Department of Energy
Washington, D.C. 20545

AUG 0 2 1982

The Honorable Nunzio J. Palladino
Chairman
Nuclear Regulatory Commission
Washington, D.C. 20555

The Honorable James K. Asselstine
Commissioner
Nuclear Regulatory Commission
Washington, D.C. 20555

The Honorable Victor Gilinsky
Commissioner
Nuclear Regulatory Commission
Washington, D.C. 20555

The Honorable John F. Ahearne
Commissioner
Nuclear Regulatory Commission
Washington, D.C. 20555

The Honorable Thomas F. Roberts
Commissioner
Nuclear Regulatory Commission
Washington, D.C. 20555

Re: Clinch River Breeder Reactor Plant Docket No. 50-537 (Section 50.12 Request)

Gentlemen:

The Department of Energy, on behalf of its coapplicants, Project Management Corporation and the Tennessee Valley Authority, hereby files their supplemental responses to the Commission regarding their July 1, 1982, request under 10 C.F.R. Section 50.12.

Sincerely,

Gordon L. Chipman, Jr., Acting
Deputy Assistant Secretary
for Breeder Reactor Programs
Office of Nuclear Energy

Enclosure

cc w/Enclosure:
Distribution List

3,173

Applicants' Supplemental Responses to Commission Questions

Introduction

This is in reponse to Commissioner Asselstine's inquiry on July 29, 1982, regarding specific examples which will illustrate the benefits of transference of experience from CRBRP construction to the LMFBR Base Program and Large Developmental Plant (LDP). This response will demonstrate the very real and important benefits which will accrue to the Base Program and LDP by a 9-12 month earlier start in the CRBRP construction activities and earlier operation of the facility.

The U.S. LMFBR development program is a complex and broadly based effort to develop LMFBR technology to the point where the risks associated with proceeding with commercialization are acceptable for further development by the private sector. This effort has been underway for many years and a significant amount of work remains to be completed.

The base technology effort is directed toward research and development in specific technological areas and the use of demonstration facilities of ever-increasing size. The maximum effect of this program would be achieved if all elements of the base R&D program and demonstration facility construction and operation could be fully coordinated in their timing.

Adjustments are continually made in the pace and scope of the various elements of this program in order to optimize the program benefits through maximum coordination of its various elements. Since it would have been both impractical and unsound to terminate the LMFBR base program during the 5-year delay of Clinch River caused by the last Administration, the program has instead proceeded on a sound basis and produced a great deal of useful information. However, had Clinch River proceeded without interruption, it would have provided significant benefits to the base R&D program and the program would have been more effective.

Clinch River has benefited in some respects through the advances made in FFTF experience and base program developments. However, in a complex technology development program, it is the synchronization of projects and R&D development that produces the best results. The program plan originally envisioned in the early 1970's was structured with a goal of such optimization. The long delay in the Clinch River project has put the program seriously out of synchronization and has removed the flexibility that normally exists in adjusting program element schedules to optimize results. Consequently, the base program and LDP are proceeding without all the benefits that could have been achieved from Clinch River. Any improvement in the schedule for construction, testing, and operation of CRBRP will be of direct benefit to these other elements of our program.

General Considerations

There are several major phases in a large technical project such as an LMFBR: design, component manufacturing, construction, preoperational checkout and testing, and normal operation. In the design phase, there are several stages of progression: preconceptual, conceptual, preliminary, and then final design. At the preconceptual stage, major design objectives are established such as power output, thermal conditions, and major plant configurations. Once these decisions are made, the conceptual design is initiated in which more design decisions are reached at the system, subsystem and component level, and where initial constraints are established on interface relationships between components within a system, and between systems in the overall plant. The conceptual design effort is an iterative process which is intended to establish the general design configuration which meets the major design objectives. Preliminary design adds additional detail, defines interface relationships and constraints, and firmly establishes detailed design requirements for buildings, foundations, systems, and components. The preliminary design phase is generally several years in duration and is also iterative in nature. It results in the configuration upon which the final design, analysis, procurement, and construction activities are based.

The nature of engineering is to take all available knowledge and apply it to solving the problem at hand. Potential available solutions are constrained by the nature and degree of design change a particular solution will cause to interfacing systems and components. As the design of systems and components progresses, the degree of difficulty and cost in making a design change increases. The design process described above can, therefore, be characterized as a process in which the difficulty and cost associated with resolution of any given problem increases as the design process is pursued. Consequently, the earlier in the design process that knowledge is available to apply to the engineering task at hand, the less constrained the engineer is in reaching a solution, and the engineer is better able to reach a solution with minimum changes to the interfacing designs and to the overall cost.

This general discussion is applicable to _all_ engineering effort, whether constructing a five-story building or a complex technical project like a space shuttle. However, the more developmental the nature of the activity, the more crucial the availability of relevant information becomes to the overall success of the effort. This is particularly true for the LMFBR development program which is establishing a new technology and advancing this technology in major steps by demonstration projects.

As noted during the oral presentation to the Commission, specific technical benefits to the Base Program and LDP efforts resulting from advancing the CRBRP schedule by 9-12 months can be demonstrated. We can speak about future benefits to the Base Program and LDP with confidence on the basis of significant experience. These future benefits can be demonstrated by showing the historical experience in constructing and operating FFTF and how the flow of information from that facility did benefit the CRBRP and Base Program R&D efforts, and how those benefits were schedule related.

FFTF Information Transference to CRBRP

CRBRP has a well established and disciplined program for incorporating the experience gained through FFTF construction and operation into the CRBRP design. A CRBRP project representative was on site at FFTF throughout construction, startup and initial operation. Frequent reports were and continue to be provided to the CRBRP Project. Important experiences are identified, recorded and assigned to a CRBRP Project organization which has the responsibility to factor the experience into the design if appropriate, document the implementation, and provide a written description of what was done. This program of experience transfer has been extremely important, and a similar program for transfer of experience from CRBRP to LDP is planned and will be implemented so that as information becomes available from CRBRP, it will be directly transferred to LDP.

Attachment "A" provides specific discussion of representative examples where FFTF experience was beneficially applied in the design of CRBRP. Attachment "B" provides a subject listing of some additional instances where FFTF experience was transferred to the CRBRP design. These FFTF experiences came at different stages in the construction and operation of FFTF, and were fed back to the CRBRP design at different stages of the design process. The important points to note are:

a. Many of the experiences from FFTF were available at a sufficiently early time so that CRBRP could effectively utilize the information in the conceptual and preliminary design phases.

b. The Project was more constrained in the application of experience which was not available until the late preliminary and final design stages, increasing the difficulty of realizing the benefits of this experience and increasing costs due to design modifications on CRBRP.

Our experience shows that the earlier the information becomes available, the more beneficial its effect is on the future design and the program as a whole. The CRBRP will provide a similar pattern of information transference to the Base Program and LDP and if the 50.12 request is granted, the resulting acceleration of information transference will provide substantial improvement to the benefits to the Base Program and LDP.

Base Program Benefits

A demonstration project experience often impacts the technology development effort and follow-on demonstration projects in unanticipated ways. In addition, there are many anticipated benefits to be transferred from any given project. For the results of these development programs to be effectively utilized in the design effort for a follow-on plant, they must be initiated very early and before the need is specifically identified on a future project. For example, FFTF identified the need to do development testing on the insertion and removal of thermocouples through a conduit system in order to replace thermocouples which are located inside the reactor. This long term base program R&D development program was started before the CRBRP Project identified the specific need for the information, yet the results were available to enable basic conceptual configuration decisions on CRBRP to be made with confidence. A similar example is the development testing on filtered vent systems based on CRBRP experience which provides information to enable LDP to make basic configuraton decisions with confidence.

The FFTF development, design, construction, and initial operation has provided the necessary experience and verification to permit redirection of the base program R&D activities. Examples of this are:

- o Pipe welding technology and equipment has been developed through a long-term R&D effort through the Oak Ridge and Idaho National Laboratories. This technology was proof-tested in the construction of FFTF. As a result, the program has been concluded. The timing of program completion was directly impacted by the FFTF schedule.

- o Preoperational testing and initial operation of FFTF show successful completion of work in several areas of the Components Program. The last efforts in the areas of pipe, valves, insulation, and sodium leak detection were closed out in 1982. Stretchout of the FFTF schedule would have extended these programs.

- o Timely operation of FFTF provided operational verification of a workable fuel system for LMFBR's (including CRBRP). As a result of the successful early performance of FFTF, we have achieved confidence that the reference fuel system will perform as predicted. The predicted performance of the reference LMFBR fuel, absorber and core component systems has been verified through the early operating stage. In addition to benefiting CRBRP engineering and licensing, the verification of the reference oxide fuel system will enable reduced emphasis on alternative fuel development areas and carrying them as product improvement efforts. For example, we reduced the previously high priority carbide fuel development program to a cooperative product improvement effort with the Swiss government. Likewise, efforts with improved alloys have been redirected to achieving extended core life and improvements in fuel handling and core restraint strategies of benefit to CRBRP and subsequent projects.

- o The base R&D program has had a long-standing effort to develop and verify thermal-hydraulic performance codes, e.g. COBRA and TEMPEST. The DOE/NRC safety assessment of FFTF, and subsequent verification through operation of FFTF, has directly benefited the licensing of CRBRP and allowed DOE support of this code development effort for TEMPEST to be terminated. A delay in the schedule of FFTF would have extended this effort and delayed the licensing benefits to CRBRP.

- o Natural circulation testing on FFTF provided reactor system level information needed for verification of natural circulation analysis codes developed at HEDL, WARD and BNL and used on LMFBRs. This verification is of direct benefit to CRBRP licensing and safety analyses and has aided the base program in confidently redirecting its efforts toward solution of specific problems in smaller test facilities. Delay in obtaining this information would have significantly reduced these benefits. Because this information is available now to support the NRC safety and licensing review of CRBRP, substantial reductions in licensing uncertainties have been realized by CRBRP and the NRC.

o FFTF operational testing verified the methods and techniques developed for analyzing the radiological shield design. These methods have been developed as part of a long-term effort at Oak Ridge National Laboratory and WARD. Verification of this work through FFTF experience has enabled redirection of this work toward support of the LDP specific configurations.

o FFTF provided a demonstration of the available high temperature structural design methodology including use of design methods and criteria, computer codes, and materials properties data. this experience provided focus to the Materials and Structures Program and directly contributed to improvements in the ASME Code Case for elevated temperature components. Thus, the timing of the development of this technology was directly affected by the FFTF schedule.

In our July 29, 1982 oral presentation, we pointed out that there are significant benefits to the LMFBR base program that would accrue from the grant of the 50.12 request and a CRBRP project schedule savings of 9-12 months. Based upon our experience with FFTF, information obtained from the construction, preoperational testing, and operation of the CRBRP will be integrated into the base program as it becomes available and will serve to redirect the effort. Since the Government's role in LMFBR development effort is aimed at bringing the technology to the point of economic viability, a 9-12 months acceleration of CRBRP experience by grant of the 50.12 request should result in improved program direction, in an overall foreshortening of the duration of the Government's role in the program, and in a significant budgetary savings. It should be kept in mind that the LMFBR base program is currently funded at over $300 million per year. In view of the size of this program, acceleration of the experience from CRBRP and the application of this experience to redirect the program toward a finite set of specific problems, rather than a broad range of potential problems, will enable the

Base Program to reap substantial benefits in terms of reduced cost and duration, and increased efficiency and effectiveness.

Some specific examples of where earlier CRBRP operation is expected to benefit the base program include:

o Natural circulation testing earlier on Clinch river means improved code predictions for industrial use.

o Permits evaluations of margins in calculational codes to be conducted earlier thereby allowing uncertainty reduction in the code calculations. This results in cost reduction to any follow-on plants to which the codes are applied.

o Identifies unanticipated system interactions which can feed follow-on designs to avoid such problems (eg. covergas pressure equalization.)

o Earlier verification of performance of new (secondary control rods, heterogeneous cores, etc.) components and design features. Formally establishes the next leaping off point for future breeder designs and permits subsequent designs to proceed with more confidence.

o Because heterogeneous LMFBR cores have not operated except in ZPPR at low power, and because heterogeneous cores are deemed highly attractive by U.S. industry, it is exyremely important to demonstrate fuel burnup, thermal hydraulic, kinetics, and reactivity control characteristics of heterogeneous cores at the earliest feasible date. The early operational procedents with CRBR will be invaluable to guide future design and developments. The core design methodology, when it is confirmed for CRBR, can be used with greater confidence on larger systems.

The adequacy of system design interactions is an experimental question and cannot be totally confirmed until operation of the first-of-a-kind plant.

The shield design methodology also will be completely validated for CRBR when Clinch River goes into operation. CRBR will thus test this methodology which has significant implications to achieving economical LMFBR shield design in future reactors.

o Demonstrates the automated remotely operated fuel fabrication and processing system (SAF Line) for producing large quantities of Pu-bearing fuel. Advantage is that industry can sooner capitalize on this technology and scale up to large through-put commercial fuel fabrication plant.

o Accelerate testing of internal blankets and fueled low swelling alloys.

o Earlier demonstration of long-life cores.

o Enables early identification of areas where improvements can be made in constructibility, operability, maintainability for industrial plants.

o Flush out real operational problems and at same time show that anticipated or perceived problems are "unreal" or do not actually exist.

o Enables earliest demonstration of optimum manning levels, training, and procedures for safe and efficient power producing operations.

o Early operation of CRBRP will provide needed feedback to the base component program as follows:

Confirmation of critical technology embodied in both CRBRP and base program component development such as material selections, fabrication process requirements, NDE requirements, etc.

Identification of unanticipated component and system problems that may require further substantive development efforts to support industrialization of the breeder.

Confirmation of critical assumptions and plans concerning component repair, maintenance, and operability which influence the design of future systems and components.

Provide a reasonable period of endurance data and operating experience in advance of commitments for an industrial plant to identify potential problems which occur after significant operating periods and which must be corrected in future plants.

Finally, and perhaps most important, earlier industrialization is possible, which results in reduced Federal and industrial research and development outlays (reduced stretchout of costly programs) and earlier return on the Federal and industrial investment.

Technical Expertise

An essential element in assuring the success of the LDP is the effective transfer of expert technical staff from one task or project to another. As noted in the July 29, 1982 oral presentation, the benefits accruing from the effective transfer of expert staff include an avoidance of technical risks and potential cost and schedule impacts involved in not recognizing and incorporating experience from past projects at an early stage of design. The benefits of building and maintaining a cadre of experienced technical staff has been recognized as a key element of success in the French LMFBR program.

The process of moving an engineered project from concept to realization progresses through a series of events, many overlapping.. These steps consist of design, component manufacturing, construction, preoperational checkout startup testing, and operation. To a large extent, many of the same technical experts are involved in successive steps. For example, system and component designers fulfill important roles during the procurement, fabricaton, installation and startup stages in addition to the design stage. When project delays are incurred, various combinations of schedule related impacts occur. These impacts cause gaps in the progression between successive steps; e.g. design may be completed, with a delay imposed before procurement; design and procurement may be completed with a delay imposed before fabrication, etc. Each of these techniques employed to minimize the overall impact of a delay tends to interrupt the orderly flow of work and the utilization of the original combination of experts throughout the duration of the effort required on given systems or components. These delays also tend to represent times when key individuals become disheartened with events and leave projects for more stable or dynamic opportunities. Not only do these personnel losses impact the specific project, but they also generally result in a loss to the particular segment of the industry. For example, prior to the delay imposed on CRBRP by the last administration, Westinghouse (the prime design contractor for CRBRP) was led by a Project manager and a Technical director, each of whom who had also served in positions of high responsibility for FFTF. These gentlemen and their vast LMFBR expertise have been lost to CRBRP and the LMFBR program. Many other examples exist as well. Granting the 50.12 request and accelerating CRBRP will enhance the LMFBR program's ability to maintain the cadre of expert technical staff on CRBRP and provide for an orderly transfer to LDP so they may effectively apply their vast knowledge.

CRBRP Information Transference to LDP

CRBRP has already provided significant design and component testing input to the LDP. Frequent technical exchange meetings are held between the two projects to communicate design and analysis methodology and results. Development programs carried out by CRBRP, such as those for the secondary control rod system, the sodium pump, and the steam generator, are already of direct use in the LDP conceptual design. As the LDP design progresses beyond the pre-conceptual and conceptual stage however, LDP will require input from experience on CRBRP construction and operation at the earliest possible date in order to make most beneficial use of that experience in the LDP design.

If the 50.12 request is granted by the Commission, the Project will be able to start site preparation activities in August 1982. This action, coupled with the issuance of an LWA I and II by about August 1983, will allow for the start of limited safety related facility construction activities to proceed following site preparation. The CP is currently scheduled for issuance by June 1984 which would allow for continued construction without interruption, with the start of above-grade construction and installation of components to begin in the mid 1984 time frame. This timing will provide CRBRP experience when the LDP preliminary design effort is planned to begin. Of course, favorable action on the Section 50.12 request will, as was stated on July 29, produce a stimulus to the establishment of definitive arrangements for the LDP and help assure that this industry and international cooperative effort is successful.

Attachments "A" and "B" describe the specific benefits which were associated with the timely application of FFTF construction experience to CRBRP. Similarly, the acceleration of the construction experience from CRBRP will allow for factoring that experience directly into the conceptual and preliminary design effort for LDP. Given that significant design progress is always made in the first year of a project's preliminary design, a delay in transfer of CRBRP experience to LDP by 9-12 months represents a very significant loss in potential benefits. For example, on the current CRBRP construction schedule, assuming 50.12 approval, the installation of leak tight cell liners and pouring of concrete for these cells will occur from mid 1983 thru 1984. Confirmation of this construction technique is anticipated, but any problems encountered will be lessons learned for LDP at a stage in the LDP design which will allow for conceptual design changes to be made without major cost impact. Major components and systems such as the sodium storage tanks, sodium water reaction product separator tanks, and heat transport system piping and equipment will be installed beginning in mid 1984. Much of the experience learned from FFTF and incorporated into CRBRP will be confirmed during this time period. As with FFTF, much can also be learned for the first time from these particular construction activities, and much of the experience gained from these construction activities will be available late in the LDP conceptual design and at the start of the preliminary design beginning in late 1984, if the 50.12 request is granted. On the other hand, if the Commission does not grant the 50.12 request, more of the CRBRP experience will be out of phase with the LDP, increasing the cost and difficulty of incorporating this experience into the LDP design, and reducing the ability to maximize the beneficial use of this information.

Conclusion

In conclusion, very real and important technical benefits will accrue to the LDP and the Base Program by the Commissions' approval of the 50.12 request and subsequent initiation of site preparation activities. The resulting acceleration in the CRBRP construction schedule will advance the Department's program initiatives. Approval of the 50.12 request is essential to realize the full potential of experience from CRBRP, and to provide direction, needs, and priorities to the Base Program development work based on actual CRBRP experience to effectively incorporate that experience into the LDP and the Base program.

(3, 175) Attachment A

FFTF Information Transference to CRBRP

Introduction

The examples discussed below identify the tangible, real benefits of providing construction, acceptance test, start-up, and operating experience from one plant to the follow-on plant, and provide some insight into the magnitude of some of the difficulties encountered during the design and development of a first of a kind plant.

The quantified impact of the various individual problems cited below on the overall FFTF plant cost and schedule cannot readily be assessed. Often several problems were being resolved concurrently on FFTF and the cost and schedule impact of an individual item was not separately accumulated. The amount of advance planning needed to minimize plant schedule impact varied from several man-days to many man-weeks or man-months depending on the difficulty of the problem or the number of physical locations where corrective measures were required.

While these examples in themselves cannot be individually assigned a plant cost or schedule value, in total, they represent many millions of dollars and many man-years of engineering and construction effort. These experiences, when considered by the CRBRP project, result in substantial savings that will be realized in large cost and schedule avoidances during all phases of the project.

Containment Arrangements

FFTF construction provided invaluable information regarding the arrangement of LMFBR systems in the reactor containment building. Design engineers were able to see, first hand, the construction and maintenance advantages and disadvantages of various system arrangements. This was especially true of the auxiliary liquid metal, inert gas, and nitrogen cooling systems that are unique to liquid metal cooled reactors. As a result, the CRBRP containment has been arranged with spacing, separation, and juxtaposing of equipment to enhance constructibility and maintainability while still meeting essential safety and performance requirements.

Improved plant arrangement enhances plant operations and will substantially reduce the cost of plant maintenance over the plant lifetime by an estimated several million dollars. Improved plant arrangement has the potential for reduced crew size by arrangement of work stations so that one plant operator can monitor more equipment without loss of effectiveness, i.e., a more efficient utilization of plant operators.

Much of this plant arrangement information from FFTF was available to the CRBRP designers during the late conceptual and early preliminary design phases, allowing for maximum benefit of the information and minimizing the design changes required. Had the information been delayed one year, very significant and costly design changes would have occurred to redo design layouts and arrangements of the plant's major systems because this type of information establishes the philosophy of the configuration.

Reactor Vessel Access

FFTF design experience showed that the area above the reactor vessel and immediately surrounding the vessel, known as the reactor head access area, can easily become overcrowded. This is due to the use of this small area for access to the inside of the reactor vessel for refueling purposes as well as location of control rod systems and instrumentation. CRBRP engineers, having the advantage of the experience and information gained from FFTF, have expended considerable effort throughout the CRBRP design process to assure effective use of space in this area of the plant. The CRBRP designers made a full scale mock-up of the head access area conceptual design and utilized it extensively throughout the CRBRP design process to assure the design will efficiently support all necessary operations. This resulted in the direct translation of experience from FFTF to the conceptual, preliminary and final design of CRBRP, thus effecting savings during the construction phase and ultimately in plant maintenance and operation. If the FFTF had been delayed such that the people who had gained the experience on FFTF had not been available to the CRBRP during the design phase, then the design of the CRBRP reactor head access area would not have been able to benifically apply this experience in an efficient way.

Cell Liner Construction

Many of the plant rooms (cells) in an LMFBR are required to be leakproof to liquids and gases. To achieve this, the interior surfaces (walls, ceiling, and floor) are lined on the inside with carbon steel plates welded together. During the early phase of FFTF construction, those cells were constructed in a conventional manner using wood forms for the concrete walls and floors and then lining the inner surfaces with the carbon steel plates, welding their seams in place. Early in the FFTF construction, it was realized that, by first welding the steel plates together to form the cell walls, the liners could be used instead of the wood forms for concrete placement, resulting in a substantial saving in time and construction cost.

This technique has become the basic construction method for CRBRP and will also be employed on the LDP. This experience is typical of the high value placed on early construction experience to a follow-on plant. The information was available to CRBRP in the 1975 time frame when preliminary design of these cell liners was being initiated. Because of the early availability of this information, the cell liner design was based upon the central theme of modularization of panels and preassembly to ease construction. A one year delay to CRBRP in receiving this information would have meant completely redoing all of that design work due to the fundamental role the information plays in establishing the design philosophy of lined cells.

Leak Tight Cells (Rooms)

Construction and preoperational testing at FFTF revealed a need to enhance the construction methods for leak tight cells. More effort than originally planned was required to assure leak tightness. This extended the total time to complete this testing. Obtaining plant conditions to perform the tests while minimizing overall plant schedular delay was a major consideration for FFTF. When plant conditions were suitable, overtime effort was applied to minimize the test periods. CRBRP engineers worked in close cooperation with FFTF engineers to explore and utilize improved designs and construction methods. The CRBRP design now allows for modularized prefabrication of leak tight wall panels to improve constructibility. In addition, early construction tests will be performed on CRBRP to identify any remaining problems, assuring early, effective correction action. It is anticipated that this will result in a substantial cost avoidance for CRBRP, as well as avoiding delays at a point in the plant start-up sequence that is very difficult to rearranged without extending the total plant startup schedule.

Polar Crane Use

FFTF experienced many instances where availability of the polar crane inside the containment building caused many equipment installation efforts to be on the critical path. Further, some instances of inadequate coverage by the polar crane were determined. For example, the polar crane cannot provide a direct vertical lift of some peripheral hatch plugs. Special off-set or counterbalanced handling fixtures to accommodate this condition were necessary at FFTF, adding to the complexity of and time to perform the operation. In addition, minimal provision for load testing the polar crane was provided.

Because of this experience, CRBRP recognized quite early that, particularly during the Acceptance Test Phase, potential existed for lack of polar crane availability to cause delay to critical path efforts. To minimize potential for this to occur, CRBRP has made provision in the design of hatch plugs and hatch seals for the use of various jib cranes and other lifting devices to relieve the polar crane of many lifts of less than ten tons. The segmented design of plugs (which on FFTF were single heavy lifts) allows the use of smaller temporary and/or permanent lifting devices and, thus, relieves the work load that would otherwise be assigned to the polar crane. A delay of one year in the receipt of this information by the CRBRP designers, under normal progression of design, would have substantially increased the cost to redesign these plugs and hatches.

Optimization of polar crane coverage has occurred through judicious placement of plugs and hatches and has been verified as adequate through the use of the CRBRP model.

A method for load testing of the CRBRP polar crane has been provided in the design. This method makes allowance for use of in-containment cribbing to hold test loads, verification of floor load capability for placement of test loads, and assurance that the test may be performed without interference caused by in-containment equipment and the containment walls.

Seismic III Over I

FFTF experienced situations where the physical location of installed piping and cable trays indicated many instances of

Seismic III equipment installed over Seismic I equipment. Seismic category I equipment is designed and supported to maintain its required functional characteristics after experiencing major earthquake loads. Seismic category III equipment is not plant safety related and need not be designed or supported to maintain its function after experiencing major earthquake loads.

After essentially completing the installation of most components in the cells, it was noted that some non-safety related category III equipment was installed over safety related category I equipment. The potential failure of this category III equipment in its as installed arrangement and possibly causing damage to category I equipment resulted in a major program on FFTF to upgrade many component supports, some relocaton of equipment, or the protection of category I components to avoid the potential for major earthquake damage to this equipment.

CRBRP and FFTF engineers exchanged considerable information as a result of this experience. The CRBRP plant design was reviewed by representatives of both projects, including detailed study of the CRBRP plant scale model. The results of this detailed review indicated similar potential concerns for CRBRP. These were resolved by upgrading supports, relocation of some components, and change of pipe routing and cable tray arrangements in the CRBRP design.

This problem was identified on FFTF after much of the plant equipment had been installed, requiring an extensive field rework program which extended over a one-year period. The resulting guidance to CRBRP came at a time when the preliminary design was partially complete, resulting in the need to redo many drawings, support designs, equipment locations and pipe and cable tray routings. Had this information been apparent to CRBRP at the beginning of the preliminary design phase, there would have been minimal need to redo already completed work.

Maintenance Access to Equipment

The FFTF plant arrangement has congested areas which make difficult the prompt and expeditious performance of plant inspection and maintenance.

Some of the same engineers worked on CRBRP during the conceptual design stage. FFTF maintenance access provisions were reviewed. In particular, FFTF experience with equipment installation and removal, access and maintenance frequencies, and handling and rigging problems were examined. CRBRP capitalized on this FFTF experience by performing during the conceptual design phase a plant model review of planned equipment installation and removal paths, floor loadings, rigging equipment and manpower requirements, and individual component maintenance requirements (including maintenance frequencies). The removal studies identified at least one removal path for each piece of equipment, and at least one removal method addressing live floor loadings, installed and temporary rigging equipment needs, and equipment weights and configuration. This will result in substantial savings in maintenance costs which will be realized over the full life of the CRBRP. If the information had been delayed by one year, the conceptual plant arrangements for CRBRP, would have already been fixed, requiring design work with the attendant significant cost to make those design changes.

Shielded Door and Hatch Design

FFTF experienced various problems relating to the design of their shielded doors and hatches which provide access to the leak tight cells (both inerted and air filled) for inspection, maintenance and testing. These included items such as testability of door and hatch seals, handling characteristics, and schedule impact due to lack of separation of sealing and shielding functions of some hatches and plugs. It was evident that improvements in shielded closure designs which considered frequency of access, As Low As Reasonably Achievable (ALARA) radiation exposure cost impact, and cell environment should be reviewed by CRBRP.

As a result of this FFTF experience a Shielded Door and Hatch Study was performed during the door and hatch conceptual design phase on CRBRP. This study addressed various shielded door and closure types such as labyrinth, plug, steel hinged door, removable panels, and horizontal sliding doors, and also addressed items such as capital and operating costs, in cell maintenance frequencies, and ALARA exposure costs for each cell and closure type. Identification of this problem at FFTF during the CRBRP conceptual design phase allowed for time to perform the study and incorporate the results with minimal need to change established CRBRP design features.

The final selection of shielded closures on CRBRP represents a mixture of the various types available. Their individual applications are expected to provide significant improvements in the areas of handling, testability, ALARA and plant capital costs. Had the FFTF experience not been available in the conceptual design phase of CRBRP, considerable rework would have been required during the preliminary design phase with attendant cost and schedule impacts. The lack of an improved design would have increased plant operational costs in terms of manpower required during maintenance periods, increased radiation exposures and decreased plant availability.

<u>Closure Head Installation</u>

Final installation acceptance of the FFTF closure head to main support structure was delayed by rework associated with alignment and galling of keyway and key shims. Although the CRBRP closure head does not use this feature, the experience was beneficial to the CRBRP ex-vessel storage tank (EVST) design which incorporated an improved design of seismic keys.

This experience was provided in sufficient time to allow for the incorporation of this information into the preliminary design of the EVST with minimal design and cost impact.

Insulated Pipe Clamp Design

Heat transport system pipe clamps at FFTF used individual pieces of maramet blocks for load bearing insulation between the steel pipe clamp and the pipes themselves. Some difficulty in installation (need to hold these pieces in place until clamp was tightened and the need to use steel wool under the blocks for shimming) lead to a revised CRBRP insulated clamp design. The CRBRP design uses encapsulated blocks and insulation retaining pins as well as an improved insulating material which will avoid the need for shimming materials and will enhance installation. This could potentially reduce the installation crew size, which would have substantial impact on construction costs since several thousand pipe clamps are used on liquid metal high temperature systems.

The feedback concerning this FFTF installation difficulty was available to the CRBRP designer in sufficient time to incorporate features to ease the installation process for CRBRP without major design changes to the pipe clamp insulation design. A one year delay would have significantly increased the cost of changing the design.

Damage to Heaters

In the design of an LMFBR, trace heaters are used on sodium piping to provide the ability to keep the sodium well above its freezing temperature of about 208 degrees F. FFTF experienced problems in heater damage during the construction and plant startup phase and continues to have heater damage due to the heater ends penetrating outward from the insulation around the pipes. It is necessary, as one of the last procedures in the FFTF final cell checkout program, to have the electricians assure that all trace heater connections have not been damaged as a result of personnel working in the cell.

Because this information was made available to the CRBRP designers during the conceptual design stage of the trace heating system, the designer was able to resolve this concern by designing the heater ends to be buried under the pipe insulation to prevent damage during construction. This was done as part of the initial configuration defirition phase on the CRBRP trace heating system and did not have a cost impact. Again, a one year delay would have caused a redesign effort, with the attendent cost impacts.

Heating of Standpipe Bubbler Line

One of the FFTF primary pumps experienced sodium flooding which caused the pump shaft to become distorted. This required pump removal for repair. The flooding was in part caused by sodium blockage of a portion of the cover gas equalization line of an idle pump. The equalization line is intended to provide uniformity of argon cover gas pressure above the sodium in the reactor vessel and all three primary pumps. The pump shaft distortion was diagnosed as having been caused by the unsymmetrical rise of sodium in the annulus around the shaft. In CRBRP, the analogous line (the standpipe bubbler line) was initially not trace heated, but trace heating was added to preclude sodium from condensing there and creating a gas line blockage. Operating procedures for the CRBRP pumps were changed to minimize the time that the pony motors will be turned off, to prevent unsymmetrical sodium flooding and the resulting effects of non-uniform heating of the pump shaft.

On FFTF this problem resulted in change out of the primary pump, refurbishment of the distorted pump shaft, engineering evaluation and incorporation of corrective measures. The indirect costs of FFTF unavailability for a period of a few weeks is also a major consideration and a large potential cost. CRBRP has benefited from this experience. This operational feedback from FFTF has enabled the CRBRP design to be upgraded with minimal cost, even though the information became available late in the CRBRP design process. This is because of the relative simplicity of the design change involved.

Operational Experience

FFTF operation and preoperational testing is providing reliability data and experience important for system design and safety assessment. Information is useful in CRBRP licensing, design verification, and performance prediction. This is particularly true in the areas of thermal/hydraulic performance of the core, major component design and maintenance. Of particular importance is the ability to review the CRBRP design in light of experience bearing on accessibility for maintenance, repair, modification, or replacement. Likewise, this operating experience enables value judgements on the relative importance of operating parameters to the operators bearing directly on man-machine interface and reliable reactor operations. FFTF schedule slippage would have delayed availability of information and reduced its usefulness to CRBRP design and licensing efforts.

ATTACHMENT B

FFTF EXPERIENCES APPLIED TO CRBRP

Introduction

Attachment A discussed in detail some of the examples where experience on FFTF was applied to CRBRP. There are literally hundreds of such examples. Below is an abbreviated subject listing of many more examples, each of which resulted in knowledge being transferred to the CRBRP Project.

- o Improved gas venting capability during sodium fill of outer radial shield sleeves.
- o Closure head main support structure key shims galling.
- o Galling of lifting adaptor for Outer Core Restraint Module.
- o Attachment bolts galled in the threads in the thermal liner and the locking caps.
- o Insufficient clamping force on flexible thermocouple guide tube.
- o Rigging and handling fixture improvements for reactor vessel.
- o Improved alignment of locking tabs on the main support structure bearing pads with leveling nut.

- Seal between thermal liner and baffle liner interface seal assemblies.

- Inner core restraint modules interference with mounting brackets.

- Lack of Radial Shield holddown seat chamfers.

- Eliminated reactor center island heating and cooling piping vibration due to flow-induced vibration.

- Improved chamfers, lead-angles, and radii for assembly and disassembly of the IHX shell, thermal liner, and tube bundle.

- Head area access improvements for installation of equipment.

- Installation improvement techniques associated with the outer core restraint modules.

- Complications associated with three in-vessel handling machines.

- Reduced construction costs by using cell liners as concrete forms in construction.

- High density concrete used due to small containment vessel size.

- Construction blockouts necessary due to late design resolution.

- Expense of curved walls

- Use of concrete additives to improve cost of construction and workability of concrete.

- Saving by not using temporary pipe hangers.

- Improved definition of equipment storage and installation requirements.

- Automatic pipe welding improvements.

- Optimizing pipe spool sizes.

- Need for on-site construction storage.

- Late design of heating and ventilating systems impacted duct design, routing, and installation.

- Polar crane size considerations.

- Reactor vessel support system improvement.

- Reactor vessel support ledge thermal problems.

- Cost reductions by site fabrication of piping spools.

- Increased attention to increases in plant cable requirements.

- Preparation of construction guidelines to benefit from FFTF construction lessons.

- Costs savings from use of permanent wiring for construction power and lights.

- Development of early installation rigging requirements to improve construction sequences.
- Potential prefabrication of cells, walls, and floors.
- Use of head area mockup.
- Welding clearances.
- Use of approved thread lubricants for sodium service.
- Use of lead-in chamfers to facilitate installation of conoseal assemblies.
- IVHM studs housing holes interference.
- Design provisions for purging/flushing of piping systems.
- Overly stringent electrical installation specs.
- Protection of O-ring sealing surfaces during shipping/storage.
- Valve operation and adjustment difficulties due to location.
- Protruding features of simulated core assemblies.
- Need for efficient field change notice system established.

- Head access area shielding components interference.
- Head mounted components purge and buffer lines damage potential.
- Improved polar crane, gantry crane service location.
- Segmented maintenance cask gate interference with electrical cabinets.
- Need established for remote removal capability of primary cold trap assemblies.
- improved instructions for describing engagement of electrical nuts on terminal studs.
- Requirements for banding insulation to piping and components upgraded.
- Insulation support design improved with respect to component thermal expansion and vertical insulation support.
- Air rights considerations for periscope installation.
- Air rights considerations for installation of maintenance equipment.
- Trace heating and insulation space in penetrations between cells.
- On-head component modifications to account for thermal movement.

- Components versus piping installation sequence.
- Task force cell by cell review of seismic III over I considerations.
- Sizing of sodium tank car heating system.
- Division and scheduling of post turnover changes.
- Nelson stud plates installation.
- Piping removal to accommodate cell leak test completion.
- Construction labeling of piping, duct work, and flow direction.
- Rail stops design improvements.
- Cell hatch and plug improvement to reduce liner leakage.
- Sodium piping fill techniques.
- Monorail length for movement of heavy material.
- Electrical cross-talk at containment penetrations.
- Need for supplementary cranes.
- Cell HVAC capacity restrained by size of embedded piping.
- Need for oil trap in pump cover gas system.
- Sodium unloading station improvements.

- Concrete and steel paint and sealers improvements.
- Storage practices improved.
- Prefabricated insulation module interference.
- Handling procedures for reactor vessel inlet and outlet pipe and guard pipe placement.
- Use of computer indexes to maintain control and proper identity of components during construction, startup testing, and operation.
- Additional trace heating and insulation requirements.
- Closure head lift fixture design improvements.
- Location of inlet and outlet cell cooling ducts to enhance mixing.
- Hanger and pipe supports revisions.
- Piping blowdown features and methods for cleanliness improvement.

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

BEFORE THE COMMISSIONERS

In the Matter of UNITED STATES DEPARTMENT OF ENERGY PROJECT MANAGEMENT CORPORATION TENNESSEE VALLEY AUTHORITY (Clinch River Breeder Reactor Plant)	Docket No. 50-537 (Section 50.12 Request)

CERTIFICATE OF SERVICE

Service has been effected on this date by personal delivery or first-class mail to the following:

* The Honorable Nunzio J. Palladino
Chairman
Nuclear Regulatory Commission
Washington, D. C. 20555

* The Honorable Victor Gilinsky
Commissioner
Nuclear Regulatory Commission
Washington, D. C. 20555

* The Honorable Thomas F. Roberts
Commissioner
Nuclear Regulatory Commission
Washington, D. C. 20555

* The Honorable James K. Asselstine
Commissioner
Nuclear Regulatory Commission
Washington, D. C. 20555

* The Honorable John F. Ahearne
Commissioner
Nuclear Regulatory Commission
Washington, D. C. 20555

***Marshall E. Miller, Esquire
Chairman
Atomic Safety & Licensing Board
U.S. Nuclear Regulatory Commission
Washington, D. C. 20545

***Ruthanne G. Miller, Esq.
Atomic Safety & Licensing Board
U. S. Nuclear Regulatory Commission
Washington, D. C. 20545

Dr. Cadet H. Hand, Jr.
Director
Bodega Marine Laboratory
University of California
P. O. Box 247
Bodega Bay, California 94923

***Mr. Gustave A. Linenberger
Atomic Safety & Licensing Board
U. S. Nuclear Regulatory Commission
Washington, D. C. 20545

****Daniel Swanson, Esquire
Stuart Treby, Esquire
Office of Executive Legal Director
U. S. Nuclear Regulatory Commission
Washington, D. C. 20545 (2 copies)

*Atomic Safety & Licensing Appeal Board
U. S. Nuclear Regulatory Commission
Washington, D. C. 20545

*Atomic Safety & Licensing Board Panel
U. S. Nuclear Regulatory Commission
Washington, D. C. 20545

*Docketing & Service Section
Office of the Secretary
U. S. Nuclear Regulatory Commission
Washington, D. C. 20545 (3 copies)

William M. Leech, Jr., Attorney General
William B. Hubbard, Chief
Deputy Attorney General
Lee Breckenridge, Assistant
Attorney General
State of Tennessee
Office of the Attorney General
450 James Robertson Parkway
Nashville, Tennessee 37219

Oak Ridge Public Library
Civic Center
Oak Ridge, Tennessee 37820

Herbert S. Sanger, Jr., Esquire
Lewis E. Wallace, Esquire
W. Walter LaRoche, Esquire
James F. Burger, Esquire
Edward J. Vigluicci, Esquire
Office of the General Counsel
Tennessee Valley Authority
400 Commerce Avenue
Knoxville, Tennessee 37902 (2 copies)

**Dr. Thomas Cochran, Esquire
Barbara A. Finamore, Esquire
Natural Resources Defense Council
1725 Eye Street, N. W., Suite 600
Washington, D. C. 20006 (2 copies)

Ellyn R. Weiss, Esquire
Harmon & Weiss
1725 Eye Street, N. W., Suite 506
Washington, D. C. 20006

Lawson McGhee Public Library
500 West Church Street
Knoxville, tennessee 37902

William E. Lantrip, Esq.
Attorney for the City of Oak Ridge
Municipal Building
P. O. Box 1
Oak Ridge, Tennessee 37830

Leon Silverstrom, Esq.
Warren E. Bergholz, Jr., Esq.
U. S. Department of Energy
1000 Independence Ave., S. W.
Room 6-B-256, Forrestal Building
Washington, D. C. 20585 (2 copies)

Eldon V. C. Greenberg
Tuttle & Taylor
1901 L Street, N. W., Suite 805
Washington, D. C. 20036

Commissioner James Cotham
Tennessee Department of Economic
and Community Development
Andrew Jackson Building, Suite 1007
Nashville, Tennessee 37219

Thomas A Schmutz
For George L. Edgar
Attorney for
Project Management Corporation

DATED: August 3, 1982

---

* Hand delivery to 1717 "H" Street, N.W., Washington, D.C.

** Hand delivery to indicated address.

*** Hand delivery to 4350 East-West Highway, Bethesda, Md.

**** Hand delivery to Maryland National Bank Building, Bethesda, Md.