OPTIONAL FORM NO. 10

UNITED STATES GOVERNMENT

Memorandum

MFS file DnB

TO File # 245 DATE: March 22, 1961

THRU: Martin Biles, Chief
Test & Power Reactor Safety Branch

FROM Robert W. Sliger
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SUBJECT: REVIEW MEETING AT LA JOLLA ON MARCH 15-16, 1961

Attached to this memo is a copy of the agenda of the meeting prepared by General Atomics.

Wed., March 15, 9:00 a.m.
Mr. Titus LeClair introduced the meeting mentioning that if any of the review members wished to deviate from the program outline, that this was alright and G.A. was ready to discuss the subject in any order.

9:15 a.m. Dr. E. C. Creutz - Explains the G.A. establishment and a brief on all other work conducted by them. He then gave a brief on HTGR advantages:

1. Low Pressure and high temperatures
2. High burnup due to thorium
3. Advantages of graphite system
   a. High temperature
   b. No hot spots
   c. No fission product release problems.
4. Physics calculations are coming within 5% of measured values.
5. Control rod calculations are within 5% of measured values.
6. Heat transfer tests are conducted on fuel elements and flow tests in the core.

9:30 a.m. Mr. W. K. Davis - Stated a brief on status of engineering design. Bechtel has completed the land survey designs and structural design. Principal items are ordered and the containment building is ready to be let on contract as soon as construction permit is obtained. He then introduced the principal Bechtel job representatives.

9:45 a.m. Mr. Robert Duffield - Explains the development program on fuel elements; product control; nuclear design, thermal characteristics; coolant; instruments and control; and components.

Question was asked on limits of contaminants in the primary loop. Mr. Duffield explained that maintenance was the basis. They don't want to maintain contaminated components so the answer is not to allow elements to leak. We could have a total of several thousand curies on walls of system. The flow will be monitored before operation.

Causes of leak will be determined by a method of testing fuel elements.

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A-1666

Mr. Duffield then spoke briefly on fuel particles coating with pyrolitic carbon to retain and delay the more volatile fission product. He also spoke on physics, metals and fuel compacts.

11:00 a.m. Mr. H. Stewart - Physics discussion. It was explained that a strong effort in general physics and basic physics such as power distribution, lifetime, control, cross sections, resonance, spectrum analysis, and neutron thermalization. Stewart stated that they expect to calculate the rod worth within 1-2%. He then illustrated rod worth analysis with the following table:

No. of Rods Removed from Core	Rod Location	k	delta k
0	in	0.898	-
37	all	1.129	0.231
1	central	0.900	0.0023
3	center + 2 in second ring	0.910	0.0123
6	ring 4	0.951	0.0537
4	ring 3	0.914	0.0167

A discussion was given on temperature coefficient with the following given

	Begin of Life		End of Life	
	Over-all	Prompt	Over-all	Prompt
Temp Coeff.	-4.68	-2.54	+ 0.44	-1.36

Stewart stated that these can be measured throughout life and any corrective action taken.

In a discussion of transients Stewart stated that a free fall rod was the worst credible accident. If all rods were out and the remaining rod fell it could add 1.5% delta k based on a 100 millisec delay, 150% set point for power scram and -0.8×10^{-5} temp. coeff. The following was shown as other temperature results.

Condition	No. Rods Scrammed	Max. Fuel Temp °C
BOL	36	1820°
BOL	35	1830
BOL	18	2130
EOL	36	1860
EOL	35	1870
EOL	24	2240
EOL	18	3040

Mr. D. Turner gave a brief on graphite components.

Mr. R. Meyer gave a materials discussion on pyralitic coating of fuel particles. The coating is obtained by heating the metal particles in a stream of methane. They have determined permeability constants:

$$Kp = \frac{(\text{vol}\frac{cc}{sec})\ (\text{wall thickness})}{\pi\ (\text{meandia cm})\ (\text{lg cm})}$$

Creep rate measured is found to be 10^{-10} cm/sec. The work yet to complete is fission product retention of the fuel kernel, permeability of material, physical thermal conductivities.

Mr. Meyer also discussed the recent use of silver particles in the graphite for the internal trap.

5:00 p.m. - A general discussion was held on the temperature coeff. stating that if the reactor got above 3000°C its temp coeff would go positive and continue a divergent trend.

ACRS members brought up the point that if all shutdown rods dropped out then what can you do.

Mr. Duffield states that G.A. is working on some designs for an ultimate shutdown devise.

Question was raised by ACRS on how does the reactor core shut itself down, does it vaporize, or if it does what pressures are resultant?

Note - It is my feeling that ACRS is not recognizing that each rod is a separate devise with individual scram accumulators. On the other hand it seems that ACRS is justified in knowing what takes place if core temp goes up and what ultimately happens to the core.

5:25 p.m. - Dr. Zumwalt discussed the design of the internal fission product trap.

6:00 p.m. - Tour was made of the Triga reactor. Following the tour the meeting was adjourned.

Thursday, 3-16-61
8:30 a.m. ACRS held an executive session in an adjoining room.

8:55 a.m. - Mr. R. Minogue gave a brief on the external traps. Based on the new design using coated fuel particles the following was shown:

	Uncoated	Coated
Product Activity	39×10^6 curies	$\sim 5 \times 10^6$
Total decay	0.89×10^6 $\frac{Btu}{hr}$	$\sim 0.046 \times 10^6$
Rate accumulated Stable products	27.2 $\frac{lbs}{yr}$	$\sim$ 18.3 $\frac{lbs}{yr}$

Mr. Minogue states that the present has been on basic knowledge of components and system effects. Therefore, the final design of a component system is not established. Every access to all components is a criteria. Any steady state leakage is to be extremely small. The basis for design of the equilibrium system is a factor of 200 over actual operation, e.g.; actual 35 curies design = 7000 curies. Personnel exposure is set at 300 mrem/hr at 7000 curies. They desire to get 100 mrem/hr.

Any helium leak is fixed maximum by using 7000 curies in system and allowable on site and off-site criteria. If all helium was released to containment a worker would receive 25 R in 2.5 min.

The retention units are being scoped on design basis of 30 year life.

Mr. Art Harris - A description was given of the control rod design and test. ACRS stated that the control system is the only present way to shut this reactor off. Therefore, everything depends on its reliability.

Mr. Harris also described the reactor flow model test stating that Reynolds numbers can be simulated to about 75% of those in core.

A tour was then conducted to the G.A. shops to view the flow test and control drive tests. Both were in full operation.

11:00 a.m. - A separate meeting was held at the request of ACRS, attended by ACRS, AEC and applicant offidal.

Dr. Thompson officiated and stated the following:

We are much impressed by the R&D program. A good deal is being done on graphite and loops. However we are still worried on the over-all safety. Thompson then put the following on the blackboard for comparison

Reactor A	Consideration	HTGR
Fuel Clad Vessel Containment	Barriers	Graphite (R&D) Vessel Contain Fission Prod.
Rods Second Safety Remove Moderator	Shut off	Rods
Neg. temp coeff Void Coeff	Inherent Shut off	Negative prompt - then + on slow
Yes	Emerg. Cooling	No
Yes	Prototype	No
No	Stored Energy	Yes

With respect to the R&D program ACRS points out that:

1. You haven't looked at backup safety.
2. We'd like to know more of emergency cooling.
3. Steam leak effects.
4. We'd like to see a follow-up on the ultimate effects of a rod and coeff. accident.
5. How hot do rods get.
6. What happens if Xe gets out of core causing further heating. In essence what terminates the core.

Silverman: Dragon project is dragging and this hurts your program.

Thompson: What we need is more assurance that these problems are solvable.

McCullough: A variety of things are not understood which you may have answers to.

Mr. Le Clair: Does this mean that in some cases we should specify several alternatives and then justify our choice and reasons for elimination.

Biles: I'd like to say that I think you are pushing much on R&D and not pushing enough on Hazards.

Ergen: I feel much has come from this meeting however.

Biles: Yes, but much in hazards can still be done.

Cruetz: In the December meeting you said scope of R&D was good. What has happened to change this.

Biles: Not quite true. Your work on the systems was stated but it looks like work in all on systems and none on hazards.

Thompson:- Reads the Dec. 10 letter.

Mr. Fry: We thank you for your comments. We still want to build this facility. I'm sorry that we have left you with the impression that safety was not emphasized as much as necessary.

Thompson: We could later have some sub group meetings on specific areas. This was agreed to by all.

This concluded the meetings.