Transport of radioactive material within facilities not involving public roads or railways

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ABSTRACT

IAEA Regulations for the safe transport of radioactive material establish standards of safety which provide an acceptable level of control of the radiation, criticality and thermal hazards to persons, property and the environment that are associated with the transport of these dangerous goods. These Regulations apply to the transport of radioactive material by all modes on land, water or in the air, including transport which is incidental to the use of the radioactive material. Through the worldwide adoption of these regulations for all modes of transport, a very high standard of safety in transport has been achieved. However these regulations do not apply to radioactive material moved within a facility which is subject to appropriate safety regulations in force in the establishment and where the movement does not involve public roads or railways.

In France, nuclear research centres and industrial complexes comprise numerous facilities spread out over many acres. For instance, the Atomic Energy Commission (CEA) Centres comprise various Basic Nuclear Installations (experimental reactors, laboratories), used for research and development activities in the nuclear field. Research is focused notably on the lifetime of operating plants, future reactors, fuel performances or nuclear waste. Likewise, the nuclear fuel processing plant operated by COGEMA at La Hague sprawls over approximately 2 km. An investigation carried out by the Institute for Nuclear Safety and Protection has revealed that over 20,000 packages containing more than one hundred A2 are shipped internally every year, taking all the complexes and centres as a whole.

The French Safety Authority, which has been responsible for monitoring the shipment of radioactive materials since 1997, has therefore decided to review the internal shipment rules devised by the various sectors of industry. Generally speaking, the safety authority is requiring that justification be given for the differences between these rules and the regulations that apply to shipments travelling by public highway, which serve as a reference. The Safety Authority has also asked that beyond a certain threshold (i.e. a set quantity of fissile and/or radioactive material), licensees submit a safety file with a view to approving packages for internal shipment. It should be possible to approve all the packages concerned within around five years.

INTRODUCTION

IAEA Regulations for the safe transport of radioactive material [1,2] establish standards of safety which provide an acceptable level of control of the radiation, criticality and thermal hazards to persons, property and the environment that are associated with the transport of these dangerous goods. These Regulations apply to the transport of radioactive material by all modes on land, water or in the air, including transport which is incidental to the use of the radioactive material. Through the worldwide adoption of these regulations for all modes of transport, a very high standard of safety in transport has been achieved. However these

regulations do not apply to radioactive material moved within a facility which is subject to appropriate safety regulations in force in the establishment and where the movement does not involve public roads or railways.

1. Nuclear sites

In France, nuclear research centres and industrial complexes comprise numerous facilities spread out over many acres. This means that radioactive materials have to be moved around the sites concerned.

1.1. Atomic Energy Commission Installations

The Atomic Energy Commission (CEA) Centres comprise various Basic Nuclear Installations (experimental reactors, laboratories), used for research and development activities in the nuclear field. Research is focused notably on the lifetime of operating plants, future reactors, fuel performances or nuclear waste.

Cadarache Centre (CEA-CAD) : the Cadarache Centre is located at Saint-Paul-lez-Durance, in the Bouches-du-Rhône department. It covers an area of 1,600 hectares. The main purpose of the units installed there is the industrial application of research and development in the fields of power reactors and uranium or plutonium based fuel. It is for this reason that this Centre comprises about twenty Basic Nuclear Installations (BNI), some of which (Cabri, Scarabée and Phébus reactors) are operated by the Institute for Nuclear Safety and Protection (IPSN) for its research work.

Fontenay-aux-Roses Centre (CEA-FAR) : this CEA Centre is located in the town of Fontenay-aux-Roses, bordering on the towns of Chatillon and Plessis-Robinson, in the Hauts-de-Seine department. It occupies an area of 13.8 hectares. The Centre comprises four BNIs, pursuing research activities in the fields of chemical engineering, analytical chemistry, storage of radioactive waste and transuranians. The plutonium spent fuel analysis laboratory (RM2) and the plutonium chemistry laboratory are currently being dismantled. Only the radioactive solid and liquid waste treatment station and the interim storage facility for radioactive solid waste are still operating.

Grenoble Centre (CEA-GRE) : the Grenoble Centre, in the Isère department, is located in an industrial zone to the northwest of the city, where it tapers to a point delimited by the Drac river and Isère confluence. It occupies an area of 128 hectares. The main activities of this Centre are fundamental, non-nuclear applied research (condensed state physics, biology, electronics and materials) and applied research devoted to the development of nuclear reactor types and mainly focused on their safety (thermal hydraulic aspects).

Saclay Centre (CEA-SAC) : the Saclay Centre is located about 20 km from Paris in the Essonne department. It occupies an area of 200 hectares, including the Orme des Merisiers annex. The activities of this Centre comprise fundamental research (physics, biology, chemistry, metallurgy), supported by a wide range of laboratories using heavy equipment, such as research reactors and particle accelerators, applied research (research and

development on reactors, isotopic separation, application of ionising radiation), design, manufacture and commercialisation of artificial radioelements.

Other CEA centres working for the ministry of defence (CEA-DIF) : the CEA also operates a number of top secret BNIs for the ministry of defence. The Safety Authority for these facilities is the High Commissioner for Atomic Energy.

1.2. COGEMA Installations

COGEMA La Hague (COG-HAG) : the COGEMA La Hague complex is located on the Northwestern tip of the Cotentin peninsular, 20 km west of Cherbourg. In 1959, the Atomic Energy Commission (CEA) decided to construct the UP2 plant, for the reprocessing of fuel irradiated in natural uranium graphite-moderated GCRs. In 1974, the CEA was authorised to supplement the UP2 plant with a high level oxide shop (HAO), for the reprocessing of light water reactor fuels. The UP2 plant thus equipped and the HAO shop were put into service in 1978, forming the UP2 400 plant, with an annual fuel reprocessing capacity of 400 tons. Responsibility for operation of the site was transferred to COGEMA in 1978. By decrees of May 12, 1981, COGEMA was authorised to set up, in addition, UP3, designed for the annual reprocessing of about 800 tons of fuel from LWRs, UP2 800, same purpose and capacity and STE 3, designed for the purification of effluents from both the above plants, before release into the sea. Likewise, the nuclear fuel processing plant operated by COGEMA at La Hague sprawls over approximately 2 km.

Other COGEMA centres working for the ministry of defence (COG-MAR) : in Marcoule, in the Gard department, COGEMA also operates top secret nuclear facilities for the ministry of defence. The Safety Authority for these facilities is the High Commissioner for Atomic Energy.

1.3. TECHNICATOME Installations (TA)

TECHNICATOME operates top secret nuclear facilities for the ministry of defence at Cadarache. The Safety Authority for these facilities is the High Commissioner for Atomic Energy.

2. Volume of internal shipments

An investigation carried out by the Institute for Nuclear Safety and Protection has revealed that over 20,000 packages containing more than one hundred A_2 are shipped internally every year, taking all the complexes and centres as a whole. Following the IPSN's request that an inquiry be carried out, the CEA, COGEMA and TECHNICATOME submitted details of all their internal shipments. The IPSN interpreted the data by grouping the packages in question into categories of activity:

- F1: packages with contents between A_2 and 10 A_2,
- F2: packages with contents between 10 A_2 and 100 A_2,
- F3: packages with contents between 100 A_2 and 1000 A_2,

- F4: packages with contents in excess of 1000 A_2.

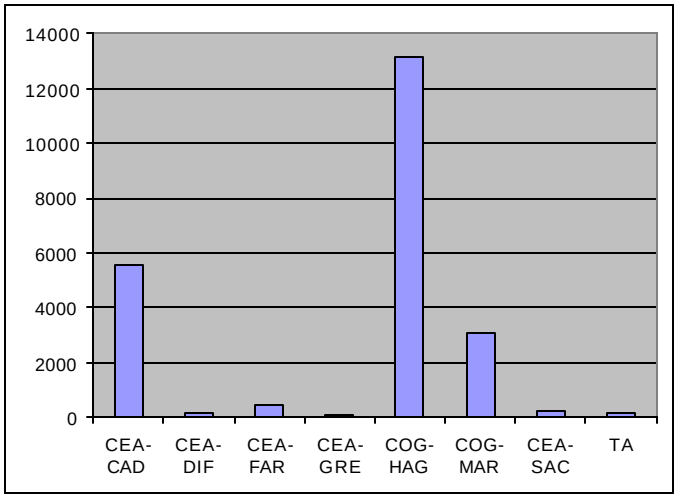

Chart 1, Total number of packages shipped internally within each centre/establishment

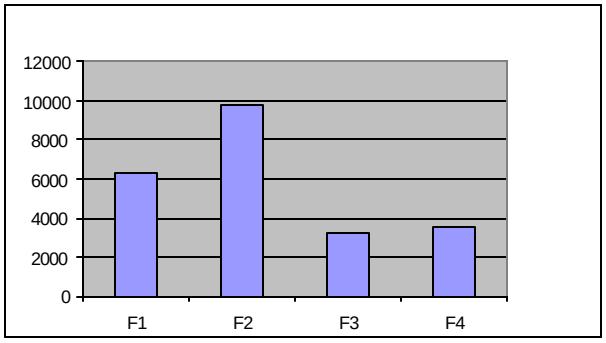

Chart 2, Number of packages shipped per category for all centres and establishments combined

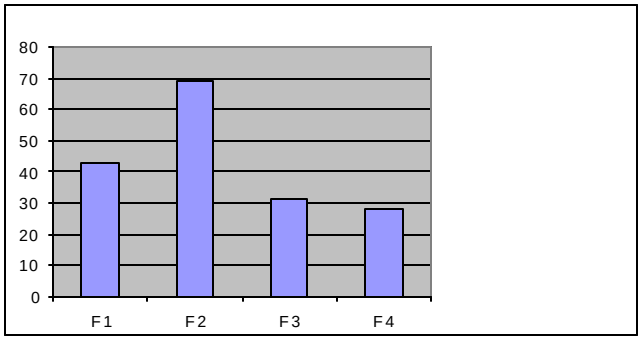

Chart 3, Total types of packages per category

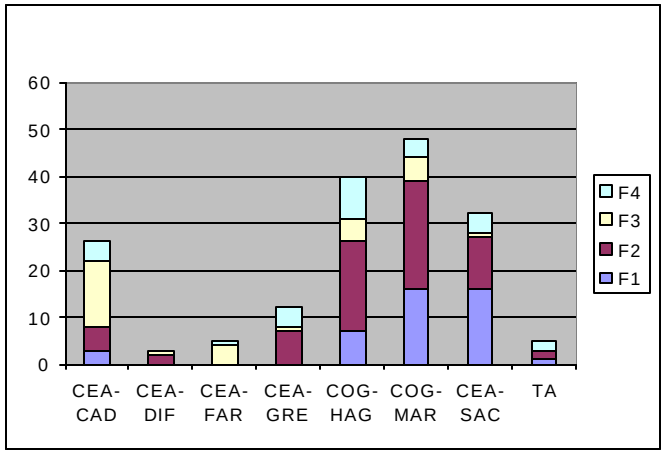

Chart 4, Number of types of packages per category of activity per centre/establishment

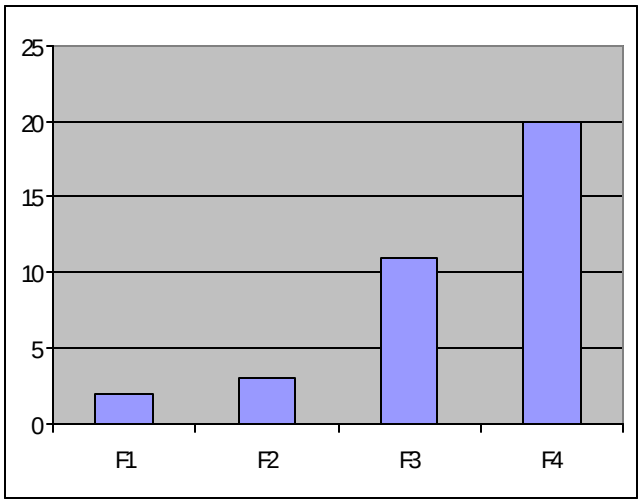

Chart 5, total types of fissile packages per category

The general conclusions of the inquiry were as follows:

- the number of types of packages depends on whether the centre is engaged in industrial activities (COGEMA) or research activities (CEA-CAD and CEA-SAC),
- this means that the ratio of shipments to types of packages is low for COG-HAG and high for research centres (CEA-CAD and CEA-SAC),
- the number of packages is practically halved when there is a change of category,
- most packages containing fissile material are in categories F3 and F4.

3. Rules in force on the sites in question

Nuclear operators have devised internal shipping rules for all packages shipped. These rules focus on the responsibilities of the individual players, the conditions under which packages are approved for internal shipment (information to be supplied for inclusion in approval file), the requirements for the casks used on site (qualification, monitoring, regular maintenance etc.), the requirements for internal shipment (radiological protection, identification, docking etc.).

4. Approach adopted by the French Nuclear Safety Authority

4.1. General principles

The French Nuclear Safety Directorate (DSIN) has been responsible for monitoring the shipment of radioactive materials for civil use since 1997 [3]. In application of the ministerial instructions of August 16, 1999 [4], supervision of the transport of radioactive and fissile materials for national security purposes falls to the High Commissioner for Atomic Energy. So that the work could be carried out jointly, the French Safety Authority decided to undertake a review of the internal shipment rules, beginning with the rules in force on CEA sites. Indeed, some of the CEA sites are home to both top secret nuclear installations and non-military basic nuclear installations. Generally speaking, the Safety Authorities are requiring that justification be given for the differences between these rules and the regulations that apply to shipments travelling by public highway, which serve as a reference. The Safety Authorities have also asked that beyond a certain threshold (i.e. a set quantity of fissile and/or radioactive material), licensees submit a safety file with a view to approving packages for internal shipment.

4.2. The 100 A_2 threshold

Although the general rules for the shipment of radioactive materials do not apply on the sites, the site industrial safety managers and plant directors are nonetheless responsible for the safety of internal shipments. One of the issues dealt with by the Safety Authorities was the level of control it should exercise prior to shipments, particularly as regards the approval of internal shipment casks. The principle adopted was that the Safety Authorities should not intervene unless a threshold equivalent in terms of risk to that adopted for intervention in the case of external shipments had been reached (A_2). Since the types of packages containing fissile material are generally in Categories F3 and F4, no decision was taken to study a specific threshold for them.

To determine this threshold (quantity of radioactive material expressed as A_2), the Safety Authorities mandated a group of experts who adopted the following working hypotheses:

- the scenarios of the Q-system currently used for external shipments were to be retained,
- liquids and gases, not specifically covered by the current Q-system, were to be assessed separately,
- the effective dose limits of the current Q-system were to be retained,
- the values of the following parameters were to be studied to make allowance for the specific nature of internal shipment:

- external irradiation due to photons: distance from package and exposure duration,
- external irradiation due to β radiation: distance from package and exposure duration,
- internal contamination through inhalation: fraction of particles put back into suspension, volume of room or vehicle, air change rate, distance from package in direction of prevailing wind,
- external contamination on contact: distance from package and exposure duration, fraction of contaminating particles dispersed,
- external irradiation due to gas cloud: volume of room, air change rate, exposure duration.

The work carried out by this group of experts was submitted to a transport safety commission of experts. The commission recommended that packages be approved by the Safety Authorities when their activity exceeded 100 A_2, except for β emitters and soluble gases (in the radiological protection sense, i.e. gases which are taken into the body when inhaled). The commission recommended that for these materials, approval be granted on a case-by-case basis by the Safety Authorities on the strength of the safety analysis report, taking the thresholds of activity requiring approval for shipment using public highways as a starting point. Since the existence of safety margins is based on operational measures, the commission recommended that nuclear operators commit themselves to taking the appropriate steps concerning the training and qualification of drivers, the procedures to be applied by drivers, escorts, and security and radiological protection personnel, the equipment made available to drivers and escorts (communication, detection and protection equipment), alarm descriptions and levels in terms of dosimetry, particularly individual operational dosimetry. Lastly, the commission recommended that, for packages containing uranium hexafluoride, approval be obtained by applying the threshold contained in the regulations for shipment on public highways.

For non-military shipments, the 100 A_2 threshold adopted implies that around twenty packages have to be approved for the Atomic Energy Commission Centres. The Competent Authority and its technical support body should be able to complete the paperwork for these approvals within a few years; those with serious implications for safety will be examined first and compensatory measures will be taken for casks that cannot be approved in the near future.

5. Preliminary examination of general rules governing internal shipment at the CEA

To prepare for the shipment safety commission charged with examining the general internal shipment rules in force at the CEA, the Institute for Nuclear Safety and Protection made a preliminary analysis of the documents submitted by the CEA. The Safety Authorities plans to examine the rules established by other operators as well.

5.1. Comments on rules relating to organisation

The quality assurance rules should be applied to internal shipments. By way of example, shipment managers could base their quality assurance programmes on those described in Safety Series No. 113 published by the IAEA [5]. Likewise, activity reports and cask tracking sheets should be submitted to the authorities.

5.2. Comments on package safety requirements

The review reveals that the release criterion of 10^{-4} A_2/h (as opposed to 10^{-6} A_2/h for shipments to be made on public highways) has to be justified, especially as regards compliance with requirements concerning exposure of shipment personnel. The differences between the tests described in the general rules for internal shipments and those laid down in the regulations for shipments on public highways also have to be justified. Indeed, drops onto a rigid surface are limited to a height of 2.5 m and the fire resistance test involves a fire lasting 10 minutes. The release criterion of 0.1 A_2 per day in accident situations seems consistent with the criterion contained in the regulations for shipments on the public highway (A_2 per week).

6. Conclusion

In France, nuclear research centres and industrial complexes comprise numerous facilities spread out over many acres. An investigation carried out by the Institute for Nuclear Safety and Protection has revealed that over 20,000 packages containing more than one hundred A_2 are shipped internally every year, taking all the complexes and centres as a whole. The approach instigated by the Safety Authorities involves a thorough review of the regulations established by nuclear operators. Even though the review has not yet been completed, shipment managers have already been asked to justify several points. In parallel, the Safety Authorities is now approving packages beyond the 100 A_2 threshold. It should be possible to approve all the packages concerned within around five years.

References

[1] **IAEA (International Atomic Energy Agency) Safety Series No. 6 (1985) *Transport Regulations*, Vienna.**

[2] **IAEA (International Atomic Energy Agency) No. TS-R-1 (ST-1, revised), 1996 (Revised) *Regulations for the Safe Transport of Radioactive Material*, Vienna.**

[3] **Decrees No. 97-710 and 97-715 of 11 June 1997 relating to the remits of the ministry for the economy, finance and industry and the ministry for the environment and territorial development.**

[4] **Inter-ministerial instruction DEF/D9901767J of 16 August 1999.**

[5] **IAEA (International Atomic Energy Agency) Safety Series No. 113 (1994), *Quality Assurance for the safe transport of Radioactive Material.***