

Emerging PFAS Regulations and the Grease Industry

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Emerging regulations of PFAS (per- and polyfluoralkyl substances), including PTFE (polytetrafluoroethylene), other FPOs (fluoropolymers) and PFPE (perfluoropolyethers), may have complex implications for grease manufacturers and their suppliers and customers.

PFAS are valued for many properties including chemical inertness, low coefficient of friction and stability over a wide temperature range, and they are used in many applications (Table 1). But PFAS degrade very slowly and accumulate in water, soil, air, the food chain and biological tissue. Specific PFAS have been determined to be toxic or have harmful effects on the health of humans and other species. Many nations currently regulate or restrict production, import and/or use of specific PFAS, and others are introducing new or expanding current regulations (Tables 2 and 3).

Table 1. Some of the many applications and industries where PFAS are used

<u>Applications</u>		
Aerosol propellants	Foam-blowing agents	Paints and coatings
Additives - aviation hydraulic fluids	Gaskets	Personal care products
Batteries	Grease thickeners	Pesticides
Bearings	Herbicides	Photographic processes
Carpets	Lab equipment	Refrigerants
Clothing	Lube base oils, additives	Sealants
Construction products	Medical devices	Single-use plastics
Cosmetics	Metal plating	Ski wax
Electronics	Mist suppressants	Stain and water proofing
Fabric coatings	Mold release agents	Surfactants
Filtration and separation media	Non-stick cookware	Tubing
Firefighting foams	O-rings	Waterproofing
Floor polishes	Packaging - food	Window frames
<u>Industries</u>		

A&D (Aerospace and defense)	Energy	Petroleum
Automotive	Lubricant	Plastics
Aviation	Metal working	Semiconductor
Chemical	Mining	Textile
Clothing	Paper	Transportation

Table 2. Existing and emerging regulations of PFAS according to the IAEG (International Aerospace Environmental Group) PFAS Regulatory Status Fact Sheet (2023)

https://www.iaeg.com/binaries/content/assets/iaeg/wg9/iaeg_pfas_fact_sheet_wg9.pdf

	Existing	Emerging
Australia	X	
Brazil		X
Canada	X	
European Union	X	X
India		
Japan	X	
Mexico		X
New Zealand	X	
People's Republic of China		X
Russia	X	
South Korea	X	
United Kingdom	X	X
United States	X	X

Table 3. Regulations and activities related to PFAS by nation (excerpted January 9, 2023, from <https://www.oecd.org/chemicalsafety/portal-perfluorinated-chemicals/countryinformation/>). The five nations (Denmark, Germany, the Netherlands, Sweden and Norway) that submitted the 2023 Proposal on the restriction of PFAS in the EU are shown in bold font.

Nation	Regulations and activities
Australia	PFAS are not manufactured. Regulations focus on import, use, contamination and waste disposal. The 'National PFAS Position Statement' states that future PFAS use should be reduced to the greatest extent practicable. The Australian Government is working with industry groups to phase out use of PFAS.
Belgium	Promotes the complete phase-out of PFAS except for essential uses until alternatives have been found. National government sponsors research and projects to develop alternatives to PFAS and screening of soil and groundwater for PFOA and PFOS to identify sites to remediate.
Canada	Manufacture, sale, offer for sale and import of PFOA, PFOS and C8-C20 PFACs along with their salts and precursors are prohibited with some

	exceptions. Monitors PFAS in air, water, sediment, aquatic and terrestrial biota, wastewater and biosolids.
Denmark	Currently bans use of all organic fluorine compounds in paper and cardboard food packaging. Addresses certain PFASs through EU regulations, encourages phase out of PFAS and encourages voluntary restrictions.
Finland	Addresses risk reduction of certain PFAS (primarily PFOA, PFOS) through EU regulations. Focuses on PFOS phase-out and alternatives. No PFOS production. Use of PFOS in firefighting foams prohibited. Limits on PFOS in drinking water is under consideration. Screens PFAS compounds in fish and surface and ground waters.
Germany	Addresses chemical risk management mainly through EU regulations. Limits amounts of PFCAs and PFASs in drinking water. Set HBM I values of 2 ng PFOA/ml and 5 ng PFOS/ml in blood plasma. The HBM I value represents the concentration of a substance in a body matrix below which adverse health effects are not expected and therefore, no exposure reduction measures are necessary. Set limits on several PFAS in drinking water.
Japan	Strictly regulates manufacture, use, export and import of PFOS and its salts. Conducts environmental monitoring of PFOS.
Korea	Any manufacture, import, export and use of PFOS, its salts and PFOS-F are restricted except for specific exemptions and acceptable use per the Stockholm Convention. Seeks to minimize use and develop alternatives of PFAS. Conducts environmental monitoring of PFOS and PFOA.
Netherlands	Addresses certain PFASs under EU regulation.
Norway	Monitors PFAS in the environment; requires waste treatment plants to screen and report levels of PFASs in their discharges and apply for permission for discharges; airports must screen and report levels of PFASs in their soil and propose measures to remediate; mapped all potential sources of PFAS in a major lake and identified main contributor; and minimized exemptions to regulation of PFOS regulation under the Stockholm Convention.
People's Republic of China	Monitors PFC production and/or emissions, focusing on PFOS and sulphonamide perfluorooctane (FOSA) in water, sediment and fishes in industry parks in Hubei and Zhejiang Provinces. Monitors PFOS and PFOA in water, sediment and fish and at an electronic waste dismantling plant in Guangdong Province and in air and water of mainland China, Hong Kong and Macau. Announced bans on production, transportation, application, imports and exports of PFOS, its salts and PFOS-F, except for specific exemptions and acceptable use, restrictions on production of PFOS and PFOA and support of R&D for alternatives to these substances.
Poland	Addresses certain PFASs under EU Regulations. All actions taken by EU are generally taken in consultation with internal stakeholders in Poland (industry,

	NGOs). Took voluntary action under the Control of Hazardous Substances in the Baltic Sea Region (COHIBA) project to raise awareness on PFOS.
Russia	<p>Regulations regarding certain PFASs are implemented in accordance with international conventions and agreements: the Baltic Marine Environment Protection Commission (HELCOM, Recommendation 31E/1), the Stockholm Convention on POPs, the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemical and Pesticides in International Trade, SAICM, and the current OECD program on the management of PFASs and transition to safer alternatives.</p> <p>Strict restriction on manufacture, import, export, and use of PFOS, its salts, and PFOS-F except acceptable uses and specific exemptions per the Stockholm Convention.</p> <p>Regulatory documents of the Customs Union (Belarus, Kazakhstan and Russia) do not indicate future bans or restrictions on those PFASs that are subject to regulations by international conventions and agreements.</p>
Sweden	Addresses certain PFASs through EU Regulations. Developed national action plans to increase safety of drinking water supplies and provide a toxic-free everyday environment. Surveyed PFAS, their uses and alternatives.
U.S.	<p>EPA considers PFAS as an urgent public health and environmental issue facing communities across the U.S. EPA developed a coordinated strategy to protect human health and the environment from PFAS. The PFAS Strategic Roadmap highlights concrete actions the Agency across a range of environmental media and EPA program offices to protect people and the environment from PFAS contamination. The Roadmap is guided by three primary goals:</p> <ul style="list-style-type: none"> • Research. Investing in research, development, and innovation to increase the understanding of PFAS exposures and toxicities, human health and ecological effects, and effective interventions that incorporate the best-available science. • Restrict. Pursuing a comprehensive approach to proactively prevent PFAS from entering air, land, and water at levels that can adversely impact human health and the environment. • Remediate. Broadening and accelerating the cleanup of PFAS contamination to protect human health and ecological systems. <p>EPA is committed to leveraging the full range of statutory authorities to better understanding and addressing risks from PFAS.</p>

North America

For decades, EPA has studied toxicity and effects of specific PFAAs on human health and the environment and implemented regulations. The manufacture, import and use of “long-chain” (C8) PFAS are heavily restricted or banned; “short-chain” C6 PFAS are

common substitutes. Chemical Data Reporting (CDR) requirements oblige manufacturers and importers to report data on the production and use of PFAS, and Significant New Use Rules (SNURs) restrict their use.

EPA's Strategic Roadmap (2021-2024) contains goals to restrict emissions and release of PFAS, remediate pollution and determine liability. The Roadmap is strongly supported by the Biden-Harris Administration and involves the VA, FDA and DOD.

In 2023, EPA proposed the first national standards for levels of six PFAS in public water systems (PWSs) (Table 4); started monitoring 29 PFAS in more than 10,000 PWSs; and started to distribute \$10 billion for removal of PFAS and other contaminants.

Table 4. EPA's proposed limits on PFAS in drinking water (Note: EPA's current Health Advisory limit is 70 ppt for total PFOA and PFOS level in drinking water. This is not an enforceable standard.)

Substance		Proposed limit
PFOA	perfluorooctanoic acid	4.0 ppt
PFOS	perfluorooctyl sulfonate	4.0 ppt
PFBS	perfluorobutane sulfonic acid	TBD
PFNA	perfluorononanoic acid	TBD
PFHxS	perfluorohexanoic acid	TBD
HYPO-DA	hexafluoropropylene oxide dimer acid and its ammonium salt	TBD

If EPA standards for PFAS in PWSs are put into practice, then states and municipalities will be required comply. Many states have started measuring PFAS levels in PWSs and investigating treatment options to remove PFAS.

In 2024, EPA is moving forward with new regulations on permits and means to measure and limit PFAS in discharges from PFAS manufacturers, metal finishers and landfills.

Canada prohibits the manufacture, sale, offer for sale and import of PFOA, PFOS and C8-C20 PFACs (perfluoroalkyl carboxylates) along with their salts and precursors, with some exceptions.

Mexico does not currently regulate or restrict PFAS. However, PFOS is imported. As a Party to the Stockholm Convention, Mexico is developing a plan to impose import and export limitations on PFOA, PFOS and related substances.

EU

The European Chemical Agency (ECHA) implements REACH, which regulates C9-C14 perfluorocarboxylic acids (PFCAs) and PFOA (C8), their salts and related substances. The REACH Candidate List of substances of Very High Concern (SVHC) contains PFOA, PFOS and C9-C14 PFCAs. Importers and manufacturers of SVHCs in the EU are obliged to provide information about PFAS to consumers and ECHA.

ECHA has global influence through its involvement in import and export of chemicals, limitations on pollution and activities of the UN such as the Stockholm Convention.

The Stockholm Convention is an international environmental treaty intended to eliminate or restrict the production and use of persistent organic pollutants (POPs) including specific PFAS (Table 5). It is in effect in 185 nations and the EU (but not the U.S., Israel or Malaysia).

Table 5. PFAS designated as POPs by the Stockholm Convention

Substance	Status
PFHxS, its salts and PFHxS-related compounds	Production and usage eliminated in 2020
PFOA, its salts and PFOA-related compounds	Production eliminated, with the exception of fire-fighting foams (covered by a different regulation). Usage eliminated except for specific exemptions in 2019.
PFOS, its salts and <u>perfluorooctane sulfonyl fluoride</u>	Production restricted to specific uses, including hard metal plating, insect baits for control of leaf-cutting ants and fire-fighting foams in 2009.
Long-chain perfluorinated carboxylic acids (C9-C21 PFCAs), their salts and precursors	Under consideration for inclusion in the Stockholm Convention and consequent elimination of global production and use.

In January, 2023, five EU Member Nations submitted a “universal” proposal to ECHA to ban the manufacture, import and use of PFAS (as defined by OECD) for nonessential applications and restrict their sale as constituents of other substances, mixtures or articles in the EU (Tables 6 and 7). ECHA published the proposal as Annex XV Restriction Report, Proposal for a Restriction on PFAS.

Table 6. The 2023 Proposal to the ECHA recommends in general a transition period of 18 months followed by a ban of PFAS in nonessential applications. In certain cases, there would be a five- or 12-year “derogation” period for development of replacements. The ban would not apply to PFAS used in essential applications where no replacement is available, e.g., certain medical devices and analytical standards.

Case	Derogation period (5 or 12 years)	Transition period (18 months)	Ban

Nonessential application, replacement available	-	X	X
Nonessential application, no replacement available	X	X	X
Essential application, no replacement available	N/A	N/A	N/A

Table 7. The Proposal to the ECHA recommends limitations on the sale of PFAS as a constituent of another substance, a mixture or an article. Note: If total fluorine exceeds 50 mg F/kg, then the manufacturer, importer or downstream user could be required to provide proof for the measured F content as either PFAS or non-PFAS upon request.

Maximum	Case
25 ppb	Any PFAS as measured with targeted PFAS analysis (polymeric PFAS excluded)
250 ppb	The sum of PFAS measured as the sum of targeted PFAS analysis, optionally with prior degradation of precursors (polymeric PFASs excluded)
50 ppm	PFAS (polymeric PFASs included).

The OECD defines PFAS as “fluorinated substances that contain at least one fully fluorinated methyl or methylene carbon atom”—in effect, any chemical with at least a perfluorinated methyl or methylene group.

Two ECHA Committees are currently evaluating the alignment of the Proposal with REACH and its feasibility and likely effects. They will report their findings to the European Commission, which together with EU Member States will decide on restrictions of PFAS.

Although the UK exited the EU, it implements some regulations from REACH and restrictions on POPs. The UK is taking steps to implement regulations that are expected to align with those proposed in the 2023 Proposal under consideration by ECHA.

BRIC

Brazil is a Party to the Stockholm Convention and expected to comply and control production and use of certain PFAS. Brazil attempted to survey domestic use and prepare an inventory of PFAS, but cooperation was minimal. Brazil produces and

imports PFAS from People's Republic of China (PRC). Environmental contamination by PFAS, primarily PFOS, is widespread.

According to the OECD, Russia signed the Stockholm Convention and several other international agreements that cover the regulation of certain PFAS. Manufacture, import, export, and use of PFOS, its salts, and PFOS-F (perfluorooctanesulfonyl fluoride) are restricted except for acceptable uses and specific exemptions per the Stockholm Convention. A different source claims that PFOA and PFOS are manufactured and used to manufacture other products in Russia.

India does not regulate PFAS at present. PFOA and PFOS are manufactured in India and used to manufacture products.

In PRC, PFOA and PFOS are manufactured and used in the production of fluoropolymers. In 2023, the New Pollutant Management Action Plan was proposed to regulate chemical registrations, ban and restrict harmful chemicals and impose standards on hazardous chemical content in products.

PFPEs, PTFE and Other FPOs

Annex E to the 2023 Proposal to restrict PFAS in the EU contains details about production and use of PFAS and proposed restrictions by sector (<https://echa.europa.eu/documents/10162/8de11d7c-c56f-e204-5072-e89f11071219>).

For lubricants, information is given in section E.2.14 Lubricants (pages 475-493). Section E.2.14 considers PFPEs, PTFE, PFAS-based additives other than PTFE, PFAS-based solvents used as carriers and PFAS-based solvents used as cleaners. Projected tonnage volumes and emissions of PFAS lubricants, alternatives, human health and environmental hazards, environmental, economic and other impacts are presented. A cost-benefit analysis of substitutes for PFAS-based lubes includes costs and functionality loss. Three options are considered (Table 8).

Table 8. Proposed restriction options for PFAS used in lubricants, from Table E.151 in Annex E to the Annex XV Restriction Report Proposal for a Restriction of PFAS, version 2, 22.03.2023, section E.2,14, Lubricants, pages 475-493. (<https://echa.europa.eu/documents/10162/8de11d7c-c56f-e204-5072-e89f11071219>)

Option	Short description	Derogation	Transition
RO1	Full ban	No	Yes, 18 months
RO2	Ban with use-specific derogations	Yes, 12 years	Yes, 18 months

Maximum additional emission scenarios	Ban with full derogation of entire PFAS groups	No	Yes, 18 months
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Section E.2.14 concluded, “According to industry stakeholders a ban of PFASs [sic] in lubricants would have significant effects on the economy...there are no drop-in alternatives under harsh conditions or for safe functioning and safety of equipment, and therefore product reformulation is needed for an extensive number of uses. The product reformulations will not only result in impacts directly related to the development and implementation of the new products, but also impacts related to elements such as quality assurance and safety measures. It is also noted how there are additional potential costs related to product functionality losses resulting in elements such as shorter lifetime, potential functional downtime, increased frequency and maintenance uses.

These impacts and challenges would mainly be passed on to downstream sectors where impacts could be 100 – 1 000 times more costly than for the lubricant sector itself, if access to PFAS-based lubricants or parts with these lubricants are no longer available. Many downstream sectors would be at risk of significantly reducing efficiency, productivity, competitiveness, and perhaps even have to discontinue their operations. The effects would be seen among many industries including automotive, aviation, medical, chemical, renewable energy sectors etc.”

The Proposal concludes that “a full ban without delay on the use of PFAS in lubricants would be likely to have substantial consequences for the lubricants sector and downstream users of PFAS-based lubricants” and recommends a 12-year derogation period to develop alternatives and an 18-month transition period (option RO2 in Table 8).

Responses

According to the American Chemicals Council (ACC), most fluoropolymers “meet internationally recognized criteria for being considered polymers of low concern (PLCs), a designation for compounds that are expected to have insignificant environmental and human health impacts.”

Henry (WL Gore & Associates, Elkton, Maryland) and colleagues published a peer-reviewed paper on toxicity, human health, and physical, chemical, thermal and biological data for FPOs. They showed that PTFE meets all 13 criteria for PLCs, is “distinctly different” from other PFAS and should be considered separately for regulatory purposes.

The analysis in Section E.2.14 of the 2023 Proposal primarily addressed PFPEs; there was little discussion of PTFE and greases. Nevertheless, the Proposal includes PTFE

and other FPOs in sections concerning applications and products other than lubricants including consumer products.

In the U.S., national advocacy organization Food & Water Watch reported that the chemical industry has been lobbying Congress about legislation “to address the crisis of PFAS contamination throughout the country.” *Time* magazine published a story that likened ‘forever chemical’ lawsuits to those of ‘big tobacco’. Safer States, the Environmental Working Group and other organizations are disseminating information to the general public about risks associated with “forever chemicals”.

Already, 26 states and some organizations have initiated many thousands of legal actions against PFAS manufacturers (including 3M, Arkema, Chemours, and Solvay) seeking damages for claims of environmental contamination and public health issues. They seek bans on PFAS and compensation including funds to defray costs of filter systems for PWSs.

In California, PFOA and PFOS are covered by Proposition 65 consumer product regulations. Maine and Minnesota passed legislation for reporting requirements and eventual total bans of nonessential use of PFAS. Multiple states have banned use of PFAS in applications such as textiles, food packaging, personal care products and firefighting foam. GreenCarCongress noted that FPOs are widely used in the automotive industry for hoses, brake lines, O-rings, seals, gaskets and batteries.

Trade organizations representing industries reliant upon PFAS are informing and warning member companies of potential implications of emerging regulations on PFAS.

In 2023, the IAEG (International Aerospace Environmental Group), a recognized global body for the aerospace and defense industries with 55 member companies, published a fact sheet, PFAS Regulatory Status, about current and emerging regulations in the U.S., EU and other countries. The PFAS Fact Sheet recommends four sets of preparations, e.g.:

- Strategy - Monitor current and pending regulations and develop plans for operations and internal communications
- Input – Develop plans for compliance, questionnaires for suppliers and timelines
- Operations – Review permits and identify materials and processes that may not be in compliance in the event that emerging regulations are implemented
- Output - Check waste streams, disclosure requirements for finished products (consumer protection), and needs for product declarations/certifications

The SPE (Society of Plastics Engineers) is extending a Call for Speakers to present at Per- And Polyfluoroalkyl Substances (PFAS) in the Plastics Industry, October 18-19, 2023, Baltimore, MD. Potential speakers will include regulatory experts, scientists, researchers, academia, and professionals who possess in-depth knowledge of the

fluoropolymer and the PFAS market, including insights into technical challenges their replacements. Industrial sectors will include:

- Material/Additives Suppliers
- Polymer Processing
- Packaging
- Medical
- Automotive/Aerospace
- Semiconductor industry
- Textile industry

The Semiconductor Industry Association (SIA) organized the Semiconductor PFAS Consortium. The Consortium is an international group of more than three dozen semiconductor manufacturers and their supply chain members. The Consortium focuses on identification of PFAS uses, alternatives, release pathways and control of emissions. Two intents are to inform public policy and legislation regarding the semiconductor industry's use of PFAS and support of research and development efforts.

The Consortium collected data and conducted studies and analyses to help formulate an industry approach to PFAS. Peer-reviewed publications, technical papers and white papers are available on the SIA website. The technical papers summarize the applications of PFAS in the semiconductor industry, the significant technical challenges that would be necessary to replace these substances in semiconductor manufacturing processes and equipment and the consequent socioeconomic impact.

The AATEC (American Association of Textile Chemists and Colorists) announced that they will hold a PFAS Conference on May 2-3, 2024, at the StateView Hotel in Raleigh, North Carolina. The Conference will focus on what the latest research, technology, and legislation regarding PFAS mean for the textiles industry. Speakers and content of presentations from their 2023 PFAS Conference are posted on their website.

ASTM International has standards to address PFAS in the environmental. In 2023, ASTM held a workshop on sources, sampling and standards of PFAS in the atmosphere. The new F15.81 subcommittee was formed as part of the committee on consumer products (F15).

Summary

Emerging regulations of PFAS present complex challenges for the grease industry and by extension, other lubrication and upstream and downstream industries.

Several thousand liquids, surfactants, solid polymers and gases with unique properties are covered by the OECD definition of PFAS (below). Broad bans of PFAS could preempt using some PFAS to replace others. Possible availability, feasibility and cost of nonfluorinated substitutes would be specific to individual applications and use conditions.

PFAS are components of many formulated products. Current formulations and systems (drills, pumps, gears, spray applicators, etc.) are optimized around use of specific PFAS. It could be problematic to project time frames and execute projects to reformulate products, retool machinery and redesign and replace systems to meet deadlines for phasing out PFAS.

Trade groups whose member companies rely upon PFAS are proactively taking steps to inform members about emerging regulations on PFAS, analyze use and emission of PFAS, assess technical challenges of replacing PFAS and model socioeconomic impact.

In the U.S., EPA continues to follow a well-defined Roadmap that is strongly supported by the federal government. In 2023, EPA proposed the first national standards for levels of six PFAS in public water systems (PWSs); started monitoring 29 PFAS in more than 10,000 PWSs; and started to distribute \$10 billion for removal of PFAS and other contaminants. If EPA standards for PFAS in PWSs are put into practice, then states and municipalities will be required comply. Many states have started measuring PFAS levels in PWSs and investigating treatment options to remove PFAS.

In 2024, EPA is moving forward with new regulations on permits and means to measure and limit PFAS in discharges from PFAS manufacturers, metal finishers and landfills.

There are currently stark differences among nations with respect to compliance with international environmental treaties, transparency, and domestic regulation and enforcement regarding PFAS. Continued lack of universality could lead to “PFAS-compliant” and “PFAS-noncompliant” products and systems. For example, Shamrock Technologies (Newark, NJ) offers products that contain less than 25 ppb PFOA and can comply with the 2023 Proposed EU regulations.

Regulations that require permitting, reporting and monitoring use, inventories, and waste streams present complicated risk scenarios and liabilities. PFAS such as fluorosurfactants used in mining and drilling (petroleum) operations and production of other chemicals including FPOs, various raw materials and different supply chains can be present in products, processing systems, waste streams and landfills. For example, metal finishing shops have attributed PFAS in their baths to contaminants introduced by parts from customers and persistent residues in their systems.

The most general and potentially the most influential emerging regulations are based on the 2023 Proposal to regulate PFAS in the EU. Notably, the Proposal analyzes the lubricant industry overall (and not the grease industry), and it focuses on PFPEs. The Proposal concludes that “a full ban without delay on the use of PFAS in lubricants would be likely to have substantial consequences for the lubricants sector and downstream users of PFAS-based lubricants” and recommends a 12-year derogation period to develop alternatives and an 18-month transition period (option RO2 in Table 8).

The 2023 Proposal considers uses of PTFE and other FPOs in products other than lubes and greases. Research supports claims that PTFE and other FPOs qualify for treatment as PLCs and should be considered separately from other PFAS for regulatory purposes.

Emerging bans on PFAS entail technical challenges including development of new quantitative analytical techniques, further studies on toxicity, health risks, exposure limits, and degradation pathways, and commercialization of filtration and other methods for remediation of polluted water and soil and treatment of waste streams.

Implications of emerging regulations of PFAS are significant for the grease industry, the lubricant industry and their customers in industries with much larger and much higher socioeconomic profiles.

Sources and Information

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<https://www.4spe.org/i4a/pages/index.cfm?pageid=8321>