Structure of present CIGRÉ survey

- Organization of the work
- Components covered
- Data collection tool
- Creation of questionnaires
- Challenges and outlook

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All sides of the survey are organized by a working group under Study Committee A3

Tasks of the WG:

- Create questionnaires, i.e. decide on what questions to ask, what definitions to use, etc.
- Establish computer tools / systems for collecting, storing and analyzing the information
- Contact and persuade utility representatives all over the world to participate by filling in the questionnaires
- Collect and quality check all incoming information
- Carry out statistical analyses of the data
- Prepare and publish results such as failure statistics, trends, recommendations etc.

The survey covers three component types + GIS substations and GIS maintenance

Components:

- Circuit-breakers (only SF_6)
- Earthing switches and disconnectors (all types and vintages)
- Instrument transformers (all types and vintages)

Substations:

- GIS (circuit-breakers, earthing switches, disconnectors and instrument transformers covered under components)

Maintenance practice:

- GIS (circuit-breakers, earthing switches, disconnectors and instrument transformers covered under components)

Two types of cards are used: *Failure cards* and *Population cards*

$$\text{Failure rate} = \frac{\text{no. of failures}}{\text{no. of components } x \text{ survey duration}} \quad [\text{year}^{-1}]$$

Example:

Two failures over a four-year period in a population of 25 circuit breakers

⇓

Failure rate: 2.0 failures per 100 c-b years

Lots of time and efforts have gone into preparing questionnaires

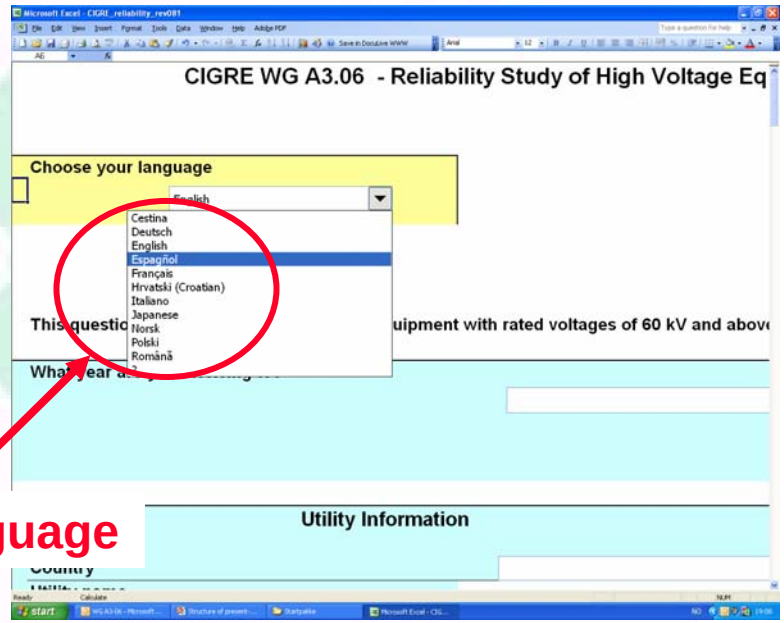
Matters of concern:

- **The information asked for must be easily available**
- **Questions must be understandable and unambiguous**
- **Comparison between earlier surveys should be possible => questions cannot deviate too much**
- **Times are changing and new issues arise => new and more questions (e.g. on maintenance policies, diagnostics)**
- **Structure, wording, syntax of the cards for the different components should preferably be the same**
- **Too comprehensive and time consuming questionnaires limit participation**
- **Too superficial questionnaires provide little information**

An Excel-based tool is used for data collection and handling

Features:

- The questionnaire is build as an Excel workbook containing failure and population cards
- Distributed by e-mail
- Has 11 languages built in
- Contains a comprehensive help function
- Extracts answers into a file that is returned
- Performs some validity checking of answers



Select language

The *Population cards* collect a few pieces of crucial information of a population

Push button and get help

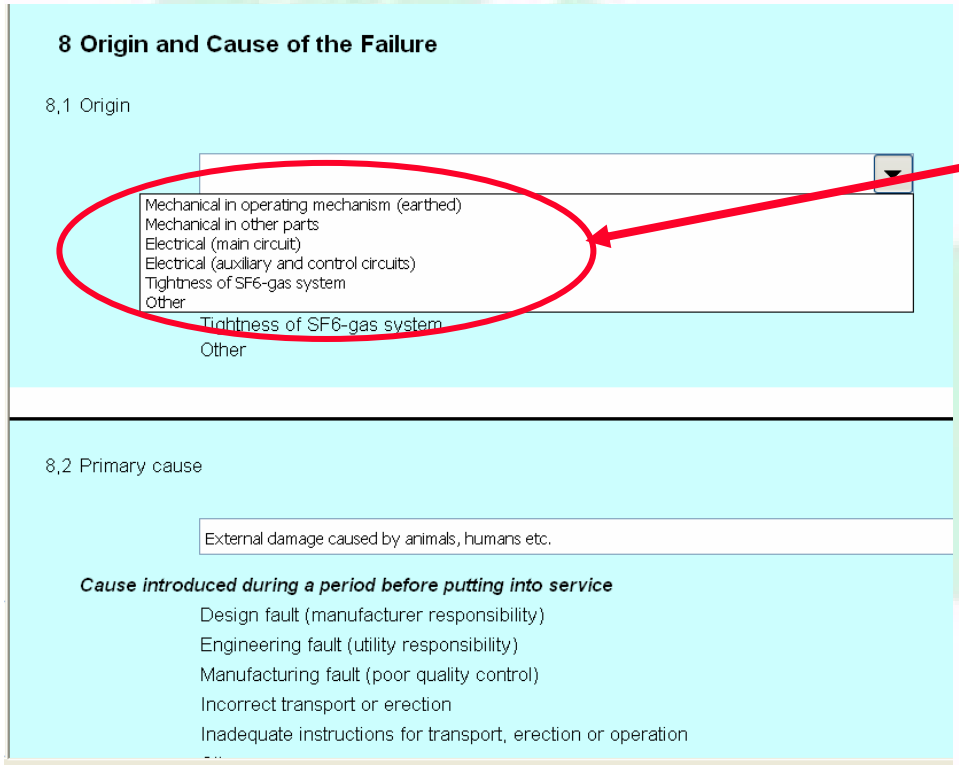
back to main menu | Extract card & Save | Single Pressure SF6 Circuit Breaker (CB) Population

If text in the cells is cut off, adjust the line height or zoom.

Rated Voltage Class ?	Main Function	Kind of Service ?	Operating Mechanism ?	Type of Enclosure	Location ? ?	Number of CBs manufactured in Period							Maintenance Philosophy ?
						before 1979	1979-1983	1984-1988	1989-1993	1994-1998	1999-2003	2004-2007	
1 : 60<= ... <100 kV	1 : Cir. breaker	1 : Overhead line	1 : Hydraulic	1 : GIS - 1 phase	1 : Indoor								1 : Time based
2 : 100<= ... <200 kV		2 : Transformer	2 : Pneumatic	2 : GIS - 3 phase	2 : Outdoor								
3 : 200<= ... <300 kV	2 : Cir. switcher / load break switch	3 : Cable	3 : Spring	3 : Live tank	3 : GIS: Indoor-Normal								2 : Condition based
4 : 300<= ... <500 kV		4 : Shunt reactor	4 : Other	4 : Dead tank	4 : GIS: Indoor-Special								3 : Run to failure
5 : 500<= ... <700 kV		5 : Capacitor			5 : GIS: Outdoor-Normal								4 : Combination
6 : >= 700 kV		6 : Bus-coupler			6 : GIS: Outdoor-Special								5 : Other
		7 : Other			7 : hybrid GIS: Indoor-Normal								
					8 : hybrid GIS: Indoor-Special								
					9 : hybrid GIS: Outdoor-Normal								
2	1	1	2	1	2	12	2			6			2
4	1	1	4	4	1			2			12		2

Numbers filled in by the utility

Information about each failure is collected by filling in *Failure cards*



The utility selects answers among alternatives listed in drop down menus

Failures are split into “Minor” and “Major” failures; “Defects” are not included

MAJOR FAILURE (ref.: IEC 60694) is failure of a switchgear and control gear which causes the cessation of one or more of its fundamental functions. A major failure will result in an immediate change in the system operating conditions, e.g. the backup protective equipment will be required to remove the fault, or will result in mandatory removal from service within 30 minutes for unscheduled maintenance.

Note: Or will result in unavailability for required service.

MINOR FAILURE is failure of an equipment other than a major failure or any failure, even complete, of a constructional element or a sub-assembly which does not cause a major failure of the equipment.

Note: Do not mix with "defect" (IEC 60694):

Imperfection in the state of an item (or inherent weakness) which can result in one or more failures of the item itself or of another item under the specific service or environmental or maintenance conditions for a stated period of time.

Failures are split into “Minor” and “Major” failures; “Defects” are not included

Included are:

MAJOR FAILURES (e.g.: does not open or close on command, dielectric breakdown, severe mechanical breakdowns etc.)

MINOR FAILURE (e.g. SF_6 and hydraulic oil leaks, minor changes in functional characteristics etc.)

Not included are:

DEFECTS (paint falling off, minor corrosion attacks, dirt etc.)

Relatively detailed information is recorded for each occurring failure

Question groups:

- Information about of the device (type of component, voltage level, kind of service, location, etc.)
- History of the failed component (age, maintenance etc.)
- Classification of the failure (minor/major, failure mode)
- Service condition during failure (breaking, out of service, etc)
- Environmental factors (lightning, ice, pollutions etc.)
- Sub-assembly or sub-component causing failure
- Origin and cause of failure (mechanical, corrosion etc.)
- Repair and consequential measures

Carrying out a world-wide survey of this type is a major and difficult undertaking!

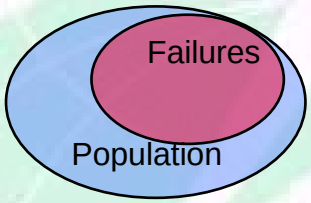
Shortcomings occur:

- There is an underreporting of failures, especially the minor ones
- We do not get complete and absolutely correct answers on all questions on all forms
- The participation is biased

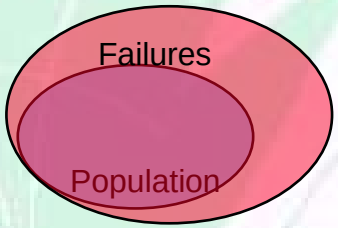
We deal with the shortcomings:

- The easy and simple way of collecting comprehensive reliability information does not exist
- Service experience statistics, even with certain known shortcomings, are of great value

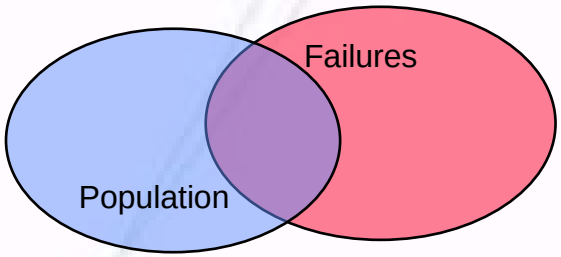
Determining *rates* requires complete and corresponding failure and population data sets



Not all failures of a population are recorded



Failures collected on components not being a part of a recorded population



General mismatch between failure and population data with regard to components and/or period in time

This is the biggest and most comprehensive reliability survey ever

Note that:

- **Fifteen years since last circuit-breaker reliability survey ended**
- **The output will be used as basis for reliability and availability analyses in decades to come**
- **Participating utilities get an unique opportunity to benchmark their performance**

This is *The Reliability Survey* "of our time"

Don't miss it!