REGULATORY OBSERVATION

REGULATOR TO COMPLETE

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Revision:	0
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Acknowledgement required by:	16/04/20
Agreement of Resolution Plan Required by:	22/05/20
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Related RQ / RO No. and TRIM Ref: (if any)**:**	
Observation title:	HEPA filter type
Lead technical topic: 21. Environmental	**Related technical topic(s):** 14. Mechanical Engineering 16. Radiological Protection 17. RadWaste, Decommissioning & Spent Fuel Management

Regulatory Observation

Background

The Pre-Construction Environmental Report (PCER) Chapter 3 (Ref. 1) discusses the minimisation of the radioactivity of gaseous radioactive waste discharges by optimising the Heating, Ventilation, and Air Conditioning (HVAC) system including the provision of High Efficiency Particulate Air (HEPA) filters to reduce the concentration of radioactive aerosols.

Interactions with the Requesting Party (RP) concerning HEPA filter type include Regulatory Query (RQ) 0194 'Management of Aerial Filtration Systems' issued by the Environment Agency (Ref. 2) and RQ 0514 'Justification for the use of Rectangular HEPA Filters' issued by the Office for Nuclear Regulation (Ref. 3):

- RQ 0194 included a query concerning the type of HEPA filters selected for the design;
- RQ 0514 contained four queries regarding HEPA filter type. These concerned:
    - quantifying the effects on building volume and space layout that would result from a change from rectangular to cylindrical HEPA filters,
    - how rectangular HEPA filters are optimised to prevent by-pass leakage,
    - quantifying the differences in HEPA filter waste volumes that would be generated over the operating and decommissioning lifetime of a UK HPR1000 reactor, noting that UK RGP is that HEPA filters are replaced after a maximum of 10 years, and;
    - requesting examples of the uneven airflow of cylindrical filters and how this causes problems in measuring the differential pressure compared to rectangular filters.

In response to RQ 0194, the RP stated that rectangular HEPA filters are used. The RQ response indicated knowledge that cylindrical HEPA filters are recommended in the UK and stated that a topic report on optioneering of the HEPA filter type (rectangular versus cylindrical) would be submitted in July 2019. The submitted Optioneering Report of the HEPA Filters Types (Ref. 4) concluded that, "After the comparison process between cylindrical type and rectangular type, the preferable type of HEPA filters in UK HPR1000 is rectangular HEPA filters". The optioneering report did not assign weighting to the criteria used to indicate their relative importance in the decision making process and the analysis would have benefited from more narrative.

In response to the four queries in RQ 0514, the RP stated that their investigations will be carried out before June 2020 which could result in the Environment Agency having a potential Generic Design Assessment (GDA) issue relating to the use of HEPA filters at Public Consultation (Ref. 5).

In the UK, cylindrical HEPA filters are preferred due to better sealing efficiency compared with rectangular HEPA filters, which reduces bypass leakage and waste volumes and thus are also better for safe change maintenance procedures (Ref. 6). Bypass leakage can result in fugitive discharges and exposure to the worker. Increased sealing efficiency reduces the potential for filter wastage resulting from failed filter tests and five cylindrical HEPA filters fit into a standard 200 litre disposal drum reducing radioactive waste (Ref. 7). The optioneering report (Ref. 4) assumed that the same number of filters will be used and did not take into account filter wastage as a result of failed filter tests.

The maximum pressure drop of 350Pa for a 950l/s flow on a cylindrical HEPA filter is specified in the industry engineering standard ES_0_1737_2 (Ref. 8). A maximum pressure drop of 420Pa for a 850l/s flow on a rectangular HEPA filter is specified in the industry engineering standard ES_0_1731_2 (Ref. 9)[1]. This implies that that circular filters will be more energy efficient than rectangular filters. The RP should therefore consider the importance of this in the overall energy efficiency of the ventilation systems. According to UK Engineering Standards (Refs. 8 and 9), cylindrical HEPA filters are rated to 950 l/s (Ref. 8) and rectangular HEPA filters are rated to 850 l/s (Ref. 9) more rectangular HEPA filters may be required for high capacity ventilation systems and therefore potentially lead to greater solid waste generation.

This Regulatory Observation (RO) has therefore been raised to:

- Explain the regulator's expectations;
- Ensure the RP provides a robust optioneering study and justification for the choice of HEPA filter type;
- Obtain confidence that adequate evidence will be provided by the RP to support the claims and arguments made in the PCER;
- Demonstrate to the regulators that the minimisation of the radioactivity of gaseous radioactive waste discharges by the optimisation of the HVAC system including the provision of HEPA filters to reduce the concentration of radioactive aerosols is Best Available Techniques (BAT).

Relevant Legislation, Standards and Guidance

The Environment Agency Radioactive Substances Regulation - Environmental Principles (REPs) (Ref. 10) contains numerous principles of relevance to HEPA filter type selection including:

- MLDP4 – Decision Making
- RSMDP3 – Use of BAT to minimise waste;
- RSMDP15 – Requirements and Conditions for Disposal of Wastes;
- ENDP4 – Environment Protection Functions and Measures;
- ENDP16 – Ventilation Systems.

The Environment Agency Process and Information Document for Generic Assessment of Candidate Nuclear Power Plant Designs (Ref. 5) requires, "A description of how the production, discharge and disposal of radioactive waste will be managed to protect the environment and to optimise the protection of people … Describe the optimisation process used and identify and justify the proposed techniques as BAT". In addition the document also states that the RP must demonstrate, "minimising (in terms of radioactivity) discharges of gaseous and aqueous radioactive wastes".

The Office for Nuclear Regulation's, Nuclear Safety Technical Assessment Guide, NS-TAST-GD-022 (Ref. 11) states, "Cylindrical rather than rectangular high efficiency particulate air (HEPA) filters are generally preferred for new plants to reduce by-passing and waste volumes. These should also be more appropriate for safe change philosophies".

National Nuclear Ventilation Forum (NNVF), ES_0_1738, Ventilation Systems for Radiological Facilities, Design Guide (Ref. 6) states, "Cylindrical (circular) filters should be used on new installations due to the increased sealing efficiency over rectangular filters and therefore reduced potential for filter wastage resulting from consequent failures of in-situ filter tests. In addition circular filters are likely to have a higher 'claimable' Decontamination Factor due to the possibility of poor sealing on rectangular filter installations".

[1] Concerning when the Engineering Standards should be applied, ES_0_1731_2 states, "It is a mandatory requirement that rectangular mini-pleat 550/850l/s capacity HEPA filters, procured under the Framework Agreement for the supply of HEPA Filters across the NDA Estate, comply with this document. Rectangular filters exist on older plants and replacement like for like is acceptable. Circular filters to ES_0_1737_2 are preferred for new installations".

Nuclear Industry Safety Directors Forum, Best Available Techniques (BAT) for the Management of the Generation and Disposal of Radioactive Wastes (Ref. 12) includes guidance on the identification and implementation of BAT and states BAT means the latest stage of development of processes, facilities or methods of operation which is practicable and suitable to limit waste arisings and disposals. BAT applies throughout the lifetime of a process, from design to implementation, operation, maintenance and decommissioning".

IAEA guidance documents relevant to ventilation systems and the control of airborne radioactive material include IAEA STI/DOC/010/325 - Particulate Filtration in Nuclear Facilities (Ref. 13), which contains details on filter geometry and the preference for cylindrical filter geometry in terms of seal and disposal of waste.

International design guidance for ventilation systems includes BS ISO 26802:2010 Nuclear Facilities - Criteria for the design and operation of containment and ventilation systems for nuclear reactors (Ref. 14). The guidance specifies that filtering devices shall be designed in order to limit the volume of wastes that they will produce.

Regulatory Expectations

Environment Agency expects the claims and arguments presented in the PCER to be adequately substantiated by suitable and sufficient evidence. Environment Agency would therefore expect the optioneering study and justification of the choice of HEPA filter to comprehensively consider the minimisation of fugitive discharges, energy use and the production and disposal of radioactive waste.

Based on the expectations from the standards and guidance listed above, Environment Agency expects the discharge of gaseous radioactive aerosols to be minimised and demonstrated to be BAT. To be able to achieve this demonstration, as part of the resolution of this RO, the RP will need to undertake and document the following activities:

- Comprehensively evaluate the choices of HEPA filter with supporting narrative (e.g. apply a weighting to the criteria to highlight their importance in the decision making process);
- Demonstrate the selection of HEPA filter has adequately considered the prevention of fugitive discharges by optimisation of the sealing efficiency. The demonstration should include detail on how rectangular HEPA filters compare to the universal fit of cylindrical HEPA filters and the achievement of adequate sealing efficiencies as filter housings age;
- Assess what impact the choice of HEPA filter has on the disposability and volume of the radioactive waste using international Operational Experience (OPEX) where appropriate;
- Consider the Environment Agency Public Consultation period for the delivery of the Resolution Plan and associated supporting documents to mitigate the risk of a having potentially unresolved GDA issue during Public Consultation.

References

[1] UK HPR1000, Pre-Construction Environmental Report Chapter 3 - Demonstration of BAT GHX00510003KPGB02GN, Revision 000-1, November 2018
[2] UK HPR1000, RQ 0194 Management of Aerial Filtration Systems, March 2019
[3] UK HPR1000, RQ 0514 Justification for the use of Rectangular HEPA Filters, November 2019
[4] UK HPR1000, Optioneering Report of the HEPA Filters Types, GHX08000003DCNT03TR, Revision A, July 2019
[5] Environment Agency Process and Information Document for Generic Assessment of Candidate Nuclear Power Plant Designs, v3 October 2016.
[6] National Nuclear Ventilation Forum (NNVF), ES_0_1738_Issue 1, Ventilation Systems for Radiological Facilities, Design Guide, Issue 1, December 2018
[7] Nuclear ventilation High Efficiency Particulate Air (HEPA) - Lessons learned, DOE, USA, 1998
[8] Procurement Specification for circular plug-in 470 and 950l/s capacity HEPA filter inserts, ES_0_1737_2, Issue 4, October 2017.
[9] Procurement Specification for rectangular mini-pleat 550/850l/s capacity HEPA filter inserts, ES_0_1731_2, Issue 3, October 2017.
[10] Environment Agency, RSR1 – Radioactive Substances Regulation - Environmental Principles (REPs), Version 2, April 2010

[11] Office for Nuclear Regulations, Nuclear Safety Technical Assessment Guide, NS-TAST-GD-022, Revision 5, April 2017
[12] Nuclear Industry Safety Directors Forum, Best Available Techniques (BAT) for the Management of the Generation and Disposal of Radioactive Wastes, Issue 1, December 2010
[13] IAEA STI/DOC/010/325 - Particulate Filtration in Nuclear Facilities, Technical Reports Series No. 325, August 1991
[14] BS ISO 26802:2010 Nuclear Facilities. Criteria for the design and operation of containment and ventilation systems for nuclear reactors

RO-UKHPR1000-0036.A1 – Comprehensively evaluate the choices of HEPA filter

In response to this Action, the RP should:

- Provide a comprehensive evaluation of the choices of HEPA filter using a process including consideration of the weighting to criteria to highlight their importance in the decision making process to demonstrate BAT;
- Clearly state the assumptions made during optineering including frequency of filter change, expected activity loading, required flow through the filters, reliability, failure rates, etc.

The response to this RO Action (ROA) may be combined with any other ROA under this RO, if deemed appropriate

RO-UKHPR1000-0036.A2 – Demonstrate the selection of HEPA filter has considered the prevention of fugitive discharges by optimisation of the sealing efficiency

In response to this Action, the RP should:

- Provide adequate supporting evidence comparing how rectangular and circular HEPA filters are optimised to prevent by-pass leakage.

The response to this ROA may be combined with any other ROA under this RO, if deemed appropriate

RO-UKHPR1000-0036.A3 – Assess what impact the choice of HEPA filter has on the volume and disposability of the radioactive waste over the operational lifetime of a UK HPR1000 reactor

In response to this Action, the RP should:

- Provide an appropriate degree of robust supporting evidence to compare the volume and disposability of radioactive waste from the rectangular and cylindrical HEPA filters, to include where appropriate the use of international OPEX and noting that UK RGP is that HEPA filters are replaced after a maximum of 10 years.

The response to this ROA may be combined with any other ROA under this RO, if deemed appropriate

RO-UKHPR1000-0036.A4 – A demonstration of BAT for the choice of HEPA filter

In response to this Action, the RP should:

- Provide a demonstration of BAT for the choice of HEPA filter to protect people and the environment

The response to this ROA may be combined with any other ROA under this RO, if deemed appropriate

Resolution required by '*to be determined by General Nuclear System Resolution Plan*'

REQUESTING PARTY TO COMPLETE

Actual Acknowledgement date:	
RP stated Resolution Plan agreement date:	