CIGRE Working Group 13.09 - Monitoring and Diagnostic Techniques for Switching Equipment

- **Scope - "Give recommendations for the application of monitoring and diagnostic techniques to circuit-breakers and other switching equipment".**

- **19 Members (13 Europe, 1 Japan, 5 N/S America)**

- **Started 1996 Interim Paper presented at Australian Regional Meeting 1997**

- **Main task is to publish Brochure (150pages +) ready for Paris 2000**

Why is there a need for this work?

Condition Monitoring has been around as long as switchgear itself (nearly).
- As diagnostic techniques used for development.
- Monitors for equipment operation, status or safety.

More recently there has been a dramatic increase in the use of Condition Monitoring, due to:
- Sensor development
- Increased processing capability
- Cost, cost and cost drivers.

Work is for users faced with overload of information, not for manufacturers or experienced users

Structure of WG Activity and Brochure Chapters

1. Definitions
2. Need for Monitoring
3. Justification for Monitoring
4. Sensors and Diagnostic Techniques
5. Design and Test Requirements
6. Dependability
7. Management of Information
8. Future

Need for Monitoring

Monitoring can be applied for a number of reasons:

- **Equipment Status**
- **Primary Voltage, Current etc.**
- **Predict Maintenance**
- **Prevent Failure**
- **Operation/Maintenance Support**
- **Active Control**
- **Commissioning Test**
- **Life Assessment**

All of these aspects have to be considered

Potential Benefits of Condition Monitoring

- Reduced commissioning time
- Reduced preventive maintenance
- Reduced failures
- Reduced breakdown maintenance
- Reduced spares usage
- Increased equipment availability
- Increased equipment life
- Increased functionality

All resulting in lower Life Cycle Costs.

Each of these can generate a "Need for Monitoring"

How to Justify “Optional” Condition Monitoring

- Even though equipment can be very reliable and have a good service record, Condition Monitoring can be justified (financially) if:
  - Life Cycle Cost approach adopted
    (All potential benefits are considered)
  - All cost factors are taken into account
- No single approach can be applied for all cases
- Work covers some example approaches which can be adapted by users

Sensors and Diagnostic Techniques

- **Main part of the Brochure (50+ pages)**
  Size of the task is considerable as have to include:

- **Range of equipment**
  (Circuit Breakers, Earth Switches, Switch Disconnectors and Disconnectors)
- **Equipment Technologies**
  (SF6, Air, Air Blast, Oil)
- **Wide range of sensors and diagnostic techniques**
- **Chapter is a “State of the art review” with summary tables and discussion.**

Basic Functions to be Monitored

To structure the work on "Need for Monitoring" and "Sensors and Diagnostic Techniques" first consider the basic functions that are provided:

- **Insulation**
- **Current Carrying**
- **Switching**
- **Mechanical Drive**
- **Control/Auxiliary Equipment**

Parameters to be Monitored

Example - Switching

Parameter	Sensor
Position	Auxiliary Switch, Proximity Switch
Operating Time	Auxiliary Switch, Main Contact Coil Current, Proximity Switches
Operating Speed	Travel (Electronic, Optical), Position Switch
Contact Wear	Wear Indicator, I^2t Monitor
Stored Energy	Pressure Gauge/Transducer

Example of Table from Chapter 4

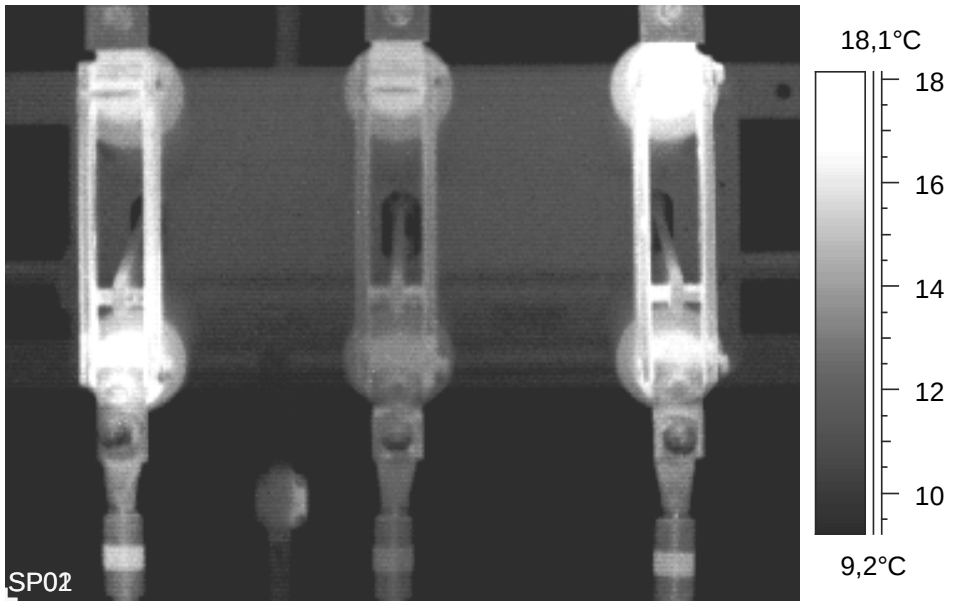
Table XX. Diagnostic techniques and sensors for testing the current carrying ability of switching equipment.

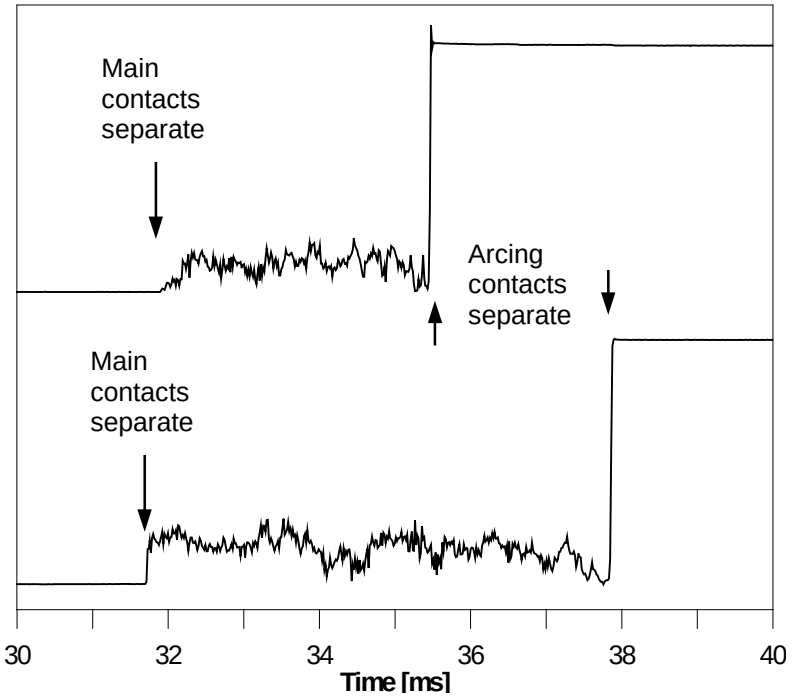
Parameter	*Application(s)*	*Method / sensor*	
Contact resistance	All	Four point resistance measurement	P
Temperature of contacts and breaker unit	All	Infrared imaging	P
		Temperature profiling with optical fibre	C, P
		Temperature at a point by:	
		• thermocouple	C, P
		• optical sensor	C, P
		• infrared sensor	C, P
	SF_6	Load and ambient temperature compensated gas pressure	C
Load current	All	Iron core current transformer	C
		Rogowski coil	C
		Optical current sensor	C
Contact penetration	All	Contact position transducer	C, P
Electric stability of closed contact	All	Partial discharge measurement	C, P
		Content of gas decomposition products	C, P

Abbreviations:

SF_6: SF_6 circuit-breakers
C: used for continuous monitoring
P: used for periodic diagnostic testing

Examples Illustrated in Chapter 4





Infrared Imaging

Dynamic resistance

By using examples the aim is to make the brochure readable

Issues on the Application of Condition Monitoring

- On-Line or Periodic Monitoring? (Chapter 3)
- Information from Data (Chapter 7)
- Need to keep systems simple and reliable (Chapter 5)
- Integration of Control, Protection and Monitoring and System architecture and communication protocols Chapter 7)

Status of Work

- Drafts completed for all sections except Chapter 8
- Final editing/compiling to be completed by end of 1999
- Issue to SC 13 by end of 1999
- Issue to Paris Central Office for publication April 2000
- Available for purchase at CIGRE 2000

Conclusions

- **Tremendous level of ongoing work and interest in Condition Monitoring (Reflected in CIGRE activities)**
- **Many choices for “philosophy of monitoring”**
- **No one single approach is possible**
- **Task of CIGRE 13-09 is to:**
  - **Disseminate knowledge on current technology**
  - **Give guidance on what is/not an appropriate technique**
  - **Provide guidance/recommendations to less experienced users**

Ongoing Work of SC 13

- Advise users of what is possible
- Guidelines on relevance of options
- Guidelines on benefits and justification
- Guidelines on issues such as:
  - Management of data
  - Architecture of systems
  - Lifetime Management (13-08)