NTEC

Nuclear Technology Education Consortium

Nuclear Technology Education Consortium
M.Sc. in Nuclear Science & Technology
Programme Handbook

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Nuclear Technology Education Consortium

MSc, Diploma & Certificate in NUCLEAR SCIENCE & TECHNOLOGY

PROGRAMME HANDBOOK

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INTRODUCTION

The purpose of this handbook is to provide information to students undertaking the postgraduate programme in Nuclear Science & Technology being delivered by the Nuclear Technology Education Consortium (NTEC).

NTEC is a consortium of UK universities and research institutes formed specifically to deliver postgraduate taught programmes in Nuclear Science & Technology.

The structure and content of the programme, which leads to qualifications up to Master's level in Nuclear Science & Technology, was established following extensive consultations with the UK nuclear sector, including industry, regulators, MoD, NDA, Government Departments and the Cogent Skills Council.

The programme is based upon a modular structure, the core of each topic within the programme being delivered in one week's intensive teaching at the relevant institution or via distance learning modules taken over 4 months. This allows the M.Sc. qualification to be obtained over three years on a part-time basis, or in one year full-time. A Postgraduate Certificate or Postgraduate Diploma in Nuclear Science & Technology may also be obtained.

NTEC comprises the Universities of Birmingham, Central Lancashire, City University London, Defence Academy College of Management and Technology, Imperial College London, Lancaster, Leeds, Liverpool, Manchester and Sheffield. Together these institutions represent more than 90% of the nuclear postgraduate teaching expertise residing in the UK's universities and research institutes. Further information is given in Appendix 4.

Each Consortium member delivers one or more modules within the syllabus according to its areas of specialisation. Modules will generally be delivered on the campus of the providing institution. Students seeking a postgraduate qualification will register at either, Liverpool, Manchester or Sheffield University. The programme is coordinated by the Nuclear Programmes office at the University of Manchester.

Students can register at either, Liverpool, Manchester or Sheffield University, which is then responsible for overall academic supervision of the student, including supervision of the Master's project & dissertation. The registering institution will also award any degree. NTEC itself does not make awards.

This handbook is provided to address Consortium-wide issues and will be supplemented by the specific student handbook provided to students by their registering university. It is however the clear responsibility of the student to ensure that s/he is fully informed about all aspects of their course.

Access to the internet is assumed. This will be used principally for access to the pre-course preparation material, dissemination of course news and the distance learning modules.

COURSE STRUCTURE

The qualifications offered are available on a taught full-time/part-time or part time distance learning basis and lead to an M.Sc. in Nuclear Science & Technology. Intermediate qualifications, a Postgraduate Diploma or Postgraduate Certificate, are also attainable. Qualifications are awarded by the university with which the student has registered and which is therefore responsible for the student's overall academic supervision.

Students who register for, and satisfactorily complete an intermediate qualification may apply for a transfer to a higher qualification.

The programme elements are 'short fat' modules, each of which accrues 15 credits. 180 credits are required for the award of an M.Sc.

The overall philosophy governing the programme structure is that students take four 'core' modules designed to give a basic grounding in either nuclear technology or decommissioning. Students undertaking a Postgraduate Diploma or M.Sc. will then take four elective modules aligned to their particular interests. It is recognised that students will come from a variety of different backgrounds and disciplines and, as far as possible, the pre-course material will be designed to ensure all students commence each module sufficiently prepared to obtain full benefit from it.

Students seeking an M.Sc. will undertake a project and dissertation. Wherever possible this will be an industrially-based project designed to be of benefit to both the student and the sponsoring company.

Typical timescales are:

Part-time taught or distance learning M.Sc. taken over 3 years:

Year 1 4 Core modules (60 credits)
(Successful completion attains Postgraduate Certificate in Nuclear Science & Technology)

Year 2 4 Elective modules (60 credits)
(Successful completion attains Postgraduate Diploma in Nuclear Science & Technology)

Year 3 Project & Dissertation (60 credits)

The maximum period for completion of a part-time course is a matter for agreement between the student and the university with which s/he has registered.

Full-time M.Sc. taken over 1 year:

4 core and 4 elective modules are taken over a period of approximately 9 months. The project and dissertation then follows.

Any module may be taken as a short course for Continuing Professional Development purposes. Students will be given an appropriate certificate but will not achieve a formal qualification from the institution delivering the module.

TAUGHT MODULE FORMAT

Modules are designed to require approximately 150 hours application by the student. The key element of the module is one week of direct teaching on the campus of one of the Consortium members.

Modules will typically contain the following elements:

1. Prior to the concentrated week of teaching, students will undertake approximately 20 hours of pre-module preparation. This may include pre-reading, research and exercises and students may be asked to prepare a short presentation for delivery at the beginning of the taught week. The purpose of this element is to enhance the effectiveness of the taught week by bringing students, who may be from varying backgrounds and disciplines, up to the same basic level of knowledge. This information will be posted on the student website around 4 weeks prior to the direct taught week.

2. One week's direct teaching by the institution delivering the module: this may include some group exercises which require the students to work together, undertake research and make a presentation to the module leader and the rest of the cohort. These activities may be subject to assessment. A module review is conducted at the end of the taught week. A mandatory requirement of each module is that students complete a feedback form, which is emailed to all students after completion of the module. Feedback should then be emailed back to the E-Learning Technologist (Ishty Hussain) within one week of completion of the module.

3. A post-module assignment based upon the subject delivered during the taught week and undertaken at the student's place of work or home. The assignment is designed to require approximately 70 hours' input by the student and will be assessed and marked. Students will be required to submit a professionally written report in response to a detailed project brief, to be delivered about 8 weeks after completion of the taught week on a date set by the module leader. The post module assignment subject and date for submission will be confirmed during the week. It is expected that all assignments will be typewritten. If this requirement presents a problem to any student it should be referred in the first instance to the Course Administrator.

4. If a module examination is incorporated, this will be taken some weeks after the taught section of module to allow students time for assimilation and revision. If an examination is not incorporated, an additional form of assessment may be introduced, such as an additional assignment.

TAUGHT MODULE DELIVERY (Part time & Full time)

All modules are taught by direct teaching, with selected modules being available in both the direct teaching and distance learning formats. Individual module delivery is subject to a minimum number of students registering for that module.

Structure of the taught week

Direct teaching modules are delivered by a number of the Consortium members. Unless otherwise notified, teaching will commence at 9 a.m. on the Monday of the given week.

It is the responsibility of the student to arrange and pay for their own travel to the modules, we only allow travel by train and you must travel down on the Sunday. Accommodation information will be emailed to you along with the pre-course material/timetable 4 weeks prior to the module start date again it is your responsibility to book and pay for this.
(FOR FULL TIME STUDENTS TRAVEL, ACCOMMODATION & FOOD EXPENSES CAN ONLY BE CLAIMED BACK AFTER YOU HAVE ATTENDED THE MODULE AND CAN TAKE UP TO SIX WEEKS TO BE REFUNDED). Train tickets should also be booked as far in advance as possible.

At the beginning of the majority of modules students will be given a folder containing the course material to be delivered. If modules incorporate laboratory work or site visits which require particular preparation or documentation, students will be notified in advance.

DISTANCE LEARNING MODULE DELIVERY (Part time)

The following 10 modules are available in distance learning format. Each module will contain the same syllabus as its counterpart delivered by direct teaching, will have the same learning outcomes and will be delivered once per annum over a fixed period of time in order to facilitate the concept of a 'virtual classroom'. 8 modules must be taken to complete the M.Sc.

Semester One (September - January)
N01 Reactor Physics, Criticality & Design
N03 Radiation & Radiological Protection
N04 Decommissioning / Waste / Environmental Management
N10 Processing, Storage and Disposal of Nuclear Wastes
N12 Reactor Thermal Hydraulics

Semester Two (February - June)
N02 Nuclear Fuel Cycle
N07 Nuclear Safety Case Development
N13 Criticality Safety Management
N29 Decommissioning Technology & Robotics
N31 Management of the Decommissioning Process

The distance learning platform is Blackboard, a web-based Virtual Learning Environment, accessible anywhere, anytime and includes course handbooks, course content, timetables, course news, discussion groups, video clips and email.

Key features:

- Content (selective release/timed release etc)
- Multimedia (animation/audio/video)
- Communication Tools (discussion/email/chat)
- Assessment (quizzes/self tests/online assignment submission)
- Course Management (student tracking/online grade book)

The teaching material is not simply pages of text or reproductions of PowerPoint slides but is created specifically for this form of delivery. It includes exercises which can be assessed by the module leader (on-line), individual self tests and group projects. It is released onto the website at pre-planned intervals to replicate the pace, albeit slower, of the taught week.

Access to the internet is essential. Students also receive a CD of the module which allows study (but not interactive exercises) to be undertaken on a lap top whilst e.g. travelling.

Unless a module contains a compulsory residential session for laboratory work, students may undertake an entire module remotely from the university campus. However an optional one day residential programme is delivered during certain taught modules, allowing students to meet the course leader and their fellow students and have the opportunity for discussions on key aspects of the module. As with the direct taught version, a significant individual assignment is incorporated as well as an examination. The latter is also taken remotely from the university campus, at a location convenient for the student and acceptable to NTEC, and will be sat simultaneously by students from the direct taught and distance learning version of each module.

Distance learning programme structure

In order to permit part-time students to complete four modules in a year, modules are delivered in parallel. An illustration of the distance learning programme structure and timetable is shown below. Students should select 2 modules per semester.

September	N01, N03, N04, N10, N12
October	
November	
December	
January	**Examinations & Assignments**
February	N02, N07, N13, N29, N31
March	
April	
May	
June	**Examinations & Assignments**

- ***Note students can mix and match the taught and distance learning modules***

Post-module assignment

Post-module assignments will be set during the taught week and the completion date confirmed. It is the responsibility of the students to ensure they know these dates. Assignments are to be typewritten and students should always retain an electronic copy of their assignments in case of mishap.

All students are required to return their post module assignments on time to the Nuclear Programmes Administrator by email. Assignments will be put through Turn-It-In before being passed to the module leader for marking. Assignments received after the due date will be assigned a mark of zero. Only if mitigating circumstances arise, such as unforeseeable or unpreventable circumstances, may a student be granted an extension. In such cases, the student should make a request to the Nuclear Programmes Office as soon as reasonably possible. Any request will be dealt with on a case by case basis.

M.Sc. PROJECT

Students registered for an M.Sc. will undertake a substantial project/dissertation. Wherever possible this will be an industrially sponsored project which will be designed to be of interest to the student as well as of intrinsic value to the sponsoring organisation. The project should be designed to require approximately 600 hours of application by the student.

Full time students will undertake the bulk of the project from June to September on completion of the taught modules. Part-time students will normally undertake the project in their third year. The project will be supervised entirely by the institution with which the student has registered and students are strongly advised to make early contact with their academic supervisor to establish the appropriate timescales for undertaking their project. As a general guide, full-time students should establish the subject of their project within the first three months of study, and part-time students mid-way through the second year.

Instructions regarding thesis preparation and presentation will be given by the student's registering university.

CANCELLATIONS

For direct teaching and distance learning, fees are payable at the start of each academic year. If a student wishes to withdraw part way through an academic year, the individual module fee for any modules undertaken in that year would be applicable at the individual module rate for that year.

In the case where a student is taking an individual module as part of CPD, cancellations confirmed in writing more than 28 days before the course commences will receive a full refund. Cancellations received between 15 & 28 days beforehand will receive a 50% refund. No refund will be available for cancellations received within 14 days of the course commencing.

If a student withdraws mid-module, the full module fee applies.

EXAMINATIONS

Examinations will be taken on the dates given in the Assignment & Examination Timetable. The location for full time students will be at one of the three registering universities and for part time taught & distance learning students examinations can be sat in your work place or a local education facility (arrangements must be made through the Nuclear Programmes Office). Students must notify the office of their location preference at least 8 weeks in advance of the examination.

Students will be informed in advance by the module leader whether an examination is 'open' or 'closed' book. The general policy within NTEC regarding the use of calculators is specified in Appendix 7.

Arrangements for any re-sits required will be undertaken on a case-by-case basis.

Student discipline

The principles governing student discipline, where modules are being taken away from the student's registering university, are given in Appendix 5.

Plagiarism

Plagiarism is a serious academic offence and the consequences are severe. It is the un-referenced use of other authors' material in assignments and dissertations.

Fuller advice is given in Appendix 6. If further guidance is necessary, contact your academic tutor.

Data Protection

The Nuclear Programmes Office which is hosted by The University of Manchester, operates in accordance with the requirements and provisions of the latter in respect of the Data Protection Act 1998.

MODULE ASSESSMENT

In general each module will comprise three assessment elements, an in-module assignment, a post-module assignment and an examination. The contribution to the overall module marks from each element may typically be:

In-module assignment - 10%; Post-module assignment - 50%; Examination - 40%;

However this will be identified for each module on the pre-course material and students should ensure they obtain this information.

Pass marks

1. The pass mark for all modules is 50% and is the same for all levels of qualification. The marks for all assessed elements of a module are summated to derive the overall module mark.

2. By agreement with the student's Programme Director, a maximum of one re-submission of a post-module assignment (by rewriting the topic) and one re-sit of the examination will be permitted per module on a maximum of 2 occasions.

3. Students should be aware however that module examination re-sits and assignment resubmissions are not an automatic right. The School of Physics & Astronomy Committee of Examiners has the right to refuse an individual student a re-sit/resubmission opportunity if there is documented evidence that work and/or attendance have been unsatisfactory and if the student has received a formal warning and has not subsequently shown significant improvement.

4. Students may be awarded a compensated pass for a Masters degree when they fail no more than 15 credits and receive a mark between 40 and 49% for those failed credits. The student must also have gained an overall average for all taught credits of 50% or more in order to be granted the compensated pass.

5. Students may be awarded a compensated pass for a Postgraduate Diploma programme when they fail no more than 15 credits and receive a mark between 40 and 49% for those failed credits. The student must also have gained an overall average for all taught credits of 50% or more in order to be granted the compensated pass.

6. Students may be awarded a compensated pass for a Postgraduate Certificate programme when they fail no more than 15 credits and receive a mark between 40 and 49% for those failed credits. The student must also have gained an overall average for all taught credits of 50% or more in order to be granted the compensated pass.

7. The maximum mark that can be credited for a module which has been failed at the first attempt will be 50%.

8. Students who fail a re-sit or resubmission on any module will be considered to have failed that element of the course in its entirety.

9. Students taking a single module (CPD) who obtain a module mark of 70% or more will be awarded a pass with Distinction.

10. Students seeking a formal qualification who obtain an average module mark of 50%-59% will be awarded a Pass. Students seeking a formal qualification who obtain an average module mark of 60%-69% (and 60% on their dissertation if applicable) will be awarded a Merit. Students seeking a formal qualification who obtain an average module mark of 70% or more, (and 70% on their dissertation if applicable) will be awarded a Pass with Distinction.

11. Students seeking a formal qualification who have failed any module at a first attempt will not be eligible for consideration for their qualification to be awarded a Distinction.

Students will be notified of their provisional module marks by the Nuclear Programmes Administrator. Final marks will be notified following the annual meeting of the Examining Board, which usually takes place in October/November.

Appeals

In the event that a student is dissatisfied with marks for an assignment or examination, s/he should in the first instance address this with the Nuclear Programmes Office.

REGISTRATION & STUDENT SUPPORT

Following acceptance onto the programme, students will be given joining instructions by their university. Although direct teaching may not commence in the week when students register, all full time students must attend registration and Introduction to Nuclear Energy course.

Students must ensure that they take the opportunity on registration day to acquire all the information they need to undertake the course. They should pay particular attention to establishing contact with their personal tutor and project supervisor (if applicable). Arrangements for the method and frequency of contact with the tutor/supervisor should be confirmed.

During the induction period students should receive information on such topics as:

- An introduction to the programme
- The roles of NTEC and the registering university, including staff members
- What is expected of the student
- Advice on completing assignments
- Plagiarism
- The examination processes
- Preliminary information on the dissertation
- Student support
- The university library
- University internet resources
- Teaching and computing facilities
- Health and Safety

Students will receive copies of both their university handbook and the NTEC student handbook.

At least 4 weeks prior to registration, students should have agreed with their university the modules they will be taking during the academic year. This should be confirmed during registration. Modules have been grouped in streams to align with the anticipated interests of students (Appendix 2). It is NTEC's intention that students elect to take one or other of the two core sets of modules in its entirety. However if a student wishes to take an alternative mix of core modules, this is permitted with the agreement of his/her tutor and if the timetable allows.

Although staff from both the student's university and NTEC will make every effort to ensure that all necessary information and guidance is provided to the student, it is the student's responsibility to ensure that s/he has all the information required to undertake the course.

Contact details are given in Appendix 1. As a general rule, issues associated with personal academic progress and direction should be addressed to the student's registering university, and programme administrators. If in doubt, ask.

In the event of illness which may affect student's ability to attend taught weeks or examinations, or impact upon the timely submission of a post-module assignment, notify the Course Administrator immediately to agree alternative arrangements. Appropriate support documentation may be required such as a doctor's sick note.

NTEC Accreditation & requirements

The NTEC MSc is accredited by:

- The Institution of Engineering and Technology (IET)
- The Institution of Mechanical Engineers (IMechE)
- The Energy Institute (EI)
- The Institute of Materials Minerals and Mining (IoM3)

For students who wish to be accredited by the IET the following requirements must be obtained:

Where a module comprises of coursework and exam elements, successful completion of the module should require a minimum mark of 40% in each element if the element contributes more than 30% to the module mark.

In order for a student to graduate with an IET accredited qualification they will need to pass the final project at the first attempt.

- **APPENDIX 1**

NTEC CONTACTS – Steering Group and Nuclear Programmes Office

Name	Institution	Email	Telephone
Steering Committee			
Professor Jon Billowes	University of Manchester	j.billowes@manester.ac.uk	0161 2754104
Dr John Inkester	UCLan	JInkester1@uclan.ac.uk	01946 517230
Dr Steve Monk	Lancaster University	s.monk@lancaster.ac.uk	01524 592983
Professor Paul Nolan	University of Liverpool	pjn@ns.ph.liv.ac.uk NTEC Chair	0151 7943377
Dr Paul Norman	University of Birmingham	p.i.norman@bham.ac.uk	0121 4144660
Prof Claire Scudder	The Defence Academy	cscudder.cmt@nd.defenceacademy.mod.uk	02392 546010
Professor Philip Thomas	City University, London	p.j.thomas@city.ac.uk	020 70408110
Dr Mark Wenman	Imperial College London	m.wenman@imperial.ac.uk	020 75946763
Dr Karl Whittle	University of Sheffield	k.r.whittle@sheffield.ac.uk	0114 222 5484
Dr Bao Xu	University of Leeds	b.h.xu@leeds.ac.uk	0113 3432423
NTEC Administration			
Mrs Karen Burton	University of Sheffield	k.a.burton@sheffield.ac.uk	0114 222 5941
Miss Jo Chesters	University of Manchester	jo.chesters@manchester.ac.uk	0161 2754267
Mr Ishty Hussain	University of Manchester	ishty.hussain@manchester.ac.uk	0161 2754389
Mrs Janet Kennedy	University of Liverpool	jmk@liverpool.ac.uk	01517943713
Mrs Mel McLoughlin	University of Manchester	mel.young@manchester.ac.uk	0161 2754575

APPENDIX 1 NTEC CONTACTS - Module leaders

Module	Module leader	Email	Telephone
N01 Reactor Physics, Criticality & Design	Dr Paul Norman	pin@np.ph.bham.ac.uk paul_i_norman@yahoo.co.uk	0121 4144660
N02 Nuclear Fuel Cycle	Dr John Inkester	jinkester@uclan.ac.uk	01946 517230
N03 Radiation & Radiological Protection	Professor Jon Billowes	jon.billowes@manchester.ac.uk	0161 2754104
N04 Decommissioning / Waste / Environmental Management	Dr John Inkester	jinkester@uclan.ac.uk	01946 517230
N05 Water Reactor Performance & Safety	Professor Geoffrey Hewitt	g.hewitt@imperial.ac.uk	020 75945562
N06 Reactor Materials & Lifetime Behaviour	Prof Grace Burke	grace.burke@materials.ox.ac.uk	0161 306 4858
N07 Nuclear Safety Case Development	Mr Matthew Knott	mknott.cmt@nd.defenceacademy.mod.uk	02392 546162
N08 Particle & Colloid Engineering in the Nuclear Industry	Dr Bao Xu	b.h.xu@leeds.ac.uk	0113 3432423
N09 Policy, Regulation & Licensing	Professor Lynda Warren	lm.warren@btopenworld.com	07764 848230
N10 Processing, Storage & Disposal of Nuclear Wastes	Dr Karl Whittle	k.r.whittle@sheffield.ac.uk	0114 222 5484
N11 Radiation Shielding	Dr Andy Boston	a.j.boston@liverpool.ac.uk	0151 7946776
N12 Reactor Thermal Hydraulics	Dr Simon Jewer	sjewer.cmt@nd.defenceacademy.mod.uk	02392 546063

APPENDIX 1 NTEC CONTACTS (continued)

Module	Module leader	Email	Telephone
N13 Criticality Safety Management	Mr Kirk Atkinson	katkinson.cmt@nd.defenceacademy.mod.uk	02392 546074
N14 Risk Management	Professor Philip Thomas	p.j.thomas@city.ac.uk	020 70408110
N21 Geological Disposal of Radioactive Wastes	Ms Alison Robinson	ajrrobinson@uclan.ac.uk	01772 893520
N23 Radiological Environmental Impact Assessment	Mr John Robertson	John.robertson@nucleustraining.co.uk	01900 605665
N29 Decommissioning Technology & Robotics	Dr Stephen Monk	s.monk@lancaster.ac.uk	01524 592983
N30 Design of Safety-Critical Systems	Dr Amos Dexter	a.dexter@lancaster.ac.uk	01524 593085
N31 Management of the Decommissioning Process	Professor Colin Bayliss	colinbayliss50@btinternet.com	01491 873659
N32 Experimental Reactor Physics (PT)	Dr Jan Rataj	jan.rataj@fjfi.cvut.cz	
N32 Experimental Reactor Physics (FT)	Professor Helmuth Böck	boeck@ati.ac.at	+431 58801 14168

APPENDIX 2 MODULE STREAMS

CORE MODULE GROUPS

Decommissioning
- N04 Decommissioning / Waste / Environmental Management
- N10 Processing, Storage & Disposal of Nuclear Wastes
- N29 Decommissioning Technology & Robotics
- N31 Management of the Decommissioning Process

Reactor Technology
- N01 Reactor Physics, Criticality & Design
- N02 Nuclear Fuel Cycle
- N03 Radiation & Radiological Protection
- N13 Criticality Safety Management

ELECTIVE MODULES – SUGGESTED STREAMS

Decommissioning
- N08 Particle & Colloid Engineering in the Nuclear Industry
- N09 Policy, Regulation & Licensing
- N14 Risk Management
- N21 Geological Disposal of Radioactive Wastes
- N23 Radiological Environmental Impact Assessment
- N30 Design of Safety-critical Systems

Environment & Safety
- N07 Nuclear Safety Case Development
- N09 Policy, Regulation & Licensing
- N10 Processing, Disposal & Storage of Nuclear Wastes
- N14 Risk Management
- N21 Geological Disposal of Radioactive Wastes
- N23 Radiological Environmental Impact Assessment

Reactor Technology
- N05 Water Reactor Performance & Safety *
- N06 Reactor Materials & Lifetime Behaviour
- N09 Policy, Regulation & Licensing
- N11 Radiation Shielding
- N12 Reactor Thermal Hydraulics
- N14 Risk Management
- N30 Design of Safety-Critical Systems
- N32 Experimental Reactor Physics**

NOTE: Core modules may, subject to timetabling restraints, be taken as electives if required.
*Dependent on relevant prior learning, it is suggested that N12 be taken before attempting N05
**N01 must have been taken before attendance on the N32 module.
*** N03 must be taken before attendance on the N23 module.

APPENDIX 3 MODULE SUMMARIES

CORE MODULE GROUPS

Decommissioning

N04 Decommissioning / Waste / Environmental Management
Examines and explains the process of decommissioning and considers how the related requirements should be taken into account in plant and equipment design. It establishes the requirements of the decontamination and clean-up process. The principles of the disposal and storage of nuclear waste are identified. The module covers the environmental principles underpinning the management of nuclear waste. A module information pack giving learning objectives, introductions and a timetable, and a printout based upon powerpoint slides used in the lecture are supplied with this module.

N10 Processing, Storage & Disposal of Nuclear Wastes
Reviews the basic approaches to nuclear waste management and introduces the fundamental principles of nuclear waste processing, storage and disposal. The main types of waste and schemes for their processing and packaging are discussed highlighting cementation and vitrification immobilisation technologies. A manual is supplied with this module.

N29 Decommissioning Technology & Robotics
The aim of this module is to provide an ability to design and plan an effective decommissioning programme. Topics covered include strategies for effective decommissioning, techniques of decommissioning economics, project assessment and management, costing and analysis. Techniques for material cutting and waste minimisation, manual techniques, human exposure and protection are included with elements of robotic systems and their integration and control. A CD is supplied with this module.

N31 Management of the Decommissioning Process
Introduces the importance of making a sound case for a particular project to proceed. It covers both the financial and economic evaluation of projects, drawing the distinction between pure financial parameters and the broader economic cost benefit analysis approach. The course module goes on to cover the management of individual projects using modern proven project management techniques with case studies and real examples. A manual is supplied with this module.

Reactor Technology

N01 Reactor Physics, Criticality & Design

After reviewing the history of the industry, different reactor designs are considered together with an overview of their basic features. Reactor physics are examined in some depth, including nuclear physics, reactor physics, criticality and radioactive decay. Reactor control and safety, accidents and risk assessment, containment and core layout and end of life issues are reviewed, concluding with consideration of advanced reactor design. No manual is supplied with this module.

N02 Nuclear Fuel Cycle

Describes the nuclear fuel cycle from the extraction of ore to disposal of waste and examines in detail, the technical, economical, safety and environmental issues involved during each stage. The processes involved in reprocessing of fuel are examined and the consequences reprocessing has, in terms of reactor fuel design and waste disposal, are discussed. Each stage is described on an international scale examining global markets and capacities. A manual is supplied with this module.

N03 Radiation & Radiological Protection

Explains the different types of radiation occurring as a result of the nuclear process and identifies means whereby levels of radiation and dosages can be detected and measured. The principles of radiation protection and design of shielding & containment facilities are outlined and the module concludes with an overview of regulations and legislation governing the impact of radiation on people and the environment. A manual is supplied with this module.

N13 Criticality Safety Management

Provides a comprehensive introduction to nuclear criticality safety and the management of nuclear criticality safety in facilities, or situations, where fissile materials are encountered outside a nuclear reactor. This module, recently updated to reflect the core competencies specified by the United Kingdom Working Party on Criticality (WPC), consists of a basic nuclear reactor physics and fuel cycle pre-course reading component (mandatory for students who have not yet completed the N01 module) and a one-week taught component which includes a presentation from a visiting lecturer from industry/government, and a crash-course in the use of a Monte-Carlo code (i.e. MONK) for criticality safety analysis. The taught component is followed by a challenging post-course criticality safety assessment that is designed to consolidate knowledge gained during the course and to enable students to join industry with a solid understanding of the criticality safety process.

ELECTIVE MODULES – SUGGESTED STREAMS

Decommissioning

N08 Particle & Colloid Engineering in the Nuclear Industry
Knowledge of particle science is important in a number of technology areas of relevance to the nuclear industry. Particles are used and manipulated throughout the whole nuclear fuel cycle; process improvements are therefore strongly dependent on an understanding of particle behaviour under different conditions. This module covers all aspects of particle technology that can be considered relevant for the modern nuclear industry. Examples of where particles are relevant within the nuclear fuel cycle are used to highlight the central importance of this topic area to a nuclear engineer or scientist. A folder containing lecture notes and technical papers are supplied with this module.

N09 Policy, Regulation & Licensing
The nuclear industry is one of the most heavily regulated industries in the UK. Regulatory issues necessarily impact upon the development of national policy in environmental and energy areas. This module covers the Nuclear Installations Act, licensing issues, Radioactive Substances Act - Discharge Authorisations, transport of radioactive material and addresses UK radioactive waste policy and national strategies within this framework. Regulators outside the UK are covered briefly.

N14 Risk Management
Introduces the concepts of risk management by reference to nuclear and other systems. Describes the mathematical analysis of risk based on probability modelling, which is extended to the case of quality modelling. A case study based on the Chernobyl accident is presented. Comparisons of risk management across industries are presented, including engineering contracting, rail transport, chemical process and pharmaceuticals as well as nuclear. Handouts are supplied with this module.

N21 Geological Disposal of Radioactive Wastes
This module will examine historic and current UK developments in radioactive waste management and will introduce both geology and hydrogeology to the student. Shallow and deep methods of geological disposal and the multi-barrier concept will be investigated using UK and overseas case studies. Techniques of investigating the suitability of sites for geological disposal will be covered together with the correct recording methodology for soil and rock description. For both types of geological disposal the near and far-field processes will be considered; as will geohazards in relation to geological time.

N23 Radiological Environmental Impact Assessment
This module covers:

- Overview and basic concepts of Radiological Environmental Impact Assessment (REIA)
- Atmospheric Dispersion Modelling
- Deposition Processes
- Exposure Pathways I Airborne and Deposited Activity
- Exposure Pathways II & III Foodstuffs, Marine Pathways
- Marine Dispersion Modelling
- Environmental Radiation Monitoring
- Radioactive Discharges in the UK – a Perspective
- Regulatory Issues and International Perspectives

*** The N03 module (Radiation & Radiological Protection) is a prerequisite for this module.**

N30 Design of Safety-critical Systems
Provides students with knowledge of the design issues relevant to safety-critical systems. Topics included cover safety standards relevant to the design of engineering systems, and the IEC 61508 Safety Lifecycle and the implementation of the various steps of the process. Hazard identification and analysis techniques such as FMEA, HAZOP, and fault trees are also addressed. A CD of notes is supplied with this module.

Environment & Safety

N07 Nuclear Safety Case Development
This module describes the statutory framework that regulates the nuclear industry and the overriding requirement to demonstrate, through an adequate and appropriate safety case, that all hazards associated with operations are effectively managed and controlled. It examines the fundamental building blocks of a 'modern standards safety case' and the supporting processes and methodologies used in developing them. No manual is supplied with this module.

N09 Policy, Regulation & Licensing
The nuclear industry is one of the most heavily regulated industries in the UK. Regulatory issues necessarily impact upon the development of national policy in environmental and energy areas. This module covers the Nuclear Installations Act, licensing issues, Radioactive Substances Act - Discharge Authorisations, transport of radioactive material and addresses UK radioactive waste policy and national strategies within this framework. Regulators outside the UK are covered briefly.

N10 Processing, Storage & Disposal of Nuclear Wastes
Reviews the basic approaches to nuclear waste management and introduces the fundamental principles of nuclear waste processing, storage and disposal. The main types of waste and schemes for their processing and packaging are discussed highlighting cementation and vitrification immobilisation technologies. A manual is supplied with this module.

N14 Risk Management
Introduces the concepts of risk management by reference to nuclear and other systems. Describes the mathematical analysis of risk based on probability modelling, which is extended to the case of quality modelling. A case study based on the Chernobyl accident is presented. Comparisons of risk management across industries are presented, including engineering contracting, rail transport, chemical process and pharmaceuticals as well as nuclear. Handouts are supplied with this module.

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Overview and basic concepts of Radiological Environmental Impact Assessment (REIA)
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Environmental Radiation Monitoring
Radioactive Discharges in the UK – a Perspective
Regulatory Issues and International Perspectives

*** The N03 module (Radiation & Radiological Protection) is a prerequisite for this module.**

Reactor Technology

N05 Water Reactor Performance & Safety

Water reactors are likely to be the main source of nuclear power for the foreseeable future. This module considers such reactors with particular reference to their performance and safety and commences with an understanding of water reactor hydraulics, heat transfer and fuel design. The main codes for predicting reactor safety (RELAP, TRAC, CATHARE, TRACE) will also be described as will CFD methods, the latter in the specific context of the generic commercial code, STARCD. Hands-on experience with codes is given. Finally, accidents beyond the design basis ("severe" accidents) are discussed. Handouts are supplied with this module.

***Dependent on relevant prior learning, it is suggested that N12 be taken before attempting N05**

N06 Reactor Materials & Lifetime Behaviour

After examining the structure of materials, corrosion and degradation, factors in the selection and usage of different materials for reactor components are considered. Pressure vessel and fracture mechanics, non-destructive testing, plant monitoring and lifetime issues including the various mechanisms encountered are reviewed. Also considered is the specification and fabrication of materials for high reliability in aggressive environments. Handouts are supplied with this module.

N09 Policy, Regulation & Licensing

The nuclear industry is one of the most heavily regulated industries in the UK. Regulatory issues necessarily impact upon the development of national policy in environmental and energy areas. This module covers the Nuclear Installations Act, licensing issues, Radioactive Substances Act - Discharge Authorisations, transport of radioactive material and addresses UK radioactive waste policy and national strategies within this framework. Regulators outside the UK are covered briefly.

N11 Radiation Shielding
This module gives an introduction to radiation shielding merging practical problems with industry standard transport codes in order to give a good understanding of the requirements for radiation shielding. The subject of radiation shielding is introduced and solutions to the particle transport equation in the context of Monte Carlo and deterministic transport codes are illustrated. Simple shielding methods will be compared with sophisticated complex calculations in order to familiarise students with the essential concepts. As well as the core material, the course has four external lecturers who are experts in their respective fields. The use of Monte Carlo and Deterministic Codes will be presented in the context of industry needs and requirements. Shielding applications and the shielding design process will be discussed.

N12 Reactor Thermal Hydraulics
Describes the thermal hydraulic processes involved in the transfer of power from the core to secondary systems of nuclear power plants. Fundamental calculations associated with these processes will explained, examples set and results discussed. A manual is supplied with this module.

N14 Risk Management
Introduces the concepts of risk management by reference to nuclear and other systems. Describes the mathematical analysis of risk based on probability modelling, which is extended to the case of quality modelling. A case study based on the Chernobyl accident is presented. Comparisons of risk management across industries are presented, including engineering contracting, rail transport, chemical process and pharmaceuticals as well as nuclear. Handouts are supplied with this module.

N30 Design of Safety-Critical Systems
Provides students with knowledge of the design issues relevant to safety-critical systems. Topics included cover safety standards relevant to the design of engineering systems, and the IEC 61508 Safety Lifecycle and the implementation of the various steps of the process. Hazard identification and analysis techniques such as FMEA, HAZOP, and fault trees are also addressed. A CD is supplied with this module.

N32 Experimental Reactor Physics
The module is based at the TRIGA low power research reactor facility of the Atomic Institute of the Austrian Universities in Vienna for full-time students. The module is based at the VR1 zero power reactor of the Czech Technical University, Prague for part-time students. Reactor neutronics and dynamics are demonstrated through experimental measurements of neutron fluxes, control rod calibrations, reactivity measurements and reactor power calibrations. An understanding and appreciation of the instrumentation and controls of a reactor are gained during the experiments and through hands-on operating experience at the reactor control panel. Safety aspects of reactor operation and fuel handling and inspection are emphasised.
* **The N01 module (Reactor Physics, Criticality & Design) is a prerequisite for this module.**

APPENDIX 4 CONSORTIUM MEMBERS

The University of Birmingham: Birmingham has more than 50 years of experience of teaching postgraduate courses related to the nuclear industry and applied and medical radiation physics. They have for some years liaised closely with industry and the regulators regarding course syllabus and delivery.

The University of Central Lancashire: The University of Central Lancashire offers an extensive range of nuclear education across all levels, including nuclear related technologies, decommissioning, leadership in the nuclear industry, programme controls and management, environment, and governance. Working closely with nuclear employers, these courses are delivered at our Preston and Westlakes campuses and nationally via our partner network. The courses are developed and underpinned by research in UCLan's John Tyndall Institute for Nuclear Research, Lancashire Business School and UCLan Centre for Sustainable Development.

City University, London: City University has a major research programme in risk and reliability in the aerospace, nuclear and medical fields. An emphasis is placed upon an interdisciplinary approach with the aim of supporting rational decision making across a variety of industries and activities. A Risk Management module is taught to students taking the M.Sc. in Energy and Environmental Technology and Economics.

Defence Academy, College of Management and Technology: The primary role of the Defence Academy is to deliver nuclear education and training to all service and civilian personnel appointed to the Defence Academy and to deliver nuclear accident procedure courses to service and civilian personnel associated with the transportation of nuclear material. The Defence Academy will use its full range of academic expertise, from a staff of almost 100, to provide the consortium with core modules on the nuclear fuel cycle and criticality safety management, and an elective module on reactor thermal hydraulics.

Imperial College London: Nuclear Technology and Nuclear Reactor Technology courses have been taught and continuously developed at Imperial over the past two decades. Around 1000 students have attended these courses which involve live reactor training on the UK's sole civilian research reactor. Imperial also offers the only course which teaches reactor technology and fuel production and processing from a chemical engineering viewpoint.

Lancaster University: Lancaster brings expertise in innovative nuclear course design including part-time industry-based schemes in Decommissioning and Safety Engineering involving modules in the Design of Safety-critical Systems and Decommissioning and Robotics Engineering.

University of Leeds : The BNFL-Leeds University Research Alliance in Particle Science and Technology provides a unique opportunity to produce multi-disciplinary teams capable of solving some of the complex problems that can arise in an industry as diverse as nuclear decommissioning or nuclear power generation. The alliance is a major contributor to the Institute of Particle Science and Engineering at Leeds with a large academic research team of 130.

REGISTERING UNIVRSITIES

University of Liverpool: The University of Liverpool runs over 20 masters training programmes in the Faculties of Science, Engineering and Medicine. A number of the programmes have been supported by EPSRC in the past with the development of computer aided learning being an important feature. The masters training programmes are completely integrated into the University quality assurance and are informed by the excellent research carried out within the University.

University of Manchester: The University has nuclear research activities in 10 departments covering aspects of materials, nuclear fuels, radiochemistry, radiation science, nuclear physics, nuclear medicine and environmental science. The university has considerable experience in industrially-focussed modular programmes and e-learning formats. Manchester has also established the Dalton Nuclear Institute to coordinate and grow its nuclear research capacity.

University of Sheffield: The Immobilisation Science Laboratory is a multidisciplinary team of 40 academic staff and researchers studying all aspects of waste immobilisation from waste generation to repository design. Its postgraduate taught courses examine the fundamental materials issues of waste management applied to wasteform processing and durability by vitrification, cementation and ceramication.

APPENDIX 5 STUDENT DISCIPLINE

1. The formal disciplinary body will be the student's registering university.

2. The module delivering institution has the authority to take immediate action if appropriate, such as exam cheating or plagiarism, and will advise the student's registering institution of the action taken and the reason.

3. The delivering institution will formally report to the student's registering university any activity which it thinks should be subject to disciplinary proceedings.

4. All such information will be routed to the student's registering institution via the Nuclear Programmes Office to ensure comprehensive student records are maintained.

5. Should a student wish to appeal against disciplinary proceedings, s/he will do so by following the complaints and appeals procedure of his/her registering university. The latter will liaise with the module delivering institution.

6. Students will not be disciplined twice for the same misdemeanour.

7. NTEC as a body has no disciplinary role but has a coordinating role and will oversee equity of student experience.

APPENDIX 6 PLAGIARISM

Plagiarism is the theft or use of someone else's work without proper acknowledgement, presenting the material as if it were one's own. Plagiarism is a serious academic offence and the consequences are severe.

Guidelines:

1. Coursework, dissertations and essays submitted for assessment must be the student's own work, unless in the case of group projects a joint effort is expected and is indicated as such.

2. Unacknowledged direct copying from the work of another person, or the close paraphrasing of somebody else's work, is called plagiarism and is a serious offence, equated with cheating in examinations. This applies to copying both from other students' work and from published sources such as books, reports or journal articles. Plagiarised material may originate from any source. It is as serious to use material from the World Wide Web or from a computer based encyclopaedia or literature archive as it is to use material from a printed source if it is not properly acknowledged.

3. Use of quotations or data from the work of others is entirely acceptable, and is often very valuable provided that the source of the quotation or data is given. Failure to provide a source or put quotation marks around material that is taken from elsewhere gives the appearance that the comments are ostensibly one's own. When quoting word-for-word from the work of another person quotation marks or indenting (setting the quotation in from the margin) must be used and the source of the quoted material must be acknowledged.

4. Paraphrasing, when the original statement is still identifiable and has no acknowledgement, is plagiarism. Taking a piece of text, from whatever source, and substituting words or phrases with other words or phrases is plagiarism. Any paraphrase of another person's work must have an acknowledgement to the source. It is not acceptable to put together unacknowledged passages from the same or from different sources linking these together with a few words or sentences of your own and changing a few words from the original text: this is regarded as over-dependence on other sources, which is a form of plagiarism.

5. Direct quotations from an earlier piece of the student's own work, if unattributed, suggests that the work is original, when in fact it is not. The direct copying of one's own writings qualifies as plagiarism if the fact that the work has been or is to be presented elsewhere is not acknowledged.

6. Sources of quotations used should be listed in full in a bibliography at the end of the piece of work and in a style required by the student's department.

7. Plagiarism is a serious offence and will always result in imposition of a penalty. In deciding upon the penalty the examining institution will take into account factors such as the year of study, the extent and proportion of the work that has been plagiarised and the apparent intent of the student. The penalties that can be imposed range from a minimum of a zero mark for the work (with or without allowing resubmission) through the down grading of degree class, the award of a lesser qualification (e.g. a pass degree rather than honours, a certificate rather than diploma) to disciplinary measures such as suspension or expulsion.

APPENDIX 7 USE OF CALCULATORS IN EXAMINATIONS

1. Electronic calculators may not be used in examinations unless specific authorisation for their use appears on the examination question paper.

2. All calculators must be battery-operated (or solar powered) and silent. Examination candidates are responsible for providing batteries for their calculators.

3. Calculators with facilities for storing and retrieving text are not permitted. Calculators, or other devices capable of acting as a calculator, which have a full range of alphabetic keys (i.e. A-Z) are not permitted; devices with keys in the range A-F for use with hexadecimal numbers are permitted.

4. Portable computers are not permitted.

5. Devices capable of communicating directly with other similar devices are not permitted.

6. Examining institutions may decide that there should be particular restrictions on calculators in individual examinations, or extensions to these provisions, where this is required by the subject matter or method of examination. Where this is the case, specific and clear instructions will be given in the rubric at the head of the examination paper.

7. Any candidate found using an unauthorised calculator in an examination will be reported for suspected cheating. The device will be immediately confiscated and the examining institution will be under no obligation to issue the student with a replacement device for the remainder of the examination

Nuclear Technology Education Consortium

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