INSTALLATION SUGGESTIONS

Storage and Rigging
Rigging of equipment on the foundation should be planned so as to assure that adequate overhead handling facilities and ample access areas are available. Where these are inadequate for the weight or dimensions of unit, I-fl factory should be advised so that dis assembly can be made prior to shipment.

Storage problems may occur dependent on conditions of storage area and length of time. Storage under controlled conditions of clean inside uniform atmosphere as to temperature and humidity can be successfully carried out for long periods. However, storage under dirty humid uncontrolled conditions can damage equipment in a short period.

Where adverse storage conditions are expected or feared it is best to specify on an Order Page that the equipment be prepared for long term storage.

Location
Air compressors should preferably be located inside a well lighted, clean room of uniform temperatures with ample surrounding area; and near the center of its air demand load, if practical.

Anticipation of resulting noise due to the sound gener ated by the particular type and size and design of compressor to be installed in the expected environ ment must also be taken into account. Due to the complexity of this problem and its many varieties of disturbance we cannot give specific instructions for your installation.

Foundation
Foundation requirements depend on type and size of the equipment to be installed.

Rotary and centrifugal designs seldom pose founda tion problems since there are no moments or unbal anced forces.

Reciprocating compressors, because of alternating movement of piston and other parts, inherently devel op shaking or inertia forces. Foundation must be designed to absorb these forces, in addition to the existing dead weight load.

Reciprocating compressor designs such as XLE, LLE, PHE, HSE have equal-weight pistons and parts so as to practically eliminate unbalanced primary (same fre quency as operating speed) forces. However, some of the following precautions should be taken against the effect of secondary and other minor forces:

1. Foundation should be placed on dry, firm, solid ground backed by bed rock. When unavailable, piling may be necessary.
2. Multiple reciprocating compressors can be placed on common foundation because the greater mass and bearing area tends to dampen movement.

3. Where vibrations carried through structure might affect instruments or personnel, then compressor foundation should be isolated.
4. Foundation design problems can arise because of the following:
    - Soil overloaded
      Solution - expand base area.
    - Foundation tilts because it is centered under compressor center of gravity.
    - Foundation rocks because resultant of vertical center of gravity and inertia force horizontal fall outside foundation base area.
      Solution - add more base area at end that is rocking.

Assembly - Erection - Start
Assembly should be in accord with instruction books, piping and electrical diagrams provided by the compa ny.

Erection should be carried out carefully keeping in mind the importance of correct grouting methods and exact alignment. Non-shrinking type grout should be used or should be of the type that is impervious to oil.

Start-up of any major size compressor unit should be done under the guidance of a competent I-fl supervi sor to minimize initial operation problems. A good beginning assures a satisfied customer, and usually minimizes problems.

First Time Start should include the following items:

1. If unit is positive displacement be sure there is a safety relief valve installed before a discharge shut off valve.
2. Oil sumps and lubricators should be filled with proper oil.
3. Lubricator lines should be filled, and lubricators must function properly.
4. Open correct valves in unloader, regulator, and dis charge line and be sure unit is unloaded.
5. Turn on cooling water (if applicable-aftercooler too.)
6. If practical turn unit over by hand.
7. Make sure rotation is correct.

Air Inlet Supply System
Air intake by compressor can be important in provid ing continuous low cost relatively maintenance-free operation, yet it is often given too little consideration. Ideally, air supply should be clean, cool and dry with out chemical fumes or vapors.

Inspection before installation should be made as to location, piping, environment and type of filtering equipment. Following remarks should guide your decisions:

Air Inlet Location
Unless compressor unit is designed to have filter for air supply mounted integrally, it is

preferable to locate air inlet from outside. Outside air is generally cooler and of higher density, thus increasing compressor actual delivery.

Air intake should preferably be located at least 10 feet above ground and away from dust-laden prevailing winds. An additional 10 feet in elevation usually will reduce the dust load by as much as 50%. Ready accessibility should be provided so that filter elements can be easily inspected or changed.

Compromises as to air intake location may be neces sary to avoid friction drop, or possible air pulsations. To avoid piping pulsations with reciprocating units, refer to instruction books.

If total equivalent inlet piping length is approximately one-quarter or three-quarter of the air column wave length (calculated as a function of the speed of sound in air and the reciprocating compressor RPM), then resonance and natural super-charging can exist. This can result in driver overload, valve breakage, vibra tion, and noise.

If encountered, a simple remedy that often minimizes this resonant condition is the installation of a sharp- edge plate orifice at the air filter outlet flange of a size one-half the inside diameter of the air inlet piping. This restriction, due to one quarter area, disrupts the reso nance and smooths out the flow.

Air Inlet Piping
Material of pipe selected should be given careful con sideration to minimize compressor maintenance.

Ferrous piping should be cleaned and coated down stream of filter to minimize corrosion and thus elimi nate the possibility of rust particles being ingested.

Cement tile should be avoided because cement dust will be gradually loosened and inhaled by compressor.

Non-ferrous material such as aluminum or plastic can be used to avoid corrosion, and its resulting particu late.

Light gauge inlet piping may be noisy unless insulated and lagged.

Air filter unit and inlet piping should be supported commensurate with its weight so that there is no excessive piping strain on compressor unit.

Environment of Inlet
Environmental conditions can be as important to the good health of machinery as it is for humanity. When locating the air inlet be observant of possible inhala tions of chemical gases, dirt, tobacco dust, lint, ash, oil soot, hydrocarbon fumes, coal dust, sand, smoke, rain, snow, insects and water vapor due to neighbor ing areas or changing winds.

The air filter may be very efficient in removing incom ing solid particles, but it may permit gases

to pass profusely. Some chemical gases are hygroscopic in nature and thus readily combine with moisture or con densate to form corrosive acids or particulate solids.

This can be minimized by moving the air inlet, establishing a barrier, or installing primary air filters such as wash water types that will remove these chemical gases before entering the system.

Air Piping System

All air piping should be clean when installed. Foreign matter such as pipe scale, sand, dirt, welding beads should be removed by chemical or mechanical means. Generally, reciprocating compressors should be temporarily fitted with a screen near the compres sor intake to assure start-up cleanliness. Installation of screen between two flanges is easy, and permits inspection and removal. These screens must be inspected regularly as system cleans up so as not to clog, break and enter the compressor.

Piping strain imposed on cylinders due to misalign ment of openings or thermal expansion should be avoided. Pipe supports and expansion joints can be helpful.

Every precaution should be taken to avoid having water enter the compressor. Discharge piping and pipeline aftercoolers should drain away from com pressor so that condensate will not flow back when unit is not operating. Manual or automatic blow-off drains should be installed at the low points and ends of system to remove condensate accumulated. Plant air piping system should be designed with air outlets at the top of piping headers so that condensate will not enter points of application.

When discharge piping is lengthy before entering aftercooler, excessive air pressure pulsations may occur causing driver overload, capacity loss, receiver noise, aftercooler tube damage; and can generate sympathetic vibrations of neighboring apparatus. Pulsation chambers and dampeners of correct size and location can usually remedy this problem.

A safety relief valve must be installed between a dis charge line shut off valve and any positive displace ment compressor. It should be capable of passing the full-load capacity of the compressor.

Discharge line check valves are not necessary for installation with reciprocating compressors since the compressor's internal discharge valves fulfill a check- flow principle. However, certain multiple systems may require check valves for special operating proce dures. In any event, to prepare a reciprocating com pressor for maintenance work, it is necessary to have a line shut-off valve and safety relief valve installed before it, along with a manual discharge line blow-off valve to make sure that compressor is absolutely free of high pressure air.

Condensate must be accumulated from separators of inter- and aftercoolers and removed from the system. If this is not done damage can occur by backing up into compressor during operation. Condensate is usu ally dirt-laden and corrosive and thus life of pistons, rings, valves, rotors, seals and bearings can all be shortened. Therefore, separator outlet drains must be open and condensate traps must be positive in action. Condensate trap drain outlets should be open and

visible so that flow can be inspected. Automatic Condensate Traps when piped for correct installation and kept clean are very helpful in removing conden sate.

Water Supply & Piping
It is important to learn before operation of unit the source of cooling water before problems develop. And if there are any questions as to its suitability, then reg ular water analysis and treatment should be carried out. Well water, riverwater, open cooling towers should all be suspect and precautions should be taken. Water can be corrosive, muddy and silty, full of foreign material such as tobacco dust and lint, and have a hardness that results in precipitation at rela tively low temperatures. All of these can impair cool ing ability of jacketed areas and heat exchangers. Build-up of foreign matter further impairs cooling abili ty thus raising water and air temperatures, and caus es a greater rate of chemical precipitation. It ends in a vicious cycle and can result in premature mainte nance.

Lubrication
Correct flow of clean oil to the vital points of any com pressor is of utmost importance. To assure a suc cessful program in providing proper lubrication, do the following:

1. Obtain from our instruction books or engineering department exact specifications of lubricating oils rec ommended and submit inquiry to reputable oil company or dealer.
2. The selected vendor should confirm that his oil meets our specifications, and that he is willing to guarantee the oil as satisfactory for the intended ser vice.
3. Oil should be stored and installed so as to preclude dirt, moisture, temperature extremes and mixing of different oils.
4. Repetitive purchases of oil should be from the same source and with the same specifications to pre vent receipt of a different grade of oil.
5. Oil, same as the recommended specification should be used, except that it should be approximate ly two SAE grades heavier and thus more viscous— and flows should be much greater than normally required. Break-in period is over when cylinders have taken on a high polish, which usually takes 2-10 hours of operation depending on the size of the unit.
6. After break-in period, cylinder lubricator oil feed rates should be drastically reduced to prevent rapid build-up of carbon on the cylinder valves.

Control Systems
The control system should fulfill the required functions and purposes. The levels of increasing sophistication are as follows:

1. Manual Control is dependent on decisions of a human being. The operator follows instructions to meet plant requirements.
2. Automatic or Sequence Control is designed to fulfill requirements automatically and in accord with instru ment schematic design.
3. Process Variable measurement provides informa tion to the operator who then makes adjustments to the system instruments to obtain desired performance.

4. Decision Making Control by logic action provides a system for automatically making decisions and acting on the basis of happenings in the process.
5. Optimizing Control makes decisions for continually resetting system instrumentation to achieve predeter mined maximum levels of process performance.

Elements of a Control System contain:

1. Sensors that measure the critical variables and transmit signals to other control elements. Transmission may be pneumatic, hydraulic or electric.
2. Monitors receive the signal from the sensors and take necessary action by means of alarm, light or shutdown.
3. Compressor Control units may have sensors and monitors that concern any or all of the following critical items:

- High lubricating oil temperature
- High intercooler outlet air temperature
- High final discharge air temperature
- High air discharge pressure
- High intercooler condensate separator level
- Low lubricating oil pressure
- Low cylinder lubricating oil level
- Cylinder lubricator rotation stopped

Compressed air for Control Systems should be clean, dry (40-50 dewpoint), and of stable pressure.

To understand the actions of the Control System, the operator must first understand the system design and its intended functions. Only then can he correctly interpret the control actions and make any necessary adjustments or repairs. Control diagrams and instruc tion books should be studied thoroughly before initial operation.

Electrical Drivers & Starters
Drivers should be selected with care consistent with the compressor requirements and plant electrical sup ply. Often it is wise to consult the power company as well as electrical manufacturer to determine correct specifications. Consideration should be given to motor types, horsepower, speed, starting torque, enclosure, insulation, voltage maintained and dips, as well as resulting power factor, necessary heaters and bearing alarms.

Generally speaking, induction motors are used rather than synchronous, except for large slow speed types because they are usually less expensive and require less complicated starting equipment and no excita tion. When plant power factor is poor it may be bene ficial either because of available system load carrying ability or power company rate penalties to install synchronous motor equipment. However, a power fac tor capacitor of correct size can be considered as an alternative in many cases.

Motors should be sized to carry maximum peak horse power using service factor tolerances, giving practical consideration to plant load continuity or variation. Enclosures should take into account and protect from existing environment such as water, dirt, moisture, chemical fumes and hazardous gases. However, motor should not be more enclosed than necessary.

Compressor starting torque requirements should be taken into account when specifying electrical equip ment. This is particularly true when reduced voltage starting is used since the available torque is reduced with the square of the ratio of the applied voltage to the rated voltage. Starting torque requirements are increased after compressor has undergone a long shutdown period in a cold room, due to high viscosity of crankcase oil. Electrical rod crankcase heaters will overcome this condition.

Lower voltage than motor rating at the terminals will cause motor to draw excess amperage and will result in motor overheating. Ten percent drop in voltage usu ally means 11% higher amperage. Surprisingly, this same phenomenon will also happen with modern compact low horsepower motors when voltage at ter minals is higher than rating, due to more dense mag netic fields operating higher on their hysteresis curves.

When automatic start-stop control is used, adequate size air receiver should be installed to prevent too fre quent starting, which can cause overheating and insu lation deterioration. Some motor manufacturers rec ommend no more than 8 starts per hour for motor size 1/2-20 HP and not more than 4 starts per hour for larger motors up to 100 HP. Limits' of 2-3 starts per hour are common for motors over 100 HP.

Record Keeping
Periodic records should be established for operation and maintenance to build a history for continual guid ance. Items that may be recorded are as follows:

1. Temperatures, pressures, electrical data
2. Oil consumption and change-out dates
3. Filters - dates when cleaned or elements changed
4. Operating hours
5. Cylinder and ring clearance measurement history on nonlubricated units.
6. Maintenance frequency - valves, coolers, jackets
7. Log of troubles that occur
8. Based on experience and history on above items establish a Preventative Maintenance Schedule and follow it regularly.

Spare Parts
It is our responsibility to assist and encourage our customers in selecting and maintaining for their stock an adequate supply of renewal parts. Having available at the customer's plant an adequate stock of parts makes maintenance easy and precludes emergency order requests.