The AP1000 Nuclear Power Plant
Global Experience and UK Prospects

Nuclear Institute – Western Branch

Thornbury

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Westinghouse UK

Westinghouse

Outline

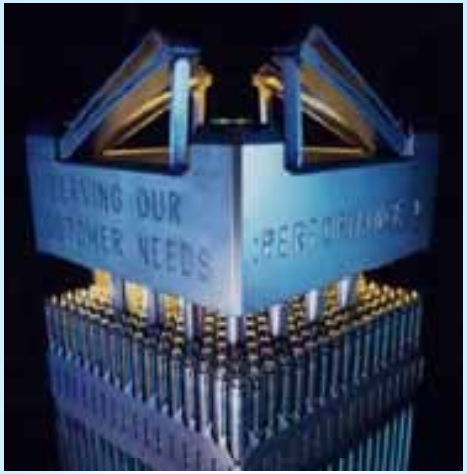
- Introduction to Westinghouse
- The AP1000™ Reactor
- Construction Update – China
- Prospects for AP1000 in the UK

Westinghouse - Three Core Businesses

Nuclear Power Plants

Specializing in the technology of new nuclear power plants and component manufacturing

Nuclear Fuel



A single-source fuel provider for PWR, BWR, VVER, AGR, and Magnox reactors worldwide

Nuclear Services

Maintenance, repair and replacement of equipment. Provider of engineering services and methods for the design, operation and safety of nuclear power plants worldwide

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Westinghouse in the UK

- Based at “Springfields” site, near Preston
- Operating safely since 1946
- Makes the fuel for the UK’s nuclear power stations
- Over 10 million fuel rods manufactured, which have avoided over 1 billion tCO_2
- Employs around 1600 people

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The AP1000™ Nuclear Power Plant

- A single AP1000 power plant will generate enough electricity to power **around 2 million UK homes…**

- … safely, reliably, affordably and with minimal emissions of CO_2

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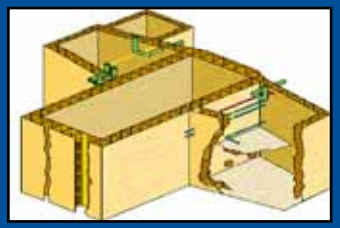
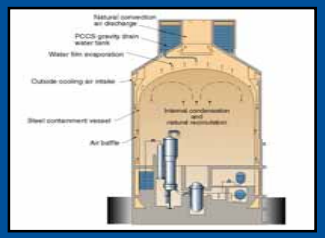
Best Solution for New Plants is *SIMPLIFICATION and STANDARDISATION*

- Design
- Safety
- Construction
- Procurement
- Operations
- Maintenance



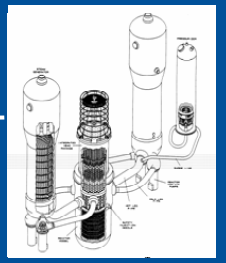
Modular Construction

AP1000



Passive Safety Systems

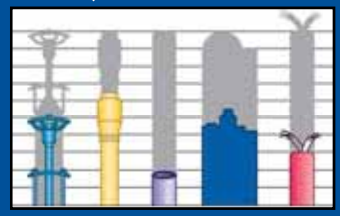
Short Engineering and Construction Schedule



Innovative Design Features

US Licensing Approval

NRC Approves Certification of Westinghouse's AP1000 Advanced Reactor Design



Reduced Components & Commodity Components

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Standardisation

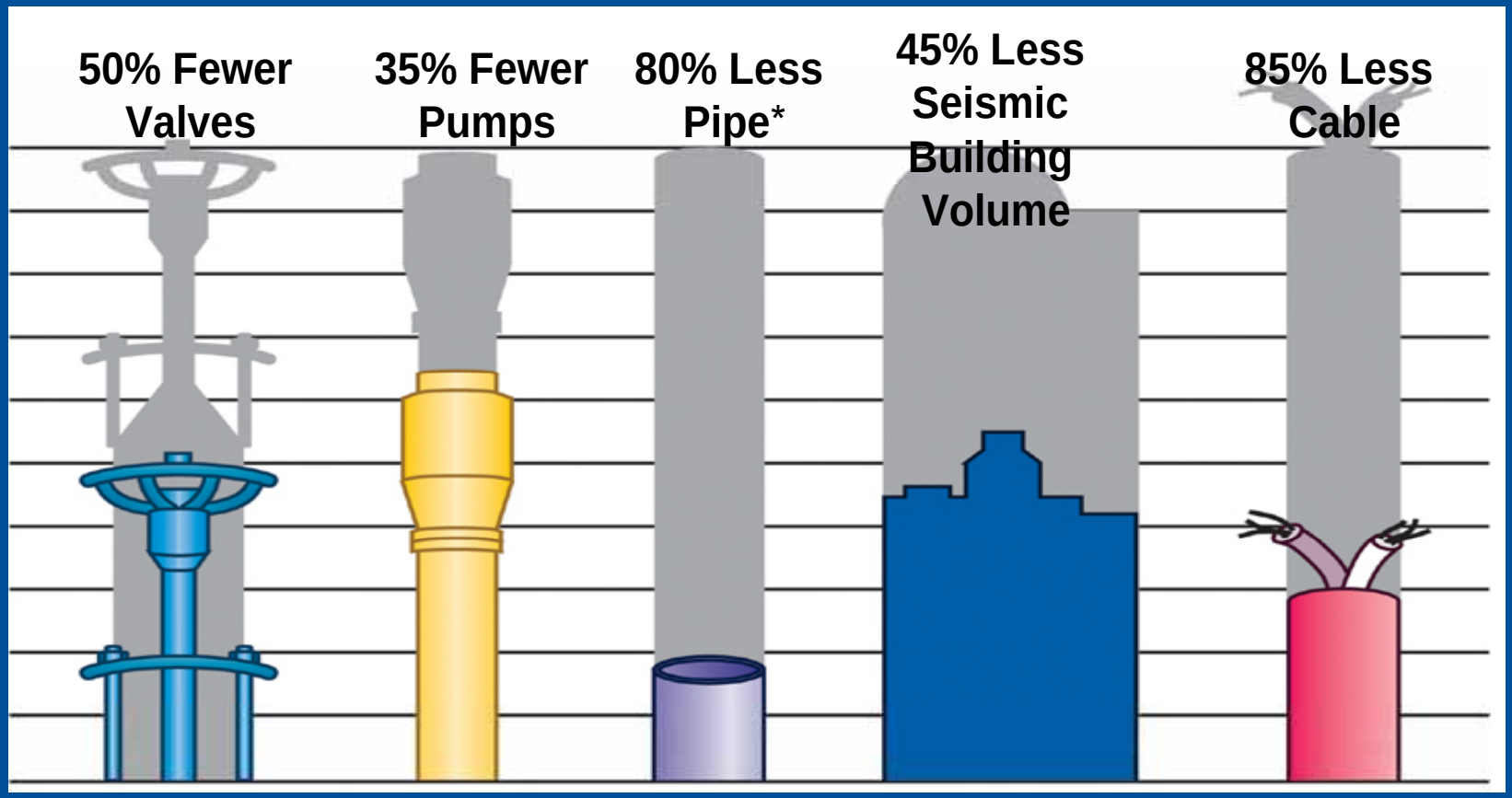
Means:

- All plants use the same suppliers for all engineered components (identical pumps, valves, instruments and heat exchangers)
- Plants are implemented by the same Westinghouse team
- There is ***one and only one*** design
- There is an Organisation Structure that manages and determines the plant configuration (Configuration Control)
- The Design is 100% complete – no field routing

And Brings:

- Predictable and timely construction, and reliable performance
- Reduced risk, coupled with improved economics

AP1000 has Fewer Components than Conventional PWRs



Compared with a conventional 1000 MW PWR

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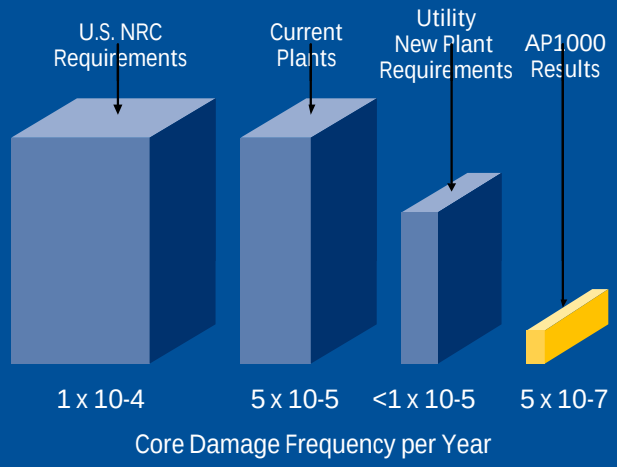
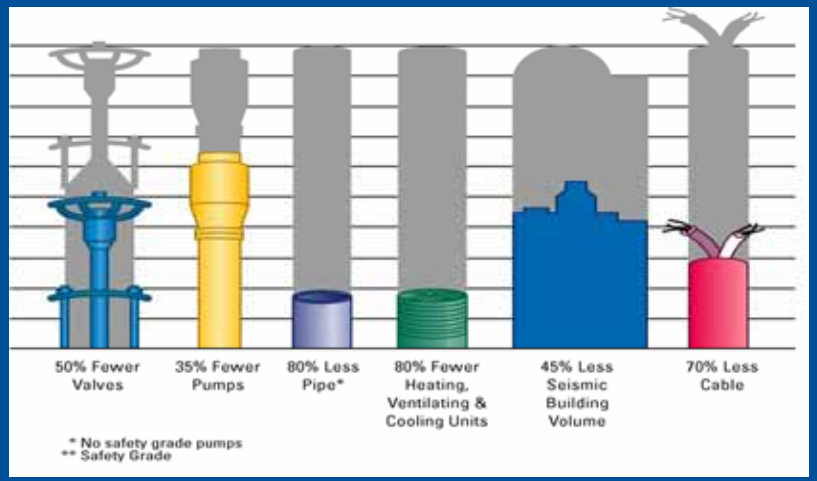
AP1000: Simpler *and* Safer

- **AP1000 passive design advantages:**
  - Dramatically safer design
  - Increased operating margins, significantly reduced unplanned capability loss factor
  - No need for AC power for safety systems to operate
  - No operator action needed for 72 hours following event
  - Smaller staff, advanced process controls
  - Shorter construction schedule
  - Lower equipment, construction costs
  - Less equipment to maintain.



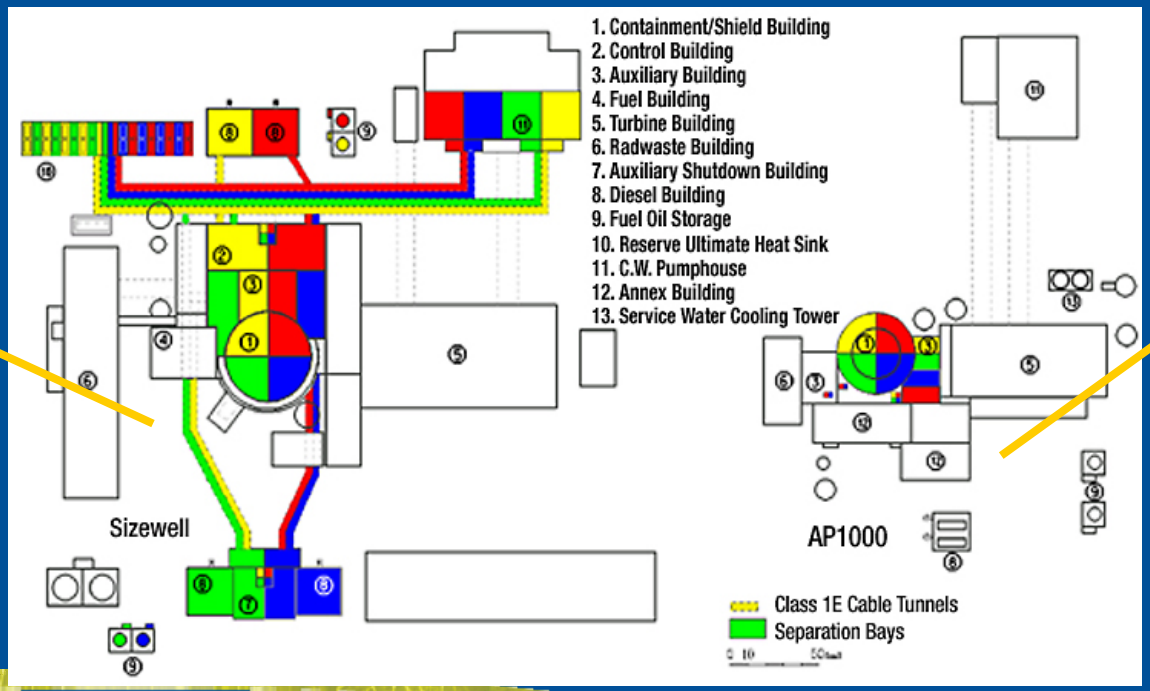


AP1000 Construction Simplification

Think: more power/m³ of concrete

	Concrete, m³	Rebar, metric tons	Power, MWe
Sizewell B:	**520,000**	**65,000**	**1188**
AP1000:	**<100,000**	**<12,000**	**1117**

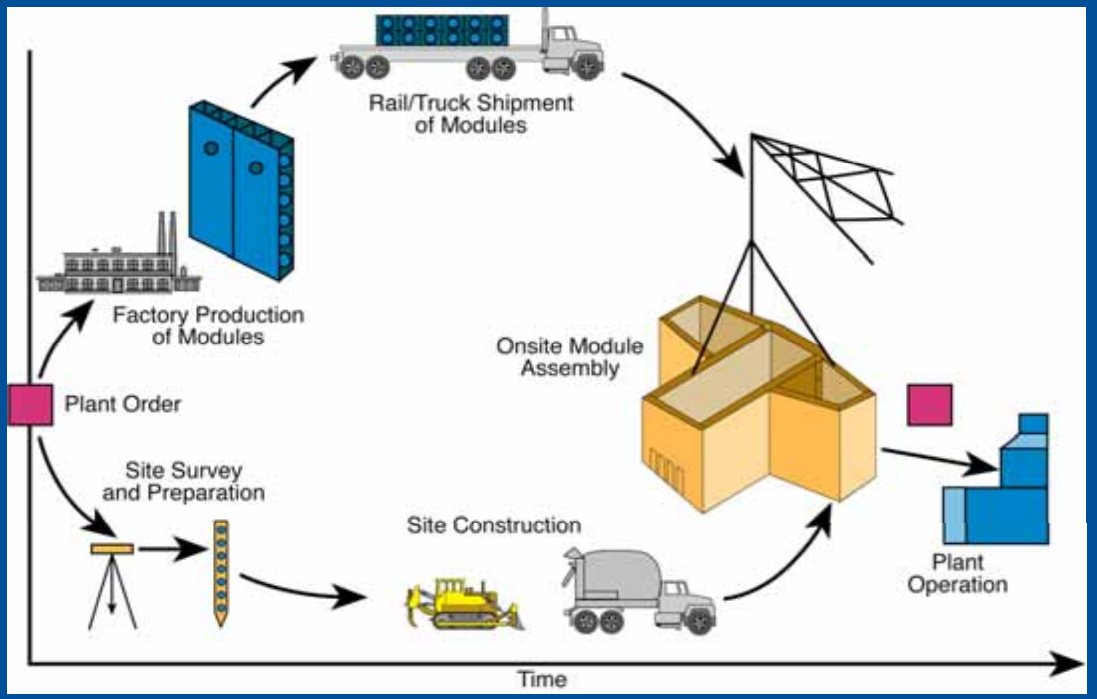
Sizewell B



AP1000

AP1000 - Modular Design for Simplified Construction

- Constructed with 300 large modules
- Factory manufacture and assembly of modules
- Pre-testing and inspection prior to shipment
- 36 month construction schedule independently supported (for Nth of a Kind)



Maturity of AP1000 Design

- Mature complete nuclear plant product from Westinghouse
  - builds on experience of operating Westinghouse plants
  - Extensive international involvement from US utilities (e.g. Duke Power), European and Asian utilities (e.g. EDF and KEPCO), nuclear engineering companies (e.g. Ansaldo, Mitsubishi and Bechtel)
- An uprate of AP600 which received US NRC Design Certification in December 1999
- AP1000 Design Certification in the US achieved late 2005
- Selected in China at Haiyang and Sanmen for third generation nuclear islands and associated technology transfer
- Selected in US at Vogtle, VC Summer & Levy sites

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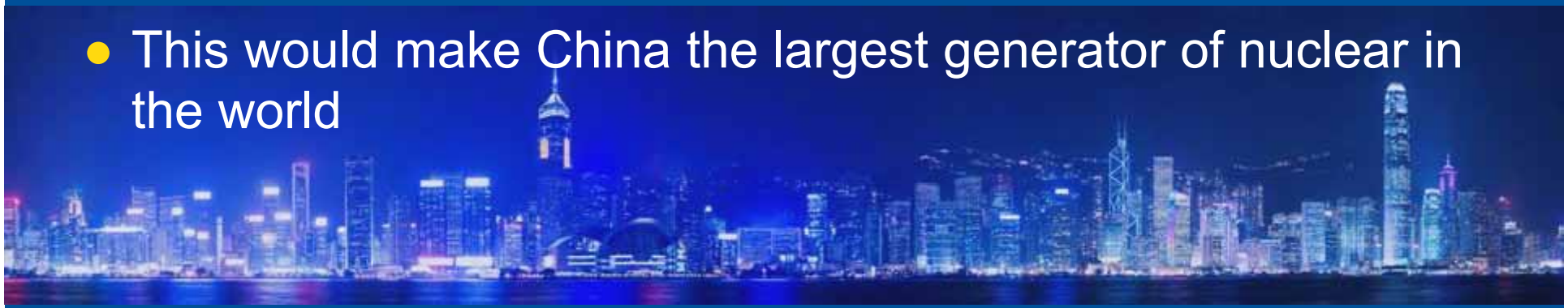
China's Demand for Electricity

- Demand growing at **13 percent per year**
- Electricity consumption is second highest in the world
- To support this growth, China is rapidly adding generating capacity (currently at 800 GWe) to **1400 GWe by 2020**
- For nuclear, aim to achieve 70 GWe by 2020, and as much as **200 GWe by 2030.**
- This would make China the largest generator of nuclear in the world



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Build of AP1000 is Underway in China

- More than **20 plants** are currently under construction
- **27 additional plants** in the planning stage with construction to begin in the next three years
- The Westinghouse **AP1000 nuclear plant** is China's announced Generation III+ technology of choice
- Currently **four AP1000 plants are under construction**, with plans to build many more in the coming years and decades

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AP1000 China Projects

- Four Generation III Nuclear Power Plants
  - 2 Units in Sanmen, Zhejiang Province
  - 2 Units in Haiyang, Shandong Province
- First two units operational in 2013 and 2014
- Sanmen Key Dates:
  - NI basemat placement: Mar 2009
  - Fuel load: May 2013
  - Commercial Operation: Nov 2013
- Haiyang Key Dates:
  - NI basemat placement: Sept 2009
  - Fuel Load: Nov 2013
  - Commercial operation: May 2014

The Consortium is composed of Westinghouse and Shaw

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Near term People's Republic of China AP1000 future?

Impression of Haiyang site

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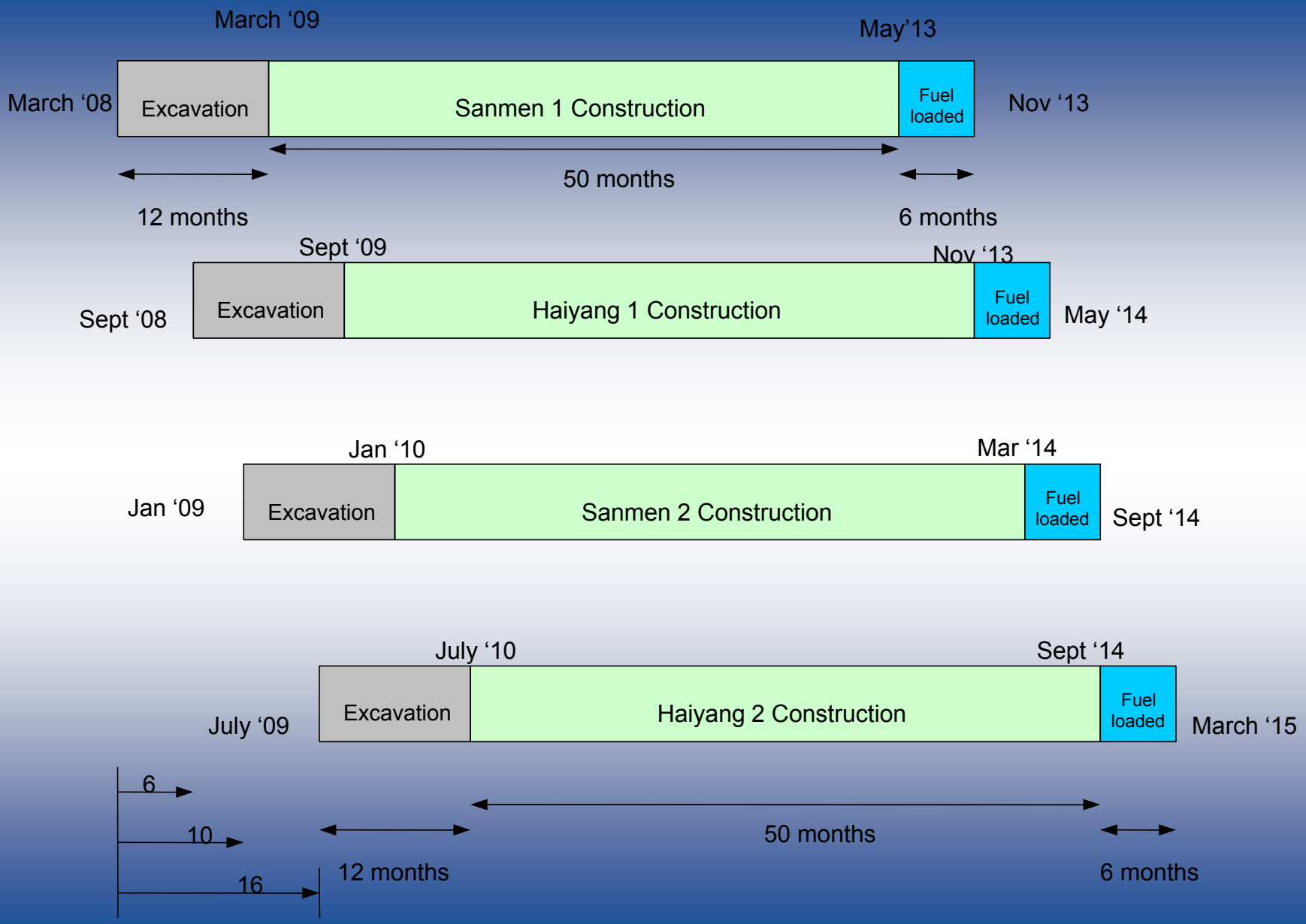
Schedule Overview – All 4 Units



China Project Key Milestones

- February 28, 2007 – Framework Contract Signed
- July 24, 2007 – Contracts Signed
  - Nuclear Island
  - Consortium Technology Transfer
  - Fuels
  - Sub-supplier Technology Transfer Contracts
- September 24, 2007 – All Contracts Effective
- December 31, 2007 – Authorization to Proceed
- March 31, 2009 – Sanmen 1 First Concrete
- September 27, 2009 – Haiyang 1 First Concrete
- November 2013 – Sanmen 1 Operational
- May 2014 – Haiyang 1 Operational

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Sanmen 1 & 2 Progress Summary

- SM 1 First Concrete Milestone Completed (March 2009)
- SM 1 Auxiliary Building Module Set in Place (June 2009)
- SM 1 CV Bottom Head Set in Place (December 2009)
- SM 1 Reactor Vessel Module Set in Place (January 2010)
- SM 1 CA05 (Walls) Module Set in Place (February 2010)
- SM 1 CV 1st Ring Set in Place (March 2010)
- SM 1 CA01 (Steam Gen. +) Set in Place (March 2010)
- SM 1 CV 2nd Ring Set in Place (June 2010)
- SM 2 First Concrete Milestone Completed (December 2009)
- SM 2 CV Bottom Head Set in Place (June 2010)

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Haiyang 1st & 2nd Quarter 2010 Construction Milestones

- CR10 - Install complete January 2010
- CA20 –Lift & set complete January 2010
- CV Bottom Head –Lift & set completed April 2010
- CA04 – Completed May 2010

- CA05 – July 2010
- CV 1st ring – July 2010
- CA01 –August 2010

- Unit 2 FCD – Completed June 2010

CA04 – Reactor Vessel Cavity / RCDT
CA01 – Steam Generator & Refueling Canal Module
CA05 – CVS / Access Tunnel / PXS-B Walls

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Positive Effects of Modular Construction

	Feb 2007 plan	Actual	Delta
First Concrete Milestone Completed	31-Mar-09	26-Mar-09	0
Auxiliary Building Module Set in Place	31-May-09	29-Jun-09	1
CV Bottom Head Set in Place	31-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	2-Jun-10	0

With the setting of the CV 2nd Ring, against the construction schedule milestones Sanmen Unit 1 has basically recovered the 6 month delay in setting the CVBH. This would not have been achievable if it were not for modular construction.

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Sanmen – June 2010

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Containment Vessel Bottom Head (CVBH)

Haiyang Unit 2 CVBH – October 31, 2010

CA20 Auxiliary Building

Haiyang Unit 2 CA20– September 30, 2010

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CA01
(Steam Generator & Refueling Canal Module)

Haiyang Unit 1 CA01 – August, 2010
Sanmen Unit 2 CA01 – September, 2010
Haiyang Unit 2 CA01 – January 31, 2011

Sanmen Unit 1
March 27, 2010

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Sanmen Unit 1 – September 2010

Steam Generators

RCP Casing from Sheffield Forgemasters

HY Channel Head Forging

HY Inter Shell Assembly

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Reactor Vessel

Middle and Lower Core Barrels

HY 1 RV Closure Head

SM #1 RV Upper Shell

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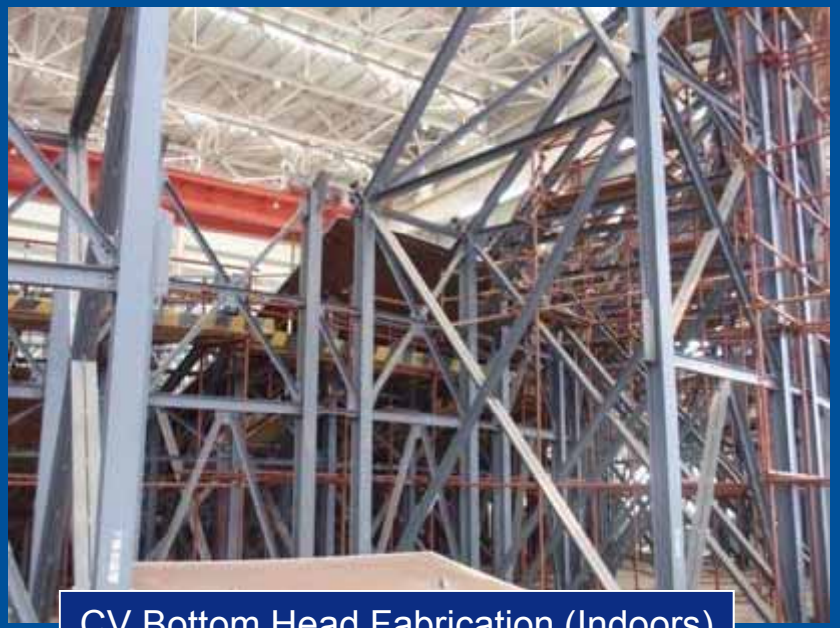
Application of Lessons Learned

First of a Kind (FOAK) Activities for Sanmen 1 and AP1000 equipment design & manufacturing have led to a number of Lessons Learned, resulting in:

- NI Basemat at Haiyang 1 and Sanmen 2 laid in less time than Sanmen 1
- Ultra-large SG & RV forging lead times were reduced for the 3rd and 4th units
- Squib Valve designs have been optimized
- CA20 (Auxiliary Building) module fabrication for Haiyang 1took far less time than for Sanmen 1
- CV Bottom Head fabrication for Haiyang 1 took far less time than for Sanmen 1
- CV Bottom Head welding at Haiyang is within a fully-enclosed building



CV Bottom Head Fabrication (Indoors) at Haiyang

Westinghouse is using modern and proven ways of capturing lessons learned and applies a process that ensures their implementation.

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Projects are On Schedule!

- Long lead materials ordered early
- All safety valves on order – Shipments started
- Developmental tests on squib valves complete
- Concrete pour times have reduced from unit to unit
- Manufacturing of heavy components is generally on schedule
- Good progress being made on modules & CV fabrication
- **Significant benefit being gained from the lessons learned from the first unit being applied to subsequent units**

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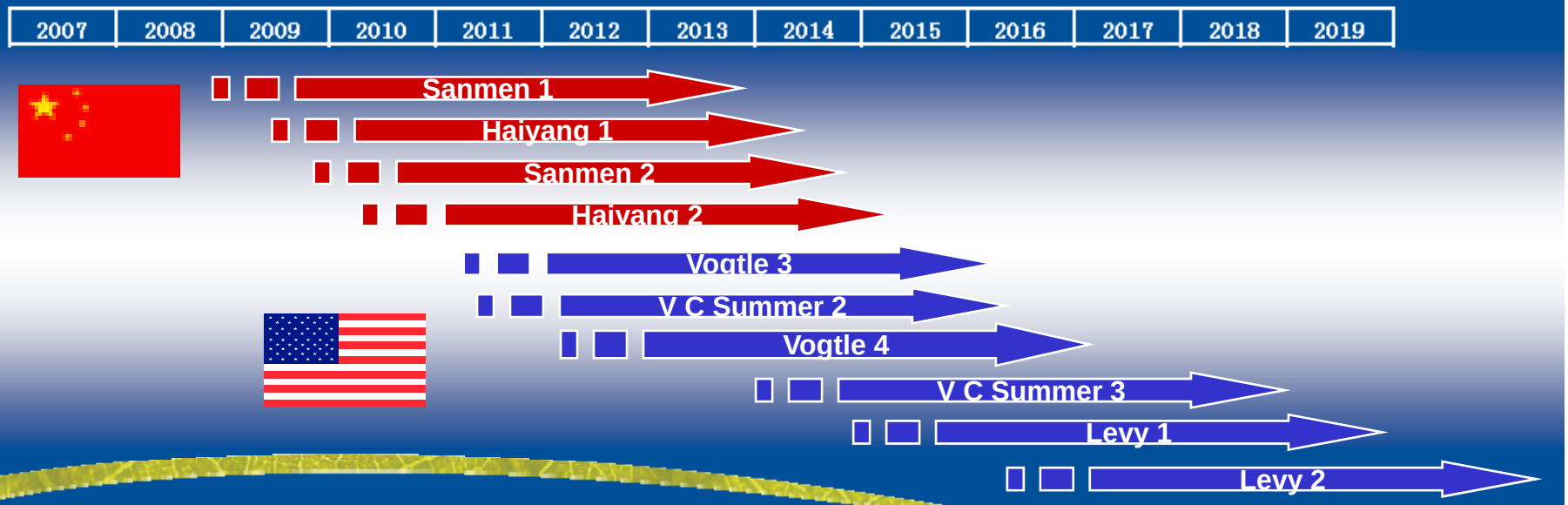
Particular Attractions of AP1000 in the UK

- Physical size – a better fit for compact UK sites
- Power output – reduced need for strengthening of the grid
- Well known to UK regulators and industry
- Modular construction – supports UK jobs in supply chain
- Opportunity to benefit from US Design Certification
- Opportunity for fuel fabrication at Springfields

Building on Success

- The experience gained in China will provide valuable insights as **additional standard plants are built in China and the U.S., UK, mainland Europe, India, and other parts of the world**
  - Increased efficiencies in construction
  - Improved processes
  - Broader, more localized supply chains



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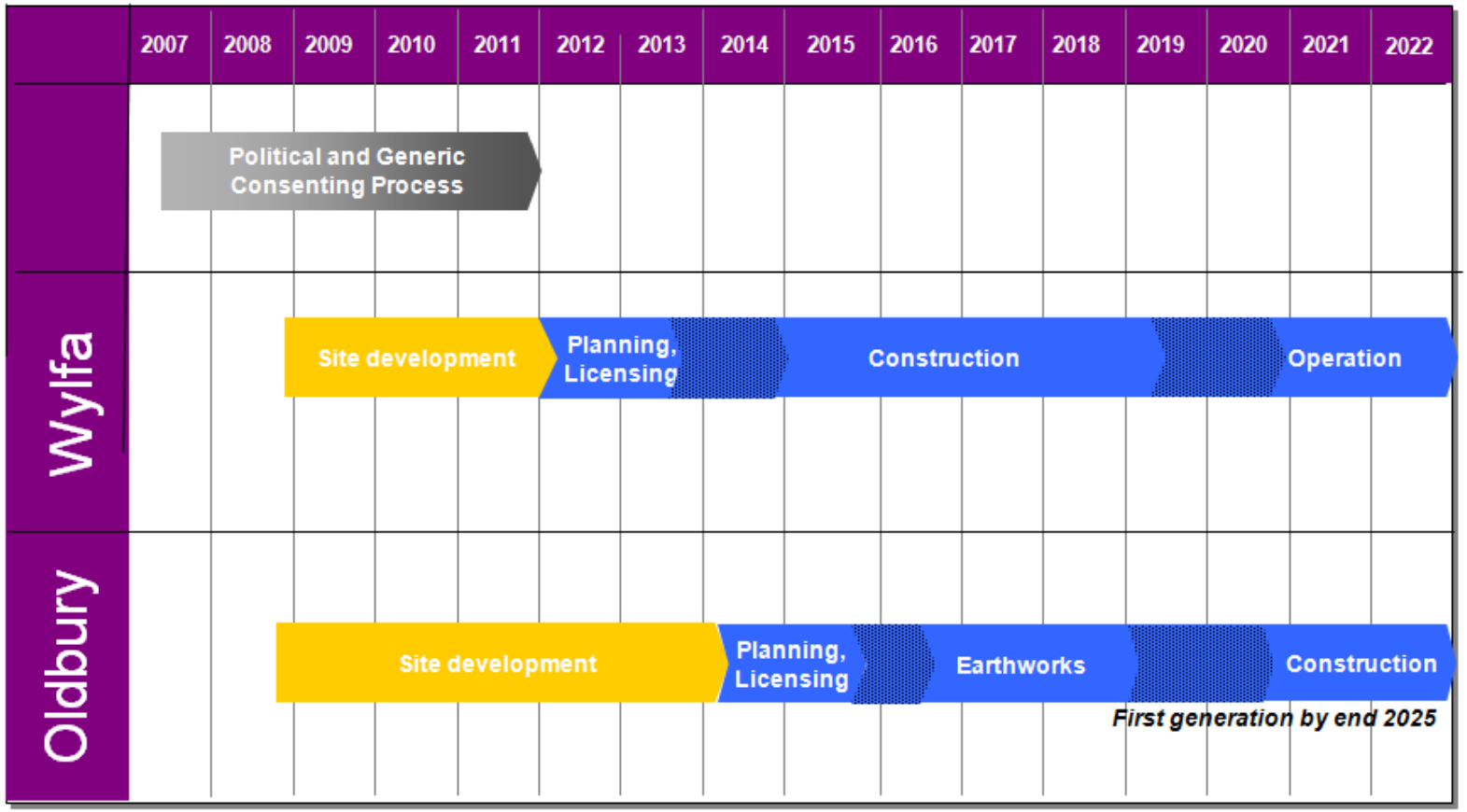
Timescales for Horizon Project

Phased programme



Source: Horizon Nuclear Power

Learning Lessons from Overseas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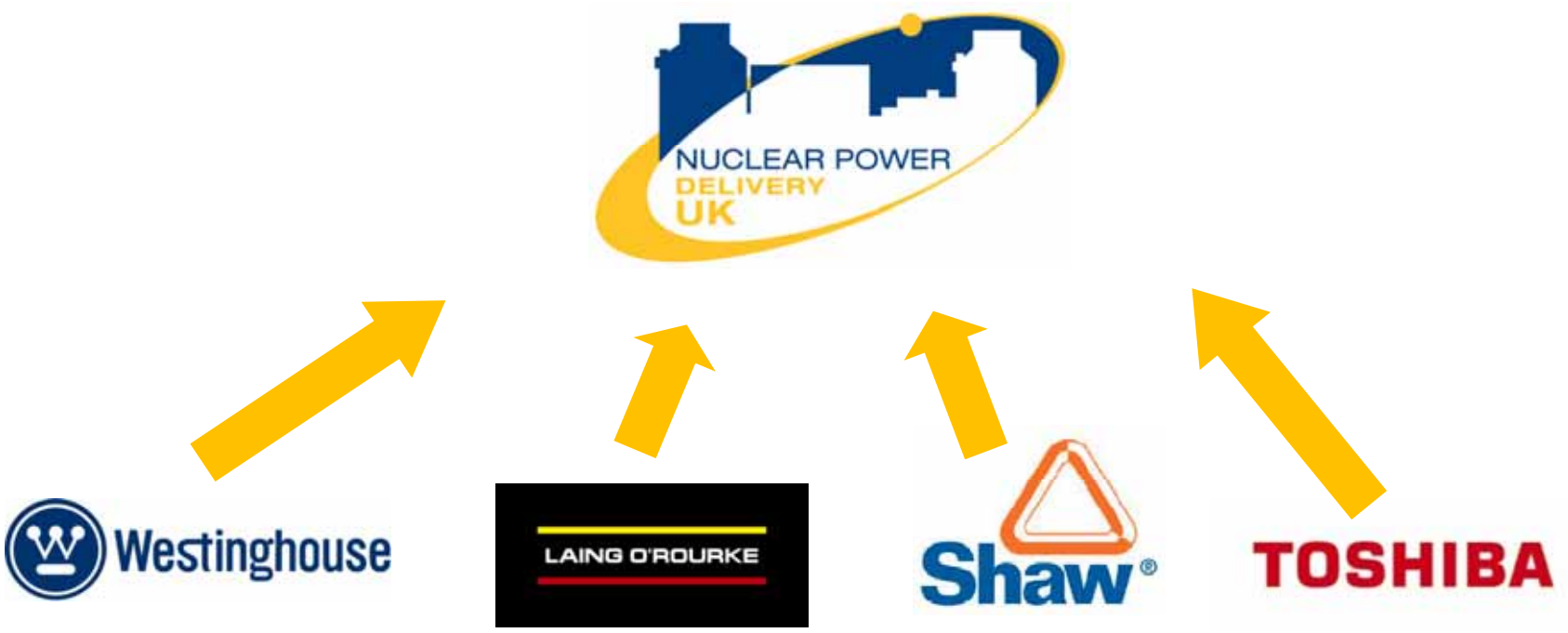
Shaw


Westinghouse
Shaw
TOSHIBA


Westinghouse
Shaw
TOSHIBA
LAING O'ROURKE

As the AP1000 programme develops around the world, it is imperative that we retain the accumulated learning and experience, whilst working with respected companies with local knowledge

Ready to Execute for Our Customers



UK Jobs Potential

- Around 80% of nuclear new build work is conventional construction, not nuclear.
- UK industry could supply 70-80% of the value of a UK nuclear programme.
- Less than 5% of current UK construction resources will be required
- With careful management, the necessary resources can be recruited and trained in time

Published 28 April 2008

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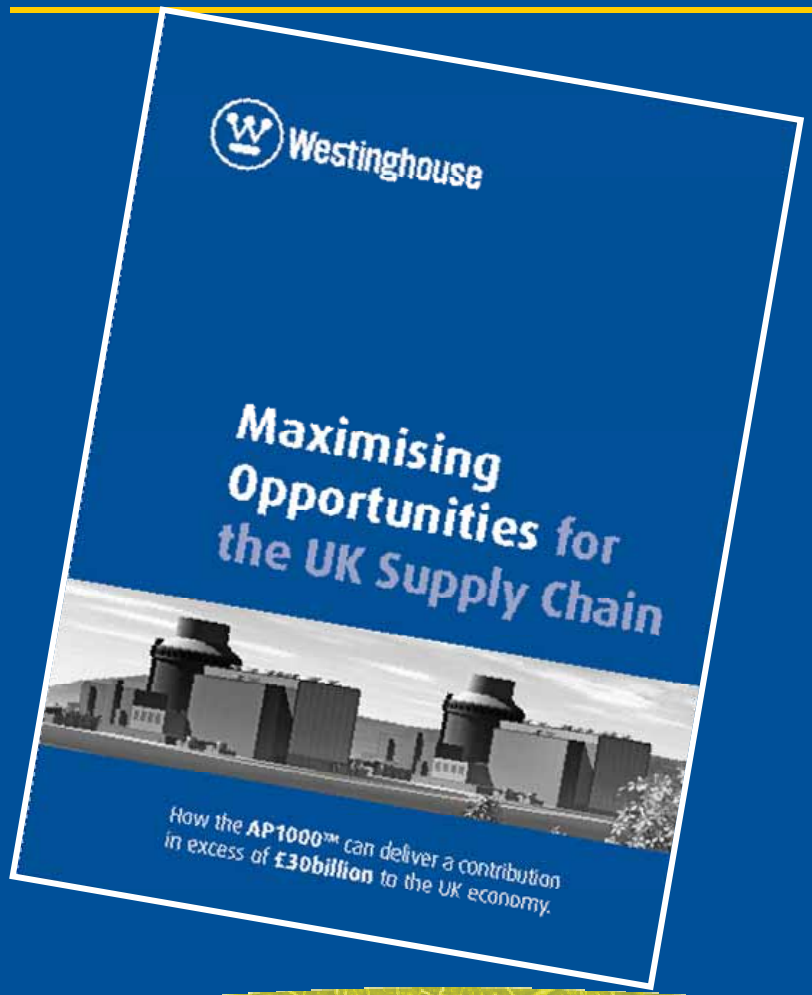
Potential £30 Billion value to UK economy



Around half from supply chain during construction

Around 35% from operation

Around 15% from fuel

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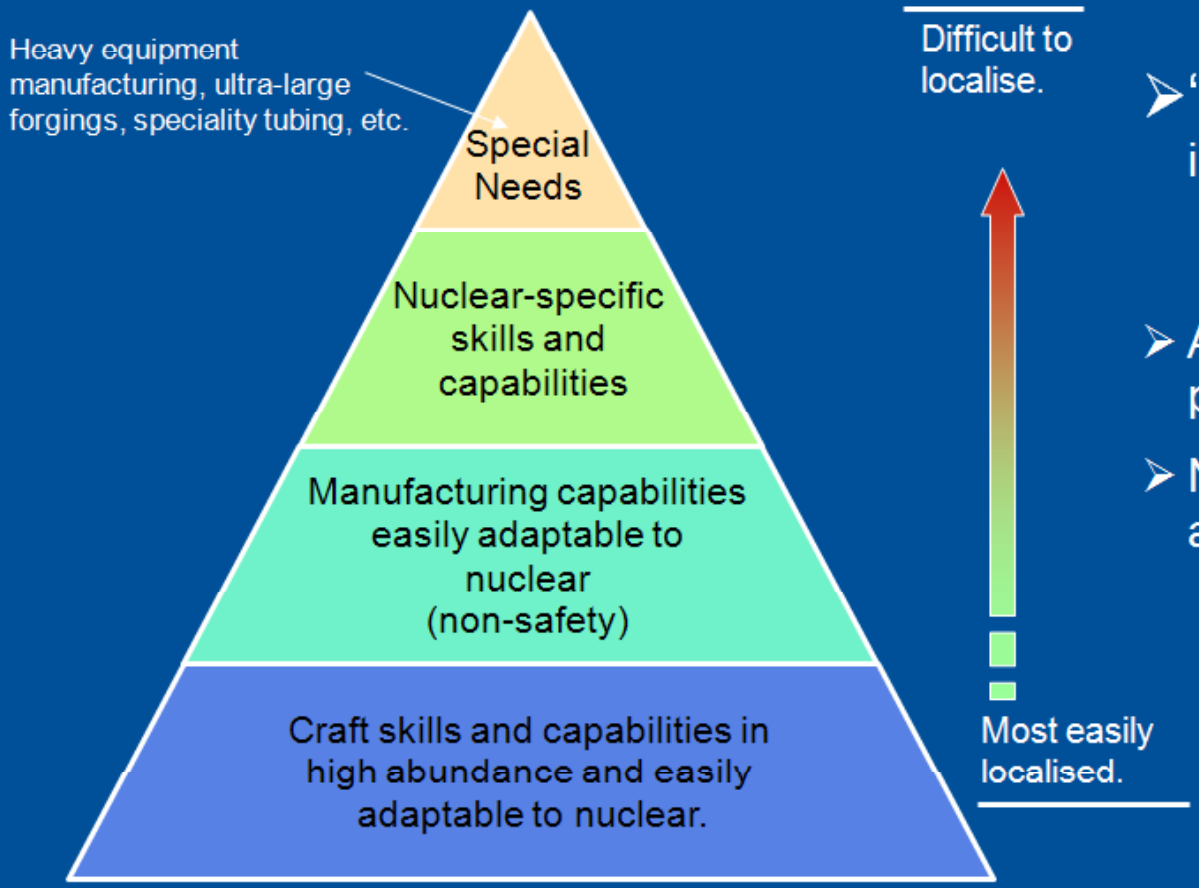
Localisation Considerations



- "Easy to localise" doesn't imply there are no issues.
  - Adequate pool of craft labour
  - Skills training
- At every level, the 'gene" pool must be deep enough.
- National programmes to address:
  - National Skills Academy for Nuclear

Investment in local skills and capacity must begin now.

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Equipment (Qty per reactor unit)

Category	Specifications	Qty
Valves (Safety)	177	700
Valves (Non-Safety)	263	4700
Pumps (non-RCP)	20	46
Tanks	11	42
Heat Exchangers	11	32

Significant Non-Safety Opportunity

Summary

- The AP1000 reactor is a modern Generation III+ design, well suited to markets around the world
- The construction programme in China is on schedule and is being watched closely by potential customers in the UK and elsewhere
- In the UK, Westinghouse and our team-mates are preparing for success with Horizon Nuclear Power and are confident that we can meet Horizon's needs
- But the *real* work starts if/when we are selected!

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Thank You