

NFLA Policy Briefing No.172



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Subject: Evacuations after Severe Nuclear Accidents

i. Overview of report

This Policy Briefing has been reproduced with kind permission from a report by independent consultant on radioactivity in the environment, Dr Ian Fairlie. It follows on from a related response submitted to the House of Commons Science and Technology Committee, which can be found on the NFLA website as NFLA Policy Briefing 146 (see the Policy Briefings section of the NFLA website <http://www.nuclearpolicy.info>). That response recommended the pre-distribution of potassium iodide tablets to a much larger area of residents in close proximity to nuclear facilities. Both briefings can also be found on Dr Fairlie's website <http://www.ianfairlie.org>.

This briefing provides an analysis by Dr Fairlie on three related matters:

1. The experience of evacuations during the Fukushima nuclear disaster.
2. Whether lengthy evacuations from large cities are feasible?
3. Some background on emergency plans for evacuations in North America.

With the UK Government transposing the European Basic Safety Standard into UK law, requiring some likely changes to the UK nuclear emergency planning regime (see NFLA Policy Briefing 168 for an overview and the NFLA's response to the proposed changes), this briefing is all the more pertinent. The NFLA Secretary is submitting Dr Fairlie's report to the Director of Civil Nuclear Resilience in the Government's Department of Business, Energy and Industrial Strategy for consideration.

1. Introduction

If another severe nuclear accident, such as Windscale (in 1957), Chernobyl (1986) or Fukushima (2011) were to occur then the adverse health effects would primarily depend on wind direction and on the nature of the accident. The main responses to a nuclear disaster are shelter, evacuation and stable iodine prophylaxis. The most important, in terms of preventing future cancer epidemics, is evacuation. This article is based on North American evacuation plans. Little is known of the detail of UK nuclear emergency evacuation plans as few, if any, are publicly available.

In North American plans, if a severe nuclear accident were to occur, able citizens would be requested to leave designated evacuation / no entry zones under their own steam and to find accommodation with family and friends in uncontaminated areas. At the same time, Government authorities would evacuate prisons, hospitals, nursing homes, care homes and certain schools.

Little, if any, consideration seems to have been given to how long such evacuations would last. For example, the large majority of the 160,000 people who left or were evacuated from Fukushima Prefecture, Japan during the accident in March 2011 are still living outside the Prefecture. Many are living in makeshift shelters e.g. shipping containers or prefab houses.

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At present, the Japanese Government is attempting to force evacuees (by withdrawing state compensation) to return to less contaminated areas, with little success. Currently, almost 7 years after the accident, an area of about 1,000 square km is still subject to evacuation and no entry orders. This compares with an area of 2,700 square km still evacuated and subject to no or restricted entry at Chernobyl almost 32 years after the accident.

2. Experience of the Fukushima Evacuation

In 2015 and 2016, the author visited Fukushima Prefecture in Japan with international study teams. These study tours were informative as they revealed information about the evacuations that differed from official accounts by TEPCO and the Japanese Government. From many discussions with local mayors, councillors, local health groups and small community groups, the following information was revealed.

The most common figure cited for evacuees is 160,000, of which 80,000 were evacuated by the authorities and the rest left on their own, often on foot, cycles and carts. It took about two weeks to evacuate all parts of the initial 20 km (later 30 km) radius evacuation areas around the Fukushima reactors.

The main reason for the delays was that many roads in the Prefecture were jammed with gridlocks which sometimes lasted 24 hours a day, for several days on end on some roads. These traffic jams were partly due to the inadequate existing road infrastructure and partly due to many road accidents. These jams were of such severity that safety crews for the Fukushima nuclear station had to be moved in and out mostly by helicopter. All public transport by trains and buses ceased. Mobile telephone networks and the internet crashed due to massive demand.

Thousands of people either refused to leave their homelands or returned later. Older farmers often refused to leave their animals behind or be moved from their ancestral lands. In at least a dozen recorded cases, older farmers slaughtered their cow herds rather than leave them behind (dairy cows need to be milked daily): a number then committed suicide themselves in several instances (see next section).

According to Hachiya et al (2014), the disaster adversely affected the telecommunications system, water supplies, and electricity supplies including radiation monitoring systems. The local hospital system was dysfunctional; hospitals designated as radiation-emergency facilities were unable to operate because of damage from the earthquake and tsunami, and some were located within designated evacuation zones. Emergency personnel, including fire department personnel, were often asked to leave the area.

At hospitals, evacuations were sometimes carried out hurriedly with the unfortunate result that patients died due to intravenous drips being ripped out, medicaments being left behind, the absence of doctors and nurses who had left, and ambulance road accidents (see next section). Many hastily-allocated reception centres (often primary schools) were either unable or ill-equipped to deal with seriously ill patients.

Much confusion resulted when school children were being bussed home, while their parents were trying to reach schools to collect their children. Government officials, doctors, nurses, care workers, police, firepersons, ambulance drivers, emergency crews, teachers, etc faced the dilemma of whether to stay at their posts or return to look after their families. In the event, many emergency crews refused to enter evacuation zones for fear of radiation exposure.

Stable iodine was not issued to most people. Official evacuation plans were either non-existent or inadequate and, in the event, next to useless. In many cases, local mayors took the lead and ordered and supervised evacuations in their villages without waiting for orders or in defiance of them. Apparently, the higher up the administrative level, the greater the levels of indecision and lack of responsibility.

In the years after the accident, the longer-lasting effects of the evacuations have become apparent. These include family separations, marital break-ups, widespread depression, and further suicides. These are discussed in a recent publication (Morimatsu et al, 2017) which relates the sad, often

eloquent, stories of the Fukushima people. They differ sharply from the accounts disseminated by TEPCO.

3. Deaths from evacuations at Fukushima

Official Japanese Government data reveal that nearly 2,000 people died from the effects of evacuations necessary to avoid high radiation exposures from the Fukushima disaster, including from suicides.

See - http://www.reconstruction.go.jp/topics/main-cat2/sub-cat2-1/20141226_kanrenshi.pdf

The uprooting to unfamiliar areas, cutting of family ties, loss of social support networks, disruption, exhaustion, poor physical conditions and disorientation resulted in many people, in particular older people, apparently losing their will to live.

See - <http://www.pref.fukushima.lg.jp/uploaded/attachment/62562.docx>

The evacuations also resulted in increased levels of illnesses among evacuees such as hypertension, diabetes mellitus and dyslipidaemia (Hasegawa, 2016), psychiatric and mental health problems (Sugimoto et al, 2012), polycythaemia- a slow growing blood cancer (Sakai et al, 2014 and 2017), cardiovascular disease (Ohiro et al, 2017), liver dysfunction (Takahashi A et al, 2017) and severe psychological distress (Kunii et al, 2016).

Increased suicide rates occurred among younger and older people following the Fukushima evacuations, but the trends are unclear. A 2014 Japanese Cabinet Office report stated that, between March 2011 and July 2014, 56 suicides in Fukushima Prefecture were linked to the nuclear accident.

See - http://www.japantimes.co.jp/news/2014/08/26/national/social-issues/fukushimas-high-number-disaster-related-suicides-likely-due-nuclear-crisis-cabinet-office/#.Vcstm_mrGzl

4. Should evacuations be ordered?

The above account should not be taken as arguments against evacuations as they constitute an important dose-saving and life-saving strategy during emergencies. Instead, the toll from evacuations should be considered part of the overall toll from nuclear accidents.

In future, deaths from evacuation-related ill-health and suicides should be included in assessments of the fatality numbers from nuclear disasters.

See - <http://www.ianfairlie.org/wp-content/uploads/2015/08/Summing-up-the-Effects-of-the-Fukushima-Nuclear-Disaster-10.pdf>

For example, although about 2,000 deaths occurred during and immediately after the evacuations, it can be calculated from UNSCEAR (2013) collective dose estimates that about 5,000 fatal cancers will arise from the radiation exposures at Fukushima, i.e. taking into account the evacuations. Many more fatal cancers would have occurred if the evacuations had not been carried out.

There is an acute planning dilemma here: if evacuations are carried out (even with good planning) then illnesses and deaths will undoubtedly occur. But if they are not carried out, even more people could die. In such situations, it is necessary to identify the real cause of the problem. And here it is the existence of NPPs near large population centres. In such cases, consideration should be given to the early closure of the NPPs, and switching to safer means of electricity generation.

5. Very Large Cities: Evacuations for lengthy periods?

If another severe nuclear accident were to occur, the death toll would depend on wind direction and whether the reactors were close to large cities. For example, Pickering NPP is located 20 miles from Toronto in Canada with an urban population of over 5 million; Indian Point NPP in the state of New York US is located 30 miles from New York City (over 9 million); and Dungeness NPP is located 50 miles from London, UK (over 9 million). These nuclear stations are just major examples of nuclear power stations located relatively close to urban centres, especially in the UK, US, and France.

If the worst were to occur and radioactive plumes from a severe nuclear accident reached large cities, would it be feasible to evacuate them quickly, and would it be feasible to do so for lengthy

periods? There appears to be little literature on these questions, but it is expected that severe logistical problems would exist with the timely evacuation of millions of residents, workers and visitors from major cities,

6. US Evacuation Plans after nuclear accidents – viability?

In the US, viable evacuation plans are a legal NRC requirement for continued reactor operation. But “viability” has often been a contentious legal issue in the past.

See - http://articles.latimes.com/1987-02-07/news/mn-1732_1_davis-besse.

For example, in the 1980s and 1990s, this issue was at the centre of court battles at the Davis-Besse reactor in Ohio and the Seabrook nuclear power station in New Hampshire. It played a critical role in the shutdown of the Shoreham reactor on Long Island, New York state.

See - <http://www.nytimes.com/1986/11/14/us/around-the-nation-court-delays-license-for-ohio-nuclear-plant.html?mcubz=3>.

After a major 1986 earthquake damaged the Perry reactor in Ohio on the north shore of Lake Erie, the then Ohio Governor, Richard Celeste, sued the US NRC to delay its issuance of the plant's operating license on the grounds of the non-viability of evacuation of large population centres nearby. The US population within 80 km of Perry nuclear station was 2,300,000. Canadian populations would have been affected but were not included.

See - https://en.wikipedia.org/wiki/Perry_Nuclear_Generating_Station#cite_note-7

An Ohio state commission concluded evacuation of nearby large cities during a disaster at Perry was not possible.

See - http://www.cleveland.com/nation/index.ssf/2011/09/perry_nuclear_reactors_risk_of.html

7. Evacuation plans in Canada

In Canada, the Ontario Government has been developing evacuation plans for the Pickering nuclear station near Toronto since 1980, but whether the feasibility of such plans has kept up with the significant population growth around the station over 40 years is an open question.

Their draft plans have involved many Government Departments and hundreds of individuals.

See –

https://www1.toronto.ca/city_of_toronto/office_of_emergency_management/files/pdf/nuclear_rsp.pdf

https://www.emergencymanagementontario.ca/english/beprepared/ontariohazards/nuclear/nuclear_plan_pickering.html

https://www.emergencymanagementontario.ca/english/beprepared/ontariohazards/nuclear/provincial_nuclear_emergency_response_plan.html#P2618_168284

However, the matter of evacuation is relatively undeveloped: future detailed plans remain to be drawn up by local governments in and near Toronto. This is perhaps unsurprising given the difficulties involved, but it appears that many issues remain to be resolved. For example:

- How long would it take to untangle traffic jams exiting the city?
- How long it would take for drivers to reach their emergency vehicles and school buses?
- Would emergency crews enter contaminated zones to deal with accidents?
- What happens when residents refuse to leave?
- How to deal with residents who return?
- How long would evacuations last? Months, years, decades?

Another issue is what happens when people, who are asked **not** to leave, decide to evacuate? In 1979, during the Three Mile Island nuclear accident near Harrisburg in Pennsylvania US, evacuation requests were made for approximately 3,500 vulnerable older people, children and pregnant women. The result was 140,000 immediately fled the area, thus creating large traffic jams which impeded the evacuations of vulnerable people. (Ziegler and Johnson, 1984).

The Canadian plans reveal that, in the event of a severe accident, evacuation will be for a radius of 20 km from the NPPs (in the direction of the plume). This differs from the US Nuclear Regulatory Commission's two emergency planning zones around NPPs – a plume exposure pathway zone with a radius of 16 km, concerned primarily with exposure to, and inhalation of, airborne radioactive contamination. Secondly, an ingestion and direct radiation pathway zone of 80 km, primarily concerned with ingestion of contaminated foods/ liquids and ground radiation from deposited Cs-137.

See - https://en.wikipedia.org/wiki/Perry_Nuclear_Generating_Station#cite_note-6

8. Conclusions

The experiences of Japanese evacuees after Fukushima discussed above are distressing to read. Their experiences were terrible, so much so that it requires Governments of large cities with nearby NPPs to reconsider their own situations and to address the question... what would happen if radioactive fallout heavily contaminated large areas of their city and required millions of residents to leave for long periods of time, e.g. several decades?

And how long would evacuations need to continue....weeks, months, years, or decades? The time length of evacuations is usually avoided in the evacuation plans seen so far. In reality, the answer would depend on Cs-137 concentrations in surface soils. The time period could be decades, as the half-life of the principal radionuclide, Cs-137, is 30 years. This raises the possibility of large cities becoming uninhabited 'ghost' towns like Tomioka, Okuma, Namie, Futaba, etc in Japan and Pripjat in Ukraine.

This bleak reality is hard to accept or even comprehend. However it is a matter that some Governments need to address after Fukushima.

Wheatley et al (2017) comprehensively examined the historical records of 216 nuclear accidents, mishaps and near-misses since the mid-1950s. They predicted the future frequencies and severities of nuclear accidents and concluded both were "unacceptably high". Wheatley et al (2016) also concluded that the relative frequency with which nuclear events cascaded into nuclear disasters remained large enough that, when multiplied by their severity, the aggregate risk to society was "very high". It is unsurprising that, after Fukushima, several major European states including Germany and Switzerland have decided to phase-out their nuclear reactors.

9. References (see Ian Fairlie's website for links to these articles)

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