For discussion
On 2 March 2000

LEGISLATIVE COUNCIL
PANEL ON ENVIRONMENTAL AFFAIRS

Water-cooled Air Conditioning Systems

INTRODUCTION

1. At the Panel Meeting held on 10 February 2000, Members asked for more detailed information on the three studies on water cooled air conditioning systems (WACS) and the pilot scheme for relaxation of using fresh water for air-conditioning purpose. This paper provides details on the implementation plan.

BACKGROUND

Findings of Preliminary Phase Consultancy Study

2. The preliminary phase consultancy study took place from September 1998 to April 1999. The study examined three basic concepts of WACS, namely Centralised Piped Supply System for Condenser Cooling (CPSSCC), Centralised Piped Supply System for Cooling Towers (CPSSCT), and District Cooling Scheme (DCS). A more detailed description of these concepts is given in Annex A. The results of the study established that compared to air-cooled air conditioning systems (AACS) WACS are more economically and environmentally attractive. Compared with AACS, CPSSCC, CPSSCT, and DCS could achieve energy savings of up to 24%, 17%, and 32% respectively.

Annex A

3. In quantitative terms, the preliminary study revealed that, depending on the degree of conversion of existing AACS to WACS, and also depending on the types of WACS to be used, the following results could be expected:

a) Savings of 7% to 10% air conditioning energy level used for non-domestic

buildings by 2018, equivalent to 1,085GWh to 1,666 GWh per year. (Taking the unit price of electricity today as roughly equal to $0.9 per kWh, the monetary savings by 2018 is equivalent to $977M to $1,500M per year);

b) Deferment of 286MW to 446MW of new electricity generation capacity by 2018;

c) Reducing greenhouse gas emission by 1.9% to 2.9% of 1990 inventory by 2018, equivalent to 600,000 tonnes to 940,000 tonnes of CO_2 by 2018.

The lower estimates are based on the assumptions of 100% fresh water cooling towers. The higher estimates are based on the assumptions of 80% fresh water cooling towers, 10% CPSSCC and 10% DCS.

4. However, the study also identified a number of concerns and constraints. These included water resources, water treatment capacity, water distribution system capacity, sewerage network capacity, and sewage treatment works capacity. The health impacts from wider use of fresh water cooling towers and the environmental impacts from WACS discharge were also of concern. Furthermore, centralized systems such as DCS would involve complex development, operations and maintenance liabilities, property rights, financing, private sector investment and customer faith issues. These issues require detailed assessment in any implementation plan.

Existing situation of water cooled air-conditioning

5. There are about 100 buildings which have installed sea water pump houses for once through condenser cooling. There are over 12,000 freshwater evaporative cooling towers installed in buildings scattered through out the territory. Many of them do not have permission from the Water Authority for connections. Annex B lists the measures taken by BD, WSD and EMSD.

Annex B

Future directions of adopting wider use of WACS

6. We recommend –

- implementation of the most energy efficienct WACS system where practicable, we would need to explore opportunities to introduce DCS in new development areas and CPSSCC in areas near the sea;
- implementation of measures to encourage the conversion of existing AACS to WACS; and
- exploring opportunities for using sea water for cooling towers.

Relaxing the existing ban to use of fresh water for air-conditioning purpose

7. A recently completed review by Water Supplies Department indicated that with the commissioning of new water treatment works in 2001, there would be sufficient capacity to meet increasing water demand for the next fifteen years arising from relaxation of the ban on the use of fresh water for air-conditioning purpose. Subsequently, an inter-departmental working group was established to look into issues associated with the greater use of freshwater cooling towers including provision of infrastructure, registration of cooling towers, monitoring of operation and maintenance to prevent spreading of Legionnaire Disease. Five areas have been selected for a pilot scheme to use freshwater for evaporative cooling towers. This pilot scheme will be announced in early 2000 for application to use fresh water for cooling purpose. Since there is no legislative requirement to monitor the operation and maintenance of the cooling towers, the applicants will be asked to comply with the Code of Practice for the Prevention of Legionnaire Disease and to cooperate for data collection as a condition of the application. The 5 areas are Nathan Road near Waterloo Road, part of Wanchai South, Tai Po Industrial Estate, Yuen Long Industrial Estate and Pokfulam. The pilot scheme will provide data on the effectiveness of measures to rationalise the existing illegal cooling towers, the rate of conversion from AACS to WACS, the impacts on water supply and sewage infrastructures, the quality of effluent and its impact on the sewage treatment plants, the compliance of the operation and maintenance procedural requirements depicted in the Code of Practice for Prevention of Legionnaire Disease. The information will contribute to the proposed territorial study. The EEO of EMSD will be coordinating the implementation of this pilot scheme, including promoting it to the potential applicants, collecting data and monitoring the operation and maintenance of the cooling towers.

Territorial WACS Implementation Study

8. We propose to conduct a 12-months territorial implementation study in October 2000 to examine in detail the environmental, health, regulatory, institutional, financial, technical and land administration issues. We will then formulate a master development plan for the phased implementation of WACS and establish control requirements to safeguard public health. The study will -

- collect and examine data including cooling capacities, cooling tower types, water treatment methods used, water consumption rates, discharge volumes, quality of cooling tower discharges from the pilot scheme.
- evaluate the demand placed on water supply and sewage infrastructure;
- identify and prioritise the implementation of DCS and CPSSCC in suitable localities;
- formulate plans and a phased implementation programme for the infrastructure upgrade and land reservation;
- assess the potential Legionnaire Disease and other health risks corresponding to the density of fresh water cooling towers;
- formulate a registration/licensing system for cooling towers to safeguard public health.

South East Kowloon Development DCS Implementation Study

9. The South East Kowloon Development is the largest development in recent years. It offers an excellent opportunity for implementing DCS. It is estimated that the South East Kowloon Development will have a non-domestic floor area of 2,200,000m^2 and an estimated annual air-conditioning energy consumption of 136 GWh using AACS. With a DCS in place, the annual saving would be around 44 GWh. (HK$ 40 million) We plan to invite private sector participation to implement a seawater-cooled DCS in South East Kowloon Development. Since a DCS requires large capital investment and long-term service

commitment between an operator and building developers, we need to examine the appropriate contractual arrangement and price control framework to protect the interest of the parties and the public. The implementation of DCS has to tie-in with the overall development programme for South East Kowloon Development. We propose to engage a 12-months consultancy service to -

- examine the technical requirements, environmental impacts and financial implications to implement a DCS system;
- examine and select an appropriate contract strategy for the DCS;
- prepare a regulatory framework on performance obligation and price setting policy;
- develop evaluation criteria and tools for tender evaluation;
- invite and pre-qualify experienced local and overseas tenderers;
- assist in preparing and assessing tenders.

Existing Wanchai and Causeway Bay Implementation Study

10. About a third of Hong Kong Island's commercial floor area is located between Arsenal Street and Victoria Park. Despite the area having the right mix and concentration of offices, commercial developments, hotels and government offices that would benefit the most from WACS, implementation was very limited. With the study for the proposed Wanchai development Phase II, there is a unique opportunity to encourage these buildings to convert from AACS to WACS.

11. However, implementing WACS in existing urban developments is often constrained by lack of suitable infrastructures, congested utilities under the road, disruption to traffic during construction, etc. We propose to engage consultancy service to -

- determine the appropriate mix of different WACS technologies
- identify and prioritise the implementation of DCS and CPSSCC in suitable areas;
- evaluate the demand on water supply and sewage infrastructure;
- formulate a phased implementation programme for the infrastructure upgrade and land reservation;

- examine the technical requirements, environmental impacts and financial implications to implement DCS system(s) and CPSSCC systems(s);
- examine and select an appropriate the contract strategy for the DCS and CPSSCC;
- assist in preparing and assessing tenders;

with a view to minimising the impacts on the businesses and local community.

Future implementation programmes

12. The above consultancy studies will provide the Administration with the data, experience and technology transfer to take on the further implementation of other DCS or CPSSCC programmes identified in the Territorial Study in-house.

The Team for WACS

13. The wide range of issues covered in these studies include land, technical, legal, utility, economic analysis and environmental issues, which are not within the management duty, expertise and knowledge of any single department. We propose to commission consultants with multi-disciplinary expertise to conduct these studies. EMSD's Energy Efficiency Office (EEO) will manage these studies with guidance from an inter-departmental working group.

14. We propose to establish a team of professionals in the EEO to manage these consultancy studies, implement the WACS master development plan and manage the registration and licensing system for freshwater cooling towers. The proposed team will have 2 senior engineers and 3 engineers led by a Chief Building Services Engineer. A separate paper is submitted to brief Members on the organisation, workload and management in EEO.

Energy Efficiency Office
Electrical and Mechanical Services Department
February 2000

TYPES OF WACS

1. Three basic concepts of WACS, namely Centralised Piped Supply System for Condenser Cooling (CPSSCC), Centralised Piped Supply System for Cooling Towers (CPSSCT), and District Cooling Scheme (DCS), have been evaluated as part of the preliminary phase study.

- CPSSCC is a system to supply sea water to the buildings' air-conditioning systems which are employing **once through condensers** having a large water consumption capacity. This system is most suitable for buildings near the sea water front.

- CPSSCT is a system to supply sea water or fresh water to the buildings' air-conditioning systems which are employing **evaporative cooling towers**. The water consumption is much less than CPSSCC. For the fresh water CPSSCT, the fresh water can come from our water mains if our current policy of disallowing fresh water for air-conditioning purpose is changed.

- DCS is a system that may employ sea water cooled once through condenser, fresh water or sea water cooling towers to provide **central supply of chilled water** to the connected building group. This system is suitable for large developments. A more detailed description of this system is followed below.

2. A DCS system comprising a large central chiller plant normally located within close proximity of the district or buildings being served. The central chiller plant produces chilled water for distribution to a number of buildings via a closed loop pipe network. The chilled water is pumped to individual buildings for use in the building air conditioning system and then returned to the central chiller plant for re-chilling. Seawater can be used for either "once through" heat rejection for water-cooled chillers and/or freshwater for make-up water within the DCS cooling tower.

3. DCS has its root of evolution and development in many developed countries for a few decades. The rapid development of DCS as business opportunities in Japan and U.S.A. is especially worthy notice.

4. Due to the prevailing weather in Japan, their systems comprising both heating and cooling supply and is known as District Heating and Cooling System (DHC). The evolution of DHC in Japan started with the stricter regulations for atmospheric pollution, and Heat Service Law enforced by The Ministry of International Trade & Industry in 1972. The oil crisis in 1973 and 1979 also gave a boost to the growing of DHC. From 1972 to 1997, there was a growth of commercial DHCs from 11 nos. to 138 nos. in Japan. This was equivalent to a cold energy service demand of 118 TJ in 1972 to 10,299 TJ in 1997. Minato Mirai 21 DHC in Yokohama is one of the latest DHC developed in Japan, it has a cooling capacity of 267 MW_c and a thermal storage of 106 MWh_{TES}.

5. Commercial DCS in U.S.A. has almost the earliest history in the world. The first DCS has been operating since 1962. During the last decade, the concept of DCS has been revitalized and became an increasingly vital benefactor to major urban centers and experienced an unprecedented expansion in downtown urban centers. Moreover, it can be mentioned that a strong trend of outsourcing of those operations which are not the core elements of business has been common in U.S.A. The rationale for this trend of outsourcing is that the developers, building owners and facility owners can be relieved from their constraints in manpower, finance and floor space resources so that they could concentrate on their core business with higher return of profits. There are less official statistics about the commercial DCS in U.S.A. With reference to the survey from the European Marketing Group on District Heating and Cooling, there were 24 nos. of commercial DCS operating in 1997, 10 of them started after 1990, and 23 nos. more were being investigated in 1997. The two famous downtown Chicago DCSs could be among the biggest DCS plants in U.S.A. The States & Adams DCS plant operated in 1995 in downtown Chicago, it has a cooling capacity of 75 MW_c and a thermal storage of 234 MWh_{TES}. Another DCS plant namely Franklin & Van Buren DCS was operated in 1996 in downtown Chicago, it has a cooling capacity of 106 MW_c and a thermal storage of 440 MWh_{TES}.

6. There are numerous other DCSs in other countries of the world under operation or development. These countries include Denmark, Finland, Norway, Sweden, France, Germany, Austria, United Kingdom, Portugal, Spain, Italy, Canada, Korea, Malaysia, Philippines, Singapore, and Saudi Arabia although their scales of systems vary widely.

Existing Actions on Illegal Cooling Towers

1. The Buildings Department (BD) would monitor the illegal structures supporting cooling towers outside external walls. Illegal structures supporting WACS outside external walls, like other projecting unauthorized building works, could pose a potential danger to the public and should therefore be removed. Before taking enforcement action, BD will co-ordinate with Water Supplies Department (WSD) to persuade building owners to relocate the cooling towers inside or on the roof of a building. Public safety is the main concern. In the past two years, BD conducted regular large-scale clearance operations to remove abandoned and/or dilapidated water cooling towers in five industrial districts. 2,500 abandon water cooling towers and their supports were removed or relocated. To safeguard public safety, BD will launch similar operations on regular basis;

2. The monitoring of the misuse of water for air conditioning was carried out by the WSD's Regional Consumer Services Sections. Prosecution was undertaken by the WSD's Prosecution Unit. Warnings would be issued if complaints were received or when breaches were identified. Some 300 warnings had been issued in the past. As ten of the establishments were repeated offenders, they had been prosecuted. The WSD would continue to enforce the Waterworks Regulations in respect of the use of mains water for air-conditioning purposes in the same way as before. If an unauthorised extension of the inside service was discovered in the course of building inspection or upon a public complaint, then the WSD would give a warning and ask the operator to remove it. The Administration's experience was that these irregularities were rectified following the warning. However, if the operator refused to rectify the unauthorised extension, he would be prosecuted. It was clear that the situation would need rationalisation. This had to be reviewed in the expectation that the ban on the use of fresh water for air conditioning would be relaxed in one or two years' time;

3. For the prevention of Legionnaires' Disease (LD), the current practice was to encourage operators of water cooling towers to follow the Code of Practice. The

understanding was that the risk of LD was not a major issue at the moment. However, this would have to be dealt with if the wider use of fresh water cooling towers was permitted. Administration would consider implementing a regulatory and control mechanism if the wider use of fresh water cooling towers was permitted. This aspect would be covered in the forthcoming territory-wide study by the Electrical & Mechanical Services Department.