ATMEA1

THE PROVEN TECHNOLOGY
READY FOR LICENSING AND
CONSTRUCTION

Andreas Goebel
ATMEA
President and CEO
1. ATMEA – The Company bringing AREVA and MHI capabilities

2. ATMEA1 – The Reactor
   1. Main features
   2. A proven technology
   3. Top level safety
   4. Ready for licensing

3. ATMEA1 Business perspectives
A Joint Venture between two World Nuclear Leaders

ATMEAl

1 NUCLEAR ISLAND DESIGNED

ATMEAl

A JOINT VENTURE OF 2 WORLD NUCLEAR LEADERS

50%

AREVA

MITSUBISHI

forward-looking energy

50%
Integrated design based on proven technology
Bringing MHI PWR Construction Experience

Note: Number in / indicates the number of loops in the plant.

① The 24th PWR plant entered commercial operation in Dec. 2009
Track Record:
98 nuclear reactors delivered

Support to Plant Completion:
Engineering, Procurement & Safety Upgrade

4 ongoing EPR™ Construction Projects:
- Olkiluoto 3 (Finland)
- Flamanville 3 (France)
- Taishan 1 (China)
- Taishan 2 (China)

Next EPR™ Project:
- Hinkley Point (U.K.)
Having activities and capabilities in:

- Mining (<300,000 tU delivered)
- Conversion & Enrichment (<40 years experience & <370,000 tU delivered)
- Fuel (135 reactors served & <200,000 assemblies supplied)
- Reactors & Services: R&D, Design, Manufacturing, Procurement, Construction, Operation and Maintenance supports
- Backend & Reprocessing (<27,000 tHM spent fuel treated, <25,000 canisters, <6,900 MOX fuel supplied)
Bringing AREVA & MHI experience

► Leveraging AREVA & MHI unique project delivery experience and best practices in Gen III+ reactors

► Supporting mining and fuel fabrication

► Serving Brazilian industry through localization

► Capitalizing on 25 years experience of technology transfer with Brazil
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ATMEA1 Reactor Main Features

<table>
<thead>
<tr>
<th>Reactor Type</th>
<th>3-Loop PWR</th>
</tr>
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<tbody>
<tr>
<td>Electrical output</td>
<td>1100 MWe Class (Net)</td>
</tr>
<tr>
<td>Core</td>
<td>157 Fuel Assemblies</td>
</tr>
<tr>
<td>Steam Pressure</td>
<td>More than 7 MPa</td>
</tr>
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<table>
<thead>
<tr>
<th>Safety System</th>
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<tbody>
<tr>
<td>3 train reliable active system with passive features + 1 diversified safety train</td>
</tr>
<tr>
<td>Severe Accident Management</td>
</tr>
<tr>
<td>Core catcher</td>
</tr>
<tr>
<td>Hydrogen re-combiners</td>
</tr>
<tr>
<td>Resists airplane crash</td>
</tr>
<tr>
<td>Pre-stressed Concrete Containment Vessel</td>
</tr>
<tr>
<td>I&amp;C</td>
</tr>
<tr>
<td>Full Digital</td>
</tr>
</tbody>
</table>

1. Reactor Building
2. Fuel Building
3. Safeguard Building
4. Emergency Power Building
5. Nuclear Auxiliary Building
6. Turbine Building
ATMEA1: Bringing Benefits

Proven design: Use only experienced or fully validated design

State-of-the-art Safety Design as Generation-III+ NPP

Economy and reliability: Maximize benefits through 60 years operation

Power plant living together with people
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The ATMEA1 Reactor is composed of fully-operated, licensed or verified systems and components of AREVA and MHI nuclear power plants. It covers:

- Systems and Structures
  - Systems and Components
  - Design Integration
  - Structures and buildings
  - Operation, maintenance and inspection of components
- Manufacturing and Constructability
- Licensing
ATMEA1 components have tens of years of operating experience in nuclear power plants

<table>
<thead>
<tr>
<th>Main ATMEA1 Components</th>
<th>Proven design from</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reactor Pressure Vessel</td>
<td>MHI + AREVA PWRs (more than 40 years, ~130 NPPs)</td>
</tr>
<tr>
<td>Fuel Assembly (17x17, 14ft)</td>
<td>N4, Doel-4, Tihange-3 (1985~, 6 NPPs)</td>
</tr>
<tr>
<td>Control Rod (B4C-AIC, 14ft)</td>
<td>N4 (1996~, 4 NPPs)</td>
</tr>
<tr>
<td>Control Rod Drive Mechanism</td>
<td>KONVOI (1988~, 3 NPPs)</td>
</tr>
<tr>
<td>Steam Generator with Economizer</td>
<td>N4 (1996~, 4 NPPs)</td>
</tr>
<tr>
<td>Reactor Coolant Pump</td>
<td>N4 (1996~, 4 NPPs)</td>
</tr>
<tr>
<td>Pressurizer</td>
<td>MHI + AREVA PWRs (more than 40 years, ~130 NPPs)</td>
</tr>
<tr>
<td>Main Coolant Pipe (Forged)</td>
<td>Tomari-3, Civaux-1, 2 (1997~, 3 NPPs)</td>
</tr>
</tbody>
</table>
A few components were developed in order to improve reliability for 60 years or to simplify the system design.

All such components have already been fully tested and validated.

Most of them have already been manufactured and constructed.

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<th>Main ATMEA1 Components</th>
<th>Proven design from</th>
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<tr>
<td>Heavy Neutron Reflector</td>
<td>EPR</td>
</tr>
<tr>
<td></td>
<td>Already licensed / manufactured</td>
</tr>
<tr>
<td>Advanced Accumulator</td>
<td>APWR</td>
</tr>
<tr>
<td></td>
<td>Full scale tested</td>
</tr>
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ATMEA1: Top Level Safety GENIII+ Reactor

APC PROTECTION

SEVERE ACCIDENT MITIGATION

DIVERSITY IN HEAT SINKS & POWER SOURCES (DIVISION X)

PHYSICAL SEPARATION

HIGH SEISMIC RESISTANCE

PROVEN DIGITAL I & C
ATMEA1 robust design with its redundant and diversified safety features ensures best-in-class safety

Internal events - External hazards - Internal hazards

PROTECT: Robust design, reliable equipment and clearly separated safety trains

COOL DOWN: Ensure the residual heat cooling function by redundant and diversified safety features

CONFINE: No/very limited environmental impact even under extreme conditions
Using realistic analyses, incorporate into the design necessary features to ensure that:

- The reactor core remains cooled and the containment function is maintained
- Spent fuel cooling and spent fuel pool integrity is maintained
- No-offsite countermeasures necessary
Protect External Hazards: Seism

- Thickened outer walls of buildings against seismic shear forces
- Large rectangular basemat to improve seismic stability
- Functions of reactor and primary system, fuel pool, all safety systems to be kept against seismic events
- Standard conditions: SSE 0.3g with US spectrum (RG 1.60)
The ground level is set to a sufficient level to avoid consequences from a Tsunami

Important buildings are protected with water-tight walls and doors

- Fuel building, Reactor building, Safeguard building
- Emergency Power sources buildings, AAC building
- Essential Service Water System route

Electrical equipment and I&C equipment are located in upper floors

Main control room
Safety electrical boards

Sea water pump

Important safety equipment (>ground level or water tight compartments)

Water tight wall, doors
Redundancy, diversity and independency:

- 3 x 100% trains (cooling chain) + 1 diversified train
- Diversified power sources and heat sinks
  - 4 emergency power sources (EPS) + 1 diversified Alternative AC power (AAC)
  - 1 ultimate heat sink (UHS1, sea water or river)
    + 1 diversified heat sink (UHS2, atmosphere)
- Clear separation between trains (Divisions)
Confine Severe Accident Mitigation

**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

All potential leakages are prevented or processed and filtered
Highly unlikely extreme external events (e.g., extreme seismic events, external flooding, etc.) present challenges to nuclear power plants.

**ATMEA1 design against extreme external hazards**

- Extend protection of necessary “permanently installed equipment” against extreme condition and use them
  - AAC, UHS2, Division-X
- Mitigation of radiological consequences in case of a severe accident
- Maintain the plant to a safe shutdown state for 7 days* before offsite means are needed

- For each site, the design is defined considering:
  - Site plausible hazards
  - Site/country specific regulatory requirements, site specificities, emergency capabilities

* 7 days assumption is to be assessed with site-specificities
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Based on the documentation submitted for the Phase 1 pre-project design review of the ATMEA1 design, CNSC staff concluded that, in general:

ATMEA understands the CNSC regulatory requirements and expectations for the design of new nuclear power plants in Canada.

At an overall level, the ATMEA1 design intent is compliant with the CNSC regulatory requirements and meets the expectations for new nuclear power plants in Canada.

(Excerpt of CNSC’s Executive Summary) (June 2013)
Safety options and design choices reviewed by the French ASN

- Against its technical guidelines defined for new builds and the French regulation
- The scope covers general PSAR topics except site specific issues
- The review process was the same as the licensing review for a reactor to be built in France

ASN considers:

- The safety options selected for the ATMEA1 Reactor do not warrant any observation
- The design choices adopted for the main equipments of the ATMEA1 Reactor are satisfactory
- Those objectives and the related safety options are in compliance with the French Technical Guidelines
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Achievements and Projects

- **Conceptual Design**
  - Definition of main features
  - Project engineering manual
  - Conceptual safety features

- **Basic Design**
  - Functional requirements
  - Safety requirements
  - General arrangement
  - Core system & component design
  - Standard Preliminary Safety Analysis Report

- **ASN* Review**
  - Positive conclusion

- **CNSC* (Canada) Review**
  - Positive conclusion

- **IAEA Report**

- **Standard Detailed Design**

- **Turkey NPP with 4 ATMEA1 at Sinop site**
  - Japan/Turkey HGA
  - Japan/Turkey IGA

*ASN: French Safety Authority  *CNSC: Canadian Nuclear Safety Commission
The ATMEA1 Reactor is selected in many countries as a potential technology for New Power Plants.
Sinop Project in Turkey Status

► **Government level** (Japan and Turkey)
  - May 3rd, 2013 Inter-Governmental Agreement
  - October 29th, 2013 Host Government Agreement (Framework)

► **Investor level**
  - Consortium: MHI and Itochu (Japan), GDF SUEZ (France), EUAS (Turkey)

► **EPC contractor level**
  - EPC consortium – MHI leadership

► **Technology**
  - ATMEA1 Nuclear Island

► **1st unit commercial operation**: 2023
Why is ATMEA1 best for Brazil?

- Secure baseload power supply thanks to an advanced Gen 3+ mid-size reactor
- Withstands Fukushima-like accident thanks to highest safety standards
- Proven technology well known in Brazil: same family as ANGRA NPPs
- Access to full support of Japan and France (finance, technology transfer,...)
- Access to MHI and AREVA’s 40 years of experience in design and construction
- Benefit of Turkish EPC project return of experience
- Benefit of AREVA involvement in the ANGRA 3 project
  - Strong ties with local suppliers
  - ATMEA1 reactor already includes ANGRA 3 design improvements
    - Additional cooling water tanks
    - Additional power supply system
    - Hydrogen recombiners
    - Aerosol ventilation and filtration system
    - Next generation digital I&C
  - Smooth ATMEA1 licensing in Brazil capitalizing on ANGRA 3
THANK YOU FOR YOUR KIND ATTENTION

ANY QUESTION?