Appendix

JEMA comment to the Restriction report on Per- and polyfluoroalkyl substances (PFAS)

The enforcement date of PFAS restriction shall be carefully studied for Infrastructure Equipment which contributes social service , otherwise the high concern of the effect on social service can be occurred. As described in this comment P 3 , Infrastructure Equipment has the feature as follows , so it is so difficult to prepare the exclusive product list on the PFAS restriction proposal.

1.Long supply chain　2. Small quantity and variety　3. Long product life

*: To have the information of including PFAS in the product , we shall try to reach the material supplier through the long supply chain, and generally the infrastructure equipment has so many parts that it is not easy to carry out the entire survey.

As described above , JEMA is not preparing the exclusive product list and but the example of the facility and product list which needs enough preparation period of 12 years or adequate exemption.

<High Concern on social service in case Industry cannot have the enough preparation period of technical study on the product reliability>

Ⅰ. Risk of stable electrical power supply

Facility	Product example	Parts including PFAS	Reason why Industry needs enough preparation period
Power generation	Turbine Generator	Main parts (The detail explantion below)	There is no substitute technically with product reliability (The detail explanation below)
	Fuel cell	Main parts (The detail explantion below)	There is no substitute technically with product reliability (The detail explanation below)
	Protection & control unit for Generator	Main parts (The detail explantion below)	There is no substitute technically with product reliability (The detail explanation below)
Power transmission & distribution	Gas Insulated Switchgear	Main parts (The detail explantion below)	There is no substitute technically with product reliability (The detail explanation below)
	Transformer	Main parts (The detail explantion below)	There is no substitute technically with product reliability (The detail explanation below)
	Protection & control unit	Main parts (The detail explantion below)	There is no substitute technically with product reliability (The detail explanation below)

Ⅱ. Risk of obstracting Hydrogen Business deployment which is requested in Carbon Neutral Society

Facility	Product example	Parts including PFAS	Reason why Industry needs enough preparation period
hydrogen production	Proton exchange membrane water electrolyzer	Main parts (The detail explantion below)	There is no substitute technically with product reliability (The detail explanation below)

1. Power Generation Facility

This facility consists of so many products , and from them the products as follows are selected to explain the technical reason.

1) Turbine Generator　2) Fuel cell

1) Turbine Generator

"Insulated connection tube" and "Sliding pad" are extracted from main parts as ones of having PFAS.

(1) Insulated connection tube

There are hydrogen gas flow outside the tube and deionized water flow inside the tube, and the specifications from the view of "Electrical strength" , "Insulating properties" , "Vibration resistance characteristics" , "Flexibility" and "Pressure resistance strength" are requested on the tube. So, Polytetrafluoroethylene (PTFE) is selected.

In consideration of the requested specifications there is no substitute , even if the substitute candidate will be found in the coming technical development phase , it will be necessary to have enough period to confirm product reliability.

(2) Sliding pad

This is sliding part to absorb the thermal elongation of stator windings under hydrogen gas atmosphere , and the specifications from the view of "Mechanical properties" , "Wear resistance" , "Compressive strength" and "Creep Properties" are requested on the pad. So, Polytetrafluoroethylene (PTFE) is selected.

In consideration of the requested specifications there is no substitute , even if the substitute candidate will be found in the coming technical development phase , it will be necessary to have enough period to confirm product reliability.

2) Fuel Cell

The stationary fuel cell is used as the power generator to provide electricity for buildings, factories and houses.

Fluoropolymers used in fuel cells and water electrolysis are core materials unique to fuel cells and water electrolysis, such as Proton Exchange Membranes (PEM) and Gas Diffusion Layers (GDL) and are essential for system construction. As mentioned by Hydrogen Europe and Deutsche Wasserstoff-und Brennstoffzellen-Verband (DWV) , the development of non-perfluorinated alternatives has been ongoing in the scientific community for decades, but there are still many challenges including poor thermal and chemical stability, poor mechanical properties, high degradation rates and short lifetimes. So there are no practical application of materials that meet the requirements at present and no substitutes are foreseen.

"Proton Exchange Membrane" , "Ionomer", "Reinforcement for Proton Exchange Membrane" , "Electrode water repellent" and "Rubber Seals" are extracted from main parts as ones of having PFAS.

(1) Proton Exchange Membrane

The Proton Exchange Membrane is applied between the anode and the cathode and have functions to move the proton, to prevent the electron conduction and to prevent the gas cross leakage. This part has very important function in Fuel Cell , so the very careful approach is necessary. The PFSA (per-fluoro-sulfonic-acid) is used in the conventional fuel cells. Technical substitute study of hydrocarbon Membrane has been carried out , Polyetheretherketone (PEEK) and block copolymer were found as candidate.

To study the details , they are not substitute now because of low durability.

The fuel cell for vehicle is required to keep the function for 20K-30K hours and fuel cell for stationary is required to keep the function for 80k hours as the stationary fuel cell is used as the infrastructure and is expected to have 10 years product life. In case it will take 5 -10 years to improve the durability for vehicle , the development period will be longer for the stationary fuel cells.

(2) Ionomer

The ionomer is mixed in the catalyst layer and the function is to conduct the proton. Therefore the same material as the Proton Exchange Membrane is used for the ionomer. Though no passage of hydrogen and oxygen is required for the Proton Exchange Membrane, it is necessary to pass the hydrogen and the oxygen for ionomer. Only the perfluoro sulfonic acid can meet both requirements.

Because of no substitute candidate , it will take longer preparation period than Proton Exchange Membrane.

(3) Reinforcement for Proton Exchange Membrane, Electrode water repellent and Rubber Seals

The substitute judgement that PTFE , FKM can be used in the product depends on the specification requirement of part. The PTFE is applied inside the Proton Exchange Membrane to improve the mechanical strength. The FKM is used as the seal material in the fuel cell stack to divide the cathode air and the anode hydrogen around each cells. Inside fuel cell cathode there are oxygen , steam and acidic atmosphere , this makes very tough condition for organic polymer materials. In the fuel cell reaction process , OH radical is generated. This OH radical has high chemical activity and attacks the proton exchange membrane.

So only PFAS which is chemically stable can be used inside fuel cell.

Water electrolysis and fuel cells, which produce and use hydrogen, are indispensable technologies for building a hydrogen society toward decarbonization of the world.

We fully agree with the opinions already given by Hydrogen Europe and DWV on PFAS regulations for fuel cells and water electrolysis.

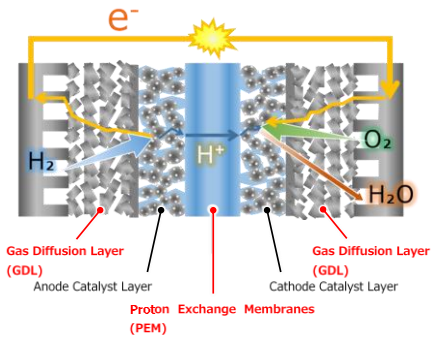

Figure 1：Schematic representation of a Membrane Electrode Assembly(MEA)

3) Protection & control unit for Generator

"Primary winding cable in current transformer inside protection & control unit" is extracted from main parts as ones of having PFAS.

(1) Primary winding cable in current transformer

Short-time dynamic overload standard test generates heat , so PFAS is selected as a counter to heat. To try to substitute PFAS , as this is heat adjustment related issue , the product volume could become several times bigger. This is much over than the normal product design change level. Product reliability evaluation shall be necessary because of big design change to the current model which reliability was confirmed through actual operation, In consideration of the protection & control unit importance in the power distribution system , the enough preparation period is requested.

And this design change makes product much bigger , so this direction may be against the Environment policy for the products such as WEEE because other Environment burden will be increased.

2. Power transmission & distribution Facility

This facility consists of so many products , and from them the products as follows are selected to explain the technical reason.

1) Gas Insulated Switchgear(GIS)　2) Transformer　3) Protection & control unit

1) Gas Insulated Switchgear(GIS)

"Nozzle mounted on arc-extinguishing chamber of gas circuit breaker" is extracted from main parts as ones of having PFAS.

(1) Nozzle mounted on arc-extinguishing chamber

For gas circuit breaker arc extinguishing chamber nozzles that control arcs generates at fault current interruption during high-speed removal of faults in power systems, PTFE is used for the nozzle. Nozzles are required to have excellent heat resistance, arc resistance, electrical insulation, and mechanical strength performances and there are no alternative materials available currently.

2) Transformer

Fluorine-based sealing materials and grease are used in some parts in accordance with the temperature environment during equipment operation, and there are no alternative materials available currently.

3)Protection & control unit

"Primary winding cable in current transformer inside protection & control unit" is extracted from main parts as ones of having PFAS.

(1)Primary winding cable in current transformer

Short-time dynamic overload standard test generates heat , so PFAS is selected as a counter to heat. To try to substitute PFAS , as this is heat adjustment related issue , the product volume could become several times bigger. This is much over than the normal product design change level. Product reliability evaluation shall be necessary because of big design change to the current model which reliability was confirmed through actual operation, In consideration of the protection & control unit importance in the power distribution system , the enough preparation period is requested.

And this design change makes product much bigger , so this direction may be against the Environment policy for the products such as WEEE because other Environment burden will be increased.

3. Hydrogen production facility

This facility consists of so many products , and from them the product as follows is selected to explain the technical reason.

1) Proton Exchange Membrane water electrolyzer

1) Proton Exchange Membrane water electrolyzer

"Proton Exchange Membrane" and "Ionomer" are extracted from main parts as ones of having PFAS.

(1) Proton Exchange Membrane

The Proton Exchange Membrane is applied between the anode and the cathode and have

functions to move the proton, to prevent the electron conduction and to prevent the gas cross leakage as same as the fuel cell. The PFSA (per-fluoro-sulfonic-acid) is used in the conventional water electrolyzer. Substitute candidate is hydrocarbon Membrane which is in study phase same as for fuel cell and this is not substitute now because of low durability and the enough preparation period is requested same as fuel cell. The water electrolyzer is expected to operate more than 10 years, therefore the durable material is required such as PFSA.

Additionally the cathode voltage is higher than fuel cell , therefore the cell materials are tend to be corrode. It might need longer time to develop the substitute material than fuel cell.

(2) Ionomer

The ionomer is mixed in the catalyst layer and the function is to conduct the proton. Therefore the same material as the proton exchange membrane is used for the ionomer. Because of no substitute candidate material, it will take long preparation period same as Proton Exchange Membrane.