

Managing spent fuel at Sizewell B

Finding the right interim solution beyond 2015



Looking to the future

At Sizewell B used or spent fuel is currently stored on site pending reprocessing or final disposal. The current storage facility for the spent fuel will, as anticipated, reach capacity by 2015 and so British Energy is reviewing the options for managing the spent fuel after that date. Managing spent fuel is nothing new; various technologies already exist and there is vast experience from across the world to draw upon.

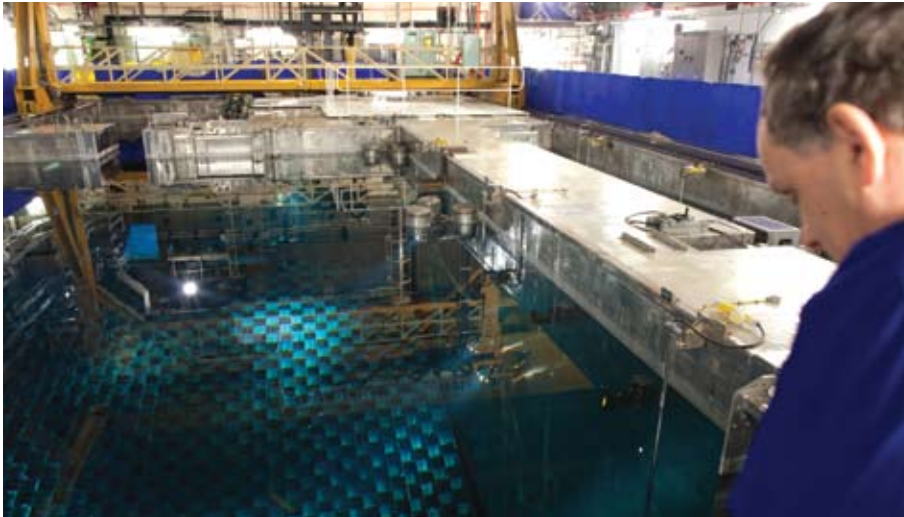
A study is being undertaken to compare the available options worldwide, taking into account Health & Safety, Technical, Environment, Political and Regulatory, and Economic factors. This leaflet will explain this study, what the options are for managing spent fuel and how British Energy will choose the most suitable option for Sizewell B. Our priority is to ensure that Sizewell B has a spent fuel management plan beyond 2015, regardless of what happens with new nuclear build at Sizewell.

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1 What is spent fuel?

Sizewell B fuel ponds



Spent fuel at Sizewell B

At the heart of a pressurised water reactor such as Sizewell B is the fuel. This is made up of small uranium oxide pellets, no more than a few millimetres thick, stacked together within a tube made of the metal zircaloy. This is called a fuel rod and 264 of these fuel rods are then braced together to form a fuel assembly.

Inside the reactor 193 of these fuel assemblies make up its core, where the process of splitting the atom to produce energy, known as fission, generates heat which is then transferred via circulating pressurised water to the steam generators. Here the heat is passed to a second, separate water circuit where it produces steam for the turbines.

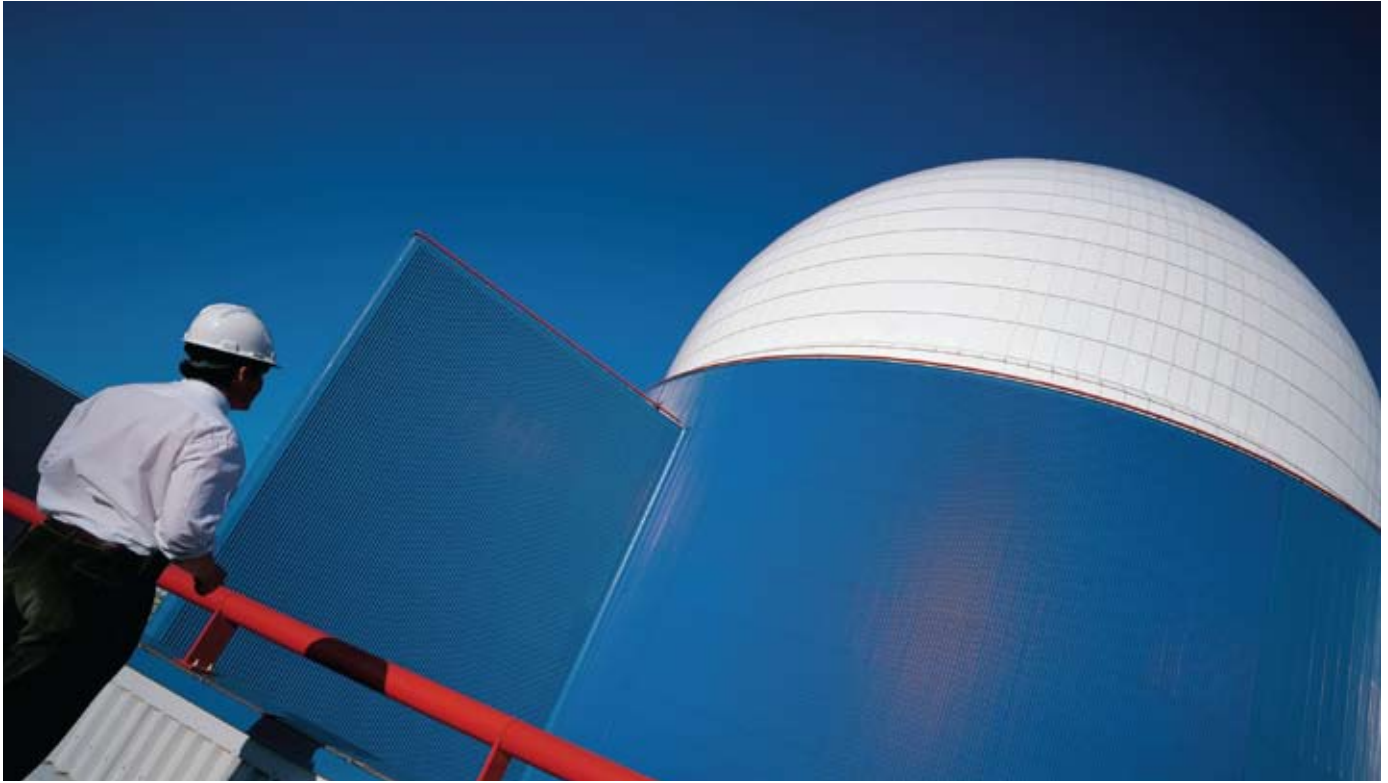
Refuelling and storing spent fuel

At Sizewell B we refuel the reactor roughly every 18 months during scheduled plant maintenance. Any fuel assemblies that have lost sufficient power to remain useful are removed and replaced by new fuel. The used or spent fuel is then transferred to a fuel pond and stored under water.

This fuel pond houses all of the spent fuel so far from the 14 year operating life of Sizewell B. The water in this fuel pond acts as a very effective barrier between the fuel, which is still producing heat and is highly radioactive, and the outside environment. The pond is also housed in a reinforced concrete facility with multiple security and safety features.

2 Why are we reviewing the future of spent fuel management at Sizewell B?

Sizewell B



Managing spent fuel at Sizewell B

Under our current arrangements for Sizewell B we expect the fuel storage pond to provide capacity up until around 2015. It was never the intention that the station's lifetime fuel needs would be accommodated in the existing fuel ponds alone. The current ponds were built to a recognised US design which in theory would allow storage of spent fuel until around 2025. However, the safety arrangements in the UK mean we will only have an allowable capacity up to 2015.

The intention is that in the longer term there will be a national geological underground repository to house high level waste from all facilities that produce such waste in the UK. The Committee for Radioactive Waste Management (CoRWM) is looking at how this might be achieved but has indicated this will not be ready for many years. As Sizewell B is due to operate until 2035, with the possibility of life extension beyond that, we need to ensure we have a suitable plan for managing spent fuel from 2015 onwards.

3 What are the options and how does BE choose?

The Best Practicable Environmental Option (BPEO) Study

Our project team at British Energy has been working on a Best Practicable Environmental Option (BPEO) Study which will help us to narrow down the most suitable options. In summary, the BPEO process is a strategic tool that enables us to decide ‘what to do’. It does this by assessing options against five main attributes, which are based on guidance from the Environment Agency (EA) and designed to make sure that the final option chosen is safe, secure and economic (see box right for attributes).

The first step of the BPEO Study process was to gather information and data in what we call an Operational Experience (OpEx) review. The purpose of the OpEx review was to research the various technologies available worldwide for the management of spent nuclear fuel. With 264 pressurised water reactors worldwide there is vast experience in these technologies to draw upon.

However, all of the options can be defined by four simple categories (see figure 1): non-mature technologies, interim storage via either wet or dry stores, reprocessing in the UK or overseas and finally deep geological disposal.

BPEO criteria - the attributes:	
Health & Safety	
Technical	
Environment	
Political/Regulatory	
Economic	

The four most appropriate options

As the spent fuel storage solution is required to be operational by 2015, it was decided that the OpEx review would concentrate only on mature technologies that would have a realistic chance of being licensed and commissioned by that date. Therefore, a range of technologies that are either at an early stage of development or are of a more speculative nature were excluded. The possibility of constructing a new wet or dry storage facility at other sites either in the UK or abroad was also ruled out under the same principle.

Direct disposal in the UK will not be available for many years and it is against UK policy to dispose of radioactive waste overseas, so these were also dismissed as options. This left us with the four options outlined in Figure 2.

Figure 1
Flow chart of screening process

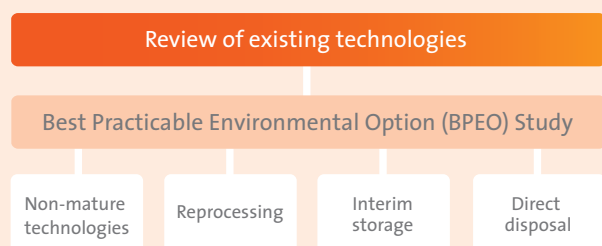
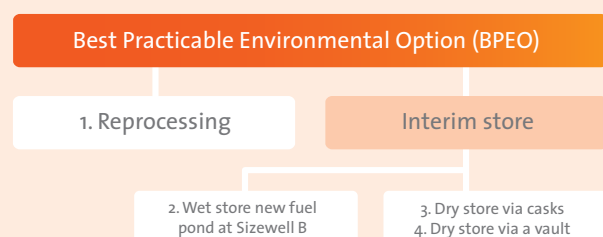


Figure 2
Flow chart of the four most appropriate final options identified



1. Reprocessing

A key characteristic of nuclear energy is that used fuel may be reprocessed and used as fresh fuel for existing and future nuclear power plants. The majority of the spent fuel can be reused as fuel but the remainder, only about 4%, would be classed as high level waste which would have to be stored at an interim site until a national deep geological disposal site is available.

Sizewell B already has some reprocessed fuel in its fuel pond ready to use during future refuelling and the fuel for the UK's Magnox and advanced gas-cooled reactors (AGR) has in the past also been reprocessed at the Thorp reprocessing plant in Cumbria (pictured below).

Many countries, such as France, Russia, Japan, India and the UK, already carry out reprocessing of spent fuel. However, we would need to consider that reprocessing at Sellafield is not expected to be available throughout the remaining operating life of Sizewell B. During reprocessing used

fuel is transported to a specialist facility where, using a relatively simple chemical process of dissolving the spent fuel in nitric acid, they can separate plutonium and unused uranium from the waste products. These can then be reused and manufactured into more fuel.

The high level waste is converted to a stable form, known as vitrified glass blocks, suitable for disposal. Any intermediate level wastes made up of the structural components of the fuel assemblies are compacted and packaged into similar containers as the vitrified waste.

This option may require a new building to be constructed to store reprocessed waste within the existing power station site.

Uranium Oxide Storage Facility in Thorp © Sellafield Ltd



Thorp reprocessing plant © Sellafield Ltd



Sizewell B fuel ponds



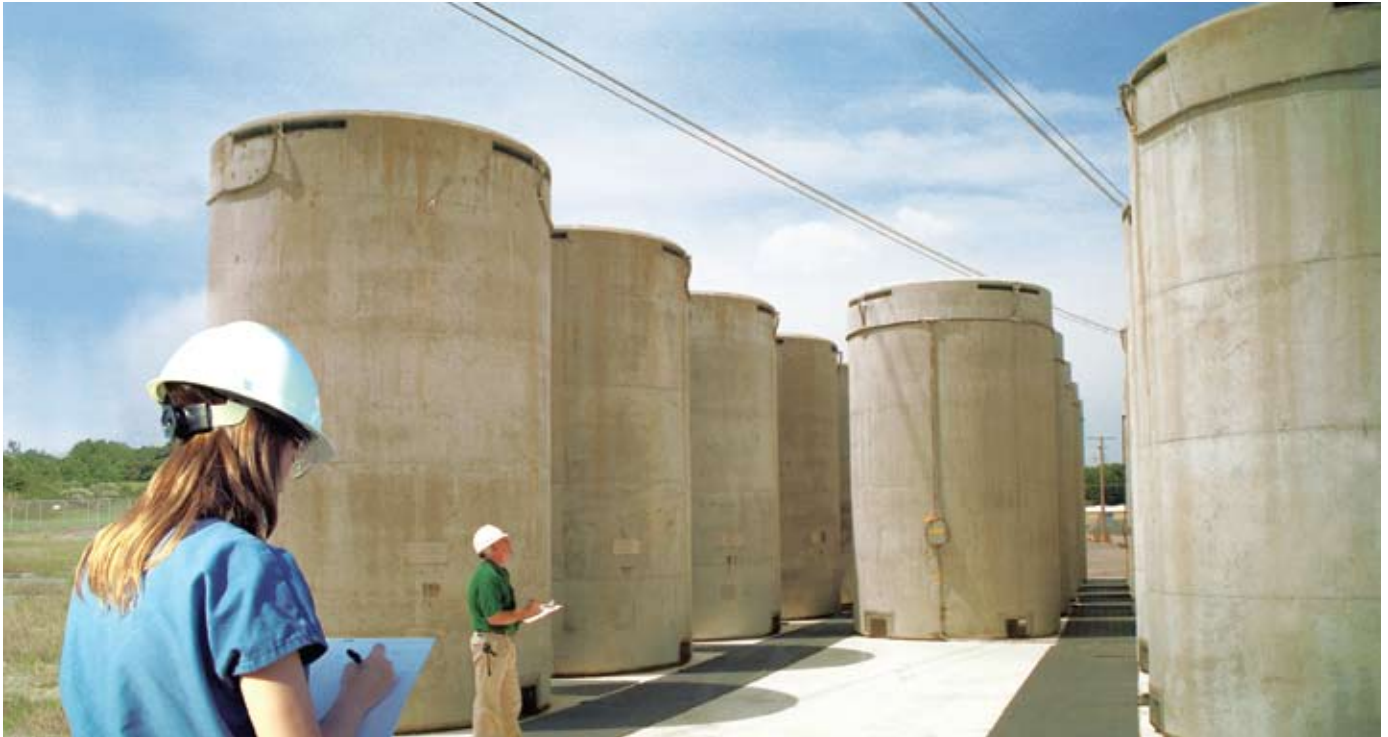
2. A new wet store fuel pond at Sizewell B

Wet storage of spent fuel in pools of water has been the main storage method worldwide for many years at power stations, reprocessing plants and national storage sites. This is done to provide initial shielding and cooling of spent fuel removed from reactors.

Fuel assemblies are usually placed vertically, using mechanical handling systems, in storage racks or baskets located at the bottom of the pool. Careful maintenance and monitoring of the pool structures is important to keep them safe and secure. The pools are designed to be resistant to movement by events such as earthquakes and are equipped with cooling systems (i.e. pumps and heat exchangers). Clean-up systems are also provided to maintain water quality and the water's chemistry is controlled to minimise corrosion of fuel assemblies. Modern pools are lined with welded stainless steel plates and have leak detection and collection systems.

The spent fuel assemblies would be loaded into a flask in the Sizewell B fuel building. The flask would then be sealed and decontaminated before being taken to the fuel pond, which would be located in a new building on the existing site at Sizewell B. The flask would enter the pond receipt bay and the bay allowed to flood to the level of the pond water. The fuel assemblies would then be removed from the flask and moved to the allocated storage position under water by the fuel handling machine.

Dry store casks in the US



3. Dry store in casks at Sizewell B

Dry cask storage is a method, already used in many other countries, of storing spent nuclear fuel that has already been cooled in the spent fuel pond. The fuel is surrounded by an inert gas within a large sealed container. These containers or casks are typically steel cylinders that are either welded or bolted closed making them leak-tight. Each cylinder is surrounded by additional steel, concrete, or other material to provide adequate radiation shielding to both the site workforce and members of the public. There are a number of dry storage cask system designs in use around the world and different types of cask designs can be used for storage, transportation or both.

In some designs, the steel cylinders containing the fuel are placed vertically in a concrete cask; in other designs the cylinders are placed horizontally. The concrete casks provide radiation shielding. Other cask designs place the steel cylinder vertically on a concrete pad at a dry cask storage site and use either metal or a combination of metal and concrete outer cylinders for radiation shielding.

The spent fuel assemblies would be loaded into a chosen cask system in the existing Sizewell B fuel building. The cask would then be sealed and decontaminated before being taken to the new dry cask store building. The cask would be placed into the storage location and during the period of storage be subject to periodic testing and maintenance. At present it is assumed that the casks would be of the dual purpose type, i.e. suitable for both storage and transport of spent fuel.

Any dry cask store at Sizewell B would require a new building to be constructed to house the casks within the existing power station site.

4. Dry store in a vault at Sizewell B

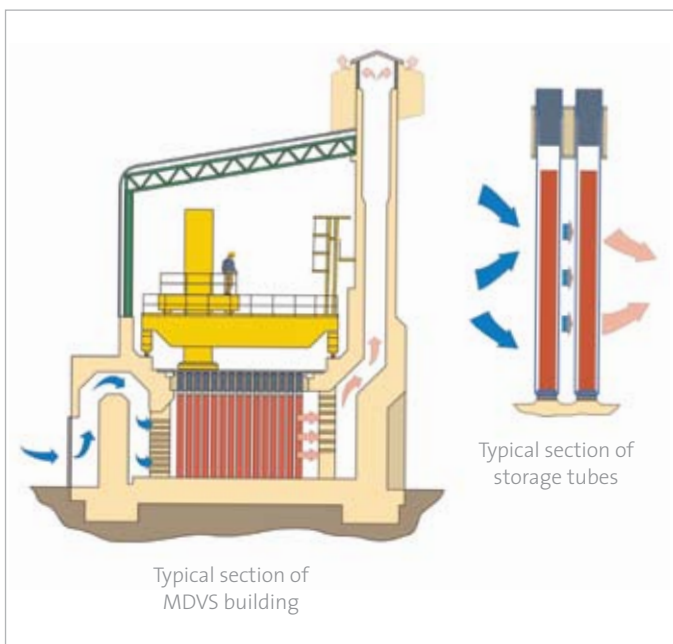
Dry vault storage is a method, already used in many other countries, of storing spent nuclear fuel that has already been cooled in the spent fuel pond. Individual fuel assemblies are stored within a sealed channel within the vault. Current examples of these vaults have been built in such a way that additional storage vault capacity can be constructed as needed.

The fuel assemblies are stored vertically and cooled by natural circulation. This acts as a self-regulating system in which higher spent fuel temperatures cause increased airflow through the vault, thereby increasing heat removal. The layout of the fuel assemblies within the vaults is carefully designed to prevent the assemblies reacting with each other.

The spent fuel assemblies would be loaded into a flask in the Sizewell B fuel building. The flask would then be sealed and decontaminated before being taken to the vault store, which would be located on the existing site at Sizewell B. Here, the fuel assembly would be lifted from the flask and dried. A shielded fuel handling machine would then transfer the fuel assembly to the allocated storage channel in the vault, which would then be filled with inert gas and sealed. During the period of storage the vault would be subject to periodic testing and maintenance.

Any dry vault store at Sizewell B would require a new building to be constructed within the existing power station site.

Cross section of a modular dry vault store (MDVS) © BNS Services



MDVS at Fort St Vrain in the US © BNS Services



4 What happens next?

Assessing the final options

At this stage of the process we are talking to our regulators the Nuclear Installations Inspectorate (NII) and the Environment Agency (EA), and you the public. The purpose of this is to understand the views of a range of Stakeholders and ensure these are taken into account during the final stages of the process.

We will evaluate the final four options by comparing their performance against the attributes described at the top of page 5 and by seeking Stakeholder views on the importance of each attribute.

The views of the public and regulators will be used as a 'sense check' against the British Energy views. This will be done by considering whether the public's and regulators' views of what is an important attribute would affect the final project decision.

This process helps British Energy to choose the most suitable spent fuel management option for Sizewell B.

The Best Practicable Means (BPM) Study

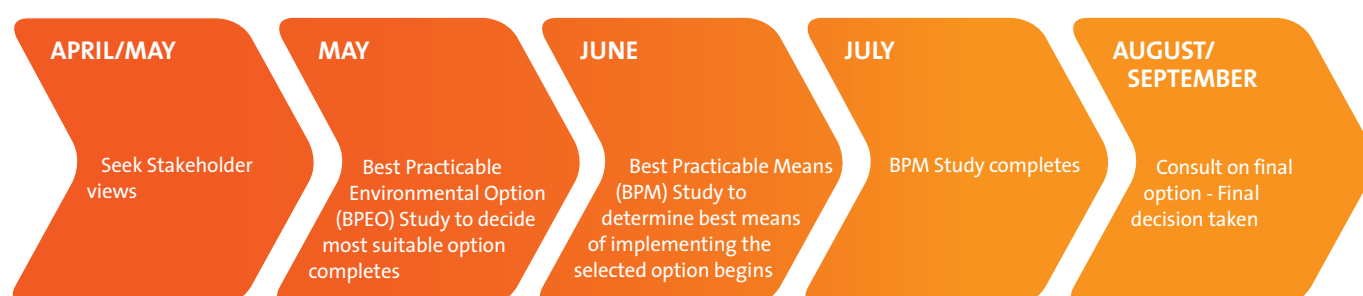
The final option will be subject to a Best Practicable Means (BPM) assessment Study. In simple terms, where the BPEO Study could be considered as 'doing the right thing', a BPM Study ensures it is 'done in the right way'.

Dependent on the selected preferred solution, BPM assessments could be carried out to determine, for example, the preferred location for reprocessing, the preferred technology for dry interim storage in casks, or the preferred technology for dry interim storage in vaults.

The planning process

For new storage onsite at Sizewell B, British Energy would require planning permission for any new buildings. Due to the timescales, a planning application would have to be submitted to Suffolk Coastal District Council at the end of this year. As a result, and running alongside the BPEO process, we will be doing some work on an Environmental Impact Assessment using dry interim storage as a model. This is to ensure that, if this is the final option chosen, we will be ready to submit a comprehensive planning application. Dry storage is being used as the model as it is widely used around the world, although that does not necessarily mean it will be the most suitable option for Sizewell B. In the event that one of the other onsite options is selected the majority of this preliminary work will be just as helpful for any alternative planning application.

The timetable



5 Getting your feedback

Send your reply by 16 May 2009 to:

**Freepost RSBK-KCTX-ULBU
Sizewell B Power Station
25 Priestgate
PETERBOROUGH
PE1 1JL**

So how can you have your say?

We want to know what is important to you. This will help us when we make the decision at the end of the BPEO Study. We will use this as a 'sense check' to ensure that our priorities are in line with those of the general public and our regulators.

In the table below you will find five main issues listed: Health & Safety, Technical, Environment, Political/Regulatory and Economic. Against each issue we would like you to indicate how highly you rate this as being a priority in the decision making process by simply putting a cross or a tick against the high, medium, low or indifferent rating. But more importantly we want you to tell us what issues you think we should be taking into account. So in the boxes provided we want to include any comments, issues or questions you might have.

Please complete and return by post by 16 May 2009:

Name _____

Address _____

Postcode _____

Telephone _____

Email _____

Sizewell B Spent Fuel Project information line

T 0800 975 5852

E mail@sizewellspentfuelproject.co.uk

Issue Health & Safety What health and safety issues do you think we should be factoring in?

Score: High Medium Low Indifferent

Issue Environment What environment issues do you think we should be factoring in?

Score: High Medium Low Indifferent

Issue Technical What technical issues do you think we should be factoring in?

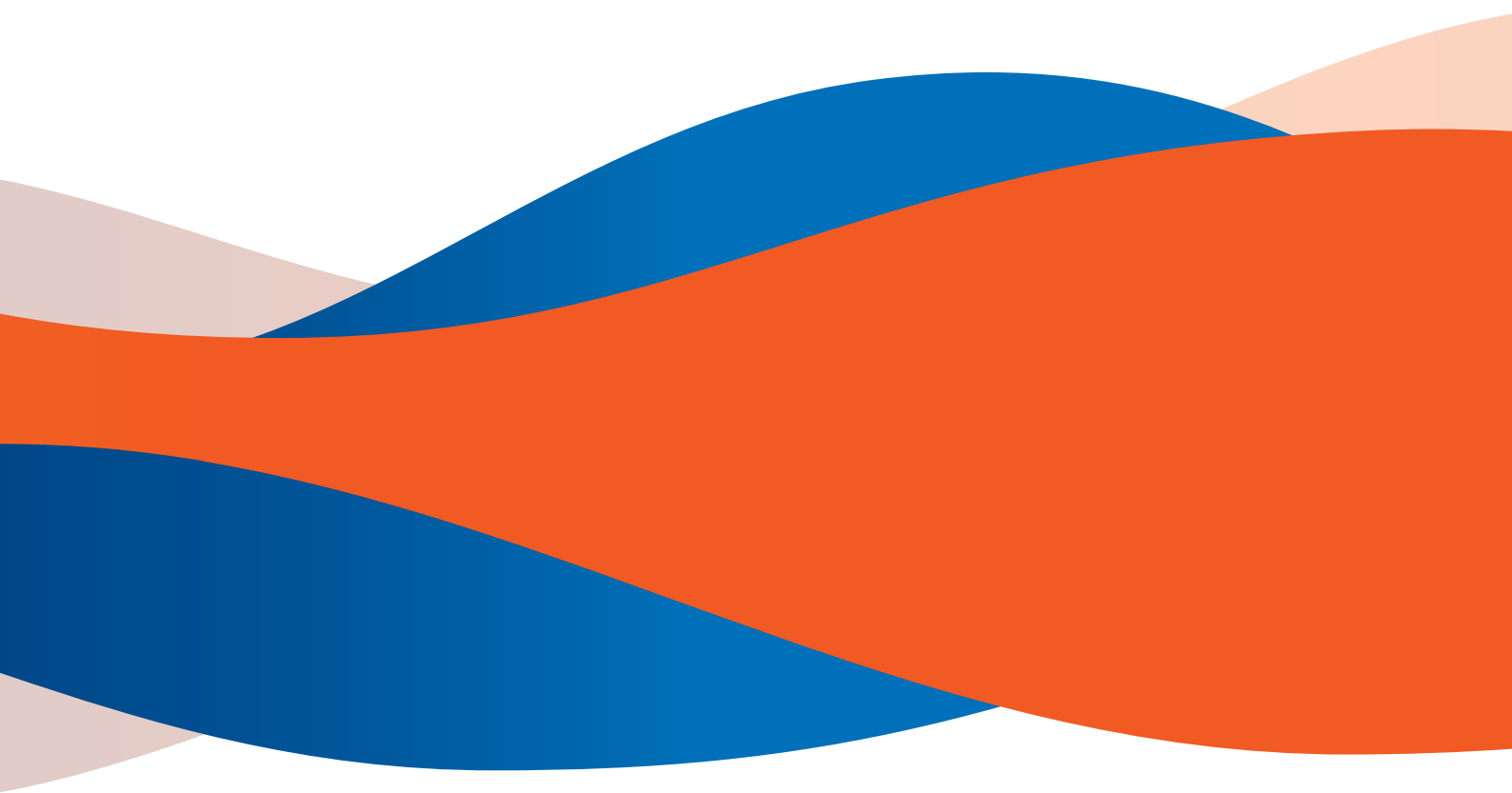
Score: High Medium Low Indifferent

Issue Political/Regulatory What political or regulatory issues do you think we should be factoring in?

Score: High Medium Low Indifferent

Issue Economic What economic issues do you think we should be factoring in?

Score: High Medium Low Indifferent



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