Organisation de Coopération et de Développement Economiques
Organisation for Economic Co-operation and Development

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NUCLEAR ENERGY AGENCY
COMMITTEE ON THE SAFETY OF NUCLEAR INSTALLATIONS

## Extended Task Force on Human Factors of the PWG-1

# IMPROVING REPORTING AND CODING OF HUMAN AND ORGANISATIONAL FACTORS IN EVENT REPORTS

64226



English text only

## ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

Pursuant to Article I of the Convention signed in Paris on 14th December 1960, and which came into force on 30th September 1961, the Organisation for Economic Co-operation and Development (OECD) shall promote policies designed:

- to achieve the highest sustainable economic growth and employment and a rising standard of living in Member countries, while maintaining financial stability, and thus to contribute to the development of the world economy;
- to contribute to sound economic expansion in Member as well as non-member countries in the process of economic development; and
- to contribute to the expansion of world trade on a multilateral. non-discriminatory basis in accordance with international obligations.

The original Member countries of the OECD are Austria, Belgium, Canada, Denmark, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The following countries became Members subsequently through accession at the dates indicated hereafter: Japan (28th April 1964), Finland (28th January 1969), Australia (7th June 1971), New Zealand (29th May 1973), Mexico (18th May 1994), the Czech Republic (21st December 1995), Hungary (7th May 1996), Poland (22nd November 1996) and the Republic of Korea (12th December 1996). The Commission of the European Communities takes part in the work of the OECD (Article 13 of the OECD Convention).

### *NUCLEAR ENERGY AGENCY*

*The OECD Nuclear Energy Agency (NEA) was established on 1st February 1958 under the name of the OEEC European Nuclear Energy Agency. It received its present designation on 20th April 1972, when Japan became its first non-European full Member. NEA membership today consists of all OECD Member countries except New Zealand and Poland. The Commission of the European Communities takes part in the work of the Agency.*

*The primary objective of the NEA is to promote co-operation among the governments of its participating countries in furthering the development of nuclear power as a safe, environmentally acceptable and economic energy source.*

*This is achieved by:*

- *encouraging harmonization of national regulatory policies and practices, with particular reference to the safety of nuclear installations, protection of man against ionising radiation and preservation of the environment, radioactive waste management, and nuclear third party liability and insurance;*
- *assessing the contribution of nuclear power to the overall energy supply by keeping under review the technical and economic aspects of nuclear power growth and forecasting demand and supply for the different phases of the nuclear fuel cycle;*
- *developing exchanges of scientific and technical information particularly through participation in common services;*
- *setting up international research and development programmes and joint undertakings.*

*In these and related tasks, the NEA works in close collaboration with the International Atomic Energy Agency in Vienna, with which it has concluded a Co-operation Agreement, as well as with other international organisations in the nuclear field.*

## COMMITTEE ON THE SAFETY OF NUCLEAR INSTALLATIONS

The Committee on the Safety of Nuclear Installations (CSNI) of the OECD Nuclear Energy Agency (NEA) is an international committee made up of senior scientists and engineers. It was set up in 1973 to develop, and co-ordinate the activities of the Nuclear Energy Agency concerning the technical aspects of the design, construction and operation of nuclear installations insofar as they affect the safety of such installations. The Committee's purpose is to foster international co-operation in nuclear safety among the OECD Member countries.

The CSNI constitutes a forum for the exchange of technical information and for collaboration between organisations which can contribute, from their respective backgrounds in research, development, engineering or regulation, to these activities and to the definition of the programme of work. It also reviews the state of knowledge on selected topics on nuclear safety technology and safety assessment, including operating experience. It initiates and conducts programmes identified by these reviews and assessments in order to overcome discrepancies, develop improvements and reach international consensus on technical issues of common interest. It promotes the co-ordination of work in different Member countries including the establishment of co-operative research projects and assists in the feedback of the results to participating organisations. Full use is also made of traditional methods of co-operation, such as information exchanges, establishment of working groups, and organisation of conferences and specialist meetings.

The greater part of the CSNI's current programme is concerned with the technology of water reactors. The principal areas covered are operating experience and the human factor, reactor coolant system behaviour, various aspects of reactor component integrity, the phenomenology of radioactive releases in reactor accidents and their confinement, containment performance, risk assessment, and severe accidents. The Committee also studies the safety of the nuclear fuel cycle, conducts periodic surveys of the reactor safety research programmes and operates an international mechanism for exchanging reports on safety related nuclear power plant accidents.

In implementing its programme, the CSNI establishes co-operative mechanisms with NEA's Committee on Nuclear Regulatory Activities (CNRA), responsible for the activities of the Agency concerning the regulation, licensing and inspection of nuclear installations with regard to safety. It also cooperates with NEA's Committee on Radiation Protection and Public Health and NEA's Radioactive Waste Management Committee on matters of common interest.

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## ABSTRACT

Screening of events indicated the causes by human and organisational factors to more than 50% and in some countries up to 70%. The jointly operated IRS (Incident Reporting System) on operating experience and lessons learnt with IAEA and NEA is a major source of information with more than 2500 experience reports so far. When the system started the analysis methods for human factors were not as developed as they have been today. Human Factor analysis requires more specific information in the reports then was given in past reports. When the NEA and IAEA reporting systems were merged together in 1997, new guidelines for reporting were developed. In order to strengthen the reporting of events involving human factors a new coding system was developed. The changes in the coding system is given in this report. It was developed in cooperation with WANO (World Association of Nuclear Operators). The present format is compatible with the corresponding WANO system

# I. INTRODUCTION

Human Performance in all aspects of design, operation, maintenance and technical support is a significant contributor to the avoidance of events in NPP. When it is less than adequate it may significantly contribute to the occurrence of events. Moreover human performance during recovery activities often influences the outcome of events. Effective event reporting systems must provide due consideration to human performance related issues.

Human errors and organisational weaknesses are known to contribute in many countries to more than half of reported events in national event reporting systems. This situation is also reflected in the reports submitted to the Incident Reporting System (IRS), which is jointly operated by the International Atomic Energy Agency (IAEA) and the Nuclear Energy Agency (NEA) of the Organisation for Economic Co-operation and Development (OECD). However the efficiency of the operating experience feedback process and the possibilities of retrieving lessons learned on an international scale, which is the main purpose of IRS, have been seriously hampered in the past by observed deficiencies in the quality, consistency and completeness of information in the identification of causes of events related to human performance issues. Improvements in the guidance and training of national IRS co-ordinators have been suggested at several occasions as a way to achieve improved reporting in this field.

The Expanded Task Force on Human Factors (ETF) has been asked by the PWG1 of the NEA to contribute to its effort in establishing improved IRS guidelines. A specific task has been agreed within ETF, dedicated to the subject of improved guidance for reporting of human and organisational factors in event reports. Several ETF member countries contributed actively to this task including France, Germany, Switzerland, the United Kingdom, the United States and Belgium.

The main objective of this task was to enable the PWG1 to improve the current situation regarding the reporting and coding of human performance deficiencies in IRS. The main effort within this task was focused on identifying the type and detail of information on human and organisational factors which should be expected and on providing guidance how this information could be presented within the body of the event reports. A secondary objective was to provide recommendations to improve the current IRS coding system with regard to human factors and more specifically the coding of human errors and organisational weaknesses. It was recognised during the execution of this task that such an improved coding system, with the necessary guidance supporting a consistent use of these codes, could be an integral part of the improved guidance document and would support the main objective of the task in indicating human and organisational factor information of interest as well as the expected level of detail.

Some limitations on the scope and freedom of activities to be developed by ETF have been set by the PWG1 and fully recognised by ETF from the very outset of this task. As the editing of new joint IAEA/NEA IRS guidelines was already well underway, a period of approximately one year was given to deliver the ETF guidance document. In order to respect this time frame a pragmatic approach had to be followed, making maximal use of existing guidance documents established by international organisations such as NEA and IAEA or by member countries (see references 3 to 6). The improved human factor reporting guidance document should be transparent and not too difficult to use by national IRS co-

ordinators, who are not human factor specialists and have not necessarily got specific training in human factor analysis techniques. Consistency and continuity with existing reporting practices within IRS had to be achieved as well (references 1 and 2). And at last, in order to achieve consistency in coding of event reports with another reporting system operated by the World Association of Nuclear Operators (WANO) for the nuclear industry, it was requested to establish within this task close collaboration with WANO, who was also in a process of improving its event reporting system.

During its discussions the task group in charge recognised inherent limitations of human factor reporting in IRS due to national culture, regulatory reporting requirements, legal issues, etc., and noticed that there is still some reluctance to provide information related to human performance. The group agreed that there was a need to stimulate utilities to provide more detailed information on human factor aspects in event reports. In this respect the establishment of a blame free reporting culture should be promoted. The benefits of improved human factor reporting should be made clear to the nuclear industry and, although IRS remains essentially a tool for regulatory bodies, these benefits should in the end also encourage industry to use more IRS reports in its operating experience feedback efforts. It was also recognised that a condition for improved human factor reporting is the availability and systematic use of human and organisational factors oriented event investigation methods. Proposed guidance for reporting human factor information in IRS should remain compatible with at present widely used event analysis methods.

In order to maintain a pragmatic approach in developing an improved guidance document, it was decided to start from existing documents, established through consultant meetings at the IAEA. At the starting point a review was made by several countries, represented in ETF, of the report IAEA-J4-CS-101/94 (reference 3), which addresses the same issue of improved human factor reporting. Some countries tried in this effort to apply the proposed reporting scheme on events in their national data base and commented on their findings. These contributions have been provided in a technical Appendix to this report. This exercise and the discussion of its results have been useful in helping to build within the task group a consensus on the issues of scope and detail of needed human factor information and on the issue of acceptable complexity of reporting schemes.

In a second phase a "Human and Organisational Factors Reporting Guidance" document has been edited, in part based on the above mentioned discussion, in part on a review of the follow up report IAEA-J4-CS-161/95 (reference 4) and of a draft document provided by the NRC, which was proposed for inclusion in a future revision of NUREG-1022 related to Licensee Event Reports (reference 5). It was stressed that in some cases detailed information on the chronology of an event, including chronology of human actions, and some additional situational information (i.e. the error forcing context) is essential to understand human behaviour and related performance problems. Application of existing event analysis and presentation techniques, including barrier analysis and use of Event and Causal Factor Charts, incorporating human actions, would contribute to a better understanding of events and lessons learned. All these aspects are addressed in the resulting improved guidance document which is presented in section II of this report. Although this guidance document has not been introduced as such in the improved IRS guidelines, a lot of elements have been integrated in the procedure for preparation of IRS reports (Appendix A of Joint IAEA/NEA IRS Guidelines).

One of the identified potential problems in reporting and retrieving human factor related information is the lack of use of a common language. It was agreed that a possible way to overcome this problem would be by reaching a consensus on the taxonomy to be used regarding reporting of human and organisational factors. The way chosen to introduce such a common taxonomy was by providing on the one hand a limited list of human and organisational factor codes, remaining manageable and preserving the odds on a consistent coding, and on the other hand a longer list of keywords supporting each proposed code. The proposed coding system should be hierarchically structured, allowing future reduction or expansion in

detail without loosing consistency in coding. The list of keywords would indicate at the same time the level of detail an event report could reach when reporting on human performance issues. In this way the list of codes and keywords would support and be coherent with the improved human factor reporting guidance document itself. The use of both proposed codes and keywords would support the complementary possibilities in the existing Advanced IRS data base to retrieve information (by guide words or by free search).

Both lists were established in close co-operation with a WANO-PC representative and were mainly derived from existing documents such as IAEA-J4-CS-161/95 (reference 4). In addition to allowing the identification of the type of human error as direct cause of an event, the proposed codes permit to indicate the type of plant staff involved and the type of activity when inadequate human actions occurred as well as the personal and organisational causal factors, which are typically identified as contributing causal factors and root causes of events. In addition to the common list with WANO, some additional codes have been provided which draw the attention of IRS national co-ordinators to the wish of ETF that also recovery actions and lessons learned from these actions receive due coverage in event reports and that the complexity of an event with regard to the chain of observed human performance deficiencies is indicated and reflected upon (single or multiple, independent or dependent failures or errors). The final lists, which came out of the integration effort of the new human factor codes with the existing IRS coding system in which ETF was not involved, are presented respectively in sections III and IV of this report. These lists are based on the proposals made by the ETF group, with some minor changes regarding the sequence of codes and the detail of coding related to the identification of plant staff involved in inadequate human actions.

Section V. mentions the reference documents used in the frame of this task.

A technical Appendix to this report presents a compilation of the contributions of individual countries to the review of the IAEA reference documents in the preparation phase of this task.

# II. IMPROVED GUIDANCE FOR REPORTING OF HUMAN AND ORGANISATIONAL FACTORS

## ~~3.2 Narrative description:~~ *Human and Organisational Factors Reporting Guidance*

### A. INTRODUCTION

This document provides specific guidance for the reporting of human and organisational factors. This guidance may be used for those event reports in which the description of corrective actions and lessons learned is particularly focusing on human performance deficiencies and organisational problems.

The guidance, which follows the standard IRS reporting format, should not be considered as an obligatory reporting scheme but could be used as a checklist. The additional information on human and organisational factors, as suggested by these guidelines, has only to be provided, when it is necessary for a good understanding of the event and in particular of the corrective actions taken and when it supports the message to be conveyed on the lessons learned.

### B. NARRATIVE DESCRIPTION

~~This section of the IRS report should provide all~~Provide relevant information on **what happened** during the event. ~~It should provide chronological information, contextual information and an identification of failures and successes in human performance. The description of human behaviour in this part should not be caus~~The description of the human actions and the related organisational aspects may enable the reader to have a clearer picture of the human behaviour and of the technical and organisational environment in which the event occurred. It may contribute to a better understanding of the ~~oriented.~~

~~**3.2.1 *The chronological information:***~~corrective actions chosen by the utility to avoid recurrence of this or similar events.

The following information may be relevant in this respect:

1. Chronological information

~~W~~Include within the description of the event the chronological sequence of all relevant human actions ~~should be included. This description should cov~~. Consider pre-event actions, initiating or contributing to the occurrence of the event, as well as the human response to the event including the recovery actions intended to terminate the event and reach a safe state.

~~The following information should be included:~~

- ~~timing and linkage of error free / erroneous actions and system responses~~

~~• "human actions" should cover~~Include in your description the timing and linkage of error-free and erroneous human actions and system responses, so that the human behaviour is clearly understood. Consider in your description of human actions detection and diagnosing activities, decision making and ~~planned action execution aspects as well as internal team or inter-team communication~~
execution of planned actions and
~~3.2.2 The contextual information:~~intra-team or inter-team communication. Mention tasks carried out in parallel by the plant staff when the error(s) occurred.

If in the analysis of the event a simulation of the event sequence was necessary in order to understand the human behaviour aspects in connection to the dynamics of a plant transient, this may also be reported and briefly discussed.

2. Situational information (information on the context)

For a better understanding of the event and of the conclusions of the caus~~al~~e analysis as well as for a better perception of the lessons learned from the event, an additional ~~information on~~explanation of the general context in which the event took place is i~~ndispensable~~mportant.

~~This contextual information should include, (only) if relevant~~When providing this situational information, the following aspects may be considered (to be mentioned only when relevant):

- ~~the~~ identification of the ~~principle actors in the event, i.e. the~~ type of NPP personnel directly involved in the initiation of the event or contributing to the event (e~~x~~.g. reactor operator, I&C technician, etc.)
- ~~the nature of the activity ( in which human errors occurred) performed at~~description of the activity contributing to the initiation of the event or affecting the recovery of the event (e~~x~~.g. periodic testing of the reactor protection system)~~, including if necessary for a good understanding a short task description~~; include, if necessary for a good understanding, a short description of the task involved
- operator/technician qualification and preconditioning (i.e. previous relevant experience) or other personal factors (presence of fatigue, stress, etc.)
- characterisation of personnel work practices (control and independent verification of task execution, work habits) and ~~communication~~communications
- characterisation of environmental work conditions
- characterisation of the man machine interface and its limitations
- information on the ~~used~~ tools ~~and its~~used and their limitations, including available procedures and work documents
- organizational aspects including task assignment and task processing (~~task preparation~~work planning and preparation), ~~team size and composition~~shift/team size and composition and use of contractors
- information on personnel work schedul~~e~~ing (including timing of activities; e.g. indicate if the problem was related to night work; time pressure due to work on critical path, etc.)
- information on the type of supervision and the supervisory methods

- system/process characteristics which are relevant for a good understanding of the human error/ behaviour (e~~x~~.g. degree of tolerance of system/process for human error, presence of a pitfall situation, etc.)
- specific plant conditions which might have had direct influence on the operator's performance such as pre-event plant configuration (including recent performance history of equipment), process parameters and other factors including off-nominal and/or dynamic conditions which resulted in unusual plant configurations and plant behaviour

~~For each of the contextual aspects from this list which is found relevant, it should be indicate~~Indicate if, and to what extent, on the day of the event, this context was different from a normal (incident~~-~~free) activity performance.

If available add figures, including layouts, photographs or drawings which allow illustration of the environment in which a failure occurred. This may facilitate the clarification and appreciation of the man-machine-interface and environmental factors.

~~3.2.3 *Identification and characterisation of failures in human performance:*~~

~~The discrepancies with regard to a normal or expected activity progress should be identified and described.~~

~~From the description of the human performance deficiencies, information should be available on~~

- ~~the nature and extension of the human error(s): was it an active error (i.e. directly initiating or affecting the event) or did it result in a latent failure ?; was it a single error or were multiple errors involved ?; were the observed human errors dependent or not ?; were the observed human errors recurrent in nature ?~~
- ~~the human error type:~~
  - ~~was it a slip or lapse ?; i.e. in spite of a good understanding of the system/ process/ procedure/ specific context and the intention to perform the correct actions, an unconscious unintended action or failure to act occurs or a wrong reflex and instinctive action takes place in a pitfall situation~~
  - ~~was it a mistake ?; i.e. a person made a wrong action because he did not understand the system/ process/ procedure/ specific context~~
  - ~~was it a violation ?; i.e. there was intentional breaking of known rules, prescriptions,... without malevolent intention~~
  - ~~was it an act of sabotage ?; i.e. there was intentional breaking of known rules, prescriptions,... with malevolent intention~~

~~The identification of the error type is supported by the provided codes for "Type of human error" and the corresponding keywords. If information would be available on the corresponding failure mode (see list of keywords for examples) this should also be provided.~~

~~The observed errors should be shortly discussed, including an explanation for actions, compromises and choices made and the reasons for the related difficulties.~~

~~3.2.4 *Identification and characterisation of recovery actions:*~~3. Identification and characterisation of recovery actions

Information on the nature and timing of recovery actions may provide additional insights into the complexity of the situation and the difficulties for the operators to detect and diagnose the problems at hand. Besides, lessons may also be learned from the positive roles of the NPP personnel involved in an event.

~~The positive roles of the different actors involved in the event should also be mentioned. A discussion of the recovery actions should be included, providing information on how the recovery was achieved. The persons involved in the recovery actions should be identified~~If relevant, include a discussion of the recovery actions, providing information on how and when the recovery was achieved (recovery in immediate response to the error, recovery by planned action or by trouble shooting, recovery directed or not directed by provided procedures). Identify the persons involved in the recovery actions (recovery performed by the person who committed the error himself, or by the team to which this person belongs, or by completely different ~~group?)~~persons or group). ~~More specifically information, if available, should be provided on: the time delay~~ Provide, if available, more specifically information on the time delay needed for the detection of the human error or system failure (including latent failures) and for the diagnosis of the safety problem/degradation. Explain the reasons for the long time delays before the problem was detected or diagnosed, if applicable.

## C. SAFETY ASSESSMENT

Address the actual and potential consequences of the observed human performance problems and discuss their safety significance. Consider potential consequences on the operability of the plant systems and on the subsequent ability of plant staff to handle plant components.

This section ~~should~~may include a discussion of the barriers which were broken by the identified human performance deficiencies (loss of defence in depth) and the effectiveness of the barrier that terminated the event (including recovery actions, the positive role of the plant staff). This information can be obtained by use of barrier analysis techniques.

~~**3.4 Observed cause, root causes and other causal factors:**~~

## D. CAUSE ANALYSIS

1. The presentation and discussion of the “direct~~" or "observed" causes~~ or observed causes” answers to the question "how did it happen?"

Identify in this respect the observed human errors, which contributed in an active way to the initiation of the event or affected in a direct way the operator or system responses to the event.
~~If the initiator of an event is a human error, the report should identify this error. It should discuss, to a certain extent and depending on~~
Discuss, depending on the available information, the results of the ~~analysis which allowed to~~human factors analysis; describe the human performance deficiencies and provide information on:

- the nature and extent of the human error(s): was it a single error or were multiple errors involved?; were the observed human errors dependent or not?; were the observed human errors recurrent in nature?

- the human error type: was it a slip or lapse?; was it a mistake?; was it a violation?; was it an act of sabotage?; if information would be available on the corresponding failure mode this should also be provided.

Note: The identification of the error type is supported by the definitions provided with the codes (or guide words) for "Type of inadequate human action" and the corresponding keywords; these keywords also identify common failure modes.

Discuss shortly the observed errors: if available provide an explanation for actions, compromises and choices made; discuss the reasons for the related difficulties experienced by the plant staff; explain the nature of the "trap" (i.e. error forcing context) that led to the error.
~~identify the type of error and related failure mode (see list of keywords for further guidance).~~
If the error was of the type "slip or lapse" describe the task characteristics or the stimuli which led to a spontaneous but inappropriate action.

If the error was of the type "mistake" describe what was not well understood and provide some details which explain the occurrence of the mistake (complexity, delay time for action too short, uncertainty, dynamic of the phenomena, etc.).

If the error was of the type "violation" describe the reasons why the person(s) involved made his (their) choice of action and the criteria applied in his (their) decision process (which compromise?).

2. The presentation of the observed causes ~~should be followed by a reporting of all identified causal factors. These are the causes that, if corrected, would not of themselves have prevented the event, but are important enough to be recognised as needing corrective action to improve the quality of the process or product.~~is followed by:

- a reporting of identified **causal factors** which are relevant to the message to be conveyed (i.e. lessons learned)
- ~~This should be followed by~~a presentation and discussion of the **root causes**.

Both causal factors and root causes provide the answers to the question "**why did it happen**?"

Human performance related causal factors and root causes are clearly not restricted to observed human errors (as observed or direct cause of an event), but are also applicable to observed technical (equipment) deficiencies. They focus on:

- the performance of individuals (i.e. personal factors such as fatigue, stress, lack of experience, etc.)
- the performance of groups (i.e. personnel work practices including independent verification practices, verbal communications, etc.)
- the conditions in which people have to work (e.g. environmental conditions, provided procedures and documents, provided tools and materials, weaknesses of the man machine interface, etc.)

- the weaknesses of the organisation (including work planning and preparation, task assignment practices, supervisory methods, etc.)
- the training which is provided to the plant staff
- and ultimately the performance of the management (e.g. unclear policies, standards and expectations, insufficient resources allocated, weaknesses in management monitoring and assessment, weaknesses in the decision process, inadequate management of the modification process, organisational and safety culture, etc.)

~~For the description of both~~They differ from the more equipment related causal factors and root causes, which have also a human component, but are strictly applicable to equipment deficiencies. The latter focus on:

- the design configuration and analysis
- the specification, manufacture and construction of the equipment
- the maintenance, testing, and surveillance practices
- intrinsic equipment performance deficiencies

~~are human performance related, further guidance is given by the list of provided~~Note:

Further guidance is provided by the list of codes (or guide words) related to *"Human performance related causal factors"* and *" Equipment related causal factors"* as well as by the corresponding keywords.

~~keywords.~~ The discussion of these causal factors should be supported by the background information (especially the ~~contextus~~situational information) that has been provided in the narrative description of the event. ~~If in the analysis of the event a simulation of the event sequence was necessary in order to understand the human aspects in connection to the dynamics of the situation, this should also be reported and briefly discussed.~~

~~A good understanding of the event sequence, its linkage with all identified causal factors and~~3. A good understanding of the event sequence and the things that went wrong, the linkage with identified observed causes, causal factors and root causes and the identification of the broken and effective barriers ~~e~~would be supported by an illustration of these event analysis results in a so-called **Event & Causal Factor Chart**. The use of such a representation technique is highly recommended. In addition, an attribution of IRS codes to the corresponding elements of the chart would help people performing IRS-searches to easily conclude, if selected reports are relevant to the investigated topic.

## D~~3.5 Corrective actions:~~. CORRECTIVE ACTIONS AND LESSONS LEARNED

~~This section should~~ Dinclude a discussion of the effectiveness of the corrective actions taken to solve the ~~human performance problems (i.e. to prevent recurrence or to lower the frequency of occurrence).~~escribe the actions taken by the NPP as a reaction to the event, in order to improve the observed human performance and solve organisational problems. Corrective actions may be split into short term (provisional) and long term (final) actions.

~~**3.6 Lessons learned:**~~

~~This section should explain~~

- ~~the reasons for the difficulties experienced by the plant staff~~
- ~~the reasons for the long time delays before the problem was detected/solved~~
- ~~the nature of the "trap" that led to the error~~
- ~~the knowledge and know-how that must be developed to eliminate the observed faults and errors (identification of lacking knowledge or know-how, attention to secondary objectives in training,...)~~

~~the measures that should be taken in plant design, organisational provisions,... in order to diminish the effects of unavoidable human errors~~

They may include:

- changes in attitudes or habits of persons or groups
- changes to training, including attention to secondary objectives in training; indicate what was lacking in terms of knowledge and know-how
- changes to procedures
- organisational changes
- improvements in ergonomics
- hardware modifications which influence man-machine interaction
- etc.

Discuss the objectives and effectiveness of the corrective actions taken to solve the human performance and organisational problems. Corrective actions may cover measures taken:

- to lower the frequency of occurrence of human failures
- to eliminate the observed human errors
- to diminish the effects of human errors which are recognised as being unavoidable
- to improve overall organisational efficiency and management control
- to improve the efficiency of detection and diagnosis in the recovery process of events

Provide a clear statement regarding the lessons learned from the event. Focus on the message to be conveyed in order to attract the attention to and facilitate the application of these (generic) lessons to other nuclear power plants in foreign countries. Lessons learned may reside in the areas of unexpected failures, causes or consequences, difficulties to detect or diagnose problem situations or to implement effective corrective actions, plant conditions which are particularly vulnerable to human errors, generic human factor weaknesses, etc.

Discuss the application of lessons learned from this event and the corrective actions, taken or planned, in other NPP of the reporting country. Consider in this respect other areas (systems, situations) where similar human failures could occur.

## III. PROPOSED LIST OF NEW HUMAN AND ORGANISATIONAL FACTOR CODES

### 5.0 CAUSE OF THE EVENT

**5.1.10 Human factors**

5.1.10.1 Slip or lapse

5.1.10.2 Mistake

5.1.10.3 Violation

5.1.10.4 Sabotage

**5.3 Inadequate human action - Plant staff involved**

5.3.1 Maintenance

5.3.2 Operations

5.3.3 Technical and Engineering

5.3.4 Management and Administration

**5.4 Inadequate human action - Type of activity**

5.4.1 Not relevant

5.4.2 Normal operations

5.4.3 Shutdown operations

5.4.4 Equipment startup

5.4.5 Planned / preventive maintenance

5.4.6 Isolating / De-isolating

5.4.7 Repair (unplanned / breakdown maintenance)

| | |
|---|---|
| 5.4.8 | Routine testing with existing procedures/documents |
| 5.4.9 | Special testing with one-off special procedure |
| 5.4.10 | Post-modification testing |
| 5.4.11 | Post-maintenance testing |
| 5.4.12 | Fault finding |
| 5.4.13 | Commissioning (of new equipment) |
| 5.4.14 | Recommissioning (of existing equipment) |
| 5.4.15 | Decommissioning |
| 5.4.16 | Fuel handling/ Refuelling operations |
| 5.4.17 | Inspection |
| 5.4.18 | Abnormal operation (due to external or internal constraints) |
| 5.4.19 | Engineering review |
| 5.4.20 | Modification implementation |
| 5.4.21 | Training |
| 5.4.22 | Actions taken under emergency conditions |
| 5.4.23 | Other activity |

| | |
|---|---|
| **5.5** | **Human performance related causal factors and root causes** |
| 5.5.1 | Verbal communications |
| 5.5.2 | Personnel work practices (including other) |
| 5.5.2.1 | Control of task / Independent verification |
| 5.5.2.2 | Complacency / Lack of Motivation / Inappropriate habits |
| 5.5.2.3 | Use of improper tools and equipment |
| 5.5.3 | Personnel work scheduling |
| 5.5.4 | Environmental conditions |
| 5.5.5 | Man-machine interface |

| | |
|---|---|
| 5.5.6 | Training / Qualification |
| 5.5.7 | Written procedures and documents |
| 5.5.8 | Supervisory methods |
| 5.5.9 | Work organisation (including other) |
| 5.5.9.1 | Shift/team size or composition |
| 5.5.9.2 | Planning / Preparation of work |
| 5.5.10 | Personal factors (including other) |
| 5.5.10.1 | Fatigue |
| 5.5.10.2 | Stress / Perceived lack of time / Boredom |
| 5.5.10.3 | Skill of the craft less than adequate / Not familiar with job performance standards |

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| **5.6** | **Management related causal factors and root causes (including other)** |
| 5.6.1 | Management direction |
| 5.6.2 | Communication or Co-ordination |
| 5.6.3 | Management monitoring and assessment |
| 5.6.4 | Decision process |
| 5.6.5 | Allocation of resources |
| 5.6.6 | Change management |
| 5.6.7 | Organizational / Safety culture |
| 5.6.8 | Management of contingencies |

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| **5.7** | **Equipment related causal factors and root causes (including other)** |
| 5.7.1 | Design configuration and analysis |
| 5.7.2 | Equipment specification, manufacture and construction |
| 5.7.3 | Maintenance, testing or surveillance |

# IV. PROPOSED LIST OF KEYWORDS CORRESPONDING TO NEW HUMAN AND ORGANISATIONAL FACTOR CODES

*EXPLANATION FOR INDIVIDUAL CODES*

## 5. CAUSE OF THE EVENT

### 5.1.10 Human factors

The following codes provide the possibility to indicate the type of human error / type of inadequate human action.

#### 5.1.10.1 Slip or lapse

A slip or lapse is an unconscious unintended action or failure to act, resulting from an attention failure or a memory failure in a routine activity: in spite of a good understanding of the system (process, procedure, specific context) and the intention to perform the task correctly, an unconscious unintended action or a failure to act occurs or a wrong reflex or inappropriate instinctive action takes place.

It includes the following errors/failure modes:

- response implementation error
- unconscious wrong action or failure to act, wrong reflex, wrong instinctive action
- wrong action or lack of action due to omission of attentional check, insufficient degree of attention, unawareness
- strong habit intrusion, unwanted reversion to earlier plan, continuation of habitual sequence of actions, failure to act because focal attention is elsewhere, failure to attend need for change in action sequence, omission of attentional check after task interruption
- interference error in two simultaneous tasks
- confusion error (wrong component, wrong unit), spatial misorientation
- omission of steps or unnecessary repeating of steps in (unconscious) action sequence due to mistimed checks

- task sequence reversal error

#### 5.1.10.2 Mistake

A mistake is an intended action resulting in an undesired outcome in a problem solving activity: a person made a wrong action because he did not understand the system, the procedure, the specific context, the prescribed task, etc.

It includes the following errors/failure modes:

- misdiagnosis, misinterpretation, situation assessment error
- wrong mental model, wrong hypothesis
- failure to detect situation, informational overload (indications not noticed, acted upon)
- use of wrong procedure
- misunderstood instructions/information
- lack of specific knowledge
- tunnel vision (focus on limited number of indications, lack of big picture)
- over-reliance on favourite indications
- not believing indications/information (lack of confidence)
- mindset/ preconceived idea/ confirmation bias/ overconfidence (failure to change opinion, discarding contradictory evidence)

#### 5.1.10.3 Violation

In spite of a good understanding of the system (process, procedure, specific context) an intentional breaking of known rules, prescriptions, etc. ,occurred without malevolent intention.

It includes following inadequate human actions:

- administrative control circumvented or intentionally not performed
- required procedures, drawings, or other references not used
- intentional shortcuts in prescribed task sequence
- unauthorised material substitution
- situation which asks for compromises between safety and other objectives (production, personal safety, etc.)
- intentional disregard of safety prescriptions/concerns

#### 5.1.10.4 Sabotage

An intentional breaking of known rules, prescriptions, etc., occurred with malevolent intention.

### 5.3 Inadequate human action - Plant staff involved

#### 5.3.1 Maintenance

Includes mechanical, electrical and instrumentation and control maintenance technicians.

#### 5.3.2 Operations

Includes control room operators and field operators.

#### 5.3.3 Technical and Engineering

Includes chemists, reactor physicists, health physicists, technical support staff (mechanical, electrical, I&C), system/project engineering staff, emergency planning staff and industrial safety staff.

#### 5.3.4 Management and Administration

Includes staff in charge of planning activities, management of contractors, QA, training, document production, security, procurement, management of stores, etc.

### 5.5 Human performance related causal factors and root causes

#### 5.5.1 Verbal communications

Includes the following causal factors:

- shift hand-over inadequate
- no communication between shifts in charge of different parts of a task
- pre-job briefing inadequate/not performed
- message misunderstood/misinterpreted
- communications equipment inadequate or not available
- receiver not listening
- communications incorrect/inadequate
- intra-team/ inter-team communication inadequate
- supervisor not notified of problem/concerns

#### 5.5.2 Personnel work practices (including other)

If other personnel work practices were involved as causal factor, they should be specified in the full text of the report.

#### 5.5.2.1 Control of task / Independent verification

Includes the following causal factors:

- self checking not used or ineffectively applied
- independent checking not used or ineffectively applied
- system alignment/isolation not verified (no redundancy in verification)

#### 5.5.2.2 Complacency / Lack of Motivation / Inappropriate habits

Includes the following causal factors:

- inattention to detail
- unsafe working practices applied
- failure to wear protective clothing
- radiological/ALARA work practices not followed
- inadvertent bumping, stepping on, or damage to equipment
- failure to maintain written logs
- lack of questioning attitude
- required procedures, drawings, or other references not used
- administrative controls circumvented or intentionally not performed
- inappropriate habits developed through group pressure / culture

#### 5.5.2.3 Use of improper tools and equipment

Includes the following causal factors:

- necessary tools/materials not provided
- improper tools or materials selected/ provided/ used
- tools not/inadequately calibrated

### 5.5.3 Personnel work scheduling

Includes the following causal factors:

- excessive overtime
- working continuously for considerable number of hours
- workers called in during unsociable hours
- working without rest day for considerable time
- problem related to night work
- frequent changes of shift
- time pressure to complete task
- unfamiliar work cycle
- too many concurrent tasks
- inadequate task interruptions/ task partitioning

### 5.5.4 Environmental conditions

Includes the following causal factors:

- lighting inadequate
- housekeeping inadequate
- temperature too hot/cold
- excessive noise level
- high humidity
- high radiation
- cramped work space
- dangerous work place
- distractions

### 5.5.5 Man-machine interface

Includes the following causal factors:

- signal conventions or antropometry of country not respected
- label missing/inadequate
- interface design inappropriate for task, interface confusing/distracting
- controls not adequate
- indications provided not adequate, information format/ organization less then adequate
- alarms provided not adequate
- alarm masking/cancelling
- too many standing or incoming alarms
- pitfall in design

### 5.5.6 Training / Qualification

Includes the following causal factors:

- training inadequate or not provided on how to perform task
- training inadequate or not provided on how to use special equipment or tools
- training inadequate or not provided on relevant system(s)/components
- training inadequate or not provided on risk aspects of task/situation
- training not based on current plant requirements
- demonstration of task proficiency not required prior to qualification
- insufficient refresher training
- lack of fidelity between simulator training and plant
- training not attended
- training standard not adequate
- training not provided to required level of competence for task
- training not provided in personnel work practice
- shortfall in on-job training / experience

- inadequate definition of required qualifications

### 5.5.7 Written procedures and documents

Includes the following causal factors:

- no document available
- document technically incorrect or incomplete
- cautionary information not included
- not up to date with plant design
- not formally stated
- unclear or complex wording
- confusing graphics
- format deficiencies
- user aids deficient / not provided
- inadequate technical review process
- responsibility for following procedure not stated
- inadequate safety assessment provided

### 5.5.8 Supervisory methods

Includes the following causal factors:

- duties and tasks not clearly explained, work orders not clearly given
- progress not adequately monitored
- supervision levels not decided prior to task
- supervisor too involved in tasks, inadequate control room oversight
- inappropriate balance between timescale and standards
- inadequate control of contractors
- frequent task re-assignment
- safety aspects of task not emphasised
- assigned task too complex

### 5.5.9 Work organisation (including other)

If other work organisation deficiencies were involved as causal factor, they should be specified in the full text of the report.

#### 5.5.9.1 Shift/team size or composition

Includes the following causal factors:

- too few / too many workers allocated to task
- too few workers of the correct trade/specialisation
- inappropriate selection of staff for task
- change in crew composition/ team leadership

#### 5.5.9.2 Planning / Preparation of work

Includes the following causal factors:

- planning done without site visit
- planning of parallel tasks inadequate
- planning conflicts not identified
- special conditions or requirements not identified
- job walkthrough not performed
- conditions not verified prior to work
- work initiated prior to ensuring all skills, parts, tools, instruments, etc., are available
- task not adequately researched prior to start, no risk analysis before task to identify potential safety problems
- work package did not address all administrative requirements
- task or routine not assigned
- co-ordination of all relevant on-site departments not achieved
- co-ordination of relevant on-site and off-site departments not achieved

#### 5.5.10 Personal factors (including other)

If other personal factors were involved as causal factor, they should be specified in the full text of the report.

##### 5.5.10.1 Fatigue

This causal factor may be present in case of:

- inadequate environmental conditions
- excessive workload
- working continuously for considerable number of hours

##### 5.5.10.2 Stress / Perceived lack of time / Boredom

These causal factors related to positive or negative stress may be present in case of:

- cognitive overload / cognitive underload (boredom)
- fear of failure/consequences
- perceived (time) pressure to complete task
- on the job distractions

##### 5.5.10.3 Skill of the craft less than adequate / Not familiar with job performance standards

These causal factors may be present when staff is:

- not familiar with job performance standards
- not familiar/well practised with task, failure to apply knowledge
- not familiar with sources/availability of information
- not familiar with tools
- not qualified for assigned task

### 5.6 Management related causal factors and root causes (including other)

If other management related factors were involved as causal factor, they should be specified in the full text of the report.

#### 5.6.1 Management direction

Policies, official guidance (standards), expectations, administrative controls are not developed, are not enforced or are not adequate (not strict enough, confusing or incomplete).

### 5.6.2 Communication or Co-ordination

Includes the following causal factors:

- policies, official guidance (standards), expectations, administrative controls not communicated effectively within the organisation
- familiarity of workers with relevant policies and/or guidance not verified
- inadequate co-ordination/communication between departments
- co-ordination/communication not sufficiently promoted by management
- inadequate communication between management and plant staff, inadequate feedback from plant staff to management, employee concerns fail to reach management attention
- no prompt management responses to employee concerns

### 5.6.3 Management monitoring and assessment

Includes the following causal factors:

- inadequate level of management involvement
- inadequate establishment/support of programs or processes
- inadequate monitoring of the effectiveness of programs or processes (e.g. review processes of documents and procedures, training programs, operating experience, QA audit program)
- inadequate monitoring of results of decisions/assignments
- inadequate assessment of the effectiveness of corrective actions
- inadequate assessment of personnel behaviour and performance

### 5.6.4 Decision process

Includes the following causal factors:

- officially designated responsibilities and accountabilities unclear
- decision process too lengthy/time consuming
- decisions based on insufficient information
- risks and consequences of decision not identified or assessed before decision is made
- management objectives did not encompass known problems

- management objective did not reflect a relevant constrain
- inadequate operating experience feedback process (corrective actions not defined, inadequate or not timely implemented, root causes of known problems not addressed)
- improvement campaigns ineffective

### 5.6.5 Allocation of resources

Insufficient resources allocated for identified objectives (includes resources such as training, supervision, documentation, tools, materials and equipment).

### 5.6.6 Change management

Includes the following causal factors:

- need for change/further change not identified
- change not implemented in adequate timescale
- inadequate resourcing of change
- consequences of change not adequately assessed
- change-related training/briefing inadequate
- change-related documentation alteration inadequate
- change-related equipment provision inadequate
- results of change not monitored for correctness

### 5.6.7 Organizational / Safety culture

Includes the following causal factors:

- punitive responses to genuine slips or mistakes
- lack of blame-free reporting culture
- staff does not have “do it right the first time” attitude
- taking of short-cuts allowed/tolerated
- low morale among plant staff
- recurrent violation of rules
- general lack of questioning attitudes
- lack of conservative approach in control room

- lack of teamwork in control room

### 5.6.8 Management of contingencies

Includes the following causal factors:

- organisation unprepared to handle unforeseen events
- no management oversight of problem solving by workers for unforeseen events
- weaknesses in emergency preparedness
- weaknesses in contingency planning

## 5.7 Equipment related causal factors and root causes (including other)

Includes the following causal factors:

- equipment operated outside design specifications
- ageing of equipment
- known problems not corrected
- degraded sub-component contributed to failure
- component beyond expected lifetime
- externally damaging condition not properly evaluated or corrected
- equipment erosion / corrosion
- failed within expected lifetime

If other equipment related factors were involved as causal factor, they should be specified in the full text of the report.

### 5.7.1 Design configuration and analysis

Includes the following causal factors:

- original design inadequate
- design documentation / prints inadequate
- design analysis deficiency
- component / material selection inadequate
- unauthorised or unreviewed modification
- inadequate review of design changes

- field walkthrough input to design inadequate
- historical design does not meet current requirements
- inappropriate reliance on human action
- deficiency in engineering of modification

### 5.7.2 Equipment specification, manufacture and construction

Includes the following causal factors:

- material used inadequate
- manufacturer fabrication / construction inadequate
- specifications provided to manufacturer inadequate
- substitute parts / material used do not meet specifications
- lack of proper tools / materials used during installation
- installation workmanship inadequate
- QA requirements not used or met during procurement process
- equipment installed does not meet all codes / requirements
- post procurement requirements not used / performed

### 5.7.3 Maintenance, testing or surveillance

Includes the following causal factors:

- corrective maintenance did not correct problems
- other problems noted during the performance of maintenance / testing not corrected
- preventive maintenance inadequate
- maintenance performed incorrectly
- testing not performed as required
- post-maintenance testing inadequate
- post-modification testing inadequate
- retest requirements not specified
- retest delayed

- test acceptance criteria inadequate
- test results review inadequate
- surveillance schedule not followed
- situational surveillance not performed
- required surveillance / test not scheduled
- incorrect parts / consumables installed / used
- failure to exclude foreign material
- incorrect restoration of plant following maintenance / isolation / testing

## 8. NATURE OF FAILURE OR ERROR

In treating this field, “failure” means physical impairment and / or unavailability of plant equipment, where “error” means human error or inadequate human action.

### 8.2 Multiple failure or multiple error

#### 8.2.1 Independent multiple failures or errors

This code should be used if within one event two or more occurrences (failures, errors) took place with different causes and where one occurrence is not a (logical or technical) consequence of another one.

#### 8.2.2 Dependent multiple failures or errors

This code should be used if within one event two or more occurrences (failures, errors) took place with different causes but where one occurrence is a consequence of another occurrence. Examples are:

- shared equipment dependencies, where one system is a support system for other systems,
- functional dependencies, where the function of one system depends on the function of another system, and
- physical interaction dependencies, where environmental effects caused by a failure (e.g. flooding after pipe break) results in failing of other equipment.

Common cause failures i.e. two or more identical or similar components fail due to the same cause should be coded in 8.3.

### 8.2.3 Recurrent failure or error

This code should be used if the same or a similar failure occurred due to the same cause in more than one event in the same plant or in different plants.

### 8.3 Common cause failure

Two or more “failures” that are the result of the same (single) cause occurred.

## 9. NATURE OF RECOVERY ACTIONS

### 9.1 Recovery by human action

Human recovery actions are effective actions taken by plant staff in response to equipment failures, inadequate human actions and plant transients in order to terminate the event.

### 9.1.1 Recovery by foreseen human actions

Foreseen human recovery actions means recovery actions taken by plant staff, which are directed by operating procedures (planned surveillance, transient response procedures, etc.)

### 9.1.2 Recovery by unforeseen human actions

Unforeseen human recovery actions are recovery actions taken by plant staff in response to observed failures, errors, transients, etc., which are not prescribed / directed by operating procedures or documents.

## V. REFERENCES

[1] IAEA Safety Series No. 93 “Systems for Reporting Unusual Events in Nuclear Power Plants”

[2] Guidelines for the NEA Incident reporting System (working document No.12 of 21.6.88)

[3] IAEA-J4-CS-101/94 "Reporting human-dominated occurrences in NPP events to the IAEA reporting system"

[4] IAEA-J4-CS-161/95 "The better reporting of causes (including human performance) and learning points for events reported to the IAEA incident reporting system"

[5] Draft Appendix on Human Factors Information for future revision of NUREG 1022

[6] Draft Operational Feedback Codes document prepared by UK Operational Experience Feedback Engineers' Trend and Pattern Working Group