Use of IRS and OSMIR Database – Lessons Learned

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Abstract

The design of reactors either Generation III e.g. operational ABWRs [1] or Generation IV takes into account experiences gained by operators. Altogether around 7000 years of reactor operational experiences are available today. In order to exchange operational experiences a few international databases were established, as a rule more than a decade ago, e.g. ISOE, Incident Reporting System (IRS) and OSART Mission Results (OSMIR). Operators, nuclear safety regulatory bodies, suppliers, designers and others are users of such databases which enable the users to study specific plant systems e.g. control of radioactive fluids or consequences of events e.g. exposures.

Radiation monitoring systems in NPPs enable control of dose rates and releases on or off site. Required characteristics of monitoring systems are described in licensing or related documentation. In the last decades an extensive evolution of monitoring systems took place [2]. Around 300 events related to PWRs from 1999 -2009 are described in the IRS, among them around 20% are related to the radiation monitoring system. The analyses of events from the IRS where leakage of radioactive materials occurred on or off site reveal that only in one case the design of radiation monitoring systems of effluent was one of the route causes. But analyses also reveal that lessons learned are still not fully taken into account. The analysis of OSMIR database shows that recommendations related to improvement of radiation monitoring systems were given to four NPPs in the period 1997-2007.

It is shown that both databases can be successfully used as complementary databases to the ISODAT global occupational exposure database prepared by the participants of the ISOE programme.

1. Introduction

In the foreseen inclusion of a use of nuclear energy in national plans for energy supply in many countries, as for example presented in [1], studies of operating experiences are very important. Such studies are equally important to countries with nuclear energy already introduced as well as for countries which are going to introduce it. Operating experiences which are primarily studied by operators are also analysed by nuclear safety regulatory bodies, suppliers, nuclear waste companies, qualified experts, decision makers as well as by other stakeholders. In addition, designers of reactors either *Generation III* e.g. operational ABWRs [1] or *Generation IV* take into account experiences gained by operators.

A study of operating experiences conducted by the operation is given in international recommendations or requirements [3, 4]. For example the IAEA states in the paragraph 2.22 given in [3] that operating organization "shall obtain and evaluate information on operating experience at other plants to derive lessons for its own operations". The study of operating experiences is usually required by national legislation as for example by implementing Article 19 of the *Convention on Nuclear Safety* [5], which explicitly tackles programmes to collect and analyse operating experiences. Furthermore, the cooperation between different parties involved in safe operation of a nuclear installation is required e.g. operators, manufacturer, research organizations, designers. Such strong commitment requires suitable tools in order to enable an analysis of operating experiences and to properly distribute lessons to be learned. Among others international databases of events in nuclear installations are such tools.

2. Databases related to events in NPPs

The IAEA together with other international organisations e.g. OECD established a few databases related to:

- events connected to nuclear installations or to nuclear technology in general
- expert reports connected to expert visits of nuclear installations.

In addition, some national regulators also published lessons learned, e.g. Nuclear Regulatory Commission publishes “reports on regulatory decisions, results of research, results of incident investigations, and other technical and administrative information« [6]. Furthermore, some databases could also include lessons learned based on the events in nuclear installations, but they are not available to regulatory authorities e.g. database ISOE 2 within *Information System on Occupational Exposure* [7], lessons learned collected by the World Association of Nuclear Operators - WANO [8].

Present-day systems mentioned above were established already decades ago and went through a few development phases including a growth in membership of contributing organizations as well as a growth related to efficient reporting and dissemination procedures.

Regarding nuclear power plants (NPPs) three international databases are widely used by regulators, namely:

- Incident Reporting System - IRS [9, 10]
- Operational Safety Review Team Mission Results (OSMIR) [11]
- International Nuclear and Radiological Event Scale (INES) [12].

Other databases also exist, for example European Nuclear Assistance Consortium (ENAC) can be used in emergency situations.

2.1. IRS

The IRS database contains information on event reports related to unusual events considered important for safety events in NPPs. The information reported is assessed and analysed by the reporting country. Furthermore database is fed back to participating countries to prevent similar occurrences at other plants. The ultimate objective is reducing the frequency as well as severity of safety significant unusual events at NPPs. As such the IRS database represents a systematic approach to provide feedback on lessons learned. The database is based on the initiative of the OECD/NEA from 1978 already and is today operated by the IAEA. The IRS is designed to be used by technical experts and the access to the database is restricted. Today more than 3500 reports exist within the system. The system enables identification of events using many options e.g. countries, date of an event. In addition, nine *categories* regarding specification of an event are built in the IRS system, e.g. reporting categories, plant status prior an event, failed/affected systems, failed/affected/components, cause of events. Each *category* is refined with *subcategory* as for example within the *category* “effect on operation” ten s*ubcategories* are defined:

- unidentified or no significant effect on operation
- reactor scram
- controlled shutdown
- load reduction
- activation of engineered safety features
- challenge to safety or relief valve
- unanticipated or significant release of radiation
- unplanned or significant radiation exposure
- personnel or public injuries
- outage extension.

In addition, the IAEA in cooperation with experts prepare comprehensive topical studies based on the reported events, for example in 2008 it published the *Analysis of Events Related to Interaction between the Grid and the Nuclear Power Plants* and in 2007 the *Maintenance Events involving Quality Assurance, Human Factors and Procedural Issues*. A few other types of documents are prepared within IRS, namely highlights for a specific period of time. For example in 2009 the IAEA published the *Highlights from Incident Reporting System (IRS) for Events in 2006-2007*. Figure 1 shows the main page of the IRS database.

Figure 1 Main page of the IRS database.

2.2. OSMIR

An IAEA mission programme, the Operational Safety Review Team (OSART), was created in 1982 in order to advice and to assist the Member States to enhance the operational safety of NPPs. Within the programme teams of experts conduct in-depth reviews of operational safety performance at an NPP. The OSMIR database is a compilation of three types of reports from the IAEA mission reports, namely:

- recommendations
- suggestions
- good practices.

The compilation is accessible through the IAEA. It is provided on a CD using *MS Access*. The database is well structured using ten so-called *review areas*, namely:

a) management
b) training
c) operation
d) maintenance
e) technical support
f) operational experience feedback
g) radiation protection
h) chemistry
i) emergency planning
j) commissioning.

Each *review area* is further structured using specific *topics*, e.g. a *review area* “training” contains 12 *topics*, among them policy and organisation, radiation protection personnel, general employee training, training programmes for control room operators and shift supervisors etc. The database contains effective search system through the text which enables analysis of the performance of NPP operators. Till 2009 around 100 OSART missions and follow up missions have been conducted. Figure 2 shows the main page of the OSMIR database.

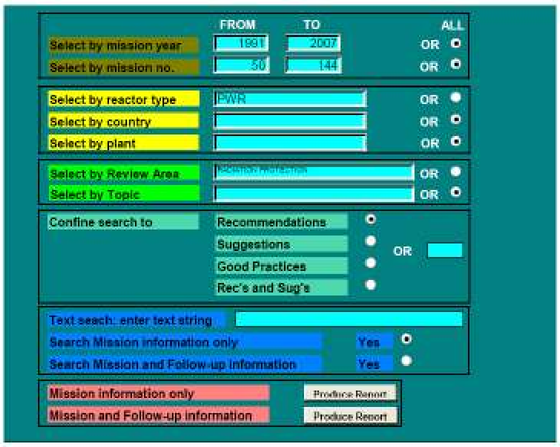

Figure 2 Main page of the OSMIR database.

2.3. INES

The INES was established in 1989. It was designed jointly by the IAEA and OECD/NEA experts. It is a tool for promptly communicating to the public safety significance regarding incidents and accidents in NPPs as well as the significance of all events associated with transport, storage and use of radio-active material and radiation sources. Today a description of events reported can be assessed by using a Nuclear Events Web-based System (NEWS).

3. Radiation monitoring systems in NPPs and databases

One of the most challenging issues concerning the siting of a new NPP is control of effluents in all life phases of an NPP. Not only designers but also investors, regulatory authorities as well as general public and international community, especially neighbouring countries, are interested in different aspects of the control of effluents. The subject is even more discussed during the operation of a facility or even during decommissioning procedures than during the siting.

Radiation monitoring systems in NPPs enable control of dose rates and releases on or off site. Required characteristics of monitoring systems are described in licensing or related documentation. In the last decades an extensive evolution of monitoring systems took place as given for example in [2]. Control of effluents is very often related to control of radioactive materials including radioactive waste at a site or even to a transfer of radioactive waste from site to storage. Even more, the above-mentioned issues are sometimes related to control of occupational exposure. As a result when assessing a specific event in an NPP all the above-mentioned issues should be studied simultaneously in order to properly identify the shortcomings or good practices in an NPP. All these issues are closely related to the technical specification of a plant.

3.1. IRS database and radiation monitoring systems

The IRS database contains around 1700 reports related to PWR NPPs, among them around 300 events occurred in the period 1999 - 2009 and around 160 in the period 2004-2009, namely from 01.01.2004 - 01.01.2009. When applying the IRS it should be taken into account that the IRS database is based on a voluntary base. Participants decide by themselves about making an analysis of an event occurred in an NPP in their country regarding IRS criteria as well as to send a report to the IRS.

The focus of the analyses is based on reported events which required monitoring possible or actual unintentional release of radioactive materials inside or outside NPPs taking into account the event in Paks 2 NPP which occurred in 2003 (http://paksnuclearpowerplant.com). In addition, the emphasis is given to events, where radiation monitoring systems were not designed or used correctly as well as to the events, where radiation monitoring systems demonstrated their importance in improvement of operational performances including safety of an NPP.

Among around 160 events mentioned above only eight are related to the *subcategory* "1.1 Unanticipated release of radioactive material or exposure", which is one of eight possible *subcategories* within "1 Reporting category". The IRS database enables the users to refine subcategories. Within the mentioned *subcategory* three possibilities exist:

- unanticipated release of radioactive material
- exposure to radiation that exceeds the prescribed dose limits for a member of the public
- unanticipated exposure to radiation for site personnel.

Analysing data of incidents which occurred in the period 2004 – 2009 and are reported within "1.1 Unanticipated release of radioactive material or exposure" a vast majority of the events are related to unanticipated release of radioactive material, namely seven events. One event is related to unanticipated exposure to radiation for site personnel and as a result no event is related to exposure to radiation that exceeds the prescribed dose limits for a member of the public.

a. unanticipated exposure to radiation for site personnel
A single reported event related to exposure of personnel occurred in Fessenheim 1 NPP, France, in January 2004. Resin release from the demineralizer into the primary circuit of the NPP caused substantial contamination leading to a hot shutdown state of the NPP at the first place and later to start the outage nearly one month earlier as planned. In addition, the NPP was shut down for more than five months. The internal exposure of one person was identified, namely a dose of 0.5 mSv, while the measured data for six other persons were below the recording threshold. Later on the internal exposures identified in 5 persons were not related unambiguously to the event. In addition to the exposures mentioned, the existence of hot spots was also identified, among others also in the auxiliary building. It can be concluded that control of internal exposure is still a challenging issue especially in cases of incidents with a relatively large scale consequences.

b. unanticipated release of radioactive material
Within unanticipated release of radioactive material group all seven events reported could be actually grouped into few groups.

- Two events are related to degradation mode of U-bend tubes of SGs and primary/secondary system leak which was identified in Cruas 4 NPP in 2006 and Fessenheim 1 NPP in 2008, both France. The N-16 monitors of secondary coolant detected a leak. The degradations discovered led to a "release of steam to the atmosphere" as reported in the IRS report of the event in Cruas 4 NPP and to "slightly tritiated steam" to the atmosphere as given in the IRS report of the event in Fessenheim 1 NPP. No trace of radioisotopes released in the environment was found. The reporters also stressed that the operators in France studied the North Anna NPP incident which had occurred in 1987 and installed appropriate N-16 monitors.
- Two events reported are related to leakages in NPPs in Japan, namely in 2005 leakage of radioactive material was discovered at Mihama 1 NPP, and in Takahama 3 NPP in 2006. As a result no radiological impact to the environment existed.
- One event relates to unauthorised discharge of tritium into the environment, namely in 2007 at Temelin 1 NPP, Czech Republic, "water containing tritium was discharged through pathways which are not authorised in rulings on the discharge of radionuclides into the environment". The direct cause of the event was a faulty and insufficient administered decision taken two days before the NPP start up at the end of the shutdown period. The industrial sewage system which was used in the discharge did not show absolute tightness due to the fact that it was not designed to be in contact with radioactive medium. As a result also tritium release was identified in the environment.
- One event is related to a cleaning procedure provided by the subcontractor, namely cleaning of the SG 1 at the Borssele NPP, the Netherlands, in 2004. The release from PORV was identified right during the cleaning procedure. Excessive foaming was observed. The deposits at a site were "very slightly radioactive" as reported in the IRS report. A route cause analysis reported is related to the design as well as to the design verification of the cleaning procedure.

- One event is directly related to inadequate design of a radiation monitoring system of effluents in the NPP, namely the incident reported in 2008 which occurred in the Asco 1 NPP, Spain. The incident is related to a cleaning up operation on the fuel transfer channel at the end of the outage in November 2007. Due to many deficiencies radioactive liquid waste contaminated a fuel building ventilation system. Radioactive contamination on the site was found after a few months and radioactive particles were found inside as well as outside the NPP. More than 2500 individuals were monitored in order to find the internal contamination. As reported measurements did not show contamination but the analysis of doses is still taking place. One of the root causes was inadequate designs of two radiation monitors related to ventilation systems.

The issues reported show that lessons learned given in the IRS database were very successfully applied in some cases. In general if the lessons learned are related to technical solutions, as for example the installation of radiation monitors, operators can quite soon find the benefit of such a lessons learned database. It cases where lessons learned feedback is related to organisational and administrative issues the benefits are usually not visible so soon.

Regarding the analysis given above it should be also taken into account that they were performed using a specific *category* within the IRS database. It should be noticed that also in the *category* "6. Effect on operation" and the *subcategory* "Unanticipated or significant release of radioactive materials" two additional events occurred in the period 2004-2009, namely in 2004 at Tihange 1 NPP, Belgium, and in 2007 at Mochovce 1 NPP, Slovakia. Both events are related to the release mentioned only inside the corresponding plants and consequently they were not included in the study.

3.2. OSMIR database and radiation monitoring systems

The OSMIR database contains recommendations, suggestions and good practices in seven *topics* within the scope of radiation protection *review area*, namely:

a) organisation and functions
b) radiation work control
c) control of occupational exposures
d) radiation protection instrumentation, protective clothing and facilities
e) radioactive waste management and discharges
f) radiation protection support during emergency
g) personal dosimetry.

Recommendations are based on findings which require corrective actions while suggestions are related to minor improvements of radiation protection.

The analysis of data provided from 1997 to 2007 in the OSMIR database shows that 43 recommendations to PWR NPPs were issued in the area of radiation protection. The recommendations are related to missions conducted at altogether 20 NPPs. Figure 3 presents the distribution of the number of recommendations related to specific *topics*. The majority of recommendations are issued within "radiation work control" *review area*, namely 44% of all recommendations are issued in this area. Altogether "control of occupational exposures" was subject to 21% of all recommendations , "organisation and functions" to 14% and "radiation protection instrumentation, protective clothing and facilities" only to 12% . Other *topics* received only a few recommendations, none was issued to the topic "radiation protection support during emergency". Nevertheless, two suggestions were given to this *topic*. It can be concluded that experts identified more than 60% of all shortcomings in everyday radiation work and control of occupational exposure.

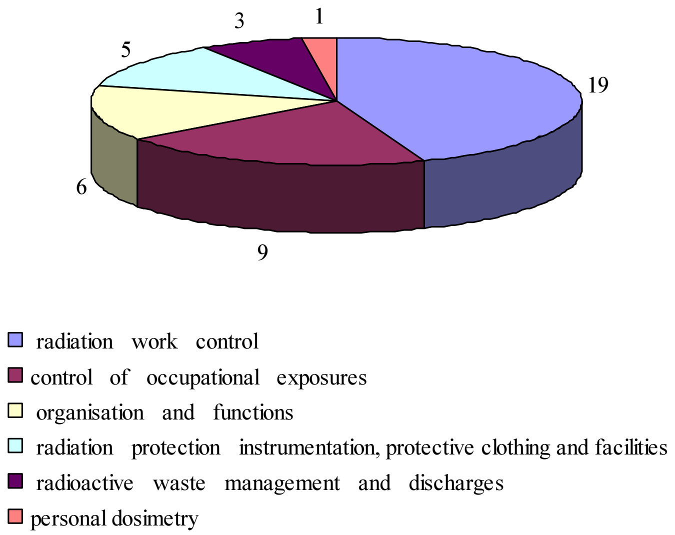

Figure 3 Distribution of the number of recommendations in the period 1997 - 2007 related to specific topics within *radiation protection* review area taken from the OSMIR database and issued to PWR NPPs.

Regarding the *topic* “radiation protection instrumentation” only five recommendations to four NPPs were issued. The recommendations can be grouped into three main topics, namely:

- establishment of an adequate system for appropriate routine calibration and surveillance of radiation instruments
- establishment of an adequate system regarding maintenance of radiation instruments
- upgrading the number and types of monitoring equipment used in normal situation and emergency situation as appropriate.

In addition, one recommendation is related to upgrading dose calculation software and to participation in national and international exercises.

5. Conclusions

The operating experience databases are one of the main tools which enable the improvement of nuclear installations safety. Such databases are maintained at NPPs [13] as well as at the international levels. In addition, as given in [14] a regulatory body must have its own operating experience programme and a capability for assessing “the full scope of operating experience issues”, e.g. new research results, broad industry trend information. The international operational experiences database related to events in NPPs, the IRS, as well as the OSMIR database based on the IAEA expert missions can be successfully used as complementary databases to the ISODAT *global occupational exposure database* prepared by the participants of the ISOE programme.

In the light of renaissance of nuclear technology and taking into account a change of generation at present NPPs as well as long life of future NPPs, i.e. around 60 years, the importance of maintaining a high quality of databases containing operating experiences is even more important.

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