

by Rejane Spiegelberg-Planer

# A Matter of Degree

*A revised International Nuclear and Radiological Event Scale (INES) extends its reach.*

Any incident taking place in a nuclear facility or involving radiation sources or radioactive substances may give rise to media and public concerns, sometimes resulting in rumors, psychological stress, social tension and even economic consequences. Therefore, timely and accurate responses to media and public concerns are key to avoiding the dissemination of confusing and non-relevant information that often circulates during incidents or emergencies.

Scales are simple way to convey a message. They are used as tools to convey clear and open messages which are also easy to understand and are provided at the right time. Importantly, they provide a solid technical basis to assist us in our judgment.

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## The Scale

INES was developed in 1990 by international experts convened jointly by the IAEA and the Nuclear

Energy Agency of the Organisation for Economic Co-operation and Development (OECD/NEA) for communicating the significance of events at nuclear installations. Since then, INES has been expanded to meet the growing need for communicating the safety significance of all events associated with radiation and radioactive material, including transport related events.

In 2008, the IAEA General Conference welcomed the revision of INES, which consolidated previous clarifications and guidance. The General Conference also urged IAEA Member States to designate INES national officers and utilize the scale to put into proper perspective the safety and radiological impact of events in the nuclear and radiation safety area, which was a major step in the worldwide use of a scale.

INES has 7 levels. The upper levels (4-7) are termed “accidents” and the lower levels (1-3) “incidents”. Events that have no safety significance are classified “Below scale or Level 0” and are termed “deviations”.

It is important to note that events with no relevance to nuclear safety or radiation protection (e.g. a non-radioactive chemical spill, or faults affecting only the availability of a turbine or generator) are termed “out of scale”.

A distinct phrase has been attributed to each level of INES in order to express the increasing severity of events from Level 1 to Level 7. These are: anomaly, incident, serious incident, accident with local consequences, accident with wider consequences, serious accident and major accident.

Currently, INES covers a wide range of practices, including radiography, uses of radiation sources in hospitals, operations at nuclear facilities, and transport of radioactive material. By putting events relat-

ing to all of these practices into their proper perspective, INES can facilitate a common understanding among the technical community, the media and the public.

The 1986 accident at the Chernobyl nuclear power plant in the USSR (now in Ukraine), is rated at Level 7 on INES — the event had widespread impact on people and the environment. One of the key considerations in developing the criteria for the INES scale rating was to ensure that the significance level of less severe and more localized events were clearly separated from this severe accident. Thus the 1979 accident at the Three Mile Island nuclear power plant is rated at Level 5 on INES, while an event resulting in a single death from radiation is rated at Level 4.

INES is intended to be applicable for all events, the vast majority of which relate to failures in equipment or procedures. Whilst many such events do not result in any actual consequences for individuals, it is recognized that some are of greater safety significance than others. If all such events were rated at Level 0, the scale would be of no value. Thus, it was agreed at its original inception that INES needed to cover not only actual consequences but also potential consequences.

## The Revision Process

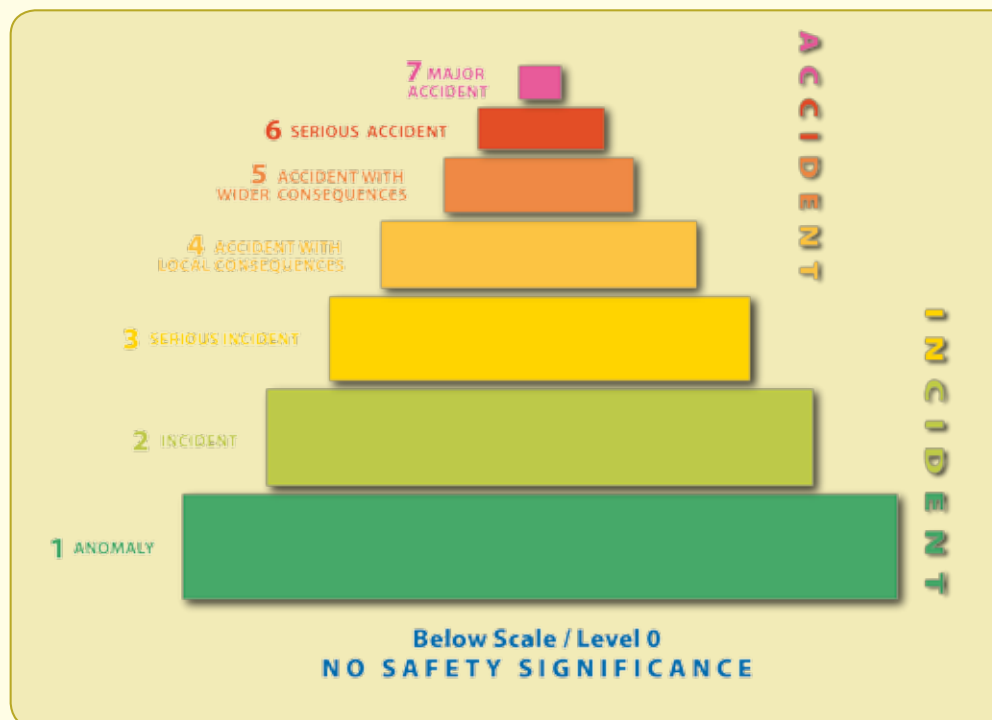
The revision of INES aimed to incorporate into one document already existing documents which served to clarify specific criteria such as:

- ① the clarification for fuel damage events at nuclear facilities in use since 2004; and
- ② the additional guidance for rating events related to radiation source and transport in use since 2006.

The revision process also served to incorporate comments received from the INES National Officers and the corrigenda of the 2001 INES Manual on the use of the Scale. To promote the consistent use of the Scale worldwide, it was also found necessary to add examples of rating and adopt appropriate terminology to all applications of the Scale.

The revision was jointly coordinated by the IAEA and the OECD/NEA and involved experts from all related areas: nuclear facilities, radiation safety and transportation. This was essential to bring uniformity and consistent criteria across all applications.

The proposal was reviewed by the 63 INES national officers, who are officially designated by Member States. They were also asked to ensure the involvement of technical experts in each area of application of the Scale. The comments were resolved in meetings with the INES advisory committee and the IAEA and OECD/NEA Secretariats. The committee received and addressed more than 330 comments from 25 countries and the Secretariats. In addition, other international organizations were also invited to major INES meetings. These included the World Association of Nuclear Operators (WANO), European Community, World Nuclear Association and FORATOM.



## Scope, Criteria

What are the changes of the new revised INES compared with the 2001 INES Manual? To begin with, it is worth noting that the scope of the scale did not change. Since 2001, INES has been applied to any event taking place at nuclear facilities or during transportation involving radioactive sources. However, the criteria used to rate those events needed better explanations, were no longer applicable or needed to be revised considering up-to-date concepts and techniques.

Ensuring consistent terminology and eliminating ambiguous interpretation was one of the goals of the revision process. Thus, criteria using words such as 'few', 'several', 'of the order of' were explained and examples provided. The meaning of concepts such

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as Below Scale and Out of Scale and the difference between them was also clarified.

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- 2 Radiological barriers and controls at facilities
- 3 Defence in depth.

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The impact on people and the environment can be localized, i.e. radiation doses to one or a few people close to the location of the event, or widespread as in the release of radioactive material from an installation.

Events involving large releases to the environment would be rated at levels 4 to 7 (accidents). Clearly these criteria only apply to practices where there is the potential to disperse a significant quantity of radioactive material. In order to allow for the wide range of radioactive material that could potentially be released, the scale uses the concept of "radiological equivalence". Thus the quantity is defined in terms of terabecquerels of iodine 131, and conversion factors are defined to identify the equivalent level for other isotopes that would result in the same level of effective dose. The criteria for releases were previously referred to as the "off-site" criteria.

For events with a lower level of impact on people and the environment, the rating is based on the doses received and the number of people exposed. Events involving doses to individuals can be rated between level 2 and level 6. However, it is not considered credible for an event involving a radioactive source to achieve level 6. The radiological accident in Goiania in 1987, rated as level 5, is an example of the highest level for such cases.

The impact on radiological barriers and controls at facilities is only relevant to major facilities handling major quantities of radioactive material such as

power reactors, reprocessing facilities, large research reactors or large source production facilities.

In those facilities, when a site boundary is clearly defined as part of their licensing, it is possible to have an event where there are significant failures in radiological barriers but no significant consequences for people and the environment (e.g. reactor core melt with radioactive material kept within the containment). It is also possible to have an event at such facilities where there is significant contamination spread or increased radiation but where there are still considerable safety layers (such as redundancy of systems, procedures, etc) remaining that would prevent significant consequences to people and the environment.

In both cases there are no significant consequences to individuals outside the site boundary, but there is an increased likelihood of such consequences to individuals or a major failure in the management of radiological controls.

Those events could be rated from level 3 to 5, the highest on record being damage to the reactor core that occurred in Three Mile Island, in the USA in 1979.

Thus, these criteria cover events such as reactor core melt and the spillage of significant quantities of radioactive material resulting from failures of radiological barriers, thereby threatening the safety of people and the environment. These criteria, together with the criteria for worker doses, were previously referred to as the "on-site" criteria.

Reduction in defence-in-depth principally covers events with no actual consequences, but where the measures put in place to prevent or cope with accidents did not operate as intended.

While many such events do not result in any actual consequences, it is recognized that some are of greater safety significance than others. If these types of events were only rated based on actual consequences, all such events would be rated at Below scale or Level 0 and the scale would be of no real value in putting them into perspective. Thus, it was agreed at its original inception that INES needed to cover not only actual consequences but also the potential consequences of events.


A set of criteria was developed to cover what has become known as "degradation of defence-in-depth". These criteria recognize that all applications involving the transport, storage and use of radioactive material and radiation sources, incorporate a number of safety provisions. The number and reli-

ability of these provisions depends on their design and the magnitude of the hazard. Events may occur where some of these safety provisions fail but others prevent any actual consequences. In order to communicate the significance of such events, criteria are defined which depend on the amount of radioactive material and the severity of the failure of the safety provisions.

Since these events involve only an increased likelihood of an accident, with no actual consequences, the maximum rating for such events is set at Level 3 (i.e. a serious incident). Furthermore this maximum level is only applied to practices where there is the potential, if all safety provisions failed, for a significant accident, i.e. one rated at Levels 5, 6 or 7 on INES. For events associated with practices with a much smaller hazard potential, e.g. transportation of small medical or industrial radioactive sources, the maximum rating on the basis of degradation of defence-in-depth is correspondingly lower.

In summary, INES Level 1 covers only degradation of defence-in-depth. Levels 2 and 3 cover more serious degradations of defence-in-depth, or lower levels of actual consequence to people or facilities. Levels 4 to 7 cover increasing levels of actual consequence to people, the environment or facilities.

Although INES covers a wide range of practices, it is not credible for events associated with some practices to reach the upper levels of the scale. For example, events associated with the transport of sources used in industrial radiography, could never exceed Level 4, even if the source was taken and handled incorrectly. For events involving radiation sources and the transport of radioactive material, only the criteria for people and the environment and for defence-in-depth need to be considered.

The final rating of an event needs to take into account all the relevant criteria described above. Each event should be considered against each of the appropriate criteria and the highest derived rating is the one to be applied to the event. 

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## Have I Got NEWS for You

The IAEA maintains a system to facilitate international communication of events. This system, namely the NEWS system, is co-sponsored by the OECD/NEA and WANO. It is not a formal reporting system and the system operates on a voluntary basis.

The purpose of NEWS is to facilitate communication and understanding between the technical community (industry and regulators), the media and the public on the safety significance of events that have attracted or are likely to attract international media interest.

Many countries have agreed to participate in the INES and NEWS system because they recognize the importance of open communication of events in a way that clearly explains their significance.

INES member countries are strongly encouraged to communicate internationally (within 24 hours if possible) according to the agreed criteria:

- ① Events which are rated at Level 2 and above; and
- ② Events which attract international public interest.

It is recognized that there will be occasions when a longer time scale is required to know or estimate the actual consequences of the event. In these circumstances a provisional rating should be given with a final rating provided at a later date.

Events are posted in the NEWS system by the INES national officers, who are officially designated by the Member States. The NEWS system includes event descriptions, ratings on INES, press releases (in the national language and in English), and technical documentation for experts. Event descriptions, ratings and press releases are available to the general public without registration. Access to the technical documentation is limited to nominated and registered experts.