

HEALTH AND SAFETY COMMISSION

NUCLEAR SAFETY ADVISORY COMMITTEE

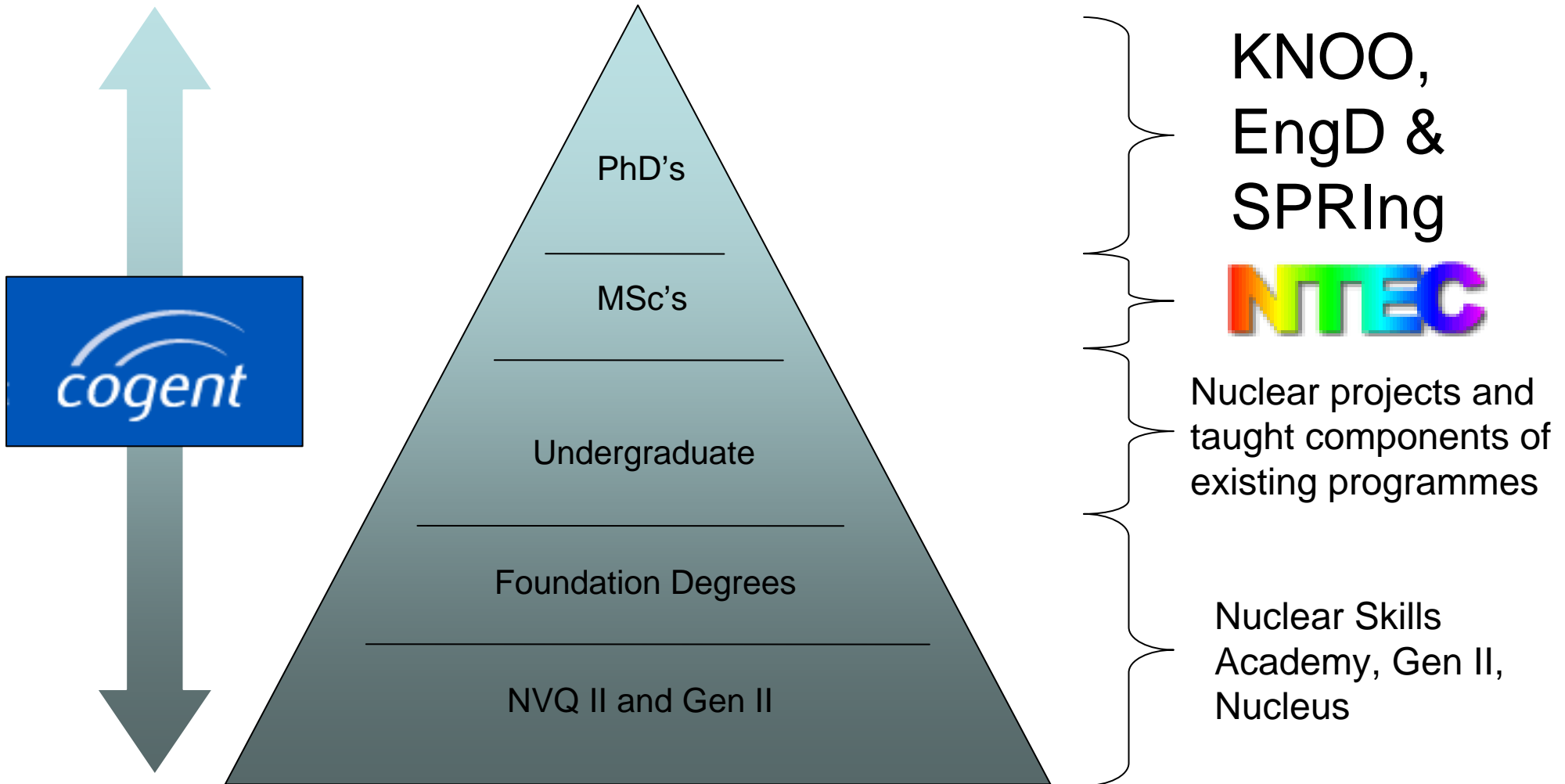
Review Group 6

University Based Research Consortia

Robin W. Grimes

Department of Materials
Imperial College London

Training Requirements



University Consortia

- Keeping the Nuclear Option Open £6.4 M
 - Research focused
- Nuclear Engineering Doctorate £5 M
 - 3+1 (management) industry based
- Sustainability of Nuclear Energy £2.1 M
 - Just starting
- Waste and Decommissioning £4 M
 - In negotiation

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Towards a Sustainable
Energy Economy
Programme

Keeping the Nuclear
Option Open

KNOO

Keeping the Nuclear Option Open

- 17 consortium members.

- Principal Investigator
- Work Package Leaders
- Investigators



- 7 Universities, Imperial College is the lead organization.

- £6.4M programme

- Consequently we focus on a limited number of specific topics but in the context of the objectives, these are broad in scope.

- Started Oct 2005.

- 16 Stakeholders: Industrial or Governmental Partners

- 24 Researchers (Post Doctoral)

- 20 PhD Students

Overview

In collaboration with key Industrial/Governmental Stakeholders and through international contacts, skills will be maintained and developed through research and training.

Objectives

- Make research contributions to nuclear power to improve cost, safety and acceptability
- Maintain the expertise necessary for the UK to remain an informed customer
- Develop tools that contribute towards a whole system approach to nuclear power generation

Themes (Work Packages)

- Fuel, thermal hydraulics and reactor systems
Leader: Simon Walker
- Materials performance and monitoring reactor conditions
Leader: Andrew Sherry
- An integrated approach to waste immobilization and management
Leader Simon Biggs
- Safety and performance for a new generation of reactor designs
Leader: Tony Goddard

1st year characterised by:

- hiring new people
- initiating new projects
- spending money on new equipment
- Generating our first results

2nd year is characterised by:

- Annual meeting 3/4 July 2007 (with EngD participation)
- Meeting of Management Groups
- Meeting of specific W/Ps to allow focus in-depth
- KNOO focus journal special issue
- Development of cross-cutting themes

3rd year could be characterised by:

- More and varied training days
 - to provide broader knowledge of nuclear science and engineering
- KNOO Industrial Visits
- KNOO short-term industrial placements

KNOO Work Package I

Fuel, thermal hydraulics and reactor systems

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London

Work Package Leader: S P Walker
(Imperial College)

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Investigators:

G F Hewitt (Imperial)
B P Axcel (Manchester)
D Laurence (Manchester)
A J H Goddard (Imperial)

KNOO Work Package I

Fuel, thermal hydraulics and reactor systems

**Imperial College
London**

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Coupling of multi-pin structural mechanics and three-dimensional transient two phase thermal hydraulic analysis for the study of severe accidents (e.g. pin ballooning under reflood conditions); crud deposition and its thermal hydraulic and neutronic effects; application of advanced CFD to Gen IV systems. Reduce conservatism.

KNOO Work Package 2

Materials performance and monitoring
reactor conditions

The University
of Manchester

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The Open University



University of
BRISTOL

Imperial College
London

Work Package Leader: A H Sherry
(Manchester)

Investigators:

Chris Scruby (Imperial College)

Dave Smith (Bristol)

Lyndon Edwards (Open)

Barry Marsden (Manchester)

James Marrow (Manchester)

Graham Hutchins (Cardiff)

KNOO Work Package 2

Materials performance and monitoring reactor conditions

The University
of Manchester

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UNIVERSITY
PRIFYSGOL
CAERDYDD



The Open University

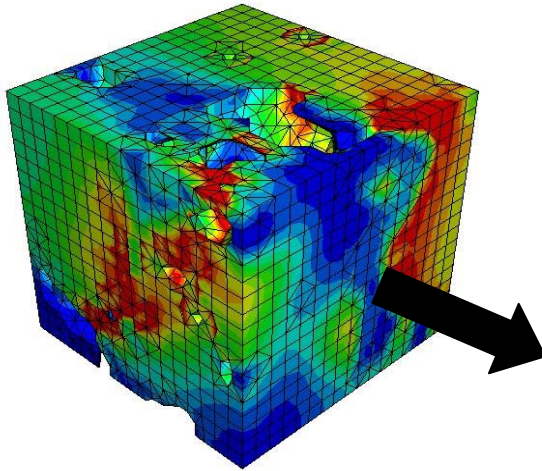
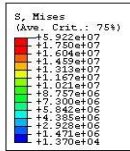


University of
BRISTOL

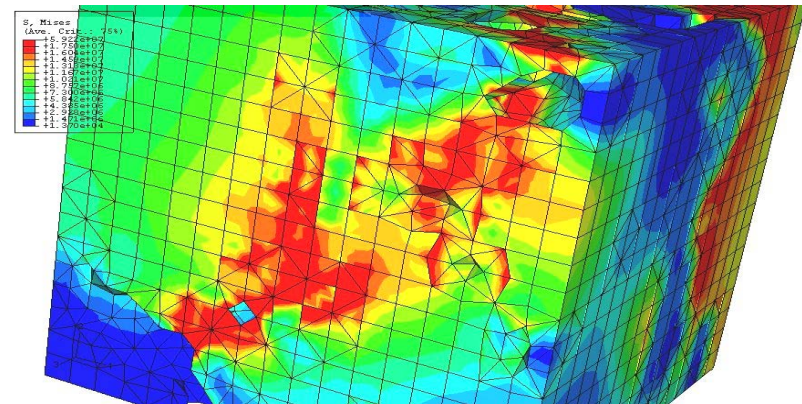
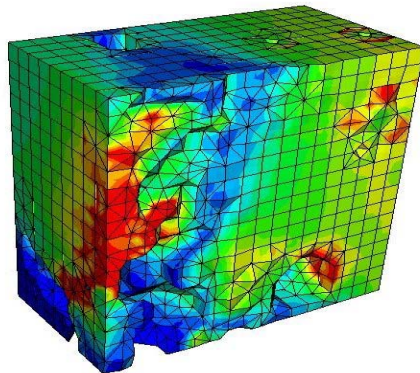
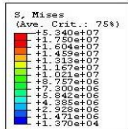
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London

Remote structural interrogation and monitoring tools; miniaturised, encapsulated monitoring systems; FE/self consistent models to assess materials; mechanical understanding and predictive models of SCC; mechanical performance of nuclear cladding and structural materials; behaviour of graphite.

Microstructural modelling of Graphite



- Stress distribution after failure (top left)
- Stress concentration in a cut-out (bottom left)
- Stress concentration nearby the pores (bottom right)





KNOO Work Package 3

Interface Science and Particulate Waste Immobilization



Work Package Leader:
S Biggs (University of Leeds)

Investigators:

W E Lee (Imperial)

N Milestone (Sheffield)

F Livens (Manchester)

R W Grimes (Imperial)

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Sellafield MAGNOX Sludge Ponds



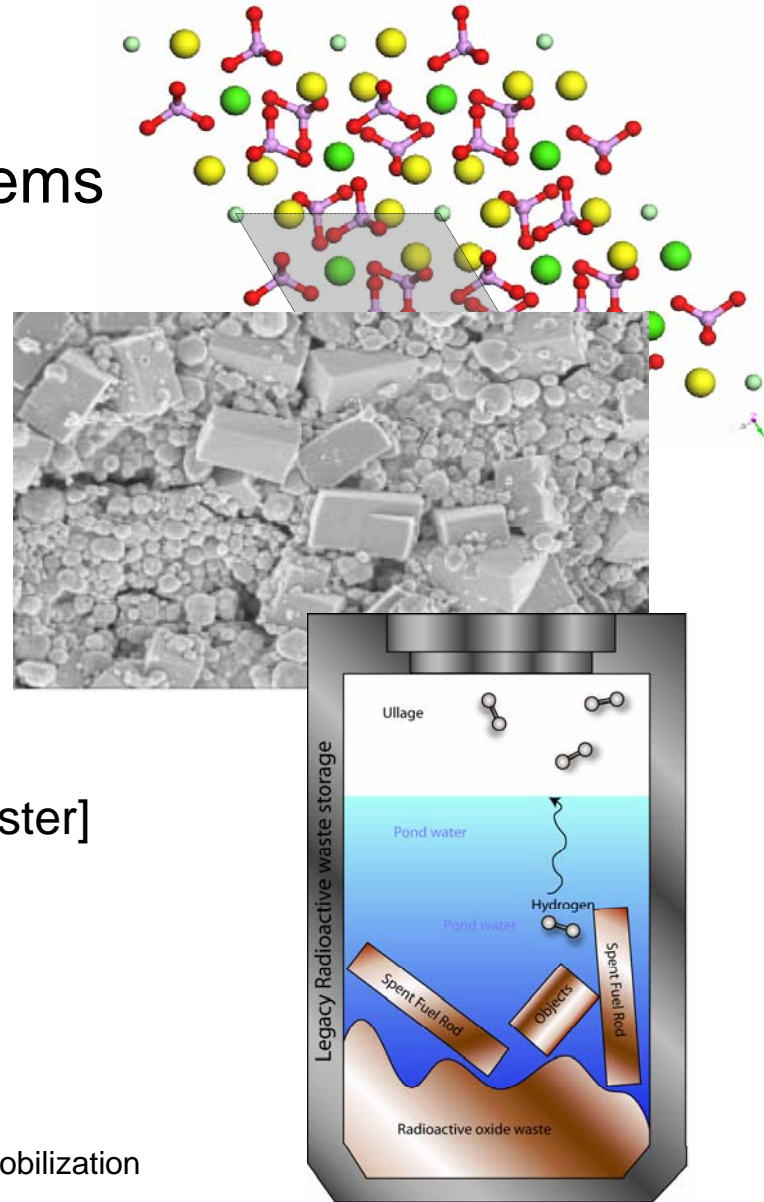
Corroded Mg Cladding; Radionuclides; Organic Material

Contents of ponds must be treated, but distribution of radionuclides within system is unknown and currently impossible to predict.

→ AT PRESENT THESE WASTES CANNOT BE TREATED

Generic research topics in Area 3

- Multi-scale modeling of particulate systems
 - Atomic scale models [Imperial]
 - Thermodynamic models [Manchester]
 - Process scale models [Leeds]
- Engineering properties
 - Microscopic-macroscopic links [Imperial/Leeds]
 - Transport and Rheology [Leeds/Sheffield]
- Waste reactivity
 - Waste hosts and wasteforms [Sheffield/Manchester]
 - Gen IV wastes [Imperial/Sheffield]
 - Waste interactions [Manchester/Sheffield]



KNOO Work Package 4

Safety and performance for a new generation of reactor designs

**Imperial College
London**

Work Package Leader:

A Goddard (Imperial College)



The Open University

Investigators:

B Axcell (Manchester)

L Edwards (Open University)

R W Grimes (Imperial)

R Allen (Sheffield)

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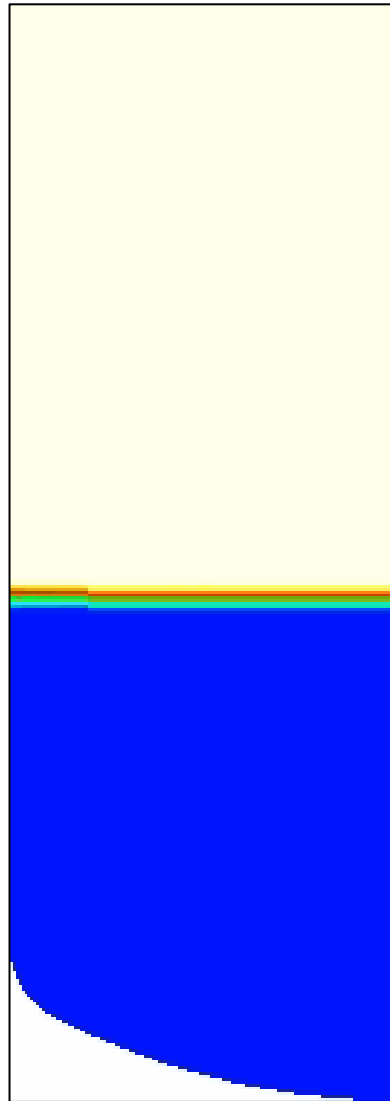
Contributing Sciences in Work Package 5

- 3D spatially coupled transient modelling (*Imperial, Part PDRA and PhD*)
- CFD applied to innovative fuel designs (*Manchester, PhD*)
- Materials Performance for candidate Gen IV materials (reapplication of WP 2 work) (*Open University*)
- Atomistic modelling for radiation damage in Gen IV materials (*Imperial, PhD*)
- Linking nuclear power to the hydrogen economy (Sheffield)

Modelling JCO criticality accident

Axi-
symmetric
model

Gas volume
fraction



Combination of a
radiation transport
code and a multiphase
cfd package

Note: radiolytic gas
formation

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KNOO
Keeping the Nuclear Option Open

Summary

- Make research contributions to nuclear power to improve cost, safety and acceptability of nuclear energy.
- Contribute to keeping available the pool of expert manpower needed.
- Contribute to keeping & developing expertise to enable the UK to remain an informed customer.
- Delivered in collaboration with key Industrial/Governmental Stakeholders and through international contacts.

Nuclear Engineering Doctorate Scheme

October 2006

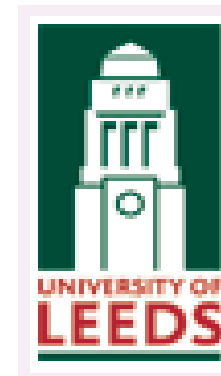


The University of Manchester
Dalton Nuclear Institute

Imperial College
London



The
University
Of
Sheffield.



Nuclear Engineering Doctorate

- 6 Universities, led by Manchester (PI: Andrew Sherry) in partnership with Imperial College.
- £5M programme.
- Start Oct 2006.
- 4 Original Stakeholders: AWE, BE, BNFL, MOD
 - NDA may become formally involved soon.
- 40 PhD Students (more subject to additional funding).
- Relationship to KNOO:
 - EngD students will attend the KNOO meetings thereby forming a *broad network of young leading nuclear engineers.*

Research Themes

Proposed centre covers all 6 of the research themes identified in EPSRC's call:

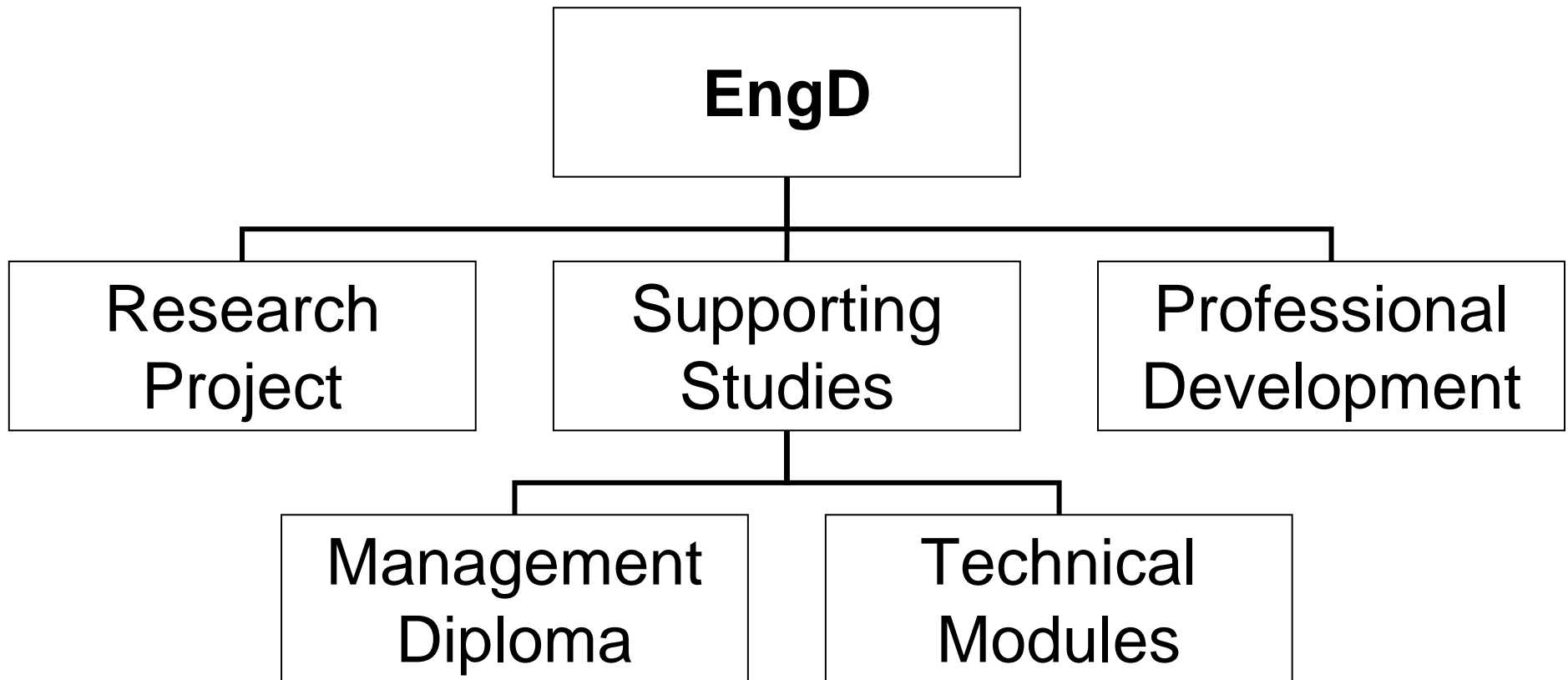
- Reactor Technology
- Waste Management
- Decommissioning
- Materials
- Socio-economic Aspects
- Safety Systems

Consortium members

- No single university can cover the broad scope of all of the research themes
- Consortium of six universities assembled led by The University of Manchester in partnership with Imperial College London
- Supporting universities selected on the basis of their capabilities and recognised track record in specific areas of nuclear research
 - University of Bristol: safety systems
 - University of Leeds: process engineering
 - University of Sheffield: waste immobilisation
 - University of Strathclyde: Socio-economic aspects and plant condition/risk management

Programme Structure

The Nuclear EngD programme will have four elements as follows



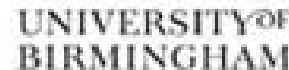
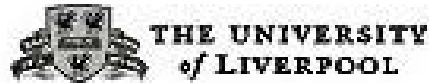
Industry Partners

- Support from industry is essential to the success of the EngD
- Letters of support have been received from the following

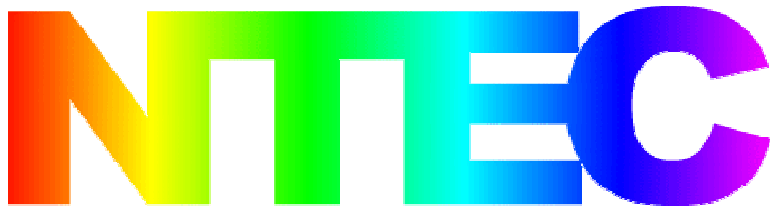


NTEC

**Nuclear
Technology
Education
Consortium**



A new UK initiative in Masters-level Nuclear education and training coordinated by the Dalton Nuclear Institute

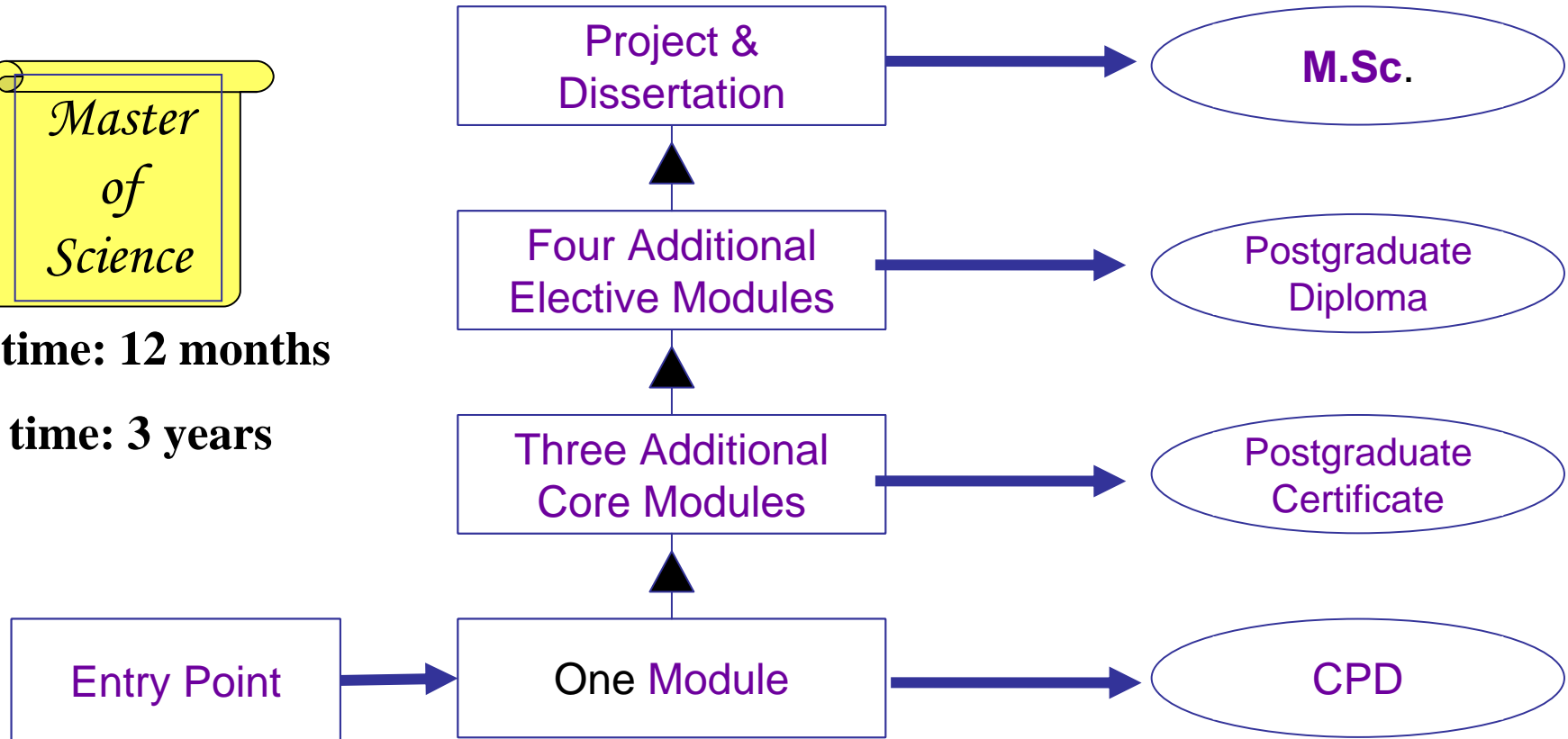


Programme Structure



Full time: 12 months

Part time: 3 years





Pathways in:

- **Decommissioning**
- **Nuclear Technology**
- **Environment & Safety**

Example: Nuclear Technology

**Reactor Physics, Criticality
& Design**

Nuclear Fuel Cycle

Safety-Critical Systems

Reactor Materials

Water Reactor Performance

Experimental Reactor Physics

Radiological Protection

Criticality Safety

**Policy, Regulation &
Licensing**

Risk Management

**Reactor Thermal
Hydraulics**

**Core
for
MSc**

Elective

UK Government Research Councils have a new £2m call for social & sustainability research into nuclear power

- Planning, regulatory and market arrangements to give investors confidence.
- Analysis of risks and benefits of new nuclear build within society.
- Assessment of potential environmental impacts of new nuclear build.
- Comparative sustainability analysis (economic, environmental and social) of different options for new nuclear build.
- Addressing security issues associated.
- Comparative assessment of nuclear with other energy generation options.

SPRIng Project

- **Lead partner** : The University of Manchester
- **Principal Investigator**: Adisa Azapagic, The University of Manchester
- **Academic partners**: City University and Southampton University
- **Other partners and collaborators**: AMEC NNC, AREVA NP, Battelle, British Energy, British Nuclear Energy Society, Centre for International Governance Innovation (Canada), Chatham House, DTI, Foreign and Commonwealth Office, Friends of the Earth Health and Safety Executive, Ministry of Defence, Nexia Solutions, SERCO, The London Press Club, UKERC, University of Sheffield, VRI (USA) and Westinghouse.
- **Total funding**: £2,123,000
- **Duration**: 36 months (expected start: November 2007)

SPRIng Project

- **Project aim**

- to develop an integrated decision-support framework for assessing the sustainability of nuclear power relative to other energy options (fossil fuels and renewables), considering both energy supply and demand.

- **Deliverables**

- Multicriteria decision-support framework for sustainability assessment of energy options.
- Sustainability assessments of the nuclear option within an integrated energy system.
- Engagement with and communication of the results of research to relevant stakeholders.

Waste and Decommissioning Call

- Nominally £4M \Rightarrow £4.2M (~30 projects max)
- Call for multiple consortia to bid.
- Likely to be at least three; only one will be successful.
- Research to cover aspects of:
 - Characterization (identification)
 - Packaging (immobilization)
 - Disposal