HTGR
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High Temperature Gas Cooled Reactors

Codes and Standards

NRC – Codes and Standards Forum

September 26, 2017

HTGR -Technology Working Group

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HTGR TWG

- Developer Companies
  - AREVA — SC-HTGR
  - X-Energy — X-100
  - Star Core Nuclear — StarCore
  - Kairos Power — KP-FHR
  - BWX-Technology — TRISO Particle Fuel Supplier

- Other Supporters and Observers
  - Duke Energy — DOE
  - EPRI — NEI

HTGR-TWG

- Mission
  - Ensure that RD&D infrastructure is created, maintained, and available to support the timely development, demonstration and deployment of high temperature gas-cooled reactor technology*.
- Objectives
  - Coordinate with DOE and National Laboratories our R&D needs to ensure that relevant work is aligned with the technology goals of the reactor designers
  - Support the advancement, development and deployment of high temperature gas-cooled reactor technology
  - Establishment of a domestic U.S. fuel supply chain including identification of and resolution to front-end of the HTGR fuel supply needs, industrial supply manufacturing of TRISO coated particle fuel, and storage or recycling of used fuel.
  - Support and coordinate efforts with other organizations and technology specific working groups to achieve shared objectives

*** Kairos Power – a salt cooled HTR developer recently joined the HTGR-TWG**

Codes and Standards

- Similar to any other reactor design our designs will be governed by hundreds of codes and standards.
- Most will be of little consequence; since they govern routine design, fabrication, construction, and installation activities
  - Heat exchanger design standards for air blast heat exchangers which we will simply order out of a catalog
  - Relevant standards which the NRC would be most interested in are various ASME, IEEE, ASCE standards
  - These standards will be invoked for major parts of the nuclear island, e.g. ASME B&PV Sect III , Div. 5, but they include many others

Codes and Standards

- Section III Div. 5 includes graphite and other high temperature materials
- It provides higher temperature rules for some conventional materials
- The value of the graphite section of Div. 5 remains to be seen, since they have never actually been applied in practice to the design of an actual reactor
- We believe they are usable and beneficial beyond the laboratory context
- The parts for metallic materials will be useful to us and essential for our next generation of HTGRs, i.e. the V-HTGR
- Good progress has already been made on Div. 5, we are not certain whether substantial additional efforts are needed until we start our design activities

Typical Standards We Intend to Use

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• Vessels	ASME Section III
• Reactor Internals	TBD - Section III Div. 5
• SGs	TEMA helical coil standard
• Graphite	ASME Section III Div. 5
• I&C	IEEE Standard (Analog or Digital)
• RCCS	ASME Section III
• Valves	TBD - ASME Section III
• Circulator	TBD - ASME Section III
• Silo Concrete	ACS standard
• Refueling machine	TBD robotics or elevator standards

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Kairos Power: KP-FHR

- Small Molten Salt (fluoride salt) High-Temperature Reactor (FHR)
- Fuel Form – TRISO coated particle fuel
- Standard Identified
  - ANS-20.1-201x, “Nuclear Safety Criteria and Design Criteria for Fluoride Salt-Cooled High-Temperature Reactor Nuclear Power Plants”

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Actively Supporting

- ASME/ANS RA-S-1.4-2013, “Probabilistic Risk Assessment Standard for Advanced Non-LWR Nuclear Power Plants,” (TrialUse)
- ANS-30.1-201x, “Integration of Risk-Informed, Performance-Based Principles and Methods into Nuclear Safety Design for Nuclear Power Plants” (new standard)
- ANS-30.2-201x, “Categorization and Classification of Structures, Systems, and Components for New Nuclear Power Plants” (new standard)
- ANSI/ANS-53.1-2011, “Nuclear Safety Design Process for Modular Helium-Cooled Reactor Plants”, R2016

Missing Standards

- At this time we cannot readily identify any additional standards outside the context of an active design program

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Q&A