EFDA EUROPEAN FUSION DEVELOPMENT AGREEMENT

Licensing ITER in Europe: AN EXAMPLE OF LICENSING A FUSION FACILITY

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(EISS team)

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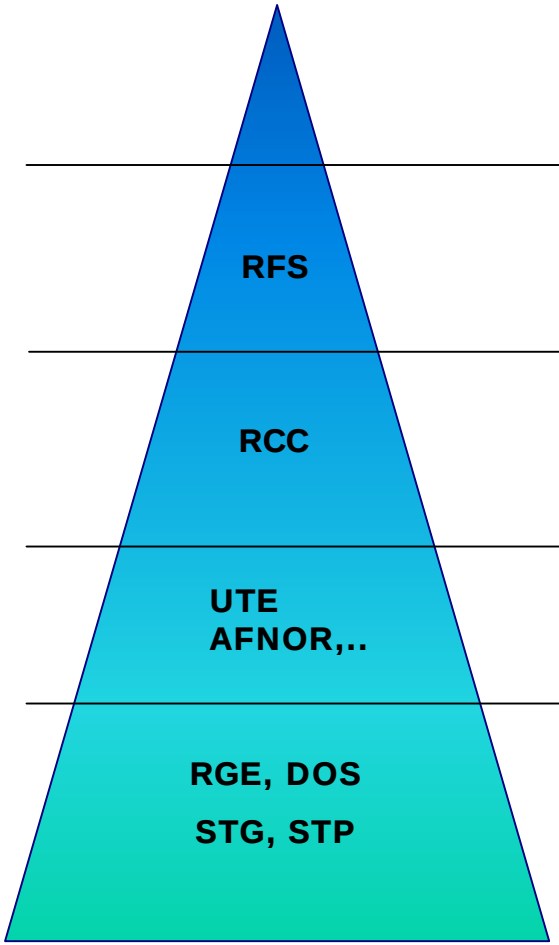
The regulatory framework

BASIC DOCUMENTS WITH REGULATORY AND TECHNICAL CONTENTS (http://www.asn.gouv.fr/)

A set of texts fixes rules and technical practices concerning nuclear safety and technics.
They are summed up down here:



Laws, Decrees & departmental orders
Pressurized appliances, Effluent releases,.., Quality management,..etc.

Fundamental Safety Rules (called in French RFS)

Recommendations given out by the authority of safety

The setting of a good practice at a precise time

Rules of conception and construction elaborated by the French nuclear industry
Elaborated by the nuclear industry, they are submitted to the exam of the safety authority.

Norms and guides of conception

Elaborated by the industry, they are not submitted to the exam of the safety authority.

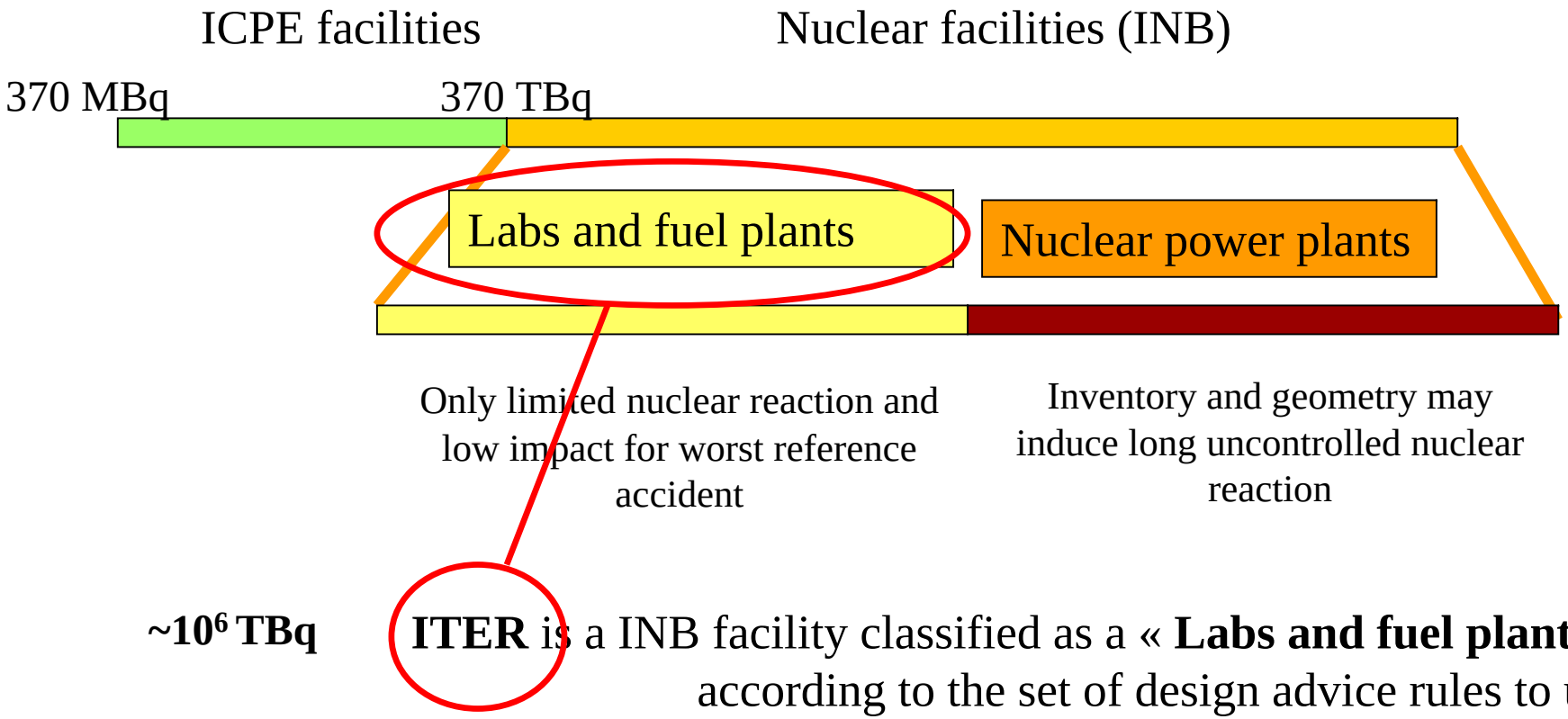
Operating rules – book of safety

Elaborated by a project and/or the operating team, they are submitted to the exam of the safety authority.

General or particular Technical specifications

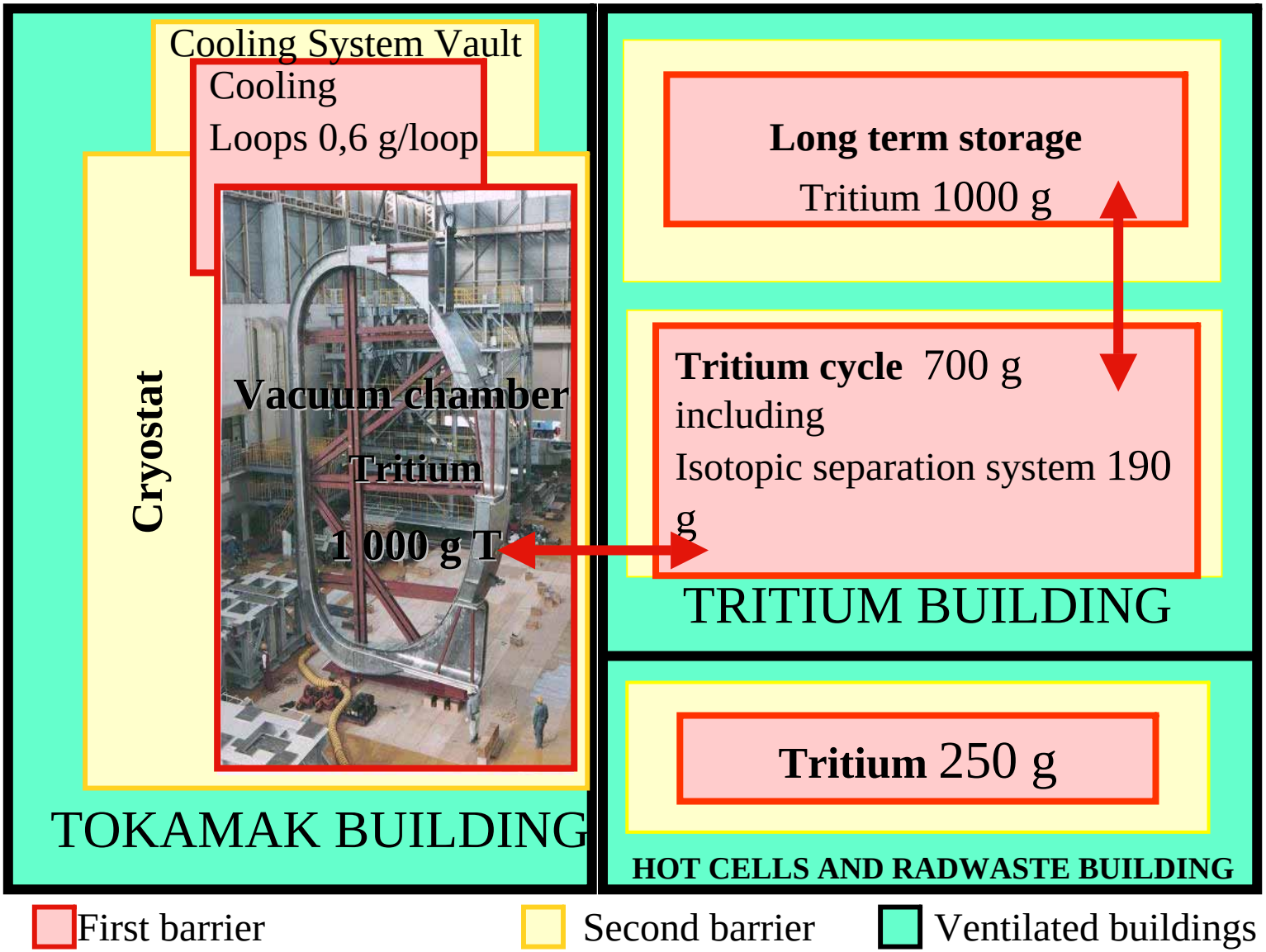
These are some specific technical documents to a specific facility

Regulatory framework since 1963

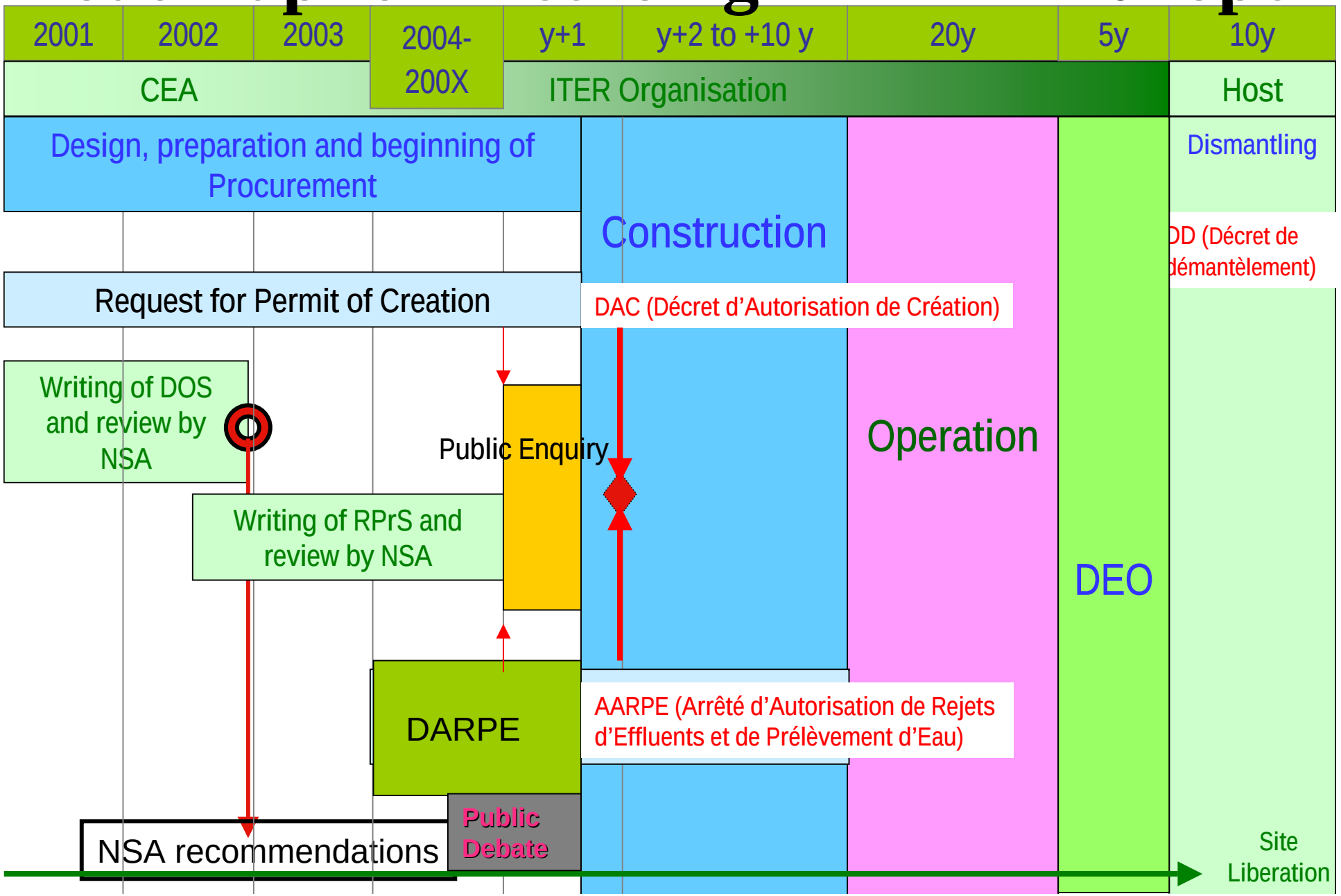


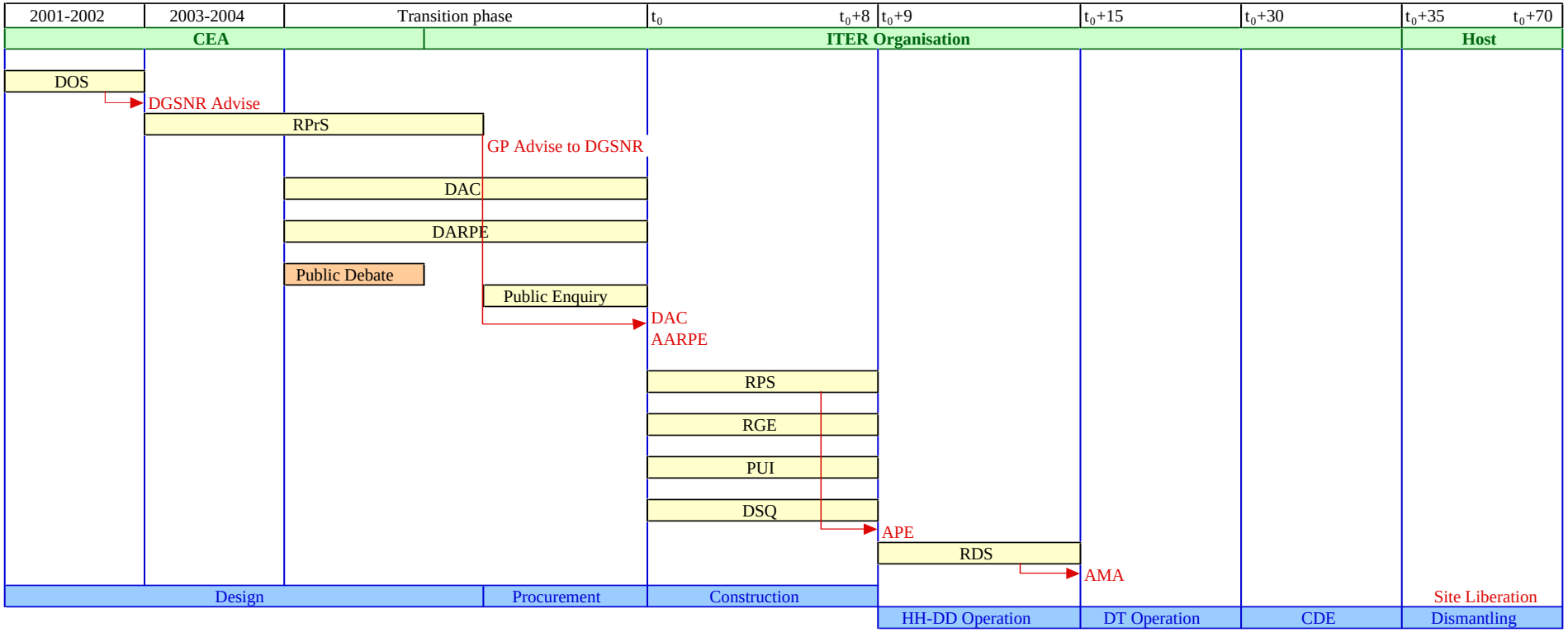
~10^6 TBq **ITER** is a INB facility classified as a « **Labs and fuel plants** » according to the set of design advice rules to use (RFS : règles fondamentales de sûreté)

DGSNR 4 July 2002


Cooling System Vault
Cooling
Loops 0,6 g/loop
Cryostat
Vacuum chamber
Tritium
1 000 g T
TOKAMAK BUILDING
Long term storage
Tritium 1000 g
Tritium cycle 700 g
including
Isotopic separation system 190 g
TRITIUM BUILDING
Tritium 250 g
HOT CELLS AND RADWASTE BUILDING
First barrier
Second barrier
Ventilated buildings

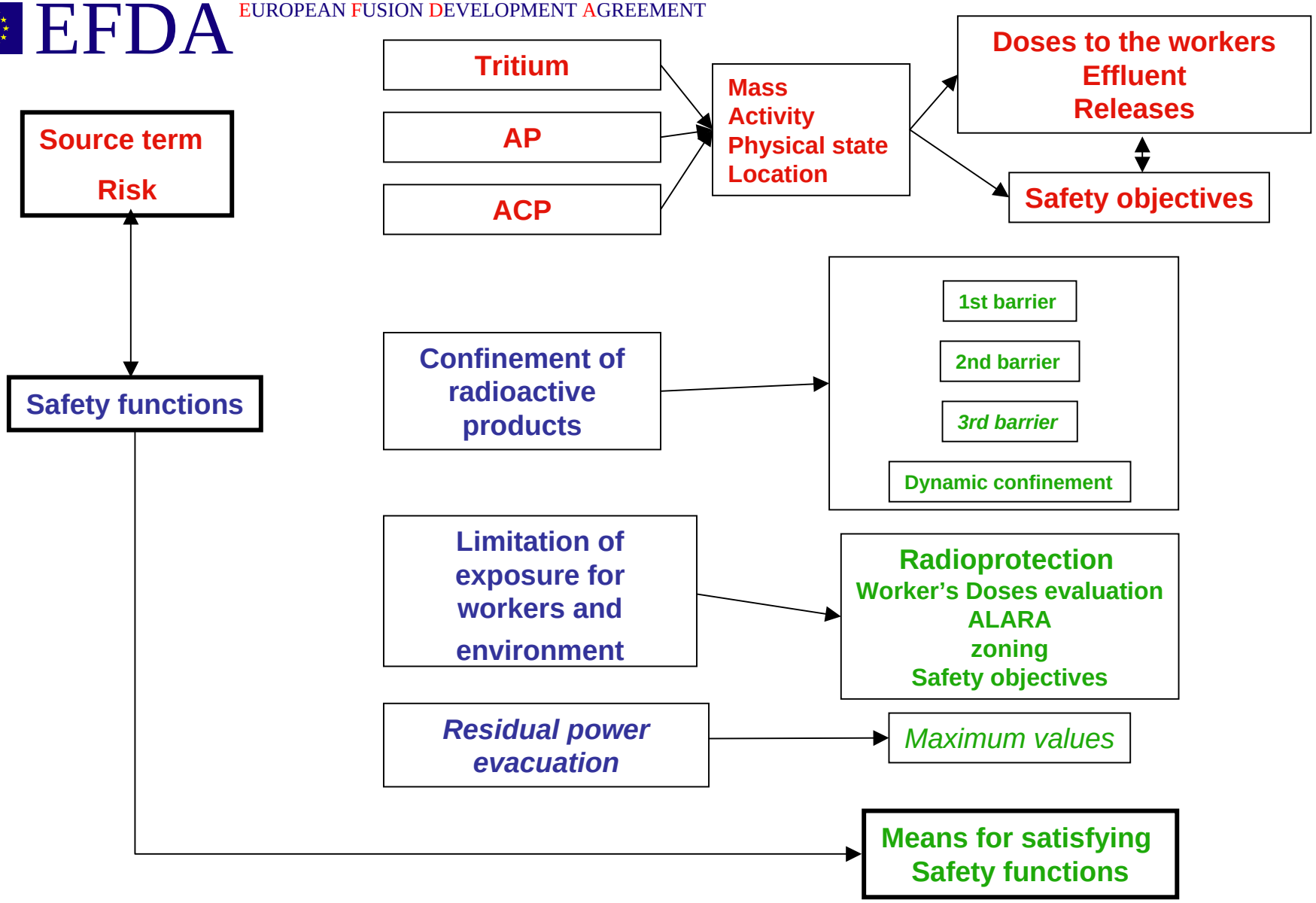
Roadmap for Licensing ITER in Europe





Acronym	*French meaning*	*English translation or meaning*
	Entities and Authorities	
ITER Org.	Entit˘ Juridique ITER	ITER Legal Entity (status to be defined)
CEA	Commissariat l'Energie Atomique	French Atomic Energy Research Institute
ASN	Autorit˘ de S¸ret˘ Nucl˘aire	French Safety Nuclear Authority
GP	Groupe Permanent	Permanent Group (in charge of Request Examination)
DGSNR	Direction G˘n˘rale de la S¸ret˘ Nucl˘aire et de la Radioprotection	ASN Legal Head
	Licensing Procedure and main documentation to be prepared	
DOS	Dossier d'Options de S¸ret˘	Description of Safety Objectives (not compulsory)
DAC	Demande d'Autorisation de Cr˘ation	Request of Authorisation of Creation
RPrS	Rapport Pr˘liminaire de S¸ret˘	Preliminary Safety Report (compulsory, to be borne by ILE)
DAC	D˘cret d'Autorisation de Cr˘ation	Decree of Authorisation of Creation
DARPE	Demande d'Autorisation de Rejet d'Effluents et de Pr˘l¸vement d'Eau	Request of Authorisation for Water Intake and Effluent Release
AARPE	Arr t˘ d'Autorisation de Rejet d'Effluents et de Pr˘l¸vement d'Eau	Decree of Authorisation for Water Intake and Effluent Release
DAPE	Demande d'Autorisation Provisoire d'Exploiter	Request for Temporary Operation
RGE	R¸gles G˘n˘rales d'Exploitation	General Rules for Operation
PUI	Plan d'Urgence Interne	Emergency Internal Plan
DSQ	Dossier de Synth¸se de la Qualit˘	Summary of Quality Assurance
APE	Autorisation Provisoire d'Exploiter	Temporary Authorisation for Operation
DAMA	Demande d'Autorisation de Mise en Actif	Request of Authorisation for Activation
RDS	Rapport D˘finitif de S¸ret˘	Final Safety Report
AMA	Autorisation de Mise en Actif	Authorisation for Activation
CDE	Cessation D˘finitive d'Exploitation	Definitive End of Operation

2.DOS: Dossier D'Options de SûretéFirst report on safety objectives



+ Illustration on the representative situations: operation, maintenance, incidents, accidents

DOS TOC SCHEME

Type of plant situation	DOSSIER D'OPTIONS DE SURETE (DOS) General Safety Objectives in DOS	ITER guidelines
	Occupational exposure	**For Public and environment**
	Dimensioning situations	
Normal	Annual individual work doses ≤ 10 mSv/a Annual mean value of individual work doses ≤ 2.5 mSv/a	Normal releases below authorised annual limits for the installation ≤ 0,1 mSv/a
Incidental	10 mSv per incident	Releases per incident below authorised annual limits for the installation ≤ 0.1 mSv/a
Accidental	Constraints related to the post-accidental management are taken into account	< 10 mSv None counter measures None consumption banning for any vegetal or animal products
	Situations beyond Design	
Hypothetical	No cliff effect	Counter measures limited in time and space

Effluents and Releases: Impact Studies

Gases and airborne particulates

Conditions

- Calculations for 10 habitations on 360°around Cadarache
- Stack height = 58 m
- Cadarache weather conditions

Results

•At “Le Château” (1.2 km), the nearest point
•For 1g of each released product

Effect of normal operation release in µSv maximum yearly dose, with the hypothesis of a mean statistical effect		
HTO/HT **for 1 gram of tritium as HTO or HT**	**Dust (Activation Product)** **for 1 gram of AP W/SS**	**Activation Corrosion Product** **for 1 gram of ACP**
5 / 0.2	0.15/1.2	0.12

For accidents, the early dose is the dose that should be taken into account for population countermeasures (in the framework of CIPR 63 for instance). Long term dose is the dose for an adult living close to the Center for his whole life after the release or after 10 years of ITER operation with tritium plasma (the value overestimates all other cases such as baby, children…).

Effect of accidental release in µSv					
HTO **for 1 gram of tritium as HTO**		**Dust* (Activation Product)** **for 1 gram of AP**		**Activation Corrosion Product** **for 1 gram of ACP**	
Early dose	*Long term dose*	*Early dose*	*Long term dose*	*Early dose*	*Long term dose*
50	100	10	50* W/SS 30/1000	0,1	30 3 witho ut rain

•Dust is supposed to be constituted of 98% Tungsten (W) and 2% Stainless-Steel (SS) activated products.
•Only W dust ==> 30 only SS dust ==>1000

Effluents and Releases
Impact Studies

Liquid estimates

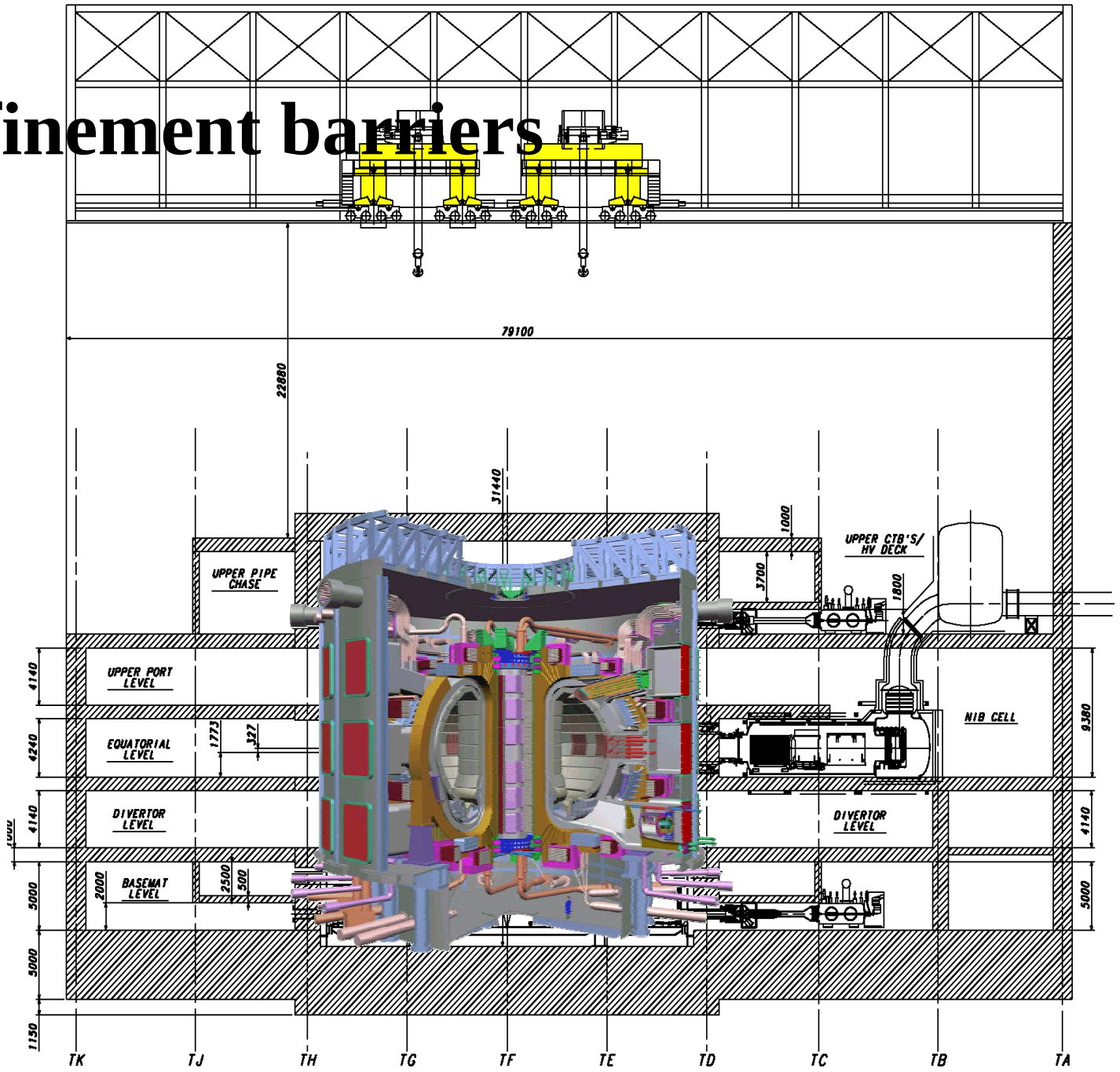
- **Conditions**
  - 0.02 TBq/a from site waste water to the Durance
- **Results**
  - ~0.1 B/l on the Durance level
  - 0.06 µSv/a at St. Paul lez Durance after 50 years of exploitation
- **Conditions**
  - 0.12 TBq/a from cooling water towers to the Durance or the Canal
- **Results**
  - ~1 Bq/l in the Durance
  - in the Canal

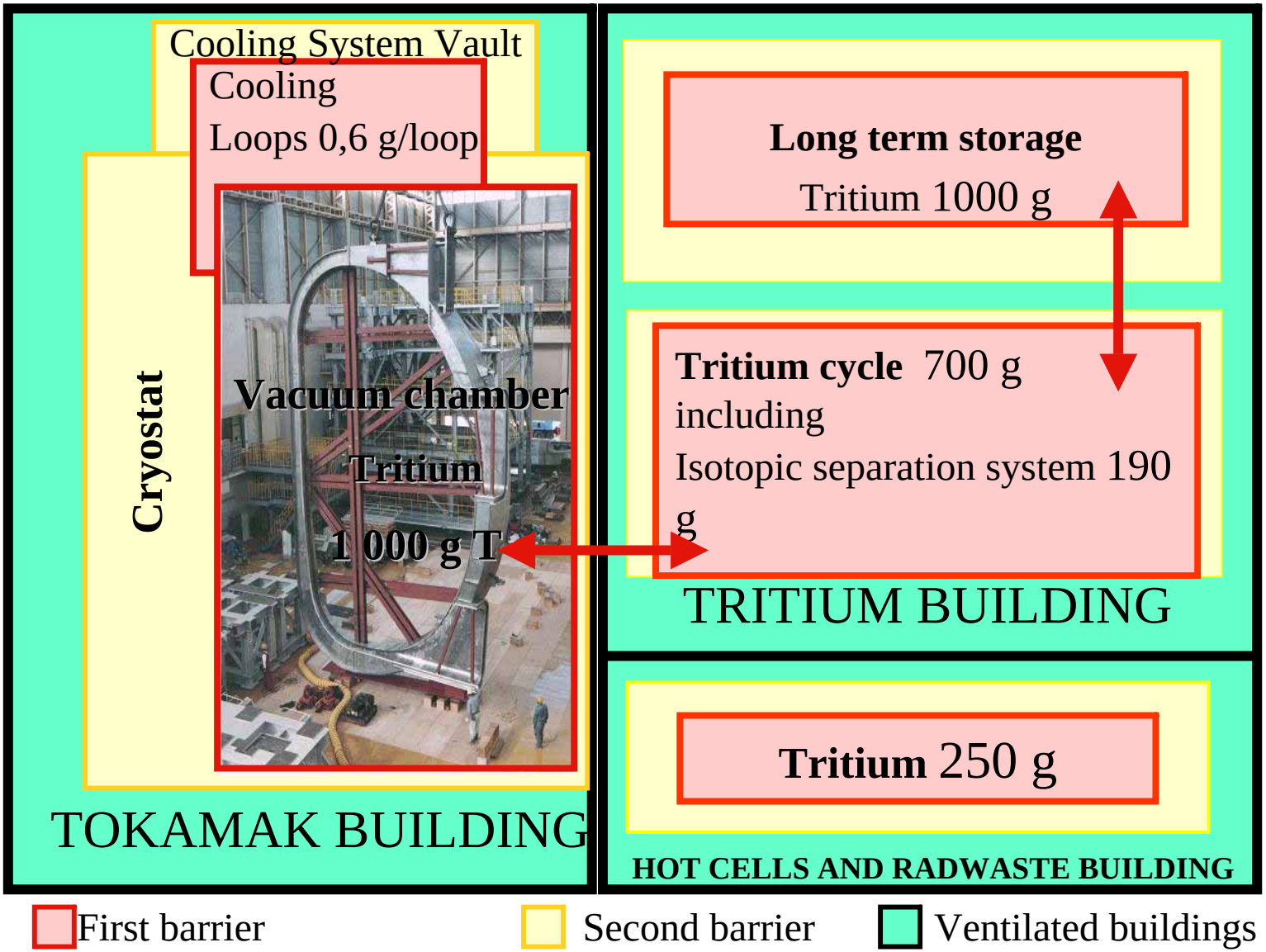
Main Function: Confinement

Proposed Implementation

Radiocactive material	First confinement system	Second confinemen Systemt
Activated dust	**(S) + (D)** tokamak + vent system with filters	**(S) + (D)** Local adjacent + vent system with filters
Cooling systems water (HTO, ACP)	**(S)** Cooling system and detritiation sustem pipes	**(S) + (D)** Cooling system room + vent system with filters
Tritium in the fuel system	**(S)** process+complementar y barrier (cryostat, glove box, guide tube) + détritiation system	**(S) + (D)** Adjacent Room + vent system with filters
Tritium in the tokamak	**(S) + (D)** tokamak +barrières supplémentaires (cryosta and extensions)+ détritiation system	**(S) + (D)** Adjacent room + vent system with filters

Confinement barriers

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Second barrier
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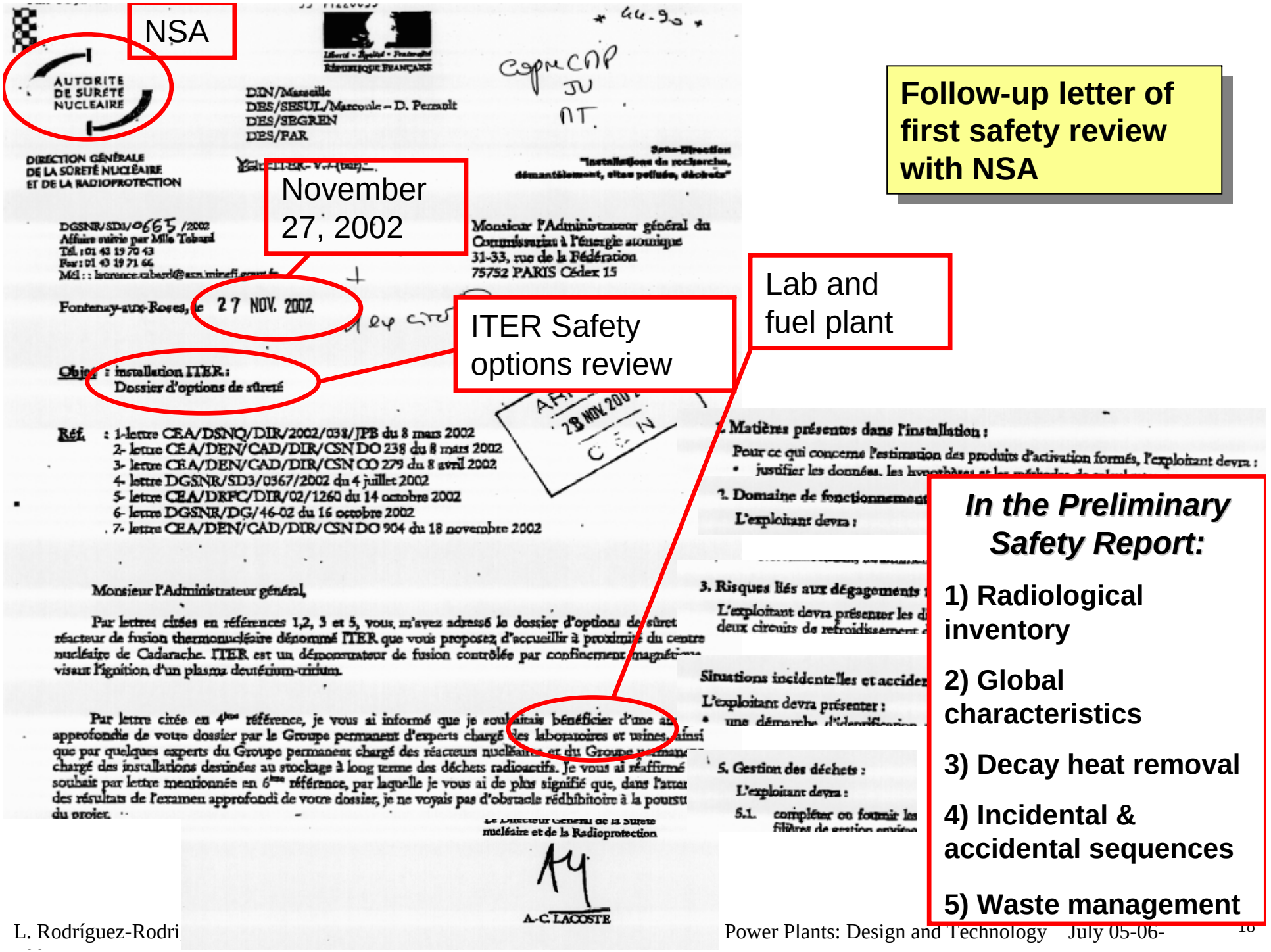
3.DOS examination and results


NSA
AUTORITE DE SURETE NUCLEAIRE
DIRECTION GÉNÉRALE DE LA SÛRETÉ NUCLÉAIRE ET DE LA RADIOPROTECTION
November 27, 2002
Fontenay-aux-Roses, le 27 NOV. 2002
Objet : installation ITER :
Dossier d'options de sûreté
ITER Safety options review
Lab and fuel plant
Monsieur l'Administrateur général,
Par lettres citées en références 1,2, 3 et 5, vous m'avez adressé le dossier d'options de sûreté
réacteur de fusion thermonucléaire dénommé ITER que vous proposez d'accueillir à proximité du centre
nucléaire de Cadarache. ITER est un démonstrateur de fusion contrôlée par confinement magnétique
visant l'ignition d'un plasma deutérium-tritium.
Par lettre citée en 4ème référence, je vous ai informé que je souhaitais bénéficier d'une ai
approfondie de votre dossier par le Groupe permanent d'experts chargé des laboratoires et usines, ainsi
que par quelques experts du Groupe permanent chargé des réacteurs nucléaires et du Groupe permanent
chargé des installations destinées au stockage à long terme des déchets radioactifs. Je vous ai réaffirmé
souhait par lettre mentionnée en 6ème référence, par laquelle je vous ai de plus signifié que, dans l'attente
des résultats de l'examen approfondi de votre dossier, je ne voyais pas d'obstacle rédhibitoire à la poursuite
du projet.
A-C LACOSTE
Follow-up letter of first safety review with NSA
In the Preliminary Safety Report:
1) Radiological inventory
2) Global characteristics
3) Decay heat removal
4) Incidental & accidental sequences
5) Waste management

DOS instruction and main results

- ✓ Instruction of the « dossier » is done by dialogue during meetings with IRSN experts.
- ✓ Examination is done by « Group Permanent », experts from Direction Générale de la Sûreté Nucléaire et de la radioprotection (DGSNR)
- ✓ DGSNR has published its advise in a letter to the administrative general director of CEA
- ✓ CEA has send to the DGSNR a list of commitments which will be kept for RPrS writing

DGSNR advise

- ✓ Correct identification of main safety issues
- ✓ Acceptable corresponding safety objectives
- ✓ Objectives adapted to Cadarache site

Recommendations

- ✓ They express Safety Authorities wishes for RPrS writing.

Commitments

- ✓ The installation owner has agreed to develop in RPrS points concerning commitments

Recommandations

- ✓ Materials & activation products
- ✓ Normal operation mode and source term limits
- ✓ Cooling systems
- ✓ Incidents & accidents
- ✓ Waste

Research and development

Source terms

Safety approach: Control of the values below foreseen limits
[Tritium-Activated Products (AP)-Activated corrosion products (ACP)]
Research on
- Trapping-Removing
- Erosion-deposition
- Cleaning
- Associated diagnostics

Related actions
- Verification and Validation of calculation Codes
- Validation of proposed solutions

Vacuum vessel explosion risk

Safety approach: exclusion +prevention-detection-mitigation
Research on
- Hydrogen production
- Dust production
- Associated diagnostics
- Mitigation

Related actions
- Verification and Validation of calculation Codes
- Validation of proposed solutions

Research and development

Tritium Cycle

Safety approach: Inventory control

Research on:

- Transport containers
- Dynamic modelling
- Removing from Vacuum Vessel

Related actions

- Verification and Validation of calculation Codes
- Validation of proposed solutions

Detritiation system

Safety approach: assessment of safety integration in the design (fire zoning)

Research on:

- Reliability of processes in case of fire

Related actions

- Validation of proposed solutions

Research and development

Remote handling

Safety approach: ALARA-Optimisation occupational radiological exposure

Research on:

- Test programme (on prototypes and in-situ)
- Recovering of robots
- Associated ORE

Related actions

- Verification and Validation of calculation Codes
- Validation of proposed solutions

Neutronics

Safety approach: ALARA-Optimisation

Realistic estimations in the future-reduction of uncertainties

Research on:

- Penetration configurations
- Real impurities of materials
- ORE review

Related actions

- Optimisation
- Verification and Validation of calculation Codes
- Validation of proposed solutions

Research and development

- **Arc in superconducting coils and busbars**
  - Safety approach: exclusion +prevention-detection-mitigation
  - Research on:
    - Effect of such arcs
    - Detection-mitigation
    - Parametric studies
  - Related actions
    - Verification and Validation of calculation Codes
    - Validation of proposed solutions

- e.i.

Commitments and expected issues

- ✓ Installation description
  - Proposal for a progressive start-up
  - Principles for SIC availability before operation
  - **Feedback from other devices.**
  - **Validation of fusion programme action and R&D**
- ✓ Site Characteristics
  - Final geological report
  - Final hydrogeological report
  - Actual physical, chemical and radiological reference data for soil and water on the site

Commitments and expected issues

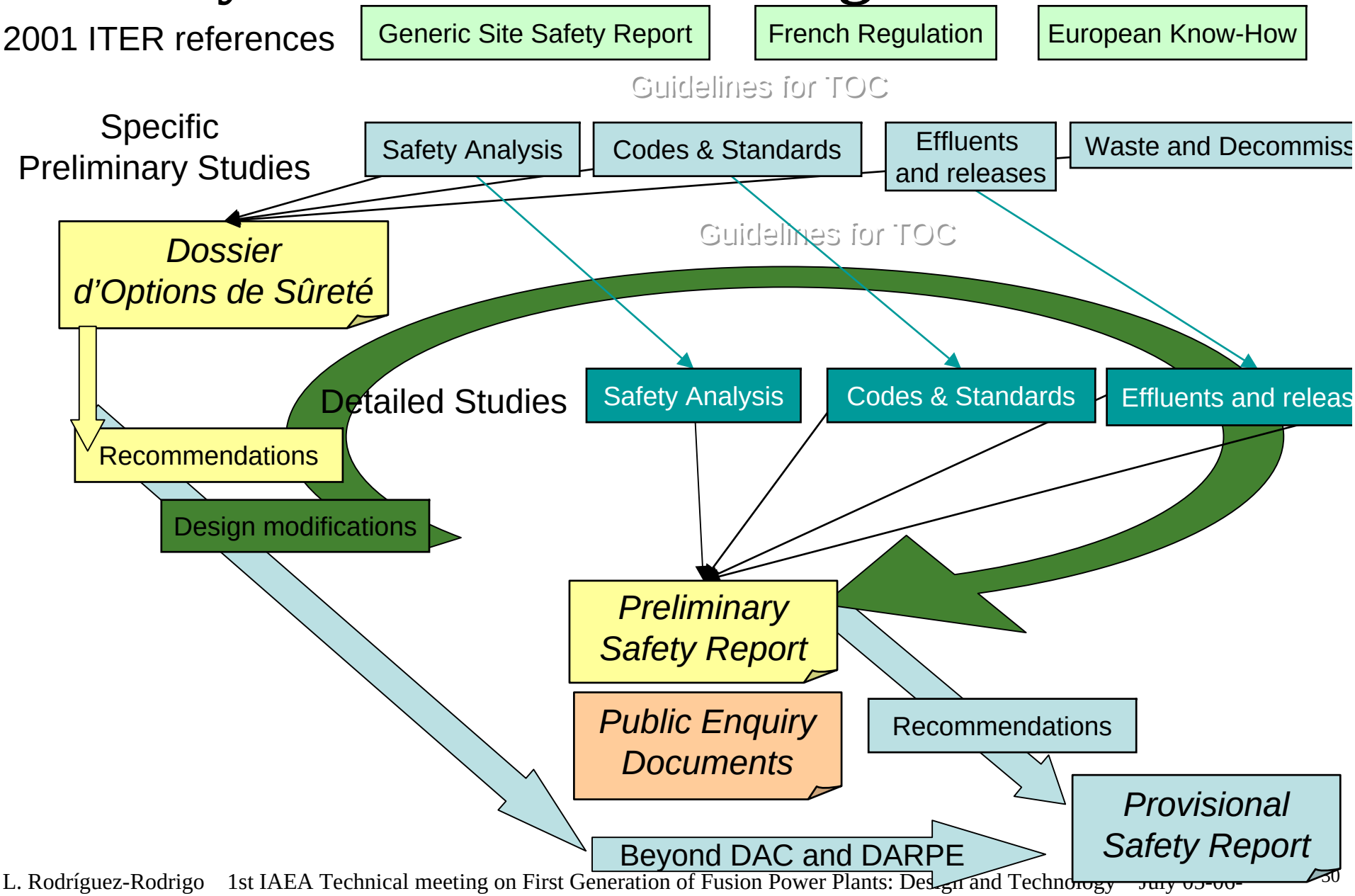
- ✓ Safety analyse and risk study
  - Safety Methodology
  - Study of dissimination of radioactive materials hazard. Confinement principals
  - Exposure to radiation
  - Hazards related to power evacuation
  - Internal hazards (in operation and during maintenance, fire and explosions, flooding, e.i)
  - External aggressions
  - Incidents and accidents analyses
  - Effluents and releases

Commitments and expected issues

- ✓ Waste and dismantling
  - Most important radio-nuclides (dominant)
  - Impact on disposals
  - Activity related with waste contamination
  - Characterization, classification, total activity…
  - Operational waste. Replacement, refurbishing inventory
  - Optimization and reduction
  - Zoning-internal waste transfer-control
  - Casks-external transfer to disposals
  - Masses and activities and processing for dismantling waste

4.RPrS: Rapport Préliminaire de Sûreté

Safety actions for Licensing ITER



Actions

Safety analyses for file completion

- Codes & Standards and safety relevant components
- Safety analyses of operation limits taking into account future experiments and installation lifetime (TBM, NBI, Diagnostics, e.i)
- Releases & Impacts: toxic effluent impact
- Maintenance programme
- Human factors incorporation into the design and operation
- Safety control room, withdraw control room and survey networks

Assessment after design modifications

- Auxiliary systems and networks
- Hot cell and radwaste dismantling
- Internal Hazards (finalise fire analysis and explosion analyses, take into account accumulation of events, i.e.)
- External Hazards (earthquake, aircraft crash, e.i, on the specific layout)
- Tritium, hot cell and radwaste buildings and associated detritiation and ventilation systems

Actions

Other issues

- Wastes: Tritium containing casks, industrial detritiation processes
- Component qualification: Tritium containers, earthquake bearings, windows, filters, e.i.
- Computer codes qualification (code manuals)
- Quality assurance and the management of quality, including information on operating organisation and technical control over safety aspects
- Demonstration of feedback of lessons from similar facilities
- Presentation of a coherent R&D programme

Safety actions for Licensing ITER

Following

- Recommendations
- Needed studies for successfully achieving and safely operating the first-of-a-kind facility as large experimental fusion device

  - Research and development
  - Studies
    - Some safety analyses for file completion
    - Assessment or safety analyses after design modifications
    - Other related issues

Objectives of Research and Development from safety point of view

TO PRESENT A COHERENT PROGRAMME

- Justification of the given predictive values including uncertainties
- Demonstration that the technical solutions are feasible or available
- Validation of safety related calculation codes
- …

RPrS → Studies are in progress

RPS → Results are available

CONCLUSION

- These recommendations and commitments must be integrated in the RPrS and lead to actions for following regulatory files, for the star-up and operation

For some recommendations and commitments, R&D should be carried out

- Short term objective (RPrS): explosion in VV to be excluded
- Medium term objective (RPS) : effective qualification of calculation codes
- Long term objective (start-up and operation) : efficiency of the remote handling