



Updates of the french criticality safety analysis guide and event database (logic)

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UPDATES OF THE FRENCH CRITICALITY SAFETY ANALYSIS GUIDE AND EVENT DATABASE (LOGIC)

Fabien Duret, Matthieu Duluc, Aurélie Bardelay (IRSN, France)

French regulations for Nuclear Criticality Safety

The Fundamental Safety Rule RFS I.3.c (1984) had been used to set out the principles for nuclear criticality safety assessment of French nuclear facilities. It has been replaced by a **ASN resolution in 2014 for civil facilities** and the **ASND instruction n°34 in 2020 for defense-related facilities**. These new resolution and instruction:

- clarify the scope for reactors loading and unloading operations and transport packages of fissile material;
- address the application of the defense in depth principle (prevention, detection and limitation of consequences) to criticality safety
- state the "double contingency" principle



A guide for practitioners

To follow regulatory evolutions, the IRSN criticality safety analysis guide, created in 2010, has been updated in 2022. IRSN guide appendix, the first diagrams present principles related to the general approach to criticality risk in France. It is a general overview of the French approach. These diagrams cover the following topics:

- civil or defense nuclear facilities **design**
- **reactors** design for safe loading or unloading operation
- **safety measures** in plants and reactors belonging to civil and defense
- **human organization** in some defense plants or reactors

Criticality engineers independent of operations and persons competent in criticality among the operating personnel give technical advice, contribute to the training of personnel and take into account feedback, ...

- a) [...] existence of one or more qualified criticality engineers or [...] at least clearly identified persons, independent of the personnel directly in charge of operating the nuclear facility, whose skills, level of information and availability enable them :
- to give a technical opinion prior to any modification, material or documentary, or any intervention that could have an impact on criticality risk control ;
 - to make technical recommendations to a person or body with authority and identified within the operator's integrated management system, concerning criticality risk prevention, including in emergency situations requiring it ;
 - to contribute to the training of personnel ;
 - to participate in taking into account feedback on criticality risk prevention ;
- b) the existence, among the personnel in charge of the operation of the INB, of persons with skills in the field of criticality safety and who can carry out, according to their level of expertise, certain technical missions similar to those of the persons mentioned in a) above.

Example of a diagram about French regulations

New topics in 2022

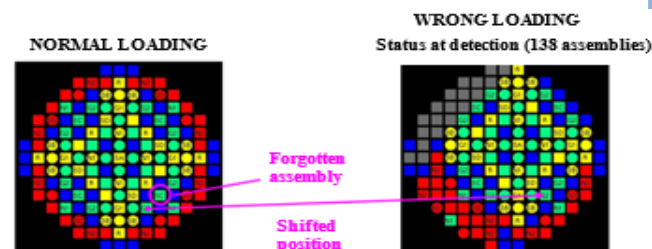
The 2022 new guide completes the original guide with new diagrams about:

- definition of the bounding **fissile medium** for reactor loading and unloading (nature of the fissile material and moderation, isotopic composition and density)
- application of "**criticality control modes**" for reactor loading and unloading (moderation, geometry, poison)
- impact of **environment** affecting neutron reflections and interactions conditions (concrete walls, distances between fissile units, etc.)
- **measurement** of fissile mass
- **criticality accidents** (alarm, protection, emergency management and means to stop an accident)

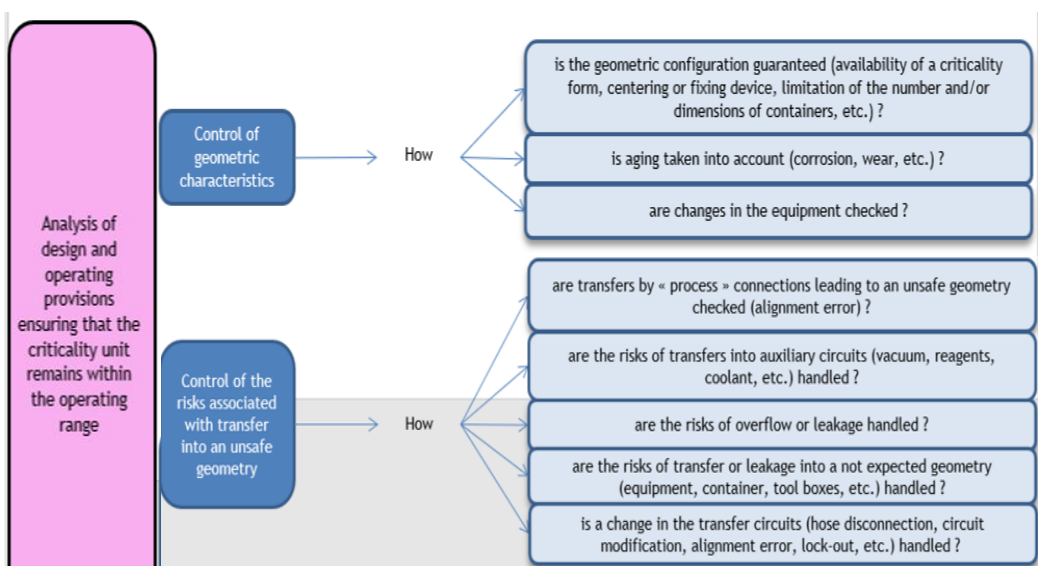
Lessons From Experience

The 2022 new guide integrates the lessons learned from NCS events occurred in French facilities. IRSN used "LOGIC", a criticality safety event database created in 2015. LOGIC gathers information on the events (nuclear operator reports, follow-up, etc.) and IRSN assessments.

There is a "virtuous circle" : new assessed events lead to complete the scenarios/questions, thus enhancing criticality safety.



Example : Near miss in Dampierre PWR core, 2001



e.g. of diagram

LOGIC				
	Accueil	Ma page	Incidents	Rapports
1	2006-009	NFS INC : Fuite de 35 litres d'uranium enrichi aux États-Unis	2006-03-06	Validé
1	2017-023	USA, Y-12 NSC - Concurrent uranium overmass and hydraulic fluid leak	2017-05-01	Validé
2	2011-041	Nuclear catastrophe narrowly avoided at Los Alamos National Laboratory	2011-08-11	Validé
1	1991-008	WILMINGTON : Accident potentiel de criticité	1991-05-28	Validé
0	2020-012	Dépassements de quatre grammes et d'un gramme de la masse de plutonium dans l'unité de criticité n° 2 "chaîne d'incinération de déchets alpha"	2020-12-11	Validé
0	2021-005	Déclenchement de l'alarme "unité de sécurité - détection chaîne gamma"	2021-02-15	Validé

Main LOGIC screen