Focus on safety: The FIRE Project

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In 2002, a group of OECD/NEA member countries established the OECD Fire Incident Records Exchange Project (OECD FIRE) to encourage multilateral co-operation in the collection and analysis of data relating to fire events at nuclear power plants. This article presents the OECD Fire Project objectives, work scope and current status, as well as preliminary insights gleaned from the data collected.

Fire hazard analyses (FHAs) and probabilistic safety analyses (PSAs) have shown that fire may be an important contributor to core damage and plant damage states, especially for older nuclear power plants (NPPs). However, realistic modelling of fire scenarios is difficult due to the scarcity of reliable data for fire analysis.

In an attempt to improve the situation, the NEA Committee on the Safety of Nuclear Installations (CSNI) established a task group to review the status and maturity of methods used in fire risk assessment for operating nuclear power plants. The task group issued a questionnaire in May 1997 to all OECD/NEA countries in which nuclear power was being generated. The summary report[1] of this activity was published in March 2000. One of its concluding remarks was as follows: "The shortage of fire analysis data is one of the major deficiencies in present fire risk assessment. In order to facilitate the situation, it would be highly important to establish an international fire analysis data bank, similar to that set up by the OECD for the CCF data collection and processing system... Such a data bank would provide fire event data on real fire cases, pilot fires (smoldering, etc.) detected/extinguished before development, dangerous or threatening situations, reliability data on fire protection measures, and the unavailability of fire fighting systems, for example, due to component failures or operational errors."

Based on the above concluding remarks, several OECD/NEA member countries agreed to establish the International Fire Incident Records Exchange Project (OECD FIRE). Nine countries have signed the project agreement (Czech Republic, Finland, France, Germany, Japan, Spain, Sweden, Switzerland and the United States). As a result, organisations producing or regulating more than 80% of nuclear energy generation worldwide will contribute data to the OECD FIRE Project, which was formally launched in January 2003.

Objectives of the OECD FIRE Project

The objectives of the OECD FIRE Project include the establishment of a framework for multinational co-operation in fire data collection and analysis. Initially started as a three-year programme (2003-2005), and recently renewed for another three-year mandate, the primary activities of the OECD FIRE Project are to:

- Define a format for collecting fire event experience in a quality-assured and consistent database.
- Collect and analyse fire events over the long term so as to better understand such events, their causes and their prevention.
- Generate qualitative insights into the root causes of fire events, which can then be

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used to derive approaches or mechanisms for their prevention or for mitigating their consequences.

- Establish a mechanism for the efficient feedback of experience gained in connection with fire events including the development of defences against their occurrence, such as indicators for risk-based inspections.
- Record event attributes to facilitate quantification of fire frequencies and fire risk analysis.

The database is planned to be used:

- To support model development, validation and related activities.
- To identify all types of events for inclusion in PSA models to ensure that all mechanisms have been taken into account.
- To evaluate fire occurrence frequencies.

With emphasis on data validity and data quality, an OECD FIRE coding format[2,3] has been developed for collecting and classifying fire event data to ensure consistent interpretations and applications.

Scope of the OECD FIRE database

The OECD FIRE Project exchanges fire data from commercial nuclear power plants only, but covers all operating modes (including construction and decommissioning phases).

The following criteria have been established for the inclusion of data:

- All fires with a visible open flame (by observation or by consequence) extinguished by manual or automatic measures shall be included if possible.
- Self-extinguished fires are to be included if they have caused significant damage. If the self-extinguished fire affected only one component, the event can be excluded.
- Explosions not resulting in an open flame are not within the scope of the database.

One challenge in setting up an international database is to ensure a consistent reporting level between countries in order to capture all events fulfilling the objectives of the project. Regulatory bodies' and utilities' reporting levels vary between member countries (e.g., absence or presence of an affect on safety equipment, different duration thresholds, etc.), and, in addition, these levels may have evolved over time. For events prior to 2003, the database includes for reference the evolution of reporting levels over time. For events post-2003, one objective of the first phase has been to define a project reporting level, which would account for the countries' policies while correctly addressing the technical objectives of the project.

Currently, the database contains 120 fire events, most of them quality-assured. The events date from the early 1980s to 2004, with the bulk of the events situated between the mid-1990s and 2004. Although the reporting of events is not exhaustive, the database provides a good platform from which to begin analysis. It is expected that 40 to 50 events will continue to be reported per year. In the table below, estimates are provided of the number of fire events theoretically available to the project. The figures represent the number of fires expected per year in operating reactors in OECD FIRE Project member countries (260 reactors).

The table presents the estimated number of fires for power operation mode and non-power operation mode. During power operation mode it can be expected that approximately 5 out of 30 fires will result in reactor shutdown. A total of 12 out of the 30 fires are expected to require fire brigade intervention. It can also be understood that the relative frequency of fires during non-power operation is much higher than during power operation.

The OECD FIRE database structure

The OECD FIRE event is described by the narrative event description and a number of description fields with attributes to be selected from predefined menus. The source of information is normally the narrative event description; the entries in the description

Estimated numbers of fire events per year

Power operation	
Events resulting in reactor shutdown	5/y
Events requiring fire brigade intervention	12/y
All events	30/y
Non-power operation	
Events requiring fire brigade intervention	8/y
All events	16/y

fields are derived from the narrative event description. Coding can also be based on documented references.

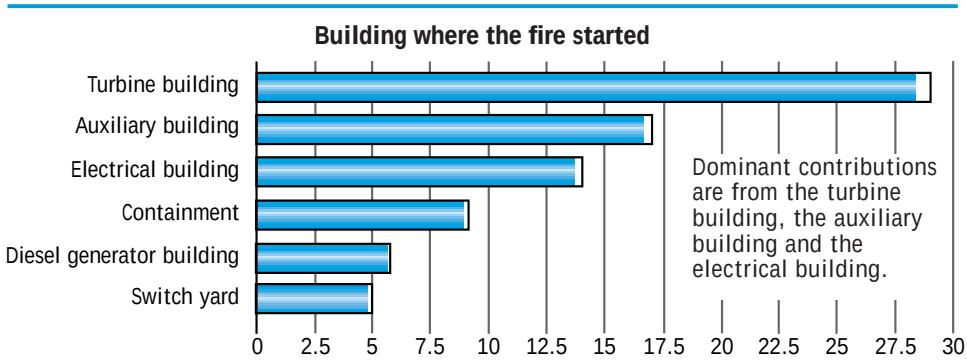
The classifications of the fire event through coded attributes provide the possibility to search for and identify specific fire events of interest in the OECD FIRE database for a wide range of applications. The bulk of the information requested in the narratives is compulsory information. However, there is also optional information, such as the amount of fire load, which is time-consuming to collect. This type of information is marked as "if available". This information can be collected at a later stage, if necessary, for a limited number of events.

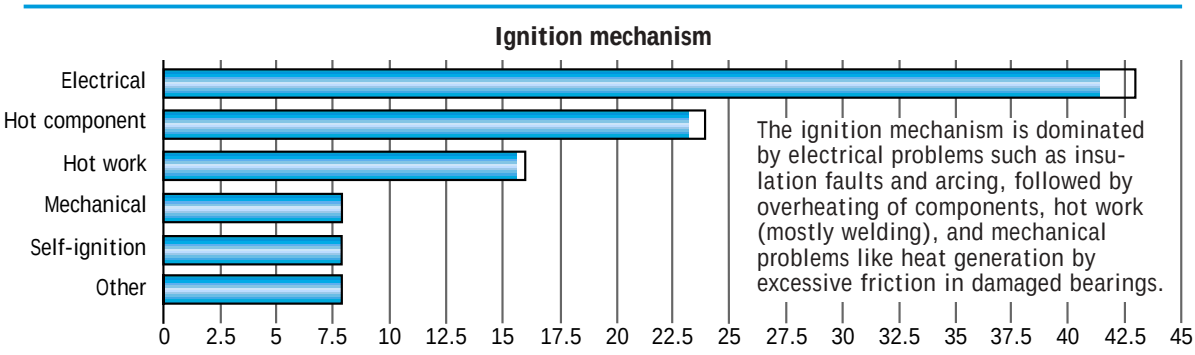
The database is divided into the following major parts:

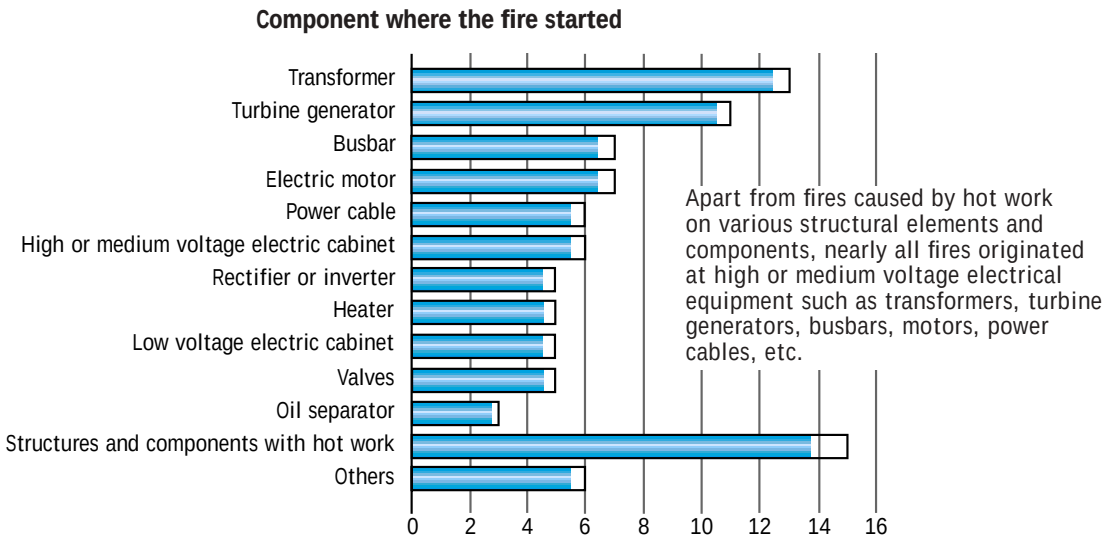
1. *Narrative event description*: The narratives begin with a short description or title of the event, followed by a detailed factual description of the fire event, including relevant circumstances.
2. *Sequence of events*: This narrative is a structured record of the event in the form of a bullet list with the time and description of the event. The reader should be able to understand how the event developed over time.
3. *Ignition phase*: This describes (by use of codes) the initial course of the fire, including items such as location of the fire, type of detection, fire loads, ignition mechanism and root cause.
4. *Extinguishing phase*: This section describes (by use of codes) the course of the event after the fire alarm was triggered (type of extinguishing equipment used, who extinguished the fire).
5. *Consequences*: The heat and smoke influence on plant operation and systems are described (by use of codes). Secondary effects and corrective actions are included.
6. *References*: These include the references used, and where to find more information on the specific fire event.

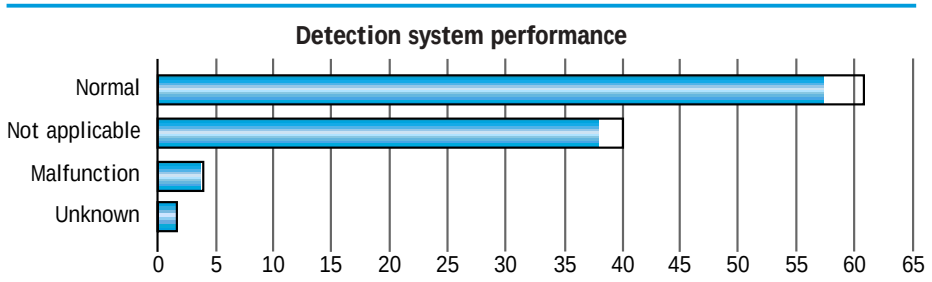
Statistical observations

A selection of basic statistical information on fire-relevant issues is presented below. On the ordinate of each chart are listed the attributes that turned out to be important for the issue considered. The number of occurrences of the selected attributes are shown on the abscissa. The statistics presented are not exhaustive; i.e. only significant contributors to the various issues are displayed.









The “Not applicable” reporting frequency is relatively high. This results mainly from situations of fires detected early and subsequently extinguished quickly by plant personnel available in the fire area, and fires at locations without detectors, for example outside buildings. Excluding the "Not applicable" cases, the detection systems are considered to have performed normally in almost all real-demand situations.

Conclusions

The number of collected reports is still too small to make corroborated statistical inferences. However, some general observations can already be made:

- Most of the fires originated at electrical equipment. The share of fires caused by hot work is also significant.
- Detection systems functioned as designed in almost all real-demand situations.
- More than 80% of the fires were successfully dealt with by manual fire fighting or by a combination of manual fire fighting and fixed system actions. The remaining ones were self-extinguished.
- No complete malfunction of fire extinguishing systems was reported. However, cases have been reported where several means of fire fighting had to be used before success was achieved.
- Few cases were reported which required the involvement of the external fire brigade to extinguish the fire.
- 14% of the events led to plant shutdown.

References

1. NEA/CSNI/R(99)27, *Fire risk analysis, fire simulation, fire spreading and impact of smoke and heat on instrumentation electronics*, 10 March 2000.
2. OECD FIRE Report PR05, *OECD FIRE Quality Assurance Program*, Final report 2003-04-28.
3. OECD FIRE Report PR02, *OECD FIRE General Coding Guidelines*, Version 4, 2003-09-19.