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Nuclear Compact Reactors

CONTRIBUTIONS OF PREVIOUS PROJECTS TO THE DESIGN OF NEW RESEARCH REACTORS

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Content

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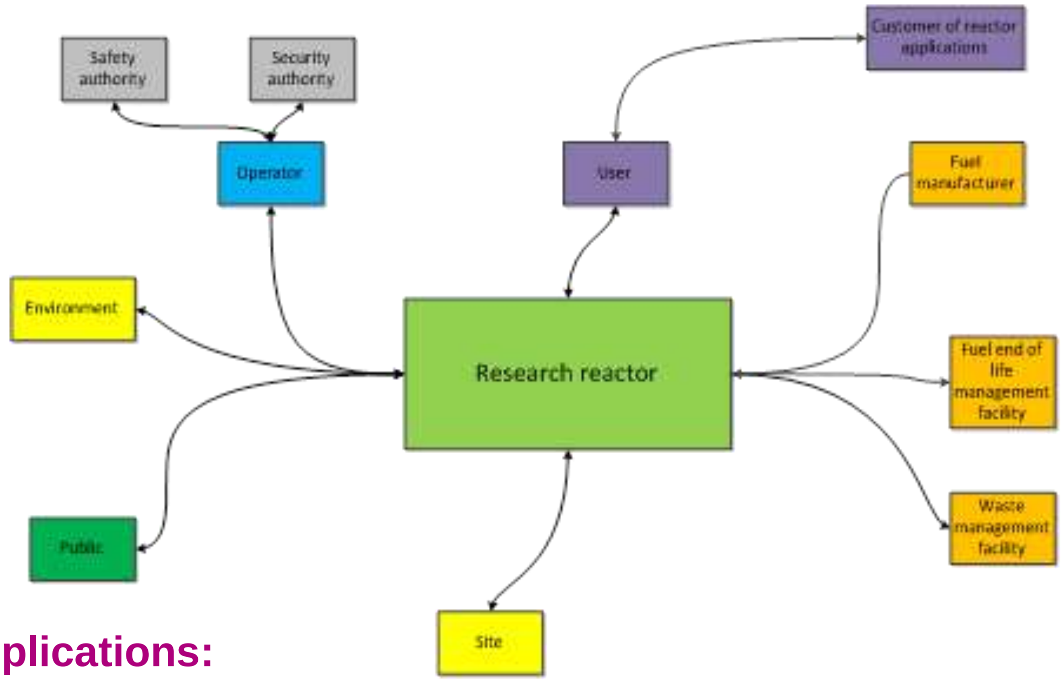
New research reactor projects requirements



Applications:

- **Most frequent: training, radioisotope production, neutron activation analysis, neutron beam applications for science and industry, and neutron transmutation doping**
- **Material and fuel testing**
- **Project specific: Application performances and balance**

Site and environment

- **Meteorological conditions**
- **Waste routes**
- **Isotope processing**
- **Integration within existing site**

Safety

- **Evolution of IAEA safety standards**
- **35-S1 NS-R4 SSR-3**
- **4th level of DiD: DEC, DEH**
- **Independence/safety groups**
- **Qualification of safety important items**
- **New national regulations**

GOOD PROJECT ACHIEVEMENT AND SUCESSFULL REACTOR UTILIZATION

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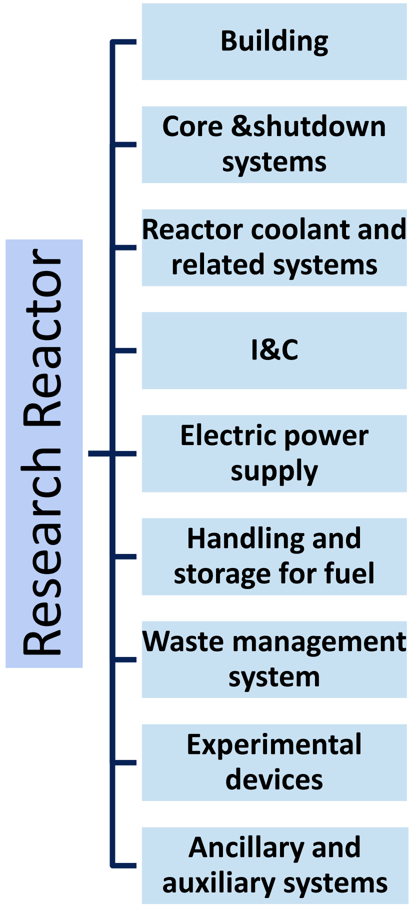
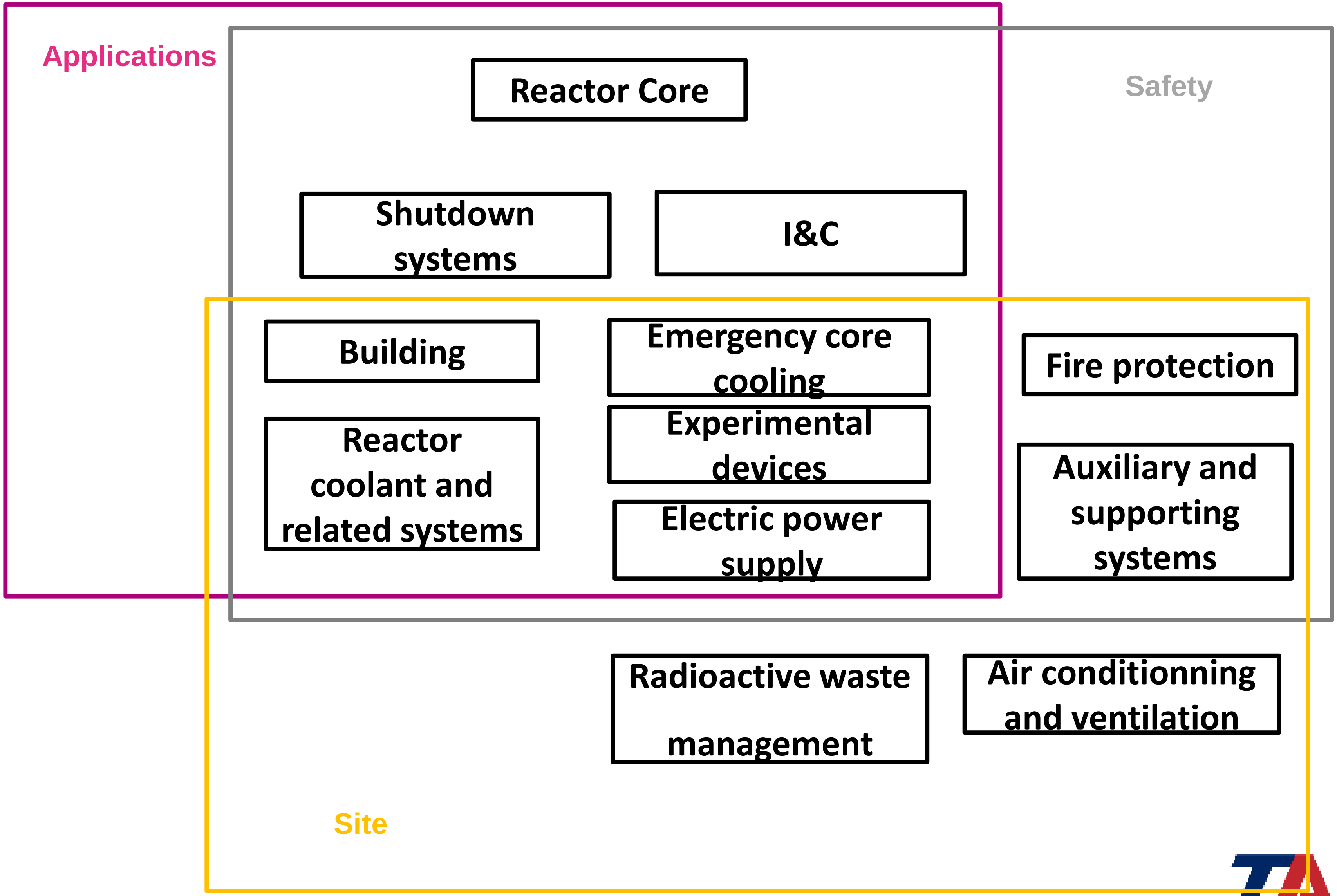
Background information



- **PBS item design includes:**
  - **concept,**
  - **functional sizing,**
  - **components : specifics, COTS,**
  - **Structural analysis**
  - **Integration**
  - **Control: automation and operator action**

Impact on design



Impact on design

- **At reactor level**
  - **building layout, reactor architecture (open core/tank-in-pool, primary flow direction), core design, reactor power, pool sizing**
  - **Driving requirements**
    - Implementation of defense in depth: DEC, DEH
    - Cooling autarchy
  - **Key success factor: right design option and sizing adressing safety requirements and performances**
  - **Consequence: New requirements impacting this level jeopardize the reutilization of previous reactor design**
- **At PBS item level**
  - **proven design character of each SSC (i.e. maturity of the SSCs design)**
  - **capability to properly implement them**

Design approach discussion
4 design strategies are considered

1. **Propose an <u>existing design without any significant change</u> or a drastic limitation of the design changes**

2. **Start from an existing design and tailor it to fit the project requirements: so-called <u>Existing design adaptation</u>,**

3. **Perform a fit to purpose design through:**
   a selection of a reference reactor type,
   a tailored system architecture and building layout to match project requirements
   a reactor architecture definition integrating a maximal number of SSCs with a proven design
   so-called <u>Built from proven design architectures and SSCs</u>

4. **Starting from scratch: totally <u>new design</u>.**
   Only way to meet very specific requirements
   Subsequent risk, cost , and schedule impact
   Extremely rare

Design approach discussion: : options 1 & 2

- **Design Strategy Option 1: Existing design without significant change**
  - **Very rare**
  - **Issue as regards regulatory and safety requirements: recent changes**
  - **Similar applications: small differences only can be implemented**

To become a viable option, specific agreement between projects would be required

- **Design Strategy Option 2: Existing design adaptation**
  - **Slight adaptation of an existing reactor overall design requires:**
    - Very limited adaptation of systems architecture
    - Building design meeting up to date safety requirements
    - Conformance of SSCs qualification/requirement
    - Site requirements not challenging design of systems housed within nuclear island
  - **Condition for success:**
    - Similar application requirements and layout and integration not challenged by external hazards
    - Very recent new safety requirements (DiD and external hazards) already considered

Efficient when possible

Successfull implementation requires unlikely conjonction of conditions

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Design approach discussion: : option 3

- **Built from proven design SSCs and architectures**
  - **selection a reactor architecture compatible with applications**
  - **new core design**
  - **plant architecture**
    - fitting with up to date defense in depth
    - integrating as far as possible already proven design SSCs,
  - **nuclear island building designed to cope with challenging hazards.**

- **Always possible**

- **Combines benefits of past and recent/ongoing project:**
  - **SSCs**
  - **Building design**
  - **Qualified safety related items**

- **Meets performances and safety requirement at efficient cost and schedule**

Good trade-off

Always implementable

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Illustration of implementation at TechnicAtome

- **Overall design and reactor architecture benefits from**
  - the JHR project, meeting up-to-date safety requirements
  - but also all previous reactors' design even the older ones

  since only the concepts are reused within an up-to-date overall architecture as regards defense in depth, meeting safety requirements

- **Core and experimental devices design benefits from**
  - Lessons learned from material testing, multipurpose and neutron beam reactors (e.g. OSIRIS, SILOE and ORPHEE),
  - LEU silicide fuel qualification at fuel element level (OSIRIS, JHR) and fuel assembly
  - Up-to-date design approaches and computer codes

- **Reactor systems benefit from combination of**
  - proven concepts from past projects
  - up-to-date sizing using up-to-date tools
  - qualified component from component database of the TechnicAtome PLM

  As regards component qualification, the very stringent Cadarache site environmental conditions become an asset for future projects

Concluding remarks

- **Contributions of previous projects and experience are key to the design of new research reactors.**

- **The recent evolution of safety requirements together with the specific utilization features raise challenges for the reutilization as a whole of pre-existing designs.**

- **Actually, relevant contributions of past projects to design of new research reactor come from:**
  - **Any research reactor projects, for the reactor core, the fuel, the core support structures and the experimental devices,**
  - **Recent nuclear reactors projects meeting up-to-date safety requirement, for**
    - **other key safety SSCs**
    - **decay heat removal means,**
    - **means of confinement,**
    - **and building providing protection against external hazards,**
  - **All recent and ongoing nuclear projects, for all other safety classified SSCs**