UL2200 GENERATOR INSTALLATION AND OPERATION MANUAL

UL FILE NUMBER: AU5210

Dear UL2200 Aksa Generating Set Users:

First of all, we would like to thank you for your choice of an Aksa Generating Set.

It is solid, safe and reliable machine, built according to the latest technology and standards.

This operating and maintenance manual is designed and developed to make you familiar with the generating system.

Please read the following instructions carefully before starting to use your machine.

This manual gives general information about mounting, operation and maintenance of the generating set. Tables and diagrams are also available outlining your generating set.

Never operate, maintain or repair your generating set without taking general safety precautions.

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

Aksa Power Generation USA does not assume responsibility for possible errors.

Aksa Power Generation USA reserves to make changes without prior notice.

DIRECTORY

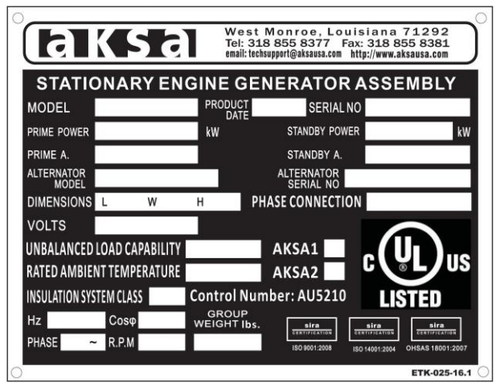
1. INTRODUCTION

SAVE THESE INSTRUCTIONS
THESE INSTRUCTIONS ARE IMPORTANT

This operations and maintenance manual has been prepared to assist the operator with the proper operation and maintenance of the generating set. Observing the suggestions and rules in this manual will ensure that the generating set operates at maximum performance and efficiency throughout the life of the unit.

Required maintenance should be performed more frequent in dirty and dusty environments in order to keep the generating set in good working condition.

Each generating set indicates the model and serial numbers on the base frame. Also, each set has a data plate(See Below) indicating the manufacture date, voltage, current, power in kVA, frequency, power factor, and weight of the generating set. This information will be necessary for spare part orders, warranty validity, and service calls.



The generating set is designed to be safe when used properly. However, responsibility for safety rests with the personnel who install, use, and maintain the set. If the following safety precautions are followed, the possibility of an accident is minimized. Before performing any procedure or operating technique, it is up to the user to ensure that it is safe. The generating set should only be operated by personnel who are authorized and trained.

Only people that have been properly trained should be allowed to operate, adjust, perform maintenance, or make repairs on Aksa Power Generation equipment. It is the responsibility of the purchaser to appoint operators with the appropriate training and skill for each job category.

Skill level 1 : Operator

An operator that is trained in all aspects of operating the unit with the push buttons and is also trained to know the safety aspects.

Skill level 2 : Mechanical technician

A mechanical technician is trained to operate the unit with the same proficiency as the operator. The mechanical technician is also trained to perform maintenance and repairs as described in the operation manual. A mechanical technician is allowed to change the settings of the controls and safety system. A mechanical technician does not work on live electrical components.

Skill level 3 : Electrical technician

An electrical technician has the same qualifications as both the operator and the mechanical technician. The electrical technician may also carry out electrical repairs within the various enclosures of the unit. This includes work on live electrical components.

Skill level 4: Specialist from the manufacturer

This is a skilled specialist sent by the manufacturer or its agent to perform complex repairs or modifications to the equipment. It is recommended that no more than two people operate the unit, more operators could lead to unsafe operating conditions. Take necessary steps to keep all unauthorized personnel away from the unit to eliminate all possible sources of danger at the unit.

The manufacturer does not accept any liability for damages caused by the use of non-original parts, Modifications, additions, or conversions made without the manufacturer's approval in writing.

The stationary engine generator assembly is to be installed over noncombustible materials and shall be located in such a manner that shall prevent combustible materials from accumulating under the generator set.

2. IMPORTANT SAFETY INSTRUCTIONS

2.1. General

1.The owner is responsible for maintaining the unit in a safe operating condition. Unit parts and accessories must be replaced if missing or unsuitable for safe operation.

2.Only operate this unit for its intended purpose and within its rated limits (pressure, temperature, speeds, etc.).

3.Gen-set and equipment shall be kept clean, i.e. as free as possible from oil, dust or other deposits.

4.To prevent an increase in operating temperature, inspect and clean heat transfer surfaces (cooler fins, intercoolers, water jackets, etc.) regularly.

5.Handle all substances with care. Keep spill containment supplies nearby in case of spills in order to prevent environmental hazards. Fuel and oil are flammable and should be kept away from any sources of ignition. The proper fire extinguisher should be kept nearby in case of fire.

WARNING

! Read and understand all safety precautions and warnings before operating or performing maintenance on the generating set.

! Failure to follow the instructions, procedures, and safety precautions in this manual may increase the possibility of accidents and injuries.

! Do not attempt to operate the generating set if any unsafe condition is known.

! If the generating set is unsafe, put danger notices and disconnect the battery negative (-) lead so that it cannot be started until the condition is corrected.

! Disconnect the battery negative (-) lead prior to attempting any repairs or cleaning inside the enclosure.

! Install and operate this generating set only in full compliance with relevant National, Local or Federal Codes, Standards, or other requirements.

2.2. Installation, Handling, and Towing

Chapter 4 and 12 of this manual cover procedures for installation, handling, and towing of generating sets. These chapters should be read before installing, moving, and/or lifting the generating set or towing a mobile set. The following safety precautions should be noted:

WARNING

! Make electrical connections in compliance with relevant Electrical Codes, Standards, or other requirements. This includes requirements for grounding and ground/earth faults.

! For stationary generating sets with remote fuel storage systems, make sure such systems are installed in compliance with relevant Codes, Standards, or other requirements.

! Engine exhaust emissions are hazardous to personnel. The engine exhaust for all indoor generating sets must be piped outdoors via leak-free piping in compliance with relevant Codes, Standards, or other requirements. Ensure that hot exhaust silencers and piping are clear of combustible material and are guarded for personnel protection per safety requirements. Ensure that fumes from the exhaust outlet will not be a hazard.

! Never lift the generating set by attaching to the engine or alternator lifting lugs. Use the lifting points on the base frame or canopy instead.

! Ensure that the lifting rigging and supporting structure is in good condition and has a capacity suitable for the load.

! Keep all personnel away from the generating set while it is suspended.

2.3. Fire and Explosion

Fuel and fumes associated with generating sets can be flammable and potentially explosive. Proper care in handling these materials can dramatically limit the risk of fire or explosion. However, safety dictates that fully charged BC and ABC fire extinguishers are kept on hand.

Personnel must know the specific uses for each one and how to operate them.

WARNING

! Ensure that the generating set room is properly ventilated.

! Keep the room, the floor, and the generating set clean. When spills of fuel, oil, battery electrolyte, or coolant occur, they should be cleaned up immediately.

! Never store flammable liquids near the engine.

! Do not smoke or allow sparks, flames, or other sources of ignition around fuel or batteries.

! Fuel vapors are explosive. Hydrogen gas generated by charging batteries is also explosive.

! Never store flammable liquids near the engine.

! Do not smoke or allow sparks, flames, or other sources of ignition around fuel or batteries. Fuel vapors are explosive.
Hydrogen gas generated by charging batteries is also explosive.

! Turn off or disconnect the power to the battery charger before making or breaking connections with the battery.

! To avoiding arcing, keep grounded conductive objects (such as tools) away from exposed live electrical parts (such as terminals). Sparks and arcing might ignite fuel or vapors.

! Avoid refilling the fuel tank while the engine is running.

! Do not attempt to operate the generating set with any known leaks in the fuel system.

2.4. Mechanical

The generating set is designed with guards for protection from moving parts. Care must still be taken to protect personnel and equipment from other mechanical hazards when working around the generating set.

WARNING

! Do not attempt to operate the generating set with the safety guards removed. While the generating set is running do not attempt to reach under or around the guards to do maintenance or for any other reason.

! Keep hands, arms, long hair, loose clothing, and jewelry away from pulleys, belts, and other moving parts.

Attention: Some moving parts cannot be seen clearly when the generating set is running.

! If equipped, keep access doors on enclosures closed and locked when not required to be open.

! Avoid contact with hot oil, hot coolant, hot exhaust gases, hot surfaces, sharp edges, and sharp corners.

! Wear protective clothing including gloves and hat when working around the generating set.

! Do not remove the radiator filler cap until the coolant has cooled. After cooling has taken place, loosen the cap slowly to relieve any excess pressure before removing the cap completely.

2.5. Chemical

Fuels, oils, coolants, lubricants, and the battery electrolyte used in this generating set are typical of the industry. However, they can be hazardous to personnel if not treated properly.

WARNING

! Do not swallow or allow skin contact with fuel, oil, coolant, lubricants, or the battery electrolyte. If swallowed, seek medical treatment immediately. Do not induce vomiting if fuel is swallowed. For skin contact, wash with soap and water.

! Do not wear clothing that has been contaminated by fuel or lube oil.

! Wear an acid resistant apron and face shield or goggles when servicing the battery. If any electrolyte is spilled on skin or clothing, flush immediately with large quantities of water.

2.6. Noise

Generating sets that are not equipped with sound attenuating enclosures can produce noise levels in excess of 105 dB(A). Prolonged exposure to noise levels above 85 dB(A) is hazardous to hearing.

WARNING

Ear protection must be worn at all times when operating or working around an operating generating set.

2.7. Electrical

Safe and efficient operation of electrical equipment can be achieved only if the equipment is correctly installed, operated, and maintained.

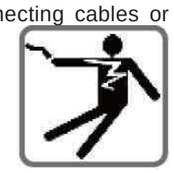
WARNING

! The generating set must be connected to the load only by trained and qualified electricians who are authorized to do so. Connections must be made in compliance with relevant Electrical Codes, Standards, and other regulations.

! Ensure that the generating set is effectively grounded in accordance to all relevant regulations prior to operation.

! The generating set should be shut down with the battery negative (-) terminal disconnected prior to attempting to connect or disconnect load connections.

! Do not touch electrically energized parts of the generating set and/or interconnecting cables or conductors with any part of the body or with any non insulated conductive object.



! Do not touch electrically energized parts of the generating set and/or interconnecting cables or conductors with any part of the body or with any non insulated conductive object.

! Replace the generating set terminal box cover as soon as connection or disconnection of the load cables is complete. Do not operate the generating set without the cover securely in place.

! Connect the generating set only to loads and/or electrical systems that are compatible with its electrical characteristics and that are within its rated capacity.

! Keep all electrical equipment clean and dry. Replace any wiring where the insulation is cracked, cut, or damaged in any other way. Replace terminals that are worn, discolored, or corroded. Keep terminals clean and tight.

! Insulate all connections and disconnected wires.

! Use only Class BC or Class ABC extinguishers on electrical fires.

grounding

warning:
High voltage

! Caution: risk of electric shock, the grounded conductor must be bonded to ground in accordance with the National Electric Code NFPA 70, this unit shall not be used in floating output applications.
! Notice: isolated neutral not bonded to frame

2.8. First Aid for Electric Shock

! Do not touch the victim's skin with bare hands until the source of electricity has been turned off.

! If possible, switch the power off. Otherwise, pull the plug or cable away from the victim by its insulation or by using some other insulated device.

! If this is not possible, stand on any dry insulating material such as dry wood and pull the victim clear of the conductor.

! If the victim is breathing, turn the victim clear of the conductor, preferably using insulated material such as dry wood.

! If victim is breathing, turn the victim into the recovery position described below. If victim is unconscious, perform resuscitation as required:

Open the airway

Tilt the victim's head back and lift the chin upwards. Remove objects from the mouth or throat (including false teeth, tobacco, or chewing gum).

Breathing

Check that the victim is breathing by looking, listening, and feeling for the breath.

Circulation

Check for pulse in the victim's neck.

If victim is not breathing, but pulse is present:

●Pinch the victim's nose firmly.

●Take a deep breath and seal your lips around the victim's lips.

●Blow slowly into the mouth watching for the chest to rise.

●Let the chest fall completely.

Give breaths at a rate of 10 per minute.

●If the victim must be left to get help, give 10 breaths first and then return quickly and continue.

●Check for pulse after every 10 breaths. When breathing restarts, place the victim into the recovery position described later in this section.

If victim is not breathing and no pulse can be found:

●Call or telephone for medical help.

●Give two breaths and start chest compression as follows:

●Place heel of hand/2 fingers Place above ribcage/ breastbone junction

●Place other hand on top and interlock fingers.

●Keeping arms straight, press down 4-5 cm at a rate of 15 times per minute.

●Repeat cycle (2 breaths and 15 compressions) until medical helps takes over.

●If condition improves, confirm pulse and continue with breaths.

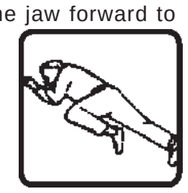
●Check for pulse after every 10 breaths.

●When breathing restarts, place the victim into the recovery position described below.

2.9. Recovery Position

●Turn the victim onto the side.

●Keep the head tilted with the jaw forward to maintain the open airway.



●Make sure the victim cannot roll forwards or backwards.

●Check for breathing and pulse regularly. If either stops, proceed as above.

WARNING

! Do not give liquids until victim is conscious.

3. GENERAL DESCRIPTION

3.1. Generating Set Description and Identification

NG-electric generating sets are independent units for the production of electric power comprised of a constant voltage synchronous generator driven by an internal-combustion, NG engine.

The sets are used for two main purposes:

a-Continuous duty sets,

These are used to produce electric power for countless requirements (Lighting, heating, etc) in areas where other sources of power are unavailable.

b-Emergency duty sets,

These are used in such instances where public utility failures are liable to cause damage to lives, to materials, to finances, (i.e. hospitals, industrial plants with non-stop operating cycles, etc) or to meet peak energy demands.

-According to their application, the sets are further divided into:
- -set for use on land
- -set for use at sea

The sets for use on land can be either:
- -stationary sets (fixed installation), or
- -mobile sets (mobile installation)

These two types of sets are available in a vast range of versions for every operating requirement with the main ones being:
- -hand control generating sets
- -stand-by generating sets

The standard stationary generating set comprises:
- -NG engine
- -synchronous generator
- -coupling
- -metal sub-base with vibration isolators
- -starter batteries
- -instrument panel
- -exhaust gas silencer.

The normal temperature range for the operation of this genset is 5°F—104°F. If the temperature drops below 23°F, a heater may be required to aid start.

This Aksa Generating Set has been designed as a complete package to provide superior performance and reliability. Figure 3.1. shows a typical generating set with major components labeled. However, each set will be slightly different due to the size and configuration of the major components. This section briefly describes the parts of the generating set. Further information is provided in later sections of this manual.

Each generating set is provided with a Rating Label (Item 1) generally fixed to the base frame. This label contains the information needed to identify the generating set and its operating characteristics. This information includes the model number, serial number, output characteristics such as voltage and frequency, output rating in kVA and kW, product date, and weight..

The model and serial numbers uniquely identify the generating set and are needed when ordering spare parts or obtaining service or warranty work for the set. AC series generating sets are Alternating Current generators. These are built for continuous operating at sites where no electricity is available (some models are accepted) or as stand-by in case of interruption of the main utility power.

The generator operates at 208/120 V in line-to-neutral mode and 277/480 V in line-to-line mode. The AC series generating set is driven by a water-cooled diesel engine.

NOMENCLATURE BREAKDOWN:

Example(Three phase Gen-set): 8-10 symbol model designation NG-150
1st-3rd – Model Series
4th-5th – symbols "NG"
6th- (Optional) Engine Type NG-PSI
7th-10th – KW ratings (30, 40, 50, 60, 80, 100, 125, 150, 200, 250, 300, 350, 400, 425)

Example(Single phase Gen-set): 8-10 symbol model designation APD-NG150
1st-3rd – Model Series
4th-5th – symbols "NG"
6th - Engine Type NG – PSI
7th-9th – KW ratings (30, 40, 50, 82, 60, 80, 100, 125, 150)

3.2. Generating Set Main Parts

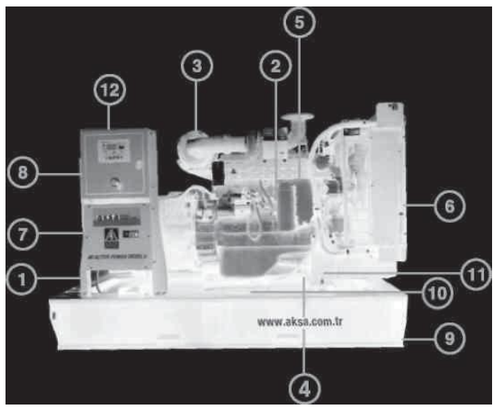


Figure 3.1. Typical generating set configuration

No.	Description
1.	Aksa generating set rating label
2.	Natural Gas Engine
3.	Air filter
4.	Battery
5.	Battery charging alternator
6.	Radiator
7.	Alternator
8.	Terminal box
9.	Base frame
10.	Vibration isolators
11.	Control Panel

3.3.PSI Engine

The Natural Gas engine powering the generating set (Item2) has been chosen for its reliability and the fact that it's design is for specifically powering generating sets. It has a heavy–duty, industrial engine with a four-stroke electric ignition system. It has been fitted with all accessories necessary to provide a reliable power supply. These accessories include, among others, a cartridge-type dry-air filter (item 3) and either a mechanical or an electronic engine speed governor. The engine cylinder block is one piece of cast iron, vertical-cylinders with inline overhead valves, and camshaft in block or V- type, according to the type.

The thermally loaded flame plate is efficiently water cooled. The crankshaft is forged in one piece of high tensile steel.

Lubrication: forced lubrication via gear pump, special paper cartridge-type filters, lubricant cooling via heat exchanger on most versions.

3.4.Engine Electrical System

The engine electrical system is 12 volt or 24 volts DC, negative ground/earth. This system includes an electric engine starter, a battery (item 4) and a battery charging alternator (item 5). For a 12-volt electrical system, one battery is given. For a 24-volt system, two lead-acid batteries are given. Other types of batteries may be fitted if they were specified.

3.5.Cooling System

The engine cooling system is water cooled. The water-cooled system is comprised of a radiator (item6), a pusher fan, and a thermostat. The alternator has its own internal fan to cool its components.

3.6.Synchronous Alternator

This is a horizontal axle alternator (synchronous three phase), on rolling bearings. It is self-ventilated within the room, has a low-loss silicon-sheet stator bundle, and an electrolytic copper winding with class H insulation.

The output electrical power is normally produced by a screen protected, drip-proof, self-exciting, self-regulating, brushless alternator (Item 7) which is fine tuned to the output of this generating set. Mounted on top of the alternator is a steel terminal box (item 8). Normally, the voltage imbalance capability is 1%, but if generator operation needs to be synchronous, this data should be reduced to 0.5%.

3.7.Coupling

Engine and alternator are firmly joined by a coupling cone that guarantees the proper assembly. If mono-support machines are used, a special flexible disk is used in place of a flexible coupling.

3.8. Base Frame

The engine and alternator are coupled together and mounted on a heavy duty steel base-frame (Item 9). State: If the base frame have an open bottom, that the stationary engine generator assembly shall be installed over noncombustible materials and shall be located such that it prevents combustible materials from accumulating under the generator set.

3.9.Vibration Isolation

The generating set is fitted with vibration isolators (Item 11) which are designed to reduce engine vibration being transmitted to the foundation on which the generating set is mounted. These isolators are fitted between the engine/alternator feet and the base frame..

3.10.Silencer and Exhaust System

Exhaust gases from the turbocharger are discharged toward atmosphere through a silencer. These gases should be vented as high as possible to prevent them from re-entering the engine via the charge air intake and polluting the radiator fins.

It is important to note that the turbocharger nozzles must always be free of loads. A stainless steel exhaust compensator is delivered with generator set. Exhaust lines of different engines shall not be mixed in a common stack, but should be routed separately in individual ducts and be enclosed within a chimney.

Suitable material is carbon steel sheet, and recommended calculation temperature is 977°F. A permanent means of drainage for rain and condensate shall be provided to prevent water from entering the silencer or the engine. An exhaust silencer is provided, shipped loosely, for installation with the generating set. The silencer and exhaust system significantly reduces the amount of noise emitted by the engine and directs exhaust gases through safe outlets.

The exhaust silencer is made of a carbon steel receiver and contains a sound attenuation and wave de-phasing system made of perforated steel sheet and heavy rock wool. It is asbestos free. The exhaust silencer is delivered in two configurations with one being industrial attenuation and the other being critical attenuation.

3.11.Control System

One of several types of control systems and panels (item 12) may be fitted to control the operation and output of the set and also protect the set from possible malfunctions. Section 15 of this manual provides detailed information on these systems and will aid in the identification of the control system fitted on the generating set.

3.12.Field Wiring

It is the customer's responsibility to provide cables with terminals to connect the genset and the loads. Terminal uses standard JG copper connections, and the terminal size is chosen according to cable size (Terminals are listed in Table 10.2 below). When connecting the load cables, a torque wrench should be used to tighten the Grade 5 bolts for each phase. Torque requirements can be found in Table 3.1. In most situations, the bus bar panel (breaker) will be mounted to the base frame. There is an access hole which can be utilized for making connections. See picture below.

Figure 3.2 Gen-set field wiring of load cables
○1Load cables connecting terminal of Gen-set
○2Load cables can be connect with gen-set through these Knock down holes
○3Grounding terminal (UL listed KDER, installation tool: 1/14" hex wrench)

The customer should also connect the ground as shown in Figure 3.3 below using a UL Listed (KDER) terminal.

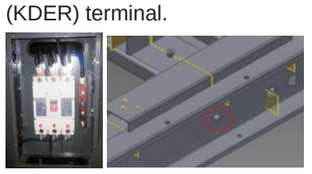


Figure 3.3 Grounding terminal

BOLT SIZE	TIGHTENING TORQUE		
	8.8 rank	10.9 rank	12.9 rank
M10	36.1ft•lb	53.1ft•lb	62.0ft•lb
M12	63.4ft•lb	92.9ft•lb	106.9ft•lb

Table 3.1

See attached Table 310.16 below in the NEC to properly size field conductors.

The proper UL listed terminals for all terminations should be selected by determining suitability for the required application.

NEC 2011 Table 310.15(B)(16) Allowable Ampacities of Insulated Conductors Rated Up to and Including 2000 Volts, 60° Through 90°C (140° Through 194°F), Not More Than The Conductors in Raceway , Cable or Earth(Directly Buried), Based on Ambient Temperature of 30°C (86°F)			
Size AWG or kcmil	Temperature Rating of Conductor [See NEC Table 310.104(A)]		
	60°C (140°F)	75°C (167°F)	90°C (194°F)
	Types TW, UF	Types: RHW THHW THW THWN XWWH	Types: TBS, SA, SIS, FEP FEPB MI, RHH, RHW-2, THHN THHW, THW-2, THWN-2, USE-2, XHH, XHHW, XHHW-2, ZW-2
COPPER			
18	....	....	14
16	....	....	20
14**	15	20	28
12**	20	25	38
10**	30	35	47
8	40	50	60
6	55	65	80
4	70	85	100
3	85	100	125
2	95	115	140
1	110	130	165
1/0	125	150	180
2/0	145	175	230
3/0	165	200	280
4/0	195	230	325
250	215	255	375
300	240	285	430
350	260	310	450
400	280	335	495
500	320	380	530
600	350	420	610
700	385	460	630
750	400	475	650
800	410	490	675
900	435	520	700
1000	455	545	725
1250	495	590	750
1500	525	625	775
1750	545	650	790
2000	555	665	800

**Refer to NEC 310.15(B)(2) for the ampacity correction factors where the ambient temperature is other than 30°C(86°F)

**Refer to NEC 240.4(D) for conductor overcurrent protection limitations.

NEC Table 310.15(B)(16):Allowed Ampactities of Insulated Conductors

Electrical ratings. & Phase configuration

	STANDBY (kW)	PRIME (kW)	STANDBY RATING AMPS			PRIME RATING AMPS			Phase configuration
			120/208 3p	277/480 3p	120/240 3p	120/208 3p	277/480 3p	120/240 3p	
APD-NG30	30	27	105	45	90	94	41	81	Three phase,Wye,Yn
APD-NG40	40	36	140	60	120	125	54	108	Three phase,Wye,Yn
APD-NG50	50	N/A	105	75	151	N/A	N/A	N/A	Three phase,Wye,Yn
APD-NG60	60	N/A	208	90	45	N/A	N/A	N/A	Three phase,Wye,Yn
APD-NG80	80	N/A	278	120	241	N/A	N/A	N/A	Three phase,Wye,Yn
APD-NG100	100	N/A	347	150	301	N/A	N/A	N/A	Three phase,Wye,Yn
APD-NG125	125	N/A	434	188	376	N/A	N/A	N/A	Three phase,Wye,Yn
APD-NG150	150	N/A	521	226	452	N/A	N/A	N/A	Three phase,Wye,Yn
APD-NG200	200	147	694	301	601	604	221	529	Three phase,Wye,Yn
APD-NG250	250	225	868	376	753	782	339	667	Three phase,Wye,Yn
APD-NG300	300	270	1042	452	903	937	406	812	Three phase,Wye,Yn
APD-NG350	350	N/A	1214	526	1052	N/A	N/A	N/A	Three phase,Wye,Yn
APD-NG400	400	360	1388	601	1203	1249	542	1083	Three phase,Wye,Yn
APD-NG425	425	383	1476	640	1280	1350	577	1153	Three phase,Wye,Yn

	STANBY (Kw)	PRIME (kW)	STANDBY RATING AMPS	PRIME RATING AMPS	Phase Configuration
			120/240 1P	120/240 1P	
APD-NG30	30	27	125.0	112.5	Single Phase Dn
APD-NG40	40	36	166.7	150.0	Single Phase Dn
APD-NG50	50	N/A	208.3	N/A	Single Phase Dn
APD-NG60	60	N/A	250.0	N/A	Single Phase Dn
APD-NG80	80	N/A	333.3	N/A	Single Phase Dn
APD-NG100	96	N/A	400.0	N/A	Single Phase Dn
APD-NG125	125	N/A	520.8	N/A	Single Phase Dn
APD-NG150	150	N/A	625.0	N/A	Single Phase Dn

Table 3.2 Electrical Rating and Phase Configuration

4.INSTALLATION, HANDLING AND STORAGE

4.1.General

Once the size of the generating set and any associated control systems or switchgear have been established, plans for installation can be prepared. This section discusses factors considered important for the effective and safe installation of the generating set.

4.2.Canopies

Installation and handling is simplified when the generating set has been equipped with a canopy. The canopy also gives protecton from the elements and protection from unauthorized access.

4.3. Moving the Generating Set

The generating set base frame is specifically designed for ease of moving the set. Improper handling can seriously damage components.

Using a forklift, the generating set can be lifted or carefully pushed/pulled by the base frame directly using the forks. Always use wood between forks and the base frame to spread the load and prevent damage.

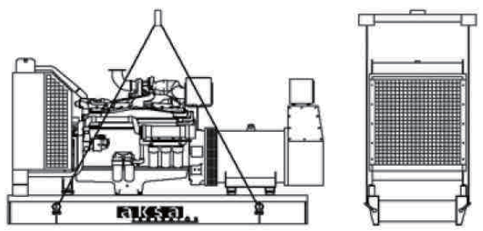


Figure 4.1. Lifting generating set by using a winch

Warning

! Never lift the generating set by attaching rigging to the engine or alternator lifting lugs.

! Ensure the lifting rigging and supporting structure is in good condition and is suitably rated.

! Keep all personnel away from the generating set while it is suspended.

! If the generating set is going to be lifted, it should be lifted by the lifting points fitted on canopied sets and most open sets.

4.4. Location

In order to start consideration for the possible layouts at a site, the following criteria must first be determined:

-The total area available and any restrictions within that area (i.e. buried or overhead services)

-A forced ventilation system is required for the equipment, which draws sufficient cooling and aspiration air into the room at the back of the alternator and discharges the air from the front of the engine. Depending upon the layout of the building, it may be necessary to install additional ductwork to achieve the airflow required.

-The access into the building, initially for the delivery and installation of the equipment, and afterwards for servicing and maintenance of the equipment.

-Protection from the elements such as rain, snow, sleet, wind-driven precipitation, flood water, direct sunlight, freezing temperatures, or excessive heat.

-Protection from exposure to airborne contaminants such as abrasive or conductive dust, lint, smoke, oil mist, vapors, engine exhaust fumes, or other contaminants.

-Protection from the impact of falling objects such as trees or poles, from motor vehicles, or from lift trucks.

-Clearance around the generating set for cooling and service access: at least 3.3 feet around the set and at least 6.6 feet of headroom above the set.

-Access to move the entire generating set into the room. Air inlet and outlet vents can often be made removable to provide an access point. Access to unauthorized personnel should be limited.

-If it is necessary to locate the generating set outside of the building, the generating set should be enclosed in a canopy. A canopy is also useful for temporary installations inside or outside of the building.

4.5. Base and Foundation

Note: Special foundations are unnecessary. A level and sufficiently strong concrete floor is adequate. The responsibility for the foundation (including seismic considerations) should be placed with a civil or structural engineer specializing in this type of work.

Major functions of a foundation are to:
Support the total weight of the generating set. Considering the vibration by the generating set, it should be isolated from surrounding structures.

To support the structural design, the civil engineer will need the following details:

-the plant's operating temperatures.
-the overall dimensions of the proposed foundation mass.
-the mounting and fixing arrangements of the generator bed-frame.

Concrete Foundations
The foundation will require at least seven days between pouring the concrete and mounting the generating set to cure. It is also essential that the foundation be level, preferably within ±
0.5° of any horizontal plane and should rest on undisturbed soil.

The following formula may be used to calculate the minimum foundation depth:

$$t = \frac{k}{d \times w \times l}$$

t = thickness of foundation in ft
k = net weight of set in lbs
d = density of concrete (take 150 lb/ft3)
w = width of foundation in (ft)
l = length of foundation in (ft)

The foundation strength may still vary depending on the safe bearing capacity of supporting materials and the soil bearing load of the installation site. Therefore, reinforced gauge steel wire mesh, reinforcing bars, or some equivalent may be required.

Vibration Isolation

Each generating set is built as a single module with the engine and alternator coupled together through a coupling chamber. This chamber utilizes resilient mounting to form one unit of immense strength and rigidity. This provides both accuracy of alignment between the engine and alternator and damping of engine vibration. This reduces the need for heavy concrete foundations that would normally be used to absorb engine vibrations so that all the generator required is a level concrete floor to take the distributed weight of the unit.

Foundation

A reinforced concrete pad provides a rigid support to prevent deflection and vibration. Typically, the foundation should be 6 to 8 inches (150 mm to 200 mm) deep and at least as wide and long as the generating set. The ground or floor below the foundation should be properly prepared and structurally suited to carry the weight of the foundation pad and the generating set. (If the generating set is to be installed above the ground floor, the building structure must be able to support the weight of the generating set, fuel storage, and accessories). If there is a chance that moisture will accumulate on the floor such as in a boiler room, the pad should be raised above the floor. This will provide a dry footing for the generating set and for those who connect, service, or operate it. It will also minimize corrosive action on the base-frame.

Levelling

A poor foundation may result in unnecessary vibration of the genset.

Connections

All piping and electrical connections should be flexible to prevent any damage caused by movement of the generation set. Fuel and water lines, exhaust pipes, and conduit can transmit vibrations at long distances.

4.6. Room Design Guidance Notes

4.6.1. Room Size Allowance

The dimensions as indicated in A & B allow for good maintenance/escape access around the generator. Ideally, a minimum distance of 30 inches should be allowed from any wall, tank, or panel within the room.

4.6.2.Inlet and Outlet Attenuators with Weather Louvers

The inlet and outlet attenuators should be installed within a wooden frame. The attenuators are based off of 4-inch airways and 8-inch acoustic modules. The attenuators should be fitted with weather louvers with a minimum of 50% free area, good airflow profile, and afford low restriction airflow access.

The weather louvers should have bird/vermin mesh screens fitted on the inside, but these screens must not impede the free flow of cooling and aspiration air. The outlet attenuator should be connected to the radiator ducting flange with a heat and oil resistant flexible connection.

4.6.3.Combustion Air Inlet

Air for engine combustion must be as clean and as cool as possible. Normally, this air can be drawn from the area surrounding the generating set via the engine-mounted air filter. However, in some cases due to dust, dirt, or heat, the air around the set is unsuitable. In these cases, an inlet duct should be fitted. This duct should run from the source of clean air (outside the building, another room, etc) to the engine-mounted air filter. Do not remove the air filter and mount it at a remote location as this can increase the possibility of dirt leaking through the ductwork and into the engine inlet.

4.6.4.Exhaust Systems

The exhaust systems shown on the layout drawings are supported by the ceiling. Should the building construction be such that the roof supports are unable to support the exhaust system, a system of support coming up from the floor will be needed for the steel exhaust. Exhaust pipes should terminate at least 7.5ft above floor level to make it reasonably safe for anyone passing by.

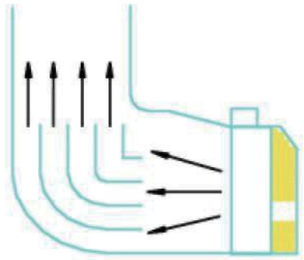
It is recommended that stainless steel bellows be fitted to the engine exhaust manifold followed by rigid pipe work to the silencer.

It is good installation practice for the exhaust system within the generator room to be insulated with a minimum of 2-inches. of high-density, high-temperature mineral insulation covered by an aluminum overclad. This reduced the possibility of operator burn injury and reduces the heat being transferred to the operating generator room.

4.6.5. Cooling and Ventilation

The engine, alternator, and exhaust pipes radiate heat which may result in temperatures high enough to adversely affect the performance of the generating set. It is, therefore, important that adequate ventilation is provided to keep the engine and alternator cool. Proper air flow, as shown in Figure 4.4., requires that the air comes in at the alternator end of the set, passes over the engine, through the radiator, and out of the room via a flexible exhaust duct. If the hot air is not vented to the outside, the fan will tend to draw the hot air back through the radiator reducing the cooling effectiveness.

Figure 4.2. Directing the air thrown from the



radiator with deviating wings

Sharp corners on the radiator hot air out let channel or its chimney must be avoided. Sharp corners can cause vented air to become trapped and recirculated reduce effectiveness of the cooling cycle (Figure 4.2. and 4.3.).

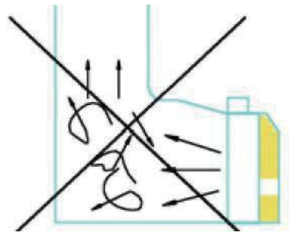


Figure 4.3. Weak ventilation

The air inlet and outlet openings should be large enough to ensure free flow of air into and out of the room. A good estimation for the openings would be to make them at least 1.5 times the area of the radiator core.

Both the inlet and outlet openings should have louvers for weather protection. These may be fixed, but preferably, should be movable in cold climates so that while the generating set is not operating the louvers can be closed. This will allow the room to be kept warm which will assist with starting and load acceptance. For automatically starting generating sets, if the louvers are movable, they must be automatically operated. They should be programmed to open immediately upon starting the engine.

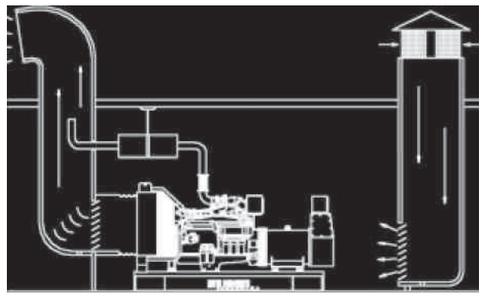


Figure 4.4. Air ventilation

4.6.6. Cable Systems

The layout drawing assumes that the change-over switch-gear is external to the generator room and located in the power distribution room. Specific project requirements can affect this layout.

The power output cables from the generator output breaker to the distribution panel must be a flexible type. The flexible power cables as installed should be laid up in trefoil, placed on support trays/ladder rack in the trench with the recommended inter-spacing, and segregated from the system control cables.

The cables should be correctly supported and rated for the installation/ambient conditions.

The flexible single-core power cables, when entering any panel, must pass through a non-ferrous gland plate.

4.6.7.Change - Over Panels

For change-over cubicles rated up to 400 Amps, the wall mounting panel with a maximum depth of 13-3/4 inches can be mounted directly above the cable trench on the side. For change-over cubicles rated at 800 Amps and higher, a floor standing panel is used which needs additionally allocated space. A minimum of 31-1/2 inches should be allowed for rear access.

4.6.8. Generator Sets

Generators up to 425 kW

Canvas ducting between the radiator and ductwork or attenuator should be a minimum of 12 inches.

Air inlet should be at rear of the alternator to allow adequate circulation.

4.6.9.Doors

Doors should always open outward. Make any necessary allowances for the generator to be moved into the room by using double doors at the attenuator space.

4.6.10. Inlet and Outlet Louvers

The inlet and outlet weather louvers should be installed within a wooden frame having a minimum 50% free area, good airflow profile, and low restriction airflow access.

The weather louvers should have bird/vermin mesh screens fitted on the inside, but must not impede the free flow of cooling and aspiration air.

The outlet weather louver should be connected to the radiator ducting flange with a heat and oil resistant flexible connection.

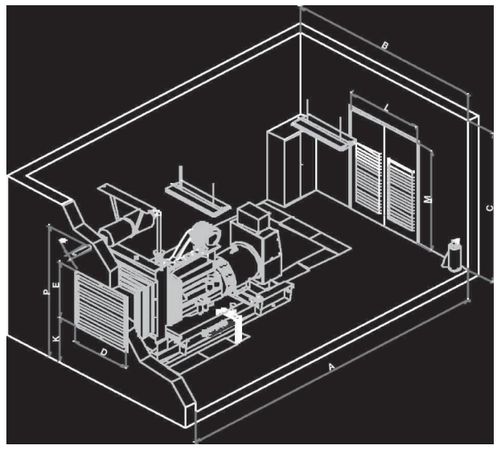


Figure 4.5. Generating set room

Genset		Generating Set Dimensions(in)		
Model	Standby Power (kW)	Length	Width	Height
APD-NG30	30	72	40	44
APD-NG40	40	72	40	44
APD-NG50	50	92	43	48
APD-NG60	60	92	43	48
APD-NG80	80	92	43	48
APD-NG100	100	92	43	48
APD-NG125	125	116	43	50
APD-NG150	150	116	43	50
APD-NG200	200	118	55	65
APD-NG250	250	118	55	65
APD-NG300	300	157	75	78
APD-NG350	350	157	75	78
APD-NG400	400	157	83	78
APD-NG425	425	157	83	78

5. FUEL SYSTEM

5.1.General

Gas fuel systems operate on either (Gaseous Propane) or natural gas.

Note: Design and install gas fuel systems in accordance with NFPA 54, National Fuel Gas Code, and applicable local codes.

All gas systems include a carburetor, secondary gas regulator, electric gas fuel solenoid shutoff valve, and flexible fuel connector

5.1.2.Fuel Recommended Physical Properties Specifications.

Physical Property @ 15°C (60°F)	Propane	Natural Gas
Normal atmospheric state	Gas	Gas
Boiling point, Initial, °C (°F) End, °C (°F)	— 42 (--44)	— --162 (--259)
Heating value, Btu /gal. (net, LHV*) /gal. (gross) /ft3 (gas)	83340 91500 2516	63310 — 1000
Density, Ft3 of gas/gal.	36.39	57.75
Wt./gal. liquid, lb.	4.24	2.65
Octane Number Research Motor	110+ 97	110+ —

Table 5.1 Fuel Recommended Physical Pro

5.1.3.Gas Lines

Never use fuel piping to ground electrical equipment. The gas supplier is responsible for installation, repair, and alteration to gas piping.

5.1.4.Line type

Use Schedule 40 black-iron pipe for gas piping. Copper tubing may be used if the fuel does not contain hydrogen sulfide or other ingredients that react chemically with copper.

5.1.5.Line size

Size piping according to the requirements of the equipment. Refer to the generator set specification sheet or the dimension drawing for detailed information on your system. In addition to the actual fuel consumption, consider the following pressure loss factors:

Pipe length
Other appliances on the same fuel supply
Number of fittings

5.1.6.Flexible connections

Rigid-mount the piping but protect it from vibration. Use flexible connections spanning a minimum of 152 mm (6 in.) between the stationary piping and the engine fuel inlet connection.

5.1.7.Gas

Regulators. Gas regulators reduce high incoming fuel pressures to lower levels acceptable for engines. Refer to the generator set spec sheet for fuel supply pressures.
Install a solenoid valve upstream from the gas regulator and the flexible fuel connector to prevent the accumulation of an explosive mixture of gas and air caused by leaks in the flexible connection or the gas regulator. The generator set installer normally wires the engine battery-powered solenoid valve to the engine starting controls to open the valve when the engine cranks or runs.

For UL compliance, the fuel solenoid valves are needed per UL 2200, Section 35.3.2.2.1.

The typical gas system uses two gas regulators:

5.1.8.Primary gas regulator. Provides initial control of gas from the fuel supply. The primary gas regulator reduces the high pressure from a tank or transmission line to the low pressure required by the secondary gas regulator(s). Typically, the primary gas regulator is set at the higher pressure value when a range is given. The gas supplier typically provides the primary gas regulator, as conditions that dictate the type of gas regulator used vary depending on the method of supplying fuel. The supplier is also responsible for providing sufficient gas pressure to operate the primary gas regulator. Primary gas regulator must be vented to the outside if installed within any building.

5.1.9.Secondary gas regulator. This low-pressure gas regulator is mounted on the engine and limits the maximum inlet pressure to engine. The engine operates satisfactorily at the lower pressure value when a range is given, but these lower pressures may result in poor response to load changes or a lack of power if the primary gas regulator is not near the engine.

5.1.10.Installation position for fuel type. The gas regulator functions normally pointing downward for both natural gas and LP gas. If only natural gas fuel is used, the gas regulator may be installed pointing upward.

5.1.11.Pressure testing. Some gas regulators provide for installation of a pressure gauge to test inlet and outlet pressures. If no such provision is available, install pipe tees in the fuel line to test pressure and use pipe plugs to plug unused openings.

5.2.LP Fuel Systems

5.2.1.Fuel characteristics. LP fuel exists as a vapor and a liquid in pressurized tanks. This makes LP gas ideal for Applications with uninterrupted (onsite) fuel supply requirements.

5.2.2.Fuel mixture. LP gas is propane, butane, or a mixture of the two gases. The ratio of butane to propane is especially important when the fuel flows from a large outdoor tank. A fuel supplier may fill the tank in the warm summer months with a mixture composed mainly of butane; however, this mixture may not provide sufficient vaporized pressure at cold temperatures to start and operate the engine. A local fuel supplier is likely to be the best source of information on what size tank is necessary to provide adequate fuel vapor.
The fuel mixture and vaporization pressure at the anticipated temperatures influence the selection of gas regulator equipment. Pure butane gas has little or no vaporization pressure in temperatures below 4°C (40°F). Even at 21°C (70°F), the pressure is approximately 124 kPa (18 psi). Some primary gas regulators do not operate at tank pressures below 207 kPa (30 psi) while others operate at incoming pressures as low as 20.7--34.5 kPa (3--5 psi).

5.2.3.Fuel consumption and tank size. Since LP fuel is supplied in pressurized tanks in liquid form, it must be converted to a vapor state before being introduced into the carburetor. The amount of vapor contained in 3.8 L (1.0 gal.) of liquid (LP) fuel is:

Butane Gas 0.88 m3 (31.26 cu. ft.)
Propane Gas 1.03 m3 (36.39 cu. ft.)

See the generator set specification sheets for fuel consumption at different loads, and contact your fuel supplier for information regarding tank sizes.

5.2.4System types. Single-source gas fuel systems include LP gas vapor-withdrawal and LP gas liquid-withdrawal.

5.3.LP Gas Vapor-Withdrawal Systems

A vapor-withdrawal system draws on the fuel vapor that collects in the space above the liquid fuel. Consider the following during installation:

Generally, allow 10%--20% of tank capacity for fuel expansion from a liquid to a vapor state. The liquid level in LP gas tanks must never exceed 90% of the tank capacity.

Maintain air temperature surrounding the tank high enough to vaporize the liquid fuel.

Applications in colder climates may require an independent heat source to increase natural vaporization within the tank. Withdraw liquid fuel and vaporize it in an electrically heated ** or LP engine water heated Vaporizer or LP gas-heated vaporizer.** Customer supplied

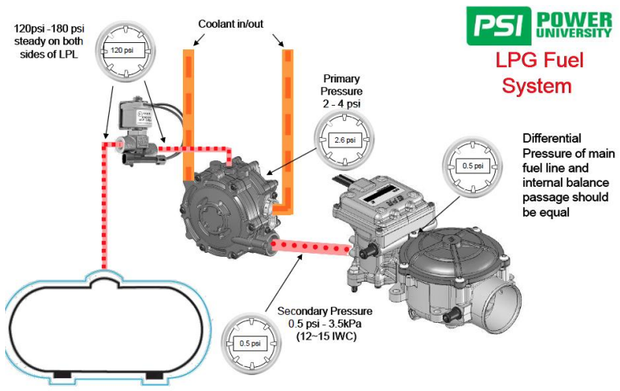


Figure 5.3 LP Withdraw System

5.4.Natural Gas Systems

The utility supplies natural gas in a vapor state. A natural gas fuel system consists of the same basic components and operates with the same general sequence as LP gas vapor-withdrawal systems. See Figure 5.4. Note that when the heat content of the fuel falls below 1000 Btu, as it does with sewage-derived and some other natural gas fuels, the generator set will not produce its rated power. The natural gas regulator is typically installed in the upright position (pointing upward).

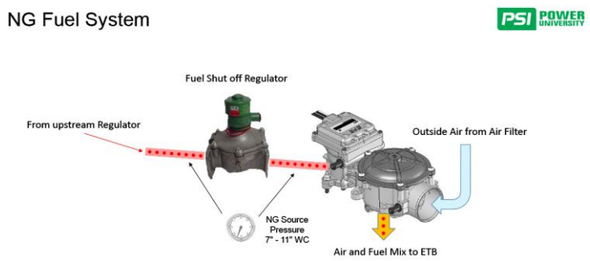


Figure 5.5 Natural Gas System

5.4.1 Combination Systems

Combination fuel source systems include:
Natural gas and LP gas

5.4.2 Combination Natural Gas and LP Gas

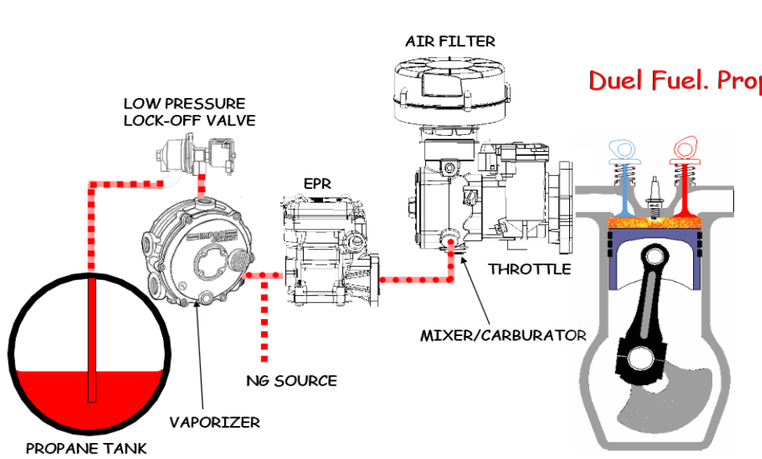
Some applications use natural gas as the main fuel and LP gas as the emergency fuel when natural gas is not available.

The natural gas and LP gas, liquid withdrawal system uses a vaporizer to change the LP liquid to gas vapor. A pressure switch on the primary fuel source closes when fuel pressure drops, a relay closes the primary fuel solenoid and opens the secondary or emergency fuel solenoid.

A separate LP gas load adjustment valve ensures the right fuel-to-air mixture in the carburetor. The load adjustment valve is located inline between the converter (vaporizer) and the carburetor.

A separate LP gas load adjustment valve ensures the right fuel-to-air mixture in the carburetor. The load adjustment valve is located inline between the converter (vaporizer) and the carburetor.

The natural gas and LP gas, vapor withdrawal system contains a separate secondary gas regulator and solenoid valve for each fuel. A pressure switch on the primary fuel source closes when fuel pressure drops, a relay closes the primary fuel solenoid and opens the secondary or emergency fuel solenoid. A separate LP gas load adjustment valve ensures the right fuel-to-air mixture in the carburetor. See Figure 5.4.2.



PSI POWER UNIVERSITY

Duel Fuel. Propane & Natural Gas

Stoichiometry Propane: 15.5 :1

Stoichiometry Natural Gas : 17.2 :1

Figure 5.4.2 Duel Fuel System

5.4.3 Pipe Size Requirements for Gas Fuel Systems

The type of fuel, the distance it must travel from gas meter/tank to fuel shutoff solenoid, and the amount consumed by the engine must be considered when determining fuel line pipe size.
To find the correction necessary for the different specific gravity of the particular fuel used, refer to Figure 6-10. Figure 6-11 is based on gas pressures of 3.4 kPa (0.5 psi, 13.8 in. water column) or less and a pressure drop of 0.12 kPa (0.018 psi, 0.5 in. water column) with a 0.60 specific gravity and with a normal amount of restriction from fittings. To calculate the correct pipe size for a specific installation, refer to the chart and follow the procedure outlined below.

Fuel	Specific Gravity	Correction Factor
Sewage Gas	0.55	1.040
Natural Gas	0.65	0.962
Air	1.00	0.775
Propane (LP)	1.50	0.633
Butane	2.10	0.535

Nominal Iron Pipe Size (IPS), In.	Internal IPS Diameter, mm (in.)	Length of Pipe, m (ft.)											
		3.0 (10)		6.1 (20)		9.1 (30)		12.2 (40)		15.2 (50)		18.3 (60)	21.3 (70)
		Fuel Consumption Value, m^3/hr. (ft^3/hr.)											
1/4	9.25 (0.364)	1.2	(43)	0.82	(29)	0.68	(24)	0.57	(20)	0.51	(18)	0.45 (16)	0.42 (15)
3/8	12.52 (0.493)	2.7	(95)	1.8	(65)	1.5	(52)	1.3	(45)	1.1	(40)	1.0 (36)	0.93 (33)
1/2	15.80 (0.622)	5.0	(175)	3.4	(120)	2.7	(97)	2.3	(82)	2.1	(73)	1.9 (66)	1.7 (61)
3/4	20.93 (0.824)	10.2	(360)	7.1	(250)	5.7	(200)	4.8	(170)	4.3	(151)	3.9 (138)	3.5 (125)
1	26.64 (1.049)	19.3	(680)	13.2	(465)	10.6	(375)	9.1	(320)	8.1	(285)	7.4 (260)	6.8 (240)
1 1/4	35.05 (1.380)	39.6	(1400)	26.9	(950)	21.8	(770)	18.7	(660)	16.4	(580)	13.9 (490)	13.0 (460)
1 1/2	40.89 (1.610)	59.5	(2100)	41.3	(1460)	33.4	(1180)	28.0	(990)	25.5	(900)	22.9 (810)	21.2 (750)
2	52.50 (2.067)	111.9	(3950)	77.9	(2750)	62.3	(2200)	53.8	(1900)	47.6	(1680)	43.0 (1520)	39.6 (1400)
2 1/2	62.71 (2.469)	178.4	(6300)	123.2	(4350)	99.7	(3520)	85.0	(3000)	75.0	(2650)	68.0 (2400)	63.7 (2250)
3	77.93 (3.068)	311.5	(11000)	218.0	(7700)	177.0	(6250)	150.0	(5300)	134.6	(4750)	121.8 (4300)	110.4 (3900)
4	102.26 (4.026)	651.2	(23000)	447.4	(15800)	362.5	(12800)	308.7	(10900)	274.7	(9700)	249.1 (8800)	229.4 (8100)

Nominal Iron Pipe Size (IPS), In.	Internal IPS Diameter, mm (in.)	Length of Pipe, m (ft.)											
		24.4 (80)		27.4 (90)		30.5 (100)		38.1 (125)		45.7 (150)		53.3 (175)	61.0 (200)
		Fuel Consumption Value, m^3/hr. (ft^3/hr.)											
1/4	9.25 (0.364)	0.39	(14)	0.37	(13)	0.34	(12)	0.31	(11)	0.28	(10)	0.25 (9)	0.23 (8)
3/8	12.52 (0.493)	0.88	(31)	0.82	(29)	0.76	(27)	0.68	(24)	0.62	(22)	0.57 (20)	0.54 (19)
1/2	15.80 (0.622)	1.6	(57)	1.5	(53)	1.4	(50)	1.2	(44)	1.1	(40)	1.0 (37)	0.99 (35)
3/4	20.93 (0.824)	3.3	(118)	3.1	(110)	2.9	(103)	2.6	(93)	2.4	(84)	2.2 (77)	2.0 (72)
1	26.64 (1.049)	6.2	(220)	5.8	(205)	5.5	(195)	5.0	(175)	4.5	(160)	4.1 (145)	3.8 (135)
1 1/4	35.05 (1.380)	13.0	(460)	12.2	(430)	11.3	(400)	10.2	(360)	9.2	(325)	8.5 (300)	7.9 (280)
1 1/2	40.89 (1.610)	19.5	(690)	18.4	(650)	17.6	(620)	15.6	(550)	14.2	(500)	13.0 (460)	12.2 (430)
2	52.50 (2.067)	36.8	(1300)	34.5	(1220)	32.6	(1150)	28.9	(1020)	26.9	(950)	24.1 (850)	22.7 (800)
2 1/2	62.71 (2.469)	58.1	(2050)	55.2	(1950)	52.4	(1850)	46.7	(1650)	42.5	(1500)	38.8 (1370)	36.2 (1280)
3	77.93 (3.068)	104.8	(3700)	97.7	(3450)	92.0	(3250)	83.5	(2950)	75.0	(2650)	69.4 (2450)	64.6 (2280)
4	102.26 (4.026)	212.4	(7500)	203.9	(7200)	189.7	(6700)	169.9	(6000)	155.7	(5500)	141.6 (5000)	130.3 (4600)

Note: When the fuel has a specific gravity of 0.7 or less no correction factor is necessary—use this table without a correction factor.

6. WATER TREATMENT

6.1.General

The engine cooling system is subject to rust and cavitation. To minimize the severity of this condition, an anti-corrosive agent can be added to clean coolant water.

An anti-freeze solution is also required to prevent freezing of the coolant in the cold weather.

6.2.Engine Coolant

Water for coolant should be clean and free from any corrosive chemicals such as chlorides, sulphates, or acids. It should be kept slightly alkaline with a pH value ranging from 8.5 to 10.5.Generally, any water that is suitable for drinking can be used, with treatment, as described below.

Protection Against Corrosion

Supplemental Coolant Additive is required to protect the cooling system from fouling, solder blooming, and general corrosion.

The use of antifreeze is also recommended as DCA4 concentrations are dependent upon the presence of antifreeze. Antifreeze also interacts with DCA4 to provide greater corrosion and protection against cavitations.

Procedure for Treating Coolant

1.Add the required amount of water and DCA to mixing container and mix it thoroughly.
2.Add the required amount of antifreeze, if used, to the water solution and mix thoroughly.
3. Add the coolant to the cooling system

Cold Weather Protection

Antifreeze must be added to the coolant to protect the engine from damage due to coolant freezing. A 1:1 water/antifreeze mixture ratio is recommended because DCA4 concentrations are dependent upon the presence of antifreeze. The dosage of DCA4 must be increased to a higher concentration if the antifreeze is not added to the coolant. Low-silicate antifreeze is recommended.

6.3. Engine Warming

There are thermostatically controlled immersion heaters operating from the main's supply. These are fitted into the cooling system, and they maintain the temperature of the coolant in cold weather.

A heater alone, fitted into the radiator, will not be adequate for starting or preventing freezing, so an antifreeze mixture should be used.

7. EXHAUST SYSTEM

7.1.Sizing

An exhaust system should be designed to dispel the exhaust gases to atmosphere at the nearest convenient point in an installation. The length of the run and the number of changes in direction should be kept to a minimum.

The calculation of the effect on the back pressure is based upon the restriction through the straight lengths of pipe, the bends, and the silencers. The smaller the bore of the pipe is, the greater its length is, and the more times it changes its direction all increase the resistance to flow.

The back pressure limit for most PSI engines is 3 inHg (76 mmHg) Take an estimate of the size of the pipe by starting with the bore of the exhaust flange off the manifold and increasing the size by 1" for each 20 ft length or 3 x 908 bends.

7.2.Routing

Once the final size and route of the pipe work and the silencer have been established, the exhaust route can be determined if the following factors are taken into consideration:

A flexible bellows unit must be fitted on the engine connection to allow the engine to move on its mountings; If the silencer is to be located within the plant room, due to its physical size and weight, it needs to be supported from the floor;

It may be necessary to install expansion joints at each change of direction to compensate for the thermal growth in the pipe during operation;

The inner radius of a 90° bend should be 3 times the diameter of the pipe See Fig. 7.1.;

The primary silencer should be mounted as close as possible to the engine;

The termination point should not be directed at combustible materials/structures, into hazardous atmospheres containing flammable vapors, where there is a danger that the gases will re-enter the plant room through the inlet air vent, or into any opening that leads to another building in the vicinity.

All rigid pipe work should be installed in such a manner that the engine's exhaust outlet is not stressed. Pipes should be routed so that they are supported by fixtures to the building fabric or by existing structural steelwork where such methods are acceptable;

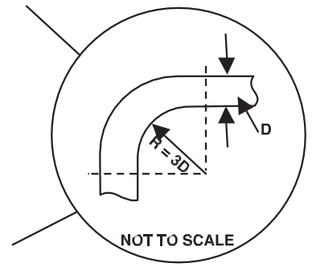


Fig. 7.1. Exhaust bend and radius

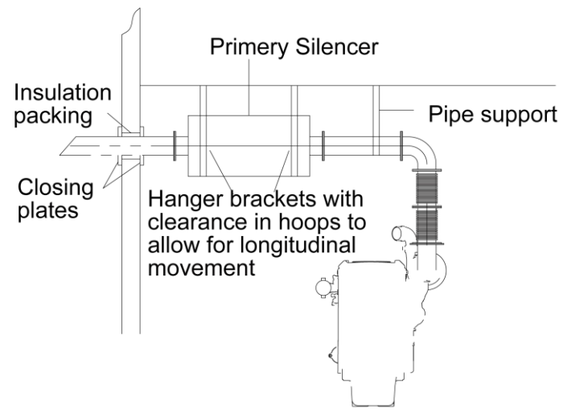


Figure.7.2. Exhaust System

8. LUBRICATING OIL

The oil system of a diesel engine is one of the most important elements of the engine. Proper engine maintenance (this subject includes oil change periods, filter change periods, paying attention about selecting the true type of oil) significantly prolongs the life of the engine.

8.1. Oil Performance Properties

The American Petroleum Institute (API) the American Society for Testing and Materials (ASTM) and Society of Automotive Engineers (SAE) has developed and preserved a system in order to classify the lubrication oils for their performance categories.

8.2. Lubrication Recommendations for Engine

SAE 5W/30 high service engine oil in Natural Gas engines are used.

The minimum API oil quality levels recommended for use is CH/CI-4, CH or CI-4 can be used in areas where CF4 oil is not yet available, but the oil interval must be reduced API CA, CB, CC, CD, CE, CG4 categories not recommended, do not use.

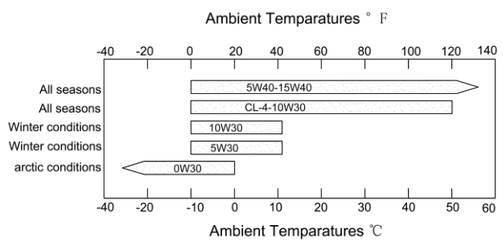


Figure: 8.1 Recommended SAE Oil Viscosity Grades vs. Ambient Temperatures

Genset			Fuel Consumption at Full Load (cfh)	Coolant Capacity (qt)	Oil Capacity (qt)	
Model	Standby Power (KW)	Engine Model				Note:Lubricating oil viscosity level will be choosen from table 8.1 according to the ambient temperature
APD-NG30	30	GM 3.0L	430	4	4	API CH
APD-NG40	40	GM 4.3L	584	7.75	4.5	API CH
APD-NG50	50	GM 5.0L	744	8.1	5	API CH
APD-NG60	60	GM 5.7L	790	8.1	5	API CH
APD-NG80	80	GM 5.7LT	1185	8.1	5	API CH
APD-NG100	100	GM 5.7LTCAC	1389	8.1	5	API CH
APD-NG125	125	GM 8.8LT	1511	14.5	8	API CH
APD-NG150	150	GM 8.8LTCA	1965	14.5	8	API CH
APD-NG200	200	NG 11.1L	2115	122.4	27	API CH
APD-NG250	250	NG 14.6L	2782	200	49.7	API CH
APD-NG300	300	NG 14.6L HO	3462	172	44.5	API CH
APD-NG350	350	NG 18.3L	3984	172	44.5	API CH
APD-NG400	400	NG 21.9L	4231	256	49.7	API CH
APD-NG425	425	NG 21.9L HO	4484	256	49.7	API CH

Table 8.1. Fuel consumption and coolant, fuel, and lubricating oil capacities and lubricating oil systems.

9. ELECTRIC STARTING SYSTEMS

Electric starting systems are generally used on all gen-sets. The power source for electric starting systems is a 12 or 24 VDC battery system. The starting voltage is determined by engine size with 24 VDC being used for larger engines to reduce starting current and, hence, the cable size. Control of starting is performed via a start solenoid which is controlled by the gen-set control system.

9.1.Battery Systems

Batteries are of two types - lead acid and NiCad. Lead acid batteries are generally used, being the least expensive. NiCad batteries are used where longer life, etc., is required.

9.2. Maintenance Batteries

Warning
Servicing of batteries is to be performed or supervised by trained personnel with knowledge of batteries and the required precautions. Keep unauthorized personnel away from batteries.

When replacing batteries, use the same number and the valve regulated(Maintenance-free) type batteries

CAUTION – Do not dispose of any battery by

CAUTION – Do not open or mutilate any battery. The released electrolyte has been known to be harmful to the skin and eyes and can be fatal.

CAUTION – A battery presents a risk of electrical shock and high short circuit current. The following precautions are to be observed when working on batteries:
1. Remove watches, rings, or other metal objects.
2. Only use tools with insulated handles.

9.3. Battery Maintenance

●Keep the top of the battery and its terminals clean.

●Cover the battery terminals and its connections with Vaseline.

●Tighten the terminals until they do not move freely. Do not over tighten.

●Check the electrolyte level periodically. It should be approximately 3/8” above the plates.

●Periodically check for any abrasions on the

alternator belt and also check the tension. Compare the belt tension to the producer's recommendations and adjust if required.

●Periodically check to make sure that the battery is charged.

9.4. Maintenance Free Batteries

Ensure that all battery connections are correct and batteries are always charged.

9.5.Starting Aids

It is customary to keep coolant temperatures at or above 104°F in order to promote quick starting on an emergency generating plant. Thermostatically controlled immersion heaters, deriving their supply from the primary source of power, are fitted into the engine cooling system to provide this heating.

9.6.Cold Cranking Ampere Rating of the Battery

We used battery listed below table for our standard.

Brand	Battery Model	Voltage	CCA	L(in)	W(in)	H(in)	Weight(lbs)
VARTA	6-QW-36LT1HD	DC12V	310	7.76	5.04	7.95	22.7
VARTA	6-QW-54HD	DC12V	410	11.4	6.85	6.85	36.6
VARTA	L2-400MF	DC12V	640	9.49	6.85	7.40	34.8
VARTA	6-QW-80L	DC12V	622	12.0	6.77	7.99	47.4
VARTA	6-QW-120B	DC12V	850	16.0	6.77	8.31	65.3
SMF	N200	DC12V	1150	20.4	10.9	348	111

Table 9.1 Batteries for starting

9.7. Battery Connection

When preparing to start the genset, place the battery onto battery support located on the base frame. Next, connect the battery cable to the battery. First connect positive pole, then connect the negative pole. When removing the battery, always remove the negative battery cable first.

10. ELECTRICAL CONNECTION

Only fully qualified and experienced electrical technicians should carry out electrical installation, service, and repair work.

Warning:

Make electrical connections in compliance with all relevant Electrical Codes, Standards, or other requirements.

10.1. Cabling

Due to movement of generating sets on their vibration mounts, the electrical connection to the set should be made with flexible cable.

The cable must be suitable for the output voltage and the rated current of the generating set. In determining the cable size, allowances should be made for ambient temperature, method of installation, proximity of other cables. etc.

All connections should be carefully checked for integrity. The current carrying capacity of power cables are given in Table 10.1 and the cable cross sections which must be used according to the generating set power are given in Table 10.2. On the other hand, there is one more important point to consider while selecting cable cross sections. If the distance between the load and the generator is too long, the voltage drop on the load side may be too high at the transient current duration. The voltage drop across a cable can be determined as follows:

$$e = \frac{\sqrt{3} \times L \times I \times (R \cos\varphi + \sin\varphi)}{-1000}$$

e = Voltage drop (V)
I = Rated current (A)
L = Length of conductors (m)
R = Resistance (Ω/km to VDE 0102)
X = Reactance (Ω/km to VDE 0102)

10.2.Protection

The cables connecting the generating set with the distribution system are protected by means of a circuit breaker to automatically disconnect the set in case of overload or short circuit. (Manual models only)

10.3.Loading

When planning the electrical distribution system, it is important to ensure that a balanced load is presented to the generating set. If loading on one phase is substantially higher than the other phases, it will cause over heating in the alternator windings, imbalance in the phase output voltage, and possible damage to sensitive 3-phase equipment connected to the system. Ensure that no individual phase current exceeds the current rating of the generating set. For connection to existing distribution system, it may be necessary to reorganize the distribution system to ensure these loading factors are met.

10.4.Power Factor

The power factor (Cos φ) of the connected load should be determined. Power factors below 0.8 lagging (inductive) can over load the generator. The set will provide its kilowatt rating and operate satisfactorily from 0.8 lagging to unity power factor (1.0) Particular attention must be given to installations with power factor correction equipment such as capacitors to ensure that a leading power factor is never present. This will lead to voltage instability and may result in voltage surges that may damage equipment. Generally, whenever the generating set is supplying the load, any power factor correction equipment should be switched off.

CABLE SIZE (AWG OR KCMIL)	AMPACITY (A) AT TEMPERATURE RATING 90°C (194°F)
10	47
8	60
6	80
4	100
2	125
1/0	140
2/0	165
3/0	180
4/0	230
250	280
300	325
350	375
400	430
500	450

Table 10.1. Current carrying capacity of power cables (Copper wire – See NEC 310.15(B)(16))

10.5.Grounding/ Earthing Requirements:

The frame of the generating set must be connected to an earth ground. Since the set is mounted on vibration isolators, the ground connection must be flexible to avoid possible breakage due to vibration. Ground connection cables or straps should have at least full load current carrying capacity and meet applicable regulations.

10.6.Insulation Test:
Before starting the generating set after installation, test the insulation resistance of the windings. The Automatic Voltage Regulator (AVR) should be disconnected and the rotating diodes either shorted out with temporary links or disconnected. Any control wiring must also be disconnected.

A 500V Megger or similar instrument should be used.

Disconnect any grounding conductors connected between neutral and earth and meg an output terminal to earth.terminal to earth.

10.7 Fuse ratings and instructions

Ampere Rating	Voltage Rating	Nominal Resistance Cold Ohms	Nominal Melting I^2t A^2 Sec.	Used for
2	250	0.076	1.87	Genset controller
3.15	250	0.037	6.7	Canopy light
6	250	.014	12.3	Voltage Sensing

User can replace the fuses without tools, when replacing the fuses, it must be the same ampere Rating (UL ,RC)

Genset		Standby load Current at 480V (single 277V)	Cable section Y V V Single core for each phase	N phase wiring harness (AWG)	Terminal Size	N	install tool
Model	StandBy Power (KW)	(A)	(AWG)			connection bolt size	
APD-NG30	30	45	6	6	N/A	M8	14mm spanner
APD-NG40	40	60	10	10	N/A	M8	14mm spanner
APD-NG50	50	75	2	2	N/A	M8	14mm spanner
APD-NG60	60	90	2	2	N/A	M8	14mm spanner
APD-NG80	80	120	2	2	N/A	M8	14mm spanner
APD-NG100	100	150	1/0	1/0	N/A	M8	17mm spanner
APD-NG125	125	188	2/0	2/0	N/A	M8	19mm spanner
APD-NG150	150	226	2/0	2/0	N/A	M8	19mm spanner
APD-NG200	200	301	2*2/0	2/0	N/A	M8	19mm spanner
APD-NG250	250	376	2*2/0	2/0	N/A	M8	19mm spanner
APD-NG300	300	452	2*3/0	3/0	N/A	M8	19mm spanner
APD-NG350	350	526	2*3/0	3/0	N/A	M8	19mm spanner
APD-NG400	400	601	3*3/0	2*3/0	N/A	M8	19mm spanner
APD-NG425	425	640	3*3/0	2*3/0	N/A	M12	19mm spanner

Genset		Standby load Current at 208V (single 120V)	Cable section Y V V Single core for each phase	N phase wiring harness (AWG)	Terminal Size	N	install tool
Model	StandBy Power (KW)	(A)	(AWG)			connection bolt size	
APD-NG30	30	105	3	3	N/A	M10	14mm spanner
APD-NG40	40	140	1/0	1/0	N/A	M10	17mm spanner
APD-NG50	50	174	2/0	2/0	N/A	M10	17mm spanner
APD-NG60	60	208	2/0	2/0	N/A	M12	17mm spanner
APD-NG80	80	278	3/0	3/0	N/A	M12	17mm spanner
APD-NG100	100	347	2*2/0	2/0	N/A	M12	19mm spanner
APD-NG125	125	434	2*2/0	2/0	N/A	M12	19mm spanner
APD-NG150	150	521	2*3/0	3/0	N/A	M12	19mm spanner
APD-NG200	200	694	3*3/0	2*3/0	N/A	M12	19mm spanner
APD-NG250	250	868	3*4/0	2*4/0	N/A	M12	19mm spanner
APD-NG300	300	1042	4*3/0	2*3/0	N/A	M12	19mm spanner
APD-NG350	350	1214	4*4/0	2*4/0	N/A	M12	19mm spanner
APD-NG400	400	1388	5*4/0	3*4/0	N/A	M12	19mm spanner
APD-NG425	425	1476	5*4/0	3*4/0	N/A	M12	19mm spanner

Table 10.2 Recommended single core cable cross section at 40°C ambient

The insulation resistance should be in excess of 1MΩ to earth. Should the insulation resistance be less than1MΩ, the windings must be dried out.

Genset		Standby load Current at 240V (single 120V)	Cable section Y V V Single core for each phase	N phase wiring harness (AWG)	Terminal Size	N	install tool
Model	StandBy Power (KW)	(A)	(AWG)			connection bolt size	
APD-NG30	30	90	5	5	N/A	N/A	14mm spanner
APD-NG40	40	120	2	2	N/A	N/A	14mm spanner
APD-NG50	50	151	1/0	1/0	N/A	N/A	14mm spanner
APD-NG60	60	180	2/0	2/0	N/A	M8	14mm spanner
APD-NG80	80	241	3/0	3/0	N/A	M8	14mm spanner
APD-NG100	100	301	2*2/0	2/0	N/A	M8	14mm spanner
APD-NG125	125	376	2*2/0	2/0	N/A	M8	19mm spanner
APD-NG150	150	452	2*2/0	2/0	N/A	M8	19mm spanner
APD-NG200	200	601	3*3/0	2*3/0	N/A	M8	19mm spanner
APD-NG250	250	753	3*3/0	2*3/0	N/A	M8	19mm spanner
APD-NG300	300	903	3*4/0	2*4/0	N/A	M8	19mm spanner
APD-NG350	350	1052	4*4/0	2*4/0	N/A	M8	19mm spanner
APD-NG400	400	1203	4*4/0	2*4/0	N/A	M8	19mm spanner
APD-NG425	425	1280	5*4/0	3*4/0	N/A	M12	19mm spanner

Genset		Standby load Current at (single) 240V (single 120V)	Cable section Y V V Single core for each phase	N phase wiring harness (AWG)	Terminal Size	N	install tool
Model	StandBy Power (KW)	(A)	(AWG)			connection bolt size	
APD-NG30	30	125	2	2	N/A	N/A	14mm spanner
APD-NG40	40	167	2/0	2/0	N/A	N/A	14mm spanner
APD-NG50	50	208	3/0	3/0	N/A	M10	14mm spanner
APD-NG60	60	250	3/0	3/0	N/A	M10	14mm spanner
APD-NG80	80	333	2*2/0	2/0	N/A	M10	17mm spanner
APD-NG100	100	400	2*2/0	2/0	N/A	M10	19mm spanner
APD-NG125	125	521	2*3/0	3/0	N/A	M12	19mm spanner
APD-NG150	150	625	3*3/0	2*3/0	N/A	M12	19mm spanner

Table 10.2 Recommended single core cable cross section at 40◦C ambient

The insulation resistance should be in excess of 1MΩ to earth. Should the Insulation resistance be less then 1MΩ, the windings must be dried out.

11. ACOUSTIC SILENCING

Controlling the amount of noise output by a generating set is becoming very important in most installations. There is a variety of components available to control the noise level.

WARNING!
Ear protection must be worn when operating or working around an operating generating set.

11.1. Exhaust Silencers:
As discussed in Section 3.10. the exhaust silencer will decrease sound level from the engine.

11.2. Canopies:

Section 4.2. discusses sound attenuating canopies that lower the noise level of the entire generating set.

11.3. Other Sound Attenuation:

For installations in buildings, there are other types of equipment such as acoustic louvers, splitter vents, and fan silencers as well as sound absorbing wall coverings that can be used to reduce the noise levels of generating sets.

12. STORAGE

Long-term storage can have detrimental effects on both the engine and alternator. These effects can be minimized by properly preparing and storing the generating set.

12.1. Engine Storage:

The engine should be put through an engine "preservation" procedure that includes cleaning the engine and replacing all the fluids with new fluids or preserving fluids.

12.2.Alternator Storage:

When an alternator is in storage, moisture tends to condense in the windings. To minimize condensation, store the generating set in a dry storage area. If possible use space heaters to keep the windings dry. After removing the generating set from storage, perform an insulation check as discussed in Section 10.6.

12.3.Battery Storage:

While the battery is stored, it should receive a refreshing charge every 8 weeks up to a fully charged condition.

13. GENERAL PRECAUTIONS AND CONTROLS WHICH MUST BE DONE BEFORE STARTING UP THE GENERATING SET.

●Make a general visual inspection on the engine and alternator. Check to see if there are any breaks, cracks, indentations, leaks, or looseness. If any of these exist, Do NOT operate the generating set before making the necessary repairs.

● Take out foreign materials such as keys, tools, cleaning wool, papers, etc. on the engine and the alternator.

● Check the fuel level in day tank. Refill with fuel if it is low.

● Check the oil level on the dipstick. Refill with an appropriate oil if it is low. Oil level should normally be close to the maximum level line.

●Look at the water level by opening the radiator tap. If it is inadequate, add more water. Water level should be approximately 1-1/8" lower than the water filling neck.

●Engine cooling water must include antifreeze according to the coolest weather conditions in the area.

●A mixture of 50% antifreeze and 50% water provides a good protection in all areas.

●Inspect the radiator air outlet hood, open if clogged, and clear away all obstructions in front of the air outlet.

● Check the air filter gauge. Clean or replace the air filter, if necessary.

● Make sure that inlet opening is not obstructed.

● Make sure that the generating set can easily take air from the environment.

●Check the battery connection cables. Take care to tighten any loose battery terminals with the proper size tool and cover with any battery terminal coating substance. in order to keep clean and avoid oxidation and corrosion of terminals.

●Open the battery caps and check the liquid level in the cells for maintenance type battery. Add distilled water, if necessary, so as to be approximately 3/8" higher than the separation. Never fill the cells with tap water, acid water, or acid.

●Ensure that the circuit breaker outlet switch is in the OFF position.

●Make sure that the emergency stop button is not pressed.

14. GENERATING SET CONTROL SYSTEMS

To control and monitor the generating set, an electronic control system has been used. The DSE7320 control system is fitted to all generating sets. This control panel provides a means of starting and stopping the generating set, monitoring its operation and output, and automatically shutting down the set in the event of critical condition arising such as low oil pressure or high engine temperature.

14.1. DSE7320, Control System with Automatic Mains Failure

The DSE Model 7320 module controls generating set system. This module has been designed to monitor the main (utility) supply.

14.1.1. Operation Manual Mode of Operation

Check the precautions and controls starting up the generating set. NOTE: If a digital input configured to panel lock is active, the LCD will display the icon. When in panel lock, changing modules will not be possible. Viewing the instruments and event logs not affected by panel lock.

To initiate a start sequence in Manual, press the pushbutton. When the controller is in manual, pressing the Start button will initiate the start sequence.

Note: There is no Start Delay in this mode of operation. The Fuel Solenoid is energized, then the Starter Motor is engaged.

The engine is cranked for a preset time period. If the engine fails to fire during this cranking attempt then the starter motor is disengaged. If you continue beyond the set number of attempts, the start sequence will be terminated and fail to start fault will be displayed accompanied by a flashing shutdown indicator.

When the engine fires, the starter motor disengages and locks out at a pre-set frequency from the alternator output. Rising oil pressure can also be used to disconnect the starter motor. However, it cannot be used for under speed or over speed detection.

After the starter motor has disengaged, the Safety On timer is activated, allowing Oil Pressure, High Engine Temperature, Under-speed, Charge Fail, and any delayed Auxiliary fault inputs to stabilize without triggering the fault.

The generator will run off load unless the main supply fails or a Remote Start signal is applied.

The generator will continue to run on load regardless of the state of the main supply or remote start input until the Auto mode is selected. If Auto mode is selected, and the main supply is healthy with the remote start on load signal not active, then the Remote Stop Delay Timer begins, after which the load is disconnected. The generator will then run off load allowing the engine to cool down for a period of time. Selecting Stop will bring the generator to a stop.

14.1.2. Automatic Mode of Operation

NOTE: If a digital input configured to panel lock is active, the LCD will display the icon. When in panel lock, changing modules will not be possible. Viewing the instruments and event logs is not affected by panel lock.

This mode is activated by pressing the AUTO push button. A LED indicator beside the button confirms this action.

Should the main (utility) supply fall outside the configurable limits for longer than the period of the main transient delay timer, the main (utility) available Green indicator LED extinguishes. Additionally, while in AUTO mode, the remote start input (if configured) is monitored. If active, the Remote Start Active indicator illuminates (if configured)

Whether the start sequence is initiated by the main (utility) failure or by remote start input, the following sequence takes place:

After the start delay, the Fuel Solenoid is energized. One second later the Starter Motor is engaged.

The engine is cranked for a pre-set time period. If the engine fails to fire during this cranking attempt, then the starter motor is disengaged for the pre-set period.

Should this sequence continue beyond the set number of attempts, the start sequence will be terminated and fail to start fault will be displayed accompanied by a flashing shutdown symbol.

When the engine fires, the starter motor should disengage and lock out at a pre-set frequency from the Alternator output. An increase in oil pressure signal can cause the starter motor to disconnect. However, it canot be used for under speed or over speed detection.

After the starter motor has disengaged, the Safety On timer is activated, allowing Oil Pressure, High Engine Temperature, Under-speed, Charge Fail, and any delayed Auxiliary fault inputs to stabilize without triggering the fault.

If an auxiliary output has been selected to give a load transfer signal, this would then activate.

On the return of the mains supply, (or removal of the Remote Start signal if the set was started by remote signal), the Stop delay timer is initiated. Once it has timed out, the load Transfer signal is de-energized which removes the load. When the Cooling timer expires, the Fuel Solenoid is de-energized, bringing the generator to a stop.

14.1.3. Test Operation

NOTE: If a digital input configured to panel lock is active, the LCD will display the icon. When in panel lock, changing modules will not be possible. Viewing the instruments and event logs is not affected by panel lock.

To initiate a start sequence in Test, press the pushbutton. When the controller is in the test mode

(indicated by an LED indicator beside the button), pressing the Start (I) button will initiate the start sequence.

Note: There is no Start Delay in this mode of operation. The Fuel Solenoid is energized, then the Starter Motor is engaged.

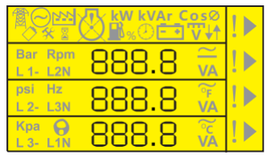
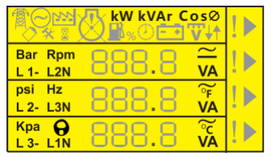
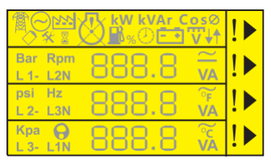
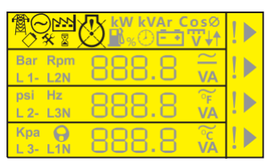
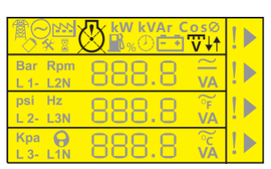
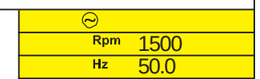
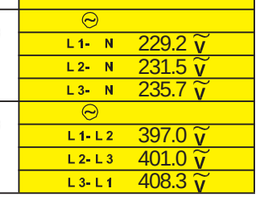
The engine is cranked for a preset time period. If the engine fails to fire during this cranking attempt, then the starter motor is disengaged. It will continue to try to start until it reaches a set number of attempts. At this point, the start sequence will be terminated and fail to start
! fault will be displayed accompanied by a flashing shutdown indicator. When the engine fires, the starter motor will disengage and lock out at a pre-set frequency from the Alternator output. Rising oil pressure can also be used to disconnect the starter motor. However, it cannot be used for under speed or over speed detection.

After the starter motor has disengaged, the Safety On timer is activated allowing Oil Pressure, High Engine Temperature, Under-speed, Charge Fail, and any delayed Auxiliary fault inputs to stabilize without triggering the fault.

The generator will continue to run on load regardless of the state of the main supply or remote start input until the Auto mode is selected. If Auto mode is selected, the main supply is healthy, and the remote start on load signal is not active, then the Remote Stop Delay Timer begins. After this, the load is disconnects. The generator will then run off load allowing the engine a cooling down period. (O) Selecting Stop de-energizes the fuel solenoid bringing the generator to a stop.

Figure 14.1. Description of Controls on DSE7320 Control Module

14.1.2 LCD Display Areas

Instruments Values	Instruments Values		
Display information units of measure	Display information units of measure		
User Configurable icons	User Configurable icons		
Status icons	Status icons		
Alarm icons	Alarm icons		
Manually Selecting an Instruments	Initial display (Hz/RPM)		
	Pressing the DOWN button the LCD will then show (Generator L-N voltages)	▼	
	Pressing the DOWN button the LCD will then show (Generator L-L voltages)	▼	

14.2. Icons and LCD Identification

14.2.1. Push But tons

Display	Description	Display	Description	Display	Description
	Stop/ Reset		Configure	ATUO	Auto mode
	Scroll		Test mode		Start (when in Manual or Test mode)
			Manual mode		

14.2.2. Starts/Measurement Units

Display	Description	Display	Description	Display	Description
L1	Phase	L2	Phase	L3	Phase
L1 - N	Phase-Neutral	L2 - N	Phase-Neutral	L3 - N	Phase-Neutral
L1 - L2	Phase-Phase	L2 - L3	Phase-Phase	L3 - L1	Phase-Phase
BAR	Pressure	Kpa	KPa Oil Pressure Units	PSI	Pressure
V	Voltage	℉	Temperatu re	Hz	Frequency
A	Amperes	℃	Temperatu re	RPM	Speed
KW	KiloWatts	kVA	Apparent po wer	Cosφ	KW divided by kVA
	Hours Run	~	AC		Genera tor
	Timer in progress		DC		Mains (Utility)
	Configuration mode acti ve	%	Fuel le vel		Event log
	Panel locked by configurable input				

14.2.3. Alarm Indications

Display	Description	Display	Description	Display	Description
	Warning Alarm		Shutdown Alarm		Electrical Trip
	Fuel		Low Oil Pressure	A↑	High Current Warning
	Charge Fail		High Coolant Temperature	V↑	Over Voltage(AC)
	Emergency Stop	!	Fail to start(Over-crank)	V↓	Under Voltage(AC)
V↑	Over Voltage (DC)		Over-speed	Hz↑	Over frequency
V↓	Under Voltage(DC)		Under-speed	Hz↓	Under frequency
▶	Auxiliary Indication	▮▶	Auxiliary Alarm (Warming or Shutdown)		

15. GENERAL PRECAUTIONS AND CONTROLS WHICH MUST BE DONE AFTER STARTING UP THE GENERATING SET

●Check for any abnormal noise or vibration on the generating set.

●Check to see if the exhaust system has any leakage.

●Monitor the generating set operation by means of the control module LCD display. Check the engine temperature and oil pressure Oil pressure must reach the normal value 10 seconds after the generating set begins operation.

●Monitor the generating set outlet voltage and frequency by means of the control module LCD display. Check the voltage to ensure that the phase-to-phase voltage is 480V and the phase to neutral voltage is 277V Check that the frequency is –62 - 64Hz on generating sets with mechanical governors and 60Hz on generating sets with electronic governors.

●If an engine block water heater is not available, run the generating set at no-load for 8 minutes and when the engine is at normal operating temperature, apply the load. For manual models, apply load to the generating set as follows:

●Set the alternator outlet circuit breaker on the panel to the ON position.

●Set the load circuit breakers (or fuses) on the distribution panel to ON position one by one. By performing this step, the generating set cannot be suddenly put under full load. The engine may stall or the alternator winding insulation burning can occur.

●Set the alternator outlet circuit breaker on the circuit to OFF position before stopping the generating set.

●Continue to run the unloaded engine for purpose of cooling period for 5 minutes before shutting genset down.

●Never operate the generating set before removing faults if any are present.

16. CONTROL PANELS

Control, supervision and protection panels are mounted on the generator base frame.

These are many fuses inside of the control panel for protection. If a fuse blows, check all related wires. After the problem is resolved, replace the fuse with the appropriate size fuse. DO NOT use a fuse of size other than what was originally in the control panel.

16.1. Control System DSE 7320

Equipment:
DSE 7320, Automatic Mains Failure module
- Static battery charger
- Emergency stop push button

DSE 7320 Module Features
- To monitor AC main supply
- Automatically controls generating set start and stop
- Provides a signal to the Automatic transfer Switch (ATS)
- Scrolling digital LCD display
- Remote communication via RS232 port or RS 485 mod bus output.
- Event logging of shutdown alarms.
- Front panel configuration of timers and alarm trip points
- Easy push button control
- STOP/RESET- MANUAL- AUTO - TEST - START

Metering Via LCD Display
- Generator Volts (L-L / L - N)
- Generator Ampere (L1, L2, L3)
- Generator Frequency (Hz)
- Generator kVA
- Generator kW
- Generator Cos
- Mains Volt (L - L / L - N)
- Mains Frequency (Hz)
- Engine cooling temperature (°C &°F)
- Engine oil pressure (PSI & Bar)
- Engine speed (RPM)
- Engine hours run
- Plant battery volt

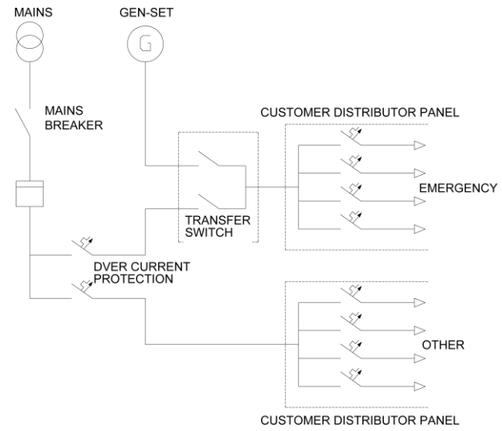
Multiple Alarms
●Under / Over generator volts; Pre-alarm and Shutdown

●Under / Over generator frequency Pre-alarm and Shutdown
● Under / Over mains volts
● Under / Over mains frequency
● Over current; Shutdown
● Low oil pressure; Pre-alarm and Shutdown
●High engine temperature; Pre-alarm and Shutdown
● Under/over speed; Shutdown
● Low coolant level; Shutdown
● Fail to start; Shutdown
● Fail to stop; Warning
● Low/High battery volts; Warning
● Charge fail; Warning
● Emergency stop; Shutdown
● Can Data Fail; Shutdown
● Can ECU Fail; Pre-Alar m and Shutdown

The Event Log
7320 control module maintains a log the last 15 shutdown alarms to enable the operator or engineer to view the past alarms history.

17. THE PLACEMENT AND INSTALLATION OF AUTOMATIC TRANSFER SWITCH (ATS)

The placement of the transfer switch and its mountings:
●Position the transfer switch near the emergency power panel.
●Locate the transfer switch in a place where it is clean, not over-heated, and good ventilation is present. If the environment temperature is above 104°F, breakers will open more easily. There must be enough work space around the transfer switch.
●A breaker may be installed between the generating set and the transfer switch, but it is not required. Current from the generating set must be distributed as equally to the three phases as possible.
●Current from one phase should not exceed the nominal current.
●If the transfer switch panel is apart from the generating set, the ATS must be placed as close as possible to the distributor panel.
●In this case, power cables are drawn from the generating set, the main panel, and emergency power panel. Furthermore, control cables must be drawn from the generating set control panel.



17.1. Typical emergency power system installation

18. ENGINE TROUBLESHOOTING

The starter motor turns the engine too slowly:
● Battery capacity to low
● Bad electrical connection
● Faulty in starter motor
● Wrong grade of lubricating oil

The engine does not start or difficult to start:
● Starter motor turns engine too slowly
● Fuel tank empty
● Fault in fuel control solenoid
● Restriction in a fuel pipe
● Fault in fuel lift pump
● Dirty fuel filter element
● Air in fuel system
● Fault in atomizers
● Colt start systems used incorrectly
● Fault in cold start system
● Restriction in fuel tank vent
● Wrong type or grade of fuel used
● Restriction in exhaust pipe

Not enough power:
● Restriction in a fuel pipe
● Fault in fuel lift pump
● Dirty fuel filter element
● Air in fuel system
● Restriction air filter/cleaner or induction system
●Restriction in exhaust pipe
●Fault in atomizers or atomizers of an incorrect type
● Restriction in fuel tank vent
● Wrong type or grade of fuel used
● Restricted movement of engine speed control
● Engine temperature is too high or low

Misfire
● Restriction in a fuel pipe
● Faulty in fuel lift pump
● Dirty fuel filter element
●Air in fuel system
●Fault in atomizers or atomizers of an incorrect type
● Fault in cold start system
● Engine temperature is too high
● Incorrect valve tip clearances

The pressure of the lubrication oil is too low:
● Wrong grade of lubrication
● Not enough lubrication oil in sump
● Defective gauge
● Dirty lubrication oil filter element

High fuel consumption:
● Restriction air filter/cleaner or induction system
● Fault in atomizers or atomizers of an incorrect type
● Fault in cold start system
● Wrong type or grade of fuel used
● Restricted movement of engine speed control
● Restriction in exhaust pipe
● Engine temperature is too low
● Incorrect valve tip clearances

Black exhaust smoke:
● Restriction air filter/cleaner or induction system
●Fault in atomizers or atomizers of an incorrect type
● Fault in cold start system
● Wrong type or grade of fuel used
● Restriction in exhaust pipe
● Engine temperature is too low
● In correct valve tip clearances
● Engine over load

Blue or white exhaust smoke
● Wrong grade of lubrication
● Fault in cold start system
● Engine temperature is too low

The engine knocks:
● Fault in fuel lift pump
● Fault in atomizers or atomizers of an incorrect type
● Wrong type or grade of fuel used
● Fault in cold start system
● Engine temperature is too high
● Incorrect valve tip clearances

The engine runs erratically:
● Fault in fuel control
● Restriction in a fuel system
● Fault in fuel lift pump
● Dirty fuel filter element
● Restriction air filter/cleaner or induction system
●Air in fuel system
●Fault in atomizers or atomizers of an incorrect type
● Fault in cold start system
● Restriction in fuel tank vent
● Restricted movement of engine speed control
● Engine temperature is too high
● In correct valve tip clearances

Vibration:
●Fault in atomizers or atomizers of an incorrect type
● Restricted movement of engine speed control
● Engine temperature is too high
● Fan damaged
● Fault in engine mounting or flywheel housing
● The engine temperature is too high:
● Restriction air filter/cleaner or induction system
● Fault in atomizers or atomizers of an incorrect type
● Fault in cold start system
● Restriction in exhaust pipe
● Fan damaged
● Too much lubrication oil in pump
● Restriction in air or water passage of radiator
● Insufficient coolant system

Crankcase pressure:
● Restriction in breather pipe
● Vacuum pipe leaks or fault in exhauster

Bad compression:
● Restriction air filter/cleaner or induction system
● Incorrect valve tip clearances

The engine starts and stops:
● Dirty fuel filter element
● Restriction air filter/cleaner or induction system
● Air in fuel system

The engine shuts down after approximately 15 seconds:
● Bad connection towards oil pressure switch/ coolant temperature switch

19. MAINTENANCE CHART

SYSTEM	MAINTENANCE MODEL	MAINTENANCE CONTENTS	DAILY OR EVERY 20 HOURS	WEEKLY	MONTHLY	3 MONTHS OR 100 HRS	6 MONTHS OR 200 HRS	12 MONTHS OR 800 HRS	24 MONTHS OR 2000 HRS
LUBRICATION SYSTEM*	CHECK	ANY LEAKAGE	√	√	√	√	√	√	√
		LUBE-OIL LEVEL	√	√	√	√	√	√	√
		ENGINE OIL PRESSURE	EVERY 12 MONTHS						
	REPLACE	LUBE-OIL FILTER					√	√	√
		LUBE-OIL					√	√	√
		LUBE-OIL AND LUBE-OIL FILTER	OIL AND OIL FILTER NEED TO BE CHANGED AFTER 50 HOURS FOR NEW OR OVERHAULED ENGINES						
	CLEAN	BREATHER OF CRANKCASE					√	√	√
COOLING SYSTEM	CHECK	ANY LEAKAGE	√	√	√	√	√	√	√
		ANY RADIATOR BLOCKAGE			√	√	√	√	√
		PIPES AND CONNECTORS			√	√	√	√	√
		COOLANT LEVEL		√	√	√	√	√	√
		ANTIFREEZE AND ANTI CORROSIVE			√	√	√	√	√
		STRAP AND ITS DEGREE OF TIGHTNESS				√	√	√	√
		FAN DRIVER AND WATER PUMP				√	√	√	√
		BELT AND FAN DRIVER OF RADIATOR (OPTIONAL FOR REMOTE PULLEY TYPE RADIATORS)	EVERY 250 HOURS						
	ADD	LUBRICATOR OF FAN DRIVER (OPTIONAL FOR REMOTE PULLEY TYPE RADIATORS)	500 HOURS			√	√	√	√
	REPLACE	COOLANT	EVERY 12 MONTHS						
	CLEAN	COOLING SYSTEM							
AIR INDUCTION SYSTEM	CHECK	AIR INDUCTION			√	√	√	√	√
		AIR FILTER		√	√	√	√	√	√
		PIPES AND CONNECTORS				√	√	√	√
	REPLACE	AIR FILTER CORE					√	√	√
FUEL SYSTEM	CHECK	ANY LEAKAGE	√	√	√	√	√	√	√
		FUEL LEVEL		√	√	√	√	√	√
		NOZZLE OF FUEL PUMP						√	√
		PIPES AND CONNECTORS					√	√	√
		FUEL PUMP			√	√	√	√	√
	CLEAN	DRAIN FUEL TANK			√	√	√	√	√
		DRAIN WATER SEPARATOR						√	√
	REPLACE	FUEL FILTER					√	√	√
	CHECK	NOZZLE AND VALVES							√
	ADJUST	FUEL INJECTION TIMING	EVERY 12 MONTHS						
		ROCKER AND VALVE					√	√	√
EXHAUST SYSTEM	CHECK	ANY LEAKAGE			√	√	√	√	√
		EXHAUST RESTRICTION							√
		EXHAUST BOLTING			√	√	√	√	√
ELECTRICAL SYSTEM	CHECK	CHARGER ALTERNATOR STRAP AND ITS DEGREE OF TIGHTNESS			√	√	√	√	√
		BATTERY		√	√	√	√	√	√
		SPECIFIC GRAVITY OF ELECTROLYTE			√	√	√	√	√
		SWITCH AND ALARM		√	√	√	√	√	√
		CONNECTOR OF START MOTOR						√	√
		STARTER	EVERY 12 MONTHS						
		ALTERNATOR	EVERY 12 MONTHS						
OTHERS	CHECK	VIBRATION IS NORMAL OR NOT		√	√	√	√	√	√
		TURBOCHARGER BEARING CLEARANCE							√
		TURBOCHARGER COMPRESSOR WHEEL AND DIFFUSER							√
		TIGHTENING DEGREE WITH BASEFRAME						√	√
	CLEAN	GEN-SET					√	√	√
OPERATE THE GEN-SET UNDER NO LOAD FOR 5 MINUTES (OPTIONAL FOR STAND-BY GENSETS	CHECK	EASE OF STARTING		√					
		COLOR OF EXHAUST SMOKE		√					
		ABNORMAL VIBRATION		√					
		ABNORMAL NOISE		√					
		ABNORMAL SMELL		√					
		PARAMETER INDICATION		√					
OPERATE THE GEN-SET WITH AT MORE THAN 1/2 LOAD FOR 15 MINUTES (OPTIONAL FOR STAND-BY GENSETS)	CHECK	EASE OF STARTING				√	√	√	√
		COLOR OF EXHAUST SMOKE				√	√	√	√
		ABNORMAL VIBRATION				√	√	√	√
		ABNORMAL NOISE				√	√	√	√
		ABNORMAL SMELL				√	√	√	√
		PARAMETER INDICATION				√	√	√	√

*For the engines with manual added lubricant for fuel pump:
Lubricant of fuel pump need to be checked once in every month; and the Lubricant shall be replaced once in each three months.

20. GENERAL PRECAUTIONS ABOUT WARRANTY

DEAR AKSA GENERATING SET OPERATOR,

PLEASE TAKE CARE TO THE FOLLOWING IN ORDER TO PREVENT THE GENERATING SET WARRANTY FROM BECOMING INVALID PRIOR TO THE TERMINATION OF THE WARRANTY PERIOD AND TO ENSURE TROUBLE-FREE OPERATION OF THE GENERATING SET.

MAINTENANCE AND REPAIR WORKS WILL NOT BE COVERED BY THE WARRANTY UNLESS THE WARRANTY CERTIFICATE, INVOICE, OR DELIVERY CERTIFICATE OF THE GENERATING SET IS SUBMITTED.

THE WARRANTY OF THE GENERATING SET WILL BECOME INVALID IN THE CASE OF ANY INTERVENTION OF ANY PERSON OTHER THAN AUTHORIZED AKSA SERVICES OR BY PRIOR WRITTEN APPROVAL FROM AKSA POWER GENERATION ON THE GENERATING SET FOR ANY REASON.

CONTROL AND MAINTENANCE WORK INDICATED IN THE PERIODICAL MAINTENANCE SCHEDULE AND THE OPERATING MANUAL MUST BE CARRIED OUT COMPLETELY AND TIMELY. THE FAILURES DUE TO INCOMPLETE OR UNTIMELY MAINTENANCE ARE NOT COVERED BY THE WARRANTY.

GENERATING SET SHOULD BE MOUNTED AS INDICATED IN THE OPERATING MANUAL OTHERWISE, THE PROBLEMS WHICH ARE LIKELY TO OCCUR WILL NOT BE COVERED BY THE WARRANTY. THE CUSTOMER IS RESPONSIBLE FOR THE FAILURES WHICH ARE LIKELY TO OCCUR IN THE CASE THAT THE DIESEL OIL USED CONTAINS DIRT OR WATER.

THE OIL TYPE INDICATED IN THE OPERATING MANUAL SHOULD BE USED IN THE ENGINE. OTHERWISE, THE FAILURES WHICH ARE LIKELY TO OCCUR WILL NOT BE COVERED BY THE WARRANTY.

BATTERIES WILL NOT BE COVERED BY THE WARRANTY IF THEY ARE SUBJECTED TO BREAKAGE, EXCESSIVE ACID FILL, OR HARDENING BY LEAVING UNCHARGED.

ON MANUAL GENERATING SETS, NEVER START OR STOP THE DIESEL ENGINE WHEN THE GENERATING SET IS UNDER LOAD. ENGINE SHOULD BE STARTED AND STOPPED AFTER LOAD IS DISCONNECTED AND THE GENERATING SET IS AT IDLE CONDITION. OTHERWISE, THE VALVES CAN BE SEIZED, THE VOTAGE REGULATOR. TRANSFORMER AND DIODES CAN BE BROKEN . THESE CONDITIONS ARE NOT COVERED BY THE WARRANTY.

OUR COMPANY DOES NOT TAKE THE RESPONSIBILITY OF THE DAMAGES ON THE MAINS SUPPLY CONTACTOR OF THE AUTOMATIC GENERATING SETS DUE TO OVERCURRENT, LOW, OR HIGH VOLTAGE.

NEVER REMOVE THE BATTERY TERMINALS WHILE THE GENERATING SET IS IN USE. EVEN A MOMENT OF DISCONNECTION CAN CAUSE DAMAGE ON THE ELECTRONIC CLOSING RELAY OF THE CHARGE ALTERNATOR AND ON THE ELECTRONIC ENGINE SPEED CONTROL CIRCUIT THESE CONDITIONS ARE NOT COVERED BY THE WARRANTY.

FAILURES DUE TO OVERLOAD AND UNBALANCED LOAD IN EXCESS OF THE GENERATING SET POWER (SUCH AS ALTERNATOR AND CONTACTOR FAILURES) ARE NOT COVERED BY THE WARRANTY.

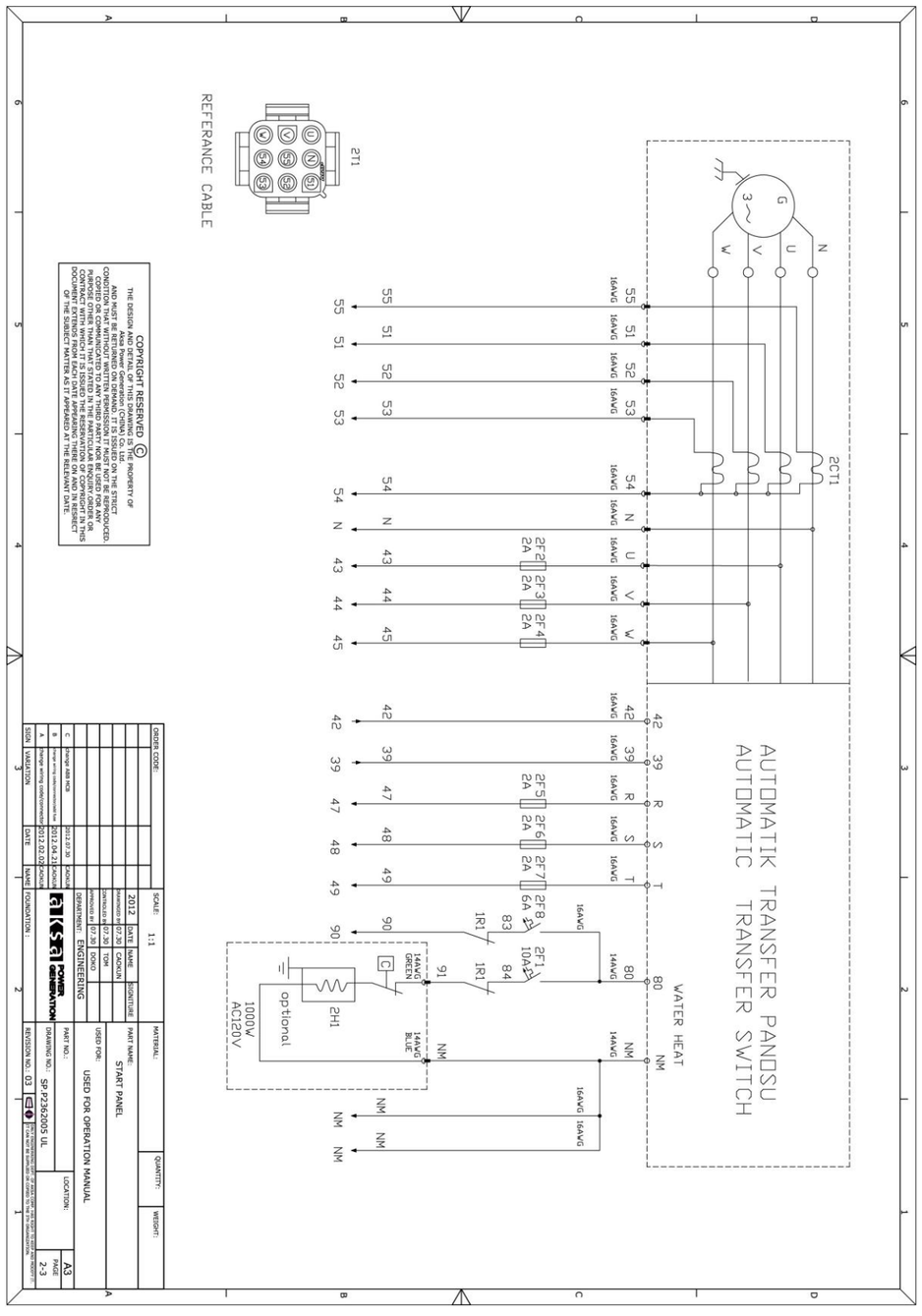
FAILURES DUE TO OVERLOAD AND UNBALANCED LOAD IN EXCESS OF THE GENERATING SET POWER (SUCH AS ALTERNATOR AND CONTACTOR FAILURES) ARE NOT COVERED BY THE WARRANTY.

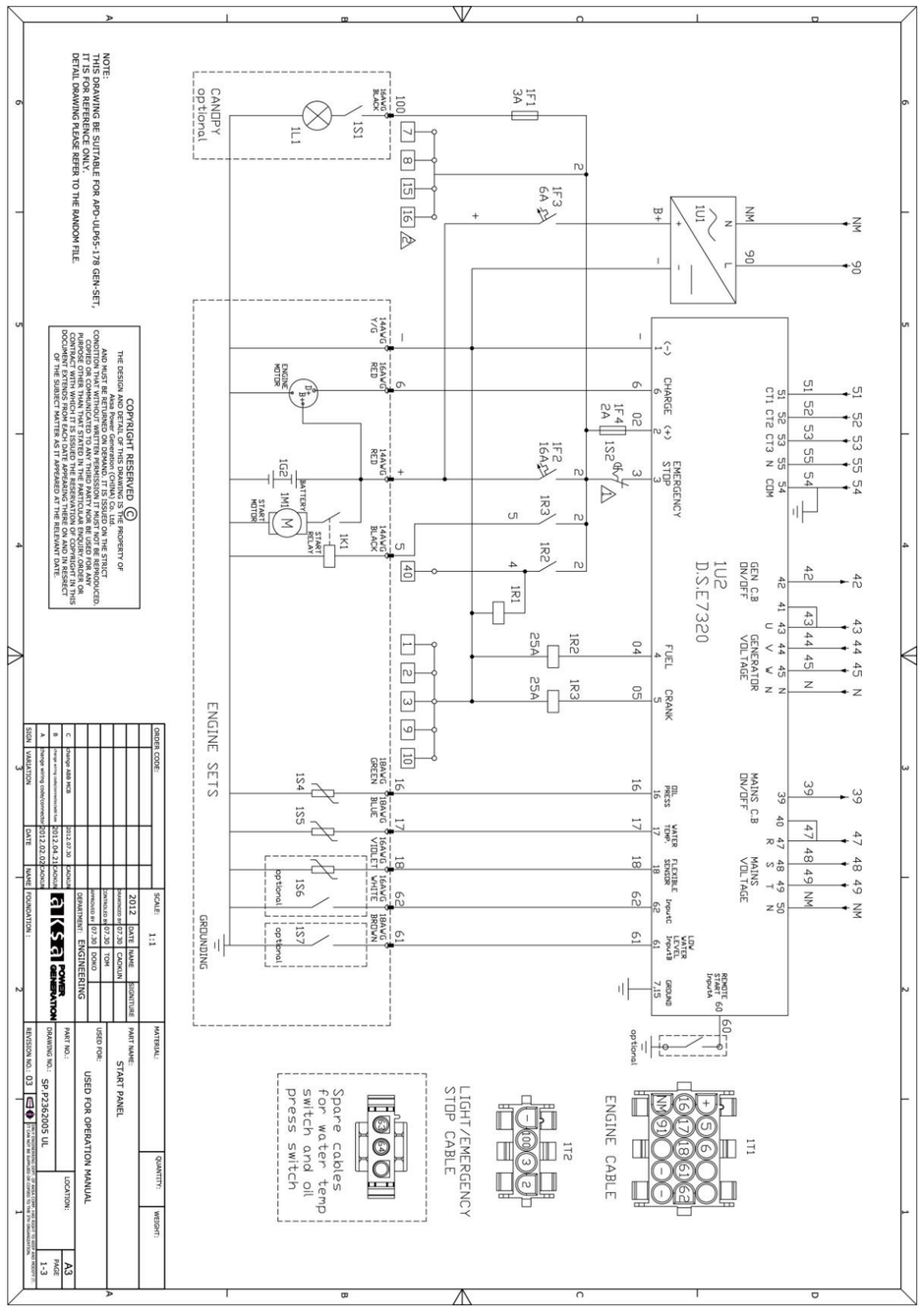
WHEN THE MANUAL GENERATING SET IS STARTED UP, IT SHOULD BE WARMED BY OPERATING AT IDLE FOR 5 MINUTES. VVHEN STOPPING THE DIESEL ENGINE, IT SHOULD BE UNLOADED AND THEN CONTINUED TO BE OPERATED FOR COOLING FOR 10 MINUTES BEFORE STOPPING.

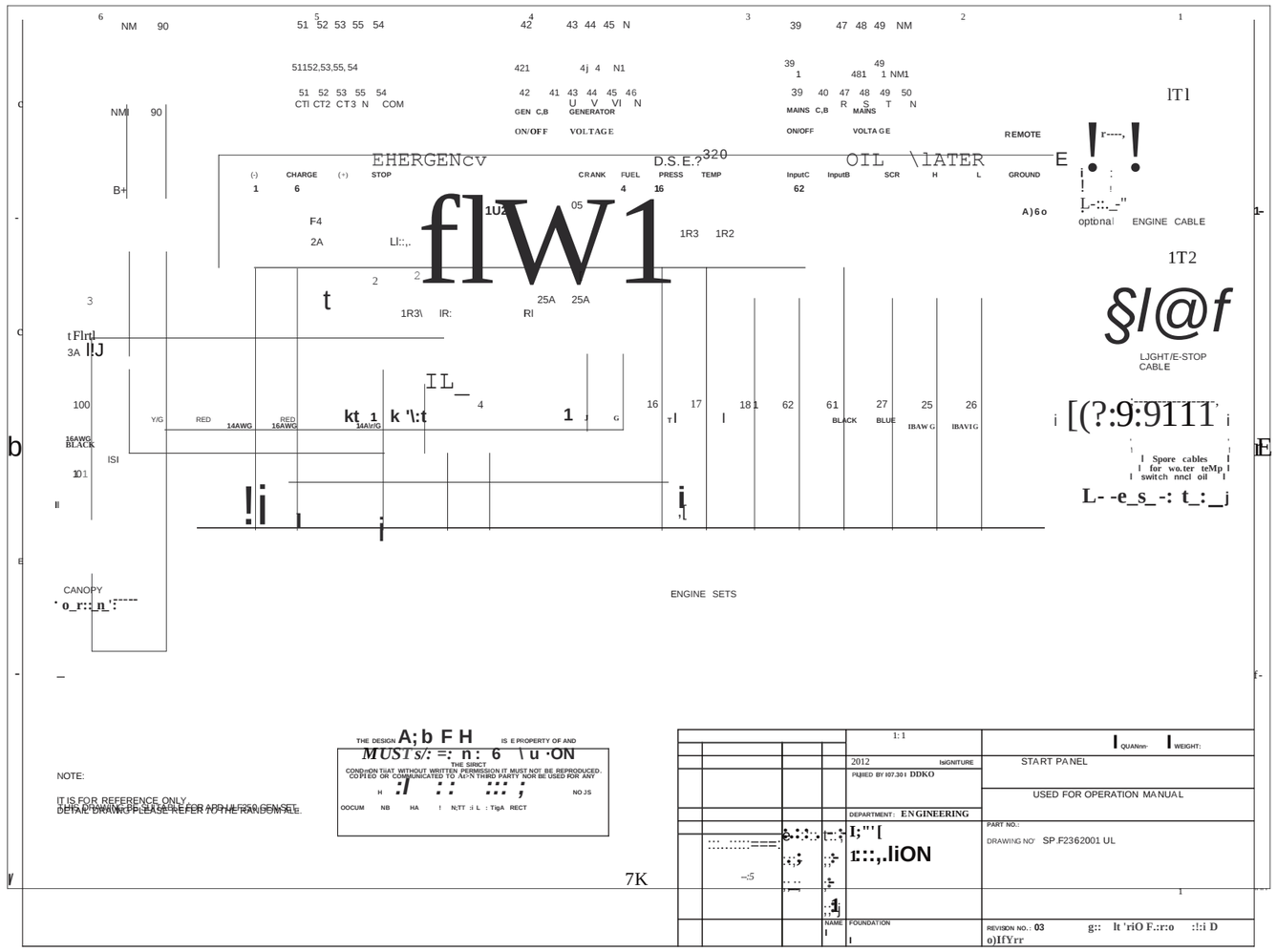
OTHERWISE, PROBLEMS WHICH ARE LIKELY TO OCCUR WILL NOT BE COVERED BY THE WARRANTY.

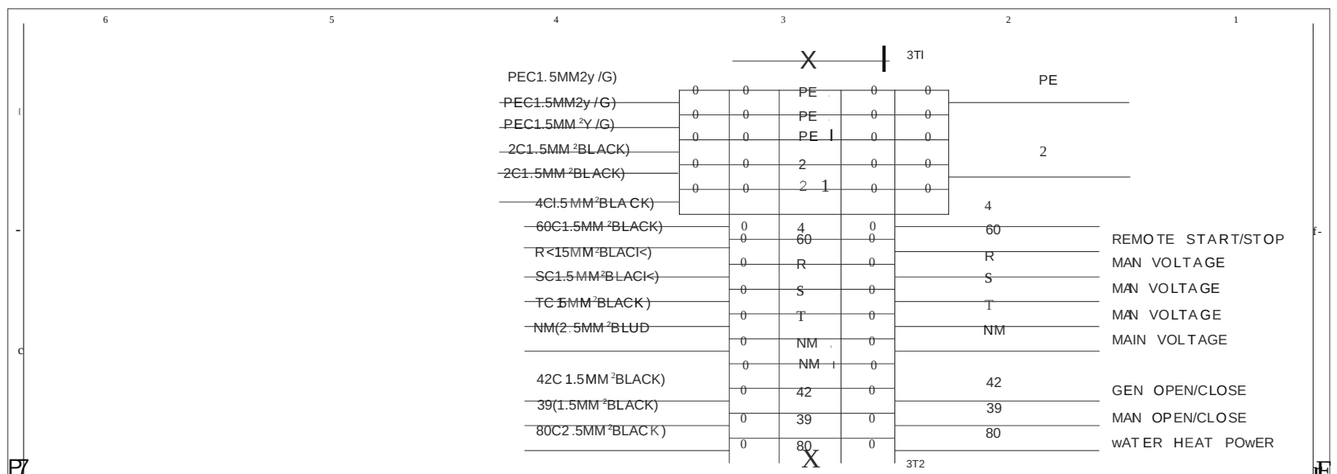
The below drawings are for reference only , subject to the drawings which be shipped with the generator set

21.ELECTRICAL WRING DIAGRAMS









25	3T2	VIEIDMULLER ADU2.5 UL	UL 1059
24	JTI	VIEIDMULLER ADU2.5/4AN UL	UL 1059
23	2HI	VIATER HEATER UL	
22	2CTI	CURRENT TRANSFORMER UL	
2I	2TI	TYCO 9HOLE 1-480706-0	UL 1977
20	1T2	TYCO 4HOLE I480703-0	UL 1977
19	ITI	TYCO 15HDLE 1-480711-0	UL 1977
I8	1F4,2F2,2F3, 2F-4,2f5,2f6, F7	216002P/F2.0A 250V 5x20CFUSD	UL 248
17	2F8	ABB S201UP K6A-1P UL <HIGH BREAKER MINI CURRENT CIRCUIT)	UL 489
16	2FI	ABB S201UP KIOA-1P UL (HIGH BREAKER MINI CURRENT CIRCUIT)	UL 489
15	1F3	ABB So7OIU K6A-1P UL <HIGH BREAKER MINI CURRENT CIRCUIT)	UL 489
14	1F2	ABB S201U K16A-1P UL <HIGH BREAKER MINI CURRENT CIRCUIT)	UL 489
I3	IFI	2163.15P/F3.15A 250V 5x20CFUSD	UL 248
12	IU2	DEEPSEA 7320 MODUEL	UL 508
11	IUI	BATTERY CHARGE AC230V/DCI2V SA	UL 1236
IO	III	CANOPY LIGHT PD771VRR DC12V	
09	IS7	LOVI VATER LEVEL SVITCH	
08	IS6	FEXBLE SENSOR	
07	ISS	VIATER TEMPERATURE SENSOR	
06	IS4	OIL PRESSURE SENSOR	
05	IS3	FUEL SOLENOID	
04	IS2	ABB UL	UL 94
03	ISI	CANOPY LIGHT SVIITCH	
02	1R2,1R3	ROCKVELL 700-HHF62Z12 UL DCI2V 25A	UL 508
01	IRI	DRM270012LTCRELAY>AND RELAY N.C CONTACTDR	UL 508
ITEM	PART NO	ITEM DESCRIPTION	

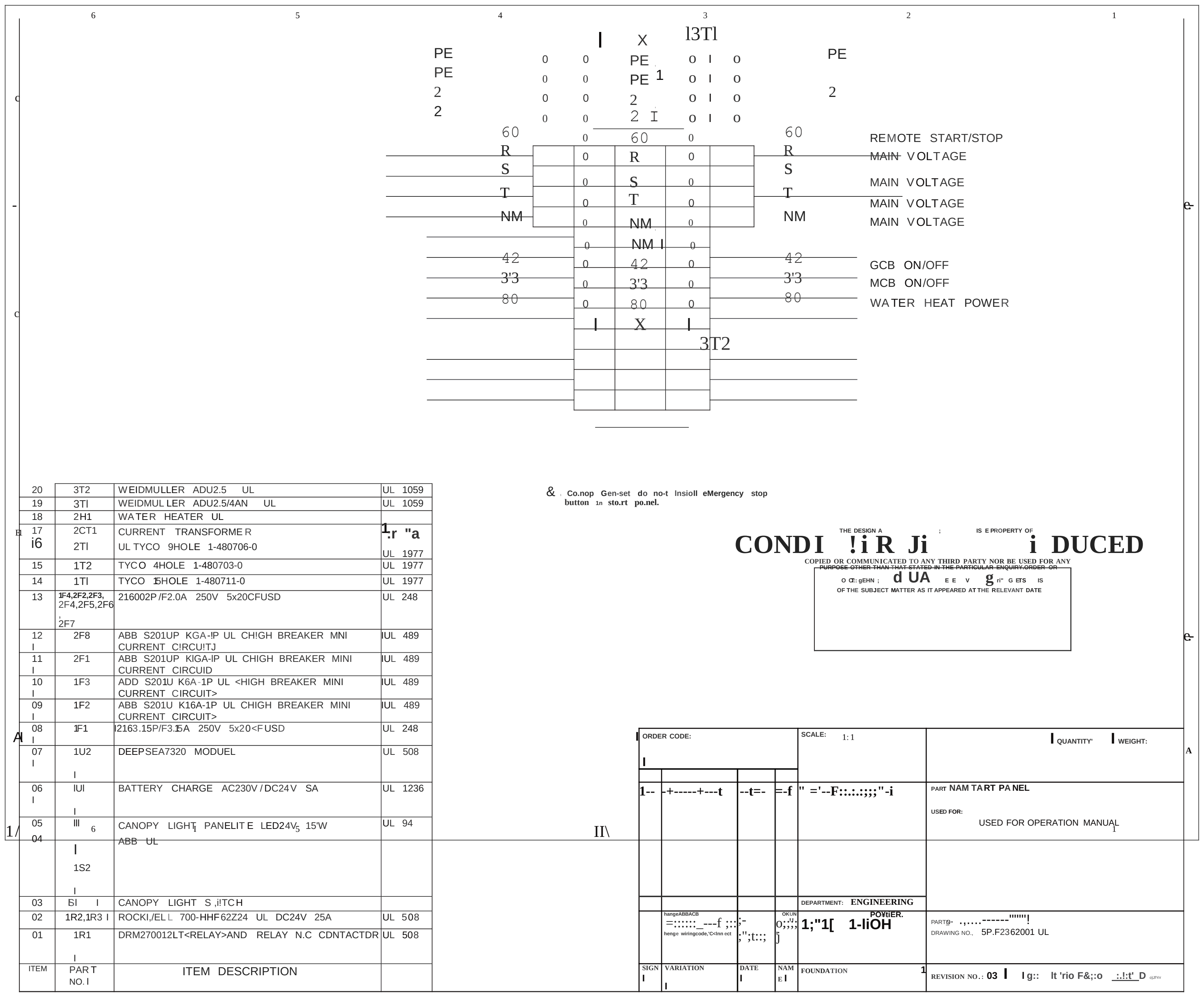
£ [Qnopy Gen-set clo not instQll eMergency stop

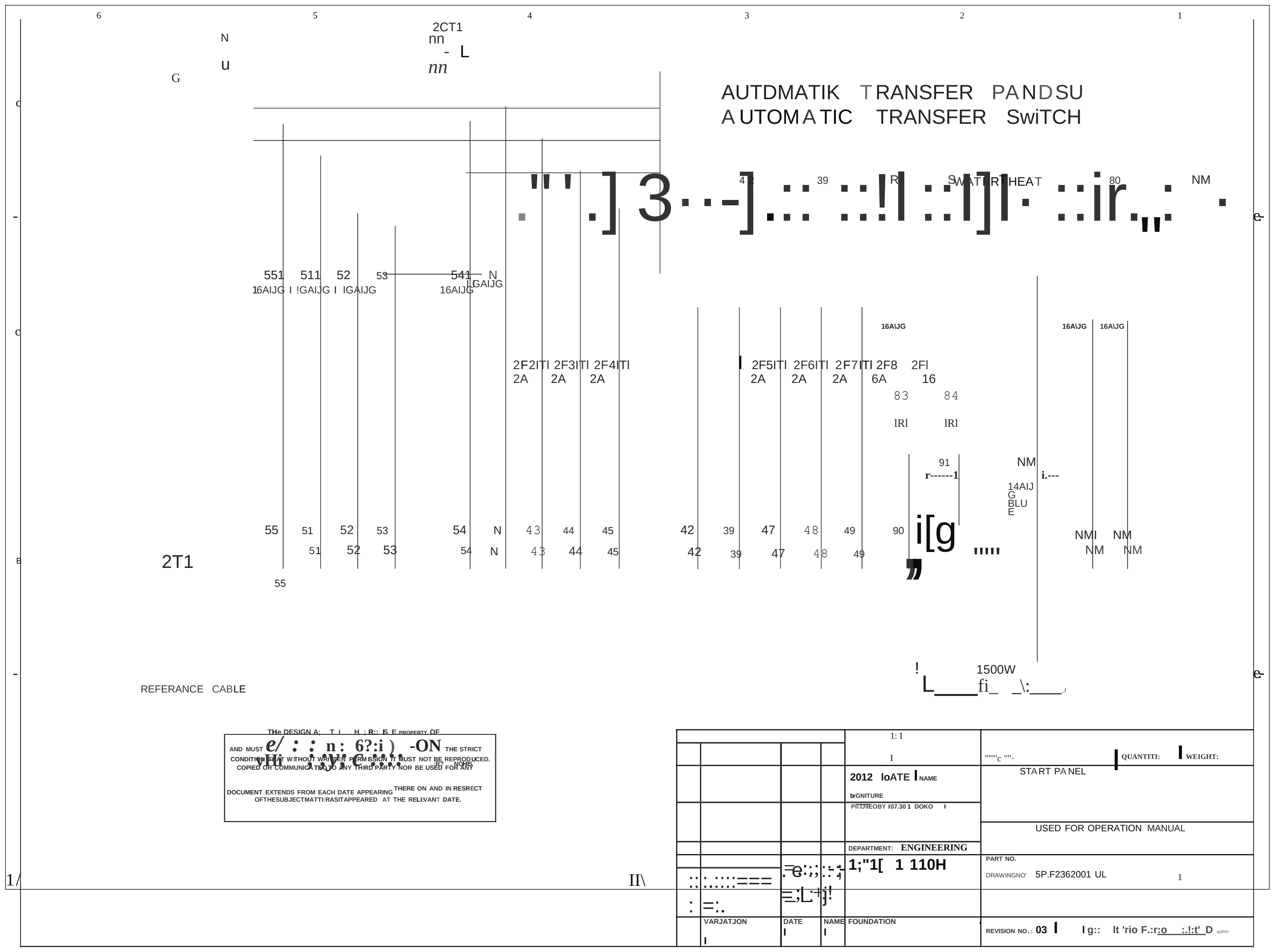
&. :TerMinQl sign of PERKINS ECM

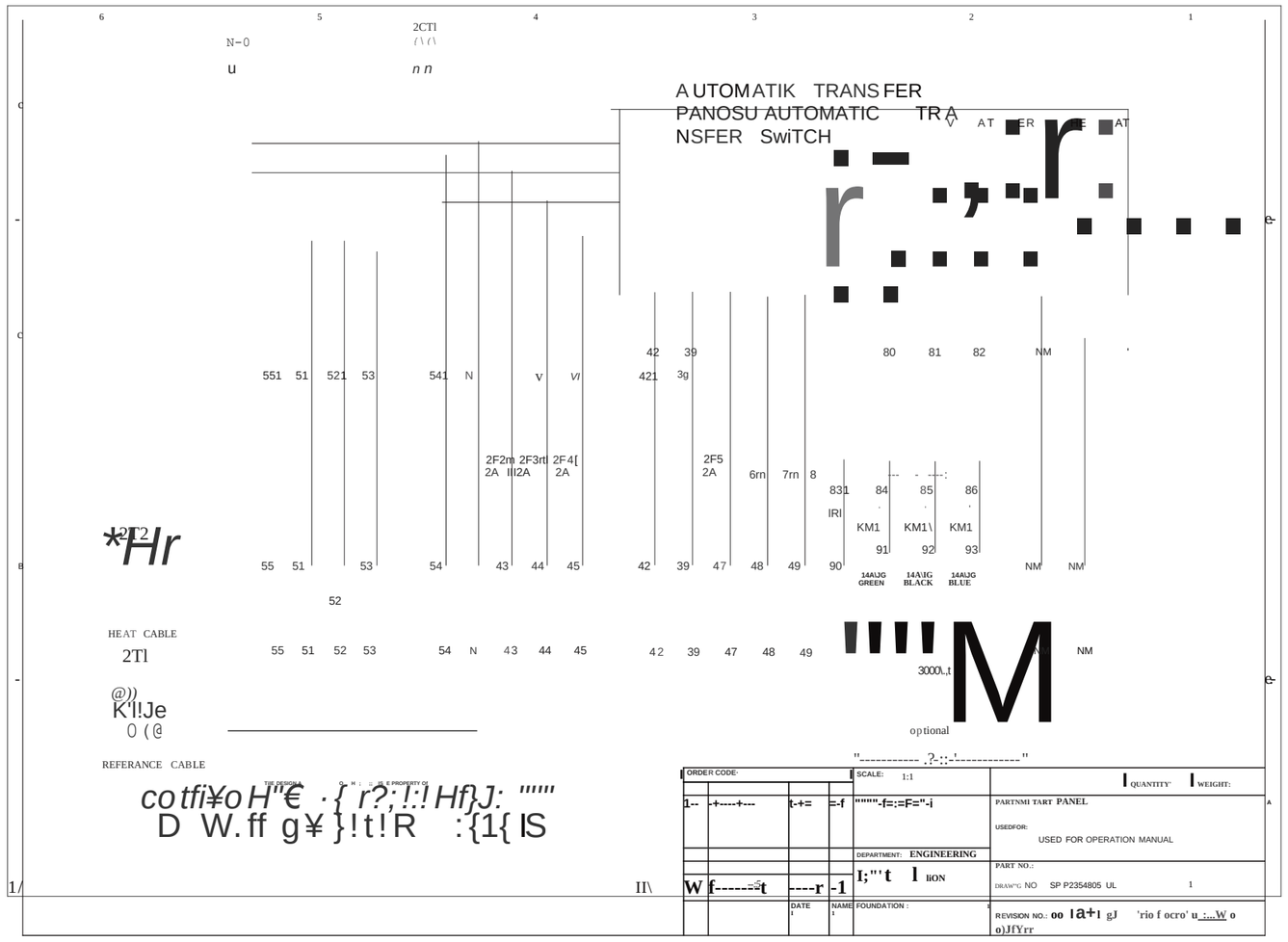
button in stQrt pQnel

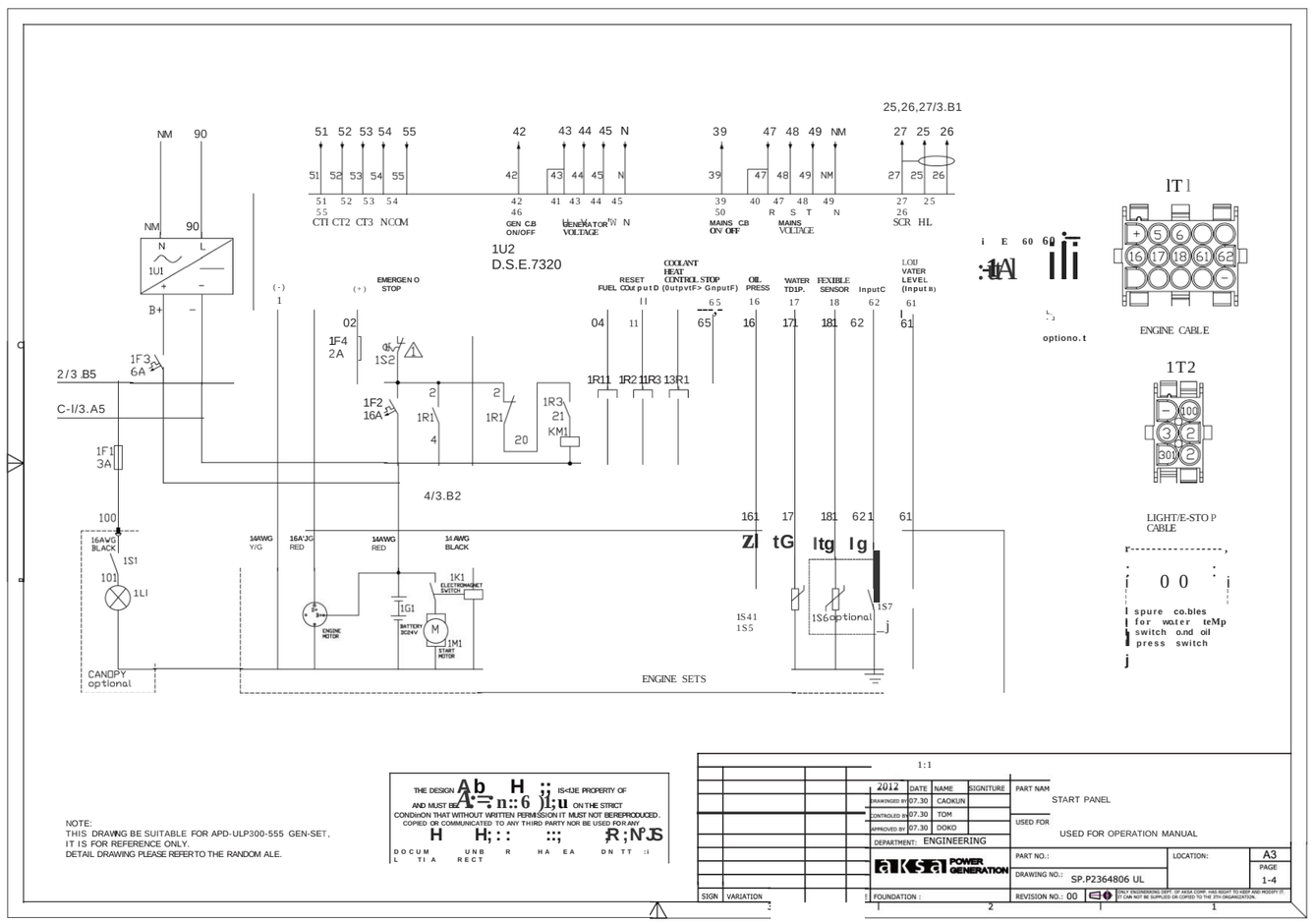
THE DESIGN IS E PROPERTY OF AND
CONDITON THAT WITHOUT WRITTEN PERMISSION IT MUST NOT BE REPRODUCED COPIED OR COMMUNICATED TO ANY THIRD PARTY NOR BE USED FOR ANY
DOCUMENT EXTENDS FROM EACH DATE APPEARING THERE ON AND IN RESRECT OF THE SUBJECT MATIER AS T APPEARED AT THE RELEVANT DATE

ORDER CODE:
SCALE: 1:1
QUANTITY:
WEIGHT:
DEPARTMENT: ENGINEERING
USED FOR OPERATION MANUAL
PART NO.:
LOCATION
REVISION NO.: 03

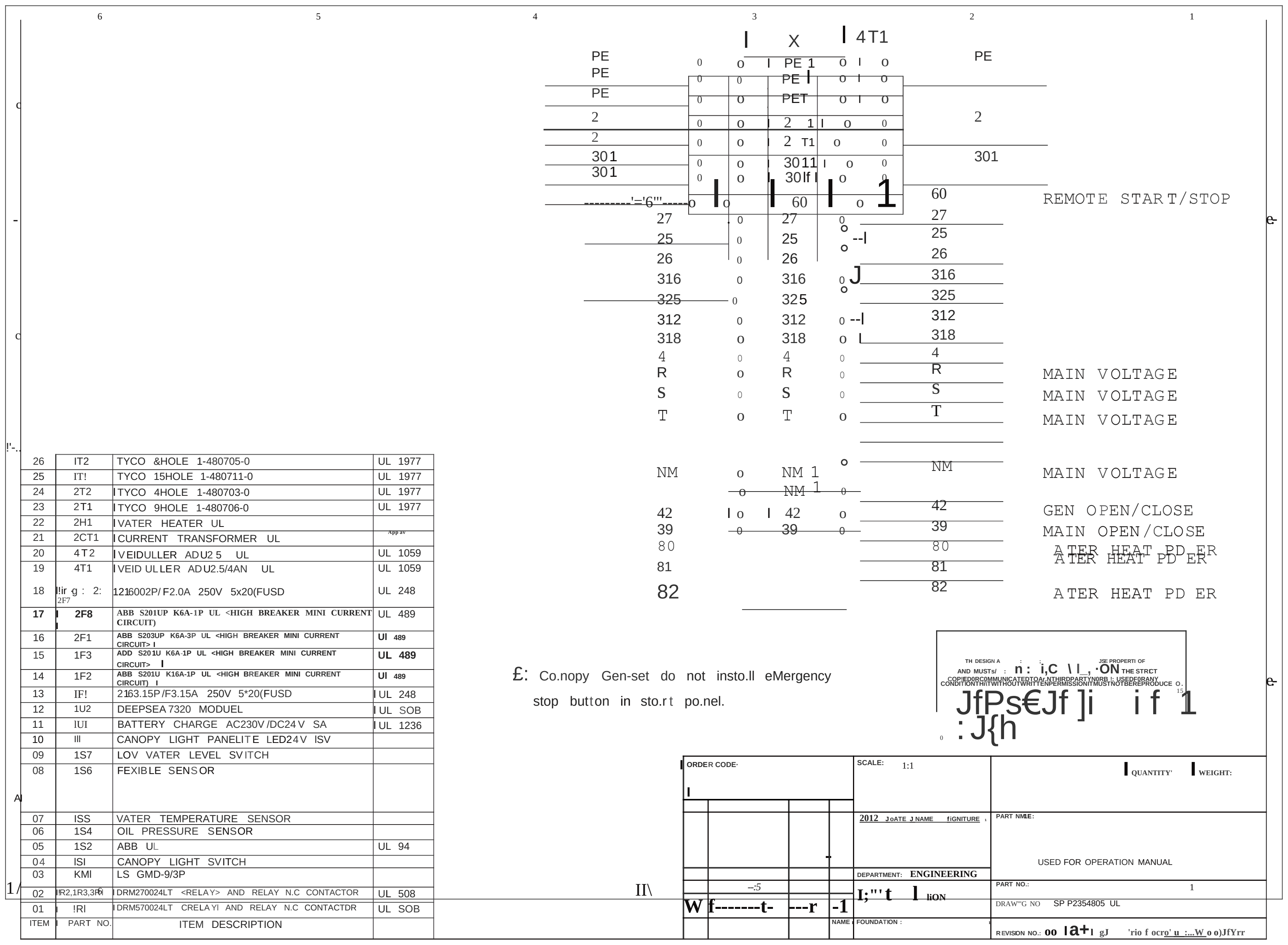

REMOTE START/STOP
MAIN VOLTAGE
MAIN VOLTAGE
MAIN VOLTAGE
MAIN VOLTAGE
GCB ON/OFF
MCB ON/OFF
WATER HEAT POWER
3T1
3T2
20 3T2 WEIDMULLER ADU2.5 UL
19 3TI WEIDMULLER ADU2.5/4AN UL
18 2H1 WATER HEATER UL
17 2CT1 CURRENT TRANSFORMER
15 1T2 TYCO 4HOLE 1-480703-0
14 1TI TYCO 5HOLE 1-480711-0
12 2F8 ABB S201UP KGA-IP UL CHIGH BREAKER MINI CURRENT CIRCUIT
11 2F1 ABB S201UP KIGA-IP UL CHIGH BREAKER MINI CURRENT CIRCUID
10 1F3 ADD S201U K6A-1P UL <HIGH BREAKER MINI CURRENT CIRCUIT>
09 1F2 ABB S201U K16A-1P UL CHIGH BREAKER MINI CURRENT CIRCUIT>
07 1U2 DEEPSEA7320 MODUEL
06 IUI BATTERY CHARGE AC230V/DC24V SA
05 CANOPY LIGHT PANELITE LED24V 15W
03 CANOPY LIGHT S,ITCH
02 1R2,1R3 ROCKI/ELL 700-HHF62Z24 UL DC24V 25A
01 1R1 DRM270012LT<RELAY>AND RELAY N.C CDNTACTDR
ITEM PART NO. ITEM DESCRIPTION
ORDER CODE:
SCALE: 1:1
QUANTITY WEIGHT:
USED FOR:
USED FOR OPERATION MANUAL
DEPARTMENT: ENGINEERING
DRAWING NO.: SP.F2362001 UL
REVISION NO.: 03
FOUNDATION


2CT1
AUTDMATIK TRANSFER PANDSU
AUTOMATIC TRANSFER SWiTCH
2T1
REFERANCE CABLE
1500W
START PANEL
USED FOR OPERATION MANUAL
DEPARTMENT: ENGINEERING
SP.F2362001 UL
REVISION NO.: 03
FOUNDATION

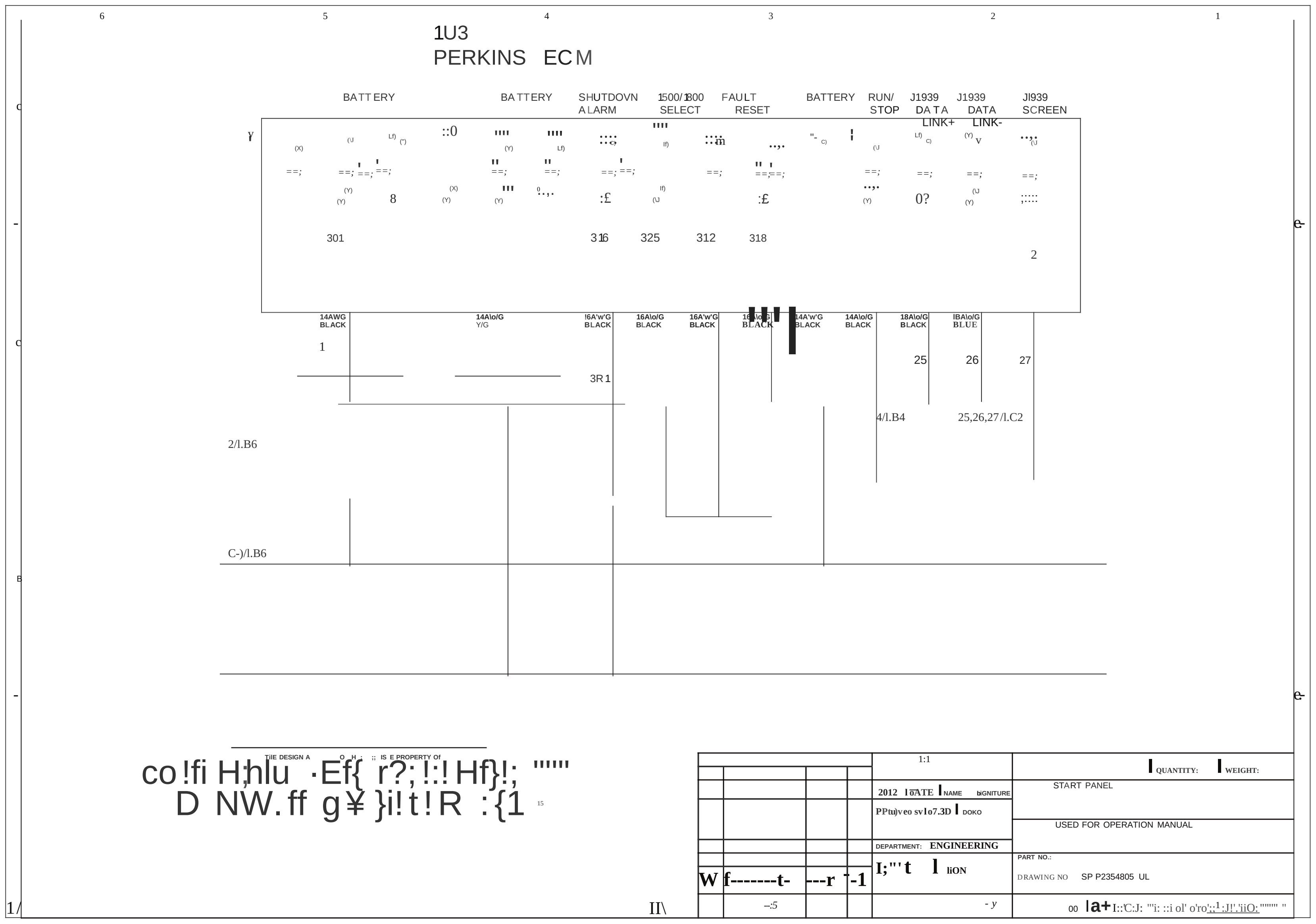


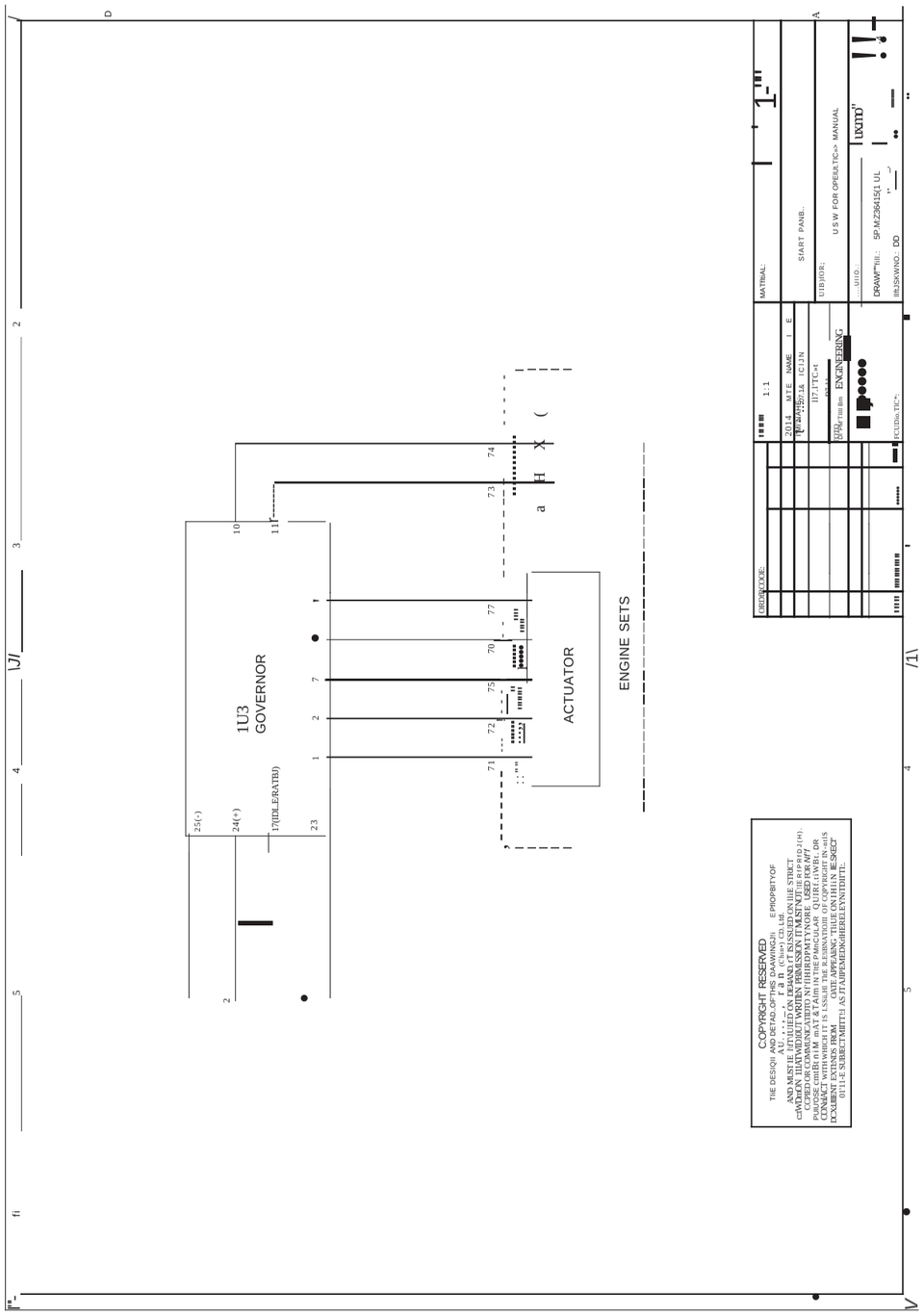


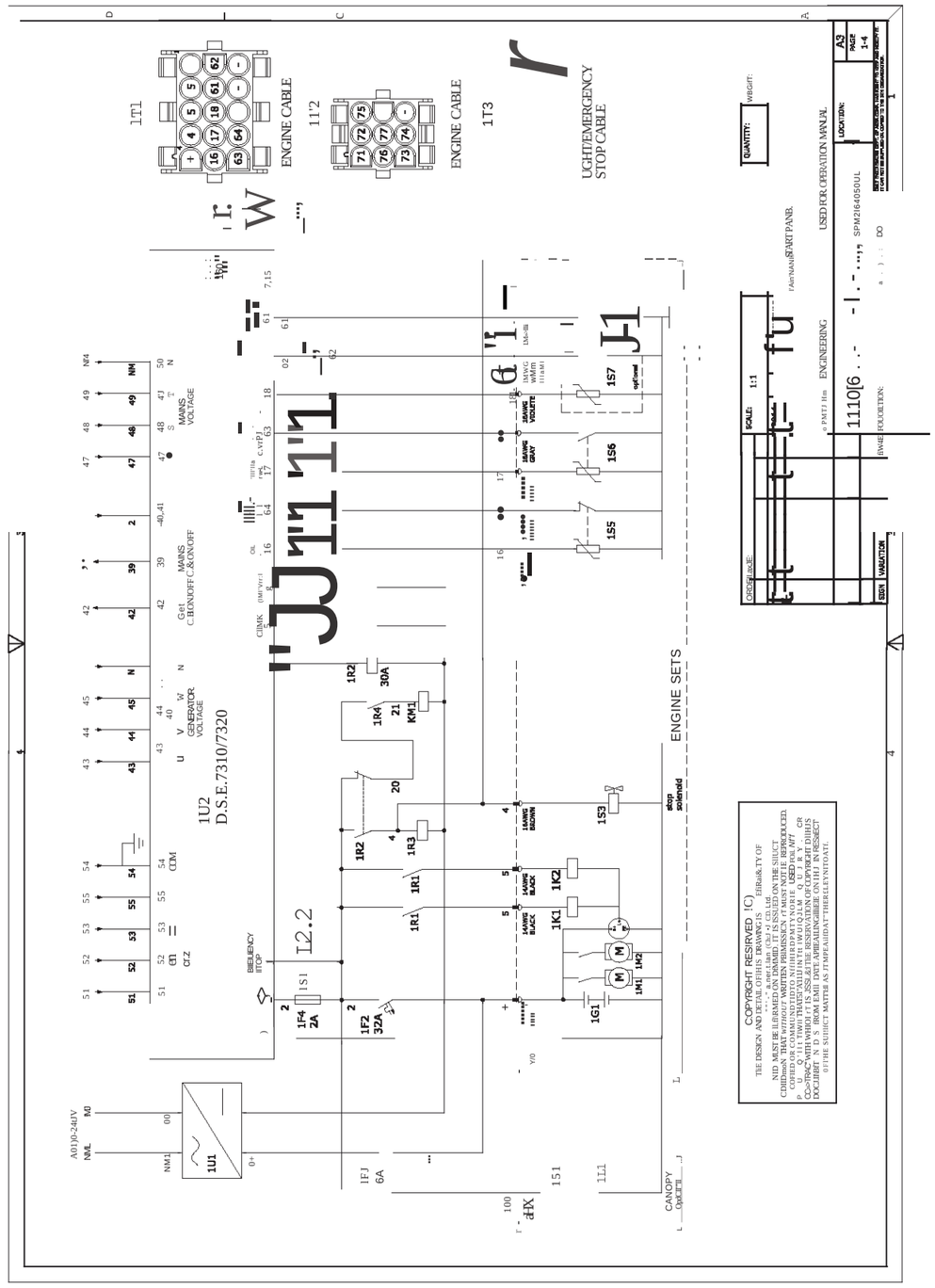
NOTE:
THIS DRAWING BE SUITABLE FOR APD-ULP300-555 GEN-SET,
IT IS FOR REFERENCE ONLY.
DETAIL DRAWING PLEASE REFERTO THE RANDOM ALE.

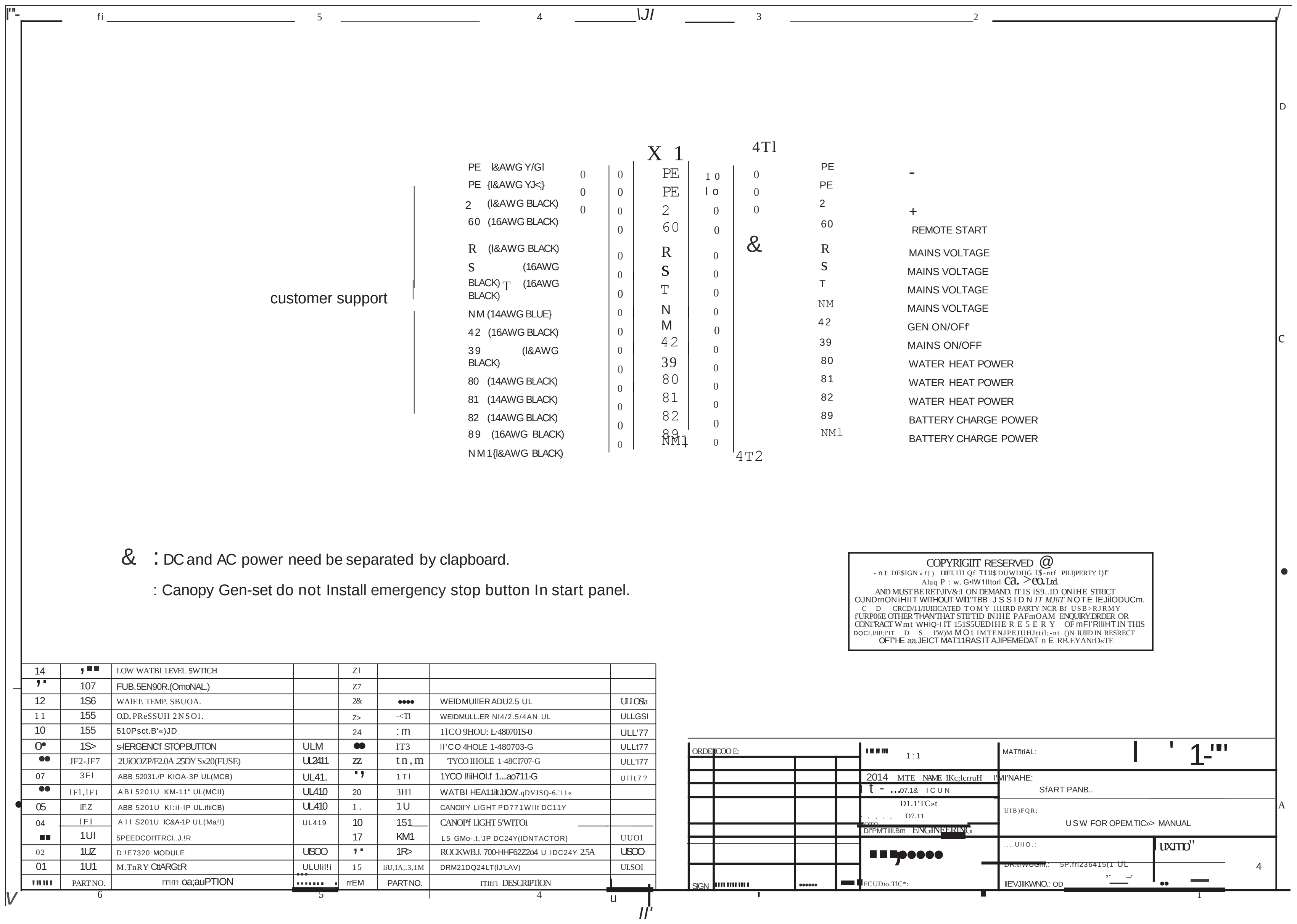


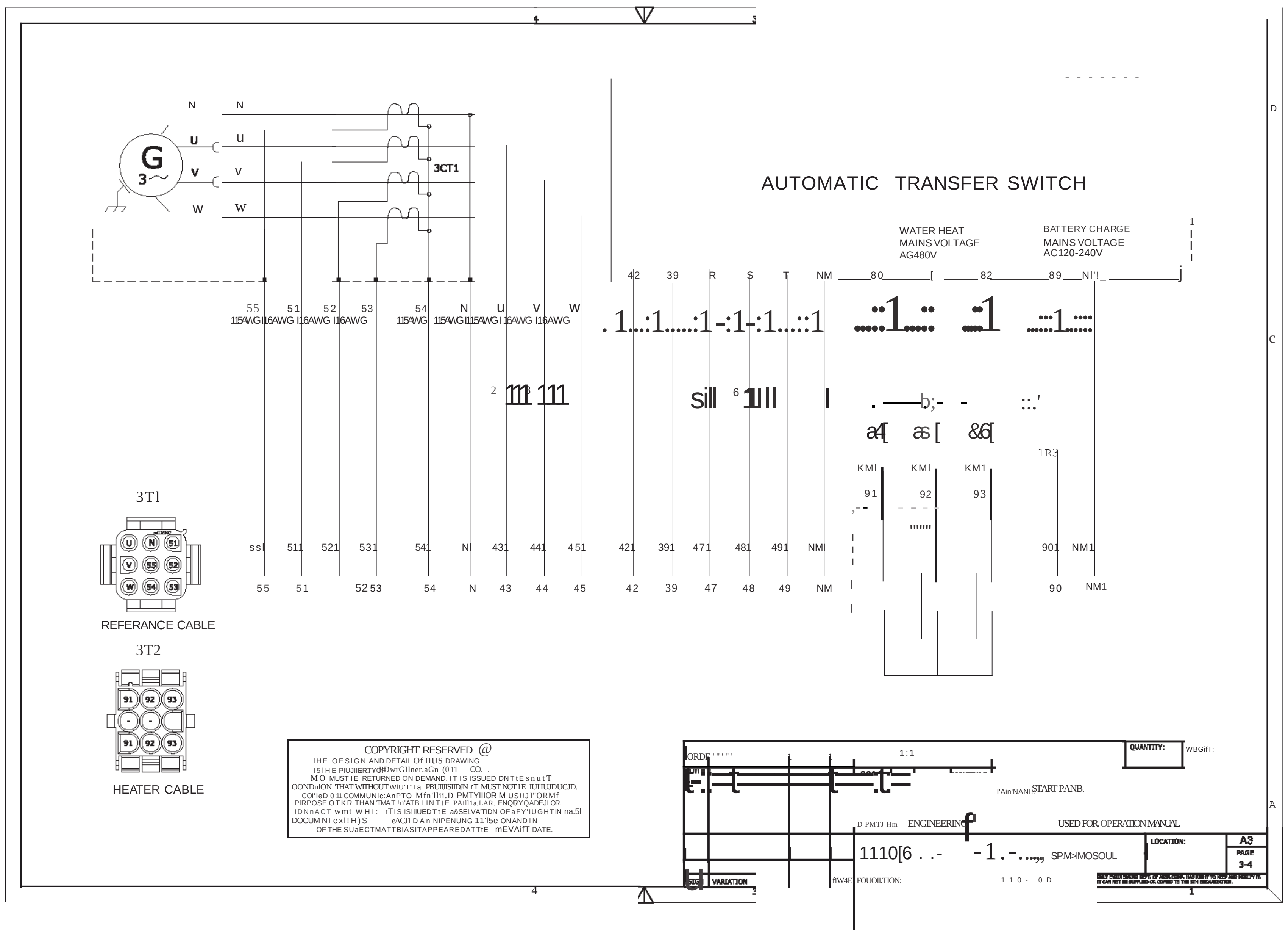
ITEM	PART NO.	ITEM DESCRIPTION	
26	IT2	TYCO 8HOLE 1-480705-0	UL 1977
25	IT!	TYCO 15HOLE 1-480711-0	UL 1977
24	2T2	TYCO 4HOLE 1-480703-0	UL 1977
23	2T1	TYCO 9HOLE 1-480706-0	UL 1977
22	2H1	VATER HEATER UL	
21	2CT1	CURRENT TRANSFORMER UL	
20	4T2	VEIDULLER ADU2.5 UL	UL 1059
19	4T1	VEID ULLER ADU2.5/4AN UL	UL 1059
18	[illegible]	1216002P/F2.0A 250V 5x20(FUSD	UL 248
17	2F8	ABB S201UP K6A-1P UL <HIGH BREAKER MINI CURRENT CIRCUIT)	UL 489
16	2F1	ABB S203UP K6A-3P UL <HIGH BREAKER MINI CURRENT CIRCUIT>	UL 489
15	1F3	ADD S201U K6A-1P UL <HIGH BREAKER MINI CURRENT CIRCUIT>	UL 489
14	1F2	ABB S201U K16A-1P UL <HIGH BREAKER MINI CURRENT CIRCUIT)	UL 489
13	IF!	2163.15P/F3.15A 250V 5*20(FUSD	UL 248
12	1U2	DEEPSEA 7320 MODUEL	UL SOB
11	IUI	BATTERY CHARGE AC230V/DC24V SA	UL 1236
10	III	CANOPY LIGHT PANELITE LED24V ISV	
09	1S7	LOV VATER LEVEL SVITCH	
08	1S6	FEXIBLE SENSOR	
07	ISS	VATER TEMPERATURE SENSOR	
06	1S4	OIL PRESSURE SENSOR	
05	1S2	ABB UL	UL 94
04	ISI	CANOPY LIGHT SVITCH	
03	KMI	LS GMD-9/3P	
02	IR2,1R3,1R6	DRM270024LT <RELAY> AND RELAY N.C CONTACTOR	UL 508
01	!RI	DRM570024LT CRELAYI AND RELAY N.C CONTACTDR	UL SOB

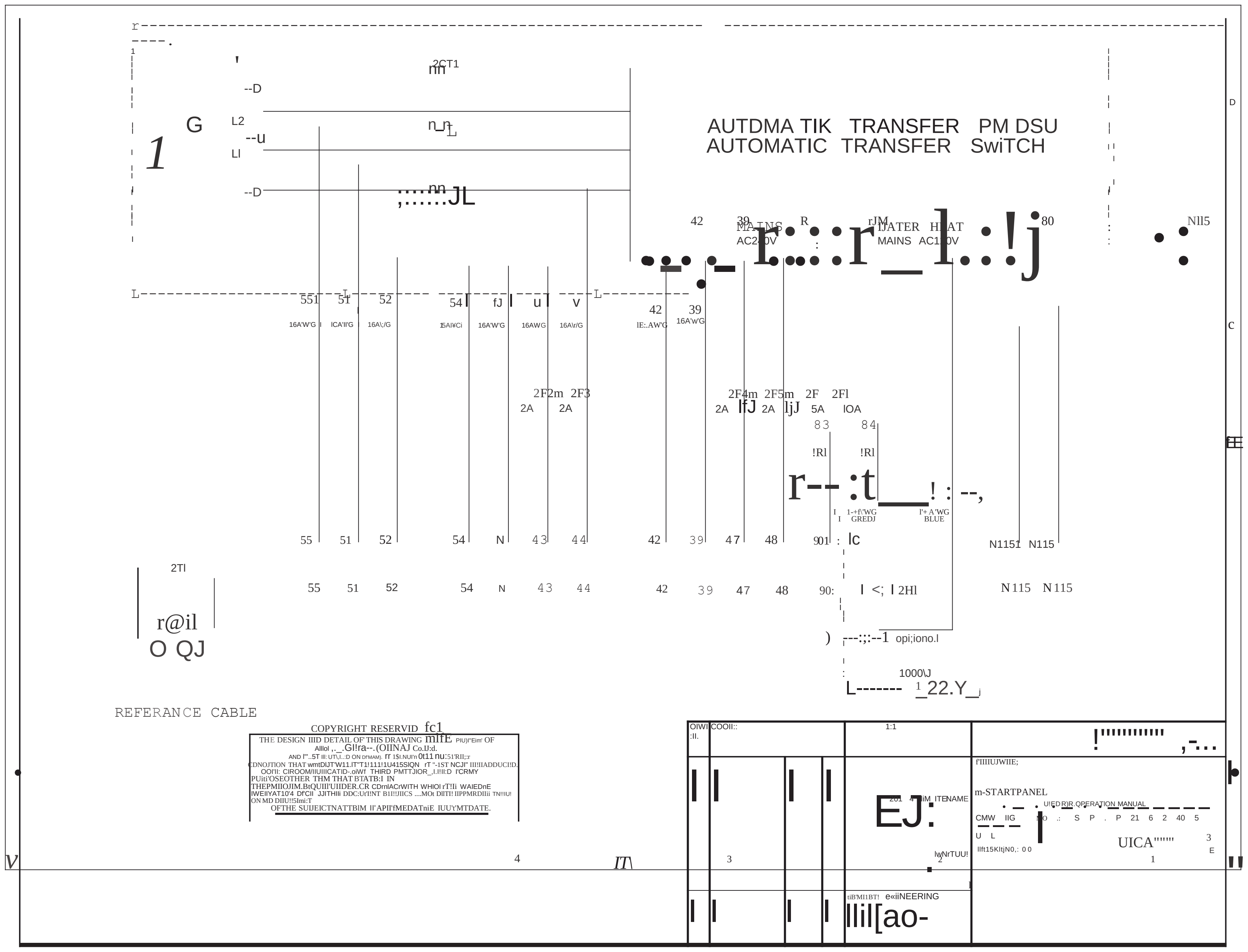


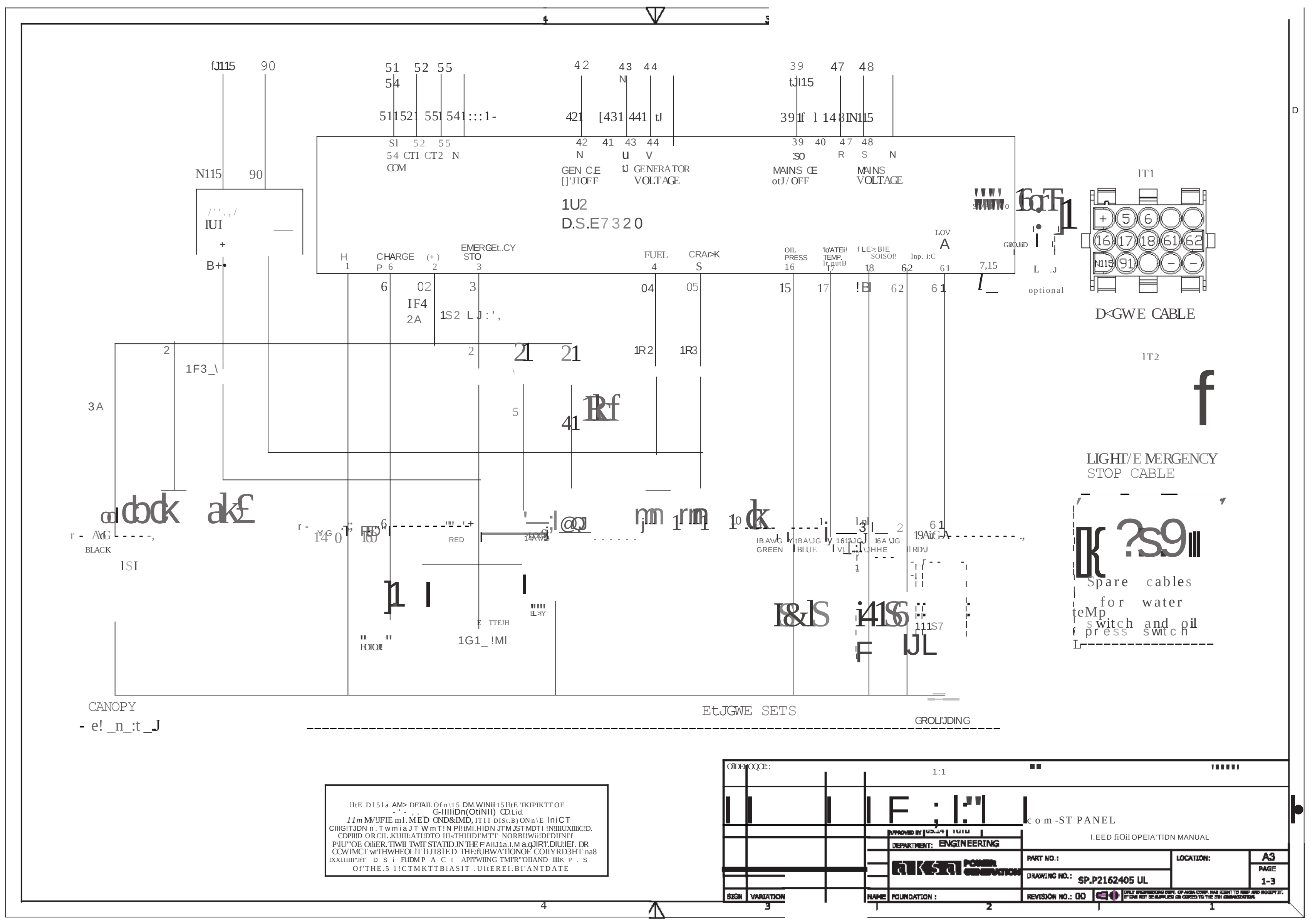

1U3
GOVERNOR
ACTUATOR
ENGINE SETS
COPYRIGHT RESERVED

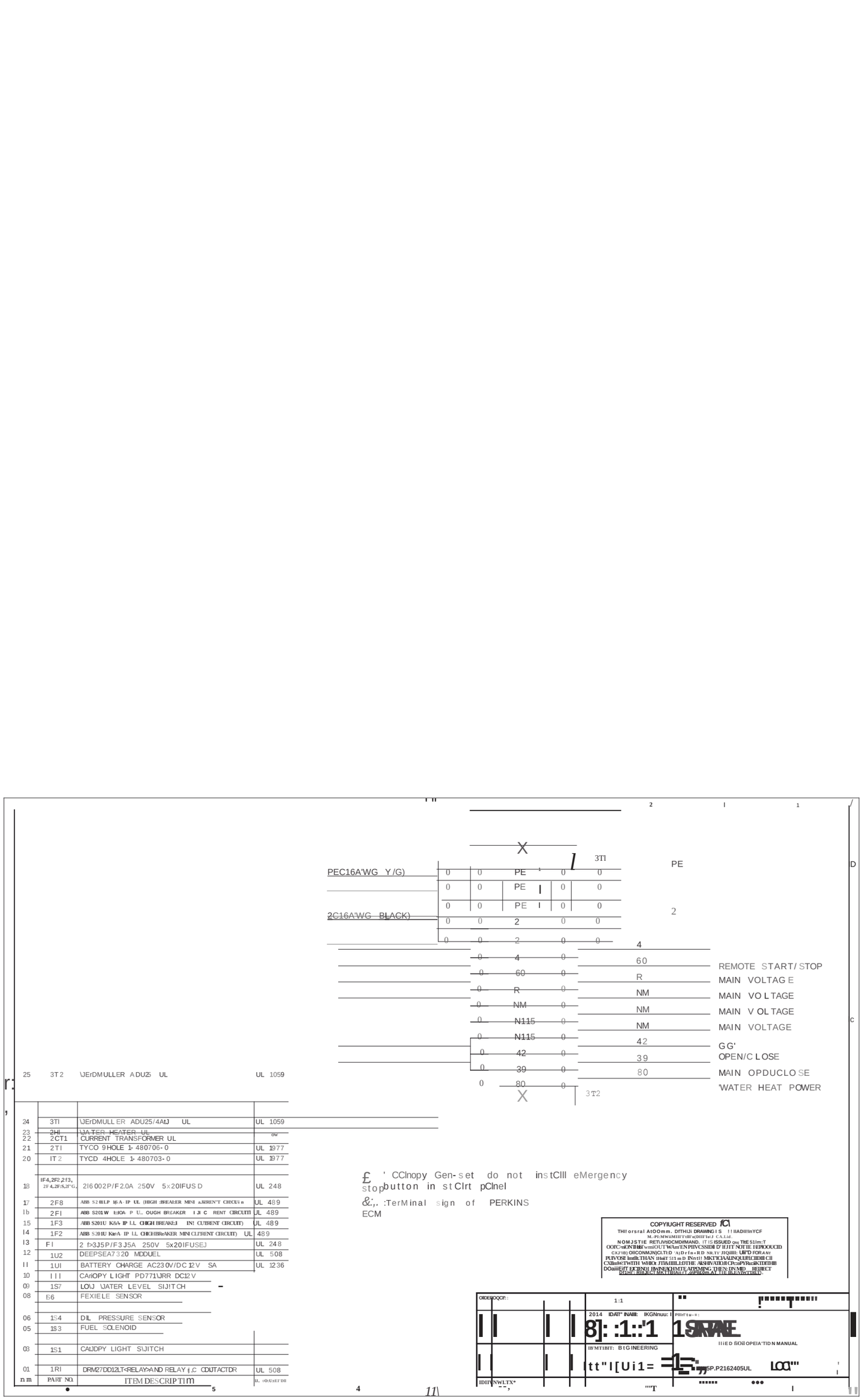

1T1
ENGINE CABLE
1T2
ENGINE CABLE
1T3
UGHT/EMERGENCY
STOP CABLE
1U2
D.S.E.7310/7320
ENGINE SETS
COPYRIGHT RESRVED


customer support
REMOTE START
MAINS VOLTAGE
MAINS VOLTAGE
MAINS VOLTAGE
MAINS VOLTAGE
GEN ON/OFF
MAINS ON/OFF
WATER HEAT POWER
WATER HEAT POWER
WATER HEAT POWER
BATTERY CHARGE POWER
BATTERY CHARGE POWER
: DC and AC power need be separated by clapboard.
: Canopy Gen-set do not Install emergency stop button In start panel.
COPYRIGHT RESERVED
START PANEL
USW FOR OPEM.TIC MANUAL


AUTOMATIC TRANSFER SWITCH
WATER HEAT
MAINS VOLTAGE
AG480V
BATTERY CHARGE
MAINS VOLTAGE
AC120-240V
3T1
REFERANCE CABLE
3T2
HEATER CABLE
COPYRIGHT RESERVED
START PANEL
USED FOR OPERATION MANUAL


AUTOMATIC TRANSFER SWiTCH
REFERANCE CABLE
COPYRIGHT RESERVED
m-STARTPANEL


D.S.E7320
GENERATOR VOLTAGE
MAINS VOLTAGE
CHARGE
FUEL
D<GWE CABLE
LIGHT/E MERGENCY STOP CABLE
Spare cables for water temp. switch and oil press switch
CANOPY
ENGINEERING
SP.P2162405 UL


PEC16A'WG Y/G)
2C16A'WG BLACK)
REMOTE START/STOP
MAIN VOLTAGE
MAIN VOLTAGE
MAIN VOLTAGE
MAIN VOLTAGE
GG'
OPEN/CLOSE
MAIN OPDUCLOSE
'WATER HEAT POWER
£ ' CClnopy Gen-set do not instCIll eMergency stop button in stClrt pClnel
&;,. :TerMinal sign of PERKINS ECM
COPYIUGHT RESERVED fC\
THI! orsral AtOOmm. DITHIJI DRAWING I S
M.-PI:MWitMIIITHB'eDIIT!at.l C.A.Lid.
NOMJSTIE RETLIVtDCMDtMAND. IT IS ISSUED Qng TRE Slim:T
OCITC=tKINTBBE\mmiOUT'WAtmTEN PHVCSSIDI D' IUTT NOTIE. IEPHOOUCID
CXJ'IB) OIICONMJNJCLTtD 'A)Dr I n+R D NR.T1' JIQIIBE. UBD FORAN
PUIVCSI InnlLTHAN IIIaiT 511 m D INnt!! MKICTICIAAIINQUUIECIIDIII CII
CXInwWTWITH WHICK JTIKIIILLIDTHE AKSHVATIOR CIcnPVIncIKTDTDIBB
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IB\MTIBIT: BtGINEERING
2014 IDATI" INAIIE: IKGNnuu: I
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SP.P2162405UL
LOO'"
25 3T2 \UErDMULLER ADU25 UL UL 1059
24 3TI \UErDMULLER ADU25/4AtJ UL UL 1059
23 2HI \JATER HEATER UL
22 2CT1 CURRENT TRANSFORMER UL ow
21 2TI TYCO 9HOLE 1-480706-0 UL 1977
20 IT2 TYCD 4HOLE 1-480703-0 UL 1977
18 IF4,2F2,2I3, 2I6002P/F2.0A 250V 5x20IFUSD UL 248
17 2F8 ABB S201LP MCA-IP UL IHIGH :BREAKER MINI aURRENT CIRCUIt UL 489
lb 2FI ABB S201W E:tOA P U.. OUGH BREAKER I JI C RENT CIRCUITI UL 489
15 1F3 ABB S201U K6A- IP I.L CHIGH BREAKEJ IN! CUIRENT CIRCUIT) UL 489
14 1F2 ABB S201U KaeA IP I.L CHICHBReAKER MINI CUIRENT CIRCUIT) UL 489
13 FI 2 f>3J5P/F3J5A 250V 5x20IFUSEJ UL 248
12 1U2 DEEPSEA7320 MDDUEL UL 508
11 1UI BATTERY CHARGE AC230V/DC12V SA UL 1236
10 III CAnOPY LIGHT PD771\JRR DC12V
09 1S7 LO\J \ATER LEVEL SIJITCH
08 E6 FEXIELE SENSOR
06 1S4 DIL PRESSURE SENSOR
05 1S3 FUEL SOLENOID
03 1S1 CAUDPY LIGHT S\JITCH
01 1RI DRM27DD12LT<RELAY>AND RELAY f.C CDUTACTDR UL 508
nm PART NO. ITEM DESCRIPTIm

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