

February 14, 2020

Project No. 99902069

US Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Subject: Kairos Power LLC
Presentation Materials for Kairos Power Pre-Submittal Meeting on Quality Assurance
Topical Report

This letter transmits presentation materials for the subject meeting between Kairos Power and Nuclear Regulatory Commission (NRC) staff to be held on February 19, 2020. The presentation slides are considered non-proprietary and are provided for NRC staff information.

If you have any questions or need any additional information, please contact John Price at price@kairospower.com or (972) 754-8221, or Darrell Gardner at gardner@kairospower.com or (704) 769-1226.

Sincerely,



Peter Hastings, PE
Vice President, Regulatory Affairs and Quality

Enclosure:

- 1) Presentation Slides for Kairos Power Pre-Submittal Meeting on Quality Assurance Topical Report (Non-Proprietary)

xc (w/enclosure):

Benjamin Beasley, Chief, Advanced Reactor Licensing Branch
Stewart Magruder, Project Manager, Advanced Reactor Licensing Branch

Enclosure 1

**Presentation Slides for Kairos Power Pre-Submittal Meeting on Quality Assurance Topical Report
(Non-Proprietary)**

(Note that the enclosed information is preliminary and pre-decisional and is subject to change during detailed planning and project execution. It is provided for planning and familiarization purposes in support of pre-application discussions with the NRC Staff.)



Kairos Power

Kairos Power Meeting

QATR Pre-Submittal Meeting

February 19, 2020

(Non-Proprietary)

Kairos Power's mission is to enable the world's transition to clean energy, with the ultimate goal of dramatically improving people's quality of life while protecting the environment.



AGENDA

- Overview of Kairos Power
 - Technology Basis
 - KP-FHR Safety Case
 - Reactor Systems Overview
 - Kairos Power Testing Program
- Kairos Power QA Program Scope
- QA Topical Report Overview
- Summary of Key Changes

Overview of Kairos Power

Overview of Kairos Power

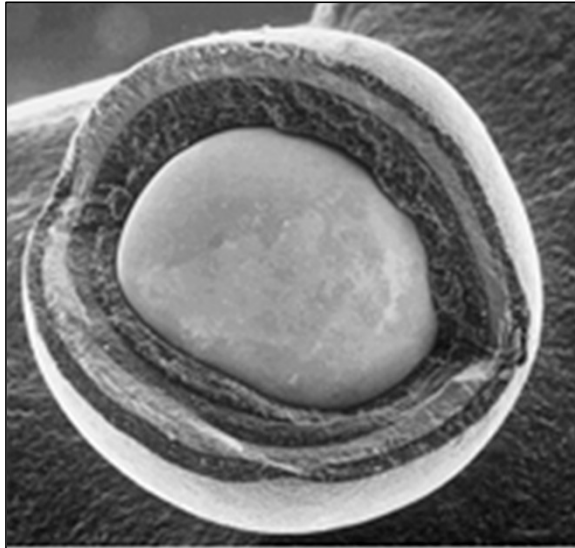
- Privately funded nuclear energy engineering and design company focused on the **commercialization** of the fluoride salt-cooled high temperature reactor (FHR)
 - Founded in 2016
 - Based in San Francisco Bay Area
 - Builds on UC Berkeley Concept Development and R&D
 - ~120 full-time employees (**and growing**) selected from diverse industries
- Development schedule driven by US demonstration by 2030 (**or earlier**) and rapid deployment ramp in 2030s
- Leverages technology from past advanced reactor designs, coupled together to provide a competitive design



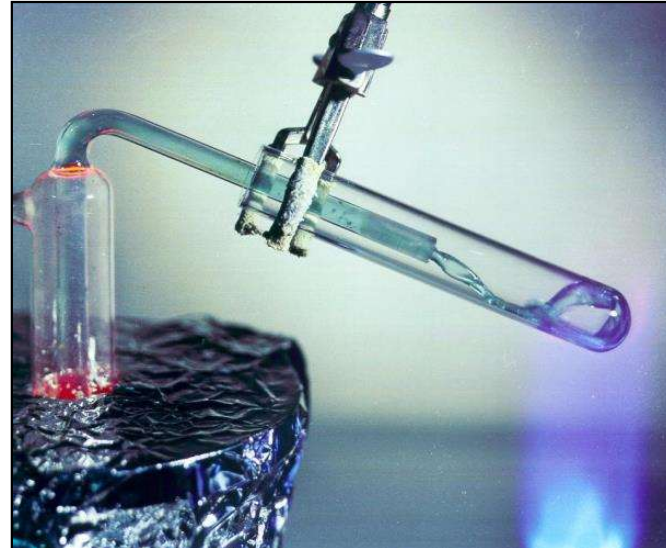
Kairos Power Headquarters
Alameda, CA

Fluoride Salt-Cooled High-Temperature Reactor (FHR) Technology Basis

Coated Particle Fuel
TRISO



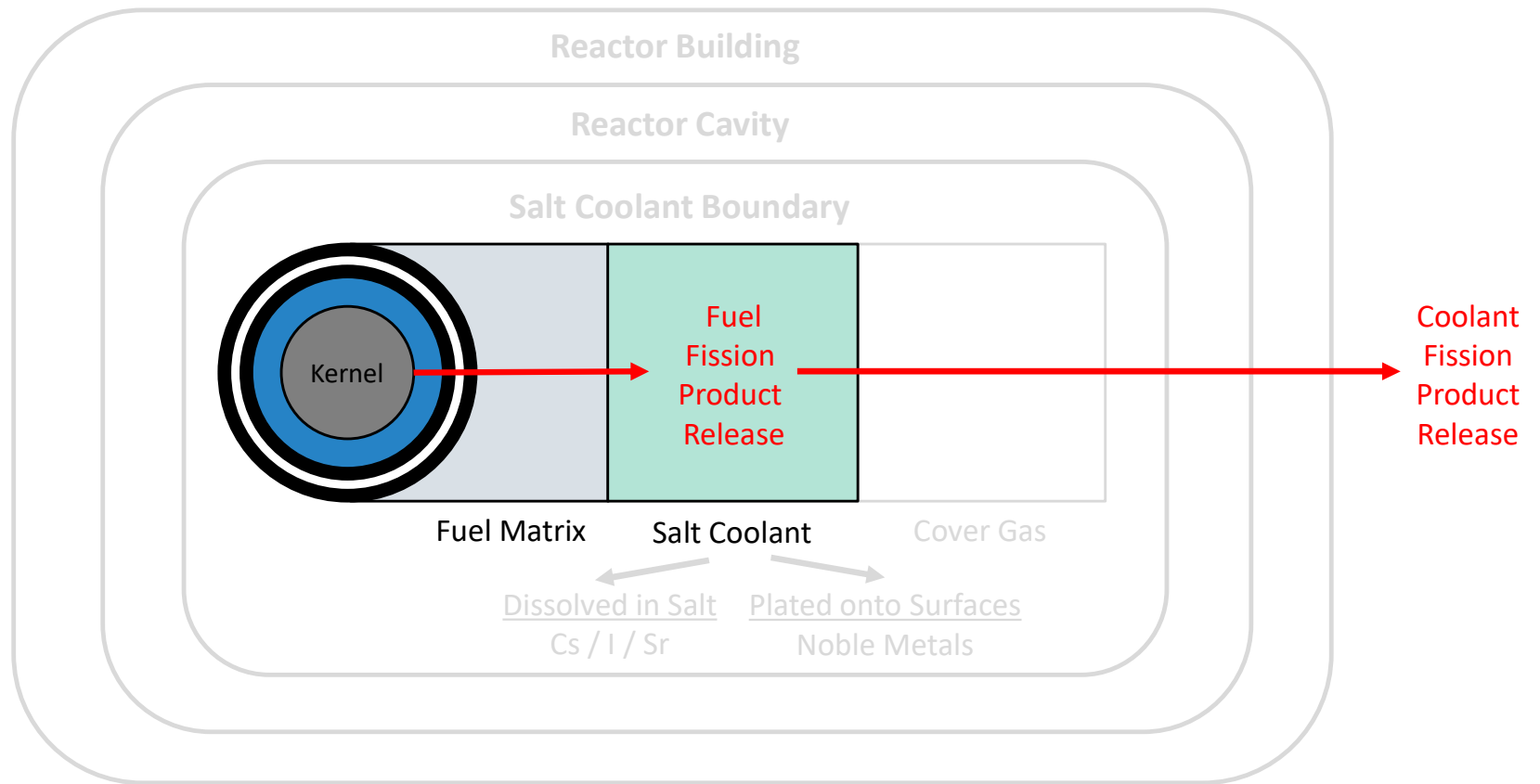
Liquid Fluoride Salt Coolant
Flibe (2LiF-BeF₂)



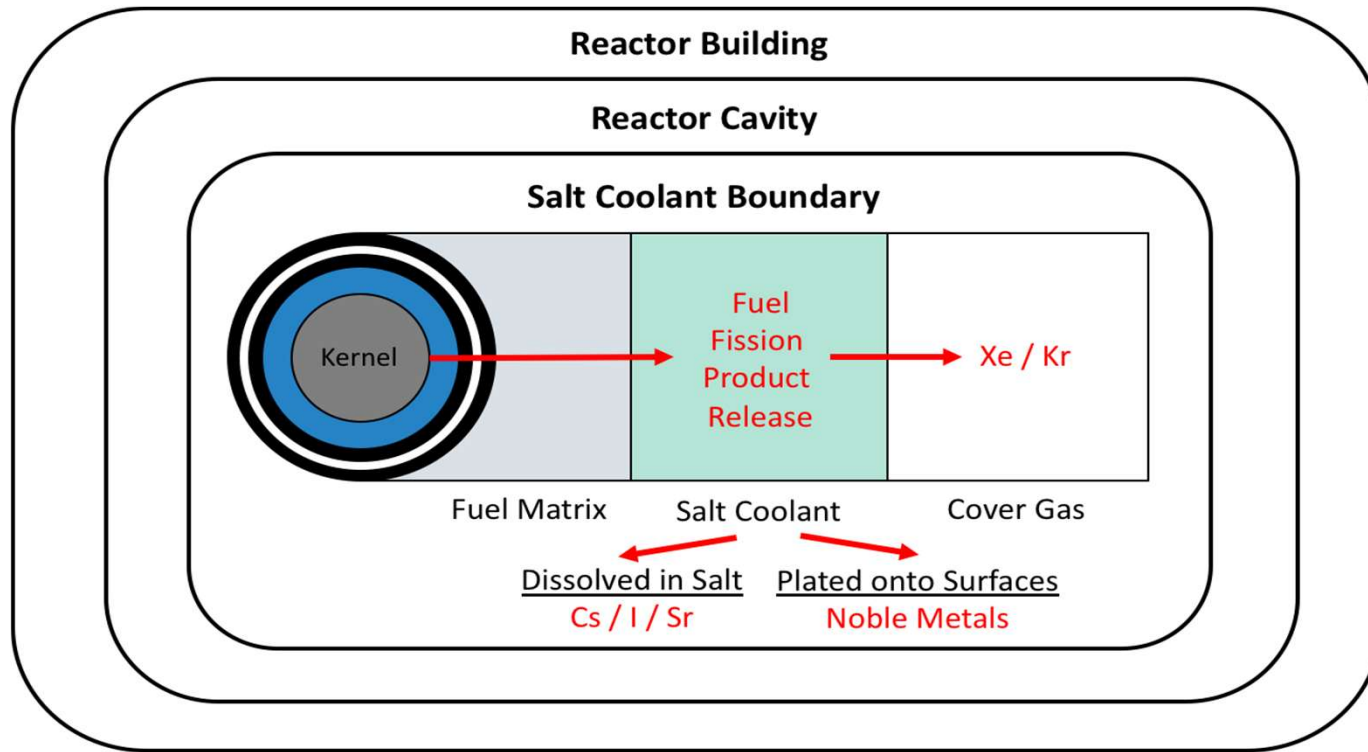
KP-FHR Safety Case

- **The fundamental safety case for the KP-FHR is rooted in the robust intrinsic safety characteristics of fuel and reactor coolant**
- **Tri-structural Isotropic (TRISO) Fuel**
 - Demonstrated fission product retention up to 1600°C
 - FHRs can operate with uniquely large fuel temperature margins
 - No incremental fuel failure expected during design basis accidents
- **Reactor Coolant - Flibe (2LiF-BeF₂)**
 - Demonstrated retention of solid fission products including cesium and iodine in Molten Salt Reactor Experiment (MSRE)
 - No exothermic reactions between the primary Flibe salt coolant and air or water
- **Low Pressure Primary System**
 - Primary heat transport system does not perform a “pressure boundary” function like traditional LWR designs
 - Loss of “reactor coolant boundary” does not result in large pressure related energy releases

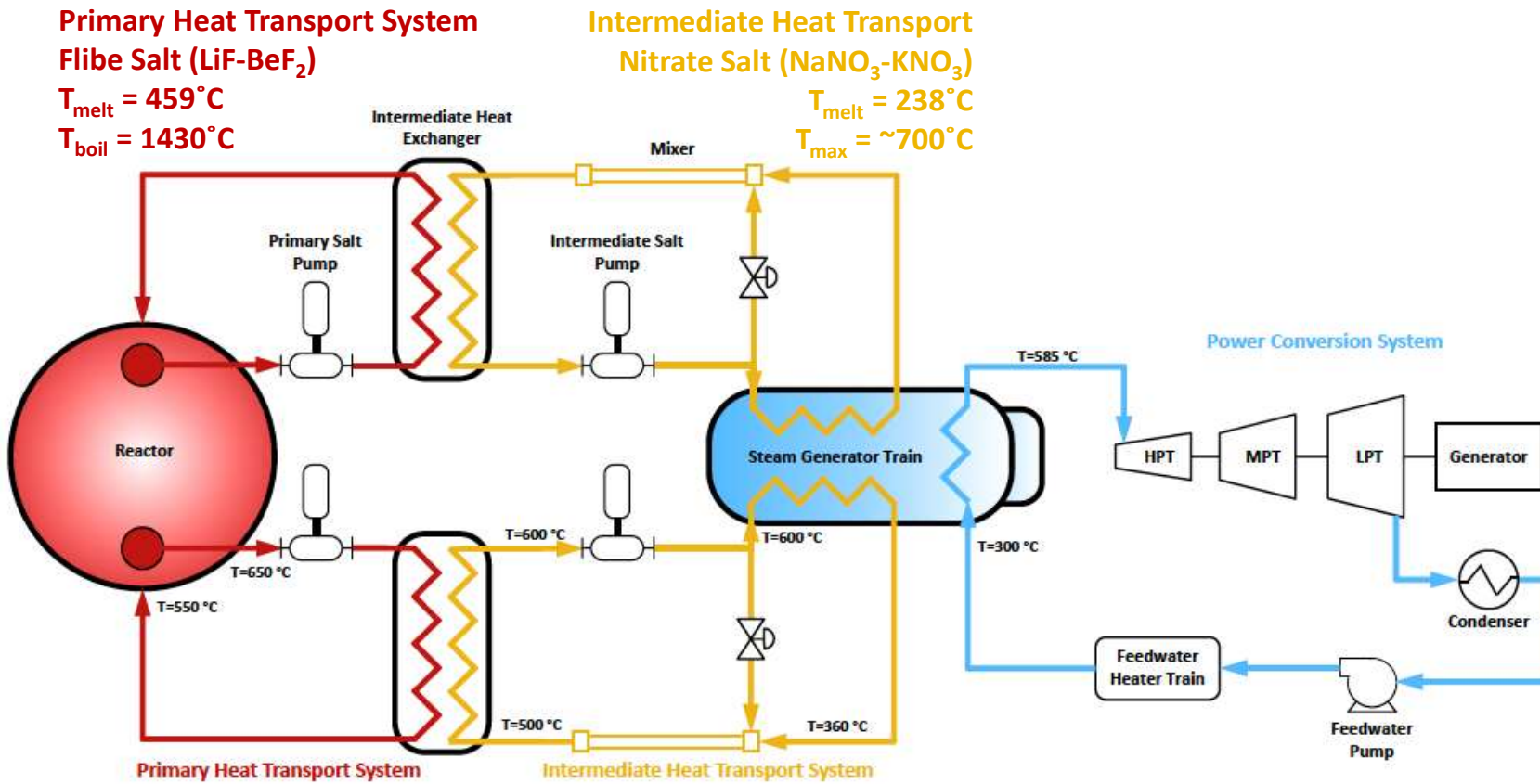
KP-FHR Safety Case – Primary Barriers to Release



KP-FHR Safety Case – Defense in Depth Barriers



Reactor Systems Overview - Basic System Configuration

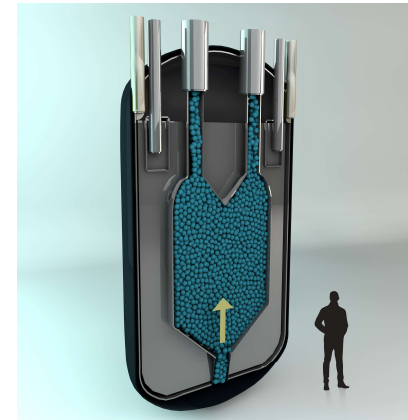


Highlights

- Accommodate system heat up and cooldown, with salt transfers
- Intermediate loop will leverage technology and suppliers of Concentrated Solar Power
- Enable multiple Ultimate Heat Sink options

Reactor Systems - Nominal Parameters & Materials

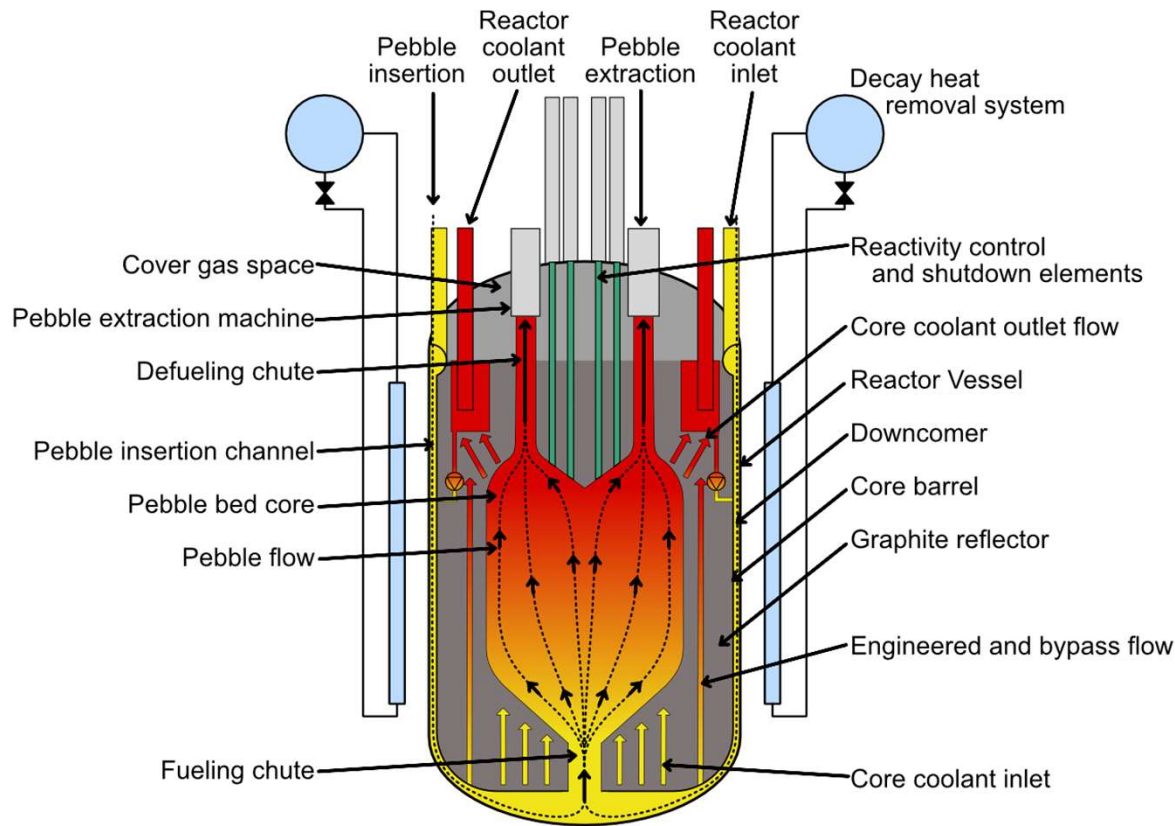
Parameter	Value/Description
Reactor Type	Fluoride-salt cooled, high temperature reactor (FHR)
Core Configuration	Pebble bed core, graphite moderator/reflector, and enriched Flibe molten salt coolant
Reactor Thermal Power	320 MW _{th}
Core Inlet and Exit Temperature	550°C / 650°C
Material for: Reactor Vessel, Internal Structures, PHTS Piping, IHTS HX	316H, ASME Section III, Division 5, conforming to 2019 composition specification requirements
RVACS	Under Evaluation for Materials Selection



Design Temperature Limits	Value
Primary Salt (Flibe) Freezing and Boiling Temperatures	459°C / 1430°C
Maximum ASME Section III, Division 5, SS316 Temperature	816°C
Accelerated Creep Rupture of SS316	~1000°C
SS316 Melting Temperature	~1400°C
Peak Fuel Temperature Limit	1600°C

Passive safety features are designed to protect the reactor vessel and fuel integrity – will not exceed demonstrated performance limits of these systems.

Reactor Systems - Core Configuration & Reactor Vessel

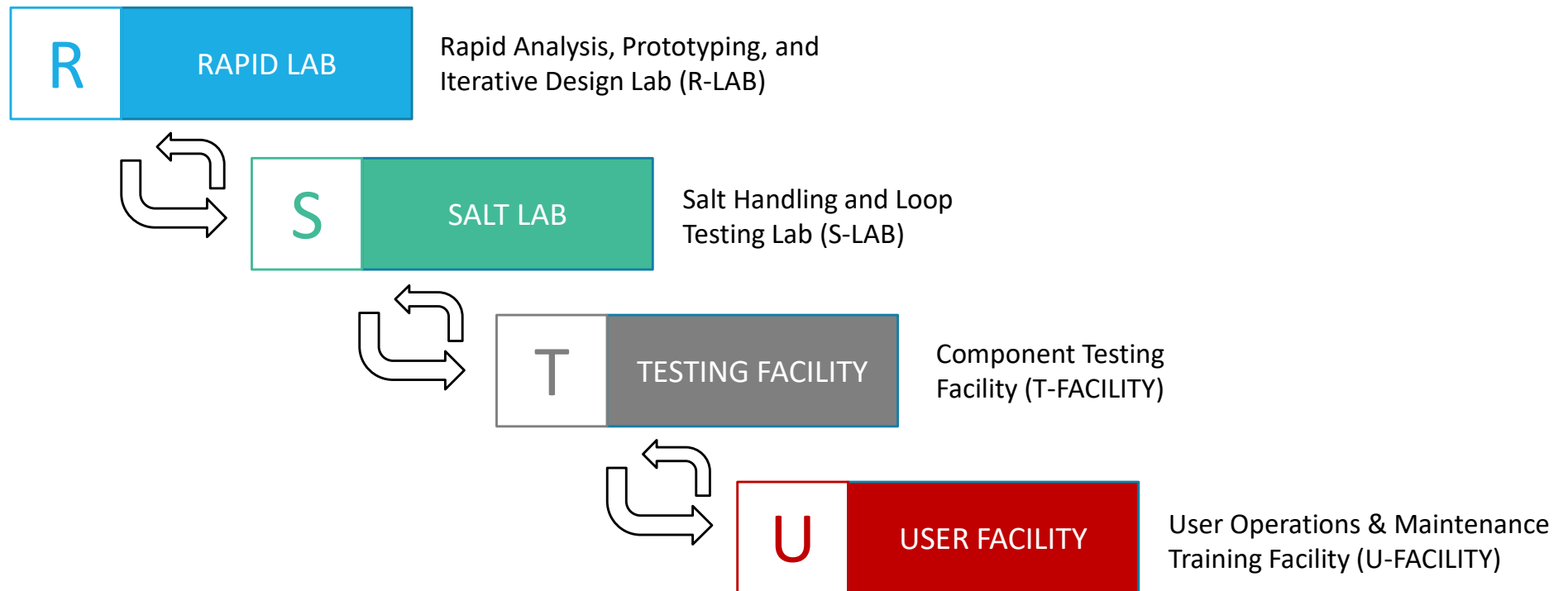


Highlights

- Pebble bed fuel, salt coolant, and graphite structures provide large thermal inertia, slow transient response, and ensure that design limits are not exceeded
- Graphite reflector designed to match the vessel service lifetime

Kairos Power Testing Program - Facilities

Rapid Technology Demonstration Requires **Non-Nuclear** Development, Validation, and Qualification Facilities



Kairos Power QA Program Scope

Kairos Power QA Program Scope

- Kairos Power development strategy is broad in nature and includes participation (directly or indirectly) in the following activities which are subject, in part, to QA program controls
 - Technology Development, including testing
 - Design of SSCs
 - Site characterization and associated plant siting activities
 - Fabrication of SSCs
 - SSC testing and qualification
 - Plant construction
 - Plant operations

QA Program Regulatory Requirements

- The primary NRC regulations that establish requirements for QA programs associated with license applications are contained in the following:
 - 10 CFR 50, Appendix A, GDC (PDC) 1, “Quality Standards and Records,” requires a QA program be established and implemented to provide adequate assurance that SSCs perform their safety functions.
 - 10 CFR 50, Appendix B, Criterion II requires that an applicant establish a compliant quality assurance at the earliest practicable time, consistent with the schedule for accomplishing the activities.
 - 10 CFR 50.34(a)(7) requires applicants for a construction permit to submit a description of the QA program to be applied to the design, fabrication, construction, and testing of the structures, systems, and components (SSCs) of the facility.
 - 10 CFR 50.34(b)(6)(ii) requires that applicants for an operating license to submit an FSAR that includes a discussion on how the applicable requirements of 10 CFR 50 Appendix B will be satisfied.
 - The requirements to provide a QA program for applicants of a combined license (COL), early site permit (ESP), and standard design certification (DC) are provided in 10 CFR 52.79(a)(25), 10 CFR 52.17(a)(1)(xi), and 10 CFR 52.47(a)(19), respectively.

QA Topical Report Overview

QA Topical Report Overview

- Scope of QA Topical Report applies to siting, design, fabrication, construction, and operation
 - Safety related SSCs subject to 10 CFR 50 Appendix B
- QA Topical Report is based on NEI 11-04 template as amended by RG 1.28 Rev. 5
 - KP QAPD based on NQA-1-2015 standard endorsed by RG 1.28 Rev 5.
 - Limited additions/departures from NEI 11-04 template
 - Primarily to reflect company specific information and bracketed content
 - Regulatory commitments (QATR Section 4) modified to reflect LMP implementation and Regulatory Analysis Topical Reports
 - Organizational description to support broad scope of activities
- QA Topical Report is written generally and broadly to allow long term QA Program implementation
 - Some program elements will not be active during NRC review/approval of the QA Topical Report, e.g. Criterion XIV, Inspection, Test, and Operating Status.
 - Implementation of selected program elements will be completed prior to the start of associated activities
 - Some licensing options may or may not be implemented for a given reactor deployment, e.g. ESP, COL. Implementation is based on licensing pathway for a given plant application.
- NRC review of QA Topical Report should be to support approval of use for total included scope
 - NRC audit and inspections should be limited to those activities implemented during an applicable phase

QA Topical Report Overview

- A draft QA Topical Report was provided on the Kairos Power electronic reading room in advance of this meeting to facilitate pre-submittal meeting discussions
- A “reviewers aid” was provided in the form of a markup to the NEI 11-04 template.
 - Additions/Departures from the NEI 11-04 template are reflected with color codes
 - Company specific content
 - Update of bracketed template information beyond company specific content (such as deletion of notes)
 - Changes to approved NEI template text, including updates to reflect RG 1.28, Rev 5 and NQA 1-2015
- A “clean version” was also provided to show the intended “final” version of the QA topical report
- Kairos Power is requesting feedback from NRC staff at this meeting
 - Acknowledgement of approach
 - Perceived challenges, if any, with conducting a review
- Kairos Power anticipates submitting the QA Topical Report in the 2nd quarter 2020

Summary of Key Changes

- **Examples of company specific changes:**

- [CA] > Kairos Power
- Executive Summary updated for Kairos Power
- Updated org chart, description, and titles
- Expanded to design, construction, and operation phases to include SDA, DC, COL, ML, ESP, LWA, CP, and/or OL
- Regulatory Guides:
 - updated revisions
 - removed or revised conformance to RGs consistent with FHR design
 - RG 1.29, Seismic Design Classification – Clarified applicability of position C.1 on seismic Category 1 SSCs for this FHR design

- **Examples of updated bracketed template information:**

- Example organization deleted from the reviewer aid
- Applicability Notes modified to parenthetical statements
- Deleted template “user” notes

Summary of Key Changes

- **Examples of changes to approved template text:**
 - Updates to adopt RG 1.28, Revision 5:
 - Update based on NQA-1-2015 (endorsed standard chosen by KP)
 - Use of laboratories accredited to ISO/IEC-17025: 2005 or 2017 for calibration or testing services
 - Updated SSC safety classification language in Part III based on LMP initiative (NSRST)
 - Updated applicability of requirements consistent with NUREG-0800, 17.5
 - Added clarification of the timing of implementation of administrative controls for plant operations
 - Added qualification of legacy technical information in accordance with NQA-1-2015, Part IV, Subpart 4.2.3 non-mandatory guidance

Questions
