HUNTERSTON B POWER STATION

Technical Safety Support Department Report

Addendum to BPM Report (HPS/TSSD/SR878) for aqueous discharges to sea following fuel free verification

Originated by: [redacted] Date: June 2024
Environmental Safety Group Head (RPA)

[redacted] Date: June 2024
Environmental Safety Engineer (Acc RWE/RWA)

Reviewed by: [redacted] Date: June 2024
Environmental Safety Engineer (Acc RWE)

Approved by: [redacted] Date: June 2024
Technical Safety Support Manager

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Executive Summary

A Best Practicable Means (BPM) Assessment (HPS/TSSD/SR878) was produced by Hunterston B power station to assess the options available to facilitate the shutdown and decommissioning of the main Cooling Water system and subsequent decommissioning activities. The BPM report was submitted to SEPA along with other referenced materials in support of an application for a variation to the HNB EASR Permit. The application requested the removal of a minimum flowrate associated with the CW system and the removal of the condition to discharge during a specified tidal window.

SEPA have requested further information in support of the application. In summary:

1. The radiation dose to a swimmer in the vicinity of the discharge point.
2. Clarification on discarding the option to extend the discharge line further out in the Firth of Clyde.
3. Clarification on the sites' intention with regard to purging the discharge line with clean water after a discharge.

An assessment carried indicates a maximum dose to a swimmer in the vicinity of the discharge outlet of 198μSv under the specified 'worst case' circumstances, that is, a concurrent discharge from both Hunterston a and Hunterston B sites at the permitted activity limits. This radiation dose is significantly below the public dose limit of 1mSv stated in the Ionising Radiation Regulations 2017 (IRR17) and below the effective site and single source dose constraints for future discharges of 0.5mSv/year and 0.3mSv/year, respectively, as applied under EASR18. It is estimated that by applying a more realistic scenario for swimmer, a maximum dose of approximately 0.25 μSv per year, would result.

Extending the discharge line further into the sea was considered and discarded early in the optioneering process. Recent annual reports show that the maximum dose to a member of public was 0.41μSv. Therefore, BPM principles are applied to ensure a proportionate response is considered in terms of the discharge line extension. Extending the discharge line was therefore discarded as an option due to the disproportionate increase in costs and inherent risks compared to the potential reduction in dose to the public.

The environmental impact and cost detriment of installing a flush system was considered to be disproportionate to the risk of residual low level radioactive effluent within the lines. Reference to 'purging the lines' in the discharge modelling report was made to represent the full contents of the tank being discharged to sea for the purposes of activity assessment. The model did not represent any dilution that may occur from purging the lines after discharge; this was confirmed in the addendum modelling report discussed in this this report.

For this reason it is not considered BPM to install a system that would allow for flushing of the discharge lines and it is not the intention of Hunterston A or Hunterston B to purge the line after a discharge. It is expected that a portion of the residual effluent in the line after discharge will be dispersed into the sea water as a result of natural displacement. Any remaining effluent in the line will be discharged into the sea at the start of the following discharge. There would be no impact on public dose assessment carried out annually.

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Report issue/amendment

Revision	Amendment	Date
000	First Issue	June 2024

Glossary

Word, Phrase or Acronym	Description
AETP	Active Effluent Treatment Plant
BPM	Best Practicable Means
CW	Cooling Water (Sea Water)
EASR or EASR18	Environmental Authorisations (Scotland) Regulations 2018
EDF	Electricity de France
FFV	Fuel Free Verification
HNA	Hunterston A Decommissioning Site
HNB	Hunterston B Power Station
LLWF	Low Level Waste Facility
SEPA	Scottish Environment Protection Agency

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1 Introduction

Hunterston B Power Station (HNB) extracts sea water from the Clyde Estuary by the main Cooling Water (CW) system to facilitate the cooling of plant systems associated with the reactors and fuel route. Following completion of the defueling phase and the station confirms Fuel Free Verification (FFV), the need for CW flow is no longer required for the reactor and fuel route safety cases. Therefore, the significant maintenance costs and electrical power required to run the CW system will no longer be justified for radioactive aqueous discharges alone.

Radioactive aqueous discharges to sea from both Hunterston A and B sites, are carried out in accordance with discharge permits issued by the Scottish Environment Protection Agency (SEPA), under the Environmental Authorisations (Scotland) Regulations 2018 (EASR18) (Ref. 1). The current permits for Hunterston A and B (Refs. 2 & 3), require a minimum discharge flow rate of 7m^3/sec. This volume and flow of water can only be achieved using the CW system.

The EASR permit for each station specifies the following conditions:

> **Manner of aqueous radioactive waste disposals**
>
> You must ensure that aqueous radioactive waste is only discharged:
>
> a. when the nominal flow of cooling water is no less than 7m^3/s;
>
> b. when the cooling water is discharging to the Firth of Clyde at National Grid Reference NS 1773 5176; and
>
> c. during the interval commencing one hour after high-tide and ending one hour before low tide.

A Best Practicable Means (BPM) Assessment (Ref. 4) was produced to assess the options available, in order to facilitate the shutdown and decommissioning of the main CW system. The BPM report was submitted to SEPA along with other referenced materials in support of an application for a variation to the HNB EASR Permit. The application requested the removal of a minimum flowrate associated with the CW system and the removal of the condition to discharge during a specified tidal window.

SEPA have requested further information in support of the application; this report provides the response to the specific queries.

2 Scope

The HNB SEPA inspector has asked for clarity on the following matters (Ref. 5):

1. *With the proposed reduction in flow and subsequent reduction/disappearance of the obvious discharge point, there would appear to be an increased risk to a member of the public from short-term releases during discharge. The documentation provided does not assess the dose to an individual, e.g. a swimmer, during the short-term release of the discharge. We request that this scenario is addressed.*

2. *Three main credible options were presented within the EDF Energy NG Ltd Best Practicable Means Report (HPS/TSSD/SR878) for changes to the aqueous discharge line. Additional information is required to explicitly justify why the option of extending the discharge line was ruled out and not considered further.*

3. *It is not explicit within the documentation provided that the station's intention is not to purge the discharge line with non-radioactive liquid following each discharge of aqueous radioactive waste. The submitted dispersion modelling report (ENE – 0328A/R1) assumes purge water will be used to ensure the full radioactivity content of the discharge has been discharged from the discharge point within the tidal window. Further detail is required to specify when the discharge is intended to be complete (i.e. dispersed over a period of time or discharged during the next discharge). In addition, this discrepancy and the consequence(s) with respect to the modelling outcomes requires to be addressed.*

3 Additional Information

3.1 Radiation dose to a swimmer near the discharge point

If the Cooling Water system is shut down, it may be possible for a member of the public to swim in the vicinity of the discharge line outlet due to less turbulence on the water surface. The early generating phase photo below shows the discharge line outlet ('the bubble'), which is approximately 350 metres from the shoreline.

Figure 1 Hunterston from the sky circa 1980

Eden Nuclear and Environment Ltd, who specialise in modelling assessments, were employed to quantify the potential risk to a swimmer i.e. carry out a dose assessment from ingested effluent (Ref. 6). It was assumed that an individual swimmer could be in the vicinity of the outlet for one hour, within the immediate 'compartment' of water 50m x 50m x 5m (12500m^3), during concurrent discharges from both Hunterston A and B, at the activity limits specified in each respective EASR18 Permit.

Data from the US Environment Protection Agency (EPA) Exposure Factors Handbook Chapter 3.7 (Ref. 6 refers) was used to ascertain potential water ingestion rates during swimming activities for an adult. An ingestion rate value of 105ml/hr was used to represent the 'worst case' scenario for a one hour swim.

Dose per unit intake values (the 'dose coefficient') for the maximum activity of permitted radionuclides were used to calculate the total dose to a swimmer for a representative ingestion of 105ml.

The report indicates a maximum dose to the swimmer of 198μSv under the specified 'worst case' circumstances. This dose is significantly below the public dose limit of 1mSv stated in the Ionising Radiation Regulations 2017 (IRR17) (Ref. 7) and below the effective site and source dose constraints for future discharges of 0.5mSv/year and 0.3mSv/year, respectively, as applied under EASR18 (Ref. 1).

This maximum dose should also be taken into context when considered against the extremely low likelihood of a concurrent discharge from both sites at the permitted activity limits:

i) At present there is an operational process in place whereby Hunterston A does not discharge concurrently with Hunterston B;

ii) Such a discharge is inconceivable within the bounds of the current operational status of each site. As can be seen in the tables below, liquid effluent discharges from each station are currently only a small fraction (at most 1.5%) of the permitted activity limits. Hunterston A has been in a decommissioning phase for almost two decades and their liquid effluent discharge activity totals are unlikely to vary much in future. Hunterston B is currently in its defueling phase and is scheduled to move into a decommissioning phase in early 2026; although the liquid effluent discharges may increase during this phase as a result of waste processing it will not in any way challenge permitted limits.

iii) Such a discharge would require to be the first discharge in a calendar year for each site to prevent the conditions of their respective EASR18 Permit being breached and prevent any further permitted discharges for the remainder of the applicable calendar year, without intervention of the regulator (SEPA).

A more likely scenario would be an individual swimmer in the vicinity of the outlet during a maximum of two discharges in the year, at the exact time of discharge, taking into account;

- weather and associated sea conditions
- seasonal daylight hours
- tidal windows utilised for discharges
- number of annual discharges from each Station (approximately 6 from Hunterston A and 24 from Hunterston B).

The tables below show the actual discharge levels from each site in recent years.

Hunterston A Discharges (2023)

Radionuclide	2023	Limit (GBq)	% of Limit 2023
H-3	0.006	30	0.02
Cs-137	0.043	160	0.03
Pu-241	0	2	0
All Alpha	0.001	2	0.05
All Non-Alpha (Excluding H-3, Cs-137 & Pu-241)	0.038	60	0.06
Volume (m^3)	195.5	N/A	N/A

Hunterston B Discharges (2019-2023)

Radionuclide	2019	2020	2021	2022	2023	Limit (GBq)	% of limit 2023
H-3	21209	89971	203918	22984	3	700000	0.0004
S-35	13.40	69.21	419.00	14.92	0.30	6000	0.0051
Co-60	0.19	0.11	0.30	0.22	0.15	10	1.4810
Other Beta	5.43	2.94	5.00	2.58	2.08	150	1.3867
Alpha	0.019	0.013	0.017	0.031	0.012	1	1.2120
Volume (m^3)	10417	8563	8793	17901	6084	N/A	N/A

There is no longer any mechanism to generate new Tritium (H-3) at Hunterston B. Future arisings would be as a result of waste processing and remain significantly lower than in the generating phase of the power station. The same applies to Sulphur-35 (S-35), which also has a very short half-life of ~ 90days.

From the information provided above, the discharges from Hunterston B are currently greater in volume and radioactivity levels than Hunterston A.

HNB carried out some simplified in-house calculations which provided similar results to the Eden report, demonstrating an annual radiation dose of approximately 0.5 μSv to a swimmer (two discharges from HNB/HNA combined, assuming a total of 24 annual discharges at 2% of the permitted annual activity limits at HNB and 6 discharges from HNA at 2% of the permitted annual activity).

HNA and HNB have a combined discharge (radiation dose to a swimmer)

		Adult micro Sv
HNA	Dose microSv/100ml (full discharge - 3 hours)	3.0E+01
	Say 6 discharges a year (limit/6)	5.0E+00
HNB	Dose microSv/100ml (full discharge - 3 hours)	1.63E+02
	Say 24 discharges a year (limit/24)	6.78E+00
	Dose from a combined discharge at pessimistic discharge rates	1.2E+01
	2% of the limits for each site (micro Sv)	2.4E-01

For context, it should be noted that a dental X-ray or the consumption of a 100g of Brazil nuts would incur a radiation dose of approximately 5 µSv and 10µSv, respectively. The dose assessments undertaken by EDF Energy and included in the annual reports and the RIFE reports remain valid.

3.2 Option to extend the line out into the Firth of Clyde

The original dispersion model report (Ref. 8) demonstrated that extending the line could facilitate dilution up to two orders of magnitude more that at the existing discharge point, due the depth of the water. However, the overall effect is negligible due to the fact that tidal movements facilitate dilution and mixing at the existing discharge point, compared to the deeper water.

The option to extend the current discharge line was discarded for two primary reasons:

i) **The associated additional costs of extending the line relative to the dose benefit to the public**

The estimated cost of extending the line was at least ~£2M, which would have been in addition to a cost of £2-3M for the chosen BPM option (Ref. 4), to thread a new line through the existing Cooling Water culvert.

The condition and stability of the seabed is unknown and there is a potential for costs to escalate if additional mitigations are required to complete installation works (see point ii) below).

Additional costs would be incurred for extending the line as further dispersion modelling would be necessary to account for a change in the permitted discharge point into the environment. This in turn would impact on the time taken for permits variations, resulting in the continued use of the CW system for a longer period and incurring additional cost.

Movement of the discharge point would require a review of the existing District Survey Monitoring programme to be undertaken, which may then result in an amended programme. The resource burden to carry out this review and/or potential amendment to the District Survey Monitoring programme incurs additional costs.

EDF produces an annual report on doses to the public in the vicinity of the power stations. Annual dose reports (Refs. 9 to 11) show that when Hunterston B was operating at power (generating phase), doses to the public were very low. Since moving into the defueling phase, the doses to the public from radioactive effluent discharges have remained unchanged. In addition to the EDF report, a report entitled ‘Radioactivity in Food and the Environment’ (RIFE) is produced by the Environment Agencies every year. The latest report (RIFE 28, Ref. 12) shows that doses to the public in the vicinity of Hunterston are very low.

ii) **The inherent risks of modifying the existing line / culvert to accommodate an extended line**

A modification was made to the existing CW culvert at the time of installation. The culvert was changed to rise up towards the end of the pipeline, due the instability of the seabed in that location. There is a high potential for similar issues to occur during works to extend the line; disruption to the seabed could damage the existing line and pose a significant risk to carrying out discharges.

In addition, marine life in the vicinity of the works would be significantly impacted.

In summary, the current District Survey Monitoring Programme has been supporting the discharge profile with the discharge point in its current location and environmental monitoring of the surrounding areas demonstrates very low dose to the public. The report for 2022 ERO/REP/0291/GEN (Ref. 11) shows that the maximum dose to a member of public was 0.41μSv. Therefore, for doses less than 1μSv for 2022, BPM principles are applied to ensure a proportionate response is considered in terms of the discharge line extension.

Extending the discharge line was therefore discarded as an option due to the disproportionate increase in costs and inherent risks compared to the potential reduction in dose to the public.

3.3 Option to purge the discharge line

A discharge dispersion modelling exercise was carried out, in order to understand the movement of radioactive effluent entering the Firth of Clyde at the permitted discharge point. A report was produced by Eden Nuclear and Environment Ltd. (Ref. 8). Reference to 'purging the lines' in the original report was made to represent the full contents of the tank being discharged to sea for the purposes of activity assessment. The model did not represent any dilution that may occur from purging the lines after discharge. Eden have confirmed this in the addendum modelling report (Ref. 6).

Flushing the line with towns-water would require a new plant system or the ability to fill the Final Delay Tanks with towns-water after a discharge. There is no readily available water supply large enough to fill the tanks rapidly; only domestic supplies are available in the Active Effluent Treatment Plant (AETP) and the Low Level Waste Facility (LLWF). It would therefore take considerable time (days) to obtain enough water to flush the lines without a new plant system being installed.

The environmental impact and cost detriment of installing a flush system was considered to be disproportionate to the risk of residual low level radioactive effluent within the lines. For this reason it was not considered BPM to install a system that would allow for flushing of the discharge lines and it is not the intention of Hunterston A or Hunterston B to purge the line after a discharge.

It is expected that a portion of the residual effluent in the line after discharge will be dispersed into the immediate water compartment as a result of natural displacement, including the natural tidal ebb and flow. Any remaining effluent in the line will be discharged into the sea at the start of the following discharge. There would, therefore, be no impact on dose modelling over a period of time e.g. a year or longer.

4 Conclusions

4.1 Dose Assessment to Swimmer

The assessment carried out by Eden Nuclear and Environment Ltd (Ref. 6) indicates a maximum dose to a swimmer in the vicinity of the discharge outlet of 198μSv under the specified 'worst case' circumstances i.e. a concurrent discharge from both Stations at the permitted activity limits. This dose is significantly below the public dose limit of 1mSv stated in the Ionising Radiation Regulations 2017 (IRR17) and below the effective site and single source dose constraints for future discharges of 0.5mSv/year and 0.3mSv/year, respectively, as applied under EASR18.

Based on the current and future operational status of each Station, there is an extremely low (negligible) likelihood of a concurrent discharge from both Stations at the permitted activity limits. Taking into account weather and associated sea conditions, seasonal daylight hours and the tidal windows utilised for discharges, and the number of annual discharges from each Station, it is more likely an individual swimmer would be in the vicinity of the outlet during a maximum of two discharges. It is calculated a more likely scenario would result in a maximum radiation dose of approximately 0.5 μSv. The annual dose assessments undertaken by EDF and included in the annual BPM report remain valid without the main Cooling Water system.

4.2 Extending the Discharge Line

Dispersion modelling (Ref. 8) demonstrated that extending the line could facilitate dilution up to two orders of magnitude more that at the existing discharge point, due the depth of the water. However, the overall effect is negligible due to the fact that tidal movements facilitate dilution and mixing at the existing discharge point, compared to the deeper water.

The current District Survey Monitoring Programme for Hunterston B has been supporting the discharge profile with the discharge point in its current location and environmental monitoring of the surrounding areas demonstrates very low dose to the public. The report for 2022 ERO/REP/0291/GEN (Ref. 11) shows that the maximum dose to a member of public was 0.41μSv. Therefore, for doses less than 1μSv for 2022, BPM principles are applied to ensure a proportionate response is considered in terms of the discharge line extension. Extending the discharge line was therefore discarded as an option due to the disproportionate increase in costs and inherent risks compared to the potential reduction in dose to the public.

4.3 Purging the Discharge Line

Reference to 'purging the lines' in the Eden Nuclear and Environment Ltd report (Ref. 8) was made to represent the full contents of the tank being discharged to sea for the purposes of activity assessment. The model did not represent any dilution that may occur from purging the lines after discharge; this was confirmed in the addendum modelling report (Ref. 6).

The environmental impact and cost detriment of installing a flush system was considered to be disproportionate to the risk of residual low level radioactive effluent within the lines. For this reason it is not considered BPM to install a system that would allow for flushing of the discharge lines and it is not the intention of Hunterston A or Hunterston B to purge the line after a discharge.

It is expected that a portion of the residual effluent in the line after discharge will be dispersed into the immediate water compartment as a result of natural displacement, including the natural tidal ebb and flow. Any remaining effluent in the line will be discharged into the sea at the start of the following discharge. There would, therefore, be no impact on dose modelling over a period of time e.g. a year or longer.

5 References

Ref.	Document Identifier	Document Title
1.	EASR18	Environmental Authorisations (Scotland) Regulations 2018
2.	EAS/P/1173609	Hunterston A Site EASR18 Permit
3.	EAS/P/1173596	Hunterston B Site EASR18 Permit
4.	HPS/TSSD/SR878	Best Practicable Means (BPM) Report for aqueous discharges to sea following fuel free verification
5.	SEPA Queries for clarification	Email from Keith Hammond on the 6th May 2024 requesting additional information.
6.	ENE – 0328A/R2	Dispersion of aqueous effluent from Hunterston power stations Annex – Additional Scenarios. Issue 2
7.	IRR17	Ionising Radiations Regulations 2017
8.	ENE – 0328A/R1	Dispersion of aqueous effluent from Hunterston power stations Issue 2.1
9.	ERO/REP/0232/GEN	Public Radiation Dose in the Vicinity of EDF Energy Nuclear Power Stations in 2018
10.	ERO/REP/0259/GEN	Public Radiation Dose in the Vicinity of EDF Energy Nuclear Power Stations in 2020
11.	ERO/REP/0291/GEN	Public Radiation Dose in the Vicinity of EDF Energy Nuclear Power Stations in 2022
12.	RIFE 28	Radioactivity in food and the environment, 2022. Government Publications (gov.uk)

6 Distribution List

Name	Position / Location
Rhonda Dubouchet	Environmental Safety Group Head (RPA)
David Macdonald	Environmental Safety Engineer (Acc RWE/RWA)
Ross Haswell	Environmental Safety Engineer (Acc RWE/RWA)
Scott Cooley	Technical Safety Support Manager
Michael Lafferty	Category G programme Manager
Bruce Skene	Transfer and Deconstruction Preparations Group Head
Andrew Dalling	Transfer and Deconstruction Preparations Manager