



EVENT INVESTIGATION

Darko Korošec, dipl. ing.
Slovenian Nuclear Safety Administration
Vojkova 59, 1113 Ljubljana, Slovenia

Abstract

The events in the nuclear industry are investigated from the license point of view and from the regulatory side too. It is well known the importance of the event investigation. One of the main goals of such investigation is to prevent the circumstances leading to the event and the consequences of the event. The protection of the nuclear workers against nuclear hazard, and the protection of general public against dangerous effects of an event could be achieved by systematic approach to the event investigation. Both, the nuclear safety regulatory body and the licensee shall ensure that operational significant events are investigated in a systematic and technically sound manner to gather information pertaining to the probable causes of the event. One of the results should be appropriate feedback regarding the lessons of the experience to the regulatory body, nuclear industry and general public.

In the present paper a general description of systematic approach to the event investigation is presented. The systematic approach to the event investigation works best where cooperation is present among the different divisions of the nuclear facility or regulatory body. By involving management and supervisors the safety office can usually improve their efforts in the whole process. The end result shall be a program which serves to prevent events and reduce the time and efforts solving the root cause which initiated each event. Selection of the proper method for the investigation and an adequate review of the findings and conclusions lead to the higher level of the overall nuclear safety.

1. Introduction

General nuclear safety should be defined in such manner that individuals, society and environment have to be protected by establishing and maintaining in nuclear power plants an effective defence against radiological hazard.

Nuclear safety important event should be defined as any event, that leads or could lead to the potential radiological hazard for individuals, society or environment; or could lead to the situation, that could cause it.

Legislative basis [1] have established general rules, in prescriptive manner, how to achieve this goal. Defence in depth is usually described as the combination of:

- conservative design
- appropriate surveillance of systems, structures and components
- mitigation measures
- safety culture that strengthen the successive protection measures against nuclear significant events.

The nuclear safety events in the nuclear industry are investigated from the license point of view and from the regulatory side too.

All nuclear safety important events shall be:

- identified through appropriate systematic investigation
- assessed with appropriate methods
- systematic root cause analyze shall be made
- appropriate corrective actions and measures shall be taken

All above mentioned actions shall be reported to the nuclear safety regulatory administration in the time frame and with the content, as it is prescribed in legislation. Recently issued guidelines [2] describe into detail criteria for the reporting of the events, also in the form of so called "Licensee Event Report". There is a lot of clarification, what sort of events shall be reported to the regulatory body and in what time frame. Generally, the relaxation about event nature, which has to be reported is made and the time period for reporting was prolonged. The inspectors for radiological and nuclear safety have the possibility to investigate into more details facts and circumstances leading to the event, as well as reviewing the findings and conclusions.

In all states with commercial nuclear energy program specific safety regimes, conventions and treaties are established. Detailed safety recommendations for different areas of managing nuclear energy are developed, issued in various safety publications, safety services and information systems, like PRIS ("Power Reactor Information System"), IRS ("Incident Investigation System") and INES ("Incident reporting System") [4]. All these bases should be treated as a basis of information and rules, entering the systematic investigation action.

2. The event investigation process

It ensures, that safety significant events are investigated in a systematic and technically sound manner to gather information related to the probable causes of the events. The investigation should provide appropriate feedback regarding the experience obtained.

The overall goals of the event investigation process are:

- to promote the public safety by reducing the potential for severe accidents
- to assure complete understanding of the technical and regulatory issues, related to the event

The simplified flow chart of the investigation process is shown on Figure 1.

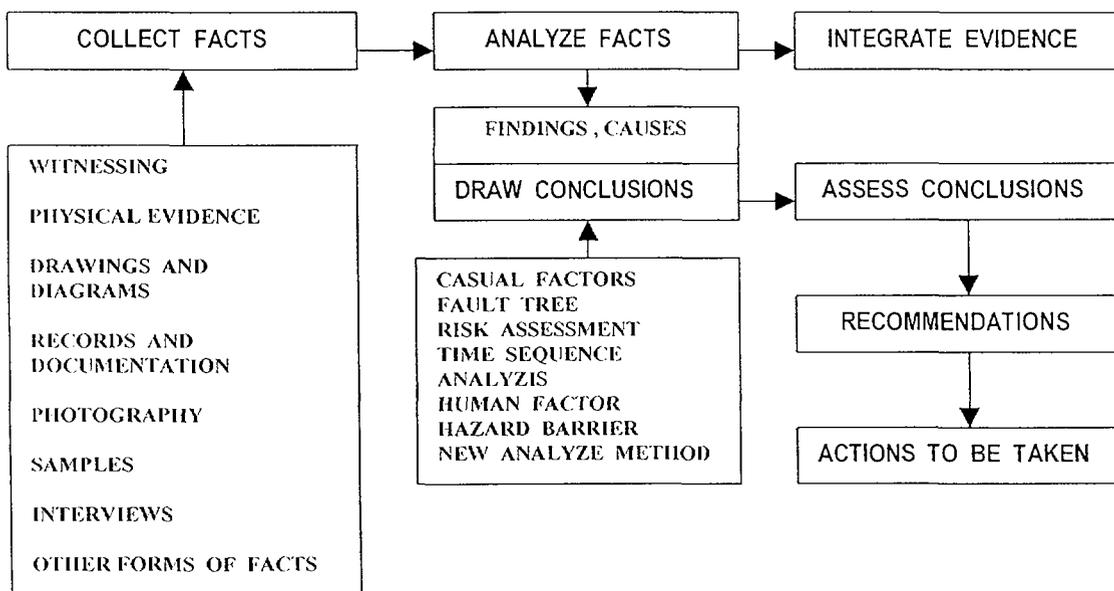


Figure 1

Usually, the investigation team has such above described investigation process structured

more in details. However, the nuclear world has developed several specific guidelines and procedures, how to investigate safety significant events. For the root cause determination special techniques and methods are developed and could be treated as an integral part of the overall event investigation.

3. Systematic approach

Systematic approach means a full set of organizational and other measures that ensures efficiency of the investigation. Typical steps in such process are well developed [3]:

- *initiation of the investigation*: reaction on event information, team staff members selection
- *conduct investigation*: plan of the investigation, managing different planned phases of investigation
- *investigative questions and different phases relationship*: selected, to the investigation goal oriented questions, to recognize the relation between different phases of the event
- *investigation activities flow chart*: systematic hierarchy of planned activities
- *proper managing of the investigation*: managing of the investigation in a effective way
- *collection of the information*: selection the amount of information, determination of importance
- *experts involvement*: in special cases and early enough
- *evidence sources and forms of fragility*: list the evidence of material and weaknesses determination
- *physical evidence tagging*: in special cases, when necessary and appropriate
- *sketch of significant locations*: useful when more locations were involved
- *photographic log sheet*: necessary when reconstruction of the event is more complex

4. Facts analysis

The basic questions asked before fact analysis, related to the event are: *who* was involved into event, *what* happened (the level of significance), *when* happened and *where* happened. With the help of partial or full answers on these questions obtained on the systematic way described in chapter 3., the analysis can start.

With all information related to the event collected, careful and complete analysis can start, to determine the potential causes of the event. During the analysis phase of the investigation the combined knowledge shall be fully utilized and also the experience from all members of the investigation team and if necessary, experts opinion.

Analysis is an ongoing process, with multiple iterative cycles, specially, when clear results are not obtained in early phase yet.

Analyzing facts, following methods should be used [3]:

- casual factors analysis
- fault tree analysis
- different type of analysis
- human error analysis
- energy barrier analysis
- MORT (“Management Oversight and Risk Tree”) analysis in case of complex event
- other specially case specific methods

Between analyzed fact the investigation team shall find the correlation, which can be multiple, complimentary or cross validated. The use of logic symbols during the analysis phase is strongly recommended due to the fact of transparency.

5. Review of the findings

After collection of all findings the systematic review is necessary. As a result the investigation report in concise form of reporting shall be issued. The usual parts of such report are: summary, facts of the investigation, conclusions and recommendations with short description of actions to be taken.

Special care shall be taken during the process of findings review to avoid misleading conclusions and even actions. Evidence sources shall be separately reviewed in the manner, what was the evidence source (human, physical, procedural) and what was its form of fragility. Time frame of the event with emphasis on action time of personnel and equipment should be treated separately to obtain information about unusual discrepancy. It is essential that the investigators deep as possible investigate the event and assess the circumstances and conditions creating the event. Effectiveness of the findings review is shown, for example, with determination of existence of contributing causative factors, like energy conditions, failed barriers, systematic errors or misleading conclusions.

Final goal is to arrive at the causes of an event and to establish appropriate remedial measures.

6. Conclusions

Slovenian Nuclear Safety Administration (SNSA) inspection division is often involved into event investigation. During regular inspections, SNSA inspectors have to act as inspection team on the way, described in present article. All phases of the investigation are not executed in described broad scope, but inspection division effort regarding safety significant events investigation in the described manner will be more efficient. Experience gained during past years are good bases for future improvement of inspection division work. Detailed investigation of the events, like steam generator leakage, main steam isolation valve failure, different instrumentation related events etc. showed, that more intensive and systematic approach to the event evaluation is needed. Experts opinion often clarifies findings. Additional training, specially related to the described systematic approach is planned in SNSA. Cooperation with nuclear power plant internal evaluation and assessment groups is necessary, but independent investigation is required from regulatory point of view. The result are presented to the power plant management and are the basis for future enforcement actions. Experience showed, that mainly nuclear power plant personnel arrest the investigation of the events on a certain level, due to the lack of personnel or available time lack. It is often worthwhile to spent more time on the event investigation due to the reason that more detailed investigation generally leads to the conclusions, which could prevent future similar events or to prevent other ones.

The use of accessible event data bases could lead to more intensive investigation and this speed up the whole process of investigation but is not enough. By the investigation team developed analytical approach, specific for each case and investigation prepared with the general tools and methods described above, will result in usable results.

Selection of the proper method for the investigation and an adequate review of the findings and conclusions lead to the higher level of the overall nuclear safety.

7. References

- [1] Zakon o varstvu pred ionizirajočimi sevanji in o posebnih varnostnih ukrepih pri uporabi jedrske energije, Uradni list SFRJ 62/84
- [2] Event Reporting Guidelines, 10 CFR 50.72 and 50.73, Rev.2, Code of Federal Register, USA, 1999
- [3] Model Mishap Investigation Manual, Conger&Elsea, Inc., 1996
- [4] Seminar on prevention of Incidents, IAEA, Ljubljana, 1994