Possible health risks due to ionising radiation in the Rutherford Building (formerly Coupland Building 1) at the University of Manchester

John Churcher[1]*, Don O'Boyle*[2]*, Neil Todd*[3]

June 2008

[1] Lecturer in Psychology, University of Manchester, 1979-2002 (retired), churcher@aulos.co.uk
[2] Lecturer in Psychology, University of Manchester, 1972-2003 (retired), djob100@orange.fr
[3] Lecturer in Neuroscience, University of Manchester (formerly Lecturer in Psychology, 1993-2005), neil.todd@manchester.ac.uk

This report is entirely the work of the authors. No other individuals or organisations have been involved in its preparation, other than in answering queries or providing requested information.

DISTRIBUTION:

Copies of this report have been sent to:

University of Manchester:

Professor Alan Gilbert	President and Vice-Chancellor
Mr Albert McMenemy	Registrar and Secretary and Head of Administration
Mr Norman B M Askew	Chairman of the Board of Governors
Professor Maynard Case	Associate Vice-President for Risk and Compliance
Professor Ian Stratford	Chairman of the Radiation Advisory Group
Professor Geoff Beattie	Head of the School of Psychological Sciences
Dr Nicholas J Merriman	Director of the Manchester Museum
Dr Timothy Westlake	Director Student Recruitment, Admissions & International Development
Dr Susan Robson	Director of Health and Safety Services
Mrs Diana L Hampson	Director of Estates
Dr Steven Bidey	Head of the Radiation Safety Unit and Radiation Protection Adviser
Dr Melanie Taylor	University Safety Advisor and Safety Team Manager
Dr James Peters	University Archivist

Health & Safety Executive:

Dr Mike Weightman	HM Chief Inspector of Nuclear Installations
Dr Joanne Nettleton	Head of Defuelled Reactor Safety (formerly HM Specialist Inspector [Radiation] of Health and Safety)

Universities & Colleges Union (UCU):

Dr Gregory Lane-Serff	President, University of Manchester UCU
Mr John Bamford	UCU Health and Safety Advisor.

Copies of the report excluding the Appendices are also being sent to former colleagues in the Department of Psychology and to others who have expressed an interest. A redacted version of the report, including Appendices but excluding items for which permission to publish has not yet been received, will be available on the web at:

http://www.drop.io/rutherfordbuilding

EXECUTIVE SUMMARY

1) The Rutherford Building at the University of Manchester, formerly known as Coupland Building 1, was found in 1999 to be radioactively contaminated and decontamination work was undertaken. The authors were at that time members of staff in the Department of Psychology, which had occupied part of the building for the previous 27 years.

2) After learning by chance about the contamination in 2001 we began trying to establish the extent of any health risk to which we, our colleagues and students, and other users of the building might have been exposed. We sought advice and information from the University's Radiological Protection Service (RPS), from other current and former staff of the University, and from the Health and Safety Executive (HSE). Appended to this report are the minutes of our meetings with staff of the RPS, correspondence, documents obtained from various sources, and other relevant material.

3) There is anecdotal evidence that radiation levels in the building were monitored before 1999, but we have been unable to find any documentation of this. It is possible that relevant documents were accidentally destroyed. There is therefore uncertainty about historical levels of radioactive contamination. The radon measurements made in 2000-2002 do not provide a basis for estimating historical levels. Results of radiochemical analysis of waste removed from the building were consistent with radon having been generated over a long period of time by natural decay of radium left in the building by Rutherford and his co-workers in the early 1900s. Radiological surveys conducted in 1999-2002 may have been incomplete, and some rooms were not surveyed.

4) The building was inspected by HM Specialist Inspector (Radiation) of Health and Safety, who visited the site in June and July 2000. From the Inspector's report it appears that she did not meet any representative of the Department of Psychology, and that she was given the impression that most of the rooms that were found to be contaminated in the Department had been used for storage. In fact all of the contaminated rooms were used extensively by staff and students for many years.

5) Significant uncertainty therefore remains concerning the nature and extent of any health risk to former occupants of the building.

6) In view of this uncertainty, we recommend that the University commission an independent review of the existing evidence, of the possibility that the surveys made in 1999-2002 were inadequate, and of the feasibility of retrospectively assessing possible health hazards in the past, and that it review its procedures and arrangements for protecting current and future occupants of the building, and for ensuring that relevant documentation is preserved and remains accessible.

7) We also recommend that the HSE review its assessment of arrangements at the University of Manchester for protecting past, present and future occupants of the Rutherford Building from the effects of ionising radiation.

CONTENTS

1. INTRODUCTION

1.1. Background

This report is a record of our attempts to evaluate the possibility that we and our colleagues and students were exposed to a health risk during the period 1976-1999 resulting from radioactive contamination of the building at the University of Manchester in which we were working as Lecturers in Psychology. The building in Coupland Street has recently been renamed the Rutherford Building, but from 1968 to 2006 it was Coupland Building 1. Before 1968 it was known as the Schuster Building, and originally as the 'New Physical Laboratories' when it was opened in 1900. Until the late 1960s it had been occupied by the Department of Physics, and between 1907 and 1919 it housed the laboratory where Ernest Rutherford and his collaborators made their pioneering studies of atomic structure. This work involved the use of radium (Ra226) and its decay products including radon gas (Rn222), as well as radioactive substances from the thorium (Th232) and actinium (U235) series. In the 1960s and 1970s staff of other Departments (*e.g.* Physiology, Education) used part of the building. From the mid-1970s until 1999 it was occupied partly by the Psychology Department and partly by the Manchester Museum. (See Appendix D).

An extension to the original building was opened in 1912, and there is historical and radiological evidence that work on radioactive substances was conducted at various locations within the complex of buildings which includes the original 1900 building and the 1912 extension. This report deals primarily with the rooms occupied by the Department of Psychology and located in the original building and its extension northwards as far as Bridgeford Street. From the information available to us it is unclear whether this represents the full extent of the area within which work with radioactive materials was taking place.

In the winter of 1999-2000 the Department of Psychology was asked to vacate the building on a temporary basis to facilitate its renovation. Because the move was expected to be temporary, academic staff were allowed to leave behind in their offices and laboratories anything to which they did not expect to require ready access. In February 2001 we discovered by chance that part of the building had been labelled a radiation hazard zone, and there was evidence that radiological measurements had been made. This was the starting point of the investigation documented in this report, as we tried to establish what had happened and why we had not been informed about it. Professor Geoff Beattie, then Head of the Department of Psychology, was kept regularly informed of what we were doing.

The investigation reported here had two phases. The first phase extended from February 2001 to June 2003, and it was initially our intention to produce a report by the end of 2003. However, by April 2003 two of us (JC, DO'B) had taken early retirement, and we were no longer able to meet easily. The work was time-consuming, it had to be done in our spare time, our resources were increasingly stretched, and eventually we shelved the project for about 4 years. The second phase extended from June 2007 to the writing of this report during the first half of 2008. We resumed the work in June 2007 shortly before the death from pancreatic cancer of our colleague Dr Hugh Wagner, who had taken early retirement. Dr Wagner had for more than 20 years occupied room 2.62 in the building. We are also aware that another colleague, Dr John Clark, who for some years occupied room 1.54 (directly below room 2.62

occupied by Dr Wagner), had died in 1992 of a brain tumour after taking early retirement.

According to a commemorative plaque on the wall of room 2.62, this was the location in 1908 of experiments by Ernest Rutherford and Thomas Royds on the helium nature of the α-particle (Rutherford & Royds, 1909). These experiments made use of substantial quantities of radon, typically the equilibrium quantity from about 140 milligrams of radium. As a result of work conducted in 1999-2000 by the University's Radiological Protection Service, we knew that this room was one of several which had remained contaminated with radium and its longer-lasting decay products including "radium D", i.e. radio lead (Pb210), and "radium F", i.e. polonium (Po210). We also found quantities of mercury beneath the floor there, as used in the Rutherford and Royds apparatus.

We have no direct evidence which would causally link the contamination to Dr Wagner's and Dr Clark's illnesses, but epidemiological data from underground miners (Darby *et al*., 1995) indicate a possible association between pancreatic cancer and cumulative exposure to radon[4], while other data (Loomis & Woolf, 1996) indicate an increased risk of both pancreatic and brain cancer with prolonged occupational exposure to a nuclear materials production plant. The death in 2006 of the Russian dissident Alexander Litvinenko has also made us aware of the extreme toxicity of polonium, its tendency to concentrate in soft tissues and organs rather than bone, and its tendency actively to disperse itself spatially over time, which could have implications for its distribution within the building (see Roessler, 2007; Icenhour, 2005). Estimating the risks to health from low levels of any type of ionising radiation is a complex and controversial question (see *e.g*. Brenner *et al.*, 2003; Wakeford, 2004), but given the primary contamination of the building, and in the absence of a clear understanding of the dynamics of the radiological environment created within it, it seems possible that the contamination may have contributed to the deaths of our colleagues.

Survey and decontamination work carried out between 1999 and 2002 showed that a number of other rooms in the building were also contaminated, and that there is good reason to believe that parts of the building are still radioactive. Documents that we obtained from the Health & Safety Executive in 2007 suggest that their Specialist Inspector, who inspected the site in June and July 2000, was not correctly informed by the University of the full extent of historical occupation of the building. We believe therefore that there remains some doubt about the health implications of the contamination. The authors of this report have all in the past occupied rooms which were established as being contaminated. Two of us (JC and DJO'B) occupied contaminated rooms for more than 20 years.

[4] Darby *et al*. present data on pancreatic cancer which demonstrates increased mortality with increasing cumulative exposure, at the $P<0.05$ level of statistical significance. For reasons that are not entirely clear, these authors then argue that this "seems likely to be a chance finding".

1.2. Aims of this report

Our aims in producing this report are:

1) to inform the University, and our current and former colleagues, of our investigation and of our grounds for believing that there remains some uncertainty about the nature and extent of ionising radiation to which staff, students and others using the building were exposed before 1999, and whether this may have affected their health;

2) to inform the Health & Safety Executive of the possibility that it may not have received accurate information from the University concerning the nature and extent of previous occupation of the building, and therefore of the risks to which previous occupants may have been exposed;

3) to assemble all the relevant documentation that we have been able to find, and to preserve and distribute it in such a way that it is likely to be available to any future enquiry;

4) to make recommendations to the University and to the Health and Safety Executive concerning the steps that should now be taken to protect the health and safety of former and current inhabitants of the building.

1.3. Structure of the report

We present first a brief account of our investigation, in roughly chronological order. We then make a number of observations about what we found. Finally we make some recommendations for consideration by the University and by the Health & Safety Executive. References are made throughout to Appendices which include the minutes of our meetings with the Radiological Protection Service, copies of correspondence that we entered into with various individuals and agencies, and copies of relevant documents that we obtained, including some correspondence between third parties.

2. FIRST PHASE OF INVESTIGATION (2001-2003)

2.1. Initial enquiries (February 2001 to June 2002)

In February 2001, accompanied by the Departmental Superintendent in Psychology (Mr Peter Harforth), one of the authors (JC) returned to his office on the second floor of the building (room 2.63, formerly D10) to recover some experimental equipment. He discovered that the room had been labelled a radiation hazard zone and left in a disordered state, with some floorboards lifted and not replaced. There were also markings to the floor and walls which suggested that local radiological measurements had been made. Mr Harforth remembered seeing a report by the Radiological Protection Service, which he thought might include details of measurements made by the Service together with a risk assessment. He undertook to obtain a copy, which Mr Churcher eventually received in June 2001. The report [see Appendix C9] contained information about measurements made in ground-floor rooms G54 and G55, but did not mention room 2.63 or any other room on the second floor. Mr Harforth then advised Mr Churcher to contact Mr Kevin Robinson of the Radiological Protection Service for further information.

In July 2001 Mr Churcher wrote to Mr Robinson and received a reply from Dr Steve Bidey, the University's Radiation Protection Adviser, who confirmed that radiological measurements had been made in room 2.63 in connection with remediation of contamination in the Building. Dr Bidey referred to a report dated 20th June 2000, giving details of potential radiation dose rates to personnel in each of the affected areas. In the case of room 2.63, low-level localised radium-226 contamination had been found in the wall above the hand wash basin, and measurements indicated that this would have resulted in a potential received dose of 0.26mSv per year, which was well within legal dose limit. He also indicated that the calculated potential doses had been submitted to the Health & Safety Executive, and accepted by their Specialist Inspector (Radiation) of Health and Safety as being well within the dose constraints. [See Appendix B1]

In October 2001 Mr Churcher wrote to Dr Bidey, requesting a copy of the relevant report, and pointing out discrepancies between the contents of his letter and what was evident in room 2.63, where a note had been left on the blackboard giving instructions to remove contaminated floorboards and look for radioactive lead (Pb-210) beneath them. In his reply Dr Bidey apologised for having given an incomplete picture in his previous letter, confirmed that Pb210/Po210 had been found beneath the floorboards in rooms 2.62 and 2.63, and gave details of the estimated dose attributable to this, which at 7.2×10^{-3} mSv per year "would have been negligible under the circumstance of normal occupational activity within this room." [See Appendix B1]

In May 2002 there were indications that further testing and remedial work had been carried out in room 2.63, and in June members of staff in Psychology were warned not to enter the lecture theatre on the same floor of the building. There followed some discussion among members of staff in Psychology, and a limited exchange of information with the Head of Conservation at the Museum, Velson Horie. Mr Churcher again contacted Dr Bidey for clarification. Meanwhile, Dr O'Boyle discovered both a radiation hazard warning notice and a written instruction not to enter on the door of his outer office (room 2.52, adjacent to the lecture theatre), and that radiation 'hotspots' had been marked on the carpet of his inner office (room 2.53)

directly below where he habitually sat at his desk. [See Appendices B2, B3]

The three of us (Mr Churcher, Dr O'Boyle, Dr Todd) then began working together to try to establish whether we and/or our colleagues had been exposed to any health hazards due to ionising radiation in the building. In July we wrote at length to Dr Bidey, reviewing the information we had received over the preceding year, noting various omissions and discrepancies, asking a number of questions for clarification, and requesting a meeting to discuss them. Appended to our letter were our own calculations of three possible contamination scenarios for rooms 2.62 (Dr Wagner's office) and 2.63 (Mr Churcher's office). [See Appendix B1]

2.2. Meetings with staff of the Radiological Protection Service (July & August 2002)

On 23rd July 2002 Mr Churcher and Dr O'Boyle met with Dr Bidey and Mr Robinson in Dr Bidey's office. In the course of this meeting we learned that the Radiological Protection Service have no record of radiological measurements in Coupland 1 prior to 1999. A considerable quantity of documents had been disposed of three years previously, due to shortage of space, and no record had been kept of which documents were destroyed. It therefore appears possible that historical documents concerning radiological measurements in Coupland I may have been among them. Further testing for contamination had been carried out in May 2002, prior to a planned temporary refurbishment of the building associated with its proposed temporary occupation by the Accommodation Office. Measured radon levels in some rooms prior to decontamination had exceeded the current Action Level of 200 bq/m^3 but Mr Robinson thought this might be due to a faulty instrument. The Radiological Protection Service were unaware of mercury (Hg) contamination that we had found under the floor of room 2.62, and we were told that this would be outside their responsibility. Full details of the meeting are given in the minutes. [See Appendix A1]

On 21st August a second meeting was held in Dr Bidey's office. Present were Dr Bidey, Mr Churcher, Mr J Duffy (University Estates Office); Dr O'Boyle; Dr D. Prime (Dr Bidey's predecessor, and Radiological Protection Officer for the University from 1976 to 1999). There was further discussion of the apparent absence of any records of radiological measurements pre-1999, and it was agreed that there is a gap in current legislation, which apparently makes no requirement for the maintenance of records of known radiological hazards for non-classified workers. There was further discussion of the reliability of those radon measurements which had exceeded the Action Level[5]. There was then an extended discussion of the possible health hazard due to radon, and of how it might be possible retrospectively to estimate radon levels in the building by various methods. It was agreed that we would draft some questions to be forwarded to NIRAS[6], the contractors responsible for identifying and removing the contaminated material from the building and for delivering it to BNFL[7], concerning the remedial measures and analysis of the waste removed as described in their report dated 18th August 2000. [See Appendices B4, C11]. Full details of this

[5] The level above which action to restrict resulting exposure is recommended or required.

[6] 'NIRAS' stands for 'NNC Independent Radiation Assessment Services', part of NNC Limited (now AMEC NNC Limited), and provides a commercial radiochemical analysis service.

[7] British Nuclear Fuels plc. The waste was delivered to the BNFL Low Level Waste Repository, Drigg, Cumbria

meeting are given in the minutes.[See Appendix A2].

2.3. Communication with the Manchester Museum (July 2002)

At the same time as writing to staff of the Radiological Protection Service requesting a meeting we approached staff at the Manchester Museum to see if they could help with our enquiries. On 10th July 2002 Dr O'Boyle spoke by telephone with Mr Velson Horie, Head of Conservation at the Manchester Museum. After consulting with the Director of the Museum (Dr Tristram Besterman) and with the Radiological Protection Service, Mr Horie recommended that we be briefed by the University's Health and Safety Services.

At a meeting with Mr Horie on 17th July, Dr O'Boyle learned that after evacuation of the building in January 2000, radiological testing of the building had been conducted prior to work starting on the Museum. New 'hotspots' had been found in areas belonging to the Museum, and as a result radiological testing was extended to the whole building, resulting in the detection of contamination and remedial work in rooms 2.62, 2.63 and Rutherford's laboratory (rooms G54 and G55). At some point the Health & Safety Executive were called in, and they specified that any work on the building which involved disturbing the fabric of the building in any way should be preceded by appropriate radiological testing. In May 2002, at the time of the re-wiring of areas of the building prior to occupation by the Accommodation Office, testing was conducted which revealed new 'hotspots' in rooms 2.53, 2.54 and the Cohen Lecture Theatre.[See Appendices B3, C22]

2.4. Correspondence with NIRAS

Following our meeting with staff of the Radiological Protection Service on 21st August 2002, we prepared some draft questions for NIRAS, requesting explanation of various apparent discrepancies in the documentation of their decontamination work. These were passed to Mr Duffy who wrote to NIRAS on this basis. In October he received a reply from Dr Stephanie Adams, author of the original NIRAS report, and after some delay this was copied to us. Dr Adams' letter referred to three relevant documents that we had not seen, despite our having been assured by the Radiological Protection Service that we had already been provided with copies of everything of relevance. We requested copies of these from the Service, which we eventually had by 4th December 2002. [See Appendix B4]

2.5. Radon measurements

Table 1 below gives a summary of measurements, assembled from the documents we have obtained, of radon levels in air taken on various occasions between 1999 and 2002. Results are given for six rooms occupied by Psychology staff including G54/55, which was Rutherford's laboratory, and 2.62/2.63, the location of the Rutherford and Royds experiment. For comparison we also give measurements taken from five rooms occupied by the Museum: CB.05, CB.09, CB.10, C 1.09 and C 1.10.

Table 1: Measurements of radon (Rn226) concentration taken before and after remediation in the Coupland 1 Building.

		June/July 2000	Jan/April 2001	May/Aug 2002	Aug/Nov 2002
MUSEUM	CB.05	**<286**	53 ± 42(#)	-	-
	CB.09	**<31**	<155	-	-
	CB.10	**<32**	<37	-	-
	C 1.09	**<274**	-	-	-
	C 1.10	**<38**	<44	-	-
PSYCHOLOGY	G54	**<31**	} <28	-	-
	G55	**<132**		-	-
	2.52	**<120**	} <135	-	-
	2.53*	**<33**		16.1 - 31.2	10
	2.54	**-**	**-**	**14.4 - 20.4**	20 - 30
	2.62	**<35**	63 ± 40(#)	10.5 - 20.4	60
	2.63	**<279**	<149	7.1 - 22.2	30
	Source:	*Appendices C6, C8*	*Appendices C17, C20*	*Appendix C23*	*Appendix C24*

All values are in Bq/m^3. Measurements taken before the remedial work to remove contamination are indicated in bold type, and those taken after remediation are in normal type. Values have not been corrected by subtraction of the mean domestic value of 21 Bq/m^3.

(*) In Appendices C23 and C24, room 2.53 is referred to as "room 2.52 inner room". It also appears that further contamination must have been found in this room, after the decontamination referred to in Appendix C17, since a handwritten note in Appendix C23 indicates that "Rooms 2.52 [*sic*] and 2.54 have had no remedial work carried out".

(#) In two cases, a recorded value is followed by a +/- value. This may refer to some form of estimated measurement error, but we have no information about what this might be.

There are a number of peculiarities about these results. First, except in the case of room 2.54, there is only a single measurement before remediation so there is no measure of reliability or means of obtaining one. Room 2.63 yields a value of 279 Bq/m^3, which is in excess of the EU 200 Bq/m^3 Action Level for domestic dwellings. Although we do not know how accurate this is, two of the rooms occupied by the Museum, CB 05 and C 1.09, also exceeded the EU domestic Action Level. Second, for the post-remediation reports there is a very considerable variation between the results obtained on different occasions, by an order of magnitude. E.g. for Room 2.63 the reports range from 7.1 to 149 Bq/m^3 ! Third, in some cases the post-remediation measures are actually higher than the pre-remediation measures. Clearly there is a considerable degree of uncertainty concerning the levels of radon contamination, both before and after remediation.

2.6. Measurements of other sources of ionising radiation

Measurements of non-radon alpha-activity in air, assumed to be mainly lead-210 and polonium-210 particles, and of gamma radiation, were made at most of the same locations in June & July 2000 (before remediation) and in January & April 2001 (after remediation). Post-remediation measurements were shown to be within 'safe' limits, but differences between the pre- and post-remediation measurements are in some instances quite large. In room 2.63, for example, non-radon alpha activity in air was 16 times greater before remediation; in rooms G54/G55 maximum direct gamma radiation was more than 300 times greater. As with the radon data, only a single pre-remediation measurement is available for each type of radiation at each location, so

that there is no measure of reliability on which to base an estimation of average historical levels. [See Appendices C7, C8, C17, C20].

2.7. Mercury contamination of room 2.62

While making our own inspection of room 2.62, we noticed a considerable quantity of mercury (Hg) lying on the upper surfaces of the ceiling plaster beneath the floorboards where these had been removed. The fact that this was not noticed or not reported by those responsible for removing the radioactive contamination, and the statement by Dr Bidey that if he had known he wouldn't have regarded it as his responsibility, suggests a dangerous lack of joined-up thinking about health and safety. We informed the University's Health and Safety service and later received an assurance from the Faculty Safety Coordinator that appropriate action would be taken [see Appendix B6].

2.8. Search for records of pre-1999 radiation monitoring

Although the Radiological Protection Service were unable to find any record of radiological measurements in the building prior to 1999, we were aware of anecdotal evidence that such measurements had indeed been made, and one of us (DJO'B) recalls someone taking occasional readings in room G55 throughout the period of more than 10 years during which it was occupied by Dr Arthur Reader [see Appendix F]. In an attempt to find records of these measurements we wrote to Mr John Collins, who had been Radiological Protection Officer to the University for 21 years from 1963 to 1984, and who is now the senior partner in Radman Associates, a firm of radiation protection advisers. His reply was prompt and courteous, but unhelpful [see Appendix B7].

We also searched for any records in the minutes of the Radiological Protection Sub-Committee of the Health & Safety Committee, and we approached various individuals: Mr Brian Clark, formerly Experimental Officer in Psychology; Professor Jim Reason, formerly Head of the Department of Psychology; Professor Robin Marshall FRS, Department of Physics [see Appendix B9]; Dr Jeff Hughes, Centre for the History of Science & Technology; Dr Susan Robson, Director of Health & Safety Services [see Appendix B5]; Professor Ian Stratford, Chair of the Radiological Protection Sub-Committee of the Health & Safety Committee [see Appendix B8]; and Dr Tristram Besterman, Director of the Manchester Museum. [see Appendix B3].

None of these enquiries produced any firm evidence of pre-1999 measurements. However, in March 2003 we had direct confirmation from Mr John Richardson, who had been a Radiation Officer in the Physics Department for 30 years. He recalled that on a number of occasions he had been asked to make measurements in Coupland, and that on at least one occasion he had done so, but that as far as he could remember this was not written up in any report. Mr Richardson said that he had initially been responsible to Mr Collins, then to Professor Willmott, and later to the Radiological Protection Service.

3. SECOND PHASE OF INVESTIGATION (2007-2008)

3.1. Correspondence with the Health & Safety Executive (HSE)

In June 2007 a formal request was made to the Health & Safety Executive (HSE) for any information relating to radiological investigations in the Coupland building. This was treated by the HSE as a request under the Freedom of Information Act, and in due course we were provided with copies of the inspection report dated 30th August 2000 by Dr Nettleton, who was then HM Specialist Inspector (Radiation) of Health and Safety, and of an internal email by her dated 24th June 2000, addressed to colleagues in the HSE, summarising her visit to Manchester Museum on 20th June and describing her plans for a subsequent visit on 12th July [see Appendices B10, C4, C12].

As we had already seen relevant correspondence between the University and Dr Nettleton, it was surprising to find that the HSE apparently did not have any copies of this. After making further enquiries on our behalf at the Manchester office, the relevant Freedom of Information Officer at the HSE (Mr Nick Williams) confirmed that no further documents were available. Mr Churcher then wrote directly to Dr Nettleton, now Head of Defuelled Reactor Inspection at the HSE, to ask if she could add anything from her memory and/or from her personal files. She replied that any paper files associated with the work would have been kept at the Manchester Office, and that she was unable to find any further electronic records of her own. She also wrote: "*...let me assure you that I do not in any way consider the issues at the Manchester Museum, or the concern you hold over those issues to be trivial.*" [see Appendix B10].

3.2. Evidence that the HSE may not have received accurate information from the University

It appears from Dr Nettleton's report that she may not have been given an accurate account of the extent of occupation of rooms in the building by staff and students in Psychology. In her report she writes: "*During recent times (up until early this year), the Coupland Building was divided into areas used by the Museum and areas used by the Psychology Department. Both have contaminated rooms (four in the Museum and six in Psychology). Of the ten rooms, nine were used only as storage areas (including G54). However, one room (G55, adjacent to G54 in the Psychology Department) was used as a postgraduate office and computer laboratory.*"

The ten contaminated rooms are not all identified in Dr Nettleton's report, but a document by Kevin Robinson dated 27th June 2000 (*i.e.* in the interval between Dr Nettleton's first and second visits), and titled "Potential radiation dose received as a result of entering the rooms listed below", identifies *eleven* rooms, and gives details of the potential radiation dose received on entering each of them [see Appendix C5]. Of these, five are in the Museum and six in Psychology. Mr Robinson is listed as one of the persons seen by Dr Nettleton during her inspections. It is therefore reasonable to assume that the six rooms in Psychology that he identified as contaminated are the same six as those referred to in Dr Nettleton's report. These are rooms G54, G55, 2.52, 2.53, 2.62, and 2.63. In Mr Robinson's document, only G54 is listed as being used for storage; G55 is listed as a postgraduate office, and rooms 2.52, 2.53, 2.62, and 2.63 are all listed as staff offices.

We know from personal experience that none of these six rooms was used mainly or exclusively as 'storage areas', except for the few months between vacation of the building in the winter of 1999-2000 and the time of the inspections in June and July 2000. Room G54 was used from 1986 onwards by postgraduate students taking the MSc in Cognitive Science, and prior to that for 10 or more years it was used by one of the authors (DJO'B), together with a colleague and various research students, to house laboratory animals. Room G55 was indeed used as a postgraduate office and computer laboratory, as stated in Dr Nettleton's report, but it was also previously used for a number of years as an office and laboratory by a member of staff in Psychology who retired some time ago (Dr Arthur Reader). Rooms 2.52 and 2.53 were occupied continuously for about 23 years as a suite of offices by one of the authors (Dr O'Boyle), and used also by various of his research students. Room 2.62 was occupied for more than 20 years continuously as an office by Dr Wagner. Room 2.63 was occupied for 20 years continuously as an office by another of the authors (Mr Churcher).

In addition to the potential hazards to regular occupants of these rooms from chronic exposure to elevated radon levels, some staff may have been exposed to a high risk of ingesting or breathing in radioactive dust. When the building was re-wired with computer cable during the building of the campus Ethernet in the 1990s, the technicians involved had to drill through the walls and ceilings to create cable ducts.

It appears from Dr Nettleton's report that during her two visits, on 23rd June and 31st July 2000 she did not meet any representative of the Department of Psychology. She did, however, meet the University's Director of Health and Safety Services, and staff of the Radiological Protection Service, Estates & Services, and Manchester Museum, as well as NIRAS, the architects and the contractors. We do not know whether Dr Nettleton saw a copy of the document by Mr Robinson dated 27th June 2000, or what information was conveyed to her by those whom she did meet. Dr Bidey's letter to Dr Nettleton of 6th July 2000 refers to a number of enclosed documents, although it is not clear whether Mr Robinson's document of 27th June 2000 is among them, and we have been unable to obtain confirmation from HSE that Dr Nettleton received the letter. Three months later, in her letter of 4th October 2000 to the University's Director of Health and Safety Services, Dr Nettleton was evidently still under an impression that the majority of contaminated rooms were used only for storage [see Appendices C12, C5, C10, C15].

It therefore seems possible that one or more of the representatives of the University who were present at the meetings provided Dr Nettleton with incorrect information concerning the history of previous occupation of the building by Psychology, or else failed to ensure that she was correctly informed. We have seen no evidence that the University has since attempted to rectify the situation by communicating to HSE the true extent of past occupancy of the building.

Details of all the staff and students in Psychology whom we can remember as having occupied rooms in the building between 1976 and 1999 are given in Appendix E. This is necessarily an incomplete list, and to trace all those still alive who occupied the building in the past would require considerably more work. Even if, as we suspect, many of the relevant Departmental records have been lost or destroyed, it should in principle be possible to reconstruct more of the history from the memories of others.

3.3. Further search for records of pre-1999 radiation monitoring

Concerning the apparent absence of records of radiological measurements in the building before 1999, Dr Nettleton notes that, with the exception of that in room G54, the contamination "*was not discovered until a radiological survey was undertaken prior to the commencement of a major construction project involving the Coupland Building. It is unclear why no previous survey was undertaken. A number of employees (Kevin Robinson and Barry Frith) have vague recollections of a survey in the 1970s or 1980s, but no records are available*." [see Appendix C12, section 2.1].

These 'vague recollections' reported to Dr Nettleton by Mr Robinson and Mr Frith in the summer of 2000 are inconsistent with the strong assertions made to us two years later by Dr Bidey and Mr Robinson [see Appendix A1] that they believed there had been no such survey, but they are consistent with the recollection of Mr Richardson, as reported above (see section 2.8).

In a further attempt to establish the facts, in November 2007 Mr Churcher wrote to Emeritus Professor John Willmott. Professor Willmott, who was also Director of the Physical Laboratories, had a long association with radiological protection at the University. He was appointed Deputy Chair of the University's Joint Committee on Radiological Protection Policy in 1967, and when the University's Health & Safety Committee was set up in 1969, in anticipation of the Health and Safety at Work Act 1974, he became Chairman of the Sub-Committee responsible for the Radiological Protection Service. Professor Willmott has not replied, and we understand that he is now in poor health.

3.4 Further consideration of the available radiological evidence from a historical perspective

Recently, one of us (NT) has begun a review of the total set of radiological measurements currently available to us, together with historical information about the uses of different rooms in the building during its occupation by the Department of Physics. This work is not complete, but some provisional conclusions may be drawn: (a) it is probable that room 2.62 and/or room 2.63 was the site of Rutherford's radium store; (b) there is quantitative evidence suggesting the continued presence within the building of significant quantities of radioactive lead (Pb210); (c) there appears to be low-level contamination throughout the building, and in addition to the 10 rooms which were identified as contaminated and subject to remediation a further 17 rooms showed levels of β and γ radiation higher than in a number of the contaminated rooms; (d) there is historical evidence that six rooms on the 1st floor of the Coupland extension were used by Rutherford for research, but these were not surveyed for contamination; (e) there is historical evidence that in addition to radium, Rutherford had obtained quantities of actinium (Ac227), thorium (Th232), and mesothorium (Ra228), and radionuclides from the thorium decay series were present in the building; (f) the radiological investigations made in 1999-2002 appear to have been guided by the assumption that the radium series alone was the source of contamination. [See Appendix H].

The six rooms that were not surveyed are: H.1.38, H.1.39, H.1.40, and a suite of three rooms comprising H.1.41. At least some of these rooms have been occupied for many years [See Appendices F, G].

4. SOME OBSERVATIONS ON THE RESULTS OF THIS INVESTIGATION

4.1. Lack of provision of information to staff

We discovered only by chance that the offices we had occupied for many years were subject to radiological survey and decontamination. There appeared to be no effective channel of communication between the Radiological Protection Service and the staff who were potentially affected by their findings. When we did ask for information, our requests were dealt with courteously and in detail, but on several occasions we were obliged repeatedly to point out discrepancies and omissions before being given the information we were seeking. As a result we still do not know if we have been provided with all of the relevant information.

4.2. Gaps in the documentary record

Our investigations have demonstrated the existence of deficiencies in the University's arrangements in the past for preserving documents relevant to the management of long-term hazards due to radionuclides. The destruction by RPS of a large quantity of documents, with no record of what was destroyed, is alarming. In any other area of work this might be merely a matter of regret to historians, but the long half-life and high toxicity of certain radionuclides means that a different standard is required in this area. It is clear that an appropriate standard has not been met or maintained by the University and, in this context, the claim that documents were destroyed to save space is shocking.

There may also be deficiencies in record-keeping by HSE . The retention period for documents relating to Inspections according to the HSE Retention Scheme is currently 9 years after a file is opened, although this may not have been in force in 2000 (HSE, 2006).

4.3. Uncertainty about whether any tests were conducted prior to 1999

There is a discrepancy between the claim by RPS that no tests were carried out before 1999, and the anecdotal evidence from Mr Richardson and others, including one of the authors of this report. Unfortunately, there is now no way of knowing whether records of pre-1999 tests were among the documents destroyed by RPS.

There is also a discrepancy between what we were told by RPS and what was said to Dr Nettleton, the Specialist Inspector. At the meeting on 23/7/2002 we were told by Dr Bidey and Mr Robinson that, as far as they were aware, no-one has worked with radioactive materials in Coupland 1 since 1947, and no radiological measurements were made between 1947 and October 1999, when RPS surveyed a number of rooms at the request of the Museum. Mr Robinson told us that he has worked for RPS since 1978, and cannot remember there being any measurements made prior to October 1999. In her report of 30/8/2000, however, Dr Nettleton recorded that Mr Robinson and Mr Frith had vague recollections of a survey in the 1970s or 1980s, but no records were available.

4.4. Uncertainty about pre-1999 levels of radon and other contaminants

The discovery of radium (Ra226), radioactive lead (Pb210) and polonium (Po210) inside the building, and the well-founded assumption that this had been left over from the work of Rutherford, Royds, Geiger, Marsden, Hevesy and others, provide grounds for believing that radon levels there have been higher than would otherwise be expected, and over a long period of time. The Ra226 was found on walls and floorboards, as well as on Rutherford's bench, and the Pb210/Po210 contamination under floorboards, in lagging material and in ceilings underneath.

Radiochemical analysis of the 2217 kilograms of material that was removed from the Coupland Building and sent to British Nuclear Fuels for disposal estimated the radionuclide fingerprint to be 74% Ra226, 13 % Pb210 and 13% Po210 [see Appendix C21 and Appendix H for discussion]. The distribution of the Pb210/Po210 is consistent with production and widespread diffusion and pooling of radon (Rn222) within the building throughout the last century, continuing until the remedial work began. However, the only records that we have been able to find of radon levels in the building prior to decontamination are based on grab-sampling on isolated occasions in June and July 2000, and the measures taken after remediation show considerable variation by an order of magnitude. We do not, therefore, have a reliable estimate of the average or cumulative total exposure, which would be necessary in order to evaluate any health risk to members of staff who occupied the rooms during the 20 years and more prior to decontamination. Levels of <279 and <149 Bq/m^3 were obtained before and after remediation in Room 2.63, which was occupied for 20 years by one of the authors. Given that the EU Action Level for domestic dwellings is 200 Bq/m^3, the US Action Level is 148 Bq/m^3 and that some authorities even recommend 74 Bq/m^3 as the appropriate level, we believe that we have reason for concern.

The University should seek to resolve these uncertainties. Various methods exist for retrospectively estimating radon exposure, and the methods we are aware of can be divided into three categories: (a) examination of physical traces in the building; (b) *in vivo* measurement of radionuclides in the bodies of former occupants; (c) *post mortem* measurements made at autopsy [see Appendices A2, B9].

Consideration of the currently available radiological evidence from a historical perspective (see section 3.4 above, and Appendix H) also underlines the importance of the advice given by NNC in January 2001 [see Appendix C17] that undetected contamination remaining in the building may result in serious hazards if disturbed by intrusive work undertaken on the building fabric, and the recommendation that the University makes and keeps records that ensure that any proposal for intrusive work in the future triggers a prior radiological risk assessment.

4.5. Uncertainty about the remit of the Radiological Protection Service and the legal responsibility of the University

The remit of the Radiological Protection Service appears to be determined largely by the legal obligations of the University, most recently under the Ionising Radiations Regulations 1999 made under the Health & Safety at Work Act 1974, which are primarily concerned with the protection of those who use ionising radiation in the

course of their work, and of others who may be affected by such work.

As early as 1912, when an extension to the building was opened, the University was aware that gamma-radiation was penetrating through walls and floors, interfering with instruments in neighbouring rooms. In his speech at the opening event, Professor Schuster referred to this problem and to the large quantities of radium employed, and said that it was "*intended to keep the new laboratories uncontaminated by radio-active matter*" (Schuster, 1912).

When the University's Health and Safety Committee and its Radiological Protection Service Sub-Committee were established in 1969, the latter was charged with ensuring: "*(a) the maintenance of a register of all existing and proposed sources of ionising radiation within the University (including the siting of all such sources); (b) the adequacy of protective measures against risks of damage, both somatic and genetic, from these radiations; (c) the maintenance of suitable departmental records of exposure for all individuals whose duties or studies bring them into proximity to the source of radiation; (d) appropriate medical supervision when necessary; (e) that those concerned are suitably informed of and experienced in the measures necessary for the protection of persons exposed to ionizing radiations.*" (University of Manchester, 1969)

In 1984, in a report to the University Council by a Working Party established to investigate the operation of the Radiological Protection Service, it was clearly recognised that its responsibilities included protection of the funding bodies "*from possible future litigation by ensuring that the common law requirement to keep the risk of radiation and contamination 'at the lowest achievable level' is observed*" (University of Manchester, 1984). By implication this includes the protection of staff, students and the general public, not only in laboratories which currently use radioactive materials, but anywhere in the University that a hazard may arise.

Because we have no records of whether radiological measurements were made in the building, and because much of the current legislation was not in force at the time radioactive substances were being actively used for research there, it is not clear whether the University simply failed to realise that there was a potential risk to occupants of Coupland 1 before 1999. As far as we are aware the University has made no attempt to find out whether such a risk existed.

Dr Nettleton wrote in her report on 30th August 2000: "*The University and Museum should have undertaken a radiation survey of the Coupland Building as soon as the possibility of radioactive contamination was noted (probably back in the 1950s). However, as the contamination is historic, it is perhaps understandable that in more recent years no survey was undertaken until the proposed construction work alerted people to the potential hazard. The majority of the rooms were used for storage, with associated low occupancy*." [see Appendix C12].

In her letter of 4th October 2000 to the University's Director of Health and Safety she wrote: "*...it is unfortunate that a full contamination survey was not conducted many years ago. and appropriate remediation work carried out. However, I recognise that the contamination is historical and that the majority of contaminated rooms were used for storage. I have also been informed that the estimated radiation doses to employees and students during use of the only occupied area are very low.*" [see

Appendix C15].

As we have shown, the apparently mitigating assumption that most of the contaminated rooms were of low occupancy is false. Given what is now known about the extent of contamination of the building, and the fact that it must be presumed still to be contaminated in those parts of its structure that have not been subject to remediation, the University has a responsibility to do whatever it reasonably can that may be necessary to protect the health of past, present and future occupants of the building.

5. CONCLUSION & RECOMMENDATIONS

There remains significant uncertainty concerning the extent to which radioactive contamination of the Coupland 1/Rutherford building may have affected the health of staff of the Department of Psychology who occupied part of it during the 25 years to 1999 and the health of others who occupied it earlier. It is possible that the surveys conducted in 1999-2002 were incomplete and/or based on inadequate historical assumptions. The existence of these uncertainties is in part due to the absence of a proactive attitude by the University towards certain possible risks to its staff, and a casual approach to record-keeping in the past.

We recommend that the University:

1) **commission an independent[8] review of the existing evidence, of the possibility that the surveys made in 1999-2002 were inadequate, and of the feasibility of making a retrospective assessment of the possible health hazards;**

2) **attempt to trace former occupants if evidence of risk to their health is found;**

3) **review its procedures for the protection from radiological hazards of the health and safety of non-classified staff, i.e. staff who are not designated as working with radioactive materials;**

4) **review its arrangements for ensuring that all current and future occupants of the Rutherford Building observe the requirement that any intrusive work to the fabric of the building be conditional on a prior radiological risk assessment;**

5) **review its provision for ensuring that relevant documentation is preserved in a readily accessible form, and regularly reviewed, for as long as the building continues to exist.**

We recommend that the Health and Safety Executive:

6) **review its assessment of the adequacy of arrangements at the University of Manchester for protection from ionising radiation of occupants of the Rutherford Building, including past occupants who are still alive;**

7) **review the adequacy of procedures for retention of documents at its Manchester office.**

[8] Due to the prominent historical role of the University of Manchester in supplying radiological expertise and training to the wider scientific and industrial community nationally, it may be necessary for advice to be sought outside the UK in order for such a review to be genuinely independent.

REFERENCES

Brenner DJ et al. (2003) “Cancer risks attributable to low doses of ionizing radiation: Assessing what we really know” *Proceedings of the National Academy of Sciences*, **100** (24) 13761-13766

Darby et al (1995) "Radon and cancers other than lung cancer in underground miners" *Journal of the National Cancer Institute* **87 (5),** 378-384.

Health & Safety Executive (2006) “HSE Business Classification Scheme and Retention Schedule, Version 6.0 (July 2006)”, p.36. http://www.hse.gov.uk/foi/busclasschem.pdf

Icenhour AS (2005) “Transport of radioactive material by alpha recoil”, *Oak Ridge National Laboratory,* report no. ORNL/TM-2005/22

Loomis DP & Woolf SH (1996) “Mortality of Workers at a Nuclear Materials Production Plant at Oak Ridge, Tennessee, 1947-1990”, *American Journal of Industrial Medicine* **29**:131-141

Roessler G (2007) “Why ^{210}Po?”, *Health Physics News*, **35** (2) 1-8

Rutherford E and Royds T (1909) "The nature of the α particle from radioactive substances", *Phil. Mag* **17,** 281-6.

Schuster, A. (1912), reported in ‘The extension of the physical and electrotechnical laboratories at the University of Manchester’, *Nature*, **8** (2211) 40 (14 March 1912).

University of Manchester (1969) *Minutes of Council,* **42** 162-165. Actum 5 (4) (c) (iii) (15th January 1969). University of Manchester Archives.

University of Manchester (1984) “Radiological Protection Service” (paper dated 3/7/1984 and pre-circulated to the Joint Management Committee for Radiological Protection, for its meeting of 8/11/1984. Archive held by Department of Estates, University of Manchester.

Wakeford R (2004) “The cancer epidemiology of radiation”. *Oncogene*, **23**, 6404–6428

Radiation hazards in Coupland 1 building

Minutes of a meeting held on 23rd July 2002, at the offices of the Radiological Protection Service.

Present: Dr S Bidey (Radiological Protection Service)
Mr J Churcher (Department of Psychology)
Dr DJ O'Boyle (Department of Psychology)
Mr K Robinson (Radiological Protection Service).

Apologies for absence:
Dr N Todd (Department of Psychology)

Background

The meeting had been arranged at the request of Mr Churcher, Dr O'Boyle and Dr Todd, to discuss questions detailed in their letter to Dr Bidey dated 10th July 2002, and in previous correspondence between Mr Churcher and Dr Bidey, concerning radiation hazards in Coupland 1 building.

Dr Bidey mentioned that the Director of the Manchester Museum, Dr T. Besterman, was aware of the concerns raised in the letter of 10th July and that he has written to Estates & Services about it, asking that staff in Psychology be kept informed of results of radiological testing in Coupland I.

Dr Bidey said that since the remedial work had been carried out in Coupland 1, the policy of RPS has been that no intrusive work should be done on the building without consulting RPS. This is to comply with a requirement made in a letter from the HSE Inspector in October 2000.

History of radiological testing in Coupland 1

Dr Bidey and Mr Robinson reported that, as far as they were aware, no-one has worked with radioactive materials in Coupland 1 since 1947, and no radiological measurements were made between 1947 and October 1999, when RPS surveyed a number of rooms at the request of the Museum. Mr Robinson has worked for RPS since 1978, and cannot remember there being any measurements made prior to October 1999.

Dr Bidey explained that when RPS moved to its present location in Williamson building 3 years ago, there was insufficient storage space for all the documents which had accumulated in its offices, which filled 7 or 8 filing cabinets. Many of these documents were therefore disposed of at the time of the move. No record was kept of which documents were disposed of, and it would not be possible to say for certain whether any of them referred to Coupland 1. There is no legal obligation on RPS to retain these records for longer than 3 years.

Mr Churcher and Dr O'Boyle observed that it therefore appears possible that measurements were made in Coupland 1 prior to 1978, and that relevant

documentation may have been lost. Dr Bidey gave an assurance that no further documentation of potential relevance to Coupland 1 would be disposed of.

It was confirmed that secretary who was in charge of these filing cabinets at the time of the move is still in post.

Answers to specific questions raised in the letter of 10th July

1. *What tests have been carried out in Coupland 1 since November 2001?* The RPS (Mr Robinson) monitored rooms in Coupland I in May 2002, prior to a planned temporary refurbishment associated with temporary occupation by the Accommodation Office. The monitoring involved testing for radioactive contamination, including preliminary measurements of radon, in some rooms. The results were written up in a report by Mr Robinson dated 20th May 2002.

2. *Have rooms on the first floor been tested?* Rooms on the first floor of the building were not monitored in May 2002 as the Accommodation Office did not intend to use any rooms on this floor.

3. *What radioactive materials have been found, etc?* Full details are given in a report by NIRAS (C5952/0013; MTC/01/026, dated 9th April, 2001) produced following the removal of contaminated material from Coupland I. It is also possible that some relevant information might be available from BNFL as they will have analysed the material before disposing of it.

4. *Other radioactive materials remaining to be discovered within the building?* see the NIRAS report

5. *Tests for radon, etc?* Some testing of radon levels has been conducted:

- **a)** by NNC at the time of the removal of contaminated material from Coupland I, for purposes of assessing the hazards to the people undertaking the work. Some pages from the relevant report by NNC were provided, and Mr Churcher observed that according to the figures shown, immediately prior to decontamination, radon levels measured in some rooms, including 2.63 (Mr Churcher's office) may have been above the current Action Level of 200 bequerels per m^3. Mr Robinson doubted the validity of this particular measurement and suggested that one of the instruments used by NNC may have been faulty, but he had no evidence for this.

- **b)** by RPS (Mr Robinson) – preliminary measurements in some rooms in May 2002 as referred to above.

Mr Churcher pointed out that both sets of radon measurements appeared to have been made over short time intervals (hours or minutes), with inadequate sampling to determine average levels with any reliability.

6. *Further radon testing?* Dr Bidey agreed to conduct fresh radon measurements in all rooms in Coupland I, using NRPB passive monitors over a sampling period of months, before any further decommissioning of contaminated material takes place. It

was understood that it is now too late to investigate by this means the radon levels which may have existed prior to decontamination.

7. *Radiometric ageing etc?* Data relevant to this may be found in the NIRAS report on analysis of removed waste material.

8. *Missing report dated 20th June 2000* Dr Bidey agreed to provide a copy of this report.

Specific issues arising

Amount of radium in room 2.63. There was some discussion about the quantity of Ra-226 found above the hand wash basin in room 2.63, which cannot be calculated from the figures provided, as these are in Bq/g with no indication of the mass of material removed. It was not entirely clear whether any material was, in fact, removed from the wall in this area. Dr Bidey and Mr Robinson could not explain the apparent discrepancy, between the reference to cutting out a 'contaminated area of plaster' from the wall of room 2.63, in the *Local Rules* document by Barry Frith dated 1/9/00, and the fact that there are no plaster walls anywhere in rooms 2.62 or 2.63.

Mercury contamination of room 2.62. Mr Churcher asked if RPS were aware of the mercury (Hg) contamination of the plaster and woodwork under the floor of room 2.62. Dr Bidey said that he wasn't but that this would be outside the responsibility of RPS.

Radon. Issues concerning radon will be discussed in detail at a later meeting when Dr Prime can be present. He will not be available until about 4 weeks from now, as he comes in 2 days per month in an advisory capacity. Dr Bidey will arrange a meeting which he will be able to attend, and will invite Mr Duffy from Estates and Services, during the last week of August, 2002.

Documentation. Mr Churcher and Dr O'Boyle tried to establish which relevant documents they had not yet seen. Some of these were available at the meeting, other would have to be located, and it was agreed to provide copies for the following day.

JC/D'OB 20/8/02

Radiation Hazards in Coupland I Building

Minutes of a meeting held on Wednesday, 21st August, 2002, in the office of Dr Bidey of the Radiological Protection Service.

Present: Dr S Bidey (Radiological Protection Service)
Mr J Churcher (Department of Psychology)
Mr J Duffy (Estates Office)
Dr D J O'Boyle (Department of Psychology)
Dr D Prime (previously of the Radiological Protection Service)

Apologies for absence:

Mr K Robinson (Radiological Protection Service)
Dr N Todd (Department of Psychology)

Background

This was the second of two meetings held to discuss possible radiation hazards in Coupland I building. It had been arranged primarily to allow discussion with Dr Prime of the possible health hazard posed by the release of radon gas in the building during the past 30 years or so. Dr Prime was the University's Radiological Protection Officer during the period 1976-1999. He had been unable to attend the first meeting on 23rd July, 2002.

It was agreed that the meeting should be tape-recorded to facilitate the writing of minutes.

Minutes of the meeting of 23rd July 2002

The minutes of the meeting of 23rd July, 2002 were approved, with one minor correction: it was Mr Robinson, rather than Dr Bidey, who had explained that when RPS moved to its present location in Williamson building 3 years ago there was insufficient storage space for all the documents which had accumulated in its offices. (p.1).

Matters arising from the minutes of the meeting of 23rd July, 2002

Possible loss of relevant documents

It was stated in the minutes (pp. 1-2) that, in view of the disposal of some documents when the RPS moved to the Williamson building, it is possible that radiological measurements were made in Coupland I prior to 1978, but that the records have been lost. Mr Bidey re-iterated his view that although this cannot be ruled out, he believes that it is unlikely, and he stated that while it was well known before that date that Rutherford's bench was possibly hazardous, there was no reason to suspect that the fabric of walls and floors in other rooms would be a problem.

Mr Churcher again asked for confirmation that no records exist of radiological measurements in Coupland I prior to 1978, when Mr Robinson was appointed. There were two reasons for asking: (a) because of the relevance of such measurements to the possibility of retrospective determination of hazards to which staff may have been exposed during a 20-year period; (b) because there is anecdotal evidence that some measurements may have been made in the 1970s: a retired colleague, Dr Hugh Wagner, who for more than 20 years occupied room 2.62, remembers someone coming to make measurements on the upper part of the wall in his room around the time when the Department

of Psychology moved into Coupland I building in the mid-1970s; and Mr Churcher remembers that around 1980 he met Mr John Collins, at that time head of the RPS, looking around the building late one evening.

The consensus view of Dr Prime, Dr Bidey and Mr Duffy was that it is very unlikely that any such records now exist, given the re-location of RPS records, and the associated 'clear-out' of documents, on at least three occasions since John Collins set up the RPS in 1963: from Brighton Place to Coupland 3; then to William Kay House/Brighton Place; and then to the Williamson Building.

Dr Prime thought that Mr Collins, his predecessor as head of the RPS, had been well-organised as a keeper of records. Mr Collins had left the University to set up a company called *Radman*.

Legal requirement for maintenance of records

It was stated in the minutes (p.1) that Dr Bidey had said there is no legal obligation for RPS to retain records for longer than 3 years. This applies only in relation to property, and not in the case of classified radiation workers (of whom the university has very few), for whom records must be kept for 50 years. Mr Churcher pointed out that this implies a gap in Health & Safety regulations in that there appeared to be no legal requirement for the maintenance of records of known potential radiological hazards to non-classified workers. Dr Bidey, Dr Prime and Mr Duffy agreed that this is the case and that it reflects an inadequacy of current legislation.

Action level for radon, and use of damaged Lucas cell

The current Action Level for radon was referred to in the minutes (p.2) as 200 Bq/m³ . Mr Duffy pointed out that whereas an Action Level of 200 Bq/m³ applies in the case of homes, the Action Level for occupational exposure is 400 Bq/m³. As a consequence, Barry Frith, in his report in June 2000[1], was not concerned by readings < 400 Bq/m³. Furthermore, all the measurements citing threshold values greater than 200 Bq/m³, including that taken in 2.63 which was Mr Churcher's room, had been made with a Lucas cell (referred to as "Green" in Mr Frith's report) which had been damaged and, as a consequence, gave a very high background reading. Therefore, the questions of what was the level in areas in which cell 'Green' was used (including room 2.63) in June 2000, and why the readings taken with this cell were not repeated with a properly-working cell, remain unanswered.

BNFL

In relation to the question of what radioactive materials have been found in Coupland I (p.2), Dr Bidey pointed out that BNFL would not necessarily have analysed the material which they received, although they retain the right to do so. Dr Bidey also indicated that BNFL considered the material which was sent them from the Coupland I building to be very low-level waste, which they were reluctant to take.

Confusion over reference to document

The "Missing report dated 20th June 2000" (p.3) of which Dr Bidey had agreed to provide a copy did not, in fact exist.

[1] *Determination of Rn222 in air Re. Museum hazard assessment*, dated 28/6/00 and included as document (vii) with Dr S. Bidey's letter to Dr J. Nettleton, Health & Safety Executive, dated 6/7/00.

Possible health hazard due to radon

1. Dr Bidey mentioned that, as agreed at the previous meeting, Mr Robinson had now installed radon detectors in rooms in Coupland I for long-term monitoring, and he had also done some further 'spot' monitoring on 7th August in various rooms, some of which had undergone remedial work and others of which hadn't. Dr Bidey provided a Table containing the results of this monitoring and of previous 'spot' monitoring on 16th May. All of the readings in the Table are low. (See Appendix 1 to these Minutes).

2. Previous radon measurements had been made by NNC prior to the removal of contaminated material, primarily for the assessment of hazard for the individuals doing the remediation work (as detailed in the local rules written by B. Frith in June, 2000 and the associated Tables of measurements in the documents labelled (v), (vi) & (vii) [2] .

3. Dr O'Boyle raised the question of the usefulness of these measurements for assessing retrospectively the chronic radon hazard to long-term (20 years or more) inhabitants of tested rooms, as opposed to assessing hazard to those undertaking remedial work, given that the measurements were effectively instantaneous 'snap-shots' and had been taken on only one occasion (aside from issue of the validity of measurements taken with the malfunctioning 'green' cell).

4. Dr Prime said that the values shown in the Table on p. vii are 'background counts', which will vary with both the instrument employed and the time at which the measurement is taken. He summarised the values in the Tables by saying: "using this technique, which you can criticise, he (Frith) wasn't able to detect any radon of any significance in any of the rooms tested". So long as background in an area is less than the Action Level of 400 Bq/m³, then ionising radiation is not a problem for individuals working in the area. However, these data are of relevance to the question of chronic exposure and hazard only in so far as that there were no measurements made which were above background. Given the wide variation in radon levels over time, which might be expected in a room e.g. as a function of degree to which air is disturbed, Dr Prime agreed that these instantaneous, 'snapshot' measurements are effectively useless in trying retrospectively to estimate radon levels during the period when the building was occupied by members of the Department of Psychology.

5. Mr Churcher pointed out that apparently we do not have any valid radon measurement prior to the start of decontamination in 1999 for any of the rooms which were tested using the 'green' cell. This includes room 2.63, which he occupied for about 20 years, and about which there are a number of other unanswered radiological questions. Dr Bidey remarked: "even if any monitoring had been done, in say, 1978, it wouldn't have been radon monitoring".

6. Additional data about radon measurements are also included in the Final Report[3] which had been provided by Dr Bidey following the meeting on 23rd July. Dr O'Boyle pointed out that there is no reference in this document to radon measurements in rooms 2.62 & 2.63 which have figured consistently in many of the other documents. Dr Bidey said that these two rooms did not figure in

[2] (v) B. Frith, *Local Rules Written by the RPA appointed by the University of Manchester*, 22/6/00;
(vi) *Hazard Data Re: Supervised Areas Designated in Coupland 1 Building, the Annex, and The Old Dental Hospital*, June 2000; (vii) *Determination of Rn222 in air Re. Museum hazard assessment*, 28/06/00; all three documents included with Dr S. Bidey's letter to Dr J. Nettleton, Health & Safety Executive, dated 6/7/00

[3] B. Frith, *Final Report for the Decommissioning of Coupland 1 Building, Manchester University*, NIRAS/NNC Ltd, January 2001 (C5952/0008 MTC/01/005 Issue: 01)

the original museum project/contract with NIRAS, but were added later. The document referred only to rooms included in that original contract. NIRAS were instructed to include rooms 2.62 & 2.63 at a later date, the implication being that radon data might be available for these two rooms. Dr Bidey said that if this is the case, the RPS haven't seen the data, there was no supplementary report which included such data, and he couldn't believe that if such data had been available, the RPS wouldn't have received them.

7. Dr Prime suggested that it was possible to estimate the radon activity from other measurements which were available. If the amount of radium actually found in Mr Churcher's room was 0.08 MBq, if the volume of the room is about 100 m^3, and if none of the radon resulting from decay of this radium were to escape the room, the maximum activity of radon which could be in there is 80 Bq/m^3.

8. Mr Churcher pointed out that according to the documentation, radium was detected on the wall above the hand washbasin in room 2.63 in 'insignificant' quantities and at a certain activity concentration, but there is no indication there of the quantity of material which was removed. The reports are inconsistent about whether material was removed from this location because the wall is described in the Local Rules[4] as being made of plaster, with instructions to cut out the contaminated areas. In fact, however, there is no plaster there, but only glazed tiles.

9. Referring to the 64 Kg of material removed from beneath the floors in rooms 2.62 and 2.63, containing 0.48 MBq of activity of Pb-210, Mr Churcher asked how it might have got there if not as a decay product ultimately of radium, via radon. He also observed that Dr Bidey in his letter had described this as entirely Pb-210, whereas in the NNC report[5] there is reference to radium being found on the floorboards, as well as to Pb-210 being found under them.

10. Dr Prime quoted from Neils Bohr's reminiscences, published in 1962 in *Rutherford at Manchester*, edited by J.B. Birks[6]. Bohr referred to the work of George Hevesy, who as early as 1911 had conceived the tracer method, and who had been led to this work as a response to a challenge by Rutherford to "separate radium D from the large amount of lead chloride, extracted from pitchblende and presented to Rutherford by the Austrian government." Since radium D is Pb-210, Dr Prime thought it was possible that room 2.63 was the one in which Hevesy was separating out Pb-210 from this material. This could be the source of the Pb-210 found in the room, in which case no radon would have been generated in its production. Dr Prime went on to suggest that this could also explain the presence of Pb-210 under the floorboards in a number of other rooms in the building, and that the pattern of its distribution was consistent with solutions having been dropped on to the floor. He cited anecdotal evidence that Hevesy was not always very careful with his materials.

11. Mr Churcher agreed that this did seem a possible explanation, but added that it seemed equally possible on the evidence available that Rutherford and Royds did their experiment on the isolation of helium in room 2.62, as indicated on the plaque in the wall of that room, and that room 2.63 was used as the preparation room for the materials. This would be consistent with the discovery of radium contamination above the wash handbasin.

12. Dr Prime cited H.R. Robinson's reminiscences in *Rutherford at Manchester*, concerning the quantity of radium in Rutherford's possession. Rutherford was initially provided by the Vienna

[4] B. Frith, *Local Rules Written by the RPA appointed by Hayverns*, 1/9/00
[5] SM Adams, *Report on the Estimation of Drum Activity of Waste Removed from Coupland 1 Building*, 9/4/01 (C5952/0013 MTC/01/026 Issue: 01)
[6] J.B. Birks (Ed.) *Rutherford at Manchester*, London: Heywood & Co. Ltd.

Academy with an unspecified quantity which he had to share with Ramsay, and later the Academy made a loan of 450 mg of radium bromide, directly for Rutherford's own use. This supply Rutherford was able to keep in his laboratories until the end of his days. The Vienna radium was received in January, 1908, so he would have had a minimum of 450 mg in his possession all the time he was in Manchester until he left in 1919, then taking it with him to Cambridge. In the meantime, some of that would have gone missing. Dr Prime estimated that this 450 mg of radium represents at least 10 GBq of activity, and assuming a constant source of radium of this size to have been in the building throughout the 10 years leading up to 1920, it would be more than enough to explain the production of all the radioactive lead found and estimated to be remaining in the building.

13. Mr Churcher said it was not clear how much radium was actually found in his room. Ms Adams' report of 9th April [7], for rooms 2.62/2.63, page 6, states: "The analysis of samples taken from contaminated floorboards shows that the contamination is due to radium -226, and is of activity concentration 1.27 Bq/g". In the summary table on the following page, against the drum reference for 2.62/2.63 the contents are described as floorboards and lagging, and only lead and polonium are mentioned. Dr Bidey's letter to Mr Churcher refers only to lead found on the undersides and sides of the floorboards. If the spots of Pb-210/Po-210 which were found underneath the floorboards had got there through the dropping of radium salts in solution on the floor which then seeped through gaps between the floorboards, then because of the long half-life of radium we would have expected to find residual radium with the Pb-210. Yet most of the documented analysis doesn't seem to mention concomitant radium.

14. Dr Prime said that if the Pb-210 came via radon as a decay product of radium, then one would not expect to find it in the same locations as any residual radium, because radon is an extremely dense gas, which gathers in pools like water when there is no ventilation. If there were some particular areas in the room where it actually drained, it would drain through those. The radon decay products, being solid, would tend to get absorbed on the lagging materials which could result in localised spots of Pb-210, which would indicate where the radon has drained out of the room.

15. There was then a discussion of when this might have occurred: it could all have happened as long ago as 1910; or it could have been happening continuously over the years, and radon could still be being generated. Dr Prime said that if radon is still being generated, it is surprising that Barry Frith didn't actually find anything at all with his monitoring. Mr Churcher pointed out that in room 2.63 the monitor which was used would only have detected a level above 279 Bq/m³. He also suggested that the pattern of movement of radon within a room, due to air currents etc., is complex and poorly understood. It was agreed that in any case a single spot measurement could not provide a reliable measure of average levels.

16. Mr Churcher asked whether it was possible to do radiometric ageing of the contaminants by looking at the ratio between the Pb-210 and the Po-210 in samples. Dr Prime replied that the amount of Po-210 would come into equilibrium with the Pb-210 in approximately 10 half-lives, which would be roughly 1300 days or 5 years. If radon had been continuously generated over many decades, including over the last 5 years, it would difficult to measure the ratio with sufficient accuracy. It had to be assumed that if Rutherford was in a room with 10 GBq of radium there would have been a vast amount of radon around, and that would have swamped out any other effect. He therefore thought such an investigation would not be feasible now.

---

[7] S.M. Adams, *Report on the Estimation of Drum Activity of Waste Removed from Coupland 1 Building*, 9/4/01 (C5952/0013 MTC/01/026 Issue: 01)

17. Mr Churcher also asked about the possibility of retrospective determination of radon levels by looking at the interaction between alpha particles and glass. The method does not determine the time of exposure, but Mr Churcher believed that one of the windows in room 2.63 had been replaced shortly after he arrived in 1979, the implication being that it might be possible to assess total radon exposure in that room since then. Dr Prime thought this would be difficult to do, and that RPS did not have the capability of doing it. It was possible that the National Radiological Protection Board, for example, might be able to do it.

18. Other methods of retrospectively estimating radon levels were briefly discussed. Dr Prime mentioned the possibility of taking bone samples *in vivo*. Mr Churcher showed Dr Prime an abstract of a recent research report on non-invasive *in vivo* measurement of Pb-210 in the skull (see Appendix 2).

19. Dr Prime stated that as Mr Churcher's and Dr O'Boyle's rooms were on the top floor of Coupland 1, it was extremely unlikely that significant levels of radon would have accumulated in them. When no-one is in a room, radon will form a pool on the floor, find any hole, go through to below, and gradually work its way down into the basement, where the highest levels would be found.

20. Dr Prime thought that it would be very difficult to work out where the Pb-210 came from: it could be from the lead which Hevesy was working with, or it could be from materials Rutherford was working with. Generally speaking it would be very unusual to have high radon levels on the 2nd floor compared to other parts of the building.

21. There was discussion of some apparent inconsistency and lack of clarity in the NIRAS reports concerning which waste was put into which drums, and how much activity of each radionuclide was estimated to be present.

22. There was further discussion of Dr Prime's estimate of 80 Bq/m^3 as the maximum radon level in rooms 2.62 and 2.63. Dr Prime said this was the equilibrium value, i.e. it assumes no disturbance, in a perfectly-sealed room with no absorption surfaces. In reality much of the radon would be absorbed and destroyed. But if the rooms were left with no-one in them, the radon levels would build up towards 80 Bq/m^3, which would represent the upper limit that it could ever achieve. It takes 10 half-lives again for the radon to come into equilibrium, which is about a month, so if the rooms were left sealed for a month the radon would approach this level.

23. Dr O'Boyle asked about a passage in Ms Adams' report of 9th April[8] about material removed from 2.52 and 2.53, which are the rooms which he occupied. On page 4, item 5, referring to these rooms we find: "Two small lengths of floorboard were cut in clean areas and removed. Results of samples taken show the contamination is again due to radium-226...These sections were put into drum ref. G54/G55/4...". Whereas in the Table on page 7, against drum reference G54/G55/4, there is reference to this drum containing "joist and lagging (Po/Pb 210)", and no reference to radium. Dr Prime agreed that there appeared to be a discrepancy, and Dr O'Boyle suggested that this raised questions about the reliability of the rest of the document.

24. Mr Churcher asked who was responsible for accepting the technical adequacy of the report on behalf of the university. Mr Duffy said that the contract is between the Estates Office and NIRAS so that if there are any queries about it, he should be making them on behalf of the Estates

[8] S.M. Adams, *Report on the Estimation of Drum Activity of Waste Removed from Coupland 1 Building*, 9/4/01 (C5952/0013 MTC/01/026 Issue: 01)

Office. Dr Bidey said that NNC, or NIRAS, were contracted to identify, remove and arrange disposal of any contamination and it was they who maintained liaison with BNFL throughout. In response to a question by Dr O'Boyle, Mr Duffy confirmed that the report would have been filed on receipt, but it would not necessarily have been checked first by his staff.

25. Dr Prime thought that only the radionuclides considered of greatest importance by NIRAS had been listed in the document.

26. Dr Prime enquired about the identity of the report's author, SM Adams. Dr Bidey replied that this is Stephanie Adams. The report had been approved by Andrew Frith, who is Barry Frith's son. Mr Churcher commented on the situation where people who were once employed by the university then become part of an external organisation which contracts to the university. Care needs to be taken about who checks what, and in whose name, when health and safety are at stake. Dr Bidey compared the situation to that in academic examinations, where marking is done internally.

27. Mr Churcher suggested that it might be possible to find out more by writing to Stephanie Adams, or to BNFL. Dr Bidey remarked that BNFL probably made their decisions about disposal on the figures supplied by NNC/NIRAS, without further checks. NIRAS had had to put pressure on BNFL to accept the waste because the amounts of activity were so low relative to the amounts they normally had to deal with. Dr Prime asked if the Environment Agency were bound to have seen a list, and Dr Bidey confirmed that they had seen it, and received a copy of the report. A revision to the University's waste-disposal authorisation had been necessary.

28. Dr O'Boyle returned to the question whether there was any way of determining radon levels over the last ten years, and Dr Prime confirmed that in his opinion this would not be possible. Mr Churcher asked whether it would be possible if full analytical information were available separately for the contamination found in each room. Dr Prime thought it would not. The only relevant figures would be those for radium and for lead, because the half-lives of the other decay products were so short. The only solid information we have, he suggested, is the figure of 0.48 MBq, of which 0.08 is due to radium and 0.4 is due to lead. The lead could be related to the work of Hevesy. Dr Bidey wondered if historical records might reveal what work was being done where in the building.

29. There was a further lengthy and inconclusive attempt to establish from the documents which drums contained material from which rooms, and to interpret the tables showing the composition of the material in each drum. Dr Bidey suggested that the inconsistencies concerning rooms 2.62 and 2.63 were due to the fact that the work had been begun by NNC at Harwell, and then transferred to NIRAS, with rooms 2.62 and 2.63 being added to the contract after the transfer. Thus NNC Harwell had not analysed any contamination from rooms 2.62 and 2.63.

30. Mr Churcher mentioned the possibility of analysing some of the radioactive material still in the building, and referred to the final report for the decommissioning of Coupland I building, in which Barry Frith is quite clear that there must be a lot of further contamination still in the building. This is the basis for current RPS policy of 'non-intrusion' regarding the building. The status of rooms G54 and 55 was discussed. Dr O'Boyle said this had been Rutherford's laboratory, that his bench was still stored there, and that the entire floor of the laboratory has been removed. Dr O'Boyle's histology laboratory had once been in an adjoining room, and a colleague (Dr Arthur Reader, now retired) used to occupy those rooms. Dr Bidey recalled teaching in the rooms opposite. Dr Prime pointed out that nearly all the activity recorded for those rooms is due to radium. He suspected that the lead in rooms 2.62 and 2.63 was therefore more likely to be due to Hevesy, since Hevesy and Rutherford were working separately. Mr Churcher and Dr O'Boyle reminded the

meeting that Rutherford and Royds had also worked in room 2.62, as attested by a plaque on the wall. Dr Bidey added that the wall tiles in that room were the originals.

31. Mr Churcher said he was not convinced of the impossibility of reconstructing historical radon levels, and mentioned the large amount of current research into techniques for doing this. The University has to consider past health and safety of its employees if new information comes into its possession about what they may have been exposed to which people weren't aware of at the time. It was not only himself and Dr O'Boyle who were potentially affected, but also all their colleagues who had used the building, and they were concerned to establish the facts. They did not wish to create unnecessary alarm, but equally they did not wish to be involved in covering something up. They also wanted to know the facts for their own health and safety, as each of them had worked in the building for over 20 years, frequently working long hours, and often arriving on a Monday morning when any radon would have accumulated in the closed rooms over the weekend.

32. Dr O'Boyle asked about the University's responsibility for informing former occupants of rooms about the possibility of any hazard. He himself had only discovered that there were active hotspots in his room a few months ago when he had gone there and seen the notice on his door. There was documentation referring to those hotspots going back a long time, but why wasn't he told about them? He asked what responsibilities does the University or the RPS have to inform people about such possible hazards. Dr Bidey replied that RPS certainly inform people who are known to be working with radioactive materials, and these people would come on safety awareness courses. Departments can also choose whether they want to have dosimetric monitoring of their workers. Dr Bidey thought that the possibility of being exposed to radiation in the past had never really arisen before for people who hadn't been knowingly working with radioactive material. Dr O'Boyle asked whether, if there had been clear evidence that anyone working in a particular room in the past had been subject to a severe hazard, he would have felt compelled to inform the person concerned or not?

33. Dr Bidey pointed out that the remediation work was contracted out to NIRAS who had appointed their own Radiation Protection Adviser, and that they had advised the RPS. NIRAS had not advised RPS of any problem arising from past occupation of the rooms.

34. It was agreed that Mr Churcher would draft some questions to send to Mr Duffy, to be forwarded to NIRAS, in an attempt to clarify the situation.

35. Dr O'Boyle and Mr Churcher undertook to prepare draft minutes of the meeting.

Appendix 1

[insert radon measurements provided by Dr Bidey 21/8/00]

Appendix 2

Radiation Protection Dosimetry paper abstract

Citation: Radiat. Prot. Dosim. 79(1-4), pp 129-132 (1998)

Retrospective Estimation of Exposure to Short-lived 222Rn Progeny by Measurements of 210Pb in the Skull

R. Scheler, K. Dettmann and J. Brose

The inhalation of 222Rn and its short-lived decay products results in the exposure of the respiratory tract followed by the skeletal deposition of 210Pb originating in the lung from 214Po. By measurement of the 210Pb activity in the skull it could be possible to estimate previous exposures for a known relationship between 210Pb content in the skeleton and exposure. The measurement technique consists of two arrays of low energy germanium detectors (LEGe) with a total active area of 8000 mm2 installed in a large shielded chamber. The interpretation of estimated 210Pb deposit in terms of exposure can be made by using 'conversion coefficients' KE(tm) for the relationship between the 210Pb activity A(tm) and cumulative exposure. The decision limit of 210Pb for the total skeleton in a counting time of 7200 s was estimated to be 17 Bq, or about 0.9 J.h.m-3 (250 WLM) of exposure. The results of the first measurements of a group of individuals living in high radon prone areas show a good qualitative correspondence with the expected 210Pb content of the skeleton.

From: **John Churcher <churcher@psy.man.ac.uk>**
To: **Kevin Robinson <Kevin.Robinson@man.ac.uk>**
Subject: **Radiation levels in Coupland I, Floor 2**
Copies to: **Geoff Beattie <beattie@fs4.psy.man.ac.uk>, Steve Bidey <Steve.Bidey@man.ac.uk>**
Send reply to: **churcher@psy.man.ac.uk**
Date sent: **Thu, 12 Jul 2001 22:21:23 +0100**

Mr Kevin Robinson
Radiological Protection Service

12th July 2001

Dear Mr Robinson

I am one of the members of academic staff in Psychology who were obliged to vacate Coupland I during the winter of 1999-2000 to facilitate building works. On 20th February this year, with Peter Harforth who was then our Departmental Superintendent, I visited my room there (second floor, room 2.63, formerly D10) to recover some experimental equipment. We discovered that my room had been labelled a radiation hazard zone and left in a mess with floorboards lifted and not replaced. There were also markings to the floor and walls which suggested that local radiological measurements had been made.

Peter Harforth told me that he remembered seeing a report by the Radiological Protection Service, which he thought might include details of measurements made by the Service together with a risk assessment. He promised to obtain a copy for me, but I did not receive it until shortly before he retired last month. The report he eventually sent me only contains information about measurements made in rooms G54 and G55, and does not mention my room or any room on the second floor. He advised me to contact you for further information.

Could you please tell me whether radiological measurements were in fact made in my room, and if so what were the results? I occupied this room continuously for the twenty years preceding the move, and I would like to know if there are any health and safety implications of my having been exposed to ionising radiation during that time.

Yours sincerely,

John Churcher
Lecturer in Psychology

Cc: Professor Beattie; Dr Bidey

University Health and Safety Services

Radiological Protection Service,
University of Manchester
7th Floor, Williamson Building,
Oxford Road,
Manchester M13 9PL

Dr S.P. Bidey
Radiation Protection Adviser
Telephone: 0161-275-6983
Fax: 0161-275-6984
E-mail: steve.bidey@man.ac.uk

THE UNIVERSITY of MANCHESTER

Dr John Churcher,
Dept of Psychology,
University of Manchester

13th July 2001

Dear Dr Churcher,

I refer to your e-mail to Kevin Robinson of 12th July, copied to myself, regarding Room 2-63 in the Coupland I Building. I can confirm that radiological measurements were indeed made in this room in connection with remediation of radioactive contamination in the Building.

A report was produced by the University Radiological Protection Service, dated 20th June 2000, detailing the potential radiation dose rates to personnel in each of the affected areas. This is presumably the report that Peter Harforth mentioned to you. In the case of Room 2-63, low-level localised radium-226 contamination was found in the area of the wall above the hand wash basin. Contamination was fixed, underneath the paint surface. Our measurements indicated that the radiation dose rate at a distance of 1 metre from the wall corresponded to a potential received dose of 0.005 microsieverts per week. Under the then applicable Ionising Radiations Regulations 1985, the radiation dose limit for employees was 50 mSv/year, with a dose constraint of 15 mSv/year. Accordingly, even assuming a 52 week working year, your annual dose would have been 0.26 mSv, i.e. 1.7% of the dose constraint, or 0.52% of the legal dose limit.

Understandably, the HSE wished to be reassured that occupants of the affected areas had not received an annual radiation dose approaching the legal limit. The calculated potential doses received in each of the affected areas, including room 2-63, were submitted to HSE at their request, and these were accepted by their Specialist Inspector (Radiation) of Health and Safety as being well within the dose constraints.

As Radiation Protection Adviser therefore, I hope that I can reassure you that your radiation exposure during the period of occupancy preceding the move would have been negligible.

Yours Sincerely

Dr Steve Bidey
Radiation Protection Adviser

From: **John Churcher <churcher@psy.man.ac.uk>**
To: **Dr Steve Bidey <Steve.Bidey@man.ac.uk>**
Subject: **Re: Radiation levels in Coupland I, Floor 2**
Copies to: **Professor Geoff Beattie <beattie@fs4.psy.man.ac.uk>**
Send reply to: **churcher@psy.man.ac.uk**
Date sent: **Wed, 31 Oct 2001 19:10:16 -0000**

Dr Steve Bidey
Radiation Protection Adviser
Radiological Protection Service

31st October 2001

Dear Dr Bidey,

Thankyou for your letter of 13th July, which was helpful and detailed. Please accept my apologies for not acknowledging it sooner.

The report by the University Radiological Protection Service dated 20th June 2000, which you mention in your letter, appears to be different from the one that Peter Harforth showed to me, which was dated 4th July 2000. Could I please see a copy of the report which you mention?

While I am to some extent reassured by the figures you quote in your letter, there is a discrepancy which I want to bring to your attention, between the information you have provided about radiological measurements made in room 2-63, and what I have observed there.

On the blackboard in this room someone has written the following note in chalk:

"(1) Empty room
(2) tent
(3) Remove floor coverings with monitoring
4) Remove floor boards where contaminated
5) Look for Pb-210 under f.b."

The areas of floorboard which have in fact been removed are (i) an area of a few square inches by the sink; (ii) an area of similar size near the door to the adjoining room; (iii) an area about 2 feet by 2 feet, at the north-east end of the room under the right-hand window. This third area, by far the largest, is immediately beneath where I sat for most of the time I was working in the room.

In your letter you refer only to radium-226 contamination, and only in the area of the wall above the hand wash basin, the implication being that there was no contamination found elsewhere in the room. Is this the case? If so, can you tell me why the largest area of floorboard was removed at the north-east end of the room? Was contamination other than with radium-226 found anywhere in the room?

I would be grateful for your comments.

Yours sincerely,

John Churcher
Lecturer in Psychology

University Health and Safety Services

Radiological Protection Service,
University of Manchester
7th Floor, Williamson Building,
Oxford Road,
Manchester M13 9PL

Dr S.P. Bidey
Radiation Protection Adviser
Telephone: 0161-275-6983
Fax: 0161-275-6984
E-mail: steve.bidey@man.ac.uk

THE UNIVERSITY of MANCHESTER

Dr John Churcher,
Dept of Psychology,
University of Manchester

2nd November 2001

Dear Dr Churcher,

Thank you for your email of 31st October. I am enclosing with this letter a copy of the report (dated 20th June 2000) to which I referred in my earlier correspondence of 13th July. You will recall that the radiation survey to this report relates was undertaken on the emptied room (2-63), before demolition/reconstruction commenced, and that contamination with radium-226 was found in the area of the wall above the hand wash basin, underneath the paint surface. During this initial survey, the upper surface of the vinyl floor surface was also monitored using standard instrumentation, and no abnormal radiation dose was detected.

As you may be aware, contamination was found in a number of additional rooms in the Coupland I building, and based largely on the likely extent of the remediation required, a specialist decommissioning company (NIRAS Ltd) was appointed to act as Radiological Protection Adviser to Hayverns Limited, who were contracted to carry out the removal of contaminated building fabric. In a number of rooms, and in the absence of a floor covering, NIRAS detected low-level Pb-210 contamination on the sides and undersides, but NOT the top surface of the floorboards, in localised areas. Removal of the vinyl flooring, in several areas, was advised, prior to reinvestigation for floor-associated radioactivity. These rooms included 2-63, and would account for your observations of floorboards having been removed in the areas you describe in your letter.

On removal of the vinyl floor coverings from rooms 2-62 and 2-63, contamination with Pb-210 was indeed found, albeit at very low levels. As in other areas, this was associated with the sides and undersides of the floorboards, and the underlying lagging material, which were subsequently removed. The ***combined*** activity for rooms 2-62 and 2-63 was 0.48 MBq in a total mass of 64kg of removed material. The presence of this contamination may not have been revealed in the initial survey of these areas (i) because of the location of the bulk of the activity on the *underside* of the flooring, and (ii) because of attenuation by the vinyl floor covering then in place.

If we 'round-up' the total activity of these rooms 2-62 and 2-63 to 0.5 MBq, and assume a "worst case" in which all the activity was derived from a single point source between the floorboards of room 2-63, standard reference tables* indicate that at a distance of 30cm (and assuming no intermediate attenuation by shielding, e.g. vinyl), the radiation dose to body tissues from 0.5 MBq would have been 3.6×10^{-6} mSv h^{-1}. Under the then applicable Ionising Radiations Regulations (1985), the radiation dose limit for employees was 50 mSv/year, with a dose constraint of 15 mSv/year. Accordingly, and assuming a 2000 hour occupancy of room 2-63 during a typical working year, your annual dose *at this distance from the source* would have been:

2000 x 3.6 x 10^{-6} mSv, i.e. **7.2 x 10^{-3} mSv y^{-1}** .

This equates to (7.2 x 10^{-3}/15) %, i.e. 0.00048 % of the applicable dose constraint of 15 mSv, or (7.2 x 10^{-3}/50) %, i.e. 0.000144 % of the legal dose limit of 50 mSv.y^{-1}. This is obviously a very conservative estimate of the dose received, as it assumes that all the activity derived from a single, unshielded point source.

I must apologise for giving you an incomplete picture in my previous letter, which was based solely on the initial survey, and did not take account of the subsequent reinvestigation by the contractors under the guidance of NIRAS, following removal of the floor covering.

However, I hope that I am able to reassure you that your radiation exposure from this (additional) source would have been negligible under the circumstances of normal occupational activity within this room.

Yours Sincerely

Dr Steve Bidey
Radiation Protection Adviser

* Delacroix D., Guerre J.P., Leblanc P. & Hickman C. (1998) "Radiation Protection Dosimetry" vol 76 Nos 1-2, p118.

From:	**John Churcher <churcher@psy.man.ac.uk>**
To:	**Dr Steve Bidey <Steve.Bidey@man.ac.uk>**
Subject:	**Re: Radiation levels in Coupland I, Floor 2**
Copies to:	**Professor Geoff Beattie <beattie@fs4.psy.man.ac.uk>**
Send reply to:	**churcher@psy.man.ac.uk**
Date sent:	**Sun, 18 Nov 2001 15:52:35 -0000**

Dr Steve Bidey
Radiation Protection Adviser
Radiological Protection Service

18th November 2001

Dear Dr Bidey,

Thankyou for your letter of 2nd November in reply to my email of 31st October, and for the care you have taken in giving me a clear and detailed answer to my enquiry.

Yours sincerely,

John Churcher
Lecturer in Psychology

From: **John Churcher <churcher@psy.man.ac.uk>**
To: **Dr Steve Bidey <Steve.Bidey@man.ac.uk>**
Subject: **Re: Radiation levels in Coupland I, Floor 2**
Copies to: **Prof Geoff Beattie <beattie@fs4.psy.man.ac.uk>, Dr Neil Todd <todd@fs4.psy.man.ac.uk>**
Send reply to: **churcher@psy.man.ac.uk**
Date sent: **Tue, 2 Jul 2002 21:44:30 +0100**

From: John Churcher <churcher@psy.man.ac.uk>
To: Dr Steve Bidey <Steve.Bidey@man.ac.uk>
Subject: Re: Radiation levels in Coupland I, Floor 2
Copies to: Prof Geoff Beattie <beattie@fs4.psy.man.ac.uk>, Dr Neil Todd <todd@fs4.psy.man.ac.uk>,
Sally Anne Bray <bray@fs4.psy.man.ac.uk>
Send reply to: churcher@psy.man.ac.uk
Date sent: Tue, 2 Jul 2002 21:40:16 +0100

Dr Steve Bidey
Radiation Protection Adviser
Radiological Protection Service

2nd July 2002 [*please note corrected date*]

Dear Dr Bidey,

I refer to our correspondence between 12th July and 18th November 2001, concerning contamination of Coupland I building, room 2.63.

On 29th May this year I found that a new notice had been attached to the door of the room, which read: "Room 2.63, Monitored by RPS, floor OK, walls OK, 14/5/02, remedial work carried out by NNC Ltd." This suggests that further radiological testing has been carried out since November. In the last few days I learned that members of our Department have been asked not to go into the Cohen Lecture Theatre, which is on the same floor of the building, due to radioactive contamination there. Can you please tell me what tests have been carried out in Coupland I since November, why, and what has been found in them?

In your letter of 2nd November 2001 you mentioned the discovery of Ra-226 underneath the paint surface on one wall of room 2.63. The report enclosed with your letter also mentions alpha in air monitoring during the decommissioning works carried out by Hayverns Limited. What were the results of this monitoring?

Were levels of radon (Rn-222) or of alpha particles in the air in the room also monitored *before* the decommissioning works were begun, and could there have been a health hazard from radon resulting from decay of Ra-226 and diffusing through the paint surface?

I notice that in your letter of 2nd November you refer to the report you enclosed as dated 20th June 2000, whereas the report is actually dated 1/9/00. Can you confirm that

I have the correct document?

Yours sincerely,

John Churcher
Lecturer in Psychology
------- End of forwarded message -------

Department of Psychology
The University of Manchester, Oxford Road,
Manchester M13 9PL
Telephone: 0161-275-2553 *Fax*: 0161-275-2588
Web: http://www.psy.man.ac.uk

THE UNIVERSITY
of MANCHESTER

Dr S P Bidey
Radiation Protection Adviser
Radiological Protection Service
7th Floor, Williamson Building

10th July 2002

Dear Dr Bidey,

Radiation hazards in Coupland 1 building

We are concerned about the continuing possibility of health hazards due to ionising radiation in the Coupland 1 building, in which we worked prior to January 2000, for 20, 20 and 5 years, respectively. We refer to your previous correspondence with Mr Churcher between 12th July and 18th November 2001, and we are writing to request a meeting with you to discuss certain discrepancies and gaps in the information which we currently possess.

In your letter of 13th July 2001 you wrote: "*In the case of Room 2.63, low-level localised radium-226 contamination was found in the area of the wall above the hand wash basin. Contamination was fixed, underneath the paint surface. Our measurements indicated that the radiation dose at a distance of 1 metre from the wall corresponded to a potential received dose of 0.005 microsieverts per week .... Accordingly, even assuming a 52-week working year, the annual dose would have been 0.26 mSv, i.e., 1.7% of the dose constraint*". In your letter of 2nd November, you wrote that "*contamination was found in a number of additional rooms in the Coupland 1 building*", and that NIRAS Ltd. subsequently detected "*low-level Pb-210 contamination on the sides and undersides, but NOT the top surface of the floorboards, in localised areas*". You went on to report that the combined activity for rooms 2.62 and 2.63 was 0.48 MBq in a total mass of 64 kg of removed material, and you calculated that, at a distance of 30 cm, this equates to only 0.00048% of the applicable dose constraint of 15 mSv per year.

Although you indicated that this contamination was detected only 'in localised areas', we are not clear that it may not in fact be more widely and evenly distributed. The implication in your letter is that before removing floorboards the activity was detectable at only very low levels, and then only after first removing the vinyl flooring. It seems possible, therefore, that Pb-210 may also be present in significant quantities under the floorboards where these have *not* yet been lifted, and that local variations in the level of contamination and/or in the effectiveness of shielding by the floorboards makes this undetectable unless boards are removed. In rooms 2.62 and 2.63, it is evident that the

boards covering only a small portion of the floor area have yet been lifted, and it is hard to see how any material under the remaining areas could have been examined or extracted without removing the entire floor. The actual quantity of Pb-210 under the floors of these rooms may thus be greater, and more evenly distributed, than is implied in your letter.

This would be consistent with the possibility that the Pb-210 has resulted from the decay of radon gas (Rn-222) within the building as an intermediate decay product of Ra-226, and that at some time in the past this radon may have been present in the air in one or more of the rooms in Coupland 1, at concentration levels sufficient to damage the health of their occupants, before finding its way to the space under the floorboards, where it would have accumulated and eventually decayed into deposits of Pb-210. Even if the Pb-210 is not evenly distributed, this could be due to local 'pooling' of radon due to uneven surfaces under the floor, and/or differential deposition rates on different materials.

It is not clear whether the Ra-226 found on the wall in room 2.63 is of sufficient quantity to explain all of the Pb-210 under the floor, since (a) we still don't know how much Pb-210 there is, or was, under the floor; and (b) we don't know how much radium there is, or was, on the wall. According to the document enclosed with your letter (headed 'Local Rules Written by the RPA appointed by Hayverns', by Barry Frith and dated 1/9/00), under the heading 'Decommissioning of room 2.63' it is stated that "*Measurements made on samples taken from the location of more readily detectable contamination in room 2.62 have been used to assess the maximum likely exposure. In 2.62 measurements confirm the presence of radium-226 at an activity level of <1.27 Bq/g*". Since we don't know the mass of contaminated material, we can't estimate the amount of Ra-226 which is, or was, there. There is also an apparent discrepancy between this document, and what can be observed in room 2.63. The document states: "*The contaminated area of plaster should be removed by cutting in the clean areas. Once removed debris should be sealed into plastic bags, monitored for surface contamination and taken to CB.10 to be drummed*". There is no plaster in the area above the wash hand basin: the wall is of painted brick, and there is no visible evidence that any bricks have been removed.

Whatever the true quantities of Ra-226 and Pb-210 in rooms 2.62 and 2.63, the amount of radon necessary to produce the 0.48 MBq of Pb-210 activity already found there, if generated at a steady rate by radium sources which have remained in the building since the time of the experiments for which they were prepared, and if diffused through the air within the rooms before finding its way to the space under the floorboards, could be sufficient to cause a serious health risk to the occupants. Similar considerations would apply to any other rooms in which Pb-210 contamination is found. One of us [Dr Todd] has made a number of calculations which are given in the attached Appendix. For example, assuming a constant radium source over 80 years, this would require 0.55 MBq of activity to produce the amount of Pb-210 found by NIRAS Ltd, which is significantly higher than your estimates of radium activity, unless the total amount of contamination on the walls was about 500 kg @ 1Bq/g, but it is not possible to determine the amount of contamination from the figures you have provided. Given the higher relative biological effectiveness of alpha-emitters, including all the active elements in the decay series between radium and Pb-210, it is possible that a single order of magnitude error in estimates of dosage could result in significant biological hazard. It is, of course, possible that the amount of Pb-210 found could simply be the faint glow of residual activity from experiments carried out some 80 years ago by Rutherford and colleagues. Or the material discovered could be the result of *both* residual radium *and* residual Pb-210

contamination. In order to determine which of these contamination scenarios is more likely, radon testing would seem to be necessary.

Since your correspondence with Mr Churcher last year, it appears that further radiological measurements have been made in a number of rooms in the building. In May this year, a handwritten notice was attached to the door of room 2.63, which reads: "*Room 2.63, Monitored by RPS, floor OK, walls OK, 14/5/02, REMEDIAL WORK CARRIED OUT BY NNC Ltd.*" A similar notice on the door of room 2.62 reads: "*Room 2.62, Monitored by RPS, 15/5/02, REMEDIAL WORK CARRIED OUT BY NNC Ltd, One area of floor contamination found and marked with tape.*" Both notices are initialled in the same hand (KJR?), and similar notices are to be found on the doors of all of the rooms in the building, except those on the first floor. Last week we learned that members of our Department have been asked not to enter the Cohen Lecture Theatre, which is on the second floor (the same floor as rooms 2.62 and 2.63), due to radioactive contamination there. And Dr O'Boyle has recently discovered that on the outer door of the rooms (2.52) on the same floor that he occupied for about 20 years, there is now a radiation hazard warning notice, with the warning "DO NOT ENTER", and that a patch of carpet on the floor of the inner room has been marked "CAUTION". This is also the case for the room (2.54) next door to room 2.52.

In view of the concerns which we have detailed above, we should be grateful if you would provide us with answers to the following questions:

- What tests have been carried out in Coupland 1 since November 2001, or are being carried out now, why were they done and what has been found in them?
- Have the rooms on the first floor been tested?
- What radioactive materials have been found in the building, where, in what quantities and at what activity levels?
- Are you satisfied that no more Ra-226 or Pb-210 or other radioactive materials remain to be discovered within the building?
- What assumptions have you made concerning levels of radon gas (Ra-222) and radon progeny in the air inside the building over the past twenty-five years? Were radon levels, or levels of alpha in air, ever monitored in Coupland 1 *before* the decommissioning began?
- If radon levels have not been monitored, would you be willing to start monitoring them immediately, i.e. before any further decontamination of the building?
- Has any radiometric ageing of the Pb-210 been carried out, e.g. by measuring the proportion of residual polonium 210 (Po-210)? This would provide indirect evidence about whether radon has been present while we were occupying the rooms, or only much earlier.
- In your letter of 2nd November, you refer to an enclosed report dated 20th June 2000, whereas the 'Local Rules' document actually enclosed is dated 1/9/00 and is not really a report, but a set of instructions for decommissioning of room 2.63. Is there also a report on the decommissioning work that was actually done, i.e. one prepared after the work was completed?

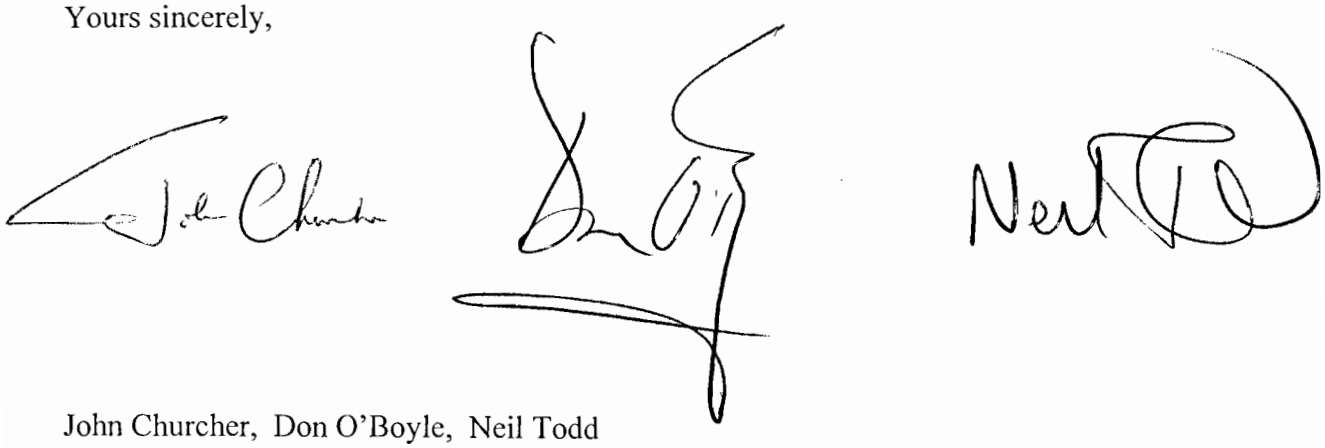
- The 'Local Rules' document mentions alpha in air monitoring to be carried out *during* the decommissioning works carried out by Hayverns Limited. What were the results of this monitoring?

- What is the relationship between the Radiological Protection Service, NIRAS Ltd, NNC Ltd and Hayverns Ltd, and how is responsibility for radiological protection divided between these agencies?

- Would you be willing to supply us with copies of, or allow us access to, any previous documents relating to radiological protection in Coupland 1, to acquisition, storage and use of radioactive materials in the building, to the decontamination of areas in which radioactive materials have been detected, and to the decommissioning of radioactive facilities located there, including records of any measurements made, and the instruments used?

We would be grateful for an early opportunity to meet you to discuss these questions. We are most easily contactable by email at the addresses given below.

Yours sincerely,



John Churcher, Don O'Boyle, Neil Todd
Lecturers in Psychology

churcher@psy.man.ac.uk
oboyle@psy.man.ac.uk
todd@psy.man.ac.uk

APPENDIX: POSSIBLE CONTAMINATION SCENARIOS FOR ROOMS 2.63 AND 2.62

Assume the following:

Atomic weights of Pb-210 and Ra-226 are 82 and 88 respectively.
Half-lives of Pb-210 and Ra-226 are 20 years and 1600 years respectively.
Avogadro's constant = 6.02 * 10E23.
1g Ra-226 has activity of 34 GBq = 3.4 * 10E10 (Rutherford 1913, p 132),
=> 1g Pb-210 has (1600/20) * 3.4 * 10E10 = 2.72 * 10E12 Bq

Mass of Pb-210 in 2.63 and 2.62 = (0.48 * 10E6)/ (2.72 *10E12) = 1.76 * 10E-7 grams

No. atoms Q of Pb-210 = (1.76 * 10E-7 / 82) * 6.02 * 10E23 = 1.29 * 10E15.

Two possible simple models of how this amount of Pb-210 formed.

CASE 1: A constant source of Ra-226 of amount R0 has been present in room for 80 years.

Given length of time, can ignore short half-life elements.

Amount Q of Pb-210 at time t approximately given by

Q = (R0*lambda1/(lambda2 - lambda1))*(exp[-lambda1*t] - exp[-lambda2*t])

(equation (4) from Rutherford (1913) "Radioactive Substances and their Radiations").

where

lambda1 = time-const Ra-226 = 0.693/1600 = 4.33 * 10E-4 (years)-1
lambda2 = time-const Pb-210= 0.693/20 = 0.0345 (years)-1

What is R0?

R0 = Q * (lambda2 - lambda1)/ (lambda1 * (exp[-lambda1*t] - exp[-lambda2*t]))

R0 = Q * (0.0345 - 0.000433)/ (0.000433 * 0.903) = Q*87.1

R0 = 87.1 * 1.29 * 10E15 = 1.12 * 10E17 (since Q = 1.29 * 10E15)

Mass of Ra-226; therefore, 88 * (1.12 * 10E17/ 6.02 * 10E23) = 1.63 * 10-5 grams

This amount of Ra-226 would have an activity of

3.4 * 10E10 * 1.63 * 10-5 = 5.5 * 10E5 = 0.55 MBq

This number is reasonable given that at equilibrium 1 gram of radium will produce about 8.6 milligr of radio-lead (Rutherford 1913) and we have calculated an equivalent of 7.9 milligrams (i.e. calculat ratio of lead to radium is correct order of magnitude).

CASE 2: A constant source of Ra-226 of amount R0 was present in room for 10 years up to 192 Thereafter removed and remaining products allowed to decay

The amount of Pb-210 Q0 that would have been present 80 years ago to produce Q is given by

Q = Q0*exp [-lambda2 * t]

Q0 = Q/exp [-lambda2 * t] = Q*15.8 = 15.8* 1.29 * 10E15 = 2.04 * 1OE16 atoms.

How much radium required to produce this amount of radio-lead in 10 years?

R0 = Q0 * (lambda2 - lambda1)/ (lambda1 * (exp[-lambda1*t] - exp[-lambda2*t]))
where t = 10.

R0 = Q0 * (0.0345 - 0.000433)/ (0.000433 * 0.287) = Q0* 0.034/1.24 * 10E4 = Q0*274

R0 = 5.6 * 10E18 atoms.

Mass of Ra-226 in 1910 would have been 88 * (5.6 * 10E18/ 6.02 * 10E23) = 8.2 * 10E-4 grams,

which would have an activity of 2.4 * 10E6 Bq = 2.4 MBq.

CASE 2b: A constant source of Ra-226 of amount R0 was present in room for 1 year in 1909 during experiments of Royds and Rutherford. Thereafter removed and remaining products allowed to decay.

The amount of Pb-210 Q0 that would have been present 93 years ago to produce Q is given by

Q = Q0*exp [-lambda2 * t]

Q0 = Q/exp [-lambda2 * t] = Q*24.74 = 24.74* 1.29 * 10E15 = 3.2 * 1OE16 atoms.

How much radium required to produce this amount of radio-lead in 1 year?

R0 = Q0 * (lambda2 - lambda1)/ (lambda1 * (exp[-lambda1*t] - exp[-lambda2*t]))
where t = 1.

R0 = Q0 * (0.0345 - 0.000433)/ (0.000433 * 0.033) = Q0* 0.034/1.45 * 10E5 = Q0*2345

R0 = 7.5 * 10E19 atoms.

Mass of Ra-226 in 1909 would have been about 88 * (7.5 * 10E19/ 6.02 * 10E23) = 1.1 * 10E-3 gra

which would have an activity of 3.7 * 10E7 Bq = 37 MBq.

APPENDIX: POSSIBLE CONTAMINATION SCENARIOS FOR ROOMS 2.63 AND 2.62 (corrected version)

Assume the following:

Atomic weights of Pb-210 and Ra-226 are 210 and 226 respectively.
Half-lives of Pb-210 and Ra-226 are 20 years and 1620 years respectively.
Avogadro's constant 6.02 * 10E23.
1g Ra-226 has activity of 37 GBq 3.7 * 10E10 (Rutherford 1913, p 132),
> 1g Pb-210 has activity of **3.22** * 10E12 Bq

Mass of Pb-210 in 2.63 and 2.62 (0.48 * 10E6)/ (3.22 *10E12) **1.48*** 10E-7 grams

No. atoms Q of Pb-210 (1.48 * 10E-7 / 210) * 6.02 * 10E23 **4.24E14**.

Two possible simple models of how this amount of Pb-210 formed.

CASE 1: A constant source of Ra-226 of amount R0 has been present in room for 80 years.

Given length of time, can ignore short half-life elements. Amount Q of Pb-210 at time t approximately given by

Q (R0*lambda1/(lambda2 - lambda1))*(exp[-lambda1*t] - exp[-lambda2*t])

(equation (4) from Rutherford (1913) "Radioactive Substances and their Radiations").

where
lambda1 time-const Ra-226 0.693/1620 4.28 * 10E-4 (years)-1
lambda2 time-const Pb-210 0.693/20 0.035 (years)-1

What is R0?

R0 Q * (lambda2 - lambda1)/ (lambda1 * (exp[-lambda1*t] - exp[-lambda2*t]))
R0 Q * (0.0345 - 0.000428)/ (0.000428 * 0.903) Q*88.1
R0 88.1 * 4.24E14 3.73E16 (since Q 4.24E14)

Mass of Ra-226; therefore, 226* (3.73E16/ 6.02E23) 1.4 * 10-5 grams

This amount of Ra-226 would have an activity of 3.7 * 10E10 * 1.4 * 10-5 5.2 * 10E5 0.52 MBq

This number is reasonable given that at equilibrium 1 gram of radium will produce about 8.6 milligrams of radio-lead (Rutherford 1913) and we have calculated an equivalent of 10.6 milligrams (i.e. calculated ratio of lead to radium is correct order of magnitude).

CASE 2: A constant source of Ra-226 of amount R0 was present in room for 10 years up to 1920. Thereafter removed and remaining products allowed to decay.

The amount of Pb-210 Q0 that would have been present 80 years ago to produce Q is given by

Q Q0*exp [-lambda2 * t]

Q0 Q/exp [-lambda2 * t] Q*15.8 15.8* 4.24E14 6.7E15 atoms.

How much radium required to produce this amount of radio-lead in 10 years?

R0 Q0 * (lambda2 - lambda1)/ (lambda1 * (exp[-lambda1*t] - exp[-lambda2*t]))
where t 10.

R0 Q0 * (0.0345 - 0.000428)/ (0.000428 * 0.288) Q0* 0.034/1.24 * 10E4 Q0*276

R0 1.85 * 10E18 atoms.

Mass of Ra-226 in 1910 would have been 226 * (1.85 * 10E18/ 6.02 * 10E23) 6.9 * 10E-4 grams,

which would have an activity of 2.5 * 10E6 Bq 2.5 MBq.

CASE 2b: A constant source of Ra-226 of amount R0 was present in room for 1 year in 1909 during experiments of Royds and Rutherford. Thereafter removed and remaining products allowed to decay.

The amount of Pb-210 Q0 that would have been present 93 years ago to produce Q is given by

Q Q0*exp [-lambda2 * t]

Q0 Q/exp [-lambda2 * t] Q*24.74 24.74* 4.24E14 1.05E16 atoms.

How much radium required to produce this amount of radio-lead in 1 year?

R0 Q0 * (lambda2 - lambda1)/ (lambda1 * (exp[-lambda1*t] - exp[-lambda2*t]))
where t 1.

R0 Q0 * (0.0345 - 0.000428)/ (0.000428 * 0.0336) Q0* 0.034/1.45 * 10E5 Q0*2369

R0 2.5 * 10E19 atoms.

Mass of Ra-226 in 1909 would have been about 226 * (2.5E19/ 6.02E23) 9.38E-3 grams,

which would have an activity of 3.5 * 10E7 Bq 35 MBq.

From: **John Churcher <churcher@psy.man.ac.uk>**
To: **Dr Steve Bidey <Steve.Bidey@man.ac.uk>**
Subject: **Re: Radiation hazards in Coupland 1 building**
Copies to: **Dr Don O'Boyle <oboyle@psy.man.ac.uk>, Dr Neil Todd <todd@fs4.psy.man.ac.uk>, Mr Kevin J Robinson <mwxsskjr@mail1.mcc.ac.uk>, Prof. Geoffrey Beattie <beattie@fs4.p**
Send reply to: **churcher@psy.man.ac.uk**
Date sent: **Thu, 25 Jul 2002 00:49:25 +0100**

Dear Dr Bidey,

Thankyou for meeting with Dr O'Boyle and me on Tuesday (23rd July), and for giving us your time and assistance. Please convey our thanks also to Mr Robinson.

We are preparing draft minutes of our discussion, which we were hoping to send you by the end of this week, but we are unable to complete them until after we return from holidays on 13th August. As you know, we are trying to gather as complete a set as possible of documents relevant to the radioactive contamination of Coupland 1, and we currently have received only the following from you:

Untitled report by Kevin Robinson dated 11th October 1999 (2 pages);

Untitled report by Kevin Robinson dated 18th October 1999 (2 pages);

"Potential radiation dose received as a result of entering the rooms listed below" by Kevin Robinson, dated 27th June 2000 (1 page);

Untitled report by E Kelly dated 4 July 00 (2 pages);

"Local Rules Written by the RPA appointed by Hayverns", by Barry Frith, dated 1/9/00 (2 pages);

"Residual contamination survey of Coupland 1 Building, the Annexe and the Old Dental Hospital", by SM Adams of NIRAS/NNC Ltd, Issue 02, September 2000 (21 pages, including Appendices, and Addendum by Barry Frith);

Letter from Dr Jo Nettleton, HM Specialist Inspector (Radiation) of Health and Safety, to Dr Susan A Robson, dated 4th October 2000 (2 pages);

Draft report by S. Adams dated 20/03/01, on estimation of total activity per drum (4 pages);

"Report on the Estimation of Drum Activity of Waste Removed from Coupland 1 Building" by SM Adams, Issue 1, dated 9th April 2001 (9 pages including Appendix;)

"Coupland One Building Temporary Refurbishment Project", by Kevin Robinson dated 20th May 2002 (4 pages);

In addition we have a collection of items, collated as a single document and hand-numbered (v) to (viii), which appear to be part of a sequence of appendices to some other document. These are:

(v) "Local Rules Written by the RPA appointed by the University of Manchester", by B. Frith, dated 22 June 2000 (2 pages);

(vi) "Hazard Data Re: Supervised Areas Designated in Coupland 1 Building, the Annex, and The Old Dental Hospital" (1 page);

(vii) "Determination of Rn222 in air Re. Museum hazard assessment", dated 28/06/00 (1 page);

(viii) "Non radon alpha activity in air Manchester Museum Project" (1 page).

Could you please provide us with copies of:

(a) any reply by the University to the letter from Dr Jo Nettleton dated 4th October 2000;

(b) the document to which the items marked (v) to (viii) were appended, together with appendices (i) to (iv), and any others;

(c) any other documents you have which refer to radioactive contamination in Coupland 1 building, including correspondence between the University, the Health and Safety Executive, NIRAS/NNC Ltd, BNFL, Hayverns, .

When we met in your office, we noticed that all the documents you showed us were taken from a single collection which you referred to as the 'Museum' file. Would you allow us, under your supervision, to look through this collection in your office, in order to satisfy ourselves that we have as complete a set as possible of documents relevant to Coupland 1? Alternatively, can you assure us that nothing else in that file is potentially relevant to the questions we have brought to your attention?

Meanwhile we look forward to meeting with you and Mr Robinson again, and with Dr Prime, Dr Todd and Mr Duffy, towards the end of August as agreed.

Your sincerely,

John Churcher

University Health and Safety Services

Radiological Protection Service,
University of Manchester
7th Floor, Williamson Building,
Oxford Road,
Manchester M13 9PL

Dr S.P. Bidey
Radiation Protection Adviser
Telephone: 0161-275-6983
Fax: 0161-275-6984
E-mail: steve.bidey@man.ac.uk

THE UNIVERSITY of MANCHESTER

Mr John Churcher,
Department of Psychology,
University of Manchester

25th July 2002

Dear Dr Churcher,

Thank you for your e-mail received this morning. I have noted your request for the additional documents (a-c) on page 2 of your e-mail.

As regards item (a), you will recall that correspondence between HSE and the university was directed to Dr Susan Robson, as Director of Health and Safety, and not to myself. I do not therefore have a copy of the university's response to Dr Nettleton's letter of 4th October 2000, and you should therefore contact Dr Robson directly for this. What I can provide you with is a copy of the information that was requested by HSE, which was provided by NIRAS for Dr Robson's reply, and which is enclosed.

With regard to item (b), the items labeled v-viii (Local Rules and hazard data – NIRAS origin) represent four of the items of information requested by HSE following the initial visit of their inspector to the university in July 2000. A copy of my letter to HSE which accompanied these items (dated 6th July 2000) is enclosed. Of the remaining four items (i-iv), you already have item i, but I enclose a further copy for your information. Items (ii-iv) are probably not relevant to any of the questions you are asking, but the DRS in the Museum (Dr David Green) has these documents, which specifically relate to mineral inventories and storage conditions/handling procedures within the museum. Please contact Dr Green if you wish to inspect these.

There is one further document which I think you should see, issued by NIRAS in January 2001 (C5952/0008), which describes the radiological conditions remaining in remediated rooms in the Coupland 1 Building. I enclose a copy for your information.

Although you now have all the available documentation relating to the waste activities removed, together with the pre-existing and remediated radiation dose levels, we obviously have further documents in the "Museum" file. However, the vast majority of this is (i) correspondence in respect of our Authorisation with the Environment Agency for the storage and disposal of the waste material, (ii) correspondence between NIRAS and BNFL relating to the acceptance criteria for the drummed waste, and (iii) correspondence and certification relating to transportation of the loaded isocontainer to BNFL. You are obviously welcome to view these, should you so wish.

Finally, you may already know that we have ordered 15 of the radon tracker devices from BNFL, and Kevin Robinson will be in contact with you in due course regarding the installation of these.

Yours sincerely,

Dr Stephen P. Bidey
Radiation Protection Adviser

c.c. Dr Susan Robson, Director of Health and Safety

From: John Churcher <churcher@psy.man.ac.uk>
To: Dr Steve Bidey;
cc: Kevin J Robinson; Sally Bray; John Duffy; Richard Sandland; Don O"Boyle; Neil Todd; Geoff Beattie;
Subject: NRPB radon measurements in Coupland 1 building
Date: 25 October 2002 16:48:42

Dear Dr Bidey,

I understand from our Departmental Administrator, Sally Bray, that Estates and Services will be preparing for re-wiring work in Coupland 1 early in November. The NRPB radon monitors which you installed there following our meeting on 23rd July will shortly have been in place for three months, which is the normal measurement period specified by NRPB. Will you be taking steps to ensure that these are removed and returned safely to NRPB for analysis before there is any chance of their being inadvertently removed, contaminated or interfered with by the contractors?

Yours sincerely,

John Churcher

From: John Churcher <churcher@psy.man.ac.uk>
To: Dr Steve Bidey;
cc: Kevin J Robinson; Sally Bray; John Duffy; Richard Sandland; Don O"Boyle; Neil Todd; Geoff Beattie;
Subject: (Fwd) NRPB radon measurements in Coupland 1 building
Date: 11 November 2002 19:05:12

Dear Dr Bidey,

I wrote to you on 25th October as below, and received a reply from Kevin Robinson saying the matter would be dealt with in a few days, since when I have heard nothing from you or from him.

Have the radon detectors in Coupland I been retrieved and returned to NRPB yet? I understand that contractors may be commencing work after
the end of this week, and I am concerned to ensure that these radon measurements will not be compromised.

Yours sincerely,

John Churcher

From:
To: churcher@fs4.psy.man.ac.uk
Subject:NRPB radon measurements in Coupland 1 building
Date sent: Fri, 25 Oct 2002 17:39:55 +0100

I am on holiday for a few days.

Your e-mail will be dealt with as soon as possible, upon my return.

Best regards,

Kevin Robinson.

------- Forwarded message follows -------
From: John Churcher
To: Dr Steve Bidey
Subject: NRPB radon measurements in Coupland 1 building
Copies to: Kevin J Robinson , Sally Bray ,
John Duffy , Richard Sandland ,
Don O'Boyle , Neil Todd ,
Geoff Beattie
Send reply to: churcher@psy.man.ac.uk

Date sent: Fri, 25 Oct 2002 16:48:42 +0100

Dear Dr Bidey,

I understand from our Departmental Administrator, Sally Bray, that Estates and Services will be preparing for re-wiring work in Coupland 1 early in November. The NRPB radon monitors which you installed there
following our meeting on 23rd July will shortly have been in place for three months, which is the normal measurement period specified by NRPB. Will you be taking steps to ensure that these are removed and returned safely to NRPB for analysis before there is any chance of their being inadvertently removed, contaminated or interfered with by the contractors?

Yours sincerely,

John Churcher

From: Dr. Stephen Bidey <Sbidey@fs1.scg.man.ac.uk>
To: churcher@fs4.psy.man.ac.uk;
Subject: Re: (Fwd) NRPB radon measurements in Coupland 1 building
Date: 12 November 2002 09:40:42

Dr Churcher -

Radon monitors have been retrieved and sent to NRPB.

Please note that no date has yet been fixed for contractors to commence the Coupland I rewiring project. Please consult with Patrick Seller in the university design office over the timing of this.

Dr Stephen P. Bidey, Radiological Protection Service,
7th Floor Williamson Building, Oxford Road,
Manchester M13 9PL, U.K.
Telephone: 0161-275-6983
Fax: 0161-275-6984
E-mail: steve.bidey@man.ac.uk

From: John Churcher <churcher@psy.man.ac.uk>
To: Dr. Stephen Bidey;
cc: Don O"Boyle; Neil Todd; Kevin J Robinson;
Subject: Re: (Fwd) NRPB radon measurements in Coupland 1 building
Date: 13 November 2002 17:17:12

Dear Dr Bidey,

Thankyou for confirming that the radon monitors have been retrieved and sent to NRPB. Please would you let me know when you have the results?

Yours sincerely,

John Churcher

From: "Dr. Stephen Bidey"
Organization: University of Manchester
To: churcher@fs4.psy.man.ac.uk
Date sent: Tue, 12 Nov 2002 09:40:42 +0000
Subject: Re: (Fwd) NRPB radon measurements in Coupland 1 building
Priority: normal

> Dr Churcher -
>
> Radon monitors have been retrieved and sent to NRPB.
>
> Please note that no date has yet been fixed for contractors to
> commence the Coupland I rewiring project. Please consult with
> Patrick Seller in the university design office over the timing of
> this.
>
>
> Dr Stephen P. Bidey, Radiological Protection Service,
> 7th Floor Williamson Building, Oxford Road,
> Manchester M13 9PL, U.K.
> Telephone: 0161-275-6983
> Fax: 0161-275-6984
> E-mail: steve.bidey@man.ac.uk

From: Dr. Stephen Bidey <Sbidey@fs1.scg.man.ac.uk>
To: churcher@fs4.psy.man.ac.uk;
Subject: Re: (Fwd) NRPB radon measurements in Coupland 1 building
Date: 13 November 2002 17:35:38

From: "John Churcher"
To: "Dr. Stephen Bidey"
Date sent: Wed, 13 Nov 2002 17:17:20 -0000
Subject: Re: (Fwd) NRPB radon measurements in Coupland 1 building
Send reply to: churcher@fs4.psy.man.ac.uk
Copies to: Don O'Boyle ,
Neil Todd ,
Kevin J Robinson
Priority: normal

> Dear Dr Bidey,
>
> Thankyou for confirming that the radon monitors have been retrieved
> and sent to NRPB. Please would you let me know when you have the
> results?
>
> Yours sincerely,
>
> John Churcher
>
> From: "Dr. Stephen Bidey"
>
> Organization: University of Manchester
> To: churcher@fs4.psy.man.ac.uk
> Date sent: Tue, 12 Nov 2002 09:40:42 +0000
> Subject: Re: (Fwd) NRPB radon measurements in
> Coupland 1 building
> Priority: normal
>
> > Dr Churcher -
> >
> > Radon monitors have been retrieved and sent to NRPB.
> >
> > Please note that no date has yet been fixed for contractors to
> > commence the Coupland I rewiring project. Please consult with
> > Patrick Seller in the university design office over the timing of
> > this.
> >
> >

> > Dr Stephen P. Bidey, Radiological Protection Service,
> > 7th Floor Williamson Building, Oxford Road,
> > Manchester M13 9PL, U.K.
> > Telephone: 0161-275-6983
> > Fax: 0161-275-6984
> > E-mail: steve.bidey@man.ac.uk
>
>
>_____

I will do this, of course. Based on the last time we had such an assessment done by NRPB, the results may take 2 - 3 months to appear.

Steve Bidey

Dr Stephen P. Bidey, Radiological Protection Service,
7th Floor Williamson Building, Oxford Road,
Manchester M13 9PL, U.K.
Telephone: 0161-275-6983
Fax: 0161-275-6984
E-mail: steve.bidey@man.ac.uk

From: John Churcher <churcher@psy.man.ac.uk>
To: Dr. Stephen Bidey;
Subject: Re: (Fwd) NRPB radon measurements in Coupland 1 building
Date: 18 November 2002 21:46:38

Dear Dr Bidey,

I understand from NRPB that they expect these results to be ready by the end of the month. So perhaps things have improved since we last used the service.

John Churcher

From: Dr Don O"Boyle <Oboyle@fs1.fse.man.ac.uk>
To: churcher@fs1.fse.man.ac.uk;
Subject: (Fwd) Re: radon detectors
Date: 19 December 2002 16:44:26

------- Forwarded message follows -------
From: "Dr. Stephen Bidey"
Organization: University of Manchester
To: oboyle@fs4.psy.man.ac.uk
Date sent: Wed, 18 Dec 2002 11:00:27 +0000
Subject: Re: radon detectors
Priority: normal

From: "Dr Don O'Boyle"
Organization: University of Manchester
To: steve.bidey@man.ac.uk
Date sent: Wed, 18 Dec 2002 10:47:23 +0000
Subject: radon detectors
Send reply to: oboyle@fs4.psy.man.ac.uk
Priority: normal

> Dear Dr Bidey,
> Any sign of the results from the radon detectors in Coupland I?
> Best wishes,
> Don O'Boyle
>
>
> ******************************
> Dr Donald J O'Boyle
> Department of Psychology,
> University of Manchester,
> Coupland Street,
> Manchester M13 9PL
> U.K
>
> email: oboyle@psy.man.ac.uk
> Tel: +44 (0)161-275-2590
> Fax: +44 (0)161-275-2685
> Dept tel: +44 (0)161-275-2585
> ******************************

No inforamtion yet. I will forward it when we receive it from NRPB.

Dr Stephen P. Bidey, Radiological Protection Service,
7th Floor Williamson Building, Oxford Road,
Manchester M13 9PL, U.K.
Telephone: 0161-275-6983
Fax: 0161-275-6984
E-mail: steve.bidey@man.ac.uk
------- End of forwarded message -------

****

Dr Donald J O'Boyle
Department of Psychology,
University of Manchester,
Coupland Street,
Manchester M13 9PL
U.K

email: oboyle@psy.man.ac.uk
Tel: +44 (0)161-275-2590
Fax: +44 (0)161-275-2685
Dept tel: +44 (0)161-275-2585
****

From: John Churcher <churcher@psy.man.ac.uk>
To: Dr. Stephen Bidey;
cc: John Duffy; Don O"Boyle; Neil Todd;
Subject: Documents mentioned by Stephanie Adams
Date: 21 November 2002 15:11:58

Dr Steve Bidey

Radiation Protection Adviser

Radiological Protection Service

21st November 2002

Dear Dr Bidey,

In her reply dated 8th October to Mr Duffy's letter of 6th September, Stephanie Adams of NIRAS mentions three documents which appear to be relevant to our discussions, but which I believe I have not seen. These are referred to in her letter as: (i) L2000103; (ii) a Waste Characterisation document which gained BNFL approval before disposal; and (iii) MTC/01/024. Do you have copies of any or all of these, and if so please could I have copies of them?

Your sincerely,

John Churcher

University Health and Safety Services

Radiological Protection Service,
University of Manchester
7th Floor, Williamson Building,
Oxford Road,
Manchester M13 9PL

Dr S.P. Bidey
Radiation Protection Adviser
Telephone: 0161-275-6983
Fax: 0161-275-6984
E-mail: steve.bidey@man.ac.uk

THE UNIVERSITY of MANCHESTER

Mr J. Churcher,
Dept of Psychology,
Coupland I Building,
University of Manchester

22nd November 2002

Dear Mr Churcher,

Further to your e-mail of 21st November, please find enclosed copies of the following documents generated by NIRAS Limited:

L2000103 (Analytical Report dated 18th August 2000);
MTC/01/024 (Final Report on the Decommissioning of Rooms 2.62 and 2.63, dated July 2001);
Wastestream Characterisation Document for LLW Waste Disposal to BNFL.

Yours sincerely,

Dr S.P. Bidey

From: John Churcher <churcher@psy.man.ac.uk>
To: Dr. Stephen Bidey;
cc: Don O"Boyle; Neil Todd;
Subject: Re: Documents mentioned by Stephanie Adams
Date: 02 December 2002 23:32:01

Dr Steve Bidey
Radiation Protection Adviser
Radiological Protection Service

2nd December 2002

Dear Dr Bidey,

Thankyou for your prompt reply to my email of 21st November and for sending me copies of the three documents requested. Page 4 of document L2000103 (the NIRAS Analytical Report) is missing from the copy you sent me. This is apparently the page on which the actual results are given. Please would you send me a copy of this missing page?

I was surprised to find that document MTC/01/024, which you also sent,
is the 'Final Report for the Decommissioning of Rooms 2.62 and 2.63', and that it contains radon and non-radon dose calculations for these rooms. At our meeting with you on 23rd July you agreed to provide Dr O'Boyle and me with all the relevant documents, and much of our second meeting on 21st August was taken up with discussion of precisely these two rooms, one of which was my office. When we asked why these rooms were not mentioned in the main final report from NIRAS (MTC/01/005), you told us they had not been part of the original contract, and that there was no supplementary final report dealing with them. Yet three months later, when I give you the document number from Stephanie Adams' letter, you send me the report the following day.
The relevance of this document to our enquiries could not be plainer, so why did you not send it to us three months ago?

Dr O'Boyle and I are still preparing minutes of our meeting on 21st August, but this is proving to take longer than expected. We will send you the draft as soon as it is completed.

Yours sincerely,

John Churcher

University Health and Safety Services

Radiological Protection Service,
University of Manchester
7th Floor, Williamson Building,
Oxford Road,
Manchester M13 9PL

Dr S.P. Bidey
Radiation Protection Adviser
Telephone: 0161-275-6983
Fax: 0161-275-6984
E-mail: steve.bidey@man.ac.uk

THE UNIVERSITY of MANCHESTER

Mr J. Churcher,
Department of Psychology,
Coupland I Building,
University of Manchester.

3rd December 2002

Re: Documents mentioned by Stephanie Adams

Dear Mr Churcher,

Thank you for your e-mail of 2nd December. I enclose a copy of page 4 of the NIRAS document L2000103, which you should have received with my earlier mailing.

We apologise for the fact that the NIRAS document MTC/01/005, which relates to the Final Decommissioning of Rooms 2.62 and 2.63, was not included in the documentation that you received earlier in the year. As you know, decommissioning of these rooms did not form part of the original NIRAS contract with the Manchester Museum and therefore the report was not filed with the documentation relating to the main contract. You should indeed have received this at an earlier stage and I apologise again for this oversight. As this document was generated by NIRAS, please feel free to contact Barry Frith or Stephanie Adams if you have any queries.

We anticipate receiving radon monitoring data from NRPB within the next few weeks, and will forward you a copy of that report. In the meantime, I look forward to receiving the minutes of our meeting held on 21st August, when you have prepared these.

Yours sincerely,

Dr Stephen Bidey

From: John Churcher <churcher@psy.man.ac.uk>
To: Dr Steve Bidey;
cc: John Duffy; Don O"Boyle; Neil Todd;
Subject: Re: Documents mentioned by Stephanie Adams
Date: 04 December 2002 17:02:01

Dr Steve Bidey
Radiation Protection Adviser
Radiological Protection Service

4th December 2002

Dear Dr Bidey,

Many thanks for your prompt written reply to my email of 2nd December, and for sending me the missing page of the NIRAS document.

I am grateful for your suggestion that I contact Barry Frith or Stephanie Adams with any queries, and I may have some follow-up queries to Ms Adams' letter of 8th October, a copy of which I assume you have received by now from John Duffy. Mr Duffy has asked, however, that any further communication with NIRAS should go through him, as there is a contractual chain that he would like to preserve. I can see the wisdom of this and for the time being at least I shall send any further queries to him for forwarding to NIRAS.

Yours sincerely,

John Churcher

From: John Churcher <churcher@psy.man.ac.uk>
To: Dr Steve Bidey;
cc: John Duffy; Don O"Boyle; Neil Todd; Kevin J Robinson;
Subject: Draft minutes of meeting on 21st August 2002
Date: 22 December 2002 17:42:10

Dr Steve Bidey
Radiation Protection Adviser
Radiological Protection Service

22nd December 2002

Dear Dr Bidey,

Attached are our draft minutes of the meeting on 21st August. I apologise for the length of time it has taken to produce them, but the quality of the tape-recording was poor and this has slowed us down considerably.

We will be asking for a further meeting with you sometime in the New Year, but in the meantime please would you let me know if you find anything in these draft minutes which appears to be inaccurate?

Also, would you please forward a copy to Dr Prime with a request for his comments, or let me know his email and/or postal address so that I may do so?

Yours sincerely,

John Churcher

Attachments:
C:\My Documents\University\Radiation\Minutes of a meeting held on 21st August 2002.doc

From: Dr. Stephen Bidey <Sbidey@fs1.scg.man.ac.uk>
To: churcher@fs4.psy.man.ac.uk;
Subject: Re: Draft minutes of meeting on 21st August 2002
Date: 07 January 2003 10:30:57

Dear Dr Churcher,

Thank you for the draft minutes. I have forwarded a copy of these to Dr Prime and we will get back to you with any comments, in due course.

I would be grateful if you would give us as much notice as possible of any further meeting that you wish to convene - January and February are extremely busy months for me with regard to undergraduate teaching. I would also appreciate an advance agenda of the items that you would wish to cover in a further meeting.

Thanks,

Dr Steve Bidey
Dr Stephen P. Bidey, Radiological Protection Service,
7th Floor Williamson Building, Oxford Road,
Manchester M13 9PL, U.K.
Telephone: 0161-275-6983
Fax: 0161-275-6984
E-mail: steve.bidey@man.ac.uk

From: John Churcher <churcher@psy.man.ac.uk>
To: Dr. Stephen Bidey;
cc: Don OBoyle; Neil Todd;
Subject: Re: Draft minutes of meeting on 21st August 2002
Date: 09 January 2003 11:06:56

Dear Dr Bidey,

I look forward to receiving your comments on the draft minutes, and any
by Dr Prime, in due course.

Have you still not received the results of the radon monitoring from NRPB? When I spoke to a lady there in mid-November she gave me to understand that she expected the results to be available by the end of November.

Yours sincerely,

John Churcher

From: "Dr. Stephen Bidey"
Organization: University of Manchester
To: churcher@fs4.psy.man.ac.uk
Date sent: Tue, 7 Jan 2003 10:30:57 +0000
Subject: Re: Draft minutes of meeting on 21st August 2002
Priority: normal

> Dear Dr Churcher,
>
> Thank you for the draft minutes. I have forwarded a copy of these to
> Dr Prime and we will get back to you with any comments, in due course.
>
>
> I would be grateful if you would give us as much notice as possible of
> any further meeting that you wish to convene - January and February
> are extremely busy months for me with regard to undergraduate
> teaching. I would also appreciate an advance agenda of the items that
> you would wish to cover in a further meeting.
>
> Thanks,
>
> Dr Steve Bidey

> Dr Stephen P. Bidey, Radiological Protection Service,
> 7th Floor Williamson Building, Oxford Road,
> Manchester M13 9PL, U.K.
> Telephone: 0161-275-6983
> Fax: 0161-275-6984
> E-mail: steve.bidey@man.ac.uk

From: Dr. Stephen Bidey <Sbidey@fs1.scg.man.ac.uk>
To: churcher@fs4.psy.man.ac.uk;
Subject: Re: Draft minutes of meeting on 21st August 2002
Date: 09 January 2003 13:20:38

Dear Mr Churcher,

Further to your enquiry, Kein Robinson contacted NRPB earlier this week concerning the radon monitoring results. he was informed that the raw data is currently in the process of being dealt with by one of their senior Scientific Staff. I will convey further information to you once it is to hand.

yours sincerely,

Steve Bidey

Dr Stephen P. Bidey, Radiological Protection Service,
7th Floor Williamson Building, Oxford Road,
Manchester M13 9PL, U.K.
Telephone: 0161-275-6983
Fax: 0161-275-6984
E-mail: steve.bidey@man.ac.uk

University Health & Safety Services

Radiological Protection Service

7th Floor, Williamson Building, Oxford Road, Manchester M13 9PL

THE UNIVERSITY
of MANCHESTER

Mr J. Churcher
Department of Psychology
Coupland 1 Building
University of Manchester

14th January 2003

Dear Mr. Churcher,

Please find enclosed a copy of the results from the NRPB radon tracker devices placed in the rooms specified.

These results are below that allowed under current legislation for exposure as an employee.

Please note the date of the NRPB report.

K Robinson

From: John Churcher <churcher@psy.man.ac.uk>
To: Mr Kevin Robinson;
cc: Dr. Stephen Bidey; Don OBoyle;
Neil Todd;
Subject: NRPB report
Date: 18 January 2003 20:40:03

Dear Mr Robinson,

Thankyou for forwarding the recent NRPB report on radon measurements in Coupland 1.

Yours sincerely,

John Churcher

From: Dr Don O"Boyle <Oboyle@fs1.fse.man.ac.uk>
To: Sbidey@fs1.scg.man.ac.uk;
cc: churcher@fs1.fse.man.ac.uk; todd@fs1.fse.man.ac.uk;
Subject: queries
Date: 20 February 2003 10:10:06

Dear Dr Bidey,

As we agreed, I'm sending you a brief message to confirm what we talked about on the phone yesterday, in respect of 3 issues:

1. Approval of the minutes of the meeting of 21st August in

your room (present: SB, JC, JD, DJOB, DP)

You indicated that you and Dr Prime are happy to approve the minutes, but that you didn't know whether this is the case for Mr Duffy (or whether he had, in fact, received a copy of the minutes). You agreed to contact Mr Duffy to find out, and then would let me know the outcome.

2. The possibility of testing of the window glass in John

Churcher's room (2.63) and the neighbouring room

(2.62) in Coupland I for past alpha activity.

At one of our previous meetings we had discussed this possibility, as as a potential means of re-constructing something of the history of alpha activity in these rooms, and I asked you on the phone whether we could pursue this. You said that you thought that Dr Prime had already done so: that, following the meeting of 21st August, he had contacted NRPB to explore the possibility, but that they had indicated that they wouldn't/couldn't? do it. You mentioned that you thought that he had also contacted a company or someone in Ireland about the matter but you didn't know the outcome. You agreed to ask Dr Prime to report back formally to the us (ie those present at the meeting of 21st August) when he next visited the university next month. You also said that you thought that had Dr Prime got anywhere with the matter or had anything of significance to report to us, he would have done so before now.

3. NRPB report of 9th Jan, 2003 of radon measurements in

Coupland I: the issue of variation of radon concentration

with height in the building

According to the report, the mean values of radon gas concentration given by each the two monitors placed in each of rooms 2.62 and 2.63 in Coupland I during the 3-month testing period was, respectively, 60 (2.62) and 30 (2.63) Bq/cubic metre. I mentioned to you that while we understand that these values appear to fall comfortably short of the current activity limit of 200 set by NRPB, John Churcher, Neil Todd and I were concerned that the recorded mean values might represent an underestimation of the true activity level to which inhabitants might have been exposed, given the tendency of radon to move down through a building (which we discussed at length at our meeting of 21st August) and the fact that room 2.62 and 2.63 are on the second floor of Coupland I. You said that you took the point and that you would chase this up with NRPB.

I think that's it. Let me know if you think that I've misrepresented what you said.

Best wishes,

Don O'Boyle

****

Dr Donald J O'Boyle
Department of Psychology,
University of Manchester,
Coupland Street,
Manchester M13 9PL
U.K

email: oboyle@psy.man.ac.uk
Tel: +44 (0)161-275-2590
Fax: +44 (0)161-275-2685
Dept tel: +44 (0)161-275-2585

From: Dr Don O"Boyle <Oboyle@fs1.fse.man.ac.uk>
To: steve.bidey@man.ac.uk;
cc: churcher@fs1.fse.man.ac.uk; todd@fs1.fse.man.ac.uk;
Subject: Re: queries
Date: 23 February 2003 15:36:36

Dear Dr Bidey,
Thanks for your reply to my message, and for the corrected value of the radon Action Level for workplaces. I'll consult my colleagues about whether or not we should like Mr Robinson to measure radon levels in the room(s) immediately below 2.63 and get back to you asap. If we were to do so, could we compare directly the value(s) obtained using the 'pylon' method with those obtained using the monitors analysed by NRPB? And might it be worthwhile contacting NRPB to invite their comments on whether or not the values of 60 Bq m-3 on the second floor of the building are of any potential concern?
Best wishes,
Don O'Boyle

From: "Dr. Stephen Bidey"
Organization: University of Manchester
To: oboyle@fs4.psy.man.ac.uk
Date sent: Fri, 21 Feb 2003 17:10:47 +0000
Subject: Re: queries
Send reply to: steve.bidey@man.ac.uk
Priority: normal

> Dear Dr O'Boyle,
>
> Thanks for your email summarising our recent telephone
> conversation. I will confirm back to you with regard to points (1) and
> (2) in due course.
>
> With regard to the NRPB Radon monitoring, you should be aware
> that the "action level" for radon in workplaces is 400 Bq m-3, and
> NOT 200 Bq m-3. The latter value applies to domestic dwellings.
>
> Our records show that the room(s) immediately below room 2.63 in
the
> Coupland I Building have not been monitored for radon. I understand
from
> Kevin Robinson that there would be no problem in us carrying out
such

> a survey, using our own 'pylon' equipment, but we would need to gain
> access to the room, which we understand is currently locked.
>
> Yours sincerely,
>
> Dr Steve Bidey
>
>
> Dr Stephen P. Bidey, Radiological Protection Service,
> 7th Floor Williamson Building, Oxford Road,
> Manchester M13 9PL, U.K.
> Telephone: 0161-275-6983
> Fax: 0161-275-6984
> E-mail: steve.bidey@man.ac.uk

****

Dr Donald J O'Boyle
Department of Psychology,
University of Manchester,
Coupland Street,
Manchester M13 9PL
U.K

email: oboyle@psy.man.ac.uk
Tel: +44 (0)161-275-2590
Fax: +44 (0)161-275-2685
Dept tel: +44 (0)161-275-2585
****

From: John Churcher <churcher@psy.man.ac.uk>
To: Dr. Stephen Bidey;
cc: Don OBoyle; Neil Todd;
Subject: Coupland 1
Date: 23 February 2003 23:41:55

Dear Dr Bidey,

I shall shortly be sending you for your information copies of enquiries I am sending to Professor Robin Marshall FRS, Department of Physics; Dr Jeff Hughes, Centre for the History of Science & Technology; Dr Susan Robson, Director of Health & Safety Services; and Dr Tristram Besterman, Director of the Manchester Museum. The enquiries are all similar in content, and the aim is to try to discover if there are any records anywhere of radiological investigations of Coupland 1 before 1999, and to try to find out more about which radionuclides were kept where and in what quantities.

Yours sincerely,

John Churcher

University Health and Safety Services

Radiological Protection Service,
University of Manchester
7th Floor, Williamson Building,
Oxford Road,
Manchester M13 9PL

Dr S.P. Bidey
Radiation Protection Adviser
Telephone: 0161-275-6983
Fax: 0161-275-6984
E-mail: steve.bidey@man.ac.uk

THE UNIVERSITY of MANCHESTER

Mr J. Churcher,
Department of Psychology,
Coupland I Building,
University of Manchester.

24th March 2003

Dear Mr Churcher,

Susan Robson of the University Health and Safety Services has asked me to respond to your e-mail to her, dated 24th February.

You will be aware from our meetings last year that the Radiological Protection Service has no records of any radiation monitoring in Coupland 1 prior to 1999. As we have discussed in our previous meetings, David Prime and Kevin Robinson, who have each been involved in Radiological Protection for 25 years, have never been asked to determine residual radiation in that building prior to the recent works. It is interesting to note that John Richardson was asked to monitor the area for residual radioactivity. Did he tell you whether he made or kept any records of this and if so, what were his findings? You will appreciate that I never had any dealings with John Richardson as I only joined the RPS in 1998, at which time Dr Gavin Smith was the DRS for Physics Department

I have re-checked the Minutes of the Radiological Protection Subcommittee, and these only go back as far as 1993. If you have not already done so, may I suggest that you contact the present Chair of the Committee, Professor Ian Stratford, to see if copies of the Minutes held by previous Chairs of the Subcommittee were transferred to him and, if so, how far they go back in time.

Yours sincerely,

Dr Stephen Bidey
University Radiological Protection Service

c.c. Dr Susan Robson

From: **"STEPHEN LEE" <lee@fs4.psy.man.ac.uk>**
Organization: **Psychology Dept**
To: **psy-teaching@lists.man.ac.uk**
Date sent: **Mon, 1 Jul 2002 13:49:02 GMT**
Subject: **don't go in Cohen Lecture Theatre/lee email fixed**
Priority: **normal**

Some of you will know that I have had email problems recently. Garry has fixed these this morning, for which many thanks, and normal service is now I think resumed. The only residual effect is that I have I lost 'copies to self' of messages sent in the last few days, as the option to save these had reset itself, so if I appaer vague about any communication I've sent you that may be the reason.

anyway,

I'm sure few people are going up to the Cohen at present, but we have just been told that radiation levels in there are a cause for concern and we have been asked to stop people going in it.

This of course is interesting news for those of us who taught up there for 15 or 20 years, I suppose the people most at risk may have been the workmen who spent most of the summer asleep on the benches up there six or seven years ago

---
This email distribution list supports teaching in the Department of Psychology. Emails sent to psy-teaching@lists.man.ac.uk are forwarded to teaching, secretarial and technical staff. Archives of the list can be accessed via Departmental Pmail (Noticeboards)and on the web at http://lists.man.ac.uk/mailman/private/psy-teaching/

From: **John Churcher <churcher@psy.man.ac.uk>**
To: **psy-teaching@lists.man.ac.uk**
Subject: **Re: don't go in Cohen Lecture Theatre/lee email fixed**
Send reply to: **churcher@psy.man.ac.uk**
Date sent: **Mon, 1 Jul 2002 17:13:56 +0100**

Please can you let me have full details, Stephen, of what you have been told about the radiation hazard in the Cohen, and why we have been asked to stop people going into it?

Between 12th July and 18th November 2001 I was in detailed email and paper correspondence with the University's Radiological Protection Service, initially with Kevin Robinson and then with Dr Steve Bidey, the University's Radiation Protection Adviser, concerning the possible health hazards of radiation to which I have been exposed continuously over a twenty-year period in Coupland room 2.63, which was my office until we were moved out of that building. The walls were contaminated with radium-226 and, as I eventually discovered after pointing out a discrepancy in what I had been told initially, there was also a source of Pb-210 under the floorboards, immediately beneath the chair on which I normally sat. I asked detailed questions about the nature and locations of the radiations sources found, and the measurements which had been made, and eventually I was to some extent reassured by what Dr Bidey told me. The email correspondence was copied to Geoff; I don't know if Dr Bidey's paper correspondence was.

On 29th May this year I found that a new notice had been attached to the door of room 2.63, which read: "Room 2.63, Monitored by RPS, floor OK, walls OK, 14/5/02, remedial work carried out by NNC Ltd." Since this notice implies that further testing has been carried out since November, I have been intending to write again to Dr Bidey to ask why. Stephen's message about the Cohen has now pushed this to near the top of my list of priorities.

John Churcher

From: **"V Horie" <mzfascvh@mail1.mcc.ac.uk>**
Organization: **Manchester Museum**
To: **oboyle@fs4.psy.man.ac.uk**
Date sent: **Wed, 10 Jul 2002 15:22:27 +0100**
Subject: **Coupland 1**
Priority: **normal**

Dear Don

As you know, dealing with radiation is fraught with hazards. The regulatory hazards appear to be far greater than health implications! I have therefore consulted with my Director and with the RPS.

The conclusion is that you should be briefed properly by the people who know what they are talking about. My knowledge is limited to the elements we dealt with in the building work. My understanding is that the HSE is satisfied that no psychology and museum users of Coupland 1 in the past or future will have been exposed to significant risks and that measures are in place to prevent the hazard. We are finding that some people's perception of the risk is far greater than the actual risks.

We are recommending to the University Health and Safety Services that they brief you and your colleagues so that you can be satisfied that you have not been exposed to hazards.

I am sorry that I cannot give you the information you need. But your list of reasonable questions led way outside my knowledge or competence. In this as elsewhere, a little knowledge is a dangerous thing. If I can help in other ways, please get back to me.

Velson Horie
Keeper of Conservation
The Manchester Museum
The University
Manchester
M13 9PL
UK
tel. +44 161 275 2656, fax +44 161 275 2674
Website: http://www.museum.man.ac.uk/

From: John Churcher <churcher@psy.man.ac.uk>
To: Dr Tristram Besterman;
cc: Don OBoyle; Neil Todd; Geoffrey Beattie; Velson Horie; Stephen Bidey;
Subject: Coupland 1
Date: 24 February 2003 00:03:39

Dr Tristram Besterman
Director of the Manchester Museum

24th February 2003

Dear Dr Besterman,

With my colleagues Dr Don O?Boyle and Dr Neil Todd, I am trying to reconstruct part of the radiological history of the Coupland 1 building, which as you know formerly housed Rutherford?s laboratories and was part of the Physics Department. As members of the Department of Psychology and former occupants of the building we are trying to establish the nature and extent of any hazard due to radioactive contamination, to which staff working there in the past may have been exposed. Dr O?Boyle met Dr Velson Horie, Keeper of Conservation, for a preliminary discussion of this on 17th July 2002.

We have been in correspondence with Dr Steve Bidey of the University?s Radiological Protection Service (RPS), and had two meetings with him last year. At the second of these Mr John Duffy of Estates & Services was also present, as well as Dr David Prime, who is now retired from the RPS. As you know, in 1999-2000 extensive contamination was found, and specialist contractors were engaged to assess the problem and to remedy it. Dr Bidey has provided us with copies of various documents relating to this process, and a list of these is attached.

As far as Dr Bidey and Dr Prime are aware, no radiological investigations of the building were made prior to 1999 when the RPS was asked to advise on residual contamination in connection with proposed future use of the building. We were very surprised to learn this, and we are wondering whether it can be correct. It seems particularly surprising given that, for much of the last century, knowledge of the possible hazards and how to assess them must have been more advanced at Manchester than at most other places. I am writing separately to Professor Robin Marshall FRS of the Department of Physics, and to Dr Susan Robson, Director of

Health & Safety Services, to ask if they might know of any records of such an investigation, or of any archive in which such records might be found.

We are also trying to establish if it would be possible retrospectively to estimate radon levels over the 25 years prior to 1999. We know from the documentation provided by Dr Bidey that both radium (Ra-226) and radioactive lead (Pb-210) were found and removed from various locations within the building. On the historical evidence it appears that Rutherford had at least 450mg of radium in the building between 1908 and 1919, and that in 1911 he asked George de Hevesy to try to separate Pb-210 from several hundred kilograms of radioactive lead which was stored in the basement. (See the reminiscences by Neils Bohr, and by H.R. Robinson, in J.B. Birks [Ed.] ?Rutherford at Manchester?; and de Hevesy?s 1944 Nobel lecture). We would like to try to establish how much, if any, of the Pb-210 found recently in the building was still being generated within the building between 1974 and 1999 as a decay product of radium; and how much was already in the building, either because it had been generated there much earlier, or because it had arrived there as Pb-210 in the first place. Our thinking is that if it were possible to estimate the amount of Pb-210 which was still being generated from radium, we should be able estimate radon concentrations in the building during that period. In this connection, I am also writing to Dr Jeff Hughes of the Centre for the History of Science & Technology, to ask if he can help with any information.

Dr O?Boyle, Dr Todd and I intend to prepare a report on our investigations later this year, and to submit it to Dr Robson as well as to Professor Beattie and our colleagues in the Department of Psychology. Our report will include minutes of our meetings with RPS, and we will of course send you a copy. We are aware that this is potentially a sensitive issue for the Museum in terms of public relations, and I want to stress that we are taking care not to mislead anyone, and that we are avoiding inappropriate publicity which might cause unnecessary alarm. At the same time, we have a duty to our colleagues to let them know any results of our investigations in due course. We are also concerned to establish the facts for ourselves, having been occupants of the building.

We would be grateful for any assistance or information which you feel would help us in our enquiries.

Yours sincerely,

John Churcher
Honorary Lecturer in Psychology

Cc: Dr O?Boyle, Dr Todd, Professor Beattie, Dr Horie, Dr Bidey

From: John Duffy <John.Duffy@man.ac.uk>
To: John Churcher; Donald Oboyle;
cc: Steve Bidey;
Subject: Coupland I Building
Date: 29 August 2002 15:19:17

When we met last week you were going to give me some questions you wished to raise with NIRAS that I promised to deal with on your behalf.

Are you yet in a position to give me these details as I will shortly be going on holiday and would like to action this matter before I leave.

Kind regards.
John Duffy CEng, MCIBSE
Deputy Director
Office of the Director of Estates
Tel: 0161 275 2270
Fax: 0161 275 2208
Email: john.duffy@man.ac.uk

From: John Churcher <churcher@psy.man.ac.uk>
To: John Duffy;
cc: Steve Bidey; Don O"Boyle; Kevin Robinson; Neil Todd;
Subject: Re: Coupland I Building
Date: 29 August 2002 16:12:50

Dear Mr Duffy,

Many thanks for a your email. A letter detailing the questions for NIRAS/NNC Limited is appended. I finished it yesterday but I wanted to discuss the content with Dr O'Boyle before sending it to you.

With best wishes,

John Churcher

From: "John Duffy"
Organization: University of Manchester
To: "John Churcher" ,
"Donald Oboyle"
Date sent: Thu, 29 Aug 2002 15:19:17 +0100
Subject: Coupland I Building
Send reply to: john.duffy@man.ac.uk
Copies to: "Steve Bidey"
Priority: normal

> When we met last week you were going to give me some
> questions you wished to raise with NIRAS that I promised to deal with
> on your behalf.
>
> Are you yet in a position to give me these details as I will shortly
> be going on holiday and would like to action this matter before I
> leave.
>
> Kind regards.
> John Duffy CEng, MCIBSE
> Deputy Director
> Office of the Director of Estates
> Tel: 0161 275 2270
> Fax: 0161 275 2208
> Email: john.duffy@man.ac.uk

Attachments:

C:\My Documents\University\Radiation\Letter to J H Duffy.doc

Department of Psychology
The University of Manchester, Oxford Road,
Manchester M13 9PL
Telephone: 0161-275-2553 *Fax*: 0161-275-2588
Web: http://www.psy.man.ac.uk

From: **John Churcher, Lecturer in Psychology**
Telephone: 0161-275-2595

THE UNIVERSITY of MANCHESTER

J H Duffy, CEng, MCIBSE
Deputy Director
Head of Property Services
Office of the Director of Estates
Beyer Building

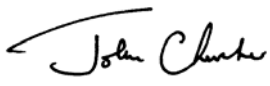
28th August 2002

Dear Mr Duffy,

Radiation hazards in Coupland 1 building

Following the meeting on 21st August at the offices of the Radiological Protection Service, at which we met with Dr Bidey, Dr O'Boyle, and Dr Prime to discuss radiation hazards in Coupland 1 building, I am appending as agreed some questions which I think should be put to NIRAS/NNC Limited, arising out of their reports for the University in connection with the residual contamination survey and decommissioning of the Coupland 1 building. Please feel free to copy these questions verbatim when you write to NIRAS/NNC Limited. I would be grateful if you would keep me informed of the progress of your correspondence with them.

Yours sincerely,



John Churcher
Lecturer in Psychology

Cc: Professor Beattie, Dr Bidey, Dr O'Boyle, Dr Todd,

Questions for NIRAS/NNC Limited, arising out of their reports for the University in connection with the residual contamination survey and decommissioning of the Coupland 1 building.

1. In the document *Local Rules Written by the RPA appointed by Hayverns in compliance with Regulation 17 of the Ionising Radiations Regulations 1999,* by Barry Frith and dated 1/9/00, which is concerned with the decommissioning of room 2.63, reference is made to contamination with radium (Ra-226) in the area of the wall above the wash hand basin. At section 7, 'Working Instructions', reference is made to removing a "contaminated area of plaster", by "cutting in the clean areas". There is in fact no plaster wall in room 2.63; the walls are faced with the original glazed tiles. Can NIRAS/NNC explain this discrepancy between the *Local Rules* and the actual situation at the site, and can they clarify whether any contaminated material was in fact removed from the wall above the wash hand basin? If contaminated material was removed from there, do they know how much (mass) and with what level of activity?

2. In Barry Frith's letter of 26th October 2000 to Dr S A Robson, Director of Health & Safety, reference is made to the discovery of Pb-210 beneath the floorboards in rooms 2.62 and 2.63, and modified estimates of 500 kBq are given for the total activity in each of these rooms. In section 2 of this letter it is implied that the contamination of rooms 2.62 and 2.63 with Ra-226 was of trivial magnitude, and that all of the estimated activity was due to Pb-210. However, in the *Report on the Estimation of Drum Activity of Waste Removed from Coupland 1 Building*, by S M Adams and dated 9th April 2001, in section 7 on page 6, it is stated that the analysis of samples from contaminated floor boards in these rooms showed that contamination was due to Ra-226 at a concentration of 1.27 Bq/g in 64 kg of removed material, as well as to Po/Pb-210. From the figures given in the table at the bottom of page 6 of the report it can be calculated that about 17% of the total activity of 0.48 MBq was due to Ra-226. Can NIRAS/NNC comment on this discrepancy?

3. In the same table on page 6, the 'Drum ref.' is shown as '2.62/2.63', and this is repeated in the Summary table on page 7. In the Appendix on pages 8 and 9 an Activity Assessment is provided in the form of a table which breaks down the total activity by contributions from various isotopes. However, the left-hand column of this table, headed 'Package ID' does not appear to correspond to all of the Drum references shown in the tables on pages 6 and 7. Are data for the analysis of the activity in rooms 2.62 and 2.63 included anywhere in this Appendix? If not, are the data available? Are NIRAS/NNC aware of any further analysis conducted by BNFL on the material sent to them, before it was finally disposed of?

4. Why are rooms 2.62 and 2.63 not referred to at all in the *Final Report for the Decommissioning of Coupland 1 Building, Manchester University,* by Barry Frith and dated January 2001?

5. I understand from Dr Bidey that the documents titled *Hazard Data Re: Supervised Areas Designated in Coupland 1 Building, the Annex, and The Old Dental Hospital*, and *Determination of Rn222 in air Re. Museum hazard assessment,*

which were included as enclosures (vi) and (vii) with Dr Bidey's letter of 6th July 2000 to Dr J Nettleton, were provided by NIRAS/NNC Limited. These documents include measures of the concentration of radon (Rn-222), and non-radon alpha activity, in rooms 2.62 and 2.63. The radon concentration in room 2.63 is shown as <279 Bq/m^3. Dr Bidey and Dr Prime have suggested that the relatively high figure must be because the particular lucas cell used for that sample, which appears to be the one labelled 'green', was contaminated. Can NIRAS/NNC comment on this? If they made the measurement, knowing that the cell was contaminated, why did they not repeat it with an uncontaminated cell?

John Churcher 28th August 2002

Telephone 0161 275 2270
Our Ref JHD/VM
Your Ref
E-mail john.duffy@man.ac.uk

Date 6 September, 2002

NIRAS NNC Limited
Warrington Road
Risley
WARRINGTON
WA3 6BZ

cc: Steve Bidey
Mike Begley

Dear Sirs,

Coupland I – Radioactive Decontamination

Following the recent radioactive decontamination of the University's Coupland I Building the building occupants have formally raised a number of concerns. I have undertaken to take these up with you on their behalf, and I would be pleased if you could give me your answers to the points set out below:

1. In the document *Local Rules Written by the RPA appointed by Hayverns in compliance with Regulation 17 of the Ionising Radiations Regulations 1999*, by Barry Frith and dated 1/9/00, which is concerned with the decommissioning of room 2.63, reference is made to contamination with radium (Ra-226) in the area of the wall above the wash hand basin. At section 7, 'Working Instructions', reference is made to removing a "contaminated area of plaster", by "cutting in the clean areas". There is in fact no plaster wall in room 2.63; the walls are faced with the original glazed tiles. Can NIRAS/NNC explain this discrepancy between the *Local Rules* and the actual situation at the site, and can they clarify whether any contaminated material was in fact removed from the wall above the wash hand basin? If contaminated material was removed from there, do they know how much (mass) and with what level of activity?

2. In Barry Frith's letter of 26th October 2000 to Dr S A Robson, Director of Health & Safety, reference is made to the discovery of Pb-210 beneath the floorboards in rooms 2.62 and 2.63, and modified estimates of 500 kBq are given for the total activity in each of these rooms. In section 2 of this letter it is implied that the contamination of rooms 2.62 and 2.63 with Ra-226 was of trivial magnitude, and that all of the estimated activity was due to Pb-210. However, in the *Report on the Estimation of Drum Activity of Waste Removed from Coupland I Building*, by S M Adams and dated 9th April 2001, in section 7 on page 6, it is stated that the analysis of samples from contaminated floor boards in these rooms showed that contamination was due to Ra-226 at a concentration of 1.27 Bq/g in 64 kg of

removed material, as well as to Po/Pb-210. From the figures given in the table at the bottom of page 6 of the report it can be calculated that about 17% of the total activity of 0.48 MBq was due to Ra-226. Can NIRAS/NNC comment on this discrepancy?

3. In the same table on page 6, the 'Drum ref.' is shown as '2.62/2.63', and this is repeated in the Summary table on page 7. In the Appendix on pages 8 and 9 an Activity Assessment is provided in the form of a table which breaks down the total activity by contributions from various isotopes. However, the left-hand column of this table, headed 'Package ID' does not appear to correspond to all of the Drum references shown in the tables on pages 6 and 7. Are data for the analysis of the activity in rooms 2.62 and 2.63 included anywhere in this Appendix? If not, are the data available? Are NIRAS/NNC aware of any further analysis conducted by BNFL on the material sent to them, before it was finally disposed of?

4. Why are rooms 2.62 and 2.63 not referred to at all in the *Final Report for the Decommissioning of Coupland I Building, Manchester University,* by Barry Frith and dated January 2001?

5. I understand from Dr Bidey that the documents titled *Hazard Data Re: Supervised Areas Designated in Coupland I Building, the Annex, and The Old Dental Hospital,* and *Determination of Rn222 in air Re. Museum hazard assessment,* which were included as enclosures (vi) and (vii) with Dr Bidey's letter of 6th July 2000 to Dr J Nettleton, were provided by NIRAS/NNC Limited. These documents include measures of the concentration of radon (Rn-222), and non-radon alpha activity, in rooms 2.62 and 2.63. The radon concentration in room 2.63 is shown as <279 Bq/m^3. Dr Bidey and Dr Prime have suggested that the relatively high figure must be because the particular lucas cell used for that sample, which appears to be the one labelled 'green', was contaminated. Can NIRAS/NNC comment on this? If they made the measurement, knowing that the cell was contaminated, why did they not repeat it with an uncontaminated cell?

I look forward to receiving your reply in due course.

Yours faithfully,

J H Duffy
Deputy Director of Estates

Registrar and Secretary's Department

Office of the Director of Estates

The University of Manchester, Oxford Road, Manchester M13 9PL

THE UNIVERSITY of MANCHESTER

Telephone : 0161 275 2270
Our Ref : JHD/VM
Your Ref :
E-mail : john.duffy@man.ac.uk

Date : 7 November, 2002

Mr J Churcher/Dr D J O'Boyle
Department of Psychology
Coupland I Building

Dear Mr Churcher/Dr O'Boyle,

Radiation Hazards in Coupland I Building

You may recall that I wrote to NIRAS regarding the concerns you raised about radiation hazards in the Coupland I Building. I have now received a reply (copy attached) and must apologise for the delay in forwarding it to you.

I trust this response answers your questions and gives you the assurance you were seeking.

Kind regards.

Yours sincerely,

J H Duffy
Deputy Director of Estates

NIRAS
NNC Independent Radiation Assessment Services

Telephone: (01925) 895588
Fax: (01925) 895551

Adding value through knowledge

Our Ref: NIRAS/E200000/let/26 Your Ref:JHD/VM

Mr. J. Duffy
Deputy Director Estates & Services
The University of Manchester
Beyer Building
Oxford Road
Manchester,
M13 9PL

8 October 2002

Dear Mr. Duffy

RE: COUPLAND I- RADIOACTIVE DECONTAMINATION

In response to your letter regarding the radioactive decontamination of Coupland 1 are the following.

Point 1. Local Rules for 2.63.

The reference made in report ref. MTC/2000/051 to radium contamination in the area of wall above the hand washbasin is to a finding reported by the University RPS. However, the monitoring survey undertaken by NIRAS as part of a hazard assessment did not detect contamination in this location, nor was any detected during the remediation operation. No remediation (removal of plaster/tiles) of the location was undertaken.

Point 2. An apparent contradiction in the assertion that Ra-226 is negligible compared with the activity of Pb-210/Po-210

In estimating the activity in drums, NIRAS has assigned the activity concentration of samples taken from localised "hot spots" to the total mass of material removed during their remediation. The very much greater mass of floorboards removed, by cutting in clean areas, to remove hot spots contaminated with Ra-226 over estimates the total activity of that radionuclide. The estimates of total activity in the waste are obviously very much on the safe side.

Point 3. Drum reference confusion?

The appendix in report ref. MTC/01/026 relates to initial work undertaken by NNC Harwell and to the activity of the floorboards and other debris removed from C.1.10 only. The floorboards removed from C.1.10 had been left, wrapped in plastic, pending disposal via a suitable route. In order to affect disposal, the floorboards were cut into sections and packaged in drums to meet the requirements of BNFL. The following drum ref. numbers were used.

Drum ref	Contents
C.1.10/FB1	P003
	P0011
	P0013
C.1.10/FB2	P001
	P007
	P009
C.1.10/FB3	P002
	P006
	P0012
C.1.10/FB4	P004
	P008
C.1.10/FB5	P005
	P0010

Three samples were analysed by NIRAS (reported in L2000103). The results of analysis in terms of Bq/g were related to a gross gamma count to give the activity concentration of samples taken from other rooms. This was the method used to determine the activity concentration in room 2.62/2.63.

Before the waste was disposed to Drigg a very comprehensive and long process was undertaken before the waste was accepted. This included a Waste Characterisation document, which gained BNFL approval before disposal. I am not aware of any further analysis carried out on the waste by BNFL before it was finally disposed of.

Point 4.

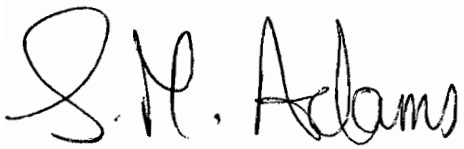
Rooms 2.62 and 2.63 are not referred to in the final report dated 2001. This is because at a meeting between you, Velson Horie, Barry Frith and myself it was agreed that there were three categories of rooms: those within the museum project- Category 1, those impinging on the museum project- Category 2 and other areas not involving the Museum project -Category 3 including rooms 2.62 and 2.63 which would be the responsibility of the University. A new order was raised for this work and a final report was written once the remediation was complete. This was reported in MTC/01/024.

Point 5.

It is correct that Radon daughter measurements were made using a cell that was known to have a higher background than the others used. The limit of detection achievable by this cell is, therefore higher than that achievable by the other cells i.e. <279 Bq/m^3.
NRPB recommends an action level of 200Bq/m^3 for radon in domestic dwellings. The Ionising Radiations Regulations 1999 do not apply to work, other than a practice, in radon atmospheres of less than 400Bq/m^3. A less than figure of 279 Bq/m^3 is therefore judged to be not unsatisfactory in this case.

I hope that these responses satisfy your concerns. If you have any outstanding issues either Barry Frith or myself would be happy to meet with you and other persons concerned.

Yours sincerely
for NNC Limited



Stephanie Adams MSc, BSc (Hons)
Consultant Physicist

Email: stephanie.adams@nnc.co.uk

From: John Churcher <churcher@psy.man.ac.uk>
To: John Duffy;
cc: Sue Robson; Stephen Bidey; Ian Stratford; Don OBoyle; Neil Todd; Geoffrey Beattie;
Subject: Minutes of RPSC prior to 1993
Date: 29 April 2003 23:39:03

Mr J H Duffy
Deputy Director of Estates & Services

29th April 2003

Dear John,

In connection with our enquiries into radioactive contamination of the Coupland 1 building, I am trying to locate the Minutes of meetings of the
the Radiological Protection Sub-Committee of the Health & Safety Committee prior to 1993.

I wrote recently to Dr Robson, Director of Health & Safety Services, asking if she has access to them. Dr Robson referred me to Dr Bidey, who referred me to Professor Stratford, Chair of RPSC. Professor Stratford informs me that his predecessor, Professor Tallentire, is of the view that, if they exist, the Minutes would be held by Estates and Services.

Can you tell me whether or not these Minutes are held by Estates and Services, and if so whether I may see them?

With best wishes,

John Churcher

From: John Duffy <John.Duffy@man.ac.uk>
To: churcher@fs4.psy.man.ac.uk;
Subject: Re: Minutes of RPSC prior to 1993
Date: 30 April 2003 08:56:37

John,

This pre-dates me!

Before I joined the university I believe the Director of Estates & Services did have responsibility for H&S and it is possible, but unlikely, that we have kept copies as far back as 1993.

Let me check it out and get back to you.

John

From: John Churcher <churcher@psy.man.ac.uk>
To: john.duffy@man.ac.uk;
Subject: Re: Minutes of RPSC prior to 1993
Date: 30 April 2003 18:27:57

Dear John,

It is the Minutes from *before* 1993 that I am trying to find, and in particular those from the years 1974 onwards, when the University's Health & Safety structure was established, presumably as a legal requirement, following the Robens report and the Health and Safety at Work Act 1974.

Best wishes,

John C

From: John Duffy <John.Duffy@man.ac.uk>
To: churcher@fs4.psy.man.ac.uk;
cc: susan.a.robson@man.ac.uk; valerie.a.myddelton@man.ac.uk;
Subject: Re: Minutes of RPSC prior to 1993
Date: 22 May 2003 13:35:29

John,

Sorry for the delay. A search of our archives has identified a number of files for the period 1983 - 1989 that may be what you are looking for.
I am quite happy for you to examine these but as they form part of the university archives I would not want them to leave our office. If you wish to do this I can book you into our conference room and make them available.
If this is OK with you please contact my secretary, Val Myddelton (52283) who can make the arrangements.

Kind regards

John

From: John Churcher <churcher@psy.man.ac.uk>
To: john.duffy@man.ac.uk;
cc: valerie.a.myddelton@man.ac.uk; susan.a.robson@man.ac.uk;
Subject: Re: Minutes of RPSC prior to 1993
Date: 03 June 2003 17:12:10

Dear John,

Many thanks for this. I shall contact Val Myddelton shortly to arrange to view them as you suggest.

With best wishes,

John C

From: John Churcher <churcher@psy.man.ac.uk>
To: Dr Susan Robson;
cc: Don OBoyle; Neil Todd; Geoffrey Beattie; Stephen Bidey;
Subject: Coupland 1
Date: 23 February 2003 23:54:28

Dr Susan Robson
Director of Health & Safety Services

24th February 2003

Dear Dr Robson,

With my colleagues Dr Don O?Boyle and Dr Neil Todd, I am trying to reconstruct part of the radiological history of the Coupland 1 building, which as you know formerly housed Rutherford?s laboratories and was part of the Physics Department. As members of the Department of Psychology and former occupants of the building we are trying to establish the nature and extent of any hazard due to radioactive contamination, to which staff working there in the past may have been exposed. We have been in correspondence with Dr Steve Bidey of the University?s Radiological Protection Service (RPS), and had two meetings with him last year. At the second of these Mr John Duffy of Estates & Services was also present, as well as Dr David Prime, who is now retired from the RPS. As you know, in 1999-2000 extensive contamination was found, and specialist contractors were engaged to assess the problem and to remedy it. Dr Bidey has provided us with copies of various documents relating to this process, and a list of these is attached.

As far as Dr Bidey and Dr Prime are aware, no radiological investigations of the building were made prior to 1999 when the RPS was asked to advise on residual contamination in connection with proposed future use of the building. We were very surprised to learn this, and we are wondering whether it can be correct. It seems particularly surprising given that, for much of the last century, knowledge of the possible hazards and how to assess them must have been more advanced at Manchester than at most other places. I note that in a letter to you of 4th October 2000, Dr Jo Nettleton, HM Specialist Inspector (Radiation), writes: ?As I indicated during my inspection on 31st July of this year, it is unfortunate that a full contamination survey was not conducted many years ago, and appropriate remediation work carried out?. I

understand that the University?s Health & Safety Committee was set up following the report of the Robens Committee in 1974, and that Professor Wilmott was the first Chair of its Radiation Sub-Committee. The Department of Psychology moved into the building at around the same time, so it seems possible that the matter may have been reviewed then. Do you know of any records of such an investigation which have come to light since July 2000, or of any archives which might contain such records? Do you have records of the proceedings of the Health & Safety Committee and of its Radiation Sub-Committee from their inception, or do you know where these are? Was a thorough search of relevant archives made at the time of the Inspector?s visit?

We are also trying to establish if it would be possible retrospectively to estimate radon levels over the 25 years prior to 1999. We know from the documentation provided by Dr Bidey that both radium (Ra-226) and radioactive lead (Pb-210) were found and removed from various locations within the building. On the historical evidence it appears that Rutherford had at least 450mg of radium in the building between 1908 and 1919, and that in 1911 he asked George de Hevesy to try to separate Pb-210 from several hundred kilograms of radioactive lead which was stored in the basement. (See the reminiscences by Neils Bohr, and by H.R. Robinson, in J.B. Birks [Ed.] ?Rutherford at Manchester?; and de Hevesy?s 1944 Nobel lecture). We would like to try to establish how much, if any, of the Pb-210 found recently in the building was still being generated within the building between 1974 and 1999 as a decay product of radium; and how much was already in the building, either because it had been generated there much earlier, or because it had arrived there as Pb-210 in the first place. Our thinking is that if it were possible to estimate the amount of Pb-210 which was still being generated from radium, we should be able estimate radon concentrations in the building during that period. Do you know of any records of the quantities of different radionuclides brought into the building and where they were kept?

There is one matter which I feel I should bring to your attention without further delay. In the course of checking the situation in and around room 2.63 of the building, which used to be my office, I discovered last summer that in the adjoining room 2.62, where floorboards have been removed by the contractors in order to remove radioactive contamination from the sub-floor space, numerous globules of what appears to be liquid mercury (Hg) are visible on the upper surface of the plaster ceiling to the room

beneath. There was also a small amount of mercury at the bottom of a recently-drilled hole in the upper surface of one of the floor joists, which I assumed had been made by the contractors when removing one of the radioactive ?hotspots?. At our meeting with Dr Bidey on 23rd July last year I asked if RPS were aware of the mercury contamination, and Dr Bidey said that he wasn?t but that this would be outside the responsibility of RPS. When I visited the site again recently (on 22nd February), the mercury had not been removed, so I thought I ought to make sure you know that it is there. Were you already aware of its presence?

Dr O?Boyle, Dr Todd and I intend to prepare a report on our investigations later this year, and to submit it to you as well as to Professor Beattie and our colleagues in the Department of Psychology. Our report will include minutes of our meetings with RPS. Meanwhile, we would be grateful for any help or suggestions you may feel able to provide. I am writing with similar enquiries to Professor Robin Marshall FRS, in the Department of Physics, and to Dr Jeff Hughes, Lecturer in the History of Science and Technology. I am also writing to Dr Tristram Besterman, Director of the Manchester Museum, to let him know where we have got to and to ask if he has any relevant information.

Yours sincerely,

John Churcher
Honorary Lecturer in Psychology

Cc: Dr O?Boyle, Dr Todd, Professor Beattie, Dr Bidey

From: Susan Robson <susan.a.robson@man.ac.uk>
To: churcher@fs4.psy.man.ac.uk;
Subject: RE: (Fwd) Coupland 1
Date: 16 March 2003 21:26:23

Dear Dr Churcher,
Iam sorry you have received no reply, but you should have been notified via
my e mail that I was away. Indeed I returned to the uk only last night and a
family crisis will mean that I will be delayed getting into work on Monday.
I will of course give due considration to your letter then. I had only just arrived at the university when this important issue arose. As you are already aware Dr Bidey and John Duffy as wellas David Prime(who is still
retained for consultant advise in certain areas) are well aware of all the issues and I would hope that any information available would come from them
and they will I know help as much as possible. I will however make enquieries and get back to you as soon as possible. I am at present ploughing through 188 e mails, but you will knlw what that is like
Regards, Susan Robson

From: John Churcher <churcher@psy.man.ac.uk>
To: Susan Robson;
cc: Don OBoyle; Neil Todd;
Subject: RE: (Fwd) Coupland 1
Date: 16 March 2003 22:37:42

Dear Dr Robson,

Thankyou for your prompt response on finally receiving my email, and I can well understand that you have quite a lot to cope with at the moment. I look forward to hearing from you again in due course when you have had the opportunity to make further enquiries.

With best wishes,

John Churcher

From: susan.a.robson@man.ac.uk <susan.a.robson@man.ac.uk>
To: John Churcher;
Subject: Re: Coupland 1
Date: 20 March 2003 09:33:20

Dear Dr Churcher,
I have now had the opportunity of an initial discussion with Steve Bidey to address once again the issues in your e mail. He will be responding directly following consultation with David Prime(you will be aware that David is a national authority on Radon) Meanwhile as Peter Nicholson is on prolonged sick leave I have passed on the issue re the mercury for action by the appropriate H&S coordinator who will contact you directly.
Yours sincerely, Susan Robson
Dr Susan Robson
Director Health and Safety Services
182-184 Oxford Rd
Manchester
Tel: 0161 275 6971
M13 9GP
Tel: + 44 (0)161 275 6971/2
Fax: + 44 (0)161 275 6989

From: John Churcher <churcher@psy.man.ac.uk>
To: Dr Susan Robson;
cc: Don OBoyle; Neil Todd; Geoffrey Beattie; Stephen Bidey;
Subject: Re: Coupland 1
Date: 23 March 2003 22:06:56

Dr Susan Robson
Director of Health & Safety Services

23rd March 2003

Dear Dr Robson,

Thankyou for your email of 20th March in response to mine of 24th February, and I look forward to hearing again from Dr Bidey concerning the matters raised, as well as from the appropriate Health & Safety coordinator concerning the mercury.

As I indicated in my email of 24th February, we had meetings with Dr Bidey and Dr Prime last year, in which they told us that they believe no radiological investigations of Coupland 1 were made prior to 1999. It was
because of our doubts about this that I wrote to you to ask if you knew of
any relevant records that Dr Bidey and Dr Prime might not have seen.

Since then, I have last week had the opportunity to speak with John Richardson, now retired, who I understand was for Radiation Officer in the Department of Physics for 30 years. He tells me that after that Department vacated the Coupland building in 1968 he was asked a number of times about residual radioactivity there, and that at least once
he went there to make measurements. He also remembers that at some
point the responsibility for this was transferred to the newly formed Radiation Protection Service.

I would like to establish whether any records of such investigations exist,
and in particular the minutes of the sub-committee originally chaired by Professor Wilmott. When we discussed this with them last year Dr Bidey and Dr Prime did not appear to have had access to these minutes.

Yours sincerely,

John Churcher
Honorary Lecturer in Psychology

Cc: Dr O?Boyle, Dr Todd, Professor Beattie, Dr Bidey

From: susan.a.robson@man.ac.uk <susan.a.robson@man.ac.uk>
To: John Churcher;
Subject: Re: Coupland 1
Date: 25 March 2003 09:44:28

Dear DR. Churcher,
As previously advised we will be responding ASAP to your detailed questions. However I have asked Kath Davidge the Safety Coordinator for your area to look into the issue of the mercury. The responsibility for clearance may be a complex one and estates and the original contractor may be involved depending on the terms of their contract. However what is important is that the issue is dealt with.
Kind regards, Susan Robson
Dr Susan Robson
Director Health and Safety Services
182-184 Oxford Rd
Manchester
Tel: 0161 275 6971
M13 9GP
Tel: + 44 (0)161 275 6971/2
Fax: + 44 (0)161 275 6989

From: susan.a.robson@man.ac.uk <susan.a.robson@man.ac.uk>
To: John Churcher;
Subject: RE: (Fwd) Coupland 1
Date: 01 April 2003 10:45:41

Dear Dr Churcher,
Catherine Davidge and David Massey have been looking into the Mercury spillage issue and I have asked them to respond to you to explain what action they have and intend to take. I would like to thank you for drawing this to my attention. Purely by chance ,only last week in London, I heard of an identical problem in a LOndon Hospital.
I,m afraid that I am old enough to remember playing with Mercury on a Lab. Bench, so I am not really surprised when I hear of spillages.
I hope that their action on this issue addresses your concerns?
Yours sincerely, Susan Robson
Dr Susan Robson
Director Health and Safety Services
182-184 Oxford Rd
Manchester
Tel: 0161 275 6971
M13 9GP
Tel: + 44 (0)161 275 6971/2
Fax: + 44 (0)161 275 6989

From: John Churcher <churcher@psy.man.ac.uk>
To: Susan Robson;
cc: catherine.davidge@man.ac.uk; david.a.massey@man.ac.uk; Steve Rigby; Don OBoyle; Neil Todd; Geoffrey Beattie; Sally A Bray;
Subject: RE: (Fwd) Coupland 1
Date: 01 April 2003 21:08:24

Dr Susan Robson
Director of Health & Safety Services

1st April 2003

Dear Dr Robson,

Thankyou for your email earlier today about the mercury contamination in Coupland 1, Room 2.62. I have also received an email from Catherine
Davidge, about the actions which she and David Massey have taken. These seem to me to be satisfactory, and I have replied thanking her.

As well as containment of any risks due to this particular instance of contamination, there is a more general issue to be considered, about why it was not discovered and reported by any of the people involved in
assessment and remediation of the radioactive contamination in Coupland 1 during the past four years. The mercury was not difficult to find, and those involved in removing the radioactive contamination from under the floorboards in 2.62 would have had ample opportunity to notice it. I suspect there may be a certain lack of joined-up thinking between different groups of professionals involved, and I wonder if there
are any changes in Health & Safety procedures which ought to be considered with a view to reducing the risk of this happening again. I will
go into this in more detail in the report on radioactive contamination of Coupland 1 which Dr O'Boyle, Dr Todd and I will be producing in due course.

Like you, I am old enough to remember playing with mercury at school, though even then as I recall we were warned about its toxicity. In the case of the Coupland building, the historical evidence suggests that relatively large quantities may have been spilled, since Rutherford required mercury to be freshly distilled on site for his experiments, and there were frequent breakages of the glass equipment used.

Yours sincerely,

John Churcher

From: "susan.a.robson@man.ac.uk"

Organization: University of Manchester
To: "John Churcher"
Date sent: Tue, 1 Apr 2003 10:45:41 +0100 Subject:
RE: (Fwd) Coupland 1 Send reply to: susan.a.robson@man.ac.uk
Priority: normal

> Dear Dr Churcher,
> Catherine Davidge and David Massey have been looking into the
> Mercury spillage issue and I have asked them to respond to you to
> explain what action they have and intend to take. I would like to
> thank you for drawing this to my attention. Purely by chance ,only
> last week in London, I heard of an identical problem in a LOndon
> Hospital. I,m afraid that I am old enough to remember playing with
> Mercury on a Lab. Bench, so I am not really surprised when I hear of
> spillages. I hope that their action on this issue addresses your
> concerns? Yours sincerely, Susan Robson Dr Susan Robson Director
> Health and Safety Services 182-184 Oxford Rd Manchester Tel: 0161
275
> 6971 M13 9GP Tel: + 44 (0)161 275 6971/2 Fax: + 44 (0)161 275
6989

From: susan.a.robson@man.ac.uk <susan.a.robson@man.ac.uk>
To: John Churcher;
cc: catherine.davidge@man.ac.uk; david.a.massey@man.ac.uk; Steve Rigby; Don OBoyle;
Subject: RE: (Fwd) Coupland 1My Response
Date: 02 April 2003 16:46:21

Dear Dr Churcher,
I share your concerns and am looking into the issue.
I will get back to you. Meanwhile you will have noted the prompt and appropriate response from the Health Coordinators. They were appointed only last year following intensive lobbying by Peter Nicholson and myself. We were aware of the real difficulties we were all experiencing previously, and their appointment should result in tangible improvements with ensuring that individuals and faculties comply with H & S legislation.
I have contacted John Duffy in estates who is now responsible for putting in place the arrangements for decontamination of the rooms involved.
Regards, Susan Robson
Dr Susan Robson
Director Health and Safety Services
182-184 Oxford Rd
Manchester
Tel: 0161 275 6971
M13 9GP
Tel: + 44 (0)161 275 6971/2
Fax: + 44 (0)161 275 6989

From: Catherine Davidge <catherine.davidge@man.ac.uk>
To: churcher@fs1.fse.man.ac.uk;
cc: Sue Robson \(E-mail\; Dave Massey \(E-mail\; Steve Rigby \(E-mail \;
Subject: Suspected mercury presence in 2.62 & 2.63
Date: 01 April 2003 15:18:36

Dear Dr Churcher,

Dr Robson asked me to follow up the matter that you raised in your email to her (23/2/03) regarding the suspected presence of mercury in Coupland 1 (Rooms 2.62 2.63). I am writing to inform you of the outcome and the action taken with respect to this whilst waiting for the decision on final clearance.

My colleague Mr Massey (RSD Safety Coordinator) and I met with Mr Steve Rigby on 31st March 2003 to view the rooms and assess the situation. We agreed that the substance in 2.62 did appear to be mercury. In view of the information Mr Rigby gave regarding the current situation that Psychology are no longer located in that area and it is the domain of Estates and Services (E&S) we have requested that the following action be taken:

1) Dr Robson to inform Diana Hampson of the presence of the mercury and that removal be included in any subsequent refurbishment programme
2) Request that E&S secure the area to prevent unauthorised access by replacing the missing door locks to the two rooms in question and putting signage up on the corridor side of the doors reminding that access is for authorised persons only (key holders can be contacted via the Estates Office).
3) E&S examine the possibility of restricting access to the building to those areas being occupied at the moment, and positioning signage to that effect.

Thank you for your information and trust that you will find these arrangements satisfactory.
Yours sincerely,

Catherine Davidge

~~~~~~

Catherine Davidge
Safety Coordinator
Faculty of Science & Engineering
Room 5.03 Simon Engineering Building
University of Manchester
Oxford Rd
Manchester
M13 9PL

Tel +44 (0)161 275 7542
Fax +44 (0)161 275 4042
Email catherine.davidge@man.ac.uk
http://www.intranet.man.ac.uk/rsd/personnel/hss/index.htm
~~~~~~

From: John Churcher <churcher@psy.man.ac.uk>
To: Catherine Davidge;
cc: Sue Robson; Dave Massey; Steve Rigby; Don OBoyle; Neil Todd; Geoffrey Beattie; Sally A Bray;
Subject: Re: Suspected mercury presence in 2.62 & 2.63
Date: 01 April 2003 20:57:55

Catherine Davidge
Safety Coordinator
Faculty of Science & Engineering

1st April 2003

Dear Ms Davidge,

Thankyou for following up the matter of mercury contamination in Coupland 1, room 2.62, and for letting me know what action has been taken. The arrangements you describe, for dealing with the immediate situation while awaiting a decision on final removal of the contamination,
seem to me to be sensible and satisfactory.

I shall write separately again to Dr Robson about whether any change in
Health & Safety procedures might be advisable which would result in such contamination being discovered more readily in future.

Yours sincerely,

John Churcher

Department of Psychology
The University of Manchester, Oxford Road,
Manchester M13 9PL
Telephone: 0161 275 2553 *Fax*: 0161 275 2588
Web: http://www.psy.man.ac.uk

From: **John Churcher, Lecturer in Psychology**

John Collins BSc, MSE, CEng, MICE
Radman Associates
Harvey House, Bollington
Macclesfield
Cheshire SK10 5JR

27th August 2002

Dear Mr Collins,

I'm writing in the hope that you may be able to help me from your memory of your time at the University of Manchester. Do you remember any investigation or measurement being made of residual radioactivity in the Coupland 1 building, where Rutherford and his colleagues had been working before 1919? Some contamination has recently been found there, and a quantity of material has been removed, including from the room which I occupied as my office for 20 years.

Dr Steve Bidey, of the University's Radiological Protection Service, has been very helpful in providing me with information about this, but neither he nor his technician, Mr Kevin Robertson, nor Dr David Prime (now retired) can recall any investigation in the Coupland building prior to 1999. On the other hand, my colleague Dr Hugh Wagner, now retired, who occupied the adjoining room to mine when Psychology moved into the building in the 1970s, remembers someone coming to measure radiation in his room at the time. This is the room on the second floor in which Rutherford and Royds first demonstrated that alpha particles are charged atoms of helium. Dr Bidey can find no records of any investigation in RPS files, but he has also told me that some of the early records of the Service may have been lost when its offices were moved to its present location in the Williamson building a few years ago.

Hence my writing to you, as I understand that you established the Service and ran it for many years. I hope you do not mind me writing to ask you about events long ago, and I realise that you may not be able to help me with any information, but I should be grateful for anything you may be able to tell me.

Yours sincerely,

John Churcher
Lecturer in Psychology

Radman Associates

Mr. John Churcher
Dept. of Psychology
University of Manchester
Manchester M13 9PL.

30 August 2002

Dear John,

Thank you for yours of 27 August. I was a lecturer in Civil Engineering at UMIST in the early 70's, but also Radiation Protection Officer on account of previous experience.

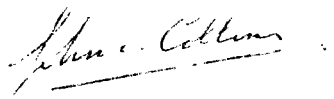
At that time I used to come to Owens to talk matters over with D.C. Henry, who was RPO there. I recall him taking me to the Coupland Building to see the small linear accelerator, which was operating at the Oxford Road end of the building. Physics had the whole building, I believe, and when a larger linac was built across Oxford Road, the small one was dismantled and sold into Portugal.

I recall seeing a plaque on the wall of a basement laboratory declaring that Rutherford and Geiger had worked there, but nothing on the second floor.

The joint service with the United Manchester Hospitals and the City Council was established somewhat later, at first in Brighton Place and then in the Old Medical School. After I took early retirement in 1984 the RPS under David Prime returned to Brighton Place.

I'm sorry that I cannot be more helpful.

Yours sincerely,



John C.Collins

From: John Churcher <churcher@psy.man.ac.uk>
To: Professor Ian Stratford;
cc: Don OBoyle; Neil Todd; Sue Robson; Stephen Bidey; Geoffrey Beattie;
Subject: Minutes of RPSC prior to 1993
Date: 14 April 2003 13:40:35

Professor Ian Stratford
Chair of the Radiological Protection Sub-Committee
University Health & Safety Committee

14th April 2003

Dear Professor Stratford,

I am writing to ask if you have access to Minutes of the Radiological Protection Sub-Committee prior to 1993, and if so whether I may see them. I have been in correspondence with Dr Susan Robson, Director of Health & Safety Services, who has referred me to Dr Steve Bidey, Radiation Protection Adviser, who in turn has referred me to you.

With my colleagues Dr Don O?Boyle and Dr Neil Todd, I am trying to reconstruct part of the radiological history of the Coupland 1 building, which as you know formerly housed Rutherford?s laboratories and was part of the Physics Department. As members of the Department of Psychology and former occupants of the building we are trying to establish the nature and extent of any hazard due to radioactive contamination, to which staff working there in the past may have been exposed.

We have been in correspondence with Dr Bidey, and had two meetings with him last year. At the second of these Mr John Duffy of Estates & Services was also present, as well as Dr David Prime, who is now retired
from the Radiological Protection Service. As you know, in 1999-2000 extensive contamination was found, and specialist contractors were engaged to assess the problem and to remedy it.

As far as Dr Bidey and Dr Prime were aware, no radiological investigations of the building were made prior to 1999 when the RPS was asked to advise on residual contamination in connection with proposed future use of the building. We were very surprised to learn this,
and we wondered whether it could be correct. It seemed particularly surprising given that, for much of the last century, knowledge of the

possible hazards and how to assess them must have been more advanced at Manchester than at most other places. I note that in a letter
to Dr Robson of 4th October 2000, Dr Jo Nettleton, HM Specialist Inspector (Radiation), writes: ?As I indicated during my inspection on 31st July of this year, it is unfortunate that a full contamination survey was not conducted many years ago, and appropriate remediation work carried out?.

Recently I had the opportunity to speak with John Richardson, now retired, who I understand was Radiation Officer in the Department of Physics for 30 years. He tells me that after that Department vacated the Coupland building in 1968 he was asked a number of times about residual radioactivity there, and that at least once he went there to make
measurements. He also remembers that at some point the responsibility for this was transferred to the newly formed Radiation Protection Service, and that for some of the time he was reporting to Professor John Wilmott.

I understand that the University?s Health & Safety Committee was set up
following the report of the Robens Committee in 1974, and that Professor Wilmott was the first Chair of the Radiation Sub-Committee. The Department of Psychology moved into the building at around the same time, so it seems possible that the matter may have been reviewed then.

I wrote recently to Dr Robson to ask if she knew of any relevant records
that Dr Bidey and Dr Prime might not have seen. She has referred me to
Dr Bidey, who writes that he has re-checked the Minutes of the Sub-Committee to which he has access and that these only go back as far as
1993. He suggests that I contact you to see if copies of the Minutes held
by previous Chairs were transferred to you.

I have also been in correspondence with Professor Robin Marshall FRS, who tells me that he has personally searched and enquired about all historical documents in the Department of Physics up to the present time, and that he has seen nothing at all that relates to radiology. Professor Marshall has suggested that I might get in touch directly with

Professor Wilmott, who is now retired. In the first instance I am following
Dr Bidey's advice and asking you as the current Chair of the Sub-Committee.

Yours sincerely,

John Churcher
Honorary Lecturer in Psychology

From: Professor Ian Stratford <ian.j.stratford@man.ac.uk>
To: churcher@fs4.psy.man.ac.uk;
Subject: Re: Minutes of RPSC prior to 1993
Date: 22 April 2003 08:49:36

Dear Dr Churcher,

Thank you for your email. I'm making some enquiries to see if I can unearth any of the minutes you are interested in.

Regards,
Ian

^^
Ian J. Stratford
Professor of Pharmacy and Dean of Research
School of Pharmacy and Pharmaceutical Sciences
University of Manchester
Coupland III Building
Oxford Road M13 9PL
Manchester, UK
Tel: +44(0)161-275-2487
Fax: +44(0)161-275-8342
Email: ian.stratford@man.ac.uk
http://pharmacy.man.ac.uk
^^

From: Professor Ian Stratford <ian.j.stratford@man.ac.uk>
To: churcher@fs4.psy.man.ac.uk;
cc: sbidey@fs1.scg.man.ac.uk;
Subject: Re: Minutes of RPSC prior to 1993
Date: 29 April 2003 09:28:22

Dear John,

I'm sorry I don't have the minutes of meetings you are looking for. I've talked with my predessessor Professor Alan Tallentire and he was of the view that, if they exist, the minutes you are looking for would be held by Estates and Services.

Sorry I can not be more helpful.

Best wishes.
Ian
==========

From: John Churcher <churcher@psy.man.ac.uk>
To: Robin Marshall;
cc: Don OBoyle; Neil Todd; Geoffrey Beattie; Stephen Bidey;
Subject: Coupland 1
Date: 23 February 2003 23:51:25

Professor Robin Marshall FRS
Department of Physics

24th February 2003

Dear Professor Marshall,

I am writing to ask for your help in an attempt to reconstruct part of the radiological history of the Coupland 1 building, which as you know formerly housed Rutherford?s laboratories and was part of the Physics Department. Dr Don O?Boyle, Dr Neil Todd and I are members of the Department of Psychology, and as former occupants of the building we are trying to establish the nature and extent of any hazard due to radioactive contamination to which staff working there may have been exposed. We have been in correspondence with Dr Steve Bidey of the University?s Radiological Protection Service (RPS), and had two meetings with him last year. As you may know, in 1999-2000 extensive contamination was found, and specialist contractors were engaged to assess the problem and to remedy it. Dr Bidey has provided us with copies of various documents relating to this process, and a list of these is attached.

As far as Dr Bidey is aware, no radiological investigations of the building were made prior to 1999 when the RPS was asked to advise on residual contamination in connection with proposed future use of the building. We were very surprised to learn this, and we are wondering whether it can be correct. It seems particularly surprising given that, for much of the last century, knowledge of the possible hazards and how to assess them must have been more advanced at Manchester than almost anywhere else in the world. I understand that the University?s Health & Safety Committee was set up following the report of the Robens Committee in 1974, and that Professor Wilmott was the first Chair of its Radiation Sub-Committee. The Department of Psychology moved into the building at around the same time, so it seems possible that the matter may have been reviewed then. Do you know of any records of such an investigation, or of any archives

which might contain such records? Are there any in the possession of the Department of Physics?

A second question concerns our attempt retrospectively to estimate radon levels over the 25 years prior to 1999. We know from the documentation provided by Dr Bidey that both radium and radioactive lead were found and removed from various locations within the building. On the historical evidence it appears that Rutherford had at least 450mg of radium in the building between 1908 and 1919, and that in 1911 he asked George de Hevesy to try to separate Pb-210 from several hundred kilograms of radioactive lead which was stored in the basement. (See the reminiscences by Neils Bohr, and by H.R. Robinson, in J.B. Birks [Ed.] ?Rutherford at Manchester?; and de Hevesy?s 1944 Nobel lecture). We would like to try to establish how much, if any, of the Pb-210 found recently in the building was still being generated within the building between 1974 and 1999 as a decay product of radium; and how much was already in the building, either because it had been generated there much earlier, or because it had arrived there as Pb-210 in the first place. Our thinking is that if it were possible to estimate the amount of Pb-210 which was still being generated from radium, we should be able estimate the radon concentrations in the building during that period. Do you know of any records of the quantities of different radionuclides brought into the building and where they were kept? Did William Kay keep such records, for example, and do these still exist? Do you have any thoughts on other ways in which it might be possible retrospectively to estimate radon levels.

My colleagues and I would be grateful for any help or suggestions you may feel able to provide. I am sending similar enquiries to Dr Jeff Hughes, in the Centre for the History of Science, Technology and Medicine, and to Dr Susan Robson, Director of Health & Safety Services.

Yours sincerely,

John Churcher
Honorary Lecturer in Psychology

Cc: Dr O?Boyle, Dr Todd, Professor Beattie, Dr Bidey

Manchester
24.03.03

Dear John,

Thank you for your interesting questions. Here are some comments from me. I produce them and send them to you as a scientist and they represent my personal views and are based on my knowledge of nuclear physics and the history of the Department of Physics and Astronomy. Therefore what I say is not the official policy of the Department and University.

In your first paragraph, you suggest that awareness of possible hazards was more advanced in Manchester than anywhere else in the world. You may be right. But it is a relative and not an absolute statement. On the one hand, when Rutherford knew he was leaving for Cambridge, and he knew Kay was not going with him, he summoned his new steward in Cambridge, Crowe, to be taught how to handle radioactive materials by Kay. Crowe was radiologically on his own after 1919 and ended up having fingers amputated. Despite knowledge of the dangers, de Hevesy, being convinced that his landlady in Heaton Chapel was recycling the food leftovers, and despite her denials, dabbed an isotope onto a piece of uneaten meat. Next day, the meat pie was found to be radioactive. Today's quantitative knowledge of the effects of radiation are largely based on the studies of Hiroshima victims. This is ongoing to this day. In 1957, Windscale caught fire and contaminated the local environment. An official government enquiry at the time said that no one was harmed in any way. Thirty years later, post Health & Safety committees and Wilmott, a fresh look deduced that probably about 30 unidentifiable people died prematurely through Windscale radiation induced cancers. Even if Rutherford, de Hevesy and Kay were around to be blamed, they simply cannot be judged by our standards. One thing never changes; people in the past tend not to know as much as people in the present. This should stop us from being judgmental of the past, but it doesn't! We shall also be judged and found wanting.

Your first question enquires into the existence of records and archives concerning radiological surveys in the building Coupland 1, which was occupied by the Department of Physics from 1900 till 1967. I can tell you that I have personally searched and enquired about all historical documents that this Department may possess from its origins until now. There are some interesting books and papers and these are being collected and archived into the JRLUM on Deansgate. I have seen nothing at all that relates to radiology. Either it was not kept, or, and this is my top guess, we may live in an age of documentation but our predecessors did not. I have a

suggestion. There are three former Directors of the Physical Laboratories who can be approached and asked. I refer to Professor S Devons who took over from Blackett in 1953. He was followed by Professor (now Lord) Flowers 1953-1967 and he was succeeded by Professor Wilmott who was already a Professor of Nuclear Physics in the Department when we occupied the Coupland St buildings. The office of our current Director Professor Moore can probably forward any correspondence. This could take you back more than half a century.

You have done some good research into certain activities concerning radioactivity at the time of Rutherford and your comments about the presence of radium and 'radio-lead' around 1911 are correct. However, I do not see a scientific or practical relation between the radium and the lead and it is important not to mix and confuse their roles. The several 100s of kg of lead, which came from the then Czechoslovakia, can be described as radioactive in the same way that *all* lead is radioactive. The degree of radioactivity in a lump of lead is determined by the date of refinement, when the uranium in the ore was removed, essentially by chemical means. The uranium-238 feeds the alpha decay chain of which lead-206 is one step. At refinement, the uranium is mainly removed and the feeding into lead-206 stops. The lead-206 then decays with a half life of about 22 years and ends up as lead-210, stable and not radioactive. So there was nothing radioactively special about Rutherford's lead in the department in 1911. If freshly refined, it had its maximum radioactivity. But most important, it was not producing radium or radon and the lead-206 was decaying via X-rays, virtually all of which were absorbed within the lead. There would be some emission from the surface but I would have happily sat on a bench of such lead for few hours without worrying. Indeed, natural lead is not considered a radiological hazard by roofers.

It is relatively easy to work out the relative amounts of lead-206 and lead-210 in a sample that has arisen through the decay of uranium-238 since the creation of the solar system and planets. A back of the brain calculation gives about 1 atom of lead-206 to every 100,000,000 lead-210 atoms when the ore is in the ground. After refining, the amount of lead-206 reduces by a half every 22 years and most important, does not produce any further lasting radio-isotopes.

In his Nobel lecture, de Hevesy describes how Rutherford told him he should be able to remove the radioactive component, then called radium-D, from the "radio-lead' if he was 'worth his salt'. Alas, radium-D turned out to be an isotope of lead and no method of chemistry will separate out one lead atom from another just because its nucleus is 2% lighter.

Therefore, I see the lead as a red herring in the radiological history of the department. It was never a hazard and did not produce hazards.

If lead-206 AND lead-210 were found in Coupland, then the ratio of the two could be used to determine where it came from. If the 206 is less than 1 part in 100,000,000 of the 210, then the two isotopes of lead might have come from the 'radio-lead' such as scraping against surfaces. But there was always chunks of lead in the Physics department in the years before 1967, being used for shielding. It would be radioactive to the level that any lead is so this also could have scraped off anywhere. If the lead found in Coupland came from radium decay, then the sum of 206 and 210 atoms equals the number of radium atoms that have decayed. Given the time scales, since 1911, this gives a ratio of more than 1 part of 206 to 16 parts 210. Quite a difference!

This has brought me on to radium. Rutherford got 450mg from Vienna and I can tell you he regarded it as much more precious than gold. When he was promised the sample; Ramsey offered to act as postman and essentially stole Rutherford's gift and kept it in London offering Rutherford access to it! ER was furious and never forgave Ramsey. He got another sample and you can be sure he did not slosh it around once it was put into solution. However, we know that at least a small drop fell into the drawer of Rutherford's desk because it is there to this day, and can be measured. We have the desk, locked away. It is not dangerous; it is a valuable historical artifact. A tiny bit of radium goes along way. It has a half life of 1620 yrs.

Having said all that, I must make the professional observation that if I were interested in establishing what was happening in the Coupland Building from 1967 to 1999, I would work backwards from the thorough measurements in 1999 and not try to run activities in 1907-1919 forwards. There is insufficient data from Rutherford's time and it is only guesses about what got spilt and where it came from and where it went. None of the physicists to my knowledge ever found the need to 'decontaminate' the building while they were there and as you point out, they were more aware than anyone. Therefore, what was found in 1999 is by far the best basis on which to work. This would provide a reasonable estimate of radon concentrations in the years before and could be extrapolated backwards with reliability for a few decades.

Perhaps I may surprise you by saying that even if one knew the exact amount of radium left behind as contamination in say 1919, this would provide an UNDERESTIMATION of the subsequent radon levels. This is

because uranium and thorium is everywhere. We live on a naturally radioactive planet. Humans have adapted to it. It was far worse in the past. Life couldn't start till radioactive levels fell to less than lethal levels. Two thirds of the way through the total lifetime of the solar system, a natural uranium reactor was burning away in Africa. I was a student in that Coupland building. I remember the tiles, especially the green ones. These tiles would have been fitted in the period up to the opening in 1900 and the glazing is almost certainly tinted by uranium salts. It was standard in Victorian times; they loved tiles. Radioactivity was discovered in 1895 so there was no known reason not to use uranium in glazing. These tiles will ooze radon at some level. Today, people haven't found the need to strip such tiles, indeed, they are prized. The risk is taken, just like living in granite houses.

Another way to establish whether the radon levels in that building were abnormal or not would be to analyse the teeth and hair of people who worked there for any length of time. They will show levels of lead-206 and lead-210 which can be easily measured by e.g. neutron activation and these numbers can be compared with a control sample of people who never worked there. Both samples will show lead-206 and lead-210 because everyone has such isotopes in their body. Hair is easy, teeth less so. Yet another study would be to investigate whether people who worked in Coupland have suffered more lung disease than control samples. The real, non lethal but palpable effects of excessive radon are pulmonary lesions, again easy to diagnose and count.

If it sounds like I have a comfortable attitude to radiation, it is partly because I lecture a course in Applied Nuclear Physics where I thought I had better learn as much about the applied physics to match my knowledge of the nuclear physics. I studied and worked in what you call Coupland 1 for 8 years from age 18 to 26. It doesn't bother me. I am even comforted by research into Hiroshima inhabitants that shows that some level of radiation is actually beneficial and there is a J-curve to represent damage versus dose. Radiation produces free radicals in human tissue and at some level it seems to keep the immune system exercised and on its toes. Too much and the system can't cope. Too little and it goes to sleep.

Prof Robin Marshall
24.03.03

HSE Health and Safety Executive

FOI 1 - FOI Enquiry Form

This form can be completed online and sent by email or alternatively can be printed and sent to the address at the bottom of this page. You do not have to use this form, but it will help us deal with your request as promptly as possible if you do. If you prefer, you can make your request in writing (e.g. Letter, email, fax or other form which we can use for reference).

Requests for personal information that we may hold about an applicant must always be made in writing to comply with the Data Protection Act 1998.

Applicant Name John Churcher

Address

Email address churcher@aulos.co.uk

Fax number

(At least one of the above (address, email, fax number) must be provided for contact purposes)

Telephone number *(optional)* _ Date *21/06/2007*

Description of the information being requested

Any information relating to radiological inspections of the Coupland Building at the University of Manchester (now renamed the Rutherford Building), parts of which were occupied until 1999 by Manchester Museum and the Department of Psychology, including: correspondence, notes or memoranda concerning meetings or other communications with the University, or with NIRAS NNC Ltd.

(click here if you would like to add more comments)

Any other details which might help us identify and locate the information

A letter dated 4/10/2000 from Dr Jo Nettleton, HM Specialist Inspector (Radiation) of Health and Safety, to Dr Susan A Robson, Director of Health and Safety Services, University of Manchester (your ref. *160105570/0287059),* refers to an inspection by Dr Nettleton on *311712000.* An earlier letter dated *61712000* from Dr Stephen A Bidey, Radiation Protection Adviser to the University,

(click here if you would like to add more comments)

In what format would the information be preferred?
(Some of these options may not be possible, and there may be charges depending on what is requested. This will be confirmed before the information is provided.)

Paper copy D Electronic copy (if available) ✓

Pre arranged personal inspection at an HSE office or Information Centre D Summary D

Special requirements

I would be grateful if you could let me know the email address of Dr Nettleton, who I understand from your website is now Head of Defuelled Reactor Inspection. Alternatively, I would be ask that my email address and this request be copied to her.

click here if you would like to add more comments)

This form can be emailed by clicking on the Continue button at the end of this form and selecting the send email link, or alternatively send it by post to:

HSE Infoline
Caerphilly Business Park
Caerphilly, United Kingdom.
CF833GG
Telephone: +44(0)8701 545500
Fax +44(0)2920859260

- You can use this form for information requests under the Freedom of Information Act 2000, the Environmental Information Regulations 2004, or the Data Protection Act 1998. You do not need to work out which of these apply we will do this. We may need some proof of identity if you are requesting your own personal information

V02 (03/05)

Description of the information requested (continued)

Click here to go back to Page 1

Other details which might help up identify and locate the information (continued)

to Dr Nettleton, refers to a meeting held during the preceding week, at which apparently Dr Nettleton was also present.

If there are reports or other documents whose volume would make it excessively costly to reproduce, I would in th first instance request a list of their titles, from which I would be able to make a subsequent, selective request for copies.

As Dr Nettleton observes in her letter of 4/1 0/2000, a full contamination survey was not conducted prior to the decontamination undertaken in 1999-2000. Although the University apparently has no records of any pre-1999 surveys, there is anecdotal evidence that some measurements were made. Any reference to pre-1999 surveys, or to the lack of them, would be of interest. Similarly, any reference to rooms occupied by the Department of Psychology, as distinct from Manchester Museum, would be of interest.

Electronic copy is preferred, but any form would be acceptable.

Click here to go back to Page 1

Special requirements (continued)

Click here to go back to Page 1

From: Nick.Williams@hse.gsi.gov.uk
To: churcher@aulos.co.uk
Subject: FOI enquiry 2007060376 - Information relating to radiological inspections of the Coupland Building at the University of Manchester.
Date sent: Thu, 19 Jul 2007 14:35:00 +0100

Dear Mr Churcher,

Freedom of Information Request Reference No: 2007060376

Thank you for your request for information about:

Information relating to radiological inspections of the Coupland Building at the University of Manchester.

Your request was received on 21/6/2007 and I am dealing with it under the terms of the Freedom of Information Act 2000 (the Act).

I can confirm that the Health and Safety Executive holds the following information:
1. Email dated 24/6/2000 (See attached file: Museum.pdf)
2. Inspection report dated 30/8/2000. (See attached file: gen37.pdf)

This information can be disclosed and copies are enclosed.

The information supplied to you continues to be protected by the Copyright, Designs and Patents Act 1988. You are free to use it for your own purposes, including any non-commercial research you are doing and for the purposes of news reporting. Any other re-use, for example commercial publication, would require the permission of the copyright holder. Most documents supplied by HSE will have been produced by government officials and will be Crown Copyright. You can find details on the arrangements for re-using Crown copyright on HMSOnline at:

http://www.hmso.gov.uk/copyright/licences/click-use-home.htm

Information you receive which is not subject to Crown Copyright continues to be protected by the copyright of the person, or organisation, from which the information originated. You must ensure that you gain their permission before reproducing any third party (non Crown Copyright) information.

If you have any queries about this letter, please contact me. Please remember to quote the reference number above in any future communications.

If you are unhappy with the decisions made by HSE in relation to your request you may ask for an internal review by contacting me.

If you are not content with the outcome of the internal review you have the right to apply directly to the Information Commissioner for a decision. The Information Commissioner can be contacted at:

The Information Commissioner's Office
Wycliffe House
Water Lane
Wilmslow
Cheshire
SK9 5AF
Tel: 01625 545700
Fax: 01625 524510
Email: mail@ico.gsi.gov.uk
Website: http://www.informationcommissioner.gov.uk

Yours sincerely

Nick Williams
FOI Officer
Health and Safety Executive
Chemical Risk Management Unit
Corporate Health Sciences Division
4N.3 Redgrave Court
Merton Road
Bootle
Merseyside L20 7HS
UK
Tel. +44 (0) 151 951 3500
Fax. +44 (0) 151 951 3595

Case reference: 2007060376

Author: MIME:joanne.nettleton@ukf.net at netmail
Date: 24/06/2000 18:35
Normal
TO: Nigel Bunce at HSE-FOD-AREA-16
TO: Roger Gladwell at HSE-FOD-AREA-16
CC: Hugh Wolfson at HSE-FOD-AREA-16
CC: James Taylor at hse-fod-area-08
CC: Joanne Nettleton at HSE-FOD-AREA-16
Subject: Manchester Museum
---------- Message Contents
Nigel/Roger

summary of the manchester museum from friday 23rd june

(Hugh, James for info...James, manchester museum is a small museum on oxford road, owned by the university)

Nigel passed me a notification of intention to work with ionising radiation which was appended to a construction notification. The IR work consisted of the removal of radioactively contaminated fittings & buildings arising out of historic contamination. I visited on friday to assess the situation. summary below:

1. Before work commenced in the coupland building, it was decided to carry out a survey for radioactive contamination (because this building housed rooms which were used by Rutherford, Geiger & Moseley, amongst others). The survey indicated that more contamination was present than expected and a larger survey was carried out. Results as below

Coupland Building (Museum Owned section): 3 contaminated room plus one with elevated dose rate due to contamination in adjacent room)

Coupland Building (owned by Psychology Department): 4 contaminated rooms.

Old Dental School (main museum building): 1 contaminated room found so far.

It is considered unlikely that any further areas are contaminated (historic use), but I have asked that the museum undertake a written assessment in relation to all areas (in particular areas of public access). This should be waiting for me when I return to the office on 11th July.

Of the contaminated areas, 1 is an office used by the Head of Mineralogy, 2 were computer labs used by Psychology Post Grad students and the rest were store rooms (I think).

Very little work has so far been done by the museum to characterise the contamination, but the results from the one area where this has been done (a storeroom) indicate that the contamination is Radium-226 (& decay products).

Only the room where post grad student sat has been subject to any assessment to estimate exposure of persons....& this only considered external dose rate (no consideration of internal hazard to include radon). The results from this assessment relate to a small patch of contamination in the middle of the computer lab (student sat around the edge at terminals). The contact dose rate of the hot spot was 5.9 microSv/hr, & that at the terminals was background)

I have asked the museum to complete a full assessment of historic exposures (from 1985 onwards) by the time I return. I hope/expect these to be low as it appears that contamination is fixed (ie little risk of spread) and in some cases on floor boards under vinyl. However, no consideration has yet been given to radon & daughters (which is relevant if contamination is Radium-226).

One area has already been just about cleared by NNC (Harwell) and the waste from this (floorboards, vinyl etc) is stored in a secure area within one of the rooms (the environment agency are aware). No estimates are available as to the total amount, but looking at preliminary figures for Bq/g & multiplying by the estimated size of contaminated areas, we might be talking of MBq or GBq (not insignificant).

I plan to revisit the site on wednesday 12th July for the whole day. In the morning (9.30 onwards) I will discuss the dose estimates and risk assessment for public areas. I will also discuss why this contamination was not found until building work was planned (there was obviously a suspicion that it existed as a survey was carried out before work commenced). I will also look at management of IR hazards from the sample collections (there is an RPS & local rules etc which I didn't get chance to see on friday as the RPS was on leave....good back up eh !). The university Radiological Protection Service are appointed as RPA for this

In the afternoon (1pm onwards) I will look at the risk assessment, method statements, local rules, training, supervision etc in relation to the planned work to remove the identified contamination. An external RPA (NNC Warrington) has been appointed for this work. I was informed that the actual work will be carried out by construction workers who have not yet received training. The work is likely to be dusty & so internal radiation hazard is likely to be very important. I have been informed that the work will not start until I have revisited (the construction company is Hayvern Ltd, Farnworth)

Hope this helps with background if any queries come through.

Jo

Summary Sheet of NW RSG Inspector's Report

NW RSG		Source of Request	FOD16	FMU	200009
Name of firm	University of Manchester				
Address	The Manchester Museum, Oxford Road, Manchester M13 9PL				
RSG File No		**RSG Job No**	765/1		
Subject of Report	Historical radioactive contamination found prior to major construction project				
Initiation	w	**Request Date**	15th June 2000	**Priority**	other
Date of Report	30th August 2000				
Date of Visit(s)	23rd June, 31st July 2000				

Visited by	**Unit/Division**
Jo Nettleton	NWSG

Persons Seen	**Position**
Sue Robson	University Director of Health and Safety Services
Velson Horie	Manchester Museum Keeper of Conservation
Dave Green	Mineralogist and Museum RPS
Helen Thornton	Museum Services Manager and Health and Safety Representative
Kevin Robinson	University Radiation Protection Service (Technician)
Steve Bidey	University Radiation Protection Service (RPA)
David Prime	University Radiation Protection Service (RPA)
Barry Frith	NIRAS (RPA for remediation and construction work only); was previously employed by the University as RPA
John Duffy	University Director of Estates
David Smith	University Estates
Barry Chadwick	University Estates
Steve Marsh	NJSR Planning Supervisors
John Frian	Appleyard and Trew Project Manager
David Billington	Hayvern Contract Manager
Jed Higginbottom	Hayvern Site Supervisor
Haley Dunn	Hayvern Health and Safety Manager
John Steventon	Ian Simson Architects

10459

Relevant Papers Yes

SUMMARY

Visits were made to the Manchester Museum (address as above) to investigate the reported discovery of

radioactive contamination on site during a survey carried out prior to a major construction project. All of the contaminated areas are within the Coupland Building, which was used by early physicists and chemists (including Rutherford and Geiger) during the latter part of the 19th and early part of the 20th Centuries. Surveys have indicated that the radioactive contamination in all areas is from the Uranium-238 decay chain. The University and Museum should have undertaken a radiation survey of the Coupland Building as soon as the possibility of radioactive contamination was noted (probably back in the 1950s). However, as the contamination is historic, it is perhaps understandable that in more recent years no survey was undertaken until the proposed construction work alerted people to the potential hazard. The majority of the rooms were used for storage, with associated low occupancy. The exception is G55, the postgraduate room in the Psychology Department. Estimated radiation doses to people in this room are not significant and as the contamination was located underneath flooring materials such as linoleum and boarding, the potential for contamination would probably be negligible. The University have employed NIRAS to direct remediation work, and this will be undertaken subject to appropriate risk assessment and control measures. A radiation survey of the rest of the Museum site has located no further radioactive contamination.

The Museum's systems for control and use of radioactive samples require significant improvement in order t comply with IRR99. This is already underway and I have requested that confirmation be forwarded to me when complete

Author	Jo Nettleton	**Grade**	3	**Discipline**	Radiation
RSG Action: copies to	ccmail: Nigel Bunce, Roger Gladwell, Hugh Wolfson hard copy:				

FI2501 (Rev 11/97)

INSPECTION REPORT

UNIVERSITY OF MANCHESTER
THE MANCHESTER MUSEUM
OXFORD ROAD, MANCHESTER M13 9PL

IONISING RADIATIONS REGULATIONS 1999 (IRR99)

1. Introduction

1.1 Following a request for specialist advice, visits were made to the Manchester Museum (address as above) to investigate the reported discovery of radioactive contamination on site during a survey carried out prior to a major construction project. The construction work is being undertaken by Hayvern and a number of other companies

are involved in the project (see front page of report). Persons interviewed are listed on the front page of this report. The proposed methods for remediation work were reviewed. In addition, an inspection was made of the Museum's current arrangements for management of radiation protection in relation to the keeping and work on numerous radioactive rock samples.

1.2 The Museum have appointed Steve Bidey and Dave Prime from the University Radiological Protection Service to act as radiation protection advisers, RPA, for the handling of radioactive rock samples. Barry Frith (NIRAS) has been appointed as RPA for remediation work in the Coupland Building.

2. Inspection Findings: Historical use of radioactive materials at the Museum and resultant contamination

2.1 All of the contaminated areas are within the Coupland Building, which was used by early physicists and chemists (including Rutherford and Geiger) during the latter part of the 19th and early part of the 20th Centuries. Surveys have indicated that the radioactive contamination in all areas is from the Uranium-238 decay chain (including Radium-226) One of the ten contaminated rooms (G54, a storeroom) contained a bench (used by Rutherford) which was known to be contaminated prior to the surveys undertaken. The Museum plan to retain this bench as an exhibit, behind glass and subject to appropriate control. The radioactive contamination within the other rooms (and indeed further contamination within the room where the bench was stored) was not discovered until a radiological survey was undertaken prior to the commencement of a major construction project involving the Coupland Building. It is unclear why no previous survey was undertaken. A number of employees (Kevin Robinson and Barry Frith) have vague recollections of a survey an the 1970s or 1980s, but no records are available. The contaminated bench was apparently something of an attraction and even featured on the television programme 'Local Heroes', but there was no control over access into room G54 and this was not designated as Controlled or Supervised. A piece of hardboard was fitted over the contaminated area of the bench (in the 1950s) to prevent spread of contamination (though hardboard is not ideal for this purpose as it is not impervious). The bench is now kept in a locked and signed room.

2.2 During recent times (up until early this year), the Coupland Building was divided into areas used by the Museum and areas used by the Psychology Department. Both have contaminated rooms (four in the Museum and six in Psychology). Of the ten rooms, nine were used only as storage areas (including G54). However, one room (G55, adjacent to G54 in the Psychology Department) was used as a postgraduate office and computer laboratory.

2.3 At the time of my first inspection, a number of surveys had been undertaken, initially by the University Radiation Protection Service and then by NNC (Harwell). These surveys had indicated the location of contamination and given an idea of dose rates (no assessment of the amount of activity present in Bq or Bq/g, or Radon-222 concentration had been undertaken). In the majority of rooms surveyed, the external dose rate was

below 1 Svh^{-1}. In room C1-10 (storage) the dose rate was 12 Svh^{-1} from contaminated brickwork and in rooms G54 and G55 localised hot spots at up to 50 Svh^{-1} were identified. An initial dose assessment had been carried out for persons sitting at computers in G55. The hot spot was located more than 1m from any work station and thus estimated doses to persons were not significant. No consideration to internal radiation hazard from Radon-222 had been included in the calculation.

2.4 Following my initial inspection, I requested that further work be undertaken to assess doses from the contamination (to include internal radiation, particularly from Radon-222) and to survey all public areas of the Museum. NIRAS (a Warrington based subsidiary of NNC Harwell who carried out the initial work) completed a full survey of the Coupland Building. All of the contaminated rooms had been emptied and I asked that contamination monitoring be carried out on items which had been removed. Measurable levels of Radon-222 were found in a number of the rooms surveyed, but the levels were below 400 Bqm^{-3} (and so IRR99 are not applicable to work within, in terms of Radon-222). I am still awaiting renewed dose estimates (but expect these to be insignificant). None of the items removed from the Coupland Building were found to be contaminated. The University Radiation Protection Service carried out a survey of Museum areas currently in use. No radioactive contamination or elevated dose rate levels were found in the Museum's public areas (or indeed any of the Museum buildings). A number of rock samples were located within the office of an employee (Dave Green, the Mineralogist) and these were initially mistaken for contamination. This is discussed more fully in Section 3. Work is still ongoing to obtain an estimate of the total radioactivity present.

2.5 The University has appointed Barry Frith (NIRAS) as RPA for the Coupland Building remediation and construction work. During my first inspection, I toured the Coupland Building and noted that not all the contaminated rooms were locked or had warning signs indicating the presence of radioactive material, although all rooms are within the secure demolition site. Since that time, all of the rooms have been locked and designated as Supervised Areas. This status is likely to be changed upon commencement of remediation work. Local Rules are in place for necessary access into these areas.

2.6 Prior to the extent of radioactive contamination being known, NNC carried out some remediation work in one of the rooms (C1-10, the dose rate is thus now significantly lower than the 12 Svh^{-1} reported before work commenced). This work was stopped when the other contaminated areas were identified, but has generated a significant amount (volume) of radioactively contaminated waste which is currently being stored in room C1-09. The estimated activity of this is 39 MBq. The material (floor boards, brickwork etc) must be down-sized and moved before remediation of C1-09 can commence and a suitable store is to be found (The Environment Agency are involved in the discussion). I informed the Museum of the need to ensure that down-sizing and removal of the material is subject to a suitable prior risk assessment and the necessary controls (local rules, supervision, contingency plans, radiation monitoring, training of workers involved, restriction of exposure etc to ensure compliance with IRR99). In addition, the need for a secure store was emphasised.

2.7 Barry Frith is currently drawing up risk assessments for the remediation work. This will be carried out by three Hayvern employees (Jed Higginbottom plus two others). These have not yet received training, but I was informed that this will be done by Barry Frith and that he, or another trained NIRAS employee, will be on site at all times during the work. I was shown a draft set of local rules which require some amendment (for example improved contingency plans and a more suitable investigation level than the current value of 15 mSv). No specific details are yet available as to the systems to be employed (such as damping down of brick work where possible) or of appropriate PPE. I was informed that an employee dose constraint of 1 or 2 mSv will be set for the complete operation. I discussed the need to consider hazards other than ionising radiation within the risk assessment. It was agreed that copies of the risk assessment and method statement will be sent to me before work commences (I have not yet received these).

3. Inspection Findings: Current use of radioactive materials at the Museum

3.1 The Museum has an inventory of approximately 150 radioactive mineral samples, though the inventory is currently being updated. The samples mainly contain Uranium-238 and daughters and have surface dose rates varying from 5 Svh^{-1} up to 500 Svh^{-1}. In addition, the Museum occasionally examines samples brought in by members of the public (see Paragraph 3.3 and 3.4). The University Radiological Protection Service provides radiation protection advice and Steve Bidey and David Prime (employed by the Service) are appointed as radiation protection advisers, RPA. David Green (Mineralogist) is appointed as radiation protection supervisor, RPS.

3.2 I was informed that all samples (except those temporarily being held for members of the public) are kept in a safe (designated as a Controlled area) within a locked room (designated as a Supervised area). Although I was told that no dose rate above background was measurable outside the room, I was able to detect a dose rate of at least 8 Svh^{-1} using a FAG compensated Geiger instrument (which may in fact under read at the energies of Uranium-238 and some of its daughters). The safe had been moved to the storeroom in January 1999 (using an appropriate system of work). However, despite recommendation from Kevin Robinson that radiation monitoring should be carried out following the move, this appears not to have been done. IRR99 (and the previous IRR85) require suitable monitoring to be undertaken at the boundaries of designated areas to ensure that the area has been correctly designated. In addition, I consider that the dose rate of at least 8 Svh^{-1} is not as low as reasonably practicable, as required by Regulation 8 IRR99. In fact the Museum agreed that it would be very practicable to reduce this dose rate (either by moving the safe further into the room or by addition of extra shielding). It is unfortunate that this was not carried out in 1999, but as occupancy of the area is usually low, it is unlikely that significant exposures to radiation will have been received. No monitoring for Radon-222 has been carried out in the storeroom and I advised that this be undertaken.

3.3 Local rules are available for entry into the storeroom and handling of the sources. However, in the latter case, the working procedures are inadequate to deal with the high surface dose rate associated with some of the samples (a fact which was noted in a letter

from a technician at the University Radiological Protection Service in 1986, but which appears to have been ignored by both the Museum and the RPA). In addition, the local rules do not cover the specific issue of samples on loan from members of the public (initial check for dose rate and contamination hazard, handling and temporary storage). The Museum have now purchased a Geiger based monitor to carry out an initial check of dose rate. During the survey for contamination, it was originally believed that one room in the main Museum building (the old Dental School) was contaminated. However, it was discovered that the high dose rate (up to 15 Svh^{-1} on contact) was actually due to a number of samples in the room (Dave Green's office) which had been loaned by a member of the public. Dr Green had been on leave at the time of the survey. The Museum agree that control over such sources must be significantly improved. New local rules are being drafted, extra storage cabinets are being purchased and a major review of source handling is underway.

3.4 The Museum queried the legal situation regarding the temporary holding of sources loaned by members of the public, specifically what action they should take if the sources are found to be significantly radioactive, but the owner still insists on the sources being returned to him. The Museum are drawing up an information sheet to give to such people, which includes a warning of the associated hazard. This situation is not limited to radioactive sources, as a wide variety of materials and objects (some of which are hazardous) are brought to the Museum by members of the public for investigation and return. This matter is under consideration.

3.6 The Museum do have an X-ray set. However this has not been functional for a number of months and X-ray analysis of samples is now carried out at the Stopford Building facility. I advised that the plug be removed from the Museum set and that it be disposed of appropriately.

4. Discussion

4.1 The University and Museum should have undertaken a radiation survey of the Coupland Building as soon as the possibility of radioactive contamination was noted (presumably this would have been back in the 1950s when the hardboard was placed over Rutherford's bench). However, as the contamination is historic, it is perhaps understandable that in more recent years no survey was undertaken until the proposed construction work alerted people to the potential hazard. The majority of the rooms were used for storage, with associated low occupancy. The exception is G55, the postgraduate room in the Psychology Department. Estimated radiation doses to people in this room are not significant and as the contamination was located underneath flooring materials such as linoleum and boarding, the potential for contamination would probably be negligible. The University have employed NIRAS to direct remediation work, and this will be undertaken subject to appropriate risk assessment and control measures. A radiation survey of the rest of the Museum site has located no further radioactive contamination.

4.2 The Museum's systems for control and use of radioactive samples require significant

improvement in order to comply with IRR99. This is already underway and I have requested that confirmation be forwarded to me when complete.

Jo Nettleton (Dr)
NWRSG

From: John Churcher <churcher@aulos.co.uk>
To: Nick.Williams@hse.gsi.gov.uk
Subject: Re: FOI enquiry 2007060376 - Information relating to radiological inspections of the Coupland Building at the University of Manchester
Date sent: Mon, 15 Oct 2007 18:01:12 +0100

Dear Mr Williams,

Freedom of Information Request Reference No: 2007060376

Thankyou for your reply dated 19/7/2007 to my request for information relating to radiological inspections of the Coupland Building at the University of Manchester. I am grateful to you for supplying me with copies of an email by Dr Nettleton dated 24/6/2000 and her inspection report dated 30/8/2000.

As my request was for "any information relating to radiological inspections of the Coupland Building....including correspondence, notes or memoranda concerning meetings or other communications with the University, or with NIRAS NNC Ltd", I am surprised that you have not also sent me any other correspondence between the Health and Safety Executive and the University on this matter.

Would you please confirm that Dr Nettleton did actually receive the letter dated 6/7/2000 from Dr Bidey, and that the eight documents mentioned in that letter were actually enclosed with it?

Would you also please let me know whether Dr Nettleton received a reply to her letter dated 4/10/2000 to Dr Robson, and if possible let me have a copy of any reply that she received?

Finally, would you please confirm that the Health and Safety Executive is not in possession of any other information falling within the scope of my original request?

Yours sincerely,

John Churcher

From: Nick.Williams@hse.gsi.gov.uk
To: churcher@aulos.co.uk
Subject: FOI enquiry: 2007110197
Date sent: Mon, 12 Nov 2007 15:03:53 +0000

Case reference: 2007110197

Dear Mr Churcher,

Freedom of Information Request Reference No: 2007110197

Thank you for your request for information about:

Information relating to radiological inspections of the Coupland Building at the University of Manchester

Your request was received on 16/10/2007 and I am dealing with it under the terms of the Freedom of Information Act 2000 (the Act).

I am writing to advise you that following a search of our paper and electronic records, I have established that the information you requested is:

not held by the Health & Safety Executive

If you have any queries about this letter, please contact me. Please remember to quote the reference number above in any future communications.

If you are unhappy with the decisions made by HSE in relation to your request you may ask for an internal review by contacting me.

If you are not content with the outcome of the internal review you have the right to apply directly to the Information Commissioner for a decision. The Information Commissioner can be contacted at:

Information Commissioner's Office
Wycliffe House
Water Lane
Wilmslow
Cheshire
SK9 5AF
Tel: 01625 545700
Fax: 01625 524510
Email: mail@ico.gsi.gov.uk
Website: http://www.informationcommissioner.gov.uk

Yours sincerely

Nick Williams

FOI Officer
Health and Safety Executive
Chemical Risk Management Unit
Corporate Specialist Division
Science and Technology Group
4N.3 Redgrave Court
Merton Road
Bootle
Merseyside L20 7HS
UK
Tel. +44 (0) 151 951 3500
Fax. +44 (0) 151 951 3595

From: John Churcher <churcher@aulos.co.uk>
To: Nick.Williams@hse.gsi.gov.uk
Subject: Re: FOI enquiry: 2007110197
Date sent: Tue, 13 Nov 2007 14:47:04 +0100

Dear Mr Williams,

You ref: 2007110197

Thankyou for your reply to my request for information. I am writing to ask for clarification of your reply, which is ambiguous.

In my request I asked if you would confirm that Dr Nettleton did actually receive the letter dated 6/7/2000 from Dr Bidey, and that the eight documents mentioned in that letter were actually enclosed with it, and whether Dr Nettleton received a reply to her letter dated 4/10/2000 to Dr Robson.

When you advise me that the information I requested is not held by the Health & Safety Executive, which of the following do you mean: (i) that this correspondence was received, but is no longer held by HSE; (ii) that it was never received; or (iii) that the HSE does not have any record of whether or not it was ever received?

Yours sincerely,

John Churcher

From: <Nick.Williams@hse.gsi.gov.uk>
To: <churcher@aulos.co.uk>
Subject: RE: FW: FOI enquiry: 2007110197
Date sent: Thu, 29 Nov 2007 15:34:24 -0000

Dear Mr Churcher,

I have now received a response to your enquiry for information which has resulted in no further documents being found.

I am sorry to have been unable to help you further.

Yours sincerely,

Nick Williams
Health and Safety Executive
Chemical Risk Management Unit
Corporate Specialist Division
Science and Technology Group
4N.3 Redgrave Court
Merton Road
Bootle
Merseyside L20 7HS
UK
Tel. +44 (0) 151 951 3500
Fax. +44 (0) 151 951 3595

From: John Churcher <churcher@aulos.co.uk>
To: Joanne.Nettleton@hse.gsi.gov.uk
Subject: Radiological inspection of Coupland 1 Building, University of Manchester
Date sent: Sun, 02 Dec 2007 18:11:00 +0100
Send reply to: churcher@aulos.co.uk
Copies to: Nick.Williams@hse.gsi.gov.uk

Dr Joanne Nettleton
Health and Safety Executive
Nuclear Directorate
Redgrave Court
Merton Road
Bootle
L20 7HS

Sunday 2nd December 2007

Dear Dr Nettleton,

Your email address has been given to me by Nick Williams, FOI Officer at Bootle. I am writing to ask for your help in connection with your inspection of a building at the University of Manchester during the summer of 2000, when you were HM Specialist Inspector (Radiation) at the North West Division of HSE. Originally Ernest Rutherford's laboratory, at the time of your inspection the building was called Coupland 1, and for about 25 years up to 1999 it had been occupied by the Manchester Museum and by the Department of Psychology.

Before retiring from the University in 2002 I was a Lecturer in Psychology, and for 20 years I occupied a room in the building which was later found to be contaminated with radium and Pb210/Po210, a fact that I subsequently discovered only by chance. Since then, with two of my former colleagues who also occupied rooms in the building, I have been trying to reconstruct its radiological history in order to find out whether we were exposed to any health risk, and whether the health of current and future occupants is being adequately safeguarded. We are preparing a report and when it is finished, which I hope will be within a few months, we will send a copy to HSE.

I have obtained copies of a letter to you from Dr Stephen Bidey, the University's RPA, dated 6th July 2000, and of your letter dated 4th October 2000 to Dr Susan Robson, the University's Director of Heath & Safety. A request to HSE for further information was forwarded to Mr Williams, who has sent me copies of your inspection report dated 30th August 2000, and of your email to Nigel Bunce and Roger Gladwell, dated 26th June 2000, in which you summarised your initial visit. Copies of this material are attached, in chronological order.

As far as I can tell from your report, although you met with representatives of the Museum, the University's Health and Safety Service, including the RPS, and various contractors, no-one from the Department of Psychology was present at the meetings. It seems possible that you were not correctly informed by the University about the nature and extent of occupation of the building by staff and students in Psychology. In your report you wrote: "The majority of the rooms were used for storage, with associated low occupancy. The exception is G55, the postgraduate room in the Psychology Department." This view is repeated in your letter of 4th October 2000, where you wrote: "I recognise that the contamination is historical and that the majority of contaminated rooms were used for storage". If this is what you were told by representatives of the University, you may have had no reason to doubt it, since the building had been vacated some months earlier and its general condition was consistent with its having been unoccupied for a longer time.

In reality, from the mid-1970s until 1999 nearly all of the rooms in our half of the building were occupied as offices and laboratories by staff and/or students of the Department, in many cases by the same individuals continuously for long periods. A recent discussion with one of my former colleagues resulted in our jointly recalling by name 31 individuals who worked there for periods ranging from a few months to 23 years. Members of technical staff were also involved extensively in drilling holes through walls and floors when the building was rewired for a computer network in the 1980s, and could therefore have been at risk of inhaling contaminated dust.

Mr Williams has been unable to find out for me whether you actually received Dr Bidey's letter or the documents mentioned in it as enclosures, or whether you received a reply to your letter to Dr Robson. I understand that he has contacted your Manchester office about it but is unable to find any record of the correspondence. This rather surprised me, since as I understand it your document retention policy specifies a retention period for paper documents of nine years after a file is opened.

I am therefore writing to you personally to ask whether you are able to add anything, from memory and/or from your personal files. Were you in fact given to understand by representatives of the University that the majority of rooms had been unoccupied for a long time? Did you receive Dr Bidey's letter with the enclosures, and a reply to your letter to Dr Robson, and were you satisfied with what was sent? I realise that I am asking about a piece of work that you did several years ago, when you were working in a different capacity, and that in comparison with the sort of risks you now have to manage my enquiry may seem trivial. Neverthless I thought it worth writing to ask you.

Yours sincerely,

John Churcher

Cc: Nick Williams

From: <Joanne.Nettleton@hse.gsi.gov.uk>
To: <churcher@aulos.co.uk>
Subject: RE: Radiological inspection of Coupland 1 Building, University of Manchester
Date sent: Mon, 3 Dec 2007 15:43:48 -0000
Copies to: <Nick.Williams@hse.gsi.gov.uk>, Peter.Griffin@hse.gsi.gov.uk

Dear Dr Churcher

Thankyou for the note below.

Firstly, let me assure you that I do not in any way consider the issues at the Manchester Museum, or the concern you hold over those issues to be trivial.

Prior to your email, I have been contacted by colleagues regarding the initial enquiry that you made and have looked through all the electronic files I hold to see if there is anything to respond to your question. I forwarded all copies of these files to the team dealing with your query. Unfortunately, I do not think they answer your question and I no longer have any of the hand written notes made during inspections and meetings. The paper files associated with the work would have been kept at the Manchester Office, but I understand that this line of enquiry has been unsuccessful.

Without such documents, I cannot shed any more light on your queries (I have racked my brain, but cannot add anything)

I understand that this will be a disappointing response.

kind regards

Jo Nettleton

Dr Jo Nettleton
Head of Defuelled Reactor Inspection
Nuclear Safety Directorate
Division 1
Redgrave Court
Bootle L20 7HS

Telephone 0151 951 4799
Fax 0151 951 4163

The University of Manchester
Department of Psychology
Coupland 1 Building

11th October 1999

The Radiological Protection Service were requested to survey several rooms within the building for any residual radioactive contamination, since the building had historically been the Physics Department where work by Ernest Rutherford (1907-1919) was carried out using radium-226.

The rooms as listed below were directly monitored using a Berthold LB1210B instrument.

G-51, G-52, G-53, G-54, G-55, G-56, G-57, 1-53, 2-52, 2-53, 2-60, 2-61, 2-62, 2-63

The original walls to bench height, skirtings and floor areas were monitored.

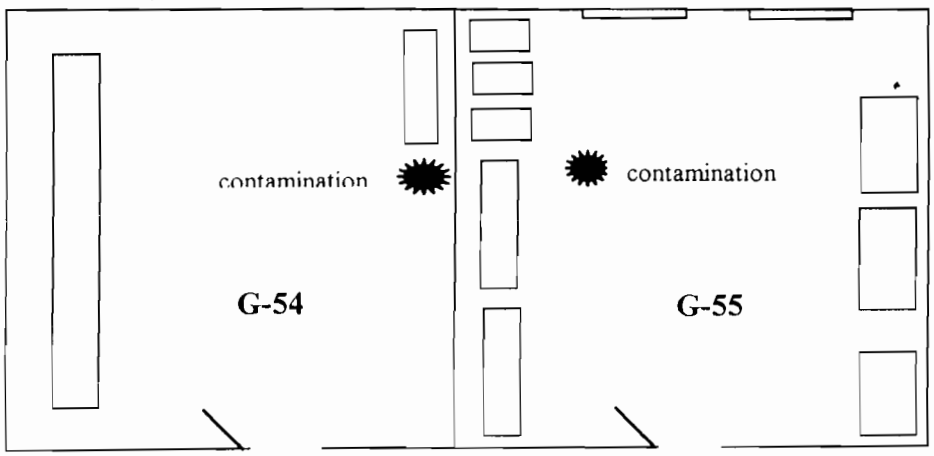
Low levels of contamination were found in rooms 2-62 and 2-63.

Within room 2-62 the contamination was found at the far end of the room in the vicinity of the worn areas of the vinyl. The level of contamination can be considered insignificant, however it will be necessary to ensure that air borne dust is not created should the vinyl be replaced at a future date.

The contamination within room 2-63 was detected on the wall above the hand washbasin; the level of contamination can be considered insignificant and is fixed in place by the paint finish.

Higher levels of contamination were detected in rooms G-54 and G-55. Further monitoring of these rooms was carried out.

Rooms G-54 and G-55 were the original Rutherford Laboratory and were once one large room. Contamination was detected at a level of 300 counts per second in the areas indicated on the diagram below.



The areas of contamination found in room G-55 and G-56 were monitored for dose rate levels using a Mini Instruments "Smart-Ion" dose rate instrument.

The general background of the instrument was found to be 1.6 $\mu Sv.h^{-1}$ (microsieverts per hour) and the dose rate from the areas of contamination was found to be 7.5 $\mu Sv.h^{-1}$.

After background correction is taken in to account the level of radiation dose can be calculated to be 5.9 $\mu Sv.h^{-1}$.

This level of radiation exposure can be considered acceptable under the Ionising Radiations Regulations 1985 for a forty-hour per week occupancy level. Therefore the Radiological Protection Service consider that any persons working within this room should not have exceeded any exposure limits as laid down in the regulations.

As a matter of general safety and radiation exposure limitation it may be prudent to ensure that staff and student occupancy of this room is reduced.

Should future refurbishment of the floor areas in these two rooms take place, it will be necessary to ensure that air-borne dust is not created.

Kevin J. Robinson.

The University of Manchester Museum
Oxford Road

18th October 1999

The Radiological Protection Service was requested to monitor several rooms belonging to the Museum within the Coupland One Building.

The following rooms were monitored: CG-01, CG-02, CG-03, CG-04, CB-05, CB-09, CB-10, CB-11, CB-13, CB-14, CB-110 and the Cohen Lecture Theatre.

Contamination was detected in the following rooms:

CB-05, CB-09, CB-110

CB-05

The contamination was located in the Geiger, Nuttall Room and was at a level of 20 counts per second, this was detected on the right hand side window ledge. The contamination is fixed by the painted surface.

This level of contamination can be considered insignificant, however if at any time in the future it is required to refurbish the window ledge area, the RPS recommend that further assistance and advice is sought.

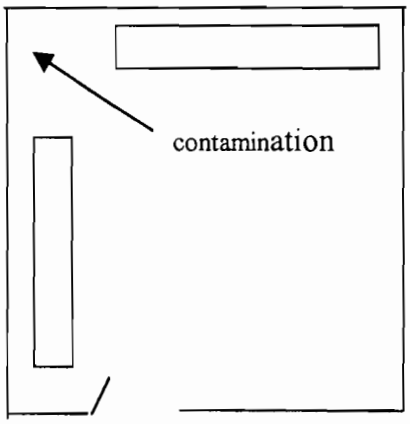
CB-09

The contamination within this room was detected on the window ledge immediately opposite the entrance door and to the right hand side of the sink unit. The level of contamination was found to be 150 counts per second.

This level of contamination can be considered insignificant, however if at any time in the future it is required to refurbish the window ledge area, the RPS recommend that further assistance and advice is sought

CB-110

Contamination was detected along the skirting of the room in the corner to the left hand side in relationship to the entrance door – please see the diagram below. The level of contamination was found to be 300 counts per second. This contamination may give rise to air borne radioactive dust depending on the level of future refurbishment; further advice from the RPS must be sought prior to contractors entering the area.



Conclusions

All direct monitoring was carried out using either a Berthold LB1210B or LB1210D; it is assumed that all contamination is due to radium-226.

It is possible that other areas of contamination exist throughout these rooms, since it was not possible to gain access to all of the floor and wall areas.

Kevin J. Robinson.

Local Rules Written by the RPA appointed by the University of Manchester in compliance with Regulation 17 of the Ionising Radiations Regulations 1999

These Local rules refer to areas designated, on the basis of radiation hazards from radioactive material in the form of residual contamination, as Supervised Areas in the University's Coupland 1 Building, the Annex and the Old Dental Hospital, including laboratories historically used by Rutherford.

Rooms designated as Supervised Areas are:-

CB 05, CB.09, CB.10, G.23 (G55), G.24 (G54), C.1.09, C.1.10, 2.21, 2.22, 2.62, 2.63 in Coupland 1 Building, and Room 2.05 in the Old Dental Hospital

Hazard Assessment

Radioactive contamination remaining in the rooms identified is likely to be primarily naturally occurring radioactive material. Analysis indicates that in some cases there may be some disruption in the natural decay series secular equilibrium. The contamination is surface and at depth. The radiological hazard is due to both external and internal radiation.

A radiation survey undertaken by NIRAS, and reported in "Residual contamination survey of Coupland 1Building, the Annex and Old Dental Hospital, Manchester University" has yielded the data on which this assessment is made.

External hazard

ocal surface contact dose rates of 50μSv/h are to be found in Rooms G54, G55. The calised nature of the hazard and the low occupancy of the area is likely to result in posures which are well with any relevant limit.

ternal Hazard

th the contamination being to a large extent absorbed within the matrix of the affected ation, the availability for ingestion and inhalation depends greatly on the degree of urbance. Casual entry into the rooms which dose not involve work which would cause removal and/or suspension of surface contamination, is likely to result in low risk.

likelihood of an occurrence that would result in Radiation Accident is low.

Internal Hazard must be re-assessed should work be undertaken which is likely to rb contamination in a way which makes it available for ingestion or inhalation.

Contingency Plan

No reasonably foreseeable occurrence is likely to result in a Radiation Accident. No contingency plan is required.

Dose investigation level

An investigation shall be carried out should monitoring of the area indicate that any person has received an effective dose of 15 mSv. for the first time in a calendar year.

Radiation Protection Supervisor.

The University has appointed Mr. Kevin Robinson as Radiation Protection Supervisor.
The University uses the designation Departmental Radiation Supervisor

Radiation Protection Adviser

Dr. Steven Bidey (University)
Mr. Barry Frith (for Museum refurbishment operations)

Access to the areas

Access to the areas is unrestricted to informed and trained persons; subject to the restrictions written into the Operating Procedures.

Operating Procedures

Only work involving no disturbance or disruption of the areas marked "Contaminated" must be undertaken. Occupancy should be kept as low as practicable.

B.Frith.

22 June 2000

Author: MIME:joanne.nettleton@ukf.net at netmail
Date: 24/06/2000 18:35
Normal
TO: Nigel Bunce at HSE-FOD-AREA-16
TO: Roger Gladwell at HSE-FOD-AREA-16
CC: Hugh Wolfson at HSE-FOD-AREA-16
CC: James Taylor at hse-fod-area-08
CC: Joanne Nettleton at HSE-FOD-AREA-16
Subject: Manchester Museum
---------- Message Contents
Nigel/Roger

summary of the manchester museum from friday 23rd june

(Hugh, James for info...James, manchester museum is a small museum on oxford road, owned by the university)

Nigel passed me a notification of intention to work with ionising radiation which was appended to a construction notification. The IR work consisted of the removal of radioactively contaminated fittings & buildings arising out of historic contamination. I visited on friday to assess the situation. summary below:

1. Before work commenced in the coupland building, it was decided to carry out a survey for radioactive contamination (because this building housed rooms which were used by Rutherford, Geiger & Moseley, amongst others). The survey indicated that more contamination was present than expected and a larger survey was carried out. Results as below

Coupland Building (Museum Owned section): 3 contaminated room plus one with elevated dose rate due to contamination in adjacent room)

Coupland Building (owned by Psychology Department): 4 contaminated rooms.

Old Dental School (main museum building): 1 contaminated room found so far.

It is considered unlikely that any further areas are contaminated (historic use), but I have asked that the museum undertake a written assessment in relation to all areas (in particular areas of public access). This should be waiting for me when I return to the office on 11th July.

Of the contaminated areas, 1 is an office used by the Head of Mineralogy, 2 were computer labs used by Psychology Post Grad students and the rest were store rooms (I think).

Very little work has so far been done by the museum to characterise the contamination, but the results from the one area where this has been done (a storeroom) indicate that the contamination is Radium-226 (& decay products).

Only the room where post grad student sat has been subject to any assessment to estimate exposure of persons....& this only considered external dose rate (no consideration of internal hazard to include radon). The results from this assessment relate to a small patch of contamination in the middle of the computer lab (student sat around the edge at terminals). The contact dose rate of the hot spot was 5.9 microSv/hr, & that at the terminals was background)

I have asked the museum to complete a full assessment of historic exposures (from 1985 onwards) by the time I return. I hope/expect these to be low as it appears that contamination is fixed (ie little risk of spread) and in some cases on floor boards under vinyl. However, no consideration has yet been given to radon & daughters (which is relevant if contamination is Radium-226).

One area has already been just about cleared by NNC (Harwell) and the waste from this (floorboards, vinyl etc) is stored in a secure area within one of the rooms (the environment agency are aware). No estimates are available as to the total amount, but looking at preliminary figures for Bq/g & multiplying by the estimated size of contaminated areas, we might be talking of MBq or GBq (not insignificant).

I plan to revisit the site on wednesday 12th July for the whole day. In the morning (9.30 onwards) I will discuss the dose estimates and risk assessment for public areas. I will also discuss why this contamination was not found until building work was planned (there was obviously a suspicion that it existed as a survey was carried out before work commenced). I will also look at management of IR hazards from the sample collections (there is an RPS & local rules etc which I didn't get chance to see on friday as the RPS was on leave....good back up eh !). The university Radiological Protection Service are appointed as RPA for this

In the afternoon (1pm onwards) I will look at the risk assessment, method statements, local rules, training, supervision etc in relation to the planned work to remove the identified contamination. An external RPA (NNC Warrington) has been appointed for this work. I was informed that the actual work will be carried out by construction workers who have not yet received training. The work is likely to be dusty & so internal radiation hazard is likely to be very important. I have been informed that the work will not start until I have revisited (the construction company is Hayvern Ltd, Farnworth)

Hope this helps with background if any queries come through.

Jo

versity Health & Safety Services
adiological Protection Service
7th Floor, Williamson Building, Oxford Road, Manchester M13 9PL

THE UNIVERSITY of MANCHESTER

University of Manchester
Museum and Coupland 1 Building
Museum and Psychology Rooms

Potential radiation dose received as a result of entering the rooms listed below
In accordance with the Ionising Radiations Regulations 1985

27th June 2000

Room number	Usage	Occupancy maximum per week	Doserate at one centimetre	Potential Received Dose Per week calculated at one metre
CB 05 museum	Storage	1 hour per week	< 0.5 $\mu Sv.h^{-1}$	0.00005 µSv
CB 09 museum	Storage	1 hour per week	5 $\mu Sv.h^{-1}$	0.0005 µSv
CB 10 museum	Storage	1 hour per week	< 0.5 $\mu Sv.h^{-1}$ *	0.00005 µSv
C1-10 museum	Storage	1 hour per week	12 $\mu Sv.h^{-1}$ #	0.0012 µSv
D2-05 museum	Staff office	20 hours per week	1.0 $\mu Sv.h^{-1}$ *	0.002 µSv
G 54 psychology	Storage	10 hours per week	50 $\mu Sv.h^{-1}$ *	0.05 µSv
G 55 psychology	Postgraduate Office	35 hours per week	50 $\mu Sv.h^{-1}$ *	0.175 µSv
2-52 psychology	Staff office	25 hours per week	<0.5$\mu Sv.h^{-1}$	0.00125 µSv
2-53 psychology	Staff office	25 hours per week	< 0.5$\mu Sv.h^{-1}$	0.00125 µSv
2-62 psychology	Staff office	35 hours per week	< 0.5$\mu Sv.h^{-1}$	0.00175 µSv
2-63 psychology	Staff office	10 hours per week	< 0.5 $\mu Sv.h^{-1}$	0.0005 µSv

* = Doses based on radiation levels as indicated in the NIRAS report, project reference C5952/0008

Contamination now detectable within the brickwork **was not** detectable by the RPS survey, due to lead shielding being fitted to the wall (date of fitting unknown). Level indicated above measured within the floor area

{ } Room with same user

1851 - 2001 one hundred and fifty years of excellence

Kevin J. Robinson

etermination of Rn222 in air Re.Museum hazard assessment.

28/06/00

ackground counts in 10 mins

Cell	green	pink	blue	yellow
Counts in 10 m	387	5	129	6
Cell efficiency	1.13	1.19	1.19	1.17

o.	Cell	Time sample taken	Counts in 10 mins	Net counts in 10 mins	sigma sample	sigma background	sigma net counts/min	2xsigma c/min	c/hr	corrected counts/hour	corrected counts at sample time	Radon conc. Bq/m^3	Reported result Bq/m3
2.1 0.	green	12.03	328	-59	1.81	1.97	2.67	5.35	320.87	294.38	309.87	274.22	<274
2.1 10	pink	12.07	10	5	0.32	0.22	0.39	0.77	46.48	42.64	44.88	37.72	<38
655	blue	2.05	54	-75	0.73	1.14	1.35	2.71	162.33	148.93	156.77	131.74	<132
654	yellow	2.10	4	-2	0.20	0.24	0.32	0.63	37.95	34.81	36.65	31.32	<31

Background on 29/06/00

Cell	green	pink	blue	yellow
Counts in 10 m	368	6	109	5
Cell efficiency	1.13	1.19	1.19	1.17

Room	Cell	Time sample taken	Counts in 10 mins	Net counts in 10 mins	sigma sample	sigma background	sigma net counts/min	2xsigma c/min	c/hr	corrected counts/hour	corrected counts at sample time	Radon conc. Bq/m^3	Reported result Bq/m3
CB05	green	12.55	411	43	2.03	1.92	2.79	5.58	334.93	307.27	323.44	286.23	<286
R... .b	yellow	13.50	6	1	0.24	0.22	0.33	0.66	39.80	36.51	38.44	32.85	<33
R... 2 5z	ue	13.45	44	-65	0.66	1.04	1.24	2.47	148.43	136.18	143.34	120.46	<120
C...	pink	14.00	4	-2	0.20	0.24	0.32	0.63	37.95	34.81	36.65	30.80	<31

After 3 hours

05/07/00

Room	Cell	background c in 10 min	Time sample taken	Counts in 10 mins	Net counts in 10 mins	sigma sample	sigma background	sigma net counts/min	2xsigma c/min	c/hr	corrected counts/hour	corrected counts at sample time	Radon conc. Bq/m^3	Reported result Bq/m3
2.62	pink	8	13.45	5	-3	0.22	0.28	0.36	0.72	43.27	39.69	41.78	35.11	<35
2.63	green	382	13.50	357	-25	1.89	1.95	2.72	5.44	326.21	299.28	315.03	278.79	<279

06/07/00

16.00

Room	Cell	c in 10 min background	Time sample taken	Counts in 10 mins	Net counts in 10 mins	sigma sample	sigma background	sigma net counts/min	2xsigma c/min	c/hr	corrected counts/hour	corrected counts at sample time	Radon conc. Bq/m^3	Reported result Bq/m3
CB.10	pink	4	11.10	7	3	0.26	0.20	0.33	0.66	39.80	36.51	38.03	31.96	<32

Non radon alpha activity in air Manchester Museum Project
Work done in support of hazard assessment re: work other than that involving structural disruption

Supervised Area Monitoring Jun-00

Alpha counter parameters

Background	cts	time (s)	Rate Bgrd
	1	600	0.001667

NatU Eff determination using a 25 Bq alpha ref.	cts	time	Rate Ref.
	3780	600	6.3

Eff.% 25.19333

Sample	Counting Room	Lab Job Number Air Sampler on	off	Flow rate litres/min	vol m3	cts	time	Rate Sam	Act conc. Bq/m3	Error 95%c.l.	Report Bq/m3
1	53 (2.22)	11:30	14:30	70	12.6	9	600	0.015	0.0042	0.00332065	0.0042 ± 0.0033
2	C.1.10	11:55	15:45	70	16.1	10	600	0.016667	0.003698	0.00272561	0.0037 ± 0.0027
3	G54	14:15	15:50	70	6.65	1	600	0.001667	0	0.00281376	< 0.0028
4	C.1.09	11:55	14:15	70	9.8	7	600	0.011667	0.00405	0.00381867	0.0041 ± 0.0038
5	G55	14:01	15:50	50	5	5	600	0.008333	0.005292	0.00648185	< 0.0065
6	52 (2.21)	12.22	16:10	70	15.96	4	600	0.006667	0.001244	0.00185372	< 0.0019
7	CB 09	12:17	16:05	70	15.96	3	600	0.005	0.000829	0.00165802	< 0.0017
8	CB 05	12:15	16:00	50	11.25	5	600	0.008333	0.002352	0.00288082	< 0.0029
9	2.62	13:50	15:40	68	7.48	8	600	0.013333	0.006191	0.00530656	0.0062 ±0.0053
10	2.63	13:55	15:40	42	4.41	27	600	0.045	0.039003	0.01587572	0.04 ±0.016
11	CB 10										
12	D. 2.05										

Hazard Data Re; Supervised Areas Designated in Coupland 1 Building, the Annex, and The Old Dental Hospital.

Summary of results of measurements made in areas designated Supervised Areas for the purpose of Hazard Assessment, and Designation verification.

Supervised Area Room No.	Maximum Gamma Dose Rate µSv/h	Radon Air Concentration Bq/m^3	Alpha activity (other than Rn+) in air Concentration Bq/m^3	Comments
CB 05	<0.5	<286	<0.0029	
CB 09	<0.5	<31	<0.0017	
CB10	<0.5	<32		No electrical supply for air sampler.
52 (2.21)	<0.5	<120	<0.0019	
53 (2.22)	<0.5	<33	0.0042±0.0033	
G54	50	<31	<0.0028	
G55	50	<132	<0.0065	
C.1.09	<0.5	<274	0.0041±0.0038	
C.1.10	<0.5	<38	0.0037±0.0027	
D 2.05	1.0			
2.62	0.5	<35	0.0062±0.0053	
2.63	0.5	<279	0.040±0.016	

Note: It is taken that the most radiotoxic material present is nat. U. (Lung class W), for which the air concentration equal to 15mSv/y is taken to be 3Bq/m3. (IRR85)

Note: Maximum Gamma Dose rate is that found at "surface contact" with the location of highest contamination.

University Health & Safety Services

Radiological Protection Service

7th Floor, Williamson Building, Oxford Road, Manchester M13 9PL

THE UNIVERSITY of MANCHESTER

University of Manchester
Museum Building
Coupland 1

4 July 00

Radiation Survey

The Radiological Protection Service monitored the highest detected levels of contamination in the following rooms. The levels detected are as follows:-

Room G54 – inner room

Instrument used	Area	Results
Berthold LB 1210B	Floor against partition wall	Approx. 1200 cps
900 mini Type D	Floor against partition wall	50 µSv/h at 1 cm

Room G55

Instrument used	Area	Results
Berthold LB 1210B	Floor against partition wall	Approx. 1300 cps
900 mini Type D	Floor against partition wall	50 µSv/h at 1 cm
Berthold LB 1210B	Under carpet on lino	300 cps
900 mini Type D	Under carpet on lino	13 µSv/h at 1 cm

Recommendations

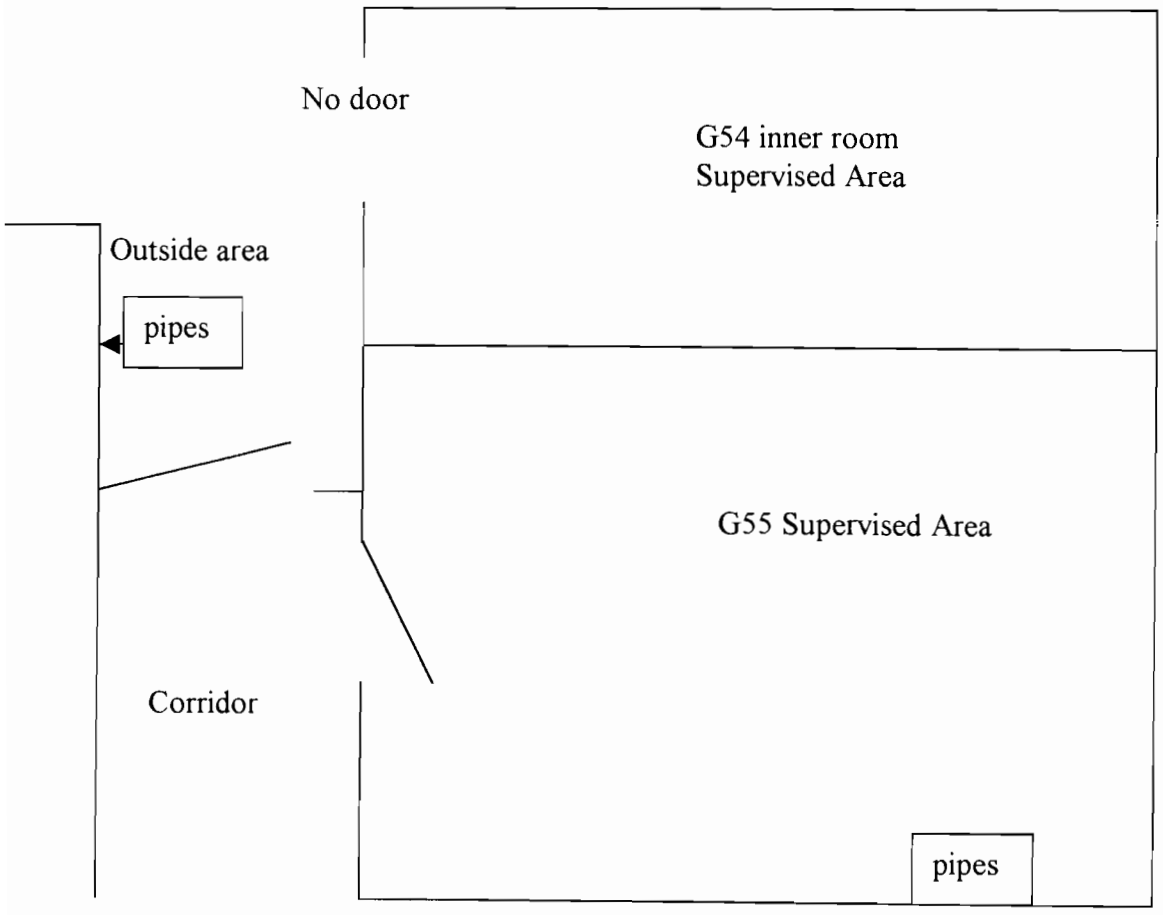
G54

Hayvern Ltd (the on-site contractors) require access to the outside area of room G54 (see diagram) to remove some pipes. The outside area and the pipes were monitored with the Berthold LB 1210B and no contamination was detected. As the Supervised Area room does not have a door it is recommended that the doorway is sealed off to prevent access thereby allowing the work to be carried out by the contractors in the outside area.

This work can be undertaken as soon as the contractors wish. The presence of Niras personnel and/or the Radiological Protection Service are not required for this work.

G55

Hayvern Ltd wish to remove some pipes from inside this room. The room is a Supervised Area and access is not allowed without a member of the Radiological Protection Service in attendance. No contamination was detected in the area immediately round the pipe work although the top of the pipes could not be reached and therefore have not been monitored. It may be possible to cordon off the radioactive area of the room for the work to proceed but this will need further discussion.



E Kelly
Radiological Protection Service

University Health and Safety Services

Radiological Protection Service,
University of Manchester
7th Floor, Williamson Building,
Oxford Road,
Manchester M13 9PL

Dr S.P. Bidey
Radiation Protection Adviser
Telephone: 0161-275-6983
Fax: 0161-275-6984
E-mail: steve.bidey@man.ac.uk

THE UNIVERSITY of MANCHESTER

Dr J. Nettleton,
Health and Safety Executive,
Quay House,
Quay Street,
Manchester M3 3JB

6th July 2000

Manchester Museum

Dear Dr Nettleton,

In my capacity as RPA to the University of Manchester, I am enclosing the following documentation, as requested at your meeting at the Manchester Museum last week. I apologise for being unable to attend that meeting. The documents comprise:

(i) Dose calculations for occupants of contaminated rooms;
(ii) Report on room D2-05;
(iii) Museum Local Rules;
(iv) Museum mineral sample inventory;
(v) Local Rules written by the RPA appointed by the University of Manchester in compliance with Regulation 17 of the Ionising Radiations Regulations 1999;
(vi) Hazard data re: Supervised Areas designated in Coupland I Building, the Annex, and the Old Dental Hospital;
(vii] Determination of Rn222 in air Re: Museum hazard activity;
[viii] Non radon alpha activity in air: Manchester Museum Project - work done in support of hazard assessment re: work other than that involving structural disruption.

I trust that this documentation is in order,

Yours sincerely,

Dr Stephen P. Bidey
Radiation Protection Adviser

encs:

Commercial in Confidence

QA .....
C595/0008

NIRAS

NNC Independent Radiation Assessment Services

Analytical Report

Report Reference: L2000103

Client: Manchester University Museum

Analysis of samples from museum

18 August 2000

Prepared by: J. D. Turner (Signature of Project Analyst) JOE TURNER (Print name)

Issue Approved by: (Authorised Signature) G. W. WILLETTS (Print name)

Position: Laboratory Project Manager

Issue Date: 18/07/01

NNC Limited Warrington Road Risley Warrington Cheshire WA3 6BZ

QA .....
C5952/0008

1 Administrative Details

1.1 Laboratory Job Details

1.1.1 Laboratory Job Number

L2000103

1.1.2 Analysing Laboratory

NIRAS, NNC Limited
Warrington Road, Risley
Warrington, Cheshire, WA3 6BZ

1.1.3 Contact

Barry Frith / Andrew Frith

1.1.4 General Sample Description

3 active samples from Manchester University Museum

1.1.5 Analysis / Determinands Requested

High resolution gamma-spectrometry

1.1.6 Completion Date

18 August 2000

1.2 Client Details

1.2.1 Client Name and Address

The University of Manchester
The Manchester Museum
Oxford Road
Manchester
M13 9PL

1.2.2 Contact

Barry Chadwick

1.2.3 Order Number

20712

2 Sample Preparation and Pre-Treatment

2.1 Samples

The samples were analysed as received

3 Analytical Methods

3.1 High resolution gamma spectrometry

High resolution gamma spectrometry is undertaken using high purity germanium (HPGe) detectors, coupled to a computerised multi-channel analyser (MCA), with peak search and peak shape functions and validated isotope library.

System calibration is undertaken for standard geometries using a nationally traceable mixed gamma reference, in the range 60 keV-1836 keV.

The samples were placed into a laboratory standard geometry container, this was placed on the detector, and analysed for an appropriate length of time. The software system is programmed to undertake a spectral "peak search" for statistically significant peaks, and to identify and quantify the radionuclides present. The system will also report minimum detectable activities (MDA's) for specific radionuclides.

3.2 Determination of activity concentration by direct gamma counting

Samples from areas where the contamination fingerprint was determined by gamma spectrometry were counted on a gamma detector sensitive to low energy gamma photons and bremsstrahlung from beta radiation. The relationship between activity concentration and gamma detector response was determined, and used to determine the activity concentration of samples.

Commercial in Confidence

QA .....
C595/0008

4 Results

4.1 High resolution gamma spectrometry

NIRAS Reference	Client Reference	Radionuclide	Activity Concentration ($Bq.g^{-1}$)		
L2000103-70	Under Floor dust from Room G55 between Joists 2-3	Bi-212		<	3.7
		Pb-212		<	0.43
		Bi-214	0.90	±	0.32
		Pb-214	0.44	±	0.31
		Ra-226	70.1	±	7.7
		Ac-228	0.571	±	0.094
L2000103-85	Wall sample from room C.1.10 Local contamination	Pb-210	4103	±	677
		Bi-212		<	2.6
		Pb-212		<	0.38
		Bi-214	1.00	±	0.49
		Pb-214		<	0.39
		Ra-226		<	5.5
		Ac-228	0.243	±	0.094
L2000103-92	Brick/Mortar dust from Brick 5/6 Under window Room CB 05	Bi-212		<	2.4
		Pb-212		<	0.40
		Bi-214	14.41	±	0.65
		Pb-214	12.20	±	0.73
		Ra-226	53.7	±	8.3
		Ac-228	0.81	±	0.24

QA ...
C5952/0008

5 *Quality Assurance*

5.1 Quality System

An internal quality system was used for this analysis.

5.2 Traceability of Reference Materials

5.2.1 High Resolution Gamma Spectrometry

National Physical Laboratory mixed radionuclide standard 60-1836 keV, 1 June 1999,

ampoule number E4651/99

certificate number R1922.

5.3 Statement of Uncertainties

The uncertainties quoted relate to random counting errors, combined in quadrature, at 95.4% confidence limits (2σ).

5.4 Sources of Nuclear Data

X-Ray and Gamma-Ray Standards for Detector Calibration IAEA-TECDOC-619. International Atomic Energy Agency, Vienna 1991.

The Radiochemical Manual. G. Longworth (Ed) AEA-Technology (1998).

5.5 Decay Corrections

No decay corrections have been applied. Approximate reference dates for results are: gamma spectrometry 4-9 August 2000.

6 *Comments and observations*

The comments in this section are made to assist the client. As they often include some form of interpretation, these comments are specifically excluded from UKAS accreditation.

It should be noted that the values quoted for Ra-226 are maximum values, assuming all the counts in the 186 keV photopeak are due to Ra-226. U-235 has been assessed using its 144 keV photopeak, to avoid any interference from Ra-226.

Summary Sheet of NW RSG Inspector's Report

NW RSG		**Source of Request**	FOD16	**FMU**	200009
Name of firm	University of Manchester				
Address	The Manchester Museum, Oxford Road, Manchester M13 9PL				
RSG File No		**RSG Job No**	765/1		
Subject of Report	Historical radioactive contamination found prior to major construction project				

Initiation	w	**Request Date**	15th June 2000	**Priority**	other
Date of Report	30th August 2000				

Date of Visit(s) 23rd June, 31st July 2000

Visited by	**Unit/Division**
Jo Nettleton	NWSG

Persons Seen	**Position**
Sue Robson	University Director of Health and Safety Services
Velson Horie	Manchester Museum Keeper of Conservation
Dave Green	Mineralogist and Museum RPS
Helen Thornton	Museum Services Manager and Health and Safety Representative
Kevin Robinson	University Radiation Protection Service (Technician)
Steve Bidey	University Radiation Protection Service (RPA)
David Prime	University Radiation Protection Service (RPA)
Barry Frith	NIRAS (RPA for remediation and construction work only); was previously employed by the University as RPA
John Duffy	University Director of Estates
David Smith	University Estates
Barry Chadwick	University Estates
Steve Marsh	NJSR Planning Supervisors
John Frian	Appleyard and Trew Project Manager
David Billington	Hayvern Contract Manager
Jed Higginbottom	Hayvern Site Supervisor
Haley Dunn	Hayvern Health and Safety Manager
John Steventon	Ian Simson Architects

10459

Relevant Papers Yes

SUMMARY

Visits were made to the Manchester Museum (address as above) to investigate the reported discovery of

radioactive contamination on site during a survey carried out prior to a major construction project. All of the contaminated areas are within the Coupland Building, which was used by early physicists and chemists (including Rutherford and Geiger) during the latter part of the 19th and early part of the 20th Centuries. Surveys have indicated that the radioactive contamination in all areas is from the Uranium-238 decay chain. The University and Museum should have undertaken a radiation survey of the Coupland Building as soon as the possibility of radioactive contamination was noted (probably back in the 1950s). However, as the contamination is historic, it is perhaps understandable that in more recent years no survey was undertaken until the proposed construction work alerted people to the potential hazard. The majority of the rooms were used for storage, with associated low occupancy. The exception is G55, the postgraduate room in the Psychology Department. Estimated radiation doses to people in this room are not significant and as the contamination was located underneath flooring materials such as linoleum and boarding, the potential for contamination would probably be negligible. The University have employed NIRAS to direct remediation work, and this will be undertaken subject to appropriate risk assessment and control measures. A radiation survey of the rest of the Museum site has located no further radioactive contamination.

The Museum's systems for control and use of radioactive samples require significant improvement in order t comply with IRR99. This is already underway and I have requested that confirmation be forwarded to me when complete

Author	Jo Nettleton	**Grade**	3	**Discipline**	Radiation
RSG Action: copies to	ccmail: Nigel Bunce, Roger Gladwell, Hugh Wolfson hard copy:				

FI2501 (Rev 11/97)

INSPECTION REPORT

UNIVERSITY OF MANCHESTER
THE MANCHESTER MUSEUM
OXFORD ROAD, MANCHESTER M13 9PL

IONISING RADIATIONS REGULATIONS 1999 (IRR99)

1. Introduction

1.1 Following a request for specialist advice, visits were made to the Manchester Museum (address as above) to investigate the reported discovery of radioactive contamination on site during a survey carried out prior to a major construction project. The construction work is being undertaken by Hayvern and a number of other companies

are involved in the project (see front page of report). Persons interviewed are listed on the front page of this report. The proposed methods for remediation work were reviewed. In addition, an inspection was made of the Museum's current arrangements for management of radiation protection in relation to the keeping and work on numerous radioactive rock samples.

1.2 The Museum have appointed Steve Bidey and Dave Prime from the University Radiological Protection Service to act as radiation protection advisers, RPA, for the handling of radioactive rock samples. Barry Frith (NIRAS) has been appointed as RPA for remediation work in the Coupland Building.

2. Inspection Findings: Historical use of radioactive materials at the Museum and resultant contamination

2.1 All of the contaminated areas are within the Coupland Building, which was used by early physicists and chemists (including Rutherford and Geiger) during the latter part of the 19th and early part of the 20th Centuries. Surveys have indicated that the radioactive contamination in all areas is from the Uranium-238 decay chain (including Radium-226) One of the ten contaminated rooms (G54, a storeroom) contained a bench (used by Rutherford) which was known to be contaminated prior to the surveys undertaken. The Museum plan to retain this bench as an exhibit, behind glass and subject to appropriate control. The radioactive contamination within the other rooms (and indeed further contamination within the room where the bench was stored) was not discovered until a radiological survey was undertaken prior to the commencement of a major construction project involving the Coupland Building. It is unclear why no previous survey was undertaken. A number of employees (Kevin Robinson and Barry Frith) have vague recollections of a survey an the 1970s or 1980s, but no records are available. The contaminated bench was apparently something of an attraction and even featured on the television programme 'Local Heroes', but there was no control over access into room G54 and this was not designated as Controlled or Supervised. A piece of hardboard was fitted over the contaminated area of the bench (in the 1950s) to prevent spread of contamination (though hardboard is not ideal for this purpose as it is not impervious). The bench is now kept in a locked and signed room.

2.2 During recent times (up until early this year), the Coupland Building was divided into areas used by the Museum and areas used by the Psychology Department. Both have contaminated rooms (four in the Museum and six in Psychology). Of the ten rooms, nine were used only as storage areas (including G54). However, one room (G55, adjacent to G54 in the Psychology Department) was used as a postgraduate office and computer laboratory.

2.3 At the time of my first inspection, a number of surveys had been undertaken, initially by the University Radiation Protection Service and then by NNC (Harwell). These surveys had indicated the location of contamination and given an idea of dose rates (no assessment of the amount of activity present in Bq or Bq/g, or Radon-222 concentration had been undertaken). In the majority of rooms surveyed, the external dose rate was

below 1 Svh^{-1}. In room C1-10 (storage) the dose rate was 12 Svh^{-1} from contaminated brickwork and in rooms G54 and G55 localised hot spots at up to 50 Svh^{-1} were identified. An initial dose assessment had been carried out for persons sitting at computers in G55. The hot spot was located more than 1m from any work station and thus estimated doses to persons were not significant. No consideration to internal radiation hazard from Radon-222 had been included in the calculation.

2.4 Following my initial inspection, I requested that further work be undertaken to assess doses from the contamination (to include internal radiation, particularly from Radon-222) and to survey all public areas of the Museum. NIRAS (a Warrington based subsidiary of NNC Harwell who carried out the initial work) completed a full survey of the Coupland Building. All of the contaminated rooms had been emptied and I asked that contamination monitoring be carried out on items which had been removed. Measurable levels of Radon-222 were found in a number of the rooms surveyed, but the levels were below 400 Bqm^{-3} (and so IRR99 are not applicable to work within, in terms of Radon-222). I am still awaiting renewed dose estimates (but expect these to be insignificant). None of the items removed from the Coupland Building were found to be contaminated. The University Radiation Protection Service carried out a survey of Museum areas currently in use. No radioactive contamination or elevated dose rate levels were found in the Museum's public areas (or indeed any of the Museum buildings). A number of rock samples were located within the office of an employee (Dave Green, the Mineralogist) and these were initially mistaken for contamination. This is discussed more fully in Section 3. Work is still ongoing to obtain an estimate of the total radioactivity present.

2.5 The University has appointed Barry Frith (NIRAS) as RPA for the Coupland Building remediation and construction work. During my first inspection, I toured the Coupland Building and noted that not all the contaminated rooms were locked or had warning signs indicating the presence of radioactive material, although all rooms are within the secure demolition site. Since that time, all of the rooms have been locked and designated as Supervised Areas. This status is likely to be changed upon commencement of remediation work. Local Rules are in place for necessary access into these areas.

2.6 Prior to the extent of radioactive contamination being known, NNC carried out some remediation work in one of the rooms (C1-10, the dose rate is thus now significantly lower than the 12 Svh^{-1} reported before work commenced). This work was stopped when the other contaminated areas were identified, but has generated a significant amount (volume) of radioactively contaminated waste which is currently being stored in room C1-09. The estimated activity of this is 39 MBq. The material (floor boards, brickwork etc) must be down-sized and moved before remediation of C1-09 can commence and a suitable store is to be found (The Environment Agency are involved in the discussion). I informed the Museum of the need to ensure that down-sizing and removal of the material is subject to a suitable prior risk assessment and the necessary controls (local rules, supervision, contingency plans, radiation monitoring, training of workers involved, restriction of exposure etc to ensure compliance with IRR99). In addition, the need for a secure store was emphasised.

2.7 Barry Frith is currently drawing up risk assessments for the remediation work. This will be carried out by three Hayvern employees (Jed Higginbottom plus two others). These have not yet received training, but I was informed that this will be done by Barry Frith and that he, or another trained NIRAS employee, will be on site at all times during the work. I was shown a draft set of local rules which require some amendment (for example improved contingency plans and a more suitable investigation level than the current value of 15 mSv). No specific details are yet available as to the systems to be employed (such as damping down of brick work where possible) or of appropriate PPE. I was informed that an employee dose constraint of 1 or 2 mSv will be set for the complete operation. I discussed the need to consider hazards other than ionising radiation within the risk assessment. It was agreed that copies of the risk assessment and method statement will be sent to me before work commences (I have not yet received these).

3. Inspection Findings: Current use of radioactive materials at the Museum

3.1 The Museum has an inventory of approximately 150 radioactive mineral samples, though the inventory is currently being updated. The samples mainly contain Uranium-238 and daughters and have surface dose rates varying from 5 Svh^{-1} up to 500 Svh^{-1}. In addition, the Museum occasionally examines samples brought in by members of the public (see Paragraph 3.3 and 3.4). The University Radiological Protection Service provides radiation protection advice and Steve Bidey and David Prime (employed by the Service) are appointed as radiation protection advisers, RPA. David Green (Mineralogist) is appointed as radiation protection supervisor, RPS.

3.2 I was informed that all samples (except those temporarily being held for members of the public) are kept in a safe (designated as a Controlled area) within a locked room (designated as a Supervised area). Although I was told that no dose rate above background was measurable outside the room, I was able to detect a dose rate of at least 8 Svh^{-1} using a FAG compensated Geiger instrument (which may in fact under read at the energies of Uranium-238 and some of its daughters). The safe had been moved to the storeroom in January 1999 (using an appropriate system of work). However, despite recommendation from Kevin Robinson that radiation monitoring should be carried out following the move, this appears not to have been done. IRR99 (and the previous IRR85) require suitable monitoring to be undertaken at the boundaries of designated areas to ensure that the area has been correctly designated. In addition, I consider that the dose rate of at least 8 Svh^{-1} is not as low as reasonably practicable, as required by Regulation 8 IRR99. In fact the Museum agreed that it would be very practicable to reduce this dose rate (either by moving the safe further into the room or by addition of extra shielding). It is unfortunate that this was not carried out in 1999, but as occupancy of the area is usually low, it is unlikely that significant exposures to radiation will have been received. No monitoring for Radon-222 has been carried out in the storeroom and I advised that this be undertaken.

3.3 Local rules are available for entry into the storeroom and handling of the sources. However, in the latter case, the working procedures are inadequate to deal with the high surface dose rate associated with some of the samples (a fact which was noted in a letter

from a technician at the University Radiological Protection Service in 1986, but which appears to have been ignored by both the Museum and the RPA). In addition, the local rules do not cover the specific issue of samples on loan from members of the public (initial check for dose rate and contamination hazard, handling and temporary storage). The Museum have now purchased a Geiger based monitor to carry out an initial check of dose rate. During the survey for contamination, it was originally believed that one room in the main Museum building (the old Dental School) was contaminated. However, it was discovered that the high dose rate (up to 15 Svh^{-1} on contact) was actually due to a number of samples in the room (Dave Green's office) which had been loaned by a member of the public. Dr Green had been on leave at the time of the survey. The Museum agree that control over such sources must be significantly improved. New local rules are being drafted, extra storage cabinets are being purchased and a major review of source handling is underway.

3.4 The Museum queried the legal situation regarding the temporary holding of sources loaned by members of the public, specifically what action they should take if the sources are found to be significantly radioactive, but the owner still insists on the sources being returned to him. The Museum are drawing up an information sheet to give to such people, which includes a warning of the associated hazard. This situation is not limited to radioactive sources, as a wide variety of materials and objects (some of which are hazardous) are brought to the Museum by members of the public for investigation and return. This matter is under consideration.

3.6 The Museum do have an X-ray set. However this has not been functional for a number of months and X-ray analysis of samples is now carried out at the Stopford Building facility. I advised that the plug be removed from the Museum set and that it be disposed of appropriately.

4. Discussion

4.1 The University and Museum should have undertaken a radiation survey of the Coupland Building as soon as the possibility of radioactive contamination was noted (presumably this would have been back in the 1950s when the hardboard was placed over Rutherford's bench). However, as the contamination is historic, it is perhaps understandable that in more recent years no survey was undertaken until the proposed construction work alerted people to the potential hazard. The majority of the rooms were used for storage, with associated low occupancy. The exception is G55, the postgraduate room in the Psychology Department. Estimated radiation doses to people in this room are not significant and as the contamination was located underneath flooring materials such as linoleum and boarding, the potential for contamination would probably be negligible. The University have employed NIRAS to direct remediation work, and this will be undertaken subject to appropriate risk assessment and control measures. A radiation survey of the rest of the Museum site has located no further radioactive contamination.

4.2 The Museum's systems for control and use of radioactive samples require significant

improvement in order to comply with IRR99. This is already underway and I have requested that confirmation be forwarded to me when complete.

Jo Nettleton (Dr)
NWRSG

Local Rules Written by the RPA appointed by Hayverns
in compliance with
Regulation 17 of the Ionising Radiations Regulations 1999

These Local rules refer to the decommissioning of the contaminated areas, as described in Report Ref. MTC/2000/051, in the University's Coupland 1 Building, the Annex and the Old Dental Hospital

1 Decommissioning of room 2.63

2 Hazard Assessment.

Decommissioning of room 2.63

Low level localised radium-226 contamination has been detected in this room in the area of the wall above the wash hand basin. The level detected is trivial in occupational exposure terms, its removal is desirable. It is to be removed by physical removal of the affected material.

The principal radiological hazard resulting from this work will arise from the production of dust and airborne contamination. The main hazard is alpha internal contamination from the inhalation of contaminated dust.

Measurements made on samples taken from the location of more readily detectable contamination within room 2.62 have been used to assess the maximum likely exposure. In 2.62 measurements confirm the presence of radium –226 at an activity concentration of <1.27Bq/g.

In assessing the hazard, it is assumed that the dust generated will be of the same activity concentration as found in the most active location, even though any cutting/breaking operation will be undertaken on the perimeter of the area of contamination where direct monitoring shows contamination to be absent. An average dust concentration of 5.0 mg/m^3 (1) and an average breathing rate of 1.2m^3/hr (2) are assumed for the estimated 4 hours exposure required to accomplish to task.

On this basis the intake is calculated at 0.024g of dust and 0.03 Bq of radium-226. The dose coefficient for radium 226 is taken as $1.6x10^{-5}$ Sv/Bq (3), giving a committed equivalent dose of 0.48μSv.

3 Restriction of exposure

Personal protective equipment, in the form of disposable overalls (with hoods) and gloves will be worn by personnel working in the Supervised Area, as will respiratory PPE of an approved type. Local dust control will be achieved using an industrial vacuum cleaner.

4 Area Designation.

The Hazard Assessment has estimated the dose is low for this procedure and can be done under Supervised Area conditions. The room 2.63 is designated a Supervised Area.

5 Monitoring Procedures.

5.1 Alpha in air monitoring.

Monitoring of alpha concentrations in air will be carried out for the duration of the work in the Supervised Area. The filter on the air sampler will be changed daily and analysed. Records will be kept.

5.2 Personnel monitoring.

Monitoring of hands and feet will be carried out by NIRAS, when personnel leave the Supervised area. A record of monitoring results will be made and kept.

6 Radiation Protection Supervisor.

The Radiation Protection Supervisor for Hayverns is: Ged Higginbottom

7 Working Instructions.

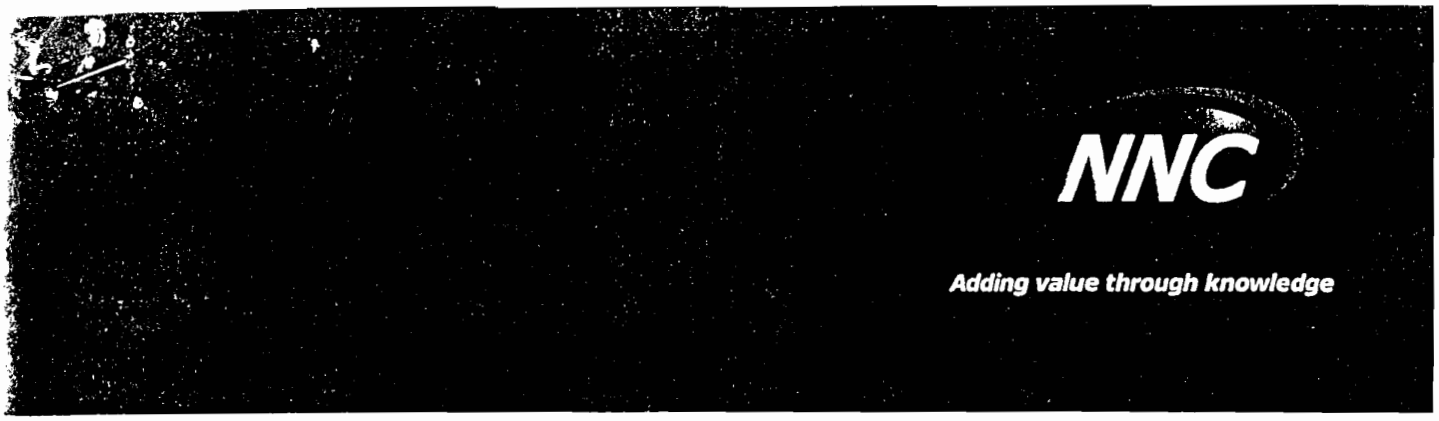
On entry into the Supervised Area, all PPE should be donned. The contaminated area of plaster should be removed by cutting in the clean areas. Once removed debris should be sealed into plastic bags, monitored for any surface contamination and taken to CB.10 to be drummed.

Barry Frith

1/9/00

References

(1) NRPB-R143 Hazard Assessment of Working with Ores Containing Elevated Levels of Natural Radioactivity.
(2) NRPB Guide to Dose Coefficients
(3) The Radiochemical Manual 1998 (data adapted from ICRP 68 (25)9)



Residual contamination survey of Coupland 1 Building, the Annexe and the Old Dental Hospital, Manchester University

by

S M Adams

CLIENT: Manchester University

[illegible]
[illegible] Warrington [illegible]
Warrington Cheshire WA[illegible]
Tel 01925-895588 Fax [illegible]

[illegible]
MTC/2000/052
Issue 02
Sept 2000

DOCUMENT ISSUE RECORD

Adding value through knowledge

Document Title	Residual contamination survey of Coupland 1 Building, the Annexe and the Old Dental Hospital,
Project:	C5952/0008

Purpose of Issue : Addition of addendum

Security Class : Commercial-in-Confidence

Issue	Description of Amendment	Originator/ Author	Approver	Date
01	For Issue	S Adams	A J Frith	May 2000
02	Addition of addendum to cover additional areas monitored	S.M. Adams S Adams	A J Frith	Sept 2000

Previous issues of this document shall be destroyed or marked **SUPERSEDED**

Distribution: Client, File

1 Introduction.

NIRAS have been appointed by Manchester University to provide radiological services to the investigation of residual contamination in Coupland 1 Building, the annexe and the Old Dental Hospital, including the laboratories historically used by Rutherford.

The objective was to carry out a radiological survey to investigate and identify areas of any residual contamination which may have radiological implications for persons undertaking the work or where demolition waste may be considered radioactive waste.

2 Method.

2.1 Scope of the survey

2.1.1 Monitoring

The current information on the potential contaminants based on the history of what was used by Rutherford and also some limited analysis undertaken on radioactive waste originating from Coupland 1 suggests that radium-226 is a likely contaminant of these buildings. Uranium may also have been used during this period. With the diverse use of radionuclides at the University from the early 20th Century to present day, the presence of other contaminants should not be ruled out.

With this in mind, two monitoring techniques were selected, one that would be highly sensitive to variations in gamma radiation and the other that would detect contamination with beta emitting radionuclides.

The gamma monitoring was undertaken with 2" x 2" sodium iodide scintillation detectors operated such that they would be able to detect gamma energies of 60 keV and above. Typical background count rates for this instrument are approximately 1 x 10^4 counts per minute, although higher background count rates may result from building materials that contain elevated levels of naturally occurring radioactivity. This monitor was used in each room for monitoring the floor and the wall, at waist height.

The beta contamination monitoring was undertaken using a large area gas proportional monitor, the Berthold LB122. The typical background for this instrument is 25 - 30 counts per second, but is again subject to the variations in natural activity of the building materials in the areas being monitored. This monitor was used for identifying any residual contamination in the walls, again at waist height and any other places where the gamma monitoring identified elevated readings.

Where areas of contamination were identified, further monitoring was undertaken for alpha radiation using a Mini Instruments 900 / AP2 alpha monitor, and for gamma dose rate using a Mini Instruments 1000R.

2.1.2 Rooms

Surveying was undertaken in the rooms identified in the plans provided by Velson Horie (curator of conservation). A copy of these plans is attached in Appendix A, in order that the room references can be identified.

2.1.3 Limitations

The scope of the survey was limited by the access to a number of rooms and the access to particular areas of walls and floor in certain rooms, for example by the presence of bookcases etc. These instances are noted in the survey listing given in Appendix B.

The survey was limited in scope to the surveying of gamma and beta radiation. Alpha radiation measurements were only made where contamination was identified by the gamma or beta measurements. It should be noted that whilst the gamma and beta surveying techniques are able to detect radiations from radium-226 and uranium and their decay products, the survey would not detect "pure" alpha emitters. This limitation was accepted as the majority of areas were covered with paint or carpet or linoleum, and as such it would not be possible to detect any alpha radiation other than from contamination on the current surface.

3 Results.

The areas where contamination was detected are described below. In order to form a complete survey record, the areas where an earlier survey by the University's Radiological Protection Service detected contamination are also included (*in italics*).

A full list of NIRAS survey results, including the rooms where access was not possible, is given in Appendix B. A copy of The University's Radiological Protection Service report is enclosed in Appendix C.

3.1 Coupland 1 Building.

3.1.1 Basement.

Room CB. 10

A hot spot was found on the floor towards the far end of the room. The gamma flux meter gave a maximum reading of 50,000cpm. Further investigation gave no reading for either beta or alpha radiation. The absence of a beta count rate suggests that the contamination may be at some depth. The dose rate measured, using a Series 1000R mini monitor gave <0.5μSv/hr.

CB.05 – contamination was detected on the right hand side window ledge and
CB.09- contamination was detected on the window ledge immediately opposite the entrance door and to the right hand side of the sink.

3.1.2 Ground floor.

Room 54. (Rutherford's lab) (Drawing No. 1003 ref. G.24)

A hot spot was found on the floor in the corner of the room. The Bicron gamma flux meter gave a maximum reading of 500,000cpm. The Berthold gave a maximum reading of 80cps on the wall.
Further investigation gave no reading for alpha, although this cannot be eliminated as the floor was covered with lino.
A series 1000R dose rate meter gave a reading of 50μSv/hr at contact.

Room 55. (Rutherford's lab) (Drawing No. 1003 ref. G.23)

Again a hot spot was found on the floor, directly opposite the dividing wall from room 54. The Bicron gave a reading of 500,000cpm and the Berthold gave readings of 1321cps on the floor and 253cps on the wall.
Further investigation gave no reading on the mini 900 alpha monitor. Again alpha cannot be eliminated as the floor is covered with lino.
The contact gamma dose rate, measured using a mini 1000R, was 50μSv/hr.

3.1.3 1st Floor

Room C. 1. 10.

An area is marked on the far wall. The Bicron gave a maximum reading of 25000cpm and the Berthold gave readings of 1338cps at contact and 98cps at 10cm.
The mini 900 alpha detector detected localised hot spots with readings of 15, 20 and the maximum of 100cps.

3.1.4 2nd Floor.

Room 52 and 53. (Drawing No. 1005 ref. 2.21 and 2.22 respectively)

The Bicron detected a localised area of raised gamma flux on the floor, beneath the black boards, in rooms 52 and 53. These are back to back with the partition wall. The maximum Bicron reading in rooms 52 and 53 was 40000cpm. No readings were observed for beta and similarly for alpha, although alpha cannot be eliminated as the floor was carpeted.

2.62 (Drawing No. 1005 ref. 2.01) contamination was found in the far end of the room in the vicinity of the worn vinyl and
2.63 (Drawing No. 1005 ref. 2.02) contamination was detected on the wall above the hand washbasin.

3.2 Old Dental Hospital.

3.2.1 2nd Floor

Room D_2.05.

The Bicron detected an area of elevated gamma flux in the corner of the room, giving a reading of 90000cpm. No beta or alpha radiation was detected, although the floor was carpeted so alpha cannot be eliminated. The mini 1000R-dose rate meter gave a maximum reading of 1μSv/hr.

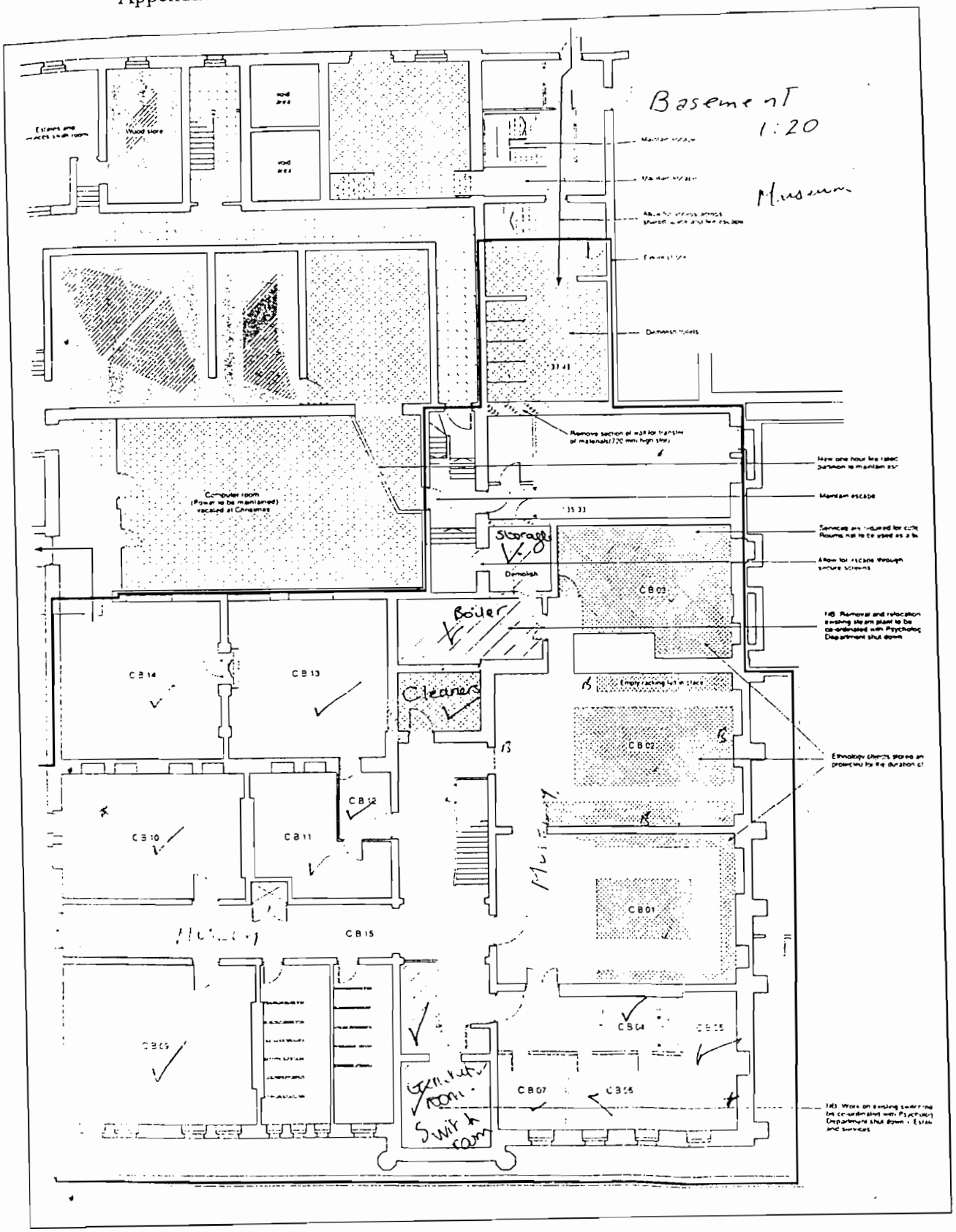
4 Conclusions.

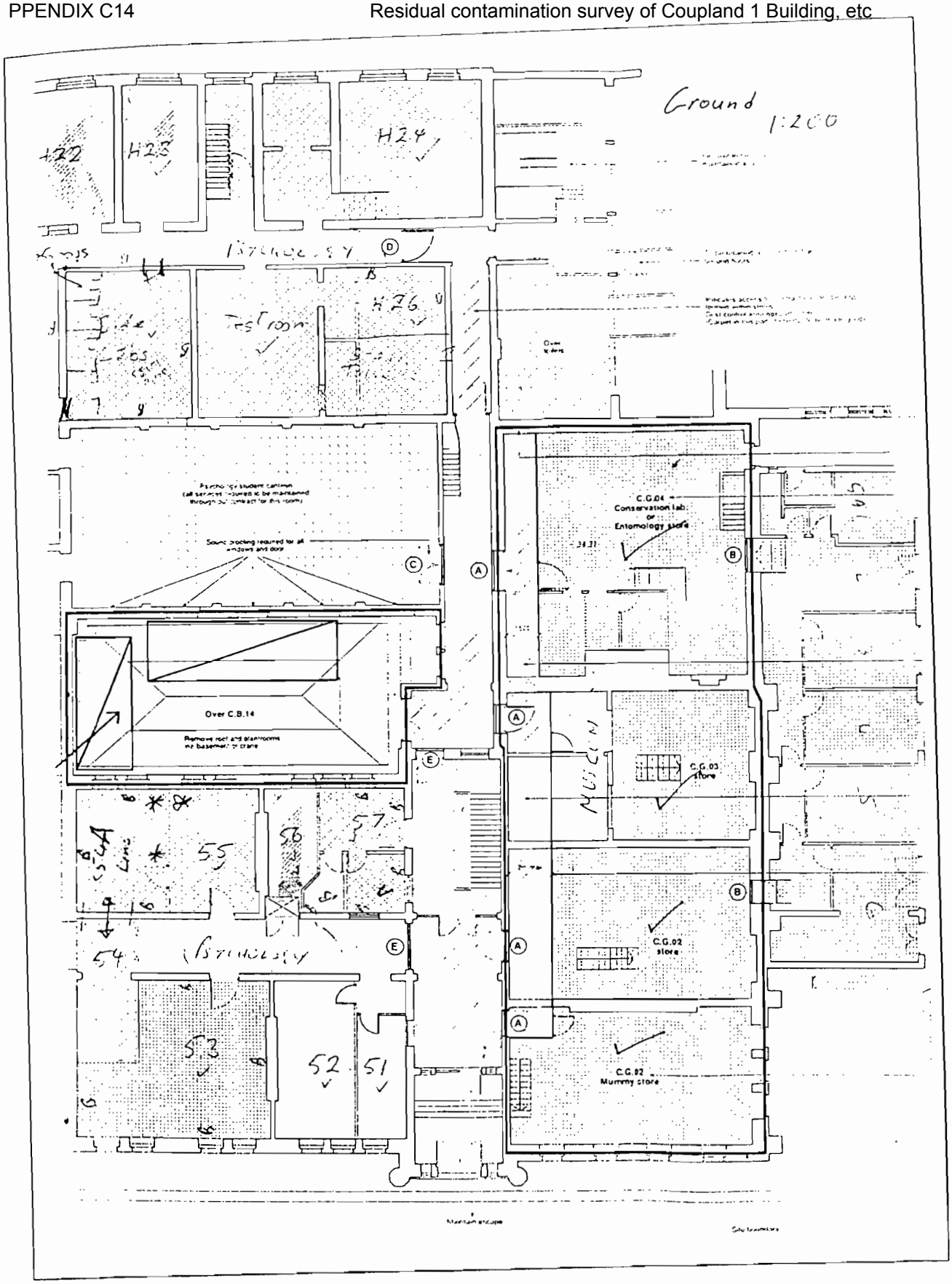
The survey has detected localised contamination at a number of locations. These areas need to be sampled and analysed in order to determine the radionuclide content and activity concentration, and to estimate the waste volume in the Exempt, Very Low Level Waste, and Low Level Waste streams.

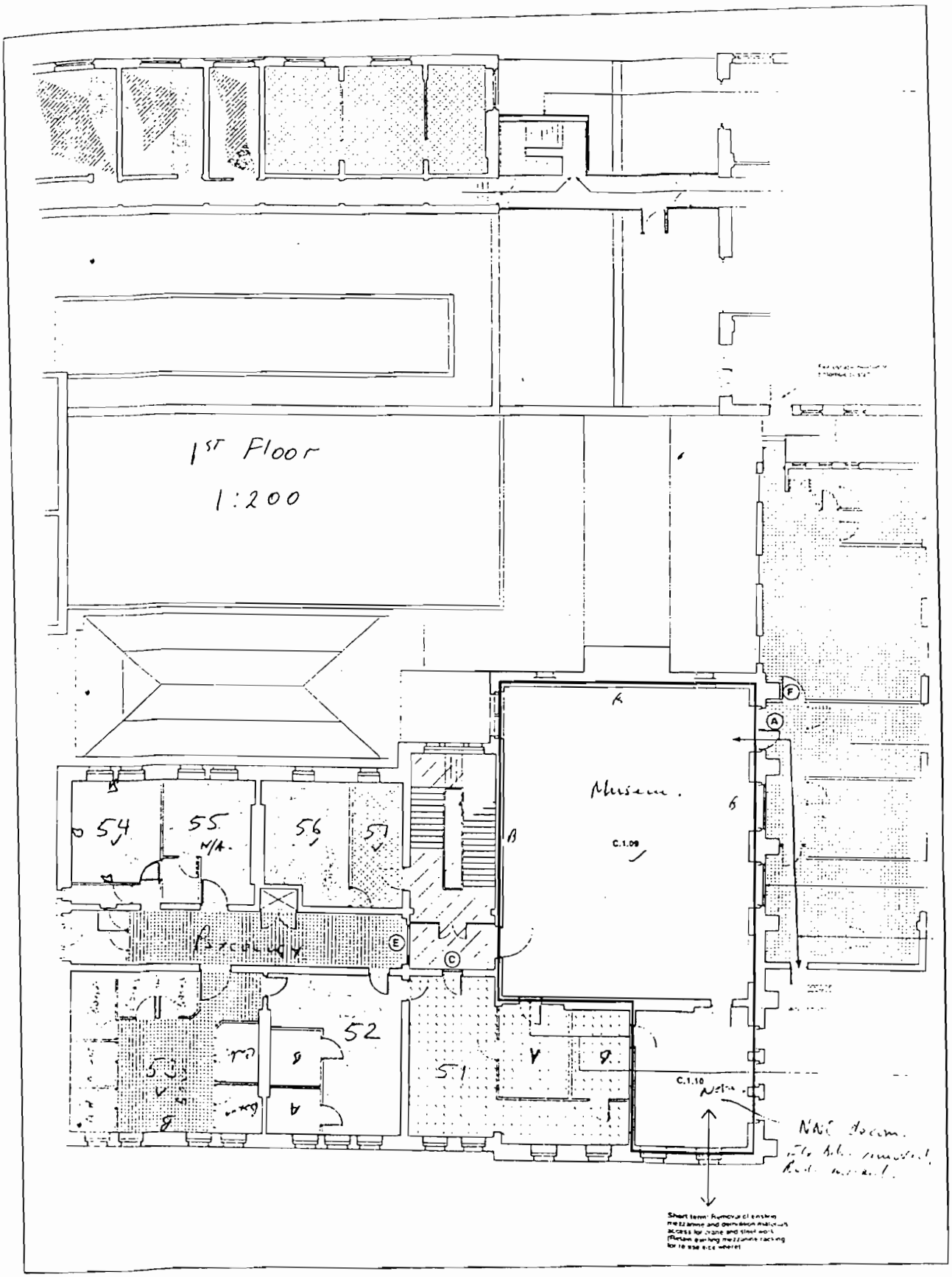
Once this has been established, the best method for remediation can be determined, along with the appropriate radiological precautions for the operation.

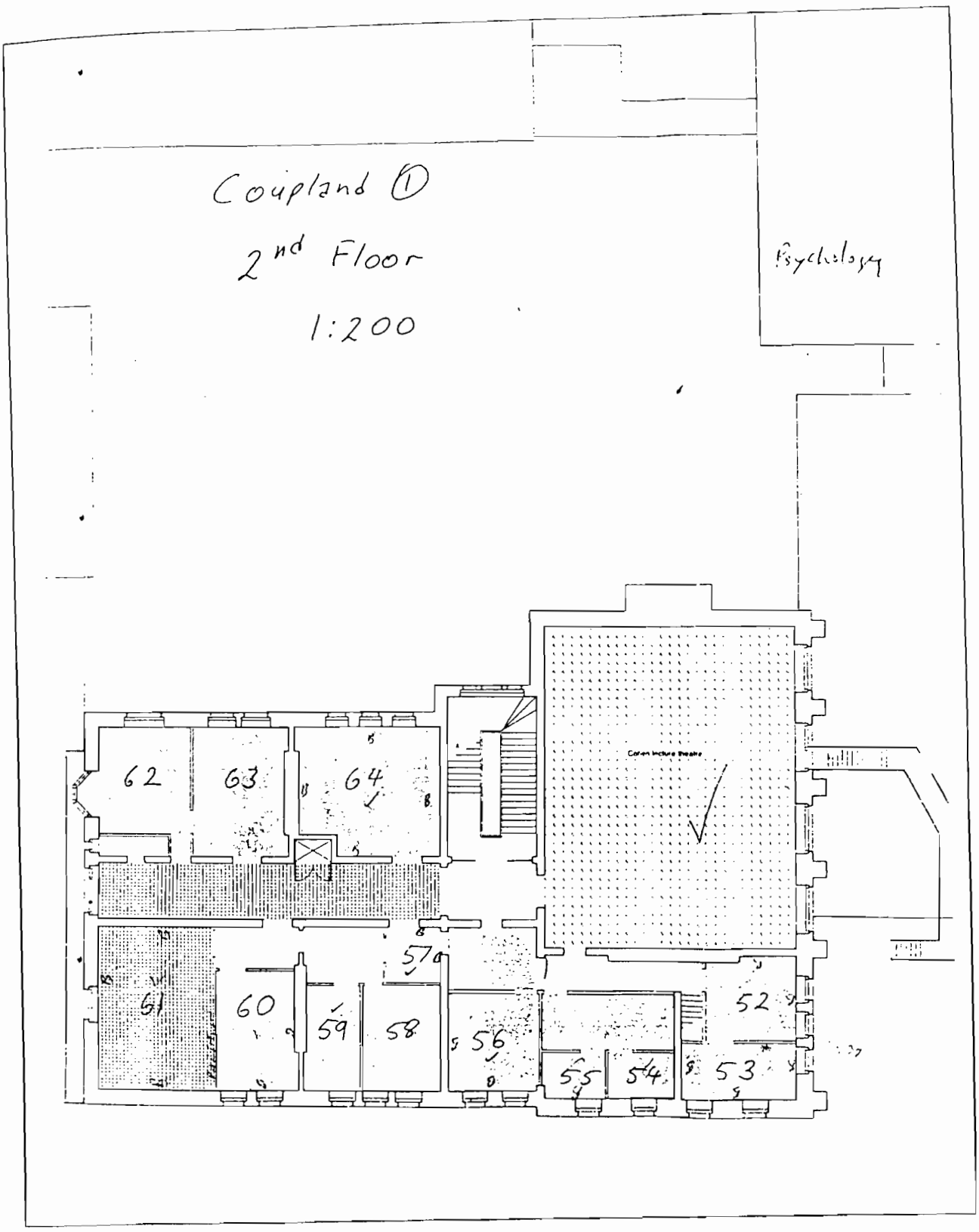
It must be noted that due to the levels of occupancy in the Old Dental building, the Annexe and other obstructions in Coupland 1 that was largely unoccupied, the scope of the survey was limited.

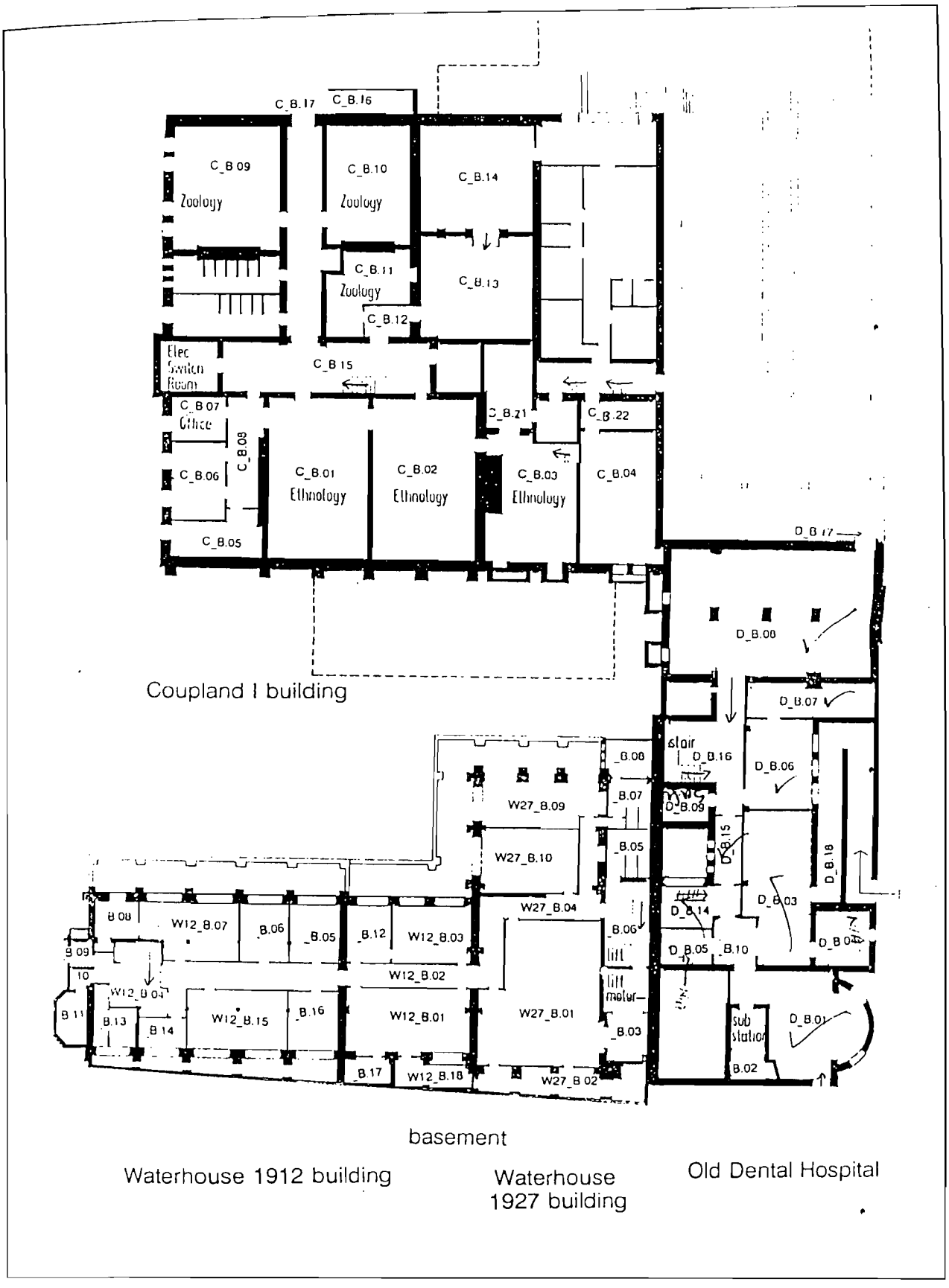
Appendix A: Plans of Coupland 1 building and the Old Dental Hospital

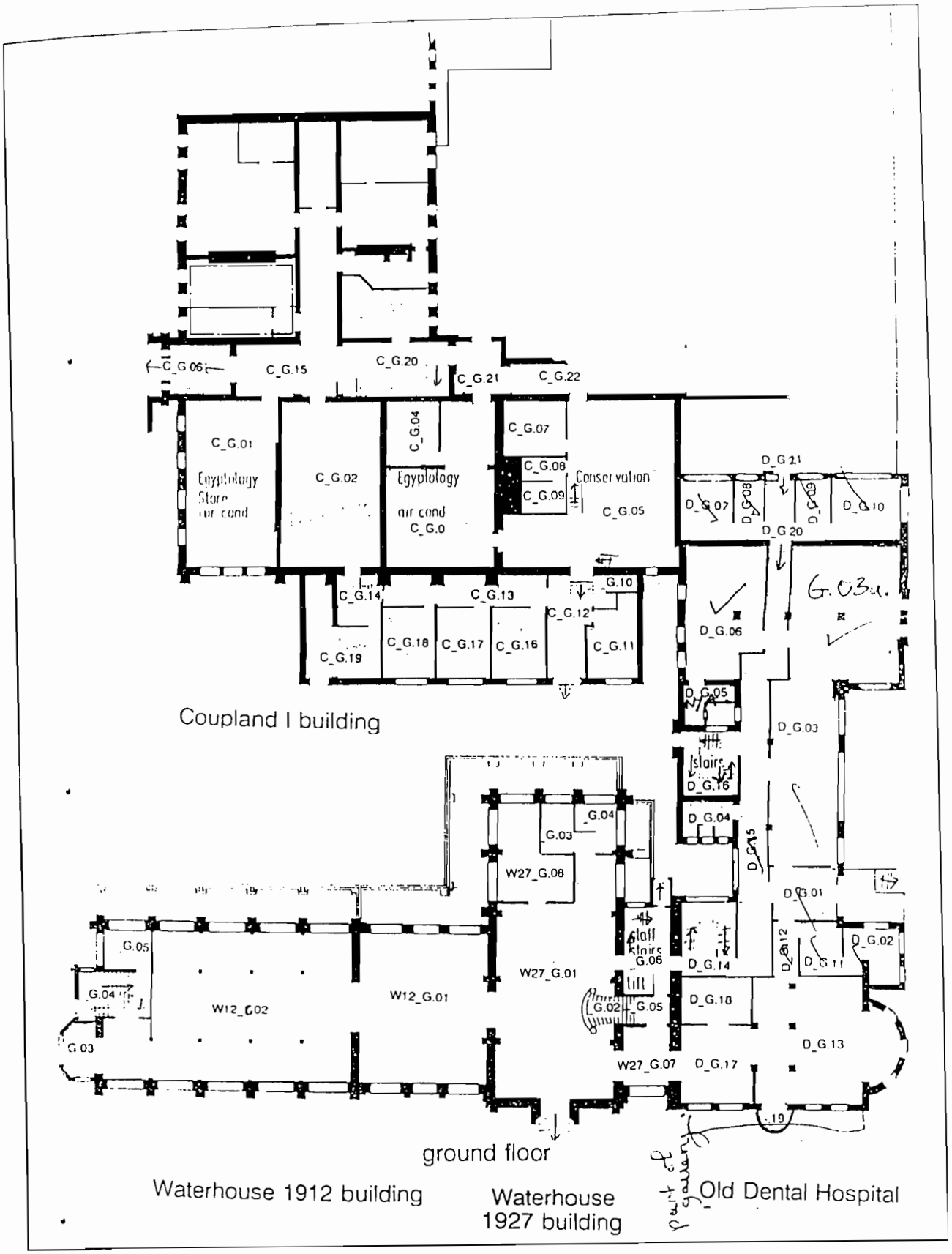


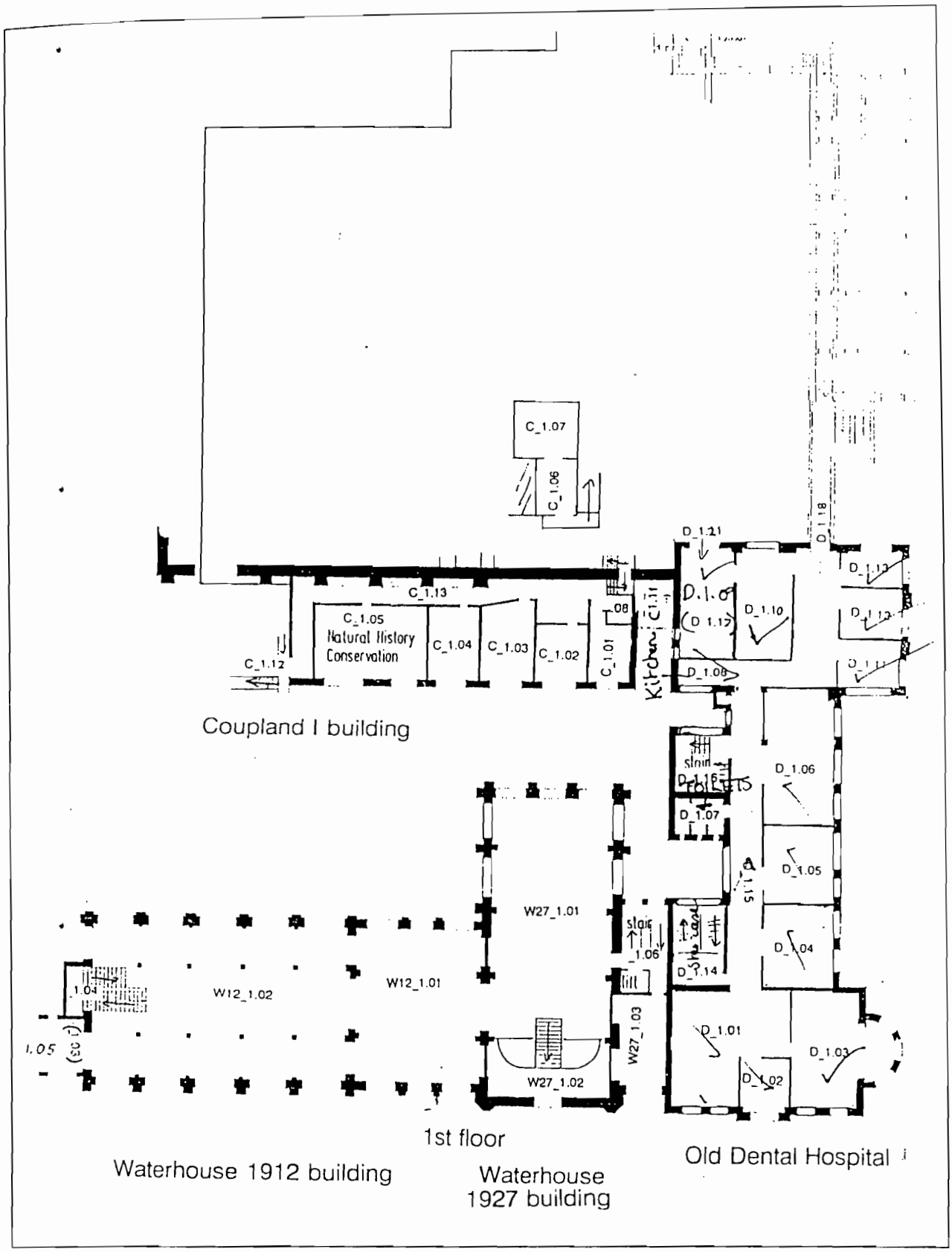

Ground
1:200
H22
H23
H24
H26
Over C.B.14
C.G.04
Conservation lab
or
Entomology store
C.G.03
store
C.G.02
store
C.G.01
Mummy store
52
51

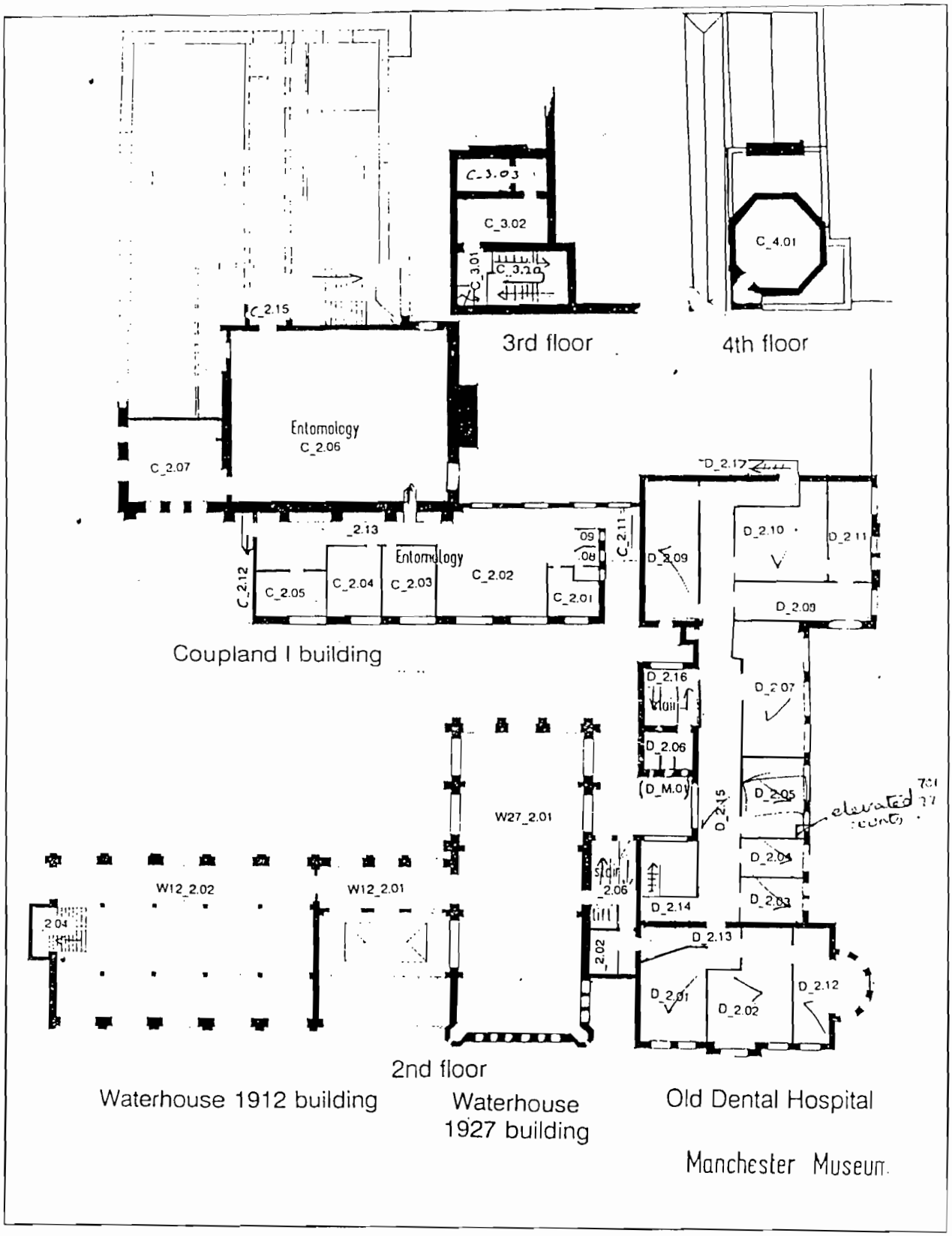

1st Floor
1:200
54
55
56
57
52
51
C.1.09
C.1.10
Museum.


Coupland 1
2nd Floor
1:200
Psychology
62
63
64
51
60
59
58
57
56
55
54
53
52


C_B.17
C_B.16
C_B.09
Zoology
C_B.10
Zoology
C_B.14
C_B.11
Zoology
C_B.13
C_B.12
Elec Switch Room
C_B.15
C_B.07
Office
C_B.21
C_B.22
C_B.08
C_B.06
C_B.01
Ethnology
C_B.02
Ethnology
C_B.03
Ethnology
C_B.04
C_B.05
D_B.17
D_B.00
Coupland I building
D_B.07
stair
D_B.16
D_B.06
W27_B.09
D_B.09
W27_B.10
D_B.15
D_B.18
W27_B.04
D_B.14
D_B.03
B 08
W12_B.07
B.06
B.05
B.12
W12_B.03
B 09
10
W12_B.02
W12_B.04
B 11
B.13
B.14
W12_B.15
B.16
W12_B.01
W27_B.01
lift
lift motor
D_B.05
B.10
D_B.04
sub station
D_B.01
B.03
B.02
B.17
W12_B.18
W27_B.02
basement
Waterhouse 1912 building
Waterhouse 1927 building
Old Dental Hospital


C_G.06
C_G.15
C_G.20
C_G.21
C_G.22
C_G.01
Egyptology Store
C_G.02
C_G.04
Egyptology
air cond
C_G.0
C_G.07
C_G.08
C_G.09
Conservation
C_G.05
D_G.21
D_G.07
D_G.08
D_G.09
D_G.10
D_G.20
G.03a.
C_G.14
C_G.13
C_G.12
G.10
C_G.19
C_G.18
C_G.17
C_G.16
C_G.11
D_G.06
D_G.05
D_G.03
Coupland I building
Stairs
D_G.16
D_G.04
G.04
G.03
W27_G.08
D_G.15
D_G.01
G.05
G.04
W12_G.02
W12_G.01
W27_G.01
staff stairs
G.06
D_G.14
D_G.12
D_G.11
D_G.02
lift
G.02
G.05
D_G.18
G.03
D_G.13
W27_G.07
D_G.17
19
ground floor
Waterhouse 1912 building
Waterhouse 1927 building
Old Dental Hospital


C_1.07
C_1.06
C_1.13
C_1.05
Natural History
Conservation
C_1.04
C_1.03
C_1.02
C_1.01
C_1.12
Coupland I building
D_1.21
D_1.18
D_1.13
D_1.10
D_1.12
D_1.09
D_1.11
D_1.06
D_1.07
D_1.05
D_1.04
D_1.01
D_1.03
D_1.02
W27_1.01
W27_1.03
W27_1.02
W12_1.01
W12_1.02
1st floor
Waterhouse 1912 building
Waterhouse
1927 building
Old Dental Hospital


C_3.03
C_3.02
C_3.01
C_3.10
C_4.01
C_2.15
3rd floor
4th floor
Entomology
C_2.06
C_2.07
D_2.17
_2.13
Entomology
C_2.12
C_2.05
C_2.04
C_2.03
C_2.02
C_2.01
09
08
C_2.11
D_2.09
D_2.10
D_2.11
D_2.08
Coupland I building
D_2.16
D_2.07
D_2.06
(D_M.01)
D_2.15
W27_2.01
D_2.05
elevated
D_2.04
W12_2.02
W12_2.01
2.04
2.06
D_2.14
D_2.03
D_2.13
2.02
D_2.01
D_2.02
D_2.12
2nd floor
Waterhouse 1912 building
Waterhouse
1927 building
Old Dental Hospital
Manchester Museum

Appendix B: Full Survey Results

Coupland 1: 2nd Floor

Room Number	Berthold (cps)	Bicron (1 min count)	Bicron reading Floor (cpm)	Bicron reading Wall (cpm)	Comments
52	Floor 41 Wall 31	18789	40000 beneath blackboard	20000	Room empty
53	Floor 45	21437	40000 beneath blackboard		Room empty
54	Wall 35	17605	25000	20000	Room empty
55	31	14156			
56	33	16338	20000	20000	
57	31	15483	<20000	inaccessible	
58	Wall 35	17991	20000	26000 (brick)	Room empty
59	Wall 29	16995	22000	25000(brick)	Room empty
60	Wall 25	15047	20000	20000	Room empty
61	Wall 30	10250	20000		Cardboard boxes in room
62	Locked- no	Key available			
63	Wall 31	18789	22000		
64	Wall 25	18938	25000	21000	Room empty
Cohen lecture theatre	Wall 35	17584	24000	24000	

Coupland 1: 1st Floor

Room Number	Berthold (cps)	Bicron (1 min count)	Bicron reading Floor (cpm)	Bicron reading Wall (cpm)	Comments
51	Floor 30 Wall 33 (B) Sink 28	18958	20000 sink 20000	20000	
51A	27	16739	20000	19000	bench tops 19000
51B	Bench & floor 30 Walls 25	17700	21000	20000	Bench tops 22000
52	Sink 33 Wall& floor 30	18481	20000	21000	Sink & bench 23000
52A	28	18605	21000	20000	Sink 20000 Bench 23000
52B	29	17962	20000	20000	
53	22	11326	15000		Storage area
54	30	22589	22000		Benches
55	Not	accessible			
56	20.6	13372	20000	20000	
57	34 benches	14237	15000	15000	Benches
C 1.09	30	13830	20000	20000	

Coupland 1: Ground floor.

Room Number	Berthold (cps)	Bicron (1 min count)	Bicron reading Floor (cpm)	Bicron reading Wall (cpm)	Comments
51	Walls 30	19332	24000	24000	Sink 22000
52	Walls 33	20394	23000	24000	
53	30	13363	20000		Limited access-storage room
54	27	15051			
54A		33567	>500000		Rutherford's laboratory.
55	Floor 1321 Wall 253 Other walls 44	33441	>500000 in corner of room		Rutherford's laboratory.
56	26	15493	25000	25000	
57	32	17489	20000		
57A	33		22000		
57B	31		25000		
CG.02 Mummy store	31	12815	20000	21000	most of floor inaccessible.
CG.02 Store	33	13304	19000	21000	
CG.03	36	10413	21000	23000	Most walls inaccessible.
CG.04	31	14673	21000	22000	Room in use.
H22 (Full of filing cabinets)	30	16719	16000	28000	
H23	Sink 36 Walls 33	20195	23000	22000	Sink 25000cpm
H24 (on two levels)	Corridor wall 31 Room 36	21925	Corridor 18000 Room 25000	Corridor 18000 Room 29000	
Side labs	31	16277	20000	20000	
Test room	34	16361	23000	24000	Empty room
H26	32	15317	20000	20000	Empty room

Coupland 1: Basement

Room Number	Berthold (cps)	Bicron (1 min count)	Bicron reading Floor (cpm)	Bicron reading Wall (cpm)	Comments
CB.01	Walls 31	16314	19000	20000	Limited access to walls and floors
CB.02	27	15711	20000	20000	Storage centre
CB.03	24	11881	15000		Storage centre and walls.
CB.04	Walls and sink 30	17729	22000	20000	Sink & bench 22000
CB.05	30	17536	25000	23000	Pipework 30000cpm
CB.06	Walls 31	16856	22000	20000	
CB.07	Walls & sink 28	17394	20000	23000	Storage boxes limiting access to floor.
Switch room	Walls max 39 (glazed tiles)	20009	22000	26000	
CB.09	32	17583	25000 under sink		Museum storage bays, benches.
CB.10	37	25996	50000 far end of room	29000	Benches 30000 Sink 28000
CB.11	30	18124	20000		Room empty
CB.12	26	19253	20000	20000	Entrance room
CB.13	22	12204	15000	Show cases	
CB.14	24	14055	21000	21000	Sink 20000
Cleaners room	30	18303	20000	20000	Lockers, benches
Store room		17971	21000	Walls inaccessible	
Boiler room	31	15292			

Lower Ground floor annex

Room Number	Berthold (cps)	Bicron (1 min count)	Bicron reading Floor (cpm)	Bicron reading Wall (cpm)	Comments
Bone room 1	Walls 18 Sink & bench 22	14856	15000	14000	Limited access to floor and walls
Bone room 2	Full of	Polystyrene	Fillings.		
Bone room 3	19 sink 22	10323	12000	12000	
Bone room 4	21	12059	15000	15000	
Test room	20	12780	12000	10000 sink 15000	
Plant room	24	14258	15000	15000	
Constructor's workshop	23	11070	12000	15000	Limited access.

Ground floor annex.

NOTE: The rooms along this corridor are all in use and so the monitoring of the walls and floor was limited by office equipment.

Room Number	Berthold (cps)	Bicron (1 min count)	Bicron reading Floor (cpm)	Bicron reading Wall (cpm)	Comments
GA1	20	11282	15000	15000	Coffee room
GA2	18	10288	15000	12000	Office
GA3	21	9043	12000	10000	Storage room
GA4	18	10364	10000	10000	Office V. Horie
GA5	20	9324	12000	12000	Benches
GA6	20	10061	12000	12000	labs
Corridor			Reading in cupboards 15000		Mainly cupboards

First floor annexe

Room Number	Berthold (cps)	Bicron (1 min count)	Bicron reading Floor (cpm)	Bicron reading Wall (cpm)	Comments
C Johnson	22	9071	12000	10000	Limited access to walls and floor
Office	Sink 22 Wall 14	9204	10000	13000	Limited access to walls and floor
Study room	20 sink 25	6295	12000	12000	
Storage area	24	5870	12000	12000	
Passageway	12	9441	10000	15000	Cupboards along length
Spirit room	20	7854	12000	12000	

Old Dental Hospital.

Basement.

NB. Most of the rooms surveyed in the old dental hospital are still in use and hence there was limited access to the floor and walls.

Room Number	Berthold (cps)	Bicron (1 min count)	Bicron reading Floor (cpm)	Bicron reading Wall (cpm)	Comments
DB.01	23	11583	17000	16000	Contained dinosaur
DB.02	Not	monitored			Sub station
DB.03	20	11807	15000	15000	Storage, limited access
DB.04	Not	accessible			
DB.05	Not	accessible			
DB.06	23	12569	18000	18000	
DB.07	23	13872	15000	19000	
DB.08	25	9645	10000		Storage room
DB.09	Safe- not	accessible			
DB.10	Not	monitored			
DB.14	-	14692	18000	25000- glazed brick 15000- concrete	corridor
DB.15	-	16504	20000	18000	corridor
DB.16	Not	monitored			Stair case

Ground floor.

Room Number	Berthold (cps)	Bicron (1 min count)	Bicron reading Floor (cpm)	Bicron reading Wall (cpm)	Comments
DG.01	19	11542	15000	15000	
DG.02	19	11542	15000	15000	Paint store
DG.03	Walls 19 Sink 30	10851	13000	14000	Teaching room
DG.03a	24	11311	15000	15000	Conference room
DG.04	Not	monitored			
DG.05	Not	Accessible	Store room-	full	
DG.06	21	10508	15000	16000	
DG.07	17	9468	12000	12000	
DG.08	18	7257	12000	12000	
DG.09	17	10176	10000	11000	kitchen
DG.10	23	10176	15000	12000	
DG.11	20	11542	15000	15000	Cleaner's store
DG.12	19	11542	15000	15000	corridor
DG.15	27- tiles	-	18000		corridor

Note- room DG.13, DG.14, DG.17 and DG.18 were not monitored as these form part of the Gallery.

1st Floor

Room Number	Berthold (cps)	Bicron (1 min count)	Bicron reading Floor (cpm)	Bicron reading Wall (cpm)	Comments
D_1.01	21	9646	10000	10000	Offices
D_1.02	18	9646	10000	10000	Offices
D_1.03	19	10599	11000	14000	Offices
D_1.04	Not	monitored			
D_1.05	21	10752	12000	14000	Office
D_1.06	18	9005	10000	11000	
D_1.07	Toilets	Not	monitored		
D_1.08	-	12870	13000	17000- tile	Kitchen
D_1.09	20	10385	15000	15000	Printing room
D_1.10	18	10361	12000	12000	Photo studio
D_1.11	-	12574	14000	13000	Limited access
D_1.12	18	11943	13000	11000	Dark room- limited access
D_1.13	19	12062	12000	11000	Limited access

Residual contamination survey of Coupland 1 Building, the Annexe and the Old Dental Hospital

Addendum to the report MTC 2000 051

Radiation monitoring has been undertaken in Coupland 1 Building, the Annex and the Old Dental Hospital, and the results reported in MTC 2000 051. The report indicates that monitoring was restricted in some locations and not undertaken in areas where access was not available. In areas relevant to Phase 2b demolition the Museum/Psychology escape stair well and ground floor toilets were not monitored at the time. These areas have now been monitored, and localised contamination has been found on the wall between the stair well and Psychology. The total activity associated with the contaminated area is estimated at 2kBq. The area is to be remediated before demolition. With this exception, and subject to the limitations described in the report, no occupationally significant radiation hazard was detected in areas to be demolished.

There is no reason to believe that the areas in question have been used for work with radioactive materials and have become contaminated as a result. The detection of contamination in the stair well, whilst giving confidence in the surveys ability to detect low level contamination, casts some doubt, however, and there may be similar low levels of contamination that have gone undetected. There is a remote possibility, therefore, that demolition debris leaving the site as waste may be "radioactive" as defined in the Radioactive Substances Act 1993.

Our experience with the decommissioning of the Universities Research Reactor, where "non radioactive" demolition debris was removed from site under similar circumstances, leads us to believe that the Environment Agency would expect lorry loads of demolition debris to be monitored before leaving the site. I recommend, therefore, that this be done so as to demonstrate that on the basis of waste increments equal to a "lorry load" the waste leaving site meets the requirements of the Radioactive Substances (Phosphatic Substances and Rare Earths etc.) Exemption Order 1962.

It is emphasised that this procedure is very much a confirmatory checking procedure designed to generate records that confirm compliance with the conditions of the Exemption Order.

Barry Frith

25th Sept 2000

HSE
Health & Safety Executive
Field Operations Directorate - North West Division

HM Principal Specialist Inspector Hugh Wolfson

Dr Susan A Robson
Director
Health and Safety Services
University of Manchester
Waterloo Place
182/184 Oxford Road
Manchester M13 9GP

Your Reference:

Our Reference: 160105570/0287059

4th October 2000

Dear Dr Robson

THE IONISING RADIATIONS REGULATIONS 1999 (IRR99)

I write in relation to the radioactive contamination within the Coupland Building at the Manchester Museum. As I indicated during my inspection on 31st July of this year, it is unfortunate that a full contamination survey was not conducted many years ago, and appropriate remediation work carried out. However, I recognise that the contamination is historical and that the majority of contaminated rooms were used for storage. I have also been informed that the estimated radiation doses to employees and students during use of the only occupied area are very low. The University has now employed a specialist firm (NIRAS) to undertake remediation and this work should be carried out in compliance with IRR99. During my inspection I requested that a number of improvements be made to the control of radioactive materials at the Museum as detailed in Appendix One. Please confirm what progress has been made in relation to these required improvements.

I also requested that copies of a number of documents be forwarded to me as follows:

1 Revised dose estimates of persons using Room G55 (to include the contribution from Radon-222).

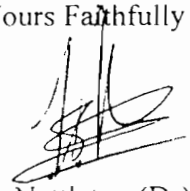
2. An estimation of the total radioactivity present in each affected area.

3 Risk assessments and local rules for proposed remediation work, as required by IRR99

I have not yet received copies of items 1 or 2. I have received items 3 and have only two comments to make in relation to these: The choice of dose investigation level is still set at 15mSv. Following discussions during my inspection, I had understood that this would be reduced to a much lower level. I was also informed that a member of NIRAS staff would be present at all times during remediation work. Please confirm that this is still the case

If you wish to discuss any of the above points, please do not hesitate to contact me at the address on the letterhead

Yours Faithfully



Jo Nettleton (Dr)
HM Specialist Inspector (Radiation) of Health and Safety

cc Mr Roger Gladwell HSE
cc Miss Eileen Mercer HSE
cc Mr Nigel Bunce HSE
cc Mrs Margot Checkley Manchester City Council
cc Mr Barry Frith NIRAS (letter only)

NIRAS
NNC Independent Radiation Assessment Services

Telephone: (01925) 895588
Fax: (01925) 895551

Adding value through kno

Our Ref: NIRAS/E2000002/let/48.doc Your Ref:

Dr S A Robson
Director
University of Manchester
Health & Safety Services
Waterloo Place
182/184 Oxford Road
Manchester
M13 9GP

26 October 2000

Dear Susan,

Re Response to HSE Letter

I write to respond to Jo. Nettleton's request for more information in the specific areas referred to in her letter to you of 4th Oct 2000. I will deal with each point in turn.

1) Revision of dose estimates

Dose rates for persons occupying rooms G54 and G55 have been made and reported by the University at 27th June 2000. These were based on occupancy factors taken to be appropriate to the usage. The annual dose to occupiers may be calculated as the weekly dose multiplied by 50. This gives values of 2.5μSv/y and 8.75μSv/y. Added to these must be the dose due to radon-222+ and the intake of non radon-222 activity in air.

The radon-222 concentrations were determined by "grab sampling" and shown to be less than 31 Bq/m^3 and less than 132Bq/m^3* respectively. Using the rough assumption that occupational exposure to 400Bq/m3 for 2000hrs results in 2mSv/y, for the occupancy factor used, the resulting additional dose is <0.04mSv in room G54 and < 0.58mSv in room G55.

Measurements were made of the non-radon daughter alpha activity in air. Results obtained were less than 0.0028Bq/m^3 and less than 0.0065Bq/m^3 respectively. If we assume that as a worst case this represents the concentration of lead 210, and that 1Bq/m3 equates to 15mSv/y (IRR85 Schedule 2 col. 3), the additional dose is <0.01mSv and <0.09mSv, calculated on the basis of the reported occupancy.

The revised dose estimate for people who have occupied rooms G54 and G55 is <0.053mSv/y and < 0.68mSv/y respectively.

* Please note that the higher less than figure is due to a lower sensitivity for the particular lucas cell used in the measurement.

2) An estimate of the total activity in affected areas

An estimate of the total contamination in each affected area was made on 18/6/00 with an amendment on 17/10/00 to take into account the discovery of lead-210 beneath floorboards. I attach a copy. The first estimate was made on the basis that, with the exception of room C.1.10 the activity was due to Ra-226, and the affected area was contaminated at a similar level as the location of the highest activity from which a sample was taken and analysed. This and the localised nature of the contamination made for a worst case estimate. At the time contamination had been detected in rooms 2.62 and 2.63 but was at such a low level as to be regarded as trivial. It was not included in our estimate.

Since these estimates was made we have discovered localised areas of lead-210 beneath floorboards during remediation work in rooms 2.62 and 2,63.

Lead-210 beneath floorboards is not detectable from above, and we can not, therefore, say how many such areas remain undetected. The nature of the contamination is consistent with liquid spills on the floor dripping through gaps in the floorboards to give very local spots of activity. We were able to estimate the activity in each detected spot by direct comparison with a lead-210 test source and estimate the maximum activity to be 50kBq.

We judge on the basis of the number of detected spots of lead-210 in G54/G55, i.e. the worst affected room, that there are at most 10 undetected locations per affected room or combination of rooms, i.e. a total of 0.5MBq/ affected room or combination of rooms. This amount of activity must, therefore, be added to our original estimate where rooms have wooden floors, i.e.

A modified estimate is therefore

Room No.	Volume of waste (m^3)	Mass (kg)	Activity
G54/G55	1.76	902	9.2MBq
CB.05*	16.9x10-3	38.8	1.67MBq
CB.09*	8.44x10-3	19.4	9.7kBq
CB.10*	1.44x10-3	3.3	16kBq
2.52/2.53	4.5x10-3	2.3	1.36MBq
C.1.10*	94.5x10-3	153	12.82MBq
2.62			500kBq
2.63			500kBq

*Rooms without wooden floors

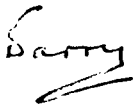
3) The use of investigation levels

The dose investigation level of 15mSv (the default level) has been written into the local rules. I did not want to commit us to formal investigations at lower levels in circumstance where we have no experience of what to expect. Alternative arrangements for achieving the objective of Reg 8(1) are in place.

Contingency Plans written with respect to areas designated Supervised and Controlled, in each case requires an investigation into the operation of dose restriction procedures when air monitoring detects concentrations of non-radon alpha activity which for a year's continuous working would result in an effective dose of 15mSv. This concentration is derived from the 85 Regs. The maximum period between exposure and air concentration result being available is 5 working days. This means that the efficacy of exposure controls is reviewed about weekly, and action taken when doses exceed 0.3mSv in a working week. This acts as an early warning of potential exposure at the investigation level, and provides an early response mechanism for corrective action long before an investigation would be required under Reg. 8(7), and is along the lines of Paragraph 156 of the G.Ns.

I trust that the above will be sufficient for the Inspector's requirements but should additional information or explanation be required please get in touch.

Yours sincerely
for NNC Limited



Barry Frith
Senior Consultant

Email: barry.frith@nnc.co.uk

Estimates of waste volume, mass and total activity.

1 Rooms G54 and G55.

The floor board area to be removed from rooms G54 and G55 is estimated at:

200cm x 800cm x 2.5cm = **400,000cm^{-3}**.

The density of wood is taken to be 0.513g/cm^{-3}.

Therefore total mass of wood is approx. **205,000g**.

The average activity concentration of radium –226 is 9.6Bq/g giving a total activity of **2MBq**.

Also to be removed from rooms G54 and G55 are 5 joists at 800cm x 30cm x 8cm, giving a total volume of **960,000cm^{-3}**. Using the density of wood given above, the total mass is **492,000g.**

Using the activity concentration given above, the total activity is **4.7MBq**.

Using the same volume and mass for the ceiling to be removed from CB.10, the total activity of the ceiling is **2MBq**.

Therefore the total activity of the waste removed from the floor in rooms G54 and G55 and the ceiling in room CB.10 is 8.7MBq.

2 Room CB.05.

It is estimated that 10 bricks will be removed in order to remove the contamination. The dimensions of each brick will be taken as 22.5cm x 10cm x 7.5cm, giving the total volume of brick removed as **16875cm^{-3}**.

Therefore, taking the density of brick as 2.3g/cm^{-3}, the total mass the brick is **38810g**.

The average activity concentration of radium- 226 is 43Bq/g, giving a total activity of **1.67MBq**.

3 Room CB.09.

Again it is estimated that five bricks will be removed. From the calculation above, the mass of five bricks is **19406g**.

The average activity concentration of radium- 226 is 0.5Bq/g, giving a total activity of **9.7kBq**.

4 Room CB.10.

The contamination is localised and is on the concrete floor. As the contamination is localised, cutting out a volume of concrete of 12cm x 12cm x 10cm should remove the contamination. The total volume is **1440cm^{-3}**.

Taking the density of concrete as 2.3g/cm^{-3}, the total mass of concrete is **3312g**. The average activity concentration of radium- 226 is 4.9Bq/g, giving a total activity of approx. **16kBq**.

5 Rooms 2.52 and 2.53.

The area contaminated is the wooden floor. As the contamination is localised it may be possible to cut out an area of 30cm x 30cm in each room.

The total volume of wood removed is **4500cm^{-3}** (assuming the floorboards are 2.5cm thick) with a mass of **2308g**.

The activity concentration of radium-226 is 0.37Bq/g, giving a total activity of **854Bq**.

6 Room C.1.10

In total 21 bricks have been shown to be contaminated. Twenty of these bricks have an activity concentration of 24Bq/g, with one brick of activity concentration 4000Bq/g.

The mass of one brick is 2.75kg.

Calculation of total activity:

20 bricks x 2750g x 24Bq/g = 1.32MBq +
1 brick x 2750g x 4000Bq/g = 11MBq

Total activity = 12.32MBq

Calculation of total mass:

21 contaminated bricks will be removed along with 35 clean bricks.

56 x 2.75kg = 154kg.

Calculation of total volume:

From above the volume of one brick is 1687.5cm^{-3}, therefore the volume of 56 bricks is calculated to be:

56 x 1687.5 = 94500cm^{-3}

7 Summary

Room No.	Volume (m^{-3})	Mass (Kg)	Activity
G54 & G55	1.76	902	8.7MBq
CB.05	16.9×10^{-3}	38.8	1.67MBq
CB.09	8.44×10^{-3}	19.4	9.7kBq
CB.10	1.44×10^{-3}	3.3	16kBq
2.52 & 2.53	4.5×10^{-3}	2.3	854Bq
C.1.10	94.5×10^{-3}	153	12.32MBq

B. Frith
18/06/00

Amendment.

During the decommissioning additional contamination of lead-210 was found. Two patches of lead-210 were detected on the steel girder in rooms G54/G55. Monitoring of the contaminated area using a 2"Geiger counter was off scale. A lead-210 solution of known activity 1kBq was prepared, with the 2" GM giving a reading of 50cps. Therefore the off scale reading suggests an activity of at least 10kBq. An estimate of the activity is taken to be 50kBq.
Also lead-210 was detected on the lagging beneath the floorboards in rooms 2.52/2.53. Again an estimate of the activity is taken to be 50kBq.

Summary

The table below has been amended to incorporate the activity of lead 210 in room G54/G55 and 2.52/2.53

Room No.	Volume (m^{-3})	Mass (Kg)	Activity
G54 & G55	1.76	902	8.75MBq
CB.05	16.9×10^{-3}	38.8	1.67MBq
CB.09	8.44×10^{-3}	19.4	9.7kBq
CB.10	1.44×10^{-3}	3.3	16kBq
2.52 & 2.53	4.5×10^{-3}	2.3	50.8kBq
C.1.10	94.5×10^{-3}	153	12.32MBq

17/10/00

Final Report for the Decommissioning of Coupland 1 Building, Manchester University

by

B Frith

Client: Manchester University

NIRAS
NNC Limited, Warrington Road, Risley
Warrington, Cheshire WA3 6BZ
Tel: 01925-895588 Fax: 01925-895551

C5952/0008
MTC/01/005
Issue: 01
January 2001

DOCUMENT ISSUE RECORD

Adding value through knowledge

Document Title	Final Report for the Decommissioning of Coupland 1 Building, Manchester University
Project:	C5952/0008

Purpose of Issue : For Issue

Security Class : Commercial-in-Confidence

Issue	Description of Amendment	Originator/ Author	Approver	Date
01	For Issue	B Frith	A J Frith	January 01

Previous issues of this document shall be destroyed or marked **SUPERSEDED**

Distribution: Client, File

CONTENTS

1 EXECUTIVE SUMMARY

This final report describes the radiological conditions which remain in remediated rooms in the Coupland 1 Building. The report recognises the possibility that undetected, and undetectable contamination may remain, which is of little radiological hazard significance in its present condition, but may result in serious hazards if disturbed by intrusive work undertaken on the building fabric. It is recommended that the University or other occupier of the building makes and keeps records that ensure that any proposal for intrusive work in the future triggers a prior radiological risk assessment in accordance with Regulation 7(1) of the Ionising Radiations Regulations 1999.

2 INTRODUCTION

NIRAS were appointed RPA to Manchester University and its contractors Hayverns during refurbishment work in Coupland 1 Building. This work involved the removal of contamination resulting from past work with radioactive materials, the most significant of which was work in the early 1900s by Ernest Rutherford. An initial survey of the building, described in report ref. MTC/2000/051 detected a number of contaminated areas. In each of the rooms where contamination was detected, and before work likely to disturb the building fabric was begun, measurements were made of radon concentrations, non-radon alpha activity in air concentrations and dose rates. On the basis of information received from Manchester University RPS Service regarding occupancy of the locations, likely doses to past occupants were estimated.

During remediation of areas where contamination had been detected, the lifting of floorboards quickly revealed significant lead-210/polonium-210 contamination in the form of very localised "hot spots" present in the space beneath the floorboards of the rooms and the ceiling of the rooms below. The nature of the emissions from these radionuclides, makes their presence on floor surfaces readily detectable, but the mass absorption of the floor and ceiling materials makes contamination between floor and ceiling undetectable from above the floor or below the ceiling. The methods used in the initial survey had not anticipated that contamination could have entered the space below floorboards without leaving detectable contamination on the floor surface. Remediation has been completed so as to remove, as far as reasonable practicable, contaminated floorboards. In addition, where lead-210/polonium-210 contamination has been detected between floor and ceiling as a result of floorboard removal, that contamination has also be removed.

It must be accepted that there is a possibility that undetected lead-210/polonium-210 contamination might be present beneath floorboards in other areas of Coupland 1 Building. Any radiological impact on the working environment due to any remaining undetected contamination may need to be assessed by appropriate monitoring.

Following remediation of all areas *where contamination was found*, the radon concentration, the non-radon alpha activity in air concentration, and gamma dose rate have been measured in order to assess likely future exposure to occupants. This report describes methods used and from the results, makes estimates of the doses that may be received by future occupants. These estimates include contributions from any undetected undisturbed lead-210/polonium-210 that may remain.

3 METHOD

3.1 Clearance criteria

All detected contamination in the affected rooms was removed by physical means and the resulting contaminated debris drummed for disposal. The remediated areas were monitored using a 2" end window GM counter to ensure that remaining contamination was less than 0.4Bq/cm^2 of lead-210+polonium-210 averaged over 300cm^2.

The following measurements were then made.

3.2 Radon concentrations

Radon measurements were taken using a Pylon Model AB-5 Portable radiation monitor and calibrated LUCAS LCA-2 scintillation cells. Background readings were taken for each cell before "grab samples" were collected. Radon measurements were taken in each of the Category 1 and Category 2 rooms, which are defined below:

Category 1: Areas included in the Museum Project, present and future.
This includes rooms CB.10, CB.09, CB.05 and C.1.10.

Category 2: Areas outside but impinging on the Museum Project.
This includes rooms G54/G55 and 2.52/2.53.

Samples were allowed to reach equilibrium before counting, and the radon concentration calculated using the equation provided with the calibration certificate as follows

$$\text{Radon conc. (Bq/m}^3\text{)} = \frac{\text{sample counts/hr- background counts/hr}}{\text{AB5 efficiency x Delay correction factor x Cell efficiency}}$$

Values for AB5 efficiency, Delay correction factor and cell efficiency were all provided from the NRPB calibration data for this unit.

Note: at the time of writing of this Report the author is not content with the calibration procedures used, and the matter is the subject of exchanges with NRPB Chiltern

3.3 Non- radon alpha activities in air

Airborne particulates were collected over a period, of typically three hours, using portable air samplers of the type, L60 or L150. Samples were collected on Glass Fibre filters, which were kept in Petri dishes for 3 days before counting to permit the decay of any radon daughters. The alpha activity on the filters was then assessed in the laboratory and the non-radon alpha activity concentration calculated.

3.4 Gamma dose rates

Gamma dose rates were measured in the centre of each room, at 1m height above the floor. The instrument used to take these measurements was of the type Mini Instruments Series 6-80. The calibration factor used is that applicable to outdoor environmental measurements with no attempt to correct for differing geometry or directional effects. The "excess" dose rate is calculated by subtracting a mean value for domestic dwellings. The conversion of Gy to Sv assumes a factor of 1 as it is not possible to assign a source detector geometry.

4 RESULTS

4.1 Radon concentrations.

Room	Radon Concentration (Bq/m^3)
CB.05	53±42
CB.09	<155
CB.10	<37
G54/G55	<28
C.1.10	<44
2.52/2.53	<135

Note; the limit of detection is a function of the Lucas cell used for the measurement.

4.2 Non- radon alpha activity in air concentrations

Room	NIRAS Lab Job No	Non-radon alpha in air concentrations (Bq/m^3)
CB.05	L2000131-70	<0.0026
CB.09	L2000131-69	<0.0010
CB.10	L2000131-68	<0.0013
G54/G55	L2000131-67	<0.0007
C.1.10	L2000131-72	<0.0005
2.52/2.53	L2000131-71	<0.0010

4.3 Gamma dose rates

Room	Gamma Dose Rate (μGy /hr)
CB.05	0.16
CB.09	0.15
CB.10	0.15
G54/G55	0.14
C.1.10	0.14
2.52/2.53	0.15

5 DOSE CALCULATIONS

5.1 Dose from radon.

The dose due to exposure to radon-222 and daughters is calculated on the basis of the rough assumption that occupational exposure to 400Bq/m^3 for 2000hrs results in 2mSv/yr, and the natural background for radon is the mean of that found in domestic dwellings

Room	Radon Concentration (corrected for mean domestic value (21Bq/m^3*))	Annual dose due to Radon (corrected for mean domestic dwelling radon concentrations) (mSv)
CB.05	<74	<0.37
CB.09	<134	<0.67
CB.10	<16	<0.08
G54/G55	<7	<0.04
C.1.10	<23	<0.12
2.52/2.53	<114	<0.57

* NRPB-R190 Natural Radiation Exposure in U.K. Dwellings

5.2 Dose from non-radon alpha activity in air

The dose due to the inhalation of non-radon alpha activity in air is calculated on the basis that lead-210 and polonium 210 are the main contributors. The worse case dose coefficients for these are 8.9x10^{-7}Sv/Bq and 3x10^{-6}Sv/Bq respectively (taken from ICRP Publication 68). Annual doses are calculated using a 2000hours /year occupancy (occupational exposure) and a breathing rate of 1.2m^3/hr (taken from ICRP 23).

Room	Non-radon alpha in air concentrations (Bq/m^3)	Committed Dose equivalent (mSv)
CB.05	<0.0026	<0.024
CB.09	<0.0010	<0.009
CB.10	<0.0013	<0.012
G54/G55	<0.0007	<0.006
C.1.10	<0.0005	<0.005
2.52/2.53	<0.0010	<0.009

5.3 Dose from external radiation

The dose rates measured are corrected for the domestic mean rate and the annual excess dose calculated on the basis of 2000 hrs. exposure i.e. occupational exposure.

Room	Excess Gamma dose rate (corrected for domestic mean value of 0.06μGy/hr)	Annual excess dose from external radiation (mSv).
CB.05	0.10	0.20
CB.09	0.09	0.18
CB.10	0.09	0.18
G54/G55	0.08	0.16
C.1.10	0.08	0.16
2.52/2.53	0.09	0.18

6 CONCLUSIONS AND RECOMMENDATIONS

The total dose above background received by a worker occupying the above rooms in the Coupland 1 Building for 2000 hours per year, from external and internal radiation is, in the worst case estimated to be less than 0.86mSv/year. This is well within dose limits for workers (20mSv/y) and within the target dose for workers not normally exposed to radiation as part of their work (1mSv/y).

Similar calculations as above can be carried out for a member of the public visiting Coupland 1 building, the museum. Assuming that a visitor may spend 4 hours in the building the total dose received would be about 1.7μSv/y. The annual dose limit for members of the public is 1mSv/y, with a constraint of 300μSv/y. The dose received from visiting this building is likely to be well within these values.

Although doses due to occupancy are satisfactorily low, it is important to recognise that the methods used for detecting radioactive contamination are not sensitive to some contaminants when not present on accessible surfaces. There may remain, therefore, undetected contamination, which is of negligible radiological significance whilst unexposed and undisturbed, but which could become a significant radiological hazard should work be undertaken on the fabric of the building.

It is important, therefore, that the University makes and keeps records that ensure that any proposal for work in the future triggers a prior radiological risk assessment.

DRAFT

Estimation of the total activity per drum.

1 Rooms G54 and G55.

The results of analysis of samples taken from areas of detectable contamination on the floor of these rooms indicate that the contamination is due to radium –226, and that the activity concentration at the location of highest detectable contamination was 9.6Bq/g. The contamination appears to be consistent with the spilling of radioactive solutions, it being localised in discrete areas.

All the floorboards from these rooms were lifted and monitored for contamination. Areas of contamination were cut away, by cutting in clean areas of the board, and drummed.

In total 15 drums were filled from the contaminated areas in these rooms. Assuming the activity concentration for all contaminated boards drummed to be 9.6Bq/g, the total activity can be calculated as below.

The activity discovered beneath the floorboards was shown to be lead-210/polonium-210, and was found to be in very discrete spots and largely associated with the lagging between the joists. Two similar patches of this contamination were found on the upper surface of a steel joist beneath the floorboards. These patches were judged to be at least as contaminated as the highest found elsewhere in the rooms. An estimation of the total activity on each spot was made by direct beta monitoring using a "reference" source of lead-210/polonium-210 prepared in the NIRAS laboratory. The estimated maximum activity of each patch was 10kBq of Pb-210 and 10kBq Po-210; i.e. 20kBq in total. The estimation of the total activity in each drum containing "lagging" is calculated on the basis of there being the waste from 20 locations of contamination at 20kBq, and there being negligible mass associated with the lagging.

Drum ref	contents	mass (kg)	activity conc (Bq/g) Ra-226	Total activity Bq	Addition for Po/Pb-201	Total Bq	**Total Activity MBq**
G54/G55/1	floorboards	36	9.6	3.46E+05		3.46E+05	**0.35**
G54/G55/2	floorboards	49	9.6	4.70E+05		4.70E+05	**0.47**
G54/G55/3	floorboards + lagging (Po/Pb 210)	57	9.6	5.47E+05	4.00E+05	9.47E+05	**0.95**
G54/G55/4*	joist + lagging (Po/Pb 210)	22	9.6	2.11E+05	4.00E+05	6.11E+05	**0.61**
G54/G55/5	floorboards + lagging (Po/Pb 210)	23	9.6	2.21E+05	4.00E+05	6.21E+05	**0.62**
G54/G55/FB6	floorboards	49	9.6	4.70E+05		4.70E+05	**0.47**
G54/G55/FB7	floorboards	46	9.6	4.42E+05		4.42E+05	**0.44**
G54/G55/FB8	floorboards	76	9.6	7.30E+05		7.30E+05	**0.73**
G54/G55/9	floorboards	55	9.6	5.28E+05		5.28E+05	**0.53**
G54/G55/10	floorboards	47	9.6	4.51E+05		4.51E+05	**0.45**
G54/G55/FB11	floorboards	63	9.6	6.05E+05		6.05E+05	**0.60**
G54/G55/12	floorboards	45	9.6	4.32E+05		4.32E+05	**0.43**
G54/G55/13	floorboards+ lagging (Pb/Po-210)	67	9.6	6.43E+05	4.00E+05	1.04E+06	**1.04**
G54/G55/14	floorboards+ lagging (Pb/Po-210)	28	9.6	2.69E+05	4.00E+05	6.69E+05	**0.67**
G54/G55/15	floorboards+ lagging (Pb/Po-210)	49	9.6	4.70E+05		4.70E+05	**0.47**
		712					**8.83**

* this includes the Pb/Po-210 from room 2.52 & 2.53

DRAFT

2 Room CB.05.

Brickwork in this room was found to be contaminated with radium-226. The average activity concentration of radium- 226 in samples taken from locations of detected contamination was 43Bq/g. The contamination was removed by working on and removing uncontaminated brickwork which was disposed along with contaminated bricks. As a worst case for disposal purpose it is assumed that all the bricks disposed are contaminated at the average activity concentration.

3 Room CB.10.

The contamination in this room was found to be due to radium-226 and localised in one area of the concrete floor. The mass of the concrete floor removed is estimated at 4kg. The average activity concentration of radium- 226 is 4.9Bq/g, giving a total activity of approx. **20kBq**.

Drum ref.	Contents	mass (kg)	activity conc (Bq/g) Ra-226	Total activity Bq	**Total MBq**
CB.05 no1	Bricks	36	43	1.55E+06	**1.55**
CB.05/CB.10 no 2	bricks	24	43	1.03E+06	**1.05**
	concrete CB.10	4	4.9	1.96E+04	

4 Room CB.09.

Areas of contamination were detected on the brickwork on the windowsill and on the wooden window frame. Analysis of samples taken gave an average activity concentration of radium-226 of 0.66Bq/g. Again the contamination was removed by working on and removing uncontaminated brickwork which was disposed along with contaminated bricks. As a worst case for disposal purpose it is assumed that all the bricks disposed are contaminated at the average activity concentration.

Drum ref.	contents	mass (kg)	activity conc. (Bq/g) Ra-226	Total activity Bq	**Total Activity MBq**
CB.09	bricks	84	0.66	5.54E+04	**0.06**

5 Rooms 2.52 and 2.53.

Two small lengths of floorboards were cut in clean areas and removed. Results of samples taken show the contamination is again due to radium-226 at an average concentration of 0.72Bq/g. These sections were put into drum ref. G54/G55/4 and since they occupy a small percentage of the mass, as a worse case estimate have been taken to be of activity conc. of those in room G54/G55. Once the floorboards had been removed, two areas of localised lead/polonium –210 were detected and removed. Again this activity is included in drum ref. G54/G55/4. The activity of each localised spot of contamination is taken to be 20kBq in total, as estimated by comparison with a reference prepared by NIRAS.

DRAFT

6 Room C.1.10

A number of samples were taken from the contaminated brickwork in room C.1.10. Analysis of these samples confirmed that the contamination present was due to lead/polonium-210. Samples from a single brick gave an activity concentration of 4000Bq/g. The average activity concentration of samples taken from other contaminated bricks is 24Bq/g. The contamination was removed by working on and removing uncontaminated brickwork which was disposed along with contaminated bricks. As a worst case for disposal purpose it is assumed that one brick of estimated mass of 3kg had an activity concentration of 4000Bq/g and the remaining mass of bricks in the drum are contaminated at the average activity concentration of 24Bq/g.

Drum ref	contents	mass (kg)	activity conc (Bq/g) Po-210	Total activity Bq	**Total MBq**
C.1.10/brick 1	bricks	122	24	2.93E+06	**14.93**
	brick	3	4000	1.20E+07	

The floorboards removed by NNC at the beginning of this project were assessed and the total activity determined. The floorboards were wrapped in plastic and each one labelled. NIRAS cut each of these into smaller sections, which were then drummed. In total 5 drums were filled from the contaminated floorboards from room C.1.10. The total activity of each labelled, wrapped floorboards package had previously been calculated. The activity in each drum is shown below.

Drum ref	contents	mass (kg)	Activity Bq	**Total Activity MBq**
C.1.10/FB1	P003	73	2.40E+05	**0.27**
	P0011		1.71E+04	
	P0013		1.60E+04	
C.1.10/FB2	P001	65	7.35E+04	**0.22**
	P007		7.40E+04	
	P009		7.49E+04	
C.1.10/FB3	P002	23	9.06E+04	**0.20**
	P006		8.11E+04	
	P0012		2.37E+04	
C.1.10/FB4	P004	21	7.95E+04	**0.15**
	P008		7.46E+04	
C.1.10/FB5	P005	43	9.90E+04	**0.14**
	P0010		3.92E+04	

In addition there are six drums containing contaminated boards and other debris. The total activity of each of these drums had been assessed by NNC at the beginning of this project and is summarised in the table below.

Drum ref	contents	mass (kg)	Activity Bq	**Total MBq**
C.1.10 001	boards	82	1.61E+07	16.1
C.1.10 002	vacuum bag & other debris	91	5.88E+06	5.88
C.1.10 003	boards	89	2.48E+06	2.48
C.1.10 004	boards	86	2.48E+06	2.48
C.1.10 005	vacuum bag, vinyl & bag rubble	101	5.68E+06	5.68
C.1.10 006	boards & vacuum bag	53	7.01E+06	7.01

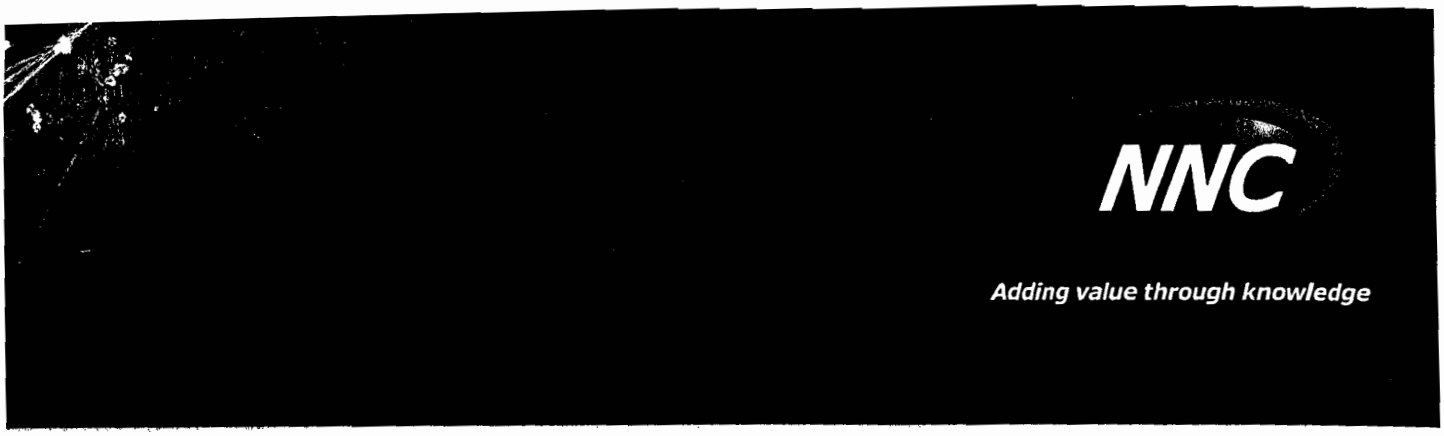
DRAFT

7 Rooms 2.62 & 2.63

The analysis of samples taken from contaminated floor boards shows that the contamination is due to radium –226 and is of activity concentration 1.27Bq/g.
Once the contaminated floorboards had been removed, discrete areas of lead/polonium-210 was once again discovered beneath on the lagging material. There were 20 localised spots of contamination, each spot having an activity 20kBq in total, as estimated by comparison with a reference prepared by NIRAS.

Drum ref.	contents	mass (kg)	activity conc. (Bq/g) Ra-226	Total activity Bq	Addition for Po/Pb-201	Total Bq	Total MBq
2.62/2.63	Floorboards + lagging	64	1.27	8.13E+04	4.00E+05	4.81E+05	0.48

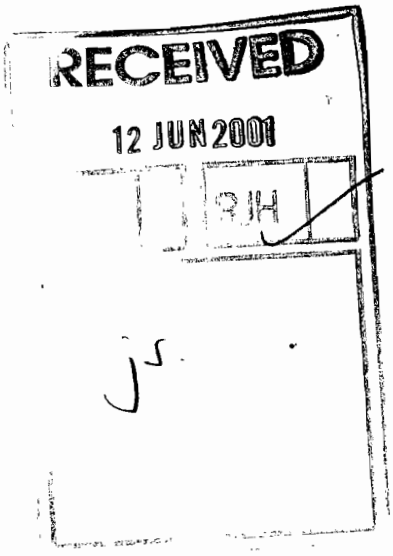
S. Adams
20/03/01



REPORT ON THE ESTIMATION OF DRUM ACTIVITY OF WASTE REMOVED FROM COUPLAND 1 BUILDING

by

S M Adams



NIRAS
NNC Limited, Birchwood Park,
Birchwood, Warrington
Cheshire WA3 6BZ
Tel: 01925-895588 Fax: 01925-895551

C5952/0013
MTC/01/026
Issue: 01
9 April 2001

DOCUMENT ISSUE RECORD

Adding value through knowledge

Document Title	Report on the estimation of drum activity of waste removed from Coupland 1 building
Project:	C5952/0013

Purpose of Issue : For Issue

Security Class : Commercial-in-confidence

Issue	Description of Amendment	Originator/ Author	Approver	Date
1	For Issue	S M Adams	A J Frith	9/4/01

Previous issues of this document shall be destroyed or marked **SUPERSEDED**

Distribution: Client, File

C5952/0013
Issue : 01
Date : 9 April 2001

3050Oct99 Controlling procedure - QP 7, QP40

1 Rooms G54 and G55.

The results of analysis of samples taken from areas of detectable contamination on the floor of these rooms indicate that the contamination is due to radium –226, and that the activity concentration at the location of highest detectable contamination was 9.6Bq/g. The contamination appears to be consistent with the spilling of radioactive solutions, it being localised in discrete areas.

All the floorboards from these rooms were lifted and monitored for contamination. Areas of contamination were cut away, by cutting in clean areas of the board, and drummed.

In total 15 drums were filled from the contaminated areas in these rooms. Assuming the activity concentration for all contaminated boards drummed to be 9.6Bq/g, the total activity can be calculated as below.

The activity discovered beneath the floorboards was shown to be lead-210/polonium-210, and was found to be in very discrete spots and largely associated with the lagging between the joists. Two similar patches of this contamination were found on the upper surface of a steel joist beneath the floorboards. These patches were judged to be at least as contaminated as the highest found elsewhere in the rooms. An estimation of the total activity on each spot was made by direct beta monitoring using a "reference" source of lead-210/polonium-210 prepared in the NIRAS laboratory. The estimated maximum activity of each patch was 10kBq of Pb-210 and 10kBq Po-210; i.e. 20kBq in total. The estimation of the total activity in each drum containing "lagging" is calculated on the basis of there being the waste from 20 locations of contamination at 20kBq, and there being negligible mass associated with the lagging.

Drum ref	contents	mass (kg)	activity con (Bq/g) Ra-226	Total activity (Ra-226) Bq	Addition for Po/Pb-201	Total Activity Bq	**Total Activity MBq**
G54/G55/1	floorboards	36	9.6	3.46E+05		3.46E+05	**0.35**
G54/G55/2	floorboards	49	9.6	4.70E+05		4.70E+05	**0.47**
G54/G55/3	floorboards + lagging (Po/Pb 210)	57	9.6	5.47E+05	4.00E+05	9.47E+05	**0.95**
G54/G55/4*	joist + lagging (Po/Pb 210)	22	9.6	2.11E+05	4.00E+05	6.11E+05	**0.61**
G54/G55/5	floorboards + lagging (Po/Pb 210)	23	9.6	2.21E+05	4.00E+05	6.21E+05	**0.62**
G54/G55/FB6	floorboards	49	9.6	4.70E+05		4.70E+05	**0.47**
G54/G55/FB7	floorboards	46	9.6	4.42E+05		4.42E+05	**0.44**
G54/G55/FB8	floorboards	76	9.6	7.30E+05		7.30E+05	**0.73**
G54/G55/9	floorboards	55	9.6	5.28E+05		5.28E+05	**0.53**
G54/G55/10	floorboards	47	9.6	4.51E+05		4.51E+05	**0.45**
G54/G55/FB11	floorboards	63	9.6	6.05E+05		6.05E+05	**0.60**
G54/G55/12	floorboards	45	9.6	4.32E+05		4.32E+05	**0.43**
G54/G55/13	floorboards+ lagging (Pb/Po-210)	67	9.6	6.43E+05	4.00E+05	1.04E+06	**1.04**
G54/G55/14	floorboards+ lagging (Pb/Po-210)	28	9.6	2.69E+05	4.00E+05	6.69E+05	**0.67**
G54/G55/15	floorboards+ lagging (Pb/Po-210)	49	9.6	4.70E+05	4.00E+05	4.70E+05	**0.87**
		712					**9.24**

* this includes the Pb/Po-210 from room 2.52 & 2.53

2 *Room CB.05.*

Brickwork in this room was found to be contaminated with radium-226. The average activity concentration of radium- 226 in samples taken from locations of detected contamination was 43Bq/g. The contamination was removed by working on and removing uncontaminated brickwork which was disposed along with contaminated bricks. As a worst case for disposal purpose it is assumed that all the bricks disposed are contaminated at the average activity concentration.

3 *Room CB.10.*

The contamination in this room was found to be due to radium-226 and localised in one area of the concrete floor. The mass of the concrete floor removed is estimated at 4kg. The average activity concentration of radium- 226 is 4.9Bq/g, giving a total activity of approx. **20kBq**.

Drum ref.	Contents	mass (kg)	activity conc (Bq/g) Ra-226	Total activity Bq	**Total Activity MBq**
CB.05 no1	Bricks	36	43	1.55E+06	**1.55**
CB.05/CB.10 no 2	bricks	24	43	1.03E+06	**1.05**
	concrete CB.10	4	4.9	1.96E+04	

4 *Room CB.09.*

Areas of contamination were detected on the brickwork on the windowsill and on the wooden window frame. Analysis of samples taken gave an average activity concentration of radium-226 of 0.66Bq/g. Again the contamination was removed by working on and removing uncontaminated brickwork which was disposed along with contaminated bricks. As a worst case for disposal purpose it is assumed that all the bricks disposed are contaminated at the average activity concentration.

Drum ref.	contents	mass (kg)	activity conc. (Bq/g) Ra-226	Total activity Bq	**Total Activity MBq**
CB.09	bricks	84	0.66	5.54E+04	**0.06**

5 *Rooms 2.52 and 2.53.*

Two small lengths of floorboards were cut in clean areas and removed. Results of samples taken show the contamination is again due to radium-226 at an average concentration of 0.72Bq/g. These sections were put into drum ref. G54/G55/4 and since they occupy a small percentage of the mass, as a worse case estimate have been taken to be of activity conc. of those in room G54/G55. Once the floorboards had been removed, two areas of localised lead/polonium –210 were detected and removed. Again this activity is included in drum ref. G54/G55/4. The activity of each localised spot of contamination is taken to be 20kBq in total, as estimated by comparison with a reference prepared by NIRAS.

6 *Room C.1.10*

A number of samples were taken from the contaminated brickwork in room C.1.10. Analysis of these samples confirmed that the contamination present was due to lead/polonium-210. Samples from a single brick gave an activity concentration of 4000Bq/g. The average activity concentration of samples taken from other contaminated bricks is 24Bq/g. The contamination was removed by working on and removing uncontaminated brickwork which was disposed along with contaminated bricks. As a worst case for disposal purpose it is assumed that one brick of estimated mass of 3kg had an activity concentration of 4000Bq/g and the remaining mass of bricks in the drum are contaminated at the average activity concentration of 24Bq/g.

Drum ref	contents	mass (kg)	activity conc (Bq/g) Po-210	Total activity Bq	**Total Activity MBq**
C.1.10/brick 1	bricks	122	24	2.93E+06	**14.93**
	brick	3	4000	1.20E+07	

The floorboards removed by NNC at the beginning of this project were assessed and the total activity determined (see Activity assessment in Appendix 1). The floorboards were wrapped in plastic and each one labelled. NIRAS cut each of these into smaller sections, which were then drummed. In total 5 drums were filled from the contaminated floorboards from room C.1.10. The total activity of each labelled, wrapped floorboards package had previously been calculated. The activity in each drum is shown below.

Drum ref	contents	mass (kg)	Activity Bq	**Total Activity MBq**
C.1.10/FB1	P003	73	2.40E+05	**0.27**
	P0011		1.71E+04	
	P0013		1.60E+04	
C.1.10/FB2	P001	65	7.35E+04	**0.22**
	P007		7.40E+04	
	P009		7.49E+04	
C.1.10/FB3	P002	23	9.06E+04	**0.20**
	P006		8.11E+04	
	P0012		2.37E+04	
C.1.10/FB4	P004	21	7.95E+04	**0.15**
	P008		7.46E+04	
C.1.10/FB5	P005	43	9.90E+04	**0.14**
	P0010		3.92E+04	

In addition there are six drums containing contaminated boards and other debris. The total activity of each of these drums had been assessed by NNC at the beginning of this project and is summarised in the table below (The main contaminants are described in Appendix 1).

Drum ref	contents	mass (kg)	Activity Bq	**Total Activity MBq**
C.1.10 001	boards	82	1.61E+07	16.1
C.1.10 002	vacuum bag & other debris	91	5.88E+06	5.88
C.1.10 003	boards	89	2.48E+06	2.48
C.1.10 004	boards	86	2.48E+06	2.48
C.1.10 005	vacuum bag, vinyl & bag rubble	101	5.68E+06	5.68
C.1.10 006	boards & vacuum bag	53	7.01E+06	7.01

7 Rooms 2.62 & 2.63

The analysis of samples taken from contaminated floor boards shows that the contamination is due to radium –226 and is of activity concentration 1.27Bq/g.
Once the contaminated floorboards had been removed, discrete areas of lead/polonium-210 was once again discovered beneath on the lagging material. There were 20 localised spots of contamination, each spot having an activity 20kBq in total, as estimated by comparison with a reference prepared by NIRAS.

Drum ref.	contents	mass (kg)	activity conc. (Bq/g) Ra-226	Total activity Bq	Addition for Po/Pb-201	Total Bq	**Total Activity MBq**
2.62/2.63	Floorboards + lagging	64	1.27	8.13E+04	4.00E+05	4.81E+05	0.48

8 *Summary*

	Drum ref	contents	Gross mass (kg)	Net mass (kg)	**Total Activity MBq**
	G54/G55/1	floorboards (Ra 226)	54	36	0.35
	G54/G55/2	floorboards (Ra 226)	67	49	0.47
	G54/G55/3	floorboards + lagging (Po/Pb 210)	75	57	0.95
	G54/G55/4	joist + lagging (Po/Pb 210)	40	22	0.61
	G54/G55/5	floorboards + lagging (Po/Pb 210)	41	23	0.62
	G54/G55/FB6	floorboards (Ra-226)	66	49	0.47
	G54/G55/FB7	floorboards (Ra-226)	64	46	0.44
	G54/G55/FB8	floorboards (Ra-226)	93	76	0.73
	G54/G55/9	floorboards (Ra-226)	72	55	0.53
	G54/G55/10	floorboards (Ra-226)	65	47	0.45
	G54/G55/FB11	floorboards (Ra-226)	80	63	0.60
	G54/G55/12	floorboards (Ra-226)	63	45	0.43
	G54/G55/13	floorboards (Ra-226)+ lagging (Pb/Po- 210)	85	67	1.04
	G54/G55/14	floorboards (Ra-226)+ lagging (Pb/Po- 210)	45	28	0.67
	G54/G55/15	floorboards (Ra-226)+ lagging (Pb/Po- 210)	67	49	0.87
	C.1.10/FB1	floorboards (Ra-226)	91	73	0.27
	C.1.10/FB2	floorboards (Ra-226)	83	65	0.22
	C.1.10/FB3	floorboards (Ra-226)	41	23	0.2
	C.1.10/FB4	floorboards (Ra-226)	38	21	0.15
	C.1.10/FB5	floorboards (Ra-226)	60	43	0.14
	C.1.10/brick 1	bricks (Pb/Po- 210)	142	125	14.93
	C.1.10 001	floorboards (Ra-226)	82	64	16.1
	C.1.10 002	vacuum bag & other debris (Ra-226)	91	73	5.88
	C.1.10 003	boards (Ra-226)	89	71	2.48
	C.1.10 004	boards (Ra-226)	86	68	2.48
	C.1.10 005	vacuum bag, vinyl & bag rubble (Ra-226)	101	83	5.68
	C.1.10 006	boards & vacuum bag (Ra-226)	53	35	7.01
	CB.05 no1	bricks (Ra- 226)	54	36	1.55
	CB.05/CB.10 no 2	bricks (Ra- 226)	46	28	1.05
	CB.09	bricks (Ra-226)	101	84	0.06
	2.62/2.63	Floorboards + lagging (Pb/Po- 210)	82	64	0.48
Total	**31**		**2217**	**1668**	**67.91**

APPENDIX 1

NNC Limited Activity Assessment Mcrfp

ACTIVITY ASSESSMENT

Date of Assessment	16/06/00
AWO/DAWO	M Calloway

Package ID	Description	Dose Rate (uSv/h)	Weight (kg)	Height/Dia (cm)	Width (cm)	Length (cm)	Vol(m3)	SA(cm2)	Probe Response		Count Rate		Total Activity (Bq)
									Alpha	Beta	Alpha CPS	Beta CPS	
.10 P001	Contaminated Floor Boards	0.15	55	20.0	22.0	173.0	7.6.E-02	1.54E+04	6.5	5	5.00E+00	2.00E+01	7.35E+04
0 P002	Contaminated Floor Boards	0.15	50	16.0	22.0	206.0	7.3.E-02	1.64E+04	6.5	5	1.00E+01	2.00E+01	9.06E+04
C[illegible] P003	Contaminated Floor Boards	0.15	55	16.0	23.0	206.0	7.6.E-02	1.68E+04	6.5	5	1.50E+01	6.00E+01	2.40E+05
C1.[illegible] 004	Contaminated Floor Boards	0.15	55	16.0	22.0	210.0	7.4.E-02	1.67E+04	6.5	5	5.00E+00	2.00E+01	7.95E+04
C1.1[illegible] 005	Contaminated Floor Boards	0.15	80	30.0	18.0	205.0	1.1.E-01	2.08E+04	6.5	5	5.00E+00	2.00E+01	9.90E+04
C1.10 P006	Contaminated Floor Boards	0.15	60	30.0	17.0	170.0	8.7.E-02	1.70E+04	6.5	5	5.00E+00	2.00E+01	8.71E+04
C1.10 P007	Contaminated Floor Boards	0.15	50	22.0	16.0	195.0	6.9.E-02	1.55E+04	6.5	5	5.00E+00	2.00E+01	7.40E+04
C1.10 P008	Contaminated Floor Boards	0.15	50	29.0	13.0	190.0	7.2.E-02	1.67E+04	6.5	5	3.00E+00	2.00E+01	7.46E+04
C1.10 P009	Contaminated Floor Boards	0.15	40	17.0	12.0	280.0	5.7.E-02	1.66E+04	6.5	5	5.00E+00	2.00E+01	7.94E+04
C1.10 P010	Contaminated Floor Boards	0.15	20	22.0	20.0	60.0	2.6.E-02	5.92E+03	6.5	5	1.70E+01	2.00E+01	3.92E+04
C1.10 P011	Contaminated Floor Boards	0.15	10	20.0	10.0	53.0	1.1.E-02	3.58E+03	6.5	5	5.00E+00	2.00E+01	1.71E+04
C1.10 P012	Contaminated Floor Boards	0.15	15	31.0	10.0	53.0	1.6.E-02	4.97E+03	6.5	5	5.00E+00	2.00E+01	2.37E+04
C1.10 D001	200l drum with contaminated boards	0.15	85	-	-	-	2.2.E-01	1.00E+05	6.5	5	5.20E+01	7.65E+02	1.61E+07
C1.10 D002	200l drum vacuum bag and other debris	0.15	90	-	-	-	2.2.E-01	-	6.5	5	-	-	5.88E+06
C1.10 D003	200l drum with contaminated boards	0.15	90	-	-	-	2.2.E-01	1.00E+05	6.5	5	1.20E+01	1.15E+02	2.48E+06
C1.10 D004	200l drum with contaminated boards	0.15	90	-	-	-	2.2.E-01	1.00E+05	6.5	5	1.20E+01	1.15E+02	2.48E+06
C1.10 D005	200l drum vacuum bag, 1m2 vinyl, bag rubble	0.15	100	-	-	-	2.2.E-01	-	6.5	5	-	-	5.68E+06
C1.10 D006	200l drum with contaminated boards, vacuum bag	0.15	55	-	-	-	2.2.E-01	-	6.5	5	-	-	7.01E+06

No of Item
18

Average DR	Tot Wt (kg)
0.15	1050

Tot. Act (Bq)
4.06E+07

3.87E+07

Prepared by

03/07/00 Page 1 Signature...

TOTAL ACTIVITY (BQ)											
Alpha Activity (Bq)					Beta Gamma Activity (Bq)						
Ra226	Rn222	Po210	Po218	Po214	Ra228	Pb214	Ac228	Pb212	Bi214	Pb210	Bi210
5.42E+03	2.51E+03	2.51E+03	2.51E+03	2.51E+03	2.90E+01	2.44E+03	3.39E+01	2.41E+01	2.08E+03	5.09E+04	2.51E+03
6.68E+03	3.09E+03	3.09E+03	3.09E+03	3.09E+03	3.57E+01	3.01E+03	4.17E+01	2.97E+01	2.56E+03	6.28E+04	3.09E+03
1.77E+04	8.21E+03	8.21E+03	8.21E+03	8.21E+03	9.47E+01	7.98E+03	1.11E+02	7.87E+01	6.79E+03	1.67E+05	8.21E+03
5.86E+03	2.71E+03	2.71E+03	2.71E+03	2.71E+03	3.13E+01	2.64E+03	3.66E+01	2.60E+01	2.25E+03	5.51E+04	2.71E+03
7.30E+03	3.38E+03	3.38E+03	3.38E+03	3.38E+03	3.90E+01	3.29E+03	4.56E+01	3.24E+01	2.80E+03	6.86E+04	3.38E+03	
5.98E+03	2.77E+03	2.77E+03	2.77E+03	2.77E+03	3.19E+01	2.69E+03	3.73E+01	2.65E+01	2.29E+03	5.62E+04	2.77E+03
5.45E+03	2.53E+03	2.53E+03	2.53E+03	2.53E+03	2.92E+01	2.46E+03	3.41E+01	2.42E+01	2.09E+03	5.13E+04	2.53E+03
5.51E+03	2.55E+03	2.55E+03	2.55E+03	2.55E+03	2.94E+01	2.47E+03	3.43E+01	2.44E+01	2.11E+03	5.17E+04	2.55E+03
5.85E+03	2.71E+03	2.71E+03	2.71E+03	2.71E+03	3.13E+01	2.63E+03	3.66E+01	2.60E+01	2.24E+03	5.50E+04	2.71E+03
2.89E+03	1.34E+03	1.34E+03	1.34E+03	1.34E+03	1.54E+01	1.30E+03	1.80E+01	1.28E+01	1.11E+03	2.71E+04	1.34E+03
1.68E+03	5.83E+02	5.83E+02	5.83E+02	5.83E+02	6.73E+00	5.67E+02	7.86E+00	5.59E+00	4.82E+02	1.18E+04	5.83E+02
1.75E+03	8.09E+02	8.09E+02	8.09E+02	8.09E+02	9.33E+00	7.86E+02	1.09E+01	7.75E+00	6.69E+02	1.64E+04	8.09E+02
1.19E+06	5.50E+05	5.50E+05	5.50E+05	5.50E+05	6.34E+03	5.34E+05	7.42E+03	5.27E+03	4.55E+05	1.12E+07	5.50E+05
4.34E+05	2.01E+05	2.01E+05	2.01E+05	2.01E+05	2.32E+03	1.95E+05	2.71E+03	1.92E+03	1.66E+05	4.07E+06	2.01E+05
1.83E+05	8.49E+04	8.49E+04	8.49E+04	8.49E+04	9.79E+02	8.25E+04	1.14E+03	8.13E+02	7.02E+04	1.72E+06	8.49E+04
1.83E+05	8.49E+04	8.49E+04	8.49E+04	8.49E+04	9.79E+02	8.25E+04	1.14E+03	8.13E+02	7.02E+04	1.72E+06	8.49E+04
4.19E+05	1.94E+05	1.94E+05	1.94E+05	1.94E+05	2.24E+03	1.89E+05	2.62E+03	1.86E+03	1.60E+05	3.94E+06	1.94E+05
5.17E+05	2.39E+05	2.39E+05	2.39E+05	2.39E+05	2.76E+03	2.33E+05	3.23E+03	2.29E+03	1.98E+05	4.86E+06	2.39E+05

TOTAL ACTIVITY (Bq)	
Alpha	Beta/Gamma
1.546E+04	5.804E+04
1.906E+04	7.155E+04
5.057E+04	1.899E+05
1.672E+04	6.276E+04
2.083E+04	7.818E+04
1.705E+04	6.402E+04
1.557E+04	5.846E+04
1.569E+04	5.888E+04
1.670E+04	6.270E+04
8.238E+03	3.093E+04
3.591E+03	1.348E+04
4.982E+03	1.870E+04
3.387E+06	1.271E+07
1.237E+06	4.643E+06
5.226E+05	1.962E+06
5.226E+05	1.962E+06
1.195E+06	4.485E+06
1.475E+06	5.535E+06

TOTAL 'DRIGG' ACTIVITY (Bq) T1/2 > 3months	
Alpha	Beta/Gamma
5.420E+03	5.096E+04
6.681E+03	6.282E+04
1.773E+04	1.667E+05
5.860E+03	5.510E+04
7.301E+03	6.864E+04
5.978E+03	5.621E+04
5.459E+03	5.133E+04
5.490E+03	5.170E+04
5.854E+03	5.504E+04
2.888E+03	2.715E+04
1.259E+03	1.184E+04
1.746E+03	1.642E+04
1.187E+06	1.116E+07
4.336E+05	4.076E+06
1.832E+05	1.723E+06
1.832E+05	1.723E+06
4.188E+05	3.938E+06
5.169E+05	4.860E+06

TOTAL ACTIVITY (BQ)											
Alpha Activity (Bq)					Beta Gamma Activity (Bq)						
Ra226	Rn222	Po210	Po218	Po214	Ra228	Pb214	Ac228	Pb212	Bi214	Pb210	Bi210
2.99E+06	1.39E+06	1.39E+06	1.39E+06	1.39E+06	1.60E+04	1.35E+06	1.87E+04	1.33E+04	1.15E+06	2.81E+07	1.39E+06

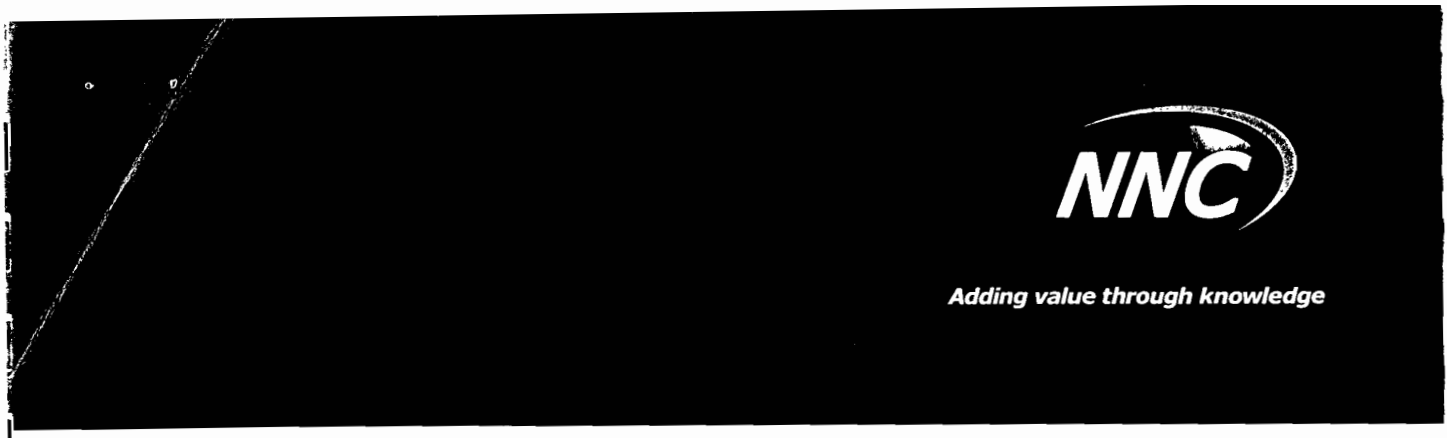
TOTAL ACTIVITY (Bq)	
Alpha	Beta/Gamma
8.543E+06	3.207E+07

TOTAL ACTIVITY (Bq)	
Alpha	Beta/Gamma
2.995E+06	2.815E+07

Prepared by

03/07/00

Signature..... ....



Final Report for the Decommissioning of Rooms 2.62 & 2.63 Coupland 1 Building, Manchester University

by

S M Adams

Client: Manchester University

NIRAS
NNC Limited, Birchwood Park, Birchwood
Warrington, Cheshire WA3 6BZ
Tel: 01925-895588 Fax: 01925-895551

C5952/0013
MTC/01/024
Issue: 01
April 2001

DOCUMENT ISSUE RECORD

Adding value through knowledge

Document Title	Final report for the Decommissioning of rooms 2.62 & 2.63, Coupland 1 Building, Manchester University.
Project:	C5952/0013

Purpose of Issue : Final Issue

Security Class : Commercial-in-Confidence

Issue	Description of Amendment	Originator/ Author	Approver	Date
1	Final Issue	S M Adams	B Frith	05/04/01

Previous issues of this document shall be destroyed or marked **SUPERSEDED**

Distribution: Client, File

CONTENTS

1 EXECUTIVE SUMMARY

This final report describes the radiological conditions, which remain in remediated rooms 2.62 and 2.63 (Category 3 areas) in the Coupland 1 Building. The report recognises the possibility that undetected, and undetectable contamination may remain, which is of little radiological hazard significance in its present condition, but may result in serious hazards if disturbed by intrusive work undertaken on the building fabric. It is recommended that the University or other occupier of the building makes and keeps records that ensure that any proposal for intrusive work in the future triggers a prior radiological risk assessment in accordance with Regulation 7(1) of the Ionising Radiations Regulations 1999.

2 INTRODUCTION

NIRAS were appointed RPA to Manchester University during refurbishment work in Coupland 1 Building. This work involved the removal of contamination resulting from past work with radioactive materials, the most significant of which was work in the early 1900s by Ernest Rutherford. An initial survey of the building, described in report ref. MTC/2000/051 detected a number of contaminated areas.

During remediation of category 1 and category 2 areas where contamination had been detected, the lifting of floorboards quickly revealed significant lead-210/polonium-210 contamination in the form of very localised "hot spots" present in the space beneath the floorboards of the rooms and the ceiling of the rooms below. The nature of the emissions from these radionuclides, makes their presence on floor surfaces readily detectable, but the mass absorption of the floor and ceiling materials makes contamination between floor and ceiling undetectable from above the floor or below the ceiling. The methods used in the initial survey had not anticipated that contamination could have entered the space below floorboards without leaving detectable contamination on the floor surface. Remediation has been completed so as to remove, as far as reasonable practicable, contaminated floorboards. In addition, where lead-210/polonium-210 contamination has been detected between floor and ceiling as a result of floorboard removal, that contamination has also be removed.

It must be accepted that there is a possibility that undetected lead-210/polonium-210 contamination might be present beneath floorboards in rooms 2.62 and 2.63 and in other areas of Coupland 1 Building.
Any radiological impact on the working environment due to any remaining undetected contamination may need to be assessed by appropriate monitoring.

Following remediation of these category 3 areas *where contamination was found*, the radon concentration, the non-radon alpha activity in air concentration, and gamma dose rate have been measured in order to assess likely future exposure to occupants. This report describes methods used and from the results, makes estimates of the doses that may be received by future occupants. These estimates include contributions from any undetected undisturbed lead-210/polonium-210 that may remain.

3 METHOD

3.1 Clearance criteria

All detected contamination in the affected rooms was removed by physical means and the resulting contaminated debris drummed for disposal. The remediated areas were monitored using a 2" end window GM counter to ensure that remaining contamination was less than 0.4Bq/cm^2 of lead-210+polonium-210 averaged over 300cm^2.

The following measurements were then made.

3.2 Radon concentrations

Radon measurements were taken using a Pylon Model AB-5 Portable radiation monitor and calibrated LUCAS LCA-2 scintillation cells. Background readings were taken for each cell before "grab samples" were collected. Radon measurements were taken in rooms 2.62 and 2.63.

Samples were allowed to reach equilibrium before counting, and the radon concentration calculated using the equation provided with the calibration certificate as follows

$$\text{Radon conc. (Bq/m}^3\text{)} = \frac{\text{sample counts/hr- background counts/hr}}{\text{AB5 efficiency x Delay correction factor x Cell efficiency}}$$

Values for AB5 efficiency, Delay correction factor and cell efficiency were all provided from the NRPB calibration data for this unit.

Note: at the time of writing of this Report the author is not content with the calibration procedures used, and the matter is the subject of exchanges with NRPB Chiltern

3.3 Non- radon alpha activities in air

Airborne particulates were collected over a period, of typically three hours, using portable air samplers of the type, L60 or L150. Samples were collected on Glass Fibre filters, which were kept in Petri dishes for 3 days before counting to permit the decay of any radon daughters. The alpha activity on the filters was then assessed in the laboratory and the non-radon alpha activity concentration calculated.

3.4 Gamma dose rates

Gamma dose rates were measured in the centre of each room, at 1m height above the floor. The instrument used to take these measurements was of the type Mini Instruments Series 6-80. The calibration factor used is that applicable to outdoor environmental measurements with no attempt to correct for differing geometry or directional effects. The "excess" dose rate is calculated by subtracting a mean value for domestic dwellings. The conversion of Gy to Sv assumes a factor of 1 as it is not possible to assign a source detector geometry.

4 RESULTS

4.1 Radon concentrations.

Room	Radon Concentration (Bq/m^3)
2.62	63 ± 40
2.63	<149

Note; the limit of detection is a function of the Lucas cell used for the measurement.

4.2 Non- radon alpha activity in air concentrations

Room	NIRAS Lab Job No	Non-radon alpha in air concentrations (Bq/m^3)
2.62	L2001025-18	<0.0029
2.63	L2001025-19	0.0025 ± 0.0022

4.3 Gamma dose rates

Room	Gamma Dose Rate (μGy /hr)
2.62	0.166± 0.008
2.63	0.173± 0.008

Note: Errors are counting errors at 95% confidence level.

5 DOSE CALCULATIONS

In calculating the dose from each route of exposure the sum of the measured value plus the error has been used to generate a worse case result.

5.1 Dose from radon.

The dose due to exposure to radon-222 and daughters is calculated on the basis of the rough assumption that occupational exposure to 400Bq/m^3 for 2000hrs results in 2mSv/yr, and the natural background for radon is the mean of that found in domestic dwellings

Room	Radon Concentration (corrected for mean domestic value (21Bq/m^3*))	Annual dose due to Radon (corrected for mean domestic dwelling radon concentrations) (mSv)
2.62	<82	<0.41
2.63	<128	<0.64

* NRPB-R190 Natural Radiation Exposure in U.K. Dwellings

5.2 Dose from non-radon alpha activity in air

The dose due to the inhalation of non-radon alpha activity in air is calculated on the basis that lead-210 and polonium 210 are the main contributors. The worse case dose coefficients for these are 8.9×10^{-7}Sv/Bq and 3×10^{-6}Sv/Bq respectively (taken from ICRP Publication 68). Annual doses are calculated using a 2000hours /year occupancy (occupational exposure) and a breathing rate of 1.2m^3/hr (taken from ICRP 23).

Room	Non-radon alpha in air concentrations (Bq/m^3)	Committed Dose equivalent (mSv)
2.62	<0.0029	<0.03
2.63	<0.0047	<0.04

5.3 Dose from external radiation

The dose rates measured are corrected for the domestic mean rate and the annual excess dose calculated on the basis of 2000 hrs. exposure i.e. occupational exposure.

Room	Excess Gamma dose rate (corrected for domestic mean value of 0.06μGy/hr)	Annual excess dose from external radiation (mSv).
2.62	<0.114	<0.228
2.63	<0.121	<0.242

6 CONCLUSIONS AND RECOMMENDATIONS

The total dose above background received by a worker occupying the above rooms in the Coupland 1 Building for 2000 hours per year, from external and internal radiation is, in the worst case estimated to be less than 0.92mSv/year. This is well within dose limits for workers (20mSv/y) and within the target dose for workers not normally exposed to radiation as part of their work (1mSv/y).

Similar calculations as above can be carried out for a member of the public visiting Coupland 1 building, the museum. Assuming that a visitor may spend up to one hour in these rooms, the dose received would be about 5μSv/y. The annual dose limit for members of the public is 1mSv/y, with a constraint of 300μSv/y. The dose received from visiting this building is likely to be well within these values.

Although doses due to occupancy are satisfactorily low, it is important to recognise that the methods used for detecting radioactive contamination are not sensitive to some contaminants when not present on accessible surfaces. There may remain, therefore, undetected contamination, which is of negligible radiological significance whilst unexposed and undisturbed, but which could become a significant radiological hazard should work be undertaken on the fabric of the building.

It is important, therefore, that the University makes and keeps records that ensure that any proposal for work in the future triggers a prior radiological risk assessment.

Quality Plan for the Disposal of LLW to BNFL

Reference : UOM/COUPLAND1

Issue : 01

WASTESTREAM CHARACTERISATION FOR LLW DISPOSAL TO BNFL

Consignor: THE UNIVERSITY OF MANCHESTER

BNFL Consignor Code: 07UOM

Waste Origin Location: COUPLAND 1, MANCHESTER UNIVERSITY

Wastestream No.: WS074

Wastestream Name:

Document Reference: UOM/COUPLAND1

Issue: 01 *Issue Date:* 04/09/01 *Valid until:* 04/09/03

Controlled Copy No.: _____

Author: S. M. Adams

Approved By: S. Fritz

Endorsed By: _____

BNFL Approval: _____ LLWMS Technical Manager

Distribution

Commercial Manager, LLWMS, British Nuclear Fuels plc., B90, Sellafield, Cumbria, CA20 1PG

Quality Plan for the Disposal of LLW to BNFL

Description of Originating Process

The radioactivity which caused the waste contamination arose from ...

past work with naturally occurring radioactive materials, the most significant of which was research work in the early 1900s by Ernest Rutherford.

The aim of the University Project was to determine the extent of any contamination and to remove it in order that the refurbishment of the Coupland 1 building could continue. Initial work in room C.1.10 was carried out by NNC Harwell. All the floorboards were taken up, monitored and wrapped in polythene. Other waste generated was drummed in 200 litre drums. The waste generated by the operation of NNC Harwell has been assessed and their report is included in the report ref. MTC/01/026.

NIRAS were then appointed RPA to Manchester Museum and University and asked to carry out a full survey of Coupland 1 building, the annexe and the Old Dental Hospital. A number of areas of localised contamination were detected, and the methods used and contaminated areas are reported in report ref. MTC/2000/051.

Samples were taken from each of the contaminated areas in the highest location. Three of these samples were analysed by gamma spectroscopy, the results of which are included in report ref. L2000103.

Then remediation work was carried out in each area under Local Rules. All remediation work was undertaken in such a way as to avoid disruption of the contaminated area. That is to say areas were removed by cutting operations in surrounding uncontaminated areas. Thus minimising the re-suspension and spread of contamination.

All waste removed was packed as closely and tightly as practicable into 200litre drums.

Estimated Wastestream Arisings - "Best Estimate" data

Expected timescale for waste consignments:
One-off in 6 months

Wastestream lifetime estimates:

Volume: 31 x 200litre drums ($6m^3$) *Mass:* 2217kg

Quality Plan for the Disposal of LLW to BNFL

	TOTAL ACTIVITY (MBq)	SPECIFIC ACTIVITY (MBq/t)
Uranium	0	0
Ra-226 & Th-232	50	23
Other Alpha * Po-210	9	4
Total Alpha	59	27
Carbon-14	0	0
Iodine-129	0	0
Tritium	0	0
Cobalt-60	0	0
Others ** Pb-210	9	4
Total Non-Alpha	9	4

Justification for zero uranium- not identified by gamma spectroscopy and zero non- alpha work predates manmade isotopes.

* defined as alpha emitting radionuclides with half-lives greater than three months excluding uranium, radium-226 and thorium-232

** defined as the sum of:

i) beta-emitting radionuclides with half-lives greater than three months excluding carbon-14, iodine-129, cobalt-60 and tritium; and

ii) iron-55

Physical and Chemical Composition

Percentage composition by weight of:

Metal	25%
Soil/Rubble	20%
Soft Organic (e.g. paper, cloth)	1%
Plastics/Rubber	0.01%
Wood	53.99%
Other materials	0%

The principal "other materials" are ....

The moisture content of the waste is ....
<1%

Quality Plan for the Disposal of LLW to BNFL

Reference : UOM/COUPLAND1

Issue : 01

Excluded Materials Content

	PRESENT	NOT PRESENT
Free Liquid		x
Oil or grease		x
Fire or explosion hazard materials		x
Pressurised gas cylinders or aerosol cans		x
Ion Exchange materials		x
Complexing agents		x
Putrescible wastes		x
Hazardous, biological, pathogenic or infectious materials		x
Special Wastes		x
Strong oxidising, acid or alkaline compounds		x
Materials which will react significantly with water or cement grout		x

If the waste to be consigned contains any of the "excluded materials", state how these have been made safe for disposal and quote the Form number (if required) giving BNFL approval:

Waste Processing and Packaging

Describe any conditioning of the waste (e.g. in-drum compaction, incineration, grouting) which will be carried out prior to it's consignment to BNFL:

All waste generated during the remediation work was packed into drums as tightly as practicable. Non-compatible waste was mixed with compatible waste. A D5 is submitted regarding uncompactible waste in drums.

LLW (including any secondary waste arisings) will be consigned to BNFL in the following containers :

For Compactable Waste to WAMAC

	YES/NO
200 litre drums in an IP2 rated full height ISO container	NO
IP2 rated 200 litre drums (loose) – subject to BNFL agreement	NO
200 litre drums in IP2 rated drum overpacks - subject to BNFL agreement	NO
Other Containers (subject to BNFL agreement):	NO

Quality Plan for the Disposal of LLW to BNFL

For Uncompactable Waste

	YES/NO
Approved half-height ISO Disposal Container	NO
Approved third-height ISO Disposal Container	NO
Uncontainerised items - subject to BNFL agreement	NO
Other Containers (subject to BNFL agreement): A D5 has been submitted	YES

Activity Assessment and Radionuclide Fingerprint

The activity content of the waste is assessed by measuring ....

The activity was assessed as follows:

1) for Ra-226
Samples were taken from each location. Uniformity of the nature of the contamination was confirmed by qualitative gamma spectroscopy and counted using a gross gamma system. The ratio of the activity concentration to gross gamma was used to estimate the activity of other samples.
2) for Pb/Po-210
The activity in very localised areas of Pb/Po-210 contamination was assessed by direct comparison with a "mock" contamination spot prepared from a known activity Pb/Po-210 solution. The activity of the solution was measured by alpha counting with a natural uranium source used as a reference.

These measurements are used to derive the activity content by using a conversion factor of ...

See above.

The radionuclide fingerprint of the waste was derived from ...

The analysis of a selected number of samples taken from contaminated areas by gamma spectrometry.

The fingerprint is consistent with that expected from the source of the radioactive contamination, and additional radionuclides not measured, because

High resolution gamma spectrometry was undertaken using high purity germanium (HPGe) detectors, coupled to a computerised multi-channel analyser (MCA), with peak search and peak shape functions and validated isotope library. The radionuclides identified are naturally occurring radioactive materials consistent with the work carried out by Rutherford.

The radionuclide fingerprint and the radioactivity declaration for a consignment (or a typical expected example) is attached.

Quality Plan for the Disposal of LLW to BNFL

Summary of the radionuclide fingerprint:

Ra-226 – 74%
Po-210 – 13%
Pb-210 – 13%
The radionuclide content and activity concentration of samples is included in report ref. L2000103.

The principal limitations and errors in the waste activity assessment are …

The assessment of the activity in each localised spot of Pb/Po-210 in the lagging, since removing a sample for analysis would remove the majority of the activity.
Samples were in the main taken from the hottest spot and will result in an over estimation.

Compliance with BNFL Disposal Radioactivity Limits

The waste consignments will be controlled to comply with LLW specific activity limits, fissile content limits and Wastestream limits by the following method:
Gamma spectroscopy of samples taken confirms the presence of Ra-226, Po-210 and Pb-210 radionuclides only. There are no fissile contents in the consignment. The total activity (MBq) and specific activity MBq/t for the consignment are detailed above and are within the activity limits described in CFA section A17.

Quality Plan for the Disposal of LLW to BNFL

Drum inventory

Drum unique identifier	contents	Gross mass (kg)	Net mass (kg)	Total Activity MBq	%compactible	%non-compactible
000001/07UOM	floorboards	54	36	0.35	0	100
000002/07UOM	floorboards	67	49	0.47	0	100
000003/07UOM	floorboards + lagging	75	57	0.95	10	90
000004/07UOM	joist + lagging	40	22	0.61	20	80
000005/07UOM	floorboards + lagging	41	23	0.62	10	90
000006/07UOM	floorboards	66	49	0.47	0	100
000007/07UOM	floorboards	64	46	0.44	0	100
000008/07UOM	floorboards	93	76	0.73	0	100
000009/07UOM	floorboards	72	55	0.53	0	100
000010/07UOM	floorboards	65	47	0.45	0	100
000011/07UOM	floorboards	80	63	0.60	0	100
000012/07UOM	floorboards	63	45	0.43	0	100
000013/07UOM	floorboards + lagging	85	67	1.04	10	90
000014/07UOM	floorboards + lagging	45	28	0.67	10	90
000015/07UOM	floorboards + lagging	67	49	0.87	10	90
000016/07UOM	floorboards	91	73	0.27	0	100
000017/07UOM	floorboards	83	65	0.22	0	100
000018/07UOM	floorboards	41	23	0.2	0	100
000019/07UOM	floorboards	38	21	0.15	0	100
000020/07UOM	floorboards	60	43	0.14	0	100
000021/07UOM	bricks	142	125	14.93	0	100
000022/07UOM	floorboards	82	64	16.1	0	100
000023/07UOM	vacuum bag & other debris	91	73	5.88	10	90
000024/07UOM	floorboards	89	71	2.48	0	100
000025/07UOM	floorbaords	86	68	2.48	0	100
000026/07UOM	vacuum bag, vinyl & bags of rubble	101	83	5.68	10	90
000027/07UOM	Floorboards, vacuum bag & other debris	53	35	7.01	10	90
000028/07UOM	bricks	54	36	1.55	0	100
000029/07UOM	bricks	46	28	1.05	0	100
000030/07UOM	bricks	101	84	0.06	0	100
000031/07UOM	floorboards + lagging	82	64	0.48	0	100
		2217	1668	68		

Coupland One Building
Temporary Refurbishment Project

20th May 2002

The Radiological Protection Service was requested to monitor several rooms within the Coupland One Building pending the temporary refurbishment of these areas.

Monitoring Procedure

Walls were monitored to a height of approximately 1.5 metres above the floor using a Berthold LB1210B instrument and the floors were monitored using a Berthold LB122 instrument mounted on a floor trolley. Monitoring was only carried out where the walls and floor were accessible. Dose rates were taken using a Mini-Instruments Mini-Rad 1000. False partition walls were not monitored, since these are not original to the building.

Ground Floor Rooms

B-1 area

This consists of two inner rooms and an ante-room leading to the corridor, each room has a vinyl floor covering in place.

Monitoring did not reveal any levels of contamination in the areas monitored, however it is possible that low-energy contamination may exist beneath the floor covering which would not be detected by this survey.

B-7 area

Monitoring did not reveal any levels of contamination in the areas monitored, however it is possible that low-energy contamination may exist beneath the floor covering which would not be detected by this survey.

Rutherford Room G53

The floor of this room is covered by green coloured carpet, monitoring of the walls and floor was carried out.

Monitoring did not reveal any levels of contamination in the areas monitored, however it is possible that low-energy contamination may exist beneath the floor covering which would not be detected by this survey.

Postgraduate Room G54

This room consist of the initial walk-in area and a room to the left-hand-side (the right-hand-side room is the Rutherford Laboratory – see below). Both rooms have brown coloured carpeting.

Monitoring did not reveal any levels of contamination in the areas monitored, however it is possible that low-energy contamination may exist beneath the floor covering which would not be detected by this survey.

Rutherford Laboratory G55

This room has a bare-plywood floor and has not monitored on this survey, since extensive remedial work has already been carried out by NNC (NIRAS) Limited.

Store Room G56

This room has a grey vinyl floor covering. Access was not possible to all of the floor or wall areas due to the equipment still being stored.

Monitoring did not reveal any levels of contamination in the areas monitored, however it is possible that low-energy contamination may exist beneath the floor covering which would not be detected by this survey.

Second Floor Rooms

Cohen Lecture Theatre

This room has been monitored on previous surveys; no contamination has been detected at these times. No additional monitoring was considered necessary, since the RPS were informed that no restructuring would be taking place.

Room 2-52 and Inner Room

There was no contamination detected within 2-52, however an area of contamination was detected in the inner room, on the floor, the area was marked with chalk and a warning sign attached to the door. A dose rate reading taken from the area indicated a dose rate of 0.5 $\mu Sv.h^{-1}$ (microsieverts per hour). Air monitoring was carried out using a Pylon instrument. Results from the air monitoring indicate an increased radiation dose of 0.1 $Sv.h^{-1}$, giving a maximum dose rate of 0.6 $Sv.h^{-1}$.

The radon level is 31.24 $Bq.m^{-3}$; this is greatly below the level where it would be required to take remedial action.

Room 2-54

An area of contamination was detected on the floor, the area was marked with chalk and a warning sign attached to the door. A dose rate reading taken from the area indicated a dose rate of 0.5 $\mu Sv.h^{-1}$ (microsieverts per hour). Air monitoring was carried out using a Pylon instrument. Results from the air monitoring indicate an increased radiation dose of 0.07 $Sv.h^{-1}$, giving a maximum dose rate of 0.57 $Sv.h^{-1}$.

The radon level is 20.46 $Bq.m^{-3}$; this is greatly below the level where it would be required to take remedial action

Rooms 2-55 and 2-56

Monitoring did not reveal any levels of contamination in the areas monitored, however it is possible that low-energy contamination may exist beneath the floor covering which would not be detected by this survey.

Link Corridor 2-52 to 2-56

The link-corridor between the above rooms has a green coloured carpet covering, the floors and original walls were monitored no contamination was detected.

Rooms 2-57, 2-58, 2-59, 2-60, 2-61

Monitoring did not reveal any levels of contamination in the areas monitored, however it is possible that low-energy contamination may exist beneath the floor covering which would not be detected by this survey.

Link Corridor 2-57 to 2-61

The link-corridor between the above rooms has a carpet covering, the floors and original walls were monitored no contamination was detected.

Lift-Shaft Cupboard

It is intended to place a file-server in this area. Monitoring of the floors and walls did not reveal any levels of contamination. There is a covering over the original floor-boards under which low energy contamination could exist. Please see the general conclusions of this report.

Room 2-62

This room has had remedial work carried out by NNC (NIRAS) Limited. A small area of low-energy contamination was detected near the through-door with room 2-63. This was marked with a warning sign and a warning label fixed to the door. The area of contamination would be easy to remove by use of a jig-saw. Please contact the RPS for further advice.

Room 2-63

This room has had remedial work carried out by NNC (NIRAS) Limited. No contamination was detected on the walls or floors.

Second Floor Toilet and Sink Area

The floor is the original floor; however parts of the original walls have been plastered over. Monitoring did not reveal any levels of contamination.

Conclusions

Room 2-52 inner room

Given that the dose rates detected would give rise to an annual exposure of just over that for members of the public (annual allowance =1000 μSv) occupancy would be limited to 1666 hours per annum. However this is a very simplified calculation, since it would mean that a person would have to remain stationary on the radioactive area for their full occupancy of the room, which is highly unlikely.

Room 2-54

Given that the dose rates detected would give rise to an annual exposure of just over that for members of the public (annual allowance =1000 μSv) occupancy would be limited to 1754 hours per annum. However this is a very simplified calculation, since it would mean that a person would have to remain stationary on the radioactive area for their full occupancy of the room, which is highly unlikely.

Should it be required that the vinyl and carpet coverings be removed at a future date then care must be taken to ensure the safety of workers and further monitoring must be carried out of the underlying surfaces.

Since this is a temporary project, it would be feasible to cover the areas where contamination has been found with plywood and then re-carpet over the plywood, leaving the existing carpets in place. This would not give rise to any significant radiation hazard to occupants. However the Estates Department should bear in mind that this is not a final solution to the contamination within these rooms.

KS Robinson

Kevin J. Robinson

Cc Mr. J. Duffy Estates Department

APPENDIX 1 to minutes of the meeting with RLBS on 21.3.02)

Coupland One Building

Radon Results					
Position	Date	Rn Bq/m3	EEC Rn Bq/m3	Dose µSv/h	NOTES
Coupland 1 Bld Room 2-52 inner room	16 May 2002	21.32973	8.531894	0.071099	Doors and windows closed
Coupland 1 Bld Room 2-52 inner room	16 May 2002	29.086	11.6344	0.096953	Doors and windows closed
Coupland 1 Bld Room 2-52 inner room	16 May 2002	31.24052	12.49621	0.104135	Doors and windows closed
Coupland 1 Bld Room 2-52 inner room	16 May 2002	16.15889	6.463556	0.053863	Doors and windows closed
Coupland 1 Bld Room 2-52 inner room	16 May 2002	22.62245	9.048978	0.075408	Doors and windows closed
Coupland 1 Bld Room 2-54	17 May 2002	15.29708	6.118833	0.05099	Doors and windows closed
Coupland 1 Bld Room 2-54	17 May 2002	18.31341	7.325363	0.061045	Doors and windows closed
Coupland 1 Bld Room 2-54	17 May 2002	20.46793	8.187171	0.068226	Doors and windows closed
Coupland 1 Bld Room 2-54	17 May 2002	18.31341	7.325363	0.061045	Doors and windows closed
Coupland 1 Bld Room 2-54	17 May 2002	14.43527	5.77411	0.048118	Doors and windows closed
Coupland 1 Bld Room 2-62	07 August 2002	19.17522	7.670086	0.063917	Joining door open, windows closed
Coupland 1 Bld Room 2-62	07 August 2002	13.14256	5.257025	0.043809	Joining door open, windows closed
Coupland 1 Bld Room 2-62	07 August 2002	15.29708	6.118833	0.05099	Joining door open, windows closed
Coupland 1 Bld Room 2-62	07 August 2002	19.17522	7.670086	0.063917	Joining door open, windows closed
Coupland 1 Bld Room 2-62	07 August 2002	20.46793	8.187171	0.068226	Joining door open, windows closed
Coupland 1 Bld Room 2-62	07 August 2002	17.4516	6.98064	0.058172	Joining door open, windows closed
Coupland 1 Bld Room 2-62	07 August 2002	10.55714	4.222857	0.03519	Joining door open, windows closed
Coupland 1 Bld Room 2-63	08 August 2002	7.540815	3.016326	0.025136	Joining door closed, windows closed
Coupland 1 Bld Room 2-63	08 August 2002	7.109911	2.843965	0.0237	Joining door closed, windows closed
Coupland 1 Bld Room 2-63	08 August 2002	14.43527	5.77411	0.048118	Joining door closed, windows closed
Coupland 1 Bld Room 2-63	08 August 2002	7.540815	3.016326	0.025136	Joining door closed, windows closed
Coupland 1 Bld Room 2-63	08 August 2002	14.43527	5.77411	0.048118	Joining door closed, windows closed
Coupland 1 Bld Room 2-63	08 August 2002	22.19154	8.876617	0.073972	Joining door closed, windows closed

Monitoring Carried Out Using Pylon Passive Detector Method

NOTES

Rooms 2-52 & 2-54 Have had no remedial work carried out

Rooms 2-62 & 2-63 Remedial work carried out by NNC (NIRAS)

INVESTOR IN PEOPLE

www.nrpb.org

National Radiological Protection Board

National Radiological Protection Board, Chilton, Didcot, Oxon OX11 0RQ
Telephone: (01235) 831600 Fax: (01235) 833891

Report of Radon Measurements

For:	Mr K Robinson The University of Manchester Rad Prot Service, 7th Floor Williamson Building, Oxford Rd Manchester M13 9PL
Subject:	Measurement of radon-222 concentrations
Date of report:	9 January 2003

The concentrations of radon-222 at the locations given on the attached sheet were measured with NRPB radon gas passive monitors. The cumulative exposures recorded by the monitors were converted to concentrations averaged over the exposure time. Background corrections and calibration factors were obtained from control monitors kept at NRPB.

The table shows the average radon gas concentration at each location in units of becquerels per cubic metre of air (Bq m^{-3}). The random uncertainties in the measurement are estimated to be 15%.

Tracy D Gooding

Report of Radon Measurements

Customer The University of Manchester

Measurement site The University of Manchester - RPS
7th Floor, Williamson Building
Oxford Road

Detno	Position	Date placed	Date removed	Radon gas concentration Bq m^{-3}
01412480	Cohen Lecture Theatre - Undercroft Window Side	14/08/02	04/11/02	10
01412414	Coupland 1 Building - Room 2-52 Inner Room - 2m	14/08/02	04/11/02	10
01412433	Coupland 1 Building - Room 2-52 Inner Room - Centre of Room 1m	14/08/02	04/11/02	10
01412408	Coupland 1 Building - Room 2-54 2m	14/08/02	04/11/02	20
01412411	Coupland 1 Building - Room 2-54 Centre of Room 1m	14/08/02	04/11/02	30
01412415	Coupland 1 Building - Room 2-62 Centre of Room 1m	14/08/02	04/11/02	60
01412488	Coupland 1 Building - Room 2-62 centre of Room 2m	14/08/02	04/11/02	60
01412418	Coupland 1 Building - Room 2-63 Centre of Room 1m	14/08/02	04/11/02	30
01412470	Coupland 1 Building - Room 2-63 Centre of Room 2m	14/08/02	04/11/02	30

APPENDIX D: CHRONOLOGY OF EVENTS, 1900-1999

1900	Opening of the building, as the New Physical Laboratories (later known as Schuster Building)	*Nature*, July 12, 1900, pp.250-251
1907	Rutherford arrives in Manchester	
1908	Rutherford and Royds demonstrate that alpha particles are helium atoms, in rooms 2.62/2.63	E. Rutherford and T. Royds[1], *Phil. Mag*. 17, 281-6 (1909).
1908	Rutherford receives 450mg radium bromide from Vienna Academy	Appendix A2
1911	Hevesy tries to separate Pb-210 from several hundred kilograms of radioactive lead stored in the basement.	Reminiscences by Neils Bohr, and by H.R. Robinson, in J.B. Birks [Ed.] *Rutherford at Manchester*; and de Hevesy's 1944 Nobel lecture).
1912	Opening of extension to the building for Electrical Engineering	*Nature*, 14 March, 1912, p.40
1919	Rutherford leaves Manchester	
…		
1963	Radiological Protection Service established by Mr JC Collins	Health & Safety Bulletin, May 1976 (University of Manchester Archives)
1967	Professor JC Willmott appointed Deputy Chair, Joint Committee on Radiological Protection Policy	Minutes of Council (40) 255 (University of Manchester Archives)
1968	Schuster Building renamed Coupland 1 Building	Minutes of Council (41) 182 (University of Manchester Archives)
1969	Establishment of Health & Safety Committee, with Radiological Protection Sub-Committee	Minutes of Council (42) 162-165 (University of Manchester Archives)
1972	Department of Psychology starts to move into the building	Minutes of Council (43) 173 (University of Manchester Archives)
1976	Dr D Prime appointed Assistant Radiological Protection Officer	Health & Safety Bulletin, September 1976 (University of Manchester Archives)
1978	Mr KJ Robinson joins Radiological Protection Service.	Appendix A1

1984	Working Party on the Radiological Protection Service reports to Council. Mr JC Collins takes early retirement as Radiological Protection Officer, succeeded by Dr D Prime.	Minutes of the Radiological Protection Service Committee, 25/10/1985 (University of Manchester Archives)
mid-1990s	Construction of campus Ethernet, involving drilling by technical staff of walls and ceilings throughout the building.	Remembered by two of the authors (JC & DJO'B)
1998-1999	Dr SP Bidey appointed to Radiological Protection Service. Dr D Prime retires, succeeded by Dr Bidey as Radiation Protection Adviser	Appendix B1
1999	Radiological Protection Service moves to Williamson building. Documents destroyed to save space.	Appendix A1
October 1999	Partial radiological survey of the building by Mr KJ Robinson	Appendices C1, C2
December 1999	Department of Psychology vacates building after 27 years' continuous occupation	

APPENDIX E: CHRONOLOGICAL SEQUENCE OF DOCUMENTS

Date	Document	Appendix
11 October 1999	Untitled document by K J Robinson	C1
18 October 1999	Untitled document by K J Robinson	C2
June 2000	Non radon alpha activity in air Manchester Museum Project	C7
June 2000	Hazard Data Re Supervised Areas Designated in Coupland Building, etc.	C8
22 June 2000	Local Rules Written by the RPA appointed by the University	C3
24 June 2000	summary of the manchester museum from friday 23rd june (Email from Dr J Nettleton to colleagues at HSE)	C4
27 June 2000	Potential radiation dose received (Report by K J Robinson)	C5
28 June 2000	Determination of Rn222 in air Re. Museum hazard assessment	C6
4 July 2000	Radiation survey (Report by E Kelly)	C9
6 July 2000	Manchester Museum (Letter from Dr S Bidey to Dr J Nettleton)	C10
18 August 2000	NIRAS Analytical Report: analysis of samples from museum	C11
30 August 2000	HM Inspector's report, Manchester Museum: Historical radioactive contamination found prior to major construction project	C12
1 September 2000	Local Rules Written by the RPA appointed by Hayverns	C13
September 2000	Residual contamination survey of Coupland 1 Building, the Annexe and the Old Dental Hospital, Manchester University	C14
4 October 2000	Letter from Dr Nettleton to Dr Robson	C15
26 October 2000	Re Response to HSE Letter (Letter from Barry Frith to Dr Susan Robson)	C16
January 2001	Final Report for the Decommissioning of Coupland 1 Building	C17
20 March 2001	Draft Estimation of the total activity per drum	C18
April 2001	Final Report for the Decommissioning of Rooms 2.62 & 2.63	C20
9 April 2001	Report on the Estimation of Drum Activity of Waste Removed	C19
12 July 2001	Radiation levels in Coupland I, Floor 2 (Email from John Churcher to K Robinson)	B1

13 July 2001	Letter from Dr Steve Bidey to John Churcher	B1
4 September 2001	Quality Plan for LLW Disposal to BNFL	C21
31 October 2001	Re: Radiation levels in Coupland I, Floor 2 (Email from John Churcher to Dr Steve Bidey)	B1
2 November 2001	Letter from Dr Steve Bidey to John Churcher	B1
18 November 2001	Re: Radiation levels in Coupland I, Floor 2 (Email from John Churcher to Dr Steve Bidey)	B1
20 May 2002	Coupland One Building Temporary Refurbishment Project	C22
1 July 2002	don't go in Cohen Lecture Theatre/lee email fixed (email from Stephen Lee to psy-teaching@lists.man.ac.uk)	B2
1 July 2002	Re: don't go in Cohen Lecture Theatre/lee email fixed (Email from John Churcher to psy-teaching@lists.man.ac.uk)	B2
2 July 2002	Re: Radiation levels in Coupland I, Floor 2 (Email from John Churcher to Dr Steve Bidey)	B1
10 July 2002	Radiation hazards in Coupland I building (Letter from John Churcher, Don O'Boyle, & Neil Todd to Dr SP Bidey)	B1
10 July 2002	Coupland 1 (Email from Velson Horie to oboyle@fs4.psy.man.ac.uk)	B3
25 July 2002	Re: Radiation hazards in Coupland 1 building (Email from John Churcher to Dr Steve Bidey)	B1
25 July 2002	Letter from Dr Stephen P Bidey to John Churcher	B1
August 2002	Coupland One Building, Radon Results (May & August 2002)	C23
20 August 2002	Minutes of a meeting held on 23rd July 2002, at the offices of the Radiological Protection Service.	A1
27 August 2002	Letter from John Churcher to Mr JC Collins	B7
28 August 2002	Radiation hazards in Coupland 1 building (Letter from John Churcher to JH Duffy)	B4
29 August 2002	Coupland I Building (Email from John Duffy to John Churcher, Donald O'Boyle	B4
29 August 2002	Re: Coupland I Building (Email from John Churcher to John Duffy)	B4
30 August 2002	Letter from John C Collins to Mr John Churcher	B7
6 September 2002	Coupland I - Radioactive Decontamination (Letter from JH Duffy to NIRAS NNC Limited	B4

8 October 2002	RE: COUPLAND 1- RADIOACTIVE DECONTAMINATION (Letter from Stephanie Adams to Mr J Duffy	B4
25 October 2002	NRPB radon measurements in Coupland 1 building (Email from John Churcher to Dr Steve Bidey)	B1
7 November 2002	Radiation hazards in Coupland 1 building (Letter from JH Duffy to Mr J Churcher/Dr D J O'Boyle)	B4
11 November 2002	(Fwd) NRPB radon measurements in Coupland 1 building (Email from John Churcher to Dr Steve Bidey)	B1
12 November 2002	Re: (Fwd) NRPB radon measurements in Coupland 1 building (Email from Dr Stephen P Bidey to John Churcher)	B1
13 November 2002	Re: (Fwd) NRPB radon measurements in Coupland 1 building (Email from John Churcher to Dr Stephen Bidey)	B1
13 November 2002	Re: (Fwd) NRPB radon measurements in Coupland 1 building (Email from Dr Stephen Bidey to churcher@fs4.psy.man.ac.uk)	B1
18 November 2002	Re: (Fwd) NRPB radon measurements in Coupland 1 building (Email from John Churcher to Dr Stephen Bidey)	B1
21 November 2002	Documents mentioned by Stephanie Adams (Email from John Churcher to Dr Steve Bidey)	B1
22 November 2002	Letter from Dr SP Bidey to Mr J Churcher	B1
2 December 2002	Re: Documents mentioned by Stephanie Adams (Email from John Churcher to Dr Stephen Bidey)	B1
3 December 2002	Re: Documents mentioned by Stephanie Adams (Letter from Dr Stephen Bidey to Mr J Churcher)	B1
4 December 2002	Re: Documents mentioned by Stephanie Adams (Email from John Churcher to Dr Stephen Bidey)	B1
19 December 2002	(Fwd) Re: radon detectors (Email from Dr Don O"Boyle to churcher@fs1.fse.man.ac.uk)	B1
22 December 2002	Minutes of a meeting held on Wednesday, 21st August, 2002, in the office of Dr Bidey of the Radiological Protection Service.	A2
22 December 2002	Draft minutes of meeting on 21st August 2002 (Email from John Churcher to Dr Steve Bidey)	B1
7 January 2003	Re: Draft minutes of meeting on 21st August 2002 (Email from Dr Stephen Bidey to churcher@fs4.psy.man.ac.uk)	B1

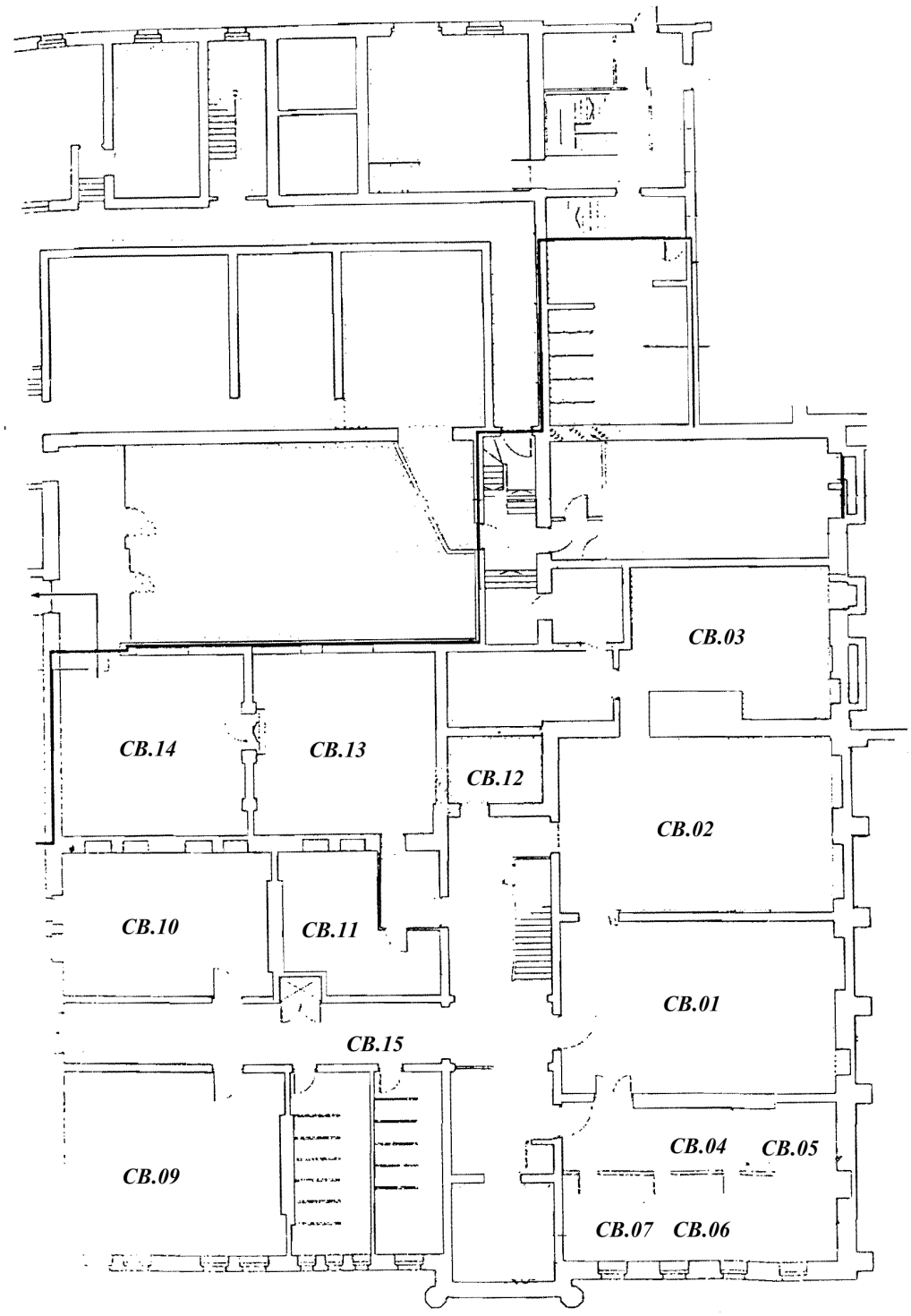
9 January 2003	Re: Draft minutes of meeting on 21st August 2002 (Email from John Churcher to Dr Stephen Bidey)	B1
9 January 2003	Re: Draft minutes of meeting on 21st August 2002 (Email from Dr Stephen Bidey to churcher@fs4.psy.man.ac.uk)	B1
9 January 2003	Report of Radon Measurements	C24
14 January 2003	Letter from K Robinson to Mr J Churcher	B1
18 January 2003	NRPB Report (email from John Churcher to Mr K Robinson)	B1
20 February 2003	queries (Email from Dr Don O'Boyle to Sbidey@fs1.scg.man.ac.uk)	B1
23 February 2003	Re: queries (Email from Dr Don O'Boyle to steve.bidey@man.ac.uk)	B1
23 February 2003	Coupland 1 (Email from John Churcher to Dr Stephen Bidey)	B1
23 February 2003	Coupland 1 (Email from John Churcher to Dr Susan Robson)	B5
23 February 2003	Letter from John Churcher to Professor Robin Marshall FRS	B9
24 February 2003	Coupland 1 (Email from John Churcher to Dr Tristram Besterman)	B3
16 March 2003	(Email from Susan Robson to John Churcher)	B5
20 March 2003	Re: Coupland 1 (Email from Dr Susan Robson to John Churcher)	B5
23 March 2003	Re: Coupland 1 (Email from John Churcher to Dr Susan Robson)	B5
24 March 2003	Letter from Dr Stephen Bidey to Mr J Churcher	B1
24 March 2003	Letter from Professor Robin Marshall to John Churcher	B9
25 March 2003	Re: Coupland 1 (Email from Dr Susan Robson to John Churcher)	B5
1 April 2003	RE: (Fwd) Coupland 1 (Email from Dr Susan Robson to John Churcher)	B5
1 April 2003	RE: (Fwd) Coupland 1 (Email from John Churcher to Susan Robson)	B5
1 April 2003	Suspected mercury presence in 2.62 & 2.63 (Email from Catherine Davidge to John Churcher)	B6
1 April 2003	Re: Suspected mercury presence in 2.62 & 2.63 (Email from John Churcher to Catherine Davidge)	B6

2 April 2003	RE: (Fwd) Coupland 1My Response (Email from Dr Susan Robson to John Churcher)	B5
14 April 2003	Minutes of Radiological Protection ServiceC prior to 1993 (Email from John Churcher to Professor Ian Stratford)	B8
22 April 2003	Re: Minutes of Radiological Protection ServiceC prior to 1993 (email from Professor Ian Stratford to John Churcher)	B8
29 April 2003	Minutes of Radiological Protection ServiceC prior to 1993 (Email from John Churcher to John Duffy)	B4
29 April 2003	Re: Minutes of Radiological Protection ServiceC prior to 1993 (email from Professor Ian Stratford to John Churcher)	B8
30 April 2003	Re: Minutes of Radiological Protection ServiceC prior to 1993 (Email from John Duffy to John Churcher)	B4
30 April 2003	Re: Minutes of Radiological Protection ServiceC prior to 1993 (Email from John Churcher to John Duffy)	B4
22 May 2003	Re: Minutes of Radiological Protection ServiceC prior to 1993 (Email from John Duffy to John Churcher)	B4
3 June 2003	Re: Minutes of Radiological Protection ServiceC prior to 1993 (Email from John Churcher to John Duffy)	B4
21 June 2007	FOI 1 - FOI Enquiry Form (Application to HSE)	B10
19 July 2007	FOI enquiry 2007060376 - Information relating to radiological inspections of the Coupland Building at the University of Manchester (Email from Nick Williams to John Churcher)	B10
15 October 2007	Re: FOI enquiry 2007060376 - Information relating to radiological inspections of the Coupland Building at the University of Manchester (Email from John Churcher to Nick Williams)	B10
12 November 2007	FOI enquiry: 2007110197 (Email from Nick Williams to John Churcher)	B10
13 November 2007	Re: FOI enquiry: 2007110197 (Email from John Churcher to Nick Williams)	B10
29 November 2007	RE: FW: FOI enquiry: 2007110197 (Email from Nick Williams to John Churcher)	B10
2 December 2007	Radiological inspection of Coupland 1 Building, University of Manchester (Email from John Churcher to Dr Joanne Nettleton)	B10
3 December 2007	Re: Radiological inspection of Coupland 1 Building, University of Manchester (Email from Dr Joanne Nettleton to John Churcher)	B10

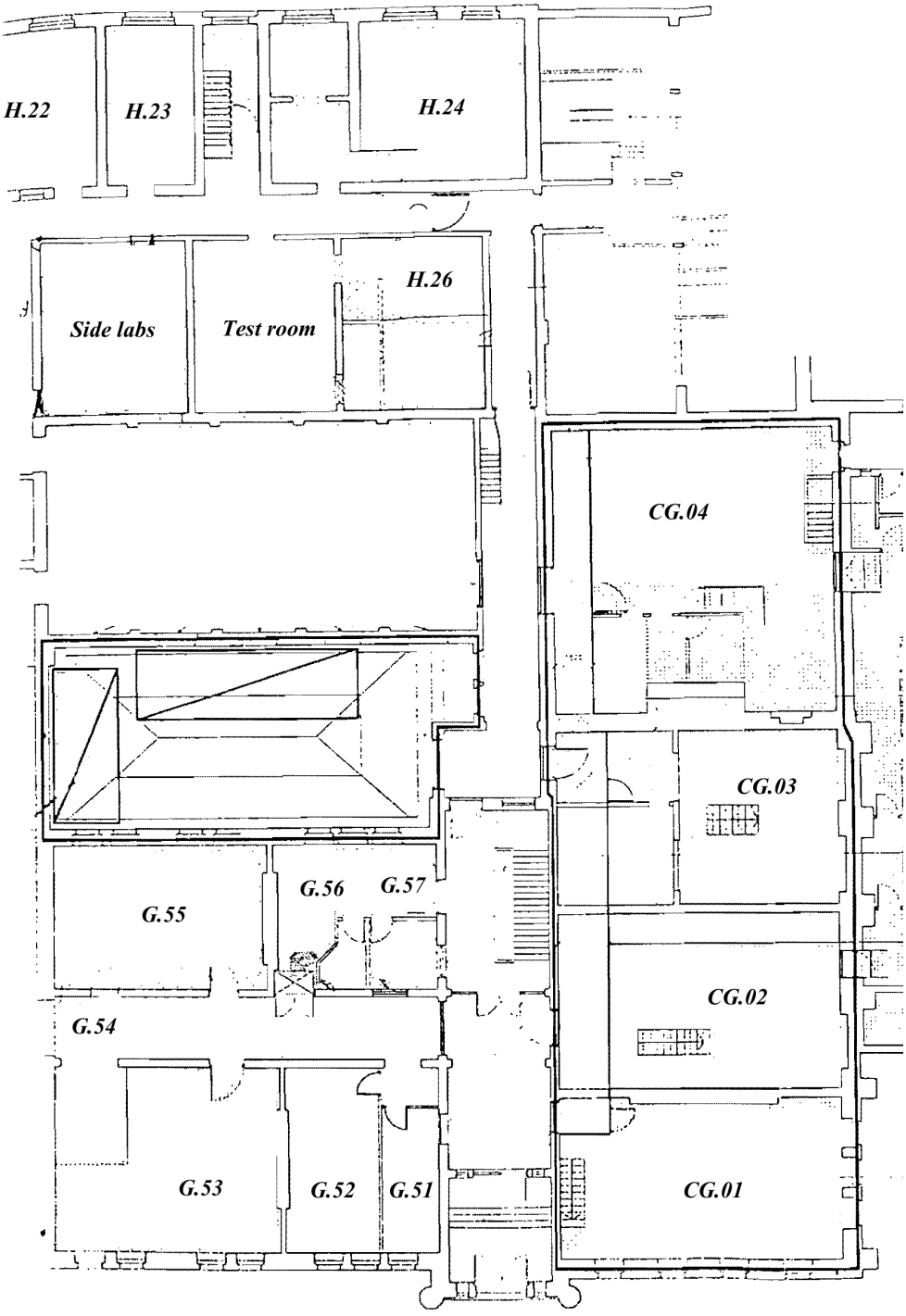
APPENDIX F: FLOOR PLANS OF THE BUILDING

These plans are based on those included in *Residual contamination survey of Coupland I Building, the Annexe and the Old Dental Hospital*, by S.M.Adams [see Appendix C14].

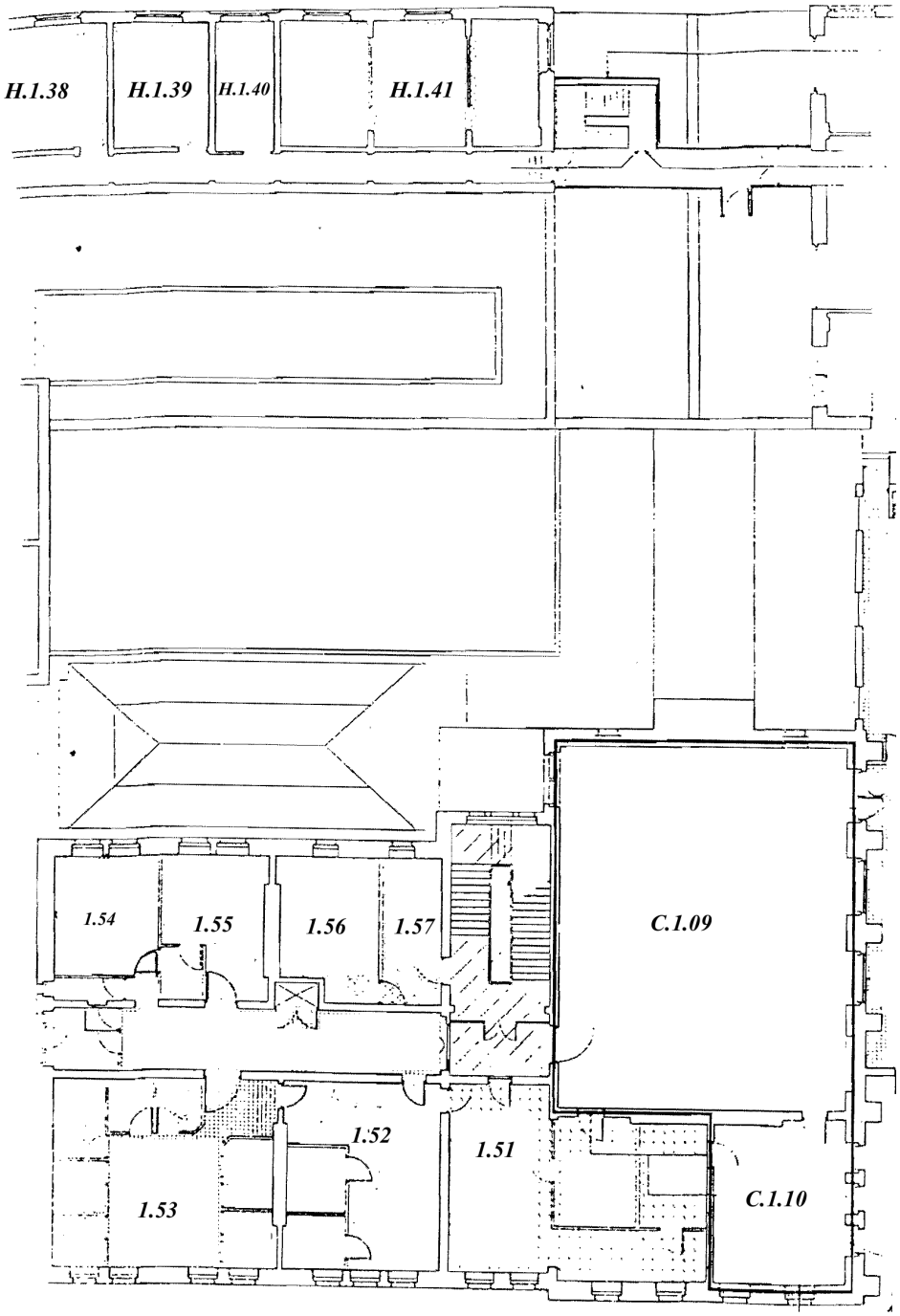
Basement


CB.03
CB.14
CB.13
CB.12
CB.02
CB.10
CB.11
CB.01
CB.15
CB.04
CB.05
CB.09
CB.07
CB.06

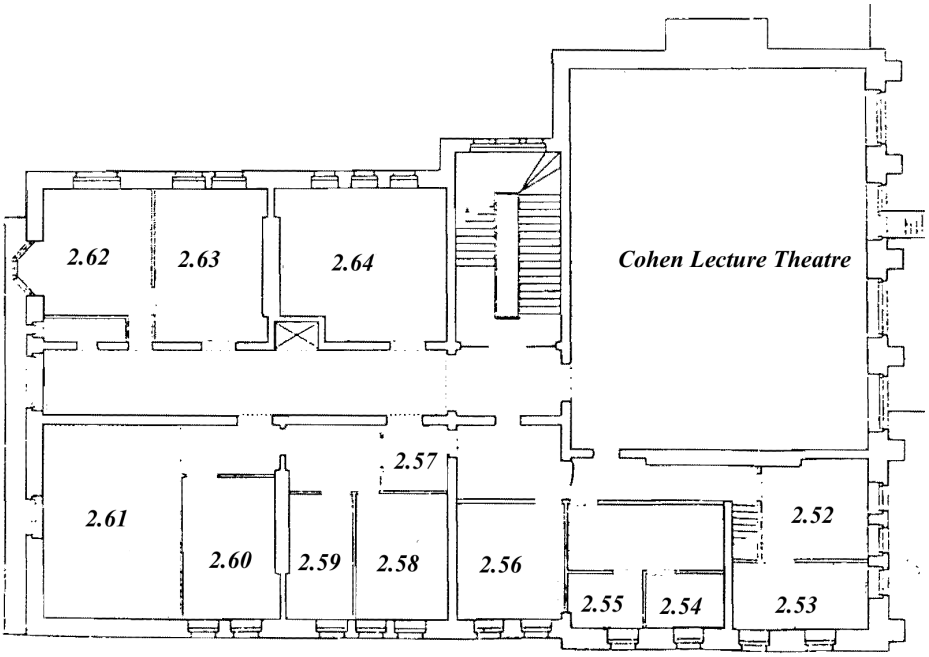
Ground floor



First floor



Second floor



APPENDIX G: HISTORICAL OCCUPANCY OF THE BUILDING, 1976-1999

The table below is a partial reconstruction of historical occupancy of the Coupland 1 Building (now renamed Rutherford Building) by staff and students of the Psychology Department, 1976-1999. Details are based on personal recollections by two of the authors (JC and DJO'B) in 2007-8.

Room	*Use*	*Occupant(s)*	*From*	*To*	*Years*
CB??	Workshops	Terry Evans			
	..	Don Stringer			
	..	Larry Farrell			
	..	Peter Harforth			
G51	Office	??			
	..	Brian Clark			
	..	Tony Dixon			
	..	Dorothy Bishop			
	..	Nuala Brady			
	..	Claudia Metzler (?)			
G52	Office	Dorothy Bishop (?)			
		Claudia Metzler			
G53	Office/Department Computing Lab	Arthur Reader			
	Main Departmental Seminar Room	[All academic staff and postgraduate students]			
	Office	[Postgraduate students (MSc in Cognitive Science)]			
	Departmental Exams Office	Julie Hampson			
G54	Animal house	Don O'Boyle	1973	1986	13
	..	Adrian Bakes			
	..	John Wearden			
	..	Kevin Silber			
	..	Andrew Speakman			
	..	Jane Mitchell			
	Laboratory	[Postgraduate students (MSc in Cognitive Science)]	1986		
G55	Office/Laboratory	Arthur Reader			>10
	Office/Laboratory	[Postgraduate students (MSc in Cognitive Science)]			
G56	Histology laboratory	Don O'Boyle	*c.*1978	1986	8
	..	Adrian Bakes			
	..	Andrew Speakman			
	..	Kevin Silber			
	..	Jane Mitchell			
G57	Laboratory	[Postgraduate students]			
	Office	Steve Stradling			

Room	*Use*	*Occupant(s)*	*From*	*To*	*Years*
H22	Office	Arthur Reader			
	..	Cliff Bell			
H23	Office	John Dearnaley			
H.1.38	Office	Elena Lieven			>20
H.1.39	Office	Peter Lloyd			
H.1.40	Office	Cliff Davies			
H.1.41	Offices	[Postgraduate students]			
1.51	Office	Margaret Gregory	1971	1973	
	Laboratory (Operant Conditioning)	John Wearden			
	..	Adrian Bakes			
	..	Don O'Boyle			
1.52	Laboratory	Don O'Boyle			
	Office	Jonathan Foster			
	..	Andrew Mayes			
1.53	Divided into laboratory cubicles & used for research. ..	Don O'Boyle			
		Adrian Bakes			
		Kevin Silber			
		[Undergraduate students]			
1.54	Office	John Clark			
	..	Steve Stradling			
1.55	Office/Laboratory	John Boddy			
	Office	Cliff Davies			
	..	Andrew Gregory			?15
1.56	Office	Paul Arnold			
1.57	Office	Ian Christensen			?20
	..	Tom Whiston (?)			
2.52	Office	Don O'Boyle	1976	1999	23
	..	Kevin Silber			
	..	Andrew Speakman			
2.53	Office	Don O'Boyle	1976	1999	23
2.54	Office	Tony Manstead			?10
2.55	Office	Betty Byers Brown			

Room	*Use*	*Occupant(s)*	*From*	*To*	*Years*
2.56	Office	Stephen Lee			
	..	Rosanna Cousins			
2.58	Office	Jim Reason			
2.59	Office	John Bowers			
	..	Ivan Leudar			
2.60	Office/Laboratory	Neil Todd			
2.61	Office/Laboratory	[Postgraduate students]			
2.62	Office	Hugh Wagner	?1976	1999	?23
	..	Neil Todd			
2.63	Office	John Churcher	1979	1999	20
2.64	Office/Laboratory	Graham Mole			3
	..	John Churcher			
	..	Sue Ormerod			3
	..	Martin Lea			
	..	[Postgraduate students]			
ALL		Steve McKnight			
ALL		Steve Rigby			
ALL		Garry Byrne			
ALL		Larry Farrell			
?		Richard Skemp			
?		Florence MacNeill			
?		Pat Rabbitt			

Historical and radio-archaeological perspectives on radioactive contamination in the Rutherford Building.

Neil Todd
Life Sciences
University of Manchester

I BACKGROUND

The 'New Physical Laboratory' at Manchester, opened in 1900 and was directed by Arthur Schuster, Langworthy Professor of Physics. Before Rutherford arrived 80-90 mg of radium bromide was obtained, purchased with funds from a lecture series by Schuster on "Rays and Radioactivity" in 1903, and some work on radioactivity took place, notably by Makower during his tenure a Research Fellow 1903 - 1906 (Schuster and Hutton,1906). Shortly after Rutherford's arrival in Manchester in 1907, as the 2nd Langworthy Professor, an additional amount equivalent to about 250 mg of radium (probably in the form of the bromide) was obtained on loan from the Vienna Academy (Rutherford and Royds, 1908). This assignment of radium (Ra226) compound arrived in January 1908. At about the same time Rutherford also acquired from the Royal Society the residues from about 1 tonne of pitchblende, which included actinium (Ac227) and radiolead (Pb210). In addition, in 1908-1909 he obtained amounts of thorium (Th232) and mesothorium (Ra228) compounds from Otto Hahn, his erstwhile research student from Canada (Eve, 1939). These various consignments allowed Rutherford to undertake studies in radioactive substances from all three natural decay series: RADIUM (U238), ACTINIUM (U235) and THORIUM (Th232). His tenure oversaw a very considerable period of expansion in research in radioactivity, initiated in Canada, with assistance from a number of students and co-workers, including Royds, Geiger, Marsden, Hevesy, Chadwick, Darwin and others. This work at Manchester finished in 1919 when he was appointed to the Cavendish Laboratory in Cambridge and it is understood that Rutherford took with him his consignment of radium.

Rutherford was succeeded in the Langworthy Chair by WL Bragg (1919 - 1937), PMS Blackett (1937 - 55), S Devons (1955 - 60), and BH Flowers (1961 - 1972). In 1967 the Department of Physics moved to a new building and from the mid-1970s until 1999 it was occupied partly by the Psychology Department and partly by the Manchester Museum. In 1999 radioactive contamination was discovered in the Coupland Building in rooms historically occupied by Physics. Subsequently between 1999 and 2001 several surveys and analyses were carried out on contamination found in 10 rooms. These rooms were 2.62, 2.63, 2.52/2.53 on the 2nd floor, C 1.09 and C 1.10 on the 1st floor, G54, G55 on the ground floor. Two other rooms were also found to be contaminated, CB110 and D 2.05, which were not part of the original 1900 building and evidence was later found of contamination in 2.54. As a result remediation was carried out to remove contamination and further analyses were carried out on this material. These data, while obtained for the purpose of health and safety, are also of historical interest for the light that they may shed on research activity and methods during the Rutherford period.

The aim of this Appendix is to attempt to correlate contemporary accounts of research activity in the Physical Laboratories with the location and radio-chemical analysis of recent measurements of contamination. We may draw on three sources of information: (1) accounts by contemporaries, spanning Rutherford's time at Manchester, (2) peer review articles from Rutherford and co-workers (1907 - 1919) (3) the recent measurements of radioactive contamination obtained from 2000 - 2003 during the project to expand the Manchester museum.

II: HISTORICAL PERSPECTIVES

II. 1 The 'New Physical Laboratory' in 1906.

A detailed account of the New Physical Laboratory is provided in a publication by the University of Manchester in 1906 in commemoration of 25 years of Arthur Schuster's Professorship (Schuster 1906). The building was constructed of four floors consisting of a basement, ground, 1st and 2nd floors. The ground floor was primarily devoted to electrical engineering and electro-chemistry, except for G55/54 which was designated for "private research" and a workshop next door (G56/57). The 1st floor was primarily devoted to elementary teaching of practical physics and included a general and elementary physics laboratory C1.09 as well as specialised teaching laboratories for acoustics, optics and electricity and a "balance room" off the general laboratory. The 2nd Floor and basement were primarily designated for research with named "research" rooms 2.63 on the 2nd floor and CB.05, CB.09 and CB.10 in the basement. The 2nd floor also housed a small and a large lecture theatre and associated preparation room.

Table 1: Contaminated Rooms and their Functional Designation 1906.

Floor	Room	1906 Designation	Contemporary Room Label
2nd	2.52/2.53	"Preparation room"	-
	2.54	"Apparatus Room"	-
	2.62	"Transit room"	"Royds"
	2.63	"Research"	-
1st	C 1.09	"Elementary Lab"	-
	C 1.10	"Balance Room"	-
Ground	G 54/55	"Private research"	"Rutherford"
Basement	CB 05	"Liquid air and research"	"Geiger/Nuttall"
	CB 09	"Research"	-
	CB 10	"Research"	-

Table 1 above shows each of the contaminated rooms in the New Physical Laboratory, their 1906 designation and contemporary label as understood by commemorative plaques. Room 2.62 had on a wall to the right of the door a plaque commemorating the Rutherford and Royds (1909) experiment to determine that the α-particle was a helium nucleus. Room G54/55 contained "Rutherford's bench", believed to have been used for experiments on the artificial disintegration of nitrogen (Rutherford 1919). Room CB 05 is referred to as the "Geiger-Nuttal" room and is believed to be where Geiger and co-workers carried out experiments on counting and scattering of α-particles.

In 1912 an expansion of the New Physical Laboratories took place, in part due to the pressure on space due to the amount of nuclear research taking place, and much of the engineering part of the Department took up residence in the extension.

II. 2 Accounts of Rutherford at Manchester by Contemporaries.

Rutherford's position at Manchester was greatly assisted by the presence at the New Physical Laboratories of William Kay (1879 - 1961), who became chief steward, and of Hans Geiger who had been Schuster's research assistant. He also had the benefit of the help of chemist Boltwood for the period 1907-1908 who had considerable experience in the handing of radium (Robinson 1942). An invaluable insight into Rutherford's use of the New Physical Laboratories may be obtained from the recollections of these men. In an interview with William Kay by Devons (Hughes, 2008), two references to room use are made. On p. 102 "Well, the radium room was right at the top at the far end. That's where we kept the radium. That's where all the glass apparatus was, but the other room, where we did all the atom work was right at the bottom, a room on the ground floor. And of course, the rooms was all over the place, you see, and Moseley did all his work in the room underneath that, you see." Kay also refers to the presence of Boltwood when asked about handling the emanation. In the section on the disintegration of nitrogen (p. 111) Devons asks "He used to have a room downstairs?" to which Kay replies "It was done underneath the room there. Yes, No.9, I think it was, or No. 15....".

Shortly after Rutherford's death in 1937 Geiger (1938) recalled: "When I look back on the five years which I spent with Rutherford as a young physicist in Manchester, many delightful impressions spring to mind. I see his quiet research room at the top of the physics building, under the roof, where his radium was kept, and in which so much well-known work on the emanation was carried out. But I also see the gloomy cellar in which he had fitted up his delicate apparatus for the study of the a-rays. Rutherford loved this room. One went down two steps and then heard from the darkness Rutherford's voice, reminding one that a hot-pipe crossed the room at head level, and that one had to step over two water-pipes....There was also a cheerful room upstairs, in which we all met for a cup of tea in the late afternoon."

Also of relevance to this account is Geiger’s recollection of the consequences of the escape of radon. "I always like to recall another little episode, which occurred at the time when much work was being done in the laboratory with sources of radiation consisting of extremely thin tubes filled with emanation. It was necessary to exercise great care lest any of this emanation should escape, for it spread rapidly throughout the building, and by virtue of its activity made experimental work an impossibility for periods of many hours. In his typically drastic manner, Rutherford had threatened the severest penalties for offenders in this manner. One day I noticed that it had become impossible to use an electroscope in my room, where I had fitted up the first counting experiments for Rutherford, and before long other research workers emerged from the neighboring rooms with the same sad story. We were not long in discovering that that the emanation had come from Rutherford's own laboratory, where at that moment he was actively engaged with his experiments.".

The recollections of Kay and Geiger concur that the research rooms where the radium was kept and where the emanation experiments took place were on the top floor (Table 2). In conjunction with the Schuster (1906) description of the laboratory and the plaque to commemorate the Rutherford and Royds (1909) experiment, we can be fairly confident that rooms 2.62/63 of the Coupland 1 plan were the "radium rooms". It is not clear though how the work was divided between 2.62 and 2.63.

Table 2: Contaminated Rooms and Recollections of Kay and Geiger.

Room	1906 Designation	Kay/Geiger 1907 - 1919	Associated researchers	Contemporary Room Label
2.52/2.53	"Preparation room"	-	-	-
2.54	"Apparatus Room"		-	
2.62	"Transit room"	"Radium room"	Boltwood, Lantsberry	"Rutherford/Royds"
2.63	"Research"	"Radium room"	Rutherford	
C 1.09	"Elementary Lab"	-		-
C 1.10	"Balance Room"	-		-
G 54/55	"Private research"	Rutherford Lab	Rutherford	"Rutherford"
CB 05	"Research"	-	-	"Geiger/Nuttall"
CB 09	"Research"	Rutherford Lab	Rutherford	
CB 10	"Research"	Rutherford Lab	Moseley	

We may also be confident that the ground floor laboratory referred to by Kay where the "atom work" was carried out was G54/55, since there were no other research rooms in the Schuster (1906) plan, the rest being devoted to engineering. Kay also referred to rooms underneath the ground floor, one used by Moseley and another which was used by Rutherford for the disintegration experiments. Assuming the same numbering system, Kay's room No. 9 probably corresponds to CB 09. The adjacent room CB 15, probably Kay's No. 15, was the "student cloak room" in the Schuster plan and continued to be used as a gents' toilet during the occupation by Psychology. CB 10 is immediately underneath G54/55 and could be the Moseley room. It is likely that the cellar room described by Geiger was one of the basement rooms, possibly CB 9. The contemporary naming of CB 05 as the "Geiger, Nuttal Room" is consistent with Geiger's anecdote concerning the emanation leak from Rutherford's lab. If the leak had come from the ground floor lab G55/54 the radon would rapidly diffuse into the corridor and down the stairs to affect all the basement research rooms, CB 05, CB 09 and CB 10, at the same time. It is also possible that the leak came from the "Radium room" on the top floor, but this would have the same effect. Table 2 above summarises these observations.

If the above recollections of Kay and Geiger provide evidence for the use of the rooms designated in 1906 for research, there are four other contaminated rooms which were designated for other purposes. These are 2.52/53 the "Preparation Room", 2.54 the "Apparatus Room", C1.09 the "Elementary lab" and C 1.10 the "Balance Room". Without any direct recollections of these rooms we may only speculate. However, some reasonable guesswork is possible.

A further clue to the origin of contamination in rooms other than those designated for research is that Geiger was responsible for training research students on experimental methods in

radioactivity (Robinson, 1943; Makower and Geiger, 1912). In addition, due to a shortage of workers, selected 2nd year students were given a course on methods and carried out experimental projects using radioactive materials in their 3rd year. Robinson (1943) also recalls that the training laboratory for work on radioactive substances was also used as the tea-room. "I am sure that the laboratory tea-table, situated in the radiation training laboratory, was far from the least important bench in the laboratory. Rutherford provided tea and biscuits every day, and nearly always attended himself, sitting at the table, with the rest of us perched on stools and the neighboring benches." In view of Geiger's recollection of the tea-room being upstairs, the location of the radiation training lab could be either the Apparatus Room on the 2nd floor, the Elementary Lab or the Balance Room on the 1st floor. However, the absence of benches, according to the Schuster (1906) plan, rules out the Balance Room and later in his account Robinson refers separately to the "elementary lab", thus leaving rooms 2.54/55/56 the "Apparatus Room" as the likely candidate for the tea-room/radiation training lab. Further evidence to support this view is also provided in Robinson's recollection of the Friday colloquium which would have been held in the Large Lecture Theatre (Cohen Theatre). "We saw him at his best and most inspiring at the physics colloquium, which met on Friday afternoons. The meetings, ..., were preceded by an enormous tea-party, ...". The Apparatus Room is adjacent to the Lecture Theatre and in fact was accessible directly from the Theatre.

The "Preparation Room" (2.52/53) adjoined the large lecture theatre on the 2nd floor and would have been used frequently for the purpose of preparing lecture demonstrations, for which Kay had a reputation. Robinson (1943) recalled: "Officially, students specializing in physics had no lectures from the professor in the first year, but in practice we used to attend his elementary lectures as regularly as we could, partly because they were really illuminating, whatever the topic, and partly for the beautiful experiments which Kay prepared for them.". It is entirely plausible that some contamination occurred during the preparation of a lecture or colloquium demonstration. However, given also that this room was adjacent to the Apparatus Room which plausibly was Geiger's training lab it is possible that the Preparation Room was also used for this purpose.

There remains the issue of the Balance Room C 1.10 which, as described in detail below, was in fact the most highly contaminated. Schuster described this room as follows: "Leading out of the Elementary Laboratory are a Balance Room, which contains the delicate balances used for more advanced physical exercises, and a room for Electrical Measurements." (Schuster & Hutton, 1906, p.3). We may only speculate that this room may have been used on a regular basis for the careful weighing out of small quantities of radioactive compounds, not least amounts of pitchblende residues, which would have been required to meet the demand of 15 or so full-time researchers who were active before the outbreak of war in 1914.

III: RADIO-ARCHAEOLOGICAL PERSPECTIVES

Turning now to the details of the contamination, between October 1999 and January 2003 a number of reports (Appendix C) were produced relating to surveys and analyses that were done in Coupland 1 (including the 1912 extension), the Annex and the old Dental Hospital. These reports relate to measurements of α, β and γ counts, estimated dose rate, measurements of radon and non-radon α, and analyses of radionuclide activity. We consider below three aspects of these reports.

III. 1 Measured α, β and γ Count Rate .

Table 3: Summary of Activity Counts.

Room	β+γ (cps) Oct 1999	β+γ (cps) July 2000	β+γ (cps) Sept 2000	γ (cpm) Sept 2000	α (cps) Sept 2000
2.52/2.53 2.62 2.63	- "low level" "low level"	- - -	31-45 - 31	20-40k - 22k	
C 1.09 C 1.10	- -	- -	30 98-1338	20k 25k	 15-100
G 54/55	300	300-1300	44-1321	>50k	
CB 05 CB 09 CB 10	20 150 -	-	30 32 37	23-30k 25k 29-50k	

Three surveys were carried out to measure count rates which are summarised in Table 3 above for the 10 rooms which were identified in the surveys as being contaminated. β+γ were measured with a Bertholt LB 1210B and Bertholt LB 122, γ measured was with a Bicron instrument calibrated to detect energies > 60 keV and α measured with a Mini Instruments 900/AP2. The first two surveys were quite limited in extent but the September 2000 survey was extensive covering the Coupland I Building, the Coupland Annex and the Old Dental Hospital. This indicated particular hotspots in CB 10, G55/54, C.1.10 and 2.52/53.

Table 4: Cross comparison of β+γ and γ counts in the Coupland 1, Annex and Old Dental Hospital.

Floor	Coupland β	Annex β	Hospital β	Coupland γ	Annex γ	Hospital γ
2	24 - 45			20 - 40k		
1	20 - 1338	12 - 25	18 - 21	15 - 25k	10 - 13k	10 - 17k
G	26 - 1321	18 - 20	18 - 27	18 - >50k	10 - 15k	10 - 16k
B	26 - 37	18 - 23	20 - 23	20 - 50k	10 - 13k	9 - 25k

A major problem with interpreting these data, however, is judging what is the appropriate background level. Given that the Sept 2000 survey was extensive though, it is possible to determine a background by comparing counts in Coupland 1 with counts in the Annex and Hospital and this is shown is Table 4 above. It is immediately apparent that levels and ranges of

both β and γ counts are quite different indicating a generally raised activity in the Coupland Building. This suggests that in addition to the 10 rooms identified which required remediation, there was a general low-level contamination throughout the Coupland. Some of the raised count could be due to building material and in particular the coloured glaze used in some of the wall tiles. However, this could not account for the uniformity of the raised level as the coloured tiles were not present in all of the rooms.

Table 5: Activity counts for New Physical Labs and 1912 extension.

Room	1906 Designation	Inferred use by Rutherford and co-workers	β (cps)	γ (cpm)
Cohen	L Lecture Theatre	Radioactivity demos?	35	24k
2.52/53	"Preparation room"	Radioactivity demos?	**31-45**	**20-40k**
2.54/55/56	"Apparatus Room"	Training Lab/Tea Room?	**31-35**	**20-25k**
2.57/58/59	"Museum"	Research?	21-35	25-26k
2.60/61	"Grating Room"	Research?	25-30	20k
2.62	"Transit room"	Royds/Boltwood Experiments	-	-
2.63	"Research"	Radium Room	**31**	**22k**
2.64	S Lecture Theatre		25	25k
C 1.09	"Elementary Lab"	Teaching?	**30**	**20k**
C 1.10	"Balance Room"	Research?	**98-1338**	**25k**
1.51	"Electricity "		28-33	20k
1.52	"Electricity"		28-33	20-21k
1.53	"Optics"		22	15k
1.54/55	"Sound & General"		30	22k
1.56	"Private Room"		21	20k
1.57	"Ante Room"		34	15k
G 51/52	"Reading Room"	Research?	30-33	24k
G 53/54	"AC Currents"		27-30	20k
G 54/55	"Private Lab"	Rutherford Lab	**44-1321**	**>50k**
G 56/57	"Workshop"	Research?	26-33	20-25k
CG 01	"Electricity"		31	20k
CG 02	"Switchboard"		31	21k
CG 03	"Electrochemistry"		24	15k
H22	1912 expansion	Research?	30	16-28k
H23	1912 expansion	Research?	33-36	22-25k
H24	1912 expansion	Research?	31-36	18-29k
H26	1912 expansion	Research?	32	20k
CB 01	"Photographic Room"	Moseley?	31	20k
CB 02	"Spectroscopic Research"		27	20k
CB 03	"Boiler Room"		24	15k
CB 04/05/06/07	"Liquid Air & Research"	Geiger/Nuttall Lab	**30**	**23-25k**
CB 09	"Research"	Rutherford Research	**32**	**25k**
CB 10	"Research"	Research	**37**	**29-50k**
CB 11/12	"Supplementary Workshop"		30	20k
CB 13	1912 expansion		22	15k
CB 14	1912 expansion		24	21k

Given the apparent widespread activity in the Coupland 1 Building it is useful to consider the values in more detail. Table 5 shows the activity count for the entire Coupland Building including rooms which formed part of the 1912 expansion. Those rooms which were originally identified as the being contaminated are shown in bold. Those rooms with β> 30 and γ > 20 k

are underlined to indicate possible contamination, the criteria are chosen as they are the levels obtained from C.1.09 which was deemed to be contaminated. Thus, in addition to the original 10 rooms a further 17 rooms are implicated as being possibly contaminated. It is interesting to note which rooms were NOT contaminated by these criteria. On the top floor only the Small Lecture Theatre, on the 1st floor the Optics Room, the Private Room and Ante Room, on the ground floor only the Electrochemistry Lab and in the basement the Boiler Room, the Spectroscopic Research Lab, and the two 1912 extension rooms.

It is possible that some of the additional rooms were contaminated by the general leakage of emanation from the 10 original rooms. It is more likely, however, that many of these additional rooms were the site of research activity by Rutherford's students and co-workers. As described above, at the peak of activity before the 1914-1918 war, the New Physical Laboratories housed the experimental work of 15 or more research students, in addition to Rutherford's own Lab and those of the staff, e.g. Geiger. There was therefore a very considerable pressure on space and on equipment and it was for this reason that the Physical Laboratories underwent an expansion in 1912. According to Eve (1939) "The number of research students at Manchester had greatly increased and it was essential to secure more space. This had been duly provided, and on March 1st there was an opening ceremony..." p211. This was described in *Nature* (1912) by Schuster: "The steady growth of the department and the increase of the number of those engaged in original investigation have, in recent years, placed great pressure on the space of the laboratory. This was emphasised by the nature of many of the researches in radio-activity, in which large quantities of radium are employed. The effect of the γ rays, which are able to traverse the walls and floors of the laboratory, disturbed the measurements of the workers not only in the immediate vicinity, but also in neighboring rooms. In order to provide additional space, the Council of the University decided to remove the department of electrical engineering from the physical laboratory proper and to locate it in a new building. In these new engineering laboratories, part of the first floor, containing six research rooms, has been set aside for physics, while a small electrochemical laboratory has been erected outside for work on radio-active substances. The physics department has thus the use of the space formerly occupied by electrical engineering [on the ground floor]. The addition of a number of new research rooms for physics, removed some distance from the main physical laboratory will prove of great advantage for the purpose of original investigation, especially for radio-activity and allied subjects. It is intended to keep the new laboratories uncontaminated by radio-active matter, and they will be employed mainly for the more delicate measurements."

It would thus appear that the research activity was undertaken throughout the Coupland Building and some indication of suggested sites are given in Table 6. For example, Room 2.57/58/59, which is indicated as a "Museum" in the Schuster (1906) plan, has the same elevated count rate as the "Apparatus Room" which is indicated as the location of Geiger's training laboratory. Given also its proximity to the Radium Room it would potentially be a good location for Rutherford to house one of his students. The pattern of α and γ counts observed in Table 6 indicates that research in radioactivity did also take place in the new extension, where there is a cluster of activity in particular in rooms H23-26 on the ground floor. Curiously, six rooms on the first floor (H.1.38, H.1.39, H.1.40, and H.1.41), where Schuster indicated that six rooms were set aside for physics, were not included in the radiological surveys.

III. 2 Radionuclide Analysis

Table 6: Radionuclide analysis of material from contaminated rooms.

Radionuclide	Decay Mode γ(MeV)	$T_{1/2}$	CB. 05 Bq/g	G55 Bq/g	C.1.10 Bq/g	C. 1.10 MBq
RADIUM						
Ra226	α, γ(0.19) 5.4%	1600 a	53.7	70.1	<5.5	2.99
Rn222	α	3.82 d				1.39
Po218	α	3.1 m				1.39
Pb214	β, γ(0.35) 47%	27 m	12.2	0.44	<0.39	1.35
Bi214	β, γ(0.61) 46%	20 m	14.4	0.9	1.0	1.15
Po214	α	0.16 ms				1.39
Pb210	β, γ(0.05) 81%	22 a			4103	28.1
Bi210	β	5 d				1.39
Po210	α	140 d				1.39
THORIUM						
Th232	α	14 billion a				
Ra228	β, no γ	5.8 a				0.016
Ac228	β, γ	6.1 h	0.81	0.57	0.243	0.019
Th228	α, γ(0.08) 28%	1.9 a				
Pb212	β, γ(0.24) 81%	11 h	<0.4	<4.3	<0.38	0.013
Bi212	β, γ	61 m	<2.4	<3.7	<2.6	
Tl208	β, γ(2.16) 100%	3.1 m				

Prior to remediation gamma ray spectroscopy was reported for three samples [See Appendix C11, NIRAS Analytical Report] and the detailed analysis of material remediated from Room C. 1.10 was reported [Appendix C19]. A summary of these data are given in Table 6. For rooms CB.05 and G55 the spectroscopy indicated that contamination was primarily due to Ra226, while for C.1.10 a strong Pb210 source was indicated. The strong Pb210 signature was confirmed from analysis of the remediated material.

There are a number of issues arising from these analyses. We may assume that all or most of the contamination has been present in the Coupland Building for about 100 years. Under ideal conditions for a closed system the isotopes, including Pb210, would be in secular equilibrium and have the same activity level. Clearly the measurement process would disturb the equilibrium, but we may infer from the low values for Pb214/Bi214 and the absence of Pb210, which is a gamma emitter, that the sampling based on hotspots will have significantly underestimated the Rn222 and accumulated active deposits of Pb210 produced by the contamination in CB 05 and G55. We return to this issue below.

Another issue is that these analyses indicate the presence of isotopes from the thorium series, but these are not commented on by those responsible for the report. We should not be surprised that Th232 series isotopes were found as there were many studies making use of these substances during Rutherford's time. Given that thorium (Th228) and thalium (Tl208), the immediate daughter of Bi212, are significant gamma emitters it seems curious these were was not indicated. The high value of Pb210 in C.1.10 suggests that the contamination was from work done with the pitchblende residues obtained by Rutherford which would have had a high content of radio-lead.

It seems curious also that there was no indication of isotopes from the actinium series which would have been present in the pitchblende residues. Actinium (Ac227) has a half-life of 22 years, about the same a Pb210, and its daughters, Fr223, Th227, Ra223, Rn 219, Pb211 and Bi211 are significant gamma emitters. Pb211 in particular being chemically inseparable from the Pb210 would have been present from the pitchblende. These observations together suggest that the printed analyses were selective and that the authors of the various reports included in Appendices C were guided by the assumption that the contamination was primarily due to Ra226.

III.3 Analysis of the Remediated Material

Table 7: Estimated activity of Ra226 and Pb210 in remediated material

Room	Ra 226 (Bq/g)	Pb210/Pb210 (No of spots @ 20 kBq)	Mass (kg)	Activity (MBq)
2.52/2.53 2.62/2.63	0.37-0.72 1.27	2 20	2.3 64	0.051 0.48-1.0
C 1.09 C 1.10	- <5.5 24-4000 (Pb210)	- -	- 3-751	- 14.93-55.54
G 54/55	9.6-70.1	6	712-902	8.83-9.3
CB 05 CB 09 CB 10	43-53.7 0.5-0.66 4.9	- - -	38.8 19.4 3.3	1.67 0.0097 0.016
		28	**1668**	**68**

Table 7 summarises the quantity, activity and estimated radionuclide content of the remediated material. The analyses conclude that apart from C.1.10, which showed a strong Pb210 profile, the contamination was interpreted as due primarily to Ra226. The largest amount of material was taken from G55/54 the Rutherford Lab followed by C.1.10, which together account for the vast bulk of the total mass removed and of the total activity. Three rooms were identified as having significant Pb210/Po210 under the floor boards, 2.62/63, 2.52/53 and G55/54. It was estimated that a significant amount of Pb210/Po210 would have been present that was not detected in other rooms.

An issue of critical importance for estimating historic levels of Rn222 is the origin of the Pb210/Po210 found under the floor boards. The location underneath the gaps is indicative that it was a result of the dense radon seeping through the gaps. Room 2.62/63 according to the Kay/Geiger account was the storage location of Rutherford's radium and the site where many experiments using radium emanation took place. We may be sure that some of the Pb210 is an historic remnant from escaped emanation during the period 1908 1919, but given that some Ra226 contamination was found, then some of the Pb210/Po210 would have been generated between 1919 and 1999 when the contamination was discovered.

Assuming that the values for contamination found in 2.62/63 are accurate then at 1.27 Bq/g the 64 kg of remediated material would contain 0.082 MBq of Ra226 and the 20 spots of

Pb210/Po210 would total to 0.40 MBq. If secular equilibrium had been achieved between Ra226 and newly generated Pb210 then at most there would be 0.082 MBq of Pb210 so that 0.32 MBq of activity would be due to historic emanation escape. The activity in 1919 can be calculated as follows. The number of atoms of any radioactive substance S is given by $S = S_0 \exp(-\lambda t)$ where S_0 is the initial number and λ is the decay-constant, which for Pb210 is 3.15×10^{-2} y^{-1} (Rutherford 1913). The activity A at any time is λS so that if 80 years had passed since Rutherford took his radium off to Cambridge then the activity in 1919 would be $A / \exp(-\lambda \times 80) = 3.2 \times 10^5 / 8 \times 10^{-2} = 4 \times 10^6$ or about 4 MBq. The radium having been present in 2.62/63 for between 1 to 10 years between 1908 and 1919 the activity ratio would have been about 1:10 as shown in Figure 1 below. Thus it would have required the equivalent of about 40 MBq or about 1 mg of radium to be continuously exposed to produce this activity level of Pb210 in 1919.

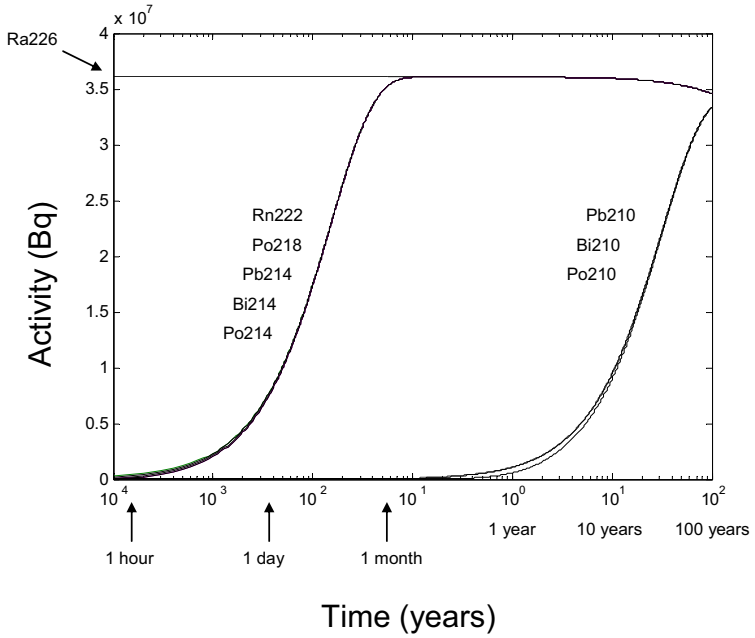


Figure 1. Activity from 1 mg of radium and daughters calculated from equations provided in Chapter XI "Theory of Successive Transformations" in Rutherford (1913) *Radioactive Substances and Their Radiations.* CUP. The time axis is logarithmic. 1 mg of radium has an activity of 37 MBq. The Pb210 would have an activity between 1 – 5 MBq after an exposure of 1 – 10 years and reaches secular equilibrium with radium after about 100 years. Rn222 and daughters reach equilibrium after about one month.

An alternative, perhaps more realistic contamination scenario was that Rutherford's equivalent of 250 mg
of radium, which was kept in 2.62/63 (the "Radium Room"), was exposed, i.e. unsealed, during a series of short accidents. This poses the following question. How long would 250 mg of radium need to be exposed to produce 4 MBq of Pb210 activity in 1919? The answer can be found in article 161 of Rutherford (1913) which tells us that the activity level A_T of a daughter isotope after exposure of the parent for time T is $A_T = A_0(1 - \exp(-\lambda T))$, where A_0 is the parent activity. Thus the exposure time T is given by $T = -\ln(1 - A_T / A_0)/\lambda$. In this case the parent activity is 9.25 GBq and for these values T computes to about 5 days. Over a period of 10 years of occupation this seems reasonable.

We may also attempt to calculate the activity of Rn222 from an activity of 0.082 MBq. In secular equilibrium the Rn222 would also have an activity which it would reach after about a month (see Figure 1). Thus under ideal conditions with no through-flow of air, then after a month the Rn222 would have an activity of 0.082 MBq. If the room has a volume of 125 cubic metres then there would an activity density of about 660 Bq/ m^3, but ideal conditions are unlikely so that the activity density is likely to be less than this. The measured activity in 2.63 prior to remediation was 279 Bq/ m^3.

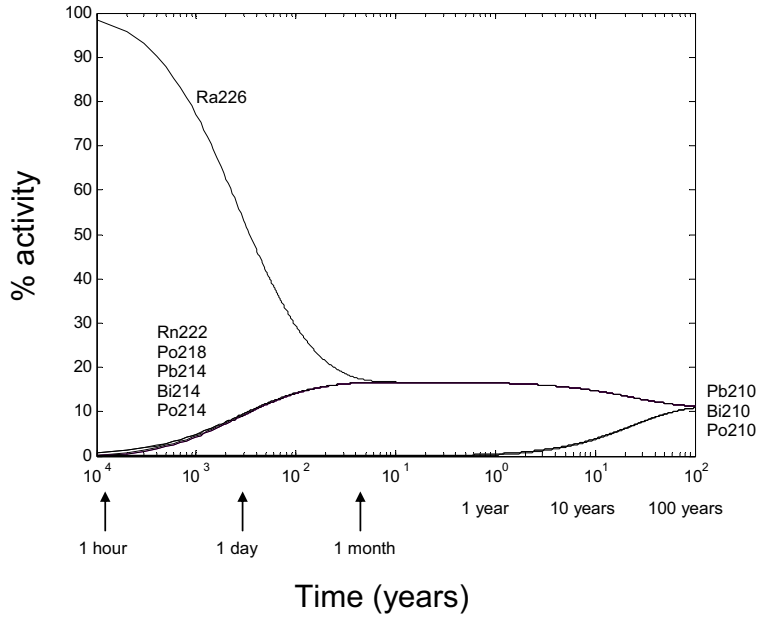


Figure 2. Activity of radium and daughters expressed as a percentage of total activity, calculated from equations provided in Chapter XI "Theory of Successive Transformations" in Rutherford (1913) *Radioactive Substances and Their Radiations.* CUP. Rn222 and daughters reach equilibrium after about one month and Pb210 and daughters reaches secular equilibrium with radium after about 100 years.

The Wastestream Characterisation document [Appendix C21] estimated the summary of the radionuclide fingerprint to be 74% Ra226, 13% Pb210, 13% Po210 activity concentration. Given that the radium has been present for nearly 100 years, in a closed system the Pb210/Po210 would be in secular equilibrium with the Ra226 (see Figure 2) so that we should expect a ratio of 33%, 33%, 33% for these three isotopes. The observed ratio is indicative that the Rn222 had widely dispersed over the century to form active deposits throughout the building so that the grab sampling used for remediation which focused on the vicinity of the hot spots has clearly missed a possibly considerable amount of Pb210/Po210. Excluding the activity from room C 1.10 the total activity of remediated material is about 10 MBq of which 0.74 MBq is due to Ra226. In equilibrium this would produce 0.74 MBq of Pb210, Bi210 and Po210. Subtracting the 0.13 MBq of Pb/Bi/Po210 which was present in the remediated material would leave about 0.6 MBq each of Pb/Bi/Po210 in the building, a total of 1.8 MBq, which is not an inconsiderable amount.

IV DISCUSSION

The historical and radiological data from the contamination found in the Rutherford (Coupland 1) Building has been reviewed. A number of issues have arisen which are of importance both from a health and safety perspective of persons occupying the building in the intervening years between 1919 and 1999 and from a radio-archaeological perspective on the history of nuclear physics.

It is clear that research using radio-active material in the building was much more widely spread than at first anticipated. Photographs of staff and research students from 1910 and 1913 show 21 and 23 personnel (Birks 1962) and such was the pressure on space that the building was extended in 1912. Consistent with this view, the whole of the original building of the New Physical Laboratories has a higher β and γ activity count compared with the neighboring Annex and Old Hospital. Within the New Physical Laboratories and extension there is also a considerable variation. In addition to the "hot spots" in G55 the "Rutherford Lab", C.1.10 the "Balance Room", CG.05 the "Geiger-Nuttall Room", 2.52/53 the "Preparation Room", 2.62/63 the "Radium Room", there were several "warm zones" as indicated in Table 5 which included rooms in the 1912 extension. For example, there is a cluster of rooms on the ground floor (H23-26) which had distinctly elevated counts. In this regard it is possible that rooms on the 1st floor of the 1912 extension above this cluster which were not surveyed could well be contaminated and it should be a matter of some urgency that the University Radiological Protection Service carry out further measurements. Of interest also is the location of the external building which was designated in 1912 for radiochemistry, which if still in existence could well be contaminated.

Of historical interest are the attitudes to radioactive contamination. It is clear from Schuster's short piece in *Nature* (1912) that contamination was considered to be a big problem, but not from a health and safety perspective. It was considered a problem because of the interference it caused to the progress of research. This is clear from Geiger's anecdote concerning the effect of a leak of emanation and it is clear from Rutherford's own description of the problem in his 1913 text: "In a laboratory in which radio-active experiments are constantly made, it is desirable that all sources of active matter should be kept in sealed vessels, in order to avoid possible radio-active contamination due to the distribution of radio-active material. This is especially important with a substance of a high activity like radium. The presence in a closed room of an unsealed capsule containing a few milligrams of radium salt, on account of the escape of the emanation, is sufficient in the course of a day to increase greatly the spontaneous leak of neighboring electrometers and electroscopes. It is highly important not to perform chemical work with strong preparations of radium in a laboratory used for radio-active measurements, for general experience has shown that it is almost impossible to avoid a permanent radio-active contamination of the laboratory in consequence. Such work should be done in a building outside the main laboratory. In many laboratories, the radium emanation is now used in the place of radium itself for many experiments. It is important that this emanation should be kept in sealed vessels, and the work of transference should be done in some part of the laboratory where any accident involving the escape of emanation shall not lead to the contamination of the main part of the building. The disturbance of measurement due to the escape of radium emanation is for the most part temporary in character; but a continuous escape of emanation leads ultimately to all the surface of the building becoming strongly active due to the deposition of the products of slow

decay derived from the emanation. If accurate work with small activities is to be done in a laboratory, the importance of handling all radio-active material with the greatest care cannot be too strongly insisted upon." [p 112-113, Rutherford, 1913].

The 1912 expansion then, in particular the use of six rooms referred to by Schuster on the 1st floor of the extension, was seen as an opportunity for the use of "virgin" laboratories for fine measurements in the properties of radiation and its interaction with matter free from the general contamination which had already taken place by 1912 in the original New Physical Laboratory, and of which the elevated β and γ counts measured in 2000 are the afterglow. It is a question of some considerable archaeological interest to see if this ideal had actually been achieved in these rooms, and so the urgency for a new survey is not only one of health and safety. For the same reason the location of the external building used for radiochemistry should be identified. It is worth adding that given the nature of the contamination in C.1.10 one may speculate that this may have been the site of some radiochemistry using the pitchblende residues as it was fairly well removed from the main sites of work in the basement and on the top floor.

Although thorium series isotopes were indicated in the NIRAS and waste analyses [see Appendices C11, C21] there is a noteworthy absence of any comment or discussion of contamination from the extensive work carried out on thorium isotopes. We know from the numerous publications that there was wide use of thorium, not least by Geiger, Nuttall and Marsden (e.g. Darwin and Marsden, 1912; Geiger and Nuttall, 1912; Rutherford and Geiger, 1910). A further striking feature of the radionuclide analysis was the complete absence of any isotopes from the actinium series. Again we know from the numerous publications that there was a very substantial use of actinium and its decay products (e.g. Geiger and Marsden, 1910; Geiger 1911; von Hevesy 1911; Marsden and Wood, 1913, Marsden and Perkins, 1914). Marsden in particular seems to have devoted a considerable time to work on actinium (six of fourteen published articles from the Rutherford period). The same argument may be applied to the absence of any indication of uranium given that there were many publications during the Rutherford period referring to the use of uranium (e.g. Geiger and Nuttall 1912; Rutherford and Geiger 1910; Hevesy and Putnoky, 1913). It is of course possible that particular care was taken with uranium minerals, but given the above discussion of the accidents which did take place, it is quite possible that some uranium contamination did occur, particularly during the chemical work of Hevesy and Putnoky (1913). Again the location of the external building devoted to radiochemistry should be a matter of urgency for the University.

As detailed above, in addition to the absence of analyses concerning a number of isotopes in the analytic reports (Appendix C11 and C19), particularly from the actinium series, it would appear that a substantial amount of Pb/Bi/Po210 remains in the Rutherford (Coupland I/Schuster) Building. A more thorough remediation which removed all of the lagging in all of the rooms may have been preferable. It is apparent that the survey, the analysis of remediated material and the remediation itself were incomplete. Given the assumptions concerning the history of work in nuclear physics at Manchester, e.g. that it was done primarily using Ra226, this is perhaps understandable. It should be hoped, however, that the University will take the opportunity it now has to complete this work with a full and proper regard for the history and radio-archaeology of the Rutherford Building and the radio-active contamination contained within it. It is a matter of considerable regret that the radiological analyses did not consider the ratios of isotopes of stable

lead, which would have provided an invaluable source of information. It may not be too late for this analysis to be done if radio-active material remains in the building.

REFERENCES

Birks, J (1962) *Rutherford at Manchester.* Heywood and Company, London.

Darwin C and Marsden E (1912) The transformations of the active deposit of thorium. *Proc Roy Soc A*. **87**, 17-29.

Eve, A (1939) *Rutherford: Being the Life and Letters of the Rt Hon Lord Rutherford.* CUP, Cambridge.

Geiger H (1911) The transformation of the actinium emanation *Phil Mag* VI. 22, 201-204.

Geiger H (1938) Memories of Rutherford in Manchester. *Nature* **141**, 244

Geiger H and Marsden E (1910) The number of alpha particles emitted by the emanations of actinium and thorium. *Phys Zeit* **11,** 7 - 11.

Geiger H and Nuttall J (1911) The range of the alpha particles from uranium. *Phil Mag* VI. **23,** 439-445.

Geiger H and Nuttall J (1912) The range of the alpha particles from the thorium and actinium products. *Phil Mag* VI. **24,** 647-654.

von Hevesy G (1911) Detection of actinium in minerals *Phys Zeit* **12,** 1213-1214.

von Hevesy G and von Putnoky L (1913) The diffusion of uranium. *Phil Mag* VI. **25,** 415-418.

Hughes J (2008) William Kay, Samuel Devons and memories of practice in Rutherford's Manchester laboratory. *Notes Rec. R. Soc.* (2008) **62**, 97 121

Makower W and Geiger H (1912) *Practical Measurements in Radioactivity.* London: Longmans, Green & Co.

Marsden E and Wood A (1913) A method for the determination of the molecular weights of the radioactive emanations with application to actinium emanation *Phil Mag* VI. **26,** 948-952.

Marsden E and Perkins P (1914) The transformations in the active deposit of actinium *Phil Mag* VI., **27,** 690-703.

Robinson H (1942) Rutherford: Life and Work to the Year 1919, with Personal Reminiscences of the Manchester Period. *Proc Phys Soc.* **55** (3), 161-182

Rutherford E (1913). *Radioactive Substances and Their Radiations.* CUP.

Rutherford E (1919) Collision of alpha particles with light atoms IV. An anomalous effect in nitrogen. *Phil Mag* VI. **37,** 581-587.

Rutherford E and Geiger H (1910) The number of alpha particles emitted by uranium and thorium and by uranium minerals *Phil Mag* VI. **20,** 691-698.

Rutherford E and Royds (1908) Spectrum of the Radium Emanation *Nature*. **78,** 220-221.

Rutherford E and Royds (1909) The nature of the alpha particle from radioactive substances *Phil Mag* VI. **17,** 281-286.

Schuster (1912) reported in 'The extension of the physical and electrotechnical laboratories at the University of Manchester', *Nature*, **8** (2211) 40 (14 March 1912).

Schuster and Hutton (1906) *The physical laboratories of the University of Manchester: a record of 25 years' work*. Manchester University Press.