

From the Chief Medical Officer
Dr Henrietta Campbell CB

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To: Chief Executive of Boards for onward distribution to:

Directors of Public Health
CCDCs
Private Hospitals

Castle Buildings
Stormont Estate
Belfast BT4 3SQ
Tel: 028 9052 0563
Fax: 028 9052 0574

To: Chief Executives of Trusts for onward distribution to:

Email: Henrietta.Campbell@dhsspsni.gov.uk

Medical Directors
Nursing Directors
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Date: 30 December 2004

Dear Colleague

Isolation Rooms (including Mechanically Ventilated Rooms): Best Practice Standards for Capital Planning

Please find enclosed/attached a copy of *Isolation Rooms (Including Mechanically Ventilated Rooms): Best Practice Standards for Capital Planning*.

This paper focuses on the mechanical ventilation and configuration of specified isolation rooms and delineates requirements in relation to standards for hospital new-build and enhancement, and to the current provision of such facilities in Northern Ireland. It was first commissioned by the Department's Regional Advisory Committee on Communicable Disease Control (RACCCDC). I and the Chief Executive of the Health Estates Agency, Mr John Cole have endorsed it and now ask Board and Trust Chief Executives to put it into effect wherever relevant.

The genesis of the decision to commission the report was concern expressed regarding the lack of regional standards for isolation facilities. A regional working group chaired by Mrs Liz Qua, Principal Nurse Health Estates was then set up by RACCCDC to consider optimum standards for such facilities in Northern Ireland, in relation to both new build and refurbishment of existing buildings.

The working group recommended standards for source isolation rooms and protective isolation rooms but did not issue guidance for building combined source and protective isolation rooms at this time, believing that more evidence-based research was required in this area.

In a related development, an exercise to determine departmental policy on numbers, distribution and type of isolation facilities in the acute sector required in Northern Ireland is being undertaken through a regional group convened by the Chief Executive of the Health Estates Agency, Mr John Cole. It intends to inform all new capital development projects currently in planning and establish funding and procedural arrangements for bringing current facilities up to required standards.

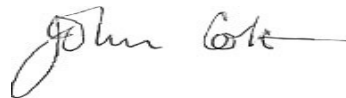
You will be informed in due course of the outcome of that exercise.

For further information contact Mrs Liz Qua on (028) 90523828 or email elizabeth.qua@dhsspsni.gov.uk.

Yours sincerely



HENRIETTA CAMPBELL (DR)
CMO



JOHN COLE
(CHIEF EXECUTIVE, HEA)

This letter is available at www.dhsspsni.gov.uk and also on the DHSSPS Extranet which can be accessed directly at <http://extranet.dhsspsni.gov.uk> or by going through the HPSS Web at <http://www.n-i.nhs.uk> and clicking on DHSSPS.

ISOLATION ROOMS (INCLUDING MECHANICALLY VENTILATED ROOMS): BEST PRACTICE STANDARDS FOR CAPITAL PLANNING

This paper focuses on the mechanical ventilation and configuration of specified isolation rooms and makes proposals in relation to standards for hospital new build and enhancement, and in relation to the current provision of such facilities in Northern Ireland. Assessment of reasonable practicality, suitability and cost implications will require to be undertaken on individual refurbishment schemes. Sample isolation rooms layouts are provided in Appendix 2.

Commissioned in June 2003 by the Regional Advisory Committee on Communicable Disease Control (RACCCDC), the paper with its recommendations were finally approved at the RACCCDC meeting on 7 October 2004. Health Estates, in conjunction with the Chief Medical Officer, will, once endorsed, take these proposals forward, within the Department of Health, Social Services and Public Safety (DHSSPS) and into the Health Service.

INTRODUCTION

Human sources of infecting micro-organisms in hospitals may be patients, personnel or visitors and may include persons with acute disease, persons in the incubation period of a disease, persons colonised by an infectious agent, or persons who are chronic carriers of an infectious agent. Other sources can be the patient's own endogenous flora, which may be difficult to control and environmental objects that have become contaminated, including equipment and medications.¹

The primary aim of infection control is to prevent the spread of infection between patients, visitors and staff by control or containment of potentially pathogenic organisms. Many of these micro-organisms can be controlled by basic infection control practices such as hand hygiene and environmental hygiene as discussed in 'Standard Precautions' below. However, certain organisms, transmitted via the airborne route can only be contained by isolating the source patient in a negative pressure isolation room, and certain immunocompromised patients can only be protected by isolating the patient for their own protection in a positive pressure isolation room.

Eliminating transmission can never be guaranteed but certainly the built environment can help to minimise and reduce the risks along with sound deployment of clinical

¹ Extracted from *Recommendations for Isolation Precautions I Hospitals* (Part II) CDC, Hospital Infection Control Practices Advisory Committee (HIPAC)
<http://www.cdc.gov/ncidod/hip/ISOLAT/isopart2.htm>

practice and procedures. The Joint Working Group of the Hospital Infection Society² emphasises “the role of the clean environment in preventing the spread of infections in hospitals”. An isolation room does not negate the need for a high standard of infection control practices.

Biological agents come under COSHH regulations therefore individual risk assessments should be undertaken to determine the mode of transmission.

ISOLATION PRECAUTIONS

The Centers for Disease Control (CDC) Atlanta via the Hospital Infection Control Practices Advisory Committee (HICPAC) and the Joint Working Group of the Hospital Infection Society³ advocates two tiers of isolation precautions⁴. The first tier is ‘Standard Precautions’ and these are the precautions designed for the care of all patients in hospitals i.e. the primary strategy for successful nosocomial infection control. The second tier, ‘Transmission-Based Precautions’, are for patients known or suspected to be infected by epidemiologically important pathogens spread by airborne or droplet transmission or by contact with dry skin or contaminated surfaces and are based on the modes of transmission of a specific organism. This tier is dealt with later.

‘Standard Precautions’ apply to contact with blood, all body fluids, secretions and excretions (except sweat), non-intact skin and mucous membranes and include procedures and practice for⁵:

- Hand hygiene
- Use of gloves;
- Use of mask, eye protection and or face shield;
- Wearing of plastic aprons or gowns;
- Use of patient-care equipment;
- Environmental control;
- Handling of linen
- Occupational health and blood borne pathogens
- Medical equipment

² *Review of Hospital Isolation and Infection Control Related Precautions* – Report of the Joint Working Group of the Hospital Infection Society, June 2002

³ *Review of Hospital Isolation and Infection Control Related Precautions* – Report of the Joint Working Group of the Hospital Infection Society, June 2002

⁴ Recommendations for Isolation Precautions in Hospitals (Part II), CDC, Hospital Infection Control Practices Advisory Committee - HICPAC) <http://www.cdc.gov/ncidod/hip/ISOLAT/isopart2.htm>

⁵ Recommendations for Isolation Precautions in Hospitals (Part II), CDC, Hospital Infection Control Practices Advisory Committee - HICPAC) <http://www.cdc.gov/ncidod/hip/ISOLAT/isopart2.htm> pages 9-10,12

MODES OF TRANSMISSION

- **Contact transmission** – the most frequent mode of transmission of nosocomial infections, divided into two subgroups:
 - Direct contact – this involves body surface to body surface contact and physical transfer of micro-organisms between a susceptible host and an infected or colonised person and can occur between carer (doctor, nurse, visitor) and patient, or between patient and patient;
 - Indirect contact – this involves contact of a susceptible host with a contaminated intermediate object e.g. fomites, medical and patient care equipment, inanimate objects.
- **Droplet transmission**, theoretically, is a form of contact transmission, however the mechanism is quite distinct. Droplets are generated from the source person during coughing, sneezing and talking and during certain procedures such as suctioning and bronchoscopy. Transmission occurs when droplets containing micro-organisms are propelled within a three-foot radius and deposited on the host's mucous membranes e.g. conjunctivae, nasal mucosa or mouth. Droplet transmission should not be confused with airborne transmission.
- **Airborne transmission** – this occurs by dissemination of either airborne droplet nuclei [small particle residue, 5µm or less] of evaporated droplets containing micro-organisms that remain suspended in the air for long periods) or dust particles containing the infectious agent. Such micro-organisms (e.g. *Mycobacterium tuberculosis*, rubeola and varicella viruses) can be dispersed widely by air currents and therefore special air handling and ventilation are necessary;
- **Common vehicle transmission** – this applies to micro-organisms transmitted by contaminated items such as food, water, medications, and devices;
- **Vectorborne transmission** – this occurs when vectors such as mosquitoes, flies, rats and other vermin transmit micro-organisms.

FUNDAMENTALS OF ISOLATION PRECAUTIONS

The fundamentals of infection control measures include:

1. Hand washing - the single most important measure; gloving does not replace hand washing;
2. Limiting the movement and transport of infected patients;

3. Decontamination of medical equipment;
4. Use of personal protective equipment (PPE);
5. Careful handling of sharps and clinical waste;
6. Soiled linen and laundry procedures;
7. Routine and terminal cleaning procedures;
8. Patient placement; appropriate patient placement is a significant component of isolation precautions.

Patient placement/bed management

Trusts need to have a bed management system⁶ that not only helps to find the most appropriate bed for a patient but also helps to prevent cross-infection by tracking the use of single rooms for potentially infected patients. Insufficient single rooms will lead to patients with infections being 'housed' in open ward areas. If insufficient single rooms are available cohort nursing i.e. placing patients with the same infection, but no other infection, in a discrete clinical area where they are cared for by staff who are restricted to those patients, helps to prevent the spread of infection to other clinical areas. This is more easily achieved where wards are divided into small bays of 2-4 beds which can be isolated further by the closure of doors at the entrance/exit and which have en suite sanitary facilities.

General recommendations for bed management for best infection control⁷ include:

- Bed centres should be at least 3.6m apart;
- There should be sufficient single rooms, PEL (04) 04 issued 21st May 2004 allows for 50% single ensuite rooms, to prevent patients known to be at risk being 'housed' in open ward areas.
- Beds in a cohort should be kept to a minimum number possible as this will greatly assist in the prevention of cross-infection;
- Design, accessibility and space in patient areas all contribute to ease of cleaning and maintenance;
- Spacing must take account of access to equipment around the bed and access for staff to hand-wash facilities;
- Consideration can be given to permanent screens between bed spaces as an aid to prevent frequent traffic and thus the potential for micro-organism transfer.

DESIGN AND ROLE OF ISOLATION ROOMS

Purpose:

- To separate patients who are likely to be infectious to other persons.

⁶ *Infection Control in the Built Environment – Design and Planning*, NHS Estates, 2002 (paras. 4.19-4.20)

⁷ *ibid* para. 4.20

- To provide an environment that will allow reduction of the concentration of airborne particles through various engineering methods.
- To prevent escape of airborne particles from such rooms into the corridor and other areas of the facility using directional airflow.
- To protect patients who are immunocompromised from potential harmful pathogens.

Isolation includes:

1. Source isolation to separate an infected patient from other patients and visitors in a single room to help prevent the spread of infection.
2. Cohort source isolation to segregate a number of patients with the same infection together in one ward when there are inadequate number of single rooms, to help prevent the spread of infection.
3. Protective isolation to separate an immunosuppressed patient to minimise the acquisition of an exogenous infection.

ISOLATION ROOM TYPES

Single room

Often the term 'side room' is used interchangeably with 'single room'.

This is a room with space for one patient and usually contains as a minimum: a bed; locker/wardrobe; and clinical hand-wash basin plus a small cupboard with worktop.

En suite single room

As above but with any combination of en suite sanitary facility, that is, shower, shower and toilet, bath and toilet or just toilet etc., includes hand rinse facility.

Mechanically ventilated single room

As above, but with either negative pressure ventilation for infectious patients, (source isolation), or positive pressure for immunocompromised patients (protective isolation); may or may not have an anteroom. It is assumed that these rooms will have an en suite sanitary facility.

CLASSIFICATION OF MECHANICALLY VENTILATED ISOLATION ROOMS

	Standard (normal pressure)	Source (negative pressure)	Protective (positive pressure)
Ventilation type	Balanced air pressure difference between the room and the adjacent corridor	Lower air pressure in the room than in the adjacent corridor	Greater air pressure in the room than in the adjacent corridor
Aim of transmission-based precautions	To prevent contact or droplet transmission	To prevent airborne transmission from the isolated patient	To prevent transmission of pathogens from the outside environment to profoundly immunosuppressed persons
Examples of infectious states	MRSA, VRE, gastroenteritis, cutaneous anthrax, hepatitis A, meningococcal infection	Measles, chicken pox, suspected or proven pulmonary or laryngeal tuberculosis, SARS	Prevention of aspergillosis in bone-marrow transplant recipients

Although simultaneous source and protective (SS&P) isolation rooms, are not included in this report, under rare circumstances it may be advantageous to protect other staff and patients from infection spread by that patient e.g. bone marrow transplant patient with chickenpox.

Most Trusts will currently not have need of such facilities and so detailed descriptions of specifications are not provided here. In the event that these rooms are required, the recommendations given in this document for example, a stand alone ventilation system, suitable surface finishes, room sizes/layouts, etc. must be applied.

Some members of the group are concerned about a potential increased risk to staff of becoming contaminated with the infectious agent in current designs which provide a combined (SS&P) solution.⁸

Accordingly, the authors would draw to the attention of those few Trusts requiring this type of facility, that they should ensure that additional precautions are taken, either in working practices and/or design arrangements, to reduce potential risk to staff to an acceptable level.

Anteroom - an enclosed ventilated room adjacent to the isolation room whose purpose is

⁸ *Guidelines for Environmental Infection Control in Healthcare Facilities. Recommendations of CDS and Healthcare Infection Control Practices Advisory Committee (HICPAC) 2003.*

- to provide a barrier against the entry/exit of contaminated air into/out of the isolation room.
- to provide a controlled environment for donning/removal of PPE, decontaminating equipment, and for clinical hand wash.

Currently the option of having switchable ventilation from source (negative pressure) to protective (positive pressure) is not recommended because of the inherent difficulty of providing failsafe mechanisms and the risk of user error: patients requiring source (negative pressure) isolation have been mistakenly placed in a protective (positive pressure) room with a subsequent spread of infection.

Ventilation requirements as part of control of infection are distinct from those provided as part of the environmental ventilation standards.

NHS Estates Health Building Notes and HTM 2025⁹ (currently under revision) give advice on natural ventilation, general extract ventilation for wards, theatres and specialist areas.

Ventilation recommendations for isolating patients with pulmonary TB can be found in:

the 1994 Centers for Disease Control (Atlanta) recommendations on design criteria in *Guidelines for Preventing the Transmission of Mycobacterium Tuberculosis in Health Care Facilities*¹⁰

- the Department of Health's 1998 Interdepartmental Working Group report on the Prevention and Control of Tuberculosis in the United Kingdom (1998, Annex D, pp83-85) which featured a negative pressure isolation room used for Multi-Drug Resistant Tuberculosis¹¹
- the Joint TB Committee of the British Thoracic Society's *Control and Prevention of TB in the UK – Code of Practice 2000* (Thorax; 2000.49: 1193-1200)¹²

⁹ *Hospital Technical Memorandum (HTM) 2025 Ventilation in Healthcare Premises*, NHS Estates

¹⁰ <http://www.cdc.gov/mmwr/preview/mmwrhtml/00035909.htm>

¹¹ <http://www.doh.gov.uk/tbguide.htm>

¹² <http://thorax.bmjournals.com/cgi/content/full/55/11/887>

INFECTION CONTROL AND VENTILATION REQUIREMENTS FOR ISOLATION ROOMS

A SOURCE ISOLATION ROOMS (Negative Pressure)

Recommendations

1. Maintain a negative pressure gradient from the bedroom to the anteroom to the corridor.
2. Exhaust air ductwork should be independent of the buildings common exhaust air system.
3. Locate extract air outlets above or close to the patient.
4. Extract air should terminate in a safe location away from the fresh air supply inlet and ideally 1.2 metres above the highest part of the building. Where this is not possible or there are other buildings in close proximity, pre and HEPA filters should be used.
5. The extract ventilation system should be designed on a duty and standby basis with automatic changeover in the event of fan failure.
6. The extract fans should be located at the end of the system so as to induce negative pressure throughout the ductwork, therefore reducing the potential for leakage.
7. Each room should have a dedicated Air Handling Unit capable of fully air conditioning the supply in (heating, cooling and humidification). A minimum of EU9 grade filters should be used on the supply air system.
N.B. High Efficiency Particulate Air (HEPA) filters may be fitted on the supply air system, but this is not a requirement.
8. Design the supply air system so as the directional flow of fresh air is from behind the staff over the patient.
9. The supply air system should provide 100% fresh air. (No re-circulation.)
10. In the event of supply fan failure, the extract fan duty will be set back to maintain pressures and air flows.
11. The supply and extract ventilation should be of a constant volume type arrangement.

12. The supply and extract system should maintain an air change rate of 12-15 air changes per hour when the air filters are at their maximum pressure drop. (A minimum of 145/l/s is required for smaller rooms.) (See Appendix 1).
13. The ventilation system should be designed to maintain a 15 Pascal (Pa) pressure differential between rooms.
14. All ductwork systems should be labelled as hazardous with the proper warning notices clearly visible.
15. Where fire/smoke dampers are installed, the dampers should be of the proportional torque control type to ensure that in the event of a generator test they will not fully close and shall fully open once power has been restored.
16. The achievement and control of the negative pressure gradient may be achieved through the consideration of the use of pressure stabilizers installed at low level between the bedroom, lobby/interim although this would be dependent on the final systems design.
17. Audio and visual alarms must be located at the entrance to the anteroom and bedroom to warn nursing and maintenance staff of unsafe conditions. The continuous monitoring alarm system should have local audio and visual indications with remote indication at nursing stations. The system should also be interlinked into the existing Building Management system and have adjustable time delay so as to eliminate nuisance calls. The alarm system should be capable of recording the systems data.
18. The supply/extract fans, together with the monitoring system, should be fed from the essential electrical supply.
19. The light fitting should be recessed and rated IP44.
20. Patient nurse call systems should have the capacity for direct speech between the nurse and patient. Pay telephone facilities shall be available.
21. Clinical wash hand basins (WHBs) should be fitted in the anteroom and bedroom. The WHBs should be sited beside the door. The en suite sanitary facility should be fitted with a hand rinse basin, WC and shower. Hands free taps may be considered.
22. The room should be as airtight as possible.
23. The door of the anteroom and bedroom should be fitted with a Vistamatic type window to allow for visual observation of the patient.

24. The bedroom windows should be of a double-skinned, non-openable type with an electrically or manually operated blind sandwiched between the inner and outer panes of glass. The inner window panel should be lockable.
25. The ceiling should be of a solid, non-porous type construction with no service inspection hatches.
26. The wall finishes should be of a standard theatre specification.
27. Floor finishes should be easily cleaned with a continuous coved skirting and welded joints.
28. All doors should be self-closing.
29. The anteroom should be a minimum of 7m².
30. Staff should be able to see and observe the patient.
31. Patient to be able to see staff and have an outside view, where possible.
32. No fabric curtains, privacy screens or blinds.
33. Good signage.
34. Surfaces to be smooth, easy to clean, durable to appropriate hospital cleaning protocols and resistant to damage.
35. No ledges, including window ledges.
36. Avoidance of tight angles and recesses.
37. Enough space to clean fixtures and furnishings.
38. No fixed cupboards in bedroom.
39. No bulky fixed items.

See Appendix 2 – Sample Isolation Rooms Layouts: (a) Single Source Isolation Room (Negative Pressure)

B PROTECTIVE ISOLATION ROOMS (Positive Pressure)

Recommendations

1. Maintain a positive pressure gradient from the bedroom to the anteroom and corridor.
2. Each room should have a dedicated Air Handling Unit capable of fully air conditioning the supply in (heating, cooking and humidification). High Efficiency Particulate Air filters (HEPA) should be fitted to the supply air system.
3. Locate supply air outlets above or close to the patient. (Supply air should be at low velocity to reduce a draught effect on the patient.)
4. Design the supply air system so as the directional flow of fresh air is across the patient towards the anteroom.
5. The extract or exhaust air ductwork should be independent of the building exhaust air system.
6. The supply and extract system should maintain an air change rate of 12-15 air changes per hour when the air filters are at their maximum pressure drop. (A minimum of 145/l/s is required for smaller rooms.) – doesn't apply to positive pressure.
7. The ventilation system should be designed to maintain a 15 Pascal (Pa) pressure differential between rooms.
8. The achievement and control of the positive pressure gradient may be achieved through the consideration of the use of pressure stabilizers installed at low level between the bedroom, lobby/interim although this would be dependent on the final systems design.
9. In the event of supply fan failure, the extract fans would automatically switch off so as to maintain positive pressure.
10. The supply and extract ventilation should be of a constant volume type arrangement.
11. Where fire/smoke dampers are installed, the dampers should be of the proportional torque control type to ensure that in the event of a generator test they will not fully close and shall fully open once power has been restored.

12. Clinical wash hand basins (WHBs) should be fitted in the anteroom and bedroom. The WHBs should be sited beside the door. The ensuite sanitary facility should be fitted with a hand rinse basin, WC and shower. Hands free taps may be considered.
13. The supply/extract fans, together with the monitoring system, should be fed from the essential electrical supply.
14. Audio and visual alarms must be located at the entrance to the anteroom and bedroom to warn nursing and maintenance staff of unsafe conditions. The continuous monitoring alarm system should have local audio and visual indications with remote indication at nursing stations. The system should also be interlinked into the existing building management system and have adjustable time delay so as to eliminate nuisance calls. The alarm system should be capable of recording the systems data.
15. The light fittings should be recessed and rated IP44.
16. Patient nurse call systems should have the capacity for direct speech between the nurse and patient. Pay telephone facilities shall be available.
17. The room should be as airtight as possible.
18. The door of the anteroom and bedroom should be fitted with a Vistamatic type window to allow for visual inspection of the patient.
19. The bedroom windows should be of a double-skinned, non-openable type with an electrically or manually operated blind sandwiched between the inner and outer panes of glass.
20. The ceiling should be of a solid, non-porous type construction with no service inspection hatches.
21. The wall finishes should be of a standard theatre specification.
22. Floor finishes should be easily cleaned with a continuous coved skirting and welded joints.
23. All doors should be self-closing.
24. The anteroom should be a minimum of 7m².
25. Staff should be able to see and observe the patient.
26. Patient to be able to see staff and have an outside view, where possible.
27. No fabric curtains, privacy screens or blinds.

28. Good signage.
29. Surfaces to be smooth, easy to clean, durable to appropriate hospital cleaning protocols and resistant to damage.
30. No ledges, including window ledges.
31. Avoidance of tight angles and recesses.
32. Enough space to clean fixtures and furnishings.
33. No fixed cupboards in bedroom.
34. No bulky fixed items.

See Appendix 2 – Sample Isolation Rooms Layouts: (b) Single Protective Isolation Room (Positive Pressure)

RACCDC working group on isolation facilities: membership

Dr Nizam Damani (Consultant Microbiologist, Craigavon Area Hospital)
Mr Jeff Dudgeon (DHSSPS Health Protection Team, secretary)
Mr Joe George (Principal Engineer, DHSSPS Health Estates)
Dr Gerry Glynn (Consultant Microbiologist, Altnagelvin Hospital,)
Dr Sara Hedderwick (Infectious Diseases Consultant, RVH)
Dr Paddy Kearney (Consultant Microbiologist/Infection Control Doctor, Antrim Area Hospital)
Mr Nigel Keery (Divisional Estates Officer/Engineer, RVH)
Dr Elizabeth Mitchell (Principal Medical Officer, DHSSPS)
Mrs Elizabeth Qua (Principal Nurse, DHSSPS Health Estates, Chair)
Dr Paul Rooney (Consultant Microbiologist, Northern Ireland Public Health Laboratory)
Mr Aidan Smyth (Nurse Planning Adviser, DHSSPS Health Estates)
Ms Irene Thompson (Senior Infection Control Nurse, RVH)

The group acknowledges the assistance of Dr Janice Thompson, a researcher currently working with DHSSPS.

October 2004

SAMPLE CALCULATIONS FOR SMALLER REFURBISHED ISOLATION ROOMS

Consider two isolation rooms of different dimensions, but with the same contamination source. It is impossible to determine an average contamination rate, so assume a patient is expiring a steady rate of airborne contaminants of one particle per second.

Room 1: 4m x 4m x 2.7m³ (an average sized room)
 12ACHR = 144 litres per second
 Contamination rate = 1 particle per second

Then steady state concentration = $1/144 = 0.0069$ particles/l or 6.9 particles/m³.

Room 2: 3m x 4m x 2.7m = 32.4m³ (a slightly smaller room)
 12 ACHR = 108 litres per second
 Contamination rate = 1 particle per second

Then steady state of concentration = $1/108 = 0.0092$ particles/l or 9.2 particles/m³.

Although the air change rate is the same for both rooms, the steady state of concentration of contaminants in room 2 is 33 per cent greater than that in room 1. If ventilation design is instead based on litres per second per patient, using a minimum of 145 litres per second per patient, then the ventilation of room 2 will achieve a particle concentration equivalent to that of room 1, independent of room volume.

Appendix 2

SAMPLE ISOLATION ROOMS LAYOUT

(a) Single Source Isolation Room (Negative Pressure)



(b) Single Protective Isolation Room (Positive Pressure)



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