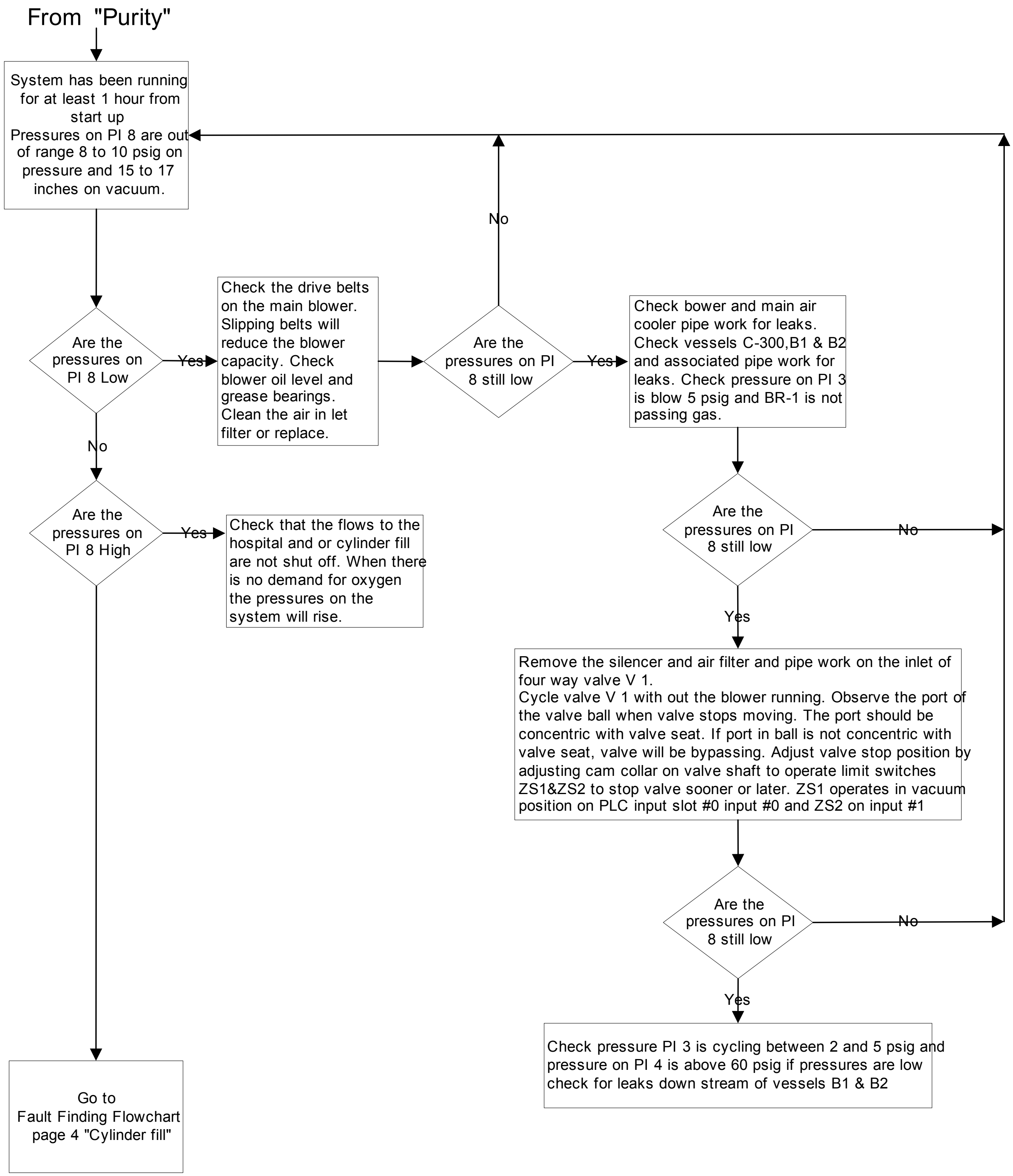

Table 15. Cylinder Filling Troubleshooting Flowchart.