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11 July 2012

Mrs Sharon Tong
Clerk to Panel on Security
Legislative Council Secretariat
Legislative Council Complex
1, Legislative Council Road
Central, Hong Kong
(Fax: 2185 7845)

Dear Mrs Tong,

Panel on Security

At the meeting of the Panel on Security on 3 April 2012, Members discussed the Daya Bay Contingency Plan (DBCP) and exercise preparation, and requested the Administration to provide supplementary information on a number of issues. The required information is set out below.

Possible impacts of a nuclear accident on water supply in Hong Kong

Members were concerned about the possible contamination of drinking water in Hong Kong in the event of a nuclear accident at the Guangdong Daya Bay Nuclear Power Stations (GNPS) and the countermeasures to be adopted.

According to the Consultancy Report on the Environmental Aspects of the Daya Bay Nuclear Power Station undertaken by the United Kingdom Atomic Energy Authority (UKAEA), even under extreme and extraordinary circumstances in which a major radiological release from GNPS occurred with a radioactive plume travelling towards a reservoir, the impact on water supply would still be fairly minimal. Theoretically speaking, in normal dry weather, the radioactivity in reservoir water will only approach the derived intervention levels established in accordance with the International Atomic Energy Agency (IAEA) when the release of depositable radioactivity from Daya Bay reaches 10^{17} Bacquerel (Bq), that is, a magnitude equivalent to the Chernobyl nuclear accident. Even under extremely pessimistic circumstances in which there is a heavy downpour when the radioactive plume passes over the reservoir, an amount of 10^{15} Bq of depositable radioactivity will only render the radioactivity concentration of reservoir water equivalent to the derived intervention levels applicable to drinking water.

Hong Kong's sources of water come from Dongjiang and rainfall from catchments (local water sources). Of the overall water supply, 70% to 80% comes from Dongjiang and 20% to 30% from local water sources. Located at the north of Daya Bay, the main stream of Dongjiang is more than 50 km away from the nuclear power stations, with mountains in between to serve as a barrier. Southeasterly wind is a prerequisite to cause radiological contamination of Dongjiang. The nearest Hong Kong reservoirs to Daya Bay are Plover Cove and High Island Reservoirs. Both are located at the southwest of Daya Bay and are at a distance of about 30 km from the nuclear power plants. Northeasterly wind is a prerequisite to cause radiological contamination of Plover Cove and High Island Reservoirs. Taking account of the potential extent of radiation release caused by a Daya Bay nuclear accident as well as the relative geographical positions of the Dongjiang and the local reservoirs, it is basically impossible to have both water sources to be radiologically contaminated and become unusable at the same time.

In the event that the source of water supply is temporarily contaminated, a number of urgent protective measures can be taken, as follows:

- Shenzhen Reservoir is part of the Dongjiang water supply system. Should the radiological contamination level exceed the control limits, the Water Supplies Department (WSD) may request Guangdong Province to arrange for temporary suspension of water supply to Hong Kong. During that short period, Shenzhen Reservoir will be replenished and diluted by the Dongjiang continuously. In addition to the sedimentation and physical decay of radionuclide[1], the radioactivity will be greatly reduced. When it comes to a safety level, the water supply to Hong Kong will be resumed. It is worth noting that the Dongjiang water supplying to Hong Kong is conveyed directly from the water intake point at Qiaotou about 60km away from the Shenzhen Reservoir through mostly enclosed dedicated aqueducts to the Shenzhen Reservoir. The water will then be conveyed to Muk Wu Pumping Station in Hong Kong through pipelines. Apart from Hong Kong, over 40 million people living in towns and cities along the river are also supplied with Dongjiang water. The flow of Dongjiang is very huge and can be regulated by three major reservoirs (such as Xinfengjiang Reservoir) situated upstream of the river.

- Should the supply from Dongjiang be suspended, Hong Kong will be supplied with water from local reservoirs. The storage capacity of Hong Kong reservoirs can meet four to six months' demand locally in general.

- Should the reservoirs be affected by radioactive plume, the radionuclide will usually settle on the bottom soil of the reservoirs. In addition to the physical decay of radionuclide, the radioactivity will be greatly reduced. The WSD

[1] For example, iodine-131 has a half-life of 8 days, i.e. half of the iodine-131 concentration in water will be lost in 8 days. And only 1/16 of the iodine-131 concentration will be left in water after one month.

will closely monitor the water quality and draw water from different intake points at different depths of the reservoirs for treatment by water treatment plants before delivering it to meet Hong Kong's demand for water supply.

- The water treatment process in Hong Kong includes coagulation/flocculation, sedimentation and filtration, which enables effective removal of radioactive substances in water. The WSD will adjust the amount of coagulant used in the treatment process and lengthen the sedimentation time to minimise the level of radioactivity in water and to ensure that the radiation level in water in Hong Kong conforms to international safety standards. According to the World Health Organisation's Guidelines for Drinking-water Quality (4th Edition, 2011), processes of flocculation, sedimentation and filtration can remove radioactive substances, such as iodine and caesium, by 10% to 40%. The effectiveness of the water treatment process in radionuclide removal varies, depending on factors such as the types of nuclides, the state in which they exist and their proportion of particle adsorption.

- Flexible implementation of various countermeasures will ensure that the supply of water is safe for consumption in accordance with international safety standards.

International standard for radioactive substances in drinking water and standards in Japan and Hong Kong

Members requested the Administration to make comparison among international standard for radioactive substances in drinking water and standards in Japan and Hong Kong. The information is tabulated below:

Radionuclide	Hong Kong's standard (laid down in accordance with IAEA's standards before May 2011)	Japan's provisional (emergency) standard	IAEA's Operational Intervention Levels (OILs) (since May 2011)
Iodine-131	1000	300 (adult) 100 (infant)	3000
Caesium-134	500	200	1000
Caesium-137	600	200	2000
Strontium-90	100	-	200
Sum of ratios	≤ 1	-	≤ 1

(Unit: Bq/L)

The standard for radioactivity of drinking water in Hong Kong is established according to the IAEA's recommendations and endorsed by the Radiological Protection Advisory Group of the Department of Health that it is applicable to Hong Kong's overall population, including different groups such as infants and young children.

The IAEA is the international authority in providing scientific-based guidelines for nuclear incidents. Following the Fukushima nuclear incident, the IAEA has issued the General Safety Guide No. GSG-2 "IAEA Safety Standards: Criteria for Use in Preparedness and Response for a Nuclear or Radiological Emergency", which sets out among others the OILs of radiologically contaminated water, e.g. the OIL for iodine-131 is 3 000 Bq/L. Compared with the latest OILs set by the IAEA for nuclear incidents, the current standard for radioactivity of water in Hong Kong (1 000 Bq/L for iodine-131) is even more stringent.

Despite the difference in value between Hong Kong's drinking water radioactivity standard and Japan's provisional (emergency) standard, the standards in Hong Kong and Japan provide a comparable level of radiological protection, thus safeguarding the water supply during a nuclear accident. Both the standard in Hong Kong and Japan's provisional (emergency) standard cover the limits imposed on common radionuclides (e.g. iodine-131, caesium-134, caseium-137). The standard in Hong Kong also covers strontium-90. Most important of all, the standard in Hong Kong requires, inter alias, the sum of ratios between the measured activity concentration and derived intervention level of each nuclide should not exceed unity, whereas the standard in Japan does not have such a requirement.

<u>Example</u>

Given that the radionuclide levels conform to Japan's standards for adults (i.e. 300 Bq/L of iodine-131, 200 Bq/L of caesium-134 and 200 Bq/L of caesium-137), the "sum of ratios" for these three types of nuclides will be (300/1000) + (200/500) + (200/600) = 1.03, which is greater than 1. This will not be able to conform to the standard in Hong Kong.

The standard for radioactivity of drinking water in Hong Kong and the protective actions in place can effectively ensure the supply of safe drinking water at the time of a nuclear accident.

Resources implication of S1 type accidents

Members were also concerned about the potential impacts on Hong Kong and possible implications on the emergency response in the event of an S1 type accident.

As the design of pressurised water reactors (PWRs) adopted in GNPS and Lingao Nuclear Power Station (LNPS) is an improved version based on the French PWRs, it is appropriate to model on the technical justifications of emergency planning zones as defined areas for contingency planning adopted by France.

The French source term S3 represents major releases that are reasonably foreseeable in various scenarios. This very large source term assumes the occurrence of a very severe accident with core meltdown at nuclear reactors and breach of containment at the same time, which may be classified as the highest level (i.e. Level 7) of the International Nuclear and Radiological Event Scale rating. In this connection, source term S3 is adopted in the Accident Consequence Assessment System (ACAS) simulation study, serving as a basis of reference for the maximum conceivable release in the most pessimistic nuclear accident.

The amount of radioactivity associated with source term S3 is in fact very huge, being 100 to 1000 times more than the release quoted in the UKAEA's consultancy report which was compiled for the purpose of preparing the DBCP, or hundreds of thousands times more than the radioactivity released in the Three Mile Island nuclear accident, the worst ever accident involving a PWR with a similar design.

The radioactivity released by source term S1 will be a hundred times or so more than that of source term S3, of which the magnitude is even greater than the release of the Chernobyl nuclear accident. Source term S1 originates from total containment failure (for example, from a steam explosion or hydrogen explosion), resulting in off-site release in the "early" phase of an accident. The design features of French PWRs have specifically aimed at avoiding occurrence of such scenarios. Those features include provision of large and strong containment and installation of various facilities, such as control rods and baron replenishing systems, external main and back-up power supplies, a number of internal emergency diesel generators, multiple safety watering system and spraying system inside containment, and facilities that provide cooling water and emergency electricity by utilising the steam generated from the heat of the reactors, etc., to prevent containment failure due to damage of the reactor. Therefore, the French experts consider that an accident leading to a source term S1 off-site release is unlikely to occur and thus do not adopt source term S1 as the technical basis for defining the emergency planning zone.

As the GNPS and LNPS are basically French design, it is appropriate and scientific to make reference to the French source term S3 in the review of the DBCP as the technical basis for the purpose of defining emergency planning zones for detailed pre-planning of protective actions to a reasonable extent.

As a matter of fact, we have not seen any advanced countries in Europe and America that directly adopt source term S1 as the basis of defining emergency planning zones. Such practice is also not conducive to the actual deployment in an emergency response.

Response to a submission

The Government's response to the submission by the IEEE Hong Kong Section Energy & Power Chapter is set out at Annex.

Yours sincerely,

(Andy YK YEUNG)
for Secretary for Security

Annex

Views from IEEE Hong Kong Section Energy & Power Chapter

The key points of the Government's response to the submission of the IEEE Hong Kong Section Energy & Power Chapter are set out below.

1. In page 8 of the submission, it is stated that "The first fundamental principle of the Daya Bay contingency planning is: 'Contingency planning should accommodate all accidents that are reasonably foreseeable and be capable of being applied in case of less likely but potentially very severe accidents' . Apparently, the Fukushima Daiichi Nuclear Power Plant Incident in Japan is not only a reasonably foreseeable accident, it has actually happened. A similar accident in Daya Bay is also reasonably foreseeable."

   Whether a nuclear accident is reasonably foreseeable depends on the risk level of an individual nuclear power plant. And it should be determined through scientific and factual analysis. A number of critical factors need to be considered, including the geographic environment of the site, the meteorological condition, the types of reactors, design and construction year of the nuclear power plant and the safety countermeasures, etc. Although a nuclear accident did happen in Fukushima, as these factors are different for the two nuclear power plants, it is not appropriate to conclude that similar accidents are reasonably foreseeable in Daya Bay. Since the design of the nuclear reactors and the protective measures taken in the Fukushima Nuclear Power Plant and the Daya Bay Nuclear Power Plant are different, what had happened in the Fukushima Nuclear Power Plant cannot be directly applied to the Daya Bay Nuclear Power Plant. For example, the design features of the PWR reactor in Daya Bay include provision of large and strong containment and installation of various facilities, such as control rods and baron replenishing systems, external main and back-up power supplies, a number of internal emergency diesel generators, multiple safety watering system and spraying system inside containment, and facilities that provide cooling water and emergency electricity by utilising the steam generated from the heat of the reactors, etc., to prevent containment failure due to damage of the reactor.

2. In page 9 of the submission, a simulation map of a Daya Bay nuclear accident is presented by directly and mechanically applying the measurement results of Japan's Fukushima nuclear accident to Hong Kong. Such simulation has not taken into account the differences in the design of the nuclear power plants. The geographical and meteorological conditions in the two places are also completely different. Using it as the basis for assessing the situation at Daya Bay is neither scientific nor appropriate. The relevant result can hardly serve as a reference.

3. The possible impact of a nuclear accident on water supply in Hong Kong (page 11 of IEEE's submission) has already been discussed in detail in our letter. In Hong Kong, the nearest reservoirs to Daya Bay are Plover Cove and High Island Reservoirs. Both are located at the southwest of Daya Bay at a distance of about 30 km from the nuclear power plants. The main stream of Dongjiang is located north of Daya Bay and is more than 50 km away from the nuclear power stations, with mountains in between to serve as a barrier. Taking account of the relative geographical positions of the Dongjiang and the local reservoirs, it is basically impossible to have both water sources to be radiologically contaminated and become unusable at the same time. In addition, as seen from the Fukushima incident, the activity concentration of the iodine-131 found in tap water in Litate, Fukushima (about 30-40 km from the Fukushima Nuclear Power Plant) on 20 March 2011 (eight days after the radiological release) was 965 Bq/l. Seven days later, the iodine-131 concentration in tap water had already dropped to level below 100 Bq/l. On 11 April 2011, iodine-131 was no longer detected in tap water. The cesium-137 concentration was also much lower than that of Japan's provisional standards for emergency.

4. Specific evacuation and sheltering arrangements for Ping Chau (pages 13-14 of IEEE's submission), including assessment of countermeasures, transportation for evacuation, places for sheltering etc, have already been set out in detail in Chapter 6 of the DBCP. It is worth noting that the evacuation for Ping Chau is preventive in nature. As demonstrated in the exercise carried out in April this year, a precautionary evacuation had already been arranged in Ping Chau before an off-site release from the nuclear power plant ever occurred.

5. In page 14 of the submission, it is proposed that the Accident Consequence Assessment System (ACAS) of the Hong Kong Observatory adopts the actual data of the Fukushima nuclear incident as the source terms of the system when carrying out a simulation study. As a matter of fact, both the GNPS and the LNPS adopt the basic French design, which is different from that of the Fukushima Nuclear Power Plant. Therefore, it would be more appropriate to refer to the source terms adopted by France (instead of those in the Fukushima incident) when doing the assessment. Detailed information about the source terms adopted by France is already set out in the letter.

6. The Operational Intervention Levels (OILs) mentioned in page 15 of the submission is not the latest standards stipulated by the IAEA in relation to the OILs for nuclear contingency, while the DBCP has adopted the latest standards on nuclear emergency promulgated by the IAEA. For detailed information, please see Annex 1.5 of Chapter 1 of the DBCP or the 2011 IAEA Report - "Criteria for Use in Preparedness and Response for a Nuclear or Radiological Emergency: General Safety Guide No. GSG-2".

7. Page 16 of the submission mentions about the setting up of Emergency Planning Zone. The comprehensive review of the DBCP has confirmed that it is scientifically justified and appropriate to maintain a 20 km radius for Emergency Planning Zone 1. This arrangement is in line with the prevailing IAEA standards and best practices in advanced countries. The Hong Kong Observatory has made use of the new generation ACAS to simulate the consequences of the worst possible accidents at nuclear power stations in Daya Bay, including severe accidents at the highest level of the International Nuclear and Radiological Event Scale (i.e. Level 7). The simulation has confirmed that the evacuation zone set at 20km radius is appropriate. As for places outside the 20km zone, .i.e. most part of Hong Kong, staying indoor is the best way to protect against the temporary passage of the plume. Concrete buildings in Hong Kong are generally effective in substantially reducing exposure to radiation.