Sizewell C Project

Radioactive Substances Regulation (RSR) Permit Application

Appendix C

Support Document C1 – Plant Monitoring

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1 INTRODUCTION

1.1 Purpose

1. The purpose of this Support Document is to describe the plant monitoring arrangements as part of the permit application to demonstrate how NNB Generation Company (SZC) Limited (SZC Co.) will ensure compliance with permit conditions, including the application of Best Available Techniques (BAT).
2. For the purpose of this document, the term 'monitoring' includes the taking of samples and measurement, either on-line or in a laboratory, of Radioactivity, chemical and physical properties of both in-process and discharge effluents.
3. Discharge monitoring enables the operator to demonstrate compliance with the permit conditions and limits. Prior to discharge, in-process monitoring enables the operator to:
    - Understand individual system contribution to discharges so that appropriate management of waste can be selected going forward;
    - Identify where increases in discharge results may come from within the plant including identification of leaks;
    - Ensure automatic containment or alarm in the event of activity (increased) detection;
    - Use results for the validation of the function and performance of environmental protection equipment.
4. The demonstration of BAT for compliance with in-process and discharge monitoring requirements of the Radioactive Substances Regulations (RSR) Environmental Permit conditions [Ref 2] will be presented for the gaseous, liquid and solid radioactive waste streams expected to be generated at the SZC plant.

1.2 Scope

5. The Generic Design Assessment (GDA) [Ref 3] and subsequent Hinkley Point C (HPC) RSR permit application [Ref 4] proposed monitoring techniques for the UK EPR™ based on international best practice, which demonstrated that the design would also comply with UK regulatory requirements. The subsequent Environment Agency decision document [Ref 5] contained Information Conditions (IC) to confirm the monitoring requirements and demonstrate BAT had been applied. These included IC4 [Ref 6] which required NNB GenCo (HPC) to provide the Environment Agency with a report that demonstrated that requirements for the sampling and monitoring of discharges have been adequately considered in the design of the plant. IC4 has since been closed and the findings are reflected in this report (particularly in the details contained in Section 4) and the SZC design. Further ICs relating to monitoring, and which have not yet been closed for HPC, are not expected to change the arrangements presented in this document.
6. A consistent state of design is referred to as a reference configuration; RC0 is the basis of design configuration for SZC. This includes all of the design changes from the GDA through to the HPC RC2 (fit for commissioning) design, including lessons learned from Flamanville 3 and other external events such as Fukushima. It follows the established replication strategy that has been adopted for SZC that looks to copy as much of the design from HPC as possible unless there are site specific differences that require adaption.
7. Full details of the design history and replication strategy adopted can be found in the SZC RSR Permit Application Head Document [Ref 7].

8. Importantly, for the RSR permit, the nuclear island where all radioactive material and waste is generated, stored prior to treatment, monitored and disposed from is identical at SZC as it is to HPC. This results in the proposed discharge limits at SZC being identical to those granted at HPC (see RSR Permit Application Support Document B (Disposal of Radiological Waste) [Ref 8] for further detail).

9. This document does not:

- justify the proposed outlets, which are defined in RSR Permit Application Support Document A.1 (Environment Case) [Ref 9]; or
- provide the justification for the proposed limits, which is covered in RSR Permit Application Support Document B (Disposal of Radioactive Wastes) [Ref 8]; or
- detail Environmental Monitoring arrangements, which is covered by RSR Permit Application Support Document C2 (Environmental Monitoring) [Ref 1].

1.3 Regulatory Context and Best Practice Guidance

10. The SZC facility has been designed to comply with regulatory requirements and meet relevant requirements specified in national and international standards, so far as is reasonably practicable, and to meet Relevant Good Practice.

11. The arrangements identified in this document will be subject to periodic review, taking into account operational experience and knowledge to ensure that monitoring arrangements remain BAT throughout the lifetime of the plant. The information presented in this document is considered at this stage to represent BAT.

1.4 Definitions

Term / Abbreviation	Definition
APG	Steam Generator Blowdown System
ASG	Emergency Feedwater System
BAT	Best Available Techniques
C-14	Carbon-14
Co-60	Cobalt-60
Cs-137	Caesium-137
DWN	Nuclear Auxiliary Building Ventilation System
DWQ	Effluent Treatment Building Ventilation System
DWV	HXA/HVL/HVD Ventilation System
EBA	Containment Sweep Ventilation System
EPE	Environmental Protection Equipment
EPF	Environmental Protection Function
ETB	Effluent Treatment Building
FD	Floor Drains
FPS	Flow Proportional Sampler

Term / Abbreviation	Definition
GDA	Generic Design Assessment
H-3	Tritium
HCA	Outfall Pond Building
HEPA	High Efficiency Particulate Air filter
HHI	Intermediate Level Waste solid waste store
HHK [ISFS]	Interim Spent Fuel Storage
HK	Fuel Building
HL	Safety Auxiliaries Building
HN [NAB]	Nuclear Auxiliary Building
HPC	Hinkley Point C
HQC	Extension of HN for Unit 2
HR [RB]	Reactor Building
HRGS	High Resolution Gamma-Ray Spectrometry
HXA	Tanks Building
HVAC	Heating, Ventilation and Air Conditioning
HVD	Hot Workshop, Hot Warehouse and Facilities for Decontamination
HVL	Hot Laundry
IC	Information Condition
I-131	Iodine-131
IRWST	In-containment Refuelling Water Storage Tank
KEPE	Key Environmental Protection Equipment
KER	Liquid Radwaste Monitoring and Discharge System
KRC	Body Contamination and Dosimetry Monitoring System
KRT	Plant Radiation Monitoring System
MCERTS	Monitoring and Certification Scheme
ND	Nominal Diameter
PTR [FP(P)CS]	Fuel Pool Cooling and Treatment System
RC2	Reference Configuration 2
RCV [CVCS]	Chemical Volume & Control System
REA [RBWS]	Reactor Boron & Water Make-Up System
REN/RES	Nuclear Sampling System / Secondary Sampling System
RIS/RA	Safety Injection System (in RA mode)

Term / Abbreviation	Definition
RPE [NVDS]	Nuclear Island Vents and Drainage System
RSR	Radioactive Substances Regulations
SBE	Laundry & Hot Decontamination System
SEH	Car park drainage system
SEK	Site Liquid Waste Discharge System
SEO-EP	Building surface water run off system
SLBR	System Level Best Available Technique Reviews
SP	Sampling Point
SZC	Sizewell C
SZC Co.	NNB Generation Company (SZC) Limited
TEG	Gaseous Waste Treatment System
TEN	Effluent Treatment Sampling System
TEP [CSTS]/[CSS]	Coolant Storage and Treatment System
TER	Additional Liquid Waste Discharge System
TES	Solid Waste Treatment System
TEU [LWPS]	Liquid Waste Treatment System
TD	Techniques Documents
WAC	Waste Acceptance Criteria

1.5 References

Ref	Title	Document No.	Version	Location	Author
1.	SZC RSR Permit Application Support Document C2 – Environmental Monitoring	100199174	1	EDRMS	SZC Co.
2.	How to comply with your environmental permit for radioactive substances on a nuclear licensed site	GEHO0812BUSS-E-E, 478_10	2	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/296431/geho0812buss-e-e.pdf	Environment Agency
3.	Generic design assessment UK EPR™ nuclear power plant design by AREVA NP SAS and Electricité de France SA	NNB-OSL-REP-001714	Jun, 2010	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/292844/geho0510bruv-e-e.pdf	EDF Energy/Areva NP
4.	Radioactive Substances Regulation Environmental Permit Application for Hinkley Point C	NNB-OSL-REP-000169	Jul, 2011	https://www.edfenergy.com/download-centre	NNB GenCo (HPC)

Ref	Title	Document No.	Version	Location	Author
5.	Application by NNB Generation Company Ltd to carry out radioactive substances activities at Hinkley Point C Power Station – Decision document	EPR/ZP3690SY/A001	2013	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/291292/LIT_7931_658948.pdf	Environment Agency
6.	Report to demonstrate that the sampling of discharges have been adequately considered in the design of plant to meet IC4 of the HPC RSR Permit EPR/ZP3690SY	100146597	1	EDRMS	NNB Genco (HPC)
7.	SZC RSR Permit Application Head Document	100115743	1	EDRMS	SZC Co.
8.	SZC RSR Permit Application Support Document B – Disposal of Radioactive Waste	100198811	1	EDRMS	SZC Co.
9.	SZC RSR Permit Application Support Document A.1 – Environment Case	100198762	1	EDRMS	SZC Co.
10.	SZC RSR Permit Application Support Document A2 – Integrated Waste Strategy	100197505	1	EDRMS	SZC Co.

2 RADIOACTIVE WASTE SOURCES

12. The following sections set out the radioactive waste sources anticipated for gaseous, liquid and solid waste streams in order to demonstrate suitable and sufficient monitoring is included in the design for SZC with information on the monitoring requirements covered in Sections 3 and 4.

2.1 Gaseous effluent sources

13. As shown in flow diagrams A.1 and A.2 in Appendix A, radioactive gaseous effluent originates primarily from three different sources:

    - Firstly, primary coolant off-gas, which is treated in the Gaseous Waste Processing System (TEG) and the Nuclear Auxiliary Building Ventilation System (DWN) prior to discharge via the main stack of each UK EPR^{TM} unit;
    - Secondly, gaseous effluent collected in the ventilation circuits of the various buildings of the Nuclear Island and then discharged via the main stacks;
    - Thirdly, gaseous effluent from the secondary circuit is collected in the Condenser Vacuum System prior to discharge via the main stacks.

14. All three sources will be treated by the use of High Efficiency Particulate in Air (HEPA) filtration abatement prior to final discharge, and, if required following the detection of elevated gamma radiation, via iodine traps for adsorption abatement prior to discharge. The use of HEPA filtration and iodine traps on the discharge line is the final abatement mechanism. This does not impact upstream abatement mechanisms such as that provide by the TEG delay beds for the abatement of noble gases.

15. There are other discharges expected from 'minor' outlets, these include the Interim Spent Fuel Store, Interim Intermediate Level Waste Storage Facility (HHI) and the Main Steam Release Train (VDA).

16. Further details of the generation and management of gaseous effluents can be found in RSR Permit Application Support Document A.1 (Environment Case) [Ref 9]. The proposed disposal routes are presented in RSR Permit Application Support Document A.2 [Ref 10].

2.2 Liquid effluent sources

17. As shown in flow diagram A.3 in Appendix A, radioactive liquid effluent originates primarily from four different sources:
18. Firstly, recyclable primary coolant is treated in the Coolant Storage and Treatment System (TEP) and Chemical Volume Control System (RCV) and the boric acid and water reused in the primary circuit coolant.
19. Secondly, non-recyclable liquid effluent is collected and segregated by the Nuclear Island Vents and Drainage System (RPE) and is directed to the appropriate treatment in the Liquid RadWaste Treatment System (TEU) prior to discharge via the Liquid Radwaste Monitoring and Discharge System (KER), Additional Liquid Waste Discharge System (TER) or the Site Liquid Waste Discharge System (SEK).
20. Thirdly, water drained from the secondary circuit is treated according to its nature and collected in discharge tanks (of the SEK or the KER/TER for the steam generator blowdown water) prior to discharge.
21. All of these liquid effluents are discharged through a common discharge outlet.
22. There are other discharges expected from ‘minor’ discharge outlets not expected to contain radioactive material, however, trace quantities may be detectable in certain situations. These include:
    - Water run-off collection systems from on-site and off-site car parks (SEH), and buildings (SEO-EP system) that are ultimately discharged via the outfall tunnel;
    - The return line of circulating seawater cooling system;
    - The spillway designed to return seawater from each unit’s Forebay in the event of cooling water pump failure coinciding with high tide; and,
    - Sea wall drainage system returns rainwater and wave topping of the sea wall.
23. Further details of the generation and management of liquid effluents can be found in RSR Permit Application Support Document A.1 (Environment Case) [Ref 9]. The proposed disposal routes are presented in RSR Permit Application Support Document A.2 [Ref 10].

2.3 Solid radioactive wastes

24. Solid radioactive waste is generated during operations and decommissioning. The use of in-process monitoring of liquid and gaseous waste streams will inform the subsequent solid radioactive waste management activities also ensuring the compliance of waste packages to meet the relevant waste acceptance criteria. Examples include the monitoring of differential pressure across HEPA filters to inform when they should be changed therefore generating solid waste and the monitoring of water filters with local dose sensors to optimise solid radioactive waste generation.
25. RSR Permit Application Support Document A.1 [Ref 9] describes how avoidance and minimisation of waste (including discharges) is achieved through plant design. Wastes that are unavoidably produced have their activity concentrated and contained so far as is reasonably practicable. This results in gaseous and liquid waste streams being abated with a transfer of activity into a solid form. Where a reasonably practicable means of abatement exists the principle of concentrate and contain of radioactivity into solid waste arisings, in accord with Government policy, will be achieved for SZC. Secondary wastes (i.e. those additional wastes generated

from the treatment of primary waste streams, such as used personal protective equipment) supporting operations, including maintenance activities, will also generate solid waste.

26. It is expected that the following solid waste streams will arise during operation and require monitoring:

- Ion-Exchange Resins;
- Wet Sludge;
- Cartridge Filters;
- Evaporator Concentrates;
- Air and Water Filters;
- Dry Active Wastes;
- Oils and Solvents; and
- Metal Scraps and other metallic wastes.

3 SZC ENVIRONMENT CASE FOR MONITORING

27. RSR Permit Application Support Document A.1 provides the full Environment Case for SZC and presents in full Claim 5 which demonstrates fully how SZC Co. shall undertake appropriate monitoring of the radioactive waste sources, as covered in Section 2, to check compliance with the conditions of the RSR permit.

28. The information provided in RSR Permit Application Support Document A.1 is not repeated fully in this document however in order to demonstrate that the monitoring arrangements are BAT, this section provides a summary of how BAT has been incorporated within the monitoring arrangements using a 'Claims', 'Arguments' and 'Evidence' approach, defined as:

- Claim - A high-level statement of what is being sought in terms of environmental optimisation. The Claim may be based on a specific permit condition or regulatory requirement;
- Argument - An element which contributes to achieving a claim (or claims) and which links the evidence to the claim. This element can be deterministic, qualitative and/or quantitative. The argument contributes to the demonstration that a claim is valid; and
- Evidence - This is used as the basis of the argument i.e. how the argument can be validated and which allows further examination where required. Evidence can be facts, (e.g. based on established scientific principles and prior research or practices elsewhere), or assumptions.

29. Figure 3-1 provides an overview of the 4 Arguments supporting Claim 5 which are then discussed in the sections below.

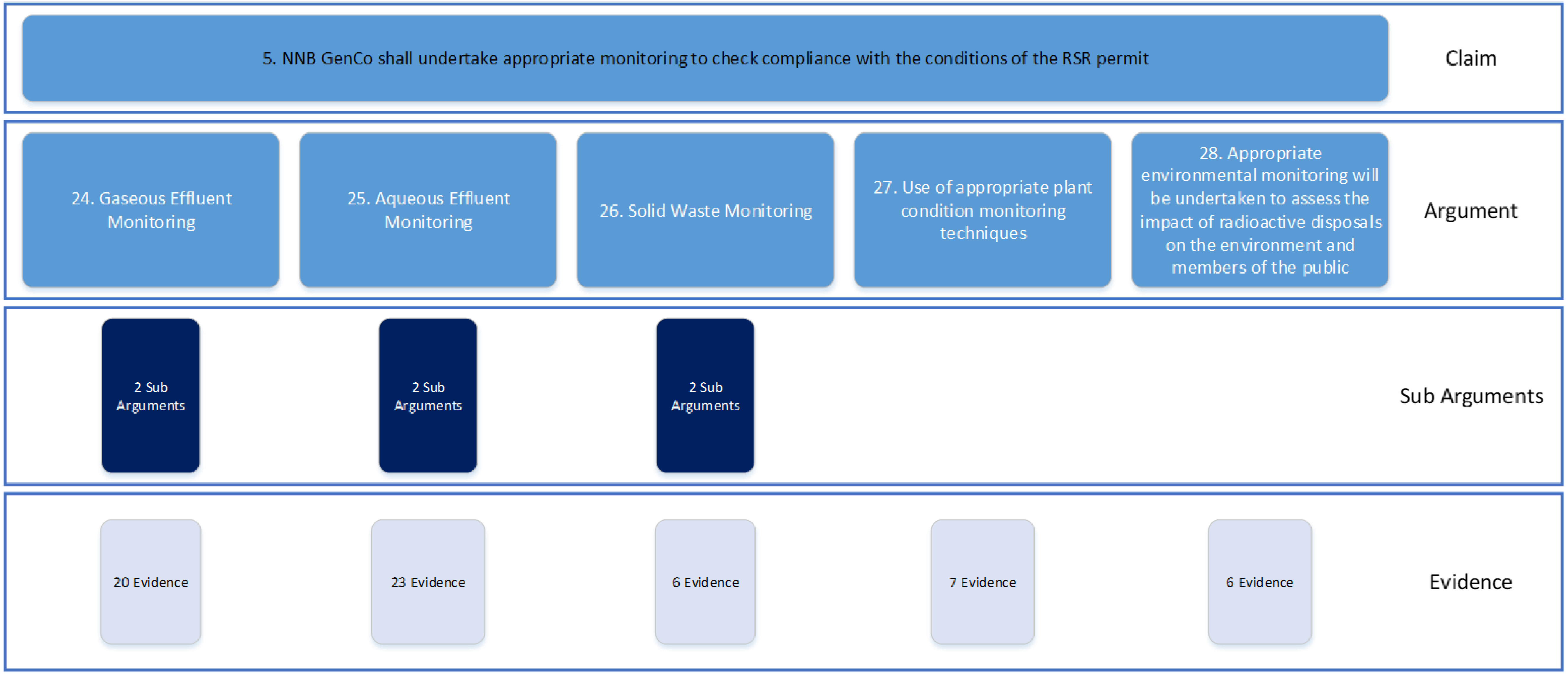


Figure 3-1 Overarching Structure of Claim 5

4 DEMONSTRATION OF APPROPRIATE MONITORING FOR SZC

30. At the design stage the intent is to demonstrate a full understanding of the requirements for monitoring systems and consideration for appropriate design features, i.e. requisite space for plant, have been considered. For SZC this includes a replication of the arrangements developed for HPC.

31. The SZC starting design is defined as Reference Configuration 0 (RC0), this includes monitoring requirements included as a result of the HPC RSR permit IC4 Report [Ref 6]. This IC report demonstrates for HPC that monitoring requirements are suitable; adequate space has been made available; and, the layout of the buildings have been considered before the commencement of construction of relevant, specified, buildings. This ensures that monitoring, for the purpose of demonstrating compliance with the limits presented in the RSR permit, can be carried out by the operator post construction. Going forward, this IC report is considered applicable to SZC and specifications of monitoring regimes for SZC will be developed as the plant moves towards operation. Further related HPC RSR Permit ICs are still open for the HPC design. It is expected that this will include replication of the requirements for monitoring and analytical equipment, as will be defined through the HPC RSR Permit IC Reports and incorporated into SZC normal business. Further discussion regarding the wider implementation of the SZC replication strategy is provided in the SZC RSR Permit Application Head Document [Ref 7].

32. Monitoring is considered an Environmental Protection Function (EPF) of the plant, other EPFs include minimisation, containment, abatement, treatment, mitigation, and optimisation.

33. Plant that carries out or contributes to the EPF are classified as Environmental Protection Equipment (EPE) and can be a system, comprising discrete items of equipment (such as demineraliser, filters and stack sampling and analysis equipment); a structure (such as stacks, bunds and outfall structures); or a component (such as tank level gauges). EPE may be considered as Key Environmental Protection Equipment (KEPE) i.e. the most significant EPE and hence prioritised as part of the risk assessment process.

34. There are three principal methods of plant monitoring to be used at SZC which align with the arguments presented in Figure 3-1**Error! Reference source not found.**:

    - in-process monitoring (summarised in Section 4.1) to provide feedback to enable trending and potential adjustment of plant performance to ensure environmental discharges are optimised; and
    - discharge monitoring of gaseous and liquid waste (summarised in Section 4.2) to ensure compliance with environment permit discharge conditions. This data also provides valuable plant condition information i.e. HEPA filter performance, which also acts as an indirect method of process monitoring.
    - Solid waste characterisation and sentencing (summarised in Section 4.3).

35. The fourth argument, the demonstration of BAT is applicable to each of these principal methods and the approach to BAT is covered in each of the following sections.

36. Further details of the proposed KEPE and EPE associated with monitoring and the full evidence can be found in the RSR Permit Application Support Document A.1 (Environment Case) [Ref 9].

4.1 In-process monitoring

37. This section summarises the principals, key systems involved and how these are deemed BAT for in-process monitoring of liquid and gaseous effluent.

38. In-process monitoring of the composition of radioactive substances in primary coolant, process fluids, reactor off-gas and associated effluent is primarily carried out for plant operations. In-process monitoring is also carried out to support compliance with the RSR permit and this generally falls under the following categories:

- In-process monitoring: To provide data enabling the appropriate segregation of wastes to optimise abatement, treatment and/or storage of effluents prior to discharge. As per the engineering hierarchy of control, monitoring can result in automatic plant actions such as the diversion of effluent through iodine traps. Monitoring can also provide information to operators to determine the appropriate action;
- Monitoring of process effluents: To provide the trending of activity from the source term through to treatment and storage prior to discharge;
- Plant monitoring: This includes the measurement of plant conditions which enable the diagnostic of systems or components serving an environmental protection function; such as differential pressure across filters, pool water temperature, etc. This monitoring can also help identify trends in the composition of effluents that may indicate longer term trends in plant performance.

39. The in-process monitoring of radioactive effluent is expected to cover the radionuclides and groups of radionuclides identified as significant for discharge limits as indicated in Table 4-1; the justification for their selection and the rationale for the proposed limits and advisory levels, is presented RSR Permit Application Support Document B [Ref 8]. Other radionuclides may be monitored periodically to provide further trending of plant performance.

40. The following key systems as shown in detail in flow diagrams A.1, A.2 and A.3 in Appendix A, contribute to the in-processing monitoring capability at SZC. Monitoring requirements have been based on an assessment of BAT criteria established from international, British and French standards. The BAT criteria consider the location, isokinetics (where appropriate); representativeness, operation and maintenance requirements recognising that in some cases these requirements may be competing. As such the BAT criteria aim to balance these competing factors such as minimising sample line lengths while ensuring a representative sample and operator safety. This BAT criterion and the outcome of the assessment is covered in more detail in the Environment Case presented in RSR Permit Application Support Document A.1 however key features of the monitoring system are given here.

4.1.1 Plant Radiation Monitoring System (KRT)

41. For systems containing liquid effluent, the KRT system provides on-line measurements such as gamma activity, beta activity or dose rates of effluent or equipment to enable suitable segregation, treatment and storage of effluents as well as providing operational data for trending. KRT monitoring is carried out across the nuclear island including the RCV, the TEP, the Liquid Waste Treatment System (TEU) as well as sumps and drains. The KRT sensors are identified in diagram A.3.

For gaseous effluent monitoring, the KRT provides in-process monitoring of the Active Heating, Ventilation and Air Conditioning (HVAC) systems including but not limited to the DWN and the Effluent Treatment Building Ventilation System (DWQ) as shown in diagram A.1; as well as monitoring of the Gaseous Waste Processing System (TEG), as shown in diagram A.2. KRT gaseous monitoring provides on line measurements of gamma activity as well as the sampling of effluents to ensure suitable treatment of gaseous effluents as well as providing operational data for trending and verification of abatement performance.

4.1.2 TEN (Effluent Treatment Building Sampling System)

The TEN system provides samples for in-process monitoring of liquid effluents from the TEU system via sampling sinks or gloveboxes on the recirculation line of effluent storage tanks for analysis in the laboratory to determine suitability of effluent for treatment, further storage or discharge. When needed the tank samples may also be used to provide backup samples for discharge reporting if the Flow Proportional Sampler (FPS), discussed in Section 4.2.2, is not available.

42. The TEN provides in-process monitoring of 9SBE (Site Laundry and Hot Decontamination System) liquid effluents, the Liquid Waste Processing System (TEU) liquid effluents, the Solid Waste Treatment System (TES) concentrates, the KER, Site Liquid Waste Discharge System (SEK) and the Additional Liquid Waste Discharge System (TER).

4.1.3 Nuclear Sampling System/Secondary Sampling System

43. The REN/RES systems enable the monitoring and optimisation of the primary and secondary coolant systems, a fundamental aspect for the minimisation at source of radioactive waste generation by allowing operators to ensure conditions are maintained in the UK EPR^{TM} to ensure, among other things the integrity of fuel cladding to minimise control of gaseous releases.

44. In addition, the REN system provides monitoring of plant conditions enabling the diagnostic of systems or components which serve an environmental protection function; such as the sampling of effluent upstream and downstream of demineralisers and filters.

45. The REN system provides on-line measurements of: Boron concentration; conductivity; hydrogen and oxygen concentrations; and samples of liquid effluent from systems. The systems that are measured include, but are not limited to, the Reactor Coolant System, RCV, the Fuel Pool Cooling System (PTR) and the RPE.

46. The RES system provides on-line measurements and samples of liquid effluent from the secondary side of the steam generator, including the Steam Generator Blowdown System (APG).

4.1.4 Other In-Process Plant Monitoring

47. All systems containing EPE and KEPE will also undergo plant monitoring to ensure and verify the availability and effectiveness of equipment to deliver its EPF. Conditions such as temperature, pressure and flow are monitored throughout the plant and are considered integral to the system they serve. Examples of this include differential pressure monitoring devices in the HVAC systems.

4.2 Discharge monitoring

48. This section summarises the principles, key systems involved and how these are deemed BAT for discharge monitoring.

49. Discharge monitoring is required to demonstrate compliance with the limits and conditions specified within the SZC RSR permit. Trending the results of this monitoring is also useful for determining plant performance and can provide early indication of any plant/system deterioration. Consequently, the systems used to provide discharge monitoring are shown in flow diagrams B.1 & B.2 in Appendix B, and identified below.

50. The primary goal of discharge monitoring is to demonstrate compliance with the permitted annual limits and quarterly notification levels. The radionuclides identified as significant for these limits and levels are defined in RSR Permit Application Support Document B [Ref 8], and given in Table 4-1.

Table 4-1 Radionuclides and Groups of Radionuclides Requiring Monitoring

Liquid Effluent	Gaseous Effluent
Tritium (H-3)	Tritium (H-3)
Carbon-14 (C-14)	Carbon-14 (C-14)
Cobalt-60 (Co-60)	Iodine (I-131)
Caesium-137 (Cs-137)	Noble gases
Other radionuclides	Beta emitting radionuclides associated with particulate matter

51. The following sections provide the detail of the systems used to monitor the radionuclides in Table 4-1.

4.2.1 Gaseous discharge monitoring

52. A diagram of gaseous discharge stack and sampling lines is shown in B.1 in Appendix B. This diagram shows that in order to monitor for the radionuclides given in Table 4-1, there are three sampling lines which run along inside the discharge stack. Each of these lines is duplicated for back up of the primary line. The sampling lines have been located following an assessment of BAT criteria established from international, British and French standards. The BAT criteria include location, isokinetics (where appropriate), representativeness, operation and maintenance requirements recognising that in some cases these requirements may be competing. As such the assessment of the BAT criteria ensures a compromise of these competing factors such as minimising sample line lengths while ensuring a representative sample and operator safety. This BAT criterion and the outcome of the assessment is covered in more detail in the Environment Case presented in RSR Permit Application Support Document A.1, however, key features of the monitoring system are given here.

53. The primary sampling lines located in the stack are routed to a sampling room where a combination of on-line analysers and samplers - part of the KRT - are located. The different KRT monitors are grouped together on the three lines as follows:

- One sampling line supplies the beta gas monitors. The first is the ‘normal’ range monitor designed to detect elevated discharges. The second ‘accident’ range monitor is designed to detect elevated activity falling outside of expected operating parameters. This would indicate the plant is in accident conditions.
- One sampling line supplies the online gamma spectrometer. This is replaced with a 24h sampler on the redundant train; and
- One large-diameter primary sampling line used to supply three secondary sampling lines. These supply effluent to: a particulate and I-131 sampling device; a H-3 sampling device; and C-14 sampling device respectively.

54. The second set of sampling lines are routed to a separate room. The equipment is identical to those described above with the exception that the online gamma spectrometer is replaced with a sampler capable of taking a composite sample over a 24hr period, and will automatically generate a new composite sample every 24hrs - hence referred to as a ‘24hr sampler’. The sample can be analysed in the laboratory if required in the event of failure of the gamma spectrometer.

55. The location of the samplers has been assessed and presented in the HPC RSR permit IC4 report, which demonstrates that the design and location of gaseous sampling points provide sufficient space for equipment,

with safe and suitable access, and suitable environmental conditions. Given the replication strategy, these arrangements will be identical for SZC. The final specification for sampling and monitoring equipment will be subject to feedback from HPC; however, equipment will be specified in accordance with relevant codes and standards. This will ensure that monitoring equipment is sufficiently sensitive to readily demonstrate compliance with the proposed limits set out in RSR Permit Application Support Document B. This will also ensure that the levels of detection as specified in the EU Commission Recommendation 2004/2 Euratom are met, where relevant.

56. In addition to the monitoring of radionuclides, the flow of effluent discharged from the stack is monitored. Flow meters are located in the stack for continuous monitoring of the discharge flow rate, in accordance with recommendations of ISO2889:2010 (See RSR Commitment 5) for systems where flowrate can vary by >20% (flow rate may vary greatly between normal operational states and reactor shutdown). Hatches will also allow for periodic manual flow rate monitoring to ensure the continuous flow meters are properly calibrated in accordance with the Monitoring and Certification Scheme (MCERTS) standard for Continuous Emission Monitoring Systems (CEMs), and allow suitable and safe access for maintenance of the flow monitors.

57. The minor gaseous outlets (identified in Section 2.1) will not be continuously monitored. Discharges from these outlets will need to be assessed to check that total emissions remain below 5% of the respective discharge limits specified in the RSR permit. It is expected that discharges from minor outlets will be calculated based on process data however for HHI discharges thee may be potential to monitor through the use of spot samples however this is not confirmed. This is regarded as proportionate to the level of risk associate with the very low levels of discharges released from these outlets.

4.2.2 Liquid discharge monitoring

58. A diagram of gaseous discharge stack and sampling lines is shown in B.2 in Appendix B. This diagram shows that the SZC site liquid discharge systems will serve both UK EPR^{TM} units and comprise of the following:

- KER: The Liquid Radwaste Monitoring and Discharge System which collects, monitors and discharges treated effluent from the Nuclear Island direct to the discharge outfall;
- TER: Additional Liquid Waste Discharge System which provides backup capacity for storing liquid effluent. This system does not have a separate discharge line and is discharged via the KER network; and
- SEK: The Site Liquid Waste Discharge System which collects, monitors and discharges liquid waste from the Conventional Island, including the Turbine Hall and effluent from the Nuclear Island that is not normally active direct to the discharge outfall.

59. The KER and SEK systems represent the main discharge pathway for radioactive liquid effluent from the Nuclear Island and site facilities and as such are identified as the Main Outlets of disposal of aqueous waste. TER is also identified noting that the final discharge route is via the KER discharge line. These systems mainly consist of large tanks housed in the Tanks Building (HXA) with components to enable to isolation, recirculation and discharge of effluent.

60. Liquid monitoring equipment will be provided for each main aqueous discharge outlet to undertake measurements for tritium, C-14, Co-60, Cs-137 and 'other radionuclides' discharges in liquid effluents as identified in Table 4-1. Monitoring is required prior to discharge to ensure suitability of effluent for discharge and when effluent is being discharged through the associated outlet to provide a representative measurement for reporting. The equipment includes:

- Sampling sinks used for representative sampling from each tank (KER, SEK and TER if used) to check for chemical and radiological compliance and sanction its discharge;

- Tank levels sensors fitted within each KER/TER/SEK tank to provide the operator with an indication of the effluent volume contained within the tanks;
- Flow meters to monitor the volume and flow rate of liquid effluent that's is discharged via the KER/TER/SEK tanks;
- FPS for sampling during discharge to provide a sample representative of the entire discharge actually made for analysis in the laboratory of the identified radionuclides for statutory reporting;
- Radiation monitoring is provided by the KRT. This does not provide samples for analysis and does not contribute to discharge reporting however provides additional assurance to prevent erroneous discharges by continually monitoring the discharge line for any increases in radioactivity.

61. As demonstrated in the HPC RSR permit IC4 report, the arrangements for the KER and SEK proportional flow samplers, and the design of the HXA building ensure that:
    - Representative sampling will be achieved through suitable sampling arrangements;
    - Sufficient space has been allocated for the equipment to not foreclose options for procurement later on; and,
    - Suitable and safe access to equipment is available to operators for sample collection or maintenance; or to the EA for witnessed sampling when required.

62. In addition, the application of the MCERTS standard for automatic water sampling equipment was reviewed and it is acknowledged that where MCERTS certified FPS are available and fit for purpose, they must be used. It is noted that at the time of writing this document, no equipment has yet been certified for use in pressurised systems, and no other UK EDF nuclear site is currently using a certified FPS for pressurised systems. Following good practice however, the FPS themselves will meet the equivalent standard BS EN 16479 (See RSR Commitment 5 [Ref 7]).

63. Equipment will be provided to ensure that monitoring equipment is sufficiently sensitive to readily demonstrate compliance with the proposed limits set out in RSR Permit Application Support Document B. This will also ensure that the levels of detection as specified in the EU Commission Recommendation 2004/2 Euratom are met, where relevant.

64. The proposed minor discharge outlets (identified in Section 2.2) will not be continuously monitored. Discharges from these outlets will need to be assessed to check that total emissions remain below 5% of the respective discharge limits specified in the RSR permit. The minor outlets will include provisions for manual sampling to enable these checks to be carried out at an appropriate frequency. This is regarded as proportionate to the level of risk associate with the very low levels of discharges released from these outlets.

65. In the event of failure of FPS or flow meters used on the discharge lines the discharge of effluent will be stopped. Given the ability to stop discharges of liquid effluent (unlike gaseous discharges) it is not considered BAT to provide a second set of equipment for back up. In the event that discharge is required - and this equipment remains unavailable - tank samples and level sensor measurements may be used for discharge reporting. However, this will be minimised as far as reasonably practicable by ensuring that; for the FPS and flow meter during operation, a robust maintenance strategy is in place. This shall be based on the feedback provided by the supplier of the equipment to cover equipment lifetime, lead times, replacement frequency and failure rates and repair time calculations.

4.2.3 Solid waste monitoring

66. This section summarises the principals, key systems involved and how these are deemed BAT for solid waste monitoring.

67. Solid waste monitoring falls under two categories;

- Sentence monitoring defined as any monitoring carried out that will be used as an input to characterise the waste package for transfer off-site for treatment/disposal.
- In-process monitoring defined as monitoring that provides information to inform solid radioactive waste management decisions (e.g. changing a filter).

68. Section 2.3 provides the radioactive solid wastes which require monitoring. For each of these solid waste categories an assessment has been carried out to demonstrate that the establishment of waste stream fingerprints and the use of a scaling factors approach based on BS ISO 21238:2007 for all wastes (apart from oils and solvents) is BAT (See RSR Commitment 5). The justification is based on OPEX from the approaches to characterisation in France and at SZB and other operators globally, and is based on the fact that Co-60 will be a dominant radionuclide for all waste streams at HPC. Specific details of how fingerprints will be established for each waste stream will be developed following the generation of wastes.

69. Waste packages will be monitored via appropriate methods e.g. drum monitors, to determine the activity contained within. The activity measured, waste package and conditioning process characteristics will be used to determine the volume, activity and other information needed by waste service providers (Low Level Waste and Very Low Level Waste) or the HHI. In addition, characterisation data will be used to determine the radionuclide breakdown of the waste for compliance demonstration purposes associated with Waste Acceptance Criteria (WAC) or Letter of Compliance requirements as applicable.

70. Table 4-2 outlines the preferred monitoring techniques to be used for SZC characterisation of solid waste.

Table 4-2 Solid Waste Streams with associated preferred monitoring techniques

Waste Stream	Preferred Monitoring Technique
Active Resins	Sample taken via glove box with destructive offsite analysis to generate fingerprint and High Resolution Gamma-Ray Spectrometry (HRGS) for key radionuclides and application of scaling factors.
Charcoal Filters and Iodine Traps	Manual sample of charcoal media followed by on site laboratory based HRGS for gamma emitting radio isotopes and liquid Scintillation analysis for H-3 and C-14.
Concentrates	Sample taken via glove box with destructive offsite analysis to generate fingerprint and on site laboratory based HRGS for key radionuclides and application of scaling factors.
DAW and Metallic Waste	Swabs taken from across the plant to generate fingerprint for site. Low Resolution Gamma-Ray Spectrometry (LRGS) Drum Scan for key radionuclides and application of scaling factors.
Active Air Filters	Fingerprint from relevant plant areas applied. LRGS drum scan for key radionuclides and application of scaling factors.
Sludges	Manual samples taken to generate fingerprint on campaign basis Laboratory Based HRGS for key radionuclides and application of scaling factors.
Water filters: Filters removed manually	Fingerprint established based on effluent/ swabbing LRGS drum scan for key radionuclides and application of scaling factors.

Water filters: Filters removed by filter handling machine	Fingerprint is generated based on effluent source term and this is combined with dose rate measurements taken at the point of filter change.
APG Resins	Manual resin sample to establish fingerprint and laboratory based HRGS for key radionuclides and application of scaling factors
Oils and Solvents	Manual samples on campaign basis. Laboratory based HRGS for key radionuclides and application of scaling factors. Liquid Scintillation counting for H-3 and C-14

71. SZC Co. will implement processes for the management of solid radioactive waste that ensure compliance with the requirements of the RSR environmental permit and will be proportionate to the environmental risk. As part of these processes SZC Co. will adopt detailed and documented monitoring procedures that provide measurement data to enable effective decision making.

72. BAT will be implemented for the assessment of all solid radioactive waste streams to allow appropriate, consistent and traceable decisions to be made regarding the appropriate treatment, conditioning and sentencing of such wastes. SZC Co. will ensure appropriate assessments are made for waste sentenced for disposal or transfer whilst minimising the risk that waste could be incorrectly classified or mis-routed. SZC Co. will ensure that all techniques remain effective and that changes are adequately assessed, categorised and managed appropriately. The following systems contribute to the monitoring of solid waste:

    - Body Contamination and Dose Monitoring system (KRC) is primarily used for personnel contamination monitoring however it also provides dose monitoring of liquid filters to inform filter change and management of these as solid waste.

    - The TES system provides monitoring to characterise and enable correct consignment, ensuring they meet the Waste Acceptance Criteria (WAC) of the facility to which the waste will be sent for treatment and/or disposal, prior to leaving SZC. A number of process parameters other than radionuclides or chemicals have the potential to influence the generation, storage treatment or disposal of radioactive solid waste.

      The

73. Various techniques are used in the TES including measurements of the amount of grout, water and waste as well as the formulation of grout and the amount of polymer, water, hardening agent and spent ion exchange resin used during encapsulation processes. Many of these also contribute to discharge monitoring.

74. Further details of solid waste generation, categorisation and management can be found in RSR Permit Application Support Document A.2 [Ref 10].

5 FORWARD ACTION PLAN

75. The information in this support document provides appropriate information on the arrangements for environmental monitoring at SZC for the stage of development during this RSR permit application process. The actions identified in this Forward Action Plan demonstrate the necessary arrangements for monitoring, measurement and assessment of radioactive waste generated from SZC so that it can be in place in a timely manner, and that the various limitations and conditions of the RSR environmental permit are complied with at

the appropriate time. This plan has been captured as part of the Forward Work Plan for the RSR permit application [SZC RSR CMT4] [Ref 7].

76. The following activities as shown in Figure 5-1 will be carried out for SZC.

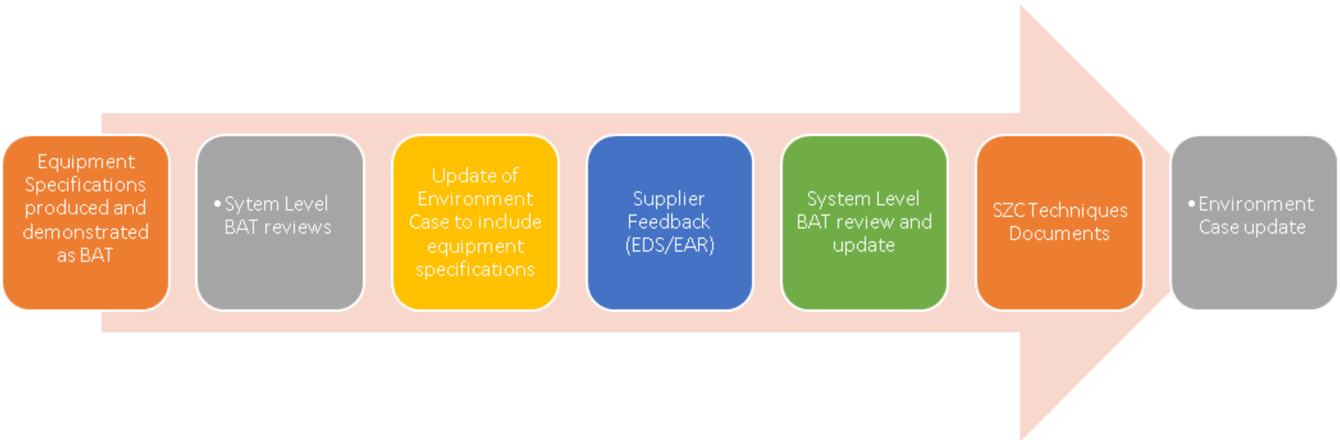


Figure 5-1 Expected activities for continual demonstration of BAT for monitoring

5.1 Equipment Specifications demonstrated as BAT.

77. SZC Co. will demonstrate the application of BAT in the detailed selection of equipment required to take samples, analyse and monitor radioactive waste and effluent. The standard to be specified to contractors responsible for procurement of monitoring/sampling equipment will specify the requirements that will ensure a high level of protection of the environment overall, whilst being technically and economically viable (thus satisfying the definition of BAT). Through the identification and justification of the technical characteristics the final design/selection of this equipment will be informed. Where practicable, this will include demonstration of relevant good practice against published codes and standard, or a comparison with existing OPEX in a way proportionate to the impacts and risks associated with the management and monitoring of radioactive waste disposals. This activity is intended to close the RSR IC5 for the HPC permit and will be replicated as per the replication strategy defined in the Head Document for SZC [Ref 7].

5.2 System Level BAT Reviews (SLBR)

78. SLBRs will be carried out to ensure that the design of systems considered key to supporting compliance with the RSR permit have the necessary design requirements to fulfil this requirement which included monitoring. The SLBRs will provide evidence for the Environment Case that the key systems have the appropriate monitoring in place at the appropriate stage of design. The following key systems will each undergo a SLBR;

- KRT (Plant Radiation and Monitoring System)
- TES (Solid Waste Treatment System)
- TEU (Liquid Waste Processing System)
- DWN (Nuclear Auxiliary Building)
- DWQ (Effluent Treatment System)
- TEN (Effluent Treatment Building Sampling System)

5.3 Supplier Feedback

79. Suppliers of monitoring equipment will produce where appropriate, Environment Design Summary (EDS) documents. The purpose of the EDS reports is to provide a mechanism for contractors to demonstrate that the design of equipment meets the specification and functional requirements, as a result of detailed design activities they may carry out, or where changes or deviations are made to justify that BAT can be demonstrated.

80. On completion of contract activities, suppliers will provide where appropriate an Environmental Analysis Report (EAR). The purpose of the EAR reports is to provide a mechanism for contractors to demonstrate that the system/equipment supplied by them meets the design and functional requirements agreed through the approval of the EDS. This could include Factory Acceptance Testing (FAT) and commissioning test results where this is in the scope of the contract. The EDS and EAR will provide further evidence for the Environment Case that the appropriate monitoring in place at the appropriate stage of design is BAT.

5.4 Techniques Documents (TDs)

81. The purpose of the TDs is to define and document the possible techniques to be employed to determine the activity of radioactive waste disposals. The precise format and structure of the Techniques Documents is still to be determined but is expected to reflect operating experience gained from other operating stations.

82. The TDs will ensure that the operator is able to carry out the appropriate monitoring including, sampling, measurement and analysis to ensure compliance with the RSR permit conditions.

6 CONCLUSION

83. The SZC design is based on the accepted GDA and its development into HPC RC2, informed by operational experience from the wider EDF fleet and from learning taken from the RSR application process for HPC. The demonstration of BAT to the plant monitoring systems, particularly as detailed in RSR Permit Application Support Document A.1, illustrates the improvements and learning SZC Co. has applied since the HPC application was made.

84. The design of SZC monitoring arrangements is considered BAT on the basis that plant monitoring has been fully considered throughout the design process. This will be used to ensure in-process optimisation to minimise waste generation and discharges at source, and for compliance purposes when demonstrating permit limits and conditions are being met.

85. As the SZC project develops, SZC Co. will demonstrate that the specification of equipment to fulfil the monitoring arrangements are BAT based on the application of relevant codes and standards recognised as relevant good practice. During the procurement process SZC Co. will continue to monitor the development of equipment supply, to ensure equipment meets all specified requirements and that installation is completed successfully. This will ensure that the established BAT criteria is not compromised. The Forward Action Plan (Section 5) details the further work required to demonstrate that monitoring systems remain BAT during the design, procurement and construction process. This is done through the production of System Level BAT assessments after each significant milestone (e.g. on completion of design and then following commissioning), as well as supporting documentation (i.e. Techniques Documents); to be completed as the process continues towards operations. The Forward Action Plan details that SZC Co. fully understand the outstanding actions needed to continue applying BAT to the plant, and that they are cognisant and engaged in the process, so that all aspects are managed and completed in suitable timescales.

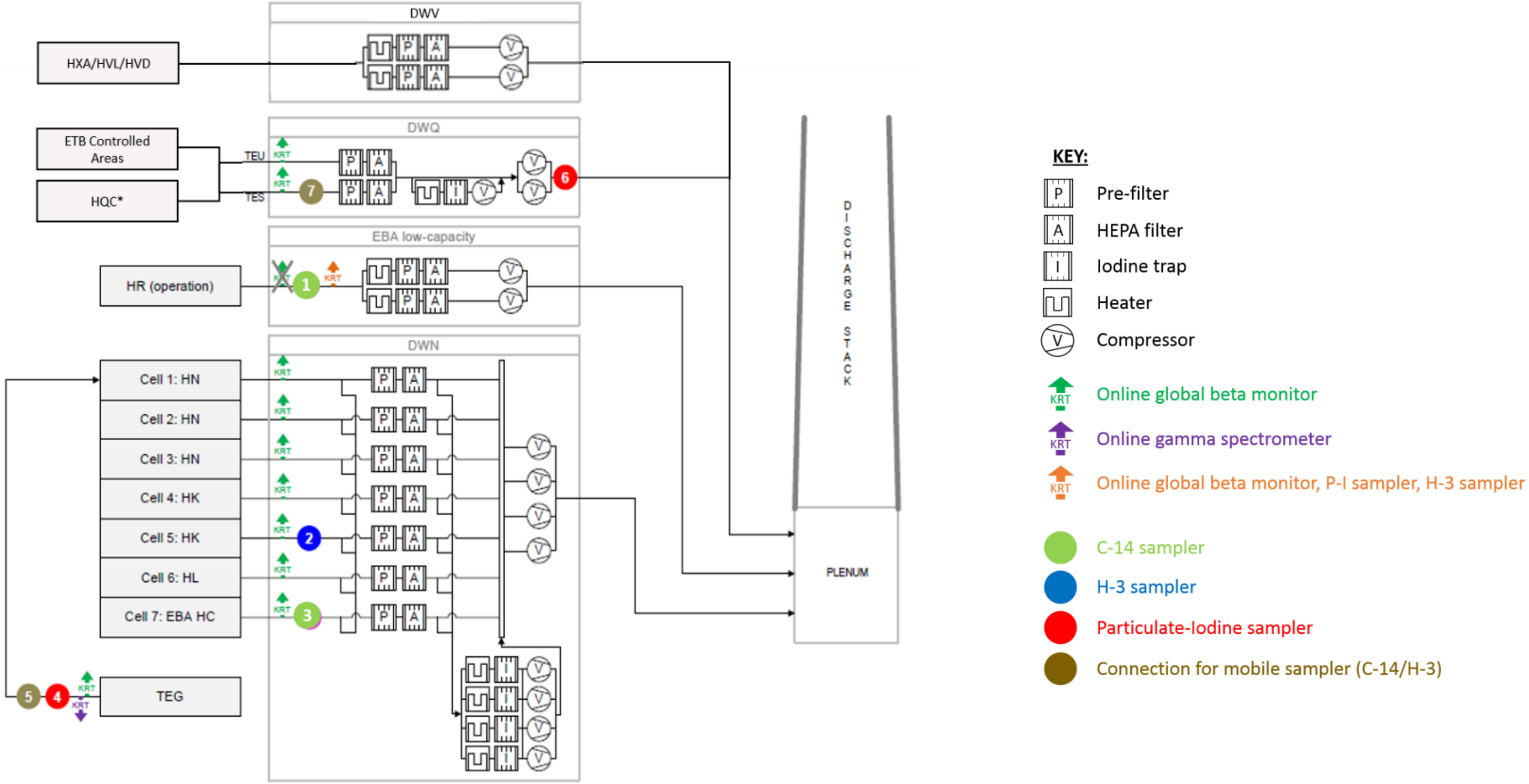
86. The arrangements identified in this document will be subject to periodic review, taking into account operational experience and knowledge to ensure that monitoring arrangements remain BAT throughout the lifetime of the

plant. However, information presented in this document is considered at this stage of the SZC design to represent BAT, while ensuring no option is foreclosed

NOT PROTECTIVELY MARKED

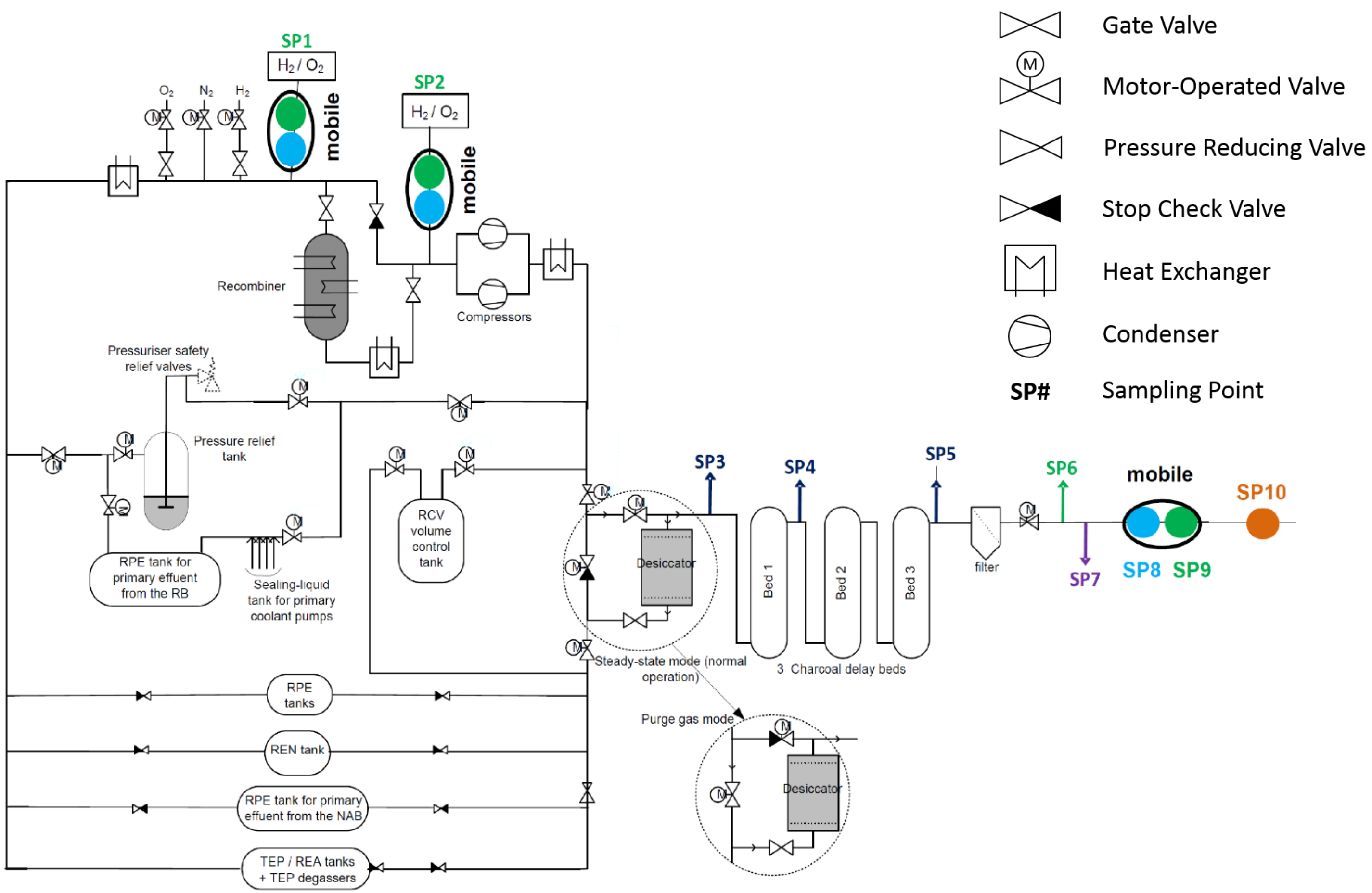
APPENDIX A. IN-PROCESS MONITORING SYSTEMS FLOW DIAGRAMS

A.1. Gaseous Effluent

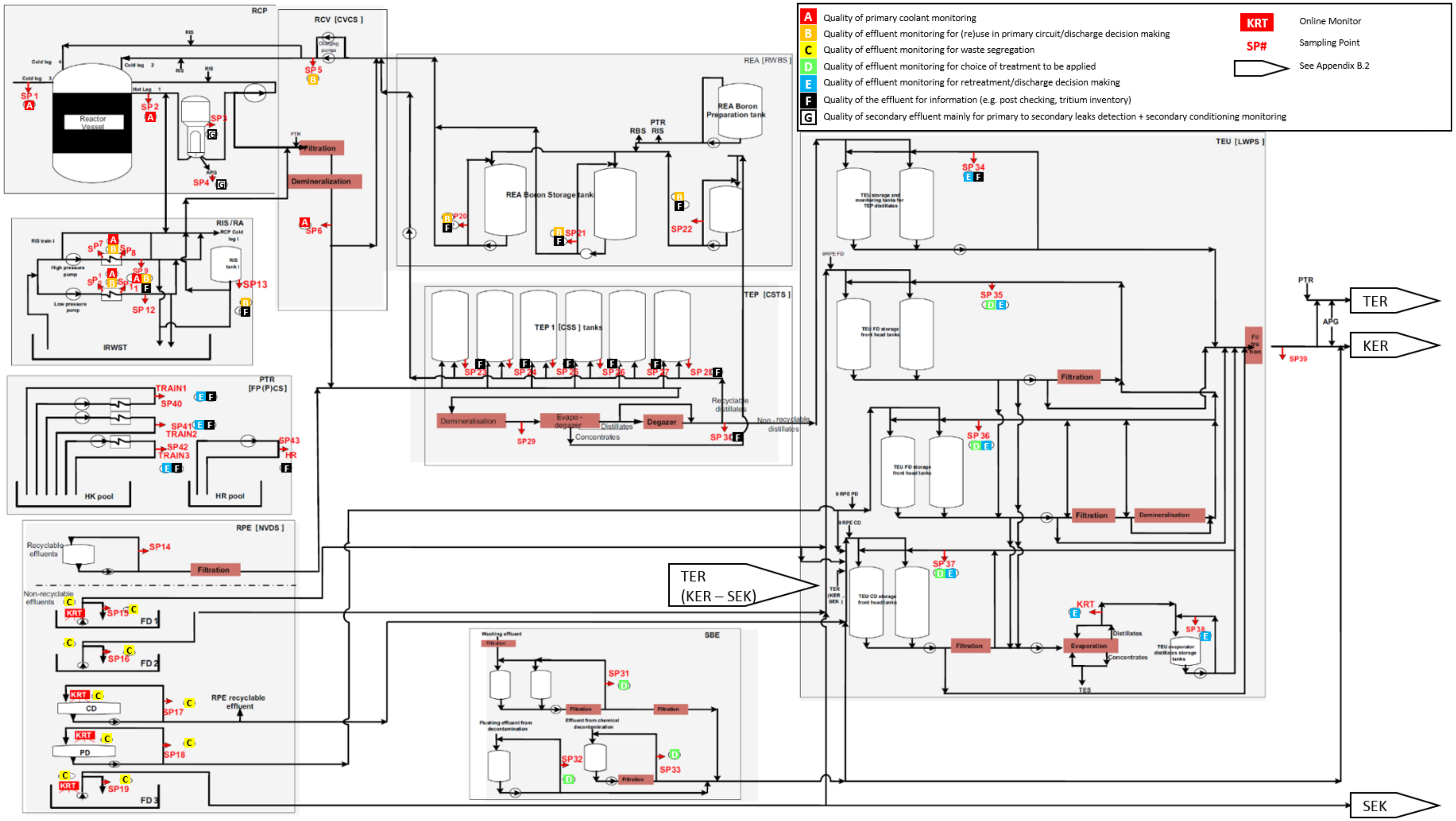


*HQC is directed to 9DWQ. The sampling shown is located on 2DWQ

A.2 Gaseous Waste Treatment System (TEG)

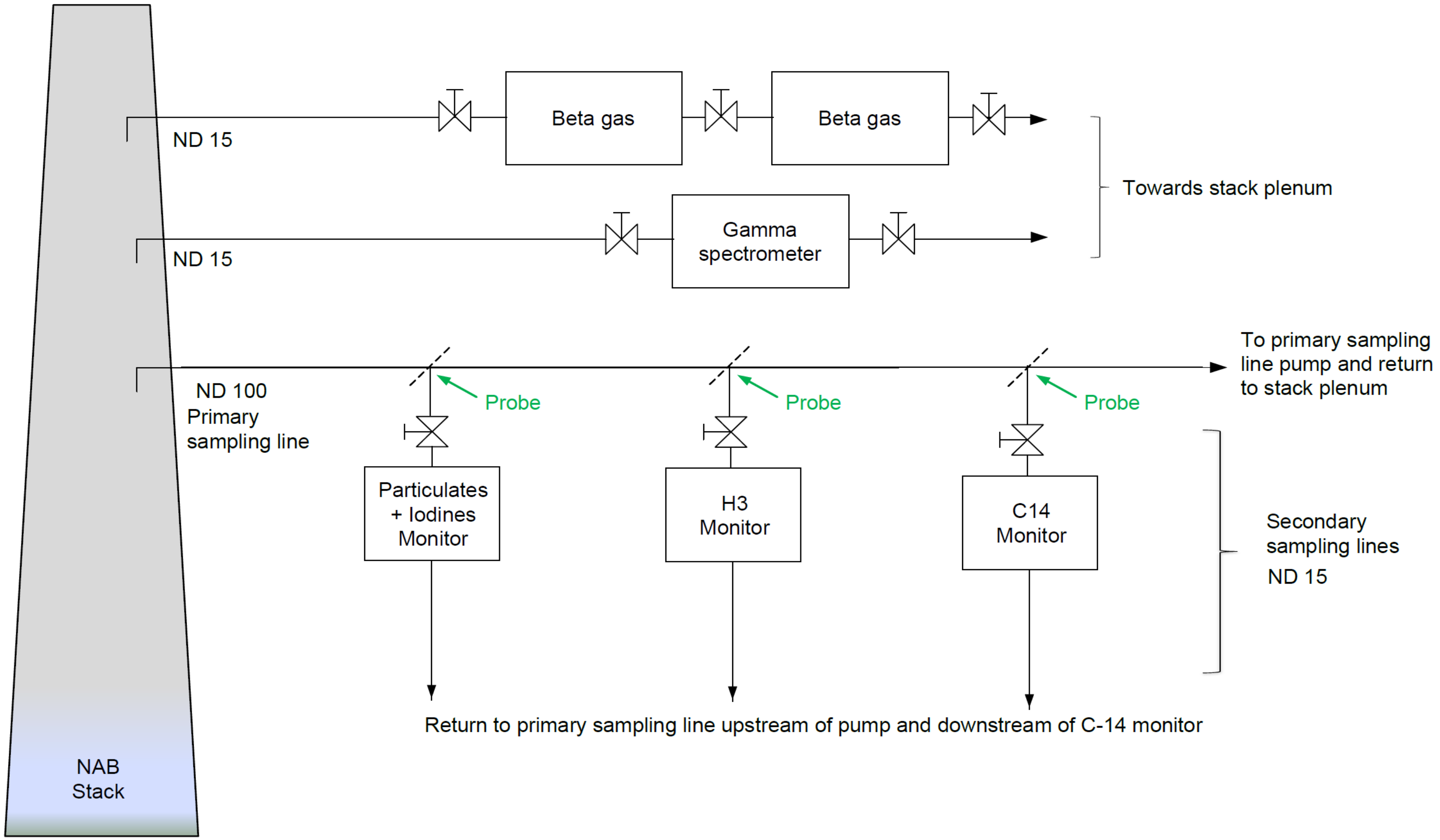


A.3 Liquid effluent

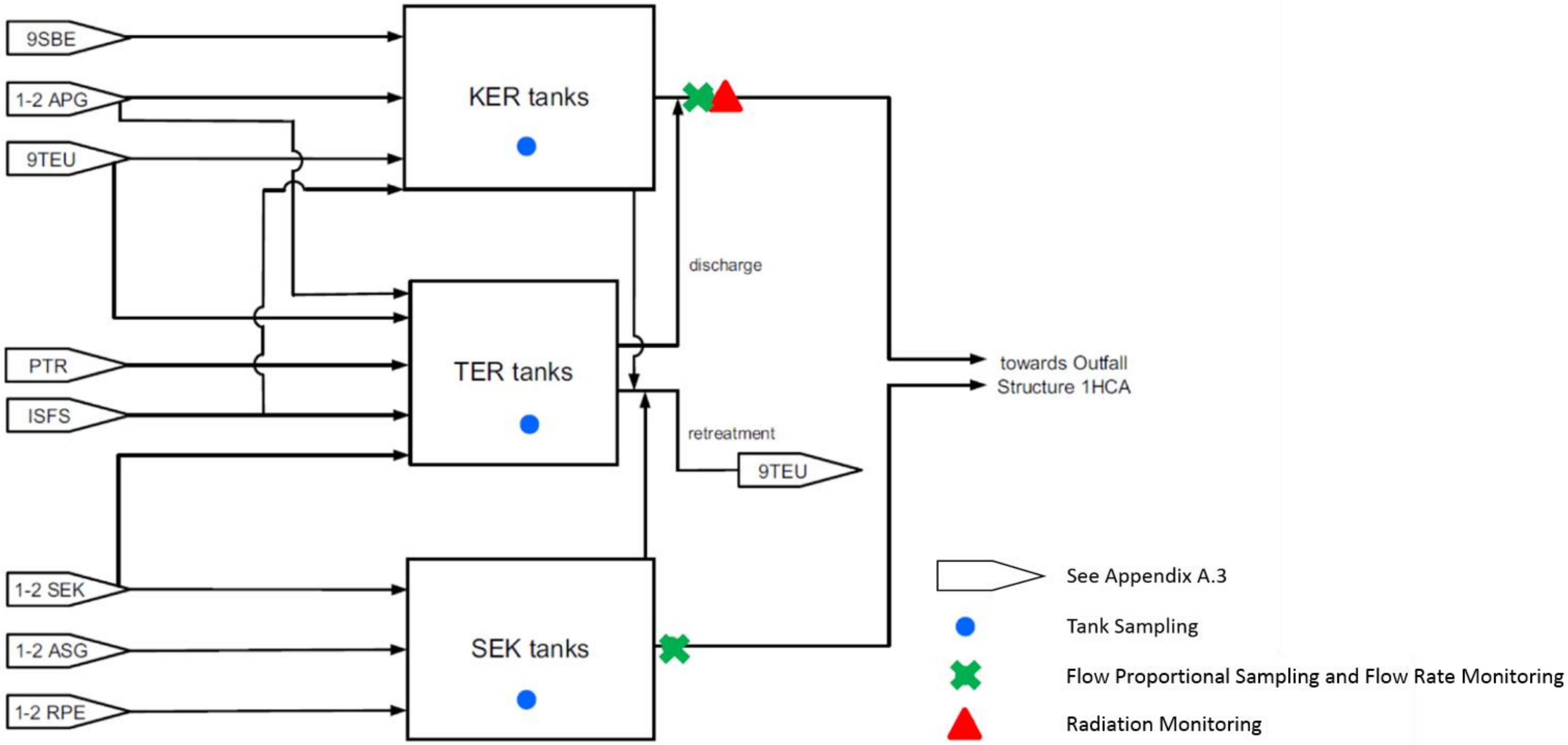


APPENDIX B. DISCHARGE MONITORING SYSTEMS FLOW DIAGRAMS

B.1. Gaseous Discharges



B.2. Liquid discharges



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