SCALE RESISTANT HEAT EXCHANGERS FOR LOW TEMPERATURE GEOTHERMAL BINARY CYCLE POWER PLANT

Contract DE-EE-0004423

Final Report

Energent Corporation

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Executive Summary

Phase 1 of the investigation of improvements to low temperature geothermal power systems was completed. The improvements considered were reduction of scaling in heat exchangers and a hermetic turbine generator (eliminating seals, seal system, gearbox, and lube oil system).

A scaling test system with several experiments was designed and operated at Coso geothermal resource with brine having a high scaling potential. Several methods were investigated at the brine temperature of 235 ºF. One method, circulation of abradable balls through the brine passages, was found to substantially reduce scale deposits. The test heat exchanger was operated with brine outlet temperatures as low as 125 ºF, which enables increased heat input available to power conversion systems. For advanced low temperature cycles, such as the Variable Phase Cycle (VPC) or Kalina Cycle, the lower brine temperature will result in a 20-30% increase in power production from low temperature resources.

A preliminary design of an abradable ball system (ABS) was done for the heat exchanger of the 1 megawatt VPC system at Coso resource. The ABS will be installed and demonstrated in Phase 2 of this project, increasing the power production above that possible with the present 175 ºF brine outlet limit.

A hermetic turbine generator (TGH) was designed and manufacturing drawings produced. This unit will use the working fluid (R134a) to lubricate the bearings and cool the generator. The 200 kW turbine directly drives the generator, eliminating a gearbox and lube oil system. Elimination of external seals eliminates the potential of leakage of the refrigerant or hydrocarbon working fluids, resulting in environmental improvement. A similar design has been demonstrated by Energent in an ORC waste heat recovery system.

The existing VPC power plant at Coso was modified to enable the “piggyback” demonstration of the TGH. The existing heat exchanger, pumps, and condenser will be operated to provide the required process conditions for the TGH demonstration. Operation of the TGH with and without the ABS system will demonstrate an increase in geothermal resource productivity for the VPC from 1 MW/(million lb) of brine to 1.75 MW/(million lb) of brine, a 75% increase.

Introduction

Geothermal resources throughout the world can potentially be a significant source of electrical power. The majority of geothermal resources, however, are composed of low temperature brines (300 °F and lower). Low-temperature resources include naturally occurring hot water reservoirs, co-produced fluids, enhanced geothermal systems (EGS), and separated hot water from flash steam power plants. Because the capital costs of geothermal power systems are very high, the viability of low-temperature resource usage depends heavily on optimizing the conversion of low grade thermal energy into electricity. Organic Rankine Cycle systems (ORC), commonly used for energy conversion of low-temperature resources, cannot maximally utilize the thermal energy because of the pinch point limitation: this binary cycle system employs a boiling refrigerant in the heat transfer from the resource, which restricts energy conversion due to latent heat transfer.

Power cycles that either avoid this restriction or minimize its severity have been developed. In the Variable Phase Cycle, for example, a refrigerant is chosen that allows for sensible heat transfer at pressure. In the Kalina Cycle, a refrigerant mixture has a variable boiling point. The potential of these cycles to achieve higher energy conversion rates is hampered by other limitations, however. Namely, the formation of mineral scale on heat exchanger surfaces increases as the temperature of the cooled brine decreases to lower temperatures. This fouling reduces the performance of the heat exchanger and thus, the utilization of the geothermal resource. Cleaning these heat exchangers is expensive and typically requires a system shutdown – a further cost.

This project described herein targeted two facets of low-temperature geothermal resource utilization. The issue of heat exchanger fouling in low-temperature geothermal power systems was addressed by testing several scale-resistant heat exchangers on a small scale, each using a different method. These approaches included the anti-scalant chemical additives, abradable sponge balls, and an electromagnetic device. Tests were conducted at Coso geothermal fields operated by Terra-Gen using separated hot water from upstream steam power plants. The test heat exchangers were designed to drop the geothermal brine to a lower temperature than currently permitted for the bulk of the brine at the site.

The second project component was the design of a hermetic turbine-generator assembly to be submerged in the working fluid. The hermetic unit eliminates the need for a shaft seal and prevents emissions of high global warming potential (GWP) refrigerants. The design incorporates a Variable Phase Turbine for which a gearbox is not required: the turbine rotor is directly overhung on the generator shaft. Less maintenance and capital costs are needed for such a design compared to conventional systems, which improves the feasibility of low-temperature resource utilization.

Both components of the project are to be combined into a later demonstration project at Coso: the Geothermal Scale Resistant Heat Exchanger power plant (Geo-SRX) will be designed to operate at lower brine temperatures than previously advisable – possible through use of a successful and economical scale-control method. Geo-SRX, rated for 200 kW, will use the refrigerant R-134a as a working fluid in a Variable Phase Cycle (VPC) power plant. The VPC can potentially increase energy conversion of the low-temperature brine by up to 30% more than an ORC. The system will be operated for 60 days to confirm the performance advantages of the VPC and scale-resistant method and to determine optimal operation conditions and methods, materials usage, and outlet brine composition.

This project will have extensive benefits, not least of which is the average increase in power production from low-temperature geothermal resources. This increase is estimated to be 25-30% over conventional methods in the resource temperature range of 150-300 °F, potentially adding 25-35 GWe in production potential for low-temperature geothermal, enhanced geothermal, and co-produced fluid systems. Additionally, there are capital cost savings associated with the turbine-generator system and heat exchanger maintenance. This combination can make previously under-utilized low-temperature geothermal resources more commercially viable.

Project Scope

This project developed and demonstrated technology that will reduce the costs and improve the reliability of power generation from low-temperature geothermal fluids. Two approaches have been used:

> Demonstration of a heat exchanger method to maximize the heat extraction from low temperature geothermal fluids while preventing scale formation within the heat exchanger.
>
> Demonstration of a cost-effective energy conversion cycle that can fully utilize the available heat extracted from the low temperature geothermal fluids. A hermetic turbine-generator was developed, greatly simplifying the power conversion device.

The project has accomplished the former by developing and testing a scale-resistant heat exchanger on a small scale. The best heat exchanger technology was determined to be the abradable ball heat exchanger. The best heat exchanger technology will be combined with the designed hermetic turbine-generator into a 200 kW VPC power plant at Coso geothermal fields. This Geo-SRX plant will be operated for 60 days to demonstrate performance.

Phase I Accomplishments

The Phase I tasks to be performed and discussion of the completed work are listed below.

1 Develop and Design Scale Resistant Heat Exchanger

1.1 Characterize Geothermal Resource

The geothermal resource at Coso has been characterized for chemical content:

Component	Concentration (mg/kg)
Na	6500
K	1015
Ca	229
Li	46.2
Mg	0.58
Sr	23.6
B	222
SiO_2	528
Cl	11660
F	2.74
SO_4	63.8
HCO_3	54.8

Table 1.1: Chemical analysis of well 47A-20, 12/15/2010; pH = 6.87

1.2 Design of Test Scale Resistant Heat Exchangers

1.2.1 The abradable heat exchanger will be designed for a tube bundle with a small number of tubes (< 20). The abradable cleaning ball distribution system will be designed to allow for periodic circulation and recollection of the cleaning balls.

The abradable ball heat exchanger design incorporates a system of eight solenoid valves and two y-strainers in order to recirculate the sponge balls. This system does not require the pumps or compressed air seen in commercial systems. This design simplified operation for small-scale testing as groups of solenoid valves simply needed to switch from closed to open and vice versa. The process and instrumentation diagram for this heat exchanger is shown in Figure 1.2.1.

1.2.2 The fluidized bed heat exchanger will be designed for a tube bundle with a small number of tubes (< 20). Bed material will be evaluated; candidate materials include sand and small metallic particles. The brine will flow on the shell side of the shell-and-tube heat exchanger.

The fluidized bed heat exchanger was designed as a three-stage, single-tube heat exchanger using glass spherical beads for the bed material. The current model for the heat exchanger is shown below.

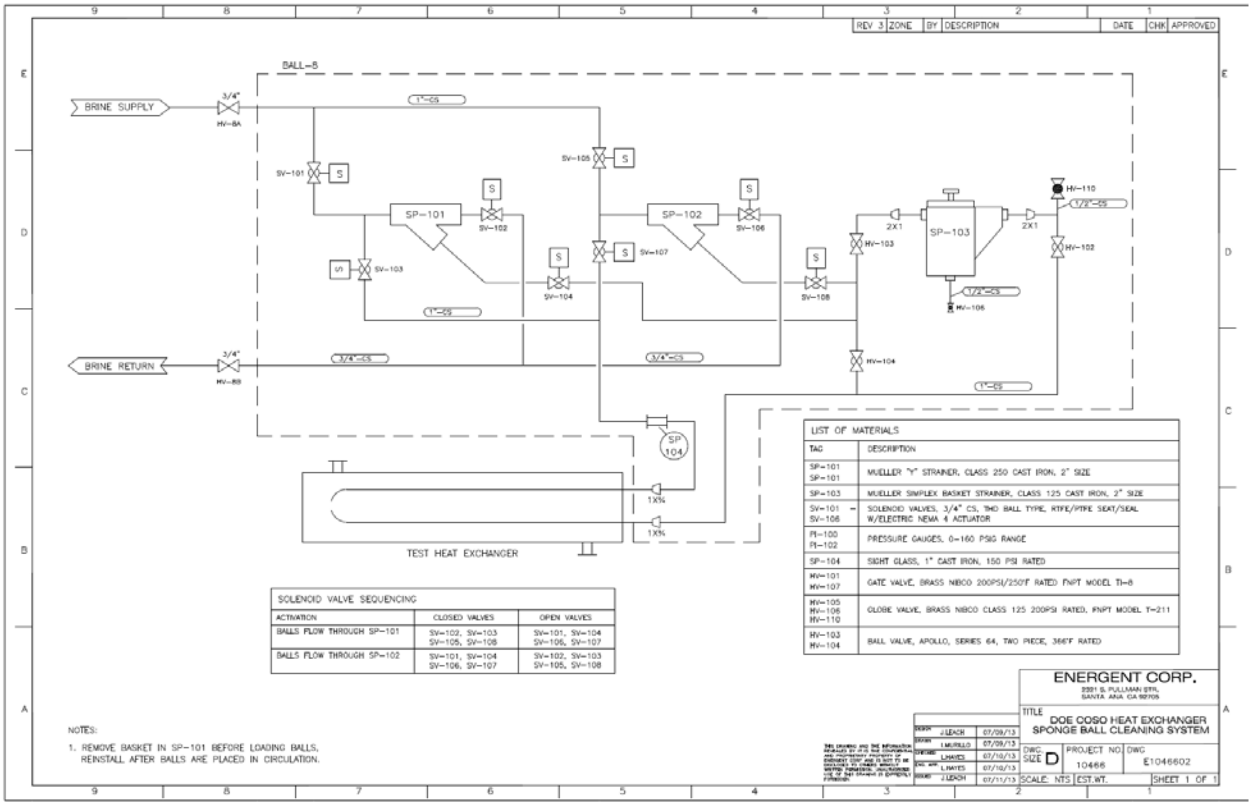


Figure 1.2.1: Process and instrumentation diagram for abradable heat exchanger.

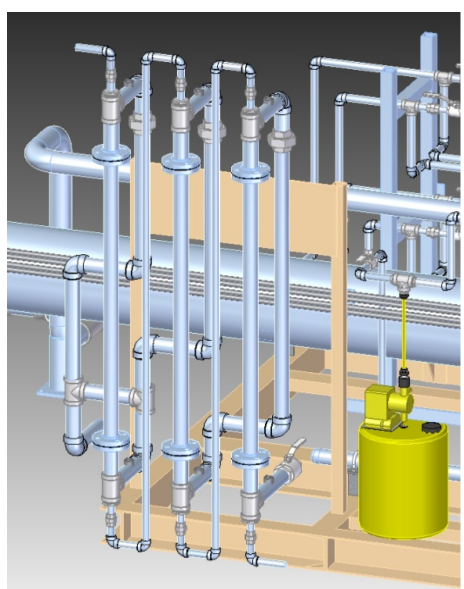


Figure 1.2.2: Model of fluidized bed heat exchanger

1.2.3 An additional shell-and-tube heat exchanger will be designed for use with the precipitation and removal chemical injection technique. The injection system will be designed as well as the particle removal system at the exit of the heat exchanger.

We contacted the company that implements a method of precipitating all silica out of geothermal brine and discovered that the cost of the method was prohibitively expensive. We decided not to test this method for the project.

1.2.4 Four single tube heat exchangers will be designed for use with additive injection.

These heat exchangers were designed as tube heat exchangers in a common shell: all the tubes were placed in a single bath similar to a shell-and-tube heat exchanger bundle.

1.2.5 The electromagnetic device for scale prevention will be selected and procured. An additional single tube heat exchanger will be designed for use with the electromagnetic device.

We selected an electromagnetic scale prevention device known as ScaleBlaster, Model SB-150 (Clearwater Enviro Technologies, Inc., Clearwater, Florida). The

1.2.6 Design system skid and instrumentation for heat exchanger test

Figure 1.2.6.1 shows a model of the heat exchanger skid, and Figure 1.2.6.2 shows the process and instrumentation diagram for the full heat exchanger system. The system uses cooling water to cool the geothermal brine. Filters a distance away of the heat exchangers were used to simulate the reinjection wells.

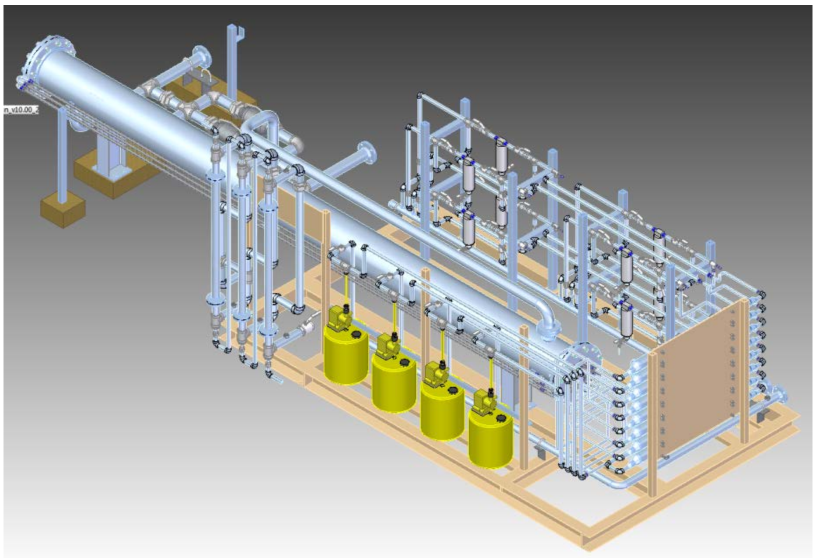


Figure 1.2.6.1: Heat exchanger skid model

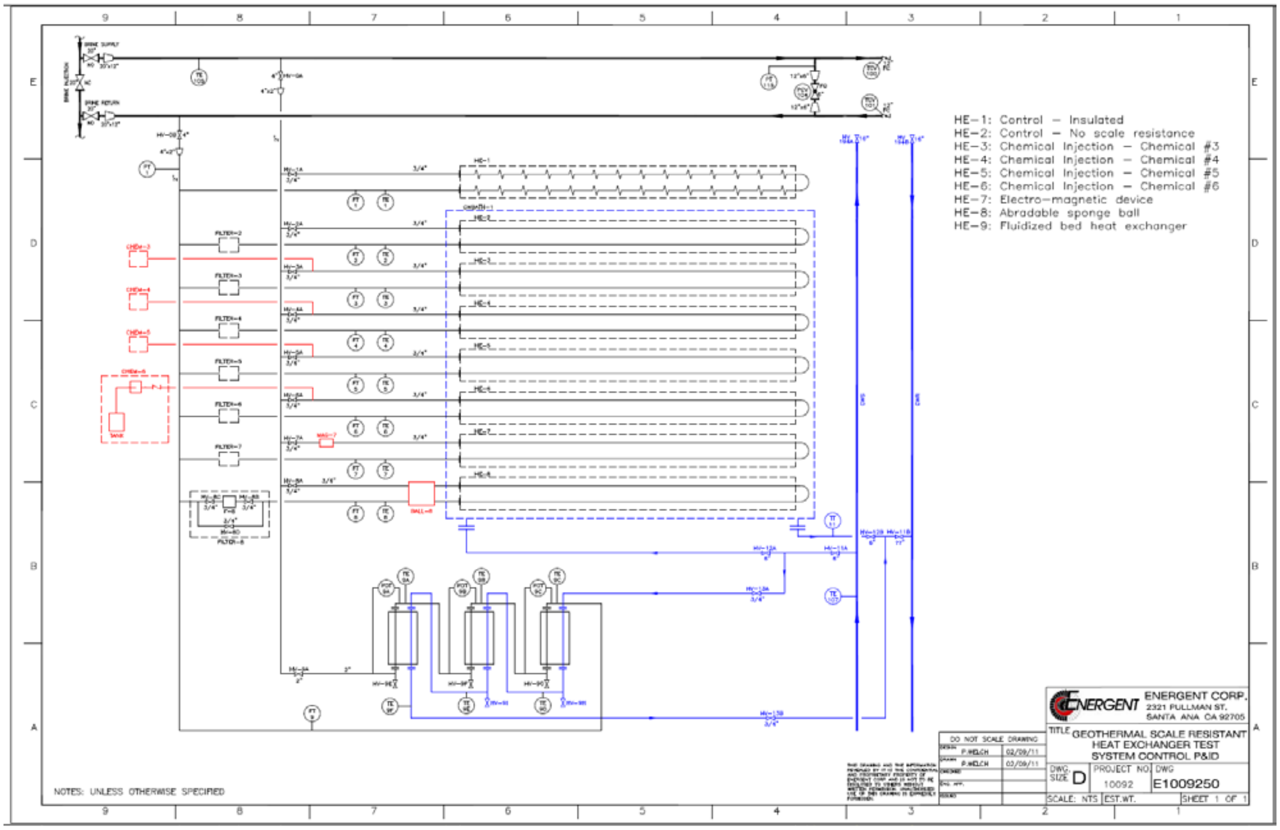


Figure 1.2.6.2: Process and instrumentation diagram for heat exchanger test

1.2.7 Design injection systems

The injection systems for the anti-scalant chemicals use diaphragm metering pumps.

1.2.8 Find procurement channels for the consumables for each of the heat exchanger types

We used anti-scalants from Multi-Chem, ChemTreat, and GE Water. The table below lists the chemicals used as well as the target and actual dosages for each chemical. Feed rates were based on an average brine flow rate of 3.75 gpm, which was reached at the beginning of the tests. However, the flow rate declined such that the actual dosage ended up being larger than calculated.

Supplier	Chemical Name	Target dosage	Actual dosage*
Multi-Chem	MX 2-3628	130 ppm	252 ppm
ChemTreat	GS8464	14.5	31
ChemTreat	CL4700	11	23
GE Water	PDC9486	25	54

Table 1.2.8: Chemical anti-scalants used in heat exchanger tests.
*Actual dosage based on average flow rate.

1.2.9 *Prepare testing procedures and criteria for each heat exchanger type*

Testing procedures are described below.

Control experiment procedures: There are two control experiments in the heat exchanger design. The first control is an insulated tube that carries geothermal brine but does not exchange heat with the cooling water. The second control is a tube heat exchanger within the main cooling shell. This heat exchanger does not use any method of scale control. Brine flows through these tubes in the same way as the other heat exchangers: flow is modulated through the inlet globe valves. The inlet temperature for all control and heat exchanger inlets is monitored by a common RTD in the brine supply line. The outlet temperatures for all control and heat exchanger outlets are monitored by separate RTD's at each outlet.

Abradable ball heat exchanger procedure: Controlling the movement of sponge balls throughout the abradable ball heat exchanger was accomplished through control of eight solenoid valves. Two sets of four solenoid valves controlled movement of the balls through two tubing circuits by alternately switching each set from open to closed and vice versa. (See Figure 1.2.1.)

Anti-scalant chemical heat exchanger procedures: The chemicals to be tested require regular dosages to be added to the heat exchangers. Metering pumps were used to feed the chemicals into the brine at the heat exchanger inlets.

Electromagnetic heat exchanger procedure: The connection of the ScaleBlaster device to the heat exchanger is made by attaching a metal coil to piping at the heat exchanger inlet. The system begins running when the power to the device is turned on.

1.3 Construct Scale Resistant Heat Exchangers

The heat exchanger test system designed in Task 1.2 will be built and the consumables (chemical additives, abradable cleaning balls, fluidized bed material) will be procured.

The system skid excluding the fluidized bed heat exchanger was fabricated, shipped to the testing site, and connected to fluid and electrical lines. Figure 1.3 shows the installed heat exchanger skid.

1.4 Test Scale Resistant Heat Exchangers

The heat exchanger test system built in Task 1.3 will be tested for a period of 2 months.

Testing of the heat exchanger was begun in June 2014 and completed in August 2014. Temperature and flow data was recorded at least once daily during the testing period. A few issues caused the system to be shut down at different times, but data was collected from a running system for a total of 30 days. Controlling the flow rates of the system was difficult because of significant pressure fluctuations in the brine supply as well as site restrictions on pressure regulation of the brine.

Roughly a week after testing began, the brine flows through the heat exchangers had decreased substantially because the outlet filters had clogged, restricting flow. The system was restarted after directing the flow to bypass the filters. Within a week of the system restart, the flow meters showed incorrect readings because they were obstructed by scale and debris. The system was shut down for a different problem: the sight gauge on the abradable ball heat exchanger – a section of clear plastic tubing – disconnected from the heat exchanger tubing, likely because of high brine pressures.

Given the problems with low brine flow, the system was later restarted with the addition of suction pumps. The sight gauge was replaced by metal tubing. The next period of testing lasted for 19 days until pump failure led to a shutdown.

Flow rates, which fluctuated considerably, ranged from below 1 gpm to 5.5 gpm. The inlet brine temperature ranged from 188 ºF to 241 ºF with an average of 233 ºF. The average outlet temperatures across all heat exchangers ranged from 117 ºF to 132 ºF.

1.5 Evaluate SRX Test Results

The test results from Task 1.4 will be evaluated and modifications will be made, if necessary, to the test set-ups

Various data and indicators were used to analyze the test, including temperature data, scale thickness measurements, and visual inspection of scale.

<u>Scale appearance on outlet filters</u>: Basket filters (mesh size 100) were used downstream of the heat exchanger outlets in order to simulate reinjection wells. The filters were clogged roughly a week after starting brine flow and were removed. (The mesh size may not be appropriate.) The quality of scale was different for each heat exchanger. White scale was presumed to be majority silica scale while reddish-brown scale was deemed rust. Since the tubing is carbon steel, some amount of rust was expected. The filter for the electromagnetic scale device heat exchanger appeared to have the most rust while the heat exchanger with chemical PDC9486 appeared to have the most silica scale. See Figure 1.5.1 for filter photos.

<u>Scale thickness</u>: After a period of two months, the scale thickness of the heat exchangers tubing was measured using a thickness gauge (Fischer Deltascope FMP10). The inlet and outlet of each heat exchanger was measured ten times and then the values averaged. Results are listed in Table 1.5.2.

Upstream conditions related to the different scale control methods affected each heat exchanger inlet, leading to deviations from the control's inlet thickness. The heat exchanger with chemical MX 2-3628 had an inlet thickness of 9.8 mils, the lowest of any heat exchanger and even less than that of the control (17.1 mils). The outlet thickness was the second lowest of all (27.4 mils) but just slightly lower than that of the control (29.6 mils). This shows that this chemical performs better than the control across the temperature range but favors the higher temperature range. All of the other chemicals performed worse than the control for the length of the heat exchanger. This could be explained by an unsuitable dosage. Further testing with other dosages would be required to determine the optimal dosages for each chemical.

The electromagnetic device (ScaleBlaster) had larger scale thicknesses than those of the control at both the inlet and outlet. Given the filter appearance, the scale may be composed mainly of rust rather than silica. Even if silica scale is prevented, rust remains an issue using this device for carbon steel tubing. Testing this device on other materials would be advisable.

The inlet scale thickness for the abradable ball heat exchanger exceeds that of the control (29.6 mils vs. 17.1 mils for the control), but the outlet thickness is by far the least of all the heat exchangers. In fact, the outlet has less scale than the inlet at 10.2 mils. This heat exchanger appears to perform the best given the thickness data.

Heat exchanger data: Analyzing the temperature data proved difficult for a few reasons. The flow rates were not able to be controlled, but also large brine supply pressure fluctuations caused corresponding fluctuations of brine flow. Also, the design of the heat exchangers, which features separate heat exchanger tubes all in the same shell, results in a shell-side (cooling water) environment that is different for every heat exchanger. This made it difficult to compare outlet temperature data as well as other calculated qualitative values among the different heat exchangers. Evaluation of the outlet temperature data revealed some differences in temperature, but the data seemed inconsistent with the scale thickness data (see Figure 1.5.2). This may be attributable to the differences in shell-side environments. Studies of the heat exchanger coefficient yielded inconclusive results even when taking different flow rates into account. For these reasons, we deferred to the scale thickness data for the scale prevention recommendation. This is consistent with the industry practice of measuring scale formation on coupons at a single temperature.

➔ ***Go/No-Go Decision for Task 1.6*** - *Retesting of Scale Resistant Heat Exchangers will be based on whether further testing is necessary to select the scale resistance technique.*

The results of the test are adequate to select ABS for the GEO-SRX, but we recommend additional testing in Phase II to provide useful information for the geothermal community.

(a) (b)

Figure 1.3: Photos of installed heat exchanger; (a) Detail of abradable ball heat exchanger; (b) Heat exchanger skid.

(c)

(d)

Figure 1.3 ***(continued)*****:** Photos of installed heat exchanger; (c)-(d) Heat exchanger skid.

Heat exchanger	Outlet filter scale description
Insulated tube control	N/A (no filter used)
Control heat exchanger	Majority white with brown patches
Chemical injection: MX 2-3628	Majority white with brown patches
Chemical injection: GS8464	Majority white with brown patches
Chemical injection: CL4700	Patchy brown and white
Chemical injection: PDC9486	Bright white with some brown spots
Electromagnetic scale device	Reddish brown with white patches
Abradable ball heat exchanger	Majority white with brown patches

Table 1.5.1: Description of scaling on outlet filters
*The abradable ball heat exchanger was not properly running during period of flow through the filters. This heat exchanger was running nearly like control heat exchanger.

	inlet (mils)	outlet (mils)
Insulated pipe	N/A	N/A
Control heat exchanger	17.12	29.59
Chemical injection: MX 2-3628	9.79	27.38
Chemical injection: GS8464	19.35	34.22
Chemical injection: CL4700	18.40	40.23
Chemical injection: PDC9486	34.10	41.03
Electromagnetic scale device	25.90	38.57
Abradable ball heat exchanger	29.61	10.16

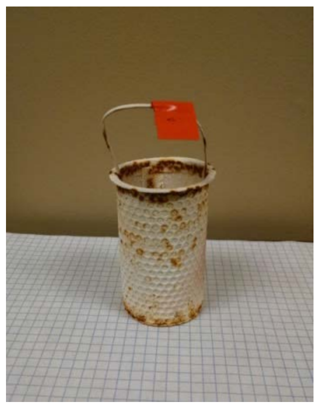
Table 1.5.2: Scale thickness measurements for heat exchanger inlets and oulets.


(a) control


(b) MX 2-3628


(c) GS8464


(d) CL4700


(e) PDC9486


(f) electromagnetic device


(g) abradable ball heat exchanger

Figure 1.5.1: Outlet filters after air drying

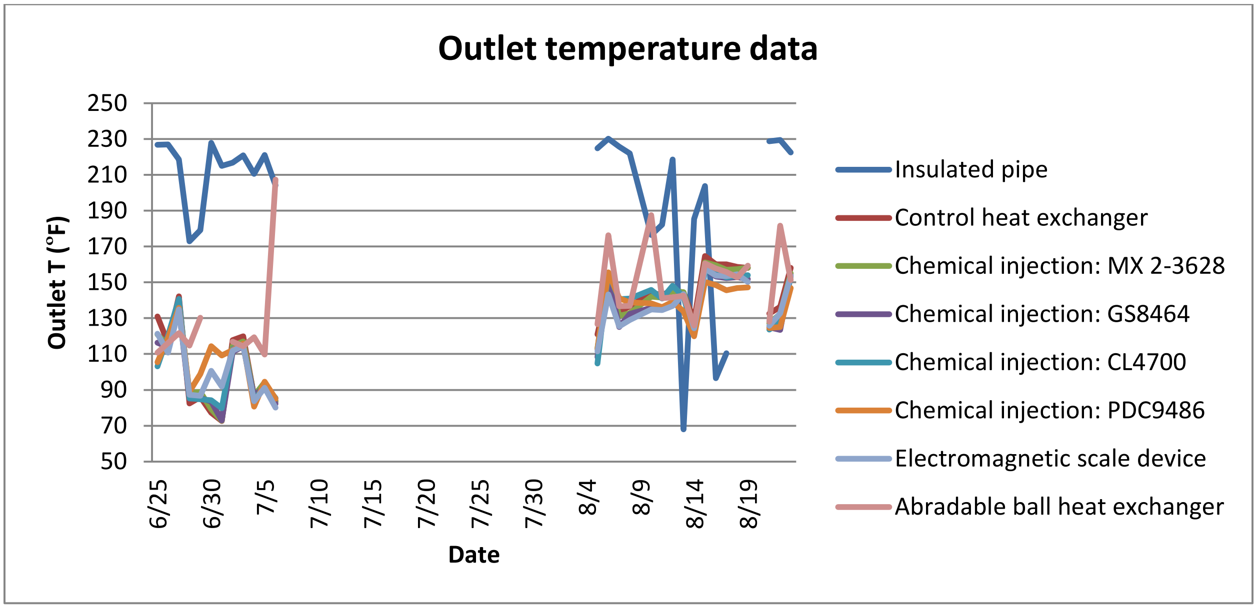


Figure 1.5.2: Outlet temperature data; breaks in data correspond to system shutdown or instrument failure.

1.6 Second Test of Scale Resistant Heat Exchangers

The heat exchanger test system built in Task 1.3 will be tested for a period of 2 months including modifications based on evaluations from Task 1.5.

We did not elect to conduct more testing at this time, but we do recommend future testing.

1.7 Evaluation and Selection of Full-Size Scale Resistant Heat Exchanger

The second round of heat exchanger testing will be evaluated. Based on the results, the scale resistant technology to be used in the full-scale power plant will be selected.

Based on the results, we determined that the abradable ball heat exchanger was the most effective method of controlling scale formation. We have decided to pursue this method.

1.8 Design of Scale Resistant Heat Exchanger

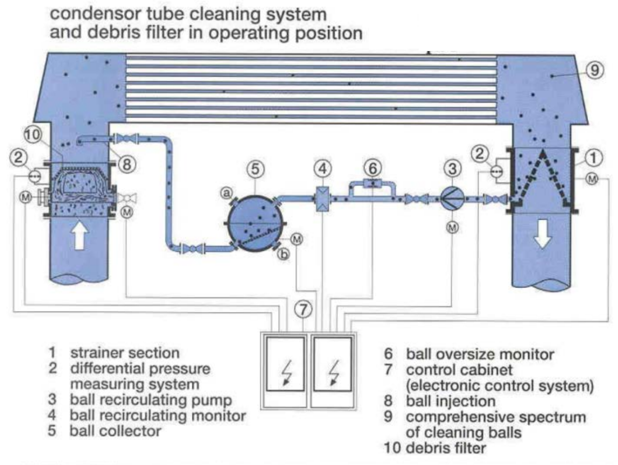
The full-size scale resistant heat exchanger will be designed for the binary cycle.

The full size scale resistant heat exchanger implementing ABS will be based upon units currently used for condensers. A commercial design quoted for the Geo-SRX is shown in Figure 1.8.

1.9 Reporting

A detailed report on the results of the scale resistant heat exchanger testing will be submitted.

Detailed reporting of the test results is in section 1.5 of this report.



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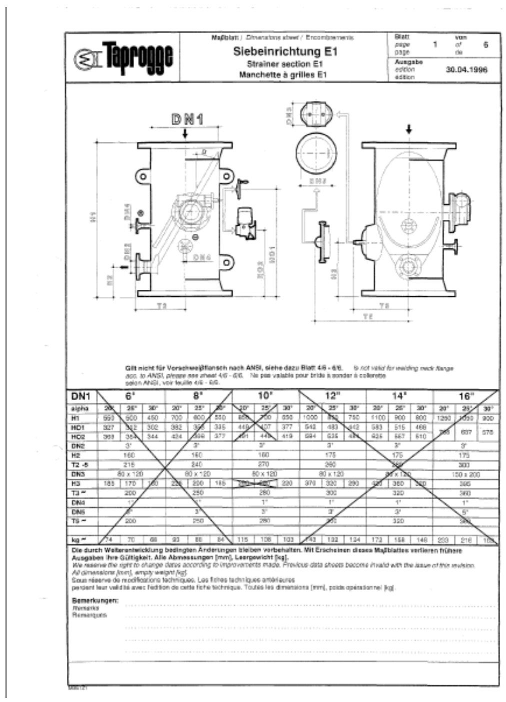

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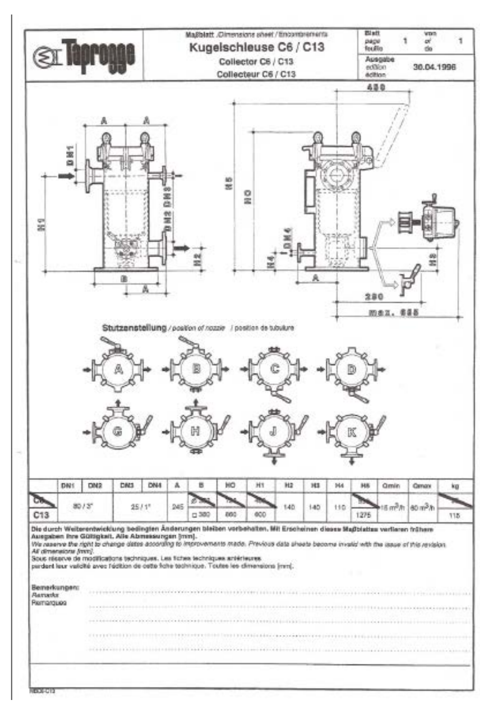


(c)

Figure 1.8: Taprogge tube cleaning system; (a) diagram of system; (b) strainer diagram; (c) collector diagram.

2 Design Hermetic Variable Phase Turbine-Generator Assembly

This section describes the design of the hermetic flashing liquid expander (Variable Phase Turbine) with the generator.

2.1 Review Refrigerant Materials Compatibilities

Materials commonly used in generators will be evaluated for their compatibility with refrigerant R134a. Materials will be selected for each component in the generator to be submerged in the refrigerant.

The compatibility of the R134a with several materials and resins as applied to the construction of generators and the Variable Phase Turbine was investigated in previous jobs. Energent's previous field experience has not shown any operating problems due to poor compatibility of materials with the refrigerant, and there have not been any reported issues for the last two years.

Materials Compatibility

Material	Genetron 134a	Genetron 134a/PAG	Genetron 134a/ Polyol Esters
Ethylene Propylene Diene Terpolymer	S	S	S
Ethylene-Propylene copolymer	S	S	S
Chlorosulfonated Polyethylene	S	Us	Us
Polyisoprene	S	Su	U
Chlorinated Polyethylene	Su	Su	Us
Neoprene (Chloroprene)	S	S	Su
Epichlorohydrin	S	Su	Us
Polyvinylidene fluoride and copolymer of vinylidene fluoride and hexafluoropropylene	U	S	Us
Silicone	Us	S	Su
Polyurethane	S	U	Su
Nitrile	Su	Su	Su
H-NBR	S	Su	S
Butyl rubber	S	S	Su
Natural rubber	Su	U	U
Polysulfide	S	U	U
Nylon	S	Su	Su
Polytetrafluoroethylene	S	S	S
PEEK	S	S	S
ABS	S	U	U
Polypropylene	Su	Su	S
Polyphenylene sulfide	Su	U	Su
Polyethylene terephthalate	S	U	S
Polysulfone	S	Us	S
Polyimide	S	Su	Su
Polyetherimide	S	Su	S
Polyphthalamide	S	U	U
Polyamideimide	S	S	S
Acetal	S	U	U
Phenolic	S	S	Su
Epoxy resin	S	S	S

Note: S: Suitable, Su: Suitable with some exceptions, U: unsuitable, Us: Unsuitable with some exceptions. In either case, rankings should be used with caution since they are judgements based on limited sampling. Customers should consult the manufacturer or do further independent testing

Figure 2.1: Manufacturers table for material compatibility in the presence of R134a. [Honeywell International Inc. "Honeywell Genetron 134a: Properties, Uses, Storage, and Handling." (2006)]

Literature from R134a manufacturers as well as seal and generator manufacturers (such as DuPont and Parker) has been reviewed extensively by Energent and used to select suitable materials. Figure 2.1 shows information provided from such a manufacturer. The seal design, for example, uses the material Kalrez (a compound of polytetrafluoroethylene) as it has been listed as satisfactory by all literature sources. Similarly, resins and metals were evaluated for compatibility with R134a.

2.2 Design of Submerged Generator

The submerged generator will be designed for use with R134a.

The submerged generator was specifically designed for use with R134a. The generator drawing is shown in Figure 2.2.1. The bearings selected for the generator are ceramic roller ball bearings of the type 6317 deep grooved shown in Figure 2.2.2. The bearing manufacturer in previous applications has indicated a bearing L10 life of almost 5 years for the bearings. The turbine-generator unit is of a horizontal orientation so that the bearing must withstand both axial and radial thrust. The thrust values are well within the manufacturers recommended limits.

2.3 Design of Variable Phase Turbine Assembly

The VPT will be designed for the process conditions of the power plant. The design will be flexible to accommodate changing conditions or return temperature by changing nozzle inserts. The design will mate the turbine rotor and the hermetic generator developed in Task 2.2.

The turbine is designed for the process conditions of the power plant. This design is flexible to accommodate changing process conditions. The design mates the turbine rotor and the hermetic generator presented above.

2.3.1 Mechanical Design

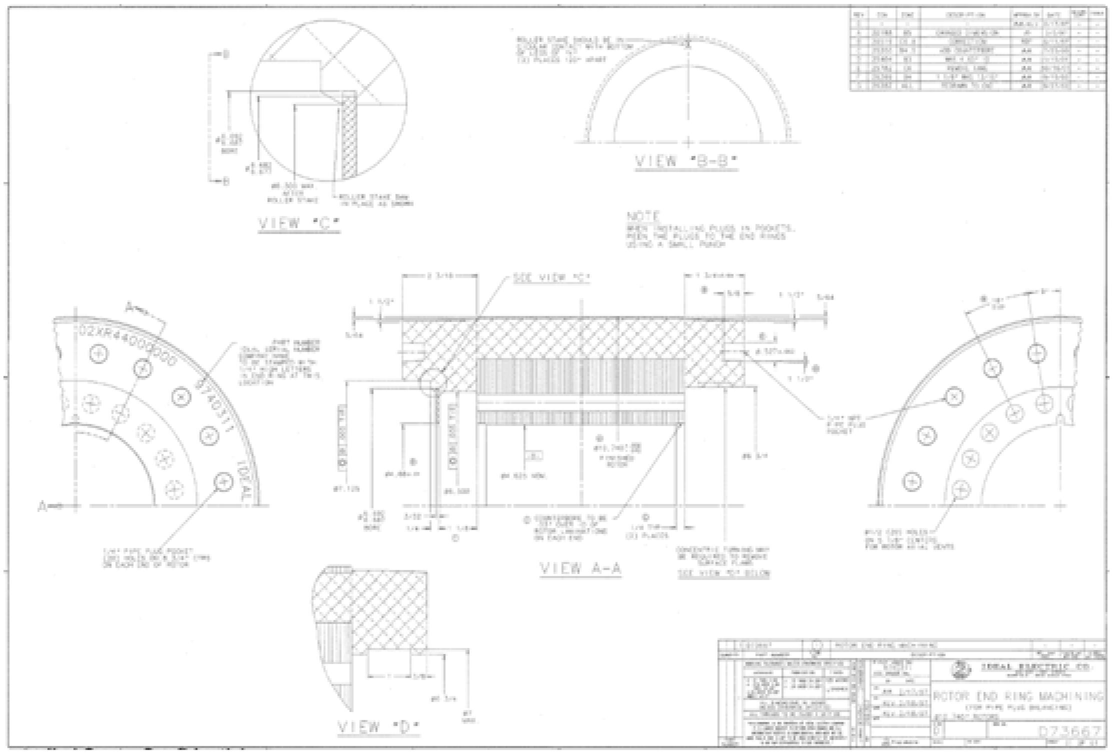
A general arrangement layout of the hermetic sealed turbine-generator is seen in Figure 2.3.1. The detailed drawings from manufacture are found in Appendix B. The turbine is designed to produce 200 kW of electric power. The generator manufacturer states that the generator peak efficiency is 95.8%, but for design purposes we assume a more conservative efficiency of 93% to ensure the 200 kW can be reached.

2.3.2 Computational Fluid Dynamics (CFD)

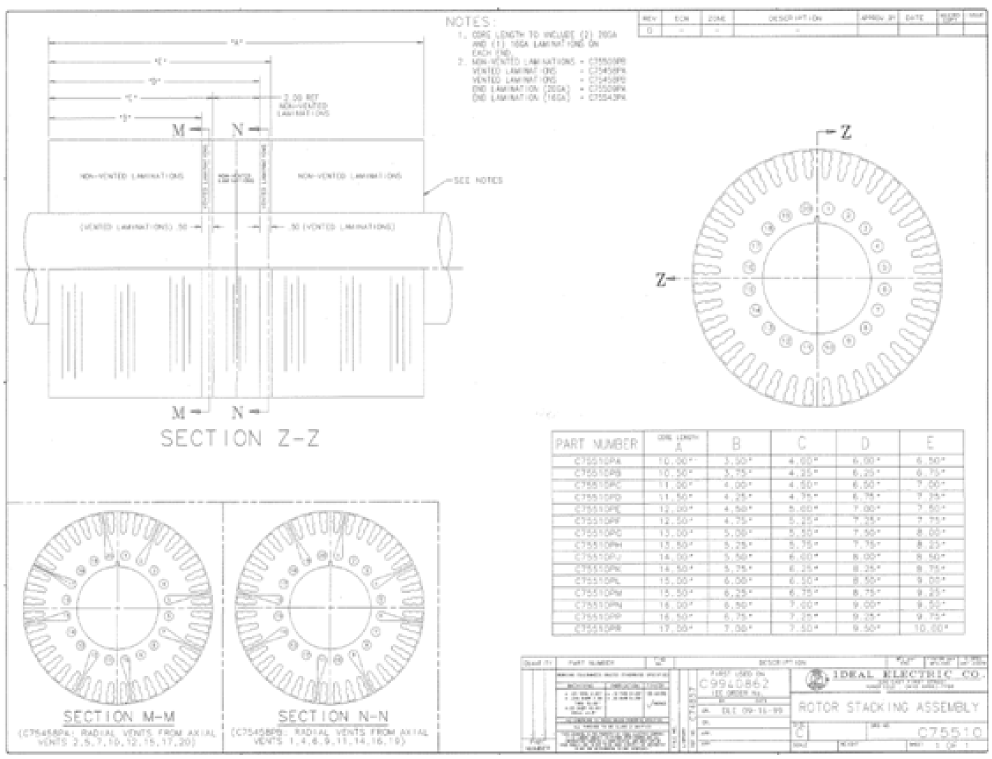
The software Numeca Fine Turbo CFD was applied to optimize the aerodynamic design of this flashing liquid expander. The fluid R134a was modeled by CFD in the two phase flow region using tables computed from the GERG equation of state. With regard to the design optimization, attention was paid to the impulse turbine flow path, which includes the stator and rotor blades. Figure 2.3.2 shows the relative velocity vectors in the stator and rotor blade passages for the final design blade geometry. The flow incidence angles on the rotor blades are well matched to the flow from the upstream stator blades.

2.3.3 Rotordynamic Design

Bearing coefficients from the bearing manufacturer were applied to ensure the rotordynamic design was suitable for the service intended. Figure 2.3.3 shows the rotordynamic model for the rotating assembly of the turbine where the impeller and generator are modeled with added mass and added rotating inertia. The 1st lateral bending mode is found at 8261.4 rpm which is well above the operating speed of 3600 rpm. As such, this rotating assembly is called a stiff shaft design. No rotordynamic problems are expected since the machine will operate well below the 1st lateral bending mode.



(a)



(b)

Figure 2.2.1: Generator drawings used in the design of the R134a turbine assembly.

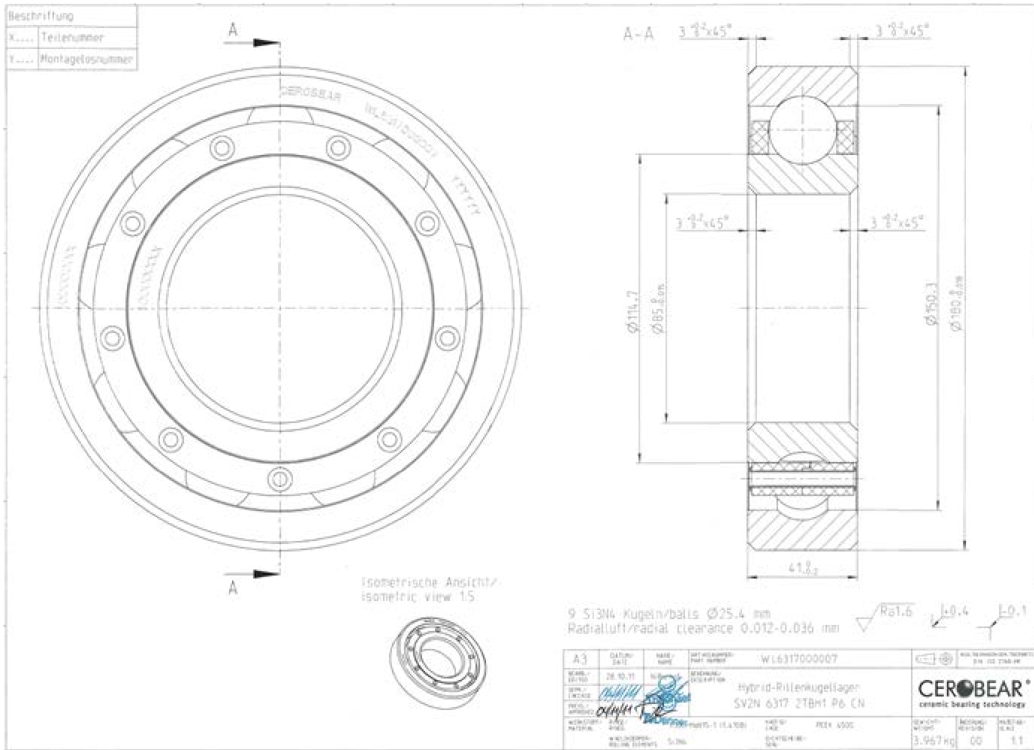


Figure 2.2.2: The ceramic ball bearings applied in the design of the R134a turbine.

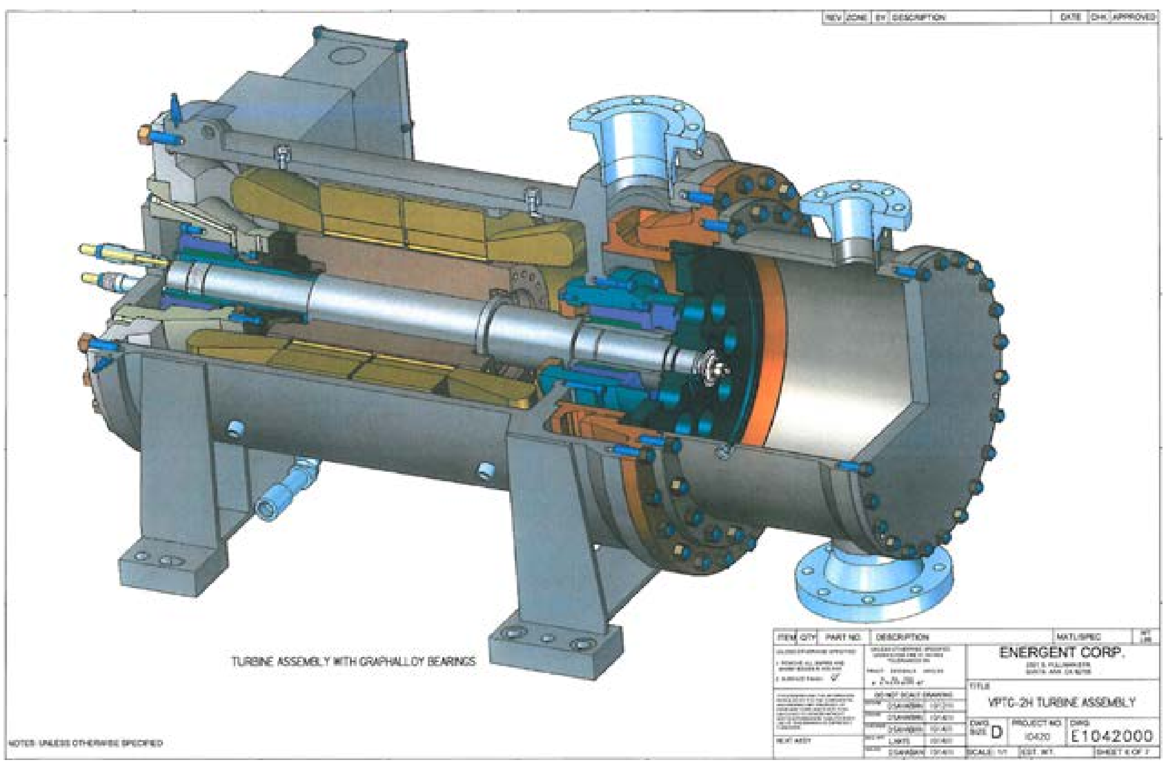


Figure 2.3.1: A section view of design of the hermetic sealed 200 kW turbine.

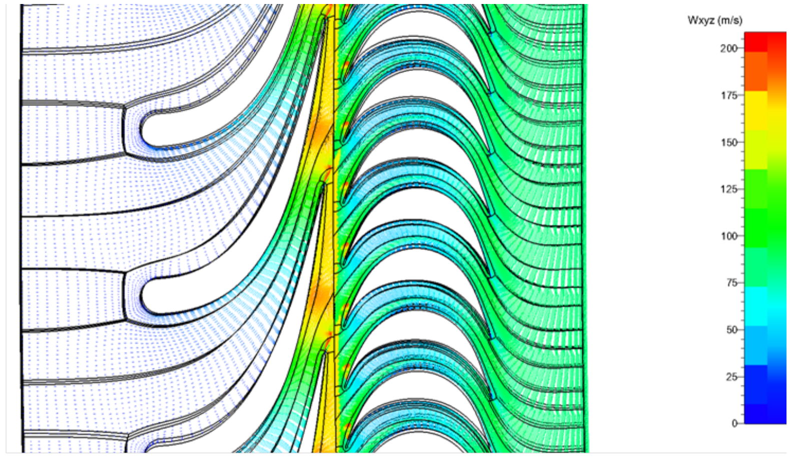
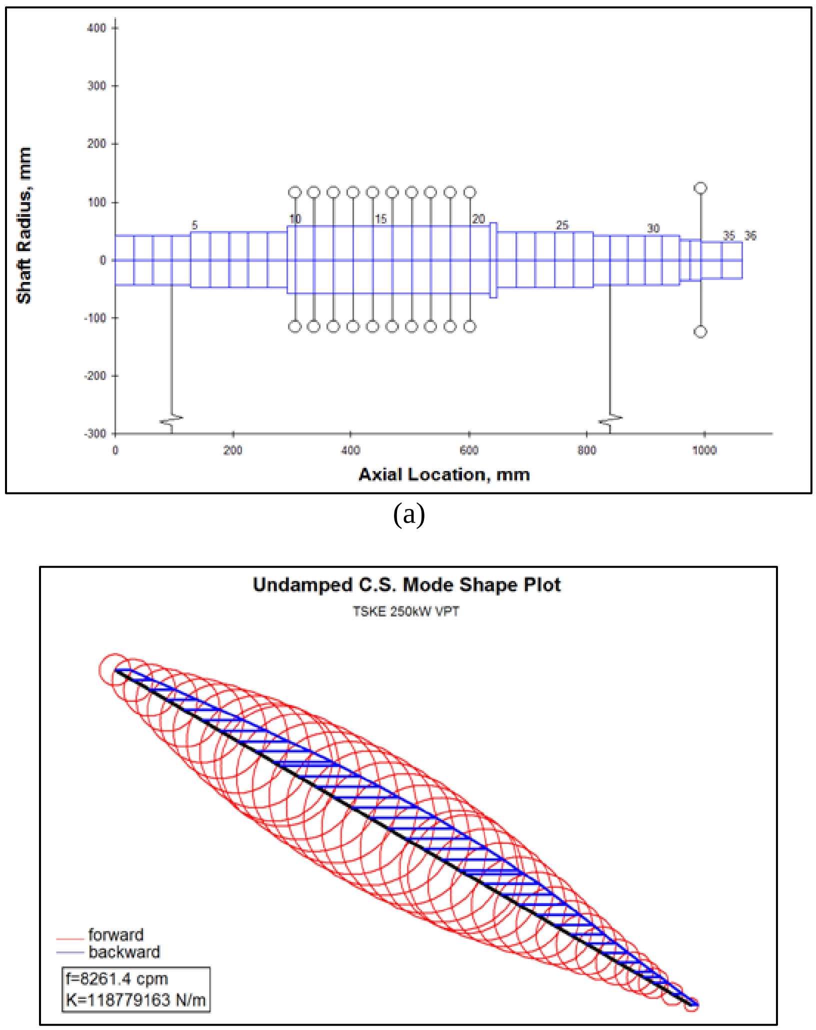


Figure 2.3.2: Relative velocity vectors in the turbine stator and rotor blade passages.



(a)

(b)

Figure 2.3.3: Rotordynamic simulation model and results for the 1st lateral bending mode of the flashing liquid expander (turbine-generator).

2.4 Procurement Specifications

Manufacturing drawings and procurement specifications will be prepared for the generator and Variable Phase Turbine.

The manufacturing drawings and specifications for the flashing liquid expander design are included in Appendix B.

2.5 Reporting

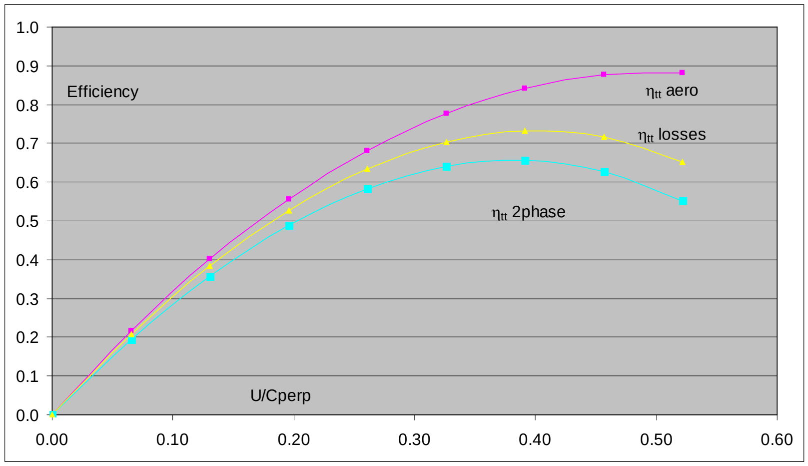
A report on the design of the hermetic VPT-generator will be written and submitted.

The flashing liquid expander is designed to produce 200 kW of electric power with an assumed generator efficiency of 93%. The flow parameters taken for the design are as follows:

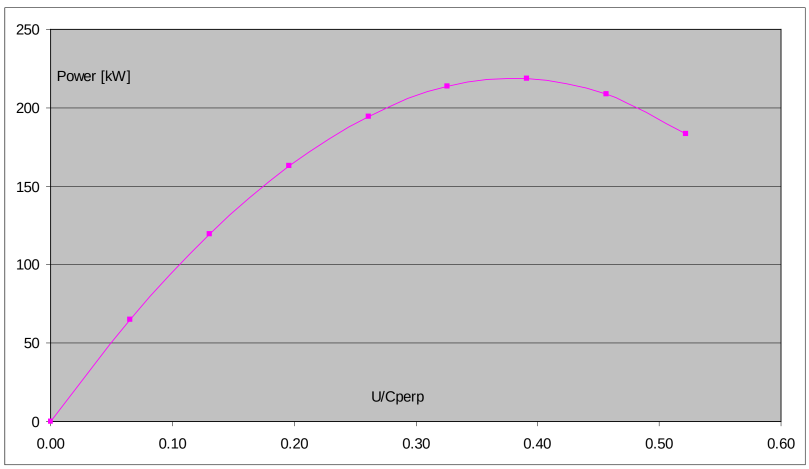
Parameter	**Value**
Fluid	Tetrafluoroethane (R134a)
Pressure Inlet Turbine	40.6 bara (588.33 psia)
Temperature Inlet Turbine	100.7 C (213.31 ºF)
Pressure Outlet Turbine	8.1 bara (117.155 psia)
Speed of Turbine	3600 rpm
Mass Flow to Turbine	16.562 kg/s (36.52 lb/s)

Table 2.5: Flow parameters for VPT design.

Figure 2.5 shows the predicted efficiency and shaft power of the turbine as a function of the U/C (turbine tip speed vs. isentropic spouting velocity of the flow). Ideally the peak efficiency and power should be 0.5, but as expected the flow losses cause the optimal U/C to move lower to nearly 0.38. The efficiency graphs show three curves: The highest total-total efficiency curve is simply the aerodynamic efficiency of the design without any partial admission losses. The middle curve includes the effects of partial admission. Finally, the lower curve includes the added influence of losses due to the two-phase flow. The total-total efficiency of the turbine-generator lies at nearly 66%, and the peak generator output power lies at 200 kW.



(a)



(b)

Figure 2.5: The efficiency (a) and shaft power (b) curves for the R134a Flashing Liquid Expander.

3 Design Balance of Plant

3.1 Site Coordination

Work together with Terra-Gen Operating Company to detail scope of project for each party. Plan site layout and identify available utility resources as well as manpower. Specify brine, cooling water, and electrical tie-in points.

The existing 1 MW VPC system will be used to provide all utility resources as well as the brine supply and electrical tie-ins. The TGH skid and tie-ins will be located within the present 1 MW VPC system boundaries. Energent will operate the TGH with oversight from Terra-Gen on the utility resources.

3.2 Thermodynamic Design

Based on the desired net power level of 300 kWe and the resource conditions, the thermodynamic design of the plant will be completed

The VPC system code was used to analyze the thermodynamic performance. The thermodynamic system design is provided in Figure 3.2. The flow will be a partial flow from the heat exchanger of the full 1 MW system. As shown for a 175 ºF brine outlet temperature a brine flow rate of 200,000 lb/h will be required to produce 200 kW (with a 10% margin).

Enabling the ABS system will allow the brine exit temperature to drop to 125 ºF. As shown in Figure 3.2, only 114,000 lb/h of brine are required to produce 200 kW (with a 10% margin) at this temperature. Thus, enabling the ABS has the potential, in this case, to increase resource productivity from 1 MW/(million lb/h) to 1.75 MW/(million lb/h), a 75% increase!.

3.3 Gather Required Permits and Applicable Codes

No additional permits are required. The TGH is a hermetic unit. It is designed to the same codes as the 1 MW Variable Phase Turbine. No additional brine, cooling water, or electrical utilities are required.

3.4 Complete Regulatory and Environmental Permitting

No additional permits are required. See Section 3.3.

3.5 Prepare major equipment specifications

The only additional equipment is electrical components. The electrical single line is shown in Figure 3.5 with the electrical equipment specifications shown.

3.6 Piping Design and Stress Analysis

Based on the plant layout, piping design and stress analysis will be performed.

With the “piggyback” approach only two piping runs and a drain line are required. Both lines will have sufficient flexibility.

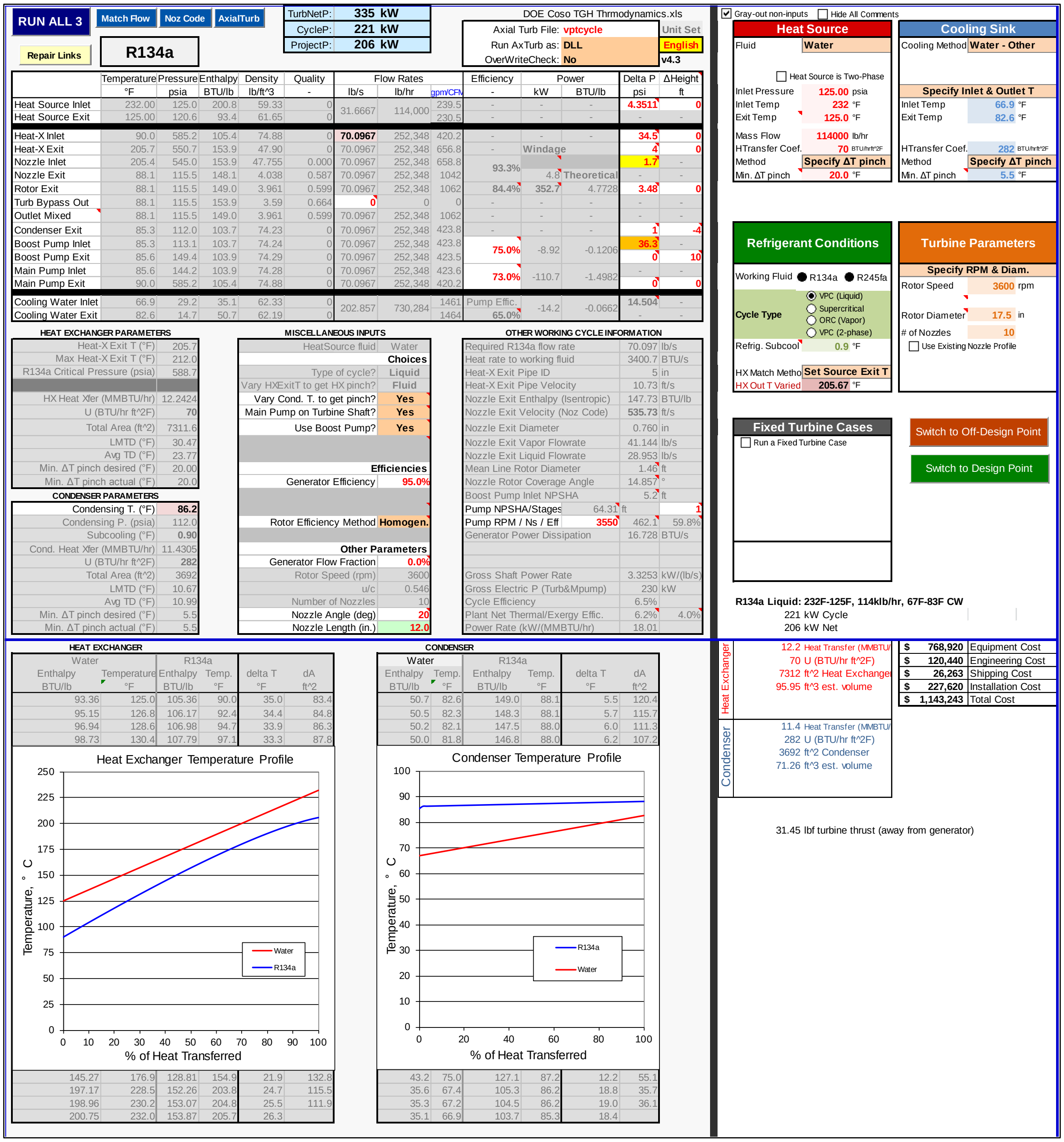


Figure 3.2: Thermodynamic system design

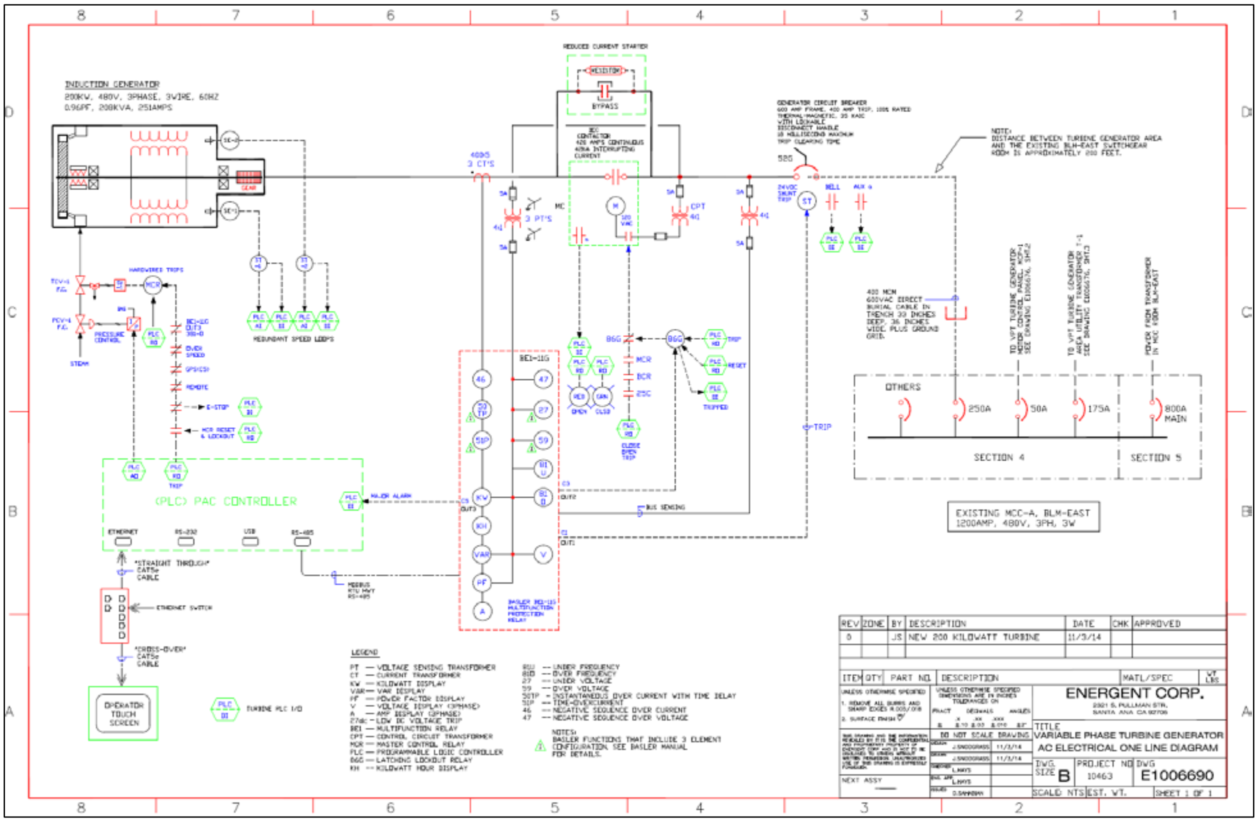


Figure 3.5: Electrical single line drawing.

3.7 Instrumentation and Valve Selection

Based on the process conditions, instrumentation and valves will be selected.

Instrumentation and valves will be the same as the 1 MW VPC system.

3.8 Instrumentation and Electrical Wiring Diagrams

The electrical single line is shown in Figure 3.5.

3.9 Skid and Foundational Work

The skid will have a reinforced concrete pad 4 feet by 6 feet as shown in the layout drawing of Figure 3.11. The pad will be 1 foot thick.

3.10 Design Ancillary Systems

The vacuum pump, refrigerant handling equipment, instrument air compressor, lubrication system and sealing system will be designed. No sealing system is required for the turbine.

All auxiliary systems of the 1 MW VPC system will be used. Process conditions will be established by starting and operating the 1 MW VPC system. The TGH will be started and operated using the two interconnecting valves.

3.11 Final Plant Configuration and Layout

The final plant configuration and layout will be completed.

Figure 3.11 is a layout of the plant configuration showing the TGH location and inter-relationship with the 1 MW VPC system.

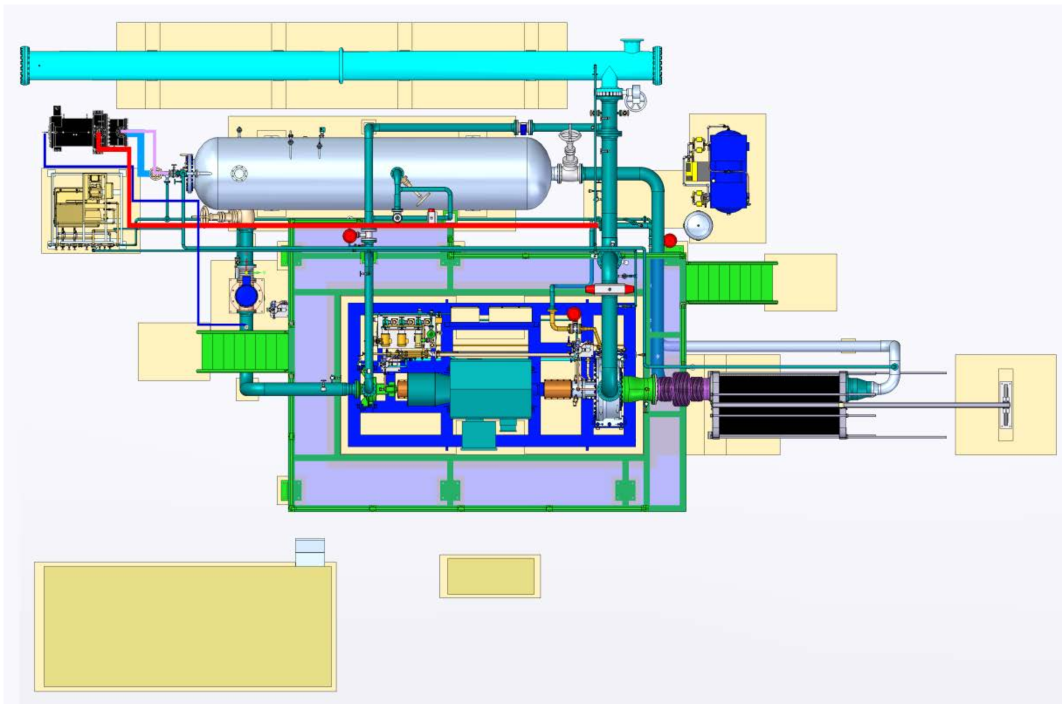


Figure 3.11: Plant configuration

3.12 Economic Feasibility Study

Prepare capital cost evaluation as well as OPEX summaries. Cost/benefit analysis will be analyzed as well as LCOE and ROI.

The “piggyback” approach requires a new study based upon the 1 MW VPC experience and design of a full size TGH when the demonstration is completed. The capital cost should be reduced compared to the present system due to elimination of the lube oil system, seals, and seal oil system. The generator should also see a reduction in cost.

3.13 Reporting

A detailed report on the design of the Geo-SRX system will be submitted along with the Economic Feasibility Study completed in Task 3.12.

The design of the TGH is detailed in this final report. The balance of plant (namely, the 1 MW VPC system) is reported in the final report on contract DE-FG36-05GO15153. The economic feasibility will be determined with the final design of a full size TGH incorporating the cost experience of the 1 MW VPC system.

- ***Go/No-Go Decision for Phase II** - Based on the progress review upon the completion of Phase I, the project will be evaluated for Phase II. The expected criteria for evaluation are the outcome of the SRX testing, design of the hermetic VPT-generator, design of the Geo-SRX power system, and total expected capital cost of Phase II.*

  We recommend a decision to go ahead on Phase II. Valuable information will be generated and added commercial power from low temperature geothermal resources will be produced.

Conclusion
We have demonstrated that the abradable ball heat exchanger is the most promising of the methods tested for controlling scale formation in geothermal heat exchangers. While recommending further testing of the other methods, we plan to implement an abradable ball system (ABS) for the existing Variable Phase Cycle (VPC) at Coso. We have designed a hermetic turbine generator (TGH) rated for 200 kW to be combined with the scale control method for the Geothermal Scale Resistant Heat Exchanger power plant (Geo-SRX).

Appendix

Appendix A: Variable Phase Cycle Innovation

Low-temperature geothermal resources, enhanced geothermal resources, and separated brine from flash plants are significant sources of energy. However, their characteristically low temperature results in low efficiency power systems and thus, high costs per installed kilowatt of power. To produce power from these resources, the surface plant must maximize the conversion of available energy to power.

Organic Rankine Cycle - Current State of the Art
A common characteristic of these low-temperature energy resources is that the temperature decreases nearly linearly (sensible heat) as heat is transferred to the power conversion system. This behavior is in contrast to evaporating flows, which absorb heat at a nearly constant temperature as the phase changes (latent heat). Organic Rankine Cycles (ORC's) utilize evaporating flows on the refrigerant side of heat transfer between the source and the working fluid. Figure 1 shows an example ORC operating with R134a. The geothermal heat source enters the vaporizer at 220 °F and exits at 155 °F. Liquid R134a exits the refrigerant pump (1), heats to boiling (1a), and then entirely boils in the vaporizer (1b). The vapor is subsequently superheated (2) and expanded through a turbine (3). The fluid then condensed (3a and 3b) and subcooled (4), at which point it is pressurized in the refrigerant pump to close the cycle.

ORC's pinch point between (1a) and the cooling geothermal flow limits the geothermal water return temperature. All standard fluids behave this way in ORC. The ideal thermodynamic cycle would eliminate this boiling pinch point to recover more heat from the geothermal resource while efficiently converting the recovered heat into electricity. Thermodynamic cycles have been developed that approach ideal behavior.

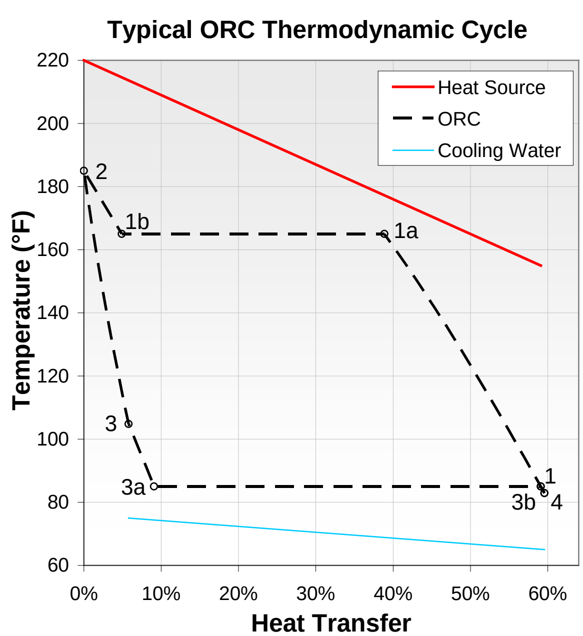


Figure A.1: ORC temperature profile

Variable Phase Cycle

Thermodynamic cycles have been developed to overcome the limitation caused by the constant temperature boiling of a single component fluid. Trilateral and supercritical cycles, known together as the Variable Phase Cycle, are the ideal thermodynamic cycles for low-temperature sensible heat recovery[1].

In the trilateral cycle, liquid working fluid is pressurized and then heated in the heat exchanger with no vaporization. This heated liquid is then directly expanded in a two-phase expander. To close the cycle, the exiting low pressure fluid is condensed. The phase change in the heat exchanger gives the VPC a sensible heat profile, eliminating the pinch point restriction encountered by the ORC.

In the supercritical cycle, liquid working fluid is pressurized above its critical pressure such that it will not undergo a phase change as it is heated. Instead, it transitions from a subcooled liquid state to a supercritical fluid state. This supercritical fluid is then expanded in a turbine and then condensed at the lowered pressure. Both supercritical expansion and two-phase expansion may share the same turbine concept.

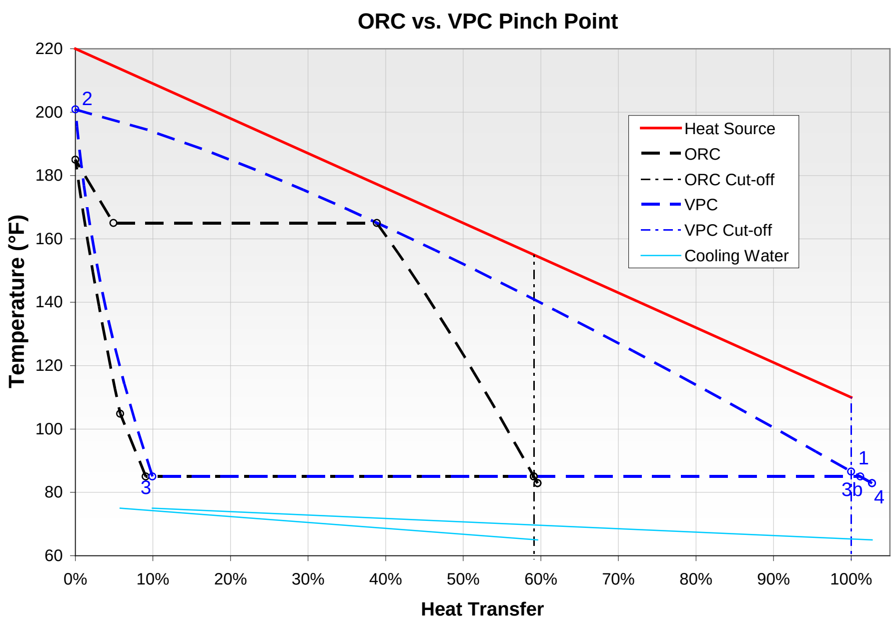


Figure A.2: VPC and ORC temperature profile comparison

Figure A.2 illustrates the contrast between ORC and VPC using R134a as the working fluid. In the scenario shown, the VPC absorbs 69% more heat from the resource than the ORC. The overall cycles were modeled assuming an adiabatic pump efficiency of 77%, adiabatic turbine efficiencies of 85% for the ORC turbine and 80% for the VPC turbine, and a gearbox efficiency of 98% for the ORC. The VPC generated 35% more net electricity than the ORC.

Consisting of a pump, a liquid heat exchanger, a turbine, and a condenser, the VPC is a simple system with lower cost elements than most ORC systems. A significant advantage of this energy conversion system is the heat exchanger: a counter-current liquid heat exchanger is used to recover geothermal

[1] DiPippo R. "Ideal Thermal Efficiency for Geothermal Binary Plants." *Geothermics*, 36, 276-285 (2007).

energy instead of a heat recovery boiler, which requires a large separator drum along with extensive operating and maintenance costs. The lack of an efficient, reliable two-phase turbine has prevented prior use of the VPC. However, development of a turbine that operates with two-phase or supercritical fluids now permits use of this technology.

Variable Phase Turbine

The Variable Phase Turbine (VPT) is comprised of a set of fixed nozzles and an axial impulse rotor. The two-phase nozzle is the thermodynamic energy conversion element of the VPT (Figure A.3). Enthalpy is converted to two-phase kinetic energy in a near isentropic expansion that breaks up the liquid phase into small droplets. Momentum is transferred from the gas to the droplets by pressure and shear forces. The small diameter of the droplets results in a close coupling of the gas and liquid, producing efficient acceleration of both phases. The fluid at the nozzle inlet may be in liquid, two-phase, supercritical, or vapor phases.

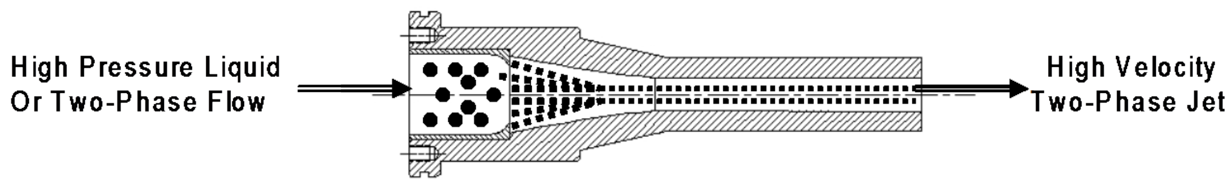


Figure A.3: Schematic of two-phase VPT nozzle

Two-phase kinetic energy is efficiently converted to shaft power by reversing the direction of the tangential component of the flow velocity in an axial impulse turbine. The turbine is designed with a special blade contour to minimize momentum and friction losses of the liquid impinging on the surface and flowing over the surface (Figure A.4). A true impulse turbine with no reaction or pressure drop in the rotor, the runaway speed is limited to no more than the two-phase jet velocity and axial thrust on the rotor is minimized. Maximum droplet impact velocity for typical expansion conditions is 300-500 feet per second. No erosion results, as the threshold impact velocity for erosion of the titanium alloy wheel is in excess of 1,000 feet per second.

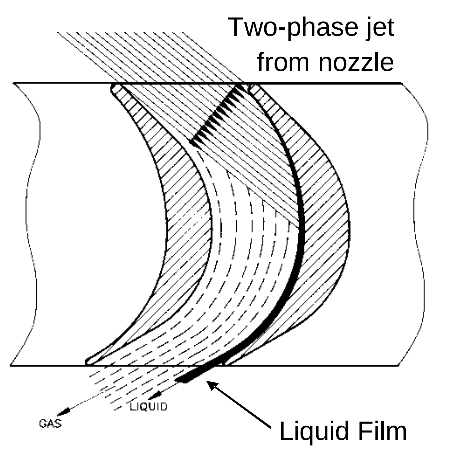


Figure A.4: Schematic of flow path in two-phase VPT blades

The arrangement of the VPT is similar to a conventional axial impulse turbine (Figure A.5). The nozzles are inclined at a tangential angle to the rotor. The two-phase impulse wheel is a blisk—that is, an integrally bladed rotor—which has low stress. It incorporates a shroud to control the location of any stray liquid. Liquid leaving the rotor separates onto the duct walls. Two-phase nozzle efficiency, typically between 90% and 97%, is influenced strongly by the surface tension of the working fluid and the vapor density at the condensing pressure. The standard refrigerants used in low-temperature geothermal applications are ideal in these aspects because of their low surface tension and high vapor density.

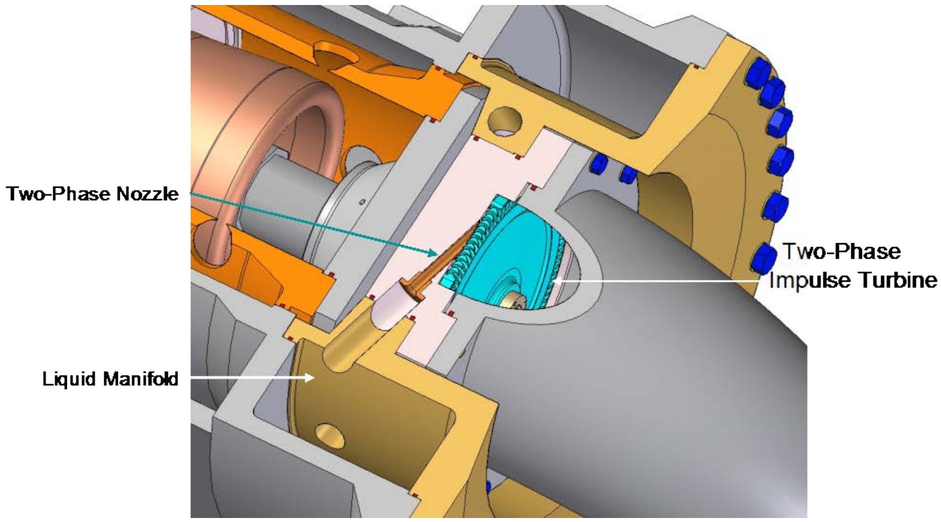


Figure A.5: Variable Phase Turbine nozzle and rotor arrangement. Rotor efficiency is typically between 78% and 85% and is influenced strongly by the vapor quality at the exit of the nozzle.

Variable Phase Turbine: Application to the Variable Phase Cycle

Designed for two-phase expansions, the VPT allows for efficient realization of the VPC. The VPT is also suitable for supercritical versions of the VPC. Figure A.6 is a schematic of the Variable Phase cycle applied to geothermal power generation. Geothermal fluid enters the heat exchanger where the available heat energy is transferred into the energy conversion working fluid. The lack of a phase change in the heat exchanger makes the VPC stable and simple to control. After heating in the heat exchanger, the liquid is flashed in two-phase nozzles. The high momentum, low velocity two-phase stream drives the turbine rotor at synchronous speed to the generator. This eliminates the need for the expensive gearbox required for ORC vapor turbine systems, thereby improving reliability and reducing maintenance needs. The exhaust from the turbine is condensed in a standard compact condenser. The condensate is then pressurized by a hermetic pump and circulated through the liquid heat exchanger to close the cycle.

The use of refrigerant working fluids in the VPC enables lubrication and cooling of the generator by those working fluids. The lube oil system and seals required for ORC systems are thus eliminated. The result is a zero emissions hermetic assembly without the expense and reliability problems associated with those components in an ORC.

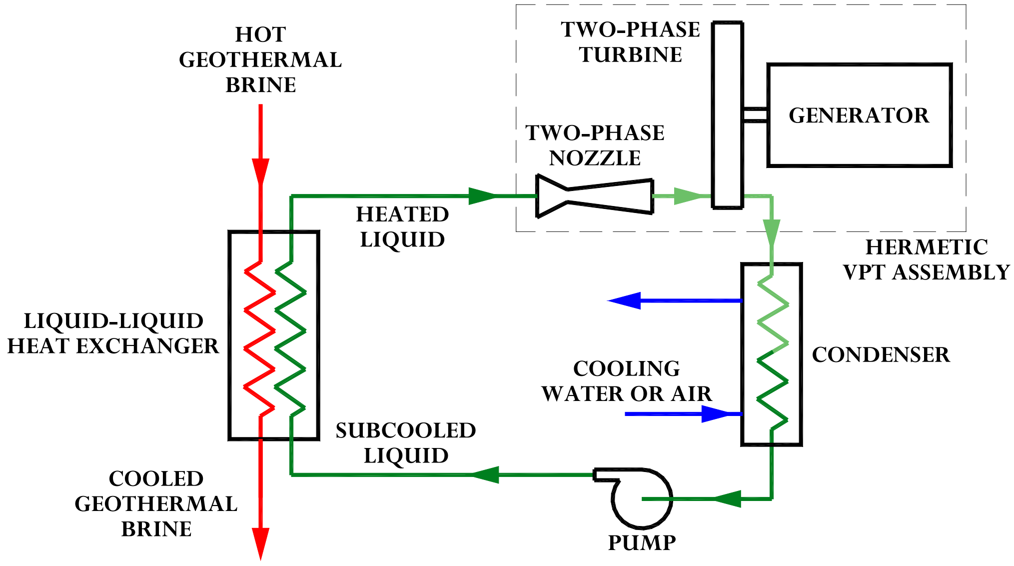


Figure A.6: Variable Phase cycle process flow diagram

Variable Phase Cycle: Application to the Commercial Geothermal Market
Figure A.7 is a compact waste heat recovery system designed under a DOE study for recovery of heat from a brine stream at 245°F. The unit was designed for factory assembly and testing with facile installation at the site.

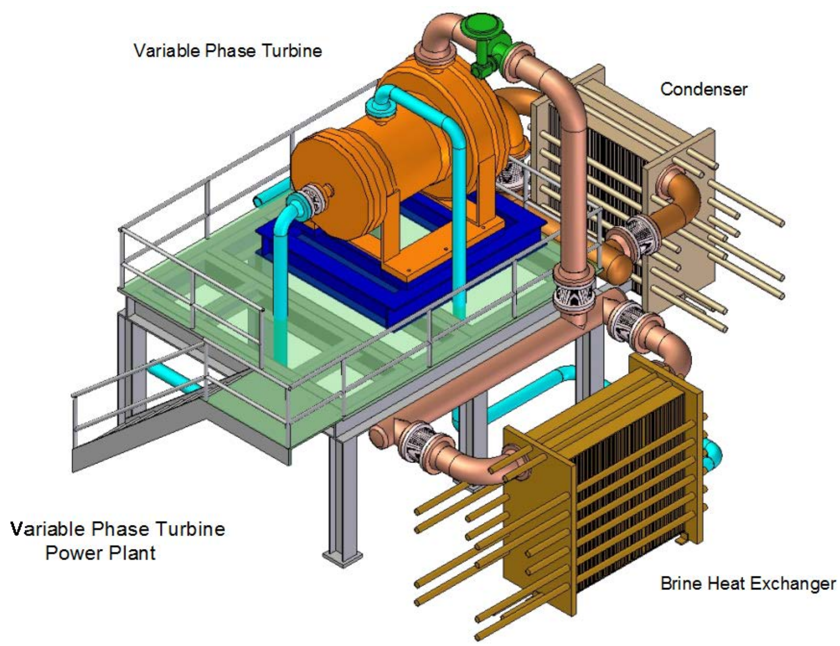


Figure A.7: VPC 1 MW geothermal power plant with plate-and-frame heat exchangers

The turnkey price for a 1 megawatt system, including factory assembly and checkout, site work, and electrical interconnection, was estimated to be $1,278,915 or $1,279/kWe. These costs are based upon the first article system. By comparison, the typical installed costs for ORC systems of this scale are in the range of $3,000 to $4,000/kW. Costs are reduced due to the use of a simpler heat exchanger and the elimination of the gearbox, lube oil system, and seals. We believe the heat exchanger costs in particular will be further reduced via economies of scale.

The VPT has the additional advantage of being able to accommodate widely varying power levels for a single given rotor and housing design. Because the nozzles' inserts are discrete, they can be blanked off or changed out for nozzles with different profiles. Discrete nozzles allow for variations in resource production without bypassing flow or operating at part-load efficiency. The range of conditions that can be accomplished with a particular turbine and rotor design is thus quite large, and a set of modular power skids can be developed that are quickly deployable with lower cost. The elimination of the gearbox increases efficiency and reliability, reduces complexity and capital cost, and eliminates the associated lube-oil subsystem present in typical organic Rankine cycle systems.

The VPC utilizing a VPT is simple and stable. These two factors are critical in achieving a quick, successful start-up of a geothermal power plant. Factory assembly and checkout can be performed to reduce on-site startup time and costs.

The Variable Phase cycle is able to generate more electricity from a given geothermal well. Increased electrical production decreases all other costs on a per kW basis. Consider a potential project where the exploration, drilling, and surface plant costs total $6,000,000: an organic Rankine cycle may produce 1,500 kWe whereas a Variable Phase cycle could produce 2,000 kWe with the same resource. Thus, the cost per kW is reduced from $4,000/kWe to $3,000/kWe. This cost reduction may enable an otherwise economically nonviable project.

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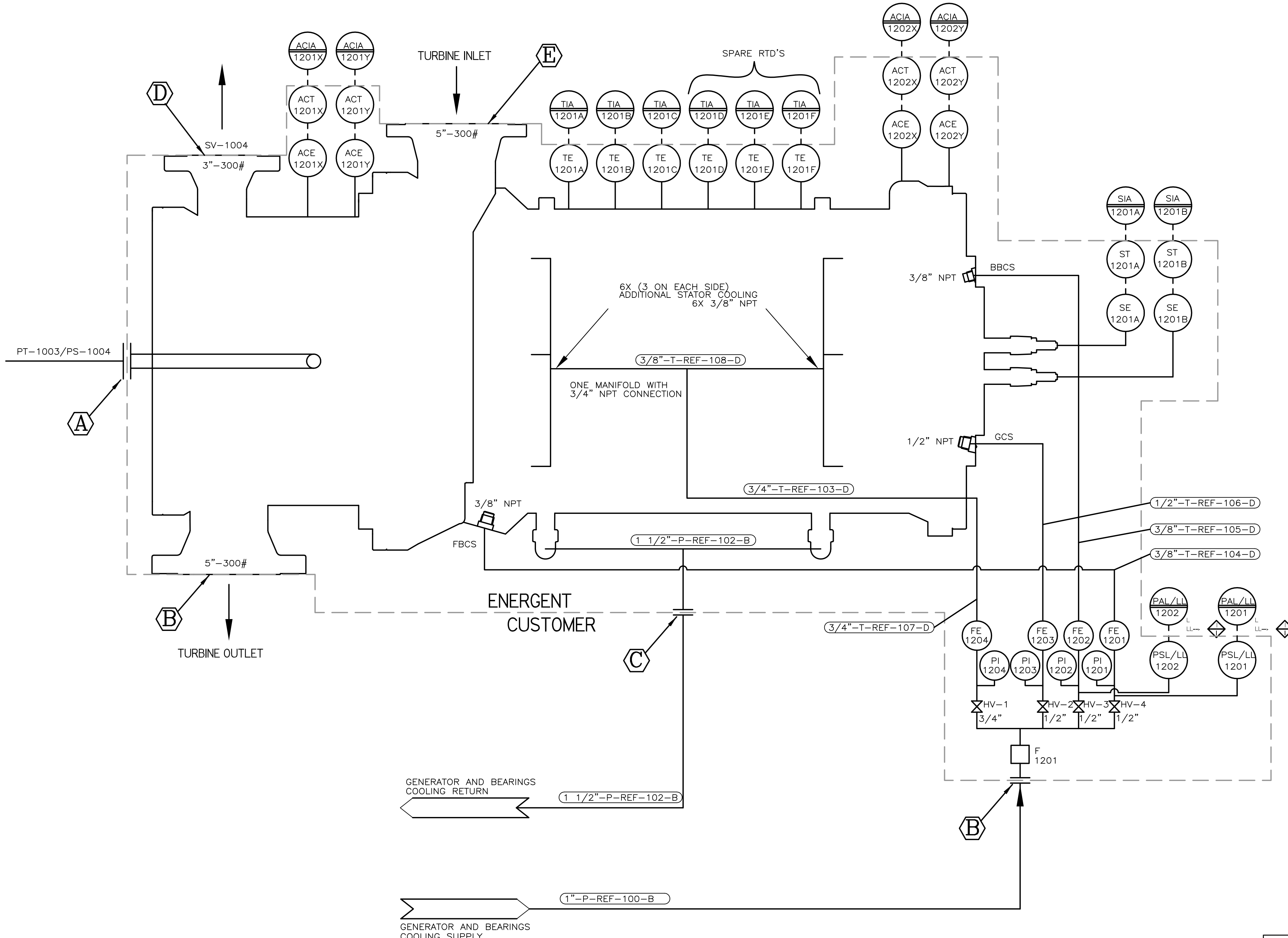

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2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

FRACT	DECIMALS			ANGLES
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ENERGENT SKID INTER-CONNECT

TAG	DESCRIPTION	SIZE
A		1/2"-300#
B	GEN. AND BEARINGS COOLING SUPPLY	1"-300#
C	GEN. AND BEARINGS COOLING RETURN	1 1/2"-300#
D		3"-300#
E	TURBINE INLET	5"-300#
F	TURBINE OUTLET	5"-300#

PIPE/TUBE LINE IDENTIFICATION

XX-XXX-XXX-XX-XXX

LINE SIZE

LINE TYPE
P - PIPE
T - TUBE

SYSTEM DESIGNATOR
AI - INSTRUMENT AIR
AST - AMMONIA-STEAM
CS - CONDENSATE
LO - LUBE OIL
NI - NITROGEN
WC - COOLING WATER

LINE NUMBER

MATERIAL CLASS
A - 300# STAINLESS STEEL
B - 150# STAINLESS STEEL
CS - 150# CARBON STEEL
D - TUBING STAINLESS STEEL

INSULATION CLASS
A - ACOUSTICAL
T - THERMAL
B - ACCOUSTICAL AND THERMAL
P - PERSONAL PROTEXTION

INSULATION THICKNESS

EQUIPMENT-INSTRUMENT DESIGNATORS

AC - ACCELEROMETER
F - FILTER
FE - FLOW ELEMENT
BBCS - BACK BEARING COOLING SUPPLY
FBCS - FRONT BEARING COOLING SUPPLY
GCS - GENERATOR COOLING SUPPLY
HV - ISOLATION VALVE
PSL - PRESSURE SWITCH LOW
PI - PRESSURE INDICATOR
TE - RTD
SE - SPEED PROBE

EQUIPMENT-INSTRUMENT LOCATION - CONDITION

TAG NO.	LOCATION	DESCRIPTION	CONDITION	SETTING	
				ALARM	TRIP
ST-1	SKID	STEAM TURBINE	THERMAL BLANKET	-	-
GB-1	SKID	GEARBOX	ACOUSTICAL BLANKET	-	-
G-1	SKID	GENERATOR	-	-	-
TE-1, PT-1	TURBINE INLET SPOOL	TURBINE INLET TEMP AND PRESS	PLC DISPLAY/TRIP	-	24 BAR(G)
TE-2, PT-2	TURBINE OUTLET SPOOL	TURBINE OUTLET TEMP AND PRESS	PLC DISPLAY	-	-
TE-3	TURBINE CASING	TURBINE CASING TEMP	START-UP SETTING	-	-
TE-4	GEARBOX	LS DRIVEN BRG TEMP	ALARM/TRIP	107°C	116°C
VE-1X, VE-1Y	GEARBOX	LS DRIVEN BRG VIBRATION	ALARM/TRIP	63.5 microns	101.6 microns
ZE-1Y, ZE-2Y	GEARBOX	LS SHAFT AXIAL POSITION	ALARM/TRIP	127.0 microns	254.0 microns
TE-5	GEARBOX	LS DRIVE BRG TEMP	ALARM/TRIP	107°C	116°C
VE-2X, VE-2Y	GEARBOX	LS DRIVE BRG VIBRATION	ALARM/TRIP	63.5 microns	101.6 microns
TE-6	GEARBOX	HS DRIVE BRG TEMP	ALARM/TRIP	107°C	116°C
VE-3X, VE-3Y	GEARBOX	HS DRIVE BRG VIBRATION	ALARM/TRIP	38.1 microns	57.2 microns
TE-7, TE-9	GEARBOX	THUST DRIVE/DRIVEN BRG TEMP	ALARM/TRIP	107°C	116°C
TE-8	GEARBOX	HS DRIVEN BRG RTD	ALARM/TRIP	107°C	116°C
VE-4X, VE-4Y	GEARBOX	HS DRIVEN BRG VIBRATION	ALARM/TRIP	38.1 microns	57.2 microns
AC-1	GEARBOX	ACCELEROMETER	ALARM	6g's	-
SE-1, SE-2	GEARBOX	LOW SPEED SHAFT RPM	ALARM/TRIP	3150 RPM	3300 RPM
TE-10, TE-11	GENERATOR	FRONT AND BACK BRG RTD	ALARM/TRIP	95°C	100°C
TE-12, TE-14, TE-16 TE-13, TE-15, TE-17	GENERATOR	WINDING RTD'S (1 PER PHASE) 3 SPARES	ALARM/TRIP	140°C	150°C
PSH-1A, 1B	SEAL MANIFOLD FILTER	FILTER DPI	PSH-1 ALARM	.69 BAR (G)	-
PSL-1, PSLL-1	SEAL MANIFOLD	NITROGEN PRESSURE	PSL-1 ALARM PSLL-1 TRIP	12.06 BAR(G) -	- 11.72 BAR(G)
DPT-1	STEAM TURBINE	DIFF. PRESS. TURBINE WHEEL FRONT AND TURBINE WHEEL BACK	PLC DISPLAY	-	-
DPT-2	SEAL MANIFOLD	DIFF. PRESS. NITROGEN SUPPLY TO SEAL AND TURBINE WHEEL BACK	PLC DISPLAY	-	-
F-1A, 1B	SEAL MANIFOLD	FILTER	-	-	-
FE-1	SEAL MANIFOLD	FLOW TRANSMITTER	PLC DISPLAY	.170 NM3/HR	.220 NM3/HR

VALVES LIST/OTHER COMPONENTS

TAG	SIZE	LOCATION	DESCRIPTION
TCV-1	6"-300#	SKID - INLET SPOOL PIPE	TRIP VALVE (DOUBLE-OFFSET BUTTERFLY TYPE)
PCV-1	6"-300#	SKID - INLET SPOOL PIPE	CONTROL VALVE (ROTARY GLOBE TYPE)
PCV-3	1/2"-300#	SKID - PRESSURE BALANCE MANIFOLD	CONTROL VALVE (STEM SLIDE)
HV-1, HV-2	1"	SKID - ISOLATION VALVE FOR PT	GATE VALVE
HV-3, HV-4	1"	SKID - ISOLATION VALVE FOR CASING DRAIN TRAP	GATE VALVE
CV-1	1/2"	SKID - SEAL MANIFOLD	SWING CHECK VALVE
PCV-2	1/2"-150#	SKID - SEAL MANIFOLD	CONTROL VALVE (STEM SLIDE)
TP-1	1"	SKID - CASING DRAIN MANIFOLD	VARIABLE ORIFICE TRAP
HV-5	1/2"	SKID - SEAL MANIFOLD ISOLATION VALVE	BALL VALVE
PSV-1	1/2"	SKID - SEAL MANIFOLD	RELIEF VALVE
HV-6, HV-7	1/2"	SKID - SEAL MANIFOLD FILTER ISOLATION VALVE	3-WAY VALVE
PI-1	1/2"	SKID - SEAL MANIFOLD	PRESSURE GAUGE
T-1	-	SKID - SEAL MANIFOLD	NITROGEN STORAGE TANK

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED
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2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
FRACT ± | DECIMALS .X ±.10 .XX ±.03 .XXX ±.010 | ANGLES ±2°

DO NOT SCALE DRAWING

NEXT ASSY

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	P.BOYLE	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA CA 92705

TITLE
TURBINE SYSTEM VPTG 2H P&ID

DWG. SIZE D | PROJECT NO 10466 | DWG E1046601

SCALE: NTS | SHEET 2 OF 2

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED

MAX ALLOWABLE LOADS FOR TURBINE CONNECTIONS PER NEMA SM-23

1 ALLOWABLES FOR EACH NOZZLE

FOR INLET AND OUTLET (5"-300#) $3Fr + Mr \leq 2500$

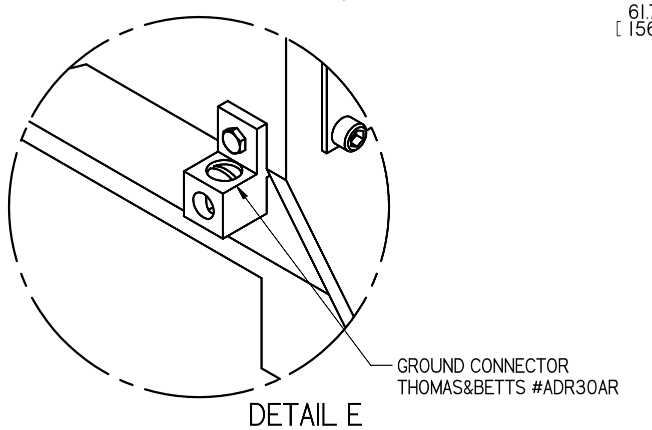
FOR RELIEF VALVE (3"-300#) $3Fr + Mr \leq 1500$

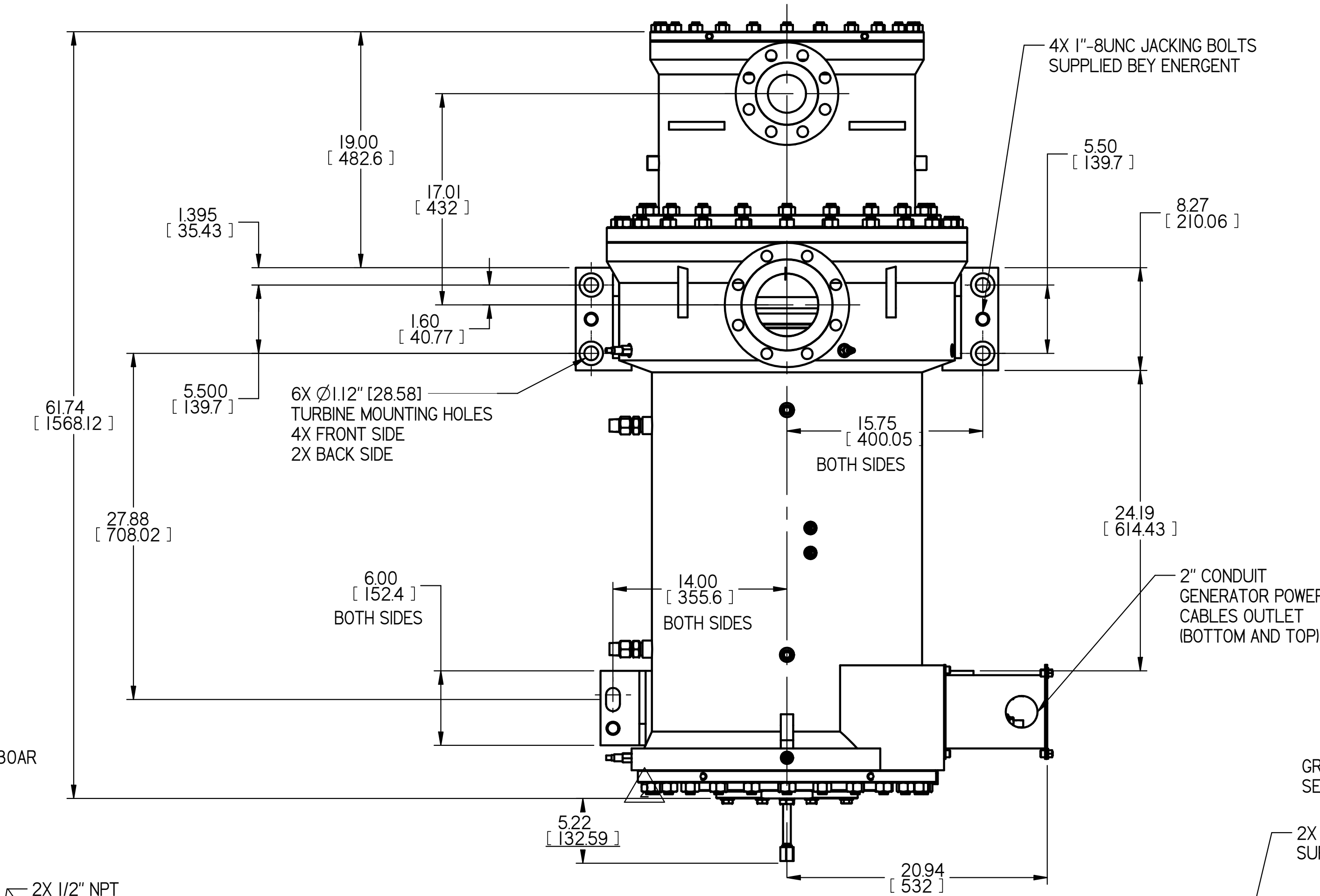
Fr = RESULTANT FORCE AT NOZZLE (LB)
Mr = RESULTANT MOMENT AT NOZZLE (FT-LB)

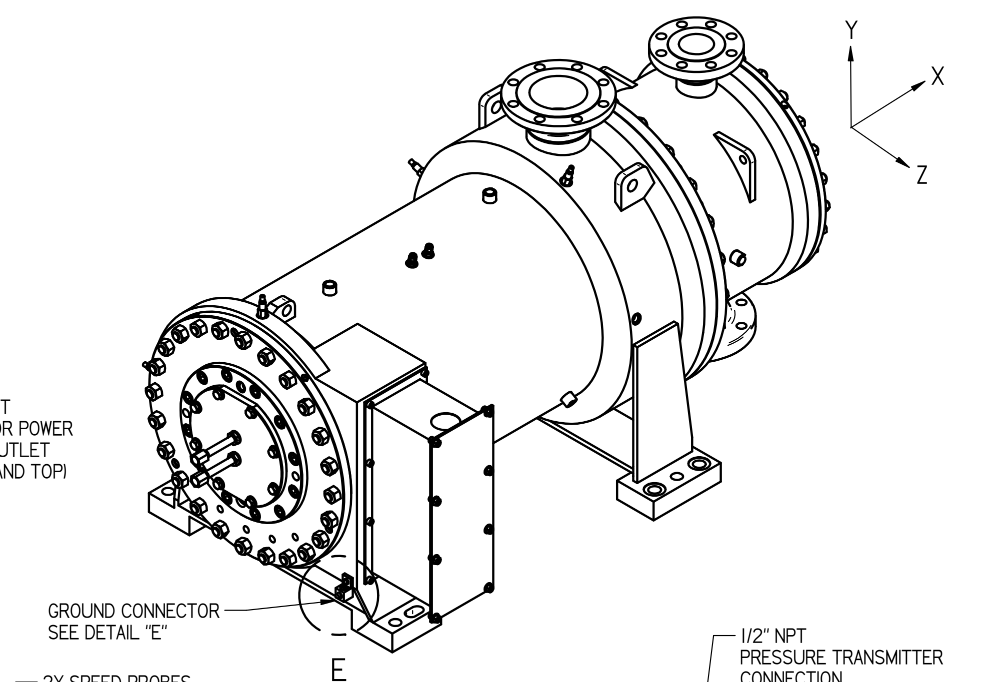
2 COMBINED ALLOWABLES FOR THE TURBINE

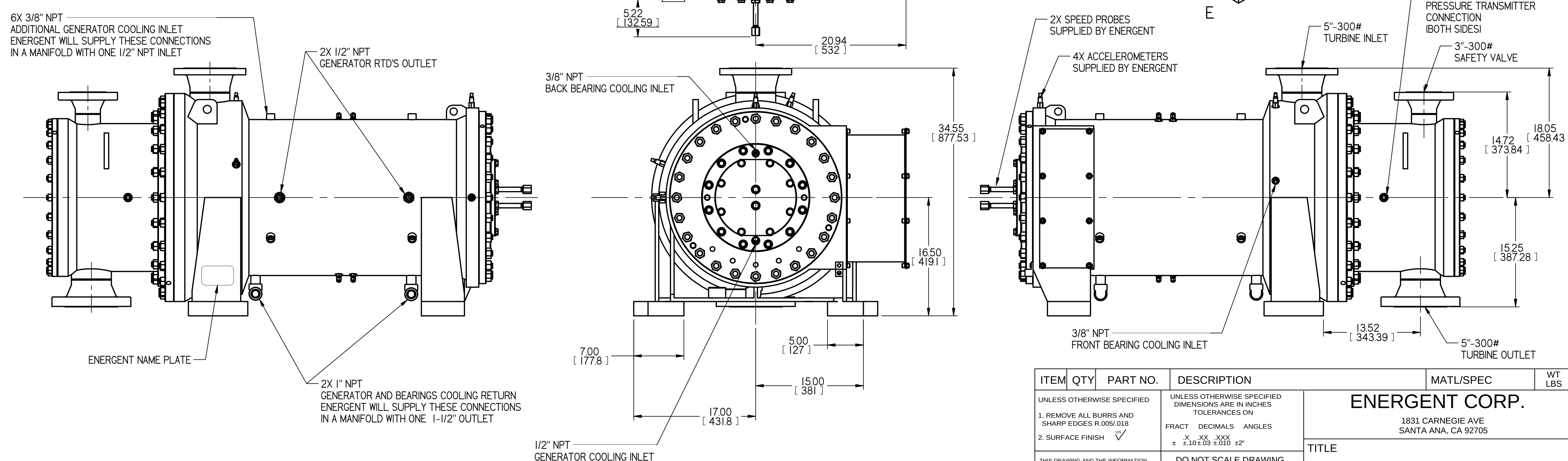
$2Fc + Mc \leq 1850$

Fc = COMBINED RESULTANT OF INLET, OUTLET AND RELIEF (LB)
Mc = COMBINED RESULTANT OF INLET, OUTLET AND RELIEF (FT-LB)









ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
FRACT DECIMALS ANGLES
± .X ±.10 .XX ±.03 .XXX ±.010 ±2°

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NEXT ASSY

DO NOT SCALE DRAWING

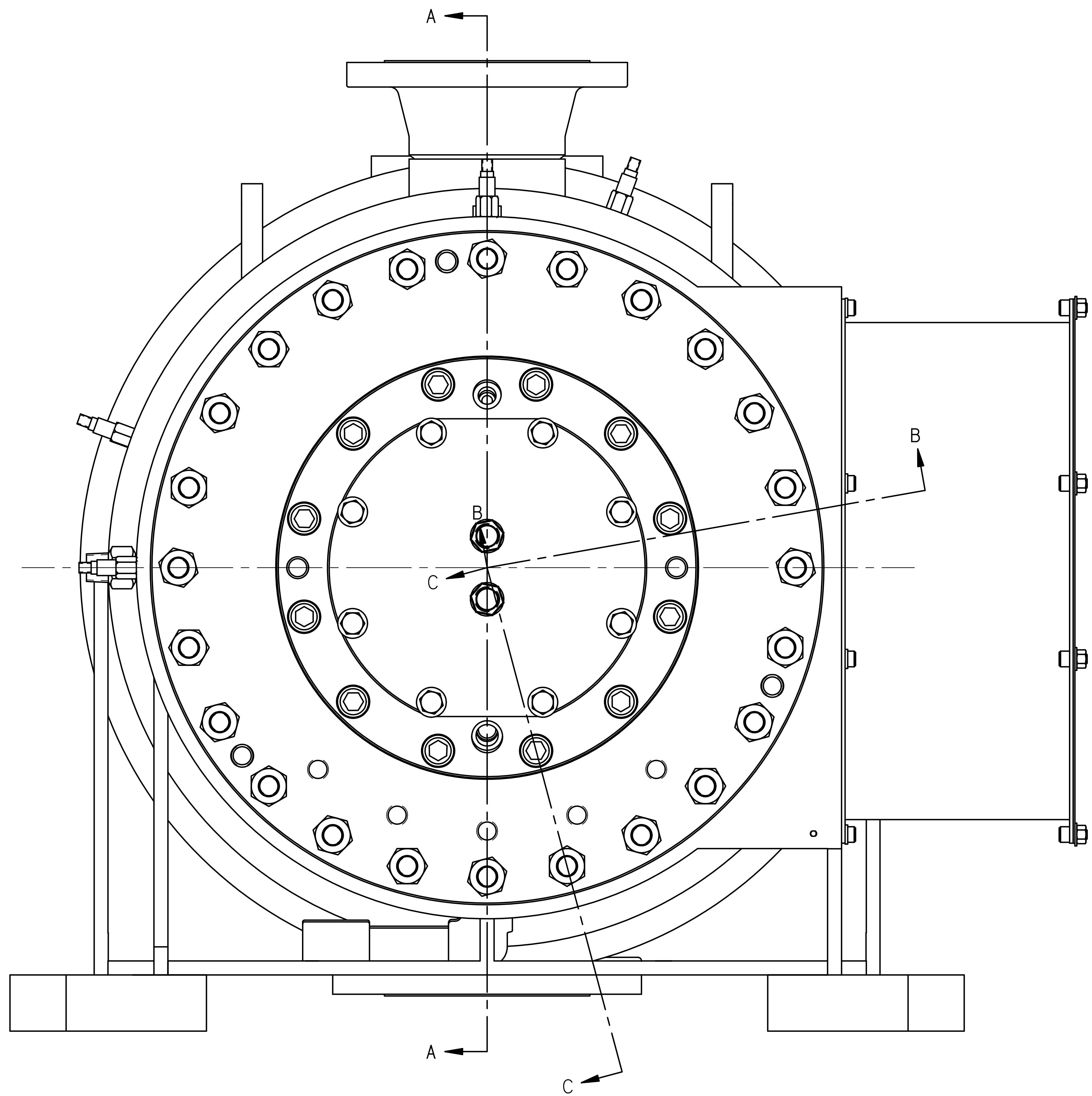
DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

TITLE
VPTG-2H TURBINE ASSEMBLY

DWG. SIZE	PROJECT NO.	DWG
D	10466	E1046650
SCALE: 1/1	EST. WT.	SHEET 1 OF 7

NOTES: UNLESS OTHERWISE SPECIFIED



ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS
69	1	E1046653-001	ABRADABLE SEAL ASSEMBLY		
68	1	E1046667-001	SPACER-BACK BEARING SHAFT SLEEVE #1	316SS ASTM A240	.41
67	2	E86017-034	SEALING WASHER	—	—
66	1	E82900-283	"O" RING 2-283	—	—
65	4	E1046672-001	FRONT BEARING - LABYRINTH RING #2	316SS ASTM A240	—
64	4	08501-024	MALE STRAIGHT CONNECTOR, SWAGELOK SS-400-1-6ST	316SS ASTM A240	—
63	1	E1046671-001	FRONT BEARING - LABYRINTH RING #1	BRONZE C93200	11.9
62	1	E1046676-001	FRONT BEARING - SHAFT SLEEVE #2	316SS ASTM A240	9.2
61	1	E1046678-001	BACK BEARING - SHAFT SLEEVE #2	316SS ASTM A240	9.3
60	1	E82900-237	"O" RING 2-237	—	—
59	2	E1046661-001	DEEP GROOVE BAL BEARING, CEROBEAR 6317	—	—
58	1	E1042031-001	BEARING LOCK-NUT (SKF KMT-17)	—	2.53
57	1	E1046674-001	BACK BEARING - LABYRINTH RING #2 ASSY	—	21.85
56	24	E89110-008	5/8"-11UNC NUT	ASTM A194 GR 2H	2.02
55	24	E05000-028	5/8"-11UNC X 2.50" LG STUD	ASTM A193 GR B7	5.07
54	1	E1046669-001	TURBINE HOUSING OUTLET - END COVER	ASTM A516 GR 70	126
53	1	E82900-388	"O" RING 2-388	—	—
52	1	E1046665-001	TURBINE OUTLET HOUSING	ASTM A516 GR 70	232.5
51	1	E89600-052	EXPANDING CLAMP, RIVERHAWK IC-5312	—	2.1
50	20	E05000-011	3/4"-10UNC X 3.0" LG STUD	ASTM A193 GR B7	7.63
49	1	E82900-389	"O" RING 2-389	—	—
48	24	E05000-027	3/4"-10UNC X 3.25" LG STUD	ASTM A193 GR B7	9.4
47	1	E1046668-001	TURBINE NOZZLE ASSEMBLY	316SS ASTM A240	365
46	1	E82900-394	"O" RING 2-394	—	34.23
45	1	E1046655-001	TURBINE WHEEL ASSEMBLY	ALUM 7075-T6	
44	1	E82900-152	"O" RING 2-152	—	—
43	1	E1046675-001	FRONT BEARING - SHAFT SLEEVE #1	4140 AMS 2301	12.4
40	8	E86015-020	1/2"-13UNC X 2.50" LG SHCS	ASTM A193 GR B7	.1.44
39	1	E1046662-001	GRAPHALLOY BEARING HOLDER - FRONT SIDE	316SS ASTM A240	30.6
38	2	E82900-273	"O" RING 2-373	—	—
37	1	E1046664-001	HOUSING - FRONT BEARING	ASTM A516 GR 70	81
35	1	E1046672-001	FRONT BEARING - LABYRINTH RING #2	BRONZE C93200	10.3
34	12	E86015-019	3/8"-16UNC X .75 LG SHCS	ASTM A193 GR B7	.53
33	1	E1046651-001	TURBINE SHAFT	4140 AMS 2301	141
32	1	E1042021-001	GENERATOR - ROTOR	—	234
31	1	E82900-018	"O" RING 2-018	ASTM A36	.31
30	1	E1042020-001	GENERATOR - STATOR	—	791
29	1	E1046660-001	TURBINE HOUSING	ASTM A516 GR 70	1488
28	8	E86015-018	1/2"-13UNC X 2.0" LG SHCS	ASTM A193 GR B7	.1.3
27	1	E1046663-001	GENERATOR - COOLING NOZZLE	ASTM A516 GR 70	22
26	2	E82900-259	"O" RING 2-259	—	—
25	1	E1046673-001	BACK BEARING - LABYRINTH RING #1	BRONZE C93200	3.5
24	8	E86015-017	3/8"-16UNC X .62" LG SHCS	ASTM A193 GR B7	..32
23	1	E82900-248	"O" RING 2-248	—	—
22	3	99004-094	1/4"-20UNC X .50" LG SET SCREW	—	.02
21	1	E1046677-001	BACK BEARING - SHAFT SLEEVE #1	4140 AMS 2301	16.2
20	2	E1046658-001	GRAPHALLOY BEARING	—	—
19	1	E1046659-001	GRAPHALLOY BEARING HOLDER - BACK SIDE	316SS ASTM A240	27.2
18	2	E82900-262	"O" RING 2-262	—	—
17	1	E82900-151	"O" RING 2-151	—	—
16	8	E86015-016	1/2"-13UNC X 1.0" LG SHCS	ASTM A193 GR B7	.86
15	4	00650-308	ACCELEROMETER, SKF CMSS2100	—	.81
14	1	E82090-468	"O" RING 2-468	—	—
13	1	E82900-278	"O" RING 2-278	—	
12	1	E1046657-001	END COVER - BACK SIDE	ASTM A516 GR 70	153
11	68	E89110-007	3/4"-10UNC NUT	ASTM A194 GR 2H	13.64
10	24	E05000-011	3/4"-10UNC X 3.0" LG STUD	ASTM A193 GR B7	9
9	12	E86015-015	3/4"-10UNC X 2.0" LG SHCS	ASTM A193 GR B7	5
8	1	E1046656-001	HOUSING - BACK BEARING	ASTM A516 GR 70	148
7	1	E82900-373	"O" RING 2-273	—	—
6	8	E86017-010	1/2" LOCK WASHER	—	—
5	8	E86017-006	1/2" FLAT WASHER	—	—
4	8	E99002-013	1/2"-13UNC X 1.0" LG HHCS	ASTM A193 GR B7	—
3	1	E1046654-001	END CAP -BACK SIDE	ASTM A516 GR 70	31
2	4	E82900-205	"O" RING 2-113	—	—
1	2	E89610-019	SPEED PROBE, AI-TEK 70085-1010-412	—	—

UNLESS OTHERWISE SPECIFIED

1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

FRACT	DECIMALS		ANGLES
	.XX	.XXX	
±	±.10 ±.03	±.010	±2°

ENERGENT CORP.

1831 CARNEGIE AVE
SANTA ANA, CA 92705

TITLE
VPTG-2H TURBINE ASSEMBLY

DO NOT SCALE DRAWING

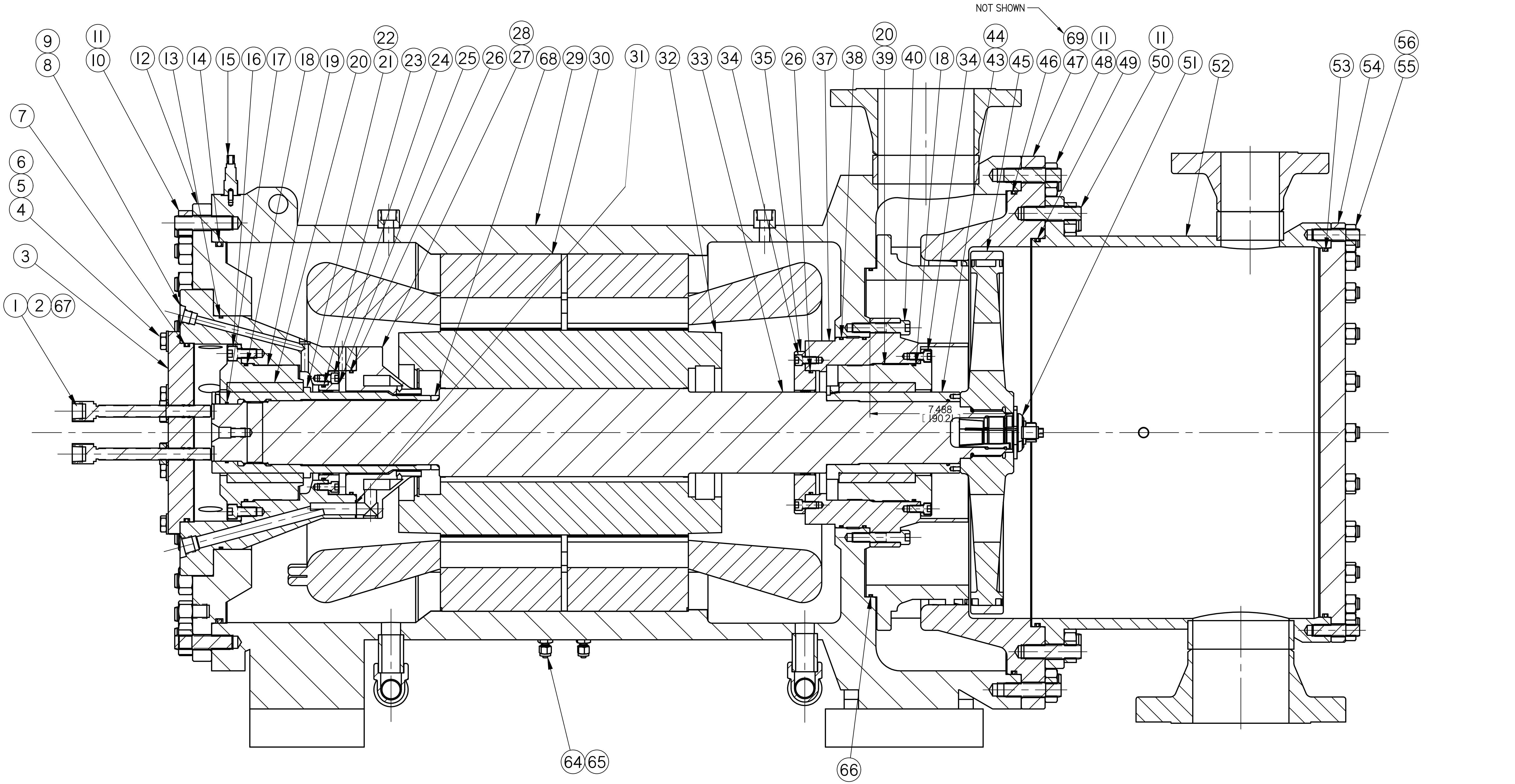
DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

NEXT ASSY

DWG. SIZE	PROJECT NO.	DWG
D	10466	E1046650
SCALE: 1/1	EST. WT.	SHEET 2 OF 7

NOTES: UNLESS OTHERWISE SPECIFIED

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED



SECTION A-A
WITH GRAPHALLOY BEARINGS

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
FRACT DECIMALS ANGLES
± .X ±.10 .XX ±.03 .XXX ±.010 ±2°

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NEXT ASSY

DO NOT SCALE DRAWING

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DRAWN	E.GUZMAN	10/17/14
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ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

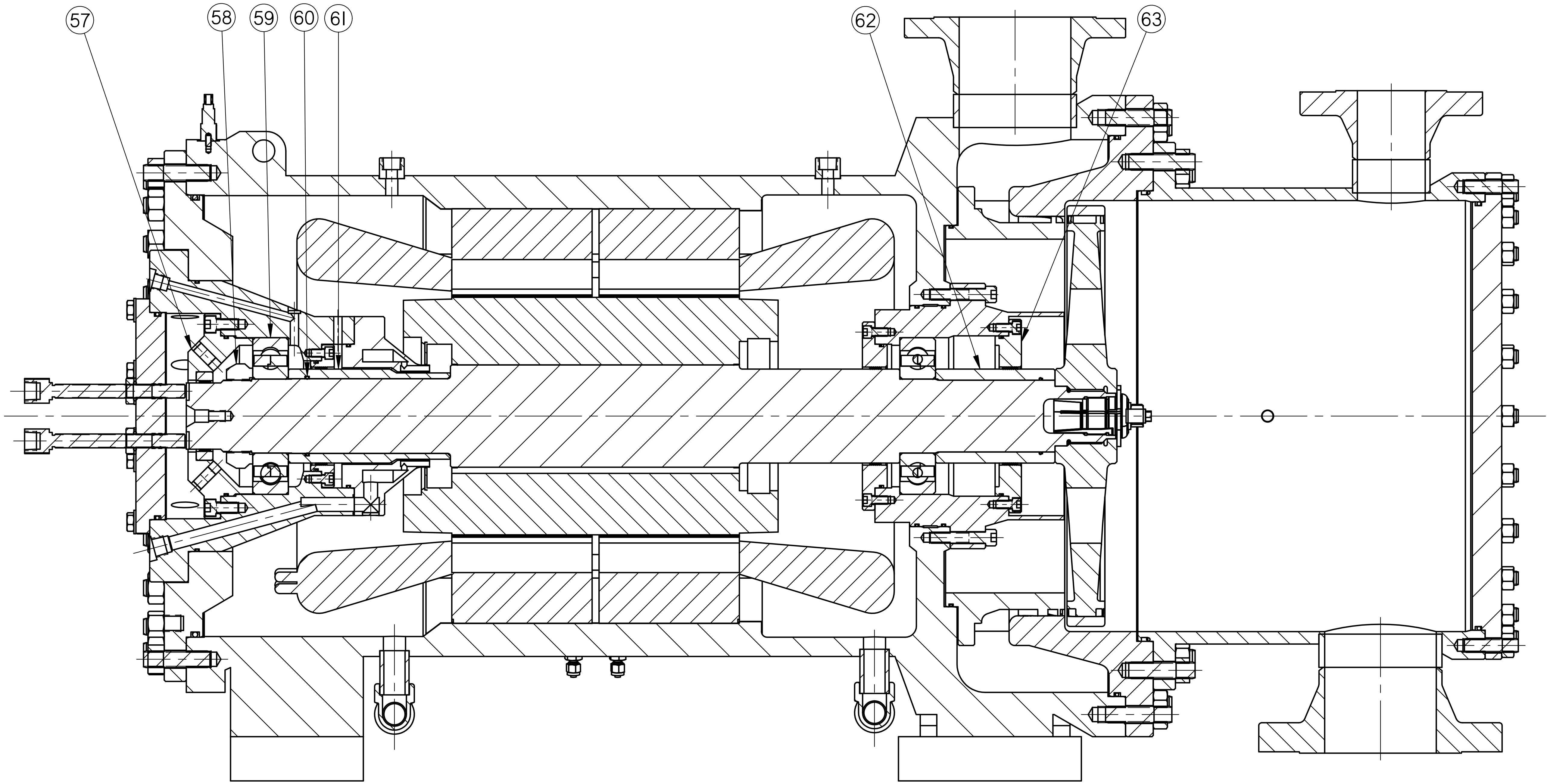
TITLE
VPTG-2H TURBINE ASSEMBLY

DWG. SIZE D | PROJECT NO. 10466 | DWG E1046650

SCALE: 1/1 | EST. WT. | SHEET 3 OF 7

NOTES: UNLESS OTHERWISE SPECIFIED

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED



SECTION A-A
WITH DEEP GROOVE BALL BEARINGS

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

FRACT	DECIMALS	ANGLES
±	.X ±.10 .XX ±.03 .XXX ±.010	±2°

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ISSUED	K.KAUPERT	10/17/14

ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

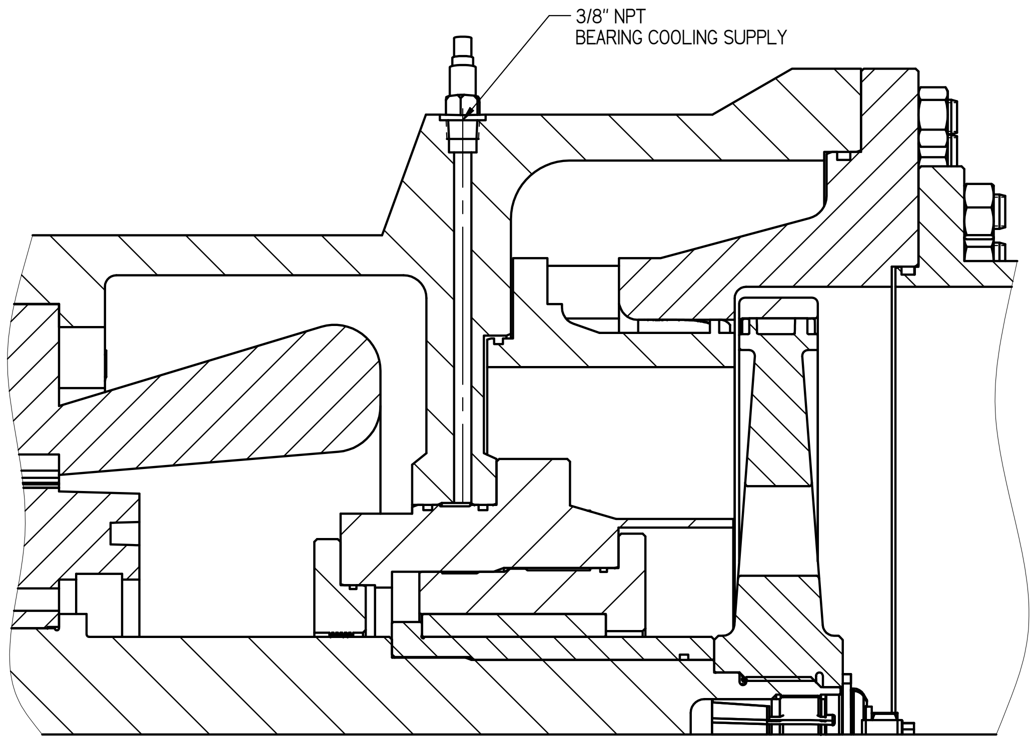
TITLE
VPTG-2H TURBINE ASSEMBLY

DWG. SIZE D | PROJECT NO. 10466 | DWG E1046650

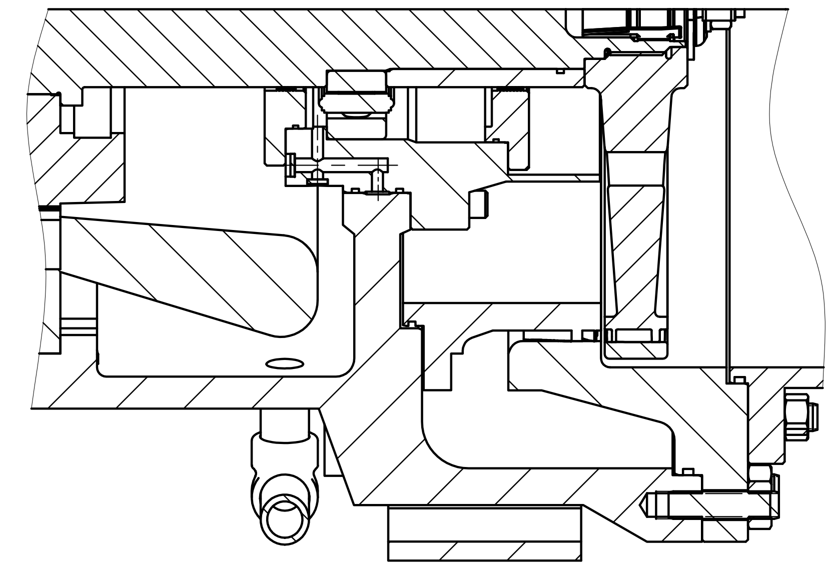
SCALE: 1/1 | EST. WT. | SHEET 4 OF 7

NOTES: UNLESS OTHERWISE SPECIFIED

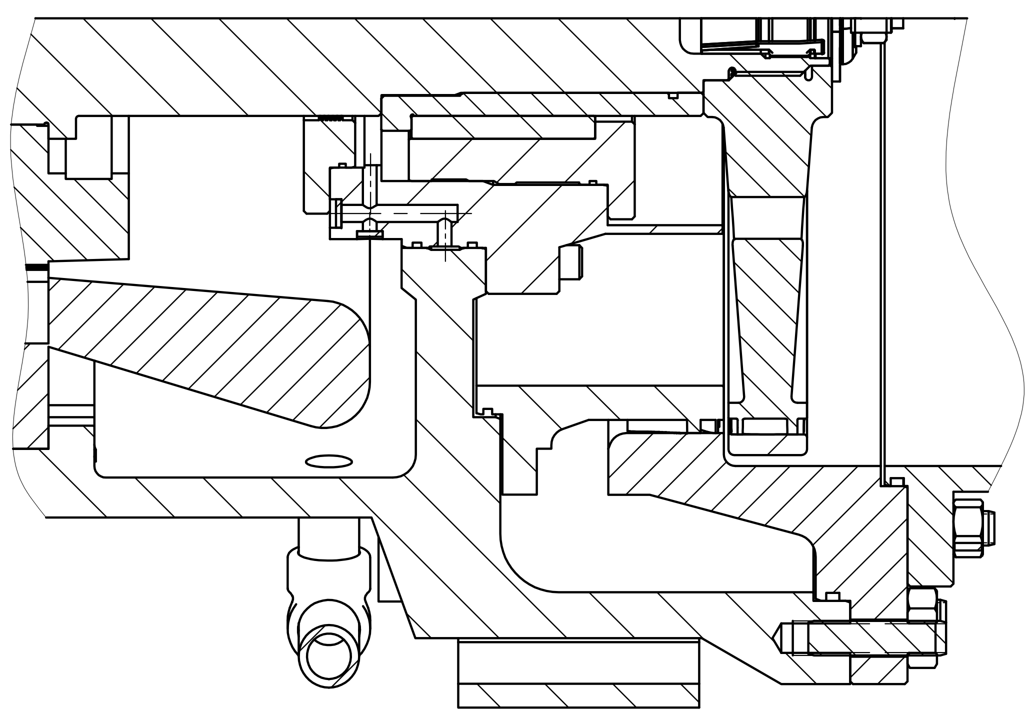
REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED



SECTION B-B



SECTION C-C
WITH DEEP GROOVE BALL BEARIGNS



SECTION C-C
WITH GRAPHALLOY BEARIGNS

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED

1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125√

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

FRACT	DECIMALS			ANGLES
	.X	.XX	.XXX	
±	±.10	±.03	±.010	±2°

DO NOT SCALE DRAWING

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ISSUED	K.KAUPERT	10/17/14

NEXT ASSY

ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

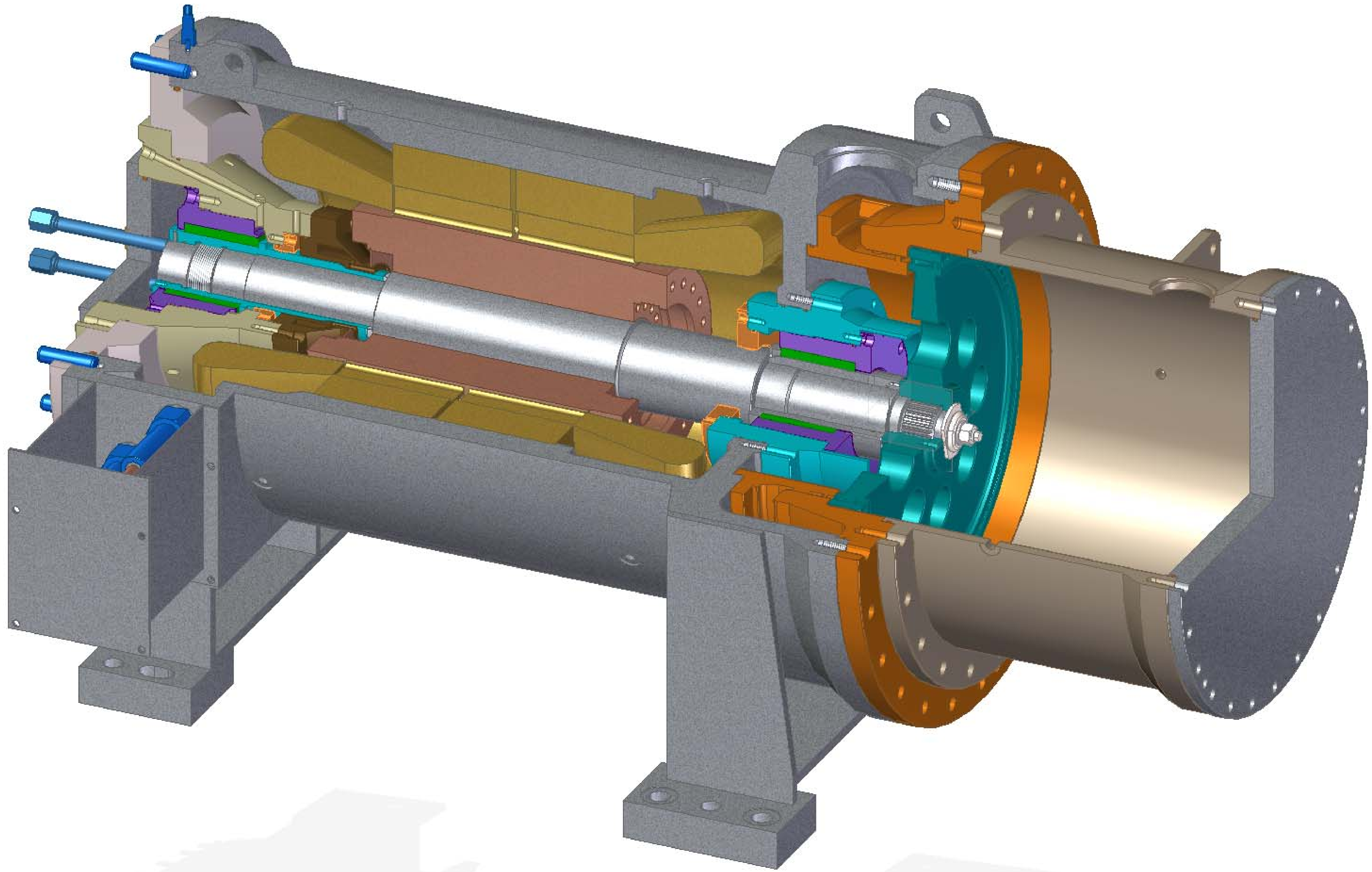
TITLE
VPTG-2H TURBINE ASSEMBLY

DWG. SIZE D | PROJECT NO. 10466 | DWG E1046650

SCALE: 1/1 | EST. WT. | SHEET 5 OF 7

NOTES: UNLESS OTHERWISE SPECIFIED

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED



TURBINE ASSEMBLY WITH GRAPHALLOY BEARINGS

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED

1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

FRACT DECIMALS ANGLES
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ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

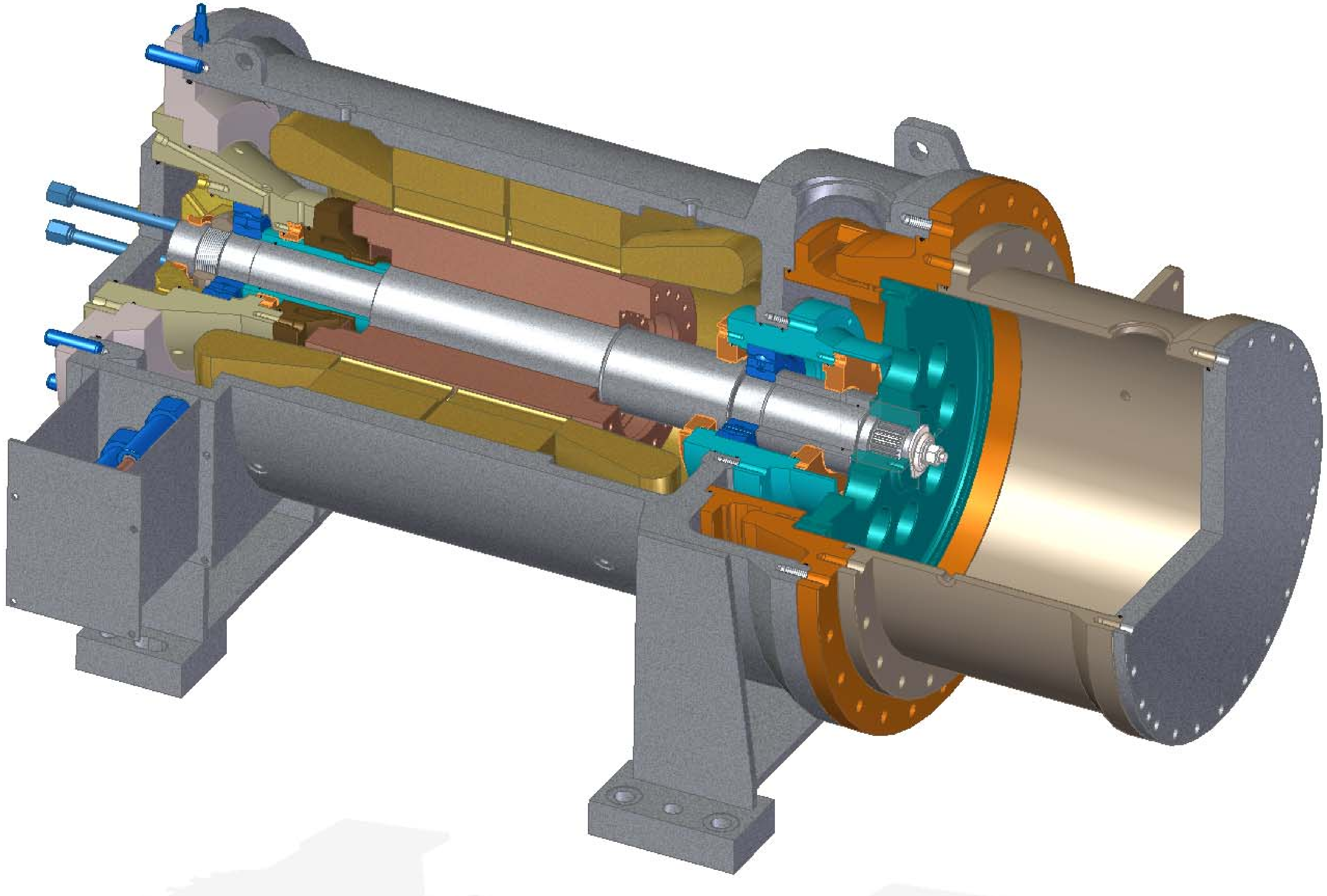
TITLE
VPTG-2H TURBINE ASSEMBLY

DWG. SIZE D | PROJECT NO. 10466 | DWG E1046650

SCALE: 1/1 | EST. WT. | SHEET 6 OF 7

NOTES: UNLESS OTHERWISE SPECIFIED

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED



TURBINE ASSEMBLY DEEP GROOVE BALL BEARINGS

NOTES: UNLESS OTHERWISE SPECIFIED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED

1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125 √

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

FRACT	DECIMALS			ANGLES
	.X	.XX	.XXX	
±	±.10	±.03	±.010	±2°

NEXT ASSY

DO NOT SCALE DRAWING

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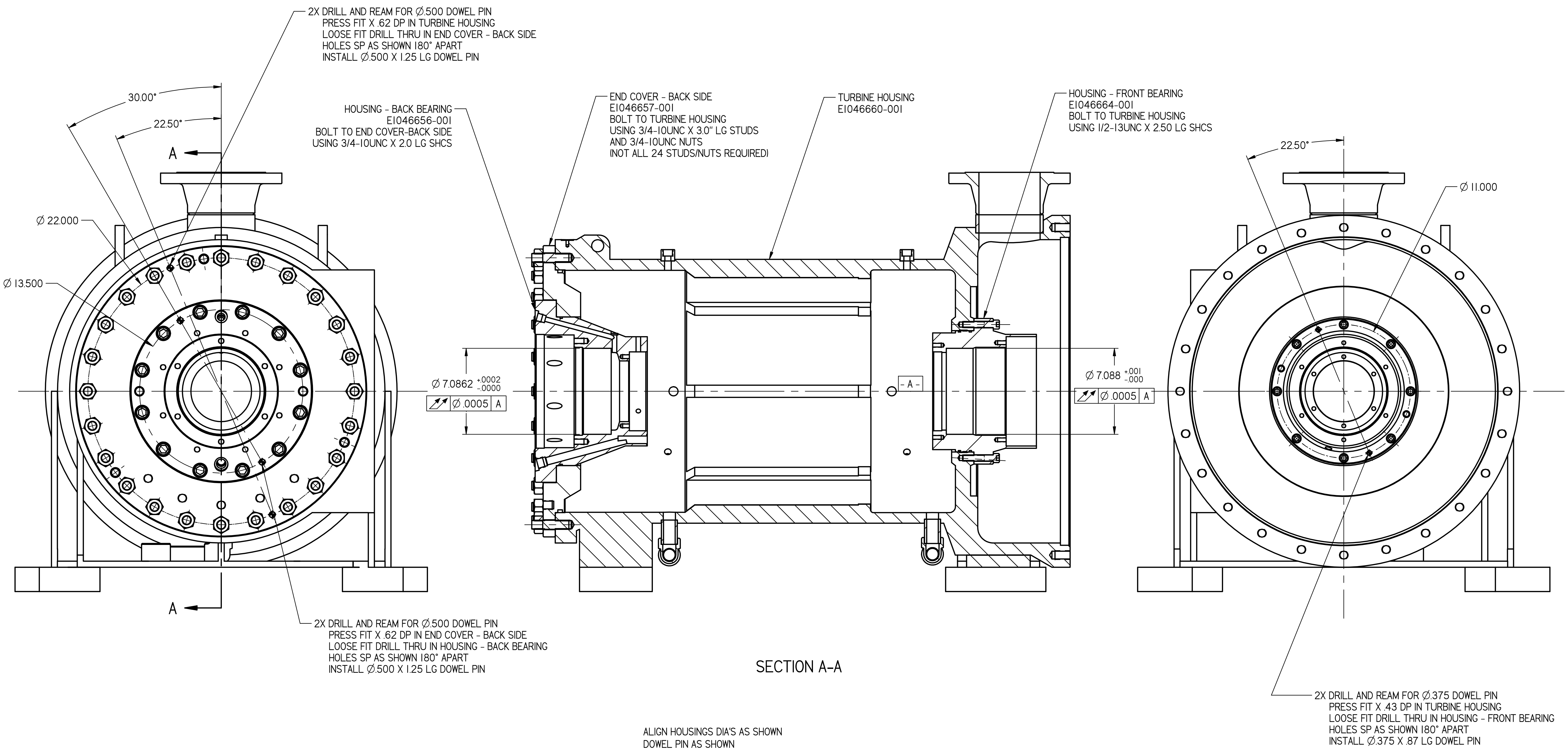
ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

TITLE
VPTG-2H TURBINE ASSEMBLY

DWG. SIZE	PROJECT NO.	DWG
D	10466	E1046650

SCALE: 1/1 | EST. WT. | SHEET 7 OF 7

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED



ALIGN HOUSINGS DIA'S AS SHOWN
DOWEL PIN AS SHOWN

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED

1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125 √

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ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

NEXT ASSY 1046650

ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

TITLE
HOUSINGS - FINAL ALIGNMENT

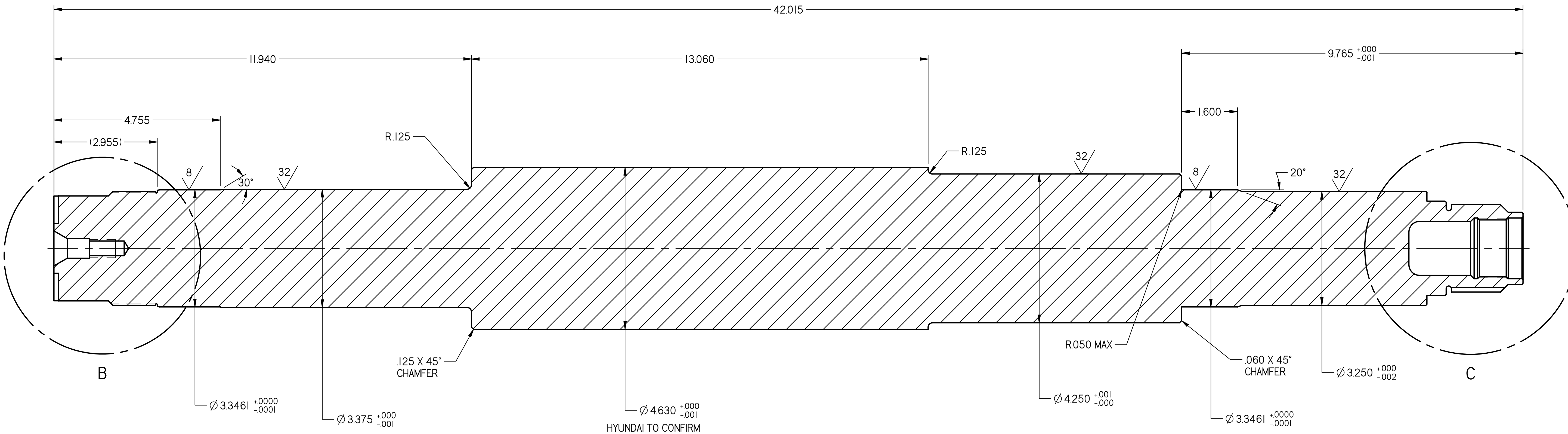
DWG. SIZE D | PROJECT NO. 10466 | DWG E1046666

SCALE: 1/1 | EST. WT. | SHEET 1 OF 1

1 VENDOR TO SUPPLY FINAL ALIGNMENT INSPECTION REPORT

NOTES: UNLESS OTHERWISE SPECIFIED

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED



SECTION A-A

2. ALL DIA'S TO BE CONCENTRIC WITH EACH OTHER WITHIN .0005 TIR

1. MATERIAL IS 4140 PER AMS-6382, OIL QUENCHED/TEMPERED, 95 KSI MIN YIELD, 40RC MIN HARDNESS
SUPPLY CHEMICAL, MECHANICAL AND HEAT TREATMENT TEST REPORTS

NOTES: UNLESS OTHERWISE SPECIFIED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
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NEXT ASSY
E1046650

DO NOT SCALE DRAWING

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

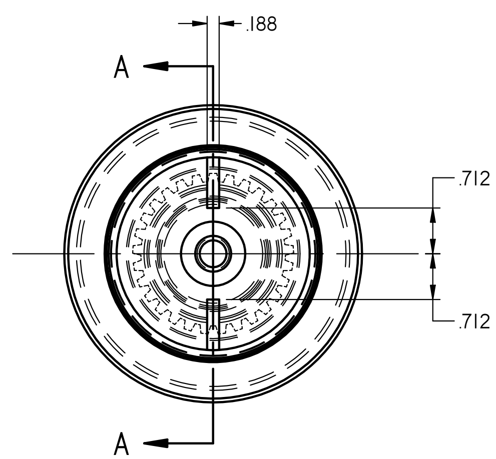
ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

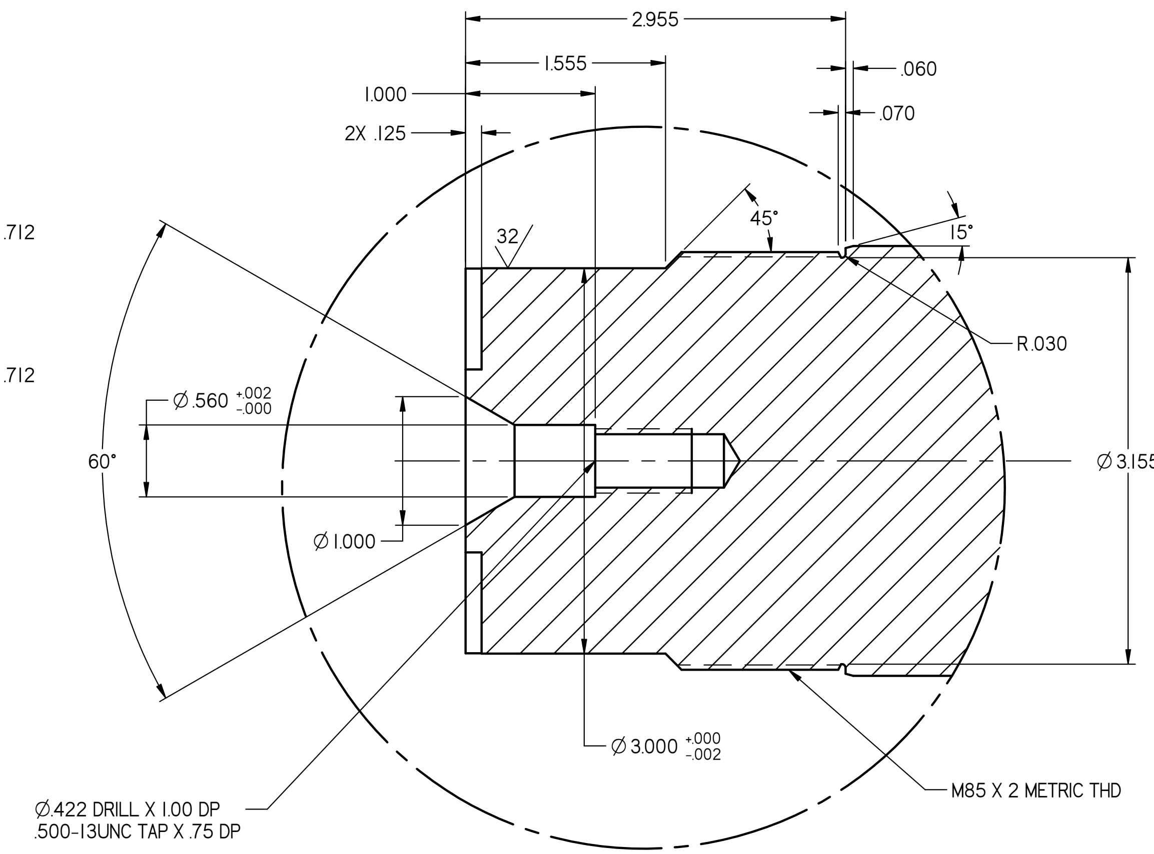
TITLE
TURBINE SHAFT

DWG. SIZE D | PROJECT NO. 10466 | DWG E1046651

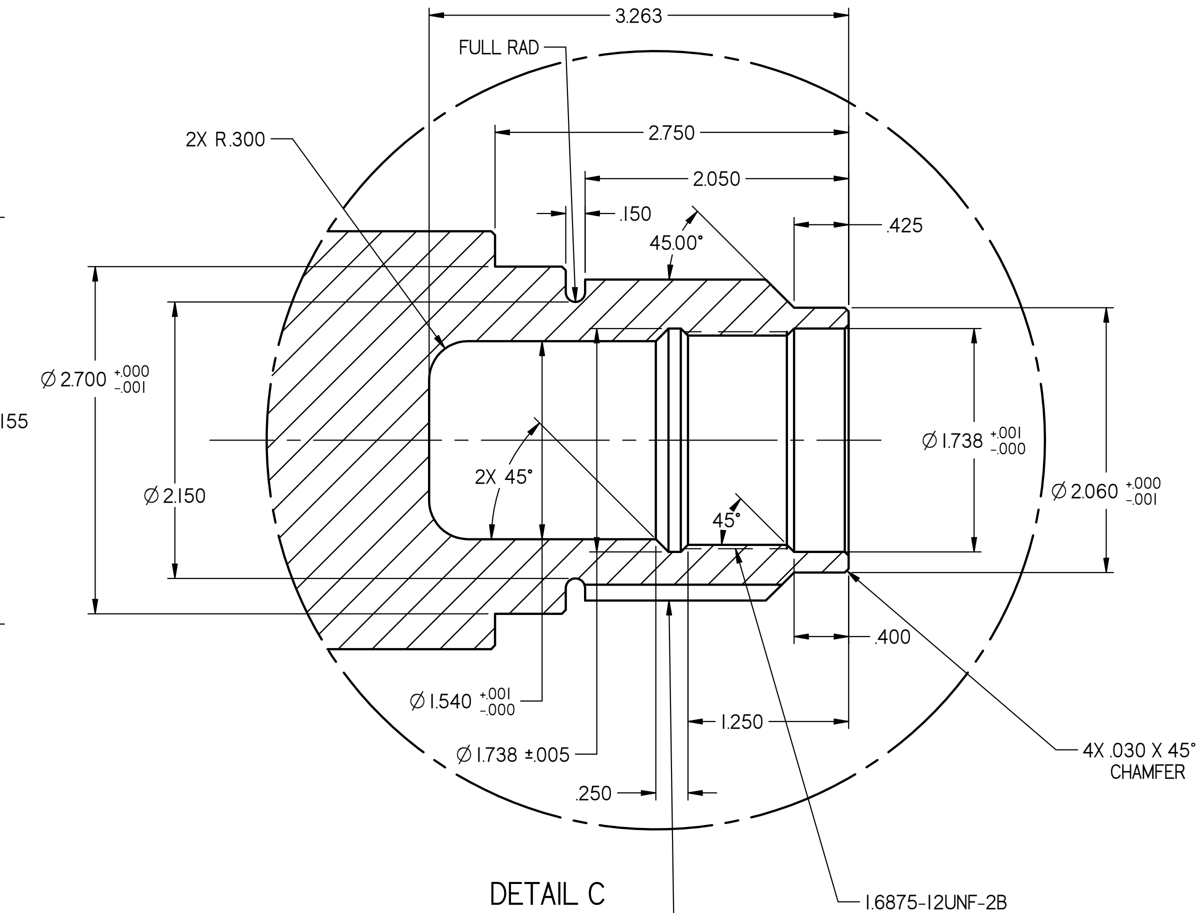
SCALE: 1/1 | EST. WT. | SHEET 1 OF 3

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED





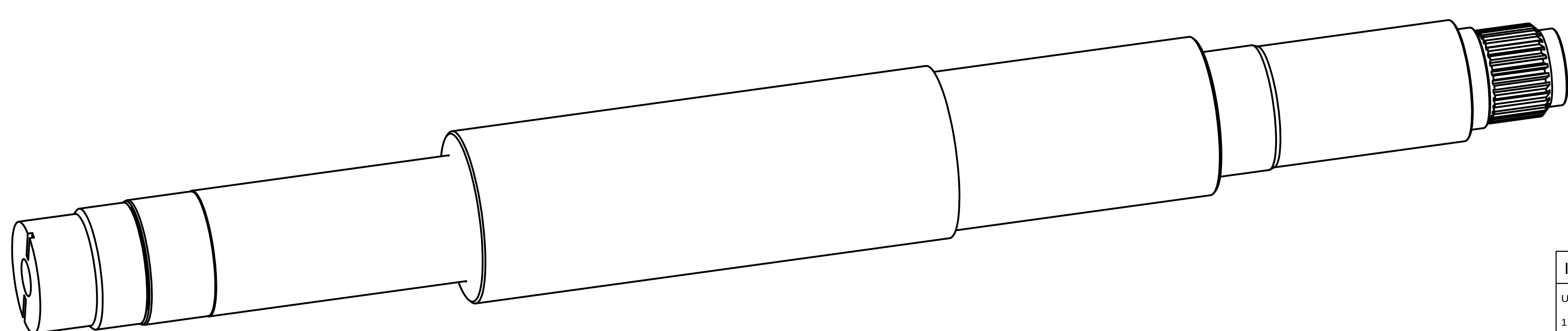
DETAIL B



DETAIL C

INVOLUTE SPLINE PER ANSI B92.1
FILLER ROOT SIDE FIT

NO OF TEETH	29
SPLINE PITCH	12/24
PRESSURE ANGLE	30°
BASE DIA	2.0929
PITCH DIA	2.4167
MAJOR DIA	2.500
FORM DIA	2.328
MINOR DIA	2.247
CIRCULAR TOOTH THK	
MAX EFFECTIVE	.1309
MIN ACTUAL	.1263
MIN MEAS OVER PINS	2.6544
PIN DIA	.1600
FILLET RAD	.027



ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
FRACT DECIMALS ANGLES
± .X ±.10 .XX ±.03 .XXX ±.010 ±2°

DO NOT SCALE DRAWING

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

NEXT ASSY
E1046650

ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

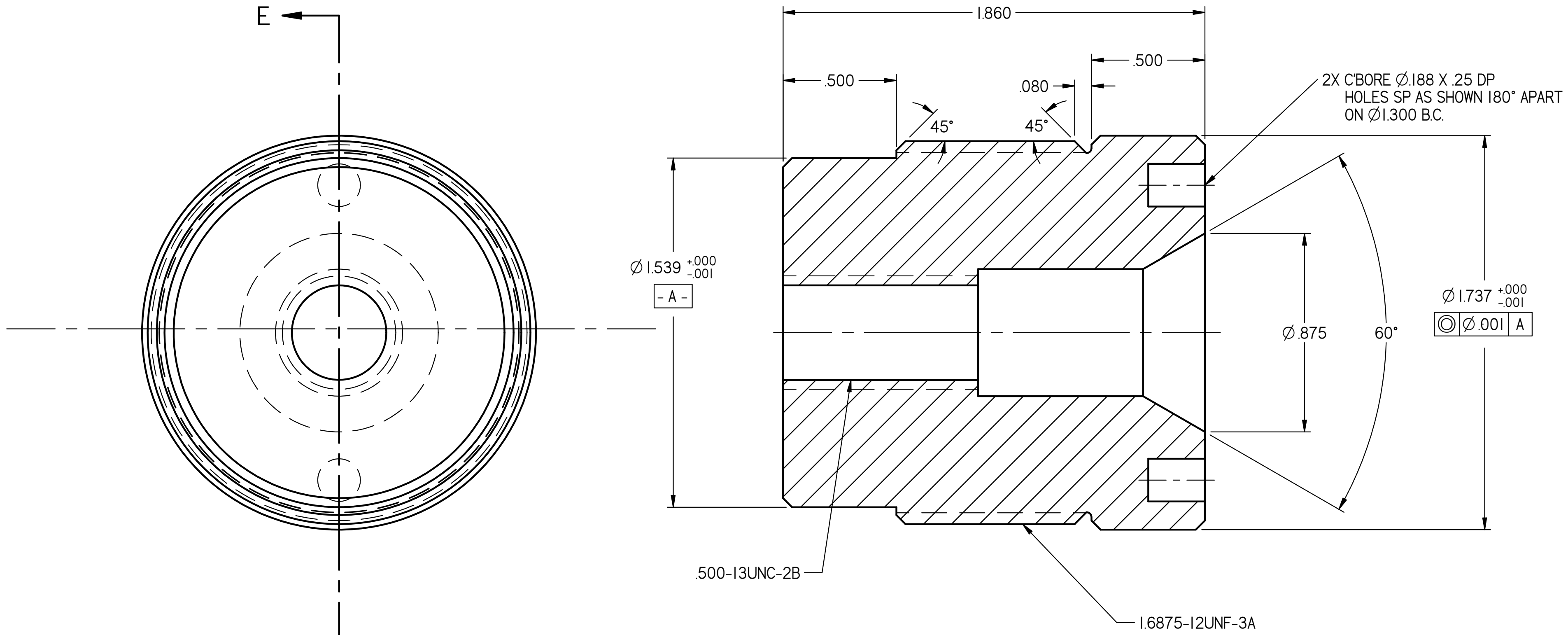
TITLE
TURBINE SHAFT

DWG. SIZE D | PROJECT NO. 10466 | DWG E1046651

SCALE: 1/1 | EST. WT. | SHEET 2 OF 3

NOTES: UNLESS OTHERWISE SPECIFIED

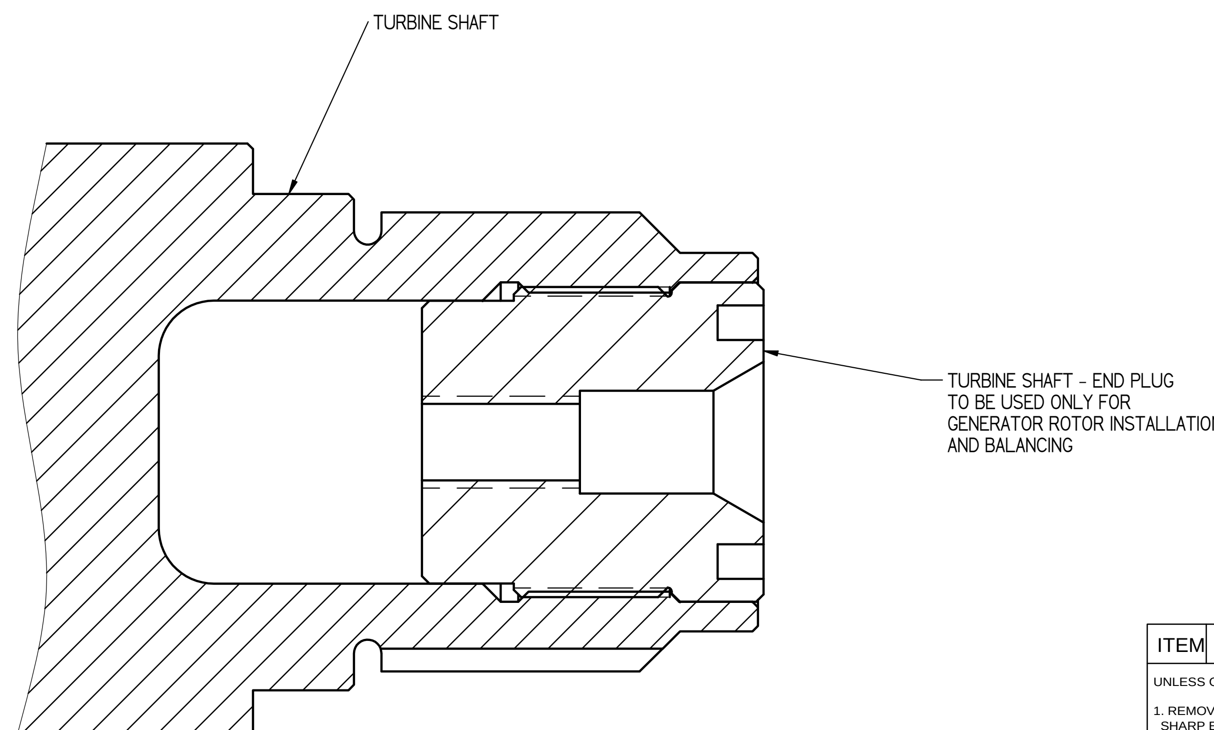
REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED



TURBINE SHAFT - END PLUG

MAT'L: SAME AS SHAFT

SECTION E-E



NOTES: UNLESS OTHERWISE SPECIFIED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
FRACT DECIMALS ANGLES
± .X ±.10 .XX ±.03 .XXX ±.010 ±2°

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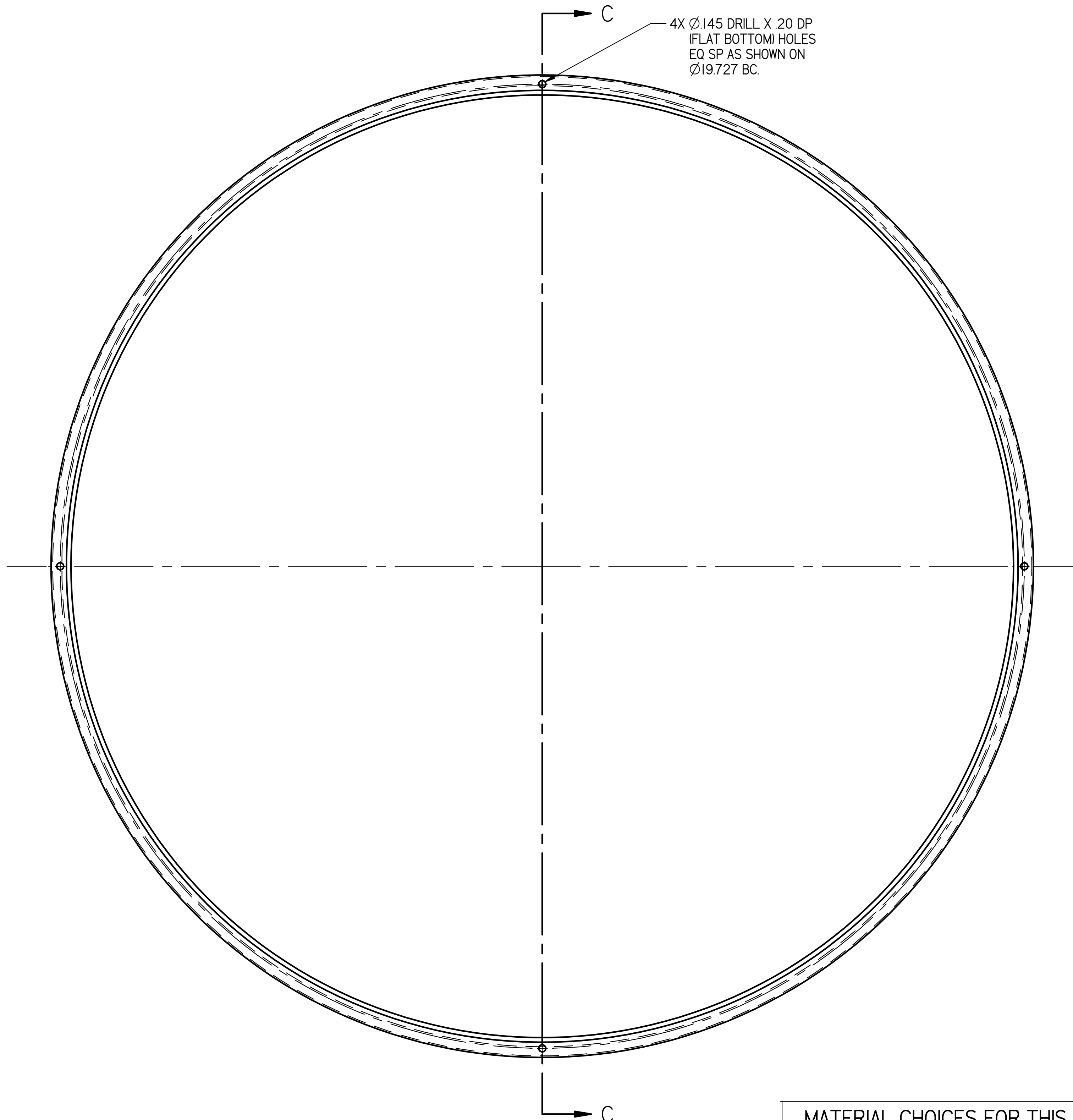
ISSUED	K.KAUPERT	10/17/14

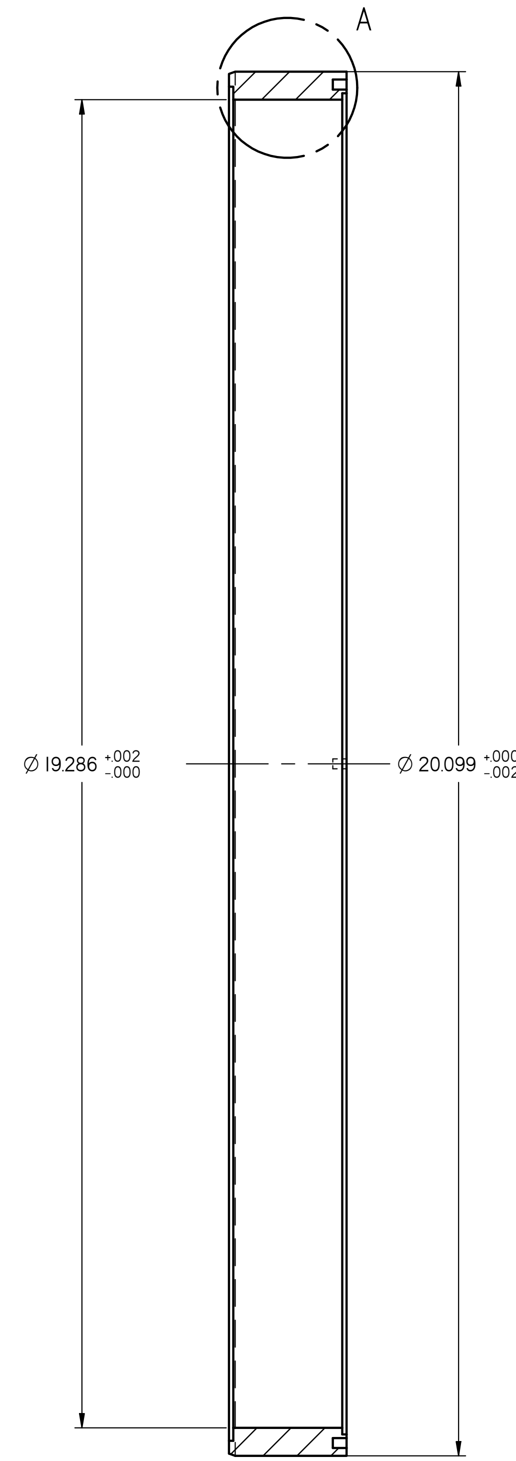
NEXT ASSY E1046650

ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

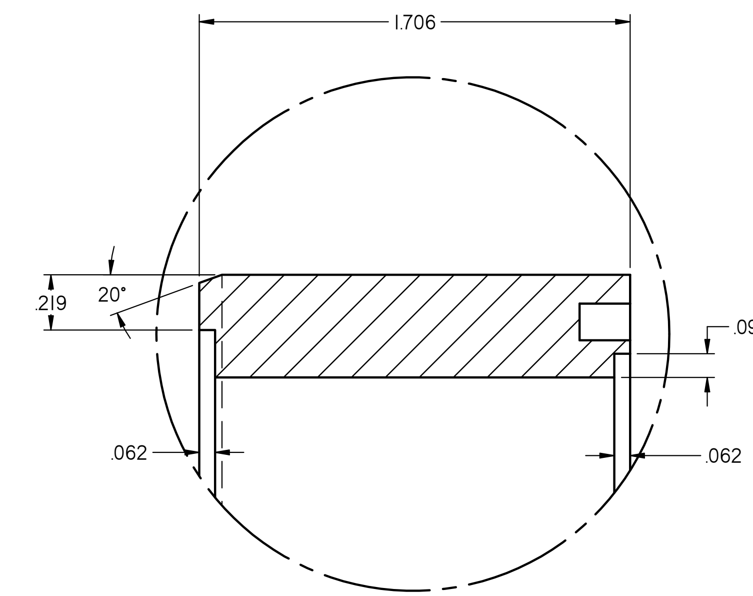
TITLE
TURBINE SHAFT

DWG. SIZE	PROJECT NO.	DWG
D	10466	E1046651
SCALE: 1/1	EST. WT.	SHEET 3 OF 3

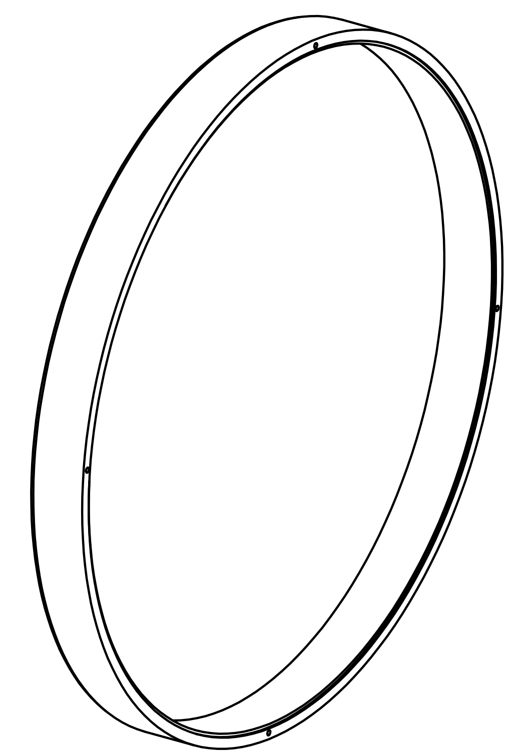




SECTION C-C



DETAIL A



REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED

MATERIAL CHOICES FOR THIS RING ONLY	
DASH	MATERIAL
-001	FLOUROSINT 500
-002	TEFLON PTFE
-003	DELRIN UNITAL-H

NOTES: UNLESS OTHERWISE SPECIFIED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

FRACT	DECIMALS	ANGLES
±	.X ±.10 .XX ±.03 .XXX ±.002	±2°

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NEXT ASSY E1046650

DO NOT SCALE DRAWING

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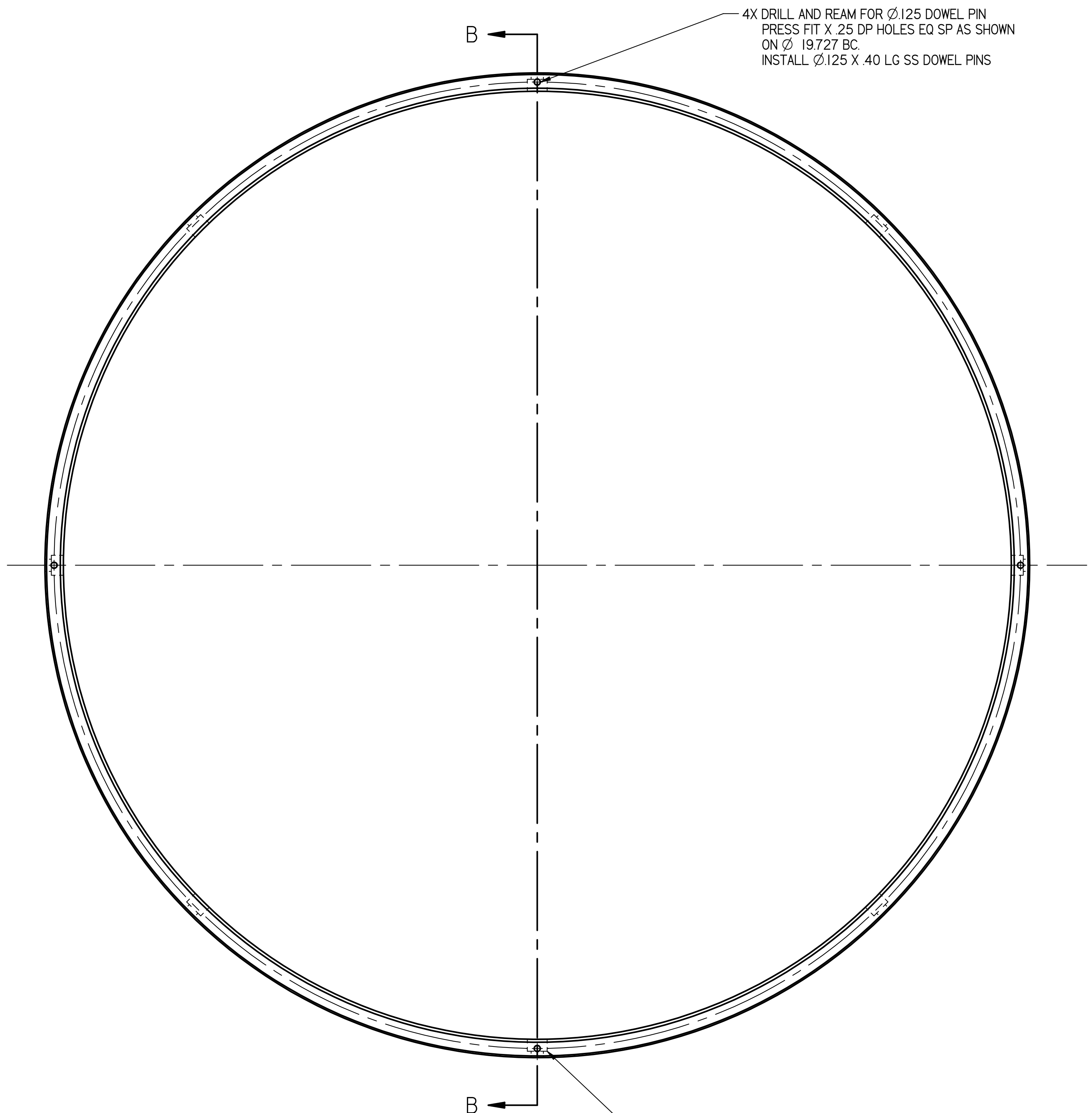
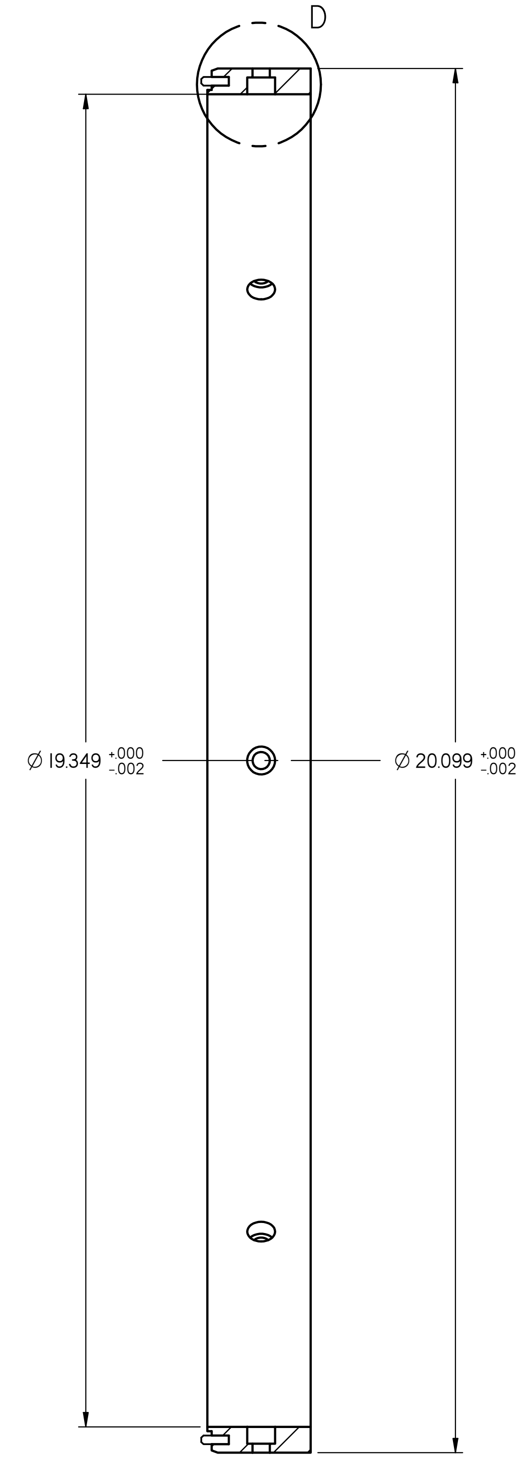
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

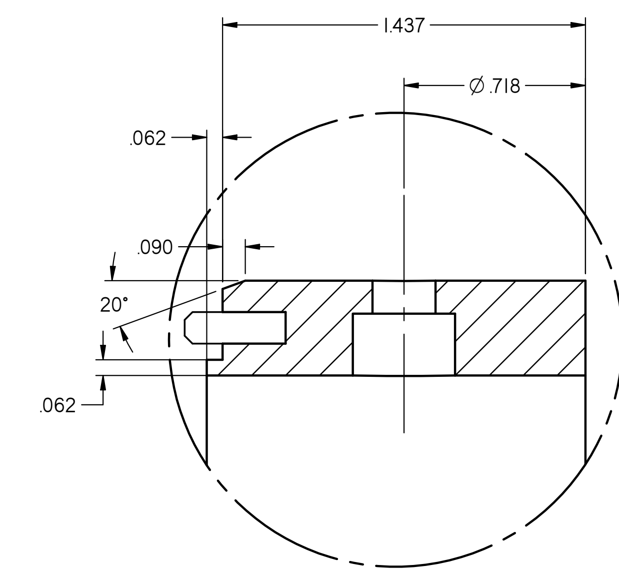
TITLE
ABRADABLE SEAL ASSEMBLY

DWG. SIZE	PROJECT NO.	DWG
D	10466	E1046653
SCALE: 1/1	EST. WT.	SHEET 1 OF 2

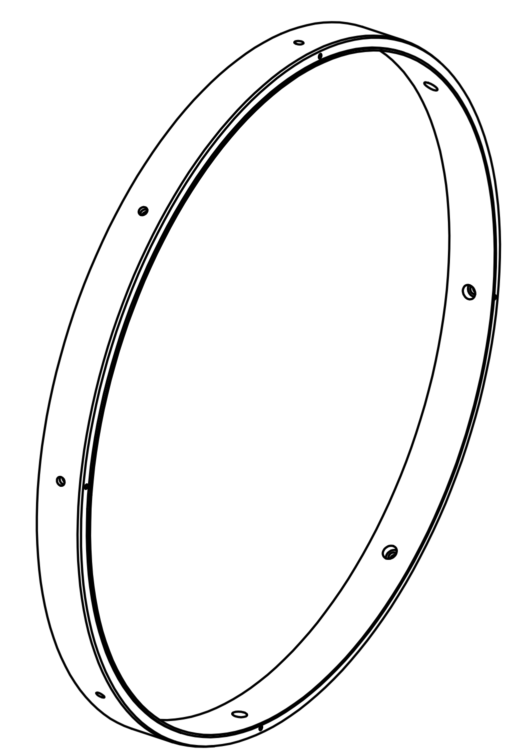




SECTION B-B



DETAIL D



MAT'L IS: AL 6061-T6

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
FRACT DECIMALS ANGLES
± .X ±.10 .XX ±.03 .XXX ±.002 ±2°

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NEXT ASSY E1046650

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ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

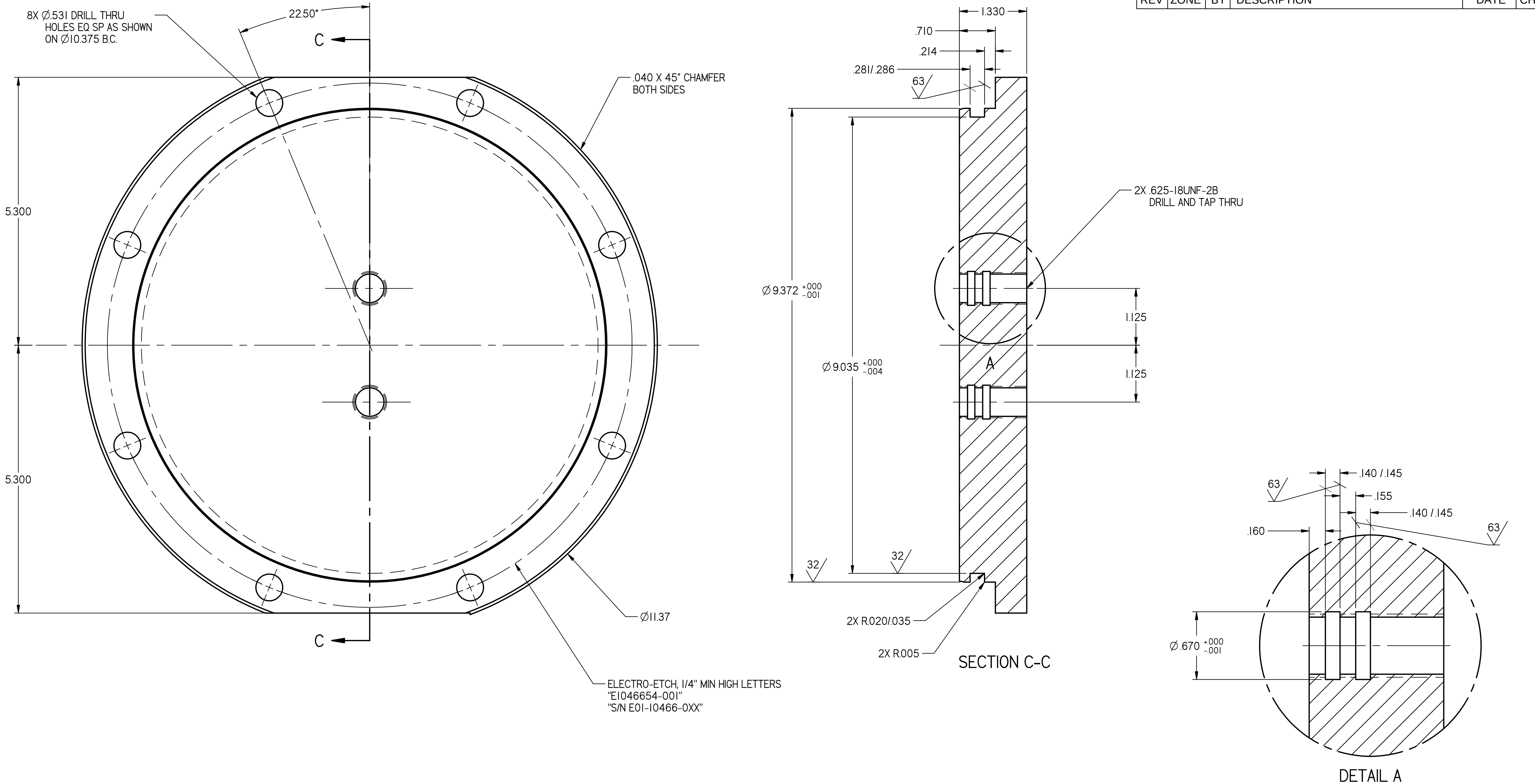
TITLE
ABRADABLE SEAL ASSEMBLY

DWG. SIZE D | PROJECT NO. 10466 | DWG E1046653

SCALE: 1/1 | EST. WT. | SHEET 2 OF 2

NOTES: UNLESS OTHERWISE SPECIFIED

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED



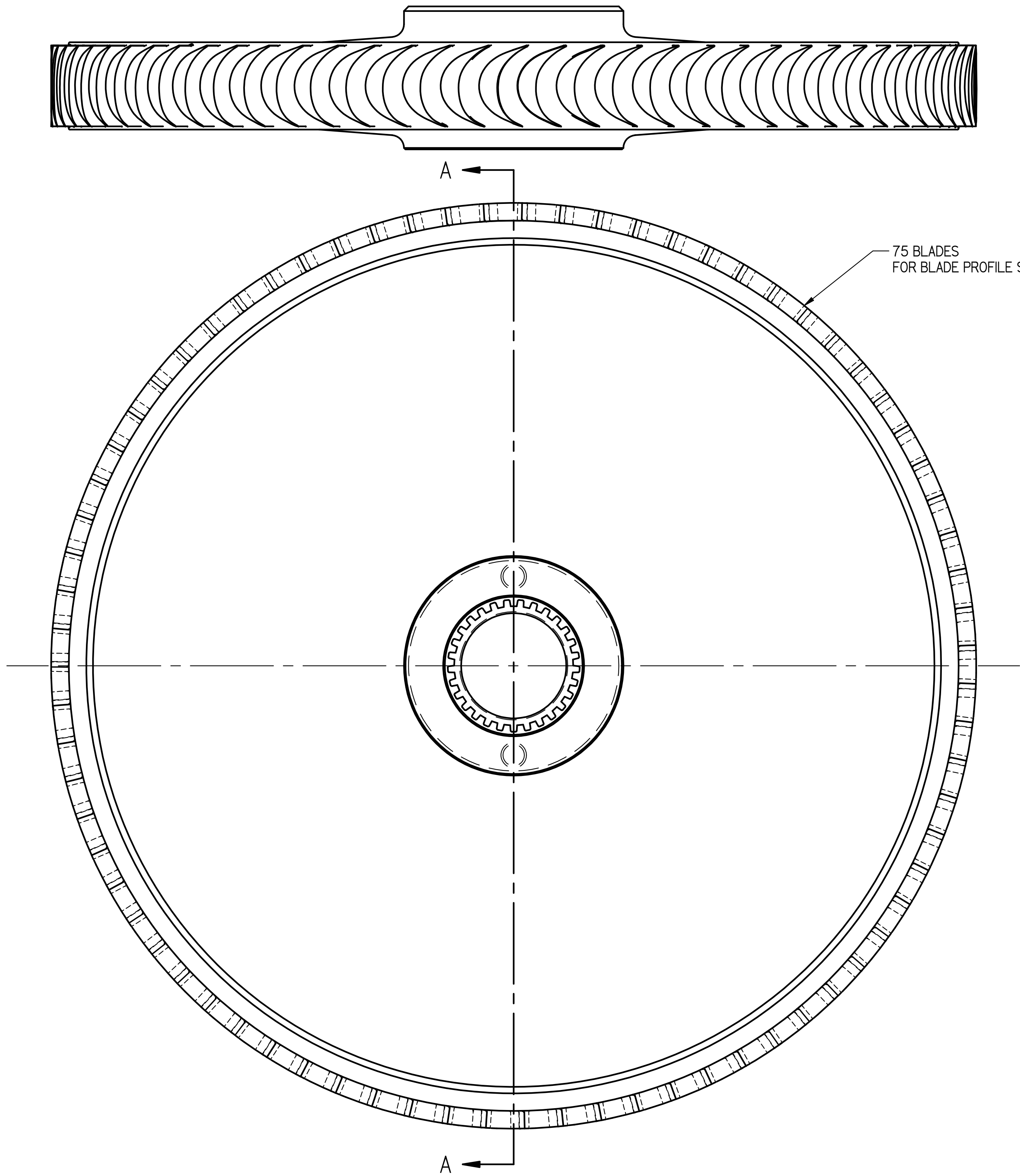
1. MATERIAL IS PRESSURE VESSEL PLATE PER ASTM A516 GR 70
PROVIDE CHEMICAL, MECHANICAL AND HEAT TREATMENT TEST REPORTS

NOTES: UNLESS OTHERWISE SPECIFIED

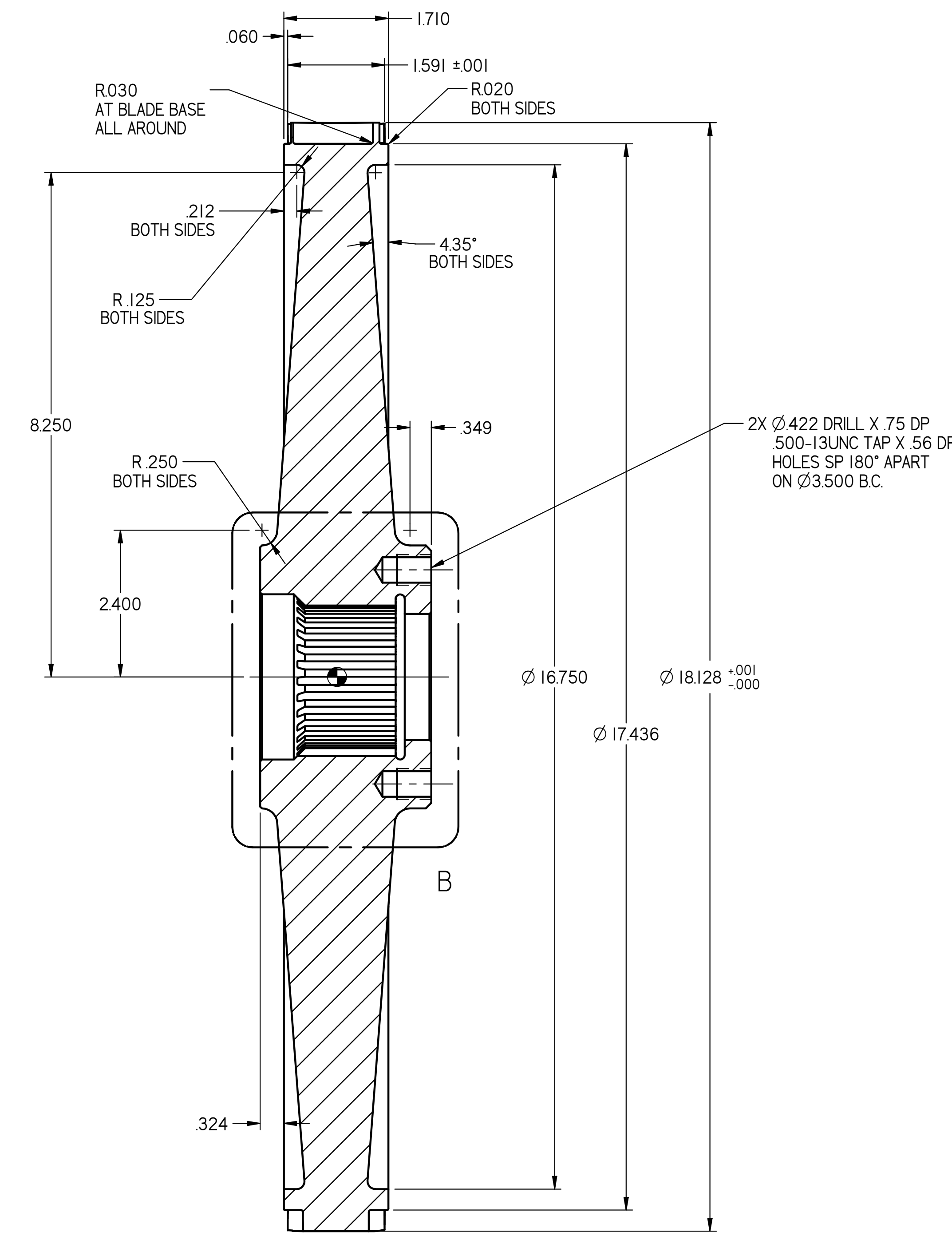
ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED 1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018 2. SURFACE FINISH	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACT DECIMALS ANGLES ± .X ±.10 .XX ±.03 .XXX ±.010 ±2°		ENERGENT CORP. 1831 CARNEGIE AVE SANTA ANA, CA 92705
THIS DRAWING AND THE INFORMATION REVEALED BY IT IS THE CONFIDENTIAL AND PROPRIETARY PROPERTY OF ENERGENT CORP AND IS NOT TO BE DISCLOSED TO OTHERS WITHOUT WRITTEN PERMISSION. UNAUTHORIZED USE OF THIS DRAWING IS EXPRESSLY FORBIDDEN.	DO NOT SCALE DRAWING		TITLE END CAP - BACK SIDE
	DESIGN E.GUZMAN	10/17/14	
	DRAWN E.GUZMAN	10/17/14	DWG. SIZE D | PROJECT NO. 10466 | DWG E1046654
	CHECKED I.MURILLO	10/17/14	
NEXT ASSY	ENG. APP. L.HAYS	10/17/14	
	ISSUED K.KAUPERT	10/17/14	SCALE: 1/1 | EST. WT. | SHEET 1 OF 1

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED



TURBINE WHEEL - DISK



SECTION A-A

2. ALL DIA'S TO BE CONCENTRIC WITH EACH OTHER WITHIN .0005 TIR

1. MATERIAL FOR TURBINE WHEEL DISK, SHROUD AND PINS IS ALUM 7075-T6 PER QQ-A-260/12
76KSI MIN TENSILE STRENGTH, 65KSI MIN YIELD STRENGTH
PROVIDE CHEMICAL, MECHANICAL AND HEAT TREATMENT TEST REPORTS

NOTES: UNLESS OTHERWISE SPECIFIED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED

1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

FRACT DECIMALS ANGLES
± .X ±.10 .XX ±.03 .XXX ±.010 ±2°

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NEXT ASSY E1046650

DO NOT SCALE DRAWING

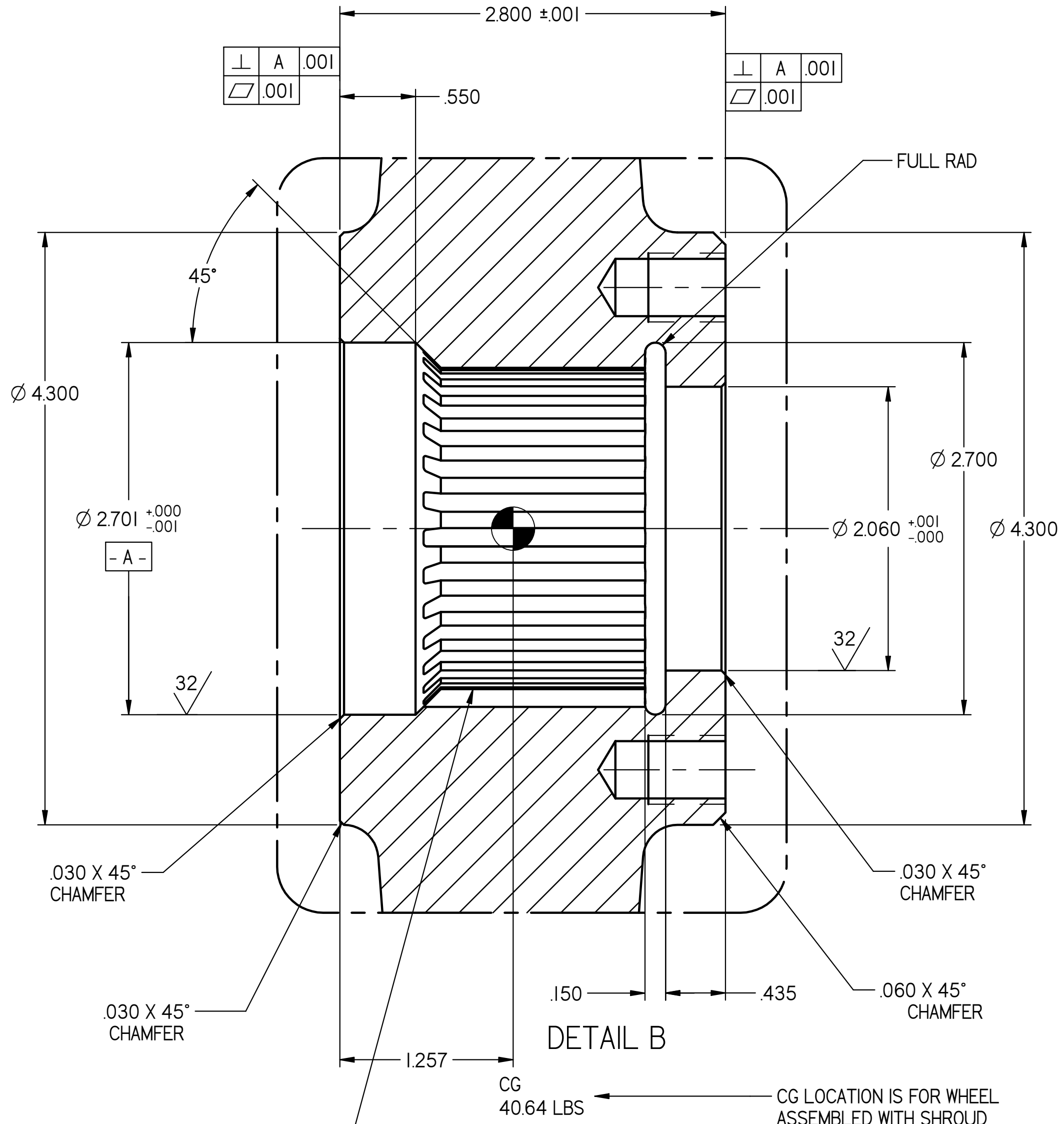
DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

TITLE
TURBINE WHEEL ASSEMBLY

DWG. SIZE	PROJECT NO.	DWG
D	10466	E1046655

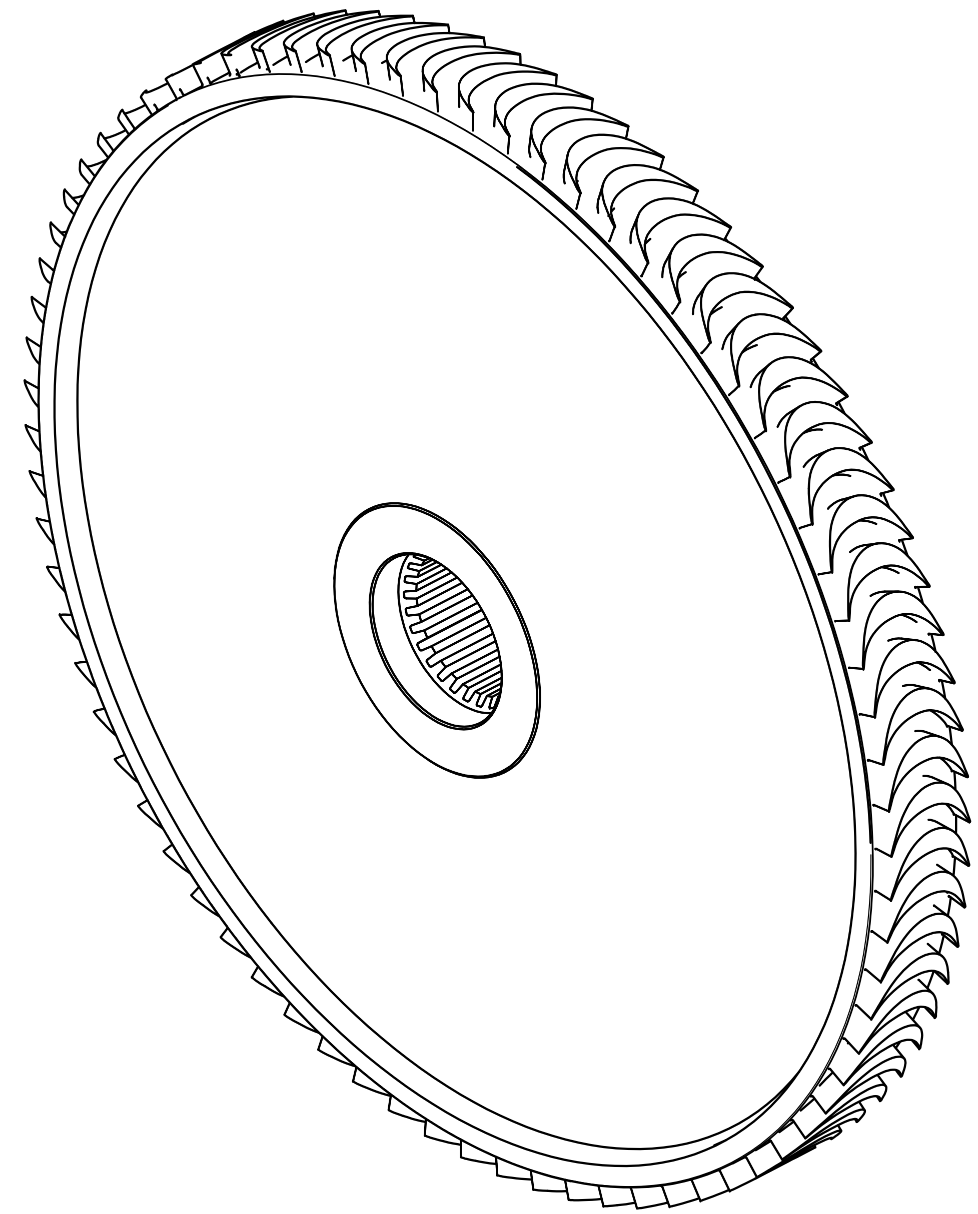
SCALE: 1/1 | EST. WT. | SHEET 1 OF 4



DETAIL B

INVOLUTE SPLINE PER ANSI B92.1
FILLER ROOT SIDE FIT

NO OF TEETH	29
SPLINE PITCH	12/24
PRESSURE ANGLE	30°
BASE DIA	2.0929
PITCH DIA	2.4167
MAJOR DIA	2.586
FORM DIA	2.505
MINOR DIA	2.334
CIRCULAR SPACE WIDTH	
MAX ACTUAL	.1355
MIN EFFECTIVE	.1309
MAX MEAS BETWEEN PINS	2.2139
PIN DIA	.1440
FILLET RAD	.023



REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125√

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
FRACT ± | DECIMALS .X ±.10 .XX ±.03 .XXX ±.010 | ANGLES ±2°

DO NOT SCALE DRAWING

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

NEXT ASSY E1046650

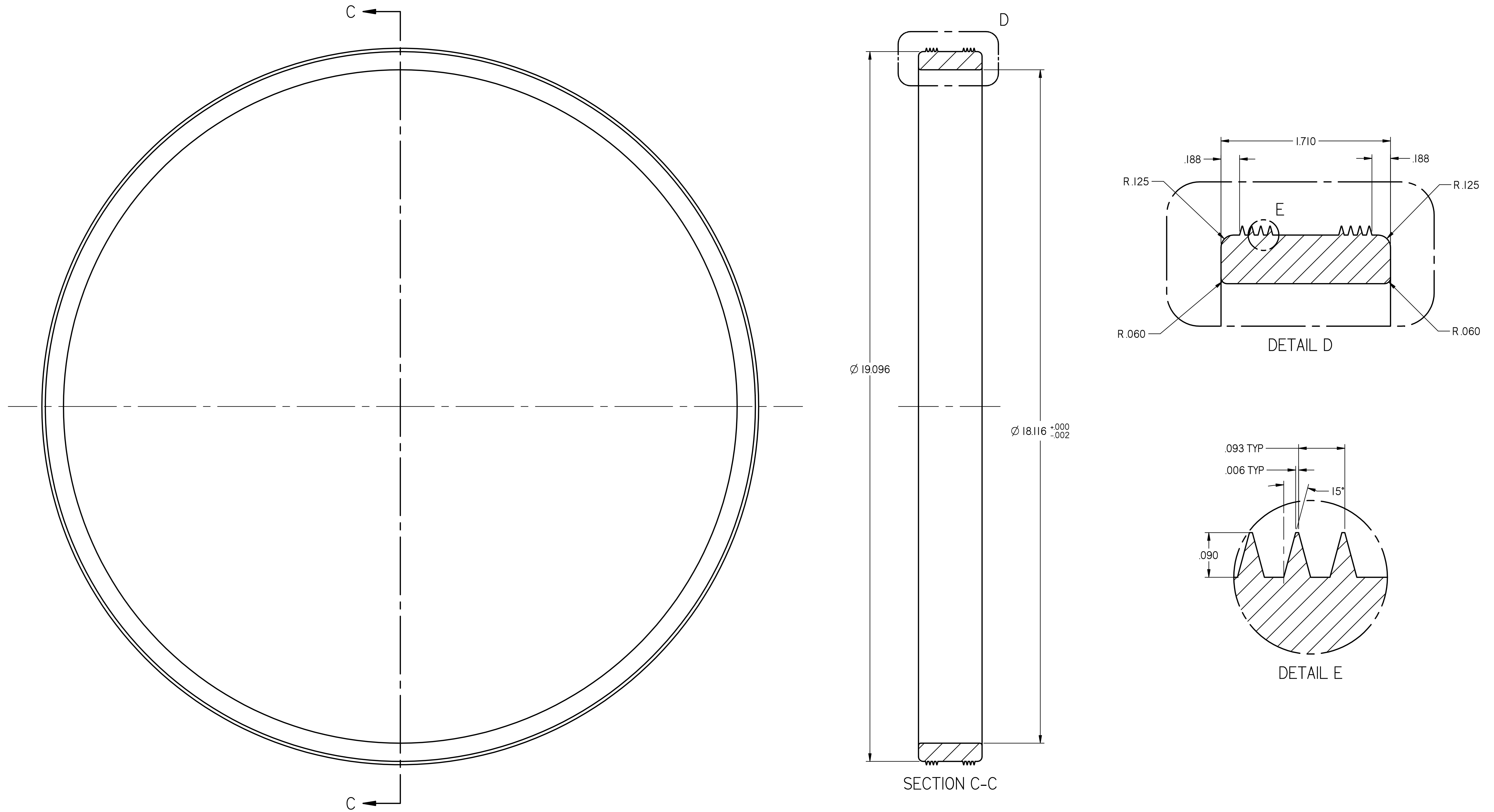
ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

TITLE
TURBINE WHEEL ASSEMBLY

DWG. SIZE D | PROJECT NO. 10466 | DWG E1046655
SCALE: 1/1 | EST. WT. | SHEET 2 OF 4

NOTES: UNLESS OTHERWISE SPECIFIED

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED



TURBINE WHEEL - SHROUD

1. ALL DIA'S TO BE CONCENTRIC WITH EACH OTHER WITHIN .0005 TIR

NOTES: UNLESS OTHERWISE SPECIFIED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED

1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

FRACT DECIMALS ANGLES
± .X ±.10 .XX ±.03 .XXX ±.010 ±2°

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NEXT ASSY E1046650

DO NOT SCALE DRAWING

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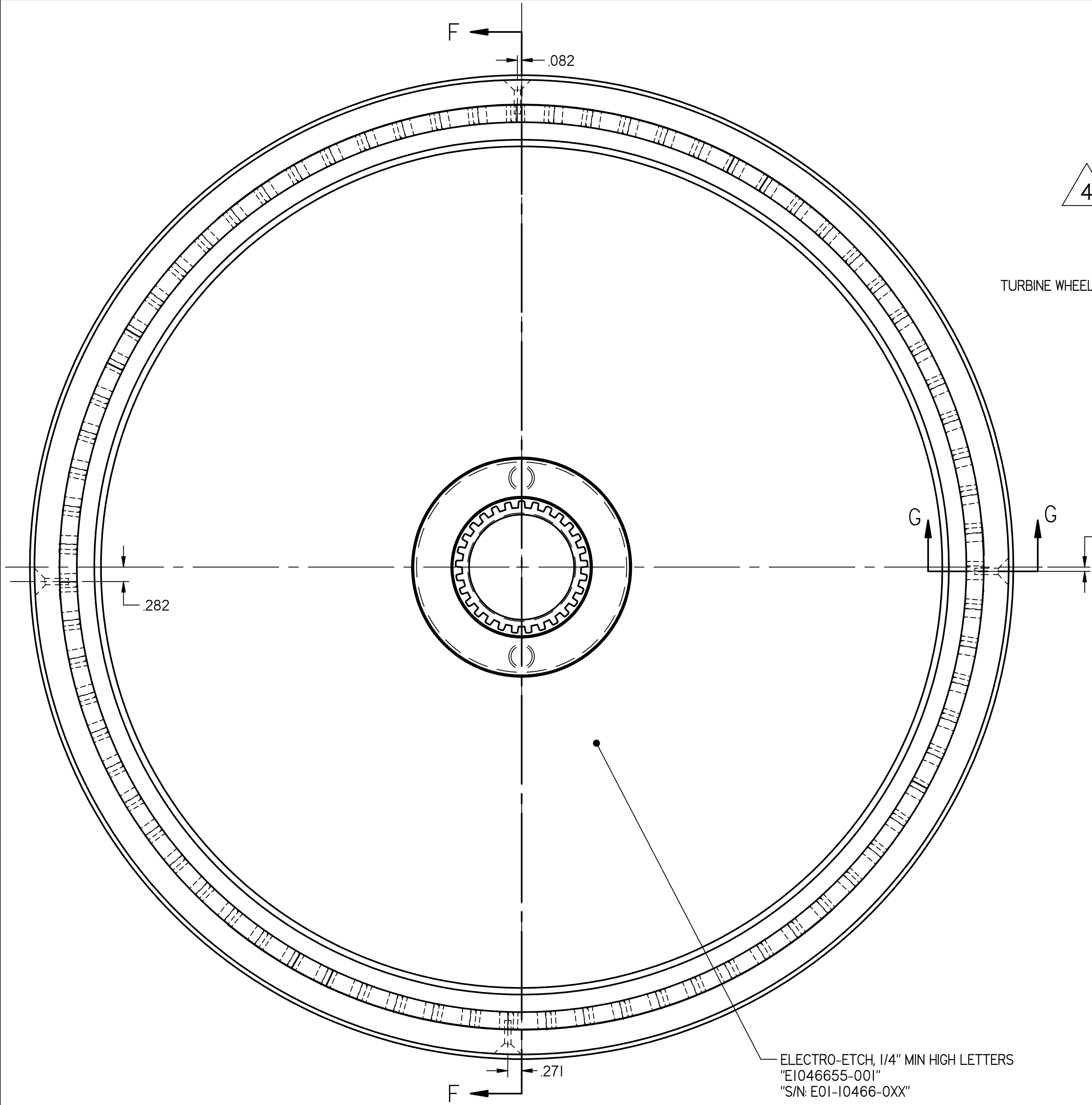
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

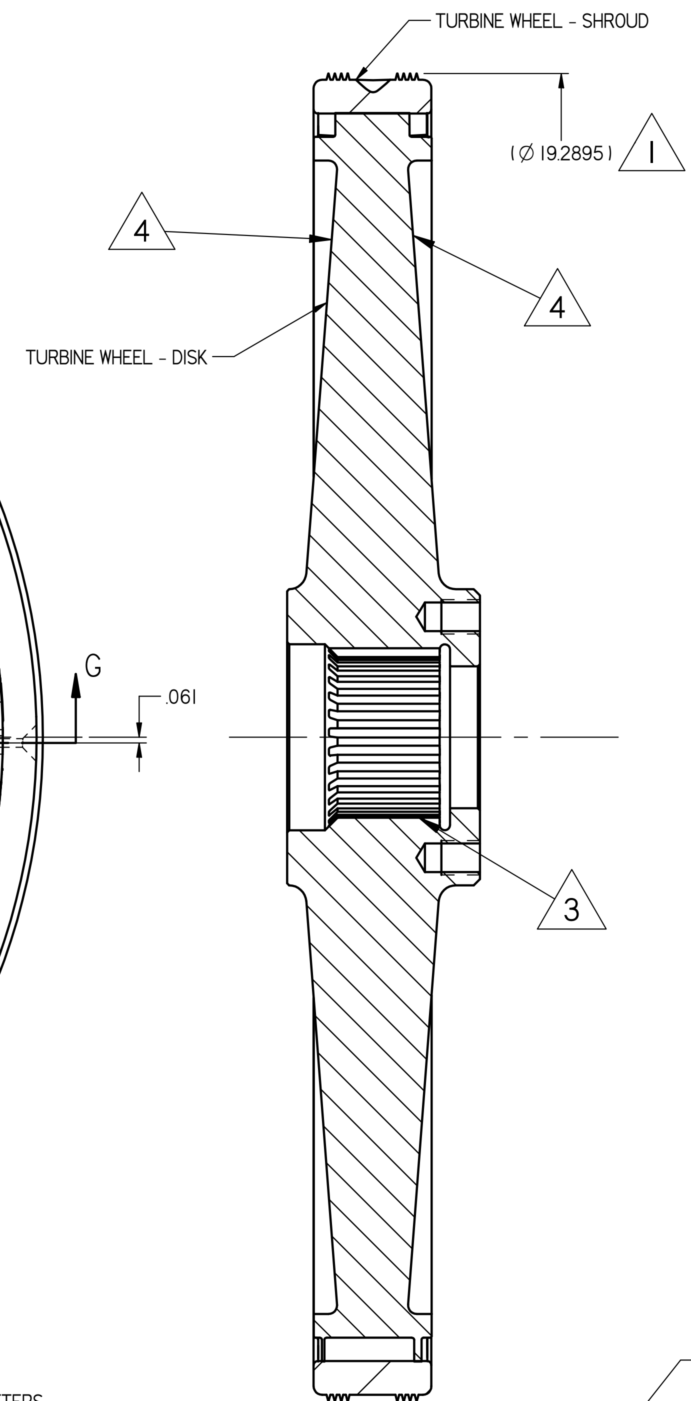
ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

TITLE
TURBINE WHEEL ASSEMBLY

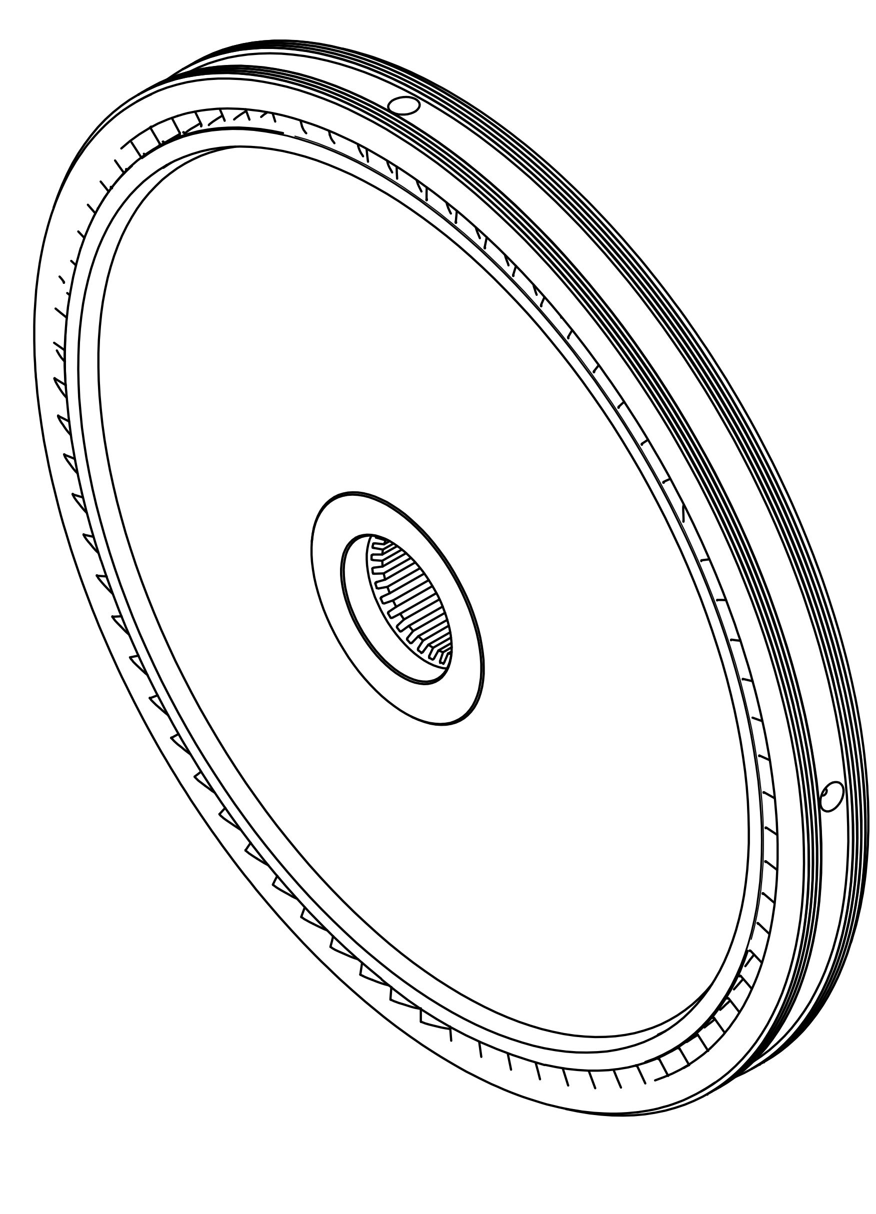
DWG. SIZE D | PROJECT NO. 10466 | DWG E1046655

SCALE: 1/1 | EST. WT. | SHEET 3 OF 4



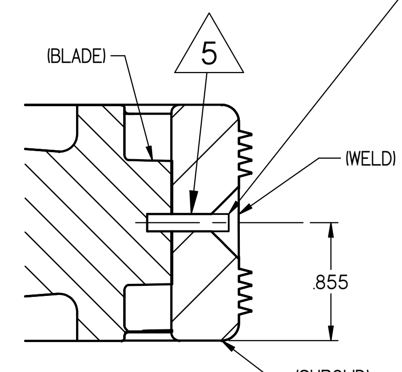


SECTION F-F



DRILL & REAM X ↧0.690 for Ø.125 PINS
THRU SHROUD AND WHEEL BLADES
C-DRILL Ø.400 X 82° ON SHROUD
4 PLACES AS INDICATED ON MAIN VIEW.

FULLY PRESS IN 0.700" LONG DOWEL PINS
WELD SHUT HOLES AND GRIND OFF RESIDUAL
WELD MATERIAL TO A SMOOTH FINISH.



SECTION G-G

5 DOWEL PIN PROCEDURE IS TO BE DONE AFTER SHROUD IS MOUNTED ONTO WHEEL BLADES.

4 BALANCE WHEEL TO .015 OZ-IN EACH PLANE
NO HOLES ALLOWED; SMOOTH FINISH ALL GRINDING SURFACES

3 AVOID CONTACT WITH SPLINES - NO FIXTURE DURING BALANCING

2 SHROUD ASSEMBLY - HEAT SHROUD TO 150°F, INSTALL ONTO THE WHEEL

1 DIAMETER AT OPERATION TEMPERATURE OF 131°F (55°C)

NOTES: UNLESS OTHERWISE SPECIFIED

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED
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2. SURFACE FINISH

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ISSUED	K.KAUPERT	10/17/14

NEXT ASSY E1046650

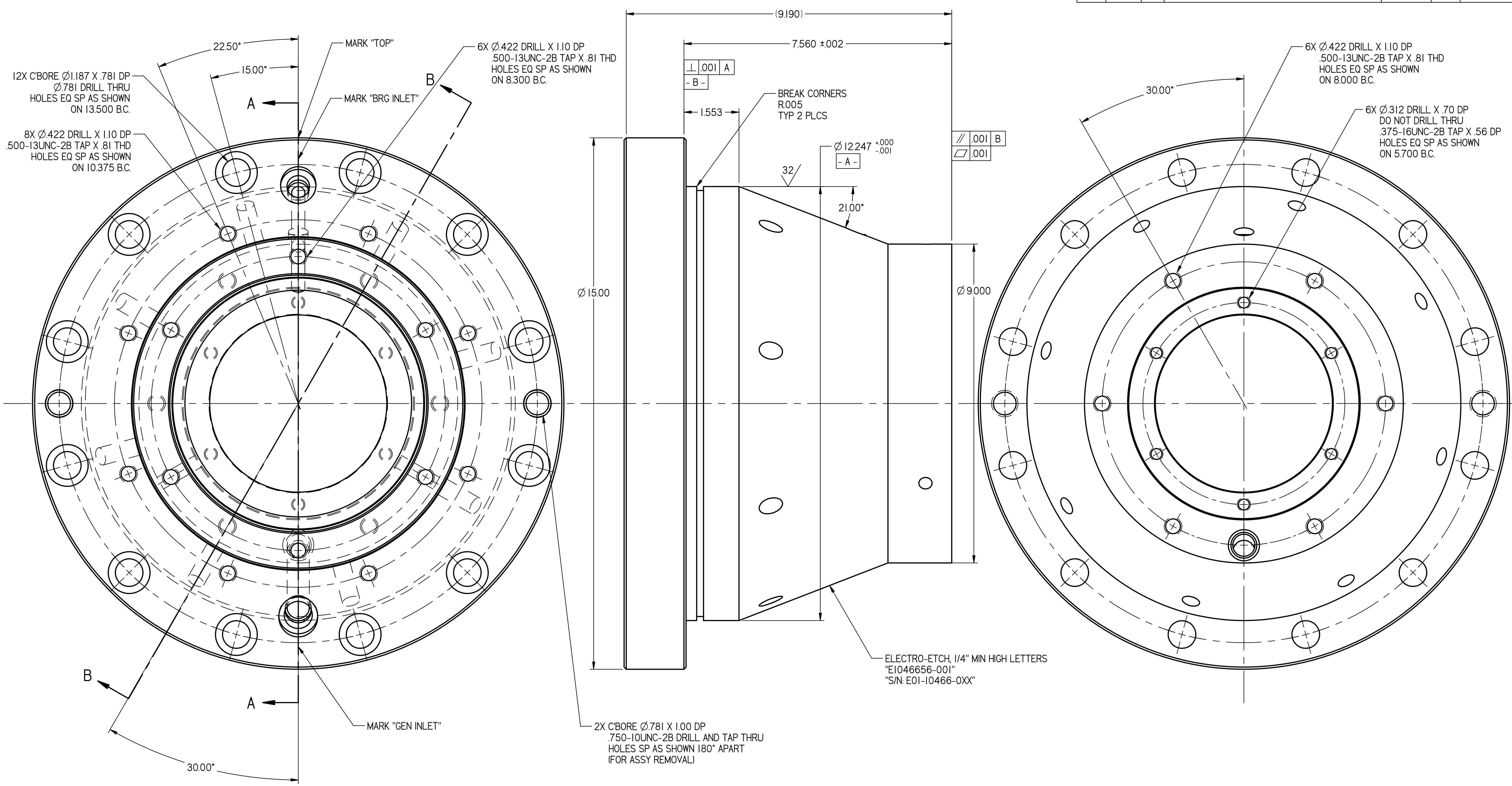
ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

TITLE
TURBINE WHEEL ASSEMBLY

DWG. SIZE D | PROJECT NO. 10466 | DWG E1046655

SCALE: 1/1 | EST. WT. | SHEET 4 OF 4

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED



ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
FRACT DECIMALS ANGLES
± .X ±.10 .XX ±.03 .XXX ±.010 ±2°

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NEXT ASSY E1046650

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ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

TITLE
HOUSING - BACK BEARING

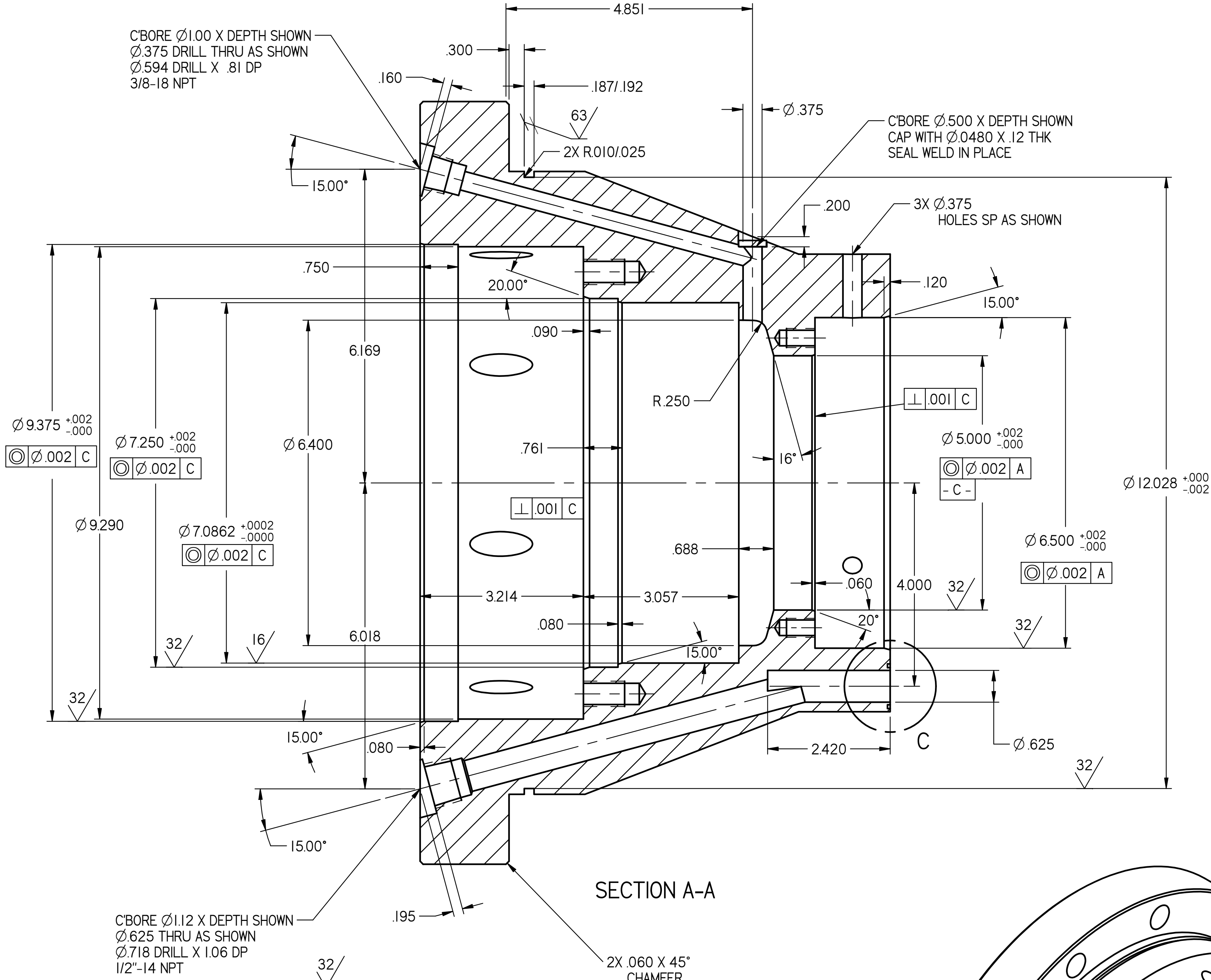
DWG. SIZE D | PROJECT NO. 10466 | DWG E1046656

SCALE: 1/1 | EST. WT. | SHEET 1 OF 2

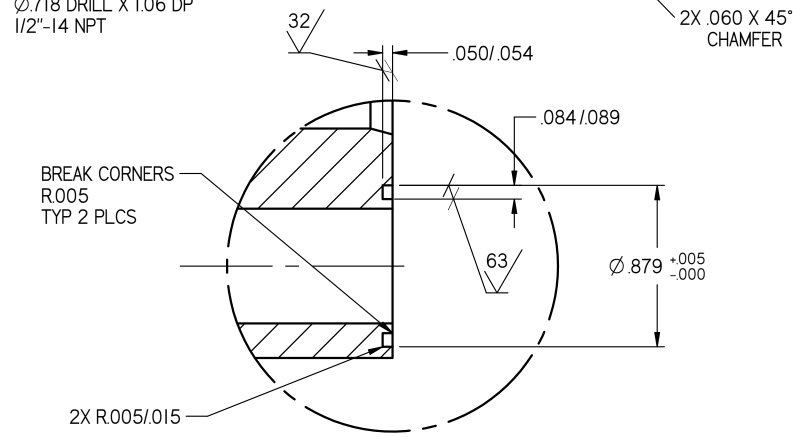
1. MATERIAL IS PRESSURE VESSEL PLATE PER ASTM A516 GR 70
PROVIDE CHEMICAL, MECHANICAL AND HEAT TREATMENT TEST REPORTS

NOTES: UNLESS OTHERWISE SPECIFIED

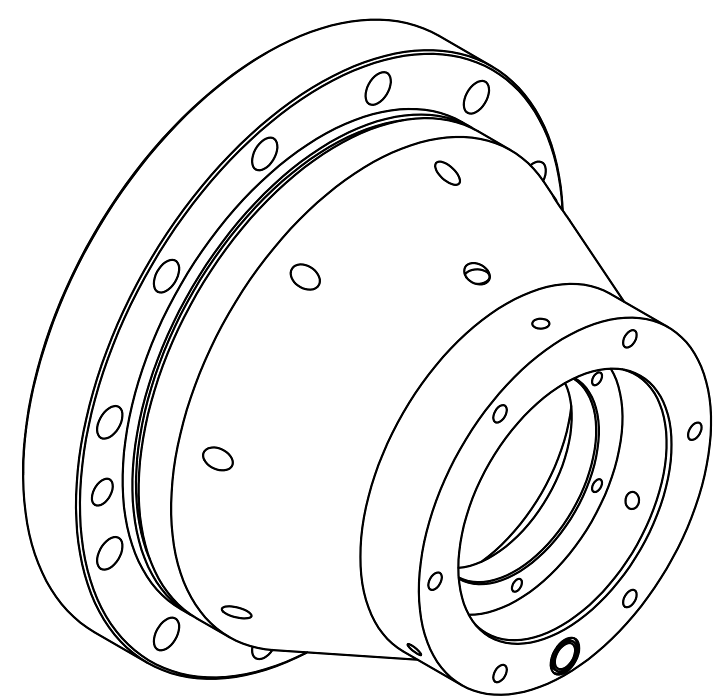
REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED

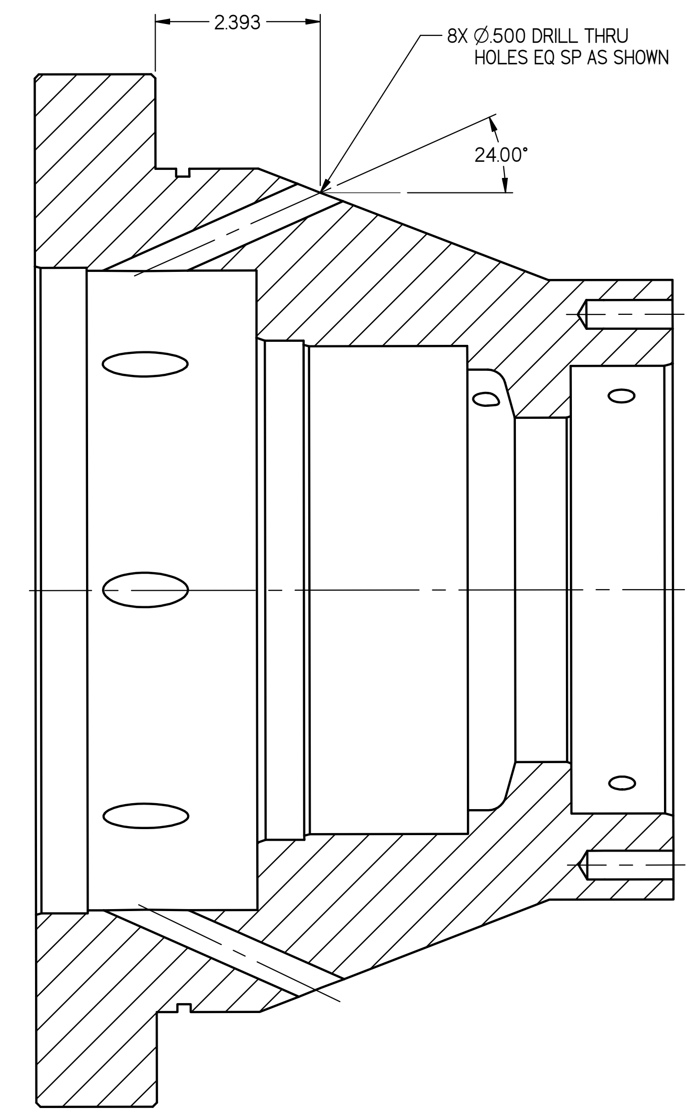


SECTION A-A



DETAIL C





SECTION B-B

NOTES: UNLESS OTHERWISE SPECIFIED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED

1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

FRACT DECIMALS ANGLES
± .X ±.10 .XX ±.03 .XXX ±.010 ±2°

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DO NOT SCALE DRAWING

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DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

NEXT ASSY E1046650

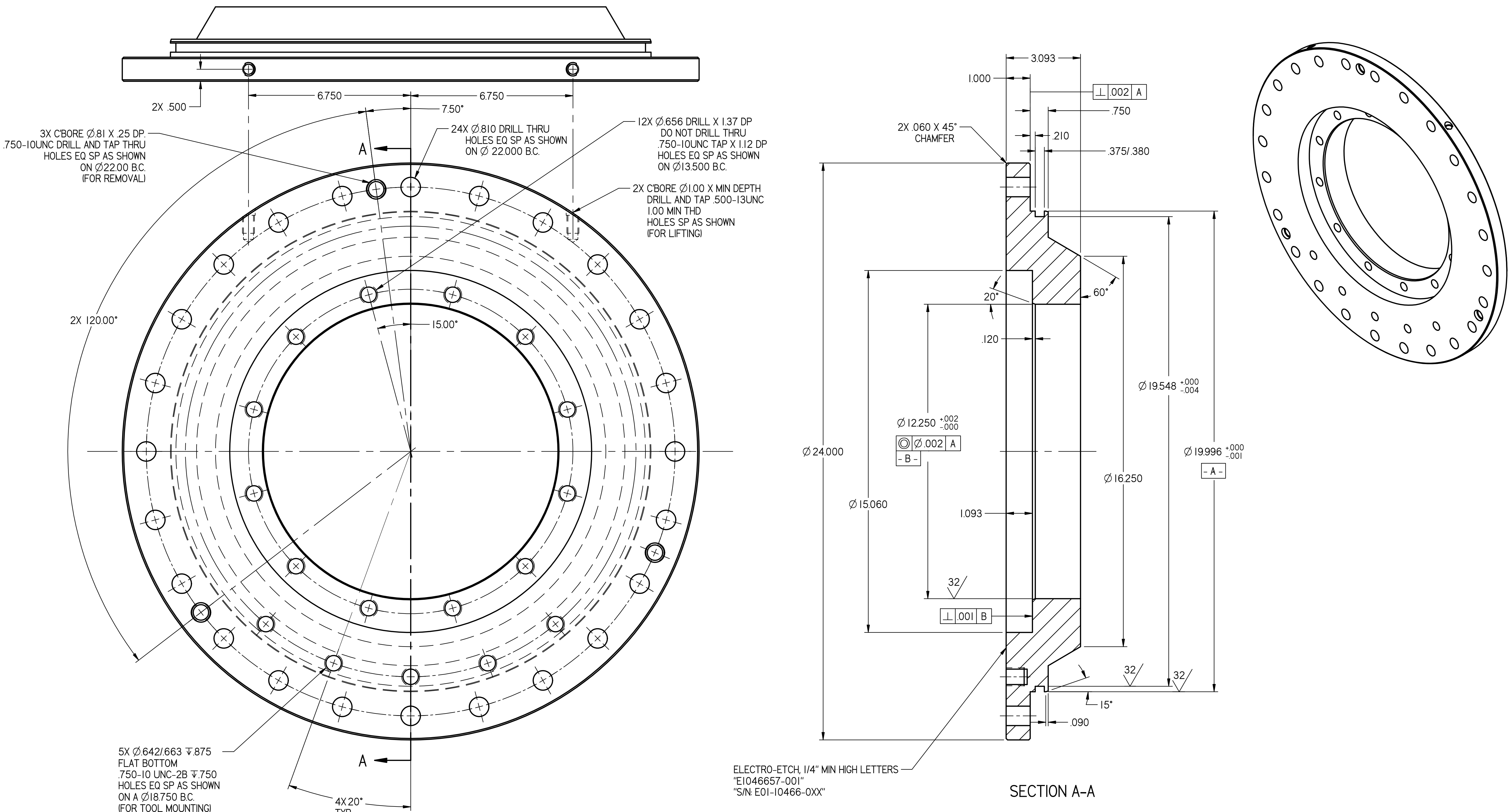
ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

TITLE
HOUSING - BACK BEARING

DWG. SIZE D | PROJECT NO. 10466 | DWG E1046656

SCALE: 1/1 | EST. WT. | SHEET 2 OF 2

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED



ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED

1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

FRACT	DECIMALS	ANGLES
±	.X ±.10 .XX ±.03 .XXX ±.010	±2°

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NEXT ASSY 1046650

DO NOT SCALE DRAWING

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

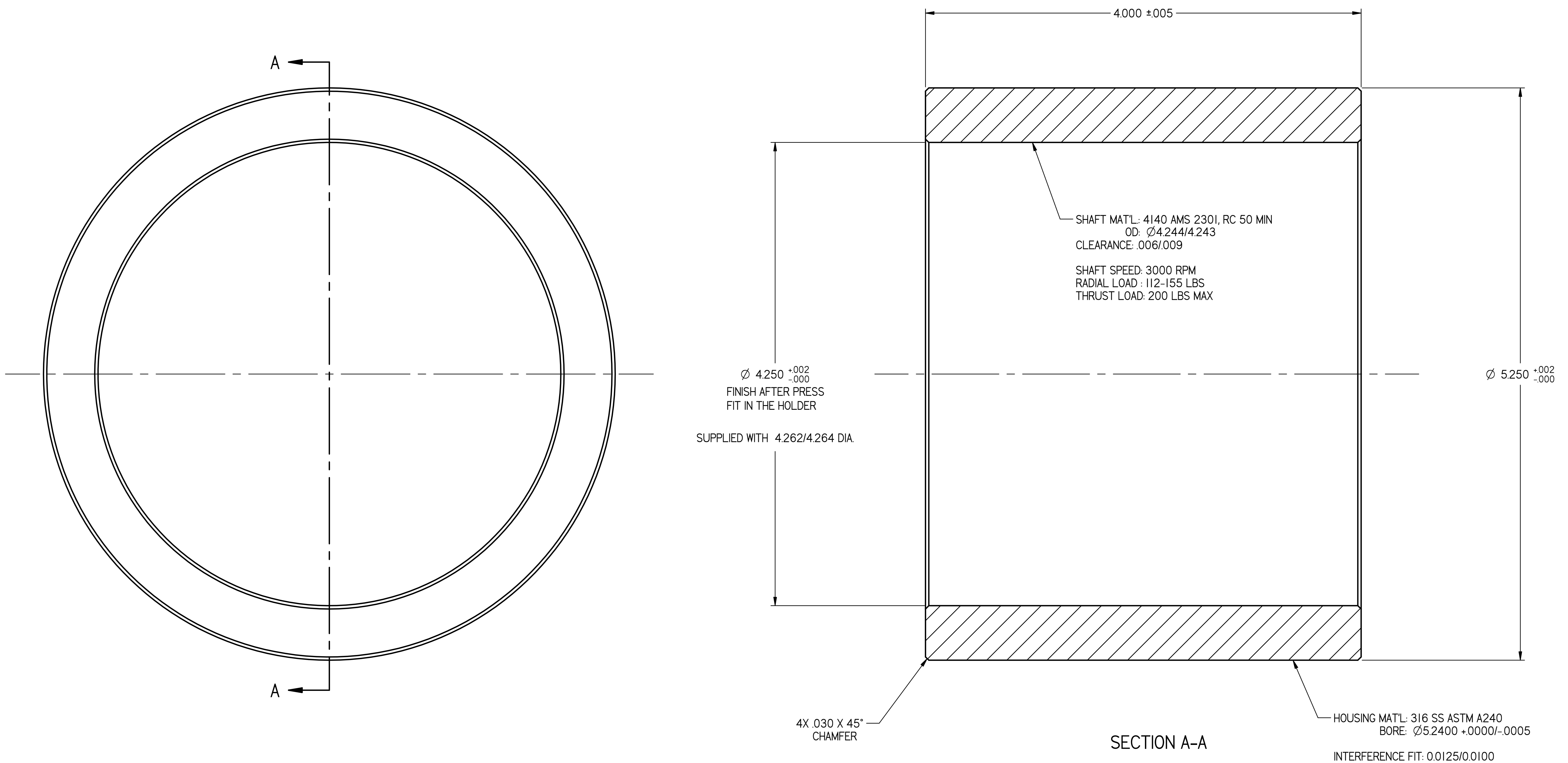
TITLE
END COVER - BACK SIDE

DWG. SIZE	PROJECT NO.	DWG
D	10466	E1046657
SCALE: 1/1	EST. WT. 153 LBS	SHEET 1 OF 1

1. MATERIAL IS PRESSURE VESSEL PLATE PER ASTM A516 GR 70.
   PROVIDE CHEMICAL, MECHANICAL AND HEAT TREATMENT TEST REPORTS.

NOTES: UNLESS OTHERWISE SPECIFIED

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED



2. SERVICE IS LIQUID REFRIGERANT R134a, 90°F, 119 PSIA, .16-.22 Cp VISCOSITY

1. MATERIAL IS GRAPHALLOY GRADE GM 343.3 (SUPPLIED BY GRAPHITE METALLIZING CORP, YONKERS NY)

NOTES: UNLESS OTHERWISE SPECIFIED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED

1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

FRACT	DECIMALS .X	.XX	.XXX	ANGLES
±	±.10	±.03	±.010	±2°

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DO NOT SCALE DRAWING

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DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

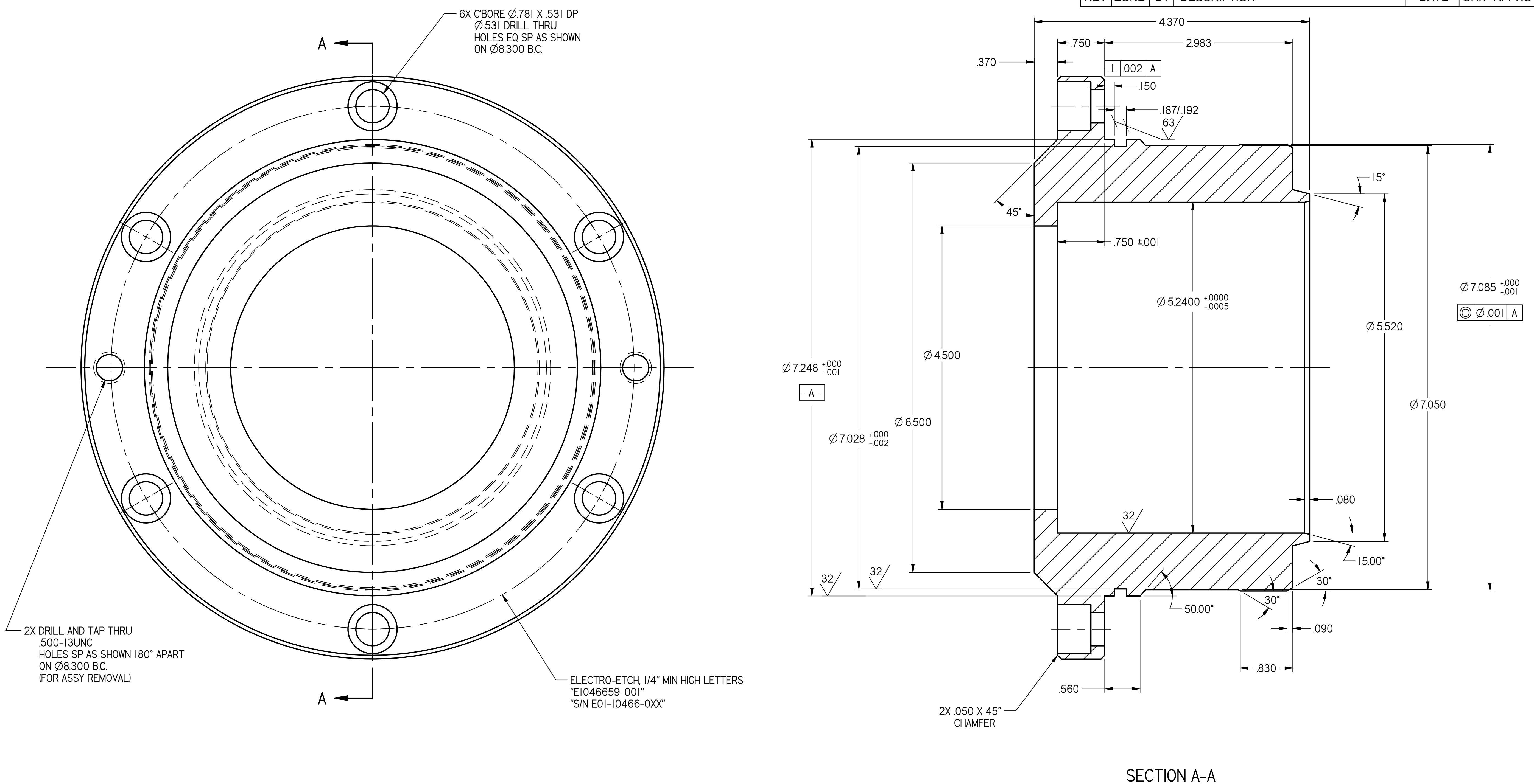
NEXT ASSY 1046650

ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

TITLE
GRAPHALLOY BEARING

DWG. SIZE	PROJECT NO.	DWG
D	10466	E1046658

SCALE: 1/1 | EST. WT. | SHEET 1 OF 1



ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
FRACT DECIMALS ANGLES
± .X ±.10 .XX ±.03 .XXX ±.010 ±2°

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NEXT ASSY 1046650

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DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

ENERGENT CORP.
2321 S. PULLMAN STR.
SANTA ANA CA 92705

TITLE GRAPHALLOY BEARING HOLDER BACK SIDE

DWG. SIZE D | PROJECT NO. 10466 | DWG E1046659

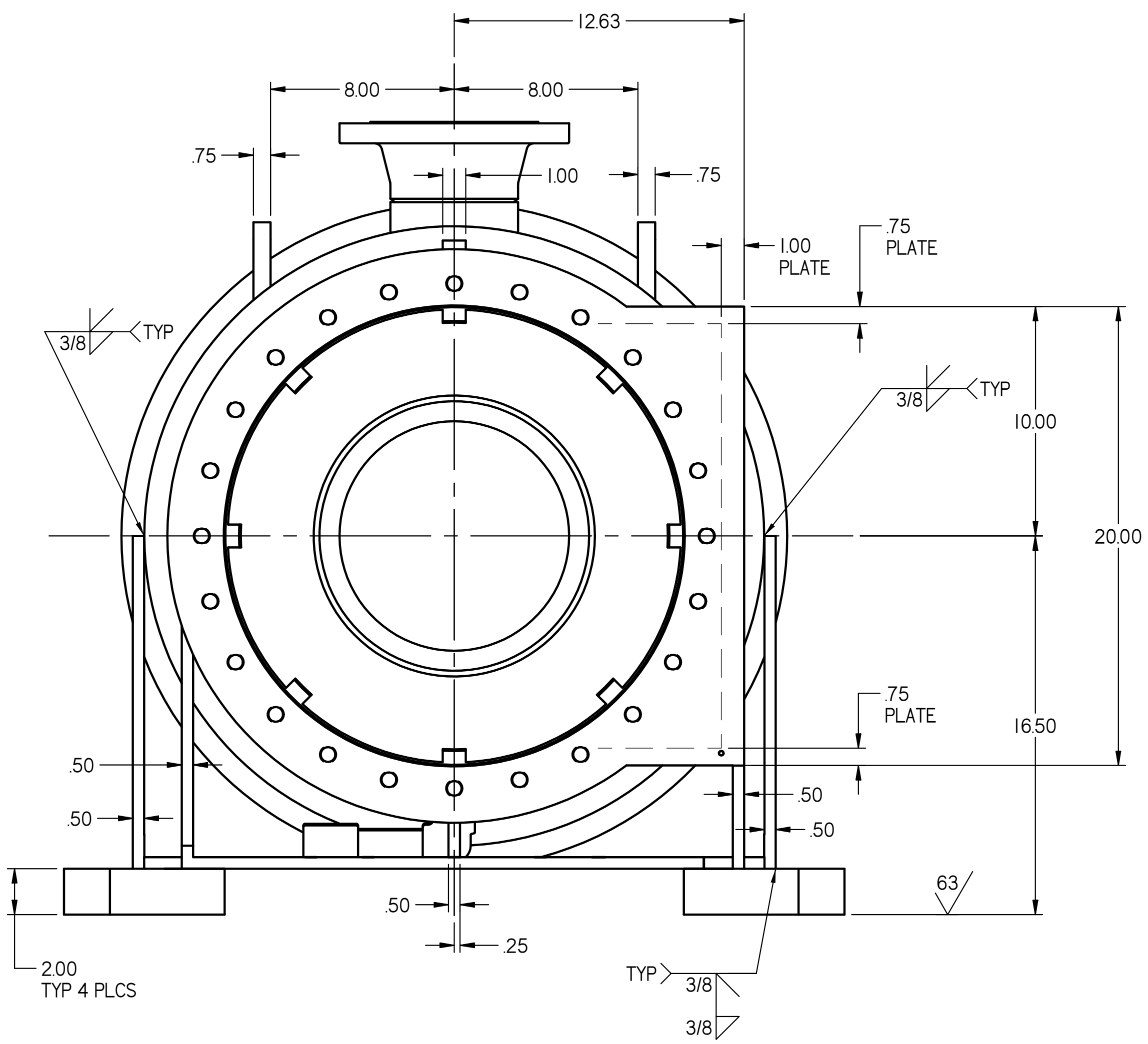
SCALE: 1/1 | EST. WT. | SHEET 1 OF 1

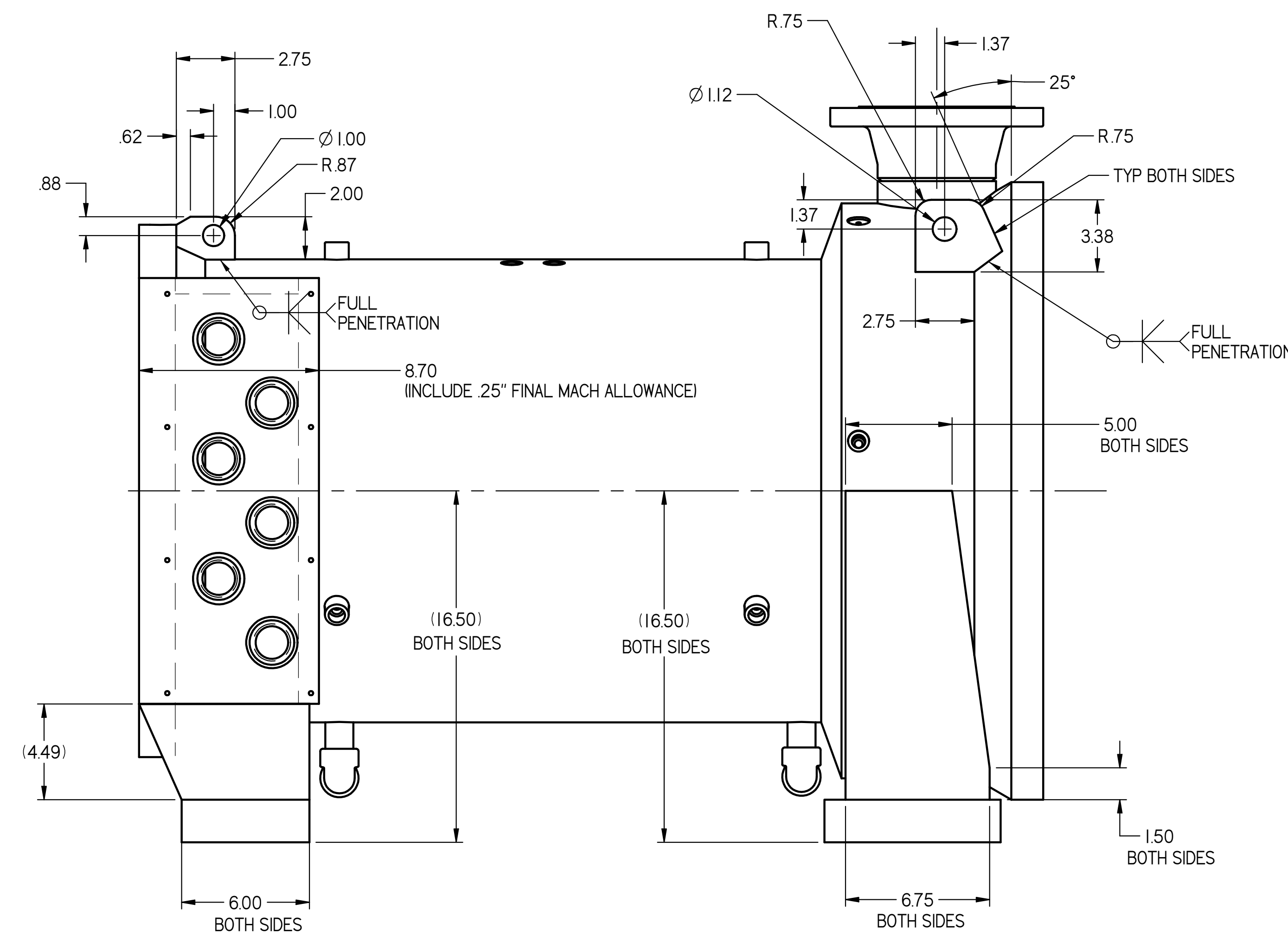
REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED

1. MATERIAL IS SS316 PER ASTM A240
   SUPPLY CHEMICAL, MECHANICAL AND HEAT TREATMENT REPORTS

NOTES: UNLESS OTHERWISE SPECIFIED

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED





PREL MACHINING/WELDMENT - SHEETS 1 THRU 4

3. ALL FLANGE BOLT HOLES TO STRADDLE CENTER LINES

2. FABRICATION TO BE THOROUGHLY CLEANED AND SAND BLASTED BY FABRICATOR

1. MATERIAL: EXCEPT WHERE NOTED, ALL PLATES ARE PER ASTM A36
CASING SHELL IS PRESSURE VESSEL PLATE PER ASTM A516 GR70
SHELL CAN BE A WELDMENT
VENDOR TO SUPPLY CHEMICAL, MECHANICAL AND HEAT TREATMENT REPORTS

NOTES: UNLESS OTHERWISE SPECIFIED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
FRACT DECIMALS ANGLES
± .X ±.10 .XX ±.03 .XXX ±.010 ±2°

NEXT ASSY 1046650

DO NOT SCALE DRAWING

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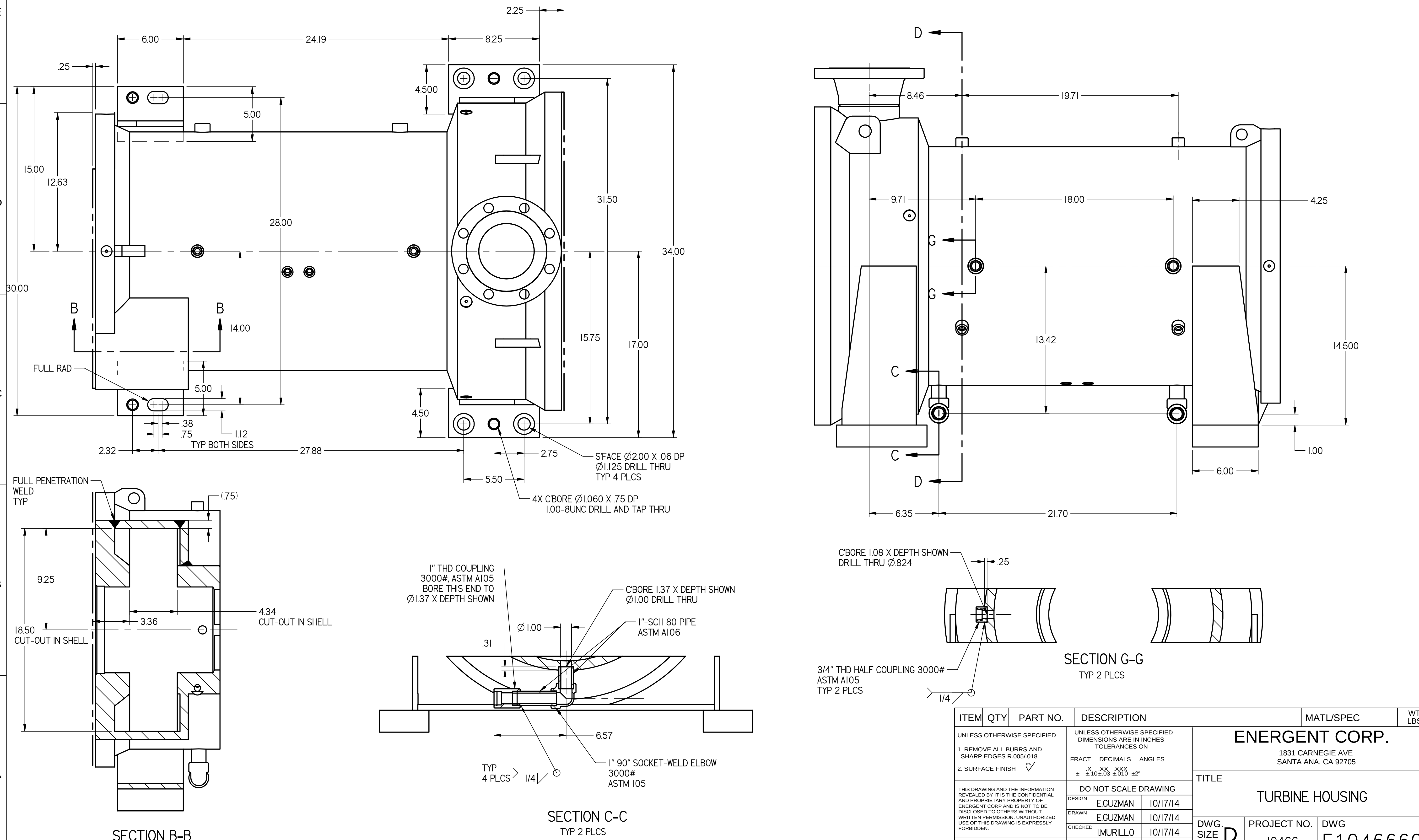
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

TITLE
TURBINE HOUSING

DWG. SIZE	PROJECT NO.	DWG
D	10466	E1046660
SCALE: 1/1	EST. WT. 1488 LBS	SHEET 1 OF 11

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED



ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED

1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

FRACT	DECIMALS			ANGLES
±	.X ±.10	.XX ±.03	.XXX ±.010	±2°

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ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

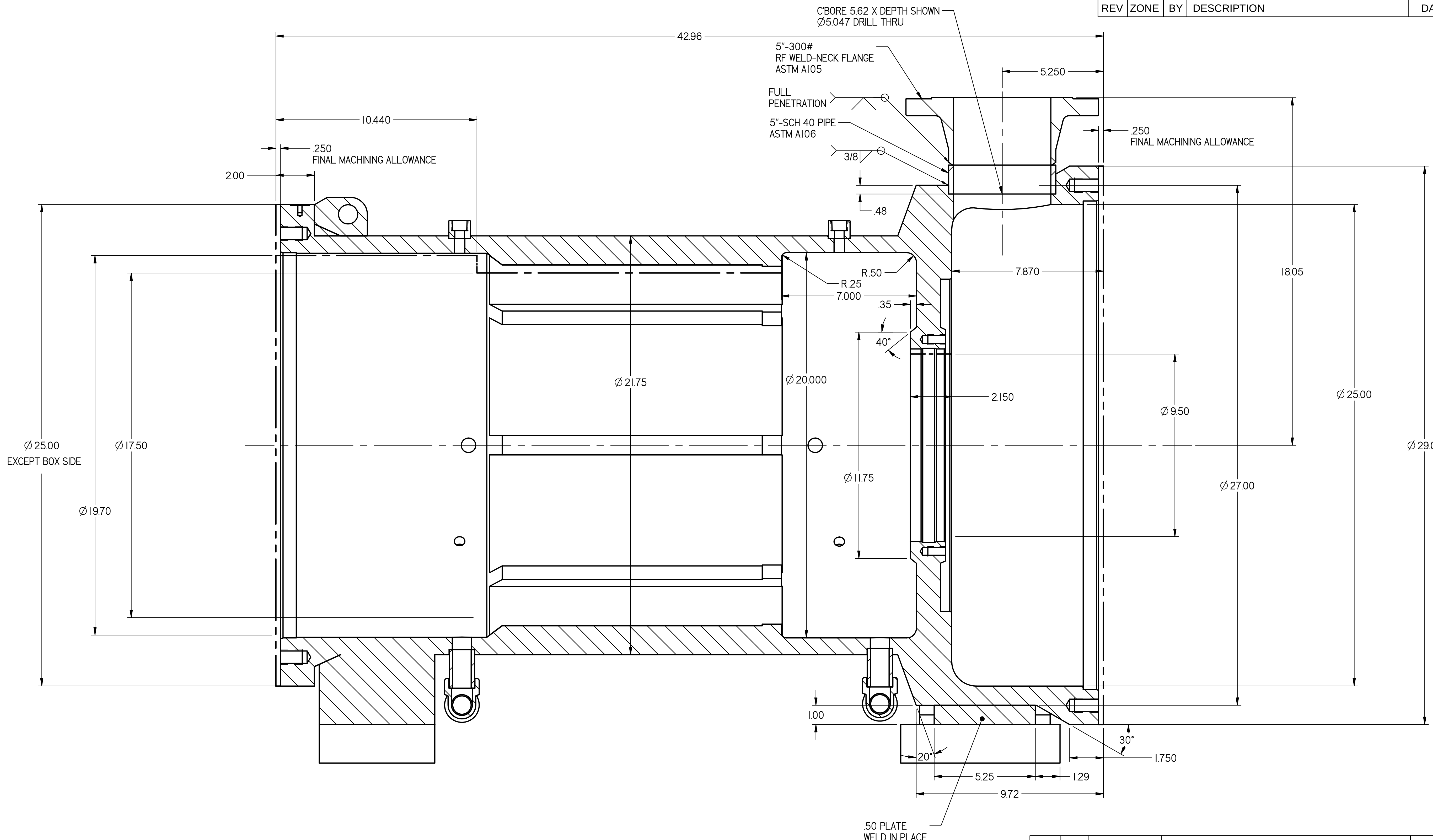
NEXT ASSY 1046650

ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

TITLE
TURBINE HOUSING

DWG. SIZE	PROJECT NO.	DWG
D	10466	E1046660
SCALE: 1/1	EST. WT.	SHEET 2 OF 11

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED



SECTION A-A

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED

1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

FRACT	DECIMALS			ANGLES
±	.X ±.10	.XX ±.03	.XXX ±.010	±2°

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ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

NEXT ASSY 1046650

ENERGENT CORP.

1831 CARNEGIE AVE
SANTA ANA, CA 92705

TITLE

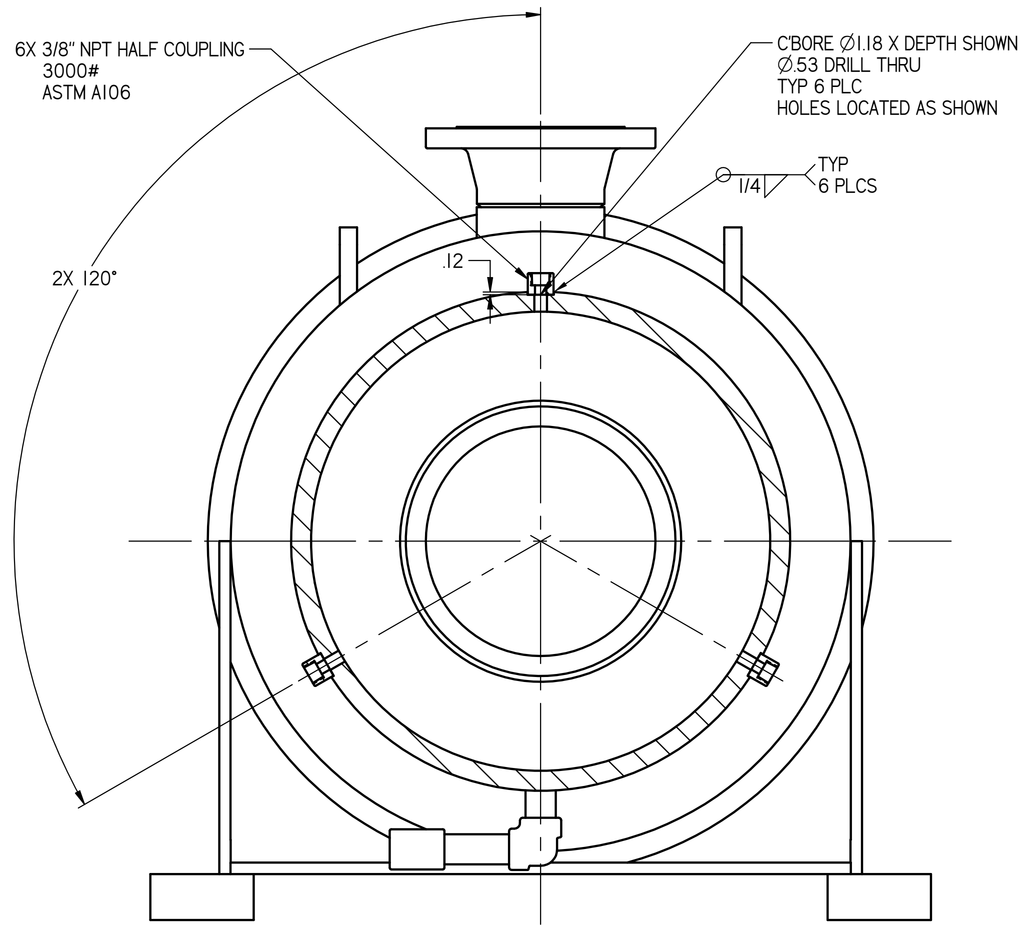
TURBINE HOUSING

DWG. SIZE D | PROJECT NO. 10466 | DWG E1046660

SCALE: 1/1 | EST. WT. | SHEET 3 OF 11

NOTES: UNLESS OTHERWISE SPECIFIED

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED



SECTION D-D
TYP 2 PLCS

NOTES: UNLESS OTHERWISE SPECIFIED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED

1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

FRACT	DECIMALS			ANGLES
±	.X ±.10	.XX ±.03	.XXX ±.010	±2°

DO NOT SCALE DRAWING

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CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

NEXT ASSY 1046650

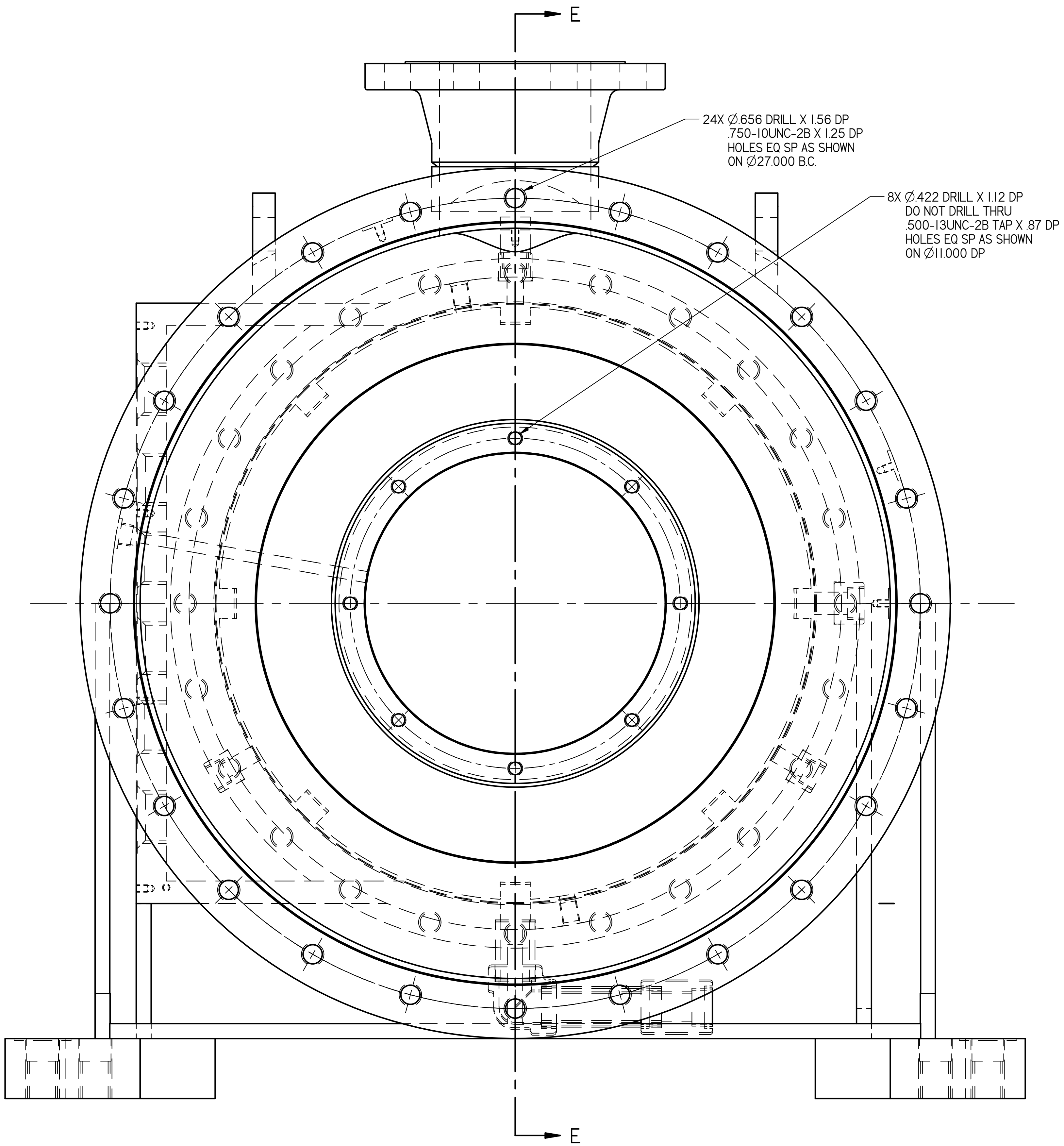
ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

TITLE
TURBINE HOUSING

DWG. SIZE D | PROJECT NO. 10466 | DWG E1046660

SCALE: 1/1 | EST. WT. | SHEET 4 OF 11

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED



FINAL MACHINING - SHEETS 5 THRU 10

NOTES: UNLESS OTHERWISE SPECIFIED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED

1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

FRACT	DECIMALS			ANGLES
±	.X ±.10	.XX ±.03	.XXX ±.010	±2°

DO NOT SCALE DRAWING

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

NEXT ASSY 1046650

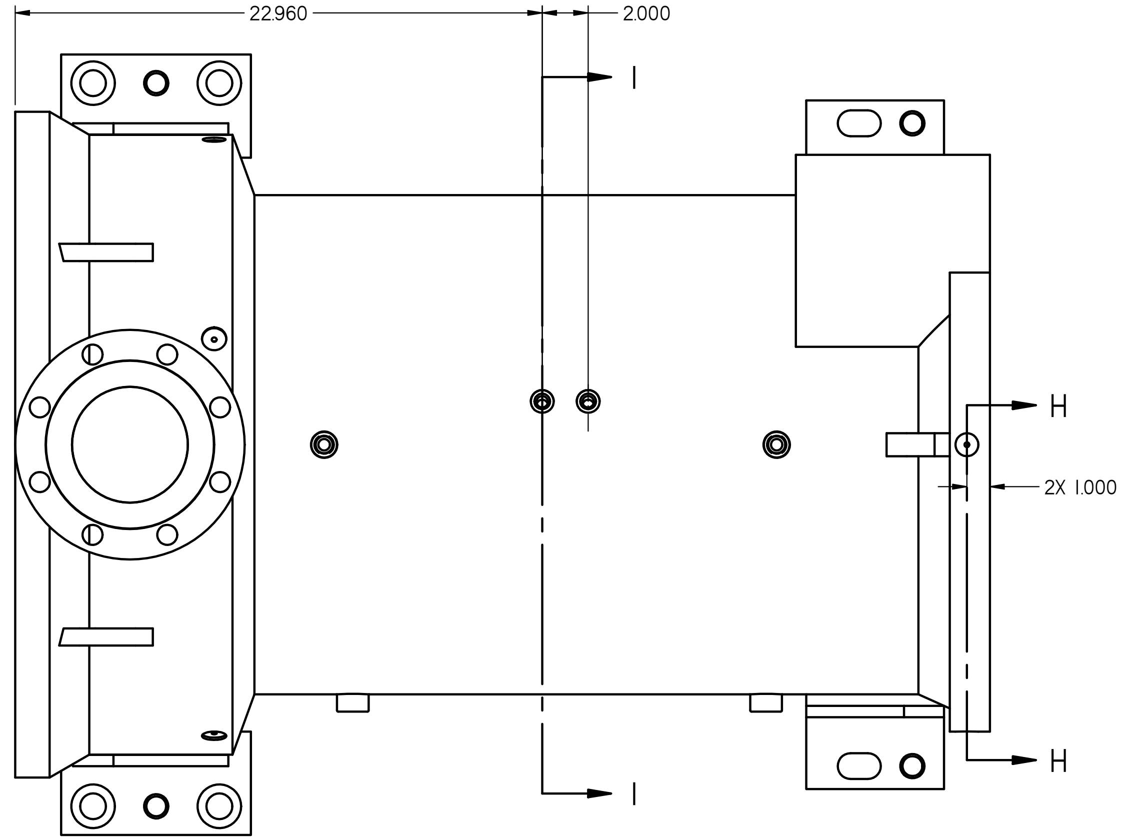
ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

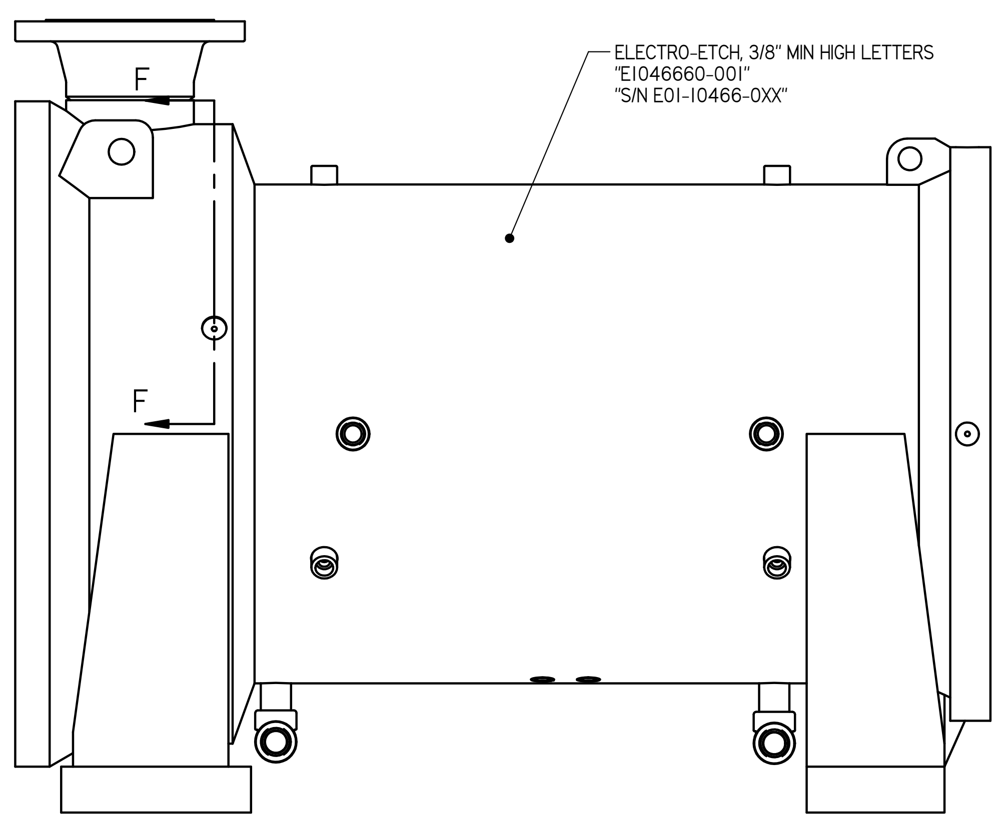
TITLE
TURBINE HOUSING

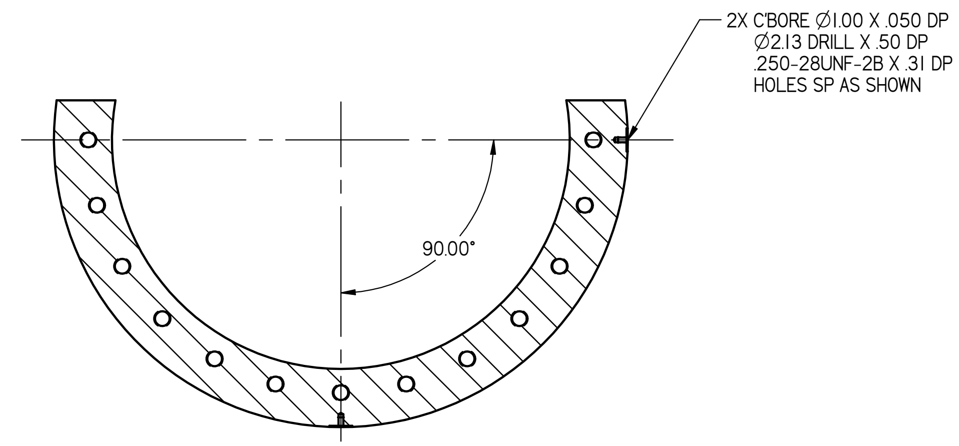
DWG. SIZE	PROJECT NO.	DWG
D	10466	E1046660

SCALE: 1/1 | EST. WT. | SHEET 5 OF 11

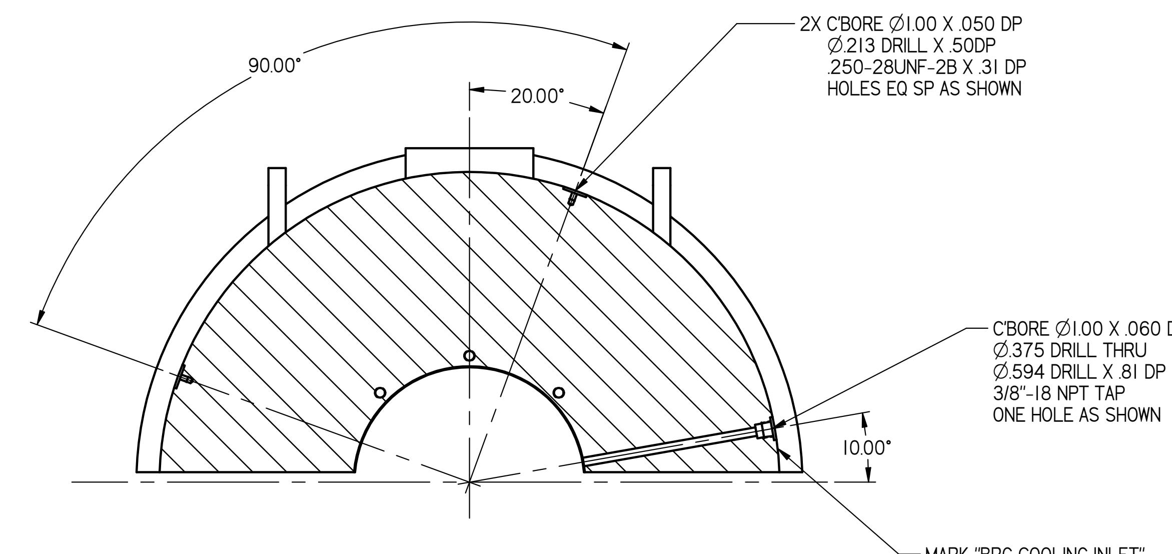
REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED







SECTION H-H



SECTION F-F

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED

1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

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± .X ±.10 .XX ±.03 .XXX ±.010 ±2°

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ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

NEXT ASSY 1046650

ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

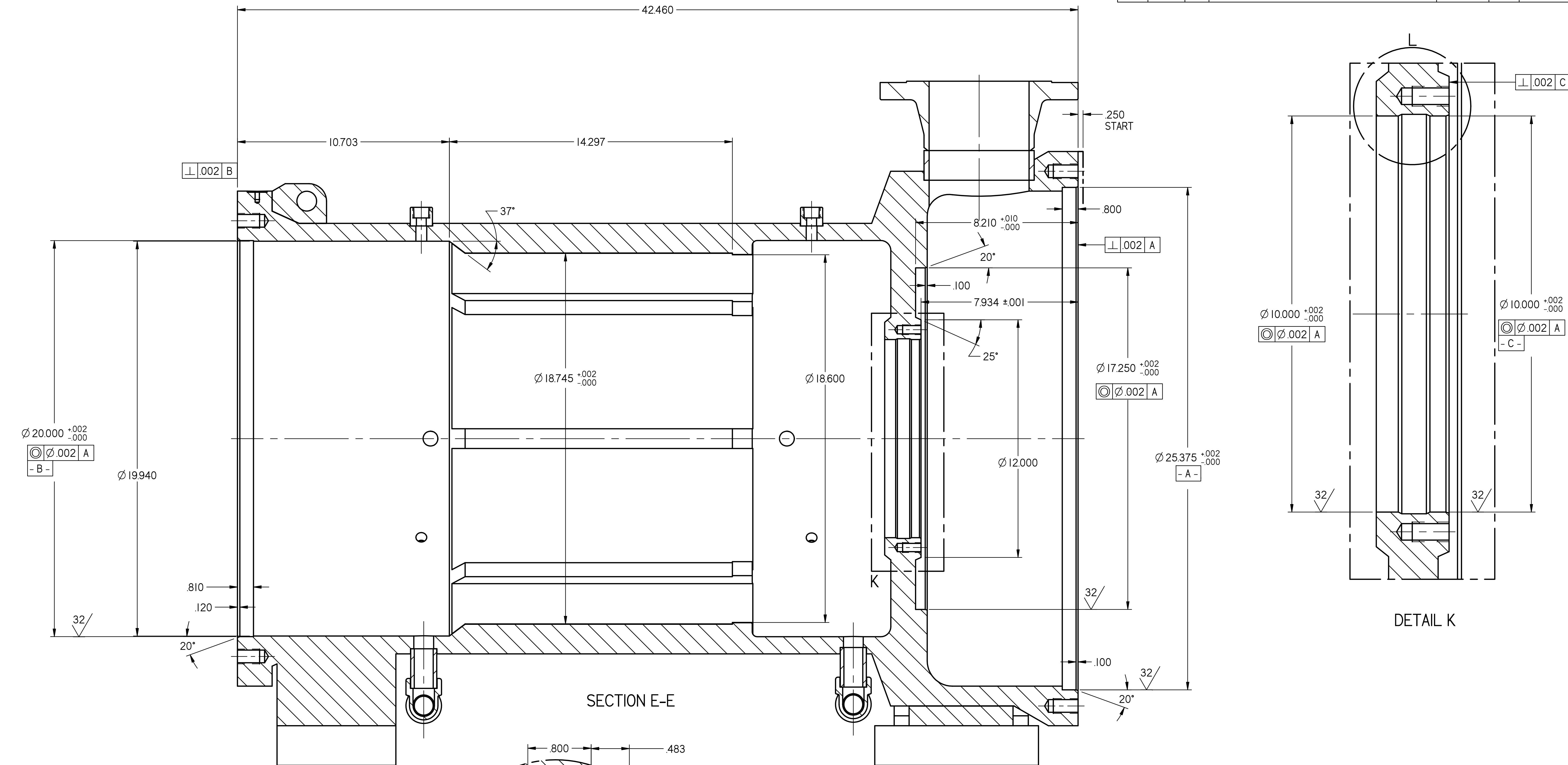
TITLE
TURBINE HOUSING

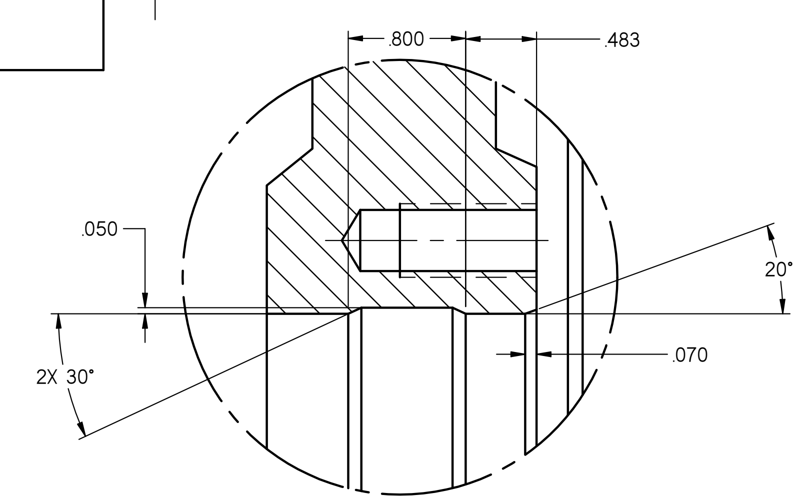
DWG. SIZE D | PROJECT NO. 10466 | DWG E1046660

SCALE: 1/1 | EST. WT. | SHEET 6 OF 11

NOTES: UNLESS OTHERWISE SPECIFIED

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED





ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
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NEXT ASSY 1046650

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ISSUED	K.KAUPERT	10/17/14

ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

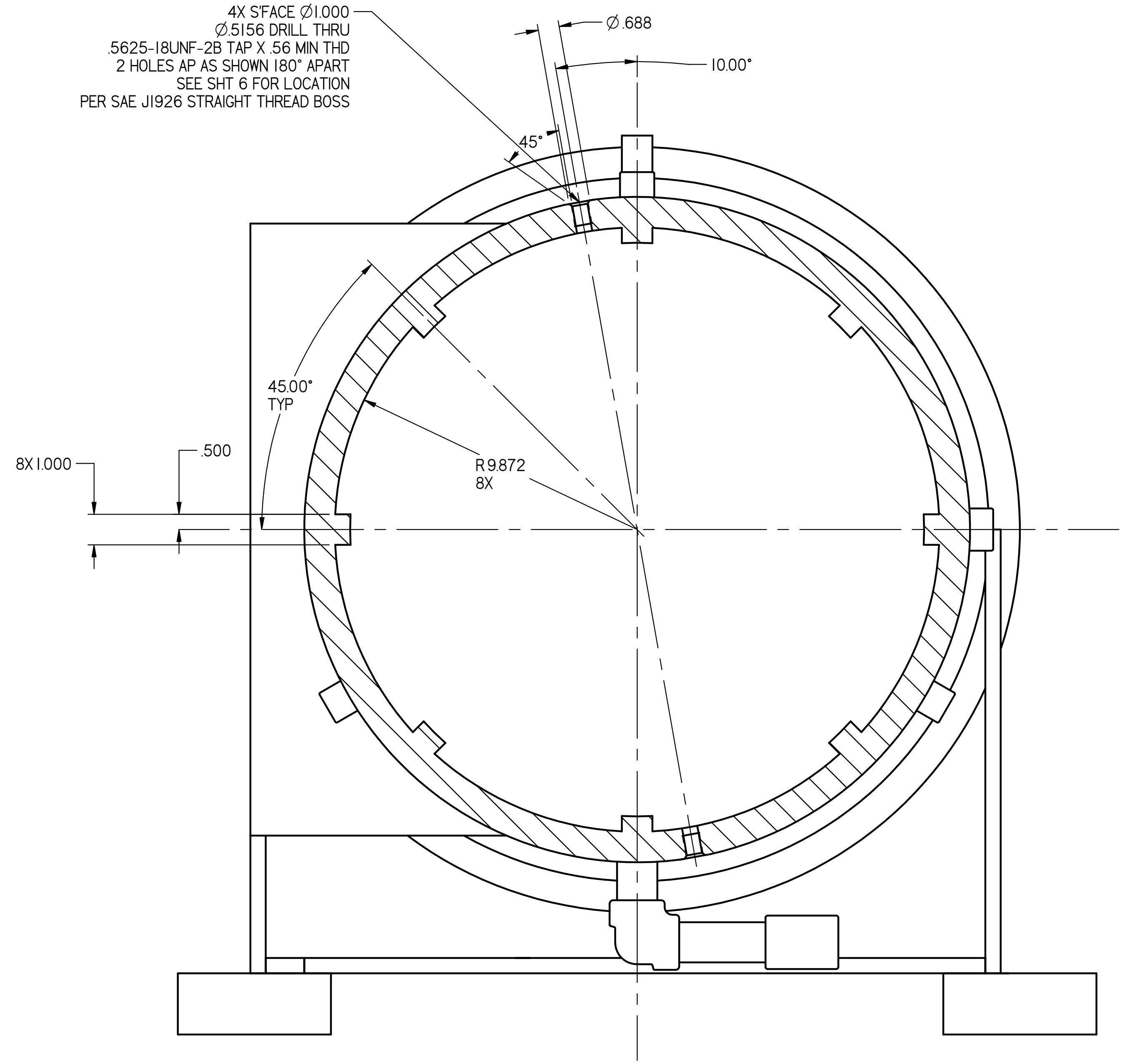
TITLE
TURBINE HOUSING

DWG. SIZE D | PROJECT NO. 10466 | DWG E1046660

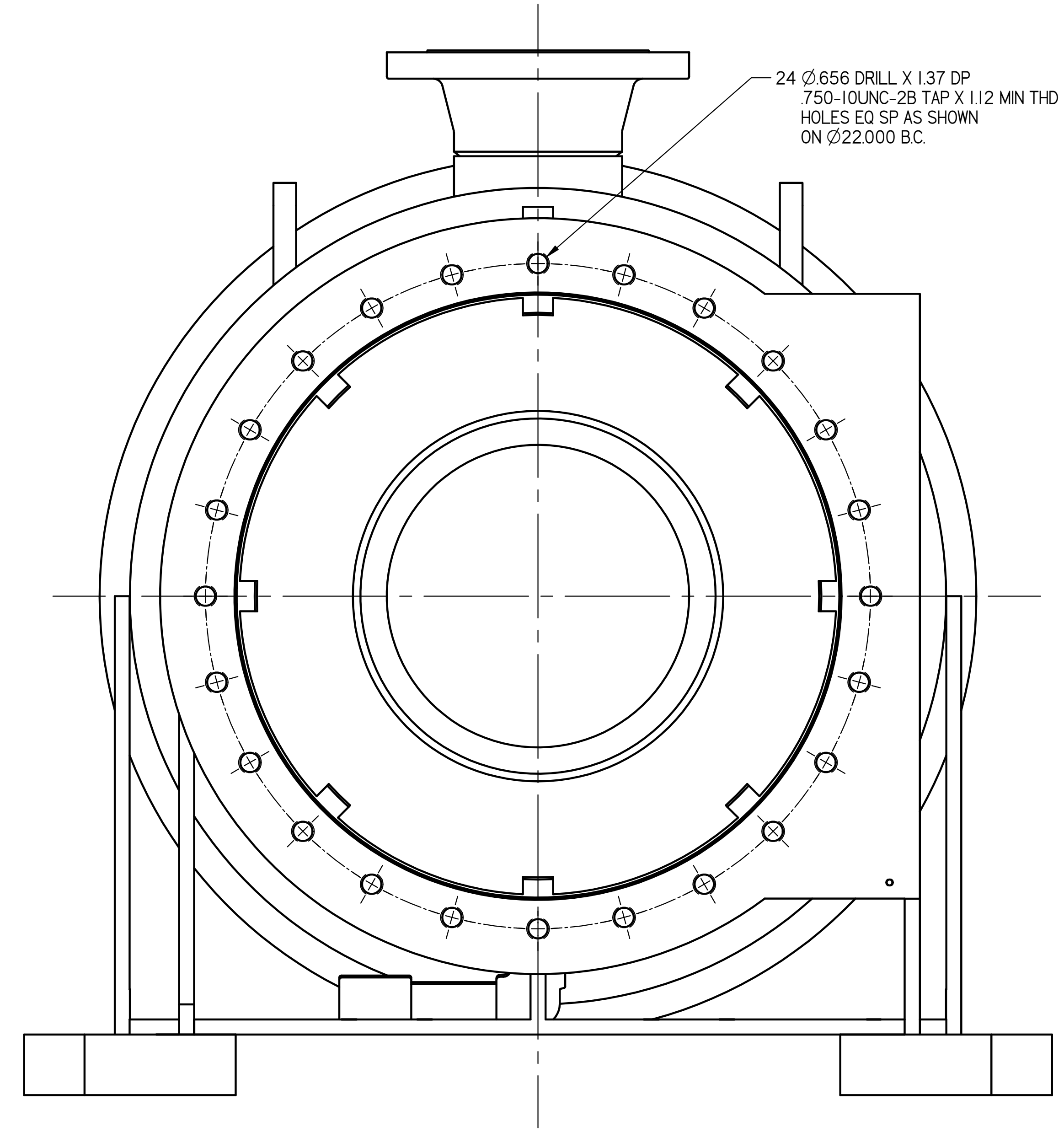
SCALE: 1/1 | EST. WT. | SHEET 7 OF 11

NOTES: UNLESS OTHERWISE SPECIFIED

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED



SECTION I-I



ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED

1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

FRACT	DECIMALS	ANGLES
±	.X ±.10 .XX ±.03 .XXX ±.010	±2°

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ISSUED	K.KAUPERT	10/17/14

NEXT ASSY 1046650

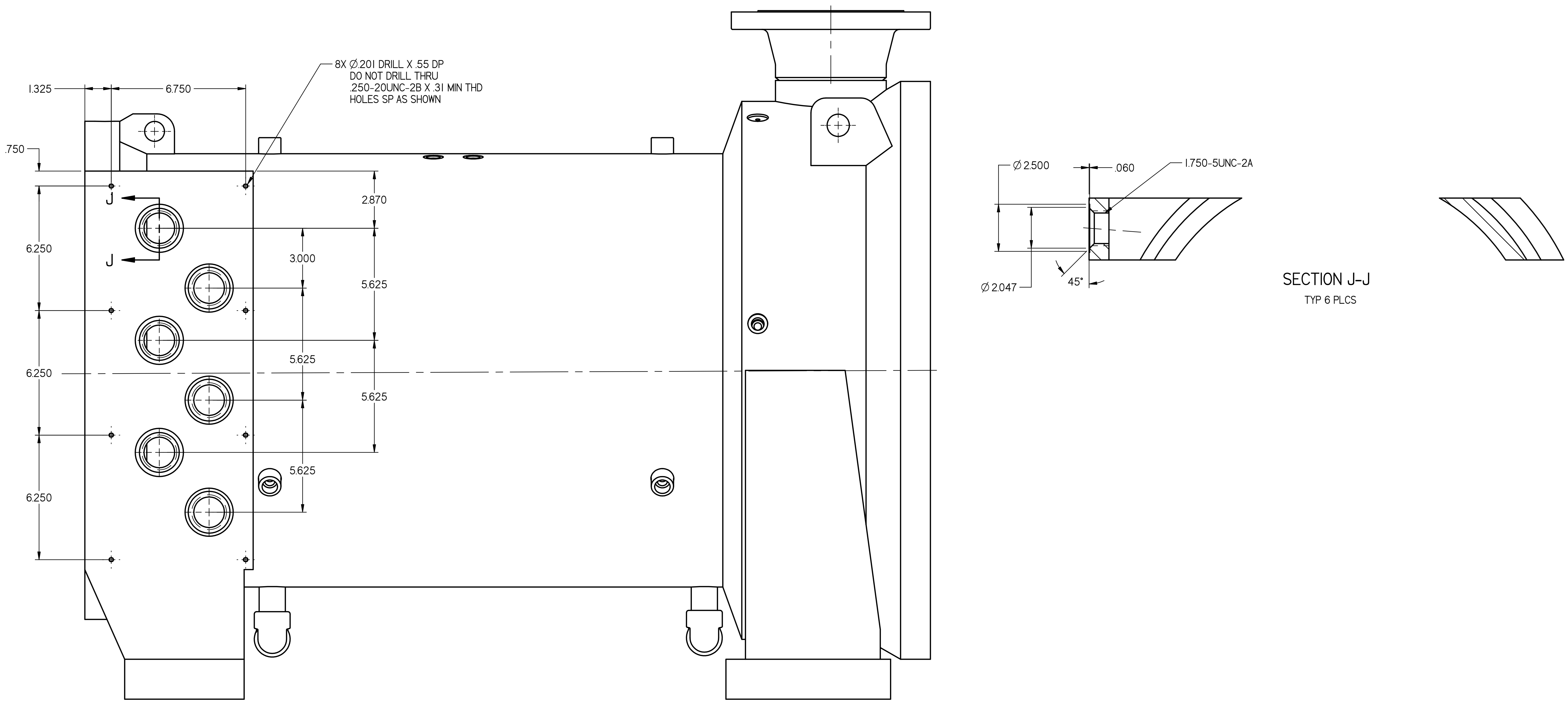
ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

TITLE
TURBINE HOUSING

DWG. SIZE	PROJECT NO.	DWG
D	10466	E1046660

SCALE: 1/1 | EST. WT. | SHEET 8 OF 11

NOTES: UNLESS OTHERWISE SPECIFIED



REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED

NOTES: UNLESS OTHERWISE SPECIFIED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH

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± .X ±.10 .XX ±.03 .XXX ±.010 ±2°

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ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

NEXT ASSY 1046650

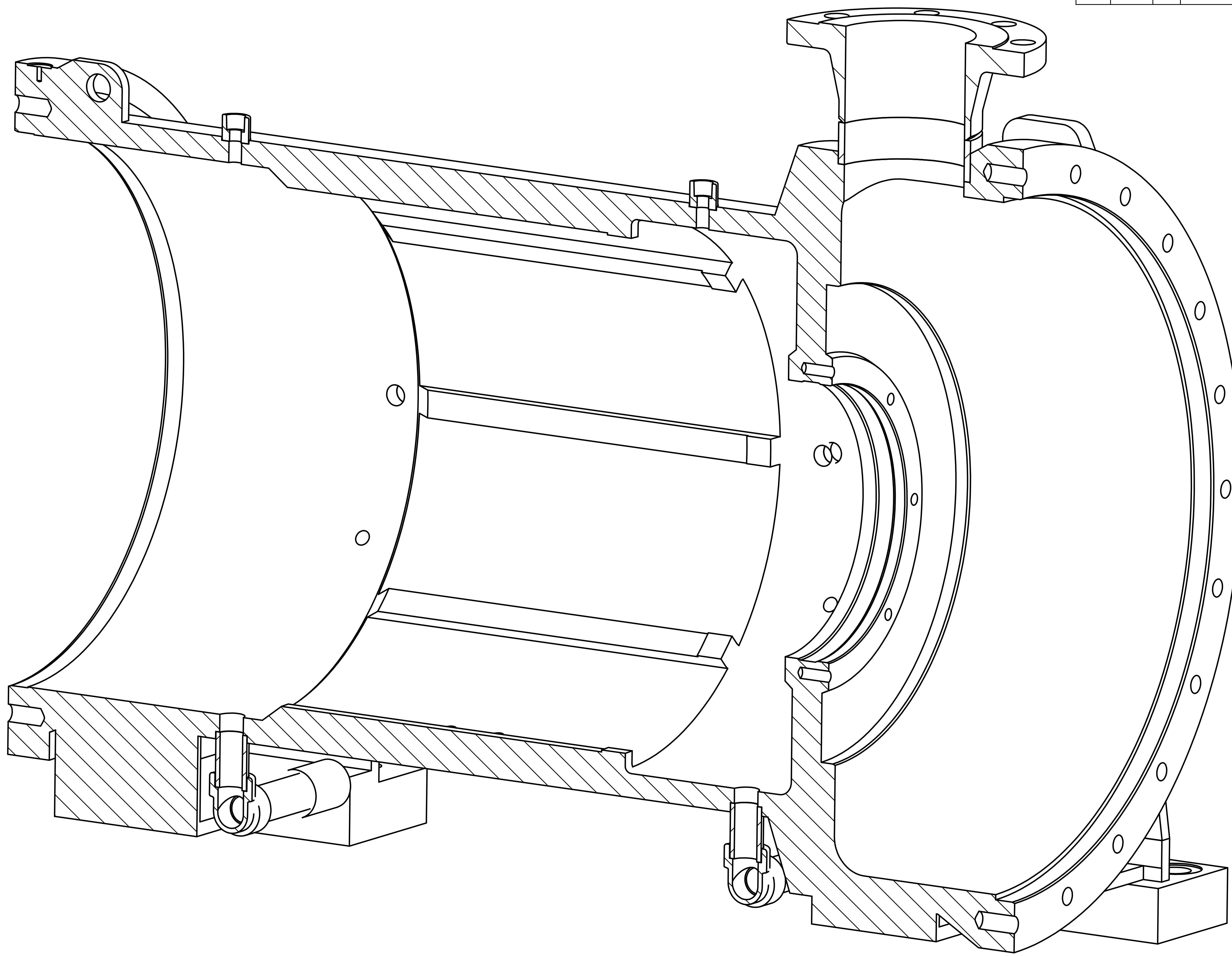
ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

TITLE
TURBINE HOUSING

DWG. SIZE D | PROJECT NO. 10466 | DWG E1046660

SCALE: 1/1 | EST. WT. | SHEET 9 OF 11

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED



ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED

1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON

FRACT	DECIMALS			ANGLES
	.X	.XX	.XXX	
±	±.10	±.03	±.010	±2°

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NEXT ASSY 1046650

ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

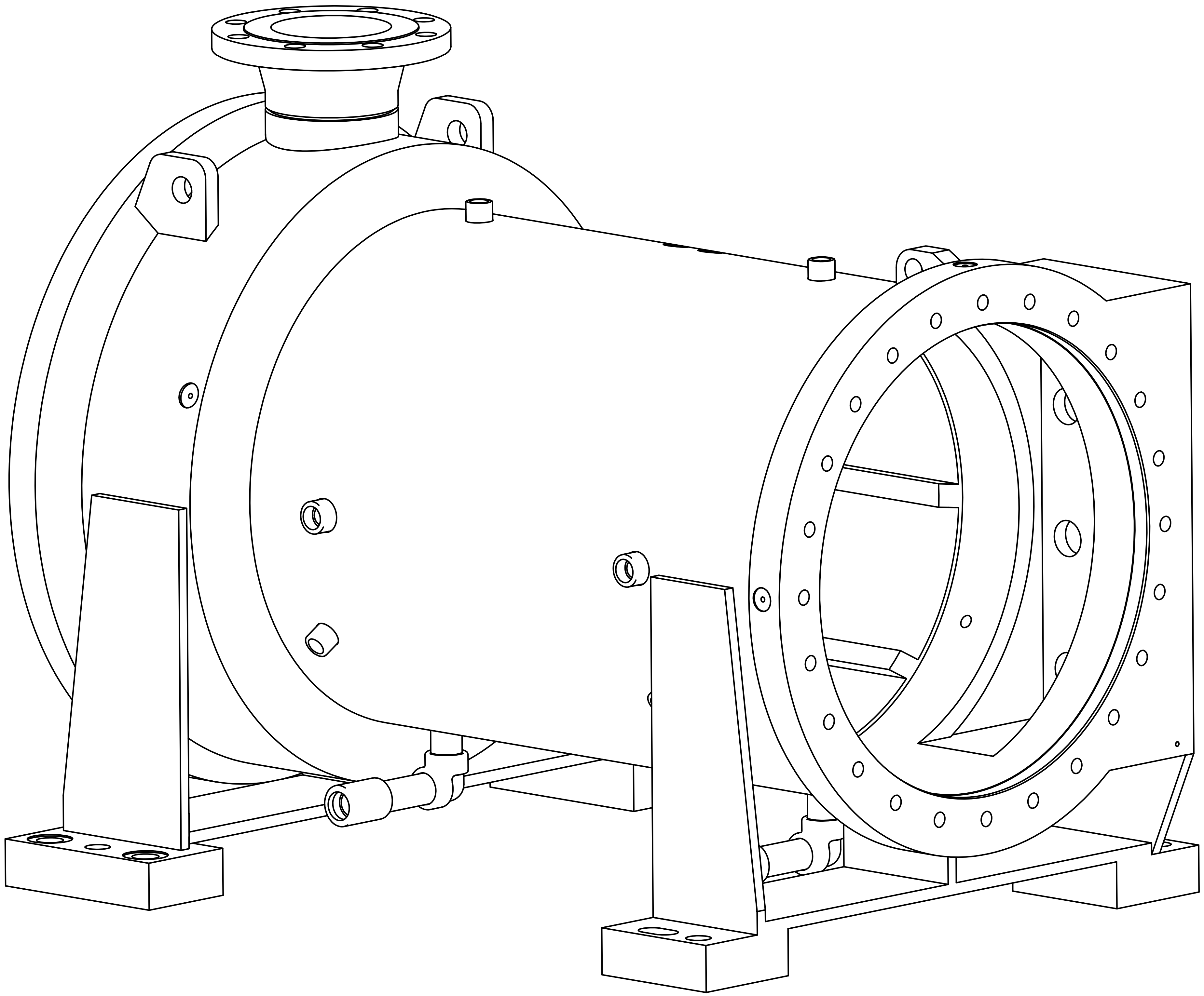
TITLE
TURBINE HOUSING

DWG. SIZE	PROJECT NO.	DWG
D	10466	E1046660

SCALE: 1/1	EST. WT.	SHEET 10 OF 11

NOTES: UNLESS OTHERWISE SPECIFIED

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED



ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED

1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125 √

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

FRACT	DECIMALS			ANGLES
	.X	.XX	.XXX	
±	±.10	±.03	±.010	±2°

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NEXT ASSY 1046650

ENERGENT CORP.

1831 CARNEGIE AVE
SANTA ANA, CA 92705

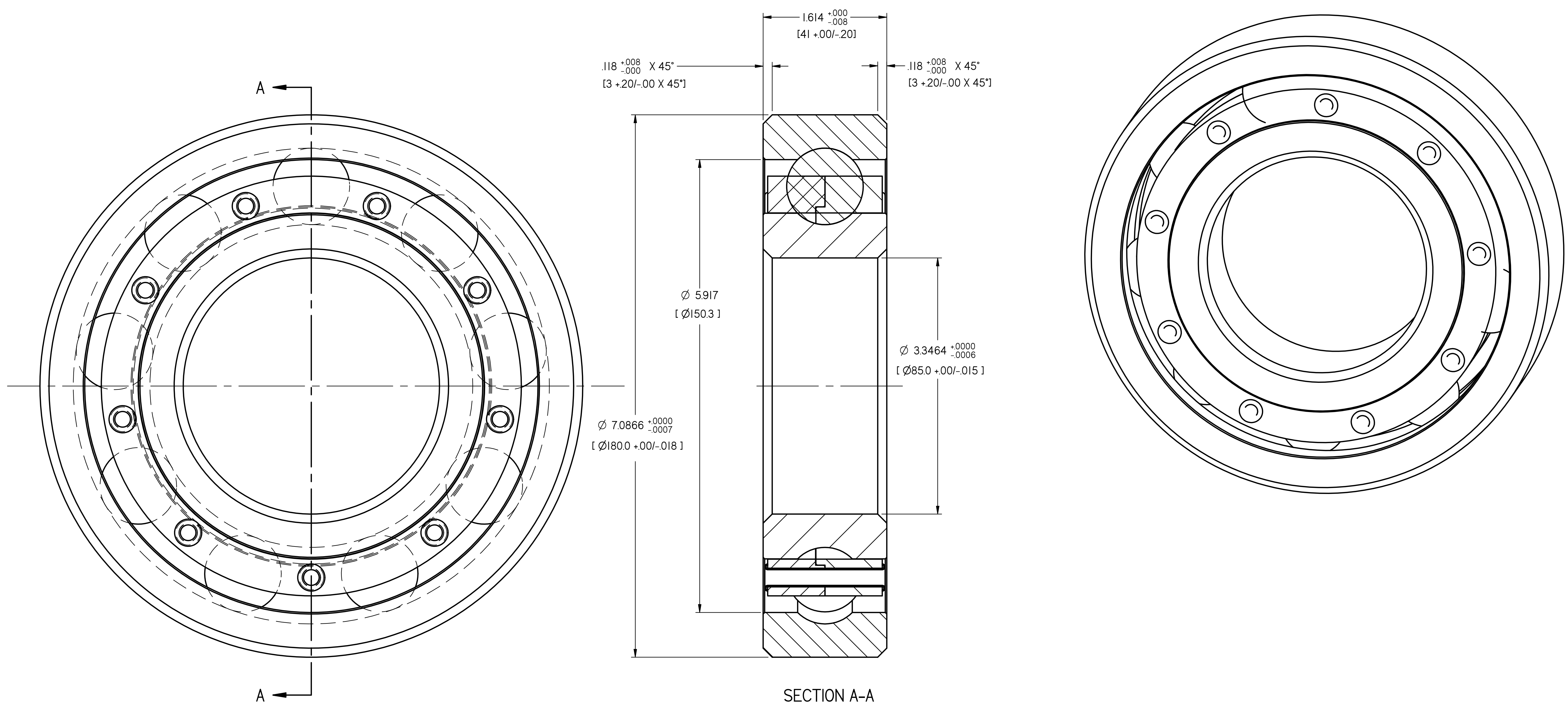
TITLE

TURBINE HOUSING

DWG. SIZE	PROJECT NO.	DWG
D	10466	E1046660

SCALE: 1/1	EST. WT.	SHEET 11 OF 11

NOTES: UNLESS OTHERWISE SPECIFIED



BEARING PARAMETERS

	MIN	MAX	NOMINAL
RADIAL CLEARANCE	.0005 [0.012]	.0014 [0.036]	—
FREE CONTACT ANGLE	5°	10°	—
END PLAY	.0081 [0.206]	.0159 [0.404]	.0122 [0.311]
	INNER RACE	OUTER RACE	
CURVATURE	.0122 [0.515]	.0208 [0.530]	

	FRONT BEARING		BACK BEARING	
BEARING LOAD	160.74 LBS [715 N]		107.5 LBS [478.2 N]	
BEARING STIFFNESS	Kxx	Kyy	Kxx	Kyy

BEARING ASSEMBLY PARAMETERS

	FRONT BEARING	BACK BEARING (FIXED)	MATERIAL
SHAFT OD	3.3461 /3.3460 [84.990/84.988]	3.3461/3.3460 [84.990/84.988]	4140 AMS-6382
HOUSING ID	7.088/7.089 [180.035/180.060]	7.0862/7.0864 [179.989/179.995]	ASTM A516 GR 70

1. BEARING VENDOR : CEROBEAR, BRG SV2N 6317 STBHI P6 CN, PART NO. WL6317000007

NOTES: UNLESS OTHERWISE SPECIFIED

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125 √

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
FRACT DECIMALS ANGLES
± .X ±.10 .XX ±.03 .XXX ±.010 ±2°

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NEXT ASSY 1046650

DO NOT SCALE DRAWING

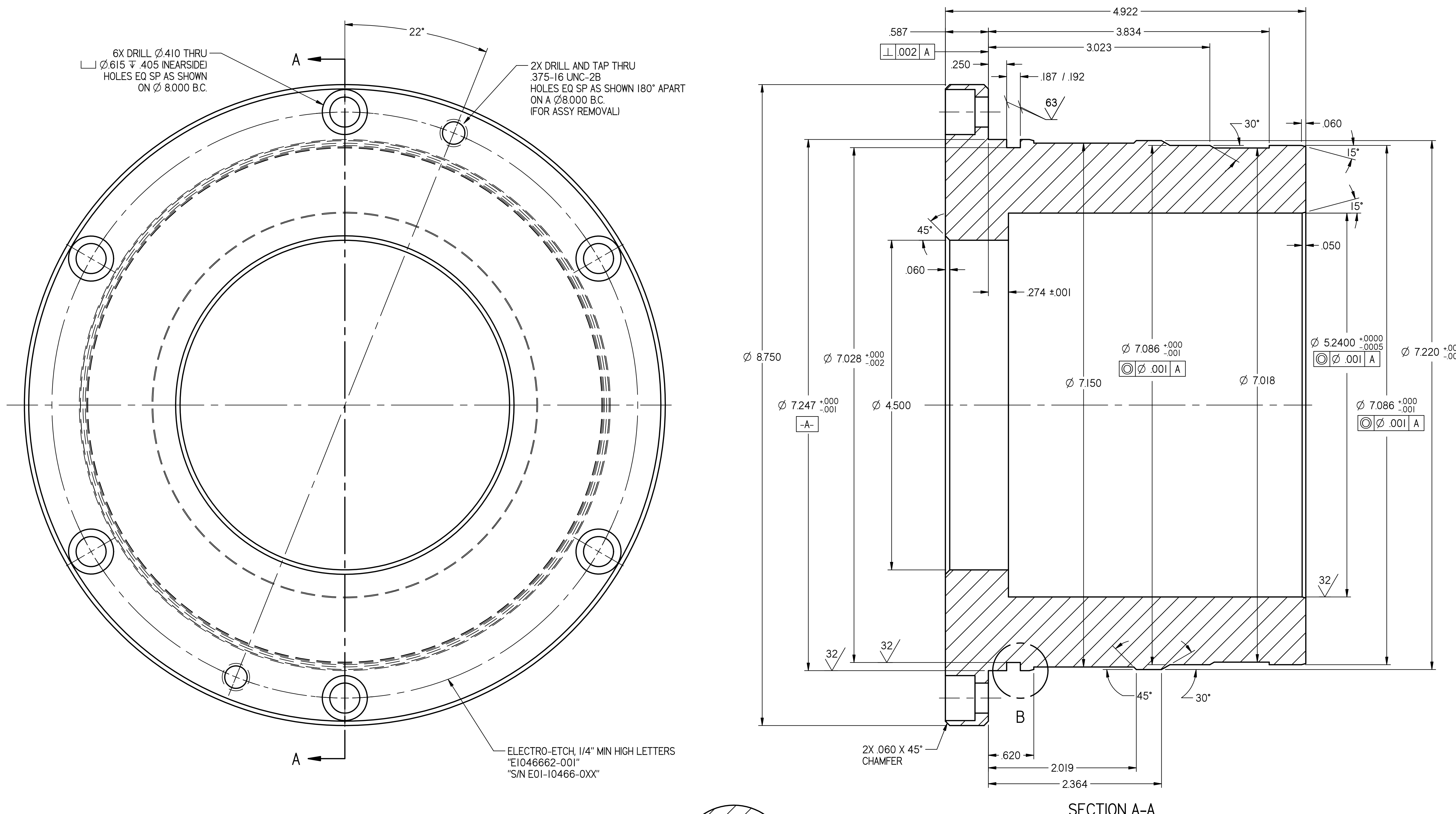
DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

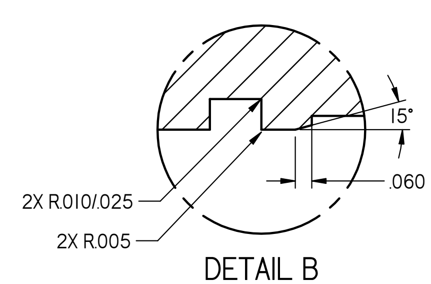
ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

TITLE
DEEP GROOVE BALL BEARING

DWG. SIZE D | PROJECT NO. 10466 | DWG E1046661

SCALE: 1/1 | EST. WT. | SHEET 1 OF 1





1. MATERIAL IS SS316 PER ASTM A240
SUPPLY CHEMICAL, MECHANICAL AND HEAT TREATMENT REPORTS

NOTES: UNLESS OTHERWISE SPECIFIED

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125 √

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
FRACT DECIMALS ANGLES
± .X ±.10 .XX ±.03 .XXX ±.010 ±2°

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NEXT ASSY 1046650

DO NOT SCALE DRAWING

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

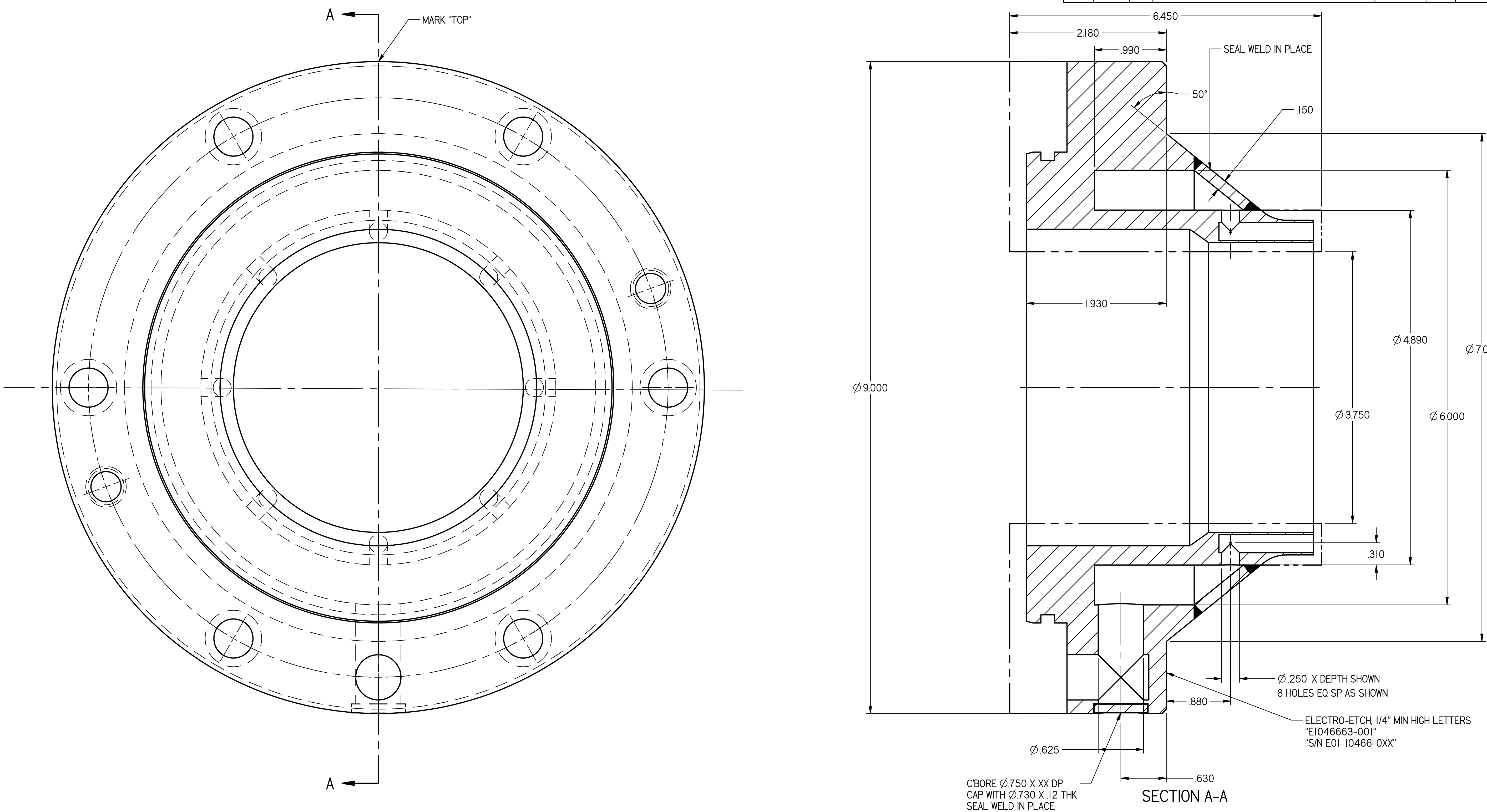
ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

TITLE GRAPHALLOY BEARING HOLDER FRONT SIDE

DWG. SIZE D | PROJECT NO. 10466 | DWG E1046662

SCALE: 1/1 | EST. WT. 30.5 LBS | SHEET 1 OF 1

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED



ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
FRACT DECIMALS ANGLES
± .X ±.10 .XX ±.03 .XXX ±.010 ±2°

THIS DRAWING AND THE INFORMATION REVEALED BY IT IS THE CONFIDENTIAL AND PROPRIETARY PROPERTY OF ENERGENT CORP AND IS NOT TO BE DISCLOSED TO OTHERS WITHOUT WRITTEN PERMISSION. UNAUTHORIZED USE OF THIS DRAWING IS EXPRESSLY FORBIDDEN.

NEXT ASSY 1046650

DO NOT SCALE DRAWING

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

TITLE
GENERATOR - COOLING NOZZLE

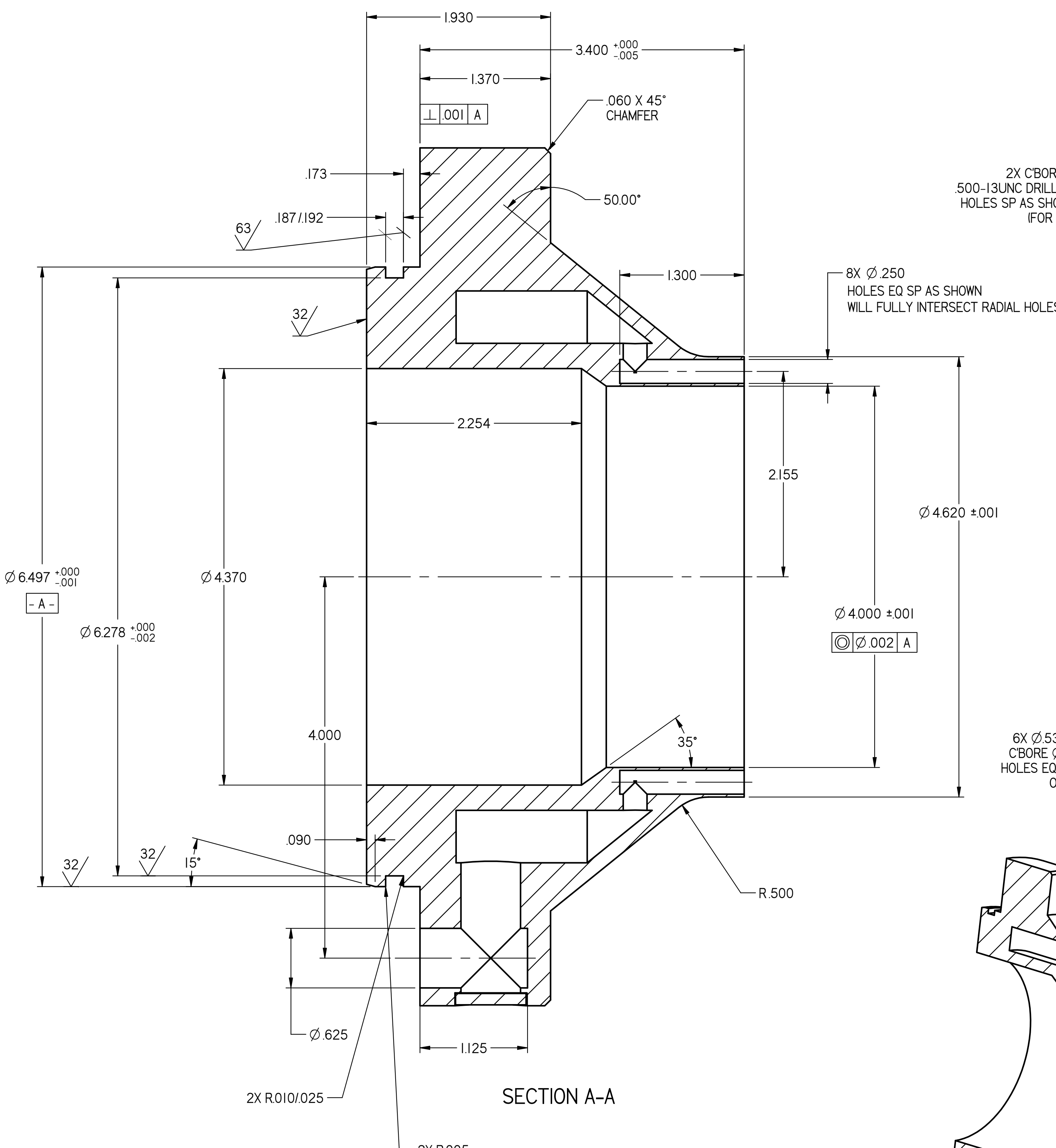
DWG. SIZE D | PROJECT NO. 10466 | DWG E1046663

SCALE: 1/1 | EST. WT. 22 LBS | SHEET 1 OF 2

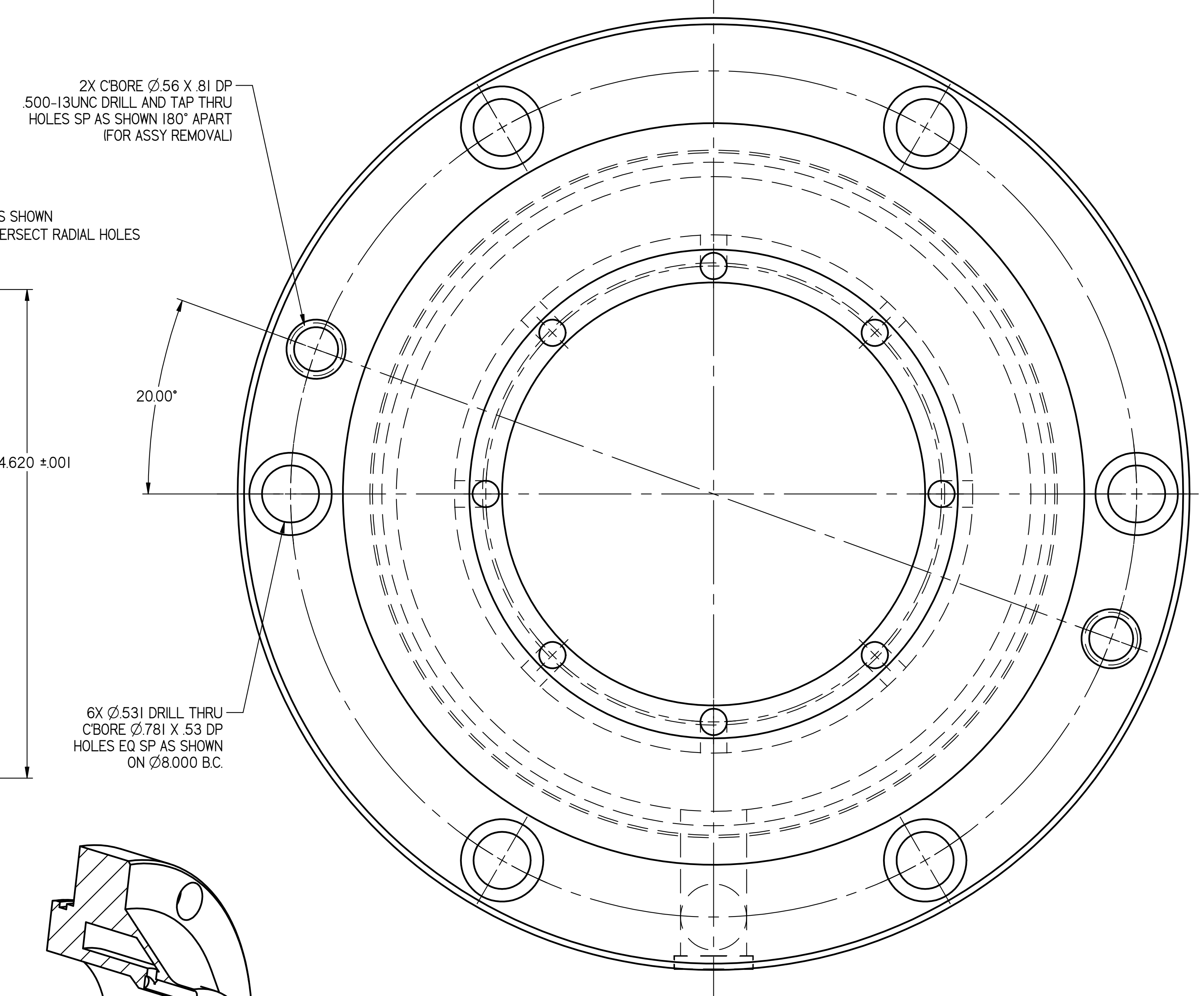
1. MATERIAL IS PRESSURE VESSEL PLATE PER ASTM A516 GR 70
PROVIDE CHEMICAL, MECHANICAL AND HEAT TREATMENT TEST REPORTS

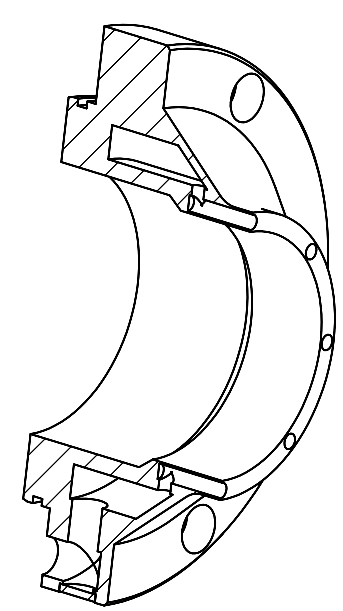
NOTES: UNLESS OTHERWISE SPECIFIED

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED



SECTION A-A





ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

FRACT	DECIMALS		ANGLES
±	.X ±.10 .XX ±.03	.XXX ±.010	±2°

ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

DO NOT SCALE DRAWING

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

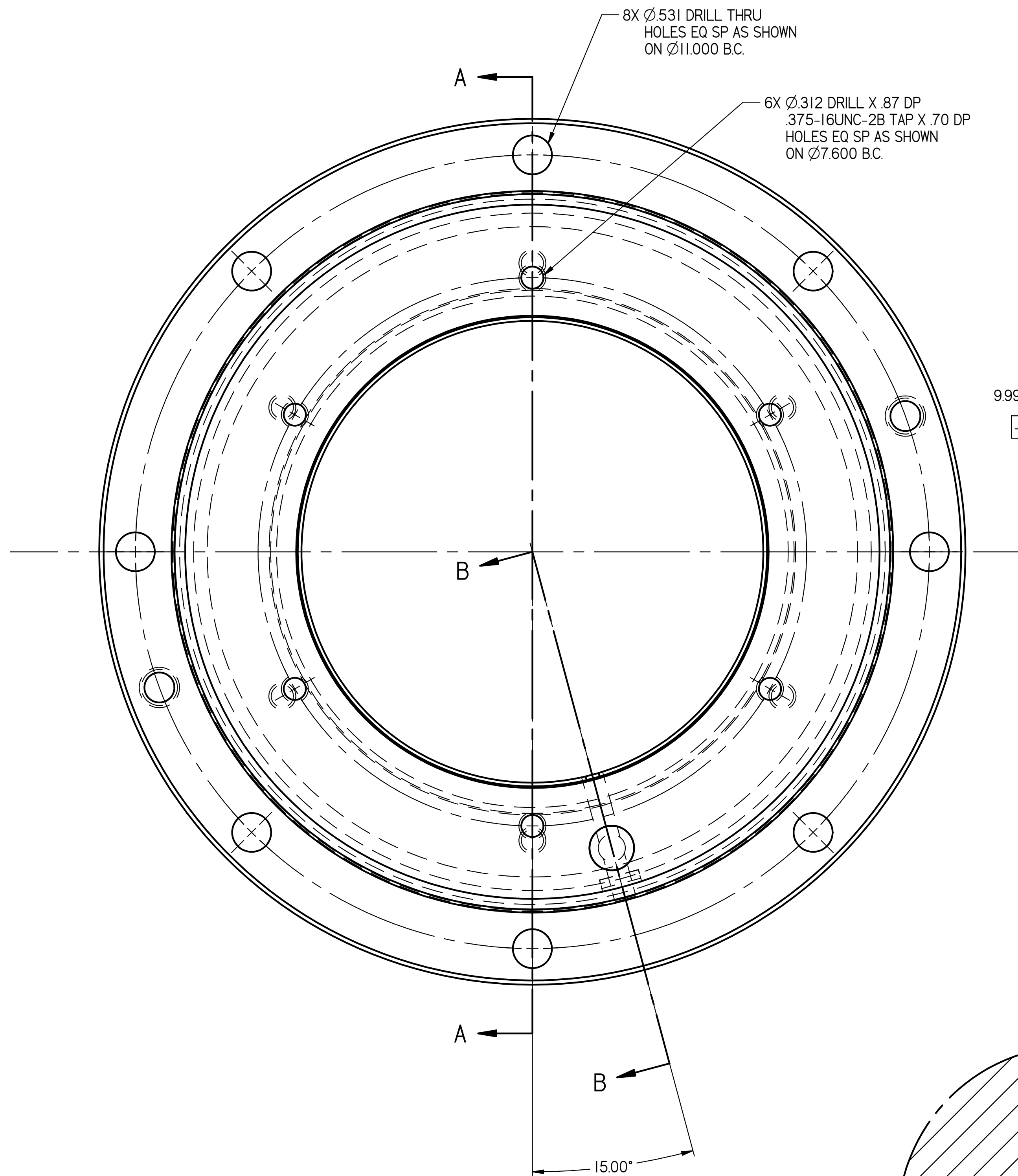
TITLE
GENERATOR - COOLING NOZZLE

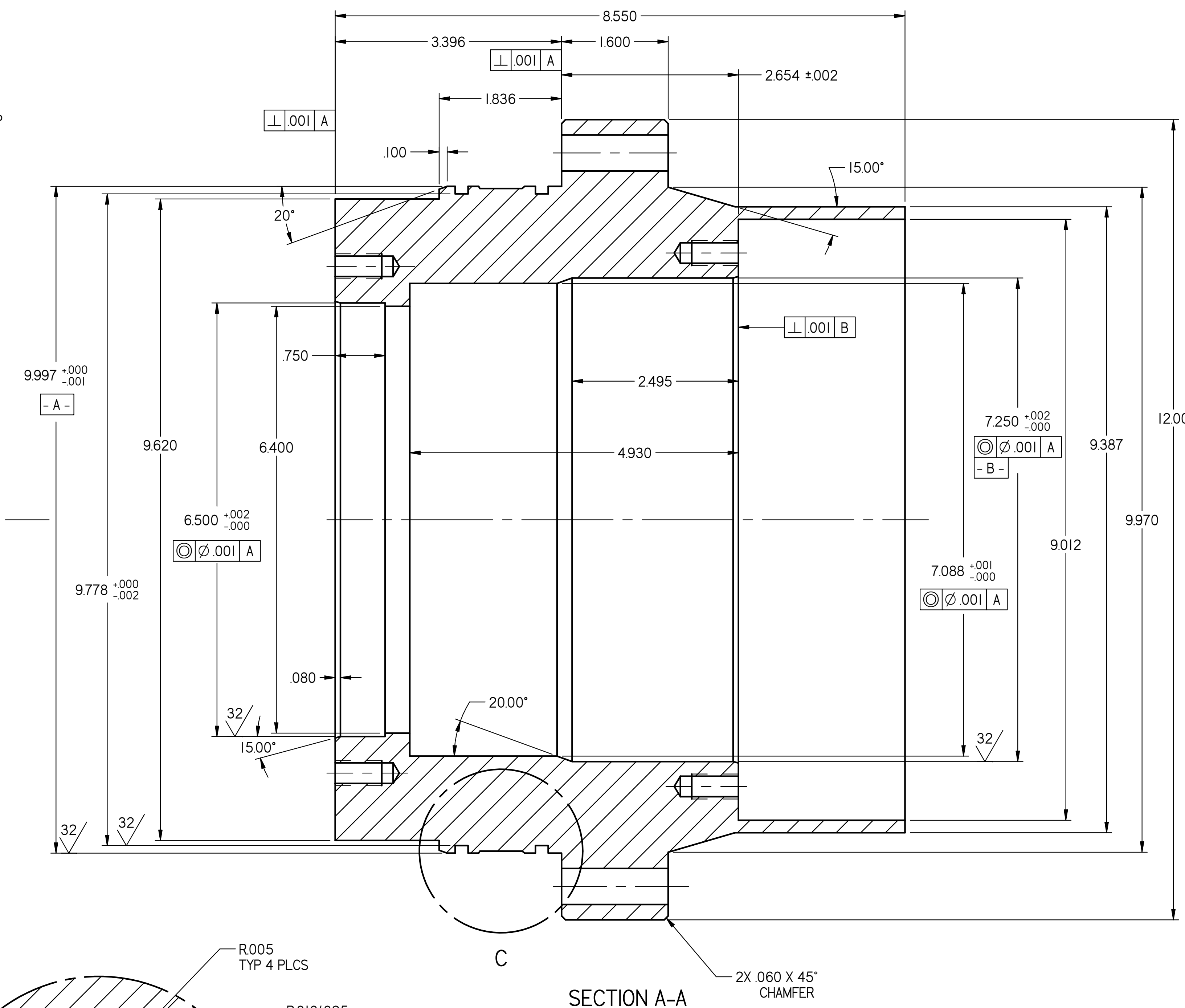
DWG. SIZE	PROJECT NO.	DWG
D	10466	E1046663

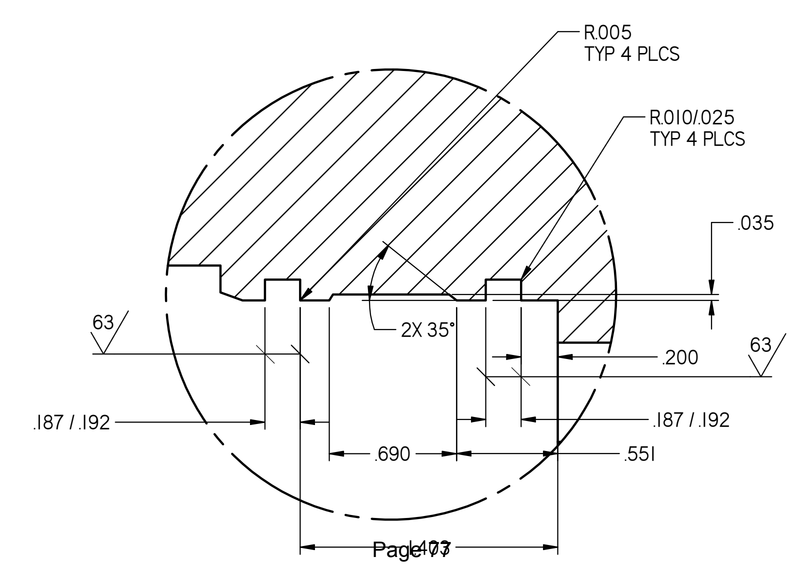
NEXT ASSY 1046650

SCALE: 1/1 | EST. WT. | SHEET 2 OF 2

NOTES: UNLESS OTHERWISE SPECIFIED







DETAIL C

1. MATERIAL IS PRESSURE VESSEL PLATE PER ASTM A516 GR 70
PROVIDE CHEMICAL, MECHANICAL AND HEAT TREATMENT TEST REPORTS

NOTES: UNLESS OTHERWISE SPECIFIED

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
FRACT DECIMALS ANGLES
± .X ±.10 .XX ±.03 .XXX ±.010 ±2°

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NEXT ASSY 1046650

DO NOT SCALE DRAWING

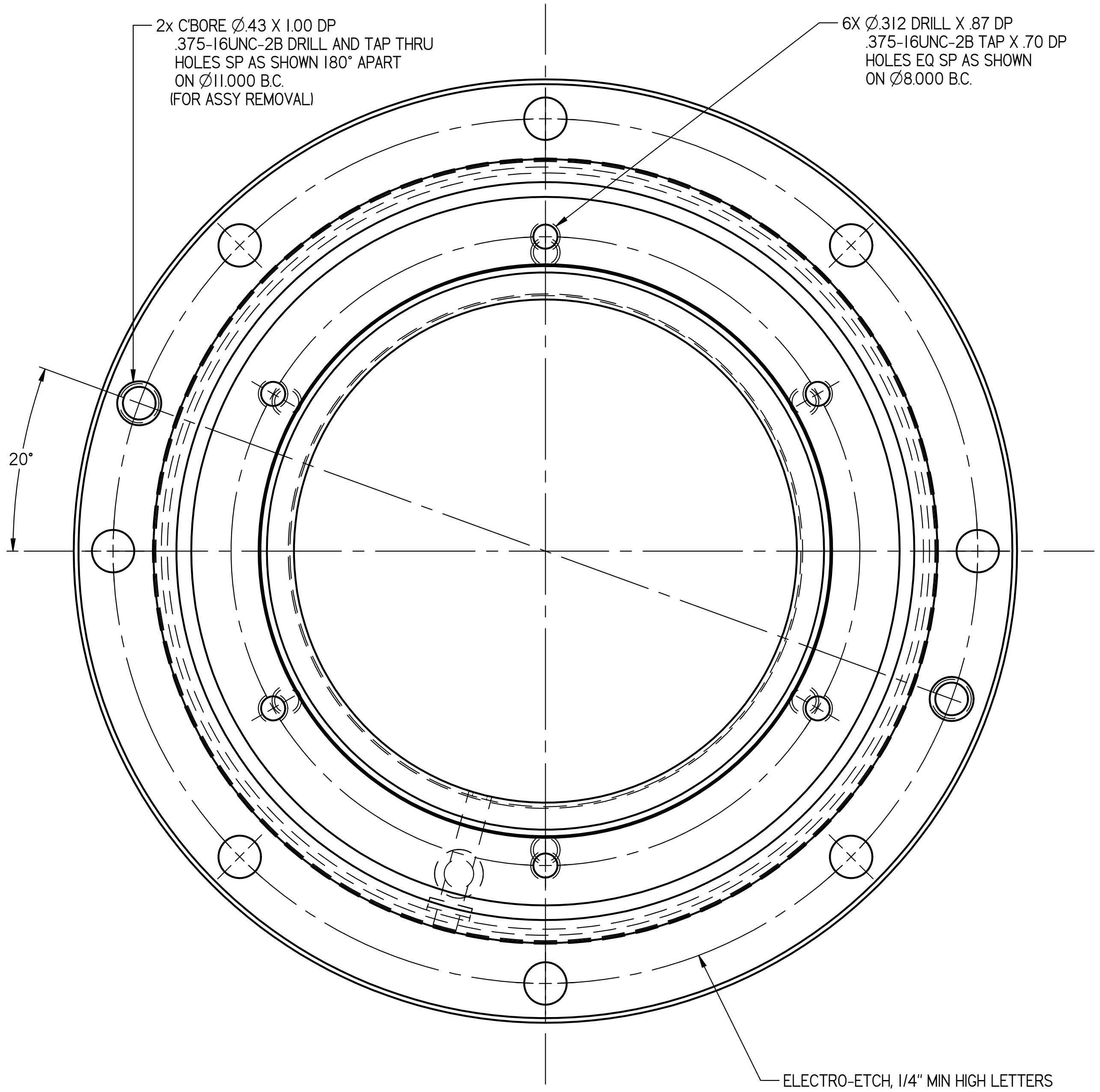
DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

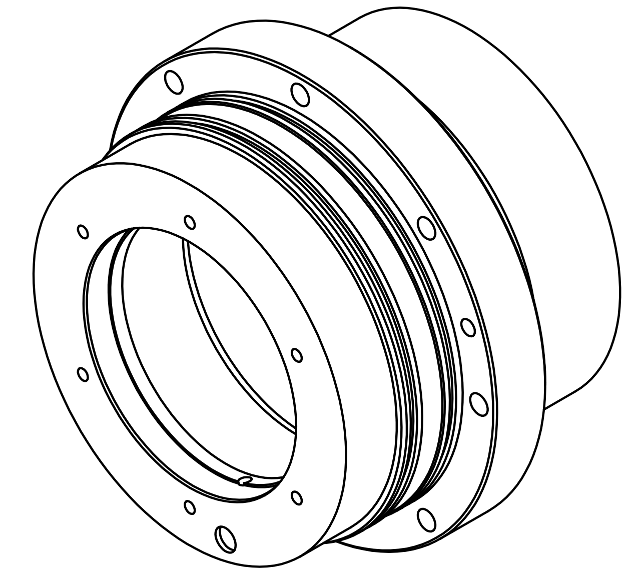
ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

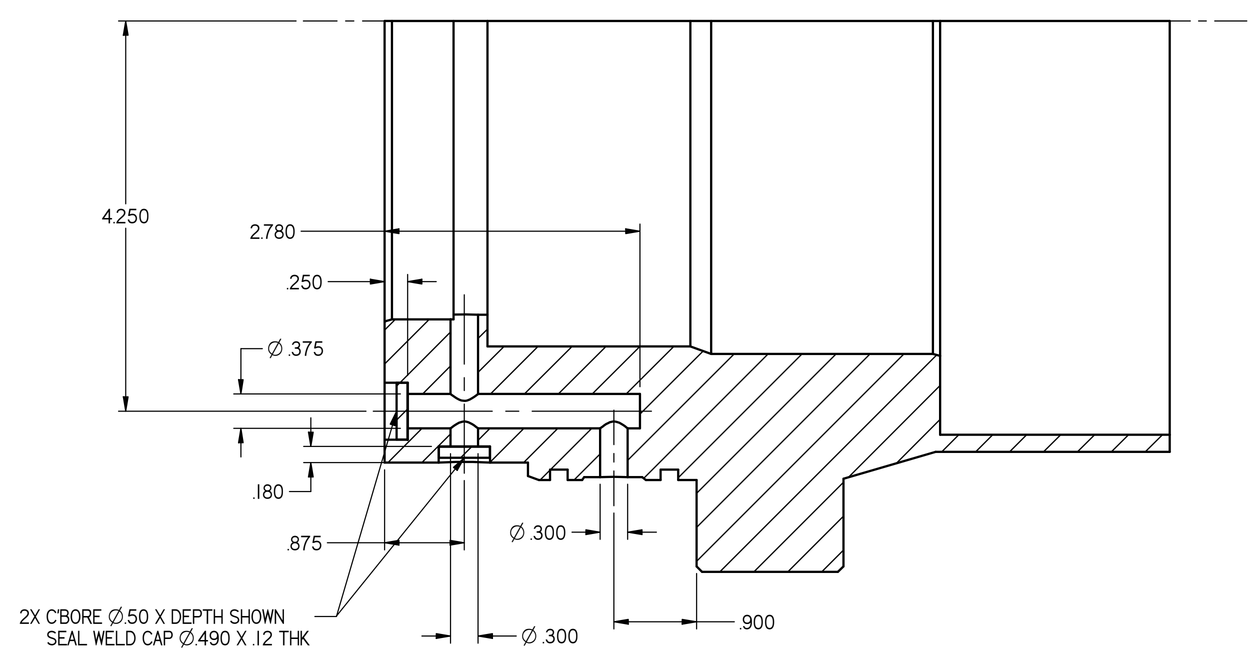
TITLE
HOUSING - FRONT BEARING

DWG. SIZE D | PROJECT NO. 10466 | DWG E1046664

SCALE: 1/1 | EST. WT. 81 LBS | SHEET 1 OF 2







SECTION B-B

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED

1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

FRACT DECIMALS ANGLES
± .X ±.10 .XX ±.03 .XXX ±.010 ±2°

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NEXT ASSY 1046650

DO NOT SCALE DRAWING

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

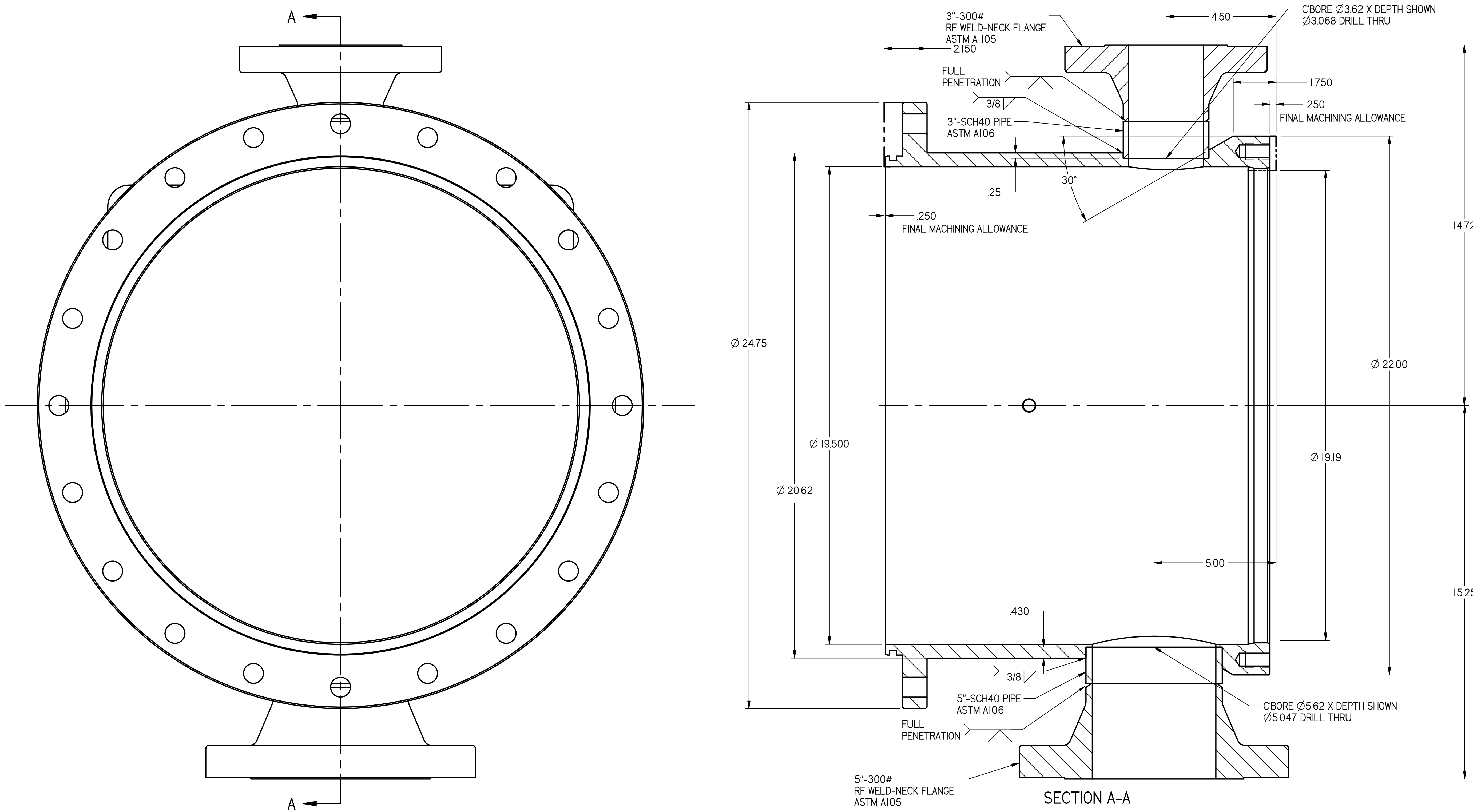
TITLE
HOUSING - FRONT BEARING

DWG. SIZE D | PROJECT NO. 10466 | DWG E1046664

SCALE: 1/1 | EST. WT. | SHEET 2 OF 2

NOTES: UNLESS OTHERWISE SPECIFIED

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED



ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

3. ALL FLANGE BOLT HOLES TO STRADDLE CENTER LINES
2. FABRICATION TO BE THOROUGHLY CLEANED AND SAND BLASTED BY FABRICATOR
1. MATERIAL: EXCEPT WHERE NOTED, PRESSURE VESSEL PLATE ASTM A516 GR 70
VENDOR TO SUPPLY CHEMICAL, MECHANICAL AND HEAT TREATMENT REPORTS

NOTES: UNLESS OTHERWISE SPECIFIED

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
FRACT DECIMALS ANGLES
± .X ±.10 .XX ±.03 .XXX ±.010 ±2°

NEXT ASSY 1046650

DO NOT SCALE DRAWING

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

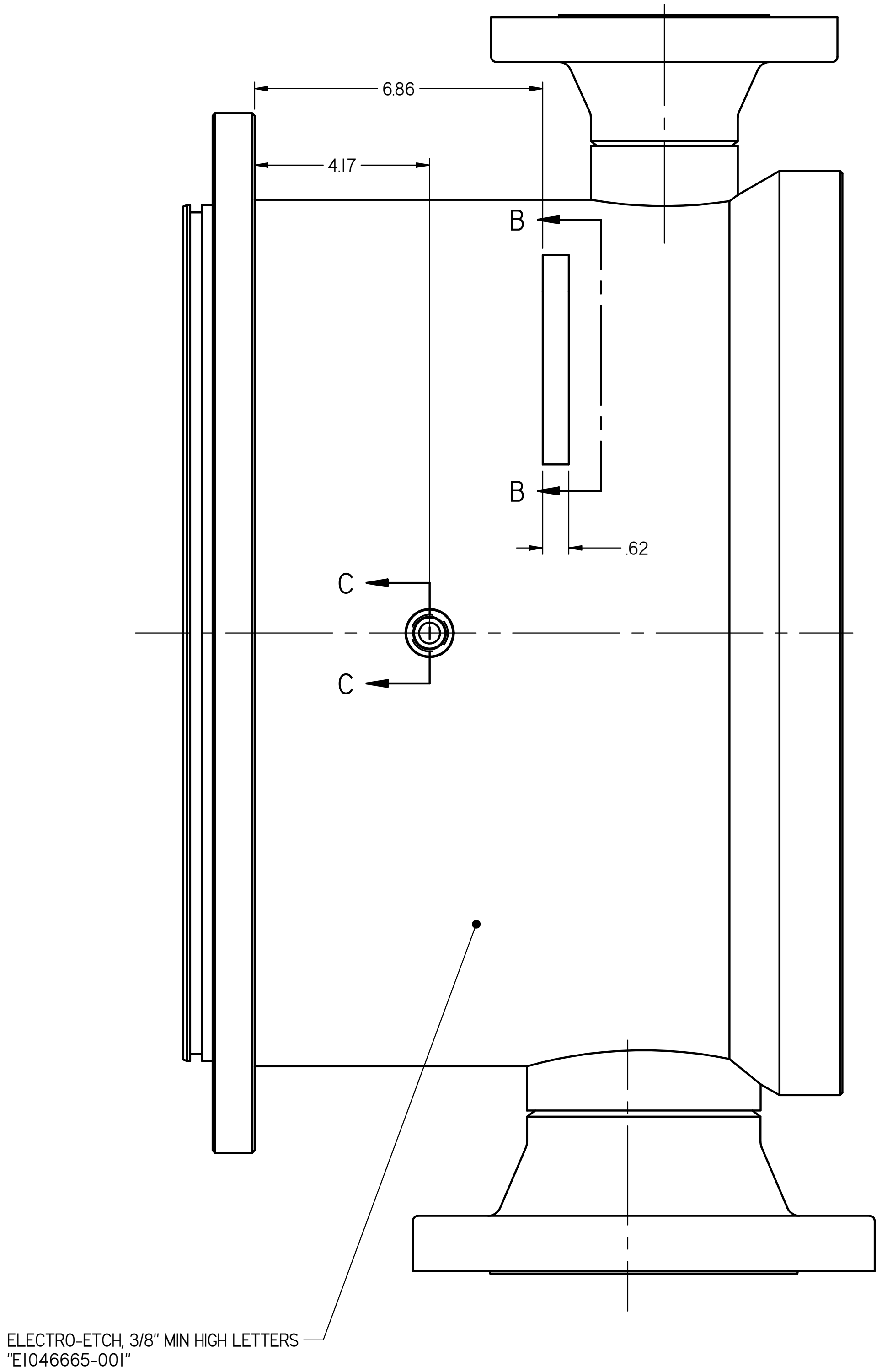
ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

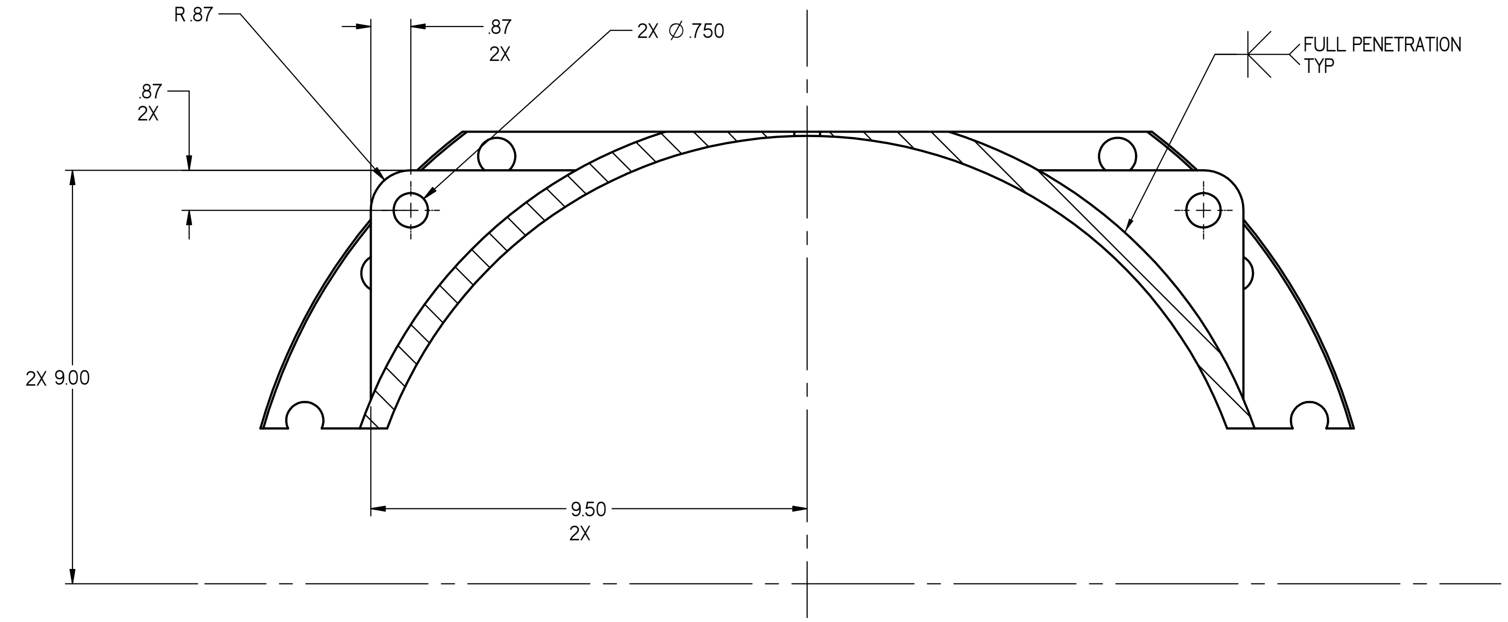
TITLE
TURBINE OUTLET HOUSING

DWG. SIZE D | PROJECT NO. 10466 | DWG E1046665

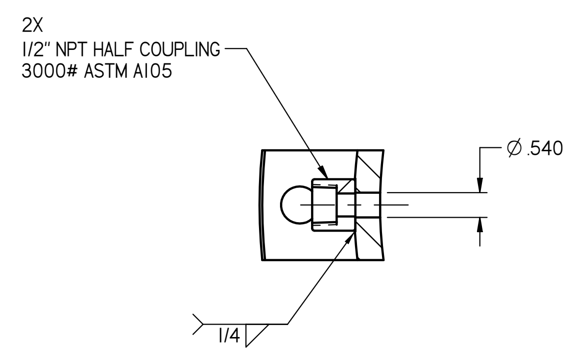
SCALE: 1/1 | EST. WT. 232.5 LBS | SHEET 1 OF 4

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED





SECTION B-B



SECTION C-C
TYP BOTH SIDES

NOTES: UNLESS OTHERWISE SPECIFIED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
FRACT DECIMALS ANGLES
± .X ±.10 .XX ±.03 .XXX ±.010 ±2°

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NEXT ASSY 1046650

DO NOT SCALE DRAWING

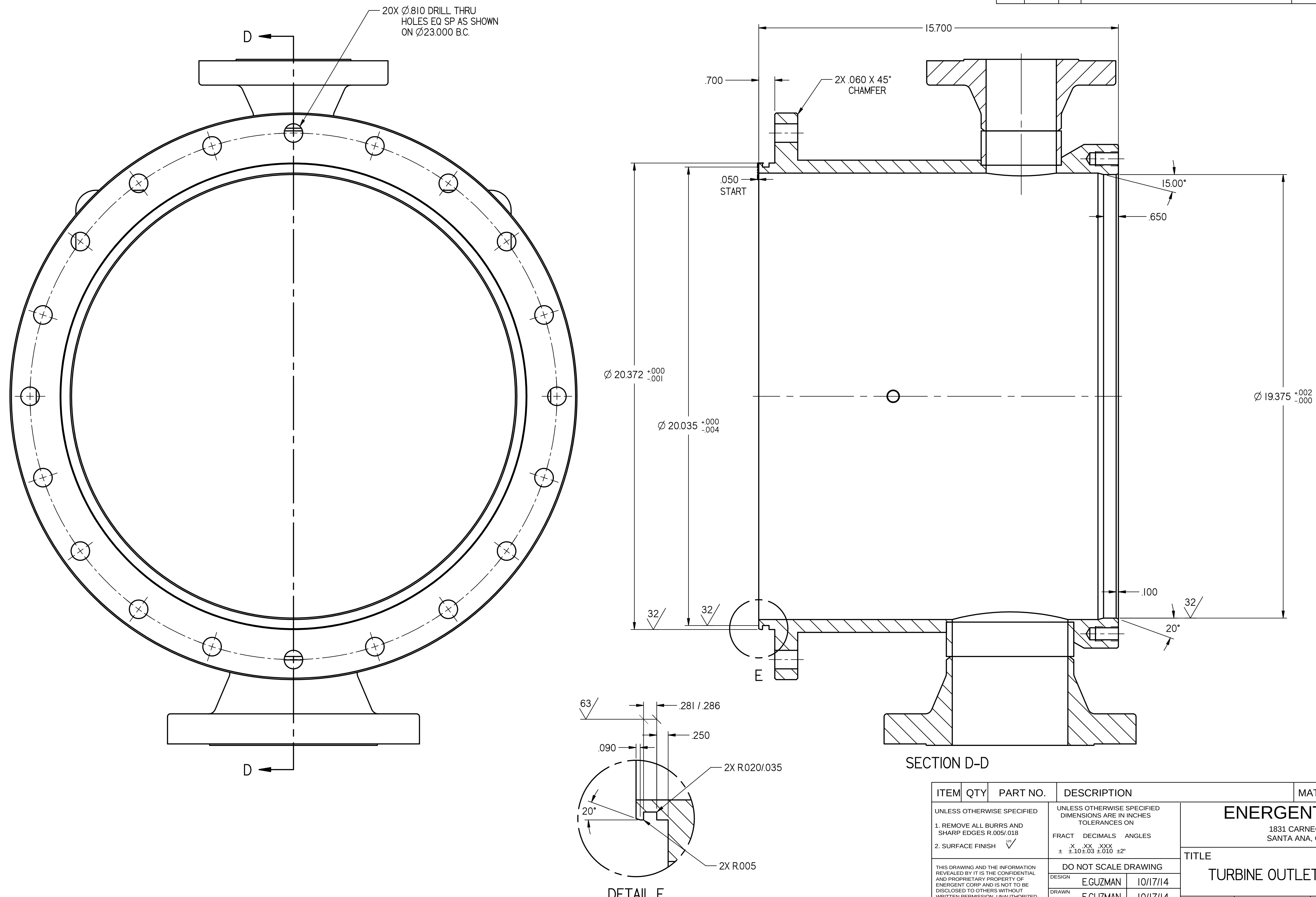
DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

TITLE
TURBINE OUTLET HOUSING

DWG. SIZE	PROJECT NO.	DWG
D	10466	E1046665
SCALE: 1/1	EST. WT.	SHEET 2 OF 4

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED



NOTES: UNLESS OTHERWISE SPECIFIED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED

1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

FRACT	DECIMALS			ANGLES
	.X	.XX	.XXX	
±	±.10	±.03	±.010	±2°

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DO NOT SCALE DRAWING

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

NEXT ASSY 1046650

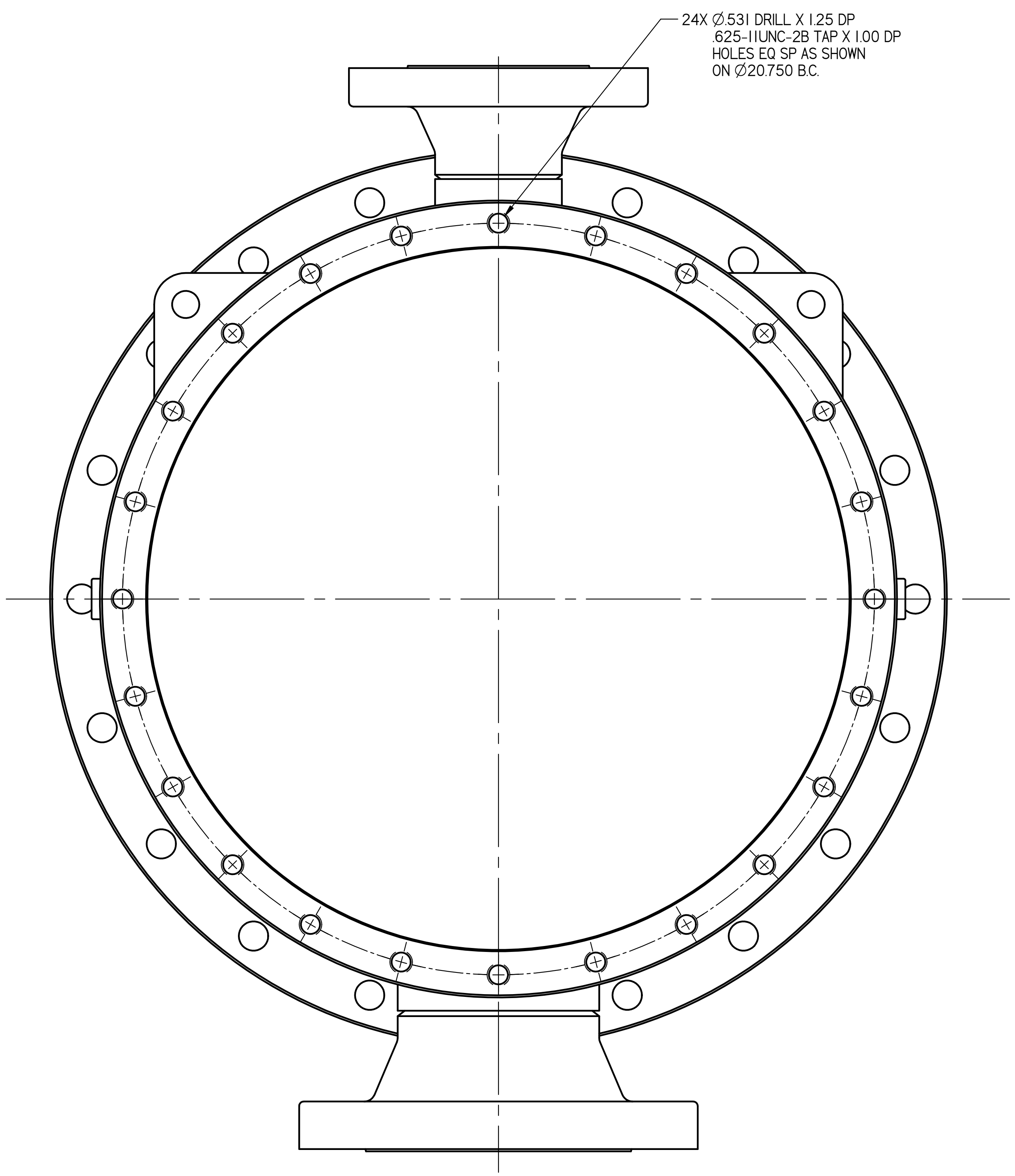
ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

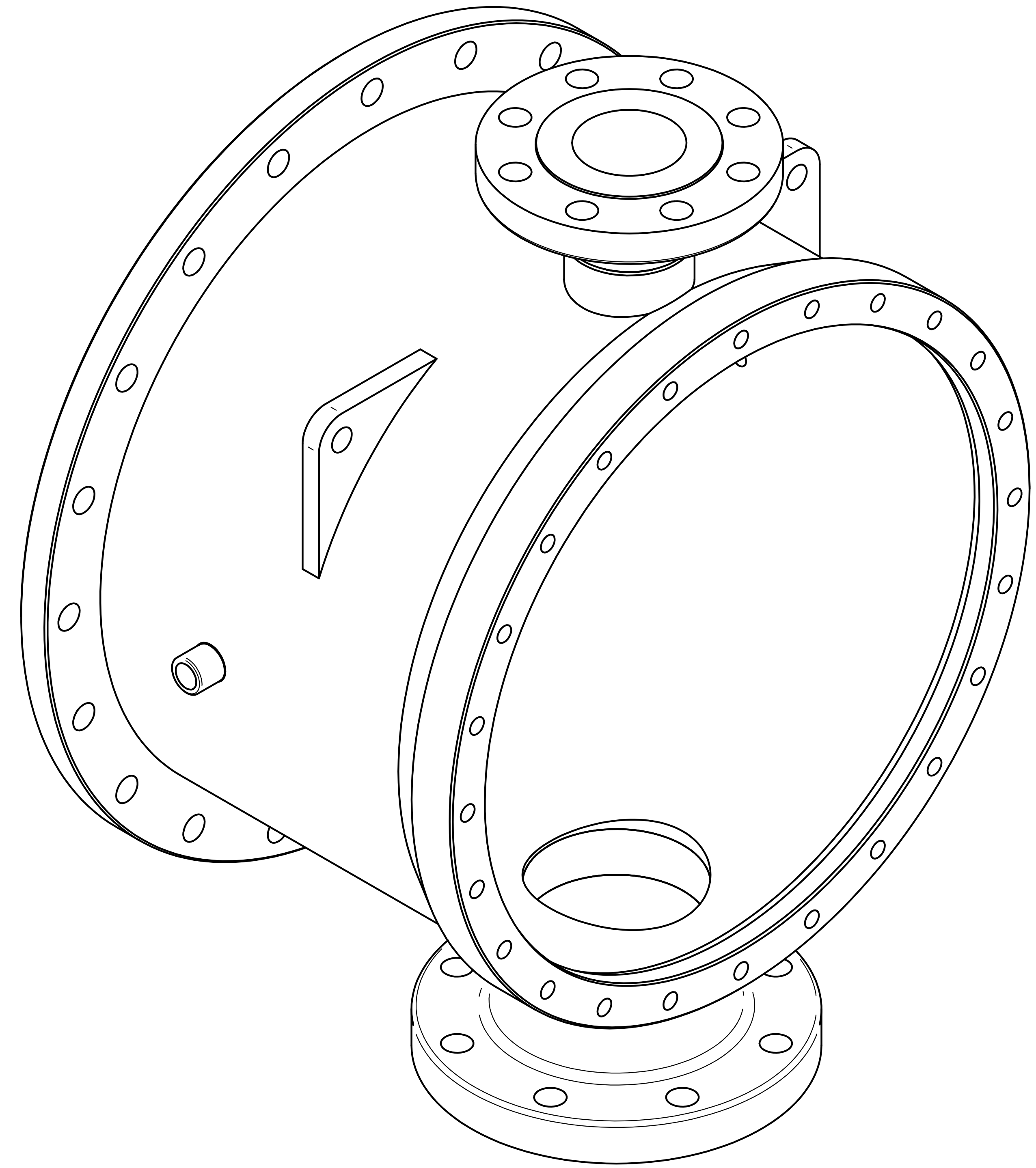
TITLE
TURBINE OUTLET HOUSING

DWG. SIZE	PROJECT NO.	DWG
D	10466	E1046665

SCALE: 1/1	EST. WT.	SHEET 3 OF 4

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED





ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED

1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125 √

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON

FRACT	DECIMALS			ANGLES
	.X	.XX	.XXX	
±	±.10	±.03	±.010	±2°

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DO NOT SCALE DRAWING

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

NEXT ASSY
1046650

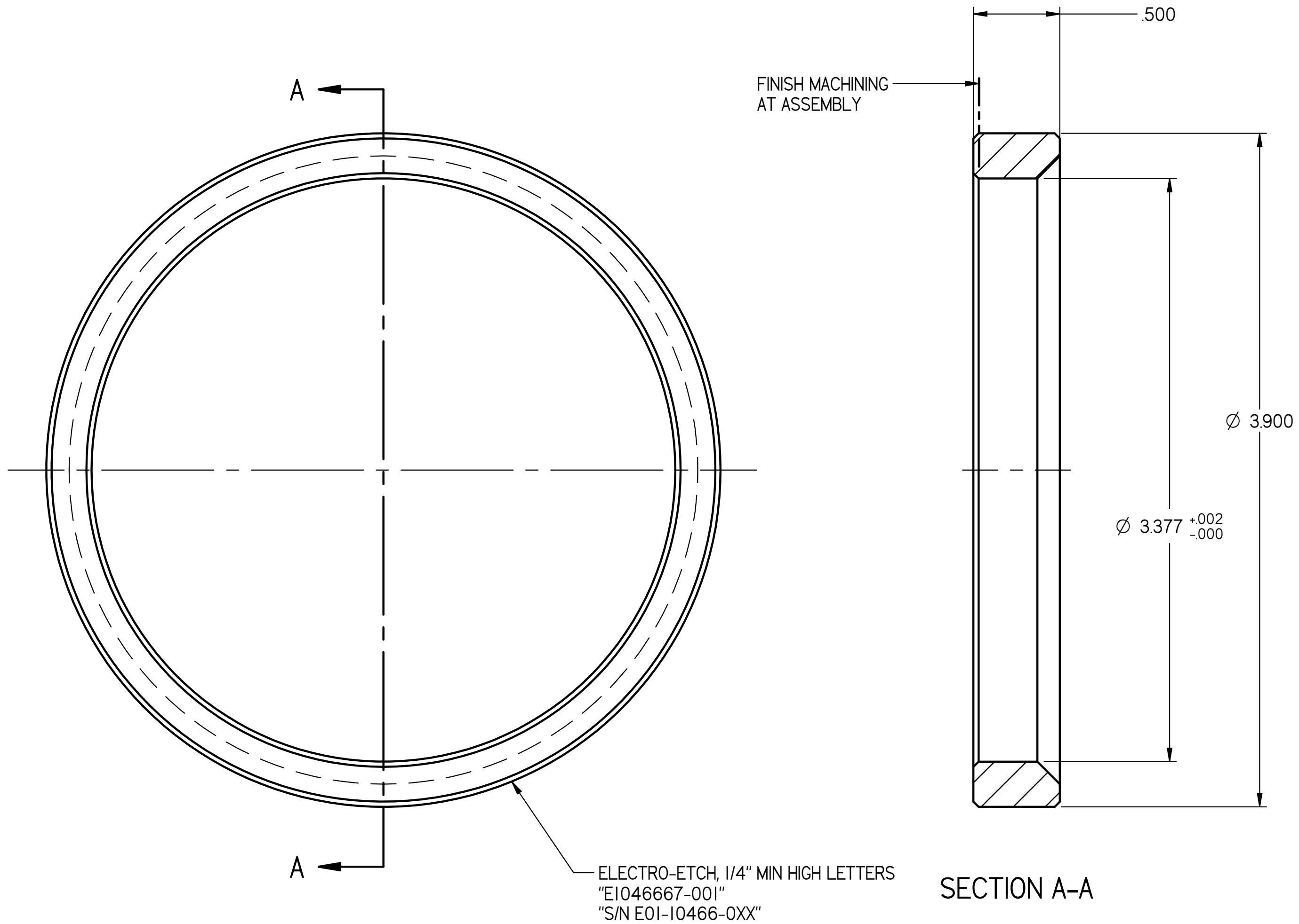
ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

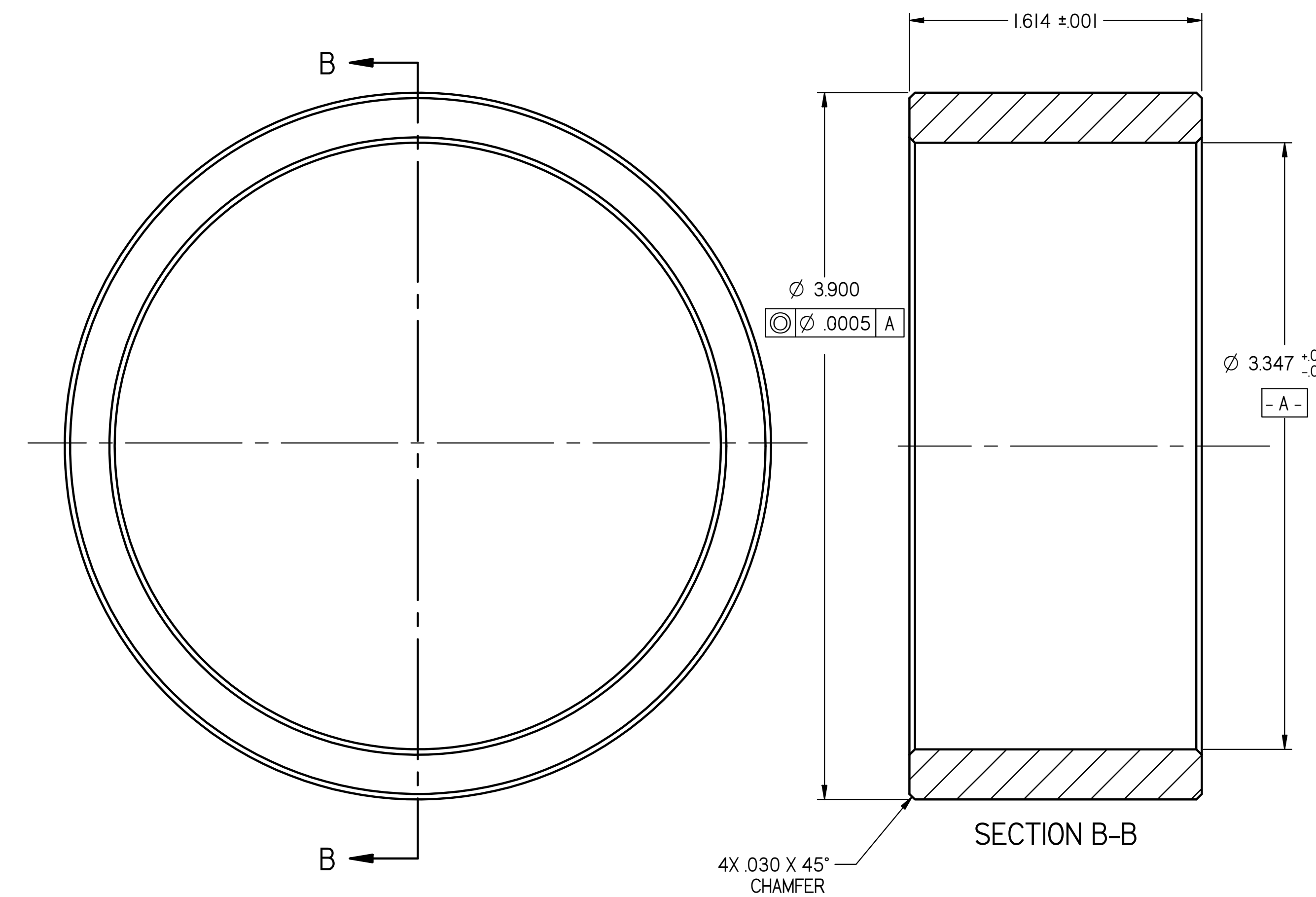
TITLE
TURBINE OUTLET HOUSING

DWG. SIZE	PROJECT NO.	DWG
D	10466	E1046665
SCALE: 1/1	EST. WT.	SHEET 4 OF 4

NOTES: UNLESS OTHERWISE SPECIFIED

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED





SPACER - BACK BEARING SHAFT SLEEVE #1

MAT'L: 316SS PER ASTM A240

SPACER - TURBINE SHAFT SUB-ASSY BALANCING

MAT'L: ALUM 6061-T6

NOTES: UNLESS OTHERWISE SPECIFIED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
FRACT DECIMALS ANGLES
± .X ±.10 .XX ±.03 .XXX ±.010 ±2°

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NEXT ASSY 1046650

DO NOT SCALE DRAWING

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

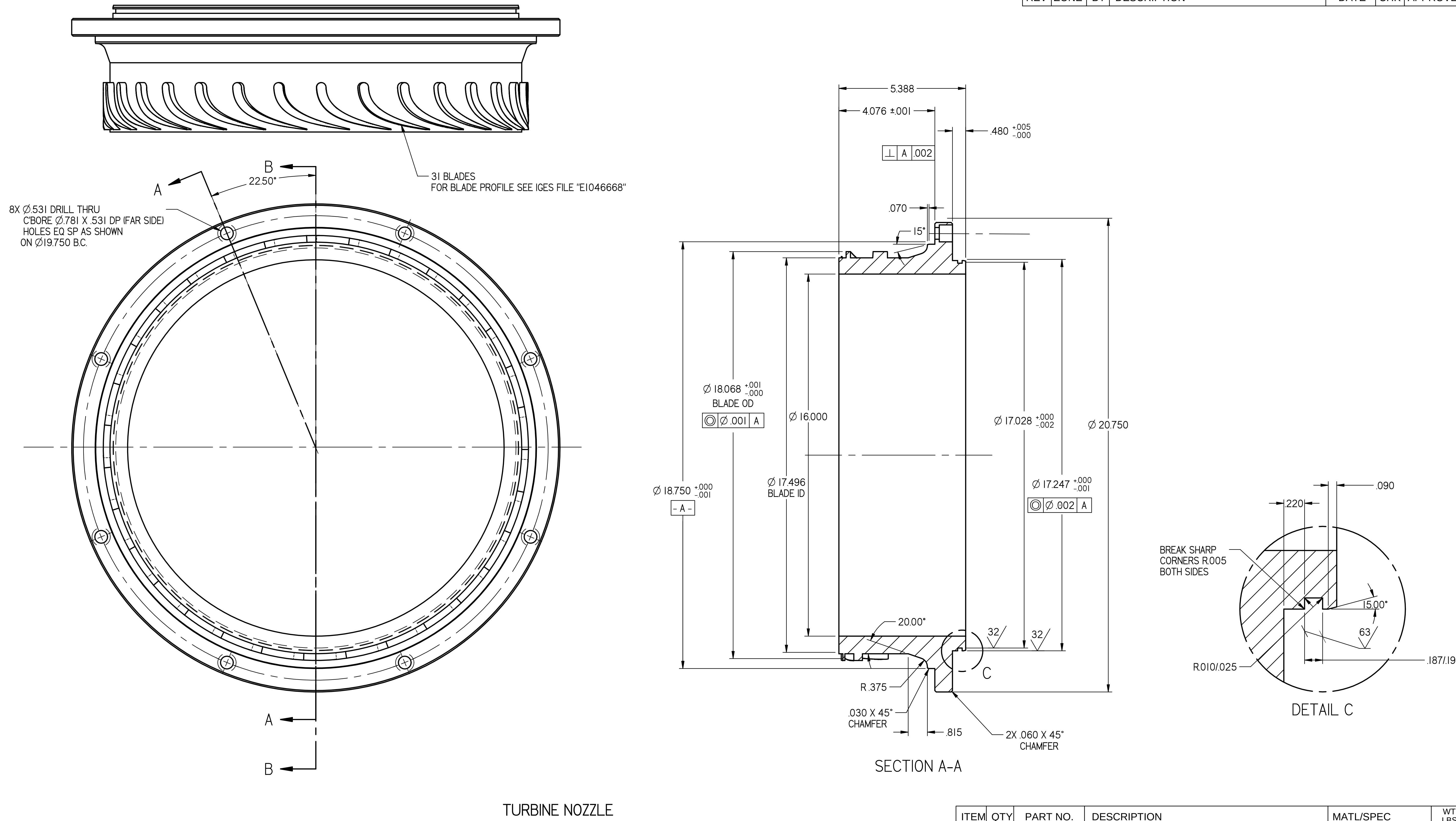
ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

TITLE
SPACER

DWG. SIZE D | PROJECT NO. 10466 | DWG E1046667

SCALE: 1/1 | EST. WT. | SHEET 1 OF 1

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED



TURBINE NOZZLE

1. MATERIAL IS PRESSURE VESSEL PLATE PER ASTM A516 GR 70
PROVIDE CHEMICAL, MECHANICAL AND HEAT TREATMENT TEST REPORTS

NOTES: UNLESS OTHERWISE SPECIFIED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
FRACT DECIMALS ANGLES
± .X ±.10 .XX ±.03 .XXX ±.010 ±2°

NEXT ASSY 1046650

DO NOT SCALE DRAWING

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

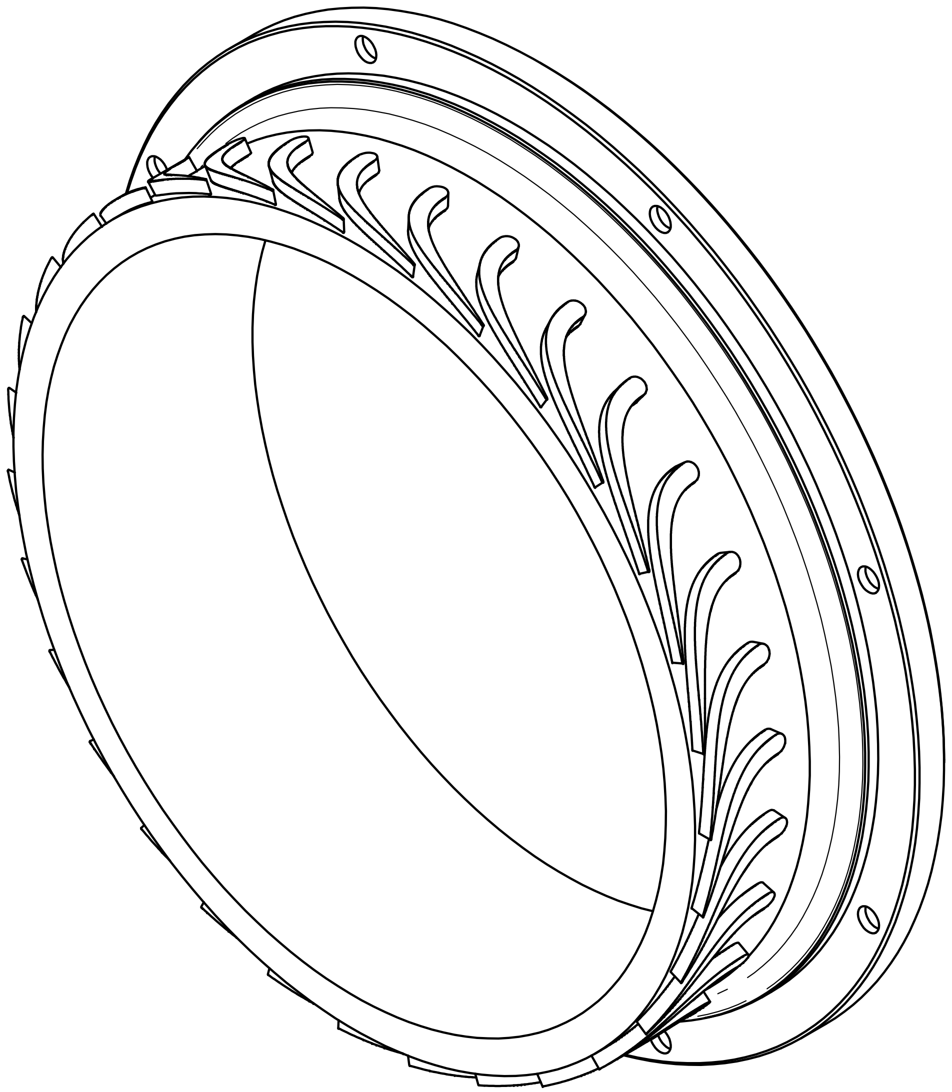
ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

TITLE
TURBINE NOZZLE ASSEMBLY

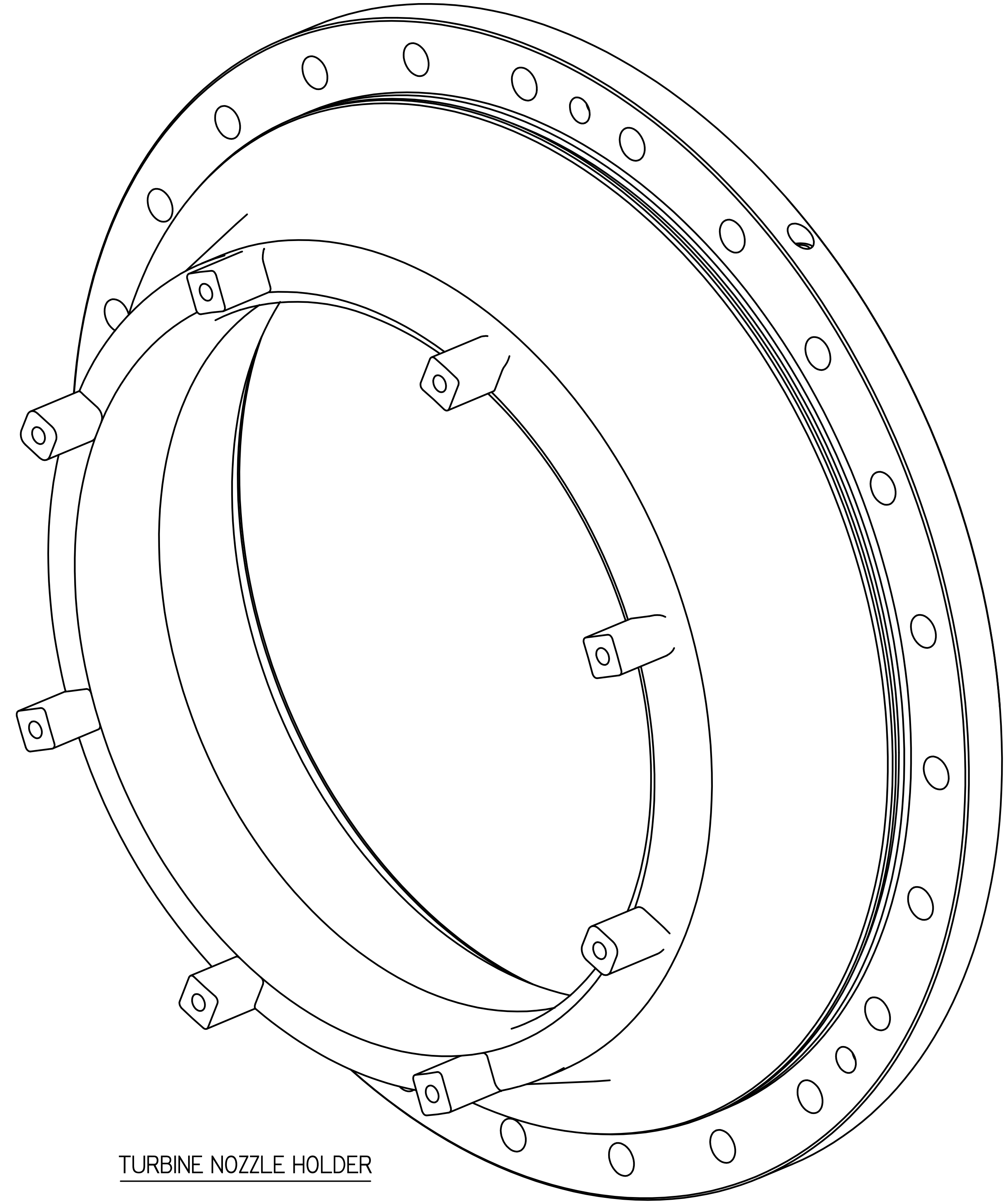
DWG. SIZE D | PROJECT NO. 10466 | DWG E1046668

SCALE: 1/1 | EST. WT. | SHEET 1 OF 6

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED



TURBINE NOZZLE



TURBINE NOZZLE HOLDER

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED

1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125√

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

FRACT	DECIMALS			ANGLES
	.X	.XX	.XXX	
±	±.10	±.03	±.010	±2°

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NEXT ASSY 1046650

DO NOT SCALE DRAWING

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

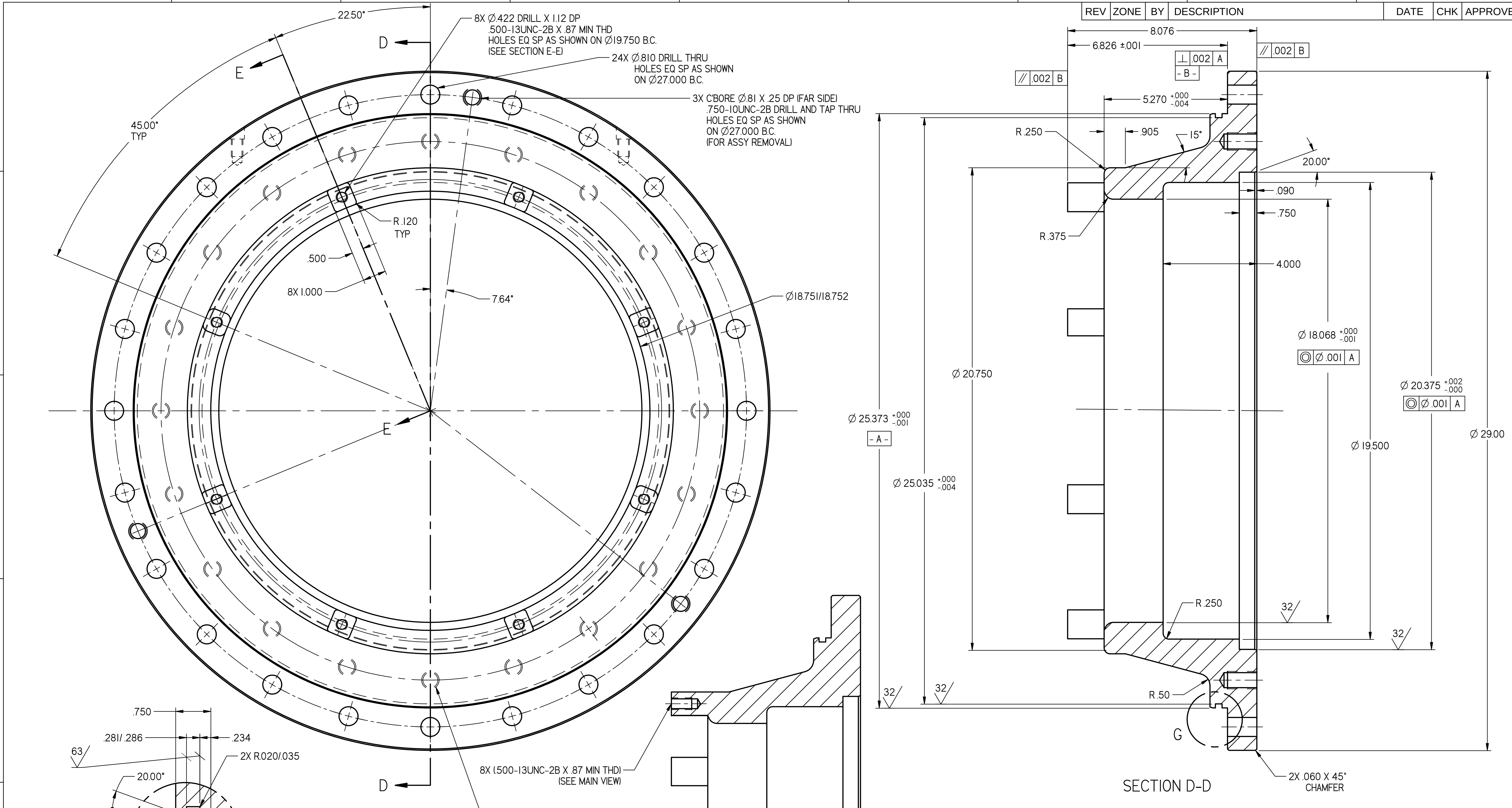
ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

TITLE
TURBINE NOZZLE ASSEMBLY

DWG. SIZE	PROJECT NO.	DWG
D	10466	E1046668

SCALE: 1/1 | EST. WT. | SHEET 2 OF 6

NOTES: UNLESS OTHERWISE SPECIFIED



NOTES: UNLESS OTHERWISE SPECIFIED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED

1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

FRACT DECIMALS ANGLES

± .X ±.10 .XX ±.03 .XXX ±.010 ±2°

THIS DRAWING AND THE INFORMATION REVEALED BY IT IS THE CONFIDENTIAL AND PROPRIETARY PROPERTY OF ENERGENT CORP AND IS NOT TO BE DISCLOSED TO OTHERS WITHOUT WRITTEN PERMISSION. UNAUTHORIZED USE OF THIS DRAWING IS EXPRESSLY FORBIDDEN.

DO NOT SCALE DRAWING

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

NEXT ASSY 1046650

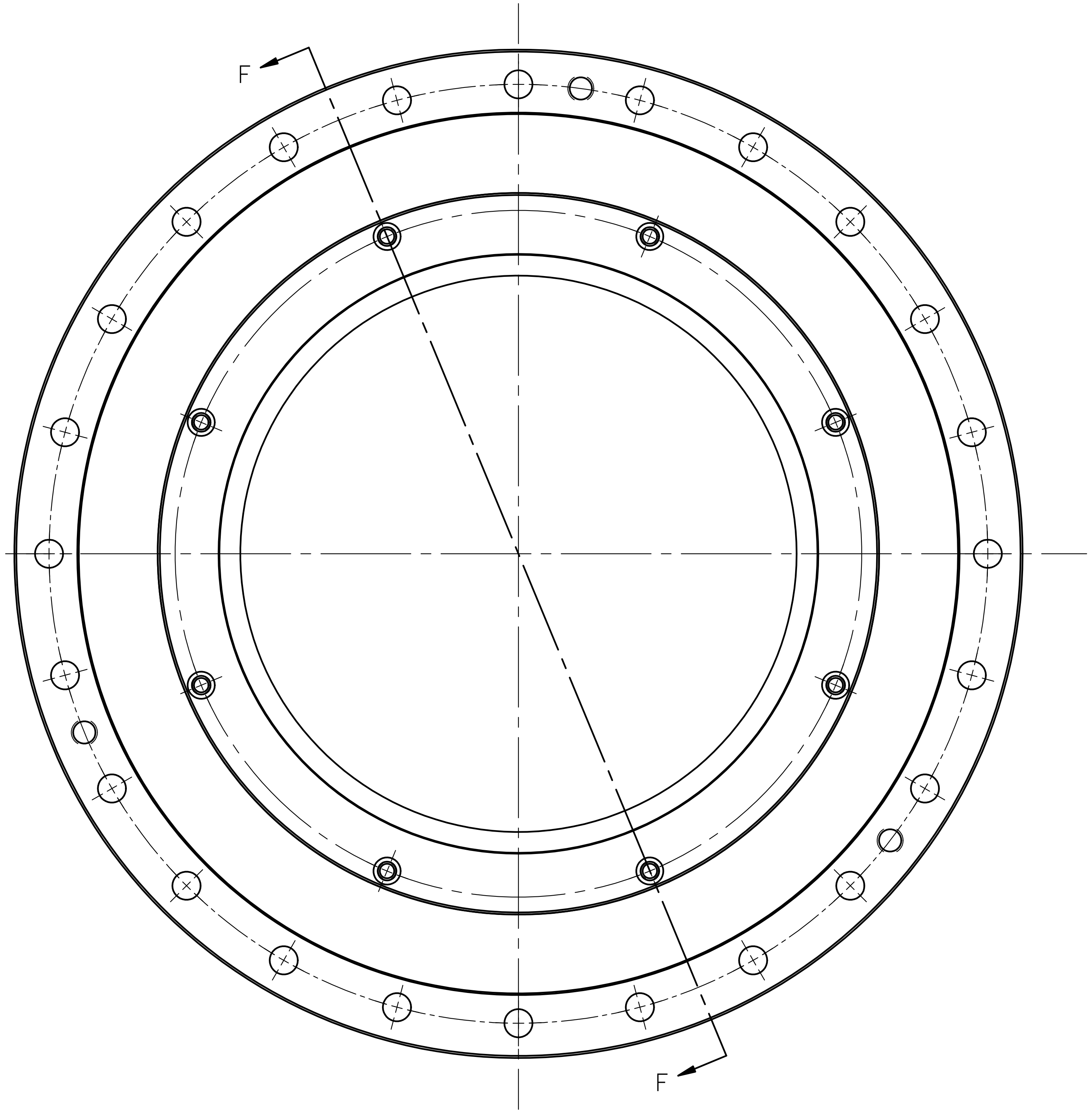
ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

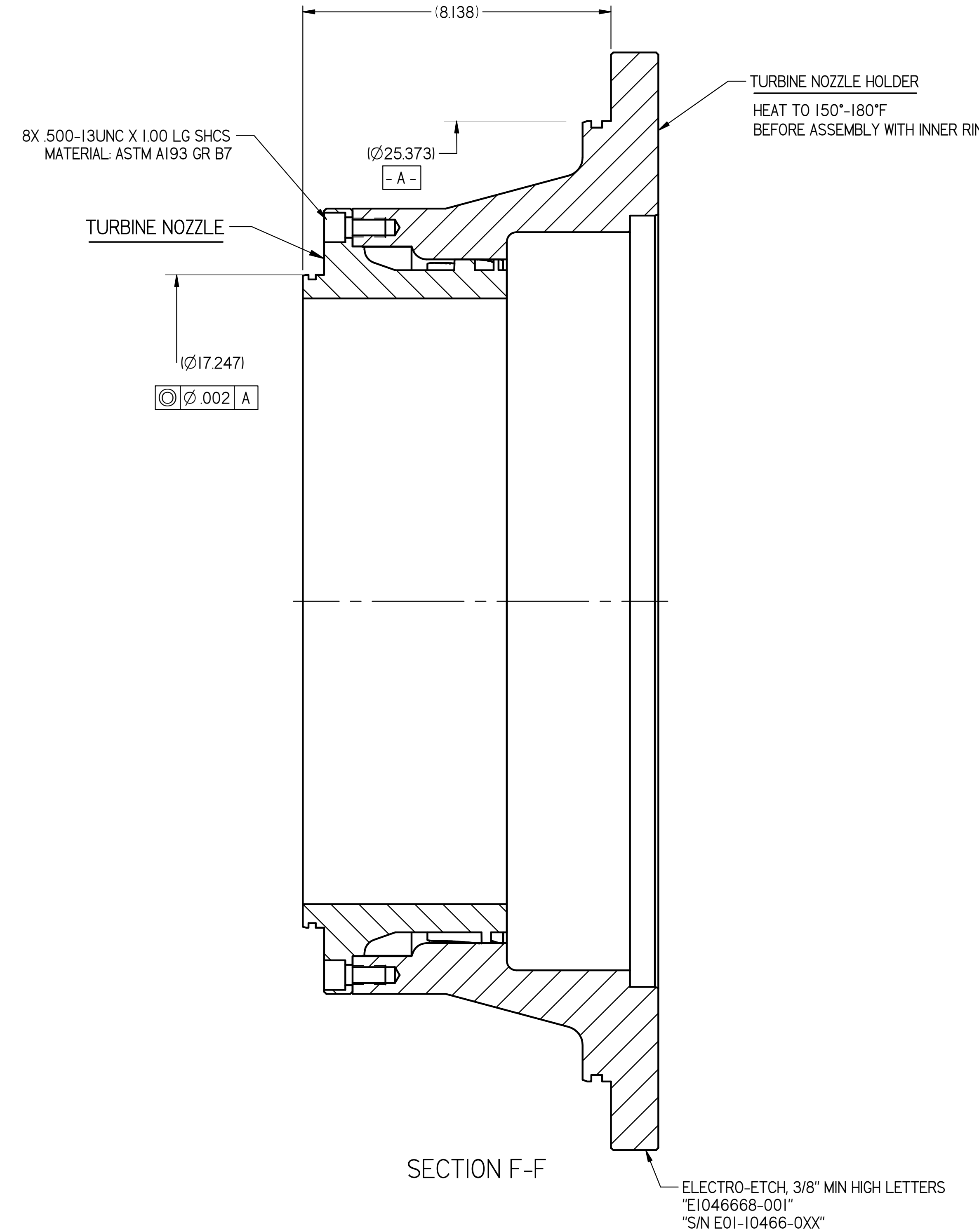
TITLE
TURBINE NOZZLE ASSEMBLY

DWG. SIZE D | PROJECT NO. 10466 | DWG E1046668

SCALE: 1/1 | EST. WT. | SHEET 3 OF 6

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED





ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED

1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH $\sqrt{}$ 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

FRACT	DECIMALS			ANGLES
±	.X ±.10	.XX ±.03	.XXX ±.010	±2°

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NEXT ASSY 1046650

DO NOT SCALE DRAWING

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

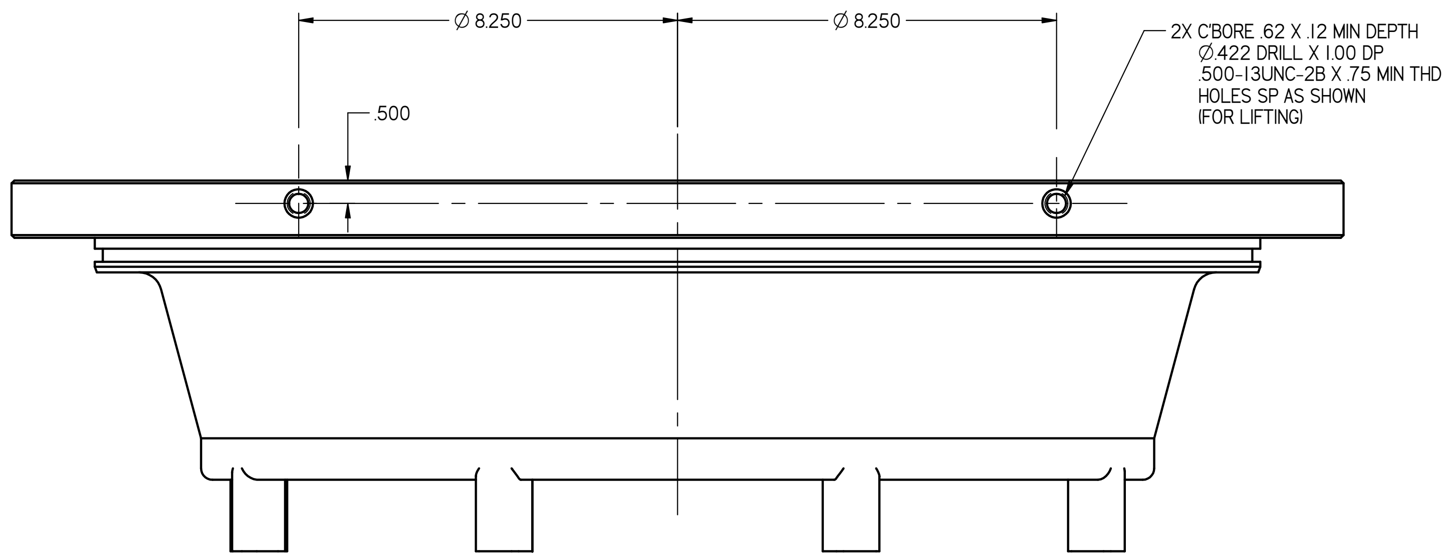
TITLE
TURBINE NOZZLE ASSEMBLY

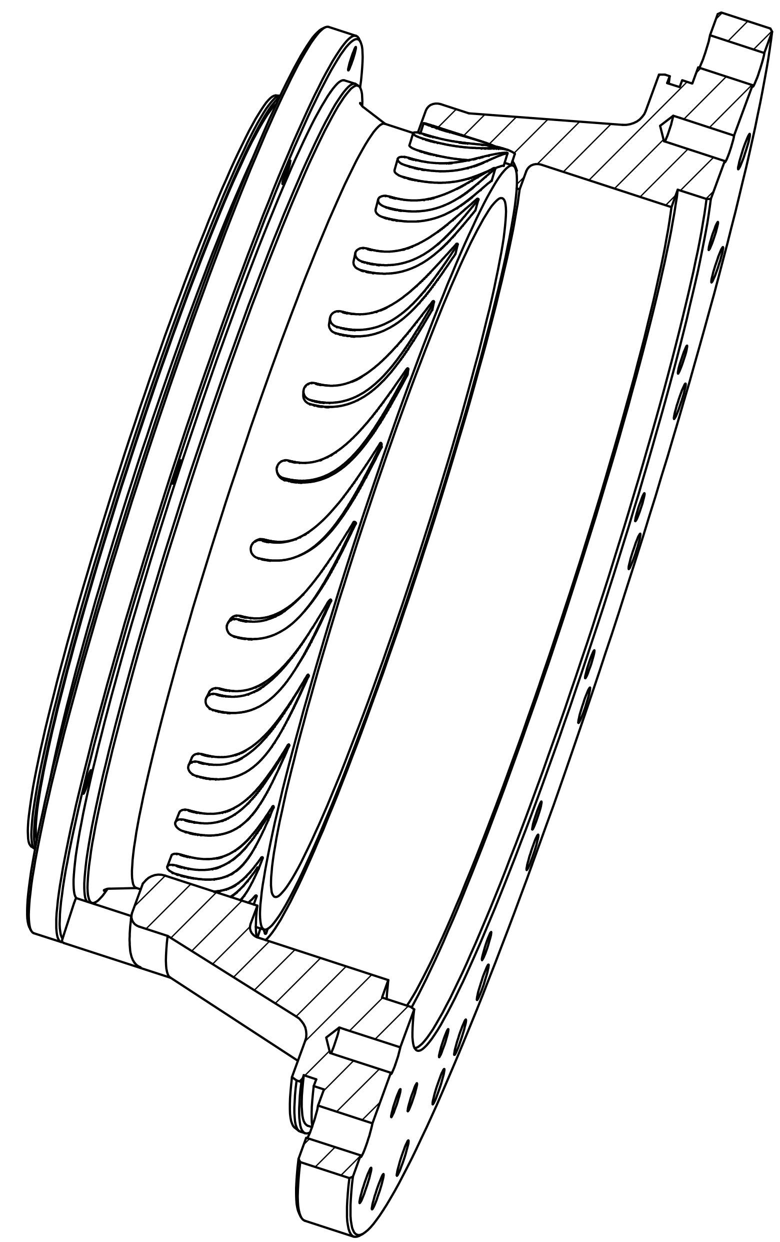
DWG. SIZE	PROJECT NO.	DWG
D	10466	E1046668

SCALE: 1/1 | EST. WT. | SHEET 4 OF 6

NOTES: UNLESS OTHERWISE SPECIFIED

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED





ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED

1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

FRACT	DECIMALS .X	.XX	.XXX	ANGLES
±	±.10	±.03	±.010	±2°

DO NOT SCALE DRAWING

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

NEXT ASSY 1046650

ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

TITLE
TURBINE NOZZLE ASSEMBLY

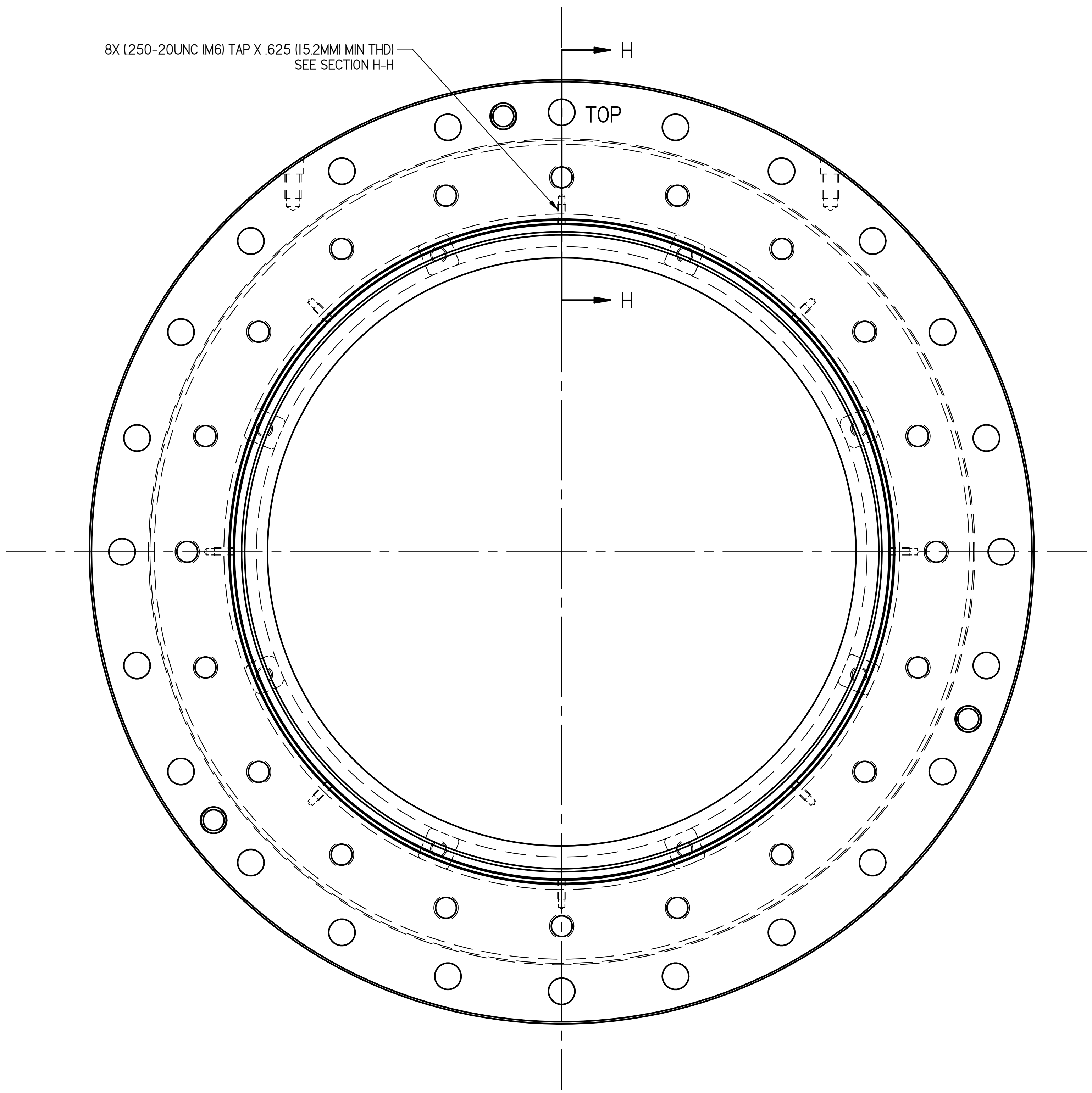
DWG. SIZE	PROJECT NO.	DWG
D	10466	E1046668

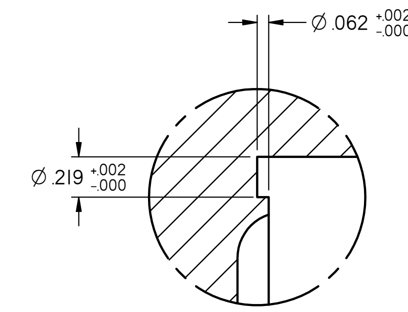
SCALE: 1/1 | EST. WT. | SHEET 5 OF 6

NOTES: UNLESS OTHERWISE SPECIFIED

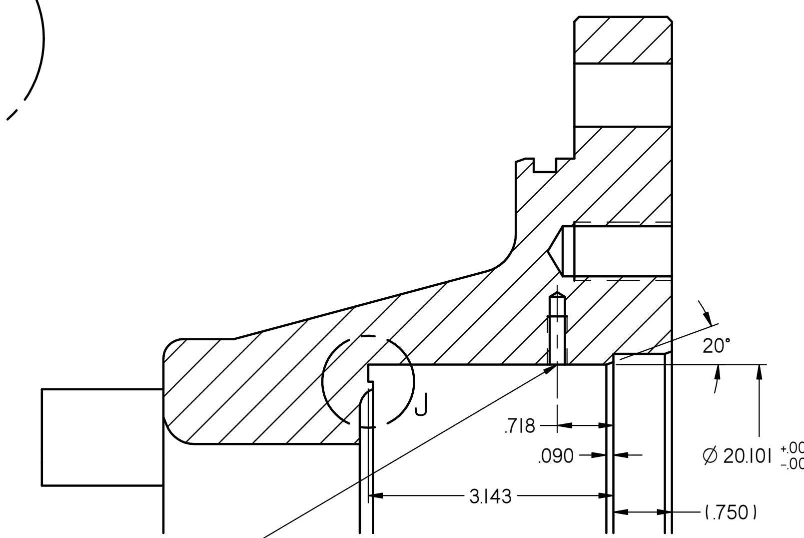
REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED

8X (.250-20UNC (M6) TAP X .625 (15.2MM) MIN THD)
SEE SECTION H-H



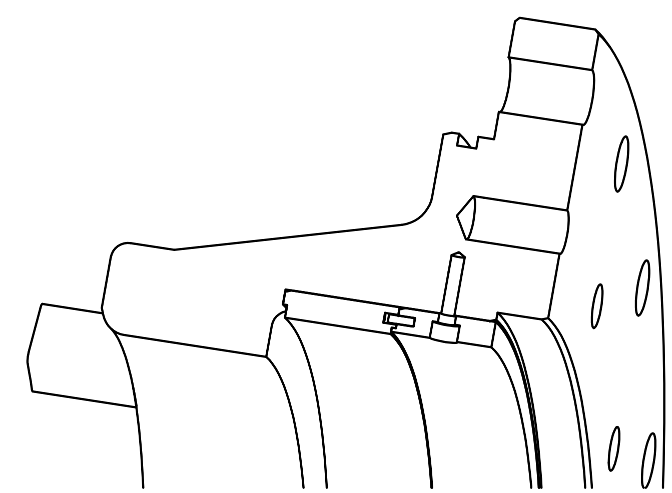


DETAIL J



8X #7 (Ø.201) DRILL X .750 (18.6MM) DP MAX
.250-20UNC (M6) TAP X .625(15.2MM) MIN THD
HOLES EQUALLY SPACED (SEE MAIN VIEW)

SECTION H-H



SEAL RING AND RETAINER

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH √

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
FRACT DECIMALS ANGLES
± .X ±.10 .XX ±.03 .XXX ±.002 ±2°

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DO NOT SCALE DRAWING

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

NEXT ASSY 1046650

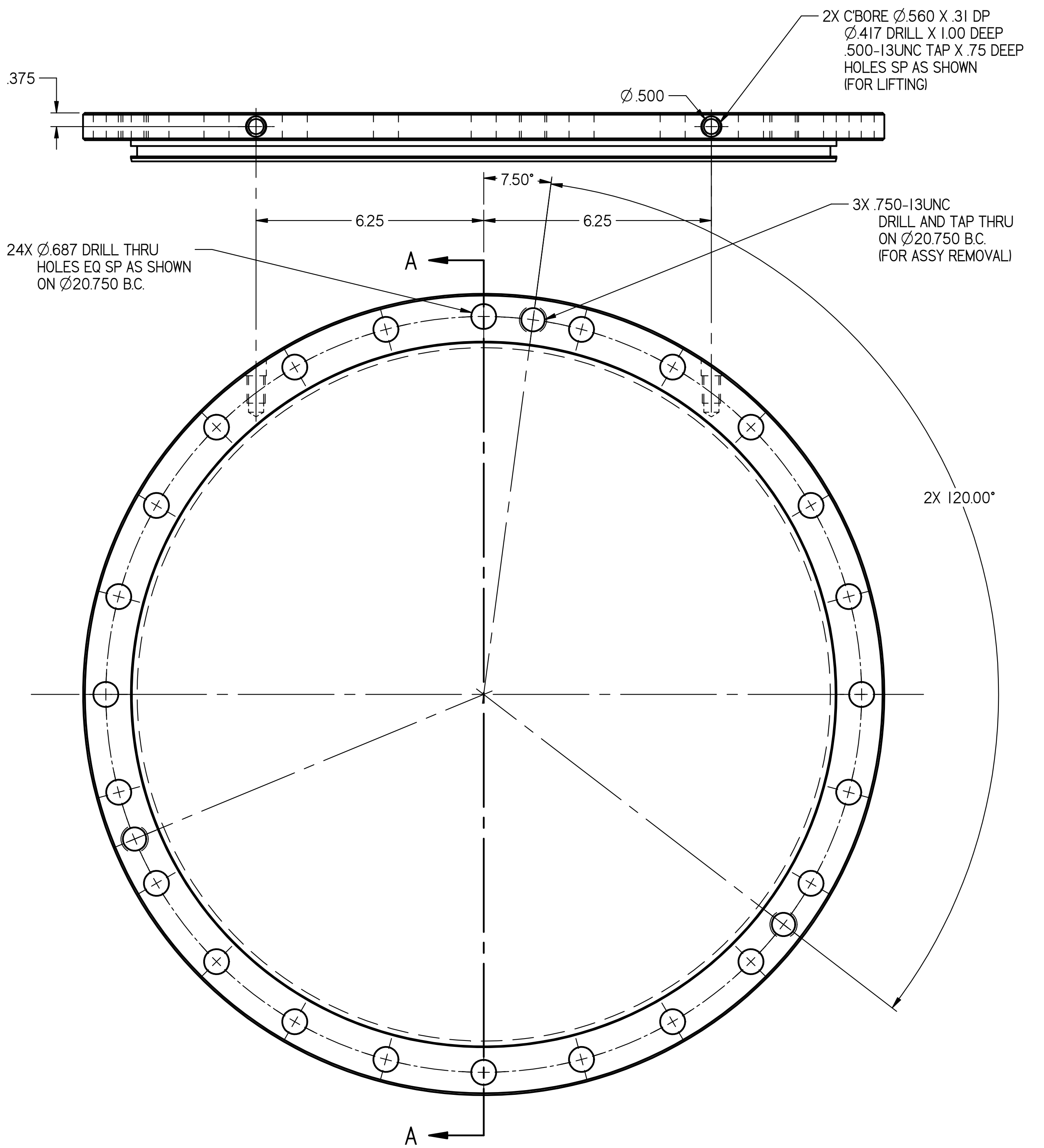
ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

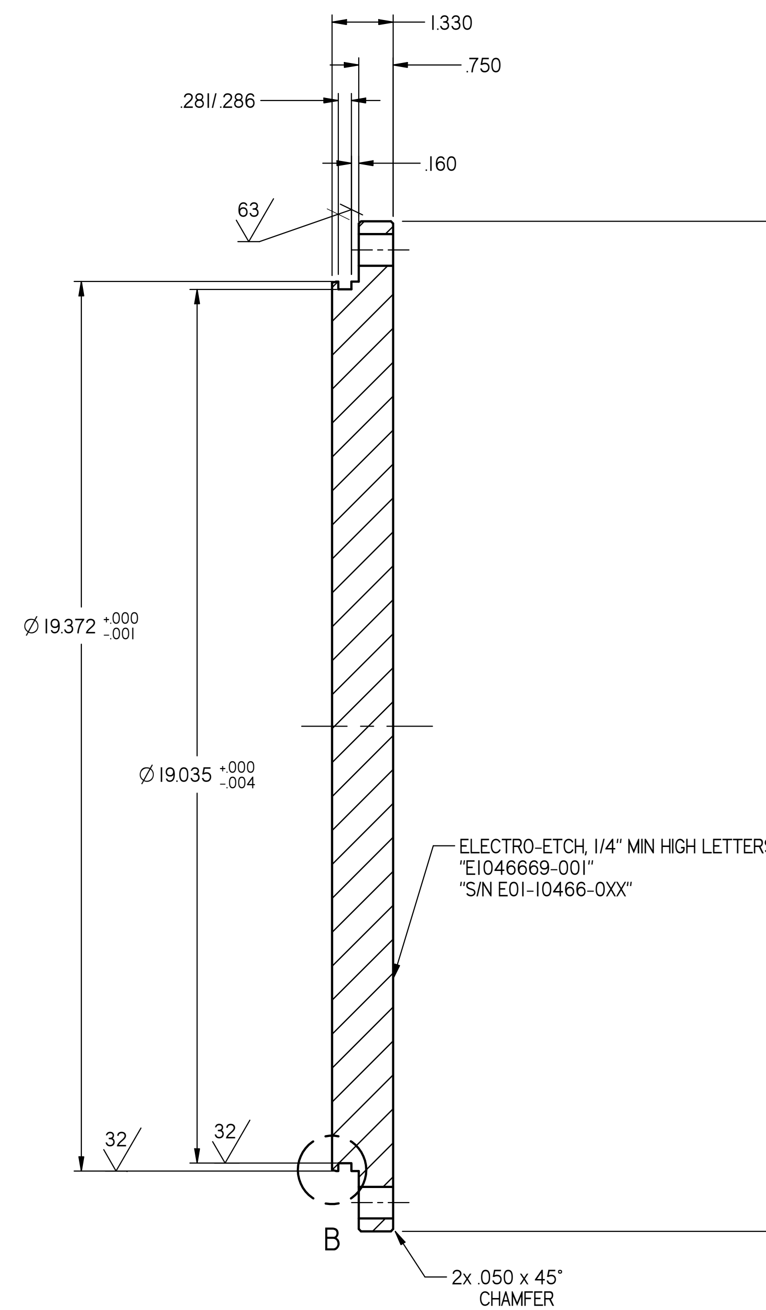
TITLE
TURBINE NOZZLE ASSEMBLY

DWG. SIZE D | PROJECT NO. 10466 | DWG E1046668

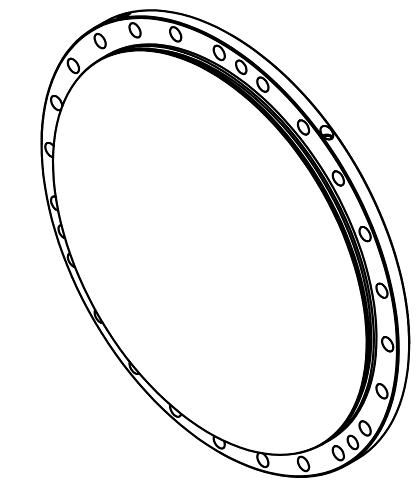
SCALE: 1/1 | EST. WT. | SHEET 6 OF 6

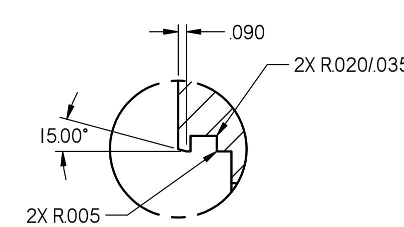
NOTES: UNLESS OTHERWISE SPECIFIED





SECTION A-A





DETAIL B

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED

1. MATERIAL IS PRESSURE VESSEL PLATE PER ASTM A516 GR 70
   SUPPLY CHEMICAL, MECHANICAL AND HEAT TREATMENT REPORTS

NOTES: UNLESS OTHERWISE SPECIFIED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
FRACT DECIMALS ANGLES
± .X ±.10 .XX ±.03 .XXX ±.010 ±2°

THIS DRAWING AND THE INFORMATION REVEALED BY IT IS THE CONFIDENTIAL AND PROPRIETARY PROPERTY OF ENERGENT CORP AND IS NOT TO BE DISCLOSED TO OTHERS WITHOUT WRITTEN PERMISSION. UNAUTHORIZED USE OF THIS DRAWING IS EXPRESSLY FORBIDDEN.

NEXT ASSY 1046650

DO NOT SCALE DRAWING

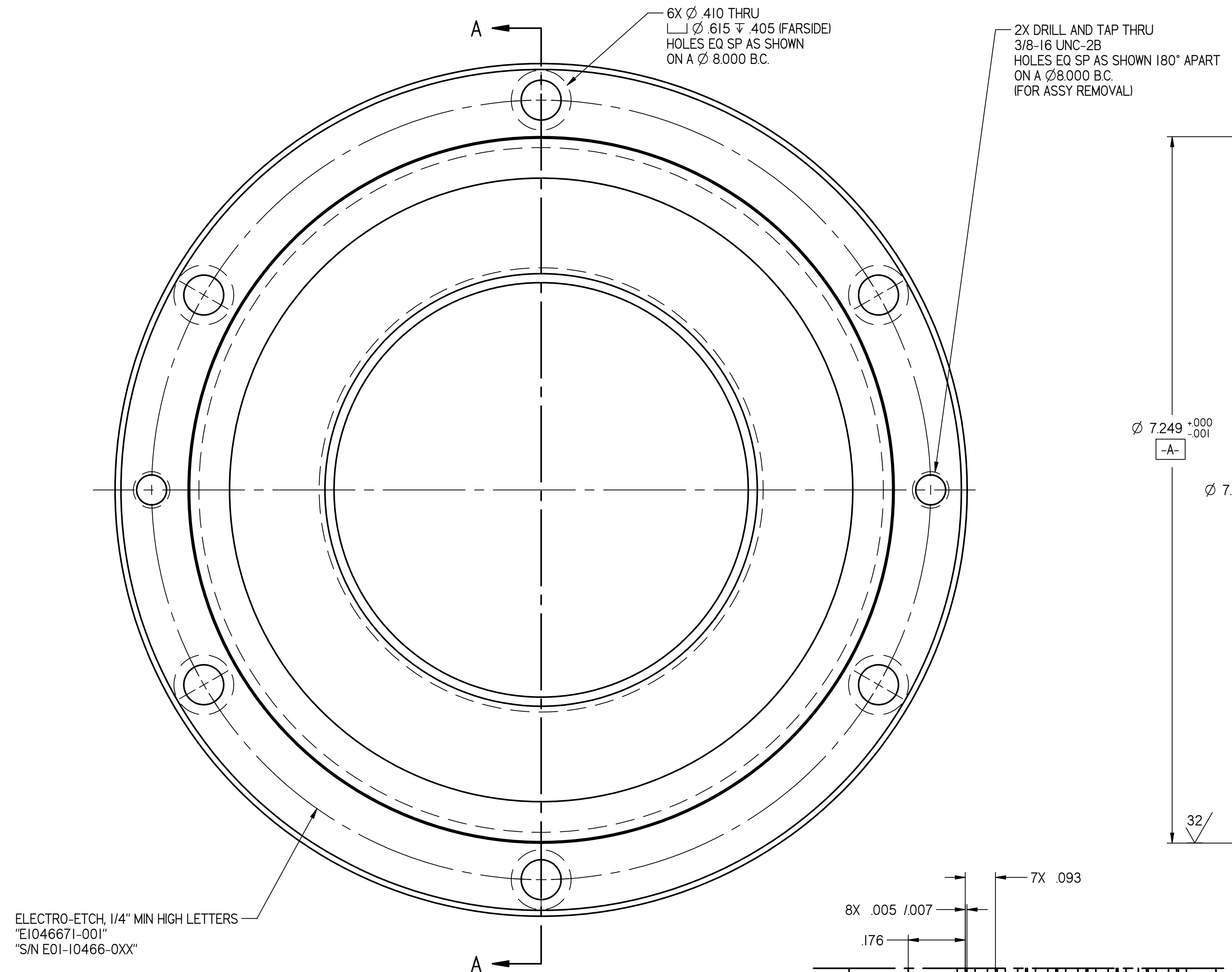
DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

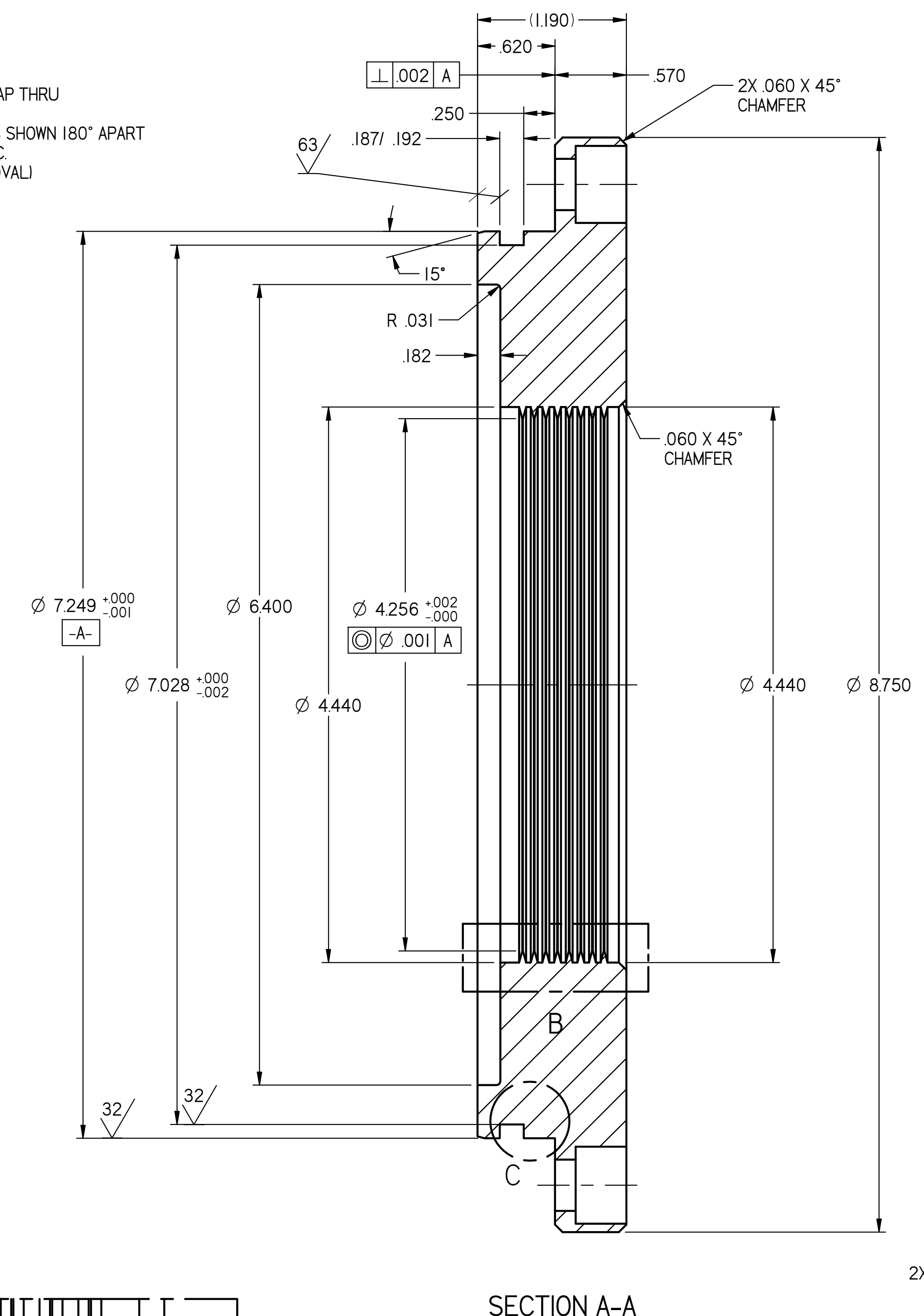
ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

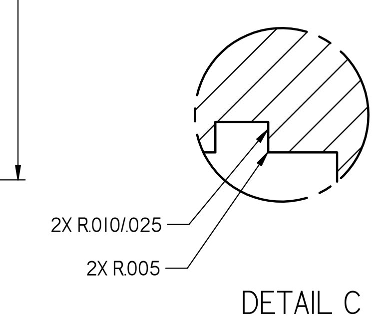
TITLE TURBINE HOUSING OUTLET END COVER

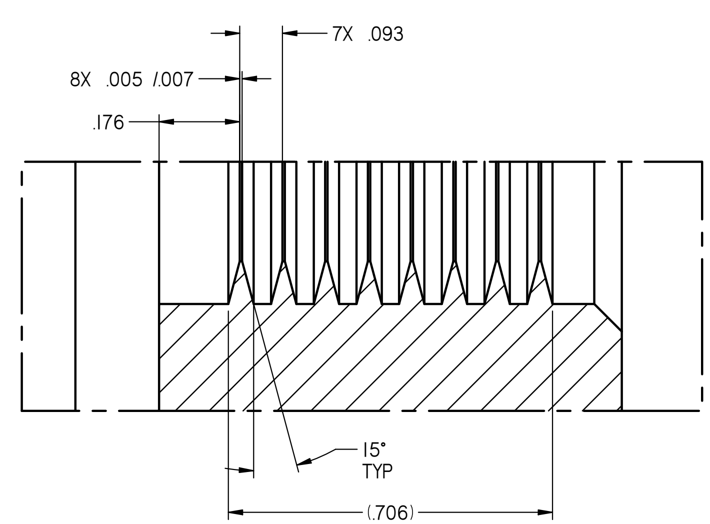
DWG. SIZE D | PROJECT NO. 10466 | DWG E1046669

SCALE: 1/1 | EST. WT. 126 LBS | SHEET 1 OF 1









NOTES: UNLESS OTHERWISE SPECIFIED

1. MATERIAL IS BRONZE C93200
SUPPLY CHEMICAL, MECHANICAL AND HEAT TREATMENT REPORTS

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
FRACT DECIMALS ANGLES
± .X ±.10 .XX ±.03 .XXX ±.010 ±2°

THIS DRAWING AND THE INFORMATION REVEALED BY IT IS THE CONFIDENTIAL AND PROPRIETARY PROPERTY OF ENERGENT CORP AND IS NOT TO BE DISCLOSED TO OTHERS WITHOUT WRITTEN PERMISSION. UNAUTHORIZED USE OF THIS DRAWING IS EXPRESSLY FORBIDDEN.

NEXT ASSY 1046650

DO NOT SCALE DRAWING

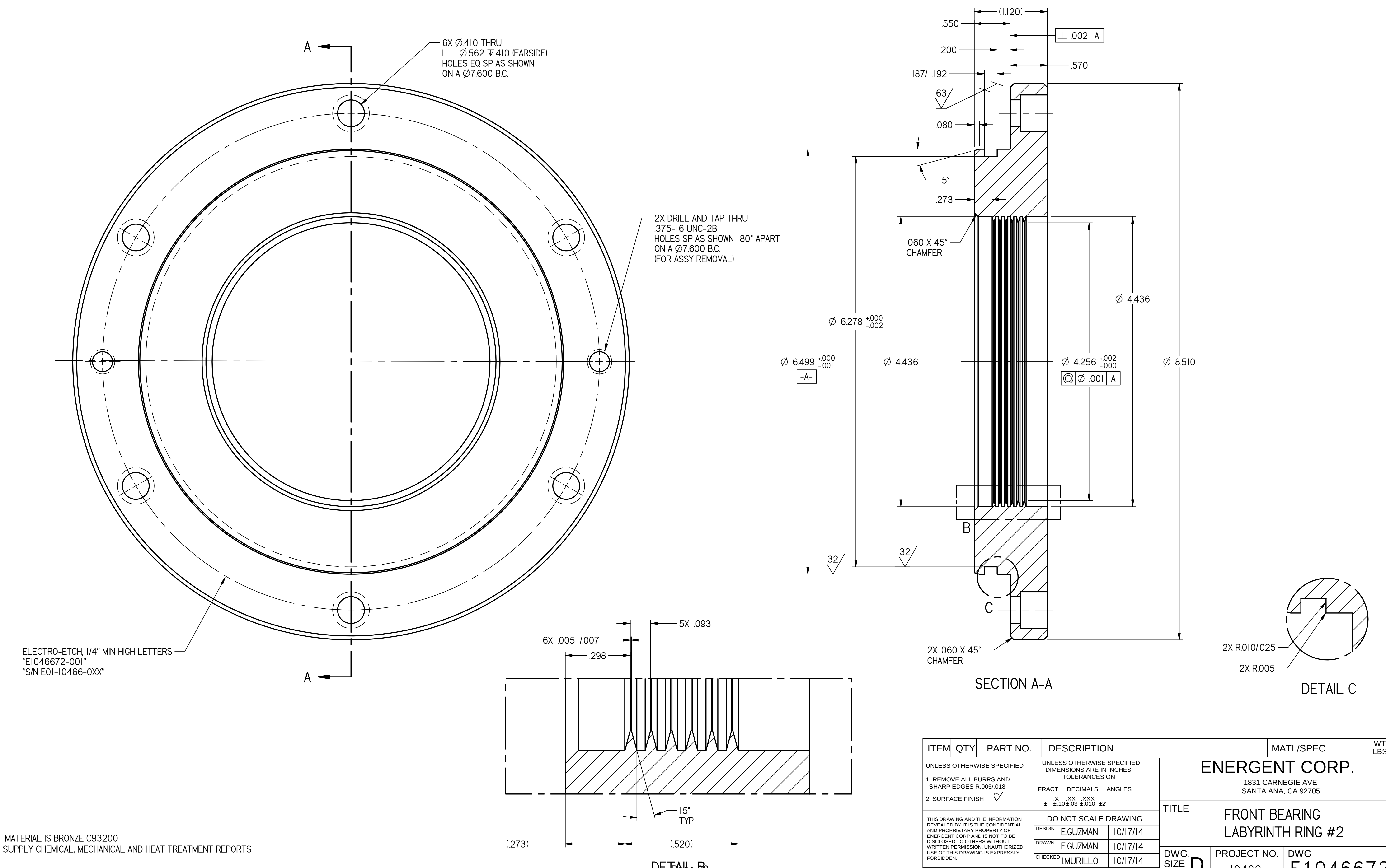
DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

TITLE FRONT BEARING LABYRINTH RING #1

DWG. SIZE D | PROJECT NO. 10466 | DWG E1046671

SCALE: 1/1 | EST. WT. 11.9 LBS | SHEET 1 OF 1



1. MATERIAL IS BRONZE C93200
SUPPLY CHEMICAL, MECHANICAL AND HEAT TREATMENT REPORTS

NOTES: UNLESS OTHERWISE SPECIFIED

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
FRACT DECIMALS ANGLES
± .X ±.10 .XX ±.03 .XXX ±.010 ±2°

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NEXT ASSY 1046650

DO NOT SCALE DRAWING

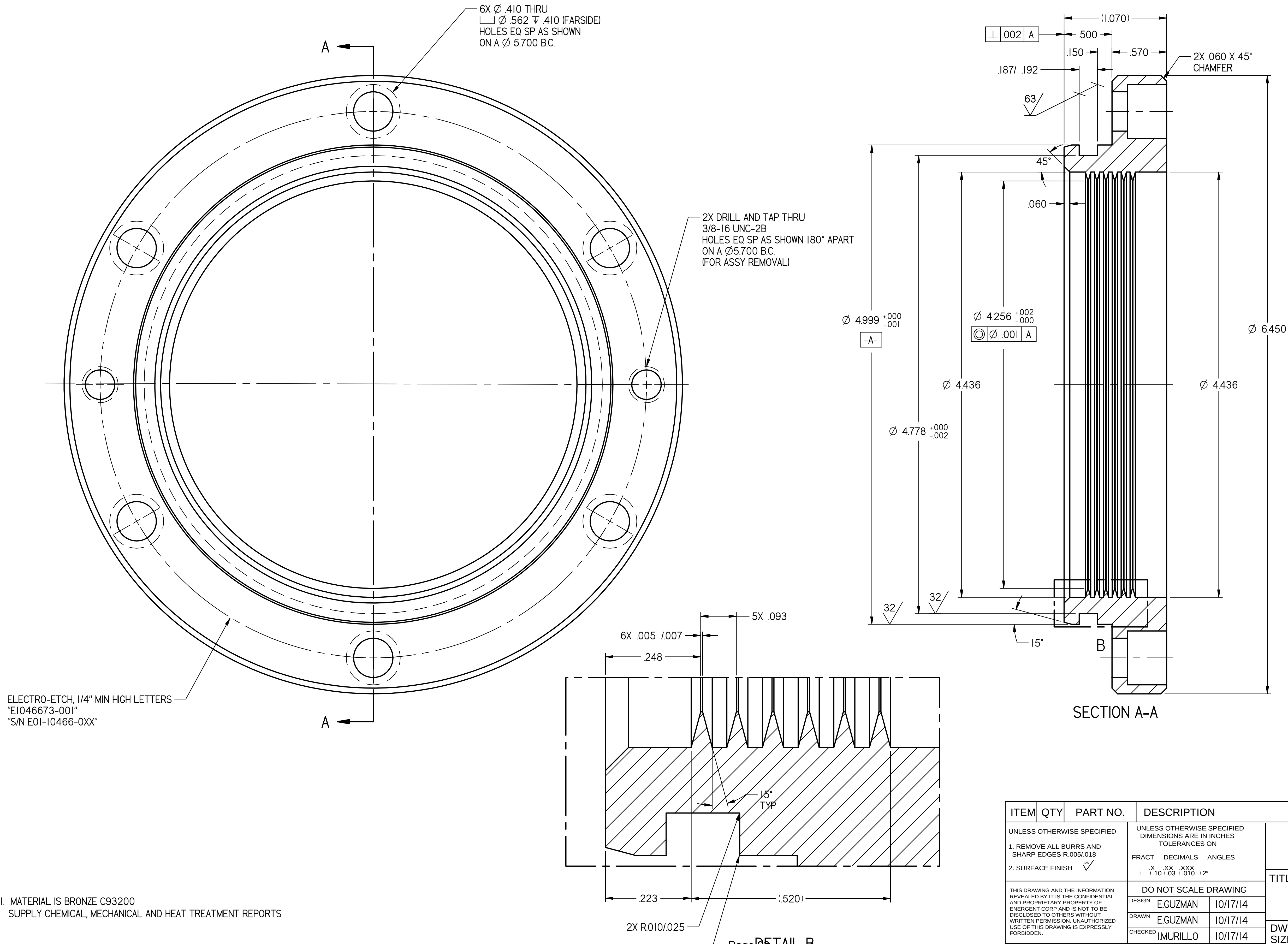
DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

TITLE FRONT BEARING LABYRINTH RING #2

DWG. SIZE D | PROJECT NO. 10466 | DWG E1046672

SCALE: 1/1 | EST. WT. 10.2 LBS | SHEET 1 OF 1



1. MATERIAL IS BRONZE C93200
SUPPLY CHEMICAL, MECHANICAL AND HEAT TREATMENT REPORTS

NOTES: UNLESS OTHERWISE SPECIFIED

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125√

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
FRACT ± — DECIMALS .X ±.10 .XX ±.03 .XXX ±.010 — ANGLES ±2°

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NEXT ASSY 1046650

DO NOT SCALE DRAWING

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

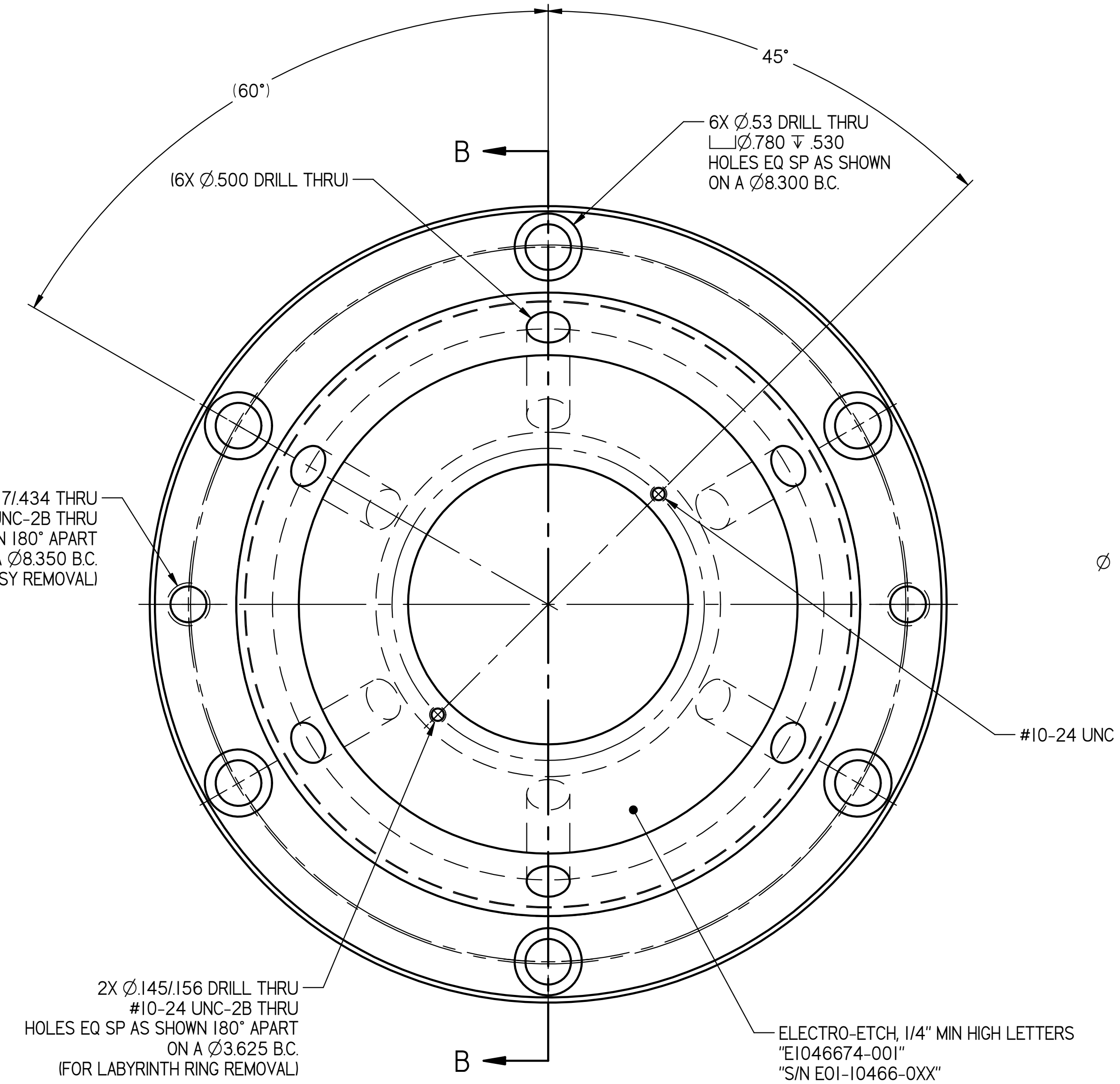
ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

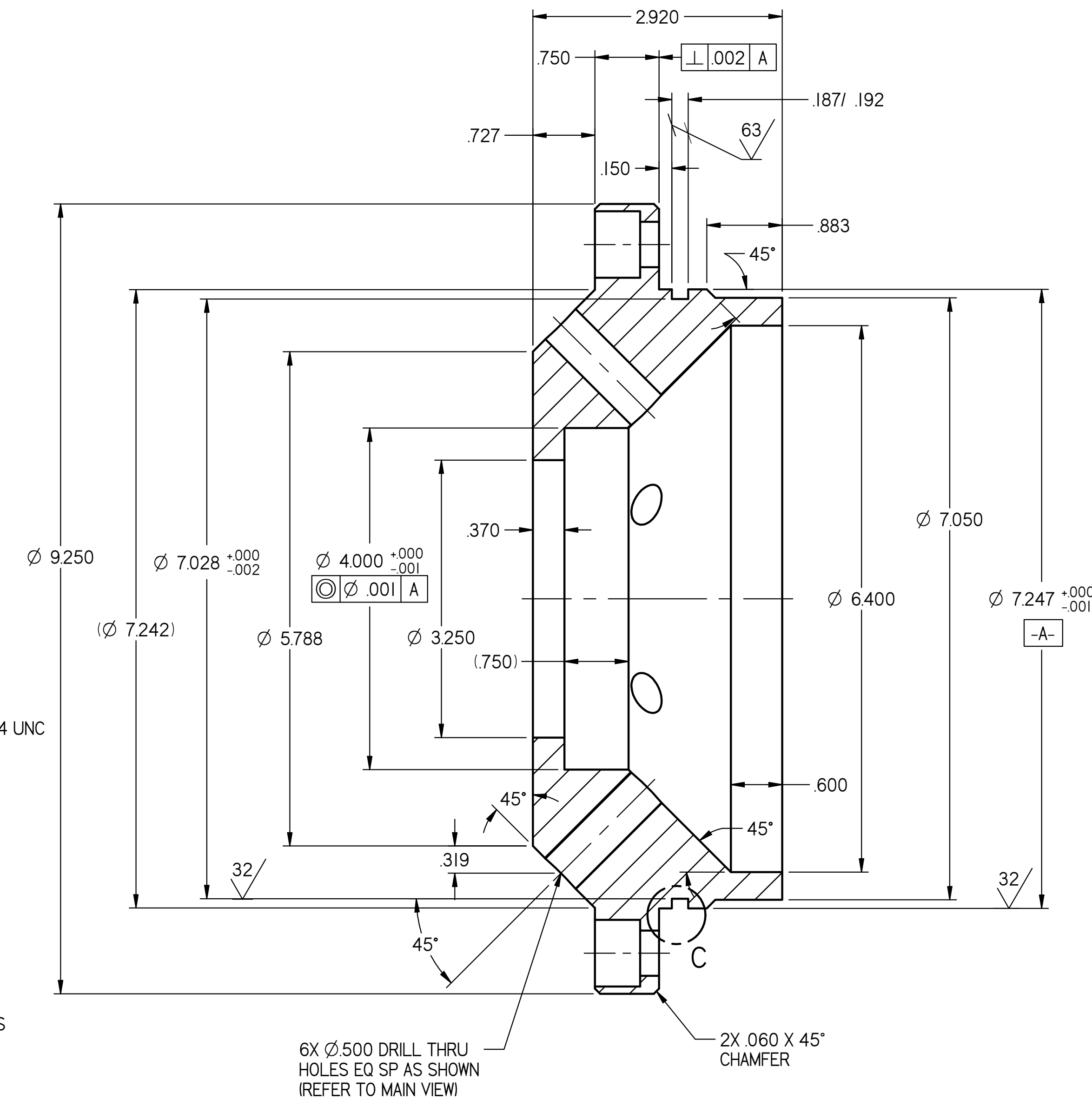
TITLE BACK BEARING LABYRINTH RING #1

DWG. SIZE D | PROJECT NO. 10466 | DWG E1046673

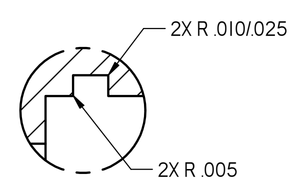
SCALE: 1/1 | EST. WT. 3.5 LBS | SHEET 1 OF 1

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED





SECTION B-B



DETAIL C

−01

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
FRACT DECIMALS ANGLES
± .X ±.10 .XX ±.03 .XXX ±.010 ±2°

ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

TITLE
BACK BEARING
LABYRINTH RING #2 ASSY

DO NOT SCALE DRAWING

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

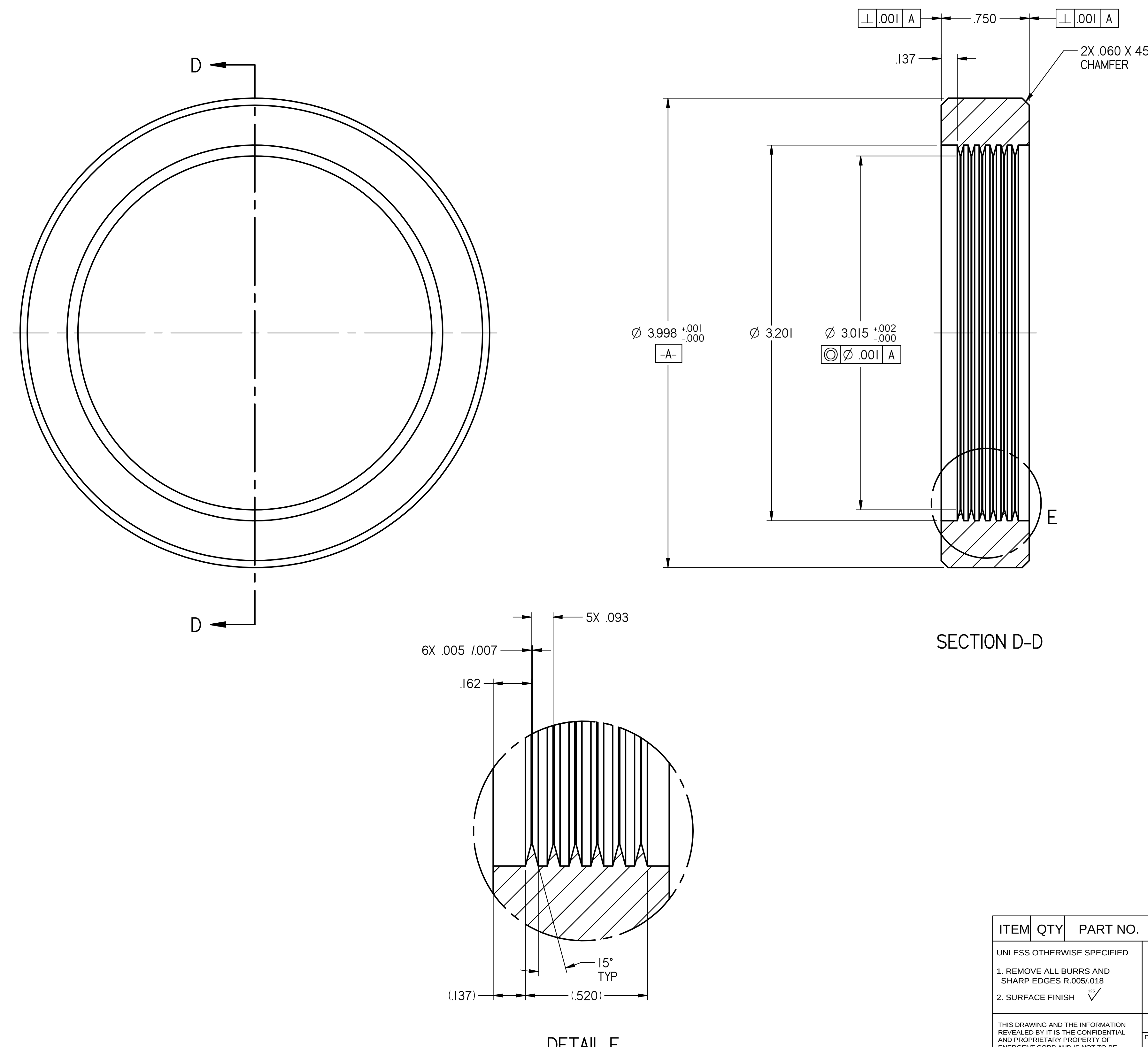
NEXT ASSY 1046650

DWG. SIZE D | PROJECT NO. 10466 | DWG E1046674

SCALE: 1/1 | EST. WT. 20.8 LBS | SHEET 1 OF 3

1. MATERIAL IS SS316 PER ASTM A240.
SUPPLY CHEMICAL, MECHANICAL AND HEAT TREATMENT REPORTS.

NOTES: UNLESS OTHERWISE SPECIFIED



−02

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED

1. MATERIAL IS BRONZE C93200.
   SUPPLY CHEMICAL, MECHANICAL AND HEAT TREATMENT REPORTS.

NOTES: UNLESS OTHERWISE SPECIFIED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED

1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125√

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

FRACT	DECIMALS			ANGLES
±	.X ±.10	.XX ±.03	.XXX ±.010	±2°

DO NOT SCALE DRAWING

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DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

NEXT ASSY 1046650

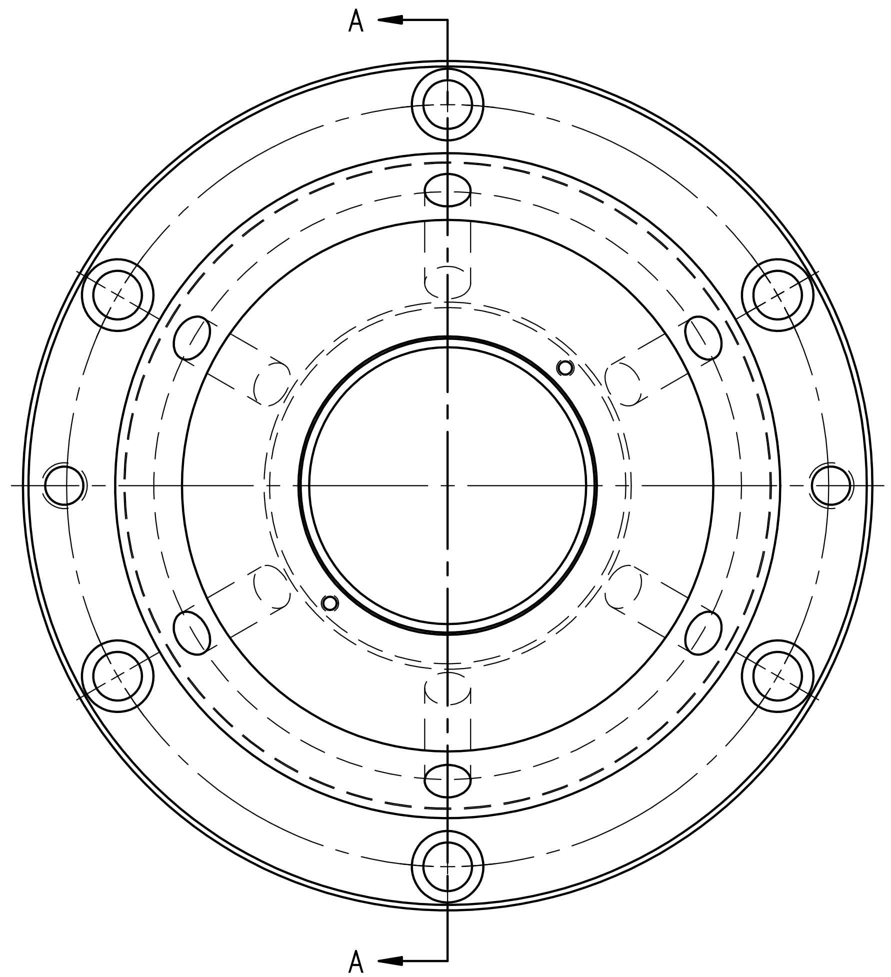
ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

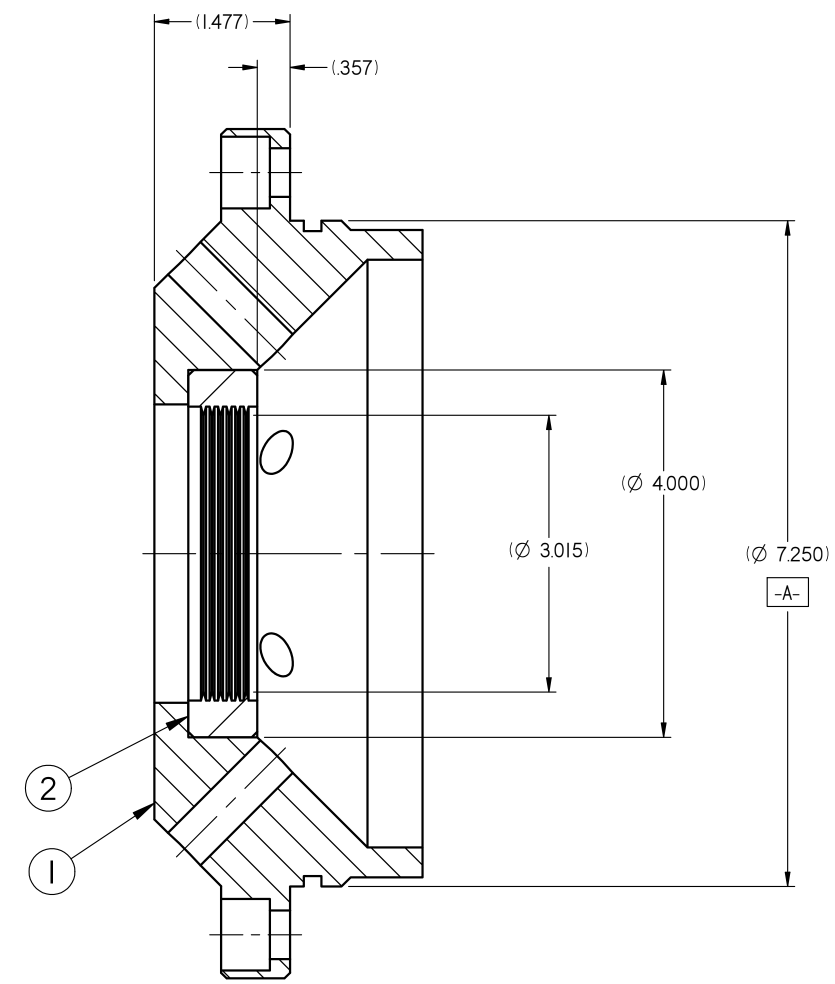
TITLE
BACK BEARING
LABYRINTH RING #2 ASSY

DWG. SIZE	PROJECT NO.	DWG
D	10466	E1046674

SCALE: 1/1	EST. WT. 1.2 LBS	SHEET 2 OF 3

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED





SECTION A-A

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS
-02			BACK LABYRINTH RING		
-01			BACK BEARING LOCKING PLATE		

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125√

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
FRACT ± DECIMALS .X ±.10 .XX ±.03 .XXX ±.010 ANGLES ±2°

DO NOT SCALE DRAWING

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

NEXT ASSY 1046650

ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

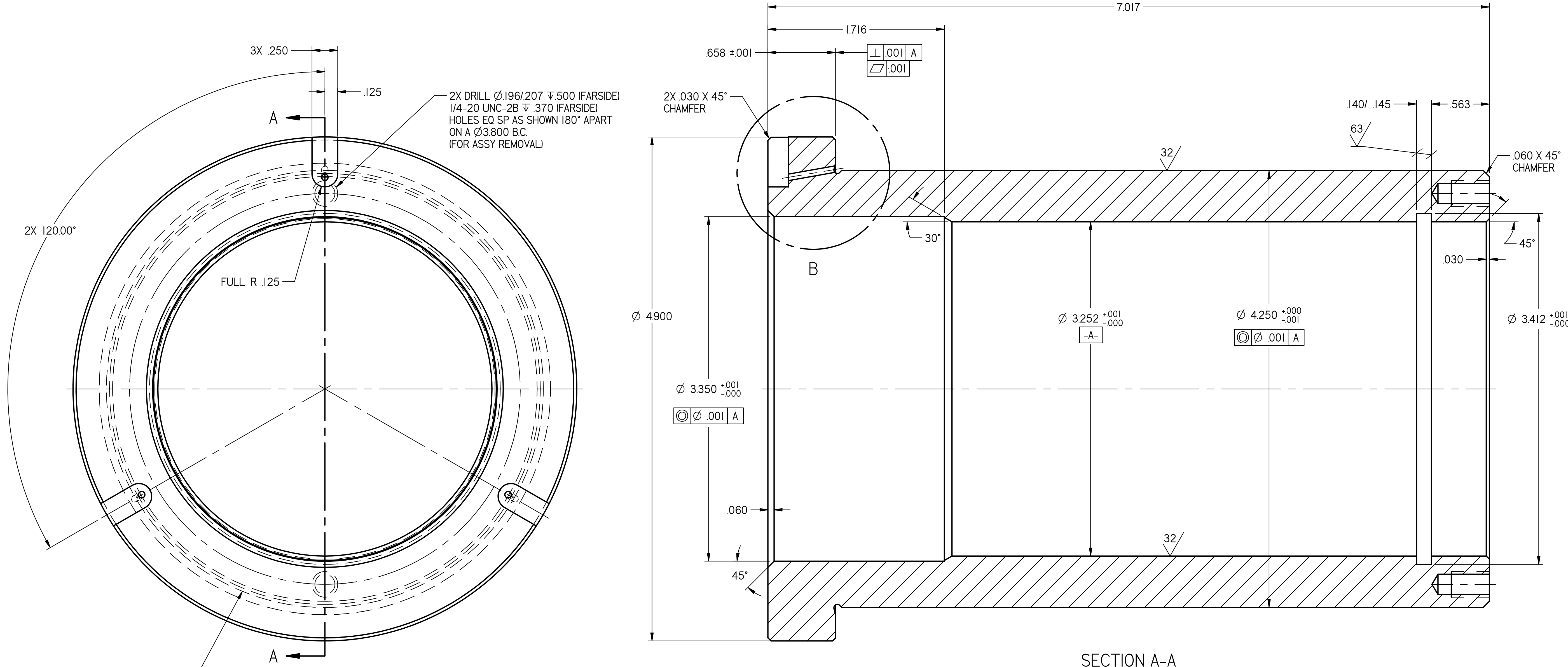
TITLE
BACK BEARING LABYRINTH RING #2 ASSY

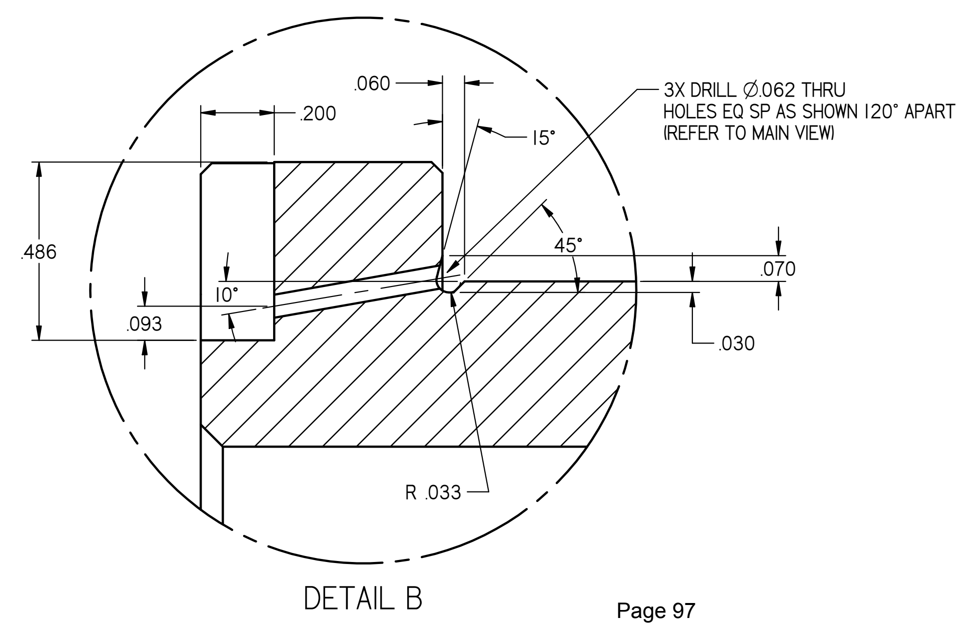
DWG. SIZE D | PROJECT NO. 10466 | DWG E1046674

SCALE: 1/1 | EST. WT. 22 LBS | SHEET 3 OF 3

NOTES: UNLESS OTHERWISE SPECIFIED

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED





1. MATERIAL IS 4140 PER AMS-6382. HEAT TREAT TO 50RC MINIMUM. SUPPLY CHEMICAL, MECHANICAL AND HEAT TREATMENT REPORTS.

NOTES: UNLESS OTHERWISE SPECIFIED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
FRACT DECIMALS ANGLES
± .X ±.10 .XX ±.03 .XXX ±.010 ±2°

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NEXT ASSY 1046650

DO NOT SCALE DRAWING

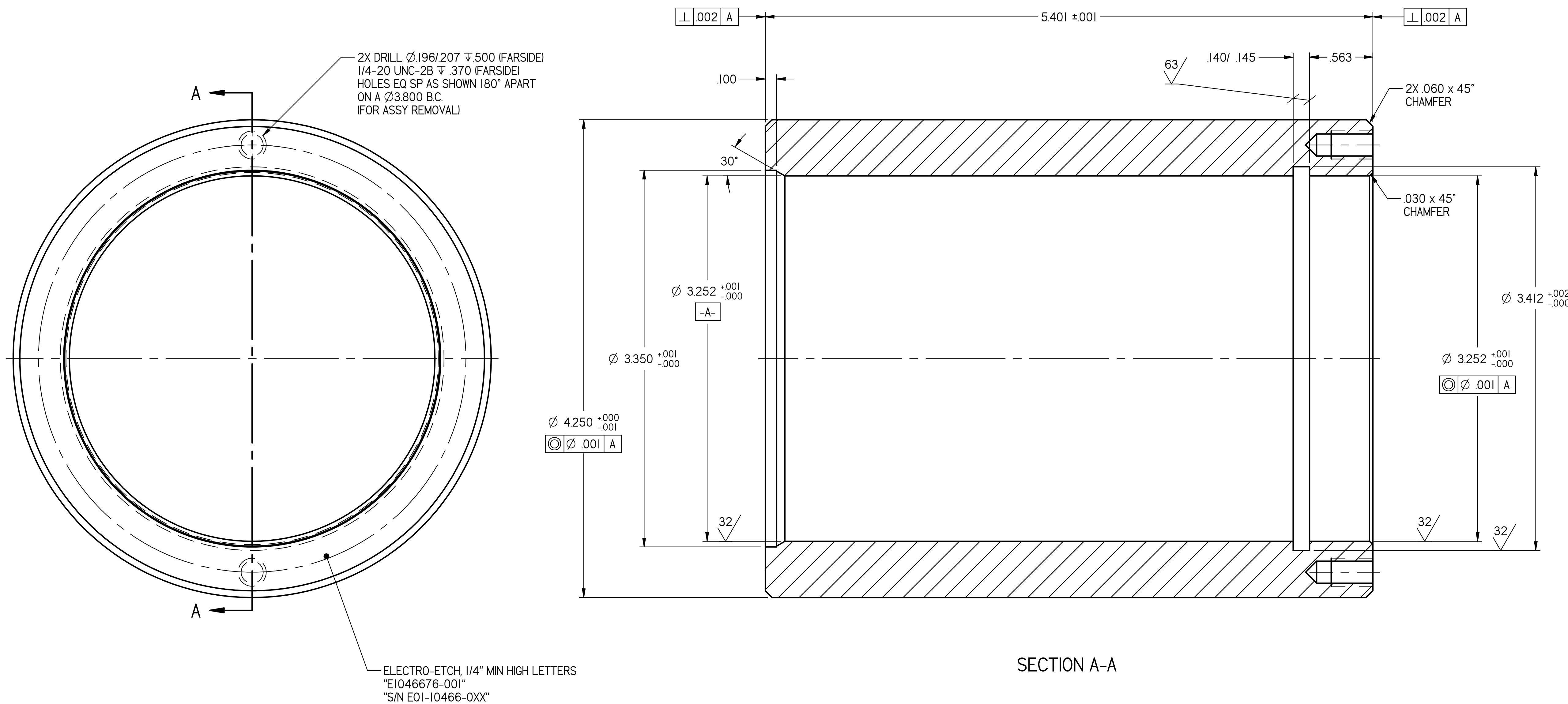
DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

TITLE
FRONT BEARING - SHAFT SLEEVE #1

DWG. SIZE D | PROJECT NO. 10466 | DWG E1046675

SCALE: 1/1 | EST. WT. 12.4 LBS | SHEET 1 OF 1



NOTES: UNLESS OTHERWISE SPECIFIED

1. MATERIAL IS SS316 PER ASTM A240.
SUPPLY CHEMICAL, MECHANICAL AND HEAT TREATMENT REPORTS.

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

FRACT	DECIMALS		ANGLES
±	.X ±.10	.XX ±.03 / .XXX ±.010	±2°

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DO NOT SCALE DRAWING

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

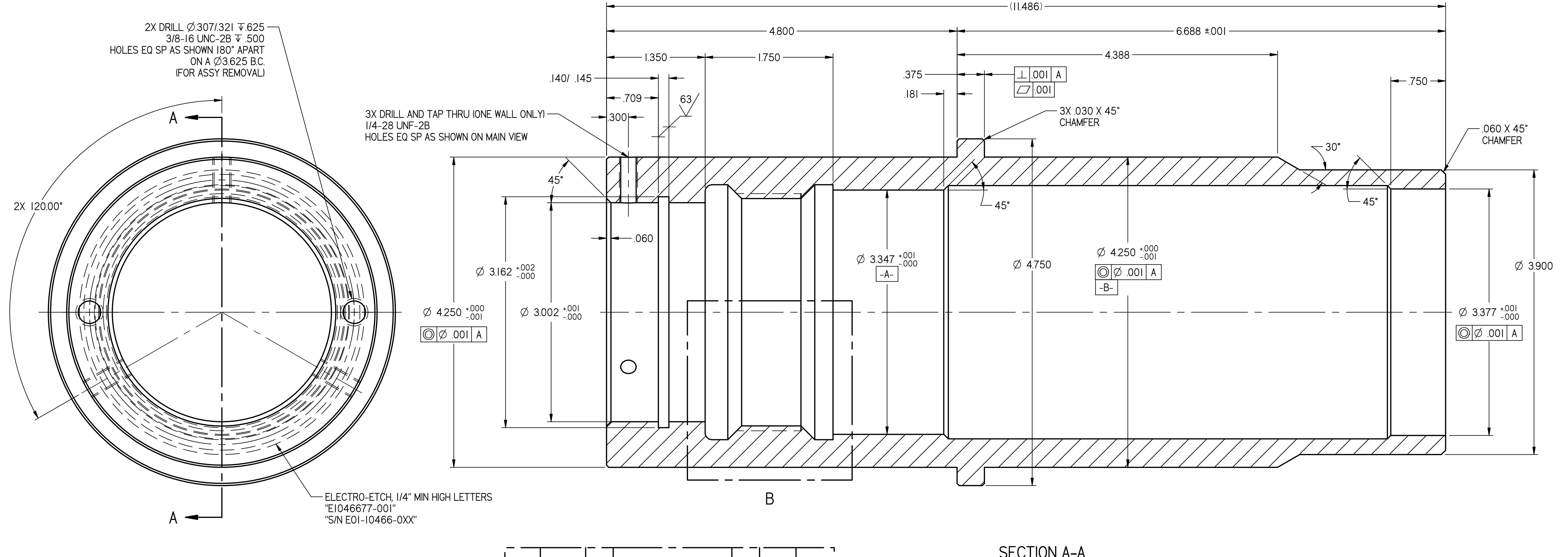
NEXT ASSY 1046650

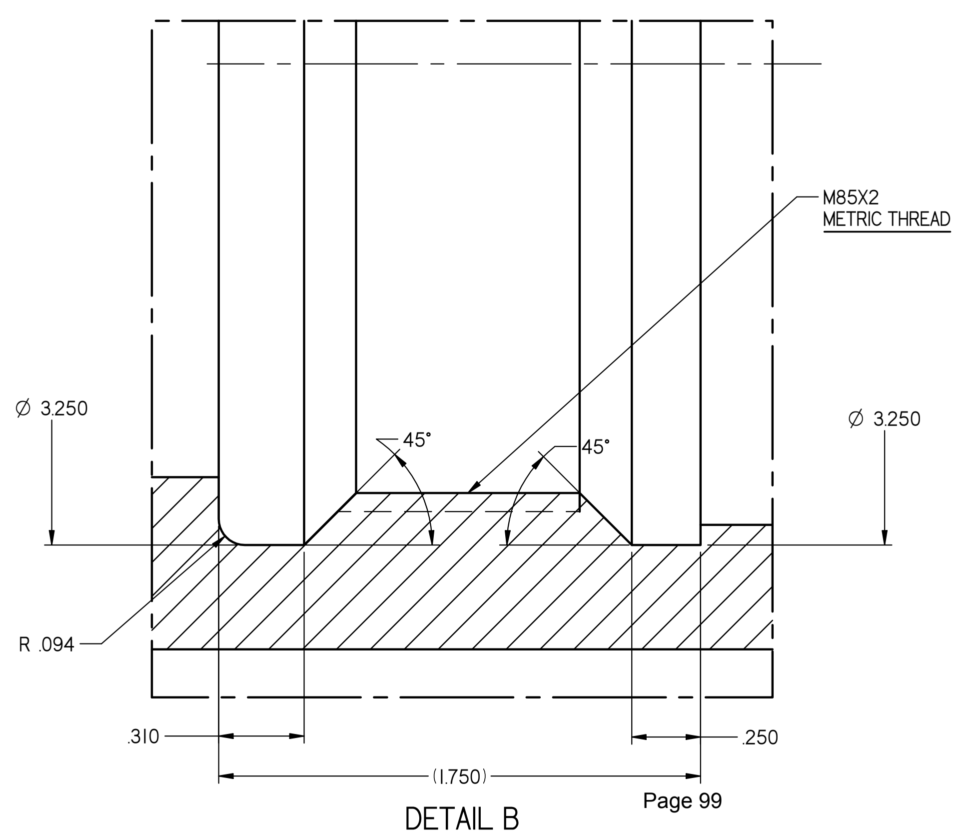
ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

TITLE
FRONT BEARING - SHAFT SLEEVE #2

DWG. SIZE D | PROJECT NO. 10466 | DWG E1046676

SCALE: 1/1 | EST. WT. 9.1 LBS | SHEET 1 OF 1





1. MATERIAL IS 4140 PER AMS-6382. HEAT TREAT TO 50RC MINIMUM. SUPPLY CHEMICAL, MECHANICAL AND HEAT TREATMENT REPORTS.

NOTES: UNLESS OTHERWISE SPECIFIED

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
FRACT DECIMALS ANGLES
± .X ±.10 .XX ±.03 .XXX ±.010 ±2°

DO NOT SCALE DRAWING

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

NEXT ASSY 1046650

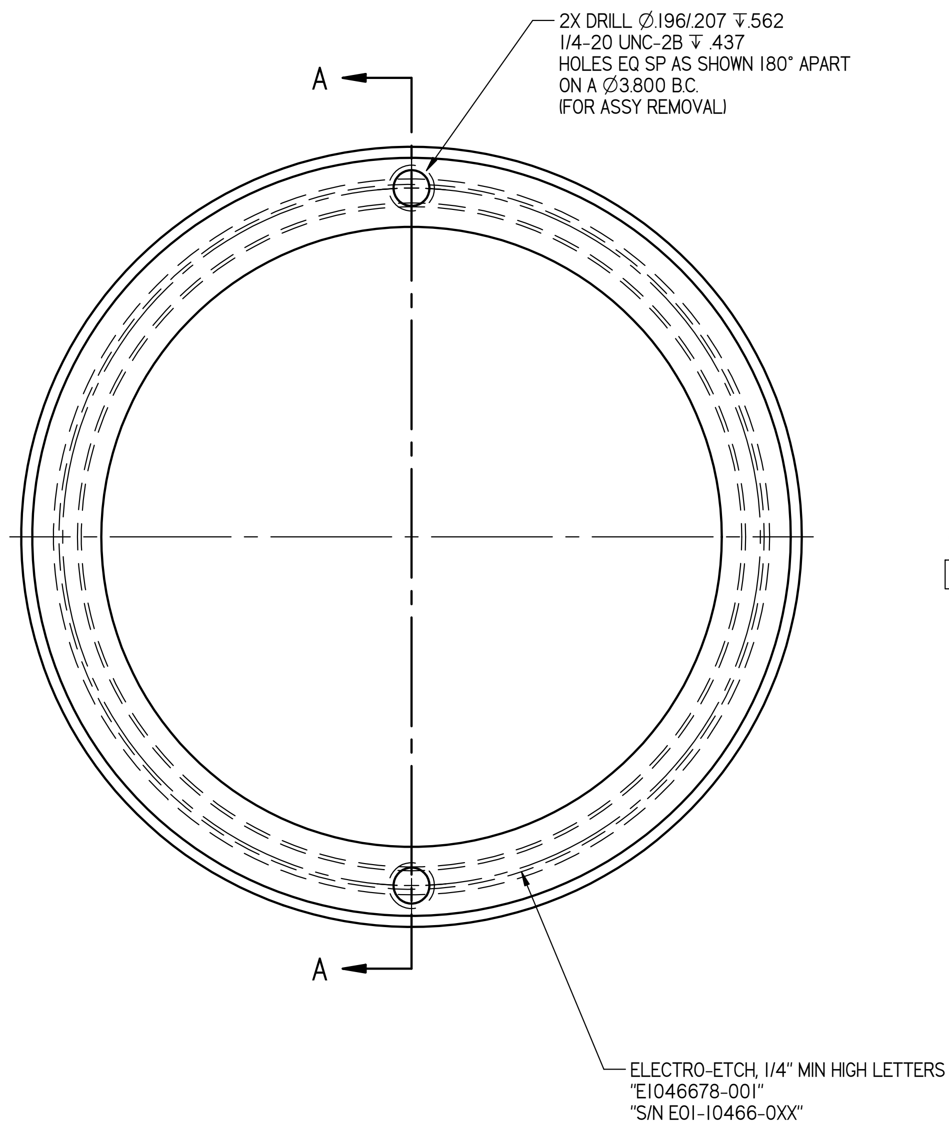
ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

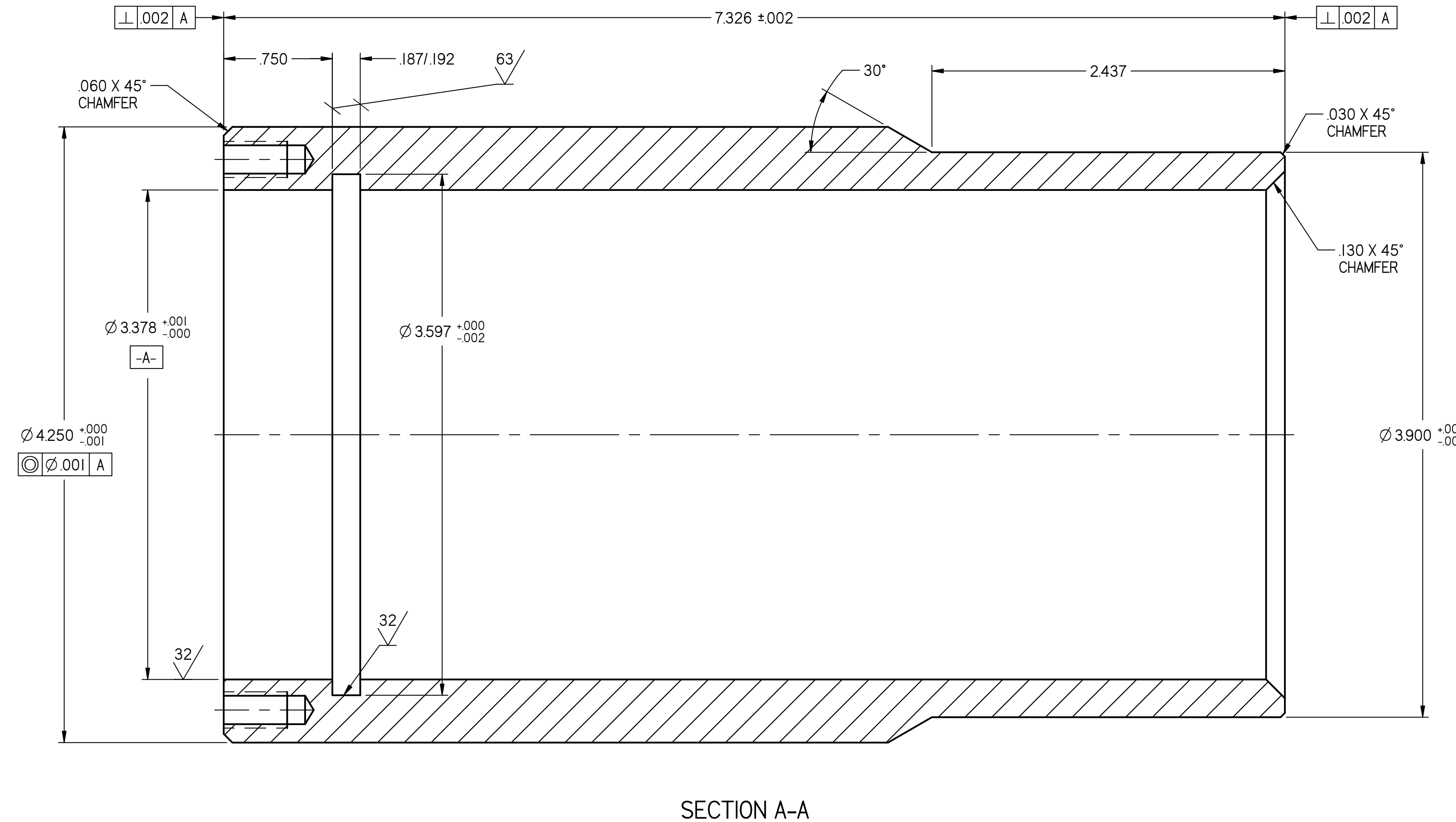
TITLE
BACK BEARING - SHAFT SLEEVE #1

DWG. SIZE D | PROJECT NO. 10466 | DWG E1046677

SCALE: 1/1 | EST. WT. 16.0 LBS | SHEET 1 OF 1

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED





SECTION A-A

NOTES: UNLESS OTHERWISE SPECIFIED

1. MATERIAL IS SS316 PER ASTM A240.
SUPPLY CHEMICAL, MECHANICAL AND HEAT TREATMENT REPORTS.

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
FRACT ± — DECIMALS .X ±.10, .XX ±.03, .XXX ±.010 — ANGLES ±2°

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NEXT ASSY 1046650

DO NOT SCALE DRAWING

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

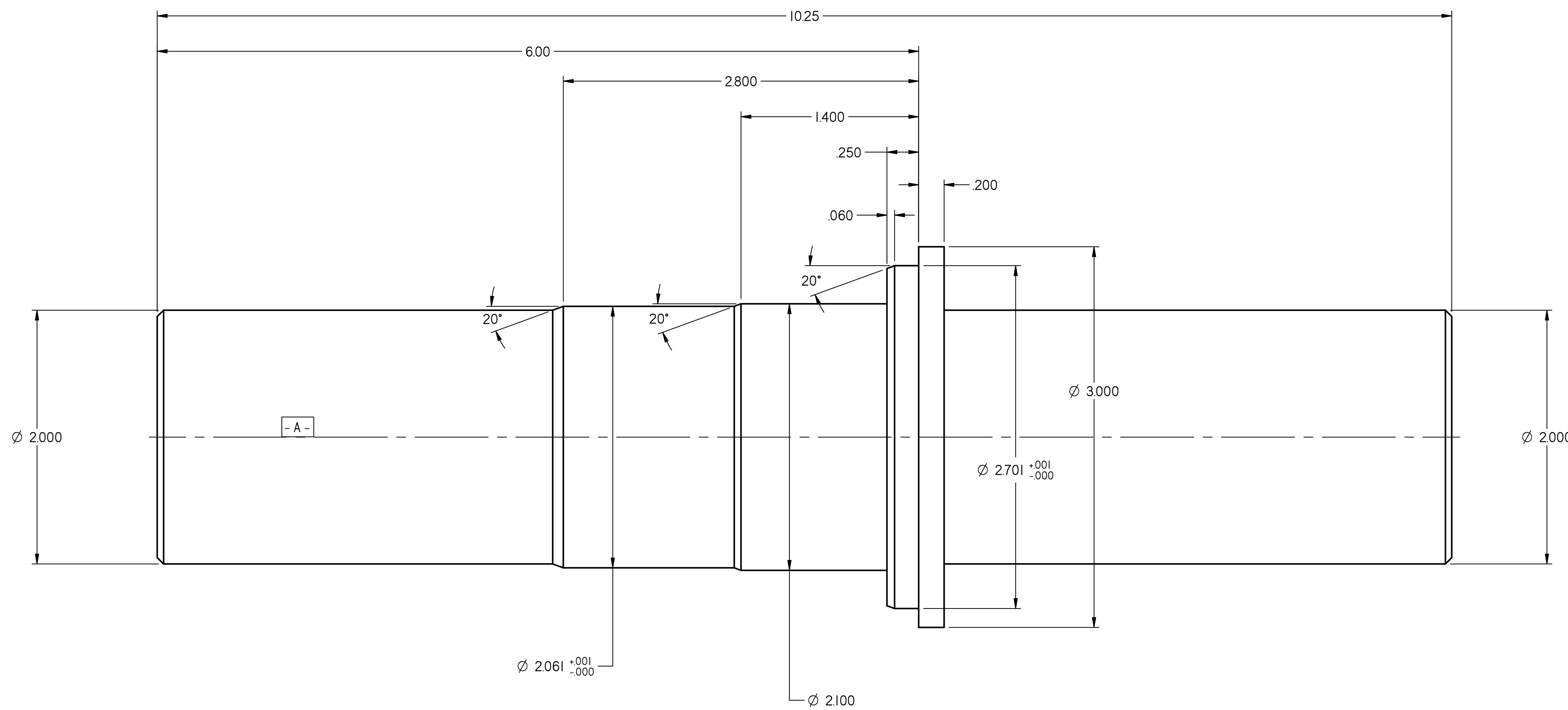
ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

TITLE
BACK BEARING - SHAFT SLEEVE #2

DWG. SIZE D | PROJECT NO. 10466 | DWG E1046678

SCALE: 1/1 | EST. WT. 9.6 LBS | SHEET 1 OF 1

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED



NOTES: UNLESS OTHERWISE SPECIFIED

1 MATERIAL IS 316 SS
2 SHAFT END CENTERS OK
3 ALL DIA'S TO BE CONCENTRIC WITH EACH OTHER ◎ | Ø.0005 | A

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
FRACT DECIMALS ANGLES
± .X ±.10 .XX ±.03 .XXX ±.010 ±2°

NEXT ASSY

DO NOT SCALE DRAWING

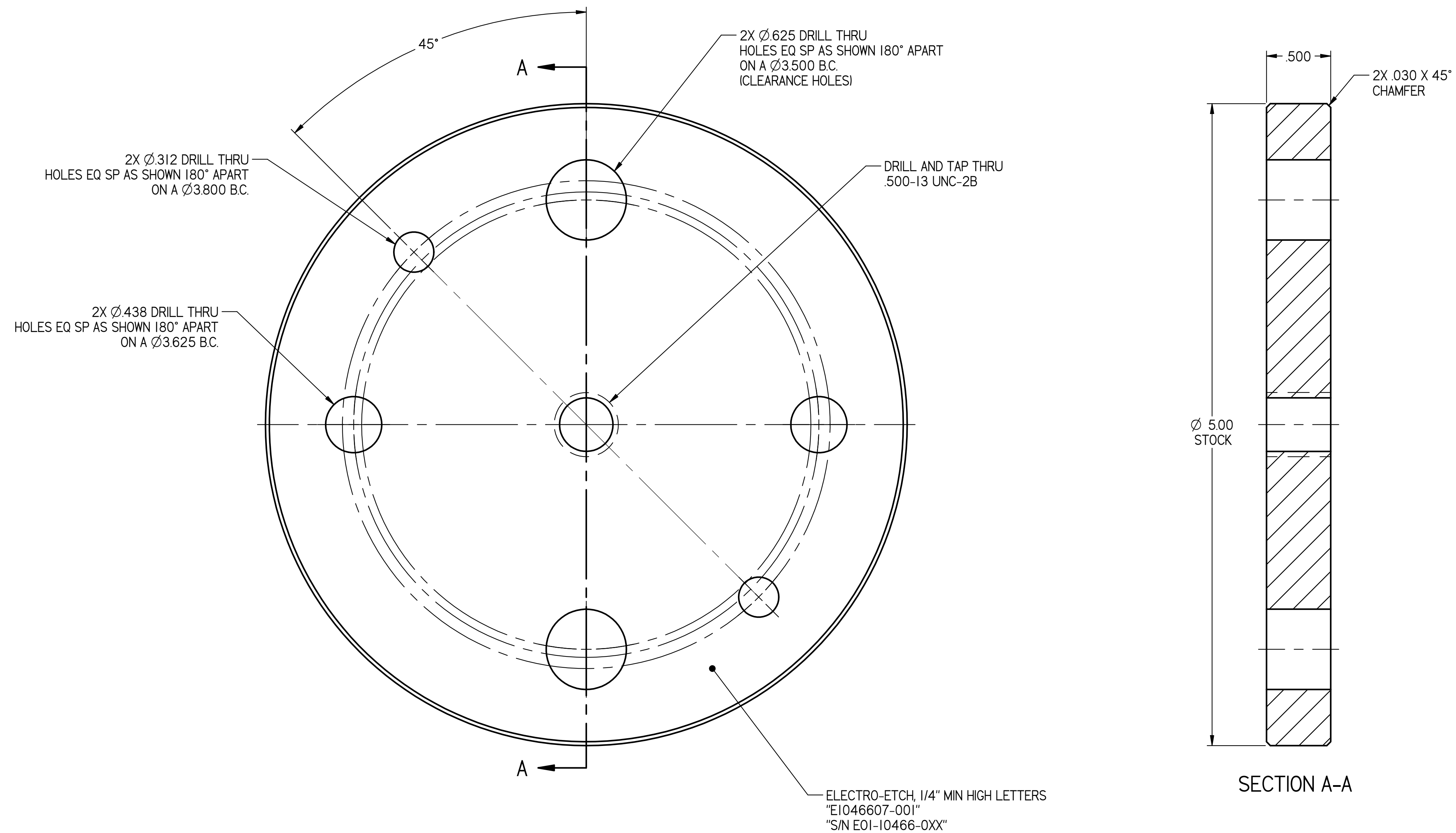
DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

TITLE
TURBINE WHEEL - BALANCING SHAFT

DWG. SIZE	PROJECT NO.	DWG
D	10466	E1046606
SCALE: 1/1	EST. WT.	SHEET 1 OF 1

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED



1 MATERIAL IS 1010 CRS OR SIMILAR
SUPPLY CHEMICAL, MECHANICAL AND HEAT TREATMENT REPORTS

NOTES: UNLESS OTHERWISE SPECIFIED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
FRACT DECIMALS ANGLES
± .X ±.10 .XX ±.03 .XXX ±.010 ±2°

NEXT ASSY 1046650

DO NOT SCALE DRAWING

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

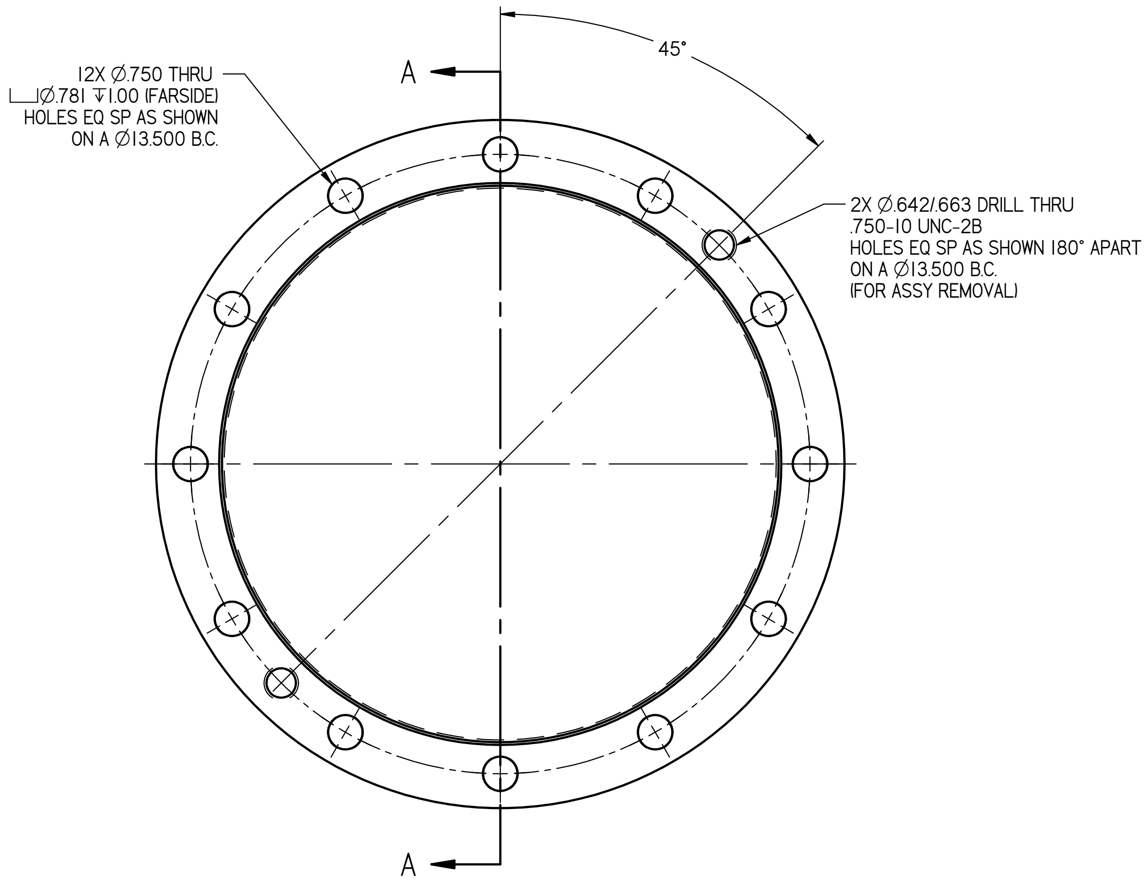
ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

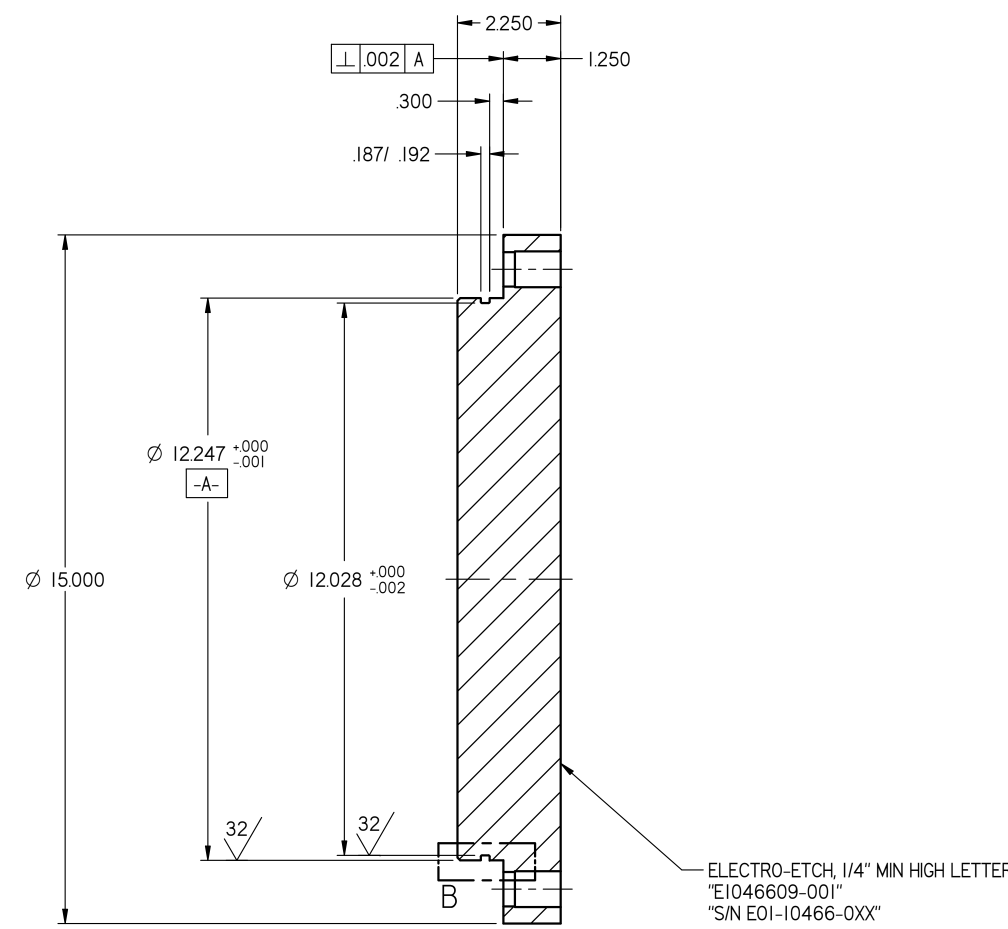
TITLE
TURBINE WHEEL - PULLER PLATE

DWG. SIZE D | PROJECT NO. 10466 | DWG E1046607

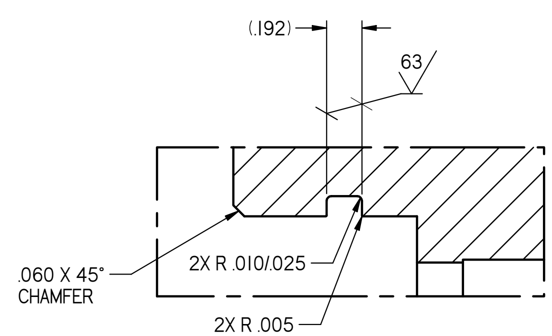
SCALE: 1/1 | EST. WT. 2.6 LBS | SHEET 1 OF 1

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED





SECTION A-A



DETAIL B

1. MATERIAL IS ALUM 6061-T6.
SUPPLY CHEMICAL, MECHANICAL AND HEAT TREATMENT REPORTS.

NOTES: UNLESS OTHERWISE SPECIFIED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125 √

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
FRACT ± | DECIMALS .X ±.10 .XX ±.03 .XXX ±.010 | ANGLES ±2°

NEXT ASSY 1046650

DO NOT SCALE DRAWING

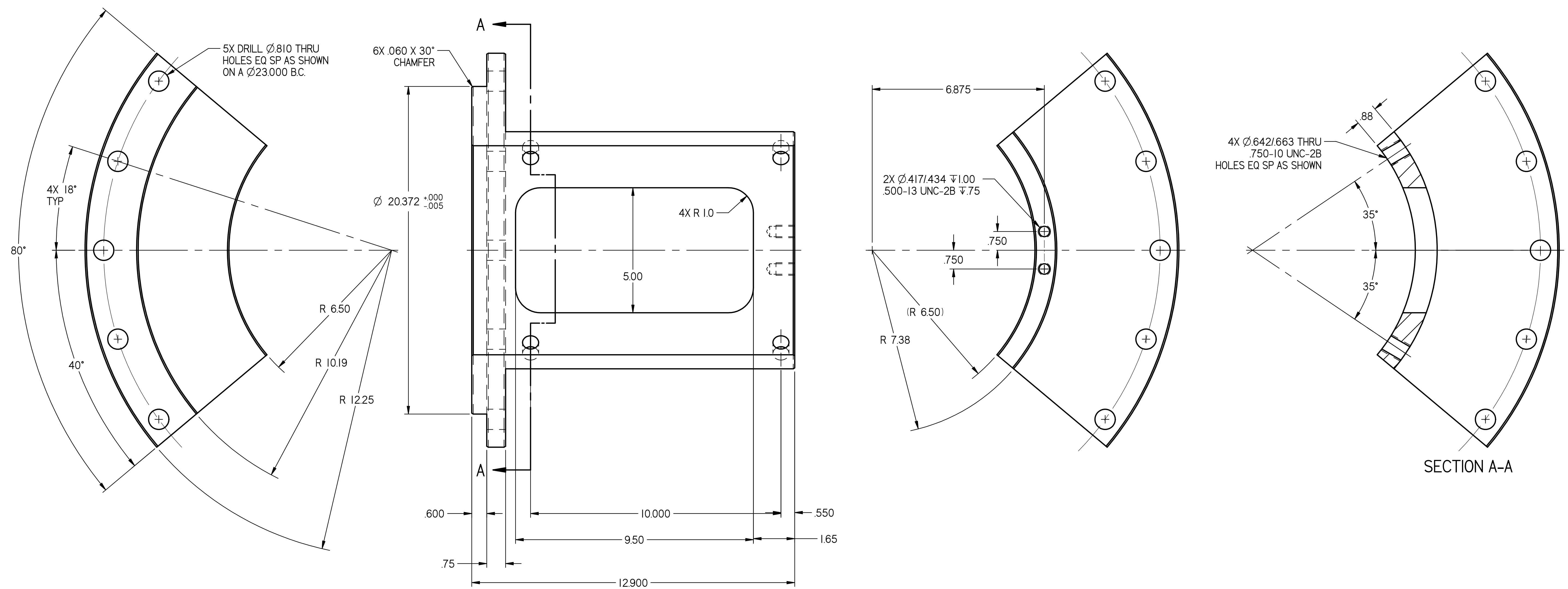
DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

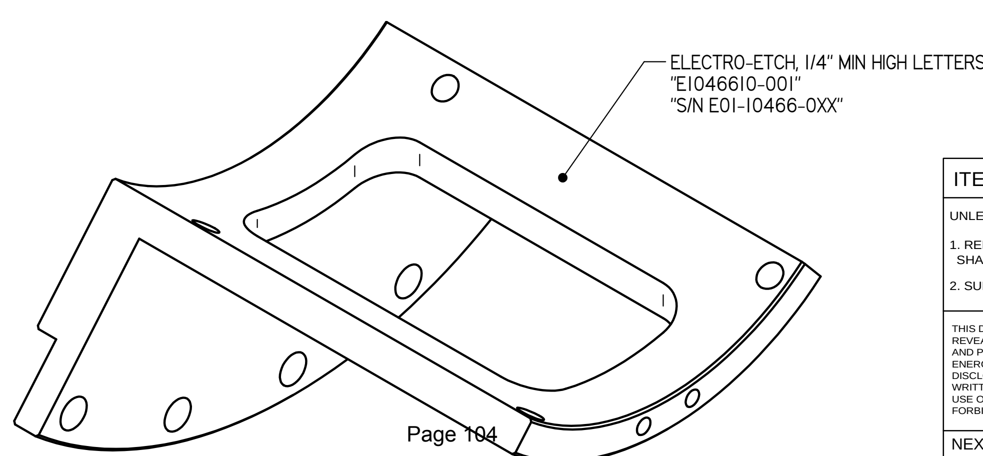
ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

TITLE
CAP - PRESSURE TEST

DWG. SIZE D | PROJECT NO. 10466 | DWG E1046609

SCALE: 1/1 | EST. WT. 10.2 LBS | SHEET 1 OF 1





REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED

1. MATERIAL IS ALUM 6061-T6.
   SUPPLY CHEMICAL, MECHANICAL AND HEAT TREATMENT TEST REPORTS.

NOTES: UNLESS OTHERWISE SPECIFIED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED

1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

FRACT	DECIMALS			ANGLES
±	.X ±.10	.XX ±.03	.XXX ±.010	±2°

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NEXT ASSY 1046650

DO NOT SCALE DRAWING

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

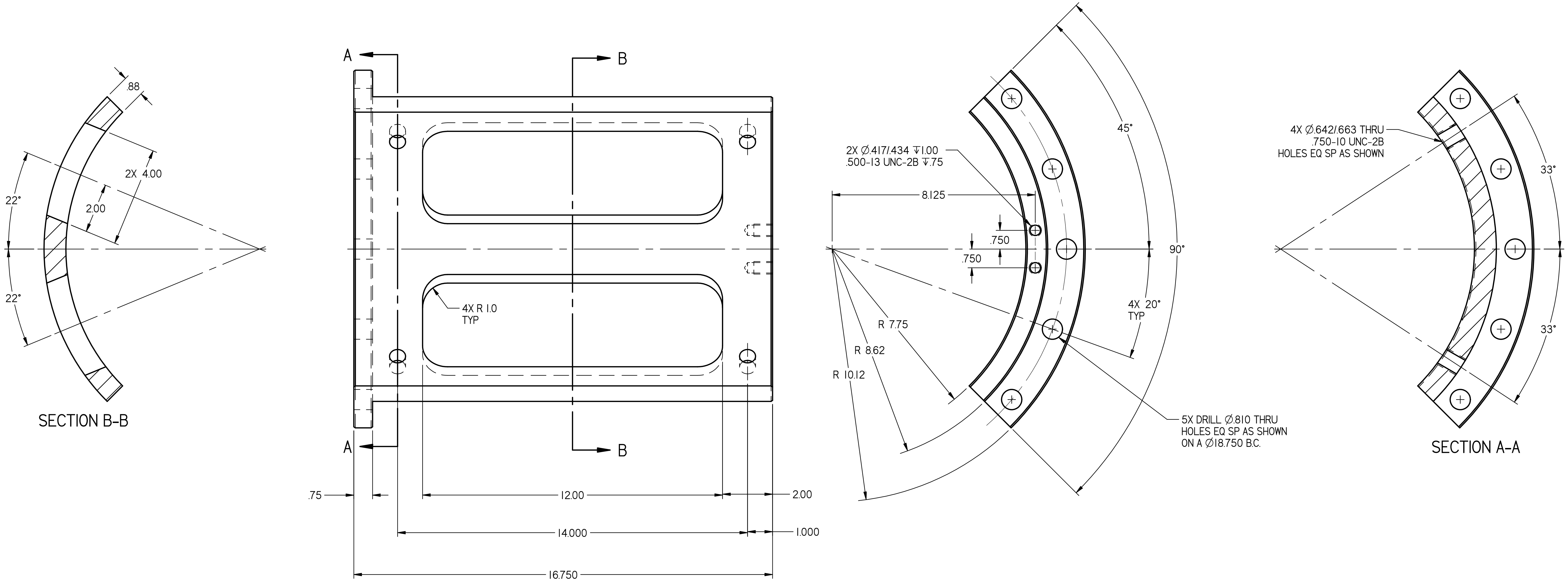
ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

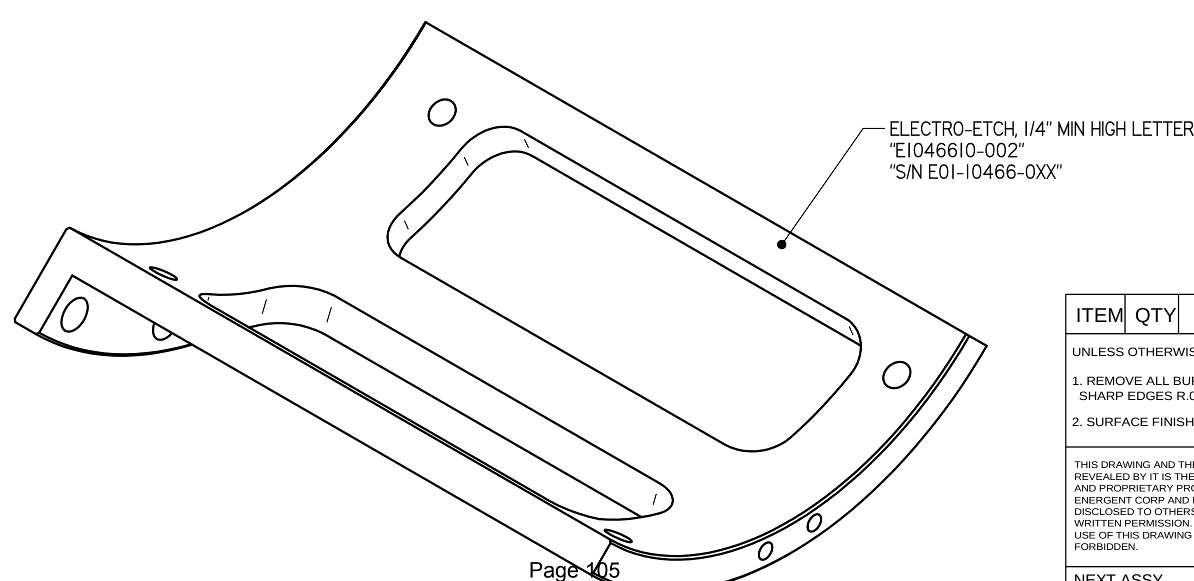
TITLE
ASSEMBLY FIXTURES

DWG. SIZE	PROJECT NO.	DWG
D	10466	E1046610

SCALE: 1/1	EST. WT. 13.2 LBS	SHEET 1 OF 7

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED





ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
FRACT ± DECIMALS .X ±.10 .XX ±.03 .XXX ±.010 ANGLES ±2°

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NEXT ASSY 1046650

DO NOT SCALE DRAWING

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

TITLE
ASSEMBLY FIXTURES

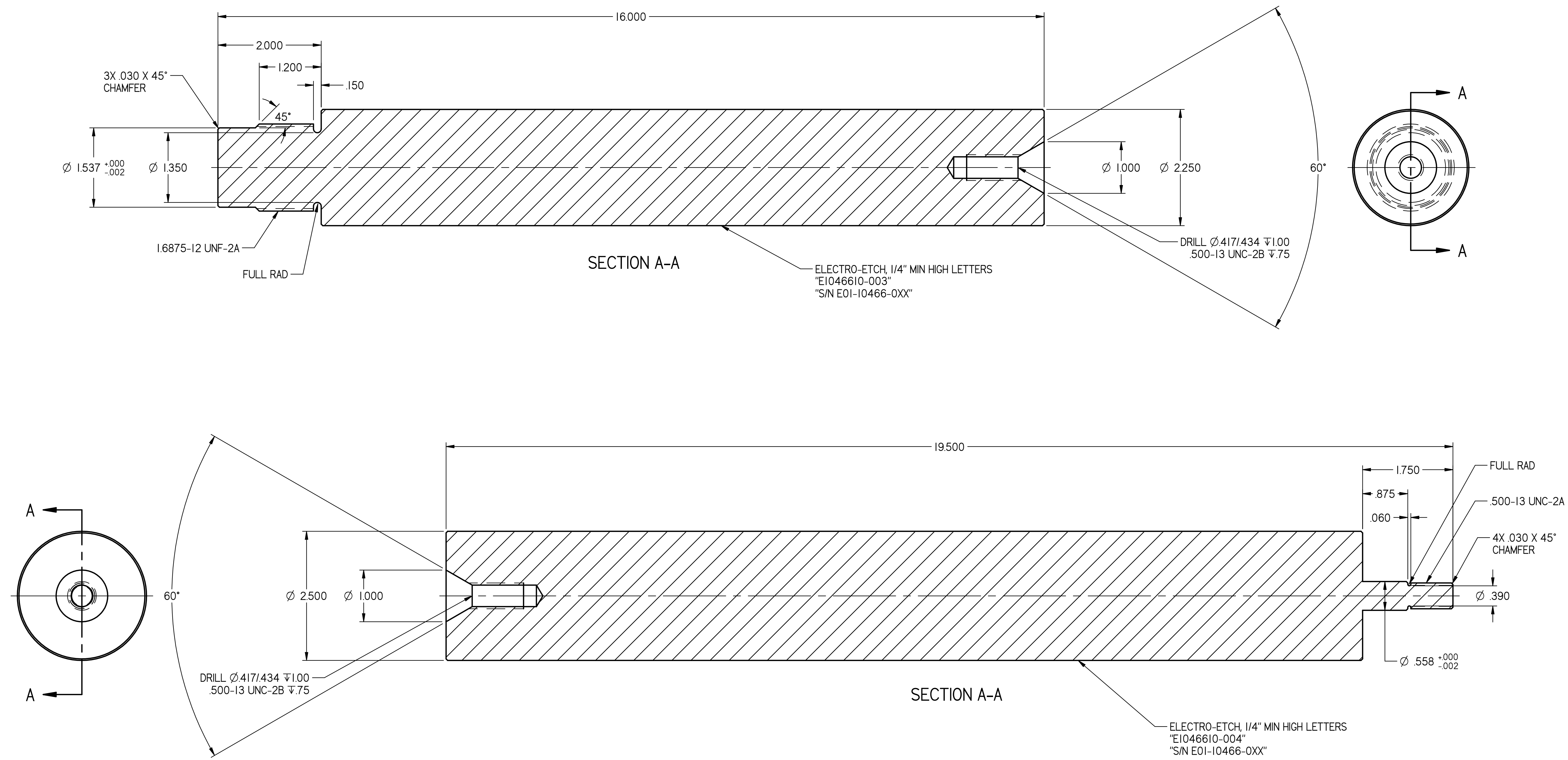
DWG. SIZE	PROJECT NO.	DWG
D	10466	E1046610

SCALE: 1/1 | EST. WT. 11.6 LBS | SHEET 2 OF 7

1. MATERIAL IS ALUM 6061-T6.
SUPPLY CHEMICAL, MECHANICAL AND HEAT TREATMENT TEST REPORTS.

NOTES: UNLESS OTHERWISE SPECIFIED

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED



ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED

1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125√

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

FRACT	DECIMALS			ANGLES
±	.X ±.10	.XX ±.03	.XXX ±.010	±2°

DO NOT SCALE DRAWING

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

NEXT ASSY 1046650

ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

TITLE
ASSEMBLY FIXTURES

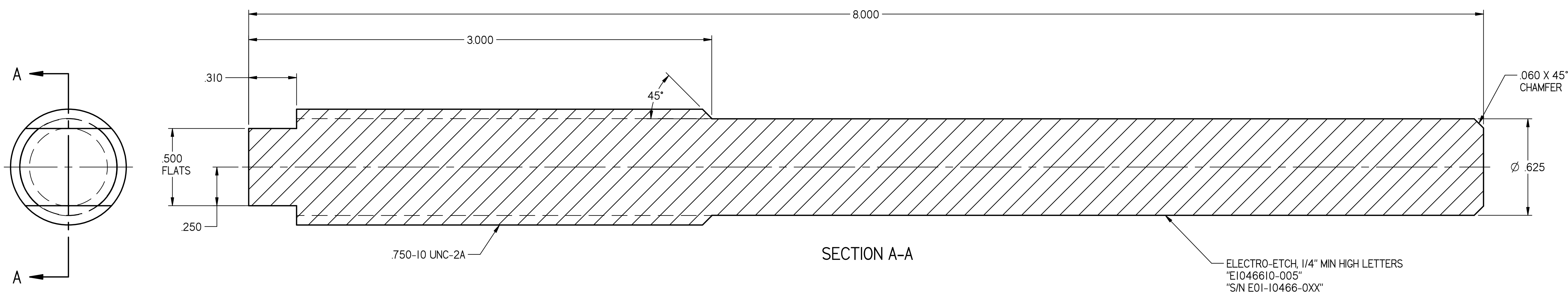
DWG. SIZE D | PROJECT NO. 10466 | DWG E1046610

SCALE: 1/1 | EST. WT. 14.3 LBS | SHEET 3 OF 7

NOTES: UNLESS OTHERWISE SPECIFIED

1. MATERIAL IS ALUM 6061-T6.
   SUPPLY CHEMICAL, MECHANICAL AND HEAT TREATMENT TEST REPORTS.

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED



NOTES: UNLESS OTHERWISE SPECIFIED

1. MATERIAL IS ALUM 6061-T6.
   SUPPLY CHEMICAL, MECHANICAL AND HEAT TREATMENT TEST REPORTS.

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
FRACT DECIMALS ANGLES
± .X ±.10 .XX ±.03 .XXX ±.010 ±2°

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NEXT ASSY 1046650

DO NOT SCALE DRAWING

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

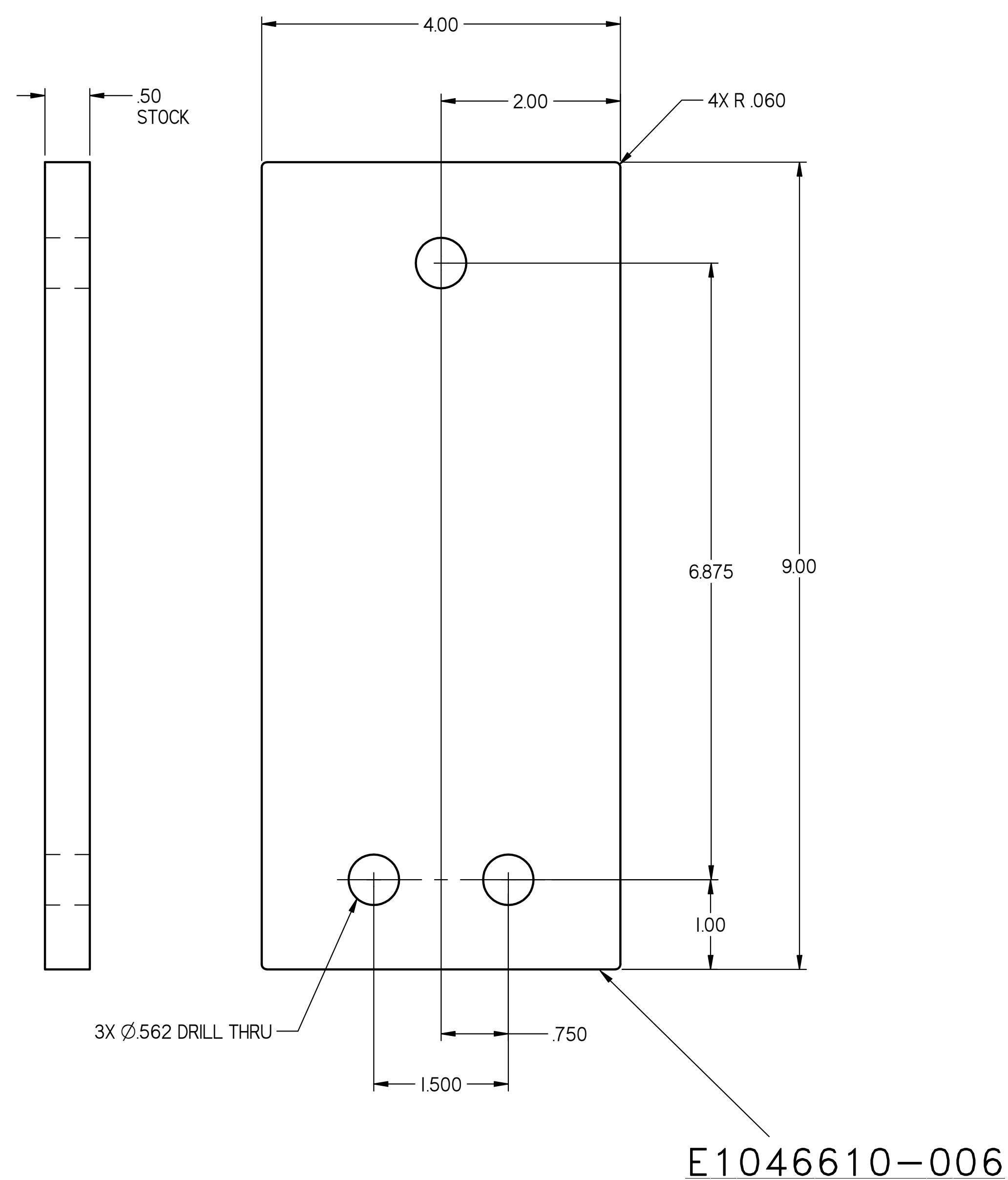
ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

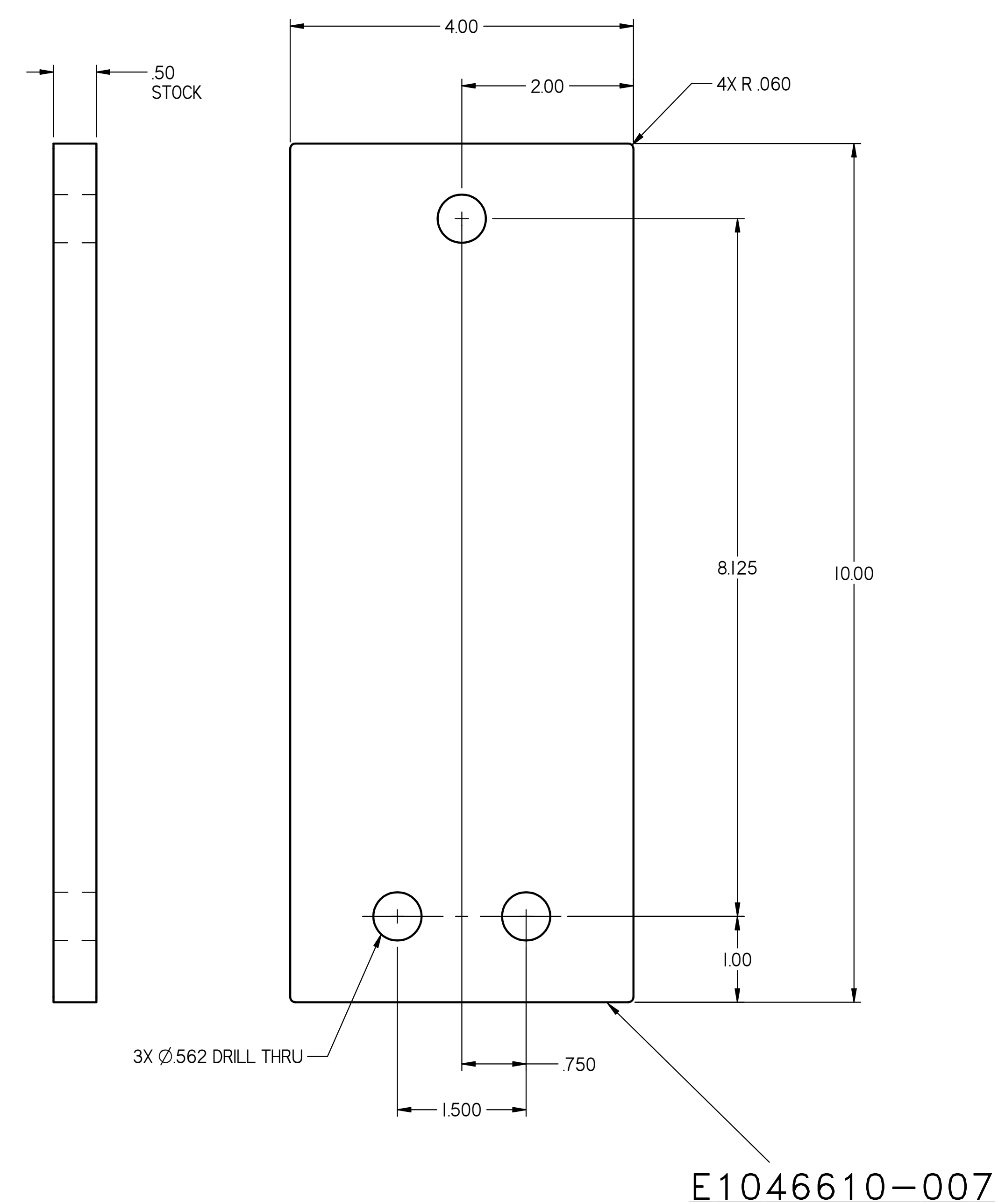
TITLE
ASSEMBLY FIXTURES

DWG. SIZE	PROJECT NO.	DWG
D	10466	E1046610

SCALE: 1/1 | EST. WT. 2.8 LBS | SHEET 4 OF 7

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED





1. MATERIAL IS CRS1018 OR SIMILAR.
   SUPPLY CHEMICAL, MECHANICAL AND HEAT TREATMENT TEST REPORTS.

NOTES: UNLESS OTHERWISE SPECIFIED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED

1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

FRACT	DECIMALS			ANGLES
±	.X ±.10	.XX ±.03	.XXX ±.010	±2°

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NEXT ASSY 1046650

DO NOT SCALE DRAWING

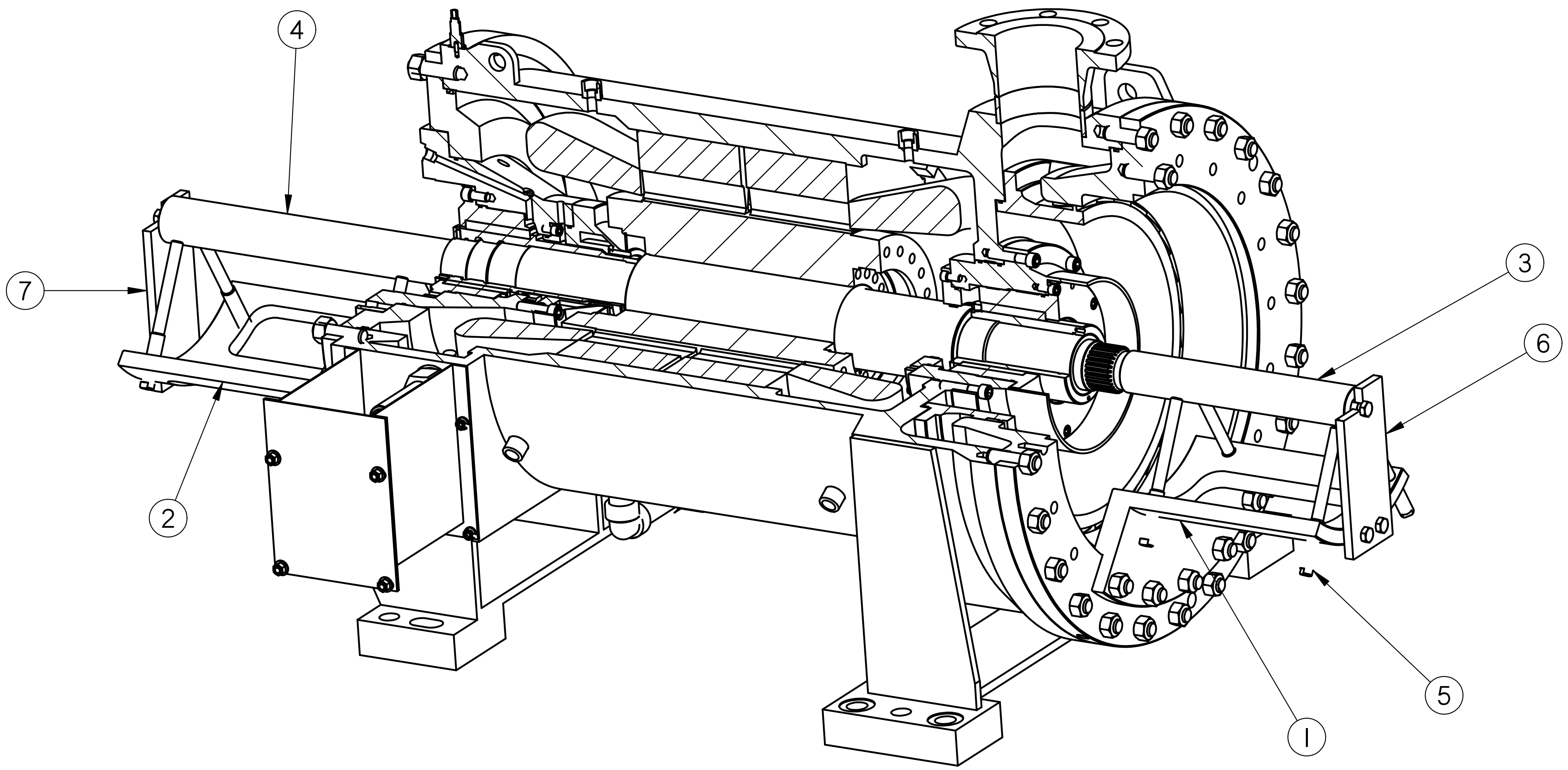
DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

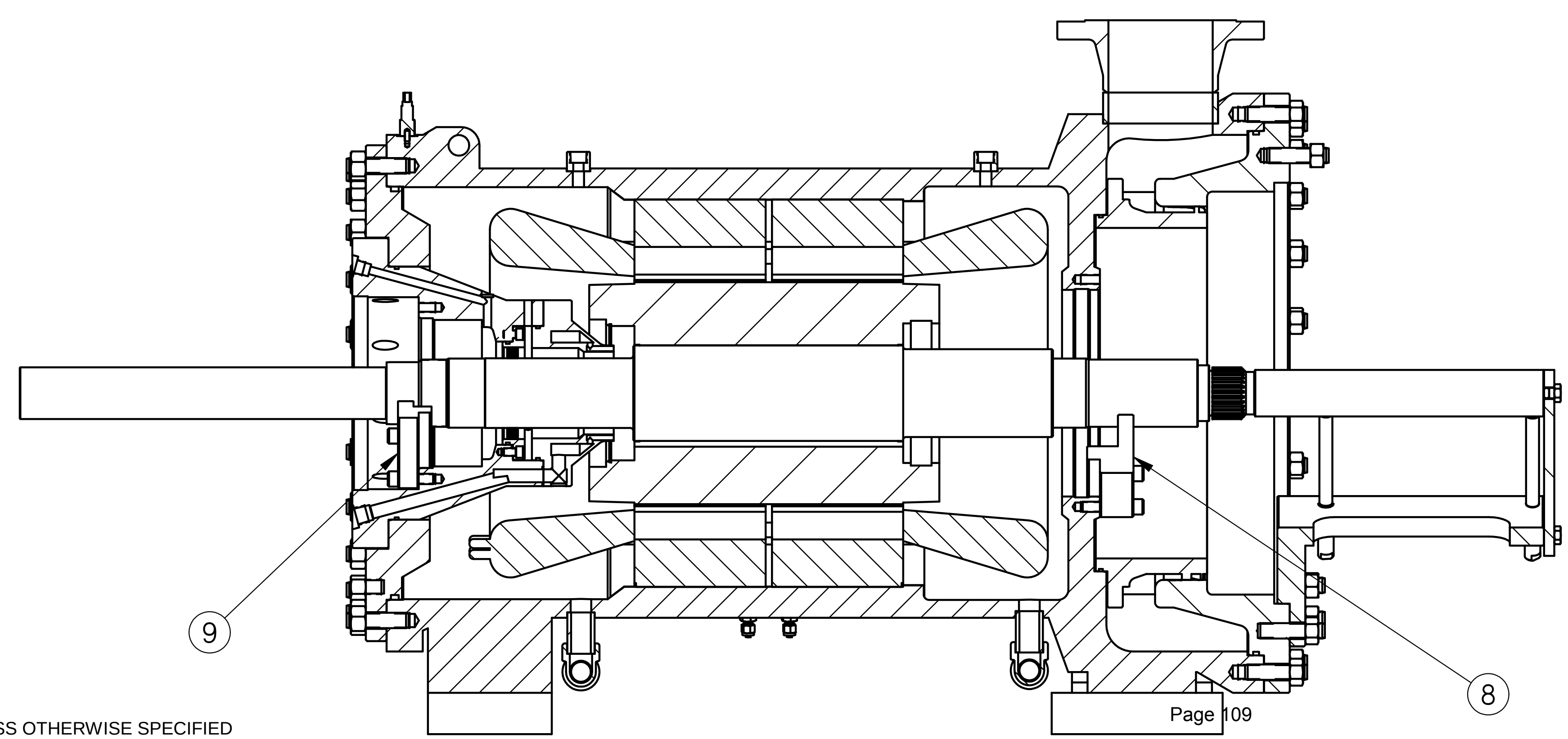
ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

TITLE
ASSEMBLY FIXTURES

DWG. SIZE	PROJECT NO.	DWG
D	10466	E1046610
SCALE: 1/1	EST. WT. 10.4 LBS	SHEET 5 OF 7

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED





ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS
9	1	-09	GUIDE - REAR		
8	1	-08	GUIDE- FRONT		
7	1	-07	ENDPLATE - REAR		
6	1	-06	ENDPLATE - FRONT		
5	8	-05	THREADED ADJUSTING SHAFT		
4	1	-04	EXTENSION SHAFT - REAR		
3	1	-03	EXTENSION SHAFT - FRONT		
2	1	-02	CATCH SUPPORT - REAR		
1	1	-01	CATCH SUPPORT - FRONT		

UNLESS OTHERWISE SPECIFIED

1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

FRACT DECIMALS ANGLES
± .X ±.10 .XX ±.03 .XXX ±.010 ±2°

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DO NOT SCALE DRAWING

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

NEXT ASSY 1046650

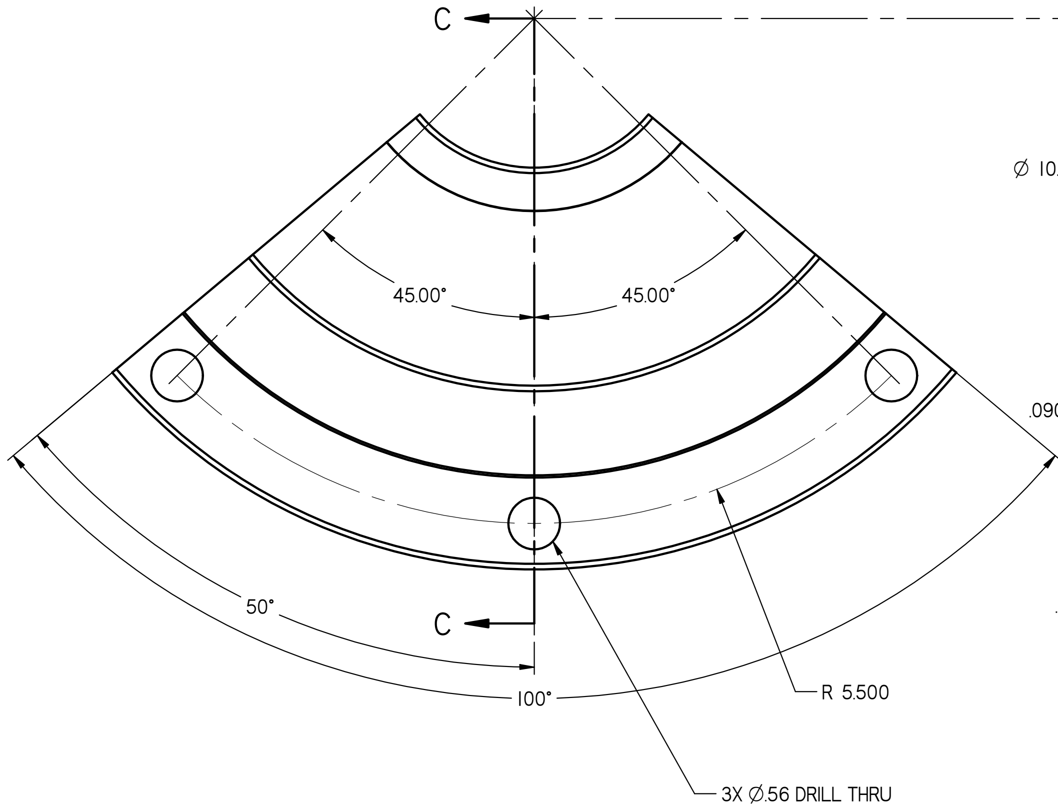
ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

TITLE
ASSEMBLY FIXTURES

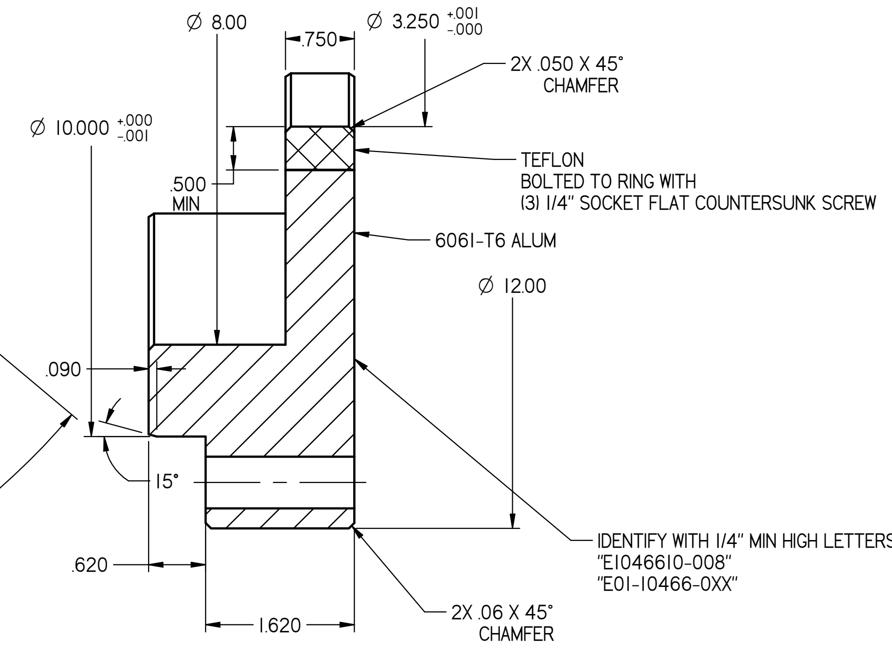
DWG. SIZE D | PROJECT NO. 10466 | DWG E1046610

SCALE: 1/1 | EST. WT. 10.4 LBS | SHEET 6 OF 7

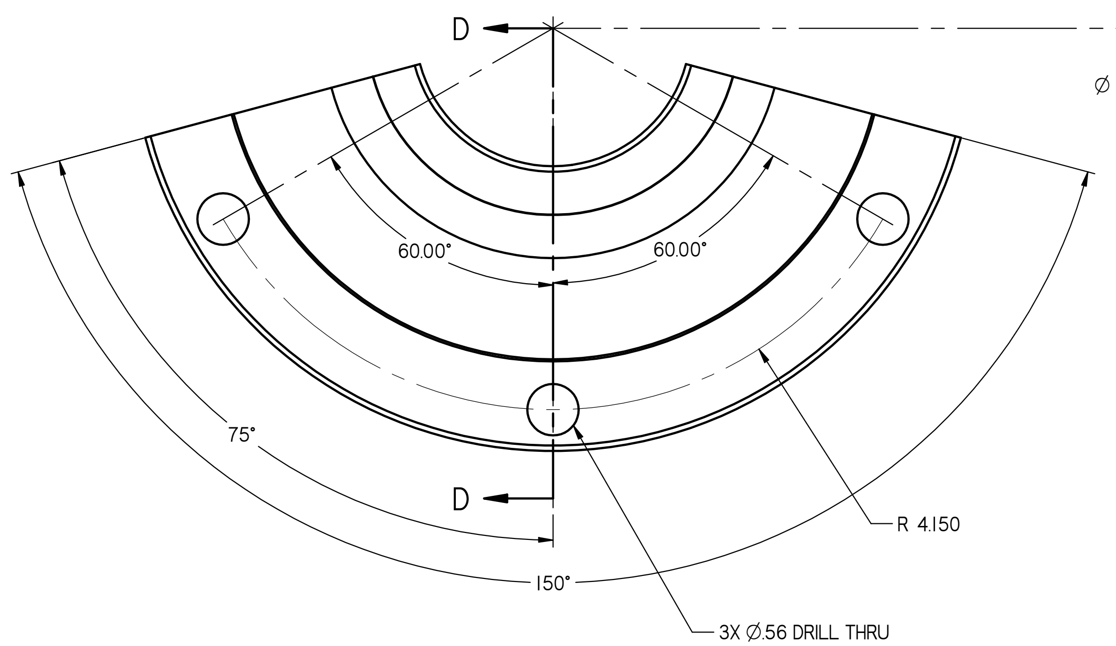
NOTES: UNLESS OTHERWISE SPECIFIED



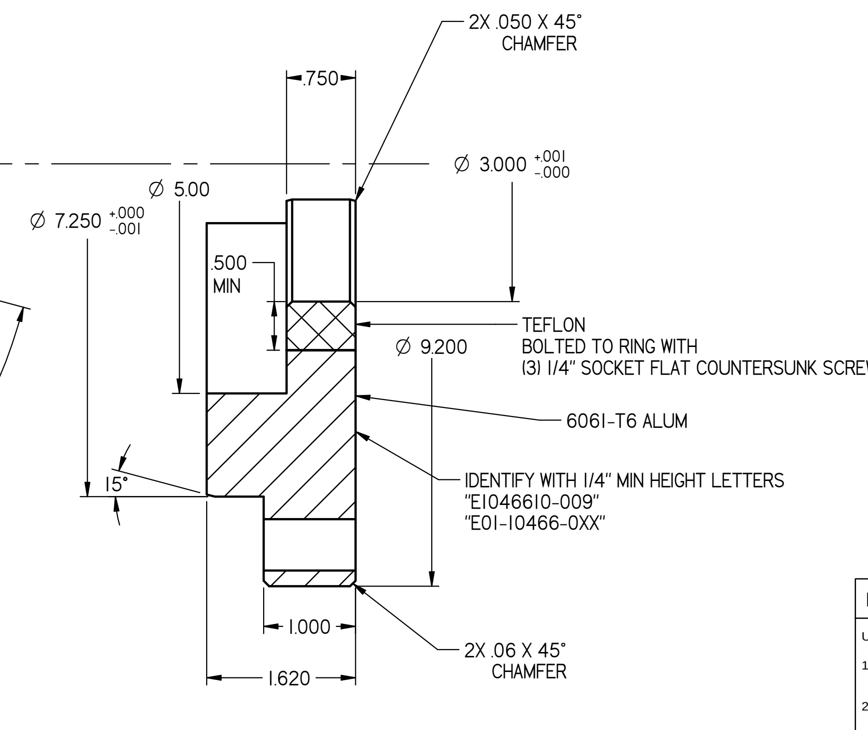
GUIDE FRONT -08



SECTION C-C



GUIDE REAR -09



SECTION D-D

NOTES: UNLESS OTHERWISE SPECIFIED

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED

1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

FRACT DECIMALS ANGLES

± .X ±.10 .XX ±.03 .XXX ±.010 ±2°

THIS DRAWING AND THE INFORMATION REVEALED BY IT IS THE CONFIDENTIAL AND PROPRIETARY PROPERTY OF ENERGENT CORP AND IS NOT TO BE DISCLOSED TO OTHERS WITHOUT WRITTEN PERMISSION. UNAUTHORIZED USE OF THIS DRAWING IS EXPRESSLY FORBIDDEN.

NEXT ASSY 1046650

DO NOT SCALE DRAWING

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

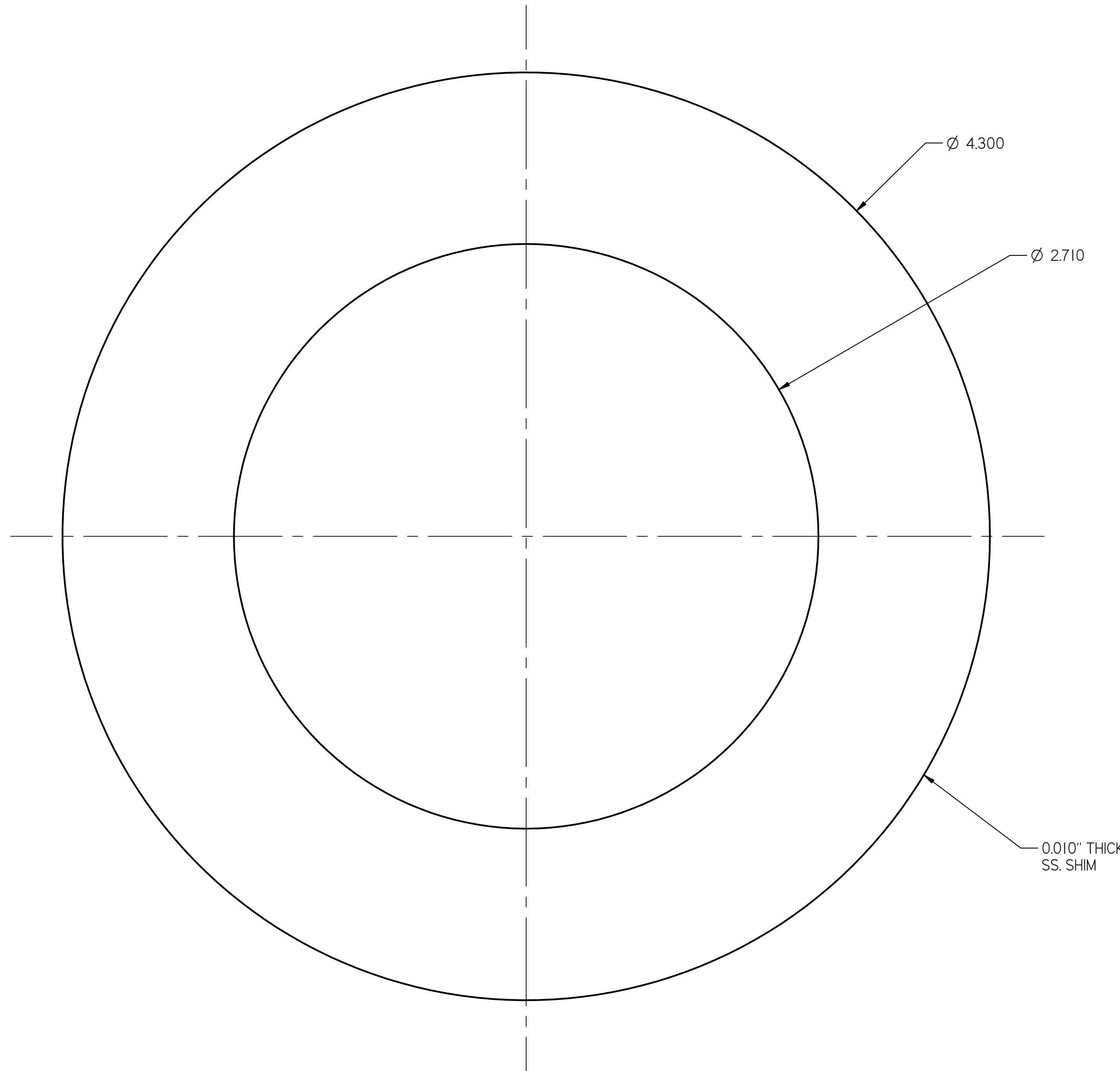
ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

TITLE
ASSEMBLY FIXTURES

DWG. SIZE D | PROJECT NO. 10466 | DWG E1046610

SCALE: 1/1 | EST. WT. 10.4 LBS | SHEET 7 OF 7

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED



MAT'L IS: SS 316

NOTES: UNLESS OTHERWISE SPECIFIED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED

1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125√

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

FRACT	DECIMALS			ANGLES
	.X	.XX	.XXX	
±	±.10	±.03	±.005	±2°

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NEXT ASSY E1046650

DO NOT SCALE DRAWING

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

ENERGENT CORP.

1831 CARNEGIE AVE
SANTA ANA, CA 92705

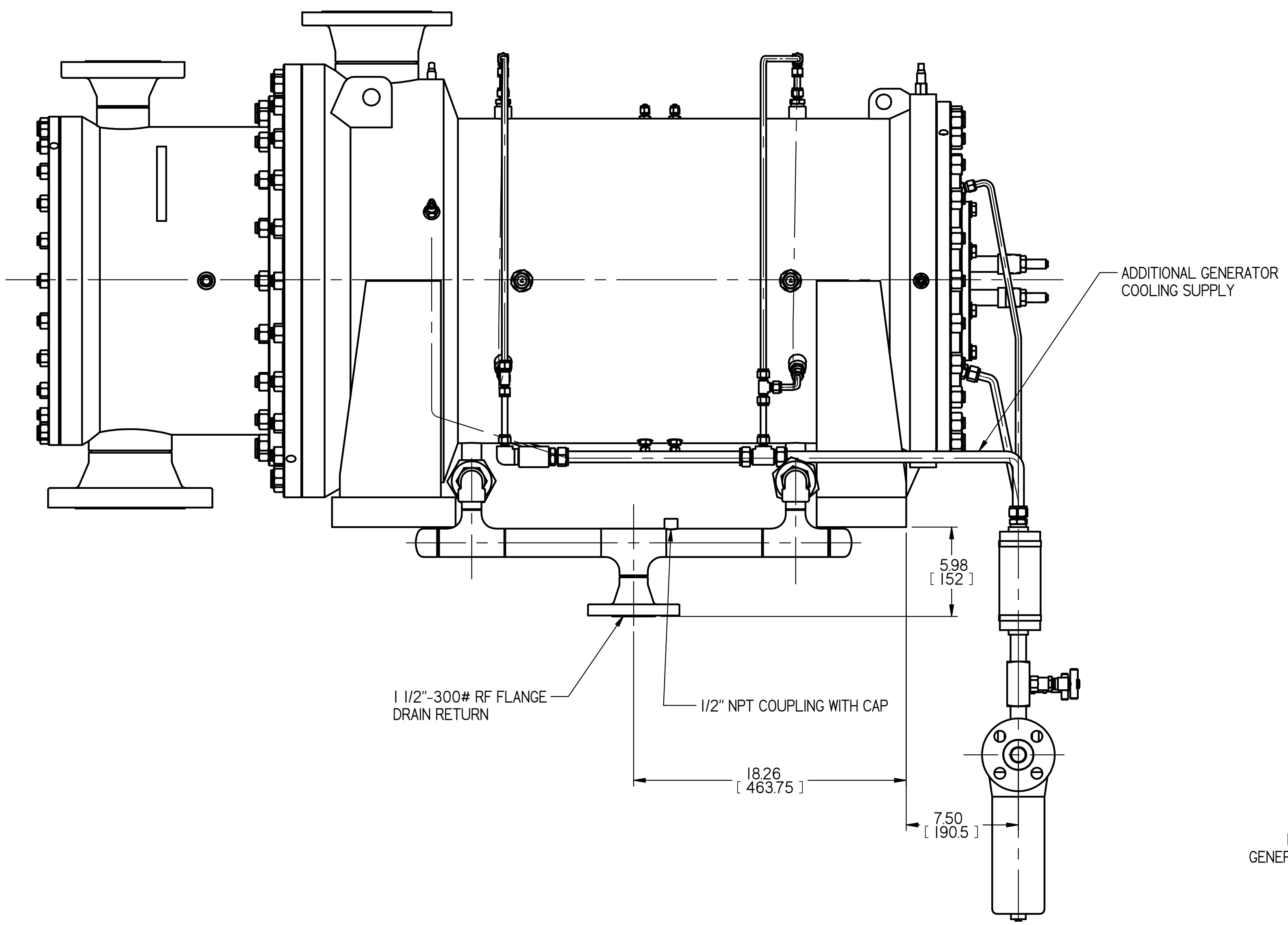
TITLE

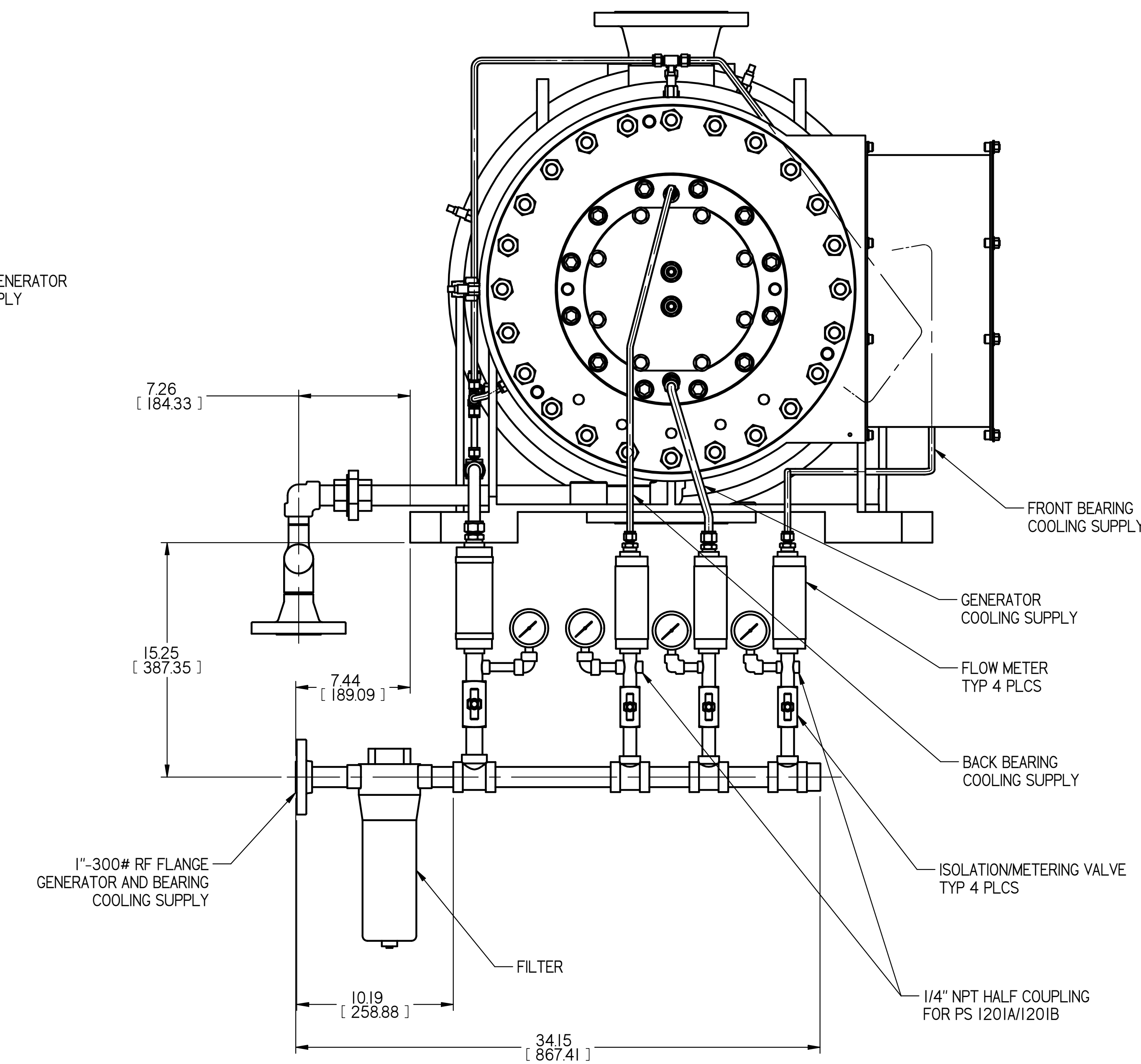
TURBINE WHEEL SHIMS

DWG. SIZE D | PROJECT NO. 10466 | DWG E1046611

SCALE: 1/1 | EST. WT. | SHEET 1 OF 1

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED





ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED

1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

FRACT	DECIMALS			ANGLES
±	.X ±.10	.XX ±.03	.XXX ±.010	±2°

DO NOT SCALE DRAWING

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

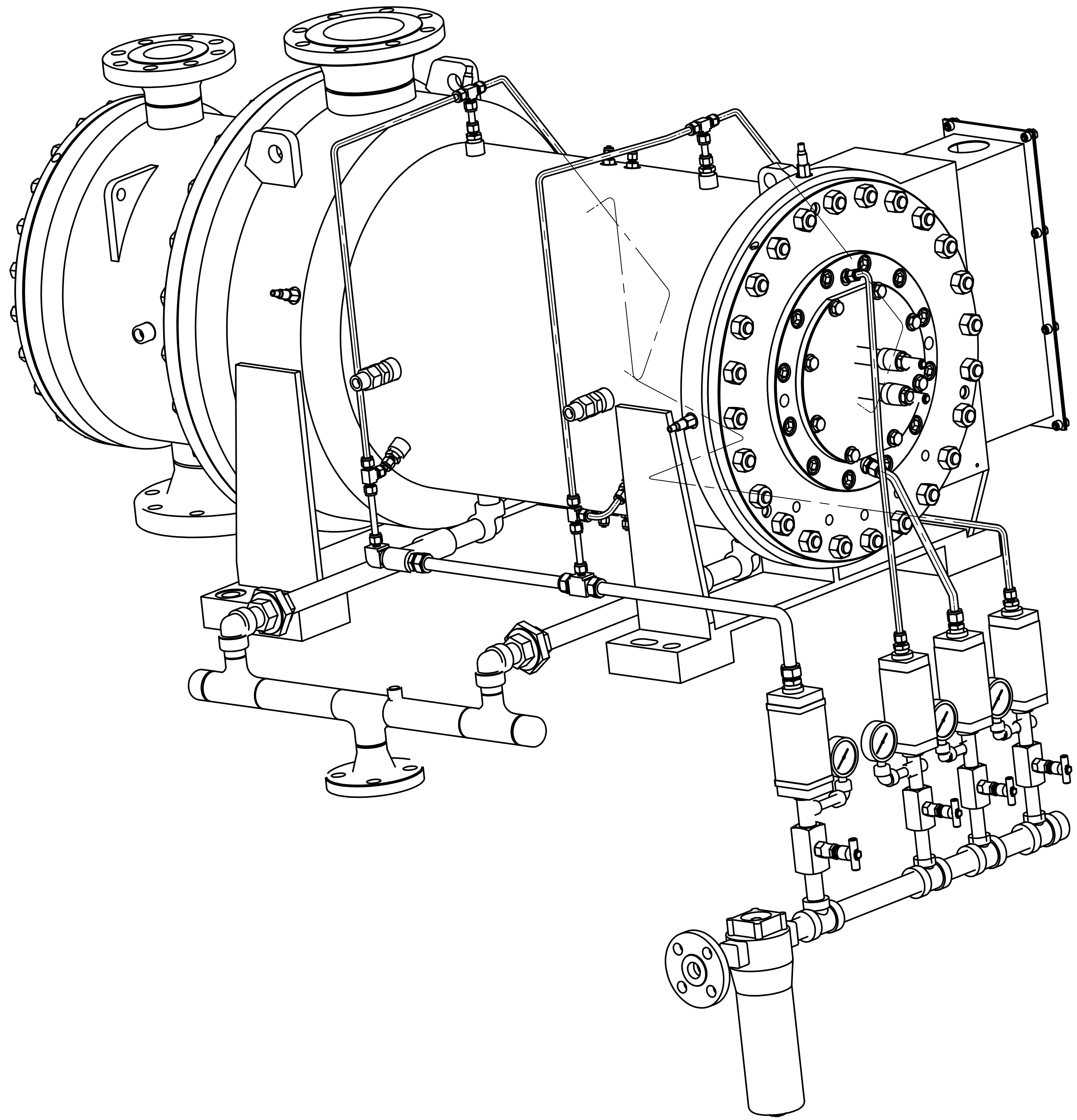
NEXT ASSY

ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

TITLE TURBINE ASSEMBLY VPTG 2H
COOLING SUPPLY AND DRAIN MANIFOLDS

DWG. SIZE	PROJECT NO.	DWG
D	10466	E1046652
SCALE: 1/1	EST. WT.	SHEET 1 OF 2

NOTES: UNLESS OTHERWISE SPECIFIED



REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED

1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

FRACT DECIMALS ANGLES
± .X ±.10 .XX ±.03 .XXX ±.010 ±2°

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NEXT ASSY

DO NOT SCALE DRAWING

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

ENERGENT CORP.

1831 CARNEGIE AVE
SANTA ANA, CA 92705

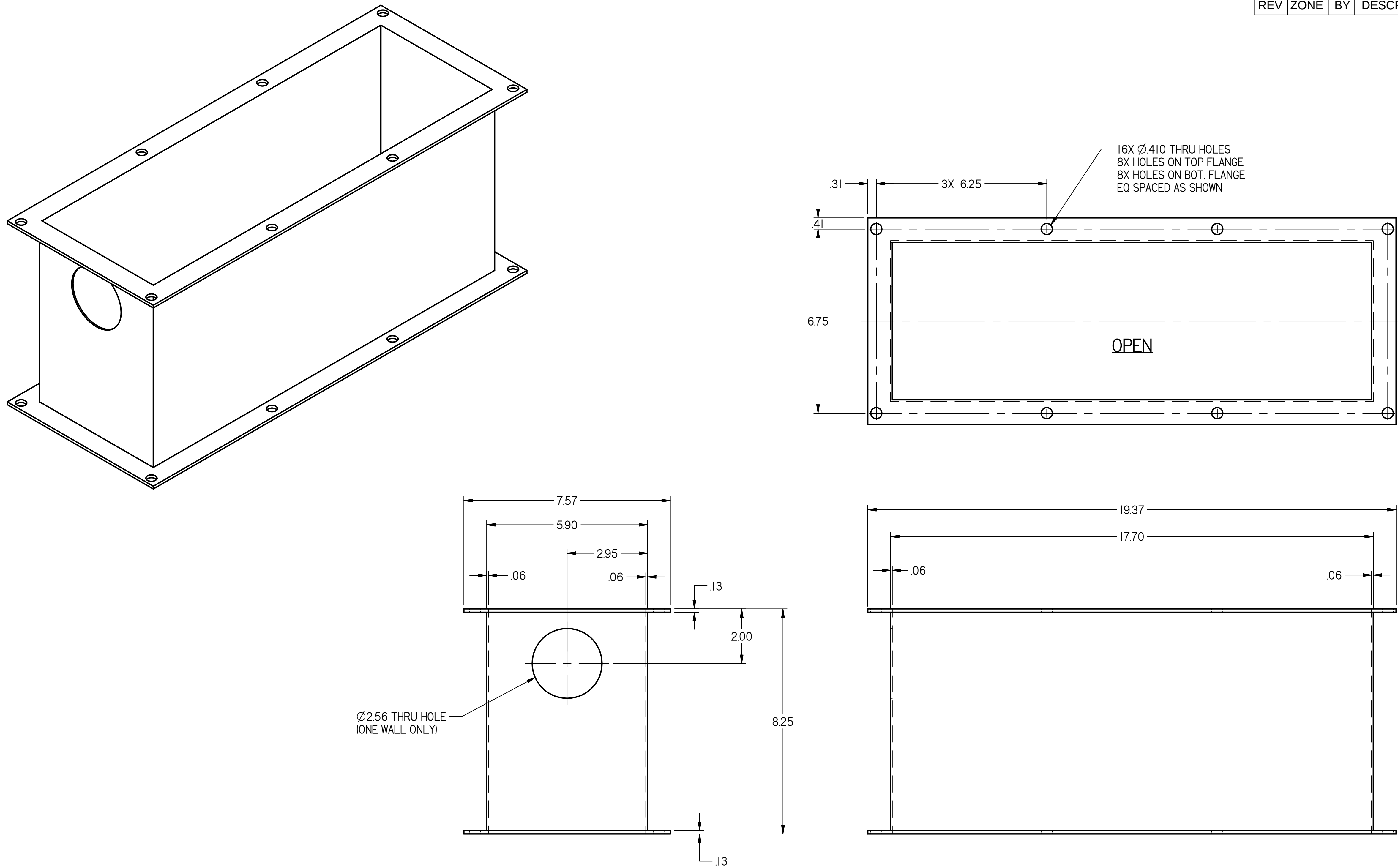
TITLE TURBINE ASSEMBLY VPTG 2H
COOLING SUPPLY AND DRAIN MANIFOLDS

DWG. SIZE D | PROJECT NO. 10466 | DWG E1046652

SCALE: 1/1 | EST. WT. | SHEET 2 OF 2

NOTES: UNLESS OTHERWISE SPECIFIED

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED



−01

1. MATERIAL IS STRUCTURAL STEEL PER ASTM A36.

NOTES: UNLESS OTHERWISE SPECIFIED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

FRACT	DECIMALS			ANGLES
±	.X ±.10	.XX ±.03	.XXX ±.010	±2°

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NEXT ASSY 1046650

DO NOT SCALE DRAWING

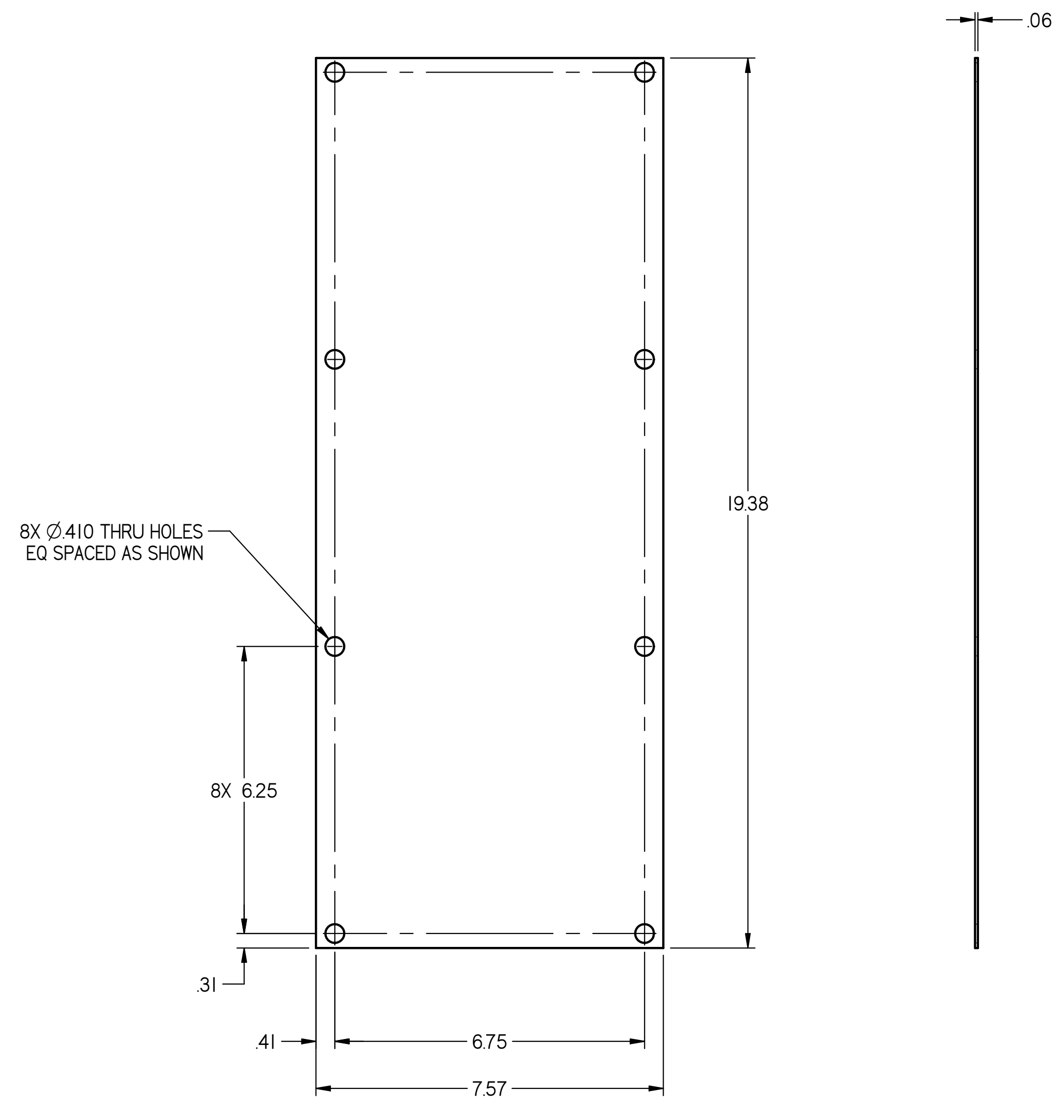
DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA, CA 92705

TITLE
ELECTRICAL BOX ASSEMBLY

DWG. SIZE	PROJECT NO.	DWG
D	10466	E1046608

SCALE: 1/1	EST. WT. 9.75 LBS	SHEET 1 OF 3



−02

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED

1. MATERIAL IS STRUCTURAL STEEL PER ASTM A36.

NOTES: UNLESS OTHERWISE SPECIFIED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
FRACT ± DECIMALS .X ±.10 .XX ±.03 .XXX ±.010 ANGLES ±2°

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NEXT ASSY 1046650

DO NOT SCALE DRAWING

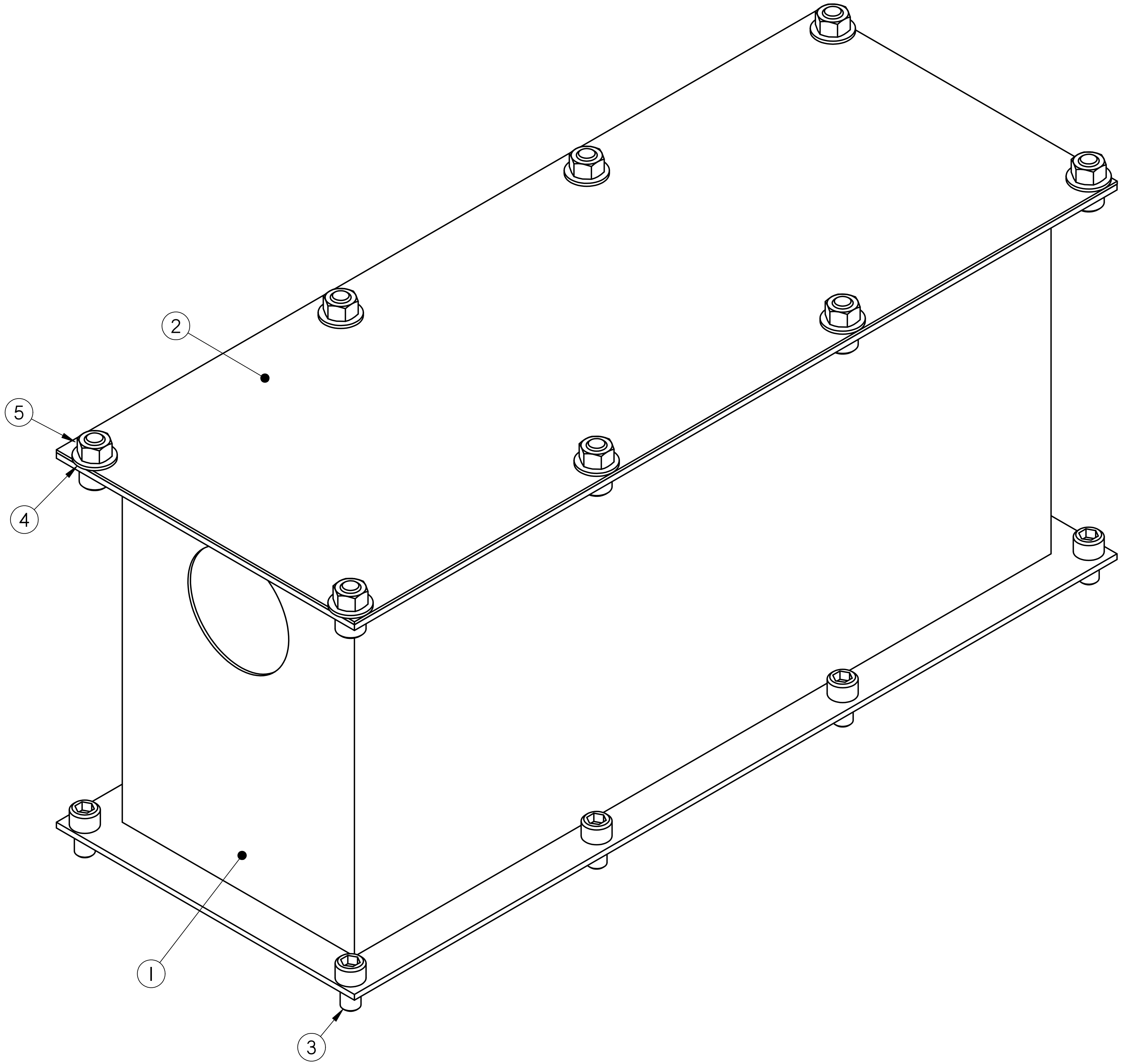
DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

ENERGENT CORP.
2321 S. PULLMAN STR.
SANTA ANA CA 92705

TITLE ELECTRICAL BOX ASSEMBLY

DWG. SIZE D | PROJECT NO. 10466 | DWG E1046608

SCALE: 1/1 | EST. WT. 2.6 LBS | SHEET 2 OF 3



REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED

ITEM	QTY	PART NO.	DESCRIPTION	MATL/SPEC	WT LBS
5	8		3/8-16 HEX NUT	ANSI B18.2.2 STEEL	
4	8		3/8" WASHER, NARROW - TYPE A	ANSI B18.22.1 STEEL	
3	16		3/8-16 X 5/8" HSH CAP SCREW	ANSI B18.3 STEEL	
-02			COVER - ELECTRICAL BOX		
-01			ELECTRICAL BOX		

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
FRACT DECIMALS ANGLES
± .X ±.10 .XX ±.03 .XXX ±.010 ±2°

ENERGENT CORP.
2321 S. PULLMAN STR.
SANTA ANA CA 92705

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DO NOT SCALE DRAWING

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED	I.MURILLO	10/17/14
ENG. APP.	L.HAYS	10/17/14
ISSUED	K.KAUPERT	10/17/14

TITLE
ELECTRICAL BOX ASSEMBLY

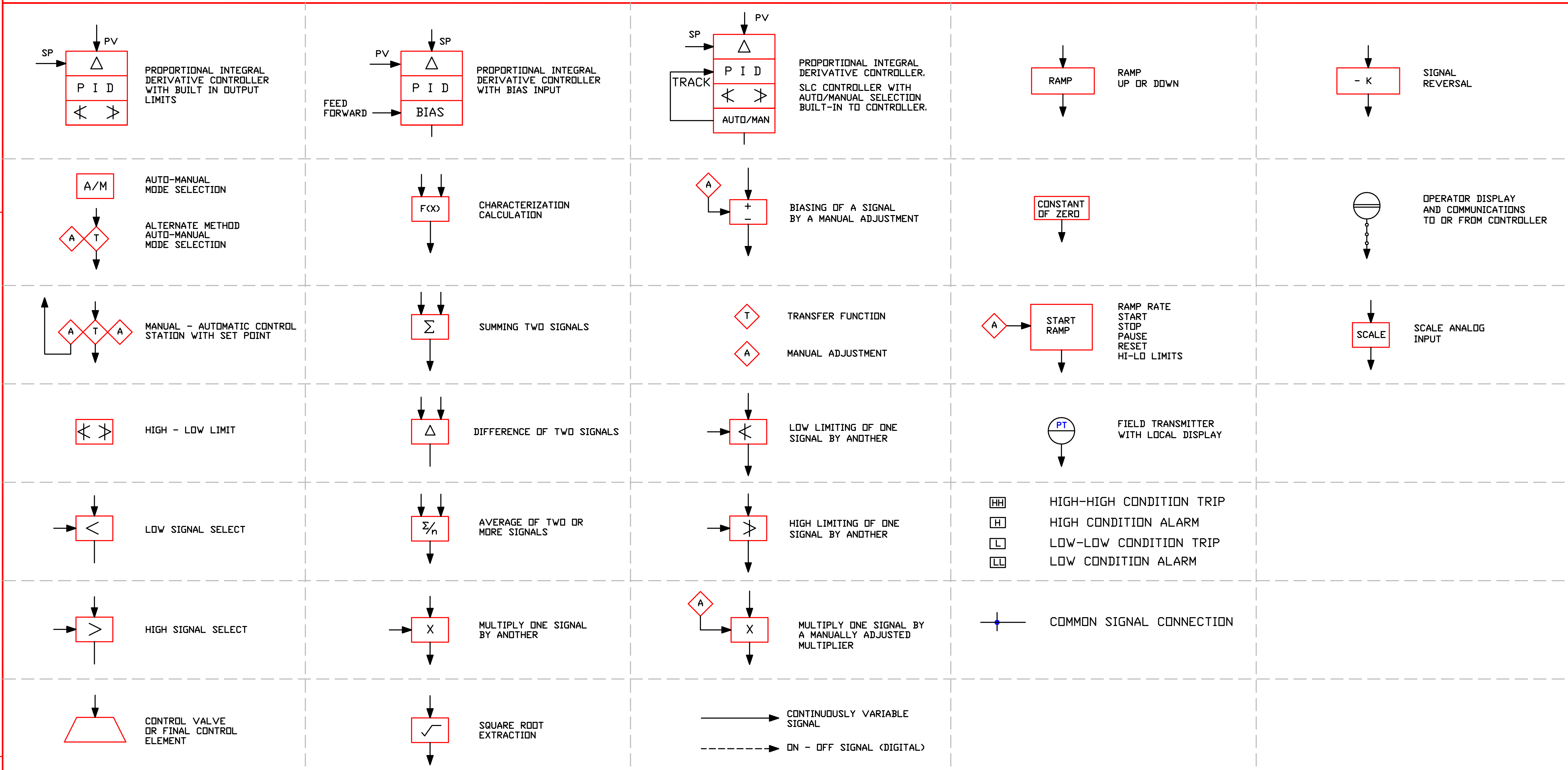
NEXT ASSY 1046650

DWG. SIZE D | PROJECT NO. 10466 | DWG E1046608

SCALE: 1/1 | EST. WT. 13.2 LBS | SHEET 3 OF 3

NOTES: UNLESS OTHERWISE SPECIFIED

SAMA FUNCTION BLOCK DEFINITIONS



NOTES:

1. "SAMA" STANDS FOR "SCIENTIFIC APPARATUS MAKERS ASSOCIATION" AND IS A SYMBOLIC LANGUAGE USED TO DESCRIBE AND DOCUMENT CONTROL STRATEGIES.
2. THIS LEGEND SHEET COMBINES SAMA STANDARD SYMBOLS, WITH NEWER ANSI/ISA 5.1 STANDARD SYMBOLS TO AID IN EXPANDING THE CONTROL CONCEPTS.
3. SAMA DIAGRAM LOGIC IS GENERIC IN NATURE, WHICH MEANS IT DOES NOT DEFINE THE SPECIFIC FUNCTIONS USED IN THE HARDWARE CHOSEN, SUCH AS PLC'S, DCS'S OR SLC'S. SAMA LOGIC DIAGRAMS DO NOT COMPLETELY DEFINE ALL LOGIC NEEDED TO CONTROL A SYSTEM AND THAT IT IS THE RESPONSIBILITY OF THE PROGRAMMER TO TRANSLATE THE SAMA DIAGRAM CONTROL CONCEPTS TO ACTUAL OPERATIONAL LOGIC.
4. THERE ARE OTHER LOGIC SIGNALS THAT WILL BE REQUIRED THAT ARE NOT SHOWN IN THESE DRAWINGS FOR SWITCHING BETWEEN CONTROL MODES, START SEQUENCING, ALARM, AND SHUTDOWN.

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

FRACT	DECIMALS			ANGLES
	.X	.XX	.XXX	
±	±.10	±.03	±.010	±2°

DO NOT SCALE DRAWING

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DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED		
ENG. APP.		
ISSUED		

NEXT ASSY

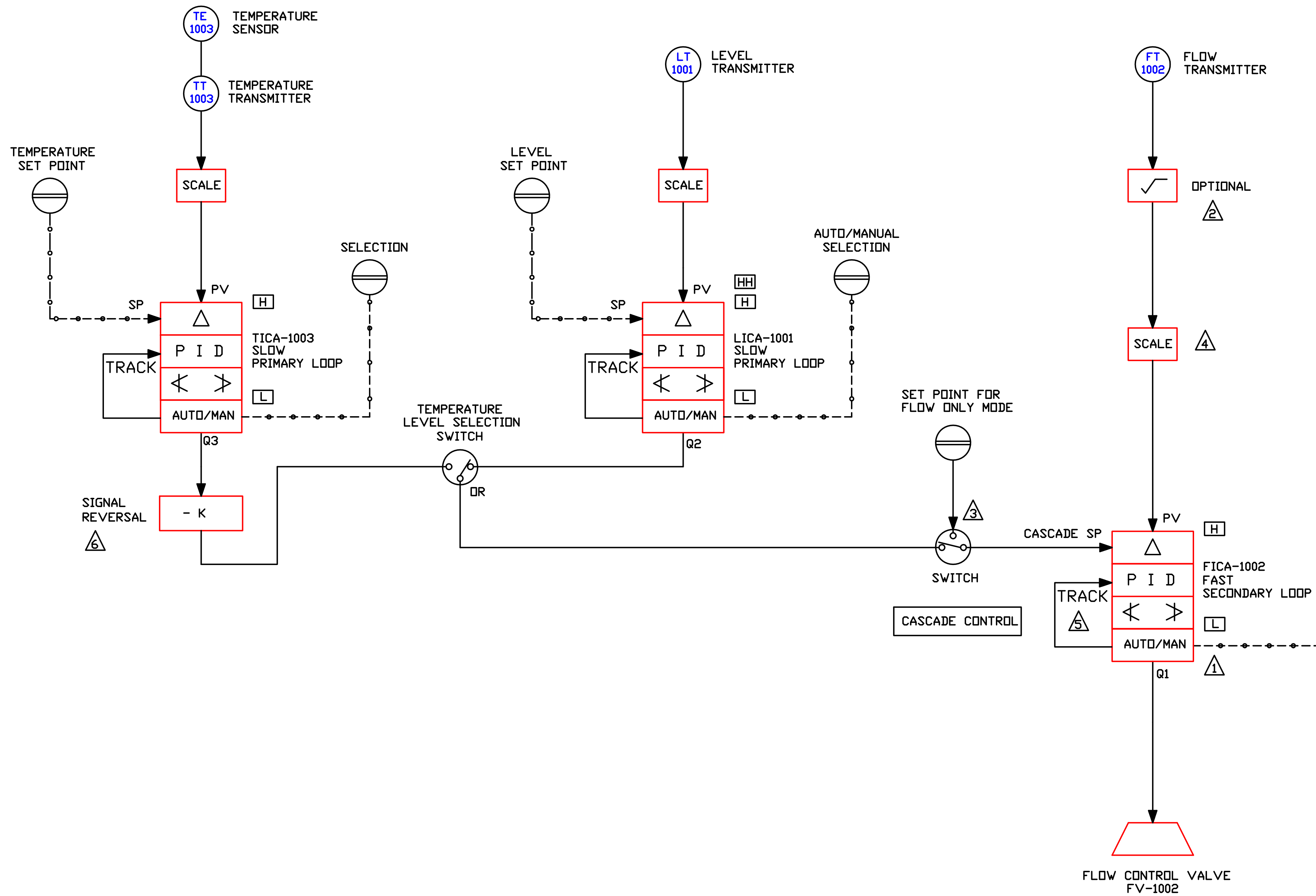
ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA CA 92705

TITLE
VARIABLE PHASE TURBINE
SAMA DIAGRAMMNG SYMBOLS LEGEND

DWG. SIZE B | PROJECT NO 10466 | DWG E1046680

SCALE: NTS | EST. WT. | SHEET 1 OF 3

VAPORIZER LEVEL CONTROL



LOGIC NOTES:

1. AUTO/MANUAL FUNCTION BUILT INTO THE SINGLE LOOP CONTROLLER AND IS ACCESSIBLE VIA FACE PLATE OR REMOTELY THROUGH COMMUNICATIONS.

2. SQUARE ROOT FUNCTION IF ORIFACE PLATE IS USED.

3. WHEN USING "SET POINT FOR FLOW ONLY MODE" VAPORIZER LEVEL AND OR TEMPERATURE WILL NOT BE AUTOMATICALLY MAINTAINED AND MAY EXCEED HIGH AND OR LOW TRIP LIMITS.

4. SCALE FUNCTIONS MAY BE WITHIN SINGLE LOOP CONTROLLER (SLC).

5. OUTPUT TRACKING FOR BUMPLESS AUTO/MANUAL TRANSFER.

6. USE SOME MEANS FOR SIGNAL REVERSAL OR USE SLC THAT PROVES REVERSE ACTING OUTPUT FOR TEMPERATURE CONTROL.

BOTH LEVEL AND FLOW CONTROLLERS SHOULD BE FORWARD ACTING CONTROLLERS.

NOTES:

1. "SAMA" STANDS FOR "SCIENTIFIC APPARATUS MAKERS ASSOCIATION" AND IS A SYMBOLIC LANGUAGE USED TO DESCRIBE AND DOCUMENT CONTROL STRATEGIES.

2. THIS LEGEND SHEET COMBINES SAMA STANDARD SYMBOLS, WITH NEWER ANSI/ISA 5.1 STANDARD SYMBOLS TO AID IN EXPANDING THE CONTROL CONCEPTS.

3. SAMA DIAGRAM LOGIC IS GENERIC IN NATURE, WHICH MEANS IT DOES NOT DEFINE THE SPECIFIC FUNCTIONS USED IN THE HARDWARD CHOSEN, SUCH AS PLC'S, DCS'S OR SLC'S. SAMA LOGIC DIAGRAMS DO NOT COMPLETELY DEFINE ALL LOGIC NEEDED TO CONTROL A SYSTEM AND THAT IT IS THE RESPONSIBILITY OF THE PROGRAMMER TO TRANSLATE THE SAMA DIAGRAM CONTROL CONCEPTS TO ACTUAL OPERATIONAL LOGIC.

4. THERE ARE OTHER LOGIC SIGNALS THAT WILL BE REQUIRED THAT ARE NOT SHOWN IN THESE DRAWINGS FOR SWITCHING BETWEEN CONTROL MODES, START SEQUENCING, ALARM, AND SHUTDOWN,

5. ALL INTERNAL SIGNALS ARE NORMALIZED TO A COMMON SCALE.

6. SEE SAMA DIAGRAM NARRATIVE FOR A MORE DESCRIPTIVE DEFINITION OF THESE CONTROL LOOPS.

7. IT IS THE RESPONSIBILITY OF THE CONTROLS DESIGNER/PROGRAMMER TO DETERMINE INTERFACE AND DISPLAY SCALES.

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

FRACT	DECIMALS .X	.XX	.XXX	ANGLES
±	±.10	±.03	±.010	±2°

DO NOT SCALE DRAWING

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED		
ENG. APP.		
ISSUED		

NEXT ASSY

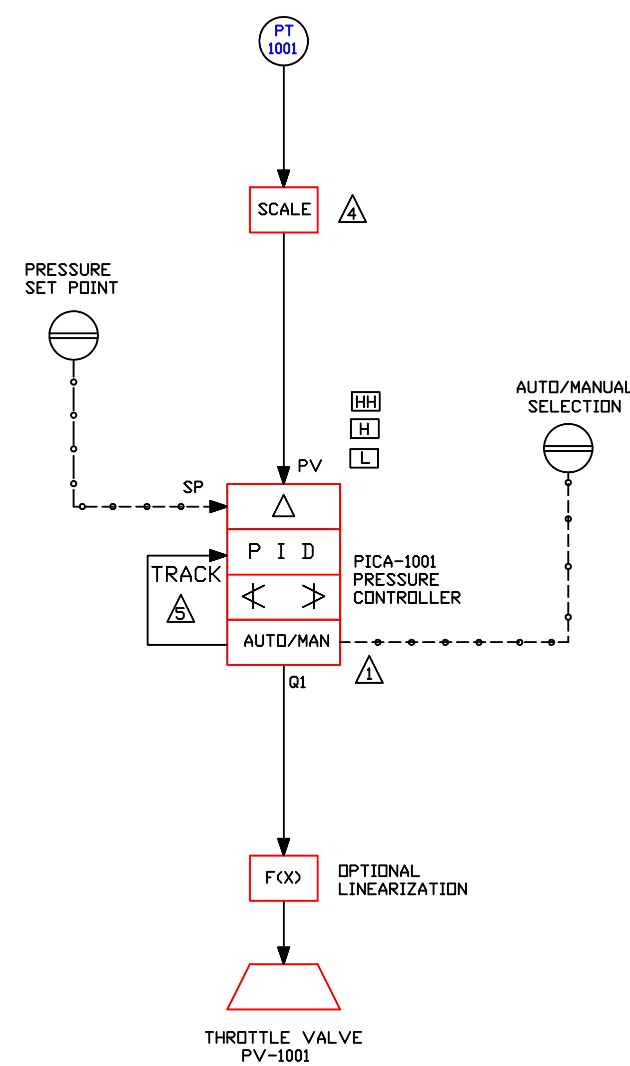
ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA CA 92705

TITLE
VARIABLE PHASE TURBINE
ANALOG VALVE CONTROL LOOPS

DWG. SIZE B | PROJECT NO 10466 | DWG E1046680

SCALE: NTS | EST. WT. | SHEET 2 OF 3

TURBINE THROTTLE VALVE CONTROL



LOGIC NOTES:

1. AUTO/MANUAL FUNCTION BUILT INTO THE SINGLE LOOP CONTROLLER AND IS ACCESSIBLE VIA FACE PLATE OR REMOTELY THROUGH COMMUNICATIONS.

4. SCALE FUNCTIONS MAY BE WITHIN SINGLE LOOP CONTROLLER (SLC).

5. OUTPUT TRACKING FOR BUMPLESS AUTO/MANUAL TRANSFER.

NOTES:

1. 'SAMA' STANDS FOR 'SCIENTIFIC APPARATUS MAKERS ASSOCIATION' AND IS A SYMBOLIC LANGUAGE USED TO DESCRIBE AND DOCUMENT CONTROL STRATEGIES.
2. THIS LEGEND SHEET COMBINES SAMA STANDARD SYMBOLS, WITH NEWER ANSI/ISA 5.1 STANDARD SYMBOLS TO AID IN EXPANDING THE CONTROL CONCEPTS.
3. SAMA DIAGRAM LOGIC IS GENERIC IN NATURE, WHICH MEANS IT DOES NOT DEFINE THE SPECIFIC FUNCTIONS USED IN THE HARDWARD CHOSEN, SUCH AS PLC'S, DCS'S OR SLC'S. SAMA LOGIC DIAGRAMS DO NOT COMPLETELY DEFINE ALL LOGIC NEEDED TO CONTROL A SYSTEM AND THAT IT IS THE RESPONSIBILITY OF THE PROGRAMMER TO TRANSLATE THE SAMA DIAGRAM CONTROL CONCEPTS TO ACTUAL OPERATIONAL LOGIC.
4. THERE ARE OTHER LOGIC SIGNALS THAT WILL BE REQUIRED THAT ARE NOT SHOWN IN THESE DRAWINGS FOR SWITCHING BETWEEN CONTROL MODES, START SEQUENCING, ALARM, AND SHUTDOWN,
5. ALL INTERNAL SIGNALS ARE NORMALIZED TO A COMMON SCALE.
6. SEE SAMA DIAGRAM NARRATIVE FOR A MORE DESCRIPTIVE DEFINITION OF THESE CONTROL LOOPS.
7. IT IS THE RESPONSIBILITY OF THE CONTROLS DESIGNER/PROGRAMMER TO DETERMINE INTERFACE AND DISPLAY SCALES.

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
FRACT DECIMALS ANGLES
± .X ±.10 .XX ±.03 .XXX ±.010 ±2°

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DO NOT SCALE DRAWING

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED		
ENG. APP.		
ISSUED		

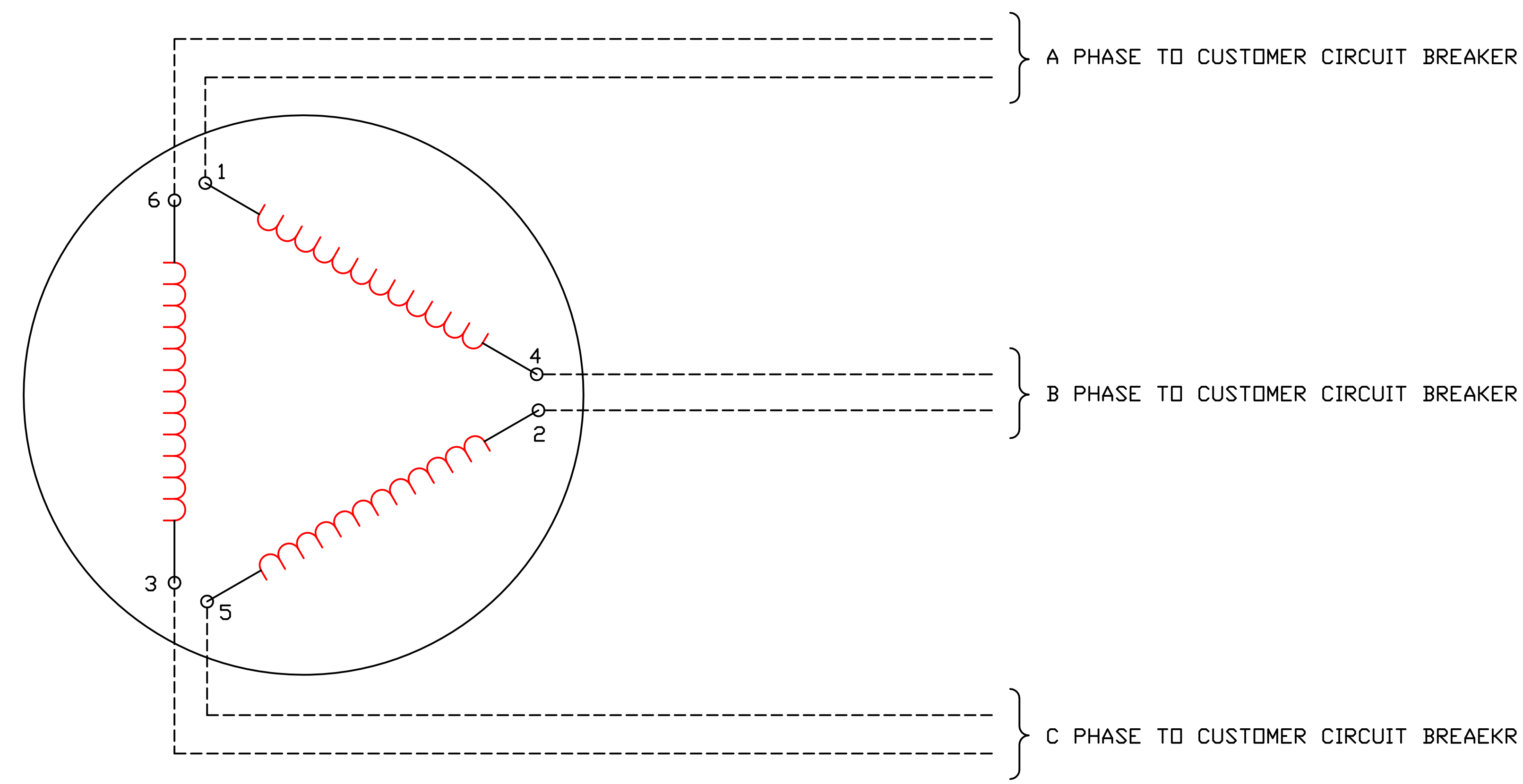
NEXT ASSY

ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA CA 92705

TITLE
VARIABLE PHASE TURBINE
ANALOG VALVE CONTROL LOOPS

DWG. SIZE B | PROJECT NO 10466 | DWG E1046680

SCALE: NTS | EST. WT. | SHEET 3 OF 3



NOTE: CUSTOMER RESPONSIBLE FOR PROPER PHASE ROTATION.

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED

UNLESS OTHERWISE SPECIFIED

1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

FRACT	DECIMALS .X	DECIMALS .XX	DECIMALS .XXX	ANGLES
±	±.10	±.03	±.010	±2°

DO NOT SCALE DRAWING

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED		
ENG. APP.		
ISSUED		

NEXT ASSY

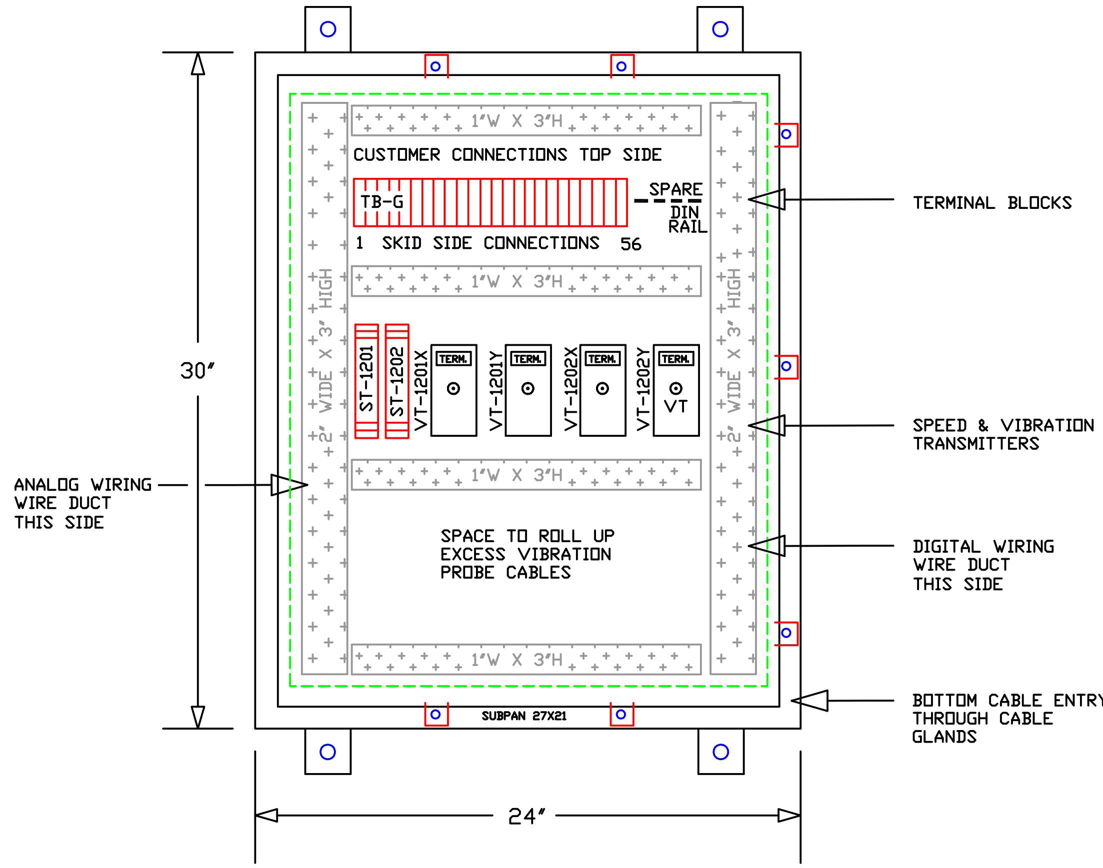
ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA CA 92705

TITLE
VARIABLE PHASE TURBINE
GENERATOR CONNECTION DIAGRAM

DWG. SIZE	PROJECT NO	DWG
B	10466	E1046681

SCALE: NTS | EST. WT. | SHEET 1 OF 1

TURBINE SKID INSTRUMENTATION
CONNECTIONS JUNCTION BOX



HOFFMAN ENCLOSURE
PART NUMBERS:

ENCLOSURE: A-30H24BLP (8 IN. DEEP)
SUB PANEL: A-30P24
NEMA 4/IP66

NOTES:

SEE BILL OF MATERIAL FOR DETAILS ON PARTS.

SEE LOOP DIAGRAMS FOR WIRING DETAILS.

WIRING NOTES:

1. ALL SIGNAL WIRING, 4-20MA, T/C, & RTD CIRCUITS SHALL BE SEGRATED FROM AC CIRCUITS AND NOISY DC SWITCHING CIRCUITS.
2. ALL WIRE AND CABLE SHALL BE LABELED AT BOTH ENDS PER DRAWINGS.
3. WIRE MARKERS SHALL BE USED THAT HAVE GOOD CONTRAST.
4. ALL CABLES USED MUST BE TRAY CABLE RATED PER NEC. (PLTC/TC)

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH 125

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

FRACT	DECIMALS .X	.XX	.XXX	ANGLES
±	±.10	±.03	±.010	±2°

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NEXT ASSY

DO NOT SCALE DRAWING

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED		
ENG. APP.		
ISSUED		

ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA CA 92705

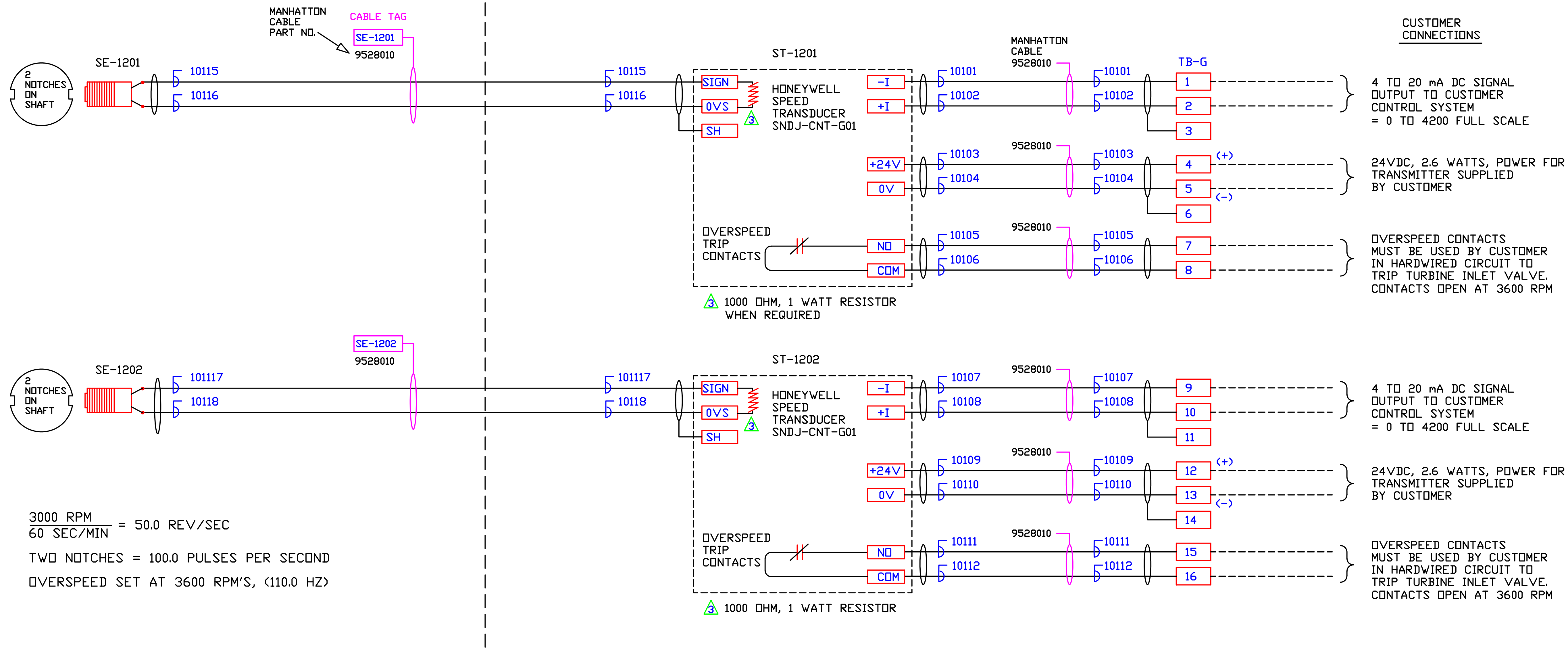
TITLE
VARIABLE PHASE TURBINE
SKID INSTRUMENT CONNECTION JUNCTON BOX

DWG. SIZE B | PROJECT NO 10466 | DWG E1046682

SCALE: NTS | EST. WT. | SHEET 1 OF 1

SKID DEVICES

SKID CONNECTION JUNCTION BOX



$\frac{3000\ \text{RPM}}{60\ \text{SEC/MIN}} = 50.0\ \text{REV/SEC}$

TWO NOTCHES = 100.0 PULSES PER SECOND

OVERSPEED SET AT 3600 RPM'S, (110.0 HZ)

HONEYWELL CONFIGURATION

MACHINE FACTOR: 1.0, 5MS
GLOBAL ALARM: SYS. ERROR OR SENSOR
SENSOR TYPE: PASSIVE
SENSOR INPUT: ANALOG
ANALOG OUTPUT: 0-140 = 4-20mA
RELAY CONTROL: ALWAYS A
RELAY LIMIT: LIMIT 1
ACKNOWLEDGE: W/O ACK. (NO HOLD)
CONFIGURATION: LIMIT 1
HIGH = 110HZ (3600)
LOW = 75HZ (RESET)
MODE: INVERSE
STATUS: ON
NOTE: LIMIT 2 NOT USED.

OVERSPEED TRANSMITTER RELAY OUTPUT

CONTACTS SHOWN, OPEN ON
OVERSPEED. NON-LATCHING.
CONTACT RATING: 250VAC, 1250VA, MAXIMUM.

WIRING NOTES:

1. ALL SIGNAL WIRING, 4-20MA, T/C, & RTD CIRCUITS SHALL BE SEGRATED FROM AC CIRCUITS AND NOISY DC SWITCHING CIRCUITS.
2. ALL WIRE AND CABLE SHALL BE LABELED AT BOTH ENDS PER DRAWINGS.
3. WIRE MARKERS SHALL BE USED THAT HAVE GOOD CONTRAST.
4. ALL CABLES USED MUST BE TRAY CABLE RATED PER NEC. (PLTC/TC)
5. ALL INSTRUMENT CABLE SHALL BE SHIELDED WITH SHIELDS GROUNDED AT ONE POINT ONLY AS PER DRAWINGS.

REV	ZONE	BY	DESCRIPTION	DATE	CHK	APPROVED

UNLESS OTHERWISE SPECIFIED
1. REMOVE ALL BURRS AND SHARP EDGES R.005/.018
2. SURFACE FINISH

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
FRACT ± | DECIMALS .X ±.10 .XX ±.03 .XXX ±.010 | ANGLES ±2°

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DO NOT SCALE DRAWING

DESIGN	E.GUZMAN	10/17/14
DRAWN	E.GUZMAN	10/17/14
CHECKED		
ENG. APP.		
ISSUED		

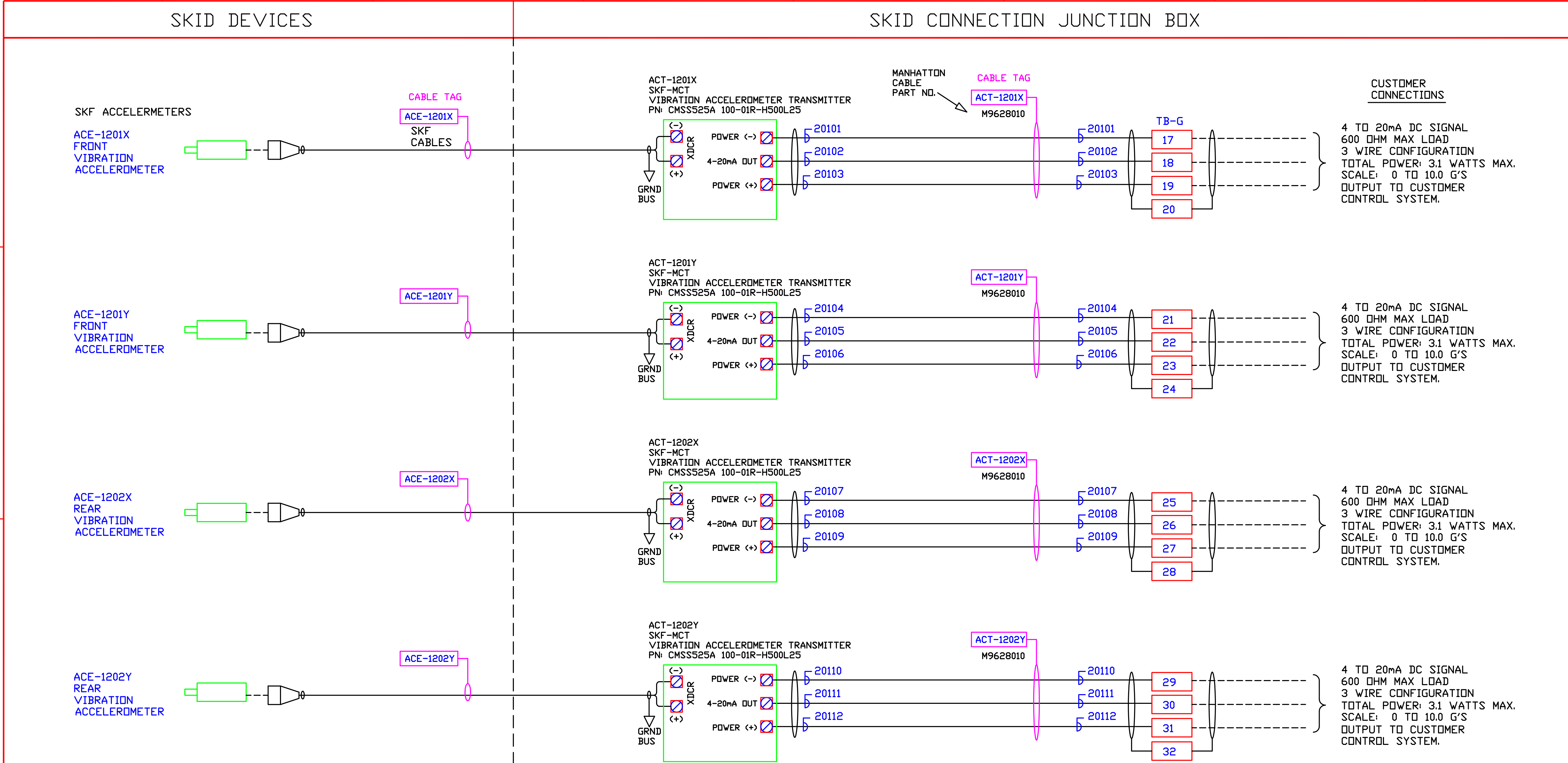
NEXT ASSY

ENERGENT CORP.
1831 CARNEGIE AVE
SANTA ANA CA 92705

TITLE
VARIABLE PHASE TURBINE
SKID WIRING DIAGRAMS

DWG. SIZE B | PROJECT NO 10466 | DWG E1046683

SCALE: NTS | EST. WT. | SHEET 1 OF 4



WIRING NOTES:

1. ALL SIGNAL WIRING, 4-20MA, T/C, & RTD CIRCUITS SHALL BE SEGRATED FROM AC CIRCUITS AND NOISY DC SWITCHING CIRCUITS.
2. ALL WIRE AND CABLE SHALL BE LABELED AT BOTH ENDS PER DRAWINGS.
3. WIRE MARKERS SHALL BE USED THAT HAVE GOOD CONTRAST.
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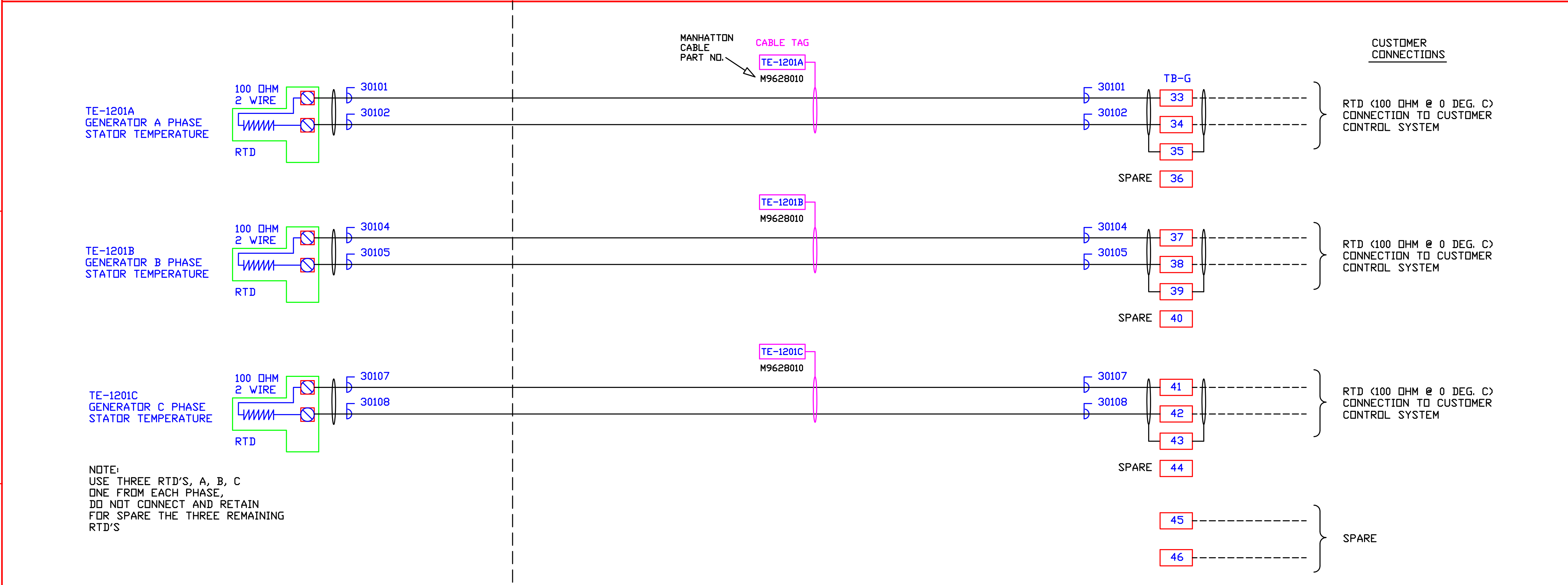
TITLE
VARIABLE PHASE TURBINE
SKID WIRING DIAGRAMS

DWG. SIZE B | PROJECT NO 10466 | DWG E1046683

SCALE: NTS | EST. WT. | SHEET 2 OF 4

SKID DEVICES	SKID CONNECTION JUNCTION BOX



NOTE:
USE THREE RTD'S, A, B, C
ONE FROM EACH PHASE,
DO NOT CONNECT AND RETAIN
FOR SPARE THE THREE REMAINING
RTD'S

WIRING NOTES:

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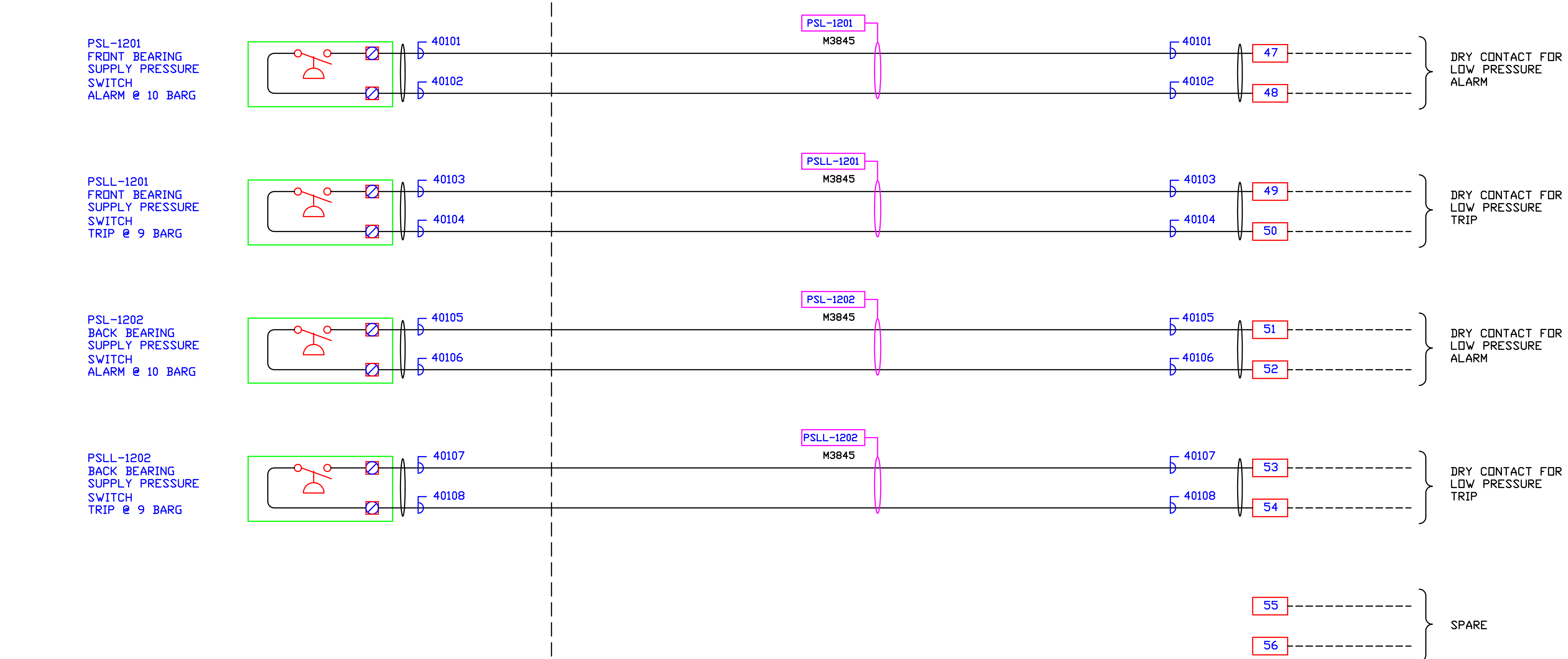
1831 CARNEGIE AVE
SANTA ANA CA 92705

TITLE
VARIABLE PHASE TURBINE
SKID WIRING DIAGRAMS

DWG. SIZE	PROJECT NO	DWG
B	10466	E1046683

SCALE: NTS | EST. WT. | SHEET 3 OF 4

SKID DEVICES	SKID CONNECTION JUNCTION BOX



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SKID WIRING DIAGRAMS

DWG. SIZE	PROJECT NO	DWG
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SCALE: NTS	EST. WT.	SHEET 4 OF 4