PVAC-E
MV METALCLAD SWITCHGEAR

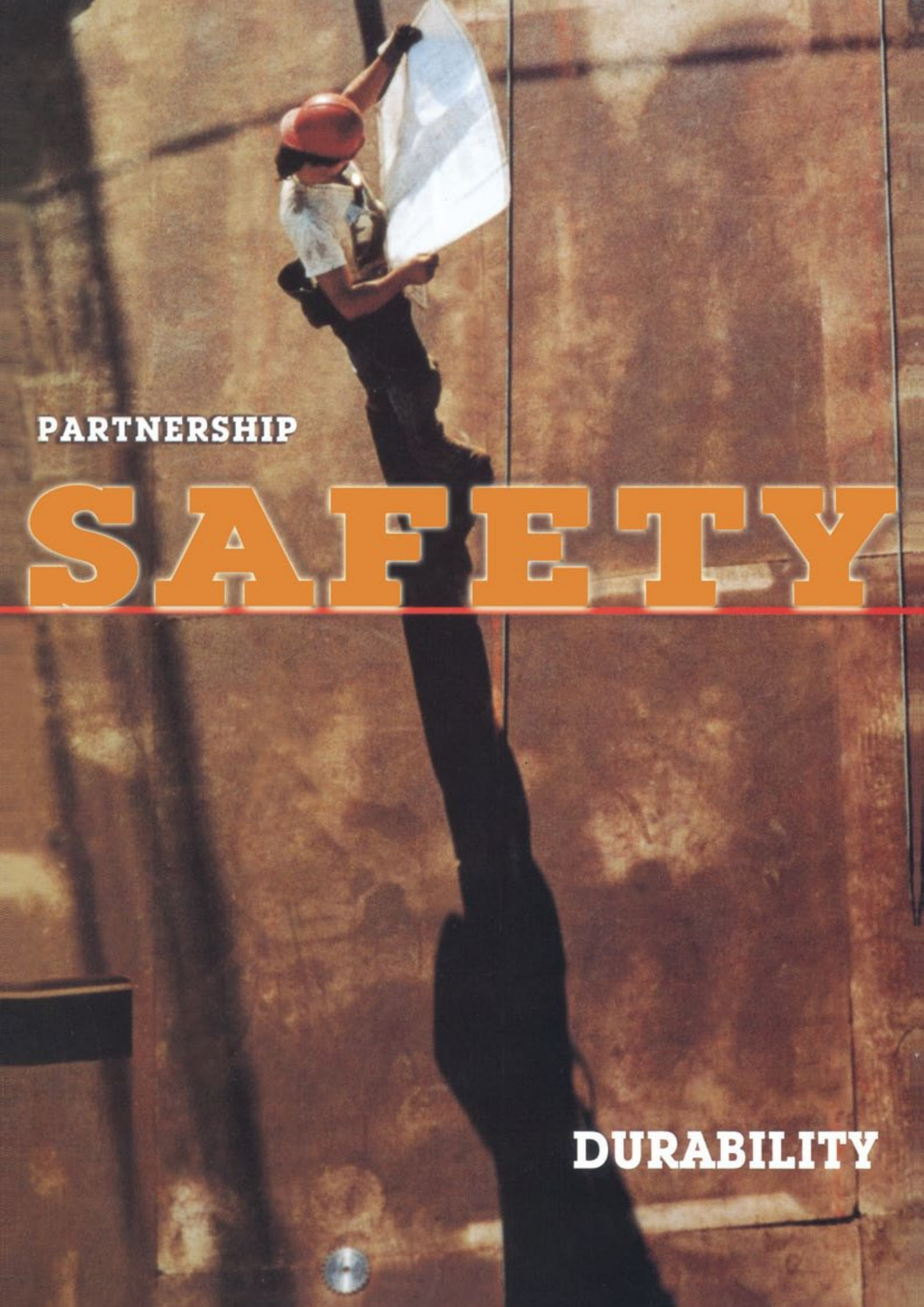
QUALITY
الفنار alfanar
PRODUCT

Approved By
Saudi Aramco

MGMT. SYS.
RvA C 046

ISO 9001:2000
Certificate No: 34039

الفنار alfanar


PARTNERSHIP
SAFETY
DURABILITY

Contents

PVAC-E MV Metalclad Switchgear 4760V-15000V 20KA-63KA

Key Features and Benefits

- Easy to maintain
- Long service life
- No greenhouse gas
- World-wide acceptance
- Reliable & quiet arc interruption
- More than 40 years interrupter experience
- Fully type tested by alfanar at KEMA lab
- The most reliable and durable metalclad switchgear according to ANSI/IEEE C37.20.2
- Customization & design capabilities are available to meet customer requirements
- alfanar's manufacturing facility is ISO 9001:2000 certified

Codes and Standards

• ANSI/IEEE C37.04	AC Power Circuit Breaker Rating Structure
• ANSI/IEEE C37.06 – 1987 & 2000	Preferred Ratings of Power Circuit Breakers
• ANSI/IEEE C37.09	Test Procedures for Power Circuit Breakers
• ANSI/IEEE C37.54	Conformance Test Procedures
• ANSI/IEEE C37.010	Application Guide for Power Circuit Breakers
• ANSI/IEEE C37.11	Power Circuit Breakers Control Requirements
• ANSI/IEEE C37.20.2	Standards for Switchgear Assemblies
• NEMA SG - 4 & 5	Power Circuit Breakers & Switchgear Assemblies

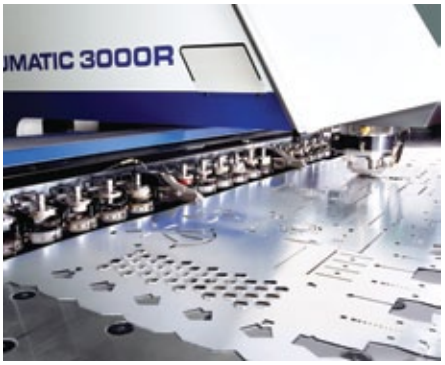
Value Addition by alfanar

Design & Customization

Design activities are made fast and effective using latest and advance software tools suitable for mechanical and electrical scope whose output is necessary for fabrication and assembly. The following design tools are being used by our engineers:

- Pro-Engineer 3D modeling software
- Autodesk Inventor Professional
- Pro-Engineer software for sheet metal work
- Elecdes
- Master CAM Software
- AutoCAD

Manufacturing



PVAC-E Panels' manufacturing and assembly is done at our
state-of-the-art facilities whose processes strictly comply with ISO 9001:2000. The processes involve, but not limited to:

- Fabrication of metal parts
- Welding
- Press
- Painting
- Electroplating
- Etc.

Finished fabricated metal parts, copper materials and other machined items to form the cubicle are further passed through fabrication quality checking before there are sent to respective production lines for assembly.

Quality Control & Assurance

High Voltage Testing Lab

Our approach to Quality is: "To prevent error before it happens." The whole system is directed towards this methodology. The aim is to achieve customer satisfaction by consistently delivering products and services on time, meeting all quality requirements and providing value for money.

The quality assurance system is primarily concerned with ensuring customer satisfaction at all stages – from design to final delivery and servicing. It includes regulation of the quality of raw materials, assemblies, products and components; services related to production; and management, production, and inspection processes.

Our manufacturing facilities for MV products follow the PDCA (Plan-Do-Check-Act) approach towards Quality Management System. The whole Quality management system is in line with ISO 9001:2000 requirement and certified by ABS Quality Evaluation Inc., USA.
Listed below are the quality assurance & control activities:

- Inspection of incoming raw material
- In-process inspection
- Finished product inspection
- Customer complaint analysis
- Calibration control of all the measuring and testing instruments
- Control of non-conforming products and initiation of corrective action
- Monitoring quality trends
- Application of appropriate statistical process control techniques at all test stages
- Systems audit (ISO 9001:2000) by trained internal auditors.

Functional Factory Test

All the finished panels are subjected to 100% routine quality checking as per the customer approved drawings and as per IEEE C37.20.2 Inspection & Test plan, instructions are followed and the results are recorded.

The inspection and tests include the following:

1- VISUAL INSPECTION AND DIMENSION CHECK
2- MECHANICAL OPERATION TEST
3- ELECTRICAL OPERATION AND CONTROL WIRING TESTS
   a) Control wiring continuity
   b) Control wiring insulation test
   c) Polarity verification
   d) Sequence tests
4- POWER FREQUENCY VOLTAGE WITHSTAND TEST ON THE MAIN CIRCUIT
5- TEST OF THE MEASURING AND PROTECTION CIRCUITS

Customer Service & After-Sales Service

alfanar Electrical Systems have a qualified team to provide prompt service to its customers.

As an added value service to our customers, supervision of the installation of switchgear and commissioning is provided by our experienced engineers as part of the offer. This further ensures proper handling of the panels which is essential for smooth execution of a project.

Mechanical Operation Test

Application of PVAC-E

Oil & Gas

Utilities

Steel & Cement Industries

Tough Seas & Salt Air

Paper Mills

GE Components Inside

POWER/VAC® VACUUM BREAKERS DESIGNED FOR QUALITY AND SAFETY

Standardization Means High Quality

A high degree of standardization has been achieved with POWER/VAC® breakers. All breakers are the same size, regardless of voltage or interrupting capability. Additionally, most parts of the frame, primary conductors, disconnects and mechanisms are interchangeable throughout the breaker product line. This results in a higher quality product and reduces training time for operating and maintenance personnel.

Interlock System Protects Operating Personnel

For personnel safety, POWER/VAC® breakers are designed with a number of mechanical and electrical interlocks. For example, breaker contacts must be open before the breaker can be moved to or from the CONNECT position. A positive mechanical stop is provided when the breaker reaches the CONNECT or TEST/DISCONNECT positions. Mechanical interference interlocks are provided to permit only the insertion of properly rated breakers into any specific compartment. These and other necessary interlocks provide a comprehensive protection system. Furthermore, springs automatically discharge when the breaker is withdrawn from the CONNECT position and breakers cannot be inserted in the closed position. Closed door draw-out design also contributes an extra measure of operator protection.

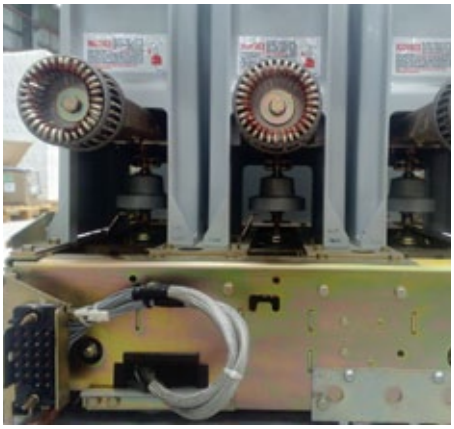
Breaker Features

1. FRONT PANEL:

Thick 11-guage steel front panel fits into a collar-frame in the equipment when the breaker is in the CONNECT position, which provides a safe grounded metal barrier between the breaker compartment and the secondary device compartment. Well marked and easy-to-read operating controls and indicators include trip button, CLOSE button, PEN/CLOSE indicator, CHARGE/DISCHARGE indicator, OPERATIONS counter and provision for manual charging of the breaker.

2. PRIMARY DISCONNECT:

The primary disconnect finger set is rugged and easy to inspect. It is designed for optimum contact, built of silver-plated copper, and tested for continuous and momentary currents. These disconnects provide proper contact integrity throughout the life of the gear for the critical primary disconnect function.



3. CONTACT EROSION INDICATOR:

GE vacuum interrupter contacts seldom wear out over the normal duty life-span of a circuit breaker. Nevertheless, a contact erosion indicator is provided for inspection convenience. It is visible when the breaker is withdrawn from the compartment, or with the front panel removed.

4. INTERRUPTER SUPPORT:

A rugged, high strength, track-resistant polyester glass support assembly firmly positions and holds the interrupter and primary conductors while providing insulation to ground and between phases. This support assembly can be removed quickly by disengaging six bolts. Only a simple alignment of contact wipe is required in the unlikely event that the interrupter assembly needs to be replaced.

5. BREAKER MECHANISM:

Both ML-17 and ML-18 mechanisms use a spring-charged, store-energy design that is mechanically and electrically trip-free and can be operated by DC control voltages of 48V, 125V, or 250V, or AC voltages of 115V, and 230V. High quality mechanism parts are precision-tooled for operating consistency, reliability, maintenance ease and plated for corrosion resistance for long life.

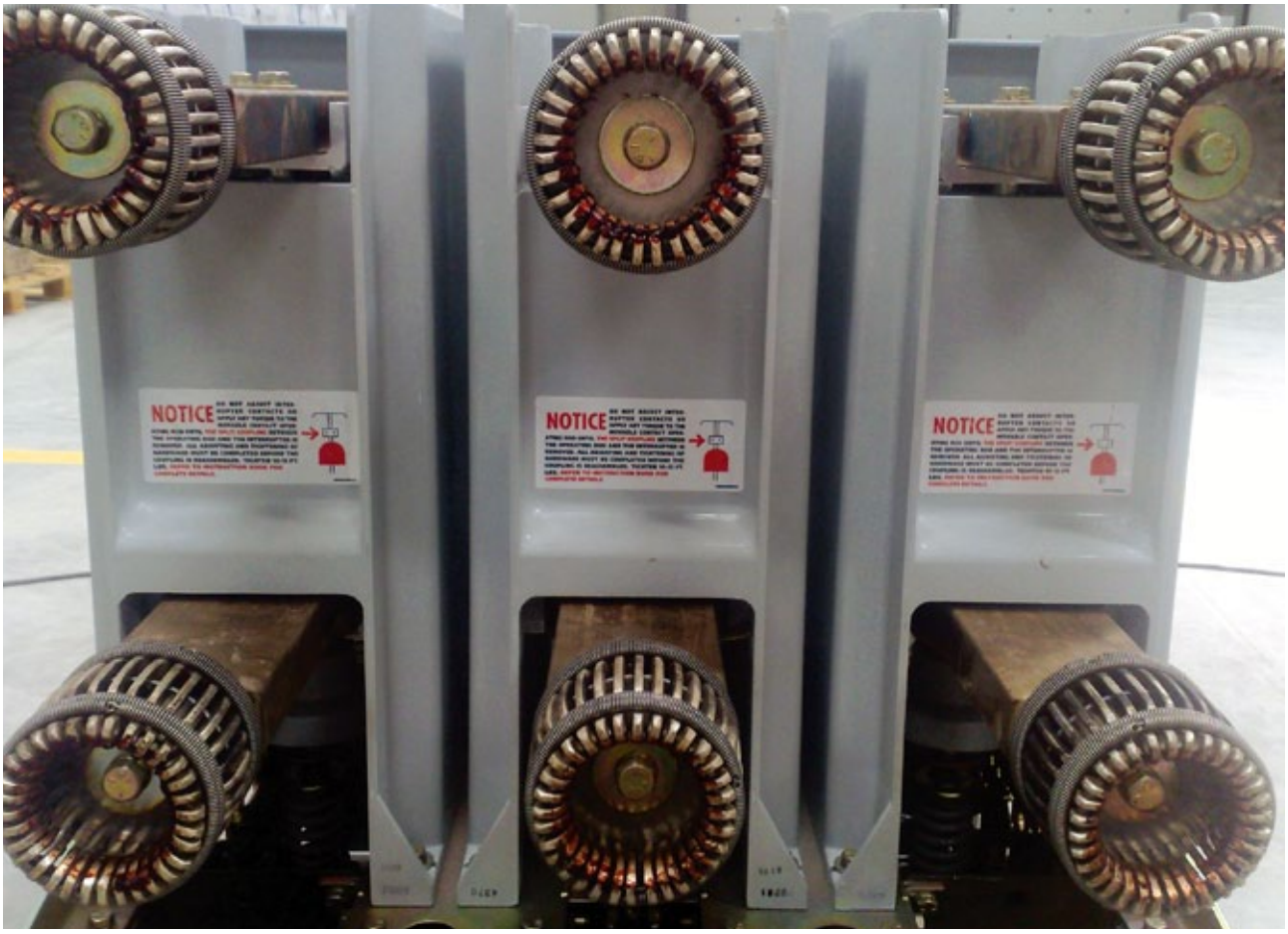
6. ROLL-IN OPTION:

A roll-in breaker is designed for use in the lower compartment of indoor switchgear or outdoor walk-in is available in all breaker ratings. The roll-in feature eliminates the need for a lift truck and reduces the required front aisle space. Upper compartments may be left empty or used as auxiliary compartments. The breaker used for this option is the same as used for the two-high product, with the addition of an undercarriage.

POWER/VAC® PUTS OVER 40 YEARS OF VACUUM INTERRUPTER EXPERIENCE TO WORK FOR YOU

The heart of every PVAC-E Switchgear is the vacuum interrupter. The POWER/VAC® interrupter is a reliable device that provides fast, quiet power switching. It consists of a pair of butt contacts, a vapor-condensing shield and a bellow through which one of the contacts moves, all sealed in a vacuum-light enclosure.

Vacuum is recognized as having many advantages over other arc interruption technologies. It is a nearly perfect dielectric for arc extinction. Also because the vacuum interrupter is smaller, the circuit breakers can be reduced in size weight and complexity. Environmentally friendly, no oil, gas or high



Design Features on PVAC-E Switchgear

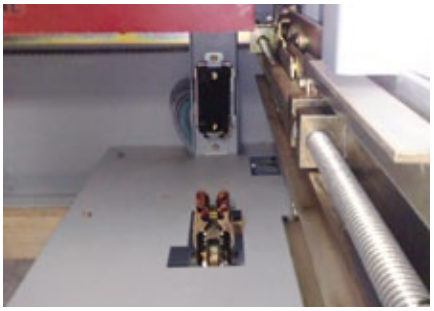
THESE SUPERIOR DESIGN FEATURES ARE STANDARD ON PVAC-E SWITCHGEAR

A. MAIN BUS COMPARTMENT

is completely isolated by 11-gauge metal barriers. Bus bars are provided with high dielectric epoxy insulation and pass through track-resistant polyester glass barriers between cubicles. All main bus is fully tin-plated after fabrication for positive contact and low resistance, and is insulated with performed boots. Porcelain insulation to ground and silver plating are optional.

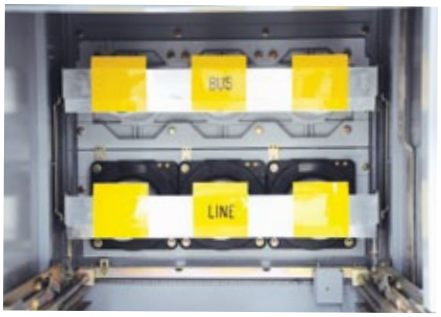
B. SECONDARY DISCONNECTS

combines the positive-contact reliability of a plug with the automatic, self aligning convenience of sliding-type contacts. While in the test position, secondary contacts are easily disengaged or reengaged by a linkage operated from the front of the circuit breaker.



C. CURRENT TRANSFORMERS

are typically located behind mechanically actuated safety shutter and barrier that isolates the primary disconnects as the breaker is moved into the DISCONNECT position. Two standard accuracy CT's per phase can be accommodated on both the line and load sides of the breaker (as many as 12 CT's per breaker). CT's are front accessible after removal of the safety shutter and barrier.

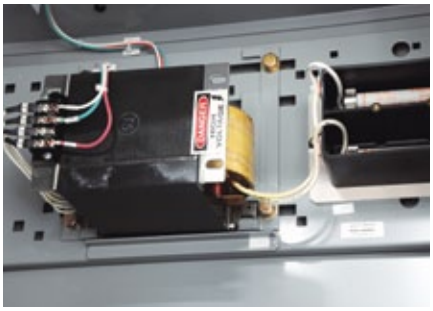


D. VOLTAGE TRANSFORMERS

meet all applicable industry standards and are mounted in an easy-access roll-out tray. VT's are automatically grounded upon withdrawal, tray provides isolation from primary connections.

E. DRY TYPE CONTROL POWER TRANSFORMERS

have molded epoxy resin insulation and are mounted in a draw out tray for easy access. Ratings run through 15kVA single phase. When a higher rating, or 3 CPT's, are required, a key interlock fused roll-out tray will be supplied with stationary CPT's mounted in the rear of the unit.



F. CABLE COMPARTMENT

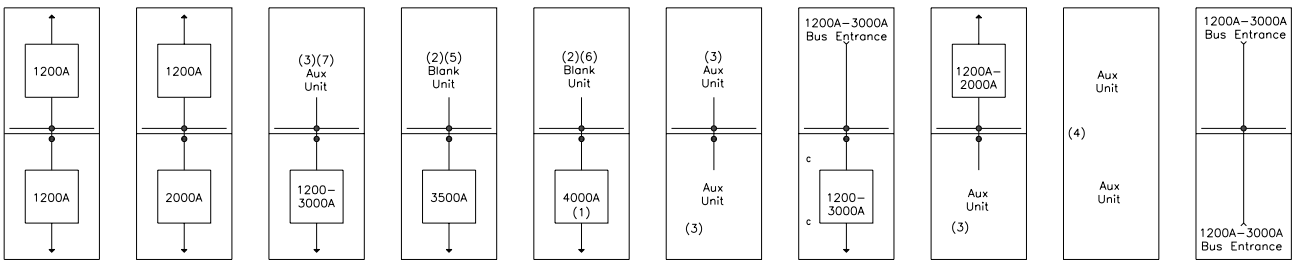
in a basic two-breaker vertical section has ample space for termination of up to two 750 MCM cables per phase, including stress cone makeup. When only one breaker is required in a vertical section, the entire cable space is available for use. In two-high breaker equipment, a vertical steel trough serves as a separation barrier from the other cable compartment. This duct is easily removed to facilitate initial installation of the "inside" cables. When the vertical steel duct is in place, there is still access to the "inside" terminations. The power cable compartment can be arranged to permit both sets of cables to exit below or above.

G. PORTABLE BREAKER LIFT

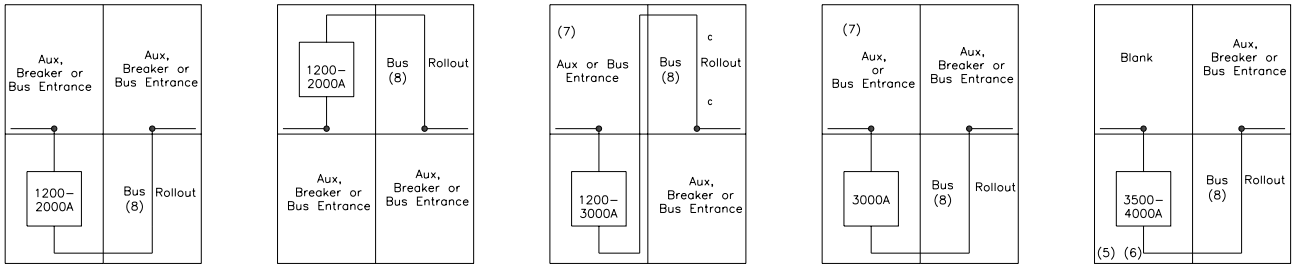
is provided for handling a breaker or roll-out during installation into a compartment, or during removal for inspection or maintenance. Lifts for both indoor and outdoor equipment have interlocks on the lifting forks to lock the breaker in place during transporting.

PVAC-E switchgear configuration

Standard Power/VAC Breaker Stacking Configurations



Standard Power/VAC Bus Tie Breaker Stacking Configurations

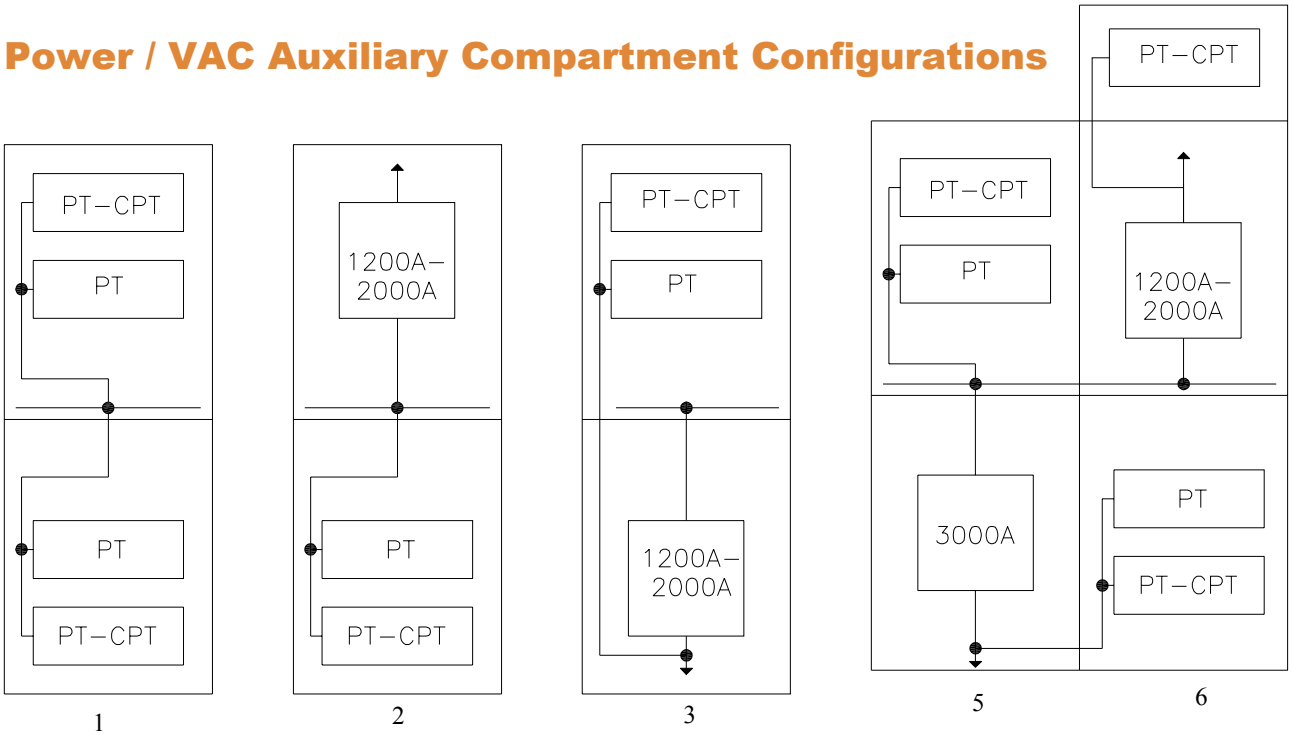


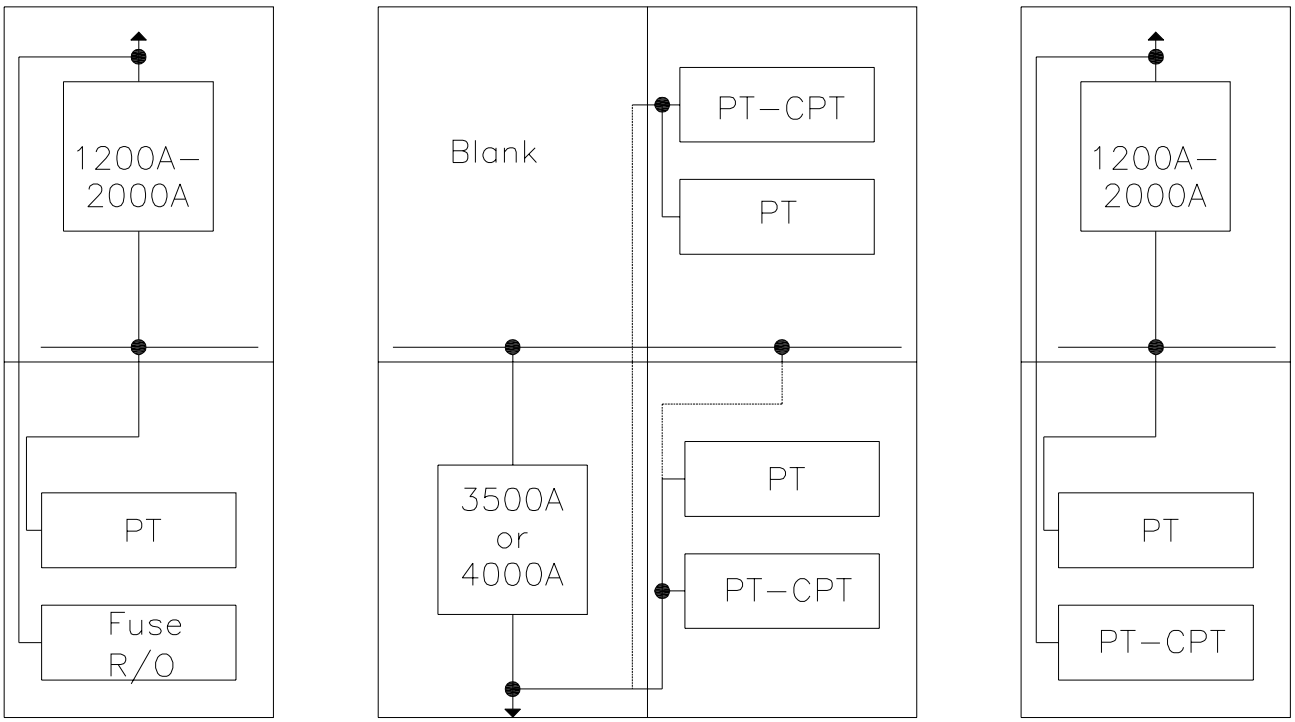
1. 4000A breaker require fans on top of structure for forced air cooling.
2. Blank Unit above 3500A & 4000A breakers have room for device mounting.
3. Auxiliary Units can contain roll-out tray for PTs & CPTs, or additional device mounting.
4. Full height Auxiliay Units can contain additional device mounting or be used for material storage.
5. 3500A must be derated to 3250A in outdoor construction.
6. 4000A is not available in outdoor construction.
7. Roll-out located above a 3000A breaker, are only available on indoor construction.
8. Auxiliary Bus Ties can contain 1 bus connected roll-out tray.

Notes:

- Each section in standard indoor construction is 36"Wx95"Hx94"D.
- Bus Ties always require two sections.
- Not all possible configurations shown,consult factory

Power / VAC Auxiliary Compartment Configurations





7 8 4

1. 4 high auxiliaries capability
2. 1200A/2000A breaker in A,two bus connected rollouts in B
3. 1200A/2000A breaker in B,two line connected rollouts in A
4. 1200A/2000A breaker in A,two rollouts in B, one line & one bus connected
5. 3000A breaker in B,two bus connected rollouts in A (Indoor only)
6. 1200A/2000A breaker in A, with line connected rollouts in superstructure. Two rollouts in B, line connected from adjacent section (3000A breaker)
7. 1200A/2000A breaker in A. Two rollouts in B,one line connected fused R/O, with large CPT mounted in rear
8. Two rollouts in A or B compartments, line connected to 3500A/4000A breaker in adjacent section, B compartment, or bus connected.

NOTES: ALL ROLLOUT TRAYS ARE HARD BUS CONNECTED. NO CABLE CONNECTED TRAYS. NOT ALL POSSIBLE CONFIGURATIONS SHOWN. CONSULT FACTORY OR GET-6600.

Devices	Ratings	Roll-out Unit	A Compartment		B Compartment	
			Lower	Upper	Lower	Upper
3-VTs (1)	5KV and 15KV	-	Yes	Yes	Yes	Yes
2-VTs (1)	5KV and 15KV	-	Yes	Yes	Yes	Yes
1-CPT (1)	5/10/15 KVA	-	No	Yes	Yes	No
1-CPT (2)	25, 37.5 KVA (4)	-	No	No	No	No
CPT Fuses (3)		Fused Unit	No	No	No	No

1. Fuses are an integral part of VT or CPT. CPTs are single phase.
2. CPT is installed in the rear cable compartment. CPT fuses are installed in a key interlocked fused roll-out in the Lower B compartment.
3. Fused rollout tray must be key-interlocked with remote CPT secondary breaker.
4. Consult factory for larger CPTs or 3-phase bank.

PVAC-E Switchgear Dimensions

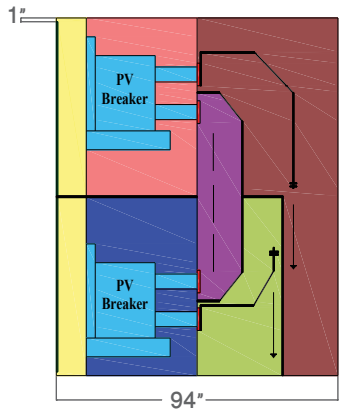
Equipment Rating		Indoor Equipment						Outdoor Equipment					
4.76KV, 8.25KV & 15KV				2-High Breaker Vertical Section (less breakers)		Auxiliary Vertical Section				2-High Breaker Vertical Section (less breakers)		Auxiliary Vertical Section	
Current Rating (Amps)	Breaker Weights (lbs)	Height (in)	Depth (in) (1)	Width (in)	Weight (lbs)	Width (in)	Weight (lbs)	Height (in)	Depth (in)	Width (in)	Weight (lbs) (2,5)	Width (in)	Weight (lbs)
1200	550	95	94	36	3050	36	2950	111 O/D 112 P/A or C/A	106 O/D 181 P/A 272 C/A	36	3550	36	3450
2000	650				3100		3000				3600		3500
3000	780				3180		3080				3680		3580
3500	850				3280		3180				3780		3680
4000	860				3300		3200				3800		3700

1. An optional 82” depth is available for some indoor applications. Consult factory
2. For Common Aisle construction (CA), add 1500 pounds to weight of two indoor vertical sections
3. Standard front aisle space required 66”, reduced minimum front aisle space of 58” is available on indoor construction
4. Weights listed are for estimating purposes only
5. For protected aisle construction (P/A), add 1100 pounds to weight of each outdoor vertical section.

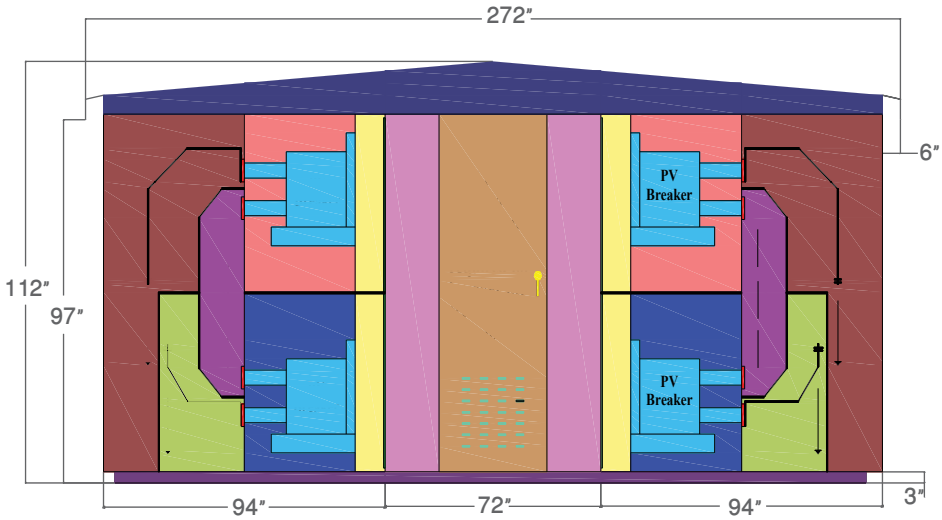
PVAC-E MV Metalclad Switchgear 4760V-15000V 20KA-63KA

Typical Section Dimensions

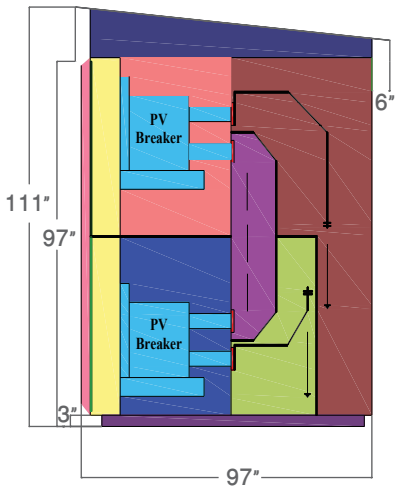
Indoor and Outdoor Equipment



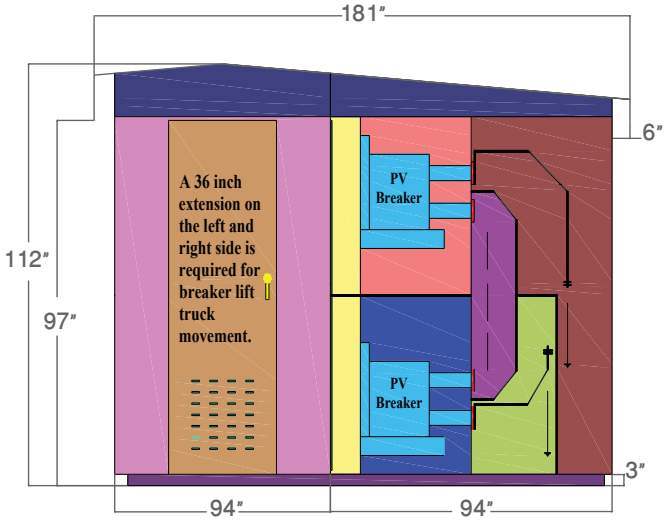
Indoor



Aisle
Outdoor Common Aisle



Outdoor Non - Walkin



Outdoor - Protected Aisle

PVAC-E switchgear characteristics

NEW POWER/VAC® Power Circuit Breaker Characteristics – KA Rated Symmetrical Rating Basis ANSI C37.06 (2000)

ANSI Rated Values									
Rated Maximum rms Voltage (kV) (1)	Rated Factor, K	Rated Withstand Test Voltage		Continuous rms Current Rating at 60HZ (amperes) (2)	Short Circuit rms Current Rating (at Rated Max. kV) (kA) (3)	Rated Interrupting time (Cycles)	Rated Permissible Tripping Delay, Y (Seconds)	2 Sec Short time Current Carrying Capability (kA)	Close and Latch Peak (2.6K x short circuit current rating) (kA)
		Low Frequency rms voltage (kV)	Crest Impulse Voltage (kV)						
4.76	1.0	19	60	1200-4000	31.5	5 or 3	2	31.5	82
				1200-4000	40	5 or 3		40	104
				1200-4000	50	5 or 3		50	130
				1200-4000	63*	5		63	164
				1200-4000	40	5 or 3		40	104
8.25				1200-4000	50*	5 or 3		50	130
				1200-4000	63*	5		63	164
				1200-4000	20	5 or 3		20	52
15		36	95	1200-4000	25	5 or 3		25	64
				1200-4000	31.5	5 or 3		31.5	82
				1200-4000	40	5 or 3		40	104
				1200-4000	50	5 or 3		50	130
				1200-4000	63	5		63	164

Notes:

1. Maximum voltage for which the breaker is designed and upper limit of operation.
2. 4000A rating is forced air-cooled, indoor construction only. 3500A must be derated to 3250A in outdoor construction.
3. Within the limitations stated in ANSI C37.04-1999.5.8.

* Exceeds ANSI C37.06-2000 preferred ratings.

PVAC-E switchgear characteristics

POWER/VAC® Power Circuit Breaker Characteristics – MVA Rated Symmetrical Rating Basis ANSI C37.06 (1987)

Identification		Rated Values									Related Required Capabilities			
		Voltage		Insulation Level		Current								
				Rated Withstand Test Voltage										
Nominal rms Voltage Class (kV)	Nominal 3-Phase Class (MVA) (6)	Rated Maximum rms Voltage (kV) (1)	Rated Voltage Range Factor (K) (2)	Low Frequency rms Voltage (kV)	Crest Impulse Voltage (kV)	Continuous rms Current Rating at 60Hz (amperes) (7) & (8)	Short Circuit rms Current Rating (at Rated Max.kV) (kA)(3)(4)	Rated Interrupting Time (cycles) (9)	Rated Permissible Tripping Delay, Y (Seconds)	Rated Maximum Voltage Divided by K (kV)	Maximum Symmetrical Interrupting Capability (5)	3 Sec Short Time Current Carrying Capability (6)	Closing and Latching Capability rms Current (kA) (10)	Close and Latch Peak (2.7K x max short circuit current rating) (kA) (6)
											K times Related Short circuit rms Current			
											(kA)	(kA)		
4.16	250	4.76	1.24	19	60	1200-4000	29	5	2	3.85	36	36	58	97
	350		1.19			1200-4000	41			4.0	49	49	78	132
	450 (6)		1.00			1200-4000	63			4.76	63	63	101	164
7.2	500	8.25	1.25	36	95	1200-4000	33			6.6	41	41	66	111
	785 (6)		1.00			1200-4000	63			8.25	63	63	101	164
13.8	500	15	1.30			1200-4000	18			11.5	23	23	37	63
	750		1.30			1200-4000	28			11.5	36	36	58	98
	1000		1.30			1200-4000	37			11.5	48	48	77	130
	1500 (6)		1.00			1200-4000	63			15	63	63	101	164

Notes:

1. Maximum voltage for which the breaker is designed and upper limit of operation.
2. K is the ratio of the maximum voltage to the lower limit of the range of operating voltage in which the required symmetrical and asymmetrical interrupting capabilities vary in inverse proportion to the operating voltage.
3. To obtain the required symmetrical interrupting capability of a circuit breaker at an operating voltage between 1/K times the rated maximum voltage and rated maximum voltage, the following formula shall be used:

   $$\textit{Required Symmetrical Interrupting Capability} = \textit{Rated short Circuit Current } X \frac{\textit{(Rated Maximum Voltage)}}{\textit{(Operating Voltage)}}$$

   For operating voltages below 1/K times the rated maximum voltage, the required symmetrical interrupting capability of the circuit breaker shall be equal to K times the rated short circuit current.
4. With the limitation stated in 5.10 of ANSI-C37.04-1991, all values apply for poly-phase and line-to-line faults. For single phase-to-phase faults, the specific conditions stated in 5.10.2.3 of ANSI-C37.04-1991 apply.
5. Current values in this column are not to be exceeded even for operating voltages below 1/K times the maximum voltage.
6. MVA Class listed for reference only. Note 4160V-450MVA, 7.2KV-785MVA and 13.8KV-1500MVA are

   not listed as preferred ratings according to table 2.1of ANSI-C37.06-1987. For these ratings the Short Time Current is on a 2 sec basis, and the peak C&L is 2.6 x S/C rating.
7. 3500A must be derated to 3250A in outdoor construction.
8. 4000A breaker is forced-air cooled, and indoor construction only.
9. 3 cycle interrupting ratings are available, consult factory.
10. Non-standard, high Close & Latch ratings are available, consult factory.

ABS Quality Evaluations

Certificate Of Conformance

This is to certify that the Quality Management System of:

Alfanar Electrical Systems

P. O. Box 564
Riyadh 11383
Saudi Arabia

has been assessed by ABS Quality Evaluations, Inc. and found to be in conformance with the requirements set forth by:

ISO 9001:2008

The Quality Management System is applicable to:

DESIGN AND MANUFACTURING OF LOW VOLTAGE SWITCHGEAR AND CONTROLGEAR ASSEMBLIES, MEDIUM VOLTAGE SWITCHGEAR AND CONTROLGEAR ASSEMBLES, ELECTRICAL WIRING ACCESSORIES, LOW, MEDIUM AND HIGH VOLTAGE CABLES, OVERHEAD CONDUCTORS AND DISTRIBUTION TRANSFORMERS.

Additional Facility: P.O. Box 282735
Dubai Investment Park
Dubai
United Arab Emirates

Activity: Multi purpose electrical enclosure manufacturing AND Low voltage Switchgear Assembly.

Certificate No:	34039
Certification Date:	27 January 2009
Effective Date:	14 December 2011
Expiration Date:	13 December 2014
Issue Date:	14 December 2011

Alex Weisselberg, President

Validity of this certificate is based on the periodic audits of the management system defined by the above scope and is contingent upon prompt, written notification to ABS Quality Evaluations, Inc. of significant changes to the management system or components thereof.
ABS Quality Evaluations, Inc. 16855 Northchase Drive, Houston, TX 77060, U.S.A.
Validity of this certificate may be confirmed at www.abs-qe.com/cert_validation.

QUALITY POLICY

The Quality Policy of alfanar is to:

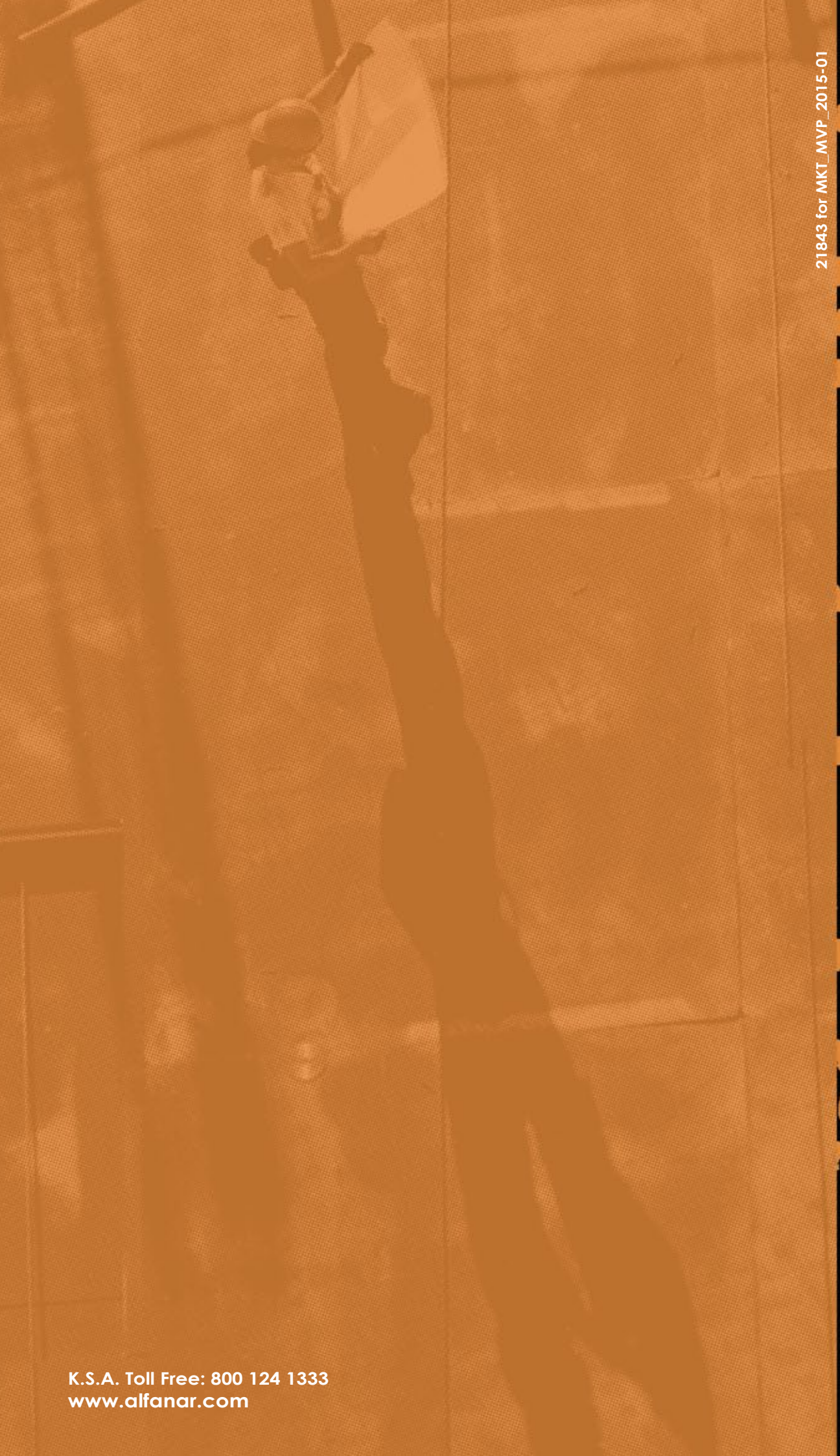
- Provide products conforming to governing standards and of consistent quality
- Excel in all our operations to achieve customer's satisfaction for products and services through continual improvement
- Develop and maintain a motivated team of competent employees and vendors
- Redefine and execute new processes and systems that meet the changing market requirements.

OUR OBJECTIVE

We reach exacting standards in the safety and distribution of power and go well beyond a customer's expectations. This is done by focusing our technology and expertise on the ultimate reward we can get, complete satisfaction of our customers.

alfanar PRODUCTS

- Oil-Immersed Distribution Transformers
- Switches and Socket Boxes
- Junction Boxes
- Service Enclosures IP65
- Stainless Steel Enclosures NEMA-4X
- Telephone Enclosures
- Circuit Breaker Enclosures – NEMA 1 & NEMA 3R Types with Multiple Outlets
- Modular Enclosures
- Load Centres
  - NEMA Type LA Load Centres
  - IEC Type LD Load Centres
  - Split Busbar Unit Type LAS/LDS Load Centres
- MCCB Distribution Boards
- Pump Control Panels
- Motor Control Centres
- LV Switchboards up to 6300A, Tested for 100KA, 1 Sec Short Circuit Withstand
- Package Substations
- Control and Automation Panels
- Relay and Control Panels
- Medium Voltage Switchgears
- Pole Mounted Metering Structures
- AC/DC Panels up to 5000A, Tested for 85kA, 1 Sec Short Circuit Withstand
- Extendable and Non-Extendable Ring Main Units



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As improvement of alfanar products is an ongoing process, technical specifications and other details shown in this catalogue may change from time to time

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