GTA 09-16-001

TACTICAL ELECTRIC POWER PLANNING & OPERATIONS

Operational Reference Guide

August 2013

Operational Energy is a significant aspect of all Army War Fighting functions

SAFETY WARNING

- High voltage is produced when generator set is in operation. **Never attempt to start the generator set unless it is properly grounded.**
- Ensure all personnel working with/on loads connected to the generator set are aware that main contactor (CB) is about to be closed before closing main contactor (CB). Failure to comply may cause injury or death to personnel.
- Do not ground yourself in standing water. Never attempt to connect or disconnect load cables while the generator set is running. Failure to comply may cause injury or death to personnel.
- High-voltage power is available when the main contactor/circuit breaker (CB) is closed. Avoid accidental contact with live components. Ensure load cables are properly connected and the load cable door is shut before closing main contactor (CB). Failure to comply may cause injury or death to personnel.
- Generator set operators are permitted to make connections to the output terminal board only. Internal distribution point connections (reconnection board) or to equipment beyond the output terminal board shall only be made by authorized maintenance personnel. Failure to comply may cause injury or death to personnel.

SAFETY CAUTION

- Operators must ensure each set has the same output capacity, same voltage connections and frequency when paralleling generator sets. Failure to comply will damage the equipment.
- Ensure the load requirement is equal to or less than the combined rated capacity of two or more generator sets. Failure to comply will damage the equipment.
- Ensure 50/60Hz generator sets are both set to the same frequency given the load requirements – 50 or 60Hz – (Based on load requirement). Failure to match the frequency will damage the mission load and/or paralleled generator set.
- Ensure load distribution selections allow for single phase balancing between all 3 phases of generator output. Failure to comply will cause generator component damages.

RESCUE VICTIM OF ELECTRICAL SHOCK

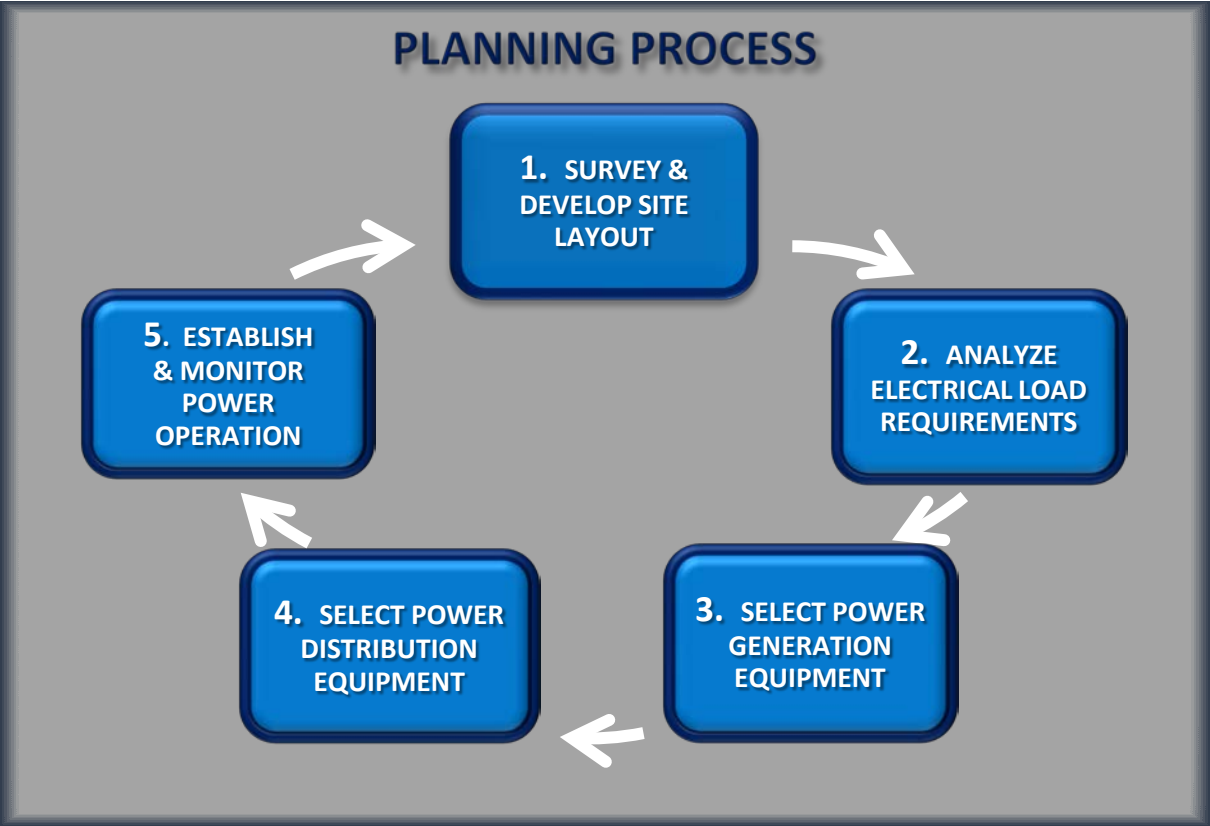
1. Do not try to pull or grab the individual. You also may become a victim of electrical shock.

2. Turn off the electrical power source, if possible.

3. If not, then attempt to pull, push, or lift the person to safety using a dry wooden pole, dry rope, or some other insulated material.

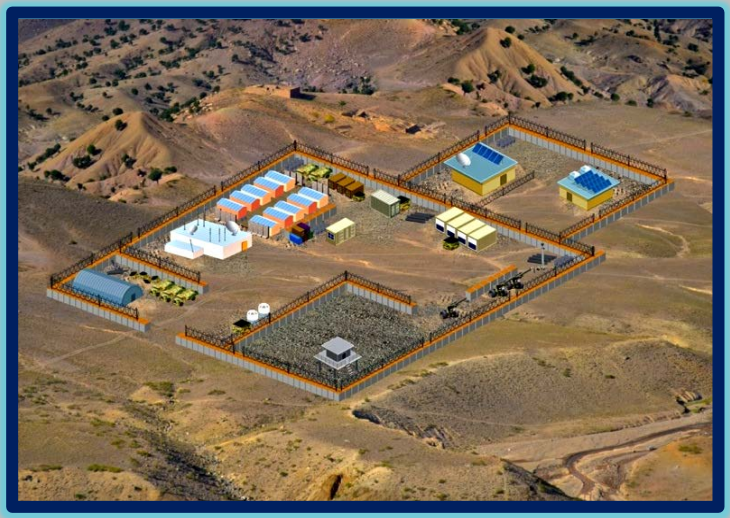
4. After victim is free of contact with the source of electricity, move victim a safe distance away and send for help (Preferably EMS).

5. Immediately start CPR if necessary.


PLANNING PROCESS
1. SURVEY & DEVELOP SITE LAYOUT
2. ANALYZE ELECTRICAL LOAD REQUIREMENTS
3. SELECT POWER GENERATION EQUIPMENT
4. SELECT POWER DISTRIBUTION EQUIPMENT
5. ESTABLISH & MONITOR POWER OPERATION

1 SURVEY & DEVELOP SITE LAYOUT

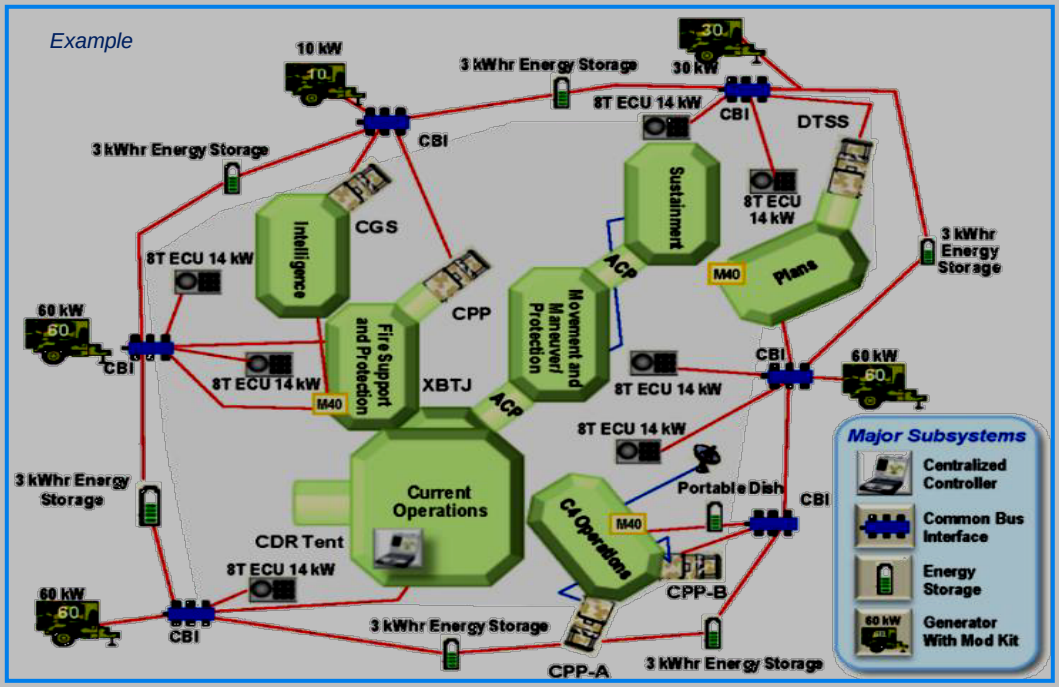
- Consider distance from loads to power source
- Vehicle traffic across cable runs and terrain water drainage



- Generator grounding & leveling requirements
- Affect of heat, exhaust discharge from generators on the site structures and equipment.
- Access to fuel storage & refueling operations, work and sleep areas

(AUTODISE is available tool)

AUTODISE Layout



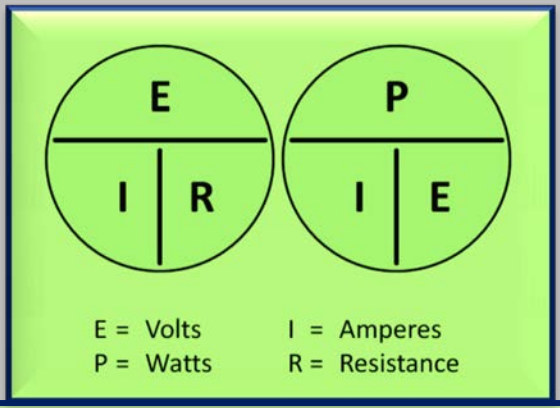
2 ANALYZE ELECTRICAL LOAD REQUIREMENTS

- Collect and analyze load data from all electrical operated devices
- Calculate total 1-phase loads using Ohms Law (P = I x E) or (E = I x R)
  3-phase loads (P = E x I x 1.732 x 0.8) or (I = P/E x 1.732 x 0.8)
- Balance all 1-phase loads within 10% of each other for phase L1 – L2 – L3 by making connections within PDISE system (3-phase loads are balanced)
- Use AUTODISE program if available (see references)

Example

KW Loads	L1 (phase 1)	L2 (phase 2)	L3 (phase 3)
ECU-1	11.0	11.0	11.0
Power Supplies	3.5	3.0	2.6
Work Stations	4.5	4.5	5.2
Lighting	1.2	1.5	1.6
Totals	20.2	20.0	20.4

Ohm's Law



1 - Phase

E = I x R	=	unit of measure - electrical pressure
I = E / R	=	unit of measure - rate of electrical current flow
R = E / I	=	unit of measure - conductor to resist current flow
P = E x I	=	unit of measure - work done per unit of time

3 - Phase

P = E x I x 1.732 x 0.8	=	work done per unit of time
I = P / (E x 1.732 x 0.8)	=	rate of electrical current flow per phase

ANALYZE ELECTRICAL LOAD REQUIREMENTS

Single Phase Inductive Loads

$$P = \frac{E \; x \; I \; x \; 0.8}{1000}$$

Three Phase Loads

$$P = \frac{1.732 \; x \; E \; x \; I \; x \; 0.8}{1000}$$

$$I = \frac{kW \; x \; 1000}{1.732 \; x \; E \; x \; 0.8}$$

P = Power in kilowatts (kW)

E = Volts (V)

I = Current in Amperes (A)

0.8 = Power Factor used for 3-phase & inductive loads (Motors)

1.732 = Constant for 3-phase calculations

3 SELECT POWER GENERATION EQUIPMENT

Select generator sizes and quantity required to build a Tactical Electric Grid or necessary spot power

Example: Maximum Power Demand is 28kW, select a 30kW or two 15kW's ….. NOT a 60kW

Hybrid Power System

15kW TQG

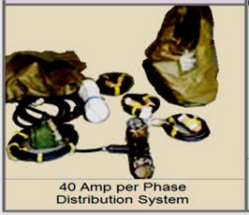
AMMPS (5kW – 60kW)

4 SELECT POWER DISTRIBUTION EQUIPMENT

- Select proper PDISE components based on site survey, load analysis and number of generator systems required
- Procure additional items through normal requisition


M60 Distribution Center


60 Amp Cable


40 Amp per Phase Distribution System

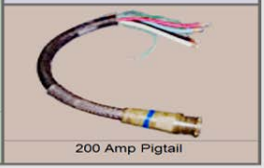

M40 Distribution Center


Service/Feeder Cable


PDISE


M100/M200 Electrical Feeder System


200 Amp Cable

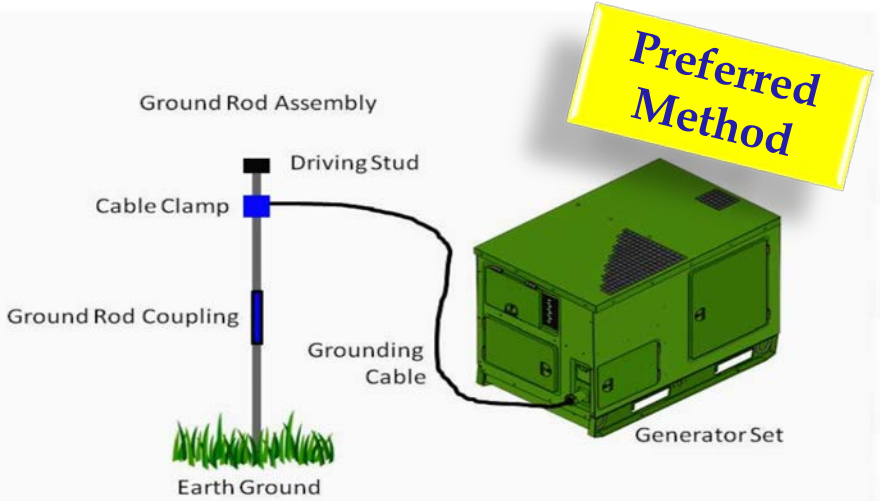

200 Amp Pigtail

PDISE Components	NSN	Part Number
PDISE M200 Feeder System	6150-01-308-5672	13229E6350
M200A/P Feeder Box		13229E6300
Cable Assembly, GRP S/F, 200 AMP/PHASE	6150-01-247-4768	97403-13226E7021
Cable Assembly, GRP PC, 200 AMP/PHASE	6150-01-247-4782	97403-13226E7025
PDISE M100 Feeder System	6150-01-308-5671	13229E6351
M100A/P Feeder Box		13229E6325
Cable Assembly, GRP S/F, 100 AMP/PHASE 50’	6150-01-256-6304	97403-13226E7024
Cable Assembly, GRP PC, 100 AMP/PHASE PIGTAIL	6150-01-256-6300	97403-13226E7020
PDISE M60 Distribution System	6150-01-307-9445	13229E6352
M60A/P Feeder Box		13229E6335
Cable Assembly, GRP S/F, 60 AMP	6150-01-247-4778	97403-13226E7018
Cable Assembly, GRP S/F, 60 AMP	6150-01-247-4793	97403-13226E7022-1
M46 Utility Assembly	6150-01-208-9751	13226E7046
20 AMP Cable Assembly	6150-01-247-4766	13226E7032-3RE
12 Outlet, 20 AMP, 3 TAPS, Branch Circuit Assembly	6150-01-251-9124	13226E7034RB
2 Duplex, Receptacle Group Enclosure Box Assembly	6150-01-251-9125	13226E7040RF
Utility Light, 25 Foot		13230E7018R
PDISE M40 Distribution System	6150-01-307-9446	13229E6353
PDISE M40 A/P Feeder Box		13229E6345
Cable Assembly, GRP S/F, 40 AMP/PHASE	6150-01-256-6301	97403-13226E7019
Cable Assembly, GRP S/F, 40 AMP PHASE	6150-01-247-4781	97403-13226E7023-2

5 ESTABLISH & MONITOR POWER OPERATION

- Connect & install PDISE components. Start from each electrical load, making connections back toward generator sets
- Emplace generator set(s) with *PROPER GROUNDING* (See examples and optional methods)
- Connect distribution cable (pigtail) to generator load terminals IAW Technical Manual (See example of standard cable connections)
- Complete PMCS and start Generator Set(s) or Power Plant (Follow parallel operation instructions IAW TM if applicable)
- Close Generator main output breaker (AC Interrupter)
- Close PDISE distribution panel breakers, working back to M40 panels
- Power up electrical loads or devices as required (This allows for gradual load increase on Generator Sets)
- Monitor operation of Power System - make adjustments when load demand changes

Standard Grounding



Properly grounding a generator set according to the technical manual is an essential safety task that can prevent electrical accidents. Soldiers must ground any set before operating it. These procedures are common to all Army Tactical Electric Power systems.

Grounding

The purpose of grounding is to ensure **SAFETY.**

Proper grounding enables circuit protective devices to function correctly when a short circuit or ground fault occurs. This protects equipment from damage and personnel from electrical shock hazard.

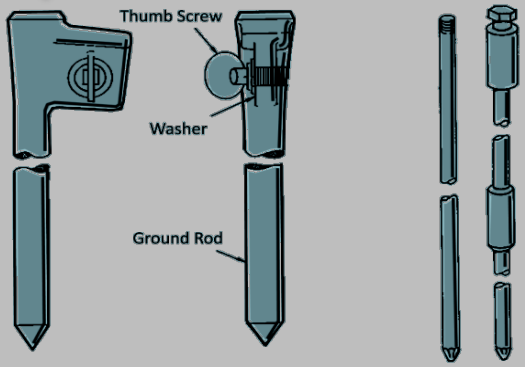
Various types of electrode configurations are used to establish a proper earth ground. The most commonly used electrode is the ground rod, which is available in various configurations. Under certain conditions, a good Earth Ground can be achieved by connecting to existing objects such as a buried metal pipe or the steel frame of a building.

Where poor soil conditions exist, other methods and combinations of methods are required.

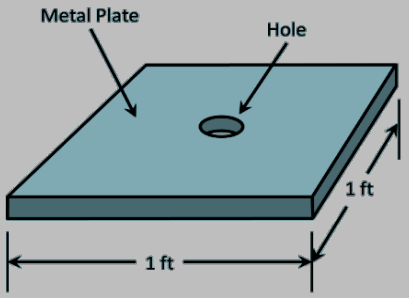
Commonly Used Options

Grounding Options

1) Ground Rods - Two are available in the Army inventory: an 8-foot ground rod, NSN 5975-00-296-5324 and NSN 5975-00-878-3791, or the 6-foot ground rod, NSN 5975-00-224-5260. The 6-ft rod is a single section, whereas the 8-foot rod is a three-section rod assembly. Both types can be installed using a sledgehammer, or for the sectional rod, a slide hammer (NSN 5120-01-013-1676).

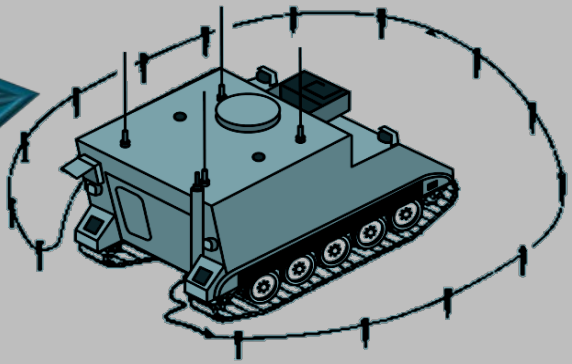


2) Grounding Plates - Though more difficult to install, plates Can achieve very low earth resistance values. The plates must have at least 2 square feet of surface contact with ground (1 ft x 1 ft plate). Plates should be a minimum of ¼ inch thick if iron or steel (1/16 inch thick if nonferrous - galvanized preferred) Do not use aluminum because it quickly oxidizes and greatly increases resistance to earth contact.



Grounding Options

3) Surface Wire Grounding Kit (SWGK) – The SWGK was designed primarily for systems requiring high mobility/quick installation and teardown operation. It consists of 15 ten inch stakes installed in a circular pattern and interconnected with a 3/16-inch steel cable. The SWGK is available in the Army inventory under the official nomenclature of Grounding Kit, MK-2551 A/U, NSN: 5820-01-263-1760



References: Field Manual 5-424, "Theater of Operations Electrical Systems" or CECOM Technical Report 98-6, for additional options and important details on grounding in poor soil conditions or difficult terrain.

Generator Load Terminals

(Standard connection - AMMPS)

Power Plants

In parallel

Ensure AMMPS skid sets are the same capacity, voltage & frequency: two 10kW 60Hz sets connected for a 208V, 3-phase output.

AMMPS and TQG power plant sets are matched already.

Parallel Operation

General procedures only - always follow instructions in the Technical Manual

1. Place generator sets side by side - designated as Unit A (Base), Unit B (Incoming), and connect paralleling cable from Unit A to Unit B.
2. Connect load cables to switchbox output load terminals and Unit B output to distribution system - PDISE highly preferred.
3. Start Unit A - adjust frequency and voltage.
4. Close AC Circuit Interrupter switch on Unit A - it's now powering the load.
5. Set switchbox ON/OFF switch to the ON position. (Switch is in the down position)
6. Start Unit B, adjust frequency and voltage to match Unit A.
7. Place switchbox TRANSFER switch in the up position.
8. Adjust Unit B frequency until synchronizing lamps change from bright to dark TOGETHER once every few seconds. (If lamps turn on/off at same time, sets are synchronized. If not, see phase rotation procedure and repeat the above steps).
9. When the lamps are dark for 3 to 5 seconds, CLOSE Unit B's AC Circuit Interrupter.
10. The power plant can now share the load equally between both generators.

Phase Rotation Procedure

- The magnetic fields of both generators must agree before they can be coupled together to operate in parallel operation.
- If the synchronizing lights blink on and off separately, phase rotation is out of phase and the two generators will not parallel. To correct this issue, shut down both generators and change any two of the phase leads (L1-L2-L3) of either generator set load terminals.
- Once accomplished, the parallel procedure should become permissive for any two 15kW - 200kW generators. Close the (*Main AC Circuit switch*) of the incoming generator and follow the steps for paralleling, the lights should blink on and off at the same time.

References

Additional Training:

- **Power Generator Operator Course:** Provides sustainment training to personnel operating tactical power generation and distribution equipment. Focus on Safety, HAZMAT Awareness training, PMCS, operational procedures, troubleshooting techniques including distribution equipment installation. This Operator training and licensing program is available and instructed by the 91D20/30 Soldiers at unit level.

- **PDISE -** Power Distribution Illumination Systems, Electrical Operator Course - Computer Based Training (Available through AKO)

  https://lwn.army.mil/training/-/wiki/main/mobile+electric+power

- **AUTODISE -** version 6.1.3 (Windows XP only) or online at US Army RDECOM - CERDIC, Ft Belvoir, VA ***www.autodise.net***

References

Field Manual 5-424, Theater of Operations Electrical Systems, 25 June 1997.

MIL-STD-633G, Department of Defense Interface Standard - Standard Family of Mobile Electric Power Generating Sources, 30 May 2013.

DoD Military Handbook-633A, DoD Standard Family of Mobile Electric Power Generating Sources, 26 January 2010.

Technical Manual 9-6150-226-13, Operator and Field Maintenance Manual for Distribution Illumination Systems, Electrical (DISE) and Power Distribution Illumination Systems, Electrical (PDISE), 1 November 2008.

Technical Manuals (10 Level - Operator's Manuals) for all Mobile Electric Power Generating Sources (MEPGS) from 2kW to 100kW.

On-Site Power Generation: A Reference Book (4th Ed.), Electrical Generating Systems Association, 2002.

NFPA 70-National Electric Code (NEC) National Fire Protection Association (NFPA).

NOTES

NOTES

NOTES

NOTES

GTA 09-16-001

Distribution Restriction:
Approved for public release, distribution is unlimited.

Contact your local Training Support Center for copies of this GTA.

Department of the Army
Sustainment Center of Excellence
Fort Lee, Virginia