Impact of the PFAS Restriction on Badger Meter- Technical and Socioeconomic assessment

Overview of Badger Meter

Badger Meter is an innovator in flow measurement, water quality and control products, serving water utilities, municipalities, and commercial and industrial customers worldwide. Our products and services are an integral part of critical infrastructure and operations; providing actionable intelligence that enables customers to deliver clean, safe drinking water to all of society – but also supporting management of wastewater, health and safety, disinfection monitoring, drug manufacture, HVAC, sustainability efforts in conservation, and safe control of chemical and petrochemical manufacturing.

Societal Benefits

Badger Meter provides equipment which critically relies upon PFAS functionality in:

- **Water treatment operations**, both for process control and for meeting required discharge limits for the EPA (Environmental Protection Agency,) UWWTD (Urban Wastewater Treatment Directive), and others. We manufacture a wide range of water and waste sensors used equally in water treatment and drinking water applications, which rely critically on PFAS. The loss of the availability of these measuring instruments would risk shut down of existing facilities due to loss of required maintenance parts and restriction of building in new construction.
- **Monitoring to ensure safe water** in distribution networks, complying with regulatory groups such as ACS (Attestation de Conformité Sanitaire,) KTW (plastics in drinking water, Kunststoff-Trinkwasser,) GDV (Godkendt til DrikkeVand,) NSF/ANSI 61 (NA Drinking Water System Components- Health Effects), and WRAS (UK) (Water Regulations Advisory Scheme), FDA (Food and Drug Administration,) 3A (Sanitary, International Dairy Foods Association, Food Processing Suppliers Association, the International Association for Food Protection and representatives of the U.S. Department of Agriculture and the U.S. Food & Drug Administration.)

  The loss of the availability of these measuring instruments would risk shut down of these existing facilities due to loss of required maintenance parts and restriction of building in new construction. Additionally, many EU members have country specific water quality testing, offering a certification consolidation opportunity.

  Examples of affected products include:
  - Residual chlorine sensors utilizing PFAS-based membranes and seals to ensure water has been disinfected in water treatment plants and individual water supplies;
  - pH sensors utilizing PFAS seals and materials, like PTFE and PVDF, to provide specific functionality for sensors used in liquids with solids that coat or degrade inferior alternatives;
  - Conductivity sensors utilizing PFAS seals and PTFE insulators that provide high resistivity, dimensional stability, superior wear, and a wider range of protection from chemical attack from additive chemical such as chlorine, or even UV exposure;
  - Oxidation-Reduction Potential (ORP) sensor utilizing PFAS seals.

- Health and safety monitoring of potentially toxic gases of personnel in facility operations, requiring intensive certification and compliance with ATEX (Atmosphere Explosive) Zone 0, CSA (Canadian Standards Association) and UL (Underwriter Laboratories) Class 1 Division 1 Hazardous Locations. Operations involving gas and oil production, mining, and chemical processing would all be affected by the loss of proper safety measurements required for those operations.
- Drug manufacture, quality control of food and beverage, disinfectant chemical processing and usage. Water and gas quality are essential measurements of all these manufacturing

processes, and each is tightly regulated by the use of only approved materials of construction. Risk to these systems would directly impact hospital operations, delays in drug production, and lack of available food products – all requiring measurement and control of water as part of processing. Large scale disinfection methods, as were common in the fight against COVID in schools and hospitals, would be dramatically affected by the loss of easily accessible toxic gas measurement equipment.

- HVAC, energy efficiency of heating and cooling tower systems, by monitoring and controlling biocides and corrosion control chemicals with pH, dissolved oxygen, conductivity, and ORP in a hot and corrosive chemical environment. Risk to these systems by loss of available control instrumentation would result in large energy efficiency losses to these systems, and damage from corrosion due to untreated water.
- Sustainability and building automation systems utilizing measurements of the usage of critical resources to promote conservation of potable water and energy. The risk of loss of monitoring these resources is an increase in water usage and increased energy usage.
- Chemical and petrochemical manufacturing by reducing the release of fugitive emissions such as carbon dioxide (CO_2) and toxic hydrocarbons such as carbon tetrachloride (CCl_4) and methane (CH_4). The risk from not having valves that can meet the fugitive emissions standards would be an increased release of greenhouse gasses or harmful gasses from the production of chemicals and petrochemicals.
- Lastly, the sole production facility for some Badger Meter equipment is located in the European Union member state of the Czech Republic. The ban of PFAS would require the closure of our current facility and a new production location opened outside of the European Union to service our customers in North America.

All of this equipment represents tens of millions of dollars of products that would no longer be able to be sold into the EU, and current customers would be left without a comparable option. The industries that use these sensors include energy production, food processing, water/wastewater treatment, as well as other life-sustaining and manufacturing industries. Badger Meter is a publicly traded company with roughly $600M of annual turnover and 2,000 employees worldwide. EU proposed regulation changes, as initially suggested, are likely to result in partial or manufacturing shut-downs presently located in the EU.

Derogations Required

As outlined in this report, there is a need to modify derogation 5n to permit PFAS in **'Analytical equipment, process measurement equipment, and laboratory equipment'** for 13.5 years.

Derogation 5n is currently very limited to diagnostic laboratory testing only and states –

"5n) The derogation for diagnostic laboratory testing includes precision refrigeration (blood bank refrigerator, vaccine storage), ultra-low temperature freezers or cryogenic storage, refrigerated centrifuges for sample separation, process chillers for precise temperature control and freeze-drying equipment. Use in in-vitro diagnostic devices is also covered. Additional information on uses of PFASs in the relevant applications can be found in Table A.103. in Appendix A.3.10"

Greater expansion can be added to encompass the use cases below, by expanding diagnostic testing to more clearly cover a wider range of applications requiring similar levels of testing, monitoring, and process control devices.

We additionally support the need to modify the derogation 6a to permit PFAS in "**Measurement Devices for monitoring and management of food and water**" for 13.5 years. Due to the complexity of identifying, qualifying and implementing PFAS-free material alternatives, a minimum 13.5 year implementation window is required as part of this modification.

Derogation 6a is currently limited to food contact, is limited to less than 13.5 years, and states:

"6a) For food contact materials used in the industrial production of food and feed, a time limited derogation is proposed. The following applications are inter alia covered by this derogation:
- *Piping and tubing for drinking water applications;*
- *Filters to capture contaminants from, for example, steam filtration in food processing;*
- *Seals, O-rings, gaskets, tubing and pipes, expansion joints;*
- *Valves and fitments, conveyor belting, chutes, guiding rails, rollers, funnels and sliding plates, tanks, funnels, rollers, linings, blades of knives and scissors, springs, filter membranes and sensor covers, lubricants;"*

It is essential that "Piping and tubing" for drinking water applications must be expanded to include all of the following in its definition: "instrument housings and measurement sensor components that either come in contact with measurement process solutions, or are fundamental components of devices required for the reliable and safe production of food and water."

Derogation extension process

Considering that PFAS substances in many applications do not have a known viable alternative, it is necessary to include a simple mechanism and formal process for extending derogation timelines beyond the timelines outlined in the dossier. All timelines outlined are the expected minimum steps to be considered and can only be started once an alternative is available. A process to allow additional time to be granted, where justifiable, is essential to reflect uncertainties in the process.

Request for distinction between Short/Long Chain PFAS and Fluoropolymers/elastomers

The provided Annex XV definition for PFAS as "substances that contain at least one fully fluorinated methyl (CF3-) or methylene (-CF2-) carbon atom, without any H/Cl/Br/I attached to it" encompasses thousands of unique chemical configurations with very different and unique chemical properties. It is recognised that this broad definition of PFAS is to ensure that 'regrettable substitution' is not undertaken to circumvent the intended restriction. This approach overlooks the very different intrinsic properties of the over 10,000 substances in the PFAS family and encompasses short chain, long chain, oligomeric, and polymeric PFAS. Many of the substances are not classified as hazardous substances according to the Classification, Labelling and Packaging Regulation[1] and they do not display the environmental and toxicological profiles associated with some PFAS which could be considered of concern. Many fluoropolymers relevant to industry, such as PTFE, meet the OECD criteria for "polymers of low concern".[2] This means that they are chemically stable, non-toxic, non-bioavailable, non-water soluble and non-mobile. We strongly request that broad exception be given to stable, non-hazardous fluoropolymers and fluoroelastomers such as PTFE, ETFE, PVDF, FKM, etc. These materials support critical components throughout industry and the physical and chemical properties of these materials

[1] Classification, labelling and packaging of substances and mixtures Regulation.

[2] A critical review of the application of polymer of low concern regulatory criteria to fluoropolymers II: Fluoroplastics and fluoroelastomers - Korzeniowski - 2023 - Integrated Environmental Assessment and Management - Wiley Online Library

will not be easily replaced by nonfluorinated compounds. Unless a differentiated restriction is implemented, irreparable damage to Europe, its citizens and its industry will be experienced.

PFAS criticality to Badger Meter products

Flow and water quality instrumentation market has an extremely high dependence on PFAS materials used as critical seals and protective material in many critical applications (e.g. seals, O-rings, gaskets, chemically resistant sensor bodies, and abrasion protection for device surfaces exposed to high physical wear.) Alternatives to PFAS are needed to meet highly demanding technical requirements, and when alternatives become available, re-certification of all associated products would be necessary for agencies protecting our safety in hazardous locations (UL, CSA, ATEX, as stated earlier, and others, as noted in "Societal Benefits") medical and disinfection purposes, and critical infrastructure in water, wastewater, chemical processing, food and beverage (FDA, 3A, NSF, WRAS, as stated earlier.)

Specifically, the electrochemical, gas, optical, flow, and pressure groups of Badger Meter use high performance PFAS related materials such as PTFE, Viton, PVDF, and others, to ensure a suitable level of product reliability and safety in a wide range of critical measuring applications. Badger Meter products utilising PFAS can be summarized in five ways –

1-As critical product **environmental sealing and protective body components of sensors** utilized in liquid and gas measuring applications for determining the conditions of water, waste water, food, and many other process liquids. Many of these PFAS polymers are selected because they are corrosion resistant, adhesion resistant, and are specifically approved by regulatory groups that we must comply with for sale when in contact with food or water – such as NSF, WRAS, FDA, etc., for direct contact with drinking water or food processes.

These materials need to have the following technical properties:

- Maintain high dimensional stability and structure over continued thermal change and chemical attack, such as the Viton seals on pH or chlorine sensors which cycle from 32 to 212F (0 to 100C) in some cases, while under pressure of 0-100 psig (0.7 MPa) and exposed to high levels of chlorine.
- Offer wide chemical compatibility for all sensors in all applications, ranging from caustic to acid, very low to very high pH, over 32 to 21F (0 to 100C.)
- High resistance to wear over a period of up to 20 years, in sensor body components subjects to high flow rates, and high concentrations of suspended solids, and high impact resistance.
- Low dielectric constant and high bulk resistivity when used as electrical insulators in sensors like two-electrode, four-electrode, and toroidal conductivity, and pH, where the dimensional or electrical change in the insulator over 32 to 212F (0 to 100C) can result in an unreliable cell constant or sensing element electrical circuit impedance problems.
- Very low self-degradation of seals and bodies under a wide range of environmental conditions, not just in liquid conditions, but also when exposed to UV in outside applications.
- Offer extremely high mechanical stability for user safety over long periods of time in higher pressure applications, as some sensors or devices can be used in applications to 200-300 psig (1.4 to 2.1 MPa,) up to 212F (100C.)

For gas instrumentation, similar sealing requirements are necessary, with the addition of human safety considerations as it needs to provide reliable gas monitoring in potentially toxic environments. Many potential PFAS-free alternatives degrade alternative polymer seals and sensor body materials. Replacing these critical sealing and body materials in liquid or gas sensor designs is expected to take well over 10-20 years due to the need for robust testing and recertification, and in many cases may not be possible at all. As these product lifespans often exceed 10 years minimum, we have built up a tremendous performance history in their long-term reliable operation, and that would be extremely difficult, if not impossible, to recreate with new alternative materials.

2-As critical **semipermeable membranes** which enable the very operation of some gas-phase sensing systems, such as dissolved oxygen sensing in aeration basins for wastewater treatment. Many of our sensors use PFAS polymer membrane barrier materials as a way to separate a specific component of a liquid or gas from the larger volume of local gas or liquid. In addition to offering the same chemical compatibly protection described for sealing, membranes are a selective barrier due to the nature of their porosity. Some may be more complex in their transfer characteristic, such as hydrophobic membranes. All of them have very specific material changes that must be fully understood to use them reliably, like porosity changes over temperature, diffusion rate changes based on thickness and temperature change, proper mechanical tension for stability in an application, chemical compatibility, and designed compensation schemes to account for interference parameters that can affect the final measurement. In one of the more simple cases, a common polarographic Clark-based sensing cell design for dissolved oxygen measurement from liquid relies on Teflon membranes for proper specific diffusion of dissolved oxygen into the electrolyte/electrode portion of the cell, reducing oxygen for the electrical measurement. The physical characteristics of the membrane must be extremely well understood, as porosity of the membrane can change over temperature or mechanical tension, affecting the diffusion rate of gas through the membrane, which can affect the balance of how the measurement is calibrated. Substitutions would be extremely time consuming to test and qualify, and would require changes to compensation design and calibrations techniques.

3-As a **binder in the sensor electrodes** to improve mechanical stability and performance of the sensors, as outlined in Case Study 3. The electrode in our sensors is the zone in which the electrochemical conversion of the target analyte occurs, creating a representation of electrical current from the converted sample.

4-In the **electronics**, which is generally part of every product we make. Much like the case with The Restriction of Hazardous Substances in Electrical and Electronic Equipment (RoHS), we cannot design in alternative components unless they are first converted in the semiconductor component market supply chain.

5- As various **mechanical parts of a wide range of chemical pumping systems that we manufacture.** Most of these products involve harsh chemicals to strip harmful substances from water and convert them into gaseous prior to detect them by our sensors. For this reason, we need to employ chemically inert and mechanically robust material to fabricate the components that meet highly corrosive acids and alkalis in the process. Inert to virtually all known chemicals, PTFE is a uniquely able to withstand exposure to such chemicals. It is also extremely stable in adverse conditions such as corrosive environment, and very high temperatures and pressures, as shown in Case Study 4. It can be moulded in various design to meet components of our analytical system. Currently, no other alternative to PTFE is available to meet these requirements.

Case Studies

The following outline specific PFAS uses in Badger Meter products to indicate the technical requirements that the PFAS components are able to withstand.

Case Study 1
Product: Q25 series pH and ORP Sensors.
PFAS used within the design: PTFE, PVDF frit (ionic bridge) for reference electrode salt bridge, Viton seals, electronic pcb (relying critically on PFAS.)
Quantity of PFAS: less than 1% of weight of product.
Viton and PTFE seals provide extremely high sealing reliability under a cycled temperature range of 14 to 212°F (-10 to 100C) under pressures up to 100 psig (0.7 MPa) at temperature, and can withstand a wide range of chemical attack that may be present in the measured process. PVDF, in sintered form, provides an ideal ionic bridge for the Ion Selective Reference Electrode, offering higher ionic flow rates over ceramic and high chemical resistance to the measured process. Internal electronic printed circuit boards are for conditioning and transmitting information.

Case Study 2
Product: H10 Electrochemical Gas sensors.
PFAS used within the design: PTFE membrane, PTFE flow restrictor, electronic pcb (relying critically on PFAS.)
Quantity of PFAS: less than 1% (0.7g) of weight of product.
PTFE membranes are extremely stable and reliable, providing a constant permeation rate across the membrane. The permeation rate of the membrane is one of the primary factors in the principles of operation of an electrochemical gas sensor. In addition to the need for stability under normal environmental conditions, the stability is required after exposure to a variety of corrosive or reactive chemicals, which are normal for the practical use of a gas sensor. The PTFE flow restrictor works in conjunction with the membrane to provide a stable sample of the gas being monitored. Changes in its dimensional characteristics through exposure to reactive gasses would induce errors in the sensor, potentially causing false readings which could place life and/or property at risk. Internal electronic printed circuit boards and their components are for conditioning and transmitting information. The sensor membrane is the fundamental operational element for the sensor, used in all gas sensing markets for monitoring of toxic gas.

Case Study 3
Product: H10 Electrochemical gas sensors – Electrodes.
PFAS used within the design: PTFE binder in Electrode matrices
Quantity of PFAS: less than 1% of weight of product.
A binder is an essential component in electrode preparation as it firmly binds the catalyst particles and conductive support for the purpose of preparing a durable free-standing electrode sheet that facilitates the electrochemical activities in a system. Our electrochemical gas sensors work on the principle of gas diffusion electrodes- where the catalysts coated on the porous membranes act at the interphase between liquid electrolyte and solid electrode. Therefore, hydrophobicity on the catalyst surface is another fundamental requirement for the fast and consistent response towards the targeted gas analytes. Polytetrafluoroethylene (PTFE) are widely used as a binder, as they have excellent chemical and thermal resistance and are best known for their binding properties. Additionally, PTFE used as the binder during electrode fabrication provides adequate hydrophobicity required at the surface of the electrodes. Since the properties of binders in the catalyst layer of electrodes used in electrochemical gas sensors influenced both the performance and lifetime of the sensors, replacing PTFE with non-PTFE binder in gas sensing will suffer from- poor sensitivity, low stability and false reading. An unreliable toxic gas sensor can potentially jeopardise workers safety as our sensors are widely used for everyday monitoring of toxic gases and substance in workplace.

Case Study 4
Product: Research Control Valves (RCV)
PFAS used within the design: PTFE packing and plug seats, FKM/FPM seals and diaphragms
Quantity of PFAS: TBD
Research Control Valves are used in all types of industry to convey and control all types of liquids and gasses. PTFE and FFKM seals are a critical component to rising stem globe valves as they provide the dynamic seal between a static housing and the translating stem. These engineered stem-seals, or packing sets prevent leakage of the process media to the external environment at a critical product interface. These seals must adapt to varying pressures, temperatures, and dynamic loads. Badger Meter uses virgin and filled PTFE in our stem seals due to its chemical compatibility, dimensional stability, elastic modulus, low friction coefficient, and seal-ability with mating rigid surfaces. Our stem seal packing sets are offered in many configurations and are capable of withstanding up to 60,000 psi (414 MPa) pressure and temperatures up to 400°F (204C). For valves that require full shut-off, Badger Meter uses PTFE or PFA at the plug/seat interface. The material of these components are critical to meeting the continuous shut-off classification (ANSI/FCI 70-2 Class VI achievable) that our customers require, as they are also resistant to plastic deformation under load. Fluoro-elastomer seal rings and diaphragms are used in our sanitary trim sets and valve actuators. These materials are chosen for their FDA certification, chemical compatibility, low friction, and elasticity. These seals are a critical part of the valve or actuator's safety function as they prevent external leakage of the process media, as well as motive fluids, to the environment.

Case Study 5
Product: Q Series Auto-Chem systems (46S-66 Auto-Chem Sulfite Monitor and Q46S/81 Sulfide Monitor)
PFAS used within the design: TEFLON (PTFE) air stripping chamber and plug, PTFE gas conditioner, and sensor flow block, Viton seal.
Quantity of PFAS: Less than 1% of product weight, about 620 gm of PTFE
Our Q series Auto-Chem systems employ concentrated mineral acids/alkalis as the essential reagents in the process of measuring dissolved chemicals in water. A PTFE air stripping chamber is a reaction vessel to mix concentrated acid and the sample to convert and stripped dissolved chemicals into acidic gas. The gas exists from the tube connected on top of PTFE plug with Viton seal on it and travels to PTFE gas conditioner to remove excess moisture. Now the dried acidic air flows to the PTFE sensor chamber to meet the senor to readout the concentration of dissolved chemical.

Case Study 6
Product: Electromagnetic Flow Meter (ModMAG)
PFAS used within the design: PTFE, PFA and ECTFE liner materials
Quantity of PFAS: TBD
Electromagnetic Flow Meters are used in all types of industry for measuring and monitoring flow rate of liquids that can have a magnetic field induced within them. PTFE liners are critical components in measuring the fluid's magnetic field generated by the electromagnets; the liners isolate the conductivity of the fluid to only the electrodes which prevents any loss of signal that would disrupt accurate flow measurements. PTFE is chosen as a liner material for its chemical compatibility, dimensional stability, elastic modulus, low friction coefficient, wear resistance, and high conductive insulation. The PTFE liners are capable of withstanding fluid temperatures up to 302°F (150C) and up

to 1400 psi (9.7 MPa) pressure. The expected lifespan of a ModMag flow meter is a minimum of 10 years, which relies on suitable materials for the application.

Additionally, the sole production facility for Mag Meters is located in the European Union member state of the Czech Republic. The ban of PFAS would require the closure of our current facility and a new production location opened outside of the European Union to service our customers in North America.

Case Study 7
Product: Industrial Oval Gear (IOG), Industrial Disc, Industrial Turbo
PFAS used within the design: FKM/FPM seals, PVDF bodies, and PTFE coatings
Quantity of PFAS: TBD
The Industrial Oval Gear Meter, Model IOG is a modular flow meter design, economical yet highly accurate and rugged. The model IOG is designed for a variety of chemical applications including petroleum-based fluids, water solutions and any other liquid compatible with the materials of construction. Viton is used as a seal between the lid and the body of the IOG meter to prevent the often toxic and corrosive process fluid from leaking. This fluid can be up to 240°F (115C) at up to 3000 psi (20.7 MPa.) Viton seals are used in applications where, due to chemical compatibility or temperature/pressure requirements exclude other seals. These seals are critical and stand as the barrier between these toxic fluids and the environment. These meters use a single Viton seal that accounts for less than 1% of the total weight of the meter. In addition, any changes to these seals would require an ATEX recertification. In applications where the stainless steel or aluminium are not acceptable, the PVDF body is offered. In addition, our rugged line of industrial disc and industrial turbo meters similarly use FKM seals in applications where chemical and temperature resistant materials are needed to prevent hazardous chemicals from leaking to the exterior of the meter. These technologies also have PTFE coated magnet assemblies to perform in these harsh environments without premature failure.

Case Study 8
Product: Nutating Disc Meters (Recordall Disc), Turbine Meters (Recordall Turbo), Compound Meters (Recordall Compound)
PFAS used within the design: PTFE
Quantity of PFAS: TBD
Nutating disc meters are highly accurate and reliable positive displacement metrology devices used extensively in the measurement of potable water and other liquids. In the case of potable water, these meters are almost exclusively used for municipal water billing purposes to allow the water operators to accurately bill end users. Expected field service life of this technology is 20 years during which time it is essential that the devices maintain accuracy and quiet operation throughout the duration. This metering technology relies on very tight mechanical tolerances of parts that are moving in very close proximity with minimal clearance in addition to components that are in constant contact and moving relative to each other. Some internal components of these devices are made from injection molded polymeric systems that have a blended PTFE content. In addition, Recordall Turbo meters have PTFE modified plastic components used in low friction bearing surfaces. Compound Meters are a dual path meter that combines the nutating disc and turbine technology in one embodiment. The addition of PTFE to the polymer matrix has many positive contributing effects to the performance and longevity of the products including adding dimension stability and toughness. Lowered coefficients of friction reduce bearing surface wear resulting in a significant increase in the durability of these engineered

parts. The removal of PTFE from the product would decrease the accuracy and lifespan of the product requiring more frequent replacement. When used for municipal water billing purposes, the meters are typically paid for and installed by the local water utility and reside in or around the end user dwelling. Loss of accuracy and lifespan of this product could have monetary implications for the water utility both in inaccurate billing quantity number and higher capital costs for more frequent replacement. More frequent replacement resulting from the decreased lifespan would increase the waste stream and accelerate the landfilling of these components.

Case Study 9
Product: Single and Dual Rotor Precision Turbines (Cox)
Potential Main Conflict Materials: PTFE
Quantity of PFAS: TBD
Precision turbine meters require high precision bearings that are also very low friction. This combination of properties allows extremely free spinning of the turbine rotor within the meters and is related to the accuracy of the device for the stated flow range. These devices cover a very large temperature range from extreme cold through extreme heat. They also have a very wide range of fluids and gasses they can be used with that are only limited by temperature and chemical compatibility. These applications can also be dry or non-lubricating and require a material for bearing retainers that are self-lubricating low friction materials that are media and temperature compatible in the application. The majority of the time PTFE, PTFE reinforced, or PFTE filled materials are the only materials that can be used in these applications.

<u>Timeframe to Develop PFAS-free Alternatives and Investment Feasibility</u>
Research and Await Approval – Only after a range of alternative possible materials for a unique and specific seal, body, or membrane is known, and pre-approved by any required regulatory agencies, our timeline for review and testing would begin. Therefore, just to begin any real work in test and validation would like take 3 years of identification, research, and discovery, while also waiting material list approvals from required certifying agencies.

Prototype – Once potential alternatives have been identified for each specific use case, we would likely spend the first 3-4 years carefully building prototypes of various new sensing assemblies in an attempt to comparison-test new possible alternatives against the existing reliable systems. This time would also require analysis on suitability for manufacturing, re-molding, etc.

Alpha Field Test - Assuming suitable candidates were determined in the first phase of review and testing, we would move those prototypes to field application testing for the next 3-4 years, again comparing them side by side with known reliable systems. This period would be quite lengthy as we need long term exposure to the new material, as our products typically last more than 7-10 years in operation, and we need to allow proper time for longer term environmental and chemical effects to take place.

Pilot Production- Any material passing this phase would potentially be designed into production, requiring an additional 2-3 years to fully release all new documentation and systems - assuming the application and usage still fits all compliance requirements buy any regulatory agencies. Some of this time is also needed for additional pilot/production testing validation.

Pre-release Certification - Finally, assuming product has been adequately reviewed and tested at all phases, official regulatory submission of production samples would be sent to the required agencies, for their own testing and review. The timing of this phase is dependent on the number of agency reviews required, and would likely required between <u>2-3 years per product</u>. So, each product would be required to go through this process, and they cannot happen simultaneously. This re-submission phase is also extremely expensive.

So, we can generally estimate that from the point an alternative is known for a specific material in a specific use case, we are like to need a minimum of 13.5 years to qualify and certify that specific part. As we have hundreds of parts that will be an issue, it is likely that only some products could feasibly be modified for such a large material scope change. In addition, it is important to note that the material could fail any part of the process review, and we may not actually conclude with an acceptable substitution.

Finally, all of the substitution cases would require costly re-submission to all required regulatory approval agencies for recertification. Overall, once a suitable PFAS-free alternative is identified it is expected that at least 13.5 years would be required to undertake the necessary qualification and move to full production. Therefore, we expect almost all cases to exceed 13.5 years in total.

There would significant risk and time associated with developing replacement technologies that are PFAS-free. While any specific estimate is difficult to provide – we would experience a **direct loss of ~$10M of revenue per year** with commensurate development costs far eclipsing that figure. Between the revenue lost and development costs, we would need to evaluate our participation in these markets which may lead to market exits and subsequent layoffs of in-region personnel.

The entire effort in time and cost to evaluate, retest, and recertify would likely prohibit the feasibility of the entire replacement project. While this might be a consideration for new product development, it does not seem like it would be feasible to make this tremendous investment in both time and money to find alternatives in so many existing products that would not jeopardize the product performance, reliability, or user safety in the use-cases.

<u>Waste and emissions</u>

Overall, as was the case with RoHS, the volume of industrial instrumentation material reaching an EOL state that enters a landfill is a very small fraction of what enters from the consumer or medical product markets. Our products are intended to offer useful lifetimes of 7-10 years, or more, and are not frequently updated or replaced like product in the consumer markets. In addition, the weight of PFAS materials, if even present, can be seen in the case statements above as generally much less than 1% of the product weight.