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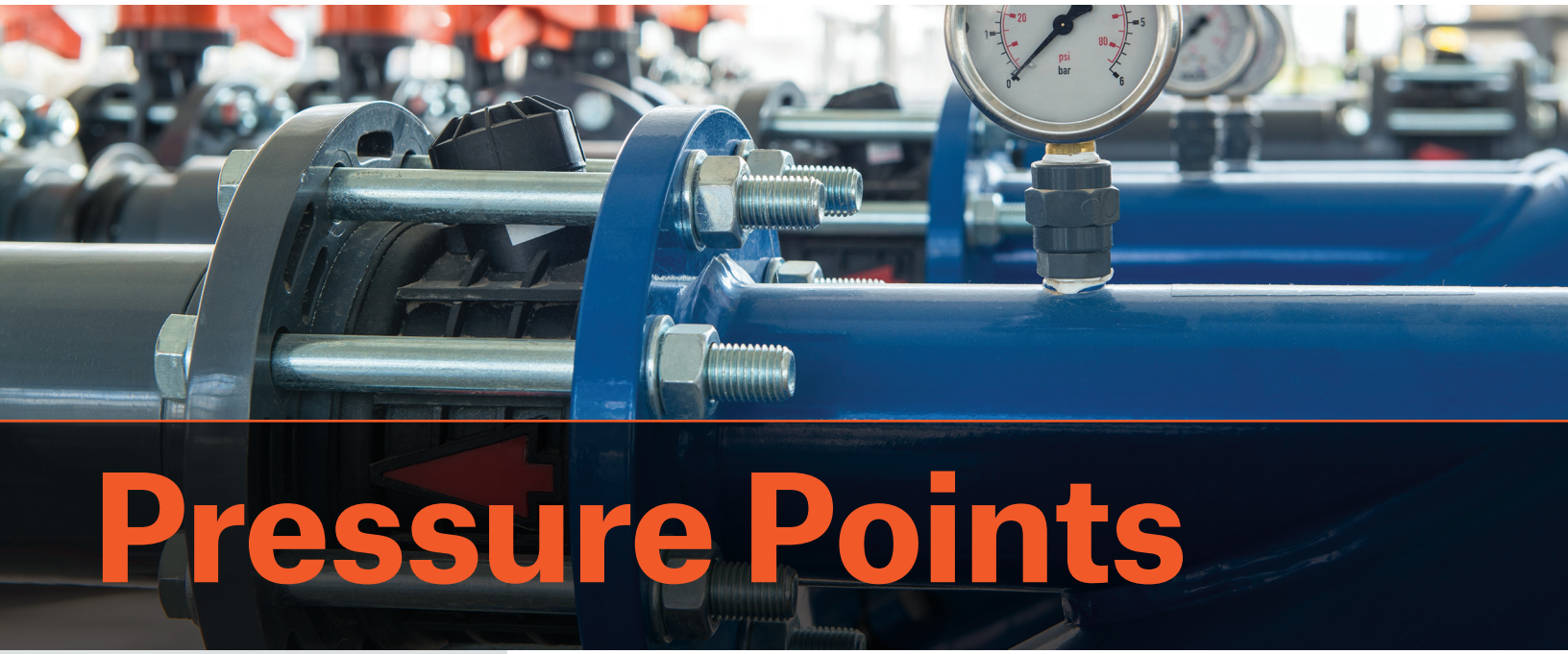

Pressure Points

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HSB, a Munich Re company, is a technology-driven company built on a foundation of specialty insurance, engineering, and technology, all working together to drive innovation in a modern world.

The age of small modular (nuclear) reactors

Author: Paul Coco, Senior Engineer

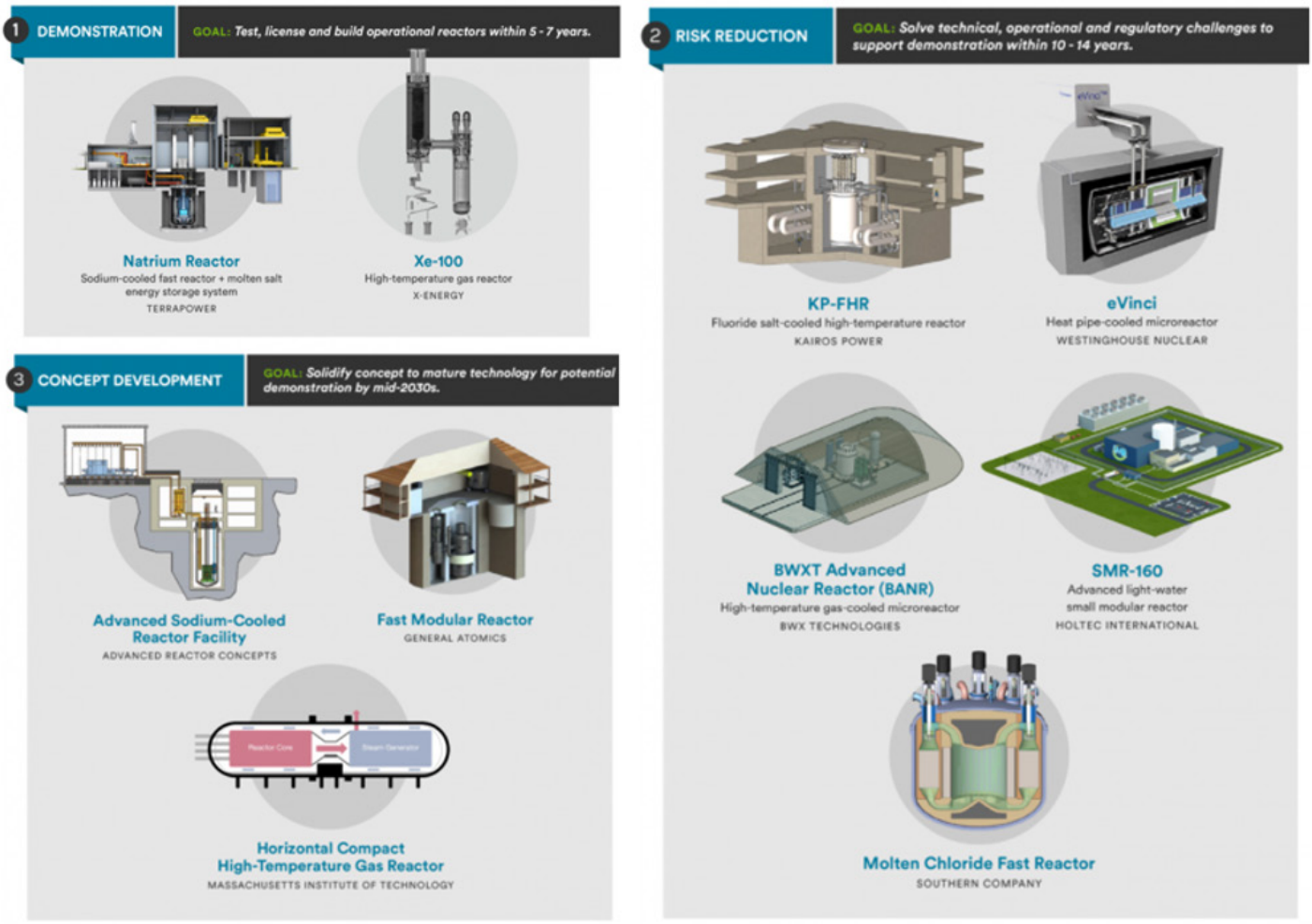
Nuclear power has come to the forefront in climate discussions as a part of the solution to reduce the world's carbon emissions. Renewable technologies such as solar, wind, hydro, and geothermal provide reasonable alternatives to replace fossil fuels, but do not provide constant reliability and cannot be fully deployed in all areas of the world. Growing global population, modernization of infrastructure and services, along with demand from electric vehicles, will increase power consumption at an exponential rate over the next 20 years. The nuclear industry has developed the next generation of advanced and small modular reactors that can be reliably built at substantially less cost, making them a suitable replacement for aging fossil fuel plants.

The US Department of Energy (DOE) defines a small modularreactor (SMR) as a reactor with an output of 300 megawatts (MW) of electricity or less. A subset of SMRs is the advanced nuclear reactors that do not use water as a coolant. These revolutionary designs are unlike the predominant design used globally in commercial nuclear power generation. Advanced reactors have many beneficial features including:

- Enhanced safety features without the likelihood of core damage
- Sustainability
- Reduction of nuclear waste
- Reduced cost and financial risk
- Eliminates the need of offsite emergency response
- Increased proliferation resistance and physical protections

SMRs can be used to support micro-grids such as islands and remote locations. Larger population centers can use a scalable approach in deploying multiple SMRs based on necessity and financial considerations. There are also proposed demonstrations for replacing coal fire plants, while keeping the existing electrical generators and switchyard. SMRs are also being considered for water desalination and hydrogen production; and one design is looking to power computers for cryptocurrency mining.

The US DOE developed the Advance Reactor Demonstration Program (ARDP) which accelerated the demonstration of advanced reactors through cost-shared partnerships with US industry. ARDP awarded funding through three different development and demonstration pathways to the following designs:



Reference: https://www.energy.gov/ne/articles/infographic-advanced-reactor-development

Funding was also provided to a Light Water SMR design (NuScale) which is projected to start commercial power operations by the year 2030. In addition, the US Department of Defense is funding Project Pele with the objective to design, build, and demonstrate a prototype mobile nuclear reactor within five years.

Due to funding in the programs mentioned above, and similar programs in Canada and the United Kingdom, we are seeing investment in the research, development, licensing, and deployment of SMRs. Multiple industry partnerships have been created by owners, designers, critical component suppliers, regulators, established utilities, and national laboratories, to streamline the testing and construction of the first commercial operating nuclear facility with target delivery dates by the year 2027 and construction beginning as early as 2022.

The design of most advanced reactors in development operates without water as the coolant and at temperatures higher than previously considered by construction codes and regulatory authorities which require the use of new materials such as graphite and ceramic. These materials are addressed in ASME Section III Division 5 and are essential for the advanced reactor designs.

Small modular reactors can supply nuclear-based power to combat climate change with reduced upfront costs and quicker return on investment as compared to older and larger nuclear power plants. These new reactors are being government funded as "first of their kind" demonstration units that are commercially viable in hopes of reducing cost for future plants.

HSB is qualified to meet inspection needs for both water-cooled nuclear plants, ASME Section III Division 1 and high temperature reactors, ASME Section III Division 5, and ready to support the nuclear industry with a fully trained staff to provide inspections, training, and quality program support.

Contact HSB for more information on SMRs, advanced reactors, and BPV III Division 5 to prepare for the age of small modular (nuclear) reactors.

About the author
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Paul Coco joined HSB in January 2014 and is a graduate of the United States Naval Academy where he earned a Bachelor of Science degree in aeronautical engineering. Paul also holds a master's degree in Engineering Management and a Master of Science in Mechanical Engineering. Paul served in the United States Navy from 2002 through 2010 which included the role of Reactor Mechanical Division Officer and Training Officer. In 2007 and through 2010, Paul joined the Mechanical Engineering Department at the United States Naval Academy where he taught Applied Engineering Thermodynamics for Naval Applications. Paul has also worked as a Reactor Operations Engineer where he conducted detailed technical reviews of nuclear licenses in accordance with federal codes and standards, and performed quality assurance inspections on domestic and international nuclear vendors for nuclear safety and related components. Within the HSB Codes and Standards group, Paul is responsible for providing code technical support to internal and external clients with a focus on nuclear construction to ASME Section III and the associated nuclear conformity assessment programs.

Update on hydrogen's role in the green economy

Author: Tom Pastor, P.E.

There have been several developments since we last published the article on hydrogen in our June Pressure Points newsletter. Here is a brief update:

United States DOE Energy Earthshots

In an effort to take action in dealing with the ever-growing climate crisis, the Department of Energy (DOE) launched an "Energy Earthshot" this past summer. Modeled after the "moonshot" goals set in the early 60s, DOE is trying to raise awareness and mobilize resources to seek and implement solutions to thwart global warming. The first "Energy Earthshot" focuses on hydrogen. The goal has been set to work toward reducing the cost of producing clean hydrogen by 80% to $1 per kilogram by 2030. Today, hydrogen produced using the traditional steam reforming method costs approximately $2 per kilogram, while green hydrogen produced using renewable energy via electrolysis costs $5 per kilogram. If this goal can be met, it would create more clean energy jobs, reduce greenhouse gas emissions, and position America to compete in the clean energy market on a global scale.

To attract and engage stakeholders, the DOE held its first Hydrogen Shot Summit August 31 – September 1, 2021. Links to the presentations including breakout panel sessions held during this first summit can be found at the following link: Department of Energy's Hydrogen Shot Summit.

It is estimated that in Fiscal Year 2022, the DOE will spend approximately $400 million to support research activities related to clean hydrogen. This is just one part of the DOE's Hydrogen Program Plan that has been developed to accelerate research, development, and deployment of hydrogen and related technologies in the United States. A copy of the Plan can be found at the following link: Department of Energy Hydrogen Program Plan.

ASME Video: When Will We See the Hydrogen Revolution?

ASME produced a short, 13-minute video that describes how companies are developing new ways of producing and using hydrogen that will result in zero carbon emissions. The video can be viewed here: When Will We See the Hydrogen Revolution?

Ask the engineer

Author: Tom Pastor, P.E.

Section VIII, Division 1 Appendix 47, Requirements for Pressure Vessel Designers
Without question, the revisions in the 2021 Edition of Section VIII, Division 1 that will have the greatest impact on pressure vessel manufacturers are the new requirements for pressure vessel designers published in Appendix 47. These requirements, along with new responsibilities for the user and the Manufacturer, given in U-2 were developed with the goal of assuring that the pressure vessel design calculations satisfy Section VIII requirements. The method chosen to accomplish this was to write rules that require that individuals performing the design have been properly trained and satisfy the minimum qualification and experience requirements given in Appendix 47.

HSB Codes and Standards have been conducting code update training on the 2021 BPVC changes since they were first issued last July, and there has been a lot of interest in how to comply with these new requirements in Appendix 47. During these training sessions, attendees submitted dozens of questions on these new rules. So, we decided to publish a selection of these questions to help code users understand the proper application of these new requirements.

Question: When do the Appendix 47 requirements become mandatory?

Response: In accordance with Appendix 43, any pressure vessel contracted to be constructed to Section VIII, Division 1 on January 1, 2022 or later must satisfy all applicable rules in the 2021 Edition of Section VIII, Division 1, including Mandatory Appendix 47.

Question: Is it necessary to qualify a vessel designer who does no design work related to U-2(g)?

Response: The new requirements published in Appendix 47 now require all individuals that perform design calculations to meet certain minimum qualification and experience requirements. Certain design activity called for under U-2(g) will require additional experience. See Appendix 47, 47-5.

Question: What are the qualification requirements for design personnel? Is it based on examination, experience, knowledge, or something else?

Response: In Appendix 47, there are actually two groups of engineers and designers. The first group are engineers and designers that are in responsible charge for the design work of the pressure vessel. The qualification requirements for individuals in responsible charge is given in paragraphs 47-2 and 47-3. Basically, education as well as work experience requirements are given for the Certifying Engineer, engineer, and designer that will be in responsible charge. But there may be other individuals that also will perform design work but are not in responsible charge. The qualification requirements for these individuals are given in 47-4. For this group, there are no minimum educational requirements, however, they must have training related with the scope, complexity, criticality, or special nature of the design activities that they will be carrying out.

Question: Is it required that the Authorized Inspector verify the qualification requirements of engineers and designers?

Response: No, however the AI should verify that the Manufacturer's Quality Control System describes the requirements for establishing and documenting the qualifications of personnel performing design activities to the code. [See 10-5(d).]

Question: Who qualifies the Certifying Engineer or designer when these design services are subcontracted to an outside organization?

Response: The qualification requirements given in 47-2 equally apply to designers, engineers, and Certifying Engineers who are engaged by the Manufacturer by contract or agreement for their services in the design of pressure vessels. The Manufacturer shall maintain a controlled document, referenced in the Quality Control System, identifying the persons that may exercise control of design work performed by others.

Question: For individuals who are not in responsible charge for the design, do they need to meet certain minimum qualifications?

Response: Yes, see 47-4.

Question: Do the responsibilities for individuals in responsible charge include responsibility for fabrication?

Response: No.

Question: Is it expected that the individuals in responsible charge for design be shown in the organization chart of the Certificate Holders quality manual?

Response: No, see 10-4.

Question: Where can we find the definition of "engineer"?

Response: A formal definition for "engineer" is not given in Appendix 3. However, per 47-2(b)(1), an engineer shall have a degree from an accredited university or college in engineering, science, or technology requiring an equivalent of four years of full-time study of higher education.

Question: Is the Engineering Department Manager who approves the design considered a designer in responsible charge, and therefore needs to meet the qualification requirements given in 47-2 or 47-3?

Response: The answer depends upon whether or not the Manufacturer has designated the Engineering Department Manager as one of the individuals in responsible charge for design. If so, then the Engineering Department Manager would need to meet the qualification requirements given in 47-2 or 47-3. For every pressure vessel to be Code stamped, the Manufacturer must identify at least one individual that will be in responsible charge of the design of the vessel.

Question: Is it possible for one or more engineers to carry out design of the pressure vessel under the direct supervision of one individual in responsible charge?

Response: Yes. The individual in responsible charge would need to satisfy the qualification requirements given in 47-2 or 47-3. The engineers or designers that are not in responsible charge must satisfy the qualifications given in 47-4.

Question: Is a Certifying Engineer always required to be in responsible charge for Section VIII, Division 1 design work?

Response: No, except when a Section VIII, Division 1 pressure vessel requires a fatigue assessment, then a Certifying Engineer must be in responsible charge of the fatigue analysis. See 47-5(b)(2). Note that a fatigue assessment does not include fatigue screening in accordance with VIII-2, 5.5.2.

Question: When a designer is qualified as per 47-3, is there any limitation to the type of pressure vessel design work that they can be in responsible charge of? For example, a complex vessel such as a vertical tower versus a simple vessel such as a propane tank.

Response: No. There are no restrictions on the type of pressure equipment for which a designer or engineer can be qualified to perform design calculations under the alternative rules of 47-3.

Question: Does Appendix 47 contain any requirements about designers and engineers having knowledge and experience working with Section VIII, Division 1?

Response: Appendix 10, 10-5(d) states that the Manufacturer's Quality Control System shall describe the requirements for establishing and documenting the qualification of personnel performing design activities to the code. Similarly, in 47-6(a)(1) the Manufacturer shall identify the minimum qualifications required for design of their products. In 47-6(b) a list of body of knowledge elements are given to assist the Manufacturer in establishing the qualification requirements for their designers and engineers.

Question: When a customer furnishes drawings and calculations that are reviewed and approved for ASME Code compliance by the Engineering Manager (Certificate Holders Responsible Charge), must the Certificate Holder obtain records and designate the customer's personnel who performed the calculations and drawings for compliance to Mandatory Appendix 47?

Response: In our opinion, we do not think it is feasible for a Manufacturer to qualify a customer's design staff as being in responsible charge. In this case, the Manufacturer needs to take full responsibility for demonstrating that the supplied design meets Code. To do this, they would either:

1. Have an internal staff member who satisfies the responsible charge definitions of either 47-2 or 47-3 review the design and drawing package and confirm that they meet all applicable Code requirements; or

2. Subcontract an outside designer or engineer who satisfies the responsible charge definitions of either 47-2 or 47-3, and this individual would review the design and drawing package and confirm that they meet all applicable Code Requirements.

About the author
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Thomas Pastor is currently Vice President of the Codes and Standards Group for HSB, Global Inspection and Engineering Services Division and has been with HSB for over 34 years. He holds a B.S. and M.S. in Civil Engineering from the University of Connecticut, is a licensed Professional Engineer in the state of Connecticut, and holds a National Board Commission. Tom's technical expertise is in the area of stress analysis and pressure vessel design, and he has presented over 150 courses and workshops on ASME boiler and pressure vessel standards to audiences around the world. Additionally, Thomas Pastor is an ASME Fellow and currently serves on several ASME committees; Senior Vice President of the Council on Standards and Certification, Member of the Board on Pressure Technology Codes & Standards, BPV-VIII Standards Committee (Pressure Vessels), Subgroup Design of BPV-VIII, and Subgroup General Requirements of BPV-VIII.

2022 technical training and marketing events

Dates	Location	Topic
January	Virtual/Americas	ASME Section III & SMR
February	Virtual/Americas	ASME Section VIII, Division I
March	Virtual/Americas	2021 Edition ASME Code Synopsis
March	Virtual/Americas	Transportation
April	Virtual/Americas	ASME Section IX Welding Requirements
April	Virtual/Americas	NBIC Repair and Alterations
May	Virtual/Americas	ASME Section VIII, Division 2
June	Virtual/Americas	ASME Section I & B31.1
July	Virtual/Americas	ASME Section III
July	Virtual/Americas	PED Series and PE(S)R
August	Virtual/Americas	ASME Section VIII – Toughness
September	Virtual/Americas	ASME Section V
October	Virtual/Americas	ASME Section II
November	Virtual/Americas	ASME Section VIII - Design

For more information on HSB training and events, please email us at GetInfo@HSB.com.

To register for an event, click here.

Please note, registration for the 2022 schedule will open after January 2, 2022. New topics will also be added throughout the year.

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