LOAD BANK
TECHNICAL MANUAL

Customer: XXXXX

Work Order: XXXXX-XX-XX

Model: LBW XXX

May 2011

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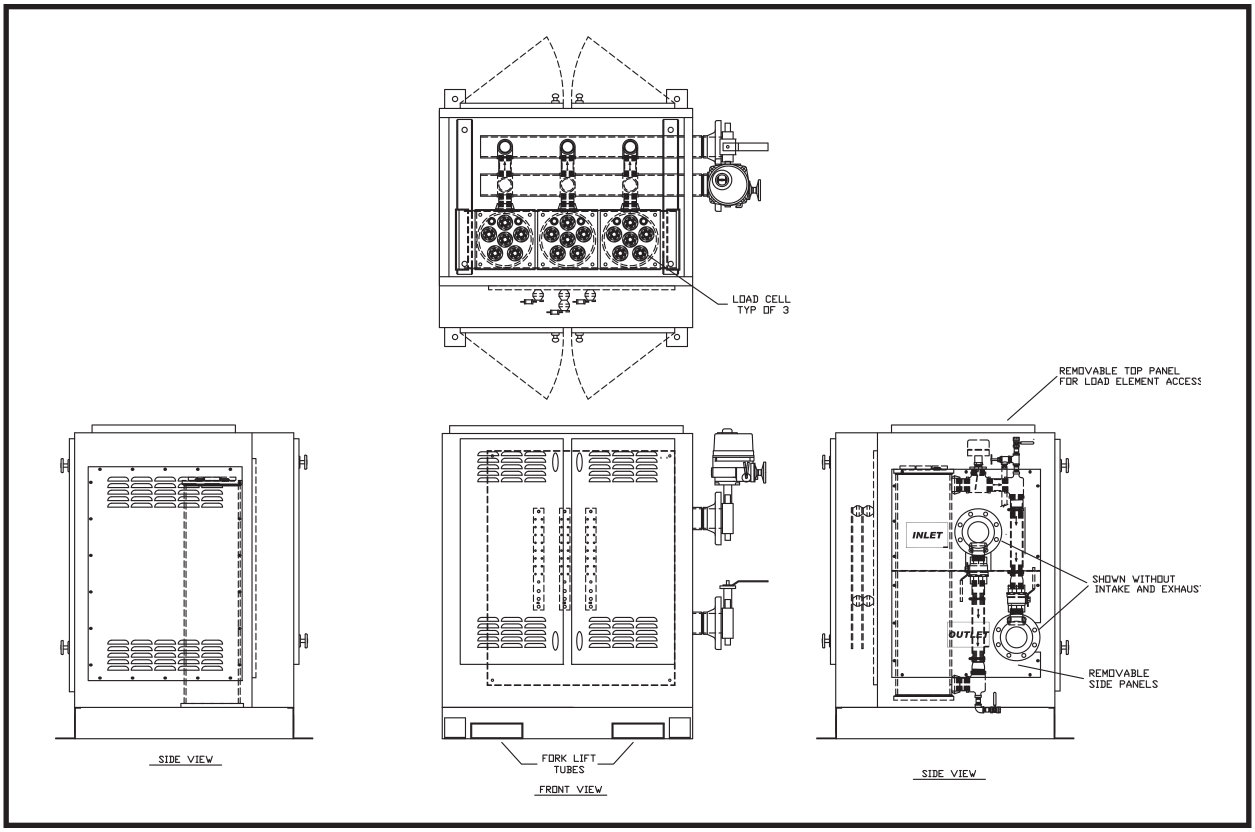

Part of Sample Pictorial Drawing

DESCRIPTION

A Simplex Load Bank is a precision test instrument specifically designed to apply a discrete, selectable resistive electrical load to a power source while measuring the response of the generator to the applied load. It also provides 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.

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 200KAIC fuses.

⚠ WARNING ⚠

This manual represents a generic configuration. Each LBW Water-Cooled Load Bank is engineered per customer specifications therefore each LBW Water-Cooled Load Bank is provided with a unique operator's manual.

Load Bank operation and status indication is via a Operator Interface (HMI) touchscreen mounted locally on the Load Bank and/or housed in a remote box. The Control System includes a Programmable Logic Controller (PLC) and 120V discrete componets. A 24VDC power supply (DCS) located in the Load Bank powers the touchscreen. Common serviceable components include Control Fuses (CF Series) and Power Fuses (F Series).

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

This Load Bank is protected against failures (loss of flow/low water, over temperature, over pressure, or leak in the water sump which could damage the Load Bank or present a safety hazard to the operator). When a 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 pressing the "Reset/Stop" button on the touchscreen.

⚠ WARNING ⚠

Always remove all power from the load bus and all fan/control power before servicing the Load Bank.

The Load Bank consists of three principal systems:

1. Control System
2. Cooling System

CONTROL SYSTEM

The Control System allows the operator to apply a desired load to the test source and measure the response of the test source to the load. This system also contains the circuitry utilized to disconnect the Load Bank from the test source in the event of cooling failures and/or improperly positioned operating controls. The Load Bank Control System is comprised of 120V discrete components.

Control Power (120V) is supplied externally via a 120V, 1ø, 60Hz, 5A source. Coolant is supplied via customer supplied devices. When sufficient flow (70 GPM) is reached the Water Flow Relays (WFS1, WFS2, and WFS3) close and energize the Water Flow Relays (WFR1, WFR2, and WFR3). WFR contacts 1–7 close and and energize the Water Flow Relay (WFR). Closed WFR contacts complete the path from the Normal Operation Relay (NOR). Open WFR contacts 9–3 interrupt the power path and a Loss of Flow / Low Water Level is indicated on the screen.

COOLING SYSTEM

The load elements in this Load Bank are cooled by an open loop fresh water system. Sensors monitor water flow (WFS), water temperature (WTS), water pressure (WPS), and water leak in sump (FSW). If a failure occurs all load is automatically dumped and the operator is alerted by an indicator on the touchscreen.The failure must be corrected and the system must be reset before a load can be re-applied.

LOAD SYSTEM

The Load System on Water-Cooled Load Banks consist of independently controlled immersion type, incolloy sheath, screw plug mounting (individually replaceable) load elements specifically designed for Load Bank systems. They are protected by 200KAIC fuses.

See Parts Legend Drawing for specific elements used.

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

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 Six Point/30 Minute Inspection is recommended before installation, as part of the 50 hour / 6 month maintenance schedule and whenever a 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. Rotate and push all switches through all positions to ensure smooth operation.
4. 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.
5. Examine all accessible internal electrical components such as fuses, contactors and transformers. Check lugged wires at these components.
6. Inspect bottom of crate/enclosure for any components that may have jarred loose during shipment such as indicator light lenses, switch knobs, etc.

INSTALLATION

Unless stated on the drawing or within this manual, consult NEC for proper wire sizes for all connections.

1. Position the Load Bank in the desired area of operation and ground it to its own independent ground.
2. Confirm the test source is properly grounded.
3. Per Pictorial Drawing connect the coolant water piping to the Load Bank Outlet and Inlet connections.
4. Per PLC Control Drawing connect TB'COM' contacts on the Load Bank to TB'R' contacts on the remote box as shown (if applicable).
5. Per load connection drawings cable the load source to the Load Bank.
6. If the 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 as shown.

   Open contacts to dump load.

   Close contacts to enable load.

⚠ WARNING ⚠

Do Not allow the Load Bank to operate unattended for extended periods.

OPERATION

1. Verify "Control Power Available".
2. Press the "Open Intake Valve" button.
3. Verify "Intake Valve Open" indicator.
4. Press the "Start" button.
5. Verify illumination of the "Normal Operation" lamp.

   During initial startup the "Reset/Stop" button may need to be pressed to clear failures while the flow/level and pressure minimums are reached.
6. Put the load source on line.
7. Adjust power source voltage and frequency.
8. Select the desired load steps by placing them in the "On" position.
9. Place the "Master Load" button in the "On" position.
10. Adjust source voltage and load. Monitor as needed.

SHUTDOWN

1. De-energize the load.
2. Circulate water through load cells for 5 minutes to assure a thorough cool down of all load elements (optional).
3. Press the "Reset/Stop" button.

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 (See Installation Procedure).

The operator also has the option of bypassing these contacts and enabling the load section by pressing the "Load Dump Active Press To Bypass" button on the Setup screen.

FAILURE DETECTION SYSTEM

This is a permissive/energize-to-run circuit in which all safety sensor contacts must be closed before load can be applied. This system includes the following component:

1. Water Flow Switches and Relay (WFS and WFR)
2. Water Temperature Switches and Relay (WTS and WTR)
3. Water Pressure Switches and Relay (WPS and WPR)
4. Coolant Leak Switch and Relay (FSW and WSR)
5. Normal Operation Relay (NOR)

The failure detection switches are factory set. WTS and WPS can be field adjusted via the transducer setscrew.

If a failure occurs all load is automatically dumped and the operator is alerted by the illumination of the corresponding lamp. The failure must be corrected and the system must be reset by turning the Load Bank Off then On before load can be re-applied. One failure may be the cause of a subsequent, separate failure: a Loss of Flow failure may cause an Over Temperature failure, etc.

MAINTENANCE

This Load Bank is designed for a minimum of service. If it is necessary to service or repair the load elements, solenoid valve, etc. one load cell, the load cell may be isolated from the others by utilizing the isolation hand valve as illustrated in the pictorial drawing in this manual. After every six months perform the following service procedure.

1. Check all internal load bank electrical connections for tightness.
2. Check load cable connections at the load bus for tightness.
3. Check all plumbing connections for integrity and visually check for any coolant leaks.

⚠ WARNING ⚠

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

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

OVER TEMPERATURE WITH WATER CIRCULATING

1. Restriction of water flow, intake or exhaust
2. Inoperative temperature switch
3. Inoperative failure relay
4. Insufficient coolant flow
5. Intake coolant temperature too high
6. Inoperative flow switch

FALSE COOLING FAILURE INDICATION

1. Inoperative Water Flow Switch
2. Inoperative Failure Relay
3. Reversed coolant flow

NO COOLING WATER CIRCULATION

1. Restriction of water flow, intake or exhaust

⚠ WARNING ⚠

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

OVERPRESSURE FAILURE

1. Boiling Coolant
2. Pressure relief valve in remote pump failed
3. Restricted exhaust
4. High input pressure

SOME LOAD STEP(S) CANNOT BE ENERGIZED (NO FAILURES INDICATED)

1. Inoperative load energized
2. Inoperative failure sensor
3. Load step resistors or fuses opened
4. Inoperative load step contactors

NO LOAD STEPS CAN BE ENERGIZED (NO FAILURES INDICATED)

1. Control Power not available
2. Control Power fuse blown

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. The Load Bank Specifications Sheet in the front of this manual lists all of the drawings included in this manual. The Work Order Number and the Drawing Numbers are also located on each drawing legend. A typical drawing legend and parts list is illustrated at right.

SIMPLEX™	SPRINGFIELD, ILLINOIS	
SCALE :	APPROVED BY :	DRAWN BY : AZM
DATE : 2/24/11		REVISED :
RESISTIVE LOAD BANK 400KW,480V,3ø,60Hz	LBW-400 CONTROL POWER DISTRIBUTION	
W.O.# 75132-11-43		DRAWING NUMBER 222531

ITEM	QTY.	PART #	DESIG.	DESCRIPTION
1	1	DWG 201240	LR1	IMMERSION HEATER 10KW, 480V, 3PH. 2" NPT SCREWPLUG
2	14	DWG 201241	LR2-15	IMMERSION HEATER 25KW, 480V, 3PH. 2" NPT SCREWPLUG
3	3	13011040	C1-C3	CONTACTOR 40A, 600V, 3POLE 120VAC COIL
4	6	13011065	C4-C9	CONTACTOR 65A, 600V, 3POLE 120VAC COIL
5	1	14036500	CF1	FUSE 5A, 600V, 200KAIC KLDR-5
6	1	15011000	[CF1]	FUSEBLOCK 30A, 600V, 1 POLE
7	3	14051500	F1-F3	FUSE 15A, 600V, 200KAIC JLLS-15
8	6	14074000	F4-F9	FUSE 35A, 600V, 200KAIC JLLS-35
9	18	14087000	F10-F27	FUSE 70A, 600V, 200KAIC JLLS-70
10	1	15012900	[F1-F3]	FUSEBLOCK 30A, 600V, 3 POLE
11	2	15016000	[F4-F9]	FUSEBLOCK 60A, 600V, 3 POLE
12	2	25670000	TB'FS, TS' TB'PS, FSW'	TERMINAL BLOCK 30A, 600V, 12-LINE
13	120	25678500	TB'CP' TB'A' TB'LD' TB'F' TB'L' TB'R' TB'V'	TERMINAL BLOCK 30A, 300V, 6 LINE

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

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

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

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

Single Phase

Current Reading: 150A   Voltage Reading: 240V

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

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	$\frac{\text{1.732 x Volts x Amps x PF*}}{1000}$	

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

		Alternating Current	Direct Current
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	$\frac{\text{1.732 x Volts x Amps x } \sqrt{1-PF^2}}{1000}$	

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

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APPENDIX C - TORQUE VALUES CONT'D

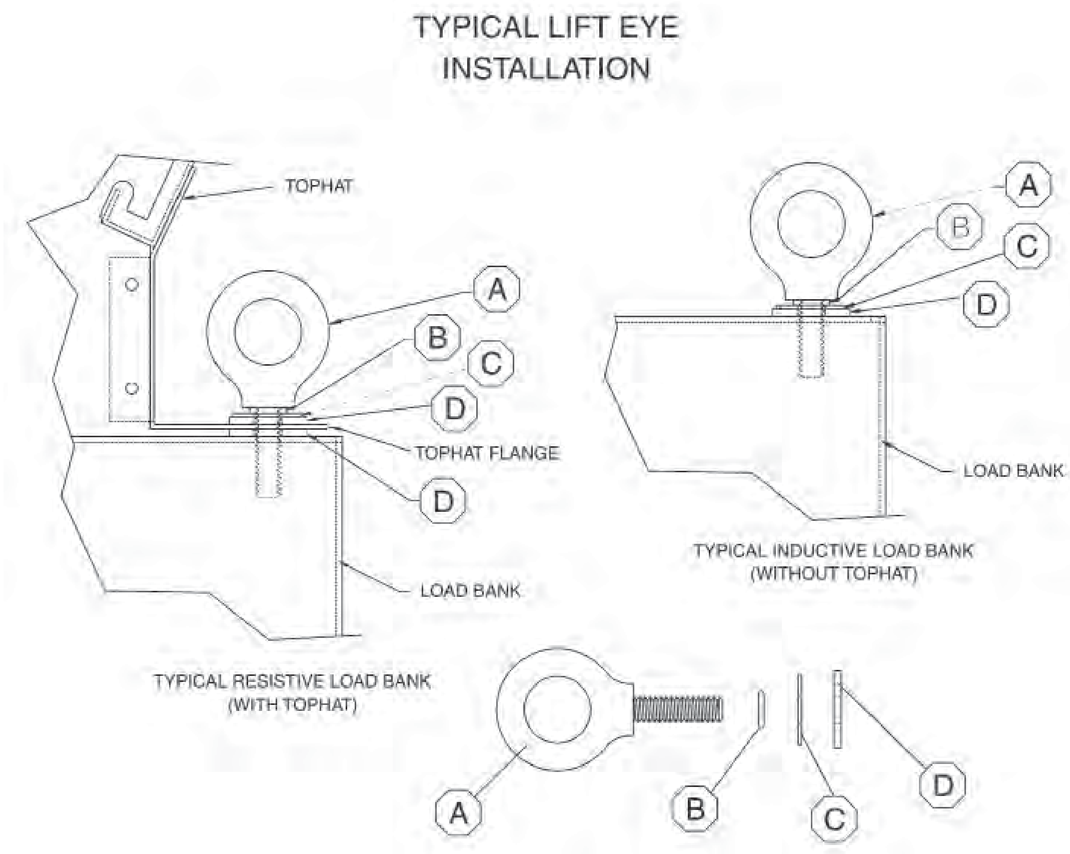
FUSEBLOCKS		
MANUF. PART NO.	WIRE SIZE	TORQUE INCH LBS
BM6031SQ, BM6032SQ, BM6033SQ; 600V, 30A	10-18 AWG	20
T60060-2SR 600V, 60A	10-18 AWG	20
T60030-3CR, 600V, 30A T60060-3CR, 600V, 60A 60100-3CR, 600V, 100A	10-14 AWG	35
	8 AWG	40
	4-6 AWG	45
	2-3 AWG	50

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

APPENDIX D - TYPICAL LIFT EYE INSTALLATION



ITEM	DESCRIPTION	1/2"	5/8"	3/4"	7/8"
A	LIFT EYE	15465000	15470000	15471000	15472000
B	O-RING	16750500	16750600	16750610	16750620
C	FLAT WASHER	20424200	20427000	20427100	20427200
D	RUBBER WASHER	20431000	20431001	20431002	20431003