立法會CB(2)1625/11-12(05)號文件
LC Paper No. CB(2)1625/11-12(05)

大亞灣民間監察會馮智活對《大亞灣應變計劃》之意見書

致：香港立法會保安事務委員會
由：大亞灣民間監察會馮智活
日期：2012 年 4 月 3 日

很高興有機會向各位議員陳述意見。
本人自 1986 年開始關注大亞灣核電站之興建及運作、和對本港之影響。
本人 1991 年至 1995 年曾任本港立法局議員。

懇請各議員致力保障市民生命健康財產，謀求在大亞灣核電站發生意外時可得最佳之保護。

港府於今年 3 月發表之《大亞灣應變計劃》，提及曾於 1987 年港府委託英國原子能管理局完成有關大亞灣核電站之《應變計劃》顧問報告 (1.2 段、及 1.25 段)，但卻刻意漠視該報告之意見及建議。港府將「針對煙羽的防護措施」，只限於 20 公里，是嚴重不足，(1.24、1.25 段) 也不是英國原子能管理局《應變計劃》顧問報告所作之建議。

1987 年英國原子能管理局發表之《應變計劃》顧問報告，顯示由大亞灣核電站吹來之輻射雲霧，是有可能吹到 *30 公里*遠之萬宜水庫。(53 頁，A)

英國原子能管理局之顧問報告清楚詳盡掩蔽所之重要(58-59 頁)，可惜保安局有意迴避。
該顧問報告指出：

1. 「香港東北區市民」可能要採取這項防禦措施。(B) 並清楚指出，「不過為周全起見，這類假設的意外，亦須顧及。」(C)
   「香港東北區市民」肯定不只是 20 公里之東平洲。
2. 「如果在適當(相當短)的時間，正確執進入掩蔽所措施，則市民所受的劑量，可以大為減少。」(可減少 50-90%) (D)
3. 進入掩蔽所之詳細方法。 (E)
4. 「…如短時間內通知市民*進入掩蔽所*」，「定會引致人心惶惶，並造成交通及運輸系統一片混亂。」(F) 如果只是涉及 20 公里之東平洲，斷不會出現這情況，故此是有可能有需要通知更大範圍的市民進入掩蔽所。
5. 「如果預計輻射劑量會超逾*進入掩蔽所*的『低緊急參考水平』，(即 *5 毫希*，62 頁，J)，便應考慮採取這項措施」。(G)
   但是，保安局現只建議「於首七天內達 *100 毫希*」才採取「進入屏蔽所」之

措施。(《大亞灣應變計劃》，附件 6.3，表 A 第二行)
政府將保障的水平，由 *5 毫希*降至 *100 毫希*！！

6. 然而，保安局留下尾巴，「…應急區 1 (即 20 公里範圍) 的防護措施…可作為日後有需要時適當地擴大防護措施適用範圍的依據。」(6.29 段) 「督導小組…可視乎情況所需，考慮採取以下措施：(a)向市民提供適當的指引，勸諭他們…即使預計(輻射)劑量低於撤離或進入屏蔽所的相關通用準則，也應*盡量留在室內*…」(6.30 段)
7. 到底是否需要在 20 公里外採取屏蔽所措施？若要，則必須事先向市民講述清楚這措施之作用、方法、安排、在什麼情況下才需進行等。否則，到時會產生大混亂。

*屏蔽所*措施簡單易做、成本極低、卻極有效地減低市民受到之輻射污染，為何不預先作此安排呢？

若有機會，本人樂意向各議員提交其他意見。

但***屏蔽所措施是必須的(最少至 50 公里範圍)***，不能不設立，否則就是不負責任！就是失職！

懇請各立法會議員努力跟進此事！

附件：
1987 年英國原子能管理局發表之《應變計劃》顧問報告，中文版 53, 58, 60 頁，英文版 60, 65,66,70 頁。

為香港政府
研究
大亞灣核電站
環境問題
顧問報告書

應變計劃

尼爾
戴維斯

本報告書
呈交香港經濟司，
以履行香港政府與
英國原子能管理局所
簽訂顧問協議
的一部分

一九八七年十二月

9.3 立法的需要

在發生任何嚴重事件後，香港如果要實施禁止污染食品進口、分發、出售和食用的防護措施，必須有法例賦予有關機構執行這些措施的權力。這些法例，亦須授權有關機構進入任何可能受影響的地區及搜集樣本。英國現時已有這類法例(參考書目23)。

9.4 實施防護措施的一般情形

如果香港受到輻射雲霧影響，必須利用初步監測結果，估計地面上的輻射沉積量。這項估計所採用的方法，已在第7章説明。這項初步估計，必須以保守的假設爲根據。倘若估計顯示水果及綠色蔬菜多數會受到嚴重污染，則應禁止這些產品的發售及食用，直到有更詳細的監測結果爲止。如果牧草受到污染，或可能受到污染，則應考慮將牛隻，特別是乳牛，遷離牧場，改以儲備的飼料餵養。

其他需較長時間才能達到消費者手上的食品，則可以按略長的時間量程處理。

隨着時間的過去，進一步的監測結果，會幫助更清楚瞭解食品內或食品表面所受到的污染程度，亦可更明確界定什麼地區或什麼產品須實施禁制。換言之，可在這時候對某類食品實施新禁制，及放寬一些食品的禁制。

此外亦須注意管制從中華人民共和國輸入可能受污染的食品。

食水亦須加以監測，主要目的是讓用户放心。不過，萬一有些水源受污染，當局應改以不受影響地區的水源供應，及／或更改食水處理方法，以便大大減低污染程度。

食品及供水受污染至何種程度才會實施禁制，視乎消費者可能吸收到的劑量而定。這個問題將在本報告書第10章討論。

9.5 食水

輻射危害

香港並無天然湖泊、河流或大量的地下水源，主要的水源是天然集水區和來自中華人民共和國的食水供應。中國供應的食水，來自深圳水庫；該水庫是東江深圳計劃的一部分。

萬一大亞灣發生嚴重輻射洩漏事件，風勢可能會把輻射雲霧吹到水塘上空，輻射物質可能沉積在水塘水面和水塘集水區。因此，食水可能受到污染。

在實際情況中，任何相信可能發生的輻射洩漏，極不可能對食水造成嚴重影響。

儲存香港食水而接近大亞灣的主要水塘，是香港的萬宜水庫和船灣淡水湖，及中國的深圳水庫。以萬宜水庫爲例，這個水庫距離大亞灣核電廠廠址約30公里，存水量爲2.8億立方公尺，水面面積約10平方公里。假如風勢將輻射雲霧吹向萬宜水庫，經過30公里的路程後，輻射雲霧會相當分散，同時水庫如有放射性沉積物，亦會被水庫的存水大量沖淡。

在一般乾爽天氣下，從大亞灣洩漏的可沉積輻射量(即不包括惰性氣體)，須達到10^{17}貝可勒爾(Bq)，水庫存水的輻射量在理論上才會接近參考書目38所指的「低導出緊急參考水平」。這個輻射量，要有相當於切爾諾貝爾事件的規模才能達到。計算下雨時的沉積率，頗爲困難(參考書目24)，但在切爾諾貝爾意外事件的輻射雲霧經過英國時，當局發覺在曾下大雨地區的沉積量，是雨量少或沒有下雨地區的100倍或以

／文康市政司負責對產品／糧食的分發、進口及售賣實施或放寬禁制。不過，文職緊急控制中心會向兩者提供意見，而監測及評估中心則會提供意見給文職緊急控制中心。

最初頒佈的產品禁令，須以一些代表性的監測及抽樣結果爲根據。稍後得知更詳盡結果後，可把受禁制的食物或地區調整。

漁農處須不時通知文職緊急控制中心監督有關該處所採取的行動，而該監督則會向市民發佈消息。

凡洩漏輻射事件波及香港，政府應勸告市民在進食前，清洗任何可能受污染的食物。

對於不適宜食用的產品，必須考慮如何處置。這項工作可能不在漁農處的專業範圍內，因此須由其他政府部門及機構協助。

9.7 設計基準以外事件

假如大亞灣反應堆發生任何設計基準事件，香港無須採取輻射雲霧防護措施，例如進入掩蔽所或疏散。不過，凡應變計劃都要考慮如何可以擴展，以應付較大型的意外。萬一大亞灣發生這類極不可能發生的意外，則鑑於香港東北區市民可能受到的劑量，便會有需要採取某些輻射雲霧防護措施，尤其是進入掩蔽所。本段的目的，是討論處理設計基準以外的大型事件所須採取的行動。以大亞灣興建的壓水式反應堆來說，發生這類意外的可能性極低，或許沒有可能發生，不過爲周全起見，這類假設的意外，亦須顧及。

進入掩蔽所

正如本報告書較早時論及，如果一個人所在的位置，是在放射性氣體及揮發性物質洩漏的順風方向，他所受到的劑量，可能主要是吸入輻射物質，其次是受飄過的雲霧直接輻照。假如人人留在户內，關上門窗及通風系統，他們所吸入的輻射物質分量，便會減少。此外，樓宇本身亦能提供一些防護，減少雲霧的直接輻照。這種方法所能避免的劑量，視乎樓宇的構造及人在樓宇內的位置而定。不過，一般來說，原可受直接輻照的劑量，有 50–90% 可以避免，而原可吸入的劑量，特別是短暫的輻射洩漏，亦約 90% 可以避免(參考書目 10)。由此可見，如能在適當的時間，正確執行進入掩蔽所措施，則市民所受的劑量，可以大爲減少。

只要能作好準備，在發生意外時向公衆發出指示，就可以在相當短的時間內讓居民進入掩蔽所。發出指示的方法，包括利用電台、電視台，及警車或直升機所配備的流動公衆廣播系統(見11.3段)。如果香港的監測站在探測到輻射前，並沒有收到任何洩漏輻射的警報，則時間尤其重要。因此，若市民事先熟悉應變計劃中的有關部分，會有很大裨益。香港在熱帶氣旋吹襲而懸掛九號或十號暴風信號時，所採取的措施，與在受到大量輻射洩漏影響時所須採取的正確行動，十分相似。

如實施進入掩蔽所措施，應勸告居民留在室內，將所有門窗、通風設備及空氣調節系統關上。門窗下若有任何明顯縫隙，應用濕毛巾堵塞。室內各人應留在建築物的中央(如建築物有地下室，則最好留在地下室)，盡量遠離窗户。在輻射雲霧經過後，須提醒市民打開窗户，開動通風設備或空氣調節系統。

只要進入掩蔽所措施能及時和有秩序地進行，而且爲時短暫，則不失爲一項有效而危險性及社會代價都很低的防護措施。如果預計輻射劑量會超逾須進入掩蔽所的「低緊急參考水平」(見第10章)，便應考慮採取這項措施。如果有大量輻射雲霧吹至，而香港未得知詳情，則會引起嚴重的問題。在這種情況下，如短時間內通知市民進入掩蔽所，定會引致人心惶惶，並造成道路交通及運輸系統一片混亂。幸而出現這種情況的機會，微乎其微。只有已證實大亞灣洩漏大量輻射，而市民可能受到的劑量大大超過「低緊急參考水平」時，才應在短時間內通知市民進入掩蔽所。

10

「緊急參考水平」

10.1「緊急參考水平」

在發生洩漏輻射物質到周圍環境的嚴重意外時，須考慮採取第9章所討論的防護措施，以減少公衆所受到的輻照。不論採取何種防護措施，多少都會妨礙市民的正常生活。因此，採取防護措施，要付出社會代價，有時甚至有風險存在。任何防護措施，必須肯定收到實效才可採用，所以假如只有極少量的輻射外洩，就不應只爲防止受到輕微劑量而採取這類措施(見5.6段)。大多數的應變計劃都以此爲原則。

在輻射事件的應變計劃中，不同的防護措施有不同的代價和風險。應付可能受到較高劑量所採取的有效防護措施，幾乎肯定不適用於應付可能受到較低劑量的情況。

限制公衆所受輻射劑量而採取的防護措施，還有一個特點。在某種程度上，採取防護措施的代價和風險，視乎實施時的當地情況而定，這點亦對決定何時採取措施有影響。由此可見，實施防護措施，並非單憑一個預測劑量水平而決定，而是以一連串預測劑量數值爲依據，當局則按照這些數值而考慮採取某項防護措施。預測劑量達到某一水平便須採取某項防護措施，這個水平稱爲「緊急參考水平」。預測劑量達到須開始考慮採取某項防護措施的水平，稱爲「低緊急參考水平」；如達到差不多肯定要採取防護措施的水平，則稱爲「高緊急參考水平」。多個組織曾就這兩個緊急參考水平的數值作出建議。表10.1、10.2及10.3列出國際放射防護委員會(參考書目15)建議的數值。這些數值一般都與其他國際專家的意見相符。

表 10.1
輻射雲霧防護措施的「緊急參考水平」

	劑量當量(毫希)	
防護措施	全身	肺、甲狀腺及任何先受輻照的器官
進入掩蔽所及服用穩定碘片		
高劑量水平	50	500
低劑量水平	5	50
疏散		
高劑量水平	500	5 000
低劑量水平	50	500

表 10.2
食物防護措施的「緊急參考水平」

	首年的推算劑量當量(毫希)	
防護措施	全身	個別先受輻照的器官
食物控制		
高水平	50	500
低水平	5	50

Consultancy on
the Environmental
Aspects of the
Daya Bay Nuclear
Power Station for the
Government
of Hong Kong

CONTINGENCY PLANNING

A P Neal
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THIS REPORT IS PRESENTED TO THE SECRETARY FOR ECONOMIC SERVICES, HONG KONG, IN PART FULFILMENT OF THE CONSULTANCY AGREEMENT BETWEEN THE GOVERNMENT OF HONG KONG AND THE UNITED KINGDOM ATOMIC ENERGY AUTHORITY

DECEMBER 1987

The levels of contamination at which foodstuffs or water supplies should be banned is based upon the potential dose to the consumer. This topic is discussed in Chapter 10 of this report.

9.5 Water

The Radiological Hazard

Hong Kong has no natural lakes or rivers or substantial underground water sources. The main water sources are therefore natural catchment and supply from the People's Republic of China. The supply from China is taken from the Shenzhen reservoir which is part of the East River—Shenzhen Scheme.

In the event of a major release of radioactivity from Daya Bay the wind could carry the plume over one or more reservoirs and radioactive material could be deposited on the surface of the reservoir and its associated catchment area. There is hence the possibility of contamination of water supplies.

In practice it is highly unlikely that any credible release of radioactivity would have any significant effect upon water supplies.

A The main reservoirs close to Daya Bay which store Hong Kong's water are High Island and Plover Cove in Hong Kong and Shenzhen in the People's Republic of China. Taking the High Island reservoir as an example; this has a capacity of 280 million cubic metres of water, and a surface area of approximately 10 square kilometres. The reservoir is located about 30 km from the Daya Bay site. If the wind were such that the plume travelled towards High Island reservoir, after travelling 30 km the plume would be fairly dispersed and also any deposition on the reservoir would be subject to massive dilution by the volume of water in the reservoir.

In average dry weather conditions it would require a release of depositable activity (ie excluding noble gases) from Daya Bay of the order of 10^{17} Bq before the activity in the reservoir water could theoretically approach the lower derived emergency reference level (DERL) given in reference 38. Such a release would be comparable with the release from Chernobyl. Calculation of deposition rates during rainfall is difficult (ref 24), however in the UK during the passage of the Chernobyl cloud it was found that deposition in areas of heavy rainfall could be a factor of 100 or more greater than those areas with little or no rainfall, (ref 25). This would imply that for the highly pessimistic scenario of the plume travelling towards the High Island reservoir and meeting heavy rainfall only as it passes over the reservoir, a release of 10^{15} Bq of depositable radioactivity could just give rise to a concentration of radioactivity in the water equivalent to the lower DERL for drinking water. The level of activity in the water would, however, be greatly reduced by the standard water treatment processes and so the level of radioactivity in the customer's supply would be much less than the lower DERL.

The hazard associated with contaminated water is principally due to its consumption. Using such water for washing, etc., is unlikely to result in any significant hazard.

Behaviour of the Deposited Activity

Radioactivity may be deposited on the surface of the reservoir and on its catchment area. Only a small fraction of the radioactivity deposited on the catchment area is likely to be transferred to the reservoir (ref 26). For example less than 2% of the Cs-137 is likely to find its way into the reservoir (ref 27). The catchment area for the High Island reservoir is about 70 km^2 compared with a surface area of the reservoir of about 10 km^2. It is clear therefore that the activity in the reservoir will initially be dominated by the activity deposited directly on the surface of the reservoir. Any activity which does enter the reservoir from the catchment area will take time to do so. In Sweden after the Chernobyl accident it was found that I-131 and Cs-137 entering lakes from run-off from the catchment area

Hong Kong has 28 marine fish culture zones, 1 350 hectares of fresh water fish ponds, plus a much larger supply of marine capture products from outside Hong Kong's territorial waters. For similar reasons to those given in the section on water supplies it is highly unlikely that any conceivable accident at Daya Bay could cause any significant contamination in fish, however to give public reassurance it may be prudent to carry out some representative sampling of fish caught in areas which may have been effected by the passage of the plume. It is also possible to estimate the level of radioactivity in fish and other seafood from measurements of the radioactivity in the water in which they are located (refs 36 and 43).

Application of Countermeasures for Agricultural Produce and Food

During the planning for any major reactor accident, information should be collated about the location of farms, markets, etc., within Hong Kong, together with details of points of entry of all imported foodstuffs. Various reactor accident scenarios should be studied and for each scenario the likely effects on the food chain should be considered. Using the results of these studies the Incident Assessor, with assistance from the Agriculture and Fisheries Department, or the Municipal Services Branch, as the case may be, would, in the event of an accident at Daya Bay, identify the food pathways and the geographical areas which may be affected. Initially, monitoring and sampling teams would be sent out to delineate the affected areas. Having identified and confirmed by initial monitoring and sampling which areas and which foodstuffs are affected, the Agriculture and Fisheries Department/ Municipal Services Branch should consider the need for interdiction of any produce/foodstuffs. The Director of the Agriculture and Fisheries/Secretary for Municipal Services should be responsible for introducing or relaxing any bans on the distribution, importation, and sale of produce/foodstuffs. However, they will be advised on this by the CCC who in turn will be advised by the MAC.

Initially, bans on produce will need to be based upon some representative monitoring and sampling results. Later when more detailed results are available, the particular produce and areas of the bans can be refined.

The Agriculture and Fisheries Department should always keep the CCC Controller informed of their actions, and he in turn will keep the public informed.

In all cases of a release of radioactivity affecting Hong Kong, the public should be advised to wash any potentially contaminated food before consumption.

Consideration must be given to the disposal of any produce deemed to be unfit for consumption. This task is likely to be outside the expertise of the Agriculture and Fisheries Department, and assistance from other Government Departments and Agencies will be required.

7 Beyond Design-Basis Accidents

Any design-basis accident at the Daya Bay reactor would not require plume countermeasures, such as sheltering or evacuation, to be introduced in Hong Kong. It is, however, a requirement of all contingency plans to consider how the plan could be extended to cope with larger accidents. In the highly unlikely event of such an accident occurring at Daya Bay, potential doses to individuals in the north-eastern sector of Hong Kong could be such that some plume countermeasures might be desirable, particularly sheltering. The purpose of this section is to discuss the actions which may be necessary to deal with large, beyond design-basis, accidents. Such accidents are highly improbable, perhaps impossible, with the type of PWR being constructed at Daya Bay, however for completeness consideration should be given to such hypothetical accidents.

Sheltering

As discussed earlier in this report, the dose received by a person standing downwind of a typical release of radioactive gases and volatiles is likely to be due primarily to inhalation of radioactive material and, to a lesser extent, due to direct radiation from the passing cloud. If people stay indoors, with the doors and windows closed and ventilation systems switched off, the amount of radioactive material they will inhale will be reduced. In addition the structure of the building will provide some shielding from the direct radiation from the cloud. The amount of dose that sheltering would prevent depends upon the construction of the building and where a person is located in a building, however, typically 50–90% of the direct radiation component of the dose which would have been received may be avoided and up to about 90% of the dose due to inhalation, especially for short duration releases (ref 10). It is clear therefore that sheltering, provided it is carried out correctly and at the appropriate time, can greatly reduce doses to the public.

Sheltering may be implemented within a reasonably short timescale, provided pre-planned arrangements have been made to issue instructions to the public at the time of the accident. These may include the use of radio and television, and mobile public address systems on police vehicles or helicopters, (see Section 11.3). The time-scale would be particularly important if no warning of a release were received until radioactivity has been detected at the monitoring stations in Hong Kong. Prior familiarity of the public with the relevant parts of the contingency plan may therefore be of great benefit. It is worth noting that actions advised in the event of a tropical cyclone following the hoisting of a No. 9 or 10 signal are similar to the correct actions to be taken in the event of a very large release of radioactive material affecting Hong Kong.

If sheltering is to be implemented, the public should be advised to stay indoors, close all doors and windows, and switch off ventilation and air conditioning systems. Any obvious gaps under doors, etc., should be plugged using, say, damp towels. Occupants should then stay in the centre of the building (or in the basement if the building has one) away from windows. It is important to ensure that once the plume has passed the public are advised to open windows and switch on any ventilation or air conditioning systems.

Provided it may be carried out in a timely and orderly manner, the introduction of sheltering for a limited period of time is regarded as a highly effective, low risk, low social cost, countermeasure. It is therefore suggested that consideration is given to its implementation if projected doses are likely to exceed the lower ERL for sheltering (see Chapter 10). A serious problem would arise if there was little notice of the arrival of a large plume. In these circumstances asking the public to shelter at short notice would undoubtedly cause great concern together with chaos on the roads and transportation systems. Fortunately such an eventuality is extremely unlikely. Asking the public to take shelter at short notice should only be initiated if there has been a confirmed very large release of radioactive material from Daya Bay, and the potential doses to the public are well in excess of the lower ERL.

Issue of Stable Iodine Tablets

One of the volatile components of a release of radioactive material which is likely to be of concern is radioactive iodine, particularly iodine-131. If iodine is inhaled it will concentrate in the thyroid of the individual concerned. This can, however, be reduced by administering stable iodine tablets either before inhaling the radioiodine, or shortly afterwards. The effect of taking the stable iodine tablets is to greatly dilute the radioiodine taken into the thyroid, (Ref 37). Taking the tablets before the arrival of any plume would reduce the subsequent dose by about 95%. The approximate effectiveness of delayed administration, in terms of averted thyroid dose from iodine-131, is as follows:

EMERGENCY REFERENCE LEVELS

10.1 Emergency Reference Levels

In the event of a major accidental release of radioactive material into the environment, consideration needs to be given to limiting any resultant exposure to the public by the introduction of the countermeasures discussed in Chapter 9. The introduction of any countermeasures interferes, to some extent, with normal living conditions, and therefore there is a social cost and in some cases risk associated with the introduction of countermeasures. The introduction of any countermeasures must achieve a net positive benefit and therefore countermeasures should not be introduced to try to avoid trivial doses which may be associated with very minor releases of radioactivity into the environment, (see Section 5.6). This principle is found in most contingency planning.

When making contingency plans for incidents involving radioactivity, different countermeasures will have different costs and risks. Countermeasures which may be beneficial when the potential doses to the public are relatively large will almost certainly be inappropriate when the potential doses to the public are relatively small.

Another feature of countermeasures for restricting doses to the public is that the costs and risks of their introduction will, to some extent, depend upon local conditions at the time of their introduction and this may have an influence upon the decisions as to when to introduce countermeasures. It follows therefore that there is not a single level of predicted dose which will trigger the introduction of a countermeasure but there will be a range of values of predicted dose over which the introduction of a given countermeasure will be considered. The level of predicted dose at which a particular countermeasure should be introduced is known as the 'Emergency Reference Level' (ERL). The predicted dose at which consideration starts to be given to the introduction of a particular countermeasure is called the lower ERL and the predicted dose at which the countermeasure will almost certainly have been introduced is called the upper ERL. Numerical values of upper and lower ERLs have been recommended by a number of organisations. The tables 10.1, 10.2 and 10.3 gives the values recommended by the International Commission on Radiological Protection (ref 15) and these are generally consistent with other international expert opinion.

TABLE 10.1 EMERGENCY REFERENCE LEVELS FOR PLUME COUNTERMEASURES

		Dose Equivalent (mSv)
Countermeasure	*Whole Body*	*Lung, thyroid and any single organ preferentially irradiated*
Sheltering and stable iodine administration		
Upper dose level	50	500
Lower dose level	5	50
Evacuation		
Upper dose level	500	5 000
Lower dose level	50	500

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