INDÚSTRIAS NUCLEARES DO BRASIL

The Role of the Radiological Protection Team as a Stakeholder in the Design Phase of a Nuclear Facility: the Case of Brazilian Conversion Plant

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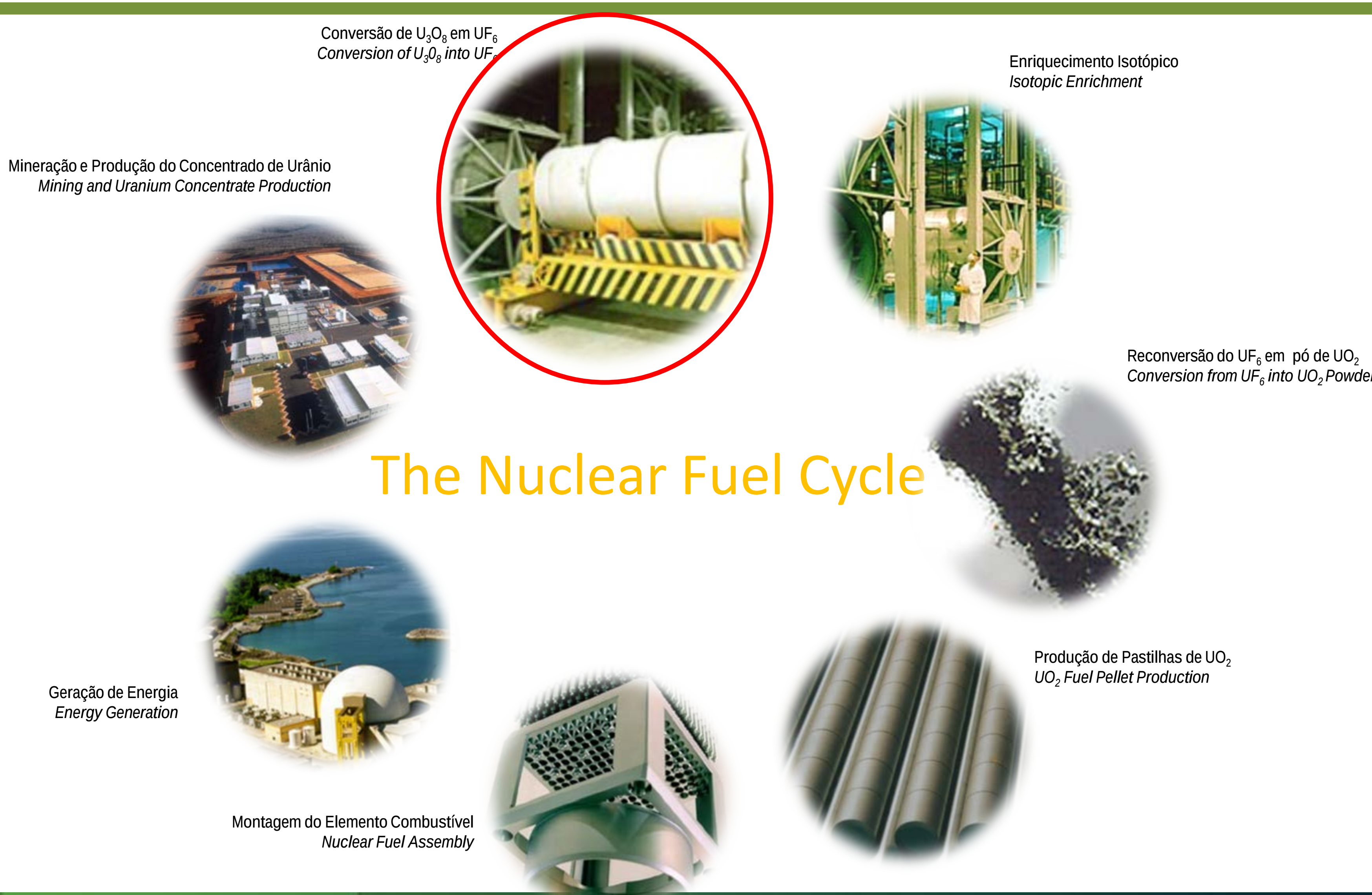

Conversion Plant Project

First view of the new facility

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Overview of the INB site

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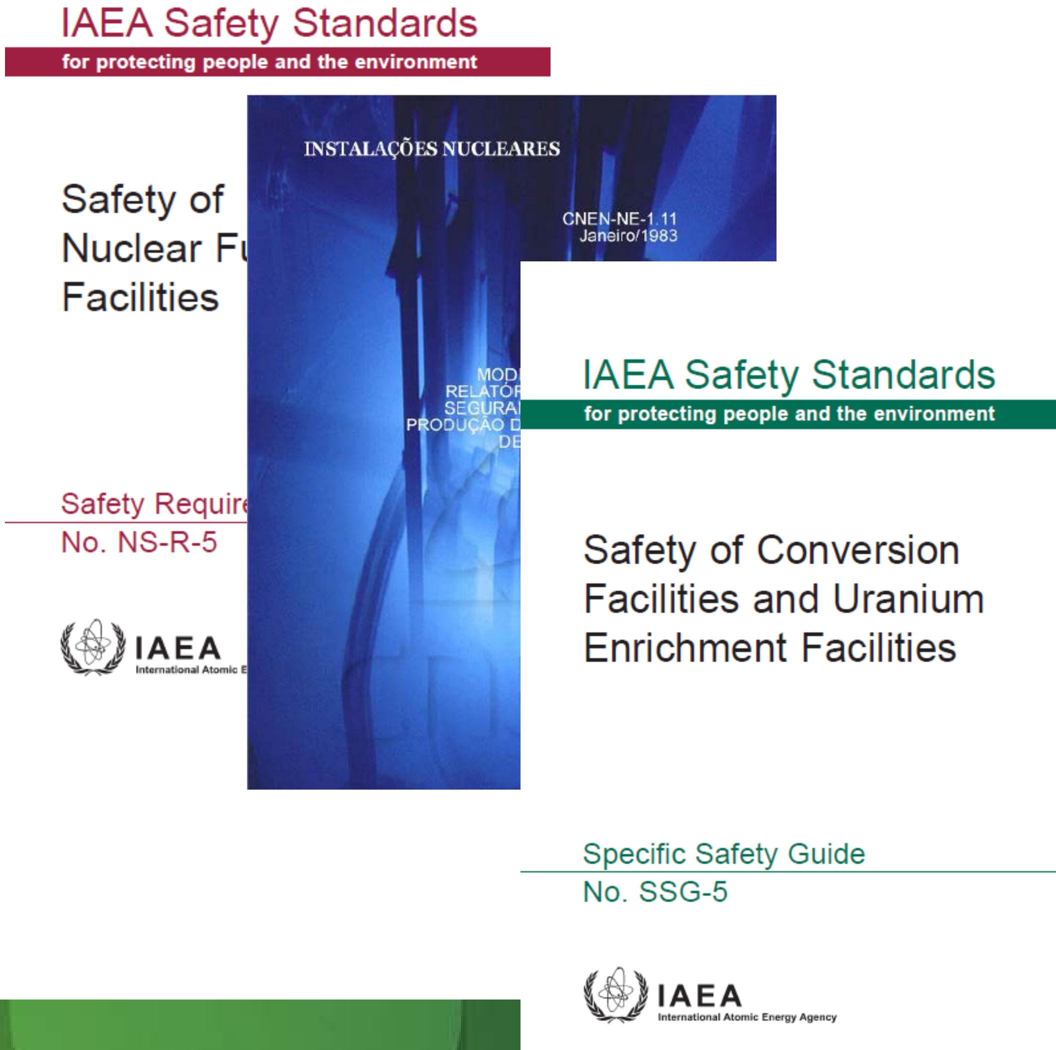

Licensing Normative Design Basis.

Nuclear

CNEN NE. 1.04/ 1.09/ 1.11 / 1.16
AIEA - Specific Safety Guide SSG- 5

Fire and Industrial Safety

Normas ABNT
NFPA

Environmental

CONAMAS 01-86/ 06/ 09-87/ 237-97/ 357/ 382-06 / 420-09

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IAEA Safety Standards

for protecting people and the environment

Safety of Conversion Facilities and Uranium Enrichment Facilities

Specific Safety Guide

No. SSG-5

IAEA

International Atomic Energy Agency

Design Basis Accidents

Design basis accidents and safety analysis

4.5. The definition of a design basis accident in the context of fuel cycle facilities can be found in para. III-10 of Annex III of Ref. [1]. The safety requirements relating to design basis accidents are established in paras 6.4–6.9 of Ref. [1].

Conversion facilities

4.6. The specification of a design basis accident (or equivalent) will depend on the facility design and national criteria. However, particular consideration should be given to the following hazards in the specification of design basis accidents for conversion facilities:

(a) A release of HF or ammonia (NH_3) due to the rupture of a storage tank;
(b) A release of UF_6 due to the rupture of a storage tank, piping or a hot cylinder;
(c) A large fire originating from H_2 or solvents;
(d) An explosion of a reduction furnace (release of H_2);
(e) Natural phenomena such as earthquakes, flooding or tornadoes[1];
(f) An aircraft crash;
(g) Nuclear criticality accidents, e.g. in a wet process area with a ^{235}U content of more than 1% (reprocessed uranium or unirradiated LEU).

4.7. The first four types of events ((a)–(d)) are of major safety significance as they might result in chemical and radiological consequences for on-site workers and may also result in some adverse off-site consequences for people or the environment. The last type of accident on the list would generally be expected to result in few or no off-site consequences unless the facility is very close to occupied areas.

4.8. The hazards listed in para. 4.6 may occur as a consequence of a postulated initiating event (PIE). Selected PIEs are listed in Annex I of Ref. [1].

4.9. The potential occurrence of a criticality accident should be considered for facilities that process uranium with a ^{235}U concentration of more than 1%. Particular consideration should be given to the potential occurrence of a

[1] For some facilities of older design, natural phenomena were not given consideration. These phenomena should be taken into account for the design of new conversion and enrichment facilities.

INB

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Safety Standards as Licensing Guide vs Plant Design Basis

IAEA Safety Standards

for protecting people and the environment

Safety of
Nuclear Fuel Cycle
Facilities

Safety Requirements
No. NS-R-5

IAEA
International Atomic Energy Agency

of health and minimization of danger to life and property and to provide for their application.

With a view to ensuring the protection of people and the environment from harmful effects of ionizing radiation, the IAEA safety standards establish fundamental safety principles, requirements and measures to control the radiation exposure of people and the release of radioactive material to the environment, to restrict the likelihood of events that might lead to a loss of control over a nuclear reactor core, nuclear chain reaction, radioactive source or any other source of radiation and to mitigate the consequences of such events if they were to occur. The standards apply to facilities and activities that give rise to radiation risks, including nuclear installations, the use of radiation and radioactive sources, the transport of radioactive material and the management of radioactive waste.

Safety measures and security measures[1] have in common the aim of protecting human life and health and the environment. Safety measures and security measures must be designed and implemented in an integrated manner so that security measures do not compromise safety and safety measures do not compromise security.

The IAEA safety standards reflect an international consensus on what constitutes a high level of safety for protecting people and the environment from harmful effects of ionizing radiation. They are issued in the IAEA Safety Standards Series, which has three categories (see Fig. 1).

Safety Fundamentals

Safety Fundamentals present the fundamental safety objective and principles of protection and safety and provide the basis for the safety requirements.

Safety Requirements

An integrated and consistent set of Safety Requirements establish the requirements that must be met to ensure the protection of people and the environment, both now and in the future. The requirements are governed by the objective and principles of the Safety Fundamentals. If the requirements are not met, measures must be taken to reach or restore the required level of safety. The format and style of the requirements facilitate their use for the establishment, in a harmonized manner, of a national regulatory framework. The safety requirements use 'shall' statements together with statements of

[1] See also publications issued in the IAEA Nuclear Security Series.

industrial processes that pose additional hazards to site personnel and the environment. Purely industrial hazards are outside the scope of this publication, but they shall be considered by the operating organization. Guidance relating to the management of specific chemical hazards may be found in the IAEA Safety Guides associated with this publication or in chemical industry standards.

SAFETY PRINCIPLES

2.3. The ten safety principles established in Ref. [1] apply to fuel cycle facilities, existing and new, throughout their entire lifetime. These principles provide the basis for the requirements for the safety of these facilities.

DEFENCE IN DEPTH

2.4. The concept of defence in depth shall be applied at the facility for the prevention and mitigation of accidents (Principle 8 of Ref. [1]). Defence in depth is the application of multiple levels of protection for all relevant safety activities, whether organizational, behavioural or equipment related [5, 6]. Application of the concept of defence in depth throughout the design and operation of a fuel cycle facility provides multilayer protection against a wide range of anticipated operational occurrences[1] and accident conditions, including those resulting from equipment failure or human error within the facility, and from events that originate outside the facility.

2.5. The strategy for defence in depth shall be twofold: first, to prevent accidents, and second, if prevention fails, to limit the potential radiological and associated chemical consequences and to prevent any evolution to more serious conditions. Defence in depth is generally structured in five different levels, as set out in Table 1, which is adapted from Ref. [5]. If one level fails, the subsequent level comes into play.

2.6. The design features, controls and arrangements necessary to implement the defence in depth concept shall be identified mainly by means of a deterministic analysis (which may be complemented by probabilistic studies) of the design and operational regime. The analysis shall be justified by the

[1] Anticipated operational occurrences: see Annex III, para. III–12.

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chemical or thermal reactions, and the kinetics of such events shall all be considered in determining the required number and strength of lines of defence.

2.8. The degree of application of each level of defence in depth shall be commensurate with the potential hazards of the facility and shall be established in the facility's licensing documentation.

LICENSING DOCUMENTATION

2.9. The operating organization shall establish and justify the safety of its facility through a set of documents known as the 'licensing documentation' (or 'safety case').[4] The licensing documentation shall provide the basis for the safe siting, construction, commissioning, operation and decommissioning of the facility, including the justification for changes. The licensing documentation shall be considered in determining whether the authorizations necessary under national legislative requirements are to be granted, and thus it forms an important link between the operating organization and the regulatory body.

2.10. The content of the licensing documentation for a facility may vary between States but at least the safety analysis report and the operational limits and conditions or equivalent shall be included. Consideration of the application of the principle of optimization of protection (Principle 5 of Ref. [1]) in the design and operation of the facility shall be included in the licensing documentation.

2.11. The safety analysis report shall provide a detailed demonstration of the safety of the facility. It shall give a detailed description of those aspects having safety significance, such as information on the input feed and the products of the facility and the corresponding limits (e.g. limits on burnup and enrichment), and it shall discuss the application of the safety principles and criteria in the design for the protection of operating personnel, the public and the environment. The safety analysis report shall contain an analysis of the hazards associated with the operation of the facility and shall demonstrate compliance with the regulatory requirements and criteria. It shall also contain safety analyses of accident

[4] In the context of fuel cycle facilities, the licensing documentation (or safety case) is a collection of arguments and evidence in support of the safety of a facility or activity. This will normally include the findings of a safety assessment, and a statement of confidence in these findings.

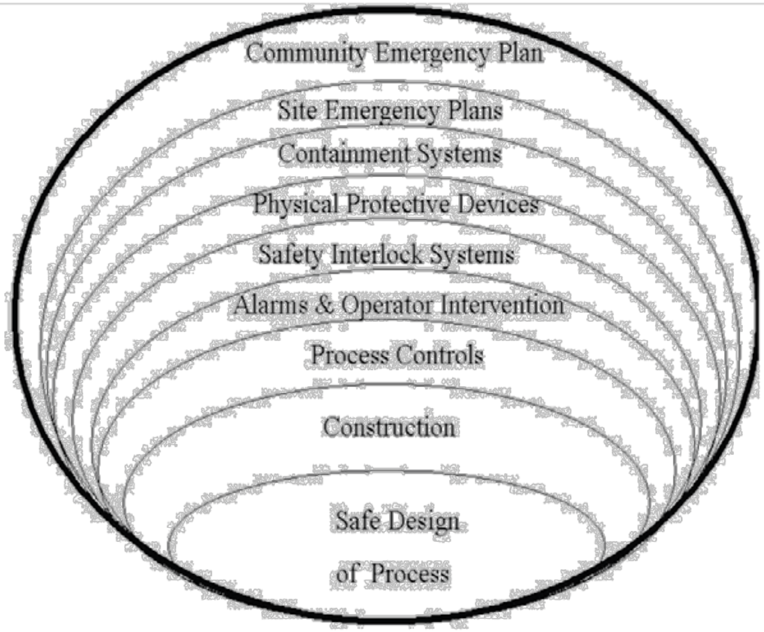
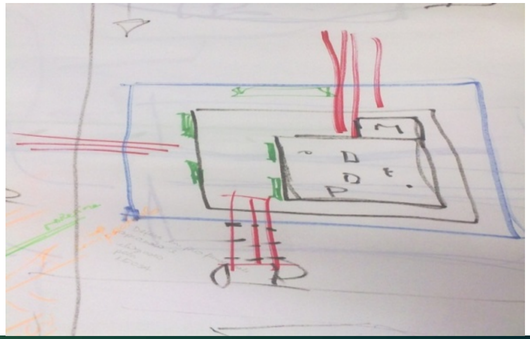


Figure 3 – Defence-in-depth elements



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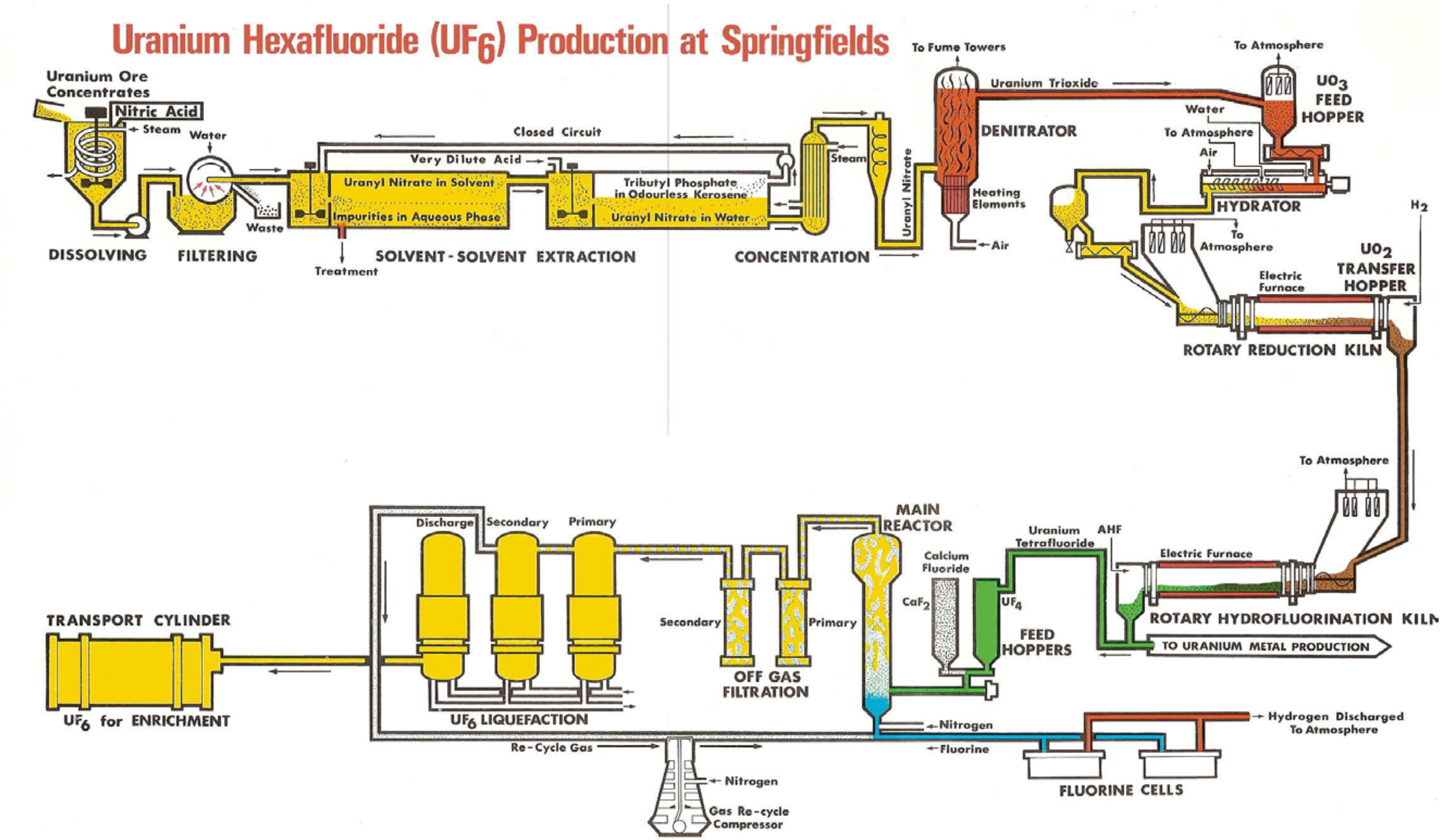

Source: SFL

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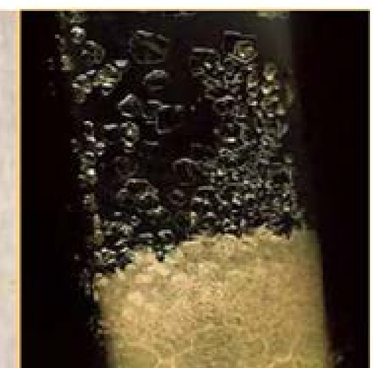
Conversion Plant uranium products

Yellowcake

uranil nitrate (Impure and Filtered)

(UO_3) (UO_2) (UF_4)



(UF_6)

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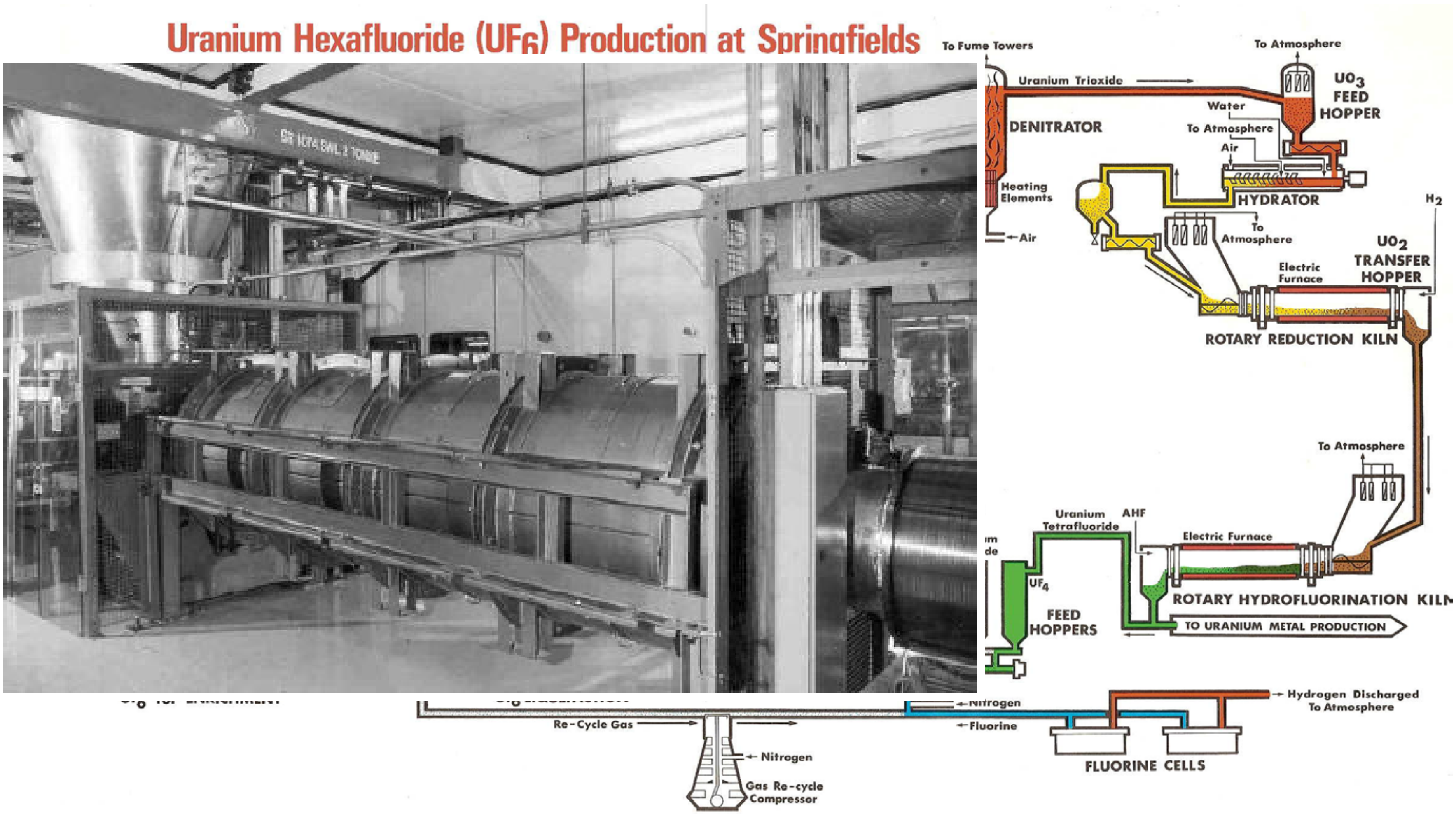

Source: SFL

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Stakeholder: “Actors with a specific interest in the development of the project”

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Radiological Protection Professionals

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Radiological Safety Requirements

Radiological Protection Principles

- Justification – “more good than harm”
- Optimisation – individual dose should be kept ALARA
- Dose limitation – “planned exposure situations”
  - **Restriction of exposure** by means of **engineering controls** and **design features**

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Methodology

- Benchmarking – Practical experience in existing Conversion Plant
  - Technical visits
  - References (only NPP!!)
- Brainstorming sessions
- Technical Meetings
  - Implementation of lessons learnt
  - “ALARA check-lists”
  - Co-operation, communication and multidisciplinary approach in optimising design

Preliminary Results

- Acknowledging the chemical process and U physical forms (Important!)
  - Identification of uranium and people preference pathways: Control of dose
  - Classification of areas: controlled, supervised and uncontrolled areas
- Layout modifications
  - Access control for entrance and exit of personnel and materials to/from the controlled areas
  - Radiochemistry Laboratory
  - Radioactive waste storage facility (DIRBA)

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Other issues in developing (challenges!!):

- Source-terms Identification
- Assessment the workers dose
- Preoperational Environmental Monitoring Program
- Emergency Response Plan

Conclusion

The approach of both Project and Radiological Protection Professionals is an ESSENTIAL **interactive process** and contributed to the **decision making**, as well as **time and cost planning**.

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