POLARIS LOAD BANK
TECHNICAL MANUAL

Customer: XXX

Work Order: XXXXX-XX-XX

Model: Polaris XXX

June 2011

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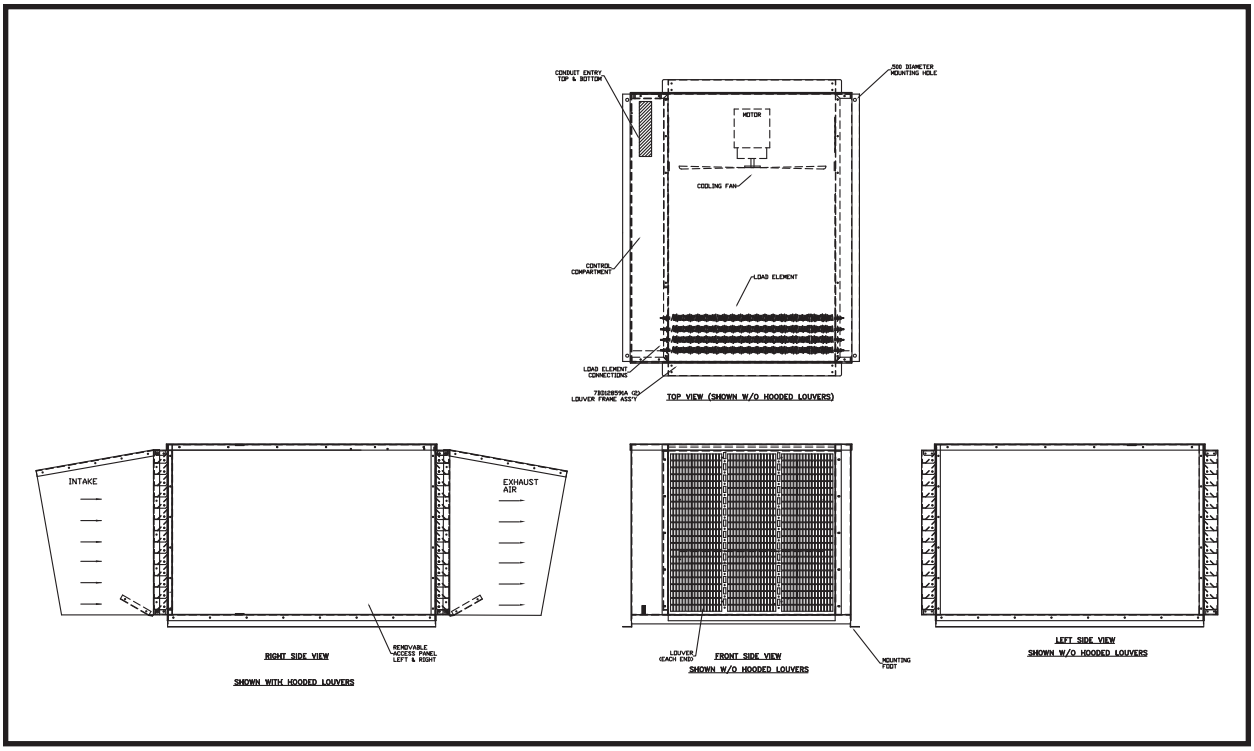
Contents



Part of Typical Pictorial Drawing

DESCRIPTION

Simplex Load Banks are precision test instruments specifically designed to apply discrete, selectable electrical load to a power source while measuring the response of the generator to the applied load. They also provide a means for routine maintenance exercise to assure long term reliability and readiness of the standby generator. Exercise Load Banks eliminate the detrimental effects of unloaded operation of diesel engine generators.

The cabinet on this Load Bank is rated Type 3R outdoor weatherproof .

Power source testing is accomplished by applying resistive load steps at unity (1.0) power factor. *See the Load Bank Specifications Sheet in the front of this manual for the rating of your Load Bank.*

The illustrations in this manual are examples only and may differ from your Load Bank.

Load application is by magnetic contactor. All load branch circuits are protected by 200,000AIC class-T fuses.

Load Bank control is via a local and/or remote control panel. The Control System is composed of 120V discrete components. Common serviceable components include Control Fuses (CF Series) and Power Fuses (F Series). Dry contacts are provided for connection to customer supplied Load Bank operating status indicators.

Load application is by magnetic contactor. All load branch circuits are protected by 200,000AIC class-T fuses.

Operating controls are protected by a hinged door. The Control Panel contains the following components:

1. Cooling Failure and Normal Operation indicator lamps
2. Mode Selector switch
3. Master and load switches

The “Normal Operation” is indicated when Control Power is available and the Cooling System is operating properly.

This Load Bank is protected against cooling failures (loss of cooling air flow, high intake or exhaust air temperature which could damage the Load Bank or present a safety hazard to the operator). When a cooling failure occurs the automatic safety features in the Control System immediately remove the load from the load source. The malfunction must be corrected and the Control System must be reset by turning the Load Bank “Off” then “On” before the load can be re-applied.

The Load Bank consists of three principal systems:

1. Control System
2. Cooling System
3. Load System

CONTROL SYSTEM

The Control System allows the operator to apply a load to the test source. This system also contains the circuitry utilized to disconnect the Load Bank from the test source in the event of cooling failures. The Control System is composed of a Programmable Logic Controller (PLC) and 120V discrete components. Fan Power and Control Power is supplied internally via the load source. The Fan Motor Contactor (FMC) energizes via a signal from PLC Output YO. Fan power is applied to the Fan Motor (MOT) through the Manual Motor Starter (MS1) and the load source.

COOLING SYSTEM

The load elements are cooled by a forced air system consisting of a fan blade directly driven by a TEFC motor creating a specified CFM. The fan motor is energized by a contactor.

LOAD SYSTEM

The Load System consists of independently controlled resistive and/or reactive load elements specifically designed for Load Bank systems. They are protected by 200KAIC, 600VAC fuses.

Simplex Resistive Load Elements conservatively operate at approximately half the maximum temperature rating of the alloy (1080°F vs. 1920°F). For example:

Alloy: FeCrAl

Ratings: 3333W@120V
4170W@139V

Connections: 120V wye (208V),
139V wye (240V, 3ø),
277V wye (480V, 3ø),
240 delta (240V, 3ø), or
480 delta (480V, 3ø).

See Parts Legend Drawing for specific elements used.

These elements are rigidly supported by high-temperature, ceramic-clad, stainless-steel supports. Element-to-element short circuits are virtually eliminated.

PRIMARY INSPECTION

Preventative visual inspections of the shipping crate and Load Bank is advised. Physical or electrical problems due to handling and vibration may occur. Never apply power to a Load Bank before performing this procedure. The following Nine Point / 30 Minute Inspection is recommended before installation, as part of the 50 hour / 6 month maintenance schedule and whenever the Load Bank is relocated:

1. If crate shows any signs of damage examine the Load Bank in the corresponding areas for signs of initial problems.
2. Check the entire outside of the cabinet for any visual damage which could cause internal electrical or mechanical problems due to reduced clearance.
3. Inspect all hinged panels and doors for smooth and safe operation, try all latches and knobs.
4. Rotate and push all switches through all positions to ensure smooth operation.
5. Check cooling system by inspecting fan motor and blade. Check fan blades for stress fractures. Slowly rotate blade by hand and note clearance of blade tip through its rotation near the housing. Observe free rotation of motor shaft.
6. Inspect all relays, timers, and control modules by opening all accessible panels. Make sure all components are secure in their bases and safety bails are in place. Spot check electrical connections for tightness. If any loose connections are found inspect and tighten all remaining connections.

If any problems are observed during Primary Inspection call the Simplex Service Manager at 217-483-1600 (24hrs.)

7. Examine all accessible internal electrical components such as fuses, contactors and transformers. Check lugged wires at these components.
8. Inspect bottom of crate/enclosure for any components that may have jarred loose during shipment such as indicator light lenses, switch knobs, etc.
9. Visually inspect element chamber for foreign objects, broken ceramic insulators, mechanical damage.

INSTALLATION

LOCATION

Type 3R Load Banks are intended for outdoor installation. The load elements in this Load Bank are cooled by a forced air system which discharges through the side of the cabinet. This Load Bank will produce a large quantity of exhaust air. Location of the Load Bank is of prime importance and should be done by trained personnel. It is one of the most critical factors involved in safe operation. The Load Bank must be positioned and installed according to large airflow requirements.

- There must be a minimum clearance of 25 feet on the discharge side and 6 feet on all other sides for horizontal airflow Load Banks.
- Load Banks installed indoors must be equipped with an exhaust air duct of minimum back pressure (supplied by others) which routes all Load Bank hot exhaust air outdoors.

- Never install any structure or object at any height above the Load Bank.
- Always locate the Load Bank in a secure area accessible by trained personnel only.
- Never point the exhaust at a nearby surface or object which may be adversely affected by high temperature.
- Never operate the Load Bank in a confined space without regard for adequate intake of air and provision for exit of high temperature exhaust.
- Consider that the Load Bank and a nearby generator set may have to compete for cooling air.
- Never bounce hot exhaust air off nearby objects and allow it to recirculate through the cooling system.
- Never operate the Load Bank in proximity to a sprinkler system.

Failure to properly install this Load Bank may result in substantial damage to or the destruction of the Load Bank, adjacent equipment and the building in which the Load Bank is installed.

⚠ WARNING ⚠

Always remove all power from the load bus and all fan/control power before servicing the Load Bank. Never operate or service a Load Bank that is not properly connected to an earthground.

PROCEDURE

1. Confirm the test source is properly grounded and ground the Load Bank to its own independent ground.
2. *If applicable, see Remote Pictorial Drawing.* Using the slots and holes provided mount the remote panel and connect it to its own independent ground.
3. Place all switches on the Control Panel in the “Off” position.
4. *See Control Section Drawing and Load Section Drawing:*
   a. If applicable, connect the Remote Contacts on the Load Bank to the corresponding contacts in the remote box as shown.
   b. Place the Current Transformer (CT1) and connect it to TB‘CT’ 1–2 as shown.
      Consult NEC for proper wire size.
   c. If Load Dump feature is desired, remove the factory installed jumper at TB‘LD’ 1–2, and connect customer supplied Load Dump contacts to TB‘LD’ 1–2.
      Close contacts to energize Load Bank.
      Open contacts to dump load.
   d. Connect the customer supplied dry contacts for Load Bank Status indicators to TB‘CF’ 1–3.
      Continuity between TB‘CF’ 1-2 indicates Normal Operation.
      Continuity between TB‘CF’ 1-3 indicates Over Temperature.
   e. Cable the load source to the Main Load Bus (MLB) on the Load Bank as shown.
      The øA cable must pass through the Current Transformer (CT1) as shown for proper operation.
      Consult NEC for proper wire size.

OPERATION

1. Start-up generator or bring other test source on line.
2. Adjust power source voltage and frequency.
3. Place the “Mode Selector” switch in the “Manual” or “Auto” position.

MANUAL

4. Verify illumination of the “Normal Operation” lamp before proceeding.
5. Visually observe correct fan operation and investigate any unusual fan related noises.
6. Check air intake for obstructions and confirm positive air flow.
7. Place the desired load switches in the “On” position.
8. Place the “Master” switch in the “On” position.

   This simultaneously applies all of the load steps which are in the “On” position.

   Trim is achieved by flipping the load steps “On” and “Off” while the “Master” switch is in the “On” position.
9. Adjust source voltage and load. Monitor as needed.

AUTOMATIC

In Automatic Mode, the Programmable Logic Controller (PLC) in conjunction with (2) CSRs, automatically apply load as needed. These devices are factory set to maintain a minimum net load on the generator equal to approximately 60% of the generator’s full load capability. Time delays between applying load steps are adjustable; *see Control Section Drawing*.

PLC and CSR Example

60kW Load Bank with 5kW Step Resolution Serving a 100kW Generator:

In this example, the (2) CSRs will be set so that CSR1 drops out (opens it’s contacts) when *total* (including the Load Bank load) generator load increases above 50kW. CSR2 will be set to pick up (close it’s contacts) when *total* generator load increases above 70kW. This establishes a “window” between 50kW and 70kW, inside of which the PLC takes no action to change Load Bank Load.

When total generator load is below 50kW, the PLC receives a signal from CSR1 to increase Load Bank load. The Load Bank will increase load in 5kW step increments, following time delays set according to Load Bank Control prints, until total load is greater than 50kW. Note that if there is no normal load on the generator, the entire 60kW of Load Bank load may be applied due to the setpoints being calculated for a 0.8 power factor.

When total generator load is above 70kW, the PLC receives a signal from CSR2 to decrease Load Bank load. In the same fashion as above, the Load Bank will remove it’s load until total generator load is below 70kW, or all Load Bank load is removed.

Adjusting the CSR

On the top of each Current Sensing Relay (CSR) dust cover there is a black adjustment knob (3/4 turn potentiometer) with an arbitrary 0.5-1.0 scale. Turn the knob clockwise for a higher current pick-up point and counterclockwise for a lower current pick-up point.

LOAD DUMP

This Load Bank contains a Load Dump feature which de-energizes all applied load when customer supplied contacts open. Normally closed to run, they are rated at 2A @ 24VDC and should be wired to TB'LD' 1–2. When these contacts open all applied load will be de-energized and the load section will be disabled. If desired, the customer may install automatic transfer switch contacts, a manual pushbutton or circuit breaker for this use. If this feature is used the factory installed jumper at TB'LD' 1–2 must be removed and a customer supplied device must be connected to TB'LD' 1–2.

SHUTDOWN

1. De-energize the load.
2. Run the cooling fan for 5 minutes to assure a thorough cool down of all load elements (optional).
3. Place the "Control Power" switch in the "Off" position.

COOLING FAILURE

If a "Cooling Failure" occurs the corresponding lamp will illuminate and the load will be de-energized. Before reapplying a load, the failure must be corrected and the system must be reset by turning the Load Bank "Off" then "On".

This is a permissive/energize-to-run circuit in which all safety sensors must energize their control relays on normal operation before load can be applied. This system includes the following components:

1. Exhaust Temperature Switch (EXTS)
2. Pressure Switch (PS)
3. Cooling Failure Relay (CFR)

MAINTENANCE

The Load Bank has been designed to require minimum maintenance. All components have been chosen for a long, reliable life. Two basic intervals of maintenance are required: each operation and every 50 hours or 6 months (whichever comes first).

EACH OPERATION

The air intake screens and louvers, fan and cooling chamber, and exhaust openings must be checked for any obstructions or foreign objects. Check fan blades for stress fractures. Due to the high volume of air circulated, paper and other items can be drawn into the air intakes. During Load Bank operation insure that air is exiting from the exhaust vent.

The load branches should be checked for blown fuses or opened load resistors. To check the fuses or load resistors, operate the Load Bank from a balanced 3-phase source and check the three line currents. The three current readings should be essentially the same. If a sizeable difference is noted one or more load fuses or load resistors may have malfunctioned.

⚠ WARNING ⚠

For continued safety and for maximum equipment protection, always replace fuses with one of equal rating only.

⚠ WARNING ⚠

Disconnect incoming power source prior to servicing.

Motor overload device: Turn Off then On to reset.

EVERY 50 HOURS OR 6 MONTHS

Check the tightness of the electrical connections. The expansion and contraction caused by Load Bank operation may result in loose connections. The vibrations caused by the cooling fan may also loosen electrical connections. If the Load Bank is transported "over the road", the electrical connections should be checked for tightness at a shorter-than-normal time interval. See "Primary Inspection".

MOTOR LUBRICATION

Motors are properly lubricated at the time of manufacture. It is not necessary to lubricate at the time of installation unless the motor has been in storage for a period of 12 months or longer (refer to lubrication procedure that follows).

Inspect the fan motor supplied with your Load Bank for grease fittings. If the motor contains grease fittings you must lubricate the motor. If lubrication instructions are shown on the motor nameplate, they will supersede this general instruction. Belt driven cooling fans have bearings which should be lubricated. Bearings should be lubricated every 50 hours of operation or 6 months whichever comes first.

Lubrication Procedure

1. Stop motor. Disconnect and lock out of service.
2. Remove contaminants from grease inlet area.
3. Remove filler and drain plugs.
4. Check filler and drain holes for blockage and clean as necessary.

⚠ WARNING ⚠

Always remove all power from the load bus and all fan/control power before servicing the Load Bank. Never operate or service a Load Bank that is not properly connected to an earthground.

⚠ WARNING ⚠

Overgreasing is a major cause of bearing and/or motor failure. The amount of grease added should be carefully controlled. Also make sure dirt and contaminants are not introduced when adding grease.

⚠ WARNING ⚠

If motor is nameplated for hazardous locations, do not run motor without all of the grease or drain plugs installed.

⚠ WARNING ⚠

If lubrication instructions are shown on the motor nameplate, they will supersede this general instruction.

RELUBRICATION TIME INTERVAL
for motors with regreasing provisions.

	NEMA Frame Size					
	140 – 180		210 – 360		400 – 510	
	1800 RPM and less	Over 1800 RPM	1800 RPM and less	Over 1800 RPM	1800 RPM and less	Over 1800 RPM
Standard	3 yrs.	8 mo.	2 yrs.	8 mo.	1 yr.	3 mo.
Severe	1 yr.	3 mo.	1 yr.	3 mo.	6 mo.	1 mo.
Seasonal	See Note 2.					

Standard: Up to 16 hours of operation per day, indoors, 100°F maximum ambient.

Severe: Greater than 16 hours of operation per day. Continuous operation under high ambient temperatures (100° to 150°F) and/or any of the following: dirty, moist locations, high vibration (above NEMA standards), heavy shock loading, or where shaft extension end is hot.

Seasonal: The motor remains idle for a period of 6 months or more.

Note:

1. For motors nameplated as “belted duty only” divide the above intervals by 3.
2. Lubricate at the beginning of the season. Then follow service schedule above.

5. Add proper type and amount of grease. See the Relubrication Time Intervals table for service schedule and Relubrication Amounts table for volume of grease required.
6. Wipe off excess grease and replace filler and drain plugs.
7. Motor is ready for operation.

   Warning: If motor is nameplated for hazardous locations, do not run motor without all of the grease or drain plugs installed.

RELUBRICATION AMOUNTS
for motors with regreasing provisions.

NEMA Frame Size	Volume cu. in. (fluid oz.)
140	.25 (.14)
180	.50 (.28)
210	.75 (.42)
250	1.00 (.55)
280	1.25 (.69)
320	1.50 (.83)
360	1.75 (.97)
400	2.25 (1.2)
440	2.75 (1.5)
500	3.00 (1.7)

Grease Type

Unless stated otherwise on the motor nameplate, the motors on this Load Bank are pregreased with a polyurea mineral oil NGLI grade 2 type grease. Some compatible brands of polyurea mineral base type grease are:

- Chevron SRI #2
- Rykon Premium #2
- Exxon Polyrex EM
- Texaco Polystar RB

TROUBLESHOOTING

This section is designed to aid the electrical technician in basic Load Bank system troubleshooting. All of the problems listed can be verified with a basic test meter and/or continuity tester. For safety reasons, when troubleshooting Load Bank systems always remove all test source power, fan/control power, anti-condensation heater power, etc.

COOLING FAN MOTOR WILL NOT OPERATE

1. Fan/Control Power not available/ incorrect
2. Inoperative Fan Motor (MOT)
3. Fan Motor Contactor (FMC) de-energized
4. Restriction of air (intake or exhaust)
5. Fan pressure switch inoperative

⚠ WARNING ⚠

When troubleshooting Load Bank systems always remove all test source power, fan/control power, anti-condensation heater power, etc.

LOAD STEP CANNOT BE ENERGIZED

1. Open load step resistor
2. Inoperative load step relays
3. Inoperative load step contactors
4. Open load step fuses

COOLING FAILURE INDICATED

Exhaust temp above EXTS setpoint:

1. Over temperature sensor failure
2. Fan failure
3. Air restriction (intake or exhaust)
4. Overvoltage condition present

Exhaust temp below EXTS setpoint:

1. Restriction of air (intake or exhaust)
2. Fan pressure switch inoperative
3. Overtemperature sensor failure

DRAWINGS AND PARTS LIST

The drawings included in this manual are the most accurate source of part numbers for your Load Bank. When ordering replacement parts for Simplex Load Banks, always consult the Parts Drawing. When contacting the Simplex Service Department always have your work order and drawing number ready for reference. *A typical drawing legend and parts list is illustrated at right.*

SIMPLEX® SPRINGFIELD, ILLINOIS

SCALE : ~	APPROVED BY :	DRAWN BY : AMN
DATE : 9/14/09		REVISED :

RESISTIVE LOAD BANK
100KW,240V,1ø,60HZ

POLARIS–100
CONTROL SECTION

W.O. #71461–09–43

DRAWING NUMBER
198282A

ITEM	QTY.	PART #	DESIG.	DESCRIPTION
1	10	DRAWING 198284	LR1-LR10	LOAD ELEMENTS PWR-WEB, 2500W @ 120V
2	8	DRAWING 198284	LR11-LR18	LOAD ELEMENTS PWR-WEB, 3125W @ 120V
3	12	DRAWING 198284	LR19-LR30	LOAD ELEMENTS PWR-WEB, 4167W @ 120V
4	2	13014100	FMC, C1	CONTACTOR 35A, 600V, 3POLE 120VAC COIL
5	4	13023000	C2-C5	CONTACTOR 63A, 600V, 3POLE 120VAC COIL
6	2	13023700	C6-C7	CONTACTOR 75A, 600V, 3POLE 120VAC COIL
7	1	14044050	CF1	FUSE 10A, 600V, 200KAIC
8	1	12608205	MS1	MANUAL MOTOR STARTER 6. 3-10 AMP ADJ. O. L.
9	2	14069500	F1-F2	FUSE 30A, 600V, 200KAIC
10	4	14081000	F3-F6	FUSE 50A, 600V, 200KAIC
11	4	14085000	F7-F10	FUSE 60A, 600V, 200KAIC
12	6	14089000	F11-F16	FUSE 80A, 600V, 200KAIC
13	1	15012000	[CF1, HF1]	FUSEBLOCK 30A, 600V, 2 POLE
14	1	15012900	[F1-F2]	FUSEBLOCK 30A, 600V, 3 POLE
15	3	15016000	[F3-F10]	FUSEBLOCK 60A, 600V, 3 POLE
16	2	15019000	[F11-F16]	FUSEBLOCK 100A, 600V, 3 POLE

APPENDIX A - ABBREVIATIONS USED IN THIS MANUAL

Listed below are abbreviations of terms found on Simplex Load Bank Systems. When following a load bank drawing utilize this guide to define abbreviated system and component names. As this is a master list, drawings and text pertaining to your equipment may not contain all these terms.

AC-Alternating current

AIC-Ampere interrupting current-maximum short circuit fault current a component can safely interrupt

AM-Ammeter

AMSW- Ammeter selector switch-selects any phase for current reading

CF-Control fuse

CFM-Cubic feet per minute-used to rate fan air flow capacity and load bank cooling requirement

CFR-Cooling failure relay-normally energized relay in cooling failure subsystem

CPC-Control power contactor

CPF-Control power fuse

CT-Current transformer- used in metering circuits

DC-Direct current

EXTS-Exhaust air temperature switch

FCB-Fan circuit breaker-circuit breaker in series with fan control power

FCVR-Fan control voltage relay-normally energized relay on relay sub-panel

FM-Frequency meter-monitors frequency of test source

FMC-Fan motor contactor-controls power to fan motor

FMSW-Frequency meter switch

FPS-Fan power switch-used to energize cooling system

GFB-Ground fault breaker

GBTR-Ground breaker tripped relay

HMI-Operator Interface

HVR-High voltage relay

Hz-Hertz-cycles per second, measurement of frequency

IFCV-Incorrect fan/control voltage

INTS-Intake air temperature switch

K-Relay coil/contact designation

KVA-Kilovolt amperes

KVAR-Kilovolt amperes-reactive

KW-Kilowatts

KWM-Kilowatt meter

KWT-Kilowatt meter transducer

LM-Louver motor

LMC-Louver motor contactor

LR-Load resistive element

LX-Load reactive element

L1-Line 1

L2-Line 2

L3-Line 3

MCB-Main circuit breaker

MDS-Main Disconnect Switch

MF-Meter fuse

MLB-Main Load Bus

MOT-Motor

NEMA-National electrical manufacturer's association

ODP-Open, drip-proof-refers to motor enclosure

OVR-Overvoltage relay-relay used in overvoltage failure system, located on relay sub-panel

OLR-Overload relay-used for motor protection

OTR-Overtemperature relay-used in failure system

PF-Power factor-in resistive only loads expressed as unity (1.0), in inductive loads expressed as lagging, in capacitive loads expressed as leading

PAR-Control power available relay-relay energized when control power is available

PFM-Power factor meter

PS-Pressure switch-switch used to detect fan failure

RR-Reset relay

RTM-Running time meter-keeps time log of equipment use.

TB-Terminal block

TDR-Time delay relay-relay which times out before contacts change state

TEFC-Totally enclosed, fan cooled-refers to motor enclosure

TEAO-Totally enclosed, air-over-refers to motor enclosure

UPS-Uninterruptable power source

V-Voltage

VSR-Voltage sensing relay

XCB-Reactive load controlling circuit breaker

APPENDIX B - CALCULATIONS & FORMULAS

The following calculations are used to determine the actual kilowatt load being applied by the Load Bank, when line voltages and currents are known (at 1.0 power factor).

3 Phase

1. Read all three line currents and find the average reading.
2. Read all three line-to-line voltages and find the average reading.
3. Multiply the average current times the average voltage.
4. Multiply the answer of step #3 times the square root of 3 (1.732).
5. Divide the answer of step #4 by 1000. The answer is the actual kilowatts of load being applied by the Load Bank.

Single Phase

1. Determine the line current.
2. Determine the line-to-line voltage.
3. Multiply the line current times the line-to-line voltage.
4. Divide the answer of step #3 by 1000.
5. The answer of step #4 is the actual kilowatts being applied by the load bank.

EXAMPLES

Using line voltages and currents:

3 Phase

Current Readings	Voltage Readings
A_1 = 249A	V_{1-2} = 481V
A_2 = 250A	V_{2-3} = 479V
A_3 = 254A	V_{3-1} = 483V

$$\text{Average Current} = \frac{A_1 + A_2 + A_3}{3} = \frac{249+250+254}{3} = 251\text{A}$$

$$\text{Average Voltage} = \frac{V_{1-2} + V_{2-3} + V_{3-1}}{3} = \frac{481 + 479 + 483}{3} = 481\text{V}$$

$$\text{Kilowatts} = \frac{\text{Volts x Amps x } 1.732}{1000} = \frac{481 \times 251 \times 1.732}{1000} = 209.1\text{KW}$$

Single Phase

Current Reading: 150A Voltage Reading: 240V

$$\text{Kilowatts} = \frac{\text{Volts x Amps}}{1000} = \frac{150 \times 240}{1000} = 36.1\text{KW}$$

The following calculations are used to determine the amount of current when the desired amount of kilowatts is applied at 1.0 power factor.

3 Phase

1. Multiply the desired amount of kilowatts to be applied by 1000.
2. Multiply the operating voltage times the square root of 3 (1.732)
3. Divide the answer of step #1 by the answer of step #2.
4. The answer of step #3 is the average line current with the desired kilowatts applied at 1.0 power factor.

Single phase

1. Multiply the desired amount of kilowatts to be applied by 1000.
2. Divide the answer of step #1 by the operating voltage.
3. The answer of step #2 is the average line current with the desired amount of kilowatts applied at 1.0 power factor.

The following calculations are used to determine a step kilowatt rating at other than a rated voltage. This is accomplished by referencing the load step to a KW value at a known voltage.

1. Determine the new unrated operating voltage.
2. Divide the new operating voltage by the reference voltage.
3. Square the answer of step #2.
4. Multiply the answer of step #3 times the reference kilowatt value of the load step which the new kilowatt rating is desired.
5. The answer of step #4 is the kilowatt rating of the load step at the new voltage.

EXAMPLES

When desired amount of kilowatts is applied at 1.0 PF:

3 Phase

Applied: 50KW Operating Voltage: 480V

$$\text{Amperage} = \frac{\text{KW} \times 1000}{\text{Volts} \times 1.732}$$

$$= \frac{50 \times 1000}{480 \times 1.732}$$

$$= \frac{50{,}000}{831.36}$$

$$= 60.1$$

Single Phase

Applied: 25KW Operating Voltage: 240V

$$\text{Amperage} = \frac{\text{KW} \times 1000}{\text{Volts}}$$

$$= \frac{25 \times 1000}{240}$$

$$= \frac{25{,}000}{240}$$

$$= 104.2$$

Determining step KW at other than rated voltage:

Applied: 80KW Operating Voltage: 450V
Rated Voltage: 480V

$$\text{Step KW} = (\text{Oper. Volt.} \div \text{Rated Volt.})^2 \times \text{Applied KW}$$

$$= (450 \div 480)^2 \times 80$$

$$= .9375^2 \times 80$$

$$= 70.3$$

FORMULAS

		Alternating Current	Direct Current
Kilowatts	1 phase	$\frac{\text{Volts x Amps x PF*}}{1000}$	$\frac{\text{Volts x Amps}}{1000}$
	3 phase	$\frac{\text{1.732 x Volts x Amps x PF*}}{1000}$	
Amperes (KW known)	1 phase	$\frac{\text{KW x 1000}}{\text{Volts x PF}}$	$\frac{\text{KW x 1000}}{\text{Volts}}$
	3 phase	$\frac{\text{KW x 1000}}{\text{1.732 x Volts x PF}}$	
KVA	1 phase	$\frac{\text{Volts x Amps}}{1000}$	
	3 phase	$\frac{\text{1.732 x Volts x Amps}}{1000}$	
Amperes (KVA known)	1 phase	$\frac{\text{KVA x 1000}}{\text{Volts}}$	
	3 phase	$\frac{\text{KVA x 1000}}{\text{1.732 x Volts}}$	
KVAR	1 phase	$\frac{\text{Volts x Amps x } \sqrt{1-PF^2}}{1000}$	
	3 phase	$\frac{\text{1.732 x Volts x Amps x } \sqrt{1-PF^2}}{1000}$	

*Power Factor, expressed as decimal.
(Resistive Load Bank PF is 1.0)

APPENDIX C - TORQUE VALUES

FAN BLADES		
FAN PART NO.	BOLT SIZE	TORQUE FT LBS // IN LBS
13820000	SET SCREW	11.7 // 140
13820500	SET SCREW	11.7 // 140
13821000	SET SCREW	8.3 // 100
13822000	1/4 — 20	7.5 // 90
13823000	1/4 — 20	7.5 // 90
13824000	1/4 — 20	7.5 // 90
13825100	1/4 — 20	7.5 // 90
13826000	1/4 — 20	7.5 // 90
13827500	5/16”	13 // 156
13827600	5/16”	13 // 156
13828000	3/8”	24 // 288

MOTORS, BRACKETS, BUS BAR CONNECTIONS		
BOLT/NUT SIZE	GRADE	TORQUE FT LBS // IN LBS
.250 (1/4-20)	Grade 5, dry	8 // 96
.250 (1/4-20)	Grade 2, dry	5.5 // 66
.312 (5/16)	Grade 5, dry	17 // 204
.312 (5/16)	Grade 2, dry	11 // 132
.375 (3/8)	Grade 5, dry	30 // 360
.375 (3/8)	Grade 2, dry	20 // 240
.437 (7/16)	Grade 5, dry	50 // 600
.437 (7/16)	Grade 2, dry	30 // 360
.500 (1/2)	Grade 5, dry	75 // 900
.500 (1/2)	Grade 2, dry	50 // 600
.562 (9/16) & up	Grade 5, dry	110 // 1320
.562 (9/16) & up	Grade 2, dry	70 // 840

CONTACTORS
See torque values on the front of the contactor.

ELEMENTS/TRAYS		
TERM/NUT SIZE		TORQUE INCH LBS
#6	Rod ends	4
#10	Element Conn.	20
1/4-20	High Voltage	Contact Simplex

MAIN LOAD BLOCKS- ALL SIZES		
CONNECTION	WIRE SIZE	TORQUE FT LBS // IN LBS
LOAD SIDE	4-14AWG	2.9 // 35
LINE SIDE	500MCM-4/0	31 // 375
	3/0-4/0	20 // 240
	2/0-6AWG	10 // 120
	8AWG	3.3 // 40

CIRCUIT BREAKERS		
STYLE	WIRE SIZE	TORQUE INCH LBS
Cutler-Hammer 1-Phase	14-10 AWG	20
	8 AWG	25
	6-4 AWG	27
	3-1/0 AWG	45
Merlin Gerin 3-Phase	14-1/0	50

APPENDIX C - TORQUE VALUES CONT'D

FUSEBLOCKS		
MANUF. PART NO.	WIRE SIZE	TORQUE INCH LBS
BM6031SQ, BM6032SQ, BM6033SQ; 600V, 30A	10-18 AWG	20
T60060-2SR 600V, 60A	10-18 AWG	20
T60030-3CR, 600V, 30A T60060-3CR, 600V, 60A 60100-3CR, 600V, 100A	10-14 AWG	35
	8 AWG	40
	4-6 AWG	45
	2-3 AWG	50

MISCELLANEOUS-TERMINALS, METERS, SWITCHES, COILS, RELAYS, XFORMERS	
CONNECTION SIZE	TORQUE INCH LBS
4	5
6	10
8	19
10	31
1/4-20"	66

TAPER-LOCK BUSHINGS	
BUSHING NUMBER	TORQUE
1008, 1108	55 IN LBS
1210, 1215, 1310, 1610, 1615	15 FT LBS
2012	23 FT LBS
2517, 2525	36 FT LBS
3020, 3030	67 FT LBS
3535	83 FT LBS
4040	142 FT LBS
4545	204 FT LBS
5050	258 FT LBS
6050, 7060, 8065	652 FT LBS
10085, 12010	1142 FT LBS

CAM-LOK STUDS	
THREADED STUD	MAXIMUM TORQUE
5/16" – 18	15 FT LBS
1/2" – 13	40 FT LBS