



## Classification system for reporting events involving human malfunctions

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CLASSIFICATION SYSTEM FOR REPORTING EVENTS INVOLVING  
HUMAN MALFUNCTIONS

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Abstract. The report describes a set of categories for reporting industrial incidents and events involving human malfunction. The classification system aims at ensuring information adequate for improvement of human work situations and man-machine interface systems and for attempts to quantify "human error" rates.

The classification system has a multifaceted non-hierarchical structure and its compatibility with Ispra's ERDS classification is described. The collection of the information in general and for quantification purposes are discussed. 24 categories, 12 of which being human factors oriented, are listed with their respective subcategories, and comments are given.

Underlying models of human data processes and their typical malfunctions and of a human decision sequence are described.

7 references.

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## TABLE OF CONTENTS

	Page
INTRODUCTION .....	5
The structure of the taxonomy .....	5
Collection of data, general .....	8
Collection of data for quantification .....	11
THE CATEGORIES OF THE TAXONOMY	
A    PLANT IDENTIFICATION .....	12
B    DATA SYSTEM IDENTIFICATION .....	13
D    EVENT DETECTION .....	14
E    PLANT STATE .....	15
F, H  SYSTEMS AND COMPONENTS AFFECTED .....	16
HM   COMPONENTS: MODES OF FAILURE .....	24
HC   COMPONENTS: CAUSES OF FAILURE .....	25
HA   COMPONENTS: ACTIONS TAKEN .....	26
G    CONSEQUENCES OF THE EVENT .....	28
J    PERSONNEL IDENTIFICATION .....	29
K    PERSONNEL LOCATION .....	30
L    PERSONNEL TASK .....	31
M    EXTERNAL MODE OF MALFUNCTION .....	33
N    POTENTIAL FOR SELF-CORRECTION .....	35
P    SITUATION FACTORS .....	36
HA   ACTIONS TAKEN .....	38
Q    INTERNAL HUMAN MALFUNCTION .....	40
R    CAUSES OF HUMAN MALFUNCTION .....	44
S    MECHANISMS OF HUMAN MALFUNCTION .....	46
T    PERFORMANCE SHAPING FACTORS .....	51
DATA COLLECTION FORMATS .....	52
REFERENCES .....	53



## INTRODUCTION

The present note is prepared to support a discussion on a set of categories which can be used in industrial incident and event reports to ensure collection of adequate information for improvement of human work situations and man-machine interface systems as well as for attempts to quantify "human error" rates.

Discussion of taxonomies to describe human tasks, performance and errors seems to be an everlasting activity among human factors specialists and the field is not very attractive after several not too successful attempts. However, if one wishes to quantify human errors, one has to identify and define the items one wants to count or measure and unless the development of modern man-machine interfaces should be controlled by piecemeal remedies after spectacular man-machine misfits - such as e.g. TMI - it is necessary to use models of human performance and define categories of problems. The basic issue is, probably, that one has to accept that the structure and members of a proper taxonomy depend very much on the intended use and the specific aspects of the work situation. One important present aspect is the rapid change in level of automation and in design of interface caused by modern information technology. Consequently, human work situation changes and the taxonomy used must be helpful for transfer of empirical data to new task designs.

### The structure of the taxonomy

To be able to quantify the frequency of inappropriate human acts in a meaningful way, it is necessary to separate cases of intrinsic human variability and spontaneous human errors from cases of psychologically normal human reactions to external events or changes in the work situation. This means that a simple classification of human errors with reference to the task sequence in terms of omission, commission, timing errors etc. is not adequate. Careful efforts should be spent to identify potential external causes with reference to categories which allow estimates of frequencies in another particular situation.

To serve as a basis for more error tolerant task and equipment design, more fundamental understanding of human malfunction in industrial work situations is needed. Event reports are an extremely valuable data source for such research, but for this purpose it is important to use a taxonomy which serve to represent the circumstances preceding and succeeding the event of human malfunction and the relation to the human task, and maintain this information in the data recorded. This leads to a multifaceted description of the human involvement in system failures as shown in Figure 1, rather than a classical, heirarchical and exclusive classification system.

The structure of this taxonomy is more important than the detailed classes related to the different facets. Some of these will depend on the specific system in question; others are preliminary classes which should be refined by future data collection and analysis. Therefore, free text comments and descriptions in the reports are necessary and the facets used in the present taxonomy can serve to indicate the type of information needed.

Emphasis has been given to obtain compatibility between the human malfunction taxonomy and the taxonomy of the European Reliability Data System under development at ISPRA (Mancini et al. 1979). The combination of the taxonomies is described in the following.

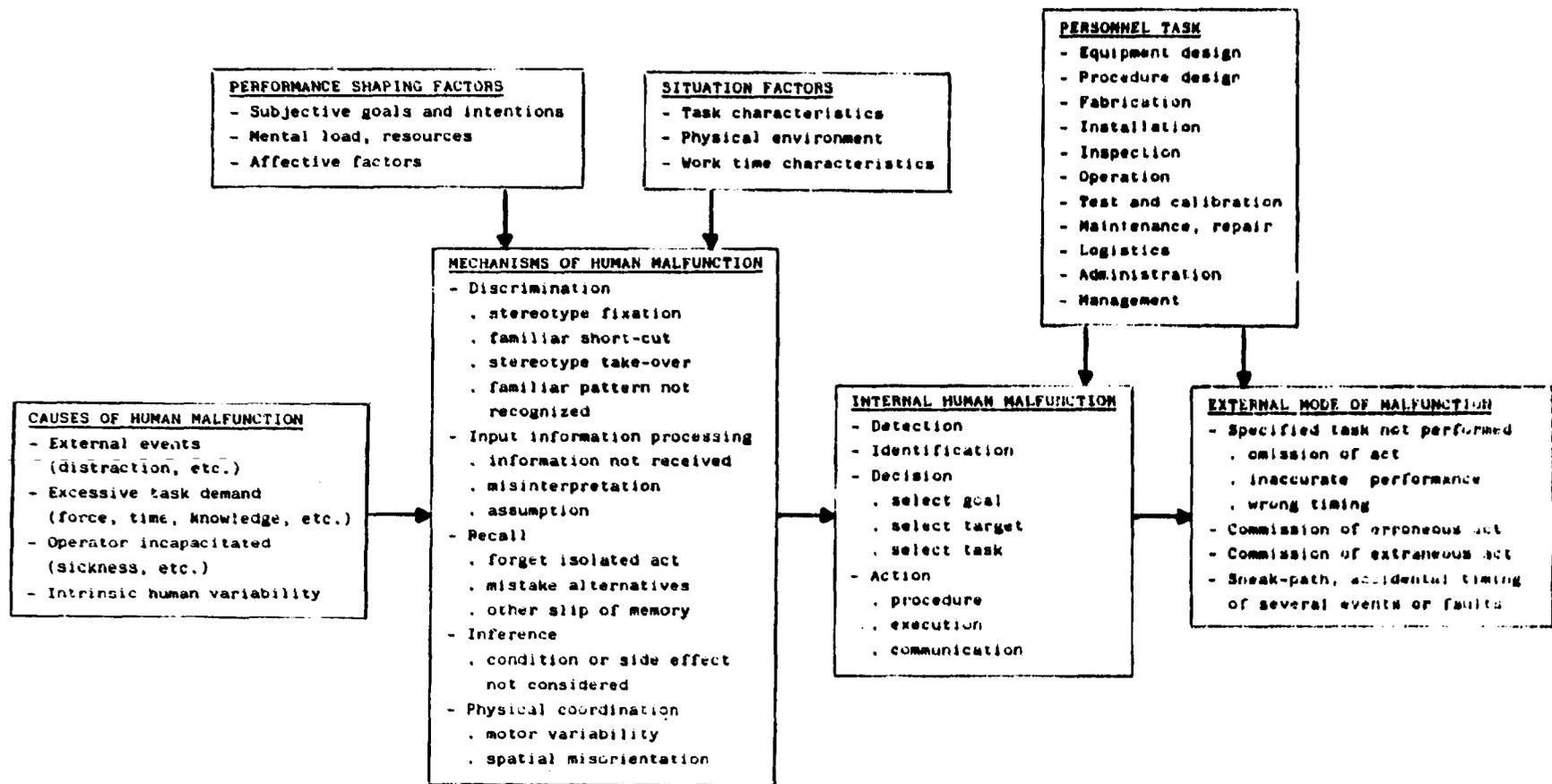


Figure 1. Multifaceted taxonomy for description and analysis of events involving human malfunction.

Collection of data, general

The means of data collection are tightly coupled to the taxonomy and its purpose: They should together constitute a good compromise between the following requirements:

- The reporting procedure should not be too difficult or require special insight (e.g. in human factors) in excess of what is reasonable from the people involved in reporting.
- The information reported should be covering and unambiguous with respect to its intended use.

It is foreseen that a good compromise can be developed only by an iterative process: the experiences from the practical event reporting and use of the information collected can be expected to lead to changes of both the reporting procedure and the taxonomy.

The above will be discussed more detailed in the following, referring to Figure 2, where the categories of the taxonomy are related to their use for event reporting and for analysis.

In order to facilitate event recording, preprinted forms will be used for categories, where reporting can be done in-plant by filling in such forms like checklists. At the outset the following categories are considered suitable for this kind of reporting:

- PLANT:
  - PLANT IDENTIFICATION
  - DATA SYSTEM IDENTIFICATION
- EVENT ANALYSIS:
  - EVENT DETECTION
  - PLANT STATE
  - SYSTEMS AND COMPONENTS AFFECTED
  - CONSEQUENCES OF THE EVENT
  - RECOVERY SITUATION
- COMPONENT RELIABILITY DATA SYSTEM:
  - MODES OF FAILURE
  - CAUSES OF FAILURE
  - ACTIONS TAKEN
- HUMAN SYSTEM:
  - PERSONNEL IDENTIFICATION
  - PERSONNEL LOCATION

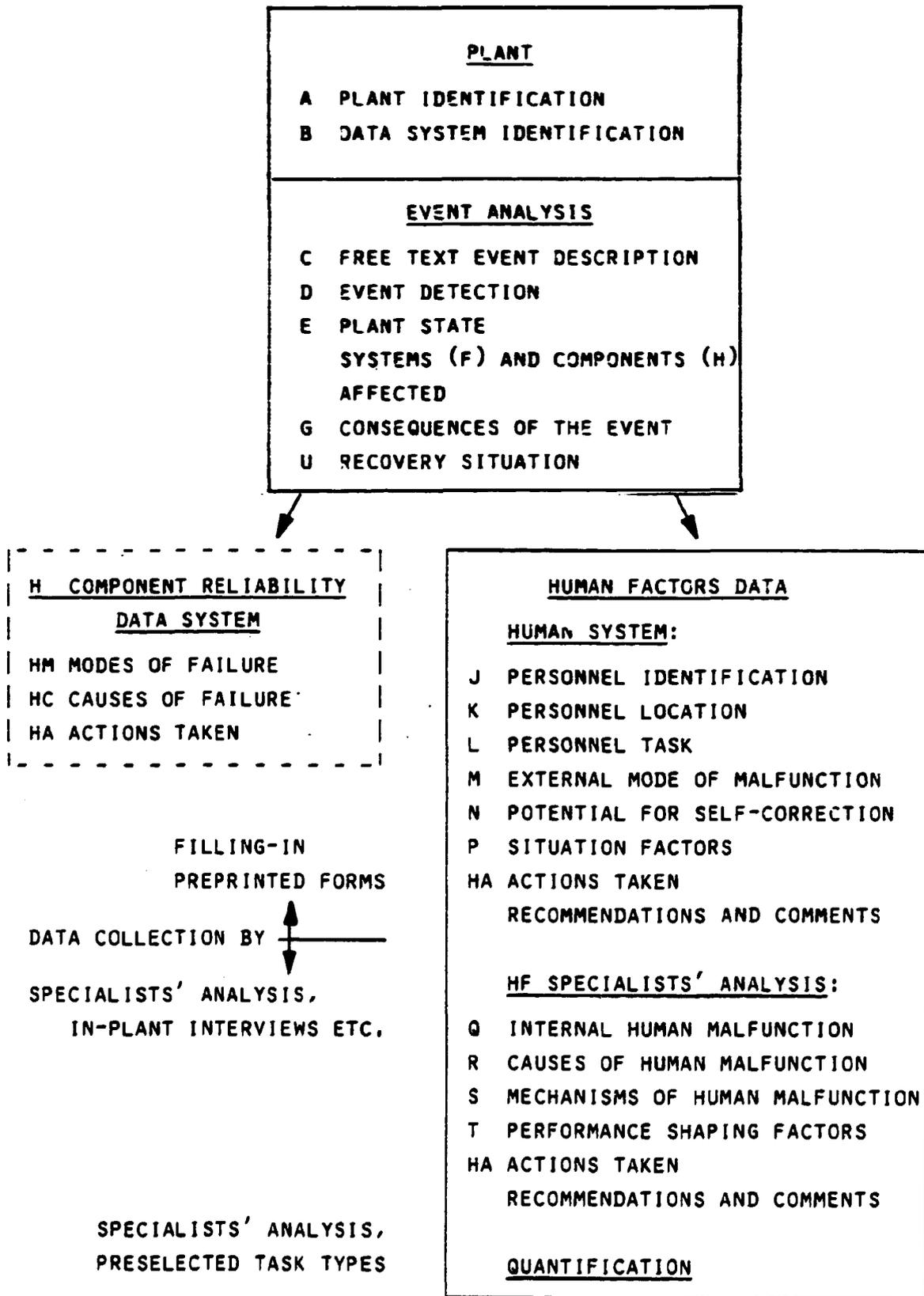


Figure 2: Use of human malfunction taxonomy.

PERSONNEL TASK  
EXTERNAL MODE OF MALFUNCTION  
POTENTIAL FOR SELF-CORRECTION  
SITUATION FACTORS  
ACTIONS TAKEN

The preprinted forms and examples of their use are presented in the document SINDOC (81)15.

FREE TEXT EVENT DESCRIPTION is intended for a short general description, abt. 10 lines of text.

The category U: RECOVERY SITUATION has been reserved for the purpose of characterizing the short term remedies applied in order to cope with a particular event. This category should be distinguished from categories HA: COMPONENTS: ACTIONS TAKEN and HA: ACTIONS TAKEN describing the long term remedies applied.

RECOVERY SITUATION has not yet been provided with subcategories and will not be discussed further in this report.

The categories SYSTEMS AND COMPONENTS AFFECTED are intended for characterization of both technical failures and human malfunctions. In case of a technical failure the classification thereafter will continue in the COMPONENT RELIABILITY DATA SYSTEM indicated by H in figure 2, specifying MODES and CAUSES OF FAILURE and ACTIONS TAKEN. In case of a human malfunction, SYSTEMS AND COMPONENTS AFFECTED will specify the physical contact/interface between the technical system and the human activity, as explained later in the comments given to this category.

The RECOMMENDATIONS AND COMMENTS under HUMAN FACTORS DATA are intended for supplementary information for the categories under HUMAN SYSTEM and, particularly, for supporting the more subtle classification under the categories:

- HF SPECIALISTS' ANALYSIS:
  - INTERNAL HUMAN MALFUNCTION
  - CAUSES OF HUMAN MALFUNCTION
  - MECHANISMS OF HUMAN MALFUNCTION
  - PERFORMANCE SHAPING FACTORS
  - ACTIONS TAKEN

The classification of these categories is considered to need human factors specialists' analysis, at least in the beginning, and also will involve e.g. in-plant interviews.

As indicated in Figure 2, the categories under PLANT and EVENT ANALYSIS are expected to be common to the component reliability data system under development at ISPRA (Mancini et al. 1979) and the taxonomy discussed in this report.

In case of events involving several subevents, e.g. component failure and human malfunction or several human malfunctions, the free text description and the three categories A, B and D could be common to the subevents, these being thereafter classified as independent events.

#### Collection of data for quantification

When data collection is planned for quantification of human error rates special categories of information must be derived from task analysis.

- "Denominator" information must be found, i.e. the frequency of opportunity for the relevant categories of human malfunction. For some spontaneous human errors this frequency is related to the task frequency; for malfunctions with external causes the relation to task frequency is more complex and the task frequency can only be used as denominator for estimation of error rates in work situations very similar to those of the plant serving as data source.
- Recovery factors: for use in quantification of human malfunction, features of the work situation related to the potential for detection of errors by the person himself is very important and should be emphasized in the task analysis aiming at denominators.

A PLANT IDENTIFICATION

- A1 Power reactors:
  - A1.1 BWR
  - A1.2 PWR
  - A1.3 Gascooled reactors, AGR, Magnox
  - A1.4 Fast breeder reactors
  - A1.5 Heavy water reactors
- A2 Research reactors
- A3 Other. Fuel manufacturing and reprocessing, transport etc.

Comments

In a data retrieval system extended to more industrial branches than that of nuclear power, the specific branches could be typified according to existing proven indexing systems.

B DATA SYSTEM IDENTIFICATION

Comments

The content of this category, having not yet been worked out in details, should include descriptors characterizing items such as:

- Identification code for the data system in relation to other corresponding data systems.
- Whether or not the event is comprising several subevents.
- Individual code numbers for the reported event and subevents, if any, also covering follow-up or supplementary information reported after the preliminary event report.
- Date of event occurrence and date of report.
- Individual code number for the power station unit (reactor) involved.

- D      EVENT DETECTION
- D1     Announced by automatic alarm
- D2     During maintenance:
  - D2.1     Planned/preventive
  - D2.2     Repair/modification
- D3     During test or special inspection
- D4     During operational activities  
          (excluding automatic alarm announcing):
  - D4.1     Preparatory activities
  - D4.2     When calling system into operation
  - D4.3     Routine surveillance during operation
  - D4.4     Other not covered above
- D5     During management activities:
  - D5.1     Review of log, recorder charts
  - D5.2     Other
- D6     Malfunction "seen, found" without further specification
- D7     Not stated, not applicable

Comments

Event detection, i.e. information regarding the way the abnormality was detected, is important to judge the role and quality of the various measures to monitor the operational state of the system. The information also makes it possible to estimate the time interval from different categories of technical faults and inappropriate human acts to their detection.

E PLANT STATE

- E1 Under construction
- E2 Preoperational, startup or power ascension tests  
(in progress)
- E3 Routine startup operations
- E4 Routine shutdown operations
- E5 Steady state operation
- E6 Stretch-out operation
- E7 Load changes during routine power operation
- E8 Shutdown (hot or cold) except refueling
- E9 Refueling
- E10 Other (including special tests, emergency shutdown  
operations, etc.)
- E11 Not applicable, not stated

Comments

The plant state should refer to the occurrence of the malfunction. (The recognition of the malfunction is classified under the category: EVENT DETECTION).

SYSTEMS (F) AND COMPONENTS (H) AFFECTED

F Systems

FA - NUCLEAR HEAT SYSTEM

- FA1 - Reactor Core System
- FA2 - Reactor Vessel Equipment
- FA3 - Primary Coolant System (PWR)
- FA4 - Pressurizing System (PWR)
- FA5 - Steam Generator System (PWR)
- FA6 - Recirculating Water System (BWR)
- FA7 - Coolant System (BWR)
- FA8 - Control Rod System (PWR)
- FA9 - Control Rod System (BWR)

FB - ENGINEERED SAFETY FEATURES

- FB1 - Reactor Containment System (PWR)
- FB2 - Reactor Containment System (BWR)
- FB3 - Containment Spray System
- FB4 - Containment Isolation System
- FB5 - Containment Pressure Suppression System (BWR)
- FB6 - Pressure Relief System (PWR)
- FB7 - Hydrogen Venting System
- FB8 - Post-Accident Containment Atmosphere Mixing System
- FB9 - Containment Gas Control System
- FB10 - Auxiliary Feedwater System (PWR)
- FB11 - Reactor Core Isolation Cooling System (BWR)
- FB12 - Emergency Boration System (PWR)
- FB13 - Stand-by Liquid Control System (BWR)
- FB14 - Residual Heat Removal System (PWR)
- FB15 - Residual Heat Removal System (BWR)
- FB16 - High Pressure Coolant Injection System (PWR)
- FB17 - Accumulation System (PWR)
- FB18 - Low Pressure Coolant Injection System (PWR)
- FB19 - Nuclear Boiler Overpressure Protection System (BWR)
- FB20 - High Pressure Core Spray System (BWR)
- FB21 - High Pressure Coolant Injection System (BWR)
- FB22 - Low Pressure Core Spray System (BWR)
- FB23 - Low Pressure Coolant Injection System (BWR)

FC - REACTOR AUXILIARY SYSTEM

- FC1 - Chemical and Volume Control System (PWR)
- FC2 - Reactor Water Cleanup System (BWR)
- FC3 - Boron Recovery System (PWR)
- FC4 - Reactor Treated Water Storage System (PWR)

- FC5 - Primary Component Cooling Water System
- FC6 - Control Rod Drive Cooling Water System (PWR)
- FC7 - Primary Loads Service Water System
- FC8 - Ultimate Heat Sink System
- FC9 - Refueling Water System
- FC10 - Reactor Water Storage System (BWR)
- FC11 - Radwaste Cooling Water System
- FC12 - Safety Equipment Compressed Air System
- FC13 - Nuclear System Fire Protection System
- FC14 - Hydrogen, Oxygen, Nitrogen Gas Distribution System
- FC15 - Nuclear System Building Servicing Equipment

#### FD - FUEL STORAGE AND HANDLING SYSTEM

- FD1 - Fuel Storage and Handling Equipment
- FD2 - Spent Fuel Pool Cooling and Cleanup System
- FD3 - Containment Pool Cooling and Cleanup System (BWR)

#### FE - RADIOACTIVE WASTE MANAGEMENT SYSTEM

- FE1 - Liquid Radwaste System
- FE2 - Solid Radwaste System
- FE3 - Gaseous Radwaste System (PWR)
- FE4 - Gaseous Radwaste System (BWR)
- FE5 - Equipment and Floor Drainage System
- FE6 - Recovered Water Storage and Distribution System
- FE7 - Steam Generator Blowdown System (PWR)

#### FF - STEAM AND POWER CONVERSION SYSTEM

- FF1 - Main Steam System
- FF2 - Turbine System
- FF3 - Turbine Steam Sealing System
- FF4 - Main Condenser System
- FF5 - Non-Condensable Gases Extraction System
- FF6 - Turbine Bypass System
- FF7 - Steam Extraction System
- FF8 - Condensate and Feedwater System
- FF9 - Moisture Separators, Reheaters System
- FF10 - Moisture Separators, Reheaters Drain System
- FF11 - Heaters Drain and Vents System
- FF12 - Various Thermal Cycle Drains and Vents System
- FF13 - Chemical Additive Injection System
- FF14 - Condensate Demineralizer System
- FF15 - Circulating Water System (open cycle)
- FF16 - Circulating Water System (closed cycle)
- FF17 - Circulating Water Treatment System
- FF18 - Cooling Towers System

**FG - POWER TRANSMISSION SYSTEM**

- FG1 - Generator System
- FG2 - Main Bus Duct System
- FG3 - Main Transformers System
- FG4 - Auxiliary Transformers System
- FG5 - Back-up Auxiliary Transformers System
- FG6 - Switchyard to Station H. V. Connection

**FH - ELECTRIC POWER SYSTEM**

- FH1 - Medium Voltage System
- FH2 - Low Voltage System
- FH3 - Vital Instrument and Computer A. C. System
- FH4 - On-Site D. C. System
- FH5 - Diesel Generator System
- FH6 - Electrical Heat Tracing System
- FH7 - Lighting and Taxed Motive Power System
- FH8 - Security System
- FH9 - Communication System
- FH10 - Cathodic Protection System
- FH11 - Grounding System

**FI - INSTRUMENTATION, SUPERVISION, MONITORING SYSTEM**

- FI1 - Computer System
- FI2 - Alarm System
- FI3 - Main Control Room Benchboards System
- FI4 - In-Core and Ex-Core Neutron Monitoring System
- FI5 - Radiation Monitoring System
- FI6 - Reactor Coolant Pressure Boundary Leak Detection System
- FI7 - Containment Leak Detection System
- FI8 - Failed Fuel Detection System (PWR)
- FI9 - Main Steam Line Radiation Monitoring System (BWR)
- FI10 - Hydrogen Monitoring System (BWR)
- FI11 - Off-Site Radiological Monitoring System
- FI12 - Seismic Monitoring System
- FI13 - Meteorological Monitoring System
- FI14 - Sampling System
- FI15 - Perturbographic System
- FI16 - Cooling Water Temperature Monitoring System

**FL - PROTECTION AND CONTROL SYSTEM**

- FL1 - Reactor Protection System
- FL2 - BOP Protection System
- FL3 - Engineered Safety Features Actuation System
- FL4 - Reactor Power Control System (PWR)
- FL5 - Reactor Power Control System (BWR)

- FL6 - Recirculation Flow Control System (BWR)
- FL7 - Feedwater Control System (BWR)
- FL8 - Pressure Regulator System (BWR)
- FL9 - Turbine Control System
- FL10 - Remote Shutdown System
- FL11 - Remote Control Logic System

**FM - PLANT BUILDINGS HVAC SYSTEM**

- FM1 - Containment Recirculation Air Cooling System
- FM2 - Containment Air Purification and Cleanup System (PWR)
- FM3 - Drywell Recirculation Air Cooling System (BWR)
- FM4 - Containment Purge System
- FM5 - Containment Low Purge and Pressure Control System (BWR)
- FM6 - Drywell Purge System (BWR)
- FM7 - Containment Pressure Relief System (PWR)
- FM8 - Annulus Recirculation and Exhaust System
- FM9 - In-Core Instrumentation Purge System
- FM10 - Control Rod Drive Mechanism Cooling System (PWR)
- FM11 - Reactor Auxiliary Building HVAC System
- FM12 - Control Room Building HVAC System
- FM13 - Fuel Building HVAC System
- FM14 - Emergency Diesel Generator Building HVAC System
- FM15 - Radwaste Building HVAC System
- FM16 - Solid Waste Storage HVAC System
- FM17 - ESF Vaults HVAC System
- FM18 - Controlled Area Service Building HVAC System
- FM19 - Ultimate Sink Structure HVAC System
- FM20 - Main Pipe Chase HVAC System
- FM21 - Interbuildings Corridors and Tunnels HVAC System
- FM22 - Auxiliary Feedwater Pumps Chase HVAC System (PWR)
- FM23 - Plant Stack and Vent Air Discharge System
- FM24 - Turbine Building HVAC System (PWR)
- FM25 - Turbine Building HVAC System (BWR)
- FM26 - Non-Essential Switchgear Building HVAC System
- FM27 - General Service Building HVAC System

**FN - SERVICE AUXILIARY SYSTEM**

- FN1 - Service Water System
- FN2 - BOP Cooling Water System
- FN3 - Chilled Water System
- FN4 - Demineralized Water Production and Distribution System
- FN5 - Raw Water Make-up System
- FN6 - Pretreated Water Distribution System
- FN7 - Potable and Sanitary Water System
- FN8 - Auxiliary Steam and Hot Water System
- FN9 - Auxiliary Boiler
- FN10 - Non-Radioactive Waste Treatment System

- FN11 - Service and Instrument Compressed Air System
- FN12 - BOP Sampling System
- FN13 - Industrial Water System
- FN14 - Diaphragm Bailing System
- FN15 - BOP Fire Fighting System
- FN16 - Service Equipment System

#### FO - STRUCTURAL SYSTEMS

- FO1 - Reactor Auxiliary Building
- FO2 - Fuel Storage Building
- FO3 - Turbine, Condensate Treatment and Heater Bay Building
- FO4 - ESF Vaults
- FO5 - Radwaste Treatment Building and Tank Farm
- FO6 - Solid Waste Storage Structure
- FO7 - Control Room Building
- FO8 - Emergency Diesel Generator Buildings and Diesel Generator Fuel Storage
- FO9 - Ultimate Heat Sink Structure
- FO10 - Controlled Area Service Building
- FO11 - Circulating Water Structure
- FO12 - Miscellaneous Shared Buildings and Structure.

#### H Components

##### H1 ANNUNCIATOR MODULES

- H1A Audio
- H1B Visual
- H1C Audio/Visual

##### H2 MECHANICAL FUNCTION UNITS

- H2A Controller/Governor
- H2B Coupling
- H2C Power Transmission Device

##### H3 PENETRATIONS, PRIMARY CONTAINMENT

- H3A Personnel Access
- H3B Fuel Handling
- H3C Equipment Access
- H3D Electrical
- H3E Instrument Line
- H3F Process Piping

H4 RECOMBINERS

H4A Flame  
H4B Catalytic  
H4C Thermal

H5 RELAYS

H6 SHOCK SUPPRESSORS/SUPPORT

H6A Hangers  
H6B Supports  
H6C Stabilizers  
H6D Snubbers

H7 GENERATORS

H7A Alternator  
H7B Converter  
H7C Dynamotor  
H7D Generator  
H7E Amplidyne  
H7F Inverter

H8 FUEL ELEMENTS

H9 VESSELS

H9A Reactor Vessel  
H9B Pressurizer Vessel  
H9C Containment/Drywell  
H9D Pressure Suppression

H10 BATTERIES

H10A Lead  
H10B Nickel Cadmium

H11 CIRCUIT BREAKER/INTERRUPTERS

H11A Circuit Breaker  
H11B Contractor  
H11C Controller  
H11D Starter  
H11E Switch  
H11F Switchgear

H12 ELECTRICAL CONDUCTORS

H12A Bus  
H12B Control Cable  
H12C Power Cable  
H12D Signal Cable  
H12E Thermocouple Extension Wire

H13 CONTROL RODS

H14 HEATERS

H14A Electric  
H14B Fuel Oil  
H14C Gas

H15 BLOWERS

H15A Compressor  
H15B Gas Circulator  
H15C Fan  
H15D Ventilator  
H15E Vacuum

H16 HEAT EXCHANGERS

H16A Heater/Superheater  
H16B Boiler  
H16C Cooler  
H16D Condenser  
H16E Evaporator  
H16F Steam Generator  
H16G Heater/Cooler  
H16H Desuperheater  
H16J Reheater

H17 CHARGE/DISCHARGE MACHINE

H18 DEMINERALIZERS

- H18A Anion
- H18B Mixed Bed
- H18C Cation

H19 CONTROL ROD DRIVE MECHANISM

H20 PUMPS

- H20A Axial
- H20B Centrifugal
- H20C Diaphragm
- H20D Gear
- H20E Reciprocating
- H20F Radial
- H20G Rotary
- H20H Vane Type
- H20J Electromagnetic
- H20K Jet

H21 TRANSFORMER

- H21A Power
- H21B Voltage
- H21C Current
- H21D Variable
- H21E Isolation
- H21F Power Step-up
- H21G Power Step-Down

H22 ELECTRIC BOARDS/PANELS

H23 TURBINES

- H23A Condensing
- H23B Noncondensing
- H23C Combustion
- H23D Hydro
- H23E Air

H24 PIPES, FITTINGS

- H24A Orifice/Diaphragm
- H24B Nozzle/Safe End
- H24C Rupture Diaphragm
- H24D Straight Section
- H24E Thermowell
- H24F Mixers
- H24G Meters (Flow)

H25 FILTER/STRAINERS

- H25A Membrane
- H25B Mechanical Restriction
- H25C Porous Solid
- H25D Chemical
- H25E Gravity
- H25F Centrifugal
- H25G Electrostatic
- H25H Self-Clean
- H25J Drum

H26 DIESEL-GENERATOR (SETS)

- H26A 2-Stroke in Line
- H26B 2-Stroke "V"
- H26C 4-Stroke in Line
- H26D 4-Stroke "V"
- H26E 2-Stroke Radial
- H26F 4-Stroke Radial

H27 SENSORS/INSTR. AND CONTROL

- H27A Vibration
- H27B Position
- H27C Pressure
- H27D Flow
- H27E Temperature
- H27F Level/Frequency
- H27G Neutronic
- H27H Nuclear (Radioprot.)

28	<u>MOTORS</u>	H31	<u>RECTIFIERS</u>
28A	Electric	H31A	Charger
28B	Hydraulic		
28C	Pneumatic	H32	<u>CONTAINMENT INTERN. STRUCTURE</u>
29	<u>VALVES</u>	H33	<u>FUEL TRANSFERT DEVICE</u>
30	<u>VALVE OPERATORS</u>	H34	<u>ACCUMULATORS</u>
30A	Electric Motor	H34A	Liquid Pressurized
30B	Hydraulic	H34B	Liquid Unpressurized
30C	Pneumat./Diaphragm/Cylinder	H34C	Gas
30D	Solenoid		
30E	Float	H35	<u>AIR/GAS DRYERS</u>
30F	Explosive		
30G	Mechanical (Pressure)		

Comments

The categories SYSTEMS AND COMPONENTS AFFECTED are including rather detailed subclasses since this part of the taxonomy is intended to cover technical failures as well as human malfunctions. When backtracking to find the cause of an abnormal event, a technical failure may be identified and localised in terms of systems and components affected. If no technical fault is identified, we have a case of human malfunction and the categories then specify the physical contact/interface between the technical system and the human activity. It may be identified as the last technical item found when backtracking the cause of the event. Component identification is considered important for the analysis of malfunctions in test, calibration and maintenance, however, a very detailed classification not being necessary. Correlation/compatibility with other (international) classification systems should be emphasized, therefore, the ISPRA classifications developed/under development are adopted. These classifications are intended for use in the ISPRA Component Event Data Bank, see Mancini et al. 1979.

HM	COMPONENTS: MODE OF FAILURE
HM1	<u>Demanded change of state is not achieved *</u>
HM1.1	won't open
HM1.2	won't close
HM1.3	neither opens nor closes/does not switch
HM1.4	fails to start
HM1.5	fails to stop
HM1.6	fails to reach design specifications
HM2	<u>Change in conditions (state)</u>
HM2.1	Classification as for suddenness and degree:
HM2.1.1	catastrophic failure
HM2.1.2	incipient failure
HM2.2	Classification as for observed state of the component:
HM2.2.1	no output
HM2.2.2	outside specifications **
HM2.2.3	operation without request
HM2.2.4	erratic output (false, oscillating, instability, drifting etc.

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\* The definitions are of general nature and have to be properly interpreted for the various items.

\*\* Including failure of item part found and repaired during preventive maintenance.

Comments

The ISPRA classification is adopted, see Mancini et al. 1979.

Correlation/compatibility with other (international) classification systems should be emphasized, therefore, the ISPRA classifications developed/under development are adopted. These classifications are intended for use in the ISPRA Component Event Data Bank, see Mancini et al. 1979.

HC	COMPONENTS: CAUSES OF FAILURE
HCA	Engineering
HCA1	engineering/design (hardware)
HCA2	engineering/design (proced./specificat.)
HCA3	other causes related to engineering
HCB	Manufacturing (in workshop)
HCC	Installation/construction (in situ)
HCD	Plant operation
HCD1	personnel error
HCD2	incorrect procedure/instructions
HCE	Maintenance, Testing, Measuring
HCE1	personnel error
HCE2	incorrect procedure/instructions
HCF	Material incompatibility (unexpected)
HCG	Expected wear, aging, corrosion, erosion, distortion, abrasion
HCH	Abnormal service condition
HCL	Pollution
HCM	Failure caused by other plant devices, by associated devices, or by off-site influence.
HCN	Unknown
HCO	Others (NOC)

Comments

The ISPRA classification is adopted, see Mancini et al. 1979.

- HA COMPONENTS: ACTIONS TAKEN
- HA2.1 Corrective Action
- HA2.1.1 Corrective maintenance
  - HA2.1.1.1 repair without disassembly
  - HA2.1.1.2 repair with partial disassembly
  - HA2.1.1.3 repair with total disassembly
  - HA2.1.1.4 recalibration, reseal, repack
  - HA2.1.1.5 adjust
  - HA2.1.1.6 repair part(s)
  - HA2.1.1.7 replace part(s)
  - HA2.1.1.8 repair component
  - HA2.1.1.9 replace component
  - HA2.1.1.10 temporary repair
  - HA2.1.1.11 temporary by-pass
- HA2.1.2 Modification/Redesign of component
- HA2.1.3 Modification of operation duty (a)
- HA2.1.4 Special surveillance (a)
- HA2.1.5 Control of similar equipment
- HA2.2 Administrative Consequences
- HA2.2.1 On Repair Schedule
  - HA2.2.1.1 Urgent Repairs
    - urgent repairs that may result from emergencies and are accomplished bypassing normal administrative procedures
    - urgent repairs accomplished without bypassing normal administrative procedures
  - HA2.2.1.2 Not-urgent Repairs
    - accomplished at a scheduled time
    - accomplished at nearest shut-down
  - HA2.2.2 On Plant Operation
    - HA2.2.2.1 Forced stop required
    - HA2.2.2.2 Stop required at short term
      - repair within 2 days
      - repair within 7 days
      - repair within 14 days
      - repair within 30 days
    - HA2.2.2.3 No unscheduled unit shut-down required
    - HA2.2.2.4 Others

HA2.2.3 Documentation

- HA2.2.3.1 - Failure reported to architect/engineer
- HA2.2.3.2 - Failure reported to NSSS vendor
- HA2.2.3.3 - Failure reported to consultant
- HA2.2.3.4 - Failure reported to component manufacturer
- HA2.2.3.5 - Failure analysis recommended
- HA2.2.3.6 - Failure analysis performed
- HA2.2.3.7 - Photographs were made
- HA2.2.3.8 - LER submitted
- HA2.2.3.9 - None of the above

HA2.3 Start-up Restrictions

- HA2.3.1 - No restriction
- HA2.3.2 - Permission by licensing authorities
- HA2.3.3 - Request Licensee Revision

Comments

The ISPRA classification is adopted, see Mancini et al. 1979.

It is identical with that used under the human factors category

ACTIONS TAKEN: Other actions taken.

- G            CONSEQUENCES OF THE EVENT
- G1           Consequent effect on system as stated in category:  
             SYSTEMS AND COMPONENTS AFFECTED
- G1.1        System inappropriately put into operation
- G1.2        Loss of system function
- G1.3        Degraded system function
- G1.4        Loss of redundancy:
  - G1.4.1      Loss of 1 train
  - G1.4.2      Loss of 2 trains
  - G1.4.3      Loss of 3 trains
  - G1.4.4      Loss of more than 3 trains
- G1.5        No significant effect on system
- G2           Consequent effect on reactor operation:
- G2.1        No significant effect
- G2.2        Delayed coupling
- G2.3        Partial standstill or power reduction
- G2.4        Turbine trip
- G2.5        Reactor shut-down (automatic/manual trip, forced  
             shut-down)
- G2.6        Abnormal off-site releases
- G2.7        Abnormal radiation level in working area

Comments

The purpose of this category is not to characterise the human malfunction but to indicate the efficiency of the various measures for stopping the propagation of the event chain initiated by the malfunction. The category is based upon that used by ISPRA with a few changes.

J	PERSONNEL IDENTIFICATION
J1	Utility management
J2	Plant management
J3	Shift supervisors
J4	Licensed operators or senior operators
J5	Non-licensed operations personnel
J6	Roving operators
J7	Maintenance and repair personnel:
J7.1	Mechanical profession
J7.1	Electrical profession
J7.2	Electronics profession
J7.4	Chemical profession
J7.5	Profession not specified
J8	Health physics personnel
J9	Design and fabrication personnel
J10	Construction personnel
J11	Contractor and consultant personnel
J12	Other foreign personnel
J13	Other not covered above
J14	Not stated

Comments

This category is intended to represent information on the educational background and organisational relation of the person. Implicitly it characterises the actual work situation of the person during the event.

K	PERSONNEL LOCATION
K1	Central control rooms
K2	Other control room consoles
K3	Relay and terminal rooms
K4	Work on equipment in plant under normal conditions
K5	Work on equipment in radiologically controlled areas
K6	Workshop
K7	Office
K8	Outdoor
K9	Other location
K10	Not stated, not applicable

Comments

This category represents a general characterisation of the work location during the occurrence of the malfunction.

- L PERSONNEL TASK
- L1 Design and design changes of equipment
- L2 Procedure design and modification
- L3 Fabrication
- L4 Installation
- L5 Inspection
- L6 Operation:
  - L6.1 Monitoring
  - L6.2 Manual acts, maneuvers and other manual operations
  - L6.3 Inventory control
  - L6.4 Supervisory control
- L7 Test and calibration:
  - L7.1 Getting access to location for work (including getting permit)
  - L7.2 Preparation of equipment and tools
  - L7.3 Execution of the actual test and calibration activity
  - L7.4 Restoration, removal of tools etc.
- L8 Maintenance and repair (modification etc.):
  - L8.1 Getting access to location for work (including getting permit)
  - L8.2 Preparation of equipment and tools
  - L8.3 Execution of the actual maintenance activity
  - L8.4 Restoration, removal of tools etc.
- L9 Logistics
- L10 Administration: recording, reporting etc.
- L11 Management: resource allocation and supervision
- L12 Other not covered above
- L13 Not stated, not applicable

Comments

The identification of the task is important to describe the circumstances during which the event occurred. Description of elements and structure of a task and correlation with data on HUMAN MALFUNCTION MECHANISMS and INTERNAL HUMAN MALFUNCTIONS are necessary to predict human performance in new or revised work situations.

The tasks of Test/Calibration and Maintenance/Repair are described rather detailed in the present taxonomy, because they were well represented in the sample on which the taxonomy has been based

and because they are immediately safety related.  
Other safety related tasks e.g. inventory control and supervisory control should be considered for extended description in actual data collection campaigns.

- M           EXTERNAL MODE OF MALFUNCTION AS LEADING TO THE STATED  
CONSEQUENCES OF THE EVENT
- M1           The specified or intended task not performed due  
to
- M1.1       Omission of task
- M1.2       Omission of act
- M1.3       Inappropriate, inaccurate performance
- M1.4       Inappropriate timing
- M1.5       Actions in wrong sequence
- M2           The effect is due to specific, erroneous acts on  
system under treatment:
- M2.1       Wrong act executed on correct component, equipment
- M2.2       Wrong component, equipment
- M2.3       Wrong time
- M3           The effect is due to extraneous act, i.e. act on  
other system than that under treatment
- M4           The effect is due to coincidence or co-effect with  
other erroneous or normal human activity or technical  
condition. Sneakpath tied to special circumstances
- M5           Not stated, not applicable

Comments

This category describes the immediate, observable external effect of human malfunction upon the task performance. It reflects the way in which the malfunction initiates the consequent chain of accidental events. This category and the correlation to categories INTERNAL HUMAN MALFUNCTION and MECHANISMS OF HUMAN MALFUNCTIONS, are important for prediction of the effect of human malfunction in a specific task and/or system.

In case of simple human malfunction, there is found a direct relation between these three categories and the structure of the task, in more complex situations involving a sequence of critical human decisions, this is not the case (see comment to INTERNAL HUMAN MALFUNCTION). Likewise, in some cases the effect cannot be predicted from a task analysis (extraneous acts). Therefore, special subcategories are given for extraneous acts and complex coincidences.

It is recommended that the content of the category EXTERNAL MODE OF MALFUNCTION is extended by future data collection campaigns for important safety related tasks as for instance repair and test/calibration. This can be done by extending the present category or, as it has been done in this taxonomy, by differentiating the description of the task. See the category PERSONNEL TASK.

- N POTENTIAL FOR SELF-CORRECTION
- N1 Lack of correction by the performing person himself  
due to:
  - N1.1 Malfunction not immediately observable
  - N1.2 Malfunction not immediately reversible
- N2 Not stated, not applicable

Comments

Information on the detection of the malfunction is important, since it is tightly coupled to the initiation of an event report, and, therefore, may bias the data reported. For instance human malfunction which is immediately corrected will not release a report, and potential for operators' self-monitoring will be an important bias on the data.

A more elaborate description of the potential for self-correction will be important, but should be part of the background description of the task for which event data are collected, not a part of the event record. The present members of the category has been used to separate the two major bias factors during analysis of existing event compilations.

- P            SITUATION FACTORS
- P1            Task characteristics, "preparedness"
- P1.1         Familiar task on schedule
- P1.2         Familiar task on demand
- P1.3         Unfamiliar task on schedule
- P1.4         Unfamiliar task on demand
- P1.5         Other not covered above
- P1.6         Not stated, not applicable
- P2            Physical environment
- P2.1         Noise
- P2.2         Uncomfortable temperature, humidity, pressure, smell  
              etc.
- P2.3         Light
- P2.4         Radiation
- P2.5         Other not covered above
- P2.6         Not stated, not applicable
- P3            Work time characteristics
- P3.1         Day shift
- P3.2         Night shift
- P3.3         In beginning of shift
- P3.4         In middle of shift
- P3.5         In end of shift
- P3.6         Not stated, not applicable

Comments

Information on factors related to the general work situation which will modify performance and probability of human malfunction is important. In the present context, the categories SITUATION FACTORS and PERFORMANCE SHAPING FACTORS are used to describe the more general work conditions, such as noise, temperature, workload, etc., and other factors which are generally affecting the state of an operator and which are not tied to a causal relation among events and acts, but rather contributing an overall modification of the performance. Physiological and psychological factors related to individuals are not recommended for inclusion into an event reporting scheme.

Important SITUATION FACTORS are related to the "preparedness" of the operator for the specific event. The taxonomy in this respect includes a distinction between familiar and unfamiliar

task and between scheduled task and task on demand.

A familiar task is a task which is performed frequently enough to enable the person to perform it by know-how, i.e. without the need for special planning or modification of procedures.

An unfamiliar task is a task which needs special planning or consideration of modification of procedures or normal work practise, or is so infrequent that use of preplanned written instructions is needed.

On schedule refers to the situation when special procedures are planned ahead or existing procedures can be studied and rehearsed, or the task is initiated by the operator according to a time schedule.

On demand represents the situation when planning has to be done concurrently with task performance and typically is based on the operators diagnosis and immediate decisions, i.e. the task is called for unexpectedly by the system, e.g. interfering with an already running task.

The distinction between SITUATION FACTORS and PERFORMANCE SHAPING FACTORS is made only to separate the information which can be recorded immediately by check lists from information which depend on human factors analysis, respectively.

Guidelines for use of the subcategories under "Task characteristics" are presented in Federsen et al. 1981.

- HA            ACTIONS TAKEN
- HA1            In order to improve human functions:
- HA1.1        Reinforcement of instructions
- HA1.2        Revision of procedures and instructions
- HA1.3        Modification of equipment design
- HA1.4        Modification of work planning
- HA1.5        Modification of work situation
- HA1.6        Modification of organisation
- HA1.7        Retraining and rehearsal
- HA1.8        Redesign of training program
- HA1.9        Other not stated
- HA2            Other actions taken:
- HA2.1        Corrective Action
- HA2.1.1      **Corrective maintenance**
- HA2.1.1.1    repair without disassembly
- HA2.1.1.2    repair with partial disassembly
- HA2.1.1.3    repair with total disassembly
- HA2.1.1.4    recalibration, reseal, repack
- HA2.1.1.5    adjust
- HA2.1.1.6    repair part(s)
- HA2.1.1.7    replace part(s)
- HA2.1.1.8    repair component
- HA2.1.1.9    replace component
- HA2.1.1.10   temporary repair
- HA2.1.1.11   temporary by-pass
- HA2.1.2      Modification/Redesign of component
- HA2.1.3      Modification of operation duty (a)
- HA2.1.4      Special surveillance (a)
- HA2.1.5      Control of similar equipment
- HA2.2        Administrative Consequences
- HA2.2.1      **On Repair Schedule**
- HA2.2.1.1    **Urgent Repairs**
- urgent repairs that may result from emergencies and are  
              accomplished by passing normal administrative procedures
- urgent repairs accomplished without bypassing normal ad-  
              ministrative procedures
- HA2.2.1.2    **Not-urgent Repairs**
- accomplished at a scheduled time
- accomplished at nearest shut-down

- HA2.2.2           **On Plant Operation**
- HA2.2.2.1       **Forced stop required**
- HA2.2.2.2       **Stop required at short term**
  - repair within 2 days
  - "       "   7 "
  - "       "   14 "
  - "       "   30 "
- HA2.2.2.3       **No unscheduled unit shut-down required**
- HA2.2.2.4       **Others**
  
- HA2.2.3           **Documentation**
- HA2.2.3.1       - Failure reported to architect/engineer
- HA2.2.3.2       - Failure reported to NSSS vendor
- HA2.2.3.3       - Failure reported to consultant
- HA2.2.3.4       - Failure reported to component manufacturer
- HA2.2.3.5       - Failure analysis recommended
- HA2.2.3.6       - Failure analysis performed
- HA2.2.3.7       - Photographs were made
- HA2.2.3.8       - LER submitted
- HA2.2.3.9       - None of the above
  
- HA2.3            **Start-up Restrictions**
- HA2.3.1        - No restriction
- HA2.3.2        - Permission by licensing authorities
- HA2.3.3        - Request Licensee Revision

Comments

This is a category describing the actions taken in order to remedy the malfunction.

The first subcategory covers actions particularly aiming at improving human functions, the second covers other actions and is identical with the ISPHA classification already given under HA COMPONENTS: ACTIONS TAKEN.

- Q INTERNAL HUMAN MALFUNCTION
- Beware: Internal human malfunction does not necessarily imply a failure or error on the part of the man.
- Q1 Detection: Operator does not respond to a demand.
- Q2 Identification of system state: Operator responds but misinterprets the system state.
- Q3 Decision:
- Q3.1 Selection of goal: Operator responds to properly identified system state, but aims at wrong goal (e.g. operation continuity instead of safety).
- Q3.2 Selection of system target state: Operator selects an improper system target state to pursue proper goal (e.g. he decreases power to 80% instead of shut-down).
- Q3.3 Selection of task: The operator selects a task, an activity which will not bring the plant to the intended target state.
- Q4 Action:
- Q4.1 Procedure: The sequence of actions performed is inappropriate or incorrectly coordinated for the task chosen.
- Q4.2 Execution: The physical activity related to the steps in the procedure is incorrect.
- Q4.3 Communication: Written or verbal messages are given incorrectly.
- Q5 Not stated, not applicable

Comments

The operator's task which is specified in the category PERSONNEL TASK in terms referring to the operational requirements of the plant will require some internal, mental data processing or decision function.

The category INTERNAL HUMAN MALFUNCTION is a causality-ordered sequence of human decision elements and is used to characterise that step/element in the decision sequence which was inappropriately performed or not performed at all due to a habitual bypass.

There is basically some ambiguity in this classification: Firstly, the description in terms of identification, decision

and execution can be done at several levels of detail in the task description. It is intended that the use in event classification should be kept at a high level referring to the overall task description. A repair task can be taken as example: the diagnostic part of this task: to find the fault, should, if incorrectly performed, be classified as "identification of system state".

Alternatively, assume that the diagnosis has been correctly performed, that the repair man's proper intention of component replacement has been stated, and that he is performing the actions necessary for the fault remedy. During this phase of activities the repair man performs actions in wrong order of succession, because he does not identify the real state of the system under repair: this should be classified as "procedure".

This is a matter of convention - but the position taken here can be defended, partly from the fact that information for classification at a very detailed level generally is not present in event reports, partly from the usefulness of the classification results for improvement of work aids.

Secondly, ambiguity is caused by the fact that malfunction in the first phases of a decision will frequently lead to inappropriate decisions later in the sequence. To describe such sequences, detailed time line analysis and identification of all critical decisions are necessary, as described by Pew et al (1981), but this analysis must be based on very careful data collection including interviews of personnel (which is only feasible if it can be done immediately after the event, for instance by studies on training simulators.)

In general, the information cannot be obtained and in the present taxonomy we suggest that classification is only done for the first element of the human decision sequence which is inappropriately performed or shunted out by stereotyped bypass. Since most event reports are backtracking the course of events to an explaining plausible cause, this first malfunction sending the operator off the proper track, is the most likely to be represented in the record. This means that in more complex situations, the causal relation from the internal human malfunction and the related error mechanisms to the external effect of the malfunction will not be preserved in the recorded data. However, from a view point of statistical quantification or generalization,

in terms of improvements, this is not too important in the present context since the variability and degrees of freedom in human responses after a wrong decision - say an identification - is so high that they can only be characterized after detailed studies.

It must be emphasized that the category INTERNAL HUMAN MALFUNCTION does not take into account any cause of the malfunction and that the term "malfunction" does not imply in itself a "human error".

The malfunction can be caused by external conditions or events, such as interfering people, wrong orders, ordered absence etc., which are all considered separately under CAUSES.

The members of the present category are derived from a model of human decision sequence which is described in detail in Rasmussen (1974) and which has been used to derive the guidelines for analysis presented in Pedersen et al. 1981. For reference the model is illustrated in Figure 3.

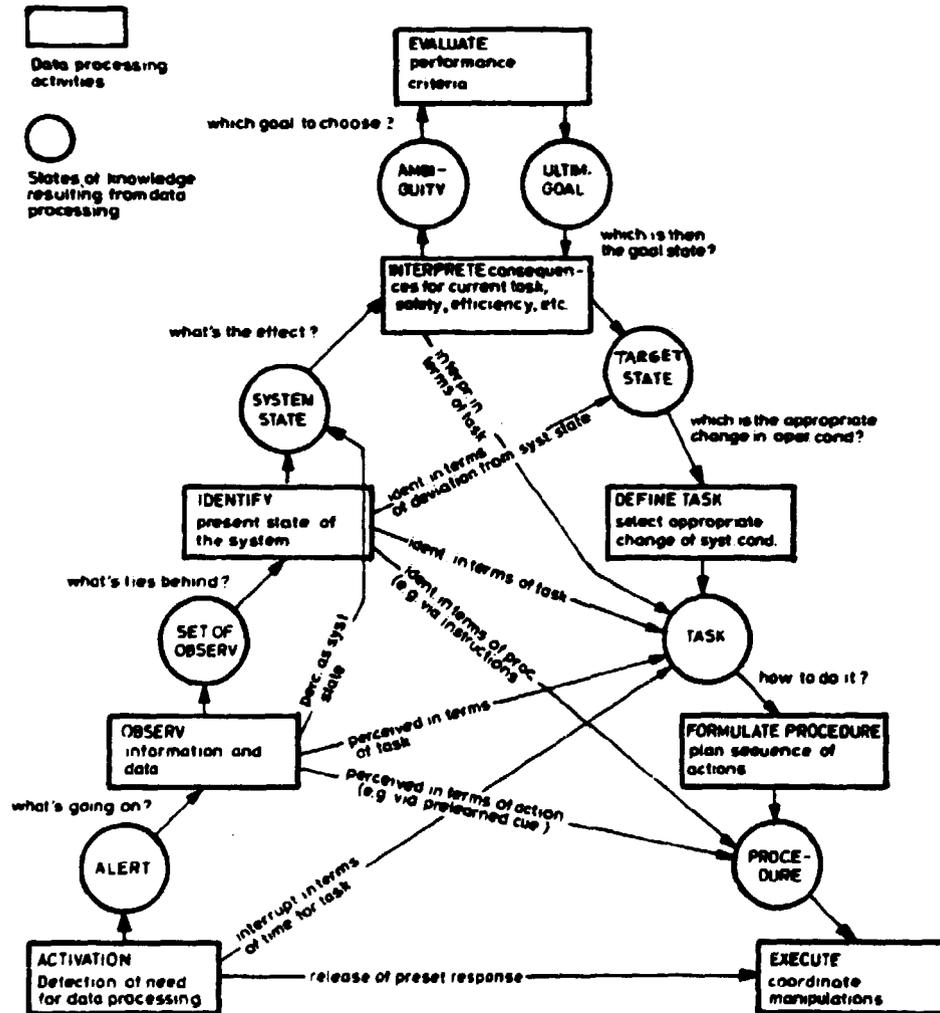


Figure 3. Model of human decision sequence.  
 Reproduced from Rasmussen, 1976.

- R CAUSES OF HUMAN MALFUNCTION
- Event or short term condition taking active part as a link in the causal chain of events
- R1 External events:
- R1.1 Distraction by system and/or environment
- R1.2 Distraction by other persons: Questions, message, noise
- R2 Excessive task demand in the specific situation:
- R2.1 Physical demand, time, force, etc.
- R2.2 State information inadequate, wrong
- R2.3 Background information related to the specific situation (knowledge, instruction) inadequate or wrong
- R3 Operator incapacitated: (sick, injured, etc.)
- R4 No external cause:
- R4.1 Intrinsic normal human variability; spontaneous human error
- R4.2 Intentional act
- R4.3 Sabotage
- R5 Other not stated above
- R6 Not stated, not applicable

Comments

Identification of possible external causes is important for many reasons. First of all, there is a natural tendency when analysing the chain of events implied in maloperation of a system to accept a human error as the explanation if an inappropriate human act is met by the causal backtracking; the tendency is natural since it is difficult to continue the causal backtracking "through" a human performance, and also it is generally accepted that it is "human to err". It is, therefore, important that special care is taken to identify possible external causes as part of an event analysis.

Common sense definition of causes is very ambiguous and, therefore, in the present context must be clarified. From a point of view of quantification of human error it is beneficial if the definition of cause is clearly related to the frequency of the events analysed. Therefore, we define as a cause an event or a change in the man's normal work condition which acts as a causal precedent to his inappropriate action. General conditions

which may affect his error proneness such as normal, but high noise level, inappropriate ergonomic design, fatigue during night shifts etc., are all considered SITUATION FACTORS or PERFORMANCE SHAPING FACTORS which influence the error probability, but - according to our definition - does not cause errors. The present members of the category "causes" should be taken as illustrative; they are based on a limited number of analyses, generally reliable information on causes is not to be found in event reports due to the reasons discussed above. Special guidelines for identification of causes as part of event analysis will be developed within the present CSNI work, based on the analysis published by Griffon (1981). More general guidelines for use of the category R: CAUSES OF HUMAN MALFUNCTION are presented in Pedersen et al. 1981.

S MECHANISMS OF HUMAN MALFUNCTION

S1 Discrimination

This group is related to the man's ability to discriminate between and select the proper mode of control of his activities. The subcategories of malfunction mechanisms are characterized by interference between the man's repertoire of stereotyped habitual - and often subconscious - responses on one side and on the other side aspects of the actual work situation during infrequent and unique task demands.

S1.1 Stereotype (skill) fixation

Definition: Man operates in skill-based domain. He does not recognize a situation calling for attention and caution.

(Cues for recognition may not be present or may be overlooked, this is characterized by the categories: CAUSE OF HUMAN MALFUNCTION, or INTERNAL HUMAN MALFUNCTION)

S1.2 Familiar association short-cut

Definition: It is recognized that conscious identification of the situation is needed but familiar cues activate incorrect intention and task in man. It is not recognized that knowledge based evaluation and planning is needed.

S1.3 Stereotype take-over

Definition: Task or act according to proper intention, but "absentmindedness" during performance leads to relapse to stereotype action links related to different act or task.

S1.4 Lack of recognition of familiar pattern

Definition: Familiar pattern relevant for the situation is not recognised, higher level knowledge-based evaluation or planning is unnecessarily and inappropriately applied.

S2 Input information processing

The subcategories are related to the man's activities in obtaining information.

That an information output malfunction has occurred is classified under:

## INTERNAL HUMAN MALFUNCTION

Erroneous function in action

Communication given incorrectly

S2.1 Information not received/sought

Definition: Cues do not activate man because sensitivity/attention is insufficient for present information level.

S2.2 Misinterpretation of information

Definition: Response is based on wrong apprehension of information such as misreading of text or instrument, misunderstanding of verbal message.

S2.3 Assumptions replace search for information

Definition: Response is inappropriately based on information supplied by the operator (by recall, guesses, etc.) which does not correspond with information available from outside.

S3 Recall

S3.1 Forgetting isolated act or function

Definition: Operator forgets to perform an isolated act or function, i.e., an act or function which is not cued by the functional context or is not having immediate effect upon the mental or motor sequence.

S3.2 Mistake among alternatives

Definition: Simple choice of wrong alternative, a category is correctly used but by wrong member, e.g., mistakes of up/down, +/-, left/right, A/B, open/closed, locked/unlocked.

S3.3 Other slips of memory

Definition: Erroneous recall of reference data values; names, item; need for actions, etc.

### Inferences

This group is covering problems of linear thought in causal nets.

S4 Side effects or latent conditions not adequately considered

Definition: The man is in a less familiar situation characterized by knowledge-based, goal-controlled performance. He performs erroneously during func-

tional inferences: The situation is not properly identified, the consequences of an event chain are not adequately predicted or an improper intention is chosen or latent conditions are not adequately considered. Consequently, the task or the intended goal is not fulfilled or adverse side effects occur or a combination of these consequences. (Can be due to oversight, lack of knowledge etc., this is characterized by the category: CAUSE OF HUMAN MALFUNCTION.

S5            Physical coordination

S5.1          Motor variability

Definition: Lack of manual precision, too big/small force applied, inappropriate timing. Including deviations from "good craftsmanship".

S5.2          Topographic, spatial orientation inadequate

Definition: In spite of man's correct intention and his correct recall of identification marks, tagging etc., he unwarily performs task/act in the wrong place or on the wrong object, because he is following his immediate sense of locality, this, however, not being applicable (not updated, surviving imprints of old habits etc.).

S6            Other identified mechanisms

S7            Mechanism not identified

Comments

This category represents an attempt to formulate a set of generic, task independent human error mechanisms. The related categories EXTERNAL MODE OF MALFUNCTION and INTERNAL HUMAN MALFUNCTION are tightly task related and reflect basically the effect of inappropriate human performance upon the task. To evaluate human performance during design of new tasks and improved work conditions, including man-machine interfaces, it is important to identify human malfunction mechanisms in generic terms relating inappropriate task performance to features of the psychological mechanisms which are the basis of the performance and to limiting properties of such mechanisms.

A human is capable of performing the same task in various different ways depending upon the state of training, the subjective

formulation of the goals and performance criteria, and consequently the role of the psychological mechanisms will be very person and situation dependent. Inappropriate task performance reflects a mismatch between task requirements and the human resources applied, and if the nature of this mismatch can be identified - irrespectively of the underlying cause - important information on the psychological mechanism applied and its limiting properties with respect to the task can be obtained.

The present category is intended to characterize cases of such resource/demand mismatch and is based on a model of operator performance derived from a preliminary analysis of 200 event reports (Rasmussen 1980). The structure of the model is illustrated in figure 4.

Guidelines for use of the category S: MECHANISMS OF HUMAN MALFUNCTIONS are presented in Pedersen et al 1981.

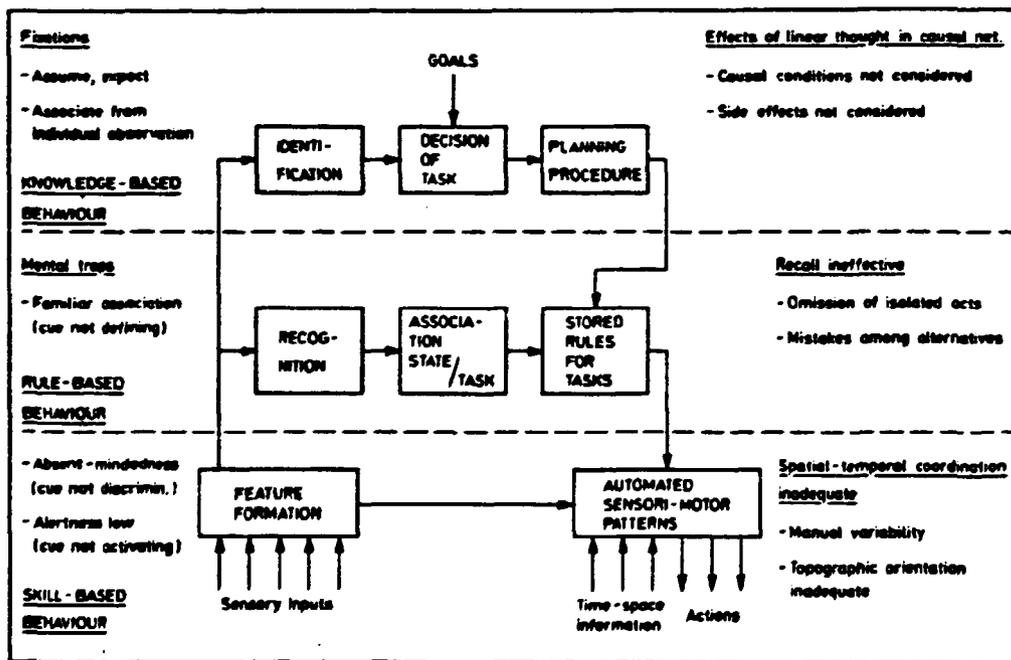


Figure 4. Model of human data processes and typical malfunctions. Reproduced from Rasmussen, 1980.

- T            PERFORMANCE SHAPING FACTORS
- T1            Subjective goals and intentions:
- T1.1         Aspects of task performance are given exaggerated promotion e.g., speed, thoroughness, accuracy, effort to avoid delay
- T1.2         Task content is inappropriately extended
- T1.3         Task perceived as secondary
- T1.4         Conflicting goals
- T1.5         Other not covered above
- T1.6         Subcategory not applicable
- T2            Mental load, resources:
- T2.1         Inadequate ergonomic design of work place
- T2.2         Overlapping tasks
- T2.3         Inadequate general education
- T2.4         Inadequate general task training and instruction
- T2.5         Other not covered above
- T2.6         Subcategory not applicable
- T3            Affective factors:
- T3.1         Social factors
- T3.2         Insufficient load, boredom
- T3.3         Time pressure
- T3.4         Fear of failure
- T3.5         Other not covered above
- T3.6         Subcategory not applicable

Comments

See comments to SITUATION FACTORS.

Guidelines for identifying performance shaping factors will be developed, based on the analysis in Griffon (1981).

Guidelines for use of the subcategories under "Mental load, resources" are presented in Pedersen et al 1981.

DATA COLLECTION FORMATS

Preprinted forms for data collection in plant and examples of their use are presented in the document SINDOC(81)15.

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<b>Risø - M -</b>	<p>Title and author(s)</p> <p>Classification System for Reporting Events Involving Human Malfunctions</p> <p>Jens Rasmussen, O. M. Pedersen, Risø, Denmark A. Carnino, M. Griffon, CEA, France G. Mancini, CEC, JRC, Ispra, Italy P. Gagnolet, EdF, France</p>	<p>Date March 1981</p> <hr/> <p>Department or group  Electronics</p> <hr/> <p>Group's own registration number(s)  SINDOC(81)14 R-6-80</p>
	<p>pages +      tables +      illustrations</p>	
	<p>Abstract</p> <p>The report describes a set of categories for reporting industrial incidents and events involving human malfunction. The classification system aims at ensuring information adequate for improvement of human work situations and man-machine interface systems and for attempts to quantify "human error" rates.</p> <p>The classification system has a multifaceted non-hierarchical structure and its compatibility with Ispra's ERDS classification is described. The collection of the information in general and for quantification purposes are discussed. 24 categories, 12 of which being human factors oriented, are listed with their respective subcategories, and comments are given.</p> <p>Underlying models of human data processes and their typical malfunctions and of a human decision sequence are described.</p> <p>7 references.</p> <p>Available on request from Risø Library, Risø National Laboratory (Risø Bibliotek), Forsøgsanlæg Risø), DK-4000 Roskilde, Denmark Telephone: (03) 37 12 12, ext. 2262. Telex: 43116</p>	<p>Copies to</p>