Nuclear Free Local Authorities
briefing

Date: 10th April 2012 No.95

Subject: **Transport of radioactively contaminated steam generators from Berkeley nuclear power plant, Gloucestershire to Sweden**

1. Introduction – NFLA briefing on proposed Canadian steam generator transport

This Nuclear Free Local Authorities (NFLA) Nuclear Policy Briefing has a close tie-in with NFLA Policy Briefing 85, which was issued on 25th July 2011 (1). Briefing 85 outlined concerns the NFLA and a large international coalition of environmental groups had with the proposed shipment of a batch of radioactively contaminated steam generators from a Bruce Power facility in Ontario, Canada across the Great Lakes and rivers, passing through the North Atlantic (and near to the Scottish Northern Islands) and arriving at a Studsvik facility in Sweden for dismantling and recycling (with the remnants of the generators returning to Canada).

Briefing 85 particularly outlined in some detail the concerns over the high levels of radioactive contamination in the generators and the accompanying risks of such a long transport across the North Atlantic Ocean.

The licence given to Bruce Power by the Canadian Nuclear Safety Commission for this transport lapsed on February 3rd, 2012 without the utility commencing any such transports (2). Bruce Power had stated publicly that it had delayed transports to allow for further discussion with indigenous 'First Nation' communities. It is not clear if, and when, Bruce Power will re-apply for a licence to the Canadian nuclear regulator for the transport of the bus-sized generators to Sweden. The NFLA welcomed this development and will monitor progress with this issue with environmental groups in Canada.

2. Shipment of 15 radioactive 'Heat Exchangers' from Berkeley Nuclear Power Station (MAGNOX reactor) via Avonmouth Docks to Nykoping Sweden.

This briefing has been developed as it has come to the attention of the NFLA that a similar type of transport has commenced from the decommissioned Magnox nuclear reactor at Berkeley in Gloucestershire of radioactively contaminated 'heat exchangers' going to the same Studsvik site in Sweden. The NFLA has commissioned a preliminary assessment of this transport and future proposed transports by the independent marine pollution consultant Tim Deere-Jones. It is planned that the NFLA and other groups will develop a more detailed report in the near future, once further details on the transports and any risks pertaining to them are clarified. This issue has been recently discussed by the NFLA Steering Committee at its meeting on the 30th March 2011 and it was agreed to research the matter in more detail.

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3. The transport licence for the Berkeley heat exchangers

The Environment Agency (of England and Wales) has issued an authorisation to Magnox Ltd for the export of 15 redundant heat exchangers from the Berkeley power station. This is valid from 23rd January 2011 to 22 January 2015 and will occur in 3 shipments. The proposed plan is for the heat exchangers to be sent by sea transport to Studsvik Nuclear AB in Sweden where the metals will be recycled (3).

The process of moving the heat exchangers began on 20th March when the first 5 units were transported by road from the Berkeley NPS to Sharpness where they were put on a barge for transport down the Severn Estuary to Avonmouth Docks. During road transport the heat exchangers were classified as “Surface Contaminated Waste”.

At Avonmouth Docks they were transhipped on to the heavy load carrier ‘AURA’ for carriage to Oxelosund in Sweden, where Studsvik Nuclear AB has a purpose built deep water terminal (4).

The heat exchangers were given maritime classification as “Cargo Haz A (71)” on the AURA.

4. The current maritime transport route

Close watch of a number of ship tracking web sites showed that the AURA left Avonmouth Docks on the night of 29th/30th March, travelling westward down the Bristol Channel off the coasts of Somerset, Devon and Cornwall. During 31st March the AURA rounded Land’s End and began to travel eastwards up the English Channel, following the established traffic separation scheme, and passed the Cotentin Peninsula (Normandy) on the French side of the Channel during 1st April.

During the night of 1st/2nd April the AURA passed through the Dover Strait and began heading north through the North Sea. During April 2nd and 3rd, AURA travelled north east through the North Sea, in the designated traffic zone adjacent to the coasts of Netherlands, north Germany and Denmark, passing through the Kattegatt, travelled through the Baltic Sea, adjacent to the coast of Sweden and arrived at the Studsvik deep sea terminal at Oxelosund (nr Nykoping) on the 5th April. Since then the AURA has been stationary, at anchor, in Oxelosund Roads.

There has been no official statement of preferred routes, and thus no guarantee, that this will be the preferred route for all future shipments.

5. The Berkeley Heat Exchangers

The 2 Berkeley Magnox reactors had a total of 16 Heat Exchangers, each made of mild steel. Each heat exchanger is 21m long, 5m in diameter and weighs approximately 310 tonnes.

The Heat Exchangers have a superficial resemblance to giant domestic boilers. Hot gas is conducted from the reactor vessel via a hot gas “in-duct” at the very top of the HE vessel and a cooled gas “out-duct” at the very bottom takes the cooled gas back into the reactor vessel.

Water is input into the Heat Exchangers, allowing the transfer of heat from the CO_2 gas to the water which is converted into steam and then piped away to spin a generator and produce electricity.

Tim Deere-Jones has submitted a request, on behalf of the NFLA, for precise details of the design and interior structure of the Berkeley heat Exchange.

6. Radioactive contamination of the Heat Exchangers

Although the contents of the heat exchangers are described as Low Level Radioactivity (5) the Studsvik Nuclear AB fact sheet (4) states that, on average the radioactivity inventory of each boiler is about 35 GBq or 35,000,000,000 Bq. (35 thousand million bequerrels). The AURA is carrying 5 such boilers.

Tim Deere-Jones has submitted a request on behalf of the NFLA for a detailed breakdown of the radioactivity content of each heat exchanger (25th March).

However, because the very hot CO2 gas is blown through the reactor core and past and over the fuel assemblies, **any** radioactive contamination from those assemblies is potentially available for transport in the high pressure gas stream and into the heat exchangers where radioactive materials are then deposited onto the internal surfaces of the Heat Exchanger body and the exchange/transfer tubing contained within.

Thus the interior of the heat exchangers is likely to be contaminated with a wide range of isotopes including a number of alpha emitters/actinides such as the 5 Plutonium isotopes commonly created by the fission of uranium fuel.

7. Demolition/recycling of Heat Exchangers

Following recycling, it is proposed that about 95% of the metal will be recycled back into the global scrap steel market, where the remaining low level radiation will be diluted and dispersed (4). About 5% of the metal is expected to be returned to UK for disposal as radioactive waste. For many years the NFLA has remained concerned about the recycling of such material back into the consumer chain.

No details of the techniques, management or radiological outcome of the demolition/dismantling process to be used on the Heat Exchangers have been provided. However, it is the case that Magnox Ltd undertook the dismantling of one of the Berkeley Heat Exchangers as a trial project in the late 1990's and a Report was supposedly written up.

Tim Deere-Jones has submitted a Freedom of Information request on behalf of the NFLA for a detailed breakdown and description of this trial project and its conclusions (the request was sent on the 25th March).

The policy authorisation issued by the Environment Agency is in line with the national UK Low Level Waste Strategy (Summer 2010) devised by the Nuclear Decommissioning Authority, and is seen by the nuclear industry/regulators as having the following advantages:

- early solution rather than solution delayed until final site clearance;
- heat exchangers will still be low level waste at final site clearance so "why not do it now?"
- accelerated hazard reduction;
- reduced problem for future generations. (5)

8. Background History of the site

The Berkeley NPS has two Magnox reactors which get their name from the magnesium alloy used to clad the uranium based fuel elements. Magnox fuel elements are loaded into vertical channels in the reactor core, which is constructed of graphite (moderator) blocks. Additional vertical channels contain control rods, which can be inserted, or withdrawn from the core, in order to adjust the rate of the fission process and the heat output. The complete assembly is then cooled by blowing CO2 (carbon dioxide) gas over, and past, the Magnox clad fuel assemblies, which are specially designed to enhance heat transfer.

Gas pressure through the reactor channels is generally reported to be about 20 Bars (about 20 times normal atmospheric pressure at sea level) and the temperature of the CO2 exiting the core is generally reported as around 400 degrees C. This very hot CO2 gas exits the reactor pressure vessel and is ducted into the heat exchangers where it transfers heat to water and generates steam, which in turn drives turbines.

The Berkeley Magnox Nuclear Power Station was the world's first commercial gas cooled reactor. It began operation in 1962 and shut down in 1989. Early Magnox reactors, such as those at Berkeley, were designed for a 30 year operating life, but most were ultimately given operating life extensions, such as Hinkley A which stayed open for 34 years, Dungeness A for

40 years, Oldbury for 44 years. By comparison, Berkeley's life span of only 27 years not only under-achieved the original design life span (the only Magnox station to achieve this status), but is also notably shorter than that of most of its sister stations.

Through the later years of the 1980's the Nuclear Installation Inspectorate carried out a series of Long Term Safety Reviews (LTSRs) at UK NPS. In 1988 the NII reported the results of their LTSR at Berkeley and identified 12 Key Generic Safety Issues (including hardware modifications and in-service operations) requiring improvement by the end of March 1989.

(Oxidisation of mild steel components as a result of exposure to high temperature/high pressure CO2 gas in both reactors and heat exchangers was consensually agreed to have been the most severe problem encountered with Magnox stations and is considered to be the major cause for de-rating of reactors)

These improvements were successfully completed at most Magnox stations through the LTSR Generic Issues programme; however this was not the case at the Berkeley Magnox station. At Berkeley the licensee/operator ceased operation at the station on 31st March 1989, thus avoiding the requirement to carry out the recommended work. The licensee/operator stated that this closure was for economic, not safety, reasons.

N.B. This licensee/operator statement does not exclude the possibility that the Berkeley station was so degraded that it required so much work to achieve the recommended improvements that it was uneconomic so to do.

The UK has 26 Magnox reactors. This means there are approximately 208 'Heat Exchangers' available for transport and recycling using the process initiated by this current action. As a result there is a potential for approximately 42 such transports over the next few years.

9. Conclusions and recommendations

- The NFLA has long argued that the transport of radioactive waste across such large distances by sea should be discouraged due to the risks relating to an accident or malicious attack. A thorough alternative radioactive waste management policy reducing unnecessary transports where possible and practical is preferred.
- Many of the issues of concern raised by the NFLA in its earlier briefing over the proposed transport of Canadian radioactively contaminated steam generators can be extrapolated for this new transport from Berkeley to Sweden.
- The NFLA will seek to work with other groups including KIMO International, Greenpeace International and environmental groups in North America and Scandinavia to ascertain further information on these transports and the potential risks from a large number of transports by sea to Sweden.
- The NFLA has developed this briefing to inform its members and coastal local authorities of this development and encourages relevant officers to consider the contingency planning and safety issues that they may want to raise with the Environment Agency. The NFLA plans to issue a more detailed briefing in the near future which will consider whether there are safer alternatives than these transports and consider the potential risks in contaminated recycled metal going back into the consumer chain.

10. References

(1) Nuclear Free Local Authorities General Policy Briefing No 85, 25th July 2011, 'Proposed transport of Canadian steam generators to Sweden'.
http://www.nuclearpolicy.info/docs/briefings/A199_(NB85)_Canadian_waste_shipments.pdf
(2) Council of Canadians website article, 3rd February 2012.
http://canadians.org/blog/?p=13379
(3) Environment Agency reference TFSRW/2011/004 can be found on:
http://www.environment-agency.gov.uk/business/sectors.103242.aspx
(4) Studsvik Fact Sheet (undated) "Details of the Berkeley Heat Exchangers Project"
(5) Berkeley Boiler Treatment Project. 8th February 2012. Presentation by Paul Oswald (head of Projects, Magnox, Berkeley and Rachael O'Donnell, Magnox Integration Manager, LLWR).