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香港特別行政區政府

The Government of the Hong Kong Special Administrative Region

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環境運輸及工務局
局長辦公室
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URGENT

BY HAND

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8 March 2004

Miss Flora Tai
Clerk to Select Committee
Legislative Council Secretariat
Room 608, Citibank Tower
Central, Hong Kong

Dear Miss Tai,

Select Committee to inquire into the handling of the Severe Acute Respiratory Syndrome outbreak by the Government and the Hospital Authority

Thank you for your letter of 13 February 2004.

My response to the questions set out in Appendix IV of your letter of 13 February 2004, together with a copy of my curricula vitae (which contains my professional qualification and experience), is attached for reference of the Select Committee.

Subject to the agreement of the Select Committee, I would like to be accompanied by my Administrative Assistant, Mr Roy Tang.

Yours sincerely,

Sarah Liao

(Sarah Liao)
Secretary for the Environment,
Transport and Works

Select Committee to inquire into the handling of the Severe Acute Respiratory Syndrome outbreak by the Government and the Hospital Authority

Reply by the Secretary for the Environment, Transport and Works in response to questions raised by the Clerk to the Select Committee in her letter of 13 February 2004

Q.1 What are your role and responsibilities as the Secretary for the Environment, Transport and Works with respect to the handling of the Severe Acute Respiratory Syndrome (SARS) outbreak? At which juncture during the SARS outbreak did you and the Environment, Transport and Works Bureau become involved in the handling of the SARS outbreak? Please provide details of your and your Bureau's involvement and specific responsibilities in the handling of the SARS outbreak? What advice did you and/or your Bureau provide in the handling of the SARS outbreak?

A.1 As the Secretary for the Environment, Transport and Works (SETW), I have the overall responsibility for the monitoring and coordination of the activities of the Government Departments under the purview of the Environment, Transport and Works Bureau (ETWB) which contributed to the effort of the Administration in handling the SARS outbreak. A detailed account of the work undertaken by these Government Departments are set out at **Appendix A**. Their efforts were channeled through the following mechanisms :-

(a) the Interdepartmental Action Coordinating Committee (IACC) chaired by the Permanent Secretary for Health, Welfare and Food;

(b) the multi-disciplinary team led by the Department of Health (DH) which undertook detailed inspections at Amoy Gardens and other locations where environmental factors were suspected to have contributed to the spread of the disease. ; and

(c) the ETWB Task Force set up on 1 April 2003, which I led, comprising staff of ETWB, the Environmental Protection Department (EPD), Electrical and Mechanical Services Department (EMSD), Drainage Services Department (DSD) and Architectural Services Department (ArchSD) which conducted detailed investigation on the possible environmental factors contributing to the spread of SARS at Amoy Gardens and visits to hospitals.

On 15 April 2003, I briefed the World Health Organization (WHO) personnel

present in Hong Kong at a meeting (organized by DH) in respect of possible environmental factors contributing to the spread of SARS at Amoy Gardens before the Government's investigation findings into the Amoy Gardens outbreak was announced on 17 April 2003.

In response to the Government's announcement on 17 April 2003, Dr David Heymann, the then Executive Director of Communicable Diseases, WHO, said, "This is a plausible hypothesis. This is the kind of study that is needed to find out what is in the environment that is transmitting the disease.".

The WHO environmental health team came to Hong Kong on 28 April 2003 for a three-week investigation into the causes of SARS outbreak at Amoy Gardens. Together with other members of the ETWB Task Force, I gave a briefing to the WHO team on the methodology and findings of the ETWB investigation on 29 April 2003. After the briefing, Dr Heinz Feldman of the WHO team told the press that the Government had done an excellent job.

During the three-week investigation in Hong Kong, the WHO team received full support from the ETWB Task Force in their work. On 16 May 2003, the WHO team released its own investigation results which were consistent with the findings by the Government.

Q.2 Following the outbreak of SARS at Amoy Gardens, did your staff participate in the site visits to Amoy Gardens conducted by the Department of Health? If not, why not? If yes, what work did your staff carry out during the site visits and what were their findings? Had the hypothesis of infection through environmental factors been raised when it was learned that there was a concentration of SARS cases in Block E of Amoy Gardens? If yes, when was the hypothesis first raised and by whom? What was your reaction?

Q.3 When exactly did you obtain preliminary evidence that suggested that the sewerage and drainage system might have been the cause for the vertical spread of SARS in Block E of Amoy Gardens? What was the preliminary evidence and by whom was it provided? What assessment did you make of the preliminary evidence? Did you take any follow-up action after studying the preliminary evidence? If not, why not? If yes, what follow-up action did you take? Did you inform the Secretary for Health, Welfare and Food immediately? If not, why not? If yes, what was his reaction?

A.2-3

On 26 March 2003, DH's Kowloon Regional Office was notified by HA's

United Christian Hospital that it had admitted 15 suspected SARS cases from seven households from Amoy Gardens.

On 29 March 2003, DH led a multi-disciplinary team which undertook detailed inspections at Block E of Amoy Gardens and the shopping mall. EPD, EMSD, DSD and WSD were members of the DH multi-disciplinary team and joined the inspections.

In the evening of 31 March 2003, EMSD debriefed me on their preliminary findings regarding the ventilation system of the lifts and sewerage system of Block E.

In the morning of 1 April 2003, I informed the Secretary for Health, Welfare and Food (SHWF) of the EMSD preliminary findings. SHWF then told me that the stool samples of SARS patients had been tested Polymerase Chain Reaction (PCR)-positive for the SARS coronavirus. Pieced this information together with the information presented to me by EMSD the night before, I suspected that the lift and sewerage systems could be probable environmental factors associated with the massive outbreak at Block E. Together with SHWF, I briefed Chief Executive's Steering Committee (CESC) on our preliminary conclusion later in the morning. The CESC decided that Block E should be evacuated and thoroughly cleansed. The Chief Executive (CE) also asked me to conduct a detailed investigation on environmental factors accounting for the infection at Block E as soon as possible.

I then chaired a meeting at noon, 1 April 2003, which was attended by staff of ETWB, EMSD, EPD, DSD and the Government Laboratory where a programme of investigation at Block E covering the following was initiated :-

(a) inspection of the sewerage system and the taking of samples;

(b) sampling in the lift plant room;

(c) air sampling in flats to detect micro-organisms;

(d) smoke tests at the lift lobbies of infected floors; and

(e) swab sampling from toilet bowls and floor drains of infected floors.

On 2 April 2003, together with the ETWB Task Force, I conducted a site inspection at Amoy Gardens.

On 3 and 4 April 2003, together with the ETWB Task Force, I conducted detailed investigation into the possible environmental transmissions of SARS

at Amoy Gardens with support from DH staff.

On 5 April 2003, I presented the preliminary findings in the form of a technical report to CESC (see **Appendix B**).

Q.4 On 4 April 2003, you invited Dr Stephen NG Kam-cheung to attend a meeting held that evening regarding the SARS outbreak at Amoy Gardens? Why did you invite Dr NG to the meeting? What exactly was discussed and which other government officials were also present at the meeting? What were the details and outcome of the discussion? Further to that meeting, did you meet with Dr NG again regarding the SARS outbreak at Amoy Gardens? If yes, when did you meet with Dr NG again? What was discussed with Dr NG and what was the outcome?

A.4 Dr NG met with SHWF and me in the afternoon of 4 April 2003 (Note 1). I was invited to participate in the meeting as my personal professional background on environmental health could be useful to the investigatory work of SHWF and the DH. Also in attendance were representatives from ETWB (PSET, DS(E)2, AA/SETW and Press Secretary/SETW) and DH (Dr Paul Saw and Dr Thomas Tsang). Although the Government then already had some preliminary evidence indicating that the sewerage system might have been involved in the vertical spread of SARS cases in Block E, all other possible factors, including person-to-person spread, contamination of water supplies, garbage, lift system, rats and cockroaches were also actively investigated.

At the meeting, Dr NG expressed his views on the outbreak at Block E of the Amoy Gardens, citing rats as the most probable cause. He made the following points in respect of his hypothesis that rats could have been responsible for the outbreak :-

(a) rats were somehow carrying the coronavirus through contacts with contaminated garbage at the garbage collection point or the toilets of restaurants at the podium of Block E to which infected residents might have visited; and

(b) The rats moved along the pipes of Block E, urinated on the pipes and contaminated the water supplies.

(Note 1) : Contrary to the testimony of Dr Stephen Ng on 28 February 2004, it is the clear recollection of attendees that SHWF did join the meeting on 4 April 2003.

In response to Dr NG's hypothesis, apart from stating the general criteria for infection of a population, namely exposure and dose, I pointed out that it was not possible that the urine of rats could have seeped through the cracks, if present, of the pipes supplying water to the residential units due to positive pressure inside the pipes. As an alternative, Dr NG also postulated that the urine of rats could have contaminated the water supplies at source (i.e. at the main water tanks on the rooftop of Block E). However, I also highlighted that the chlorine in the water should have prevented the extended isolated survival of the virus.

The meeting also noted that no worker at the garbage collection point and the restaurants at the podium of Block E was infected. If those areas had been the "sources" of the contamination for the rats, then the possibility of infections of those individuals would be extremely high. At the end of the meeting, I was of the opinion that Dr NG had not substantiated his hypothesis with convincing scientific arguments.

I did not meet with Dr NG again after the meeting of 4 April 2003 although we did exchange e-mail and talked over the phone.

Q.5 The Government released its summary report in respect of the SARS outbreak at Amoy Gardens on 17 April 2003. Why did the Government not release the full report to the public? What were the findings for the spread of SARS in Blocks B, C and D of Amoy Gardens? Were your advice and/or views sought on the summary report prior to its release? If not, why not? If yes, what advice and/or views did you provide and were they incorporated in the summary report?

A.5 On the basis of the investigation at Amoy Gardens, ETWB produced a technical report on 5 April 2003 **(Appendix B)**, the findings of which were incorporated into the investigation findings released by the Government on 17 April 2003. I was consulted on these investigation findings before they were released by DH and was content that the gist of the findings of the ETWB Task Force on the Amoy Gardens outbreak had been reflected. As the investigation was led by DH, I was not involved in the decision relating to the release of the investigation findings.

Q.6 In addition to the above-mentioned report, are there reports on other studies related to the outbreak in Amoy Gardens carried out by other organizations such as tertiary institutions? If so, have you studied such reports and what are your views on such reports?

A.6 I was aware of other studies being undertaken by other organization such as tertiary institutions before the release of the Government's investigation findings on 17 April 2003. In fact, I have had discussions with some of the researchers.

Since the release of the Government's investigation findings, a number of studies conducted by local tertiary institutions on the possible causes of the Amoy Gardens outbreak were also reported in the media. These reports either confirmed the findings of the ETWB Task Force or provide further insights/hypothesis on the operation of aerodynamics or fluiddynamics of the Amoy Gardens or the sewerage system of Block E.

On 16 May 2003, WHO released its own investigation findings on the Amoy Gardens outbreak and they were consistent with the investigation findings of the Government.

Q.7 On 15 April 2003 (Note 2), you visited Tuen Mun Hospital. What was the purpose of your visit and why was the visit necessary at that point in time? Who accompanied you on the visit? What was observed during the visit and what were the findings? Did you give any advice and/or views on the infection control measures and facilities of the hospital? If not, why not? If yes, what were your advice and/or views? Did you take any follow-up action after the visit? If not, why not? If yes, what follow-up action did you take?

Q.8 On 23 April 2003, you visited Princess Margaret Hospital. What was the purpose of your visit and why was the visit necessary at that point in time? Who accompanied you on the visit? What was observed during the visit and what were the findings? Did you give any advice and/or views on the infection control measures and facilities of the hospital? If not, why not? If yes, what were your advice and/or views? Did you take any follow-up action after the visit? If not, why not? If yes, what follow-up action did you take?

Q.9 On 16 May 2003, you visited Alice Ho Miu Ling Nethersole Hospital. What was the purpose of your visit and why was the visit necessary at that point in time? Who accompanied you on the visit? What was observed during the visit and what were the findings? Did you give any advice and/or views on the infection control measures and facilities of the hospital? If not, why not? If yes, what were your advice and/or views?

(Note 2): The visit to Tuen Mun Hospital took place on 15 May 2003, not 15 April 2003.

Did you take any follow-up action after the visit? If not, why not? If yes, what follow-up action did you take?

Q.10 On 16 May 2003, you also visited Tai Po Hospital. What was the purpose of your visit and why was the visit necessary at that point in time? Who accompanied you on the visit? What was observed during the visit and what were the findings? Did you give any advice and/or views on the infection control measures and facilities of the hospital? If not, why not? If yes, what were your advice and/or views? Did you take any follow-up action after the visit? If not, why not? If yes, what follow-up action did you take?

A.7-10

Since mid April 2003, the ETWB Task Force provided the SARS hospitals of the Hospital Authority (HA) with advice and suggestions on how their hardware, such as their sewerage, ventilation and air purification systems, could be improved to help reduce the chance of cross-infection among their health-care staff. Reports No. 3 and 4 of **Appendix C** summarize the work of the ETWB Task Force on this front.

To ensure that the hardware improvement proposed by my staff were practicable given the inherent constraints, I visited the following hospitals (Note 3) :-

Date	**Hospital**
23 April 2003	Princess Margaret Hospital
12 May 2003	Queen Mary Hospital (QMH)
14 May 2003	Prince of Wales Hospital (PWH)
15 May 2003	Tuen Mun Hospital (TMH)
16 May 2003	Tai Po Hospital Alice Ho Miu Ling Nethersole Hospital

On the basis of my 20-year experience as a practitioner in occupational safety and environmental health, I also made observations on infection control at these hospitals during my visits, which includes the health safety practices and management systems promulgated by HA and adopted by health-care workers.

(Note 3) : During the visit to these hospitals, I was given the opportunity to visit active SARS wards at QMH, PWH and TMH.

The senior management of HA and the hospital managements were closely involved throughout my hospital visits.

Four reports (No. 1 to No. 4 reports as per **Appendix C**) were produced by the ETWB Task Force which were submitted to HWFB on 24 May 2003.

Report No. 1 summarizes the observations of the ETWB Task Force based on the visits to the hospitals and discussions with their management. On the basis of these observations, suggestions were made on improvement measures with a view to help reduce the chance of health-care staff in those hospitals contracting SARS while at work.

In Report No. 2, observations are made and hypotheses are provided on the SARS cases in the hospitals based on the information gathered during the visits to the hospitals. Improvement suggestions are also included.

Reports No. 3 and 4 deal mainly with medium to long term physical/engineering measures.

Dr Sarah Liao
Secretary for the Environment, Transport and Works
6 March 2004

Appendix A

Efforts of Government Departments under the charge of the Environment, Transport and Works Bureau during the SARS Outbreak

This note sets out the efforts made by the government departments under the charge of the Environment, Transport and Works Bureau (ETWB) towards the combat of SARS.

Transport Department

2. As a member of the Interdepartmental Action Coordinating Committee (IACC), the Transport Department (TD) had the following roles and functions :-

(a) to co-ordinate actions of transport operators on the transport front to prevent the spread of SARS;

(b) to help increase awareness of passengers and public transport trades of SARS and enhance hygienic condition of transport carriers;

(c) to monitor impact of SARS on the ridership of public transport systems; and

(d) to develop and implement measures to improve the operating environment of the affected transport trades.

3. The measures taken by TD included :-

(a) issued sector-specific health advice in consultation with the Department of Health (DH) and used reserved radio airtime slots to publicize messages to transport operators and passengers on relevant health guidelines;

(b) stepped up publicity efforts by organizing health talks for operational staff of minor transport operators and cleansing campaigns for taxis, public light buses, coaches and nanny vans;

(c) monitored actions taken by transport operators through weekly returns

and experience sharing sessions;

(d) devised helping measures for the affected trades to improve their operating environment and to help them to save cost (in addition to the measures announced by the Chief Executive on 23 April 2003) which included :-

(i) concessionary parking charges for taxis and nanny vans;

(ii) relaxation of stopping restrictions for taxis;

(iii) lifting of 4-5pm clearway restrictions for all modes and some location specific restrictions for public light buses;

(iv) adjustment of service levels of MTR, franchised buses and scheduled public light buses in accordance with change in passenger demand; and

(e) developed contingency transport plans in the event of an outbreak of SARS within individual public transport organizations.

Environment Protection Department

Hospital Improvement Work

4. In April and May 2003, EPD staff worked with EMSD, ArchSD and HA colleagues on measures to help reduce the chance of public health-care workers in hospitals SARS being cross-infected. Specifically EPD colleagues helped in offering comments and advice on the following :-

(a) a new local exhaust system for individual patients in the SARS wards;

(b) the use of HEPA air purifiers; and

(c) ventilation system design for the SARS wards.

SARS and Chlorinated Compounds in Environmental Waters

5. To help confirm that disinfection measures taken by the hospitals were effective in preventing SARS virus form spreading into environmental waters through sewerage systems, EPD collected water samples from Kai Tak Nullah, the Stonecutters Island sewage outfall area, Ma Wan Fish Culture Zone, Ma Wan Beach, Golden Beach, and sewage samples from Stonecutters Island Sewage Treatment

Works (STW) and Sandy Bay STW for virus analysis. All water and sewage samples yielded negative results for SARS virus.

6. As large amounts of bleach and detergent were used during the SARS outbreak for disinfection, EPD collected marine samples from various sites, including central Victoria Harbour, Stonecutters Island STW outfall area, northwestern water, Mirs Bay, and Ma Wan and Wong Wan Fish Culture Zones for testing of harmful chlorinated by-products, e.g. trichloromethanes, chlorophenols, dioxins [PCDD/ PCDF]. All water samples were negative for the presence of chlorinated by-products.

[redacted] Hotel

7. EPD joined DoH to investigate into the clustered SARS cases at [redacted] Hotel. The team looked into the reported cases in relation to the floor layout, air ventilation and conditioning system, sewer system, and room cleaning service and procedures. It was found that the ventilation and sewage systems would unlikely be the main pathway for transmission of the disease.

Lower Ngau Tau Kok Estate, Ngau Tau Kok

8. EPD participated in the investigations into the SARS cases at Lower Ngau Tau Kok Estate but could not identify any evidence showing the sewerage system or other environmental factors being responsible for the spread of disease.

Hing Tung House, Tung Tau II Estate

9. EPD staff participated in the investigation by visiting a stack of units on the upper floors with reported SARS cases. EPD staff accompanied WHO experts during their independent investigation.

Harbour Plaza Hotel

10. In response to a reported SARS case involving a guest who stayed at the Hotel, EPD staff visited the Hotel. A thorough examination on the design and layout of the ventilation system and soil pipe for the guest rooms revealed no cause for concern. Swab samples taken by DH from the guest room also yielded negative results for the virus.

Koway Court, Chai Wan

11. EPD joined the investigation by DH on the cause for the cluster of cases in the Estate. No evidence, however, were found that the virus spread through the environmental pathway.

Wing Shui House, Lik Yuen Estate

12. EPD staff participated in a joint investigation into a cluster of cases involving 5 households and more than 10 patients. No environmental pathway could be established.

Electrical and Mechanical Services Department

13. Following the formation of the Task Force under ETWB to provide HA with technical advice on how the existing ventilation system of SARS wards could be improved, a working group on enhancement of infectious disease facilities of the public hospital system was set up in June 2003 under the ICCA. The working group was chaired by PS/HWFB. EMSD was one of the members of the working group and was requested to provide technical advice and engineering support to the working group.

14. EMSD assisted DH in the investigation on the ventilation system including the lift shaft room at the Block E of Amoy Gardens.

15. EMSD, as a member of the ETWB Task Force, coordinated and provided engineering support to HA with advice/suggestions, from ventilation and other building service perspective, to help reduce the chance of SARS cross-infection of public health-care workers in hospitals. Installation of local exhaust systems and HEPA air purifiers were recommended to hospitals to reduce the risks of spreading the virus during the application of BiPAP. Long term improvement proposal for the engineering system to combat SARS spread in hospitals were drawn up for HA's consideration.

Drainage Services Department

16. As a member of ICCA, DSD was responsible for :-

(a) ensuring that the sewerage system in the vicinity of suspected/confirmed AP cases was functioning properly; and

(b) cleansing of public sewers in the vicinity, if required by DH.

Following the operation protocol developed for the Multi-disciplinary Response Team, DSD was engaged in the cleansing of public sewers in areas such as Tai Po, Sha Tin and Kwai Chung.

17. As a member of the ETWB Task Force, DSD was responsible for :-

(a) entering selected flats in Block E of Amoy Gardens to carry out dye testing of the toilets bowls and bathtubs; and

(b) conducting swab sampling in sewage discharge pipes at Amoy Gardens for the examination of E. Coli as an indicator of faecal contamination.

18. Apart from the above, DSD undertook the following work during the SARS period :-

(a) inspecting and cleansing drains and sewers in SARS affected areas (such as Lower Ngau Tau Kok Estate); downstream of hospitals (such as United Christian, Wong Tai Sin); and downstream of holiday camps serving as quarantine camps (the Sai Kung Outdoor Recreation Centre);

(b) assisting FEHD in disposing sewage collected from the Lady MacLehose Holiday Village; and

(c) rectifying the expedient connections at Tung Tau Estate Block 22.

Architectural Services Department

19. ArchSD arranged a maintenance term contractor to assist DSD in removing the cleaning eyes of the above ground drainage system in Amoy Gardens for inspection and collection of sewage samples by the Department of Health to carry out clinical/laboratory analysis.

20. ArchSD's maintenance staff has attended the five SARS hospitals and explained to the hospital management the operation and maintenance of the hospital drainage system.

21. ArchSD is responsible for the maintenance of Schedule I hospitals. In connection with the SARS outbreak, ArchSD carried out alterations and additions at the request of the hospitals between March and May 2003. Works included the addition of showers and wash-hand facilities, minor alterations and partitioning, and disinfection facilities to the drainage system. Subsequently, ArchSD was commissioned as the works agent for the improvement works to the isolation wards in six hospitals involving 927 beds, under PWP No. 8056MM, of APE $355M. 95% of the works had been completed by end February 2004.

Water Supplies Department

22. The Water Supplies Department (WSD) was one of the members of the DH multi-disciplinary team investigating the SARS outbreak at Amoy Gardens. The activities carried out by WSD in connection with the above investigation were :-

(a) examining both the public fresh and flushing water supply systems outside Amoy Gardens, and the private plumbing systems (fresh water, flushing water and fire service) inside Amoy Gardens to see if there were any irregularities that could cause contamination to the fresh water system; and

(b) taking water samples in accordance with procedures suitable for biological samples from various locations inside Amoy Gardens as directed by the Department of Health and delivering the water samples to the Government Laboratory for analysis.

Environment, Transport and Works Bureau
March 2004

Appendix B

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Spread of Sever Acute Respiratory Syndrome (Sars) at Block E of Amoy Gardens Assessment of Possible Environmental Agents

BACKGROUND

1.1 Severe Acute Respiratory Syndrome (Sars) is an acute respiratory infection that has been reported since late 2002 in a number of regions, including Hong Kong.

1.2 The latest medical research indicates that a coronavirus is the primary cause of the disease. So far, all the evidence points to the possibility that transmission is by respirable droplets and direct contact with infected persons' secretions.

1.3 The outbreak of Sars in Hong Kong, as in the case of a similar outbreak in Hanoi, Vietnam in February 2003, began with infections by hospital staff who came into contact with Sars patients. The disease went beyond the initial focus in local hospitals in mid March 2003. The outbreak was notably serious at Amoy Gardens, in particular residents of units 7 and 8 in Block E, their families and persons with associations with them.

1.4 Since the outbreak in mid March 2003, there have been over 700 confirmed Sars cases, out of which over 200 are related to health workers, nearly 300 are residents of Amoy Gardens and the rest are scattered.

1.5 Whilst the mode of transmission of the virus for health workers is reasonably well understood, the spread of Sars at Amoy Gardens is a puzzle. The high Sars incidence as well as the sustained intensity of the infection at Amoy Gardens points to the possibility that the transmission of the virus may involve environmental agent in addition to person-to-person transmission.

1.6 The purpose of this investigation is to explore the possibility of modes of transportation of the virus through the environment and to evaluate the most likely cause or conjugate of causes.

AMOY GARDENS

2.1 Amoy Gardens is one of the early generation of high-rise private housing estates built in 1981. It is located in Ngau Chi Wan in Kwun Tong District, which is relatively dense in population. The estate is located at the foot of a hill side and is separated from other surrounding housing estates by roads. The development provides small-sized housing flats, accommodating a population round 19,000.

2.2 There are 19 residential blocks (Block A to S) of 33-storey sitting on a deck of podium with three levels of shopping arcade. The estate was designed as a balanced self-contained community with its own car parking, supermarkets, banks, restaurants, shopping mall and a cinema. The deck of the podium provides the sitting area, car park space, and the ground level for entrance to the residential blocks.

2.3. Block E is of particular concern in the incident. It is sited near to the perimeter of the estate **(Annex A)**. Block E, like other blocks in the estate, consists of eight flats (Units 1 to 8) of typical design, with floor areas in the range around 48 square metres. The eight flats on each floor, with two in each of four orientations, are built around a rectangular-shaped central core containing three passenger lifts **(Annex B)**. Each flat is furnished with one toilet and one kitchen together with living and bed rooms. Flats of the same stack in different floors are served by plumbing and drainage piping systems running vertically along the external wall **(Annex C)**.

2.4 Since mid March this year, there has been an outbreak of Sars infection amongst the residents. The index patient was identified by Department of Health to be a dialysis patient who visited unit XXXX, Block E. Subsequent victims numbers quickly grew to 273 by 4 April 2003, with the bulk of the affected located in Block E, units 7 and 8, while Block B, C and D have the next highest and the rest are scattered in the remaining blocks.

POSSIBLE AGENT 1: AIR

3.1 Hong Kong is well known for its extremely dense population in the urban area – over 5 million people commuting to work everyday within an area of 100 square kilometres. The public transport system comprising buses, mass transit railways, minibuses and ferries move over 4.5 million people per day. The infected Sars people have travelled on this system but the infection rate amongst the population has remained below 0.01%. Airborne transmission in such as congested place would have resulted in long exceeded multiples of this

level.

3.2 During the Amoy Gardens outbreak, none of the staff working in the shopping arcade and the management office, who come into frequent contact with the residents, has been reported to have contracted Sars.

3.3 The patients from Amoy Gardens represent people from all walks of life – such as worker in the railway station, government officers, bank clerks, librarians, immigration officers, etc. However, we have not observed a connected spread of the disease at the workplace.

3.4 The rate of spread at Amoy Gardens was fast, but it is mainly concentrated in Block E and, to a lesser extent, Blocks B, C and D. There is no case in the extensive commercial complex housing restaurants, cinemas and shopping arcades. This phenomenon, together with the general infection pattern in the community, refutes the postulation of diffusion through air, which would have shown much more random dispersion.

3.5 All the air samples taken in residential units of Amoy Gardens, inside the lift cars, inside the lift plant room and from the exhaust of the lift chamber of Block E are PCR-negative. Air samples taken inside the lift cars, inside the lift plant room and from the exhaust of the lift chamber of the other five blocks of Amoy Gardens are also PCR-negative. Admittedly a negative sampling result does not completely exclude the presence of airborne Sars virus at all those locations. But it serves to illustrate that the airborne concentration is below detection limit of the PCR.

3.6 Similarly, all the swab samples taken from the filter of the lift plant room of Block E and the other five blocks of Amoy Gardens are PCR-negative.

POSSIBLE AGENT 2: SOLID (Garbage/Food)

4.1 One garbage cleaner is responsible for collecting refuse for the whole of Block E in the night. Passenger lifts are used to transport refuse collected. The cleaner takes the lift to the top of the block and tugs garbing bags into the passenger lift and collect refuse as she cases down the block.

4.2 Body fluids (including sputum, mucous secretions, saliva, dialysis fluid, blood etc.) of Sars patients containing the virus could have been among household garbage. If handled carelessly, the secretions or materials attaching the secretions could have ended up on the floor and the wall of the building or at the podium of Amoy Gardens. For example, the secretions of a Sars patient

could have ended up on the wall or ground of another floor of Block E or on the wall or ground of the podium if the garbage bag leaked. Or, the secretions could have been spread to the other blocks of Amoy Gardens as the push carts for transporting the garbage circulated within the estate. Residents of Amoy Gardens could then have brought the secretions home through their shoes and got the infection.

4.3 However, the phenomenon that residents of the lower floors of Block E of Amoy Gardens, who would have been subject to the same risks, seem to be less vulnerable to contracting Sars cannot be accounted for. Also the source of such contaminant would not be sufficient for such an outbreak.

POSSIBLE AGENT 3: SEWAGE

5.1 The sewerage system at Amoy Gardens comprises an 11 cm PVC sewage downpipe from the top floor to the 4th floor where it is joined by a similar kitchen drainage pipe also extending through the height of the building. For the sewer duct, there is a parallel air vent pipe duct of 3 cm in diameter re-joining the sewer pipe at the root level. The kitchen pipeduct is vented at the top.

5.2 The toilet bowl, the floor drain, the bath tub, and wash basin in the bathroom are all connected to the external sewer pipeduct. The kitchen sink and floor drain are connected directly to the kitchen duct.

5.3 If the sewage system is properly maintained, there should not be any possible route of exposure to the residents. However, upon investigation, it has been found that there were frequent complaints from the residents that the sewer was blocked and that foul smell detected in both the kitchen and the bathroom. The water in the toilet bowls showed turbulence due to gas gushing out.

5.4 As the sewage pipes are connected to a system to which the floor drains of the bathrooms are also connected, the virus could have been spread within Block E through the floor drains. For example, sewage droplets carrying the virus could be sucked into a bathroom through the floor drain due to negative pressure created by switching on the bathroom's exhaust fan with the bathroom's door closed. The droplets would then have come into contact with the residents. The droplets could also spread into the light well between units 07 and 08 of Block E through the exhaust fan. (**Annex D**)

5.5 From visual inspection, there are also signs of leakage from the sewage pipeducts along the external walls of the blocks. In which case, virus in the sewage pipes could have become droplets outside of the sewage system if

there is leakage in the pipes. The droplets could have been carried into the residential units through air-conditioning units or windows located close to the leakage points through negative pressure (**Annex E**).

5.6 Pests such as rats and cockroaches (the latter as a mechanical carrier) could also have been spreading the virus within Block E or the other blocks of Amoy Gardens.

5.7 Any findings by the Department of Health of how long the AP virus can live within a sewage environment would also facilitate the study of sewage as a possible environmental agent.

HYPOTHESES

6.1 There are a number of hypotheses of the high incidence rate at Block E and the spread of Sars to other blocks of Amoy Gardens: -

(A) The sewage in Block E contains infectious virus at some point in time.

(B) Residents of middle to upper floors at Units 7 and 8 had the highest exposure possibility.

(C) There are additional route of entry from the sewer pipe to the residence.

(D) Residents in Block E are subject to the infecting agent (sewage) from Unit 7.

(E) Blocks under the same sewerage system are infected by the same event.

Tests to Demonstrate the Hypotheses

Hypothesis A

6.2 A swab sample taken from the toilet seat of an infected household in Block E of Amoy Gardens is PCR-positive. Independent analysis by a university laboratory has also demonstrated the presence of the virus in the facecal and urinal discharges of the Sars patients.

6.3 The sewage within the pipes could have been a media for the corona virus where it remains infectious for a period of time. (Length of survival to be provided by Department of Health).

Hypothesis B

6.4 Unit 7 and unit 8 are separated by a narrow six-feet 'canyon'. Their bathroom window, exhaust fan, master bedroom window and air conditioner, cloth rack faces each other in this small, dark and humid space. Sewage runs down the sewer downpipes and if there are leaks along the pipe, they should be detected. However the test of drains using a tracer dye conducted on April 2003 did not show any visible leakage. The testing could not be done with pressure for fear of bursting the old pipe duct which is nearly 10 years. However, stains were observed at the junction between the wall and the external pipe at many of the joints (**Annex F**). There is a high possibility of seepage.

Inspection

6.5 At the inspection of the accessible portions of the duct, a large crack is found on the sewage vent pipe (**Annex G**). It is likely that such cracks are present in the system elsewhere. Accessibility and time did not allow inspection at every unit.

6.6 Everytime when someone flushes the toilet along this pipeduct, droplets will be discharged and floats in the 'canyon' space. The windows opening into the master bedroom will let the droplets in.

Physical Testing

6.7 A smoke test was done to demonstrate the chimney effect of the canyon on 4 April 2003. The puff of smoke rises rapidly in a plug and disperses when reaching the roof. The updraft effect was clearly demonstrated. (A video recording is available)

6.8 In addition, a SF6 tracer gas tests was conducted by releasing the tracer gas at Unit 13XX and measuring the dispersed gas at Unit 33XX and at Unit 7XX. The level of SF6 at Unit 33XX showed a dilution of 100 times while at the 7th floor, it was not detectable.

6.9 In this case the infectious sewage inside the pipe will remain for a reasonable period during which time there will be constant supply of droplets of sewage containing the virus. The residents who were sleeping in Units 7 and 8 must have been exposed to this droplet containing the sewage of the infectious patient at Unit XXXX. At the same time the clothes on the rack will also be contaminated by the deposition of the droplets through out the period when they were on the drying lines. The persons at these locations will be receiving sufficient dose unawarely.

6.10 The residents in the lower floors are not affected because of the updraft effect of the canyon.

Hypotheses C

7.1 The floor drain in the toilet is linked to the sewer vent pipe. It is however isolated by a U-tube with water blockage. Out of the 8 units tested, one clearly demonstrates that the U has dried up and air enters the bathroom from the sewer. This is especially apparent if the exhaust fan is turned on in the bathroom as illustrated with the smoke test. (A video is available).

7.2 Since the units of the block are of the same design, the possibility of sewer droplets entering units is highly likely especially with the U-tube is dried and blockage occurs in the downpipe.

Hypotheses D

8.1 The sewerage system is connected at the podium level at every block (**Annex H**). Hence the sewer of all units in Block E will be contaminated along with Unit 7, although diluted. The negative pressure created by exhaust fans in bathrooms will draw in the droplets from the sewage downpipe. Infection spreads to all units of Block E.

Hypotheses E

9.1 The sewage trunk pipe join all blocks in Amoy Gardens, at ground level before entering the government sewerage, protected by a manhole trap. The gradient of the trunk pipe has a "watershed" between Block F and Block E: which means sewage flows only from E to D but to F. The sewerage diagram shows the flow of sewage (**Annex I**).

9.2 Although by the time the sewage from Block E reaches the trunk sewer, it is further diluted, nonetheless the virus can still reach each unit via the floor drain mechanism.

CONCLUSION

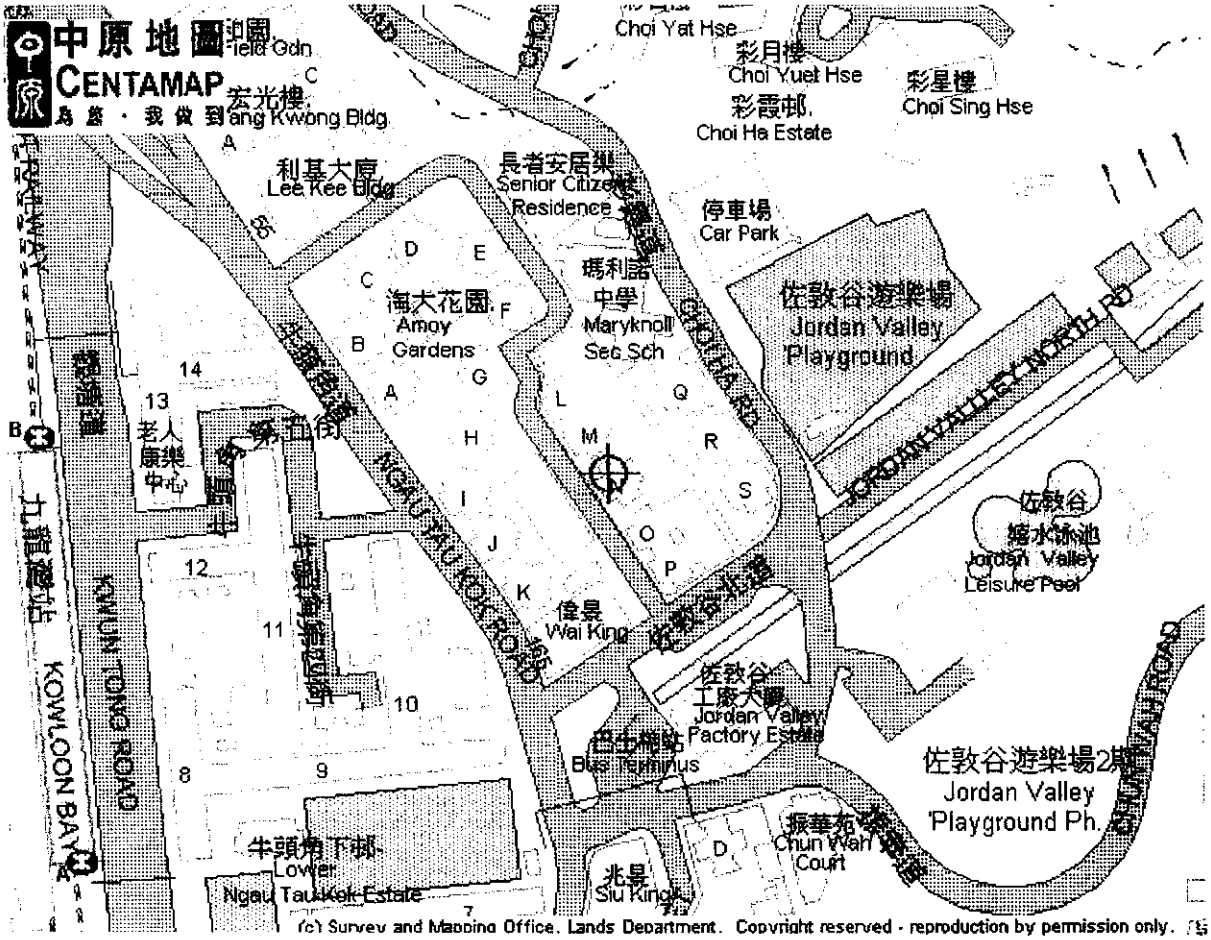
10.1 The source of virus is from the sewerage system and can be shown to be transmitted through droplets to the Phase I residents in graded intensity; all with non-refutable reasons. The incidence of infection is determined by DOSE of the virus:

Dose = Concentration x Exposure time

10.2 The droplet dose will not infect a passer by, however for residents in the units, they are subject to a much higher dose. The hypothesis also confirms with the varying concentration of the sewage is comparable to the incident rate, i.e. Block E is greater than the rest of the Blocks A, B, C, D, and as Block F is not in the same system, its incident rate is exceptionally low.

----- Ends ------

Annex A


中原地圖
CENTAMAP
Choi Yat Hse
彩月樓
Choi Yuet Hse
彩霞邨
Choi Ha Estate
彩星樓
Choi Sing Hse
利基大廈
Lee Kee Bldg
長者安居樂
Senior Citizen
Residence
停車場
Car Park
佐敦谷遊樂場
Jordan Valley
Playground
瑪利諾
中學
Maryknoll
Sec Sch
海大花園
Amoy
Gardens
JORDAN VALLEY NORTH RD
佐敦谷
泳水泳池
Jordan Valley
Leisure Pool
KWUN TONG ROAD
KOWLOON BAY
偉景
Wai King
佐敦谷
工廠大廈
Jordan Valley
Factory Estate
巴士總站
Bus Terminus
佐敦谷遊樂場2期
Jordan Valley
Playground Ph. 2
振華苑
Chun Wah
Court
兆景
Siu King
牛頭角下邨
Lower
Ngau Tau Kok Estate
老人
康樂
中心
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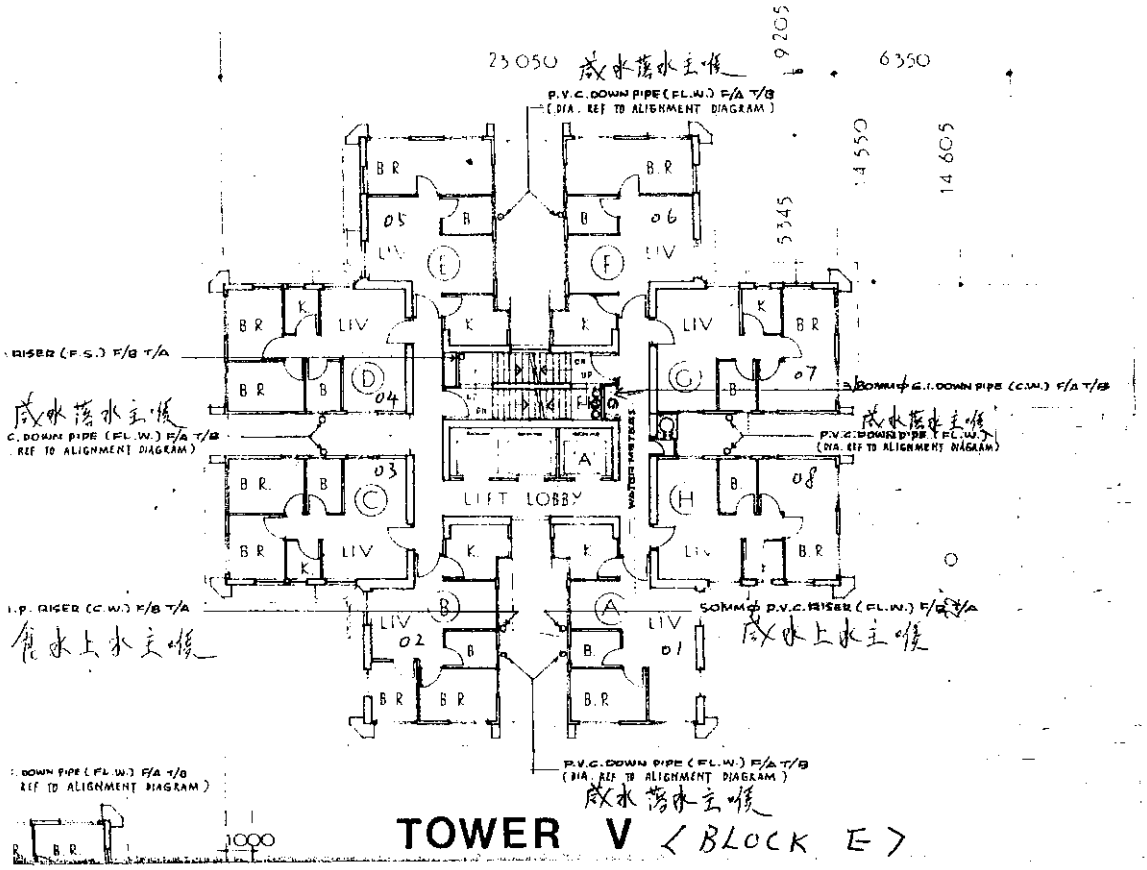
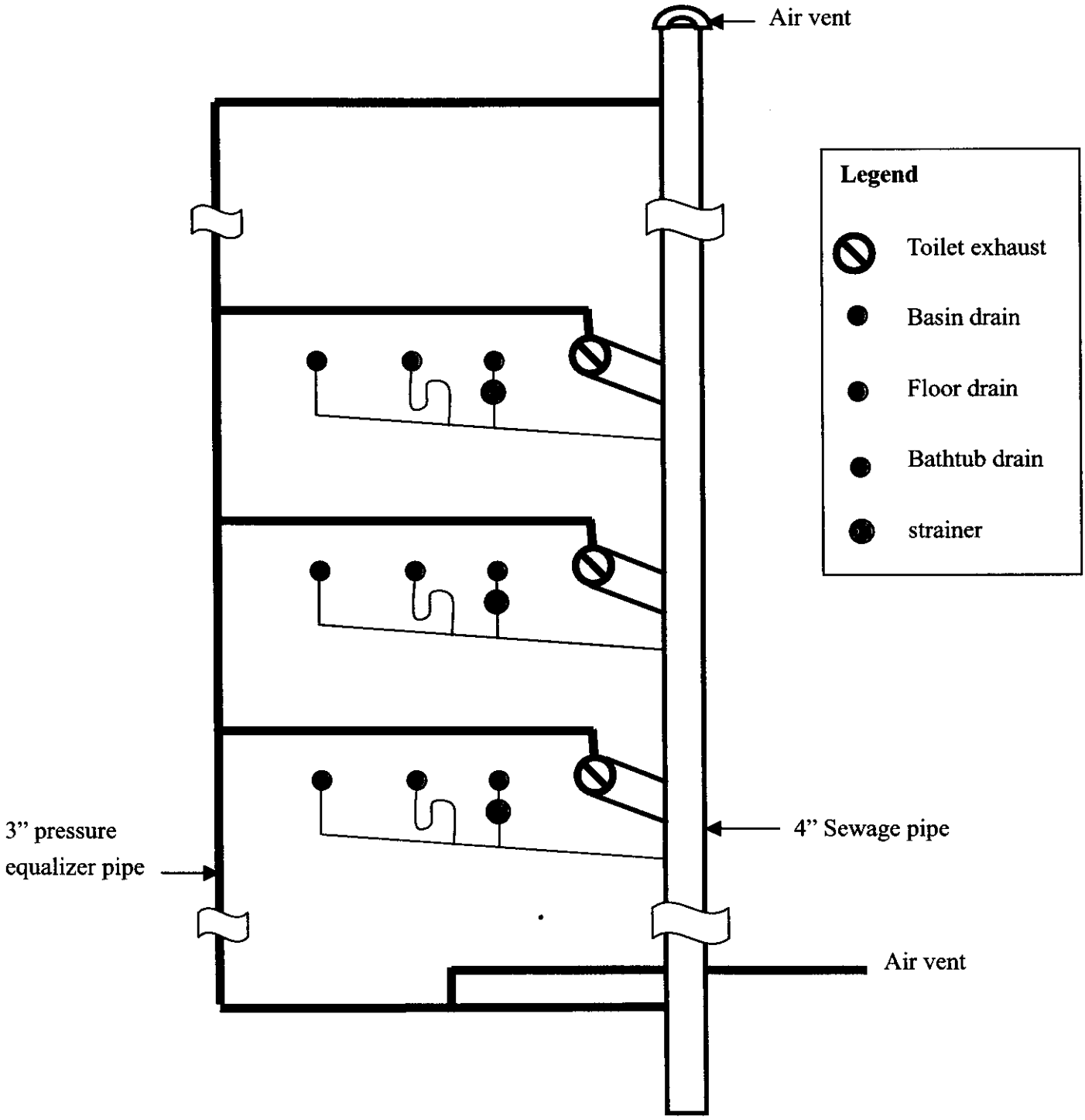
Annex B


23050
9205
6350
14550
14605
5345
P.V.C. DOWN PIPE (FL.W.) F/A T/B
(DIA. REF TO ALIGNMENT DIAGRAM)
RISER (F.S.) F/B T/A
C. DOWN PIPE (FL.W.) F/A T/B
(DIA. REF TO ALIGNMENT DIAGRAM)
50MM Φ C.I. DOWN PIPE (C.W.) F/A T/B
P.V.C. DOWN PIPE (FL.W.)
(DIA. REF TO ALIGNMENT DIAGRAM)
I.P. RISER (C.W.) F/B T/A
50MM Φ P.V.C. RISER (FL.W.) F/B T/A
LIFT LOBBY
WATER METERS
B.R.
LIV
K
B
01
02
03
04
05
06
07
08
P.V.C. DOWN PIPE (FL.W.) F/A T/B
(DIA. REF TO ALIGNMENT DIAGRAM)
1000
TOWER V (BLOCK E)

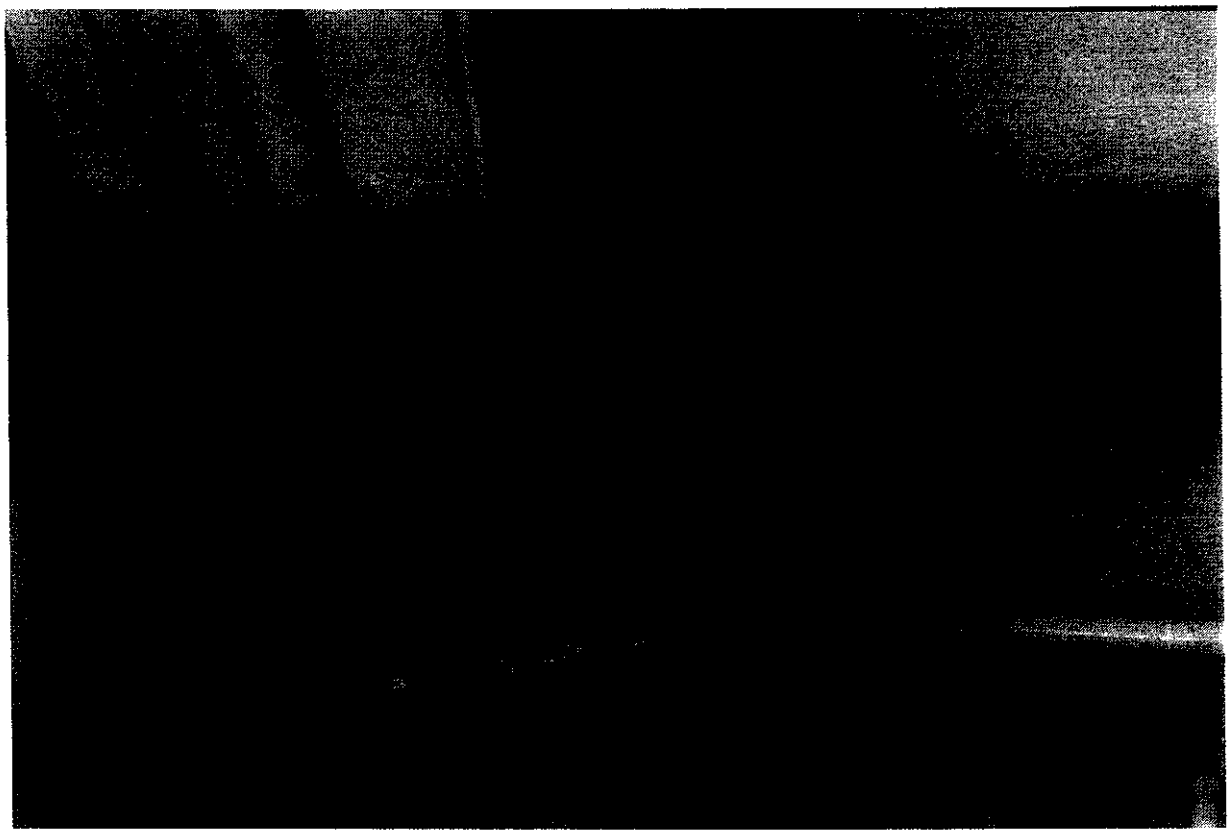
Annex C

Annex D

Schematic diagram of the sewage pipes
Flats 7 and 8 of Block E, Amoy Garden

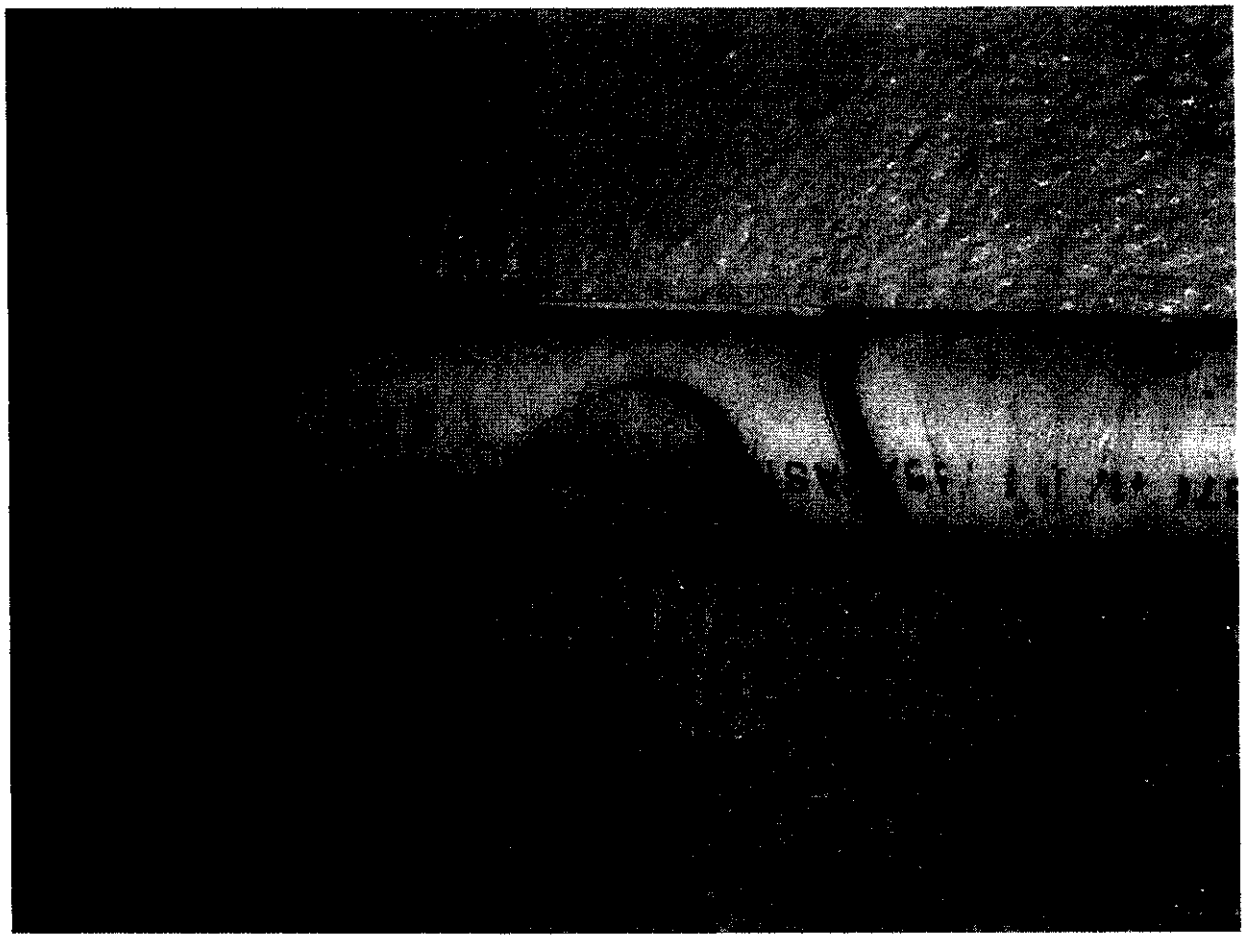


Annex E

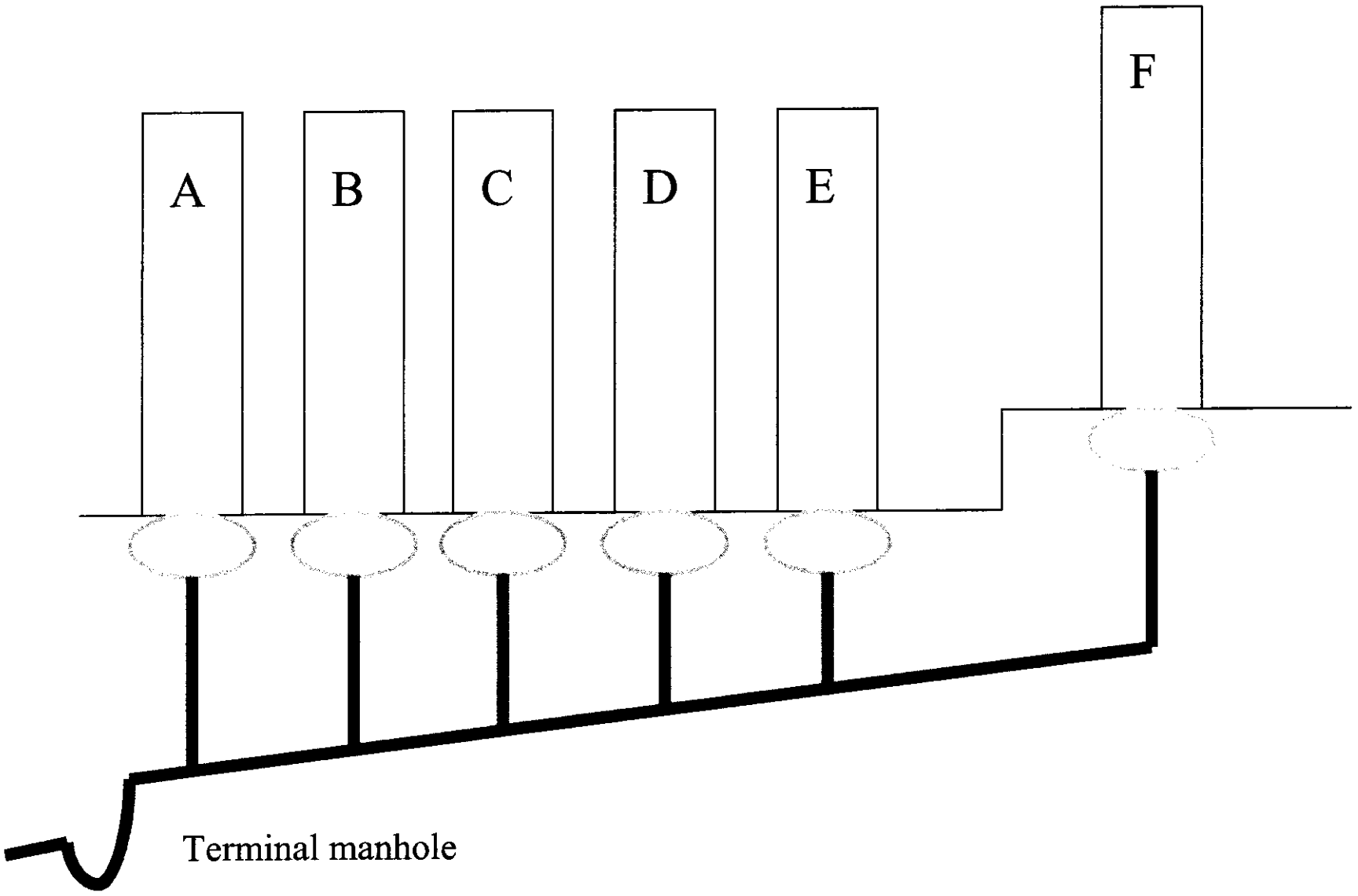


Annex F

Annex G



Annex H



Appendix C

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Reports of ETWB Task Force on SARS

Report No.1	**Health and Safety Practices in SARS Hospitals**
Report No.2	**Observation and hypothesis on infection cases of health-care staff**
Report No.3	**Measures Implemented by the Task Force at Princess Margaret Hospital** **Further Short to Medium Term Improvement Suggestions for PMH**
Report No.4	**Longer Term Suggestions for SARS Wards, Fever Wards and General Wards**

Environment, Transport and Works Bureau
23 May 2003

CONFIDENTIAL

ETWB Task Force on SARS

Report No.1 : Health and Safety Practices in SARS Hospitals

INTRODUCTION

Since the outbreak of SARS in Hong Kong, two departments under the Environment, Transport and Works Bureau (ETWB), namely Architectural Services Department (ArchSD) and Electrical and Mechanical Services Department (EMSD), have been providing the Hospital Authority's SARS hospitals that are maintained by them with advice and suggestions on how their hardware, such as their sewerage, ventilation and air purification systems, could be improved to help reduce the chance of cross-infection among their health-care staff. To better coordinate their work and the liaison with the Hospital Authority (HA), a Task Force has been set up by the Secretary for the Environment, Transport and Works (SETW) in her Bureau since mid-April 2003. Other than ArchSD and EMSD, the Environmental Protection Department (EPD) has joined the Task Force to enhance the professional advice offered to HA and the SARS hospitals. **Reports No.3 and 4** summarise the work of the Task Force on this front.

2. Other than the Task Force's work to help HA to improve the hardware, the software side of infection control, which includes the health safety practices and management systems promulgated by HA and adopted by health-care workers, is equally important if not more so. SETW has been asked by the CE to conduct a quick inspection of five SARS hospitals – Prince of Wales Hospitals (PWH), Queen Mary Hospital (QMH), Tuen Mun Hospital (TMH), Alice Ho Miu Ling Nethersole Hospital (NH) and Tai Po Hospital (TPH) – based on her own health safety professional expertise. With the agreement of the Secretary for Health, Welfare and Food and the Chief Executive of HA, her team and she visited the five hospitals between 12 and 16 May 2003 and checked their observations against the hospital health and safety

checklist at Annex.

3. This report summarises their observations based on the single visits to the hospitals and discussions with their management. On the basis of their observations, attempt is made to suggest improvements that may help to reduce the chance of health-care staff in those hospitals contracting SARS while at work.

4. In **Report No.2**, observations are made and hypotheses are provided on the SARS cases in the hospitals based on the information gathered during the visits to the five hospitals. Improvement suggestions are also included.

5. HA is considering construction of a purpose-built SARS block at a site to be identified. A meeting has been held with the Chief Executive of HA on the general approach and strategy for the proposed project. Another report on this is being prepared and will be ready once the cost estimates have been worked out.

SUMMARY OF OBSERVATIONS AND IMPROVEMENT SUGGESTIONS

A. Personal Protective Equipment (PPE)

General Observation	Suggestion
• The standard of PPE for health-care staff in the SARS wards varied amongst hospitals. TMH staff used barrier-man and airmate, while QMH staff were equipped only with operation theatre (OT) robes, N95 facemasks and shoe covers. The majority of hospitals made protective robes, gloves, shoe covers, N95 facemasks and face shield/goggles standard issues. Some hospitals used disposable	• To explain to health-care staff what the best practice is in respect of using PPE for protecting their health and enhancing safety, and the need to always use only PROPER and APPROPRIATE PPE. • To provide good training to staff on the use of PROPER and APPROPRIATE PPE and provide two-way communication channel for addressing health-care staff's

gowns, the liquid repellent material of which could not show up stains even when contaminated with SARS patients' secretions. Some gowns used could not cover and hence protect the clothing underneath from contamination.	feedback and concerns. • To review the statistics of cross-infection and their correlation with the type of PPE used for the infected and the control group, with the objective of allaying the fears of health-care staff with regard to the possibility of getting infected due to inadequate PPE.
• Some hospitals directed that staff dispose of N95 facemasks after each use, while some ordered staff to reuse them. Others used N95 facemasks in conjunction with a surgical mask on top - the latter was disposed of after each use while the N95 facemasks were reused.	• Immediate measure: to conduct fit test and teach health-care staff how to use N95 facemasks properly (*Small size may be tighter but it is not better.*) • If supply of N95 is not a problem, to consider instructing all staff not to reuse them.
• HA has prepared a visual guide for gowning. The majority but not all of the staff followed the procedures recommended in the visual guide.	• To improve education of and communication with staff on the need to strictly observe the gowning procedures. SARS ward officers-in-charge to audit closely to ensure strict compliance.
• Staff working for long hours in full protective gear could make them too tired to fully observe safety procedures. The problem of heat stress caused by impervious protective clothing could add burden on the staff.	• To reduce shift hours of staff working in SARS wards. Another option is for staff of the same shift to swap duties in the hot and warm zones in the middle of a shift.

B. Procedures related to Infection

General observation	Suggestion
• Staff have been asked to wash hands frequently and particularly after handling a patient. However, the wearing of gloves and the lack of hand washing facilities have deterred staff from washing their hands as frequently as they should. Some staff wore two layers of gloves, which does not help to prevent infection but adds onto the heat stress and the inconvenience to wash hands.	• To instruct staff to observe proper hand hygiene in ALL wards. Gloves are not substitutes for hand washing. The facilities in the wards should include ample washbasins fitted with proper faucets or automatic sensors. Gloves if used should be handled carefully and taken off when not needed with hands washed immediately.
• Some patients were either not wearing a facemask or not wearing them properly.	• To strictly enforce the proper wearing of facemasks by SARS patients.
• Patients were unevenly distributed in some of the wards.	• To spread SARS patients more evenly in the wards to avoid over-burdening staff serving wards with a higher number of patients.
• It was not sure if all hospitals had engaged security guards to regulate access to SARS wards. In one hospital, a reporter seemed to be able to walk around freely within the hospital.	• To provide security guards to regulate access to floors with SARS wards. • To regulate the movement of SARS patients: they should be provided with clothing which can differentiate them from other patients. • To put in place an enforceable

	system to prevent SARS patients from leaving the SARS wards without approval of medical personnel.
• In most hospitals, no lift was designated for use for transport of SARS patients.	• To designate a lift for access to the SARS wards. • To review and step up cleansing and disinfection of wards. In particular, the cleansing of all surfaces should be carried out as aerosols may settle on them.
• The frequency of ward cleansing and disinfection was not standardized.	
• One of the wards (in TMH) had made a number of innovations- (a) clear demarcation with colour tapes to segregate the hot/warm/clean zones; and (b) staff were ordered not to cross the hot/warm zones.	• To provide clear visual or physical demarcation of the clean, warm and hot zones in the SARS wards. • All hospitals should try this hot/warm zone buddy system so that duty staff can switch between hot and warm zones to provide relief to workers over the 8-9 hour shift day.
• One of the hospitals (QMH) made it a policy from the beginning to deploy the most experienced clinician for screening of patients and daily inspections (up to six times per day) of the triage/fever wards. • The fever and general wards appeared to be a source of infection, especially in the cases where elderly patients turned out to be Sars but did not show Sars symptoms .	• Most careful triage of patients is important for preventing "invisible SARS patients" from infecting patients in general wards. All hospitals should assign their best and most appropriate doctors to conduct diagnosis and intensely search for SARS patients. Transfers may be necessary to provide the right staff. • Elderly people are particularly vulnerable to infection and should be discouraged from getting treatment in hospitals at this time. An option would be to arrange for

	doctors to visit them at their homes.

C. Physical systems

General observation	Suggestion
Gowning Facility • Most of the SARS wards did not have full-length mirrors for staff to check whether they were gowning properly. Some wards were very constrained in space and cross-infection could occur in the gowning process.	Gowning Facility • To provide full-length mirror and automatic water tap in SARS wards in general and in the gowning areas in particular. • To provide adequate gowning space for SARS wards.
• Some wards did not have a proper gowning area. The gowning area of one of the wards was actually located within the hot zone.	• Before taking off their PPE, staff should use a wet paper towel to wipe down exposed surfaces to remove possible accumulated aerosols before gowning down.
• The standard of water taps in the gowning areas also varied amongst hospitals. One of the hospitals did not have elbow-tap while a few were equipped with taps with automatic on/off sensor. In one of the hospitals, there were no water taps and alcohol gel had to be used to disinfect hands. In some hospitals, there were no paper towel rack, and the rubbish bins had a flip top only.	• SARS officers-in-charge to walk through every step of the gown up/gown down procedure at every ward to check that every item used do not require touching by the hand for operation (e.g. taps with infra-red sensors, pedal bins). • An observer should monitor the behaviour of staff at every ward carefully. • Clear signs should be posted to prohibit entry by anyone who is not properly gowned in accordance with the requirements posted in the gown

	up area. ICN or whoever is in charge of the ward should be given full authority to bar non-compliant entry or exit.
Ward Layout • Most SARS wards did not have automatic door opening/closing device, and hands had to be used for entering/exiting the wards.	Ward Layout • To install electrical door opening/closing device in SARS wards.
• The use of transparent curtains in cubicles in one of the hospitals demonstrates that beds could be effectively separated and airflow maintained directional.	• To try out transparent curtains in other hospitals. • The number of patients per cubicle should not be more than 4 and the beds should be at least 2 metres apart.
Ventilation • Only one ward designed for TB had sufficient air change of 12 per hour with 100% fresh air. It also had a quenching device to wash out the wards. Most ICUs are positive pressure. Now all wards have been altered to negative pressure through the installation of exhaust fans at the windows. However, this has raised the room temperature to 25 ℃, which is too high for staff in PPE to work reasonably comfortably. • The provision of local extraction was not used in all of the hospitals. • The ventilation design in the triage wards and general wards allowed an	Ventilation • Please see Reports 3 and 4 of the Task Force. The general approach is: • The use of local extraction ventilation is recommended to reduce viral concentration in air. • The use of proper air filtration units which provide HEPA filters to clean up the used air and allow it to be recirculated. • Long term solution is to upgrade the ventilation system in the wards.

air change of 4-6 per hour with only 20% fresh air. • A hospital (Nethersole) had air current flowing from the dirty area to clean area.	

D. Action in case of accidents/near misses

General observation	Suggestion
• The "Safety Manuals" did not provide details on how to handle a throw-up or spill of patient's excretory materials. There was also no strict warning over dissociated ventilators or tubings from SARS patients.	• All hospitals should follow a general guideline from HA and prepare its own accident procedure suitable for its peculiar situation on what to do in case of accidents such as spilling happening in a SARS ward with particular emphasis on how to protect the staff.
• Some hospitals have carried out detailed analyses of all accidents or near misses and shared the findings with staff, while others made no such analyses.	• A systematic accident analysis should be carried out and where possible a re-construction should be demonstrated to teach staff how to prevent recurrence and how to protect themselves in such situations. The probable cause of infection should be evaluated meticulously with the help of questionnaire surveys.
• None of the SARS wards had emergency showering facilities.	• To install emergency showering facilities where possible.
• We did not examine any accident records or reports on analysis except being given verbal accounts	• An audit on all infection cases and analysis should be conducted on a regular basis with feedback to staff

on what had probably happened. • Some hospitals engaged in individual counselling to let staff know that the management does care for them.	members to clarify such causes. • Counselling should be enhanced.

E. Communication with staff

General observation	Suggestion
• All hospitals provided some form of training to staff and channels for communication. • Forums are held in all hospitals from time to time for top management to listen to staff grievances and answer their concerns and problems.	• A hierarchical organisation is necessary for a hospital to function, but it should be designed in such a way as to allow staff air their views or concerns on emotional issues such as SARS infection outside of the hierarchy. • An interactive website at HA headquarters for news and ideas on SARS could provide a good platform to stimulate discussions. • SARS ward officers-in-charge should hold frequent (daily) exchanges with their staff, so that problems and concerns specific to individual wards could be dealt with effectively and in a timely fashion at the working level. • Policy issues and operational issues should be clearly defined.

ETWB
23 May 2003

Hospital Health and Safety Checklist

1. Personal Protective equipment
   1.1 standardization for different operations
   1.2 training and surveillance
   1.3 maintenance programme

2. Procedures related to infection
   2.1 Handling of SARS patients
   2.2 Handling of samples of patients
   2.3 Decontamination of utensils and materials
   2.4 Personal decontamination

3. Physical systems :
   3.1 area segregation
   3.2 ventilation systems
   3.3 sewage systems
   3.4 other systems (e.g. air supply, water supply)

4. Action in case of accidents/ near misses
   4.1 Accident procedures (e.g. SARS patient in general ward)
   4.2 Accident/near miss reporting
   4.3 Accident analysis & remedial action (including counselling)
   4.4 Briefing of staff

5. Communication with staff
   5.1 communication system- form and frequency
   5.2 feedback mechanism and representative
   5.3 decision-making body in HA

AUDIT PROCEDURES

1. The above checklist will be sent to the relevant hospital before the audit
2. A pre-audit meeting will be held with the management of the hospital to agree on the actual audit procedure
3. An examination of all available documents related to the checklist will be conducted.
4. An inspection will be conducted

4.1 Wards: three main areas where accidental infections have occurred and one area where no infection has occurred.
4.2 Sewage system and pipe ducts
4.3 Ventilation system – AHUs etc
4.4 Water supply system
4.5 Garbage collection system

CONFIDENTIAL

ETWB Task Force on SARS

Report No.2 : Observation and hypothesis on infection cases of health-care staff

1. General discussions on infected cases took place during the meeting at each of the five hospitals with the objective of understanding how such incidents are investigated and also the likely cause of infection. By May 15 2003, the questionnaire at Annex was drawn up by the ETWB team for the purpose of obtaining data critical for statistical analysis of the 379 infection cases. The objective is to find out the most likely factors that caused the infection: the PPE used, the physical conditions, the activities that were most hazardous and human error.

2. The questionnaire was given to Dr. William Ho, Chief Executive of the Hospital Authority, who informed us that investigation of a similar nature was now taking place and our questionnaire would be included.

3. Without the benefit of the statistics, a preliminary analysis of the infection scenarios has been conducted and the following hypotheses based on dose-response have been formulated -

   ➢ The infected person was exposed to a sufficient dose of the virus through a long period of exposure to a relatively low but sufficiently high level.

   The conditions under which the over-exposure could have occurred are:

   - Inappropriate use of facemask – this could be N95 or other forms and leakage is high.
   - Having stationed at a location where air current brings infectious virus through- people tend to be sedentary for long hours.
   - Long period of close contact with patients – e.g. over 30 minutes of close encounter during feeding.
   - Talking to patients at close range over a substantial period of

time.

➢ The infected person was exposed to a sufficient dose of the virus through a very short exposure to a high level. The conditions are:

- The exposure to an aerosol-filled environment caused by a nebuliser
- The spilling of a patient's excretory material causing splashing.
- Cutting oneself in a SARS ward and contacted contaminated surfaces.
- Being sprayed by a patient's body fluid (Regurgitation due to intubation, vomiting, spitting or coughing).
- Touching infected surfaces during gowning down process.

4. Based on the above scenarios, the HA should immediately draw up measures to reduce the dose likely to be received by staff. Our preliminary suggestions are:

- Ensure the proper use of PPE
- Reduce the number of hours working in high risk areas (the buddy system which allows changing over)
- Instruct staff in SARS ward to stay upstream of infection and move about regularly.
- Minimise the number of gowning down and up.
- Provide proper facilities for cleaning up.
- Improve the ventilation in the wards, in particular to remove the aerosol in the air and prevent accumulation.
- Frequent disinfection of all surfaces.
- When in close encounter with patients for substantial amount of time, use local extraction device to reduce exposure.
- When carrying out processes such as intubation, wear full protection with face shield – unless equipped, do not touch patients.
- Minimise human error through training and indoctrination. Equally important is to maintain optimal health and relieve stress.

5. It must be emphasized that in the end the above hypothesis has to be justified through statistics on the infection cases. To that end, the

questionnaire survey and data treatment would be critical in terms of providing justification for action to taken by HA, in particular regarding PPE.

6. Documentation on all procedures, training, communication and decision making rationale is also of paramount importance in establishing evidence that due care has been taken and that a health and safe system of work has been put in place to minimise accidents. In the realms of accident prevention the famous Heinrich Principle states that "95% of accidents are caused by the act of people" and so human error cannot be totally eradicated. HA however must be ready to demonstrate that it has fulfilled its management responsibility by doing all that is reasonably practicable.

ETWB
23 May 2003

Questionnaire for Infected Medical Workers

Patient Code (initials) : _____

Code No. (to be filled in by ETWB) : _____

Date of Questionnaire : _____

1. On-set date : _____

2. Job nature :

   - ☐ Doctor
   - ☐ Nurse
   - ☐ Medical Health Assistant
   - ☐ Cleansing Staff
   - ☐ Others : _____

3. Age : _____

4. Female/Male : _____

5. Number of years working in the profession : _____ Years

6. Number of years working in the same hospital : _____ Years

7. Working experience with SARS related work before infection :

   _____ Weeks

8. Hospital and ward number you worked in 3-5 days prior to disease onset :

   Hospital : _____
   Ward No. : _____

9. Personal Protection Equipment you used 3-5 days prior to disease onset. Please tick :

- ☐ Barrier-man
- ☐ N95 face mask
- ☐ Surgical mask
- ☐ Hair cover
- ☐ Face shield/goggle
- ☐ Gloves
- ☐ Waterproof protective robe
- ☐ OT robe
- ☐ Shoe cover
- ☐ Others : _____

10. Training received on health and safety :

_____

11. Face mask fit test conducted or not :

- ☐ No
- ☐ Yes

12. Health – any known disease prior to SARS infection :

_____

13. Number of off days per week : _____ Days

14. Duration of daily work shift :

- ☐ less than 7 hours
- ☐ 7-8 hours
- ☐ 9-10 hours
- ☐ 11-12 hours

15. Participation in SARS focus groups or workshops :

☐ No
☐ Yes.
Details : _____
_____
_____

16. Close contact with SARS patients in the 3-5 days prior to disease onset :

☐ No
☐ Yes.
Details : _____
_____
_____

17. Episode of patient vomiting or directly coughing to you in 3-5 days prior to disease onset :

☐ No
☐ Yes.
Details : _____
_____
_____

18. Close contact for over 30 minutes with SARS patients, such as feeding, prior to disease onset :

☐ No
☐ Yes.
Details : _____
_____
_____

19. Handling SARS patient's excretory material 3-5 days prior to disease onset:

☐ No
☐ Yes.
Details : _____
_____
_____

20. Whether you had been involved in intubation for SARS patients:

☐ No
☐ Yes.
Details : _____
_____
_____

21. Did you work in a ward where nebulizer was in use :

☐ No
☐ Yes.
Details : _____
_____
_____

22. Did you work in a ward where a 100% oxygen breather was in use :

☐ No
☐ Yes.
Details : _____
_____
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ETWB Task Force on SARS

Report No.3 : Measures Implemented by the Task Force at Princess Margaret Hospital
Further Short to Medium Term Improvement Suggestions for PMH

Introduction

As Princess Margaret Hospital (PMH) is designated as a SARS hospital with the largest number of SARS patients, the Task Force started by doing a pilot study on PMH. The objective is to identify the areas for which improvements are called for and to present short to medium term improvement suggestions to HA. HA could then also consider introducing the improvement suggestions for PMH in other SARS hospitals as they deem necessary. This report summarises the measures that the Task Force has implemented at PMH in collaboration with HA and PMH, and sets out other short to medium term improvement suggestions that have been put to HA for consideration.

Measures Implemented by ETWB Task Force at PMH

2. The Task Force has studied the present air-conditioning/ventilation system and sewer system of PMH and put in place the following temporary measures to improve their operations -

(a) Air cleaners with a HEPA filter and UV disinfection system have been placed in the SARS wards since mid-April to reduce aerosol contents in the wards.

(b) The exhaust outlet of the service tunnel where the sewer pipes are housed has been installed with a HEPA filter since 27 April to avoid aerosol emissions from the exhaust system.

(c) Three automatic disinfection systems have been installed in

the three rooftop flushing water reservoirs serving Blocks A to F to provide additional disinfection at the toilet bowls, urinals and individual WC cisterns. PMH has put the two automatic disinfection systems that serve Blocks A, B C and D into operation. Block E and F are being thoroughly cleansed and the automatic disinfection system serving these blocks will be put into operation as necessary. (The sewage of Tuen Mun Hospital, QMH and Ruttonjee Hospital is discharged into the Harbour after having gone through a screening plant only. As a short-term measure, disinfectant is being added manually to the toilet flushing water reservoirs serving the SARS wards in these three hospitals. HA has been asked to consider installing automatic disinfection systems in the toilet flushing water reservoirs of these three hospitals.)

Further Suggestions of the Task Force for PMH
(Presented to HA in mid-May 2003)

3. The Task Force has suggested that the following short to medium term measures be implemented to improve the ventilation of the SARS wards in PMH -

Short Term Measures

4. To address the concern of aerosol emissions from BiPAP treatment, the Task Force has discussed with PMH's administration and the nursing staff about the provision of an enclosure with local exhaust for SARS patients using BiPAP. Two prototypes have been tested and it has been demonstrated before PMH's staff that both of them are capable of reducing significantly the spread of aerosols generated during the BiPAP treatment into the ward area. Appendix 1 shows the final model suggested by the Task Force and accepted by PMH. PMH is now considering the number of units that should be installed and where they should be installed within PMH. In developing this final design, we have taken on board many ergonomics-related comments of PMH's nursing staff on the previous two prototypes. When more experience is gained in the use of the local exhaust system, further adjustments could

be made as necessary. In order to allow the wider use of BiPAP, it is important for HA to forge a consensus on the system in other SARS hospitals and start the installation in them as soon as possible. The Task Force is ready to install the systems at PMH's SARS wards and in other SARS hospitals upon PMH/HA's request. Once these local exhaust systems are in place, the wards could, to a certain extent, rely less heavily on the window-type exhaust fans, some of which could then be switched off as appropriate so as to help enable the temperature of the wards to be maintained at a comfortable level when summer comes.

Medium Term Measures

5. Since additional exhaust fans have been added to the wards to increase the air changes, the cooling capacity of the air-conditioning system is significantly hampered. While the temperature of the wards can be maintained at 22-24℃ for the time being, this level of temperature, which is required to cater for the need of the health care workers to continue to wear sufficient protective clothing and gears, cannot be maintained when the weather becomes hotter unless improvement measures are implemented. To tackle the problem, the Task Force has considered the following three options that can be implemented within a couple of weeks. A comparison of the pros and cons of these options is at Appendix 2.

(a) **Option 1 — Improve the existing air-conditioning system**
Additional air conditioning plants will be installed inside the SARS wards to meet the additional cooling load. The installation will take about two weeks to complete and it requires the ward concerned to be vacated during the installation work.

(b) **Option 2 — Install HEPA filter and some form of disinfection at existing air handling units**
The existing air handling units of the SARS wards will be retrofitted with HEPA filters and some form of disinfection to clean and sterilize the return air. Return air will be switched on and the additional extraction provided by the exhaust fans will be reduced in order to lower the cooling load. As in

Option 1, the installation will take about two weeks to complete and it requires the ward concerned to be vacated during the installation work.

(c) **Option 3 — Install HEPA filters in the SARS wards and air return grilles**

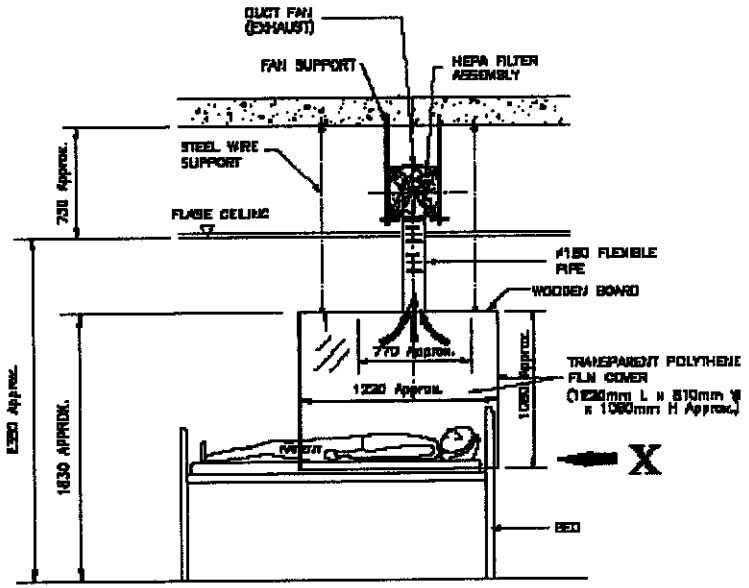
If the wards cannot be vacated, an alternative is to install industrial grade HEPA filters inside the wards and general grade HEPA filters at air return grilles to remove air-borne aerosols. As in Option 2, air return will be switched on and the additional extraction provided by the exhaust fans will be reduced in order to lower the cooling load.

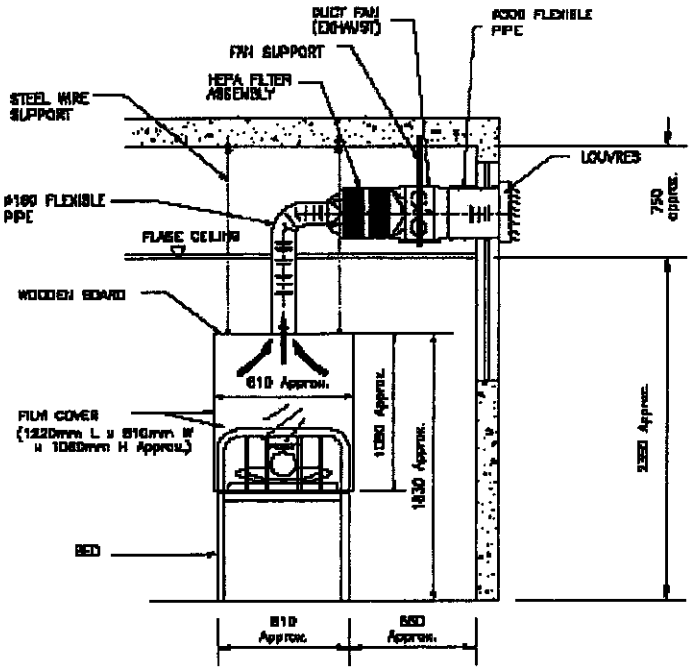
6. HA has indicated their preference for Option 3. As a follow-up, the Task Force has examined a number of air purifiers equipped with HEPA filters. Two models are considered suitable for us in SARS wards. One is a floor-standing air purifier. Depending on the size of the cubicle, it can support 10-12 air changes per hour (ACH). The second is a mobile unit that can be installed with a hose for directional extraction and air purification. Both units can effectively filter out particles and droplets in the air. Tests done at Nethersole Hospital have shown that when the particle count in incoming air is over 20,000, the particle count after filtering can drop to zero. During the tests, a smoke generator was used to generate droplets to simulate contamination in a ward. With the use of these units, the particle count in a ward contaminated with 0.3 micron droplets at a concentration of 400,000 per litre could be reduced to below 5000 within 15 minutes. The two units are for different purposes. The floor-standing unit can be used in the cubicles for reducing the background load of droplets. The mobile unit can be used whenever a health care worker requires local extraction when performing his duties.

7. The installation of local exhaust systems for patients using BiPAP, a mobile air purifying unit for use for ad hoc and emergency operations and a floor-standing air purifying unit to reduce the droplet load form an effective package to reduce or even replace the use of exhaust fans quickly. The package can also be applied to other SARS

hospitals both for the purposes of reducing reliance on exhaust fans, thus helping to solve the heat load problem arising from enhanced air changes, and improving the protection for health-care workers. The Task Force stands ready to help HA draw up the specifications for purchasing the air purification units.

ETWB
23 May 2003





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Location: PRINCESS MARGARET HOSPITAL	Dwg. title: NEGATIVE AIR PRESSURE MOCK UP TENT (VERSION 3)		Name	Date	Scale: NTS	Rev: B	HEALTH SECTOR DIVISION
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		Checked	DANIEL YEO	MAY 03	Dwg. no.: PMH/0305/01		Electrical & Mechanical Services Department
		Approved					

Appendix 2 to Report No.3

Comparison of Medium Term Options for Improving the Ventilation and Air-conditioning Systems of SARS Wards

Option	Pros	Cons
Option 1: Improve the existing air-conditioning system	Negative pressure in wards and cubicles can be maintained. 100 % fresh air intake (i.e. no return air) and hence chance of cross-infection among cubicles will be reduced to a minimum.	High in both initial and recurrent (e.g. electricity) expenditures. At least one cubicle in each of the concerned wards has to be assigned as an air-conditioning plant room. Depending on the number of wards to be converted, the existing power supply may not be capable of meeting the additional electricity demand. The wards would need to be vacated for about 14 days for the installation work.
Option 2: Install HEPA filters and UV light at existing air handling units	Much lower initial and recurrent expenditures. Less space (a side ward or 1/2 cubicle) is needed for housing the air cleaning equipment.	It can only maintain negative pressure at "ward" level. Cubicles will be under positive pressure, i.e., air will flow from cubicles to other ward area.

Option	Pros	Cons
	No powers supply constraint.	Staff may have concern about the effectiveness of cleaning of return air.
Option 3: Install HEPA filters in the SARS wards and air return grilles	Simple installation by direct plugging the equipment into the power socket outlet. No need to vacate wards for site work. No power supply constraint.	As Option 2, it can only maintain negative pressure at "ward" level. Cubicles will be under positive pressure, i.e., air will flow from cubicles to other ward area. Staff may have concern about the effectiveness of cleaning of return air. High equipment cost.

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ETWB Task Force on SARS

Report No.4 : Longer Term Suggestions for SARS Wards, Fever Wards and General Wards

Introduction

For the longer-term, HA is considering designating a small number of hospitals as SARS hospitals and suitably modify them for such use. Tentatively, the hospitals to be designated are PMH, Alice Ho Miu Ling Nethersole Hospital (NH), Ruttonjee Hospital, United Christian Hospital (UCH) and Queen Elizabeth Hospital (QEH). HA is also considering setting up suitably designed "fever wards" in all major hospitals to tackle the problem of "invisible SARS patients" infecting patients in general wards. The Task Force will help with the detailed design of these facilities and later on with the actual works required once HA has decided on the hospitals to be designated as SARS hospitals, how many wards in each of them to be converted and on the configuration of the "fever" wards. The Task Force will also help to check that the general wards in the hospitals are maintained under positive pressure and that they meet ASHRAE standards. This report sets out the longer-term suggestions for SARS wards, fever wards and general wards.

Suggested Improvement Works for SARS Wards

2. The following suggestions are in line with WHO and CDC's recommendations -

(a) negative pressure gradient – airflow from corridor (clean) to anteroom and then to patient room (less clean);

(b) 100% fresh air supply at greater than or equal to 12 ACH;

(c) low level exhaust for better air flow pattern;

(d) airtight patient room to prevent cross contamination among rooms;

(e) ensuite bathrooms (shower, toilet and hand-wash basin);

(f) self closing doors; and

(g) staff facilities, such as preparation room, gowning and de-gowning rooms and toilets.

Suggested Improvement Works for Fever Wards

3. The number of in-hospital patients displaying fever symptom is high since fever is a common symptom of a wide range of diseases. However, it is of vital importance to properly segregate these patients to prevent cross-infection. Since the number of potential SARS patients in these fewer wards will be low (the experience of some hospitals has shown that it is about 5%), the viral load will not be as high as that in confirmed SARS wards. Therefore, another set of features are suggested, as summarized below -

(a) negative pressure gradient – airflow from corridor (clean) to anteroom and then to patient room (less clean);

(b) fresh air supply to follow international standard for patient rooms and some of the air will be recirculated to the air handling equipment whereby the air will be cleansed with appropriate devices, such as HEPA filter, UVGI and/or bio-oxygen generator, etc. Provision of HEPA filter regeneration to facilitate maintenance should also be explored;

(c) low level exhaust for better air flow pattern; and

(d) clear partition screen with open top between patient beds to prevent cross-infection.

Suggested Improvement Works for General Wards

4. For general wards, the main objective is to prevent contaminated air, if any, from entering the wards. Particularly, it is important when a general ward and a SARS ward are on the same floor. To address this issue, the following features are suggested -

(a) positive pressure gradient – airflow from patient room to corridor in the ward and then out of the ward through the main door; and

(b) fresh air supply and return air flow rate to follow international standard for patient rooms.

ETWB
23 May 2003