

# USE OF CIGRE SURVEY TO IMPROVE CEPS REPORTING SYSTEM ABOUT FAILURES

**WGA3-06 Tutorial**  
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**CEPS, a.s.**

## **Basic Data about CEPS, a.s.**

**CEPS, a.s. – the only one TSO company in CR**

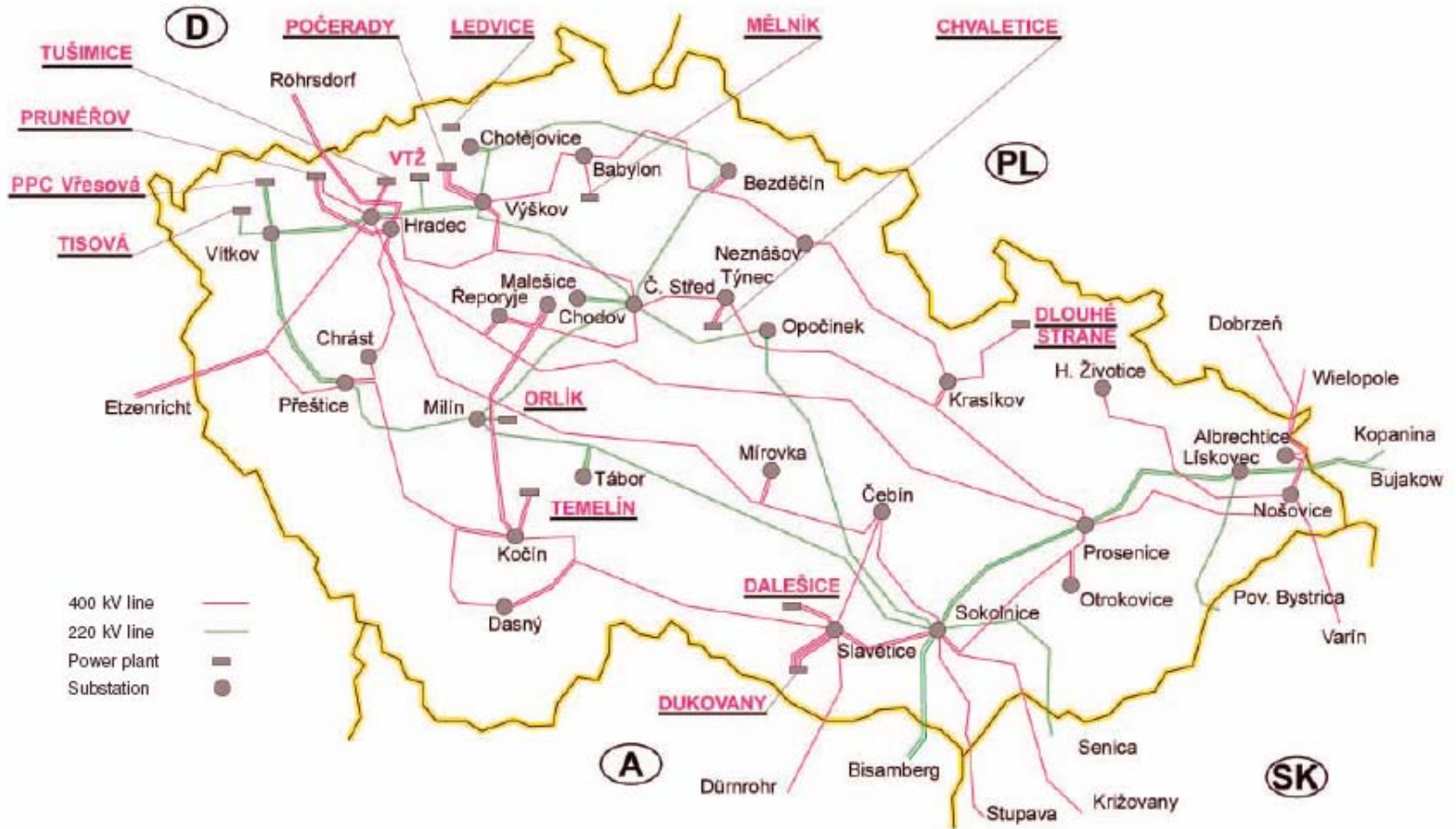
**Foundation :** **1998**

**Ownership :**

- **Osinek, a.s. ( National Property Fund) 51%**
- **Ministry of Finance 34%**
- **Ministry of Labour and Social Affairs 15%**

**Number of employees :** **430**

# Grid Structure



## Transmission system of the Czech Republic (situation as of 31.12.2004)

Equipment	Bohemia	Moravia	CR in total
<b>400 kV line</b> (km)	1 914	987	2 901
of which double line (km)	377	132	509
<b>220 kV line</b> (km)	886	554	1 440
of which double line (km)	249	229	478
<b>110 kV line</b> (km)	45	60	105
of which double line (km)	39	17	56
<b>400 kV cross-frontier lines</b> (-)	4	6	10
<b>220 kV cross-frontier lines</b> (-)	0	6	6
<b>400 kV substations</b> (-)	16	8	24
<b>220 kV substations</b> (-)	11	3	14
<b>110 kV substations</b> (-)	1	1	2
<b>400/220 kV transformers</b> (-)	2	2	4
<b>400/110 kV transformers</b> (-)	27	14	41
<b>220/110 kV transformers</b> (-)	14	6	20
<b>Transformation capacity (MVA)</b>	11 190	6 000	17 190

# AM (Maintenance) Corporate environment

- HQ + 3 regional centers
- Main volume of maintenance (preventive as well as corrected) outsourced
- Small skilled teams able to provide diagnostic tasks – to keep the know-how within company
- Maintenance based upon EQ types rules (standards), outage plans coordinated by dispatch center
- **In 2002 launched a project to improve asset management IT (grid, equipment, types, unplanned and planned events, maintenance planning and results inventory and statistics)**
- Before, all technical data stored in xls/doc/mdb/paper

## **2002 project goal:**

**“Build an IT system for support of Asset Management allowing its technical and economical optimization”**

# Project history and future

## History

- **2002 – II/2003 : analysis of initial state, benchmarking, theoretical model** (KPI's, weights of system components, lifetime modeling, reliability and costs evaluation, maintenance tasks and intervals optimization (CBM, RCM, RBM etc.), **selection of suitable IT tool**
- **II/2003 – II/2005 : creation and service of centralized “tailor made” technical information IT (B-SW)** : all inventories, equipment and grid history, maintenance planning and optimization, interconnection with currently existing expert systems and dispatch center outage planning IT, easy access to information from any point within company, evaluation of trends and statistics calculations
- **II/2005 : top management decision to buy SAP**
- **III/2005 – I/2006 – B-SW “transfer” to SAP**
- **I/2006 – ? – productive service of SAP R/3 PM module**

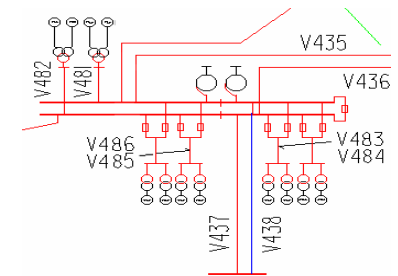
## Future

- **SAP R/3 Data warehouse implementation (BIW, SEM)**
- **TID system for integrated collection and automatic expert evaluation of monitored parameters (data from SCADA, fault recorders, transformer and special monitoring systems)**

# First step: Structured terminology

**Objects**  
(Installation place)

Identification of a specific place where an equipment is to be installed in network (using single line diagram)



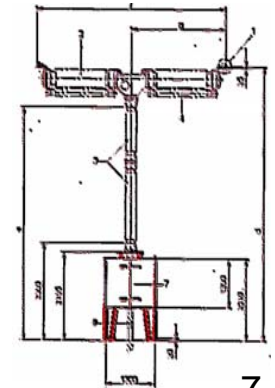
**Components**  
(Equipment)

Identification of a specific equipment (using its serial number)



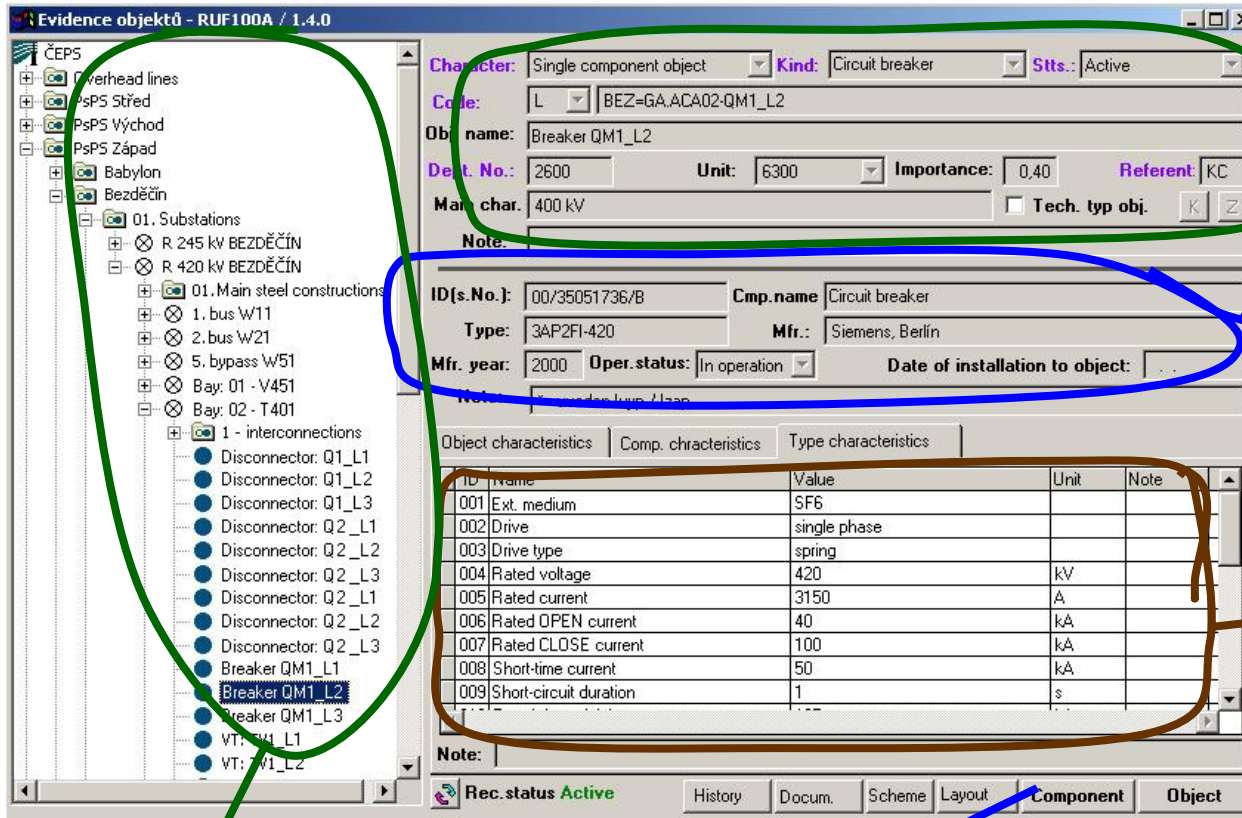
**Types**  
(Class)

Identification of equipment groups of the same design (using manufacturer's designation & specification)





# Equipment population



The screenshot shows the 'Evidence objektů - RUF100A / 1.4.0' software interface. The left pane displays the 'Object tree' with a hierarchical view of the project structure, including '01. Substations' and '01. Main steel constructions'. The main pane shows the 'Object data' for a 'Circuit breaker' (Breaker QM1\_L2). Below this, the 'Component details' section includes fields for 'ID(s.No.)', 'Type', 'Mfr. year', and 'Oper. status'. At the bottom, the 'Object details' section contains a table of characteristics.

ID	Name	Value	Unit	Note
001	Ext. medium	SF6		
002	Drive	single phase		
003	Drive type	spring		
004	Rated voltage	420	kV	
005	Rated current	3150	A	
006	Rated OPEN current	40	kA	
007	Rated CLOSE current	100	kA	
008	Short-time current	50	kA	
009	Short-circuit duration	1	s	

**Object data**  
Cigre : Rated U, Location, Service

**Comp. data**  
Cigre: Manufacturing year

**Type data**  
Cigre : Operating mech., Main insulation, Type of enclosure

Object tree

Component details

Object details



# Events database

## Object events:

- **Unplanned outage**
- **Planned outage**
- **Service switch-off**

## Type events:

- **Random failures**
- **Systematic failures (design, manufacturing, installation, ageing, etc. ) see CIGRE questionnaire “Cause”**

## Components events:

- **Major failure**
- **Minor failure**
- **Corrective maintenance**
- **Preventive maintenance (acc. to CEPS standard or extraordinary)**
- **Commissioning**
- **Disassembly**
- **Disposal**

**Links between different events has to be recorded to describe causes and consequences**

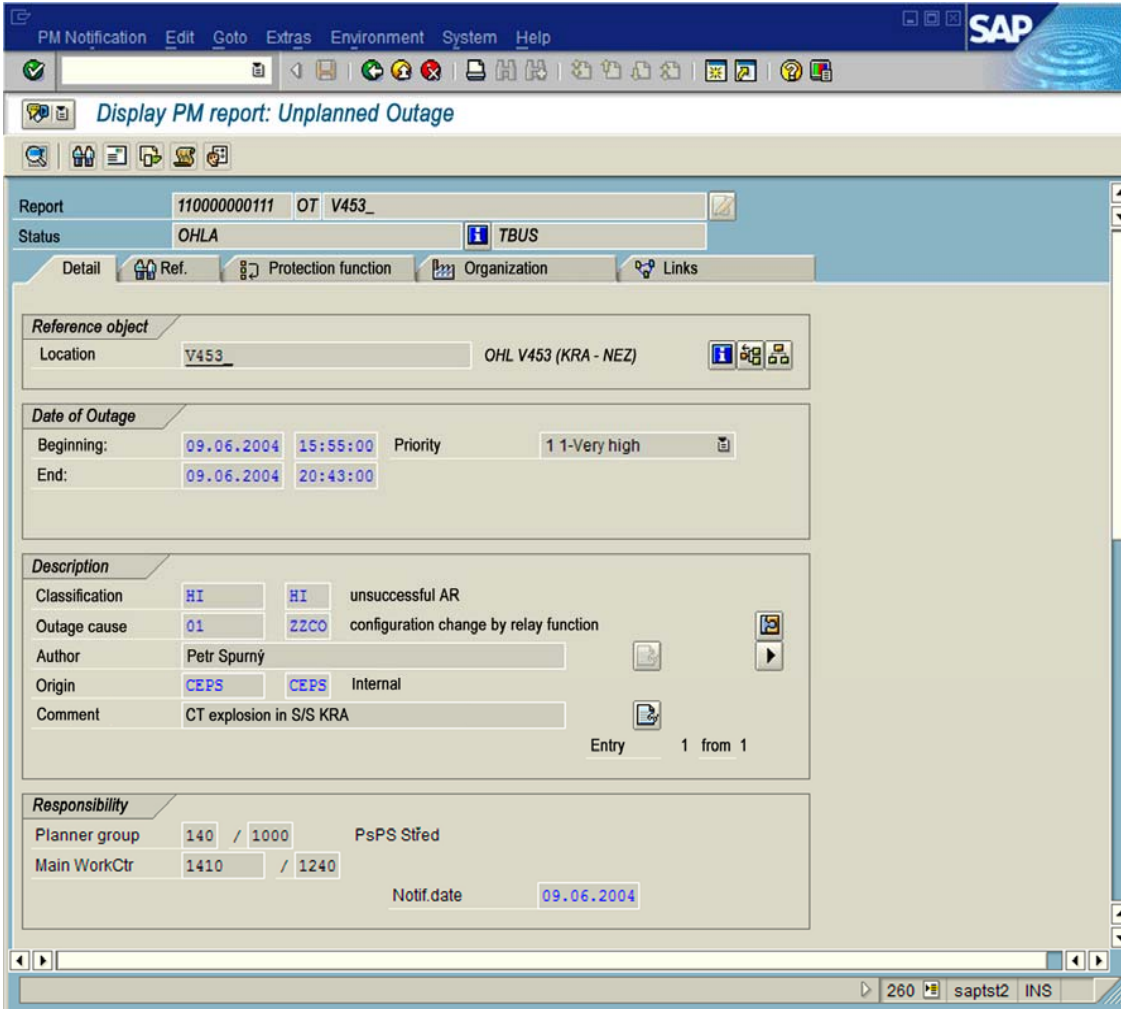
# Example of unplanned event

## 420 kV CT AOK (1996) explosion in 2004

- Normal service of OHL
- Two strokes into OHL conductor - 5-10 km distance, 10 kA, 2<sup>nd</sup> stroke at the end of single pole autoreclosing sequence



# Example of unplanned events inventory – Outage report



The screenshot shows the SAP PM Notification interface for an unplanned outage. The main window title is "Display PM report: Unplanned Outage". The report details are as follows:

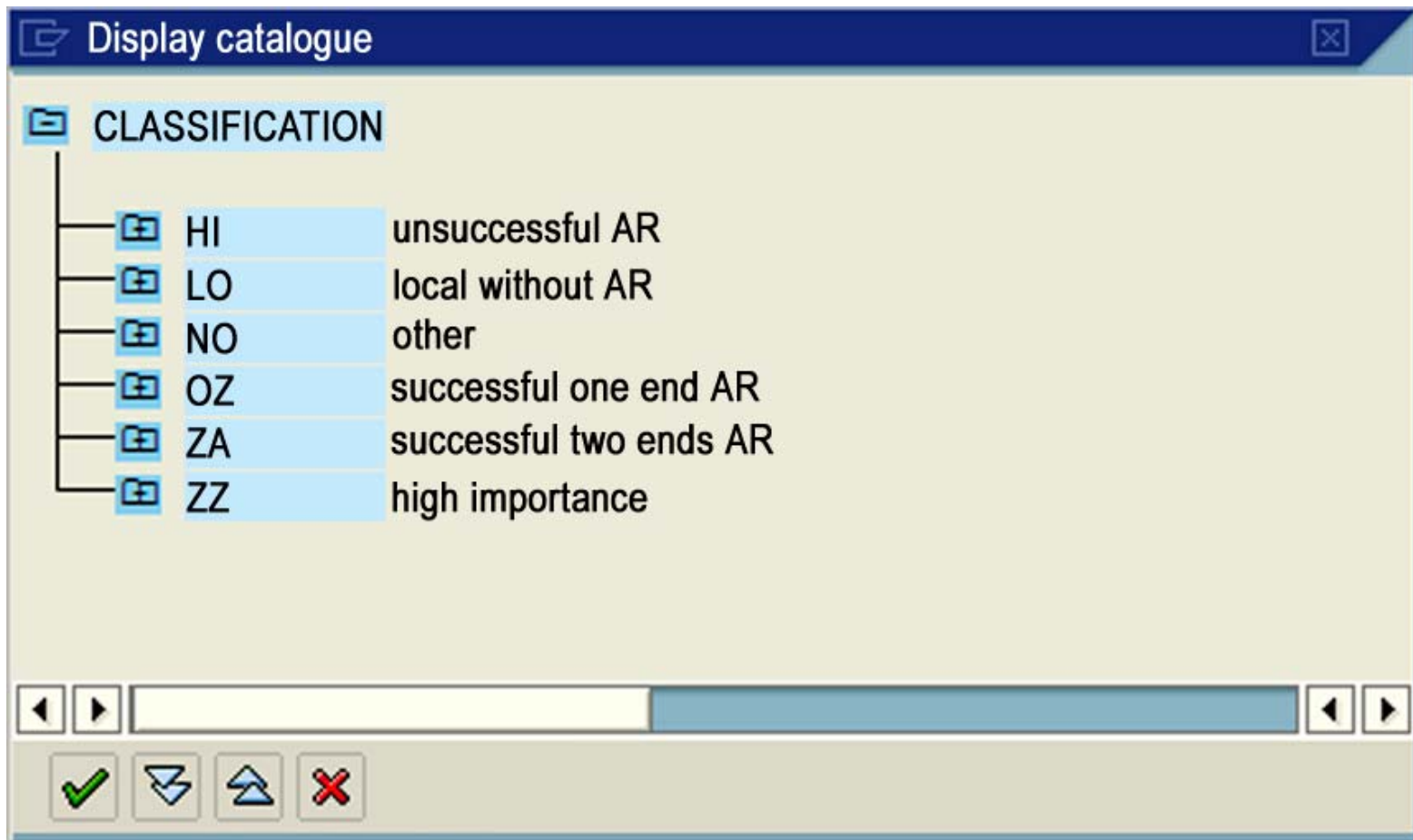
Report	110000000111	OT	V453_
Status	OHLA	TBUS	
Reference object	Location: V453 OHL V453 (KRA - NEZ)		
Date of Outage	Beginning: 09.06.2004 15:55:00	End: 09.06.2004 20:43:00	Priority: 1 1-Very high
Description	Classification: HI HI unsuccessful AR Outage cause: 01 ZZCO configuration change by relay function Author: Petr Spurný Origin: CEPS CEPS Internal Comment: CT explosion in S/S KRA Entry 1 from 1		
Responsibility	Planner group: 140 / 1000 PsPS Střed Main WorkCtr: 1410 / 1240 Notif. date: 09.06.2004		

Dispatch center enters a record about the outage on the same day of the outage

## Categories:

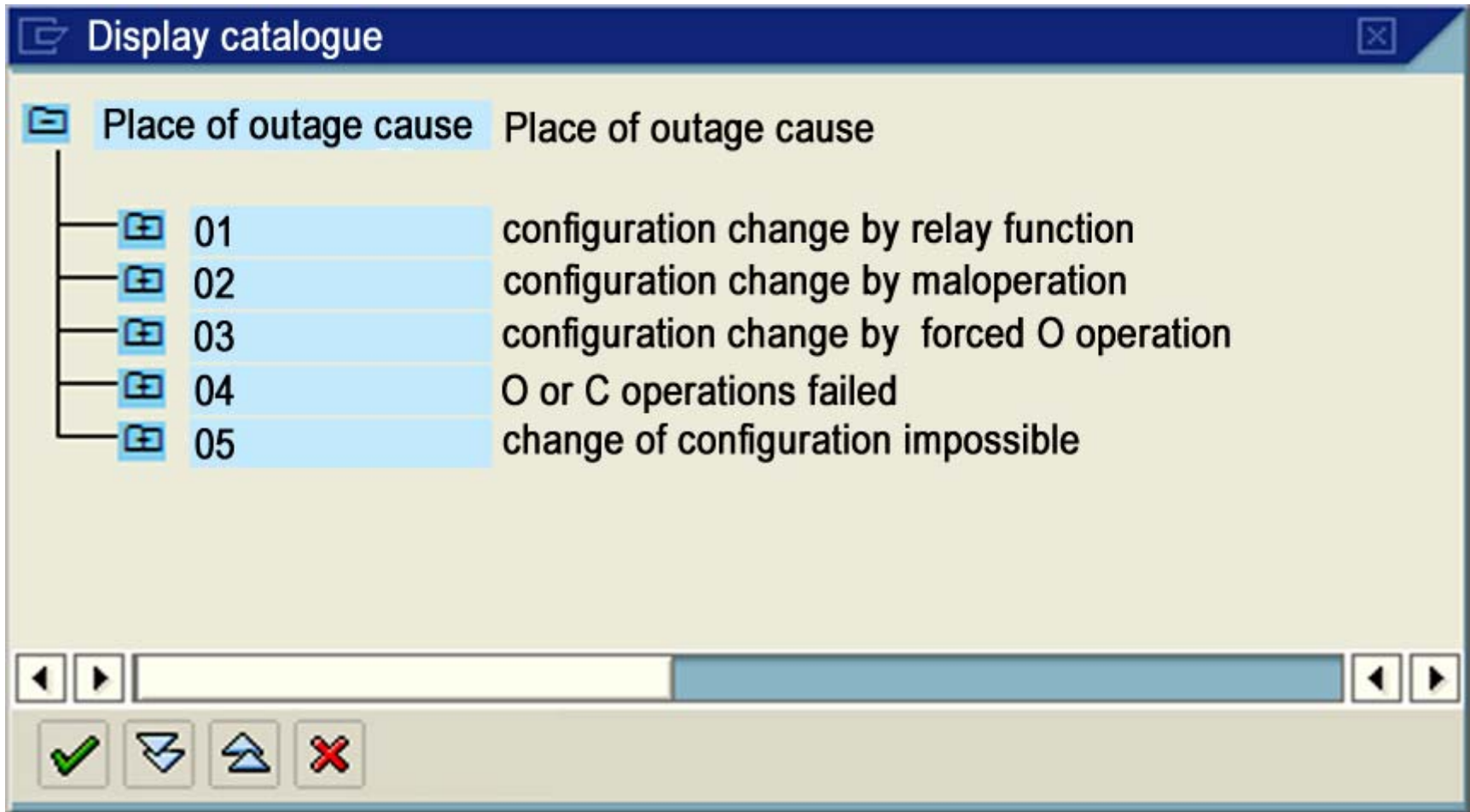
- Classification
- Outage Cause
- Origin
- Termination mode

# Example of unplanned events inventory – Outage classification

A screenshot of a software window titled 'Display catalogue'. The window has a blue title bar with a close button on the right. Below the title bar, there is a tree view structure. The root node is 'CLASSIFICATION', which is expanded to show six sub-items: 'HI', 'LO', 'NO', 'OZ', 'ZA', and 'ZZ'. Each sub-item is represented by a folder icon, a two-letter code, and a descriptive text. At the bottom of the window, there is a scroll bar and a toolbar with four icons: a green checkmark, a blue folder icon, a blue folder icon with an arrow, and a red 'X' icon.

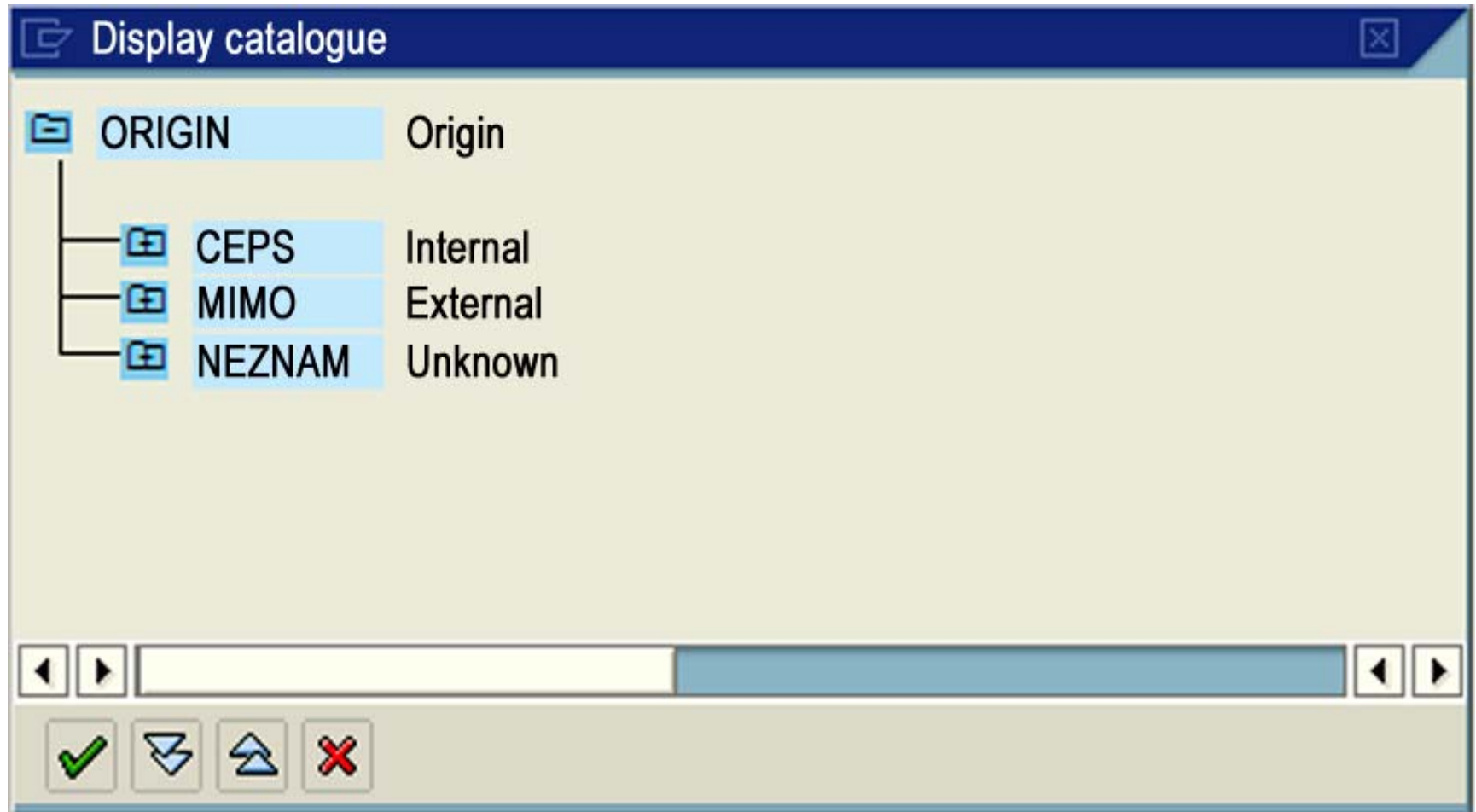
Code	Description
HI	unsuccessful AR
LO	local without AR
NO	other
OZ	successful one end AR
ZA	successful two ends AR
ZZ	high importance

## Example of unplanned events inventory – Outage cause

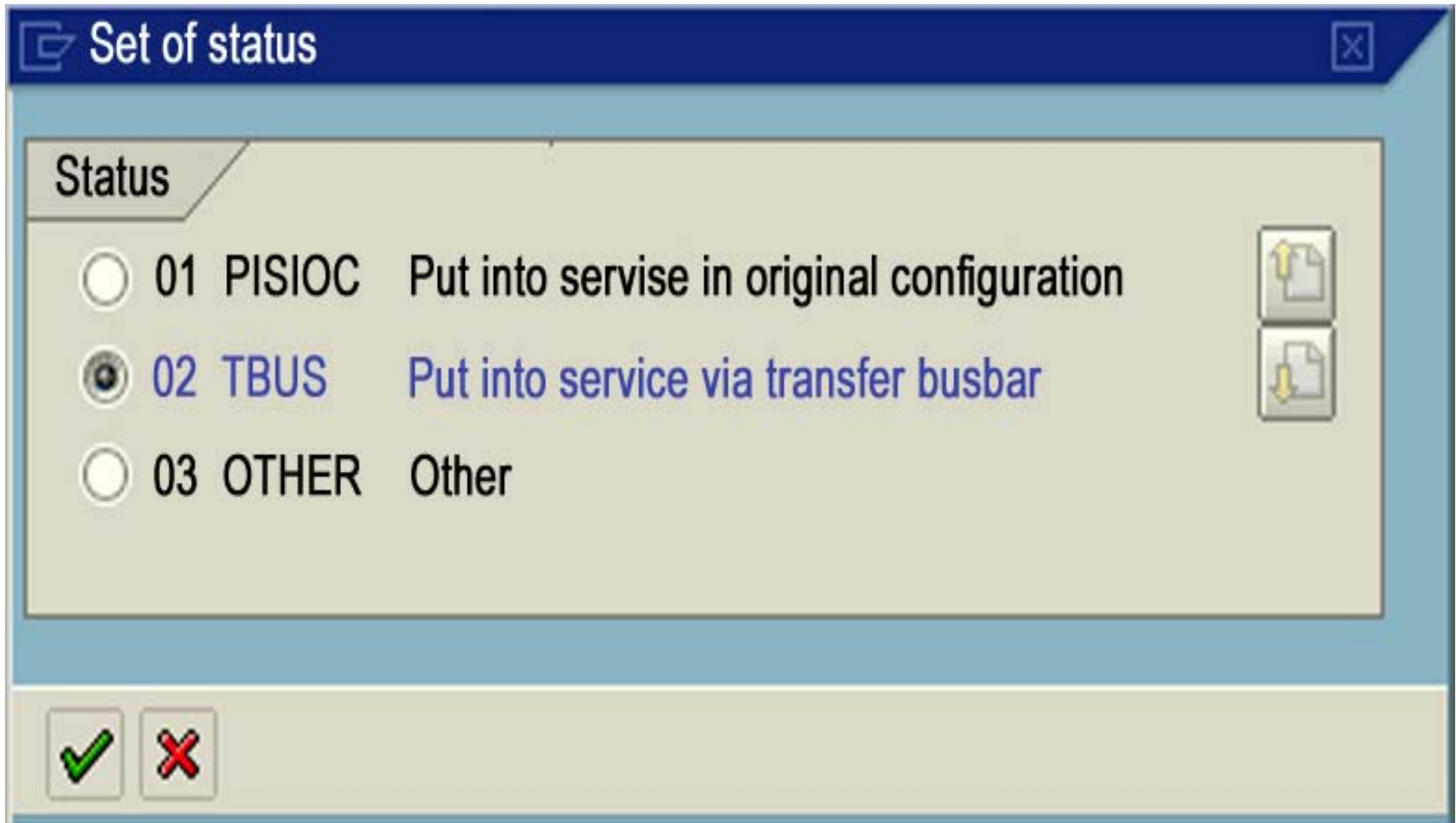
A screenshot of a software application window titled "Display catalogue". The window has a blue title bar with a close button in the top right corner. The main content area is light yellow and displays a tree view under the heading "Place of outage cause". The tree view shows five sub-items, each with a blue folder icon, a two-digit number, and a descriptive text. At the bottom of the window, there is a search bar with left and right arrow buttons, and a toolbar with four icons: a green checkmark, a blue envelope, a blue upward-pointing arrow, and a red 'X'.



# Example of unplanned events inventory – Outage origin



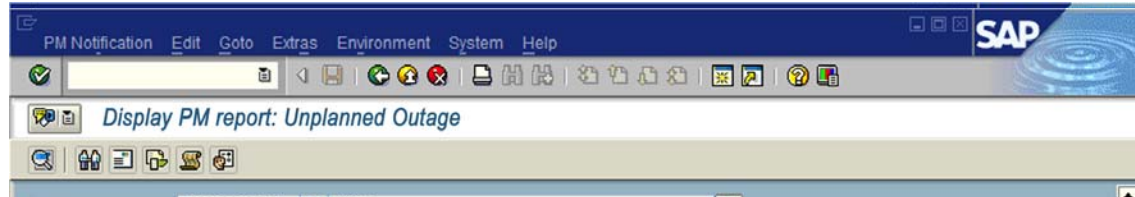
## Example of unplanned events inventory – Mode of outage termination

A screenshot of a software dialog box titled "Set of status". The dialog has a blue header bar with a close button (X) in the top right corner. Below the header is a light blue area containing a "Status" section with a tabbed appearance. This section lists three radio button options: "01 PISIOC Put into servise in original configuration", "02 TBUS Put into service via transfer busbar", and "03 OTHER Other". The "02 TBUS" option is selected, indicated by a filled radio button. To the right of the text are two document icons with yellow arrows pointing up and down. At the bottom of the dialog is a light beige bar containing a green checkmark icon and a red X icon.

Status	
<input type="radio"/> 01 PISIOC	Put into servise in original configuration
<input checked="" type="radio"/> 02 TBUS	Put into service via transfer busbar
<input type="radio"/> 03 OTHER	Other



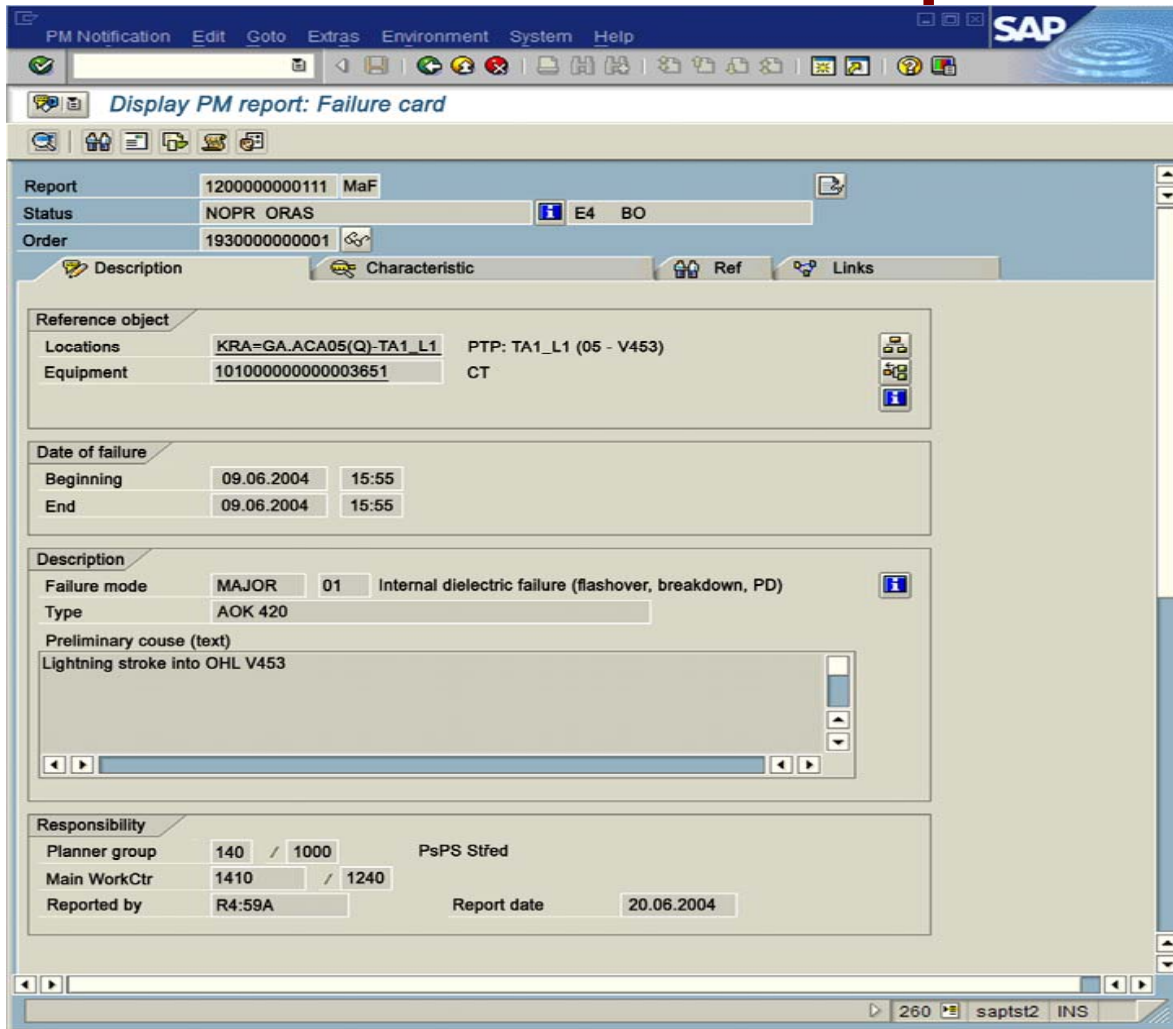
# Example of unplanned events inventory – Outage link to failure report



## Links

REPORT	TYPE	STATUS	EQUIPMENT TYPE
<a href="#">120000000074</a>	MaF	PŘZA ZPHL	AOK 420

# Example of unplanned events inventory – Failure report



The screenshot shows the SAP PM Notification Failure card interface. The title bar reads "Display PM report: Failure card". The main content area is divided into several sections:

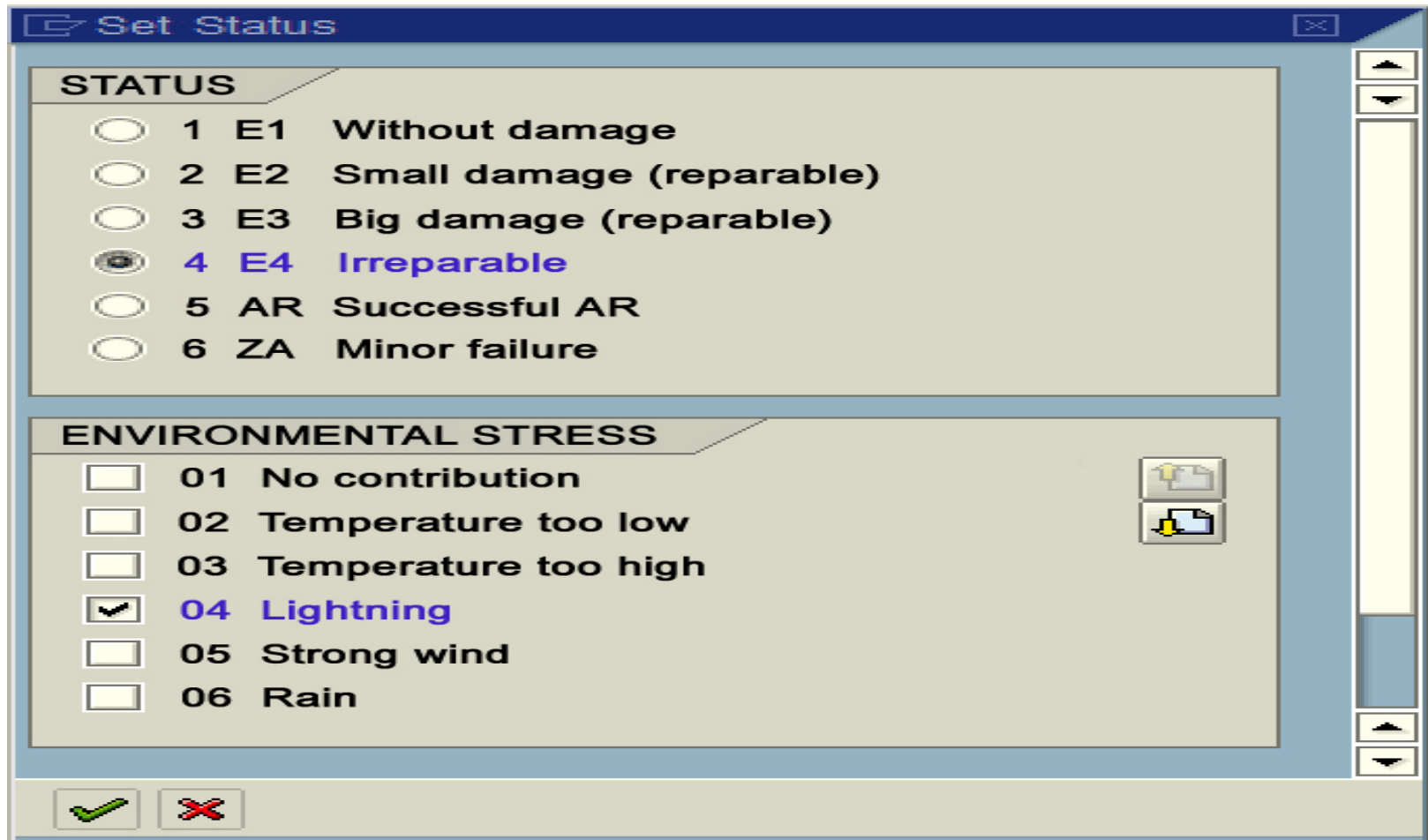
- Report Information:** Report number 1200000000111, Status NOPR ORAS, Order 1930000000001.
- Reference object:** Locations KRA=GA.ACA05(Q)-TA1\_L1, Equipment 101000000000003651.
- Date of failure:** Beginning 09.06.2004 15:55, End 09.06.2004 15:55.
- Description:** Failure mode MAJOR 01 Internal dielectric failure (flashover, breakdown, PD), Type AOK 420. Preliminary cause (text): Lightning stroke into OHL V453.
- Responsibility:** Planner group 140 / 1000, Main WorkCtr 1410 / 1240, Reported by R4:59A, Report date 20.06.2004.

Regional center enters a record about basic information about the failure within one week

Description :

- Status : type of the failure and environment contribution
- Failure mode

# Example of unplanned events inventory – Type of the failure and environment contribution



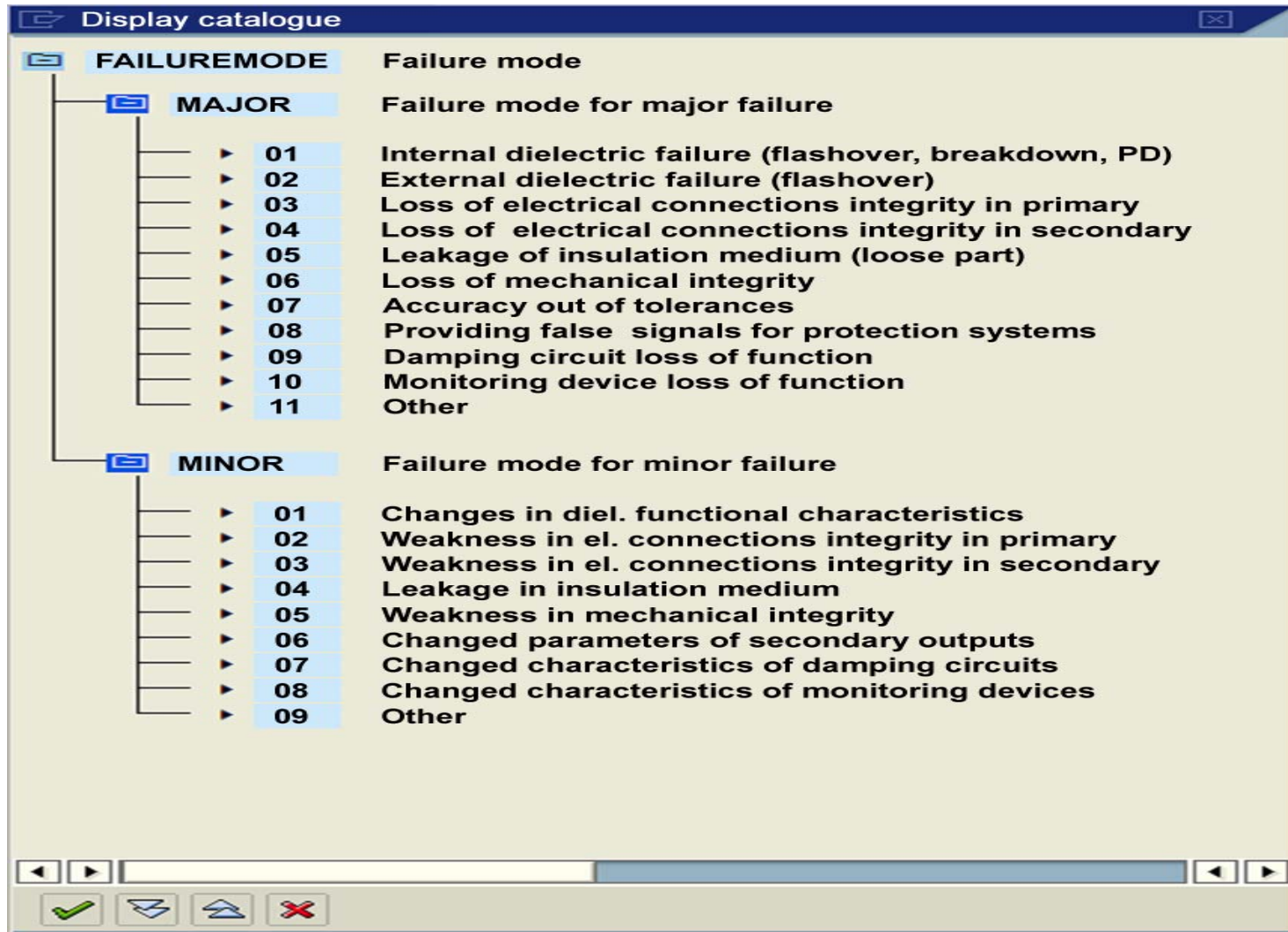
The screenshot shows a 'Set Status' dialog box with two main sections: 'STATUS' and 'ENVIRONMENTAL STRESS'. The 'STATUS' section has six radio button options, with '4 E4 Irreparable' selected. The 'ENVIRONMENTAL STRESS' section has six checkbox options, with '04 Lightning' checked. There are also two icons on the right side of the 'ENVIRONMENTAL STRESS' section and a status bar at the bottom with a green checkmark and a red X icon.

STATUS	
<input type="radio"/>	1 E1 Without damage
<input type="radio"/>	2 E2 Small damage (reparable)
<input type="radio"/>	3 E3 Big damage (reparable)
<input checked="" type="radio"/>	4 E4 Irreparable
<input type="radio"/>	5 AR Successful AR
<input type="radio"/>	6 ZA Minor failure

ENVIRONMENTAL STRESS	
<input type="checkbox"/>	01 No contribution
<input type="checkbox"/>	02 Temperature too low
<input type="checkbox"/>	03 Temperature too high
<input checked="" type="checkbox"/>	04 Lightning
<input type="checkbox"/>	05 Strong wind
<input type="checkbox"/>	06 Rain

# Example of unplanned events inventory – Failure mode

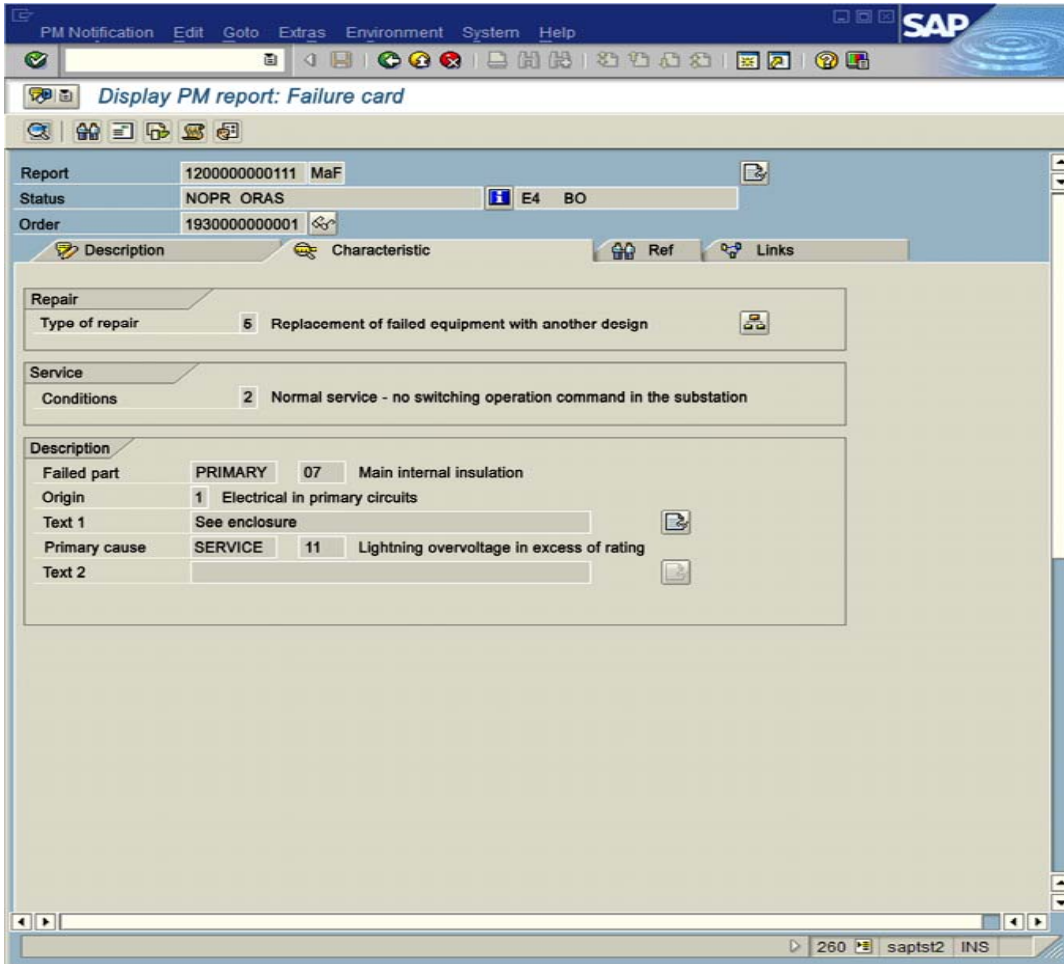


**Display catalogue**

- FAILUREMODE** Failure mode
  - MAJOR** Failure mode for major failure
    - ▶ 01 Internal dielectric failure (flashover, breakdown, PD)
    - ▶ 02 External dielectric failure (flashover)
    - ▶ 03 Loss of electrical connections integrity in primary
    - ▶ 04 Loss of electrical connections integrity in secondary
    - ▶ 05 Leakage of insulation medium (loose part)
    - ▶ 06 Loss of mechanical integrity
    - ▶ 07 Accuracy out of tolerances
    - ▶ 08 Providing false signals for protection systems
    - ▶ 09 Damping circuit loss of function
    - ▶ 10 Monitoring device loss of function
    - ▶ 11 Other
  - MINOR** Failure mode for minor failure
    - ▶ 01 Changes in diel. functional characteristics
    - ▶ 02 Weakness in el. connections integrity in primary
    - ▶ 03 Weakness in el. connections integrity in secondary
    - ▶ 04 Leakage in insulation medium
    - ▶ 05 Weakness in mechanical integrity
    - ▶ 06 Changed parameters of secondary outputs
    - ▶ 07 Changed characteristics of damping circuits
    - ▶ 08 Changed characteristics of monitoring devices
    - ▶ 09 Other

Navigation icons: back, forward, search, refresh, close.

# Example of unplanned events inventory – Failure characteristics



The screenshot shows the SAP PM Notification interface for a failure card. The report number is 1200000000111 (MaF), status is NOPR ORAS, and order is 1930000000001. The failure details are as follows:

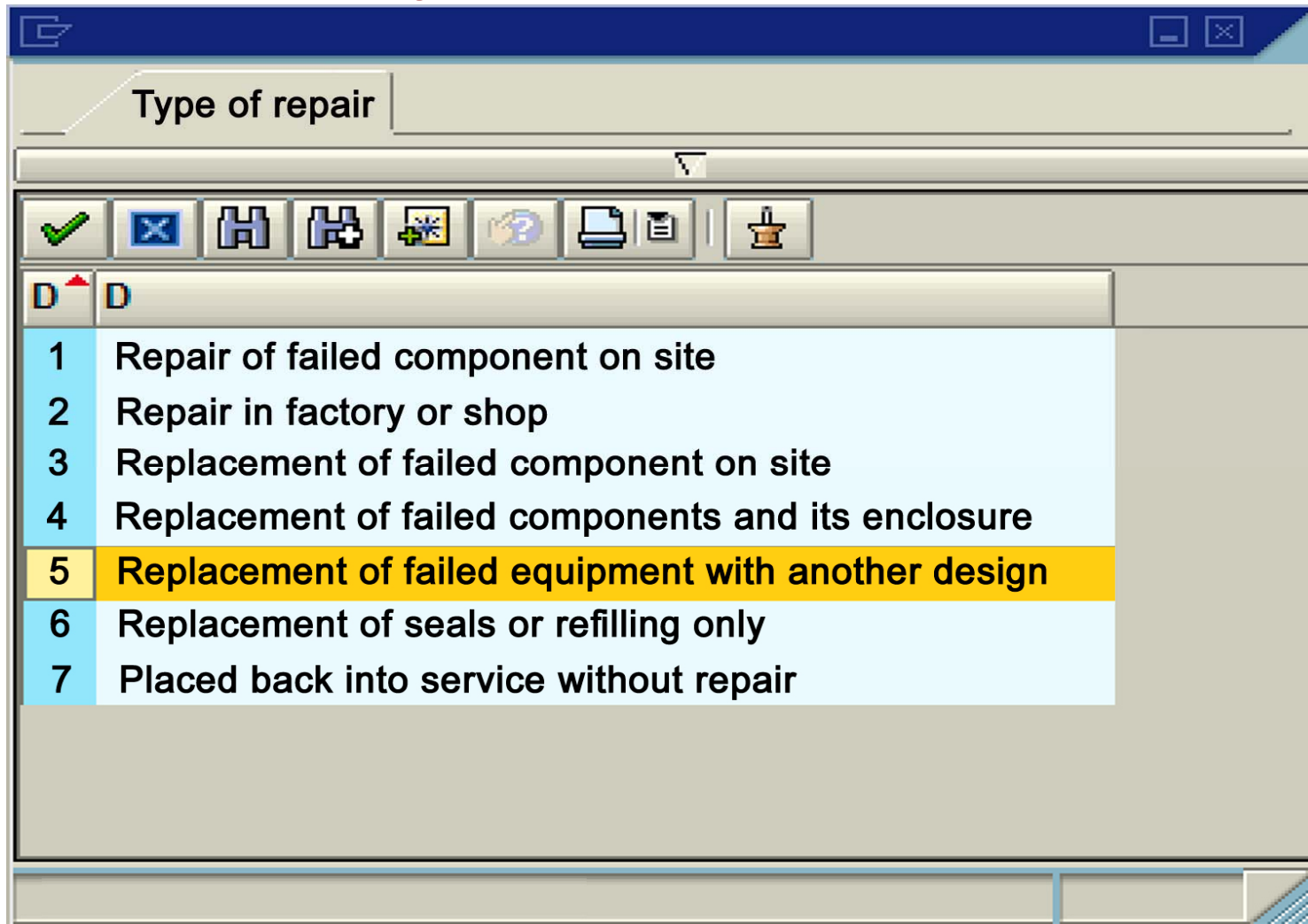
Section	Field	Value	Description
Repair	Type of repair	6	Replacement of failed equipment with another design
	Conditions	2	Normal service - no switching operation command in the substation
Description	Failed part	PRIMARY 07	Main internal insulation
	Origin	1	Electrical in primary circuits
	Text 1		See enclosure
	Primary cause	SERVICE 11	Lightning overvoltage in excess of rating
	Text 2		

Regional center enters a record about the failure details when they are known

Failure characteristic:

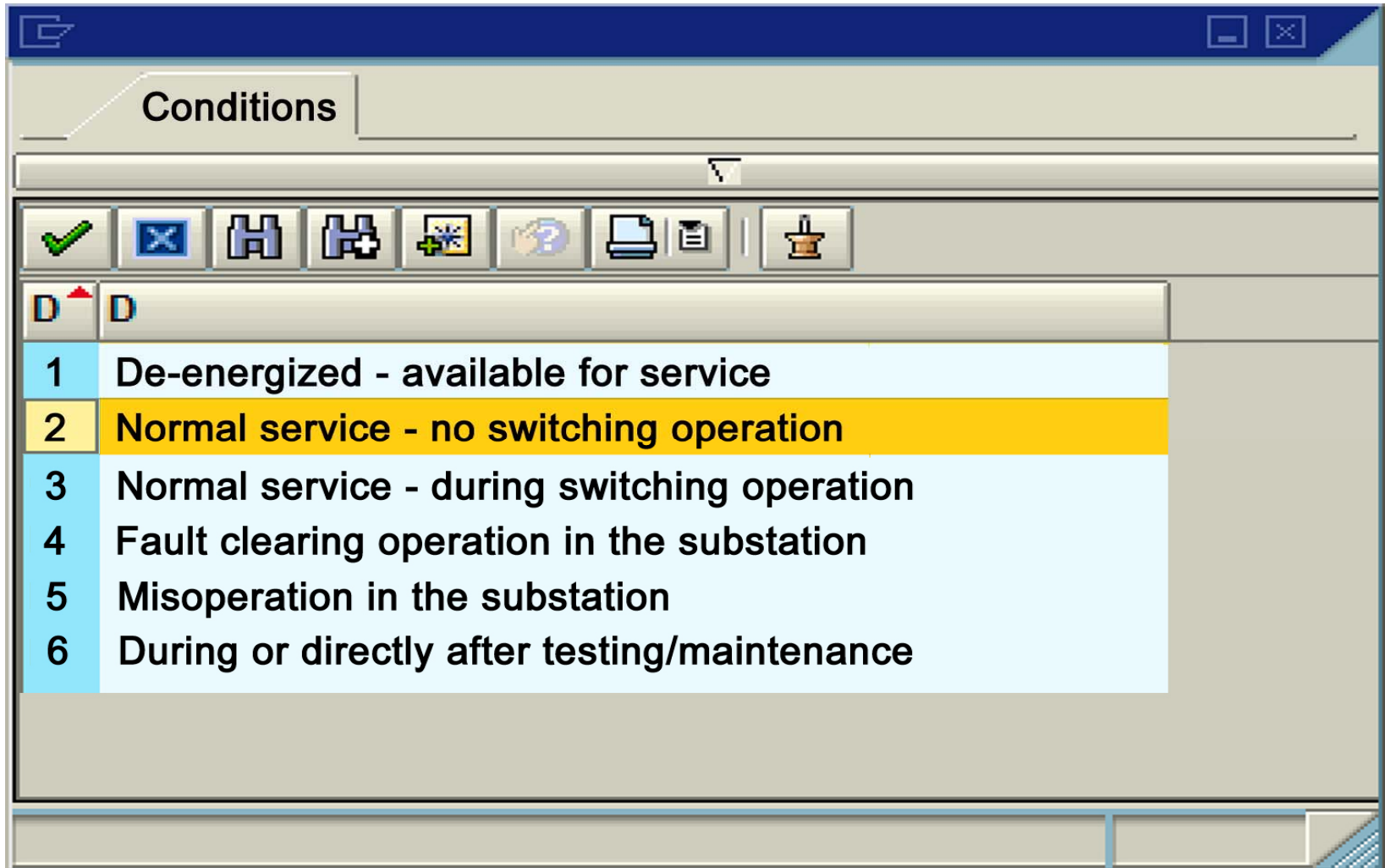
- Type of the repair
- Service condition
- Failed part
- Origin
- Primary cause

## Example of unplanned events inventory – Type of the repair





## Example of unplanned events inventory – Service conditions



The screenshot shows a software window titled "Conditions" with a toolbar containing icons for checkmark, close, home, add, help, print, and save. Below the toolbar is a list of conditions:

D	D
1	De-energized - available for service
2	Normal service - no switching operation
3	Normal service - during switching operation
4	Fault clearing operation in the substation
5	Misoperation in the substation
6	During or directly after testing/maintenance



# Example of unplanned events inventory – Failed part

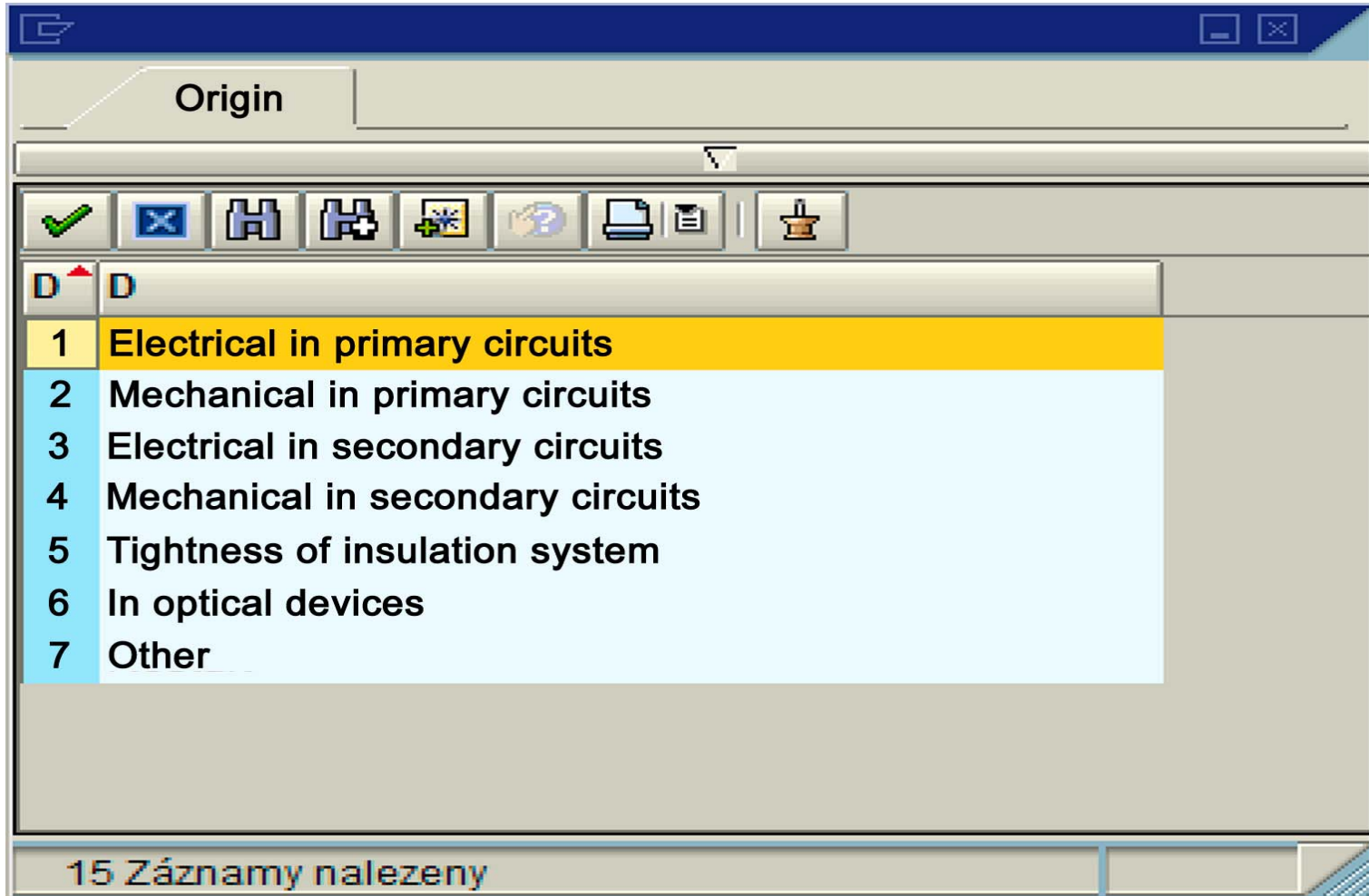
Display catalogue

**FPART** Failed part

- OTHER** Other
  - PRIMARY** Component in primary part
    - ▶ 01 HV tank (primary terminals incl.)
    - ▶ 02 Insulator (porcelain, composite or resin)
    - ▶ 03 Earthed metal tank or enclosure
    - ▶ 04 Bushing (internal tube)
    - ▶ 05 Spacer or any other rigid HV internal insulation
    - ▶ 06 Rigid HV external insulation
    - ▶ 07 Main internal insulation
    - ▶ 08 Primary winding
    - ▶ 09 Capacitors in CVT
    - ▶ 10 Components for expansion control of insulation medium
    - ▶ 11 Sealing (e.g. gaskets and O-rings)
    - ▶ 12 Primary part at optical IT
    - ▶ 13 Optical fiber in primary part of optical IT
    - ▶ 14 Part of component in primary part but unidentified
  - SECONDA** Internal component in secondary part
    - ▶ 16 Secondary winding
    - ▶ 17 Secondary winding insulation
    - ▶ 18 Shielding of secondary winding
    - ▶ 19 Internal earthing connections and bushings
    - ▶ 20 Internal damping circuits components
    - ▶ 21 Secondary reconnection taps
    - ▶ 22 Optical device in optical IT
    - ▶ 23 Transmission optical fiber at optical IT
    - ▶ 24 Electrical circuit at optical IT
  - EXTERNA** External (air insulated) accessory
    - ▶ 26 Terminal board
    - ▶ 27 External earthing
    - ▶ 28 External cable connection
    - ▶ 29 Pressure monitoring device
    - ▶ 30 Pipes and sealing for pressure monitoring device
    - ▶ 31 High frequency equipment protection components
    - ▶ 32 Monitoring devices other than pressure
    - ▶ 33 Any other accessory at optical IT

Navigation icons: back, forward, home, refresh, close

# Example of unplanned events inventory – Failure origin

A screenshot of a software application window titled "Origin". The window has a blue title bar with standard minimize, maximize, and close buttons. Below the title bar is a search bar. A toolbar with various icons (checkmark, close, zoom, etc.) is located below the search bar. The main area contains a list of items, with the first item "1 Electrical in primary circuits" highlighted in yellow. The list is as follows:

D	D
1	Electrical in primary circuits
2	Mechanical in primary circuits
3	Electrical in secondary circuits
4	Mechanical in secondary circuits
5	Tightness of insulation system
6	In optical devices
7	Other

At the bottom of the window, a status bar displays the text "15 Záznamy nalezeny".

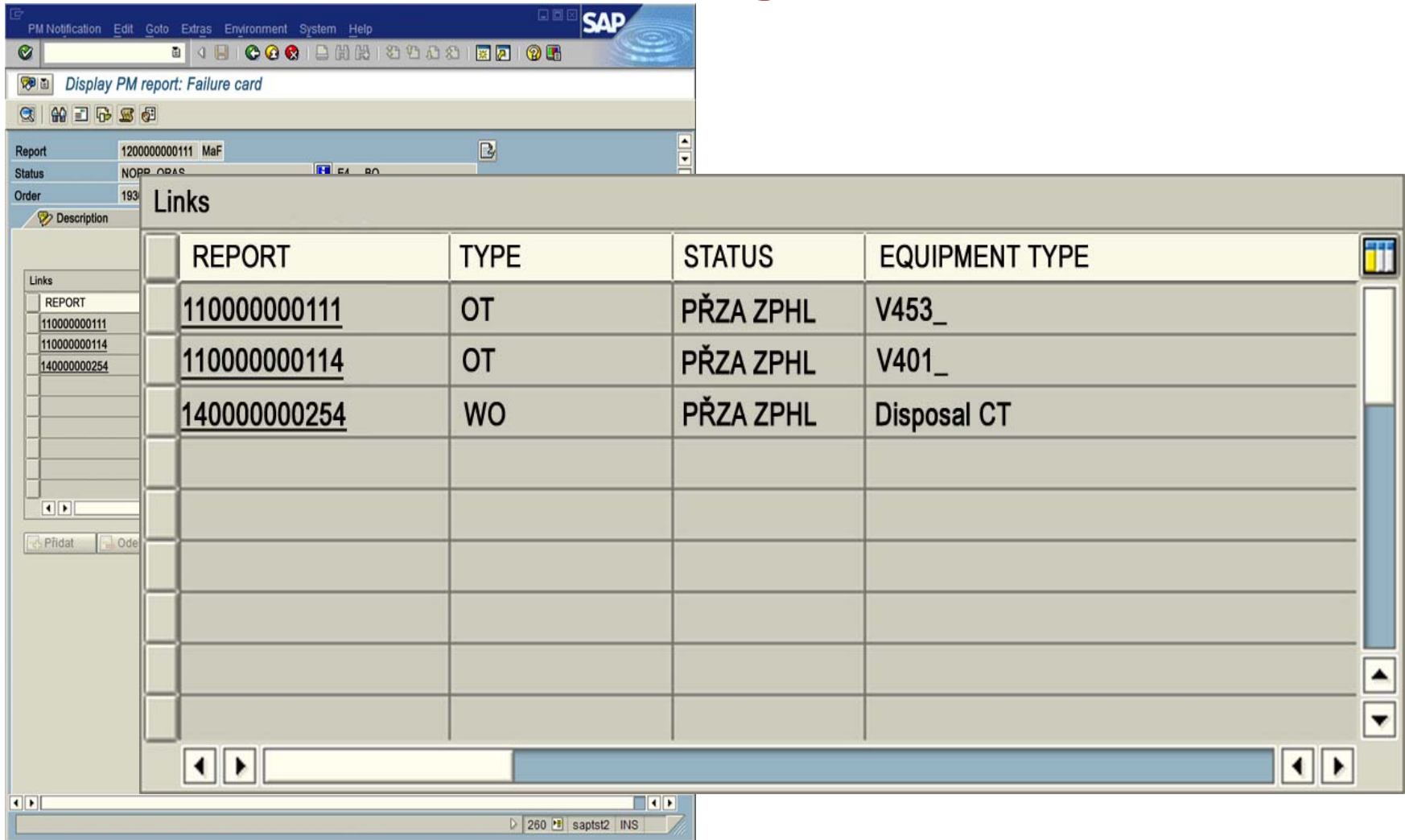
# Example of unplanned events inventory – Failure primary cause

Display catalogue

CAUSE		Primary cause
OTHER		Unknown other causes
BEFORE		Period before putting into service
	▶ 01	Design fault (manufacturer responsibility)
	▶ 02	Engineering fault (utility responsibility)
	▶ 03	Manufacturing fault (poor quality control)
	▶ 04	Incorrect transport or erection
	▶ 05	Inadequate instructions for transport, erection, operation
	▶ 06	Other
SERVICE		
	▶ 08	Current in excess of rating
	▶ 09	Voltage at power frequency in excess of rating
	▶ 10	Switching overvoltage in excess of rating
	▶ 11	Lightning overvoltage in excess of rating
	▶ 12	Mechanical stress in excess of rating
	▶ 13	Environmental stresses in excess of ratings
	▶ 14	Corrosion
	▶ 15	Wear / Ageing
	▶ 16	Incorrect operation
	▶ 17	Incorrect monitoring
	▶ 18	Electrical failure of adjacent equipment
	▶ 19	Mechanical failure of adjacent equipment
	▶ 20	Human error
	▶ 21	Incorrect maintenance
	▶ 22	External damage caused by animals, humans etc.
	▶ 23	Other abnormal service conditions

Navigation icons: back, forward, search, close

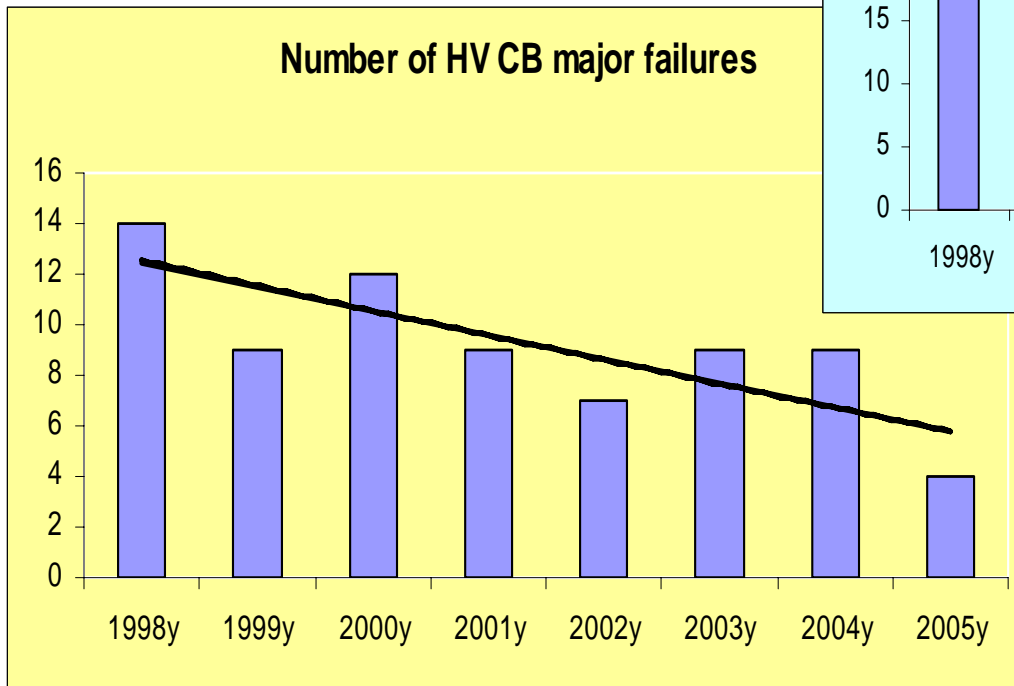
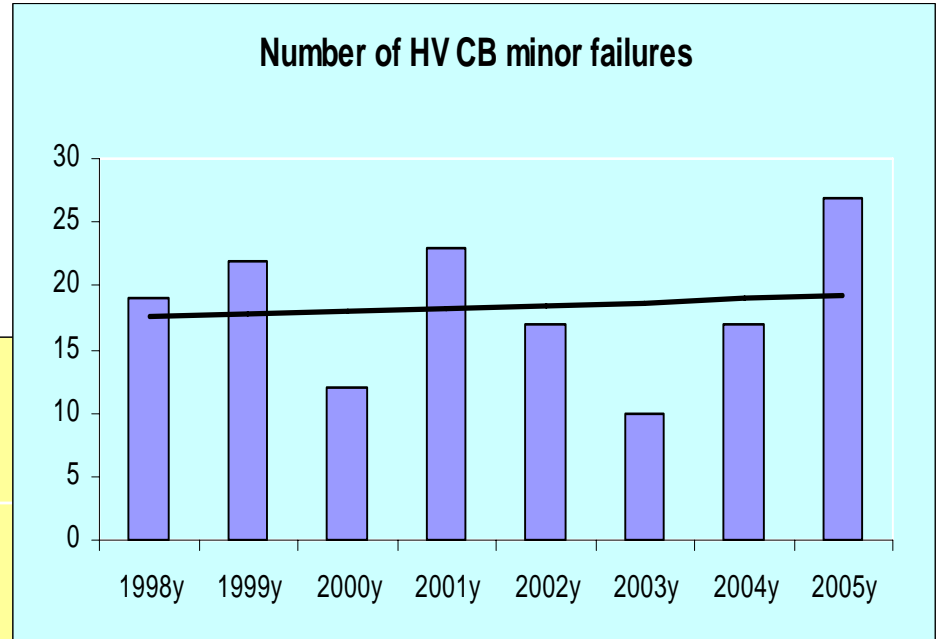
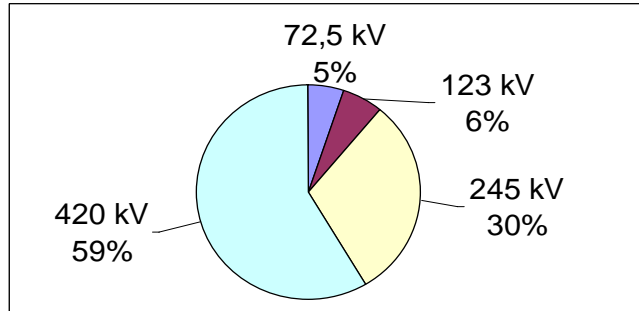
# Example of unplanned events inventory – Failure links to outage and work order



The screenshot shows the SAP PM Notification interface. The main window displays a failure card for report 120000000111. Below the card, a 'Links' table lists related reports and work orders.

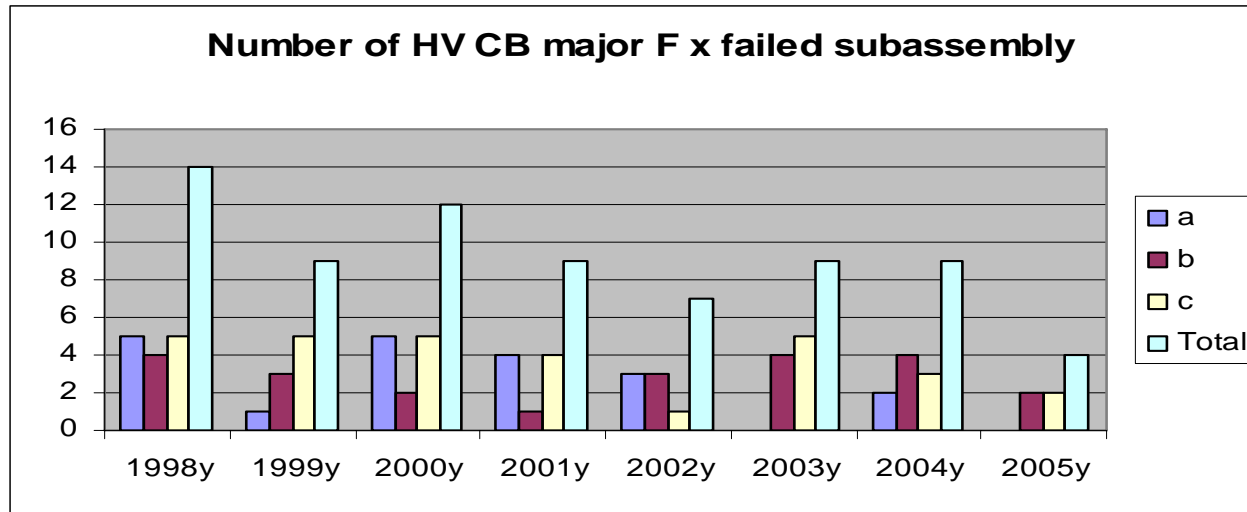
REPORT	TYPE	STATUS	EQUIPMENT TYPE
<u>110000000111</u>	OT	PŘZA ZPHL	V453_
<u>110000000114</u>	OT	PŘZA ZPHL	V401_
<u>140000000254</u>	WO	PŘZA ZPHL	Disposal CT

# Example of equipment analyses



**class 1 to 4 :  
308 live tank CBs**

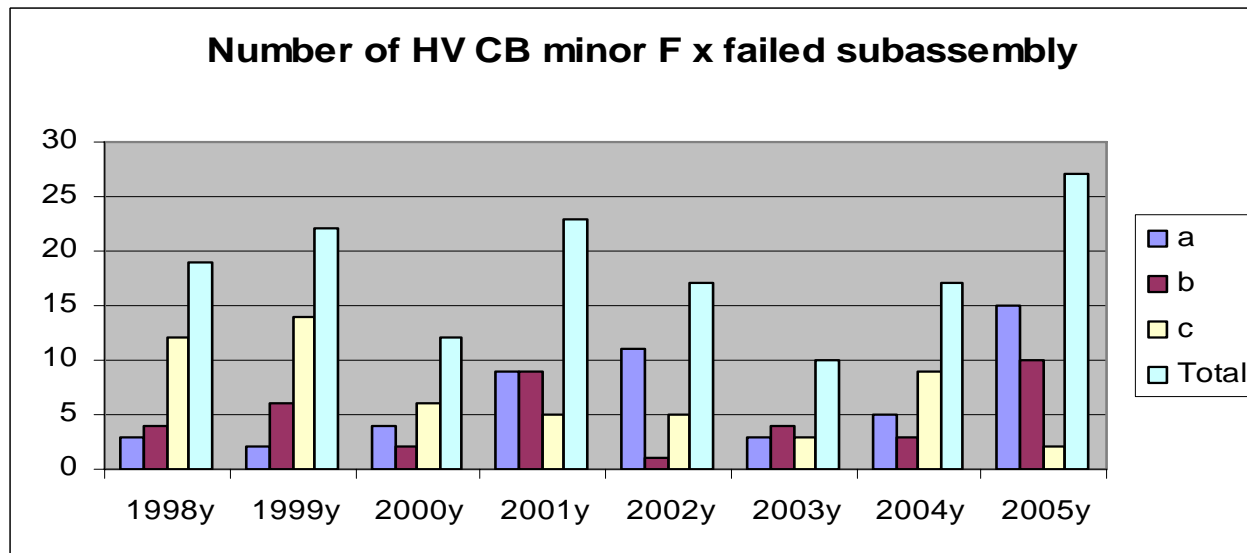
# Example of equipment analyses



**a – Comp. in primary circuit**

**b – Comp. in control, auxiliary or monitor. circuit**

**c – Comp. in operating mechanism**





## Conclusion

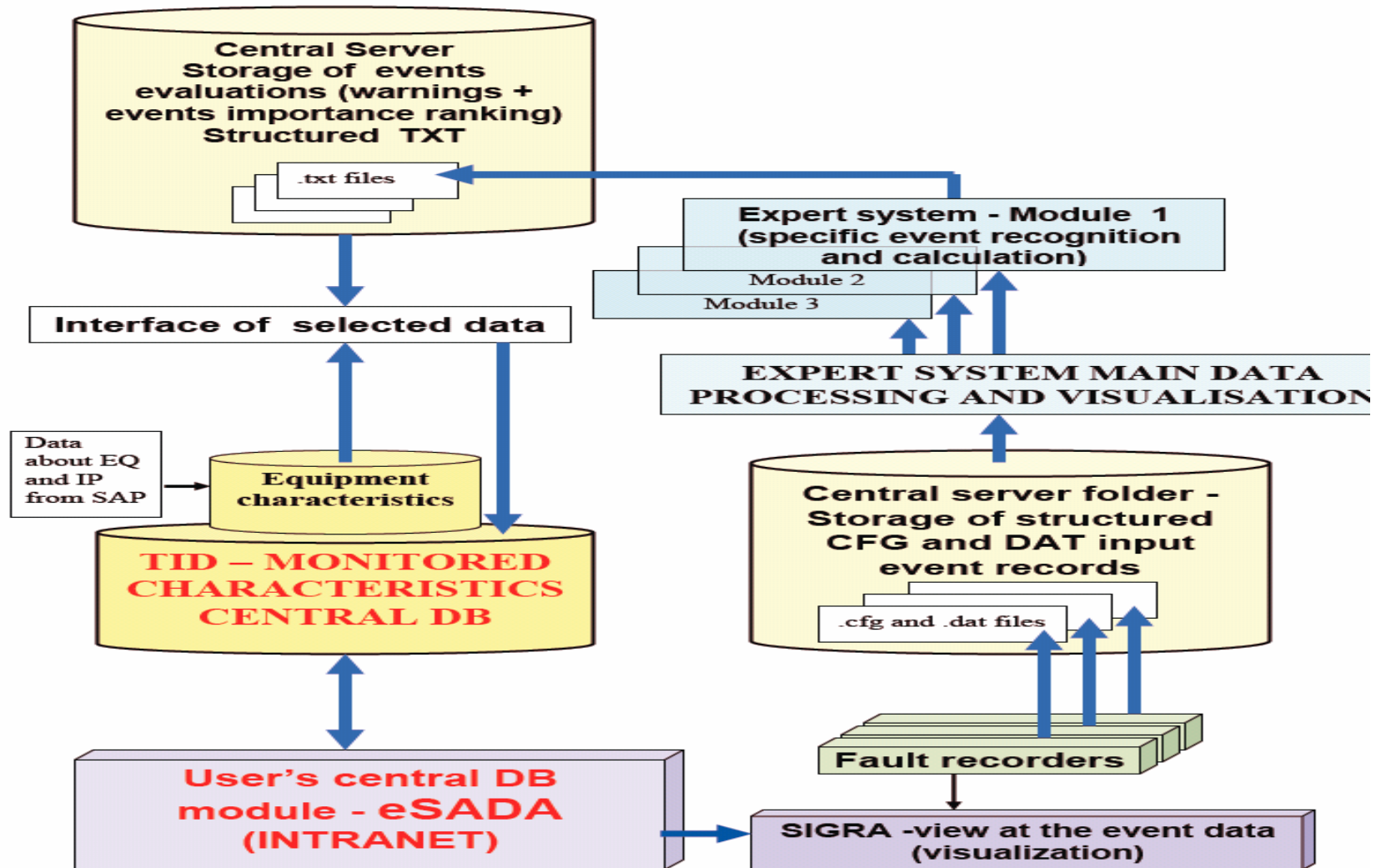
- **Structured data collection allows analysis of equipment history**
- **Automation (match codes) can bring high added value to the data collection process by making it as simple as possible to the personnel**
- **Using the history of unplanned and planned events, the equipment condition can be evaluated to support AM decision making process**
- **The system can be used to justify decisions of equipment refurbishment, replace or changing maintenance intervals and tasks, allowing flexible long-term work planning**



# Future challenges

- ➡ **Automatic collection of monitored data (SCADA, fault recorders, transformer monitors, etc.)**
- ➡ **Interconnection to expert systems**
  - **to evaluate automatically monitored data**
  - **to deliver recommendations about maintenance rules changes**
- ➡ **Interconnection to economical system to evaluate corporate risk of AM decisions**

# Future challenge – Example : Data from fault recorders





**The whole system than will look like a  
nice, organized city**

