



# Installation Manual

## Generator Set

### QSK60G and QSV91 Engine with PowerCommand® 3.3 Control

C995 N5C, C995 N5C (Spec B)  
C1160 N5C, C1160 N5C (Spec B)  
C1200 N5C, C1200 N5C (Spec B)  
C1400 N5C, C1400 N5C (Spec B)  
C1540 N5C, C1540 N5C (Spec C)  
C1750 N5C, C1750 N5C (Spec C)  
C2000 N5C, C2000 N5C (Spec C)  
C1000 N6C, C1000 N6C (Spec B)  
C1100 N6C, C1100 N6C (Spec B)  
C1250 N6C, C1250 N6C (Spec C)  
C1400 N6C, C1400 N6C (Spec C)  
C1540 N6C, C1540 N6C (Spec C)  
C1750 N6C, C1750 N6C (Spec C)  
C2000 N6C, C2000 N6C (Spec C)  
C1000 N6, C1000 N6 (Spec B-C)  
C1250 N6, C1250 N6 (Spec B-C)  
C1350 N6, C1350 N6 (Spec B-C)  
C1700 N6, C1700 N6 (Spec B)



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# 1 IMPORTANT SAFETY INSTRUCTIONS

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SAVE THESE INSTRUCTIONS. This manual contains important instructions that should be followed during installation and maintenance of the generator set and batteries.

Safe and efficient operation can be achieved only if the equipment is properly operated and maintained. Many accidents are caused by failure to follow fundamental rules and precautions.

## 1.1 Warning, Caution, and Note Styles Used in This Manual

The following safety styles and symbols found throughout this manual indicate potentially hazardous conditions to the operator, service personnel, or equipment.

 <b>DANGER</b>
<i>Indicates a hazardous situation that, if not avoided, will result in death or serious injury.</i>

 <b>WARNING</b>
<i>Indicates a hazardous situation that, if not avoided, could result in death or serious injury.</i>

 <b>CAUTION</b>
<i>Indicates a hazardous situation that, if not avoided, could result in minor or moderate injury.</i>


<b>NOTICE</b>
Indicates information considered important, but not hazard-related (e.g., messages relating to property damage).

## 1.2 General Information

This manual should form part of the documentation package supplied by Cummins with specific generator sets. In the event that this manual has been supplied in isolation, please contact your authorized distributor.

<b>NOTICE</b>
It is in the operator's interest to read and understand all warnings and cautions contained within the documentation relevant to the generator set, its operation and daily maintenance.

### 1.2.1 General Safety Precautions

 <b>WARNING</b>
<i>Hot Pressurized Liquid</i> <i>Contact with hot liquid can cause severe burns.</i> <i>Do not open the pressure cap while the engine is running. Let the engine cool down before removing the cap. Turn the cap slowly and do not open it fully until the pressure has been relieved.</i>

**⚠ WARNING*****Moving Parts***

***Moving parts can cause severe personal injury.***

***Use extreme caution around moving parts. All guards must be properly fastened to prevent unintended contact.***

**⚠ WARNING*****Toxic Hazard***

***Used engine oils have been identified by some state and federal agencies to cause cancer or reproductive toxicity.***

***Do not ingest, breathe the fumes, or contact used oil when checking or changing engine oil. Wear protective gloves and face guard.***

**⚠ WARNING*****Electrical Generating Equipment***

***Incorrect operation can cause severe personal injury or death.***

***Do not operate equipment when fatigued, or after consuming any alcohol or drug.***

**⚠ WARNING*****Toxic Gases***

***Substances in exhaust gases have been identified by some state and federal agencies to cause cancer or reproductive toxicity.***

***Do not breathe in or come into contact with exhaust gases.***

**⚠ WARNING*****Combustible Liquid***

***Ignition of combustible liquids is a fire or explosion hazard which can cause severe burns or death.***

***Do not store fuel, cleaners, oil, etc., near the generator set.***

**⚠ WARNING*****High Noise Level***

***Generator sets in operation emit noise, which can cause hearing damage.***

***Wear appropriate ear protection at all times.***

**⚠ WARNING*****Hot Surfaces***

***Contact with hot surfaces can cause severe burns.***

***The unit is to be installed so that the risk of hot surface contact by people is minimized. Wear appropriate PPE when working on hot equipment and avoid contact with hot surfaces.***

**⚠ WARNING*****Electrical Generating Equipment***

***Incorrect operation and maintenance can result in severe personal injury or death.***

***Make sure that only suitably trained and experienced service personnel perform electrical and/or mechanical service.***

**⚠ WARNING**

**Toxic Hazard**  
*Ethylene glycol, used as an engine coolant, is toxic to humans and animals. Wear appropriate PPE. Clean up coolant spills and dispose of used coolant in accordance with local environmental regulations.*

**⚠ WARNING**

**Combustible Liquid**  
*Ignition of combustible liquids is a fire or explosion hazard which can cause severe burns or death. Do not use combustible liquids like ether.*

**⚠ WARNING**

**Automated Machinery**  
*Accidental or remote starting of the generator set can cause severe personal injury or death. Isolate all auxiliary supplies and use an insulated wrench to disconnect the starting battery cables (negative [-] first).*

**⚠ WARNING**

**Fire Hazard**  
*Materials drawn into the generator set are a fire hazard. Fire can cause severe burns or death. Make sure the generator set is mounted in a manner to prevent combustible materials from accumulating under the unit.*

**⚠ WARNING**

**Fire Hazard**  
*Accumulated grease and oil are a fire hazard. Fire can cause severe burns or death. Keep the generator set and the surrounding area clean and free from obstructions. Repair oil leaks promptly.*

**⚠ WARNING**

**Fall Hazard**  
*Falls can result in severe personal injury or death. Make sure that suitable equipment for performing tasks at height are used in accordance with local guidelines and legislation.*

**⚠ WARNING**

**Fire Hazard**  
*Materials drawn into the generator set are a fire hazard. Fire can cause severe burns or death. Keep the generator set and the surrounding area clean and free from obstructions.*

**⚠ WARNING**

**Pressurized System**  
*Pressurized systems can rupture/leak which can result in severe personal injury or death. Use appropriate lock out/tag out safety procedures to isolate from all energy sources before performing any service tasks. Use PPE.*

**⚠ WARNING****Confined Areas**

*Confined spaces or areas with restricted access or potential to entrap can cause severe personal injury or death.*

*Use appropriate lock out/tag out safety procedures to isolate from all energy sources. Use PPE. Follow site specific lone worker protocols/permits to work.*

**⚠ CAUTION****Manual Handling Heavy Objects**

*Handling heavy objects can cause severe personal injury.*

*Use appropriate lifting equipment and perform tasks with two people where doing so would make completion of the task safe.*

**⚠ CAUTION****Power Tools and Hand Tools**

*Tools can cause cuts, abrasions, bruising, puncture injuries.*

*Only trained and experienced personnel should use power tools and hand tools. Use PPE.*

**⚠ CAUTION****Sharp Edges and Sharp Points**

*Projecting corners/parts may cause cuts, abrasions and other personal injury.*

*Use PPE. Be aware of sharp edges and corners/sharp points. Cover/protect them.*

**NOTICE**

Keep multi-type ABC fire extinguishers close by. Class A fires involve ordinary combustible materials such as wood and cloth. Class B fires involve combustible and flammable liquid fuels and gaseous fuels. Class C fires involve live electrical equipment. (Refer to NFPA No. 10 in the applicable region.)

**NOTICE**

Before performing maintenance and service procedures on enclosed generator sets, make sure the service access doors are secured open.

**NOTICE**

Stepping on the generator set can cause parts to bend or break, leading to electrical shorts, or to fuel leaks, coolant leaks, or exhaust leaks. Do not step on the generator set when entering or leaving the generator set room.

**NOTICE**

Remove fuel from subbase fuel tank before conducting any hot work.

## 1.3 Generator Set Safety Code

Before operating the generator set, read the manuals and become familiar with them and the equipment. Safe and efficient operation can be achieved only if the equipment is properly operated and maintained. Many accidents are caused by failure to follow fundamental rules and precautions.

**⚠ WARNING****Electrical Generating Equipment**

***Incorrect operation and maintenance can result in severe personal injury or death.***

***Read and follow all Safety Precautions, Warnings, and Cautions throughout this manual and the documentation supplied with the generator set.***

### 1.3.1 Moving Parts Can Cause Severe Personal Injury or Death

- Keep hands, clothing, and jewelry away from moving parts.
- Before starting work on the generator set, disconnect the battery charger from its AC source, then disconnect the starting batteries using an insulated wrench, negative (–) cable first. This will prevent accidental starting.
- Make sure that fasteners on the generator set are secure. Tighten supports and clamps; keep guards in position over fans, drive belts, etc.
- Do not wear loose clothing or jewelry in the vicinity of moving parts or while working on electrical equipment. Loose clothing and jewelry can become caught in moving parts.
- If any adjustments must be made while the unit is running, use extreme caution around hot manifolds, moving parts, etc.

### 1.3.2 Positioning of Generator Set - Open Sets

The area for positioning the set should be adequate and level, and the area immediately around the set must be free of any flammable material.

## 1.4 Electrical Shocks and Arc Flashes Can Cause Severe Personal Injury or Death

**⚠ WARNING**

***Any work with exposed energized circuits with potentials of 50 Volts AC or 75 Volts DC or higher poses a significant risk of electrical shock and electrical arc flash. These silent hazards can cause severe injuries or death. Refer to standard NFPA 70E or equivalent safety standards in corresponding regions for details of the dangers involved and for the safety requirements.***

Guidelines to follow when working on de-energized electrical systems:

- Use proper PPE. Do not wear jewelry and make sure that any conductive items are removed from pockets as these items can fall into equipment and the resulting short circuit can cause shock or burning. Refer to standard NFPA 70E for PPE standards.
- De-energize and securely isolate electrical systems prior to working on them. Secure isolation is intended to prevent injury due to unexpected start-up of equipment or the release of stored energy.
- De-energize and securely isolate all circuits and devices before removing any protective shields or making any measurements on electrical equipment.
- Follow all applicable regional electrical and safety codes.

Guidelines to follow when working on energized electrical systems:

**NOTICE**

It is the policy of Cummins Inc. to perform all electrical work in a de-energized state. However, employees or suppliers may be permitted to occasionally perform work on energized electrical equipment only when qualified and authorized to do so and when troubleshooting, or if de-energizing the equipment would create a greater risk or make the task impossible and all other alternatives have been exhausted.

**NOTICE**

Exposed energized electrical work is only allowed as per the relevant procedures and must be undertaken by a Cummins authorized person with any appropriate energized work permit for the work to be performed while using proper PPE, tools and equipment.

In summary:

- Do not tamper with or bypass interlocks unless you are authorized to do so.
- Understand and assess the risks - use proper PPE. Do not wear jewelry and make sure that any conductive items are removed from pockets as these items can fall into equipment and the resulting short circuit can cause shock or burning. Refer to standard NFPA 70E for PPE standards.
- Make sure that an accompanying person who can undertake a rescue is nearby.

## 1.4.1 AC Disconnect Sources

**⚠ WARNING*****Hazardous Voltage***

***Contact with high voltages can cause severe electrical shock, burns, or death.***

***The equipment may have more than one source of electrical energy. Disconnecting one source without disconnecting the others presents a shock hazard. Before starting work, disconnect the equipment, and verify that all sources of electrical energy have been removed.***

## 1.4.2 High Voltage Equipment (Above 1 kVAC)

- Special equipment and training is required to work on or around high voltage equipment. High voltage equipment presents a hazard of electrical shocks and arc flash. Operation and maintenance must be done only by persons trained and experienced to work on such devices using appropriate PPE as defined by the task and voltage. Improper use or procedures will result in severe personal injury or death.
- Do not work on energized equipment. Unauthorized personnel must not be permitted near energized equipment. Due to the nature of high voltage electrical equipment, there is the hazard of arc flash and induced voltage remains even after the equipment is disconnected from the power source. Plan the time for maintenance with authorized personnel so that the equipment can be de-energized and safely grounded.

## 1.5 Fuel and Fumes Are Flammable

Fire, explosion, and personal injury or death can result from improper practices.

- DO NOT permit any flame, cigarette, pilot light, spark, arcing equipment, or other ignition source near the generator set or fuel system.
- Fuel lines must be adequately secured and free of leaks. Fuel connection at the engine should be made with an approved flexible line. Do not use copper piping on flexible lines because copper will become brittle if continuously vibrated or repeatedly bent.
- Be sure all fuel supplies have a positive shutoff valve.

- Be sure the battery area has been well-ventilated prior to servicing near it. Lead-acid batteries emit a highly explosive hydrogen gas that can be ignited by arcing, sparking, smoking, etc.

### 1.5.1 Gaseous Fuels

- Natural gas is lighter than air, and will tend to gather under covered areas.

### 1.5.2 Spillage

Any spillage that occurs during operation, maintenance, oil top-off, or oil change must be cleaned up before starting the generator set.

### 1.5.3 Do Not Operate in Flammable and Explosive Environments

Flammable vapor can cause an engine to over speed and become difficult to stop, resulting in possible fire, explosion, severe personal injury, and death. Do not operate a generator set where a flammable vapor environment can be created, unless the generator set is equipped with an automatic safety device to block the air intake and stop the engine. The owners and operators of the generator set are solely responsible for operating the generator set safely. Contact your authorized Cummins distributor for more information.

## 1.6 Exhaust Gases Are Deadly

- Provide an adequate exhaust system to properly expel discharged gases away from enclosed or sheltered areas, and areas where individuals are likely to congregate. Visually and audibly inspect the exhaust system daily for leaks per the maintenance schedule. Make sure that exhaust manifolds are secured and not warped. Do not use exhaust gases to heat a compartment.
- Make sure the unit is well ventilated.

### 1.6.1 Exhaust Precautions

<b>⚠ WARNING</b>
<p><b>Hot Exhaust Gases</b>  <i>Contact with hot exhaust gases can cause severe burns.</i>  <i>Wear personal protective equipment when working on equipment.</i></p>

<b>⚠ WARNING</b>
<p><b>Hot Surfaces</b>  <i>Contact with hot surfaces can cause severe burns.</i>  <i>The unit is to be installed so that the risk of hot surface contact by people is minimized. Wear appropriate PPE when working on hot equipment and avoid contact with hot surfaces.</i></p>

<b>⚠ WARNING</b>
<p><b>Toxic Gases</b>  <i>Inhalation of exhaust gases can cause asphyxiation and death.</i>  <i>Pipe exhaust gas outside and away from windows, doors, or other inlets to buildings. Do not allow exhaust gas to accumulate in habitable areas.</i></p>

**⚠ WARNING****Fire Hazard**

**Contaminated insulation is a fire hazard. Fire can cause severe burns or death.**

**Remove any contaminated insulation and dispose of it in accordance with local regulations.**

The exhaust outlet may be sited at the top or bottom of the generator set. Make sure that the exhaust outlet is not obstructed. Personnel using this equipment must be made aware of the exhaust position. Position the exhaust away from flammable materials - in the case of exhaust outlets at the bottom, make sure that vegetation is removed from the vicinity of the exhaust.

The exhaust pipes may have some insulating covers fitted. If these covers become contaminated they must be replaced before the generator set is run.

To minimize the risk of fire, make sure the following steps are observed:

- Make sure that the engine is allowed to cool thoroughly before performing maintenance or operation tasks.
- Clean the exhaust pipe thoroughly.

## 1.7 Precautions to be Taken Prior to Performing Electric Welding on or Around the Generator Set

Precautions need to be taken prior to performing electric welding on or around the following Plant Room and Generator set ancillary equipment in order to avoid permanent damage to sensitive electronic components:

- Any location on the generator set or generator set bed frame.
- Any fuel supply or ventilation pipes directly connected to the generator set.
- Any coolant supply or return pipes directly connected to the generator set.
- Any exhaust ducting directly connected to the generator set.
- Any lubricating oil supply or drain pipes directly connected to the generator set.
- Any crankcase ventilation system pipework directly connected to the generator set.
- Any cable supports directly connected to the generator set and Generator Control Panel.
- Any air supply system ducting that is directly connected to the generator set.
- Any other item (not listed above) that requires welding that is directly connected to the generator set, generator set bed frame and Generator Control Panel.

If fitted, disconnect both the Positive (+) and Negative (-) cables from the main starting batteries before welding on the generator set. Always disconnect the earth lead first and reconnect last.

Attach the welder ground cable no more than 0.61 metres (2 feet) from the area being welded. Do not connect the ground cable of the welder to any ECM cooling plate, ECM or other electronic/electrical component.

Disconnect the following engine mounted electronic modules and components (location will vary according to generator set model) prior to performing any electronic welding:

- All ECM Modules
- Woodward throttle driver module(s) (if fitted)
- Woodward throttle actuator module(s) (if fitted)
- Woodward ProAct III Digital Plus throttle driver/ actuator (if fitted)
- Fuel control module(s) (FloTech)
- All engine-mounted pressure sensors:
  - Fuel inlet pressure sensor(s) – Fuel outlet pressure sensor(s)

- Dungs DSSV mounted sensor (if fitted – Valve Proving System (VPS) only).
- HT and LT cooling pressure sensors – Pre and after-oil filter pressure sensors (as fitted)
- Main oil pressure sensor – Turbocharger outlet pressure sensor (MAP) – Turbocharger inlet pressure sensor (if fitted) – Inlet manifold pressure sensor(s) (after- throttle) – Exhaust thermocouple signal converter (if fitted)

Additionally, the following need to be isolated via their isolation switches:

- Generator set Interface Box (DC box) – if fitted
- Generator set AC box – if fitted
- Generator set Interface Box (GIB) – if fitted
- Generator Control Panel (GCP)

## 1.8 Earth Ground Connection

The neutral of the generator set may be required to be bonded to earth ground at the generator set location, or at a remote location, depending on system design requirements. Consult the engineering drawings for the facility or a qualified electrical design engineer for proper installation.

### **NOTICE**

**The end user is responsible to make sure that the ground connection point surface area is clean and free of rust before making a connection.**

### **NOTICE**

**The end user is responsible for making sure that an earthing arrangement that is compliant with local conditions is established and tested before the equipment is used.**

## 1.9 Decommissioning and Disassembly

### **NOTICE**

**Decommissioning and disassembly of the generator set at the end of its working life must comply with local guidelines and legislation for disposal/recycling of components and contaminated fluids. This procedure must only be carried out by suitably trained and experienced service personnel. For more information contact your authorized distributor.**

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## 2 Introduction

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### WARNING

#### **Hazardous Voltage**

**Contact with high voltages can cause severe electrical shock, burns, or death.**

**Make sure that only a trained and experienced electrician makes generator set electrical output connections, in accordance with the installation instructions and all applicable codes.**

### WARNING

#### **Electrical Generating Equipment**

**Faulty electrical generating equipment can cause severe personal injury or death.**

**Generator sets must be installed, certified, and operated by trained and experienced persons in accordance with the installation instructions and all applicable codes.**

## 2.1 About This Manual

The purpose of this manual is to provide the users with accurate, general information. It is for guidance and assistance with recommendations for correct and safe procedures. Cummins cannot accept any liability whatsoever for problems arising as a result of following recommendations in this manual.

The information contained within the manual is based on information available at the time of going to print. In line with Cummins policy of continuous development and improvement, information may change at any time without notice. The users should therefore make sure that before commencing any work, they have the latest information available. The latest version of this manual is available on QuickServe Online (<https://quickserve.cummins.com>).

Users are respectfully advised that, in the interests of good practice and safety, it is their responsibility to employ competent persons to carry out any installation work. Consult your authorized distributor for further installation information. It is essential that the utmost care is taken with the application, installation, and operation of any engine due to their potentially hazardous nature. Careful reference should also be made to other Cummins literature. A generator set must be operated and maintained properly for safe and reliable operation.

For further assistance, contact your authorized distributor.

### 2.1.1 Additional Installation Manual Information

The purpose of this manual is to provide the Installation Engineer with sound, general information for the installation of the generator set. Refer to the Generator Set Operator Manual for additional information which must also be read before operating the set.

This manual provides installation instructions for the generator set models listed on the front cover. This includes the following information:

- Mounting Recommendations - for fastening the generator set to a base and space requirements for normal operation and service.
- Mechanical and Electrical Connections - covers most aspects of the generator set installation.
- Prestart - checklist of items or procedures needed to prepare the generator set for operation.
- Installation Checklist - reference checks upon completion of the installation.

This manual does not provide application information for selecting a generator set or designing the complete installation. If it is necessary to design the various integrated systems (fuel, exhaust, cooling, etc.), additional information is required. Review standard installation practices. For engineering data specific to the generator set, refer to the Specification and Data Sheets. For application information, refer to Application Manual T-030, "Liquid Cooled Generator Sets." To find this manual online:

1. Go to [powersuite.cummins.com](http://powersuite.cummins.com)
2. Click on "Login" on the Home page.
3. Click on "Library".
4. Click on "Technical Documents".
5. Click on "Technical information".
6. Click on "Liquid Cooled Genset Application Manual".

## 2.2 Schedule of Abbreviations

This list is not exhaustive. For example, it does not identify units of measure or acronyms that appear only in parameters, event/fault names, or part/accessory names.

ABBR.	DESCRIPTION	ABBR.	DESCRIPTION
AC	Alternating Current	LED	Light-emitting Diode
AMP	AMP, Inc., part of Tyco Electronics	LTS	Long Term Storage
ANSI	American National Standards Institute	LVRT	Low Voltage Ride Through
ASOV	Automatic Shut Off Valve	MFM	Multifunction Monitor
ASTM	American Society for Testing and Materials (ASTM International)	Mil Std	Military Standard
ATS	Automatic Transfer Switch	MLD	Masterless Load Demand
AVR	Automatic Voltage Regulator	NC	Normally Closed
AWG	American Wire Gauge	NC	Not Connected
CAN	Controlled Area Network	NFPA	National Fire Protection Agency
CB	Circuit Breaker	NO	Normally Open
CE	Conformité Européenne	NWF	Network Failure
CFM	Cubic Feet per Minute	OEM	Original Equipment Manufacturer
CGT	Cummins Generator Technologies	OOR	Out of Range
CMM	Cubic Meters per Minute	OORH / ORH	Out of Range High
CT	Current Transformer	OORL / ORL	Out of Range Low
D-AVR	Digital Automatic Voltage Regulator	PB	Push Button
DC	Direct Current	PCC	PowerCommand® Control
DEF	Diesel Exhaust Fluid	PGI	Power Generation Interface
DPF	Diesel Particulate Filter	PGN	Parameter Group Number

ABBR.	DESCRIPTION	ABBR.	DESCRIPTION
ECM	Engine Control Module	PI	Proportional/Integral
ECS	Engine Control System	PID	Proportional / Integral / Derivative
EMI	Electromagnetic interference	PLC	Programmable Logic Controller
EN	European Standard	PMG	Permanent Magnet Generator
EPS	Engine Protection System	PPE	Personal Protective Equipment
E-Stop	Emergency Stop	PT	Potential Transformer
FAE	Full Authority Electronic	PTC	Power Transfer Control
FMI	Failure Mode Identifier	PWM	Pulse-width Modulation
FRT	Fault Ride Through	RFI	Radio Frequency Interference
FSO	Fuel Shutoff	RH	Relative Humidity
Genset	Generator Set	RMS	Root Mean Square
GCP	Generator Control Panel	RTU	Remote Terminal Unit
GND	Ground	SAE	Society of Automotive Engineers
LCT	Low Coolant Temperature	SCR	Selective Catalytic Reduction
HMI	Human-machine Interface	SPN	Suspect Parameter Number
IC	Integrated Circuit	SWL	Safe Working Load
ISO	International Organization for Standardization	SW_B+	Switched B+
LBNG	Lean-burn Natural Gas	UL	Underwriters Laboratories
LCD	Liquid Crystal Display	UPS	Uninterruptible Power Supply
		VPS	Valve Proving System

## 2.3 Related Literature

Before any attempt is made to operate the generator set, the operator should take time to read all of the manuals supplied with the generator set, and to familiarize themselves with the warnings and operating procedures.

### NOTICE

**A generator set must be operated and maintained properly if you are to expect safe and reliable operation. The Operator manual includes a maintenance schedule and a troubleshooting guide.**

**The Health and Safety manual must be read in conjunction with this manual for the safe operation of the generator set:**

- Health and Safety Manual (0908-0110)

The relevant manuals appropriate to your generator set are also available, the documents below are in English:

- Owners Manual for QSK60G and QSV91 Engine with PowerCommand 3.3 control (0908-0209)
- Installation Manual for QSK60G and QSV91 Engine with PowerCommand 3.3 control (A029R140)

- Recommended Spares List (RSL) for QSK60G (A046W059)
- Recommended Spares List (RSL) for QSK60G (A046W060)
- Recommended Spares List (RSL) for QSV91 (<2MW) (A046W061)
- Recommended Spares List (RSL) for QSV91 (>2MW) (A046W064)
- Service Manual for PowerCommand 3.3 Control (0900-0670)
- Parts Manual for QSK60G (A029C810)
- Parts Manual for QSV91 (A029B383)
- Service Tool Manual (A043D529)
- Failure Code Manual (F1115C)
- Application Manual T-030, *Liquid Cooled Generator Sets* - for application information (A040S369)
- Engine Operation & Maintenance Manual for QSV81/91 (4021313)
- Engine Operation & Maintenance Manual for QSK60G (4021395)
- Engine Owners Manual for QSV81/91 (4915546)
- Engine Owners Manual for QSK60G (4915558)
- Warranty Administration Manual (4021290)
- ESB Warranty Statement - Lean-Burn Gaseous Fuel Generating Set (A050L829)

### 2.3.1 Further Information - Literature

Contact your authorized distributor for more information regarding related literature for this product.

## 2.4 After Sales Services

Cummins offers a full range of maintenance and warranty services.

### 2.4.1 Maintenance

#### **WARNING**

##### ***Electrical Generating Equipment***

***Incorrect operation and maintenance can result in severe personal injury or death.***

***Make sure that only suitably trained and experienced service personnel perform electrical and/or mechanical service.***

For expert generator set service at regular intervals, contact your local distributor. Each local distributor offers a complete maintenance contract package covering all items subject to routine maintenance, including a detailed report on the condition of the generator set. In addition, this can be linked to a 24-hour call-out arrangement, providing year-round assistance if necessary. Specialist engineers are available to maintain optimum performance levels from generator sets. Maintenance tasks should only be undertaken by trained and experienced technicians provided by your authorized distributor.

### 2.4.2 Warranty

For details of the warranty coverage for your generator set, refer to the Global Commercial Warranty Statement listed in the Related Literature section.

In the event of a breakdown, prompt assistance can normally be given by factory trained service technicians with facilities to undertake all minor and many major repairs to equipment on site.

Extended warranty coverage is also available.

For further warranty details, contact your authorized service provider.

**NOTICE**

**Damage caused by failure to follow the manufacturer's recommendations will not be covered by the warranty. Please contact your authorized service provider.**

### **2.4.2.1 Warranty Limitations**

For details of the warranty limitations for your generator set, refer to the warranty statement applicable to the generator set.

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# 3 System Overview

This section provides an overview of the generator set.

## 3.1 Generator Set Identification

Each generator set is provided with a nameplate similar to that shown below. The nameplate provides information unique to the generator set.

### 3.1.1 Nameplate - Open Generator Set

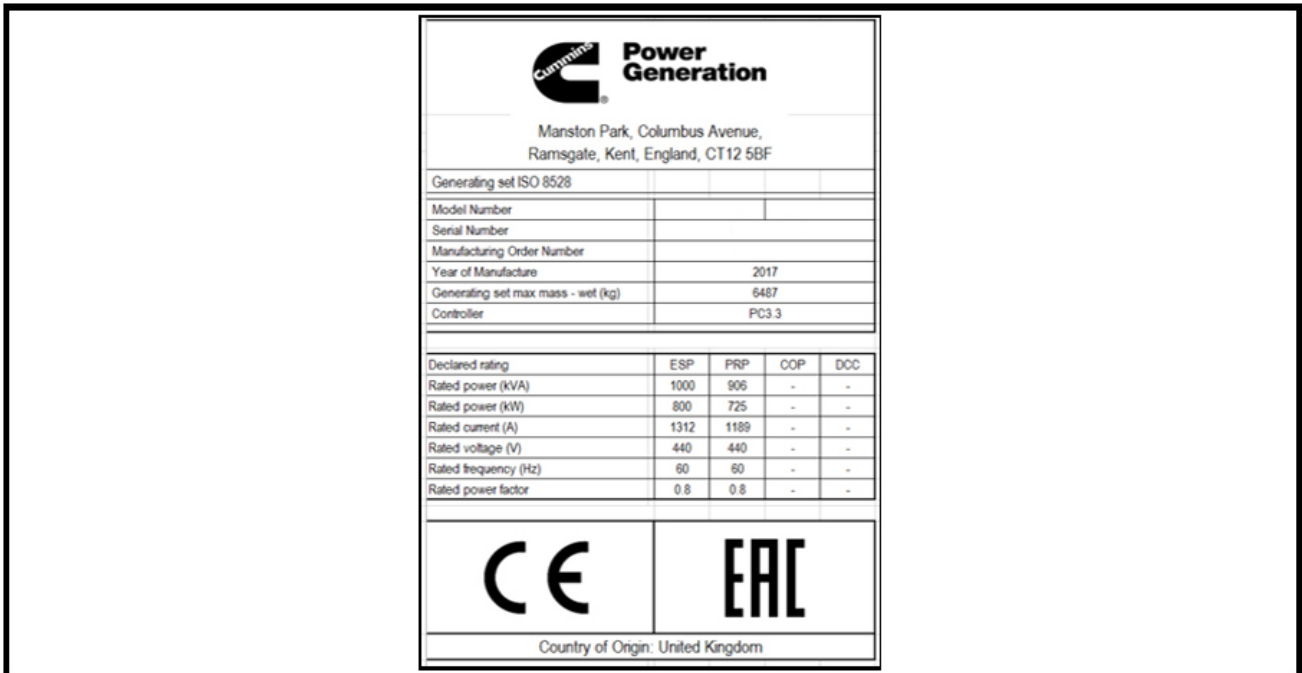


FIGURE 1. TYPICAL OPEN GENERATOR SET NAMEPLATE

## 3.2 Generator Set Components

The main components of a typical QSV91G engine generator set are shown below, and referred to within this section.

There are various options listed although they may not be available for all models.

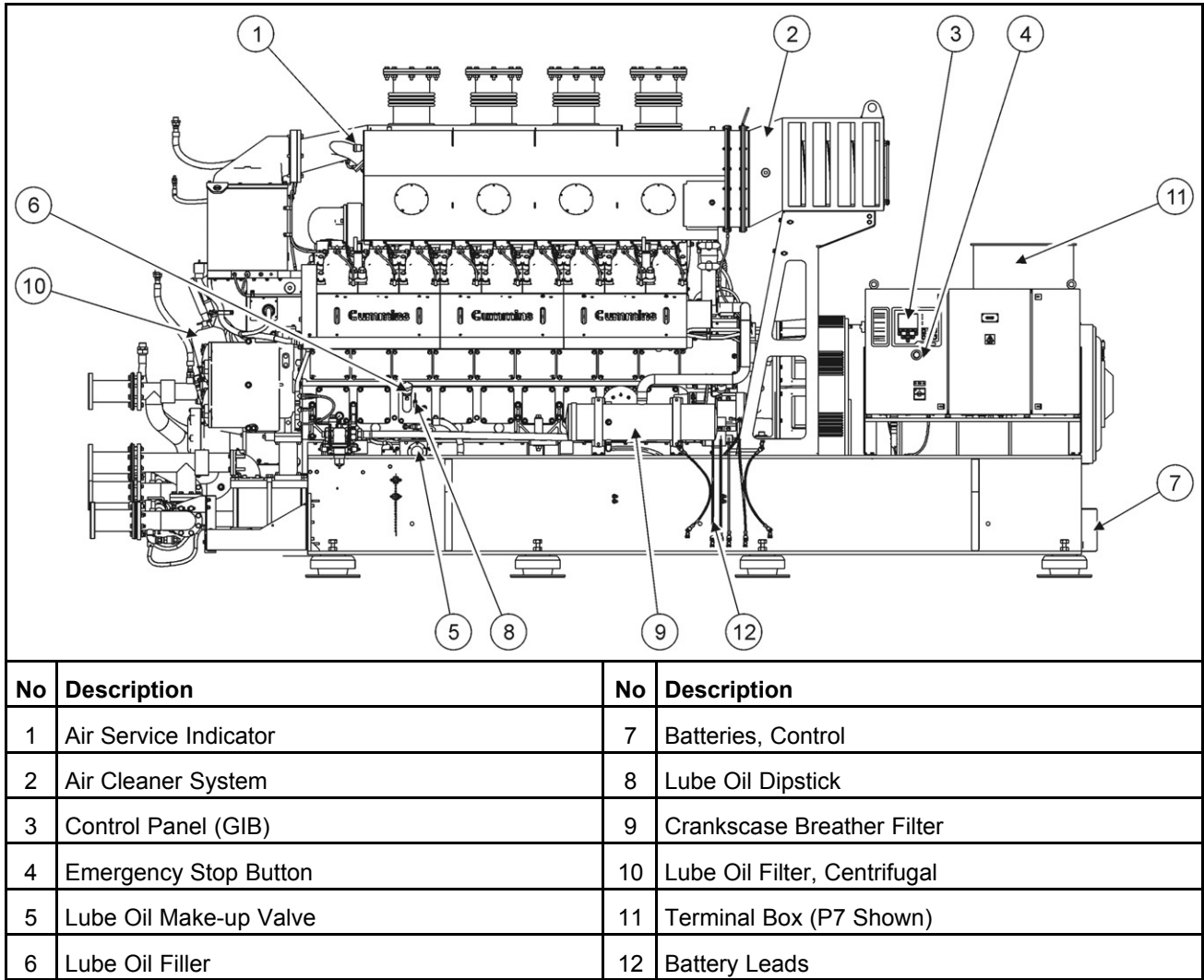


FIGURE 2. TYPICAL QSV91G ENGINE GENERATOR SET

### 3.3 Generator Set Rating

For details of the generator set rating, refer to the generator set nameplate. For operation at temperatures or altitudes above those stated on the nameplate, a derate may be necessary.

### 3.4 Engine

For additional engine specific information, refer to the relevant engine manual for your generator set.

### 3.5 Sensors

Various generator set parameters are measured by sensors, and the resulting signals are processed by the control board.

Engine-mounted sensors monitor a number of different systems, such as:

- Lube Oil Pressure
- Cooling System Temperature

## 3.6 System Options

### 3.6.1 Mains (Utility) Battery Charger - Wall Mounted

A 24 VDC - 30 Amp mains (utility) powered battery charger is wall mounted. For more information, see [Section 9.6 on page 55](#).

### 3.6.2 Heaters

#### 3.6.2.1 Heater Supply and Isolation

A heater supply is required for the operation of the engine and alternator heaters (if fitted).

**NOTICE**

The incoming power supply is isolated using the isolator switch in the GIB.

### 3.6.3 Remote Radiator Installation

Special requirements apply if your generator set includes a remote radiator. For more information, refer to [Section 7.8 on page 39](#).

### 3.6.4 Gas Train

**NOTICE**

Installation, maintenance and testing of gas pipe work system must be carried out by suitably trained and experienced personnel.

Natural Gas is supplied to the engines' fuel management system through a flexible pipe attached to a gas train. The gas train includes a main shut-off valve and other gas control components. Control equipment for the fuel/air ratio and engine speed, are provided on the generator set.

A typical gas train, starting at the gas main supply point, includes the components shown below.

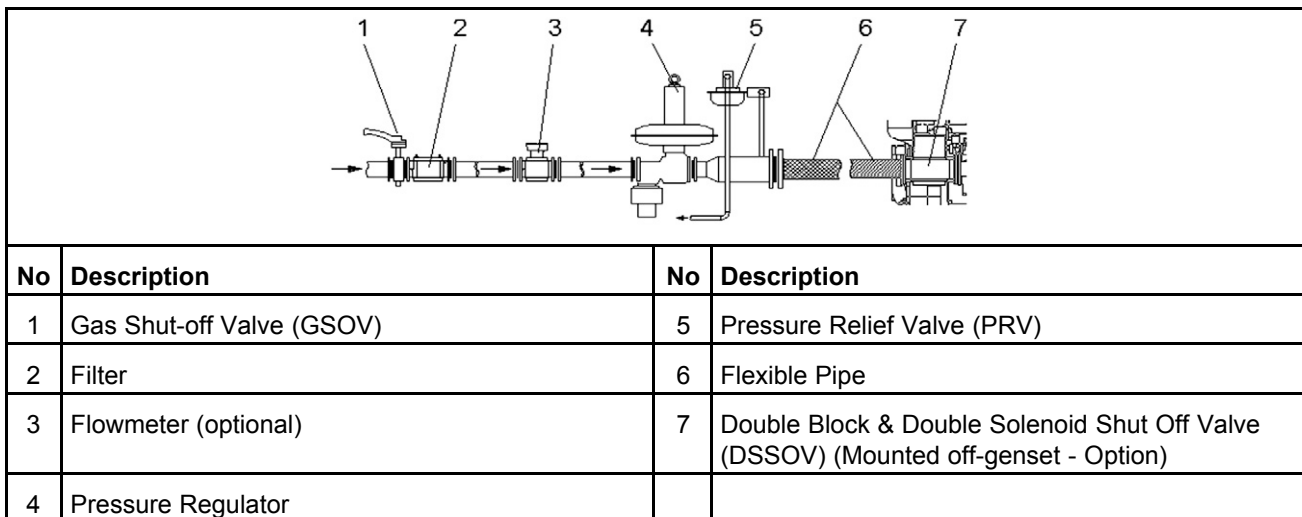


FIGURE 3. TYPICAL GAS TRAIN

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## 4 Installation Overview

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These installation recommendations apply to typical installations with standard model generator sets. Whenever possible, these recommendations also cover factory designed options or modifications. However, because of the many variables in any installation, it is not possible to provide specific recommendations for every situation. If there are any questions not answered by this manual, contact your nearest authorized distributor for assistance.

### 4.1 Application and Installation

A power system must be carefully planned and correctly installed for proper operation. This involves two essential elements.

- **Application** (as it applies to generator set installations) refers to the design of the complete power system that usually includes power distribution equipment, transfer switches, ventilation equipment, mounting pads, cooling, exhaust, and fuel systems. Each component must be correctly designed so the complete system will function as intended. Application and design is an engineering function generally done by specifying engineers or other trained specialists. Specifying engineers or other trained specialists are responsible for the design of the complete power system and for selecting the materials and products required.
- **Installation** refers to the actual set-up and assembly of the power system. The installers set up and connect the various components of the system as specified in the system design plan. The complexity of the system normally requires the special skills of qualified electricians, plumbers, sheet-metal workers, etc. to complete the various segments of the installation. This is necessary so that all components are assembled using standard methods and practices.

### 4.2 Safety Considerations

The generator set has been carefully designed to provide safe and efficient service when properly installed, maintained, and operated. However, the overall safety and reliability of the complete system is dependent on many factors outside the control of the generator set manufacturer. To avoid possible safety hazards, make all mechanical and electrical connections to the generator set exactly as specified in this manual. All systems external to the generator (fuel, exhaust, electrical, etc.) must comply with all applicable codes. Make certain all required inspections and tests have been completed and all code requirements have been satisfied before certifying the installation is complete and ready for service.

#### **WARNING**

##### ***Fall Hazard***

***Falls can result in severe personal injury or death.***

***Make sure that suitable equipment for performing tasks at height are used in accordance with local guidelines and legislation.***

### 4.3 Standby Heating Devices

Cummins requires installing standby generator sets (life safety systems) with engine jacket water coolant heaters in order to ensure a 10 second start. Jacket water coolant heaters are also recommended in prime and continuous applications where time and load acceptance is to be minimized.

The jacket water coolant heater provided by Cummins rated to provide the above requirements in ambient temperatures as low as 4 °C (40 °F). Although most Cummins generator sets will start in temperatures down to -32 °C (-25 °F) when equipped with engine jacket water coolant heaters, it might take more than 10 seconds to warm the engine before a load can be applied when ambient temperatures are below 4 °C (40 °F).

On generator sets equipped with a graphic display, the **Low Coolant Temperature** message, in conjunction with illumination of the Warning LED, is provided to meet the current requirements. The engine cold sensing logic initiates a warning when the engine jacket water coolant temperature falls below 21 °C (70 °F). In applications where the ambient temperature falls below 4 °C (40 °F), or there exists a high amount of cold airflow, the jacket water coolant heater may not provide the necessary heating. Under these conditions, although the generator set may start, it may not be able to accept load within 10 seconds. When this condition occurs, check the coolant heaters for proper operation. If the coolant heaters are operating properly, other precautions may be necessary to warm the engine before applying a load.

## 4.4 Product Modifications

Agency certified products purchased from Cummins comply only with those specific requirements and as noted on company product specification sheets. Subsequent modifications must meet commonly accepted engineering practices and/or local and national codes and standards. Product modifications must be submitted to the local authority having jurisdiction for approval.

# 5 Specifications

## 5.1 Generator Set Specifications

**NOTICE**

Specifications are dependent on generator set model, application and installations. For specific generator set information contact your authorised distributor.

**TABLE 1. TYPICAL SPECIFICATIONS**

MODELS	C1540 N5CB, C1750 N5CB, C2000 N5CB & C1540 N5CB Spec D, C1750 N5CB Spec D, C2000 N5CB Spec D, C1540 N6CB Spec D, C1750 N6CB Spec D, C2000 N6CB Spec D, C1750 N6B Spec D, C2000 N6B Spec D	
<b>Engine</b> Cummins Series	QSV91G	
<b>Generator kVA/kW Rating</b>	See generator set nameplate for rating information.	
<b>Engine Fuel Connection</b> Inlet/Outlet Thread Size	Refer to generator set outline drawing supplied (A059D245)	
<b>Maximum Weight</b>	25873 kg (57040 lbs)	
<b>Fuel</b>	Regulated Fuel Pressure (dependant on engine model/rating) to engine	120 mBar [1.7 psi] - 200 mBar [2.9 psi]
	Fuel Inlet Pressure Supplied to Regulator; Three Options:	Option 1 - up to 1.25 Bar [18 psi] Option 2 - up to 1.80 Bar [26 psi] Option 3 - up to 3.00 Bar [44 psi]
	Fuel Solenoid Safety Settings - Low Fuel Pressure Safety	80-90 mBar [1.1-1.3 psi]
<b>Exhaust</b>	Back Pressure - (Maximum) at Rated Speed and Load	500 mm H2O [19.7 in H2O]
	Exhaust Gas Temperature after cylinder 1200 rpm rated (Maximum)	693°C [1280°F]
	Exhaust Gas Temperature after cylinder 1500 rpm rated (Maximum)	693°C [1280°F]
	Exhaust Temperature after turbocharger (Maximum)	555°C [1031°F]
<b>Electrical System</b> Starting Voltage	24 Volts DC	
<b>Coolant Capacity</b> Engine Coolant Capacity HT Engine Coolant Capacity LT	424 liters [112 U.S. gal] 295 litres [77.93 U.S. gal]	
<b>Lubricating System</b> Oil Sump Capacity QSV91 (high/low)	560/435 liters [148/115 U.S. gal]	

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## 5.2 Engine Fuel Consumption

**NOTICE**

Engine fuel consumption is particular to the generator set installation. See data sheet for specific information.

# 6 Installing the Generator Set

Generator set installations must be engineered so that the generator set will function properly under the expected load conditions. Use these instructions as a general guide only. Follow the instructions of the consulting engineer when locating or installing any components. The complete installation must comply with all local and state building codes, fire regulations, and other applicable regulations.

Requirements to be considered prior to installation are:

- Level mounting surface
- Adequate cooling air
- Adequate fresh induction air
- Discharge of generator set air
- Non-combustible mounting surface
- Discharge of exhaust gases
- Electrical connections
- Accessibility for operation and servicing
- Noise levels
- Vibration isolation

## CAUTION

***Depending on your location and intended use, ensure that international, national or local laws and regulations regarding Air Quality Emissions have been observed and complied with. Be sure to consult local pollution control or air quality authorities before completing your construction plans.***

## 6.1 Transportation

### WARNING

#### ***Heavy Load***

***Incorrect lifting or repositioning can cause severe personal injury or death.***

***Make sure that only suitably trained and experienced personnel transport and handle generator sets and associated components.***

### WARNING

#### ***Heavy Load***

***Incorrect lifting or repositioning can cause severe personal injury or death.***

***Do not lift the generator set by attaching to the engine or alternator lifting points. Do not stand under or near the generator set when lifting.***

- Ensure the generator set is prepared for transport. If necessary drain fluids and ensure that acid or fumes do not leak from the battery (where applicable).
- If the generator set is transported over long distances, protect it against environmental influences by sealing it in a plastic cover or similar.
- Ensure the generator set is secured to the vehicle with suitable securing straps. Wooden chocks and pallets alongside the securing straps can prevent movement during transportation.

- If required, attached impact indicators to the generator set. Upon delivery, check these impact indicators and contact the transport company immediately if an impact has been detected. Impacts can cause serious damage to the generator set and its components.
- Ensure that the generator set cannot turn over during transportation.
- Do not overload the transport vehicle. Under no circumstances should the generator set be started while inside a truck.
- Lifting eyes where fitted are to be checked at regular intervals to ensure they are damage free and tight.

## 6.2 Location

### WARNING

#### **Electrical Generating Equipment**

***Incorrect operation and maintenance can result in severe personal injury or death.***

***Make sure that only suitably trained and experienced service personnel perform electrical and/or mechanical service.***

### WARNING

#### **Incorrect installation**

***Incorrect installation of the generator set, service or parts replacement, can result in severe personal injury, death, and/or equipment damage.***

***Service personnel must be trained and experienced to perform electrical and mechanical component installation.***

### NOTICE

**Depending on your location and intended use, additional laws and regulations may require for you to obtain an air quality emissions permit before beginning installation of your generator set. Be sure to consult local pollution control or air quality authorities before completing your construction plans.**

Generator set location is decided mainly by related systems such as ventilation, wiring, fuel, and exhaust. The set should be located as near as possible to the main power service entrance. Exhaust gases must not be able to enter or accumulate around inhabited areas.

Provide a location away from extreme ambient temperatures and protect the generator set from adverse weather conditions.

Use the following information to locate the generator set for optimal operating conditions:

**Surface:** Concrete or compacted gravel with the generator set resting on solid, poured concrete blocks, or timber blocks spaced at reasonable intervals around the perimeter of the generator set.

**Leveling:** Level the generator set from side-to-side within + 3.5°, and end-to-end within +2.5°.

**Placement:**

- Generator sets should be a minimum of 5 m (16.4 ft) apart to allow for adequate access.
- Make sure that the air inlets are not obstructed by surrounding trees, buildings, or other obstructions.
- Make sure noise distribution (to prevent echoing) is kept to a minimum.
- Consider exhaust for immediate neighbors.
- The prevailing wind direction should be considered so that the engine combustion air inlet is upwind and the exhaust discharge is downwind.

- The immediate area around the proposed location of the mounting surface should be evaluated for proper drainage so that moisture run-off is sufficient to prevent ponding around the unit(s).

### 6.3 Moving the Generator Set

**⚠ WARNING**

**Heavy Load**  
***Incorrect lifting or repositioning can cause severe personal injury or death.***  
***Make sure that only suitably trained and experienced personnel transport and handle generator sets and associated components.***

It is essential that there are sufficient trained and experienced personnel in attendance to ensure the lifting and transportation of the generator set is undertaken in a safe and appropriate manner and in accordance to local guidelines and legislation.

**⚠ WARNING**

**Heavy Load**  
***Incorrect lifting or repositioning can cause severe personal injury or death.***  
***Do not lift the generator set by attaching to the engine or alternator lifting points. Do not stand under or near the generator set when lifting.***

Before lifting the generator set, lifting points, angle of slings, mass, access to intended site, and the distance of movement should all be taken into account when organizing a suitable crane/hoist. Consult the generator set information supplied with your generator set for details of dimensions and mass.

- Ensure that the crane operating area is able to support the mass of the crane and the generator set.

**⚠ WARNING**

**Mechanical Hazard**  
***Failed components may be ejected or operate incorrectly which can cause severe personal injury or death.***  
***Do not climb the generator set; this may damage critical parts.***

- Ensure the equipment used for lifting is adequate to support the weight of the generator set.
- Attach the lifting device to the lifting points only, using suitable shackles, chains and spreader bars.
- Slowly tighten the slings. Inspect the lifting attachments before commencing a full lift to ensure they are attached correctly.
- Hoist the generator set slowly using the indicated lifting points only.

**⚠ DANGER**

**Raised Load.**  
***Contact with a lifted generator set can result in severe personal injury or death.***  
***Never stand underneath a lifted generator set.***

- Guide the generator set with ropes at a safe distance, to prevent uncontrolled rotation when positioning the generator set.
- Move the generator set to the desired location and place in position, bringing the set down slowly.

- Loosen the slings; unhook and remove the shackles.

### 6.3.1 Lifting the Generator Set

Refer to the drawings supplied for information on lifting points, angle of slings, mass, and centre of gravity before organizing a suitable crane/hoist to move the generator set.

## 6.4 Mounting

Generator sets are mounted on a steel skid that provides proper support, which is sited on mechanical spring isolators to provide adequate vibration isolation per application.

### NOTICE

**The use of unapproved isolators may result in harmful resonances and may void the generator set warranty.**

Mount the generator set on a substantial and level base such as a concrete pad. A non-combustible material must be used for the pad.

The fixing centers for the mounting bolts can be found on the generator set *Outline Drawing* referenced in [Appendix D on page 95](#)

### 6.5 Access to Set

Generally, at least 1 meter (3.3 feet) of clearance should be provided on all sides of the generator set for maintenance and service access. (Increase clearance by width of door if optional housing is used.) Lighting should be adequate for operation, maintenance and service operations and should be connected on the load side of the transfer switch so that it is available at all times.

## 6.6 Vibration Isolator Installation and Adjustment Procedure

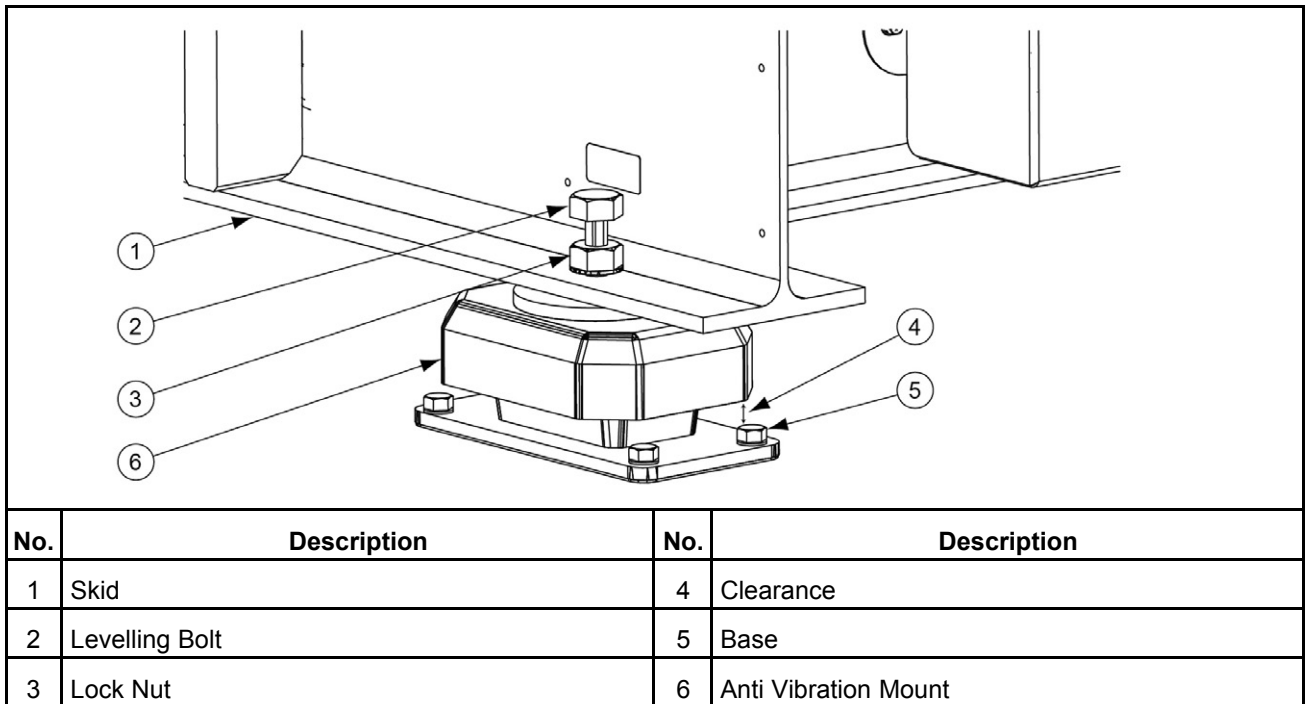
The helical spring isolators are enclosed in an aluminium casting. The isolator is levelled by adjusting the top fixing screw.

1. Install the vibration isolators on the generator set support structure using the positions indicated on the drawings supplied. The isolators should be shimmed or grouted to make sure that all of the isolator bases are within 0.25 inch (6 mm) elevation of each other. The surface that the isolator bases rest on must also be flat and level. Lock the isolators in place with ground fixings.
2. Place the generator set onto the isolators while aligning the skid's mounting with the threaded isolator hole. The top plates will move down and approach the base of the isolator as load is applied.
3. Once the generator set is in position, the isolators may require adjusting so that the set is level. The isolators are adjusted by inserting the leveling bolt through the skid and into the isolator (the leveling bolt's locking nut should be threaded up towards the bolt head).

A nominal clearance of 0.5 inch (12 mm) or greater is desired (but may depend on generator set mass). This will provide sufficient clearance for the movement that occurs during startup and shutdown. If the 0.5 inch (12 mm) clearance is not present, turn the levelling bolt until the desired clearance is achieved.

4. If the radiator and engine are mounted on separate skids, make sure the radiator skid and engine/alternator skid are level with each other after adjusting the isolators. If not level, proper component alignment cannot be achieved.
5. If the generator set is not yet level, adjust the leveling bolts until the set is level and sufficient clearance still remains. (Clearance on all isolators should be roughly equal).

6. Once all isolators have been set, lock the leveling bolt in place with the lock nut.



**FIGURE 4. VIBRATION ISOLATOR INSTALLATION**

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# 7 Mechanical Connections

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The generator set mechanical system installation includes connecting the fuel, exhaust, ventilation, and cooling systems. Before starting any type of fuel installation, all pertinent state and local codes must be complied with and the installation must be inspected before the unit is put in service.

## 7.1 Fuel System

In all fuel system installations, cleanliness is of the utmost importance. Make every effort to prevent entrance of moisture, dirt, or contaminants of any kind into the fuel system. Clean all fuel system components before installing. Use only compatible metal fuel lines to avoid electrolysis when fuel lines must be buried. Buried fuel lines must be protected from corrosion.

### 7.1.1 Gaseous Fuel Supply

The primary factors in successful installation and operations of a gas fuel system are:

- The gas supplied to the generator set must be of acceptable quality. Refer to the Application Manual T-030, "Liquid Cooled Generator Sets" for more detailed information about Cummins approved fuel types and quality.
- The gas supply must have sufficient pressure (defined for each generator set on the respective data-sheets). Care must be taken to be sure that the gas supply *at the generator set*, not just at the source, is of proper pressure for operation. The specified pressure must be available while the generator set is running at full load.
- The gas must be supplied to the generator set in sufficient volume to support operation of the generator set. This is normally a matter of selecting fuel line size to be large enough to transport the volume of fuel needed. For LP vapor-withdrawal fuel systems the size and temperature of the fuel tank also affects this requirement.

Failure to meet the minimum requirements of the generator set in these areas will result in the inability of the generator set to operate, or inability to carry rated load, or poor transient performance. Insufficient flow can also result in engine damage or catastrophic failure.

### 7.1.2 Gaseous Fuel Quality

Gaseous fuels are actually a mixture of several different hydrocarbon gases such as methane, ethane, propane and butane; other gaseous elements such as oxygen and nitrogen; vaporized water; and various contaminants, some of which are potentially damaging to an engine over time. The quality of the fuel is based on the amount of energy per unit volume in the fuel and the amount of contaminants in the fuel.

#### 7.1.2.1 Energy Content

One of the most important characteristics of the gaseous fuel used in a generator set is the heat value of the fuel. The heat value of a fuel describes how much energy is stored in specific volume of the fuel. Gaseous fuel has a low heat value (LHV) and a high heat value (HHV). The low heat value is the heat available to do work in an engine after the water in the fuel is vaporized. If the low heat value of a fuel is too low, even if a sufficient volume of fuel reaches the engine, the engine will not be able to maintain full output power, because sufficient energy is not available in the engine to convert to mechanical energy. If the LHV is below 33720 KJ/M<sup>3</sup> or 905 BTU/ft<sup>3</sup> the engine may not produce rated power at standard ambient temperature conditions.

If the local fuel has a higher energy content than 37259 KJ/M<sup>3</sup> or 1000 BTU/ft<sup>3</sup>, the actual flow requirements in M<sup>3</sup>/min or ft<sup>3</sup>/min will be lower and the pressure requirements drop slightly. Conversely, if the local fuel has a lower energy content than 37259 KJ/M<sup>3</sup> or 1000 BTU/ft<sup>3</sup>, the actual flow requirements in M<sup>3</sup>/min or ft<sup>3</sup>/min will be higher and a higher minimum supply pressure will be needed to meet published performance for any given generator set.

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Each engine may have slightly different performance characteristics based on the type of fuel provided, due to differences in engine compression ratio, and whether the engine is naturally aspirated or turbocharged.

### 7.1.2.2 Pipeline Natural Gas

The most common fuel for generator sets is called Pipeline Natural Gas. In the US, Dry Pipeline Natural Gas has specific qualities, based on federal requirements. In other countries, Pipeline Gas may vary in content, so fuel characteristics should be verified prior to use with a generator set. US Pipeline Gas is a mixture composed of approximately 98% Methane and Ethane with the other 2% being hydrocarbons such as Propane and Butane, Nitrogen, Carbon Dioxide and water vapor. "Dry" means that it is free of liquid hydrocarbons, such as gasoline, but NOT that it is free of water vapor. Dry Pipeline Gas typically has a LHV of 936 BTU/ft<sup>3</sup>, and a HHV of 1,038 BTU/ft<sup>3</sup>.

### 7.1.2.3 Field Gas

The composition of Field Natural Gas varies considerably by region and by continent. Careful analysis is necessary prior to using Field Natural Gas in an engine. Field Natural Gas can contain heavier hydrocarbon gases such as Pentane, Hexane and Heptane, which may require derating of the output of the engine. Other contaminants, such as Sulfur, may also be present in the fuel. A typical Field Gas might have an LHV of 1203 BTU/ft<sup>3</sup>, and an HHV of 1,325 BTU/ft<sup>3</sup>.

### 7.1.2.4 Contaminants

The most harmful contaminants in gaseous fuels are water vapor and Sulfur.

Water vapor is damaging to an engine because it may cause uncontrolled burning, pre-ignition, or other effects that can damage an engine. Liquid vapor or droplets must be removed from the fuel prior to entry into the engine by use of a dry filter that is mounted in the fuel system prior to the primary fuel pressure regulator. The dew point of fuel gas should be at least 20 °F (11 °C) below the minimum ambient temperature at the installation site.

Sulfur and Hydrogen sulfides will cause corrosion and serious damage to an engine over a relative short period of time. Different engines have different levels of tolerance to sulfur contamination, and some engines simply should not be operated with fuel that contains significant Sulfur content. Contact the engine manufacturer for approval of specific engines with specific fuels. The effects of Sulfur in the fuel can be counteracted in part by use of high-ash Natural Gas lubricating oils. In general, engines should not be operated with fuels in excess of 10 parts per million (ppm).

Certain fuels, such as those derived from land fill applicants, can have useful chemical energy content, but very high sulfur levels (>24 ppm). These fuels are often termed "sour gas". If this fuel is scrubbed of the Sulfur content, it can be used as fuel for many engines, provided that it has sufficient BTU content.

### 7.1.2.5 Fuel Analysis

The gaseous fuel supplier can provide a fuel analysis that describes the chemical makeup of the fuel to be provided. This fuel analysis can be used to make certain that the fuel is suitable for use in the specific engine proposed for a specific application, and also to verify that the BTU content of the fuel is sufficient to provide necessary kW output of the machine. Gas suppliers may change the Pipeline Natural Gas composition without notice, so there is no long-term guarantee of performance, but the process of evaluation of the fuel can be briefly described as:

1. List the percent of each gas constituent in the fuel.
2. Calculate the percent of the total fuel that is combustible. The combustible portion of the fuel is 100% less the inert component percentages. Inert components include Oxygen, Carbon Dioxide and water vapor.
3. Calculate the percent of each combustible component of the fuel.
4. Verify acceptability of the fuel by checking the percent of each combustible element vs. the recommendations of the engine manufacturer.

For example, for a gas analysis of:

90% Methane

- 6% Ethane
- 2% Hydrogen
- 1% Normal Pentane
- 1% Nitrogen
- Total percent inert elements: 1%
- Total combustible: 100% - 1% = 99%
- % Methane: 90% ÷ 99% = 91%
- % Ethane: 6% ÷ 99% = 6.1%
- % Hydrogen: 2% ÷ 99% = 2%
- % Normal Pentane: 1% ÷ 99% = 1%

See the following tables for a typical listing of Maximum Permissible Combustibles in Cummins Gas generator sets. Note that in this example, the analysis shows the fuel will be acceptable for a lower compression ratio engine (typically around 8.5:1) but not for a higher compression engine. A higher compression engine will have more stringent fuel composition requirements but may operate satisfactorily with a derating of its output - consult the engine manufacturer.

5. Verify the rating of the generator set based on the use of the proposed fuel.

The total BTU content of the fuel will determine the rating of the generator set when using fuel of a specific composition. If any component of the fuel has more than the specific value allowed derating will be required. Consult the engine manufacturer for fuel requirements and derating instructions.

Note that the fuel derating and the altitude/temperature derating 21 are not additive. Only the maximum value of the fuel derate or the altitude/temperature derate need be applied.

Turbocharged engines have unique fuel composition requirements due to higher cylinder pressures. To avoid problems with pre-ignition or denotation, power output derating is required if propane and/or ISO-Butane content exceed the percentages listed in the following tables.

**TABLE 2. MAXIMUM ALLOWABLE PERCENTAGES FOR ENGINE FUEL COMBUSTIBLES**

	8.5:1 Compression Ratio	10.5:1 Compression Ratio
Methane (C <sub>1</sub> )	100	100
Ethane (C <sub>2</sub> )	100	100
Propane (C <sub>3</sub> )	10	2
ISO-Butane (IC <sub>4</sub> )	7	0.2
Hydrogen (H <sub>2</sub> )	7	trace
Normal Butane (NC <sub>4</sub> )	3	0.2
ISO-Pentane (IC <sub>5</sub> )	3	0.2
Normal Pentane (NC <sub>5</sub> )	1	0.1
Hexane (C <sub>6</sub> )	1	0.1
Heptane (C <sub>7</sub> )	1	0.1

**TABLE 3. MAXIMUM ALLOWABLE PERCENTAGES OF CONSTITUENT GASES BEFORE DERATING TURBOCHARGED ENGINES**

	8.5:1 Compression Ratio	10.5:1 Compression Ratio
Methane	N/A	N/A
Ethane	N/A	N/A

Propane	5%	*
ISO-Butane	2%	*

\*High compression ratio turbocharged engines cannot consume any Propane or ISO-Butane.

## 7.2 Exhaust System

### ⚠ WARNING

*Inhalation of exhaust gasses can result in severe personal injury or death. Use extreme care during installation to provide a tight exhaust system. Terminate exhaust pipes away from enclosed or sheltered areas, windows, doors, and vents. Do not use exhaust heat to warm a room, compartment, or storage area.*

### ⚠ WARNING

*Hot exhaust pipes can start a fire and cause severe injury or death if improperly routed through walls. Use an approved thimble where exhaust pipes pass through wall or partitions.*

### ⚠ CAUTION

*Weight applied to the engine manifold can result in turbocharger damage. Support the silencer and exhaust piping so no weight or stress is applied to the engine exhaust elbow.*

### ⚠ CAUTION

*Gaseous fuels are susceptible to high condensation levels in the exhaust. It is important to have properly routed/sized exhaust systems to prevent harm to turbochargers and Oxygen sensors (HEGO).*

### NOTICE

**Liability for injury, death, damage, and warranty expense due to use of unapproved silencers or modifications to the exhaust system becomes the responsibility of the person installing the unapproved silencer or performing the modification. Contact your authorized distributor for approved exhaust system parts.**

Pipe exhaust gases outside. Locate the exhaust outlets away from any air inlets to avoid gases re-entering. Exhaust installations are subject to various detrimental conditions such as extreme heat, infrequent operation, and light loads. Regularly inspect the exhaust system both visually and audibly to see that the entire system remains fume tight and safe for operation.

Where applicable, refer to NFPA 37, Section 6-3, *Stationary Combustion Engines and Gas Turbines*, for accepted design practices. Build according to the code requirements in effect at the installation site.

The exhaust system should use sealed joint type fittings where possible to provide a tight exhaust system. Use of slip type fittings (secured with a clamp) may allow leakage of exhaust gases into the building if not fitted correctly. Check to make sure there are no exhaust leaks.

Use an approved thimble (see [Figure 5 on page 35](#)) where exhaust pipes pass through a wall or partition. Insulated wall/roof thimbles are used where exhaust pipes pass through a combustible roof or wall. This includes structures, such as wood framing or insulated steel decking, etc. Uninsulated wall/roof thimbles are used where exhaust pipes pass through a non-combustible wall or roof, such as concrete. Where applicable, refer to NFPA 37, Section 6-3, *Stationary Combustion Engines and Gas Turbines*, for accepted design practices. Build according to the code requirements in effect at the installation site.

Rain caps are available for the discharge end of vertical exhaust pipes. The rain cap clamps onto the end of the pipe and opens due to exhaust discharge force from the generator set. When the generator set is stopped, the rain cap automatically closes, protecting the exhaust system from rain, snow, etc.

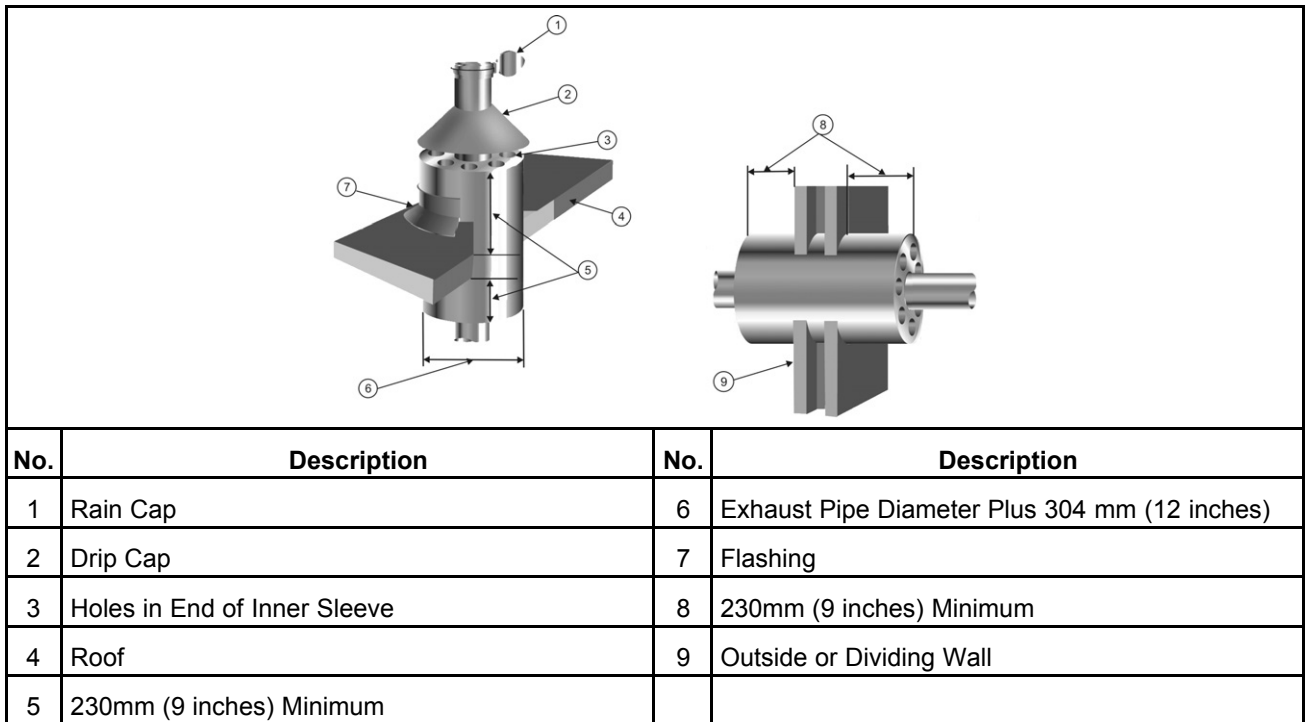
Use a section of flexible exhaust pipe between the engine and remainder of exhaust system. Support the exhaust system to prevent weight from being applied to engine exhaust outlet elbow/turbocharger connection.

The exhaust system design should meet local code requirements.

Avoid sharp bends by using sweeping, long radius elbows and provide adequate support for the silencer and tailpipe. Pitch a horizontal run of exhaust pipe downward (away from engine) to allow any moisture condensation to drain away from the engine. If an exhaust pipe must be turned upward, install a condensation trap at the point where the rise begins (see [Figure 6 on page 36](#)).

Shield or insulate exhaust lines if there is danger of personal contact. Allow at least 305 mm (12 inches) of clearance if the pipes pass close to a combustible wall or partition. Before installing insulation on exhaust system components, check the exhaust system for leaks while operating the generator set under full load and correct all leaks.

Refer to Application Manual T-030, "Liquid Cooled Generator Sets" for more detailed information about sizes of exhaust system pipes and fittings.



**FIGURE 5. EXHAUST THIMBLE**

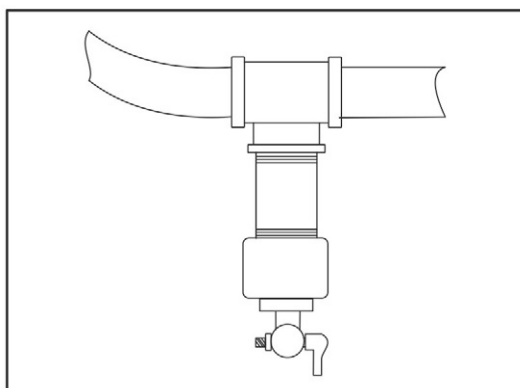
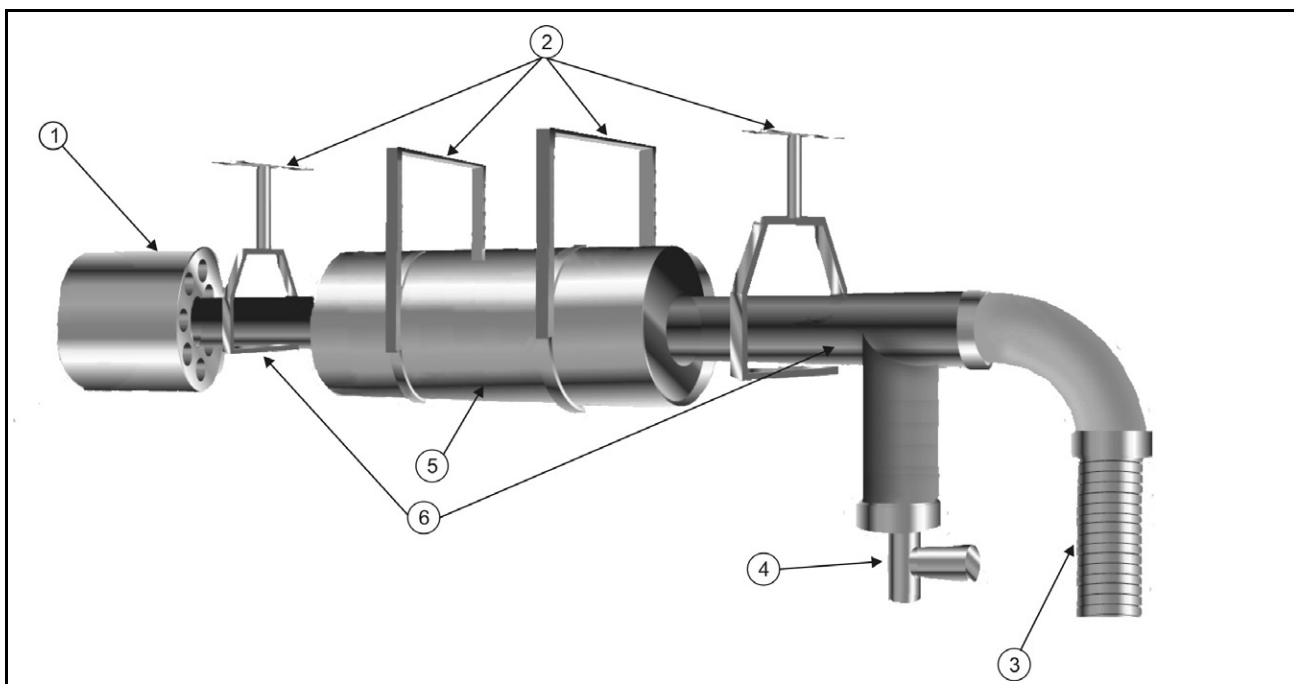


FIGURE 6. CONDENSATION TRAP



No.	Description	No.	Description
1	Exhaust Thimble	4	Water Trap with Drain
2	Support Brackets	5	Muffler
3	Flexible Bellows	6	Exhaust Pipe

FIGURE 7. TYPICAL SUSPENDED EXHAUST SYSTEM

### 7.3 Ventilation and Cooling

**⚠ WARNING**

**Toxic Gases**  
*Engine and radiator cooling air may carry carbon monoxide gas, which can cause asphyxiation and death.*  
*Pipe exhaust gas outside and away from windows, doors, or other inlets to buildings. Do not allow exhaust gas to accumulate in habitable areas.*

Generator sets create considerable heat that must be removed by proper ventilation.

Generator sets in factory-mounted housings for outdoor installation are designed for proper cooling and ventilation.

Indoor installations require careful design with respect to cooling and ventilation. In an indoor installation, all radiator cooling air must be discharged to the out-of-doors. Duct adapter kits are available.

Outdoor installations normally rely on natural air circulation but indoor installations need properly sized and positioned vents for required airflow.

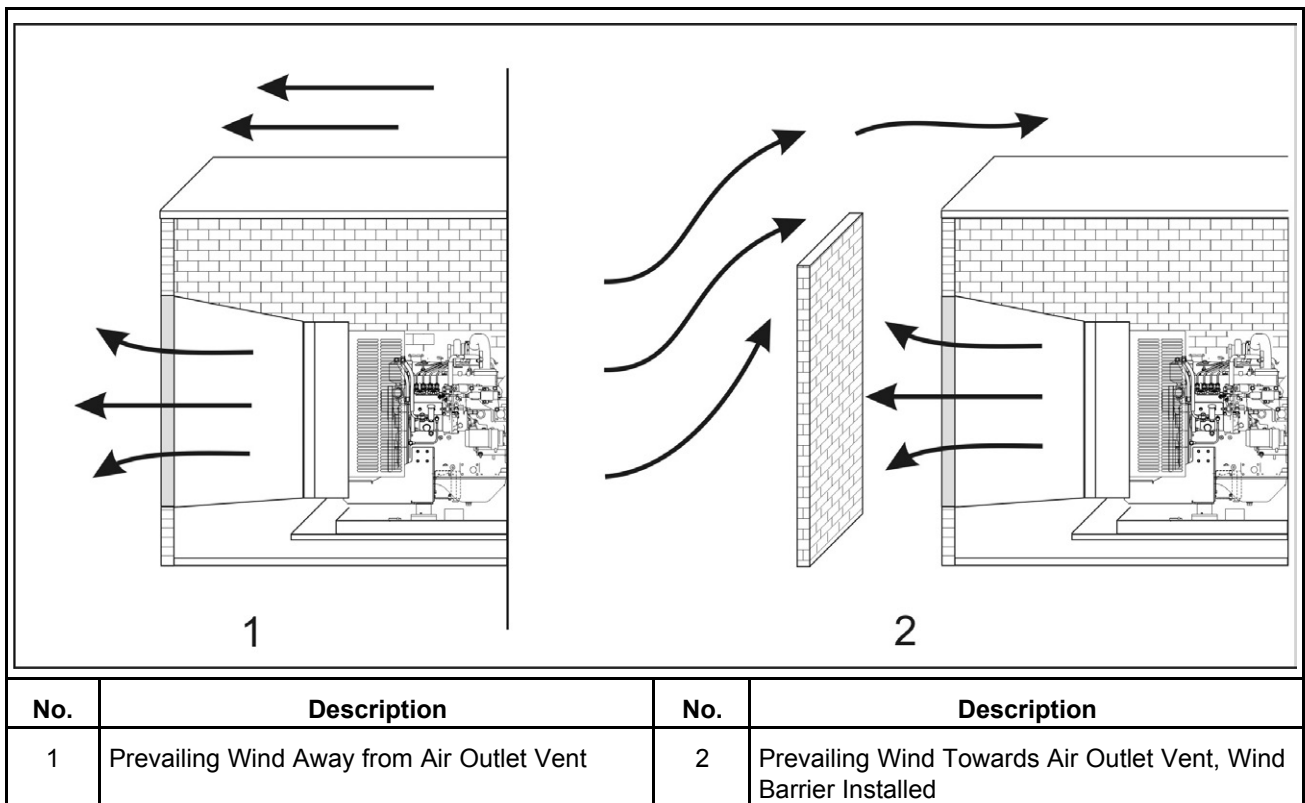
Transfer the stray voltage from the cooling system to the ground through the skid.

## 7.4 Vents and Ducts

1. For indoor installations, locate vents so incoming air passes through the immediate area of the installation before exhausting. Install the air outlet higher than the air inlet to allow for convection air movement.
2. Size the vents and ducts so they are large enough to allow the required flow rate of air.
3. Wind will restrict free airflow if it blows directly into the air outlet vent. Locate the outlet vent so the effects of wind are eliminated, or if the outlet vent cannot be located as mentioned, install a wind barrier. See [Figure 8](#).

**NOTICE**

The "free area" of ducts must be as large as the exposed area of the radiator. Refer to the generator set Specification Sheet for the airflow requirements and allowed airflow restriction.



**FIGURE 8. WIND BARRIER**

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## 7.5 Dampers

Dampers or louvers protect the generator set and equipment room from the outside environment. Their operation of opening and closing should be controlled by operation of the generator set.

In cold climates, the radiator exhaust air can be recirculated to modulate the ambient air temperature in the generator set room. This will help the generator set warm up faster, and help to keep fuel temperatures higher than the cloud point of the fuel. If recirculation dampers are used, they should be designed to 'fail closed', with the main exhaust dampers open, so that the generator set can continue to operate when required. Designers should be aware that the generator set room operating temperature will be very close to the outdoor temperature, and either not route water piping through the generator set room, or protect it from freezing.

## 7.6 Air Inlet and Outlet Openings

Louvers and screens over air inlet and outlet openings restrict air flow and vary widely in performance.

A louver assembly with narrow vanes, for example, tends to be more restrictive than one with wide vanes. The effective open area specified by the louver or screen manufacturer should be used.

Radiator set cooling air is drawn past the control end of the set by a pusher fan that blows air through the radiator. Locate the air inlet to the rear of the set. Make the inlet vent opening 1.5 times larger than the radiator area.

Locate the cooling air outlet directly in front of the radiator and as close as possible. The outlet opening must be at least as large as the radiator area. Length and shape of the air outlet duct should offer minimum restriction to airflow.

A flexible duct connector must be provided at the radiator to prevent exhaust air recirculation around the radiator, to take up generator set movement and vibration, and to prevent transmission of noise. Attach the flexible duct using screws and nuts so that the duct can be removed for maintenance purposes. Before installing the duct, remove the radiator core guard.

Enclosed generator sets are primarily designed to work in an open environment. When considering installing an enclosed generator set in an enclosed environment specific application factors must be considered (air flow, exhaust gas extraction, fuel supply and storage, etc.). For advice, contact the Application Engineering Group at Cummins.

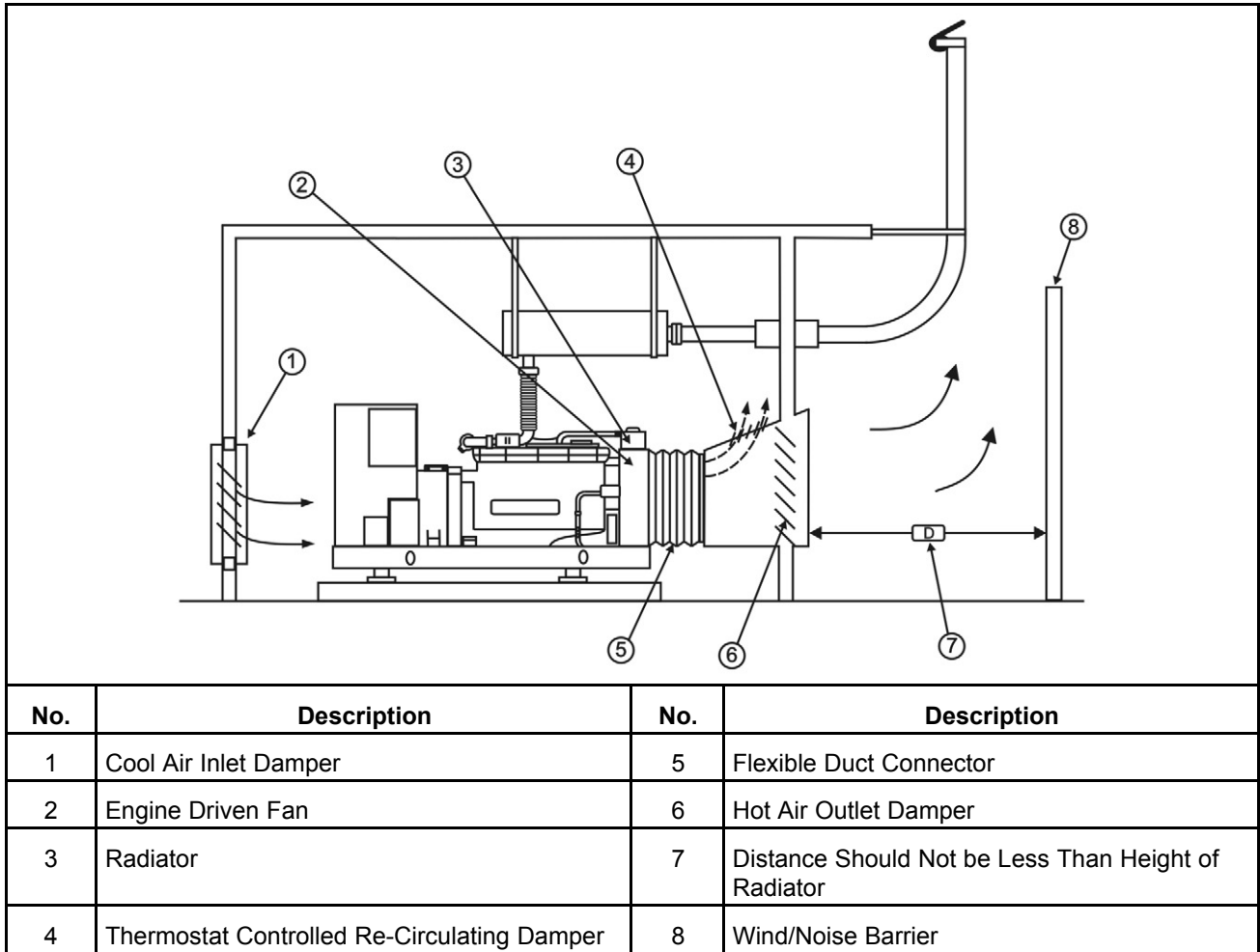


FIGURE 9. TYPICAL OPEN GENERATOR SET INSTALLATION

## 7.7 Air Cleaner Installation

Refer to Assembly Instructions particular to the generator set. See Related Literature in [Chapter 2 on page 11](#)

## 7.8 Remote Radiator Cooling

The remote radiator cooling substitutes a remote mounted radiator and an electrically driven fan in place of generator set mounted components. Removal of the radiator and the fan from the generator set reduces noise levels without forcing dependence on a continuous cooling water supply (necessary with heat exchanger cooling). The remote radiator installation must be completely protected against freezing.

Remote radiator plumbing will vary with installation. Follow recommendations given in Application Manual T-030. See product for friction head and static head limits.

### NOTICE

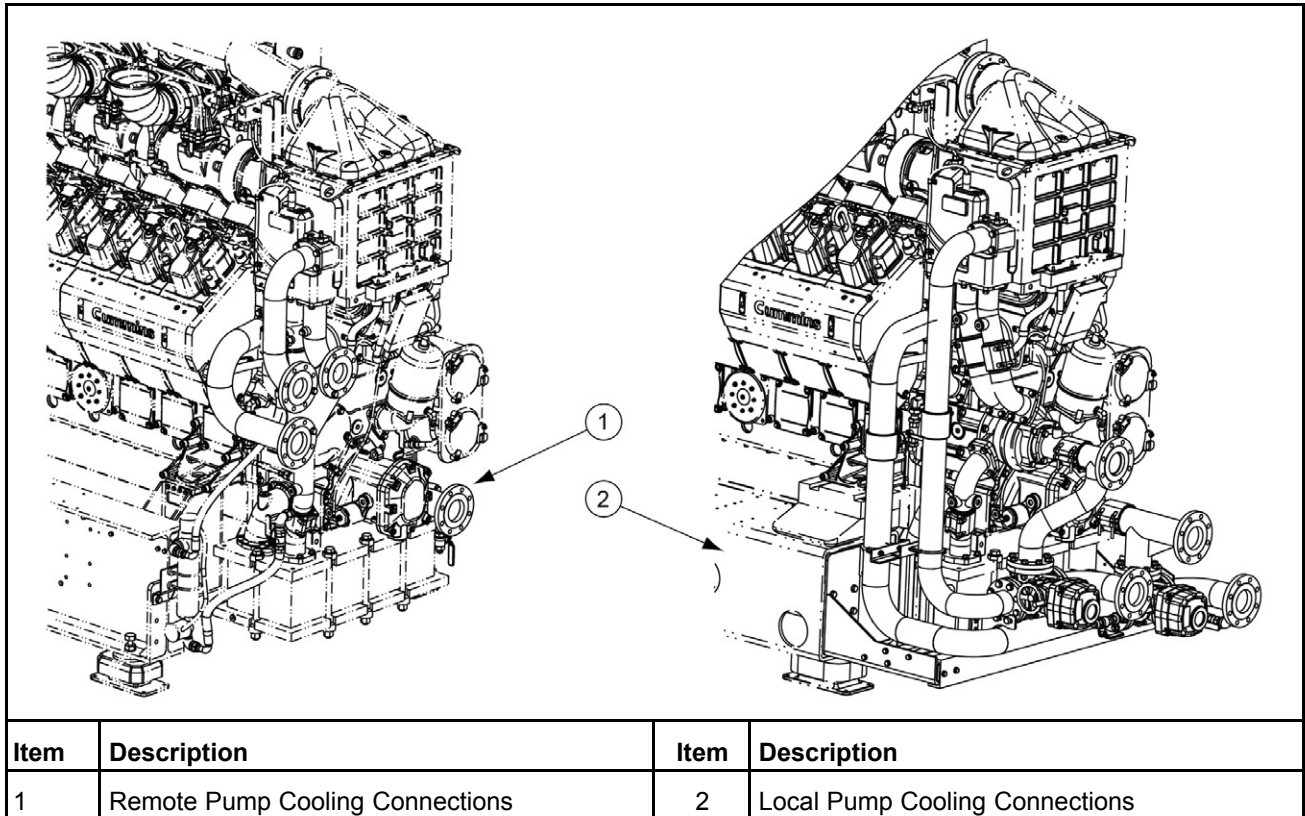
**Before filling the cooling system, make sure all hardware is tight. This includes hose clamps, cap screws, fittings, and connections. Use flexible coolant lines with heat exchanger or remote mounted radiator.**

**NOTICE**

All customer connections must be fully supported where they interface with flexible coolant flange. The support must be located within 100 mm from the flexible flange connection.

## 7.8.1 Remote Radiator Installation

Installations set up for remote radiator cooling may or may not include flanges.



**FIGURE 10. RADIATOR COOLING CONNECTIONS**

# 8 DC Control Wiring

## WARNING

### **Electric Shock Hazard**

*Voltages and currents present an electrical shock hazard that can cause severe burns or death.*

*Avoid contact with the voltage sense and bus sense leads; voltages of up to 600 VAC may still be present. These voltages could be live even when the generator set is switched off.*

## WARNING

### **Electric Shock Hazard**

*Voltages and currents present an electrical shock hazard that can cause severe burns or death.*

*Make sure all power is off before performing control wire installation.*

## WARNING

### **Electric Shock Hazard**

*Voltages and currents present an electrical shock hazard that can cause severe burns or death.*

*To prevent accidental electrocution, stand on a clean dry wooden platform or clean rubber insulating mat, make sure your clothing and shoes are dry, remove all jewelry, and use tools with insulated handles.*

The generator set control box contains connection points for remote control and monitor options.

## NOTICE

**Always run control circuit wiring in a separate metal conduit from the AC power cables to avoid inducing currents that could cause problems within the control.**

Use cable ties to keep control wiring away from sharp edges and AC power cables within the control housing.

## NOTICE

**Stranded copper wire must be used for all customer connections to the control panel. Solid copper wire may break due to the generator set vibration.**

Use flexible conduit for all wiring connections to the generator set.

## 8.1 Generator Interface Box (GIB) - PowerCommand 3.3 Control

## WARNING

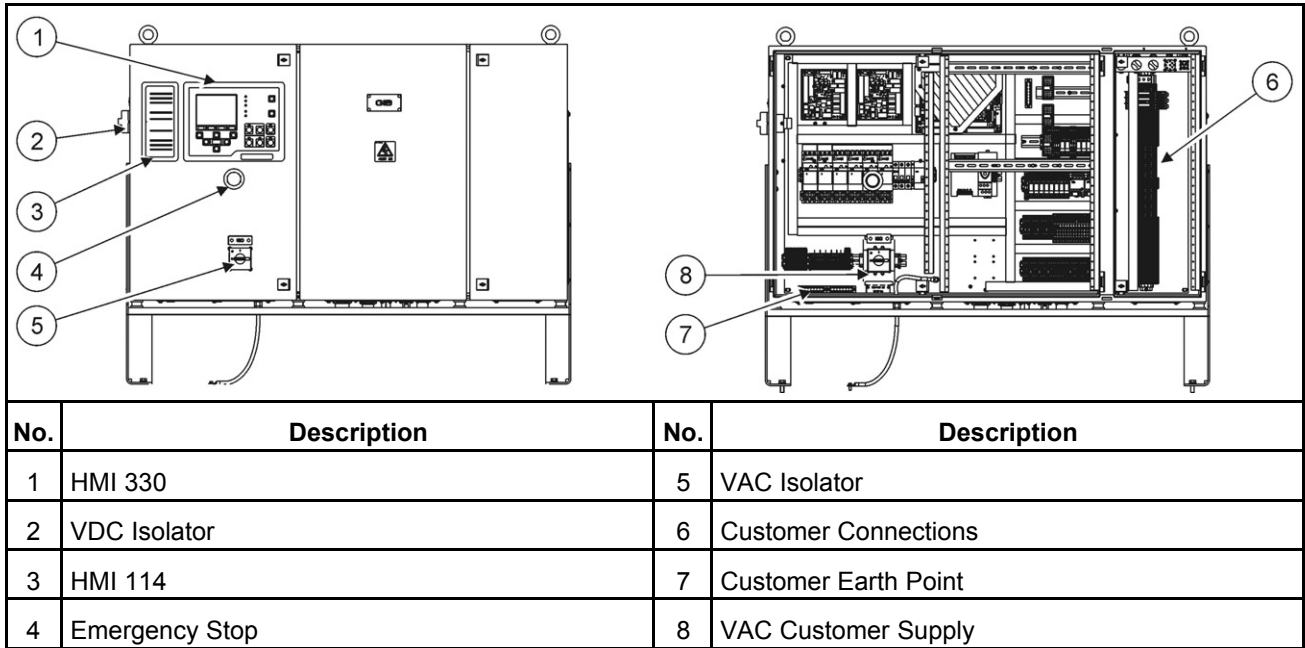
**Improper wiring can cause a fire or electrical hazard, resulting in severe personal injury or death and/or property and equipment damage.**

**NOTICE**

**Always run control circuit wiring in separate conduits from AC power cables to avoid inducing currents that could cause erratic control.**

**NOTICE**

**Use stranded copper wiring. Generator set movement and vibration can break solid copper wire.**



**FIGURE 11. GENERATOR INTERFACE BOX**

The Generator Interface Box (GIB) is a genset skid mounted module containing the Generator set Controller (PCC3300) and Human Machine Interface (HMI) and other customer interface features such as an emergency stop switch and pre-lube push-button.

Customer connections to the genset are located in the GIB. These connections include fault and alarm inputs, inputs and outputs for generator set and ancillary system control connections to the paralleling functions, and additional emergency stop inputs.

Auxiliary generator set equipment such as engine coolant heaters, alternator heaters and the oil priming pump(s) are pre-wired to the GIB. AC power must be supplied by the customer to the GIB. The generator set does not monitor the customer VAC supply. Be sure to validate customer VAC line assignments and voltage levels with a DVOM after connection to the VAC Isolator. Failure to validate may result in damage to the generator set's AC auxiliaries and / or AC auxiliary components operating improperly.

Two customer AC power supplies are required for 60Hz machines:

- 480VAC, 3 Phase, capable of 25 continuous amps
- 120VAC, 1 Phase, capable of 25 continuous amps

The maximum cable size at termination for both circuits is 6 AWG (16 mm<sup>2</sup>) with a maximum circuit breaker size of 50 amps.

One customer AC power supply is required for 50Hz machines:

- 380 to 440VAC, 3 Phase, capable of 42 continuous amps

The maximum cable size at termination for both circuits is 6 AWG (16 mm<sup>2</sup>) with a maximum circuit breaker size of 50 amps.

To accommodate the motion of the generator set during operation, use flexible conduit and stranded conductors for all wiring that is routed to and terminates in the GIB.

Specific customer power supply requirements are indicated on the wiring diagrams. See [Appendix E on page 125](#).

## 8.2 Guidelines for Customer Connections to the Control System

- Torque terminals to 0.5 Nm (4.4 in-lb)
- Wire type: Use 60 C rated minimum copper wire
- Terminal screws (if fitted) are slotted 0.6 mm
- Use flat bladed screwdriver with 2.5 mm blade
- Strip wire length to 6.0 mm (0.236 in) for screw type terminals and 10 mm (0.75 in) for push type terminals

### 8.2.1 Digital Connections

Connection points, other than relayed outputs and network are considered digital connections. The type/gauge wire to use for these connections are:

- Less than 305 m (1000 ft), use 0.5 mm<sup>2</sup> (20 gauge) stranded copper wire.
- 305 m to 610 m (1000 ft to 2000 ft), use 0.75 mm<sup>2</sup> (18 gauge) stranded copper wire.

### 8.2.2 Relay Connections

Due to the wide variety of devices that can be attached to the relay outputs, the electrical contractor must determine the gauge of the stranded copper wire that is used.

## 8.3 PowerCommand 3.3 Customer Connections

Refer to [Appendix A on page 69](#) for information on customer connections.

### 8.3.1 Configurable Outputs

Each output has normally-open contacts. The contacts can be used to control small devices, indicator lamps, or relays.

The contacts are programmed to energize by entering a code number for the desired event.

<b>NOTICE</b>
<i>Using the InPower service tool or accessing the Setup submenus is required to modify the customer outputs. Contact an authorized distributor for assistance.</i>

#### 8.3.1.1 Contact Ratings for Configurable Outputs

TABLE 4. CONTACT RATINGS FOR CONFIGURABLE OUTPUTS

Description	Value
Maximum Voltage	30 VDC
Maximum Current	3.5 Amps

## 8.3.2 Remote Start

### WARNING

#### *Automated Machinery*

***Accidental or remote starting of the generator set can cause severe personal injury or death. Make sure that the generator set cannot be started accidentally or remotely before starting work on the generator.***

### NOTICE

**Remote start terminals should only be used for a remote application. Remote start terminals are not to be shorted if the remote start function is not intended to be used.**

When the control is in Auto/Remote mode, grounding this input initiates the engine cranking and start sequence. This circuit must be opened to permit resetting a shutdown condition with the Reset input. (The remote stop is actually the removal of the remote start signal to the control.)

## 8.3.3 Configurable Inputs

Grounding any one of these inputs activates the corresponding warning or shutdown sequence.

External sensing equipment must be connected to the designated digital input.

The nature of the fault is an optional customer selection. Example inputs: Low Coolant Level, Low Fuel Level, Ground Fault, etc.

### NOTICE

***The InPower service tool or access to the Setup submenus is required to modify the customer fault inputs. Contact your authorized distributor for assistance.***

## 8.3.4 Remote Emergency Stop

Opening this input causes an immediate shutdown. Emergency stop must be reset at the remote panel, then at the front panel.

# 9 AC Electrical Connections

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## WARNING

### **Arc Flash and Shock Hazard**

***Voltages and currents present an electrical shock hazard that can cause severe burns or death.***

***Make sure that only service personnel who are trained and experienced perform electrical and mechanical component installations. The AC sensing harness and other cabling will become energized when the generator set is in operation.***

## WARNING

### **Hazardous Voltage**

***Contact with high voltages can cause severe electrical shock, burns, or death.***

***Make sure that only personnel who are trained and qualified to work on this equipment are allowed to operate the generator set and perform maintenance on it.***

## WARNING

### **Automated Machinery**

***Accidental or remote starting of the generator set can cause severe personal injury or death.***

***Isolate all auxiliary supplies and use an insulated wrench to disconnect the starting battery cables (negative [-] first).***

## WARNING

### **Combustible Gases**

***Ignition of battery gases is a fire and explosion hazard which can cause severe personal injury or death.***

***Do not smoke, or switch the trouble light ON or OFF near a battery. Touch a grounded metal surface first before touching batteries to discharge static electricity. Stop the generator set and disconnect the battery charger before disconnecting battery cables. Using an insulated wrench, disconnect the negative (-) cable first and reconnect it last.***

## WARNING

### **Electric Shock Hazard**

***Voltages and currents present an electrical shock hazard that can cause severe burns or death.***

***Avoid contact with the voltage sense and bus sense leads; voltages of up to 600 VAC may still be present. These voltages could be live even when the generator set is switched off.***

This section provides the procedure that is used to connect the AC electrical system of the generator set.

Before making any AC electrical connections, make certain the generator set cannot be accidentally started. Make sure the Operator Panel is in OFF mode. Turn off or remove AC power from the battery charger and then remove the negative (-) battery cable from the set starting battery using an insulated wrench.

If the generator set is being installed in an application where it may parallel with other generators or utility sources, the generator set control system may be energized from an external source. Lock out tag out any external source that can provide AC power to the generator set.

**NOTICE**

**Ventilate the battery area before working on or near battery. Wear goggles. Stop the generator set and disconnect the battery charger before disconnecting battery cables. Disconnect negative (-) cable first and reconnect last using an insulated wrench.**

Connecting the generator set AC electrical system involves:

- Installation of transfer switch
- Installation or verification of paralleling switchboard
- Generator output voltage selection
- Load cable connection
- Standard and optional AC equipment connections (e.g., control box heater, coolant heater, etc.).

For all output connections, including when field connection is made at the alternator terminations, installation should be completed with conductors of appropriate size, type, and rating specified in local codes (or UL). For UL compliant installations, use conductor size, X AWG, 75 °C or 90 °C copper wire, 600V. Where X AWG is the conductor size specified by the local electrical code for 75 °C at the rated output current for the generator set. For non-UL compliant installations, use cable sizes, composition, and rating per local codes. Strain relief, bending space, raceway, and other installation features should be completed in compliance with local code.

Local regulations often require that wiring connections be made by a licensed electrician, and that the installation be inspected and approved before operation. All connections, wire sizes, materials used, etc. must conform to the requirements of electrical codes in effect at the installation site.

Before starting the generator set, check to make sure that all electrical connections are secure, and that all wiring is complete. Replace and secure any access panels that have been removed during installation. Check that the load cables from the generator set are properly connected.

**NOTICE**

**Backfeed to a utility system can cause electrocution or property damage. Do not connect to any building electrical system except through an approved device and after the building main switch is opened.**

## 9.1 Transfer Switch

A transfer switch must be used for switching the load from the normal power source to the generator set (see [Figure 12](#)). Follow the installation instructions provided with the transfer switch when connecting the load and control wiring.

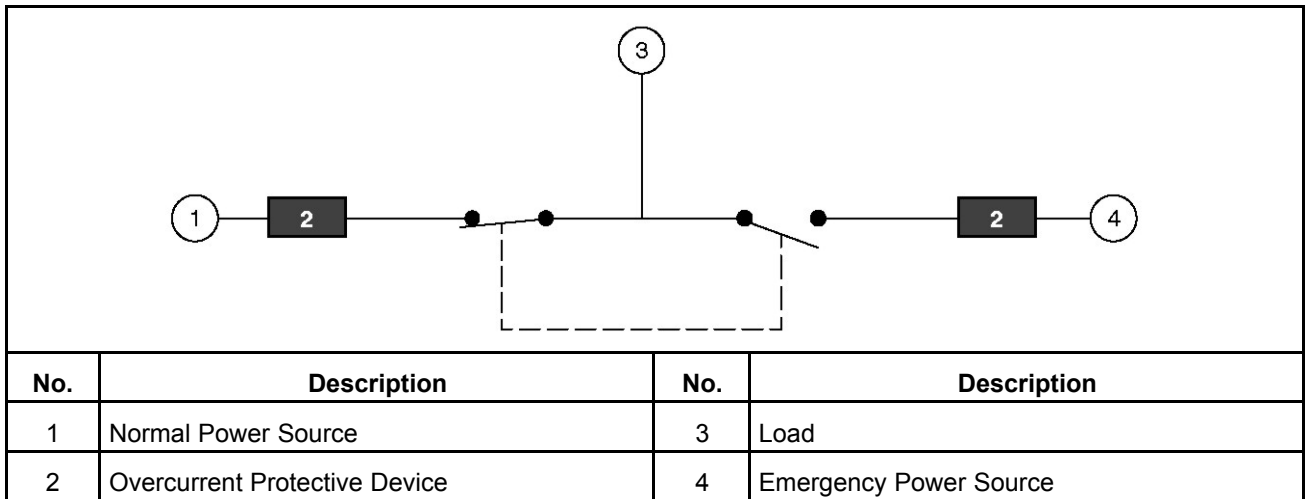


FIGURE 12. TYPICAL LOAD TRANSFER FUNCTION

## 9.2 Heaters

Coolant, alternator, and the (GIB) control panel heaters are installed and connected when the generator set is manufactured. They are switched by the control system to be on when the generating set is not running.

## 9.3 Load Connections

<b>NOTICE</b>
<b>Flexible conduit and stranded conductors must be used for connections to take up movement of the generator set.</b>

All loads are connected to the alternator by bolting stranded load wires to the appropriate terminals on the alternator reconnection terminal block or circuit breaker lugs. The terminals are marked U, V, W, and N to indicate the line and neutral connections. (Reference: U, V, and W correspond with L1, L2 and L3; and N with L0 respectively). See [Appendix D on page 95](#) for details about the following:

- Load connections
- Conduit
- Cable Size

### 9.3.1 Generator Set Load Cable Installation

To ensure optimum performance of the generator set, load cables passing through cable gland plates must be adequately protected and secured.

### 9.3.2 Cabling through Non-Ferrous Gland Plates

Single core load cables must be secured using non-ferrous cable glands.

### 9.3.3 Cabling through Ferrous Gland Plates

Single core load cables must pass through the same hole, or slotted cable gland holes as illustrated (see [Figure 13](#)). Cable glands must be made from non-ferrous material.

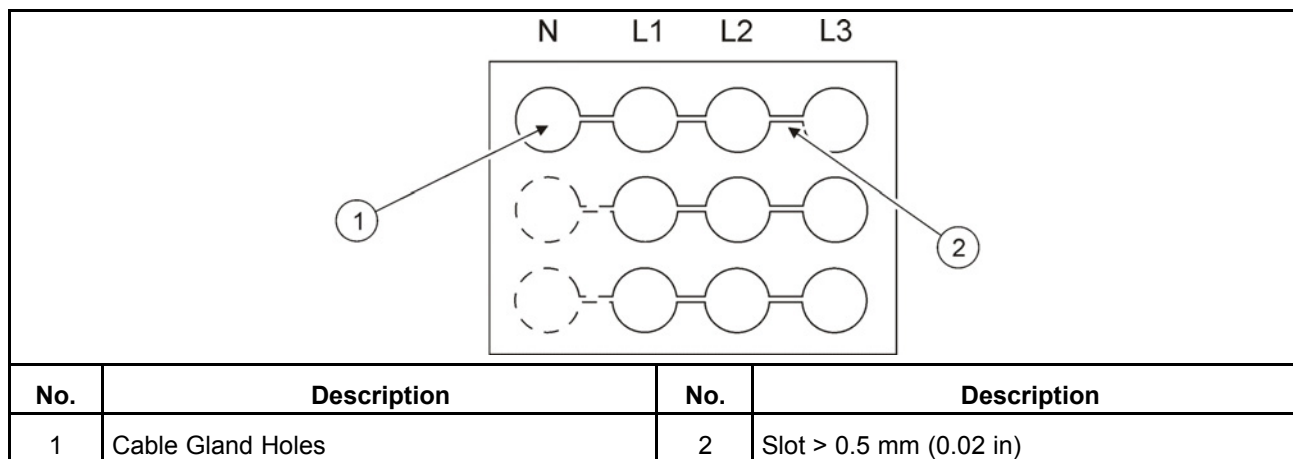


FIGURE 13. FERROUS GLAND PLATES

### 9.3.4 Distribution Cables

Single core power distribution cables should be grouped in a trefoil formation as illustrated (See [Figure 14](#)). (Trefoil grouping provides optimum cable loading and reduces electrical emissions). To minimize cable temperature rise and reduce cable de-rate factors, cable groups where possible, should be spaced to provide ventilation. Cable groups must be secured with non-ferrous material.

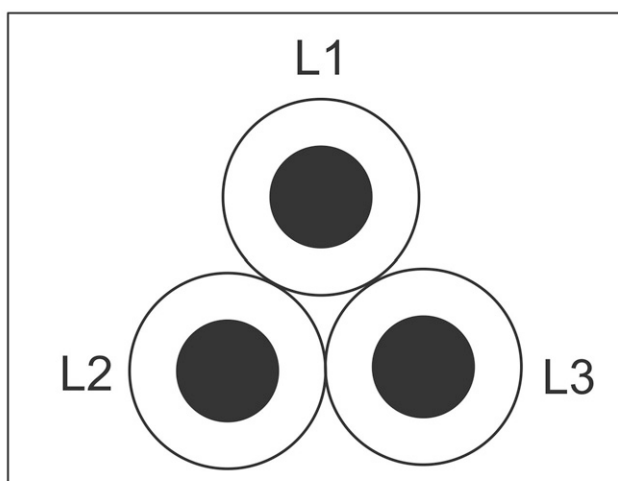


FIGURE 14. TREFOIL FORMATION

## 9.4 Load Balancing

When connecting loads to the generator set, balance the loads so that the current flow from each line terminal (L1, L2, and L3) is about the same. This is especially important if both single phase and three phase loads are connected. Any combination of single phase and three phase loading can be used as long as each line current is about the same, within 10 percent of median value and no line current exceeds the name plate rating of the generator. Check the current flow from each line after connections by observing the Operator Panel ammeter.

## 9.5 Battery Commissioning

<b>NOTICE</b>
<b>Commissioning is to be undertaken by suitably trained and qualified service personnel only.</b>


Lead-acid batteries supplied in dry-charged form are commissioned as follows:


- Pre-Commissioning Procedure
- Filling the Battery with Electrolyte
- Charging
- Fitting the Battery to the Generator Set

### 9.5.1 Safety Precautions

Servicing of batteries are to be performed or supervised by personnel knowledgeable of batteries and the required precautions. Keep unauthorized personnel away from batteries.

#### 9.5.1.1 General Precautions

 <b>WARNING</b>
<p><b>Combustible Gases</b>  <i>Ignition of battery gases is a fire and explosion hazard which can cause severe personal injury or death.</i>  <i>Laying tools or metal objects across the battery can cause arcing. Never lay tools or metal objects across the top of the battery.</i></p>

 <b>CAUTION</b>
<p><b>Electrical Shock</b>  <i>A battery presents a risk of electrical shock and high short circuit current which can cause minor or moderate injury.</i>  <i>Observe the following precautions when working on batteries.</i></p>

- Use proper PPE. Remove jewelry such as watches, rings, or other metal objects. Remove any conductive items from pockets. These items can fall into equipment and result in a short circuit, which can cause shock or burning. Refer to local standards for PPE details (in the U.S: see NFPA 70).
- Keep batteries upright to prevent spillage. Electrolyte is a dilute sulphuric acid that is harmful to the skin and eyes.
- Use tools with insulated handles to prevent the risk of electric shock.

#### 9.5.1.2 Fire Hazard

<b>NOTICE</b>
<p><b>During the charging of a battery, explosive gases are given off. Keep the battery area well ventilated and away from naked flames and sparks. Do not smoke.</b></p>

- Before disconnecting a battery, isolate the utility powered battery charger (where fitted).
- To disconnect the battery, use an insulated wrench to disconnect the negative cable first.
- To connect the battery, use an insulated wrench to connect the negative cable last.

### 9.5.1.3 Fluid Hazard

**⚠ WARNING****Toxic Hazard**

*Contact with electrolyte can cause severe personal injury.*

*Wear appropriate PPE when handling electrolyte: acid-proof protective apron, goggles, rubber gloves and boots. If electrolyte is splashed on the skin or in the eyes, flush the affected areas immediately with water and seek medical attention.*

**⚠ WARNING****Hazardous Liquid**

*Uncontrolled chemical reactions can cause severe chemical burns or death.*

*Never add undiluted sulfuric acid to a battery.*

### 9.5.2 Pre-Commissioning Procedure

1. Check for any damage to the battery case or terminals, and make sure that the battery is clean and dry.
2. Remove the vent plugs and break any seals (if present), taking care not to damage the plates or separators. The broken seal will fall into the bottom of the chamber and do no harm.

### 9.5.3 Filling the Battery with Electrolyte

1. Fill each cell of the battery with dilute sulphuric acid (electrolyte) of the correct specific gravity (SG) according to the levels on the battery label.
2. Filling must be completed in one step.
3. Allow the battery to soak for ten to fifteen minutes. If the electrolyte level has fallen, it should be restored by adding electrolyte of the correct SG to the levels given on the battery label.
4. After filling, place the battery on a commissioning charge within one hour. Charging must take place before any load is placed on the battery.

**NOTICE**

**Failure to give a commissioning charge may impair the charge capacity and life of the battery.**

### 9.5.4 Charging - Commissioning

1. Charge the battery for a minimum of four hours to ensure the acid is sufficiently mixed within the battery. If the battery has been in storage, check the manufacturer's instructions; the charging period may need extending.
2. When the generator set is running, check the charge alternator output using an induction ammeter.

### 9.5.5 Connecting the Battery to the Generator Set

**NOTICE**

**A battery must not be fitted to a generator set without charge if the specific charge of the electrolyte has fallen below 1.240 during storage.**

1. Secure the battery. Battery hold-down bolts must be tight, but not over-tight.

2. Smear the terminals with petroleum jelly, if necessary.
3. Fit the vents firmly in position and ensure that the battery is clean and dry.
4. Verify correct polarity when connecting the battery to the set. Even momentary incorrect connection can cause damage to the electrical system.
5. Use an insulated wrench connect the positive generator cable first, followed by the negative cable. Terminal connections must be tight, but not over-tight.

## 9.5.6 Electrolyte - Specific Gravity and Temperature

Maintenance-free batteries are sealed and do not require the addition of electrolyte. Some manufacturers of maintenance-free batteries provide an 'eye' or other visible means of telling when the battery is discharged or approaching the end of its useful life.

### 9.5.6.1 Checking Electrolyte Level

#### **NOTICE**

**Never add tap or well water and never allow the battery electrolyte to drop below the top of the plates, otherwise damage will occur.**

#### **NOTICE**

**Do not add water in freezing weather unless the engine will run long enough (2 to 3 hours) to make sure that water and electrolyte are thoroughly mixed.**

Check the level of the electrolyte (acid and water solution) in the batteries at least every month or 100 hours of operation, whichever occurs first. Maintain the electrolyte to the levels indicated on the battery label. Add distilled water only and recharge. Replace the vent plugs once filling is completed.

If a cell level is low, check the case for leaks.

Keep the battery case clean and dry. An accumulation of moisture will lead to a more rapid discharge and battery failure.

### 9.5.6.2 Checking Specific Gravity Using a Hydrometer

Use a hydrometer to check the specific gravity (SG) of the electrolyte in each battery cell.

Hold the hydrometer vertically and take the reading.

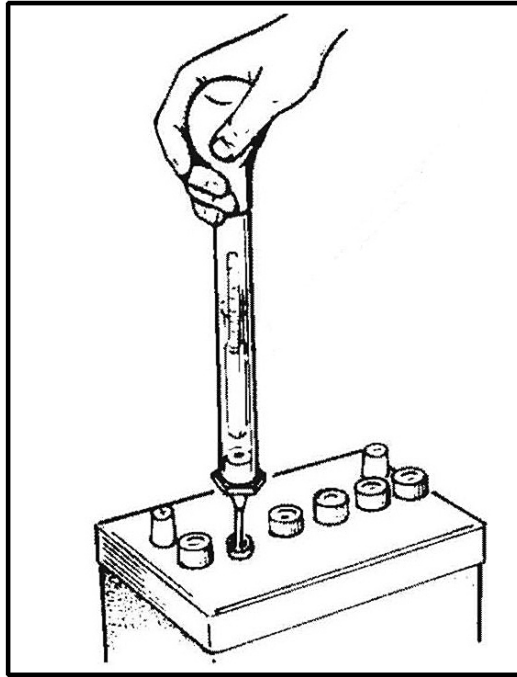


FIGURE 15. CHECKING SPECIFIC GRAVITY

### 9.5.6.3 Checking Specific Gravity Using an Acid Refractometer

Follow the instructions included with the refractometer. Obtain a small drop of liquid and place it under the clear plastic cover to check the specific gravity (SG) of the electrolyte in each battery cell.

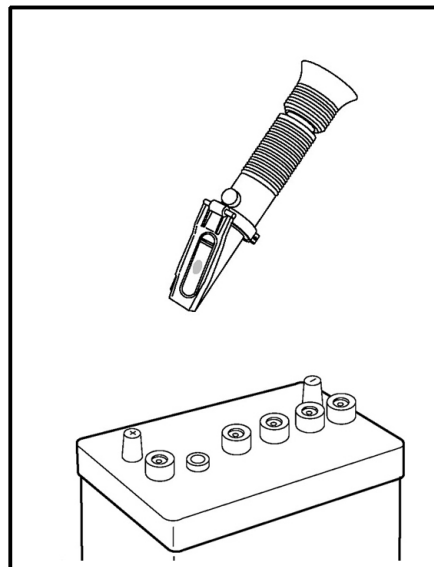


FIGURE 16. TYPICAL BATTERY ACID REFRACTOMETER

### 9.5.6.4 Specific Gravity Values for Batteries

A fully charged battery will have a corrected specific gravity (SG) of 1.260 at 25 °C (77 °F). Hold the hydrometer vertically and take the reading. Charge the battery if the reading is below 1.215. The table below shows the specific gravity of electrolyte, corrected to 25 °C (77 °F).

**TABLE 5. SPECIFIC GRAVITY**

Temperature	For Filling New Cells	At End of Chrg
Ambient temperature normally below 32 °C (90 °F)	1.270	1.270–1.290
Ambient temperature frequently above 32 °C (90 °F)	1.240	1.240–1.260
Maximum permissible temperature of electrolyte during charge	45 °C (113 °F)	45 °C (113 °F)

Correct the specific gravity reading for other temperatures by subtracting seven gravity points (0.007) for every 10 °C (18 °F) when the electrolyte temperature is above 27 °C (80 °F). Apply the correction formula as follows:

- For every 10 °C (18 °F) above 25 °C (77 °F), subtract 0.007 (7 points)
- For every 10 °C (18 °F) below 25 °C (77 °F), add 0.007 (7 points)

For example: if the specific gravity at 25 °C (77 °F) is 1.260, then the specific gravity at 15 °C (59 °F) is 1.267.

### 9.5.7 Electrolyte Levels and Bench Charging Rates

The following table shows the electrolyte level expected at a range of bench charging rates.

**TABLE 6. ELECTROLYTE LEVELS**

Battery Type	Electrolyte Level above Plates (mm)	Bench Charging Rate (A/hour)		Battery Type	Electrolyte Level above Plates (mm)	Bench Charging Rate (A/hour)
1	8	3		325	8	20
7	8	3.5		327	8	11
15	8	4		328	8	20
16	8	4		329	8	20
17	8	9		332	8	25
35	8	3.5		333	8	11
36	8	3.5		386	8	6
37	8	4		404	8	7
38	8	4		414	8	20
46	8	6		415	8	20
47	8	3		471	8	15
48	8	4		484	8	25
49	8	4		501	8	9
63	8	4		511	8	10
65	8	5		521	8	12
67	8	7		531	8	13
68	8	7		541	8	15
69	8	7		543	8	15
70	8	7		591	8	14
71	8	6		602	8	8

Battery Type	Electrolyte Level above Plates (mm)	Bench Charging Rate (A/hour)		Battery Type	Electrolyte Level above Plates (mm)	Bench Charging Rate (A/hour)
72	8	8		612	8	9
73	8	6		635	16	12
74	8	7		643	16	9
75	8	7		644	16	12
77	8	4		645	16	9
78	12	5		646	16	8
83	8	3.5		647	16	12
84	8	4		648	16	12
85	8	5		649	16	9
90	12	7		655	16	12
91	8	6		656	16	12
92	12	5		663	16	9
93	8	6		664	16	9
97	8	6		665	16	9
154	4	3.5		678	8	6
175	8	7		679	16	9
191	6	6		701	8	16
221	8	8		702	8	20
222	8	12		703	8	25
279	8	6		711	8	16
312	8	14		712	8	20
313	8	14		713	8	25
315	8	14		721	8	15
319	8	14		722	8	20
320	8	14		732	8	15
321	8	14		733	8	20
322	8	14		769	8	45
324	8	20				

**NOTICE**

If not listed in the above table use the bench rate given in the catalog, or charge at a current equal to 10% of the nominal capacity at the twenty hour rate (Amperes/hour), or 5% of the reserve capacity in minutes.

**NOTICE**

Batteries of the 800 series should be prepared in accordance with the instructions supplied with each battery.

## 9.6 Battery Charger

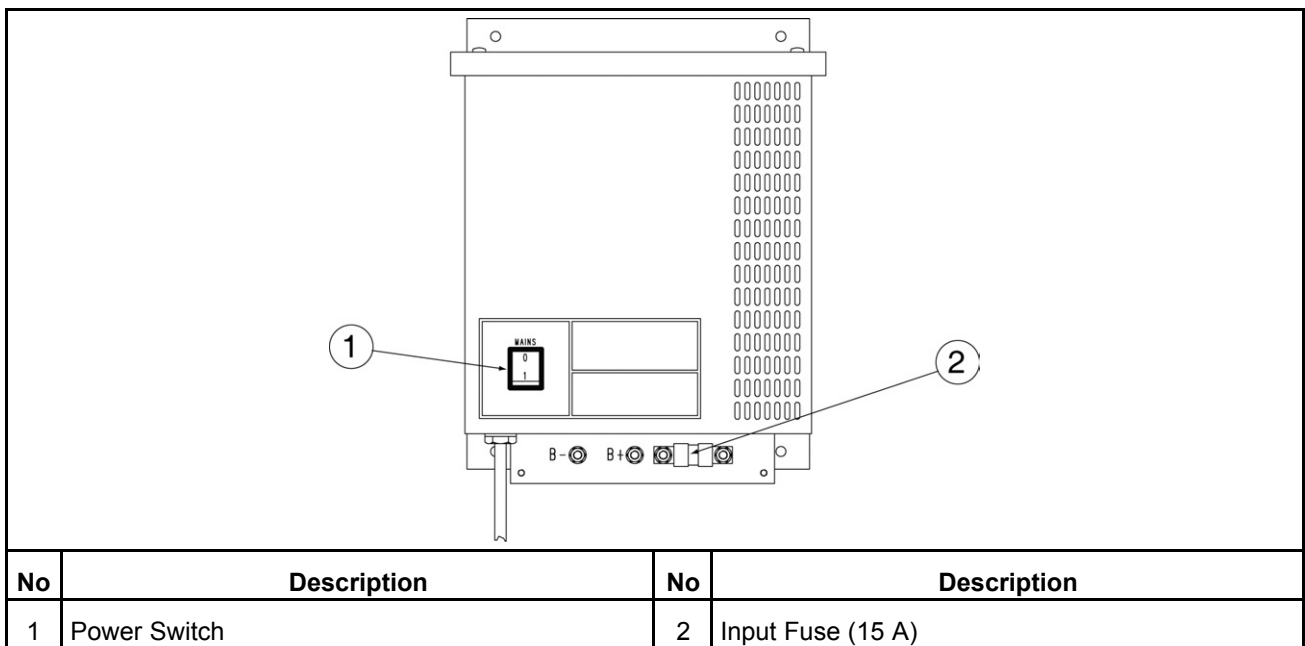
### 9.6.1 Mains (Utility) Powered Battery Charger - Wall-Mounted (24 VDC - 30 Amp)

The 30 Amp Battery Charger is of the constant voltage, current limited type, designed for the charging of vented or sealed lead acid. They are also capable of supplying a standing load whilst simultaneously maintaining the battery to its fully charged state. Designed to be left in circuit during cranking and to operate in parallel with the charge alternator mounted on the engine.

**Features:**

- Boost charge facility
- Charge fail facility
- Short circuit protected
- Reverse power protected
- Constant voltage
- Current limited
- RF suppression

The chargers are supplied loose for wall mounting.



**FIGURE 17. 30 AMP WALL MOUNTED CHARGER**

#### 9.6.1.1 Boost

As the charge cycle commences, current is limited to the maximum allowable by the electronic control circuitry. As the battery becomes increasingly charged, the current demanded by the battery reduces proportionally, until the battery terminal float voltage equals the reference voltage of the charger at which point the charger maintains a trickle charge only, which is insufficient to either overcharge the battery or cause "gassing" effects.

A Boost Charge facility enables the constant voltage of the charger to be increased, allowing charge time to be reduced and periodic equalization of battery cells to take place.

Boost charge commences on the operation of the Boost switch located on the front panel of the unit.

### 9.6.1.2 Specifications - 30 Amp

Description	Specifications
Supply Voltage:	220 to 250 Volts, 50-60 Hz AC only. Others available on request
Output:	30 Amp
Boost:	Increase of 0.35 V per cell on connection of the "BOOST" terminals circuitry
Temperature Range:	0 °C to 40 °C (32 °F to 104 °F) at full rated output power.
Protections:	Input Fuse 32 mm x 6.5 mm (1¼ x ¼")
Mechanical Details:	30 A Charger: 323 x 263 x 167 mm (12¾ x 10½ x 6½") (h x w x d)

## 9.7 Grounding

### WARNING

#### **Electric Shock Hazard**

***Voltages and currents present an electrical shock hazard that can cause severe burns or death.***

***Make sure that only service personnel who are trained and experienced perform electrical and mechanical component installations. Bonding and grounding must be done properly. All metallic parts that could become energized under abnormal conditions must be properly grounded.***

The following is a brief description of system and equipment grounding of permanently installed AC generators within a facility wiring system.

### NOTICE

***It is important to follow the requirements of the local electrical code.***

**Figure 18**, **Figure 19** and **Figure 20** illustrate typical system grounding for a 2-pole, 3-pole, and 4-pole Automatic Transfer Switch (ATS). In the 2-pole and 3-pole ATS, note that the generator neutral is connected to the ATS and is NOT bonded to ground at the generator. In the 4-pole ATS system, a grounding electrode conductor and a bonding jumper are used to connect the generator neutral to ground.

Make sure the generator set is grounded to earth in one location only. On generator sets without a circuit breaker, ground to the point indicated on the top of the generator. On generator sets with circuit breakers, use the ground lug provided in the circuit breaker box.

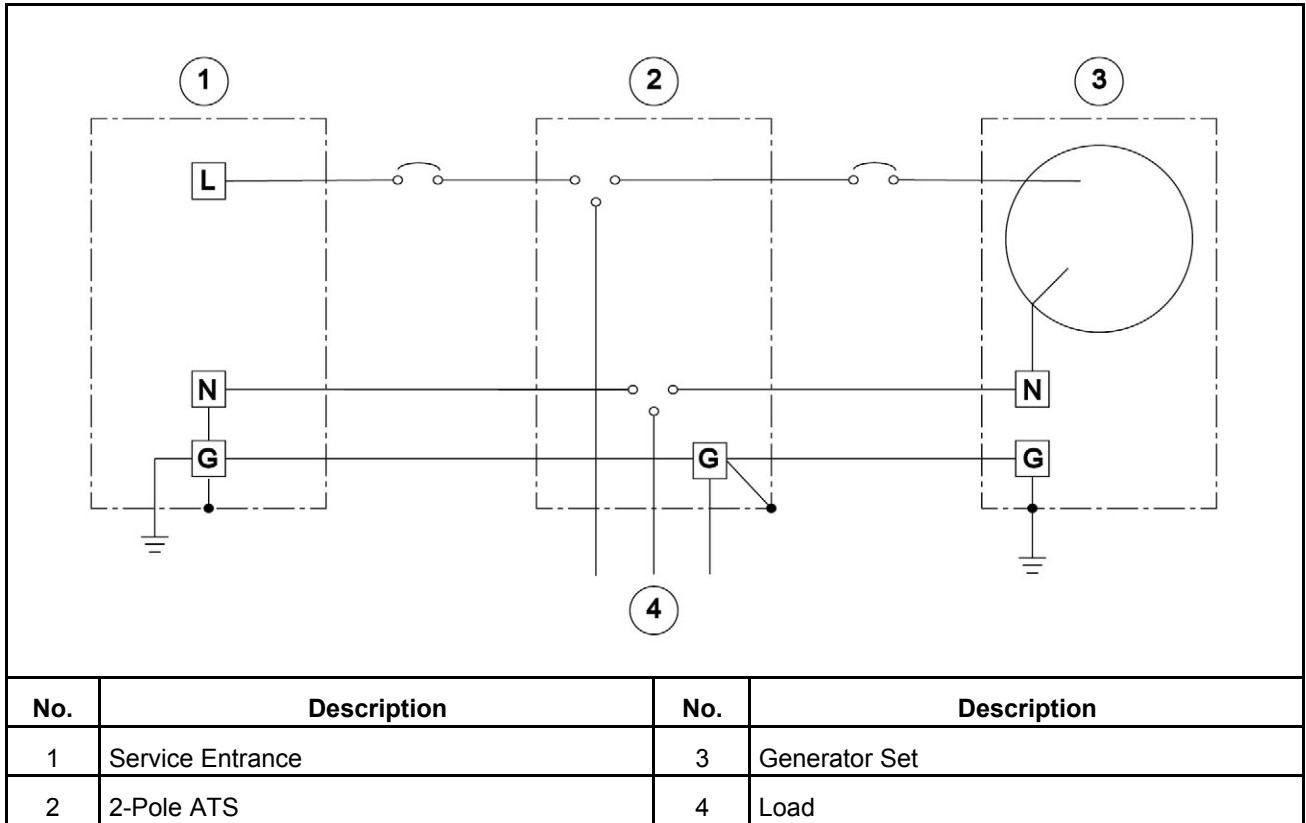


FIGURE 18. TYPICAL SYSTEM - ONE-PHASE, THREE WIRE UTILITY, TWO-POLE ATS

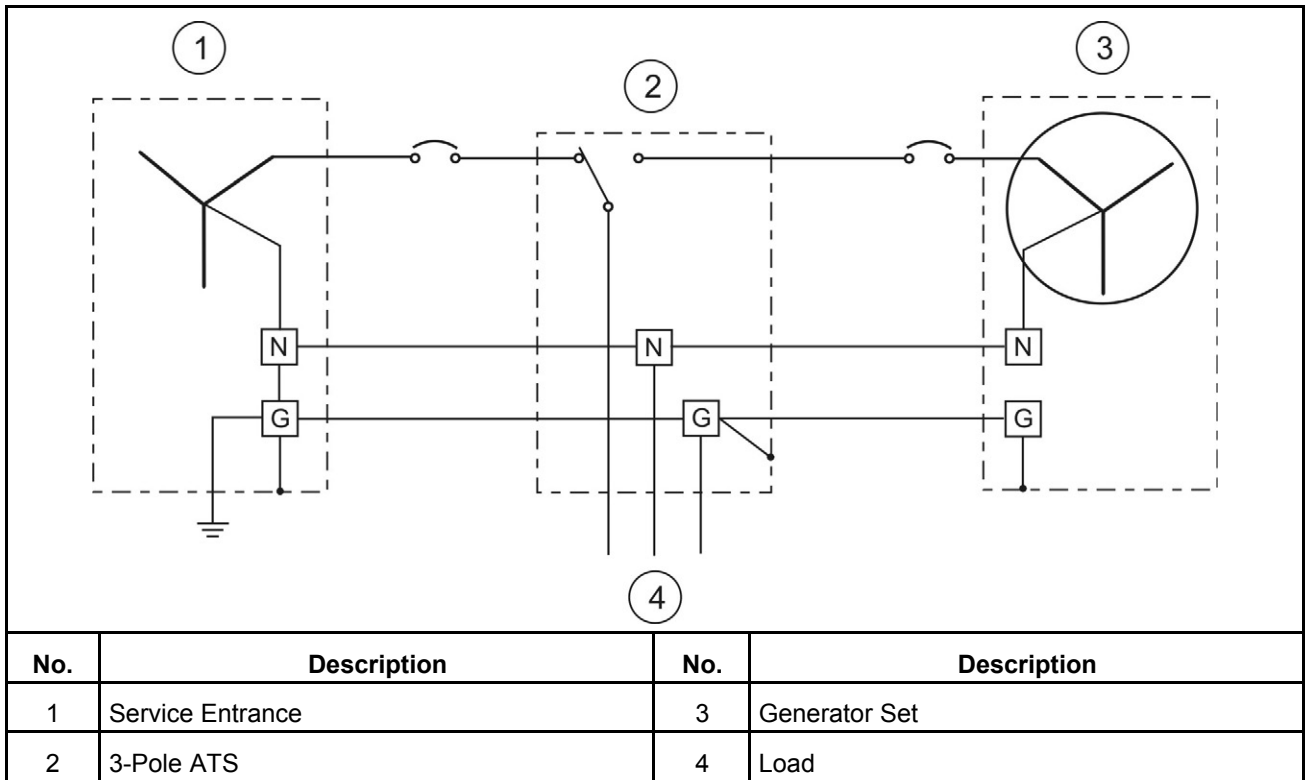
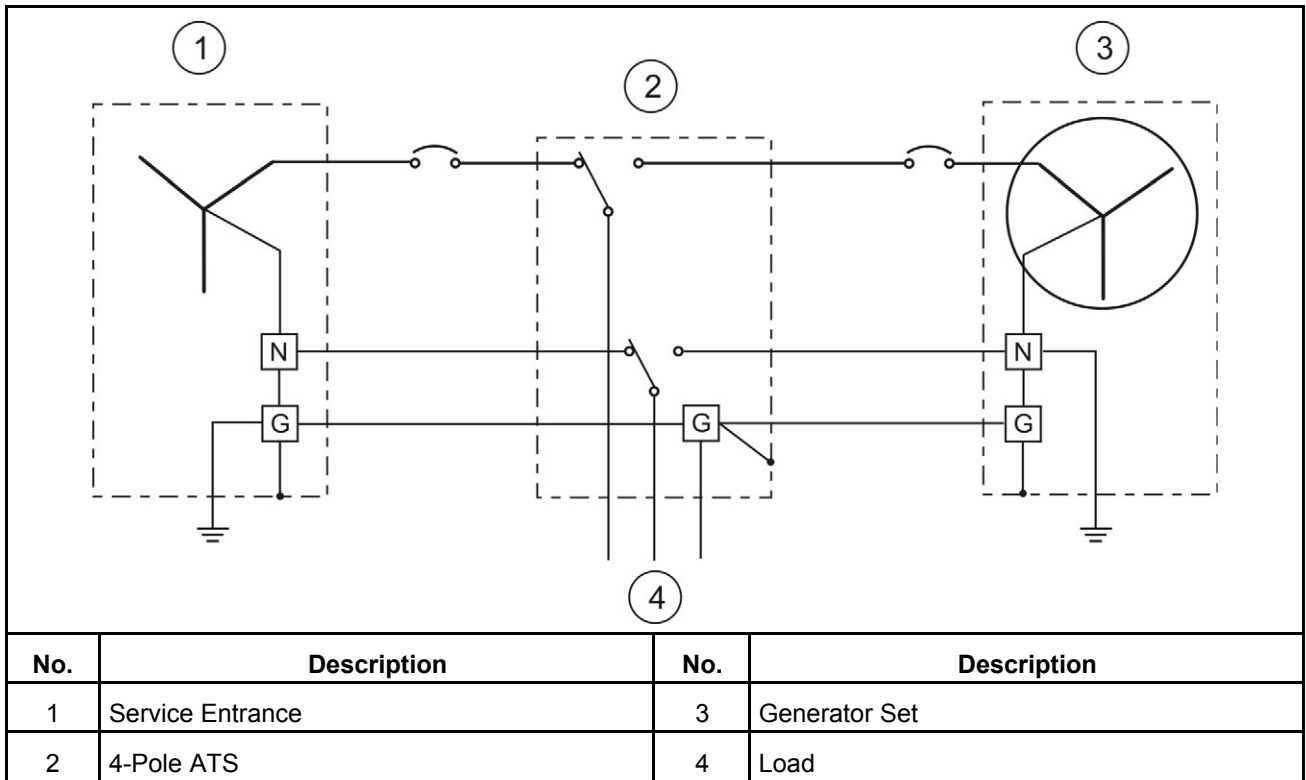


FIGURE 19. TYPICAL SYSTEM - THREE-PHASE, FOUR WIRE UTILITY, THREE-POLE ATS



**FIGURE 20. TYPICAL SYSTEM - THREE-PHASE, FOUR WIRE UTILITY, FOUR-POLE ATS**

# 10 Pre-Start Preparation

---

## WARNING

### **Electrical Generating Equipment**

***Incorrect operation and maintenance can result in severe personal injury or death.***

***Make sure that only suitably trained and experienced service personnel perform electrical and/or mechanical service.***

Before an initial start of the generator set, complete the Installation Checklist, see [Chapter 11 on page 61](#).

## 10.1 Electrical System

Verify all electrical connections are secure and all wiring is complete and inspected. Replace and secure any access panels that may have been removed during installation.

## 10.2 Battery Connections

### WARNING

#### **Automated Machinery**

***Accidental or remote starting of the generator set can cause severe personal injury or death.***

***Make sure that the generator set cannot be started accidentally or remotely before starting work on the generator.***

### WARNING

#### **Combustible Gases**

***Ignition of battery gases is a fire and explosion hazard which can cause severe personal injury or death.***

***Do not smoke, or switch the trouble light ON or OFF near a battery. Touch a grounded metal surface first before touching batteries to discharge static electricity. Stop the generator set and disconnect the battery charger before disconnecting battery cables. Using an insulated wrench, disconnect the negative (-) cable first and reconnect it last.***

Starting the unit requires one or more batteries. For more information on batteries, refer to the Model Specifications section. To prevent arcing, use an insulated wrench to connect the positive battery cable, then connect the negative battery cable.

If an automatic transfer switch is installed without a built-in charge circuit, connect a separate battery charger. Proper selection and maintenance of batteries and battery chargers is essential for system reliability.

## 10.3 Site-Specific Configuration

### NOTICE

**Site-specific configuration is to be undertaken by suitably trained and qualified service personnel only.**

The generator set is configured at the factory. Before starting the generator set, any site-specific configuration should be completed by qualified service personnel.

---

## 10.4 Starting

Refer to the generator set Operator manual for important safety precautions and recommended procedures for starting the generator set and verifying proper operation. Start the generator set and verify all engine and generator set menus are displaying the correct values.

# 11 Installation Checklist

## 11.1 Checklist

TABLE 7. GENERATOR SET INSTALLATION/ PRE-COMMISSIONING CHECKLIST

<b>Lean burn gas generator set</b>	
This checklist should be used to validate the completion of a generator set installation prior to commissioning. A checklist should be completed for each generator set of a multiple installation.	
<b>Project Details</b>	
Project Name:	
Customer (End User):	
Address of Site:	
Telephone No.:	
Email:	
Start up date:	
<b>Generator set details</b>	
Generator set model:	
Generator set serial number:	
Generator set number:	
Control type:	
Control serial number:	
System control type (if applicable):	
<b>Generator set building and services</b>	
<input type="checkbox"/>	Building and installation work complete
<input type="checkbox"/>	Site clean and access clear from obstruction
<input type="checkbox"/>	Building services complete and commissioned (lightning, lighting, electrical auxiliary supplies, water, etc.)
Observations:	
<b>Room general and safety checks</b>	
<input type="checkbox"/>	Ensure starting is inhibited until ready
<input type="checkbox"/>	Warn personnel of impending equipment start- up
<input type="checkbox"/>	Generator set clean with all guards in place
<input type="checkbox"/>	No loose materials near generator set

<b>Lean burn gas generator set</b>	
	Air ducts clear and clean
	Access and egress routes unobstructed and labelled
	Control and maintenance positions unobstructed
	Room secure-no unauthorized access
	Generator set is level-holding down bolts secure
	Pipework and cables are secure with trip hazards
	Overhead obstructions clearly marked and labelled
	All key components are labelled
	Pipework and services color coded and labelled
	Electrical bonding complete
<b>Cooling System</b>	
<b>Remote mounted radiator systems</b>	
	Header tank is adequately sized
	Overflow is clear and routed to avoid spillage
	Static/friction head is within engine/system capability Engine vent pipes inclined toward radiator/ header
	Header tanks, auxiliary tanks and system filled and cap(s) replaced
	Pipework avoids air locks-air bleed valves provided
	Pipework isolated from generator set vibration
	Pipework complete, cleaned, tested, and painted
	Pipework is adequately supported
	Auxiliary supply to fans correctly installed
	Electrical bonding completed
<b>Heat exchanger and cooling tower systems</b>	
	Header tank is adequately sized
	Overflow is clear and routed to avoid spillage
	Static/friction head is within engine/system capability
	Engine vent pipes inclined toward header tank
	Pipework avoids air locks-air bleed valves provided
	Pipework isolated from generator set vibration
	Pipework complete, cleaned, tested and painted
	Secondary cooling system is complete Cooling tower make up supply is complete
	Auxiliary supply to fans correctly installed
	Electrical bonding completed
<b>Gaseous fuel system</b>	
	Pipework complete, material and construction correct
	Regulator and shut off valves in correct locations
	Leak test and certification complete

<b>Lean burn gas generator set</b>	
	Test certificates present
	Gas present at shut off valves
<b>Fire alarm/suppression system</b>	
	Fire alarm/suppression system complete
	Sensors protected from radiant heat
	Labelling and lock off system complete
<b>Starting system</b>	
<b>Battery starting</b>	
	Starting batteries correct and installed on tray or stand
	Battery cables routed correctly and secured
	Battery charger installed and wired
<b>Compressed air/hydraulic starting</b>	
	Compressor set installed and wired
	Compressed air pipework correctly rated and installed
	Isolating valves correctly positioned and labelled
	Pipework tested, painted, and labelled
	Correct pressure regulator and HP/LP safety valves
	Flexible connection to engine fitted HP and LP air/hydraulic pressures checked
	Condensate drained
<b>Exhaust system</b>	
	Installation design prevents exhaust recirculation
	Flexible connection to engine
	Support prevents load on turbocharger/manifold
	Installation allows for pipework expansion
	Pipework/muffler supported at required intervals
	Joints welded or flanges secure with correct gaskets
	Stack/tailpipe prevents rain/snow ingress
	Flues are not combined in stack
	Condensate drain provided
	Exit directed away from buildings/personnel
	System is lagged and clad as required
	Building penetration and weathering complete and sealed
	Flammable materials properly protected
	Check stack/tailpipe and rain cap are clear
<b>Ventilation and Attenuation</b>	
	Design prevents hot air recirculation and rain ingress
	Design accounts for prevailing wind

<b>Lean burn gas generator set</b>	
	Air flow direction is from alternator to engine front
	Louver mechanisms complete and wired as required
	Check louvers are clear and free to operate
	Electrical bonding completed
	Bird guard is fitted to intake and outlet
<b>Electrical System</b>	
<b>Control system</b>	
	Field wiring to set mounted control complete
	Customer wiring to set mounted control complete
	Interconnection to remote control complete
	Emergency stop controls wired
	Select set parameters on set/system control
	Check remote control signals to set control
	Check set control signals to remote control
	Check signals to system control and switch-gear
	Check emergency stop controls
<b>Set/Switchgear/Changeover/Transfer</b>	
	Means of disconnection/isolation provided
	Switchgear installation and pretesting completed
	Power connections complete and torque- marked
	Cable tests complete and certificates available
	Verify cable flexibility at generator set
	Energize auxiliary supplies and check functionality
	Enter switchgear protection settings and record
	Utility sensing commissioned
<b>Electrical general</b>	
	All electrical boxes clean and covers replaced
	Auxiliary electrical supply complete
	Grounding system complete and tested
	Electrical bonding of services/assemblies complete
	Utility supply available as required
	Small power and lighting circuits tested and certificated
	Alternator insulation test completed
	Small power and lighting circuits tested and certificated
	Comments on any item that may affect commissioning:
<b>Checklist Completion</b>	
Checklist completed by:	

<b>Lean burn gas generator set</b>	
Date:	
Print name:	
Company:	

<b>NOTICE</b>
<b>Completion of this checklist does not relieve installer of contract obligations.</b>

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# 12 Manufacturing Facilities

U.S. and CANADA	EMEA, CIS	EMEA, CIS
Cummins Inc. 1400 73rd Ave. NE Minneapolis, MN 55432 USA	Cummins Inc. Columbus Avenue Manston Park Manston, Ramsgate Kent CT12 5BF United Kingdom	Cummins Inc. Royal Oak Way South Daventry Northamptonshire NN11 8NU United Kingdom
Toll Free 1-800-CUMMINS™ (1-800-286-6467) Phone +1 763-574-5000 Fax +1 763-574-5298	Phone +44 1843 255000 Fax +44 1843 255902	Phone +44 1327 88-6453 Fax +44 1327 88-6125
BRAZIL	CHINA	INDIA
Rua Jati, 310, Cumbica Guarulhos, SP 07180-900 CNPJ: 43.2201.151/0001-10 Brazil	Cummins Inc. No.118 South Quanli Road , Wuhan Economic& Technological Development Zone , Hubei, P.R.China 430058	Cummins Inc. Plot No B-2, SEZ Industrial Area, Village-Nandal & Surwadi, Taluka- Phaltan Dist- Satara, Maharashtra 415523 India
Phone 0800 286 6467	Phone + 86 (27) 8421 4008 Fax + 86 (27) 8421 4804	Phone +91 021 66305514
LATIN AMERICA	MEXICO	ASIA PACIFIC
3350 Southwest 148th Ave. Suite 205 Miramar, FL 33027 USA	Eje 122 No. 200 Zona Industrial San Luis Potosi, S.L.P. 78395 Mexico	Cummins Sales and Service Singapore Pte Ltd 85 Tuas South Avenue 1 Singapore 637419
Phone +1 954 431 551 Fax +1 954 433 5797	Phone +52 444 870 6700 Fax +52 444 824 0082	Fax +65 6265 6909

## 12.1 How to Obtain Service

When a product requires servicing, contact the nearest Cummins service provider. To locate the distributor, go to [www.cummins.com/support](http://www.cummins.com/support) and select Sales and Service Locator. When contacting the service provider, always supply the complete model, specification, and serial number as shown on the nameplate.

### 12.1.1 Locating a Distributor

#### In the U.S. and Canada

To easily locate the nearest certified distributor/dealer for Cummins generator sets in your area, or for more information, contact us at 1-800-CUMMINS™ (1-800-286-6467) or visit [www.cummins.com/support](http://www.cummins.com/support).

If unable to contact a distributor using the automated service, consult the Internet.

If unable to arrange a service or resolve an issue, contact the Service Manager at the nearest Cummins distributor for assistance.

When contacting the distributor, always supply the complete Model, Specification, and Serial Number as shown on the product nameplate.

**Outside the U.S. and Canada**

Refer to [www.cummins.com/support](http://www.cummins.com/support) and select Sales and Service Locator, or send an email to [ask.powergen@cummins.com](mailto:ask.powergen@cummins.com).

# Appendix A. Customer Connections

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The drawings included in this section are representative. For current complete information, refer to the drawing package that was shipped with the unit.

# A.1 A044L814 Customer Connections

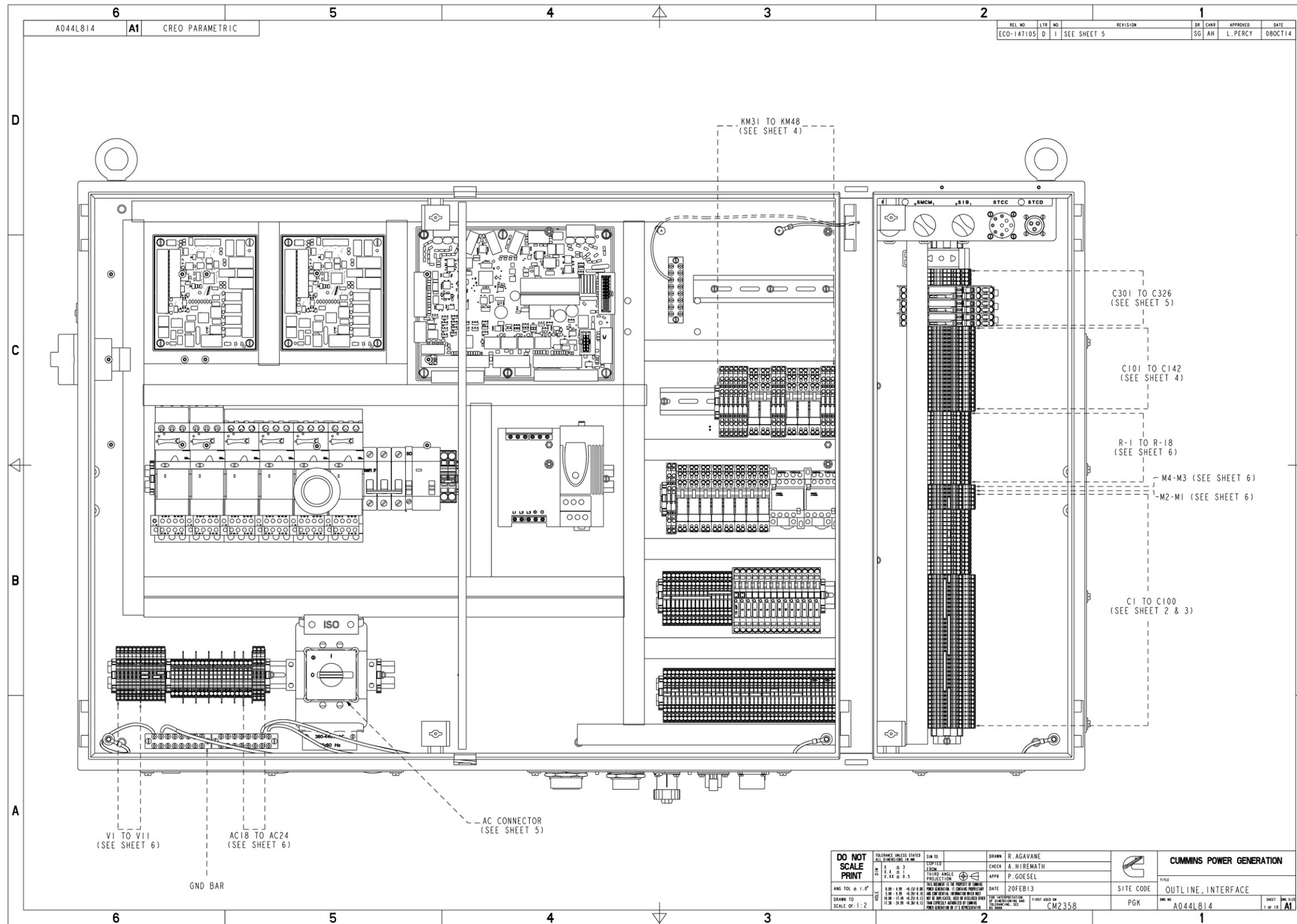


FIGURE 21. A044L814 SHEET 1 OF 10

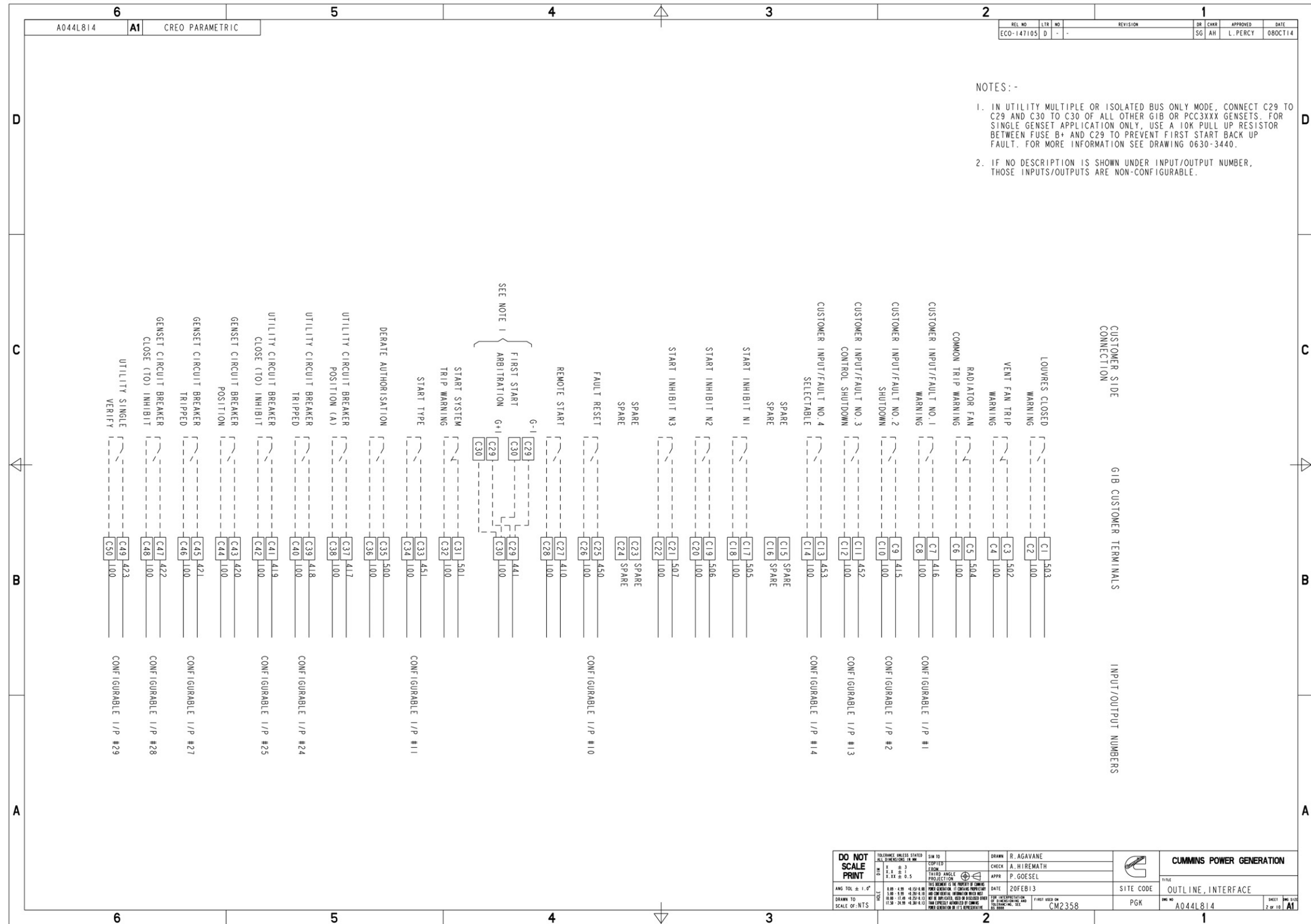
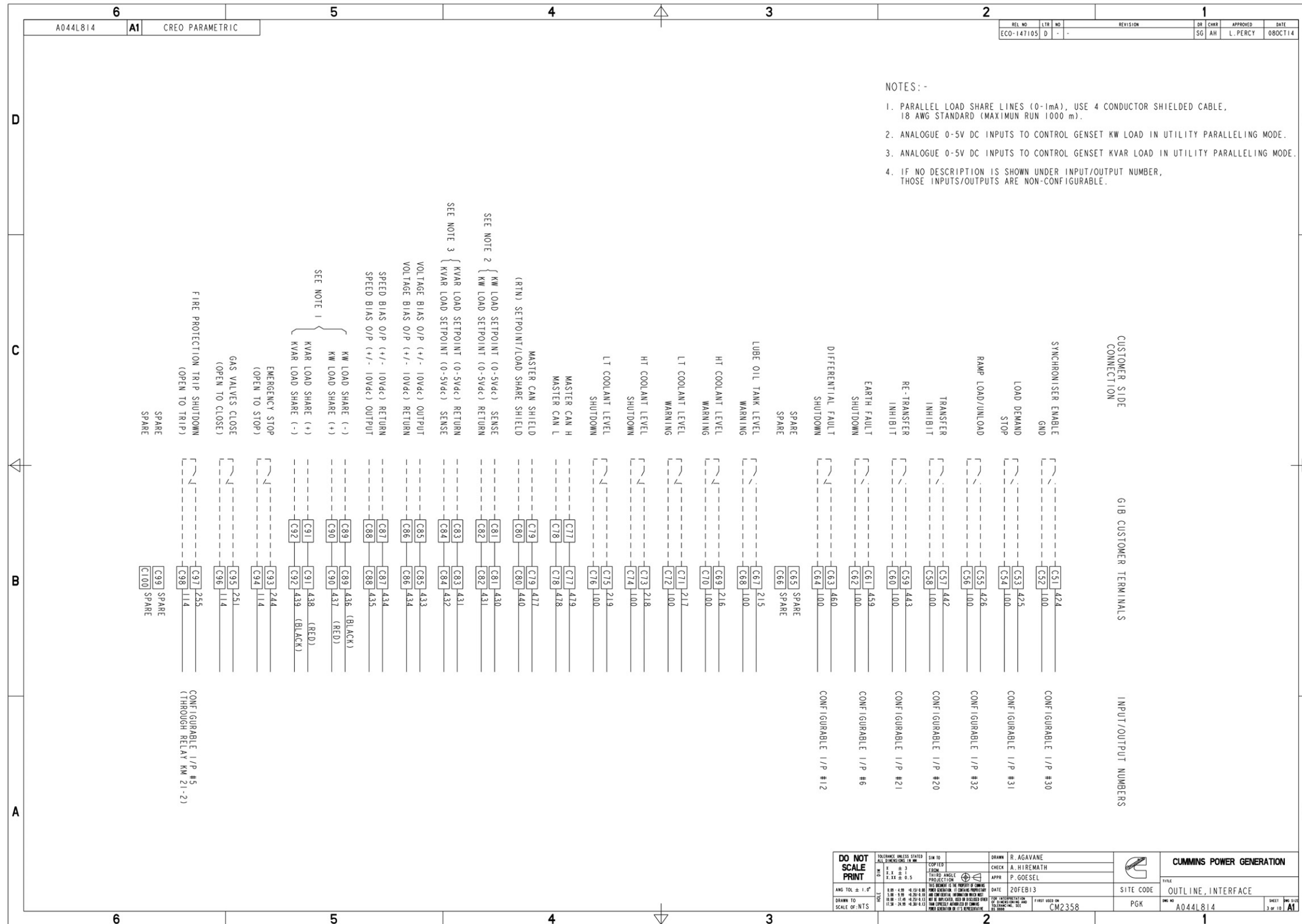


FIGURE 22. A044L814 SHEET 2 OF 10



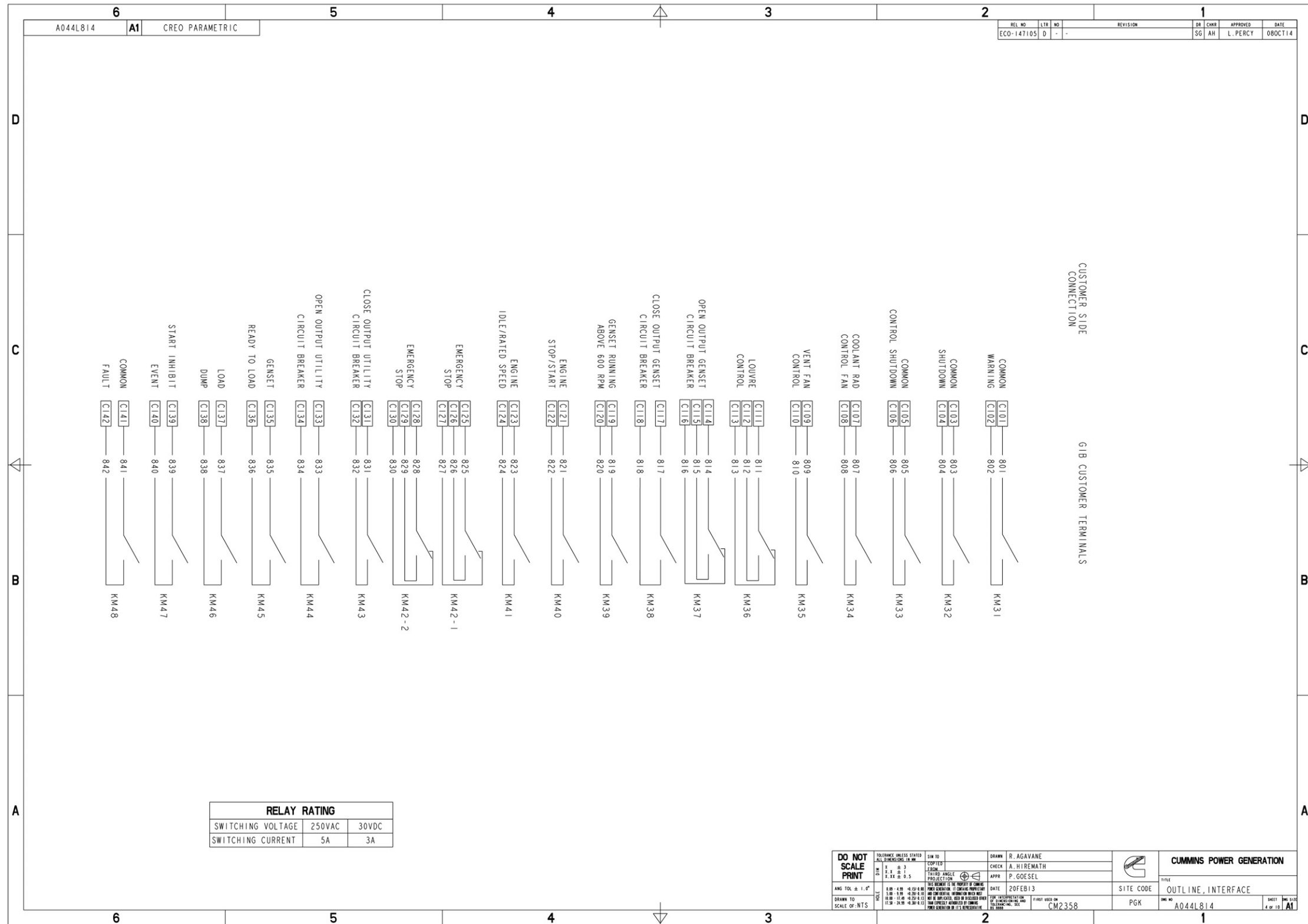


FIGURE 24. A044L814 SHEET 4 OF 10

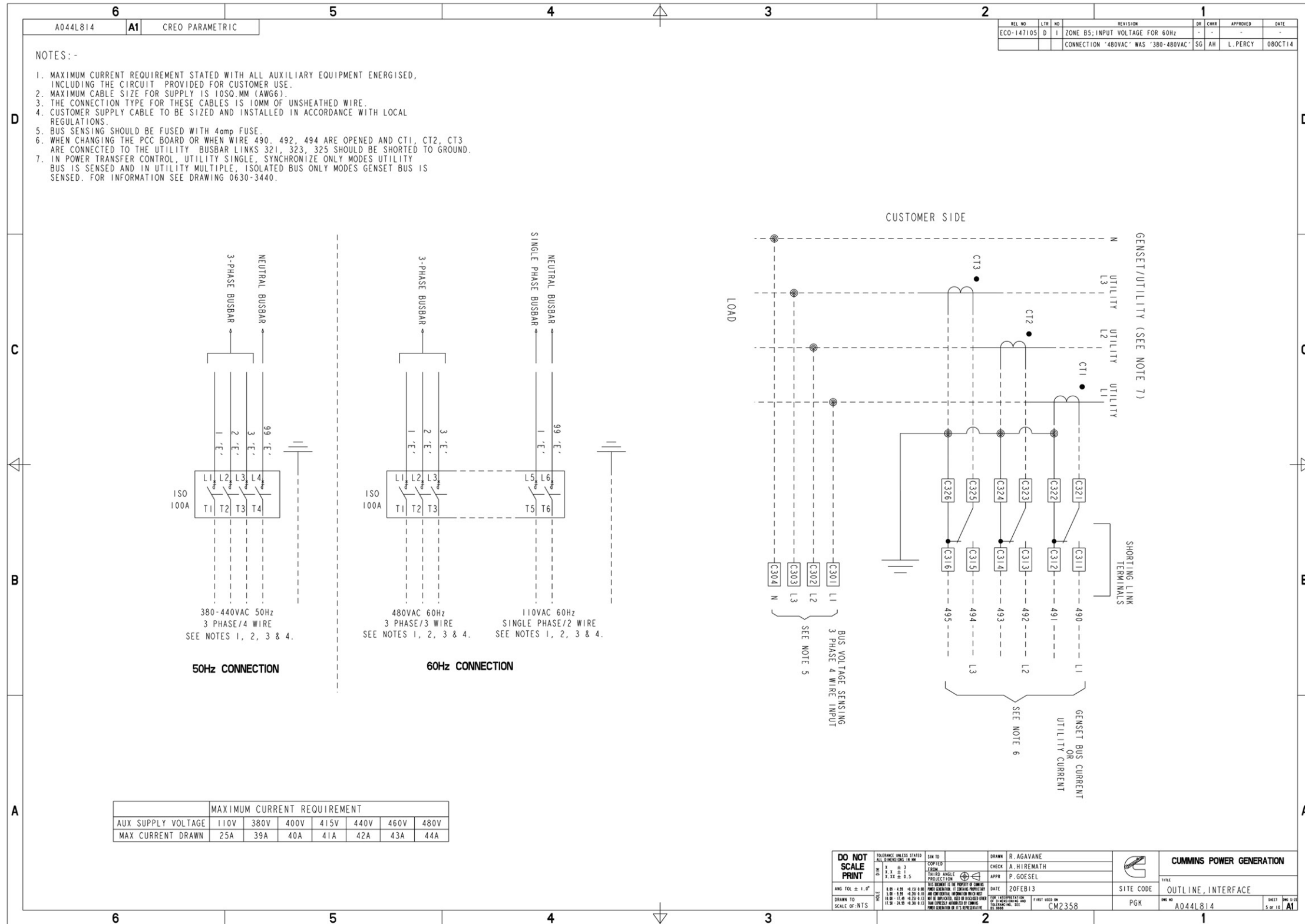


FIGURE 25. A044L814 SHEET 5 OF 10

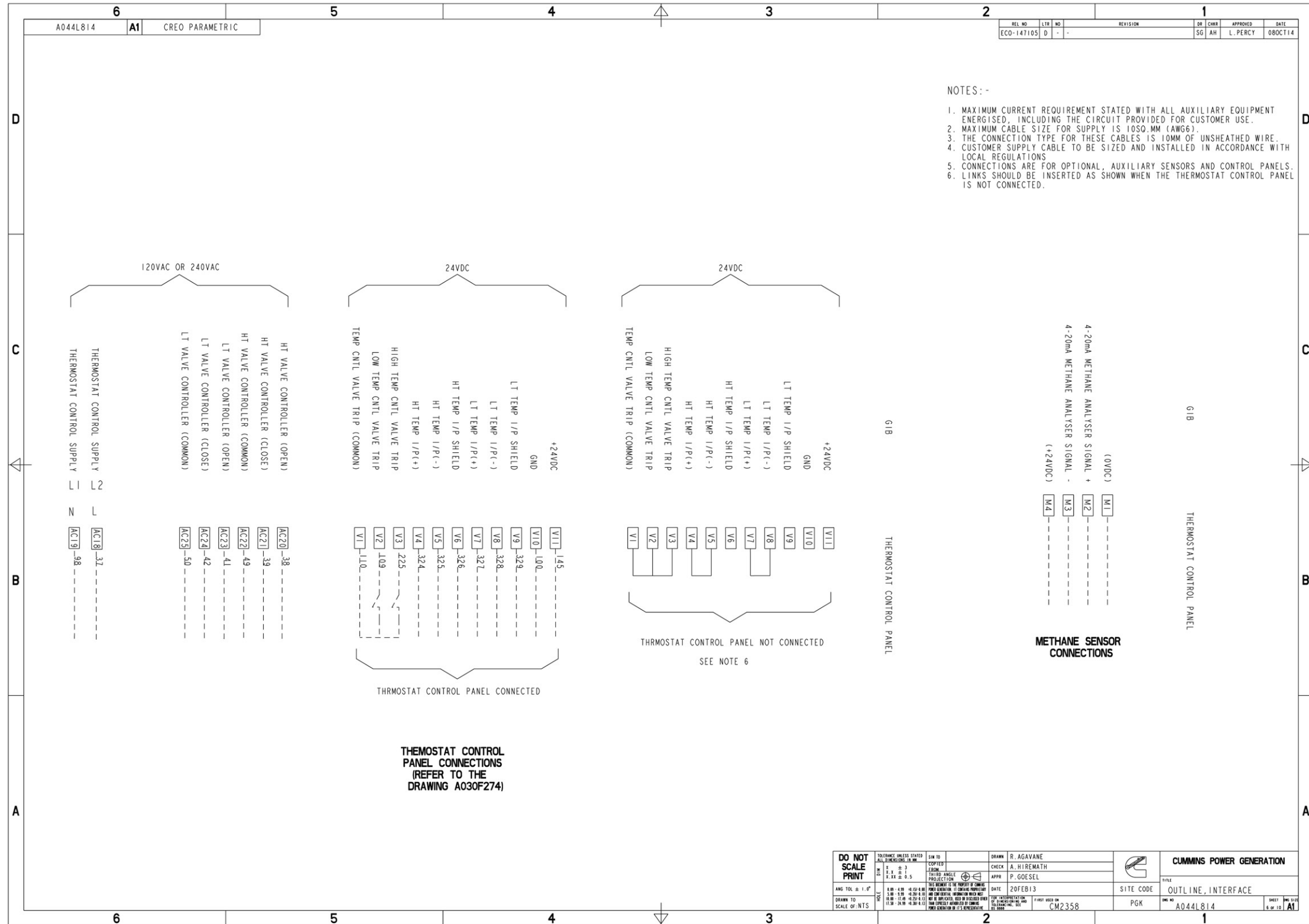


FIGURE 26. A044L814 SHEET 6 OF 10

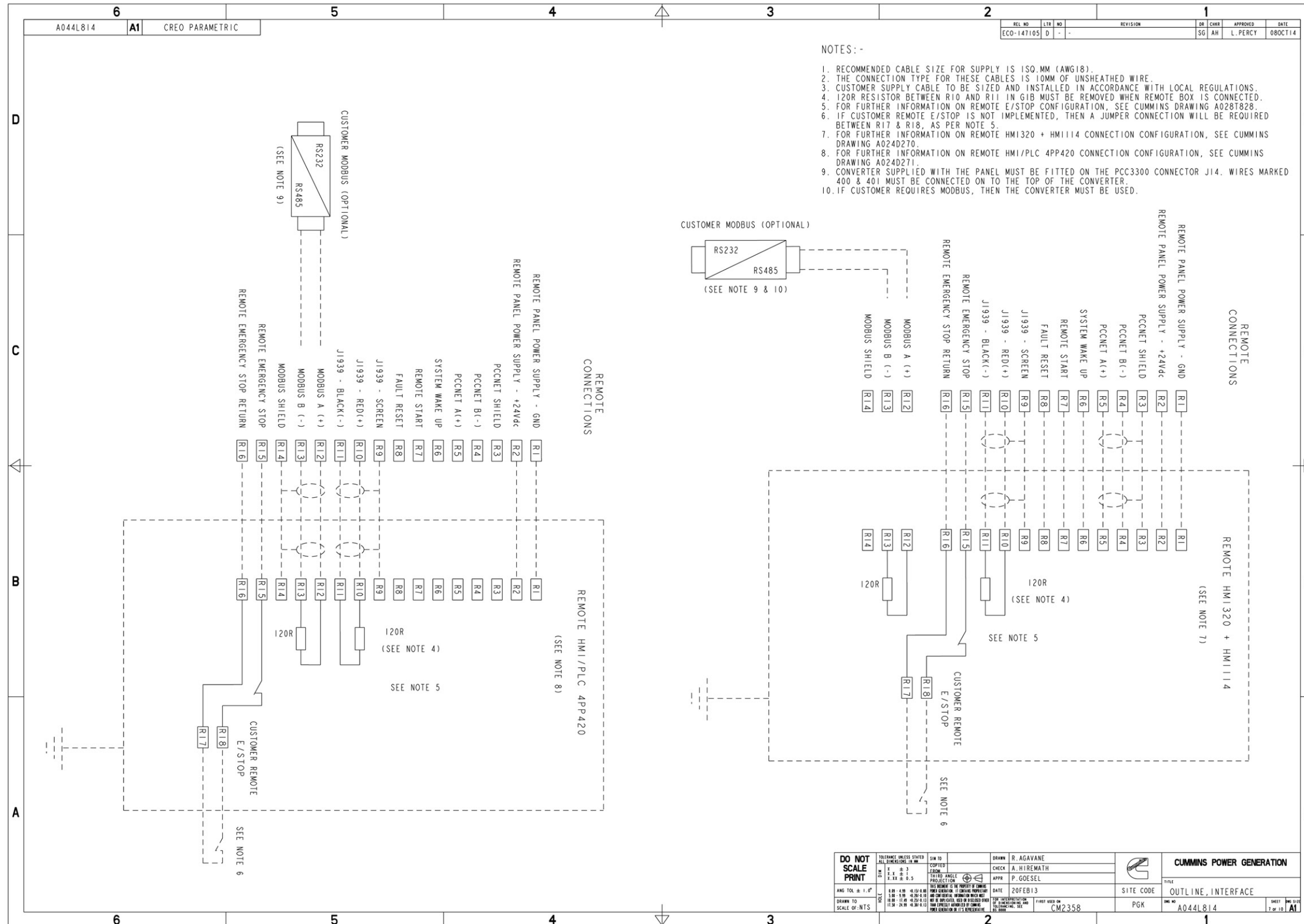


FIGURE 27. A044L814 SHEET 7 OF 10

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A044L814		AI CREO PARAMETRIC								<table border="1"> <tr> <th>REL NO</th> <th>LTR NO</th> <th>REVISION</th> <th>DR</th> <th>CHKD</th> <th>APPROVED</th> <th>DATE</th> </tr> <tr> <td>ECO-147105</td> <td>D</td> <td>-</td> <td>SG</td> <td>AR</td> <td>L. PERCY</td> <td>08OCT14</td> </tr> </table>		REL NO	LTR NO	REVISION	DR	CHKD	APPROVED	DATE	ECO-147105	D	-	SG	AR	L. PERCY	08OCT14																
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TERMINAL	DESCRIPTION	FUNCTION	CIRCUIT	CONTROL/STATE	WIRE SIZE (mm <sup>2</sup> )	WIRE SIZE (in <sup>2</sup> )	<table border="1"> <tr> <td>DO NOT SCALE PRINT</td> <td>SCALE TO: 1:1</td> <td>DATE: 20FEB13</td> <td>PKG: A044L814</td> <td>CM2358</td> </tr> </table>					DO NOT SCALE PRINT	SCALE TO: 1:1	DATE: 20FEB13	PKG: A044L814	CM2358																									
DO NOT SCALE PRINT	SCALE TO: 1:1	DATE: 20FEB13	PKG: A044L814	CM2358																																					
C1	LOUVRES CLOSED WARNING	WARNING FAULT	5VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)	<table border="1"> <tr> <td>DRWN</td> <td>R. AGAVANE</td> <td>CHECK</td> <td>A. HIREMATH</td> <td>DATE</td> <td>20FEB13</td> </tr> <tr> <td>APPR</td> <td>P. GOESEL</td> <td>DATE</td> <td>20FEB13</td> <td>PKG</td> <td>A044L814</td> </tr> <tr> <td colspan="2">CUMMINS POWER GENERATION</td> <td colspan="2">SITE CODE</td> <td>PKG</td> <td>A044L814</td> </tr> <tr> <td colspan="2">TITLE</td> <td colspan="2">OUTLINE, INTERFACE</td> <td>DATE</td> <td>20FEB13</td> </tr> <tr> <td colspan="2">DRAWN TO SCALE OF NTS</td> <td colspan="2">FIRST USED IN</td> <td>DATE</td> <td>20FEB13</td> </tr> </table>					DRWN	R. AGAVANE	CHECK	A. HIREMATH	DATE	20FEB13	APPR	P. GOESEL	DATE	20FEB13	PKG	A044L814	CUMMINS POWER GENERATION		SITE CODE		PKG	A044L814	TITLE		OUTLINE, INTERFACE		DATE	20FEB13	DRAWN TO SCALE OF NTS		FIRST USED IN		DATE	20FEB13
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DRAWN TO SCALE OF NTS		FIRST USED IN		DATE	20FEB13																																				
C2	LOUVRES CLOSED WARNING	WARNING FAULT	5VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C3	VENTILATION FAN TRIP	WARNING FAULT	5VDC, 20ma, PROTECTED	CLASS 'B', CONTACT OPEN TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C4	RADIATOR FAN COMMON TRIP WARNING	WARNING FAULT	5VDC, 20ma, PROTECTED	CLASS 'B', CONTACT OPEN TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C5	RADIATOR FAN COMMON TRIP WARNING	WARNING FAULT	5VDC, 20ma, PROTECTED	CLASS 'B', CONTACT OPEN TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C6	CUSTOMER INPUT/FAULT NO. 1 WARNING	WARNING FAULT	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C7	CUSTOMER INPUT/FAULT NO. 1 WARNING	WARNING FAULT	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C8	CUSTOMER INPUT/FAULT NO. 2 SHUTDOWN	SHUTDOWN FAULT	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C9	CUSTOMER INPUT/FAULT NO. 2 SHUTDOWN	SHUTDOWN FAULT	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C10	CUSTOMER INPUT/FAULT NO. 3 CONTROL SHUTDOWN	CONTROL SHUTDOWN FAULT	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C11	CUSTOMER INPUT/FAULT NO. 3 CONTROL SHUTDOWN	CONTROL SHUTDOWN FAULT	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C12	CUSTOMER INPUT/FAULT NO. 4 SELECTABLE	CONTROL SHUTDOWN FAULT	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C13	CUSTOMER INPUT/FAULT NO. 4 SELECTABLE	CONTROL SHUTDOWN FAULT	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C14	CUSTOMER INPUT/FAULT NO. 4 SELECTABLE	CONTROL SHUTDOWN FAULT	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C15	SPARE	SPARE	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C16	SPARE	SPARE	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C17	START INHIBIT N1	CONTROLLED STARTUP	5VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C18	START INHIBIT N1	CONTROLLED STARTUP	5VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C19	START INHIBIT N2	CONTROLLED STARTUP	5VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C20	START INHIBIT N2	CONTROLLED STARTUP	5VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C21	START INHIBIT N3	CONTROLLED STARTUP	5VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C22	START INHIBIT N3	CONTROLLED STARTUP	5VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C23	SPARE	SPARE	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C24	SPARE	SPARE	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C25	FAULT RESET	SYSTEM RESET	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C26	FAULT RESET	SYSTEM RESET	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C27	REMOTE START	START-UP FUNCTION	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C28	REMOTE START	START-UP FUNCTION	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C29	FIRST START ARBITRATION	START-UP SEQUENCE	11VDC, 20ma, PROTECTED	BIDIRECTIONAL ARBITRATION	2.5sqmm	0.65sqmm (RANG 20)																																			
C30	FIRST START ARBITRATION	START-UP SEQUENCE	11VDC, 20ma, PROTECTED	BIDIRECTIONAL ARBITRATION	2.5sqmm	0.65sqmm (RANG 20)																																			
C31	START SYSTEM TRIP WARNING	WARNING FAULT	5VDC, 20ma, PROTECTED	CLASS 'B', CONTACT OPEN TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C32	START SYSTEM TRIP WARNING	WARNING FAULT	5VDC, 20ma, PROTECTED	CLASS 'B', CONTACT OPEN TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C33	START TYPE	EMERGENCY START SELECTION	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C34	START TYPE	EMERGENCY START SELECTION	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C35	DEBATE AUTHORISATION	CONTROLLED LOAD SHARE	5VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C36	DEBATE AUTHORISATION	CONTROLLED LOAD SHARE	5VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C37	UTILITY CIRCUIT BREAKER POSITION (A)	LOAD GOVERN	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C38	UTILITY CIRCUIT BREAKER POSITION (A)	LOAD GOVERN	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C39	UTILITY CIRCUIT BREAKER TRIPPED	SHUTDOWN FAULT	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C40	UTILITY CIRCUIT BREAKER TRIPPED	SHUTDOWN FAULT	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C41	UTILITY CIRCUIT BREAKER CLOSE (TO) INHIBIT	CIRCUIT BREAKER CONTROL	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C42	UTILITY CIRCUIT BREAKER CLOSE (TO) INHIBIT	CIRCUIT BREAKER CONTROL	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C43	GENSET CIRCUIT BREAKER POSITION (A)	GENSET CB POSITION CONFIRMATION	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C44	GENSET CIRCUIT BREAKER POSITION (A)	GENSET CB POSITION CONFIRMATION	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C45	GENSET CIRCUIT BREAKER TRIPPED	SHUTDOWN FAULT	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C46	GENSET CIRCUIT BREAKER TRIPPED	SHUTDOWN FAULT	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C47	GENSET CIRCUIT BREAKER CLOSE (TO) INHIBIT	CIRCUIT BREAKER CONTROL	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C48	GENSET CIRCUIT BREAKER CLOSE (TO) INHIBIT	CIRCUIT BREAKER CONTROL	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C49	UTILITY SINGLE VERIFY	SINGLE/MULTIPLE GENSET SELECTION	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C50	UTILITY SINGLE VERIFY	SINGLE/MULTIPLE GENSET SELECTION	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C51	SYNCHRONISER ENABLE	ENABLES PCS SYNCHRONISER (IE: MAINS RETURN PLT MODE)	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C52	SYNCHRONISER ENABLE	ENABLES PCS SYNCHRONISER (IE: MAINS RETURN PLT MODE)	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C53	LOAD DEMAND STOP	CONTROLLED SHUTDOWN	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C54	LOAD DEMAND STOP	CONTROLLED SHUTDOWN	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C55	RAMP LOAD/UNLOAD	LOAD CONTROL	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C56	RAMP LOAD/UNLOAD	LOAD CONTROL	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C57	TRANSFER INHIBIT	POWER TRANSFER CONTROL	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C58	TRANSFER INHIBIT	POWER TRANSFER CONTROL	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C59	RE-TRANSFER INHIBIT	POWER TRANSFER CONTROL	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C60	RE-TRANSFER INHIBIT	POWER TRANSFER CONTROL	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C61	EARTH FAULT SHUTDOWN	SHUTDOWN FAULT	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C62	EARTH FAULT SHUTDOWN	SHUTDOWN FAULT	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C63	DIFFERENTIAL FAULT SHUTDOWN	SHUTDOWN FAULT	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C64	DIFFERENTIAL FAULT SHUTDOWN	SHUTDOWN FAULT	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C65	SPARE	SPARE	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C66	SPARE	SPARE	24VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C67	LUBE OIL TANK LEVEL WARNING	WARNING FAULT	6.6VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C68	LUBE OIL TANK LEVEL WARNING	WARNING FAULT	6.6VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C69	HT COOLANT LEVEL WARNING	WARNING FAULT	6.6VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C70	HT COOLANT LEVEL WARNING	WARNING FAULT	6.6VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C71	LT COOLANT LEVEL WARNING	WARNING FAULT	6.6VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			
C72	LT COOLANT LEVEL WARNING	WARNING FAULT	6.6VDC, 20ma, PROTECTED	CLASS 'A', CONTACT CLOSE TO ACTIVATE	2.5sqmm	0.65sqmm (RANG 20)																																			

FIGURE 28. A044L814 SHEET 8 OF 10

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A044L814		AI		CREO PARAMETRIC																					
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REL NO	LTR NO	REVISION	DR	CHKD	APPROVED	DATE																			
ECO-147105	D	-	-	-	L. PERCY	08OCT14																			
<b>GIB CUSTOMER CONNECTION APPLICATION GUIDE (INPUTS)</b>																									
TERMINAL	DESCRIPTION	FUNCTION	CIRCUIT	CONTROL/STATE	WIRE SIZE (max.)	WIRE SIZE (m.p.n.)																			
C73	HT COOLANT LEVEL SHUTDOWN	SHUTDOWN FAULT	6.6VDC, 20ma, PROTECTED	CLASS 'B' CONTACT OPEN TO ACTIVATE	2.5sqmm	0.6mm (AMG 20)																			
C74	HT COOLANT LEVEL SHUTDOWN	SHUTDOWN FAULT	6.6VDC, 20ma, PROTECTED	CLASS 'B' CONTACT OPEN TO ACTIVATE	2.5sqmm	0.6mm (AMG 20)																			
C75	LT COOLANT LEVEL SHUTDOWN	SHUTDOWN FAULT	6.6VDC, 20ma, PROTECTED	CLASS 'B' CONTACT OPEN TO ACTIVATE	2.5sqmm	0.6mm (AMG 20)																			
C76	LT COOLANT LEVEL SHUTDOWN	SHUTDOWN FAULT	6.6VDC, 20ma, PROTECTED	CLASS 'B' CONTACT OPEN TO ACTIVATE	2.5sqmm	0.6mm (AMG 20)																			
C77	MASTER CAN H	COMMUNICATION LINES	COMM NETWORK	COMMUNICATION	0.6sqmm	0.6mm (AMG 20)																			
C78	MASTER CAN L	COMMUNICATION LINES	COMM NETWORK	COMMUNICATION	0.6sqmm	0.6mm (AMG 20)																			
C79	MASTER CAN SHIELD	COMMUNICATION LINES	COMM NETWORK	COMMUNICATION	0.6sqmm	0.6mm (AMG 20)																			
C80	RETURN SETPOINT/LOAD SHARE SHIELD	GENSET PARALLELING/LOAD SHARING	GEN	SCREEN	2.5sqmm	0.6mm (AMG 20)																			
C81	KW LOAD SETPOINT (0-5Vdc) SENSE	GENSET PARALLELING/LOAD SHARING	0-5VDC, 0-1ma	CLASS 'B' CONTACT OPEN TO ACTIVATE	2.5sqmm	0.6mm (AMG 20)																			
C82	KW LOAD SETPOINT (0-5Vdc) RETURN	GENSET PARALLELING/LOAD SHARING	0-5VDC, 0-1ma	CLASS 'B' CONTACT OPEN TO ACTIVATE	2.5sqmm	0.6mm (AMG 20)																			
C83	KVAR LOAD SETPOINT (0-5Vdc) RETURN	GENSET PARALLELING/LOAD SHARING	0-5VDC, 0-1ma	ANALOG SIGNAL	2.5sqmm	0.6mm (AMG 20)																			
C84	KVAR LOAD SETPOINT (0-5Vdc) SENSE	GENSET PARALLELING/LOAD SHARING	0-5VDC, 0-1ma	ANALOG SIGNAL	2.5sqmm	0.6mm (AMG 20)																			
C85	VOLTAGE BIAS O/P (+/- 10Vdc) OUTPUT	NON-PCC LOAD SHARE MODE	±10VDC	CLASS 'B' CONTACT OPEN TO ACTIVATE	2.5sqmm	0.6mm (AMG 20)																			
C86	VOLTAGE BIAS O/P (+/- 10Vdc) RETURN	NON-PCC LOAD SHARE MODE	±10VDC	CLASS 'B' CONTACT OPEN TO ACTIVATE	2.5sqmm	0.6mm (AMG 20)																			
C87	SPEED BIAS O/P (+/- 10Vdc) RETURN	NON-PCC LOAD SHARE MODE	±10VDC	CLASS 'B' CONTACT OPEN TO ACTIVATE	2.5sqmm	0.6mm (AMG 20)																			
C88	SPEED BIAS O/P (+/- 10Vdc) OUTPUT	NON-PCC LOAD SHARE MODE	±10VDC	CLASS 'B' CONTACT OPEN TO ACTIVATE	2.5sqmm	0.6mm (AMG 20)																			
C89	KW LOAD SHARE (-)	GENSET PARALLELING/LOAD SHARING	0-1ma	CLASS 'B' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)																			
C90	KW LOAD SHARE (+)	GENSET PARALLELING/LOAD SHARING	0-1ma	CLASS 'B' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)																			
C91	KVAR LOAD SHARE (-)	GENSET PARALLELING/LOAD SHARING	0-1ma	CLASS 'B' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)																			
C92	KVAR LOAD SHARE (+)	GENSET PARALLELING/LOAD SHARING	0-1ma	CLASS 'B' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)																			
C93	EMERGENCY STOP (OPEN TO STOP)	SHUTDOWN FAULT	24VDC, 20ma, 5A FUSE	CLASS 'B' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)																			
C94	EMERGENCY STOP (OPEN TO STOP)	SHUTDOWN FAULT	24VDC, 20ma, 5A FUSE	CLASS 'B' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)																			
C95	GAS VALVES CLOSE (OPEN TO CLOSE)	CONTROL GAS FLOW	24VDC, 20ma, 5A FUSE	CLASS 'B' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)																			
C96	GAS VALVES CLOSE (OPEN TO CLOSE)	CONTROL GAS FLOW	24VDC, 20ma, 5A FUSE	CLASS 'B' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)																			
C97	FIRE PROTECTION TRIP SHUTDOWN	SHUTDOWN FAULT	24VDC, 20ma, 5A FUSE	CLASS 'B' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)																			
C98	FIRE PROTECTION TRIP SHUTDOWN	SHUTDOWN FAULT	24VDC, 20ma, 5A FUSE	CLASS 'B' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)																			
C99	SPARE				2.5sqmm	1.0mm (AMG 18)																			
C100	SPARE				2.5sqmm	1.0mm (AMG 18)																			

TERMINAL	DESCRIPTION	FUNCTION	CIRCUIT	CONTROL/STATE	WIRE SIZE (max.)	WIRE SIZE (m.p.n.)
C101	COMMON WARNING	WARNING FAULT	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'A' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)
C102	COMMON WARNING	WARNING FAULT	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'A' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)
C103	COMMON SHUTDOWN	SHUTDOWN FAULT	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'A' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)
C104	COMMON SHUTDOWN	SHUTDOWN FAULT	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'A' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)
C105	COMMON CONTROL SHUTDOWN	CONTROLLED SHUTDOWN FAULT	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'A' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)
C106	COMMON CONTROL SHUTDOWN	CONTROLLED SHUTDOWN FAULT	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'A' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)
C107	COOLANT RAD CONTROL FAN	CONTROL	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'A' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)
C108	COOLANT RAD CONTROL FAN	CONTROL	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'A' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)
C109	VENT FAN CONTROL	CONTROL	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'A' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)
C110	VENT FAN CONTROL	CONTROL	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'A' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)
C111	LOUVER CONTROL	CONTROL	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'A' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)
C112	LOUVER CONTROL	CONTROL	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'A' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)
C113	LOUVER CONTROL	CONTROL	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'A' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)
C114	OPEN OUTPUT GENSET CIRCUIT BREAKER	CONTROL	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'A' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)
C115	OPEN OUTPUT GENSET CIRCUIT BREAKER	CONTROL	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'A' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)
C116	OPEN OUTPUT GENSET CIRCUIT BREAKER	CONTROL	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'A' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)
C117	CLOSE OUTPUT GENSET CIRCUIT BREAKER	CONTROL	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'A' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)
C118	CLOSE OUTPUT GENSET CIRCUIT BREAKER	CONTROL	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'A' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)
C119	GENSET RUNNING ABOVE 600RPM	INDICATES ENGINE SPEED ABOVE 600RPM	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'A' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)
C120	GENSET RUNNING ABOVE 600RPM	INDICATES ENGINE SPEED ABOVE 600RPM	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'A' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)
C121	ENGINE START/STOP	INDICATES ENGINE HAS BEEN REQUESTED TO START OR STOP	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'A' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)
C122	ENGINE START/STOP	INDICATES ENGINE IS REQUESTED TO BE AT IDLE OR RAISED SPEED	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'A' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)
C123	ENGINE IDLE/RATED SPEED	INDICATES ENGINE IS REQUESTED TO BE AT IDLE OR RAISED SPEED	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'A' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)
C124	ENGINE IDLE/RATED SPEED	INDICATES ENGINE IS REQUESTED TO BE AT IDLE OR RAISED SPEED	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'A' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)
C125	EMERGENCY STOP	SHUTDOWN FAULT	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'C' CONTACT	2.5sqmm	1.0mm (AMG 18)
C126	EMERGENCY STOP	SHUTDOWN FAULT	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'C' CONTACT	2.5sqmm	1.0mm (AMG 18)
C127	EMERGENCY STOP	SHUTDOWN FAULT	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'C' CONTACT	2.5sqmm	1.0mm (AMG 18)
C128	EMERGENCY STOP	SHUTDOWN FAULT	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'C' CONTACT	2.5sqmm	1.0mm (AMG 18)
C129	EMERGENCY STOP	SHUTDOWN FAULT	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'C' CONTACT	2.5sqmm	1.0mm (AMG 18)
C130	EMERGENCY STOP	SHUTDOWN FAULT	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'C' CONTACT	2.5sqmm	1.0mm (AMG 18)
C131	CLOSE OUTPUT UTILITY CIRCUIT BREAKER	CONTROL	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'A' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)
C132	CLOSE OUTPUT UTILITY CIRCUIT BREAKER	CONTROL	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'A' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)
C133	OPEN OUTPUT UTILITY CIRCUIT BREAKER	CONTROL	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'A' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)
C134	OPEN OUTPUT UTILITY CIRCUIT BREAKER	CONTROL	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'A' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)
C135	GENSET READY TO LOAD	SYNCHRONIZATION CONTROL	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'A' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)
C136	GENSET READY TO LOAD	SYNCHRONIZATION CONTROL	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'A' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)
C137	LOAD DUMP	POWER CONTROL FUNCTION	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'A' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)
C138	LOAD DUMP	POWER CONTROL FUNCTION	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'A' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)
C139	START INHIBIT EVENT	STARTUP CONTROL	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'A' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)
C140	START INHIBIT EVENT	STARTUP CONTROL	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'A' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)
C141	COMMON FAULT	WARNING OR SHUTDOWN FAULT	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'A' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)
C142	COMMON FAULT	WARNING OR SHUTDOWN FAULT	5A @ 250 VAC OR 3A @ 30VDC	CLASS 'A' CONTACT OPEN TO ACTIVATE	2.5sqmm	1.0mm (AMG 18)

FIGURE 29. A044L814 SHEET 9 OF 10

6		5		4		3		2		1															
A044L814		AI		CREO PARAMETRIC																					
										<table border="1"> <tr> <th>REL NO</th> <th>LTR NO</th> <th>REVISION</th> <th>DR</th> <th>CHKD</th> <th>APPROVED</th> <th>DATE</th> </tr> <tr> <td>ECO-147105</td> <td>D</td> <td>-</td> <td>SG</td> <td>AH</td> <td>L. PERCY</td> <td>08OCT14</td> </tr> </table>		REL NO	LTR NO	REVISION	DR	CHKD	APPROVED	DATE	ECO-147105	D	-	SG	AH	L. PERCY	08OCT14
REL NO	LTR NO	REVISION	DR	CHKD	APPROVED	DATE																			
ECO-147105	D	-	SG	AH	L. PERCY	08OCT14																			
<b>GIB CUSTOMER CONNECTION APPLICATION GUIDE (METHANE INDEX)</b>																									
TERMINAL	DESCRIPTION	FUNCTION	CIRCUIT	CONTROL/STATE	WIRE SIZE (MOX)	WIRE SIZE (MIN)																			
M1	METHANE ANALYSER - GND	POWER CONNECTION	GND	-	2.539mm	0.6mm (RANG 20)																			
M2	METHANE ANALYSER - SIGNAL (+)	METHANE SENSOR CONNECTION	4-20mA	-	2.539mm	0.6mm (RANG 20)																			
M3	METHANE ANALYSER - SIGNAL (-)	METHANE SENSOR CONNECTION	4-20mA	-	2.539mm	0.6mm (RANG 20)																			
M4	METHANE ANALYSER - +24Vdc	POWER CONNECTION	+24VDC, 5A, FUSED	-	2.539mm	0.6mm (RANG 20)																			
<b>GIB CUSTOMER CONNECTION APPLICATION GUIDE (REMOTE PANEL)</b>																									
TERMINAL	DESCRIPTION	FUNCTION	CIRCUIT	CONTROL/STATE	WIRE SIZE (MOX)	WIRE SIZE (MIN)																			
R1	REMOTE PANEL POWER SUPPLY - GND	POWER CONNECTION	GND	-	2.539mm	0.6mm (RANG 20)																			
R2	REMOTE PANEL POWER SUPPLY - POSITIVE	POWER CONNECTION	+24VDC, 5A, FUSED	-	2.539mm	0.6mm (RANG 20)																			
R3	PCBNET SHIELD	PCBNET CONNECTION LINE	GND	-	1.039mm	0.6mm (RANG 20)																			
R4	PCBNET B(-)	PCBNET CONNECTION LINE	5V, 1A, FUSED	-	1.039mm	0.6mm (RANG 20)																			
R5	PCBNET A(+)	PCBNET CONNECTION LINE	5V, 1A, FUSED	-	1.039mm	0.6mm (RANG 20)																			
R6	SYSTEM MAKE-UP	CONTROLLED START-UP	24VDC, 2A, FUSED	-	2.539mm	0.6mm (RANG 20)																			
R7	REMOTE START	CONTROLLED START-UP	24VDC, 2A, FUSED	-	2.539mm	0.6mm (RANG 20)																			
R8	FAULT RESET	CONTROLLED RESET	24VDC, 2A, FUSED	-	2.539mm	0.6mm (RANG 20)																			
R9	J1939 - SCREEN	J1939 COMMUNICATION LINE	GND	-	1.039mm	0.6mm (RANG 20)																			
R10	J1939 (+) - RED	J1939 COMMUNICATION LINE	16V, 80mA, FUSED	-	1.039mm	0.6mm (RANG 20)																			
R11	J1939 (-) - BLACK	J1939 COMMUNICATION LINE	16V, 80mA, FUSED	-	1.039mm	0.6mm (RANG 20)																			
R12	RS232 - Rx	RS232 COMMUNICATION LINE	5V, 1A, FUSED	-	1.039mm	0.6mm (RANG 20)																			
R13	RS232 - Tx	RS232 COMMUNICATION LINE	5V, 1A, FUSED	-	1.039mm	0.6mm (RANG 20)																			
R14	RS232 - GND	RS232 COMMUNICATION LINE	GND	-	1.039mm	0.6mm (RANG 20)																			
R15	REMOTE EMERGENCY STOP	CONTROLLED SHUTDOWN	24VDC, 5A, FUSED	OPEN CONTACTS TO ACTIVATE	2.539mm	0.6mm (RANG 20)																			
R16	REMOTE EMERGENCY STOP	CONTROLLED SHUTDOWN	24VDC, 5A, FUSED	OPEN CONTACTS TO ACTIVATE	2.539mm	0.6mm (RANG 20)																			
R17	SPARE (E-STOP EXTENSION)	-	24VDC, 5A, FUSED	CLASS 'B' CONTACT OPEN TO ACTIVATE	2.539mm	0.6mm (RANG 20)																			
R18	SPARE (E-STOP EXTENSION)	-	24VDC, 5A, FUSED	CLASS 'B' CONTACT OPEN TO ACTIVATE	2.539mm	0.6mm (RANG 20)																			
<b>GIB CUSTOMER CONNECTION APPLICATION GUIDE (VALUE CONTROL)</b>																									
TERMINAL	DESCRIPTION	FUNCTION	CIRCUIT	CONTROL/STATE	WIRE SIZE (MOX)	WIRE SIZE (MIN)																			
V1	TEMP CONTROL VALVE TRIP	TEMP SENSOR CONNECTION	GND	-	2.539mm	0.6mm (RANG 20)																			
V2	LT CONTROL VALVE TRIP	MCB FEEDBACK	6.8VDC, 20mA, PROTECTED	CLASS 'B' CONTACT OPEN TO ACTIVATE	2.539mm	0.6mm (RANG 20)																			
V3	HT CONTROL VALVE TRIP	MCB FEEDBACK	6.8VDC, 20mA, PROTECTED	CLASS 'B' CONTACT OPEN TO ACTIVATE	2.539mm	0.6mm (RANG 20)																			
V4	HT TEMP INPUT +	TEMP SENSOR CONNECTION	24VDC, 2A, FUSED	-	2.539mm	0.6mm (RANG 20)																			
V5	HT TEMP INPUT -	TEMP SENSOR CONNECTION	24VDC, 2A, FUSED	-	2.539mm	0.6mm (RANG 20)																			
V6	HT TEMP INPUT SHIELD	TEMP SENSOR CONNECTION	GND	-	2.539mm	0.6mm (RANG 20)																			
V7	LT TEMP INPUT +	TEMP SENSOR CONNECTION	24VDC, 2A, FUSED	-	2.539mm	0.6mm (RANG 20)																			
V8	LT TEMP INPUT -	TEMP SENSOR CONNECTION	24VDC, 2A, FUSED	-	2.539mm	0.6mm (RANG 20)																			
V9	LT TEMP INPUT SHIELD	TEMP SENSOR CONNECTION	GND	-	2.539mm	0.6mm (RANG 20)																			
V10	TEMP CONTROL POWER SUPPLY +V3	TEMP SENSOR CONNECTION	GND	-	2.539mm	0.6mm (RANG 20)																			
V11	TEMP CONTROL POWER SUPPLY GND	TEMP SENSOR CONNECTION	24VDC, 5A, FUSED	-	2.539mm	0.6mm (RANG 20)																			
AC18	THERMOSTAT CONTROL SUPPLY	CONTROL	240VAC, 10A	-	2.539mm	1mm (RANG 18)																			
AC19	THERMOSTAT CONTROL SUPPLY	CONTROL	240VAC, 10A	-	2.539mm	1mm (RANG 18)																			
AC20	HT VALVE CONTROLLER (OPEN)	CONTROL	240VAC, 6A	CLASS 'A' CONTACT CLOSE TO ACTIVATE	2.539mm	1mm (RANG 18)																			
AC21	HT VALVE CONTROLLER (CLOSE)	CONTROL	240VAC, 6A	CLASS 'A' CONTACT CLOSE TO ACTIVATE	2.539mm	1mm (RANG 18)																			
AC22	HT VALVE CONTROLLER (COMMON)	CONTROL	240VAC, 6A	-	2.539mm	1mm (RANG 18)																			
AC23	HT VALVE CONTROLLER (CLOSE)	CONTROL	240VAC, 6A	CLASS 'A' CONTACT CLOSE TO ACTIVATE	2.539mm	1mm (RANG 18)																			
AC24	HT VALVE CONTROLLER (OPEN)	CONTROL	240VAC, 6A	CLASS 'A' CONTACT CLOSE TO ACTIVATE	2.539mm	1mm (RANG 18)																			
AC25	HT VALVE CONTROLLER (COMMON)	CONTROL	240VAC, 6A	-	2.539mm	1mm (RANG 18)																			

FIGURE 30. A044L814 SHEET 10 OF 10

# Appendix B. Gas Valve

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The drawings included in this section are representative. For current complete information, refer to the drawing package that was shipped with the unit.

# B.1 A035B755 Gas Valve Installation for Titan 50hz

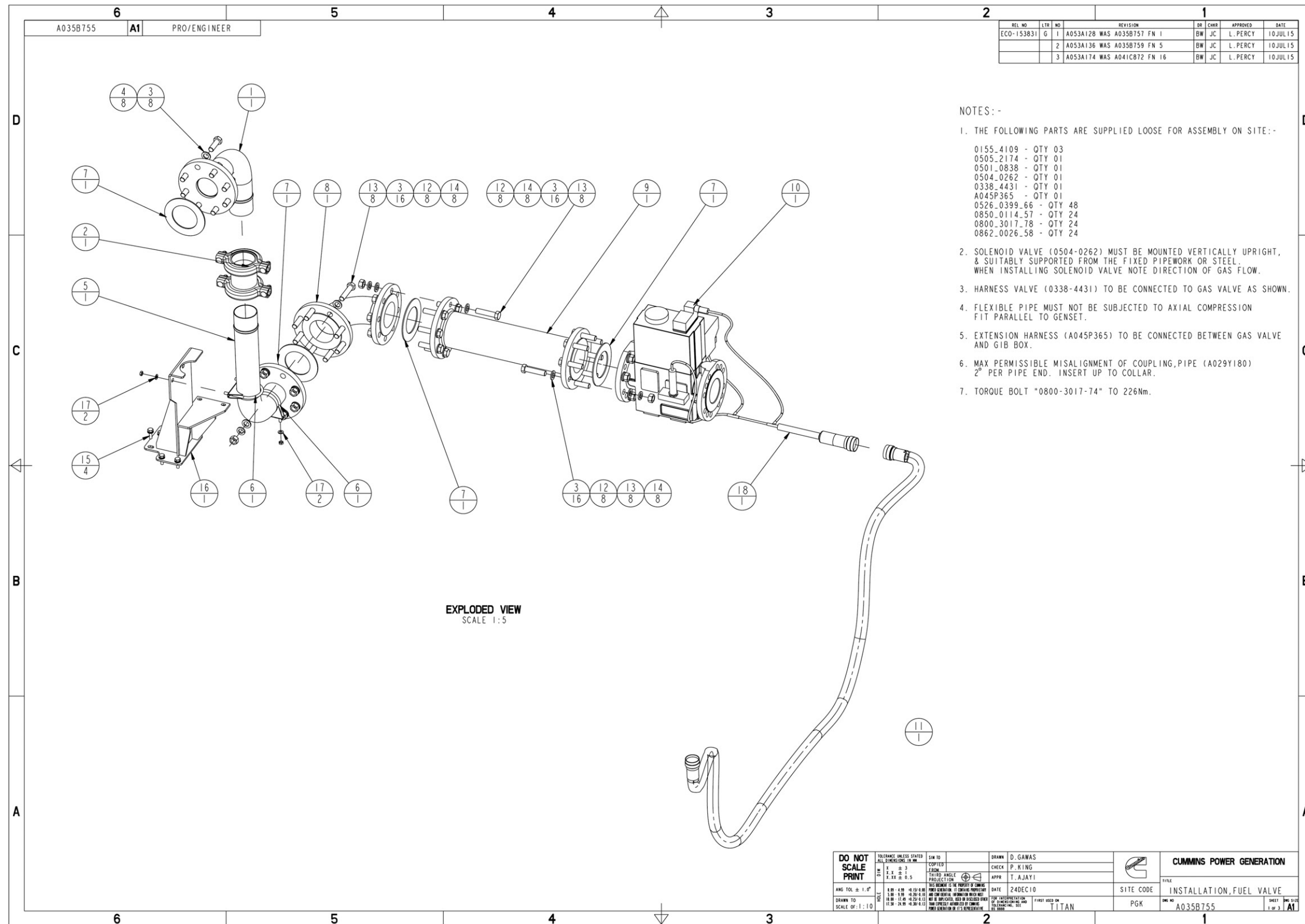


FIGURE 31. A035B755 SHEET 1 OF 3

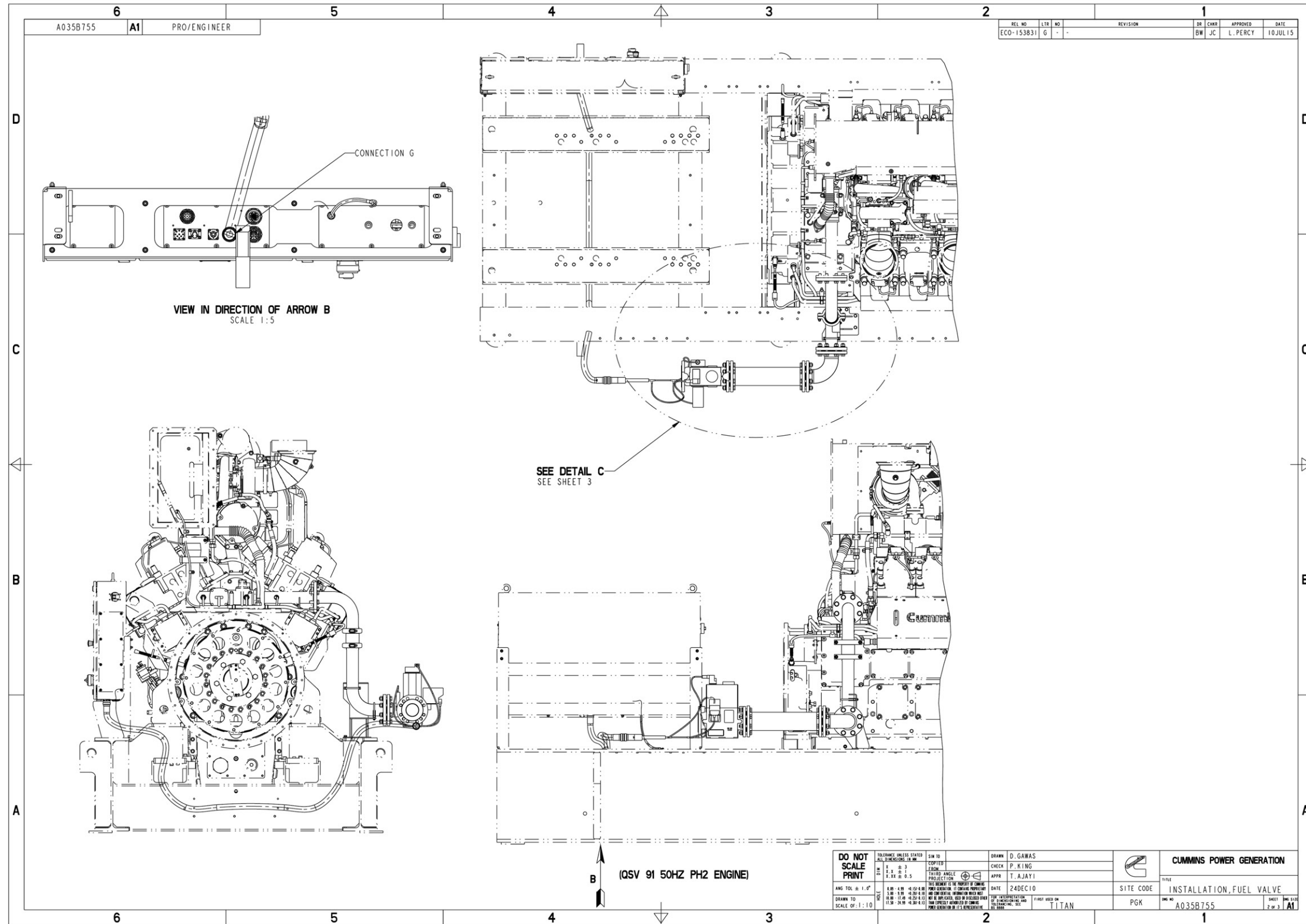


FIGURE 32. A035B755 SHEET 2 OF 3

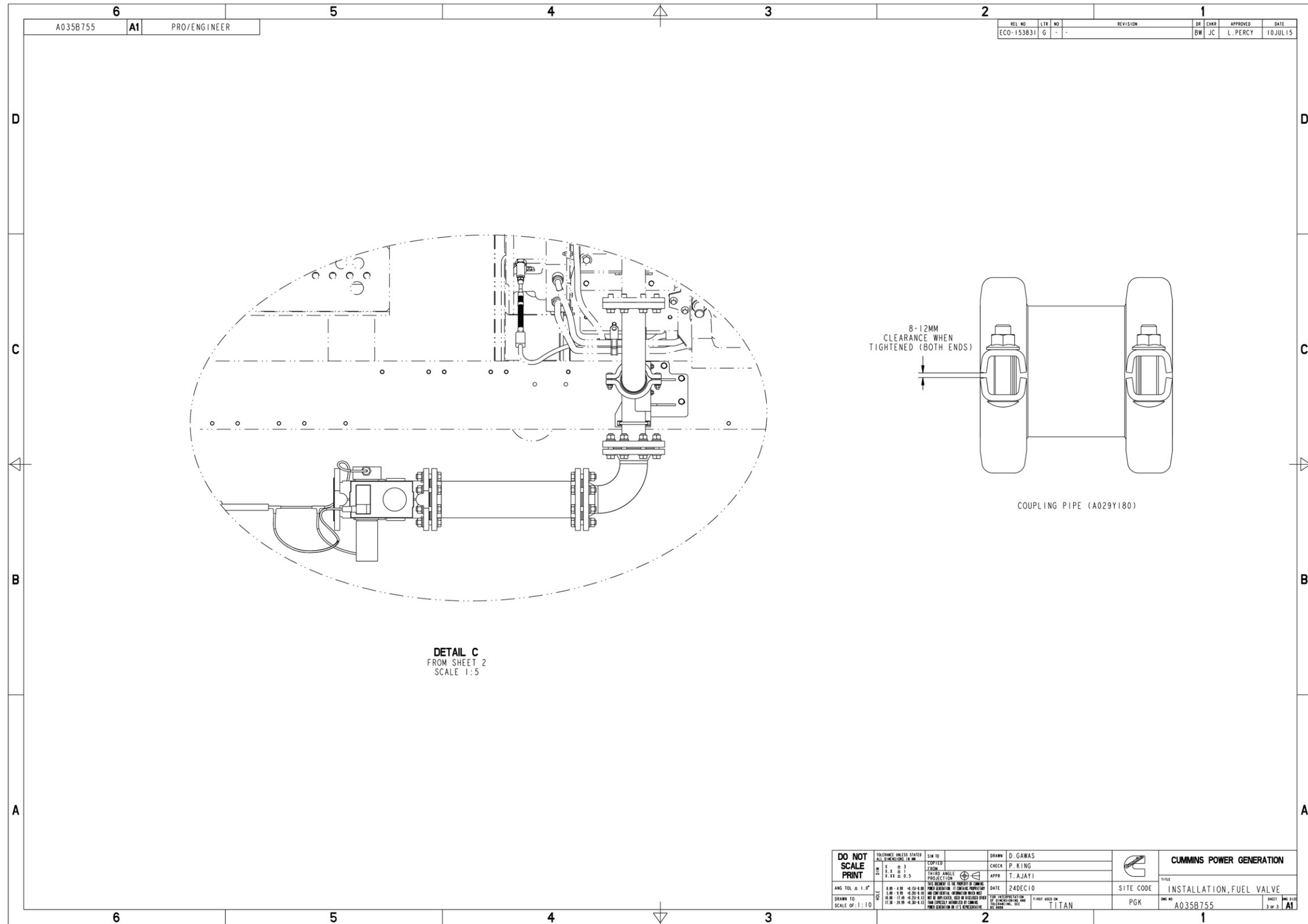


FIGURE 33. A035B755 SHEET 3 OF 3

## B.2 A054A948 Gas Valve Installation

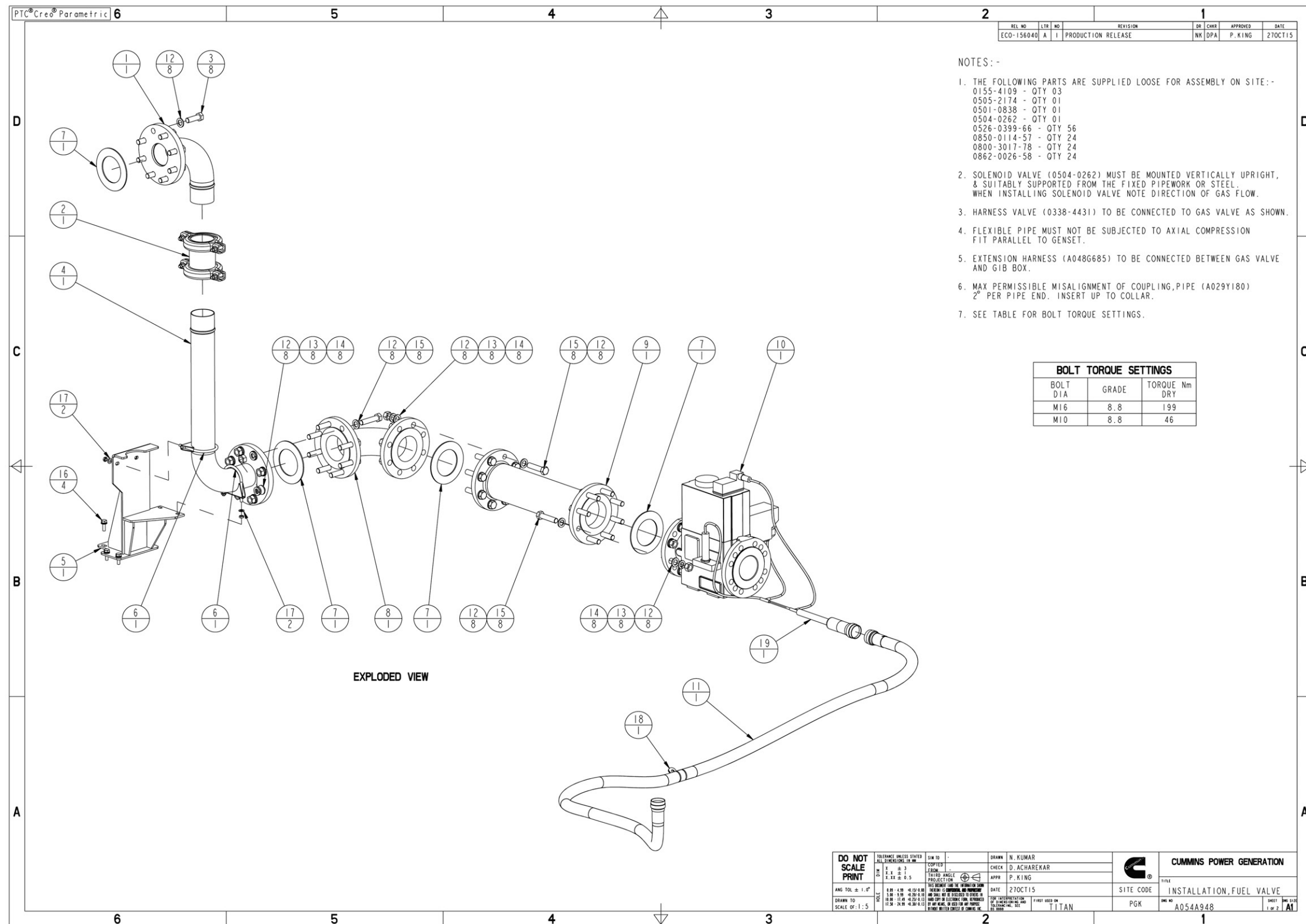


FIGURE 34. A054A948 SHEET 1 OF 2

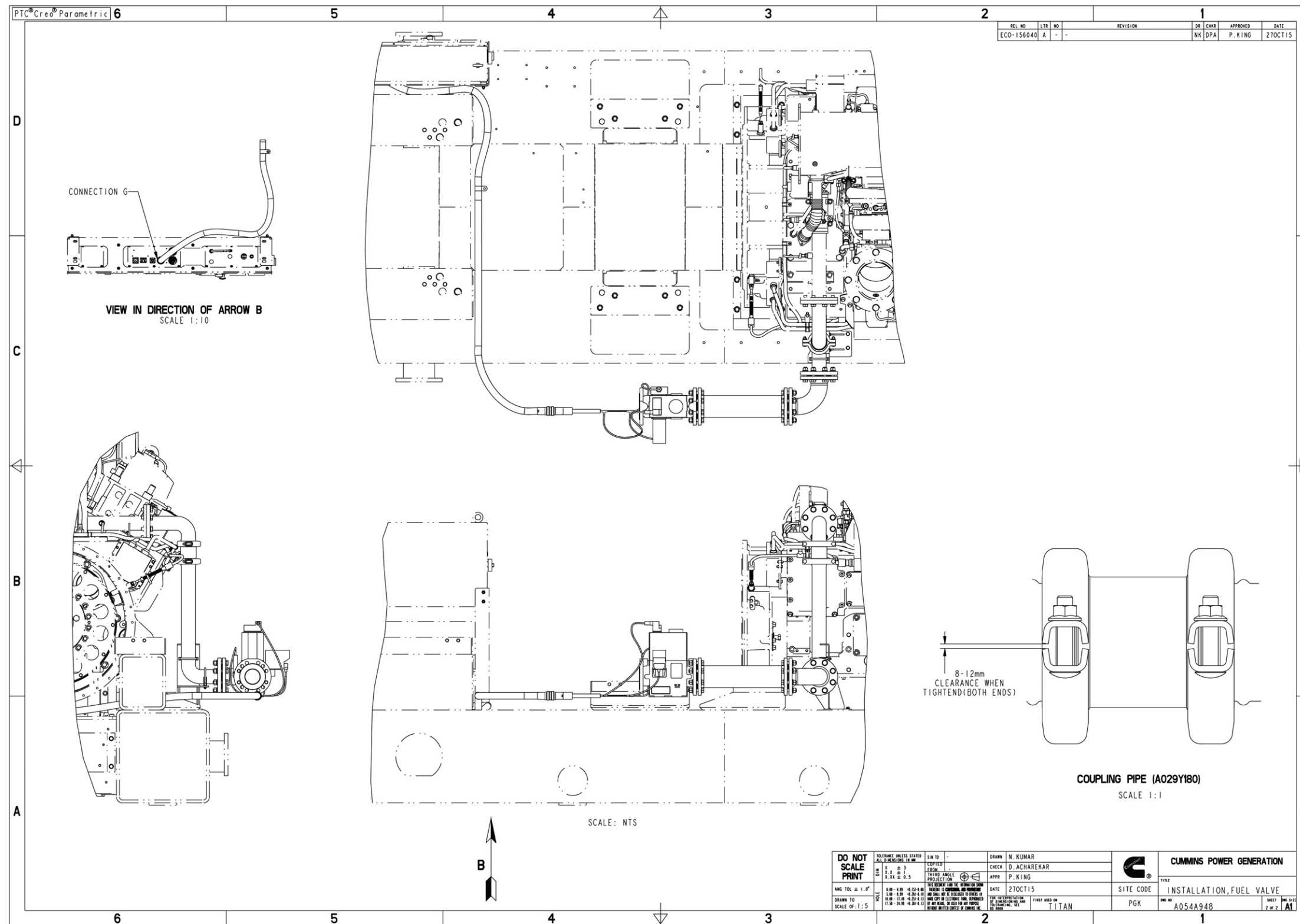


FIGURE 35. A054A948 SHEET 2 OF 2

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# Appendix C. Lifting Drawing

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The drawings included in this section are representative. For current complete information, refer to the drawing package that was shipped with the unit.

# C.1 A040J669 Lifting Drawing For 50Hz

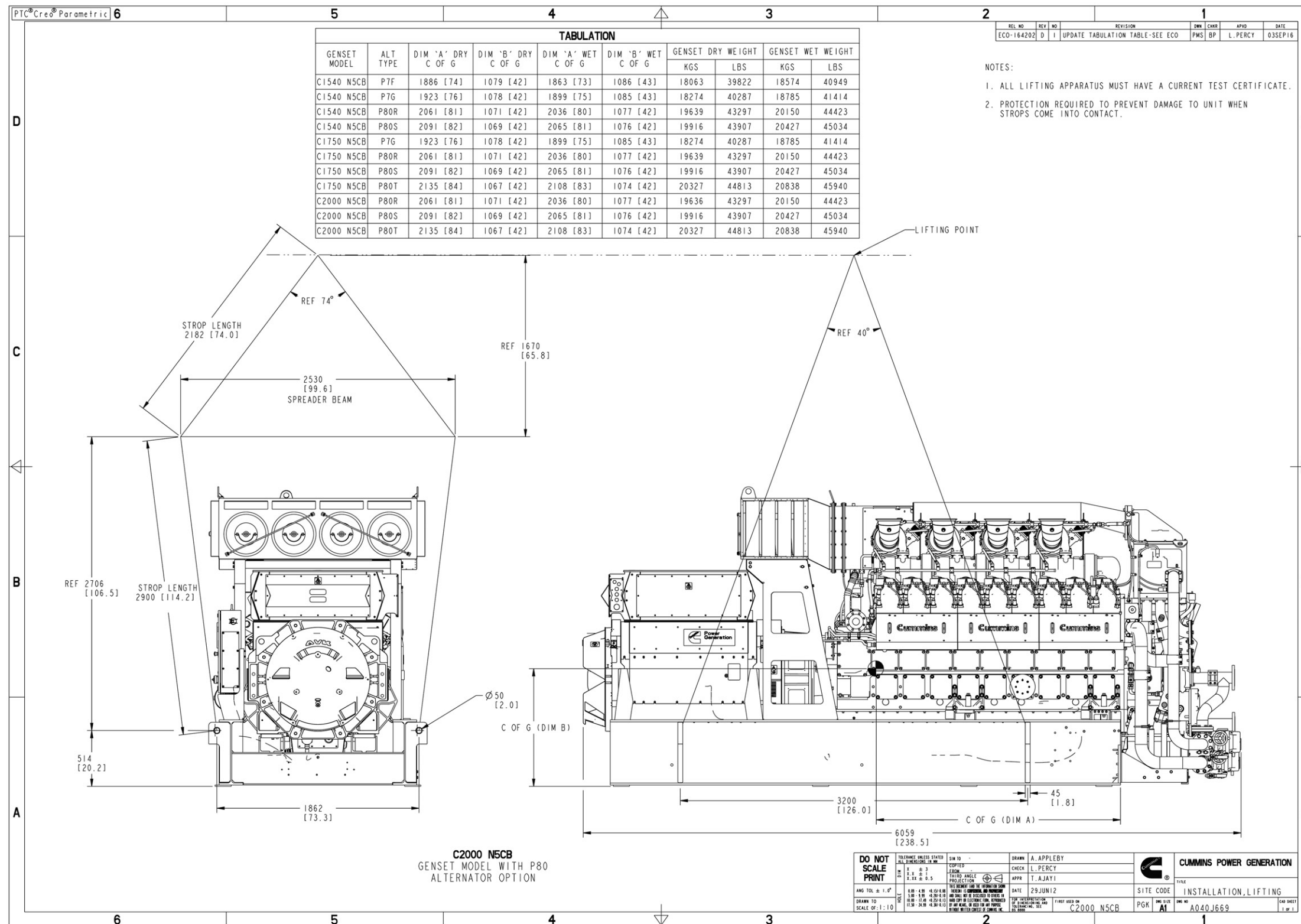


FIGURE 36. A040J669 SHEET 1 OF 1

### C.2 A040Z328 Lifting Drawing For 60Hz

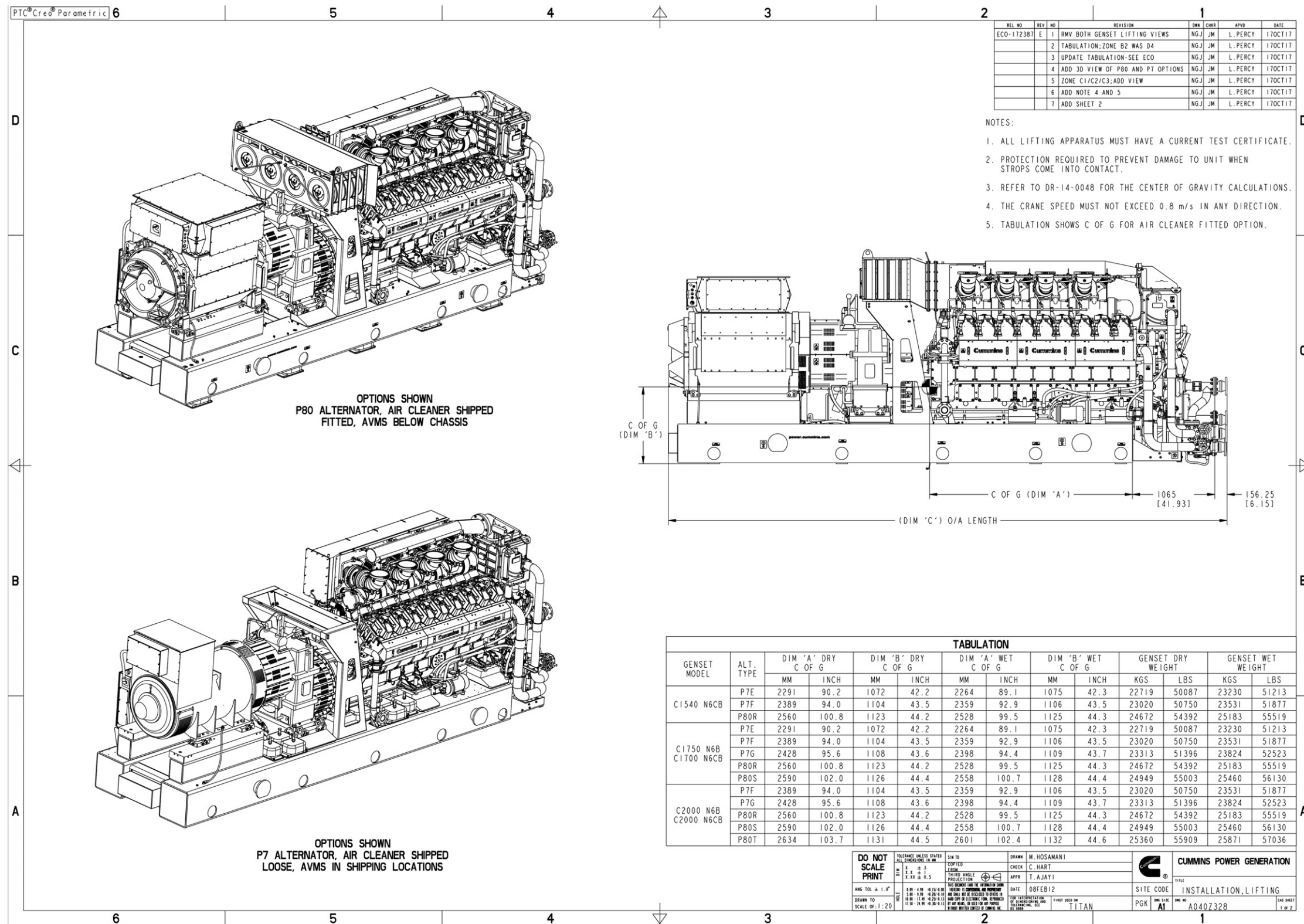


FIGURE 37. A040Z328 SHEET 1 OF 2

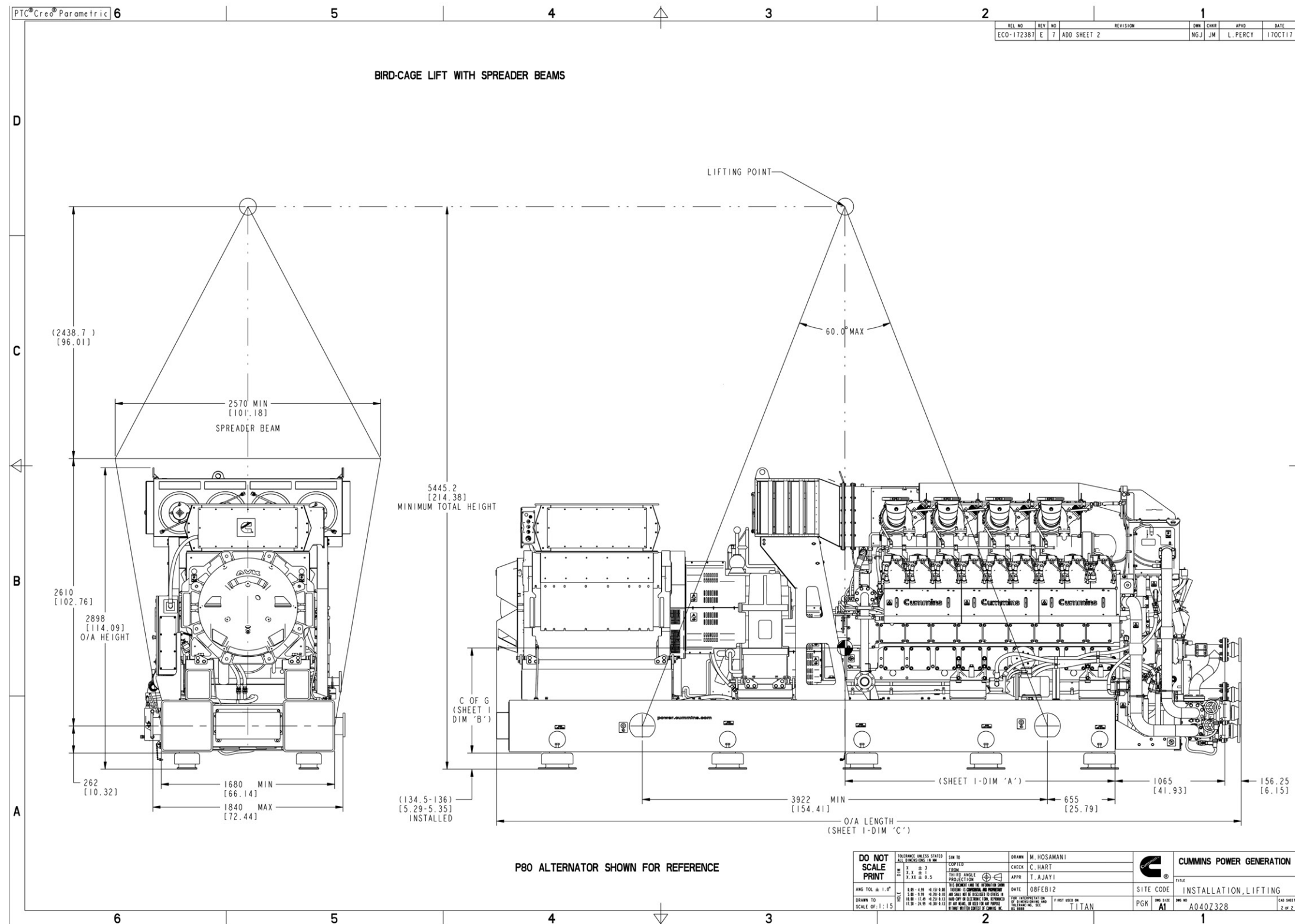


FIGURE 38. A040Z328 SHEET 2 OF 2

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# Appendix D. Outline Drawings

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The drawings included in this section are representative. For current complete information, refer to the drawing package that was shipped with the unit.

# D.1 A053P304 Outline Drawing for 50Hz

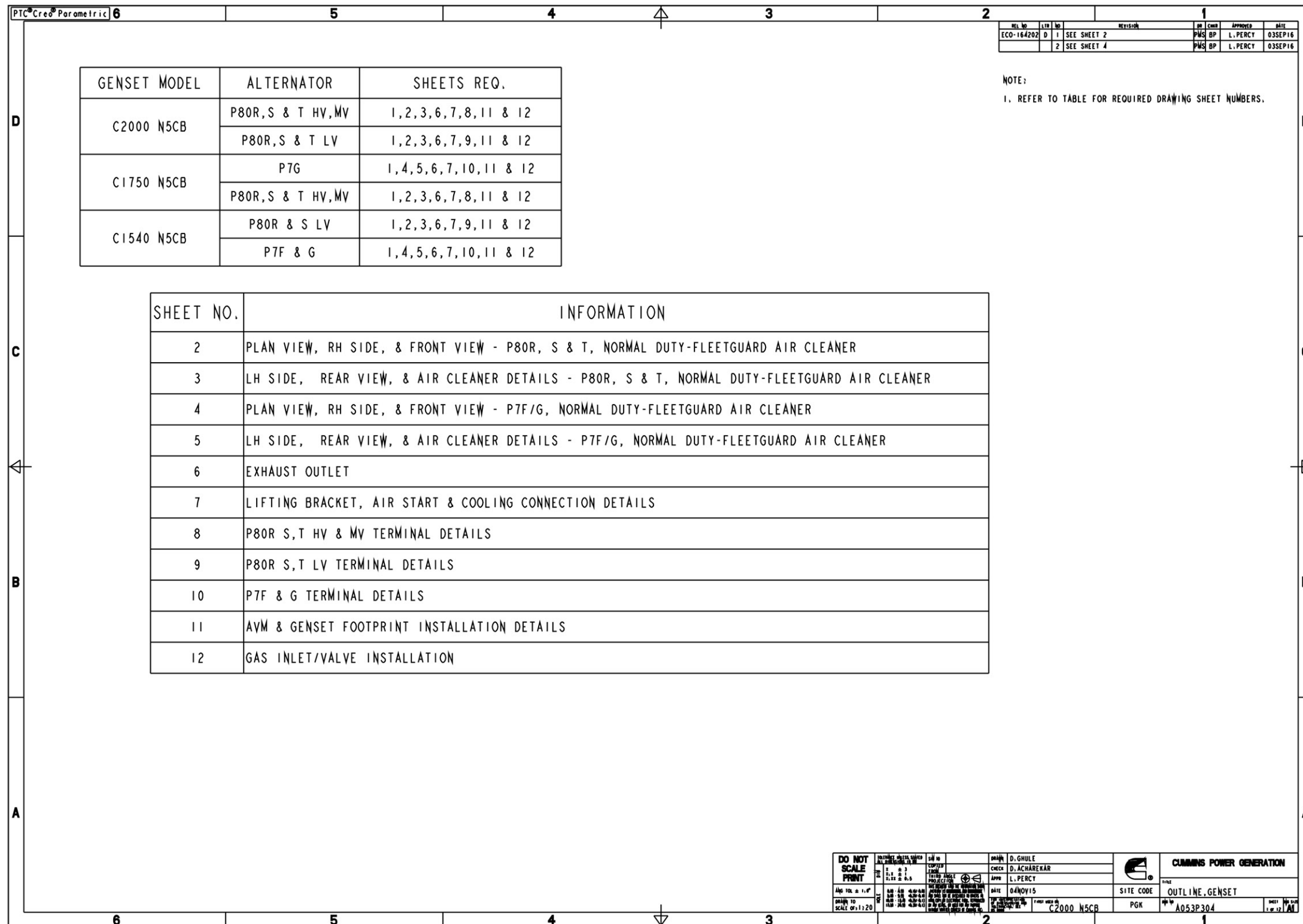


FIGURE 39. A053P304 SHEET 1 OF 12

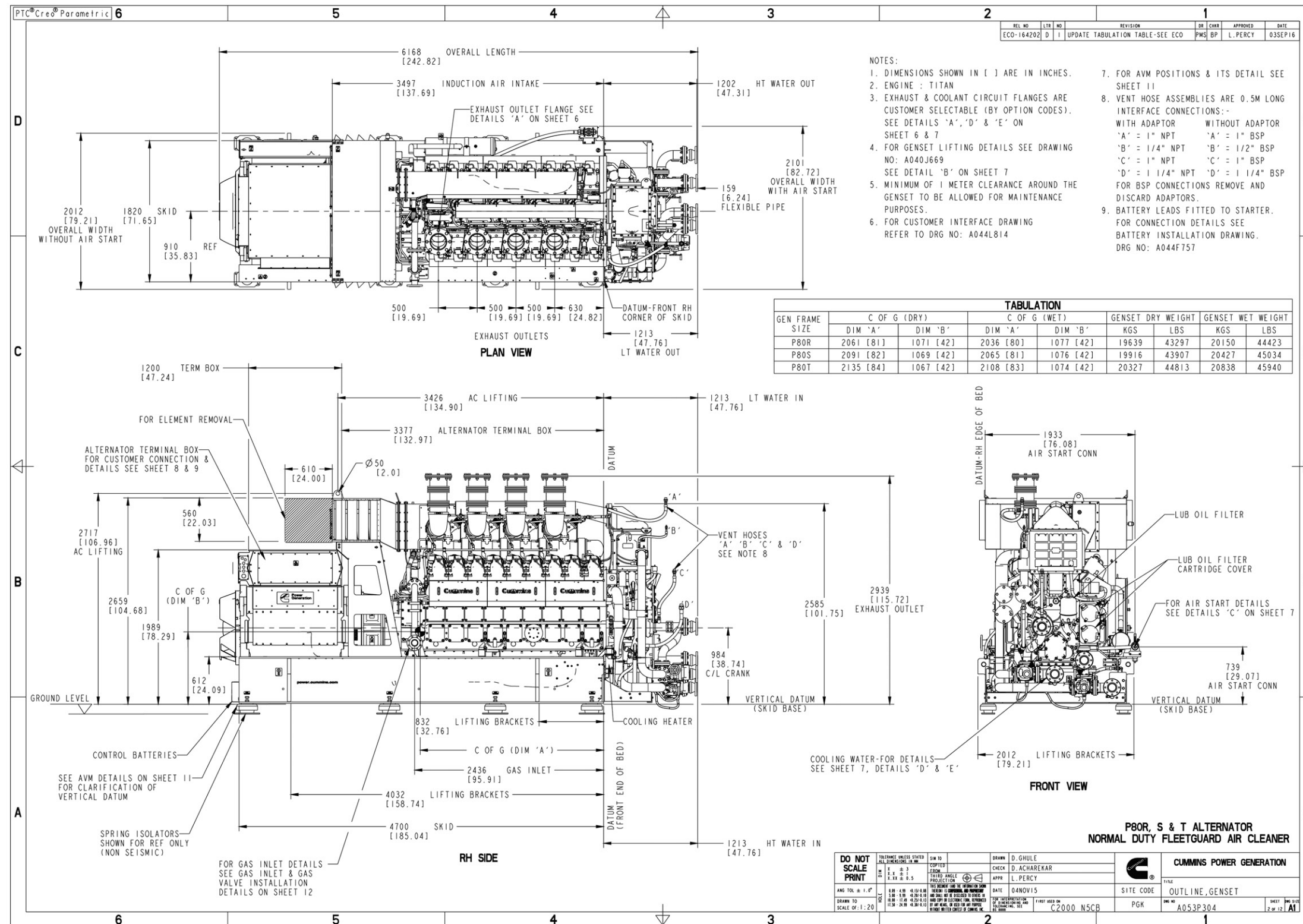


FIGURE 40. A053P304 SHEET 2 OF 12

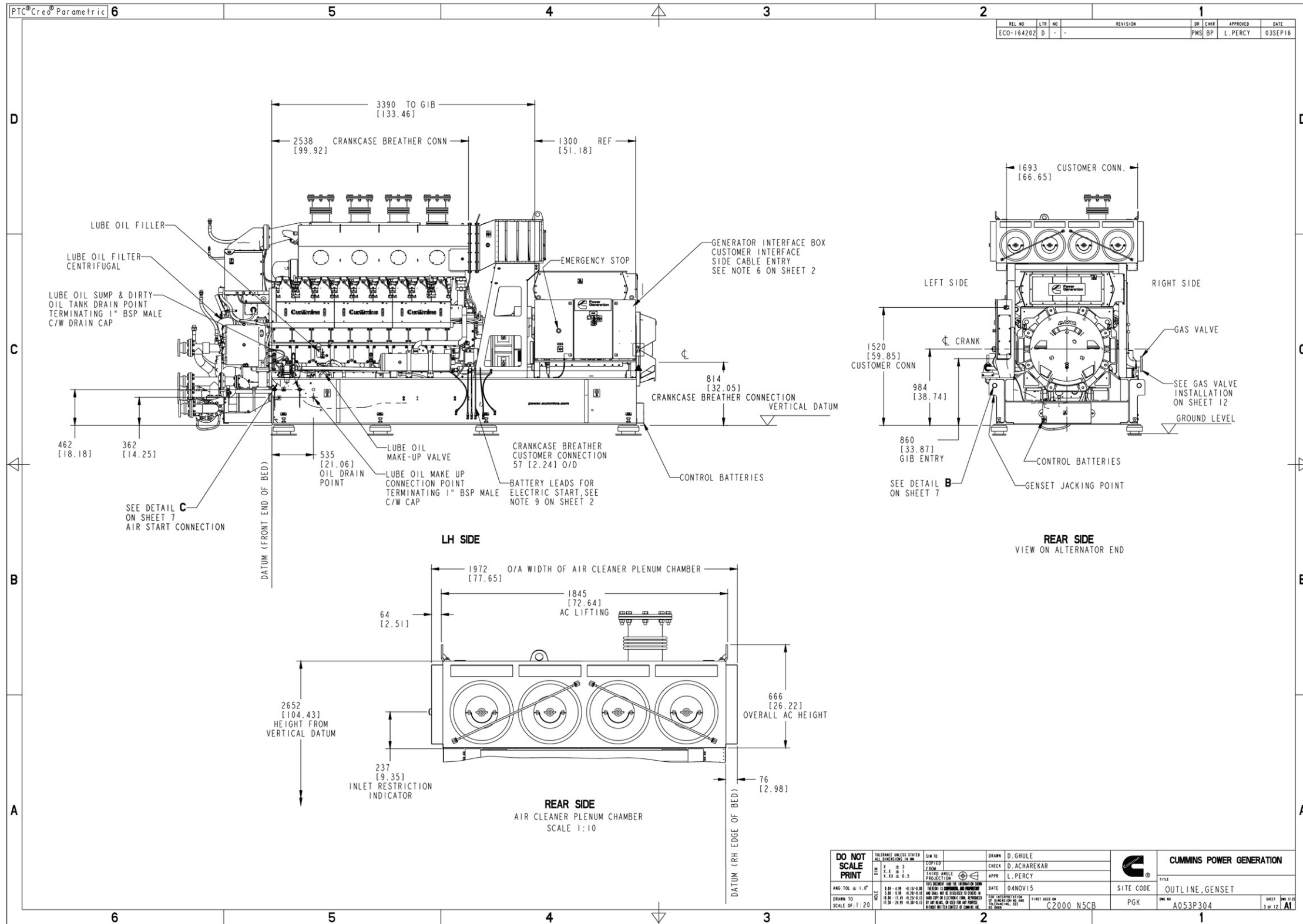


FIGURE 41. A053P304 SHEET 3 OF 12

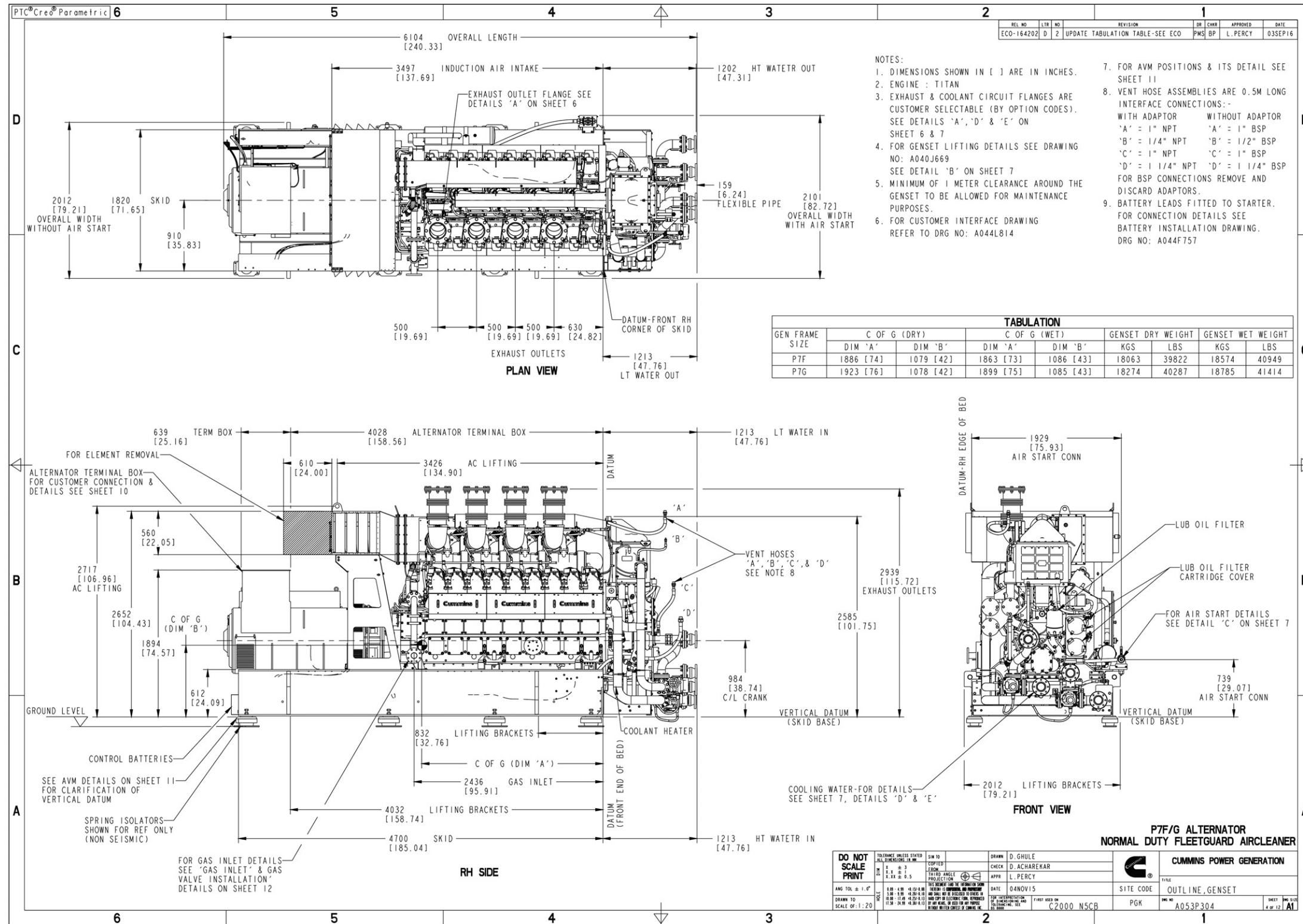


FIGURE 42. A053P304 SHEET 4 OF 12

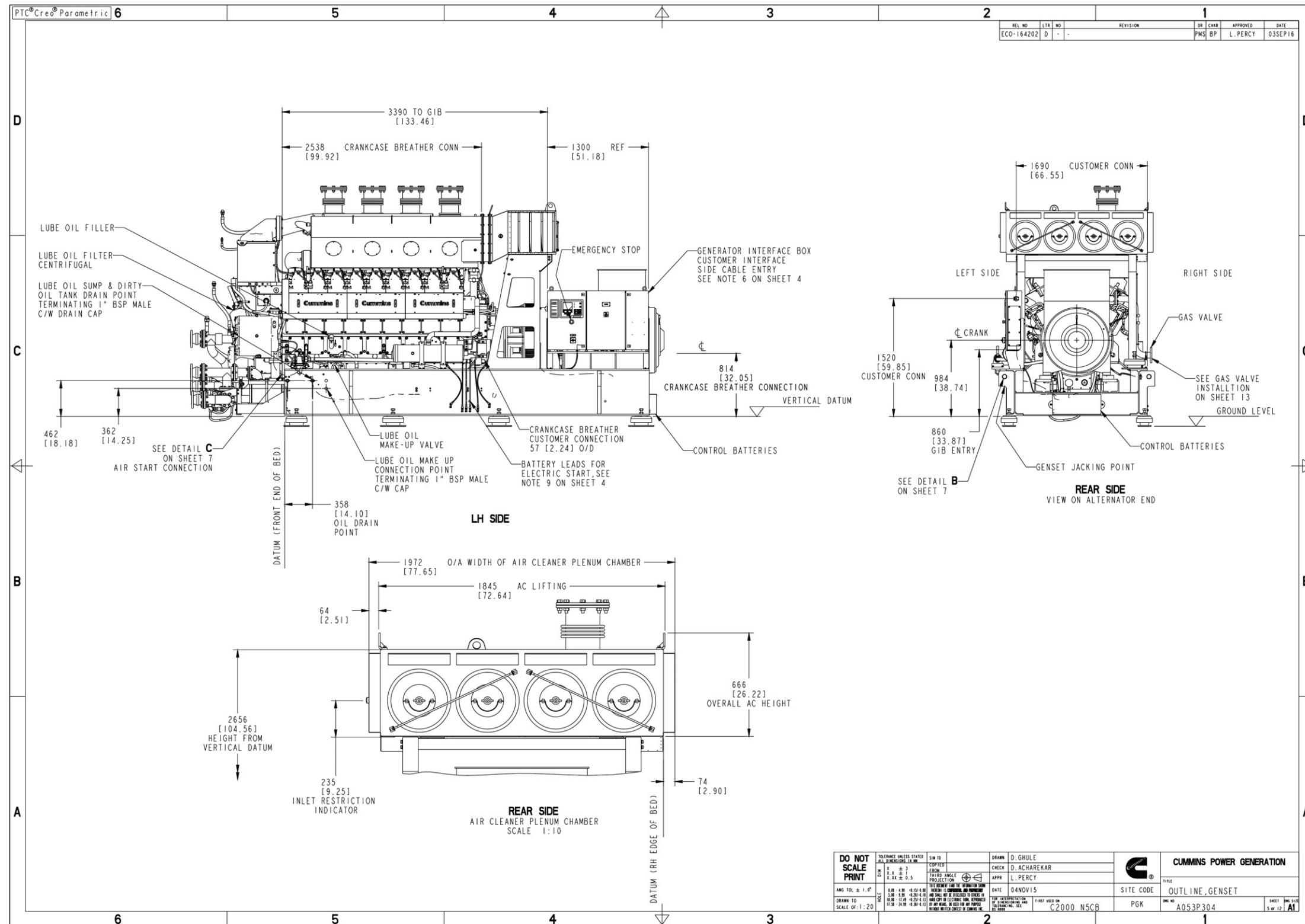


FIGURE 43. A053P304 SHEET 5 OF 12

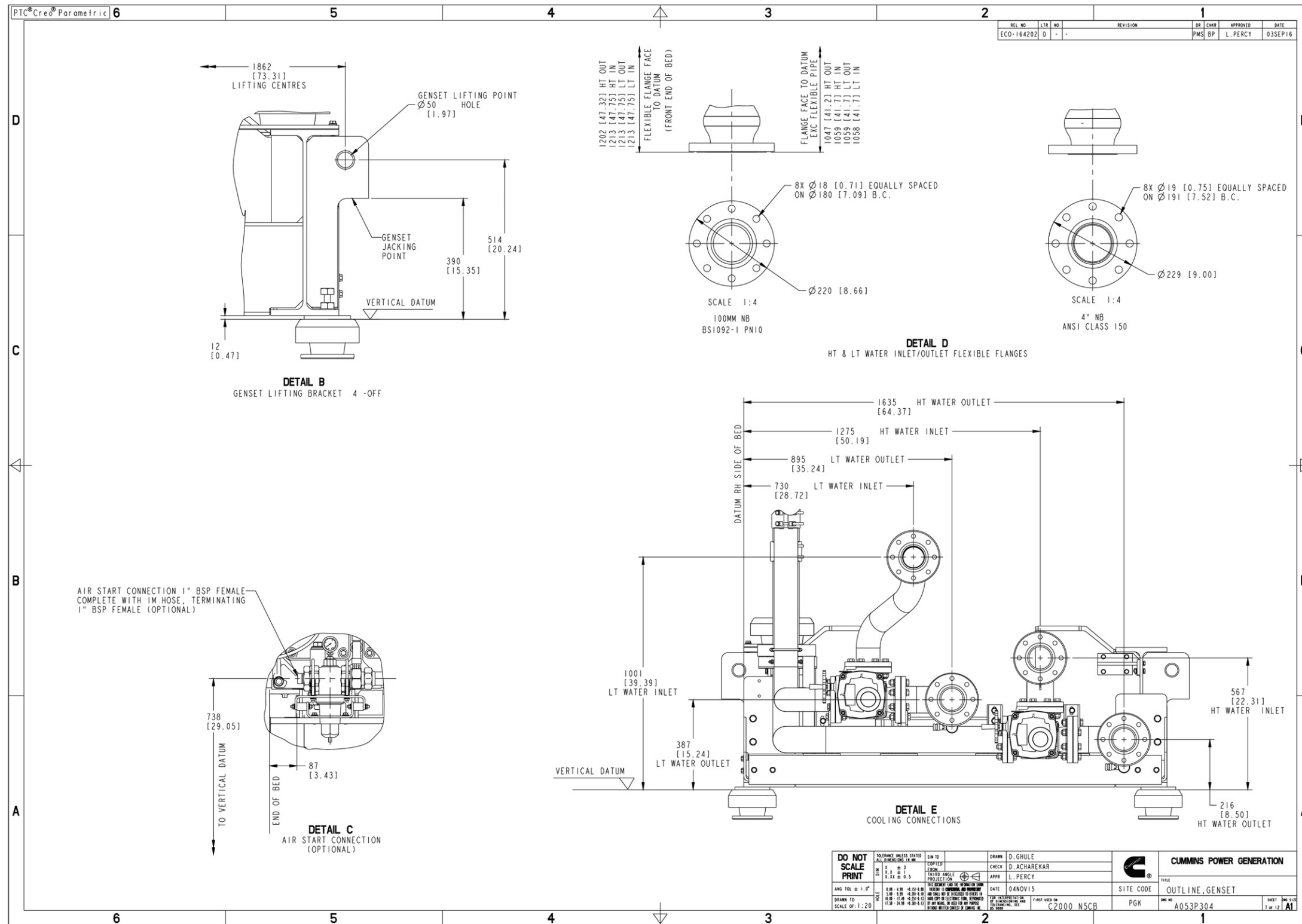


FIGURE 44. A053P304 SHEET 6 OF 12

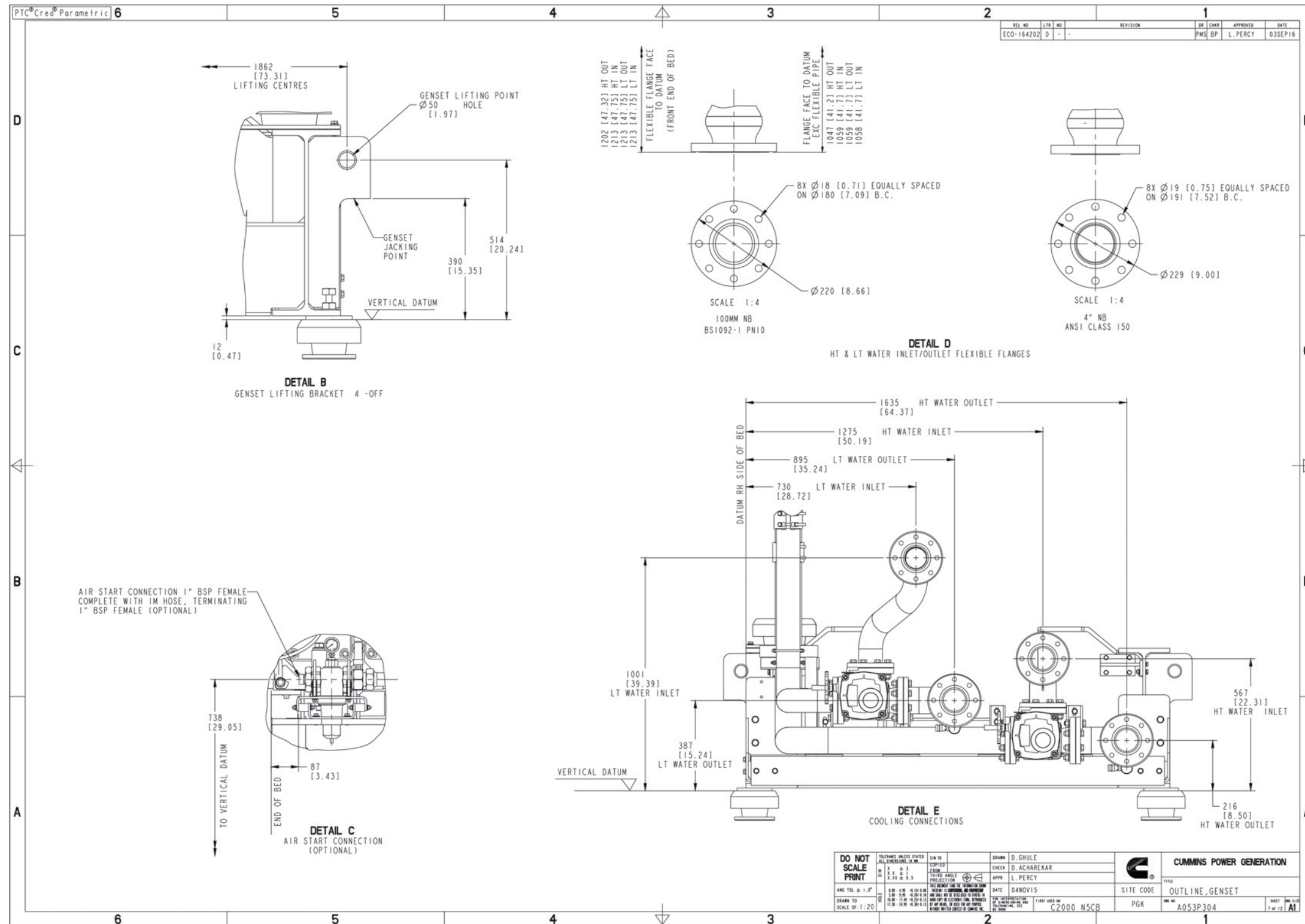


FIGURE 45. A053P304 SHEET 7 OF 12

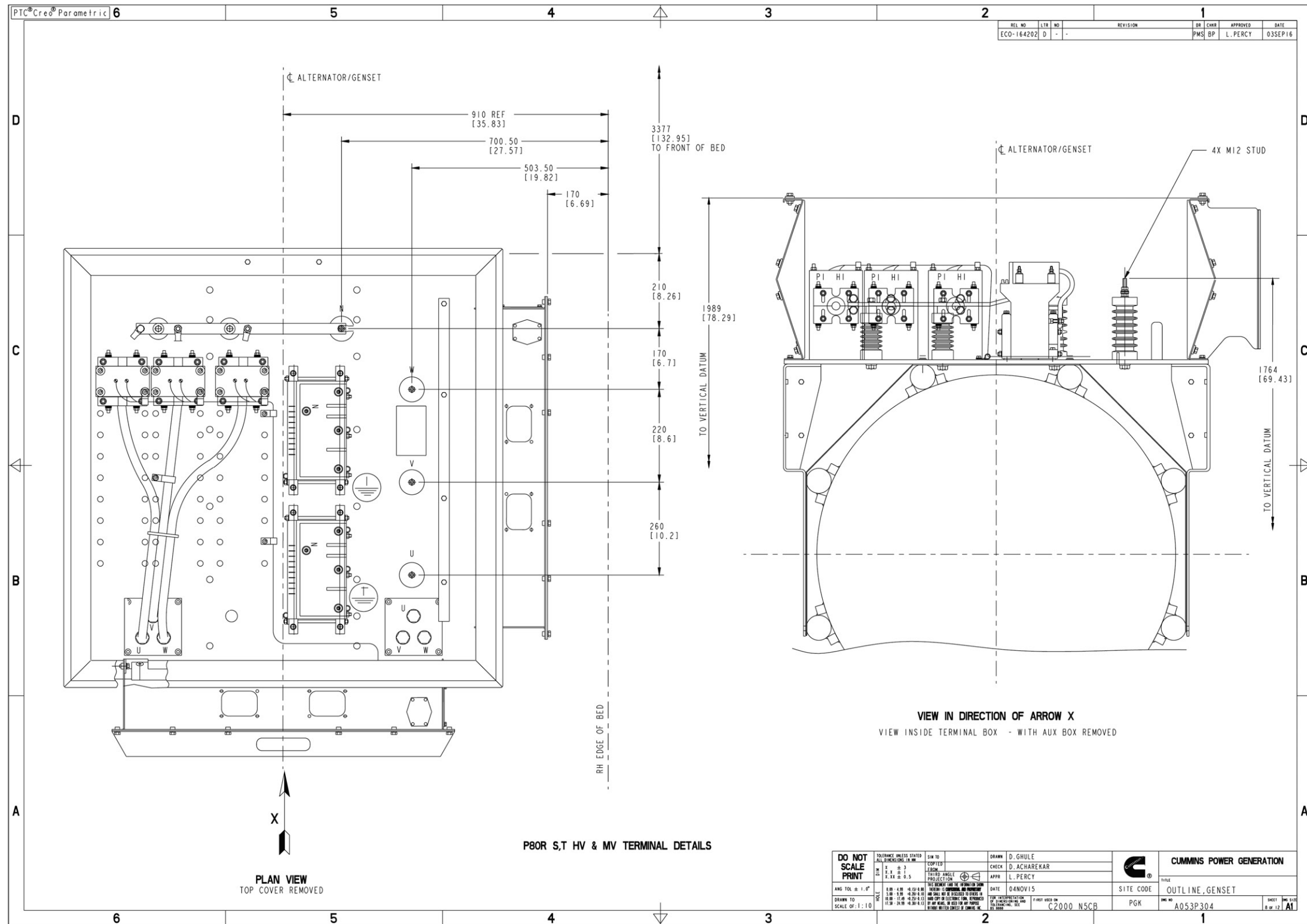


FIGURE 46. A053P304 SHEET 8 OF 12

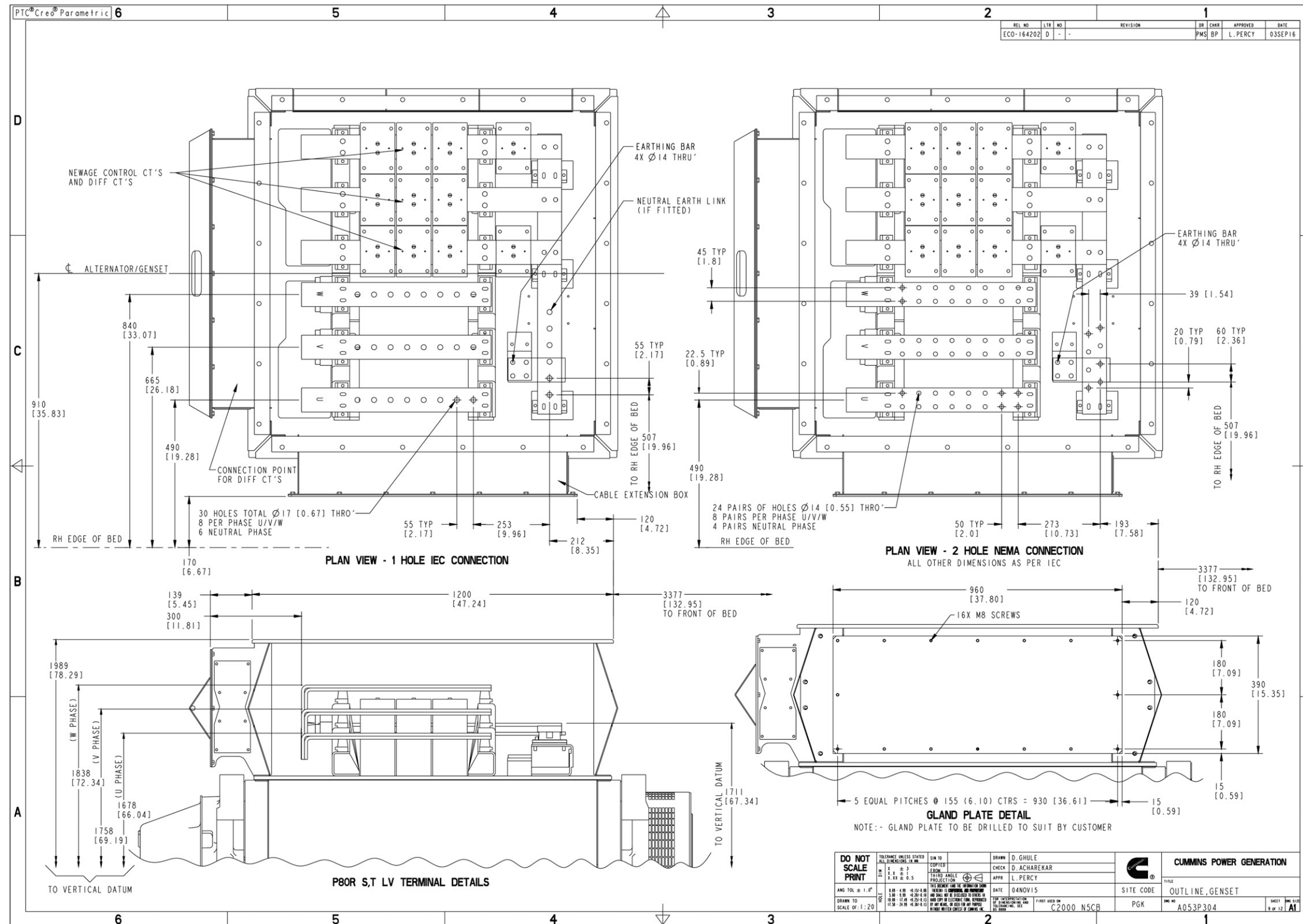


FIGURE 47. A053P304 SHEET 9 OF 12

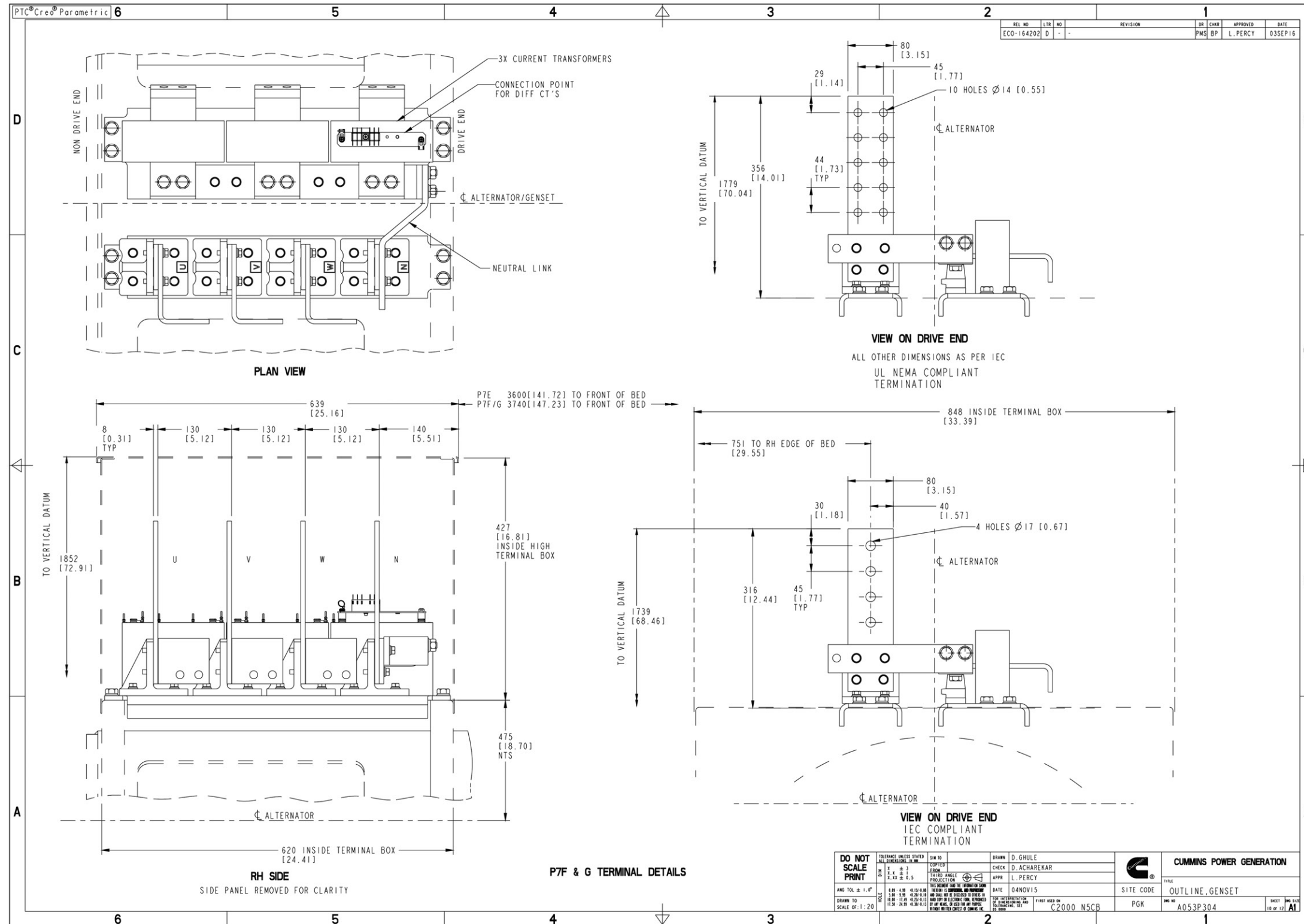


FIGURE 48. A053P304 SHEET 10 OF 12

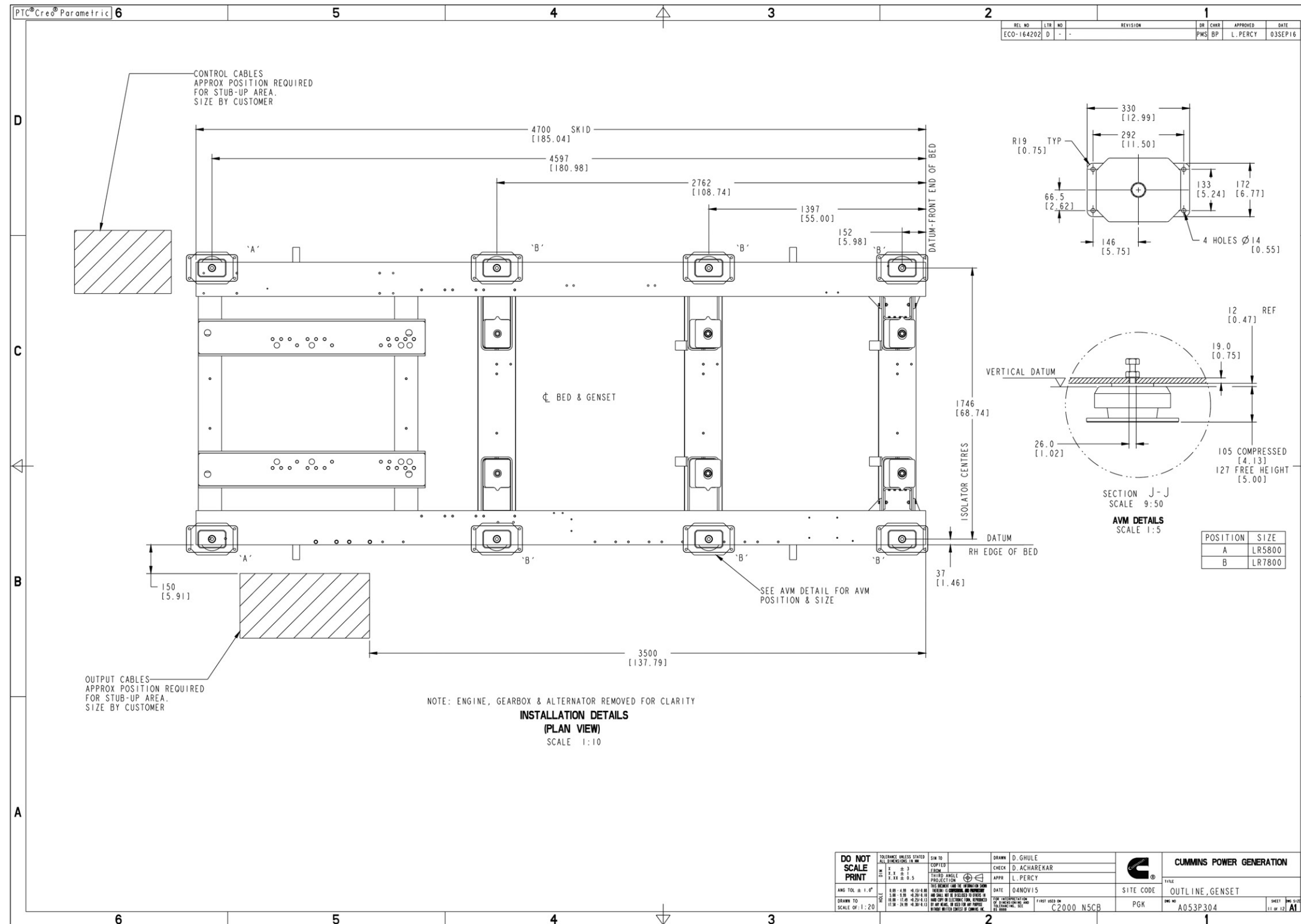


FIGURE 49. A053P304 SHEET 11 OF 12



## D.2 A035P864 Outline Drawing For 60Hz

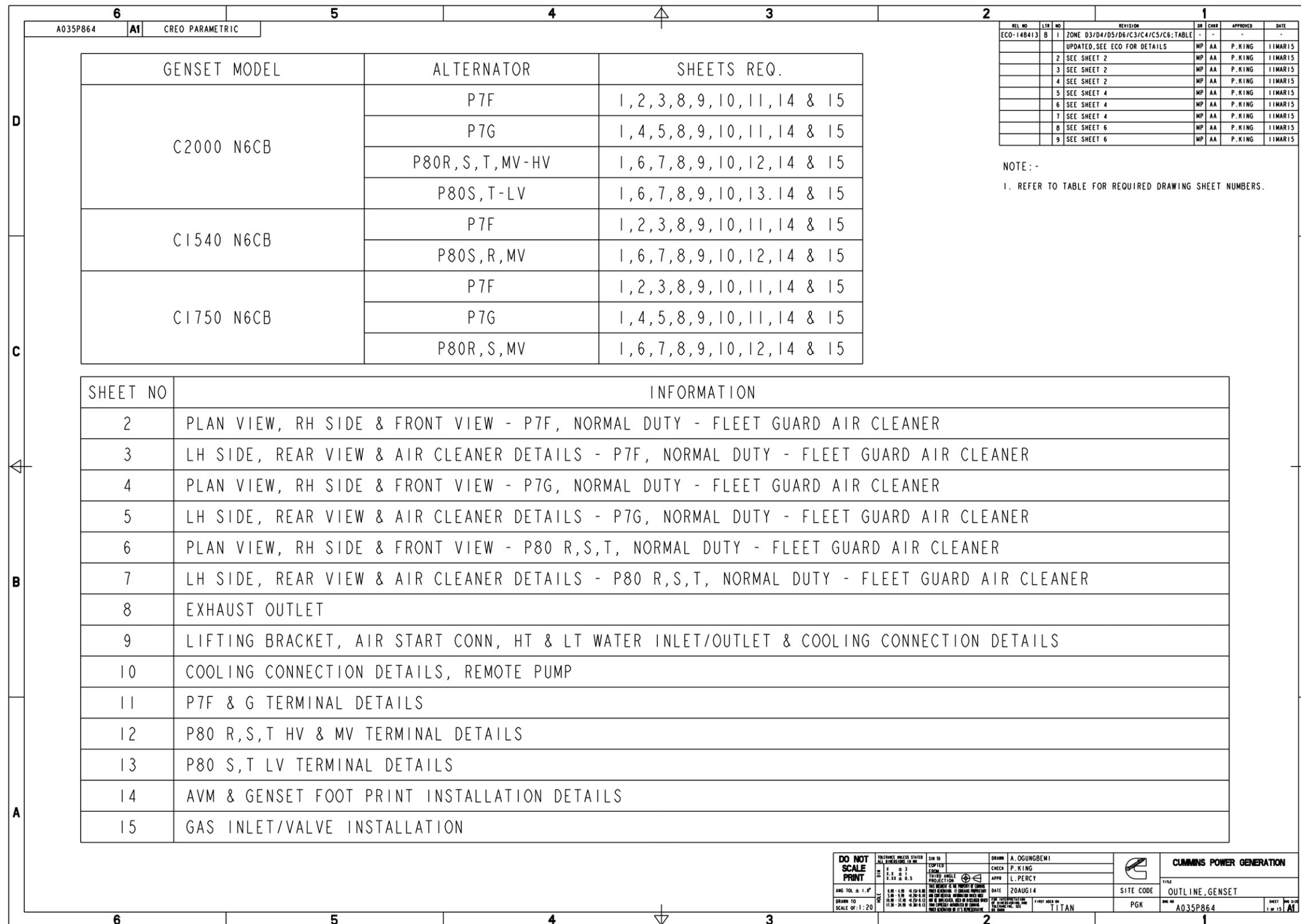


FIGURE 51. A035P864 SHEET 1 OF 15

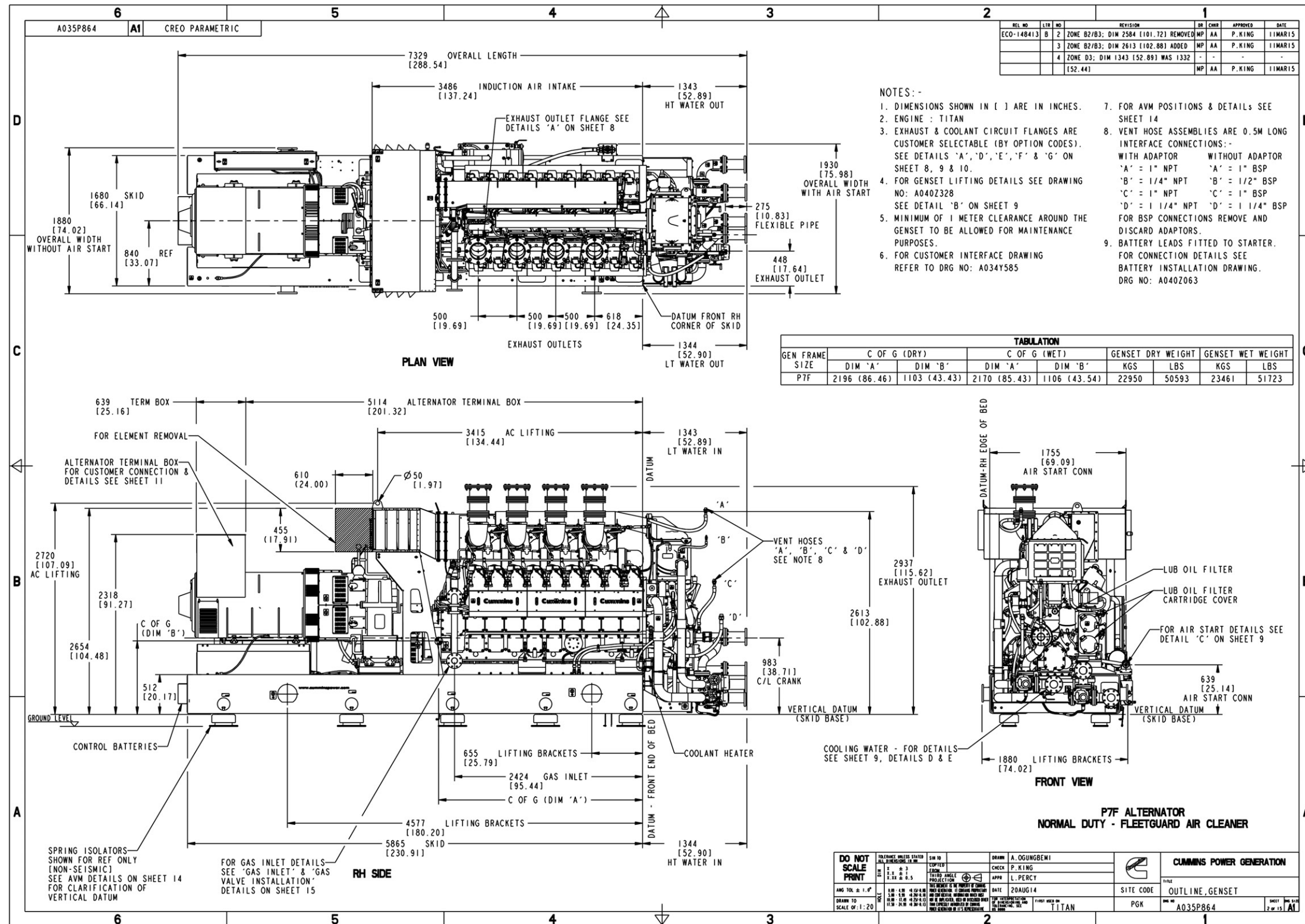


FIGURE 52. A035P864 SHEET 2 OF 15

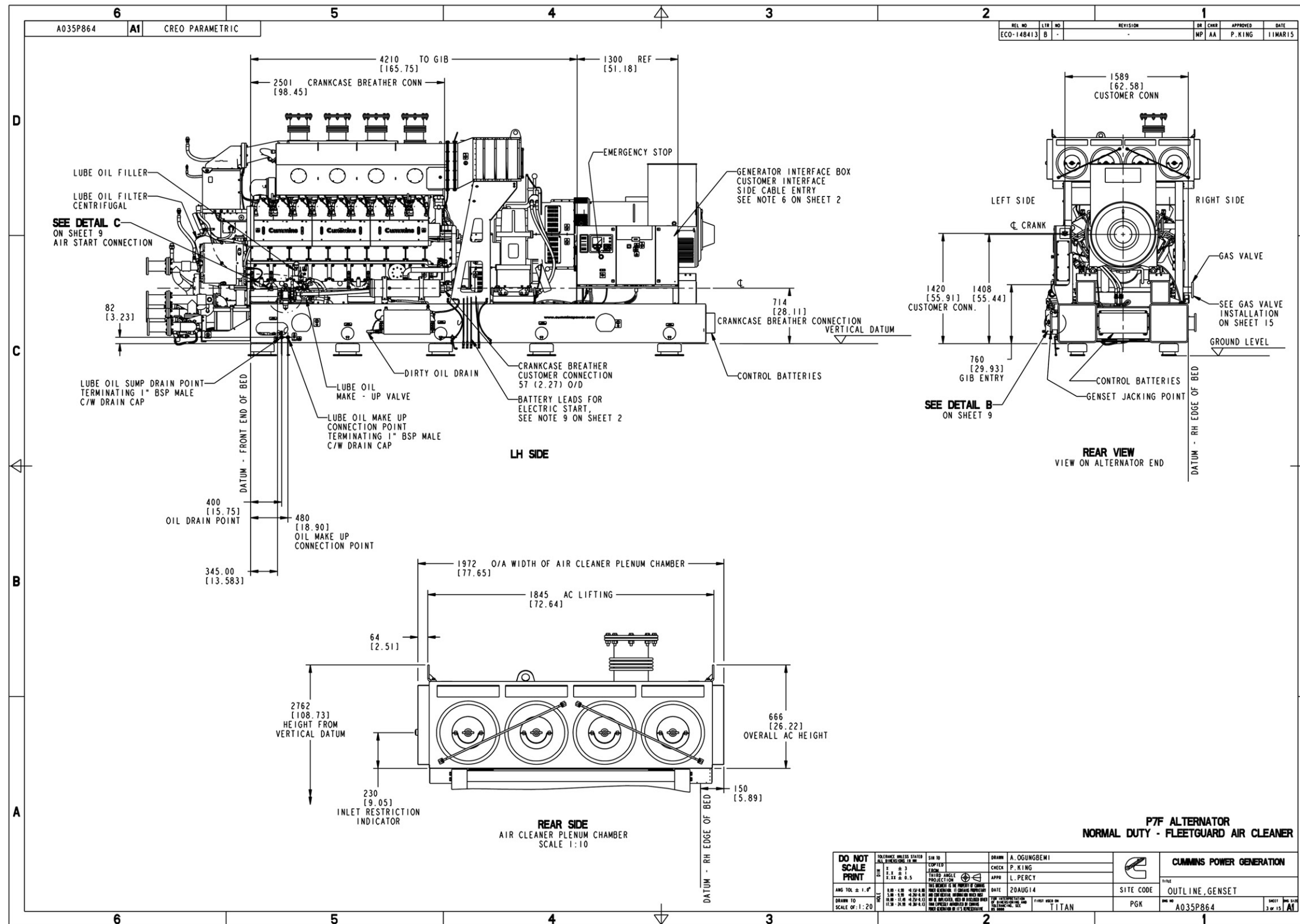


FIGURE 53. A035P864 SHEET 3 OF 15

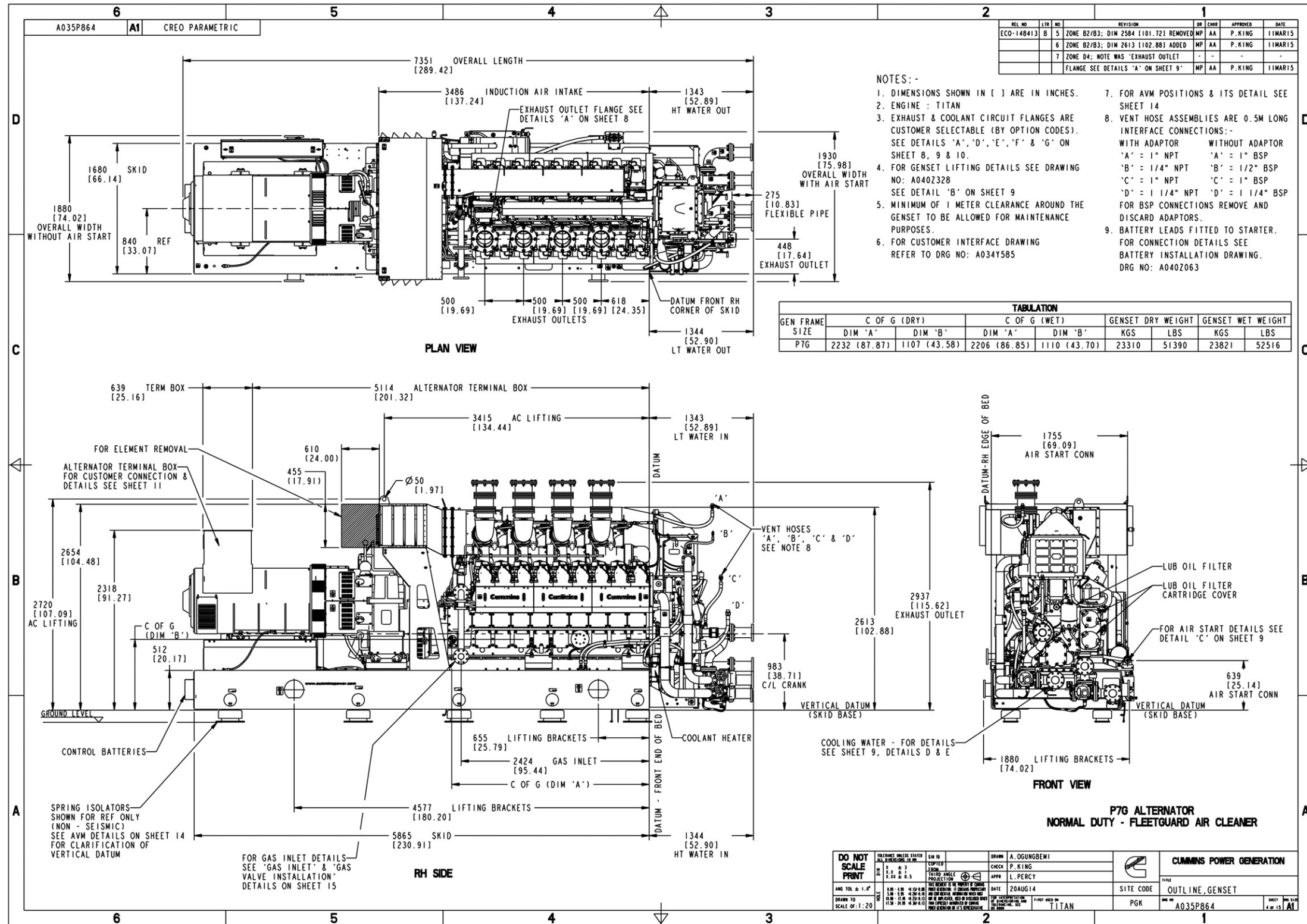


FIGURE 54. A035P864 SHEET 4 OF 15



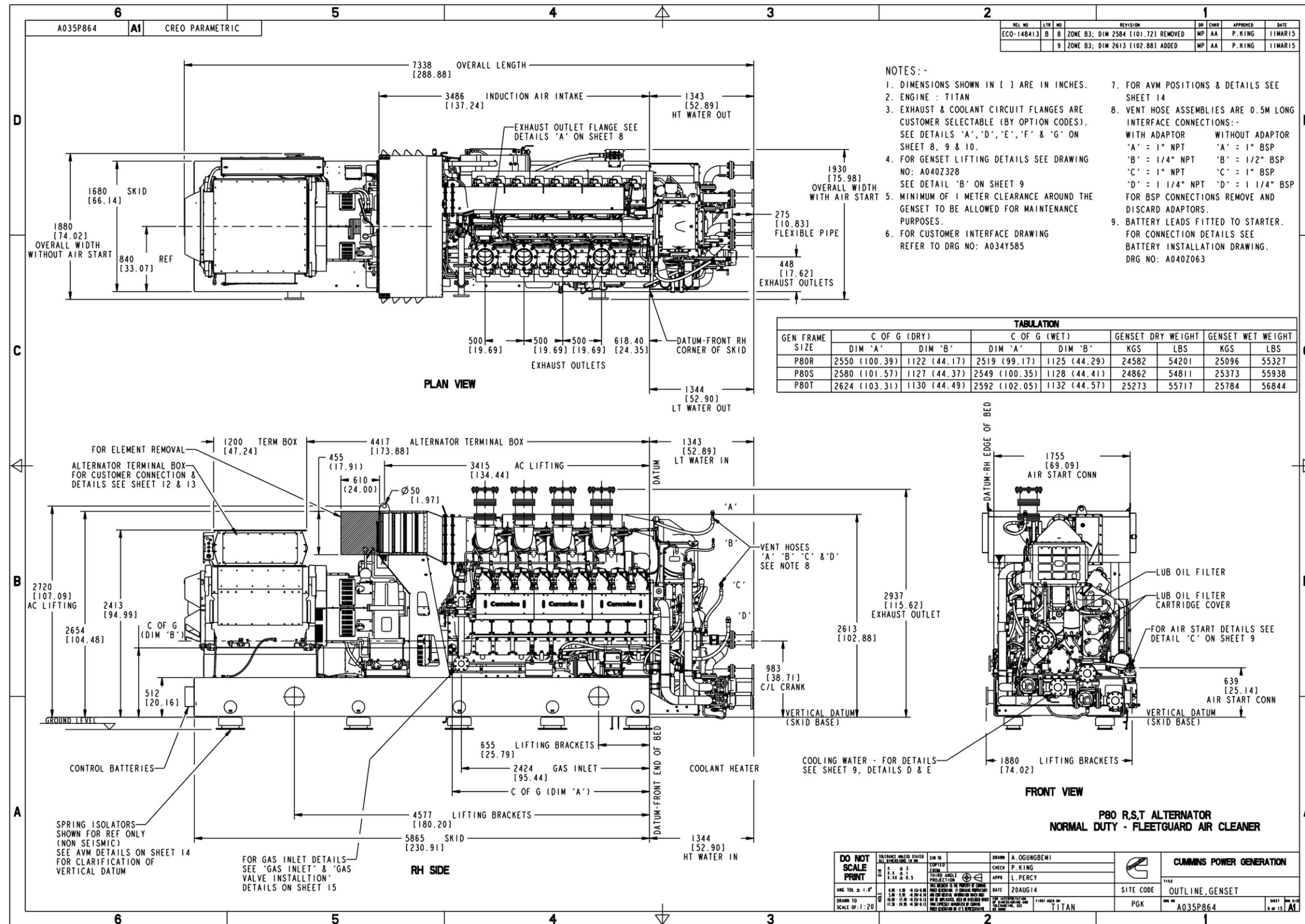


FIGURE 56. A035P864 SHEET 6 OF 15

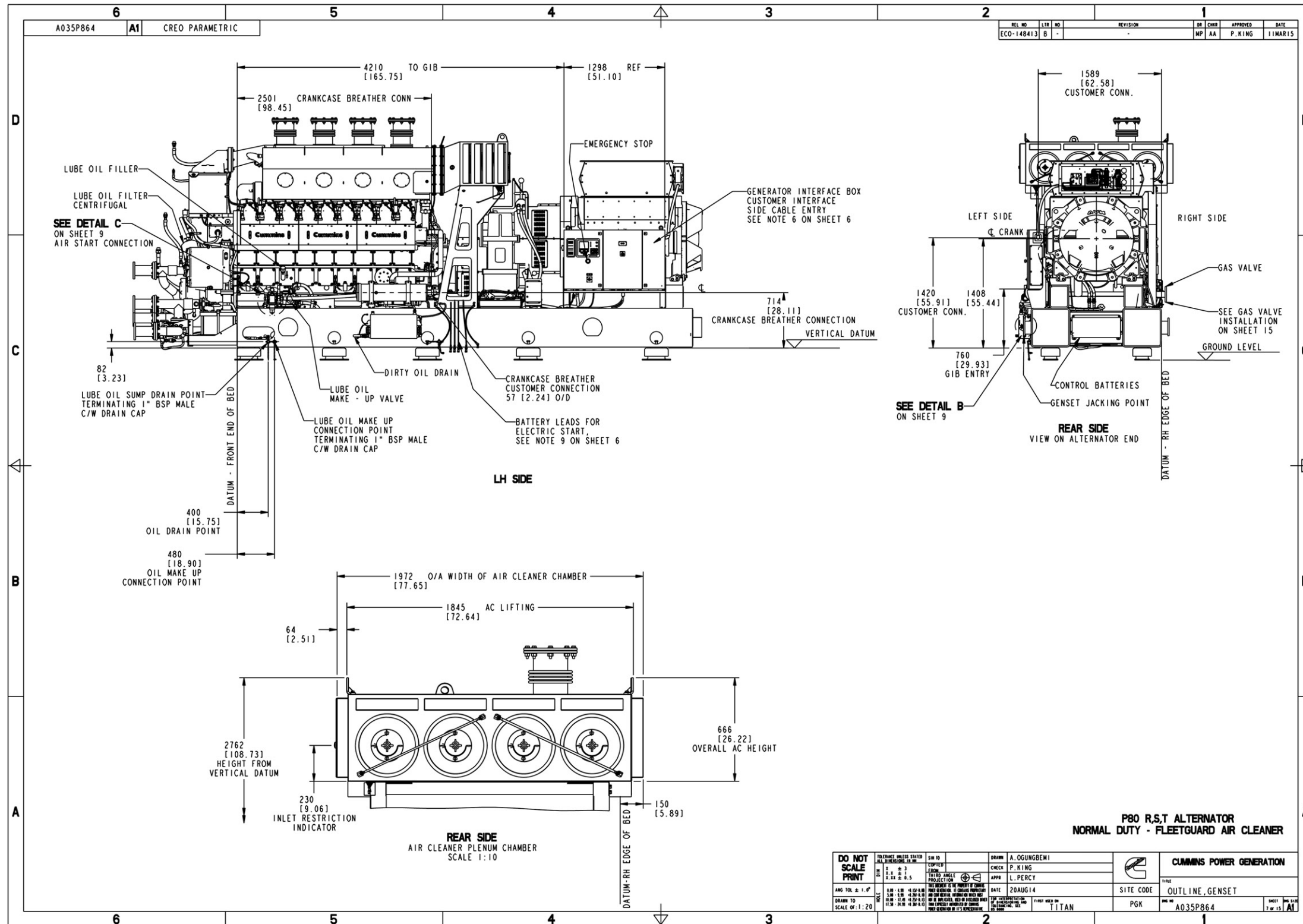


FIGURE 57. A035P864 SHEET 7 OF 15



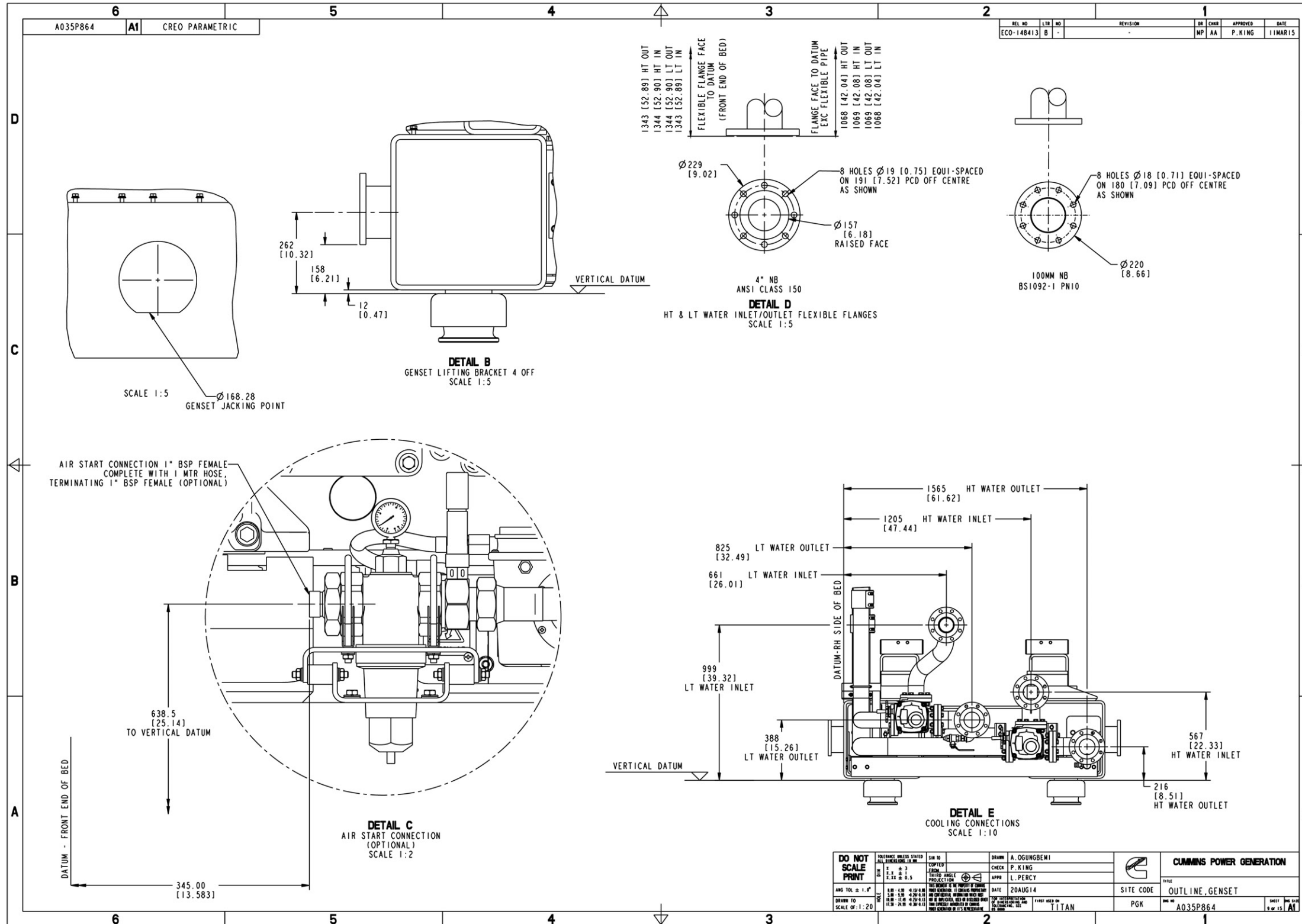


FIGURE 59. A035P864 SHEET 9 OF 15

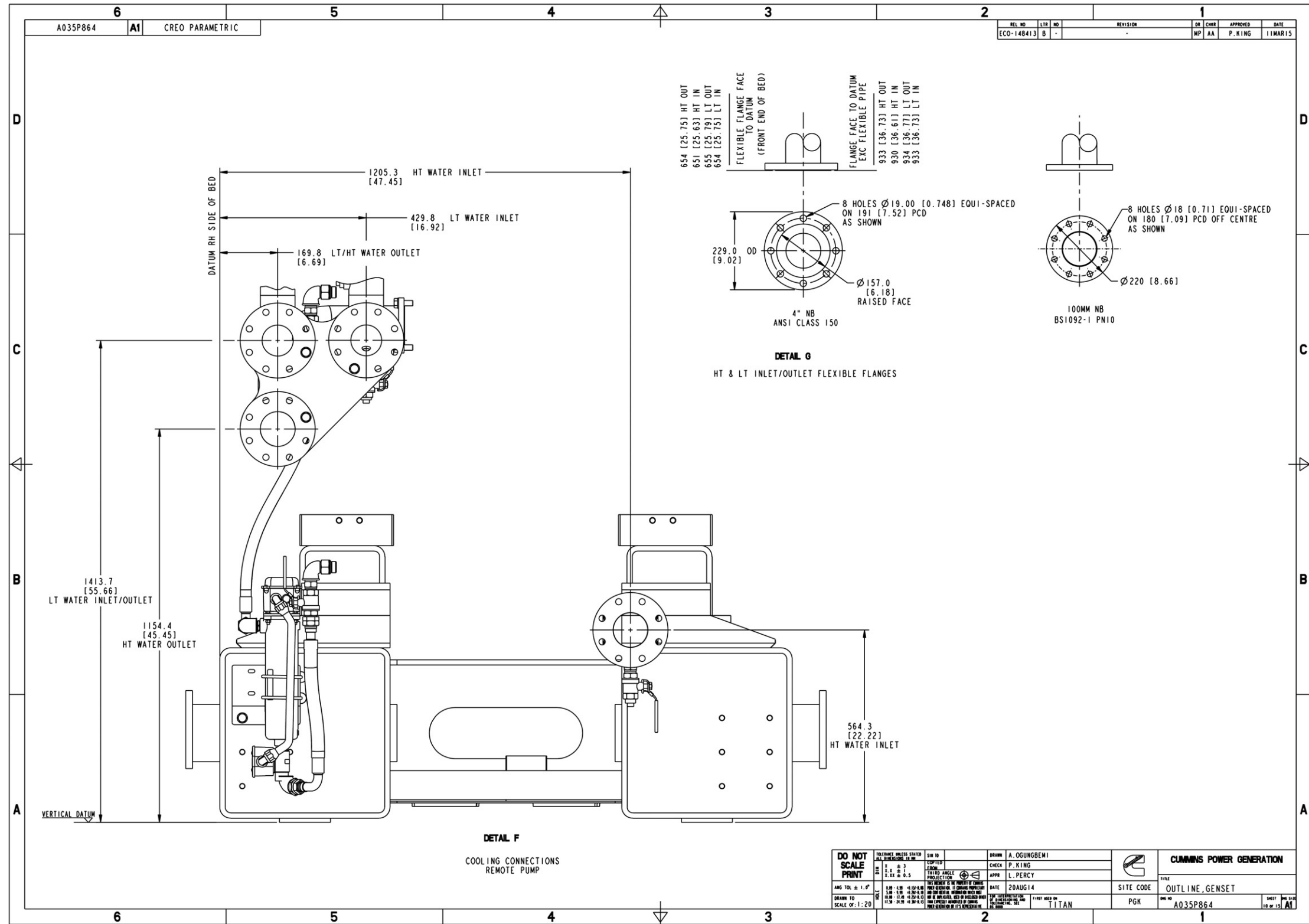


FIGURE 60. A035P864 SHEET 10 OF 15

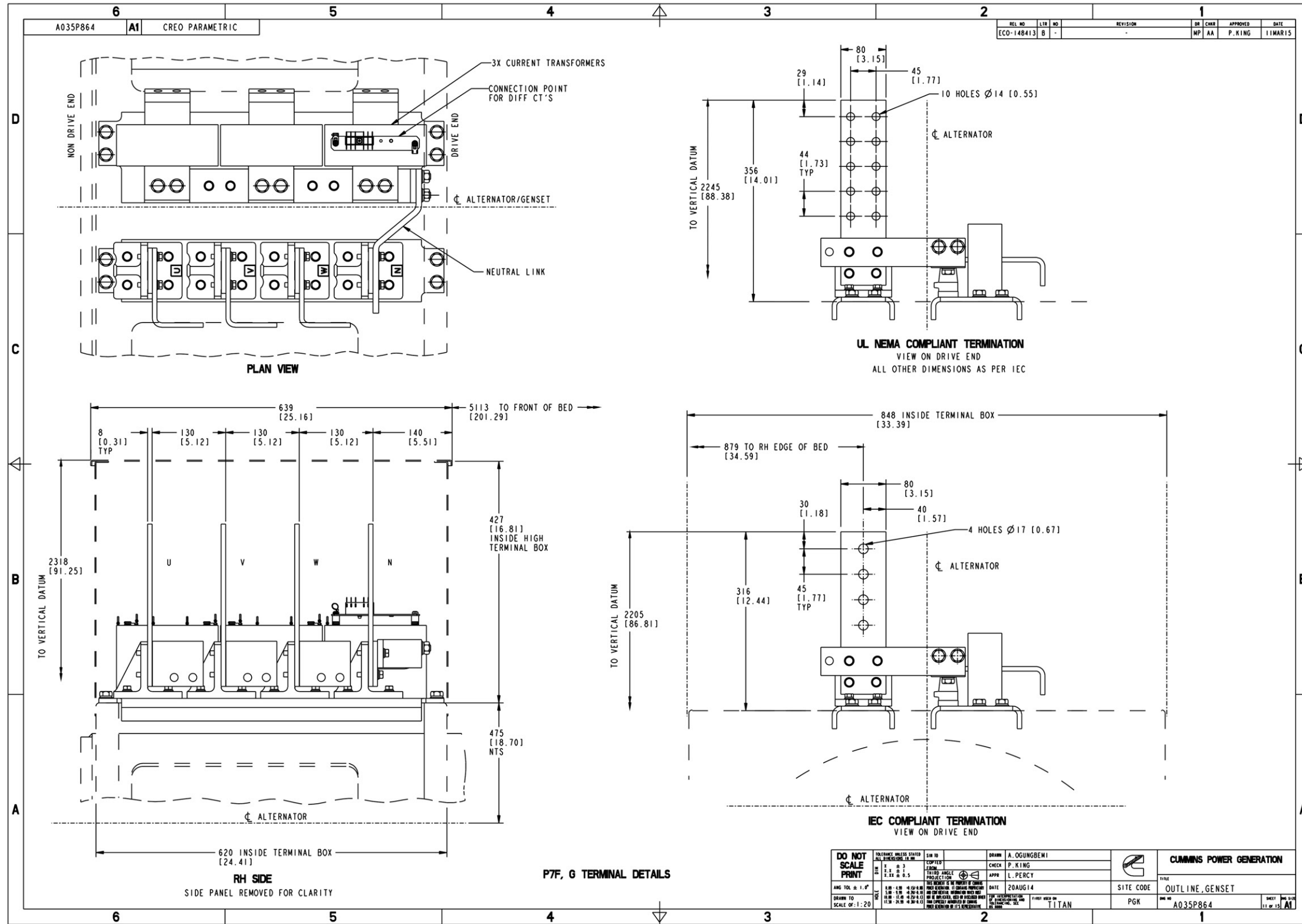


FIGURE 61. A035P864 SHEET 11 OF 15

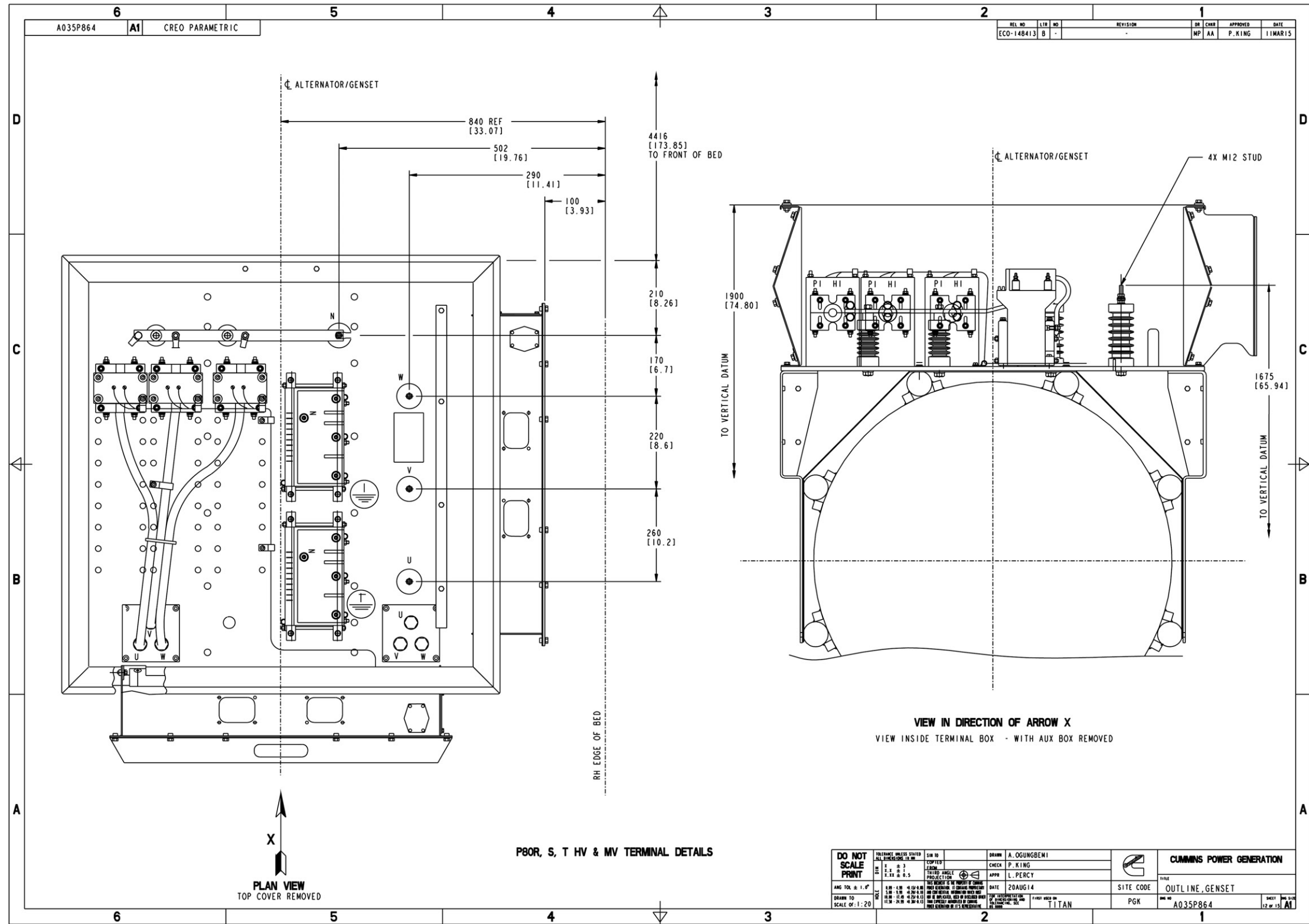


FIGURE 62. A035P864 SHEET 12 OF 15

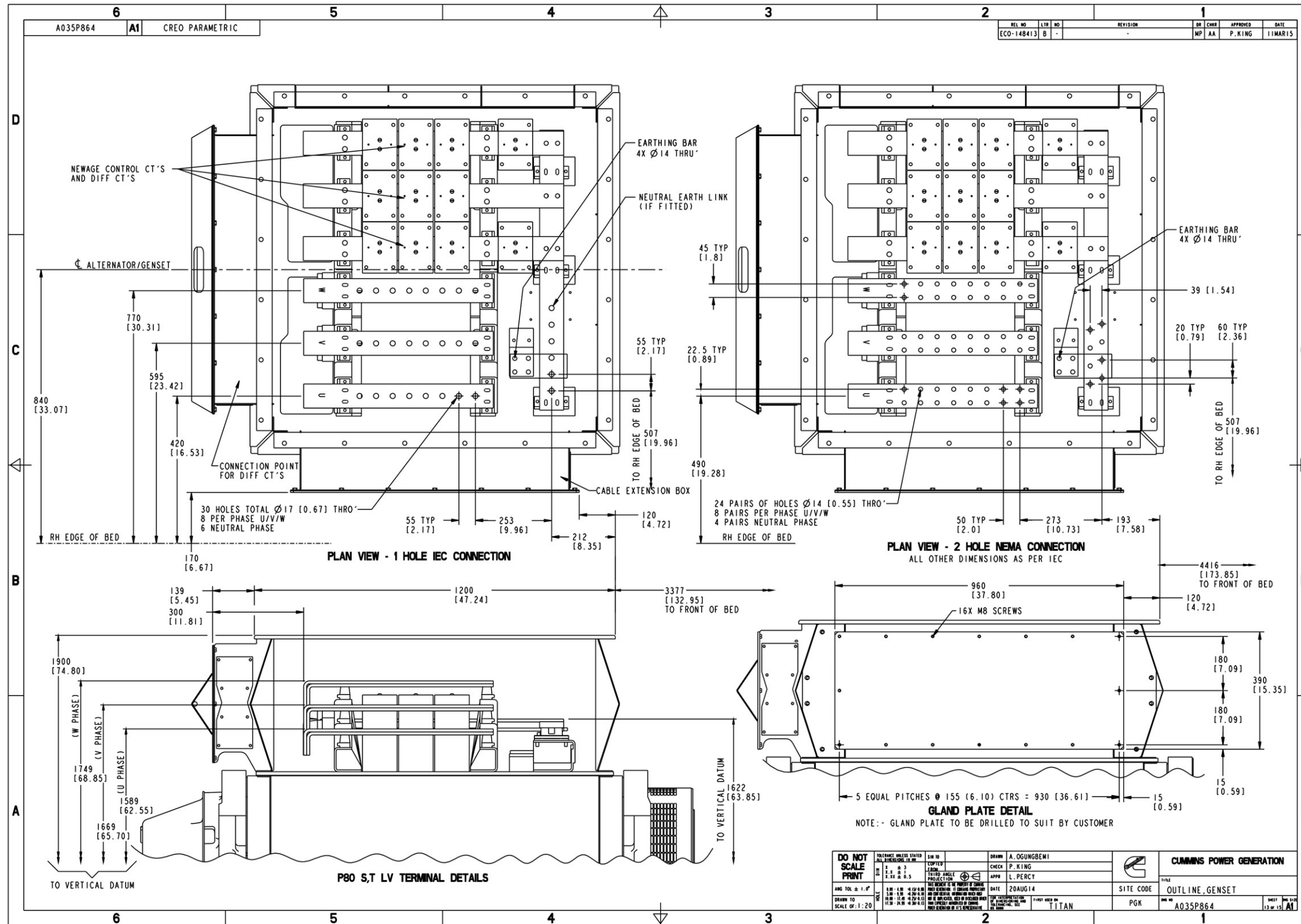


FIGURE 63. A035P864 SHEET 13 OF 15

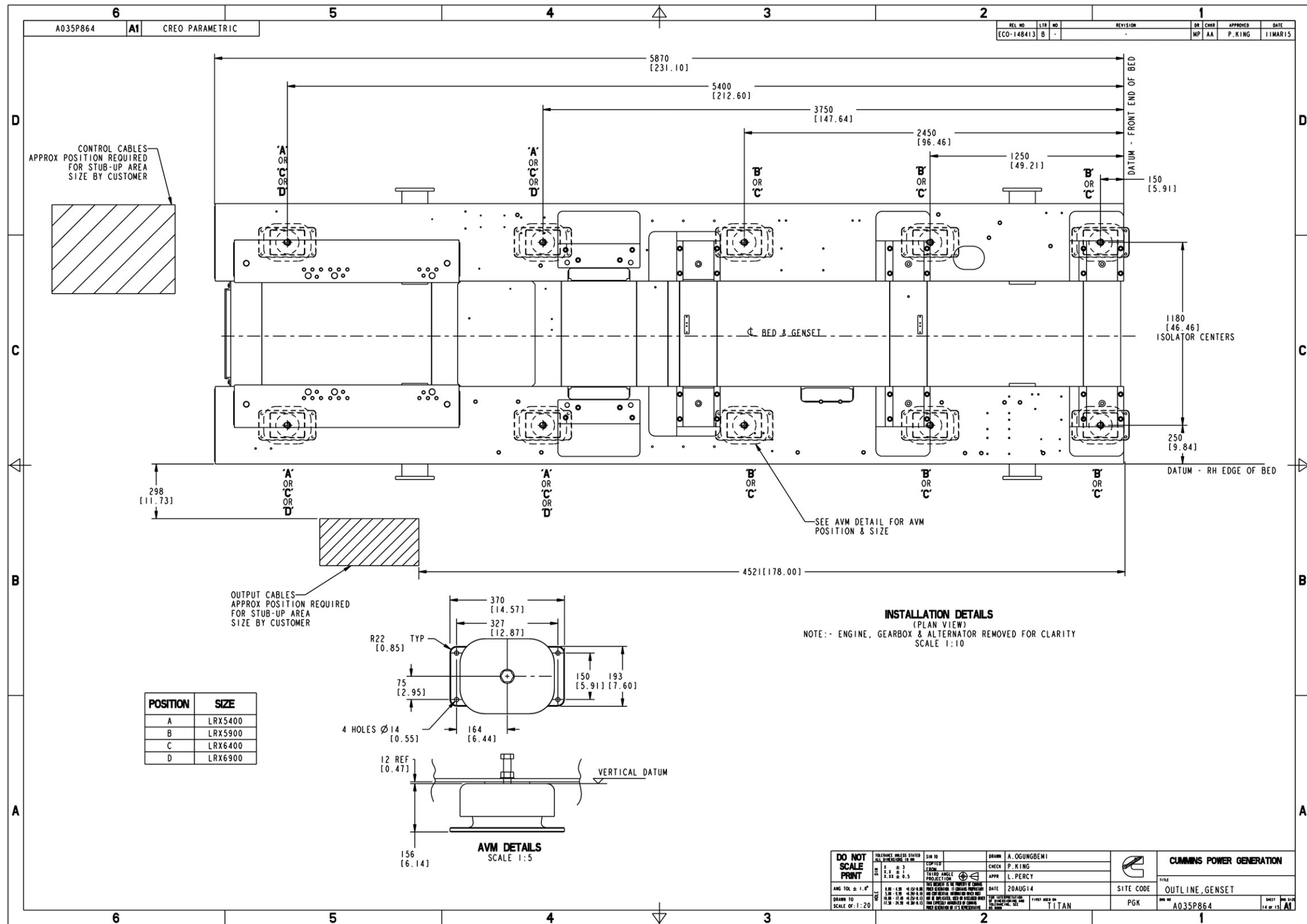


FIGURE 64. A035P864 SHEET 14 OF 15

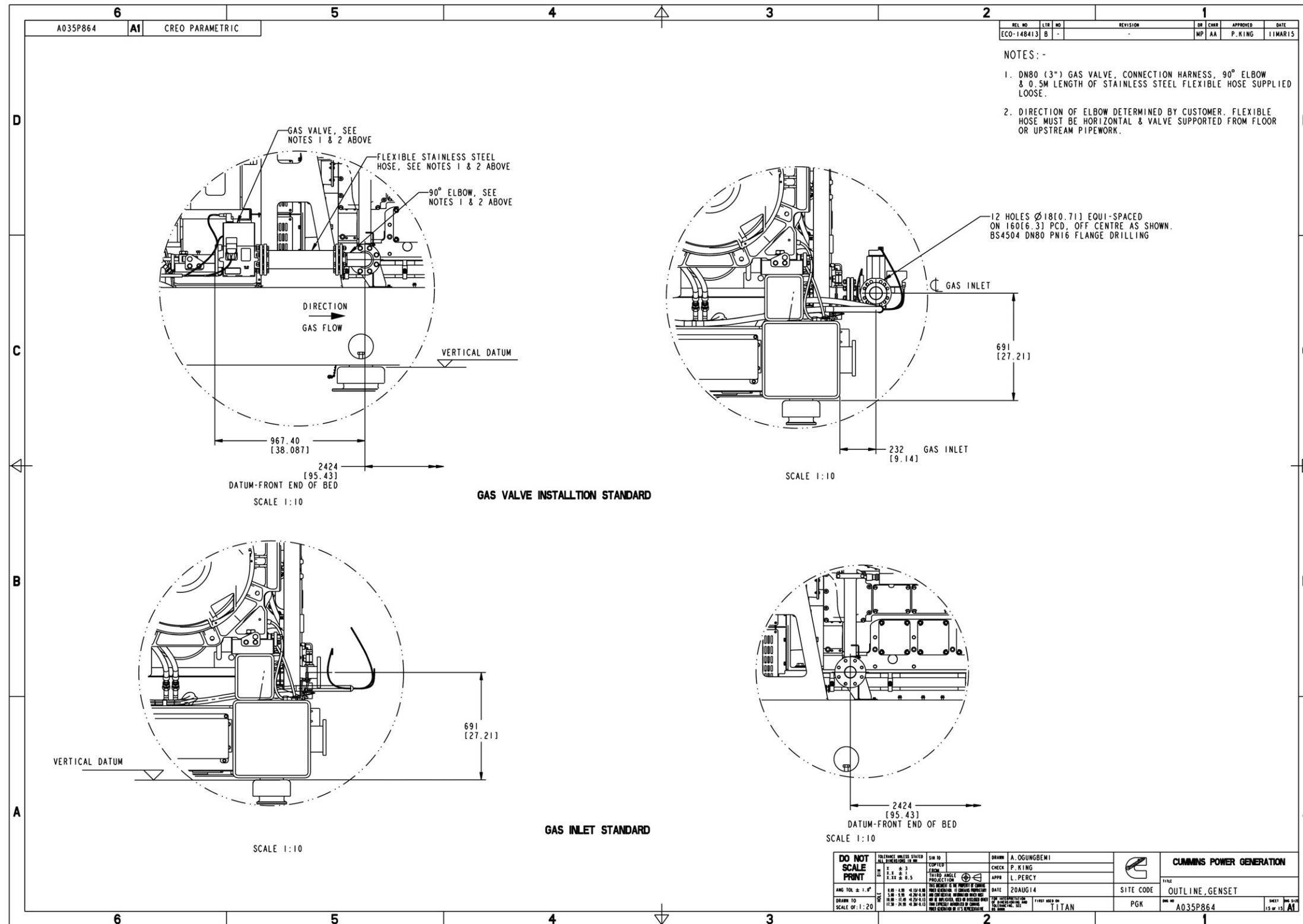


FIGURE 65. A035P864 SHEET 15 OF 15

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# Appendix E. Wiring Diagrams

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The drawings included in this section are representative. For current complete information, refer to the drawing package that was shipped with the unit.

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# E.1 A034V836 Wiring Diagram for Titan with CM700 ECM

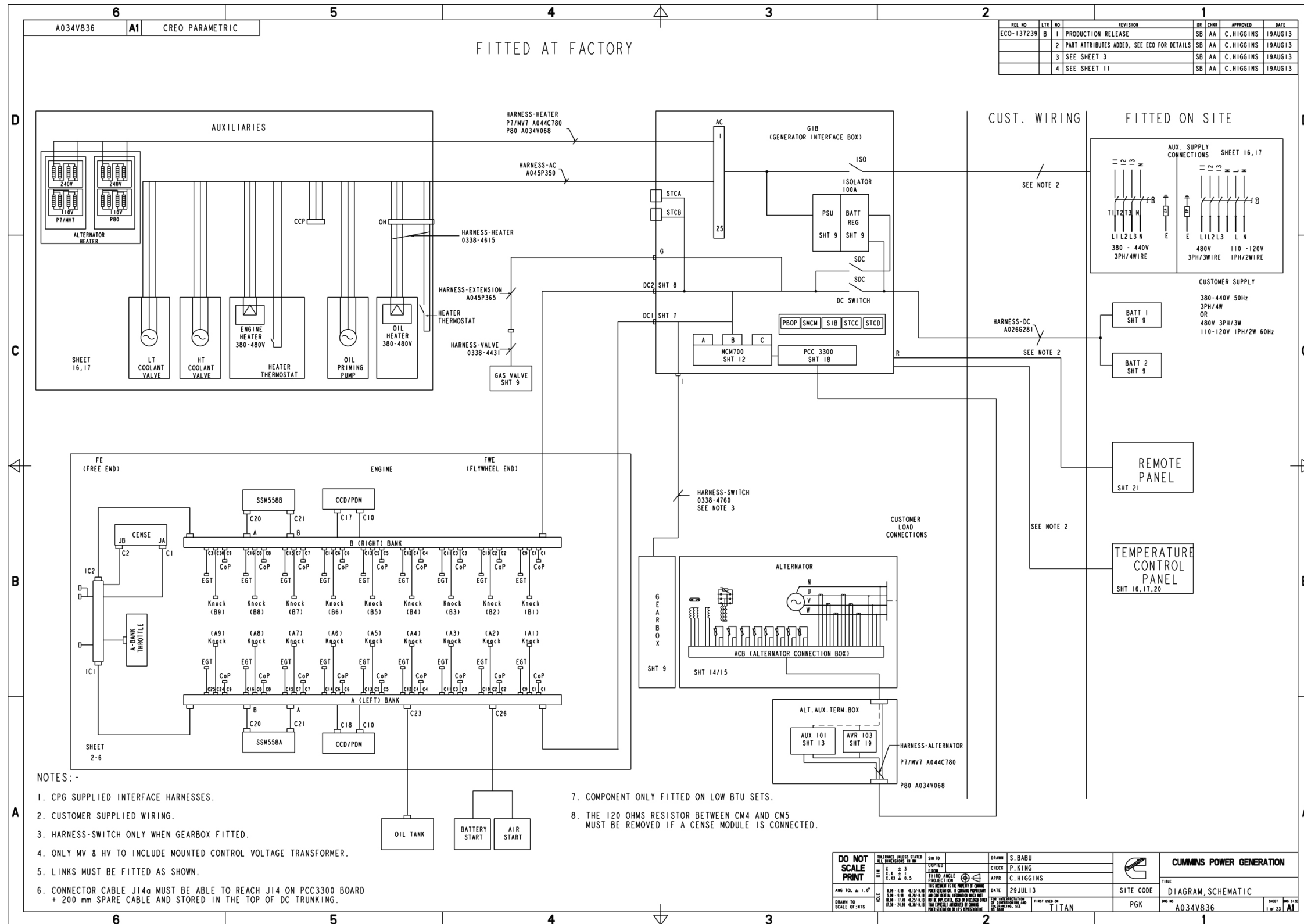


FIGURE 66. A034V836 SHEET 1 OF 23

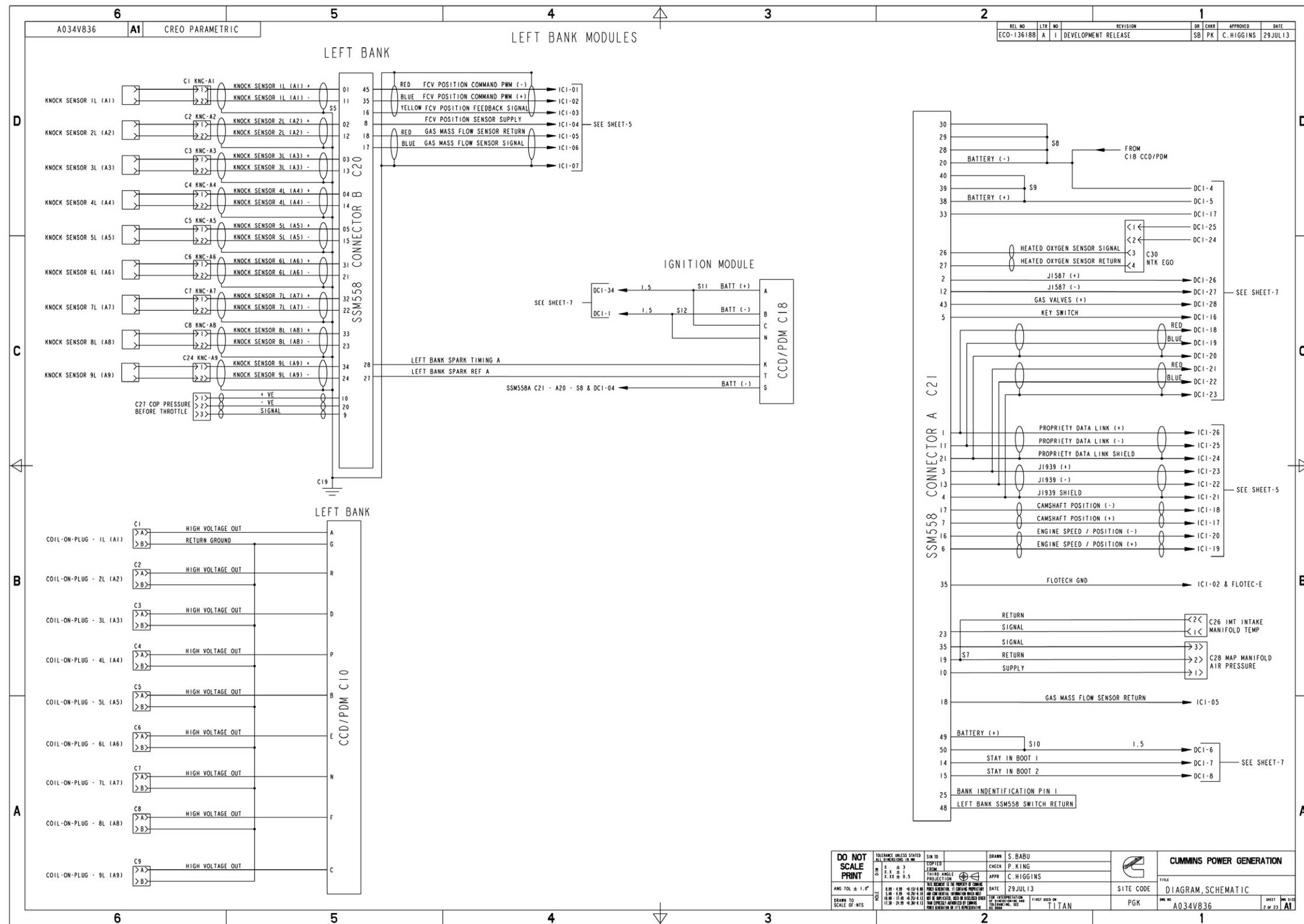


FIGURE 67. A034V836 SHEET 2 OF 23

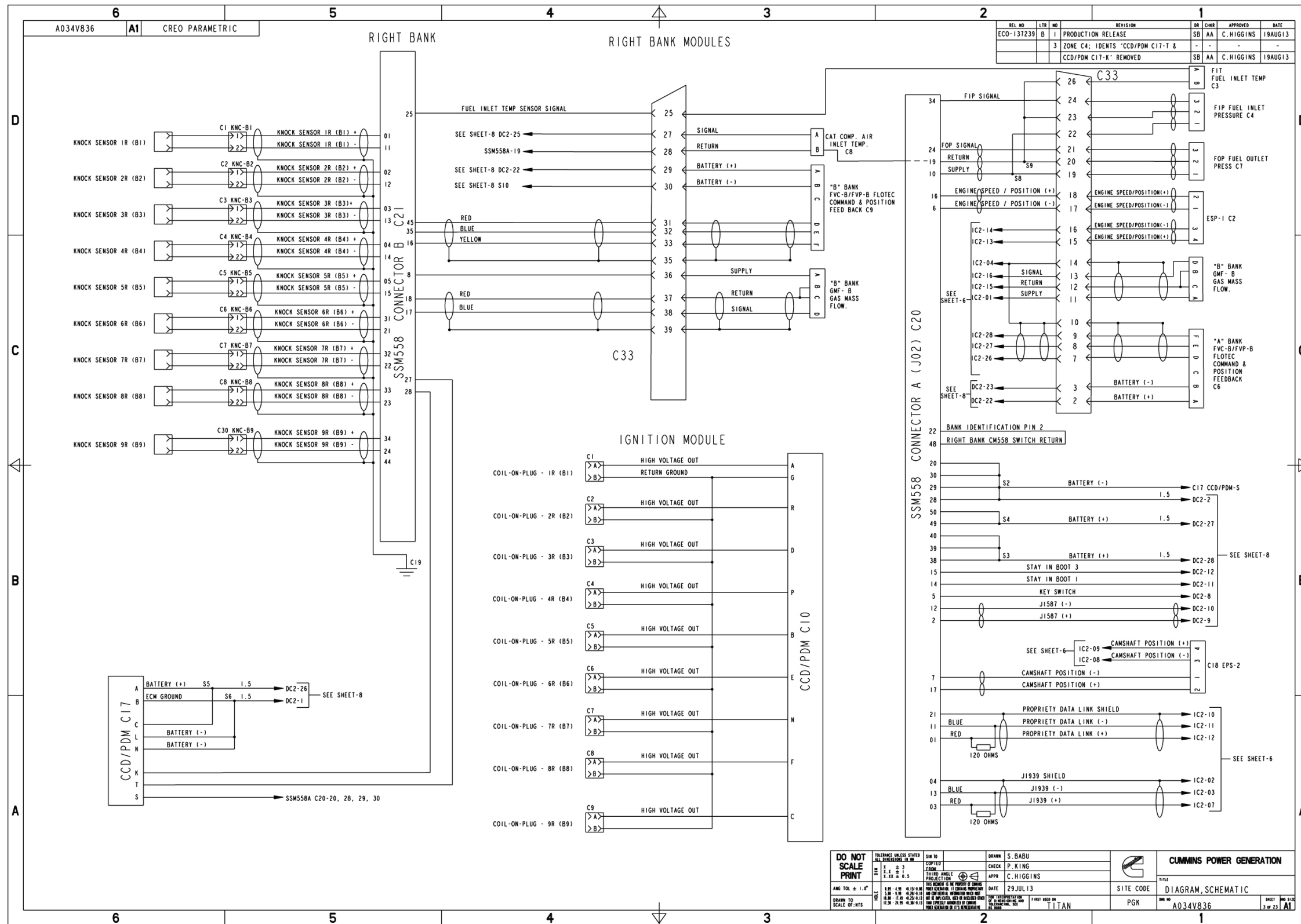


FIGURE 68. A034V836 SHEET 3 OF 23

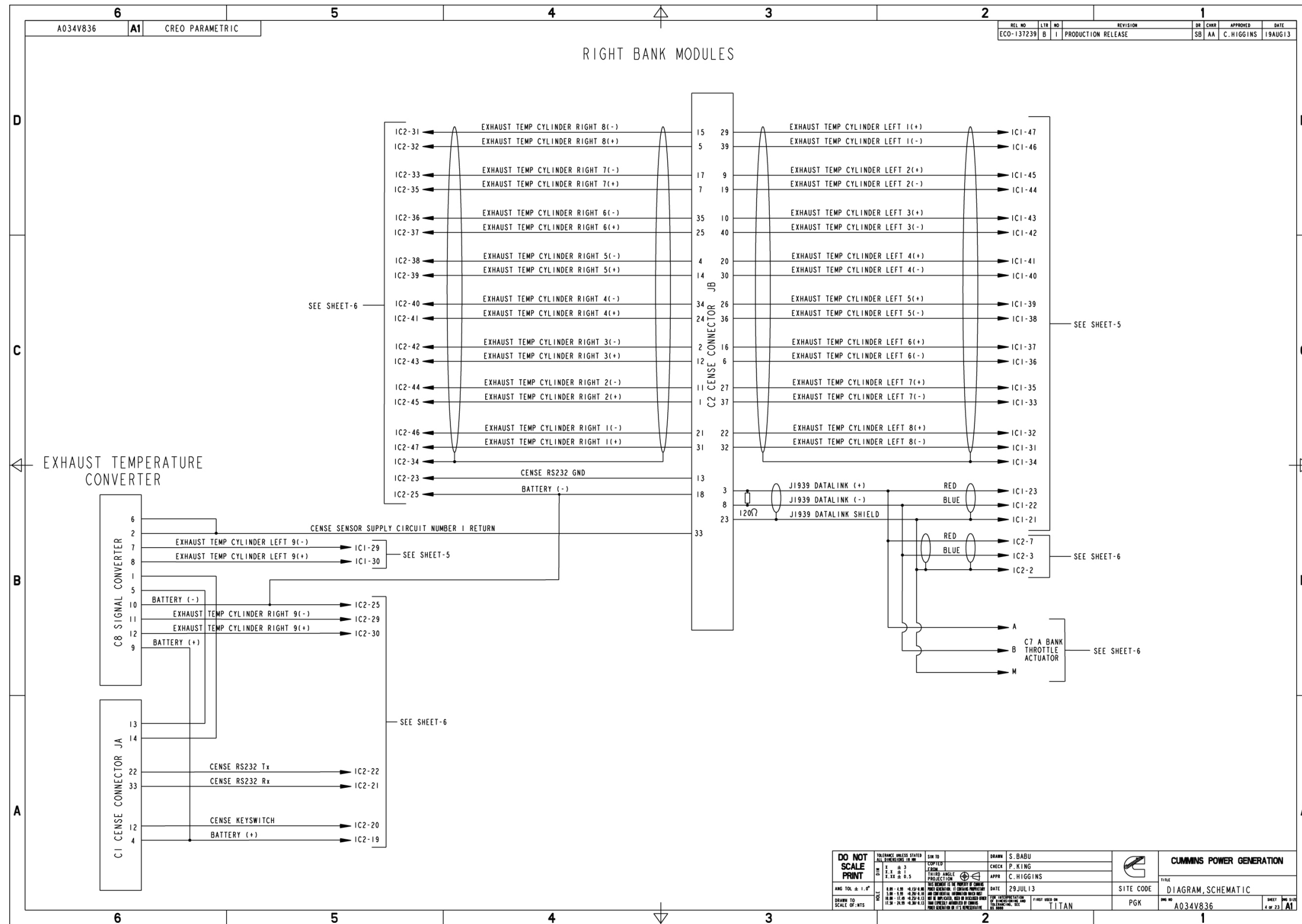


FIGURE 69. A034V836 SHEET 4 OF 23

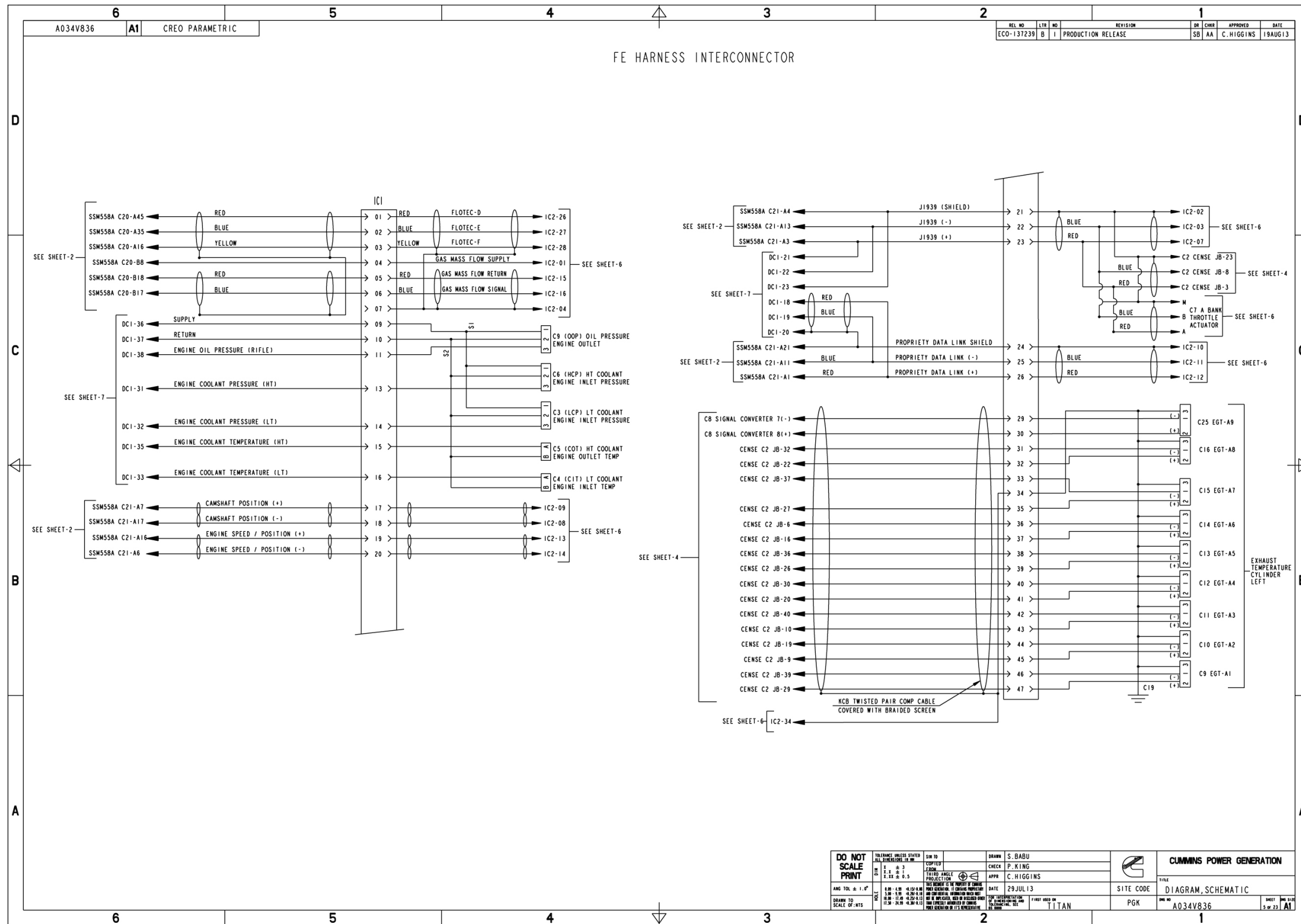


FIGURE 70. A034V836 SHEET 5 OF 23

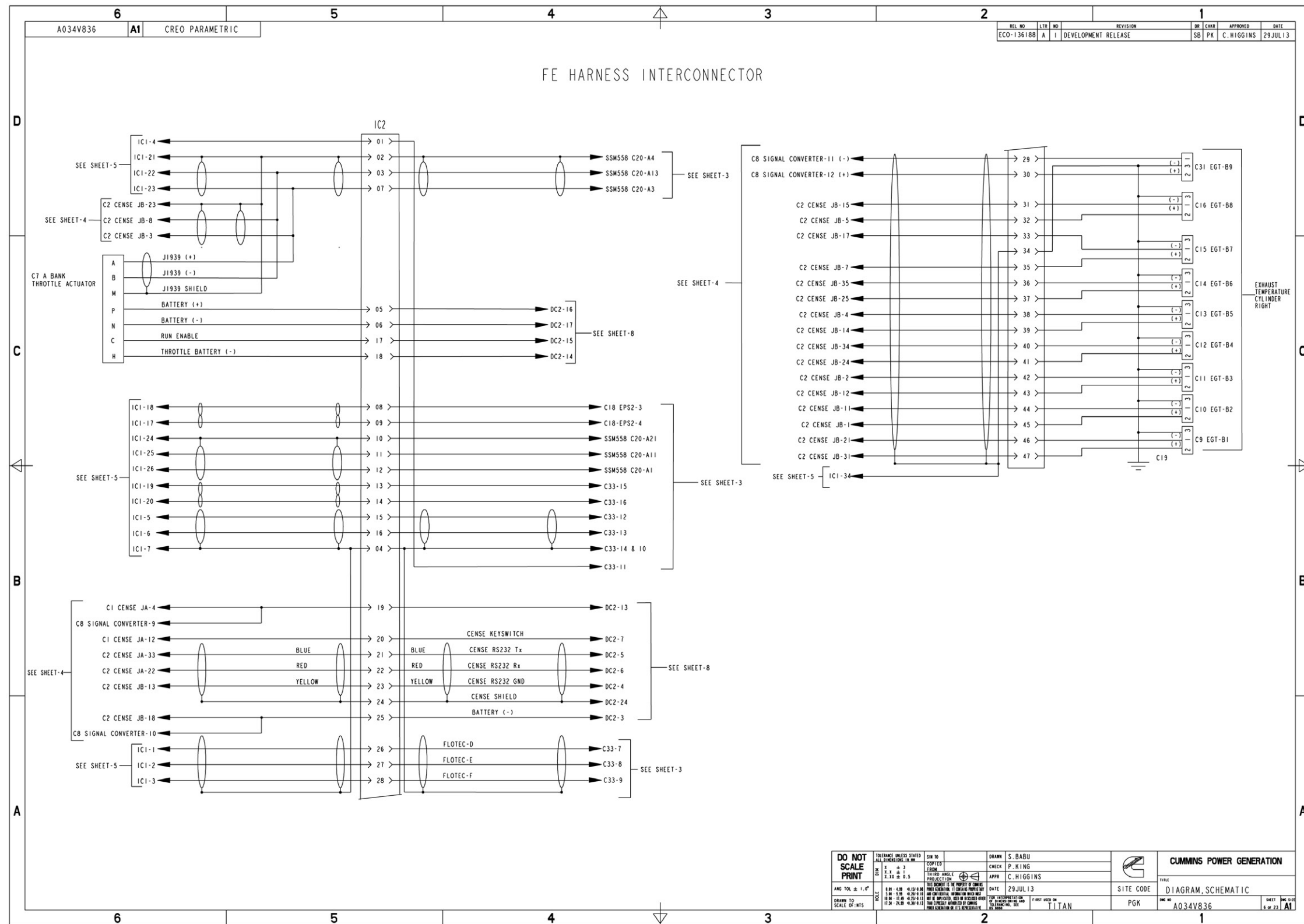


FIGURE 71. A034V836 SHEET 6 OF 23

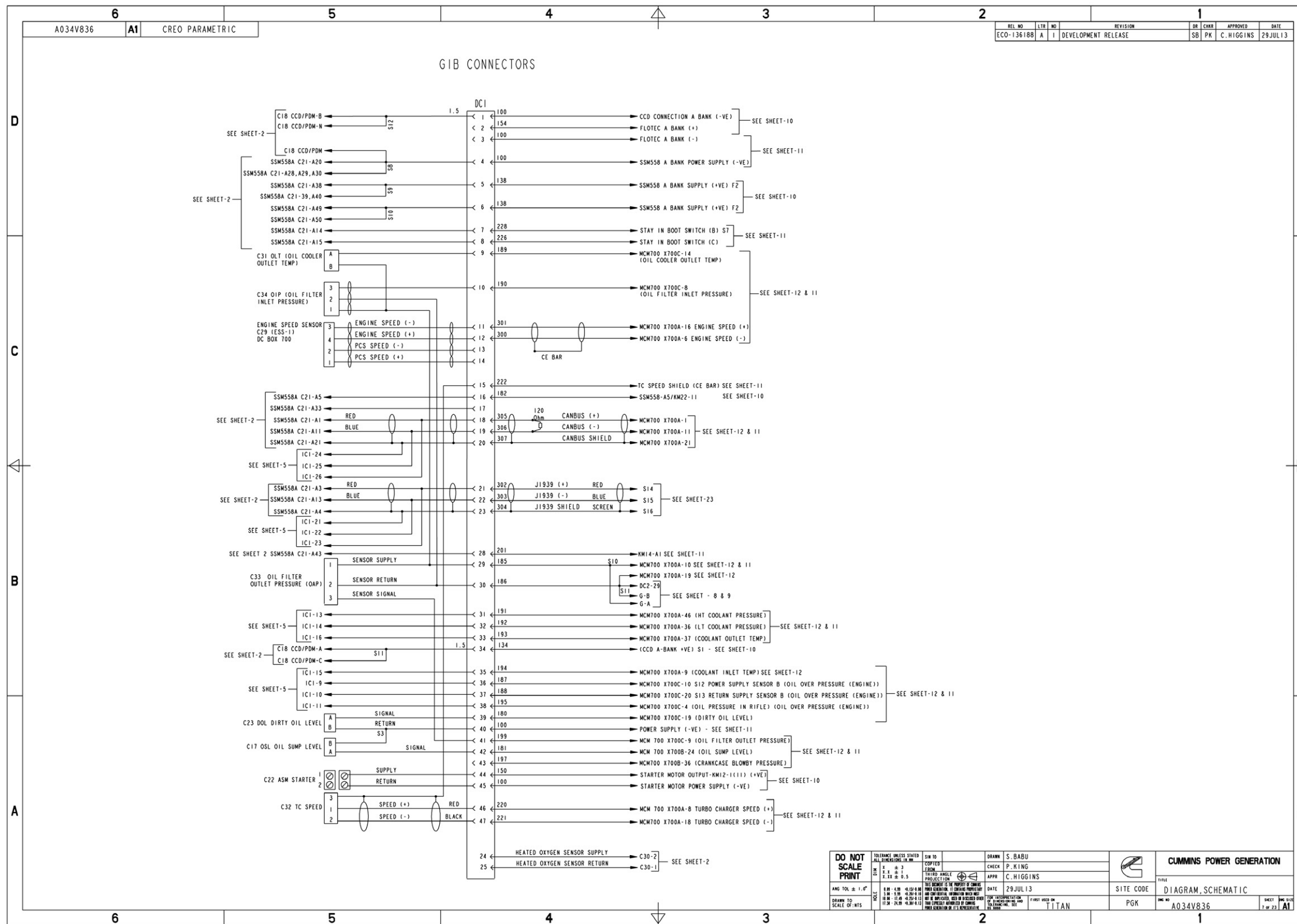


FIGURE 72. A034V836 SHEET 7 OF 23

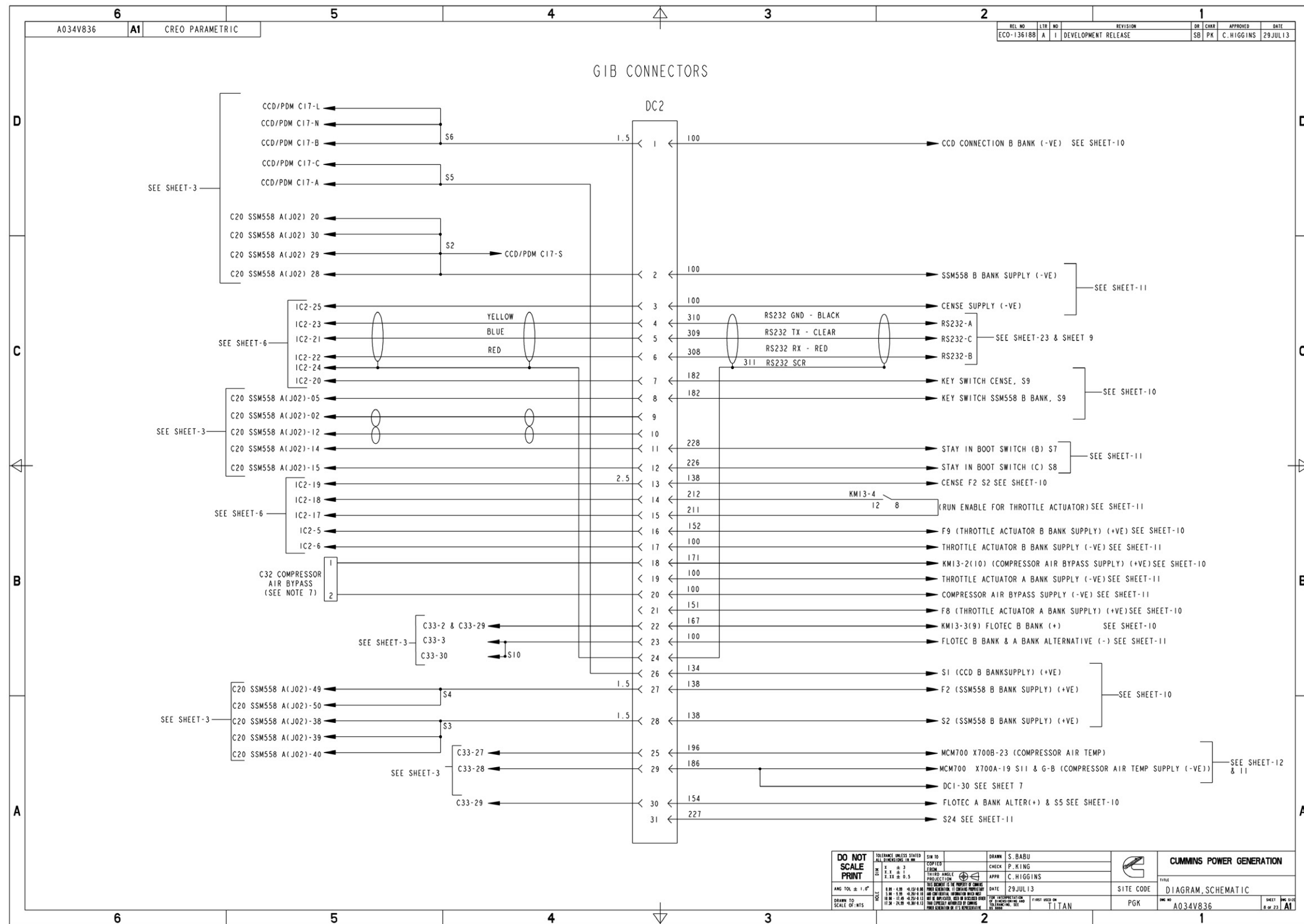


FIGURE 73. A034V836 SHEET 8 OF 23

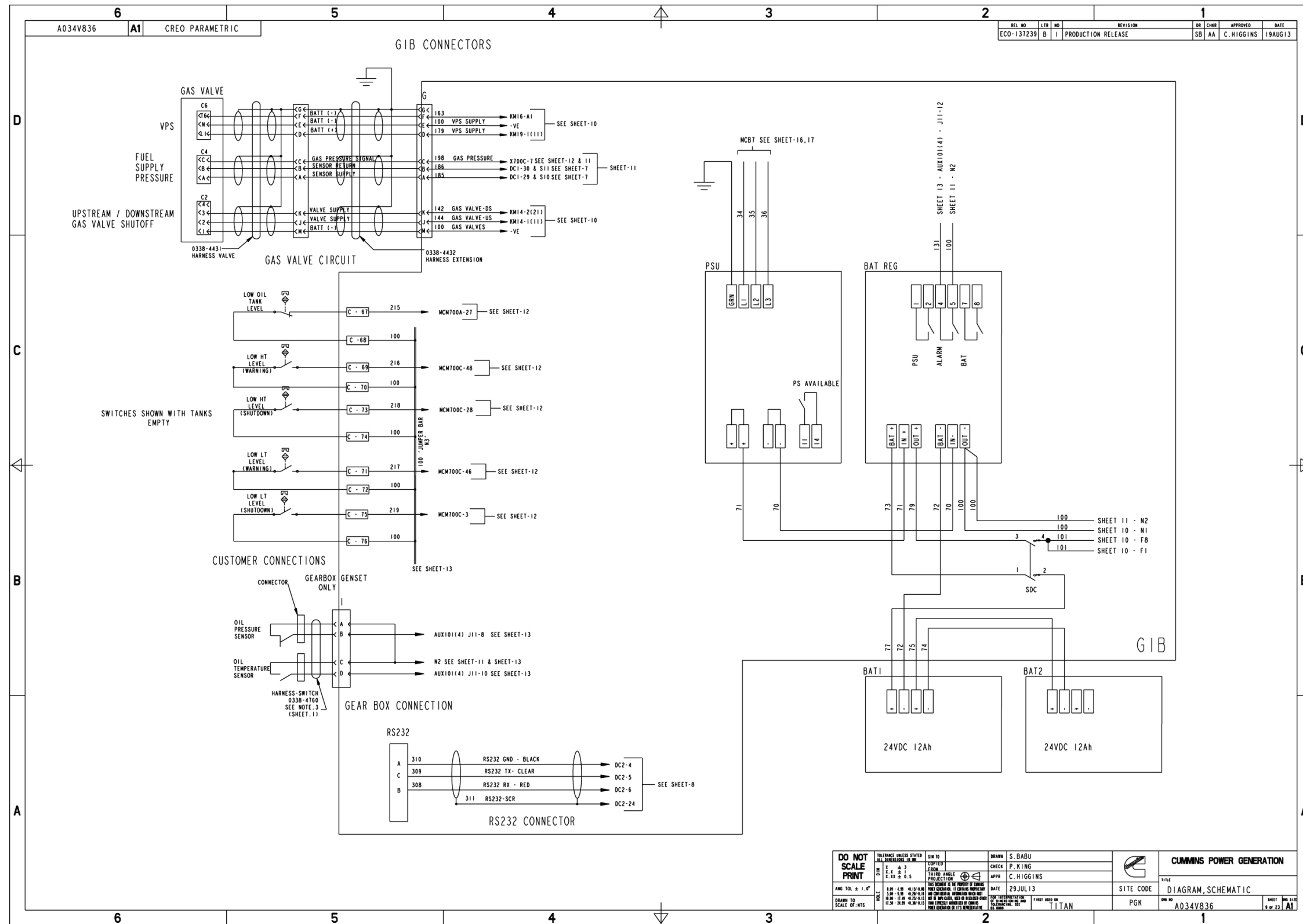


FIGURE 74. A034V836 SHEET 9 OF 23

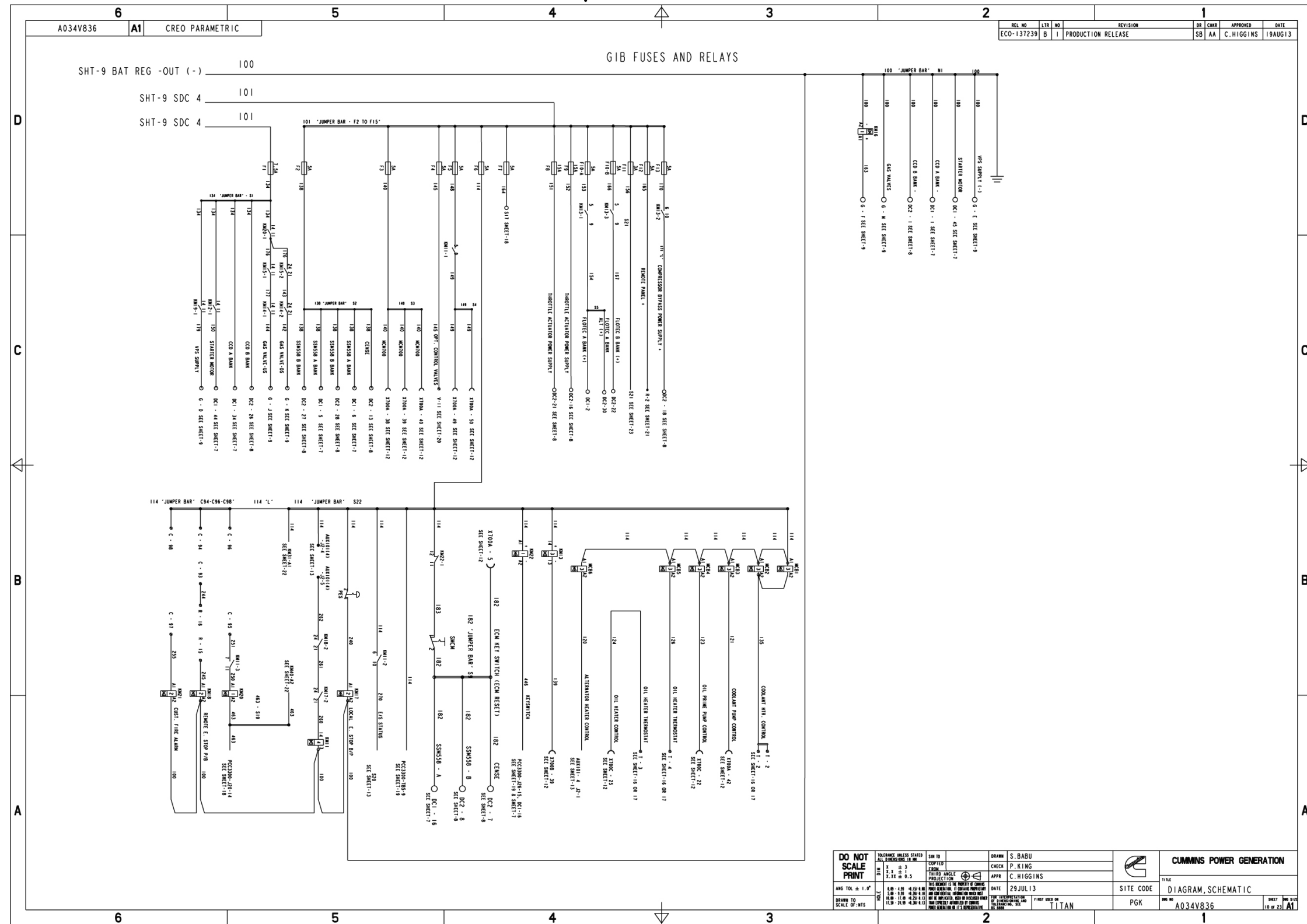
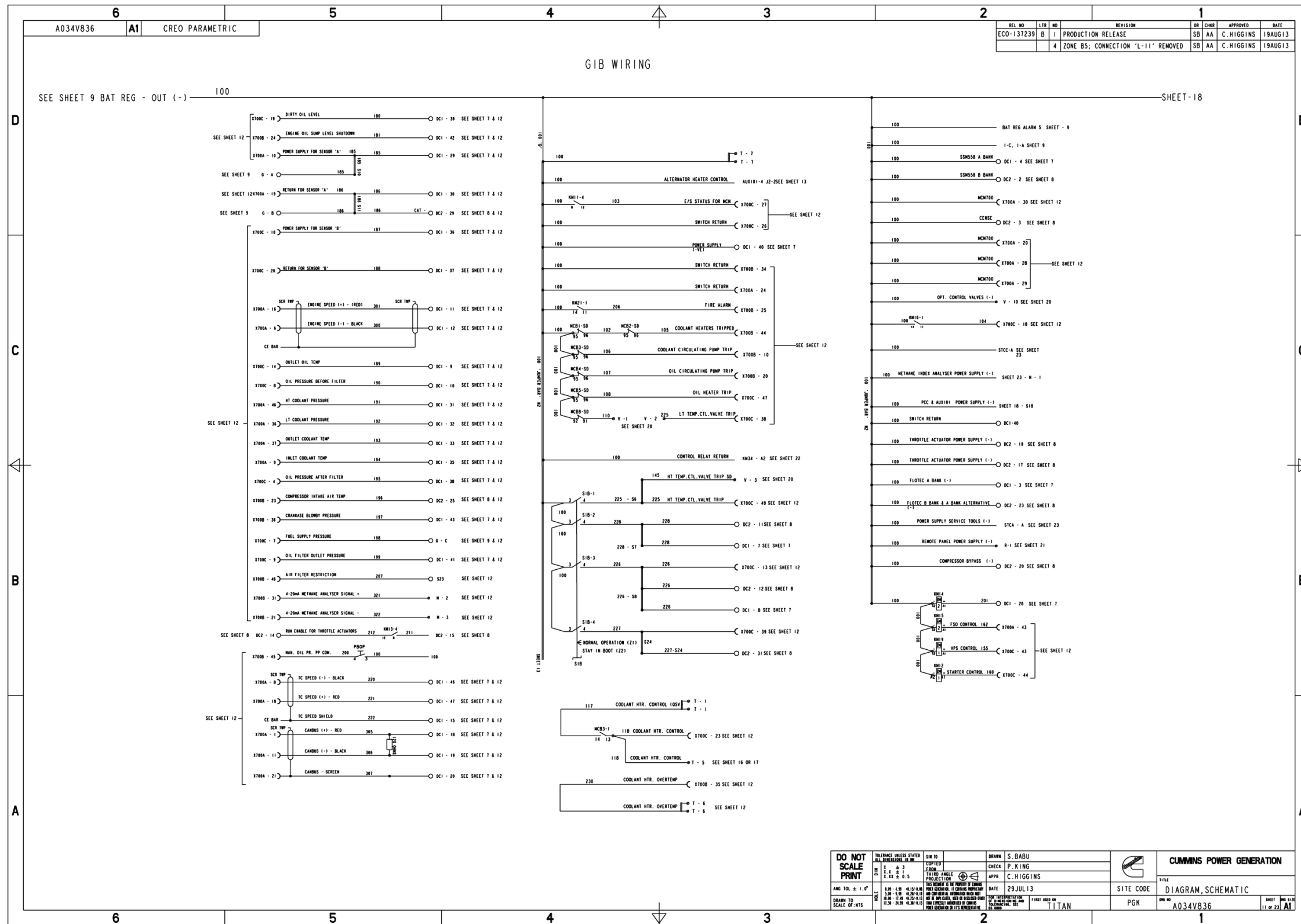


FIGURE 75. A034V836 SHEET 10 OF 23



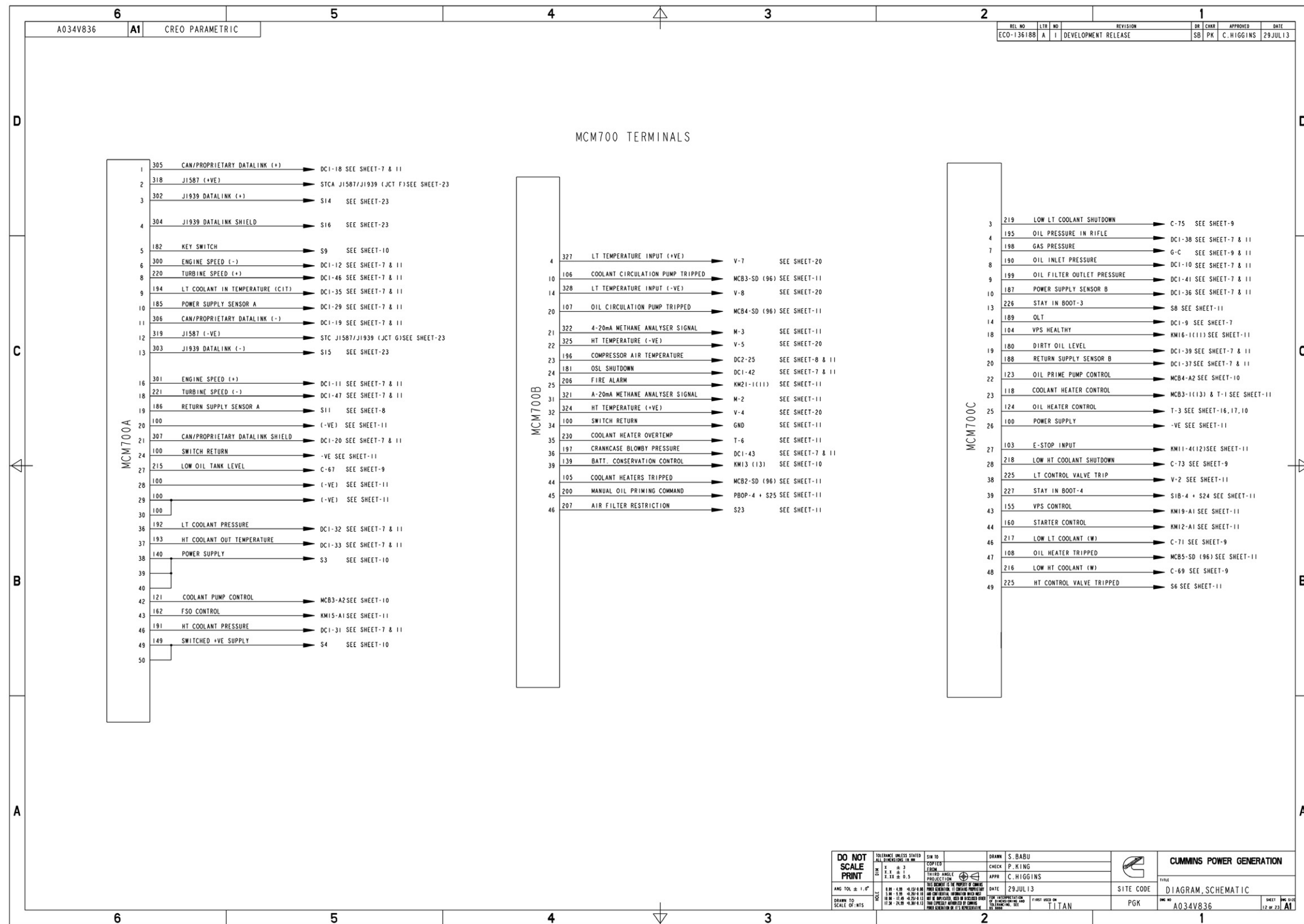


FIGURE 77. A034V836 SHEET 12 OF 23

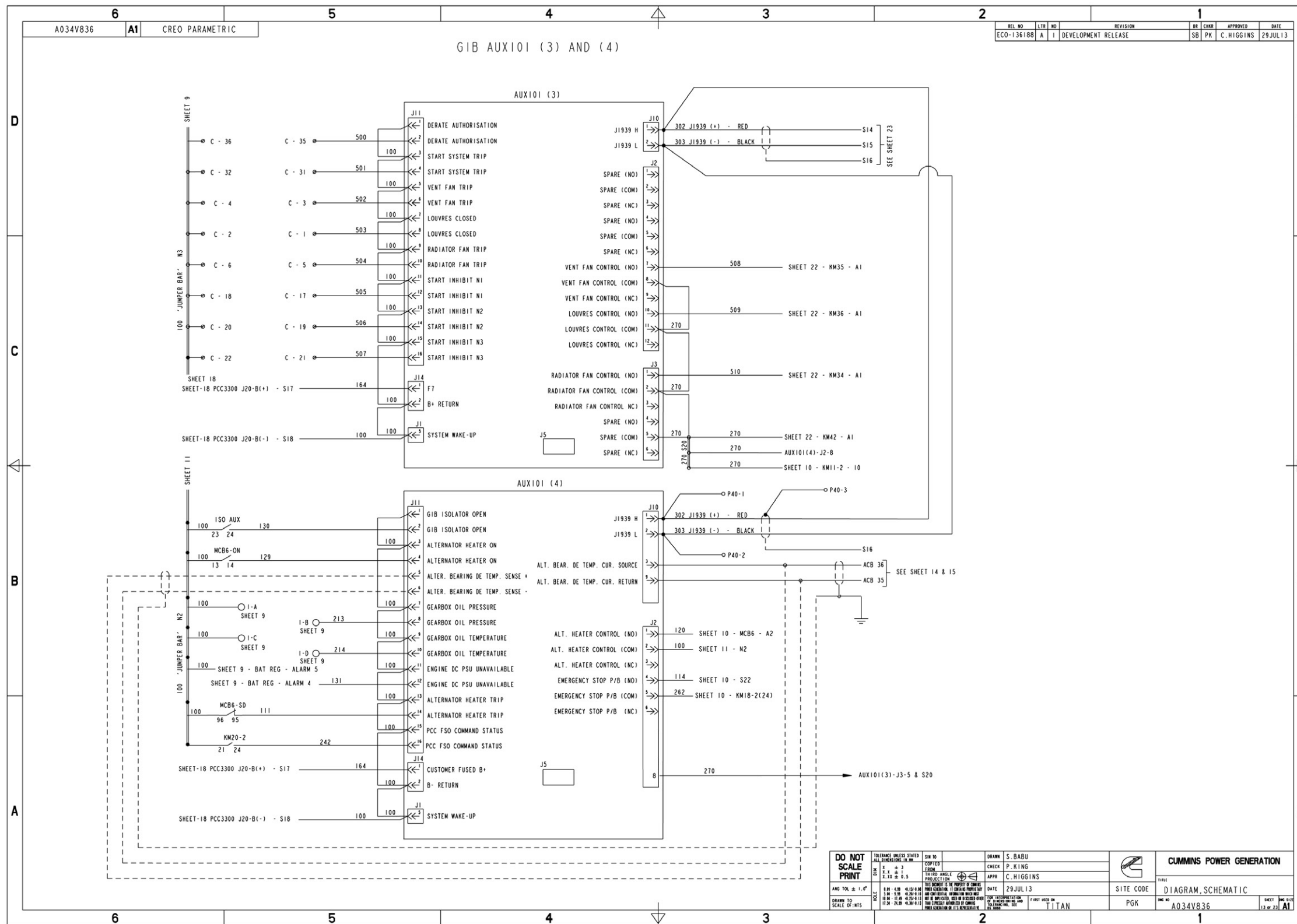


FIGURE 78. A034V836 SHEET 13 OF 23

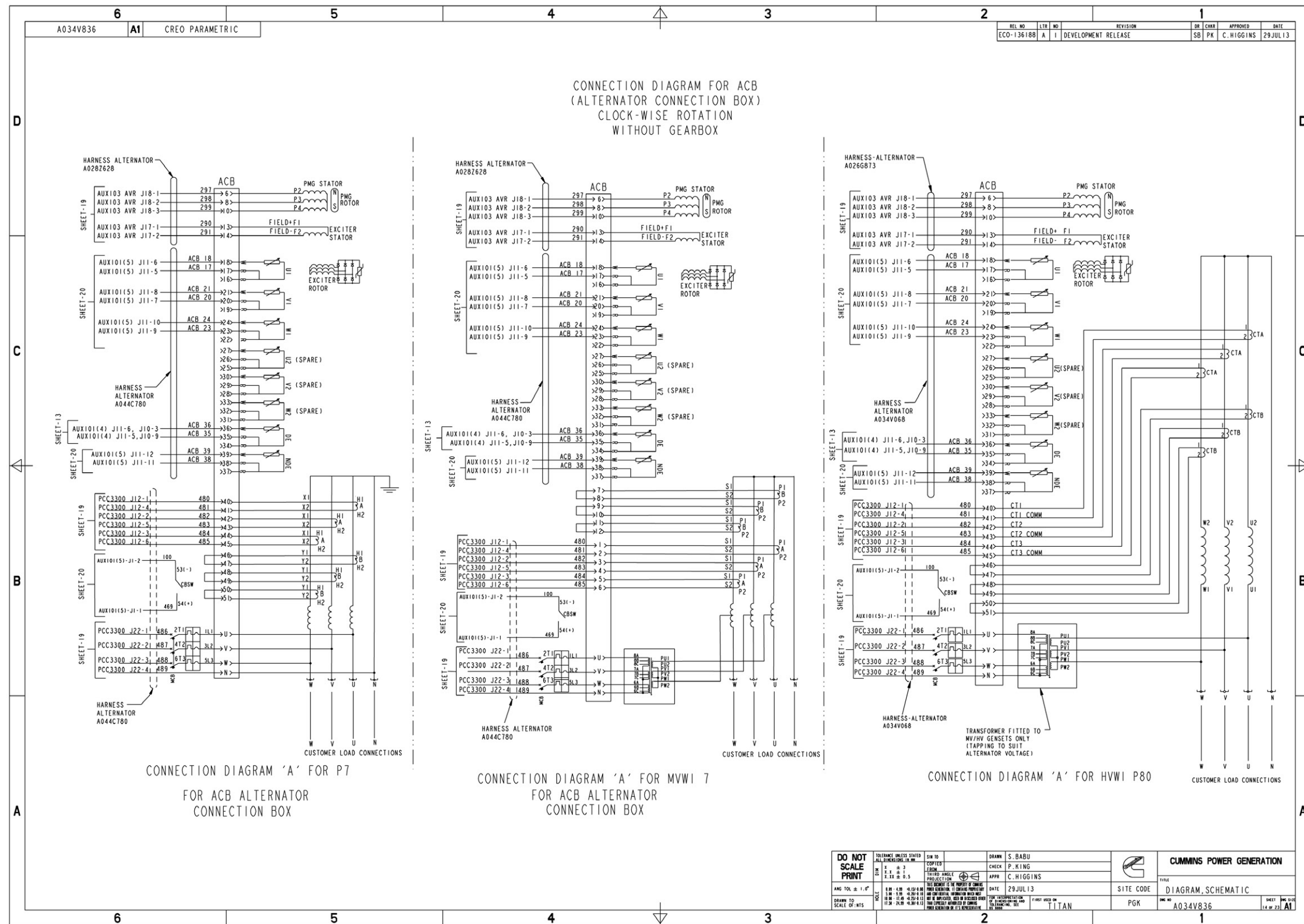


FIGURE 79. A034V836 SHEET 14 OF 23

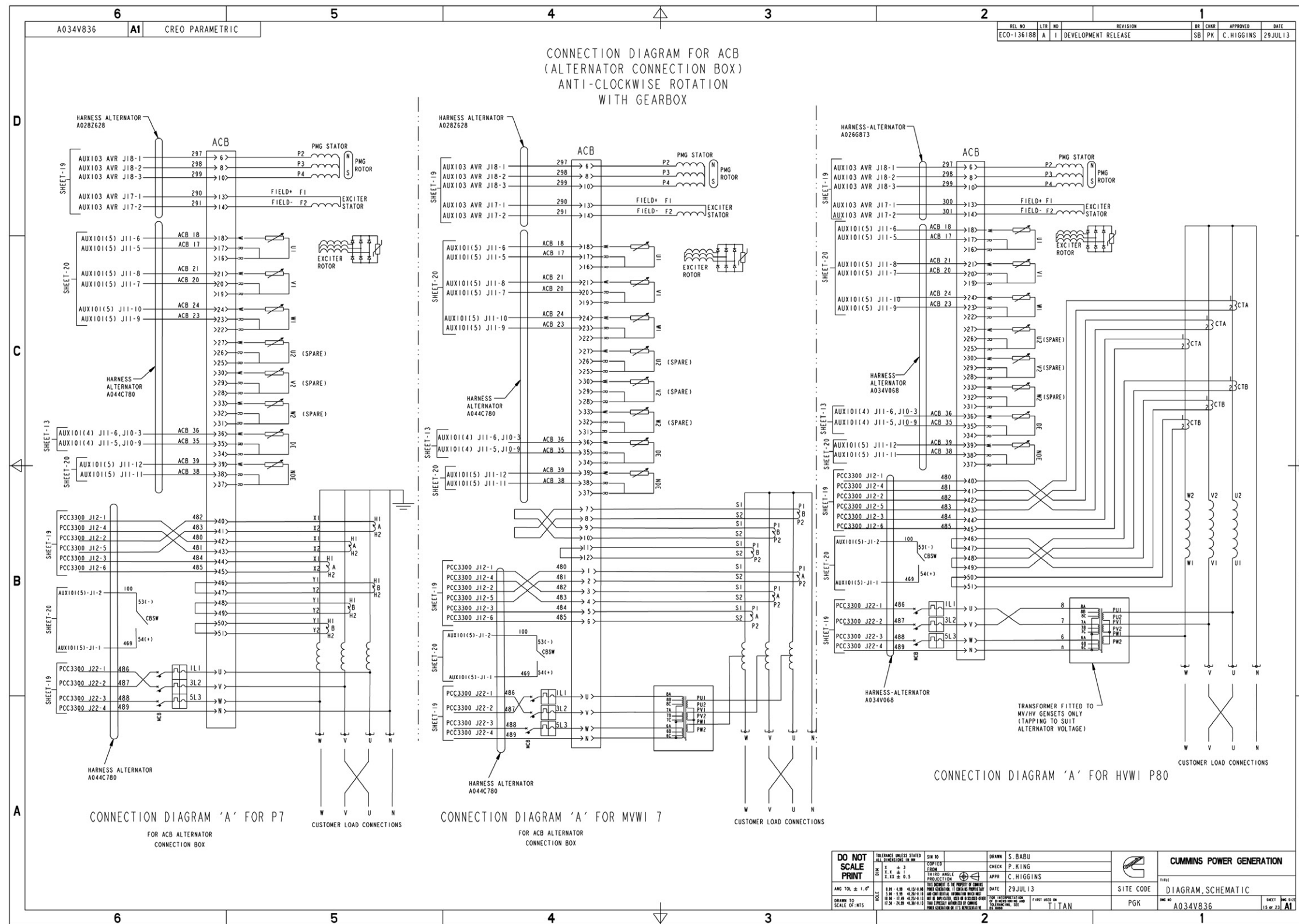


FIGURE 80. A034V836 SHEET 15 OF 23

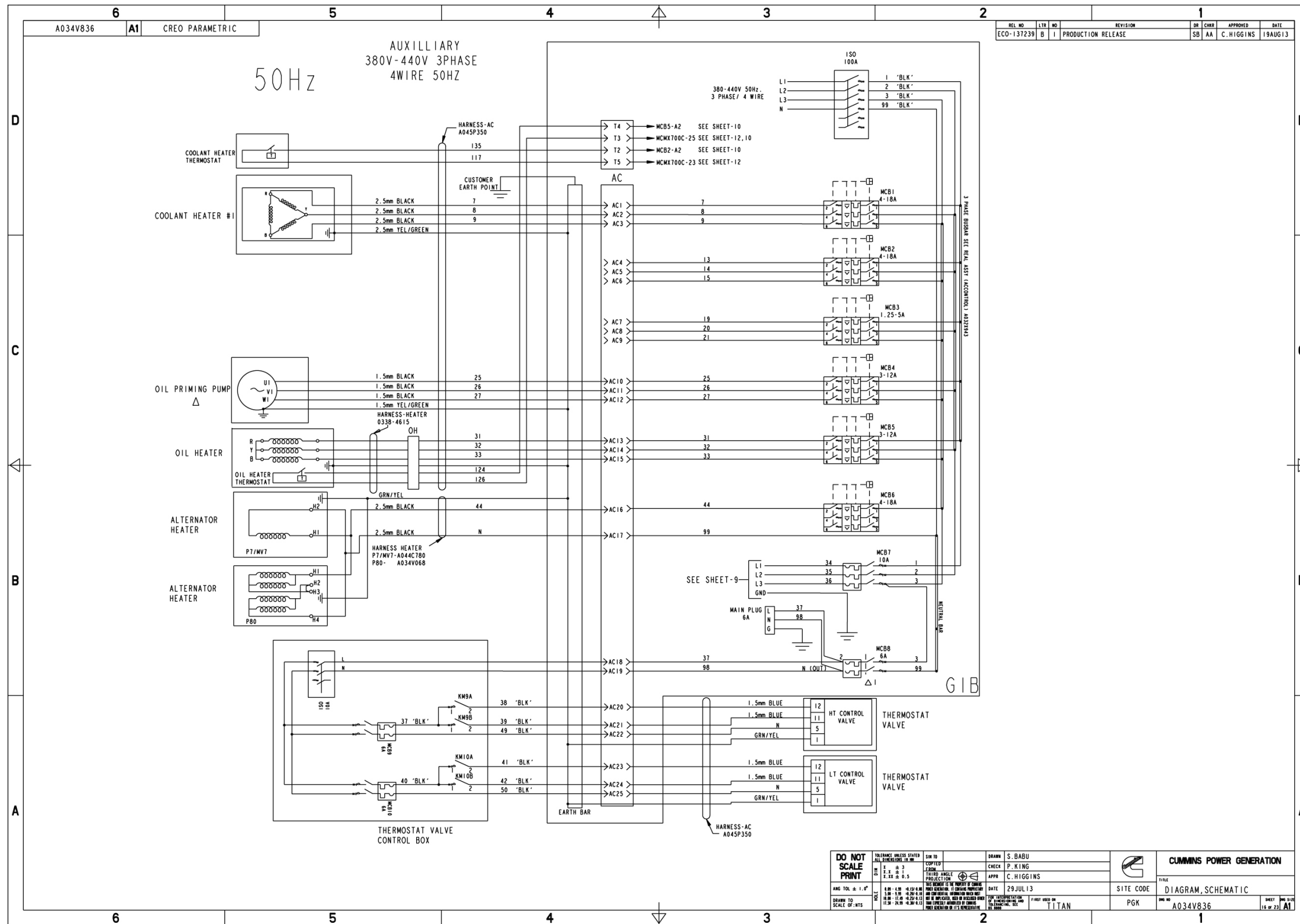


FIGURE 81. A034V836 SHEET 16 OF 23

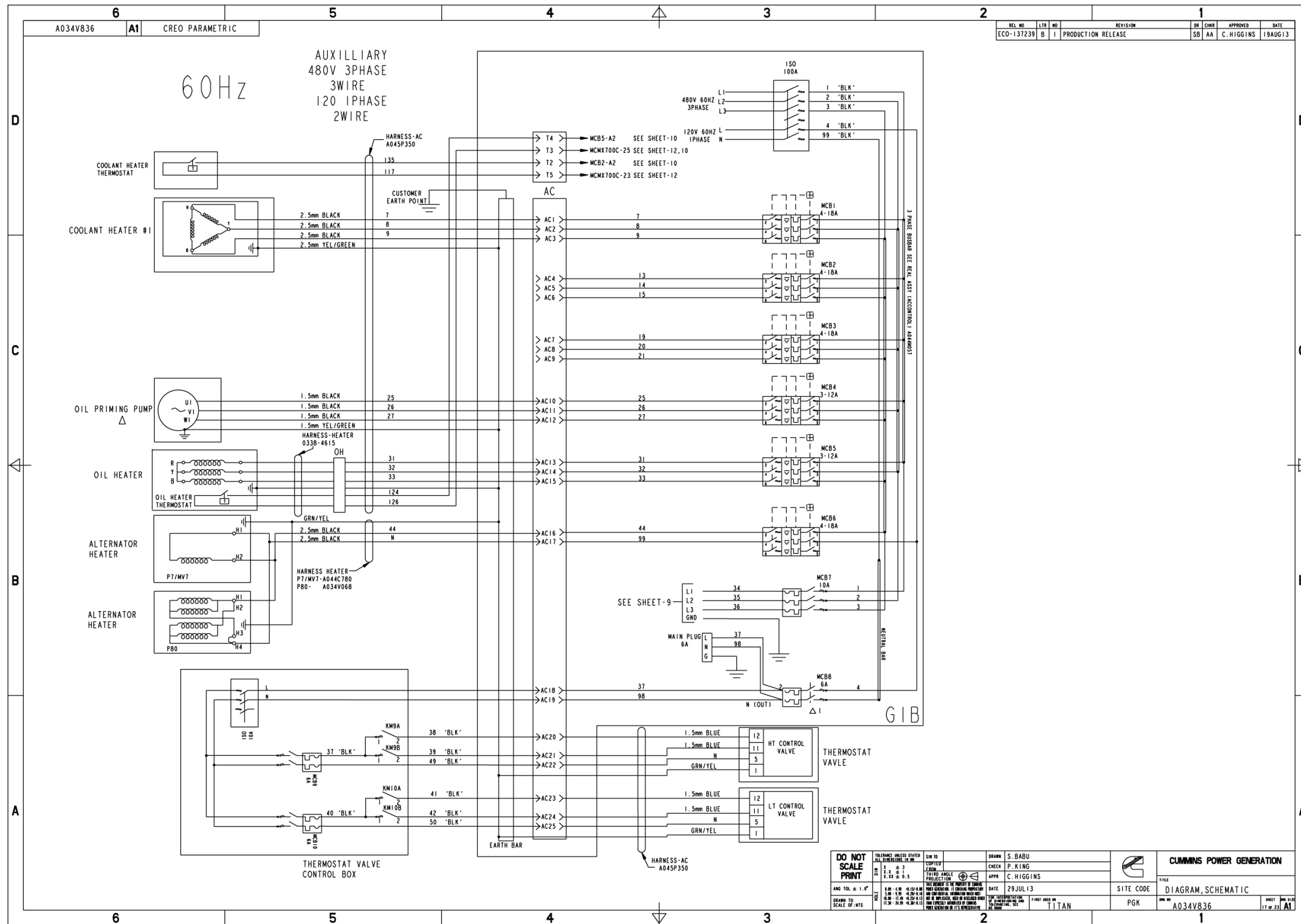


FIGURE 82. A034V836 SHEET 17 OF 23

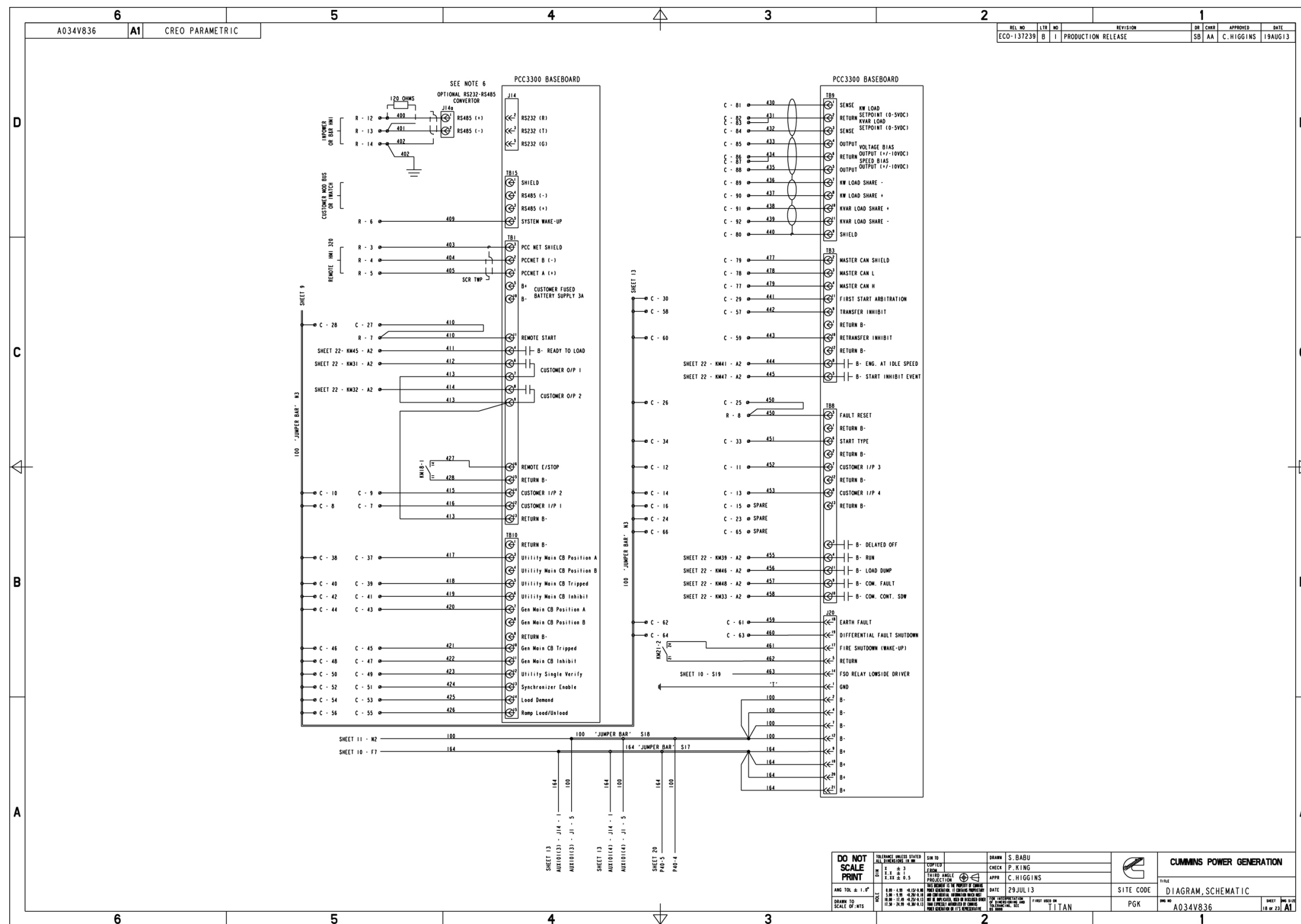


FIGURE 83. A034V836 SHEET 18 OF 23



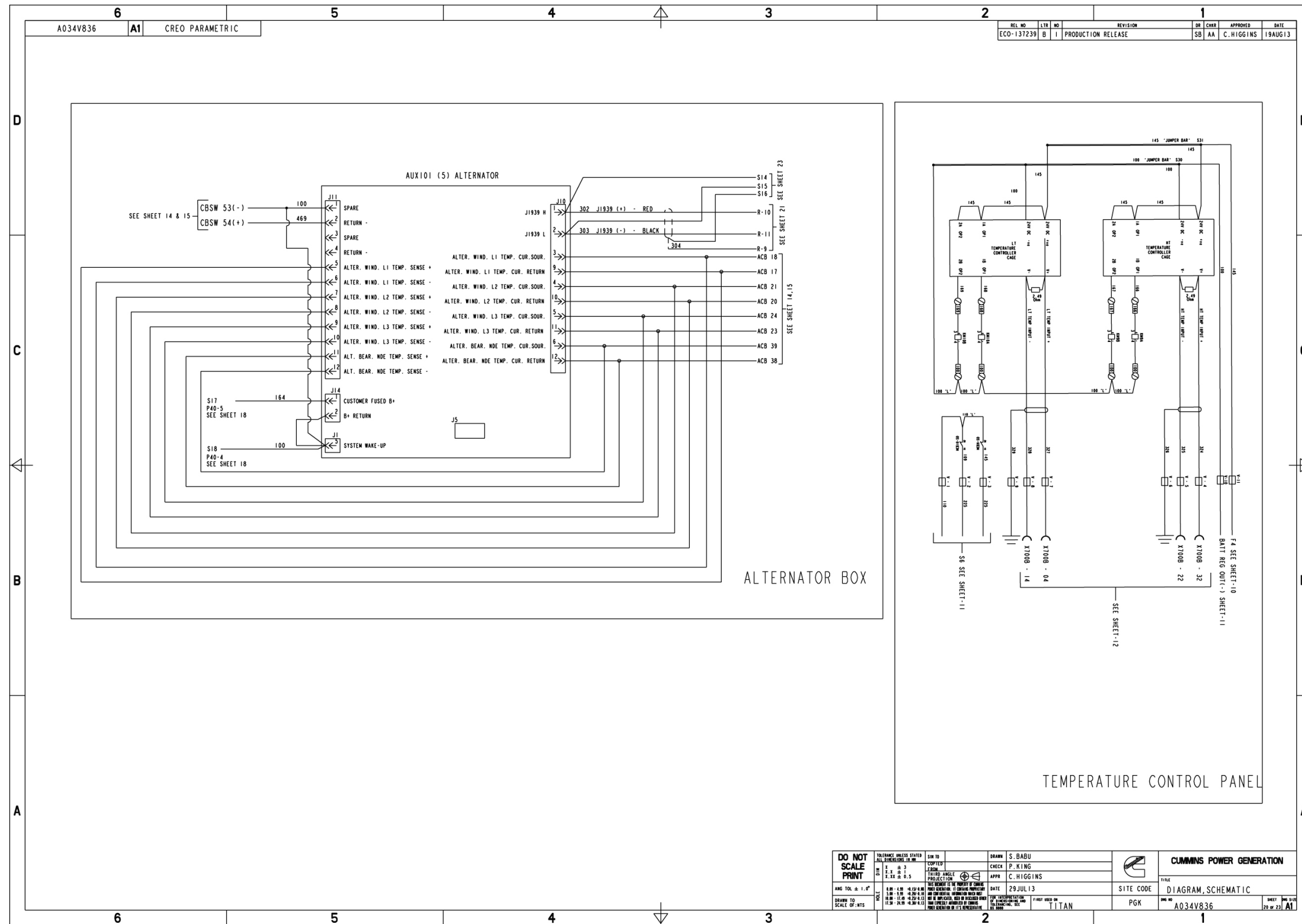


FIGURE 85. A034V836 SHEET 20 OF 23

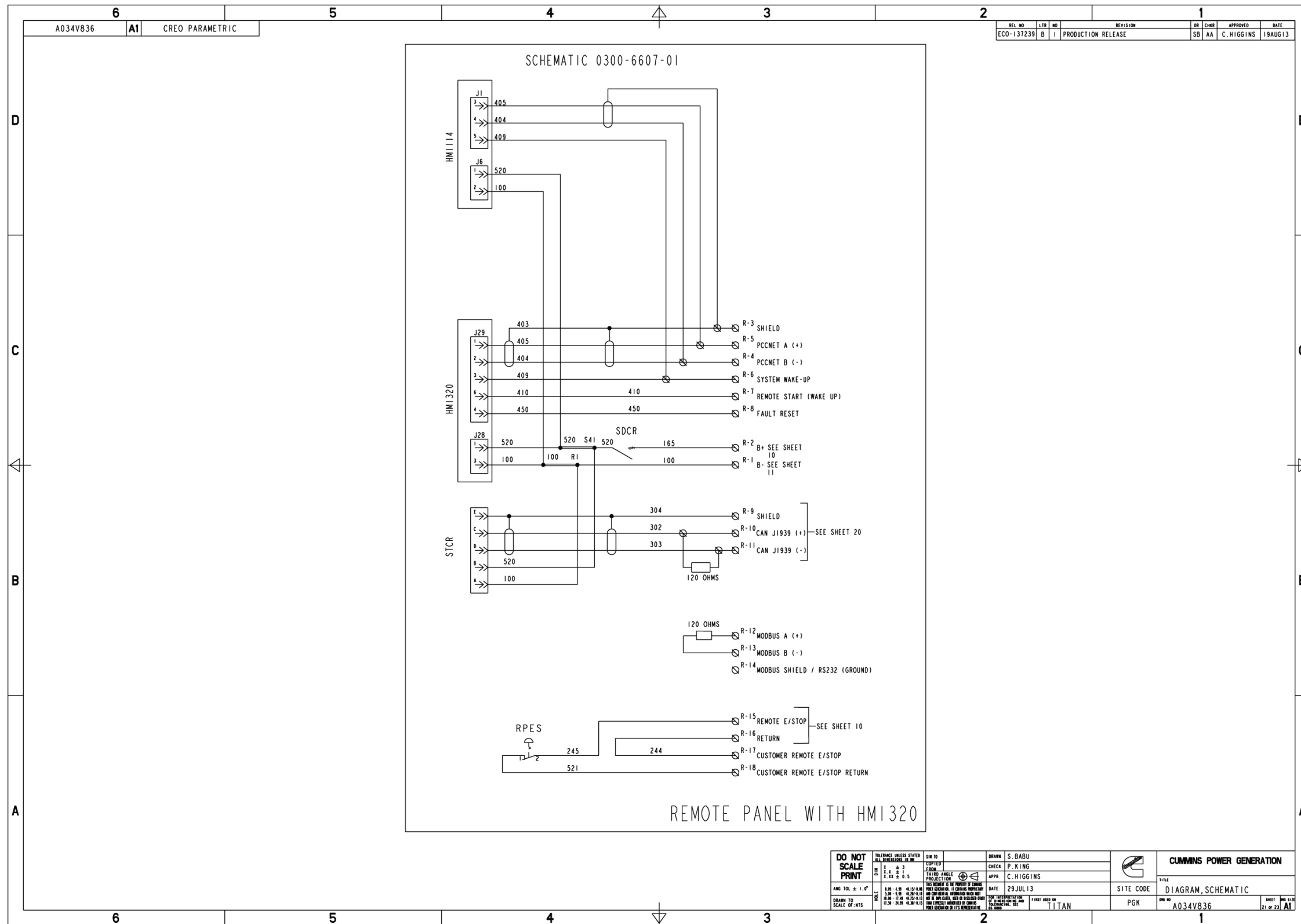


FIGURE 86. A034V836 SHEET 21 OF 23

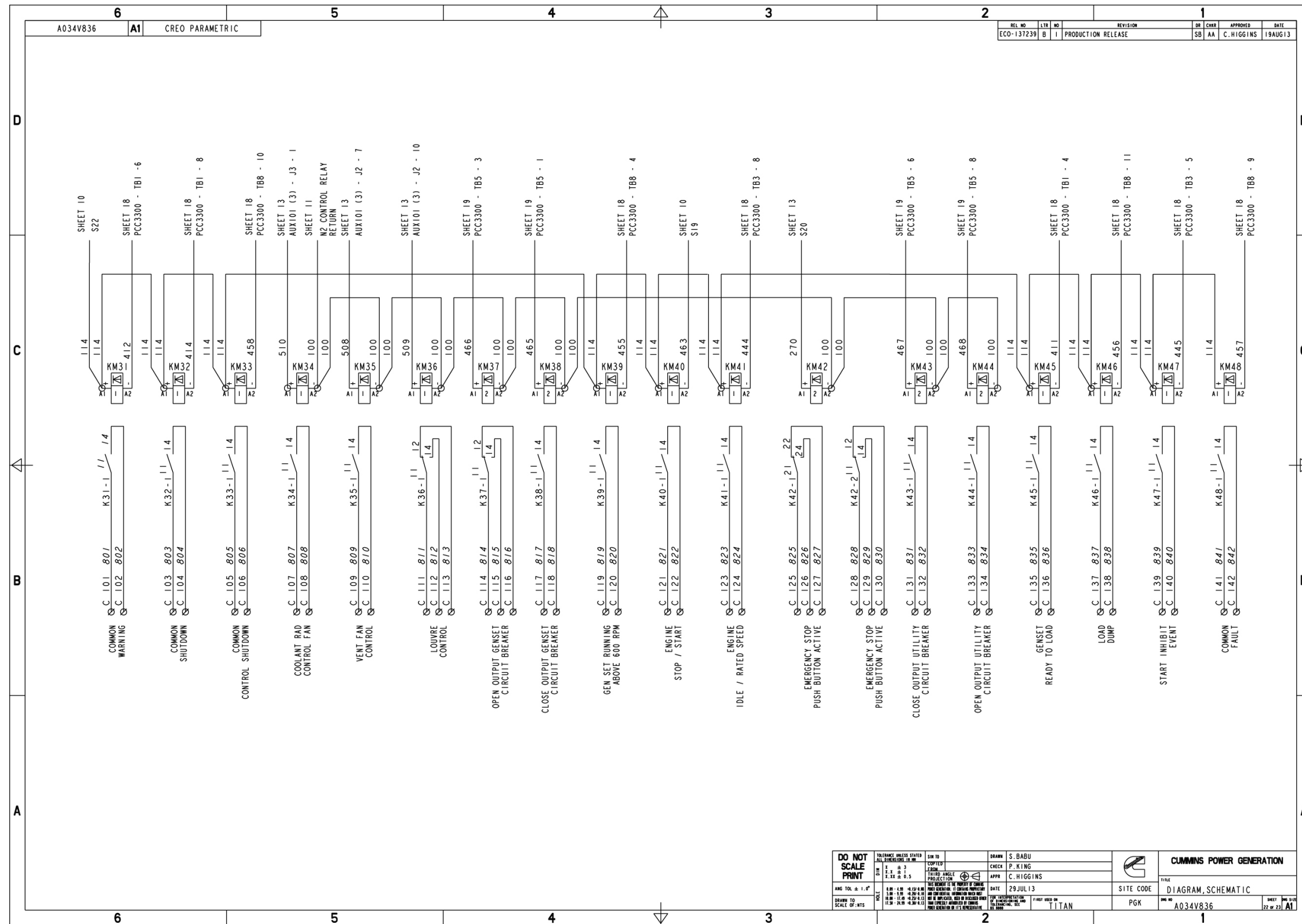


FIGURE 87. A034V836 SHEET 22 OF 23

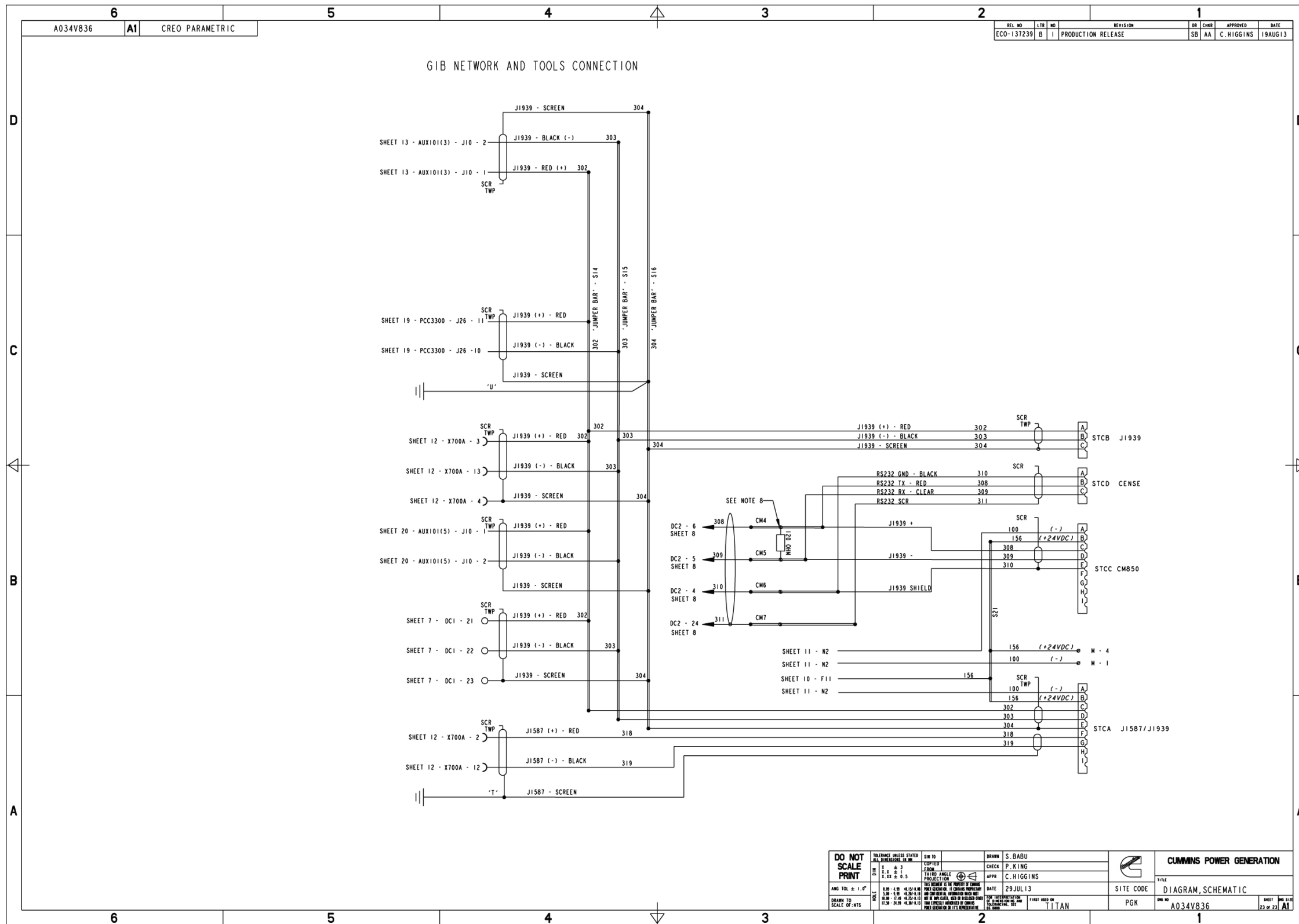


FIGURE 88. A034V836 SHEET 23 OF 23

## E.2 A049U374 Wiring Diagram for Titan with CM2358 ECM

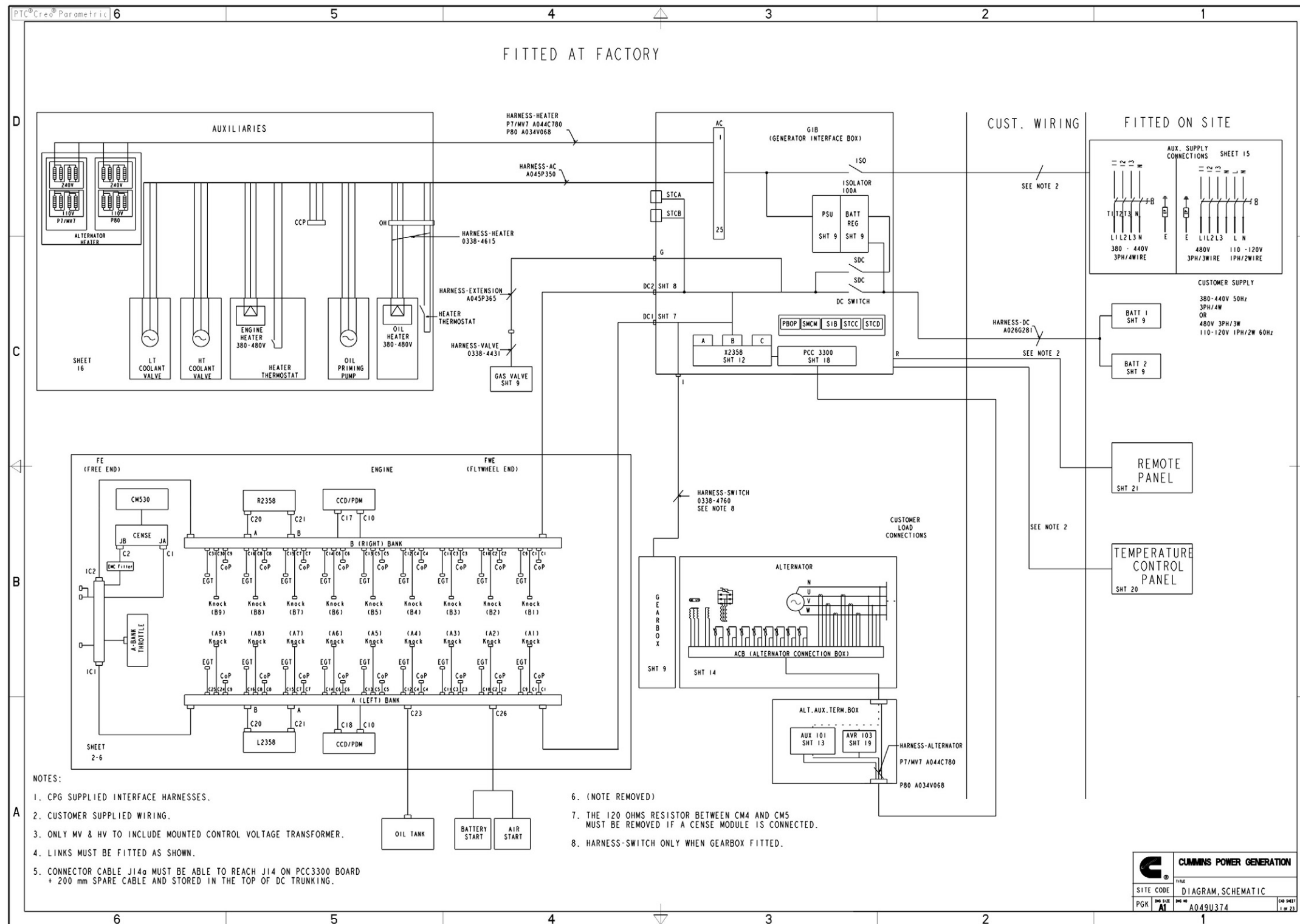


FIGURE 89. A049U374 SHEET 1 OF 23

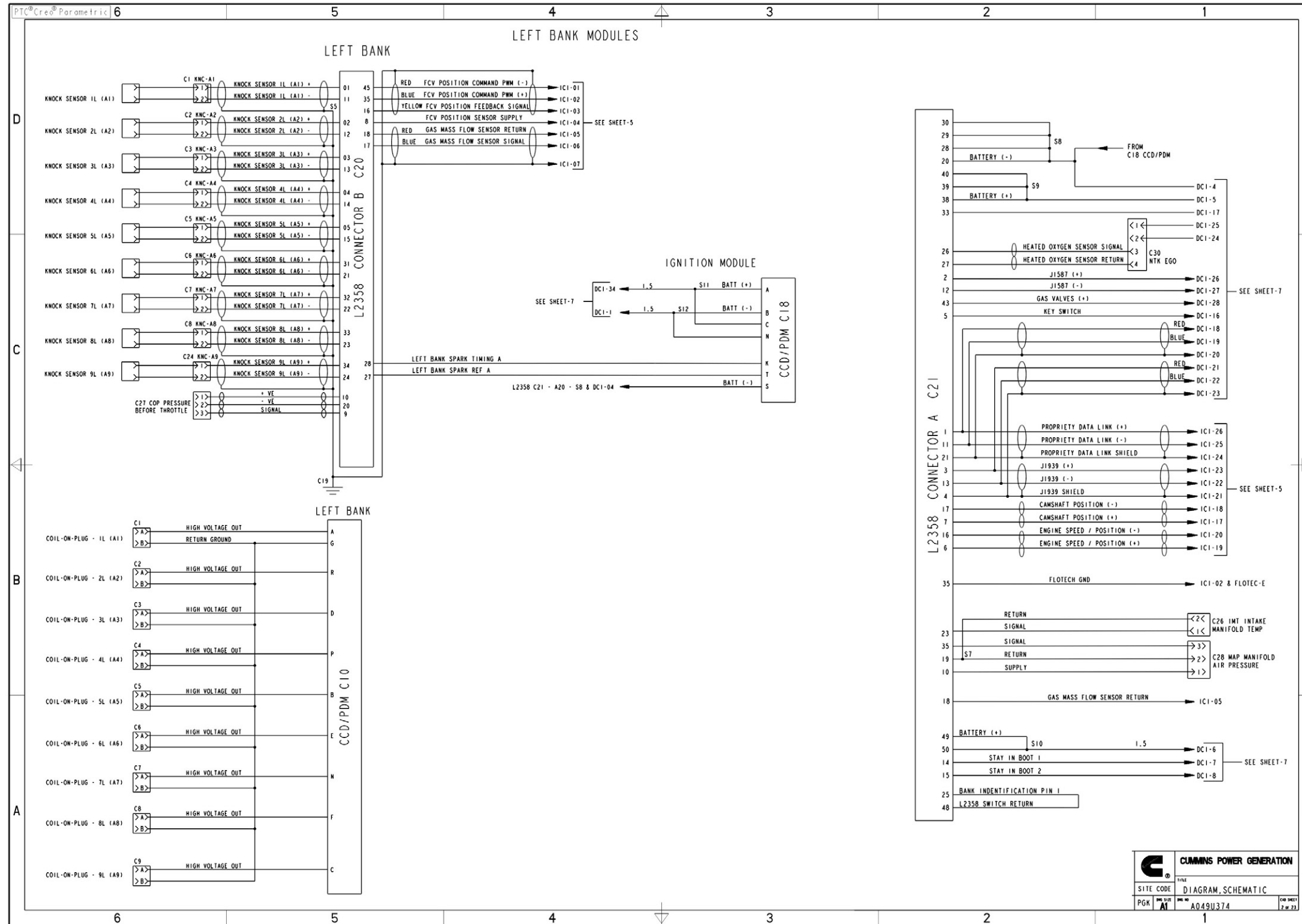


FIGURE 90. A049U374 SHEET 2 OF 23

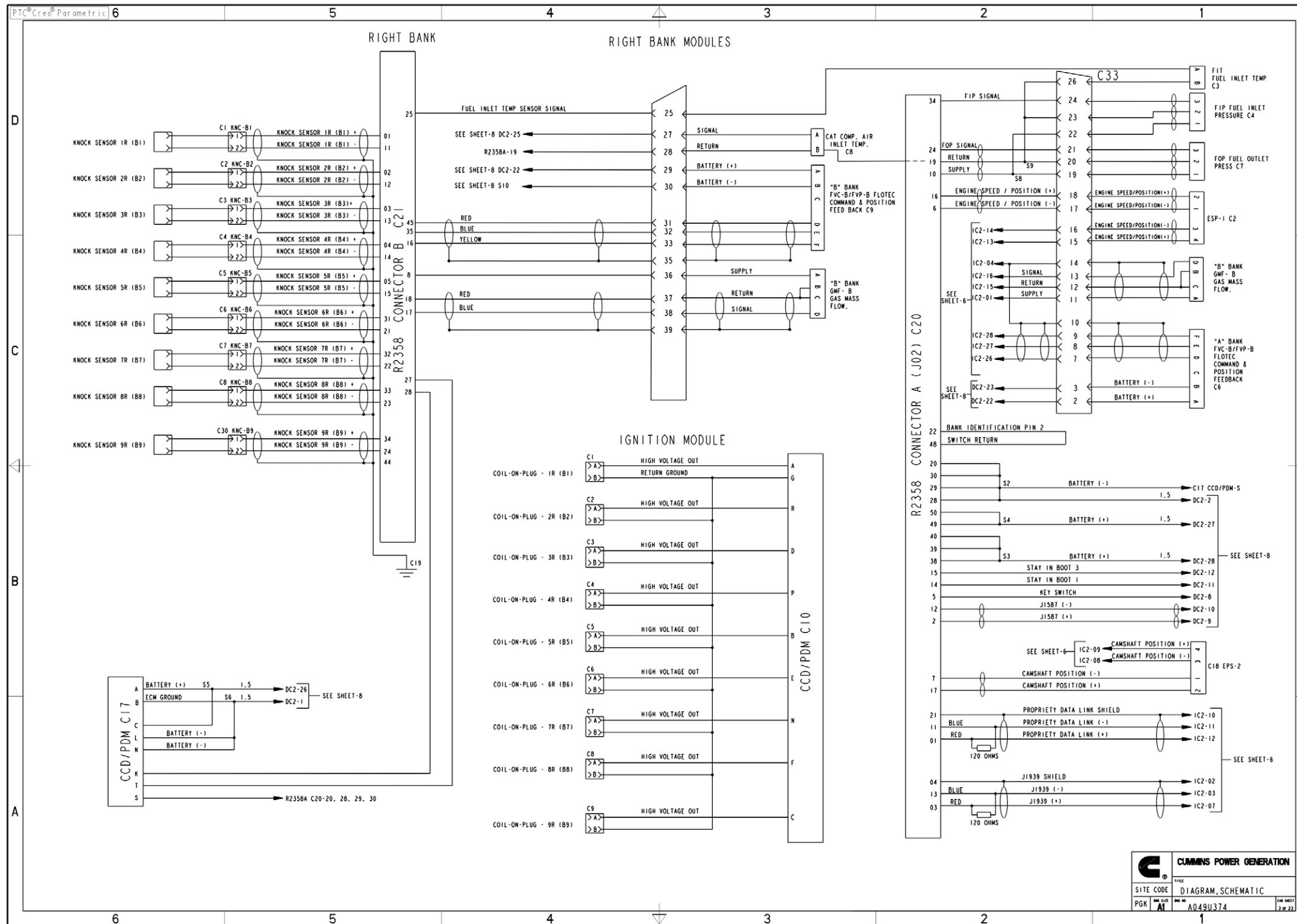


FIGURE 91. A049U374 SHEET 3 OF 23

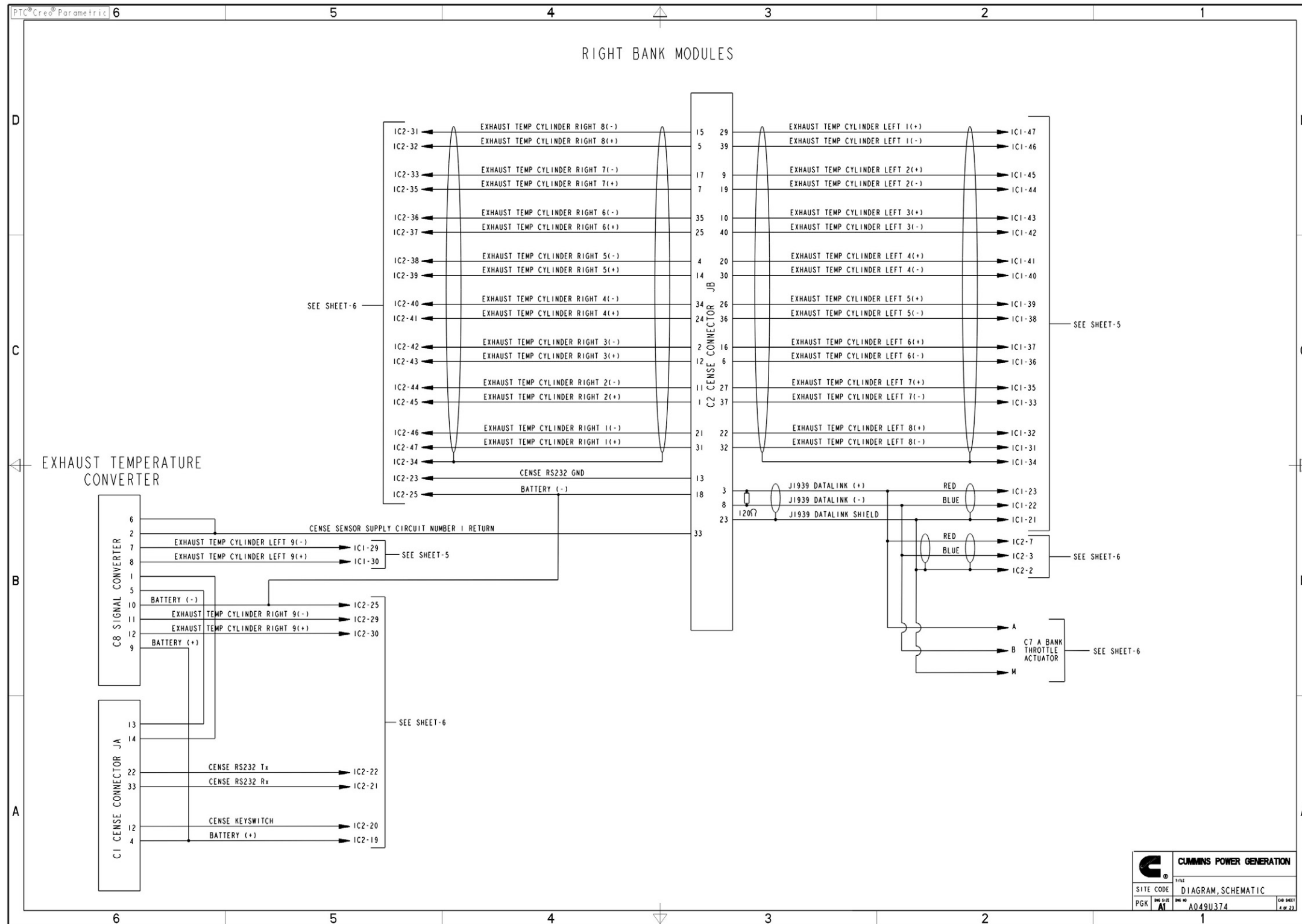


FIGURE 92. A049U374 SHEET 4 OF 23

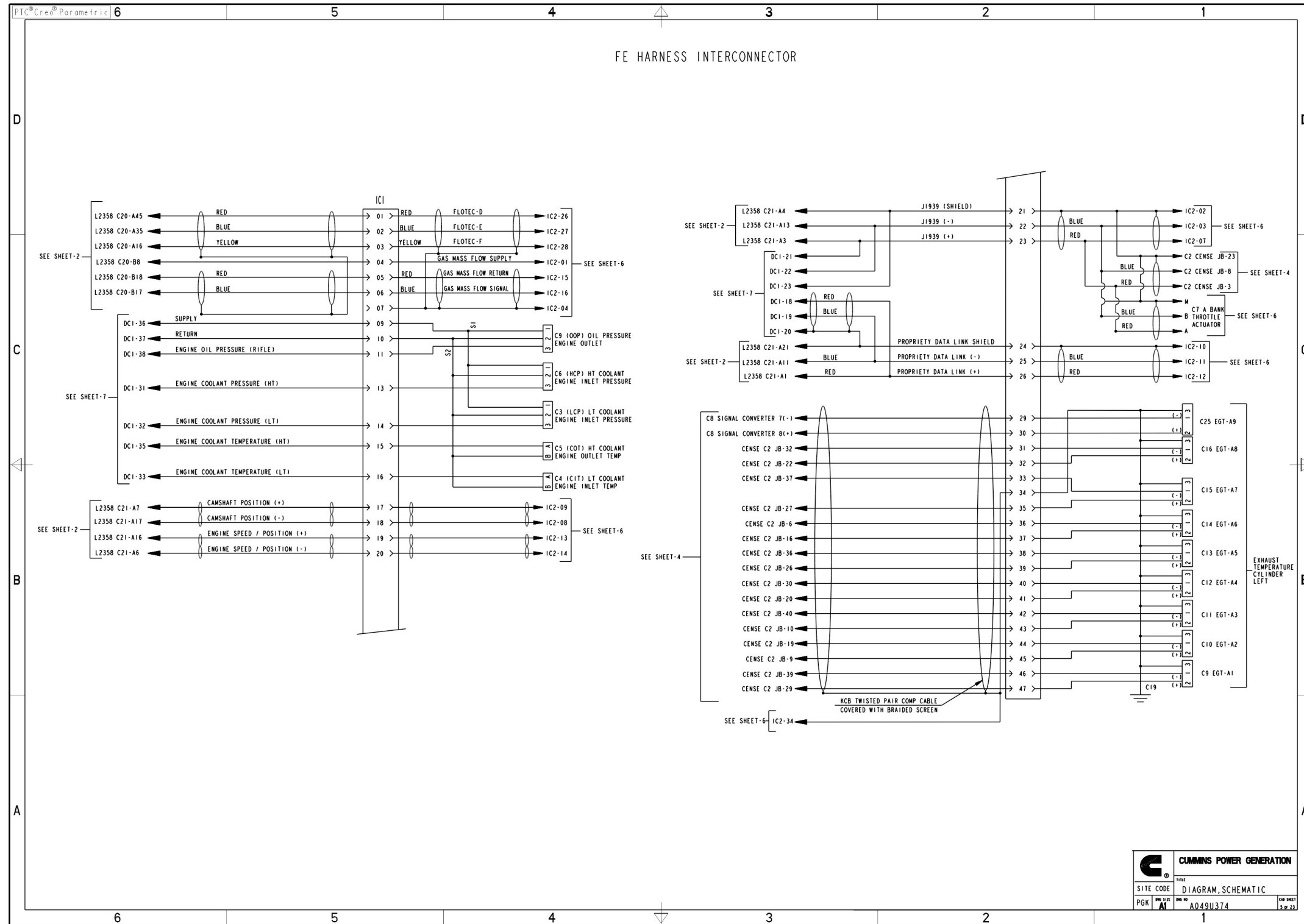


FIGURE 93. A049U374 SHEET 5 OF 23

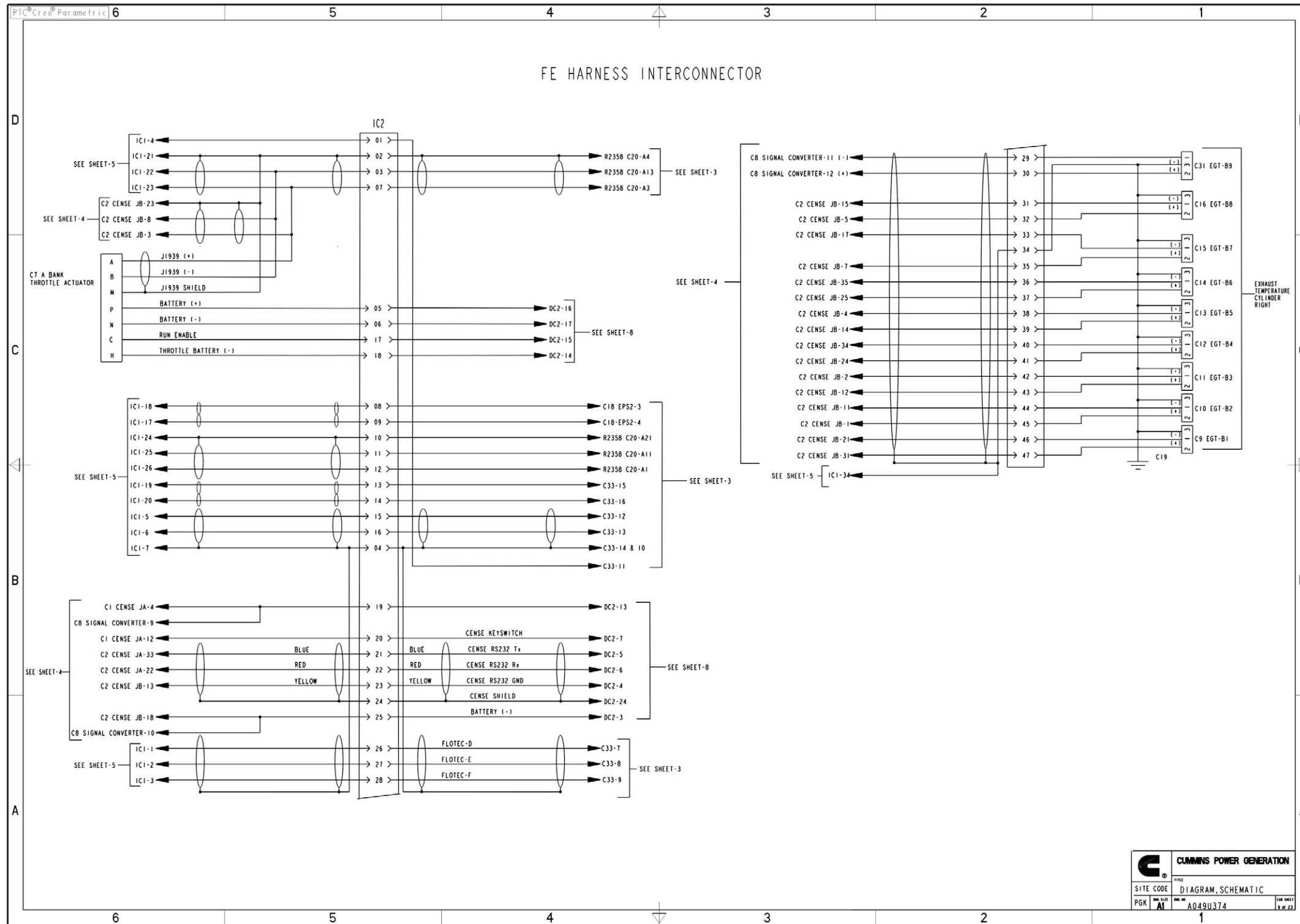


FIGURE 94. A049U374 SHEET 6 OF 23

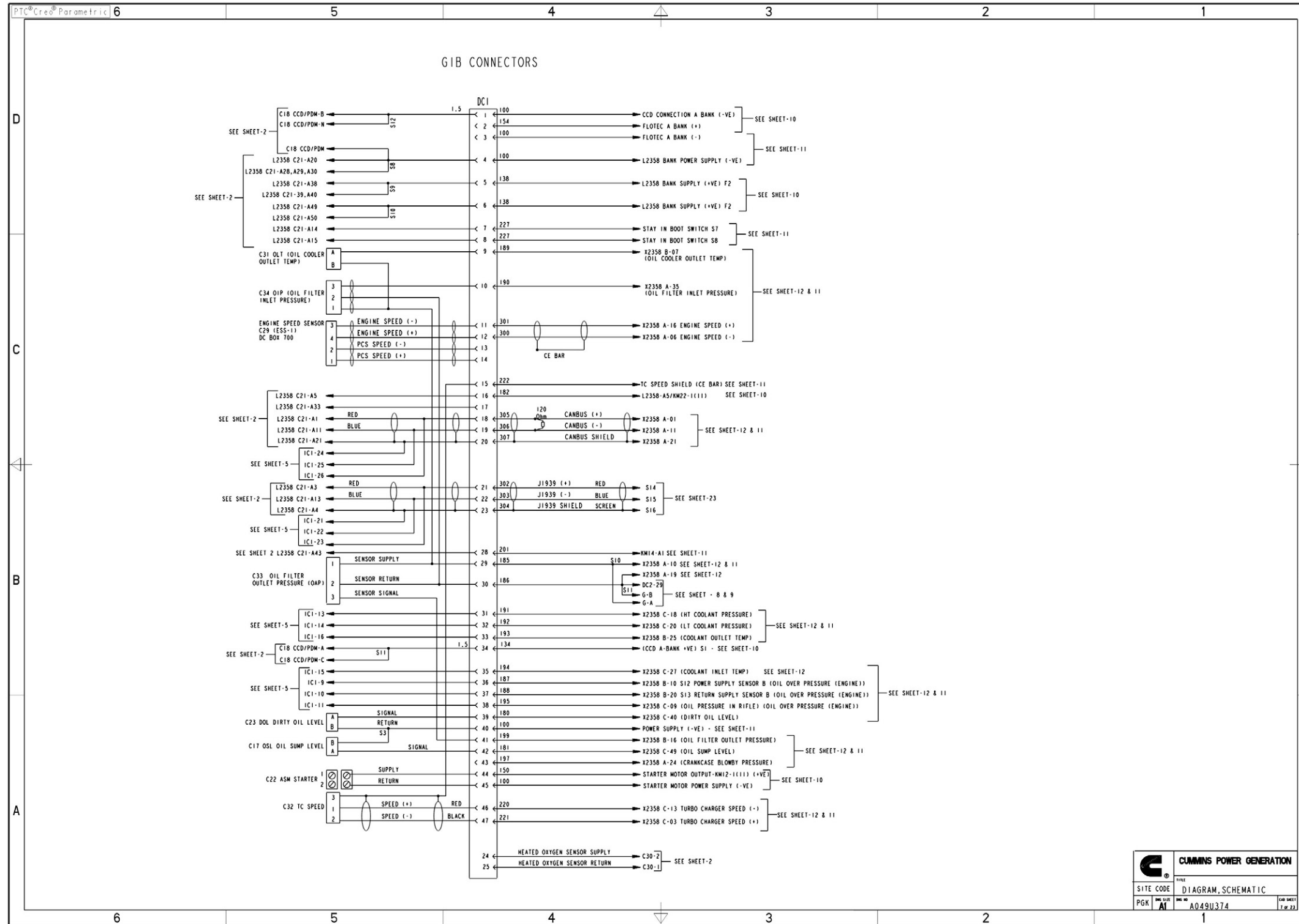


FIGURE 95. A049U374 SHEET 7 OF 23



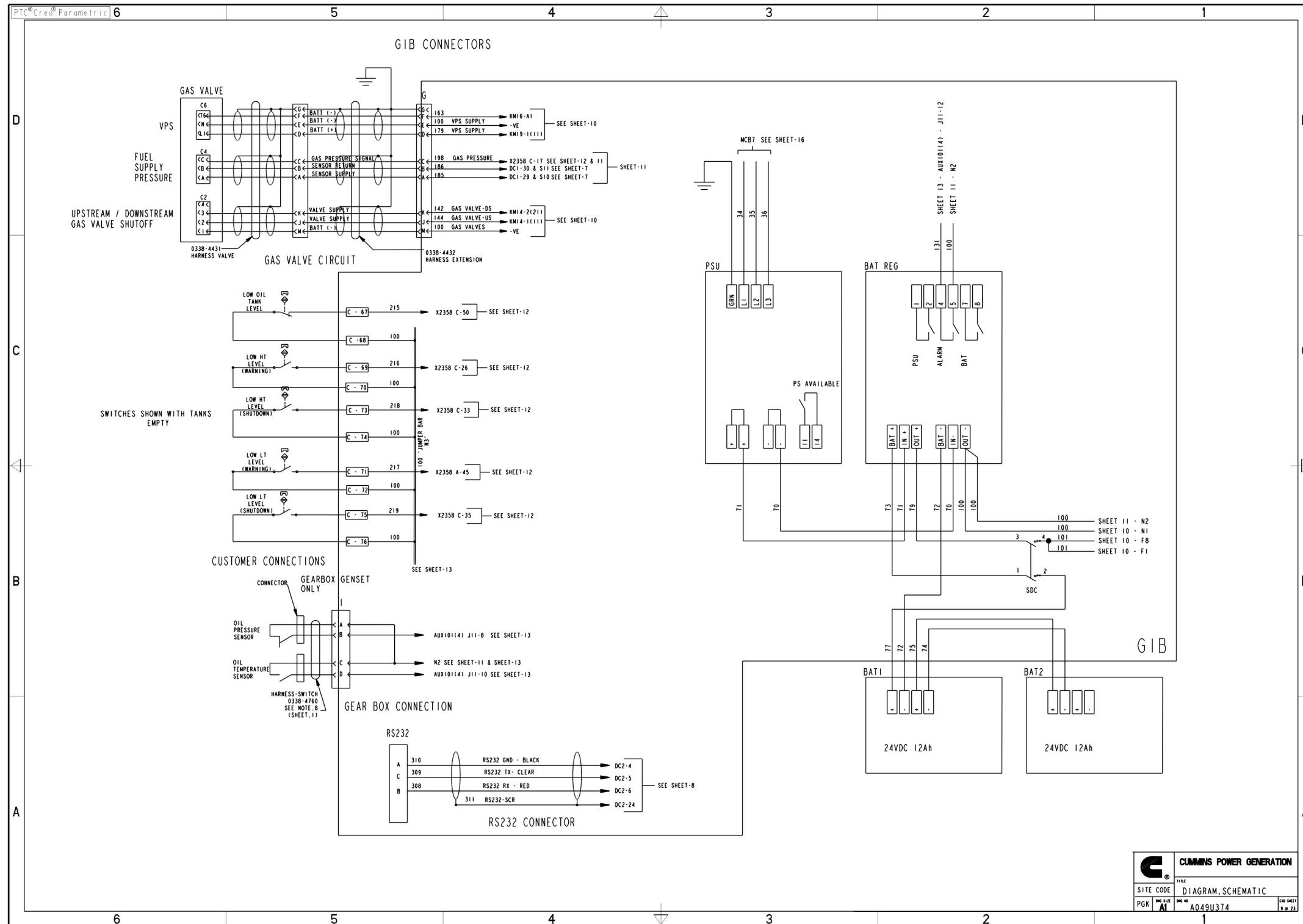


FIGURE 97. A049U374 SHEET 9 OF 23

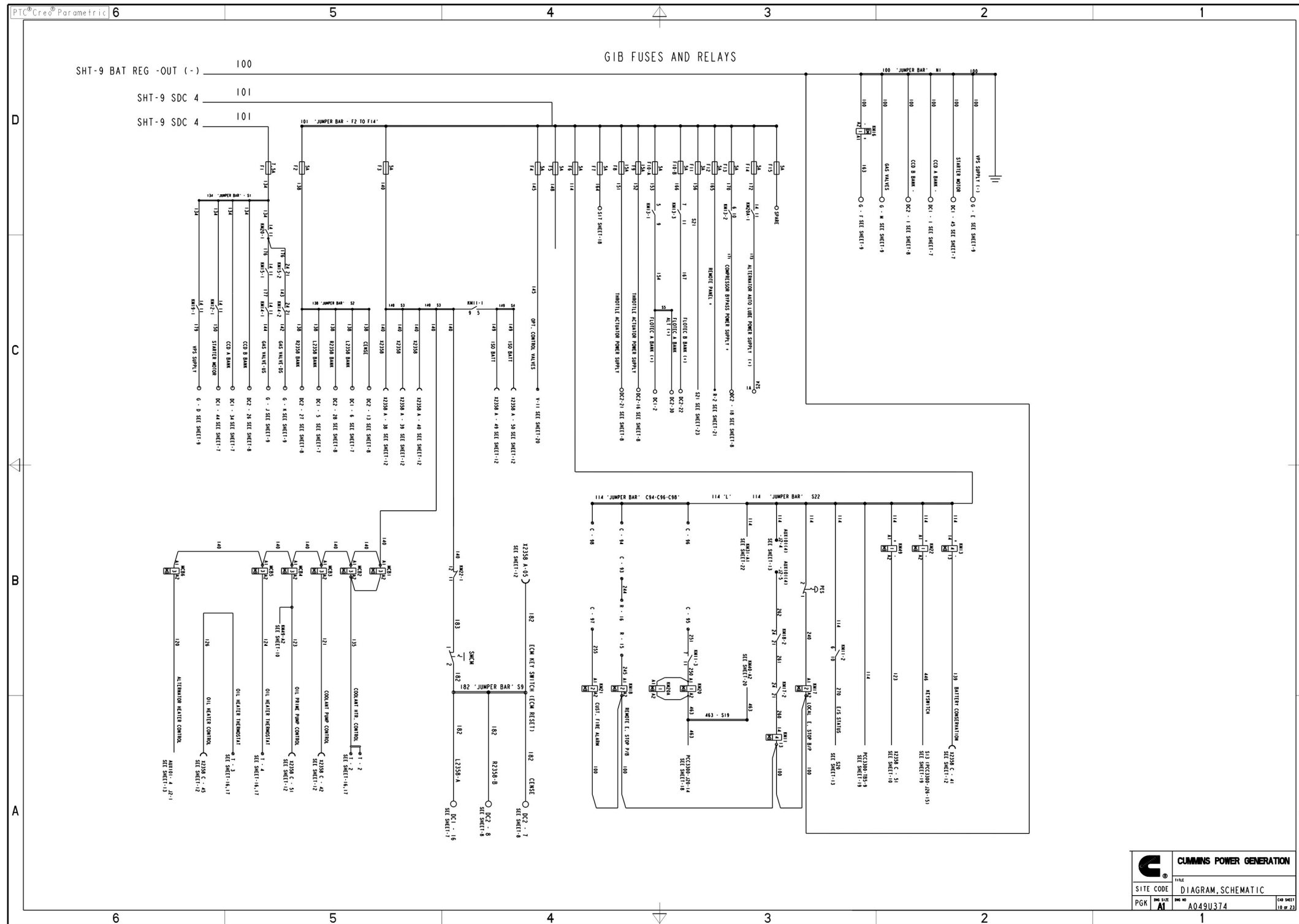


FIGURE 98. A049U374 SHEET 10 OF 23

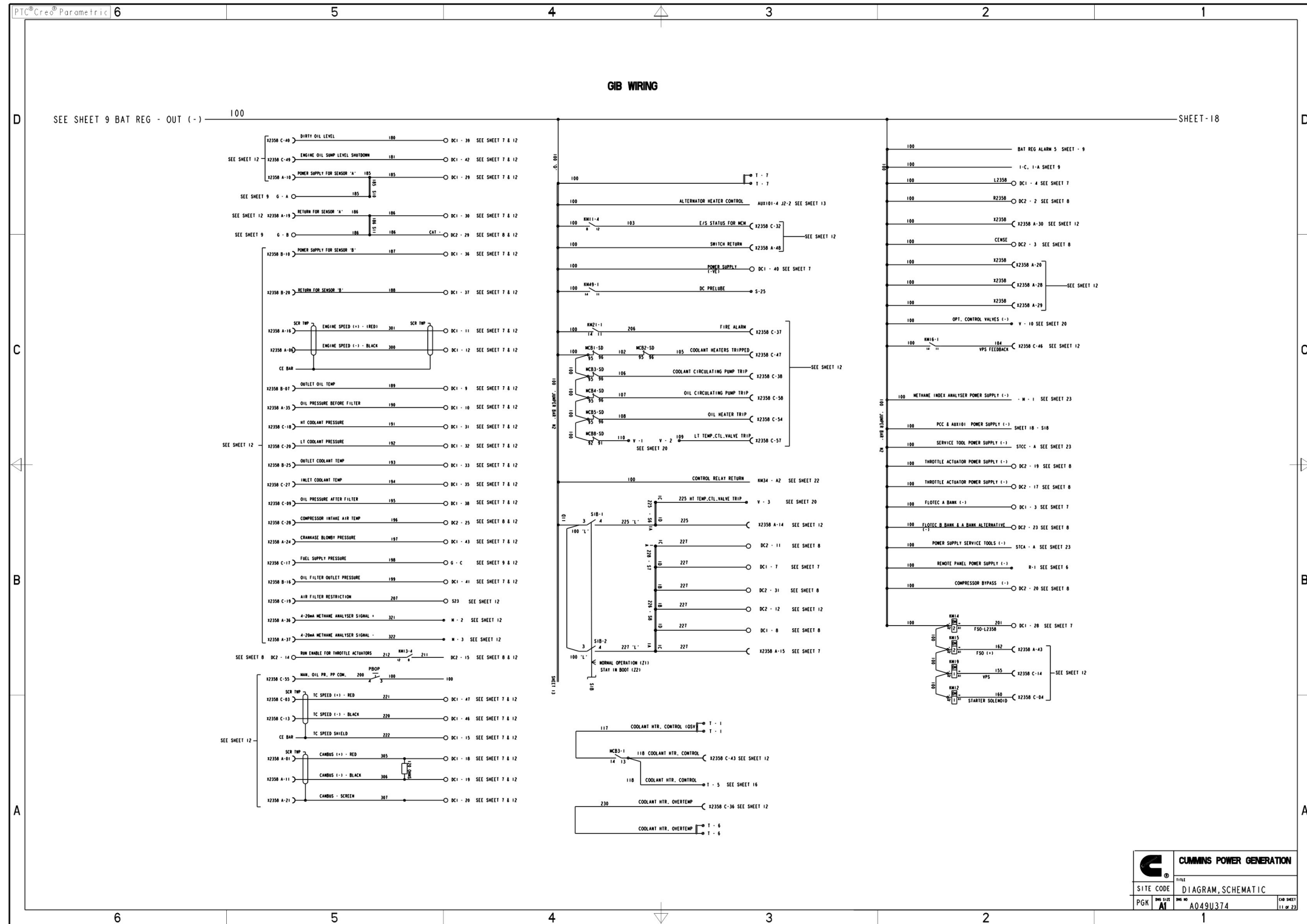


FIGURE 99. A049U374 SHEET 11 OF 23

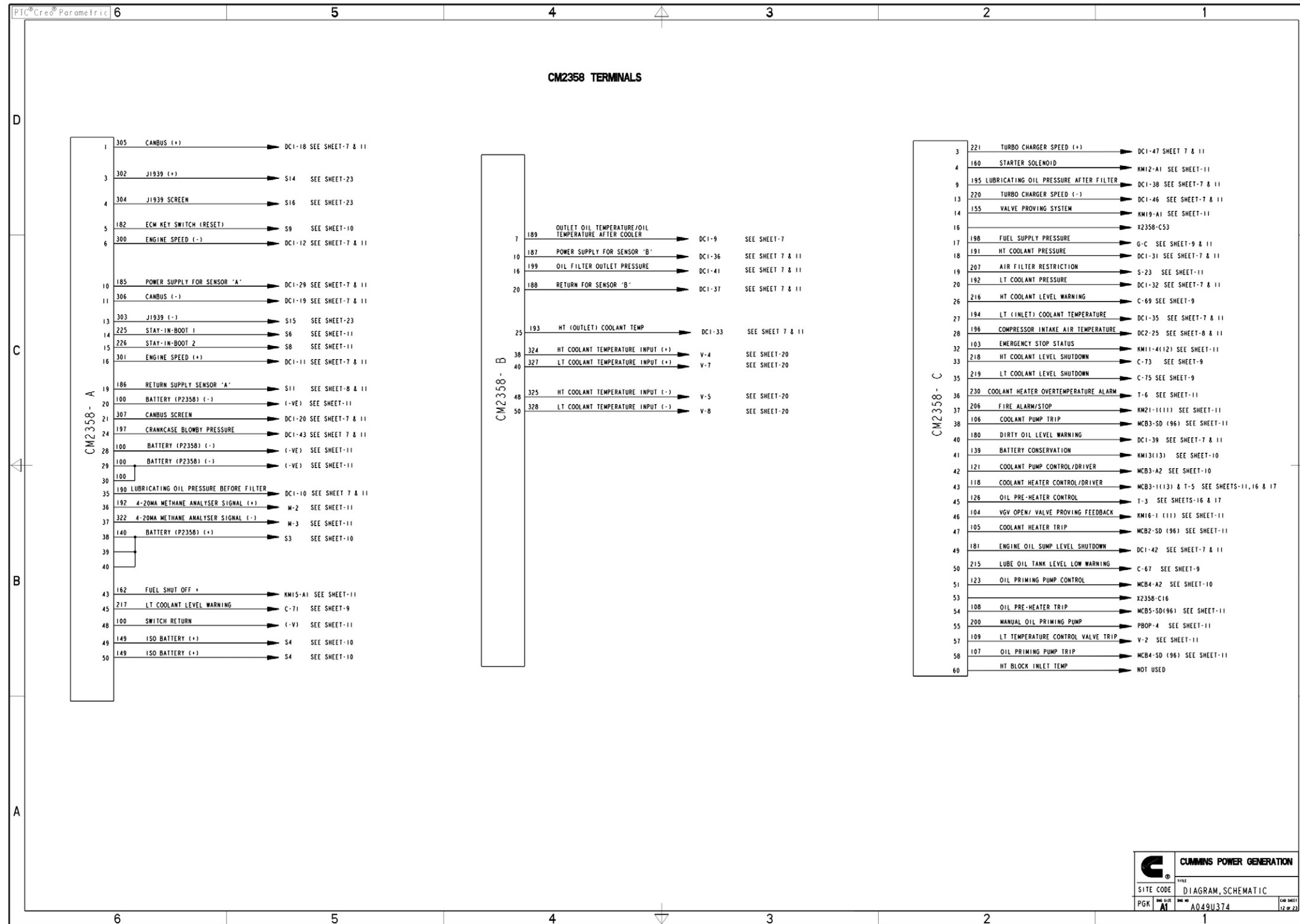


FIGURE 100. A049U374 SHEET 12 OF 23

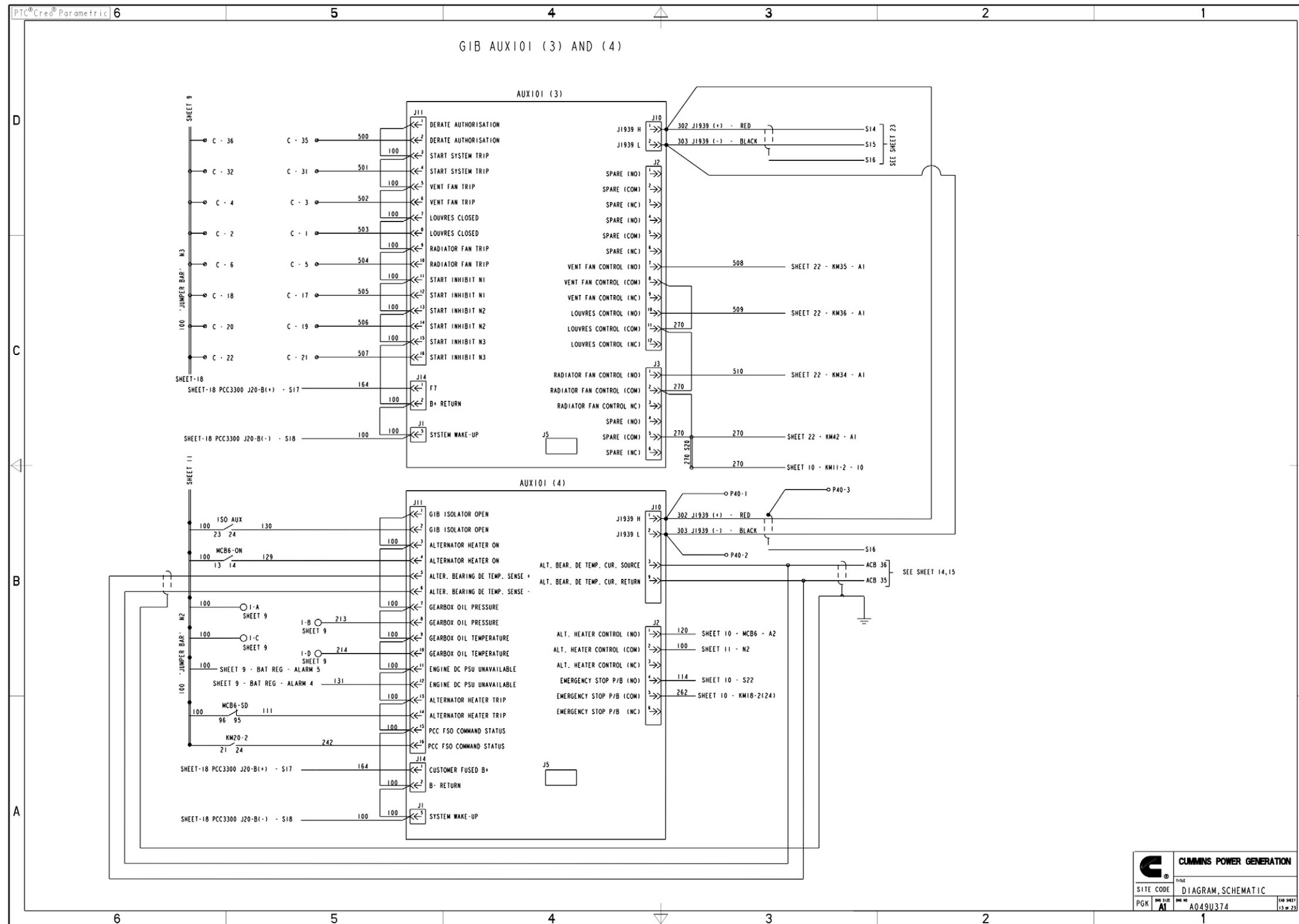


FIGURE 101. A049U374 SHEET 13 OF 23

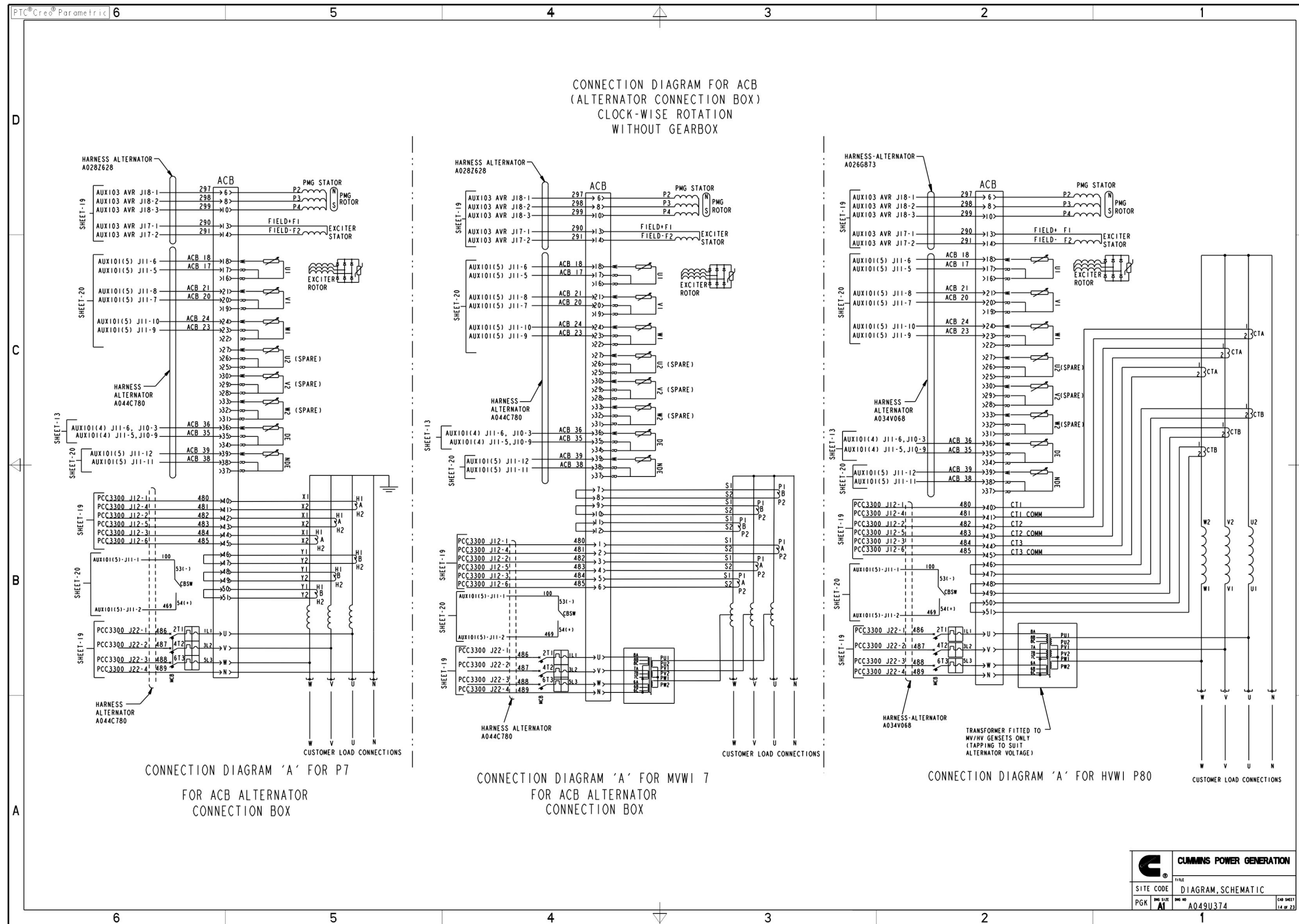


FIGURE 102. A049U374 SHEET 14 OF 23

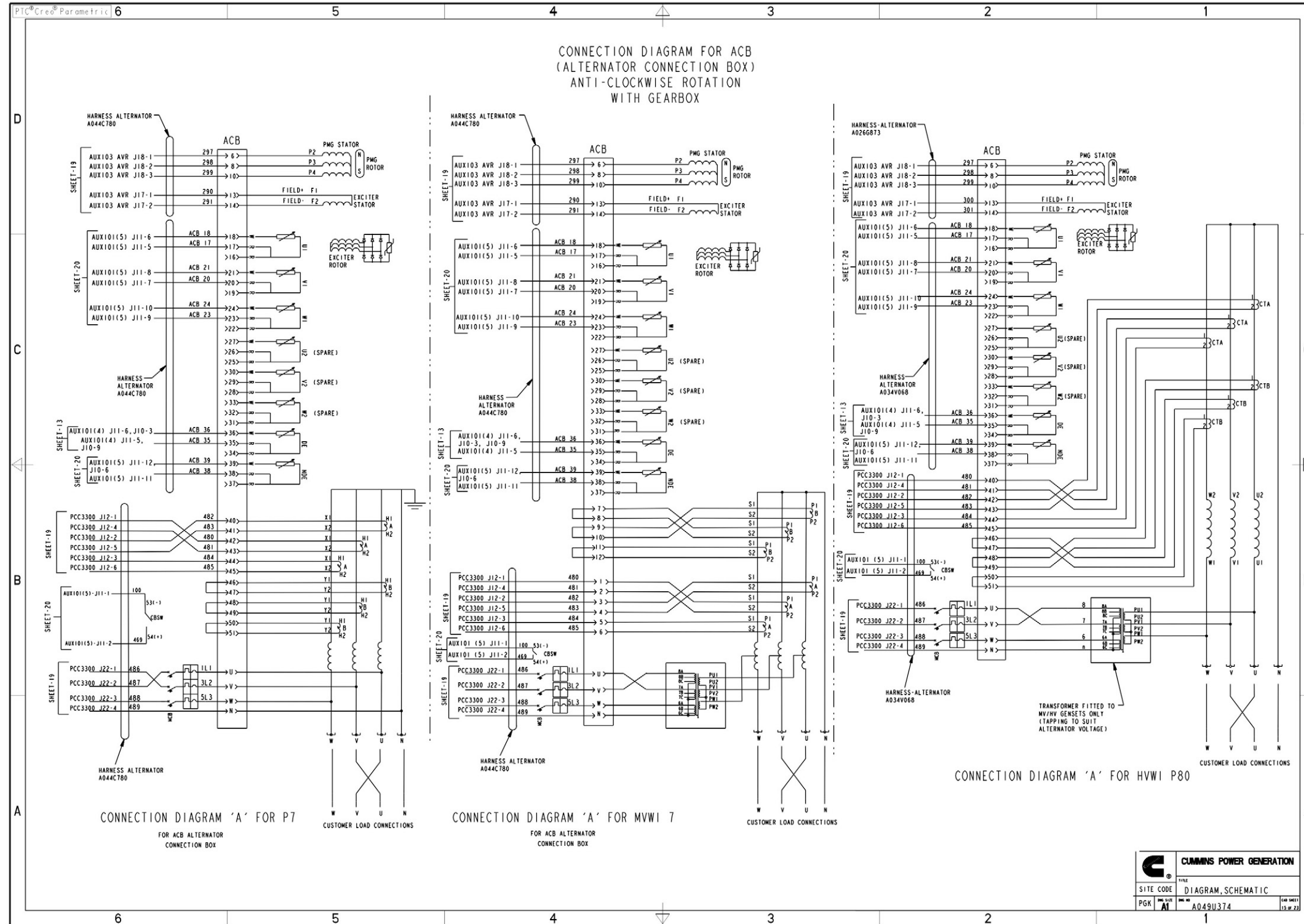


FIGURE 103. A049U374 SHEET 15 OF 23





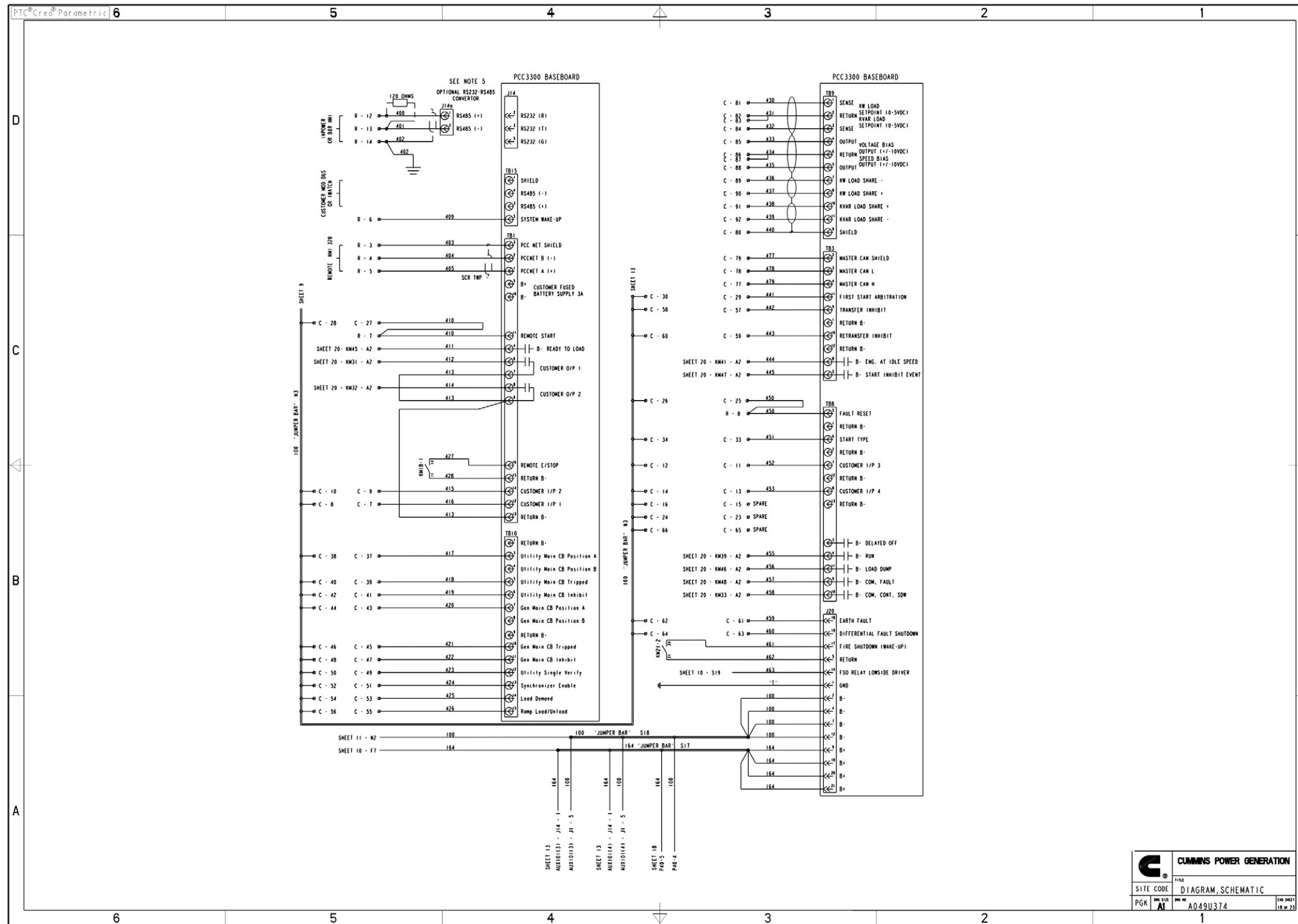


FIGURE 106. A049U374 SHEET 18 OF 23

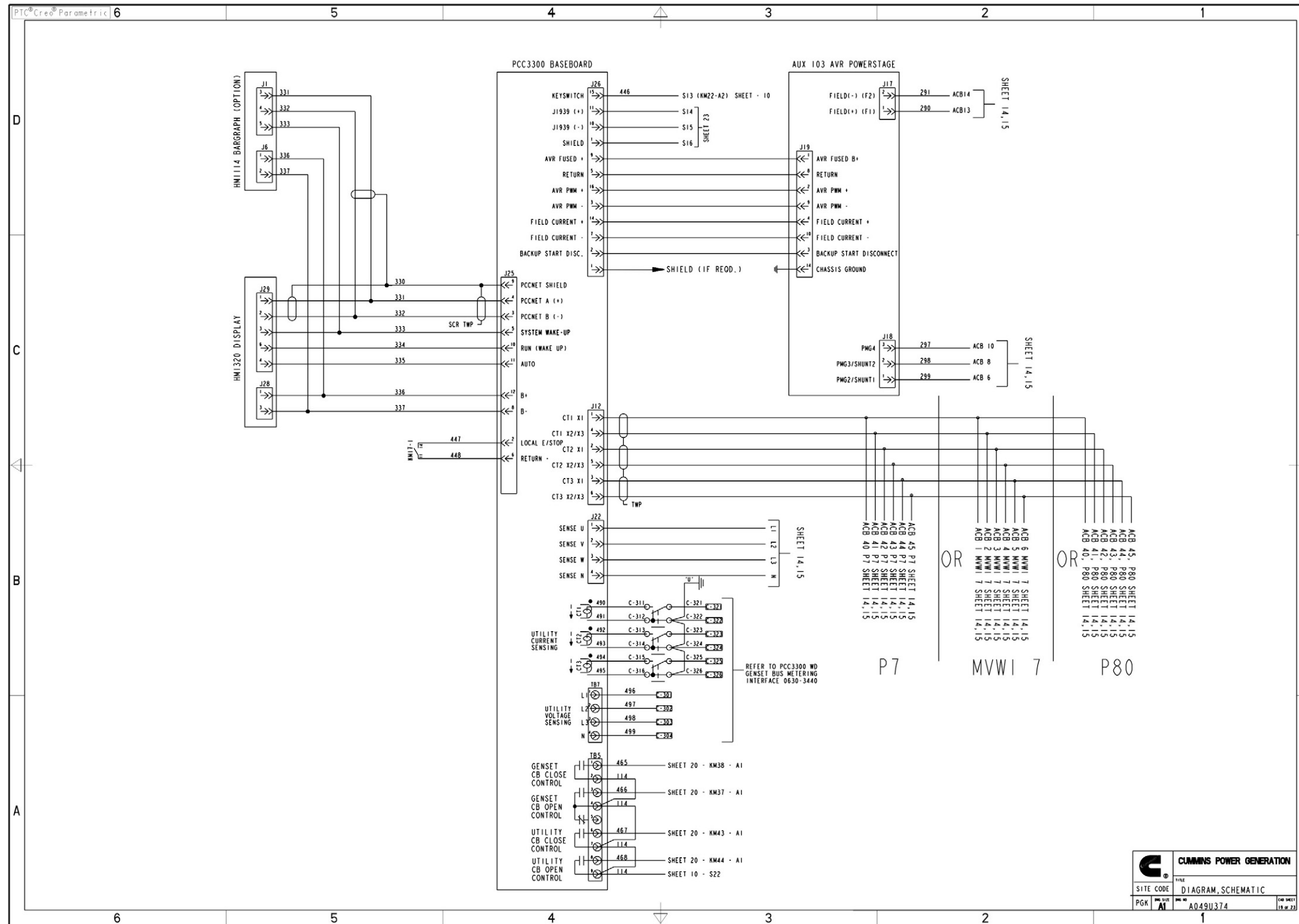


FIGURE 107. A049U374 SHEET 19 OF 23

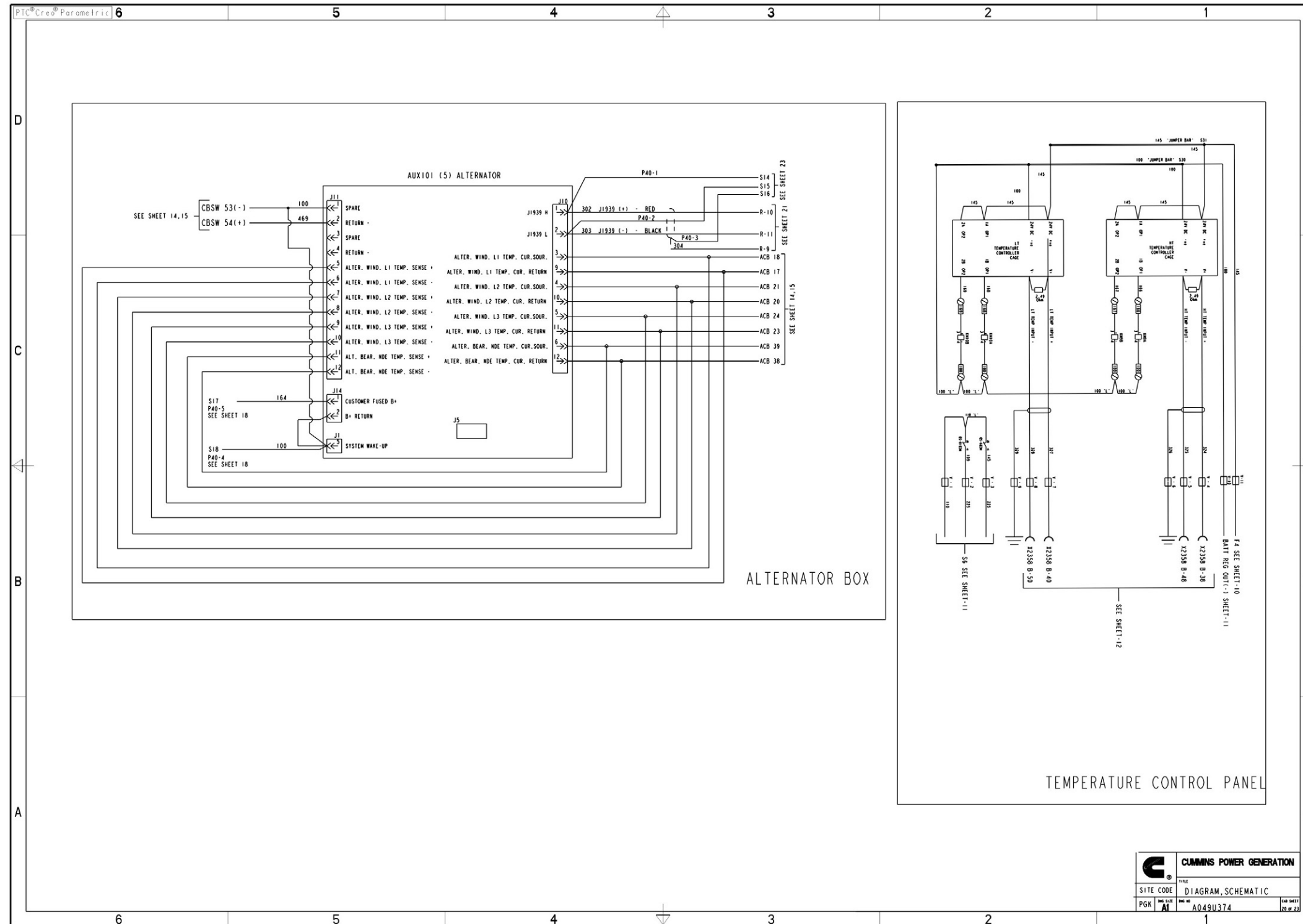


FIGURE 108. A049U374 SHEET 20 OF 23

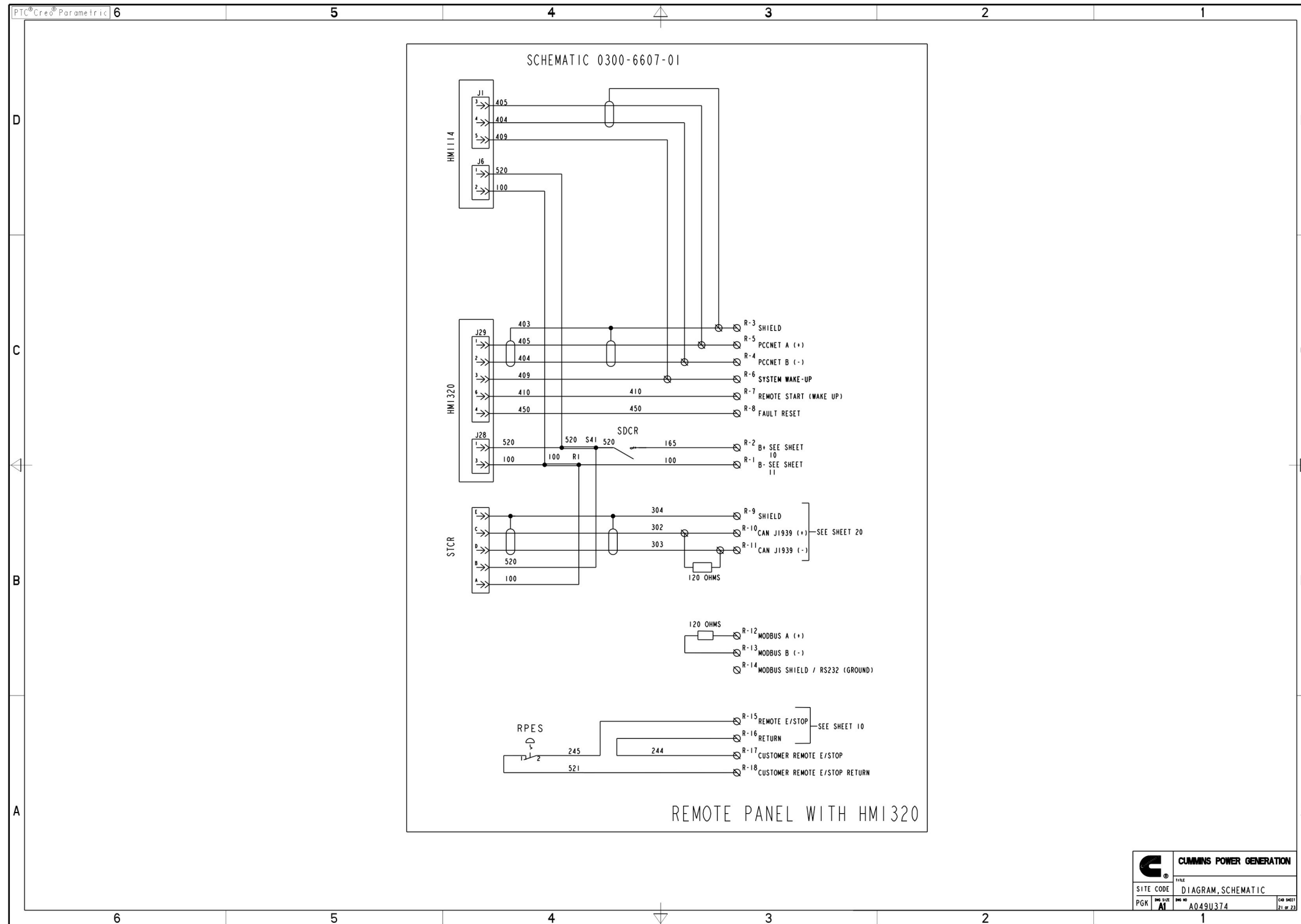


FIGURE 109. A049U374 SHEET 21 OF 23

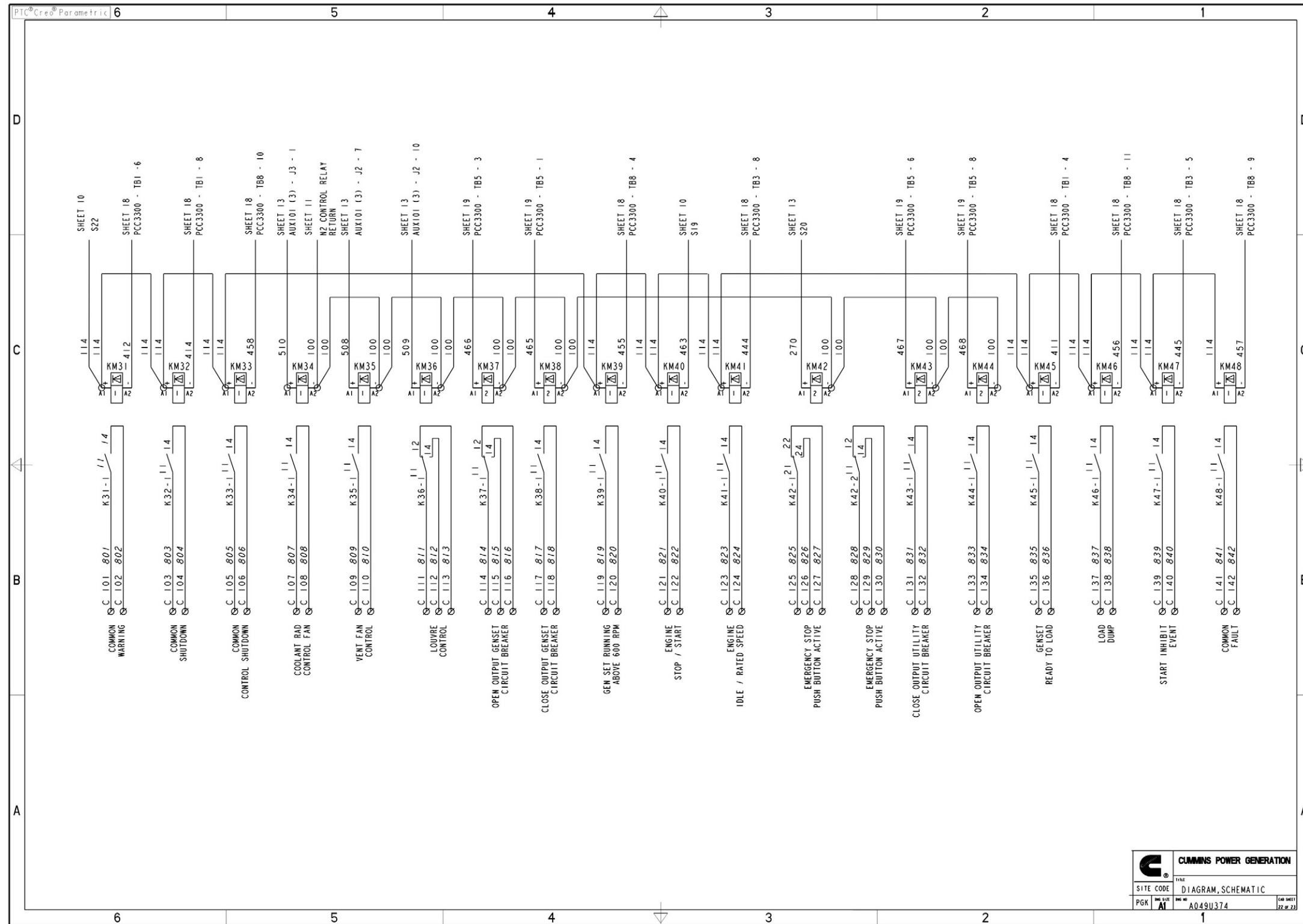


FIGURE 110. A049U374 SHEET 22 OF 23

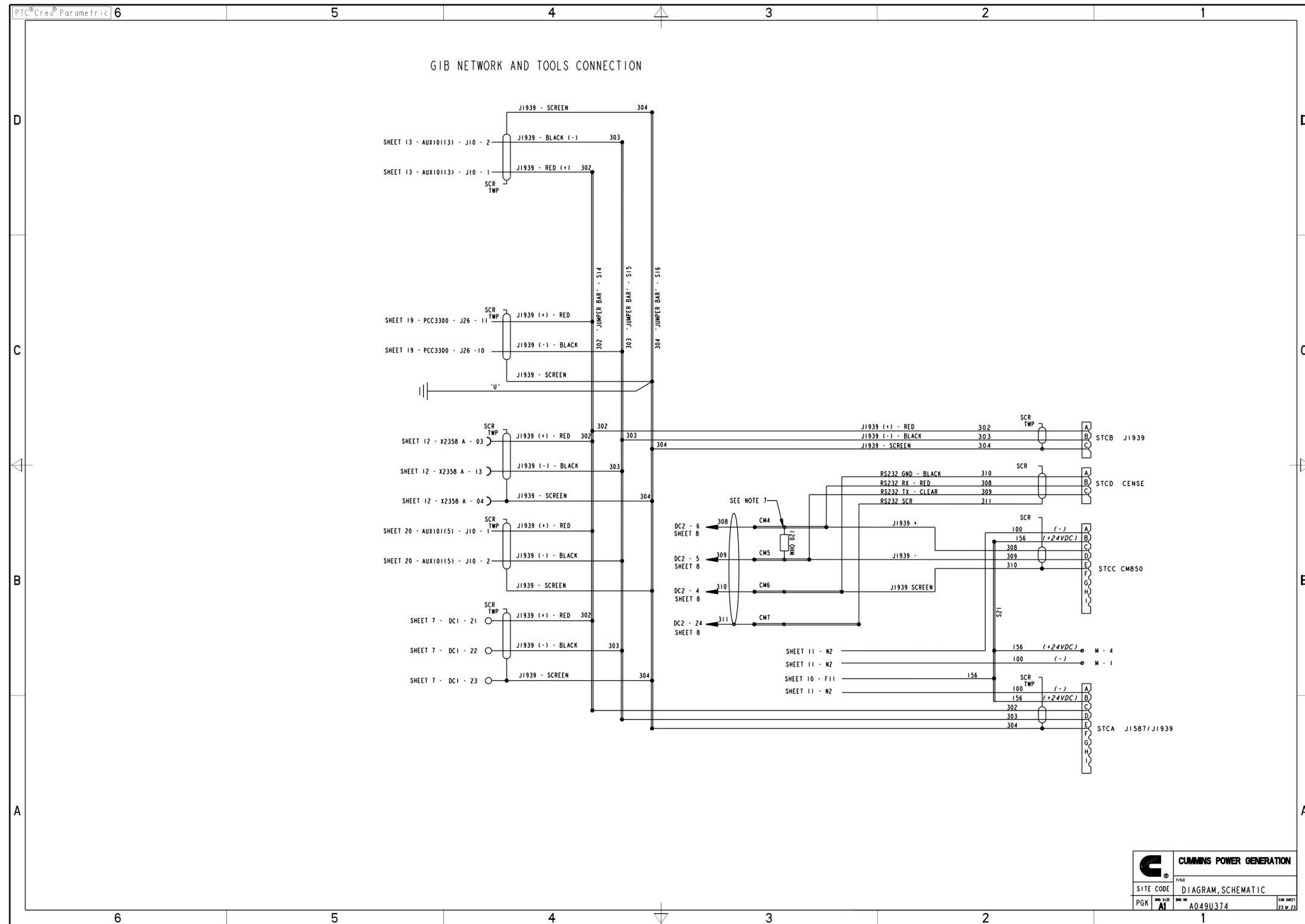


FIGURE 111. A049U374 SHEET 23 OF 23



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