EDF Energy Response

Consultation on PFAS Restrictions proposed by ECHA

September 2023
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Issue 01

Contents

1. Introduction

EDF has built an important role in the UK energy market since the early 2000s through the ownership of major generating assets and providing electricity to millions of homes. Today, EDF is the UK's largest producer of low carbon electricity. EDF operates low carbon nuclear power stations and is building the first of a new generation of nuclear plants. EDF is also one of the UK's leading renewable energy companies, specialising in wind power, solar and battery storage technology.

Our role in delivering and operating new clean energy generation across Europe is more critical than ever as the UK and its European partners transition their energy use away from fossil fuels. Low-carbon power generation will be an essential component in reaching the ambitious Climate Neutral and Net Zero targets set by European nations. The crisis in Ukraine has added further pressure to energy networks across Europe, with capacity challenges being faced by leading European nations.

With such a wide range of existing generating sites and new clean energy projects under development, the proposed restrictions on the production, sale and use of PFAS products would have far-reaching impacts to EDF. This paper provides an initial response on behalf of EDF's UK Nuclear business only. There are significant risks of the PFAS regulation to EDF Renewables' projects, including wind, solar and battery storage. These risks are being set out by European trade associations.

The ECHA consultation on PFAS is directly relevant to EDF's UK Nuclear business (hereafter referred to as 'EDF Energy'), due to our use of EU suppliers of various systems, components and consumables. The introduction of EU legislation to restrict the production and sale of PFAS could therefore impact our UK operations. It is acknowledged that legislation on restrictions to the 'use' of PFAS-containing products would not necessarily apply to EDF Energy. However, we have included comments on the proposed restricted use as it may help to build ECHA's understanding of implications for the EU's nuclear power plants.

2. Overview of EDF Response

EDF Energy are providing a high-level response to the proposed restrictions, with the objective of helping to build a shared understanding of the implications for nuclear power plants. We note that ECHA had indicated that the information and evidence relating to the energy sector was not particularly strong; we hope to address this in part. However, for reasons outlined below, EDF Energy are not currently able to provide detailed evidence on quantities relating to specific PFAS use and emissions.

EDF Energy are an 'end-user' of PFAS products. Whilst we have an awareness of products and components that are very likely to contain PFAS, we note that PFAS quantities are not always labelled or clearly stated in datasheets. We have undertaken initial activities to identify PFAS-containing products through keyword searches of our product databases and through selective reviews of safety systems. This response presents what we have learnt to date; it represents the beginning of what is expected to be a long-term activity to fully understand the implications to EDF Energy's nuclear fleet and future nuclear projects.

Our work to date has been structured into the following topics:

1) HVACR (including refrigerants, filters and other components)
2) Elastomers (focussing on seals)
3) Thermoplastics (focussing on gaskets)
4) Waste management
5) Spares
6) Nuclear New Build

A dedicated appendix on each of the six topics listed above is included, articulating the impact to our business operations from the proposed PFAS restriction. Ahead of these appendices, we have also included a section that outlines relevant characteristics of nuclear power plants that explain the requirement for using PFAS, plus a summary of our main comments.

We note that nuclear power plants would be directly affected by any adverse impacts to the manufacturing and supply of nuclear fuel. The challenges to the nuclear fuel sector have been captured within submissions by relevant nuclear fuel companies and trade associations (e.g. Nucleareurope). This EDF Energy response therefore does not include any discussion on nuclear fuel.

3. Characteristics of Nuclear Power Plants

The points listed below provide some introductory information on Nuclear Power Plants (NPPs)[1] that provides important context to subsequent discussion on the implications of PFAS restrictions. We hope this provides useful context for readers that are not familiar with NPPs.

1. NPPs are thermal generation plants, utilising the energy released from controlled nuclear reactions to produce steam. This steam is typically used to drive a turbine-generator, which generates electricity.
2. Studies have shown that the carbon emissions from nuclear power are lower than (but comparable to) renewables, and significantly lower than fossil-fuel plants. Various European nations have set out their intention to construct new NPPs as part of their efforts to decarbonise their electricity networks and heavy industry.
3. NPPs harness this incredible energy source by utilising technologies that contain many moving parts, some of which operate within harsh conditions. These conditions include high temperatures, pressures, radiation and interfaces with corrosive substances. This operational environment will have driven a need for components and materials that exert high durability over extended periods.
4. There is typically an expectation for long lifetimes of plant items, with most modern NPPs targeting 60 years of operation and beyond. NPPs will shutdown for short periods (i.e. days or weeks) throughout its operational life to undertake refuelling and essential maintenance before returning to full power for longer periods of operation.
5. As part of continued safe operations of NPPs, operators such as EDF Energy must have very high confidence in the ability of structures, systems and components to perform their claimed functions. This often involves undertaking a programme of 'qualification' on safety critical components. A qualification programme is often a lengthy process that involves running various testing and analysis of how the component performs in the range of expected operational conditions.
6. Radiological hazards are present on site, which operators are very experienced in managing safely. Our over-arching safety principles drive us to minimise the risk of exposure to operators by avoiding, or minimising, modifications and additional maintenance to plant wherever possible.
7. The nuclear sector is heavily regulated. There are various mandatory licensing and permitting processes associated with NPPs, which will vary between countries but will align with common international safety standards. These stringent regulations drive detailed, risk-based consideration of materials selection and provide strict controls on waste disposal.
8. The construction of new NPPs are long-term projects, which require significant quantities of construction materials, working fluids, cabling and equipment. The plant will ultimately deliver substantial volumes of reliable low-carbon heat and power, resulting in the consumption of comparatively small amounts of natural resources per TWh of electricity generated.
9. At the end of the operational lifetime of a NPP, it will enter defueling and decommissioning phases. There are varying strategies to decommissioning NPPs, typically defined by the pace at which the dismantling and demolition activities proceed at. Where practicable and safe to do so, modern decommissioning strategies will often seek to recover and re-use materials, minimising quantities sent for final disposal.

1 This position paper considers the impact to the EDF UK nuclear fleet, with the term NPP referring to both generating and shutdown nuclear power plants. EDF currently operates 5 generation nuclear power plants, with 3 former power stations having ceased generation. There are wider implications to the nuclear and radiological facilities that need to be considered, for example to uranium enrichment and waste treatment & disposal facilities.

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4. Key Discussion Points and Recommendations

General Comments

1. EDF Energy is supportive of the intent to protect the natural environment and human health through greater restrictions on the manufacturing and use of PFAS. We believe this must be balanced with the critical mission to decarbonise the energy sector, in pursuit of Climate Neutral and Net Zero ambitions. We must identify and avoid unintended consequences to the low-carbon energy sector that could delay our collective efforts to decarbonise.
2. Care must therefore be taken to prevent the inadvertent loss of low-carbon generation from NPPs through either (i) disruption of supply to critical commodities and components from the EU, or (ii) extended outages to modify safety-related systems to accommodate alternative products, that may ultimately result in minimal change to total PFAS emissions.
3. The ECHA proposal on PFAS restriction is expansive, covering a significant quantity of chemical substances that fall within a very broad definition of PFAS. This is proving to be challenging for EDF Energy to meaningfully assess and respond to. A more segregated and phased approach to adopting restrictions would help the quality of assessment and engagement, which then lead to appropriate restrictions being implemented. This would also enable end-users such as EDF Energy to have more meaningful and focussed discussions with its supply chain and how best to manage new restrictions. A segregated approach could focus initially on substances that already have a strong evidence base for unacceptable environmental and health impacts.
4. With respect to the nuclear sector, there is a lack of alternative substances that offer the same essential combination of performance and reliability as PFASs. The incumbent materials have many decades of proven satisfactory performance in demanding, hazardous environments. They would therefore be very difficult to replace. Even if replacement materials could be developed in a timely manner, these would be without the same level of provenance and robust testing, qualification and certification as to existing PFAS materials. As a minimum, an extensive test programme to adequately demonstrate that nuclear safety is maintained could be required.
5. The nuclear sector applies very high safety standards to all processes, procedures and handling arrangements, including sector-specific requirements. These processes ensure that new and used materials do not give risk to exposure to PFAS for either people or the wider environment, for the essential applications that are used. The emissions from NPPs are heavily regulated and only a small proportion of waste from our nuclear sites is disposed to landfill. A ban or any limitations imposed on the use of essential components could adversely impact nuclear safety-significant plant operations and maintenance, without delivering any clear reduction in environmental risk in return.

Derogations and Exemptions

6. There is a general need for increased exemption and derogation for the use of substances containing PFAS where there is an impact to nuclear safety-related plant. This recognises the need to undertake comprehensive qualification testing of alternative products once they have been developed and brought to market by manufacturers. A period of 13.5 years may be appropriate for the development of new products by manufacturers, where no suitable alternative exists, but the derogation period would not accommodate a subsequent qualification programme for nuclear safety applications.
7. Our review to date has identified initial products that could present operational risks if restricted and for which no readily available alternative exists. However, this has not been an exhaustive review across all sites. It is likely that further essential products and components will be identified as our review progresses. The main comments and recommendations on NPP exemptions and derogations to date are listed in the points 8 to 13 below.
8. Derogation 5j states "refrigerants in HVACR-equipment in buildings where national safety standards and building codes prohibit the use of alternatives.". Whilst we agree with the perceived intent of this derogation, the wording might not adequately cover nuclear safety-related buildings. EDF Energy recommend that the derogation should be amended (or a new derogation defined) to explicitly apply the derogation to nuclear facilities, including NPPs.
9. We recommend that 13.5 years would be a better length of time for a derogation associated with HEPA filters used at NPPs. This derogation could be applied to 'media for the use in filtration and separation media used high performance air and liquid applications in radiological facilities and nuclear power plants until 13.5 years after EiF.'

10. EDF Energy request the use of fluorocarbons within nuclear facilities are fully exempted, without time-limitations, from the PFAS restrictions. This recognises the essential role they play in nuclear safety-related and operationally critical systems on NPPs, with no obvious route to replacing them.
11. EDF Energy recommend that the essential use of FVMQ and AFLAS elastomeric seals is derogated for a minimum period of 13.5 years. This recognises the essential role they play in nuclear safety-related and operationally critical systems on NPPs and the time required to develop and qualify suitable alternatives.
12. EDF Energy support the exclusion or full exemption of PTFE for industrial uses from the ECHA restrictions, on the assumption that PTFE remains "of low concern" following the removal of harmful PFAS substances (e.g. PFOA, PFOS) from the manufacturing process.
13. Lubricants used in safety critical systems are likely affected by the proposal, but at this time EDF Energy have not confirmed whether alternatives would be available. As a minimum the 13.5 years derogation for lubricants in 'harsh conditions' would need to apply to NPPs to cover the qualification and implementation of available alternatives.

Restrictions on Use and Spares

14. EDF Energy recommend that NPPs (and other critical low-carbon energy generation sites) are exempt from restrictions on "use" of essential PFAS-containing products in order to ensure security of supply. We would advise that restrictions focus on the manufacturing and sale of PFAS-containing products, and non-essential uses.
15. It is important that planned low-carbon energy projects are protected from the uncertainty of impending legislation, so far as is practicable, and that the benefits from replication and learning between projects can continue to be realised. In support of this, the necessary exemptions and derogations identified for essential uses on NPPs should equally apply to the construction, operation and decommissioning stages of the stations' lifecycle.

Waste Management

16. Recognising that it will be very challenging to undertake substantial sampling and testing of both conventional and radioactive waste types, it will be important for site operators to be able to make risk-based assumptions regarding PFAS content within waste types that do not benefit from historic records or clear product PFAS concentration labelling. The provision of PFAS-related concentrations must be improved (e.g. stated within all data sheets) at the earliest opportunity.
17. Waste management facilities are in the best position to segregate similar types of waste articles that are potentially above or below the PFAS concentration limit. Clear guidance must be provided (and supported by robust evidence) on the types of destruction required, noting the associated higher cost and limited availability of high temperature incineration capacity.
18. Proposed PFAS waste management regulations need to be implemented with full consideration of any implications to radioactive waste management, preventing the creation of "orphan" radioactive wastes and avoiding unnecessary risk from radiological hazards to workers. Detailed guidance and clear governing principles will be needed on the management of PFAS within radioactive waste streams.

Appendix A. HVACR

The following main areas of risk have emerged for the HVACR[2]:

- Refrigerants used within HVACR systems (and non-HVAC refrigeration systems) at stations.
- HEPA Filters and Air Supply Filters
- Components within a HVACR system that have PFAS containing components.

These are discussed within the separate sub-sections below.

A.1 Refrigerants

The EDF Energy nuclear fleet currently utilises HVACR products from EU suppliers. If ECHA PFAS regulations result in the banning of refrigerants currently imported by EDF Energy, the main issues that would arise are:

1. Introducing alternative refrigerants into a NPP is a time-consuming process because of the rigour of the plant modification and qualification processes used to ensure that safety is assured.
2. There is a possibility that in some locations, a change to use non-PFAS containing refrigerant may require plant that is larger (to maintain the same functional performance) than the available space that houses the existing plant.
3. In scenarios where it is physically possible to replace the HVACR plant to accommodate alternative refrigerants, doing so ahead of its life expiry potentially incurs a greater environmental disbenefit, when compared to the environmental benefit gained from removing the PFAS refrigerant. This is because of the consumption of additional resources to replace working plant.

There are already a number of proposed derogations in Annex XV that potentially could apply to aspects of NPP HVACR plant, as follows:

- 5g. refrigerants in laboratory test and measurement equipment until 13.5 years after EiF;
- 5i. maintenance and refilling of existing HVACR equipment put on the market before [18 months after EiF] and for which no drop-in alternative exist until 13.5 years after EiF;
- 5j. refrigerants in HVACR-equipment in buildings where national safety standards and building codes prohibit the use of alternatives;
- 5r. insulating gases in high-voltage switchgear (above 145 kV) until 6.5 years after EIF;

Potentially the challenges of points (1) and (2) above are recognised in Derogation **5j**, that's if NPP safety-related buildings are considered "buildings where national safety standards and building codes prohibit the use of alternatives".

Whilst we agree with the perceived intent of derogation 5j, the wording might not adequately cover nuclear safety-related buildings. As a minimum, clarification is needed on how 'national safety standards' is defined within the proposal.

This concern is raised because relevant safety standards may not explicitly 'prohibit' the use of alternatives, however the requirement to implement alternatives may directly contravene nuclear safety principles set out in international standards, national nuclear regulations, nuclear site licenses or nuclear safety cases. This scenario applies to the nuclear regulations within the UK, which will not explicitly prohibit alternative products, recognising that effective safety regulation often seeks to avoid detailed and prescriptive rules. However, it would be unacceptable to allow a reduced performance of safety related systems. It is also not practicable to modify the structures and systems to accommodate larger HVACR plant with no clear reduction in risk.

> EDF Energy recommend that either (i) a new time unlimited derogation is included that explicitly covers buildings on nuclear facilities, that have a nuclear safety-related function; or (ii) the wording of Derogation 5j is updated to comprehensively cover any nuclear safety-related buildings.

[2] Note that UK nuclear industry typically use the acronym 'HVAC' rather than 'HVACR'. This report uses the term HVACR in order to remain consistent with ECHA consultation documents, but the terms are taken to be interchangeable.

For clarity, EDF Energy are not proposing that all HVACR systems at NPPs that use refrigerants should be within the scope of a derogation. For example, we are not proposing to include the air conditioning within administrative offices by the derogation. The focus would be on those which provide nuclear safety functions, due to the additional difficulty associated with modifying these systems.

A.2 HEPA Filters

There is a proposed derogation in Annex XV for filters, which states:

5e. textiles for the use in filtration and separation media used in high performance air and liquid applications in industrial or professional settings that require a combination of water- and oil repellence until 6.5 years after EiF;

EDF Energy is aware of ongoing work within an existing HEPA filter media supplier to EDF Energy's nuclear fleet, to remove the PFAS chemical from the media's chemistry. Our understanding is that the PFAS chemical is used to provide a water repellence property to the media.

Prior to use within NPPs, HEPA filters any reformulation of the filter media needs to be robustly validated. A duration of 6.5 years might not be long enough to develop replacements and complete the necessary qualification tests and assessments required. EDF Energy's understanding is that the HEPA filter media used in the HVACR extract discharge filters at radiological facilities and NPPs is the same across much of the world. This problem is far wider than just a consideration for EDF Energy's UK nuclear power plants.

EDF Energy recommend that 13.5 years would be a better length of time for a derogation associated with nuclear facilities. This derogation could be applied to 'media for the use in filtration and separation media used high performance air and liquid applications in radiological facilities and nuclear power stations until 13.5 years after EiF.'

EDF Energy have proposed to use the word media instead of textile, because media can include textiles and other materials used in filtration.

A.3 Other HVACR Filters

EDF Energy have not been able to confirm whether PFAS is used within filters on the air supply side of HVACR systems across our NPPs. We suspect this is the case and therefore these products could be affected by ECHA PFAS legislation. As these air supply side filters are not typically safety related, the impact would likely be smaller than with HEPA filters and therefore we have no comments to provide to ECHA at this time.

A.4 Components within a HVAC system

EDF Energy believe there will be PFAS within many other HVACR components, especially within compressors. The main threat seems to be to the PTFE components, in their various forms (virgin, glass-filled etc.).

EDF Energy have not yet identified components that are directly related to nuclear safety and would need to be addressed with a sector-specific derogation. We anticipate that the wider HVACR industry and supply chain will undertake work to identify essential HVACR components that cannot be readily replaced.

Appendix B. Elastomers

Generally, fluoropolymers are utilised for the retention of their unique combination of properties at elevated temperature. This section discusses elastomeric seals, identified by EDF Energy as the primary use of PFAS-containing elastomers.

B.1 Seals

Under many circumstances the choice of material will be a compromise and will depend on the details of operation. For fluoroelastomers, Viton (FKM) fluorocarbons are used extensively throughout the EDF Energy fleet. The reason for this if for their resistance to chemical attack, good dynamic sealing application performance as well as good performance at elevated temperature.

Of the principal elastomers in use for seals, 4 out of 5 of the best performing high temperature materials are PFAS substances (highlighted red in Figure 1 below). For dynamic sealing applications at elevated temperatures > +200°C, there are no alternatives to PFAS elastomers (noting the relatively weak dynamic performance of silicone rubber).

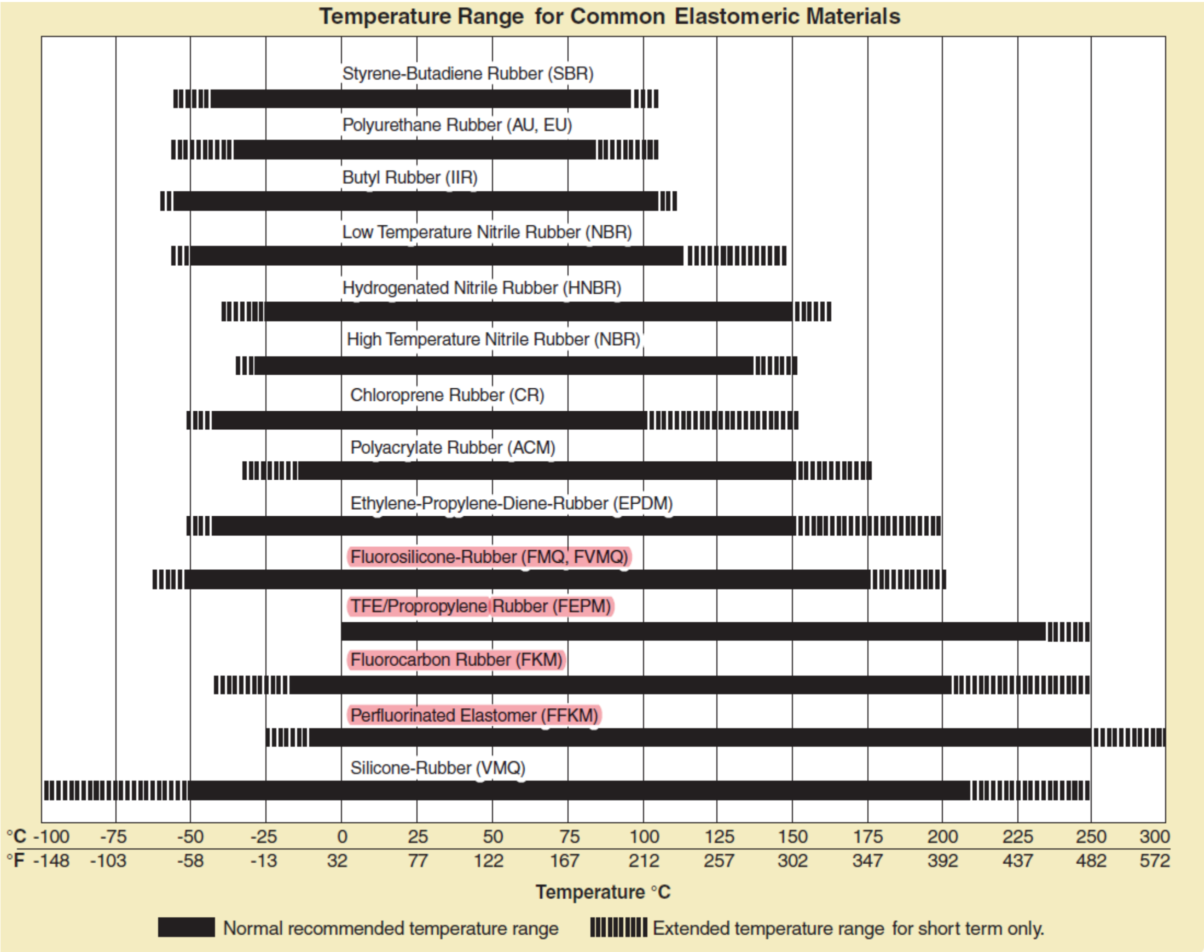

Figure 1 - Temperature Range for Common Elastomeric Materials, from Parker O-Ring Handbook ORD 5700. Parker Hannefin Corporation, Cleveland, OH. (2007)

The specified formula "Daisy" Viton E60C is the only viable candidate material for dynamic sealing applications at elevated temperatures. With no immediate alternative to Viton for many sealing applications, an extended period (i.e. decades) would be required for the nuclear sector to pivot to a new material class that could offer comparable performance. This period would allow for product development, testing and full qualification prior to implementation.

However, EDF Energy do not consider it likely that another elastomer type could offer the same level of high temperature performance. The proposal from ECHA therefore significantly reduces the operational capability of many sealing applications, potentially reducing component longevity and satisfactory performance, with no clear compensatory benefit.

EDF Energy recommend the use of fluorocarbons within nuclear facilities are fully exempted, without time-limitations, from the PFAS restrictions. This recognises the essential role they play in nuclear safety-related and operationally critical systems on NPPs, with no obvious route to replacing them.

Other PFAS elastomers to Viton are used across EDF Energy nuclear sites, as shown in Table 1 below. Whilst the applications of these alternative PFAS elastomers are less extensive than Viton, their properties have necessitated their use for various niche applications.

PFAS	Description	High Temperature Properties
Fluorocarbon (FKM)	Fluorocarbon (FKM) has excellent resistance to high temperatures, ozone, oxygen, mineral oil, synthetic hydraulic fluids, fuels, aromatics and many organic solvents and chemicals. Gas permeability is very low and similar to that of butyl rubber. Special FKM compounds exhibit an improved resistance to acids and fuels.	Up to 204°C and higher temperatures with shorter life expectancy
Fluorosilicone (FVMQ)	FVMQ contains trifluoropropyl groups next to the methyl groups. The mechanical and physical properties are very similar to Silicone Rubbers (Q, MQ, VMQ, and PVMQ). However, FVMQ offers improved fuel and mineral oil resistance but poor hot air resistance when compared with VMQ.	Up to 177°C max.
Perfluoroelastomer (FFKM)	Perfluoroelastomer (FFKM) currently offers the highest operating temperature range, the most comprehensive chemical compatibility, and the lowest off-gassing and extractable levels of any rubber material.	Up to 320°C.
Tetrafluoroethylene-Propylene (AFLAS)	This elastomer is a copolymer of tetrafluoroethylene (TFE) and propylene. Its chemical resistance is excellent across a wide range of aggressive media.	Up to approximately 232°C

Table 1 - EDF Energy identified PFAS chemicals within seals.

EDF Energy recommend the use FVMQ and AFLAS elastomeric seals is derogated for a minimum period of 13.5 years. This recognises the essential role they play in nuclear safety-related and operationally critical systems on NPPs and the time required to develop and qualify suitable alternatives.

Appendix C. Thermoplastics

C.1 Gaskets

For gaskets, the PFAS material that would present the biggest operational risk, if restricted by ECHA, is PTFE, which is used extensively throughout fleet. EDF Energy observations on the use of PTFE for gaskets on NPPs are:

1. The most commonly available thermoplastic gasket material is PTFE. It can be supplied as an expanded flexible tape that consolidates to a convenient gasket and is becoming more widely accepted for large components subjected to light duty.
2. Different gasket materials have their specific use cases across EDF Energy sites, with PTFE-based gaskets being the preferred material of choice for many applications. This is determined by the inherent strengths and limitations offered.
3. Across EDF Energy sites, PTFE is most commonly used in aggressive chemical applications or with corrosive media.
4. The filler materials in spiral wound gaskets are typically expanded graphite, PTFE or mica. Graphite can seal better, but at the higher temperatures long term oxidation is a limiting factor to overall gasket life.
5. For gaskets cut from sheets, best practice always advises using the thinnest material that the flange arrangement will allow, but thick enough to compensate for unevenness of the flange surfaces. The thinner the gasket the higher the compressive force the gasket can withstand. PTFE can typically often offer the thinnest gasket material, thereby offering improved sealing integrity.
6. If flanges are damaged or warped, and re-machining is not possible, it is necessary to fit a gasket that can accommodate the imperfections. Graphite laminate or soft PTFE gaskets are usually the best options, provided they are used within their ratings.

EDF Energy position is that PTFE offers unique benefits to deliver essential functions. Certain uses within NPPs cannot be replaced with fundamentally different alternatives (e.g. metallic or graphite gaskets) due to the specific functional requirements. It is EDF Energy's assumption that any replacement to PTFE would therefore likely be with alternative thermoplastics. EDF Energy are conscious that **PTFE is judged to be of 'low concern'** raising the question on whether replacing PTFE gasket products with alternatives that sit outside of the current PFAS definition, would result in any net environmental benefit.

Whilst their use on NPPs presents an essential and safety-critical application, it is acknowledged that the functionality offered by PTFE is likely to be essential elsewhere within the energy sector and other industries.

> EDF Energy would therefore support the exclusion or full exemption of PTFE for industrial uses from the ECHA restrictions, on the assumption that PTFE remains "of low concern" following the removal of harmful PFAS substances (e.g. PFOA, PFOS) from the manufacturing process.

If retained within the ECHA restrictions, then a time-based derogation should be applied that considers (i) the time for manufacturers to develop and bring equivalent products to market; and (ii) a subsequent period of several years (minimum) for operators within the nuclear sector to fully qualify the alternative and implement nuclear safety case updates.

C.2 Fluoro-lubricants

Some PFPE and PTFE-thickened greases are known to be used, but have not been assessed in terms of their roles and the availability of alternatives. A sufficient time-based derogation would be needed to cover the period required to bring to market, and then qualify and approve for use on NPPs. EDF Energy acknowledge the proposed derogation for lubricants, but need more time to consider the sufficiency of it:

"Lubricants where the use takes place under harsh conditions or is necessary for safe functioning and equipment safety (until 13.5 years after entry into force)"

As a minimum it is likely that EDF Energy would hope to see greater clarity that the essential uses on NPPs fall within the derogation's intent.

C.3 Other Components

In addition to PTFE gaskets, there are other thermoplastic PFAS materials and applications that are important to NPP operation, but these are expected to be much lower in number and use. A more detailed assessment would be required to confirm the actual risk to continued NPP operation.

Other known PTFE applications

Plant items on NPPs that use PTFE include (but are not limited to):

- electrical wire insulation due to good dielectric properties;
- bushing, bearings, coatings, etc. due to good low friction properties;
- threaded fastener tape for sealing applications.

Other (non-PTFE) Thermoplastics

There are other materials such as PCTFE, ECTFE, PFA, that are used across the fleet. For example, PCTFE (Kel-F) is used for Valve Seats for Equipment Qualified items. However, the extent of use of other thermoplastic PFAS is significantly less than that of PTFE.

Appendix D. Waste Management

The consultation on the ECHA proposal to restrict PFAS includes the end-of-life phase and how associated wastes are treated to destroy the PFAS content and prevent emissions. The ECHA consultation also recognises the potential for impacts on the waste industry concerning the technical and economic feasibility of implementing the proposed concentration limits. Whereas previous Appendices have highlighted the risks from supply of products from EU to the UK nuclear fleet, this topic may have less direct impact on UK operations. However, we have summarised our views on the topic below with the hope that our observations may be helpful to ECHA and identify risks that could equally apply across European NPPs and wider industry.

D.1 Identification of PFAS within conventional wastes

For effective waste management of articles they need to be easily identifiable as containing PFAS. However, there is current very limited labelling of PFAS contained within in products, and testing all waste articles for PFAS is not practicable. The assessment of the presence of PFAS within waste, particularly with aged articles, is very difficult.

The EDF-owned UK stations were predominantly built in the 1970s and 1980s. It can be assumed that some of the conventional and radioactive wastes from these stations will contain PFAS in varying concentrations. Full records of what may or may not contain PFAS within these legacy wastes, and at what concentration, are not available. Developing comprehensive waste sampling methodologies, testing and interpretation of results is expensive, and disproportionate to the risk reduction achieved. Critically there appears to be limited testing laboratory capacity available to EDF Energy.

EDF Energy will therefore need to make risk-based judgements and assumptions regarding the presence of PFAS within its wastes. For example, if manufactured prior to certain date then assume PFAS concentrations will be above the limit. A risk-based approach to identification would need to be confirmed by regulators as acceptable. This issue is likely to be prevalent across international NPPs, noting the relatively high typical age of operating nuclear reactors (see Figure 2 below).

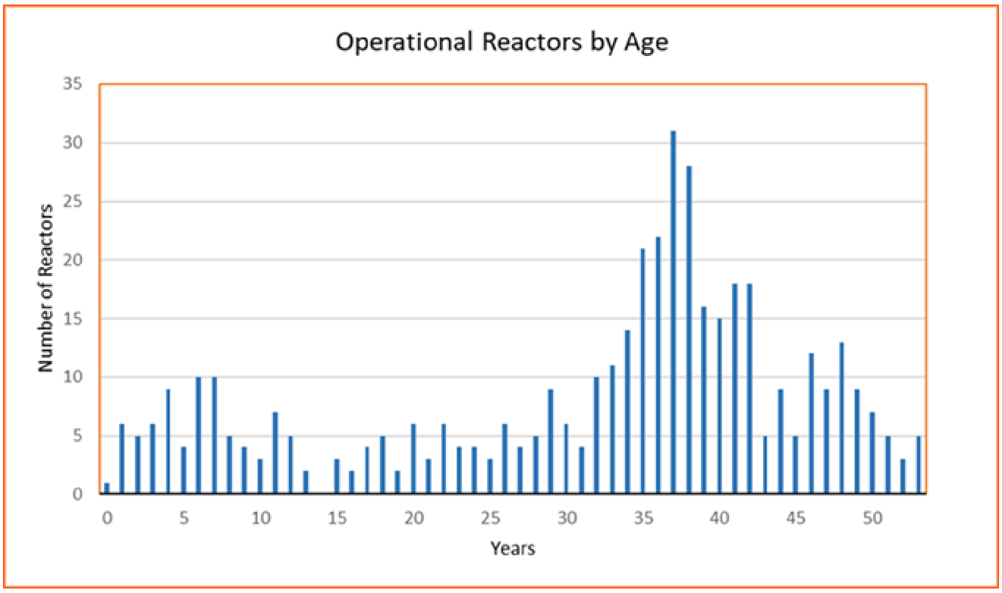

Figure 2 – Age (in years) of current international operational nuclear reactors

Robust guidance is also required to support industry with the identification and classification of high-risk articles, and the appropriate waste management strategies to be applied. The Waste from Electrical and Electronic Equipment (WEEE) guidance is one example of the guidance needed. EDF Energy would welcome further details within new guidance, as the outcome of existing WEEE guidance can still drive conservative decision making to ensure compliance with regulations. This means opportunities associated with the 'circular economy' are lost.

D.2 Identification of PFAS within radioactive wastes

Similarly for radioactive wastes, characterisation of PFAS is unlikely to be straightforward because Material Safety Data Sheets or supplier information will not always state PFAS concentrations. Waste articles and waste from decommissioning or retired plant components will be even more challenging to determine PFAS concentrations. A particular concern for EDF

Energy is if any legislative change leads to more arduous testing requirements for PFAS in radioactive waste. This is because the available resource for laboratory-based characterisation of radioactive samples is already severely constrained. It would be particularly useful for radioactive waste if there could be a set of standard assumptions to apply to, particularly with legacy waste items, with regards to likely PFAS concentrations and quantities that would reduce the requirements for testing.

Recognising that it will be very challenging to undertake substantial sampling and testing of both conventional and radioactive waste types, it will be important for site operators to be able to make risk-based assumptions regarding PFAS content within waste types that do not benefit from historic records or clear product PFAS concentration labelling.

D.3 Treatment of PFAS waste

There will need to be waste management permitting changes to enable specialist waste management facilities to process wastes with PFAS concentrations above the limit. The dual classification of waste articles as mixed hazardous and non-hazardous could allow it to be sent for further identification to allow the correct waste management technique to be identified. EDF Energy consider that waste management facilities are in the best position to segregate similar types of waste articles that are potentially above or below the PFAS concentration limit. These facilities should then divert recoverable waste below the concentration limit for destruction, with its associated higher transport and disposal costs.

EDF Energy also seek evidence that supports this consultation that the long-term disposal routes are effective for the destruction of harmful PFAS substances. We have observed changes in the disposal and recovery routes for waste as industry seeks to move waste up the waste hierarchy, EDF Energy request that clear guidance is provided on the types of destruction required, noting the associated higher cost and limited availability of high temperature incineration capacity.

Waste management facilities are in the best position to segregate similar types of waste articles that are potentially above or below the PFAS concentration limit. Clear guidance must be provided (and supported by robust evidence) on the types of destruction required, noting the associated higher cost and limited availability of high temperature incineration capacity.

Within the UK, radioactive waste has to meet the hazardous Waste Acceptance Criteria (WAC) of radioactive disposal facilities, permitted landfill sites and high temperature incinerators. For instance, the UK's Low Level Waste Repository (LLWR) WAC requires information on the levels of hazardous components for wastes "that would be categorised as Hazardous Waste if they were not deemed to be radioactive waste". The introduction of PFAS restrictions is likely to necessitate changes to the WACs applied by these facilities and could impact the acceptability of certain waste streams. Industry will require an explanatory note or guidance to clarify this relationship.

An area of particular uncertainty is the ability to dispose decommissioning waste to landfill. In 2022, only **2.4%** of EDF Energy's entire conventional waste was sent to landfill, highlighting the use of controlled and specialist disposal routes adopted by NPPs. As EDF Energy's stations progress through the decommissioning phase, an increased quantity of bulky decommissioning wastes (e.g. from site demolition) are likely to go to landfill, unless they can be re-used. If the introduction of PFAS waste management restrictions prevents both re-use of materials and landfill disposal of bulky decommissioning wastes, it could drive behaviours contrary to the policy intent of minimising radioactive waste volumes consigned to specialist disposal routes.

The majority of EDF Energy's operational radioactive waste will be incinerated (**64%** of radioactive waste from EDF Energy stations in 2022 was incinerated) thus destroying the PFAS content as a result of the preferred disposal option in any case. However, the proposals should take care to prevent the creation of "undisposable" or "orphan" radioactive wastes whereby their radioactivity is too high to be incinerated but their PFAS concentration is too high for acceptance to other radioactive waste routes, such as near surface disposal. In recognition of this risk, it may be more helpful to bring radioactive wastes explicitly into the scope of the PFAS restrictions and then to make a suitable provision that would prevent this scenario occurring.

Radioactive waste management requires stable disposal routes with relatively constant WAC. This is critical for decommissioning retired nuclear power stations as the decommissioning strategy and waste management approaches are planned years in advance of waste generation. If this consultation results in significant changes to current WAC for radioactive waste disposal partners, this could result in:

- A need to repack and segregate waste - incurring additional risk to staff.
- A need to change the planned waste management approach for decommissioning - incurring significant programme delays and cost increases.
- An increase in accumulated waste on nuclear sites if it becomes non-disposable e.g. if the activity is too high for incineration and PFAS concentration too high for other radioactive waste management routes

It is not clear how follow-on restrictions will impact the WACs for radioactive waste disposals, however significant changes could cause problems for nuclear operators.

Proposed PFAS waste management regulations need to be implemented with full consideration of any implications to radioactive waste management, preventing the creation of "orphan" radioactive wastes and avoiding unnecessary risk from radiological hazards to workers. Detailed guidance and clear governing principles will be needed on the management of PFAS within radioactive waste streams.

Appendix E. Spare Parts and PFAS 'Use'

The restriction on the "use" of PFAS-containing materials has been a point of uncertainty during our review. We note that the consultation Q&A responses have clarified that in-service components would not have to be removed from service prematurely in response ECHA restrictions following the EiF. EDF Energy strongly supports this important clarification, as any requirement to replace products and components before their end of life would result in greater waste and present additional unnecessary risks to site workers.

It has been confirmed by ECHA that the holding and transferring spares of PFAS-containing materials would be restricted by the proposed legislation. Whilst the "use" aspect of the ECHA legislation would not directly affect EDF Energy's UK sites, we have briefly shared our views on the topic below, in the interest of providing helpful context on NPPs.

To mitigate the risk of plant or component failures resulting in extended periods without operation, EDF Energy hold spares and reserves of a range of products and components. There is an expectation that EDF Energy will have appropriate risk-mitigation measures in place, to ensure security of supply of low-carbon power. The spares and stockholdings range from plant consumables, to minor components and to what EDF Energy classify as 'strategic spares'. These strategic spares are more complex in nature and would meet criteria of having high monetary value and / or long lead-lead times.

EDF Energy consider that it would present an unnecessary detrimental environmental impact to have to dispose of unused spare parts. It is highlighted that NPPs apply strict controls on the use and disposal of operational materials. The use of already-manufactured PFAS-containing products is very unlikely to result in increased dispersal of PFAS if they are used onsite, compared with being disposed of as unused spares. The requirement to dispose of PFAS-containing spares at the point of EiF would simply generate additional waste without any clear reduction in environmental risk.

The quantity of spares required is minimised through the sharing of stockpiles and strategic spare parts across the fleet management. Any restrictions placed on the transfer of spare parts would remove this benefit and ultimately drive an increase in the existing levels of spares held. This potentially adds a further environmental disbenefit.

Finally, the cost and effort from having to dispose of and replace unused strategic spares held in support of NPPs would be very high and disproportionate to any possible benefit.

EDF Energy recommend that NPPs (and other critical low-carbon energy generation sites) are exempt from restrictions on "use" of essential PFAS-containing products in order to ensure security of supply. We would advise that restrictions focus on the manufacturing and sale of PFAS-containing products, and non-essential uses.

Appendix F. Nuclear New Build

The assessment by EDF Energy on the impact to PFAS regulations on NPP has largely focussed on our operations of the existing UK nuclear fleet. EDF is also leading the construction of two new reactors at Hinkley Point C (HPC) in the South-West of the UK. This is the first new nuclear power station in the UK in over 20 years, one that utilises a significant European supply chain, and plans to operate for at least 60 years before being decommissioned. The same reactor technology (the 'EPR') has already been constructed in Olikuoto (Finland) and is nearing the start of operations at Flamanville (France).

Similar to the existing UK nuclear power stations, PFAS is prevalent in a large number of systems and components. Some are essential to the safe operation of the plant, and alternatives may not achieve the required performance without significant changes to the plant or a reduction in safety. Frequencies of replacements are system & component specific but can range from the short term (weeks/months) through to the very long term (years / decades). HPC will have a higher sensitivity impact around some specific product areas due to increased prevalence in the design (when compared to existing UK assets), with examples such as R513a Refrigerant used in a significant proportion of chillers across the plant.

The civil construction phase of the project at HPC is drawing to a close on Unit 1, moving now into the Mechanical, Electrical and HVACR phase. As a result, the current design at HPC has reached a level of stability and maturity where further design changes are technically complex and have a significant schedule & cost impact. The timing of the proposed legislation vs the construction cycle makes any consideration of design changes extremely prohibitive to now retrofit.

Examples of technical risks to HPC as a result of this proposed legislation include:

- The principal risk is the indirect consequence of obsolescence in the predominantly European supply chain to be able to provide through life support.
- A risk of availability of materials during the construction phase for Unit 2 (under current identified dates)
- A risk that divergence in approaches taken by the EU and UK on PFAS could only exacerbate availability of supplies and/or the need for design change during the operational life of the power station.

Some of the technical risks to HPC associated with the proposed PFAS legislation could be mitigated by specific derogations for essential uses. EDF Energy will not recommend further derogations within this response specifically relating to the EPR projects – further detailed assessment is needed..

Beyond HPC project, Sizewell C (SZC) are planning to construct an additional two EPR reactors in the South-East of the UK. One of the fundamental principles of this project is replication. This principle helps reduce cost & technical complexity whilst improving the schedule and operational safety. This is an example of a project that is expected to be approved, i.e. a Final Investment Decision (FID) taken, before the ECHA legislation is finalised and implemented.

> It is important that planned low-carbon energy projects are protected from the uncertainty of impending legislation, so far as is practicable, and that the benefits from replication and learning between projects can continue to be realised. In support of this, the necessary exemptions and derogations identified for essential uses on NPPs should equally apply to the construction, operation and decommissioning stages of the stations' lifecycle.

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