# KX320MCZ

## 300mm Crystal Growing Furnace Machine Specification

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*Revision (B)*

*(original language version)*

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# Document Revision History

| Rev. | ECN | Description of Change | Pg/sec Affected | Revision Date | By |
|---|---|---|---|---|---|
| - | N/A | Initial release – copied from 374-01659-1(A) | All | 05/24/19 | JAR |
| A | N/A | Updated front elevation drawing for 3.7RC | | 10/16/19 | JAR |
| B | N/A | Changed title page, added available configs to general machine specifications. Added description for magnet lift safety switches | Title pg, Sections 1 & 5 | 11/7/19 | JAR |

## Specification Approval

Name (printed) Date

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Title (printed)

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Signature

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Comments

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# Table of Contents

# 1. General Machine Specifications

- All piping is labeled for flow direction and material within.
- Note: A throat cooling tube is not included. This can be a future retrofit
- The machine can be purchased with one of the following configurations:
  - KX320 MCZC – Magnet capable which allow for future addition of a magnet and magnet lift system
  - KX320 MCZR – Magnet ready which includes all magnet lift components – only the magnet and magnet power supply are not included.
  - KX320 MCZ – Machine complete with magnet and magnet lift system.
- The machine can be supplied with the following options (please consult LCT sales for additional information)
  - Cathetometer
  - Maintenance Platform and ladder for accessing seed lift
  - Hot Zone design
  - Oxide Filters
  - Vacuum pumps
  - Throat Cooling tube
  - Internal Feeder
  - Maintenance kit
    - This kit can include various alignment and service tools for maintaining and installing the machine and hot zone. Configurations can be customized to suit customer needs and requirements.
  - Spare parts kit
    - This kit can be configured in many levels to suit customer needs and requirements

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# 2. Physical and Performance Specifications

*Features of Systems and Major Assemblies*

## 2.1. GROWTH CHAMBERS

All growth chambers are constructed of 304L and 316L stainless steel, and they are double-walled for water jacket cooling. All chamber welds are inspected for defect-free condition and are dye penetrant tested. Chamber water jackets are leak checked with a helium mass spectrometer and are hydrostatically pressure tested. See **Section 7.0** for drawings.

### 2.1.1. BASEPLATE

The baseplate is the flat bottom of the growth chamber. It has a center bore for the crucible shaft, four (4) ports for evacuation and one (1) for pressure sensors, and six (6) electrode feedthroughs.

| | |
|---|---|
| Electrodes | (4) main heater |
| | (2) bottom heater |
| Electrode port diameter | 78 mm (3.07 in) |
| Electrode material | OF Copper, water-cooled |
| Vacuum ports (4) | 150 mm (5.91 in) |
| Center bore | 164 mm (6.45 in) |

### 2.1.2. FURNACE TANK

The furnace tank is an open cylinders with flanged ends. The tank has one (1) pyrometer port for heater temperature measurement. There are no tabs on the I.D. of the furnace tank.

| | |
|---|---|
| Furnace Tank I.D. | 1275 mm (50.2 in) |
| Furnace Tank height | 1364 mm (53.7 in) |
| Pyrometer port location | 836 mm (32.9 in) above baseplate |

### 2.1.3. Furnace Tank Cover

The furnace tank cover has a domed shape, making a transition between the furnace tank and the receiving chamber. Two argon inlet ports are provided in the cylindrical neck of the cover (located opposite of each other in the throat area).

| | |
|---|---|
| Inside diameter | 1275 mm (50.2 in) |
| Tank cover throat I.D. | 420 mm (16.5 in) |
| | (other sizes available on request) |
| Camera viewport | 75 mm (2.95 in) round |
| Operator viewport | 64 mm x 350 mm oval |
| Feeder port | 150 mm (5.9 in) round |
| Shield lift ports (2) | 70 mm (2.75 in) round |

### 2.1.4. Cooling Tube

A throat cooling tube is not included with this machine configuration, but can be added as an option or retrofitted at a later date.

### 2.1.5. Isolation Valve

A pendulum style valve is located in a separate isolation chamber, to isolate the receiving chamber from the growth chamber. The isolation valve maintains furnace tank pressure and temperature conditions while allowing operator access to the receiving chamber.

There is a hinged rear door for access and cleaning.

The valve plate is lifted, lowered, and rotated using pneumatic actuators. The lift cylinder applies a positive force to the valve plate when in the down position.

| | |
|---|---|
| Ports: | (1) Ø60 mm viewport in front. |
| Isolation Valve Throat I.D. | 400 mm (15.75 in) |

### 2.1.6. Receiving Chamber

The receiving chamber is a cylindrical enclosure above the isolation valve. There is a hinged access door located at the lower portion of the chamber.

| | |
|---|---|
| Receiving Chamber I.D. | 400 mm (15.75 in) |
| Receiving Chamber Height | 3700 mm (145.7 in) |
| Ports: | (2) Seed sensing ports |

| | |
|---|---|
| | (1) 38mm viewport in access door |
| Lower Door opening | 350 mm square (13.8 in) |
| Upper Door opening | 200 mm round (7.9 in) |

### 2.1.7. Leveling Adapter

The leveling adapter is the assembly that closes the top of the upper receiving chamber, and supports the seed lift. The top flange is adjustable to allow the seed rotation axis to be plumbed vertical. The leveling adapter has one port where argon is introduced, one for the melt pyrometer, and one port for the auxiliary vacuum. A 0-1000 torr manometer is connected to report chamber pressure above the isolation valve when the valve is closed.

## 2.2. Chamber Lift Apparatus

Operators can raise chamber sections off the furnace baseplate (for furnace charging and maintenance) using the grower lift controls. Column mounted hydraulic cylinders vertically move the chambers for service and access.

Chamber lift equipment includes a dedicated hydraulic pumping unit and connecting hoses, collectively referred to as the Hydraulic System, providing power to the lift cylinders. Flow fuses stop hydraulic oil flow if rate is excessive.

See **Section 7.0** for drawings and schematics.

### 2.2.1. Receiving Chamber Lift

The receiving chamber lift raises either the receiving chamber or the receiving chamber and tank cover (when the tank cover is coupled using the user selectable locking ring).

The receiving chamber lift is rotated to the side by an electric motor, controlled from an operator pendant.

| | |
|---|---|
| Receiving Chamber Lift, Total Vertical Travel | 810 mm (31.9 in) |

### 2.2.2. Furnace Tank Lift

The Furnace Tank Lift is rotated to the side by an electric motor, controlled from an operator pendant.

| | |
|---|---|
| Furnace Tank Lift, Total Vertical Travel | 1,450 mm (57.0 in) |

## 2.3. CRUCIBLE LIFT MECHANISM

This lift mechanism utilizes a slide way and Acme lead screw for vertical motion of the rotating parts, assuring rigidity and accuracy and eliminating back-drive effects. A stepper motor drives the lead screw through a gear reducer and reinforced-belt drive train for both jog and process speeds.  A stainless steel bellows maintains a vacuum seal through the full range of vertical motion.

Electrical limit switches inhibit operation of the lift motor at the extremes of lift travel.

A DC servomotor rotates the crucible shaft through a gearbox and multi-V-belt drivetrain, providing high torque without introducing vibration.  The shaft rotation seal is a magnetic fluid type.  Jacking screws are provided to center the crucible shaft in the baseplate.

A pneumatic brake is supplied to lock the shaft for hot zone removal needs.

### 2.3.1. OPERATING SPECIFICATIONS

| | |
|---|---|
| Load rating (at crucible lift shaft) | 800 kg (1763 lbs) |
| Lift Speed and Accuracy | 0-127 mm/hr (0-5.0 in/hr) ± 1% of reading, or ± 0.25 mm/hr (0.01 in/hr), whichever is greater |
| Jog Speed (nominal) | 127 mm/min (5 in/min) |
| Total Vertical Travel | 850 mm (33.5 in) |
| Rotation Rate and Accuracy | 0-12 RPM ± 1% of reading, or ± 0.03 RPM, whichever is greater |

### 2.3.2. CRUCIBLE SHAFT

The crucible shaft is a hollow, water-cooled, rigid spindle constructed of 303 stainless steel.  Its end mount is specially designed to eliminate loosening of the loaded graphite pedestal when hot.  The coolant supply to the shaft comes through a rotary union.

| | |
|---|---|
| Cylindrical diameter above rotation seal | 120 mm (4.72 in) |

# 2.4. Seed Lift Mechanism

This lift mechanism is an evacuated aluminum enclosure that houses a translating spool, and a pulley suspended from a loadcell to measure the weight on the cable. The lift housing rotates about a hollow vertical shaft; its on-board circuitry connects with the rest of the system through a slip ring assembly. The load cell signal is digitized before being transmitted through the slip ring to minimize signal losses. The mechanism is statically balanced to provide vibration-free operation throughout its range of rotation rates. The lift spool driveshaft and housing rotation seals are a magnetic fluid type.

A stepper motor coupled to a gear reducer drives the cable spool for both process and jog speeds. A DC servomotor rotates the lift housing through a gearbox and multi-V-belt drive train, providing high torque without introducing vibration.

The seed lift limit switches and encoder are located outside of the vacuum.

Remote operation of the lift motor is provided on the same operator pendant used for the receiving chamber motion.

## 2.4.1. Operating Specifications

| | |
|---|---|
| Load rating (at seed cable interface) | 600 kg (1322 lbs) |
| Lift Speed and Accuracy | 0-508 mm/hr (0-20 in/hr) ± 1% of reading, or<br>± 0.51 mm/hr (0.02 in/hr), whichever is greater |
| Jog Speed (nominal) | 400 mm/min (15.7 in/min) |
| Total Usable Vertical Travel | 8700 mm (342 in) |
| (based on using maximum cable length) | |
| Rotation Rate and Accuracy | 0-20 RPM ± 1% of reading, or<br>± 0.05 RPM, whichever is greater |

## 2.4.2. Seed Cable

The machine is supplied with a counter-wound tungsten cable assembly. The cable, ball ends meet military specifications, and are proof load tested to 653 kg (1440 lb).

| | |
|---|---|
| Nominal diameter | 4 mm (.157 in) |
| Maximum cable length | 10,546 mm (415.2 in) |

| | |
|---|---|
| Supplied cable length | Per customer requirements |

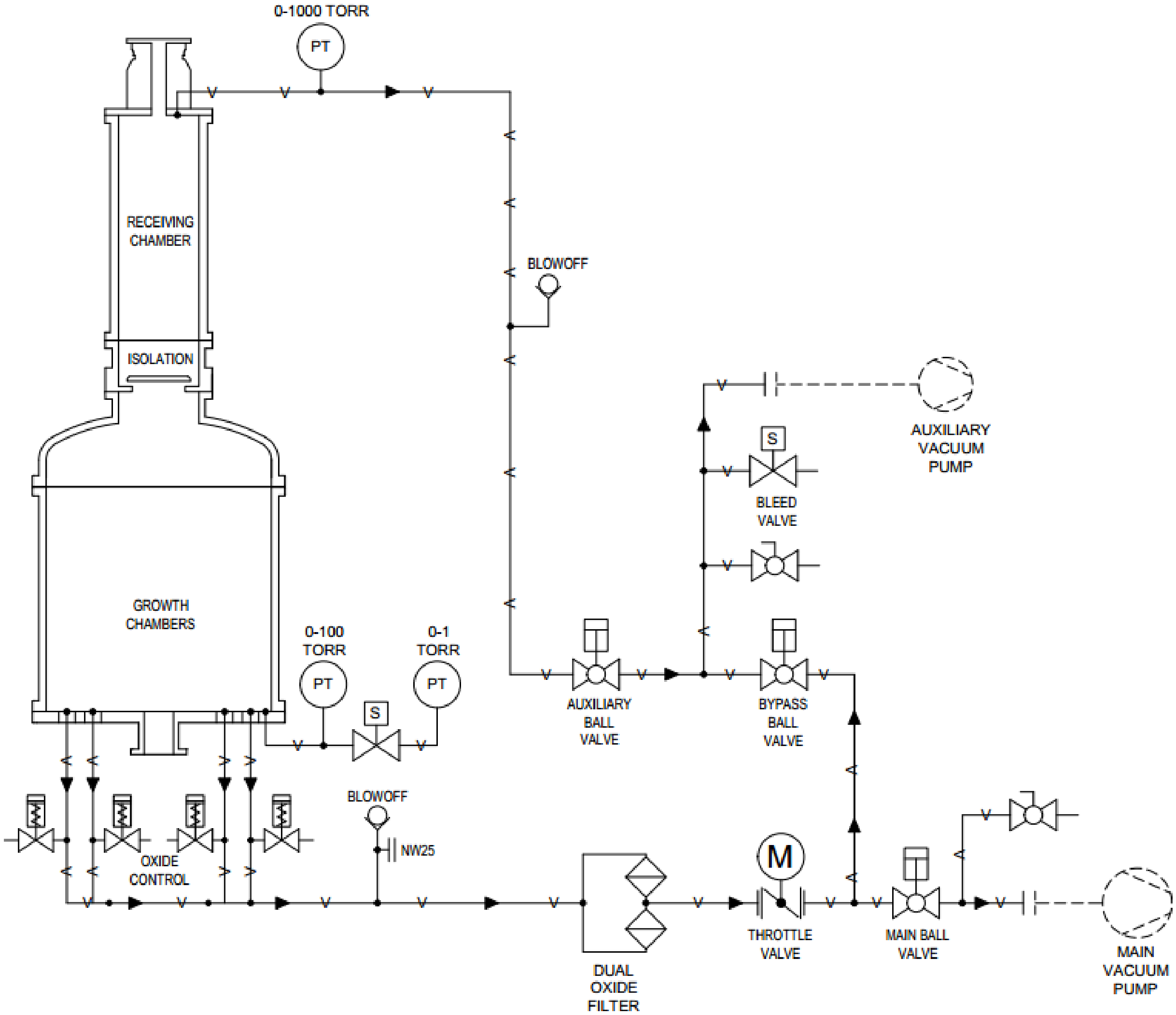
**NOTE**: Cable load capacity decreases with use.

## 2.5. SHIELD LIFT

The machine is designed to accommodate a two-point shield lift mechanism on the tank cover. The position of the shield can be controlled via the touchscreen in manual mode, and also via the computer in automatic mode. A ramp table is used to control the motion in automatic mode. The two shield lift ports are 180 degrees apart on the furnace tank cover.

| | |
|---|---|
| Lifting capacity | 200 kg (441 lbs) |
| Nominal Speed | 68 mm/min (2.68 in/min) |
| Max. Stroke | 400 mm (15.7 in) |

# 2.6. Vacuum System




System components are constructed of stainless steel. The system valves are high vacuum, pneumatic-driven ball valves.

## 2.6.1. Main Vacuum System

The main vacuum system provides the tubing and valves to evacuate from the baseplate to the leveling adapter or, if the isolation valve is closed, the growth chambers only. The system includes a throttle valve for chamber pressure control that is independent of gas flow. An NW25 flange and blank off have been added to the main vacuum line at the back of the grower for leak checking and vacuum cleaning. The flange for the main vacuum pressure relief (blowoff) is designed to be above the operator floor for easier access for cleaning. The four (4) vacuum lines are water cooled where they attach to the baseplate to preserve the o-ring seals.

| | |
|---|---|
| Line size O.D. | 152.4 mm (6.0 in) |
| Line size O.D.-After the first tee | 101.6 mm (4.0 in) |
| Line size O.D. at connection point | 101.6 mm (4.0 in) |
| Valve size (Full port ball valve) | 100 mm (4.0 in) |
| Throttle Valve bore | 63 mm (2.48 in) |

### 2.6.2. AUXILIARY (RECEIVING CHAMBER) VACUUM SYSTEM

The auxiliary vacuum system provides the tubing and valves to evacuate the receiving chamber and to equalize its pressure with furnace tank pressure during isolation.

The flange for the auxiliary vacuum pressure relief (blowoff) is designed to be above the operator floor for easier access for cleaning

The system features a stainless steel flex line, maintaining a flexible connection to the receiving chamber when raised and rotated.

| | |
|---|---|
| Auxiliary system line O.D. | 38.1 mm (1.5 in) |
| Valve size (Full port ball valve) | 38.1 mm (1.5 in) |

### 2.6.3. BYPASS BALL VALVE

A bypass valve is installed in order to provide vacuum to the growth chambers if the main vacuum pump is not operational.

| | |
|---|---|
| Valve size (Full port ball valve) | 76.2 mm (3.0 in) |

### 2.6.4. VACUUM GAUGES

Two (2) electronic manometers report chamber pressure below the isolation valve within the ranges of 0-1 torr, and 0-100 torr. The connecting tubing for the gauges below the isolation valve is ¾” [19.1 mm] diameter to help prevent clogging.

A 0-1000 torr manometer is connected to the leveling adapter to report chamber pressure above the isolation valve when the valve is closed.

### 2.6.5. Oxide Control System

The main vacuum system is equipped with four (4) air injection valves for oxide control. Actuation of the valves can be controlled by the recipe. The valves are located on the vacuum lines below the baseplate.

| | |
|---|---|
| Flow rate: | Fixed at approximately 5 liters/min or less from each injector. |

### 2.6.6. Oxide Filter

An optional dual canister oxide filter assembly will be provided with the system

### 2.6.7. Main Vacuum Pump

Optional – consult with LCT sales for available options.

### 2.6.8. Aux. Vacuum Pump

Optional - consult with LCT sales for available options.

### 2.6.9. Vacuum Integrity

The system passes testing with a helium mass spectrometric leak detector at a sensitivity of $1 \times 10^{-8}$ $cm^3$ (standard atmosphere)/sec. The control system automatically performs a rate-of-rise test of the furnace after each pumpdown state before proceeding with heater turn-on and charge meltdown.

All static chamber seals are Viton O-rings.

Rotation seals for the seed lift and crucible lift assemblies are a magnetic fluid type.

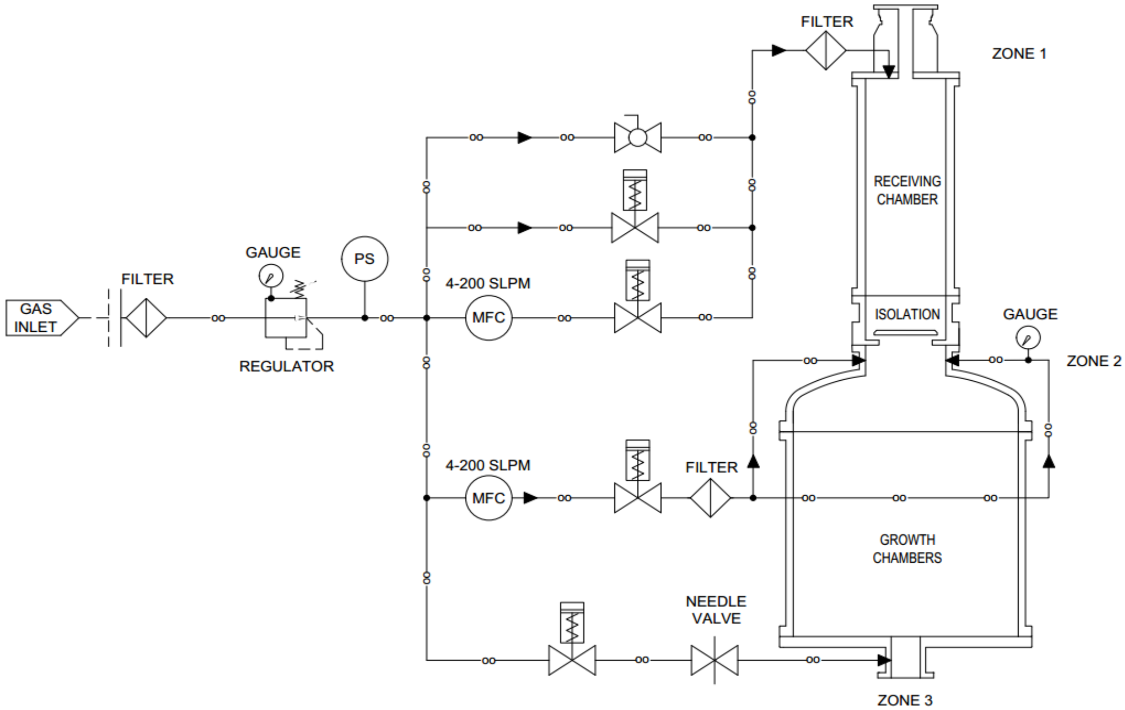
Nominal vacuum 25 mtorr typical

(Value is a function of the pump as well as the grower vacuum system)

Leak rate (rate of pressure rise) 50 mtorr / hr

# 2.7. ARGON SYSTEM

The system introduces process gas through a mass flow controller into the furnace t several points during growth runs.




The Argon distribution points are as follows:

## 2.7.1. ZONE 1: LEVELING ADAPTER

Argon that is distributed from the leveling adapter issues from an annular baffle, minimizing turbulence in the chamber.  There are (3) valves that allow flow to this entry point.

Valve 1: Manually actuated

Valve 2: Automatically actuated, non-mass flow controlled

Valve 3: Automatically actuated with mass flow control

## 2.7.2. ZONE 2: TANK COVER THROAT

Diffusers are incorporated into the two (2) argon connection points located 180°apart on the neck of the tank cover.

Valve 4: Automatically actuated with mass flow control

## 2.7.3. ZONE 3: BASEPLATE NECK

An automatic valve and needle valve are provided in the line to supply controlled argon flow to the connection on the neck of the baseplate center port.

Valve 5: Automatically actuated, non mass flow controlled.

## 2.7.4. COMPONENTS

### 2.7.4.1. Argon Filters

An argon filter is provided at the facility inlet to capture potential contamination in facility lines before it enters the grower.

Argon filters are also provided at the (2) chamber entry points to reduce line contamination in the event of a backfill event.

### 2.7.4.2. Mass Flow Controller (MFC)

There are two (2) mass flow controllers in the argon system. They precisely control flow of argon gas into the growth chambers.

| | |
|---|---|
| Gas flow range | 4–200 slpm |

### 2.7.4.3. Pressure Switch (PS)

A pressure switch monitors for a low pressure condition after the pressure regulator.

### 2.7.4.4. Valves and Regulators

Four (4) automatic valves in the argon panel assembly open and close the distribution lines that feed the various argon zones (see diagram below). A manual valve allows the operator to bypass the automatic valve and supply argon to the connections in the leveling adapter in the event of a power outage. A regulator is used before the mass flow controllers to ensure consistent gas flow at each machine.

### 2.7.4.5. Seals and Tubing

The argon system is constructed of stainless steel tubing and flexible stainless steel lines. The integrity of the argon system passes testing with a helium mass spectrometric leak detector at a sensitivity of $1\times10^{-8}$ $cm^3$ (standard atmosphere)/sec.

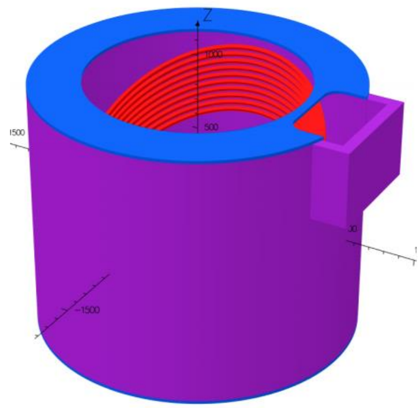
## 2.8. SUPERCONDUCTING MAGNET SYSTEM

The magnet system consists of (5) major components, the Magnet Coil, the Magnet Power Supply, Magnet Lift System and (2) Helium compressors.

The magnet coil contains superconducting skewed solenoid coils housed in a supporting enclosure that is attached to a lift mechanism.

The magnet encircles the furnace tank and provides a magnetic field that is focused on the melt during crystal growth.  The focus level of the opposing fields is set to optimize crystal growing conditions just above the melt surface where the crystal is continually forming at the transition from liquid to solid crystalline state.

The operator varies the field strength by adjusting the magnet current using touch screen controls at the KICCS™ console.  To control field strength during automatic growth KICCS™ adjusts current flow in the magnet coils per the SOP.



### 2.8.1. MAGNET COIL (MC)

| | |
|---|---|
| Magnetic Field rating: | 4,000 Gauss |
| Field Type: | Transverse |

### 2.8.2. MAGNET COOLING (MHC)

Magnet cooling is achieved using two (2) closed loop helium compressors and (2) cold heads

### 2.8.3. MAGNET POWER SUPPLY (MPSU)

The magnet power supply is a 19” rack mounted supply cabinet

### 2.8.4. MAGNET LIFT SYSTEM

The grower frame is designed to accept a magnet lift system.   The lift system is supplied with the MCZ and MCZR configurations.   It can be added later to MCZC configurations.

The magnet coil is raised up into position during growth. The magnet can only be operated within the range defined by a limit switch (this range is in the upper position of the magnet lift). The position of the magnet can be adjusted during growth to meet the process requirements.

For access to the lower portion of the hot zone, the magnet coil can be lowered down towards the base frame.

| | |
|---|---|
| Lifting actuator – qty (4) | Acme screw – Ø60mm x 9mm pitch |
| Nominal Speed | 254 mm/min (10 in/min) |

## 2.9. PNEUMATIC SYSTEM

The machine requires clean compressed dry air to actuate several air-operated valves. Due to the fact that all of the pneumatic components (except the optional vacuum pump) only require small quantities of compressed air for short periods of time, the average flow rate is very small. A pressure switch (PS) monitors for low pressure conditions. See **Section 7.0** for pneumatic schematic.

## 2.10. COOLANT SYSTEM

The system removes excess heat from grower components. Outlet sensors monitor coolant temperature and flow conditions. Heater power supply output will be disabled if minimum coolant flow conditions are not met. Surface sensors monitor the external temperature of the furnace and set off an alarm in case of malfunction. The main inlet manifold has a pressure relief for system overpressure.

| | |
|---|---|
| Outlet coolant temperature sensor | Resistive device, triggering visible/audible warnings |
| Outlet coolant flow sensor | Normally Open, interlocked with heater power supply control |
| Surface temperature sensors | bi-metal switches; 60º C (140º F) activation, triggering visible/audible warnings |
| System pressure relief | 4.5 bar (65 psig) |

### 2.10.1. COOLANT SYSTEM CONSTRUCTION

Inlet and outlet manifolds are constructed of stainless steel. Connecting hoses are terminated with brass fittings. Shutoff valves are included on all branch circuits to allow for easy maintenance and to reduce the flow of individual circuits, if desired. The cooled port covers on the tank cover are constructed of stainless steel.

# 2.11. CONTROL SYSTEM

The control system hardware is distributed in various points on the grower, and in a compact, caster-mounted unit known as the operator console. Grower operators control all signal processing and machine functions from the console.

The control system can run the entire crystal growth process automatically from pumpdown to shutdown. When a situation requires operator intervention, audible and visible signaling draws attention and prompts specific actions.

Manual switches retain control over the on/off state of such safety critical elements as the power supply unit(s), vacuum pumps, and the hydraulic pump. The control system monitors the status of all process-related manual switches.

An un-interruptible power supply (UPS) is required to ensure control of the grower and a safe shutdown in case of a power failure. See section 6.1 for the UPS requirements.

## 2.11.1. COMPUTING HARDWARE

The main controller is a Siemens ® 300-series PLC. Complex control algorithms and recipe interpretation are performed by a separate fan less, all-solid-state embedded computer. All program and data storage resides in flash memory.

The Krystal Vision diameter control system also resides in the embedded computer with hardware for communication and video acquisition. All program and data storage resides in flash memory.

A Microsoft Windows® compatible ancillary PC is provided for operation of the Windows based support programs.

## 2.11.2. OPERATOR INTERFACE

Two LCD touch-panel displays are included in the operator console.

The first display provides the control interface and Krystal Vision. All control of the process and furnace hardware is performed at this interface. Operator interaction is via touch screen integrated with the display.

The second display is used for the Windows-based recipe editing software and ancillary programs. Operator interaction is also available via a separately mounted keyboard and pointing device.

### 2.11.3. Control Software

All system control is performed by custom software resident in the PLC and the main embedded computer, which also provides operator interface functions. Execution of the process recipe is also performed by the main embedded computer, using recipes loaded from the ancillary PC.

The ancillary PC is not directly responsible for any control functions.

### 2.11.4. Ancillary Software

**Software Interfaces:**

Software supplied in the ancillary computer includes recipe editing and data collection capabilities.

**Recipe Editing:**

Recipes can be stored on an optional central WINGS server, with local editing and data monitoring functions provided at the ancillary computer. For standalone operation, a WINGSLite recipe editor is provided standard on the ancillary computer.

### 2.11.5. Process Temperature Control

An optical pyrometer measures temperature of the heater, providing for closed loop heat control.

Control loop performance: Heater temperature shall remain within ±0.5° C of any preset temperature after achieving control set point.

### 2.11.6. Seed Position Sensor

The sensor assembly consists of optical and electronic equipment that sets up an object detection range across the lower part of the receiving chamber. When seed or crystal breaks the infrared beam, the sensor transmitter sends a digital input to the control system.

### 2.11.7. Seed to Melt Contact System

System circuitry monitors the seed during the entire growth process and senses when the seed is in contact with the melt. Process control algorithms use this signal for process sequencing and operator alerts.

### 2.11.8. KRYSTALVISION™ DIAMETER CONTROL SYSTEM

The diameter system uses a high-resolution camera assembly to watch a target range across the surface of the silicon melt. Video is transmitted to the Krystal Vision computer via Gigabit Ethernet. Krystal Vision software performs measurements and preprocessing and communicates results to the process controller. Video display of crystal growth and measurement is provided.

Resolution of the measurement system is approximately ±0.05 mm.

The diameter control system performance specifications are as follows (divided according to crystal section):

| | |
|---|---|
| Shoulder | ±6 mm for the initial 40 mm over shoulder |
| Full body | ±2.5 mm over full length of straight body growth (Excluding initial 40 mm over shoulder) |
| Short term body | ±1 mm over 100 mm of straight body growth, measured between facets or perturbations through a uniform cross section. |

Note: exceptions to the above specifications will occur when factors other than control loop functions cause straight body tapering in excess of 2 mm/m.

## *2.12. HEATER POWER SUPPLY*

Power-regulated outputs provide unfiltered DC from a water cooled IGBT-controlled power supply. The system is designed for (4) live electrodes on the main heater and (2) live electrodes on the bottom heater.

| | |
|---|---|
| Output power | 200 kw @ 55 VDC<br>60 kw @ 40 VDC |

# 2.13. MACHINE AND COMPONENT WEIGHTS

## 2.13.1. MACHINE

| | |
|---|---|
| Machine (less items in 2.13.3) | 17,350 kg (38,240 lbs.) |

## 2.13.2. RIGGING WEIGHTS OF ASSEMBLIES ON MACHINE

*Below are the uncrated weights of assemblies that will need to be handled during installation. The values below are included in the total weight of the machine section listed above.*

| | |
|---|---|
| Main Frame assembly** | 3,780 kg (8,331 lbs) |
| Frame supports*** | 4,300 kg (9,500 lbs) |
| Column assembly | 4,900 kg (10,800 lbs) |
| FT lift arm | 394 kg (868 lbs) |
| Tank Cover/ ISO valve assembly | 1,016 kg (2,240 lbs) |
| Receiving Chamber | 486 kg (1,071 lbs) |
| Furnace tank | 825 kg (1,818 lbs) |
| Leveling adapter: | 78 kg (172 lbs) |
| Seed Lift | 240 kg (529 lbs) |

** Main Frame assembly weight includes frame, chamber stand, baseplate, crucible lift, main vacuum system and magnet lift components.

***Frame supports will consist of multiple pieces and will be assembled to the frame upon installation.

## 2.13.3. COMPONENTS (NOT INCLUDED IN MACHINE WEIGHT ABOVE)

| | |
|---|---|
| Heater Power Supply | 1405 kg (3096 lbs) |
| Hydraulic Pump (w/ oil) | 68 kg (150 lbs.) |
| Main Contactor box | 13 kg (29 lbs.) |
| Control console | 100 kg (220 lbs.) |
| Magnet Coil | 15,000 kg (33,060 lbs) |
| Magnet Power Supply Cabinet | 200 kg (440 lbs) |

| | |
|---|---|
| Magnet Helium Compressor (x2) | 100 kg (220 lbs) |
| Cooling Manifold skid | 122 kg (270 lbs) |
| Vacuum Valve skid | 138 kg (304 lbs) |
| Dual Filter arrangement | 440 kg (970 kg) |

# 3. Airborne Noise Emissions

The sound pressure level is < 70 dB

# 4. Water Quality

The cooling water specification was written for the three (3) general situations normally encountered. The cases are—

1. Tap water coolant
2. Closed-loop tap water coolant
3. Deionized water closed-loop system

**Case 1 – Tap Water Coolant:**

Source is recirculated or non-recirculated drinking water. Water drawn from a local well will require more critical monitoring than water from a municipal supply.

In any case, chemical composition varies, so check supply water and water in the system periodically (every 1–6 mo) per tabulated water quality chemical requirements.

**Water Quality Chemical Requirements**

*All values are expressed in milligrams per liter (PPM) unless otherwise labeled.*

| | |
|---|---|
| Conductivity (specific conductance) | 250–350 µmhos/cm |
| Alkalinity, total | 80–90 |
| Carbon Dioxide | 1.5–2.5 |
| Conductivity | 250–350 standard units |
| Dissolved Solids | 175–275 |
| Fluoride | 0.5–1.0 |
| Hardness | 125–150 |
| Chloride | 20–30 |
| Iron | 0.01–0.03 |
| Magnesium | 6–12 |
| Potassium | 0.7–1.4 |
| Sodium | 10–20 |

| | |
|---|---|
| Sulfate | 20–30 |
| Turbidity | 0–0.2 |
| pH | 7.0–8.0 |
| Nitrate | 0.5–1.5 |
| Metals (each) | <0.05 |

LCT recommends a 5 µm in-line filter for contaminants in the coolant system.

**Case 2 – Closed-loop Tap Water Coolant:**

The quality requirements are as listed above. However, closed-loop systems also should include microbiological and chemical corrosion inhibitors, water additives that are widely available from industrial suppliers. To select the proper algaecide and corrosion inhibitors, consult with the supplier. Discussion about system construction should refer to the following materials: 304L stainless steel, anodized aluminum, and copper alloy fittings.

**Case 3 – Deionized Water Closed-loop System:**

Analyze chemical characteristics of system water constantly, and closely monitor the impurities present.

LCT recommends a periodic total analysis of system water for soluble solids (use emission spectrography, if possible, to perform trace analysis). A 0.22 µm in-line filter will remove bacteria or any corrosion-generated solids or other contamination. Prevent acidity in deionized water, as it becomes extremely reactive: the water must be neutral or slightly alkaline (7.0–7.5 pH) at all times.

**NOTES**

**Note 1**: The facility should be capable of supplying minimum flow rates and recommended pressures as specified. Specifications are meant to be facility guidelines and are not intended as absolute maximums or limits to facility designs. Refer facility design to qualified engineers in that field.

**Note 2:** Minimum flow rates and pressures are defined for new chambers with clean internal water jackets only. Aging of components or internal buildup of deposits will require increased flow rates.

**Note 3:** LCT recommends use of pressure regulators on inlet coolant lines.

**Note 4:** Minimum required flow rates take precedence over maximum differential pressures.

# 5. Overall System Safety

The crystal grower has many built-in safety features in the hardware and software.

For a description of grower control software alarms and interlocks, refer to the *Control Interface Operation* manual. The following lists contain the safety features of the grower mechanical systems.

*** SYSTEM SAFETY FEATURES ***

**HEATER POWER SUPPLY (typical)**

1. Input AC reactor (power factor correction) - Fused
2. Overload protection on input to main power transformer - Unit shuts down
3. Thermal switch on main power transformer - Unit shuts down
4. Thermal switches on power semiconductor devices - Unit shuts down
5. Thermal switches on power output chokes - Unit shuts down
6. Over current protection - Alarm; power cycles between off and set point
7. Ground fault protection - Alarm
8. Control circuit transformer - Fused on primary side
9. Voltmeter circuit - Fused
10. Contactor Box supply - Fused

**CRYSTAL GROWER**

1. Flow switch - Shuts heater off after low flow activation (typically 30 sec)
2. Thermal skin sensors (one on each chamber and one on each electrode) - Alarm
3. Low/High pressure inside grower, including vacuum pump malfunction - Alarm
4. Seed lift upper and lower travel limits - Shuts motor off
5. Crucible lift upper and lower travel limits - Shuts motor off
6. Over pressure inside grower - Mechanical blow-off (4 places):
   a. Furnace Tank vacuum line
   b. Receiving Chamber vacuum line
   c. Chamber separation at tank cover
   d. Water pressure relief on inlet water manifold
7. All AC and DC circuits - Fused

8. Hydraulics - Disabled when heater is on – unless receiving chamber is not under vacuum
9. Heaters - Disabled when furnace section is open
10. Furnace tank lift - Disabled until receiving chamber/tank cover is fully swung aside
11. Flow fuses in hydraulic circuits - Stops flow if out of control
12. Overload protection on three (3)-phase power for hydraulic pump (and optional vacuum pumps) - Resettable circuit breaker.
13. Overcurrent protection in all 4 motor drives - Protected electronically and fused
14. Emergency backup panel - Provides control over many items in event of computer malfunction, i.e., heater power level, gas and vacuum valves and crucible/seed position.
15. Mimic Panel - Graphic display of valve positions, water flow and argon supply, and overheat location, ongoing in event of console monitor failure
16. Mechanical vacuum gauge - Measures chamber internal pressure, ongoing in event of computer, monitor, or power failure (Furnace Tank only if isolated)
17. Argon bypass valve - Allows controlled gas flow into tank if power fails
18. Pneumatic-driven vacuum line valves - No oil back streaming, even if power fails
19. Computer keyboard port - Allows input in event of touch screen failure
20. 12 volt power supply current - Protected electronically
21. 24 volt power supply current - Protected electronically
22. Tank cover guide - Aligns PC/TC assembly to seat on furnace tank
23. Furnace tank guide - Prevents chamber swing into Hot Zone parts
24. Isolation Valve position switch - Provides valve position feedback to control system
25. Seed Lift software limit - Shuts lift off when seed travel exceeds preset limit
26. Compressed air switch - Alarm for facility low pressure
27. Skirt on flange of tank cover to deflect gasses downwards.
28. Magnet Safety Switches – will disable magnet lift drive when (1) or more switches are actuated. These devices also provide mechanical safety when working on the magnet lift system

# 6. Facility requirements

Utility Matrix: "**X**" denotes that a facility connection is required to be supplied (by others).

| COMPONENT/ASSEMBLY | UTILITY | | | | |
|---|---|---|---|---|---|
| | ELECTRICAL POWER | COOLANT | ARGON | AIR | VENT |
| | E | C | Ar | A | V |
| Machine (M) | from CENC<br>from HPSU | **X** | **X** | **X** | |
| Hydraulic Pump (HPU) | from CB | | | | |
| Controls Enclosure (CENC) | **X** From UPS | | | | |
| Main Contactor Box (CB) | From HPSU | | | | |
| Dual Heater Power Supply (HPSU) | **X** | **X** | | | |
| Main Vacuum Pump | **X**[1] | **X** | | **X** | **X** |
| Auxiliary Vacuum Pump | **X**[1] | | | | **X** |
| Magnet Power Supply (MPSU) | **X** | | | | |
| Magnet Helium Compressor 2x (MHC) | **X**<br>**X** | **X**<br>**X** | | | |

1. Power for pumps supplied by Main Contactor Box only if pumps are supplied by LCT.

# 6.1. Electrical Power Requirements

## 6.1.1. Dual Heater Power Supply (HPSU)

The customer is responsible for locating the heater power supply in their location and providing input power connections.

| | |
|---|---|
| Voltage | 380, 400, 440, or 460 VAC(+/- 10%) |
| Phase | 3 |
| Frequency | 50/60 Hz |
| Current (Nom. Oper.) | 408 kVA (includes maximum current requirement from CB) |
| Input Power Connection: | Bus bar terminals |
| Disconnect: | Yes (Note: this does not disconnect auxiliary power connector) |
| Auxiliary Power Output: | (3) phase connector |

## 6.1.2. Main Contactor Box (CB)

The customer is responsible for mounting the Main Contactor Box in their facility. The Contactor Box receives power from the heater power supply auxiliary power connector via a 6.0 m (19.7 foot) cable supplied by LCT.

| | |
|---|---|
| Voltage | same as HPSU |
| Phase | same as HPSU |
| Frequency | same as HPSU |
| Disconnect: | Yes |
| Current (minimum) | 1 kVA (with no vacuum pumps supplied; hydraulic pump only) |
| Current (maximum) | 15 kVA (when hydraulic pump, main and auxiliary vacuum pumps supplied by LCT) |
| Power input connector | (3) phase connector |

## 6.1.3. Magnet Cooling / Helium Compressors (MHC)

Note: there are two (2) helium compressors each requiring the following:

| | |
|---|---|
| Phase: | 3 |
| Rated load current: | 16 amps |
| Voltage at 50 Hz: | 380-415V +/- 10% |
| Power consumption at 50 Hz: | 6.9 kW (8.5kW at startup) |

| | |
|---|---|
| Voltage at 60 Hz: | 480V +/- 10% |
| Power consumption at 60 Hz: | 7.5 kW (9.kW at startup) |

### 6.1.4. Magnet Power Supply (MPS)

The magnet power supply is a 19” rack mounted supply housed in a floor standing cabinet. The customer is responsible for locating the magnet power supply assembly in their location and providing input power connections.

| | |
|---|---|
| Voltage | 85-265VAC |
| Phase | 1 |
| Frequency | 47-63 Hz |
| Output: | 6V, 200A DC |

### 6.1.5. UPS Requirements (For the main control enclosure)

If the grower is equipped with an LCT supplied UPS, a cable is provided to provide power to the controls enclosure (CENC). If customer provides their own UPS, LCT will supply the mating power connector for the power input on the controls enclosure (CENC). The customer will need to provide the remaining components (ie. cable, UPS end connector) to make their own power cable.

The UPS output shall be full time (no switchover delay or glitches) and be sine wave with less than 5% total harmonic distortion.

| | |
|---|---|
| Output: | 220-230 VAC, 50 or 60 Hz, 1 phase, 3.6 kVA |
| Battery backup time: | Minimum of 20 minutes recommended. |
| Input: | Voltage and frequency to suit the available utilities. Usually the same as the output. |

# 6.2. COOLANT SUPPLY

The customer is responsible to supply cooling water (meeting the quality requirements defined in the **Water Quality** section) at the following locations:

## 6.2.1. MACHINE (M)

| | |
|---|---|
| Flow rate | 750 L/min (198 GPM) |
| Inlet temperature (Max.) | 25° C (77° F) |
| Temperature rise | 11° C (19° F) estimated |
| Inlet pressure (Max.) | 4.5 bar (65 psig) |
| Pressure differential (Min.) | 2.4 bar (35 psig)<br>(Supply pressure – Back Pressure) |
| Inlet Connection: | 2.5" FPT |
| Outlet Connection: | 2.5" FPT |

## 6.2.2. HEATER POWER SUPPLY (HPSU)

| | |
|---|---|
| Coolant flow rate (Min.) | 50 lpm (13.2 GPM) |
| Inlet pressure (Max.) | 6.0 bar (87 psig) |
| Inlet temperature (Max.) | 38° C (100° F) |
| Pressure differential (Min.) | 1.38 bar (20 psig)<br>(Supply pressure – Back pressure) |
| Inlet Connection: | 1" hose barb (clamp style) |
| Outlet Connection: | 1" hose barb (clamp style) |

## 6.2.3. MAGNET COOLING (MHC)

Note: there are two (2) helium compressors each requiring the following:

| | |
|---|---|
| Coolant flow rate (Min.) | 6-9 lpm (1.6-2.4 GPM) |
| Inlet pressure (Max.) | 6.0 bar (87 psig) |
| Inlet temperature (Max.) | 5-25° C (41-77° F) |
| Inlet Connection: | ½" MNPT |
| Outlet Connection: | ½" MNPT |

### 6.2.4. Emergency Backup Coolant

A backup coolant system is required. A 2 hour minimum emergency cool down period is required in the event of a failure in the furnace coolant loops. The backup water system excludes power supply unit(s) or vacuum pump (if so equipped). The backup supply should be gravity fed, or can be pump supplied *if the pump is powered by an emergency generator.*

**Furnace section:**

| | |
|---|---|
| Flow rate (Min) | 400 L/min (105 gpm) |
| Inlet temperature (Max) | 35° C (95° F) |
| Inlet pressure (Min.) | 3.79 bar (55 psig) |
| Pressure differential (Min.) | 3.44 bar (50 psig)<br>(Supply pressure – Back pressure) |

## 6.3. ARGON SUPPLY

The customer is responsible to supply Argon with the following specifications to the connection point on the machine:

| | |
|---|---|
| Inlet pressure (Min.) | 5.17 bar (75 psig) |
| Inlet pressure (Max.) | 10.34 bar (150 psig) |
| Argon quality | 99.998% pure per Semi spec C3.1-93 |
| Connection on machine: | ½" male Swagelok VCR (or equivalent) |

## 6.4. COMPRESSED AIR

The machine requires clean compressed dry air to actuate several air-operated valves. Due to the fact that all of the pneumatic components only require small quantities of compressed air for short periods of time, the average flow rate is very small. Nitrogen or argon may be substituted for compressed air.

### 6.4.1. MACHINE (M) CONNECTION

| | |
|---|---|
| Peak flow rate | 187 L/min (6.6 cfm) |
| Inlet pressure (Min.) | 4.82 bar (70 psig) |
| Inlet pressure (Max.) | 8.27 bar (120 psig) |
| Lockout/tagout shutoff: | Yes |
| Connection on machine: | 6mm tubing |

## 6.5. VENTING

### 6.5.1. MAIN VACUUM PUMP

Customer Supplied

### 6.5.2. AUXILIARY VACUUM PUMP

Customer Supplied

## 6.6. AMBIENT CONDITIONS

| | |
|---|---|
| Temperature | 50° F (10° C) to 86° F (30° C) |

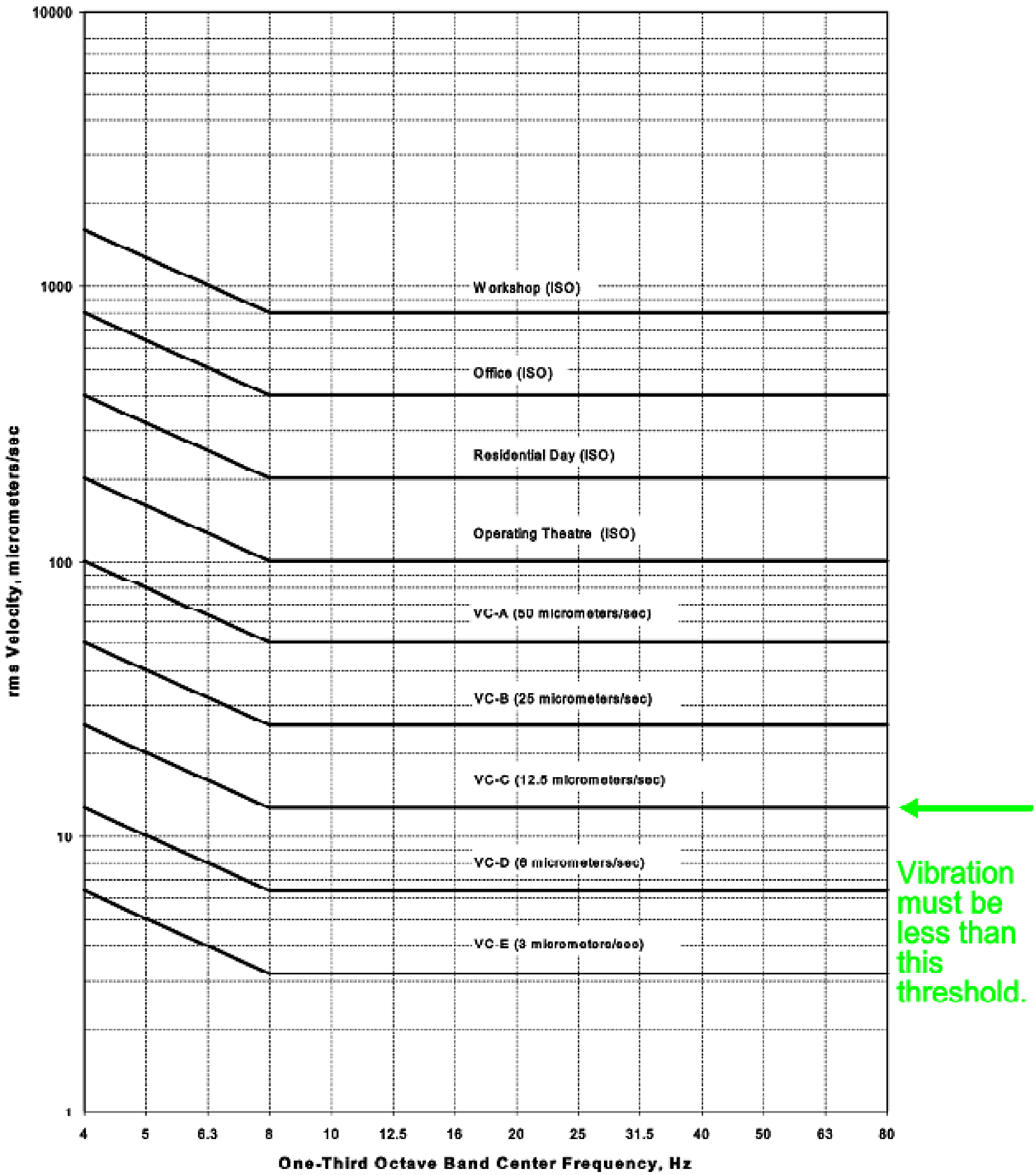
| | |
|---|---|
| Relative Humidity | 30% - 55% |

## 6.7. VIBRATIONS

The general vibration requirement for crystal growers is that they require a vibration free environment. Unfortunately, there is no specific vibration threshold that, if exceeded, will result in structure loss. The general principle is that as vibration levels increase … crystal yields tend to decrease. Therefore, it is critical that every effort be made to eliminate vibration sources as much as possible. When vibrations cannot be eliminated then isolating the grower from the vibrations is the next best option. Common sources of vibrations such as vacuum pumps and water lines should always be isolated.

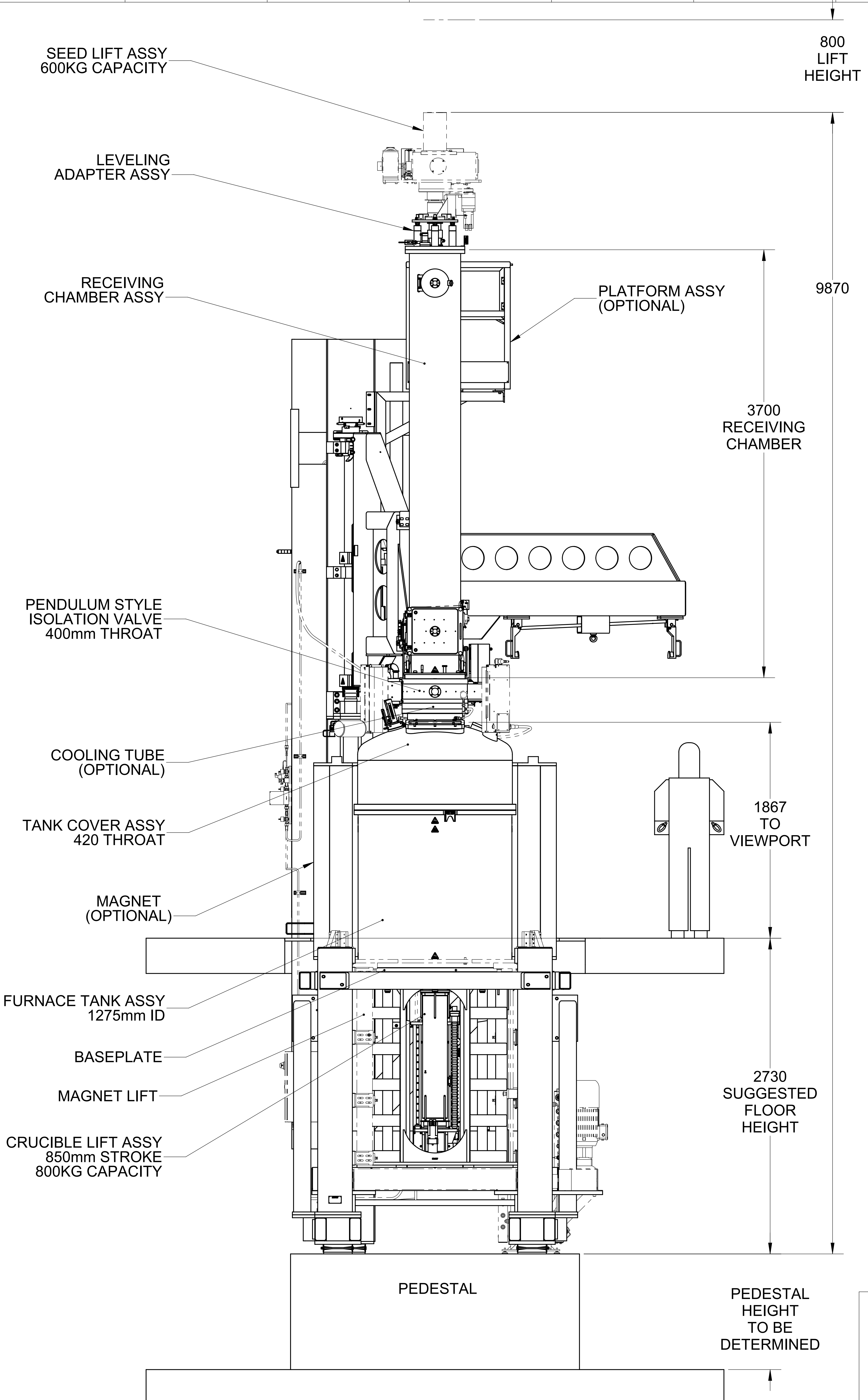
With that said, LCT does understand that in some circumstances it may not be economically feasible for a customer to eliminate all vibration energy. Therefore, based on testing LCT performed with the aid of a vibration consulting firm we have established a recommended maximum threshold (VC-C) for a crystal growing environment. (Please see the graph on the next page)

**Figure 1: Generic Vibration Criterion (VC) Curves for Vibration-Sensitive Equipment - Showing also the ISO Guidelines for People in Buildings (see Table 1 for description of equipment and uses)**



# 7. Drawings

| Drawing | Number |
|---|---|
| Elevation / Components, KX320 | 364-1304-1 |
| Chamber Layout, KX320 | 364-1269-1 |
| Electrode Layout, KX320 | 364-1270-1 |
| Frame Contact Locations | 364-1272-1 |
| Shield Lift Layout, | 364-1285-1 |
| Utilities, Water | 364-1282-1 |
| Utilities, Vacuum | 364-1283-1 |
| Utilities, Argon/Air | 364-1284-1 |
| Pedestal and Floor Opening | 364-1289-1 |
| Control Console | 364-1062-1 |
| Power Supply 200/60KW | 364-1291-1 |
| Hydraulic Pump | 364-1288-1 |
| Contactor J-Box | 364-1286-1 |
| Magnet Power J-Box | 364-1287-1 |
| Facility Sketch, KX320MCZ | 364-1271-1 |
| Diagram, Cable & Hose Lengths | |
| Diagram, Process and Instrumentation | |
| Schematic, Hydraulic System | 364-1012-1 |
| Schematic, Pneumatic System | 364-1290-1 |




| REV | ENGINEERING CHANGE NOTICE | DATE | BY | CHK |
|---|---|---|---|---|
| - | RELEASE PER ECN #2019-0019 | 6/7/2019 | BS | JR |

ALL PARTS MUST MEET LINTON SPECIFICATION #069-0009-1



METRIC
UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN mm.

HOLE TOLERANCES EXCEPT AS SHOWN

| | | | | |
|---|---|---|---|---|
| Ø1 | TO | Ø6 | +.15 | -.05 |
| Ø6.01 | TO | Ø13 | +.2 | -.1 |
| Ø13.01 | TO | Ø25 | +.3 | -.15 |
| Ø25.01 | AND | > | +.4 | -.2 |

MATERIAL

MACHINE SURFACES EXCEPT AS NOTED

TOLERANCES ON DECIMALS

| .X | .X | .XX | ANGLES |
|---|---|---|---|
| ± | ± | ± | ± 1/2° |

*UNLESS OTHERWISE SPECIFIED BREAK ALL SHARP EDGES APPROX. 0.5 R OR CHAMFER*

FINISH

| | |
|---|---|
| DRAWN: BARB SCHOENEMAN | DATE: 9/19/2018 |
| CHECKED: J. REESE | DATE |
| DESIGNER | DATE |
| ENGINEER: J. REESE | DATE |

PROJECTION

REL #

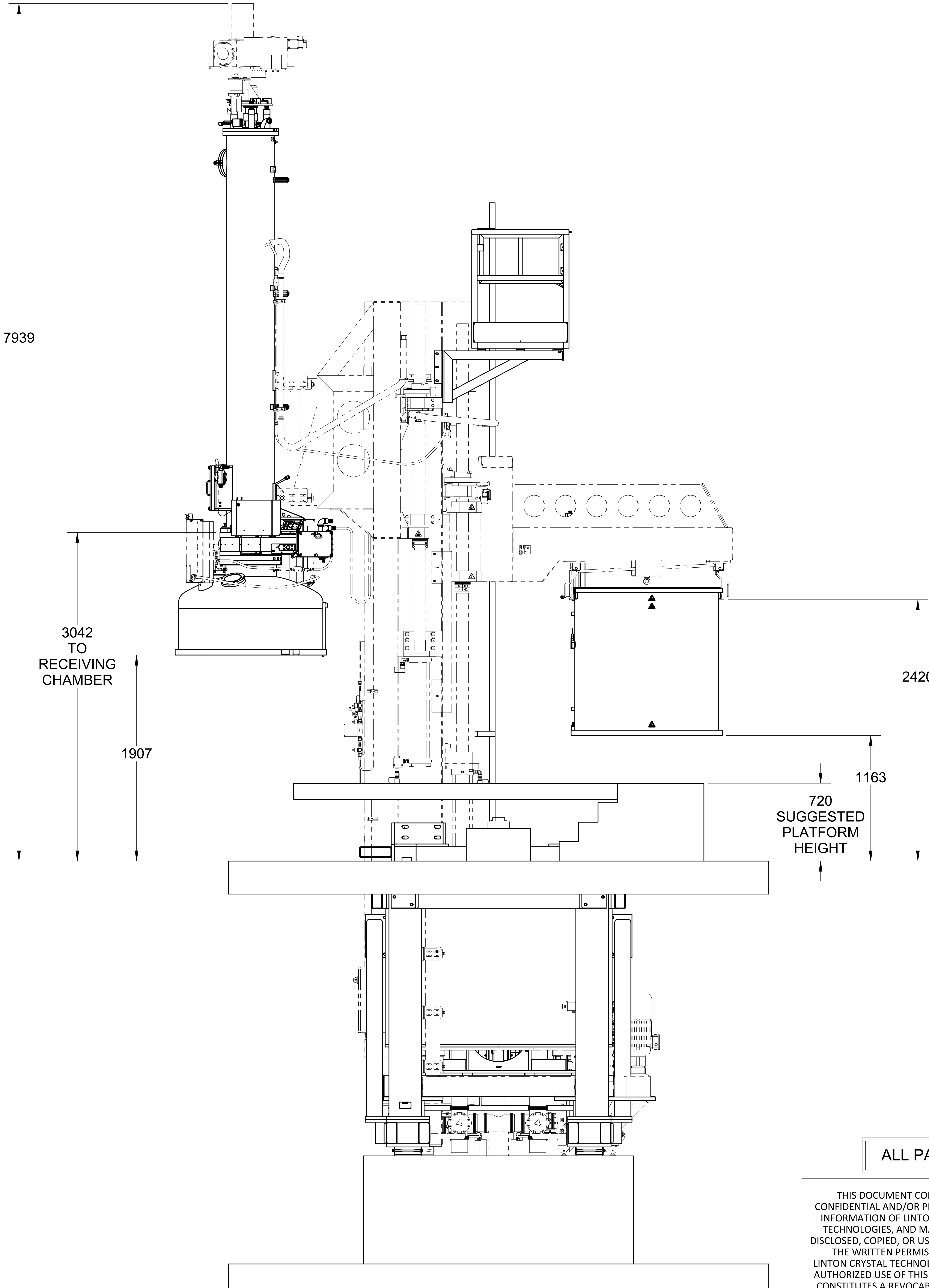
Linton Crystal Technologies

*2180 BRIGHTON-HENRIETTA TL RD.
ROCHESTER, NEW YORK 14623
U.S.A.*

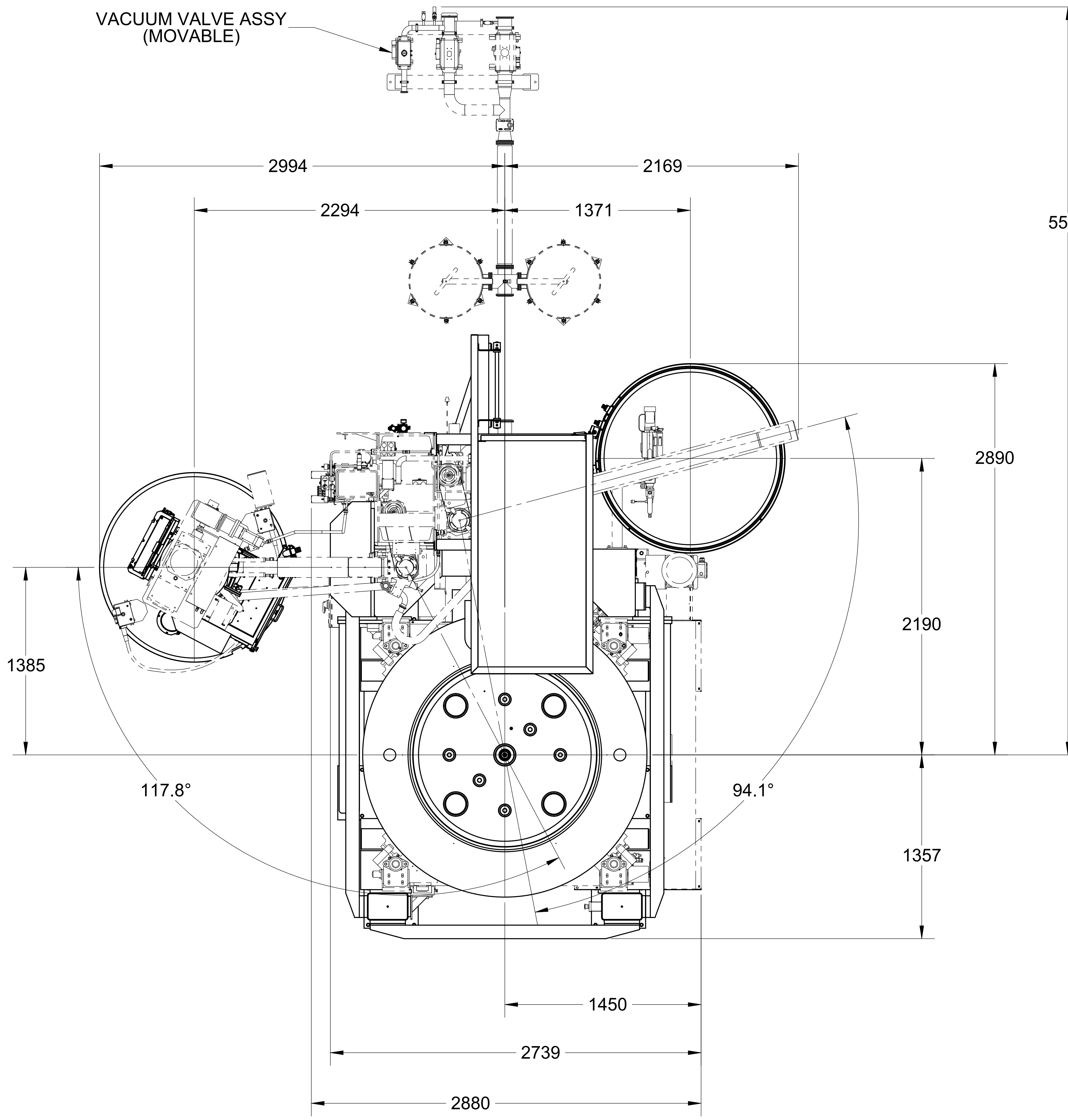
# KX320MCZ, ELEVATION & COMPONENTS

SIZE C | DWG NO 364-1304-1

SCALE 1:30 | SHT 1 OF 2




FRONT VIEW
CHAMBERS OPEN




TOP VIEW
CHAMBERS OPEN

ALL PARTS MUST MEET LINTON SPECIFICATION #069-0009-1



METRIC
UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN mm.

HOLE TOLERANCES EXCEPT AS SHOWN

| | | | | |
|---|---|---|---|---|
| Ø1 | TO | Ø6 | +.15 | -.05 |
| Ø6.01 | TO | Ø13 | +.2 | -.1 |
| Ø13.01 | TO | Ø25 | +.3 | -.15 |
| Ø25.01 | AND | > | +.4 | -.2 |

MATERIAL
SEE BOM

MACHINE SURFACES EXCEPT AS NOTED

TOLERANCES ON DECIMALS

| X. | .X | .XX | ANGLES |
|---|---|---|---|
| ± | ± | ± | ± 1/2° |

*UNLESS OTHERWISE SPECIFIED BREAK ALL SHARP EDGES APPROX. 0.5 R OR CHAMFER*

FINISH
--------

| REV | ENGINEERING CHANGE NOTICE | DATE | BY | CHK |
|---|---|---|---|---|
| - | | | | |

| | |
|---|---|
| DRAWN: BARB SCHOENEMAN | DATE: 9/19/2018 |
| CHECKED: J. REESE | DATE |
| DESIGNER | DATE |
| ENGINEER: J. REESE | DATE |

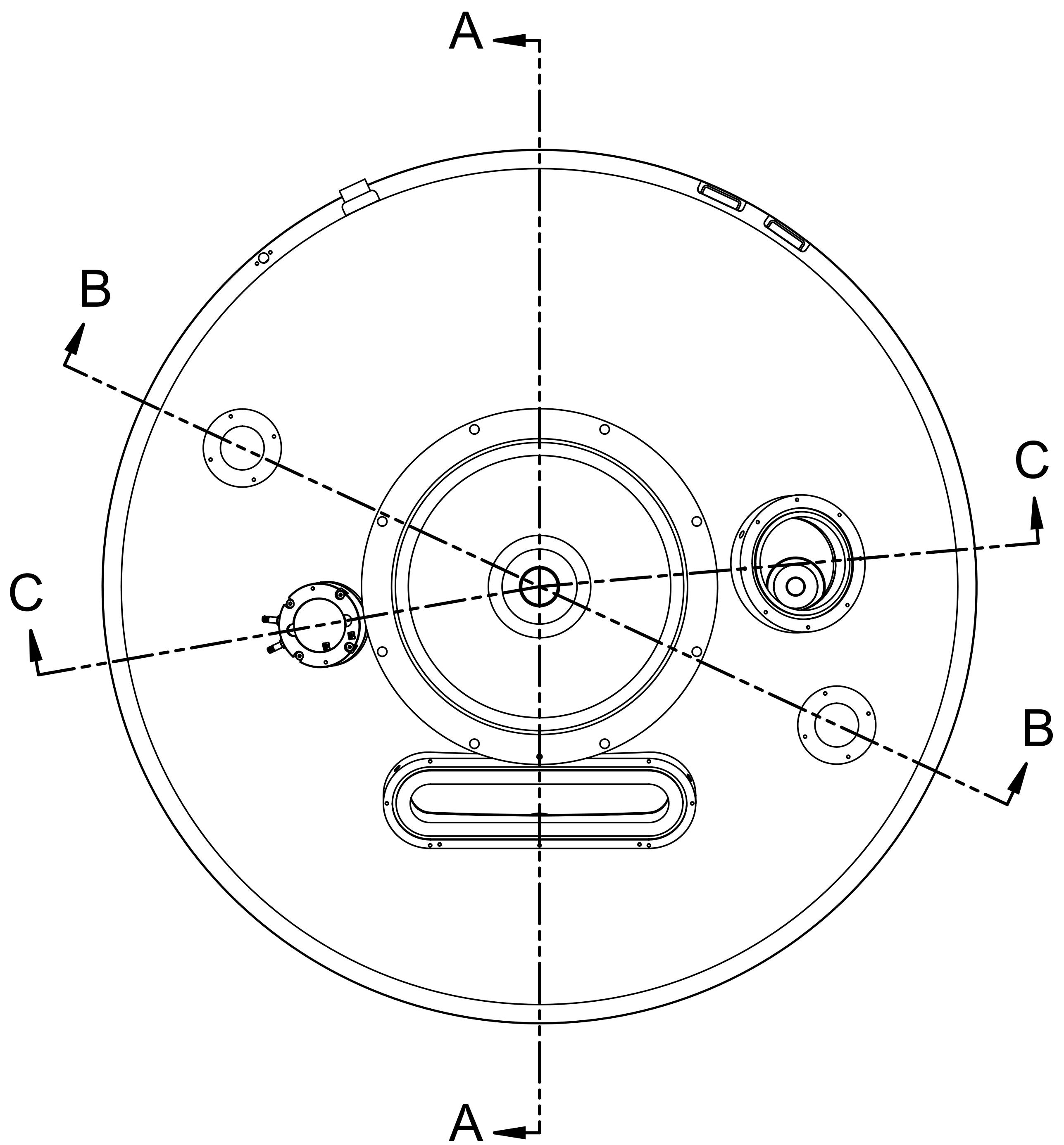
PROJECTION

REL #

Linton Crystal Technologies
*2180 BRIGHTON-HENRIETTA TL RD. ROCHESTER, NEW YORK 14623 U.S.A.*

KX320MCZ, ELEVATION & COMPONENTS

| SIZE | DWG NO | | |
|---|---|---|---|
| C | 364-1304-1 | | |
| SCALE 1:30 | | SHT 2 | OF 2 |




| REV | ENGINEERING CHANGE NOTICE | DATE | BY | CHK |
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| - | RELEASE PER ECN #01659-66 | 12/21/2018 | BS | JR |

METRIC
UNLESS OTHERWISE SPECIFIED,DIMENSIONS ARE IN mm.



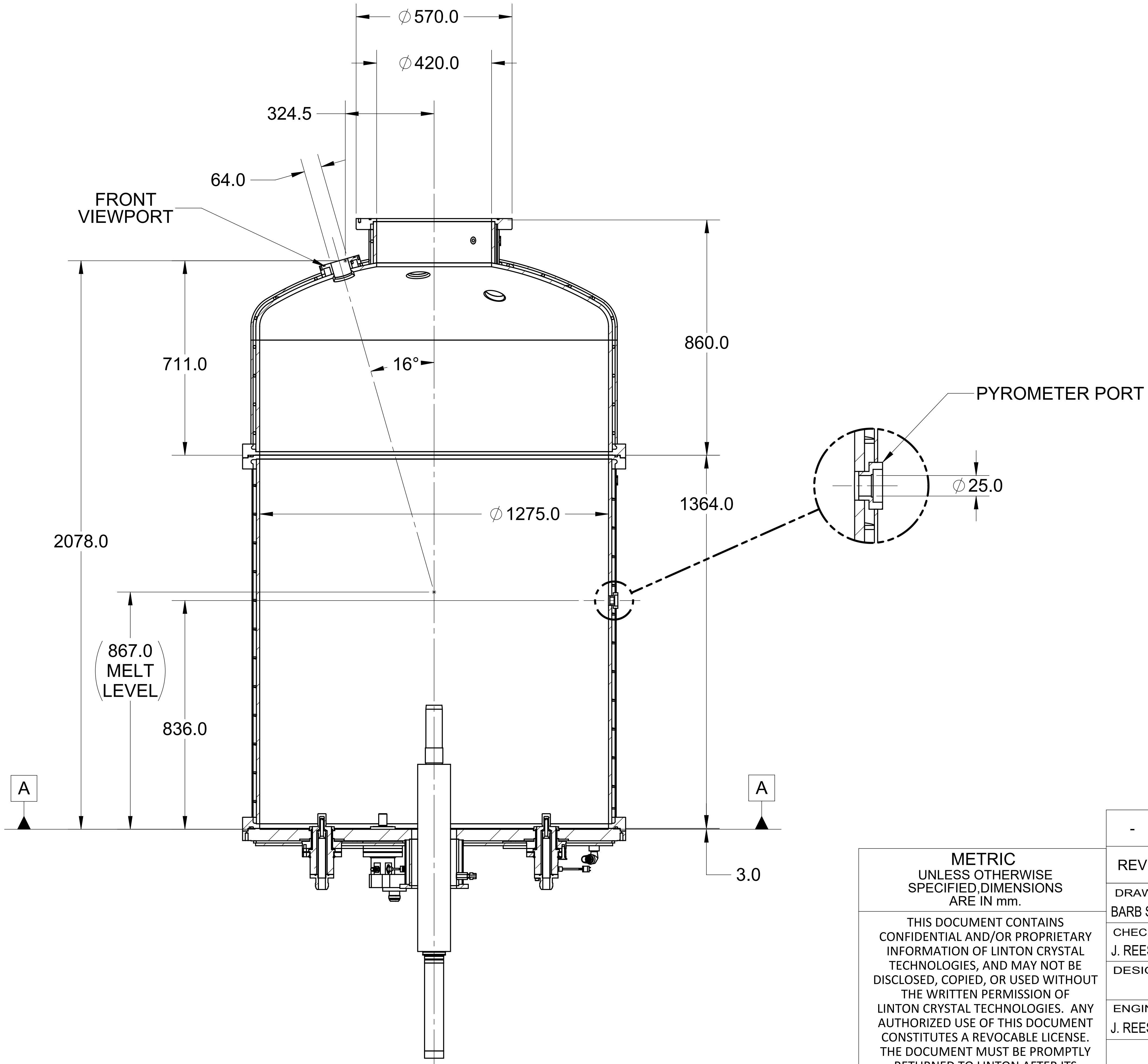
| | |
|---|---|
| DRAWN: BARB SCHOENEMAN | DATE: 8/2/2018 |
| CHECKED: J. REESE | DATE |
| DESIGNER | DATE |
| ENGINEER: J. REESE | DATE |
| | PROJECTION |
| REL # | |

Linton Crystal Technologies
2180 BRIGHTON-HENRIETTA TL RD.
ROCHESTER, NEW YORK 14624
U.S.A.

# KX320MCZ, CHAMBER LAYOUT

SIZE B | DWG NO 364-1269-1

SCALE 1:10 | SHT 1 OF 4




SECTION A-A

**METRIC**
UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN mm.



| REV | ENGINEERING CHANGE NOTICE | DATE | BY | CHK |
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| DRAWN: BARB SCHOENEMAN | DATE: 8/2/2018 |
| CHECKED: J. REESE | DATE |
| DESIGNER | DATE |
| ENGINEER: J. REESE | DATE |
| REL # | PROJECTION |

Linton Crystal Technologies
2180 BRIGHTON-HENRIETTA TL RD.
ROCHESTER, NEW YORK 14624
U.S.A.

# KX320MCZ, CHAMBER LAYOUT

| SIZE | DWG NO | SCALE | SHT | OF |
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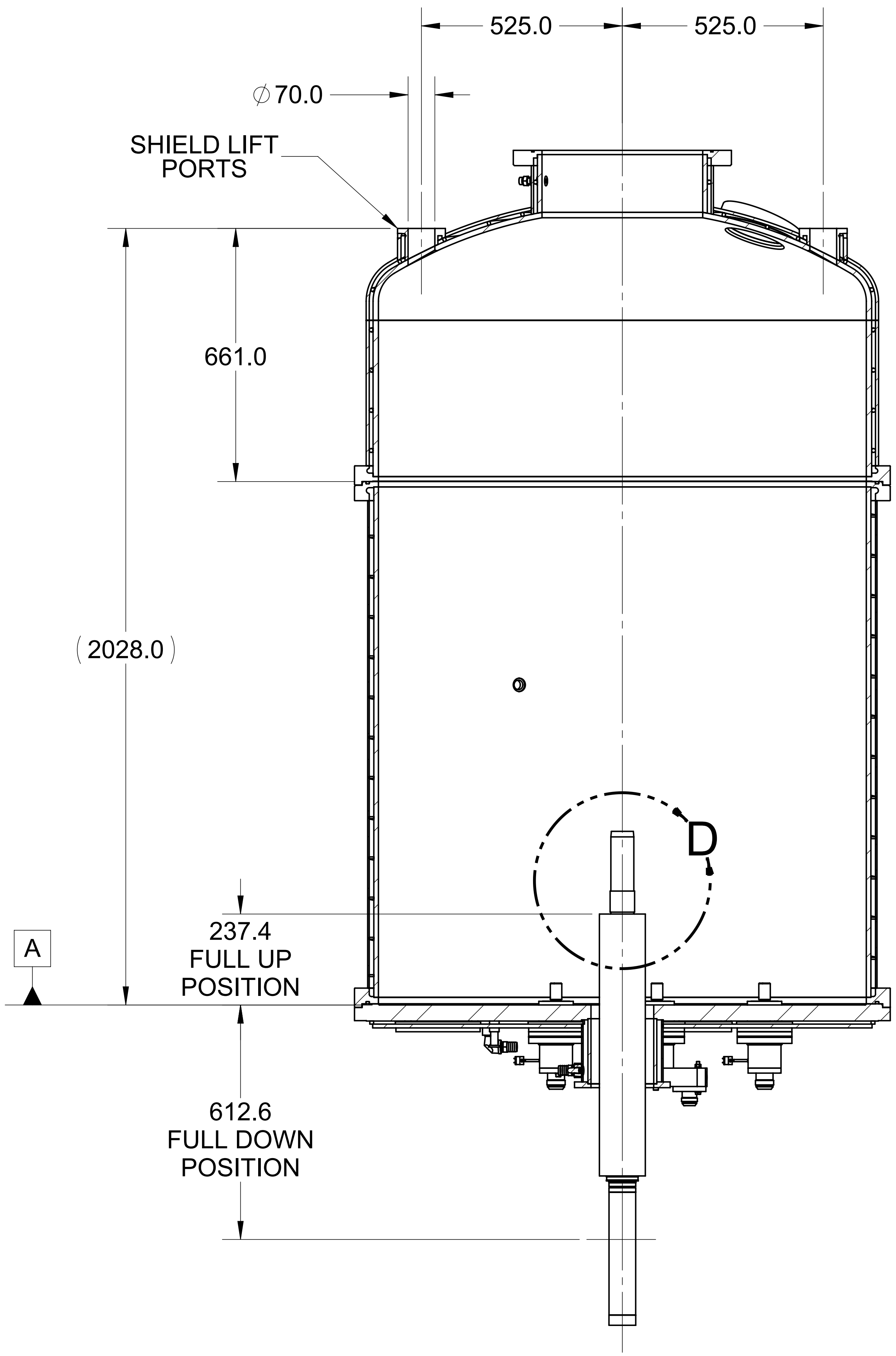
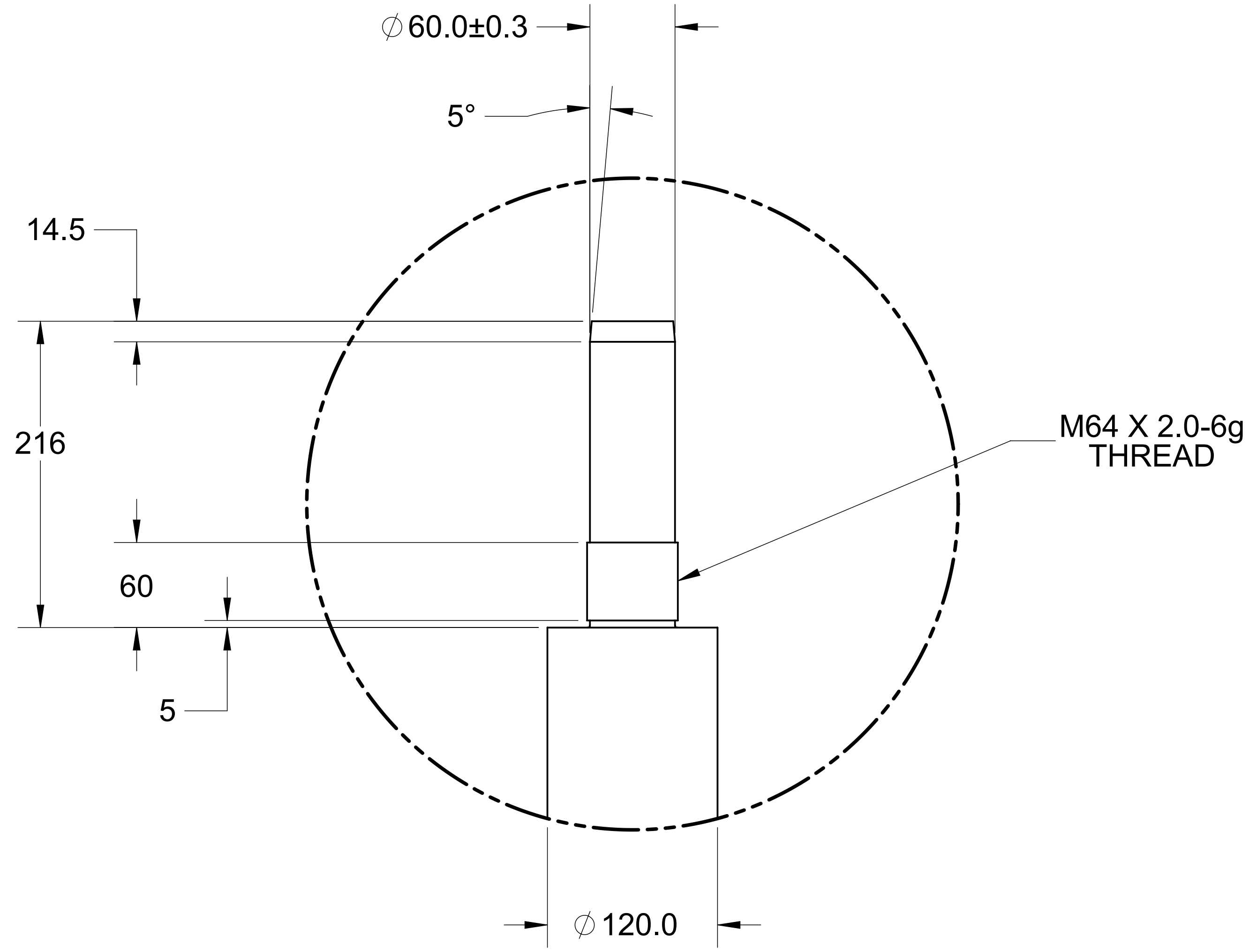
| B | 364-1269-1 | 1:15 | 2 | 4 |




SECTION B-B




DETAIL D
SCALE 1 : 5
CRUCIBLE SHAFT INTERFACE

METRIC
UNLESS OTHERWISE SPECIFIED,DIMENSIONS ARE IN mm.



| REV | ENGINEERING CHANGE NOTICE | DATE | BY | CHK |
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| | DATE |
|---|---|
| DRAWN BARB SCHOENEMAN | 8/2/2018 |
| CHECKED J. REESE | |
| DESIGNER | |
| ENGINEER J. REESE | |

PROJECTION

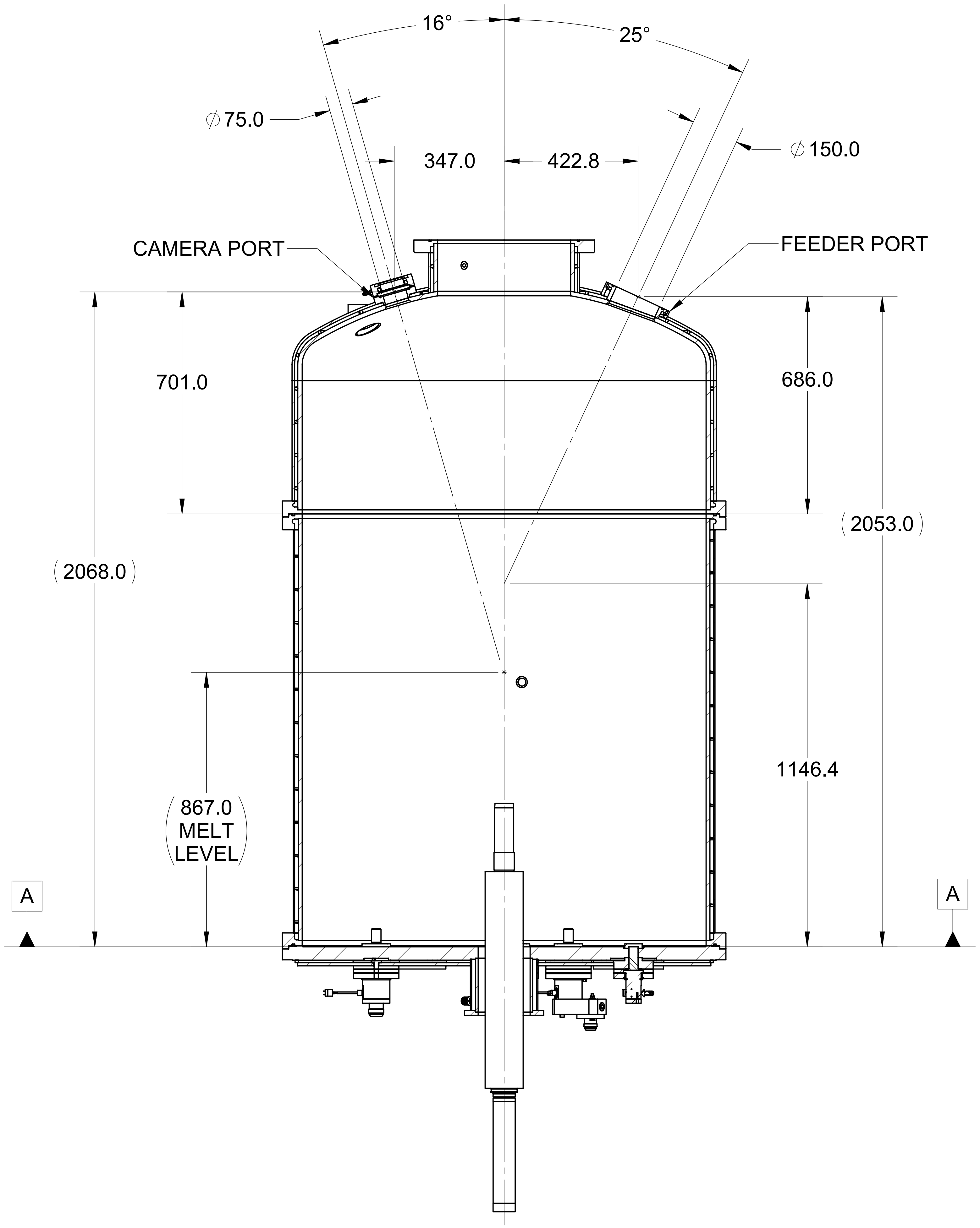
REL #

Linton Crystal Technologies
2180 BRIGHTON-HENRIETTA TL RD.
ROCHESTER, NEW YORK 14624
U.S.A.

# KX320MCZ, CHAMBER LAYOUT

SIZE B | DWG NO 364-1269-1

SCALE 1:15 | SHT 3 OF 4




SECTION C-C

METRIC
UNLESS OTHERWISE SPECIFIED,DIMENSIONS ARE IN mm.



| REV | ENGINEERING CHANGE NOTICE | DATE | BY | CHK |
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| - | | | | |

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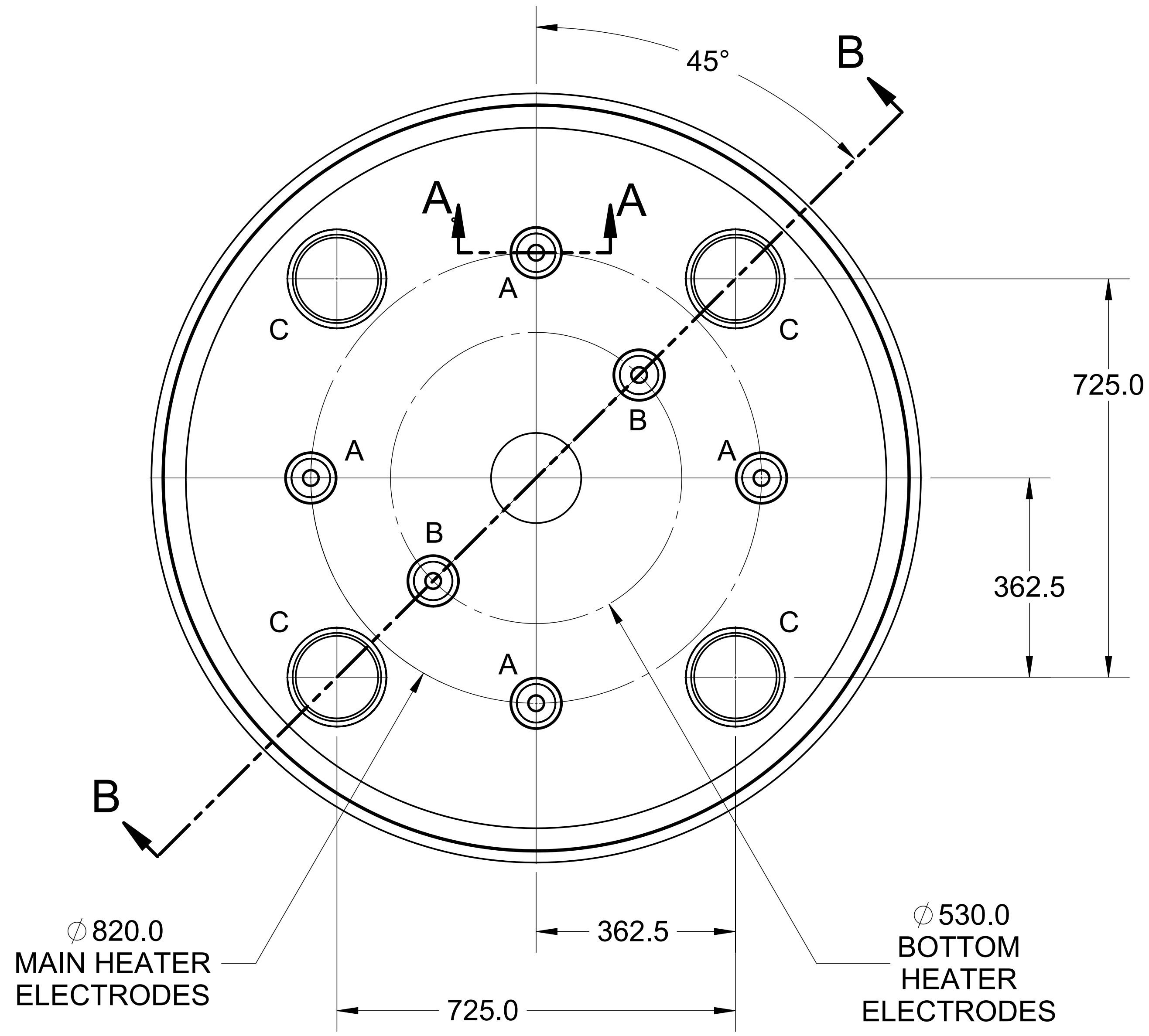
|---|---|
| DRAWN: BARB SCHOENEMAN | DATE: 8/2/2018 |
| CHECKED: J. REESE | DATE |
| DESIGNER | DATE |
| ENGINEER: J. REESE | DATE |
| PROJECTION | |
| REL # | |

Linton Crystal Technologies
2180 BRIGHTON-HENRIETTA TL RD.
ROCHESTER, NEW YORK 14624
U.S.A.

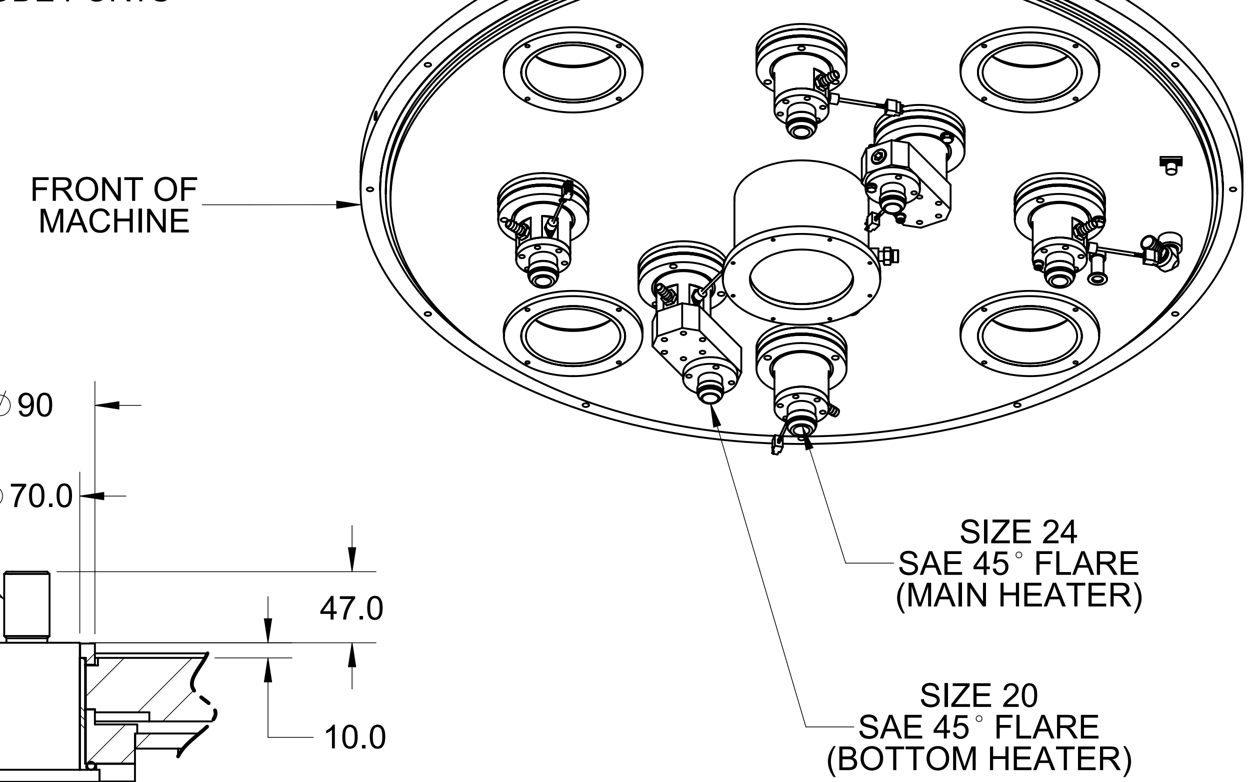
# KX320MCZ, CHAMBER LAYOUT

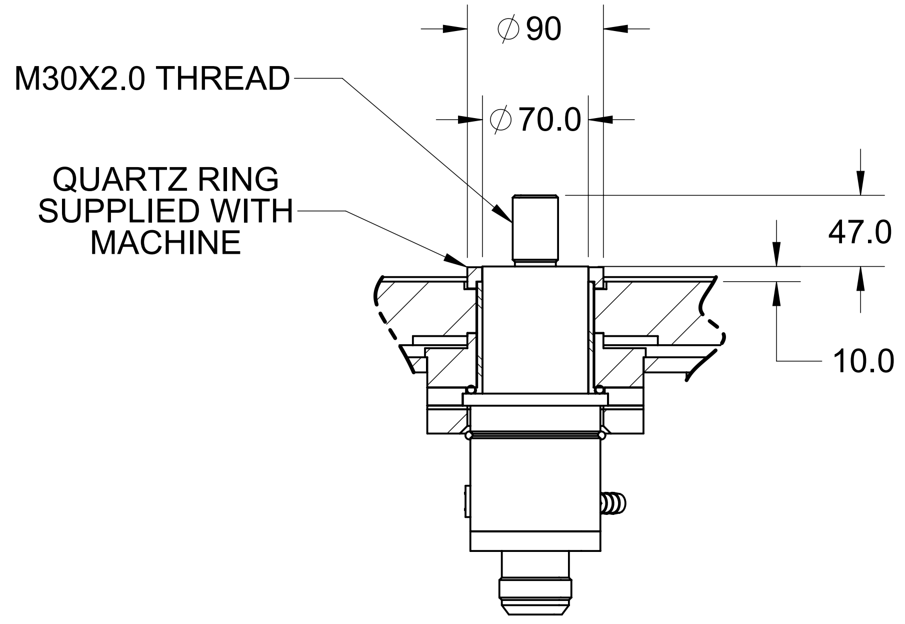
| SIZE | DWG NO | SCALE | SHT | OF |
|---|---|---|---|---|
| B | 364-1269-1 | 1:15 | 4 | 4 |

**KEY**
A = MAIN HEATER ELECTRODE PORTS
B = BOTTOM HEATER ELECTRODE PORTS
C = VACUUM PORTS

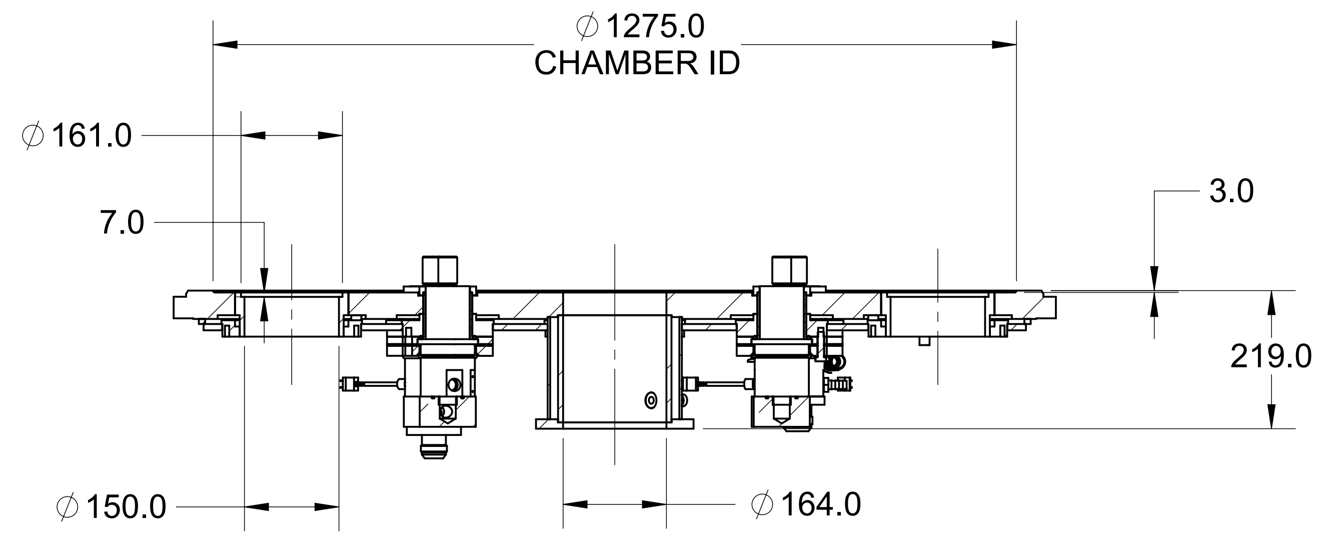



TOP VIEW
FRONT OF MACHINE




SECTION A-A
SCALE 1 : 5
DIMENSIONS TYP
FOR ALL ELECTRODES




SECTION B-B

| | | | | |
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| - | RELEASE PER ECN #01659-66 | 12/21/2018 | BS | JR |
| REV | ENGINEERING CHANGE NOTICE | DATE | BY | CHK |

METRIC
UNLESS OTHERWISE
SPECIFIED,DIMENSIONS
ARE IN mm.



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| DRAWN: BARB SCHOENEMAN | DATE: 8/2/2018 |
| CHECKED: J. REESE | DATE: |
| DESIGNER: | DATE: |
| ENGINEER: J. REESE | DATE: |

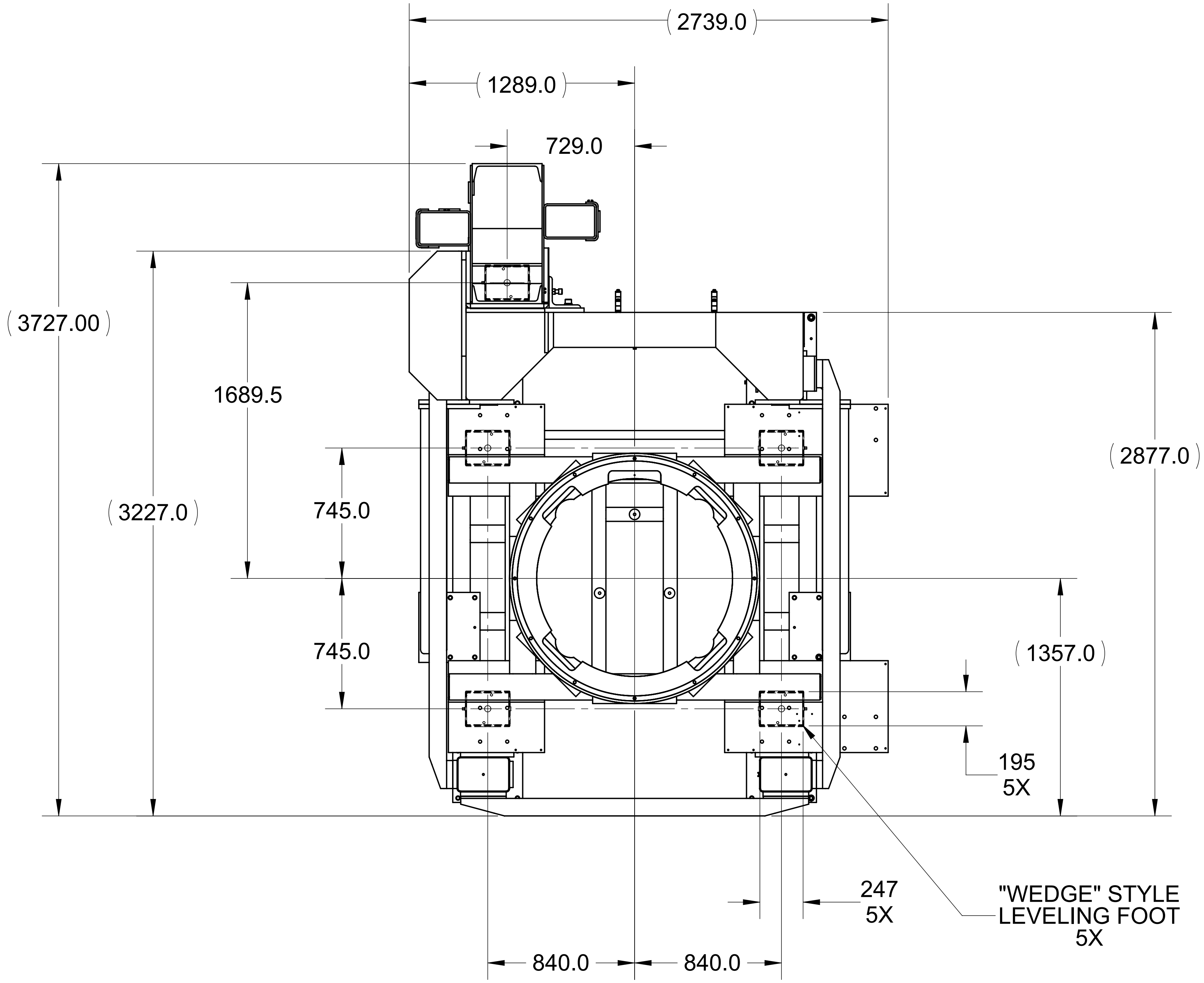
PROJECTION

REL #

Linton Crystal Technologies
2180 BRIGHTON-HENRIETTA TL RD.
ROCHESTER, NEW YORK 14624
U.S.A.

KX320MCZ, BASEPLATE LAYOUT

| SIZE | DWG NO | | |
|---|---|---|---|
| B | 364-1270-1 | | |
| SCALE 1:12 | | SHT 1 | OF 1 |




| REV | ENGINEERING CHANGE NOTICE | DATE | BY | CHK |
|---|---|---|---|---|
| - | RELEASE PER ECN #01659-66 | 12/21/2018 | BS | JR |

METRIC
UNLESS OTHERWISE SPECIFIED,DIMENSIONS ARE IN mm.

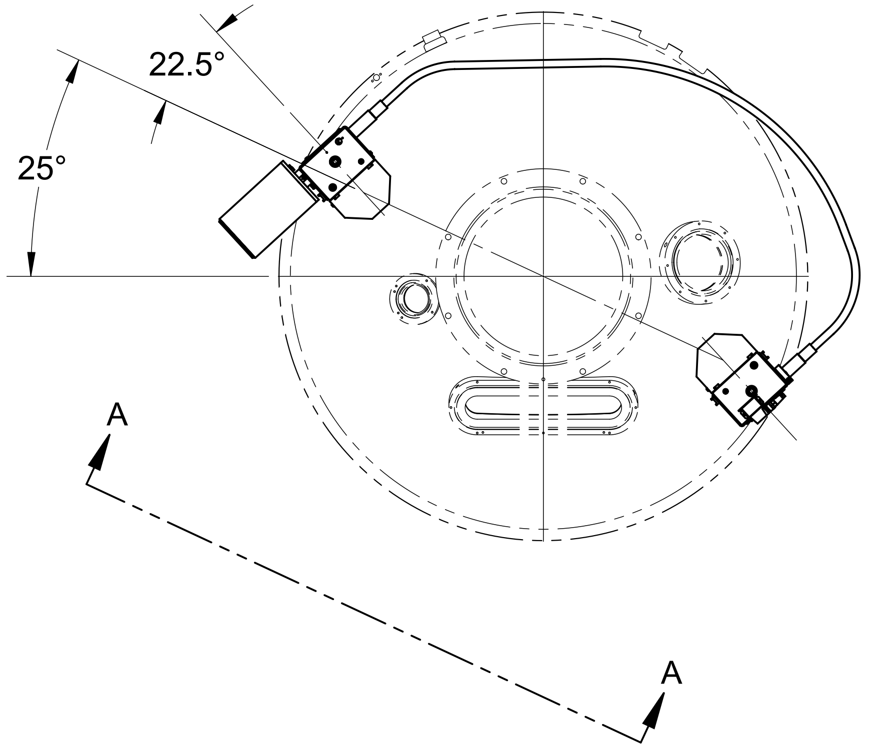


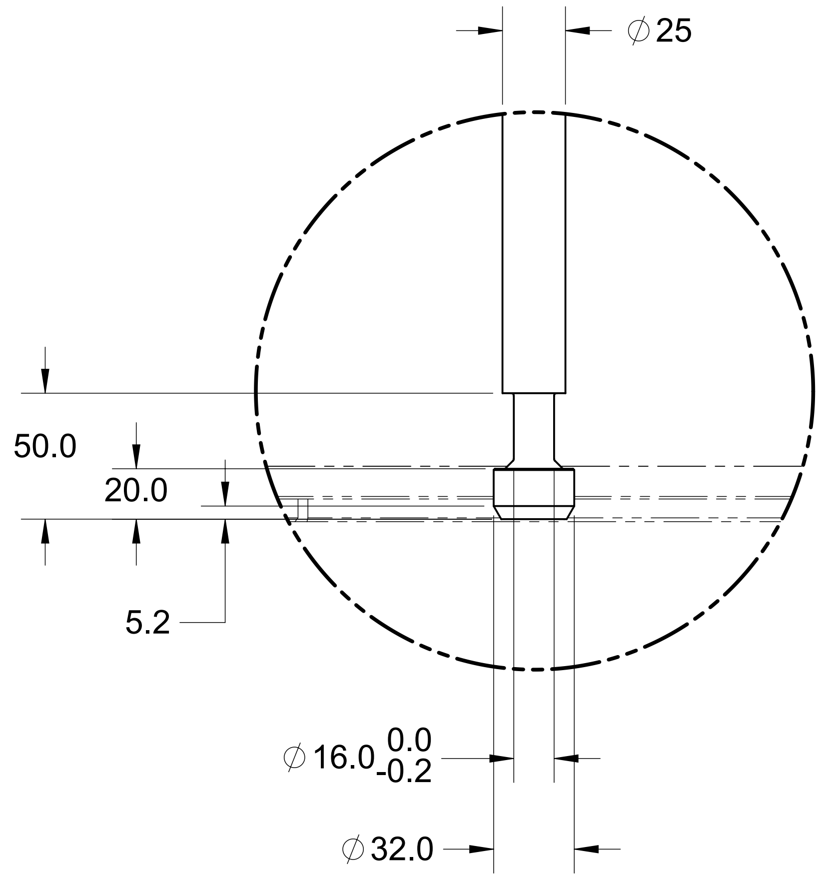
| | | |
|---|---|---|
| DRAWN | BARB SCHOENEMAN | DATE 9/19/2018 |
| CHECKED | J. REESE | DATE |
| DESIGNER | | DATE |
| ENGINEER | J. REESE | DATE |
| PROJECTION | | |
| REL # | | |

Linton Crystal Technologies
2180 BRIGHTON-HENRIETTA TL RD.
ROCHESTER, NEW YORK 14624
U.S.A.

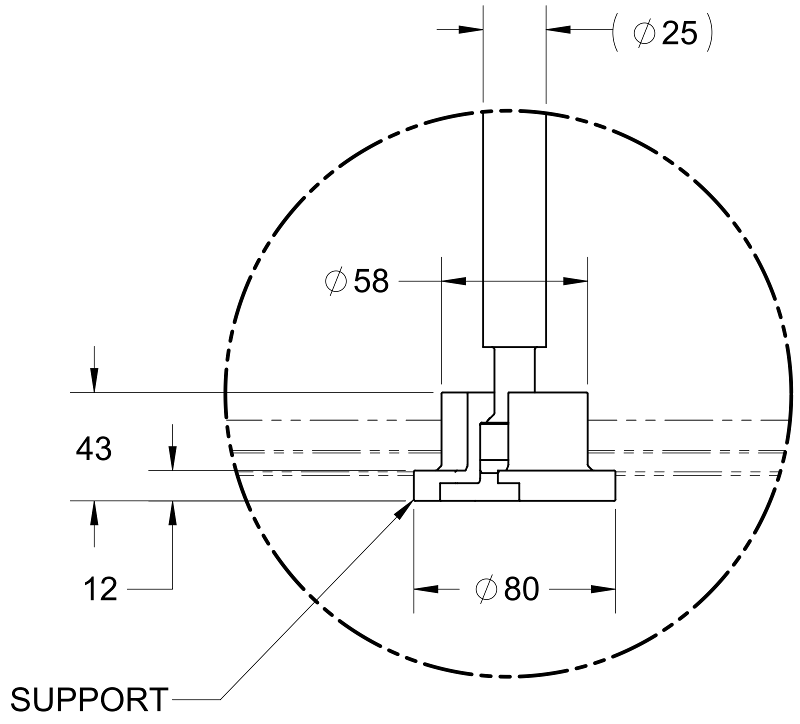
# KX320MCZ, FRAME CONTACTS

SIZE B | DWG NO 364-1272-1
SCALE 1:30 | SHT 1 OF 1

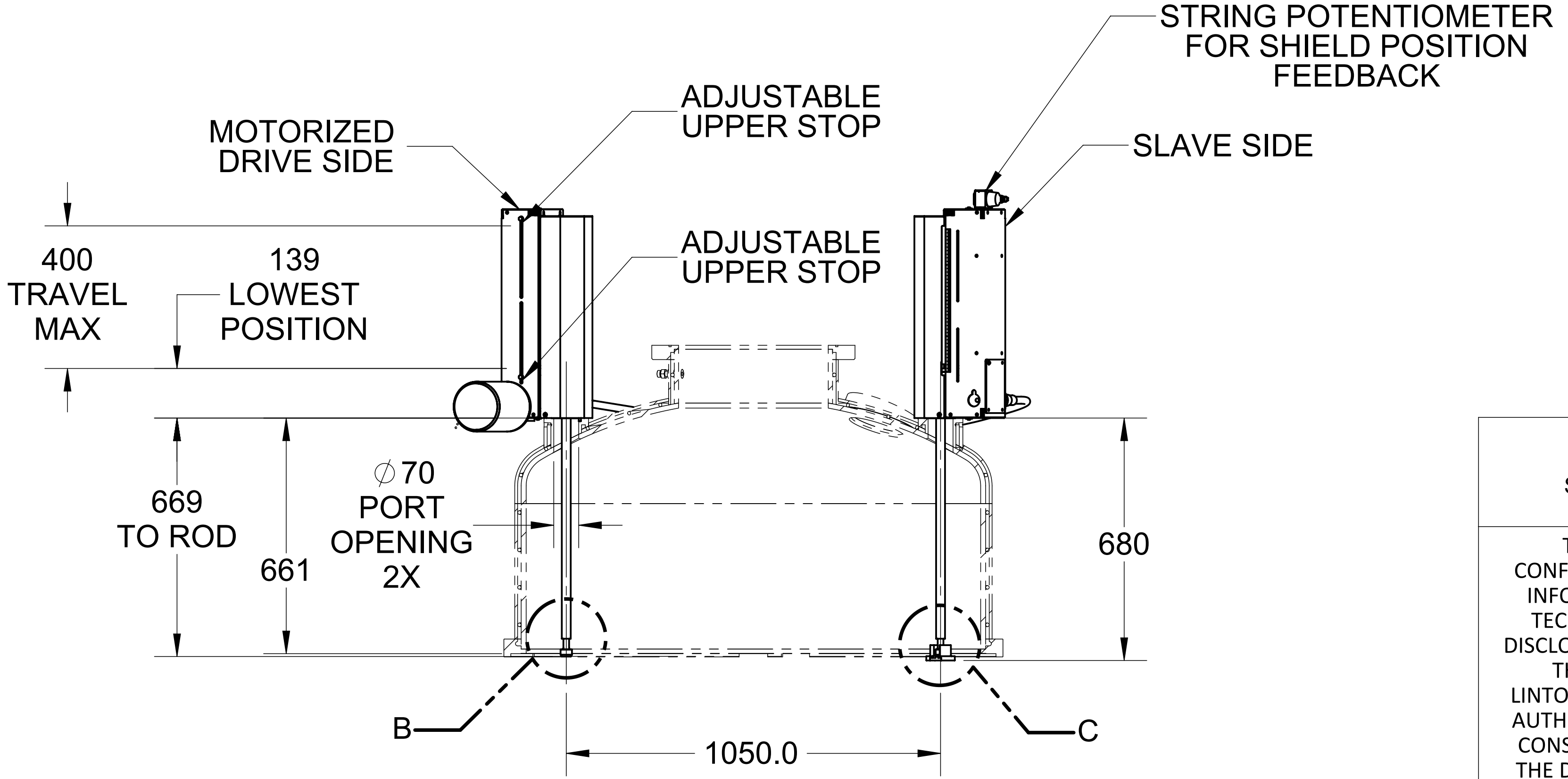



DETAIL B
SCALE 1 : 3
THIS VIEW SHOWN
WITH SUPPORT REMOVED




DETAIL C
SCALE 1 : 3




VIEW A-A
⌒ 25.0°

| REV | ENGINEERING CHANGE NOTICE | DATE | BY | CHK |
|---|---|---|---|---|
| - | RELEASE PER ECN #01659-66 | 12/21/2018 | BS | JR |

METRIC
UNLESS OTHERWISE
SPECIFIED,DIMENSIONS
ARE IN mm.



| | | DATE |
|---|---|---|
| DRAWN | BARB SCHOENEMAN | 12/12/2018 |
| CHECKED | J. REESE | |
| DESIGNER | J STEFL | |
| ENGINEER | J. REESE | |

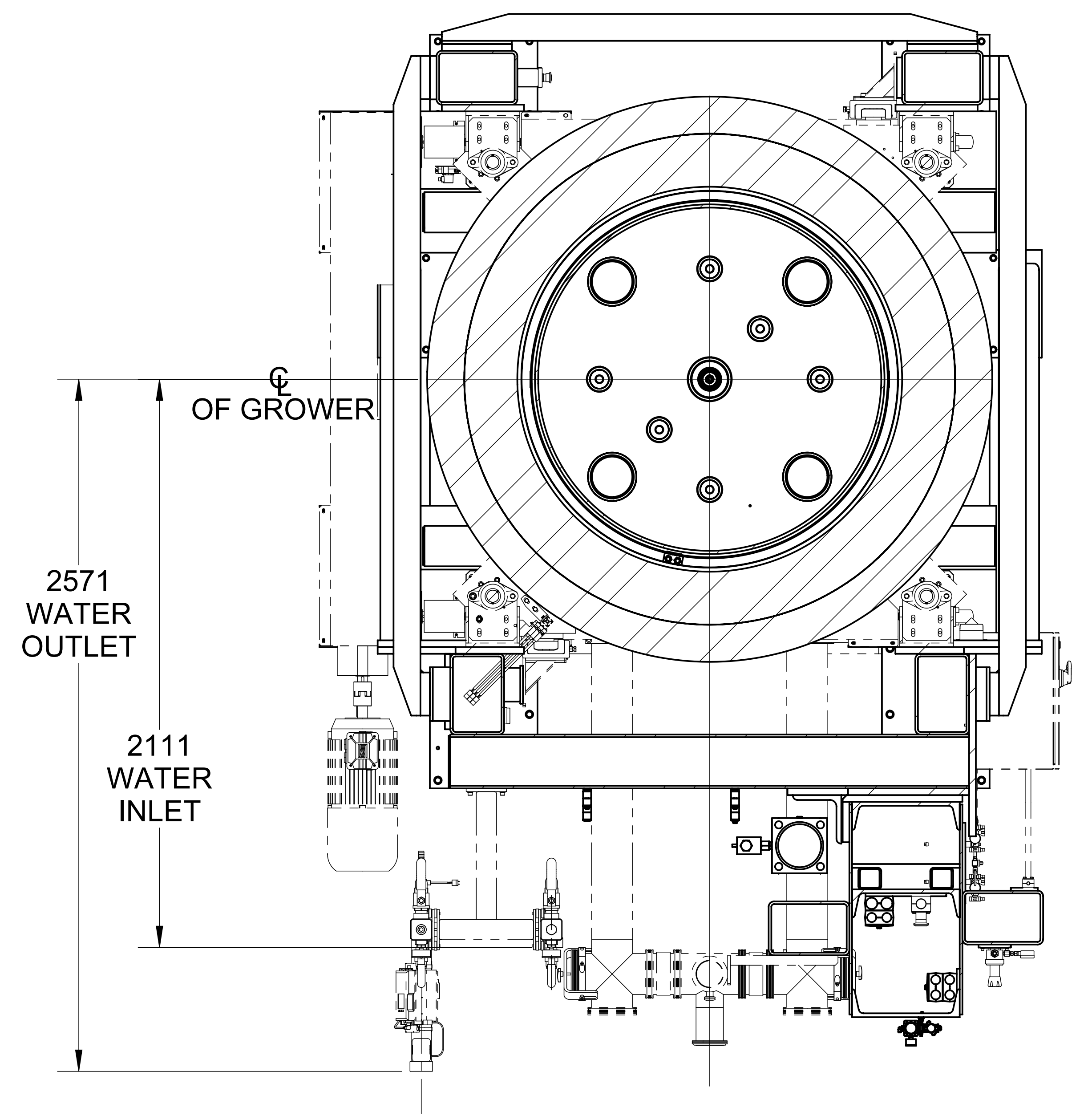
PROJECTION

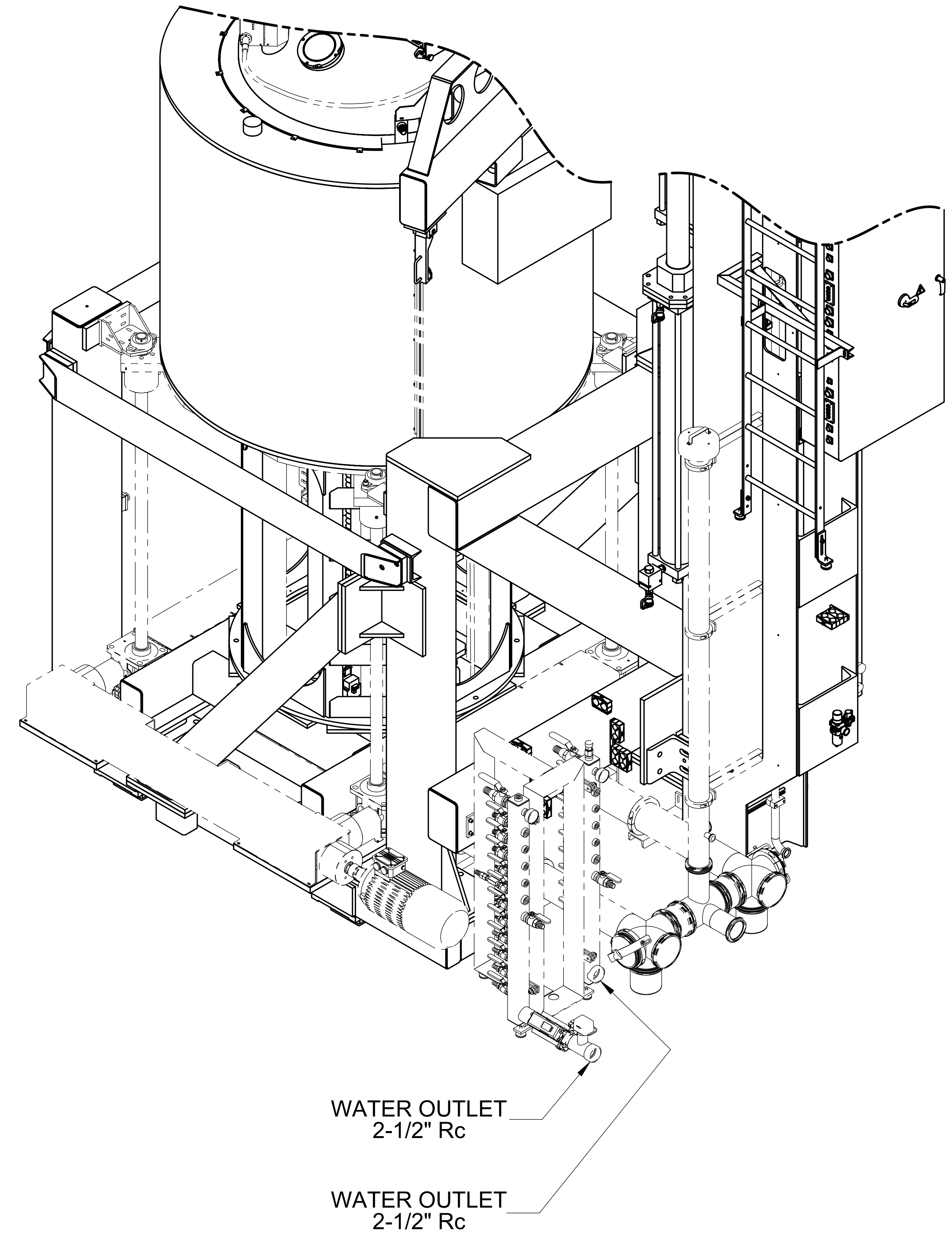
REF# SEE BOM

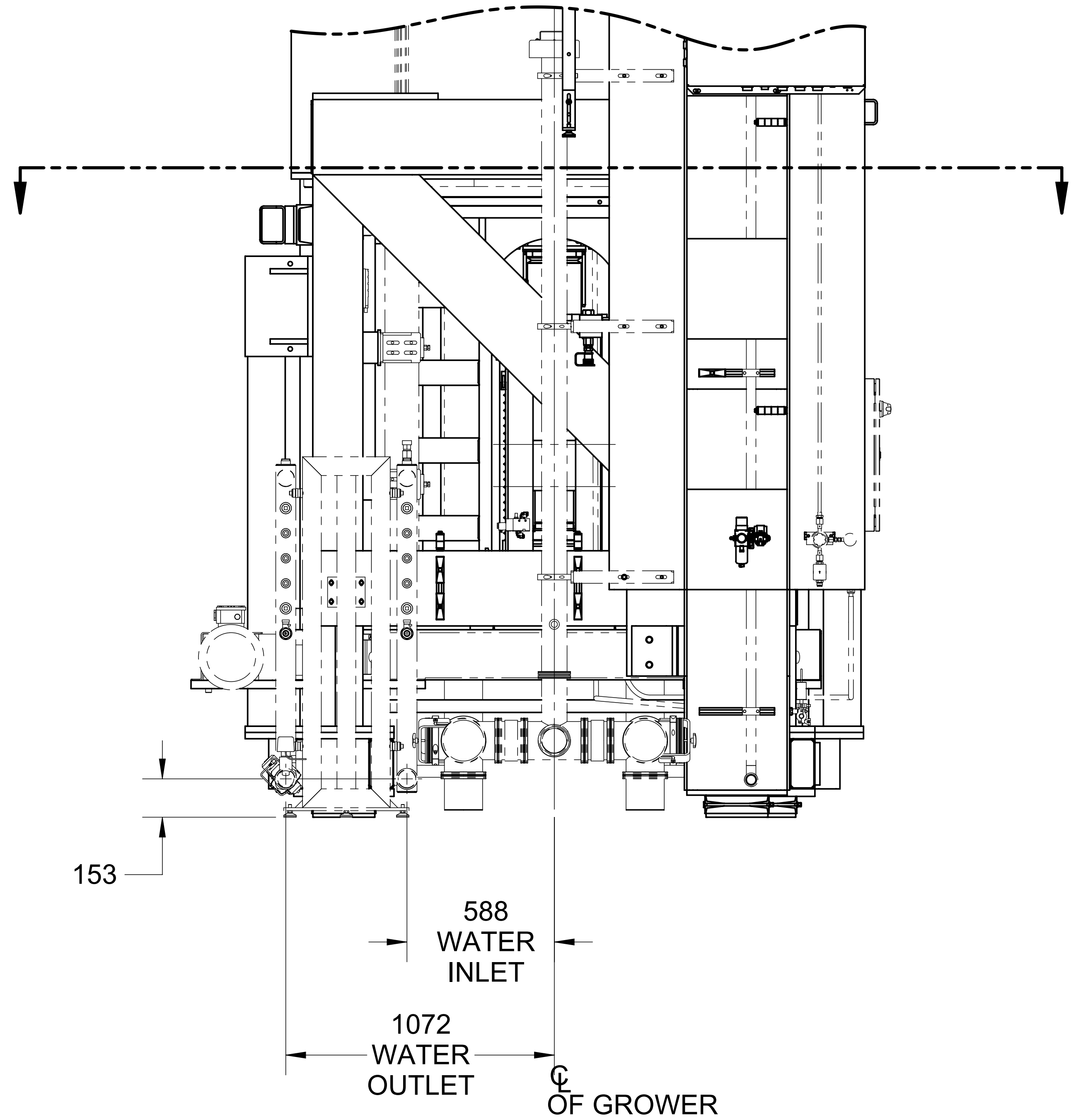
Linton
Crystal Technologies
2180 BRIGHTON-HENRIETTA TL RD.
ROCHESTER, NEW YORK 14624
U.S.A.

KX320MCZ,
SHIELD LIFT ASSY, 200KG,
1050 CTC, MOLY RODS

SIZE B | DWG NO 364-1285-1
SCALE 1:20 | SHT 1 OF 1




| REV | ENGINEERING CHANGE NOTICE | DATE | BY | CHK |
|---|---|---|---|---|
| - | RELEASE PER ECN #01659-66 | 12/21/2018 | BS | JR |

ALL PARTS MUST MEET LINTON SPECIFICATION #069-0009-1



METRIC
UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN mm.

HOLE TOLERANCES EXCEPT AS SHOWN

| | | | | |
|---|---|---|---|---|
| Ø1 | TO | Ø6 | +.15 | -.05 |
| Ø6.01 | TO | Ø13 | +.2 | -.1 |
| Ø13.01 | TO | Ø25 | +.3 | -.15 |
| Ø25.01 | AND | > | +.4 | -.2 |

MATERIAL

MACHINE SURFACES EXCEPT AS NOTED

TOLERANCES ON DECIMALS

| X. | .X | .XX | ANGLES |
|---|---|---|---|
| ± | ± | ± | ± 1/2° |

*UNLESS OTHERWISE SPECIFIED BREAK ALL SHARP EDGES APPROX. 0.5 R OR CHAMFER*

FINISH

| | |
|---|---|
| DRAWN BARB SCHOENEMAN | DATE 12/12/2018 |
| CHECKED J. REESE | DATE |
| DESIGNER | DATE |
| ENGINEER J. REESE | DATE |

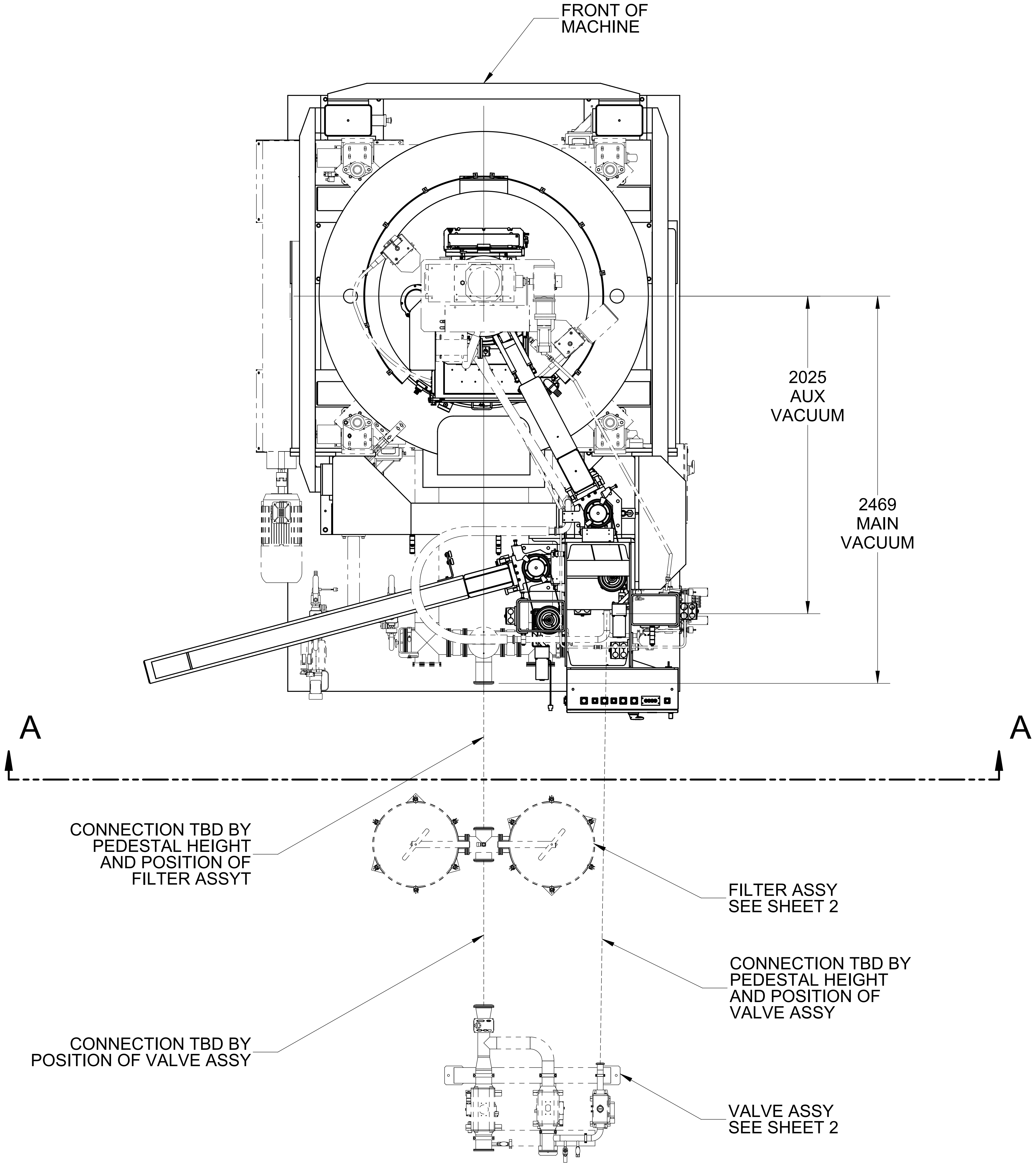
PROJECTION

REL #

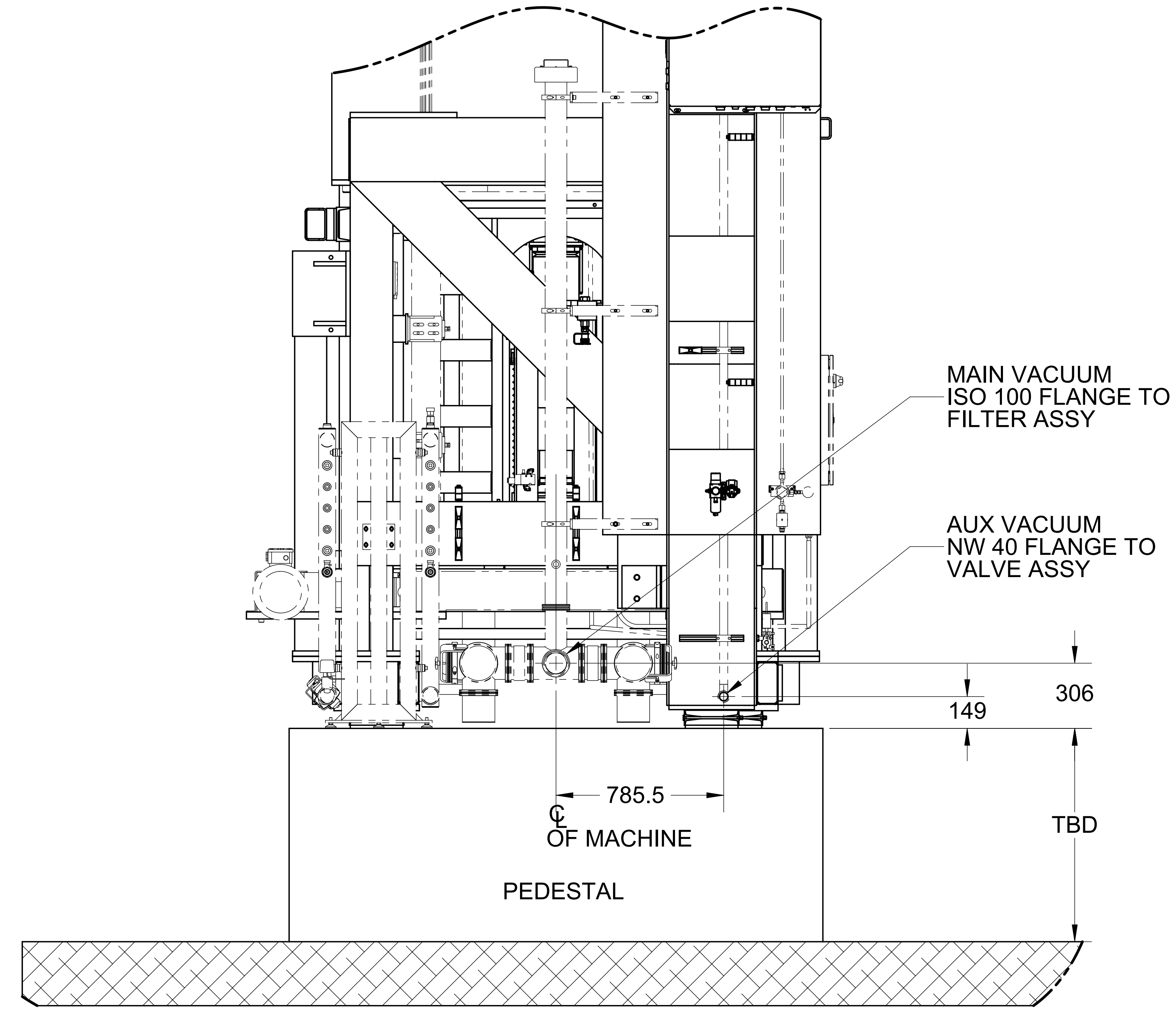
Linton Crystal Technologies
2180 BRIGHTON-HENRIETTA TL RD.
ROCHESTER, NEW YORK 14623
U.S.A.

# KX320MCZ, UTILITIES, WATER

| SIZE | DWG NO | SCALE | SHT | OF |
|---|---|---|---|---|
| C | 364-1282-1 | 1:25 | 1 | 1 |




TOP VIEW




SECTION A-A

| REV | ENGINEERING CHANGE NOTICE | DATE | BY | CHK |
|---|---|---|---|---|
| - | RELEASE PER ECN #01659-66 | 12/21/2018 | BS | JR |

ALL PARTS MUST MEET LINTON SPECIFICATION #069-0009-1



METRIC
UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN mm.

HOLE TOLERANCES EXCEPT AS SHOWN

| | | | | |
|---|---|---|---|---|
| Ø1 | TO | Ø6 | +.15 | -.05 |
| Ø6.01 | TO | Ø13 | +.2 | -.1 |
| Ø13.01 | TO | Ø25 | +.3 | -.15 |
| Ø25.01 | AND | > | +.4 | -.2 |

MATERIAL

MACHINE SURFACES EXCEPT AS NOTED

TOLERANCES ON DECIMALS

| X. | .X | .XX | ANGLES |
|---|---|---|---|
| ± | ± | ± | ± 1/2° |

*UNLESS OTHERWISE SPECIFIED BREAK ALL SHARP EDGES APPROX. 0.5 R OR CHAMFER*

FINISH

| | | DATE |
|---|---|---|
| DRAWN | BARB SCHOENEMAN | 12/12/2018 |
| CHECKED | J. REESE | |
| DESIGNER | | |
| ENGINEER | J. REESE | |

PROJECTION

REL #

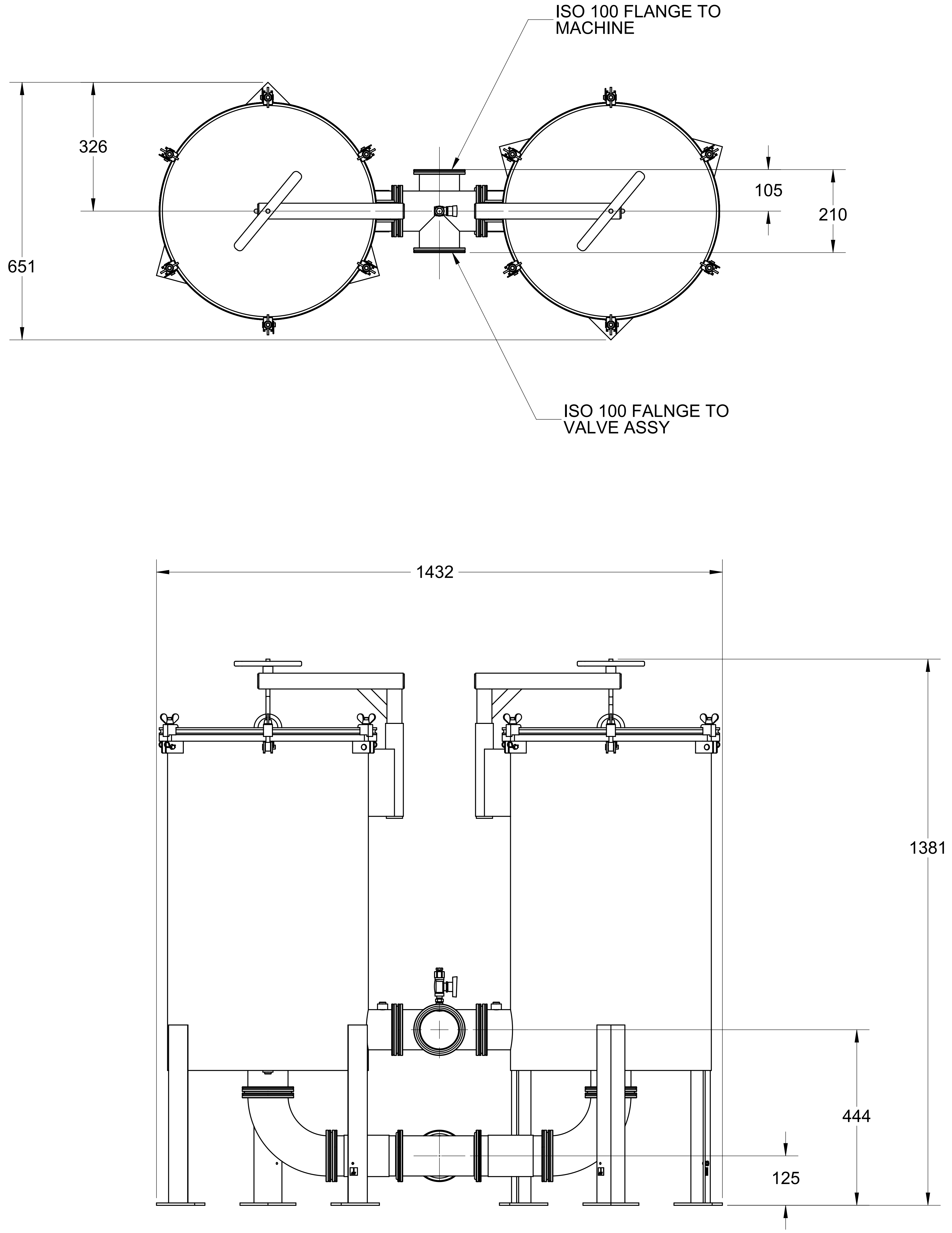
Linton Crystal Technologies
*2180 BRIGHTON-HENRIETTA TL RD. ROCHESTER, NEW YORK 14623 U.S.A.*

KX320MCZ, UTILITIES, VACUUM

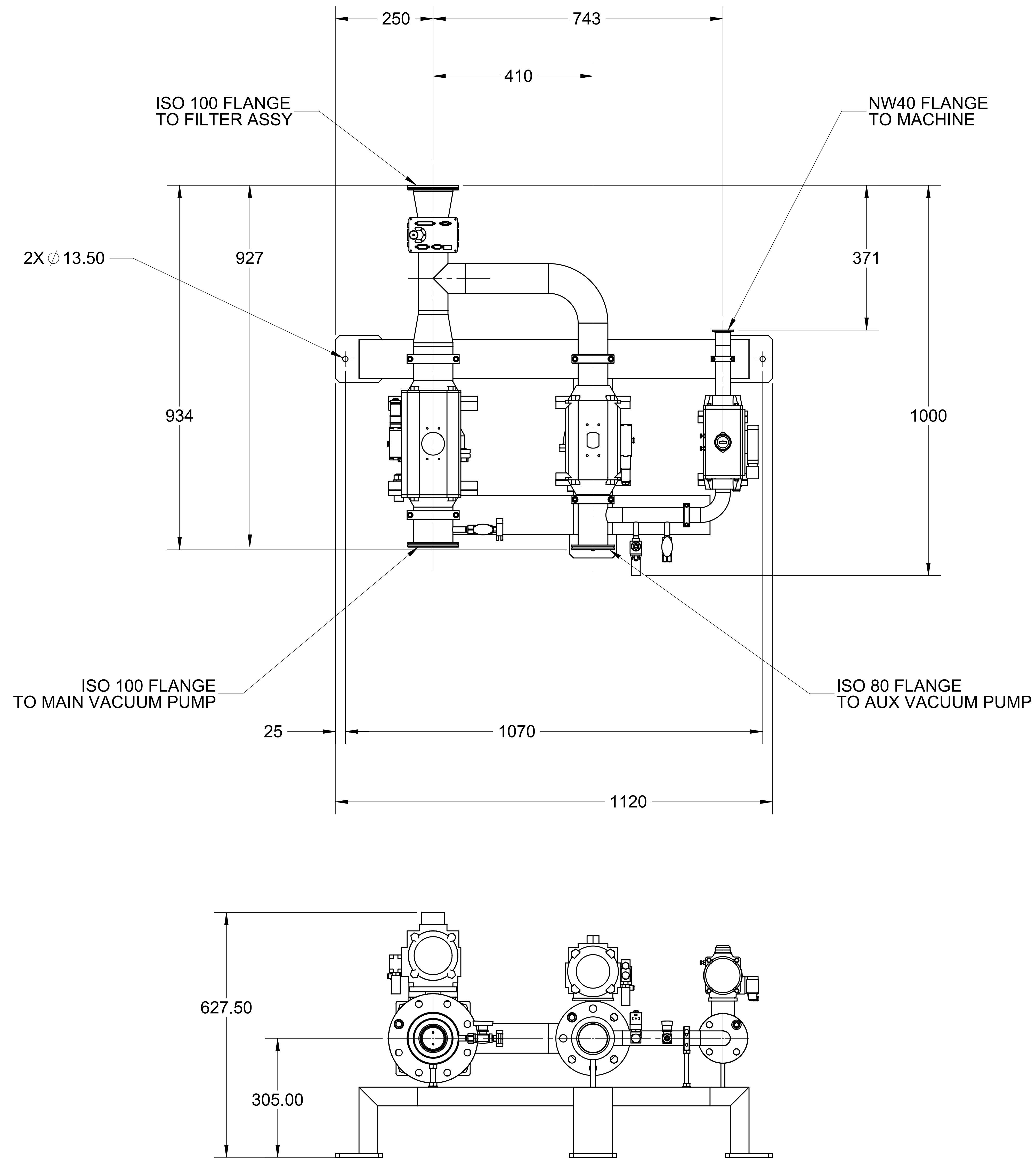
| SIZE | DWG NO |
|---|---|
| C | 364-1283-1 |

| SCALE | SHT | OF |
|---|---|---|
| 1:25 | 1 | 2 |

## FILTER ASSY DETAIL




## VALVE ASSY DETAIL




ALL PARTS MUST MEET LINTON SPECIFICATION #069-0009-1



METRIC
UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN mm.

HOLE TOLERANCES EXCEPT AS SHOWN

| | | | | |
|---|---|---|---|---|
| Ø1 | TO | Ø6 | +.15 | -.05 |
| Ø6.01 | TO | Ø13 | +.2 | -.1 |
| Ø13.01 | TO | Ø25 | +.3 | -.15 |
| Ø25.01 | AND | > | +.4 | -.2 |

MATERIAL

MACHINE SURFACES EXCEPT AS NOTED

TOLERANCES ON DECIMALS

| X. | .X | .XX | ANGLES |
|---|---|---|---|
| ± | ± | ± | ± 1/2° |

*UNLESS OTHERWISE SPECIFIED BREAK ALL SHARP EDGES APPROX. 0.5 R OR CHAMFER*

FINISH

| REV | ENGINEERING CHANGE NOTICE | DATE | BY | CHK |
|---|---|---|---|---|
| - | | | | |

| | |
|---|---|
| DRAWN: BARB SCHOENEMAN | DATE: 12/12/2018 |
| CHECKED: J. REESE | DATE |
| DESIGNER | DATE |
| ENGINEER: J. REESE | DATE |

PROJECTION

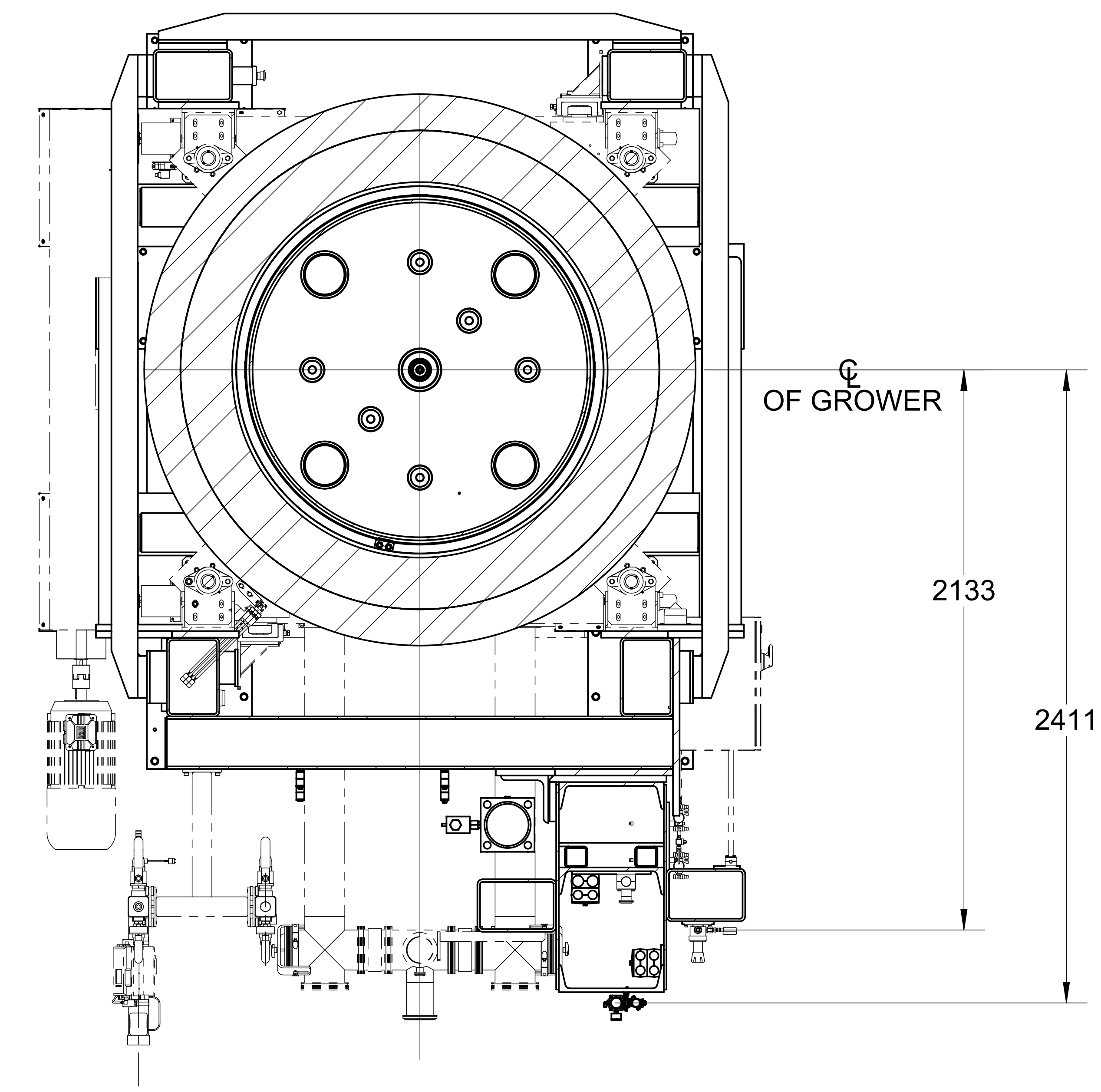
REL #

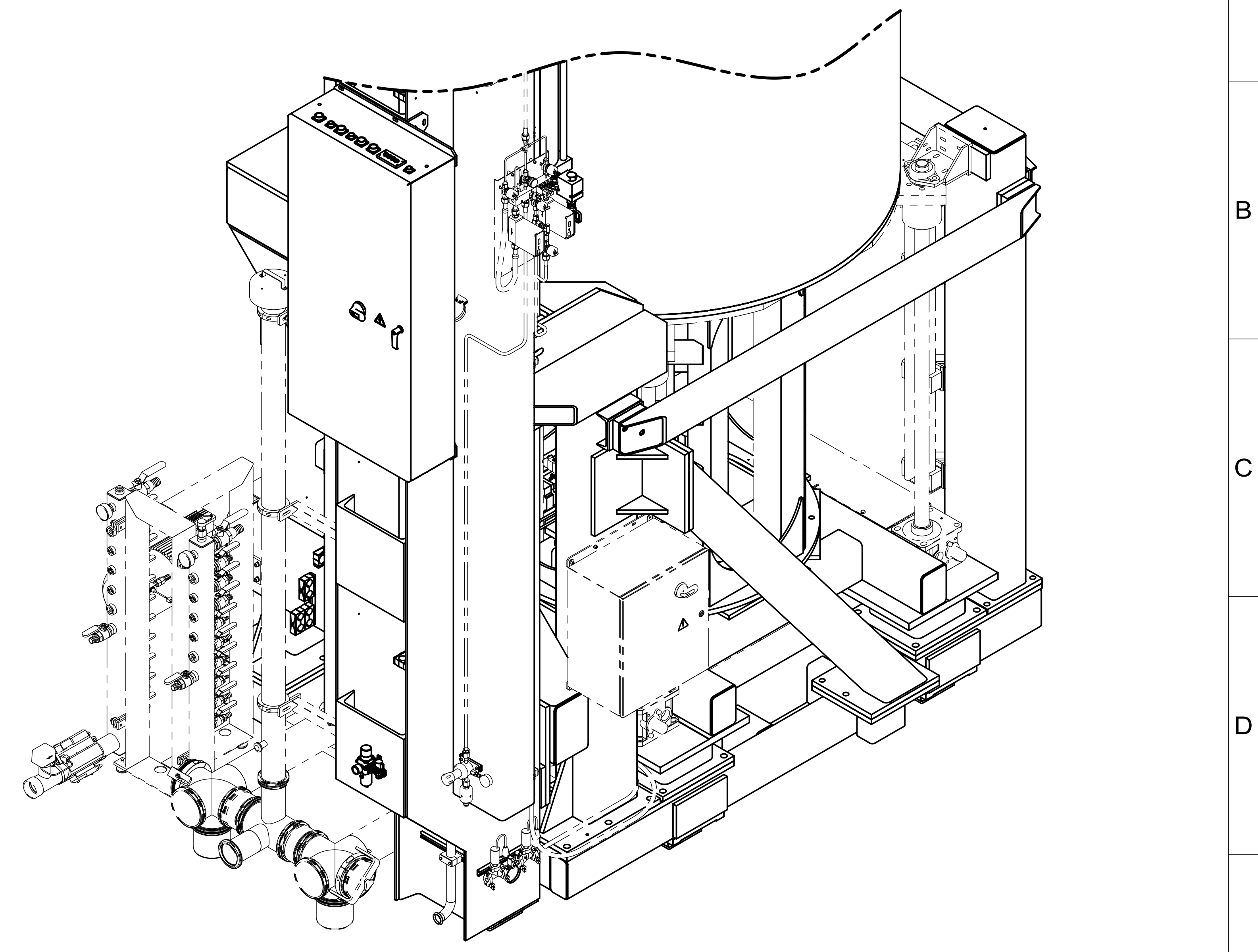

Linton Crystal Technologies
*2180 BRIGHTON-HENRIETTA TL RD. ROCHESTER, NEW YORK 14623 U.S.A.*

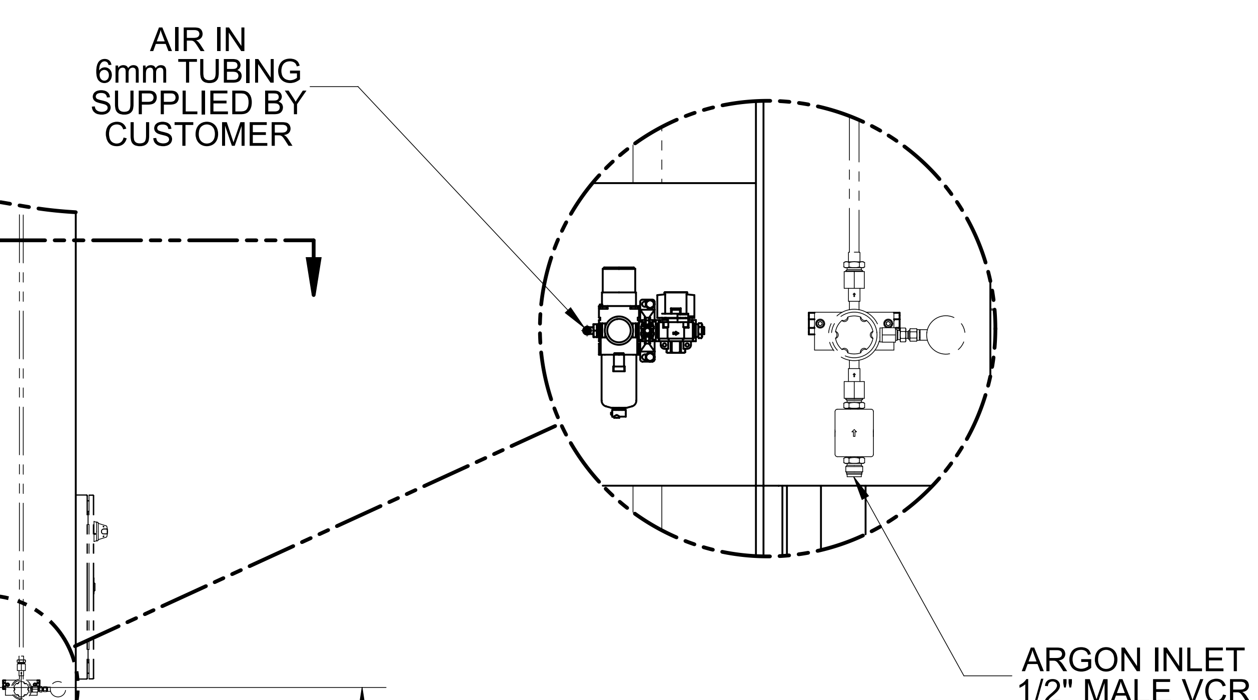

# KX320MCZ UTILITIES, VACUUM

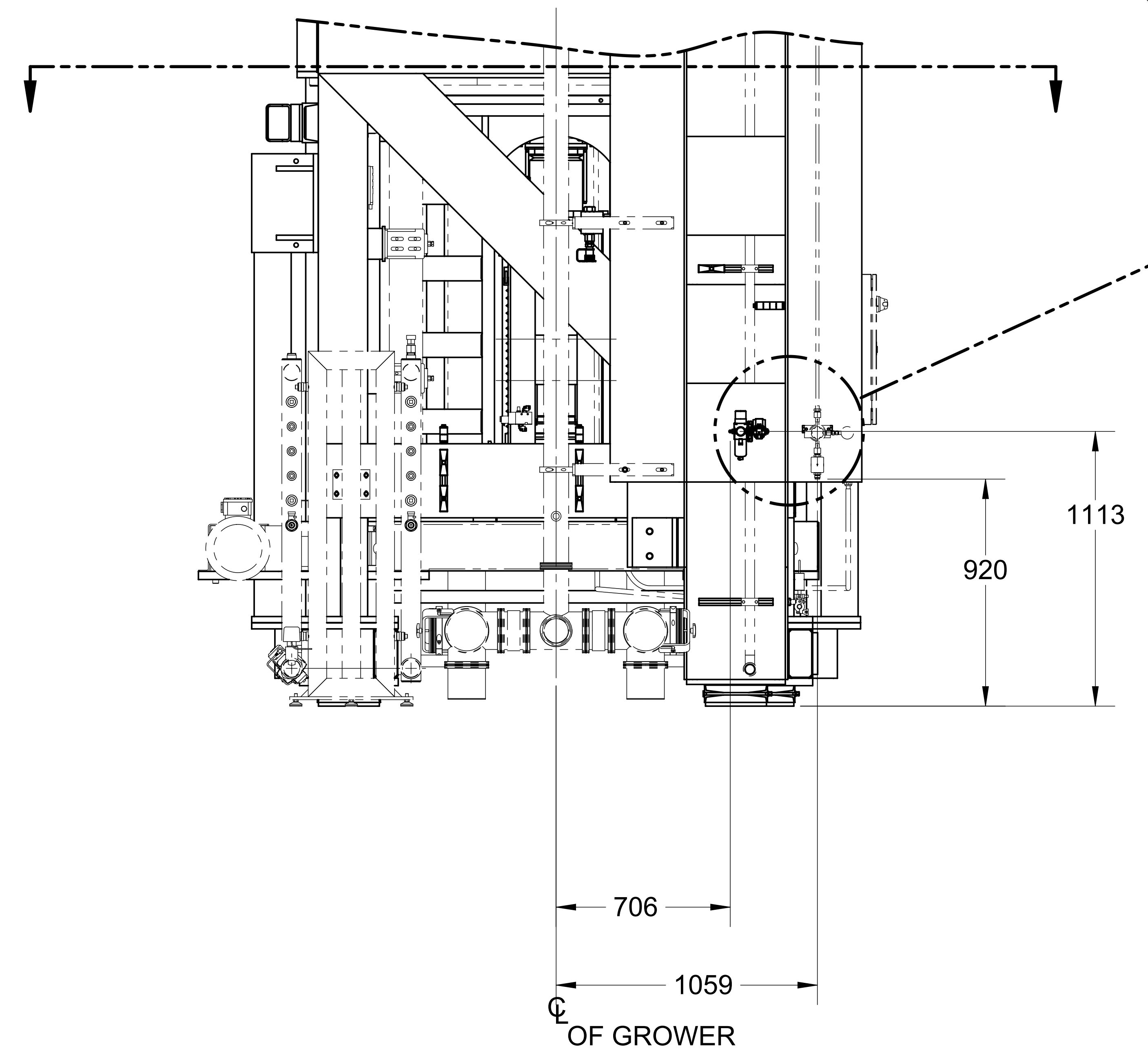
SIZE C | DWG NO 364-1283-1

SCALE 1:10 | SHT 2 OF 2






| - | RELEASE PER ECN #01659-66 | 12/21/2018 | BS | JR |
|---|---|---|---|---|
| REV | ENGINEERING CHANGE NOTICE | DATE | BY | CHK |

ALL PARTS MUST MEET LINTON SPECIFICATION #069-0009-1



METRIC
UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN mm.

HOLE TOLERANCES EXCEPT AS SHOWN

| | | | | |
|---|---|---|---|---|
| Ø1 | TO | Ø6 | +.15 | -.05 |
| Ø6.01 | TO | Ø13 | +.2 | -.1 |
| Ø13.01 | TO | Ø25 | +.3 | -.15 |
| Ø25.01 | AND | > | +.4 | -.2 |

MATERIAL

MACHINE SURFACES EXCEPT AS NOTED

TOLERANCES ON DECIMALS

| X. | .X | .XX | ANGLES |
|---|---|---|---|
| ± | ± | ± | ± 1/2° |

*UNLESS OTHERWISE SPECIFIED BREAK ALL SHARP EDGES APPROX. 0.5 R OR CHAMFER*

FINISH

| | |
|---|---|
| DRAWN BARB SCHOENEMAN | DATE 12/12/2018 |
| CHECKED J. REESE | DATE |
| DESIGNER | DATE |
| ENGINEER J. REESE | DATE |

PROJECTION

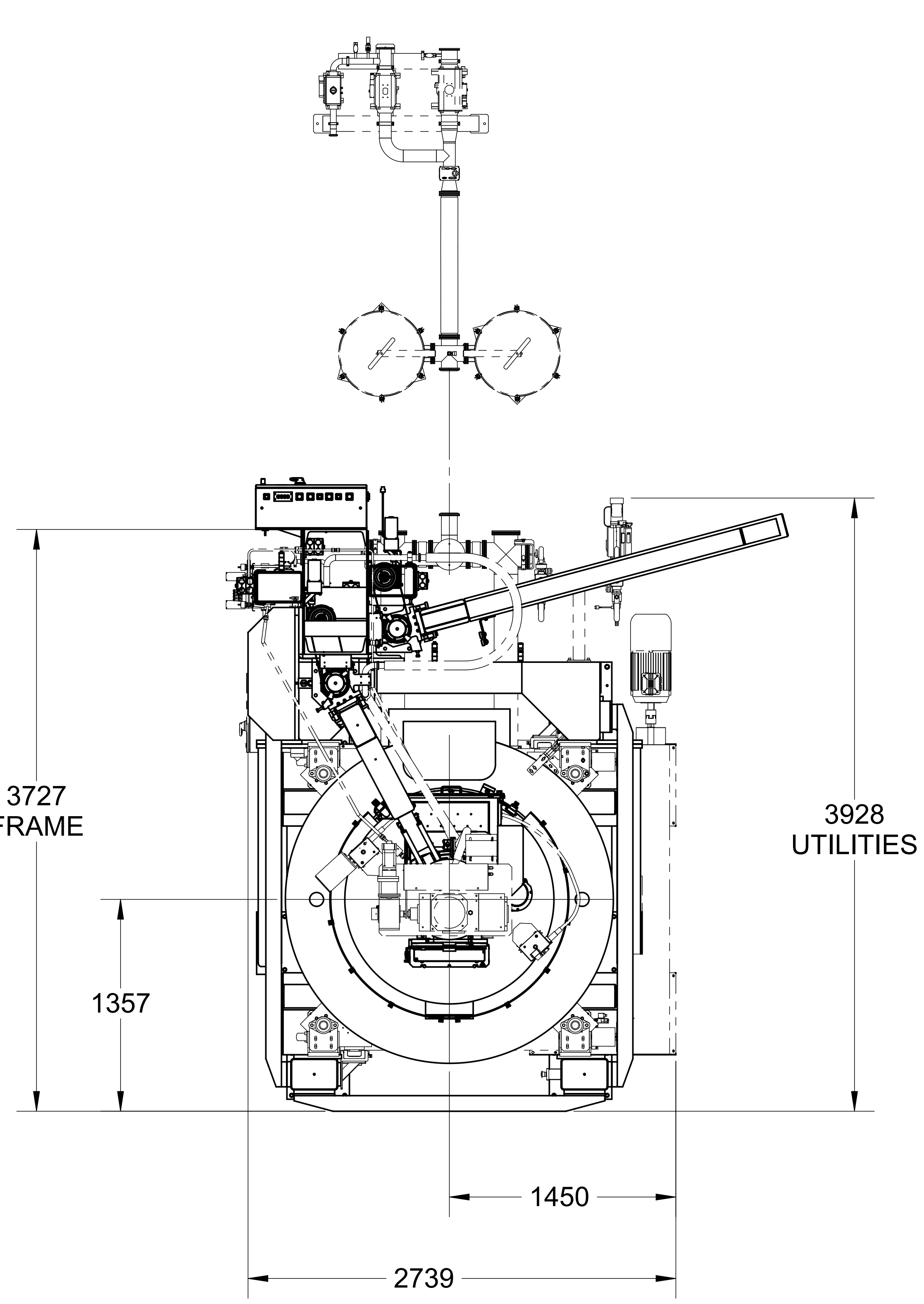
REL #

Linton Crystal Technologies

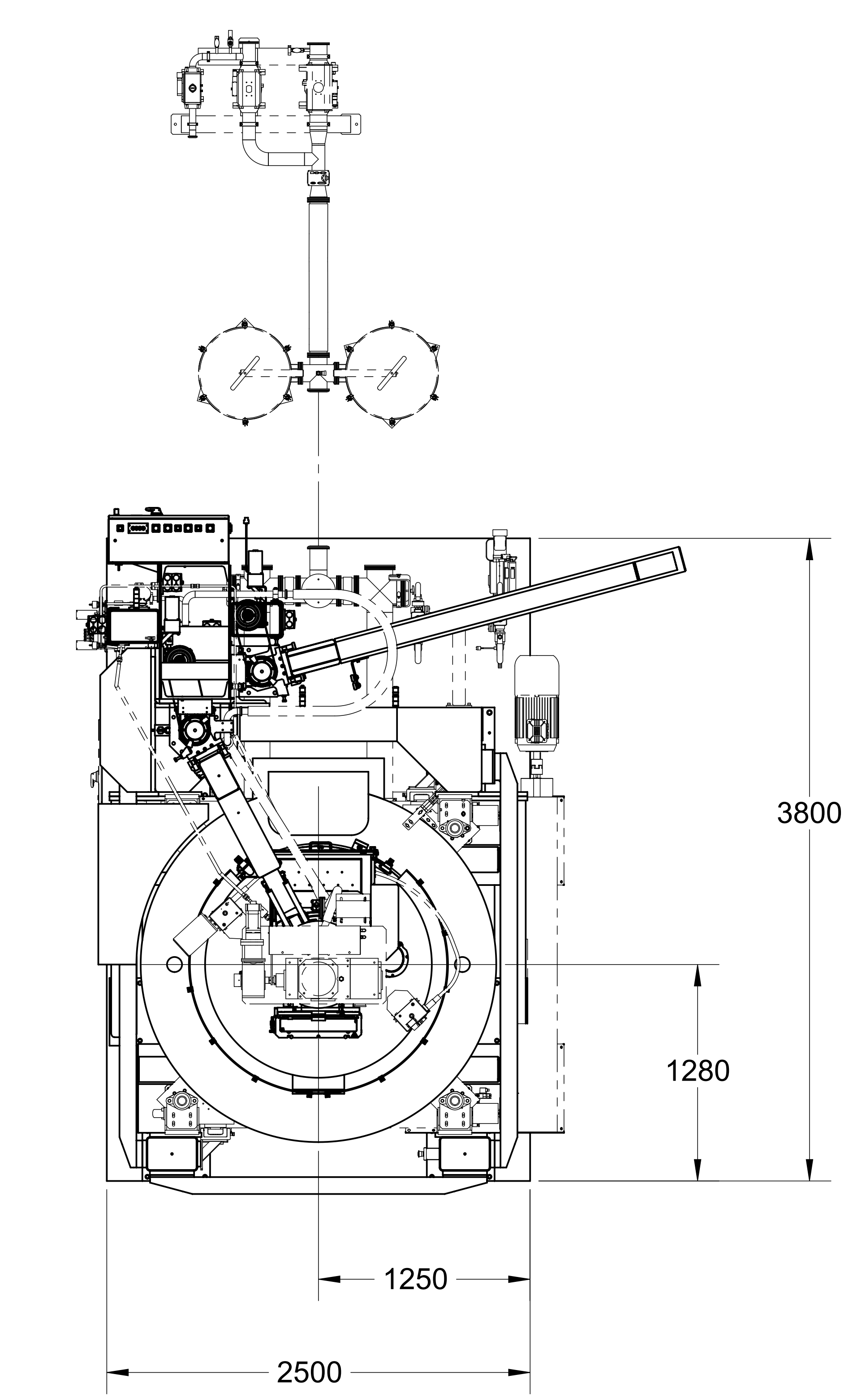
*2180 BRIGHTON-HENRIETTA TL RD.
ROCHESTER, NEW YORK 14623
U.S.A.*

# KX320MCZ, UTILITIES, ARGON/AIR

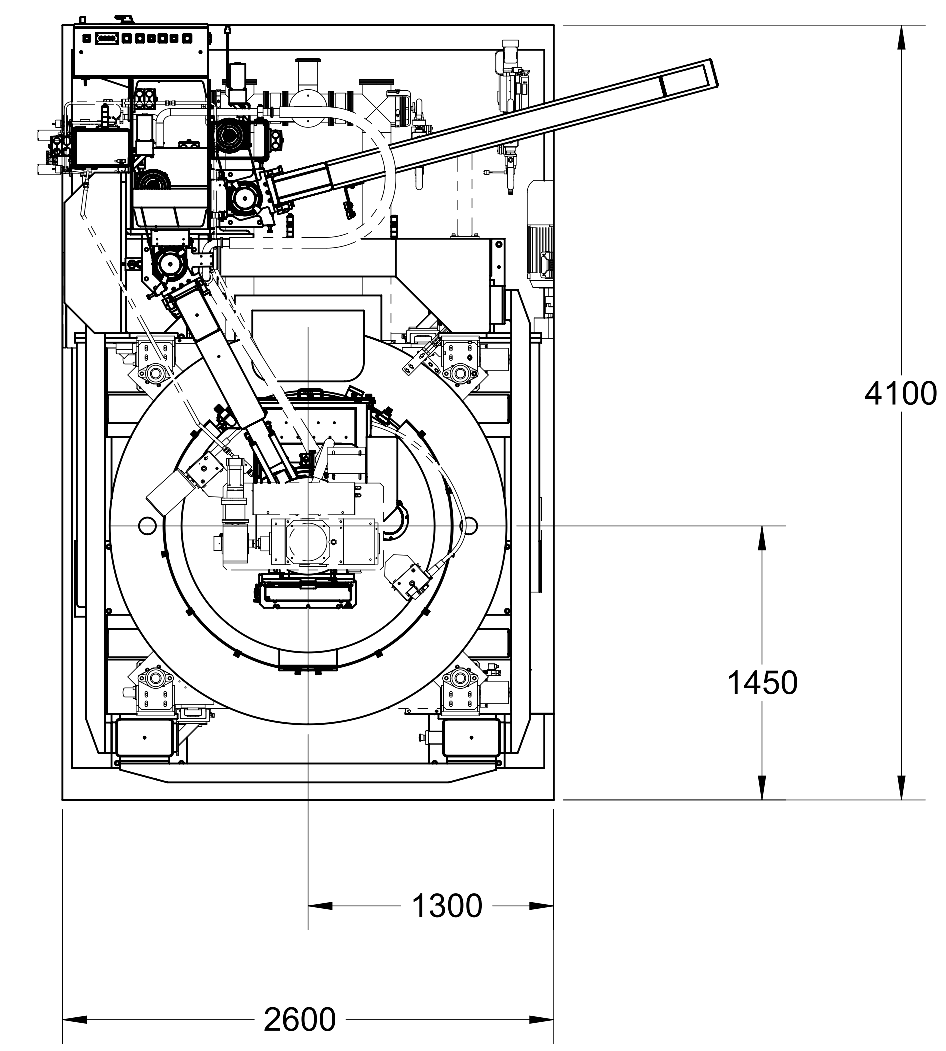
| SIZE | DWG NO | SCALE | SHT | OF |
|---|---|---|---|---|
| C | 364-1284-1 | 1:25 | 1 | 1 |




TOP VIEW
MACHINE ONLY




TOP VIEW
SUGGESTED PEDESTAL




TOP VIEW
SUGGESTED FLOOR OPENING

| REV | ENGINEERING CHANGE NOTICE | DATE | BY | CHK |
|---|---|---|---|---|
| - | RELEASE PER ECN #01659-66 | 12/21/2018 | BS | JR |

ALL PARTS MUST MEET LINTON SPECIFICATION #069-0009-1



METRIC
UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN mm.

HOLE TOLERANCES EXCEPT AS SHOWN

| | | | | |
|---|---|---|---|---|
| Ø1 | TO | Ø6 | +.15 | -.05 |
| Ø6.01 | TO | Ø13 | +.2 | -.1 |
| Ø13.01 | TO | Ø25 | +.3 | -.15 |
| Ø25.01 | AND | > | +.4 | -.2 |

MATERIAL

MACHINE SURFACES EXCEPT AS NOTED

TOLERANCES ON DECIMALS

| X. | .X | .XX | ANGLES |
|---|---|---|---|
| ± | ± | ± | ± 1/2° |

*UNLESS OTHERWISE SPECIFIED BREAK ALL SHARP EDGES APPROX. 0.5 R OR CHAMFER*

FINISH

| | | |
|---|---|---|
| DRAWN | BARB SCHOENEMAN | DATE 12/13/2018 |
| CHECKED | J. REESE | DATE |
| DESIGNER | | DATE |
| ENGINEER | J. REESE | DATE |

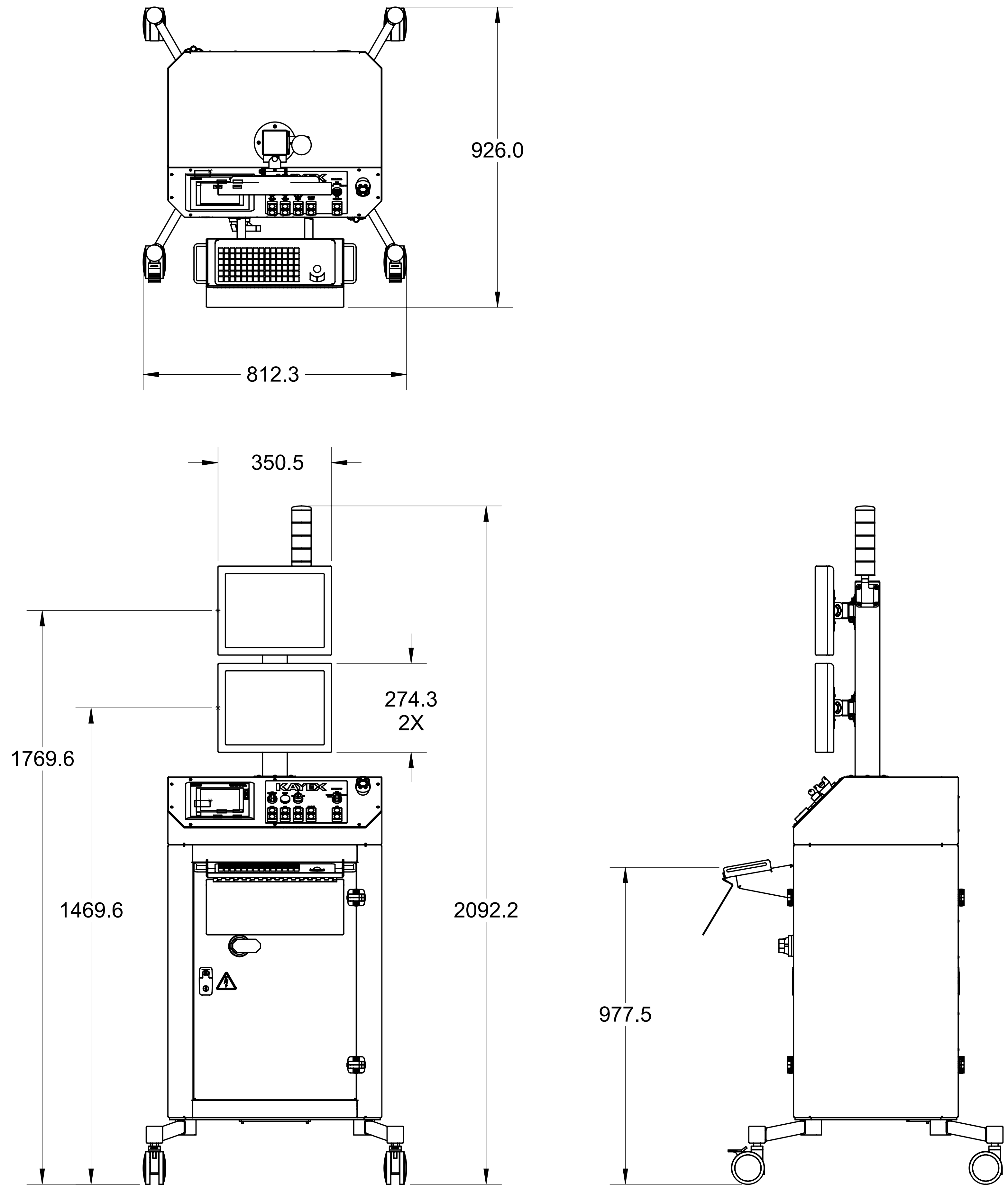
PROJECTION

REL #

Linton Crystal Technologies
*2180 BRIGHTON-HENRIETTA TL RD.
ROCHESTER, NEW YORK 14623
U.S.A.*

# KX320MCZ, PEDESTAL AND FLOOR OPENING

| SIZE | DWG NO | SCALE | SHT | OF |
|---|---|---|---|---|
| C | 364-1289-1 | 1:40 | 1 | 1 |




| REV | ENGINEERING CHANGE NOTICE | DATE | BY | CHK |
|---|---|---|---|---|
| - | RELEASE PER ECN #01607-49 | 8/5/2015 | BS | JR |

METRIC
UNLESS OTHERWISE SPECIFIED,DIMENSIONS ARE IN mm.

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| | | |
|---|---|---|
| DRAWN | BARB SCHOENEMAN | DATE 2/4/2015 |
| CHECKED | J. REESE | DATE |
| DESIGNER | | DATE |
| ENGINEER | J. REESE | DATE |

PROJECTION

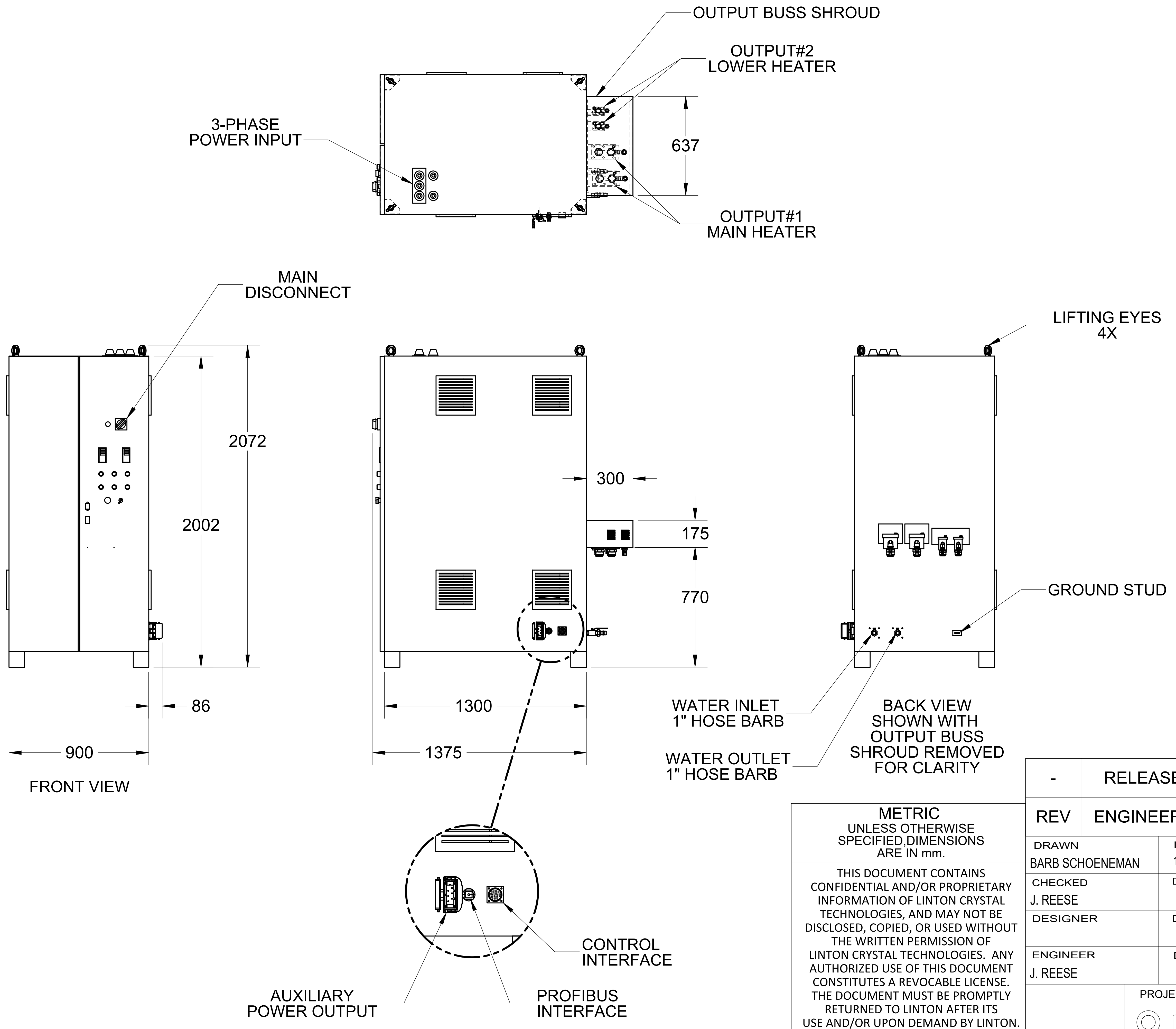
REL #

Linton Crystal Technologies
2180 BRIGHTON-HENRIETTA TL RD.
ROCHESTER, NEW YORK 14624
U.S.A.

# CONTROL CONSOLE, KICCS, (REF 122-9028-2, 9037, & 9038)

SIZE B | DWG NO 364-1062-1

SCALE 1:15 | SHT 1 OF 1




| REV | ENGINEERING CHANGE NOTICE | DATE | BY | CHK |
|---|---|---|---|---|
| - | RELEASE PER ECN #01659-66 | 12/21/2018 | BS | JR |

METRIC
UNLESS OTHERWISE SPECIFIED,DIMENSIONS ARE IN mm.

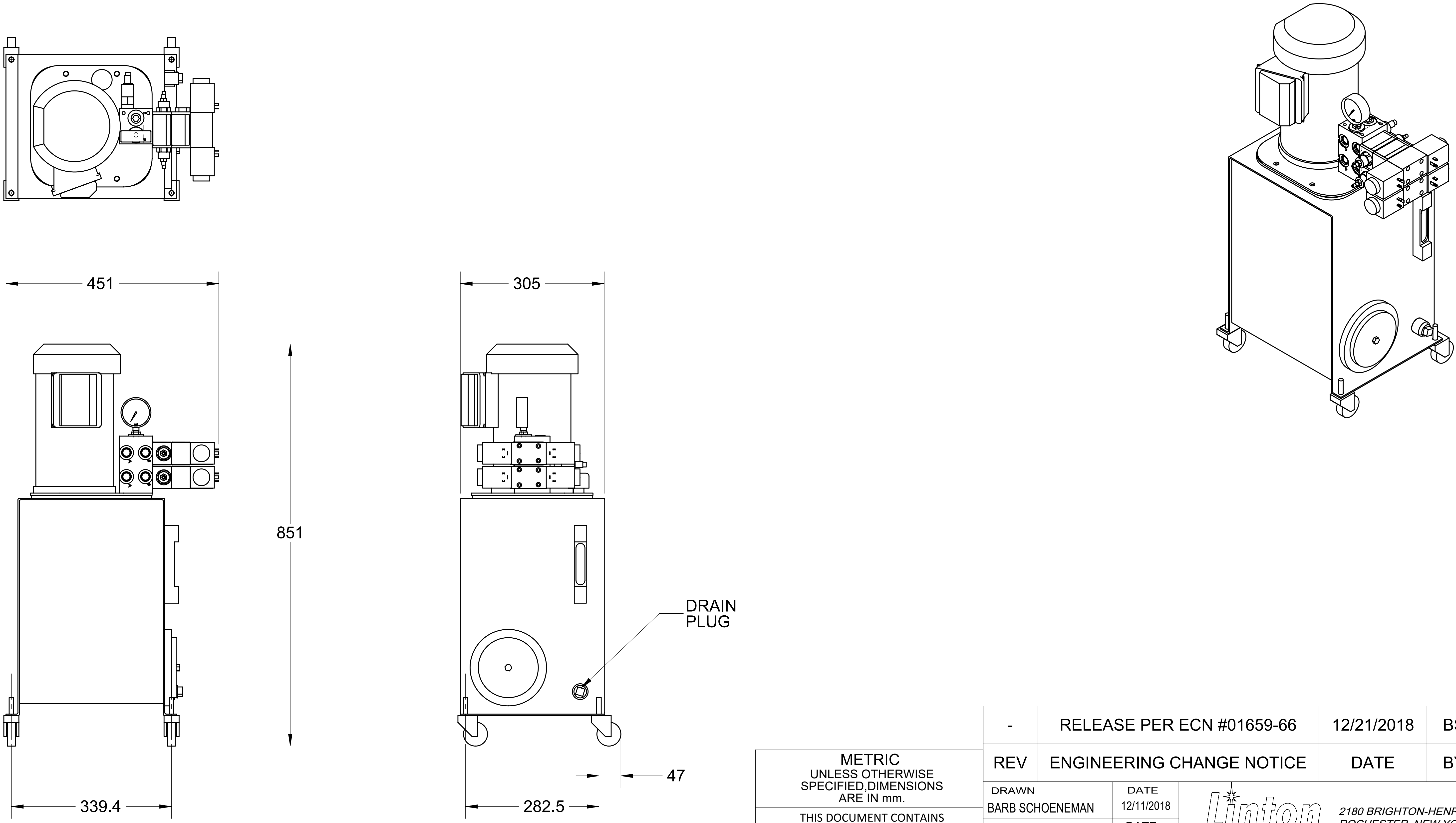


| | | |
|---|---|---|
| DRAWN | BARB SCHOENEMAN | DATE 12/12/18 |
| CHECKED | J. REESE | DATE |
| DESIGNER | | DATE |
| ENGINEER | J. REESE | DATE |
| PROJECTION | | |
| REL # | | |

Linton Crystal Technologies
2180 BRIGHTON-HENRIETTA TL RD.
ROCHESTER, NEW YORK 14624
U.S.A.

PWS,MOD,HTR,200/60KW, IGBT,PROFINET,CE (140-0252-2)

| SIZE | DWG NO | | |
|---|---|---|---|
| B | 364-1291-1 | | |
| SCALE 1:25 | | SHT 1 | OF 1 |




| REV | ENGINEERING CHANGE NOTICE | DATE | BY | CHK |
|---|---|---|---|---|
| - | RELEASE PER ECN #01659-66 | 12/21/2018 | BS | JR |

METRIC
UNLESS OTHERWISE SPECIFIED,DIMENSIONS ARE IN mm.

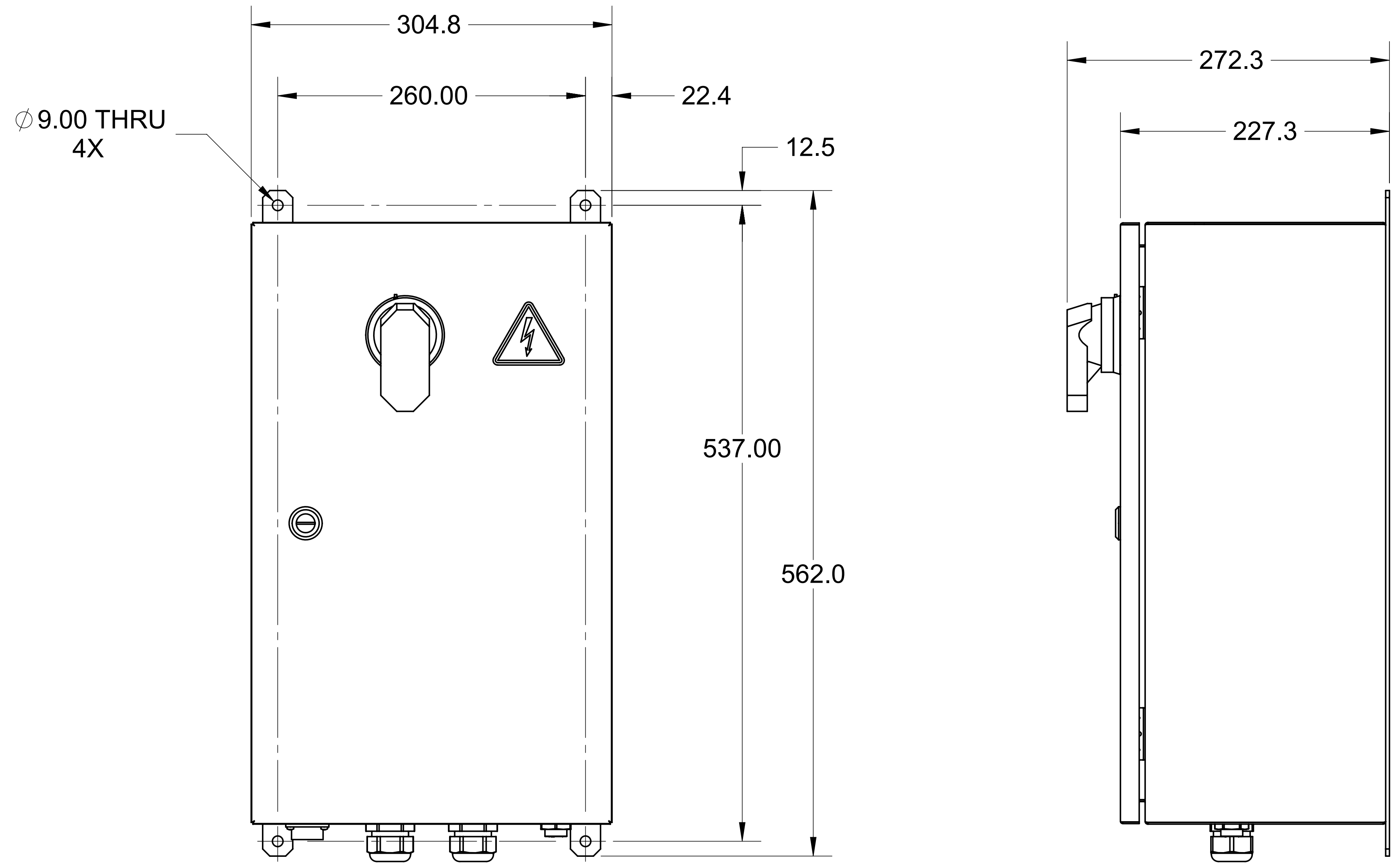


| | |
|---|---|
| DRAWN: BARB SCHOENEMAN | DATE: 12/11/2018 |
| CHECKED: J. REESE | DATE |
| DESIGNER: J. POWERS | DATE |
| ENGINEER: J. REESE | DATE |
| | PROJECTION |
| REL # | |

Linton Crystal Technologies
2180 BRIGHTON-HENRIETTA TL RD.
ROCHESTER, NEW YORK 14624
U.S.A.

# HYDRAULIC POWER UNIT (061-0182-1)

| SIZE | DWG NO | | |
|---|---|---|---|
| B | 364-1288-1 | | |
| SCALE 1:8 | | SHT 1 | OF 1 |




| REV | ENGINEERING CHANGE NOTICE | DATE | BY | CHK |
|---|---|---|---|---|
| - | RELEASE PER ECN #01659-66 | 12/21/2018 | BS | JR |

METRIC
UNLESS OTHERWISE SPECIFIED,DIMENSIONS ARE IN mm.

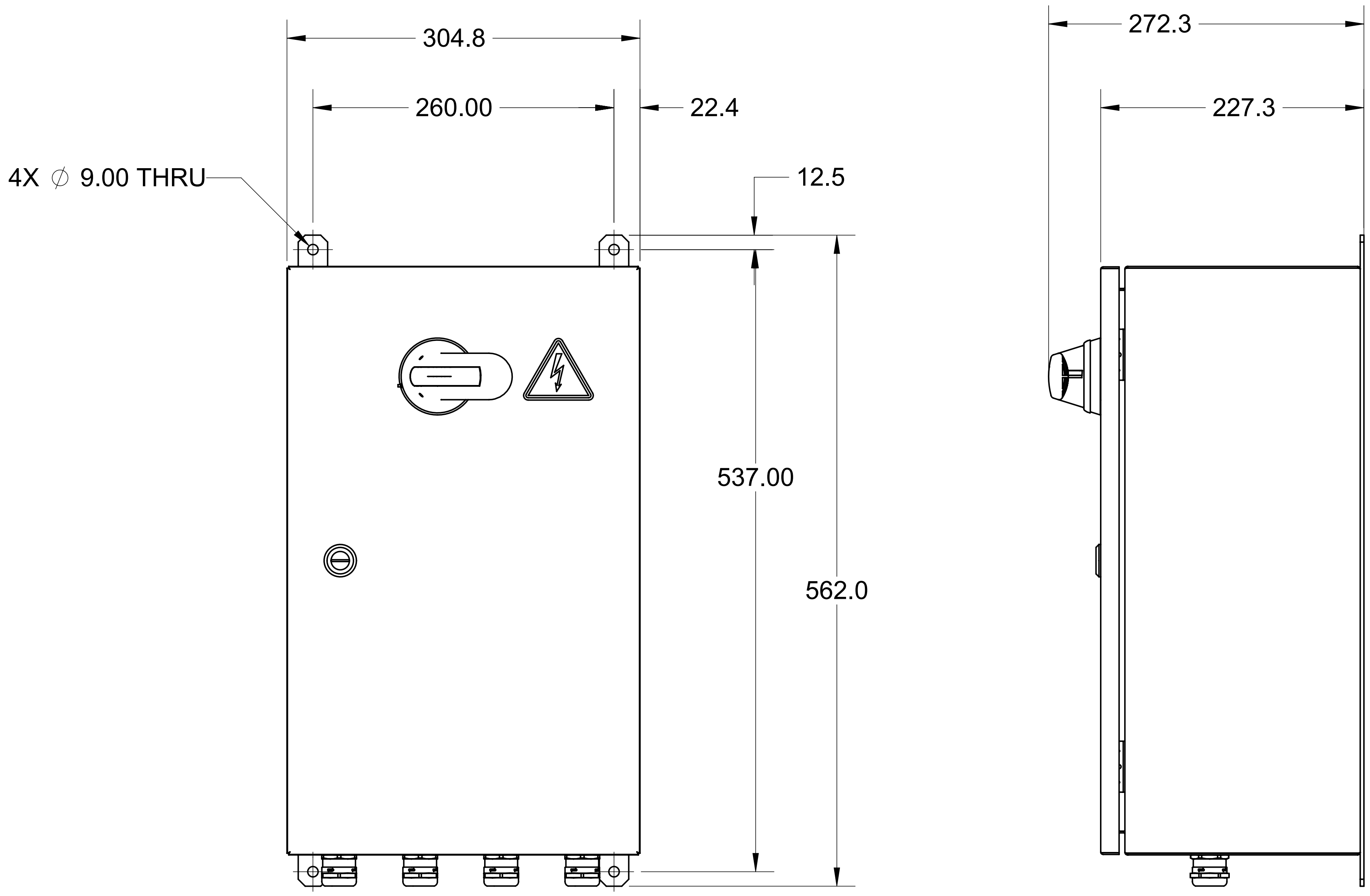


| | |
|---|---|
| DRAWN: BARB SCHOENEMAN | DATE: 12/6/2018 |
| CHECKED: J. REESE | DATE |
| DESIGNER | DATE |
| ENGINEER: J. REESE | DATE |
| PROJECTION | |
| REL # | |

Linton Crystal Technologies
2180 BRIGHTON-HENRIETTA TL RD.
ROCHESTER, NEW YORK 14624
U.S.A.

# J-BOX, CONTACTORS (114-0991-2)

SIZE: B | DWG NO: 364-1286-1
SCALE: 1:5 | SHT 1 OF 1




| REV | ENGINEERING CHANGE NOTICE | DATE | BY | CHK |
|---|---|---|---|---|
| - | RELEASE PER ECN #01659-66 | 12/21/2018 | BS | JR |

METRIC
UNLESS OTHERWISE SPECIFIED,DIMENSIONS ARE IN mm.

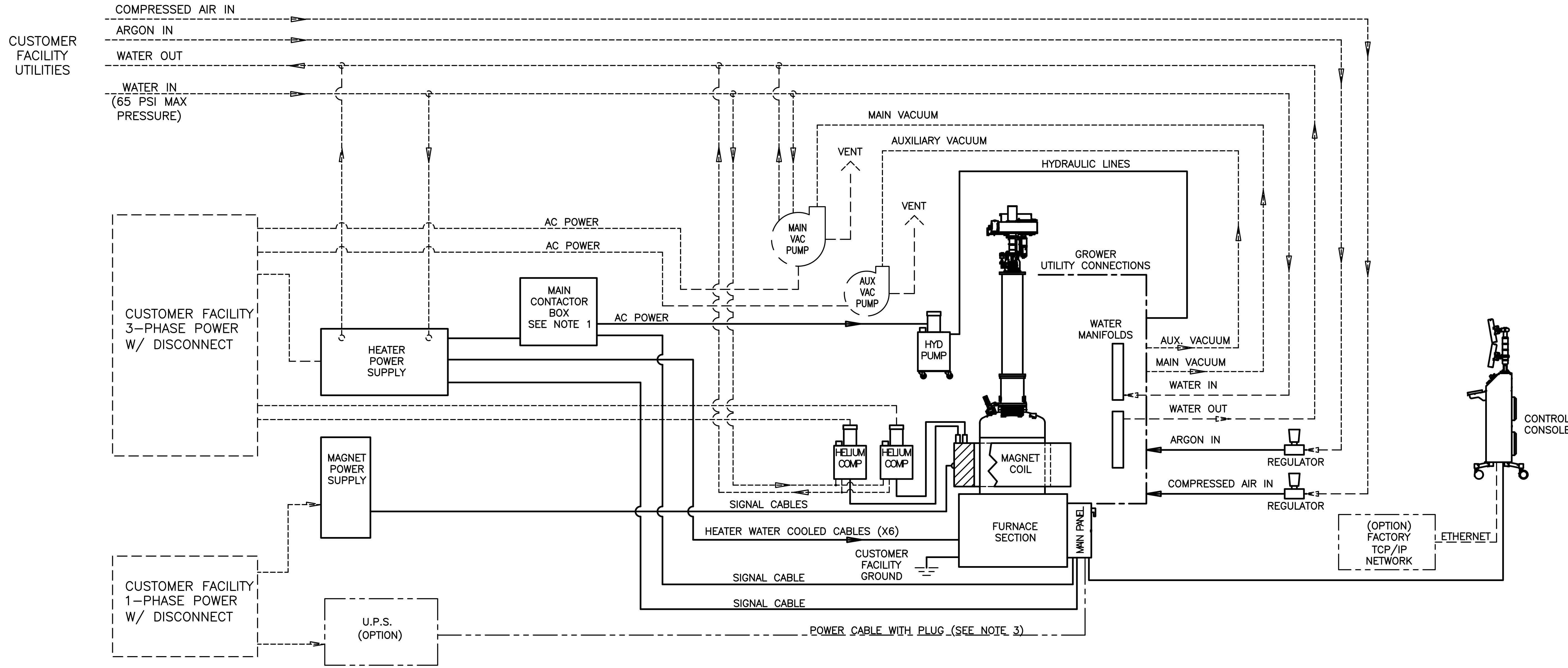


| | |
|---|---|
| DRAWN BARB SCHOENEMAN | DATE 12/6/2018 |
| CHECKED J. REESE | DATE |
| DESIGNER | DATE |
| ENGINEER J. REESE | DATE |
| | PROJECTION |
| REL # | |

Linton Crystal Technologies
2180 BRIGHTON-HENRIETTA TL RD.
ROCHESTER, NEW YORK 14624
U.S.A.

# J-BOX, MAGNET POWER (114-0992-)

SIZE B | DWG NO 364-1287-1
SCALE 1:5 | SHT 1 OF 1




NOTES:

1. MOTOR OVERLOADS, INSIDE THE MAIN CONTACTOR BOX, ARE NOT SUPPLIED BY LINTON UNLESS MAIN AND AUX VACUUM PUMPS ARE PURCHASED WITH THE GROWER. ISOLATED CONTACTS ARE SUPPLIED TO INTERFACE WITH NON-SUPPLIED PUMPS.

2. REFER TO MACHINE SPECIFICATIONS DOCUMENT FOR FACILITY REQUIREMENTS.

3. IF UPS IS NOT PURCHASED WITH GROWER, REQUIRED PLUG WILL BE PROVIDED TO INTERFACE WITH THE CONTROL ENCLOSURE ON GROWER.

4. — — — — DOTTED LINES REPRESENT CUSTOMER PROVIDED.

5. —-—-— PHANTOM LINES REPRESENT EQUIPMENT OPTIONS.

METRIC
UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN mm.



| REV | ENGINEERING CHANGE NOTICE | DATE | BY | CHK |
|---|---|---|---|---|
| | | | | |

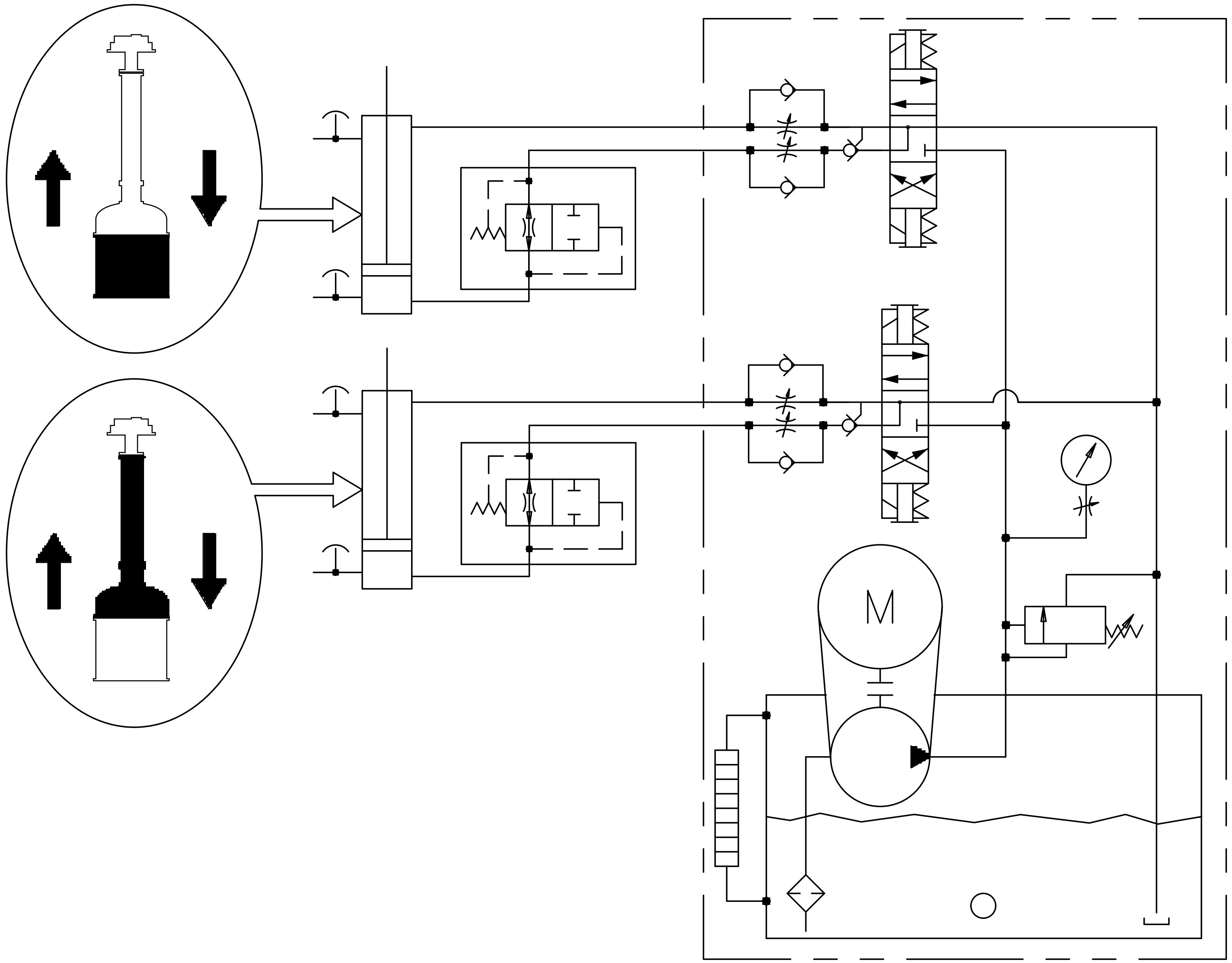
| | |
|---|---|
| DRAWN J. REESE | DATE 08/15/18 |
| CHECKED | DATE |
| APPROVED | DATE |
| ENGINEER | DATE |
| | PROJECTION |
| REL # | |

Linton CRYSTAL TECHNOLOGIES
2180 BRIGHTON–HENRIETTA TL RD.
ROCHESTER, NEW YORK 14623
U.S.A.

# FACILITY SKETCH KX320MCZ WITH SUPER CONDUCTING MAGNET

SIZE B | DWG NO 364–1271–1

SCALE –––– | SHT 1 OF 1




| REV | ENGINEERING CHANGE NOTICE | DATE | BY | CHK |
|---|---|---|---|---|
| – | RELEASE PER ECN #01532-20 | 5/2/12 | BS | JR |

ALL PARTS MUST MEET LINTON SPECIFICATION #069-0009-1



IMPERIAL
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES.

| HOLE TOLERANCES EXCEPT AS SHOWN | |
|---|---|
| ø.040 TO ø.129 | +.005 −.000 |
| ø.130 TO ø.250 | +.006 −.000 |
| ø.251 TO ø.485 | +.008 −.000 |
| ø.486 TO ø.735 | +.010 −.000 |
| ø.736 TO ø.985 | +.012 −.000 |
| ø.986 AND > | ±.010 |

MATERIAL

MACHINE SURFACES EXCEPT AS NOTED √

TOLERANCES ON DECIMALS

| .X | .XX | .XXX | ANGLES |
|---|---|---|---|
| ± | ± | ± | ± |

UNLESS OTHERWISE SPECIFIED BREAK ALL SHARP EDGES APPROX. R.020 OR CHAMFER

FINISH

| | DATE |
|---|---|
| DRAWN BARB SCHOENEMAN | 5/2/12 |
| CHECKED J. REESE | DATE |
| APPROVED | DATE |
| ENGINEER | DATE |

PROJECTION

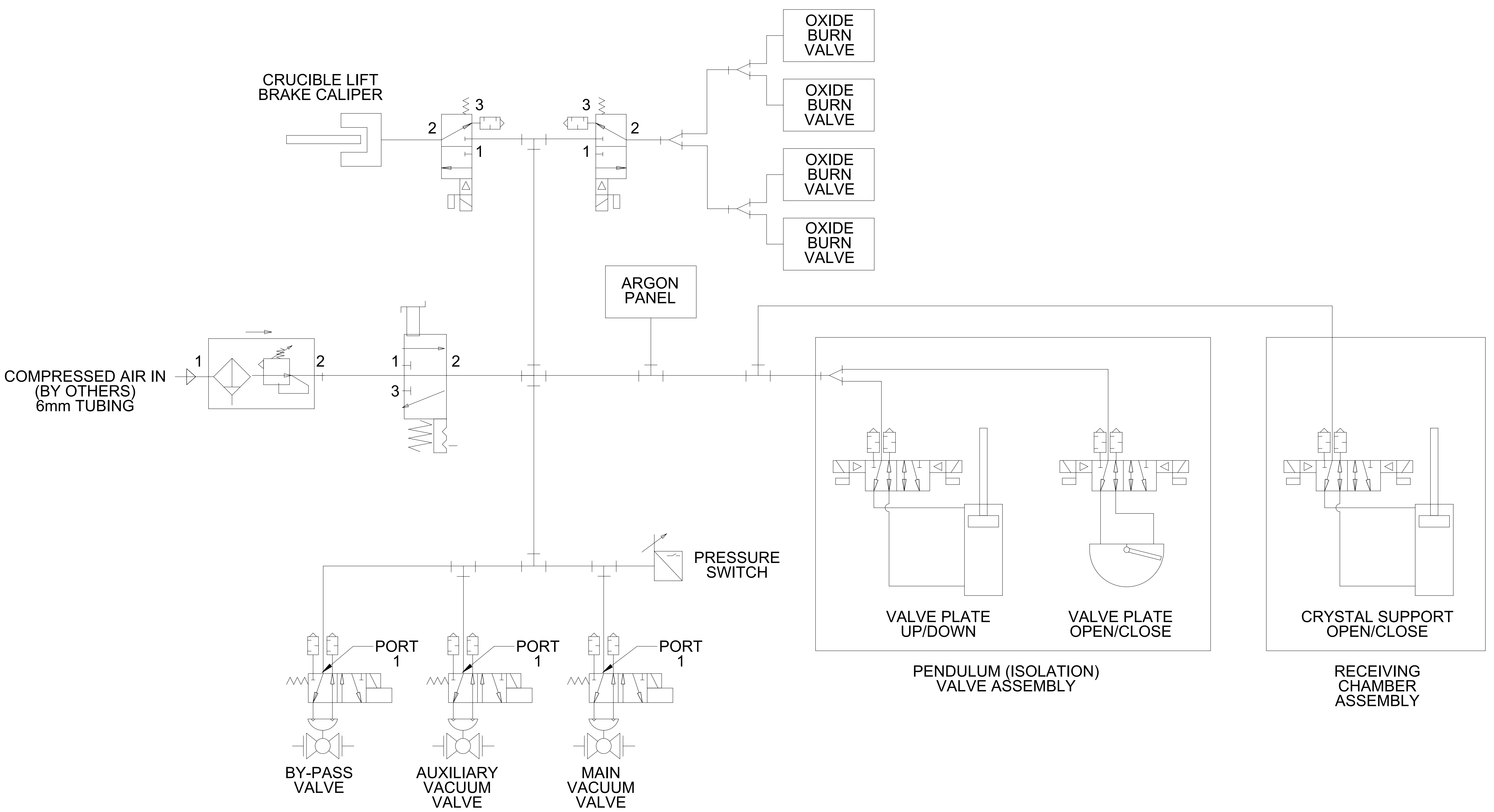
REL #

Linton
CRYSTAL TECHNOLOGIES
2180 BRIGHTON-HENRIETTA TL RD.
ROCHESTER, NEW YORK 14623
U.S.A.

# SCHEMATIC, HYDRAULIC SYSTEM

SIZE C | DWG NO 364-1012-1

SCALE ---- | SHT 1 OF 1




| REV | ENGINEERING CHANGE NOTICE | DATE | BY | CHK |
|---|---|---|---|---|
| - | RELEASE PER ECN #01659-66 | 12/21/2018 | BS | JR |

ALL PARTS MUST MEET LINTON SPECIFICATION #069-0009-1



METRIC
UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN mm.

HOLE TOLERANCES EXCEPT AS SHOWN

| | | | | |
|---|---|---|---|---|
| Ø1 | TO | Ø6 | +.15 | -.05 |
| Ø6.01 | TO | Ø13 | +.2 | -.1 |
| Ø13.01 | TO | Ø25 | +.3 | -.15 |
| Ø25.01 | AND | > | +.4 | -.2 |

MATERIAL

MACHINE SURFACES EXCEPT AS NOTED

TOLERANCES ON DECIMALS

| X. | .X | .XX | ANGLES |
|---|---|---|---|
| ± | ± | ± | ± 1/2° |

*UNLESS OTHERWISE SPECIFIED BREAK ALL SHARP EDGES APPROX. 0.5 R OR CHAMFER*

FINISH

| | | |
|---|---|---|
| DRAWN | BARB SCHOENMEAN | DATE 12/13/18 |
| CHECKED | J. REESE | DATE |
| DESIGNER | | DATE |
| ENGINEER | J. REESE | DATE |

PROJECTION

REL #

Linton Crystal Technologies
*2180 BRIGHTON-HENRIETTA TL RD. ROCHESTER, NEW YORK 14623 U.S.A.*

# KX320MCZ, PNEUMATIC SYSTEM

SIZE C | DWG NO 364-1290-1

SCALE 1:1 | SHT 1 OF 1

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2180 Brighton-Henrietta Townline Road
Rochester, New York 14623