NUCLEAR EDUCATION IN BRITISH UNIVERSITIES

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EXECUTIVE SUMMARY

This study is the second to be undertaken by the HSE-NII on the status of nuclear education in British universities and brings up to date the information contained in the report published on 17 October 2000.

Its purpose is not only to define the health of nuclear education in British universities but also provide a body of information which can be used to determine the way forward in nuclear education. Nuclear education being defined as that which is of interest to the regulated industry and the courses being those that contain more than the basics of nuclear structure that are inherent in a physical science degree such as Chemistry or Physics.

For this study, twenty-four universities were approached, including the twenty-two that were approached last time, and all responded. Twenty-two were found to be teaching nuclear topics. As far as is known, this covers all of the universities that are involved in teaching nuclear subjects; there are over 130 colleges and universities in the UK. As in the first study, information was also obtained from the Ministry of Defence establishment, HMS Sultan.

The study identified thirteen universities, including HMS Sultan, involved in postgraduate nuclear teaching; the first study identified twelve. The number of courses with a nuclear content also increased in the period between the two reports - from twenty-one to twenty-three. The total number of students experiencing nuclear education at the postgraduate level has remained constant at about 320 a year. The number of those following courses with more than 5% nuclear content has also remained the same at about 165. However, the numbers of those following courses that have a totally nuclear content has dropped from 82 to 72 a year if all postgraduate courses are considered and from 56 to 43 a year if only masters courses are considered. This study identified 5 postgraduate diploma or certificate courses and 4 masters courses that are entirely nuclear; the first study identified 3 postgraduate diploma or certificate courses and 5 masters courses.

Nuclear education at the undergraduate level remains at the level of taster modules within mainstream science degrees. The nuclear content of the final degree awarded ranges from <1% to 20% but the higher figure relates to only to one university and applies to only two or three students. Compared to the first study, there has been a slight increase in the number of universities teaching nuclear subjects at the undergraduate level, up from eighteen to nineteen, and an increase in the number of modules on offer, up from thirty-five to forty-three. The number of students having any nuclear content to their degree has increased slightly in the period between the reports from about 1300 a year to about 1460 a year whilst those having more than a 5% nuclear content to their degree has risen from about 310 a year to 360 a year. To these figures can be added those pertaining to HMS Sultan: eleven courses and 500 students, the latter being an increase of 100 from the first study. The data are not amalgamated with those from the universities as not all of the courses are relevant to civilians, not all are at degree level and those that are at that level are not part of a degree.

The facilities for nuclear teaching have remained largely unchanged since the first report. Many are over 25 years old, some even older, and although there are some new laboratories and equipment and some laboratories have been refurbished and kept up to date, quite a few are in their original state. There is only one civil research reactor in the country and the last remaining hot cells were closed several years ago.

Whilst, overall, the extent of nuclear teaching has been about maintained since the last report this is unlikely to continue for much longer. Already the level of nuclear teaching is very at low at many of the twenty-two universities and it is likely to disappear at seven of them in the next few years, principally because of staff retirements.

The report concludes that nuclear education is in a very fragile state and makes a number of recommendations aimed at realising an education capability that is commensurate with the needs of the industry.

I. INTRODUCTION

This study is the second to be undertaken by the HSE-NII on the status of nuclear education in British universities and brings up to date the information contained in the report published on 17 October 2000.

The format of the first report has been largely retained so that direct comparisons between the two can be made more easily. With the increasing trend toward modular postgraduate courses it seems more appropriate to examine postgraduate teaching in its entirety rather than just masters courses; the heading of "masters" used last year has been replaced by "postgraduate" this, and postgraduate certificate and diploma courses are now included. At the end of each university entry, significant changes that have occurred since the first report have been summarised in green if they herald good news and red if they are the harbinger of gloom. A summary of the findings, including comparisons with data from the first report, is given overleaf.

As before, the objectives of the study are essentially twofold:

- To determine the health of nuclear education in British universities
- To provide a body of information which can be used to determine the way forward in nuclear education.

It should be emphasised that nuclear education in this report is defined as that which is of interest to the regulated industry. The courses listed are those that contain more than the basics of nuclear structure that one would expect to find in a physical science degree such as Chemistry or Physics.

The study was carried out between October and December 2001.

Twenty-four universities were approached, including the twenty-two that were approached last time, and all responded. Twenty-two were found to be teaching nuclear topics - the same number as last time but a slightly different cohort as two universities had ceased nuclear teaching and two more had started. As in the first study, information was also obtained from the Ministry of Defence establishment, HMS Sultan. In the majority of cases the respondents were those that had contributed to the first report, so adding to the continuity of the entries as well as providing an inbuilt check on their veracity. As far as is known, all of the universities involved in nuclear teaching have been included; there are over 130 universities and colleges in the UK.

II. SUMMARY OF NUCLEAR EDUCATION

i) Postgraduate teaching

Table 1, overleaf, is a summary of postgraduate courses having some nuclear content.

The introduction of new funding arrangements, noted in the first report, brought changes that were not unexpected. The MSc in Applied Radiation Physics at Birmingham and the MSc in Radiation Physics at Queen Mary and Westfield both failed to attract Research Council funding and have closed. The former had 100% nuclear content and the latter 5-10%. In contrast, Liverpool secured a Masters Training Package for the MSc in Radiometrics as did Surrey for their MSc in Radiation and Environmental Protection; both courses have a 100% nuclear content. Loughborough also obtained a Masters Training Package for their new MSc in Analytical and Pharmaceutical Chemistry, which replaces the two MScs in Analytical Chemistry and Medicinal Chemistry. The nuclear content of the new course is about the same, at 5%, as each of the outgoing ones.

The trend towards modular courses, identified in the first study, continues. Apart from Liverpool and HMS Sultan, there is now also Birmingham, where the current PGCert will be offered as an MSc if there is sufficient demand, and Loughborough.

In 2000, twelve universities, including HMS Sultan, were involved in postgraduate nuclear teaching; today there are thirteen. Whilst Queen Mary and Westfield College has been lost, Hull and Lancaster have been gained.

The number of postgraduate courses with a nuclear content also increased in the period between the reports - from twenty-one to twenty-three. Birmingham lost the MSc in Applied Radiation Physics but gained the PGCert in Radioactive Waste Management and Decommissioning - both 100% nuclear. Queen Mary and Westfield College lost the MSc in Radiation Physics, 5-10% nuclear. Loughborough consolidated two MScs into one; the nuclear content remains the same at about 5%. Lancaster has introduced a new MSc in Safety Engineering with a maximum nuclear content of 65%. HMS Sultan has introduced a new PGCert/Dip course in Nuclear Reactor Chemistry, which is 100% nuclear. At Hull there is a nuclear input to two existing masters courses. Both contain typically less than 5% nuclear but that could rise to 33% if the project component of the course were a nuclear topic.

In the first study, five MSc courses with 100% nuclear content were identified. With the loss of the Applied Radiation Physics MSc at Birmingham, there are now four.

In contrast, the number of postgraduate courses below MSc level with a 100% nuclear content has increased from three to five. The additions are the PGCert in Radioactive Waste Management and Decommissioning at Birmingham and the PGCert/Dip in Nuclear Reactor Chemistry at HMS Sultan.

Over the period of the two reports, the total number of students attending postgraduate courses with any nuclear content has remained constant at about 320 a year, although the number of courses has increased from twenty-one to twenty three.

If those courses having a nuclear content greater than 5% are considered, then the student total remains unchanged at about 165 a year. There was a slight increase in the number of these courses from fourteen to fifteen.

If all the courses that have a 100% nuclear content are considered, then student numbers have dropped from 82 to 72 a year.

If only MScs that have a 100% nuclear content are considered then the numbers have dropped from 56 to 43 a year.

ii) Undergraduate teaching

Table 2, overleaf, is a summary of undergraduate courses having some nuclear content.

Nineteen universities, excluding HMS Sultan, offer a total of 43 undergraduate courses with some nuclear content. This is an increase of 1 university and 8 courses compared to 2000.

In 2000, seventeen courses, or just under half, were optional. The latest figures show that twenty-two courses, or just over half, are optional.

As was found in the first study, nearly all of the courses, whether compulsory or optional, are examined.

In 2000, the nuclear content of the final degree awarded ranged from<1% to 10%. Currently, it ranges from <1% to 20% but the higher figure relates to only one university, Hull, and only applies to 2 or 3 students.

The total number of students attending courses with a nuclear content has increased slightly from about 1300 a year to around 1460. The difference is mainly due to the introduction of nuclear teaching at Leeds and an increase in the popularity of existing courses at Surrey and Manchester. In addition there have been some other minor gains and losses. However, the percentage increase in the number of students (12%) fails to match the percentage increase in the number of courses (23%).

In contrast, and more importantly, the number of students taking a degree with a nuclear content greater than 5% has increased from about 310 a year to around 360.

To these figures can be added those pertaining to HMS Sultan. Although HMS Sultan has been included in Table 2 for completeness the data have not been amalgamated with the university data because not all the courses are at degree level and even those that are at that level are not part of a degree. In addition, not all of the courses are relevant to civilians.

As in 2000, HMS Sultan offers 11 stand-alone courses, lasting from a day to a year, and 5 of these are examined. The number of students attending these courses has increased from 400 a year to 500 a year.

iii) Facilities

The age and expected lifetime of the different types of experimental facilities varies from university to university and Table 3, overleaf, is a summary of the principal facilities.

Although many are over 25 years old, some even older, most have been refurbished at some stage during their lifetime and are serviceable for the foreseeable future.

There are some new facilities, for example the Accelerator Laboratory and Tandetron accelerator at Surrey; a few have been refurbished recently, for example the radiochemistry laboratories at Manchester and the Van de Graaff at Salford; but some, for example the 30 year old radiochemistry laboratories at Imperial, remain in their original state.

There is only one civil research reactor left in the country, the Imperial College CONSORT reactor at Silwood Park and in the last three years the only two hot cell facilities in universities have closed (at Salford and UCL).

iv) Future

Overall, it is anticipated that nuclear teaching will remain at about the present level for the next few years. However, beyond that it is likely to decline:

- At Strathclyde, nuclear teaching is expected to cease in 2002 or 2003 when the lecturer retires.
- At Swansea and Plymouth, nuclear teaching is dependent upon a visiting lecturer and is likely to last only another 3 years.
- At Loughborough, nuclear teaching seems dependent upon one Professor and when he retires it is likely that nuclear teaching will cease.
- At Leeds, the nuclear teaching is dependent upon support from industry and is unlikely to last beyond five years.
- At Bath, undergraduate teaching will decline and finally cease over the next few years following the move of one lecturer to another university and the retirement of another from undergraduate teaching. Proposals for a new course with a nuclear content have been shelved.
- At other universities, for example Birmingham, Salford and Manchester (Engineering Dept), nuclear teaching is dependent upon retired staff who continue to work part time.
- At Queen Mary and Westfield, nuclear teaching has ceased not only because of the failure to attract funding but also because of the ill health of the only lecturer with the necessary expertise and enthusiasm to pursue it.
- At De Montfort, following a decision by the university, nuclear teaching will effectively cease at the end of the academic year 2001/02. All of the radiochemistry teaching laboratories have already been closed and the research laboratories will close shortly. The introduction of a new undergraduate course with a significant nuclear content that was being mooted last year has been shelved. One nuclear physicist and the nuclear chemistry Professor have retired.

However, it is not all doom and gloom - there are some encouraging signs as well:

- At Birmingham, three more companies have joined the Partnering Agreement, taking the total to 11, to support the PTNR MSc and the recently introduced PGCert in Radioactive Waste Management and Decommissioning.
- At Lancaster, the new MSc in Safety Engineering has a strong nuclear option and in its first year is well supported by industry.
- At Liverpool, the number of students taking the Radiometrics MSc has increased from six in 1998 to fifteen in 2001 and the number of students taking modules has increased by over 40% in the last year.
- At HMS Sultan, a new course has been introduced; the PGCert/Dip in Nuclear Reactor Chemistry, and the total number of students attending courses has increased from 400 to 500 over the last year.
- At Surrey, there has been an increase in the nuclear content of some courses and an increase in the number of students taking them. With new facilities, the university anticipates that nuclear teaching will expand.
- At Manchester, there has been an increase in the number of undergraduate students pursuing the radiochemistry option. This is seen as a direct result of hosting the BNFL Centre for Radiochemistry Research. The university is considering establishing a School of Nuclear Sciences and has received HEROBIC money to establish the feasibility of this.

III. CONCLUSIONS

1. If nuclear education were a patient in a hospital it would be in intensive care.

2. Its health seems to depend more on the enthusiasm of individuals than the commitment of institutions.

3. Although nuclear courses are taught at 22 of the 130 or so universities in the UK the level of nuclear teaching is very low at many of them and at 7 teaching is likely to disappear in the next few years.

4. Compared to the number of science, engineering and technology students, those experiencing nuclear education constitute a woefully small percentage.

5. An increase in the number of courses with a nuclear content at both postgraduate and undergraduate levels has failed to produce a corresponding increase in the number of students.

6. There is a worrying decline in the already small number of students pursuing totally nuclear postgraduate courses.

7. Nuclear education at the undergraduate level has been reduced to the level of taster courses within mainstream science degrees.

8. In many universities the facilities for nuclear teaching, whilst serviceable, are old; such an image of decaying elegance is unlikely to attract students.

9. It seems unlikely that, unless action is taken, nuclear education will be robust and flexible enough to support the industry as it evolves

IV. RECOMMENDATIONS

1. Immediate action is needed; otherwise nuclear education will slowly disappear.

2. The nuclear industry needs to identify what competences it is going to need, in the short-term, as well as the medium- to long-term, and work with universities to ensure that courses are in place to meet those needs. That in-house training can be pursued in the absence of an external knowledge base is a non sequitur.

3. The focus of nuclear education should be on postgraduate courses as it is at this level that the main specialisation into disciplines of relevance to the nuclear industry occurs. Further, because of the way university funding operates it is far easier for industry to support or initiate postgraduate courses than undergraduate ones. The move towards modular postgraduate courses and the introduction of postgraduate certificates and diplomas should broaden the appeal of nuclear subjects and attract more students, but in the move away from masters courses, care needs to taken that quality is not compromised at the expense of quantity.

4. Every effort should be made to preserve, and even expand, nuclear teaching at the undergraduate level. Help may be given in divers ways, for example through visiting lecturers, assistance with projects or the donation of equipment. Whilst not educationally significant to the industry, these courses are invaluable in alerting students to the possibility of a career in the industry or postgraduate study in a nuclear discipline. Given the image that the industry has and the concerns already being articulated about the quality of applicants then the industry needs all the help it can get, and undergraduate modules should provide some.

5. Support should be given to the concept of a School of Nuclear Sciences, whether it be at Manchester or elsewhere. However, care should be taken to ensure that there is diversity and choice and that like the proverbial eggs, all the nuclear courses do not end up in one basket.

6. Investment in facilities should be made as this would not only help teaching directly but might also help attract students onto courses.

7. Other countries are facing a similar situation to the UK. International cooperation and collaboration should be pursued both in seeking ways to overcome the problem of declining nuclear education whilst needing to retain the competences necessary for the safe running of the industry and in establishing courses.

8. Whilst it is the responsibility of the industry to stimulate supply by increasing demand, Government could help by moving nuclear a little further up the agenda of Foresight and the Research Councils, for example.

TABLES

Table 1. Summary of postgraduate courses relevant to nuclear education.

UNIVERSITY	TITLE OF COURSE	NUMBER OF STUDENTS PA	NUCLEAR CONTENT OF COURSE
BIRMINGHAM	MSc Physics and Technology of Nuclear Reactors	5 -10	100%
	MSc Medical and Radiation Physics	10	55%
	PGCert in Radioactive Waste Management and Decommissioning	5	100%
CITY	MSc Energy and Environmental Technology and Economics	12	5%
	MSc Information Engineering	25	5%
	Radiation Protection*	6 – 10	17%
HULL	MBA Engineering Innovation	10	<5% typically (33% with project)
	MSc Advanced Materials, Processes and Manufacturing	10	<5% typically (33% with project)
IMPERIAL	MSc Environmental Diagnosis	15	15%
LANCASTER	MSc Safety Engineering (nuclear option)	15	65%
LIVERPOOL	MSc/PGDip/PGCert Radiometrics	15**	100%
LOUGHBOROUGH	MSc/PGDip/PGCert Analytical and Pharmaceutical Chemistry	12	5%
MIDDLESEX	MSc Occupational Health and Safety	30	1%
PLYMOUTH	Various MSc	45	5%
HMS SULTAN	MSc Nuclear Reactor Technology and Safety Management	3 – 8	100%
	4 PGCert/PGDip courses	24 - 34	100%
SURREY	MSc Radiation and Environmental Protection	20	100%
	MSc Medical Physics	25	50 – 75%
SWANSEA	MRes	15	5%
UNIVERSITY COLLEGE LONDON	MSc Radiation Physics	20 –25	50%

* Radiation protection is an optional module in the MSc programme for medical radiographers.

**60 - 70 students take MSc modules

Table 2. Summary of undergraduate courses relevant to nuclear education.

UNIVERSITY	TITLE OF MODULE	COMPULSORY	EXAMINED	NUMBER OF STUDENTS PA	PERCENT OF DEGREE
BATH	Nuclear industry case studies	Yes			<1%
BIRMINGHAM	Nuclear Power Plant	Yes	Yes	5 – 17	1%
	Fission and Fusion	No	Yes	35	
	Applied Nuclear Laboratory	No	Assessed by report	35	
CAMBRIDGE	Energy and Power Generation	No	Yes	35	<1%
	Power Station Simulation	No	Assessed by report	18	<1%
	Nuclear Power Engineering	No	Yes	16	2%
CITY	Nuclear Reactor Simulation and Control	No	Yes	6	5%
	Nuclear Energy	Yes	No	25	1%
DE MONTFORT	Applied Radiation & Nuclear Chemistry	No	Yes	20	2%
	Radiochemistry	Yes	Yes	50 - 70	<1%
	Medical Applications of Radioisotopes	Yes	Yes	100	<5%
	Radiopharmaceutical Chemistry	Yes	Yes	100	<5%
HULL	Lifecycle Engineering	No	Yes	10-20	3%
	Environmental Engineering	No	Yes	10-20	3%
	Final Year Project	Yes	Assessed by report	2-3	20%
IMPERIAL	Nuclear Reactor Technology	No	Yes	35	8%
LEEDS	Nuclear Process Engineering	Yes	Yes	35	3%

UNIVERSITY	TITLE OF MODULE	COMPULSORY	EXAMINED	NUMBER OF STUDENTS PA	PERCENT OF DEGREE
LIVERPOOL	Nuclear Power and Environmental Radiation	No	Yes	40 for all three courses	3%
	Nuclear Physics	No	Yes		3%
	Instrumentation for Radiation Detection	No	Yes		3%
LOUGHBOROUGH	Radiochemistry and Macromolecules	Yes	Yes	90	4%
	Radiochemistry and Physical Chemistry	No	Yes	20	
MANCHESTER	Introduction to Radioactivity and Radiochemistry	Yes	Yes	140	2%
	Nuclear and Radiochemistry	No	Yes	100	10%
	Nuclear Power Plant	No	Yes	30	7%
MIDDLESEX	Radioactivity, Measurement and Monitoring	Yes	Yes	20	<1%
	Environmental Radioactivity and Risk	Yes	Yes	20	<1%
	Radioactive Waste Disposal	Yes	Yes	30	<1%
	Radioactivity and Radioactive Decay	Yes	Yes	15	<1%
PLYMOUTH	Nuclear Power	No	Yes	45	
SALFORD	Nuclear and Particle Physics	Yes	Yes	70	4%
	Nuclear detector project	No	Assessed	4 - 8	2%
SHEFFIELD	Nuclear Reactor Engineering	No	Yes	35	<3%
SHEFFIELD HALLAM	Practical Application of Fracture Mechanics to fatigue and Environmentally Assisted Cracking	Yes	Yes	20	<1%
SOUTHAMPTON	Applied Nuclear Physics	No	Yes	25	5%
	Nuclei and Particles	Yes	Yes	65	5%
STRATHCLYDE	Nuclear Physics	No	Yes	20	6%

UNIVERSITY	TITLE OF MODULE	COMPULSORY	EXAMINED	NUMBER OF STUDENTS PA	PERCENT OF DEGREE
HMS SULTAN	A range of 11 courses below post-graduate level	Most are stand alone courses for SQEP training	5 are examined	>400 in total	100%
SURREY	Nuclear Physics	Yes	Yes	70 for this and the following two courses	3%
	Radiation Detection and Measurement	Yes	Yes		3%
	Nuclear Medicine Imaging	Yes	Yes		3%
	Nuclear Structure and Reactions	Yes	Yes	40	3%
	Radiation Biophysics	No	Yes	25	3%

Table 3. The number, age range and expected lifetime of nuclear facilities at universities

FACILITY	NUMBER	RANGE (years)	EXPECTED LIFETIME
Cyclotron	1	50	indefinite
Dynamitron	1	30	indefinite
Radiochemistry Labs	7	1 - 30	2005 - 2015
Research reactor	1	36	2010 - 2035
Van de Graaff	1	30	2005 -2010
Hot cells	0		
Tandetron accelerator	1	1	indefinite

APPENDIX 1

STATUS OF NUCLEAR EDUCATION BY UNIVERSITY

University of Bath
University of Birmingham
University of Cambridge
City University
De Montfort University
Heriot-Watt University
The University of Hull
Imperial College of Science, Technology & Medicine
Lancaster University
University of Leeds
University of Liverpool
Loughborough University
University of Manchester
Middlesex University
University of Plymouth
Queen Mary and Westfield College, London
University of Salford
University of Sheffield
Sheffield Hallam University
University of Southampton
University of Strathclyde
HMS Sultan
University of Surrey
University of Wales, Swansea
University College London

UNIVERSITY OF BATH

i) Postgraduate

No taught courses in nuclear subjects.

ii) Undergraduate

There are some modules on the Materials Science and Engineering course in the Department of Engineering and Applied Sciences which include examples and case studies from the nuclear industry. This degree is being phased out and will disappear over the next two years as the remaining students progress through their university careers; the final student cohort will graduate in 2003. The nuclear component of the course is less than 5%.

iii) Facilities

There are no nuclear specific facilities at the university but access can be gained to facilities at AEAT at Windscale or BNFL Magnox labs at Berkeley.

iv) Future

The teaching of nuclear subjects is likely to decline in the next few years.

v) Changes from HSE-NII report of 17 October 2000 to this report

- **The proposed course on Management of Materials, which was to contain some nuclear modules, has been shelved.**
- **With the departure of one lecturer and the retirement of another from undergraduate teaching, there are no longer any undergraduate research projects with a nuclear engineering content.**
- **From being a stable situation, it is now foreseen that the teaching of nuclear subjects will decline at Bath over the next few years.**

UNIVERSITY OF BIRMINGHAM

i) Postgraduate

The School of Physics and Astronomy offers two nuclear-related Masters courses one of which, the MSc in Physics and Technology of Nuclear Reactors (PTNR), is totally nuclear power oriented. The second course is in Medical and Radiation Physics (M&RP) and has a nuclear content of about 55%.

The PTNR MSc is taken by between 5 and 10 students a year, while about 10 students a year take M&RP. On both courses, students do practical work at the university and there is also a project. For PTNR this is usually done as a work placement in the nuclear industry. Both courses are full-time but recently the PTNR course has been re-written in a modular form so that it can be taken part-time and it is expected that it will also be available electronically for distance learning in the future.

A new Postgraduate Certificate in Radioactive Waste Management and Decommissioning started in 2001 and has currently attracted 5 students. The course has a 100% nuclear content.

ii) Undergraduate

The Department of Metallurgy and Materials delivers 10 hours of lectures on Nuclear Power Plant to 4th Year MEng students. Between 5 and 17 students a year take this module, which is compulsory and which is examined. There is no practical work associated with the lectures, which constitute about 1% of the degree.

The School of Physics delivers a number of nuclear courses:

An optional course of 24 hours of lectures on Fission and Fusion is taken in the last year of either the 4 year MSci or 3 year BSc programmes by about 35 students a year. It is examined. There is no directly linked practical work, but many of the same students also take the Applied Nuclear Laboratory course. This consists of 80 hours of practical work using the facilities in the MSc laboratory. Assessment is by written reports.

Some 100 2nd year students take a course in Nuclear Physics. About 75 3rd year students take the Nuclear and Particle Physics course and approximately 20 4th year students take the Nuclear Structure course.

iii) Facilities

An approximately 50 year old Cyclotron is available (another is being decommissioned). The 30-year-old Dynamitron is now solely dedicated to Boron Cancer Therapy. No end date is proposed for either machine. There is a laboratory for radiation measurement that was established 40 years ago but which has been constantly updated. In addition the Silwood Park reactor is used 1 day a year as part of the PTNR course.

iv) Future

In 1999, following EPSRC withdrawal of funding for the PTNR course, a Partnering Agreement was established comprising the university, the industry[1] and the Regulator (HSE-NII), that assessed the value of the course and put in place arrangements, including financial support, to secure its future. An earlier MSc course, Applied Radiation Physics ceased at the end of the 2000-2001 year following withdrawal of EPSRC support. However, the Partnering Agreement Steering Committee recommended training provision in Radioactive Waste Management and Decommissioning and a new Postgraduate Certificate course commenced in 2001 in its place. Should there be sufficient support for this new course it could grow into a Diploma or MSc in its own right. With these changes, nuclear teaching at Birmingham looks secure for the foreseeable future and there are prospects of expansion.

v) Changes from OECD Survey of 1998 to HSE-NII report of 17 October 2000

There was little or no change in the extent of nuclear teaching, the facilities available or the number of students taking nuclear courses.

vi) Changes from HSE-NII report of 17 October 2000 to this report.

- The PTNR course continues and three more companies, AWE, DML and W S Atkins, have joined the Partnering Agreement.
- A new post-graduate course in Radioactive Waste Management and Decommissioning has commenced.
- The Applied Radiation Physics MSc ceased at the end of the 2000-2001 year following withdrawal of EPSRC funding.
- Some reduction in the number of students applying to take postgraduate nuclear courses has been noted (the APR course accounted for 10-16 and the intake to the PTNR course has dropped from 8-10 to 5-10).

[1] BNFL, BNFL MAGNOX, BE, NNC, Rolls Royce Marine, AEAT, UKAEA, AWE, DML and WS Atkins.

UNIVERSITY OF CAMBRIDGE

i) Postgraduate

No taught courses in nuclear subjects.

ii) Undergraduate

The Department of Engineering offers three series of lectures with a nuclear content. All are optional but are either examined or assessed.

Energy and Power Generation is an optional 32 lecture course of which the optional nuclear power component is 4 lectures (4hours). About 35 students a year take this during the 3rd year of their BA as part of their Engineering Tripos Part IIA. It constitutes less than 1% of their degree but it is examined.

Power Station Simulation is an option which comprises of 2 lectures plus a one-day activity on reactor simulators. This is currently taken by 18 students a year during the 3rd year of their BA as part of their Engineering Tripos Part IIA. This constitutes less than 1% of their degree. Assessment is via a report.

The Department also offers a 12 lecture course, including 3 hours of practical work, on Nuclear Power Engineering. This option is taken by about 16 students a year in the 4th year of their MEng as part of their Engineering Tripos Part IIB. This constitutes about 2% of their degree and is examined.

iii) Facilities

The university has a counting laboratory, which is 30 years old and has a life expectancy of the foreseeable future. There is also access to simulators at Sizewell B.

iv) Future

It is anticipated that all three nuclear options will continue for the foreseeable future at the present level of tuition. From 2002-2003 the 12 lecture course on Nuclear Power Engineering will be available to students in both the 3rd and 4th years of the course.

v) Changes from OECD survey of 1998 to HSE-NII report of 17 October 2000

In 1998 Cambridge included all of their engineering undergraduates in the data of students taking nuclear relevant courses and so a direct comparison between the two surveys was impossible. However, as far as could be judged, the extent of nuclear teaching appeared to have been maintained over the two years, with possibly a slight increase in the number of students.

vi) Changes from HSE-NII report of 17 October 2000 to this report

- From 2002-2003 the Nuclear Power Engineering module will be extended to students in 3rd year of their course.

CITY UNIVERSITY

i) Postgraduate

The MSc in Energy and Environmental Technology and Economics, run by the School of Engineering, offers 10 hours of lectures on nuclear energy, technology and economics. In addition, there is a 3-day/22 hour module in risk management and a 3-day/22hour module on the decommissioning of large industrial plant, which includes 8 hours on nuclear decommissioning. The introduction to nuclear energy is compulsory and is examined. About 12 students a year take the MSc, the nuclear content of which is about 5%.

The MSc in Information Engineering run by the Department of Electrical, Electronic & Information Engineering has an optional 3 hours of lectures on nuclear reactor control, which are examined. 25 students a year attend in total, with about 10 taking the nuclear option. The latter constitutes 5% of the MSc.

The Department of Radiography runs a course on Radiation Protection about every other year, which comprises 45 hours of lectures. It can be taken either as an optional module in the MSc programme for medical radiographers or as a stand-alone short course. In both cases it is examined. The course caters for between 6 and 10 students and for those taking it as part of their MSc it constitutes about 17% of their degree.

ii) Undergraduate

The BEng (Hons) Electrical Engineering run by the Department of Electrical, Electronic & Information Engineering has 3 hours of lectures on nuclear reactor simulation and control. About 25 students per annum take the main course, with about 6 taking the nuclear option which is examined. The nuclear content of the degree for those that take the option is 5%.

The BEng (Hons) Mechanical Engineering run by the Mechanical Engineering and Aeronautics Department has 2 hours of lectures on nuclear energy. This is a compulsory part of the course but it is not examined. About 25 students per annum attend and the nuclear component constitutes about 1% of their degree.

iii) Facilities

Those pursuing the radiography course have access to a Radiation Physics lab, Medical Imaging suites and Dosimetry equipment, all of which are quite recent and are expected to last for at least 10 years. Otherwise, the university does not have any nuclear specific facilities. With the exception of the radiography students, who may do a dose related study on radiation use in hospitals, none of the students on the courses cited do any practical work for the nuclear options.

iv) Future

The extent of nuclear teaching is likely to remain as described for at least the next five years. The recent closure of the nearby Queen Mary and Westfield Radiobiology

Department has meant that lecturers for the Radiography course will have to be sought elsewhere.

v) Changes from the HSE-NII report of 17 October 2000 to this report.

- There has been a slight increase in nuclear content in the Energy and Environmental Technology and Economics MSc (formerly Energy Technology and Economics)
- The number of students enrolling on this course has decreased (from 16 to 12).

DE MONTFORT UNIVERSITY

i) Postgradtuate

No taught courses in nuclear subjects.

ii) Undergraduate

The Department of Chemistry offers a number of modules in nuclear related areas.

An optional module, which is examined, in Applied Radiation and Nuclear Chemistry is offered to final year undergraduates taking the BSc in Applied Chemistry. Currently about 20 students a year take this option, which is of 15 hours duration and constitutes about 2% of their degree. The module does not include any practical work.

A module on Radiochemistry, comprising 6 hours of lectures is delivered to between 50 and 70 2nd year undergraduates. This module, which is examined, is part of the compulsory Analytical Chemistry component taught on a number of BSc and HND courses. It constitutes less than 1 % of the degree.

A module on the Medical Applications of Radioisotopes is a compulsory, examined, component of the BSc in Biomedical Science. It is taken by about 100 students a year and constitutes less than 5% of their degree.

The 100 or so students a year taking the MPharm have to follow a course on Radiopharmaceutical Chemistry. This module, which is examined, constitutes less than 5% of their degree.

iii) Facilities

All of the Radiochemistry teaching laboratories have been closed and the research laboratories will be closed in October 2002.

iv) Future

Radiochemistry and nuclear chemistry will cease to be taught as of October 2002.

v) Changes from OECD survey of 1998 to HSE-NII report of 17 October 2000

In 1998, around 400 students were estimated to attend degree programmes including Radiochemistry lectures and practicals. In the later survey this figure had dropped to around 280. There was no change in the facilities available.

vi) Changes from HSE-NII report of 17 October 2000 to this report.

- **All of the Radiochemistry teaching labs have been closed. This is a loss of 8 hours for the module on Radiochemistry, 4 hours for the module on**

Medical Applications of Radioisotopes and 16 hours for the module on Radiopharmaceutical Chemistry for MPharm students.

- **The Applied Radiation and Nuclear Chemistry module has been reduced from 48 hours to 15.**
- **Plans to introduce a new degree based on the Applied Radiation and Nuclear Chemistry course has been shelved.**
- **The Radiochemistry research labs will be closed in October 2002.**
- **All Applied Radiation and Nuclear Chemistry teaching will cease in October 2002.**
- **One lecturer in nuclear physics and one Professor in nuclear chemistry have retired.**

HERIOT-WATT UNIVERSITY

i) Postgraduate

No taught courses in nuclear subjects.

ii) Undergraduate

A visiting lecturer from BNFL used to give 8 of the 24 lectures on the Nuclear Science and Technology module. With the departure of the main instigator and lead lecturer to another university this module has ceased.

iii) Changes from HSE-NII report of 17 October 2000 to this report.

- Following the move of the lead lecturer, the undergraduate nuclear module has ceased.

THE UNIVERSITY OF HULL

i) Postgraduate

The MBA Engineering Innovation includes lifecycle engineering of nuclear technology and risk in design of large plant, including nuclear. About 10 students a year take the course, which has a nuclear content of <5%. An extensive project forms part of the course and if a nuclear energy related topic is chosen then the nuclear content rises to about 33%.

The MSc in Advanced Materials, Processes and Manufacturing includes modules on environmental engineering and hence deals with risk and nuclear issues. About 10 students a year take the course, which has a nuclear content of <5%. This rises to about 33% if a nuclear energy related project or dissertation is undertaken.

iii) Undergraduate

Students have an option of pursuing modules in lifecycle engineering and environment engineering, both of which have a small nuclear component. Between 10 and 20 students a year choose these options, which gives their degrees about 3% nuclear content. Students may also choose a nuclear topic for their final year project. If they do, and currently 2-3 a year choose to, the nuclear component of their degree rises to about 20%.

iv) Facilities

There are no specialist facilities for teaching nuclear subjects.

v) Future

It is anticipated that nuclear teaching will at least continue at the current level for the foreseeable future.

vi) Changes from HSE-NII report of 17 October 2000 to this report

- The arrival of a lecturer with an interest in nuclear energy has made an impact at both post-graduate and undergraduate levels. The University of Hull did not feature in the report of 17 October 2000.

IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY & MEDICINE

i) Postgraduate

The Department for Environmental Science & Technology, within the Faculty of Life Sciences, offers an MSc in Environmental Diagnosis. This is based at Silwood Park in the Analytical Research Group and currently caters for about 15 students a year. The nuclear content of the MSc is about 15% and it contains 28 hours on Radioactivity and the Environment. The teaching is complemented by a five-month research project carried out in the field of radiochemistry. The projects are usually proposed by the industry or the regulatory bodies. In addition a 12 hour course on neutron activation analysis is provided to the Chemistry Department; this is also offered as a short course for PhD and MSc students.

As part of a wider programme focussing on research there are PhD programmes in nuclear criticality safety, reactor structural mechanics, radionuclides in groundwater and waste disposal engineering, and plasma physics.

ii) Undergraduate

An optional module in Nuclear Reactor Technology is offered by the Department of Mechanical Engineering to some 35 Final year undergraduates on the Master of Engineering (first degree) course. The course is examined and constitutes about 8% of the degree. There is a full day of practical work based around the Silwood Park reactor and visits to Oldbury power station and the British energy Oldbury Nuclear training centre.

Post-experience courses based on the undergraduate format are also available on an annual basis for industry and utilise the rector for 2-3 days.

iii) Facilities

The university has the only civil research reactor in the country, at Silwood Park, near Ascot, Berkshire. Apart from the 35 students on IC's own Nuclear Reactor Technology course, the reactor is used by about 10 students a year on the Birmingham MSc in Physics and Technology of Nuclear Reactors, 2-5 students on the Nuclear Advanced Course from HMS Sultan and about 30 students a year on the Surrey MSc in Medical Physics. The College is also working with Surrey to offer practical training for the MSc in Radiation and Environmental Protection and also with Lancaster for the nuclear component of the MSc in Safety Engineering. For all of these students, attendance at Silwood Park, which is typically one day, constitutes less than 1% of their degree.

Apart from teaching, the reactor is used on a commercial basis for sample irradiation and to offer a neutron activation analysis service. The reactor is 36 years old and has a further life expectancy of between 10 and 35 years, depending on the political climate and the ability to refuel it. Rated at 100kW thermal power, CONSORT is owned and operated by Imperial College of Science, Technology and Medicine. The reactor is used by companies within the nuclear field for a diversity of applications, such as uranium assay, criticality dosimetry support and isotope production. Use is

not limited to the nuclear industry alone and customers come from many fields including archaeology, the chemical industry and aerospace, to name but three.

The radiochemical laboratory and associated preparation and counting rooms date from 1971 and have not been refurbished. The instrumentation in the counting rooms dates from the 1980s. NAA is dependent upon the Silwood Park reactor.

iv) Future

It is hoped to update the radiochemistry labs and the facilities in them as soon as possible and to expand both teaching and research to encourage students with an interest in radioactive waste disposal and decommissioning.

There is a good level of industrial support, through visiting lecturers, for the undergraduate course and it is anticipated that this will run for at least a further 5 years. No expansion of nuclear teaching is predicted.

The CONSORT reactor has experienced difficult times and new sources of funding are being urgently sought by offering a wider range of training packages and commercial activities. Invitations are being extended to other universities for the reactor to become a part of Master Training Package initiatives. Fuel supply and reprocessing are being discussed with the UKAEA and DTI, following the closure of the research reactor fuel cycle area and associated plant at Dounreay.

v) Changes from OECD survey of 1998 to HSE-NII report of 17 October 2000

At the undergraduate level the number of students taking the Nuclear Reactor Technology module appeared to drop from about 60 a year to about 40 a year; the number of MSc students remained the same. The facilities available remained unchanged between the two surveys.

vi) Changes from HSE-NII report of 17 October 2000 to this report

- There has been a slight increase, from 12 to 15, in the number of MSc students.
- At the undergraduate level the number of students taking the Nuclear Reactor Technology module has decreased slightly, from 40 to 35, due to the introduction of alternative options in the final year.

LANCASTER UNIVERSITY

i) Postgraduate

The Department of Engineering has established a new MSc in Safety Engineering, which started in the academic year 2001. In addition to four compulsory modules associated with generic safety engineering, students take two modules relating to one of three industrial areas - rail, aerospace and nuclear. For nuclear, the modules are in Nuclear Engineering and Nuclear Safety. Each of the six modules consists of two one-week sessions of around 20 hours of lectures plus the equivalent of two weeks of practical/assessed course work. In addition to the six modules, students complete a six-month project. The nuclear content of the course thus varies from virtually nothing to about 65% for those choosing a nuclear subject for their project. About 15 students are taking the nuclear option in the academic year 2000-2001.

ii) Undergraduate

Undergraduate projects (undertaken on an individual basis in the third year and as a team in the fourth year) often comprise technologies or relevance to the nuclear field, including nuclear instrumentation and robotics.

iii) Facilities

The Physics Department possesses neutron sources. There is access to a hot cell at VSEL (Barrow) and the Research Reactor at Silwood Park. The Engineering Department has expertise in and access to Monte-Carlo simulation tools, including SRUGGLE and MCNPX.

iv) Future

It is anticipated that the teaching of nuclear subjects will grow at Lancaster. EPSRC funding is being sought for the MSc course and beyond that initial five-year support it is intended that the course will be self-financing.

v) Changes from HSE-NII report of 17 October 2000 to this report

- Introduction of a MSc in Safety Engineering with a potential significant nuclear content. About 15 students taking the nuclear option in 2000-2001.

UNIVERSITY OF LEEDS

i) Postgraduate

No taught courses in nuclear subjects.

ii) Undergraduate

The Department of Chemical Engineering runs a compulsory module on Nuclear Process Engineering for final year students taking BEng/MEng Chemical Engineering or Environmental Chemical Engineering, BEng Chemical and Mineral Engineering, Energy Engineering or Safety Engineering and BSc Process Technology. Currently about 35 students a year undertake the course, which comprises 22 hours of lectures and some 50 hours of study time and constitutes about 3% of the degree. The module, which does not include any practical work, is examined and also assessed through course work.

iii) Facilities

There are no specialist facilities for teaching nuclear subjects.

ii) Future

It is anticipated that the present level of nuclear teaching will remain about the same for about the next five years unless there is more help from industry.

iii) Changes from HSE-NII report of 17 October 2000 to this report

- The BNFL research alliance with the university has led to a visiting lecturer delivering an undergraduate module. The University of Leeds did not feature in the 17 October 2000 report.

UNIVERSITY OF LIVERPOOL

i) Postgraduate

The Physics Department offers short courses in Radiometrics. Fourteen one-week modules are available with each module consisting of about 40 hours of lectures and practicals. The courses are examined as part of a MSc, a PGDip or a PGCert; masters level CATS points are awarded. About 60 – 70 people a year attend the modules. They may be taken individually or in sufficient numbers to constitute a MSc, a PGDip or PGCert in Radiometrics. A PGCert in Decommissioning and Radioactive Waste Monitoring is also offered. The nuclear component of these courses is 100%. The 14 modules are currently being developed to include computer-aided learning and assessment. Three modules have been completed and the remainder should be complete within 4 years. At this point the modules will be available in part as distance learning courses. All modules are part of the CPD programme.

ii) Undergraduate

The Physics Department offers three nuclear options on the BSc or M.Phys in Physics: Nuclear Power and Environmental Radiation, Nuclear Physics and Instrumentation for Radiation Detection. The options, which are examined, consist of 30, 15 and 15 lectures respectively (about 150, 75 and 75 hours work including private study) and are delivered during the third or fourth year of the course. Up to 40 students a year take the options and if all three are taken they constitute about 10% of their degree. Practical and project work are part of the degree course and some practicals and projects, particularly in years 3 and 4, make significant use of nuclear instrumentation.

iii) Facilities

The university has a 4 year old radiochemistry laboratory, a 10 year old nuclear instrumentation laboratory, a 10 year old gamma detector laboratory, a 3 year old neutron detector laboratory and a 10 year old low background laboratory. All of these facilities have a life expectancy in excess of 10 years.

iv) Future

The life expectancy of the Masters level courses and the CPD programme is dependent upon demand from industry, which pays the attendance fees. Currently the numbers are increasing. The course has support of a Masters Training Package from EPSRC for the next 4 years. The life expectancy of the undergraduate modules are anticipated as being in excess of 10 years. Overall, it is thought that there would be a slight expansion in the teaching of nuclear subjects over the next 5 years.

v) Changes from the OECD Survey of 1998 to the HSE-NII report of 17 October 2000

The number of undergraduates taking the nuclear option dropped slightly from 50 in 1998 to 40 in 2000. The number taking the MSc in Radiometrics was recorded as 6 in 1998. A direct comparison between the two surveys is impossible because only the

number of students taking modules, rather than the MSc, were provided for the HSE-NII report. Between 1998 and 2000 a new radiochemistry laboratory and a new neutron detector laboratory were built. Overall, the teaching of nuclear subjects increased slightly in the two years.

vi) Changes from HSE-NII report of 17 October 2000 to this report.

- The number of students taking the MSc in Radiometrics has increased to 15 and the number taking modules has increased from 40-50 to 60-70.
- EPSRC Masters Training package has been obtained.
- Two more nuclear related undergraduate options are available.

LOUGHBOROUGH UNIVERSITY

i) Postgraduate

The MSc programmes in Analytical Chemistry and Medicinal Chemistry have been replaced by a Masters Training Package in Analytical and Pharmaceutical Chemistry. The Department of Chemistry offers three modes of study: i) one year full time study leading to a MSc; ii) part time study over 2 -5 years leading to a MSc or PGDip or PGCert; iii) participation in specific modules without necessarily progressing to a programme award. Radiochemistry is taught as part of the 20 credit Environmental module. A period of supported student learning precedes 8 hours of formal lectures, 2 hours of tutorials and 12 hours of laboratory work. Out of the 22 students following the course, 12 are taking Radiochemistry, which constitutes about 5% of the degree.

ii) Undergraduate

Radiochemistry is taught to undergraduates on the following BSc and MChem degree programmes: Chemistry, Chemistry with Analytical Chemistry, Chemistry with Forensic Analysis, Medicinal and Pharmaceutical Chemistry, Chemistry with Materials, Chemistry with Environmental Science and Chemistry and Sports Science.

During the second year a compulsory module, Radiochemistry and Macromolecules is taught. This consists of 9 hours of lectures, 12 hours of practicals and 2 hours of tutorials. Taken by some 90 students a year it constitutes about 4% of their degree.

During the third year there is an optional course on Radiochemistry and Physical Chemistry. This consists of 20 hours of lectures, 12 hours of practicals and 2 hours of tutorials. About 20 students a year take this course, which is examined.

iii) Facilities

The Radiochemistry labs are 35 years old, with a life expectancy of a further 15 years. The gamma radiation cell is also 35 years old and has a life expectancy of a further 10 years. The Department has access to the facilities at BNFL's Technology Centre (BTC) at Sellafield.

iv) Future

The extent to which nuclear subjects are taught is likely to remain the same for at least the next 5 years. However, the life expectancy of radiochemistry is very much dependent upon the principal lecturer – when he leaves it is anticipated that radiochemistry will close down.

v) Changes from OECD Survey of 1998 to HSE-NII report of 17 October 2000

There was little or no change in the throughput of students, the number of hours devoted to teaching radiochemistry at both masters and undergraduate levels or the facilities.

vi) Changes from HSE-NII report of 17 October 2000 to this report.

- Nuclear teaching at the postgraduate level is more secure with a Masters Training Package to support a new course with a range of qualification options.

UNIVERSITY OF MANCHESTER

i) Postgraduate

No taught courses in nuclear subjects.

ii) Undergraduate

The Department of Chemistry delivers an Introduction to Radioactivity and Radiochemistry (8 hours plus practical work) to some 140 1st year undergraduates. Some 120 2nd year undergraduates receive 8 hours of lectures plus practical work on F-element chemistry. Both of these courses, which are components of all BSc and MChem degrees, are compulsory and are examined; they each constitute about 2% of the degree. Final year students may elect to take a course in Nuclear and Radiochemistry (24 hours). About 100 a year choose this option, which is examined, as part of their BSc or MChem and which constitutes about 10% of their degree. About 15 students a year do a 24 week radiochemistry project and a further 20 do a 12 week one.

The School of Engineering offers an optional course module, which is examined, on Nuclear Power Plant (24 hours) to 3rd year BEng and MEng students. About 30 students a year take this option, which constitutes about 7% of their degree.

iii) Facilities

The Department of Chemistry hosts the BNFL Centre for Radiochemistry Research. The radiochemistry laboratories were refurbished in 2001, providing a "low active" laboratory and counting room and a suite of controlled laboratories. Experimental work can be carried out with up to 10 MBq alpha. Dedicated equipment includes alpha, beta and gamma counting, electrochemistry and luminescence spectroscopy. The School of Engineering does not have any specialist equipment for teaching nuclear subjects, although it has excellent general laboratory facilities and a vibrant Nuclear Engineering Research Group. There is access to the Calder Hall simulator.

iv) Future

In the Department of Chemistry, it is anticipated that the teaching of nuclear subjects, principally radiochemistry, will expand. In the School of Engineering the teaching of nuclear subjects is likely to remain fairly constant, with the present course good for at least 10 years. The possibility of expanding nuclear-related topics further, through the establishment of a School of Nuclear Sciences, is under consideration.

v) Changes from OECD Survey of 1998 to HSE-NII report of 17 October 2000

The OECD survey recorded 3 masters degrees a year being awarded. This was not apparent two years later. Apart from that, there was little or no change in the number of students taking nuclear courses. The facilities available remained the same but were due to be refurbished in 2000. The establishment of the BNFL Centre for

Radiochemistry Research in 1999 was expected to underpin this competence and promote a wider interest in nuclear subjects.

vi) Changes from HSE-NII report of 17 October 2000 to this report.

- Radiochemistry laboratories refurbished and new equipment installed.
- An increase from 70 to 100 final year students electing to take the Radiochemistry option.
- The length of Radiochemistry projects lengthened (from 12 weeks to 24 in one case and 2 weeks to 12 in the other) and an increase in the number of students doing them (from 10 to 15 and from 3-5 to 20 respectively).
- The establishment of a School of Nuclear Sciences is under consideration.

MIDDLESEX UNIVERSITY

i) Postgraduate

The School of Health, Biological and Environmental Sciences delivers 3hrs of lectures on Risk Management in the Nuclear Industry as part of the MSc in Occupational Health and Safety taken by about 30 students a year. There is also some MSc project work on radon.

ii) Undergraduate

The Department of Health, Biological and Environmental Sciences provides a course on Radioactivity, Measurement and Monitoring (3hours) and Environmental Radioactivity and Risk (4 hours) on the BSc in Environmental Science, which is taken by some 20 students a year. There is an input on Radioactive Waste Disposal (2 hours) to the BSc in Environmental Health, taken by about 30 students a year. Radioactivity and Radioactive Decay (4hours) is taught on the Foundation Science Course and there is also about 8 hours of practical tuition. About 15 students a year take this course. All the courses are compulsory and are examined. In addition there is some BSc project work on radon.

iii) Facilities

The university has a Low Level Radiochemistry Laboratory, which is 10 years old and in need of upgrading. There is various counting equipment ranging in age from new to very old but all with a life expectancy of at least 5 years.

iv) Future

The nuclear components of the courses are essential to them and will survive as long as the courses do. It is anticipated that the level of teaching of nuclear subjects might increase over the next five years. It is possible that the school could start radiation-related courses for paramedics. The university is also interested in initiating postgraduate radiological protection and health physics courses.

v) Changes from HSE-NII report of 17 October 2000 to this report

- No changes.

UNIVERSITY OF PLYMOUTH

i) Postgraduate

See below.

ii) Undergraduate

In the Department of Mechanical and Electrical Engineering, a visiting lecturer delivers a module on Nuclear Power (25 hours) to about 45 students a year who are following BSc, MSc and PhD degrees. The module is optional but it is examined; there is no practical work associated with it.

iii) Facilities

There are no laboratory facilities for nuclear work.

iv) Future

The course has been in existence for five years and is expected to last at least another three. The level of teaching of nuclear subjects is likely to remain the same for the foreseeable future.

v) Changes from HSE-NII report of 17 October 2000 to this report

- No changes

QUEEN MARY AND WESTFIELD COLLEGE, LONDON

i) Postgraduate

Following the failure to attract EPSRC funding and the ill health of the only academic with the necessary interests and qualifications, the course in Radiation Physics has ceased.

ii) Changes from HSE-NII report of 17 October 2000 to this report

- Failure to attract EPSRC funding has lead to closure of the Radiation Physics course that had run since 1957. Between 12 and 15 students a year took the course.
- Ill health of the only academic with the necessary experience and qualifications has meant that Radiation Physics will no longer be taught at QMW.
- Students wishing to pursue Radiation Physics are registered at UCL.

UNIVERSITY OF SALFORD

i) Postgraduate

The MSc in Analytical Chemistry contains about 17% radiochemistry techniques and also some modules on nuclear medicine. The course is not running in the academic year 2001 - 2002.

ii) Undergraduate

All students taking a Physics or Physics with… degree take a final year core module on Nuclear and Particle Physics, which contains a significant section on nuclear power. This is delivered in the Joule Physics Laboratory, School of Sciences and comprises 16 lectures and 8 tutorials. About 70 students a year take the module, which is compulsory and is examined. It constitutes about 10% of the final year, or about 4% of their degree. Those on the MPhys course have the option of a nuclear project (gamma and charged particle detection). This is taken by 4-8 students a year and at 36 laboratory hours accounts for about 2% of the degree.

There is also introductory material in the First Year course on Atomic and Nuclear Physics and some additional information in the medical physics options relevant to medical applications.

iii) Facilities

The (Cockroft) Radio Chemistry Labs are over 30 years old and have a life expectancy of a further 5 years. However, these may be reallocated unless new research programmes are forthcoming - the Centre for Radiochemistry Research at the nearby University of Manchester offers strong competition. There is a 5 year old activated carbon test rig with a life expectancy of 20 years and facilities for nuclear detector experiments that are 10 years old and can be expected to last for a further 10 years. The 30 year old Van de Graaff generator is being refurbished with a view to expanding its commercial work, mainly in the area of surface analysis using nuclear reaction analysis.

iv) Future

The present nuclear modules are regarded as being an essential part of a physics degree and should continue indefinitely. At the undergraduate level, consideration is being given to a course in Physics with non-conventional energies which would teach fission and fusion alongside wind and solar etc. A post-graduate course could be financed via a Masters Training Package, funded by the EPSRC. This could be run with the existing part-time staff but a serious commitment to the area would clearly involve new permanent staff.

v) Changes from OECD Survey of 1998 to HSE-NII report of 17 October 2000

The number of students and the extent of nuclear teaching were unchanged from the OECD survey. In terms of facilities, the OECD survey recorded the existence of a hot

cell which was listed as expected to last until 2000; it was closed that year. The 30 year old radiochemistry laboratories were also listed as expected to last until 2000 but were subsequently rescheduled to last until 2005. The 30 year old Van de Graaff generator was also predicted to last until 2000. Neither the activated carbon test rig nor the facilities for nuclear detector experiments were included in the OECD survey.

vi) Changes from HSE-NII report of 17 October 2000 to this report

- The Van de Graaff generator is being refurbished.
- Consideration is being given to a new undergraduate course with a substantial nuclear content.

UNIVERSITY OF SHEFFIELD

i) Postgraduate

No taught courses in nuclear subjects

ii) Undergraduate

The Department of Chemical and Process Engineering offers an optional module in Nuclear Reactor Engineering to 3rd Year Undergraduates taking the BEng or MEng degrees. The course provides a broad-base introduction to the theory and practice of nuclear reactors for power production About 35 students a year choose this option, which is examined but which does not contain any practical work. The course counts for 10 credits in the 3rd year out of a total of 120 credits for the year, ie less than 3% of their degree.

iii) Facilities

The university does not have any specialist facilities for teaching nuclear subjects.

iv) Future

The present option is expected to continue for the foreseeable future with the extent of nuclear teaching remaining the same as at present.

v) Changes from HSE-NII report of 17 October 2000 to this report

- No changes.

SHEFFIELD HALLAM UNIVERSITY

i) Postgraduate

No taught courses in nuclear subjects

iii) Undergraduate

The School of Engineering runs a course of interest to nuclear engineers, The Practical Application of Fracture Mechanics to Fatigue and Environmentally Assisted Cracking. For those pursuing a Materials degree, the course, taken in Year 3, is compulsory and is examined. About 20 students a year take the module which constitutes <1% of the degree. It is also available as a CPD course, with between 7 and 14 candidates a year taking it, in which guise it is not examined.

iv) Facilities

There are no nuclear specific facilities at the university although the School of Engineering has mechanical autoclaves which can simulate a PWR pressure vessel or boiler conditions. The equipment is over 20 years old but is considered likely to last for another 20 years. There is also access to facilities at AEA Risley. The School of Engineering has a number of research contracts with the nuclear industry in the areas of SCC, corrosion fatigue testing and modelling.

v) Future

It is considered that the nuclear content of courses will always remain a small percentage.

vi) Changes from HSE-NII report of 17 October 2000 to this report

- An undergraduate module of relevance to nuclear engineers has been running for some time but this is the first time details have been captured in a survey. Sheffield Hallam University did not appear in the 17 October 2000 report.

UNIVERSITY OF SOUTHAMPTON

i) Postgraduate

No taught courses in nuclear subjects.

ii) Undergraduate

Third year students on the BSc Physics and MPhys degrees can take a module on Applied Nuclear Physics (30 lectures of 45 min each) delivered by the Department of Physics and Astronomy. About 25 students a year choose this option, which is examined, but which does not contain any practical work. It constitutes about 5% of their degree.

The Department of Physics and Astronomy also delivers a compulsory module on Nuclei and Particles (30 lectures of 45 min each) to third year BSc Physics and MPhys students. About 65 students a year attend and this module constitutes about 5% of their degree. The module is examined but there is no practical work associated with it.

iii) Facilities

There are no specialist facilities for teaching nuclear subjects.

iv) Future

The optional course on Applied Nuclear Physics is seen as lasting for the foreseeable future. The compulsory module is an integral part of the degrees and will last as long as the degrees are offered.

v) Changes from HSE-NII report of 17 October 2000 to this report

- The Applied Nuclear Physics module is likely to continue for the foreseeable future; it was considered as only lasting another year or so before being subsumed into Applied Physics.

UNIVERSITY OF STRATHCLYDE

i) Postgraduate

No taught courses in nuclear subjects.

ii) Undergraduate

The Department of Physics and Applied Physics offers an option in Nuclear Physics (23 hours of lectures and 4 of tutorials) to 4th (Final) Year students on the BSc Physics, Applied Physics and Laser Physics courses. About 20 students a year attend. The option is examined and constitutes about 6% of the degree.

iii) Facilities

The university has beta, gamma and cosmic ray spectrometers, which are about 25 years old and have a life expectancy of a further 5. There are also two Rutherford Scattering machines of the same vintage. A more recent acquisition is a Moessbauer Spectrometer, which is only four years old and is expected to last for another 10.

iv) Future

The life expectancy of the nuclear option is dependent upon one academic and with his retirement in 2002 or 2003 module will probably terminate.

v) Changes from HSE-NII report of 17 October 2000 to this report.

- Previously it was anticipated that the nuclear option would last for another 5 years. It now seems as though the course will terminate when the principal lecturer of the nuclear option retires in 2002 or 2003.

Nuclear Department
HMS SULTAN
(Associated Institute of the University of Surrey)

i) Postgraduate

The Department offers a range of post-graduate courses:

MSc Nuclear ReactorTechnology and Safety Management
PGDip Nuclear Reactor Technology
PGDip / PGCert Radiological Protection
PGDip Nuclear Plant Engineering
PGDip /PGCert in Nuclear Reactor Chemistry (to be offered from May 02)

The MSc in Nuclear Reactor Technology and Safety Management lasts a full academic year (one module in each academic term) and is typically undertaken by between 3 and 8 students a year. Student performance is continually assessed and the course contains between 60 –100 hours of practical work. The course is offered in modular format and if students take this route they have up to 48 months to complete the degree.

A PGDip in Nuclear Reactor Technology is offered and run separately to the MSc course and is taken by 10-18 students a year. This stand-alone course is conducted over 26 weeks and of the total 1000 hours, 80 are devoted to practical work. As a precursor to the PGDip course, the Department is able to offer a Nuclear Preparatory Course, which lasts 460 hours and of which 60 hours are practical work, for students without the specific entry qualifications to join the PGDip course directly. Some 4-6 students a year take this route.

The Postgraduate Diploma in Nuclear Radiological Protection is offered in a modular format comprising 3 modules, each of 4 weeks duration, and a project usually conducted within the student's workplace. Students successfully completing all 3 modules and the project are eligible for the award of the PGDip. Successful completion of the first two modules and the project results in the award of Postgraduate Certificate in Nuclear Radiological Protection. About 8 students a year attend. The PGDip route comprises some 460 hours, including 80 hours practical work, plus the workplace project.

The Postgraduate Diploma in Nuclear Plant Engineering is awarded to students who successfully complete a course of study comprising the Nuclear Engineers Course (NEC), the Nuclear Technical Personnel Course (NTPC), and the pre-NTPC (a 4 week precursor to the NTPC). All 3 courses are available as separate modules and approximately 6-8 students per year complete the full PGDip course of study. The NEC is of 400 hours duration, including 30 hours practical work, plus a workplace project and constitutes about 40% of the PGDip. The NTPC is of 310 hours duration of which 40 hours are practical work.

The Nuclear Department is currently seeking validation from the University of Surrey for the award of a PGDip and PGCert in Nuclear Reactor Chemistry. The course will be offered in a modular format with module 1 comprising 12 weeks of lectures and

laboratory based study (a total of 460 hours) and module 2 a workplace project assessed through dissertation and oral presentation. Subject to formal validation the PGDip will be awarded to students successfully completing both modules 1 and 2. Students electing not to undertake module 2 but successfully completing module 1 will be eligible for the award of the PGCert.

ii) Other courses

In addition to the postgraduate courses detailed above, the Nuclear Department offers an extensive range of courses which are appropriate for SQEP training. Direct comparisons of training levels for these courses are difficult due to the specialist nature of much of the training but range from introductory through to graduate level. Some courses are offered to commercial clients including UKAEA and DML.

Course Title	Hours	Typical No. Students pa	Examined
Nuclear Introductory Course	75	120	Yes
Nuclear Introductory Short Course	39	12	Yes
Health Physics Nuclear Accident Response Course	40	10	No
Senior Health Physics Nuclear Accident Response Course	40	10	No
Nuclear Systems Designers Course	230	8	Yes
Nuclear Instrumentation Calibration Course	110	6	Yes
Nuclear Accident Procedures Course	40	140	No
Nuclear Accident Procedures Course (Transport)	40	100	No
Nuclear Site Safety Justification Course	40	54	No
Nuclear Vanguard Technical Mangers Brief	37	6	No
Nuclear Warship Support Course	350	50	Yes

iii) Facilities

The Nuclear Department has extensive lecturing, laboratory and training support facilities including an irradiation facility, a Pantatron, x-ray equipment, scanning electron microscope (SEM), neutron generator, and laboratories covering Radiochemistry, Chemistry, Physics, Engineering, Radiological Protection and Gamma Spectroscopy.

The Department also has a number of hi-fidelity reactor control room simulators and a 'telewall' reactor plant simulator. Most of the equipment is less than 2 years old, the exceptions being the Pantatron and the SEM which are over five years old. All the equipment has a life expectancy of at least another 10 years.

iv) Future

It is expected that all the courses listed above will continue for the foreseeable future with the breadth and depth of courses increasing as the Department expands its work in the Decommissioning and Safety Management fields. Bespoke courses will also be developed with industry as required.

v) Changes from HSE-NII report of 17 October 2000 to this report

- A new PGDip / PGCert in Nuclear Reactor Chemistry is due to start in May 2002.

UNIVERSITY OF SURREY

i) Postgraduate

The Department of Physics offers two MSc courses.

The MSc in Medical Physics comprises 258 taught hours, of which 109 are nuclear orientated, and 108 laboratory hours, of which 48 are nuclear based. In addition there is a three-month dissertation project and a significant fraction of the students take nuclear oriented projects. Overall, the nuclear content of the degree thus varies from just under half to about three-quarters, depending on project choice. The equivalent of about 25 full-time students a year take this degree.

The MSc in Radiation and Environmental Protection comprises 204 hours of teaching and 110 hours of practicals plus a three month dissertation. The equivalent of about 20 full-time students a year take the course, which has a 100% nuclear content.

ii) Undergraduate

As part of the MPhys/BSc degree courses in Physics, Physics with Nuclear Astrophysics and Physics with Medical Physics, the Department of Physics delivers 24 hours of lectures on Nuclear Physics, 12 hours of lectures on Radiation Detection and Measurement and 12 hours of lectures on Nuclear Medicine Imaging to 2nd year students. In addition students undertake 16 hours of practical work associated with these lecture courses. About 70 students a year attend these lectures and practicals, which are a compulsory part of their degree and which are examined. In addition there are two final year modules on Radiation Biophysics and in Nuclear Structure and Reactions, each comprising 20 hours of lectures. Thus, the nuclear content of the degree ranges from12-15%.

iii) Facilities

The University has state of the art Radiation Teaching Laboratories and Nuclear Physics Research Labs. There is a modern Neutron Irradiation Lab and modern Low Background Counting Facilities. All of these facilities have a long life expectancy. There is a new Accelerator Laboratory housing a new £1M 2MV Tandetron accelerator and associated 1 micron micro-beam. There is also access to the Imperial College Reactor at Silwood Park, other research reactors overseas and cyclotrons and accelerators both in the UK and overseas. The life expectancy of these facilities varies from uncertain to long.

iv) Future

The MSc in Medical Physics is popular and has a good life expectancy. The extent of nuclear teaching is likely to further expand over the next few years as increasing emphasis is being given to new developments in radiotherapy and nuclear medicine in response to the Government's directive to combat cancer. The Research Council funding for the MSc in Radiation and Environmental Protection is guaranteed until

2005/06. The nuclear oriented undergraduate courses are an integral part of the degrees and the level of contribution will remain as long as the degrees are offered.

v) Changes from HSE-NII report of 17 October 2000 to this report

- Research Council funding is guaranteed for the MSc in Radiation and Environmental Protection until 2005/06.
- There has been an increase, from 40 to 70, in the number of undergraduates taking the 2nd year MPhys/BSc Physics courses with a nuclear content.
- Two new final year undergraduate modules with a nuclear content, Radiation Biophysics and Nuclear Structure and Reactions are being offered. The nuclear content of the MPhys/BSc degree courses has consequently risen from 5-10% to 12-15%.
- There is a new Accelerator Laboratory housing a 2MV Tandetron accelerator and associated 1micron micro-beam.
- It is anticipated that the extent of nuclear teaching will expand over the next few years.

UNIVERSITY OF WALES, SWANSEA

i) Postgraduate

A visiting lecturer delivers a 20 hour module on the estimation and management of risk, including financial risk, insurance risk, investment risk and the risks associated with aspects of Nuclear Power on the MRes course. Typically 15 students a year attend and it forms about 10% of the taught part of the MRes degree ie about 5% overall. The module, which does not include any practical work, is optional but is examined.

ii) Undergraduate

No nuclear courses reported.

iii) Facilities

There are no laboratory facilities for nuclear work.

iv) Future

The module has been taught for the past five years and is expected to be taught for the next three. The extent of nuclear teaching is predicted as remaining at the current level for the foreseeable future.

vi) Changes from HSE-NII report of 17 October 2000 to this report.

- No changes.

UNIVERSITY COLLEGE LONDON

i) Postgraduate

The Department of Medical Physics & Bioengineering offers a MSc in Radiation Physics. The nuclear content of the course is estimated at being about 50% and topics such as interactions of radiations, detection of radiations, dosimetry etc are taught. All of these topics are compulsory and are examined. Usually 20 –25 part-time and full-time students enrol on the MSc each year.

ii) Undergraduate

No nuclear teaching reported.

iii) Facilities

The university has a radiopharmacy, which is 30 years old with an indefinite life expectancy. There are various detection systems, which are 20 years old and have a life expectancy of a further 10 years.

iv) Future

The course, which has been running since 1956, has been without Research Council support for a number of years, the recent application being unsuccessful, but with numbers remaining healthy it is anticipated that it will continue for the foreseeable future.

v) Changes from OECD Survey of 1998 to HSE-NII report of 17 October 2000

There was little or no change in the number of students and the extent of nuclear teaching over the period between the two reports. The hot cell listed in the OECD survey did not appear in the later survey and it is presumed that this was closed. Otherwise there were no changes in facilities.

vi) Changes from HSE-NII report of 17 October 2000 to this report

- With the termination of the MSc course in Radiation Physics at QMW (cf) students are registered at UCL.