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12/3/64
DATE

*Classification changed 12/3/64
Ref: CNLM 5855 11/5/64*

Dear Mr. Pennington:

In accord with the request in your letter of September 14, 1964, we have reviewed the document entitled "Preliminary Title I Design Report, SNAP-50/SPUR Nuclear Test Facility" and our comments and recommendations are set forth below. This information should be adequate to permit the architect/engineering firm to proceed with the Title I design. However, a detailed documentation of these comments and recommendations is in preparation and will be transmitted to you in the near future.

The Containment Concept

The location of the subject test facility at CANEL in the vicinity of populated areas dictates the use of a containment concept of unquestionable reliability. To achieve this reliability we believe, in accord with the growing trend, that a double containment concept is essential.

Off-site dose calculations indicate that the maximum permissible leak rate for the containment vessel following a nuclear accident must not exceed 0.1 percent of the total volume in twenty-four hours. This leakage rate has been shown to be obtainable in containment vessels of more or less conventional design under ideal test conditions. However, two considerations tend to indicate that this criterion alone may not be adequate to permit safe operation of the proposed reactor test. First, the exposure of personnel working on-site to the potential on-site doses resulting from this leakage rate may be unacceptable. This problem, while not strictly a public safety consideration, is of vital importance in view of the relatively large number of people employed at CANEL and requires further detailed consideration. Secondly, the containment vessel leak rate can be determined only under ideal low temperature static conditions and then with

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great difficulty. The containment must, however, not exceed this leak rate after a nuclear excursion has occurred. The assumption that the high temperature, blast effect, and missiles associated with such an excursion will not affect the leak rate is of doubtful validity. In view of these questions, we feel that a properly designed double containment system is mandatory to insure public and on-site safety.

The subject report proposed double containment but the concept presented fails to provide this in the true sense.

First, the volume provided between the primary and secondary containment structure is small compared to the volume contained in the primary containment vessel, being in the ratio of about one to eight. Under these circumstances, the degree of dilution and mixing of the material leaking from the primary vessel is small and the effectiveness of the secondary containment vessel is therefore limited. Second, all of the auxiliary systems and equipment required for servicing the proposed experiments, including the large primary vessel coolant and gas handling equipment, are located outside of the secondary containment vessel. Since much of this equipment communicates directly with the space inside the primary containment vessel, the outer walls or envelope of this equipment constitutes primary fission product containment. Thus, this equipment violates the principle of double containment since it provides only a single wall between the interior of the primary containment vessel and the atmosphere. Based on previous experience, it will be difficult to insure adequate leak tightness and resistance to over-pressure and blast in much of this equipment.

We therefore recommend that as much of this equipment as possible, and particularly the large gas handling and cooling equipment, be located outside the primary vessel and inside the secondary containment vessel. This location also minimizes the number of critical piping pass-throughs in the outer or secondary containment envelope. We consider pass-throughs, even though well designed, to be particularly vulnerable to leakage and damage from blast and over-pressure.

The Maximum Credible Accident

A controlling factor in the structural design of the primary containment vessel is the magnitude of the maximum credible nuclear accident. We have previously specified a nuclear energy release of 5×10^6 Btu for the maximum credible nuclear excursion based on extrapolation of previous LCRE calculations. This value was used to establish the design proposed in the report. Recent calculations which we have been making confirm this value as a reasonable number to use for design purposes. Additional calculations

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are in progress but we can see no prospect for a substantial reduction in this number. In addition, the chemical energy release from the reaction of liquid metals and other reactive substances with oxygen and other materials within the primary vessel must be considered. A value of 1.5×10^6 Btu was used in the report for this energy release. It appears that this number may not include energy resulting from the reaction of liquid metals and other reactive substances with the air released from the low density blast shield concrete, with the concrete itself, and with other materials which may be exposed by damage to the interior of the test cell resulting from a nuclear excursion.

The location of the reactor at the time of a nuclear excursion is also of vital importance. The present plan for test operations in this facility calls for removal of the reactor and its associated systems from the vacuum vessel by hoisting the assembly vertically to a position above the assembly floor. Four types of accidents to the reactor must be considered with the reactor in this position. First, the desire to achieve reasonable test cycle schedules in the facility may ultimately require that the reactor be removed from the vacuum vessel before the afterheat power has reached a safe level for self-cooling of the reactor. In this case a meltdown accident of the type resulting in the maximum credible accident can be postulated. Secondly, it may be impossible to insure complete safety of the reactor control devices when the reactor is in the elevated position, since long time operation may distort or otherwise damage the control mechanisms. In this case the control runaway type of accident must be considered. Thirdly, the possibility of an inadvertent drop of the reactor assembly into the open vacuum vessel or onto the false floor used to cover the vacuum vessel pit during reactor disassembly must be considered. This accident has not yet been studied but both compaction of the core and forced motion of the control elements must be taken into account. The shock upon impact in such an accident could result in a very high ramp rate in reactivity addition. Finally, the possibility of dropping equipment, fixtures, shield slabs or other heavy items on the reactor, either in the pit or in the elevated position, must be considered.

Although these accident possibilities will be studied in detail to determine their probability and consequences, we believe that they cannot be disregarded and, therefore, the primary containment vessel must be designed to withstand the consequences of the maximum credible accident to the reactor no matter where the reactor might be located on the vacuum vessel center line from the bottom of the vacuum chamber to the point of highest vertical lift.

Vacuum Chamber Size

The vacuum chamber shown in the report, 12 feet in diameter by 25 feet high, is too small to accommodate all of the reactor and powerplant tests in the 300 Kwe to 1 Mwe power ranges, which are the specified development objectives

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for the SNAP-50/SPUR program. The preliminary vacuum chamber sizes we have given to you previously have been reviewed and we have analyzed what makes the most technical sense to meet the SNAP-50/SPUR test objectives. These requirements are set forth in the following table.

<u>Reference Design No.</u>	<u>Type of Test</u>	<u>Current Estimated Minimum Vacuum Chamber Size</u>
5	300 Kwe Powerplant Test	15' dia. x 30' long
4	1 Mwe Powerplant Test	22' dia. x 42' long

Preliminary studies indicated that at least a 19' dia. x 30' long vacuum chamber was required to meet the test objectives for SNAP-50/SPUR. Some of our more recent powerplant studies show that a SNAP-50/SPUR 1 Mwe powerplant located on an uprated Saturn IB or Saturn V would occupy a space about 21 feet in diameter by 38 feet long. Therefore, it appears mandatory at this time to consider using a vacuum chamber approximately 22 feet in diameter by 42 feet in length. In our estimation, this vacuum chamber size will also be satisfactory for reactor tests employing single-phase liquid metal heat removal systems up to 10 Mwt power level.

Facility and Access Requirements

The proposed facility concept does not include a separate clean room, a disassembly hot cell, a warm area, a waste disposal area, and adequate access doors. It has been our practice to do assembly of liquid metal systems and components in clean areas only, and our test experience justifies this approach. With the multitude of assembly work that will have to be done at the NTF, a clean-type building or area is required for receiving and assembling of liquid metal systems and components.

A disassembly hot cell and warm area should be provided so that disassembly and decontamination of specific test items can be performed readily for final shipment and examination in the CANEL Hot Laboratory. At present, the CANEL Hot Laboratory does not have the required capacity for these disassembly and decontamination operations.

The amount of radioactive waste following a test in the NTF will amount to hundreds of pounds of liquid metal plus thousands of pounds of structural material that has to be processed. Additional capability must be provided at CANEL. Considering the problems of transporting high activity material, even on-site, it seems most sensible to locate this additional waste disposal capability at the NTF or nearby the source of material to be handled.

Finally, properly sized access doors are not provided in the proposed facility concept and must be incorporated. The door opening should be sized to permit movement of the largest test assemblies and any other facility component or systems that might have to be initially installed or replaced at a later time. In our judgment these access doors should be at least 24 feet by 24

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feet. Welded closures may of course be considered if mechanical closures or "doors" appear impractical in this size.

Cost Estimate Review

The cost estimate as presented, contains items grouped together in such a way that we could not perform an accurate item-by-item check. However, some items that are singled out, such as the NaK heat dump system, appear to be estimated too low. For example, our estimate for the NaK-air cooler, exclusive of blowers, based on ICRE quotations is approximately \$148,500. This compares to \$62,700 for this cooler, including the cost of the blowers given in the report. We suggest, therefore, that an item-by-item review be made with the Catalytic Construction Company to determine the validity of their cost estimates.

Recommendations

In consideration of the above discussion, it is recommended that the Title I design effort of Catalytic Construction Company and Nuclear Utilities Services be continued through completion on the basis of the following .

1. It is recommended that the Nuclear Test Facility design proceed on a "double containment" concept. The primary containment vessel should be designed to contain blast, contain the over-pressure resulting from the maximum postulated accident, provide shielding and provide a leakage barrier for fission products and air-borne contaminants after an accident. Since it appears doubtful that a single barrier can be proven sufficient as a fission product barrier, a "secondary" vapor containment vessel of adequate volume should be provided.

A high quality leaktight vessel designed to meet the requirements of this "secondary containment" and completely housing the "primary containment vessel", and all possible associated facility equipment and systems should be considered. This air-filled building will minimize the number, complexity, and cost of penetrations and will provide accessibility to auxiliary systems for maintenance, repair, and operation without compromising the safety of the containment system.

At this early stage in the design of the SNAP-50 reactor, the best estimate that can be made of the energy release for the maximum credible nuclear accident is 5×10^6 Btu. It is also our judgment that the Title I effort must be based on the proposition that this nuclear excursion can occur anywhere on the vertical centerline of the containment vessel above the vacuum chamber as well as within

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it. An adequate allowance for chemical reactions must also be made. Whether 1.5×10^6 Btu, as reported, is a sufficient allowance is questionable and should be carefully investigated.

2. The test cell and associated facility items must be sized to accommodate the largest anticipated test article. At present this test article is a 1 Mwe, flight configuration powerplant, less the flight radiators, which will require a vacuum chamber approximately 22 feet in diameter and 42 feet high.
3. Certain items, which in our judgment are absolutely necessary for the proper conduct of a nuclear test program, have not been included in the Catalytic Construction Company proposed concept. It is recommended that the Nuclear Test Facility be provided with the clean assembly areas, disassembly areas, hot cells, warm areas, and waste disposal areas required for logical processing of materials and assemblies of materials into the test cell prior to a test and out of the test cell following a test. As part of this effort, the design of a large blast and pressure proof access door to the "primary containment vessel" must be studied. This door must measure at least 24 x 24 feet.
4. It is recommended that Catalytic Construction Company in the future provide more detail in the cost estimates with particular regard to the cost of individual items of equipment and the cost of fabrication and inspection under the high standards of cleanliness required for many of the systems.

The above comments and recommendations are based on the ground rules for the SNAP-30/SPUR program as we understand them and represent our best judgment at this time. You recognize however, that to meet the time schedule set forth for the facility design, these comments and recommendations are necessarily based as noted upon studies and calculations which are as yet incomplete. We will continue to make every effort to complete the important studies and calculations and to improve the definition of the detailed requirements imposed upon the nuclear test facility as rapidly as we can.

We will be pleased to discuss these recommendations and the facility work in progress with you at any time.

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Very truly yours,

PRATT & WHITNEY AIRCRAFT

W. Doll

General Manager - CANEL

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