

## **ITEM FOR FINANCE COMMITTEE**

### **CAPITAL WORKS RESERVE FUND**

### **HEAD 708 – CAPITAL SUBVENTIONS AND MAJOR SYSTEMS AND EQUIPMENT**

#### **Hong Kong Observatory**

#### **New Subhead “Replacement of the Storm-detecting Weather Radar at Tai Mo Shan”**

#### **New Subhead “Procurement of a High Performance Computer System”**

Members are invited to approve the creation of the following two new commitments for the Hong Kong Observatory –

- (a) \$48 million for the replacement of the storm-detecting weather radar at Tai Mo Shan; and
- (b) \$90 million for the procurement of a high performance computer system.

### **PROBLEM**

The storm-detecting weather radar of the Hong Kong Observatory (HKO) at Tai Mo Shan (TMS) is aging and needs to be replaced. Also, the computing power of HKO’s existing high performance computer (HPC) system is no longer adequate to meet its latest operational needs.

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## PROPOSAL

2. The Director of the HKO, with the support of the Secretary for Commerce and Economic Development, proposes to create two new commitments of \$48 million and \$90 million for the replacement of the storm-detecting weather radar at TMS and the procurement of an HPC system respectively, so as to enable HKO to sustain quality weather services to the Hong Kong community and enhance its capability for forecasting and monitoring high-impact weather affecting Hong Kong.

## JUSTIFICATION

3. HKO is the official meteorological authority in Hong Kong. It is committed to providing quality weather services to the general public and specialised users in the aviation and marine community. Timely and reliable weather forecasts and warnings are crucial in ensuring our community can get better prepared for the evolving weather conditions on a daily basis and, more importantly, help reduce loss of life and damage to property and minimise disruption to economic and social activities during hazardous weather. To enable HKO to deliver such a critical mission, HKO has to count on the support of up-to-date meteorological equipment and systems. Storm-detecting weather radars and HPCs are two cases in point.

### Storm-detecting Weather Radar at TMS

4. At present, HKO operates two storm-detecting weather radars. Housed in stations located at remote hilltops at TMS and Tate's Cairn, these storm-detecting weather radars are primarily used for monitoring heavy rain and strong wind associated with severe weather (such as tropical cyclones)<sup>1</sup>. Information gathered by the radars is crucial to HKO for tracking the movement and strength of severe weather systems, thus enabling HKO to provide timely forecasts and warnings, such as those related to tropical cyclone, thunderstorm, rainstorm, flood and landslide.

5. The two weather radars work in tandem to ensure the quality and uninterrupted availability of weather data. At times when any radar in the pair is not serviceable due to maintenance or repair, HKO will rely on the other radar to maintain weather services to the general public.

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<sup>1</sup> The two radars can detect and estimate the intensity and location of rain up to 500 km from Hong Kong, as well as wind information up to 250 km from Hong Kong respectively. The Tate's Cairn weather radar, which was procured more recently, possesses more advanced capabilities and helps monitor other severe weather conditions such as hails.

6. The existing radar at TMS was commissioned in 1999 and has been in operation for around 20 years, which is significantly longer than its normal serviceable life time. A number of its critical spare parts are now out of production. Given HKO's declining stock of these critical spare parts, the existing TMS radar can hardly maintain proper functioning beyond 2022. Timely replacement of the radar at TMS is essential for sustaining the forecast and warning services relating to severe weather.

7. Subject to funding approval by the Finance Committee (FC), HKO will procure the replacement radar by open tender. The functions of the new radar will be largely similar to the weather radar at Tate's Cairn (commissioned in 2015<sup>2</sup>), including the "dual-polarisation" feature for providing additional information to allow more accurate estimation of rain intensity. Since the existing radar at TMS was procured two decades ago, the proposed replacement radar will capture the latest technology in delivering the relevant functions.

8. During installation and testing of the replacement radar, HKO will rely on the Tate's Cairn weather radar and other backup arrangements for storm detection to minimise impact on weather services.

9. Effective radiation safety measures in accordance with international standards will also be included in the tender technical requirement to ensure that the new radar fully meets the radiation safety requirements.

### **HPC System**

10. Similar to other weather centres, HKO adopts Numerical Weather Prediction (NWP) as one of the basic tools for weather forecasting. Under the NWP approach, future weather is simulated on HPC systems by mathematical models. The outputs from such simulations (for parameters including pressure, wind, temperature, humidity and rainfall) provide useful basis for experienced weather forecasters to formulate weather forecasts for the public and specialised users. Such outputs are particularly crucial for HKO to provide an early forecast of high-impact weather such as tropical cyclone and heavy rain. The NWP simulation process involves a huge volume of meteorological data and complicated mathematical models, and therefore requires significant computing resources.

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<sup>2</sup> The preceding radar at Tate's Cairn had been in use for about 20 years since 1994, before it was replaced by the existing radar in 2015.

11. Between the two existing HPC systems of HKO, the one supporting public weather forecast was commissioned in 2010<sup>3</sup>. Upon a more recent review, HKO sees the need to enhance the whole system, as the existing HPC system only has a total computing power of 0.0264 petaFLOPS<sup>4</sup> and is unable to meet HKO's latest operational needs. For example, the existing system can only support NWP models for weather forecasts up to three days ahead at a horizontal resolution of ten kilometres, and up to 15 hours ahead at a higher horizontal resolution of two kilometres. For weather forecasts beyond the aforementioned periods, HKO has to rely entirely on NWP data from meteorological authorities and centres outside Hong Kong. Such NWP data could not always provide the necessary details regarding the weather conditions in and around Hong Kong, and the frequency of updating (only two to four times a day) falls short of HKO's requirement of at least eight times a day.

12. In light of the above limitations with the existing system, and having balanced the costs and benefits concerned, HKO considers it optimal for the proposed HPC system to have a higher computing power in the order of 1.3 petaFLOPS for generating more detailed local weather forecast for Hong Kong up to at least five days ahead and at a finer horizontal resolution up to 24 hours ahead<sup>5</sup>.

13. When compared with the existing HPC system for public weather services, the proposed system would be able to run NWP model at higher resolution to better capture spatial difference and the detailed topography of Hong Kong, which are important factors affecting forecasts on regional weather conditions (such as temperature and wind strength) and short-lived weather phenomena (such as rainstorms). The proposed HPC system will also enable the running of the NWP model for multiple times with slightly different settings, thereby providing stronger support for probabilistic forecasts of high-impact weather (such as tropical cyclone and rainstorm). Moreover, the proposed HPC system, by working with the other existing system for HKIA (see footnote 3 above), will help improve weather services for specialised users, such as the aviation community, by generating probabilistic forecasts on the trajectory of aircraft under the effect of hazardous weather.

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<sup>3</sup> The other existing HPC system was commissioned in 2013, and is primarily used for aviation weather service purposes and covers mainly the Hong Kong International Airport (HKIA) area.

<sup>4</sup> PetaFLOPS is a common metric used for measuring the performance of computing systems. One petaFLOPS means performing  $1 \times 10^{15}$  floating point operations per second.

<sup>5</sup> For local forecasts over a longer term, HKO will continue to make reference to NWP data from meteorological authorities outside Hong Kong.

14. The proposed HPC system will also contribute to the provision of urban-scale weather forecast when combined with the data from the Multi-functional Smart Lamppost Pilot Scheme, one of the initiatives in the Smart City Blueprint spearheaded by the Innovation and Technology Bureau. Furthermore, the NWP model run by the proposed HPC system is expected to support a number of international meteorological projects undertaken by HKO, notably those relating to nowcasting of high-impact weather events in Asia for reference by meteorological organisations in the region. Through taking part in these international projects, HKO can benefit from wider exchange of weather data with other meteorological authorities which can in turn support its core duties of providing weather services for Hong Kong.

15. Subject to FC's funding approval, HKO will procure the new HPC system by open tender. Early preparation for drawing up the specifications, taking into account the required features as mentioned above, is underway. In view of the lead time required for procurement, installation and testing, the new HPC system is expected to come into operation in 2022<sup>6</sup>.

## FINANCIAL IMPLICATIONS

16. The estimated costs of replacing the Storm-detecting Weather Radar at TMS and procuring the proposed new HPC system are as follows –

	<b>Storm-detecting Weather Radar at TMS (\$ million)</b>	<b>Proposed new HPC system (\$ million)</b>
Non-recurrent costs	48.0	90.0
Recurrent costs per annum	2.4 (full-year effect from 2023-24)	11.5 (full year effect from 2023-24)

### **Storm-detecting Weather Radar at TMS**

#### *Non-recurrent Expenditure*

17. The estimated cost breakdown of replacing the Storm-detecting Weather Radar at TMS is as follows –

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<sup>6</sup> Upon commissioning of the replacement HPC, the existing HPC will be deployed for other supportive functions for processing of NWP outputs, such as generation of weather maps and graphics, and for research work.

	<b>\$ million</b>
(a) Hardware	32.2
(b) Software	4.5
(c) Implementation	6.9
(d) Contingency (10 % of (a)+(b)+(c))	4.4
<b>Total</b>	<b>48.0</b>

18. On paragraph 17 (a), the estimate of \$32.2 million will cover the cost of acquiring the new radar, including networking equipment, initial spare parts, consumables and test equipment.

19. On paragraph 17 (b), the estimate of \$4.5 million will cover the cost of acquiring software for radar control, products display, data reception and processing, as well as the operating system and hiring of contract staff for in-house software development.

20. On paragraph 17 (c), the estimate of \$6.9 million is for the implementation of the radar project, including delivery, installation, testing, commissioning, documentation and training services.

21. On paragraph 17 (d), the estimate of \$4.4 million represents a 10% contingency on the items set out in paragraph 17 (a) to (c) above.

22. The cashflow projection of the non-recurrent cost is set out as follows –

<b>Financial Year</b>	<b>2020–21</b>	<b>2021–22</b>	<b>2022–23</b>	<b>2023–24</b>	<b>Total</b>
<b>Non-recurrent expenditure (\$ million)</b>	1.1	3.3	39.1	4.5	<b>48.0</b>

### ***Recurrent Expenditure***

23. It is estimated that the proposal of replacing the weather radar at TMS will entail an annual recurrent expenditure of \$2.4 million upon full implementation in 2023-24, with breakdown as follows –

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<b>Financial Year</b>	<b>2020-21 (\$ million)</b>	<b>2021-22 (\$ million)</b>	<b>2022-23 (\$ million)</b>	<b>2023-24 and onwards (\$ million)</b>
(a) Light and power	-	0.3	0.3	0.3
(b) Rental of communication links	-	0.2	0.2	0.2
(c) Specialised spare parts and consumables	-	-	-	1.4
(d) Expert support services	-	-	-	0.5
<b>Total</b>	-	<b>0.5</b>	<b>0.5</b>	<b>2.4 per annum</b>

24. On paragraph 23 (a) to (d), the estimated recurrent expenditure is for the necessary light and power, communication links, specialised spare parts and consumables, and expert support services for maintaining the operation of the replacement radar.

### **HPC System**

#### ***Non-recurrent Expenditure***

25. The estimated cost breakdown of the new HPC system is as follows –

	<b>\$ million</b>
(a) Contract staff for software development	3.8
(b) Hardware, software and implementation services of the HPC system	78.0
(c) Contingency (10 % of (a)+(b))	8.2
<b>Total</b>	<b>90.0</b>

26. On paragraph 25 (a), the estimate of \$3.8 million will cover the cost of contract staff for providing IT support in the development of NWP model on the new HPC system.

27. On paragraph 25 (b), the estimate of \$78.0 million is for the acquisition of hardware, software and implementation services for the HPC system, including computer servers, storage, networking equipment and software, operating systems, etc.

28. On paragraph 25 (c), the estimate represents a 10% contingency on the items set out in paragraph 25 (a) to (b) above.

29. The cashflow projection of the non-recurrent cost is set out as follows –

<b>Financial Year</b>	<b>2020-21</b>	<b>2021-22</b>	<b>2022-23</b>	<b>2023-24</b>	<b>Total</b>
<b>Non-recurrent expenditure (\$ million)</b>	1.1	2.1	78.2	8.6	<b>90.0</b>

### ***Recurrent Expenditure***

30. It is estimated that the proposal of procuring the HPC system will entail an annual recurrent expenditure of \$11.5 million upon full implementation in 2023-24, with breakdown as follows –

<b>Financial Year</b>	<b>2020-21 (\$ million)</b>	<b>2021-22 (\$ million)</b>	<b>2022-23 (\$ million)</b>	<b>2023-24 and onwards (\$ million)</b>
(a) Light and power	-	-	2.5	2.5
(b) Maintenance and other professional services	-	-	-	9.0
<b>Total</b>	-	-	<b>2.5</b>	<b>11.5 per annum</b>

31. On paragraph 30 (a) to (b), the estimated recurrent expenditure is for the necessary light and power as well as professional services for maintaining the HPC system.

**/IMPLEMENTATION .....**



**IMPLEMENTATION PLAN**

32. The estimated implementation schedule of replacing storm-detecting weather radar at TMS is as follows –

	<b>Target completion date</b>
(a) Tender invitation	June 2019
(b) Award of contract	December 2019
(c) Delivery of new radar to site	October 2021
(d) Installation of new radar	March 2022
(e) Testing and commissioning of new radar	August 2022

33. The estimated implementation schedule of procuring the HPC system is as follows –

	<b>Target completion date</b>
(a) Tender invitation	June 2020
(b) Award of contract	September 2021
(c) Delivery and installation of HPC system	July 2022
(d) Software development	July 2022
(e) Testing and commissioning of HPC system	July 2022

**PUBLIC CONSULTATION**

34. We consulted the Legislative Council Panel on Economic Development on 25 February 2019. Members supported the proposals.

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Commerce and Economic Development Bureau  
 Hong Kong Observatory  
 May 2019