

# INES RATING OF RADIATION PROTECTION RELATED EVENTS

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In the presentation, based on the draft Manual [1.], a short review of the use of the INES rating of events concerning radiation protection is given, based on a new INES User's Manual edition. The presentation comprises a brief history of the scale development, general description of the scale and the main principles of the INES rating. Several examples of the use of the scale for radiation protection related events are mentioned. In the presentation, the term "radiation protection related events" is used for radiation source and transport related events outside the nuclear installations.

## A) BRIEF INES HISTORY

The International Nuclear Event Scale (INES) was developed in 1990 jointly by the IAEA and the OECD/NEA in order to ensure consistent form of communication on the radiation risks associated with a particular event. Its primary purpose was to facilitate communication and understanding between the nuclear community, the media and the public on the safety significance of events occurring at nuclear installations.

In 1992 the scale was refined and extended to any event associated with radioactive material and/or radiation, including the transport of radioactive materials. In 2001 an updated edition of the INES User's Manual [2.] was issued bringing clarification in the use of INES and providing refinement for rating transport related and fuel cycle related events.

Further work was carried out on potential and actual consequences of radiation source and transport related events. In 2006 the Additional Guidance for the INES National Officers on rating transport and radiation source events [3.] was issued.

The new INES User's Manual (2008 edition) is going to be issued. It integrates all events including radiation source and transport related events into a single document.

## B) GENERAL DESCRIPTION OF THE SCALE

Events are classified on the scale at seven levels: Levels 1–3 are termed "incidents" and Levels 4–7 "accidents". Events without safety significance are termed "deviations" and are classified "Below scale/Level 0". Events that have no safety relevance with respect to radiation or nuclear safety are not classified on the scale.

For communication of events to the public, a distinct phrase has been attributed to each level of the INES scale. In order of increasing severity these are: anomaly, incident, serious incident, accident with local consequences, accident with wider consequences, serious accident, and major accident. The scale is a logarithmic one; the design aim was that the severity of an event would increase by about an order of magnitude for each increase in level on the scale.

The structure of the scale is shown in Table 1. Events are considered in terms of their impact on three different areas: impact on people and the environment; impact on radiological barriers and controls at facilities; and impact on defence-in-depth.

It should be noted here, that 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.



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**Table 1. General criteria for rating events on the INES Scale**

Description and INES Level	People and Environment	Radiological Barriers and Controls at Major Facilities	Defence-in-Depth
Major Accident Level 7	<ul style="list-style-type: none"> <li>• Major release of radioactive material with widespread health and environmental effects requiring implementation of planned and extended countermeasures.</li> </ul>		
Serious Accident Level 6	<ul style="list-style-type: none"> <li>• Significant release of radioactive material likely to require implementation of planned countermeasures.</li> </ul>		
Accident with Wider Consequences Level 5	<ul style="list-style-type: none"> <li>• Limited release of radioactive material likely to require implementation of some planned countermeasures.</li> <li>• Several deaths from radiation.</li> </ul>	<ul style="list-style-type: none"> <li>• Severe damage to reactor core.</li> <li>• Release of large quantities of radioactive material within the installation with a high probability of significant public exposure. This could arise from a major criticality accident or fire.</li> </ul>	
Accident with Local Consequences Level 4	<ul style="list-style-type: none"> <li>• Minor release of radioactive material unlikely to result in implementation of planned countermeasures other than local food controls.</li> <li>• One death from radiation.</li> </ul>	<ul style="list-style-type: none"> <li>• Fuel melt or damage to fuel resulting in more than 0.1% release of core inventory.</li> <li>• Events involving radioactive release of a few thousand TBq within an installation with a high probability of significant public exposure.</li> </ul>	
Serious Incident Level 3	<ul style="list-style-type: none"> <li>• Exposure in excess of ten times the statutory annual limit for workers.</li> <li>• Non-lethal deterministic health effect (e.g., burns) from radiation.</li> </ul>	<ul style="list-style-type: none"> <li>• Events resulting in exposure rates of more than 1 Sv/hr in an operating area.</li> <li>• Severe contamination from a few thousand TBq in an area not expected by design, with a low probability of significant public exposure.</li> </ul>	<ul style="list-style-type: none"> <li>• Near Accident at a nuclear power plant with no safety provisions remaining.</li> <li>• Lost or stolen highly radioactive sealed source.</li> <li>• Misdelaivered highly radioactive sealed source without adequate radiation procedures in place to handle it.</li> </ul>

<p><b>Incident Level 2</b></p>	<ul style="list-style-type: none"> <li>• Exposure of a member of the public in excess of 10mSv.</li> <li>• Exposure of a worker in excess of the statutory annual limits.</li> </ul>	<ul style="list-style-type: none"> <li>• Radiation levels in an operating area of more than 50 mSv/hr.</li> <li>• Significant contamination within the facility into an area not expected by design.</li> </ul>	<ul style="list-style-type: none"> <li>• Significant failures in safety provisions but with no actual consequences.</li> <li>• Found highly radioactive sealed orphan source, device or transport package with safety provisions intact.</li> <li>• Inadequate packaging of a highly radioactive sealed source.</li> </ul>
<p><b>Anomaly Level 1</b></p>	<p>Anomalies beyond the authorized operating regime such as:</p> <ul style="list-style-type: none"> <li>• Exposure of a member of the public in excess of statutory annual limits.</li> <li>• Exposure of a worker in excess of dose constraints.</li> <li>• Unplanned contamination or dose</li> <li>• Minor problems with safety components with significant defence in depth remaining.</li> <li>• Low activity lost or stolen radioactive source, device or transport package.</li> <li>• Missing source, device or transport package subsequently recovered intact within an area under control.</li> </ul>		
<p><b>Deviation Below Scale / Level 0</b></p>	<p>No Safety Significance</p>		

## **C) PRINCIPLES OF THE SCALE CRITERIA**

Each event needs to be considered against each of the relevant areas – the event rating is then the highest level from consideration of each of the three areas.

### **1. People and the environment**

The simplest approach to rating actual consequences to people would be to base the rating on the doses received. However, for accidents, this may not be an appropriate measure to address the full range of consequences as it does not communicate the true significance of what happened at the installation, nor does it take account of the potential widespread contamination. Thus, for the accident levels of the INES scale (4-7) criteria have been developed based on the quantity of radioactive material released, rather than the dose received. Clearly these criteria only apply to practices where there is the potential to disperse a significant quantity of radioactive material.

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.

### **2. Radiological barriers and controls**

In facilities handling major quantities of radioactive materials, where 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. It is also possible to have an event at such facilities where there is significant contamination spread or increased radiation but where there is still considerable defence-in-depth 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 in the first case there is an increased likelihood of such consequences to individuals, and in the second case such failures represent a major failure in the management of radiological controls. It is important that the rating of such events on the INES scale takes appropriate account of these issues.

### **3. Defence-in-depth**

The INES scale is intended to be applicable to all radiological events and all nuclear or radiation safety events, the vast majority of which relate to failures in equipment or procedures. 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/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 the INES scale 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. 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 only involve 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).

One final issue that is addressed under defence-in-depth is what is described in the Manual as additional factors, covering as appropriate, common cause failure, issues with procedures and

safety culture. To address these additional factors, the criteria allow the rating to be increased by one level from the rating derived solely by considering the significance of the actual equipment or administrative failures.

For events related to radiation sources and transport of radioactive material, the possibility of increasing the level due to additional factors is included as part of the rating tables rather than as a separate consideration. The criteria set in the rating tables combine all the three elements of defence-in-depth mentioned above, i.e., the amount of radioactive material, the extent of any failure of safety provisions and additional factors.

## **D) USING THE SCALE**

The INES scale is a communication tool. The purpose of the INES scale is simply to help to put into perspective the safety significance of those events that are to be communicated.

It is not the purpose of the INES scale, or the international communication system associated with it, to define the practices or installations that have to be included within the scope of the regulatory control system, nor to establish requirements for events to be reported by the users to the regulatory authority or to the public. The communication of events and their INES scale ratings is not a formal reporting system. Equally the criteria of the scale are not intended to replace existing well-established criteria used for formal emergency arrangements in any country.

It is not appropriate to use the INES scale to compare safety performance between facilities, organizations or countries.

It is important that communications happen promptly; otherwise a confused understanding of the event will occur from media and public speculation. In some situations, where not all the details of the event are known early on, it is recommended that a provisional rating is issued based on the information that is available and the judgement of those understanding the nature of the event. Later on a final rating should be communicated and any differences explained.

## **E) EXAMPLES**

In the presentation, several examples taken from the draft Manual [1.] are discussed. The examples in the draft Manual cover all kinds of radiation protection related events.

## **REFERENCES**

- [1.] INES Scale User's Manual, Draft 4.4 – 19 June 2008, IAEA, Vienna
- [2.] The International Nuclear Event Scale (INES) User's Manual, 2001 Edition, IAEA-INES-2001, IAEA, Vienna, 2001
- [3.] Working Material, Rating of Transport and Radiation Source Events, Additional Guidance for the INES National Officers, IAEA-INES WM 04/2006, IAEA, Vienna, 2006