Sizewell C Diesel Generators Combustion Activities Environmental Permit Application - Schedule 5 Response

BAT and CBA Assessment

NNB Generation Company (SZC Co.)

Project number: 60578253

June 2021

Quality information

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Revision History

Revision	Revision date	Details	Authorized	Position
1	14th June 2021	Initial draft	Helen Watson	Associate Director
1	21st June 2021	Final	Helen Watson	Associate Director
2	23rd June 2021	Generator type for DNB added to Table 6.2	Helen Watson	Associate Director

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1. Introduction

AECOM Infrastructure & Environment UK Ltd (AECOM) has been commissioned by NNB Generation Company (SZC Co.) to undertake a Cost Benefit Analysis (CBA) and Best Available Techniques (BAT) assessment for the diesel generators to be used at the proposed Sizewell C (SZC) nuclear power station, located in Sizewell, Suffolk.

SZC Co. has submitted a Development Consent Order (DCO) application for the SZC nuclear power station and due to the inclusion of twelve back-up diesel generators, which have a combined thermal input in excess of 50 megawatts thermal (MW_{th}), an Environmental Permit (EP) application for the Combustion Activities (under Schedule 1 of the Environmental Permitting (England and Wales) Regulations 2016) has also been made for this aspect of the SZC site.

As part of the determination process for the Combustion Activity Environmental Permit (EPR/MP3731AC/A001), the Environment Agency (EA) have issued a Schedule 5 notice (Request for Further Information). Question 1 – Best Available Techniques (BAT) of the Schedule 5 notice states:

> *“BAT is the use of generators which can meet the latest emission standards for standby plant. The latest standards are equivalent or better than ‘TA-Luft 2g’ or Tier II USEPA with guaranteed emissions of 2,000 mg/m^3 for NOx; 650 mg/m^3 for CO, 130 mg/m^3 for particulates and dust and 150 mg/m^3 for hydrocarbons (Data Centre FAQ Draft version 10.0).*
>
> *In section 3.1.1 of the Application Document ref. 100207658 Rev.02 you state ‘Emissions from the EDGs and UDGs are below the TA-Luft 2g Standards for CO, PM and SO_2, however they exceed the NOx limit.’ Furthermore, you state that ‘Unlike other standby generators, the safety classified EDGs and UDGs will be required to meet stringent nuclear safety requirements. A nuclear safety case has been prepared which requires that the diesel generators meet safety functional requirements, be safety qualified and meet relevant quality standards including the RCC-E Design and Construction Rules for Electrical Components of PWR Nuclear Islands. Therefore, the draft Environment Agency data centre headlines FAQ guidance emission standards are not considered relevant to the nuclear qualified EDGs and UDGs. You also state that ‘The cost to classify an alternative diesel generator with reduced NOx emissions (if this is even possible to meet the availability and reliability requirements) would be grossly disproportionate to the benefit’.*
>
> *We acknowledge the requirement for the engines to meet the stringent nuclear safety requirements, however we need to ensure that the combustion units on site minimise emissions as far as is practicable.*
>
> *Therefore:*
>
> *Please provide a detailed BAT cost benefit justification on classifying an alternative diesel generator with the latest emissions standards. This should consider the reduction on emissions and their impact, and feasibility and cost of the safety qualifying an alternative diesel generator. You should also carry out a search for alternative cleaner generators that meet the nuclear safety requirements. This should include availability of any suitable diesel generators that achieve better environmental standards than proposed in the application.”*

A BAT assessment and CBA has therefore been carried out in order to identify BAT for the Combustion Activities at the SZC site, in terms of the benefits of reduced oxides of nitrogen (NOx) emissions associated with generators that could meet the TA Luft 2g standard, against the costs of qualifying replacement units to be approved for use in a nuclear safety case.

1.1 Background Information

Each of the two UK EPR™ units at the SZC site will require four 23.1 MW_{th} (9.59 megawatts electrical (MW_e)) Essential Diesel Generators (EDGs) and two 10.53 MW_{th} (3.75 MW_e) Ultimate Diesel Generators (UDGs), to act as emergency back-up generators to enable the safe shut down of site operations in the event of a loss of off-site power event (LOOP).

The diesel generator units proposed are those that have been substantiated to meet the stringent nuclear safety functional requirements required within the nuclear safety case for the currently under construction Hinkley Point C Nuclear Power Station (HPC). The diesel generators underwent a rigorous testing regime, in order to be approved for use at HPC. As such, it is envisaged that the same diesel generators would be used for the SZC project.

The emissions of NOx associated with the proposed diesel generators are currently in excess of the TA-Luft 2g standard of 2,000 mg/m^3 (at 5% oxygen), which has been cited by the EA as representing BAT for emergency generators for data centres.

1.2 Regulatory Requirements

The Industrial Emissions Directive (IED) (European Council Directive 2010/75/EU) (IED)[1] forms the basis of regulation for Large Combustion Plant (LCP) (combustion units >50MWth), such as the Combustion Activities associated with the SZC site. The IED lays down rules on integrated prevention and control of pollution arising from specified industrial activities (listed as Annex 1 within the Directive) designed to prevent or, where that is not practicable, to reduce emissions into air, water and land and to prevent the generation of waste, in order to achieve a high level of protection of the environment taken as a whole. Central to the principle of IED is the requirement on operators to take appropriate preventative measures against pollution through the application of Best Available Techniques (BAT).

Chapter III and Annex V, Part 2 of the IED sets out the expected performance requirements for Large Combustion Plant which come into operation after 1st January 2016, and specifically includes Emission Limit Values (ELVs) for combustion gases.

In addition, European BAT Reference documents, or BRefs, have been drawn up for each of the principal sectors defined within the IED, to provide guidance on techniques that may be considered to represent BAT. The BRef for LCP was published by the European Commission at the end of 2017. In addition to the BRef, further clarification of the requirements for BAT is published in a BAT Conclusion document[2]. According to Article 14(3) of the IED, BAT conclusions shall be the reference for setting the permit conditions for installations covered by the Directive.

The BRef and BAT Conclusion documents detail BAT-Associated Emissions Levels (AELs) for the release of combustion gases from Large Combustion Plant.

Chapter III Article 29 of the IED details the aggregation rules for combustion activities with a total rated thermal input of 50MW or more, such as the SZC site. Specifically relevant to the SZC site is the requirement for *"separate combustion plants which are installed in such a way that, taking technical and economic factors into account, their waste gases could in the judgment of the competent authority, be discharged through a common stack, are to comply with the EU-wide emission limit values and monitoring requirements laid down in Annex V of the IED."*

It is considered that the SZC diesel generators could not be aggregated to release their emissions via a common stack. Each diesel generator must be capable of operating entirely independently and a shared stack would potentially restrict this ability. As such, for the purpose of nuclear safety, each diesel generator must have a separate, independently operated stack.

As the SZC site standby generation plant does not contain individual units (or units which share a common stack) with capacities over 50 MWth, the LCP BRef BAT-AELs do not apply. In addition, it is further noted that many of the LCP BAT conclusions relating to operating techniques specifically exclude

[1] The EU Withdrawal Act 2018 maintains established environmental principles and ensures that existing EU environmental law will continue to have effect in UK law, including the IED and BAT Conclusion Implementing Decision made under it.
[2] European Commission. (2017). Commission Implementing Decision (EU) 2017/1442 of 31 July 2017 establishing best available techniques (BAT) conclusions, under Directive 201/75/EU of the European Parliament and of the Council, for Large Combustion plants. "BAT Conclusions"

standby plant and plant operating less than 500 hours a year, which would be the case for the proposed EDGs and UDGs.

The twelve back-up generators are defined as 'Medium Combustion Plant' in accordance with the aggregation rule in the Medium Combustion Plant Directive (MCPD)[3], however again it is considered that the plant does not fall under the scope of the MCPD, as the specified emission limit values are not applicable to combustion plant that operate for less than 500 hours/ year (over a five year averaging period). The SZC diesel generators will have a defined nuclear safety role under a nuclear licence issued by the Office for Nuclear Regulations, and therefore are considered to be 'excluded generators' as defined in Schedule 25B of the Environmental Permitting Regulations 2018 (as amended).

In the absence of any legislative limits for the emissions from diesel generators operating as emergency back-up plant, the EA produced a draft guide on their headline approach for permitting Data Centres within the context of IED and Environmental Permitting Regulations for Schedule 1.1 Part A Combustion Activities 'Chapter II' sites aggregated to >50MWth input[4]. The EA has cited this guide as being applicable to the SZC site in their Schedule 5 request, indicating that, "*BAT is the use of generators which can meet the latest emission standards for standby plant. The latest standards are equivalent or better than 'TA-Luft 2g' or Tier II USEPA.*" The standards detailed in TA Luft 2g are shown in Table 1.1.

Table 1.1: TA Luft 2g - Emission Limit Values (ELVs) for Diesel Generators

Emission	Concentration mg/Nm^3 (at 5% O_2)[1]	Concentration mg/Nm^3 (at 15% O_2)[2]
Oxides of nitrogen (NOx)	2,000	740
Carbon Monoxide (CO)	650	240
Particulates	130	50
Hydrocarbons	150	55

[1] as stated in the TA Luft 2g standard
[2] as required for UK compliance

As a working draft framework approach, the Data Centre guide is not a legal document, and it is recognised within the guide that permitting and day to day regulation must necessarily be on a site-specific basis.

In addition, the use of diesel generators for the continuity of supply for a Data Centre is not directly comparable to the requirement for continuity of supply for a nuclear power plant. In the case of a nuclear power plant, the diesel generators are relied upon to maintain cooling of the reactor, and as such maintain the reactor integrity and core melt. This is very different to the failure of a diesel generator for a Data Centre. A nuclear power plant has a defined nuclear safety requirement, and the diesel generators need to meet stringent safety function requirements, in terms of reliability and availability and meet relevant EN standards including the RCC-E Design and Construction Rules for Electrical Components of Pressurised Water Reactors (PWR) Nuclear Islands. The qualification process for nuclear safety classified diesel generators involves a rigorous and costly testing regime, ensuring they can continue to operate under a wide range of extreme conditions, which is not the case for Data Centres.

The determination of BAT is specific to a particular installation in a particular location, as there may be geographical, technological or local environmental reasons why a particular technique cannot be applied to the installation's process. In some cases, this could mean that the competent authority permits emission concentrations above those stated as BAT, provided a justification is given for the departure.

[3] European Commission. (2015). Directive (EU) 2015/2193 of The European Parliament and of the Council on the limitation of emissions of certain pollutants into the air from medium combustion plants (Medium Combustion Plant Directive)
[4] Environment Agency. (2018). Data Centre FAQ. Draft version 10.0 H.Tee 01/06/18 – Release to Industry.

2. Proposed Diesel Generators for the Sizewell C Project

2.1 Required Operation

The role of the emergency back-up diesel generators is to provide electrical power supply to the Key Safety Classified Systems of the nuclear power station in the event of a loss of off-site power event (LOOP), enabling the nuclear power station to come to, and maintain, a safe shutdown state. Failure of the emergency back-up diesel generators to perform this safety critical role therefore has the potential to result in a nuclear incident.

During normal operation, both the EDGs and UDGs will undergo periodic testing, as it is essential to ensure that the back-up generators and associated equipment are in good working order, and therefore ready to perform their nuclear safety function, if required.

The commissioning phase of the SZC diesel generators is anticipated to last for two years, and during this time it is anticipated that each UDG will be tested for 738 hours and each EDG will be tested for 242.5. This totals 4,892 hours of testing to be carried out over two years (i.e. 2,446 hours per year). It is likely that the actual testing regime to be applied will take less time than this, but to provide a conservative assessment these hours have been used.

Once installed and commissioned, the diesel generators would only be routinely operated for maintenance purposes and during periodic nuclear safety tests. The EP application conservatively assumed 60 hours per year for each EDG and UDG (based on operational experience on the most recent ‘N4’ generation of nuclear power station in France). The actual running hours are expected to be lower than this and will depend on the manufacturer’s recommendations and safety case requirements, however a maximum of 720 hours of diesel generator operation (60 hours for each of the 12 diesel generators) is assumed per year.

The actual operation of the diesel generators will be minimised as far as possible but will be adequate to ensure that they remain fit for their nuclear safety purpose.

It is anticipated that once installed, due to the low number of annual operational hours, the diesel generator will have a lifetime of 60 years, with planned refurbishment after 30 years. For the purpose of the assessment, a lifetime of 60 years for the diesel generators has been assumed.

2.2 Generic Design Assessment

Generic design assessment (GDA) is the process used by the nuclear regulators (Office for Nuclear Regulation (ONR) and the Environment Agency) to assess new nuclear power station vendor designs. It allows the regulators to assess the safety, security and environmental elements of new reactor design early in the design development for a generic site, prior to any site-specific planning, licensing or permit application.

The purpose of the GDA is to provide advice to the designers about any issues identified by the regulators so that these can be resolved at the design stage. This increases regulatory effectiveness and efficiency and, for developers, helps reduce their commercial risks on costs and timescales. The process can take a number of years to complete and involves the ONR and EA undertaking technical assessments of the submissions, consultation with overseas regulators and a comments and consultation process.

Areva and EDF commenced the process of GDA approval for the UK EPR™ planned for installation at HPC and SZC in 2007. In December 2012 a Design Acceptance Confirmation (DAC) and Statement of Design Acceptability (SoDA) for the UK EPR™ Reactor Design, was issued, concluding a 5-year long GDA process. In 2012 a nuclear site licence was granted to install and operate two UK EPR™ at HPC.

2.3 Nuclear Safety Case Approval Process

The ‘nuclear safety case’ is a term used to encompass the totality of the documentation developed by a designer, licensee or dutyholder to demonstrate the design meets relevant safety assessment criteria and that the risks are As Low as Reasonably Practicable (ALARP). Paragraph 86 in the ONRs Safety Assessment Principles (SAPs) states that:

> *"A safety case is a logical and hierarchical set of documents that describes risk in terms of the hazards presented by the facility, site and the modes of operation, including potential faults and accidents, and those reasonably practicable measures that need to be implemented to prevent or minimise harm."*

Given their important safety role in the safe shutdown of a nuclear power station, in the event of an emergency situation, the diesels generators are complex electric-mechanical equipment and their qualification in accident conditions must be compliant with a rigorous subset of requirements. As such the diesel generators themselves are required to be 'Nuclear Classified' for use on the UK EPR^{TM} at SZC'.

Nuclear Classification requires any equipment or systems within a nuclear facility that fulfil a nuclear safety function to be suitably and sufficiently assessed to prove that it will deliver this function when required.

There are a number of codes and standards employed for the design and manufacture of nuclear plant. Nuclear construction codes, such as Rules of Design and Construction (RCC) have been developed by the French Society for Design and Construction rules for Nuclear Island Components (AFCEN) in partnership by industry, engineering firms, manufacturers, building control firms and operators. The RCC represents a collection of best practices in accordance with IAEA requirements. There are codes for mechanical equipment (RCC-M) and for electrical equipment (RCC-E) and they are applicable to the design, manufacture and installation of nuclear safety critical components.

RCC-E details a set of requirements and relevant good practices for pressurised water reactor (PWR) design and construction practices related to the electrical and instrumentation and control (I&C) systems and components, and electrical engineering documents dealing with systems, equipment and layout designs. The qualification of equipment and the methodology to be employed in RCC-E is complex, as equipment may well be required to operate in extreme operating conditions (temperature, humidity and Safe Shutdown Earthquake Seismic Loading for example).

In order to ensure that the design and manufacture of the nuclear power station fulfils the RCC-E requirements, EDF have developed a series of Technical Specifications ("Book of Technical Specifications or "BTS") and Technical Rules ("Book of Technical Rules" or "BTR").

In the UK, this process is delivered via a process of Equipment Qualification (EQ), which is a fundamental requirement of the UK's approach to safety assessment for nuclear facilities and differs from other international approaches.

Nuclear technology vendors are required to demonstrate to the ONR that any safety-related and safety-critical equipment used in their reactor designs will function correctly and reliably on demand. EQ is delivered by several different means, these being:

1. Design assurance in accordance with procedures that comply with the requirements of ONR TAG Design Safety Assurance, NS-TAST-GD-057, Revision 6;

2. Procurement of equipment in accordance with procedures that comply with the requirements of ONR TAG Supply Chain Management Arrangements for the Procurement of Nuclear Safety Related Items or Services, NS-TAST-GD-077, Revision 6;

3. Qualification testing of all Safety Related Systems (SRS) and Safety Related Instrumentation (SRI) in accordance with procedures and processes that comply with the requirements of ONR TAG Safety Related Systems & Instrumentation, NS-TAST-GD-031, Revision 6; and,

4. Commissioning (both in factory and at site) in accordance with procedures that comply with the requirements of ONR TAG Control and Instrumentation Aspects of Nuclear Plant Commissioning, NS-TAST-GD-028 Revision 6.

The UKs qualification processes differs from other international regulatory regimes in that it is goal based, where nuclear operators/ site licensees will need to demonstrate that their components and systems will operate safely as intended, not just that they meet the prescribed International Atomic Energy Agency (IAEA) standards. This difference means that any proposed changes to the SRS or SRI will require a full repeat of all aspects of the EQ process. This therefore means that diesel generators that have been approved for use in France (for example) would not be directly available for use in the UK without going through the full EQ process.

The diesel generators for the HPC UK EPR^{TM} have undergone EQ stages 1 - 3, with elements of item 4 commencing as the diesel generators are in the process of being constructed at the site. This process has therefore 'approved' the SRS and SRI for use on both the HPC and SZC UK EPR^{TM}, up to EQ stage 3. At present there are no other diesel generators that are SRS or SRI approved for use on the UK EPR^{TM} within the UKs regulatory environment, given that the GDA and site Pre-Construction Safety Report (PCSR) approval process for the UK EPR^{TM} specifically covers the plant proposed for HPC and SZC only.

As a key safety element any change to the diesel generators, their associated equipment or their building housing would potentially require Category 1 or High Category 2 nuclear safety changes. This would therefore be likely to result in major disruption to the SZC schedule and substantial additional project costs.

The cost of the design and qualification activities contract for all the HPC diesel generators is more than £63 million (further detail provided in Section 3.2.3) and therefore if required again for the SZC site the majority of these costs would again apply, and the process would result in a 12-month delay for the redevelopment and then up to 4 years for requalification.

2.3.1 Diesel Generators

The proposed EDG's from Bouyges (Hyundai Heavy Industries (HHI) Design and Supply) are the largest nuclear qualified EDG's currently available and they have also been qualified for use on the UK EPR^{TM} to be built at SZC. Consequently, any alternative EDGs would need to go through the process of EQ, as described above. As stated previously, although other diesel generators may have been approved for nuclear use in other countries, the regulatory regime in the UK is such that the additional EQ process would need to be completed, therefore incurring the additional cost of this process.

The proposed UDG's from Rolls Royce have also been qualified for use on the UK EPR^{TM} and through this qualification process; consequently, any alternatives would be required to go through the EQ process.

During EQ of both the EDGs and UDGs, numerous and detailed tests are performed to demonstrate conformity with the safety and technical requirements which are nuclear specific and client specific. The EQ process includes two stages:

- The functional qualification to demonstrate the capacity of the generator set to perform its function by meeting the functional specifications; and,
- The seismic qualification to check the capacity of the equipment to remain operational during and after an earthquake.

The related EDF BTR covers the requirements of the diesel generators themselves, and all auxiliary equipment, such as the fuel systems, cooling systems, piping, exhaust systems (such as the stack), the alternator, electrical control and instrumentation (C&I), provisions of the generator building etc. The full design and qualification of the diesel generators therefore includes the following systems and sub-systems:

- Engine/ generator;
- Fuel system;
- Air intake/ filtration;
- Exhaust;
- Cooling;
- Lubrication system;
- Electrical control & instrumentation;
- Operator systems;
- Site electrical architecture (potentially including Grid Code Compliance);
- HVAC systems;
- Site exhaust systems (incl. stacks);

- Diesel fuel handling facilities (incl. fuel farms); and
- Other ancillary supporting systems.

The diesel generators are large pieces of equipment and therefore need specialist testing facilities. Typically, suppliers will have a broad range of international clients lined up for several years ahead, therefore additional tests require significant advance planning and technical preparation. The testing is complex, with specified durations required for different types of tests, some of these are up to 1,000 hours. It is therefore likely that the tests would take a minimum of 18 months to complete, although are more likely to take 4 years. The tests cover the following aspects of the diesel generators:

- Compressed air plant starting systems;
- Alternator stator;
- Alternator auxiliaries;
- Generator sets themselves including:
  - Start tests;
  - Starting tests followed by stable load (50 tests in total);
  - Load pick-up tests;
  - Testing with non-load operation;
  - Sudden discharge test; and
  - Endurance test (100 operations of 10 hours each).

A number of the tests require subsequent equipment disassembly, inspection and technical analysis to inform compliance justifications.

The associated requirements are designed to ensure the diesel generator systems are able to both start and continue running in many adverse condition scenarios e.g. following extreme events that have caused a station trip, with various engine load and operation periods, in the extremes of environmental conditions, accounting for through-life conditions (such as wear over a very long life (60 years)).

All the analysis and design would need to be completed in a manner that is consistent with the overall site safety case and the necessary approvals/ acceptances (incl. regulatory via the ONR) would need to be repeated.

2.3.2 Electrical Systems

Beside the diesel generators there are sub systems (such as electrical C&I) that must be qualified for continued functionality following extreme events. This can require physical testing and highly specialised analysis to determine their durability, in a format that is statistically significant (perhaps many tests, many components) in order to underpin a safety case to the satisfaction of the ONR.

The C&I systems have additional requirements for nuclear installations, particularly the requirement for SMART devices (sensors, programmable logic controller (PLC), controllers, logic, instrumentation) which need to be proven to be safe, secure and reliable above and beyond what is required for any other purpose the diesel generators may be used for.

These are essential to enable the diesel generators to start when required (i.e. in an emergency). The EDG system is designed with analogue controls specifically to avoid this complexity. The UDGs uses RR proprietary SMART devices, and therefore any replacement generators would require a series of SMART device approvals.

Any changes to the PLC's on the diesel generators would need to be reapproved for Nuclear Safety, unless the manufacturer is using one already approved, and any software would need to be full tested and approved, adding addition time and cost.

2.3.3 Generator Buildings

The proposed diesel generators will be housed within bespoke buildings. The current diesel generator building layouts are densely packed with very little room for equipment modification and they need to allow enough space to maintain the diesel generators; this could include full removal and replacement.

At present the site layout currently allows enough space, however with alternative generators there may not be adequate room without the need to re-position other onsite buildings. In addition, there is limited space within the current HPC UK EPR plot plan, which is being replicated for the SZC design, and the areas where the diesel building can be moved are very limited as the diesel generators need to be as close as possible to the turbines and as far as possible from internal and/or external hazards.

If there were any changes to the diesel generators and their bespoke buildings then it would require a full structural and architectural redesign to accommodate the alternatives, which would impact on the structural and seismic design of the buildings. It is considered that this would impact on contracts, schedule, the plot plan as well as the cost and difficulty of the redesign and the relevant nuclear safety approvals. Based on costings that were produced as part of the UK EPR HPC - Combined Deterministic/ Probabilistic assessment of the Turbine Missile hazard, redesign of the diesel generator buildings could result in additional costs in excess of £120 million.

Any changes to the building designs and layouts that impact the external features of the facility will also have an impact on the DCO application, potentially resulting in a DCO variation request which brings with it project delays and increased risks associated with challenge and potentially rejection.

2.4 Hinkley Point C Replication Strategy

Given the costs and timescales involved in the diesel generator qualification process, as outlined in Section 2.3, the diesel generators selected for the SZC site are based on a full replication of the design currently under construction for HPC.

This enables the SZC site to maximise the opportunity to derive value from a ‘Second of a Kind’ (SOAK) development, reusing the detailed design and adopting a systematic approach to capturing, quantifying and applying lessons learned. These benefits are not only applicable for the design phase, but will continue to be realised throughout construction, commissioning, operation and decommissioning phases.

In order to realise the benefits of being a SOAK development, all equipment provided for the SZC site has been planned to be an exact replication of the equipment that will be manufactured for HPC. It means that the engineering design works and equipment qualification work will be re-used on SZC and as a result, a high level of cost savings and reduction of the risk on these activities are expected.

The justification for the replication of the HPC design, as far as reasonably practicable, is based on the benefit gained by a stable and mature design, which has been demonstrated as constructible at HPC. Nuclear power stations are very complex with multiple barriers to prevent and minimise radioactive waste generation, abate and treat waste to reduce discharges to the environment and mitigate the probability and consequences of unplanned events. The complex and intricate interrelationship between structures, systems and components (SSC) means that even small changes need to be carefully scrutinised and analysed to ensure that perceived benefits do not have unintended consequences that can outweigh any improvement. This process must also consider the impact of any change if it is inadequately conceived or implemented.

The ONR has recognised that the proposed replication approach may be appropriate regarding the sequence between HPC and SZC for maintaining a high level of safety and considers that there is a safety benefit in the replication. A formal judgement on whether replication is the appropriate approach is expected later this year from the ONR.

Replication of the safety case requirements and ALARP conclusions that apply for HPC are applicable by default to SZC. This is particularly important in relation to the diesel generators which are required to be safety classified systems and have been selected to ensure that they (and all their associated equipment) can meet the probability of failure on demand/ reliability rates rather than bespoke systems that have not been previously substantiated or proven to meet the required strict safety requirements.

It is difficult to estimate the potential costs involved should alternative diesel generators be required for the SZC site, given the complexity of the design and qualification process the potential for Category 1 or high Category 2 nuclear safety changes, and that the conclusions that risks are ALARP for alternative diesel generators. A conservative assumption on the cost savings involved considers that if replication for the diesel generators is achieved on SZC, savings of between £39 - £45 million (see Table 3.2) are expected compared to the HPC actual costs of more than £63 million. This cost saving is conservative as it is only concerned with the design and qualification process of the diesel generators themselves. It does not take into account:

- Redesign of the diesel generator buildings;
- Redesign of the site layout;
- Redesign of the site electrical distribution network;
- Revisions to relevant nuclear safety approvals; and
- Variations to the DCO resulting from potential changes to the site layout.

As such, requiring alternative diesel generators to be used, is estimated could cost up to £200 million, and therefore would potentially make the whole SZC project unviable as it would no longer provide the benefits of being a SOAK project.

3. BAT Options for Assessment

For the purpose of the assessment, two options have been considered for the diesel generators for the SZC site, these are:

- **Option 1**: Proposed Diesel Generators – NO_x emissions in excess of the TA Luft 2g Standard; and
- **Option 2**: Diesel Generators with NOx emissions at the TA Luft 2g Standard.

3.1 Option 1 – Proposed Diesel Generators

3.1.1 NO_x Emissions

The emissions from the proposed diesel generators, compared to the TA Luft emissions are show in Table 3.1.

Table 3.1: Current Proposed Diesel Generators Against the TA Luft 2g Standard

Emission	TA Luft 2g Standard Emission Concentration mg/Nm^3 (Option2)	Proposed EDGs Emission Concentration mg/Nm^3 (Option 1)	Proposed UDG Emission Concentration mg/Nm^3 (Option 1)
Oxides of nitrogen (NOx)	740	1,918	1,143
Carbon Monoxide (CO)	240	150	194
Particulates	50	50	6.4
Hydrocarbons	55	TBC	TBC

All emissions provided at 15% O_2.

It can be seen in Table 3.1, that the emission concentrations of NOx from the proposed diesel generators are more than twice those of the TA Luft 2g standard for the proposed EDGs, and one and a half times those of the of the TA Luft 2g standard for the proposed UDGs.

All other emissions are within the TA Luft 2g standard, the remainder of the assessment therefore considered NOx emissions only.

3.1.2 Feasibility

As detailed in Section 2, the use of the proposed diesel generators enables all the discussed benefits of replicating the HPC design. Option 1 therefore is considered the most feasible option for the SZC site, as no timely or costly re-qualification process would be required for alternative diesel generators.

The proposed diesel generators have already been qualified to meet the stringent nuclear safety case requirements, required by the UK EPR™ and all associated equipment and buildings have been specifically designed to house the proposed generators, and to be fit for purpose.

3.1.3 Costs

As the proposed generators have already been qualified for their intended nuclear safety case purpose, there are no costs associated with Option 1.

3.2 Option 2 - Diesel Generators with NOx emissions at the TA Luft 2g Standard

3.2.1 NO_x Emissions

For the purpose of the assessment, it has been assumed that alternative suitably sized diesel generators that can comply with the TA Luft 2g standard (NOx emissions of 740mg/Nm^3), can be sourced, however it is not known whether this is actually the case.

3.2.2 Feasibility

As discussed in Section 2, the diesel generators need to be compliant with stringent nuclear-specific and client/ location specific requirements. The proposed diesel generators are the only diesel generators that have gone through the UK's EQ process and been qualified for the UK EPR™ plant that has GDA approval.

As such, an initial phase of potential supplier engagement would be required to identify whether suitable alternative diesel generators are available, it is likely that this could take up to one year to complete. If a suitable alternative is identified, and even if they have nuclear approval in another country, detailed design and the UK EQ process would still need to be carried out, and it is anticipated that this could take up to a further four years to complete. It would require detailed technical studies to balance many factors within the expert domains of diesel generators, electrical architecture, civil building design, mechanical and electrical system engineering and operations/ maintenance. It would in parallel need detailed nuclear safety studies to determine the impacts on safety cases and regulatory approvals.

As well as the diesel generators themselves, the associated electrical systems (including the entire power station electrical distribution network), fuel systems and buildings would also require redesigning to accommodate alternative diesel generators, as described in the relevant sub-sections of Section 2.3. This would therefore result in a substantial project delays, of potentially up to 4 years and increase of project costs and risks.

Any changes to the current design could potentially require Category 1 or High Category 2 nuclear safety changes. This would be likely to result in major disruption to the SZC schedule and substantial additional project costs. It may also impact the DCO process, again resulting in further delays and added cost to the project. It is considered that the project delays and additional costs involved would basically make the project unviable, as it would no longer provide the benefits of a SOAK project.

3.2.3 Costs

The cost of design and qualification process for alternative diesel generators are considerable, therefore the benefits of replicating the HPC design results in significant savings. The current SZC assumptions consider that if replication is achieved, savings of between £39 - to £45 million are expected compared to the HPC actual costs (£63 million). The breakdown of cost savings is shown in Table 3.2.

Table 3.2: Costs of Diesel Generator Qualification Process

Design Element	HPC Costs (£k) (Jul-20)	Package specific SZC % Targets		Savings range (£k)		Comments
		Low	High	Low	High	
Studies and design	£31,450	70%	80%	£22,020	£25,160	Design not fully mature on HPC, expected to be finished in 2021. Savings based on replication of 100% of the design. Savings unlikely to be 100% due to some documentation to evidence final replication (substantiation notes).
Qualification process	£20,380	80%	90%	£16,310	£18,340	High savings in this element, HPC suggests 100% savings, however some documentation to evidence final replication (substantiation notes) are required from the supplier. Overall, 80-90% savings envisaged for this element.
Project management	£11,300	5%	15%	£565	£1,690	Savings of 5-15% based on the value of Studies and Design as a rough % of the contract value and considering the savings range for Studies and Design.
Total	**£63,130,000**			**£38,895,000**	**£45,190,000**	

As stated earlier, it is considered that this is a very conservative assumption on the additional costs involved, as it does not take into account any of the following that could also be required:

- Redesign of the diesel generator buildings;
- Redesign of the site layout;
- Redesign of the site electrical distribution network;
- Revisions to relevant nuclear safety approvals; and
- Variations to the DCO resulting from potential changes to the site layout.

For the purpose of a conservative assessment, the lowest possible cost saving of £38.9 million from Table 3.2 has been applied in the assessment. It is considered the use of this cost is very conservative as actual costs are likely to be significantly higher than this, potentially up to £200 million, however if using the lowest possible cost results in the assessment concluding that the proposed diesel generators represent BAT, then this conclusion will only be strengthened if costs are higher.

4. Basic Evaluation of Options

An initial basic evaluation of the available options has been carried out. The assessment needs to determine whether the reduced emissions achieved by Option 2 outweighs the costs associated with qualifying alternative diesel generators.

4.1 Option 1 - Proposed Diesel Generators

For the purpose of the assessment, this Option is considered as the "Business as Usual" (BAU) case and the "Proposed Derogation" case.

4.1.1 Emissions

The annual average NO_x emissions for the proposed diesel generators are 1,918mg/Nm^3 for the EDGs and 1,143mg/Nm^3 for the UDGs, and therefore are not compliant with the TA Luft 2g standard. Testing of the proposed diesel generators on the Hinkley Point C site has indicated that the actual emissions from the UDGs are likely to be lower than those indicated above, although they are still in excess of the TA Luft 2g standard. The actual emissions performance will be known once the HPC units are commissioned and operating and could therefore result in emissions lower than those presented in this assessment.

The two years of commissioning carried out on the diesel generators will result in a total of 4,892 hours of operation, and the annual NOx release during this time has been calculated. The annual NOx release during the operational phase has been based on an assumed 60 hours operation per generator per year, however it is considered that actual plant testing hours could be lower than this. This data has been used to calculate the annual mass emission of NOx from the diesel generators and is shown in Table 4.1.

Table 4.1: Option 1 - Calculation of the Annual NOx Mass Emission from the Diesel Generators

				Commissioning			Operation		
DG	Total Number of Engines	NOx Emission Conc^n (mg/Nm^3)	Emission Rate[1] (Kg/hr)	Hours per engine	Total Hours for all Engines	Total Emissions (Te)[2]	Annual Hours per engine	Total Annual Hours for all Engines	Total Annual Emissions (Te)
UDG	4	1,143	15	738	2,952	46	60	240	4
EDG	8	1,918	110	242.5	1,940	214	60	480	53
Total	**12**	**-**	**-**	**-**	**4,892**	**260**			**57**

[1] Per engine
[2] Over two-year commissioning period.

Annual NO_x releases of up to 130 tonnes per year for two years during the commissioning phase are expected and 57 tonnes per year during the operational phase of the SZC site.

For the purpose of the assessment, it has been assumed that commissioning will commence in 2032, with routine operation therefore commencing in 2034. It has been assumed that the diesel generators will operate for a total of 60 years. The total NOx emissions over the lifetime of the plant will therefore be in the region of 3,548 tonnes.

4.1.2 Damage Costs

The Department for Environment, Food and Rural Affairs (Defra) have developed 'damage costs' to enable proportionate analysis when assessing relatively impacts on air quality. Damage costs are a set of impact values, measured per tonne of emission of different pollutants, which estimates the societal costs associated with changes in pollutant emissions.

The damage costs that have been applied to the NOx emissions have been derived from the Defra Air Quality Appraisal: Damage Cost Guidance[5]. The guidance details relevant damage costs based on the sector, the source of the emission and the location.

The SZC Combustion Activities Environmental Permit covers a Part A process (i.e. a 'large industrial process' regulated by the Environmental Permitting Regulations), with the emissions being released via stacks that are <50m tall.

East Suffolk Council website states that the population of the borough is 246,913 and the borough covers an area of 1,262 km^2, as such the average population density is 196 people per km^2. The relevant damage cost category from Table 2 within the Damage Cost Guidance is therefore Category 1 (i.e. Stack Height < = 50m and all small points, average population density < = 250 km^2).

The 2020 Category 1 central damage costs for NOx (at 2017 prices) is £1,512 per tonne of NOx. Damage costs need to be adjusted to the new price base using Gross Domestic Product (GDP) deflators[6] to the base year for the assessment (i.e.2021), equalling £1,633 per tonne of NOx.

Solely based on the base year value of £1,633 per tonne of NOx, the damage costs of 3,548 tonnes of NOx being released over the 60-year lifetime of the diesel generators would be £5,793,340.

4.1.3 Costs

There are no costs associated with this option, as the qualification process has already been carried out for the HPC site.

4.2 Option 2 - Diesel Generators with NOx emissions at the TA Luft 2g Standard

For the purpose of the assessment, this Option is considered as the "BAT" case.

4.2.1 Emissions

As per Option 1, the two years of commissioning carried out on the diesel generators will result in a total of 4,892 hours of operation. The annual NO_x release during the operational phase has been based on an assumed 60 hours operation per year. This data has been used to calculate the annual mass emission of NOx from the alternative diesel generators and is shown in Table 4.2.

Table 4.2: Option 2 - Calculation of the Annual NOx Mass Emission from the Diesel Generators

				Commissioning			Operation		
DG	Total Number of Engines	NOx Emission Concn (mg/Nm³)	Emission Rate[1] (Kg/hr)	Hours per engine	Total Hours for all Engines	Total Emissions (Te)[2]	Annual Hours per engine	Total Annual Hours for all Engines	Total Annual Emissions (Te)
UDG	4	740	10	738	2,952	30	60	240	2
EDG	8	740	43	242.5	1,940	84	60	480	21
Total	**12**	**-**	**-**	**-**	**4,892**	**114**			**23**

[1] Per engine
[2] Over two-year commissioning period.

[5] Available at: https://www.gov.uk/government/publications/assess-the-impact-of-air-quality/air-quality-appraisal-damage-cost-guidance accessed 7th May 2021.
[6] Available at: TAG Data Book - GOV.UK (www.gov.uk) accessed 7th May 2021

This results in an annual NOx release of up to 57 tonnes per year for two years during the commissioning phase and 23 tonnes per year during the operational phase of the SZC site. This more than halves the annual mass emission of NOx from the site over Option 1.

Over a 60-year lifetime, the total NOx release from the alternative diesel generators would be 1,457 tones, a reduction of 2,092 tonnes over the proposed diesel generators.

4.2.2 Damage Costs

At the central damage costs for NOx of £1,633 per tonne the total damage costs of 1,457 tonnes of NOx being released would therefore be £2,378,181. This therefore represents a difference of £3,415,160 in the damage costs between the two options.

4.2.3 Costs

As detailed in Table 3.2 above, the anticipated costs for the re-qualification of alternative diesel generators has been estimated to be a minimum of £38.9 million.

4.3 Summary of Available Options

A summary of the total emissions and costs for the two options assessed is provided in Table 4.3.

Table 4.3: Options Summary

Option	NOx ELV mg/m^3	Emissions (Tonnes/ Year)	Damage Costs (£/Year)	Total Damage Costs	Qualification Costs
		NO_x	NO_x	£	£
Option 1 – Proposed Diesel Generators	1,143 / 1,918	130 commissioning 57 routine	£212,290 commissioning £93,081 routine	£5,793,340	£0
Option 2 – Alternative Diesel Generators (TA Luft 2g)	740	57 commissioning 23 routine	£93,081 commissioning £37,559 routine	£2,378,181	£38,900,000
Difference				**£3,415,160**	**£38,900,000**

Table 4.3 therefore demonstrates that the reduction in the damage costs between the two options of £3,415,160 is grossly disproportionate to the associated minimum cost of £38.9 million for sourcing and qualifying alternative diesel generators. If the actual costs of alternative diesel generators is higher, as anticipated, this conclusion is strengthened further.

5. Cost Benefit Assessment

Central to the principle of the IED, is the requirement on operators to take appropriate preventative measures against pollution through the application of BAT. The definition of BAT includes the use of technological (and managerial) measures, which are developed on a scale suitable for implementation under economically and technically viable conditions, to achieve a high level of environmental protection as a whole.

A detailed review of the options to achieve BAT, incorporating the costs and benefits (both environmental and fiscal) can then determine the most appropriate technique to apply at the specific facility.

5.1 Discounted Cash Flow Analysis

An assessment of the costs associated with each of the options using a Discounted Cash Flow (DCF) analysis technique is the recommended assessment method for consideration of BAT.

A DCF has been prepared using the EA's Industrial Emissions Directive Cost-Benefit Assessment (IED CBA) Tool. The CBA tool used for the assessment was obtained from the EA website[7] and is the BETA Version of the tool, which was updated in May 2020 with the revised air quality damage costs.

Whilst it is recognised that this version of the tool is still under development, it was considered appropriate for use, due to the tool containing the revised damage costs, rather than using the earlier version of the tool (Version 6.17, September 2017) which contains damage costs from 2013. The CBA tool has been provided in excel format together with this report.

The CBA tool utilises a method developed within the UK to allow a full CBA using capital and operating costs for the site options and the cost 'savings' (or benefits) of the reduced pollution emissions. The tool incorporates the cost of accessing financial capital into the calculations, but this is discounted using the social discount rate. The cost of capital calculation is carried out by the "Payment (PMT) function" in Excel, which is designed for a slightly different purpose but works well in this case. The PMT function calculates the constant periodic payment needed to pay off an investment given a particular interest rate and a particular time period in which to pay off that investment.

For each option the tool takes the investment as the initial upfront investment, the interest rate as the central weighted average cost of capital (WACC) percentage entered into the tool, and the length of the investment as the length of the appraisal.

The tool allows the user to enter identified costs of each proposed option (for example, capital project costs, operational costs, and associated additional emissions) and benefits (for example, the welfare value of emissions removed) across the lifetime of the equipment. Cost and benefits reflect 'additional' costs and benefits of each option. This produces an overall Net Present Value (NPV) for each option, compared against the presented derogation option. Options are then ranked to show an overall preferred option.

5.1.1 CBA Assessment

The various aspects taken into consideration for the analysis are as follows:

- Costs for requalification of alternative diesel generators; and
- Emissions of NO_x.

The period of assessment has been assumed to be 60 years reflecting the planned lifetime of the diesel generators.

[7] Available at: https://www.gov.uk/government/publications/industrial-emissions-directive-derogation-cost-benefit-analysis-tool accessed 7th May 2021.

A summary of the outcome of the CBA Tool is presented in Table 5.1. This compares the cost and benefits of both Options. A positive Net Present Value (NPV) indicates that the benefits exceed the costs, whilst a negative NPV demonstrates that the costs outweigh the benefits. The basis of the calculation, using the UK's Environment Agency's IED Cost Benefit Analysis Tool is presented in Appendix A.

Table 5.1: Cost/Benefit Assessment of Options (Comparison made to Option 1)

Option	Annual Average NO_x (mg/Nm^3)	Annual NO_x release (T/yr)	Upfront Investment Costs (£m)	Air Pollutant Emissions (£m)	PV Costs (£m)	PV Benefits (£m)	NPV (£m)	Ranking based on NPV
Business as Usual / Proposed Derogation **Option 1** – Proposed Diesel Generators	1,143 / 1,918	130/ 57	-	3.6	-	-	-	1
BAT-AEL **Option 2** –TA-Luft Diesel Generators	740	57/ 23	63.7	1.5	66.1	2.1	-64	2

The CBA output demonstrates that Option 2 results in a disproportionate cost to the value of nearly £64 million when considering the environmental benefit gained from NO_x removal achieved over Option 1. This is due to the costs associated with qualifying alternate plant, and the relatively low annual mass emissions from the diesel generators overall, given the low number of operational hours proposed.

It can be therefore be demonstrated that Option 1 – Proposed Diesel Generators represents the preferred Option, despite the higher potential NO_x release, against the implementation of Option 2 which would achieve the TA Luft 2g standard. If the actual costs of alternative diesel generators is higher, as anticipated, this conclusion is strengthened further.

6. Other Considerations

6.1 Environmental Impacts of NO_x Emissions of Local Air Quality

Although not explicitly considered in the CBA assessment above, consideration is given here to the predicted impacts of the NO_x emissions from the different options on local air quality. The Schedule 5 requested noted the need to minimise emissions as far as practicable and ensure that there are no breaches of Air Quality Standards (AQS), as detailed in Article 18 of the IED. Article 18 states:

> *"Where an environmental quality standard requires stricter conditions that those achievable by the use of best available techniques, additional measures shall be included in the permit, without prejudice to other measures which may be taken to comply with environmental quality standards."*

The EP application and the DCO submission both included an air quality assessment which considered NO_x emissions of the proposed diesel generators (i.e. demonstrative of the impacts associated with Option 1 in this assessment), however the impacts of diesel generators with lower emissions were not considered. Consideration of the impacts from both options is presented in the sections below.

6.1.1 Option 1 – Proposed Diesel Generators Associated Environmental Impacts

The impacts of the proposed diesel generators were assessed for the commissioning scenario, the routine operational scenario and the LOOP scenario.

<u>Commissioning</u>

The maximum predicted annual average process contribution (PC) for NO_2 at any receptor during the commissioning scenario modelled was 0.6µg/m^3. This PC represents 1% of the relevant AQS objective and therefore can be considered insignificant in accordance with the EA's screening criteria. When the PC is added to the local pollutant concentration of 5.9µg/m^3 it results in a PEC of 6.5µg/m^3, representing 16% of the AQS objective. No breaches of the annual average AQS are therefore predicted for the commissioning scenario.

Maximum hourly predicted NO_2 PCs (as the 99.79th percentile of hourly averages) for the commissioning scenario were estimated to be a maximum of 85% of the AQS at one receptor location, all other receptors experienced significantly lower impacts. When the PC is compared to the AQS minus twice the long-term background concentration it represents 91% of the AQS. Given that the standard applies to the 99.79th percentile of hourly averages, 18 exceedances of the standard can occur before the standard is actually breached, therefore as no breaches are predicted at all for the commissioning period, it is considered highly unlikely that this could actually occur.

<u>Operation</u>

During routine operation, the maximum annual average PC predicted for NO_2 at any receptor was 0.2µg/m^3, and therefore lower than the impacts predicted for the commissioning period. No breaches of the annual average AQS are therefore predicted for the routine operational scenario.

Maximum hourly predicted NO_2 PCs (as the 99.79th percentile of hourly averages) during the routine operating scenario is estimated to be a maximum of 21% of the AQS. When the PC is compared to the AQS minus twice the long-term background concentration it represents 22% of the AQS and therefore indicates that an exceedance of the hourly AQS during routine testing activities is extremely unlikely.

<u>LOOP</u>

As a LOOP event would be short in duration, only short-term impacts have been assessed. Exceedances were predicted for two receptor locations, however it is considered extremely unlikely that these exceedances would actually occur given:

- The very low probability of a long LOOP event (2 – 24 hours) actually occurring (predicted to be once in the lifetime of a fleet of nuclear sites);
- The low probability of a short LOOP event (<2 hours) actually occurring (a limited number of times during the lifetime of SZC); and
- The LOOP event would need to occur for 18 hours for there to be an actual exceedance and occur at the same time as the unfavourable meteorological conditions that result in the exceedance.

It is therefore considered that an exceedance of the hourly AQS would be extremely unlikely.

Ecological Impacts

The annual average NOx critical level is not predicted to be exceeded at any habitat site during commissioning or routine testing.

Although exceedances of the daily critical level are predicted at six habitat sites (Minsmere - Walberswick Heaths and Marshes[8] SAC, SPA, Ramsar and SSSI, Sizewell Marshes SSSI, Suffolk Beaches CWS, Reckham Pits Wood CWS, Sizewell Levels CWS and Minsmere South Levels CWS), it is considered that the assessment is very conservative as it is unlikely that any diesel generators would be operational for a period of 24 hours at any time.

Although depositional impacts at the majority of habitat sites can be screened as insignificant, there are a number of sites where this is not possible, and background deposition is already exceeding the relevant site critical loads. Again, the assessment presented for the Environmental Permit application is considered very conservative and actual impacts are likely to be significantly lower. Further assessment of the depositional impacts has been carried out and the results provided in a further Schedule 5 response (Question 2 – Air Quality Assessment). This concluded that the impacts were insignificant at all but one County Wildlife Site receptor, however further information on the sensitivity of the receptor indicates that depositional impacts would be unlikely to affect the receptor.

The conclusions of the additional assessment for the Schedule 5 response (Question 2 – Air Quality Assessment) indicate that it is unlikely that routine operation of the diesel generators will result in impacts arising from deposition of nitrogen or acidifying species.

6.1.2 Option 2 - Associated Environmental Impacts

As the impacts at human health receptors indicated that no exceedance are likely to occur as a result of the proposed diesel generators, then this would also be the case for alternative generators with lower emissions.

In terms of the ecological impacts, TA Luft 2g compliant diesel generators would still result in exceedances up to 200% of the daily average NOx critical level at three habitat sites (Minsmere - Walberswick Heaths and Marshes SAC, SPA, Ramsar and SSSI, Sizewell Marshes SSSI and Sizewell Levels CWS) when assessed in the same way as the current diesel generators.

There is therefore no change in conclusions on the significance of any air quality effect as a result of the use of TA Luft 2g compliant diesel generators.

6.2 National Emissions Ceiling Directive - NECD

The revised NECD (2016/2284/EU), which entered into force on 31st December 2016, set new emission reduction commitments for each Member State for the total emissions of NO_x, oxides of sulphur, non-methane volatile organic compounds, ammonia and particulate matter (less than 2.5μm in diameter).

The NECD has been transcribed into UK regulations in the National Emissions Ceiling Regulations 2018 (S.I 2018 No. 129). The reduction commitments for the UK are to reduce annual emissions from

[8] SAC = Special Area of Conservation, SPA = Special Protection Area, SSSI = Site of Scientific Interest, CWS = County Wildlife Site

a 2005 baseline of 1,728 kilotonnes by 55% by 2030 (i.e. 778 kilotonnes), and by 73% from 2030 (i.e. 467 kilotonnes).

The routine operation of the proposed diesel generators would result in maximum annual emission of 57 tonnes per year. By 2030 this represents 0.01% of the NECD for the UK. The annual emissions from diesel generators that would be TA Luft compliant would represent 0.005% of the NECD target for 2030.

Given these very low values, it is considered that the NO_x emissions from the SZC site will have a limited impact on the UK's overall NO_x emissions, and minimal impact on the UK's ability to remain below the NECD emission ceiling whichever diesel generators were installed on site.

6.3 Alternative Diesel Generators within the UK Fleet

SZC has carried out a review of diesel generators within the UK Nuclear Fleet, in order to compare the emissions from the proposed diesel generators for the SZC site, with those employed at other locations. This data is provided in Table 6.1.

Table 6.1: Summary of UK Nuclear DG Fleet NOx Emissions

Diesel Generators	Engine Type	Thermal Input (MWth)	Other Info	NO_x (mg/Nm^3)
Proposed SZC DGs				
SZC EDGs	Hyundai Heavy Industries Diesel Generators	23	Proposed ELV	1,918
SZC UDGs	MTU Diesel Generators	10.5	Proposed ELV	1,143
Alternative Generators				
Sizewell B (SZB) EDGs	Rolls Royce Mirlees Diesel Generators	23.5	Permitted ELV	1,800
			Actual monitored	1,261
Sizewell B (SZB) Battery Charging Diesel Generators	CAT Prime Diesel Generators	2.7	Permitted ELV	No Limit Set
			Actual monitored	1832
Dungeness Power Station (DNB) EDGs	Ruston Diesel Generators	9.2	Permitted ELV	No limits set
			Reported in Permit Application	2,300
			Actual monitored	1,544
Torness Power Station (TOR) EDGs	X-train Mirrlees type KV12 Diesel Generators	14.4	Permitted ELV	1,800
			Actual monitored	1,571
	Y-train Mirrlees type KV16 Diesel Generators	18.6	Permitted ELV	1,800
			Actual monitored	1,767
Heysham B Power Station (HYB) EDGs	X-train Mirrlees type KV12 Diesel Generators	13.7	Permitted ELV	2,500
			Actual monitored	1,981

Diesel Generators	Engine Type	Thermal Input (MWth)	Other Info	NO_X (mg/Nm^3)
	Y-train Mirrlees type KV16 Diesel Generators	17.3	Permitted ELV	2,500
			Actual monitored	2,462

Note: Where multiple engines have been monitored, or where monitoring data has been provided for multiple years, the highest of all results reported has been shown in the table.

It can be seen in Table 6.1 that the EDGs employed at the SZB sand TOR sites have a similar NOx emission ELV to the proposed EDGs for the SZC site, however it should be noted that the actual monitored emissions are below the ELV. It is anticipated that this will also be the case for the proposed SZC generators, however until the proposed DGs are fully commissioned at HPC, this cannot be confirmed.

Table 6.2 provides a visual summary of all the points considered in the assessment carried out.

Table 6.2: Visual Summary of the Assessment

	Feasibility	Emissions (mg/Nm^3)				Costs £ million			Impact		
Options	**Qualified for use within UK EPR**	**NOx**	**CO**	**Particulate Matter**	**Hydrocarbon**	**Qualification Process**	**Total Damage Costs**	**NPV**	**Ecological Impacts**	**Human Impact**	**Impact on NECD**
Option 1: Proposed EDGs	Yes	1,918	150	50	TBC	0	£5.8	-	Largely insignificant, although high daily NOx	Insignificant	0.01%
Option 1: Proposed UDGs	Yes	1,143	194	6.4	TBC						
Option 2: Diesel Generators with NOx emissions at the TA Luft 2g Standard	No	740	240	50	50	£38.9 - £45.2	£2.4	£64	Largely insignificant, although high daily NOx	Insignificant	0.005%

7. Conclusions

AECOM has been commissioned by SZC Co. to undertake an assessment of the application of BAT for the managment of NO_x from the proposed diesel generators at the SZC site.

A BAT assessment and CBA has been carried out in order to identify the BAT option for the diesel generators, in terms of the benefits of diesel generators with lower NOx emissions, against the proposed diesel generators that have already been approved for use.

The BAT assessment and CBA tool have been completed based on data provided by the technology providers and the project engineers.

The CBA demonstrates that Option 2 (alternative diesel generators that could achieve the TA Luft 2g standard) shows a disproportionate cost when considering the environmental benefit gained from NO_x removal achieved over Option 1 (proposed diesel generators). This is due to the additional CAPEX involved with the redesign and qualification process that would be required to replace the proposed diesel generators.

In addition, brief consideration of the local environmental impacts of Option 1 and Option 2 in terms of NOx emissions against AQS objectives, Critical Levels and Critical Loads has been carried out. It is considered that the impacts associated with Option 1 are unlikely to result in an exceedance of the AQS objectives and although alternative lower emission diesel generators may reduce impacts at ecological sites, they may still result in potential exceedances of the daily critical level. There is therefore no change in conclusions on the significance of any air quality effect as a result of the use of TA Luft 2g compliant diesel generators.

Finally, consideration of the NECD has been carried out, and it is considered that compared to the UK's ceiling targets, the emissions from the proposed diesel generators are unlikely to have any impact on the UK's ability to comply with the Directive and therefore this does not impact upon the preferred Option.

It is therefore considered that Option 1 – Proposed Diesel Generators represents BAT for the SZC site.

Appendix A – CBA Tool

Electronic spreadsheet.

aecom.com