## 1 SCOPE

This document details the application of SOP 287 issued by the Electricity Association.

## 2 ISSUE RECORD

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| Issue Date | Issue No | Author | Amendment Details |
|---|---|---|---|
| December 2001 | 1 | Alastair Graham | Initial Issue |

## 3 ISSUE AUTHORITY

| Author | Owner | Issue Authority |
|---|---|---|
| Alastair Graham<br>Senior Project Engineer | Alastair Ferguson<br>Senior Operational Support Engineer | Eric Leavy<br>Engineering Services Manager<br><br>…… |

## 4 SOP DETAILS

**TYPE:** Switchgear & Equipment, 132kV Switching Isolator, type RVS 300

**ORIGINATING REC:** SP Power Systems

**DATE:** 7/12/2001

**NO. INSTALLED IN MANWEB:** 22
**NO. INSTALLED IN SCOTLAND:** 0

**STATUS:** Restriction

The following restriction shall apply to all substations detailed in Appendix 1 containing live switchgear of the above type:

1. Live operation of the Switching Isolators shall be permitted only by remote operation

2. Automatic operation from protection equipment shall be rendered inoperable on all switching isolators (disconnectors) of this or similar type pending further detailed investigations

**REASON:**

A Switchgear & Equipment (Brush), 132kV switching isolator failed disruptively at ICI Wade substation on the 28th November 2001. This has been attributed to mechanical resistance. Report SWG – 05 – 05 gives more details.

**UPDATE:**

**REMEDIAL ACTION:**

1. All switching isolators shall be 'exercised' off line as soon as practicable and any units failing to operate completely must be maintained prior to being returned to network service.

2. Maintenance shall be conducted annually as per SP Power Systems document 'Best Working Practise No 81, Maintenance of 132kV Switch Disconnector, Brush Power Equipment type RVS300 mark I and II', Appendix 2

## Appendix 1: Substation Sites with RVS300 Switching Isolators

| substation | circuit | nomenclature |
|---|---|---|
| Bold | 132/33kV Transformer T2 | '215' |
| Bootle | 132/33kV Transformer T2A | '215A' |
| Brymbo | 132/33kV Transformer T1C | '115C' |
| Carrington | Warrington 1 | 300 |
| Carrington | Warrington 2 | 700 |
| Dallam | 132/33kV Transformer T1 | '115' |
| Garston | 132/33kV Transformer T2 | '213' |
| Gateacre | Lister Drive (Via Edge Lane) / SpekeT3 | '500' |
| Huyton | 132/33kV Transformer T1 | '115' |
| I.C.I. Wade | 132/33kV Transformer T1 | '115' |
| I.C.I. Wade | 132/33kV Transformer T2 | '215' |
| Lister Drive | 132/33kV Transformer T2 | '215' |
| Oswestry | 132/33kV Transformer T2 | '215' |
| Paradise Street | 132/33kV Transformer T1 | '115' |
| Paradise Street | Lister Drive 405 | '125' |
| Percival Lane | Salt Union | 100' |
| Percival Lane | 132/33kV Transformer T1 | '115' |
| Prescot | 132/33kV Transformer T1B | '115B' |
| Ravenhead | 132/33kV Transformer T1A | '115A' |
| Sankey Bridges | 132/33kV Transformer T1 | '115' |
| Sealand | 132/33kV Transformer T4 | '415' |
| Welshpool | 132/33kV Transformer T1 | '115' |

**Appendix 2: Best Working Practise No 81, Maintenance of 132kV Switch Disconnector, Brush Power Equipment type RVS300 mark I and II**

SOUTH OF SCOTLAND ELECTRICITY BOARD

TRANSMISSION/DISTRIBUTION DIVISION

TRANSMISSION OPERATION AND MAINTENANCE SECTION

# BEST WORKING PRACTICE NO. 81

# MAINTENANCE OF 132 KV SWITCH DISCONNECTOR

# BRUSH POWER EQUIPMENT TYPE RVS300 MARK I AND II

Revised & Issued July 1986

CONTENTS

# 1 GENERAL

1.1 All operations and work carried out under these instructions shall comply with the requirements of the SSEB Safety Rules, Generation and Transmission (Electrical and Mechanical), the Health and Safety at Work Act and other Safety Documents as issued.

1.2 Description

The interrupter unit is a sealed unit encased in a porcelain insulator containing SF6 gas under pressure. The breaking unit consists of two contacts in series per phase. High value linear resistors within the porcelain are connected across the breaks for voltage dividing purposes.

The operating sequence from the closed position, is that the initial rotation of the centre post insulator trips the interrupters, being followed by vertical opening of the air-break disconnector. Before the completion of the disconnector stroke, and at a safe electrical clearance the interrupter is reclosed in preparation for a subsequent closing operation. The closing operation, effected by reverse operation of the torque insulator, is carried out solely by high speed operation of the disconnector into its fixed contacts.

To cover emergency and maintenance operations, with the switch disconnector on an isolated circuit, manual operation is provided.

Two versions of the disconnector are in service; the Mark I which is equipped with an American hydraulic push pull mechanism, easily distinguished by the manual operation lever at the rear of the mechanism box, and the Mark II design which is provided with a British hydraulic power mechanism. Manual operation on the Mark II version is provided by means of sockets fitted on the power mechanism torque tube above the mechanism box into which an operating bar is fitted.

## 2 REFERENCE MANUALS AND DOCUMENTS

2.1 Manufacturers Manual for Installation, Operation and Maintenance.

2.2 Transmission Manual T4 Brush Power Equipment 132 kV Switching Isolation and Earth Switch Type RVS300.

2.3 Transmission Design Circulars (TDCs):

TDC 324 Issue B dated 12.7.76 - Manual Operation of 132 kV Switch – Isolators
TDC 388 Issue A dated August 1970 - Wiring Modifications
TDC 531 Issue B dated 6.7.79 - Seizure of Sequence Mechanism Shaft Bearings
TDC 554 Issue A dated 13.10.75 - Pressurised Gas Bottles.
TDC 751 Issue A dated 7.3.86 - Torque Drive Mechanism - Leakage of Hydraulic Fluid.

2.4 Defects on Apparatus:-

CSM11/195 - Failure to Open (Not applicable to Yoker) CSM11/271 - Charge Fail Alarm.

2.5 Transmission Memorandum.

## 3 MAINTENANCE PROCEDURE

The maintenance procedures adopted incorporate information contained in the Manufacturers Maintenance Recommendations, Transmission Design Circulars, Design Memorandum, CSM11 defect documents and operational experience.

Because of the tendency on this type of switch disconnector for the sequence device bearings to seize up with severe consequences (see TDC 531) it has been found necessary to carry out a major inspection and maintenance on an annual basis.

# 4 INSPECTION AND MAINTENANCE INSTRUCTIONS

## 4.1 Inspection

Routine weekly inspection is carried out from ground level as part of the weekly substation inspections. Interrupter Head Pressure Indicator, Interrupter Head Contact Indicator and Accumulator Pressure are checked at this time.

## 4.2 Maintenance

### 4.2.1 Recommended lubricants:-

For contact surfaces - Elvolube contact lubricant For clevises, ball joints etc. - thick engine oil For bi-metal current carrying joints - Densal paste
Hydraulic fluid - UCON Hydrolube AC, Available from Works (MK I Design)
Hydraulic fluid S & E Spec. 42, available from Works (MK II Design)
No other hydraulic fluid should be used.

Note: Before any maintenance is carried out withdraw fuses from power mechanism.

### 4.2.2 Interrupter and Sequencing Unit

The Interrupter Unit and Sequencing Unit are sealed and require no maintenance. The gas pressure indicators at the rear of the units should be inspected. The "operational" indication is silver/grey. If the indicator shows red the Interrupter Unit must be replaced before any further operation takes place. The interrupter open/close indicators should be checked for correct indication i.e. yellow - open, silver - closed or green - open, red - closed on modified interrupter units.

**WARNING**

Should it be found necessary at any time to replace the Interrupter Unit, no attempt should be made to dismantle it before reference is made to the appropriate standard documents relating to SF6, e.g. TDM 3/16 and 3/33.

Wash down the insulator porcelains, including the Interrupter Unit, and inspect for cracks and chipping.

### 4.2.3 Disconnector

**WARNING**

The closing stroke must be continuous in the closing direction. Any reversal of stroke will cause the interrupters to trip, in which case the disconnector should be brought to the fully open position to ensure re-cocking of the interrupters.

Open the disconnector a little way, by hand to permit inspection of contacts.

Wipe contact surfaces clean with a solvent, and inspect for signs of wear or burning. Slight pitting can be rectified by using a clean smooth file - **do NOT** use emery cloth. More severe damage necessitates replacement.

To replace a fixed contact assembly, open the disconnector partly. Remove the four bolts, Fig. 17 holding the contacts to the support casting on each side and lift the assembly off. Reverse the procedure to replace.

The moving contact is supplied complete with the blade and will not be supplied separately because of the bi-metal joint between the tip and the blade tube which has to be made under controlled conditions in the Works. When replacing the blade follow the installation instructions in manufacturers instruction manual including the pre-loading procedure, and paying particular attention to the method of making the bi-metal joint.

Inspect the probe and are horns for signs of burning. Badly burnt parts should be replaced. To replace the are horns, knock out the small roll pin and slacken the grub screw. Set the disconnector blade closed (if the probe is in good condition), drop the replacement arc horns into the sockets, turn them until in contact with the probe, and tighten the grub screws. Drill through 1/8 in. dia. and replace the roll pins.

To replace a probe, unscrew it complete with anti-corona bell. Fit the new probe with Loctite, grade AA, on the threads.

After maintenance all contacts should be lightly smeared with contact lubricant on all contact surfaces.

Check the tightness of:-

Insulator fixing bolts;

Top-hamper fixing bolts;

Drive rod locknuts;

Drive clamp bolts.

Also check the split pins in all clevis pins.

Oil all clevis pins and wipe off surplus. Alternatively, remove the pins, clean, grease and refit. Use new stainless steel or brass split pins.

Having checked the insulator fixing bolts on the rotating posts, the latch-in clearance of sequencing mechanism must be checked. (See 4.2.4).

### 4.2.4 Latch-in Clearance

It is very important that, when the toggle links are on toggle (see Fig. 2) all three levers above the Sequencing Mechanism are against their stops (Fig. 1).

Check latch-in clearance of sequencing mechanism via the circular inspection port on the top cover plate.

Remove the two screws securing the port cover, and check inside as follows:

(a) With the toggle link set "on toggle" (Fig. 2) there should be a "latch-in" clearance of 1/8" $\pm$ 1/32" nominal between the main rod latch and the main rod arm. (The main rod is the upper, larger diameter rod of the two). See Fig. 5 and Fig. 6.

(b) As the Switch Disconnector is moved towards the CLOSED position the latch-in clearance is taken up as the latch engages with the spring-loaded main rod arm to hold it in the cocked, closed position.

(c) With the Switch Disconnector CLOSED, latch-in is indicated by engagement of the latch with the main rod arm. This verifies that the Interrupter Unit is closed and cocked.

When all settings have been verified, exposed threads of drive rods and phase couplings should be wrapped with Denso tape.

### 4.2.5 Power Operating Mechanism

For a full description and operating instructions of the power mechanism, refer to the appropriate instructions manual.

In common with any hydraulic unit, the power mechanism will benefit from occasional operation. It is recommended that this is carried out at least every six months.

#### 4.2.5.1 Mark I Design Only

Once a year the fluid level should be topped up with UCON Hydrolube AC. Total capacity 6 pints (340 cc).

(a) Set the circuit breaker on the control panel to OFF, and put the Circuit Selector Link in the "Drain and fill" position (fig. 9B).

(b) Attach the 7/16 in (OD) plastic tube provided to the Drain-Fill elbow on the right side of the filler block (fig. 9A).

(c) Put the free end of the tube to the bottom of the spare container of hydraulic fluid provided.

(d) Attach the 5/16 in (OD) plastic tube provided to the breather at the bottom of the Ram Unit and provide a can to collect overflow.

(e) Turn by hand both knurled thumbscrews on the left side of the Filler Block (fig. 9A) as far as possible counterclockwise.

(f) Set the circuit breaker on the control panel to ON.

(g) Press the FILL button on the valve block and hold till fluid runs out of the 5/16 in breather tube.

(h) Press the DRAIN button to remove a further quarter pint (15 cc) via the filter tube. This allows for fluid expansion in service without discharge via the breather.

(i) Re-tighten both knurled thumbscrews on the filler block by hand. Use no tools. To tighten, turn clockwise.

The hydraulic system is now topped up. The plastic filling pipe can be removed and stored away.

Test the operation of the Power Mechanism first by 'inching' slowly through one or two cycles.

Once every two years the system should be drained and refilled with fresh fluid. Proceed as for topping up, except that

(a) leave the filling orifice disconnected until all fluid has drained out (do not omit to provide a container capable of accepting at least six pints);

(b) then proceed as for topping up.

It is important that in draining and refilling the fluid, pipes and containers should be absolutely clean, free from dust or dirt and other fluids. Containers which have been used for petroleum products should never be used. Used fluid should be discarded.

4.2.5.2 Mark II Design Only

Once a year the accumulator should be checked as follows:

(a) Remove motor fuse.

(b) Discharge accumulator slowly (taking 1 min. approx.).

(c) Wait 5 mins. For fluid to settle.

(d) Insert motor fuse whilst observing pressure gauge:

(e) If the pointer moves almost instantaneously to at least halfway up the first Red sector (or 800 p.s.i.) the accumulator is maintaining its storage pressure satisfactorily. If not, the accumulator is suspect. Refer to TDC 554.

Note: To restore to operational condition, allow pressure to build up to automatic cut-out point in green sector on gauge. If the motor cuts out on time delay, remove control fuse and re-insert to reset timing relay.

(f) Checking of oil level:-

Check fuses are withdrawn
Operate the accumulator discharge lever until all pressure is released
Remove filler plug
Remove level plug
Check level
Top up if necessary (with S & E Spec.: 42 oil)
Replace level and filler plugs
Replace fuses, if maintenance is complete.

It is important that in topping up operations, the fluid, all pipes and containers should be absolutely clean, free from dust or dirt or other fluids. Containers which have been used for petroleum products must never be used.

4.2.5.3 General

Inspect the auxiliary switch contacts and clean these if necessary. Smear lightly with petroleum jelly.

Check that the hydraulic unions are properly tightened.

Check heaters.

Check conditions of mechanism box and clean/paint if necessary.

Check condition of paintwork generally

Check earth connections for continuity.

The above general checks together with any comments should be recorded on the results check sheet (Appendix 1).

4.3 Testing

4.3.1 Conductivity

The conductivity of the interrupter contacts should be checked using a digital Microhmeter connected between the connector pad and mechanism sequencing mechanism case. The maximum value should not exceed 80 microhms. The results should be recorded on the results sheet (see Appendix 2 or 3).

4.3.2 Insulation

With the switch open insulation across the contacts should be measured using the same connecting points as in 4.3.1. The results should be within the range of 2.8 to 3.5 Megohms.

The results should be recorded on the results sheet (see Appendix 2 or 3).

4.3.3 Timing

The following times shall be recorded on the results sheet (see Appendix 2) both before any maintenance is carried out and on completion of maintenance.

Any target times which cannot be met shall be reported to the Group Engineer before further action is taken. Particular attention should be paid to TDC 531.

| | Mark I | Mark II |
|---|---|---|
| (a) From initiation to interrupter contacts open | 500-560 ms | 560-580 ms |
| (b) From initiation to isolator contacts open | 690-750 ms | 740-760 ms |
| (c) From initiation to interrupter contacts reset | - | 1200-2000 ms |
| (d) From initiation to isolator contacts make | 880-1000 ms | 940-960 ms |
| (e) From interrupter contacts open to disconnector Contacts open | 180-220 ms | |

The spread across any two phases should not exceed 15 milliseconds for either Mark I or Mark II.

APPENDIX 1

132 kV SWITCH DISCONNECTOR TYPE RVS 300

SUBSTATION: SWITCH NO: DATE:

GENERAL INSPECTION

Tick items of work completed or comment as appropriate.

| | | COMMENTS |
|---|---|---|
| Aux. Switches inspected | | |
| Aux. Switches cleaned and greased | | |
| Hydraulic connections checked | | |
| Heaters checked | | |
| Mechanism Box cleaned out | | |
| Mechanism Box painted | | |
| General condition of paintwork | | |
| Earthing checked | | |

REMARKS

FITTER: ENGINEER:

APPENDIX 2

132 kV SWITCH DISCONNECTOR TYPE RVS 300 MARK I

SUBSTATION: SWITCH NO: DATE:

WEATHER: TEMP:

TIMING TESTS

| Timing Test | Accumul. Pressure p.s.i. | Target Time m.sec. | Time m.sec. | | |
|---|---|---|---|---|---|
| | | | R | Y | B |
| Close initiation to Disconnector Contacts Close | | 880-1000 | | | |
| Trip initiation to Interrupter Contacts open minimum | | 500-560 | | | |
| Trip initiation to Disconnector Contacts open maximum | | 690-750 | | | |
| Trip initiation to Interrupter Contacts Close | | 1200-2000 | | | |
| Interrupter open to Isolator open | | 180-220 | | | |
| Interrupter contact Spread to open between an two phases | | Less than 15 | | | |

CONDUCTIVITY TEST (SWITCH CLOSED)

| Item | Maximum Permissable Resistance | Red | Yellow | Blue |
|---|---|---|---|---|
| Connector Pad to Mech. Casing (Interrupter C/S) | 80 Microhms | | | |

INSULATION TEST (SWITCH OPEN)

| Item | Expected Range | Red | Yellow | Blue |
|---|---|---|---|---|
| Connector Pad to Mech. Casing (Interrupter C/S) | 2.8-3.5 Megohms | | | |

ENGINEER:

APPENDIX 3

132 kV SWITCH DISCONNECTOR TYPE RVS 300 MARK II

SUBSTATION: SWITCH NO: DATE:

WEATHER: TEMP:

TIMING TESTS

| Timing Test | Accumul. Pressure p.s.i. | Target Time m.sec. | Time m.sec. | | |
|---|---|---|---|---|---|
| | | | R | Y | B |
| Close initiation to Disconnector Contacts Close | | 940-960 | | | |
| Trip initiation to Interrupter Contacts open minimum | | 560-580 | | | |
| Trip initiation to Disconnector Contacts open maximum | | 740-760 | | | |
| Trip initiation to Interrupter Contacts Close | | 1200-2000 | | | |
| Interrupter contact Spread to open between an two phases | | Less than 15 | | | |

| Item | Maximum Permissable Resistance | Red | Yellow | Blue |
|---|---|---|---|---|
| Connector Pad to Mech. Casing (Interrupter C/S) | 80 Microhms | | | |

INSULATION TEST (SWITCH OPEN)

| Item | Expected Range | Red | Yellow | Blue |
|---|---|---|---|---|
| Connector Pad to Mech. Casing (Interrupter C/S) | 2.8-3.5 Megohms | | | |

ENGINEER: