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The INES scale of nuclear incidents and accidents

PRESENTATION AND OBJECTIVES

In the same way as for natural phenomena such as earthquakes, wind and avalanches, France in 1987 set up a scale of severity for nuclear events, which the IAEA used extensively as a basis for the INES scale (International Nuclear Event Scale).

This scale, which was implemented internationally in 1991, is based partly on objective and partly on subjective criteria. It is used by about sixty countries and its purpose is to facilitate media and public perception of the scale of any nuclear incidents. It is not an assessment tool and cannot in any circumstances be used as a basis for international comparison. There is in particular no strict correlation between the number of non-serious incidents declared and the probability of a serious accident occurring in a facility.

NATURE OF THE EVENTS RATED ON THE INES SCALE

The INES scale is designed to cover events occurring in all civil nuclear installations, including those classified as secret, and during nuclear material transports. These events are rated by the ASN on 8 levels from 0 to 7, depending on their severity.

Application of the INES scale to nuclear installations is based on three rating criteria (columns 2, 3 and 4 of the following table):

- **off-site impact**, assessed in terms of radioactive releases that can affect the public and the environment;
- **on-site impact**, which can affect workers and the conditions of the installations;
- **degradation of the lines of defence** in depth of the installation, consisting of successive barriers (safety systems, procedures, technical or administrative checks, etc.) placed between the radioactive products and the environment.

For transportation of radioactive materials on the public highway, only the off-site impact and degradation of the defence in depth criteria are used for application of the INES scale.

EXAMPLES OF EVENTS RATED ON THE INES SCALE

Level 0. In France: several hundred events are rated level 0 every year. They concern deviations from the normal operation of the facilities or the normal transportation of radioactive materials, but which have no impact in terms of safety.

Level 1. In France: about a hundred events are rated level 1

CRITERIA OR SAFETY ATTRIBUTES

	OFFSITE IMPACT	ONSITE IMPACT	DEFENCE IN DEPTH DEGRADATION
7 MAJOR ACCIDENT	Major release: widespread health and environmental effects		
6 SERIOUS ACCIDENT	Significant release: likely to require full implementation of planned counter-measures		
5 ACCIDENT WITH OFFSITE RISK	Limited release: likely to require partial implementation of planned counter-measures	Severe damage to reactor core/ radiological barriers	
4 ACCIDENT WITHOUT SIGNIFICANT OFFSITE RISK	Minor release: public exposure of the order of prescribed limits	Significant damage to reactor core/ radiological barriers/fatal exposure of a worker	
3 SERIOUS INCIDENT	Very slight release: public exposure at a fraction of prescribed limits	Severe spread of contamination/acute health effects to a worker	Near accidents – no safety barriers remaining
2 INCIDENT		Significant spread of contamination/ overexposure of a worker	Incidents with significant failures in safety provisions
1 ANOMALY			Anomaly beyond the authorized operating conditions
0 DEVIATION	No safety significance		
OUT OF SCALE EVENT	No safety relevance		

every year. These comprise anomalies, deviations from facility normal operating conditions or from normal transportation operations, owing to equipment failure, human error, or inadequate compliance with procedures.

Level 2. In France: 2005: anomaly concerning certain safety pumps in EDF's 900 MWe reactors which could, in certain accident situations, lead to loss of the cooling water recirculation function. 2004: generic anomaly affecting certain marshalling boxers in EDF nuclear power plants. This could have prevented various items (motors, valves) from operating in accident conditions involving the presence of water or steam in the reactor building. 2003: anomaly concerning the nuclear reactor cooling water recirculation system which could, in certain accident conditions, lead to clogging of the recirculation system sump filters for all the PWR reactors.

Level 3. In France: 2002: incident rated by the Swedish competent authority during transport by Federal Express (FedEx) between Sweden and the United States, via Roissy airport, of a package which at arrival registered a dose rate higher than the acceptable regulatory limit. 1981: fire in a storage silo at La Hague.

Abroad: 2005: detection of a radioactive leak from a pipe between the dissolver and a tank in the Thorp fuel reprocessing plant in Sellafield (United Kingdom). 2002: on the Davis Besse power plant reactor (United States) discovery of a cavity in the reactor vessel closure head caused by boric acid corrosion of the metal. 1997: fire and explosion in a low-level effluent bituminization facility in Tokai-Mura, Japan, with acute irradiation of three workers, two of whom subsequently died.

Level 4. In France: 1980: damage to the core of the Saint-Laurent A1 reactor.

Abroad: 1999: criticality accident in a fuel fabrication facility in Tokai-Mura, Japan, with acute irradiation of three workers, two of whom subsequently died. 1973: release of radioactive material following an exothermal reaction in a reprocessing tank in the Windscale plant (United Kingdom).

Level 5. In France: none.

Abroad: 1979: partial meltdown of the Three Mile Island reactor core in the United States.

Level 6. In France: none.

Abroad: 1957: explosion of a tank of radioactive products in the Kyshtym reprocessing plant in the USSR.

Level 7. In France: none.

Abroad: 1986: explosion of reactor 4 in the Chernobyl nuclear power plant in Ukraine.

USE OF THE INES SCALE IN FRANCE

All nuclear safety-significant events are reported by the licensees to the ASN within 24 hours. This declaration comprises a proposed rating on the INES scale, to be approved by the ASN, which has sole responsibility for the final rating decision.

Using the INES scale enables the ASN to select those events and incidents which are sufficiently important for it to issue a communication:

- **all incidents rated level 1 and above** are systematically published on the ASN's asn.gouv.fr website. Journalists are informed of incidents rated level 2 and above by press releases and telephone calls;
- **incidents rated level 0** are not necessarily made public by the ASN. They may be published if of particular interest to the media.

EXPERIMENTAL CLASSIFICATION OF A RADIATION PROTECTION EVENT ON THE INES SCALE

In 2003, the ASN initiated an international program designed to provide a severity scale for classifying radiation protection incidents affecting all nuclear activities (nuclear installations, radioactive sources, medical installations, etc.). On the basis of the French proposal, the International Atomic Energy Agency (IAEA) experimented in the member countries with a new section of the INES scale related to radiation protection incidents, including radioactive sources and transportation of radioactive materials. This takes into account the relationship between the radiological risk and the severity of the event, as presented in the table opposite. Initially, France limited the experiment to systematic application of this new scale to nuclear installations. With a view to broader application to medical, industrial and research facilities the ASN in 2005 used this experimental scale to give a level 2 rating to an irradiation incident that occurred in the Frédéric Joliot hospital unit in Orsay.

EVENT	NUMBER OF EXPOSED INDIVIDUALS AND FINAL RATING		
	Minimum rating	Number of individuals	Final rating*
Death or lethal dose received	4	> 10	6
		> 1	5
		1	4
Deterministic effect or potential deterministic effect according to the dose received	3	> 10	5
		> 1	4
		1	3
Exposure higher than 1 Sv or 1 Gy	4	> 100	6
		> 10	5
		≤ 10	4
Exposure higher than 100 mSv	3	> 100	5
		> 10	4
		≤ 10	3
Worker exposure to a dose higher than the regulation annual limit exposure of a member of the public to a dose higher than 10 mSv	2	> 100	4
		> 10	3
		≤ 10	2
Worker exposure to a dose higher than one quarter the regulation annual limit or exposure of a member of the public to a dose higher than the annual dose limit	1**	> 100	3
		> 10	2
		≤ 10	1

* Select the higher rating

** When a dose limit is exceeded as a result of accumulated exposure over a given period of time, the ASN systematically attributes a level 1 rating because of the lack of safety culture