WORLD HEALTH ORGANIZATION
REGIONAL OFFICE FOR THE WESTERN PACIFIC

WHO Western Pacific Region Public Information Unit, Tel: (63 2) 528 9991; Email: PIO_Unit@wpro.who.int

MISSION

To investigate risk factor involved in the possible environmental transmission of 'Severe Acute Respiratory Syndrome' (SARS) in specified residential buildings in the Special Administrative Region of Hong Kong. The investigation is conducted in the context of assisting the Hong Kong authorities.

SITE - AMOY GARDENS ESTATE

BACKGROUND

Around March 21, 2003, an unusual cluster of SARS cases occurred in Block E of the Amoy Gardens Estate with apartment units 7 and 8 most affected. The initial epidemiological investigation and the unusual high number of cases affecting these two units prompted the hypothesis that environmental factors may have been involved in the transmission of the SARS-related coronavirus.

ACTIVITIES

Site visits were performed to evaluate the building as situated in its surroundings, to study in detail the mechanical building systems including water supply, wastewater disposal and ventilation systems serving all occupancies in various fashions, and to take environmental samples for laboratory testing.

DESCRIPTION OF TARGET BUILDING

- General Features

- High-rise private housing estate built in 1981
- 'Cruciform' towers built on a podium harbouring a shopping mall and park decks.
- Living space for approximately 20,000 residents
- Each tower has more than thirty floors with eight living units each (approx. 48 m^2 per unit)
- Units are separated by light wells (see footnote) (6 meters deep; 1.5 meters or 2.3 meters wide)
- Light wells are open-air utility channels between living units and contain plumbing risers connecting to all bathrooms.
- Light wells act as a light source and a ventilation plenum; bathroom and living room ventilators discharge exhaust air into the light well; combustion gases of gas fired hot water heaters discharge into the light well.

- Plumbing System

- Potable water supply system distributing water from a roof mounted storage tank and serving all fixtures except the water closet.
- Potable hot water is generated using gas-fired instant water heaters.

- Water closet flush water system uses seawater.
- Wastewater stream is divided into separated 'grey' (kitchen) and 'black' (bathroom) systems; each condominium stack is vertically connected to the same riser.

- Heating

- Space heating is not required and no facility has been installed for that purpose.

- Ventilation / Air Conditioning

- Windows of each unit can be opened; powered ventilators and air conditioning units are installed at the option of the owner.

RESULTS

- The physical condition of the building structure is generally good and meets international standards.
- The building management provides the necessary administrative and technical support.
- The existing plumbing system meets the needs to contain waste within piping provided it is operated by the multitude of users as per original design intent.
- The air exhaust system in the bathrooms discharges copious quantities of droplets in the bathroom into the light well and ultimately into the outer building boundary layer where the droplets can re-enter the building at other locations.
- There is no strong enough evidence to link the broken vent pipe discovered at the bottom of the light well to the spread of the virus.
- All attempts to recover live virus from collected swabs were negative. In addition, all attempts to find genetic material ('footprints') of the SARS-related coronavirus were also negative.

CONCLUSIONS

- At the time of the outbreak, the floor drain traps in many apartments seemed to have not been filled with water for long periods. Thus they had lost their sealing function and generated an open connection to the soil stack. In the case of a running exhaust fan and a closed door, droplets would have been drawn from the soil stack into the bathroom through the floor drain. This could have contaminated the bathroom.
- A break of a flush water pipe serving unit 8 on March 21, 2003, led to an overnight shut down of the flush water system. This event most likely decreased the flow in the soil stack and thus would have favoured the generation and movement of droplets in the soil stack. In addition, bucket flushing would have increased the generation of droplets in the bathroom.
- The running exhaust fan would have transported contaminated droplets present or generated in the bathroom into the light well. These droplets would have continued to move with momentum in the light well until they had reached a wall. At that point they would have likely moved up due to the natural current within the light well. The droplets would have risen to the top of the building, but might have been disturbed on its way by other active ventilators discharging into the light well. Should the contaminated air have encountered an open window, it might have entered into other apartments even several floors away from the source.

- Laboratory testing showed no evidence for live virus still being present in Amoy Gardens. Nor did it show any evidence for remaining genetic material ('footprints') of the SARS-related coronavirus.

CONCLUDING REMARK

It seems highly likely that an unfortunate sequence of environmental and health events happened simultaneously and contributed to the spread of the SARS-related coronavirus in the Hong Kong residential estate of Amoy Gardens.

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*Note: In construction terms, the light well is actually a re-entrance