LCQ22: Concentrations of ozone in air

Following is a question by the Hon Kenneth Leung and a written reply by the Secretary for the Environment, Mr Wong Kam-sing, in the Legislative Council today (January 30):

Question:

According to a paper of the Environment Bureau, it is forecast that in 2025, the concentrations of ozone (O3) in air in most areas of Hong Kong will exceed the relevant level of the Air Quality Objectives (AQOs) and be higher than the existing level. Under the prevailing AQOs, the number of days on which the maximum daily 8-hour mean concentration of O3 in air exceeds 160 µg/m3 (number of exceedances) should not be more that nine per calendar year, whereas the number of exceedance allowed under the guidelines of the World Health Organization (WHO) is zero. In addition, the findings of a study conducted by the University of Hong Kong has indicated that increasing the numbers of exceedances allowed for air pollutant concentration levels will cause the annual mean concentrations of air pollutants to exceed the WHO's standards, and lead to adverse health effects. In this connection, will the Government inform this Council:

(1) of the (i) highest maximum daily 8-hour mean concentration and the number of exceedances in respect of O3, and (ii) the annual mean and long-term changes of O3 concentration, as recorded by each air quality monitoring station in Hong Kong in each of the past five years;

(2) whether it will tighten the prevailing AQOs in relation to O3 concentration, and reduce the number of exceedances allowed in respect of O3 concentration to zero as prescribed in WHO's guidelines, as well as formulate a more stringent emission reduction policy to reduce the concentration of O3 in air; if so, of the details; if not, the reasons for that;

(3) whether it knows the O3 emission trend as recorded by the Guangdong-Hong Kong-Macao Pearl River Delta Regional Air Quality Monitoring Network in each of the past five years, and the annual mean concentration level of O3 last year; a list of the air quality monitoring stations of the Network, with the locations of such monitoring stations marked on a map;

(4) given that O3 is formed by the chemical reactions of nitrogen oxides (NOx) and volatile organic compounds (VOC) in air under sunlight, of the respective emissions of NOx and VOC, their major contributors and emission trends in Hong Kong, in each of the past five years;

(5) whether it will expand the existing air quality monitoring network, with a view to monitoring the air quality of Hong Kong more effectively; if so, of the details; if not, the reasons for that; and

(6) of the existing air pollution control measures targeted at O3, VOC and

NOx respectively (including the schemes undertaken solely by the Hong Kong Government and those in collaboration with the Guangdong Provincial Government); whether it has assessed the effectiveness of such measures on a regular basis; if so, of the details?

Reply:

President,

Ozone (O3) is a complicated regional air pollution problem. It is not directly emitted from pollution sources but formed by chemical reactions amongst various air pollutants in the ambient air. O3 is mainly formed by photochemical reactions of nitrogen oxides (NOx) (including nitric oxide (NO) and nitrogen dioxide (NO2)) and volatile organic compounds (VOC) under sunlight. On the other hand, O3 can be consumed by having chemical reactions with NO to form NO2. In recent years, local measures have been implemented to reduce vehicular NOx (comprising mainly NO and some NO2) emissions, which also led to less O3 consumption in urban and roadside areas, and hence a rise in O3 level in these areas. This phenomenon is similar to those experienced by many other cities when tackling their air pollution problems. To reduce our local O3 concentration, continuous reduction in NOx and VOC emissions in the whole region including Hong Kong is necessary.

My reply to the question raised by the Hon Kenneth Leung is as follows:

(1) Over the past five years (i.e. 2014 to 2018), the ambient and roadside concentrations of major air pollutants including respirable suspended particulates (RSP or PM10), fine suspended particulates (FSP or PM2.5), NO2 and sulphur dioxide (SO2) in Hong Kong have dropped by 20 per cent to 45 per cent, indicating the effectiveness of the emissions reduction measures implemented in recent years. That said, due to relatively high regional background O3 concentrations and reduction in local vehicular emissions of NO, the ambient and roadside O3 concentrations have shown a rising trend for the same period. Figures on the annual highest 8-hour average O3 concentrations, the compliance with the Air Quality Objectives (AQO) for O3, and the annual average O3 concentrations at each general and roadside air quality monitoring station (AQMS) from 2014 to 2018 are set out in Annex 1.

(2) and(6) Regarding the AQO for O3, the "Introduction" chapter of the World Health Organisation (WHO) Air Quality Guidelines (WHO AQGs) clearly states that the air quality standards set in each country will vary according to specific approaches to balancing risks to health, technological feasibility, economic considerations and other political and social factors.

The WHO AQGs do not provide recommendations on the number of allowable exceedances when formulating the guideline values of the concerned air pollutants (including O3). In view of the fact that air quality may violate the standards owing to uncontrollable circumstances such as extreme weather, Chapter 8 of the WHO AQGs states that when the air quality standards are set to be legally binding, governments could quantify the compliance criteria through establishing the number of allowable exceedances. The WHO AQGs have

also quoted the number of allowable exceedances for the 8-hour O3 standard set by the European Union at 25 times per year and the allowable exceedances for the 24-hour NO2 standard set in South Africa at three times per year as examples to illustrate that the numbers of allowable exceedances for different air pollutants concentration limits vary among different places.

Hong Kong's prevailing AQO for 8-hour O3 is set at the Interim Target-1 level of the WHO AQGs, and the number of allowable exceedance is set at nine times per year. We have established a general air quality monitoring station (AQMS) in Tap Mun where there is no local air pollution source, with a view to monitoring the regional background air pollution. The annual concentrations of O3 recorded at Tap Mun AQMS have been staying at the highest level in the territory over the past years, while the number of exceedances for the maximum 8-hour O3 concentration has also been the highest amongst the AQMSs. This shows that Hong Kong has been affected by regional O3 pollution, particularly when the regional O3 concentration rises to high level under enhanced photochemical activities (e.g. due to influence of the subsiding air of a tropical storm resulting in fine and hot weather with light wind) resulting in exceedances of the AQO. The predicted air quality modelling results show that the O3 concentration in Tap Mun in 2025 would be similar to the current level. The implementation of various emission reduction measures will further reduce the emission of NO, leading to less O3 to be consumed by NO in the urban area. As a result, the air quality modelling results predict that O3 concentration in the urban areas of Hong Kong will be increased slightly in 2025. Therefore, we consider that, at this stage, there is no room to tighten the AQO for O3 or reduce the number of allowable exceedances.

To tackle the O3 pollution, the Government is implementing a two-pronged strategy – to reduce the local O3 precursors (i.e. NOx and VOC), as well as to strengthen regional cooperation.

Key measures to reduce local NOx emissions include tightening emissions from power plants, progressively phasing out about 82 000 pre-Euro IV diesel commercial vehicles by the end of 2019, subsidising the franchised bus companies to retrofit eligible Euro II and Euro III franchised buses with selective catalytic reduction (SCR) devices, and tightening the vehicle emission standard to Euro VI in phases, etc. Key measures to reduce VOC emissions include controlling VOC contents of regulated products (e.g. paints, adhesives, sealants, consumer products, printing inks, etc.), tightening emission standards of vehicles and strengthening the emissions control on petrol and liquefied petroleum gas (LPG) vehicles.

We will continue to pursue new initiatives to reduce NOx and VOC emissions. These include conducting a review on “The Seventh Technical Memorandum for Allocation of Emission Allowances in Respect of Specified Licences” for power plants this year with a view to further tightening their emissions; preparing to progressively phasing out about 40 000 Euro IV DCVs by the end of 2023, tightening the emission standards for newly registered motorcycles to Euro IV in 2020, tightening the emission standards for light buses to Euro VI in 2021, and fully subsidising franchised bus companies in

conducting trials to retrofit Euro IV and Euro V franchised buses with enhanced SCR systems; as well as reviewing the feasibility to further tightening the VOC limits of regulated architectural paints.

The Hong Kong SAR government has been collaborating with Guangdong authorities to improve the regional air quality. In 2012, the Hong Kong and Guangdong governments set the 2015 emission reduction targets and the 2020 emission reduction ranges for four major air pollutants (including NOx and VOC) in the Pearl River Delta Region. At the end of 2017, both sides confirmed the attainment of emission reduction targets in 2015 and finalised the reduction targets for 2020 (see Annex 2). Both governments have been working hard to push forward the next phase of Guangdong-Hong Kong emission reduction cooperation and have set up a science team to jointly carry out a study on post-2020 air pollutant emission reduction targets and concentration levels for Hong Kong and Guangdong, with a view to formulating a regional emission reduction plan beyond 2020.

Due to the complicated formation and transport mechanism of O3 and the variety of VOC species and sources, both governments have strengthened scientific studies on O3 and VOC in order to further understand the O3 formation in the region and help formulate the effective control measures. Both sides are adding the real time VOC monitoring in the regional air monitoring network in phases and plan to set up a 3-dimensional air pollutant monitoring network by using Light Detection And Ranging (LIDAR) to measure the concentrations of O3 and suspended particulates at heights, so as to understand their formation and transportation. In 2017, the Environmental Protection Department (EPD) had also set up a supersite at Cape D'Aguilar to use advance equipment to collect data for scientific study and better understanding of the formation of regional pollution including O3 and fine suspended particulates, and help devise policy to tackle the pollution problems.

(3) Figures on the annual average concentrations of O3 from 2013 to 2017 (Note 1), site information and spatial distribution of monitoring stations of Guangdong-Hong Kong-Macao Pearl River Delta Regional Air Quality Monitoring Network are set out in Annex 3. Similar to that in Hong Kong, the O3 concentrations recorded in the monitoring network showed an upward trend from 2013 to 2017.

Note 1: 2018 data is under preparation and hence not available.

(4) The EPD compiles the Hong Kong Air Pollutant Emission Inventory every year to analyse the distribution and trends of major air pollution sources in Hong Kong. The emission inventories for 2017 and 2018 are still under preparation. The total emissions (Note 2) of NOx and VOC from 2012 to 2016 are tabulated in Annex 4.

Note 2: Excluding emissions from hill fires.

The emissions of NOx and VOC in 2016 decreased by 20 per cent and 9 per cent respectively, compared with 2012. Vessels, power plants and vehicles

were the top three sources of NOx emissions, accounting for 37 per cent, 29 per cent and 18 per cent of total NOx emissions in 2016, respectively, whereas non-combustion sources (such as hair spray and adhesive), vehicles and vessels were the top three sources of VOC emissions, accounting for 58 per cent, 18 per cent and 17 per cent of total VOC emissions, respectively.

(5) The EPD operates an air quality monitoring network (AQMN) in Hong Kong with 13 general AQMSs and three roadside AQMSs. The primary objectives of setting up the AQMN are to collect data for assessing the impact of air pollution on the public, facilitate the formulation of air quality management strategy and evaluate its effectiveness. To achieve these objectives, the EPD makes reference to internationally recognised guidelines (such as that of the United States Environmental Protection Agency) in the design of the AQMN and site selection of the monitoring stations. A stringent quality control and quality assurance system is also in place to ensure the data are highly accurate, reliable, representative and internationally comparable. Factors considered in designing the AQMN include the spatial distribution of AQMSs in the network, coverage of existing AQMSs, types of development areas, local population, the distribution of traffic flow and pollution sources, the need to monitor regional air pollution levels, topography and local development plans.

The EPD conducts annual review on the AQMN based on established mechanisms and international guidelines to confirm the functionality and representativeness of the AQMN. Pursuant to the 2015 AQMN review, having considered the uniqueness of the topography and future population and development plans of the North District and Southern District , the EPD plans to set up a general air quality monitoring station each at North District and Southern District. The construction work for the two stations will start in mid-2019 and the stations are expected to commence trial run at the end of this year or early next year. By then the total number of general air quality monitoring stations in Hong Kong would be increased to 15. The EPD will conduct regular review to continue to improve the AQMN.