Nuclear Free Local Authorities

briefing

Date: 26th May 2016 **No.146**

Subject: Inquiry on Science in Emergencies: chemical, biological, radiological or nuclear incidents - written evidence to the House of Commons Science & Technology Committee

i. Overview of report

This report gives an overview of a response sent in to the House of Commons Science and Technology Committee by independent consultant on radioactivity in the environment, Dr Ian Fairlie. The NFLA Secretariat contributed some information to the response, and the NFLA is supportive of the response. Dr Fairlie has kindly agreed to let the NFLA Secretariat reproduce the response, which will be of interest to member councillors, emergency planning officers, public health officers and environmental health officers.

The response considers the Committee's inquiry into the role of scientific information in emergency incidents. Dr Fairlie's response focuses on emergency planning and the issue of releasing potassium iodine tablets to the public to provide some support in the event of an incident which involves a release of radiation. With Belgium and the Netherlands recently reversing their policy to issue such tablets to their entire populations following information in recent terrorist attacks in Brussels and Paris, this response puts forward the benefits of considering such a response in the UK.

ii. Executive Summary of submission

Because of the risk of possible terrorist attacks at 15 UK nuclear reactors and over 20 nuclear reactors in nearby countries; and because of the increasing age of nuclear reactors, there is a need for greater preparedness to deal with nuclear accidents and incidents.

In the event of a nuclear accident or incident, the three main responses are shelter, evacuation, and iodine prophylaxis. This evidence deals with the latter.

The prior ingestion of stable iodine is an effective means of protecting the thyroid gland from thyroid cancer and other thyroid effects, especially among children. It is necessary to consume stable iodine immediately after a nuclear incident: the best way to provide this is the advance distribution of stable iodine prior to any accident or incident.

After the 1986 Chernobyl nuclear disaster, where stable iodine supplies for most people either did not exist or were not distributed, epidemics of thyroid cancer occurred in Belarus, Russia and Ukraine. These did not occur in neighbouring Poland where KI supplies had been rapidly distributed to all people throughout the country.

After the 2011 Fukushima nuclear disaster, although central supplies of stable iodine existed, inadequate planning, faulty communications, disorganisation and the inability to deliver supplies, resulted in stable iodine tablets largely not being distributed or being distributed too late

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In the UK, the Government has refrained from pre-distributing stable iodine tablets to the public. The decision not to pre-distribute KI may have been influenced by considerations other than public safety. Information on the locations of KI supplies, KI stocks held, and arrangements for their distribution in the event of a nuclear incident or accident is generally unavailable.

After the warning of a nuclear accident or incident, it appears that the Government may intend to distribute KI to “schools, hospitals and evacuation reception centres” and “collection centres” for collection by the public. It is likely that such KI distribution would take one to two days or longer, depending on the sizes of the affected areas. During this time, plumes could continue to cross such areas depending on the nature of the accident, wind direction and velocity.

Although it is unclear, it seems that the Government assumes that most thyroid doses will arise via the food pathway, mainly from the ingestion of milk and leafy green vegetables. This pathway could take a few days and could give time for KI distribution to take place. However recent scientific evidence indicates that inhalation is more important than ingestion for radio-iodine doses. This means advance KI distribution is necessary.

Several EU countries have already pre-distributed KI to all families. KI supplies and dose information are available on line from non-UK sources.

Recommendations:

1. Stable iodine tablets, with clear dose instructions and the reasons for their advance distribution, should be distributed to all families within at least 30 km of nuclear facilities in the UK without waiting for an incident or accident to occur.

2. Since radioactive plumes could reach large urban populations (e.g. >500,000 people) located beyond 30 km, KI pre-distribution should carried out here as well. This is because rapid evacuations from such large cities would be impractical, but their inhabitants should still be afforded some protection.

3. For this reason, and to deal with the possibility of plumes from nuclear reactors on the Continent, consideration should be given to KI pre-distribution to all families throughout the UK, as occurs in several other countries.

Introduction

1. Dr Ian Fairlie is an independent consultant on radiation in the environment with degrees in chemistry and radiation biology. (www.ianfairlie.org.) His doctoral studies at Imperial College and at Princeton University examined the health effects of nuclear waste technologies. Dr Fairlie was Scientific Secretary to the UK Government’s former Committee Examining Radiation Risks of Internal Emitters (www.cerrie.org). Dr Fairlie is a Member of the Society of Radiological Protection.

2. Dr Fairlie was recently commissioned by the Government of the City of Vienna to write a report on the continuing health effects from Chernobyl. This has been published - see https://www.global2000.at/sites/global/files/GLOBAL_TORCH%202016_rz_WEB_KORR.pdf
My evidence draws heavily from this report, particularly its chapter on ‘Conclusions and Recommendations’ which is drawn to the Committee’s attention.

3. The Committee’s background note states that the inquiry coincides with the 5th anniversary of the Fukushima Daiichi nuclear disaster in Japan and the 30th anniversary of the Chernobyl disaster in Ukraine. This evidence solely concerns nuclear accidents and incidents and is mainly focused on stable iodine prophylaxis.

Need for Increased Preparedness

4. There is a need for greater preparedness to deal with possible incidents or accidents at nuclear facilities for three reasons. First is the increased awareness of that terrorist attacks could be made against them. Recent press and media reports - (http://www.independent.co.uk/news/world/europe/brussels-attacks-airport-metro-bombings-isis-terror-group-nuclear-power-station-surveillance-footage-a6949821.html) after the terrorist attacks on Brussels airport and on Maalbeek metro station on March 23, indicate that the terrorists may have been planning to attack Belgium's Doel and Tihange nuclear power stations. This led, inter alia, to staff evacuations from the latter. http://www.mirror.co.uk/news/world-news/brussels-attacks-tihange-nuclear-power-7607460

5. The second reason is that most (14 out of 15) of the UK's nuclear reactors are very old and are approaching or past their original planned lifetimes. Old age is one of the two most hazardous times for nuclear reactors: the other is when reactors are first started up. Several reports have drawn attention to cracking and graphite corrosion at UK AGR reactors. The old age of these reactors has resulted in increased numbers of stoppages for maintenance and de-ratings of reactor power outputs.

6. By continuing to operate AGR reactors beyond their designed lifespans, it is considered that we are going through an experiment and, in effect, hoping nothing will go wrong[1].

7. The third reason is the existence of about 20 reactors in nearby countries. For example, 14 French reactors are situated on the English Channel. The six French reactors at Gravelines are only 40 km from the UK coast and 160 km from London, as the crow flies. Other nearby reactors are located in Belgium, Germany and the Netherlands. Plumes from the Chernobyl nuclear disaster in 1986 reached all parts of the UK despite its 2,000 km distance.

8. In European countries, the proximity of cross-border nuclear reactors is a serious political issue. For example, the German Government has complained to the French Government about the French reactors at Fessenheim near Franco-German border. Luxembourg and Germany have also raised concerns over Cattenom, another French nuclear power station. In addition, in March 2016, the Swiss city of Geneva filed a legal complaint against the French nuclear station at Bugey. The legal action came after repeated demands by the Swiss Government for France to close the plant were unanswered. http://www.thelocal.fr/20160304/germany-demands-france-shut-old-nuclear-plant-near-border

Existing Guidance on Preparedness

9. The UK Government has published nuclear emergency planning guidance to help local planners, Whitehall departments, Devolved Administrations and agencies to carry out nuclear emergency planning. The Nuclear Emergency Planning and Response Guidance (NEPRG) is the primary source of guidance for local planners to enable them to write effective plans. This guidance - https://www.gov.uk/government/publications/national-nuclear-emergency-planning-and-response-guidance - has been published in five parts:
   - Concept of Operations
   - Part 1 - Preparedness
   - Part 2 - Response
   - Part 3 – Recovery
   - Annexes

[1] In more detail, graphite bricks in the core of AGRs are gradually being eroded and lost. This is important as graphite is the moderator in AGRs and moderator loss crucially affects the reactivity of the reactor core. The ONR regulates the state of graphite bricks and does not allow reactors to lose more than a set percentage of their weight before they are classed as having reached the end of their lives. Graphite cracking also has to be taken into account by the regulator when setting a weight loss limit. However EDF can apply to the regulator to increase the weight loss limit in order to extend the life of the power plant. It is not reassuring that the Office of Nuclear Regulation raises the limit it sets for weight loss in the graphite blocks when asked to do so by EDF with little apparent scrutiny of the matter. For some official concerns here, see paragraphs 2 and 41 in http://www.hse.gov.uk/foi/releases/ar6106.pdf and paragraphs 4, 5 and 8 in http://www.hse.gov.uk/foi/releases/ar16405.pdf

10. In addition, the Ministry of Defence (MOD) Nuclear Accident Response Organisation has published information re nuclear weapons and military nuclear facilities – https://www.gov.uk/guidance/nuclear-emergency-planning-and-atmospheric-testing-programme. However MOD's preparedness has been criticised in the past. See – http://www.nuclearinfo.org/article/accidents-safety/flawed-mod-nuclear-response-could-place-emergency-personnel-risk

11. The Department of Energy and Climate Change (DECC) has also discussed the issue of preparedness in the event of an incident at civilian nuclear facilities in its publication "Nuclear Emergency Planning and Response Guidance" – https://www.gov.uk/government/publications/national-nublic_health_England_clear-emergency-planning-and-response-guidance published in October 2015.

12. In addition, "Nuclear Emergencies Information for the Public" was published in 2013 and reprinted in 2015 by Public Health England – https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/467198/Nuclear_emergencies_-_information_for_the_public_October_2015.pdf

13. Furthermore, UK nuclear operators are required under the Radiation (Emergency Preparedness and Public Information) Regulations (REPPIR) (2001) to prepare emergency plans. http://www.hse.gov.uk/radiation/ionising/reppir.htm# However, the advance distribution of stable iodine to families near nuclear facilities is not stipulated under REPPIR.

14. The above publications indicate that Government Departments have considered nuclear emergency matters and they are to be commended for their detailed attentions. Planning and publications are necessary and welcome especially for the three main countermeasures – advice on sheltering indoors, evacuation plans, and stable iodine prophylaxis. But it is considered that the Government needs to be pro-active as well, especially as regards the advance distribution of stable iodine before any accident or incident occurs.

Stable Iodine Prophylaxis

15. After a nuclear accident or incident, stable (i.e. non-radioactive) iodine tablets[2] are widely recognised as an effective way of protecting the thyroid gland from thyroid cancer, especially among neonates, babies, infants, children and adolescents. https://ec.europa.eu/energy/sites/ener/files/documents/165.pdf.
Also see: http://www.nap.edu/catalog/10868/distribution-and-administration-of-potassium-iodide-in-the-event-of-a-nuclear-incident

16. This is because taking stable iodine effectively blocks the uptake of yet more iodine – this time radioactive iodine - from nuclear accidents and incidents. Such prophylaxis only prevents the uptake of iodine nuclides. Many other hazardous nuclides would be released from nuclear incidents or accidents, including caesium-134, caesium-137, strontium-90, hydrogen-3 (tritium), carbon 14, various radioactive noble gases, and uranium and plutonium isotopes. Stable iodine tablets would not provide protection against these nuclides.

17. The most important iodine isotope is Iodine-131 with a half-life of 8.02 days. Other short-lived isotopes include Iodine-133 with a half-life of 20.8 hours, and Tellerium-132 with a half-life of 3.2 days whose decay product is Iodine-132 with a half-life of 2.3 hours. This means that about 3 months after the accident almost all radioactive iodine will have decayed away.[3] The other radionuclides listed in the previous paragraph will persist – some for centuries.

18. In the UK, stable iodine is not currently pre-distributed to families: it appears that Government may intend to distribute KI to "schools, hospitals and evacuation reception centres" and "collection centres" (see Annex A) after the warning of a nuclear accident or incident. The areas to be covered by KI distribution would depend on the kind of accident/incident and size and

[2] either potassium iodide (KI) or potassium iodate (KIO_4)
[3] except for ^{129}I which has a long half-life of 16 million years, but ^{129}I doses are estimated to be very low

velocity of the plume, but it is likely that such KI distribution would take a minimum of one to two days, probably longer. During this time, plumes could continue through these areas.

19. Although it is not apparently stated in Government literature, it seems that the Government assumes that most thyroid doses will be via the food pathway, mainly by the ingestion of milk and leafy green vegetables. For example, UNSCEAR (2008) reported that the main ^{131}I uptake was ingestion via the grass pasture-cow-milk pathway. This pathway would take a few days and would give time for KI distribution to take place.

20. However recent scientific evidence indicates that inhalation is likely to be more important than ingestion for radio-iodine doses. This is discussed in detail in Annex B. Inhalation would occur immediately as the plume passes, and it means that KI distribution a day or two later would be largely ineffective or certainly not as effective as advance KI distribution.

Lessons from Chernobyl

21. During April/May 1986, the Chernobyl nuclear disaster in the USSR released radioactive plumes which resulted in >40% of the land surface of Europe being contaminated, several thyroid cancer epidemics, and in tens of thousands of predicted future cancers. See the TORCH-2016 report.
https://www.global2000.at/sites/global/files/GLOBAL_TORCH%202016_rzWEB_KORR.pdf

22. Despite Chernobyl being >2,000 km away, its plumes contaminated large areas of the UK. Food restriction orders on Cs-137 contaminated sheep farms in Cumbria and Wales lasted until 2012.

23. It is notable that although thyroid cancer epidemics occurred as a result in Belarus, Russia and Ukraine, they did not occur in neighbouring Poland where KI supplies were rapidly distributed among hospitals, police stations, doctor surgeries, health clinics, schools, libraries, local government offices, and chemist shops. This is discussed in more detail in Annex C.

24. One of the lessons from Poland's experience of Chernobyl is that its Government had fortuitously manufactured and stored 90 million doses of 100 mg KI (i.e. 9 tonnes of KI) for a population of about 35 million people prior to the Chernobyl accident. For the UK, it can be estimated that, in a worst-case scenario covering all of the UK, the 25 million families should each be given a bubble pack of 10 x 65mg tablets of KI, i.e. requiring a total of 16 tonnes of KI.

25. It could be legitimately asked whether the Government has such stocks of KI to protect the public in the event of a worst-case accident or incident.

Lessons from Fukushima

26. The major Japanese earthquake and tsunami of March 11, 2011 initiated a severe nuclear accident at the Fukushima Daiichi nuclear plant. Over the following week, three reactor buildings exploded releasing plumes which deposited radioactivity especially over Fukushima Prefecture and adjacent prefectures. The accident prompted widespread evacuations of local populations, large economic losses, and the eventual shutdowns of all nuclear power plants in Japan.

27. In 2012, an independent investigation panel, established by the Rebuild Japan Initiative Foundation, reviewed how the Japanese Government, the Tokyo Electric Power Company (Tepco), and other agencies had responded. A review[4] of the panel's findings by its Project Director stated that all agencies were "*thoroughly unprepared on almost every level for the cascading nuclear disaster…. This lack of preparation was caused, in part, by the public myth of absolute safety that nuclear power proponents had nurtured over decades. The lack of preparation was aggravated by dysfunction within and between government agencies and Tepco, particularly in regard to political leadership and crisis management….. The investigation*

[4] Funabashi Y, Kitazawa K. Fukushima in Review: A Complex Disaster, a Disastrous Response. *Bulletin of the Atomic Scientists* 2012; **14:** 917-937.

*found that the tsunami that began the nuclear disaster could and should have been anticipated [*by the Government and Tepco*]".*

28. The precise details of KI distribution after the accident at Fukushima are unclear: none was distributed prior to the accident. On March 15, three days after the start of the radioactive releases, the nearby towns of Futaba, Tomioka, Iwaki and Miharu distributed in-stock KI pills to local residents without waiting for instructions from Tokyo (Hamada et al, 2012)[5]. Futaba and Tomioka directly instructed their residents to take the pills (Hayashi, 2011)[6] again without waiting for Tokyo orders. On March 16, four days after the start of the accident (when about half of the radioactive iodine releases had occurred[3]), the Government issued instructions to make KI available. However, there was little take-up in many areas because, by then, most evacuations had already taken place (Hamada et al, 2012)[2].

29. In 2014, the US National Academy of Sciences published a major report on the lessons learned from Fukushima - http://www.nap.edu/catalog/18294/lessons-learned-from-the-fukushima-nuclear-accident-for-improving-safety-of-us-nuclear-plants
This recommended the pre-distribution of stable iodine supplies to the public. It concluded, inter alia:
    - *"Emergency management plans in Japan at the time of the Fukushima Daiichi accident were inadequate to deal with the magnitude of the accident, requiring emergency responders to improvise.*
    - *Decision-making processes by government and industry officials were challenged by the lack of reliable, real-time information on the status of the plant, offsite releases, accident progression, and projected doses to nearby populations.*
    - *Coordination among the central and local governments was hampered by limited and poor communications.*
    - *Protective actions were improvised and uncoordinated, particularly when evacuating vulnerable populations (e.g., the elderly and sick) and providing potassium iodide.*
    - *Different and revised radiation standards and changes in decontamination criteria and policies added to the public's confusion and distrust of the Japanese government.*
    - *Clean-up of contaminated areas and possible resettlement of populations are ongoing efforts three years after the accident with uncertain completion timelines and outcomes.*
    - *Failure to prepare and implement an effective strategy for communication during the emergency contributed to the erosion of trust among the public for Japan's government, regulatory agencies, and the nuclear industry.*

Lessons for the UK

30. There are several lessons for the UK in these reports. First, if a nuclear accident or incident were to occur, its plume could distribute radioactivity over parts or indeed all of the UK relatively quickly, depending on wind direction, wind velocity and rainfall. All areas of the UK were affected by the contamination from the Chernobyl accident in 1986. This means that advance planning and preparedness are vital, in particular that stable iodine should be distributed before any accident or incident were to occur rather than waiting for them.

31. The speed and invisibility of radioactive plumes from nuclear accidents and incidents are matters of concern. For this reason, since the Chernobyl accident in 1986, the Government has operated a 24 hour, 365 day monitoring system, RIMNET (phase 2), to detect radioactive plumes see https://www.gov.uk/government/collections/radioactive-incident-monitoring. This system monitors gamma dose rates hourly at 96 UK sites and checks them for abnormal increases. Should these be detected, it is presumed that the Government's radiological response would be activated. The details here are not disclosed, but it is assumed that warnings

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[5] Hamada N et al (2012) Safety regulations of food and water implemented in the first year following the Fukushima nuclear accident. Journal of Radiation Research, 2012, 00, 1–31
[6] Hayashi Y (2011) Japan Officials Failed to Hand Out Radiation Pills in Quake's Aftermath. The Wall Street Journal, September 29.

and information would be issued via radio, TV and the internet to those living in affected areas to seek shelter if outside, or to stay indoors and close windows and doors if inside. At the same time, people would be advised to take stable iodine tablets. This would apply especially to pregnant women, nursing women, infants, children and adolescents.

32. However an inconsistency may arise if members of the public are required to collect iodine tablets from whichever centres the Government has decided to store them and/or make them available. People could then be faced with conflicting advice to stay inside and to go outdoors. In addition, it is possible that car owners may decide to leave affected areas despite any official advice to the contrary. Possible traffic jams could hamper or prevent the Government from evacuating citizens and from distributing iodine supplies. According to several anecdotal reports, this actually occurred at Fukushima.

33. The above considerations mean that practical steps need to be implemented to ensure quicker responses and better preparedness, especially KI prophylaxis. For example, the independent TORCH-2016 report on Chernobyl concluded as follows - https://www.global2000.at/sites/global/files/GLOBAL_TORCH%202016_rz_WEB_KORR.pdf

"*In addition to providing timely and accurate information, government health authorities and disaster planners need to improve their preparedness for future accidents by:*

- *providing stable iodine in advance to all citizens within at least 30 km of all nuclear reactors*
- *stocking emergency levels of radioactivity-free water supplies, long-life milk and dried food supplies*
- *pre-distributing information leaflets to the public explaining what to do in the event of an emergency and explaining why precautionary measures are necessary*
- *planning evacuations*
- *constructing and staffing permanent emergency evacuation centres*
- *carrying out emergency evacuation drills*
- *planning subsequent support of evacuated populations*
- *planning how to help those who choose to remain in contaminated areas*
- *increasing the mental health training of primary physicians and nurses*
- *moving the site of care to primary care settings, and*
- *informing citizens that these measures have been taken.*

It may be argued that these measures are unnecessary and/or too expensive. However this report shows that they are indeed necessary. Governments which choose to promote potentially dangerous energy policies should also fund the necessary precautions in case of accidents. "

Advance Distribution of Stable Iodine

34. Stable iodine tablets (KI) is not pre-distributed to members of the public in the UK. It is understood that "adequate" KI stocks are kept in "regional centres" and some "large hospitals" for utilisation by health authorities and emergency services should an incident/accident occur. KI stocks and the locations of regional centres are not disclosed. For example, in 2013, when queries were made by local councillors in Scotland about stocks of stable iodine, the reported result was "confusion, secrecy and buck-passing": the Scottish Government refused to answer queries - http://www.robedwards.com/2013/06/where-are-the-anti-radiation-pills-meant-to-prevent-cancers-no-one-will-say.html

It is understood that the reason given for this secrecy is that such information could be advantageous to groups mounting a malicious attack.

35. It is therefore impossible for the public to know whether there are sufficient tablets to cater for a large-scale nuclear incident, whether these can be distributed quickly within the required time to be of medical use, and how they will be able to obtain KI tablets during a nuclear incident or accident.

Official Guidance

36. The Government's guidance on KI distribution (set out in Annex C) is considered unsatisfactory. The main failure is on promptness of taking KI tablets. Although the official guidance recognises this is vital, it then states
"….plans should consider the most appropriate way to provide tablets to those who require them in as timely manner as possible".

"The Director of Public Health local to a licensed nuclear site is responsible for ensuring that there are appropriate arrangements for the prompt distribution of potassium iodate tablets and for authorising their administration."

37. It is submitted that "*the most appropriate way*" and "*appropriate arrangements*" are unhelpful to members of the public: actual pre-distribution is required. This is actually suggested in para 5.3.9 of Annex C but only as a possibility.

38. The problem is that, even with the emergency requisitioning of hundreds of private and public vehicles, the <u>prompt</u> distribution of iodine tablets to schools, hospitals, emergency centres and collection centres etc. could be difficult and limited perhaps to a radius of a dozen kilometres. The question arises as to what would happen if large traffic jams occurred due to evacuations?[7]

39. It is noted that arrangements are to be made re KI tablets for "authorising their administration". However, one of the lessons from Fukushima is that such central authorisations (from Tokyo) simply did not occur until too late: indeed, as noted above, several local townships went ahead and distributed at-hand stocks to the public without central permission. How can we ensure that such poor communications do not recur in the UK, in the event of an accident/incident?

Public Safety to be Paramount

40. The paramount issues here are public safety and protection. As KI distribution is a public health matter, key decisions (e.g. dose intervention levels, KI distributions, zone sizes etc.) should be made by the Department of Health and their Directors of Public Health. Obviously, close liaison with other agencies is necessary, but in cases of differing views, the KI technical recommendations of the Department of Health should normally prevail, unless amended by the Civil Contingencies Committee (i.e. COBRA).

41. The prevalence of other considerations has led to unfortunate situations. For example, in 2015, EDF (Energy) stated it intended to pre-distribute stable iodine tablets near its Sizewell reactor in Sussex but that it would reduce the previous suggested catchment area from a 2.4 km radius around the reactor to a 1 km one.
http://www.itv.com/news/anglia/2013-01-08/sizewell-locals-to-get-anti-radiation-pills/
This decision was apparently objected to by local people -
http://tasizewellc.org.uk/index.php/news/28-emergency-plans-for-nuclear-power-plants-at-sizewell.

Advance KI Distribution in Other Countries

42. The reluctance to pre-distribute KI and the prevailing of other considerations contrast with other European countries which have pre-distributed, or will shortly pre-distribute, stable iodine to many or all of their citizens[8]. For example,
    - Austria is known to have done so already to all families,
    - Ireland (http://news.bbc.co.uk/1/hi/england/2053301.stm)
    - Luxembourg (http://www.independent.co.uk/news/world/europe/luxembourg-hands-out-iodine-pills-over-fears-of-french-nuclear-mishap-9802668.html

[7] London is already considered a traffic nightmare by many, even without a major emergency.
[8] From experience in other countries, one minor problem re: KI pre-distribution to homes is that KI pills can get lost. A possible solution is the recommendation to attach the child-resistant KI bubble packs to indoor electricity meters, out of the reach of young children.

- France (http://www.english.rfi.fr/environment/20151226-france-distribute-iodine-tablets-near-nuclear-power-stations)
- Switzerland (http://zug4you.ch/iodine_tablets_to_be_distributed_to_every_household.html)
- Part of the City of Toronto in Canada. (http://www.thestar.com/news/gta/2015/11/10/east-end-given-iodine-pills-as-nuclear-disaster-precaution.html)

43. In addition, other countries have recently stated they intend to pre-distribute stable iodine, including:
   - Belgium http://www.independent.co.uk/news/world/europe/belgium-to-give-iodine-pills-to-entire-country-in-case-of-nuclear-fallout-radiation-terrorist-attack-a7006651.html and
   - The Netherlands http://www.politico.eu/article/dutch-follow-belgian-lead-and-stock-up-on-iodine-pills-nuclear-power-plants-accident-protection/

44. Stable iodine supplies are readily on sale on-line and dosage advice is available from the UN's World Health Organisation. http://www.who.int/ionizing_radiation/pub_meet/Iodine_Prophylaxis_guide.pdf

Conclusions and Recommendations

45. It is concluded that, to ensure preparedness, quicker responses and better public protection, practical steps need to be implemented before any nuclear accident or incident occurs. In particular, the pre-distribution of stable iodine (either as potassium iodide or iodate) is an effective way of protecting the thyroid gland, especially for infants and children. However stable iodine should be swallowed immediately after it is known that there has been a nuclear incident/accident. Unfortunately, information on the whereabouts of KI supplies, their stocks and their planned distribution is withheld.

46. Several other countries and areas have already pre-distributed KI – apparently without difficulty. It is therefore recommended that stable iodine, along with precise dose instructions and the reasons for pre-distribution, should now be distributed to families within at least 30 km of UK nuclear reactors.

47. Where it is anticipated that plumes from nuclear incidents and accidents could reach large urban populations (e.g. >500,000 people) located beyond 30 km, then pre-distribution should cover these areas as well, as quick evacuations from such cities would not be feasible and their inhabitants would still need to be afforded some protection.

48. For this reason, and because of the possibility of reactor accidents/incidents abroad, it is recommended that consideration be given to advance KI distribution to all families throughout the UK, as occurs in other countries.

ANNEX A: UK Government Guidance

i. The Government's position on the distribution of stable iodine is set out in DECC's 2015 publication "Response" https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/472422/NEPRG02_-_Response.pdf

ii. This states, inter alia:

"5.3.8.In order to maximise the effectiveness of stable iodine, the tablets must be administered promptly. Consequently, plans should consider the most appropriate way to provide tablets to those who require them in as timely manner as possible. The Director of Public Health local to a licensed nuclear site is responsible for ensuring that there are appropriate arrangements for the prompt distribution of potassium iodate tablets and for authorising their administration. This is usually done in consultation with the nuclear operator, local authority and emergency services within the framework of existing planning procedures.

5.3.9 Tablets could be distributed in a number of ways which might include:

- *Pre - distribution including schools and hospitals, evacuation reception centres;*
- *Distribution on the day by specified organisations 'door - to - door' or at the reception centres; and*
- *Pre - distribution to collection centres where a single member of each premises* [sic] *is advised to collect tablets for their premises on declaration*

5.3.10 Where appropriate the Director of Public Health can also choose to pre - authorise administration of the tablets based on an agreed set of circumstances so that the nuclear operator can issue the advice to take the tablets promptly along with other public protection advice such as the request to shelter.

5.3.11 Where countermeasure strategies recommend sheltering in combination with potassium iodate tablets, emergency plans should include arrangements for ensuring that a sheltering population has prompt access to these tablets.

5.3.12 In the event of a radiation emergency where there was no requirement for the issue of stable iodine tablets the public should be told that there has been no release of radioactive iodine, therefore potassium iodate tablets will not be needed.

5.3.13 Stocks of stable iodine tablets will be managed at a local level. Additional reserve quantities are held centrally in national stockpiles. Planning should take into consideration the timescales for deployment of extra tablets should they be required for more widespread issue. PHE would be responsible for coordinating the delivery of additional tablets and NHS would be responsible for arranging distribution to the public."

ANNEX B: Iodine: Inhalation Doses vs. Ingestion Doses

i. Recent scientific evidence indicates that, for radio-iodine doses, inhalation is more important than ingestion. The evidence exists in three published studies and in an unpublished study in German. In all studies, the problem was that older iodine dose models using air concentrations were faulty as they used wrong assumptions - in particular that inhalation was unimportant compared to ingestion.

ii. The first two studies show that older inhalation models gave incorrect iodine doses when compared with doses using urine samples. Hölgye and Malátová (2012) used iodine-131 levels in urine from two healthy males in the city of Vienna, Austria (measured in May 1986) to estimate iodine intakes and committed effective doses. These were higher than dose estimates based on early models using air concentrations. This finding was similar to the conclusion reached earlier by Malátová and Skrkal (2006) regarding iodine inhalations in then Czechoslovakia in May 1986 after the Chernobyl accident.

iii. Part of the reason for higher doses is that inhalation occurs much sooner after the accident/incident than milk ingestion. This could have led to intakes of not only iodine-131 but also iodine isotopes with short half-lives and high specific activities, i.e. higher doses. These include ^{133}I with a half-life of 20.8 hours, and ^{132}Te with a half-life of 3.2 days whose decay product is ^{132}I with a half-life of 2.3 hours.

iv. The third study by Seidel et al (2012) (unpublished and only in German) showed that iodine inhalation doses in Austria immediately after Chernobyl were on average about 50% to 60% of total iodine doses. The range extended from 15% to 85% depending on iodine particulate concentrations in air which in turn depended on the existence of rainfall.

v. More recently, Michel et al (2015) observed that thyroid doses estimated retrospectively from remaining concentrations of ^{129}I (half-life = 16 million y) and ^{137}Cs (half-life = 30 y) in Ukraine underestimated substantially (by factors of 3 or more) the actual thyroid doses measured in situ in actual patients in 1986.

vi. The authors interpreted this as follows: the new retrospective doses were estimated using models dominated by ^{131}I ingestion because ^{131}I inhalation was thought to play a minor role. The models and the ^{129}I and ^{137}Cs deposition data provided good estimates for ingestion doses but not inhalation doses. If highly contaminated clouds passed without wet deposition there would be little ground deposition of iodine (i.e. low ingestion doses) but inhalation doses could be high.

vii. The conclusion from these studies is that iodine inhalation doses could be greater than ingestion doses- contrary to current dose models for iodine. The main factor is rainfall: in its absence, inhalation doses will be greater than ingestion doses. In other words, iodine inhalation must be taken into account as a significant contributor to radiation exposures after an accident or incident.

References to Annex B

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ANNEX C: Iodine Prophylaxis in Poland in 1986

i. Contrary to Belarus, Ukraine, Russia, and later in Japan, in 1986 Poland organised a very rapid, countrywide, distribution of KI to reduce thyroid doses. This is described in the informative article by Nauman and Wolff (1993)[9] which is recommended reading for emergency planners in the UK and which is the basis for the following account.

ii. Prior to 1986, the Polish authorities had the foresight to manufacture and stock (in regional centres) 90 million doses of 100 mg of KI, i.e. 9 tonnes, for a population of about 36 million people.

iii. Very early on April 28, 1986[10], the Polish Government learned that radioactive plumes were reaching Poland, possibly from a nuclear accident in the Soviet Union. The Government worked on emergency plans throughout the early hours, and at noon on April 28, it ordered KI supplies to be distributed immediately from its regional depots to all hospitals, surgeries, health clinics, fire stations, police stations, schools, public libraries, local government offices, town halls and chemists throughout the entire country.

iv. At the same time, the Government instructed all citizens to report to these centres to collect KI supplies. This distribution took about 3 days with 10.5 million Polish children >17 years and ~7 million adults obtaining iodine prophylaxis. About 95% of children received tablets. Few details are available as to how this feat was carried out: the logistics appear remarkable. Many volunteers helped with the distribution, especially in remoter villages.

v. The authors noted that the quickness of this exercise was largely made possible due to the centralised nature of the (then communist) Polish Government where transport, health, fire, police, pharmacy and school systems were under strict Government control. Largely but not completely. In a fascinating insight, Nauman and Wolff also report that 23% of adults and 6% of children took iodine prophylaxis before the start of the Government's program at midday on April 28, i.e. even before they were advised to do so by the Government. This was confirmed by the "*brisk increase in sales of tincture of iodine in pharmacies throughout the country*" on April 27 and 28.

vi. The authors stated that "*Since speed is of the essence, it follows that a well-planned emergency response and protective mechanism must be in place before an accident occurs and preferably tested by some sort of mock alert.*" (emphasis in original)

vii. Among their other recommendations were the needs for

- prior agreement on the dose intervention level, i.e. the dose above which evacuations would be carried out
- prior consideration of arrangements for evacuations near all nuclear facilities
- storage of "readily available" KI throughout the country (shelf life of foil-wrapped supplies was stated to be many years)
- 130 mg KI tablets provided a longer duration of protection than 65 mg tablets
- dosimetry equipment to be in place before accidents and available in several centres or in mobile units
- identification of supplies of uncontaminated foods and milk
- "*most important of all*", a decision as to who will be in charge.

[9] Nauman J Wolff J Iodide prophylaxis in Poland after the Chernobyl reactor accident: benefits and risks. Am J Med. 1993 May 94(5):524-32.
[10] 2 days after the accident on April 26, but the Soviet Union did not confirm that there had been a major accident at Chernobyl until about a week later.

Acronyms and Abbreviations

C	chemical symbol for carbon
CERRIE	Committee Examining the Radiation Risks of Internal Emitters
COBRA	Cabinet Office Briefing Room A
Cs	chemical symbol for caesium
DECC	Department of Energy and Climate Change
DH	Department of Health
EC	European Commission
EDF (Energy)	UK subsidiary of Electricité de France
H	chemical symbol for hydrogen
Gy	gray (unit of absorbed radiation dose)
I	chemical symbol for iodine
K	chemical symbol for potassium
KI	chemical symbol for potassium iodide
km	kilometre
mg	milligram (one thousandth of a gram)
MOD	Ministry of Defence
RIMNET	Radiological Incident Monitoring Network
Sr	chemical symbol for strontium
Te	chemical symbol for tellurium
TEPCO	Tokyo Electric Power Company
TORCH	The Other Report on Chernobyl
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation