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**CHART INDUSTRIES, INC.
TEST CHAMBER
PRE-INSTALLATION/
SITE PREPARATION MANUAL**

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OVERVIEW

This manual is intended to be read well before the shipment of your test chamber. This manual will cover various utility requirements and things that are needed for the most successful installation and operation of the chamber. This manual should serve as a guideline and should provide answers to the most frequently asked questions regarding our *standard chambers*. If you have ordered a non-standard chamber, or have additional questions after reading this manual, please feel free to call for additional support. Our toll-free number is 1-888-877-3093. Any information in this manual is subject to change without notice.

SAFETY

Your safety is extremely important to us. Many of the following sections provide installation guidelines to ensure a safe installation of the chamber. Chart Industries, Inc. is very confident that if the chamber is installed with the following guidelines, the chamber will provide years of safe and successful operation. If you have any questions about the safety of this equipment, please don't hesitate to ask.

Oxygen Monitor

It is recommended to install an area oxygen monitor in the room the chamber is to be installed. The Chart test chamber uses liquid nitrogen to cool the chamber. The liquid nitrogen vaporizes in the chamber. The resulting vapor is designed to vent out of the chamber to the outside environment. However, if a leak should occur, there is a risk of creating an oxygen deficient atmosphere. An area oxygen monitor would detect when the oxygen level in the room drops or becomes an unsafe level. If an oxygen monitor is required for your installation, please call your Chart Industries, Inc. sales representative, or call our toll free number 1-888-877-3093 for details. Chart Industries, Inc. has oxygen monitors and calibration kits available.

Noise Levels

The vibration model chambers (TVC and REAL) will produce elevated levels of noise. It is not uncommon to experience noise levels as high as 70-80 dB. The noise level depends on vibration levels expected in test. If the vibration level is not expected to exceed 10 gRMS, the noise levels will not be as great. If the vibration level is going to be greater than 10 gRMS, the noise level should be considered when selecting where the chamber is placed. Safety precautions may be necessary if higher (greater than 30 gRMS) vibration levels will be tested.

PLACEMENT OF THE CHAMBER

When deciding where to place the chamber, it is important to consider many factors. The rest of this manual should be read before selecting the final location for the chamber as the placement of the chamber may affect the costs of certain utilities etc. These considerations will help in selecting the gross general area that the chamber will be located (which particular lab or end of building for example). Once the general location has been selected, there are some other items to consider when placing the chamber.

Refer to the drawings at the end of this manual for locations of various utility connections to the chamber. Note the control box is mounted on one side of the chamber. There should be adequate room available on this side to facilitate any service of the controls. There are also access ports on the same side of the chamber as the control box. These ports may be used to supply power to the device under test, or may be used for data acquisition wiring to the device under test.

The TC/TVC-4, REAL-36, REAL-36T, REAL-30T, REAL-30, REAL-48T, and REAL-48, and REAL-96 have doors on the front and back. Many customers like to utilize one set of doors to load the device under test and the other set of doors to remove the device under test. Sometimes customers like to use both sets of doors to facilitate easier access to instrument or set up the device under test rather than reaching in from one side alone. It should be considered whether or not you will want both sets of doors accessible in your installation.

The side of the chamber opposite the control box contains the liquid nitrogen plumbing¹. There should be some room left on this side to facilitate any service as required to these components. This side also has access ports that can be used for powering or acquiring data from the product under test. The side of the chamber that has the liquid nitrogen plumbing also has a safety valve that extends from the side wall of the chamber. Refer to the O&D drawing at the end of this manual for dimensions.

It is common to have a computer or rack of test equipment for the chamber. This computer or test equipment is usually placed on the control box side or the liquid nitrogen side of the chamber. Room should be left to comfortably utilize this equipment.

It is required in some communities that the chamber be bolted to the floor. In some communities it is required that the room not be completely sealed off and have open air into the adjoining room. It is advised that the local ordinances are considered ahead of time so that any required permits etc are obtained before the chamber arrives.

¹ The REAL-20/20T has the liquid nitrogen connection on the top of the chamber rather than the side.

Fork Lift Requirements

The chambers are considerably heavy. It should be arranged to have a fork-lift available with enough capacity and proper fork size to move the chambers into place when they arrive. The forks of the forklift should extend completely under the chamber. The support of the chamber is on the edges, not in the center. Care should be taken to not put load on the center of the chamber floor. The following table lists chamber weights and required fork lengths:

Table 1 - Fork Lift Requirements

CHAMBER MODEL	WEIGHT	REQUIRED FORK LENGTH	MAXIMUM FORK SPACING
REAL-20T ²	750 lbs. (340 kg)	40 inches (101.6 cm)	26 inches (66.0 cm)
TC-4	1,650 lbs. (748 kg)	50 inches (127.0 cm)	30 inches (76.2 cm)
REAL-36T	2,850 lbs. (1,293 kg)	52 inches (132.1 cm)	33 inches (111.8 cm)
REAL-30T	1,950 lbs. (884 kg)	41 inches (104.1 cm)	33 inches (83.8 cm)
REAL-48T	3,300 lbs. (1,497 kg)	73 inches (185.4 cm)	56 inches (142.2 cm)
REAL-20 ²	900 lbs. (408 kg)	40 inches (101.6 cm)	26 inches (66.0 cm)
TVC-4	1,900 lbs. (862 kg)	50 inches (127.0 cm)	30 inches (76.2 cm)
REAL-36	3,300 lbs. (1,497 kg)	52 inches (132.1 cm)	33 inches (111.8 cm)
REAL-30	2,350 lbs. (1,066 kg)	41 inches (104.1 cm)	33 inches (83.8 cm)
REAL-48	4,500 lbs. (2,041 kg)	73 inches (185.4 cm)	56 inches (142.2 cm)
REAL-96	9,000 lbs. (8,082 kg)	73 inches (185.4 cm)	56 inches (142.2 cm)

The chambers have control boxes, nitrogen control valves and compressed air assemblies mounted on the sides of the chamber. As a result, it is recommended the forks of the forklift run from front doors to back doors.

To protect the chamber from tilting away from the forklift, it is recommended to strap the chamber to the forklift. It is also possible that the chamber would tilt toward the forklift. To protect the chamber, its doors and windows, it is recommended to put some padding between the chamber and the forks. Shipping blankets work well for this.

² The REAL-20/20T chamber is on casters. This chamber should be able to be wheeled into place without a forklift.

LIQUID NITROGEN

All of the Chart chambers utilize liquid nitrogen for the cooling of the chamber. It is suggested that the chambers obtain the liquid nitrogen from a bulk storage tank with vacuum insulated piping plumbed to the chamber. Utilizing a bulk tank and vacuum insulated piping will allow the most efficient and highest performance from the chamber. When handled properly, liquid nitrogen is very safe. However, only trained professionals should handle and install liquid nitrogen and associated equipment.

Liquid Nitrogen Tank

It is common and preferred to supply the test chamber with liquid nitrogen from a bulk storage tank that sits outside the facility on a concrete pad³. The liquid is then piped into the building and to the test chamber. The liquid nitrogen bulk tank can be obtained in one of three (3) ways:

1. The bulk tank can be purchased outright from Chart Industries, Inc.
2. The bulk tank can be rented from the customer's gas supplier.
3. The customer may already have a bulk tank on-site for other manufacturing or testing processes that require liquid or gaseous nitrogen. In this case, the size of the tank should be evaluated to ensure enough capacity to support the additional use of liquid for the new test chamber.

The bulk tank can be purchased outright from Chart Industries, Inc. This option typically gives the customer the greatest flexibility and can also be shown to be most economical. Chart Industries, Inc. personnel would be happy to demonstrate various economic models that will help each customer decide what is best for them. Please feel free to call us for assistance.

If the bulk tank is not purchased from Chart Industries, Inc., it can be rented from the gas supplier. In this case, the gas supplier will normally do the project management for the installation of the pad and tank. If the tank is rented from the gas supplier, the gas supplier will normally handle all maintenance of the tank. The gas supplier will charge a monthly rental or "facility" fee for the pad, tank and any other equipment needed.

Whether purchasing or renting a tank, it is important to specify certain features that will help obtain maximum performance and minimum operational costs. The insulation system of the tank plays a big role in loss rates of the tank. Some of the older tanks on the market are insulated with perlite insulation. These tanks will not perform as well as

³ Selecting a site for a bulk tank and orchestrating the installation can be a long process. If you would like help with this, Chart Industries, Inc has a site preparation manual for bulk tanks. Please feel free to call if you would like a copy of this manual.

a newer tank that has a composite, super-insulation system. The vacuum level of the tank is also very important. A tank should have a cold vacuum level⁴ of 1-2 microns. Elevated vacuum levels will cause additional heat leak into the tank, which will produce increased loss rates.

It is recommended that the tank have a vacuum insulated liquid withdrawal and valve. This connection point and valve can be a large source of heat leak as it is exposed to liquid nitrogen all of the time. If it is not vacuum insulated, it will be the source or a large ice ball around the valve. This ice ball, if not controlled, can make the valve difficult to operate. If the valve is near other components, the ice ball can grow large enough that it will cover or push against the components, which may break them.

Although many tanks in the market have a maximum allowable working pressure (MAWP) of 250 psig (17.2 barg), the chambers only require 50 psig (3.4 barg). Often tanks are purchased with the 250 psig (17.2 barg) MAWP because they provide the greatest flexibility to be used for higher pressure applications in the future. There is another standard pressure for MAWP, which is 175 psig. In either case, it is important that the tank be configured to supply the chambers with liquid nitrogen at 50 psig (3.4 barg). This may require adjusting the pressure building regulator, economizer regulator, using a phase separator or other devices. Chart Industries, Inc. manufactures a complete line of accessories to help facilitate the liquid nitrogen requirement.

If your facility has a requirement for gaseous nitrogen at higher pressures (100 psig for example), it is possible to utilize one liquid nitrogen bulk tank to supply both the high pressure gas application and the low pressure liquid application (test chamber). Chart Industries, Inc. manufactures many different products that will help eliminate the need for two bulk tanks, one running at high pressure and one operating at low pressure.

⁴ This vacuum reading should be made when the inner vessel has liquid in it and is cold. Vacuum levels will be higher when the inner vessel is warm with no liquid in it.

Liquid Nitrogen Piping

The nitrogen tank and vacuum insulated piping can be purchased from Chart Industries, Inc., or it can be leased from a local industrial gas supplier. The following information is intended to assist in the design, specification and installation of the piping to ensure the most efficient and highest performance of the test chamber. The end of this manual has a sample piping installation drawing that illustrates the optimum layout for an installation.

The piping connecting the liquid nitrogen tank to the chamber needs to be insulated due to the extreme low temperatures of liquid nitrogen. The most efficient insulation available is vacuum insulation. If the piping is not vacuum insulated, but insulated in some other way, such as foam, it will greatly increase the operation cost of the chamber. The increased operation cost is due to the greater heat leak through the insulation, which will cause additional liquid nitrogen boil-off. A Chart Industries, Inc. representative would be happy to model your system for you and demonstrate a computer model that will calculate a heat leak and operating cost comparison between vacuum insulated pipe and foam insulated pipe.

The piping layout should be done with minimal bends and tees in the system. Each bend and tee will increase pressure drop, increase heat leak and increase the cost of the equipment to purchase and install. The pipe should be sized to provide adequate flow to the chamber, with some forethought of expansion in the future. The following table shows maximum flow rates for the different standard chamber sizes. Note that these are maximum flow rates and typically only occur when the test is trying to ramp down in temperature at its maximum rate. This flow rate may or may not be sustained for long periods of time. This depends wholly on the test being run and the product under test.

Table 2 - Liquid Nitrogen Maximum Flow Rates

CHAMBER MODEL	MAXIMUM NITROGEN FLOW RATE
REAL-20T, REAL-20	9 gallons per minute (34 liters per minute)
TC/TVC-4, REAL-30T, REAL-30	12 gallons per minute (45 liters per minute)
REAL-36T, REAL-36	21 gallons per minute (79 liters per minute)
REAL-48T, REAL-48	24 gallons per minute (91 liters per minute)
REAL-96T, REAL-96	48 gallons per minute (182 liters per minute)

To support these flow rates, we recommend the following pipe sizes feeding the chambers. Note that these sizes represent the size of the individual drops to the chambers and not the size of the header that may feed multiple chambers.

Table 3 - Chamber Liquid Nitrogen Pipe Size

CHAMBER MODEL	CHAMBER DROP PIPE SIZE
REAL-20T, REAL-20	½ inch pipe size
REAL-36, REAL-36T, TC/TVC-4	1 inch pipe size
REAL-48T, REAL-48	1 inch pipe size
REAL-30T, REAL-30	½ inch pipe size
REAL-96T, REAL-96	(2x)1 inch pipe size

The test chambers are frequently installed in laboratory type environments or other facilities where expansion in the future is likely. Because of this, we recommend putting a cap bayonet on the end of the pipe section just before the pipe drops down through the ceiling to the chamber. This bayonet will greatly increase the system flexibility for adding additional chambers or other liquid nitrogen uses to other areas of the building.

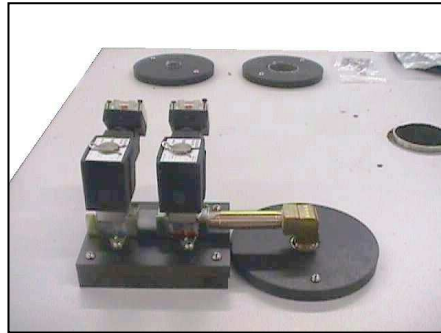
It is recommended that the end of the piping section feeding the chamber be done with flexible vacuum insulated pipe. This will allow for any slight variances in chamber placement or shifting of the chamber if necessary. While flexible pipe is convenient and many times simpler to install, it should not be used excessively. The flexible piping is more expensive to buy, and causes flow restriction and additional heat gain in the system.

It is common to install a cryo-vent in the piping system. The cryo-vent should be installed at the highest local elevation. The cryo-vent will help ensure liquid nitrogen at the use-point. This is done as any gas bubbles in the nitrogen line will tend to migrate to the highest elevation. The cryo-vent will vent this gas product, keeping the pipe section full of liquid nitrogen. Cryo-vents are typically installed outside of the building up on the roof, so the nitrogen gas vents to the atmosphere. If the cryo-vent is installed inside the building, care must be taken in how the vented gas is handled for safety considerations. If the nitrogen gas is vented in a smaller area, care must be taken such that there is no risk of an oxygen deficient atmosphere.

At the end of the piping section, it is recommended to put a manual shutoff valve. It is recommended that this valve be vacuum insulated and be of type to cause minimal flow restriction. In the section of pipe that is between the manual shutoff valve and the first solenoid valve on the chamber, a line pressure relief valve should be installed. If the manual shutoff valve and the solenoid valve were to both close while there is liquid trapped between them, the heat leak through the insulation will vaporize the liquid nitrogen and greatly increase the pressure in the pipe to dangerous levels. A line pressure relief valve will protect from this as it relieves the pressure back to safe levels.

Any pipe sections valves or components that are not vacuum insulated are likely to acquire condensation, frost, and ice. When the chamber is not in use, it is likely that this ice will melt and drip water. This is important to remember for safety reasons as it may cause water puddles on the floors, or up in the ceiling. If vacuum insulated pipe, valves and components are not going to be used, the installer should be prepared to put some form of drip pan beneath the components.

Chart chambers⁵ come standard with a vacuum insulated liquid nitrogen control valve assembly. This feature gives a completely frost and water free connection of the liquid nitrogen piping to the chamber. The vacuum insulation eliminates the need for insulating the valves with unsightly insulation after installation. If the valves ever need servicing, they do not need to be re-insulated. The valve assembly also eliminates any dripping of water on lab equipment or the floor, which is often an issue with the facilities and safety groups. The following is a picture of the valve assembly installed on a chamber.



1 - REAL-20 Solenoid valves for LN2 control.



2 - REAL-30 LN2 control valves.

⁵ REAL-20/REAL-20T chamber does not have this feature due to its small size.

Vacuum insulated pneumatically actuated cooling safety valve.

Vacuum insulated female bayonet liquid nitrogen connection.

Vacuum insulated, pneumatically actuated cooling control valve.



3 - REAL-36 & 48 LN2 control valves.

If portable Dewars are used to supply the chamber with liquid nitrogen, it is common to use flexible transfer hoses to connect the Dewar to the chamber⁶. If this is done, it is highly recommended that vacuum insulated hoses are used. Vacuum insulated hoses will make the system as efficient as possible, as well as minimize the condensation and water on the floor. Chart Industries, Inc. manufactures a wide variety of vacuum insulated and non-vacuum insulated flexible transfer hoses for cryogenic use. Vacuum insulated hoses are also safer to use as it reduces the risk of personnel touching extremely cold surfaces and getting severe frostbite.

⁶ Chamber performance will be diminished if the liquid nitrogen is not supplied from a bulk tank and appropriately sized piping system.

ELECTRICAL REQUIREMENTS

The electrical requirements for chambers vary with location. Chambers used internationally require different electrical power than standard domestic chambers. This is a very important factor to take into consideration when preparing for a chamber. Table 4 illustrates the electrical requirements of chambers used in various countries.

Table 4: International Voltage Requirements

COUNTRY	ELECTRICAL REQUIREMENTS
UNITED STATES	460 VAC 3 Phase
CHINA	380 VAC 3 Phase
INDIA	415 VAC 3 Phase
KOREA	380 VAC 3 Phase
MALAYSIA	415 VAC 3 Phase
SINGAPORE	415 VAC 3 Phase

Standard domestic chambers require 460 VAC 3 Phase power with a ground. All other electrical power required by the chamber is generated from the incoming 460 VAC by use of transformers and DC power supplies contained within the chamber's control system. The acceptable range for this nominal voltage is 440-480 VAC. ***Voltage outside this range is excessive and would cause premature failure of the electrical components on the chamber.*** The following table illustrates the current requirements of the different chambers:

Table 5 - Chamber Electrical Current Requirements @ 460 VAC 3 Phase

CHAMBER MODEL	ELECTRICAL REQUIREMENTS
REAL-20T, REAL-20	30 Full Load Amps
TC/TVC-4	65 Full Load Amps
REAL-30T, REAL-30	65 Full Load Amps
REAL-36T, REAL-36	100 Full Load Amps
REAL-48T, REAL-48	140 Full Load Amps
REAL-96T, REAL-96	280 Full Load Amps

For chambers that require 415 VAC 3 Phase power with a ground, the acceptable range for nominal voltage is 397-433 VAC. ***Voltage outside this range is excessive and would cause premature failure of the electrical components on the chamber.*** The following table illustrates the current requirements of the different chambers:

Table 6: Chamber Electrical Current Requirements @ 415 VAC 3 Phase

CHAMBER MODEL	ELECTRICAL REQUIREMENTS
REAL-20T, REAL-20	40 Full Load Amps
TC/TVC-4	80 Full Load Amps
REAL-30T, REAL-30	80 Full Load Amps
REAL-36T, REAL-36	135 Full Load Amps
REAL-48T, REAL-48	165 Full Load Amps
REAL-96T, REAL-96	330 Full Load Amps

For chambers that require 380 VAC 3 Phase power with a ground, the acceptable range for nominal voltage is 363-396 VAC. ***Voltage outside this range is excessive and would cause premature failure of the electrical components on the chamber.*** The following table illustrates the current requirements of the different chambers:

Table 7: Chamber Electrical Current Requirements @ 380 VAC 3 Phase

CHAMBER MODEL	ELECTRICAL REQUIREMENTS
REAL-20T, REAL-20	35 Full Load Amps
TC/TVC-4	85 Full Load Amps
REAL-30T, REAL-30	85 Full Load Amps
REAL-36T, REAL-36	90 Full Load Amps
REAL-48T, REAL-48	152 Full Load Amps
REAL-96T, REAL-96	304 Full Load Amps

For chambers that require 208 VAC 3 Phase power with a ground, the acceptable range for nominal voltage is 199-217 VAC. ***Voltage outside this range is excessive and would cause premature failure of the electrical components on the chamber.*** Common chamber models using this voltage are the REAL-20T and REAL-20.

Table 8: Chamber Electrical Current Requirements @ 208 VAC 3 Phase

CHAMBER MODEL	ELECTRICAL REQUIREMENTS
REAL-20T, REAL-20	56 Full Load Amps

The grounding wire is very important for safety reasons, as well as to minimize the electrical noise in the controls. Any electrical noise will adversely affect the readings and operation of the controller and control circuit. Providing a very low impedance ground path will help minimize this noise. The following table illustrates recommended ground wire sizes for the different chambers:

Table 9 - Recommended Ground Wire Sizes

CHAMBER MODEL	RECOMMENDED GROUND WIRE SIZE
REAL-20T, REAL-20	10 gauge
TC/TVC-4	6 gauge
REAL-36T, REAL-36	6 gauge
REAL-48T, REAL-48	6 gauge
REAL-30T, REAL-30	6 gauge
REAL-96T, REAL-96	6 gauge

Also keep in mind that the ground wire should be sized based on the breaker in the plant feeding your system. This requirement and any other local codes or ordinances may take precedence over the above table.

The wiring should be run into the room the chambers will be in. Each chamber should be on a circuit breaker in that room. Conduit with the power and ground wires should be run from the circuit breaker panel to the chamber. It is recommended that the last three (3) to four (4) feet of the conduit before the chamber be flexible. This will make connection to the chamber easier as well allow for any slight shifts of the chamber for many various reasons (floor expanding/contracting over different seasons, etc).

COMPRESSED AIR REQUIREMENTS

All chamber models require compressed air to operate. The thermal only models (TC-X and REAL-XT) use compressed air to operate instruments on all models and the door clamping devices on the larger models. The vibration models (TVC-X and REAL-X) used compressed air for the instruments, vibration system and door clamping devices on the larger models. In any model, there is only one connection point for the compressed air supply. The location of the connection point is shown on drawings at the end of this manual for each particular model. The compressed air should be run through a filter and air dryer before it reaches the chamber to minimize damage to the chamber (see following requirements). It is recommended to use a screw type compressor rather than a reciprocating type compressor to keep the air as clean as possible.

The quality of the air per ANSI/ISA Standard S7.0.01-1996*:

Pressure Dew Point

Pressure dew point (pdp) measured at the chamber inlet shall be at least 10°C (39°F) below the minimum temperature to which any part of the air system is exposed. Regardless of minimum exposure temperature, the dew point shall not be greater than 2°C (35°F) at line pressure. If dew point consistency is an issue at your facility, additional monitoring is recommended.

Particle Size

A maximum particle size of less than 10 microns is required for chamber operation. If any maintenance or modification of the air system is done, the system should be retested for particle size of less than 10 microns.

Lubricant Content

Oil content of air at the chamber inlet shall not exceed one (1) ppm (w/w or v/v). Use of automatic oilers before the chamber inlet is not recommended.

*ISA Standard S7.3-1981 may be used in place of ANSI/ISA Standard S7.0.01-1996

The following table lists recommended compressed air line sizes, and required pressures and flow rates:

Table 10 - Compressed Air Requirements

CHAMBER MODEL	RECOMMENDED LINE SIZE	REQUIRED AIR PRESSURE	REQUIRED AIR FLOW RATE
REAL-20T	3/8 inch	80 psig (5.5 barg)	15 SCFM (0.4 m ³ /min)
TC-4	3/8 inch	80 psig (5.5 barg)	15 SCFM (0.4 m ³ /min)
REAL-30T	3/8 inch	80 psig (5.5 barg)	15 SCFM (0.4 m ³ /min)
REAL-36T	3/8 inch	80 psig (5.5 barg)	15 SCFM (0.4 m ³ /min)
REAL-48T	3/8 inch	80 psig (5.5 barg)	15 SCFM (0.4 m ³ /min)
REAL-20	1/2 inch	90 psig (6.2 barg)	50 SCFM (1.4 m ³ /min)
TVC-4	3/4 inch	100 psig (6.9 barg)	40 SCFM (1.1 m ³ /min)
REAL-30	3/4 inch	100 psig (6.9 barg)	70 SCFM (2.0 m ³ /min)
REAL-36	3/4 inch	120 psig (8.3 barg)	80 SCFM (2.3 m ³ /min)
REAL-48	3/4 inch	120 psig (8.3 barg)	140 SCFM (4.0 m ³ /min)
REAL-96	(2x) 3/4 inch	120 psig (8.3 barg)	280 SCFM (4.0 m ³ /min)

When plumbing the compressed air line, it is recommended to have a manual shutoff valve as well as at least one (1) to two (2) feet of flexible line just before the connection to the chamber. This valve and flexible line will make the installation and service of the chamber easier.

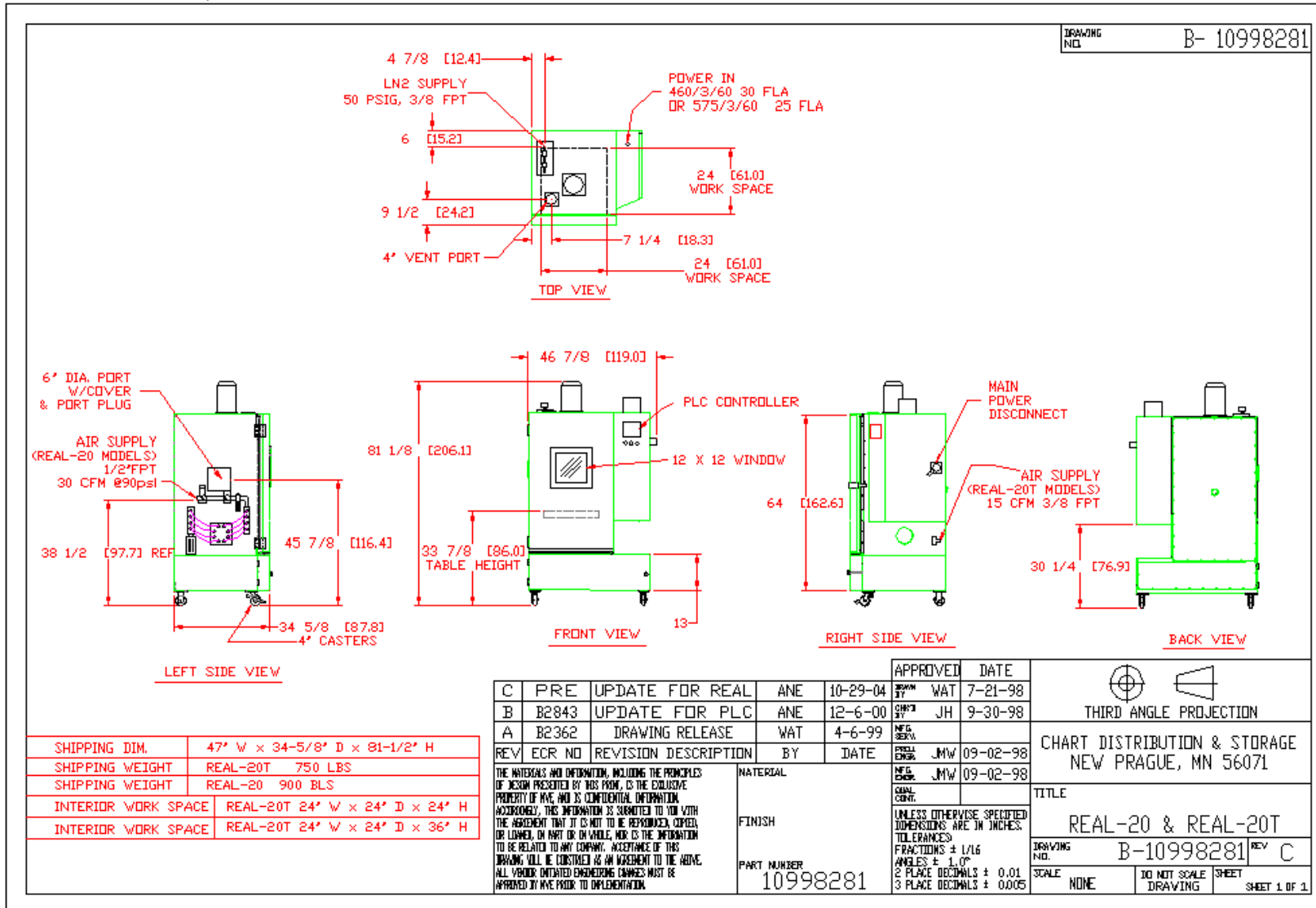
CHAMBER VENTS

All of the chambers require venting out of the chamber. The venting is required to heat and cool the chamber properly. The vent should be plumbed outside the building in the least restrictive path possible to reduce the moisture drain inside. Ninety-degree bends and horizontal runs should be avoided. The best possible path is a straight vertical path to the outside. The vents should not have any blowers, fans or restrictions in line. A blower or any powered exhaust on the chamber may defeat the purpose of the gaseous nitrogen purge (if equipped), which reduces air and moisture access into the chamber by keeping a positive pressure in the chamber. Any restrictions in the vent flow will result in decreased chamber performance. The chamber will not be able to obtain the high temperature ramp rates with restricted vent gas flow. In addition, if the vent gas is restricted too much, the chamber will tend to burn up heaters. The REAL-36, REAL-36T, REAL-48T and REAL-48 have two (2) vent ports. These vent ports can be manifolded together to one common vent stack. The following table lists the required vent sizes:

Table 11 - Chamber Vent Sizes

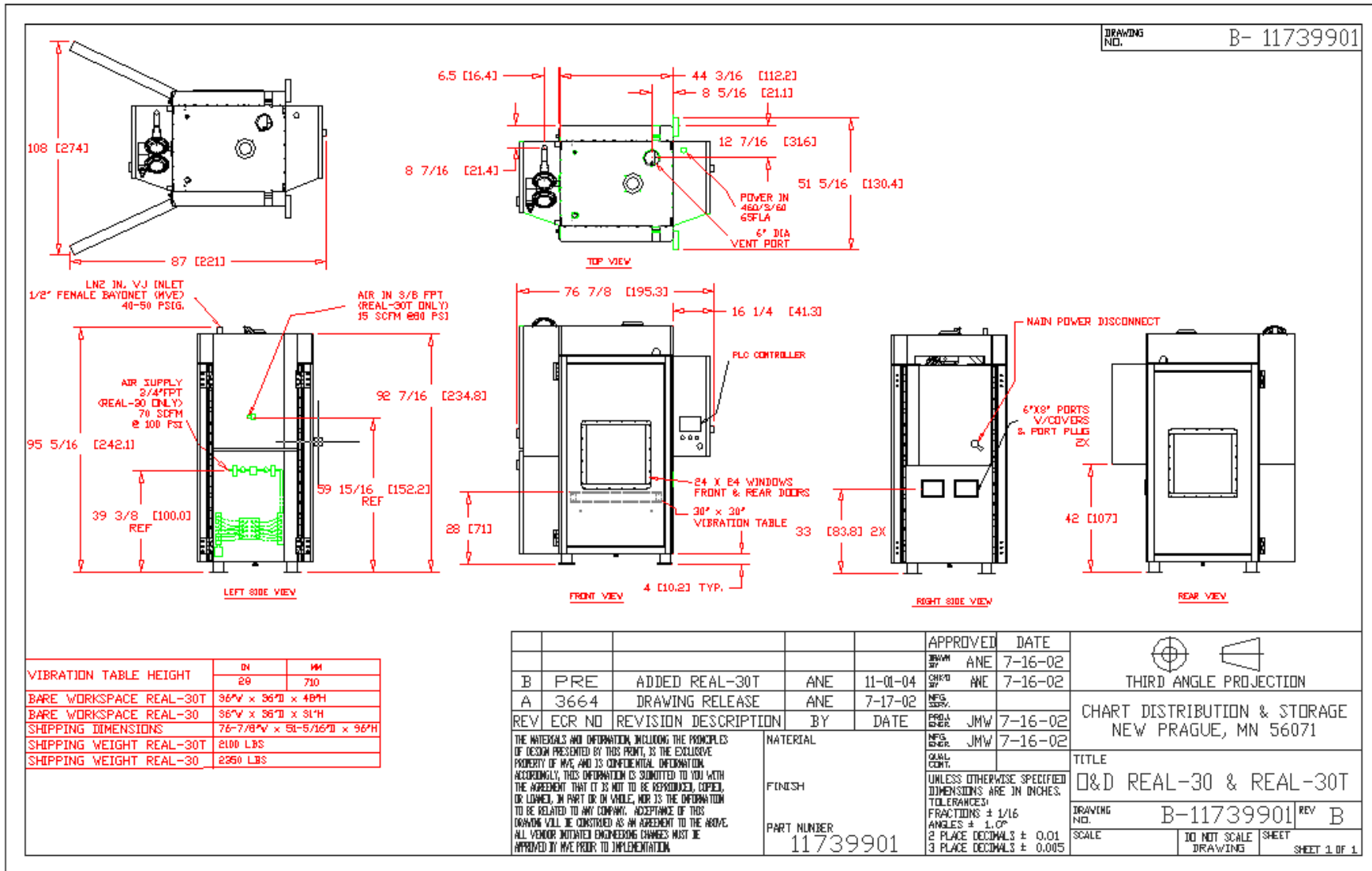
CHAMBER MODEL	VENT SIZE	MANIFOLDED VENT SIZE
REAL-20T, REAL-20	(1) 4 inch (101.6 mm)	N/A
TC/TVC-4	(1) 6 inch (152.4 mm)	N/A
REAL-36T, REAL-36	(2) 6 inch (152.4 mm)	(1) 9 inch (228.6 mm)
REAL-48T, REAL-48	(2) 6 inch (152.4 mm)	(1) 9 inch (228.6 mm)
REAL-30T, REAL-30	(1) 6 inch (152.4 mm)	N/A
REAL-96T, REAL-96	(4) 6 inch (152.4 mm)	(2) 9 inch (228.6 mm)

When venting the chamber, the plumbing should be typical pipe used in venting applications. However, this plumbing should not be of a plastic material (PVC, etc.) as it will not endure the extreme temperature of the gas being exhausted. It is recommended to insulate the vent plumbing out of the chamber. The plumbing has thermally controlled gas flowing through it which may be cold and cause condensation to form on the outside of the vent plumbing. This condensation can then drip on the floor or ceiling tiles, which can cause safety hazards. Insulating the exhaust duct will minimize these effects. This can be done by wrapping the piping in a vapor barrier insulation sleeve to reduce condensation.



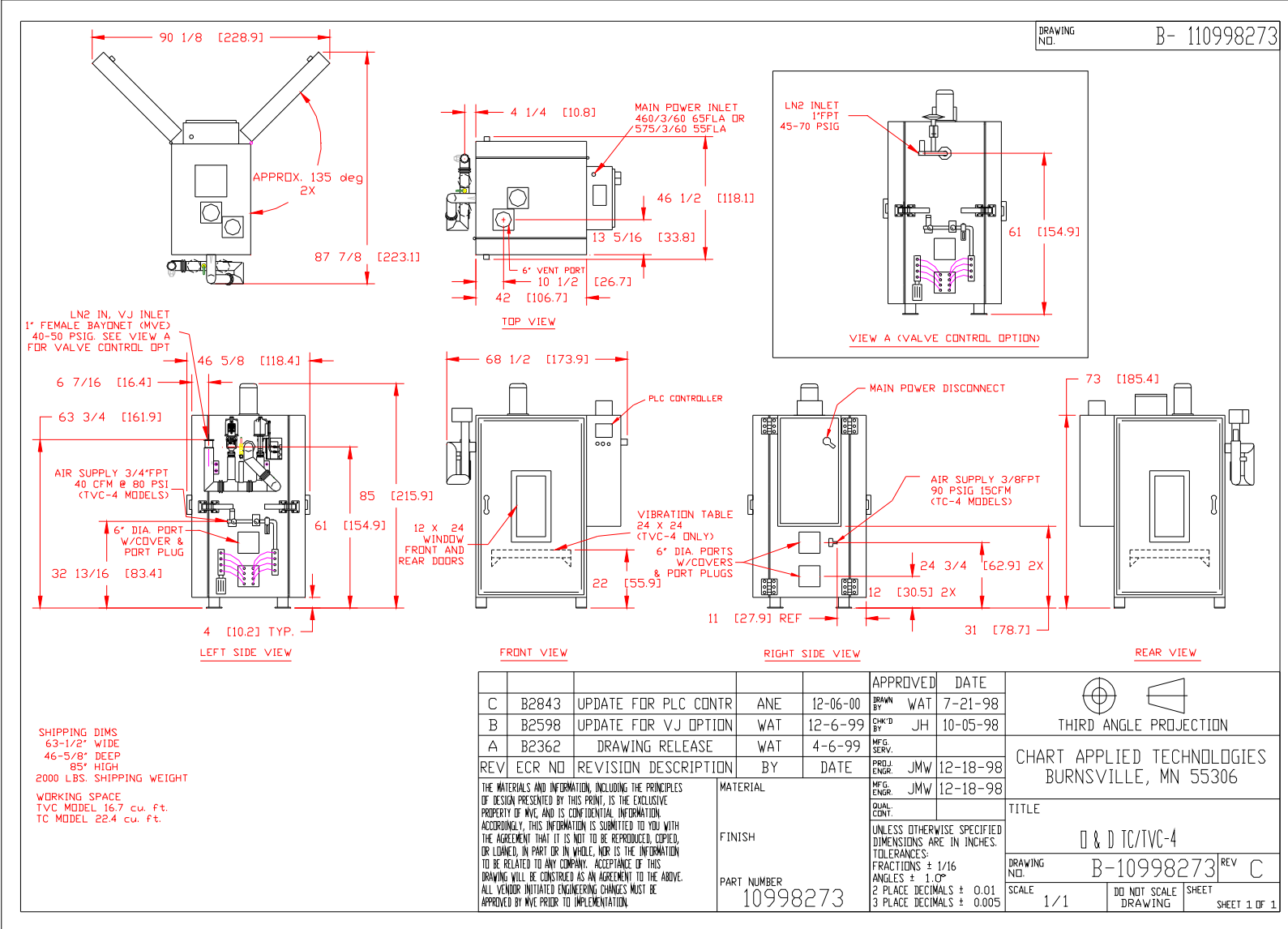
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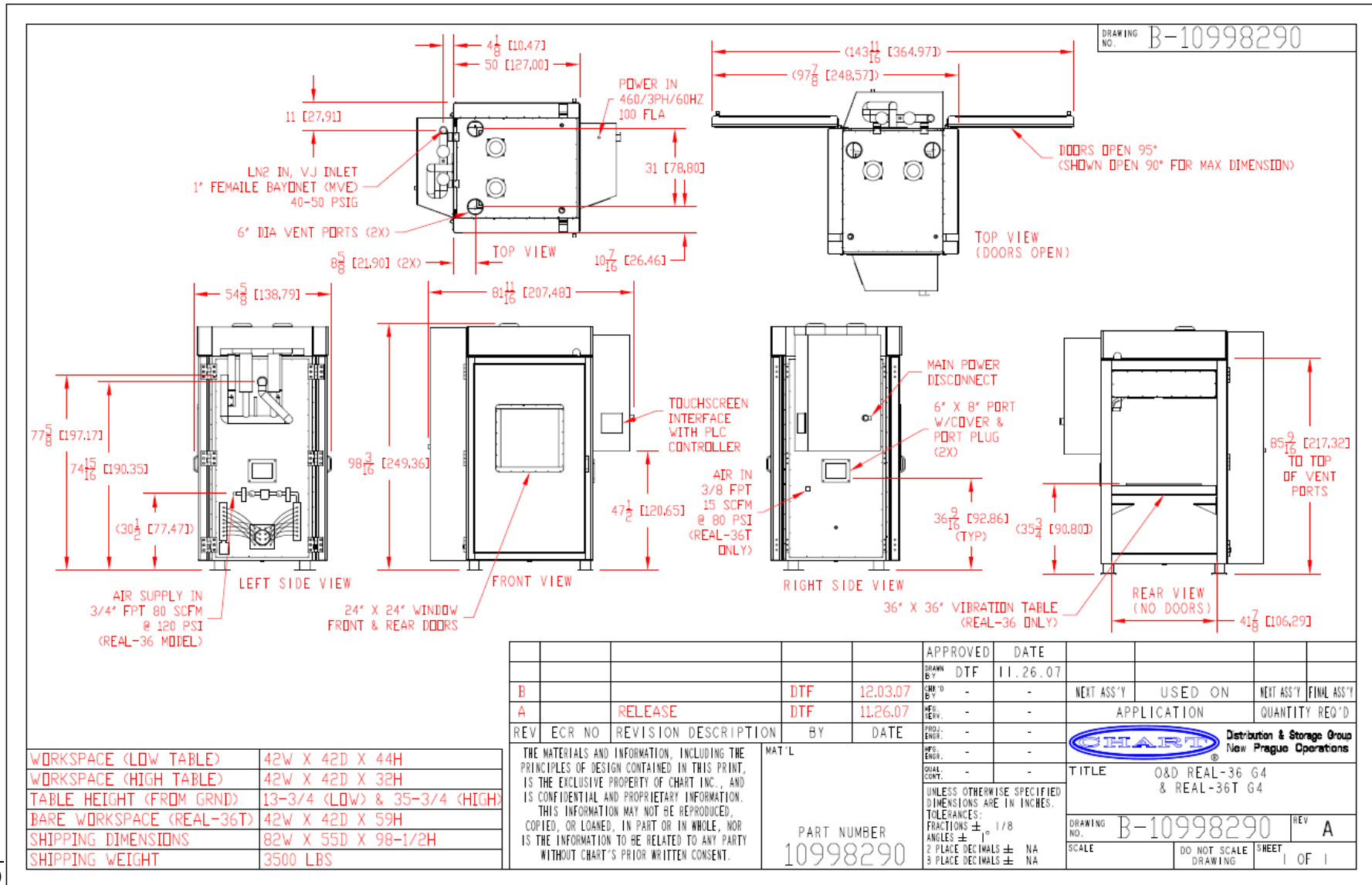
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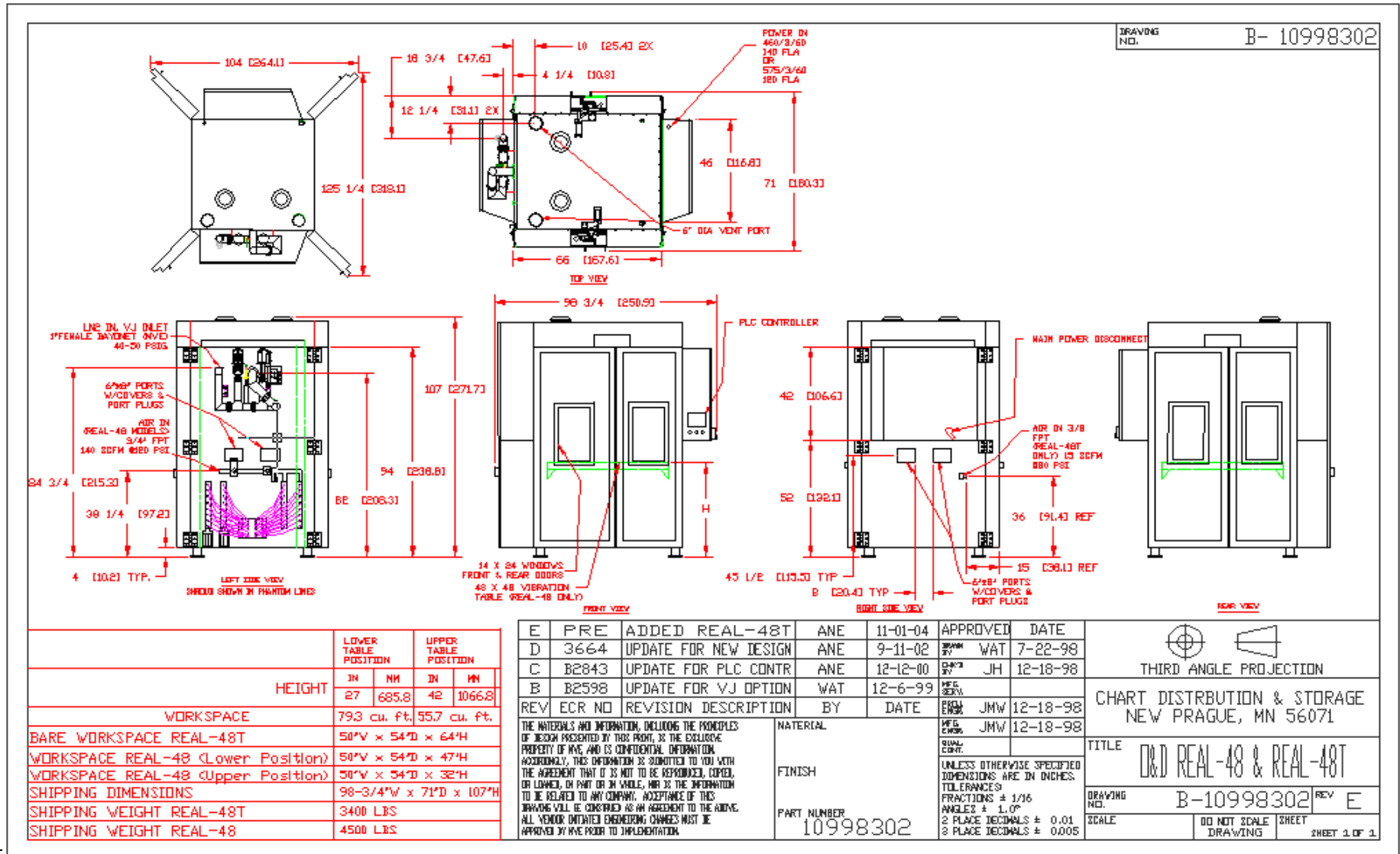
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