www.iaea.org/NuclearPower/Downloads/Technology/meetings/2011-Jul-4-8-ANRT-WS/

AP1000® Overview

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Agenda

- **AP1000 Design Philosophy**
  - **AP1000 Passive safety functions**
  - **AP1000 Robustness against external events**
- **AP1000 Licensing Activities & Status**
- **AP1000 Deployment Activities & Status**

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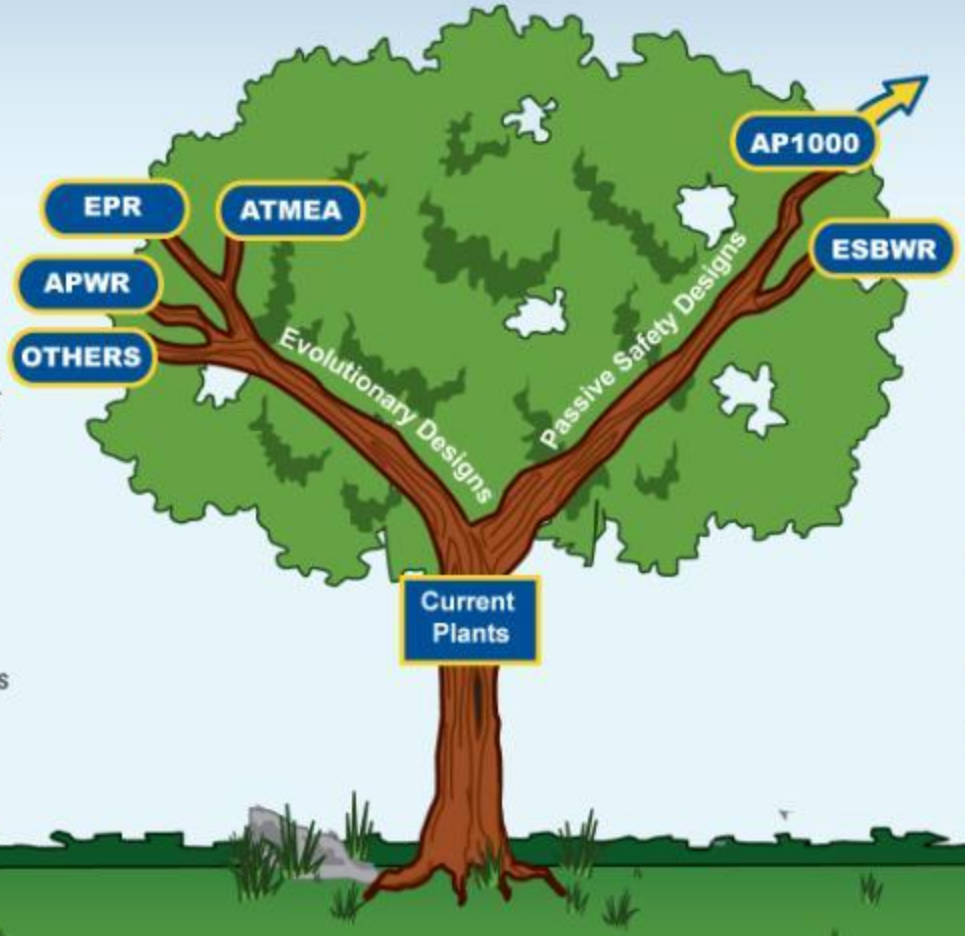
AP1000 Plant Design Objectives

- **Greatly Simplified Plant**
  - Construction, Maintenance, Operation, Safety
- **Increased Operation and Safety Margins**
  - Design Basis Accidents, PRA (core melt prevention & mitigation)
- Competitive Cost of Power**, Less Than Coal Plant**
- **Short Construction Schedule** (3 Years for nth of a kind)
- **Modular Construction,** Leverage simplification to maximize certainty of cost, schedule, and enhance quality through workshop fabrication
- **Licensing Certainty & Reduced Customer Costs**
  - NRC Final Design Approval / Certification – extensive testing of passive systems
  - Pre-Engineered / Pre-Licensed Standard Design: Reduce Costs, Increase Licensing Certainty
- No Plant Prototype**; Proven Components / Systems**
- **Improved Availability**, Inspection, ORE, Maintenance

Evolutionary PWRs

- Updates of current 3 & 4-loop designs
- Extensive, safety-grade support systems
- Off-site ac for safety action and safety diesel or turbine -driven generators as backup
- Greater reliance on operator action
- Ultimate heat sink: heat exchangers/water systems



Why AP1000 passive designs?

- Less concrete & steel/MWe
- Simpler, less equipment, less safety-grade equipment, no safety-grade pumps
- Fewer Seismic 1 structures
- Shorter construction schedules
- Less maintenance, maintenance-free canned reactor coolant pumps, simpler Tech Specs
- Much less reliance on operator action to mitigate accidents (72 hours)
- Independent of off-site ac power to operate safety systems
- Ultimate heat sink: ambient air

The preferred technology in the US and China

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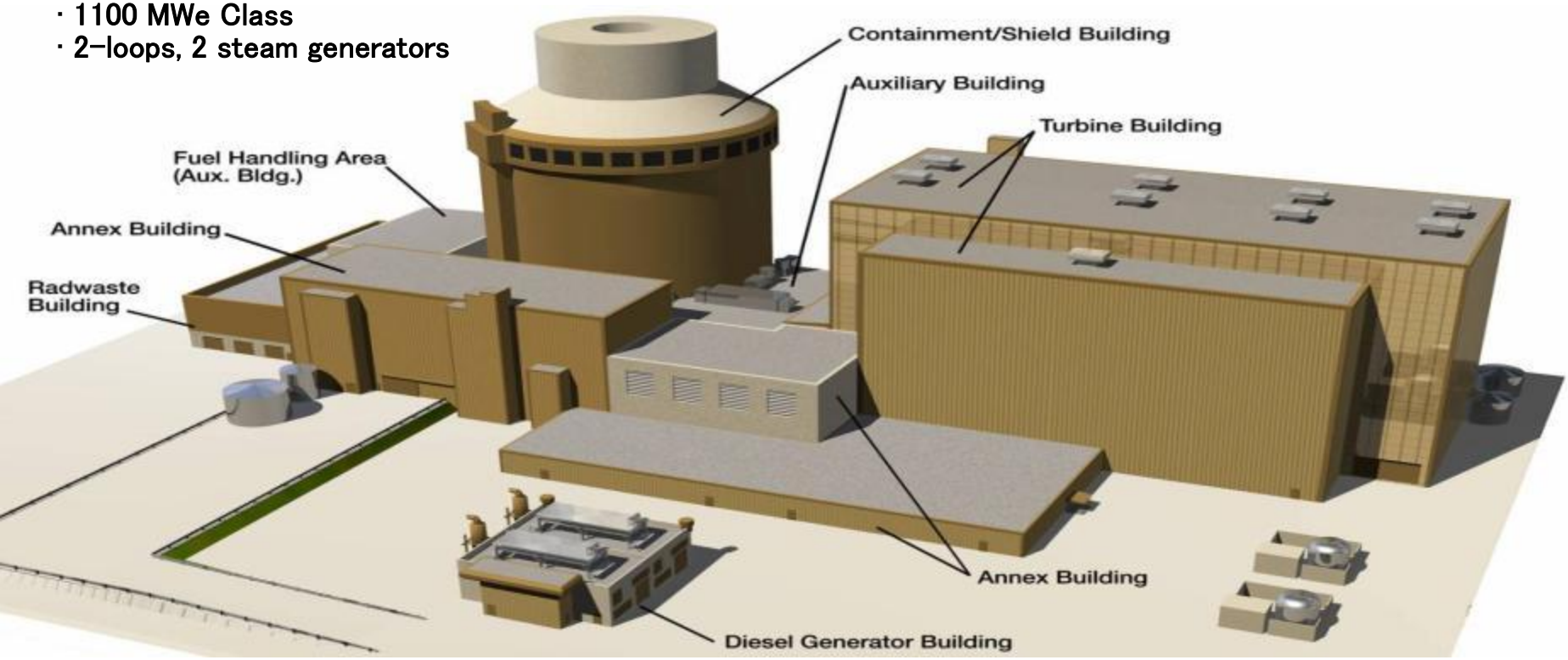
Westinghouse AP1000

A compact station

- 3415 MWt. Primary system
- 1100 MWe Class
- 2-loops, 2 steam generators



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AP1000 Approach to Safety

- **Passive Safety-Related Systems**
  - Use "passive" processes only, no active pumps, diesels, ….
    - One time alignment of valves
    - No support systems required after actuation
  - Greatly reduced dependency on operator actions
  - Mitigate design basis accidents without active systems
  - Meet NRC PRA safety goals even without credit of active systems
- **Active Defense in Depth-Related Systems**
  - Reliably support normal operation
    - Redundant equipment powered by onsite diesels
  - Minimize challenges to passive safety systems
  - Not required to mitigate design basis accidents

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AP1000 Approach to Safety Defense In Depth

- First Level is usually the Defense in Depth active features
  - Automatically actuated before passive features
  - High quality industrial grade equipment
- Another level is the passive safety features
  - Provides safety case for licensing
  - Highest quality nuclear grade equipment
- Functional diversity within the passive features provides additional levels
  - Example; passive feed/bleed backs up PRHR HX
- Available for all shutdown and at-power conditions
  - More likely events have more levels of defense

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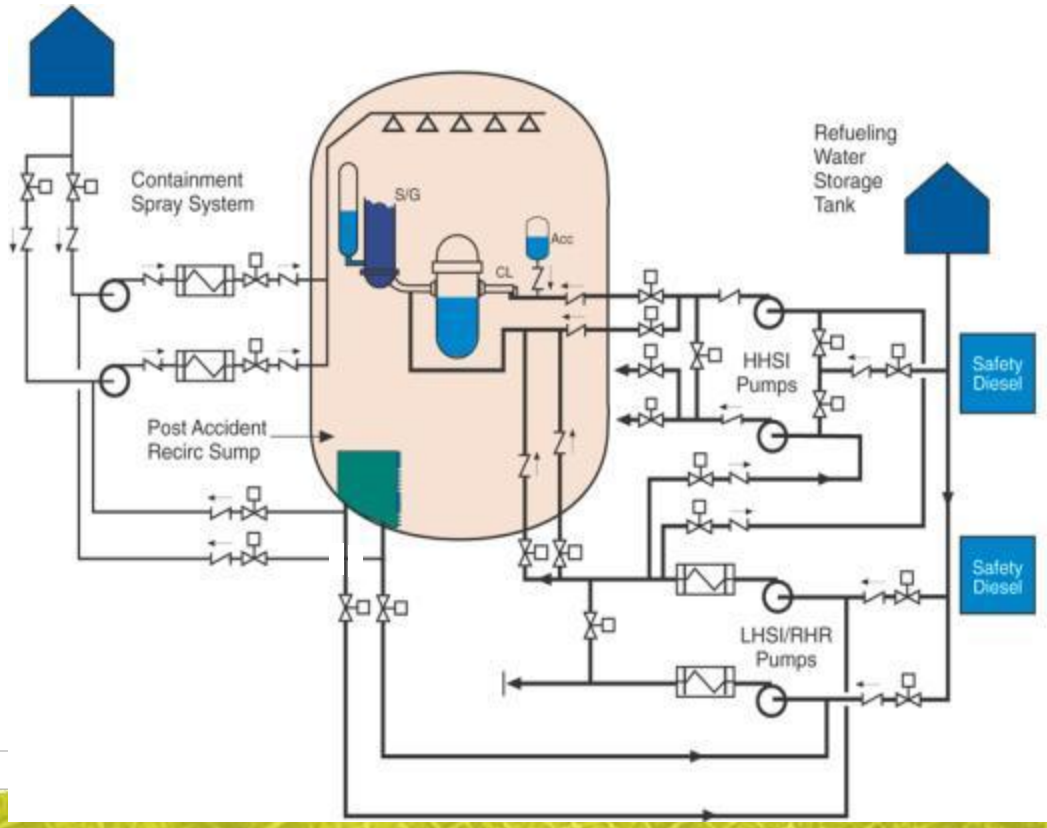
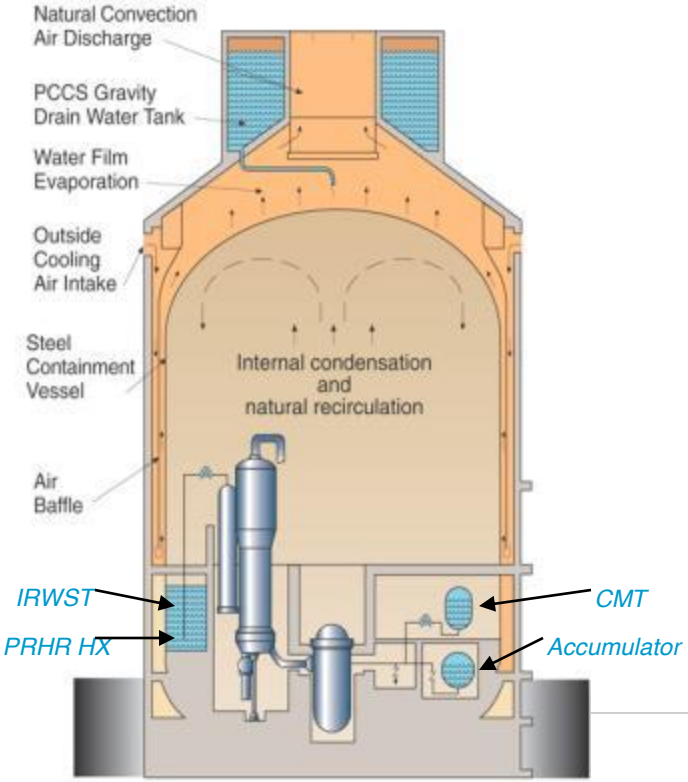
Simplification of Safety Systems Dramatically Reduces Building Volumes

AP1000™

Standard PWR



AP1000



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Simplification: Smaller Footprint

Evolutionary PWR **AP1000**

Size Matters

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Major Safety Advancements of AP1000

- No Reliance on AC Power; Long Term Plant Safety Assured without Active Components (Natural Forces Only)
  - For Station Blackout (SBO), AP1000 meets aggressive 72 hours coping time requirements for passive plants
    - Active plants SBO coping period requirement is 8 hours or less
  - Significant risk reduction for loss of power events:
    - For advanced active plants design, LOOP / SBO events are a dominant contributor to the Core Damage Frequency (in the range of 25+%)
    - AP1000 CDF contribution for loss of Offsite Power / SBO is 0.4%
- No Operator Action Required to Assure Safety
- In Severe Accidents, Reactor Vessel Cooling Keeps Core in Vessel
- Large Margin to Safety Limits
- Defense in Depth - Active Systems Provide ADDITIONAL first line of defense

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Major Safety Advancements of AP1000 Event/Threats Response Summary

Events /Threats	Westinghouse AP1000
Earthquakes and Floods	Seismic Design: AP1000 designed to withstand an earthquake that would happen once in every 10,000 years. Plants are being sited in seismically stable regions Robust: Designed to withstand other natural disasters: flooding, tornados, tsunamis, hurricanes.
Station Blackout (no AC power sources)	AP1000 can be safely shut down and maintained during a station blackout for 7 days. The advanced passive safety features rely on natural forces such as gravity, natural circulation, condensation and convection. The ultimate heat sink is the atmosphere. Power Sources • Redundant safety-related DC batteries support safe shutdown for 72 hours (3 days). • Two redundant 80 kw ancillary diesel generators provide cooling water to the containment shell and spent fuel pool. Ancillary diesels can run for 4 days with no offsite support. • Two redundant 4 MW standby diesel generators can power equipment for 7 days with no offsite support (not required to cope with station blackout) Water Sources • Passive Containment Cooling Tank provides cooling to the containment shell for 72 hours • Ancillary Storage Tank provides cooling to the containment shell and to the spent fuel pool after 72 hours for a period for 4 more days

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Major Safety Advancements of AP1000 Event/Threats Response Summary

Events /Threats	Westinghouse AP1000
Containment Integrity	Containment Design: The 44.5 mm (1¾") steel containment is a high integrity steel pressure vessel surrounded by a shield building that protects it from missiles, including aircraft impact. Hydrogen Management: Battery powered hydrogen igniters & passive hydrogen recombiners prevent explosions
Spent Fuel Pool Integrity and Cooling	Structure: Spent fuel pool features 1+ m (3-5') thick, heavily reinforced concrete structures lined with steel Makeup Water: Spent fuel will remain covered with water sources located in the spent fuel building for at least 3 days. Following 3 days, water is provided by the ancillary storage tank. Robust Building: Designed for protection against seismic events, natural disasters and aircraft impact.
Control Room Habitability	Heavily shielded room with a 72-hour air-pressurization system. Control room dose minimal

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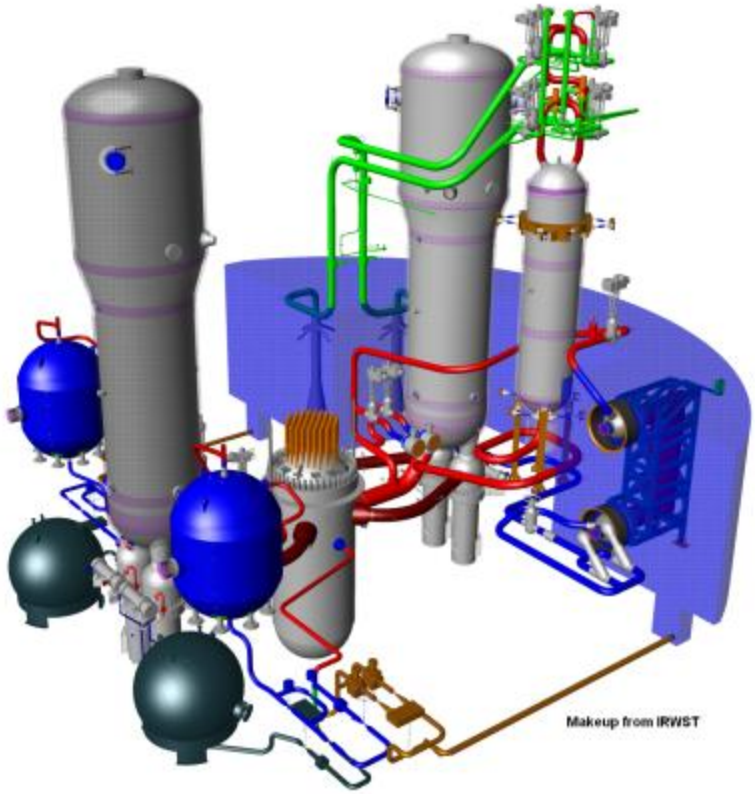
AP1000 Passive Core Cooling System Eliminate the need for AC Power

- **Passive Residual Heat Removal** (PRHR HX)
  - Natural circ. heat removal replaces auxiliary feedwater pumps
- **Passive Safety Injection**
  - Core Makeup Tanks (CMT)
    - Full RCS pres, natural circ. inject (replaces high head injection pumps)
  - Accumulators (ACC)
    - Similar to current plants
  - In-containment Refueling Water Storage Tank (IRWST) Injection
    - Low pres (replaces low head injection pumps)
  - Containment Recirculation
    - Gravity recirc. (replaces pumped recirc)
  - Automatic RCS Depressurization
    - Staged, controlled depressurization



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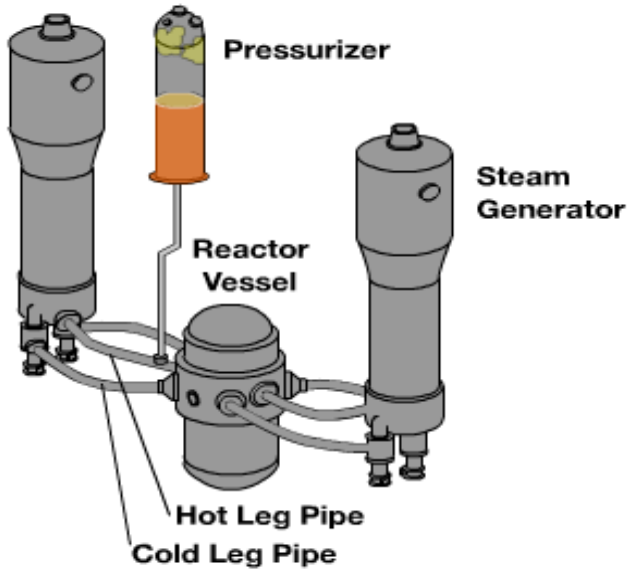
Passive Safety Injection Operation During a LOCA



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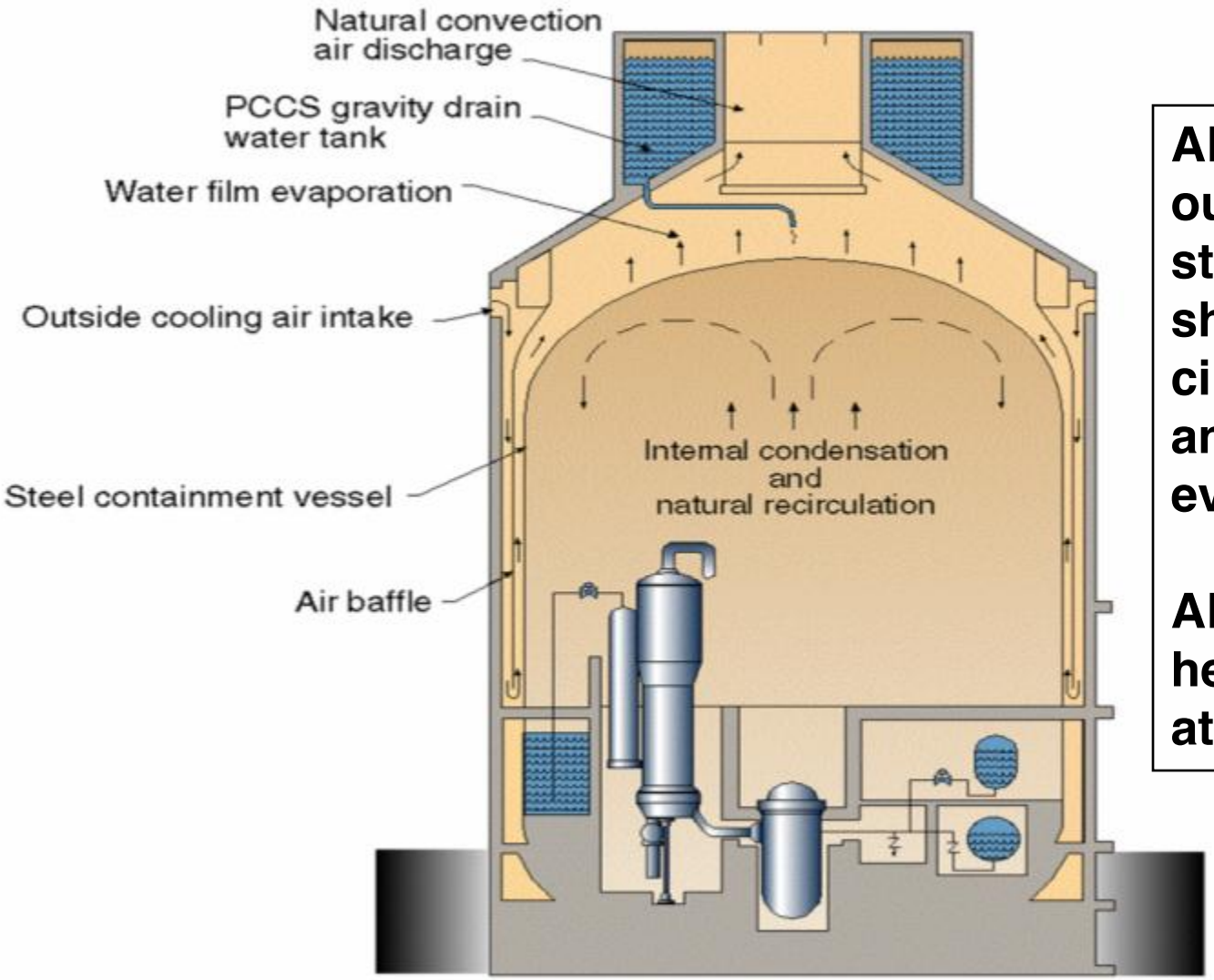
Passive Containment Cooling System



AP1000 PCS cools outer surface of steel containment shell using natural circulation of air and water evaporation.

AP1000 ultimate heat sink is the atmosphere.

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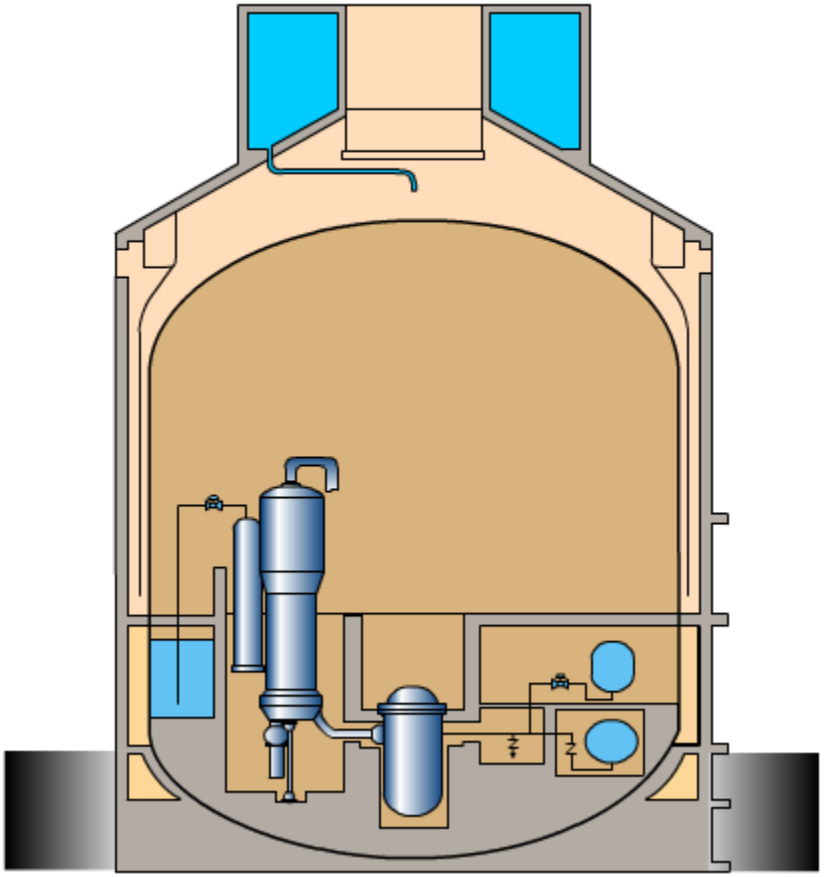
Passive Containment Cooling Operation During a LOCA



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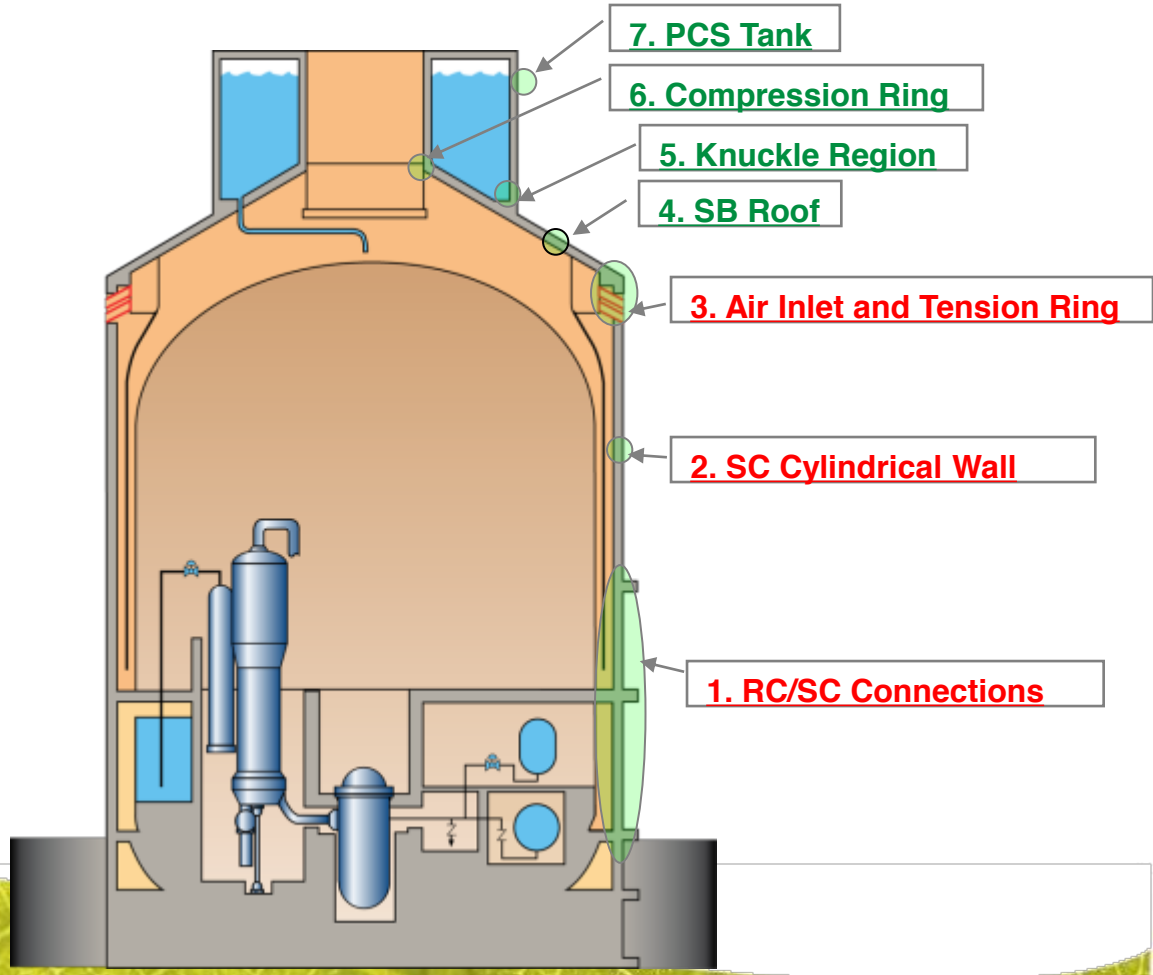
Enhanced Shield Building Design

Aircraft Crash Requirements and Seismic Performance

Shield Building Design Features

Hardened design to meet Aircraft Crash requirements

- RC/SC connection redesigned to improve ductility
- Reinforced cylindrical wall with tie bars between steel plates
- Increased SC plate thickness to improve strength and ductility
- Revised the air inlet/ tension ring design for constructability and strength



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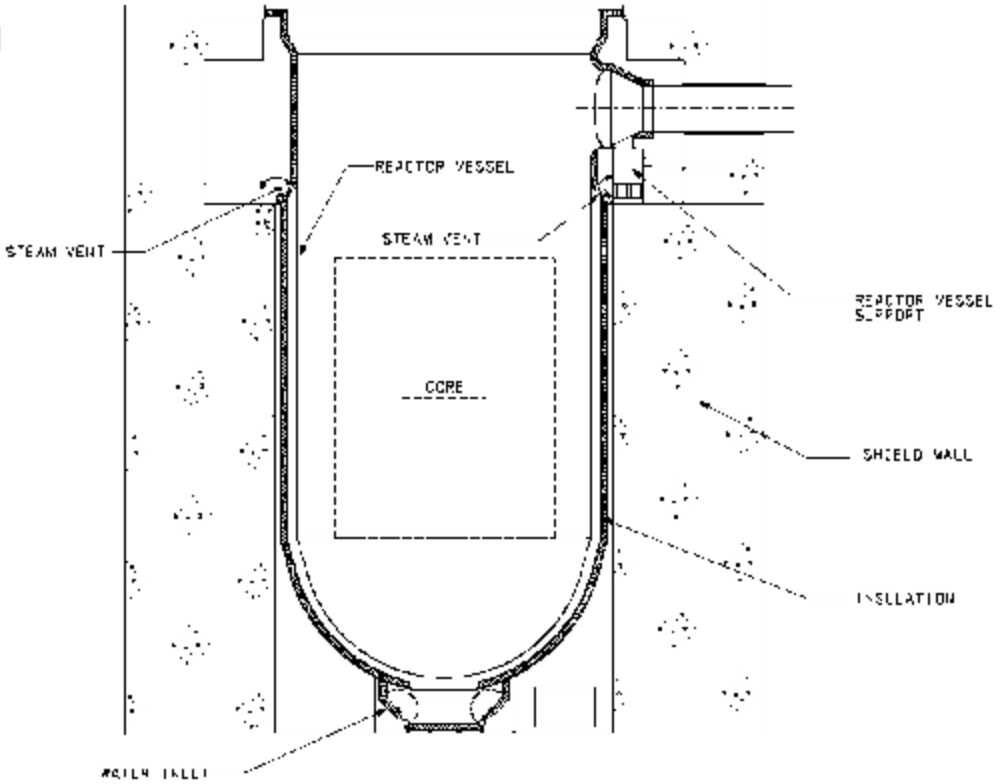
Severe Accidents Addressed

- In-Vessel Retention (IVR)
  - External reactor vessel cooling
  - Provides reliable means of cooling damaged core
  - Prevents vessel failure
  - AP600/AP1000 tests and analysis of IVR reviewed by U.S. NRC
- High Pressure Core Melt
  - Eliminated by ADS
- Hydrogen Detonation
  - Prevented by igniters and passive autocatalytic recombiners
- Steam Explosions
  - In-Vessel – no RV failure
  - Ex-Vessel – eliminated by IVR
- Core Concrete Interaction
  - Eliminated by IVR



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Why In-Vessel Retention

1. **PRA/PSA shows ex-vessel phenomena risk significant. IVR prevents ex-vessel phenomena**

2. **Simple strategy for operators: Provide water**

3. **Core melt does not attack containment barrier**

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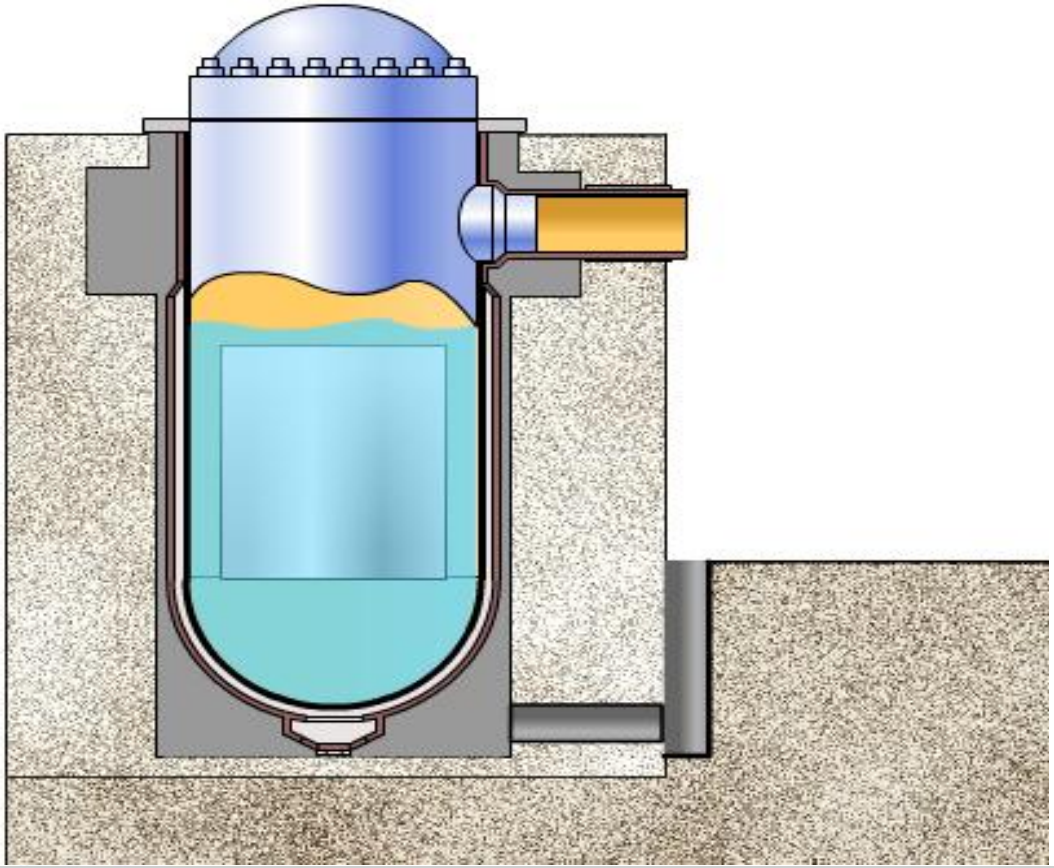
AP1000 In-vessel Retention Capability



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Spent Fuel Pool Cooling Lines of Defense

- **During Normal and Abnormal Conditions, the active defense in depth and duty systems provides highly reliable spent fuel pool cooling**
  - Spent Fuel Cooling System, Residual Heat Removal System, Component Cooling Water System, Service Water System all have 2*100% design for active components
  - Offsite power backup provided by 2*100% Onsite Standby Diesel Generators with automatic startup on loss of offsite power
- **For unlikely events with extended loss of AC power (station blackout) and/or loss of heat sink, the safety case for the AP1000 is provided by passive means**
  - Simple or no operator actions are required for 72 hours
  - Beyond 72 hours, one of the two PCS Recirculation Pumps (powered by the Ancillary Diesel Generators) is used to pump water from the Ancillary Tank to the Spent Fuel Pool. The Ancillary Tank contains sufficient volume of makeup water to continue this action from 72 hours to approximately 7 days.
- **Even for Extreme Events, the Spent Fuel Pool spray system provides an additional line of defense to provide fuel cooling**

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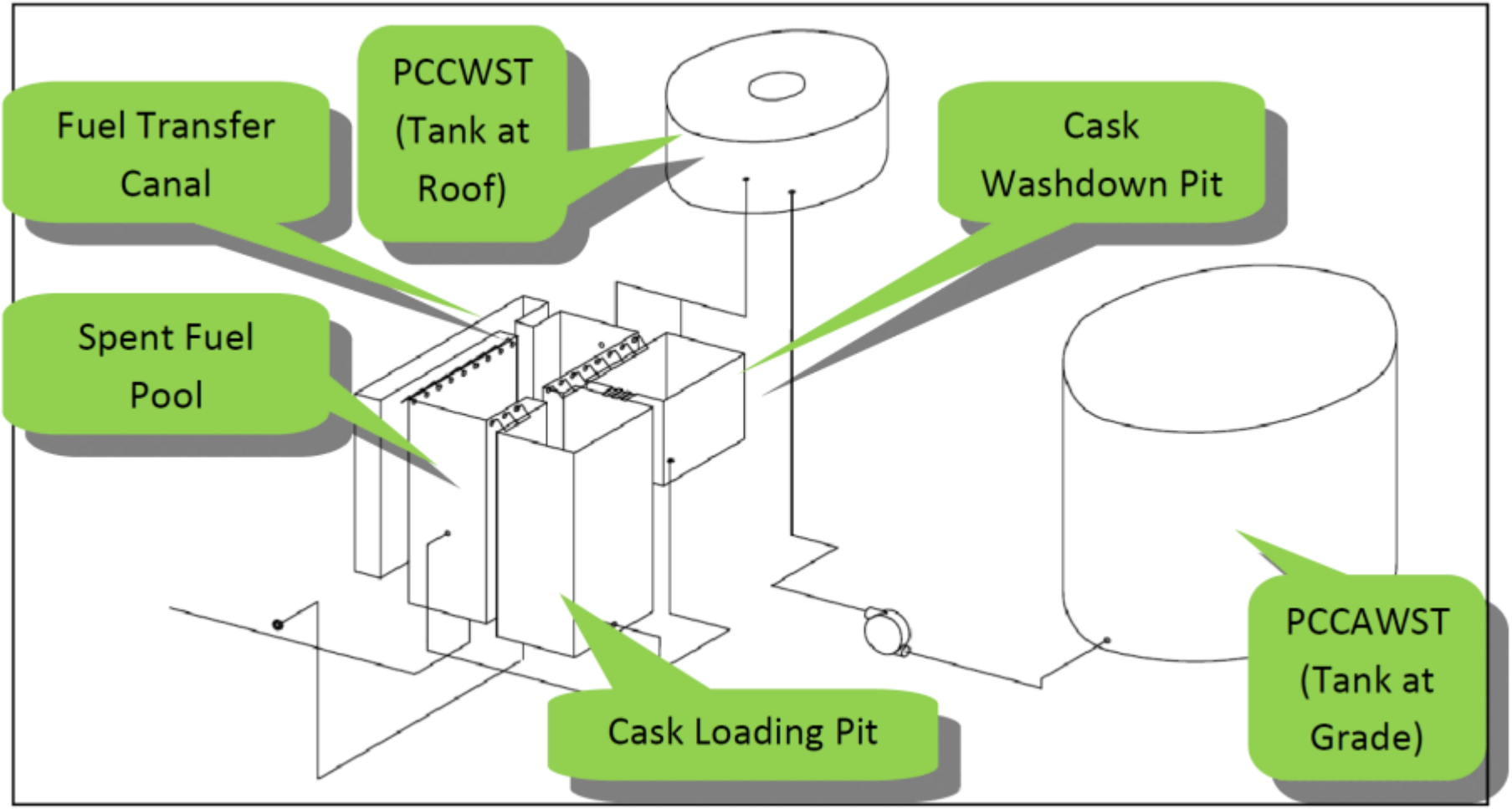
Spent Fuel Pool
AP1000 Makeup Capability – 7 days



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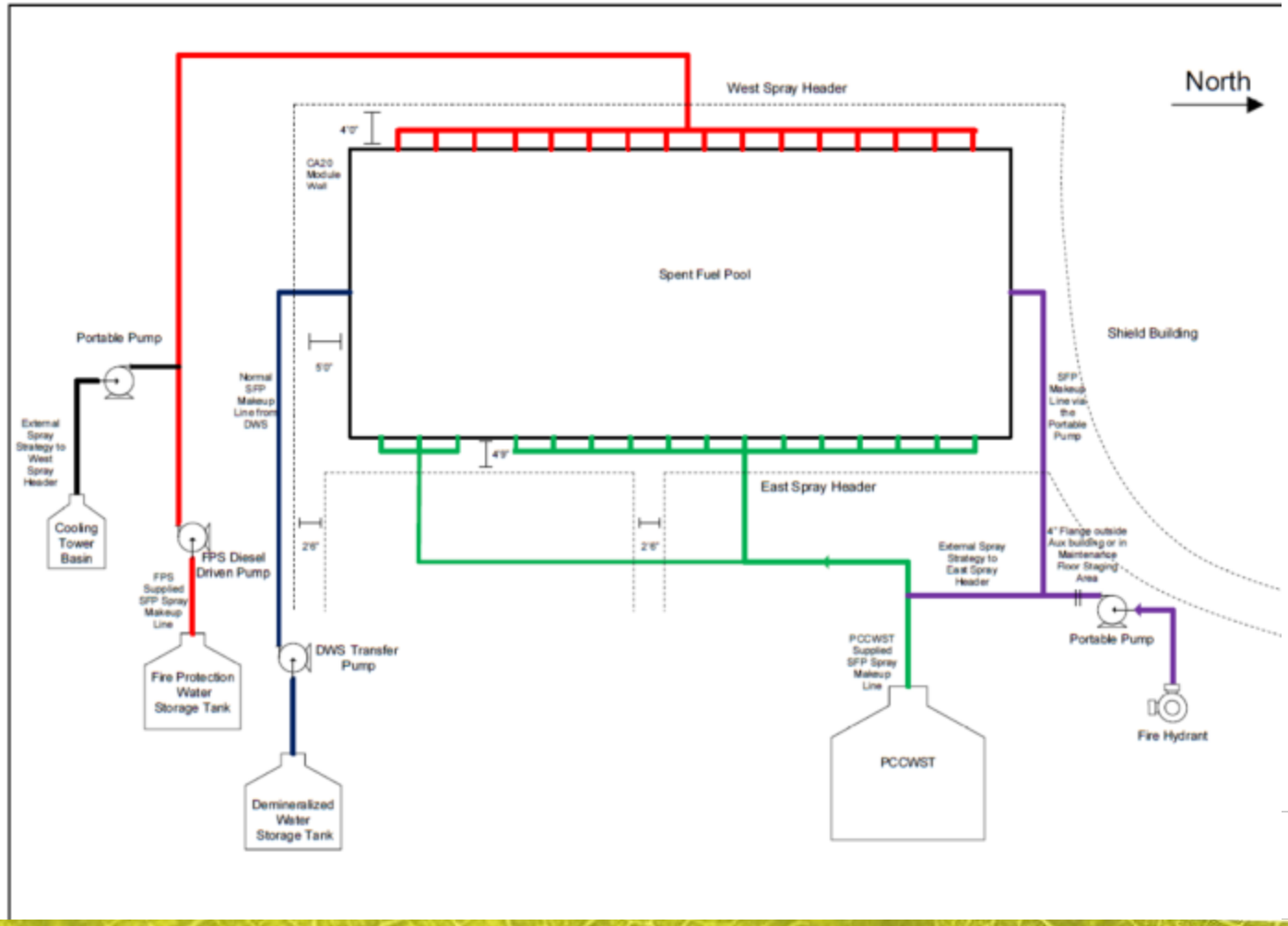
Spent Fuel Pool

AP1000 Makeup (in addition to 7 day capability)



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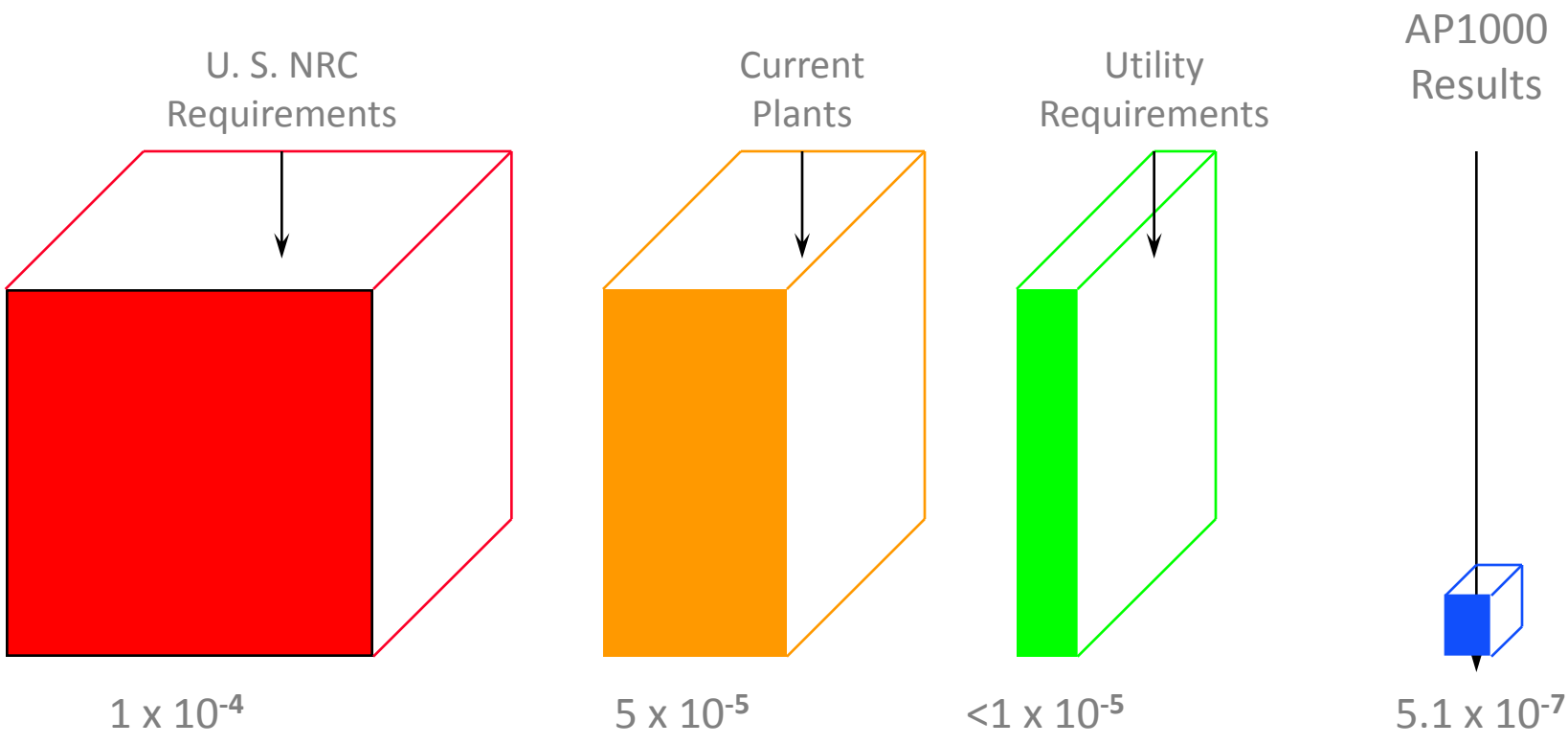
AP1000 Provides Safety and Investment Protection



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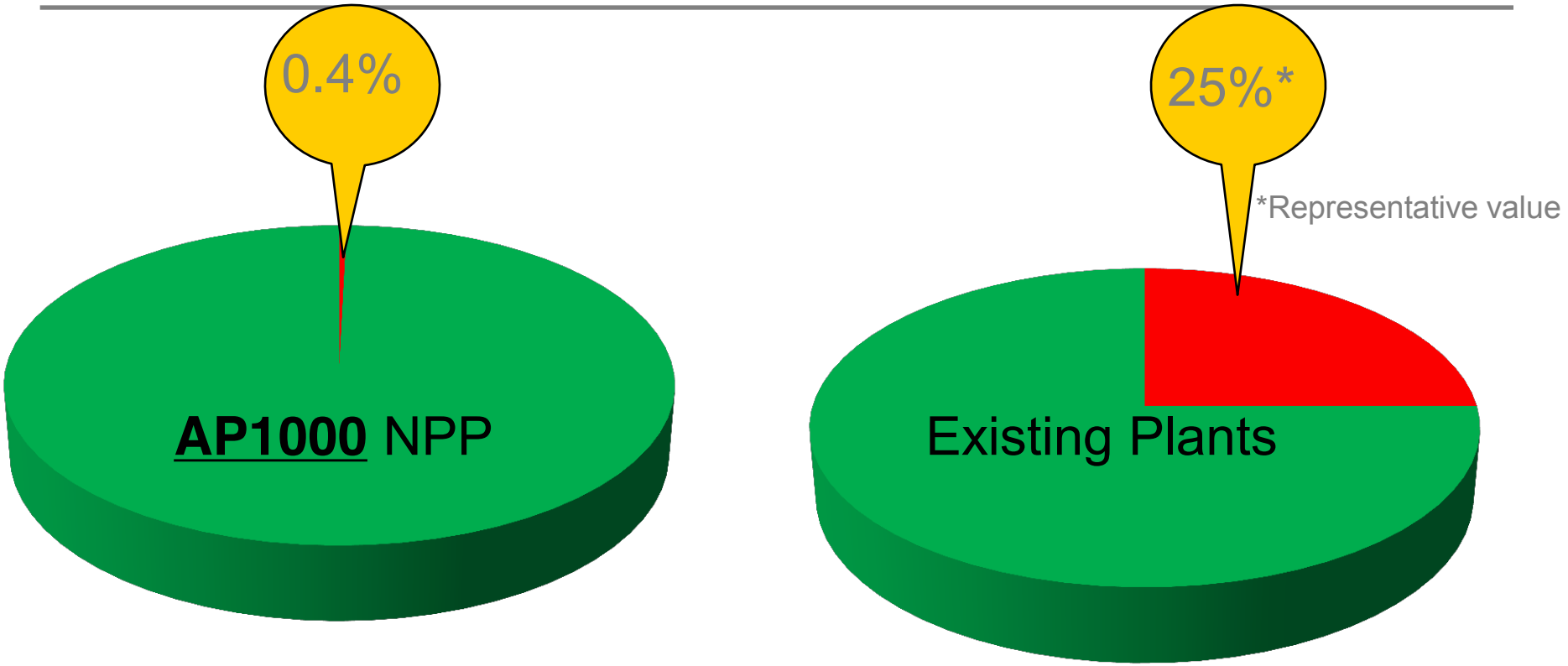
Comparison of Contribution of Loss of Offsite Power and SBO to Core Damage Frequency (CDF)



AP1000 Passive Safety Concept achieves a dramatic reduction in risk resulting from loss of offsite power events (e.g. Station Blackout) comparedeven to the most advanced active PWR designs

AP1000 Licensing & Deployment Activities

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AP1000 Licensing Activities & Status

- US NRC Design Certification
  - Regulatory Certainty
  - Amendment Objectives
  - Special Topic Status
- International Licensing Activities
  - UK GDA
  - China
  - Additional International Activities

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Rulemaking History

- AP1000 (Revision 15) Design Certification rule was approved by the NRC Commissioners December 30, 2005
- In March 2006 Westinghouse started submitting Technical Reports to address Design Related COL open items. Over 141 Technical Reports submitted

- Revision 17 of DCD was submitted September 15, 2008 and represented a "Design Freeze" point for licensing review
- Revision 18 DCD issued on December 1, 2010 for rulemaking
- FRN Issued Proposed Rule for Public Comment on February 24, 2011
- Revision 19 DCD issued on June 13, 2011 providing resolution of all known NRC open confirmatory items associated with NRC's Final Safety Evaluation Report

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Amendment Objectives

- **Increase Standardization** - Reduce COL applicant licensing risks by closing design related COL open items and Design Acceptance Criteria (DAC)
- **Increase Site Applicability** - Environmental parameters expanded and Certified Site Interface expanded from hard rock to hard rock and all soils
- **Shield Building Design Improvements** – Modifications to comply with emerging Aircraft Impact requirements and to facilitate modular construction
- **Incorporate Changes Due to Design Finalization** - Design improvements were incorporated in accordance with 10 CFR Part 52.63(a)
  - **Regulatory**
  - **Design Centered Working Group**
  - **Design Finalization**

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UK GDA

ND/EA Quarterly Report

HSE Health and Safety Executive | Environment Agency

GENERIC DESIGN ASSESSMENT

PROGRESS REPORT

REPORTING PERIOD 1 OCTOBER 2010 – 31 DECEMBER 2010

FOREWORD

This is our final substantial quarterly report on the progress of Generic Design Assessment (GDA) of the AP1000 and UK EPR reactors before we are due to publish our conclusions on 30 June 2011. Our production of reports thereafter will be dependent upon our conclusions in June.

This report summarises the progress we have made on our assessments, discusses the key challenges that we are dealing with, and looks forward at what remains to be done to complete our GDA assessment. Our intense activity on GDA has continued throughout the quarter, with the focus being on moving towards finalising of our assessments and reaching agreement with the Requesting Parties (RPs) on the remaining key issues. One of the key elements has been our convergence meetings where we have agreed with the RPs what further information they will provide, what further work can be done within GDA Step 4, and what issues are likely to remain for addressing beyond June 2011.

For the Environment Agency, a significant milestone was reached on 18 October 2010 with the completion of the consultations on its GDA findings to date on environmental and radioactive waste matters.

Subject to further progress in some key areas over the next few months, we expect to be able to complete our GDA assessment of the generic safety cases by June 2011, at which time we also expect to be able to issue an Interim Design Acceptance Confirmation and Interim Statement of Design Acceptability for both UK EPR and AP1000. Associated with these interim positions, there will be some limited requirements for further work (called GDA Issues) that we will require both RPs to complete before we can come to final decisions on GDA.

The potential GDA Issues we have identified so far are summarised in this report, together with areas where assessment is still underway and where new issues could yet emerge, although, at this late stage in the assessment process, we would not expect these to be of major significance. We continue to communicate these to the RPs so that there are no surprises as we move forward. The convergence meetings have been pivotal to this, as was a meeting with the new build industry sector representatives in November.

We remain confident that GDA is proving to be an effective and efficient step to ensuring that safety, security and protection of the environment can be assured throughout the new build programme. Our early identification of the emerging issues demonstrates robustly our independent regulatory role and provides an opportunity for the industry to clear them at an early a stage as possible in line with its plans to build new reactors in this country.

If you have comments on any aspect of this report then please send them to us at: new.reactor.build@hse.gsi.gov.uk

Kevin Allars
Programme Director for Nuclear New Build
Health and Safety Executive

Joe McHugh
Head of Radioactive Substances Regulation
Environment Agency

TRIM Ref. 2011/00017 Page 1 of 23

We have not identified any showstoppers at this point, but some of the observations are likely to result in design changes. In these cases we are seeking to agree the principal aspects of the changes within GDA Step 4. Subject to further progress in some key areas over the next few months, **we expect to be in a position to consider issuing an Interim DAC for both UK EPR and AP1000 in June 2011.**

In previous quarterly reports we have noted the steps that Westinghouse had taken to improve its project management arrangements, and to provide more resource to the GDA project. **We are pleased to say that we have seen a concerted effort by Westinghouse to drive forward on GDA, propose solutions to clear a number of issues, and identify credible forward work plans.** We hope to see this level of effectiveness maintained for the remainder of the GDA programme in order to allow us to come to a meaningful GDA conclusion.

www.hse.gov.uk/newreactors/reports/gda-q4-10.pdf

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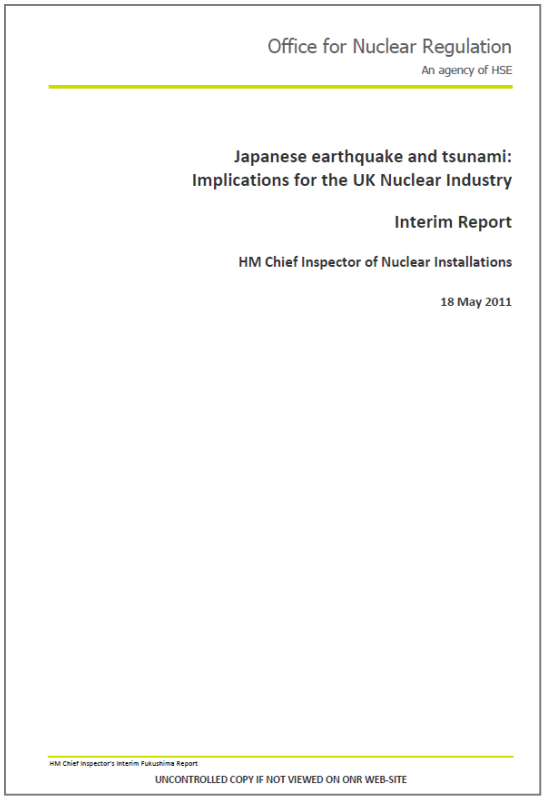
UK GDA - Weightman Report

- The Interim Weightman Report outlines 26 recommendations, it groups these recommendations into a number of sub categories including: -
  - General
  - Relevant to the Regulator
  - Relevant to the Nuclear Industry
  - Way Forward
- Response on interim report requested by 15 June
  - Westinghouse response has been provided commenting on recommendations relevant to nuclear industry
  - Response will be made public, timely likely to align with issuance of final Weightman report



Office for Nuclear Regulation
An agency of HSE

Japanese earthquake and tsunami: Implications for the UK Nuclear Industry

Interim Report

HM Chief Inspector of Nuclear Installations

18 May 2011

HM Chief Inspector's Interim Fukushima Report
UNCONTROLLED COPY IF NOT VIEWED ON ONR WEB-SITE

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Other International Licensing Activities

Additional Licensing Work Throughout The World

- China (in final FSAR Development)
- India
- Canada
- Scandinavia, Central Europe, Asia, Middle East, Africa, and South America

The worldwide nuclear community is finding AP1000 safe and licensable!

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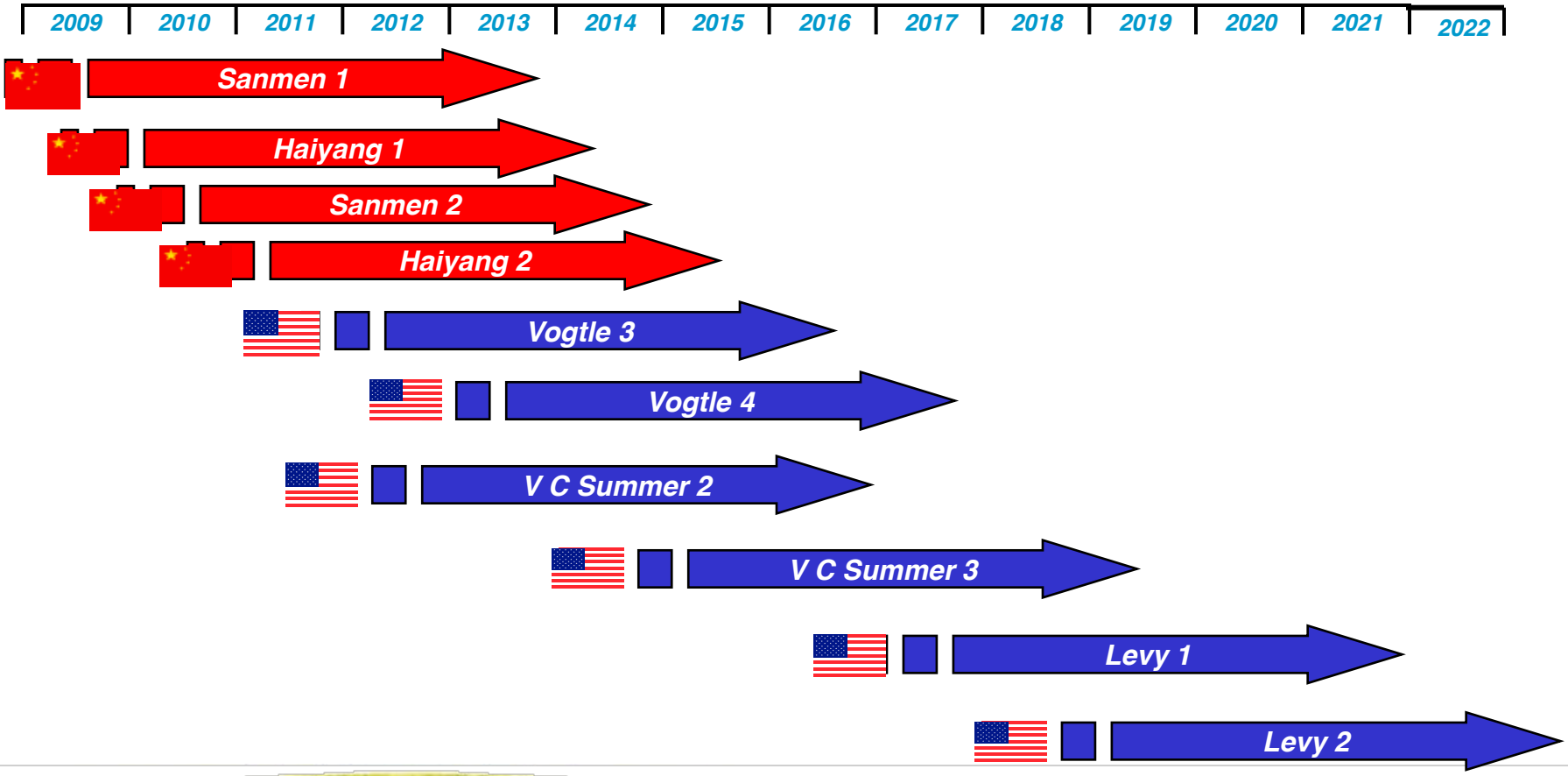
Confidence from Being Part of a Global Fleet



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What Influenced the People's Republic of China's Decision to Consider AP1000?

- New generation of advanced nuclear technology
- New, passive safety features
- Smaller Nuclear Island and building footprints
- Smaller number of safety components (reducing supply chain issues)
- Fundamental modular approach
  - Reducing construction and fabrication quality risks
  - Optimizing plant construction time
- Reduced overall schedule and cost risks
- Technology Transfer provisions support People's Republic of China (PRC) long-term commercial nuclear strategy
- Existing AP1000 Design Certification by the U.S. Nuclear Regulatory Commission (NRC)
- Westinghouse International Reputation and Pedigree

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AP1000 Construction in China

Sanmen Unit 1 - March 31, 2009

Haiyang Unit 1 - January 30, 2010

Sanmen Unit 1 - Containment

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Construction Activity SM1: Setting of CA20

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Positive Effects of Modular Construction

	Feb 2007 Plan	Actual	Delta
First Concrete Milestone Completed	31-Mar-09	31-Mar-09	0
Auxiliary Building Module Set in Place	31-May-09	29-Jun-09	1
CVBH Set in Place	30-Jun-09	21-Dec-09	6
CV 1st Ring Set in Place	31-Dec-09	18-Mar-10	3
CV 2nd Ring Set in Place	31-May-10	31-May-10	0

With the setting of the CV 2nd Ring, against the construction schedule milestones, Sanmen Unit 1 has recovered the 6-month delay in setting the CVBH.

This was achieved as a result of modular construction.

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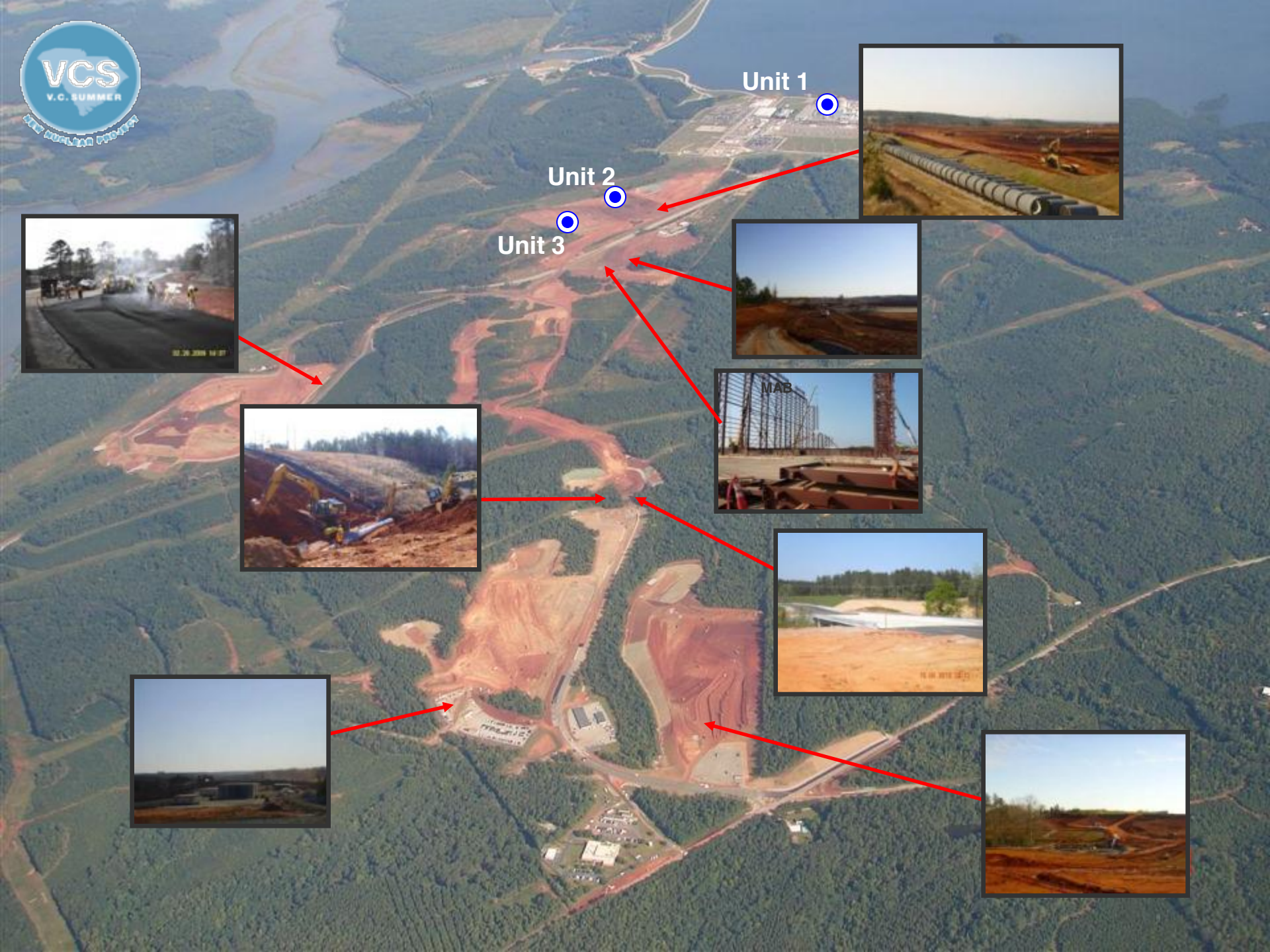
Primary Pressure Vessel Procurement

Haiyang SG Channel Head Forging

Haiyang #1 Closure Head

RCP Casing from Sheffield Forgemasters

Sanmen #1 RV Upper Shell


VCS
V.C. SUMMER
NEW NUCLEAR PROJECT
Unit 1
Unit 2
Unit 3
MAB

Vogtle 3&4

Site Layout

Excavation Work

Unit 2

Unit 1

Unit 4

Unit 3

Unit 3 Bedrock (Blue Buff Marl)

Module Assembly Bldg Pad Installation

Unit 3 Backfill

Unit 4 Backfill Begins, Unit 3 Continues

Concrete Batch Plant Erection

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Summary

- AP1000 provides passive safety features for design basis events and defense in depth systems to minimize reliance on passive safety features
- AP1000 Passive Design provides unique capabilities in response to beyond design basis events
- AP1000 Design has a high degree of maturity, including licensing reviews completed or ongoing in numerous countries worldwide
- AP1000 robustness and long coping periods provide a strong foundation to address evolving licensing requirements