

Rating of Fuel Damage Events

Further Clarification of the INES User's Manual

(Approved by the INES Technical Committee Meeting 17- 19 March 2004)

1. Background

The International Nuclear Event Scale (INES) is a means for promptly communicating to the public in consistent terms the safety significance of any reported event associated with radioactive material and/or radiation. It is not the purpose of INES to describe the activities or installations that have to be included within the scope of the regulatory control system for radiation protection, nor to establish requirements for events to be reported by the users to the regulatory authority. It is also not the purpose of INES to establish requirements for communications to the public, but when an event is communicated, this guidance provides criteria for its rating so as to put the event into proper perspective for communication purposes.

INES has 3 classification criteria: off-site, on-site and defence-in-depth. One of the key reasons was to ensure that accidents without major actual off-site consequences were given an appropriate rating. Thus accidents where a large amount of the activity escaped from its primary barrier (the fuel matrix and clad for a reactor) were defined as level 5 events. It was then necessary to define a threshold for level 5, i.e. was only 100% core melt to be rated at level 5. It was decided to use "a few %" core melt as the threshold, hence the definition below.

Another key characteristic of INES is that each of the 3 criteria only covers part of the range. Thus off-site is only levels 3 to 7. If the release is not above the threshold of level 3, it is level 0 under off-site and the other criteria, on-site impact and degradation of defence in depth must be considered. Similarly for on-site. On-site is in fact made up of three separate considerations: radiological damage (i.e. escape of activity from its first barrier, core damage for reactors), contamination spread and worker dose. Radiological/core damage is defined for levels 4 and 5. If the extent of damage is below, the threshold for level 4, then the rating according to this parameter is 0 and the other criteria, in particular the degradation of defence in depth criterion, must be considered.

2. Objectives

This note provides further clarification of the rating of events involving fuel damage or degradation. It is consistent with the principles of the INES User's Manual (2001 Edition) but provides more detailed information. It should be used in conjunction with the On-Site Definition of Levels contained in Section III-2.2. The INES National Officers are encouraged to establish on a plant-specific basis and in co-operation with the utilities derived criteria expressed in terms of symptoms (e.g. activity concentration in the primary coolant, radiation monitoring in the containment building, etc.) to facilitate a fast rating of events involving fuel damage.

3. Further Clarification

3.1. On-Site Impact

Level 5. Severe damage to the reactor core or radiological barriers

The definition “More than a few percent of the fuel in a power reactor is molten or more than a few percent of the core inventory has been released from the fuel assemblies” is based on the total inventory of the core, i.e. not just the free fission product gases (the “gap inventory”). The fuel matrix and the fuel cladding constitute the primary radiological barrier. Severe damage to this barrier, such that a few percent (i.e. of the order of 10%) of the total activity of the core is released into the reactor coolant, should thus be rated at level 5. Such an amount requires significant release from the fuel matrix as well as the gap inventory.

Level 4. Significant damage to the reactor core or radiological barriers or fatal exposure of a worker

The definition “Any fuel melting has occurred or more than about 0.1% of the core inventory of a power reactor has been released from the fuel assemblies” is also based on the total inventory of the core not just the “gap inventory”. The fuel matrix and the cladding constitute one of the radiological barriers. Thus a release of more than 0.1% of the total activity of the core could occur if either there is some fuel melting with clad failure, or if there is damage to a significant fraction (~10%) of the clad, releasing the gap inventory. Either of these events should be rated at level 4.

It should be noted that the rating based on core damage does not depend on the state of the primary circuit. The rating is expressing the fact that the primary radiological barrier has failed but that the activity is contained on the site.

It should also be noted that the on-site impact for Levels 3 and lower was not intended to be considered for fuel damage events, but for application to non-reactor installations or exposure and contamination events. Fuel damage or degradation that does not reach level 4, e.g. very localized melting that does not result in a release into the coolant of more than 0.1% of the total core activity, should be rated at level 0 under the on-site criterion and other criteria must be considered.

3.2. Defence in Depth

Fuel failures releasing less activity than the threshold for level 4, described above, should be considered against the defence in depth criterion. If the fuel damage has been caused by an initiating event, then the rating should be based on that event.

If activity levels rise above normal operational levels and are not dealt with in accordance with the technical specifications, (either the appropriate actions are not taken or the time to initiate them is too long) consideration must be given to rating the event in accordance with Part IV-section 3.3 of the INES User’s Manual.