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FOREIGN TRIP REPORT

ORNL/FTR-3687

DATE: July 25, 1990

SUBJECT: Report of Foreign Travel of O. M. Stansfield, Metals and Ceramics Division, to Federal Republic of Germany and France

TO: Alvin W. Trivelpiece

FROM: O. M. Stansfield

PURPOSE: To participate in the US/FRG Umbrella Agreement Fuel, Fission Product, and Graphite Subprogram Managers' Meeting at the Forschungszentrum (KFA) in Jülich, FRG, and a technical review of the design and fabrication of the COMEDIE loop experiment at the CEA laboratory in Grenoble, France.

SITES

VISITED: 7/10-13/90 Forschungszentrum (KFA)
Jülich, FRG

Dr. H. Nabielek
FRG Subprogram Manager
US/FRG Umbrella
Agreement for Fuel,
Fission Products, and
Graphite

7/16-20/90 Center for Nuclear Studies
Grenoble (CENG),
Grenoble, France

Mr. G. Dupont
Project Manager for
the COMEDIE loop

ABSTRACT: Travel to the Forschungszentrum (KFA) - Jülich described in this report was for the purpose of participating in the annual meeting of subprogram managers for the US/DOE Umbrella Agreement for Fuel, Fission Product, and Graphite Technology. At this meeting the highlights of the cooperative exchange were reviewed for the time period June 1989 through June 1990. The program continues to contribute technology in an effective way for both countries. Revision 15 of the Subprogram Plan will be issued as a result of the meeting. There was interest expressed by KFA management in the level of support received from the NPR program and in potential participation in the COMEDIE loop experiment being conducted at the CEA.

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At the CENG facilities in Grenoble, France, the traveler participated along with DOE and General Atomics visitors in a technical review of the design and construction of the COMEDIE loop facility. In addition to technical matters, the CY 1990 contract wording was reviewed and agreement reached so that the contract could be put in place. Lack of adequate personnel and technical problems with the high-temperature isolation valve for the heat exchangers has resulted in over a 9-month delay since January 1990. During the meeting technical problems were addressed and commitment made to staff the program adequately to minimize future delay. The COMEDIE loop remains an important part of the program to validate design codes but several design problems require resolution to improve the probability of success.

COMPREHENSIVE TRIP REPORT

I. Introduction

The USDOE program for MHTGR fuel, fission product, and graphite technology at ORNL includes tasks in both the USDOE Umbrella Agreement for Fuel, Fission Product, and Graphite Technology, and for the conduct of experiments in the COMEDIE loop in the French CEA facilities at Grenoble, France. This report describes travel to the Forschungszentrum in Jülich, FRG, for the purpose of participating in the annual Umbrella Agreement Subprogram Managers' Meeting and the following meeting in Grenoble, France, for technical review of the COMEDIE loop design and fabrication.

II. Fuels, Fission Products, and Graphite Subprogram Meeting

Dr. H. Nabielek was the host for the meeting. His attention to detail in arranging a relatively complicated agenda resulted in the efficient transfer of a large amount of information and resolution of program issues. The excellent arrangements for transportation and hotel accommodations was also greatly appreciated. The meetings began on July 10 with technical tours and proceeded through the Subprogram Managers' Meeting and Graphite Specialists' Meetings on July 11, 12, and 13. Participants in the meetings are shown in Appendix A. The results of the meetings are described below.

Technical Tours

In the morning of July 10 there was a tour of the hot cells and the Institute of Safety Research. In the afternoon, development of a SiC coated fuel sphere was described and the operating history and research conducted in the AVR was presented to the visitors. The agenda for the tours is shown in Appendix B.

Hot Cell Tour: Dr. Pott who is manager of the hot cells and Dr. Schenk, the specialist in high-temperature fuel performance testing, gave a thorough tour of the KFA hot cells. The highlight of the tour was the laboratory of Dr. Schenk where furnaces have been built for heating irradiated fuel spheres at accident conditions. There are two furnaces which operate in separate hot cell facilities. One furnace has been in use for several years and has been the primary source of both US and FRG accident condition performance data. This furnace can operate at temperatures up to 1800°C in dry helium while the release of both gas and metallic fission products are measured.

Schenk showed some new data from a reference FRG HTR Module fuel sphere irradiated to 1.5% FIMA in the DIDO reactor. The sphere had been heated 50 h at 1800°C and released less than 10^{-7} fraction of ^{131}I . This evidence

showed that there were no failed coatings and heavy metal contamination was less than 10^{-6} fraction which is typical of the FRG fuel quality.

An item of interest for fabrication of a similar furnace at ORNL is the temperature of the cold finger used to trap condensible fission products. The cold finger consists of a water-cooled probe with a detachable plate on the end which can be removed during a test for measurement of condensed fission products. Dr. Schenk said that the temperature of the cold finger is measured by a thermocouple in the probe near the interface between the probe and the detachable plate. He said the temperature of the thermocouple is maintained at $\leq 100^{\circ}\text{C}$ during a test. The plate surface is positioned about 10 cm above the fuel sphere being heated. The cold finger is never inserted inside the heater section of the furnace. Prior experience has shown that when the plate temperature exceeds 180°C no iodine can be trapped. Such a low required temperature indicates that the iodine form is I_2 rather than CsI_2 .

Calibration of the furnace system with CsI_2 has shown that for "low" releasing fuel 70% of condensable fission products were trapped, while for "high" releasing fuel only 60% was trapped. The fission products are thought to be primarily in the tantalum tube which surrounds the fuel sphere. For example, nearly 100% of strontium released from a fuel sphere can be found in the tantalum tube near the fuel ball. The furnace construction would seem to allow volatile fission products to bypass the cold finger and plate out in the furnace interior. Dr. Schenk was noncommittal regarding that possibility but he did indicate that for cesium released during heating, less than 1% could be found on the tantalum tube while only 70% was trapped on the cold finger. He did not explain where the remaining 29% was located. When the 70% correction factor is applied to the cold finger inventory for cesium there is agreement within 1 to 2% of the cesium loss measured by gamma counting of the fuel sphere before and after heating.

We were shown the hot cell facility containing the new furnace capable of heating an irradiated fuel sphere to 1600°C in helium containing air or moisture. The facility is known as "KORA." They will start testing using 0.5 atm of H_2O at 850°C . The furnace heating zone consists of an inner SiC closed-end tube inserted inside an Al_2O_3 closed-end tube. The assembly is placed inside a heater and the purge gas is forced down the annulus between the SiC and Al_2O_3 tubes and up through a small hole bored into the closed end of the SiC tube which contains the fuel sphere. There is no cold finger in the furnace so only the release of fission gases can be measured. Release of metallic fission products will be determined by gamma counting the fuel sphere before and after heating. Start of testing in the furnace is planned for September 1990.

Institute for Safety Research (ISR): Dr. Katscher provided a description of the new Institute for Safety Research (ISR) which will focus on design of advanced concepts and behavior of materials and reactor systems under

accident conditions. There is now a permanent staff of about 60 persons but they intend to reduce by attrition down to 50. Technical areas of study will be:

- o coated particle fuel performance,
- o probabilistic risk analysis,
- o development of future reactor safety criteria,
- o analysis and documentation of THTR and AVR experience,
- o safety and waste disposal,
- o safety of research reactors, and
- o non-nuclear safety with clean energy sources such as hydrogen.

An example of work on clean energy safety was a project to study the safety problems associated with transport of hydrogen on the river Elb in FRG.

As a footnote on the times, there have been other name changes of institutes at KFA, which itself is now known as Forschungszentrum to reduce the nuclear profile. The IRW under Prof. Nickel is the only institute which retains the word "Reactor" in the name. The current organization chart for KFA is shown in Appendix C.

SiC Coated Fuel Spheres: Dr. Schröder of the ISR gave a presentation of the development work they have done to produce a fuel pebble coated with SiC. The objectives are to further reduce fission product release for direct cycle application of the HTR and prevent core oxidation so that no auxiliary means of preventing air ingress will be required. They have examined four different methods of SiC coating: (1) chemical vapor deposition, (2) plasma spraying, (3) pack cementation, and (4) slip casting.

Only the slip casting method, which is proprietary to the Hoechst/Ceramtec Company, has shown the required strength and resistance to cracking and spallation during testing. In the slip casting process the fuel ball is dipped into a slurry of SiC, C, plus an additive and then the coated ball is heat treated. During heat treatment Si from the additive infiltrates the C and forms SiC. The final coating is 200 to 400 μm thick and composed of about 90% SiC and 10% Si. A coated ball was passed around for examination. It had a uniform black shiny surface with the texture of an orange peel.

The spheres with slip cast and sintered coatings were heated to 1500°C and then dropped into water 10 times without visible sign of cracking. Heating of a pure graphite ball and a coated ball in an air draft at 1500°C for 3 h reduced the graphite ball to powder while the coated ball was unchanged.

The coated balls are now undergoing irradiation testing to determine irradiation behavior. There is reason to think that the graphite substrate

may creep sufficiently during irradiation to prevent debonding of the coating due to irradiation-induced dimensional change. The fuel cycle penalty for additional silicon in the core has not been calculated but it is not expected to be significant. The most negative finding about the coating is that the coefficient of friction is higher than for the standard ball. This will limit use to those small reactors where control rods do not penetrate the core and/or require an additional coating over the SiC layer to reduce friction and production of SiC dust.

AVR Operating Experience: Mr. Ziermann gave an informative summary of AVR operation history. He was accompanied by Mr. Krüger and Mr. Wimmers.

The 15 MWe pebble bed AVR was built and operated under the sponsorship of 15 German utilities. By the end of 1988 as a result of anti-nuclear feeling in the city councils which control electricity production and adequate electricity supply, the AVR demonstration was declared complete and the reactor shut down. They expect to get approval for decommissioning in early 1992.

During operation, the AVR produced 1.6 billion KWh of electricity with a 66% availability factor. The core held 100,000 fuel balls and over 180,000 balls were used and sent on to spent fuel storage. There are 50 spheres in each storage barrel which are stored in a water pool at KFA. There is no final storage system in place. One possibility is that containers with up to 950 balls cast in concrete will be the final storage form. This is not a technical problem but it is a political and licensing problem.

In 1974 a demonstration of the high-temperature capability of the system was initiated by increasing the outlet temperature of the reactor from 850°C to 950°C. The temperature increase was obtained by reducing the coolant flow rate rather than increasing power. The outlet temperature remained at 950°C until shutdown in 1988.

The AVR was built with pressurized (10 bar) double containment because in the late 1950's the plans were for the first core to operate with uncoated fuel. The circulating activity was predicted to reach 10^7 Ci when uncoated fuel kernels were reference fuel; however, the first core actually contained BISO coated particles and then a transition to TRISO started in the 1970's. Because of the improved retention gained by coating, the maximum circulating activity in AVR was only 25 Ci.

Some observations on tritium production were interesting. There was 2 to 4 Ci of tritium circulating in the coolant. The tritium diffused through the steam generator tubes from the helium to the steam circuit but they have no quantitative data on the rate of transport. They did observe that when the pH of the feed water was increased (increased oxygen) the transport rate decreased. They believe that a more impermeable magnetite (Fe_3O_4) layer was created on the inside of the steam generator tubes and

restricted tritium transport. During operation the primary circuit was cleaned continuously and now they have several hundred liters of water contaminated with tritium in storage.

At one point during a shutdown period in the 1970's, over 20 tonnes of water leaked into the core through a 1-3 mm² hole in a steam generator tube. Nine weeks of low-temperature operation were required to evaporate the water and dry out the core. In 1984 they conducted a television camera examination of the top reflectors of the core to determine if corrosion of the graphite had taken place. There was no oxidation effects observed. In fact, 2 mm gaps between some graphite blocks was observed to have closed as a result of irradiation.

Subprogram Managers' Meeting

The agenda for the Subprogram Managers' Meeting is shown as Appendix D.

Comments by Dr. Balthesen (BMFT): On July 11 Dr. Balthesen of the BMFT opened the meeting with some general comments about the status of the program. He feels the level of cooperative work is at a low but satisfactory level. He observed that the Fuel, Fission Product, and Graphite Subprogram was the most active of the subprograms. There is concern that the Safety Subprogram has never really been active and the Metals Subprogram is inactive but not formally terminated. He suggested that the formation of the new Safety Research Institute (ISR) may help revitalize the Safety Subprogram. The German industry seems to be more of an observer than participant in the R&D needed for HTR development.

With regards to the status of fuel manufacturing, Siemens has taken over HTR fuel manufacturing responsibility from NUKEM.

On the subject of THTR, the decommissioning program is planned through the end of 1992. The industry participants are HRB, Interatom, and KFA/HTA. Funding required for the decommissioning work has not yet been identified. The amount of funding depends on the priority of the work and it is very uncertain. Dr. Balthesen will keep USDOE informed about the decommissioning tasks which they plan to carry out.

Comments by Mr. J. E. Fox (USDOE): Mr. Fox described recent changes in the organization of the MHTGR program management within DOE with E. Purvis taking the place of A. Millunzi as MHTGR Program Manager. The cost reduction study underway on the MHTGR was described as an urgent task. General support for the objectives of the Umbrella Agreement was expressed. The Safety Subprogram is definitely considered active and although the metals program has been inactive we should evaluate it on the US side to determine if we want to reactivate. Mr. Fox mentioned that competition between the NE and NPR program for personnel has resulted in less progress in some areas than desirable.

Mr. Fox indicated that safety technology work would be shifting from General Atomics to ORNL under the new DOE management. He proposed that after the IAEA sponsored fuel performance specialists meeting at ORNL on November 5-7, 1990, there be a Safety Subprogram Managers' Meeting. John Cleveland, on assignment to IAEA from ORNL, was at the meeting and agreed with the proposal.

Status of Fuel/Fission Product Technology at GA: Mr. R. F. Turner, of GA, presented papers on Graphite Design Criteria, SiC Strength Test Data, and an Overview of MHTGR Design in the USA. There was considerable interest by KFA management in progress on the MHTGR Design.

Status of Fuel/Fission Product Technology at ORNL: The traveler made presentations to KFA management and technical staff on the status of fuel and fission product technology at ORNL. Topical reports were also made on the COMEDIE loop experiment and the results of recent analysis by ORNL specialists of release of fission products during high-temperature heating and exposure to moisture. There was interest in the level of support received from the NPR program but responses by US speakers were kept very qualitative. The desire to establish a cooperative agreement for work in the COMEDIE loop was expressed by the Germans. Dr. Rollig, from HRB, was particularly vocal on the desire to participate in COMEDIE.

HFR-B1 Discussion (PWS FP-8): Mr. Rainer Conrad from Joint Research Center at Petten was present to deliver the HFR-B1 QA report (HFR/90/3084), Irradiation Report (HFR/90/3082), and raw data from the Rubicon ionization gage. Mr. Conrad indicated that gamma scan of the HFR-B1 capsule showed very uniform activity which indicated that uniform burnup was received in the three fuel holes of each cell. He reported that the power in the cells was known within 10 to 15% so the R/B reported in the Irradiation Report (HFR/90/3082) is known to within 10 to 15%.

Mr. Conrad reported that transport of HFR-B1 from Petten HFR to the KFA hot cells is now scheduled for September 1990. There has been much more administrative paperwork than required in prior years. Nearly one year has been taken to obtain the shipping license to ship the irradiated fuel from Petten to KFA. All the proper approvals should be obtained by September. Mr. Conrad requested 4 weeks of Mr. R. D. Burnette's time at Petten to finalize postirradiation data with the cost to be borne by USDOE. This request was taken under consideration by the US team. If Mr. Burnette is available and funding can be arranged, the visit of Burnette may take place in October.

Rings of SiC obtained from FRG coated particles were placed in HFR-B1 as a piggyback specimen. Some unirradiated rings were made but they cannot be located now for comparison with the irradiated rings. In addition, no strength measurement equipment remains at KFA. The KFA has lost some interest in SiC ring measurements as a means of strength determination since the failure of particles predicted with the ring strength results

in overprediction of failure by 3 to 4 orders of magnitude. The FRG SiC rings will be extracted from Cell A at ORNL. The traveler requested that the rings remain at ORNL for further examination rather than return to KFA as originally planned. Dr. Nabielek agreed with this proposal.

HFR-B2 Discussion (PWS FP-10): The traveler presented a draft of a PWS proposal by Dr. Myers of ORNL, for a new irradiation capsule in Petten, which would be a follow-on to HFR-B1, funded by FRG and directed at a more quantitative characterization of iodine release and transport from exposed kernels of UCO and UO_2 . Rainer Conrad said that there would be room for two separate cells of the type required. Dr. Nabielek said it would be important to include a sample of FRG UO_2 coated particle fuel. The proposal was made that at least three primary circuit alloys representing both US and FRG materials should be included in the test. Such a requirement would make necessary at least three separate cells. It was agreed the PWS FP-10 would be accepted through the first milestone which is a detailed experiment plan produced by ORNL.

HFR-B3 Discussion (PWS FP-11): The traveler presented a draft of a PWS proposal for a second new irradiation experiment in Petten, also proposed by Dr. Myers of ORNL. This experiment would be funded by the FRG, like HFR-B1, and would characterize fission product transport in FRG and US graphites. There was support for the proposal but the details were less well defined than with PWS FP-10, so PWS FP-11 was accepted as a draft for consideration at the next Subprogram Managers' Meeting.

US/FRG Accident Condition Models (PWS FD-24): On this project work statement, T. Dunn replaced D. Goodin as the GA task manager and B. F. Myers was added as the ORNL task manager. H. Nabielek distributed a compilation of the viewgraphs used at the 2nd Experts Meeting on Fuel Performance Under Accident Conditions, held at ORNL in June 1989 (HBK-1B-7/90). A two-month visit of Dr. Karl Verfondern to ORNL was proposed to assist in exchange of data and modeling technology. A tentative time period of November and December 1990 was selected for confirmation when KFA funding is identified and FY 1990 NE tasks at ORNL are approved.

Subprogram Plan Revision 15: On July 11, 12, and 13 the Subprogram Plan, Revision 14, was reviewed and updated to create Revision 15 which will be submitted for approval. A total of 17 PWSs remain active: 4 in the Fuel Development area; 7 in the fission product area; and 6 in the Graphite Development area. Three areas of special importance in the program are: fuel irradiation capsule HFR-B1 (PWS FP-8), fission product inventory measurements in particles (PWS FD-20), and the graphite irradiation capsule HTK-7 (PWS GD-1).

HTR Opportunities in East Germany: During informal discussions Dr. Balthesen said that unification of East and West Germany has created a major opportunity for the HTR. A large chemical company in East Germany must replace a power and process heat source because it violates the West

German air pollution laws. The company, which employs 30,000 people, is considering an HTR. The company has initiated a campaign to educate its workers, who make up most of the surrounding community, regarding the safety and benefits of an HTR power source. There are many uncertainties regarding the final deployment of this project but Dr. Balthesen (and several other KFA staff people) thought it was the most important near term opportunity for the HTR in Germany.

Exchange of Reactor Materials Technology with East Germany: During informal discussions with Prof. Nickel of the IRW, he described a cooperative arrangement he is personally making with a technical institute in East Germany. He described the East German technical people as unable to comprehend the freedom to form individual opinions and make decisions as practiced in West Germany. He sees his contribution in this area as picking out a few key technical people to communicate with. He specifically wants to avoid management level people getting in the path. By direct communication he thinks the East German counterparts will quickly adopt the more progressive approach of western technologists and more rapid progress will be made in bringing East German technology in reactor materials up to western standards. He specifically does not want the East German counterparts to come to West Germany. They should stay in East Germany where they can lead their colleagues.

III. Graphite Specialists' Meeting

There was a Graphite Specialists' meeting on July 11, 12, and 13 in parallel with the Fuel and Fission Product Subprogram meeting. The agenda for the Graphite Specialists meeting is shown as Appendix E. Dr. T. D. Burchell and Dr. E. L. Fuller from ORNL attended those meetings and participated in the update of the graphite project work statements for the Umbrella Agreement. Details of the graphite technology specialists meeting and an update of graphite project work statements can be found in their trip reports.

IV. COMEDIE Loop Technical Review Meeting

On July 14, the traveler, in the company of Mr. J. E. Fox, went from Jülich, FRG, to Grenoble, France, in preparation for a week of meetings to review the design and fabrication status of the COMEDIE loop experiment at the CENG facilities of CEA.

The meetings with the CEA COMEDIE loop team began at 9:30 a.m. on July 16. Mr. Dupont, the COMEDIE principal engineer, was the host for the meeting and did a commendable job through a week of intensive questioning and information transfer. The consultant for USDOE, Mr. T. Beresovski, contributed significantly in the meetings by frequently providing vital

translation and technical insight gained from his close working relationship developed with Mr. Dupont since the start of the project.

The participants in the meetings are shown in Appendix F. The agenda for the meetings held July 16 through July 20 is shown in Appendix G.

Status of U.S. MHTGR Program: After introductions and agreement on the agenda, Mr. Fox of the USDOE gave a presentation on the status of the US MHTGR program. He described the changes in the program since Mr. Purvis took the position of MHTGR Program Director. The primary point was that the MHTGR has a plant cost 1.5 times that of a coal-fired plant and the cost must be reduced. The cost reduction study is a major part of the US program. The program must provide by September 1992 the basis for a decision on whether or not a lead plant will be constructed. Industry must be ready to offer a proposal for a lead plant. The earliest possible availability of a certified MHTGR for a commercial order is after the year 2000. Risk sharing agreements between government and industry are key to a successful commercial MHTGR program. Resolution of key safety and licensing issues is scheduled for April 1992.

In the opinion of the traveler, the April 1992 date for resolution of key safety and licensing issues is the strongest reason for maintaining the COMEDIE loop test schedule.

Reorganization of CEA and the COMEDIE Loop Team: Mr. Bastien described the recent reorganization of the CEA. The new organization is shown in Appendix H. The major change at CENG is that Mr. Veyrat has taken a staff position in the Department of Thermohydraulics and Physics and Mr. Chenebault has taken his place as manager of the branch which has direct responsibility for COMEDIE. Mr. Dupont will now report to Chenebault rather than Veyrat. Mr. Dupont has been made responsible for an organization of about 30 people which includes tasks other than COMEDIE.

Concern was expressed by Mr. Fox that the COMEDIE project has fallen behind schedule while it was the sole task of Mr. Dupont and now he will have additional diversion of his time. Mr. Bastien and Chenebault made assurances that Dupont would be getting additional assistance so that there actually would be an improvement in the coverage of COMEDIE. As evidence of additional assistance, they pointed to Mr. Gillet who has been appointed as a full-time assistant. By the end of the week they had identified two additional engineers who will be assigned full time to the COMEDIE program to assist Dupont. Mr. Dupont will maintain his position as the COMEDIE program manager.

In the long term, the new people will make it possible for COMEDIE to maintain published schedules. It is the traveler's opinion that for the next 6 months we can expect more delays as the new team is trained and Mr. Dupont copes with his additional responsibilities.

Role of COMEDIE in MHTGR Development: Mr. Hanson (GA) presented a detailed discussion of the role of COMEDIE in MHTGR development. In summary, the COMEDIE loop data will validate design models and reduce uncertainty in the ability of the MHTGR to meet Protective Action Guidelines (PAG) during accident conditions where fission product lift off contributes to radiological exposure. Complete release of plated out fission products results in prediction of excessive exposure. The amount of lift-off of fission products is a key parameter which must be known to determine if the release remains below the PAG limit. The lift-off data base is very limited and the QA pedigree is questionable. The unique features of COMEDIE make it an essential part of the development program.

Anticipated changes to the test specification for the BD-1 test were presented to provide a preview to the CEA on upcoming modifications. No objections were raised to the proposed changes.

Ms. Cadwallader (GA) presented a review of the BD-0 test specification and results of recent thermohydraulic calculations which will be compared with measurements made during the test.

Status of ORNL/CEA COMEDIE Subcontract: The traveler presented a review of the contract work items compared with actual progress. The program is about 9 months behind the schedule proposed in January 1990. The delay has come from technical problems and lack of adequate staff to deal with the work which must be done. The CEA was asked to provide a reallocation of costs for CY 1990. Although there has been an intensive work effort, less than 10% of the costed items which form the basis for the CY 1990 contract price will be completed in CY 1990. The CEA administrator (Mr. D. Bastien) would not agree to this request because of a prior agreement with DOE that 75% of the annual contract value would be paid to the CEA in August of each year whether or not 75% of the work had been done. Only the last 25% can be withheld for lack of performance in one year. A copy of the agreement is shown as Appendix I. The CEA has obviously planned to receive at least 75% of the CY 1990 contract and has been operating at risk without a contract since January 1, 1990.

The CY 1990 contract with CEA received USDOE and ORNL approval on June 20. However, because of a delay due to an incorrectly addressed contract sent to Mr. Bastien by ORNL, the CY 1990 contract had not been signed by the CEA. Because the prior agreement with DOE appeared to have precedence, no further attempt was made to obtain a recast of the COMEDIE CY 1990 contract. Instead, considerable effort was expended during the week working with the ORNL contracts office attempting to obtain wording in the contract which was understood by the CEA and acceptable to both parties. By the end of the week there was agreement on wording but a formal copy with signatures had not been exchanged. Therefore, the CEA continues to work on COMEDIE without a CY 1990 contract in place.

In order to get an early start on CY 1991 contract administration, the traveler requested that the CEA (Mr. Bastien) begin immediately to prepare for the CY 1991 contract. The first item of business will be to revise the long-term funding plan for COMEDIE to reflect the actual work expected by the end of CY 1990 and expected CY 1991 progress with related costs. There was agreement on this course of action and a revised schedule of work and costs for CY 1991 was promised by the end of July. It is expected that the CY 1991 contract will be about 50% of the CY 1990 contract cost, because under the 75% payment rule discussed above, payment for much of CY 1991 work will be made in August 1990.

Tour of the COMEDIE Loop: Mr. Dupont led a tour of the COMEDIE loop. The Siloe reactor was in a scheduled shutdown condition so it was possible to view the core and observe all the key components of the loop. The traveler had a similar tour in February 1990. During this most recent tour, there was noticeable progress toward completion of control panels and piping required for control of pressure, flow rate, and coolant impurity level. A significant work item which remains is the installation of a calibrated flow measurement orifice to replace one of uncertified dimensions.

Tour of the Hot Cells: Mr. Gillet led a tour of the hot cells which will be used for disassembly and examination of the COMEDIE loop components after the blowdown tests. The facility was extremely clean and well organized. Unfortunately, the size of the cell in which gamma counting of heat exchanger tubes will be conducted is too small to accommodate the entire length of the tubes. Therefore, the heat exchanger tubes containing plated-out fission products will have to be cut into at least two sections with the associated risk of mechanical disruption and transport of fission products. They are exploring cutting methods such as a wire saw suggested by ORNL, which will minimize mechanical shock and vibration in the tubes. They have extensive scanning electron microscope capability in the hot cell which could be used in the characterization of the heat exchanger tube surfaces and particulates.

Status of COMEDIE Loop Operating Procedures: There are 26 operating procedures being prepared to control the operation of the COMEDIE loop. Four have been approved by Dupont, delivered to ORNL, and translated from French to English by Mr. M. E. Merrill under contract to ORNL. Four unapproved draft procedures have been sent to ORNL and translated. At the meeting on July 17, three more procedures (Nos. 22, 25, and 26), approved by Dupont were delivered and these will now be translated. Only the procedures approved by Dupont are considered formally delivered. Delivery of the remaining 19 approved procedures had been promised by Mr. Dupont by July 16. However, because of lack of staff and additional time taken to deal with technical problems, the procedures exist in draft form only and are not ready for transmittal to ORNL. Because of the traditional holiday season in August and the important test of the depressurization section in September, Mr. Dupont said he could not deliver the remaining

procedures until October 31, 1990. It is anticipated that proposed increase in staffing level discussed above will allow them to meet this most recent commitment.

Technical Problems in COMEDIE Design and Fabrication: Mr. Dupont reported a current problem the manufacturer was having in forming a TZM alloy heat shield which will surround the fuel body of COMEDIE. The ~0.25-mm-thick TZM alloy (0.1% Ti + 0.1% Zr + Mo) cracked when it was wrapped around a mandrel the size of the fuel element. Mr. Dupont requested assistance in solving the problem or recommendation of an alternate material. A telephone call was made to P. L. Rittenhouse at ORNL to describe the problem and seek advice. By return FAX on July 18, Mr. Rittenhouse indicated that cracking of TZM would be expected for the room-temperature forming which had been attempted. He provided instructions for hot forming the TZM at 500°C which would avoid the cracking problem observed at room temperature. He also suggested that if the TZM could not be formed, molybdenum or tungsten sheet would be reasonable alternatives. Mr. Dupont was appreciative of the technical assistance and took the information for transfer to the manufacturer.

The COMEDIE design incorporates pneumatic bellows valves at the inlet and exit of each of the three heat exchanger bundles where fission product plate-out will take place. The valves of one of the bundles will be closed prior to the blow-down test to preserve the fission product inventory and profile within the tube as a base line for calculating the liftoff fraction. The most serious technical problem facing the COMEDIE project is the failure of the pneumatic valve which will seal the inlet to the heat exchanger bundle. The valve must be capable of operating in the open position at 850°C for 84 days and then closing when the bellows is pressurized at the onset of blow-down simulation. Qualification tests of the valves has shown that the Incolloy 600 alloy bellows develops leaks when pressurized. The pressure differential across the bellows wall can approach 60 atm during the depressurization phase of the blow-down test. This is the third design which has failed to operate properly.

The solution offered by Mr. Dupont is to incorporate a more sophisticated control system for the pneumatic pressure in the bellows. The pressure would be automatically reduced during the depressurization phase so that the differential across the wall of the bellows was large enough to hold the valve closed but not large enough to cause failure. The feasibility of this approach will be demonstrated by qualification testing.

It is the traveler's opinion (not shared by others in the visiting team) that the Incolloy 600 bellows valve is operating beyond its temperature limit and it should be removed from the loop because malfunction during the normal operation or blow-down testing may compromise the experiment. The same valve works very well to seal the exit end of the tube bundle which operates at 350°C. Because the exit valve would remain closed, removal of the inlet valve would not permit flow through the tube during

blow-down. Only the small amount of helium (3 L STP) held in the tube would flow out unrestricted during the depressurization phase. The risk that this small flow would disturb the fission product plate-out distribution is small compared with the risk that the inlet valve will malfunction in a known or unexpected way and the test will have to be terminated early or data will be compromised. This option should be explored before significant new effort is expended and delay results from solving design problems with the current valve.

Other design issues exist but are not discussed here because they are addressed in the agreements and commitments section of this report.

Agreements and Commitments: A list of 47 technical issues had been provided by GA in setting up the agenda. Because of time limitations the high priority issues were emphasized in the extensive discussions on July 18-20. Forty of the 47 issues, including all of those with high priority were addressed. The list of issues with annotation of results by G. Cadwallader and D. Hanson is shown in Appendix J. Primarily as a result of these discussions, 36 agreements and commitments directed at resolution of problems or issues were documented. In addition, agreements and commitments from three prior meetings were reviewed and updated. The agreements and commitments are shown in Appendix K.

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

APPENDIX A

Participants in Meetings at Fuel/Fission Product and Graphite
Subprogram Manager's Meeting at KFA

July 10-13, 1990

<u>Forschungszentrum</u>	<u>USDOE</u>	<u>GA</u>	<u>ORNL</u>
H. Nabielek, (HTA)	J. E. Fox	R. F. Turner	E. L. Fuller
K. Verfondern, (ISR)			T. D. Burchell
B. Owlsly, (student) [ISR]			O. M. Stansfield
Nerungi, (student) [ISR]			
G. Pott, (IRW)			
G. Schenk, (IRW)			
W. Katscher, (ISR)			
Schroder, (ISR)			
U. Brinkman, (HTA)			
Wolf, (ISR)			
Moormann, (ISR)			
Haag, (IRW)			
Gottant, (HTA)			
Wolten, (ISR)			
H. Nickel, (IRW)			
R. Theenhaus, (VEMZ)			
B. Thiele, (IRW)			
 <u>BMFT</u>	 <u>HRR</u>	 <u>AVR</u>	 <u>Interatom</u>
E. Balthesen	Rollig	Krüger Wimmers Ziermann	Nieder
 <u>JRC. Petten</u>	 <u>IAEA</u>		 <u>SIGRI</u>
R. Conrad	J. C. Cleveland (on assignment from ORNL)		Mindermann

APPENDIX B

Agenda for Tours of the Research Center, Jülich

Dr. H. Nabelek

Research Center Jülich

6 July 1990

HTA Project

Agenda for the Visit of**Mr. J. Fox from US-DOE and Mr. O. Stansfield from ORNL****Tuesday, 10 July 1990**

10:00	Welcome at HTA (Nabelek, Verfonderen)
10:15	Hot Cell Visit (Pott, Schenk)
11:45	ISR 1 Visit (Katscher, Moormann, Verfonderen)
12:45	Lunch
14:00	Coating of Spheres (B. Schröder at HTA)
15:00	Visit to AVR (Ziermann)
16:30	Departure from HTA

Organization Plan for Forschungszentrum, Jülich

FORSCHUNGSZENTRUM JÜLICH GmbH

ORGANISATIONSPLAN

Stand 1 Juni 1990

APPENDIX D

Agenda for US/FRG Umbrella Agreement
 Fuel/Fission Product and Graphite Subprogram
 July 11, 12, 13, 1990
 Jülich, FRG

700914us

US-FRG Management / graphite experts meeting at KFA

Wednesday 11-Jul-90	09:00	Welcome at the Research Center Jülich
	09:30	US/FRG Cooperation (Dr. Balthesen)
		- Fuel, Fission Products and Graphite Turner, Stansfield, Nablelek
		- Safety Research Katscher, Wolters, Cleveland
		- AVR Experiments Krüger, Cleveland
	11:30	Petten Experiments (Conrad)
	13:00	Lunch
	14:00	Milestones Fuel Development Pott, Verfondern, Fox, Turner, Stansfield
Thursday 12-Jul-90	09:30	Milestones Graphite Development Burchell, Brinkmann, Mindermann, Haag, Turner
	11:00	Milestones Fission Product Transport Nablelek, Stansfield, Turner, Fox
	13:00	Lunch at the Waldcasino (BMFT)
	14:30	Management Meeting Report Nablelek, Stansfield, Turner, Fox
	19:00	Dinner (AVR) La Grappa, Jülich (opposite Stadthotel)
Friday 13-Jul-90	09:00	Overview Presentations (VS, Zimmer 526)
	09:00	U.S. HTGR Program (Fox, Turner, Stansfield, Burchell)
	10:30	Status of German HTR Development (Dr. Balthesen)
	11:00	Recent GA Results (Turner)
	11:25	Recent ORNL Results (Stansfield)
	11:50	Comedia Test (Stansfield)
	12:20	AVR Experiments (Krüger)
	12:45	AVR End-of-Life Program (Hantke)
	13:30	Lunch (HTA) Alte Post, Niederzier
	15:30	Departure from KFA

APPENDIX E

Agenda for US/FRG Graphite Experts' Meeting
 July 11, 12, 13, 1990
 Jülich, FRG

US/FRG MANAGEMENT / GRAPHITE EXPERTS MEETING AT KFA**GRAPHITE SECTION**

Wednesday	9.00	Welcome at KFA	
11-Jul-90	9.30	Graphite Experts Meeting	
		Overview of US DOE MHTGR Graphite Program at ORNL	Burchell
		Overview of FRG HTR Graphite Program	Brinkmann
		Candidate Graphites:	
		Graphite-Coke Examination US	Burchell
		Graphite-Coke Examination FRG	Mindermann
		ORNL Irradiation Program	Burchell
		Petten Irradiation Program	Haag
		Reflector Design:	
		Failure Mechanisms, Stress Calculations,	
		Experimental Work, Rule Making	
		FRG	Schmidt
		US	Turner
	13.00	Lunch	
	14.30	Graphite Corrosion at Accident Conditions, Experimental and Modelling Work	Katscher, Moormann
		MHTGR Graphite Oxidation Studies	Fuller
		Corrosion Data in the Design Code	Schmidt
		Future Cooperative Work	
Thursday	9.30	Milestones Graphite Development	Burchell, Fuller Brinkmann, Haag Mindermann, Turner
12-Jul-90	11.00	Irradiation Testing of HTR Graphites, Recent Results	Haag Brinkmann
		Status/Future of Creep Modelling Joint Irradiation Creep Testing in HFIR and HFR	Burchell, Haag, Tartaglia Brinkmann
	13.00	Lunch	
	14.30	Lab Tour KFA	ISR 1 IRW Katscher Haag

APPENDIX F

Participants in Meetings at CEA Laboratories, Grenoble (CENG)
for COMEDIE Loop Program Technical Review

July 16-20, 1990

CEA	USDOE	GA	ORNL
D. Bastien	J. E. Fox	D. L. Hanson	O. M. Stansfield
G. Dupont		G. J. Cadwallader	
Veyrat			
Chenebault			
R. Gillet			
Cruz			
M. Harrion			
A. Besson			
Germain			
Favrot			
I. Schuster			
La Lamlar			

CONSULTANT for DOE

T. Beresovski

APPENDIX G

Agenda for the COMEDIE Technical Review Meeting at CENG
Grenoble, France
July 16-20, 1990

CEA
Centre d'Etudes Nucléaires de Grenoble

SEDTI/DIR n° 90/NI/7483

Le 26 Juin 1990

DRN - DTP
Section d'Etude et de Développement
des Techniques d'Irradiation

NOTE

Monsieur G. DUPONT

à in fine

Objet : COMEDIE, avis de réunion

Une réunion technique avec les représentants de GA, ORNL et DOE est prévue du 16 au 20 juillet suivant la proposition d'agenda jointe.

1. Lieu : salle de réunion P2 1er étage

2. Personnes attendues :

MM.	E. FOX	DOE
	O. STANSFIELD	ORNL
	T. BERESOVSKI	consultant
	D. HANSON	GA
Mme	G. CADWALLADER	"

3. Participants CEA

MM.	BASTIEN	16, 20/7/90
	VEYRAT	16, 20
	CHENEBAULT	16, 20
	GILLET	16 au 20
	CRUZ	18, 19
	HAIRION	17 au 19
	A. BESSON	17 au 19
	GERMAIN	17 au 19
	FAVROT	19.

Calendrier

L'agenda joint précise les horaires et les thèmes abordés.

G. DUPONT

Destinataires : les participants
M. MICHEL
A.

**PROPOSED OBJECTIVES AND AGENDA
FOR COMEDIE TECHNICAL REVIEW MEETING**

GA/ORNL/DOE Visit to CENG
July 16-20, 1990

OBJECTIVES

1. Resolve outstanding technical issues for COMEDIE BD-0/BD-1 tests (or, if premature, identify action plan for resolution).
2. Finalize test requirements for COMEDIE BD-0/BD-1 tests; identify and elaborate anticipated changes/additions to BD-1 Test Specification (Revision B to be released in September 1990).
3. Review loop design for COMEDIE BD-0/BD-1 tests and assess responsiveness to test requirements; review results of component mockup tests.
4. Review draft test procedures for COMEDIE BD-0/BD-1 tests and assess responsiveness to test requirements.
5. Review COMEDIE loop refurbishment activities and component fabrication activities since 6/88.
6. Obtain CEA expert opinion on adequacy of GA thermal/hydraulic modeling of COMEDIE BD-0/BD-1 tests (G. Cadwallader).

AGENDA FOR MONDAY, JULY 16, 1990

Participants CEA : MM BASTIEN , CHENEBAULT, VEYRAT, GILLET, DUPONT

<u>Time</u>	<u>Topic</u>	<u>Lead Organization</u>	<u>Time (hr:min)</u>
9.30	1. Introduction - Meeting objectives - Review of agenda	All	1:30
10.00	2. Status of US MHTGR program	DOE	1:30
10.30	3. Role of COMEDIE in US MHTGR Program - Summary description of MHTGR - Top-level radionuclide control requirements - MHTGR radionuclide containment system - MHTGR Design Data Needs (DDNs) - DDNs satisfied by COMEDIE test program	GA	1:00
11.30	4. Summary status of ORNL/CEA contract - Status of CY90 contract - CY90 contract milestones vs. current schedule - Key programmatic issues - Advance preparation for CY91 contract	ORNL	1:00

12.30	LUNCH		1:30
14.00	5. Summary status of CEA work	CEA	1:30
	- Loop refurbishment		
	- Design activities		
	- Mockup tests		
	- Test procedures		
	- Key outstanding issues		
	- Schedule		
	- CEA reorganization		
15.30	6. Initial tour and inspection of COMEDIE loop	All	1:00

16.30

AGENDA FOR TUESDAY, JULY 17, 1990Participants CEA: GILLET, DUPONT, A. BESSON, GERMAIN, HAIRION

8.30	1. Anticipated Changes/Additions to BD-1 Test Specification	GA	0:30
9.00	2. Updated pretest predictions for BD-1 test	GA	1:00
	- Thermal/hydraulics ¹		
	- Fission gas release		
	- Fission metal release		
	- Plateout distribution		
	- Fuel/reflector element corrosion		
10.00	3. Overall loop design for BD-1 test	CEA	2:00
	- Mechanical design		
	- System parameters (pressure, flow, etc.)		
	- Outstanding issues		
12.00	LUNCH		1:30
13.30	4. Fuel element design	CEA	1:00
	- Power distribution		
	- Fuel temperature distribution		
	- Uranium loading		
14.30	5. Heat exchanger design	CEA	1:30
	- Temperature distributions		
	- Materials of construction		
	- Valves for bundle isolation		
16.00	6. Depressurization subsystem design	CEA	1:30
	- Maximum attainable shear ratios		
	- Filter efficiencies, especially for 1		
	- Depressurization valve characteristics		

17.30

¹Separate detailed discussions between Cadwallader (GA) and Germain (CEA) on GA thermal/hydraulic modeling of COMEDIE loop may take place after summary presentation.

AGENDA FOR WEDNESDAY, JULY 18, 1990Participants CEA : GILLET, HAIRION, CRUZ, DUPONT, A-BELLON

- 8.30 1. Proposed test procedures CEA 3:30
- Start up testing
 - Steady-state irradiation
 - Blowdown tests
 - Loop disassembly
 - Postirradiation examination
 - Limiting conditions for operation and corrective actions
- 12.00 LUNCH 1:30
- 13.30 1. Proposed test procedures (continued) CEA 1:00
- 14.30 2. Proposed instrumentation CEA 1:00
- System parameters (pressure, flow, etc.)
 - Fuel element temperatures
 - Coolant impurities
 - Circulating activity
 - Plateout activity
- 15.30 3. Planned postirradiation examination CEA 1:00
- Depressurization train
 - Filters
 - Plateout probes
 - Heat exchanger
 - Fuel/reflector element
 - Shipment of fuel/reflector element
- 16.30

AGENDA FOR THURSDAY, JULY 19, 1990Participants CEA : GILLET, HAIRION, DUPONT, GERMAIN, A-BELLON, FAUGET CRUZ

- 8.30 1. Outstanding issues (see attachment) All 3:30
- 12.00 LUNCH 1:00
- 13.30 1. Outstanding issues (continued) All 3:00
- 16.30

AGENDA FOR FRIDAY, JULY 20, 1990Participants CEA : BASTIEN, CHENEBAULT, VEYRAT, GILLET, DUPONT

- 9.30 1. Administrative issues All 2:00
- Future involvement of US staff
 - Future exchanges and meetings
 - Other issues identified during meeting
- 11.30 2. Agreements and commitments All 1:30
- 12.30 LUNCH 1:30
- 14.00 2. Agreements and commitments (continued) All 2:30
- 16.30

APPENDIX H

Organization Chart for the
Commissariat à l'Energie Atomique (CEA)

June 30, 1990

New Organization (30 June 1990)

Commissariat à l'Energie Atomique

Mr Bastien and
DAME DIE in
this Org

DIRECTION DES REACTEURS NUCLEAIRES

7/16/90

7/16/90

Mr Dupont and COMEDIE
in this Org

DEPARTEMENT DE
THERMOHYDRAULIQUE ET
DE PHYSIQUE. DTP

MR. SCHWARTZ
Adj. NR. VEYRAT
BALAGNY

SERVICE D'ETUDES DE
COMPORTÉMENT DES
COMBUSTIBLES.
SECC MR. CHENEBault

SERVICE D'ETUDES DE
TRANSPORTS THERMIQUES
STT

SERVICE D'ETUDES
THERMOHYDRAULIQUES
SETH MR. COURTAUD

APPENDIX I

Documentation of Yearly Procedure for Contracting and Funding
Martin Marietta Energy Systems (MMES) Subcontract with CEA for COMEDIE Work

RÉPUBLIQUE FRANÇAISE

COMMISSARIAT A L'ENERGIE ATOMIQUE

INSTITUT DE RECHERCHE TECHNOLOGIQUE ET DE DEVELOPPEMENT INDUSTRIEL

Division d'Etude et de Développement des Réacteurs

V/Réf :

N/Réf : DEDR/CRG/88-013/DB/VB

Objet : DEDR/CRG/88-012/DB/VB
du 02.23.1988

Monsieur MILLUNZI

DOE - GERMANTOWN

Mail stop B.107

WASHINGTON DC 20545

U.S.A.

SACLAY, February 26, 1988

Dear Mr MILLUNZI,

As we decided during our February 22nd meeting (Cf. letter in objet), please find enclosed the final yearly procedure for contracting and funding we discussed February 24th in GRENOBLE.

S E H E M E				
N° 100				
Arrive le :	2/27/88			
J.F. VEYRAT				
C. BAAS				
SEDIT				
Gestion				
Secrétariat				
Sereme/S				

Best Regards

D. BASTIEN
Coordinator for gas cooled reactors.

C.C. : M. KASTEN - MMES
M. BERESOVSKY
M. GRAF - DERPE
M. VEYRAT - DERPE/SEREM

24/02/1988

YEARLY PROCEDURE FOR CONTRACTING AND FUNDING.

1) CONTRACT.

- DOE : send a telex before October 15, to provide guidance regarding funding for the next year.
- CEA prepare a technical proposal for the corresponding work and send it to MMES before November 15th.
- MMES prepare the contract for the new fiscal year and send it before the end of December.

2) PAYMENT.

- CEA send an invoice for an interim payment (75%) on August 1st of each year to MMES.
- MMES remit payment to CEA withing 30 days.
- CEA will complete an estimate of costs for the completion of efforts between October 1st and December 30. CEA will provide these cost estimates to MMES by September 30 via proforma invoice.
- CEA send an invoice after completion of the yearly work.
- MMES remit payment to CEA withing 30 days.

APPENDIX J

COMEDIE Loop Program Programmatic and Technical Issues for Discussion and Resolution During the Design and Fabrication Technical Review Meeting at the CEA Facilities, Grenoble, France (CENG)
July 16-20, 1990

Priority

1. The amount of direct contact at the technical-specialist level on the COMEDIE test program has been clearly inadequate, and the program has suffered accordingly (no technical specialist from GA or ORNL has visited CENG since June 1988). High

COMMENT: Resolution of this issue is under way by DOE, per E. Fox. All parties agreed that more technical contact is necessary for successful completion of the planned test program. CEA and DOE representatives agreed that future technical review meetings should be held at the test site approximately two times per year. The next technical review meeting should take place after the depressurization mockup tests are completed; mid-November, 1990, is the target meeting date.

2. The proper lines of communication between the technical specialists at GA and CEA need to be clarified. GA is currently required to route all communication through ORNL. (We recommend that direct communication between technical specialists at GA and CEA be reauthorized with documentation to all program participants). Medium

ACTION: Resolution of this issue is under way by DOE, per E. Fox.

3. CEA should prepare monthly progress reports for the remainder of the COMEDIE test program; quarterly reporting is inadequate, given the complexity of the program, the level of expenditure (>\$100K/mo), and the infrequent contact between CEA, GA and ORNL staffs. Medium

RESULT: Monthly meetings of the COMEDIE staff are held, which are typically attended and reported upon by the DOE consultant, Mr. Beresovski. This will continue. Formal quarterly reports will continue to be provided by Mr. Dupont, but it was suggested that he should improve them by including more detail. In addition, at the end of those months when a quarterly report is not due, Mr. Dupont will send a FAX listing important progress during the month. (This will begin on a trial basis for two months starting at the end of October, per Agreement 7.19.90 #16.)

4. The schedules for the key mockup tests, BD-0 and BD-1 continue to slip; the basis for and potential risks in the CEA scheduled activities should be reviewed. Medium

COMMENT: DOE (Fox) indicated that continued schedule delays could be expected to have a very negative impact on future DOE support for the COMEDIE program.

QUALITY ASSURANCE ISSUES
FOR INVESTIGATION DURING COMEDIE VISIT

	<u>Priority</u>
1. Determine whether the planned document structure and controls are responsive to NQA-1 requirements.	Resolved
COMMENT: ORNL (Stansfield) maintained that this issue is still open and must be addressed during future QA audits.	
2. Confirm that the loop refurbishment work completed to date is consistent with drawing packages (work began before drawings were issued).	Resolved
COMMENT: ORNL (Stansfield) maintained that this issue is still open and must be addressed during future QA audits.	
3. Assess responsiveness of the draft BD-0/BD-1 Test Procedures to the BD-0/BD-1 Test Specifications; in particular, determine whether there is sufficient traceability to demonstrate how the test requirements are satisfied by the planned test procedures.	Medium
COMMENT: This issue will remain until a complete set of procedures are available for review (scheduled for 10/31/90 per Commitments 7.19.90 #18 and 20).	
4. Determine whether operating procedures are sufficiently defined that a qualified technician can run the loop or whether an engineer needs to be present whenever the loop is in operation.	Resolved
RESULT: CEA agreed that the procedures are not adequate to serve as an operating manual, nor were they intended to be much more than a checklist. A cognizant engineer must be on-site or on call at all times during loop operation.	
5. Determine adequacy of the proposed procedures to assure that English-to-French or French-to-English translation errors do not compromise the test data.	Medium
6. Confirm that the data will be recorded in ASCII format and that the time histories of selected variables can be reliably extracted and displayed.	Low
7. Confirm that the data base is configured to facilitate its electronic transfer to GA and ORNL by an international communications network, such as "BITNET."	Low

COMMENT: CEA has experience with electronic transfer of data via telephone data lines, but not via a satellite data link such as BITNET. A sample transfer of data files should be undertaken prior to the BD-0 test to confirm such a transfer via satellite.

8. Determine status of CEA response to DOE QA audit findings. Resolved

RESULT: Response sent to R. Mills via letter SEDTI/90/LE/7516 dated July 5, 1990.

TECHNICAL ISSUES
FOR INVESTIGATION DURING COMEDIE VISIT

Priority

Adequacy of Loop Design

1. Assess the adequacy of the loop design to meet the test requirements defined in the BD-0/BD-1 Test Specifications. High

RESULT: The loop design was generally found to be adequate, but problems remain in certain areas (e.g., design adequacy of plateout probes, qualification of HX isolation valve, use of a dew-point hygrometer, mechanical connection between fuel element and reflector element). Agreements and commitments have been identified to resolve these problems (e.g., Commitments 7.19.90 #4, 12, 32, and 36), and a 2000 hour proof test of the HX isolation valve is scheduled for Sept.-Dec. Complete resolution awaits completion of proof tests and the BD-0 shakedown test.

2. Review the nuclear design of the BD-1 fuel element with the cognizant CEA nuclear engineer. In particular, review the advantages and disadvantages of performing the in-reactor flux mapping with and without loose fuel particle samples. In addition, confirm that the heavy-metal loading requirements for the BD-1 fuel compacts specified by CEA in 8/88 are still applicable. Resolved

RESULT: The unperturbed, axial neutron flux profile was measured without fuel particles in January, 1990. The heavy-metal loading requirements for the BD-1 fuel element were confirmed, and it has been fabricated accordingly. In-reactor flux mapping with loose fuel particle samples is planned for December, 1990. Results will be available in February, 1991, and will be used to calculate the power and temperature distributions for BD-1.

3. Review the thermal/fluid dynamic design of the BD-0/BD-1 tests with the cognizant CEA engineer for both the steady-state and blowdown test phases. In particular, reconfirm loop pressure drops, temperature distributions, and blower characteristics. In addition, review design features intended to minimize flow maldistributions on the tube- and shell-sides of the heat exchangers. High

RESULT/ACTION: Loop pressure drops will be confirmed for out-of-pile components in the September test, as will depressurization valve characteristics and blower characteristics (Commitments 6.24.88 #32 and 34). The latest temperature distributions were acquired, with the exception of the blowdown condition corresponding to SR=1.1, which the CEA will calculate and provide by September 22, 1990. Flow maldistributions on the tube side of the heat exchanger appear to have been minimized because only the six outer tubes of each tube bundle

carry flow; the central tube will be used as a conduit for instrument lines. Furthermore, the inlet and outlet isolation valves are symmetrically placed on all three tube bundles.

4. Review the mechanical design of the heat exchanger with the cognizant CEA design engineer. In particular, review the need for tube support plates along the length of the exchanger and the adequacy of the loop design to withstand the predicted dynamic pressure differentials during the planned depressurization transients. High

RESULT/ACTION: The capability of the heat exchanger tubes to withstand the required pressure differentials was confirmed in SEDT188/NT/7420, dated 24.8.88. The connection between the tubes and the tubesheet was tested at temperature and pressure. Capability of SS316 tubesheet to withstand pressure differentials and temperatures will be evaluated by CEA, and an acoustic vibration analysis will be done by CEA, per Commitment 7.19.90 #36.

5. Evaluate the adequacy of the data and documentation confirming that the French-equivalent materials for Alloy 800H and T22 (2 1/4% Cr, 1% Mo) heat exchanger tubing meet ASTM specifications. Resolved
6. Evaluate the adequacy of the data demonstrating that the as-manufactured Alloy 800H and T22 heat-exchanger tubes meet ASTM specifications (first batch of T22 rejected because of cracks). High

ACTION: The fabrication report for the T22 tubes will be available in August. It and the similar report for the 800H tubes will document that the tube materials are consistent with the specs. They will be sent to ORNL for verification, per Commitments 7.19.90 # 28 and 29. (CEA indicated that the fabrication report for Alloy 800H tubes has already been sent to ORNL.)

7. Evaluate the test data demonstrating that the bellows valves for HX bundle isolation meet performance requirements (first three designs failed). High

COMMENT: Adequacy of the design will be evaluated after completion of 2000 hour performance test, scheduled for Sept.-Dec. CEA (Dupont) is confident that the current valve design will pass the test.

8. Evaluate the test data demonstrating that the inpile blowdown filters meet performance requirements (first design had excessive bypass flow). Resolved

RESULT: The prototype filter had excessive bypass flow because fabrication was not under adequate quality control. The design has been changed to minimize the bypass leakage. Nevertheless, the overall efficiency of the first design met the specified requirement

in spite of the bypass. (Test results were misinterpreted.) No further testing is required.

9. Evaluate the suitability of modified design for joining the fuel and reflector element; identify its advantages and disadvantages compared to the original design. Medium

RESULT: Concerns about the design were expressed. The design will be reevaluated, per Commitment 7.19.90 #12.

10. Evaluate the suitability of the depressurization valve design to reproducibility control depressurization flows to the specified rates. Medium

COMMENT: Design adequacy will be assessed in September mock-up test, per Commitment 6.24.88 #34.)

11. Evaluate the benefits and risks of removing a plateout probe after the third irradiation cycle. Resolved

RESULT: Risks associated with lifting the pressure containment section out of the reactor pool are judged to be excessive. Therefore, plateout probe removal will not be required, and the requirement will be removed from the BD-1 test specification, per Agreement 7.19.90 #13.

12. Determine availability and delivery times for replacement parts for key loop components (e.g., circulator, inpile heater, etc.). Medium

COMMENT: CEA agreed to obtain subject information from the circulator vendor, per Agreement 7.19.90 #9.

13. Determine the advisability of once again requiring the use of T22 in the BD-0 heat exchanger tubes now that the BD-0 test has been delayed until December 1990. Low

Adequacy of Instrumentation and Test Set-Up

1. Evaluate the suitability of the gamma detection system proposed for in situ gamma scanning of the loop heat exchanger (critical to finalizing the BD-1 Test Specification). High

RESULT: External gamma scanning is agreed to be technically infeasible, since the concentration of Cs-137 in the reactor pool is comparable to the expected plateout in the heat exchanger, and shielding is not possible. Per commitment 7.19.90 # 14, GA will determine if a suitable detector is available for placement inside the loop at the HX outlet. The available space to place a detector can be determined from drawings. If one is found, CEA will provide an

analysis of the gamma signal-to-noise ratio at the heat exchanger outlet, per Commitment 7.19.90 #15.

2. Evaluate the adequacy of the instrumentation to measure the system pressure, pressure differentials across major components, mass flow rate, and temperature distributions in the in-pile and out-of-pile sections of the loop during startup, steady-state irradiation, blowdown testing, and shutdown. In particular, determine if the time constants of the loop instrumentation are sufficiently short to give reliable data during the depressurization transients. High

ACTION: Documentation of response times of thermocouples, pressure sensors, flow meter (including sensors for pressure drop and temperature) is available, and will be provided by CEA by the end of August, per Commitment 7.19.90 #30.

3. Evaluate the adequacy of the gamma scanning equipment to be used to determine the plateout profiles along the heat exchanger tubes; determine if this equipment is suitable for use in the OENG hot cell environment in the event that plateout levels are significantly higher than expected. Resolved

RESULT: High plateout levels are not a problem. The background radiation levels in the hot cell are low, and the required operations to perform the gamma scanning in cell are considered routine by cognizant CEA personnel.

4. Assess adequacy of electrolytic hygrometers for measuring H₂O concentration in He coolant; determine feasibility of using dew point hygrometers for all H₂O measurements. High

ACTION: The CEA will study feasibility of using dew point hygrometers on-line in the gas analysis section, per Commitment 7.19.90 #32. They are currently using two electrolytic hygrometers that sample the main loop at the blower inlet and are planning to replace them with recalibrated cells after each reactor cycle. The extent of decalibration during a 21-day operating cycle will be determined in BD-0. The calibration procedure was provided to ORNL for review, per Commitment 7.19.90 # 33.

5. Assess the suitability of TZM thermowells for thermocouples in the graphite fuel and reflector bodies under the expected COMEDIE service environment. Low
6. Determine if the ionization gauges used for continuous circulating activity measurements are sufficiently accurate. Resolved

RESULT: DOE and CEA representatives agreed that existing loop ionization gauges are sufficiently sensitive for the present purpose (Agreement 7.19.90 #3).

7. Assess the suitability of a Gould Surface Indicator for measuring surface roughness of contaminated heat exchanger tubes in the CENO hot cell environment. Low

Adequacy of Calibration Procedures

1. Evaluate the adequacy of test equipment and procedures for calibrating the gamma detection system proposed for in situ gamma scanning of the loop heat exchanger. High

COMMENT: Defer this item until the feasibility of installing a gamma detector inside the loop is determined.

2. Evaluate the adequacy of test equipment and procedures for calibrating the electrolytic hygrometers for measuring H₂O concentration in He coolant. High

ACTION: The use of a dew point hygrometer will be studied by CEA, per Commitments 7.19.90 #31 and 32. The procedure for calibrating the electrolytic hygrometers was provided to GA and ORNL for evaluation, per Commitment 7.19.90 #33.

3. Evaluate the adequacy of test equipment and procedures for calibrating instrumentation for measuring system pressures, temperatures and mass flow rates, particularly during the depressurization transients (Flow orifice calibration procedures found inadequate by QA audit team.) High

OBSERVATION: The loop flow meter orifice will be replaced before BD-1. (A calibrated replacement orifice plate may not be available before BD-0, so that test will not be delayed for its installation.) Calibration procedures for pressure sensors are per the manufacturer. Only the newly installed thermocouples will be calibrated, by repeating the procedures used by the manufacturer to certify their original calibration. The existing thermocouples inside the old equipment will not be recalibrated.

4. Evaluate the adequacy of test equipment and procedures for calibrating gas chromatographs for measuring coolant impurities (except H₂O) (Sensitivity of CO measurement found inadequate by QA audit team.) Medium
5. Evaluate the adequacy of test equipment and procedures for calibrating gamma spectrometers for measuring circulating activity. Medium

Adequacy of Test Procedures for BD-0/BD-1

1. Assess the responsiveness of the draft BD-0/BD-1 Test Procedures to the BD-0/BD-1 Test Specifications. High

ACTION: Not all procedures are approved yet by CEA. The overall test procedures for BD-0 and BD-1 have been approved by Dupont and transmitted, as well as 7 of 26 operating modes. Three more approved operating modes were provided at the meeting: #22, 25, and 26. A few deviations from the test specifications have been noted during a cursory review. Specific comments will be transmitted to the CEA in writing. The responsiveness of the other operating modes will be assessed when they are received. CEA will send all operating modes by the end of October, per Commitment 7.19.90 #22.

2. Assess the completeness and appropriateness of the procedures for loop assembly, disassembly and post-irradiation examination. For example, review design features and procedures to assure the major loop components (fuel element, reflector element, heat exchanger, and blowdown filters) are properly installed in the in-pile section of the loop prior to startup. High

COMMENT: Mr. Dupont concurred that MO #1 on loop assembly and installation needs more detail. Based on information exchanged in this July meeting, the PIE procedures can now be reworked and finalized. Draft PIE procedures for BD-1 and BD-0 including several PIE Operating Modes will be sent by the end of October, comments will be provided by the end of November, and a complete package of procedures and operating modes will be transmitted by mid December, 1990, per Commitments 7.19.90 #18, 19, and 20.

3. Assess the completeness and appropriateness of the limiting conditions for operation and the corrective actions defined in the Test Procedures. High

ACTION: More LCOs will be drafted by GA by mid-August, 1990, along with allowable durations for their exceedance and recommended corrective action, per Commitment 7.19.90 #2.

4. Determine whether or not the Test Procedures provide sufficient detail to serve as an operating manual for a qualified technician to run the loop; determine the need for a separate operating manual. Resolved

RESULT: CEA agreed that the test procedures are not appropriate to serve as an operating manual. A cognizant test engineer must be readily available at all times during loop operation.

5. Assess whether or not human factors were given enough attention in the development of the Test Procedures; for example, determine whether or not the layout of the control room for the COMEDIE loop facilitates proper implementation of the operating procedures. Medium

COMMENT: A final determination will be made during BD-0. It was noted that certain critical loop operations (e.g., manipulation of valving during liftoff testing) cannot be accomplished from the main

COMEDIE control room, but must be effected from a separate control panel outside the bay that houses the main out-of-pile loop components. Thus, at least two operators will be needed to perform the liftoff tests, and reliable communication between them will be critically important.

Adequacy of Data Logging Procedures

1. Assess the completeness and appropriateness of the planned data logging procedures: (1) recording of all controlled test variables, (2) frequency of measurements, (3) error-checking protocols, and (4) backup procedures and degree of redundancy. High

OBSERVATION: The planned frequency of measurements is sufficient to meet or exceed specs. Two redundant computers store the data initially, then periodically send the data automatically to a large central computer. The data is placed on backup tapes or diskettes after each reactor cycle. Data is deleted from the redundant computers manually after backup, not automatically, to protect the data.

2. Assess the capability and reliability of the software and hardware to be used for data logging. Medium

OBSERVATION: Software algorithms to convert raw data to physical data are checked for accuracy before the start of testing and from time to time, but on no set schedule. CEA does not log raw data (e.g., thermocouple emf) during any SILOE experiments. The robustness and reliability of the hardware could not be assessed from the information provided. System performance during BD-0 will be closely monitored.

Adequacy of Prescribed Hold Points

1. Determine appropriateness of current hold points: (1) after third irradiation cycle and (2) before each of four blowdown tests. Resolved

RESULT: Current hold points were agreed to be appropriate. (DOE will determine who has the authority to lift holds, per E. Fox, Agreement 7.19.90 #17)

2. Determine the need for additional hold points; e.g., (1) prior to fabrication of key loop components (fuel/-reflector elements, heat exchangers), (2) prior to loop assembly, (3) prior to start of BD-0 test, and (4) prior to start of BD-1 irradiation. Resolved

RESULT: Practically, it is too late to add a hold point prior to fabrication of components. However, it was agreed to add three hold points to the BD-0 and BD-1 Test Specifications: (1) prior to loop assembly, (2) prior to the start of BD-0, and (3) prior to the start of BD-1 irradiation.

3. Assess the need for onsite inspections by QA personnel and technical specialists during prescribed hold points. High

COMMENT: DOE must assess this need and take appropriate action. DOE concurs with Mr. Dupont's suggestion that such inspections are more appropriately done by a technical specialist than by a QA person. Moreover, it was agreed that non-conformances with Test Specifications shall be dispositioned by the responsible design organization in compliance with NQA-1, Part 15.1, per Agreement 7.19.90 #6. To that end, it is anticipated that all nonconformances in existence at the time must be formally dispositioned before a hold point could be lifted.

APPENDIX K

AGREEMENTS AND COMMITMENTS FROM COMEDIE MEETING DOE/CEA

Grenoble, July 16-20, 1990

DATE	ITEM	A/C	ACTION/COMMITMENT/AGREEMENT	RESPONSIBLE	DUE DATE
7.19.90	1	C	CEA will modify the list of monitored test variables given in SEDT 90/NT/72871 to include the list of variables to be treated with the "sliding threshold" procedure, and the list of which thermocouples will be newly calibrated for the BD tests.	CEA	October 31, 1990
7.19.90	2	C	GA will issue a proposed list of LOC's and the recommended corrective actions for BD-1.	GA	August 15, 1990
7.19.90	3	A	It was agreed that the use of existing ionization gauges for measurement of circulating activity in BD-1 is adequate, and the use of more sensitive gauges is not technically justified.	—	—
7.19.90	4	C	CEA will evaluate options for redesign of the HX inlet and outlet plate out probes in order to satisfy the test specification requirements for isokinetic sampling and correct probe entrance alignment (GA recommended that the evaluation include consultation with CEA aerosol transport experts).	CEA	Sept. 30, 1990
7.19.90	5	A	It was agreed that gamma-scanning of only the first stages (Dexter paper) of the full-flow and blow down filters is sufficient in BD-0 (extremely low levels of residual radioactivity are currently present in the loop).	—	—
7.19.90	6	A	It was agreed that non-conformances with Test Specifications shall be dispositioned by responsible design organization in compliance with the requirements of NQA-1 (Part 15-1 on Test Control).	—	—

DATE	ITEM	A/C	ACTION/COMMITMENT/AGREEMENT	RESPONSIBLE	DUE DATE
7.19.90	7	C	GA will send CEA radioactivity measurements of fuel compacts two weeks prior to shipment.	GA	TBD
7.19.90	8	C	CEA will verify blower characteristics at 60 bars of pressure and complete testing of the depressurization system.	CEA	September 28, 1990
7.19.90	9	C	CEA will contact the circulator vendor to obtain drawings and establish the availability of maintenance and spare parts, and the replacement costs.	CEA	September 28, 1990
7.19.90	10	C	ORNL will provide to GA recommendations for diffusion coefficient of Cs in UCO ct. 0 to 1.0 % FIMA for use in predicting release in COMEDIE tests.	ORNL	December 31, 1990
7.19.90	11	C	CEA will develop a conceptual design for a tool to extract the fuel element block from the inpile section after irradiation in the event of failure of the existing connection between the reflector and fuel sections.	CEA	November 31, 1990
7.19.90	12	C	CEA will review the design of the connection between the reflector and fuel element sections to identify methods of strengthening the connection	CEA	August 22, 1990
7.19.90	13	A	Requirements for in situ gamma scan and plateout probe removal after the third irradiation cycle is deleted.	—	—
7.19.90	14	C	GA will determine the availability of a detector capable of withstanding 350°C for 84 days.	GA	August 31, 1990
7.19.90	15	C	CEA will provide estimates of gamma source term at HX exit, including contributions from direct shine from SILOE core, BD fuel element, neutron activation, and plateout activity if the determination of item 14 is possible.	CEA	receipt of item 14

DATE	ITEM	A/C	ACTION/COMMITMENT/AGREEMENT	RESPONSIBLE	DUE DATE
7.19.90	16	A	CEA will supply DOE, ORNL and GA a monthly listing of highlights and issues (by FAX).	CEA	October 1990 November 1990
7.19.90	17	A	DOE shall be responsible for releasing hold points imposed by Test Specifications.	DOE	
7.19.90	18	C	CEA will transmit the PIE Draft Procedures for BD-0 and BD-1, including several PIE Operating Modes.	CEA	October 31, 1990
7.19.90	19	C	ORNL will provide comments on the initial Draft PIE Procedures.	ORNL	November 30, 1990
7.19.90	20	C	CEA will transmit the complete PIE Procedures, including all PIE Operating Modes	CEA	December 15, 1990
7.19.90	21	C	CEA will estimate the difficulty, cost and schedule impact to replace the inpile pressure containment section.	CEA	December 31, 1990
7.19.90	22	C	CEA will complete preparation of the Operating Modes for the PD-O and BD-1 tests and transmit the final documents to ORNL	CEA	October 31, 1990
7.19.90	23	A	CEA will provide additional information regarding the continuing functional organization changes as it becomes available.	CEA	—
7.19.90	24	A	CEA will replace the existing loop flow meter with a new calibrated flowmeter before the BD-1 test. Installation of the new flowmeter is desirable for BD-O, but should not cause a delay of BD-O.	CEA	—

DATE	ITEM	A/C	ACTION/COMMITMENT/AGREEMENT	RESPONSIBLE	DUE DATE
7.19.90	25	C	CEA will study methods of supporting the HX tubes during the disassembly cutting operations in order to minimize any redistribution of fission product deposits. Potential solutions will be transmitted.	CEA	December 15, 1990
7.19.90	26	C	CEA will do a thermohydraulic analysis for SR = 1.1 blowdown test, using old loop configuration, and provide to GA.	CEA	September 22, 1990
7.19.90 10, 1990	27	C	CEA will up date all thermohydraulic analysis after depressurization system muckup tests, to reflect test results and as-built configuration.	CEA	November
7.19.90	28	C	Send 800H and T22 Manufacturing reports.	CEA	July 30, 1990
7.19.90	39	C	Provide confirmation that the 800H and T22 Manufacturing report provides objective evidence of compliance with ASME standards	ORNL	September 30, 1990
7.19.90	30	C	Send an analysis of response time of instrumentation	CEA	August 30, 1990
7.19.90	31	C	Determine if a dew point hygrometer can be made available at CEA for calibration	CEA	August 30, 1990
7.19.90	32	C	Determine feasibility of installing a dew point hygrometer in the COMEDIE loop	CEA	September 30, 1990
7.19.90	33	C	Evaluate the adequacy of calibration method for moisture monitor and equipment.	ORNL	September 30, 1990
7.19.90	34	C	The document distribution list has been reviewed and will be reissued.	CEA	June 31, 1990

DATE	ITEM	A/C	ACTION/COMMITMENT/AGREEMENT	RESPONSIBLE	DUE DATE
7.19.90	35	A	The contractual planning for CY 1991 was discussed and the contracting procedure indicated in the letter from M. BASTIEN to the MILLUNZI Réf. : DEDR/CRG/88-013, dated 26 Feb. 1988 will be followed.	—	
7.19.90	36	C	CEA will review mechanical design of the heat exchanger, in particular, the possibility of acoustically induced vibration of the tubes will be assessed, and the adequacy of the 316 tube sheet to 800H tube joint will be assessed.	CEA	

J.E. Fox 20 July 90

P. CHENEBAULT

20/07/90
[Signature]

February 28, 1990

**AGREEMENTS AND COMMITMENTS FROM COMEDIE MEETING
DOE/CEA**

Grenoble, February 27-28, 1990

REVISED ON JULY 20, 1990

DATE	ITEM	ACTION/COMMITMENT/AGREEMENT	RESPONSIBLE	DUE DATE
6.24.88	29	Complete fabrication of in-pile heater	CEA	Completed
6.24.88	31	Complete fabrication of electrical control panel	CEA	Completed
6.24.88	32	Complete out-of-pile loop test in by-pass mode	CEA	October 1990
6.24.88	34	Complete check-out of blow-down train and pressured balance system	CEA	October 1990
6.24.88	36	Complete in-pile qualification test of complete loop with mock-up of fuel and reflector (BDO)	CEA	February 1991
6.24.88	37	Complete manufacture and test mock-up of dust injection system	CEA	Date to be set after BD-1
4.20.89	5	Decision on inclusion of fuel characterization test in COMEDIE loop test program	DOE	Deleted

4.20.89	12	Deliver machined H-451 graphite fuel bodies to GA	CEA	Completed
4.20.89	13	Deliver H-451 graphite fuel bodies containing BD-1 test fuel to CEA	GA	September 1990
4.20.89	18	Issue pre-irradiation fuel characterization report for BD-1 test	GA	September 1990
4.20.89	28	Issue draft of BD-0 test procedure	CEA	Completed
4.20.89	29	Issue draft of BD-1 test procedure	CEA	Completed
4.20.89	30	Initiate arrangement for international transport of irradiated fuel materials	ORNL	November 1990
4.20.89	31	Determine disposition of unconsumed HX tubing from test BD-1	ORNL	September 1990
4.20.89	37	QA audit of CEA COMEDIE loop facilities by US	DOE/ORNL/GA	Completed
4.20.89	39	Next COMEDIE loop test program technical meeting to occur following completion of mock-up test of the depressurization section	DOE	Completed
6.26.89	2	Approval of BD-1 Specification	CEA	November 1990
6.26.89	5	Approval of detailed drawings for fuel element for BD-1 test	GA	Completed
2.28.90	1	Proposed audit agenda	CEA/DUPONT	Completed
2.28.90	2	Uranium loading requirements for BD-1 based on SILOE reactor flux	CEA	Completed

		measurements		
2.28.90	3	Date for shipment of BD-1 fuel element to CEA	GA/BRAMBLETT	Completed
2.28.90	4	Complete arrangements including shipping licenses for shipment of BD-1 fuel element to CENG	GA	Completed
2.28.90	5	Date for issue revised BD-1 test specification	GA	Completed
2.28.90	6	Decision regarding conduct of in situ gamma scan mock-up test	DOE	Completed
2.28.90	7	Valve component test program proposal	CEA	Completed
2.28.90	8	In-pile heater life time data	ORNL	November, 1990
2.28.90	9	Determination of lowest number of particle failures than can be detected	CEA	Completed
2.28.90	10	Processes and procedures for characterizing the heat exchanger tube surfaces	ORNL	Completed

2-2-77 2051490
A.C. MILLUNZI

J.F. VEYRAT

- END -

DATE FILMED

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