

## SPECIFICATION

### Distribution Specification – :

Specification for a combined cut-out fuse and drop-out surge arrester unit.

## APPLICATION OF THE COMBI UNIT – FREE STATE OPERATING UNIT

### 1. Description of a Combi unit

The Combi unit consists of a post insulator in the middle with a drop out type surge arrester on the one side and a drop out fuse on the other side. Should the fuse blow, only the fuse will fall open while the arrester stays closed. In the case where the surge arrester GLD operates, both the fuse and the surge arrester fall open. Figure 1 shows a Combi unit

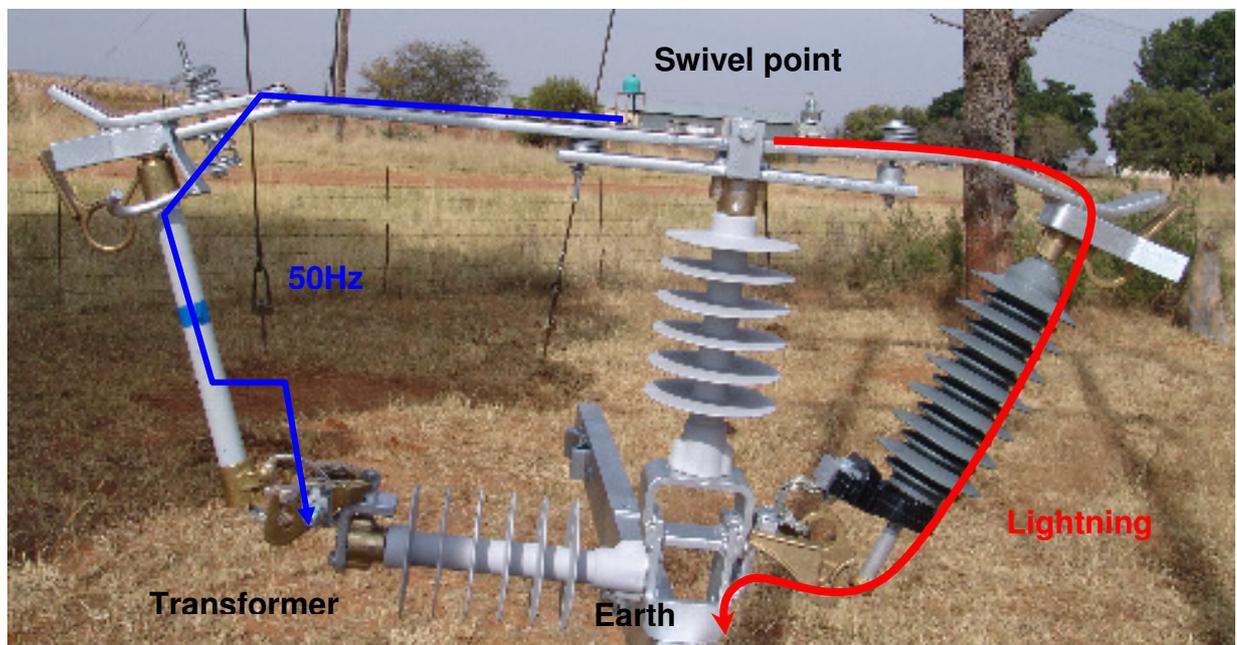


Figure 1, A Combi unit set up for tests.

### 2. Application of Combi Units.

The Combi can be used for 5 different or combination of strategies:

#### 2.1 Protection of equipment during lightning conditions

The Combi is used in this case to protect MV fuses and pole mount transformer (single or 3 phase) against lightning. It has been found that lightning mostly tends to always damage the same installations. This will relieve the pressure on spares and WMC / NMC / CC / FS staff.

## **2.2 Saving money**

In this case the Combi will only be installed at installations where equipment are damaged by lightning. As 40% of the lightning damage needs to be repaired after hours, a significant saving is made on overtime. A good return on investment (full return within a year) will be achieved if only these problem installations are populated with Combi units.

Blown arresters can be changed immediately and no booking for an outage after 34 days is needed which is saving on transport and manpower cost.

## **2.3 Improving SAIDI and SAIFI**

As the Combi make it possible to grade the fuses correctly with the feeder protection without compromising with nuisance fusing, feeder breakers will not trip any more due to pole mount installation faults. Refer to table 2.

## **2.4 Safety reasons**

A study showed that 78% of the faults in NWR are caused by lightning. It normally goes along with wet, dangerous driving conditions of which 40% may be in the dark. This makes driving challenging and unsafe in certain situations.

Fuses and surge arresters can be replaced from ground level which will eliminate electrical contact and fall from different level

## **2.5 Easy operations**

Both the arrester and fuse can be changed from ground level without doing any earthing. Except for the link stick, ladders, earths or buckets, no tools are needed. It is much less stress on the employee and it is time saving.

On installation of the Combi, the surge arresters (on the transformer tank) at a pole mount installation are removed and the fuse assembly is replaced by a Combi unit. A proper earth bonds the transformer tank with the Combi installation.

The Combi surge arresters will protect both the fuse and the transformer. As the arrester should physically not be too far from the transformer (less than 2 metres), the Combi need to be placed between 1.2m and 2m above the transformer. A Combi unit can therefore not be placed at the T-Off, one structure away from the transformer

Figure 2 shows a Combi installation. Spare arresters are left on site (hanging on the cross arm) to ensure that a failed arrester does not cause any further interruption of supply.



Single pole arrangement



Double pole arrangement

*Figure 2. Combi installation*

### **3. Background:**

The Combi Unit was initially developed to minimize the MV fuse and transformer failures during lightning activities. NWR lost annually more than 16 000 fuses (nuisance fuse failure) and more than a thousand MV transformers due to lightning activity.

The MV fuses were exposed to lightning due to the pole mount transformer configuration as it was as it was installed line side of the surge arrester. The surge arrester was only protecting the MV transformer. Should the arrester be placed line side of the fuse to protect both the fuse and transformer, the arrester could only be changed after the feeder was isolated.

A second practical difficulty was to change the surge arrester on the transformer tank. The operator had to leave ground level (fall and electric contact hazard) and needed tools to change a faulty surge arrester. Furthermore a surge arrester failure was only detected on a line inspection – which can be many months after the failure. During this time the MV transformer is then unprotected.

In order to minimize nuisance fusing, Field Services inserted 20A fuse in many pole mount installations. If a fault current had to go through the transformer windings and the earth resistance is high, the breakers tripped on Sensitive Earth Fault before the fuse operated – resulting in a line outage. A maximum size of 10A fuses are used in the Combi units to ensure correct protection grading. Table 1 shows results of a survey on fuse failures for different sizes of fuses.

Fuse size	8 A	10 A	15 A	20 A	25 A	30 A	40 A	50 A
Number of fuse blown/yr.	669	267	396	151	3	1	9	2

*Table 1. Fuse failures over a year period in a certain area. About 6% of the installed fuses failed.*

	Fuses size used	Number of breaker T&L/O operations	Number of transformer faults
Area 1	20 A	11	11
Area 2	20 A	3	3
Area 3	20 A	8	8
Area 4	8 A	1	18
Area 5	8/20 A	12	61
Area 6	20/8 A	28	65

*Table 2. Incorrect protection/fuse grading cause line trips due to fuses not operating for a transformer fault. In some cases where 20A fuses were installed, only one fuse operates (the one on the faulted phase). The other 2 x fuses feed into the fault through the transformer windings, tripping the breaker on SEF before the fuses blow.*

#### **4. Disadvantages:**

- Cost of installation. It cost a small amount more to install a Combi unit instead of the normal fuse and surge arrester arrangement.
- Should the surge arrester fail, the customer is without supply. A new arrester should therefore be installed a.s.a.p.
- The surge arrester is further away from the transformer. This results in a 95kV impulse level instead of 80kV on the transformer. However, the transformer should be insulated at 150kV.

#### **5. Advantages:**

- The pole mount transformer is never without lightning protection as the fuse drop open should the arrester fails
- The fuse is protected from lightning
- Should the surge arrester be faulty, the operator does not have to open, isolate and earth to change the arrester.
- The operator does not have to leave ground level to change an arrester or fuse thereby eliminating the risk of “electrical contact” and “fall from different level”.
- Much time are saved with to the drop out surge arrester in relation with changing a fixed surge arrester.

- The arrester can be changed immediately and it is not necessary to book an outage and come back for replacing a faulty arrester.

## **6. To date performance level:**

A total of 1064 pole mount installation were fitted with Combi units. At all these installations, at least one transformer failure occurred annually. After installation of Combis, over a period of 3 years, 11 transformers were recorded failed:

- Two installations had neither neutral arresters nor any connection between the neutral and earth. This seems to be the reason for failure of the transformers.
- One installation was hit by a lightning flash consisting of 18 strokes. The arresters failed but in the process the transformer was damaged.
- One transformer failed shortly after installation with no lightning around – maybe the transformer was already damaged.
- Seven installations still need to be visited. In the area of concern, it was found that some Combi installations were skipped during the project. Apparently not enough clearance could be found. It is not sure whether there were Combi units installed at the time of the transformer failures.

## **7. Lessons learned.**

A configuration, where the arrester protect both the fuse and transformer, resulted in a big improvement in pole mount installation and feeder performance. The fuse can now be graded properly with the feeder protection. Much less – none known of, fuses have blow due to lightning when it is in the Combi unit configuration. Secondly, of the selected sites, instead of 460 transformer failures annually, only 11 transformers over 3 years failed due to lightning.

In some cases it was found that short poles are used at pole mount transformer installations. It causes quite a space challenge to install the Combi units.

Some pole mount transformer's neutral bushing is not earthed – neither through a neutral surge arrester nor solidly. This is sometimes overlooked by the contractor, leaving the transformer without proper lightning protection.

In two cases the operators used all the spare arresters on the Combi installation without replacing the spares. This caused a case where the Combi was by-passed due to the lack of surge arresters. Should the Combi become a standard, FS will be carrying spare drop out arresters with them.

## **8. Operating issues**

The only issue so far encountered, was the weight of the surge arrester when a tiny operator want to pick it up from ground level with a fully extended link stick. However, should the operator uses the correct method (use the

telescopic function of the link stick), installation of the drop out arresters seems to be not more challenging than installing a fuse.

## **9. Operating procedure**

### **9.1 Replacing the fuse**

The fuse will be replaced according to and within the rules of changing a standard dropout fuse. Refer to ORHVS regulation 5.05.2

### **9.2 Replacing the surge arrester**

A surge arrester failure will cause the fuse to open as well. The dropout surge arrester must be replaced first from ground level. The fuse can then be closed. Should the fuses be blown as well, the fuses must be replaced according to 9.1.

### **9.3 Work to be done on installation above ground level**

The arrester need to be taken out as well when the Combi is used as an isolation point to ensure that the GLD does not explode while working on the installation.

When the fuse is opened / removed, the dropout surge arrester must also be opened / removed. It is important to open the fuse first, followed by the arrester as the arrester part of the bracket is very tight. With the fuse opened, it is much easier to pull the top fuse bracket downwards with the link stick in order for the arrester to just fall open than to try and pull the arrester open.

### **9.4 Isolation of installation**

Should the supply be disconnected for reasons other than work on the installation (cut off due to non payment), only the fuse must be opened while the arrester stay closed. This will ensure that should lightning terminated on the isolated transformer, it will still be protected.

## **10. Safety issues.**

Although electrical contact and fall from different level was eliminated, a risk of “falling object” still exist when replacing surge arresters or fuse links. Two cases (standard pole mount installations – not Combi installations) of injuries were reported where fuse links fell from the link stick onto employees. Several near misses happen daily in the region where fuses fell from link sticks.

In order to curb these incidents, a new device (insertion tool) was developed to be used for installing fuses and drop out arresters. It is easier (more stable) to install the fuses and arresters. Secondly, it is unlikely that the fuse / arrester will slip / unhook from the link stick. Figure 3 shows the insertion tool.



*Figure 3. The insertion tool to replace fuses / drop out surge arresters*

## **11. Conclusion**

Although the Combi was developed for lightning protection and to be used in areas with high lightning activity, it can also be used in other areas for safety and easy operating reasons.

As at July 2010, the Combi passed all SABS tests. The only outstanding test (for pollution and corrosion) is currently running at KIPTS and planned to be completed by April 2011. The first part (6months) of the test (inland use) was passed.

### **Free State Operating Unit**

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