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CRITICALITY SAFETY AND ORGANIZATIONAL PRINCIPLES AT THE CEA

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1. INTRODUCTION

The Commissarial à l'Énergie Atomique et aux Énergies Alternatives - CEA has ten research centers in various regions of France, each one being specialized in specific research areas. This research centers / laboratories are located in the Paris, Rhône-Alpes, Languedoc Roussillon (Rhône Valley), Provence-Alpes-Côte d'Azur, Aquitaine, Central France and Burgundy regions.

Among all of them, the research on nuclear energy is conducted mainly in 3 civil research centers[1] : Saclay in the Paris region, Marcoule in the Rhône Valley and Cadarache in the Provence region.

In mid-1999, just a few months before the Tokai – Mura criticality accident, the CEA decided to review the organization regarding criticality safety throughout its nuclear facilities in order to improve it.

It's important to note that until that time CEA's criticality safety organization had a very simple pattern. One high level criticality safety specialist named ICC (Ingénieur Criticien de Centre / Center's Criticality Engineer) was in charge of an entire nuclear center regardless of the number of nuclear facilities. This criticality "officer" function was formally established in France in 1984 by the nuclear regulator (today's Autorité de Sûreté Nucléaire – ASN).

2. CEA's ORGANIZATION

As presented at the ICNC 2003 CEA's organization [2] is based on an operational line, backed up by support resources, and a control line. The organization is specified in a CEA internal instruction from the Nuclear Safety and Protection Division (DPSN) with specific instructions for each CEA center.

Regarding criticality safety and in particular the operational line and support resources a three "level" organization was established as following (from "top" to "bottom"):

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[1] Nuclear research at the Grenoble research center has been ended in early 2000. Today all of the nuclear facilities have been decommissioned and demolition is in progress.

[2] ICNC 2003 - "The Organisation of Criticality Hazard Prevention at the CEA" JAERI-Conf 2003-019

1. a central (CEA) Criticality Safety Expertise Group (CSEG) where criticality specialists perform amongst other activities criticality calculations on behalf of the nuclear facilities and which is also in charge of criticality accident issues (until 2014 a Criticality Skill Team dedicated to criticality accident was located in Valduc near experimental facilities– closed today)
2. at each CEA center the high level expert – ICC (with a renewable term of 4 years)
3. at every nuclear facility (Installation Nucléaire de Base - INB3) where fissile materials are present, there is a local organization which is managed by a local criticality specialist named IQC (Ingénieur Qualifié en Criticité / Qualified Criticality Engineer with a renewable term of 4 years).

Regarding the control line and in particular the control function whose aim is to check the respect, the adequacy and efficiency of the measures taken by the operational line managers in order to achieve the nuclear safety goals set by the director of each CEA Center, a team usually named Cellule Sûreté (Safety Cell) which is totally independent of the aforementioned operational line, reporting directly to the director of each CEA Center, performs a thorough check of the safety documents and the operational practices. This safety team includes one person with sufficient criticality expertise named Criticality Specialist (CS).

These lines are implemented at every CEA center with licensed nuclear facilities (Installation Nucléaire de Base - INB) where fissile materials are present and where criticality safety issues can be met.

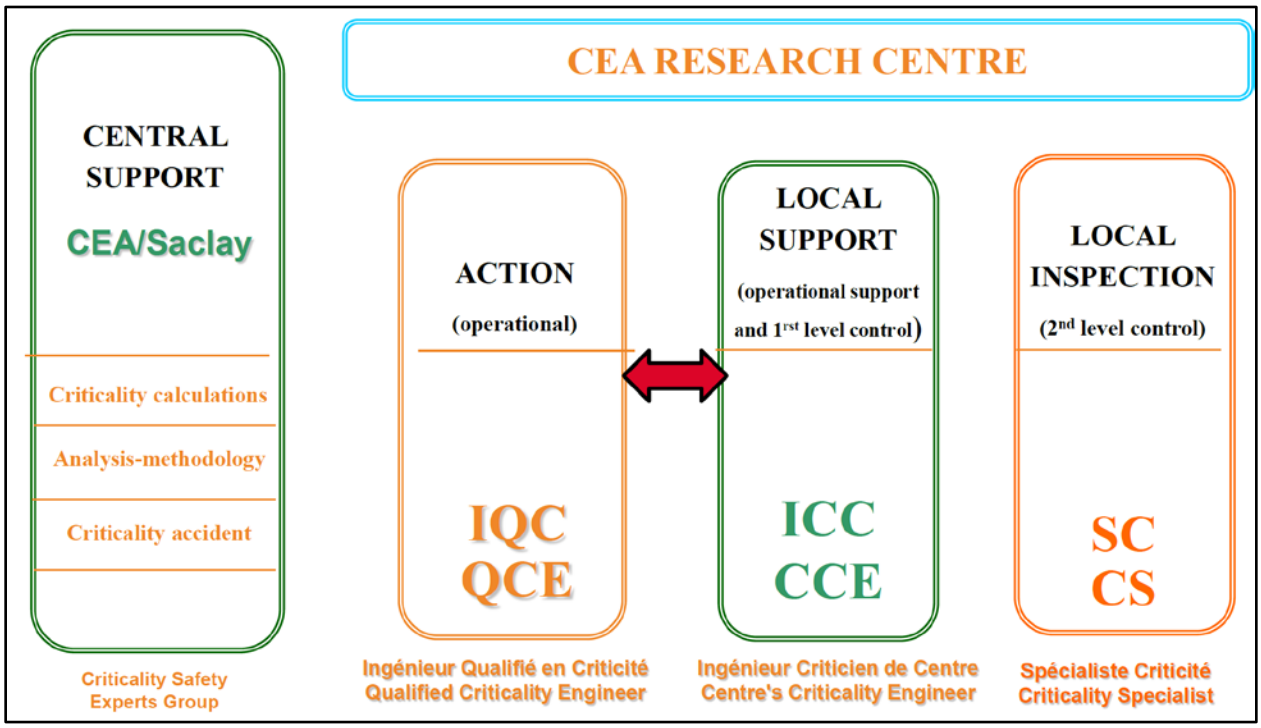

Figure 1: Organization chart

[3] the list is available at www.asn.fr

3. TRAINING FOR THE IQCs', ICCs', SCs'

3.1. Training of the IQCs'

In order to reinforce this structure an appropriate training in accordance with the responsibilities of the position, is given to the appointees' in charge of the operations or the control. Some of these positions request a “qualification agreement”.

Training for the IQC's is a two times one week process. This "*initial training*" sessions are organized by the INSTN (Institut National des Sciences et Techniques Nucléaires[4]) at Cadarache. The first one week session includes general theoretical aspects on criticality safety (an overview of fission phenomenology, cross sections, Monte Carlo codes, accidents, etc…..). The second 3 ½ days session IQC's receive "*practical training*" in which they are trained using criticality reports/calculations, procedures, operating practices, etc. They also have a quick overview of the regulatory frame regarding criticality such as nuclear laws, nuclear regulatory authority's decisions, and internal CEA recommendations as examples'.

For each training session trainees receive a certificate of attendance by the INSTN. The nuclear facility manager in which an IQC is working must put an application to the ICC for his/her "qualification". This initial qualification in the beginning criticality safety "career" is almost always accompanied by obligations and sometimes restrictions. The usual obligation is to stay in close touch with the ICC during the first months after the nomination as the IQC of the facility.

3.2. Training of the ICCs'

The ICCs' have in general a good professional background in nuclear safety in general and in criticality safety if possible. Recruitment is done among reactor/neutron physicists, nuclear safety engineers or nuclear chemistry engineers and ancient IQCs'.

Previously to their appointment they receive an approximately nine week overall training including theoretical and practical features. An ICC applicant passes a qualifying examination and must spend one week as a trainee in one French nuclear facility during which he must write an internship report followed by a presentation / oral examination of the report to a committee comprising ICCs' and senior French criticality experts.

Finally a diploma is delivered by the INSTN (training sessions take place every two years in France). It's the director of a CEA research center who demands the "qualification" of the ICC for the particular center, and a "qualification agreement" is issued by the head of the Criticality Skills Team, followed by the appointment of the candidate by the director of the CEA center as an ICC.

[4] more information at http://www-instn.cea.fr/Criticality-Safety.html

3.3. Training of the SCs'

Criticality Specialists have as a minimum requisite for training the same as the IQCs', but they often have a previous ICC's training and experience. It’s the head of the “safety cell” who demands the "qualification" of the SC for the particular center, and a "qualification agreement" is issued by the head of the Criticality Skills Team, followed by the appointment of the candidate as a SC.

4. RESPONSIBILITIES OF THE IQCs', ICCs', SC's

4.1. Responsibility of the IQCs'

The IQC exerts his responsibilities only in the area of a particular nuclear facility (INB) under the control of the INB's manager. His has authority delegation to conduct every day controls within the perimeter of the nuclear facility. He writes (alone or in common) procedures, operatory documents, controls the documents (if he's not the author), submits all the regulatory procedures referenced in the general operating rules to the ICC for validation/control.

He must solicit the ICC for detailed technical advice, especially when he's unexperienced in the job or a beginner in the nuclear facility. In both cases it's obligatory.

When he's experienced enough he conducts alone (eventually with the ICC) training sessions for his own facility workers (and periodical retraining).

He carries out the criticality safety assessments and defines the necessary criticality calculations when new installations are founded, existing installations are modified or whenever periodic regulatory assessments are led, under the guidance and support of the ICC.

4.2. Responsibility of the ICC's

The ICC is the technical authority regarding criticality safety in a nuclear center. He's is the upmost technical advisor for the IQC's, nuclear facility managers and the Center manager and as such he controls and he validates all criticality safety relevant documents, particularly criticality safety assessments.

He keeps in touch with the Criticality Skills Team on a standard basis and he participates in internal CEA's meetings regarding general criticality issues and contributes to internal regulation definition.

He makes sure that nuclear facilities are operated according to the particular rules and procedures of each one ensuring permanent sub criticality. He meets all demands of the center's facilities in the area of criticality safety.

He leads experience exchanges between the IQC's of "*his*" CEA center and takes into account the feedback on criticality safety coming from other CEA centers'.

4.3. Responsibility of the SCs'

The SC is the final formal authority regarding criticality safety in a nuclear center. As member of the safety cell he has, amongst other responsibilities, the task of checking that the installations are being operated within the regulatory authorizations, through facilities' visits, documents' and recordings' inspection and by carrying out technical and quality assessments.

He implements lessons learnt from significant criticality safety events occurred in nuclear facilities (located inside or outside his Center) and advises the Center Manager in case of any irregular or unusual situations arising in a facility and regarding criticality hazard prevention.

He controls all the criticality safety relevant documents on a formal basis before these are sent the nuclear safety authority (ASN).

5. DOCUMENTARY ORGANIZATION

5.1. General Documentary Organization

Criticality safety analysis is given into the baseline report of a nuclear facility. The outcomes of a criticality safety analysis are requirements (limits, rules, poisons, etc …). These are to be found in the Règles Générales d'Exploitation / General Operating Rules (RGE/GOR). The RGE/GOR are in general structured in to several parts but regarding criticality safety one must find two special chapters:

1. the definition domain
2. the general criticality rules.

Regarding the chapter called "definition domain" one must find all the operational requirements (limits etc ...) and in the chapter called "general criticality rules" all the general operating procedures and/or instructions. Sometimes especially in old baseline reports the "definition domain" is the first part of the "general criticality rules" chapter).

All the documents (procedures, control parameters, operating instructions, …) referenced into the "general criticality rules" chapter MUST BE / ARE approved by the ICC who's the guarantor of their technical "quality".

5.2. Document Organization Examples

In some nuclear facilities an organizational note called "criticality safety organization" summarizes in detail the hierarchy of the various documents relevant to criticality safety such as procedures, operating rules, etc. Here's the chart of this tree structure:

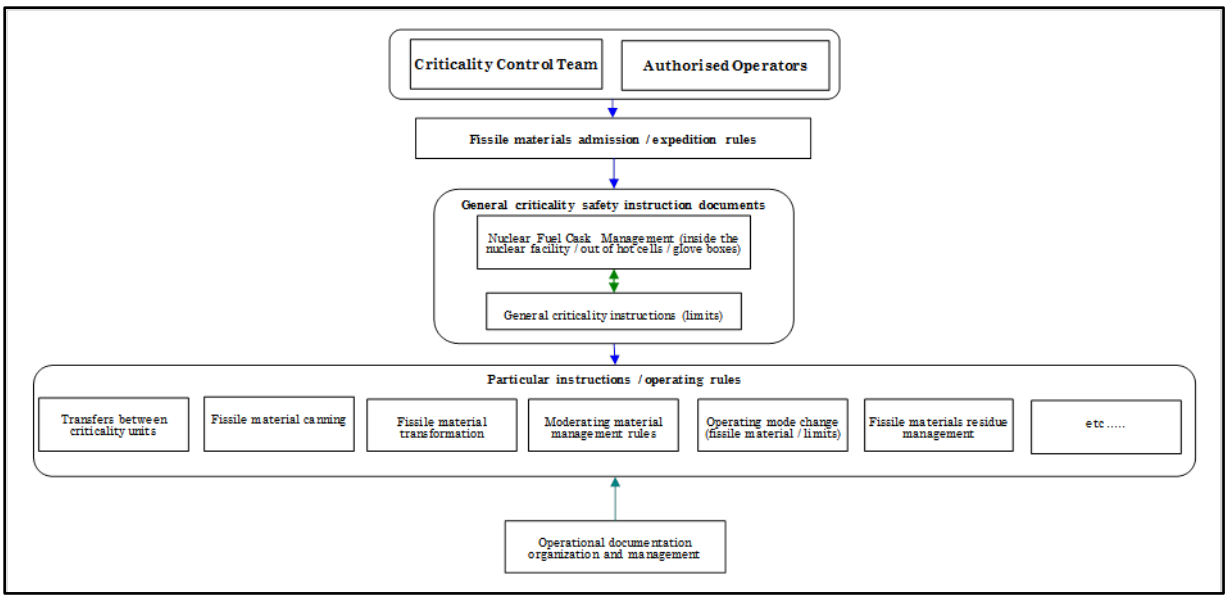

Figure 2: Documentary Organizations Chart Example

- **Criticality control team** = a team whose members trained by the IQC and ICC, have been appointed by the nuclear facility manager and are distinctly identified; they never control an operation in which they participate.

- **Authorized operators** = workers appointed by the nuclear facility manager in order to perform operations on nuclear fuel / fissile material; they can "touch", transform/modify, transfer, containerize, etc … the fissile material.

These two first documents are important regarding the double contingency principle.

- **Fissile materials admission / expedition rules** = a document describing all the steps to be taken before a cask enters or leaves the nuclear facility's area (perimeter). Example: control of the fissile material nature expected to be received versus the regulatory authorizations of the facility.

- **Nuclear Fuel Cask Management** = a document describing all the procedures necessary to the cask management (especially if the facility uses the nuclear transport Criticality Safety Index / CSI).

- **General criticality instructions (limits)** = document in which are transposed the regulatory general operation rules (GOR) into more simple operational/understandable everyday rules.

- **Particular instructions / operating rules** = particular rules for particular operations such as :
  - *Transfers between criticality units*: how to respect the addressee criticality unit's limits (example: mass limits).

- *Fissile material canning*: how to make sure fissile material can be recognized after canning

- *Fissile material transformation*: how to recognize the fissile material after transformation (example: what mass to assign to the various length parts of a initial fuel pin after cutting it)

- *Moderating material management rules*: what are the rules and how to do to respect the criticality unit's moderating material limits (quantity/amount, quality/grade)

- *Operating mode change (fissile material / limits)*: what kind of operations must be undertaken in order to make sure that another kind of fissile material can be processed into the same criticality unit (new limits)

- *Fissile material residues management*: how can we cope with fissile material residues into a hot cell / glove box (accumulation, rinsing, ..).

On an operational basis everyday controls regarding criticality issues are conducted through this documentary "structure". This "structure" is in accordance with the variety / complexity of the operations conducted in each facility, and of course nuclear workers are given the adequate training on how to use / fill in these documents necessary to conduct the various processes.

6. FINAL APPROVAL OF DOCUMENTS

Documents containing the word criticality must have been approved by the ICC before continuing to the next level of internal control / validation / approval. This is not an optional way to do, it's totally compulsory.

Documents such as safety reports, general operating rules, etc, must go through the SC's examination and approval before the director of the CEA’s center or his delegator signs them in order to be sent to the nuclear safety authority (ASN).

7. TRAINING PRACTICES – CRITICALITY EXERCISES

Among the training practices classroom training is the most usual one especially when the safety report of a facility evolves. A new processes implies new RGE/GOR, new procedures, operatory instructions, etc.

Nuclear facilities perform periodical alarm tests of the CAAS (Criticality Accident Alarm System), following constructor recommendations and also training, exercises and evacuation drills in order to check the personnel's awareness.

8. GENERAL GUIDES AND DOCUMENTS FOR CRITICALITY ENGINEERS

Criticality engineers (all levels) have guides which are available everywhere (paper, local servers, intranets). One can especially find:

- CEA N – 2051 (French criticality standard also known as "guide Maubert")
- Guide Cards[5] (fiches guides) : a collection of files (card format) each one dealing with one issue such the minimal critical mass, etc …
- A Guide for Criticality Accident Studies[6]

among other.

There are also national groups dedicated to information sharing such as the French Criticality Experts Group composed by experts from French operating companies and engineering such as: CEA, AREVA companies (NP, NC, E&P…), EURODIF, ANDRA, and also workgroups on criticality safety French codes package CRISTAL (users, validation, calculations schemes, …).

9. CONCLUSIONS

CEA has a strong criticality safety organization in general and in each center in particular (local organization).
Regarding the general organization a homogeneous process of Qualification and Appointment for the different criticality safety functions provides that criticality engineers have the good level of knowledge and skills. The central CEA's criticality skills teams in charge of methodological guides, criticality network, lessons learned, provides high level information specially on evolution of the criticality "*état de l'art*".

In each CEA's center the local organization, with the IQCs' in each nuclear facility (laboratory, storage, reactor, etc …), the SC for the entire center ensures that the operational resources, and control functions are distinctly separated. The ICC is the "man in the middle" between the support resources and the control functions.

The CEA has an overall criticality safety organization supported by a complete set of documents.

[5] file collection (ICNC'07 : A guide to summarize the main notions and principles of criticality safety : the criticality guide files collection

[6] NCSD'05 : Guide in Progress for Criticality Accident Studies