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Subject: Preliminary input for report

NRR

Attached are preliminary issues and potential policy concerns related to the PBMR and IRIS designs.

We can discuss these tomorrow (05/17).

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Issues Related to the PBMR

(The GT-MHR issues are likely covered in the MHTGR review, and similar to those listed here for the PBMR. The helium turbine issues are probably the same as for the PBMR.)

(NOTE: I do not have access to quality documents, nor time to review those available in detail, to ensure that the terminology and/or issues are well defined at this time.)

Type	Description
Policy	Containment. Apparently the PBMR uses natural air circulation passive cooling for residual heat removal (RHR). Included is a vent to the environment from the reactor/containment building (XA9846678). It is therefore likely that the containment function will not include a leak-tight requirement similar to LWRs. It will likely be argued that the source term is small or improbably to support the design. (There is a possibility that a water-based passive RHR system may be considered.)
Technical	The performance capability of the natural air circulation passive cooling system for residual heat removal (RHR) suffers from lack of data for thermal conductivity, heat transfer coefficients, heat capacity and densities (XA9846683). The performance of the passive RHR and the resulting temperatures for structures and components needs to be improved.
Technical (TECDOC-1198)	(a) The PBMR core design, with its central graphite region, if different from the geometries used to develop and quality the current generation of nuclear physics codes. Reactivity-related transients and accidents may not be adequately evaluated. (b) The primary coolant environment (temperature and materials) has a limited base of experience. Challenges to primary systems components are not well known. Failure rates may not be well known. (c) The power conversion unit is unique. Failure rates and mechanisms may not be well known (magnetic bearings, helium seals). The GT-MHR and PBMR designs are different. (d) The recuperator design is still under developments. Failure rates and mechanisms may not be well known. Performance could be an economic issue.
Technical	PRA. The PBMR design philosophy seems to be based on prevention and little information related to a PRA evaluation has been found. There is a Licensing Guide (LG-1037), "Basic Licensing Requirements for the Pebble Bed Modular Reactor," which describes a PRA including severe accidents at $<1.0\text{x}10^{-6}$ per year. However the guide allows for the consideration of exclusion of very low frequency events in the range below $1.0\text{x}10^{-6}$ per year. The expected performance of the fuel barrier may also impact the search for severe accident sequences - impact on sequences leading to a release of radioactivity.
Policy	Siting: The expected releases for the design are low and current siting criteria may be judged to be too conservative, particularly for emergency planning.

Type	Description
Policy/ Technical	Systems, structures and components (SSCs) important to safety will not be similar to those for LWRs. It is likely that the performance expectations for the PBMR will be used to determine which, if any, SSCs are defined as important to safety. Lack of performance data and lack of a PRA will make it difficult to reach closure on these SSCs. Design calls for no active safety related systems.
Policy	Acceptance of the fuel design as defense-in-depth. That is the fuel design is believed to be so good that additional (physical) barriers to the release of radioactive material are not warranted. The following safety functions are to be ensured to implement defense-in-depth: Reactivity control, heat removal and containment of radioactivity.
Staffing	(a) Nuclear physics: reactive control, burnup. NRC needs to acquire or develop appropriate confirmatory analytical tools. (b) Materials: high temperatures for components, graphite (graphite and air or graphite and air and water, or graphite and water), helium and air/water. (The reactor vessel pedestal issue was also identified during the MHTGR review.) (c) Reactor systems: gas-cooled reactor technology, design, systems interactions, etc. Thermal-hydraulic performance - normal, transient and accident. NRC needs to acquire or develop appropriate confirmatory analytical tools. (d) Balance of plant: He gas-turbine, recuperator designs; spent fuel storage (20 to 40 full power years capacity) passive (air) cooling. (e) PRA. Need to understand accident sequences, need performance (failure rate) data, and accident initiator rates. It is likely that the belief in the fuel performance will impact closure on development of a full scope PRA. Life-cycle and fatigue challenges may be import since materials are to be used near upper allowable temperatures. (f) I&E: reactor control (He feed/bleed for power control, turbine blade orientation for electrical output control). Digital control systems. (g) Engineering: seismic design. (h) Multi-unit control room (human factors, common mode, etc.).
Process	Consideration needs to be given to the development of staff expertise in support of design certification and future reactor oversite by assignment of ancillary duties to staff members to follow the development and progression of the analysis tools, test programs and component development in areas unique to integral reactor technologies. Use of contractor to supplement staff during pre-application review is probably necessary until staff expertise is developed.
Schedule	A March 12, 2001 article puts the expected start date for the demonstration PBMR in 2005.