NUCLEAR NON PROLIFERATION AND SECURITY CULTURE WITHIN EDF NUCLEAR FLEET

Michel Debes - EDF Generation
michel.debes@edf.fr

1/ Introduction: EDF as a major nuclear operator
EDF operates 58 PWR reactors on 19 sites (63 GWe), with three standardized series (34 units 900 MW, 20 units 1300 MW, 4 units 1500 MW), with a unique experience both as architect and operator. The operating experience feedback represents now up to 1500 reactor years. The goal is to operate the nuclear fleet in the long term while investing in plant modernization and updating, through systematic ten years safety reassessment processes performed under control of the French Nuclear Safety Authority (ASN). The production reached 421 TWh in 2011 (= 78% of French electricity generation). One new EPR plant (1650 MW) is under construction at Flamanville, to be commissioned in 2016. Most of the NPPs can operate in load following mode, and 22 units are loaded with MOX fuel.

EDF key strategies for sustainable nuclear generation aim to remain an industry standard worldwide:
- Nuclear safety and safety culture as a first priority, with extensive use of experience feedback. The post Fukushima complementary safety assessment has shown the good level of resistance and margins against external hazards (earthquake, flooding, loss of power supply) and led to extend further the resistance of plants against severe combinations of situations, involving multi-units, with the implementation of a dedicated "Fast Action Force" and additional "hard core" safety devices (emergency diesel generators, water supply, instrumentation...);
- Competitiveness, availability and operational performances;
- Transparency and social acceptance;
- Plant Long Term Operation, through periodical 10 years safety reassessments for each standardized series, with a goal up to 60 years;
- Security of supply and fuel cycle efficiency, through reprocessing / recycling and waste management, within appropriate policy framework;
- Succeed in the EPR Flamanville-3 construction project, while drawing experience feedback;
- Being a major player in the international development of Nuclear Power : China (construction of 2 EPR), UK (EPR generic design assessment), USA (US EPR licensing), Poland, RSA...
Regarding the fuel cycle, the strategy currently implemented by EDF, in accordance with the French national policy, is to reprocess the spent fuel and to recycle the separated plutonium using MOX fuel and the reprocessed uranium after re-enrichment (REPU fuel). This strategy, which relies on the nuclear fuel cycle industry developed in France (Areva), is a major contribution to long term nuclear energy sustainability.

The quantity of spent fuel to be reprocessed is determined in accordance with the overall recycling capacity of the reactors which have been licensed to use MOX fuel. As a matter of fact, with 58 EDF NPPs in operation (430 TWh), every year around 1200 tons of Spent Fuel are transported to La Hague (Areva) for interim storage in cooling pools and around 1050 tons of UOX spent fuel are reprocessed and recycled. It results in 10 tons of separated reactor grade plutonium, which is recycled within 120 t of MOX fuel to be loaded on 22 units 900 MW (30% core). The reprocessed uranium can also be recycled on 4 units 900 MW. On the whole, it enables around 17% of nuclear production originating from fuel recycling.

Another major result is the conditioning of high level waste by vitrification in glass canisters and intermediate level waste by compaction, in a safe and convenient form to be stored for cooling and disposed of in a geological repository when available (cf June 28, 2006 law).

Ultimately, the residual plutonium is concentrated in MOX spent fuel and stored in cooling pools, for possible reuse to start GEN4 fast reactors in the far future. The vitrified high level waste canisters are inert and do no more contain fissile material (plutonium or uranium).

2/ Nuclear material management, protection and controls
Safety, Security, Application of Non Proliferation Treaty and Safeguards (IAEA "3S") are major worldwide conditions for nuclear acceptability and development. As an operator, EDF implements governmental policies on institutional guarantees (Euratom and NPT Treaties, Safeguards agreements,…)
Concerning NPPs, which contain fuel assemblies (fresh fuel, spent fuel in cooling pool...), EDF has its specific responsibility regarding the safety and security of fissile material which are under its custody, consistent with the management and security of fuel cycle activities.

As a nuclear operator, EDF has to organize and secure its nuclear fuel supply activities. It involves the enrichment of fissile material, fabrication of fuel assemblies, and the management of spent fuel, which still contains fissile material (plutonium and uranium), through storage, reprocessing, recycling, and transportation (front end and back end). Those activities all along the fuel cycle are performed by fuel cycle industrial actors, in compliance with safety, security, safeguards and non proliferation rules, through national regulations (code of defense) and international rules and controls (Euratom Treaty, Non Proliferation Treaty, IAEA Safeguards...).

Proven industrial solutions have been implemented to address the non proliferation issues, within protected and secured facilities, transportation in secured and robust casks, under surveillance and protection rules (national regulations - code of defense, INFCIRC/225).

**Mandatory rules and regulations at international and national level**

All these activities are submitted to international and regional controls, within a strict international regulatory framework:
- Euratom Treaty (1957) and controls by European Commission inspectors;
- Non Proliferation Treaty and associated Safeguards;
- French IAEA Voluntary Offer Agreement and Additional Protocol which cover R&D and export/import activities (IAEA INFCIRC/290);
- Nuclear Suppliers Group (NSG - 1978) and guidelines for nuclear exports;
- IAEA recommendations on Physical Protection of Nuclear Material and Nuclear Facilities (INFCIRC 225);
- IAEA Convention on the Physical Protection of Nuclear Material (CPPNM, 1979);
- UN Security council resolution 1540 on the prevention of proliferation (non state actors...).

**National control of nuclear material in France**

The national rules cover all the facets of international requirements:
- Application of the "Code of defense", in compliance with international regulation (Art. L. 1332-1 & L 1333-1 and following; "PCMNIT" Order dated 17/09/09 related to Protection and Control of Nuclear Material, Facilities and Transportation...);
- Control by the Defense and Security High Civil Servant (HFDS) at the Ministry level, with dedicated national inspectors and IRSN as technical support (Nuclear Defense expertise department);
- Application to all nuclear material and facilities in France (plutonium, uranium, thorium, lithium6, deuterium, tritium) and obligation to comply with control requirements and international agreements and to prevent loss, theft or diversion of nuclear material;
- Protection and custody of nuclear material within protected facilities, under the responsibility of dedicated and authorized personnel;
- Authorization regime for holding, transport and use of nuclear material delivered by the HFDS for each facility.
Each nuclear operator bears a dedicated responsibility as holder of fissile materials in its facility, with explicit requirements against diversion of nuclear material:
- Internal expertise and organizational responsibilities;
- Specific authorization for holding sensitive material, with dedicated and authorized officers in charge of the custody of the material;
- Full knowledge of the location of any object containing nuclear material;
- Material quantity assessment (fresh fuel, spent fuel, nuclear material fissile and fertile…);
- Monitoring and detection of any anomaly, protective devices for sensitive material;
- Periodical report and inventory to national authority;
- Quality assurance, internal controls and audits.

Application within EDF nuclear facilities:
The application to EDF NPPs includes internal procedures to address these requirements:
- Designation of authorized responsibles: The Director of each nuclear plant; the responsible in charge of nuclear material and the personnel in charge of material accountancy;
- A process of nuclear material accountancy for any movement or transformation: declaration to national accountability system (IRSN); inter comparison and control between local and national system;
- A system of monitoring and follow up of nuclear material, to know at any time the location of any object or item containing nuclear material in the facility;
- A methodology support, provided by a team of experts at corporate level (Operation department of the nuclear fuel division), which acts as interface with National Control.
- Internal controls: annual physical inventory and verification of accountability system, control and record by plant management, internal audits of nuclear material accountability.

External independent controls are performed by HFDS inspectors and IRSN, planned or fortuitous, related to organization and technical domains (receipt, sending, inventory …), to check compliance with the authorization file and quality rule.

These activities are also submitted to Euratom controls with equivalent requirements: authorization regime, system of nuclear material accountancy and monitoring, with monthly declarations, and control of physical inventory by Euratom inspectors.

For EDF, four key points related to non proliferation policy are to be underlined, as seen from a responsible nuclear utility perspective:
- As an operator, implement government policies on institutional guarantees (Treaties and Safeguards, IAEA “3S” - Safety, Security, Safeguards);
- Apply Safeguards at the technical level, through material accountancy and additional measures through the application of the IAEA Additional Protocol, at each stage of nuclear material management;
- Support proposals by international organizations involved in the fuel cycle industry (fuel bank…), provided they are in line with market conditions;
- Prepare for future fuel cycle, including resistance to proliferation, while avoiding increased complexity.

3/ The EDF security culture policy: principles, organization, rules

The protection of the EDF industrial assets (human, material, knowledge…) against malevolent action is of major importance, within an evolving context, new technologies and new threats (cyber-security...). It involves human, financial and material aspects and relies on every employee and management within the company.

The security of important EDF facilities and grids, including NPPS, is governed by the application of the February 26, 2006, Governmental Order related to "vital importance activities" in France:
- "Domains of vital importance" and "operators of vital importance" are defined by governmental order;
- National security rules, based on risk analysis and threat scenarios, are edicted for each domain of vital importance;
- A "security plan" is drawn by the "operator of vital importance", in compliance with the national security rules; it includes a list of "facilities of vital importance", of which unavailability could impact economic, security or vital public interests for the country;
- A responsible in charge of security is designated within the "operator of vital importance";
- For each "facility of vital importance", a "specific security plan" is drawn, in compliance with the "security plan", and submitted to the Prefect public authority at the local level.

The EDF security policy goal is to protect human, material and knowledge assets, and to preserve operational capacity, competitiveness and public confidence, within national regulatory framework and regulation on "vital importance facilities''.

The security policy relies on the following principles:
- Involvement each employee and responsibility awareness, as part of a dedicated security culture: questioning attitude, rigor, vigilance…;
- Based on risk analysis, while preserving cost effectiveness, in proportion with potential consequences (public health and safety, environment, production and economy…);
- Integrated in operational processes, while preserving efficiency;
- Compliance with regulations, while preserving the rights of employees and privacy.

The EDF organization comprises the Security Director and the Security Department at corporate level, in charge of the general organization and policies, relationships with national authorities, coordination with operational divisions. The management of each operational division and unit bears the responsibility to implement the security policy at each level, consistent with quality policy.

The treatment of events or incident (detection, analysis, lessons drawn, experience feedback) is a tool to progress, along with reporting, internal control process and audits.
The security requirements cover the different related domains important to EDF industrial assets: security of employees against assaults; security of data according to their sensibility level; security of the information system and telecom; awareness and training of employees; relations with external suppliers or contractors; business premises; security of staff and projects abroad.

For industrial facilities and grids (facilities of "vital importance"...), the defense in depth principles are applied against the different threat scenarios. Security measures are studied at the design stage in a consistent way with nuclear safety measures, while taking into account the protective means deployed by public authorities. These risk analysis are periodically reassessed. Information regarding security is protected as necessary, while preserving transparency. Exercises and drills related to security are periodically organized to draw experience feedback, involving public authorities.

4/ Conclusion
The protection and security of sensitive materials and EDF industrial assets is of major importance to protect the environment and the public, to maintain confidence of the public and stakeholders, and to protect the EDF operational capacity and competitiveness. It relies on a safety and security culture to be developed at all levels within EDF and it is a part of EDF professionalism as a rigorous and responsible industrial company.

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