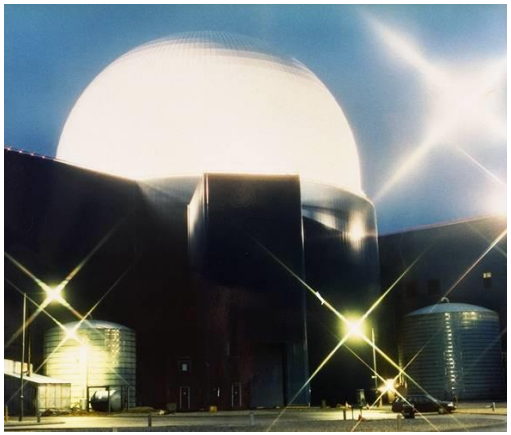
Role of Amec Foster Wheeler as a TSO in Nuclear Power development in the UK



David Boath, Vice President & Chief Engineer

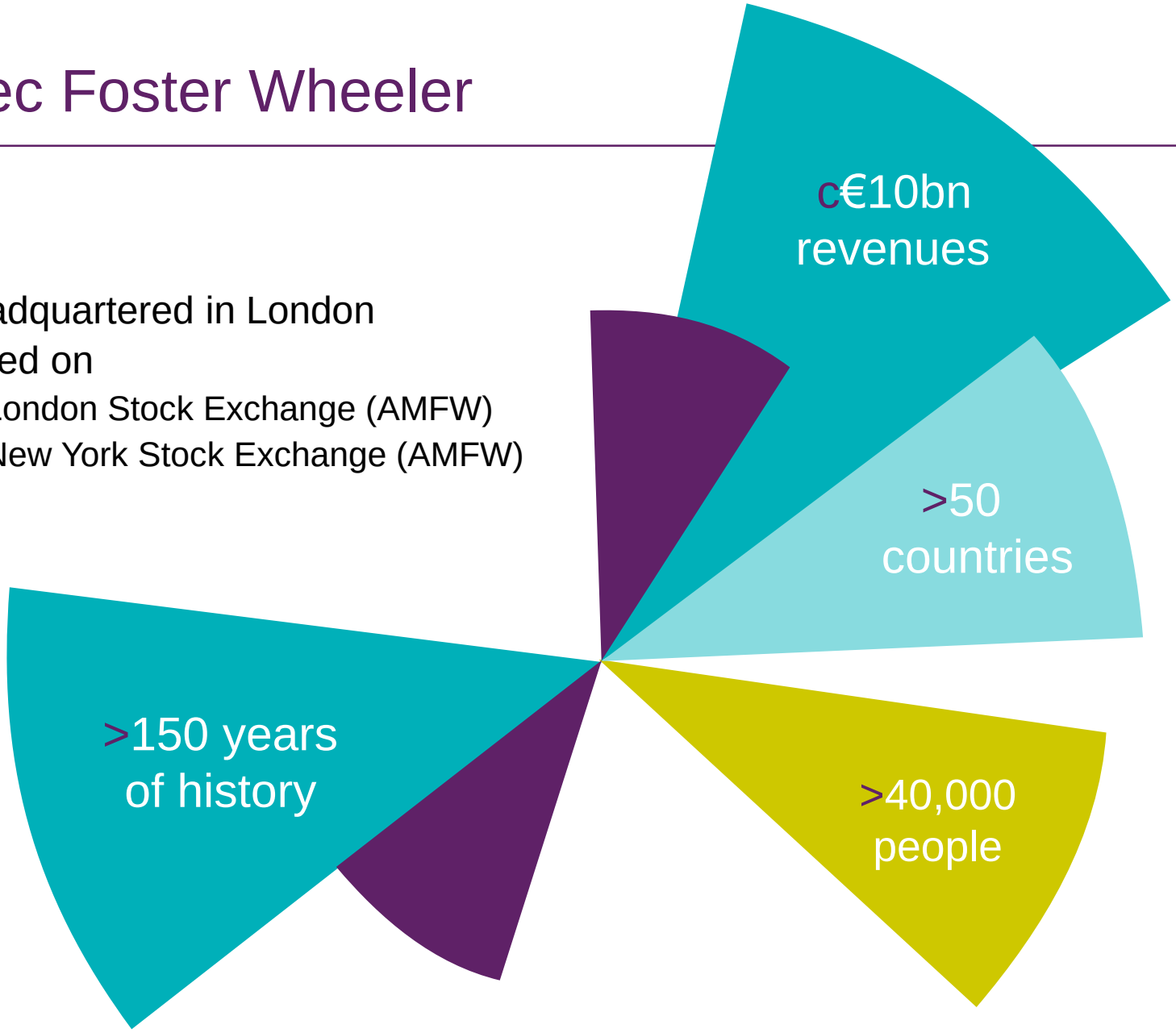
8th International School on Nuclear Power
Warsaw, October 2015

Content

- ***Who is AMEC Foster Wheeler***
- ***Nuclear history and activities***
- ***Case study on introducing PWR technology into the UK (Sizewell B)***
- ***What is a TSO***
- ***Current UK position***
- ***Personal insights***

Amec Foster Wheeler

- Headquartered in London
- Listed on
  - London Stock Exchange (AMFW)
  - New York Stock Exchange (AMFW)

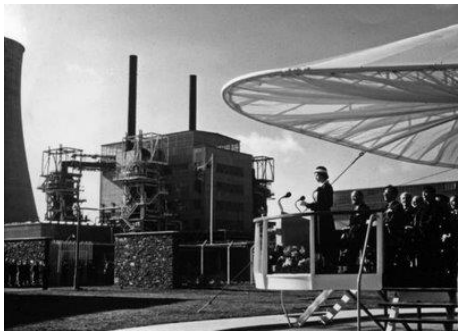


Beginning of Nuclear Power

1951
First generation of electricity by a nuclear reactor when the EBR I test reactor in USA lit up 4 light bulbs.

1954
The 5 Mwe Obninsk in Russia was the first nuclear power plant to be connected to an external grid.

1956
World's first industrial-scale nuclear power plant was opened at Calder Hall, Sellafield, UK.



UK Commercial Reactor History

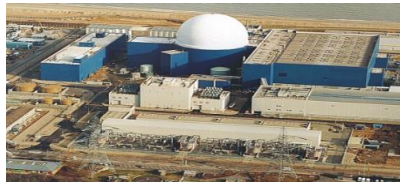
Torness AGR

Heysham 2 AGR

Heysham 1 AGR

Dungeness A Magnox Reactors

Berkeley Magnox Reactors



Sizewell B PWR

AMEC Foster Wheeler Nuclear Pedigree

. . . . 3,000 nuclear professionals . . . .

. . . . a Nuclear New Build partner for 60 yrs . . . .

Hinkley Point C

Sellafield

Foster Wheeler
AES (US)
ESRC (Serco) (UK)
Mactec (US)

2010

EDF Partnership

GDA – EPR, AP1000, ABWR

NMP Sellafield

AMEC Slovakia

AMEC Romania

Growth in Decommissioning

NCI South Africa

NSS/NCL Canada

Bruce CANDU

2000

AMEC Czech Republic

Ignalina RBMK

1990

Sizewell B
Westinghouse JV

Sizewell B PWR

Dungeness A - Magnox

1980

Magnox Station Design & Construction (all UK Consortia)

1970

AGR Station Design & Construction (all Consortia)

Heysham 1 AGR

1960

Tokai 1

1955

. . . . . a strategic role on every civil NPP ever built in the UK . . . .

. . . . a growing international presence

Introduction of PWR technology – Sizewell B

Sizewell design changes

Changes to SNUPPS design:

- additional provisions to reduce operator radiation exposure
- the adoption of two turbines
- coastal rather than inland site
- electrical frequency difference
- desire to use equipment of UK manufacture whenever possible
- include OEF and lessons learned from TMI-2,
- internal and external hazards - four train systems in the Sizewell B design compared to two trains for the original SNUPPS design
- pressure vessel integrity requirements
- enhanced radiological protection standards
  - introduction of secondary containment
  - low cobalt materials
- reliability requirements - use of diverse as well as redundant equipment
- etc, etc, etc

What is a TSO

- All nuclear regulators around the world rely on specialist technical support. In most countries this is provided by a single government/semi government owned organisation known as a Technical Safety Organisation, TSO.

- ETSON, is the European Technical Safety Organisation Network, a membership association made up of European nuclear assessment bodies (TSOs). http://www.etson.eu
- ETSON's aim is to share best practice amongst TSOs, promote harmonisation of nuclear safety practices, lobby the EU for nuclear safety research and raise standards across Europe. It also acts as an interface with European organisations such as the EU, SNETP and Global institutions such as IAEA.
- The UK is unusual in that there is no government owned TSO; the TSO function is provided solely by AmecFW for the nuclear defence regulator, MoD DNSR, and by AmecFW and a range of other consultants for the civil nuclear regulator, the ONR.

ETSON TSO definition

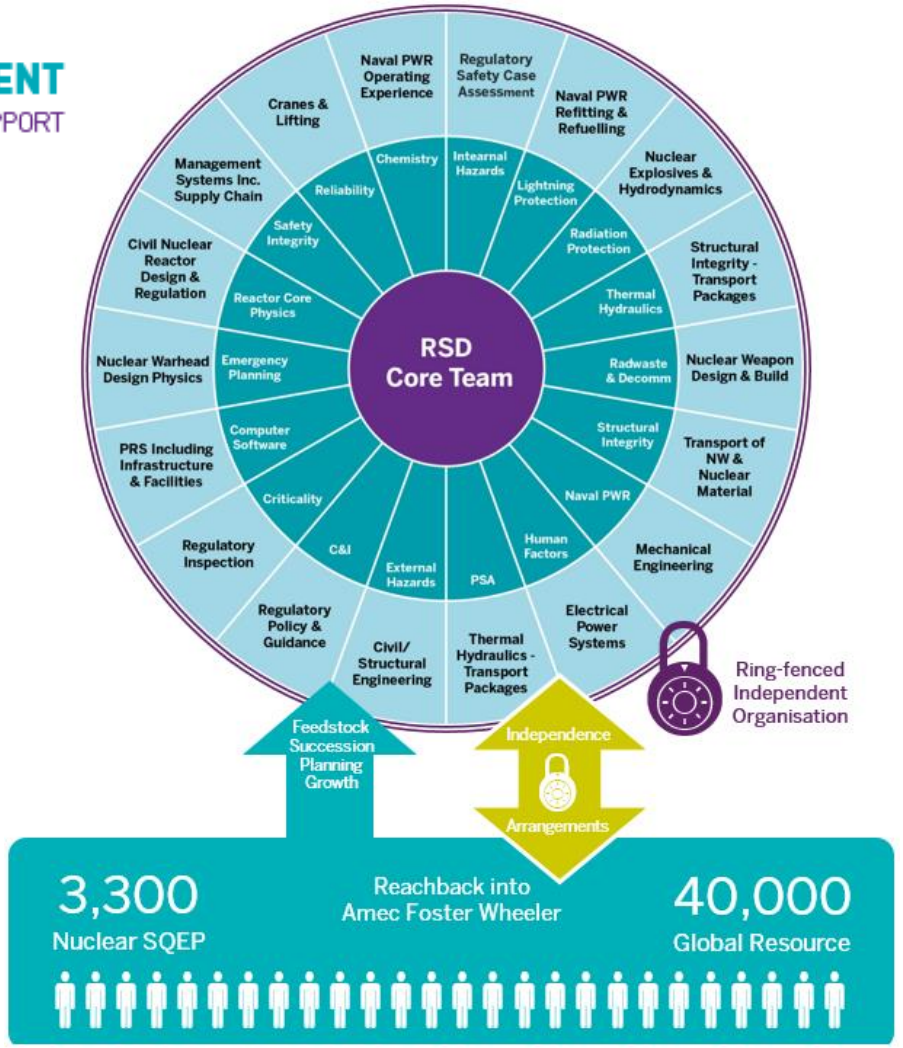
ATSO:-

- performs safety assessments with a global regulatory vision, on a regular basis and with a broad scope.
- delivers services supporting its national nuclear regulatory authorities in the field of nuclear safety, and/or waste management and/or radiation protection.
- develops and maintains a high level of competence in its field of safety assessment (knowledge, expertise, long standing experience, global overview, ethics, references).
- has a value charter and makes sure it is implemented at all levels in the organisation. The charter promotes values such as: honesty, impartiality, proactivity and initiative, consistency in the safety approach, respect for all stakeholders.
- is an independent organisation. This means that it is able to form and express its technical judgment independently from external interest.
- maintains an adequate training and knowledge management programme for its staff.
- maintains R&D programmes allowing the development of new knowledge and techniques in support of its missions, and an independence of judgement from licensees.

Code of ethics: if a TSO delivers services to a domestic or foreign licensee or vendor, it does so in full transparency with respect to the licensee's nuclear safety authority, and is able to demonstrate that conflicts of interest are avoided.

Regulatory Support Directorate

RSD INDEPENDENT REGULATORY SUPPORT



ONR Nuclear Safety Support Framework

	Technical Area:
1	Internal Hazards
2	Civil Engineering
3	External Hazards
4	Probabilistic Safety Analysis
5	Reactor Core Physics/Fault Studies
6	Control and Instrumentation
7	Essential Electrical Power Supply Systems
8	Fuel Design
9	Reactor Chemistry
10	Radiation Protection and Level 3 PSA
11	Mechanical Engineering
12	Structural Integrity
13	Human Factors
14	Managing for Safety and Quality Assurance
15	Radwaste and Decommissioning

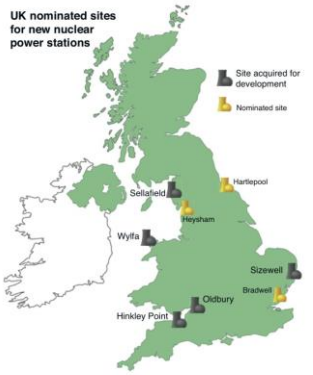
Support Provided to ONR

Technical Support has been provided over ~200 separate projects utilising over 1000 technical specialists across a broad range of support activities. Examples include:

- Fukushima Response & Stress Test Assessment
- Assessment of NDT methodology
- System Based Inspections
- Hinkley Point C Safety Assessment
- Development of TAGs
- Assessment of Periodic Review of Safety & Plant Life Extension
- New Build GDA Support for UKEPR, UKABWR & AP1000

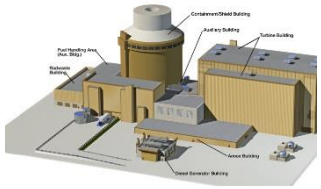
UK Nuclear New Build

- Currently 3 main players;
  - EDF - Areva (UK EPR) with Hinkley Point C & Sizewell C.
  - Horizon – GE/Hitachi (UK ABWR) with Wylfa & Oldbury.
  - NuGen – Westinghouse/Toshiba (UK AP1000) at Moorside (Sellafield).



- **EPR** has GDA/GEP approval and Licensing, Permitting & Development Consent Order (DCO) approval for HPC and is awaiting the Final Investment Decision. The remaining estimated investment is circa £16 billion with COD – 2023. EPC contracts set up with UK supply chain.
- **ABWR** is currently in Step 3 of GDA in the UK, i.e. developing the Licensing, Permitting and Development Consent Order (DCO) & GEP (EA). The remaining estimated investment is circa £15 billion with 1st COD – 2025. EPC contracts set up with UK supply chain. H-GE are engaged with key EPC contractors for 2 Reactors at Wylfa.
- **AP1000** is going through GDA/GEP re-start, due to complete in 2017. Plans for 3 reactors (total 3.4 GWe) on the site with staged COD between 2025-27. NuGen are currently developing the Licensing, Permitting, Development Consent Order (DCO).

The Westinghouse AP1000



EPR GDA changes

- Changes to the architecture of the Instrumentation and Control (I&C) systems
- Additional or suitably classified diverse reactor protection system trip signals
- Improvements to the spent fuel cooling pool
- Changes to essential support systems
- Classification methodology and upgrade of the safety classification of Structures, Systems and Components (SSCs) important to safety
- Automation of certain actions
- Other modifications that provide additional diversity, defence in depth, or other safety improvements

AP1000 GDA changes

- Categorisation of systems as safety or non-safety
- Inclusion of all radioactive materials in the Deterministic Safety Assessment and PSA
- Design codes and standards, particularly the justification of the Modular design and Civil structural codes
- Design of the secondary containment against aircraft crash
- Use of Metric SI units in the GDA application / conversion of all US (imperial units)
- Safety claims on computer control systems

Insights on the benefits of the right nuclear consultancy support

Understanding and managing regulatory expectations is the first essential.

Ensure country context is fully recognised, including legal requirements and applicable Codes and Standards.

The design of the Intelligent Customer relationships is key to ensure sufficient capacity building and the establishment of an effective Design Authority.

Technical knowledge transfer from the supply chain must be carefully managed; the procurement strategy must allow for access to relevant information at the right time.

The transfer of Design Authority experience takes time.

There are never enough SQEPs available to recruit directly.

In an international market, don't under-estimate the time to understand and accommodate cultural differences.