



**BIOGAS UPGRADER**

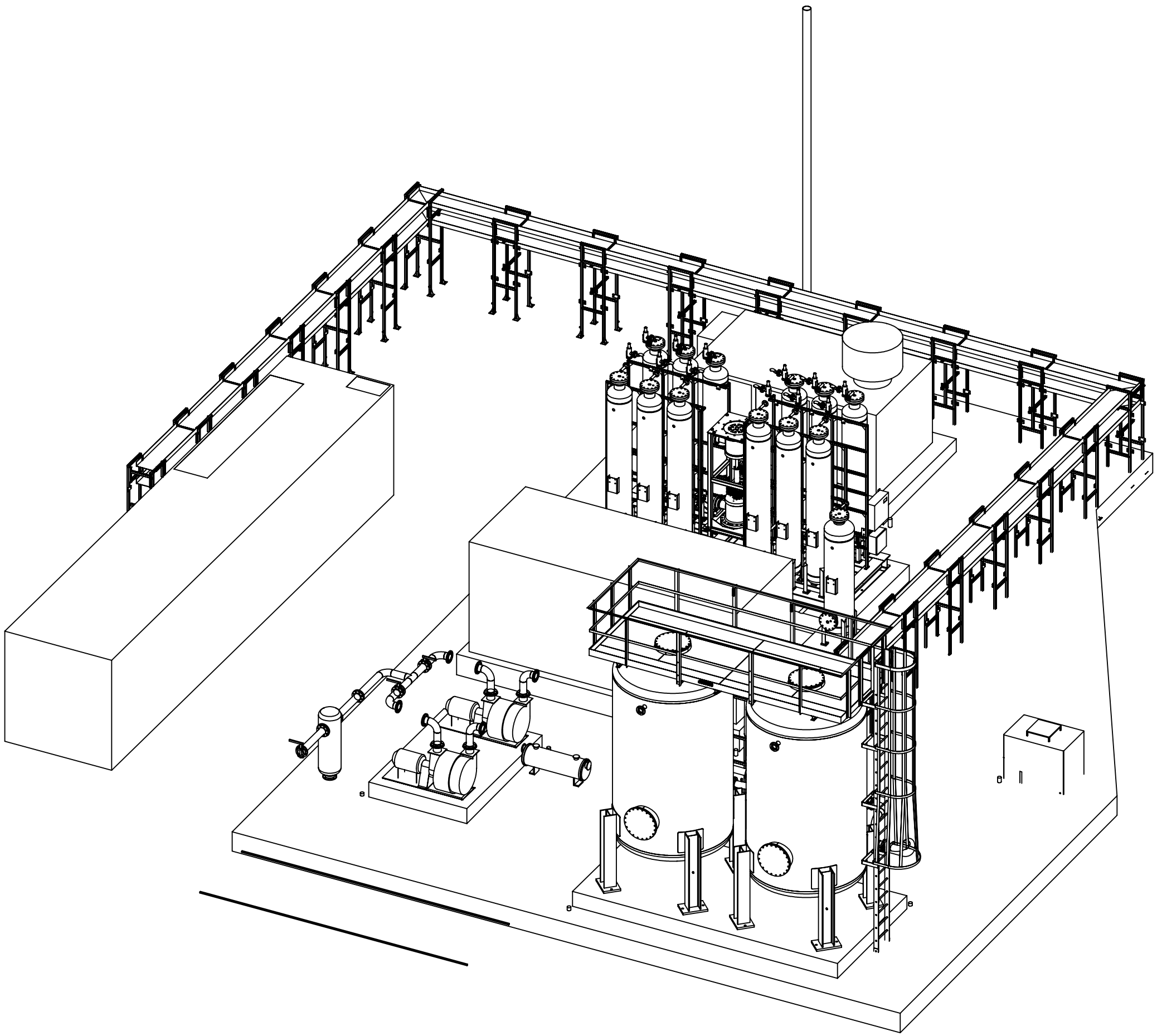
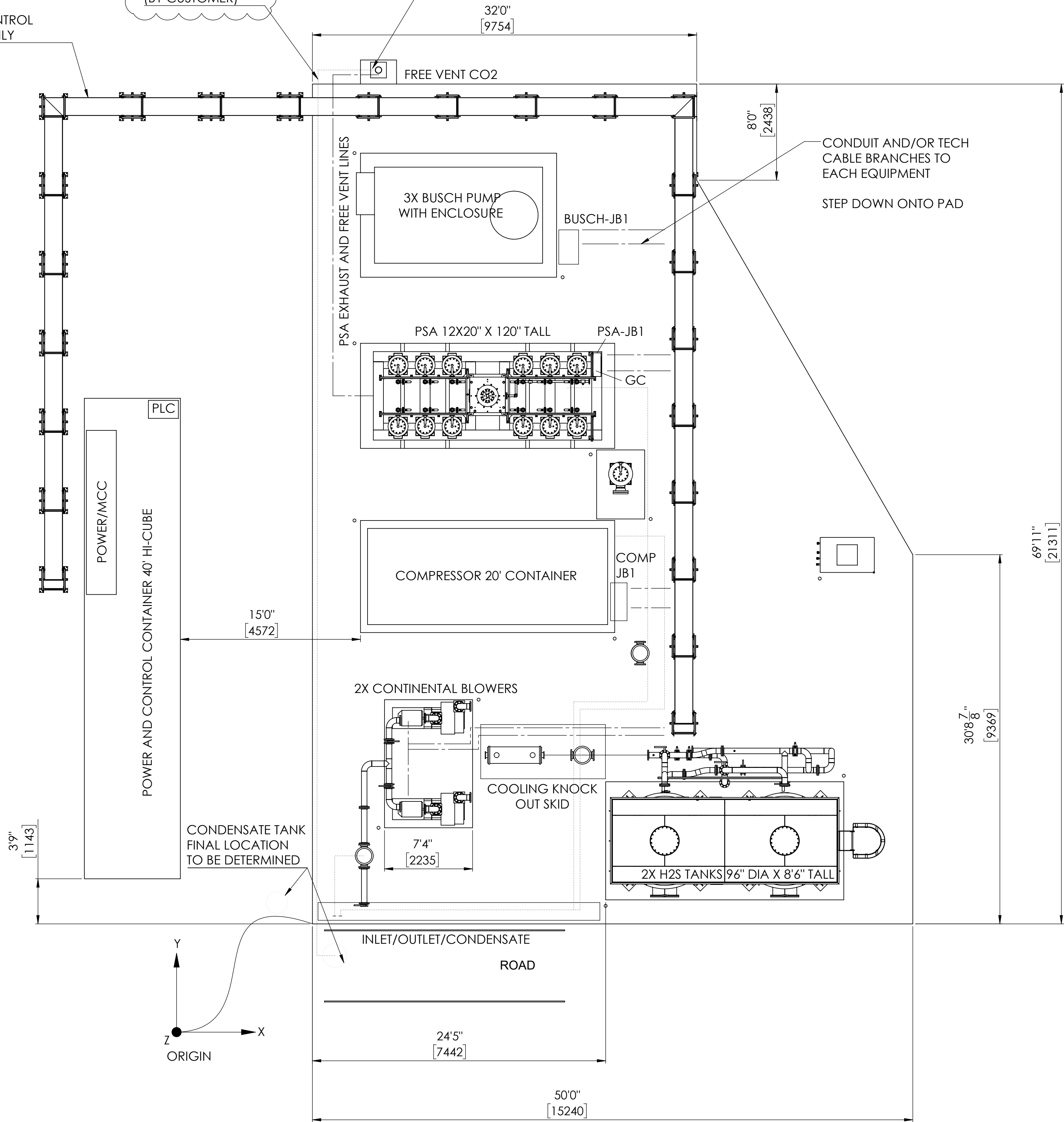


| ECN | REV | ECN DESCRIPTION | ECN BY | APPR ON | APPR BY |
|-----|-----|-----------------|--------|---------|---------|
|     | 1   | -               | ROBM   | -       | AP      |

2-LAYER CABLE TRAY SYSTEM  
18" WIDE POWER  
10-18" WIDE CONTROL  
PRELIMINARY ONLY

3" PLASTIC  
CONDENSATE PIPE  
TO RUN UNDER PAD  
(BY CUSTOMER)

CONDENSATE STACK  
MIN 10FT



NOTES:

- 1) PIPING IF SHOWN IS PRELIMINARY ONLY.
- 2) ALL VFD MOTORS TO BE WIRED BACK TO DRIVES IN MCC PANEL FOUND IN POWER CONTAINER.
- 3) JUNCTION BOXES ON BUSCH ENCLOSURE, PSA AND COMPRESSOR. SUBJECT TO CHANGE
- 4) CABLE TRAY SHOWN FOR REFERENCE ONLY TO DESCRIBE CABLE RUNS.
- 5) CONTROL CABLES RUN IN SEPERATE TRAY AS POWER CABLES IS PRELIMINARY. DETAILED DESIGN OF CABLE TRAY RUN AND CABLE TRAY LAYOUT DRAWING TO BE COMPLETED.
- 6) SEE PAD DRAWING 12399 FOR DETAILS OF RAISED PADS.
- 7) SEE EACH SUB-SYSTEMS GENERAL ARRANGEMENT DRAWING FOR LIFTING, MOUNTING AND WEIGHT INFORMATION.
- 8) ALL LINES LEADING TO BULK SULFUR REMOVAL TANKS TO BE SS316.
- 9) ALL LINES LEADING DOWN-STREAM OF H2S TANKS TO BE SS 304/304L WITH SOME SA106-GRB.
- 10) CONDENSATE LINES TO BE SA106-GRB OR A53 STEEL PIPING.
- 11) ALL INLET AND OUTLET AND CONDENSATE LINES TO BE RUN TO/FROM THE PAD ORIGIN.
- 12) CONDENSATE LINES ~1" SA53 PIPE THREADED, VENT LINE CAN BE 2" TO 3" DIA PLASTIC PIPING.
- 13) CABLE TRAY EXIT LEADS - DETAILS TO BE CONFIRMED.

| UNITS & TOLERANCES FOR FABRICATION & LAYOUT |  | APPROVALS                                              |       |            | QUADROGEN®                                       |      | Unit# 110-8828 North Fraser Way<br>Burnaby, BC, Canada V5N 0E9<br>www.quadrogen.com |           |
|---------------------------------------------|--|--------------------------------------------------------|-------|------------|--------------------------------------------------|------|-------------------------------------------------------------------------------------|-----------|
| UNITS = mm                                  |  | NAME YYYY-MM-DD                                        |       |            | TITLE:                                           |      |                                                                                     |           |
| XX = +/- 2 UNO                              |  | DRAWN                                                  | SG    | 2020-01-28 | SITE LAYOUT BIO-GAS UPGRADING PLANT<br>SALISBURY |      |                                                                                     |           |
| 0.X = +/- 1 UNO                             |  | DESIGN                                                 | ROBM  | 2020-01-28 |                                                  |      |                                                                                     |           |
| 0.XX = +/- 0.5 UNO                          |  | CHECKED                                                | ALAKH | 2020-01-28 |                                                  |      |                                                                                     |           |
| COATINGS - SEE NOTES                        |  | APPROVED                                               | ALAKH | 2020-01-28 | MFG SERIAL :-                                    |      |                                                                                     |           |
| SURFACE FINISHES - SEE NOTES                |  | NOT TO SCALE UNLESS PLOTTED ON ANSI D (22 X 34") SHEET |       |            | SIZE D                                           | OPN: | 12386                                                                               | REV 1     |
| DRAWN IN ACCORDANCE WITH ANSI Y14.5         |  | MATERIAL:                                              |       |            | SCALE 1:65                                       |      | WT. (KGS.)                                                                          | SHEET 1/1 |

## 4 DESIGN CRITERIA AND PLANT PERFORMANCE

The proposed biogas upgrading systems will have maximum input capacity of 650 SCFM. All system production and operating cost estimates are based on this feed flow. The feed stream design criteria and estimated output for the biomethane product are shown in Table 4.1 below. The stated performance for meeting product specification described in the table below is based on the customer providing the stated nominal feed biogas conditions and composition with deviations of not more than  $\pm 5\%$ .

Table 4.1: Feed and Product Balances Design Basis

| STREAM FLOWS        |                    |                  |      | 1          |       | 2                     |       | 3           |       |
|---------------------|--------------------|------------------|------|------------|-------|-----------------------|-------|-------------|-------|
| KG/H - MOL%         |                    |                  |      | TOTAL FEED |       | BIOMETHANE PRODUCT    |       | PSA EXHAUST |       |
| PROCESS STREAM      | STREAM COMPOSITION |                  | MW   |            |       |                       |       |             |       |
|                     | METHANE            | CH <sub>4</sub>  | 16.0 | 448.2      | 60.0% | 439.2                 | 97.3% | 9.0         | 3.0%  |
|                     | CARBON DIOXIDE     | CO <sub>2</sub>  | 44.0 | 811.4      | 39.5% | 24.3                  | 2.0%  | 787.1       | 96.8% |
|                     | NITROGEN           | N <sub>2</sub>   | 28.0 | 3.9        | 0.3%  | 3.5                   | 0.4%  | 0.4         | 0.1%  |
|                     | OXYGEN             | O <sub>2</sub>   | 32.0 | 3.0        | 0.2%  | 2.7                   | 0.3%  | 0.3         | 0.1%  |
|                     | HYDROGEN SULPHIDE  | H <sub>2</sub> S | 34.1 | 500 ppmv   |       | < 4 ppmv              |       | --          |       |
|                     | SILOXANES          | --               |      | <5 ppmv    |       | < 1 mg/m <sup>3</sup> |       | --          |       |
|                     | AMMONIA            | NH <sub>3</sub>  | 17.0 | < 10 ppmv  |       | < 10 ppmv             |       | --          |       |
|                     | WATER              | H <sub>2</sub> O | 18.0 | Saturated  |       | < 5 lbs/MMSCF         |       | --          |       |
|                     | TOTAL              |                  | KG/H | 1266       |       | 470                   |       | 797         |       |
| PROCESS CONDITION   | FLOW RATE          |                  | NORM | SCFM       | 650   | 393                   | 257   |             |       |
|                     |                    |                  | NORM | ACFM       | 692   | 30                    | 290   |             |       |
|                     |                    |                  | NORM | NM³/H      | 1046  | 632                   | 414   |             |       |
|                     |                    |                  | NORM | AM³/H      | 1175  | 50                    | 492   |             |       |
|                     | TEMPERATURE        |                  |      | °C         | 36    | 15                    | 96    |             |       |
|                     |                    |                  |      | °F         | 97    | 59                    | 205   |             |       |
|                     | PRESSURE           |                  |      | kPA(A)     | 102   | 1343                  | 115   |             |       |
|                     |                    |                  |      | BARA       | 1.02  | 13.4                  | 1.2   |             |       |
|                     |                    |                  |      | PSIA       | 14.8  | 194.8                 | 16.7  |             |       |
|                     |                    |                  |      | PSIG       | 0.1   | 180.1                 | 2.0   |             |       |
| PHYSICAL PROPERTIES | DENSITY            |                  |      | KG/AM³     | 1.08  | 9.34                  | 1.62  |             |       |
|                     |                    |                  |      | LB/AFT³    | 0.07  | 0.58                  | 0.10  |             |       |
|                     | VISCOSITY          |                  |      | cP         | 0.01  | 0.01                  | 0.01  |             |       |
|                     | MOLECULAR WEIGHT   |                  |      | G/MOL      | 27.13 | 16.65                 | 43.13 |             |       |

<sup>1</sup> All contaminants are not provided in this table. A full gas analysis of the feed biogas is required.

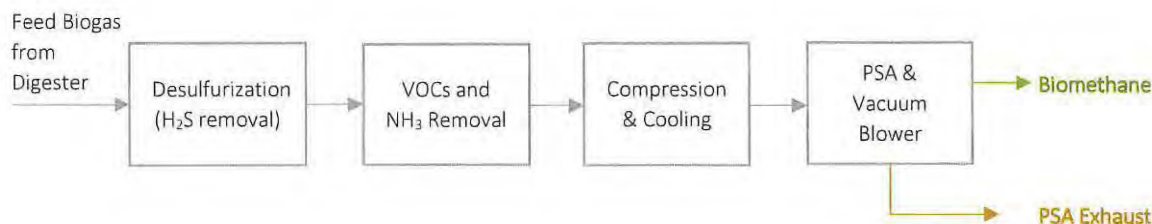
<sup>2</sup> All contaminants are not provided in this table but will meet required biomethane specifications estimated by Quadrogen.

### Notes:

- Expected methane recovery is 98%. Guaranteed methane recovery is 96%.
- An estimated condensate flow of 180 kg/hr (depending on feed biogas temperature) will be discharged to sump at design capacity from the system.

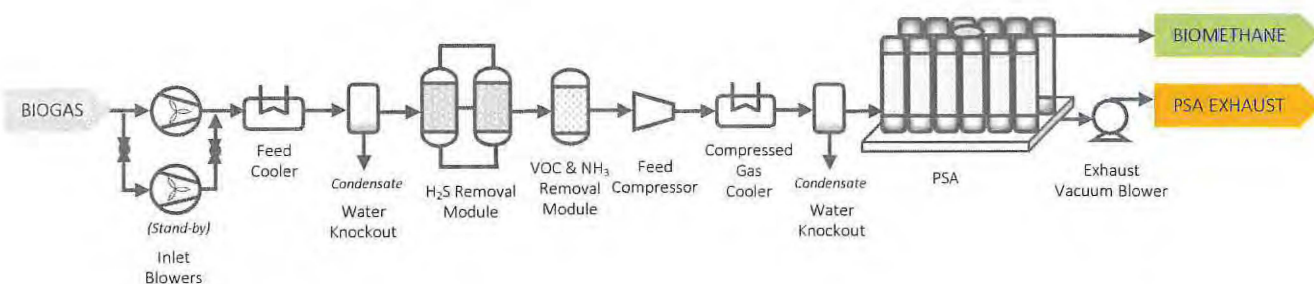
## 5 PROCESS DESCRIPTION

### Block Diagram



*Proposed block diagram of the biogas upgrading process*

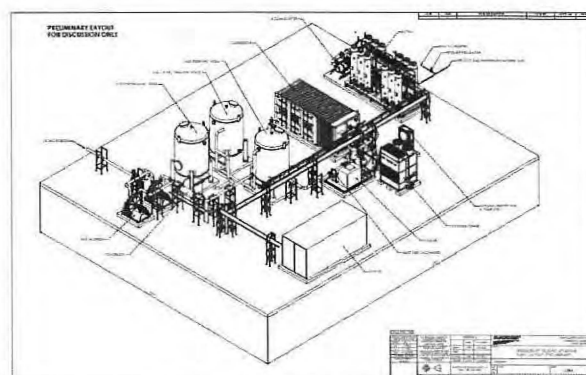
### Process Flow Diagram



*Proposed process flow diagram for IBUS*

### General Arrangement

The general arrangement is highly dependent on site-specific requirements and constraints. However, for footprint estimation purposes, please find attached sample general arrangement drawing in Appendix A. Note that the footprint of the system can be condensed to approximately half of the area shown in the sample drawing if required.



## Plant and Process Description

The IBUS is an integrated process in which biogas is treated to reduce the  $H_2S$ ,  $NH_3$  and VOCs levels, and  $N_2$ ,  $O_2$ , and  $CO_2$  are separated from the methane to produce biomethane. The IBUS is based on Quadrogen's proprietary technology that is comprised of the following steps:

| STAGE                                                                                                                                                          | DESCRIPTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  <p><i>Biogas Feed Blower</i></p>                                             | <p>Step 1: The raw biogas is compressed with a high efficiency blower from estimated 0.1 psig to approximately 4 psig, to drive the gas through the downstream <math>H_2S</math> removal module and chiller.</p>                                                                                                                                                                                                                                                                                                                                       |
|  <p><i>Chiller</i></p>                                                       | <p>Step 2: The biogas is cooled and condensate is separated with a knock-out drum.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|  <p><i><math>H_2S</math>, <math>NH_3</math> and VOCs Removal Module</i></p> | <p>Step 3: Feed biogas (at ~4 psig feed pressure) with 500 ppmv <math>H_2S</math> is captured on high capacity media beds arranged in a lead-lag configuration. All process piping and wetted parts for instrumentation such as process valves are also selectively constructed for bulk contaminant removal of <math>H_2S</math>. The expected <math>H_2S</math> level in the cleaned biogas is about 10 ppmv. Expected media change out is approximately 6 months. Then the biogas is fed to a vessel for removal of <math>NH_3</math> and VOCs.</p> |



*Feed Compressor*

Step 4: The biogas is compressed with a high efficiency screw compressor to approximately 200 psig. The biogas is then cooled with cooling water to approximately 15°C before reporting to the PSA.



*Pressure Swing Adsorption (PSA)*

Step 5: The Quadrogen PSA is designed to remove concentrations of oxygen, nitrogen, and carbon dioxide using a complex cycle that is comprised of four phases: pressure build-up, adsorption, depressurization and regeneration. Pressure build-up is achieved by equilibrating pressure with a vessel that is in a depressurization stage. During adsorption,  $N_2$ ,  $O_2$ , and  $CO_2$  are adsorbed by the media and the gas exits as biomethane. Before media saturation, biogas goes to another ready vessel. Depressurization is performed by equalizing with a second pressurizing vessel, and regeneration is achieved at atmospheric pressure.



*Exhaust Vacuum Blower*

Step 6: A vacuum is then applied to the PSA vessels to remove the contaminants out of the media and exhaust it into a burner (by customer).

## 6 OPERATING POWER CONSUMPTION ESTIMATES

The operating power estimates are based on:

- The specified feed biogas composition and maximum design flow
- Quadrogen's experienced assumptions

Table 6.1: Power Consumption Estimates

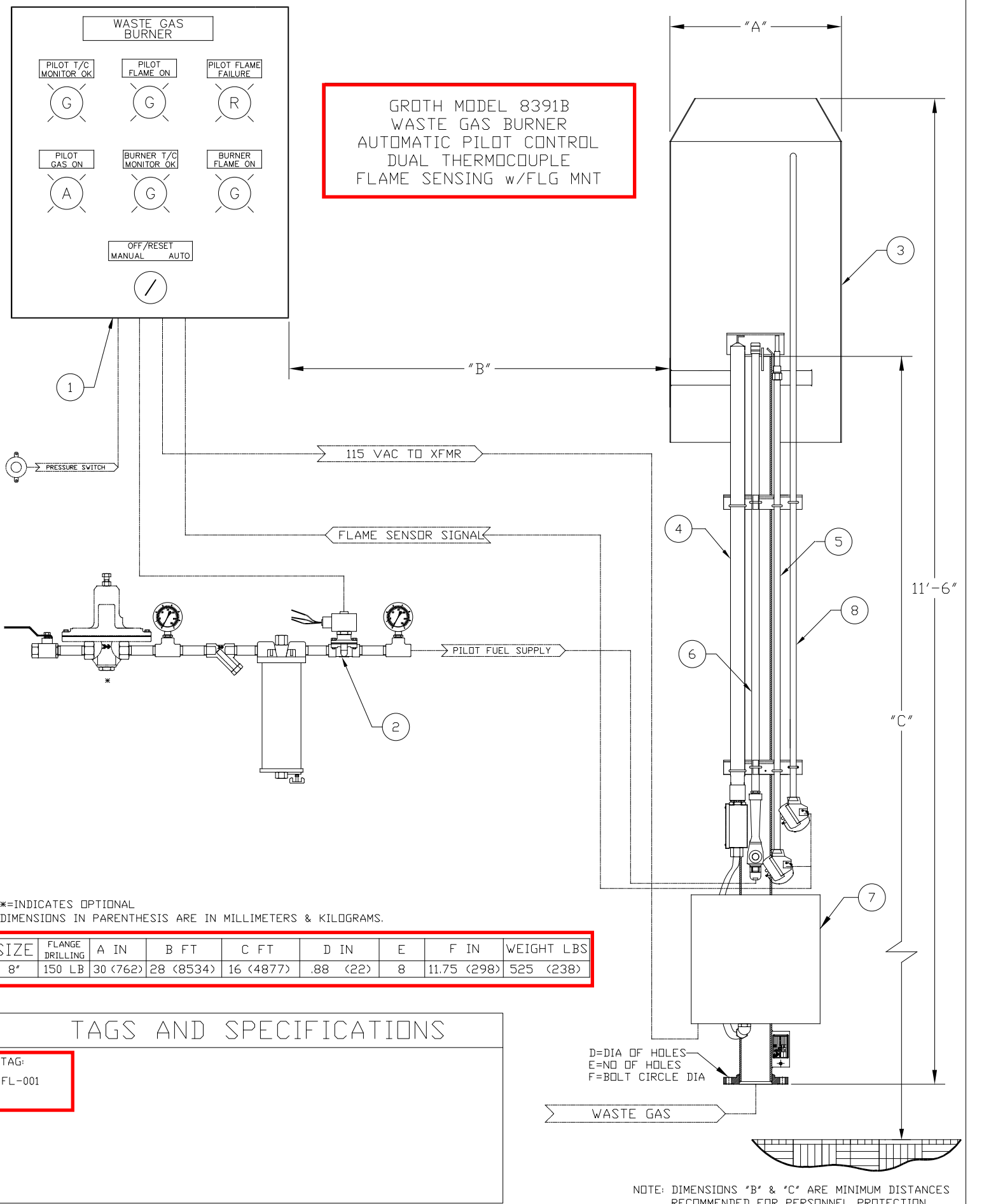
| Item                                    | Power Rating ( $\pm 10\%$ ) (kW) |
|-----------------------------------------|----------------------------------|
| Blower                                  | 30                               |
| Compressor                              | 185                              |
| PSA                                     | 1                                |
| Vacuum Pump                             | 34                               |
| Auxiliary Systems (e.g. Cooling System) | 60                               |
| <b>Total</b>                            | <b>310</b>                       |

Estimated cost for H<sub>2</sub>S media and NH<sub>3</sub>/VOCs media replacement is about \$135,000 USD/year.

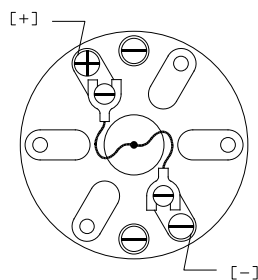
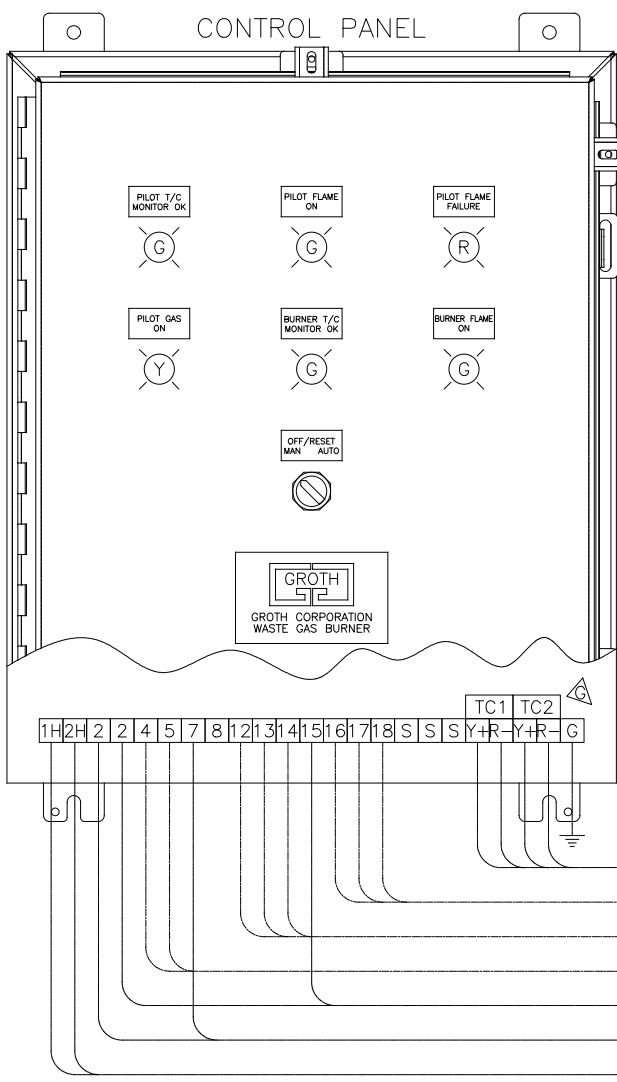


## **GAS FLARE EQUIPMENT**

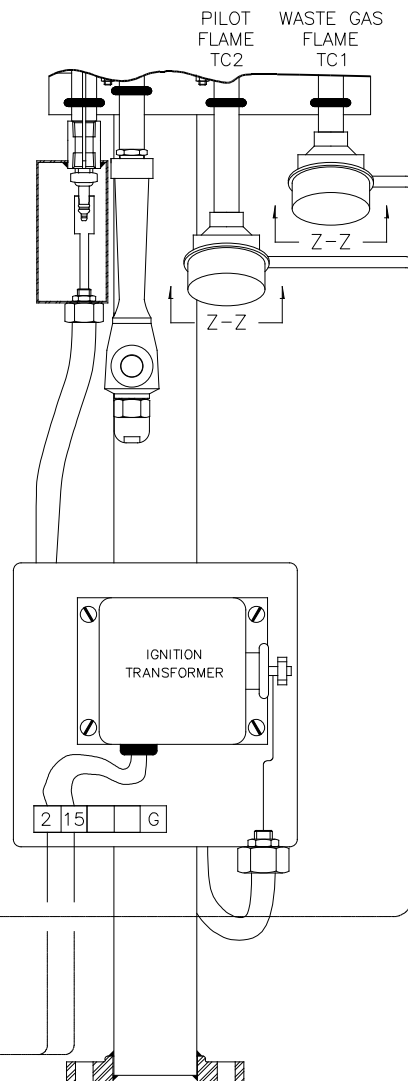




MODEL 8391A  
WASTE GAS BURNER  
CONTROL PANEL



DETAIL Z-Z  
THERMOCOUPLE CONNECTION TERMINALS  
CONNECT TYPE "K" THERMOCOUPLE WIRE  
YELLOW TO [+], TERMINAL SCREW  
RED TO [-], TERMINAL SCREW



TAGS AND SPECIFICATIONS



GROTH CORPORATION  
HOUSTON, TEXAS

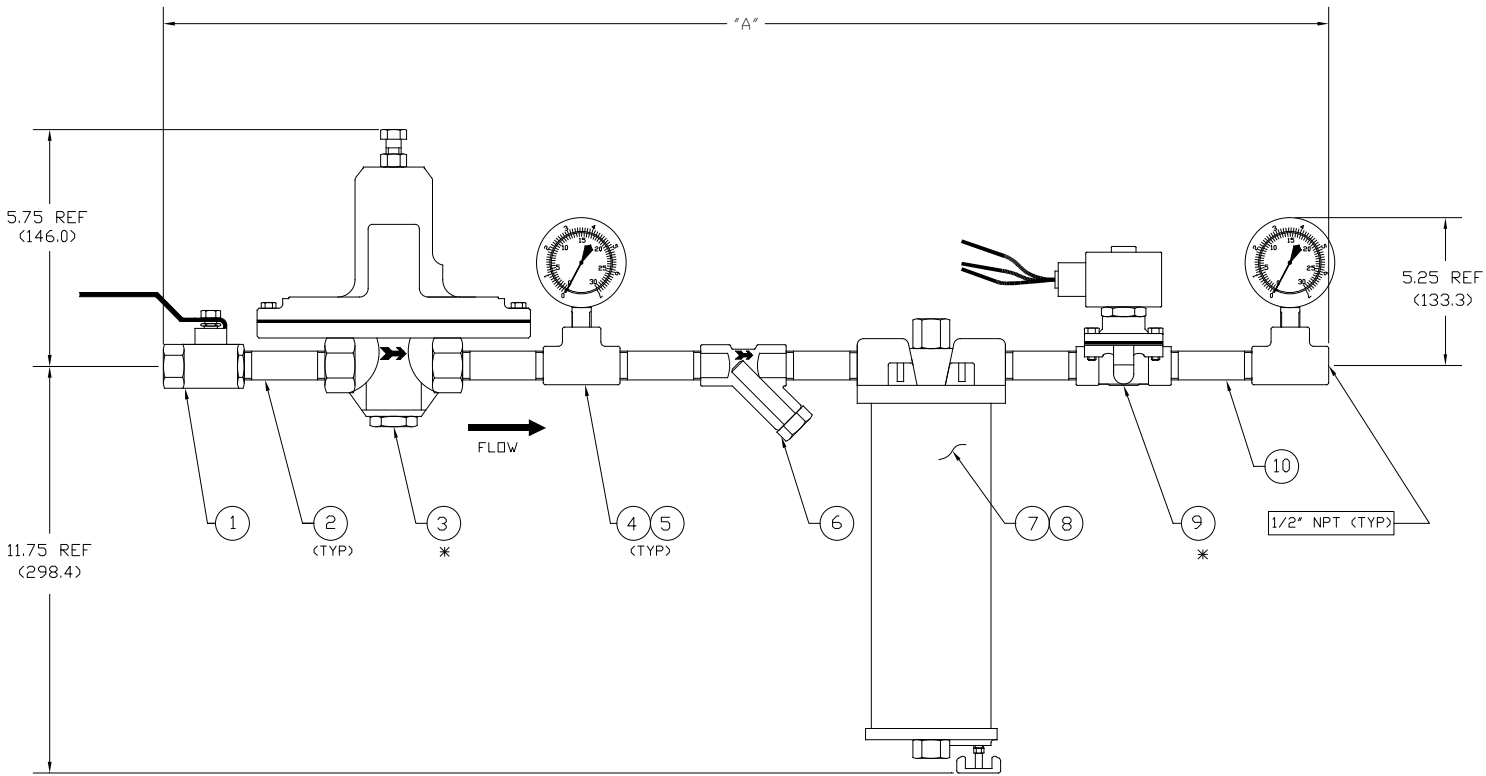
CERTIFIED

DWG. NO. CPD-8391-X-XX41

REVISION: IR

DATE: 11-27-2019

MODEL 8391A  
WASTE GAS BURNER  
PILOT FUEL MANIFOLD



| OPTIONS         | A             |
|-----------------|---------------|
| w/ITEMS 3 & 9   | 35.25 (895.3) |
| w/ITEM 3        | 30.25 (768.3) |
| w/ITEM 9        | 28.68 (728.4) |
| w/o ITEMS 3 & 9 | 23.63 (600.2) |

DIMENSIONS IN PARENTHESIS ARE IN MILLIMETERS  
NOTE: (\*)=ITEM NO. 3 & 9 ARE OPTIONAL,  
PILOT FUEL MANIFOLD TO BE  
INSTALLED BY OTHERS.

TAGS AND SPECIFICATIONS



GROTH CORPORATION  
HOUSTON, TEXAS

CERTIFIED

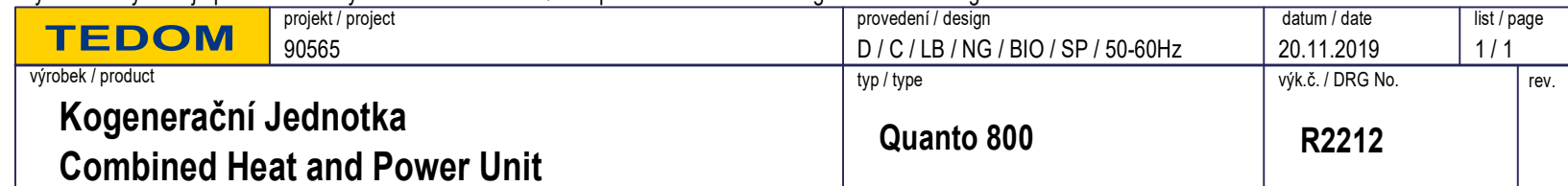
DWG. NO. C-84458

REVISION: C

DATE: 07-18-97



## COMBINED HEAT & POWER UNIT



# TEDOM CHP System Datasheet

## Key features of Kinsley TEDOM Combined Heat and Power Systems

**Complete, integrated CHP systems** - engineered, built and tested in a high-quality factory environment

**Full range of power ratings** - from 35 kW to 4.0 MW in a single engine

**Customizable, engineered solutions** to meet the specific needs of each application, including:

- o fuel - natural gas, biogas, propane
- o heat recovery - hot water, steam, chilled water
- o emissions control - rich-burn, low NOx lean-burn, SCR
- o packaging - indoor open module, indoor sound enclosure, outdoor container

**Comprehensive long-term service** by Kinsley, including 24/7 remote monitoring and U.S. parts management

|             |                     |
|-------------|---------------------|
| TEDOM Model | Quanto D800 Low Nox |
| Fuel Input  | Natural Gas         |



| System Performance    | % rated load | 100%      | 75%       | 50%       | Notes                       |
|-----------------------|--------------|-----------|-----------|-----------|-----------------------------|
| Electrical Output     | kW           | 800       | 600       | 400       |                             |
| Electrical Efficiency | %, LHV       | 41.6%     | 39.9%     | 37.4%     |                             |
| Fuel Consumption      | BTU/hr, HHV  | 7,292,308 | 5,702,256 | 4,055,615 |                             |
| Max Hot Water Output  | BTU/hr       | 3,037,392 | 2,484,518 | 1,853,150 | Jacket Water + Exhaust Heat |
| Thermal Efficiency    | %, LHV       | 46.3%     | 48.4%     | 50.8%     |                             |
| Overall Efficiency    | %, LHV       | 87.9%     | 88.3%     | 88.2%     |                             |
| Heat Rate             | BTU/kWh, LHV | 8,204     | 8,553     | 9,125     |                             |

| Heat Recovery                                                    | % rated load | 100%      | 75%       | 50%     | Notes                                   |
|------------------------------------------------------------------|--------------|-----------|-----------|---------|-----------------------------------------|
| Jacket Water Heat                                                | BTU/hr       | 1,549,411 | 1,262,736 | 945,346 | includes lube oil heat                  |
| Exhaust Heat                                                     | BTU/hr       | 1,487,981 | 1,221,782 | 907,805 | cooled to 250F                          |
| Engine Exhaust Temp                                              | °F           | 815       | 851       | 889     |                                         |
| Exhaust Mass Flow, Wet                                           | lbs/hr       | 9,973     | 7,674     | 5,339   |                                         |
| <b>Hot Water</b>                                                 |              |           |           |         |                                         |
| Maximum Supply Temperature                                       | °F           | 194       | 194       | 194     | Option for 210 F                        |
| Maximum Return Temperature                                       | °F           | 158       | 158       | 158     | 158 F is maximum for full heat recovery |
| Nominal Flow Rate (water)                                        | GPM          | 169       | 138       | 103     |                                         |
| <b>Chilled Water (with single-effect absorber)</b>               |              |           |           |         |                                         |
| Chilled Water Output                                             | RTons        | 190       | 155       | 116     | COP=0.75 using max hot water output     |
| <b>Steam (with exhaust heat recovery steam generator (HRSG))</b> |              |           |           |         |                                         |
| Steam @ 15 psig                                                  | lbs/hr       | 1,480     | 1,218     | 906     |                                         |
| Steam @ 120 psig                                                 | lbs/hr       | 1,158     | 969       | 730     | maximum practical pressure              |

| Engine Specifications          |                        |                 | Notes                                     |
|--------------------------------|------------------------|-----------------|-------------------------------------------|
| Manufacturer / Model #         |                        | MWM TCG3016 V16 |                                           |
| Cylinder arrangement, quantity |                        | V 16            |                                           |
| Speed                          | <i>RPM</i>             | 1800            |                                           |
| Oil consumption, ave           | <i>grams/kWh</i>       | 0.10            |                                           |
| Oil volume, engine             | <i>gallons</i>         | 150             |                                           |
| Oil volume, replenishment tank | <i>gallons</i>         | 95              | Additional clean/waste oil tank available |
| Major overhaul interval        | <i>operating hours</i> | 80,000          |                                           |

| Generator Specifications |                 |                     | Notes       |
|--------------------------|-----------------|---------------------|-------------|
| Manufacturer / Model #   |                 | Marelli MJB 400 LC4 | synchronous |
| Voltage / Frequency      | <i>VAC</i>      | 480                 |             |
| Speed / Frequency        | <i>RPM / Hz</i> | 1800 / 60           |             |
| Rated Power              | <i>kVA</i>      | 991                 |             |
| Rated Current            | <i>A</i>        | 1,192               |             |
| Power Factor             |                 | 0.8 - 1.0           |             |

| Fuel                          |                |             | Notes                    |
|-------------------------------|----------------|-------------|--------------------------|
| Fuel type                     |                | Natural Gas | biogas options available |
| Lower heating value (minimum) | <i>BTU/SCF</i> | 912         |                          |
| Methane Number (minimum)      |                | 80          |                          |
| Gas Pressure                  | <i>psi</i>     | 1.2 - 2.2   |                          |
| Gas Temperature (maximum)     | <i>°F</i>      | 95          |                          |

| Combustion & Ventilation Air        |              |         | Notes                                     |
|-------------------------------------|--------------|---------|-------------------------------------------|
| Combustion Air Flow Rate            | <i>CFM</i>   | 1,919   |                                           |
| Exhaust Back Pressure Allowed       | <i>psi</i>   | 0.15    | after exhaust heat exchanger and silencer |
| Heat Rejection to Ventilation Air   | <i>BTU/h</i> | 181,000 |                                           |
| Ventilation Inlet Air Temp, min/max | <i>°F</i>    | 32 / 95 | Indoor OM and SE installations.           |
| Outdoor Air Temp, min/max           | <i>°F</i>    | -4 / 95 | Outdoor C installations.                  |

| Emissions (@ 15% O <sub>2</sub> in exhaust) |                | Standard | Reduced | With SCR | Notes |
|---------------------------------------------|----------------|----------|---------|----------|-------|
| NO <sub>x</sub>                             | <i>g/bHP-h</i> |          | 0.50    |          |       |
| CO                                          | <i>g/bHP-h</i> |          | 0.60    |          |       |

| Dimensions & Noise |               | Open Module (OM) | Sound Enclosure (SE) | Outdoor Container (C) | Notes                                                                                                                                         |
|--------------------|---------------|------------------|----------------------|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| Length             | <i>ft, in</i> | 22' 0"           | 21' 0"               | 39' 5"                | Dimensions do not include accessories including exhaust silencer, exhaust heat exchanger, and cooling modules. See drawings for more details. |
| Width              | <i>ft, in</i> | 8' 10"           | 8' 3"                | 9' 10"                |                                                                                                                                               |
| Height             | <i>ft, in</i> | 7' 2"            | 10' 4"               | 9' 10"                |                                                                                                                                               |
| Operating weight   | <i>lbs</i>    |                  |                      | 66,144                |                                                                                                                                               |
| Noise Emissions    | <i>dBA</i>    | 109 @ 3 ft       | 80 @ 3 ft            | 65 @ 33 ft            |                                                                                                                                               |

System performance subject to change without notice.

3/20/2020

|                              |                            |                                                                      |
|------------------------------|----------------------------|----------------------------------------------------------------------|
| Kinsley Energy Systems       | 14 Connecticut South Drive | (800) 255-3503                                                       |
| Authorized TEDOM Distributor | East Granby, CT 06026      | <a href="mailto:sales@kinsleyenergy.com">sales@kinsleyenergy.com</a> |



## BOILER UNITS



F.W. WEBB COMPANY

\*BOILER (W-001)

Lochinvar CBN1797



## Copper-Fin® Commercial Gas Boilers

### Energy Efficient, Cost Effective Boilers

Lochinvar first introduced Copper-Fin technology to the boiler industry some 50 years ago. Since then, we've continued to refine and perfect it - adding advanced fan-assisted combustion, hot surface ignition, a unique gasketless copper finned tube heat exchanger and highly efficient insulating materials.

#### Installation Flexibility and Cost-Savings

With compact sizes that use less floor space than ever before, all Copper-Fin units are narrow enough to fit through a standard 36" doorway - an advantage most commercial boilers can't provide. Plus, thanks to special insulating materials, Copper-Fin units require only 3" clearance from combustible walls. What's more, our Stack Frame allows you to install two units in the area normally required for one. This makes it easier to fit multiple Copper-Fin boilers into cramped mechanical rooms. And you can even use a smaller diameter vent stack - up to 8" smaller than typically required for comparable atmospheric boilers - so it saves money as well as valuable mechanical room space.

#### Unique Copper-Fin Heat Exchanger



The Lochinvar Copper-Fin boiler design uses a two pass heat exchanger. Water is circulated through a row of highly-efficient, finned copper tubes.

The high rate of water flow creates a scouring action that prevents sediment and lime-scale buildup, common in conventional boilers, and the finned copper tubes allow maximum heat transfer efficiency.

To create this special heat transfer capability, Lochinvar extrudes the fins

from thick wall copper tubing to precise specifications - exactly 7 fins per inch.

The result is an integrally-finned tube with a heat transfer ratio 9 times greater than a plain copper tube.

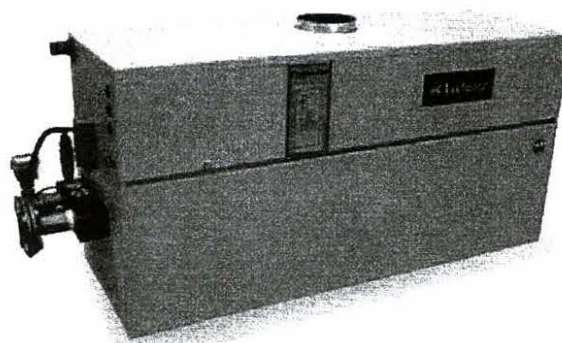
#### Heavy-Duty Gasketless Design

What's more, advanced casting processes allowed Lochinvar to develop a unique one-piece header system. This gasketless design provides enhanced reliability, improved durability and optimum performance - without the problems or failures common with O-rings and gaskets.

#### Meets the Toughest Air Quality Standards



Because of our unique fan-assisted combustion process, the Copper-Fin exceeds today's toughest NO<sub>x</sub> emissions requirements. An independent certification laboratory test gave us a rating of less than 20 ppm - corrected to 3% O<sub>2</sub>. And less NO<sub>x</sub> means a cleaner environment.



#### Enhanced to Provide Performance and Serviceability

Our enhanced Copper-Fin models offer the same reliable operation, and feature a more service friendly design. The down stream test valves and referenced gas valves are now in the upper deck for easier access, and the electrical and BMS connections have been repositioned to the front of the unit for easier installation.

The gas valves, which are referenced to the sealed combustion chamber, improve operational performance by monitoring the pressure in the sealed combustion chamber and adjusting gas flow to maintain the optimum air/fuel mixture. And the built-in air inlet filter reduces maintenance and improves performance by trapping dust and airborne particulates that can foul the burners and blowers. With dual sight glasses (one on each end), you can easily monitor burner performance and flame characteristics throughout the entire combustion chamber.

The operator interface panel provides two-stage electronic temperature control and comprehensive diagnostic status without opening the control panel. Its user friendly design simplifies service while providing additional diagnostic information through a series of LEDs.



#### Vent Cost-Savings

| Btu/hr<br>INPUT | CONVENTIONAL<br>VENT SIZE | COPPER-FIN<br>VENT SIZE | \$ SAVINGS* |
|-----------------|---------------------------|-------------------------|-------------|
| 495,000         | 10"                       | 6"                      | \$ 382      |
| 645,000         | 12"                       | 8"                      | \$ 504      |
| 745,000         | 14"                       | 8"                      | \$ 829      |
| 985,000         | 16"                       | 10"                     | \$ 1,228    |
| 1,225,000       | 16"                       | 12"                     | \$ 992      |
| 1,435,000       | 18"                       | 12"                     | \$ 1,466    |
| 1,795,000       | 20"                       | 14"                     | \$ 1,564    |
| 2,065,000       | 22"                       | 14"                     | \$ 2,398    |

\*Comparison based on 25' vent system using Type "B" double wall vent material, storm collar and vent cap.

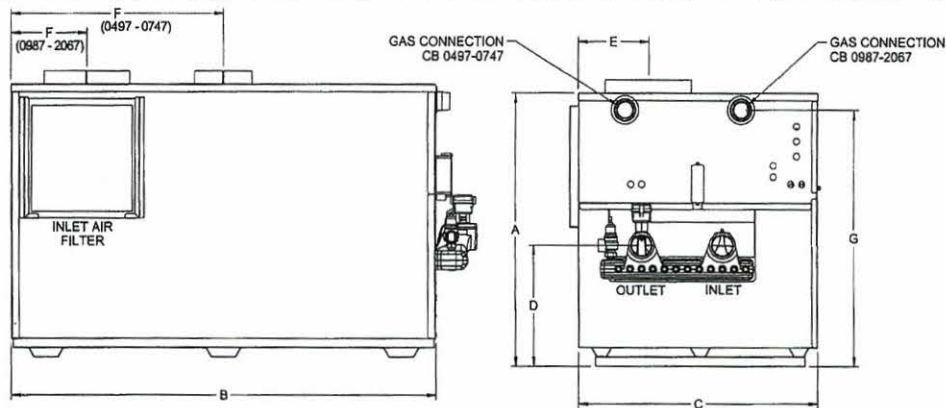


F.W. WEBB COMPANY

## \*BOILER (W-001)

Lochinvar CBN1797

### Copper-Fin® Boiler Dimensions & Specifications



| Copper-Fin Heating Boiler |           |                    |                          |           | Dimensions & Specifications |         |         |         |         |         |         |           |           |                 |
|---------------------------|-----------|--------------------|--------------------------|-----------|-----------------------------|---------|---------|---------|---------|---------|---------|-----------|-----------|-----------------|
| Model Number              | Input MBH | Heating Efficiency | Net Thermal Capacity MBH | I=B=R MBH | A                           | B       | C       | D       | E       | F       | G       | Gas Conn. | Vent Size | Shipping Weight |
| CBN0497                   | 495       | 81%                | 401                      | 349       | 31-1/2"                     | 45-1/4" | 22-1/4" | 12-1/2" | 9-1/2"  | 22-3/4" | 29-1/2" | 1-1/4"    | 6"        | 440             |
| CBN0647                   | 645       | 81%                | 522                      | 454       | 31-1/2"                     | 56-3/4" | 22-1/4" | 12-1/2" | 9-1/2"  | 28-1/2" | 29-1/2" | 1-1/4"    | 8"        | 510             |
| CBN0747                   | 745       | 81%                | 603                      | 524       | 31-1/2"                     | 64"     | 22-1/4" | 12-1/2" | 9-1/2"  | 32"     | 29-1/2" | 1-1/4"    | 8"        | 550             |
| CBN0987                   | 985       | 81%                | 798                      | 694       | 36"                         | 48-1/4" | 33-1/2" | 15-3/4" | 8-1/2"  | 8-1/2"  | 33-3/4" | 2"        | 10"       | 845             |
| CBN1257                   | 1255      | 81%                | 1,017                    | 884       | 36"                         | 58-1/2" | 33-1/2" | 15-3/4" | 9-1/2"  | 10-1/2" | 33-3/4" | 2"        | 12"       | 905             |
| CBN1437                   | 1435      | 81%                | 1,162                    | 1,016     | 36"                         | 68-3/4" | 33-1/2" | 15-3/4" | 10-1/2" | 10-1/2" | 33-3/4" | 2"        | 12"       | 1030            |
| CBN1797                   | 1795      | 81%                | 1,454                    | 1,264     | 36"                         | 82-1/4" | 33-1/2" | 15-3/4" | 11"     | 11"     | 33-3/4" | 2"        | 14"       | 1193            |
| CBN2067                   | 2065      | 81%                | 1,670                    | 1,455     | 36"                         | 92-1/2" | 33-1/2" | 15-3/4" | 11"     | 11"     | 33-3/4" | 2"        | 14"       | 1350            |

Notes: Change 'N' to 'L' for LP gas models.  
No deration on LP models.  
Performance data based on manufacturer test results.

Water connections for models CB 0497-747 are 2" NPT on 6-1/2" centers.  
Water connections for models CB 0987-2067 are 2-1/2" NPT on 11-1/4" centers.

#### Standard Features

- 81% Thermal Efficiency
- Electronic Temperature Control
- Fan Assisted Combustion
- Sealed Combustion Chamber
- Stainless Steel Burners
- Low NOx Operation Exceeds the most Stringent Air Quality Requirements
- ASME Copper Finned Tube Heat Exchanger
- 160 psi Working Pressure
- Gasketless Heat Exchanger Design
- Pump Relay w/ Delay
- Down Stream Test Valve
- Referenced Gas Valves
- Loch-Heat Ceramic Tile Combustion Chamber
- Hot Surface Ignition
- Adjustable High Limit w/ Manual Reset
- ASME Pressure Relief Valve
- Temperature & Pressure Gauge

- Flow Switch
- 24 Volt Control System
- BMS Terminal Strip
- Combustion Air Filter
- Freeze Protection
- 10 Year Limited Warranty on Heat Exchanger (See warranty for details)

#### Optional Equipment

- Alarm Bell
- Contacts on any Failure
- Contacts for Air Louvers
- Cupro-Nickel Heat Exchanger
- High & Low Gas Pressure Switch w/ Manual Reset
- Outdoor Reset Control
- Manual Reset Low Water Cut-Off w/ test
- Stack Frame
- MP<sup>2</sup> Sequencer

#### Available Firing Systems

- M9 Hot Surface Ignition with Electronic Supervision (Standard)
- M13 GE GAP/FM/CSD1
- M7 California Code

#### Venting

- Outdoor Vent Cap

Registered under U.S. Patent # 5,989,020

For Ease In Ordering  
By Model Number



This boiler is a 495,000 Btu/hr, natural gas Copper-Fin. It has M9 firing controls



**Lochinvar®**  
High Efficiency Water Heaters, Boilers and Pool Heaters



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www.Lochinvar.com

CBN-07 (Replaced CBN-06 3/10)

FG-10M-5/11-Printed in U.S.A.



F.W. WEBB COMPANY

**\*BOILER (W-001)**

Lochinvar CBN0647



## Copper-Fin® Commercial Gas Boilers

### Energy Efficient, Cost Effective Boilers

Lochinvar first introduced Copper-Fin technology to the boiler industry some 50 years ago. Since then, we've continued to refine and perfect it - adding advanced fan-assisted combustion, hot surface ignition, a unique gasketless copper finned tube heat exchanger and highly efficient insulating materials.

#### Installation Flexibility and Cost-Savings

With compact sizes that use less floor space than ever before, all Copper-Fin units are narrow enough to fit through a standard 36" doorway - an advantage most commercial boilers can't provide. Plus, thanks to special insulating materials, Copper-Fin units require only 3" clearance from combustible walls. What's more, our Stack Frame allows you to install two units in the area normally required for one. This makes it easier to fit multiple Copper-Fin boilers into cramped mechanical rooms. And you can even use a smaller diameter vent stack - up to 8" smaller than typically required for comparable atmospheric boilers - so it saves money as well as valuable mechanical room space.

#### Unique Copper-Fin Heat Exchanger



The Lochinvar Copper-Fin boiler design uses a two pass heat exchanger. Water is circulated through a row of highly-efficient, finned copper tubes.

The high rate of water flow creates a scouring action that prevents sediment and lime-scale buildup, common in conventional boilers, and the finned copper tubes allow maximum heat transfer efficiency.

To create this special heat transfer capability,

Lochinvar extrudes the fins from thick wall copper tubing to precise specifications - exactly 7 fins per inch.

The result is an integrally-finned tube with a heat transfer ratio 9 times greater than a plain copper tube.

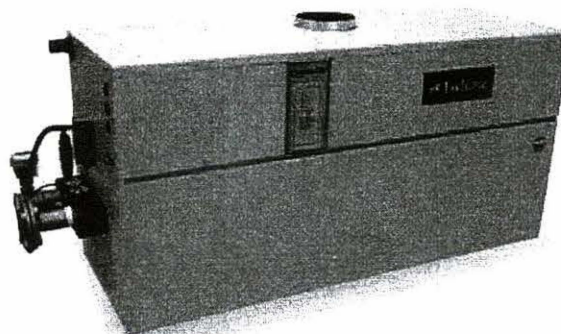
#### Heavy-Duty Gasketless Design

What's more, advanced casting processes allowed Lochinvar to develop a unique one-piece header system. This gasketless design provides enhanced reliability, improved durability and optimum performance - without the problems or failures common with O-rings and gaskets.

#### Meets the Toughest Air Quality Standards



Because of our unique fan-assisted combustion process, the Copper-Fin exceeds today's toughest NO<sub>x</sub> emissions requirements. An independent certification laboratory test gave us a rating of less than 20 ppm - corrected to 3% O<sub>2</sub>. And less NO<sub>x</sub> means a cleaner environment.



#### Enhanced to Provide Performance and Serviceability

Our enhanced Copper-Fin models offer the same reliable operation, and feature a more service friendly design. The down stream test valves and referenced gas valves are now in the upper deck for easier access, and the electrical and BMS connections have been repositioned to the front of the unit for easier installation.

The gas valves, which are referenced to the sealed combustion chamber, improve operational performance by monitoring the pressure in the sealed combustion chamber and adjusting gas flow to maintain the optimum air/fuel mixture. And the built-in air inlet filter reduces maintenance and improves performance by trapping dust and airborne particulates that can foul the burners and blowers. With dual sight glasses (one on each end), you can easily monitor burner performance and flame characteristics throughout the entire combustion chamber.

The operator interface panel provides two-stage electronic temperature control and comprehensive diagnostic status without opening the control panel. Its user friendly design simplifies service while providing additional diagnostic information through a series of LEDs.



#### Vent Cost-Savings

| Btu/hr<br>INPUT | CONVENTIONAL<br>VENT SIZE | COPPER-FIN<br>VENT SIZE | \$ SAVINGS* |
|-----------------|---------------------------|-------------------------|-------------|
| 495,000         | 10"                       | 6"                      | \$ 382      |
| 645,000         | 12"                       | 8"                      | \$ 504      |
| 745,000         | 14"                       | 8"                      | \$ 829      |
| 985,000         | 16"                       | 10"                     | \$ 1,228    |
| 1,225,000       | 16"                       | 12"                     | \$ 992      |
| 1,435,000       | 18"                       | 12"                     | \$ 1,466    |
| 1,795,000       | 20"                       | 14"                     | \$ 1,564    |
| 2,065,000       | 22"                       | 14"                     | \$ 2,398    |

\*Comparison based on 25' vent system using Type "B" double wall vent material, storm collar and vent cap.

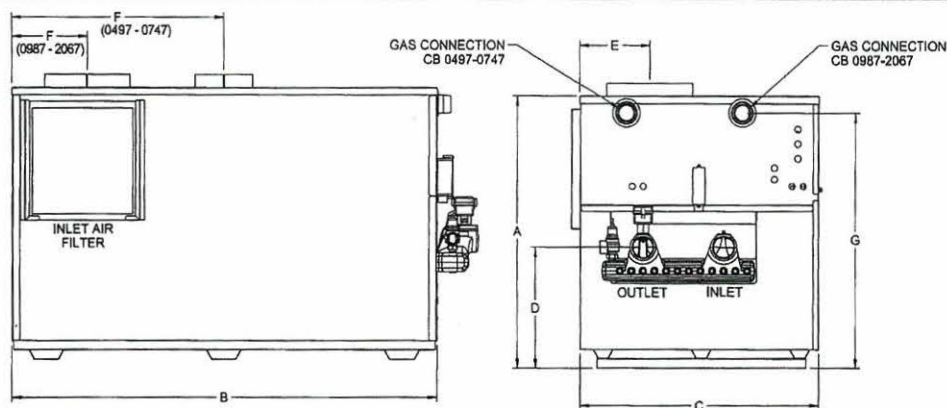


F.W. WEBB COMPANY

## \*BOILER (W-001)

Lochinvar CBN0647

### Copper-Fin® Boiler Dimensions & Specifications



|  Copper-Fin Heating Boiler |           |                    |                          |           | Dimensions & Specifications |         |         |         |         |         |         |           |           |                 |
|-------------------------------------------------------------------------------------------------------------|-----------|--------------------|--------------------------|-----------|-----------------------------|---------|---------|---------|---------|---------|---------|-----------|-----------|-----------------|
| Model Number                                                                                                | Input MBH | Heating Efficiency | Net Thermal Capacity MBH | I-B-R MBH | A                           | B       | C       | D       | E       | F       | G       | Gas Conn. | Vent Size | Shipping Weight |
| CBN0497                                                                                                     | 495       | 81%                | 401                      | 349       | 31-1/2"                     | 45-1/4" | 22-1/4" | 12-1/2" | 9-1/2"  | 22-3/4" | 29-1/2" | 1-1/4"    | 6"        | 440             |
| CBN0647                                                                                                     | 645       | 81%                | 522                      | 454       | 31-1/2"                     | 56-3/4" | 22-1/4" | 12-1/2" | 9-1/2"  | 28-1/2" | 29-1/2" | 1-1/4"    | 8"        | 510             |
| CBN0747                                                                                                     | 745       | 81%                | 603                      | 524       | 31-1/2"                     | 64"     | 22-1/4" | 12-1/2" | 9-1/2"  | 32"     | 29-1/2" | 1-1/4"    | 8"        | 550             |
| CBN0987                                                                                                     | 985       | 81%                | 798                      | 694       | 36"                         | 48-1/4" | 33-1/2" | 15-3/4" | 8-1/2"  | 8-1/2"  | 33-3/4" | 2"        | 10"       | 845             |
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| CBN1437                                                                                                     | 1435      | 81%                | 1,162                    | 1,010     | 36"                         | 68-3/4" | 33-1/2" | 15-3/4" | 10-1/2" | 10-1/2" | 33-3/4" | 2"        | 12"       | 1050            |
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| CBN2067                                                                                                     | 2065      | 81%                | 1,673                    | 1,455     | 36"                         | 92-1/2" | 33-1/2" | 15-3/4" | 11"     | 11"     | 33-3/4" | 2"        | 14"       | 1350            |

Notes: Change 'N' to 'L' for LP gas models.

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- Outdoor Vent Cap

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This boiler is a 495,000 Btu/hr, natural gas Copper-Fin. It has M9 firing controls



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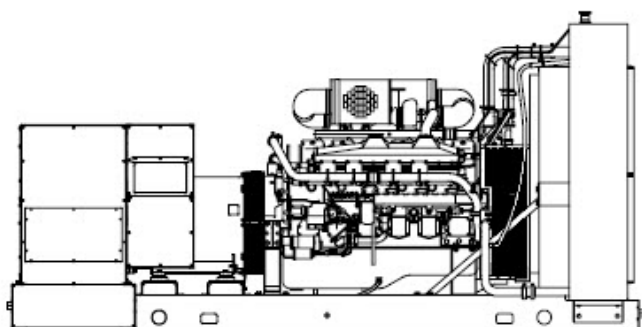
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FG-10M-5/11-Printed in U.S.A.



## **EMERGENCY (BACK-UP) GENERATOR**



## Standard Features

- Kohler Co. provides one-source responsibility for the generating system and accessories.
- The generator set and its components are prototype-tested, factory-built, and production-tested.
- The 60 Hz generator set offers a UL 2200 listing.
- The generator set accepts rated load in one step.
- The 60 Hz generator set meets NFPA 110, Level 1, when equipped with the necessary accessories and installed per NFPA standards.
- A one-year limited warranty covers all systems and components. Two-, five-, and ten-year extended warranties are also available.
- Tier 2 EPA-certified for Stationary Emergency Applications

## Alternator Features

- The pilot-excited, permanent magnet (PM) alternator provides superior short-circuit capability.

## Other Features

- Controllers are available for all applications. See controller features inside.
- The low coolant level shutdown prevents overheating (standard on radiator models only).
- Integral vibration isolation eliminates the need for under-unit vibration spring isolators.
- An electronic, isochronous governor delivers precise frequency regulation.
- Multiple circuit breaker configurations.

## Generator Set Ratings

| Alternator | Voltage | Ph | Hz | Peak kVA | Standby 130C Ratings |      |
|------------|---------|----|----|----------|----------------------|------|
|            |         |    |    |          | kW/kVA               | Amps |
| 5M4036     | 277/480 | 3  | 60 | 3200     | 760 / 950            | 1143 |

RATINGS: All three-phase units are rated at 0.8 power factor.

Standby Ratings: The standby rating is applicable to varying loads for the duration of a power outage. There is no overload capability for this rating.

Prime Power Ratings: At varying load, the number of generator set operating hours is unlimited.

A 10% overload capacity is available for one hour in twelve. Ratings are in accordance with ISO-8528-1 and ISO-3046-1. For limited running time and continuous ratings, consult the factory. Obtain technical information bulletin (TIB-101) for ratings guidelines, complete ratings definitions, and site condition derates.

The generator set manufacturer reserves the right to change the design or specifications without notice and without any obligation or liability whatsoever.

## Model: 750REOZMD, continued

### Alternator Specifications

| Specifications                               | Alternator                                |
|----------------------------------------------|-------------------------------------------|
| Alternator manufacturer                      | Kohler                                    |
| Type                                         | 4-Pole, Rotating-Field                    |
| Exciter type                                 | Brushless, Permanent-Magnet Pilot Exciter |
| Leads, quantity                              | 10, Reconnectable                         |
| Voltage regulator                            | Solid State, Volts/Hz                     |
| Insulation                                   | NEMA MG1                                  |
| Insulation: Material                         | Class H, Synthetic, Nonhydroscopic        |
| Insulation: Temperature Rise                 | 130°C, 150°C Standby                      |
| Bearing: quantity, type                      | 1, Sealed                                 |
| Coupling                                     | Flexible disc                             |
| Amortisseur windings                         | Full                                      |
| Rotor balancing (50Hz)                       | 125%                                      |
| Rotor balancing (60Hz)                       | 125%                                      |
| Voltage regulation, no-load to full-load RMS | Controller Dependent                      |
| One-Step Load Acceptance                     | 100% of rating                            |
| Unbalanced load capability                   | 100% of Rated Standby Current             |

- NEMA MG1, IEEE, and ANSI standards compliance for temperature rise and motor starting.
- Sustained short-circuit current of up to 300% of the rated current for up to 10 seconds.
- Sustained short-circuit current enabling down stream circuit breakers to trip without collapsing the alternator field.
- Self-ventilated and dripproof construction.
- Superior voltage waveform from a two-thirds pitch stator and skewed rotor.
- Digital solid-state, volts-per-hertz voltage regulator with +/-0.25% no-load to full-load regulation.
- Brushless alternator with brushless pilot exciter for excellent load response.

### Engine

#### Engine Specification

|                                            |                         |
|--------------------------------------------|-------------------------|
| Engine Manufacturer                        | Mitsubishi              |
| Engine Model                               | S12A2-Y2PTAW-2          |
| Engine: type                               | 4-Cycle, Turbocharged   |
| Cylinder arrangement                       | 12-V                    |
| Displacement, L (cu. in.)                  | 33.93 (2071)            |
| Bore and stroke, mm (in.)                  | 150 x 160 (5.91 x 6.30) |
| Compression ratio                          | 15.3:1                  |
| Piston speed, m/min. (ft./min.)            | 576 (1890)              |
| Main bearings: quantity, type              | 7, Precision Half-Shell |
| Rated rpm                                  | 1800                    |
| Max. power at rated rpm, kWm (BHP)         | 900 (1207)              |
| Cylinder head material                     | Cast Iron               |
| Crankshaft material                        | Forged Steel            |
| Governor: type, make/model                 | Electronic              |
| Frequency regulation, no-load to-full load | Isochronous             |
| Frequency regulation, steady state         | ±0.25%                  |
| Frequency                                  | Fixed                   |
| Air cleaner type, all models               | Dry                     |

## Model: 750REOZMD, continued

### Exhaust

#### Exhaust System

|                                                       |                 |
|-------------------------------------------------------|-----------------|
| Exhaust Manifold Type                                 | Dry             |
| Exhaust flow at rated kW, kg/hr. (cfm)                | 208 (7344)      |
| Exhaust temperature at rated kW, dry exhaust, °C (°F) | 473 (883)       |
| Maximum allowable back pressure, kPa (in. Hg)         | 5.9 (1.7)       |
| Exh. outlet size at eng. hookup, mm (in.)             | See ADV Drawing |

### Engine Electrical

#### Engine Electrical System

|                                                                      |           |
|----------------------------------------------------------------------|-----------|
| Battery charging alternator: Ground (negative/positive)              | Negative  |
| Battery charging alternator: Volts (DC)                              | 24        |
| Battery charging alternator: Ampere rating                           | 30        |
| Starter motor rated voltage (DC)                                     | Dual, 24  |
| Battery, recommended cold cranking amps (CCA): Qty., CCA rating each | Two, 1150 |
| Battery voltage (DC)                                                 | 12        |

### Fuel

#### Fuel System

|                                             |              |
|---------------------------------------------|--------------|
| Fuel type                                   | Diesel       |
| Fuel supply line, min. ID, mm (in.)         | 19 (0.75)    |
| Fuel return line, min. ID, mm (in.)         | 19 (0.75)    |
| Max. lift, engine-driven fuel pump, m (ft.) | 1 (3)        |
| Max. fuel flow, Lph (gph)                   | 630 (166)    |
| Max. fuel pump restriction, kPa (in. Hg)    | 10 (3.0)     |
| Fuel filter: quantity, type                 | 3, Cartridge |
| Recommended fuel                            | #2 Diesel    |

### Lubrication

#### Lubrication System

|                                       |               |
|---------------------------------------|---------------|
| Type                                  | Full Pressure |
| Oil pan capacity, L (qt.)             | 100 (106)     |
| Oil pan capacity with filter, L (qt.) | 120 (127)     |
| Oil filter: quantity, type            | 3, Cartridge  |
| Oil cooler                            | Water-Cooled  |

## Model: 750REOZMD, continued

### Cooling

#### Radiator System

|                                                                                       |             |
|---------------------------------------------------------------------------------------|-------------|
| Ambient temperature, °C (°F)                                                          | 50 (122)    |
| Engine jacket water capacity, L (gal.)                                                | 100 (26.4)  |
| Radiator system capacity, including engine, L (gal.)                                  | 303 (80)    |
| Engine jacket water flow, Lpm (gpm)                                                   | 1100 (291)  |
| Charge cooler water flow, Lpm (gpm)                                                   | 470 (124)   |
| Heat rejected to cooling water at rated kW, dry exhaust, kW (Btu/min.)                | 321 (18253) |
| Heat rejected to charge air cooling water at rated kW, dry exhaust, Kw Btu/min.       | 252 (14341) |
| Water pump type                                                                       | Centrifugal |
| Fan diameter, including blades, mm (in.)                                              | 1524 (60)   |
| Fan, kWm (HP)                                                                         | 40 (54)     |
| Max. restriction of cooling air, intake and discharge side of radiator, kPa (in. H2O) | 0.125 (0.5) |

\* Enclosure with internal silencer reduces ambient temperature capability by 5°C (9°F).

#### Remote Radiator System

|                                                   |                                                                                                                   |
|---------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|
| Exhaust manifold type                             | Dry                                                                                                               |
| Jacket water engine inlet, mm (in.)               | 95 (3.75)                                                                                                         |
| Jacket water engine outlet, mm (in.)              | 95 (3.75)                                                                                                         |
| Intercooler water engine inlet, mm (in.)          | 67 (2.63)                                                                                                         |
| Intercooler water engine outlet, mm (in.)         | 95 (3.75)                                                                                                         |
| Static head allowable above engine, kPa (ft. H2O) | 98 (32.8)                                                                                                         |
| Note:                                             | Contact your local distributor for cooling system options and specifications based on your specific requirements. |

## Operation Requirements

### Air Requirements

|                                                                                                                                                                                         |              |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| Radiator-cooled cooling air, m3/min. (scfm) *                                                                                                                                           | 1161 (41000) |
| Cooling air required for generator set when equipped with city water cooling or remote radiator, based on 14°C (25°F) rise, m3/min. rise and ambient temp. of 29°C (85°F) m3/min. (cfm) | 416 (14700)  |
| Combustion air, m3/min. (cfm)                                                                                                                                                           | 78 (2763)    |
| Heat rejected to ambient air: Engine, kW (Btu/min.)                                                                                                                                     | 69 (3912)    |
| Heat rejected to ambient air: Alternator, kW (Btu/min.)                                                                                                                                 | 47 (2673)    |

\*Air density = 1.20 kg/m3 (0.075 lbm/ft3)

## Fuel Consumption

| Diesel, Lph (gph), at % load          | Rating               |
|---------------------------------------|----------------------|
| Standby Fuel Consumption at 100% load | 232.3 Lph (61.4 gph) |
| Standby Fuel Consumption at 75% load  | 164.0 Lph (43.3 gph) |
| Standby Fuel Consumption at 50% load  | 108.2 Lph (28.6 gph) |
| Standby Fuel Consumption at 25% load  | 65.0 Lph (17.2 gph)  |
| Prime Fuel Consumption at 100% load   | 207.1 Lph (54.7 gph) |
| Prime Fuel Consumption at 75% load    | 148.2 Lph (39.2 gph) |
| Prime Fuel Consumption at 50% load    | 99.8 Lph (26.4 gph)  |
| Prime Fuel Consumption at 25% load    | 61.8 Lph (16.3 gph)  |

## Enclosure and Subbase Fuel Tank Specifications

| Fuel Tank Capacity, L (gal.) | Est. Fuel Supply Hours at 60 Hz w/Full Load | Sound Enclosure and Subbase Fuel Tank |            |            |                       |                         | Fuel Tank Height, mm (in.) | Sound Pressure with Full Load at 7 m (23 ft.), dB(A) |
|------------------------------|---------------------------------------------|---------------------------------------|------------|------------|-----------------------|-------------------------|----------------------------|------------------------------------------------------|
|                              |                                             | Max. Dimensions, mm (in.)             |            |            | Max. Weight, kg (lb.) |                         |                            |                                                      |
|                              |                                             | Length                                | Width      | Height     | With Steel Enclosure  | With Aluminum Enclosure |                            |                                                      |
| 750/800REOZMD                |                                             |                                       |            |            |                       |                         |                            |                                                      |
| Lifting Base                 | 0                                           | 8826 (347)                            | 2645 (104) | 3253 (128) | 10369 (22860)         | 10142 (22360)           | 254 (10)                   | 75                                                   |
| 3682 (973)                   | 12                                          | 9594 (378)                            |            | 3304 (130) | 12947 (28543)         | 12720 (28043)           | 305 (12)                   |                                                      |
| 6679 (1791)                  | 24                                          |                                       |            | 3507 (138) | 13373 (29481)         | 13146 (28981)           | 508 (20)                   |                                                      |
| 10824 (2859)                 | 36                                          |                                       |            | 3913 (154) | 13935 (30720)         | 13708 (30220)           | 914 (36)                   |                                                      |
| 13970 (3690)                 | 48                                          |                                       |            |            | 14267 (31453)         | 14040 (30953)           |                            |                                                      |
| 20914 (5525)                 | 72                                          | 11430 (450)                           |            |            | 15757 (34738)         | 15530 (34238)           |                            |                                                      |

**Note:** Data in table is for reference only, refer to the respective ADV drawings for details.

**Note:** Refer to TIB-114 for generator set sound data.

\* Max. weight includes the generator set (wet) with largest alternator option, enclosure, silencer, and tank (no fuel).

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