

The Organisation of Nuclear Research & Development in The United Kingdom

Greg Willetts, Consultancy Director, Clean Energy



- AMEC Introduction
- AMEC's Nuclear Capability
- UK Nuclear R&D Market Features
- AMEC Nuclear R&D Case Studies

AMEC Introduction & NuclearCapability



AMEC Pedigree - A Long Commitment to Nuclear



AMEC has been a partner to Nuclear Utilities for almost 60 years



Sellafield



Dungeness A - Magnox

Magnox Station Design & Construction

AGR Station Design & Construction

1955

1960

1970

1980

1990

Sizewell B



Sizewell B PWR

2000

Growth in Clean-Up

AMEC Romania & Czech Republic

NSS/NCL Canada



Bruce CANDA

NMP Sellafield

NCI South Africa

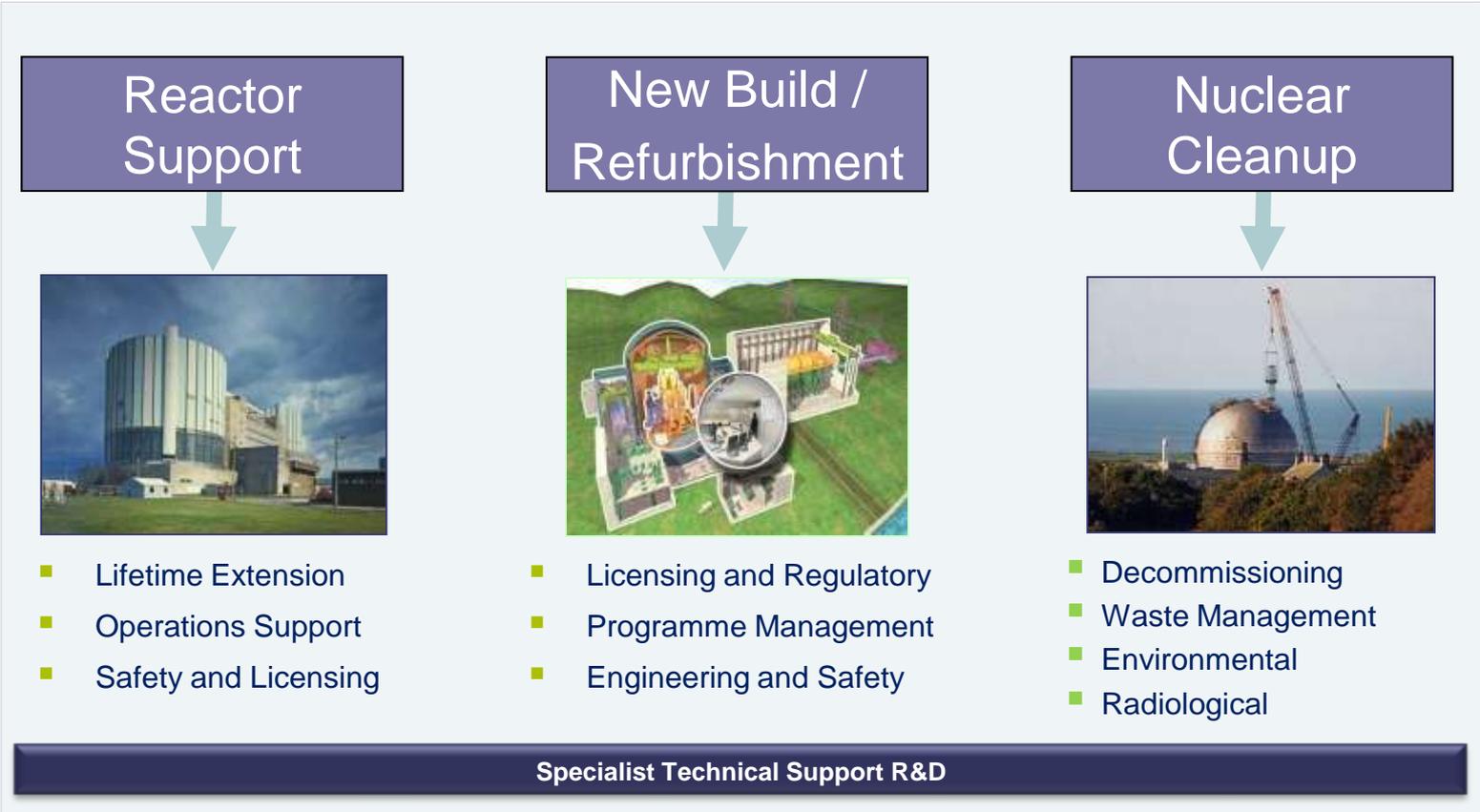
EDF (UK) Partnership

AMEC Slovakia

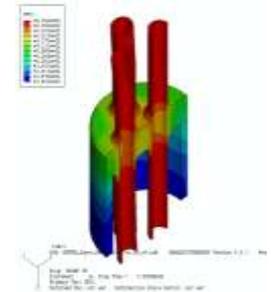
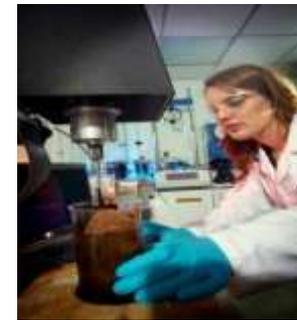
Serco Technical Services Acquisition

2012

- Over 3000 staff working solely in nuclear
- Businesses in the UK, US, Canada, Romania, France, Slovakia, Czech Republic, and South Africa
- Operations in Germany, Lithuania, Ukraine, Belarus, Russia, South Korea and UAE



- **Class leading health, safety and environmental performance: 4 years without a LTI.**
- **600 staff, majority PhD or first degree**
 - Chemistry & corrosion
 - Mechanical Testing –Test Rig build & operation
 - Remote Inspection and Operations
 - Radiochemical and Chemical analysis
 - Waste Technology and Management
 - Structural Integrity, materials, Engineering Simulation
 - Reactor Physics and Nuclear Facility Licensing/Regulator Support
 - Radiological and environmental
 - Criticality, shielding, human factors
- **Operate comprehensive (>4000m²) laboratory & engineering test rig facilities (active & non-active) in the UK and Slovakia.**
- **Largest provider of technical support to EDF in the UK for continued reactor operation and lifetime extension**
- **Largest commercial provider of radiochemical analysis in the UK**
- **Leader in R&D on materials corrosion in PWR conditions**
- **Technical advisor to the UK civil nuclear regulator and UK Defence Nuclear Regulator**



The Nuclear Future – AMEC involvement



■ New nuclear build

- UK, Finland, France, Poland, Middle East, Canada (Bruce Restart)

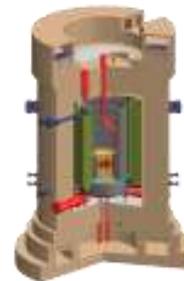
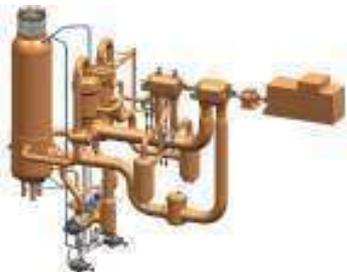
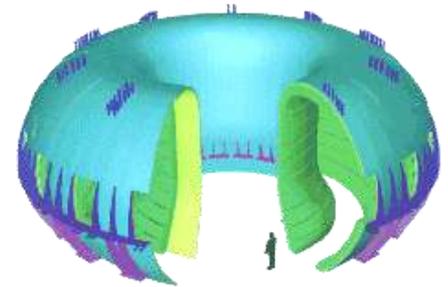
■ Advanced reactor technology development via international collaborations

- EC Frameworks
- Gen IV
- Fusion - ITER
- SNETP (Nugenia)

Operational safety and waste management

- IAEA standards development and missions
- Committee on Radioactive Waste Management

■ AMEC representatives on government committees



UK Nuclear R&D Market Features



Country		Euro (2011)
Japan		c.3.5bn
USA	DoE	c.1.5bn
France	Via state owned enterprises	c.850m
UK	Fusion accounts for c.45m	c.85m

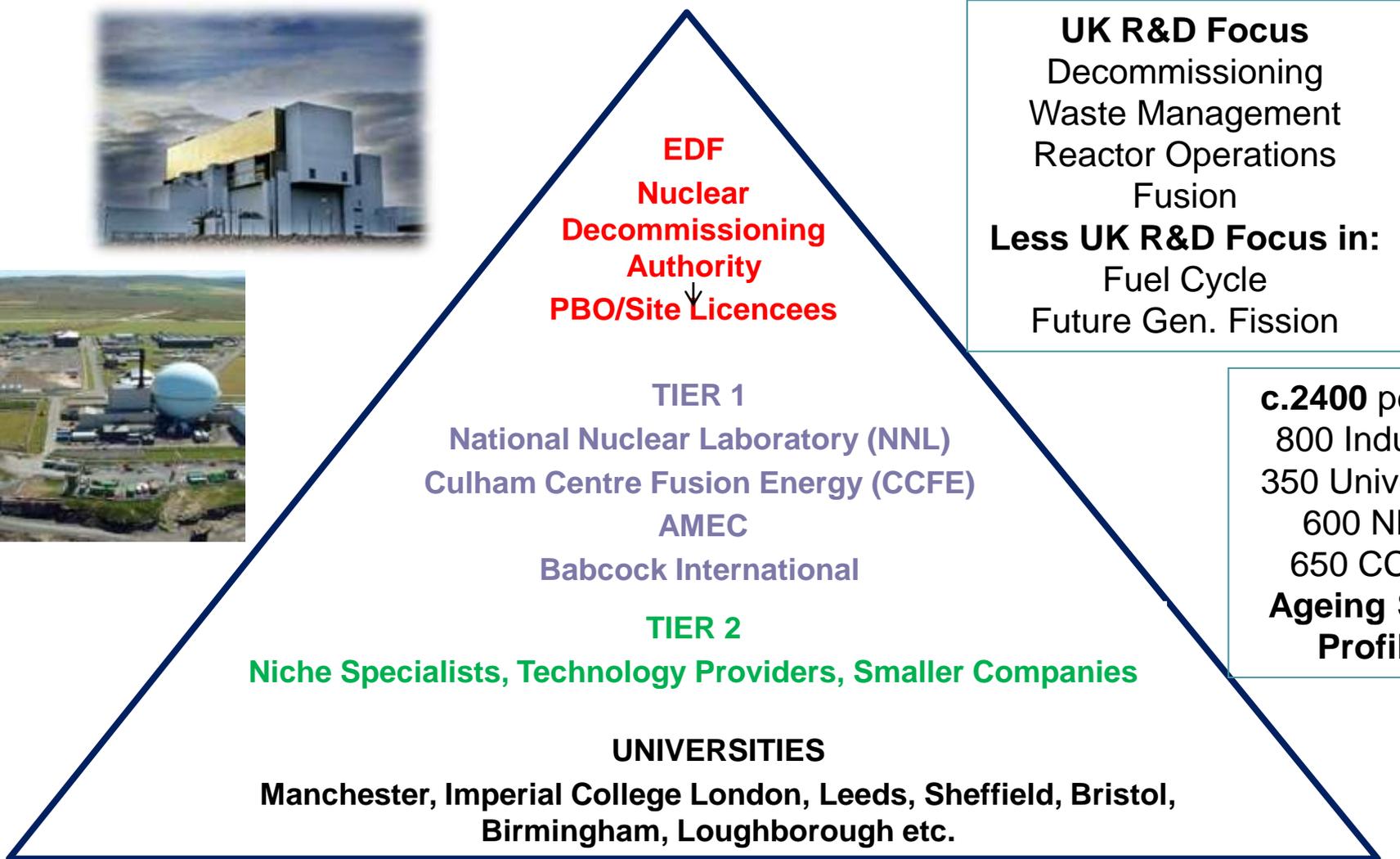


- The UK has long nuclear, R&D funding peaked at 600m Euro/yr in late 1980s
- Funding declined following UK decision to cease new nuclear build in early 1990s
- No UK Govt matched funding for European Nuclear R&D programmes since 1996

However.....

- Government funds 2.5bn Euro/yr decommissioning programme
- UK R&D organisations have adapted successfully

UK Civil Nuclear R&D Market



**EDF
Nuclear
Decommissioning
Authority**
↓
PBO/Site Licences

TIER 1
National Nuclear Laboratory (NNL)
Culham Centre Fusion Energy (CCFE)
AMEC
Babcock International

TIER 2
Niche Specialists, Technology Providers, Smaller Companies

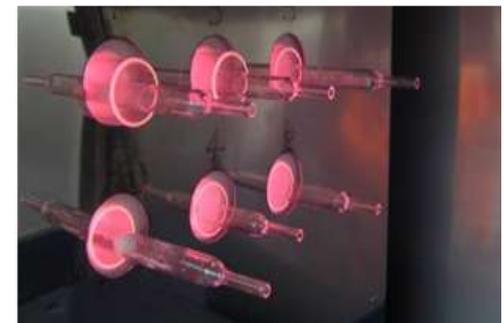
UNIVERSITIES
Manchester, Imperial College London, Leeds, Sheffield, Bristol,
Birmingham, Loughborough etc.

UK R&D Focus
Decommissioning
Waste Management
Reactor Operations
Fusion
Less UK R&D Focus in:
Fuel Cycle
Future Gen. Fission

c.2400 people
800 Industry
350 University
600 NNL
650 CCFE
**Ageing Staff
Profile**

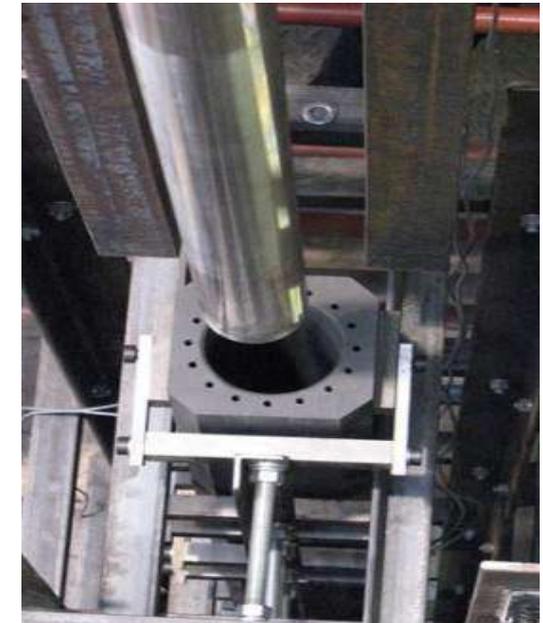
The UK Market Shape

- Small number of customers who demand R&D
- Fusion national laboratory (CCFE) is fully government funded
- NNL owned by UK Government but operated commercially in the market by a group of organisations in a “GOCO” arrangement
- Small number of large “Tier 1” commercial R&D providers such as AMEC
- Wide range of smaller “Tier 2” providers plus the university sector
- Less “pure research” and more “development”
- More “applied” and less “pure” R&D
- Tends to be shorter term R&D projects



The UK Market Shape

- Fully commercialised market
- Virtually all work is competitively tendered
- Long term framework agreements are the norm
- Customers expect the formation of groups with a Tier 1 leader to project manage the supply chain on their behalf
- Collaboration is the norm due to small number of facilities and in expertise residing in particular companies.
- Fixed price R&D tasks expected
- Target price contracts with financial penalty & bonus for delivery
- Socio economic benefits expected



AMEC Case Studies



AMEC Case Study – “Development”

EDF Hot Box Dome (HBD)

- Within an Advanced Gas Cooled Reactor the HBD is an internal structure penetrated by large number of vertical standpipes, through which fuel stringers and control rods enter the graphite core of the reactor.
- There are bleed holes within the standpipes to allow gas to flow that cools the dome surface
- It was discovered on two AGR reactors that temperatures were rising on the dome and hence output of the reactor was reduced
- A solution was required to return adequate cooling to the dome.
- The whole solution was devised and completed in under 6 months and successfully implemented at site, allowing reactor power to be restored to design levels.

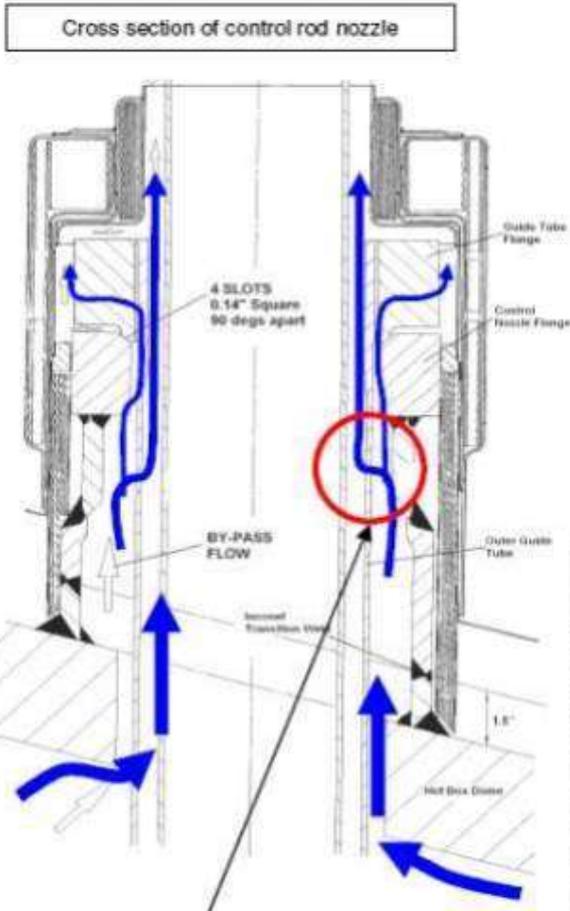


Hot Box Dome Project

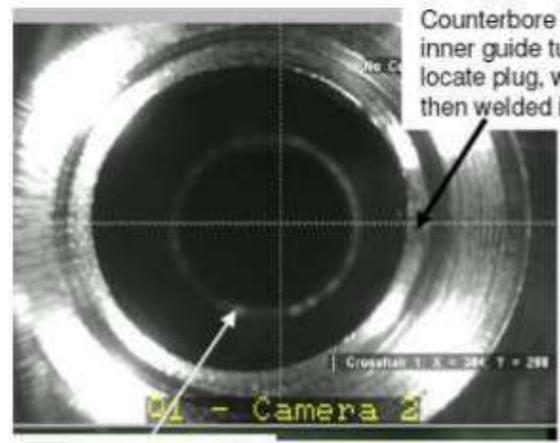


Hot Box Dome Project

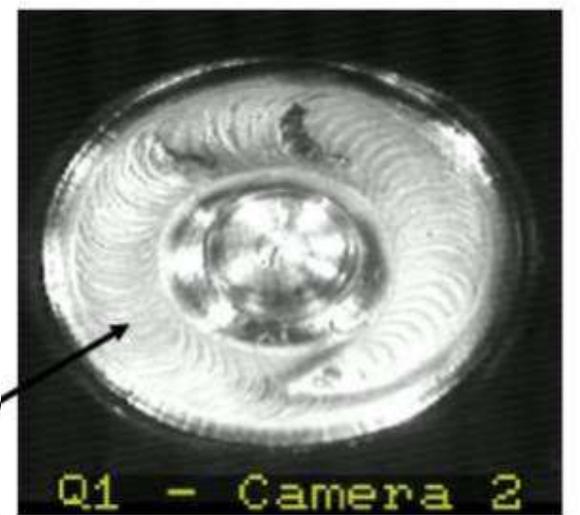
Task: 10 metres down a 100 mm dia. control rod channel, drill a 10mm bleed hole through two concentric tubes, then weld a sealing plug into the inner hole (in four locations at 90 deg.)



New bleed hole in outer guide tube – providing 5X more cooling than existing holes



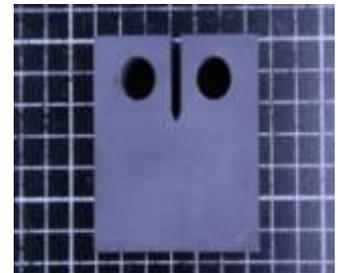
Counterbore feature on inner guide tube to locate plug, which is then welded in place



AMEC Case Study – Research into Stainless Steel Fatigue



- Research into gaining a fundamental understanding of the behaviour of stainless steel in a nuclear, high temperature, water (PWR) environment.
- Fatigue Loading of Nuclear Power Plant have been predicted by the ASME XI industry-standard correlations
- Experiments to determine how crack growth rate differs from traditional data obtained in air:
 - Frequency of loading.
 - Load ratio (minimum to maximum load
 - Stress intensity factor range.
 - Effects of flow
- Compact tension specimens of 304L stainless steel were used and crack lengths were measured in real time at up to 340°C to a resolution of about 2 microns.
- Results revealed that growth rates could be up to 70x greater than those in air and are leading to a reappraisal of the relevant ASME codes.



AMEC Case Study: Development of the Water Vapour Nitrogen (WVN) process for in-situ treatment of alkali metals



- The alkali metal cooled fast reactors at Dounreay are currently being decommissioned. An in-situ chemical conversion process to treat sodium and NaK (sodium/potassium alloy) residues was required
- The need was to reduce the chemo-toxic hazard posed by radioactive alkali metal prior to dismantling the reactor structures.
- The WVN process is a controlled reaction to convert the alkali metal into the hydroxide form by passing over a nitrogen gas with a % of water vapour
- AMEC developed the process, starting with small scale g quantity trials culminating on full scale representative geometrical features of both reactors at Kg quantities.
- The tests define the process envelope and other aspects such as orientation, frosts, crevices and impurities.
- The regulator was involved from concept and witnessed the trials at every stage as part of the method approval process
- The process has now been successfully employed for real on an industrial scale to treat the secondary systems efficiently with no safety issues



- The organisation of nuclear research and development in the UK is characterised by a low level of direct government funding.
- However there is significant UK government spend in decommissioning & waste, where government funds are passed down through Site Licence holders who exercise commercial control
- There are a small number of R&D demanders, serviced by an equally small number of major suppliers, supported by a wide ranging supply chain comprising universities and small, but important, niche providers.
- Full competition is the norm as is collaboration with an expectation of project management leadership from companies such as AMEC
- The range of AMEC R&D covers a spectrum of pure fundamental research to development tasks addressing specific customer issues.
- The UK industry is thriving and innovation still being delivered