Inspection Recommendations

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Qualified Persons

⚠ WARNING

Only qualified persons knowledgeable in the installation, operation, and maintenance of overhead and underground electric distribution equipment, along with all associated hazards, may install, operate, and maintain the equipment covered by this publication. A qualified person is someone trained and competent in:

- The skills and techniques necessary to distinguish exposed live parts from nonlive parts of electrical equipment
- The skills and techniques necessary to determine the proper approach distances corresponding to the voltages to which the qualified person will be exposed
- The proper use of special precautionary techniques, personal protective equipment, insulated and shielding materials, and insulated tools for working on or near exposed energized parts of electrical equipment

These instructions are intended only for such qualified persons. They are not intended to be a substitute for adequate training and experience in safety procedures for this type of equipment.

Read This Instruction Sheet

NOTICE

Thoroughly and carefully read this instruction sheet and all materials included in the product's instruction handbook before inspecting the Mark V Circuit-Switcher. Become familiar with the Safety Information on page 3 and Safety Precautions on page 4. The latest version of this publication is available online in PDF format at **sandc.com/en/contact-us/product-literature/**.

Retain This Instruction Sheet

This instruction sheet is a permanent part of the Mark V Circuit-Switcher. Designate a location where users can easily retrieve and refer to this publication.

Proper Application

⚠ WARNING

The equipment in this publication is only intended for specific applications. The application must be within the ratings furnished for the equipment. Ratings for the Mark V Circuit-Switcher are listed in the ratings table in Specification Bulletin 711-31. The ratings are also on the nameplate affixed to the product.

Understanding Safety-Alert Messages

Several types of safety-alert messages may appear throughout this instruction sheet and on labels and tags attached to the product. Become familiar with these types of messages and the importance of these signal words:

⚠ DANGER

"DANGER" identifies the most serious and immediate hazards that will likely result in serious personal injury or death if instructions, including recommended precautions, are not followed.

⚠ WARNING

"WARNING" identifies hazards or unsafe practices that can result in serious personal injury or death if instructions, including recommended precautions, are not followed.

⚠ CAUTION

"CAUTION" identifies hazards or unsafe practices that can result in minor personal injury if instructions, including recommended precautions, are not followed.

NOTICE

"NOTICE" identifies important procedures or requirements that can result in product or property damage if instructions are not followed.

Following Safety Instructions

If any portion of this instruction sheet is unclear and assistance is needed, contact the nearest S&C Sales Office or S&C Authorized Distributor, or call the S&C Global Support and Monitoring Center at 1-888-762-1100. Telephone numbers are also listed on S&C's website, sandc.com.

NOTICE

Read this instruction sheet thoroughly and carefully before inspecting or maintaining the Mark V Circuit-Switcher.

Replacement Instructions and Labels

If additional copies of this instruction sheet are required, contact the nearest S&C Sales Office, S&C Authorized Distributor, S&C Headquarters, or S&C Electric Canada Ltd.

It is important any missing, damaged, or faded labels on the equipment be replaced immediately. Replacement labels are available by contacting the nearest S&C Sales Office, S&C Authorized Distributor, S&C Headquarters, or S&C Electric Canada Ltd.

⚠ DANGER

Mark V Circuit-Switchers operate at high voltage. Failure to observe the precautions below will result in serious personal injury or death.

Some of these precautions may differ from your company's operating procedures and rules. Where a discrepancy exists, follow your company's operating procedures and rules.

1. **QUALIFIED PERSONS.** Access to Mark V Circuit-Switchers must be restricted only to qualified persons. See the "Qualified Persons" section on page 2.
2. **SAFETY PROCEDURES.** Always follow safe operating procedures and rules.
3. **PERSONAL PROTECTIVE EQUIPMENT.** Always use suitable protective equipment, such as rubber gloves, rubber mats, hard hats, safety glasses, and flash clothing, in accordance with safe operating procedures and rules.
4. **SAFETY LABELS**. Do not remove or obscure any of the "DANGER," "WARNING," "CAUTION," or "NOTICE" labels.
5. **OPERATING MECHANISM AND BASE.** Mark V Circuit-Switchers contain fast-moving parts that can severely injure fingers. Do not remove or disassemble operating mechanisms or remove access panels unless directed by S&C Electric Company.
6. **ENERGIZED COMPONENTS.** Always consider all parts live until de-energized, tested, and grounded. Voltage levels can be as high as the peak line-to-ground voltage last applied to the unit. Units that have been energized or installed near energized lines should be considered live until tested and grounded.
7. **GROUNDING.** The Mark V Circuit-Switcher must be connected to a suitable earth ground at the base of the utility pole, or to a suitable building ground for testing, before energizing the switch and at all times when energized.

   The ground wire(s) must be bonded to the system neutral, if present. If the system neutral is not present, proper precautions must be taken to ensure the local earth ground, or building ground, cannot be severed or removed.
8. **SWITCH POSITION.** Always confirm the **Open/Close** position of each switch.
   - Switches and terminal pads may be energized from either side.
   - Switches and terminal pads may be energized with the switches in any position.
9. **MAINTAINING PROPER CLEARANCE.** Always maintain proper clearance from energized components.

Before Starting

To ensure a Mark V Circuit-Switcher's continued proper performance, it should be inspected in accordance with the recommended schedule and procedures contained in this publication. Table 1 on page 6 and Table 2 on page 7 indicate the frequency with which each major circuit-switcher component should be inspected. Table 3 on page 8 and Table 4 on page 9 list a summary of inspection procedures appropriate for each component.

These inspection recommendations are applicable to Mark V Circuit-Switcher models having one, two, or three interrupting gaps per pole-unit.

Recommended Inspection Schedule

A mechanical-operations test value is indicated in Table 1 on page 6 and Table 2 on page 7 for those Mark V Circuit-Switcher components affected by the number of mechanical operations performed. It is a guideline to the number of **Open/Close** operations expected for the component before replacement is required.

Electrical operations limits are listed for the interrupter and disconnect live parts because these components are affected by the number of electrical operations performed. These limits depend on the circuit-switcher application, magnitude of current switched and, in some cases, the style of circuit-switcher involved. For the interrupter and disconnect live parts, the electrical operations limit may provide a more accurate guideline for the number of **Open/Close** operations expected before replacement is required.

The actual number of **Open/Close** operations for a component will depend on the nature of the application, the environment (e.g., whether subject to temperature or humidity extremes or highly corrosive or dusty atmospheres), and the observance of the recommended inspection schedule.

An inspection frequency is shown for each component. To maximize the operating life of the component, S&C recommends the user perform the inspection procedures in Table 1 on page 6 and Table 2 on page 7 at the frequency indicated by a "●"—either in number of **Open/Close** operations or years, whichever occurs more often. If the inspection results indicate or if dictated by the mechanical operations test value or electrical operations limit guideline, the component should be replaced.

Each user's own experience will determine whether more frequent inspections are required.

Note: For most transformer-protection applications, the circuit-switcher inspection frequency is approximately five years, consistent with many utilities' transformer-inspection practices.

Table 1. Recommended Inspection Schedule for S&C Mark V Circuit-Switcher Components

Component	Mechanical-Operations Test Value①, Number of Open/Close Operations	Electrical-Operations Limit				Inspection Frequency②							
		Application	Maximum Current, Amperes	Circuit-Switcher Style	Number of Open/Close Operations	Number of Open/Close Operations						Number of Years	
						1 or 2	125	250	500	1 000	2 500	1	5
Switch operator, power train, brain, and shunt-trip device	5 000	—	—	—	—						●■		●■
Interrupter	5 000	Capacitor, reactor, or load switching	250	All	5 000						●▲		●▲
			550		2 000					●▲			
			1 000		1 000				●▲				
		Load switching	1 200	All	750			●▲					
			1 600	Center-break	500			●▲					
			2 000		250		●▲						
		Fault interrupting	Secondary-fault interrupting rating of circuit-switcher	All	25	Not applicable							
			Primary-fault interrupting rating of circuit-switcher	All	10								
Disconnect live parts	5 000	Capacitor, reactor, or load switching	250	All	5 000■						●◆		●
			550		2 000■					●◆			
			1 000	Vertical-break and integer with extra-performance closing contacts	1 000■				●◆				
				Vertical-break and integer without extra-performance closing contacts	500■			●◆					
				Center-break	1 000				●				
		Load switching	1 200	Vertical-break and integer with extra-performance closing contacts	750■			●◆					
				Vertical-break and integer without extra-performance closing contacts	350■		●◆						
				Center-break	750			●					
			1 600	Center-break	500			●					
			2 000		250		●						
		Fault closing	Fault-closing rating of circuit-switcher	All	2	●						Not applicable	

FOOTNOTES ON NEXT PAGE ►

① Based on mechanical operations tests perform by S&C using a new circuit-switcher with no intervening maintenance performed.

② Frequently operated circuit-switchers (typically 200 or more Open/Close operations a year) should be inspected after the first 250 operations. Thereafter, they should be inspected at the frequency indicated. Frequently operated circuit-switchers also require annual lubrication of the disconnect live parts. See Table 3 on page 8.

● Recommended inspection frequency.

■ Shunt-trip equipped 69-kV single-gap circuit-switchers in ungrounded capacitor-switching applications must be inspected and the brains adjusted, as necessary, every 1000 operations to prevent the occurrence of occasional restrikes during opening operations. Non-shunt-trip equipped 69-kV single-gap circuit-switchers in ungrounded capacitor-switching applications must be inspected and the brains adjusted, as necessary, every 500 operations to prevent the occurrence of occasional restrikes during opening operations. See S&C Instruction Sheet 711-515.

▲ Interrupters should be checked for low gas pressure (red targets) during the user's normal day-to-day operating procedures.

◆ For vertical-break style and integer style circuit-switchers manufactured before 1983, the electrical operations limit of the disconnect live parts is approximately one-half of the value indicated because the closing contacts on these circuit-switchers apply lower contact pressure. Consequently, the recommended inspection frequency for the disconnect live parts of these circuit-switchers, in number of **Open/Close** operations, is one-half of the value indicated. Present-design closing contacts are available for field retrofit; refer to the nearest S&C Sales Office.

Table 2. Recommended Inspection Schedule for S&C Mark V Circuit-Switcher Optional Components

Component	Mechanical-Operations Test Value①, Number of Open/Close Operations	Electrical-Operations Limit				Inspection Frequency②							
		Application	Maximum Current, Amperes	Circuit-Switcher Style	Number of Open/Close Operations	Number of Open/Close Operations						Number of Years	
						1 or 2	125	250	500	1 000	2 500	1	5
Pre-insertion inductor	—	—	—	—	—			●				■	
Bypass accessory	—	—	—	—	—	Not applicable							●
Grounding switch	—	—	—	—	—								●

① Based on mechanical operations tests perform by S&C using a new circuit-switcher with no intervening maintenance performed.

② Frequently operated circuit-switchers (typically 200 or more **Open/Close** operations a year) should be inspected after the first 250 operations. Thereafter, they should be inspected at the frequency indicated. Frequently operated circuit-switchers also require annual lubrication of the disconnect live parts. See Table 3 on page 8.

● Recommended inspection frequency.

■ Frequently operated circuit-switchers equipped with pre-insertion inductors require annual cleaning of the inductor windings. See Table 4 on page 9.

Recommended Inspection Procedures

The Mark V Circuit-Switcher inspection procedures to be followed are summarized in Table 3 and Table 4 on page 9. The applicable S&C instruction sheets for the circuit-switcher, switch operator, pre-insertion inductor, grounding switch, etc., should be referenced for further details.

Table 3. Recommended Inspection Procedures for S&C Mark V Circuit-Switcher Components

Component	Inspection Procedures
General	1. Check with the nearest S&C Sales Office to determine whether there are any outstanding field notifications involving inspection, maintenance, or retrofit. 2. Check the overall cleanliness of the insulators, live parts, and exterior of the operator. If there is severe contamination, power wash with water or clean using a non-abrasive cleaning method. After washing, reapply an appropriate contact lubricant to the disconnect live parts.①
Switch operator	1. Check for evidence of water ingress, damage, excessive corrosion, or wear. 2. Check the ease of operation during slow, manual cranking using the switch operator manual operating handle. Listen for simultaneity of tripping of the interrupters. From the point at which one interrupter trips, no more than 40° of rotation should be required before the other two interrupters trip. If excessive rotation is required, contact the nearest S&C Sales Office. 3. Simulate a fault by activating the protective relay circuit (if applicable). Check electrical operation, coupled and decoupled. 4. Check for loose wiring inside the enclosure and proper functioning of the position-indicating lamps, operation counter, convenience lamp, etc. 5. Check brake operation and adjust, if necessary. 6. Check the key interlocks, if furnished, mechanically and electrically.
Power train	1. Check for evidence of damage, excessive corrosion, or wear. 2. Check the fastener tightness. 3. Observe operation during slow, manual cranking using the switch operator manual operating handle. Check for complete stroking of the various drive levers against their stops and for attainment of over toggle positions, as required. 4. Check seal condition.
Brain	1. Remove the brain cover and check for evidence of water ingress, damage, excessive corrosion, or wear. 2. Check for tightness of shunt-cable fasteners and for evidence of excessive fraying of the shunt cable. 3. Check the seal condition. 4. Replace the brain cover. Observe operation during slow, manual cranking using the switch operator manual operating handle. Listen for the tripping action of the interrupter on opening and observe operation of the interrupter targets. 5. Check for proper clearances at the brain adjustment-holding device and at the blade crank-arm stop.
Shunt-trip device	1. Remove the shunt-trip solenoid-housing cover and check for evidence of water ingress, damage, excessive corrosion, or wear. 2. Check the seal condition. 3. Replace the shunt-trip solenoid-housing cover. Simulate a fault by activating the protective-relay circuit. Verify all three shunt-trip solenoids function and the switch operator motor follows through to open the disconnect.
Interrupter	1. Check for low gas pressure (red indicator). 2. Check the fastener tightness on current-carrying parts. 3. (Optional) Check the resistance using the resistance values in Table 5 on page 10 for a vertical-break or integer-style circuit-switcher or Table 6 on page 11 for a center-break style circuit-switcher.
Disconnect live parts	1. Check for evidence of damage, excessive corrosion, or wear—especially at the fault-closing contacts and current-carrying contacts. Replace current-carrying jaw contacts if the silver-alloy inserts on two or more contact fingers are worn to the extent the blade tongue contact engages the full width of the contact finger. 2. Check the fastener tightness on current-carrying parts. 3. Observe operation during slow, manual cranking using the switch operator manual operating handle. Check for proper contact alignment. 4. Lubricate the contact surfaces with an appropriate lubricant.①

① Shell Gadus® S2 U1000 2 Lubricant, catalog number 9999-043, is available in 1 oz. tubes from S&C. Shell Darina SD2, Dow 33, or equivalent can be substituted.

Table 4. Recommended Inspection Procedures for S&C Mark V Circuit-Switcher Optional Components

Component	Inspection Procedures
Pre-insertion inductor	1. Clean the exterior finish of inductor windings using a mild soap and water solution and a soft cloth. Inspect the fiberglass roving for damage or wear. 2. If the fiberglass roving is damaged, use the touch-up kit, S&C catalog number SA-42721, to refinish any damaged surfaces. First, thoroughly wire-brush the surface to be refinished. Then, sand with No. 1 sandpaper and No. 0 sandpaper to create a smooth surface. Brush on the paint according to the directions on the label and let dry for six hours. If the coiled conductor beneath the fiberglass roving is exposed, remove the inductor from service and contact your nearest S&C Sales Office for a replacement. 3. Inspect the moving and stationary arcing rods to verify their proper setting. Replace the arcing rods if they show significant wear or erosion.
Bypass accessory	1. Check for evidence of damage, excessive corrosion, or wear. 2. Check the fastener tightness on current-carrying parts. 3. Observe operation using the stick-operated ratchet mechanism. Check for proper contact alignment. 4. Lubricate the contact surfaces with an appropriate lubricant.①
Grounding switch	1. Check for evidence of damage, excessive corrosion, or wear—especially at the jaw-contact members. 2. Check the fastener tightness on current-carrying parts. 3. Observe operation using manual operating handle. Check for proper contact alignment. 4. Lubricate the contact surfaces with an appropriate lubricant.①

① Shell Gadus® S2 U1000 2 Lubricant, catalog number 9999-043, is available in 1 oz. tubes from S&C. Shell Darina SD2, Dow 33, or equivalent can be substituted.

Resistance Values

The allowable resistance values indicated in Table 5 on page 10 and Table 6 on page 11 are provided for the convenience of users whose practices include measuring and recording the resistance over current-carrying and current-interrupting components of a circuit-switcher. Such measurements are not required to fulfill the terms of S&C's circuit-switcher warranty and should only be made by qualified personnel fully trained in the measuring equipment and the techniques for making resistance measurements on high-voltage equipment. The measurements can be used to identify areas of high resistance, to be remedied by cleaning and maintenance, or component replacement.

⚠ DANGER

De-energize and ground the circuit-switcher at all six terminals before making resistance measurements. Follow all applicable safety procedures.

Failure to de-energize and ground the circuit-switcher before making resistance measurements can result in serious injury or death.

Interrupter

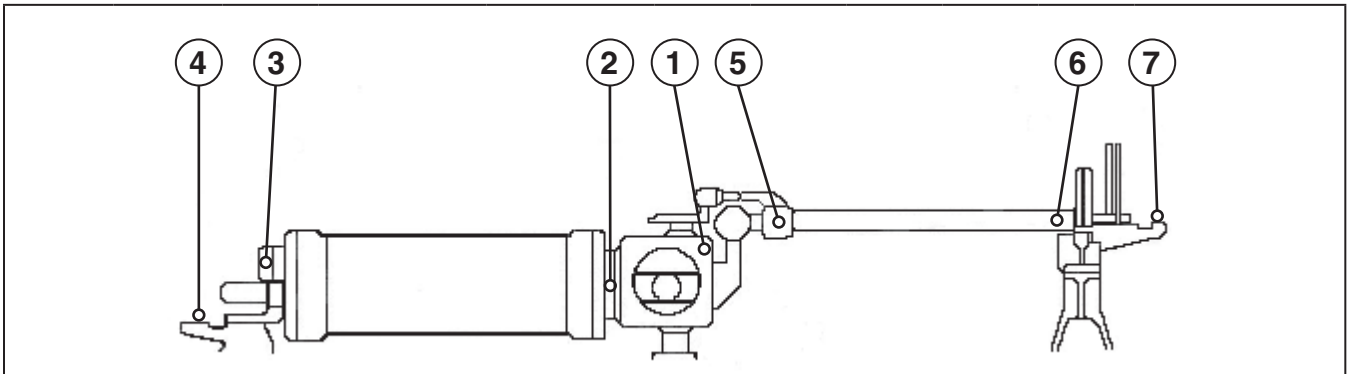
Measure the resistance between points 2 and 3 with the interrupter closed. If the measurement exceeds the allowable value indicated, measure the resistance between points 2 and 3 with the interrupter open. If that measurement exceeds the allowable value indicated, replace the interrupter.

Now, measure the resistance between points 1 and 4 with the interrupter closed. If the measurement exceeds the allowable value indicated, measure the resistance between points 1 and 2, and then measure the resistance between points 3 and 4. If either of those measurements exceeds the allowable value, disassemble the appropriate bolted connection, clean the surfaces, reapply an appropriate contact lubricant, and reassemble the connection.

Disconnect

Measure the resistance between points 4 and 7 with the interrupter closed. Subtract the value of resistance measured between points 2 and 3 with the interrupter closed. If the difference exceeds the allowable value for resistance between points 4 and 7, measure the resistance between points 6 and 7 and between points 1 and 5. If either of those measurements exceeds the allowable value, contact the nearest S&C Sales Office for assistance.

Table 5. Allowable Resistance Values for S&C Mark V Circuit-Switcher, Vertical-Break And Integer Styles



kV	Gaps	Allowable Resistance								
		In Microhms, Between Points								In Megohms, Between Points 2-3, Interrupter Open
		1-4●	2-3, Interrupter Closed		1-2	3-4	4-7■	1-5	6-7	
			Continuous Current Less Than 400 A	Continuous Current Greater Than 400 A						
34.5	1	30	600	200	15	15	130	40	40	–
46	1	30	600	200	15	15	140	40	40	–
69	1	30	600	200	15	15	160	40	40	–
	2		1 000	333						208–312
115	1	30	600	200	15	15	220	40	40	–
	2		1 000	333						208–312
138	1	30	600	200	15	15	230	40	40	–
	2		1 000	333						208–312
	3		1 500	500						312–468
161	2	30	1 000	333	15	15	240	40	40	208–312
	3		1 500	500						312–468

● Resistance between points 1 and 4 minus the actual resistance between points 2 and 3 with the interrupter closed.

■ Resistance between points 4 and 7 minus the actual resistance between points 2 and 3 with the interrupter closed.

⚠ DANGER

De-energize and ground the circuit-switcher at all six terminals before making resistance measurements. Follow all applicable safety procedures.

Failure to de-energize and ground the circuit-switcher before making resistance measurements can result in serious injury or death.

Interrupter

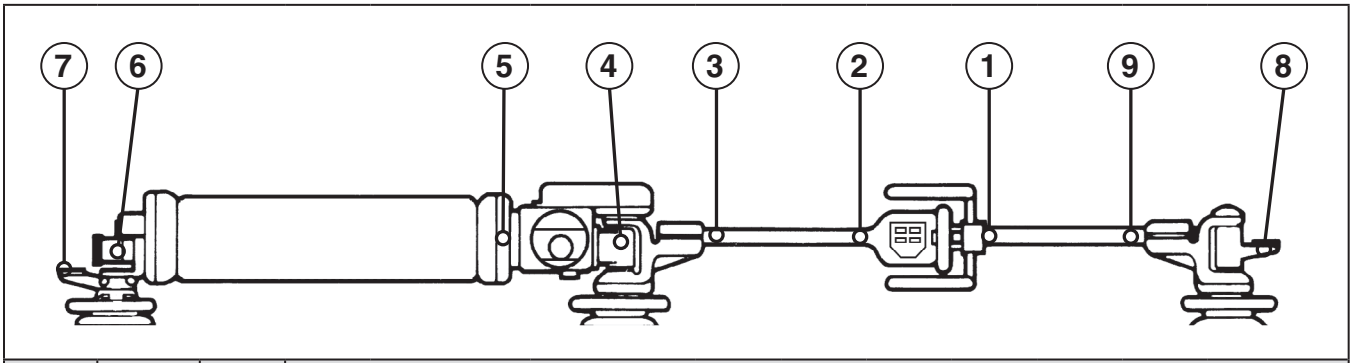
Measure the resistance between points 5 and 6 with the interrupter closed. If the measurement exceeds the allowable value indicated, measure the resistance between points 5 and 6 with the interrupter open. If that measurement exceeds the allowable value indicated, replace the interrupter.

Now, measure the resistance between points 4 and 7 with the interrupter closed. If the measurement exceeds the allowable value indicated, measure the resistance between points 4 and 5, and then measure the resistance between points 6 and 7. If either of those measurements exceeds the allowable value, disassemble the appropriate bolted connection, clean the surfaces, reapply an appropriate contact lubricant, and reassemble the connection.

Disconnect

Measure the resistance between points 7 and 8 with the interrupter closed. Subtract the value of resistance measured between points 5 and 6 with the interrupter closed. If the difference exceeds the allowable value for resistance between points 7 and 8, measure the resistance between points 8 and 9, between points 1 and 2, and between points 3 and 4. If any of those measurements exceeds the allowable value, contact the nearest S&C Sales Office for assistance.

Table 6. Allowable Resistance Values For S&C Mark V Circuit-Switcher, Center-Break Style



kV	Cont. Current, Amperes	Gaps	Allowable Resistance									
			In Microhms, Between Points									In Megohms, Between Points 5-6, Interrupter Open
			4-7●	5-6, Interrupter Closed		1-2	3-4	4-5	6-7	7-8■	8-9	
				Continuous Current Less Than 400 A	Continuous Current Greater Than 400 A							
230	1 600	3	30	1 500	500	30	30	15	15	165	30	312–468
	2 000									130		
345	1 600	3	30	1 500	500	30	30	15	15	225	30	312–468
	2 000											

● Resistance between points 4 and 7 minus the actual measured resistance between points 5 and 6 with the interrupter closed.

■ Resistance between points 7 and 8 minus the actual measured resistance between points 5 and 6 with the interrupter closed.