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ATMEA1: robust and safe Generation III+ reactor in the light of the lessons learned from Fukushima

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INTRODUCTION

ATMEA & the ATMEA1 Reactor

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Who is ATMEA?

2 world leading nuclear suppliers

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MITSUBISHI HEAVY INDUSTRIES, LTD.

Joint venture: ATMEA

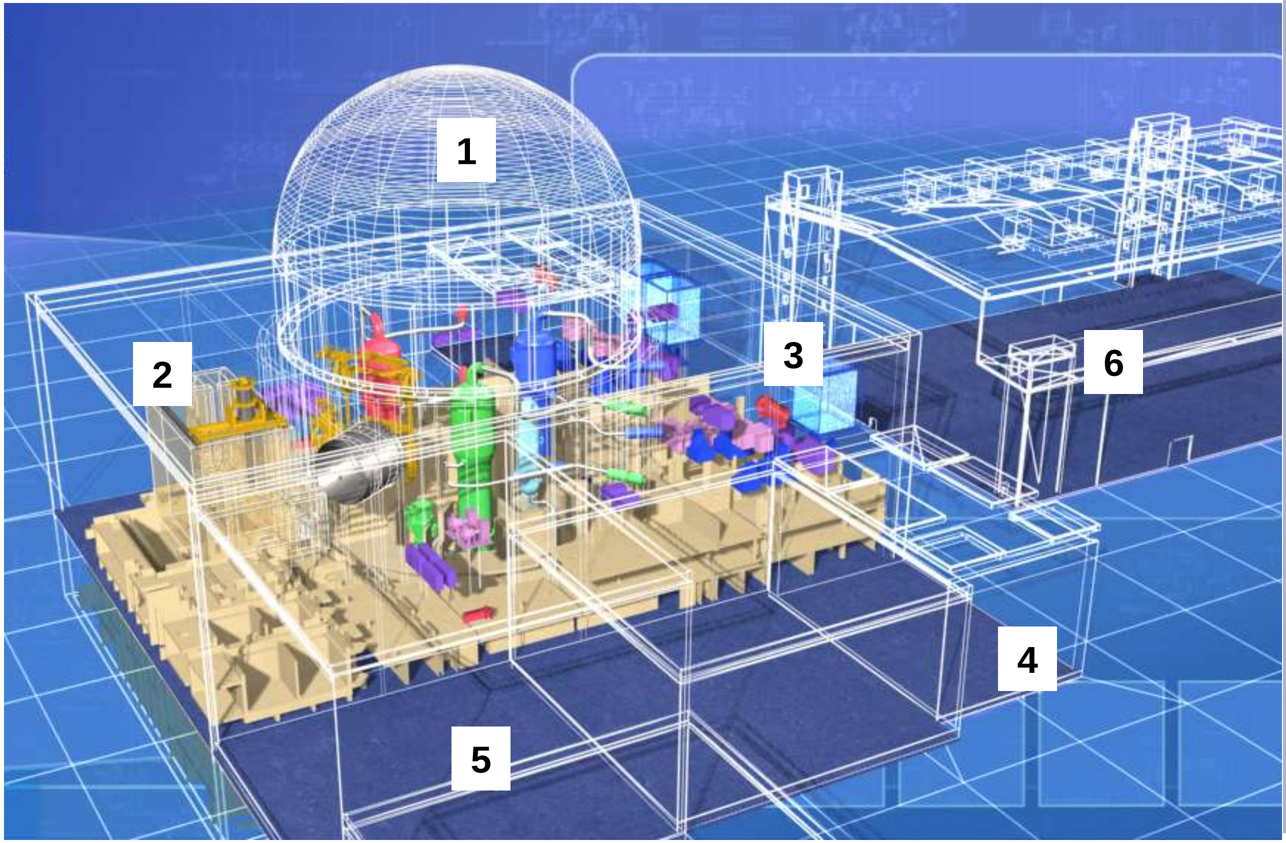
- Company name:	**ATMEA S.A.S.**
- Office Location:	**Paris La Defense**
- President & CEO:	**Philippe Namy**
- Deputy CEO:	**Makoto Kanda**
- Establishment:	**November 2007**
- Capital:	**126 Million Euros**

- Scope of activities: Development, Marketing & Sales, Construction & Commissioning activities for the **1100 MWe class Generation III+ ATMEA1 Nuclear Island**
- The ATMEA company is the **exclusive vendor** of the ATMEA1 Nuclear Island
- Organization: **Subcontract engineering work to both mother companies** for the ATMEA1 development activities

The ATMEA1 Reactor: A mid-sized Generation III+ PWR

ATMEA1 Main Features

Reactor Type	3-Loop PWR	Safety System	3-Train reliable active system with passive features
Electrical output	1100 – 1150 MWe (Net)	Severe Accident Management	Core catcher Hydrogen re-combiners
Core	157 Fuel Assemblies	Resists airplane crash	Pre-stressed Concrete Containment Vessel
Steam Pressure	More than 7 MPa	I&C	Digital



1. Reactor Building
2. Fuel Building
3. Safeguard Building
4. Emergency Power Building
5. Nuclear Auxiliary Building
6. Turbine Building

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ATMEA1
- Part 1-

Best-in class safety for public acceptance

ATMEA1 robust design with its redundant and diversified safety features ensures best-in class safety

External hazards – Large commercial airplane crash, Tsunami, Flooding, Earthquakes

PROTECT

Resistance against external hazards

Extreme external hazards beyond plant design

Consequence to cooling systems If highly conservative design margins are exceeded

COOL

Ensure the residual heat cooling function by redundant safety features

Very unlikely extreme conditions

Consequence: Loss of cooling function

CONFINE

No/very limited environmental impact even under extreme conditions

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ATMEA1 Robust Design

External hazards – Large commercial airplane crash, Tsunami, Flooding, Earthquakes

PROTECT

Resistance against external hazards

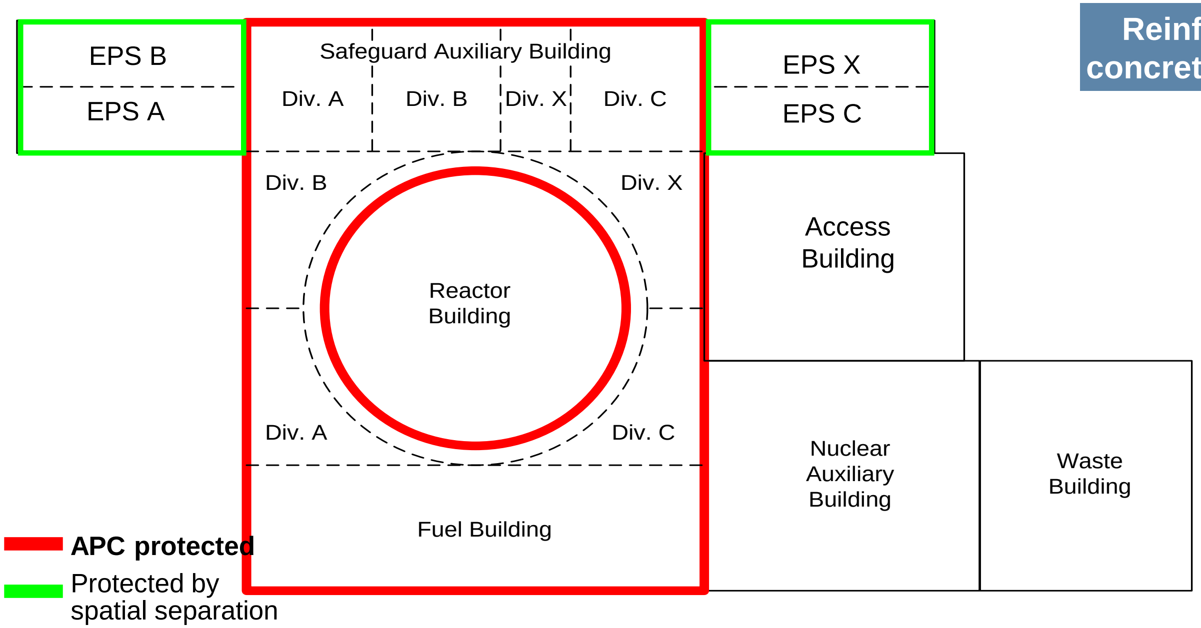
- **Ensure the proper operation of the safety systems even in case of external hazards**
  - ✓**Robust structural design with bunkerization/spatial separation**
  - ✓**Seismic resistance capability**

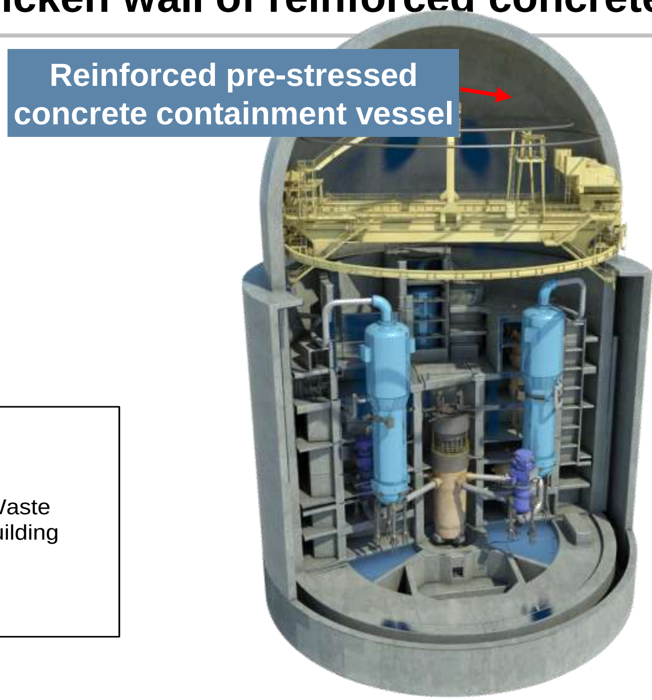
PROTECT

Protection against external hazards

(Large commercial airplane crash, Flooding, Tsunami, External pressure wave etc.)

- **Safety systems and components are protected:**
  - **Either by bunkerization (ex. building reinforcement) or spatial separation (ex. Emergency Power Sources: EPS) to secure the safety functions**
  - **Against Tsunami/Flooding in leak tight buildings**
- **Reinforced pre-stressed concrete containment Vessel, 1.8m thick**
- **Safeguard building and Fuel building with 1.8m thicken wall of reinforced concrete**





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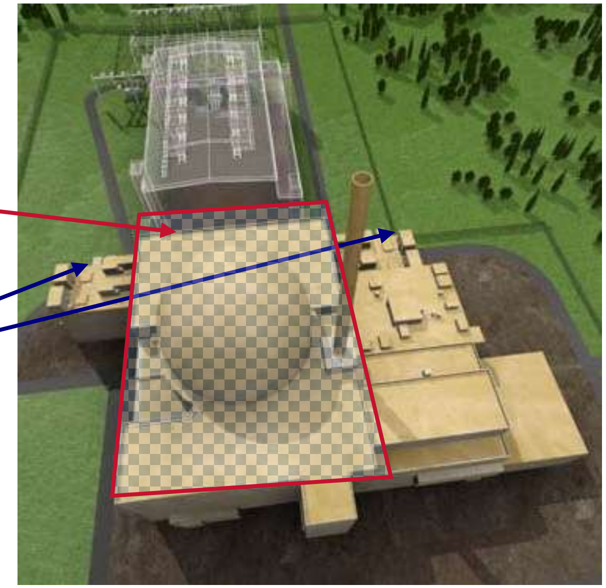
PROTECT

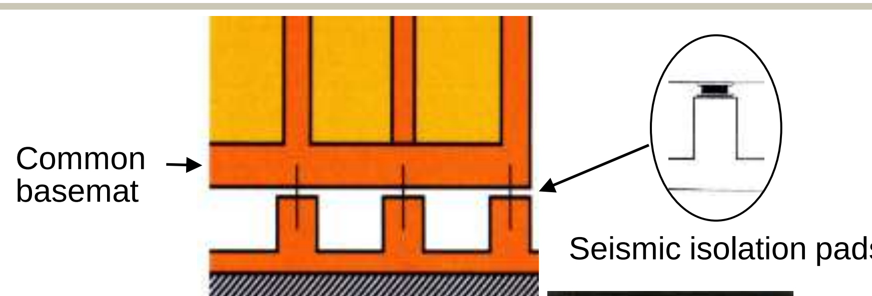
Protection against external hazards (Earthquake)

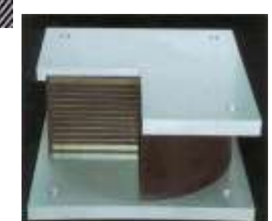
Seismic design

- **Fuel building, Reactor building, Safeguard building are on a common basemat and are Seismic Class 1**
- **Emergency Power Source buildings are Seismic Class 1**



- **The seismic level for standard design is defined as 0.3 g SSE with conservative design margins**
  (0.3g SSE = covering US-West coast-type earthquakes)
- **For much higher values, seismic relief devices are also available**
  - **Already implemented on existing AREVA NPPs, Nuclear research reactors, and Nuclear fuel facilities in operation**
  - **Widely implemented in Japan for conventional buildings**





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ATMEA1 Robust Design

PROTECT

If highly conservative design margins of PROTECTION are exceeded, a very unlikely worse case scenario of external hazards with partial damage to cooling systems is considered

ATMEA1 design takes this worse case into account

COOL

Ensure the residual heat cooling function by redundant safety features

- **Diversified Ultimate Heat Sink (UHS)**
- **EPS x 4 trains to avoid Station Black Out (SBO)**
- **Sufficient "Grace Period" even under unlikely SBO**
  - ✓ **Additional AC power generators**
  - ✓ **UHS with autonomy for 30 days**

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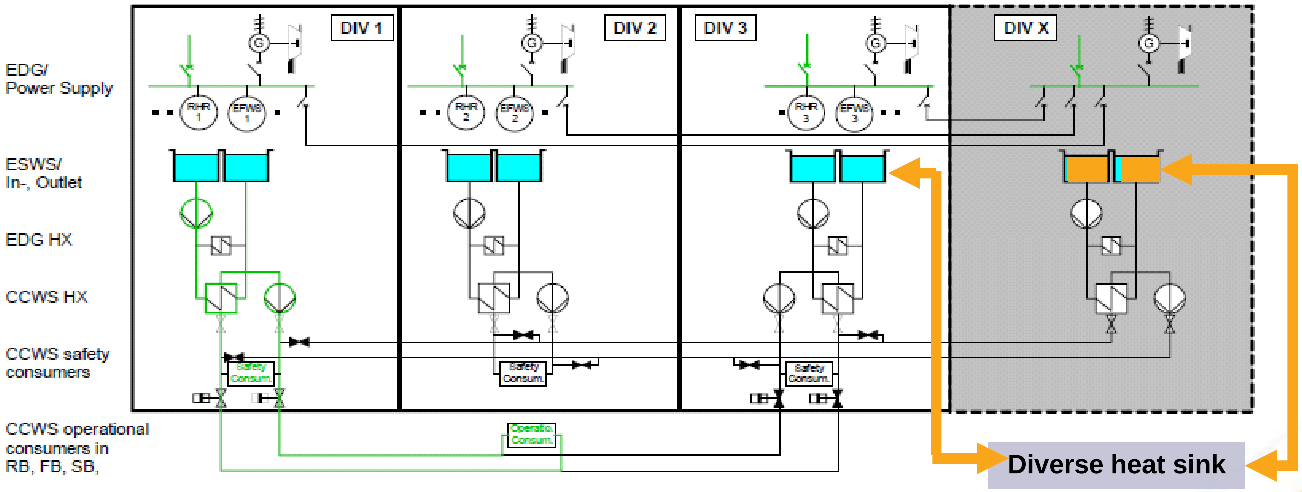
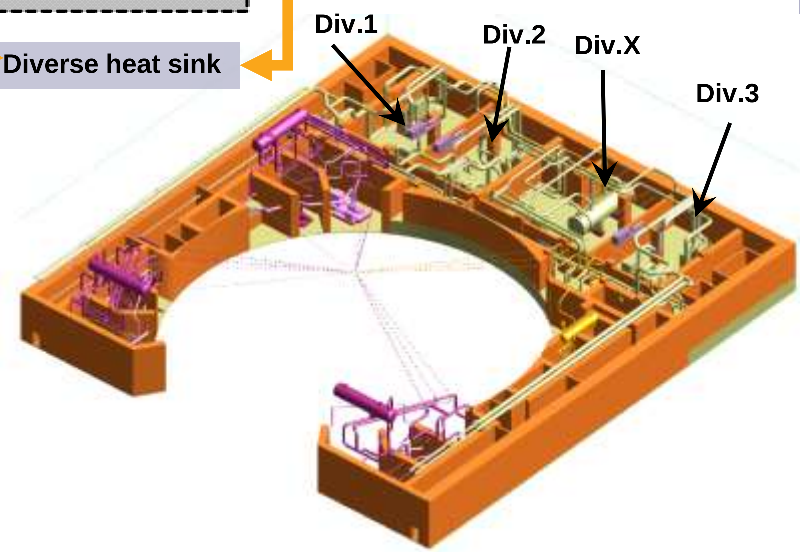
COOL

Reliable cooling system

- 3 x 100% trains plus one additional 100% safety train (Division X)
  - Each train has sufficient capacity to ensure appropriate cooling for Reactor core and Spent Fuel Pool



ex. 4 divisions of CCWS (Component Cooling Water Systems)



- Division X
  - Provides diversification in cooling equipment and heat sink
  - Allows preventive or corrective maintenance of any other train during power operation

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COOL

Diversified water sources

2 diverse Heat Sinks

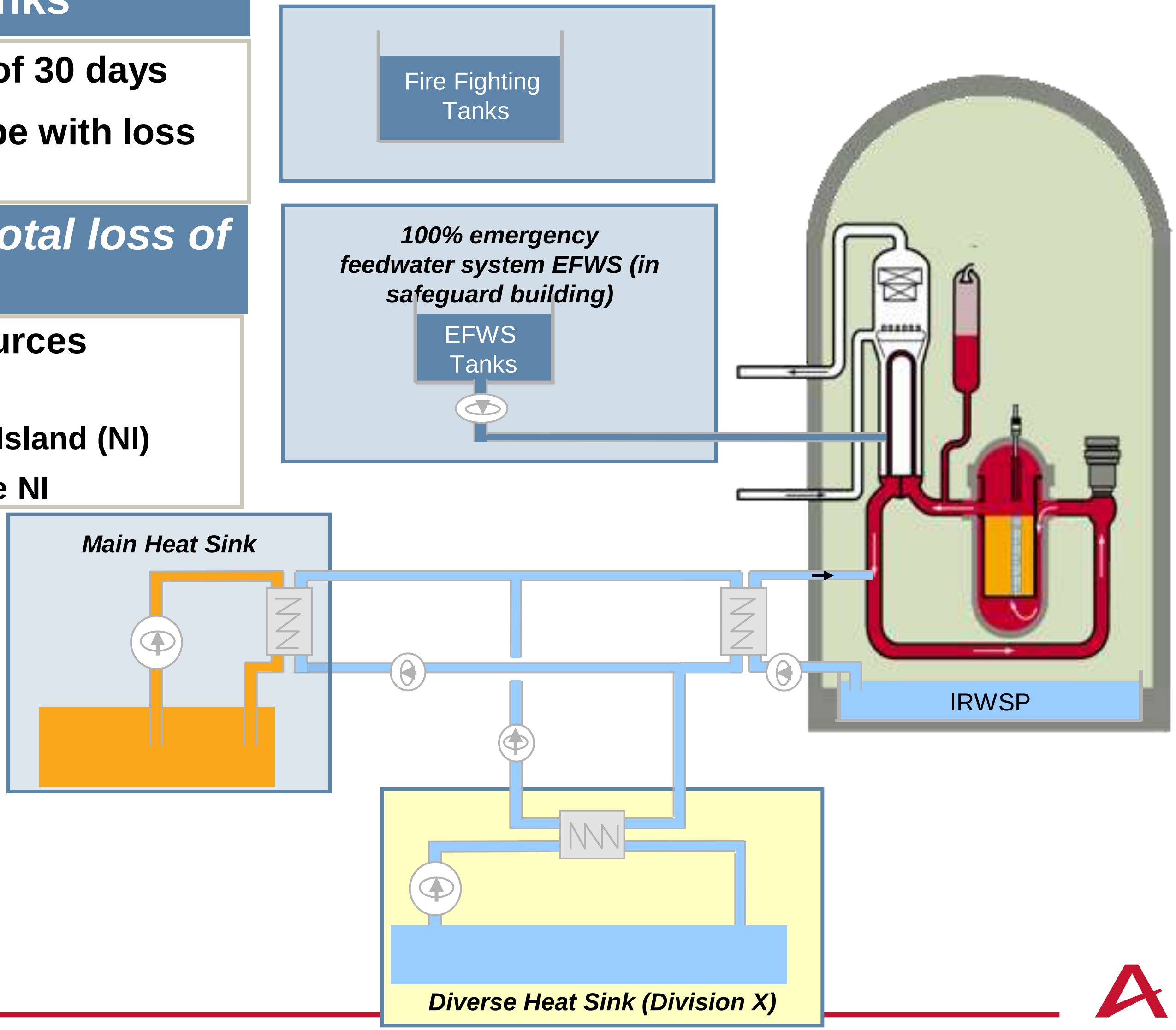
- Designed for an autonomy of 30 days
- Diverse 2nd Heat Sink to cope with loss of main Heat Sink

In very unlikely case of total loss of Heat Sinks…..

- **Diverse access to water sources available on site**
  - **EFWS, IRWSP in Nuclear Island (NI)**
  - **Fire Fighting Tank outside NI**

- ***Enough time to deploy off-site counter-measures even under very unlikely total loss of Heat Sinks***

  Ex. Fire trucks



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COOL

Reliable electricity supply

In case of Loss of Offsite Power…..

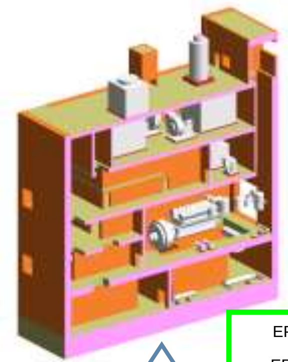
Emergency Power Sources (EPS) will provide AC Power

✓ ***Redundant 4 Diesel Generators ensures very low possibility of Station Black Out (SBO)***

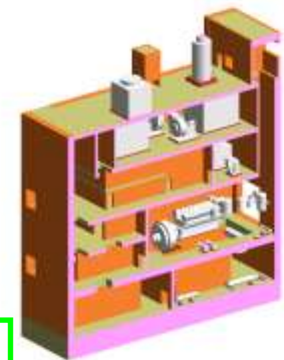
In very unlikely case of SBO….

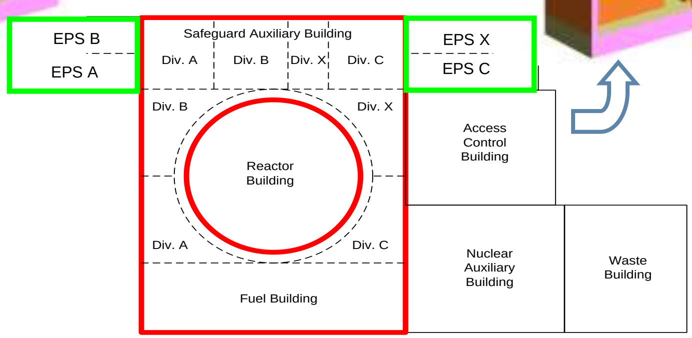
Additional Alternative AC power system (AAC) will provide AC Power

✓ ***Gas Turbine provides the electricity for more than 7 days***



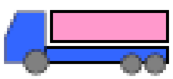
- ***Two EPS Buildings***
- ***Each building houses 2 Diesel Generators***





Enough time to deploy off-site counter-measures even under very unlikely SBO

Ex. Power supply vehicle



Gas Turbine

- ***Dedicated AAC building houses Gas Turbine***

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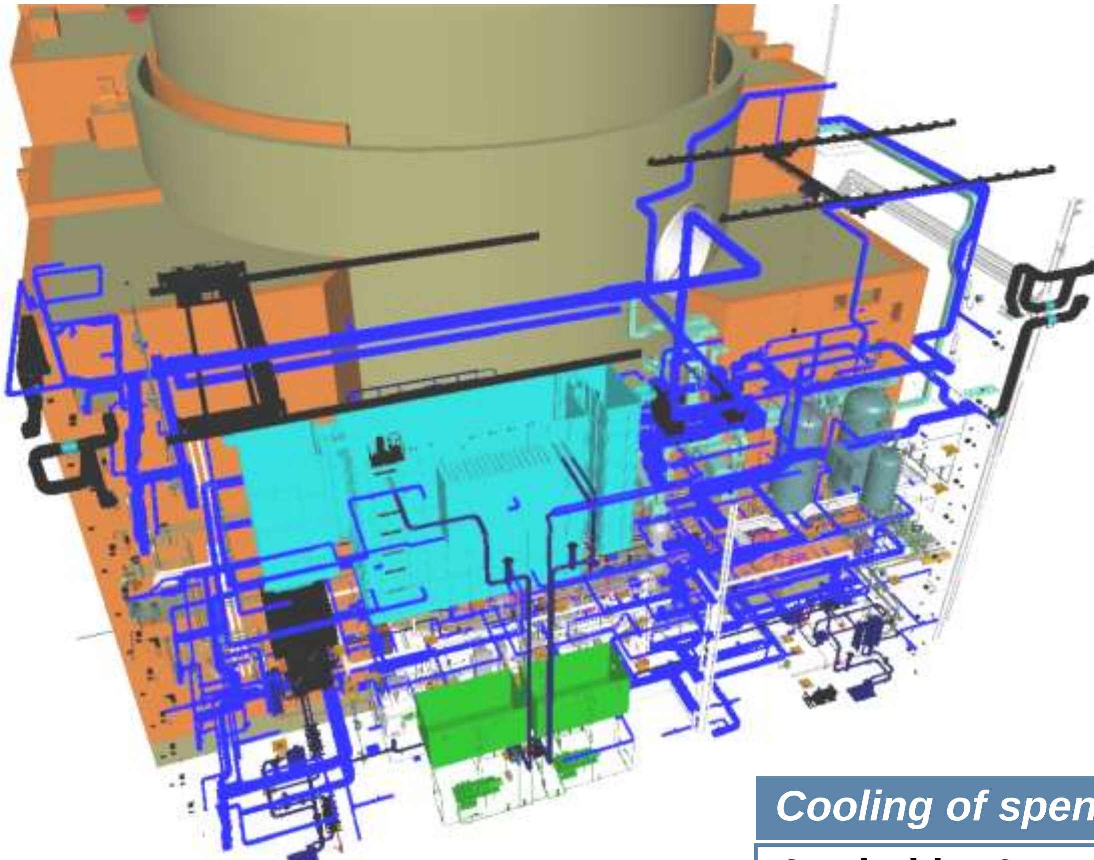
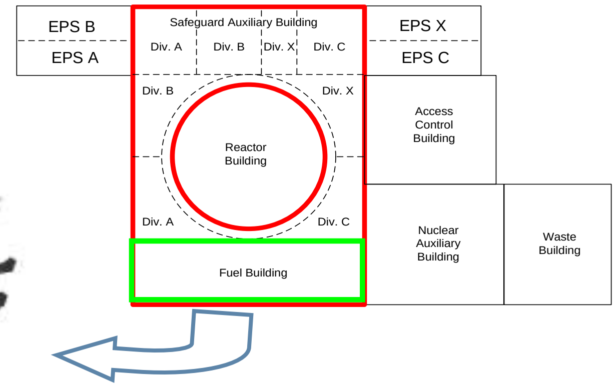
COOL

Fuel building and spent fuel pool

Fuel Building

Protected against external hazards including a large commercial airplane crash with 1.8m thicken wall of reinforced concrete





Cooling of spent fuel pool

Cooled by 2 separate and independent systems + 1 back up cooling system

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ATMEA1 Robust Design

PROTECT / COOL

Even with highly conservative design margins of PROTECTION and COOLING, it is important to consider the possibility that very unlikely extreme conditions could cause loss of cooling function

ATMEA1 design takes this very unlikely worst case into account

CONFINE

No/very limited environmental impact even under extreme conditions

- **No need of evacuation plans thanks to:**
  - ✓**Core catcher**
  - ✓**Hydrogen control**
  - ✓**Robust containment building**
  - ✓**Dedicated heat removal system**

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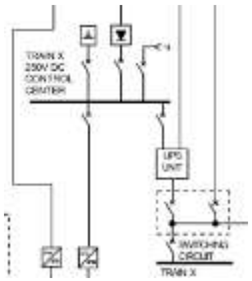
A deterministic approach for severe accident mitigation

Loss of cooling and power → **Primary side heat-up** → **RPV failure at low pressure**

Dedicated SA batteries

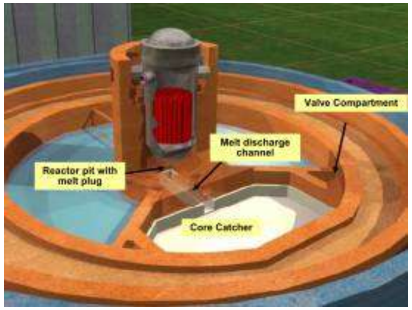


Feed necessary monitoring systems and key valves, ensures MCR habitability

Dedicated depressurization system

Avoid high pressure core melt

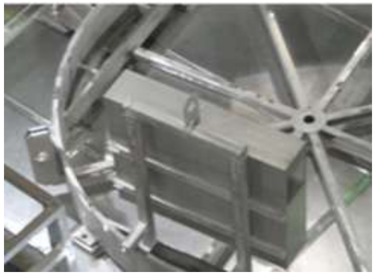
Core catcher



Spread corium and prevent basemat degradation

Release of hydrogen, pressure increase in containment

Hydrogen recombiners

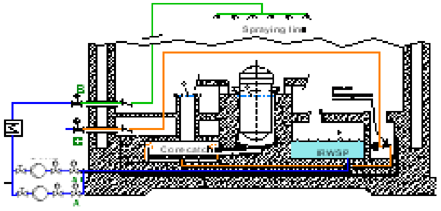


Prevent hydrogen explosions passively (Auto catalytic recombiners)

Pressure resistant containment

Prevent radiological releases

Severe accident heat removal system



Cool the corium on the long-term

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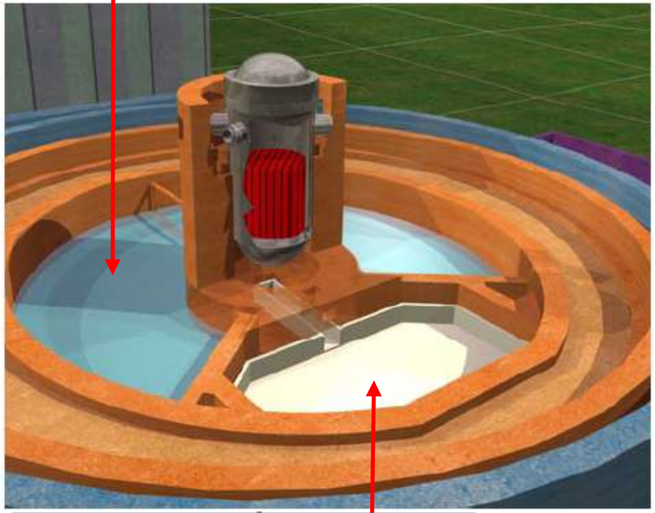
Robust Containment Building and Core catcher

Annulus

Sub-atmospheric and filtered to reduce radioisotope releases

Pre-stressed containment vessel with Steel Liner

In-Containment Refueling Water Storage Pit



Core-catcher

For long-term Severe Accident Mitigation

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ATMEA1 Robust Design
Absence of cliff-edge effect

Design margin and absence of "cliff-edge" effect

- ***With adequate design margins and appropriate safety features:***
  - ***Events exceeding design basis will not trigger drastic degradation of the plant conditions***
  - ***Necessary monitoring and control means are maintained***
  - ***Suitable grace period is provided for operators' actions***
  - ***Opportunity is given at all times for external means support***

No "cliff-edge" effect

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ATMEA Approach to First Lessons Learned from Fukushima

- **ATMEA1 short-term lessons learned program after the Fukushima accident was to validate the safety options of the design with regards to the particular type of accident of Fukushima**
  - **Basis for the elaboration of short-term feedback experience program**
    - **Content of the WENRA's proposal for stress-tests**
    - **Content of the ASN stress-tests towards the French operator**
  - **The approach was hence to re-check, in a gradual approach**
    - **Resistance of ATMEA1 to external events**
    - **Extent of design margins**
    - **Behavior of the ATMEA1 in extreme situations: loss of power situations, loss of cooling situations, cumulated losses**

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ATMEA Approach to First Lessons Learned from Fukushima

- Assessment results confirmed robustness of the current ATMEA1 design and its adequate grace time as similar Generation III+ evolutionary reactors
  - Resistance against external hazards
  - Design margin and absence of "cliff-edge" effect
  - Long-term containment integrity under severe accident conditions
- For now no need for design modifications in terms of safety options

First lessons learned from Fukushima have validated ATMEA1's safety approach

- ATMEA will make a close follow-up of national and worldwide consensus regarding additional safety dispositions that could be raised in the wake of Fukushima accident

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ATMEA1 international acceptance

- The French Safety Authority (ASN) with the technical support of the French Institute of Radiation protection (IRSN) launched in October 2010 the review of the ATMEA1 reactor safety principles within the French regulatory framework
- This review has been completed in November 2011 and final report and conclusion were issued early February 2012, including first Post-Fukushima analysis
- This review was finished with a global positive result and confirm:
  - The ATMEA1 reactor is a third generation reactor with outstanding safety features based on proven technology
  - Its robustness to cope with extreme situations
  - Confidence for licensing
- On April 30th, JAEC (Jordan Atomic Energy Commission), the main interlocutor during the preferred technology selection phases, announced it has pre-selected two preferred technologies including ATMEA1 technology
- On June 25, the national utility Nucleoeléctrica Argentina (NA-SA) has informed ATMEA that it had pre-qualified the ATMEA1 technology for the Request for Proposals that will be issued soon for the construction of its fourth Nuclear Power Plant.

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Muito Obrigado …
Thank you very much …
Muchas Gracias …

pela Atenção

End of presentation

ATMEA1 and how it would cope with Fukushima-like Events

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