This publication sets forth the data required for the user to design a support structure or pedestals for a Mark VI Circuit-Switcher; the data required to properly construct foundations for a Mark VI Circuit-Switcher on S&C Mounting Pedestals; the maximum-continuous and permissible-peak terminal pad loading limits for a Mark VI Circuit-Switcher; pole-unit wiring requirements; and external wiring and battery requirements.

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Installation on a User-Furnished Support Structure

Checklist for Required Installation Materials

The following items are included with the Mark VI Circuit-Switcher:

- Three interrupters
- Three interrupter charging motors
- Three vertical-break disconnects★
- Hardware to attach the interrupters to the disconnects
- Hardware to attach the charging motors to the interrupters
- One drive-train gearbox (double offset)
- Interphase operating shaft sections, cut to length★
- Vertical operating shaft sections, cut to length★
- Drive-train couplings and associated hardware
- Mark VI CS-1A Switch Operator.

The following items *are not* included and must be furnished by the user:

- Mounting brackets and hardware to attach the Mark VI CS-1A Switch Operator to the structure
- Mounting brackets and hardware to attach the power-train gearbox to the structure
- Hardware to attach the conduit to the structure
- Conduit and wiring to electrically connect pole-units to operator.

All of the above items are included when S&C Mounting Pedestals are furnished.

Loadings for Support Structures

The high operating speed of the vertical-break disconnect (1.5-second total travel time on closing) brings about high acceleration and deceleration rates, which result in high dynamic forces transferred to the support structure and the adjoining bus. The support structure must be designed to withstand apparatus loads, dead-weight loads, wind loads, and ice loads. Structures should be designed to limit deflections as follows:

- Horizontal deflections of the structural section to which a pole-unit is attached should not exceed ⅜ inch in any direction.
- Horizontal deflections of the structural section under static wind load should not exceed one inch.
- The total of the rotational deflections of the switch operator and the gearbox support in resisting the switch operator locked-rotor torque of 21,500 inch-pounds (2429 Newton-meters) should not exceed 5°.
- Pole-units must be mounted vertically upright, at 90° ±15°.

For purposes of supporting-structure design, it is assumed that dynamic forces and static wind loads do not occur simultaneously. Generally, the bending moments produced by dynamic forces will dictate the design of the structure and the foundation. Forces produced by wind loads must be considered in the case of high structures, as these static bending moments may exceed the dynamic moments.

In these loading diagrams, no attempt has been made to indicate a specific arrangement of the supporting structure, since there are many ways in which it can be executed. However, the values shown provide complete loading data. (Steel pedestals are available from S&C which meet the requirements outlined herein.)

For further information on the arrangement of the components for a specific installation, refer to the catalog drawing supplied by S&C.

★ A drawing or specification detailing the configuration of the user-furnished structure must be made available to S&C Electric Company at the time of order. Vertical and interphase pipe is cut to length and mounting holes on the pole-unit base may need to be customized to the user-furnished structure.

How to Determine Total Bending Moments and Total Forces

M_{wt} and M_{wl} are the wind moments in the transverse and longitudinal directions, respectively, at each Circuit-Switcher pole-unit. F_{wt} and F_{wl} are the wind forces in the transverse and longitudinal directions, respectively, at each Circuit-Switcher pole-unit. For individual pole-units mounted on independent structures of height "B," the maximum bending moment at the foundation may be found as follows:

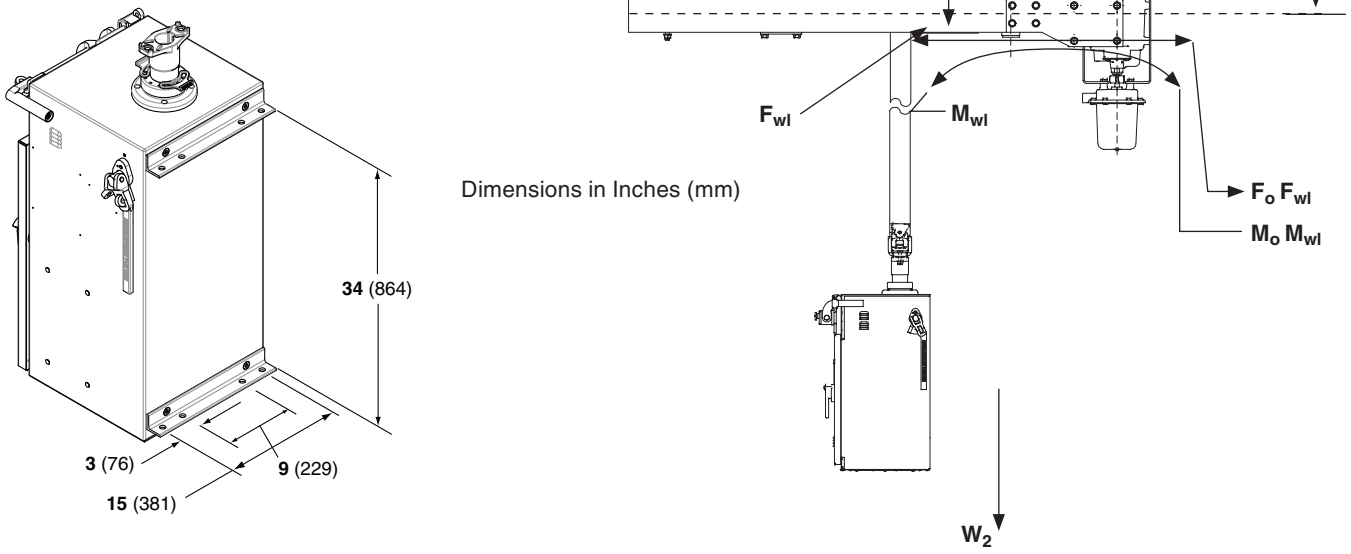
Transverse: M_{wt} + (F_{wt} × B)+ (Bending moment from wind acting on structure)

Longitudinal: M_{wl} + (F_{wl} × B) + (Bending moment from wind acting on structure)

F_c and F_o appear as forces at the Circuit-Switcher terminal pads accompanying closing and opening operations. F_c is a direct compression force resulting from closing of the Circuit-Switcher. F_o is a shear force parallel to the pole-unit base. M_o is a turning moment tending to rotate the pole-unit in a counterclockwise direction as viewed in the elevation drawings. Limiting deflections of the Circuit-Switcher supporting members to recommended values will ensure that these forces will be absorbed by the structures and not transferred to adjoining bus or other apparatus (e.g., bushings). Use of expansion joints at Circuit-Switcher terminal pads will compensate for inherent insulator-column deflection.

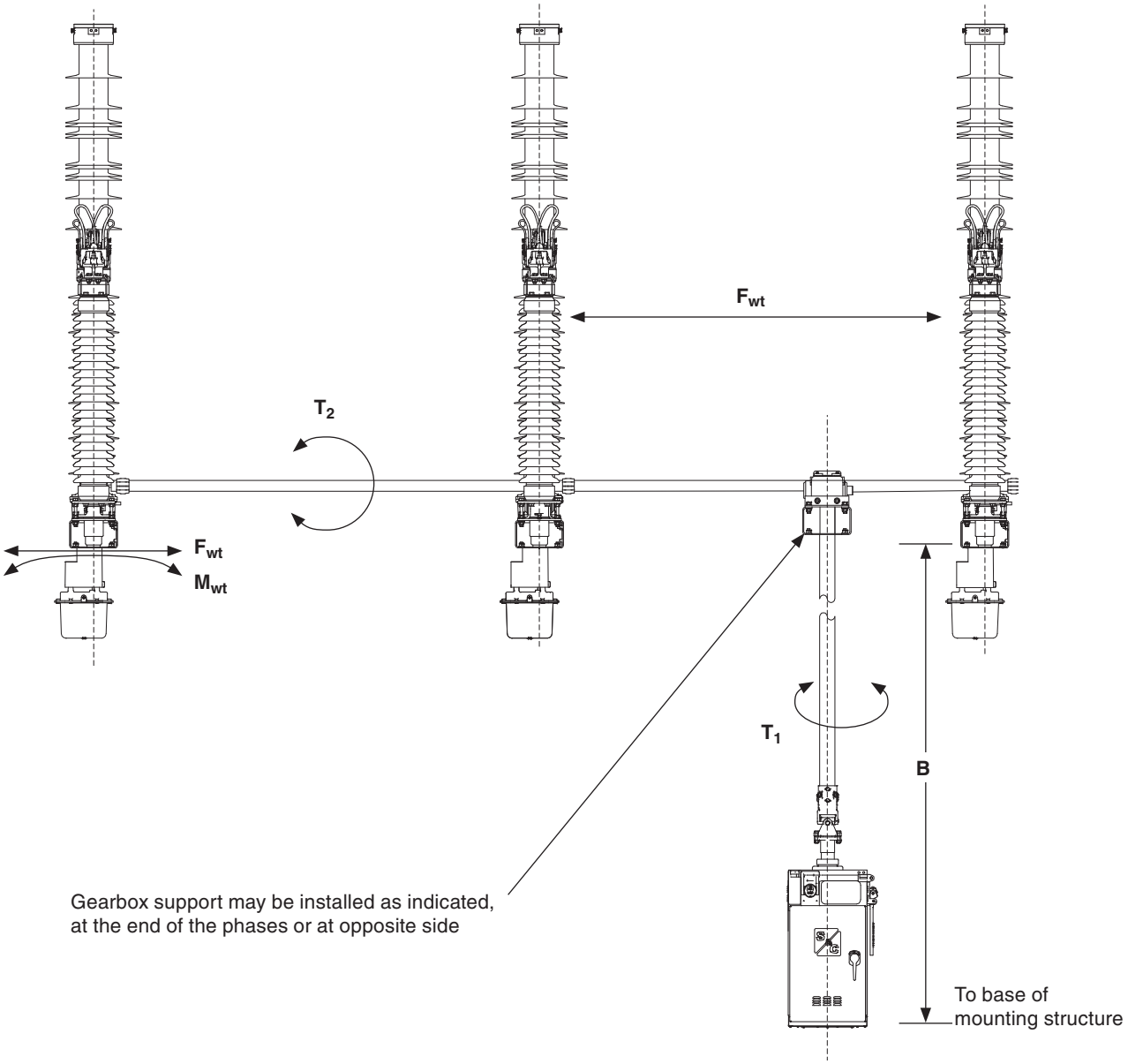
LEGEND:

- **A** = Moment arm of force F_o
- **B** = Height of pedestal or supporting structure
- **F_c** = Dynamic force accompanying closing operation
- **F_o** = Dynamic force accompanying opening operation
- **F_{wl}** = Static wind force, longitudinal
- **F_{wt}** = Static wind force, transverse
- **M_o** = Dynamic bending moment (= F_o 3 A)
- **M_{wl}** = Static wind bending moment, longitudinal
- **M_{wt}** = Static wind bending moment, transverse
- **T_1** = Switch operator locked-rotor torque
- **T_2** = Torque delivered to interphase shaft
- **W_1** = Weight of one Circuit-Switcher pole-unit
- **W_2** = Weight of switch operator
- **X** = Horizontal distance from the centerline of rotating insulator stack to center of gravity
- **Y** = Vertical distance from center of gravity to bottom of base



Dimensions in Inches (mm)

Switch operator mounting-hole spacing, inches (mm)



MAXIMUM LOADING DATA—Per pole-unit①														
Rating, kV	F_C, lbs. (New-tons)②	F_O, lbs. (New-tons)②	F_{WI}, lbs. (New-tons)②	F_{wt}, lbs. (New-tons)②	M_O, in.-lbs. (Newton-meters)②	M_{WI}, in.-lbs. (Newton-meters)②	M_{wt}, in.-lbs. (Newton-meters)②	T_1, in.-lbs. (Newton-meters)	T_2, in.-lbs. (Newton-meters)	W_1, lbs. (kg)②③	W_2, lbs. (kg)	A, in. (mm)	X, in. (mm)	Y, in. (mm)
69	225 (1001)	200 (890)	410 (1824)	425 (1890)	17,400 (1966)	7,500 (847)	9,000 (1017)	21,500 (2429)	20,000 (2260)	730 (329)	350 (158)	87 (2210)	5.5 (140)	22 (559)
115	350 (1557)	275 (1223)	530 (2358)	580 (2580)	31,400 (3548)	16,500 (1864)	18,200 (2056)	21,500 (2429)	20,000 (2260)	1040 (468)	350 (158)	114 (2896)	15 (381)	30 (762)
138	450 (2002)	350 (1557)	560 (2491)	625 (2780)	45,200 (5107)	20,500 (2316)	22,000 (2486)	21,500 (2429)	20,000 (2260)	1120 (504)	350 (158)	129 (3277)	19 (483)	34.5 (876)

① Values shown assume 100-mph (160-kmph) wind velocity.

② Per Circuit-Switcher pole-unit.

③ For Pre-insertion Inductors Option "-P6," add 240 lbs. (109 kg) per pole-unit (W1). For Pre-insertion Inductors Option "-P61," add 215 lbs. (97 kg) per pole-unit.

Foundation Loading Data for S&C Mounting Pedestals

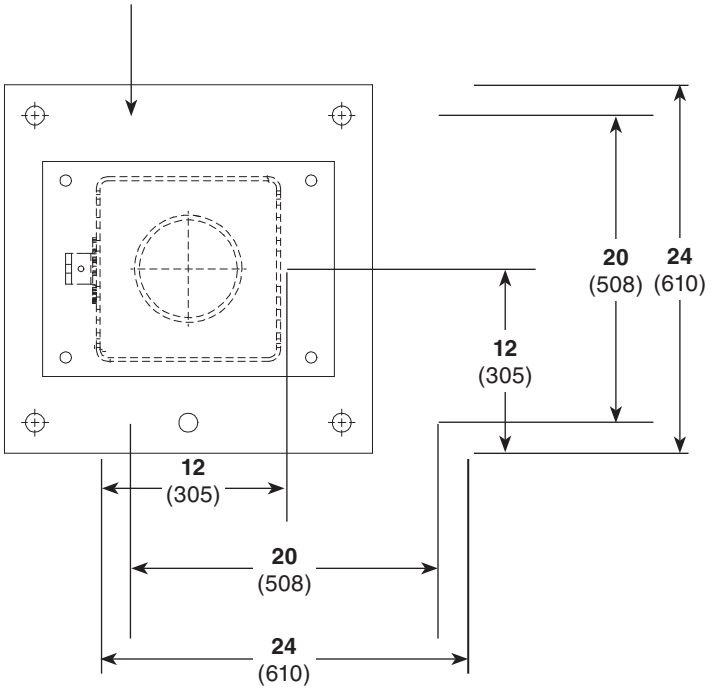
The following tables provide the loading data necessary to properly construct foundations for Mark VI Circuit-Switcher pole-units installed on S&C Mounting Pedestals. This loading data is based on the most-adverse combination of maximum terminal-pad loading limits and accounts for the dead-weight contribution of the Mark VI Circuit-Switcher, Mark VI CS-1A Switch Operator, and S&C Mounting Pedestal(s), along with wind loading of 100 miles (160 kilometers) per hour.

Mark VI Circuit-Switcher, when installed with the recommended S&C anchor bolts and with flexible-conductor connections at all six terminal pads, is capable of withstanding seismic loading of 0.2 g ground acceleration in any direction, as well as performing as intended during such loading and afterward.

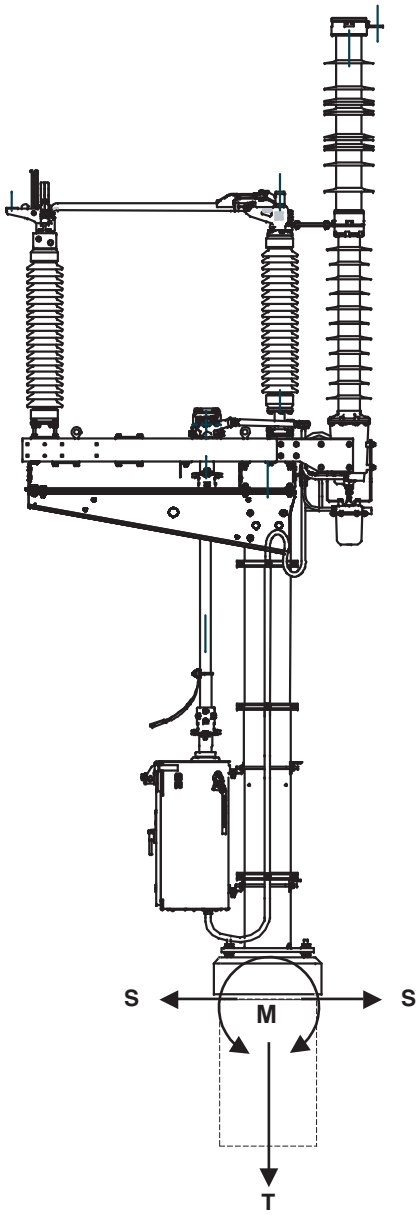
Dimensions in Inches (mm)

4 × ∅ 1¼ (32)
FOR TWO-PEDESTAL SWITCHES

4 × ∅ 1½ (38)
FOR SINGLE-PEDESTAL SWITCHES



MOUNTING PEDESTAL BASE DETAIL



MOUNTING-PEDESTAL FOUNDATION LOADING DATA—Mark VI Circuit-Switcher①②								
Rating, kV	Phase Spacing, inches (mm)	Pedestal Height, inches (mm)	Mounting Pedestal Suffix	Bending Moment, M, ft.-lbs. (Newton-meters)	Shear Load, S, lbs. (Newtons)	Thrust Load, T, lbs. (Newtons)		
						Static	Dynamic	Total
69	51 (1295)	96 (2438)	-E84	28,000 (37963)	3,200 (14234)	3,800 (16903)	3,000 (13345)	6,800 (30248)
		120 (3048)	-E104	34,000 (46098)	3,300 (14679)	3,900 (17348)	3,000 (13345)	6,900 (30693)
		144 (3658)	-E124	40,500 (54911)	3,400 (15124)	4,000 (17793)	3,000 (13345)	7,000 (31138)
	84 (2134)	96 (2438)	-E88	20,000 (27116)	2,100 (9341)	2,600 (11565)	1,500 (6672)	4,100 (18238)
		120 (3048)	-E108	24,000 (32540)	2,200 (9786)	2,700 (12010)	1,500 (6672)	4,200 (18683)
		144 (3658)	-E128	28,000 (37963)	2,300 (10231)	2,800 (12455)	1,500 (6672)	4,300 (19127)
115	84 (2134)	96 (2438)	-E88	27,500 (37285)	2,300 (10231)	3,000 (13345)	1,500 (6672)	4,500 (20017)
		120 (3048)	-E108	32,000 (43386)	2,400 (10676)	3,100 (13789)	1,500 (6672)	4,600 (20462)
		144 (3658)	-E128	36,500 (49487)	2,500 (11121)	3,200 (14234)	1,500 (6672)	4,700 (20907)
	96 (2438)	96 (2438)	-E89	27,500 (37285)	2,400 (10676)	3,100 (13789)	1,500 (6672)	4,600 (20462)
		120 (3048)	-E109	32,000 (43386)	2,500 (11121)	3,200 (14234)	1,500 (6672)	4,700 (20907)
		144 (3658)	-E129	36,500 (49487)	2,500 (11121)	3,300 (14679)	1,500 (6672)	4,800 (21351)
	102 (2591)	96 (2438)	-E81	27,500 (37285)	2,400 (10676)	3,100 (13789)	1,500 (6672)	4,600 (20462)
		120 (3048)	-E101	32,000 (43386)	2,500 (11121)	3,200 (14234)	1,500 (6672)	4,700 (20907)
		144 (3658)	-E121	36,500 (49487)	2,600 (11565)	3,300 (14679)	1,500 (6672)	4,800 (21351)
138	84 (2134)	96 (2438)	-E88	31,500 (42708)	2,500 (11121)	3,100 (13789)	1,500 (6672)	4,600 (20462)
		120 (3048)	-E108	36,500 (49487)	2,600 (11565)	3,200 (14234)	1,500 (6672)	4,700 (20907)
		144 (3658)	-E128	41,500 (56267)	2,700 (12010)	3,300 (14679)	1,500 (6672)	4,800 (21351)
	96 (2438)	96 (2438)	-E89	32,000 (43386)	2,500 (11121)	3,200 (14234)	1,500 (6672)	4,700 (20907)
		120 (3048)	-E109	36,500 (49487)	2,600 (11565)	3,300 (14679)	1,500 (6672)	4,800 (21351)
		144 (3658)	-E129	41,500 (56267)	2,700 (12010)	3,400 (15124)	1,500 (6672)	4,900 (21796)
	102 (2591)	96 (2438)	-E81	32,000 (43386)	2,500 (11121)	3,200 (14234)	1,500 (6672)	4,700 (20907)
		120 (3048)	-E101	36,500 (49487)	2,600 (11565)	3,300 (14679)	1,500 (6672)	4,800 (21351)
		144 (3658)	-E121	41,500 (56267)	2,700 (12010)	3,400 (15124)	1,500 (6672)	4,900 (21796)

① A single column is used for 69-kV Mark VI Circuit-Switchers with 51-inch phase spacing. All other models use two columns.

② Values for Pre-insertion Inductors are included in the foundation loading data.

TERMINAL-PAD LOADING LIMITS

TERMINAL-PAD LOADING LIMITS—In-line loads in the same direction①②												
Rating, kV	In-Line with Terminal Pads				Perpendicular to Terminal Pads④				Vertical to Terminal Pads			
	Maximum Continuous		Permissible Peak③		Maximum Continuous		Permissible Peak③		Maximum Continuous		Permissible Peak③	
	L_U, lbs. (Newtons)	L_L, lbs. (Newtons)	L_U, lbs. (Newtons)	L_L, lbs. (Newtons)	P_U, lbs. (Newtons)	P_L, lbs. (Newtons)	P_U, lbs. (Newtons)	P_L, lbs. (Newtons)	V_U, lbs. (Newtons)	V_L, lbs. (Newtons)	V_U, lbs. (Newtons)	V_L, lbs. (Newtons)
69	50 (224)	150▲ (672)	65 (291)	300■ (1345)	20 (90)	75▲ (336)	30 (134)	150■ (672)	250 (1112)	250 (1112)	250 (1112)	250 (1112)
115	50 (224)	150▲ (672)	65 (291)	300■ (1345)	20 (90)	75▲ (336)	30 (134)	150■ (672)	250 (1112)	250 (1112)	250 (1112)	250 (1112)
138	50 (224)	150▲ (672)	65 (291)	300■ (1345)	20 (90)	75▲ (336)	30 (134)	150■ (672)	250 (1112)	250 (1112)	250 (1112)	250 (1112)

① Higher terminal-pad loading combinations for the disconnect and interrupter terminal pads may be possible, depending on the loads each is required to carry. Contact the nearest S&C Sales Office for more information.

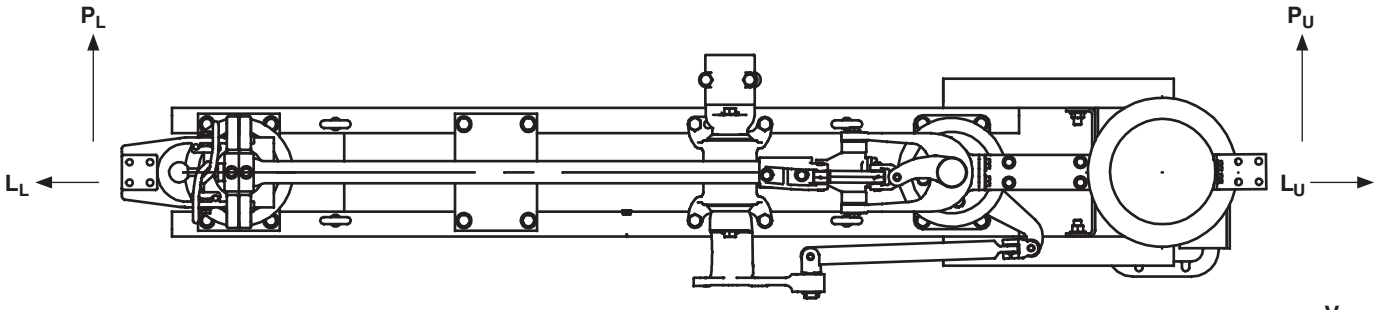
② Terminal pad ½″×3″ #356-T6 aluminum alloy for lower terminal and ½″×3″ tin-plated copper on upper terminal.

③ Permissible-peak loads are calculated at wind loads of 100 miles (160 kilometers) per hour. For terminal-pad loading limits at higher wind loads, contact the nearest S&C Sales Office.

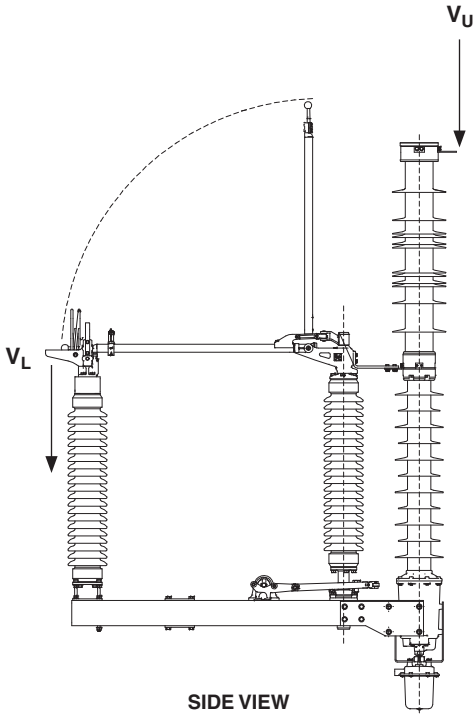
④ Perpendicular loads are calculated at a maximum pull-off angle of 30° from in-line. Contact the nearest S&C Sales Office if a more severe pull-off angle is required.

▲ With Pre-insertion Inductor Option "-P61" or "-P6" terminal-pad load is limited to 50 lbs. (224 N) on the disconnect end.

■ With Pre-insertion Inductor Option "-P61" or "-P6" terminal-pad load is limited to 100 lbs. (449 N) on the disconnect end.



TOP VIEW



SIDE VIEW

LEGEND:

L_U = Interrupter terminal pad, in-line loads
L_L = Disconnect terminal pad, in-line loads
P_U = Interrupter terminal pad, perpendicular loads
P_L = Disconnect terminal pad, perpendicular loads
V_U = Interrupter terminal pad, vertical loads
V_L = Disconnect terminal pad, vertical loads

Battery and Wiring Requirements

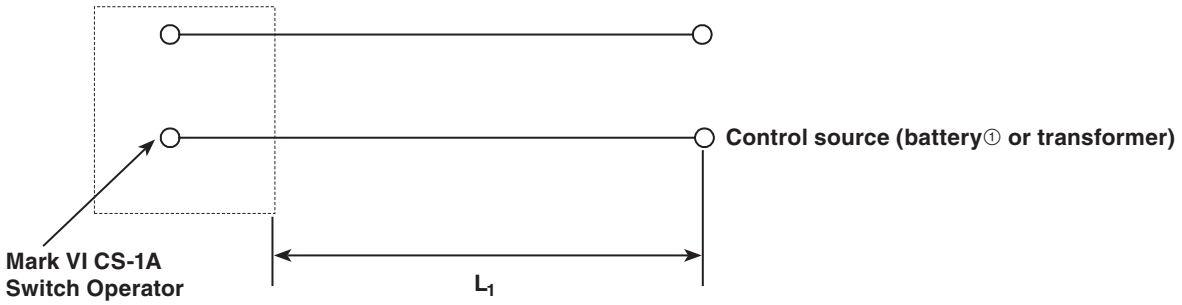
Interrupters are shipped with 12 inches (305 mm) of 20-gauge wire running from the electrical junction boxes, with butt splices on the ends for connection to pole-unit wiring. S&C recommends use of 18-gauge tinned stranded wire to connect the interrupters and motor operators to the Mark VI CS-1A Switch Operator. Shielded wire is not required.

S&C Mounting Pedestals include all necessary wiring and conduits to connect the interrupters to the Mark VI CS-1A Switch Operator. If the Mark VI Circuit-Switcher is to be installed on a user-furnished support structure or pedestals, the user must furnish the appropriate wiring and conduit.

Optional quick-connect cable is available by specifying catalog number suffix "-C2" or "-C3." Amphenol® Tri-Start connectors will be supplied in place of the interrupter electrical junction box and charging motor wiring.▲

▲ Amphenol® is a trademark of Amphenol Aerospace Division of the Amphenol Corporation.

MARK VI CIRCUIT-SWITCHER—Mark VI CS-1A Switch Operator



Catalog Number Suffix	Schematic Wiring Diagram Drawing	Control Source Voltage	Motor		Minimum Size of Control Wire for Line L1, A.W.G.②						
			Rating, Volts	Accelerating Current at Rated Voltage, Amperes	Distance, Feet						
					100	200	300	400	500	1000	2000
-A	CDR-6514	48 V dc	48	80	6	4	2	1	1/0	4/0	—
-B	CDR-6515	125 V dc	125	30	12	10	8	8	6	4	1
-D	CDR-6516	115 V 60 Hz	115	46	10	6	6	4	2	1/0	—

① Recommended minimum battery rating for Mark VI Type CS-1A Switch Operator is:

Volts, dc	One-Minute Discharge Rate, Amperes
48	75
125	36

② Where long distances and large wire sizes are encountered, comparative cost of relocating battery closer to switch operator should be considered.