

IOM SUPPLEMENT

FORM PRS-961114.01
Rev12

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26 Feb 07

General Field Erection Instructions

TO ATTENTION:

FROM: Contract Administrator

SUBJECT: PRESTART-UP AND START-UP INFORMATION
 JOB NAME:
 DESTINATION SITE
 CUSTOMER PURCHASE ORDER #
 YORK PROCESS SYSTEMS S.O. #

This information package includes very important prestart-up requirements, and start-up checklist items for your custom built refrigeration or gas compression package. Please pass this on to the appropriate personnel responsible for installation and start-up.

We define prestart-up labor/supervision as that work required to prepare the unit for actual start-up. Start-up labor/supervision is the final alignment, checking, charging and actual start-up of the equipment all as defined in the attached documentation.

This package includes:

- 1) General - Parts and Service Contacts
- 2) General Field Erection Instructions [96114_F]
- 3) Rigging information [Rigging,BA_18003,BA_18004]
- 4) Setting a Process Package Base [Setting a base]
- 5) System Commissioning and Maintenance Introduction.doc
- 6) Field pressure and vacuum testing [FPVacuum]
- 7) Proper installation of electronic equipment [S90400sb]
- 8) Low temperature operations [Lowtemp]
- 9) Long Term Storage Procedure [1200.02]
- 10) **York Turbomaster Compressor Application Checklist [AES 1500.03]**

Note: If your system includes a remote air cooled or evaporative condenser, it is very important to provide the required installation height (and piping configuration) above the receiver.

Over the years, we have found that the most successful start-ups are those that include proper planning for the time required and for determination of who will take responsibility for each aspect of the work. An authorized York service representative must perform the start-up supervision as a minimum for warranty protection, but we strongly encourage you to contact York to assist in the prestart-up labor and also to assist in planning your installation, prestart-up and start-up work.

We very much appreciate your purchase of this equipment and look forward to working with you through its initial commissioning and operating life.

Very truly yours,
PATRICIA A. GOSSARD
Contract Administrator

CC: York Service Manager
 LOU JUPIN
 Project Engineer
 RUSS DALEY
 Salesman

SALES FILE A. Bases Without Target Pads

INSTALLING AND GROUTING PACKAGED SKIDS

The foundation pad for a process system package should be level, flat and clean. The pad thickness and design should take into consideration the nature of the sub-soils and the weight of the operating package. Base slabs laid on plastic or unstable subsoil may transmit vibration and / or settle in an unpredictable fashion. Provision for

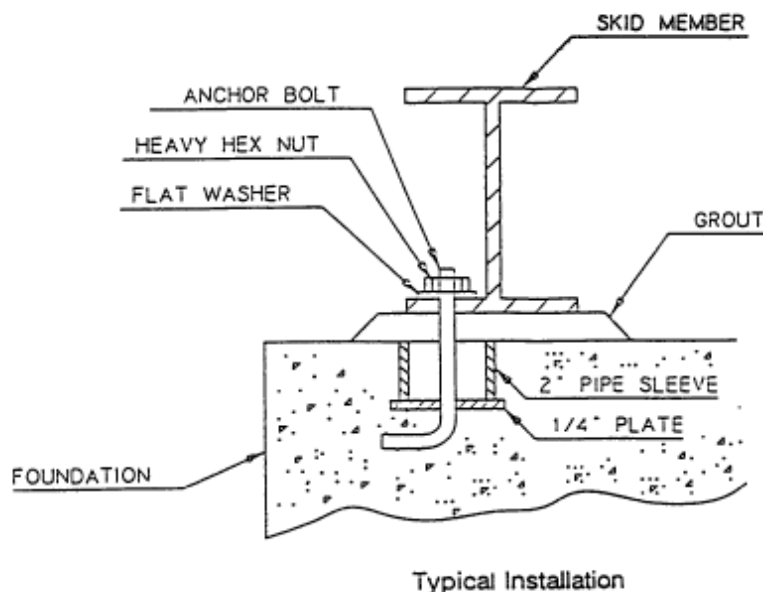
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grounding, electrical conduits and other utilities that may be necessary that must penetrate the slab should be carefully laid out in advance.

The steel base should be bolted down to concrete substructure with anchor bolts at locations shown on the drawing. Sub-structure must be level, and it should be grouted to assure continuous contact with all accessible full depth members. This is essential on structural members supporting drivelines. It is recommended that the steel base to be filled with concrete to top of base in all pockets that are accessible and free of piping (allowing access for drain valves, etc.)

Anchor bolts should be positioned in ferrules fabricated from 2 IPS (50 DIN) pipe (or equivalent). The ferrule should be flush with the surface of the rough level. Soft wadding (or equivalent) should be used to center the bolt in the ferrule during placement of the package unit. This provides bolt flexibility to allow for final position and manufacturing tolerances. After final position has been obtained, the grout should flow into the ferrules and lock the anchor bolts into position.

No less than 1" (25 mm) of non-shrink epoxy base grout is recommended. The base may be leveled using conventional procedures and verified to be level side to side and corner to corner. Care should be taken to insure cross members are supported even if no measured deflection is observed.



General Field Erection Instructions**B. Bases With Target Pads****1.0 Purpose**

- 1.1 This guidance has been issued to ensure that Packages utilizing “Target Pads” for base setting are properly interpreted and applied when setting the package base. Proper utilization of the base targets will ensure the package is installed in the same plane as when fabricated. The purpose of this procedure is to eliminate problems associated with motor, gear, and/or compressor alignments and pipe strain resulting from deformation of the base during shipment, handling and setting.

2.0 Application

- 2.1 This guidance applies only to packages utilizing target pads. Target pads are typically used on large screw compressor packages with vertical oil separators or centrifugal drivelines. Targets are sometimes used on large packages that must be bolted together in the field. Refer to the project general arrangement drawings.

3.0 General

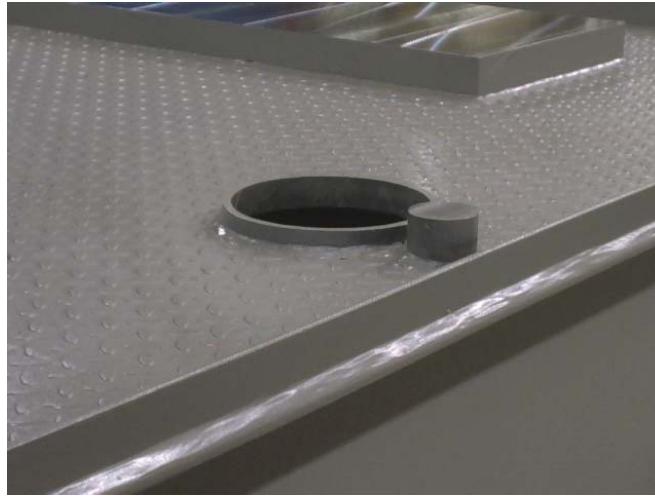
- 3.1 The package base has been designed with sufficient stiffness to prevent permanent deformation of the structure during normal handling. Because of size and weight limitations it is not possible to design a base that will not experience some deflection during handling and setting. However, if the base is installed in the same elevational relationship as it was manufactured, the components on the base should return close to their original relationship. In order to insure the package is restored to its “as built” condition a number of target posts have been installed on the base to permit measurement of the base’s elevation in several locations. During fabrication the pre-assembled base is set and steel plates are placed under each jack bolt. The base is then leveled using a transit. Readings are then taken from the top of each target and recorded on an inspection sheet. After the package has been completely assembled the elevation of all the targets are shot a second time and the deviation above and below the original zero lines are recorded. The measured deviations are then stamped on to the tops of the targets. If the base elevations are accurately re-established, less time and effort will be required to align the drive components.

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Target near base fill hole.



Leveled base at factory.

4.0 TOOLS

- 4.1 A good quality accurate surveying Instrument (transit) or equivalent
- 4.2 Tripod
- 4.3 Sliding Scale – (story pole) – with minimum graduations of 0.12" (3mm).
- 4.4 Alignment indicators or laser alignment tools.
- 4.5 Wrenches for adjusting the jack bolts.
- 4.6 3" x 3" (75 x 75 mm) or equivalent ¼" to ½" (6-12 mm) thick steel plates to place under the base jack bolts.

5.0 BASE SETUP

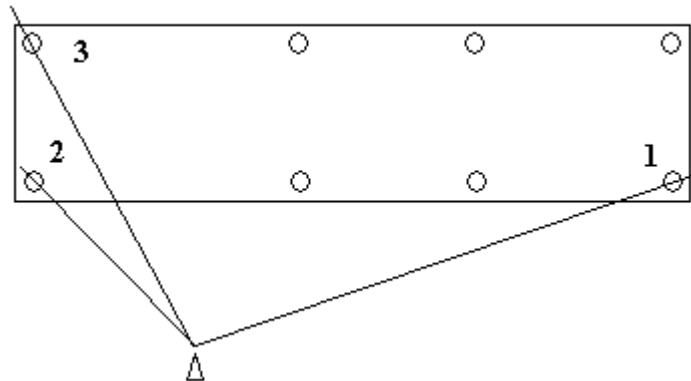
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- 5.1 The foundation should be reasonably clean, level and flat. The package frame should be located in its final position and steel plates placed under each jack bolt prior to lowering the base. Jack bolts should turn freely and may be lubricated with anti-seize compound to prevent galling. The plates should be set flush with the edge of the base so as not to protrude after grouting. The jack bolts should all extend down at least $\frac{1}{2}$ " to $\frac{3}{4}$ " inch (12 to 18 mm) below the base to allow for a minimum of 1" (25 mm) of grout under the frame after the base has been set.



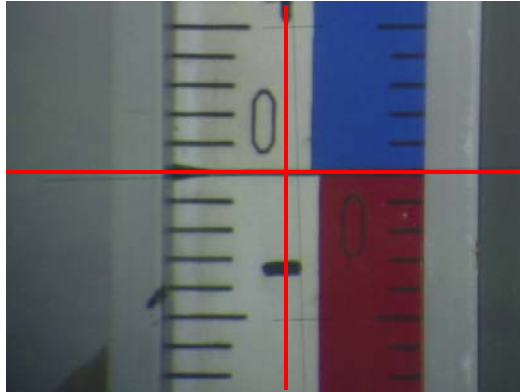
Steel plates under jackbolts to prevent gouging pad.

- 5.2 Set the transit at a point approximately halfway between the targets to be measured and approximately three (3 to 5) feet (1 to 2 M) back from the base. A position that can effectively shoot two to three of the frame corners is desirable if it can be achieved. One or more corner target posts will have a zero stamped in the top and may be used as a starting point.



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- 5.3 Verify your instrument has been properly leveled and elevated to allow comfortable viewing and that the focus is sharp and parallax free. Place the “story pole” on top of the starting target and adjust the sliding scale on the story pole until the crosshair is centered on zero. In the example above the target identified as “1” has a value of zero and could be used as a starting point.



Instrument zeroed out on target #1.

Readings below the zero division are prefixed with a minus sign.

Readings above zero are positive. The accuracy of the factory readings is to one half of one division or .06" (1.5 mm) minimum.

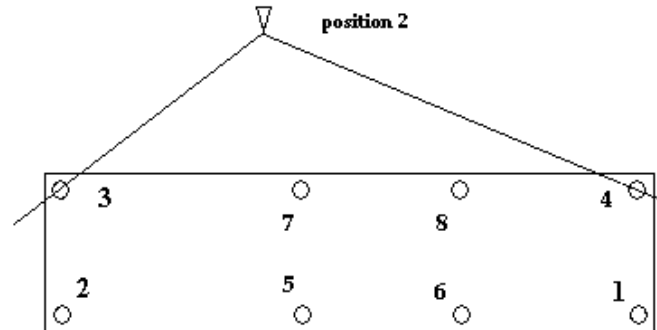


Target values are clearly stamped on the target surface.

- 5.4 There are jacking bolts provided along the sides of the base for the purpose of adjusting elevation. On large packages, there may be jacking bolts along the centerline of the package as well. The four corners of the packaged should be leveled first and then the remaining targets on the perimeter. After

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adjusting targets 3 and 4 the elevation of targets 1 and 2 should be reconfirmed from position 1 before adjusting for targets 5 through 8.



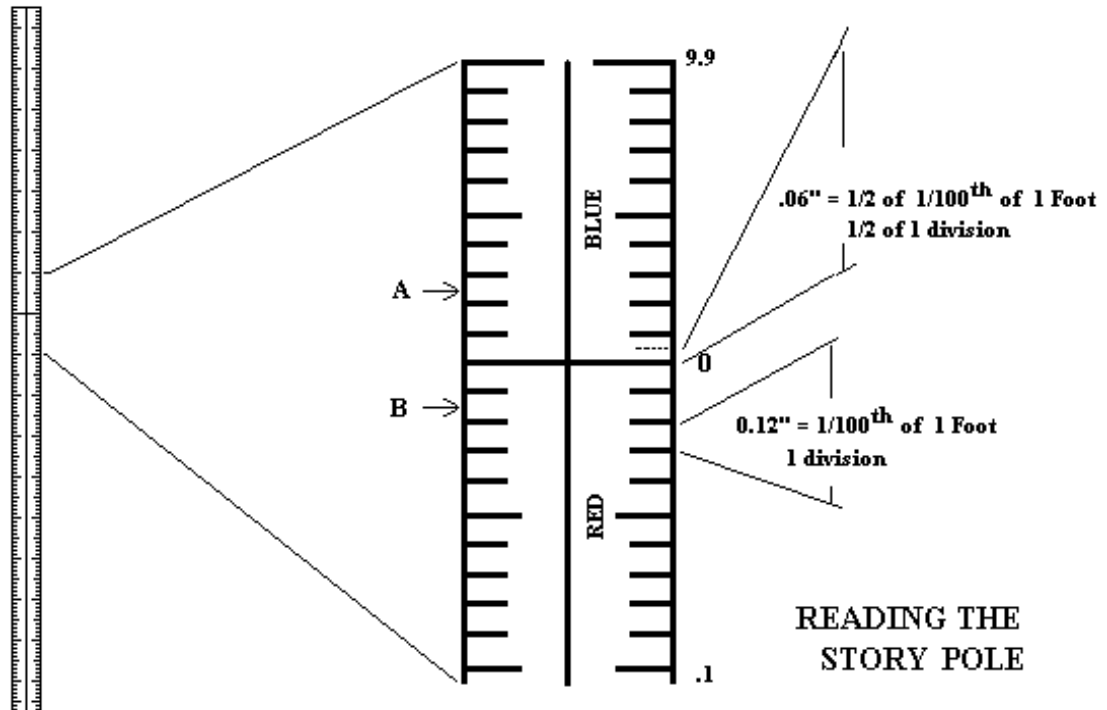
position 1

- 5.5 The jackbolts between the corners may be adjusted after the four corners have been established. After adjusting one side of the skid the opposite side should be reconfirmed. After all the perimeter jackbolts have been adjusted satisfactorily, any jackbolts near the center of the skid may be adjusted. Again, after any adjustment of a jackbolt the elevations of the other targets should be reconfirmed.
- 5.6 On centrifugal drivelines and packages with large motors or gearboxes, the coupling alignment should be rechecked prior to grouting in the skid. The alignment of the components should closely approach the factory alignment if the base has been restored to the plane defined by the deviations noted on the targets. If the alignment of the components is off more than .040" to .050" (1.0 to 1.2 mm) TIR in either angular or parallel alignment recheck the targets. Also make sure that all jackbolts are in contact with the floor.
- 5.7 If the package has been accurately leveled and the driveline components are within reasonable rough alignment the skid can be grouted in place. In order to help avoid pipe strain issues later it is suggested that the driveline be aligned prior to the installation of any interconnecting piping to the components.

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ADDENDUM A

READING THE STORY POLE



Readings below the 0 line are negative. Readings above the 0 line are positive. Reading A for example would be a positive .30 (.12+.12+.06). Reading B would be -.18 (-.12+ -.06).

Abstract

Base Fabrication Practice

Packaging has emerged as one of the prominent methods of constructing rotating equipment drive trains. This practice simplifies procurement, allows greater control of construction methods and environment, and speeds the installation process at the job site. Packaging has gained wide acceptance, especially in the process chemical and petroleum industries.

Packaging, as the term implies, is the prefabrication of equipment assemblies, usually on base weldments, fabricated from structure steel components. The base, sometimes referred to as the skid, is usually a frame that consists of steel channel or wide-flange beam members coped

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and fillet welded together at the various intersections. The beam size is selected using empirical or analytical methods in order to optimize base rigidity and cost. It is important to note that the base rigidity is optimized, not maximized. Some flexibility is permitted and expected. Some deflection of the base is observed, especially along the longitudinal members.

Bases fabricated for drivetrains (rotating equipment), usually include pieces of steel plate welded to the top of the frame assembly and milled or planed to a smooth finish. These mounting pads are positioned in the same location as the mounting feet of the rotating equipment. The pads are drilled and tapped for the hold-down bolts.

The finish on the mounting pads is typically 250 μ inch (6.4 microns) or better. The base weldment is usually positioned in free form, shimmed and secured for machining. The base is not forcefully straightened or deformed since doing so would result in residual stresses in the base. Such stresses would adversely affect the parallelism of the machined surfaces later when the base is unrestrained. The machining process utilizes indexing and milling or planing techniques that permit normal machined surface tolerances. Once the base is removed from the machine, the flatness and parallelism are altered because of the flexibility and deflection inherent in the frame.

Customer Expectations

Many contractors and millwrights are accustomed to installation practices using soleplates or the use of local machining techniques to mount rotating equipment. Soleplates embedded in aggregate (or epoxy) permit relatively precise cold misalignment¹ prior to permanent setting of the soleplates. Local machining practices allow contractors to match the mounting surface to the component foot plane. Both practices make it possible to: 1) avoid the use of tapered or stepped shims and 2) use as few as two shims to achieve the final hot alignment². Both practices are labor intensive during installation at the jobsite.

This type of expectation sometimes encourages users and/or contractors to write specifications requiring tight tolerances on the flatness and parallelism of the machined component mounting surfaces on fabricated steel bases. The intention is to reproduce the condition that results using soleplates or local machining, thus avoiding the need for tapered or stepped shims or machining at the jobsite. Some procurement specifications now refer to *leveling*, *flatness*, and *parallelism* limits. One requires mounting pads to be machined *flat* and *parallel* to within 0.002" per foot (0.17 mm per meter). Another requires the mounting surface and components to be *level* to within 0.002" per foot (0.17 mm per meter) of length and width of the mounting plates. This can be achieved on the machine tool. It cannot be retained because of base flexibility.

¹ *Cold misalignment* is the phrase describing the use of intentional parallel and angular offsets in the alignment of components to compensate for expected shaft movement. These movements are caused by operating loads and thermal growth as the equipment reaches operating temperature.

² Hot alignment is the condition of alignment concurrent with full load, full temperature operation.

General Field Erection Instructions**Definitions**

Level: describes to the deviation of the plane described by the mean of a surface profile relative to the plane described normal to the vector direction of gravitational acceleration in distance per length of surface (inch/foot).

Flatness: describes the deviation of any point on a surface from the plane described by the mean of the surface profile in distance (inches).

Parallelism: describes the deviation of the plane described by the mean of one surface profile relative to a parallel reference plane, usually the plane described by the mean of another surface profile, in distance per length of surface (inches).

Objectives

These are the primary goals of setting rotating equipment.

Alignment

Alignment of the rotating equipment must be achieved within the operating tolerances of the couplings, seals and bearing systems. If these tolerances are not met, the reliability of the rotating system is in jeopardy. High vibration, serious equipment damage, and hazard to personnel can result from hot misalignment.

Foot Plane

The feet of rotating equipment components are machined to the same plane within the tolerances of the manufacturer's machine tool and assembly process. The mounting surface is usually a machined surface with one or more shims made to achieve shaft alignment.³ When the component is placed on the mounting surface, there is a gap that results between one or more of the feet and the corresponding mounting surface. If the gap is relatively large, and is not properly adjusted for using shims, a condition called *soft foot* results. This condition imposes stresses in the component casing that can cause misalignment of bearings, seals and rotating components. The reliability of the operating component can be severely reduced if the condition is bad enough. For this reason, *foot plane* or *soft foot* is checked and limited to manageable values.

Maintenance

Maintenance becomes a consideration if a component must be moved and then realigned. For this reason, end users usually limit the number, type and material of shims used. It is also

³ Some mounting surfaces are made by locating the component feet using jackscrews and then pouring an epoxy compound between the foundation surface and the feet. This technique is usually used on small equipment where adjustments are unnecessary. Some mounting surfaces are made using plates that more or less match the component foot dimensions and can be jacked into location using permanent fine thread screw fixtures. This type of mounting is rare on large rotating equipment.

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desirable to eliminate tapered or stepped shims since they must be reinstalled in the precise orientation necessary to compensate for the existing angular gap between the foot and the mounting surface.

Constraints

Base Flexibility

As mentioned above, structural steel base beam size is selected using empirical or analytical methods in order to optimize base rigidity and cost. The base rigidity is optimized, not maximized. Some flexibility is permitted and expected. Some deflection of the base is observed, especially along the longitudinal members. This flexibility occurs in the elastic region of the stress-strain curve and is manifest when lifting and rigging of packaged units. The deflection toward the midpoint of the longitudinal span can be anywhere from a small fraction of an inch to a few inches depending on the package design and dimensions. Even if the surfaces meet requirements at the time of machining, any deflection that is imposed, after the base is machined, will affect the flatness and parallelism of the surfaces. *Figure 1* illustrates the affect of even a very small deflection on the mounting surface flatness and parallelism. For example, if a deflection δ_1 of 0.125" (3.2 mm) is permitted over a length of 10 feet (3 M), the other deflections, δ_2 and δ_3 , are on the order of .010" to .050" (0.3 to 1.3 mm). These deflections could be considered unacceptable given the stringent criteria of flatness and parallelism imposed in some specifications. In order to reproduce the "as machined" flatness and parallelism, the flatness of the base as it was set on the machine tool must be reproduced at the jobsite, within ten-thousandths of an inch! This is an insurmountable barrier in most field erection scenarios because of the available instrumentation.

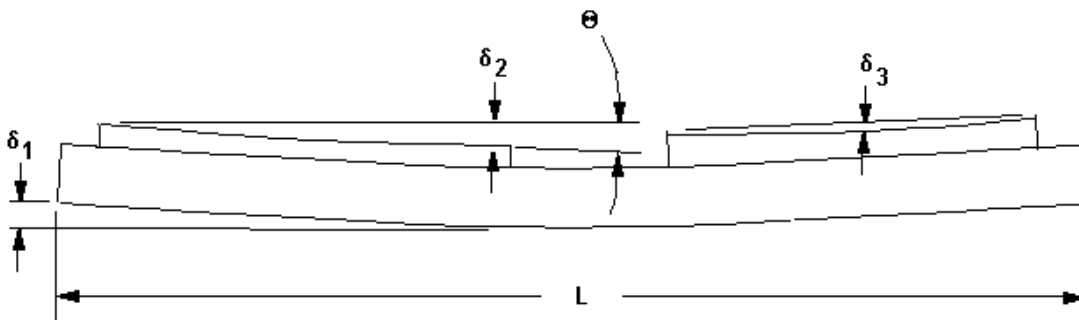


Figure 1

General Field Erection Instructions**Component Assembly and Machining Limitations**

Vertically split compressor casings provide another obstacle to very tight flatness tolerances. In many cases, the casings are machined separately prior assembly. Assembly objectives focus on bearing, shaft, rotor and bore concentricities so the foot plane becomes a secondary consideration. Combined parallel and angular offsets can result in measurement of one foot out of plane from another by .010" to .015" (0.25 to 0.38 mm), and still be within manufacturing tolerance. Manufacturers are reluctant to machine compressor casings once they have been assembled for fear of damaging the assembled machine.

Furthermore, some components, such as large motors, carry a manufacturing tolerance that permits one foot to be out of the plane of another by .005" to .010" (0.13 to 0.25 mm).

Although these issues do not affect the flatness and parallelism of the base, they do speak to the rationale of exhausting valuable resources to level the structural base mounting surfaces in such cases.

Intentional Cold Angular Misalignment

In refrigeration, it is common to impose an intentional angular cold misalignment to compensate for uneven vertical thermal growth along the length of the compressor. In the case of one five stage 55" (1400 mm) centrifugal compressor used for booster duty, an angular cold misalignment of 0.005" per foot (0.4 mm per meter) was needed to compensate for thermal growth. This results in a .005" (0.4 mm per meter) per foot taper under the feet. The typical limit imposed on *softfoot* at the foot of a component is 0.002" (0.05 mm) springback. It is often impossible to correct this *softfoot* indication without the use of tapered or stepped shims.

Again, this issue speaks to the rationale of exhausting valuable resources to level the structural base mounting surfaces.

Summary

Alignment and foot plane procedures take time to accomplish. Because it is not feasible to reproduce the "as machined" flatness of a large base within ten thousandths of an inch, it should be recognized that the time will be needed to accomplish a proper alignment at the jobsite. Up to a week may be needed in some cases. Stepped or tapered shims may be needed to compensate for any alignment or *softfoot* problems resulting from base flexibility, component foot plane variations or an intentional angular cold misalignment.

Inquiry/Order No. _____

Any system design utilizing the York Turbomaster Compressor must provide consideration of the following:

1. A check valve is necessary in the horizontal run of each compressor discharge line, as close to the compressor as possible (within 25 feet of compressor discharge flange).

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2. Machinery backspin, caused by equalizing pressures, must be minimized by using automatic valves as necessary to close suction and side streams on shutdown. The automatic pre-rotation vanes (PRV), provided as standard, can be used for the suction. If automatic PRV's are not used, a suction damper is required.
3. All piping and vessels connected to the compressor must be arranged and designed to eliminate liquid accumulation and subsequent entrance into the compressor. Do not trap any piping to or from the compressor. This requires proper design of vapor liquid separation in vessels and heat exchangers, and may require the addition of suction traps or accumulators.
4. Automatic throttling valves may be necessary on all streams entering the compressor (within 10 feet of compressor flange) in order to avoid driver stall during acceleration by an electric motor or a low torque drive. The automatic PRV's may be used to partially serve this function by throttling the first stage suction.
5. On variable speed drives, the compressor should not be permitted to idle for extended periods of time. If it is necessary that the compressor idle for more than several minutes, an automatic recycle valve may be required, depending on compressor idle speed, to prevent overheating. The valve should be mounted inside the compressor discharge check valve. The recycle gas will have to be cooled or quenched to prevent compressor overheating. If quench is used, refer to the above (Item 3) regarding elimination of liquid.
6. Automatic suction, side stream and/or discharge throttling valves may be required to limit flow during start-up, pull-down or upset conditions to avoid choke. These conditions usually occur in pipeline or parallel compressor systems or when low ambient temperatures suppress the condensing temperature. Sustained compressor operation with a head of less than roughly 60%⁴ of design (MU less than 0.3 at any stage) may result in choked flow and consequential damage. The standard automatic PRV's may be used for the suction.
7. Automatic controls to limit side load inlet pressures may be required when the side load flow is excessively high due to off-design condition, which may occur during startup. If the side load flows increase in proportion to the 1st section inlet flow, the side load pressures may increase resulting in surge of the 1st section. Pressure control valves sensing downstream pressure can be used to control this scenario.
8. All compressors operating in parallel, or required to start up against the head of an operating compressor, must be provided with individual automatic recycle valves and gas cooling as described above. The recycle gas should exit the discharge line between the compressor and its discharge check valve.
9. On variable speed drives, the compressor speed must not dwell within the range of +/-5% of a compressor critical speed. Automatic controls are necessary to ramp quickly through critical speeds, and thus avoid possible consequential damage.
10. Because of the part load characteristics of centrifugal compressors, recycle valve(s) will be required as necessary to satisfy the minimum flow requirements of each compressor section, or surging will occur. Large, independent or abrupt side loads usually require individual recycle valves and cooling.
11. Some applications with low vapor pressure gases may require the compressor be vented during standby to prevent the accumulation of condensed liquid in the oil sump and casing.
12. Whenever accumulation of condensed liquid occurs in the casing during shutdown, stage drain piping must facilitate removal of liquids prior to restart.
13. Centrifugal compressors attached to field erected piping should be provided with temporary conical (witch hat) strainers leading to all inlets to reduce the chance of compressor damage caused by residual field piping fabrication debris. Any debris that enters the compressor is likely to cause projectile damage to the rotor. Truncated (flat bottomed) geometric strainers are discouraged since they are more prone to premature failure. The strainer should include a minimum 150% open flow area with the point opposing the flow direction. Pressure taps are recommended so that the strainer's condition may be assessed. If the strainers foul, they may

⁴ The actual head at which the compressor will exhibit a choke characteristic may be anywhere from approximately 40% to 80% of the adiabatic or polytropic head at the design condition. Consult York Engineering for an accurate prediction regarding choke.

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cause reduced compressor capacity and cause compressor surge instability (risk of damage). The strainers should be removed as soon as the streams have been determined to be clean.

The equipment referenced above is not necessarily included in this quotation and depends on the scope of supply requested in the purchaser's inquiry.

GENERAL

The following instructions are intended to outline the procedure to be followed for the installation, operation, and maintenance of the YORK system.

General Installation, Operating, and Maintenance instructions are included. Where specific instruction is different from the standard service instructions, the specific instruction takes precedence. On matters not covered by the specific instructions, the standard instructions may be used. Specific instructions will be included with the Installation, Operation and Maintenance instructions later.

It is important that those responsible for the installation, operation, and maintenance of this system are provided with a copy of the IOM and they thoroughly study its contents. This will insure the successful operation of the plant.

It is recommended that the testing, charging, and adjusting of the system initially be supervised by a qualified representative of YORK INTERNATIONAL CORPORATION, and it is suggested that those who will later operate and maintain the system be present during this phase to learn first hand the procedures followed.

It is suggested that any major service maintenance operation and installation of field piping be supervised by a factory-trained service representative of YORK INTERNATIONAL CORPORATION. This is specifically recommended should it be necessary to open the compressor or system for any reason. For service or parts contact:

For <u>Service and Parts</u> contact:	Local York District Service Office - Service Manager	York International Sales & Service
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RIGGING INFORMATION

The attached pages provide typical rigging methods for packaged systems. Refer to the arrangement drawings (GA) for the method applicable to your project.

ATTACHED DRAWINGS:

BA-18003	2 SHEETS	4 LUGS
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BA-18004	2 SHEETS	8 LUGS
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RIGGING AND HANDLING

CAUTION: *THIS SCREW COMPRESSOR PACKAGE MAY BE TOP-HEAVY. USE CAUTION IN RIGGING AND HANDLING.*

The unit can be moved with rigging, using a crane or forklift, by hooking into the four lifting eyes on the compressor and motor bases. If no motor is mounted, the lifting ring should be moved to the compressor side of the center of the unit because 60 percent of the weight is toward the compressor end. If a motor is mounted appropriate adjustment in the lifting point should be made to compensate for motor weight. Adjustment of the lifting point must also be made for any additions to the standard package such as an external oil cooler, etc., as the cent of balance will be effected.

The unit can be moved with a forklift by forking under the skid, or it can be skidded into place with pinch bars by pushing against the skid. **NEVER MOVE THE UNIT BY PUSHING OR FORKING AGAINST THE SEPARATOR SHELL OR ITS MOUNTING SUPPORTS.**

SKID REMOVAL

If the unit is rigged into place the skid can be removed by taking off the nuts and bolts that are fastening the unit mounting supports to the skid before lowering the unit onto the mounting surface.

If the unit is skidded into place remove the cross members from the skid and remove the nuts anchoring the unit to the skid. Using a 5-ton jack under the separator, raise the unit at the compressor end until it clears the two mounting bolts. Spread the skid to clear the unit mounting support, then lower the unit to the surface. Repeat procedure on opposite end.

March 16, 2004

LOW TEMPERATURE OPERATIONS

On systems that are located outdoors or are in unheated buildings where the ambient temperatures could drop below +40°F, attention should be given to the insulating and/or heat tracing of compressor lube oil systems.

It is recommended that oil separators be provided with insulation as a minimum requirement to preserve the heat generated by the oil heaters. It is important that the coalescer end of the separator be insulated to prevent refrigerant condensation.

When low ambient temperatures (below +20°F) are to be encountered, attention should be given to heat tracing and insulation of lube oil lines, oil filters, oil pumps, oil coolers.

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Freeze-up protection must also be provided for all water-cooled equipment.

March 16, 2004

FIELD PRESSURE AND VACUUM TESTING

Vessels and piping were pressure tested before leaving the factory, but should be leak tested at the site. Open all valves except those to atmosphere.

CAUTION: Do not hydro test this equipment.

CAUTION: Be sure to use a pressure regulator between the nitrogen bottle and the system to prevent over pressure, which might lift the relief valves.

CAUTION: Do not use a halide torch, electronic leak detector or sulfur sticks in a hazardous area. Either will develop local temperatures capable of igniting flammable gases.

CAUTION: Do not use R-22 to leak check ammonia systems. R-22 may react with system oil or elastomers to cause a chemical incompatibility with ammonia. The result may cause the formation of compounds that will be detrimental to operating components. Sulfur sticks may be used to pinpoint leaks in a non-hazardous area. Do not use sulfur sticks in a N.E.C. hazardous area. Litmus paper and soap bubbles may also be used to help pinpoint ammonia leaks.

Slowly raise the system pressure to 80% of DWP using dry nitrogen or a mixture of dry nitrogen with R-22. If an electronic or halogen leak detector is to be used, charge R-22 gas until the system pressure is 30 PSIG. Raise the pressure to 80% of DWP with dry nitrogen. Search for leaks with a soap solution or suitable leak detector. Thoroughly check all welds, valves, gasket joints, screwed joints, etc.

Mark any leaks so they may be repaired when the pressure is released. Blow down through the charge and purge valves. Open the valves quickly and wide to take advantage of velocity to sweep along any particles of grit or scale.

If any leak is found, it must be repaired and the pressure test repeated. Repeat this procedure until all the leaks are repaired.

A final leak check should be done prior to final insulating and after initial operation to find any leaks caused by thermal exercising joints. Liquid columns and transmitters should be insulated before initial operation.

When the system is pressure tight, connect a vacuum pump capable of creating a vacuum of less than 2,000 microns. Do not use the compressor for evacuation. Evacuate the system to 2,000 microns (2mm Hg absolute). Shutdown the vacuum pump and valve it off from the system. If necessary, close off the compressor isolation valves. Hold the vacuum for four hours. If the vacuum rises more than 2,000 microns (2mm) in that period, it indicates a leak or presence of moisture and the pressure test should be repeated. If no leak is found, the vacuum test can be resumed and continued until dryness and tightness is established. Low ambient temperature will reduce the effectiveness of vacuum drying. If the temperature is cold and/or the vacuum is pulled too quickly, the moisture of free water could freeze making it difficult to detect or correct. If it is necessary to evacuate when the equipment ambient temperature is below 40°F, the equipment must be warmed (temporary structure, heaters, etc.) to achieve a satisfactory dryness.

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Before initial operation, install the elements for the refrigerant filter/drier. Consult the project installation manual for any further specific requirements.

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FROM: **Contract Administrator**

SUBJECT: **PRESTART-UP AND START-UP INFORMATION**
 JOB NAME:
 DESTINATION SITE
 CUSTOMER PURCHASE ORDER #
 YORK PROCESS SYSTEMS S.O. #

This information package includes very important prestart-up requirements, and start-up checklist items for your custom built refrigeration or gas compression package. Please pass this on to the appropriate personnel responsible for installation and start-up.

We define prestart-up labor/supervision as that work required to prepare the unit for actual start-up. Start-up labor/supervision is the final alignment, checking, charging and actual start-up of the equipment all as defined in the attached documentation.

This package includes:

- 11) General - Parts and Service Contacts
- 12) General Field Erection Instructions [96114_F]
- 13) Rigging information [Rigging,BA_18003,BA_18004]
- 14) Setting a Process Package Base [Setting a base]
- 15) System Commissioning and Maintenance Introduction.doc
- 16) Field pressure and vacuum testing [FPVacuum]
- 17) Proper installation of electronic equipment [S90400sb]
- 18) Low temperature operations [Lowtemp]
- 19) Long Term Storage Procedure [1200.02]
- 20) **York Turbomaster Compressor Application Checklist [AES 1500.03]**

Note: If your system includes a remote air cooled or evaporative condenser, it is very important to provide the required installation height (and piping configuration) above the receiver.

Over the years, we have found that the most successful start-ups are those that include proper planning for the time required and for determination of who will take responsibility for each aspect of the work. An authorized York service representative must perform the start-up supervision as a minimum for warranty protection, but we strongly encourage you to contact York to assist in the prestart-up labor and also to assist in planning your installation, prestart-up and start-up work.

We very much appreciate your purchase of this equipment and look forward to working with you through its initial commissioning and operating life.

Very truly yours,
PATRICIA A. GOSSARD
Contract Administrator

CC: **York Service Manager**
 LOU JUPIN
 Project Engineer
 RUSS DALEY
 Salesman

SALES FILE A. Bases Without Target Pads

INSTALLING AND GROUTING PACKAGED SKIDS

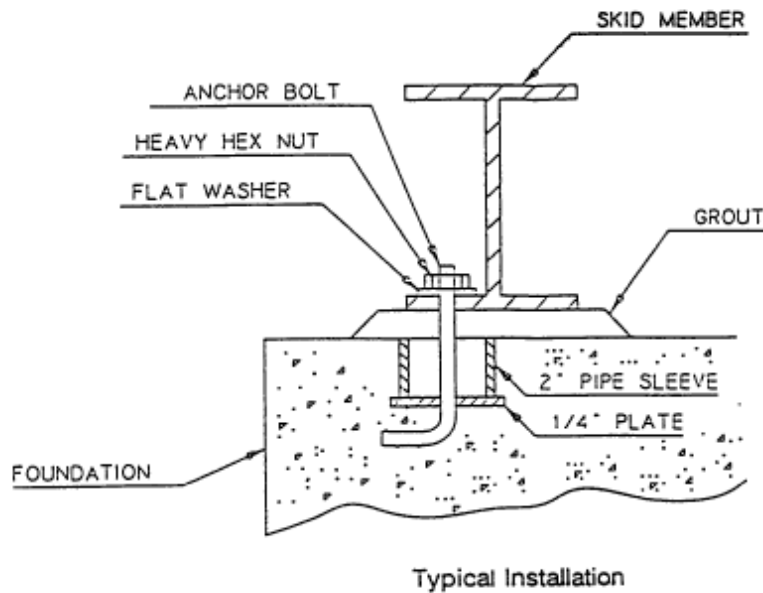
General Field Erection Instructions

The foundation pad for a process system package should be level, flat and clean. The pad thickness and design should take into consideration the nature of the sub-soils and the weight of the operating package. Base slabs laid on plastic or unstable subsoil may transmit vibration and / or settle in an unpredictable fashion. Provision for grounding, electrical conduits and other utilities that may be necessary that must penetrate the slab should be carefully laid out in advance.

The steel base should be bolted down to concrete substructure with anchor bolts at locations shown on the drawing. Sub-structure must be level, and it should be grouted to assure continuous contact with all accessible full depth members. This is essential on structural members supporting drivelines. It is recommended that the steel base to be filled with concrete to top of base in all pockets that are accessible and free of piping (allowing access for drain valves, etc.)

Anchor bolts should be positioned in ferrules fabricated from 2 IPS (50 DIN) pipe (or equivalent). The ferrule should be flush with the surface of the rough level. Soft wadding (or equivalent) should be used to center the bolt in the ferrule during placement of the package unit. This provides bolt flexibility to allow for final position and manufacturing tolerances. After final position has been obtained, the grout should flow into the ferrules and lock the anchor bolts into position.

No less than 1" (25 mm) of non-shrink epoxy base grout is recommended. The base may be leveled using conventional procedures and verified to be level side to side and corner to corner. Care should be taken to insure cross members are supported even if no measured deflection is observed.



General Field Erection Instructions**B. Bases With Target Pads****6.0 Purpose**

- 6.1 This guidance has been issued to ensure that Packages utilizing “Target Pads” for base setting are properly interpreted and applied when setting the package base. Proper utilization of the base targets will ensure the package is installed in the same plane as when fabricated. The purpose of this procedure is to eliminate problems associated with motor, gear, and/or compressor alignments and pipe strain resulting from deformation of the base during shipment, handling and setting.

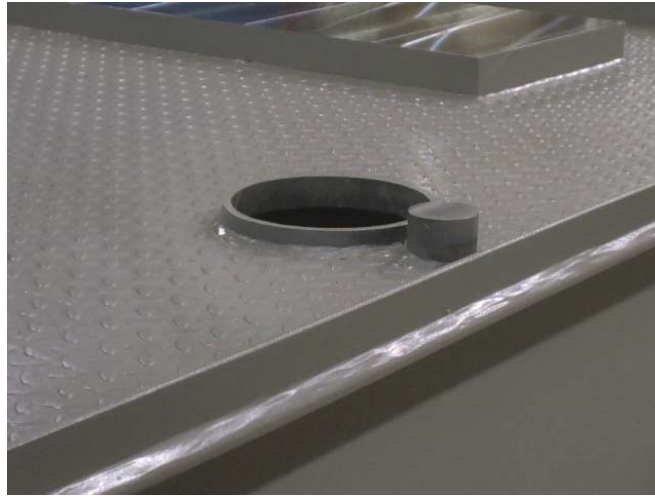
7.0 Application

- 7.1 This guidance applies only to packages utilizing target pads. Target pads are typically used on large screw compressor packages with vertical oil separators or centrifugal drivelines. Targets are sometimes used on large packages that must be bolted together in the field. Refer to the project general arrangement drawings.

8.0 General

- 8.1 The package base has been designed with sufficient stiffness to prevent permanent deformation of the structure during normal handling. Because of size and weight limitations it is not possible to design a base that will not experience some deflection during handling and setting. However, if the base is installed in the same elevational relationship as it was manufactured, the components on the base should return close to their original relationship. In order to insure the package is restored to its “as built” condition a number of target posts have been installed on the base to permit measurement of the base’s elevation in several locations. During fabrication the pre-assembled base is set and steel plates are placed under each jack bolt. The base is then leveled using a transit. Readings are then taken from the top of each target and recorded on an inspection sheet. After the package has been completely assembled the elevation of all the targets are shot a second time and the deviation above and below the original zero lines are recorded. The measured deviations are then stamped on to the tops of the targets. If the base elevations are accurately re-established, less time and effort will be required to align the drive components.

General Field Erection Instructions



Target near base fill hole.



Leveled base at factory.

9.0 TOOLS

- 9.1 A good quality accurate surveying Instrument (transit) or equivalent
- 9.2 Tripod
- 9.3 Sliding Scale – (story pole) – with minimum graduations of 0.12" (3mm).
- 9.4 Alignment indicators or laser alignment tools.
- 9.5 Wrenches for adjusting the jack bolts.
- 9.6 3" x 3" (75 x 75 mm) or equivalent ¼" to ½" (6-12 mm) thick steel plates to place under the base jack bolts.

10.0 BASE SETUP

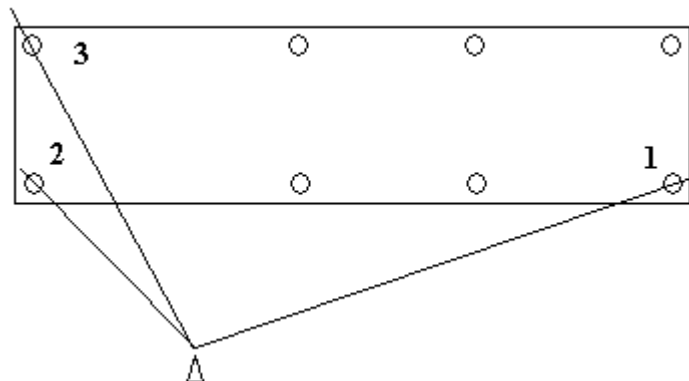
General Field Erection Instructions

10.1 The foundation should be reasonably clean, level and flat. The package frame should be located in its final position and steel plates placed under each jack bolt prior to lowering the base. Jack bolts should turn freely and may be lubricated with anti-seize compound to prevent galling. The plates should be set flush with the edge of the base so as not to protrude after grouting. The jack bolts should all extend down at least $\frac{1}{2}$ " to $\frac{3}{4}$ " inch (12 to 18 mm) below the base to allow for a minimum of 1" (25 mm) of grout under the frame after the base has been set.



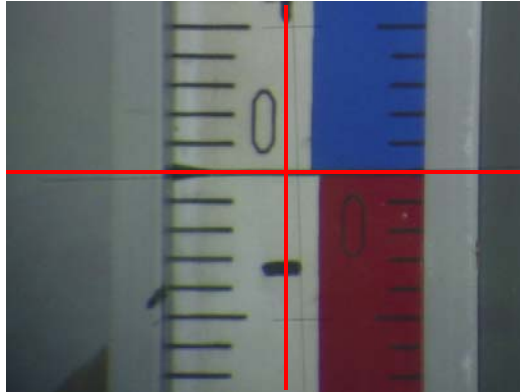
Steel plates under jackbolts to prevent gouging pad.

10.2 Set the transit at a point approximately halfway between the targets to be measured and approximately three (3 to 5) feet (1 to 2 M) back from the base. A position that can effectively shoot two to three of the frame corners is desirable if it can be achieved. One or more corner target posts will have a zero stamped in the top and may be used as a starting point.



General Field Erection Instructions

10.3 Verify your instrument has been properly leveled and elevated to allow comfortable viewing and that the focus is sharp and parallax free. Place the “story pole” on top of the starting target and adjust the sliding scale on the story pole until the crosshair is centered on zero. In the example above the target identified as “1” has a value of zero and could be used as a starting point.



Instrument zeroed out on target #1.

Readings below the zero division are prefixed with a minus sign.

Readings above zero are positive. The accuracy of the factory readings is to one half of one division or .06" (1.5 mm) minimum.

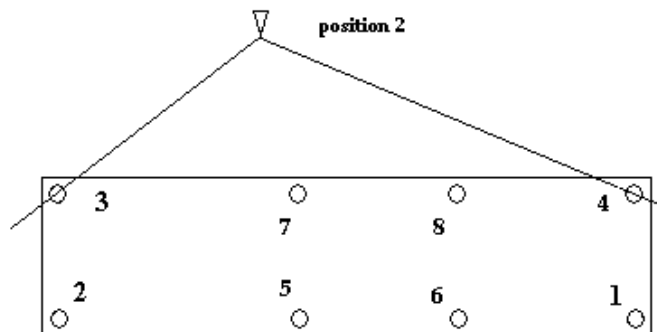


Target values are clearly stamped on the target surface.

10.4 There are jacking bolts provided along the sides of the base for the purpose of adjusting elevation. On large packages, there may be jacking bolts along the centerline of the package as well. The four corners of the packaged should be leveled first and then the remaining targets on the perimeter. After

General Field Erection Instructions

adjusting targets 3 and 4 the elevation of targets 1 and 2 should be reconfirmed from position 1 before adjusting for targets 5 through 8.



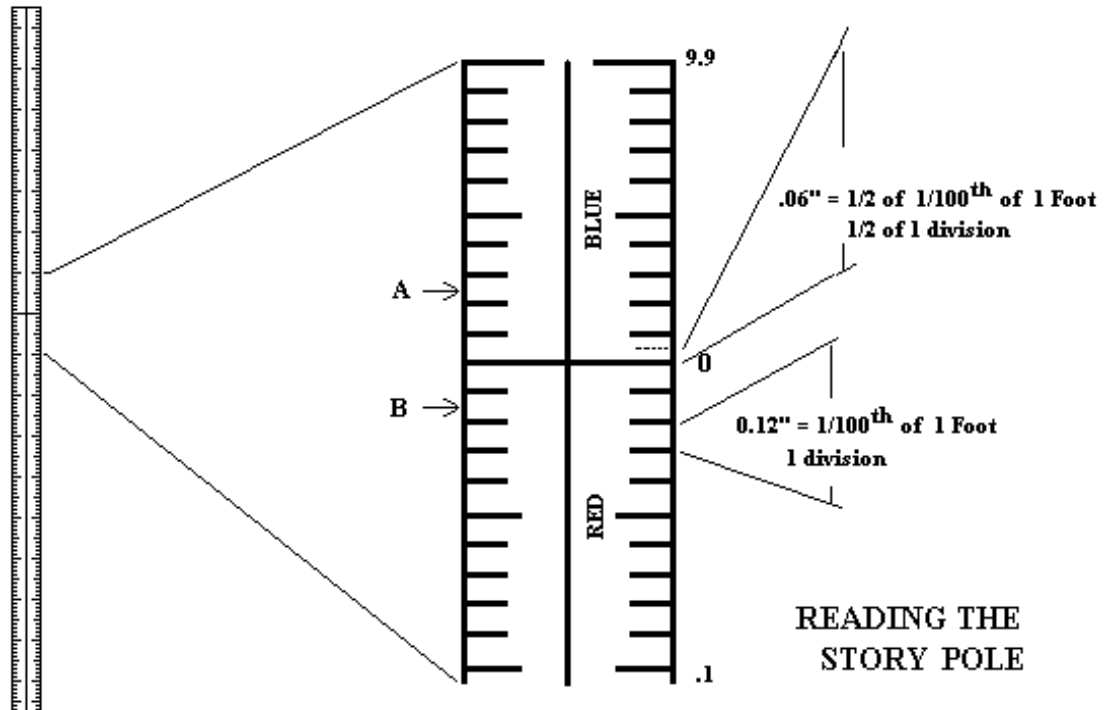
position 1

- 10.5 The jackbolts between the corners may be adjusted after the four corners have been established. After adjusting one side of the skid the opposite side should be reconfirmed. After all the perimeter jackbolts have been adjusted satisfactorily, any jackbolts near the center of the skid may be adjusted. Again, after any adjustment of a jackbolt the elevations of the other targets should be reconfirmed.
- 10.6 On centrifugal drivelines and packages with large motors or gearboxes, the coupling alignment should be rechecked prior to grouting in the skid. The alignment of the components should closely approach the factory alignment if the base has been restored to the plane defined by the deviations noted on the targets. If the alignment of the components is off more than .040" to .050" (1.0 to 1.2 mm) TIR in either angular or parallel alignment recheck the targets. Also make sure that all jackbolts are in contact with the floor.
- 10.7 If the package has been accurately leveled and the driveline components are within reasonable rough alignment the skid can be grouted in place. In order to help avoid pipe strain issues later it is suggested that the driveline be aligned prior to the installation of any interconnecting piping to the components.

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ADDENDUM A

READING THE STORY POLE



Readings below the 0 line are negative. Readings above the 0 line are positive. Reading A for example would be a positive .30 (.12+.12+.06). Reading B would be -.18 (-.12+ -.06).

Abstract

Base Fabrication Practice

Packaging has emerged as one of the prominent methods of constructing rotating equipment drive trains. This practice simplifies procurement, allows greater control of construction methods and environment, and speeds the installation process at the job site. Packaging has gained wide acceptance, especially in the process chemical and petroleum industries.

Packaging, as the term implies, is the prefabrication of equipment assemblies, usually on base weldments, fabricated from structure steel components. The base, sometimes referred to as the skid, is usually a frame that consists of steel channel or wide-flange beam members coped

General Field Erection Instructions

and fillet welded together at the various intersections. The beam size is selected using empirical or analytical methods in order to optimize base rigidity and cost. It is important to note that the base rigidity is optimized, not maximized. Some flexibility is permitted and expected. Some deflection of the base is observed, especially along the longitudinal members.

Bases fabricated for drivetrains (rotating equipment), usually include pieces of steel plate welded to the top of the frame assembly and milled or planed to a smooth finish. These mounting pads are positioned in the same location as the mounting feet of the rotating equipment. The pads are drilled and tapped for the hold-down bolts.

The finish on the mounting pads is typically 250 μ inch (6.4 microns) or better. The base weldment is usually positioned in free form, shimmed and secured for machining. The base is not forcefully straightened or deformed since doing so would result in residual stresses in the base. Such stresses would adversely affect the parallelism of the machined surfaces later when the base is unrestrained. The machining process utilizes indexing and milling or planing techniques that permit normal machined surface tolerances. Once the base is removed from the machine, the flatness and parallelism are altered because of the flexibility and deflection inherent in the frame.

Customer Expectations

Many contractors and millwrights are accustomed to installation practices using soleplates or the use of local machining techniques to mount rotating equipment. Soleplates embedded in aggregate (or epoxy) permit relatively precise cold misalignment⁵ prior to permanent setting of the soleplates. Local machining practices allow contractors to match the mounting surface to the component foot plane. Both practices make it possible to: 1) avoid the use of tapered or stepped shims and 2) use as few as two shims to achieve the final hot alignment⁶. Both practices are labor intensive during installation at the jobsite.

This type of expectation sometimes encourages users and/or contractors to write specifications requiring tight tolerances on the flatness and parallelism of the machined component mounting surfaces on fabricated steel bases. The intention is to reproduce the condition that results using soleplates or local machining, thus avoiding the need for tapered or stepped shims or machining at the jobsite. Some procurement specifications now refer to *leveling*, *flatness*, and *parallelism* limits. One requires mounting pads to be machined *flat* and *parallel* to within 0.002" per foot (0.17 mm per meter). Another requires the mounting surface and components to be *level* to within 0.002" per foot (0.17 mm per meter) of length and width of the mounting plates. This can be achieved on the machine tool. It cannot be retained because of base flexibility.

⁵ *Cold misalignment* is the phrase describing the use of intentional parallel and angular offsets in the alignment of components to compensate for expected shaft movement. These movements are caused by operating loads and thermal growth as the equipment reaches operating temperature.

⁶ Hot alignment is the condition of alignment concurrent with full load, full temperature operation.

General Field Erection Instructions**Definitions**

Level: describes to the deviation of the plane described by the mean of a surface profile relative to the plane described normal to the vector direction of gravitational acceleration in distance per length of surface (inch/foot).

Flatness: describes the deviation of any point on a surface from the plane described by the mean of the surface profile in distance (inches).

Parallelism: describes the deviation of the plane described by the mean of one surface profile relative to a parallel reference plane, usually the plane described by the mean of another surface profile, in distance per length of surface (inches).

Objectives

These are the primary goals of setting rotating equipment.

Alignment

Alignment of the rotating equipment must be achieved within the operating tolerances of the couplings, seals and bearing systems. If these tolerances are not met, the reliability of the rotating system is in jeopardy. High vibration, serious equipment damage, and hazard to personnel can result from hot misalignment.

Foot Plane

The feet of rotating equipment components are machined to the same plane within the tolerances of the manufacturer's machine tool and assembly process. The mounting surface is usually a machined surface with one or more shims made to achieve shaft alignment.⁷ When the component is placed on the mounting surface, there is a gap that results between one or more of the feet and the corresponding mounting surface. If the gap is relatively large, and is not properly adjusted for using shims, a condition called *soft foot* results. This condition imposes stresses in the component casing that can cause misalignment of bearings, seals and rotating components. The reliability of the operating component can be severely reduced if the condition is bad enough. For this reason, *foot plane* or *soft foot* is checked and limited to manageable values.

Maintenance

Maintenance becomes a consideration if a component must be moved and then realigned. For this reason, end users usually limit the number, type and material of shims used. It is also

⁷ Some mounting surfaces are made by locating the component feet using jackscrews and then pouring an epoxy compound between the foundation surface and the feet. This technique is usually used on small equipment where adjustments are unnecessary. Some mounting surfaces are made using plates that more or less match the component foot dimensions and can be jacked into location using permanent fine thread screw fixtures. This type of mounting is rare on large rotating equipment.

General Field Erection Instructions

desirable to eliminate tapered or stepped shims since they must be reinstalled in the precise orientation necessary to compensate for the existing angular gap between the foot and the mounting surface.

Constraints

Base Flexibility

As mentioned above, structural steel base beam size is selected using empirical or analytical methods in order to optimize base rigidity and cost. The base rigidity is optimized, not maximized. Some flexibility is permitted and expected. Some deflection of the base is observed, especially along the longitudinal members. This flexibility occurs in the elastic region of the stress-strain curve and is manifest when lifting and rigging of packaged units. The deflection toward the midpoint of the longitudinal span can be anywhere from a small fraction of an inch to a few inches depending on the package design and dimensions. Even if the surfaces meet requirements at the time of machining, any deflection that is imposed, after the base is machined, will affect the flatness and parallelism of the surfaces. *Figure 1* illustrates the affect of even a very small deflection on the mounting surface flatness and parallelism. For example, if a deflection δ_1 of 0.125" (3.2 mm) is permitted over a length of 10 feet (3 M), the other deflections, δ_2 and δ_3 , are on the order of .010" to .050" (0.3 to 1.3 mm). These deflections could be considered unacceptable given the stringent criteria of flatness and parallelism imposed in some specifications. In order to reproduce the "as machined" flatness and parallelism, the flatness of the base as it was set on the machine tool must be reproduced at the jobsite, within ten-thousandths of an inch! This is an insurmountable barrier in most field erection scenarios because of the available instrumentation.

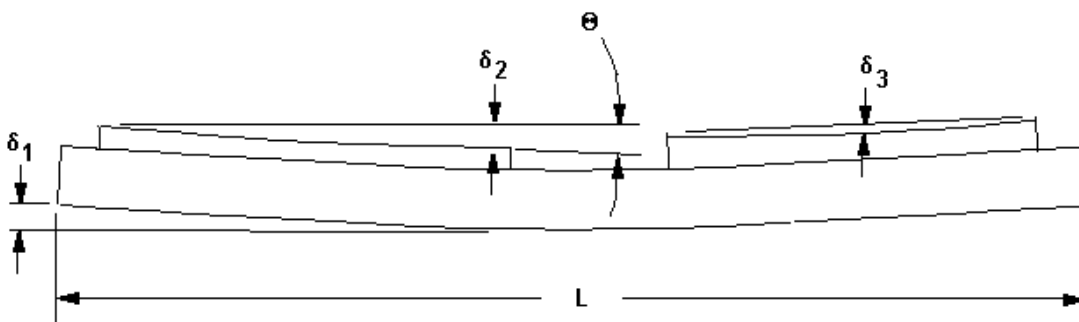


Figure 1

General Field Erection Instructions**Component Assembly and Machining Limitations**

Vertically split compressor casings provide another obstacle to very tight flatness tolerances. In many cases, the casings are machined separately prior assembly. Assembly objectives focus on bearing, shaft, rotor and bore concentricities so the foot plane becomes a secondary consideration. Combined parallel and angular offsets can result in measurement of one foot out of plane from another by .010" to .015" (0.25 to 0.38 mm), and still be within manufacturing tolerance. Manufacturers are reluctant to machine compressor casings once they have been assembled for fear of damaging the assembled machine.

Furthermore, some components, such as large motors, carry a manufacturing tolerance that permits one foot to be out of the plane of another by .005" to .010" (0.13 to 0.25 mm).

Although these issues do not affect the flatness and parallelism of the base, they do speak to the rationale of exhausting valuable resources to level the structural base mounting surfaces in such cases.

Intentional Cold Angular Misalignment

In refrigeration, it is common to impose an intentional angular cold misalignment to compensate for uneven vertical thermal growth along the length of the compressor. In the case of one five stage 55" (1400 mm) centrifugal compressor used for booster duty, an angular cold misalignment of 0.005" per foot (0.4 mm per meter) was needed to compensate for thermal growth. This results in a .005" (0.4 mm per meter) per foot taper under the feet. The typical limit imposed on *softfoot* at the foot of a component is 0.002" (0.05 mm) springback. It is often impossible to correct this *softfoot* indication without the use of tapered or stepped shims.

Again, this issue speaks to the rationale of exhausting valuable resources to level the structural base mounting surfaces.

Summary

Alignment and foot plane procedures take time to accomplish. Because it is not feasible to reproduce the "as machined" flatness of a large base within ten thousandths of an inch, it should be recognized that the time will be needed to accomplish a proper alignment at the jobsite. Up to a week may be needed in some cases. Stepped or tapered shims may be needed to compensate for any alignment or *softfoot* problems resulting from base flexibility, component foot plane variations or an intentional angular cold misalignment.

Inquiry/Order No. _____

Any system design utilizing the York Turbomaster Compressor must provide consideration of the following:

14. A check valve is necessary in the horizontal run of each compressor discharge line, as close to the compressor as possible (within 25 feet of compressor discharge flange).

General Field Erection Instructions

15. Machinery backspin, caused by equalizing pressures, must be minimized by using automatic valves as necessary to close suction and side streams on shutdown. The automatic pre-rotation vanes (PRV), provided as standard, can be used for the suction. If automatic PRV's are not used, a suction damper is required.
16. All piping and vessels connected to the compressor must be arranged and designed to eliminate liquid accumulation and subsequent entrance into the compressor. Do not trap any piping to or from the compressor. This requires proper design of vapor liquid separation in vessels and heat exchangers, and may require the addition of suction traps or accumulators.
17. Automatic throttling valves may be necessary on all streams entering the compressor (within 10 feet of compressor flange) in order to avoid driver stall during acceleration by an electric motor or a low torque drive. The automatic PRV's may be used to partially serve this function by throttling the first stage suction.
18. On variable speed drives, the compressor should not be permitted to idle for extended periods of time. If it is necessary that the compressor idle for more than several minutes, an automatic recycle valve may be required, depending on compressor idle speed, to prevent overheating. The valve should be mounted inside the compressor discharge check valve. The recycle gas will have to be cooled or quenched to prevent compressor overheating. If quench is used, refer to the above (Item 3) regarding elimination of liquid.
19. Automatic suction, side stream and/or discharge throttling valves may be required to limit flow during start-up, pull-down or upset conditions to avoid choke. These conditions usually occur in pipeline or parallel compressor systems or when low ambient temperatures suppress the condensing temperature. Sustained compressor operation with a head of less than roughly 60%⁸ of design (MU less than 0.3 at any stage) may result in choked flow and consequential damage. The standard automatic PRV's may be used for the suction.
20. Automatic controls to limit side load inlet pressures may be required when the side load flow is excessively high due to off-design condition, which may occur during startup. If the side load flows increase in proportion to the 1st section inlet flow, the side load pressures may increase resulting in surge of the 1st section. Pressure control valves sensing downstream pressure can be used to control this scenario.
21. All compressors operating in parallel, or required to start up against the head of an operating compressor, must be provided with individual automatic recycle valves and gas cooling as described above. The recycle gas should exit the discharge line between the compressor and its discharge check valve.
22. On variable speed drives, the compressor speed must not dwell within the range of +/-5% of a compressor critical speed. Automatic controls are necessary to ramp quickly through critical speeds, and thus avoid possible consequential damage.
23. Because of the part load characteristics of centrifugal compressors, recycle valve(s) will be required as necessary to satisfy the minimum flow requirements of each compressor section, or surging will occur. Large, independent or abrupt side loads usually require individual recycle valves and cooling.
24. Some applications with low vapor pressure gases may require the compressor be vented during standby to prevent the accumulation of condensed liquid in the oil sump and casing.
25. Whenever accumulation of condensed liquid occurs in the casing during shutdown, stage drain piping must facilitate removal of liquids prior to restart.
26. Centrifugal compressors attached to field erected piping should be provided with temporary conical (witch hat) strainers leading to all inlets to reduce the chance of compressor damage caused by residual field piping fabrication debris. Any debris that enters the compressor is likely to cause projectile damage to the rotor. Truncated (flat bottomed) geometric strainers are discouraged since they are more prone to premature failure. The strainer should include a minimum 150% open flow area with the point opposing the flow direction. Pressure taps are recommended so that the strainer's condition may be assessed. If the strainers foul, they may

⁸ The actual head at which the compressor will exhibit a choke characteristic may be anywhere from approximately 40% to 80% of the adiabatic or polytropic head at the design condition. Consult York Engineering for an accurate prediction regarding choke.

General Field Erection Instructions

cause reduced compressor capacity and cause compressor surge instability (risk of damage). The strainers should be removed as soon as the streams have been determined to be clean.

The equipment referenced above is not necessarily included in this quotation and depends on the scope of supply requested in the purchaser's inquiry.

GENERAL

The following instructions are intended to outline the procedure to be followed for the installation, operation, and maintenance of the YORK system.

General Installation, Operating, and Maintenance instructions are included. Where specific instruction is different from the standard service instructions, the specific instruction takes precedence. On matters not covered by the specific instructions, the standard instructions may be used. Specific instructions will be included with the Installation, Operation and Maintenance instructions later.

It is important that those responsible for the installation, operation, and maintenance of this system are provided with a copy of the IOM and they thoroughly study its contents. This will insure the successful operation of the plant.

It is recommended that the testing, charging, and adjusting of the system initially be supervised by a qualified representative of YORK INTERNATIONAL CORPORATION, and it is suggested that those who will later operate and maintain the system be present during this phase to learn first hand the procedures followed.

It is suggested that any major service maintenance operation and installation of field piping be supervised by a factory-trained service representative of YORK INTERNATIONAL CORPORATION. This is specifically recommended should it be necessary to open the compressor or system for any reason. For service or parts contact:

For <u>Service and Parts</u> contact:	Local York District Service Office - Service Manager	York International Sales & Service
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RIGGING INFORMATION

The attached pages provide typical rigging methods for packaged systems. Refer to the arrangement drawings (GA) for the method applicable to your project.

ATTACHED DRAWINGS:

BA-18003	2 SHEETS	4 LUGS
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IOM SUPPLEMENTFORM PRS-961114.01
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BA-18004	2 SHEETS	8 LUGS
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RIGGING AND HANDLING

CAUTION: *THIS SCREW COMPRESSOR PACKAGE MAY BE TOP-HEAVY. USE CAUTION IN RIGGING AND HANDLING.*

The unit can be moved with rigging, using a crane or forklift, by hooking into the four lifting eyes on the compressor and motor bases. If no motor is mounted, the lifting ring should be moved to the compressor side of the center of the unit because 60 percent of the weight is toward the compressor end. If a motor is mounted appropriate adjustment in the lifting point should be made to compensate for motor weight. Adjustment of the lifting point must also be made for any additions to the standard package such as an external oil cooler, etc., as the cent of balance will be effected.

The unit can be moved with a forklift by forking under the skid, or it can be skidded into place with pinch bars by pushing against the skid. **NEVER MOVE THE UNIT BY PUSHING OR FORKING AGAINST THE SEPARATOR SHELL OR ITS MOUNTING SUPPORTS.**

SKID REMOVAL

If the unit is rigged into place the skid can be removed by taking off the nuts and bolts that are fastening the unit mounting supports to the skid before lowering the unit onto the mounting surface.

If the unit is skidded into place remove the cross members from the skid and remove the nuts anchoring the unit to the skid. Using a 5-ton jack under the separator, raise the unit at the compressor end until it clears the two mounting bolts. Spread the skid to clear the unit mounting support, then lower the unit to the surface. Repeat procedure on opposite end.

March 16, 2004

LOW TEMPERATURE OPERATIONS

On systems that are located outdoors or are in unheated buildings where the ambient temperatures could drop below +40°F, attention should be given to the insulating and/or heat tracing of compressor lube oil systems.

It is recommended that oil separators be provided with insulation as a minimum requirement to preserve the heat generated by the oil heaters. It is important that the coalescer end of the separator be insulated to prevent refrigerant condensation.

When low ambient temperatures (below +20°F) are to be encountered, attention should be given to heat tracing and insulation of lube oil lines, oil filters, oil pumps, oil coolers.

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Freeze-up protection must also be provided for all water-cooled equipment.

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FIELD PRESSURE AND VACUUM TESTING

Vessels and piping were pressure tested before leaving the factory, but should be leak tested at the site. Open all valves except those to atmosphere.

CAUTION: Do not hydro test this equipment.

CAUTION: Be sure to use a pressure regulator between the nitrogen bottle and the system to prevent over pressure, which might lift the relief valves.

CAUTION: Do not use a halide torch, electronic leak detector or sulfur sticks in a hazardous area. Either will develop local temperatures capable of igniting flammable gases.

CAUTION: Do not use R-22 to leak check ammonia systems. R-22 may react with system oil or elastomers to cause a chemical incompatibility with ammonia. The result may cause the formation of compounds that will be detrimental to operating components. Sulfur sticks may be used to pinpoint leaks in a non-hazardous area. Do not use sulfur sticks in a N.E.C. hazardous area. Litmus paper and soap bubbles may also be used to help pinpoint ammonia leaks.

Slowly raise the system pressure to 80% of DWP using dry nitrogen or a mixture of dry nitrogen with R-22. If an electronic or halogen leak detector is to be used, charge R-22 gas until the system pressure is 30 PSIG. Raise the pressure to 80% of DWP with dry nitrogen. Search for leaks with a soap solution or suitable leak detector. Thoroughly check all welds, valves, gasket joints, screwed joints, etc.

Mark any leaks so they may be repaired when the pressure is released. Blow down through the charge and purge valves. Open the valves quickly and wide to take advantage of velocity to sweep along any particles of grit or scale.

If any leak is found, it must be repaired and the pressure test repeated. Repeat this procedure until all the leaks are repaired.

A final leak check should be done prior to final insulating and after initial operation to find any leaks caused by thermal exercising joints. Liquid columns and transmitters should be insulated before initial operation.

When the system is pressure tight, connect a vacuum pump capable of creating a vacuum of less than 2,000 microns. Do not use the compressor for evacuation. Evacuate the system to 2,000 microns (2mm Hg absolute). Shutdown the vacuum pump and valve it off from the system. If necessary, close off the compressor isolation valves. Hold the vacuum for four hours. If the vacuum rises more than 2,000 microns (2mm) in that period, it indicates a leak or presence of moisture and the pressure test should be repeated. If no leak is found, the vacuum test can be resumed and continued until dryness and tightness is established. Low ambient temperature will reduce the effectiveness of vacuum drying. If the temperature is cold and/or the vacuum is pulled too quickly, the moisture of free water could freeze making it difficult to detect or correct. If it is necessary to evacuate when the equipment ambient temperature is below 40°F, the equipment must be warmed (temporary structure, heaters, etc.) to achieve a satisfactory dryness.

General Field Erection Instructions

Before initial operation, install the elements for the refrigerant filter/drier. Consult the project installation manual for any further specific requirements.

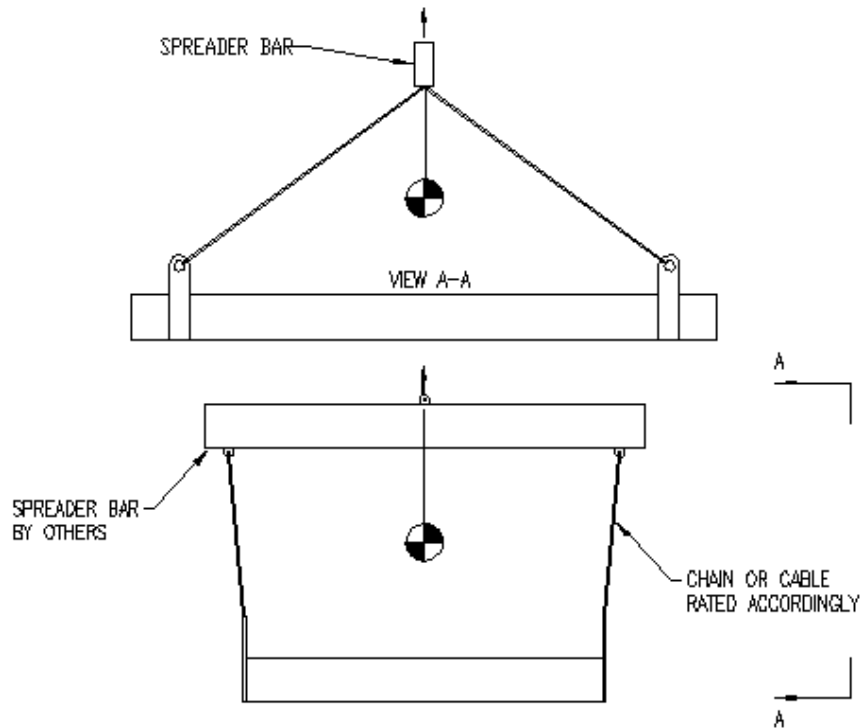


Figure 1

WARNING: Unit may be top heavy. Lifting operators must use extreme care to check the level and stability of the load before lifting the load more than a few inches. Impose an imbalance by sequentially adding weight to each corner and carefully observing the load reaction to make sure the load does not shift. Balancing chains, cables or straps are essential in both directions to prevent load shift and instability during rigging. Call YORK Process Systems Engineering for an estimate of the location of the center of gravity of the package if one is not given. **The center of gravity may not be located in the center of the package.**

NOTES:

- 1) Reference OSHA Safety And Health Standards (29 CFR 1910), sections 1910.179 and 1910.184.
- 2) Hooks, chains, cables and spreader bars shall meet manufacturer's recommendations and shall not be overloaded.
- 3) This unit shall be lifted using the four lifting lugs welded to the base as shown above. Shackles and screw pins shall be provided (by others) as shown in Figure 2 as minimum.

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- 4) Spreader bars and balancing chains must be used to prevent instability and damaging or straining system piping, instrumentation or shells.
- 5) Adjust cables or chains to insure that the package (skid) is stable and lifted level.
- 6) Lifting must be done by a qualified operator.

General Field Erection Instructions

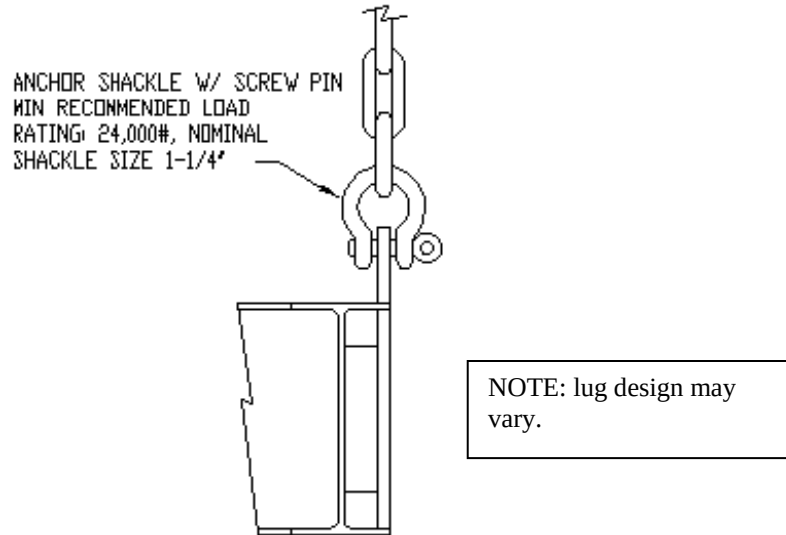


Figure 2

LIFTING LUG CAPACITY, LB/LUG		
NOMINAL BEAM MEMBER SIZE	CABLE ANGLE	
	VERTICAL	45°
W8 X 28	15,200	14,990
W8 X 67	15,200	14,990
W10 X 49	19,400	14,990
W12 X 26	21,200	14,990
W12 X 40	21,200	14,990
W16 X 36	21,200	14,990
W18 X 46	21,200	14,990

General Field Erection Instructions

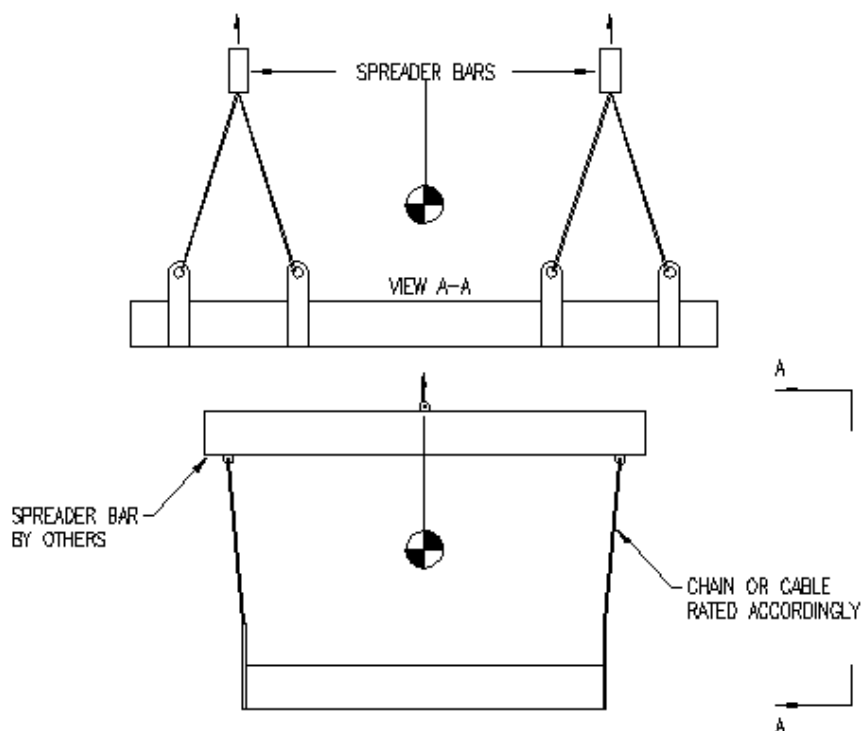


Figure 1

WARNING: **Unit may be top heavy.** Lifting operators must use extreme care to check the level and stability of the load before lifting the load more than a few inches. Impose an imbalance by sequentially adding weight to each corner and carefully observing the load reaction to make sure the load does not shift. Balancing chains, cables or straps are essential in both directions to prevent load shift and instability during rigging. Call YORK Process Systems Engineering for an estimate of the location of the center of gravity of the package if one is not given. **The center of gravity may not be located in the center of the package.**

NOTES:

- 7) Reference OSHA Safety And Health Standards (29 CFR 1910), sections 1910.179 and 1910.184.
- 8) Hooks, chains, cables and spreader bars shall meet manufacturer's recommendations and shall not be overloaded.
- 9) This unit shall be lifted using the eight lifting lugs welded to the base as shown above. Shackles and screw pins shall be provided (by others) as shown in Figure 2 as minimum.
- 10) Spreader bars and balancing chains must be used to prevent instability and damaging or straining system piping, instrumentation or shells.
- 11) Adjust cables or chains to insure that the package (skid) is stable and lifted level.
- 12) Lifting must be done by a qualified operator.

General Field Erection Instructions

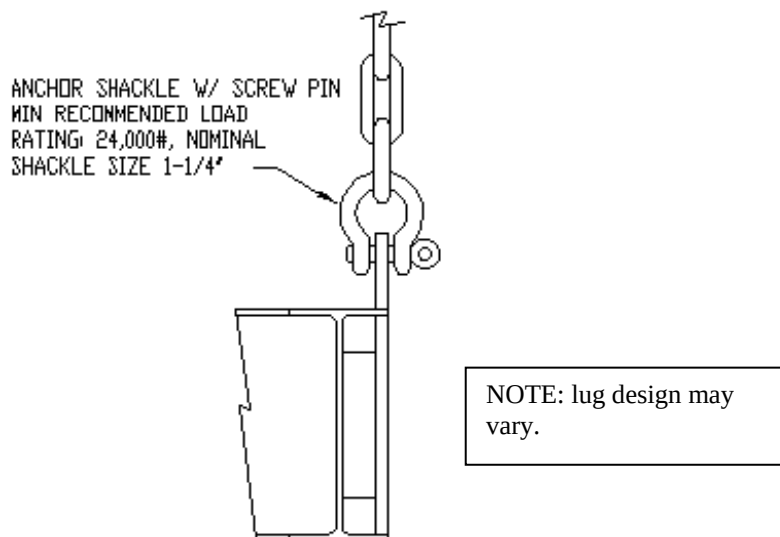


Figure 2

LIFTING LUG CAPACITY, LB/LUG		
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	VERTICAL	45°
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W8 X 67	15,200	14,990
W10 X 49	19,400	14,990
W12 X 26	21,200	14,990
W12 X 40	21,200	14,990
W16 X 36	21,200	14,990
W18 X 46	21,200	14,990

SYSTEM COMMISSIONING, OPERATING AND MAINTENANCE INTRODUCTION

For the purposes of these instructions the packaged equipment and associated Customer/End User piping system is assumed to have been installed and leak tested by the installation contractor(s).

The P&ID Drawing in Section 16 of the Installation, Operation, and Maintenance manual illustrates the division of scope and responsibility for this project.

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General Field Erection Instructions

NOTES:

- 1) The long term storage procedures in Section 1 of the Installation, Operation and Maintenance manual must be followed if applicable.
- 2) It is recommended that following an extended storage period, the plant is inspected by a York Service Representative prior to commissioning and any remedial repair work carried out. Major subvented equipment may have to be inspected by the manufacturer's representative.

The successful installation/commissioning of a refrigeration system is dependant on a number of items that require specialized attention starting with the initial setting of the equipment through the time that the start button is depressed.

PRE-START UP SUPERVISION/LABOR

Items under this category include (but not limited to):

- Leveling of the unit before grouting.
- Checking the "cold" coupling alignment(s) after grouting (the final alignment to be verified by a Factory representative).
- Verify that any ship loose items have been properly installed.
- Assure that cleanliness requirements are maintained for field installed piping.
- Verify that piping does not strain the compressor /shells.
- Pressure test leak check/vacuum dehydration of system before insulation is applied.
- Check the entire package for proper valve position to operate system.
- Verify that a proper power supply to the control panel, connected at the proper termination points, has been provided.
- Verify that proper motor protection and proper phase rotation (with coupling spacers removed) has been provided.
- Verify that the correct quantity of refrigeration and oil for charging the system (charging to be supervised by Factory representative) is available.
- If Frick/York does not supply the total refrigeration system and it includes a York "M" TurboMaster compressor refer to York TurboMaster Application Check-List (AES1500.3 attached).
- Verify that sufficient process load is available for the operation of the unit at the design conditions for initial start-up.

If not supervised by a YORK representative, documentation is required that verifies the above pre-startup tasks have been completed.

More details on these Pre-Start Up Checklist items will be found throughout this IOM or notes on the specific job drawings. The York International Service office can provide support at a per diem rate for this facet of the project, if desired.

START UP SUPERVISION/LABOR

Start up supervision must be purchased for warranty protection of the equipment. Rates can be quoted through the York International Service office in your area.

Items under this category include (but not limited to):

- Confirm successful completion of all pre-start up activities.
- Verify final alignment(s).
- Perform safety control checks on alarms and cutouts.
- Functionally test control logic, program variable setpoints.
- Supervise charging of refrigerant and oil.

General Field Erection Instructions

- Confirm with plant personnel that valves are set and test run is initiated.
- Complete a start-up log sheet on initial start up.
- Confirm and record hot alignment of all drives.
- Instruct customer personnel on the operation of the system.

LIMITATION REGARDING CONTROLS ADJUSTMENT

A great deal of care has been taken to design and manufacture this custom engineered packaged system. Nevertheless, it is not possible to operate these types of systems at the factory and therefore, design validation will occur for the first time at the installation site. The controls provided on this equipment include the necessary tuning parameters that allow matching the dynamic response of the machinery to the stimulus of the connected process load profile and external controls so that control cycling or "hunting" can be minimized. The dynamic operating characteristics of the system will change based on changes in operating load profile after startup, changes in seasonal ambient temperature, response of external process control elements, varying chemistry of process or refrigerant, equipment wear and replacement. The tuning of the controls that produces the best overall operation will likely not happen during startup since the operating profile at startup is likely not the normal profile or set of profiles.

YORK cannot guarantee that the package controls will be correctly tuned for the actual site operating conditions as received from the factory or even following a YORK supervised startup. The system will likely require fine tuning in response to variable system dynamics as described above. Further, it is highly recommended that the user/operator thoroughly read and understand the YORK instruction manuals and become familiar with the operation of the package machinery and controls. Periodic adjustments will be needed to maintain operation at peak efficiency and reliability. This adjustment is not included within YORK's scope.

Start-up supervision must be purchased separately. Most start-up situations do not reflect the final plant operating conditions and readjustment may be required by plant operators long after the York/Frick Start-Up Supervisor has left the job. It is imperative that the York/Frick Field Start-Up Supervisor gives thorough and proper instructions to the personnel who will be responsible for operating and maintaining the system.

This instruction is intended to provide general installation guidelines and is not intended to substitute for specific requirements as described in the contract Installation, Operation and Maintenance manual. Any questions or discrepancies should be referred to YORK INTERNATIONAL for resolution.

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PROCESS SYSTEMS **RECEIPT OF EQUIPMENT**

The prefabricated system consists of major equipment as shown on the General Arrangement drawing(s) provided in this manual. Each equipment item is fabricated and shipped on a structural steel skid. A flat and level concrete foundation capable of supporting the operating weight of the equipment must be provided to serve as a platform on which to mount each unit. Sufficient space to permit service of the tubes in the heat exchangers must be allowed.

NOTE: Upon receiving the equipment, inspect the unit for possible damage incurred during shipment. If damage is evident, it should be noted on the carrier's freight bill. A separate request for inspection by the carrier's agent should be made in writing and referred to YORK International Corporation.

Inventory all material upon receipt. Check each major item and all ship loose items with the PACKING LIST provided. Shortage claims must be reported to YORK International Corporation upon receipt of equipment.

Verify building dimensions pertaining to equipment location. Inspect all equipment before erecting. Use only certified or approved prints. Remove testing and shipping materials carefully.

CAUTION: THE PACKAGED UNIT IS SHIPPED WITH UP TO 15 PSIG HOLDING CHARGE OF NITROGEN. BLEED OF PRESSURE BEFORE OPENING CONNECTIONS TO PREVENT INJURY.

The unit is cleaned and tested at the factory and shipped with a holding charge of nitrogen. Care should be used to avoid unnecessary damage and loss of inert charge due to rough handling.

NOTE: In the case of vertical separator screw compressor or centrifugal compressor drivelines, the base must be leveled, using the machined targets, during installation or prior to placing the package into storage for more than six months. Refer to YORK's *INSTRUCTIONS TO ERECTING ENGINEER* drawing, 560D0124, or the equivalent for the project.

SHORT TERM STORAGE

If the equipment is to be placed in storage for a time exceeding 6 months, the factory recommends following the "Long Term Storage Guidelines" (AES1200.02) as outlined within Section 1 of this IOM. If the equipment is to be placed in storage for any time less than 6 months, the following guidelines are recommended.

The equipment should be maintained under a regulated dry nitrogen purge pressure of 10-15 psig. The equipment should be checked bi-weekly to confirm that the nitrogen pressure is held.

All electrical panels (if applicable) should be maintained under a regulated dry nitrogen purge, heated, and/or kept dry using an appropriate desiccant. Control panels should be powered-up periodically to verify the panel has not been damaged and that there is no evidence of moisture and/or corrosion.

All ship loose items must be stored in a dry area, which is conditioned as necessary to prevent damage due to overheating or freezing.

All third party equipment manufacturer's instructions for extended storage must be followed. Motors must be kept dry at all times. Motor space heaters should be energized to drive the moisture from the windings. The factory recommends meggering the motors that have been in storage prior to startup. Components may require re-lubrication. Manufacturer's instructions are located within designated Sections of this IOM.

All exposed unpainted metal surfaces, such as shafts, wheels, bare motor pads and valve stems should be greased or coated with rust preventative and re-coated periodically as required.

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Insure that valve seal caps are tight.

RIGGING

Lifting lugs have been provided for transferring the unit from the truck to its concrete foundation. Lift using lifting lugs only. Spreader bars and balancing chains must be used to prevent damaging or straining system piping, instrumentation or shells. The unit must be lifted using proper lifting apparatus. Refer to the lifting instructions provided separately. If there is any question regarding rigging, contact YORK INTERNATIONAL for instructions.

Refer to the Instructions to Erecting Engineer sent with the project specific drawings and documentation regarding mounting the skid on its foundation. It is highly recommended that the fabricated skid (when provided) be filled with concrete, finished flush with the top of the base, in all pockets that do not contain piping or other appurtenances. This will help dampen any vibration resulting from structural resonance, which is impossible to predict. If the compressor driver is a gas or diesel engine, the foundation pad must be more extensive in mass and arranged relative to the engine to absorb the unbalanced forces and moments. All driveline foundations must be designed by a qualified Civil Engineer to make sure that it will support the weight and structure of the packaged equipment and dampen vibration.

Refer to the Notes to Erecting Engineer drawing provided with the project drawings for additional specific instructions regarding equipment installation. Proceed with the installation of the field piping. Allow ample flexibility in the piping to avoid excessive strain on the equipment connections.

ALIGNMENT

Although the motor and compressor were properly aligned at the factory, there may have been some unavoidable distortion of the base during shipment and handling. YORK recommends that alignment of the rotating equipment be checked in accordance with the requirements of IOM. A preliminary alignment (+/.005") must be made after the base is leveled and prior to installation of major compressor piping. If doweling is elected, do not dowel the equipment until the final hot alignment check has been performed following compressor operation.

NOTE: Compressor hold-down bolts must be tightened to the following torque values:

HOLD-DOWN BOLT TORQUES			
Nom Bolt Size (IN)	Min Torque, FT-LB	Max Torque, FT-LB	Comments
1/2	26	38	
5/8	51	77	
3/4	92	138	
7/8	148	223	
1	223	335	RWBII 100-270, M Compressors
1 1/8	316	474	
1 1/4	451	676	RWBII 316-856
1 1/2	786	1179	

NOTE: Alignment and foot plane procedures take time to accomplish. Large driveline bases are inherently flexible. Because it is not feasible to reproduce the "as machined" flatness of a large base within ten thousandths of an inch at the site, it should be recognized that the time will be needed to accomplish a proper alignment at the jobsite. Up to a week may be needed in some cases. Stepped or tapered shims may be needed to compensate for any alignment or softfoot problems resulting from base flexibility, component foot plane variations or an intentional cold angular misalignment to compensate for non-uniform thermal growth.

NOTE: The initial misalignment valves provided in the IOM are subject to review by the qualified YORK Start-up Technician. These values are estimated based on a number of assumptions, any one of which could render the values inaccurate. The most important assumption is that all components are cold and at the same equipment ambient temperature. If the gear oil sump heaters are energized, then the vertical offsets must be adjusted accordingly.

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NOTE: The equipment required to measure shaft alignment is not provided as part of this equipment order. This equipment is considered to be specific and common to millwright trade, and to those persons qualified to perform alignment of rotating equipment. Some special fixtures may be required in order to mount instruments to perform the final hot alignment check. It may be necessary to manufacture such fixtures at the jobsite during the alignment phase.

PIPING

Interconnecting piping must be designed and fabricated using good piping practice suitable for compressor applications. Piping must be arranged to prevent trapping liquids. Discharge piping must be sized and/or sloped as necessary to prevent accumulations of oil.

CAUTION: Traps must be avoided in compressor suction piping. Liquid that accumulates in trapped suction piping will most likely damage the compressor. A trap is considered any piping that makes a drop or reduction in elevation travels horizontally for any distance then rises vertically at another point prior to the compressor inlet.

CAUTION: Centrifugal compressors (YORK M, T, K, etc) attached to field erected piping should be provided with temporary conical (witch hat) strainers leading to all inlets to reduce the chance of compressor damage caused by residual field piping fabrication debris. Any debris that enters the compressor is likely to cause projectile damage to the rotor. Truncated (flat-bottomed) geometric strainers are discouraged since they are more prone to premature failure. The strainer should include a minimum 150% open flow area with the point opposing the flow direction. Pressure taps are recommended so that the strainer's condition may be assessed. If the strainers foul, they may cause reduced compressor capacity and cause compressor surge instability (risk of damage). The strainers should be removed as soon as the streams have been determined to be clean.

All carbon steel pipe and fittings are to be cleaned prior to assembly. All internal surfaces shall be free of rust, mill scale and foreign materials. The preferred method of cleaning pipe and fittings is blasting with an abrasive media. Chemical cleaning of refrigerant piping (i.e. acid pickling, etc.) is not required and not recommended. Residues from chemical cleaning, if not completely removed, can do as much damage as the original contamination. Similarly, water-based cleaning products should be avoided because of the negative effects of moisture in refrigeration systems.

Carbon steel pipe fittings are normally supplied with a light coating for corrosion protection. This coating is removed from the weld area by grit blasting, wire brushing or grinding. Care must be taken to prevent dirt and debris from entering the piping during welding. The insides of all welds that are accessible must be cleaned. For welded pipe joints which can not be cleaned from the inside, a "clean" welding process (E.G. TIG root pass or internal weld cleaning) must be employed.

All loose foreign matter such as chips, slag, dirt, pipe dope, grease, gasket flakes etc. must be removed from the pipe before it is installed. The pipe shall be cleaned as described below immediately prior to installation.

After drive train alignment is checked and all the field piping is complete, the following check for piping strain should be made:

1. Install two dial indicators at the compressor coupling (compressor coupling must be disconnected from the driver) to indicate both horizontal and vertical movement of the compressor shaft. Set the dial indicators at zero.
2. Loosen the flange bolts in the piping to the compressor starting with the largest pipe and proceeding to the smallest pipe. With all the piping loose the compressor shaft should not have moved more than .002" (0.05mm) in either direction.
3. If the flange faces are parallel, the bolts are free in their holes and the shaft movement is within the

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preceding limits, piping strain is not apparent. The bolts can be re-tightened. If the faces are not parallel, the bolts are bound in the holes or the compressor shaft has moved more than .002" (0.05mm), then piping strain is apparent and must be eliminated.

4. After making adjustment for piping strain, tighten all of the compressor flange bolts from the smallest to the largest flange size. Recheck for piping strain as described above. Make adjustments until dial indicator movement does not exceed .002" (0.05mm).

All equipment should be leak tested at no more than 80% of the applicable relief valve setting.

CAUTION: Do not hydrostatically test nor chemically clean any piping or compressor supplied by YORK. Code pressure testing of YORK piping and compressors occurred at the factory and should not be repeated in the field. If it is necessary, it should be supervised by an authorized YORK representative.

Connect the required instrument pneumatic air piping to the unit at the designated connections.

WIRING

Field wiring consists of installing the necessary wiring to the control panel and all necessary power wiring between the disconnect switch, the motor starter(s) and the motor(s). Control wiring from the panel to the holding coil(s) of the motor starter(s) is also required. It is recommended that the panel and the base of the packaged system be grounded to reduce the possibility of electrical shock in case of a short circuit. All wiring should be done in accordance with the National Electric Code (NEC), or other jurisdictional Code for the area, and other applicable local codes and/or specifications. Always keep control wiring separate from power wiring. Refer to YORK bulletin S70-200 IOM, S70-400 IOM, S70-600 IOM, or S90-400 SB for instructions for proper installation of electronic equipment.

WARNING: After completion of field electrical continuity check, conduit seals used in hazardous areas must be sealed with fiber and compound (such as Frick part number 111Q0280327) in accordance with the fitting manufacturer's instructions provided with the seal packing material. This material is provided by others.

NOTE: If not specifically designed for high ambient temperature and sun load (E.G. vortex cooling), the control panel may require shading from direct sun load by others.

MISCELLANEOUS PROVISIONS

If filter-driers are furnished, the filter drier cores will have been shipped separately and must be installed prior to the vacuum hold test. The compressor and auxiliary equipment lube oil filters must be checked to insure that new and clean elements have been installed.

When furnished, float valves in float chambers or intercooler vessels may be wired closed for shipment. The float valves must be inspected and the wires removed before system pressure and leak checks are completed.

Frost shields used on level gages and sight ports are not necessarily sealed. All frost shields that are removable should be sealed to the mating glass using a 2-part clear epoxy or other clear sealer compatible with the environment and operating temperature. This will prevent the inclusion of frost or contamination between shield and glass during operation.

To facilitate operating and troubleshooting tests on the system, the cooling water and/or process connections to and from heat exchangers should be provided with thermometers and gauges. A small valve or valves should be installed at the highest point or points in the piping to allow venting or purging as necessary. Vent and drain connections should be extended beyond insulation to make them accessible. It is recommended that all liquid piping be thoroughly flushed to free it from foreign material before the system is placed into operation. Use care not to contaminate piping components with foreign material that may damage the system or its performance. The process piping to the refrigeration evaporator should be provided with the means of throttling the flow through the evaporator during start-up and stopping the flow during shutdown. Continued process flow through the evaporator during shutdown

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may result in excess liquid in the evaporator caused by migrating refrigerant.

Check all safety controls to make certain they perform their intended functions. Heat conductive compound (Frick PN 111Q0831 807) to be installed in thermowells prior to operation. In the case of pressure switches, connect each individually to a source of air pressure observing a gauge close to the pressure switch and bring the pressure gradually to the control point. Observe the action of the controls to determine that they perform their intended functions.

Lubricate the motor and check that the compressor separator or sump is filled with the appropriate amount of oil. The oil level should be visible in the sight glass.

NOTE: In order to preserve the factory warranty, use only the compressor oil type specified for this project. Contact YORK Refrigeration for the recommended oil type.

All compressors have operating limits. The compressor unit may not include controls to prevent the discharge pressure from dropping below the minimum required for reliable operation. The calculated minimum allowable condensing temperature is based on the higher of 1) the minimum discharge pressure below which the separator is undersized for oil carry-over, 2) the minimum system pressure differential(s) required to permit the design liquid flowrates from stage to stage (expansion valve sizing), 3) the minimum discharge pressure below which the centrifugal compressor will operate in stonewall, 4) the minimum discharge pressure below which the compressor lube system differential pressure is insufficient. Determination of the minimum discharge pressure and the need for the attendant controller are the responsibilities of the system designer, whom may not be the compressor unit supplier. To obtain the recommended minimum discharge pressure for the compressor unit, refer to the compressor drawings or contact YORK Refrigeration.

The system may or may not include a recycle (hot-gas) valve. A recycle valve is highly recommended in order to permit false loading of the compressor during start-up. Otherwise, it may not be possible to provide continued operation for calibration and troubleshooting. The provision for a hot gas valve is the responsibility of the system designer, which may not be the compressor unit supplier.

HEAT TRACING AND INSULATION

Apply heat tracing (if applicable) as recommended by P&ID prior to thermal insulation. This generally applies to compressors that can operate and start-up in low ambient temperature locations. Heat tracing and insulation combination should generally provide 100 to 140°F pipe temperature.

Thermal insulation should be applied to the cold portions of the system as indicated by the P&ID's. Any compatible cold insulation material, such as Dow, Pittsburgh or Owens-Corning expanded polystyrene, polyethylene, polyisocyanurate foam or cellular glass, is appropriate. The moisture barrier must be completely sealed since no insulation is effective if saturated with water and/or ice. The thicknesses recommended on the P&ID are based on a conductivity of 0.22 (BTU-IN/SQFT-HR- °F), 90°F ambient, no wind and 85% relative humidity.

NOTE: It is recommended that the final insulation be applied following initial operation at close to design temperatures. That is, insulate the piping and shells prior to operation, and leave flanged, threaded, and field welded joints accessible for leak checking following operation. Final insulation may be completed anytime thereafter.

Where cold piping and vessels are supported by steel structures, insulate as much of the steel structure as practical under the circumstances. This will prevent the structure from sweating (E.G. the supports beneath the evaporator). The colder the vessel, the farther from the vessel the insulation should extend. Leave removable insulation plugs at the locations of data plates, vents, drains, valve seal caps, strainer caps etc., so that access is available later. Seal around plugs with a removable bead sealant.

HOT ALIGNMENT CHECK

After at least 24 hours of successful operation of the unit, the alignment must be verified. There are two ways to accomplish this. First, if shaft proximity vibration is monitored, then vibration readings within the

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normal operating values published in this manual are considered a verification of shaft alignment. If shaft proximity vibration is not monitored, then a hot alignment check must be made. After the successful alignment verification, the unit may be doweled at the user's discretion per the IOM. The horizontal jacking bolts may be used to help lock position the driveline components following the hot alignment check (refer to IOM). Tighten the jacking bolts in contact with the casings so that they hold the casings the same way the dowel pins would. Do not pin the casing on the end at which thermal growth is expected. This end is the end opposite the dowel holes. For best seal life, parallel and angular (face) T.I.R. should not exceed .004" (0.1 mm). Refer to the compressor instruction manuals.

The feet of the components may be doweled or blocked in position using the horizontal jackscrews to help maintain the alignment. If doweling is elected, #10 Morse taper pin dowels x 4" long (not supplied) may be used. In this case, YORK recommends the following:

To properly dowel the equipment proceed as follows:

1. Drill a 9/16" (14mm) diameter hole in the gear feet directly below the output shaft. Refer to gear drawing in the IOM. Drill the feet of the compressor (shaft end) and motor (shaft end).
2. Using a No. 2 Morse Taper Reamer (rough and finishing), carefully ream the 9/16" (14mm) diameter holes until the dowel pins drive tight with approximately 3/4" (19mm) of the taper protruding.
3. After system equilibrium is reached and the final hot alignment is verified. The dowel pins should then be removed and the holes finish reamed for full depth seating. If the compressor has to be moved during cold or final alignment, re-check for piping strain.

Long term storage (6 months to 5 years) provisions are required, regardless of storage environment, if start-up and/or useful operation does not occur within six (6) months of equipment shipment. Special provisions may be required for storage of less than six (6) months if the storage area is subject to unusual environment such as high humidity, large changes in temperature, dusty atmosphere, etc.

The standard Frick Warranty covers twelve (12) months from start-up or eighteen months from shipment, whichever comes first. It is recommended that arrangements be made with the local YORK service organization (arranged through factory service) regarding surveillance and maintenance during the storage period. It will be the customer's responsibility to submit a monthly report showing the condition of the unit and noting any discrepancies to the guidelines listed herein. The attached log sheet format may be used for this purpose. The log should be sent to the Regional York Service Office that will provide the eventual start-up supervision. Failure to comply with this Long Term Storage Recommendation may affect the warranty.

Long term storage of equipment may lead to the deterioration of several components on the package over the period of time. Synthetic components such as those found in the compressor and oil pump seals may deteriorate over time even if they are kept flooded with oil. A warm and dry environment is essential to minimize corrosion damage. Otherwise, close attention to maintenance of equipment condition will be necessary.

Long term storage provisions include, but are not necessarily limited to, the following:

1. The oil separator and/or compressor sump must be charged to the minimum level with the appropriate oil type. The oil pump must be operated once a month to insure the shaft seal is lubricated with oil. The compressor shaft should be rotated by hand at the same time to wet the seal surfaces. The oil heaters should be energized to keep the oil warm and free of moisture. The panel may be kept energized for this purpose. If the equipment will be stored in a cold locale, thermal insulation or a heated enclosure should be used to prevent excessive heat loss from the heated oil reservoir or separator.

CAUTION: On multi-stage centrifugal compressors, do not energize the upper (seal) oil reservoir immersion heater since this reservoir will drain down to the lower sump over time exposing the heater elements.

2. To prevent loss of lubricating film and chemical resistance, drive shafts should be rotated monthly. This will also prevent false brinelling of anti-friction bearings. Indexing the shaft and leaving it in a different

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position after each rotation will also help avoid brinelling.

3. The compressor package and all vessels should be purged and placed under a regulated dry nitrogen purge pressure of 5 to 15 psig. The refrigerant system was evacuated and charged with dry nitrogen at the factory. If the refrigerant system was opened, or the factory charge lost, the refrigerant system should be evacuated prior to purging and charging. The process and cooling water sides of heat exchangers and associated piping should be purged with dry nitrogen until exhaust from all vent and drain valves will neither support burning of a halide torch nor indicate moisture on a cool mirror. Gauges should be installed in the appropriate locations to confirm that the nitrogen pressure is being maintained.
4. The electrical panel should be purged with dry nitrogen, heated, and/or kept dry using an appropriate desiccant. If heated, a standard incandescent light bulb may be used for the purpose (a 25 watt light bulb will suffice in many cases), but care must be used to prevent damage due to excessive heat. If a desiccant is used, it must be changed monthly as a minimum. The panel should be inspected monthly to detect evidence of corrosion.
5. Dry storage of all components is preferred, including those components or packages that are export boxed. Ship loose items should be stored in a heated, well ventilated area. In particular, sensitive electronic components, such as microprocessor based controllers, must be kept warm and dry.

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6. Any rotating equipment manufacturer's instructions for long term storage must be followed. Motors should be kept dry at all times. Motor space heaters should be energized to drive the moisture from windings. Motor enclosures should be checked periodically for accumulation of water and appropriate action taken to prevent further accumulation. Turbine steam connections may require periodic replacement of desiccant packages. In particularly harsh environments or for storage periods exceeding 18 months, consideration should be given to filling bare compressor or gearbox casings with oil. Silicone sealer may be used to seal gearbox labyrinth shaft seals and breathers prior to filling with oil. All exposed bare metal surfaces, such as shafts, wheels, bare motor pads, and valve stems should be protected and re-coated periodically with rust preventative compounds such as Castrol TARP or equal.
7. The package should be visually inspected periodically to verify all components are intact and undamaged.
8. In the case of vertical separator screw compressor or centrifugal compressor drivelines, the base must be leveled, using the machined targets, during installation or prior to storage for more than six months. Refer to the *INSTRUCTIONS TO ERECTING ENGINEER* drawing.

Repeat the following once per week:

- a. Record the nitrogen pressures. Add nitrogen if necessary to maintain 5 to 15 psig. Maintain sump oil levels. Check/replace electrical fuses for heaters. Check/replace control panel desiccant.

NOTE The continuing loss of nitrogen pressure is indicative of a leak which should be located and repaired. The unit should then be recharged with 5 to 15 psig of nitrogen pressure for the duration of the storage period.
- b. Make sure any temporary coverings such as shrink wraps, tarps, or tents are not trapping water in contact with the equipment.
- c. Check enclosures for accumulated water and drain as applicable.

Repeat the following every month:

Run the auxiliary oil pump for no longer than 3 minutes. Rotate the compressor shaft by hand. Inspect panels.

NOTE: On screw compressor units, run the oil pump only long enough to establish positive oil pressure. Oil may hang up in the compressor indicating a loss of oil in the separator. On vertical separator screw compressor units, close the main oil injection throttling valve prior to operating the oil pump. Open the valve again after pump operation. Drain the discharge piping of any accumulated oil.

Repeat the following every six (6) months:

- a. Remove all plastic wrap. Remove corrosion inhibiting coatings on machined surfaces. Inspect and treat machined surfaces. Recoat with corrosion inhibitor. Check heaters. Replace desiccants. Replace plastic wrap with a tarp to prevent condensing on the wrap material.
- b. Chemically analyze the oil charge(s). If necessary, replace oil charge(s).
- c. Blow down pneumatic piping to remove any moisture accumulations.
- d. Inspect/repair indications of rust, repaint.

When the unit is installed and ready for service, a qualified YORK representative must inspect the various components prior to start-up to insure their integrity. The major subvended item manufacturer's representative should inspect those components (motors, gears, etc.). The oil filter elements must be replaced. The lube oil pump must be operated and the control panel checked for proper functioning.

WEEKLY

LONG TERM STORAGE LOG

SIX MONTHS BEGINNING:

YORK INTERNATIONAL

(A) DRY NITROGEN PRESSURE: 5 TO 15 PSI
(B) OIL TEMPERATURE: 100 TO 150 DEG F
(C) TEMPORARY SHELTER OK (YES OR NO)
(D) EQUIPMENT (WET OR DRY)
(E) SPACE HEATERS (WARM OR COLD)

PACKAGE	SEGMENT	DATE
COMPRESSOR TAG _____		A
		B
		C
		D
		E
		A
		B
		C
		D
		E
		A
		B
		C
		D
		E
		A
		B
		C
		D
		E

MONTHLY

(F) RUN OIL PUMP (COMPLETE)
(G) ROTATE SHAFT BY HAND (COMPLETE)

EQUIPMENT	LUBE OIL		DATE
	TYPE	CHG	
COMPRESSOR TAG _____			F
			G
			F
			G
			F
			G
			F
			G
			F
			G

SEMI-ANNUALLY

(H) OIL ANALYSIS(REPLACEMENT)
(I) BLOW DOWN PNEUM PRG (COMPLETE)
(J) REPAIR/RECONT WASH SURFACES (COMPLETE)
(K) REPLACE DESICCANTS (COMPLETE)
(L) REPLACE COVERINGS (COMPLETE)

PACKAGE	DATE
COMPRESSOR TAG _____	H
	I
	J
	K
	L
	H
	I
	J
	K
	L
	H
	I
	J
	K
	L
	H
	I
	J
	K
	L

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S90-400 SB/FEB 94

File: SERVICE MANUAL - Section 90
Replaces: NOTHING (New Information)

PROPER INSTALLATION OF ELECTRONIC EQUIPMENT IN AN INDUSTRIAL ENVIRONMENT

**THIS MANUAL CONTAINS INSTALLATION INSTRUCTIONS FOR
ELECTRONIC EQUIPMENT. PLEASE READ THOROUGHLY. FAIL-
URE TO FOLLOW THESE INSTRUCTIONS COULD RESULT IN
DAMAGE OR IMPROPER OPERATION OF RELATED EQUIPMENT.**

PROPER INSTALLATION OF ELECTRONIC EQUIPMENT IN AN INDUSTRIAL ENVIRONMENT

In today's refrigeration plants, electronic controls have found their way into almost every aspect of refrigeration control. Electronic controls have brought to the industry more precise control, improved energy savings and operator conveniences. Electronic control devices have revolutionized the way refrigeration plants operate today.

The earlier relay systems were virtually immune to radio frequency interference (RFI), electromagnetic interference (EMI), and ground loop currents. Therefore installation and wiring were of little consequence and the wiring job consisted of hooking up the point-to-point wiring and sizing the wire properly. In an electronic system, improper installation will cause problems that outweigh the benefits of electronic control. Electronic equipment is susceptible to RFI, EMI, and ground loop currents which can cause equipment shutdowns, processor memory and program loss, erratic behavior, and false readings. Manufacturers of industrial electronic equipment take into consideration the effects of RFI, EMI, and ground loop currents and incorporate protection of the electronics in their designs. These manufacturers require that certain installation precautions be taken to protect the electronics from these effects. All electronic equipment must be viewed as sensitive instrumentation and therefore requires careful attention to installation procedures. These procedures are well known to instrument engineers, but are usually not followed by general electricians.

There are a few basics, that if followed, will result in a trouble-free installation. The National Electric Code (NEC) is a guideline for safe wiring practices, but it does not deal with procedures used for electronic control installation. **Use the following procedures for electronic equipment installation.** These procedures do not override any rules by the NEC, but are to be used in conjunction with the NEC code.

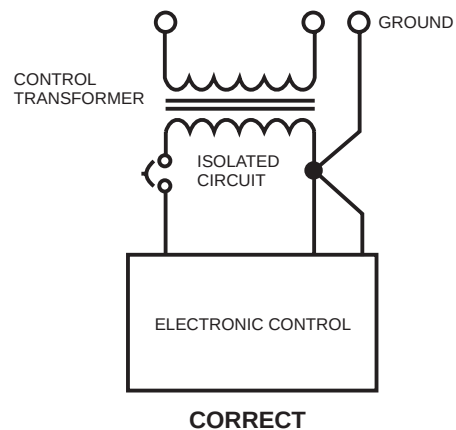
WIRE SIZING

Size supply wires one size larger than required for amperage draw to reduce instantaneous voltage dips caused by large loads such as heaters and contactors and solenoids. These sudden dips in voltage can cause the processor, whether it be a microprocessor, a computer, or a PLC to malfunction momentarily or cause a complete reset of the control system. If the wire is loaded to its maximum capacity, the voltage dips are much larger, and the potential of a malfunction is very high. If the wire is sized one size larger than required, the voltage dips are smaller than in a fully loaded supply wire, and the potential for malfunction is much lower. The NEC code book calls for specific wire sizes to be used based on current draw. An example of this would be to use #14 gauge wire for circuits up to 15 amp or #12 gauge wire for circuits up to 20 amp. Therefore, when connecting the power feed circuit to an electronic industrial control, use #12 gauge wire for a maximum current draw of 15 amp and #10 wire for a maximum current draw of 20 amp. Use this rule of thumb to minimize voltage dips at the electronic control.

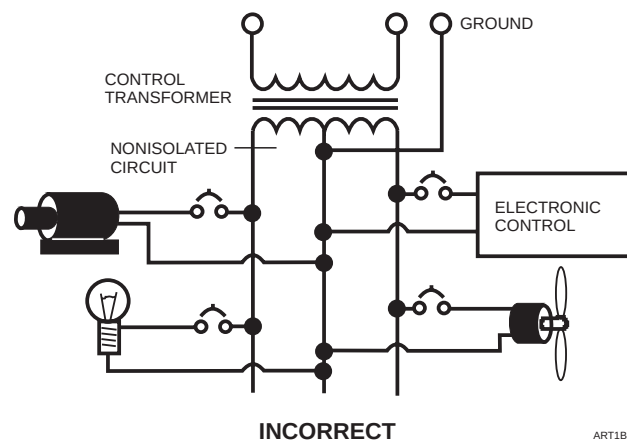
VOLTAGE SOURCE

Selecting the voltage source is extremely important for proper operation of electronic equipment in an industrial environment. Standard procedure for electronic instrumentation is

to provide a "clean" separate source voltage in order to prevent EMI, from other equipment in the plant, from interfering with the operation of the electronic equipment. Connecting electronic equipment to a breaker panel (also known as lighting panels and fuse panels) subjects the electronic equipment to noise generated by other devices connected to the breaker panel. This noise is known as electromagnetic interference (EMI). EMI flows on the wires that are common to a circuit. EMI cannot travel easily through transformers and therefore can be isolated from selected circuits. **Use a control transformer to isolate the electronic control panel from other equipment in the plant that generate EMI. (Figure 1)**



ART1T



ART1B

Figure 1

GROUNDING

Grounding is the most important factor for successful operation and is also the most overlooked. The NEC states that control equipment may be grounded by using the rigid conduit as a conductor. This worked for the earlier relay systems, but it is not acceptable for electronic control equipment. Conduit is made of steel and is a poor conductor relative to a copper wire. Electronic equipment reacts to very small currents and must have a good ground in order to operate properly; therefore, **copper grounds are required for proper operation. Note: aluminum may be used for the large three-phase ground wire.**

The ground wire must be sized the same size as the supply wires or one size smaller as a minimum. The three phase power brought into the plant must also have a **ground wire**, making a total of four wires. In many installations that are having electronic control problems, this essential wire is usually missing. A good ground circuit must be continuous from the plant source transformer to the electronic control panel for proper operation. (Figure 2) Driving a ground stake at the electronic control will cause additional problems since other equipment in the plant on the same circuits will ground themselves to the ground stake causing large ground flow at the electronic equipment.

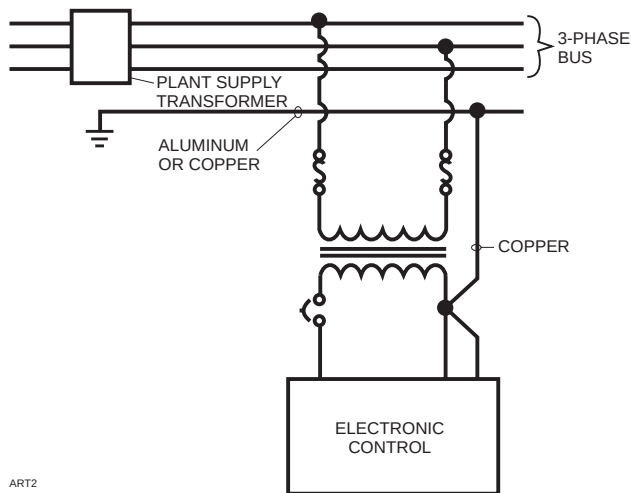


Figure 2

WIRING PRACTICES

Do not mix wires of different voltages in conduit. An example of this would be the installation of a screw compressor package. The motor voltage is 480 volts and the panel control power is 120 volts. **The 480 volt circuit must be run from the motor starter to the motor in its own conduit. The 120 volt circuit must be run from the motor starter control transformer to the control panel in its own separate conduit.** If the two circuits are run in the same conduit, transients on the 480 volt circuit will be inducted into the 120 volt circuit causing functional problems with the electronic control. Dividers must be used in wire way systems (conduit trays) to separate unlike voltages. The same rule applies for 120 volt wires and 220 volt wires. **Also, never run low voltage wires in the same conduit with 120 volt wires.** (Figure 3)

Never run any wires through an electronic control panel that do not relate to the function of the panel. Electronic control panels should never be used as a junction box. These wires may be carrying large transients that will interfere with the operation of the control. An extreme example of this would be to run the 480 volts from a motor starter through the control panel to the motor.

When running conduit to an electronic control panel, take notice of the access holes (knockouts) provided by the manufacturer. These holes are strategically placed so that the field wiring does not interfere with the electronics in the panel. **Never allow field wiring to come in close proximity with the controller boards since this will almost always cause problems.**

Do not drill a control panel to locate conduit connections. You are probably not entering the panel where the manufacturer would like you to since most manufacturers recommend or provide prepunched conduit connections. Drilling can cause metal chips to land in the electronics and create a short circuit. **If you must drill the panel, take the following precautions:** First cover the electronics with plastic and tape it to the board with masking or electrical tape. Second, place masking tape or duct tape on the inside of the panel where you are going to drill. The tape will catch most of the chips. Then clean all of the remaining chips from the panel before removing the protective plastic. It would be a good idea to call the manufacturer before drilling the panel to be sure you are entering the panel at the right place.

When routing conduit to the top of an electronic control panel, condensation must be taken into consideration. Water can condense in the conduit and run into the panel causing catastrophic failure. **Route the conduit to the sides or bottom of the panel and use a conduit drain.** If the conduit must be routed to the top of the panel, use a sealable conduit fitting which is poured with a sealer after the wires have been pulled, terminated and the control functions have been checked. **A conduit entering the top of the enclosure must have an "O" ring-type fitting between the conduit and the enclosure,** so that if water gets on top of the enclosure, it cannot run in between the conduit and the enclosure. This is extremely important in outdoor applications.

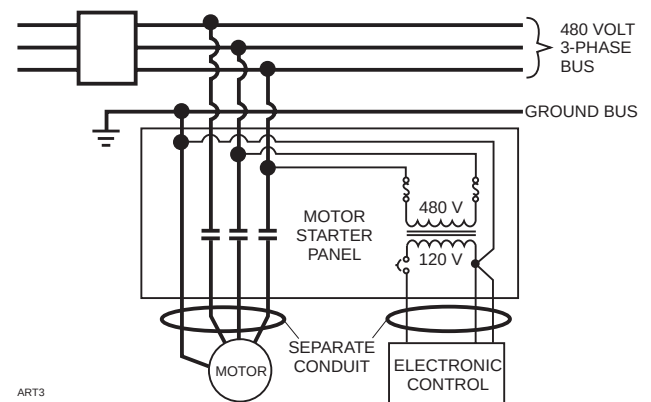


Figure 3

Never add relays, starters, timers, transformers, etc. inside an electronic control panel without first contacting the manufacturer. Contact arcing and EMI emitted from these devices can interfere with the electronics. Relays and timers are routinely added to electronic control panels by the manufacturer, but the manufacturer knows the acceptable device types and proper placement in the panel that will keep interference to a minimum. If you need to add these devices contact the manufacturer for the proper device types and placement.

Never run refrigerant tubing inside an electronic control panel. If the refrigerant is ammonia, a leak will totally destroy the electronics.

If the electronic control panel has a starter built into the same panel, be sure to run the higher voltage wires where indicated by the manufacturer. EMI from the wires can interfere with the electronics if run too close to the circuitry.

Never daisy-chain or parallel-connect power or ground wires to electronic control panels. Each electronic control panel must have its own supply wires back to the power source. Multiple electronic control panels on the same power wires create current surges in the supply wires which can cause controller malfunctions. Daisy-chaining ground wires allows ground loop currents to flow between electronic control panels which also causes malfunctions. (Figure 4)

It is very important to read the installation instructions thoroughly before beginning the project. Make sure you have drawings and instructions with your equipment. If not, call the manufacturer and have them send you the proper instructions. Every manufacturer of electronic equipment should have a knowledgeable staff, willing to answer your questions or fax additional information. Following correct wiring procedures will ensure proper installation of your electronic equipment.

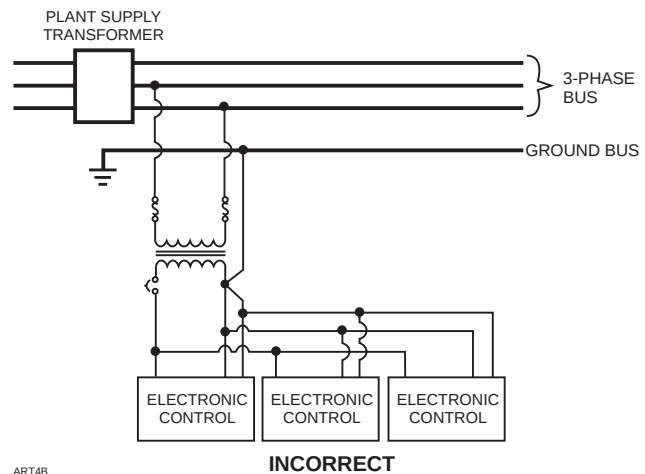
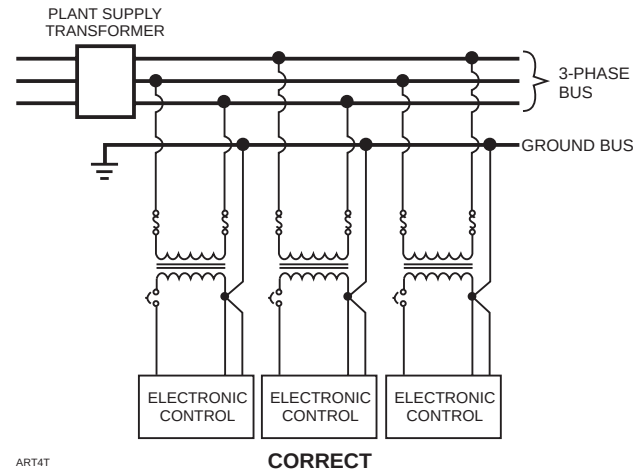


Figure 4