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# Inventory of nuclear materials in case of emergency

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**Abstract:** The crisis situations for nuclear materials in nuclear facilities are provided for in the French regulation, as the decree of 12 May 1981 specifies that " In any circumstance, the Ministry of Industry can order a physical inventory of the materials and its comparison with the accountancy records ". Such an inventory can be ordered in facilities holding category I nuclear materials, in case of a theft for example. The operators must be able to establish quickly if the stolen materials come from their facility. To test the organization set at the operators and competent authority levels respectively, five exercises of increasing complexity have already been carried out. These exercises have permitted the validation of procedures, composition of the various crisis centers, methodology for such an inventory and use of protected communication means. The authority crisis center includes members of the competent Authority and its technical support body : staff members of the IPSN. It is in charge of the national managing of the operations, in relation with one or several site crisis centers. The site crisis center is the interface between the authorities and the facility crisis center. The operations of inventory are carried out from the roughest checking to the finest ones. To be efficient during the first hours of the crisis, the authority crisis center must have data bases at the disposal of its experts, containing information about physical protection and accountancy of the nuclear materials detained by the site and the relevant facilities.

## 1. INTRODUCTION

After a short overview of the French nuclear situation, the paper describes what is an "exercise of inventory of nuclear materials in case of emergency", the method employed and a history of the inventories of this kind already carried out. Finally the paper describes more precisely a concrete example.

## 2. THE FRENCH DOMESTIC SAFEGUARDS AND THE RELEVANT REGULATION

In France, there are approximately 270 facilities holding nuclear materials classified in three physical protection categories and 55 of them hold category I nuclear materials. The majority of these facilities are part of nuclear sites, such as research centers, industrial complexes and nuclear power stations. These facilities cover the entire nuclear fuel cycle, from mining of uranium to storage of waste and plutonium recycling in the manufacture of mixed oxide (MOX) fuel, and including spent fuel reprocessing.

The French regulations, in particular the Law of July 25, 1980, the decrees of May 12 and 15, 1981 for its application and the order of March 16, 1994, provide for control by the authorities of all nuclear materials located on the French territory. This control consists of :

- evaluation of the measures taken by the licensee to guarantee the protection and control of nuclear materials. These measures are described in the various files requested from the licensee (mainly the authorization file).
- regulatory inspections carried out by sworn State-authorized officials.

The authority responsible for the implementation of these regulations is the Minister for the Industry, represented by the High Civil Servant for Defense. He is assisted by the means and skills available at the Institute for Protection and Nuclear Safety (IPSN).

In this regulatory context, the article # 12 of the decree of May 12, 1981 provides that " In any circumstance, the Ministry of Industry can order a physical inventory of the materials and its comparison with the accountancy records ". Such an inventory can be ordered in the case of a theft, a blackmail to a theft or a suspicion thereof, for example.

### **3. THE EXERCISE OF INVENTORY OF NUCLEAR MATERIALS IN CASE OF EMERGENCY**

#### **3.1. The relevant facilities**

Only facilities holding category I nuclear materials are concerned with the exercises of inventory in case of emergency and more precisely those holding plutonium, uranium enriched at 20% in uranium 235 or more and uranium 233.

#### **3.2. The approach**

A scenario is set up by the competent authority. It is assumed that a certain quantity of nuclear material, whose quality (uranium enrichment range for instance) may be specified, has been stolen from a facility.

The objective is to prepare the facilities holding sensitive nuclear materials to carry out an inventory in a very short period of time. Indeed, in case of emergency, the licensee must be able to provide within a few hours for an answer to the question : " Is it likely that the supposedly stolen nuclear materials come from my facility? " .

The facility or the facilities are chosen by the competent authority and its technical support body (staff members of IPSN) according to the interest and the objectives of the exercise.

The exercise of inventory is organized without prior notice over one day chosen during a fortnight settled in advance with the operator.

Several months before this date, the licensee compiles and updates the documents required for the exercise: emergency inventory taking procedures for the site, for the security unit and for the relevant facilities, as well as data bases that will be necessary for the competent authority.

#### **3.3. The State Authority Organization**

In the event of a real crisis, the authorities have to manage the operations of physical inventory taking at the national level, and in particular to indicate the sites and installations concerned with the inventory and to guide the operations according to information available.

They have to initiate the crisis situation . Therefore, the authority must have a crisis center at its disposal.

The authority crisis center is set up the day of the exercise in a dedicated room, equipped with the suitable means of communication. It is located in the IPSN premises. This crisis center includes members of the Nuclear Material Supervising authority as well as staff members of IPSN. Its missions are :

- assuring the interface between the licensee and the competent authorities (local or national),
- being able to supply immediately technical answers to the competent authority based on the available documents about the site and facilities.
- bringing technical support to the competent authority, making use, as needed, of the experts in the various services of the Institute to ensure the technical analyses.

This crisis center has its own means of communication, allowing for communications in a free or encrypted way (telephone, telex, fax). It is in relation with the direction crisis center management of the site(s) concerned with the exercise, and can also be in contact with local authorities or the media.

The exercise is triggered by a fax from the authority crisis center, towards the crisis center(s) of the concerned licensee(s), specifying the type of nuclear material or the type of item sought. The alarm message is delivered to the licensee, who must acknowledge receipt.

### **3.4. The organization set up by the operator**

This organization is similar to the one set up for safety matters. It depends on the configuration of the plan, but in general one management crisis center, one security crisis center and one crisis center for each facility are organized. These crisis centers are fixed within the hour following alarm.

The alarm is delivered to the security crisis center which is in charge of organizing the following actions : staff alert, plant closure (if requested) and physical protection checking (fences, absence of breaking in, checking of alarms).

The management crisis center serves as an interface between the competent authorities and the other crisis centers activated on the site. It is in charge of directing the operations of physical inventory on the site and of informing the authorities according to the information provided by the operators.

The facility crisis center is responsible for organizing the operations on the facility and answering the questions of the management crisis center. The operations of physical inventory must be organized complying with the rules of operation in the facility, thus, the first measures taken can be the halting of the processes, suspension of nuclear materials movements, requesting for assistance...

Before proceeding to the physical inventory taking itself, the facility crisis center must carry out the following preliminary steps:

- It must draw up the theoretical list of all the items held in the facility. According to this list, it is then possible to determine the number of articles making up the inventory. In fact, the available information contained in the message of alarm (related to the mass or *some characteristics of the article*), can possibly allow for restricting the number of items concerned by the inventory taking.
- This list of articles should be compared to the accounting records in the facility to make sure there is no alteration of the article data basis

- The accounting records in the facility are in turn compared to the monthly records of the facility inventory change reports sent by the Central Accounting Office of the IPSN which receives its data from all the French facilities on a daily basis.

Those operations of reconciliation are designed to make sure that any possible theft or diversion of nuclear materials in the facility has not been preceded or followed by any tampering of the local accountancy to cover up the illegal action and thus to avoid early detection.

Knowing the characteristics of the articles subject to the inventory taking, the checking proceeds from the roughest to the finest according to the following steps:

- Counting, identification and check of seals on items concerned by the inventory taking
  - Counting, identification and check of tags on non-sealed containers of items concerned by the inventory taking
    - Gross weighing of the preceding containers whose nuclear material content exceeds a specified mass (value given by the management crisis center)
    - Gross quality checking ( Uranium or plutonium presence detection through physical measurements) for the preceding non-sealed containers (a substitution by a dummy article must be considered)
    - Gross weighing and gross quality checking for sealed containers whose nuclear material content exceeds the specified mass
    - Fine quality checking of all containers whose nuclear material content exceeds the specified mass (physical measurements of isotopic composition, Pu or U net weight, U enrichment)

The first checking must be carried out while the necessary means for gross and fine measurements are settled. The human and technical resources can belong to the facility or be mobile means available on the site.

To carry out these parallel operations and minimize the time necessary to reach the objective (confirm or deny the theft or diversion), the written procedure of inventory taking must contain chronological order and time estimation for the various operations.

## **4. EXERCISE FEEDBACKS**

The goal of these exercises is :

- to validate the structures and the organization settled, on the level of the operators and on the level of the authorities as well,
- to test the various procedures,
- to check the means of communication.

These exercises must be carried out in circumstances approaching the real conditions of a crisis as much as possible. Therefore, exercises of increasing complexity have been organized since 1993.

### **4.1. Test fuel fabrication Laboratory**

This exercise took place in 1993 and the experience feedback showed the necessity of writing reflex sheets annexed to the facility procedures and the elaboration of a list of telephone and fax numbers used for the exercise. This exercise also illustrated the

importance of the use of seals (after characterization of nuclear materials) to ease and accelerate a physical inventory taking.

## **4.2. Uranium metal processing workshop**

This exercise took place in 1995. It showed the need for the planning of sequences and actions for a more satisfactory course of the inventory taking and the optimization of its duration : process operation suspension, debriefing in the various crisis centers, preparation at the very beginning of the exercise of longer term actions, sequence in the physical inventory taking, checking of the seals, characterization of the materials, elaboration of the reference frames. Thus, more detailed procedures and implementation of reflex sheets in the facility have been asked afterwards.

This exercise has not been initiated during IPSN working hours. It showed the necessity for IPSN to use a data base about the facilities holding category I nuclear materials, so that the authority crisis center can be effective in the first hours of the exercise.

This data base must provide essential information about the site and the facilities, as well those concerning physical protection as the accountancy of nuclear materials. Using this document, it is possible to know immediately the geographical situation of the site, the activities of the facilities holding category I nuclear materials, the quantities of nuclear materials, the number of articles held, or at least an order of magnitude of this number, the means available for physical protection. In the first hours of the crisis, these documents appear useful to the IPSN experts in order to quickly provide the authorities with analyses and answers even when the entire file of the installations is not available (non working hours for example).

## **4.3. Research center for Defense**

This exercise took place in 1997. It showed the need for establishing a procedure concerning the operation of the means of communication necessary to the transmission of classified data. It also appeared necessary to standardize the means of communication between the operators and the authorities and to draw up a specific list of the fax and telephone numbers usable for exercises and real crises

## **4.4. Research reactor**

This exercise took place in 1999. It showed that the methods of transfer of classified information on a site were insufficiently described.

It revealed the importance of abiding by the procedures of information circulation for a correct operation of the physical inventory taking. In fact, a centralization of information and instructions in only one point (management crisis center) avoids incompatible instructions or orders in a crisis situation.

It also showed that regular and frequent information of the management crisis center by the facility crisis center is necessary, so that the authority crisis center can be notified of the progress report of the physical inventory taking.

During this exercise, it had been requested from the operator to make sure that nuclear materials were really present in the checked articles, and that it was impossible that any of them could have been replaced by dummy items. The organization of physical measurements showed that a better definition of the methods and nature of non-destructive measurements to implement in a crisis situation was necessary.

#### **4.5. Research laboratory and reprocessing pilot facility under decommissioning**

This exercise took place in 2000. It allowed for validating the experience feedback of the preceding exercises, concerning the required documents, the composition of the various crisis centers and the links between them, the means of communication, the protection of sensitive information.

It made possible to validate the constitution, the equipment and the operation of the authority crisis center. It also made possible to validate the documents and procedures in a facility under dismantling.

This exercise differs from the others by the fact that two operators, located on the same site, were implied. The management crisis center thus comprised representatives of the two concerned operators. This exercise thus allowed for testing the interfaces between the various entities on the site, the shared responsibilities within the management crisis center, the efficiency of the system of centralized information and of data transmission towards the authority crisis center.

#### **4.6. Considerations for the future**

For this year 2001, an exercise is envisaged in a nuclear materials storage facility which poses the problem of checking a lot of items at the same time in a very short period of time. For the year 2002, it is planned to organize a physical inventory taking involving two different sites at the same time.

### **5. CONCLUSION**

All these exercises allowed for setting up a methodology in the preparation and the execution of the exercises of inventory in case of emergency. The main events which could occur in case of a crisis situation have been tested. Moreover, the increased complexity of the exercises makes possible to develop the preparation of the installations as well as the organization of the authority for a real crisis.

All these exercises made possible to establish models of the useful documents in the event of a crisis, and this for various types of facilities. The lacks or inaccuracies noted in these documents at the time of the first exercises were corrected.

These exercises have made the operators involved, as well as the companies they depend on, sensitive to the importance of an efficient training for this kind of occurrence. Finally, the implementation of exercises made possible to organize an authority crisis center and to equip it in means of communication. This crisis center is set up under the responsibility of IPSN. A procedure for the activation and operation of this crisis center has

also been written. In turn, this document will be improved with the experience feedback of the next exercises.