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SUMMARY REPORT

Part III

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FOREWORD

The Tenth Annual Meeting of the IAEA International Working Group on Fast Reactors was held at the IAEA Headquarters in Vienna, Austria, from 29 March to 1 April 1977.

The Summary Report (Part I) contains the Minutes of the Meeting.

The Summary Report (Part II) contains the papers which review the national programme in the field of LMFBRs and other presentations at the Meeting.

The Summary Report (Part III) contains the discussions on the review of the national programmes.

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1. Discussion of Dr. Inyutin's presentation

Dr. SMITH: I would like to ask Mr. Inyutin whether he has any information about the sodium void characteristics of the BN1600 and whether there is any concern in the USSR on possible positive components of the sodium void characteristics of such large reactors.

Dr. INYUTIN: I am trying to recall whether we had any discussion which might have given rise to doubts or worries on this issue and I can't remember having any such discussion.

Prof. PIERANTONI: You say that Professor Kazachkovsky in his article was aiming to have in the Soviet Union a serial construction of fast breeder reactors. How many reactors is he looking for?.

Dr. INYUTIN: The article makes the following statement: On the whole, the size of the effort in the fast reactor field is quite extensive and its realization will certainly exceed a five-year programme. But it is within this five-year plan period which ends in 1980 we intend to make decisive steps and to lay a strong foundation for the extensive development of commercial fast reactors.

Now, about the number of reactors within its series - the notion of a series in Russian begins with the number three. In addition you can consider this article as something controversial becuase in my official presentation I drew your attention to a certain delay in the construction of the BN-600 reactor in connection with certain steam generator problems. In this article Professor Kazachkovsky is promoting the desirability of increasing our stepping up efforts in the introduction of fast reactors which will in turn speed up the resolution of certain problems that we have been having.

Dr. KESSLER: As far as I remember the reactors BN-350 and BN-600 are fuelled by the uranium oxide cores. Will the reactor BN-1600 have uranium oxide core or plutonium mixed oxide cores?. If it has a plutonium oxide core, could you elaborate a little bit on your plans on the fuel cycle, which means plutonium oxide refabrication and reprocessing.

Dr. INYUTIN: Both the BN-350 reactor and the BN-600 reactor are loaded primarily with uranium oxide. We are expecting to use a mixed fuel in our subsequent chargings. However, as your question implies, Dr. Kessler, this will depend on how successfully and quickly we can resolve the question of the fuel cycle. In my view this is now "a problem of the century" and it is of interest to all countries in the world.

Mr. VAUTREY: Mr. Inyutin, you talked about steam generator problems and the time delay in connection with the BN-600. I believe that you made direct reference to the snags which you experienced with a steam generator problem involved in the BN-350 reactor. Perhaps you could give us certain additional information on this problem. What are you going to do about the BN-600 steam generator?. Are you going to modify it completely?. Are you going to have a problem with the recycling of the steam generator for that particular reactor of the BN-600?.

Dr. DÄUNERT: We had a possibility to see BN-350 last summer where we had been told that some of the steam generators had been replaced. I remember that two of the steam generators are of the original type, as you mentioned in your presentation, and what about the other one?. I think this is directly linked also to your question, Mr. Vautrey, concerning steam generator experience and BN-350.

Dr. INYUTIN: Possibly this question remains somewhat unclear because I mentioned it in various points in my presentation. I'll repeat a bit of what I then said.

We are doing intensive work directed at finding ways and means of increasing the reliability of steam generators. I have indicated the lines along which this work is being carried out.

In the case of the BOR-60 reactor, we tested steam generator models. The steam generators were both of USSR and Czechoslovakian design. All of this indicates that we are putting forward a major effort in attempting to search out the right materials and right designs of steam generators. We have intensively analyzed the operation of such steam generators.

In the case of the BN-350 reactor, as already noted, one steam generator has been operating successfully from the very start of operations, whereas three other steam generators were put into operation after overhauling and in 1976 they likewise operated without any failures whatever. The fifth loop did not function the whole year round. It was somewhere round the beginning or towards the middle of 1976, when the steam generator was fixed at this loop. So to sum up, the four afore-mentioned loops worked during the course of the whole year. However, the fifth loop hasn't functioned for a whole year. I also pointed out that we are considering the question of gradual replacement of steam generators operating on the BN-350 reactor by modular type steam generators built for us in Czechoslovakia.

The reason for using modular steam generators is, as I already pointed out, they are more convenient when you have to deal with an emergency situation. However, this does not mean that we are going to rest on this design. Modular steam generators are going to be used as an intermediate solution. We are doing some work on the design of another type of steam generator. In my paper I mentioned, for example, the reverse steam generator. We intend to install in the BOR-60 reactor a model of a steam generator for the BN-600 reactor which constitutes a straight pipe design.

Summing up I should like to say that the situation, as you can see, is far from being simple and we are attempting to resolve the problem by all means available to us, including by way of international cooperation.

Dr. DÄUNERT: Speaking about the time delay for the schedule of BN-600, to what dates are you referring?. We learned in summer last year that the start-up of BN-600 was not so clearly defined. Time delay means start-up now in what year?.

Dr. INYUTIN: The delay in the start-up of the BN-600 reactor is connected in addition to the steam generator problem with a delay in the production of a number of basic pieces of equipment for this particular nuclear station. We know that all these factors are interlinked. If we don't have a reliable steam generator, as yet, our managers are not pressing industry to install the equipment as quickly as possible. I have no specific date which I could mention as the commissioning date for the BN-600 reactor.

Dr. KESSLER: I have some more questions on the core of BN-1600 reactor. The first question: Is this a two-zone cylindrical core?. And the second related question: If I look at the maximum neutron flux of 10^{16} and the burn-up - do you know by chance the maximum rod power?.

Dr. INYUTIN: I don't recall the exact figure but I think a maximum value is something in the order of 500 W/centimetre.

Dr. KESSLER: The reason why I am asking is, the neutron flux seems surprisingly high to the reactor core concept of this size and what I would have expected is something like $(5 \text{ to } 6)\text{x}10^{15}$ for the neutron flux.

Dr. INYUTIN: The loading in some of the variants is of the two-zone type. You are quite right in your supposition. Further details you'll get in Salzburg at the next conference.

Dr. SMITH: I have a few more questions to ask. One is on the BN-1600 - you mentioned the desirability of thick breeder zones. No doubt, you have several different studies but have you any idea on what the optimum axial and radial breeder thickness is?.

Dr. INYUTIN: The term "thick breeder zones" quantitatively speaking ought to be understood as follows: The breeder zone ought to be of thickness from 30 to 50 cm. An optimal thickness depends on the specific design of the core and breeder zone, and any figure within this range that I've just mentioned can always be argued about because the optimal value does depend on specific designs.

Dr. SMITH: You mentioned when you were discussing corrosion by mixtures of sodium hydroxide and sodium the presence of a temperature threshold - I'm afraid I didn't completely understand the translation. This was a threshold of corrosion which was due to a transition from a heterogeneous reaction to a homogeneous one and perhaps you could explain that.

Dr. INYUTIN: Well, in my presentation I said the following: The presence of a so-called temperature threshold for the interaction of sodium hydroxide with sodium is due to a transition from a heterogeneous reaction to a homogeneous reaction. What does this signify?. Previously, the variation of the interaction rate was attributed to the influence of the temperature on the chemical character of this interaction. Our scientists found that the reaction threshold is attributable rather to the fact that up to a certain temperature value the sodium hydroxide is present in localized formations and it was at the surface of these local formations that interaction with sodium occurred. As the temperature increases, however, the sodium hydroxide tends to dissolve and the surface of interaction increases. I'm not sure that I'm using the right term when I say "dissolve". In other words, the reaction threshold is due not to the effect of higher temperatures on the chemical interaction of the bends, but rather to the alteration of the physical state of the material which, in turn, results in an alteration of the reaction rates.

Mr. CICOGNANI: I have two questions for Mr. Inyutin. The first question: You mention the carbide experience carried out on BOR-60 reactor. Could you tell us what relevant solution did you adopt for the thermal bonding. Is it helium or sodium bonding?. And the second question which is a little in line with the question posed by Dr. Kessler: I have perceived that a paper will be given in Salzburg at the forth-coming conference explaining this very high value of flux in the reference BN-1600 reactor. So, I will limit my question to this point. If we take together this very high flux 10^{16} with the rather high figure in the burn-up this means that the integrated dose on the cladding will be pretty high. Does this mean that you are confident to solve the problems connected with the structural materials which perhaps would be very high with such big value of fluence?.

Dr. INYUTIN: As regards the question concerning the carbide fuel I said that we do not have a final recommendation, as yet, and that is why we are conducting studies along both of the lines you mentioned. Now, as regards the core of the BN-1600, I do understand your concern but the BN-1600 reactor is not a demonstration reactor. It is a reactor which is thought of as a prototype for a commercial breeder and that is why we are presently looking for ways of producing a core which would be highly reliable. But, as you can see, the fuel elements of the BN-350 reactor are operating in a satisfactory way. Apparently, if we modify this somewhat we will be able to produce some good fuel elements for the BN-1600 as well. In any case in creating the BN-1600 we are doing everything possible to ensure the reliability of its core. I would like to note that I have listed the characteristics of just one of the variants.

2. Discussion of Dr. Yevick's presentation

Dr. SMITH: I was wondering on the resolution of the Clinch River containment arguments and discussion to which Dr. Yevick referred, if he could submit more details about what the final view on the magnitude of excursion release and strength of the containment turned out to be and things like core catchers and so on. What is the overall position?.

And could I ask then a more general question?. When you were talking of the NRC and particularly the first section of the NRC analysis branch, you mentioned codes such as ZIMMER and Supper System codes. Is the feeling in the States that the licensing authorities are likely to accept such codes or the outputs of such codes as playing a very important part in safety analysis or are they going to require rather more simple overall rules, requiring physical upper limits and so on which is a tendency of the licensing authorities in the UK?. They are not too interested in these codes, but ask what is the physical upper limit?.

Dr. KESSLER: I would like to see a little bit of more detail on the new containment concept. Could we see the third last slide on the containment in the Clinch River where this kind of inner containment surrounding the vessel cover and some others?. I guess you had also in there some kind of a core catcher.

Dr. YEVICK: In selecting the CRBRP Structural Design Basis (SDB) pressure loading, the project examined a spectrum of CDA scenarios which included core hydrodynamic disassembly. The project selected its SDB loading at a level where "significant deviation from observed physical phenomena must be assumed" in order to calculate loadings which approach the SDB level. The SDB loading, as derived in Appendix F of the PSAR, is based on fuel vapour expansion from a core having an average temperature of 4800K. If expanded to one atmosphere, the work-energy released would be 661 MW-sec, a number which is generally used as an identifier for CDA energetics magnitude. The project evaluation is that CRBRP primary containment has sufficient energy absorption capability to assure structural integrity under the SDB loading.

NRC is requiring that secondary containment integrity must be provided for at least 24 hours following a CDA. One of the functional requirements which NRC has specified for portection of secondary containment is a 1200 MW-sec SDB loading.

a. <u>1200 vs. 661 MW-sec SDB</u>

The project has appealed the 1200 MW-sec requirement. Current indications are that future R&D on CDA energetics will provide a solid basis for allowing NRC to reduce the SDB requirement to something between 661 and 1200. Recent scale-model tests have provided data which demonstrates primary containment integrity at 661 MW-sec and an additional capability to absorb 200-300 MW-sec more. Thus, it is very likely that no engineered barrier or device will be required to protect secondary containment from CDA-generated missiles.

b. Core-catcher

It appears very likely that an engineered core retention device will not be needed to meet NRC requirements. Current licensing requirements can be met by a combination of design features and an understanding of the containment response to core melt-through. Five features which provide assurance that requirements can be met are: (1) a dual containment scheme, (2) a vent/purge capability for the containment atmosphere, (3) an effluent filtration system, (4) a containment heat rejection system, and (5) an improved understanding of the containment conditions following meltdown. Additional information on each of these features is provided below:

(1) Containment Design: The current containment design consists of an inner, free standing, low leakage steel building (built to ASME boiler and pressure vessel standards) surrounded by an outer concrete shell which provides protection from external missiles. The annular region between the two can provide holdup of material leaked from the inner containment and is normally kept at a negative pressure so that uncontrolled leakage to the environment cannot occur.

(2) Vent-Purge System: Equipment to enable venting the inner containment atmosphere when pressures reach unsafe levels is provided to preclude containment failure from over pressure. A purge system which permits dilution of flammable/explosive gases in the containment to safe levels is also provided. This assures that hydrogen explosions will not occur in the containment. Instrumentation and actuation devices to monitor and control containment atmosphere pressure and hydrogen concentration are also part of the current design.

(3) Effluent Filtration System: Effluent from the vent/purge system will be cleaned by an emergency containment air cleaning system prior to release to the environment. The specific type of filtration system has not been firmly selected but a number of feasible alternatives are under consideration. A venturi scrubber and wetted fiber filter are likely candidates.

(4) Containment Heat Rejection: A heat rejection system, which consists of air circulation equipment to move and direct outside air through the annulus and over the outside of the inner steel containment shell, is provided in the current design. This system can carry heat from the inner containment, thereby reducing inner containment pressures.

(5) Accident Conditions: An improved understanding of the thermal properties and behavior of concrete at elevated temperatures contributes to our assurance that licensing requirements can be met by the current design. The release of water and CO_2 from heated concrete along with hydrogen formation and auto-ignition characteristics has enabled improved assessments of the containment response to a core melt-through event. These assessments indicate acceptable consequences.

4. Contribution of Sodium Vapor Pressure to CDA Loading

Sodium vapor is considered to be an extremely unlikely possibility as a primary CDA working fluid. This is due to the extensive evidence available which supports the theory that large scale, energetic thermal interactions between oxide fuel and sodium are very low in probability. Fuel vapor is now considered by both the project and NRC as the only primary source of working fluid available to do substantial work. It is possible for sodium entrainment and vaporization to affect the work-energy output of a fuel vapor expansion, but the effects have been shown to be minimal and in most cases tend to reduce the work-energy.

5. Utilization of Computer Codes for Licensing

Computer codes are used extensively by the project to support their analysis of CDA consequences. These codes have become the focal points over the debates between the project and NRC as to the accuracy and adequacy of safety analysis. We believe that NRC will increase their reliance on codes in the future as they develop their own for the purpose of independent confirmatory assessment.

In response to Dr. Smith's question, we believe that codes will continue to play an important role in licensing decisions and safety analysis by NRC. They provide extremely valuable tools for performing sensitivity studies and risk evaluations which can be used as a basis for rational safety evaluations.

We have come much too far in our understanding of CDA phenomena and our ability to calculate these phenomena in fast-running, economical computer codes to revert to a arbitrary decision-making based on requirements for upper physical limits. On this point, we and the U.K. are in fundamental disagreement. It comes down to a basic decision on the use of tools which, although not perfect, can provide considerable insight to a difficult evaluation process.

Dr. DEUNERT: Mr. Yevick, this is not so much a question from myself to the technical content of your paper. You know that we are all more or less affected by discussions going on in your country. I did not see in your paper any table about the budget of the next fiscal year. Otherwise, one can read in the newspapers for instance that the budget is decreased by $200 million for the next fiscal year. Could you give us some details how to read the new budget, if you would like to do so.

Dr. YEVICK: In the summary a statement is made that the fiscal year 1978 budget is $656 million and then proceeds to indicate what this budget of $656 million will do. In other words we will complete FFTF. Clinch River will continue at a slower pace. The start of the major construction would be delayed which would impact the 1984 start-up date. Base technology support will continue. Conceptual design activities for the next reactor project, the PLBR will be terminated by the end of the fiscal year 1977.

As you well know, there is a large steering group that was appointed by the President and his advisor, Dr. Schlesinger, to review the LMFBR with five sub-groups reporting to the steering group. The steering group is headed by Mr. Thorne who is now the Acting Assistant Administrator for Nuclear Energy. Members of the steering groups are:

R. D. Thorne, ERDA-Chairman of SG
T. G. Ayers - Chairman, Commonwealth Edison, Chicago
M. T. Benedict - Professor - MIT
T. D. Cochran
F. L. Culler - Deputy Director, ORNL
J. L. Everett - President - Philadelphia Electric Co.
F. Von Hippel - Professor - Princeton
R. V. Laney - Deputy Director, ANL
C. Starr - President - EPRI
R. E. Train
C. Walske - President, AIF
R. H. Williams - Professor - Princeton

There are five sub-groups covering various aspects such as cost of CRBR, should Clinch River continue, LMFBR commercialization, facilities, and fuel cycle. The steering committee will report to the President by April 8 as to their recommendations on the various scenarios at which they are looking. The scenarios are: continue with the program; to slow the program down; to cancel Clinch River; or to bypass Clinch River with a modest size commercial prototype large breeder. There is a whole series of scenarios and it is difficult to predict what is going to happen. It appears that the United States is set to go the non-proliferation route of non-reprocessing.

Dr. DAUNERT: Mr. Yevick, I think we are all very well informed because we are very much interested from our own point of view on what is going on in your country. I am experienced in reading budgets. My question was a little bit simpler: Was the budget reduced due to the fact that you had not been able to spend more money for Clinch River or was the budget reduced generally for this specific project and the work has to go slower?.

Dr. YEVICK: The work has to go slower.

Mr. LARRIMORE: The plutonium supply for the continued operation of FFTF - what is the situation on that?.

Dr. YEVICK: We already have up to four cores that will be delivered. To continue operating the FFTF will require further provision for the fuel cycle.

Prof. PIERANTONI: You underlined in your report that in the States you have about 150 nuclear units still in construction or in order for 163,000 MWe. I do not understand how you are really considering the possibility to stop reprocessing with so large a number of nuclear power stations being in construction in the States.

Dr. YEVICK: The proposition is to store the fuel.

Prof. PIERANTONI: In Italy we are now facing the possibility of storing the fuel and we have seen that it is very expensive to store fuel only for five to ten years and for three small units. I think to store fuel for about 200,000 MWe will be a very large job.

Dr. YEVICK: I agree.

Dr. DAUNERT Mr. Pierantoni, I think it would be worthwhile to concentrate on our LMFBR programs and I feel that Mr. Yevick is not in a position to give you answers which for the time being do not exist in the United States.

Dr. INYUTIN: I don't have so much a question as a comment to make. At one time I was very satisfied when I read the following U.S. conclusion on accounts on environmental program for the LMFBR - the time has come in the U.S.A. to stop the discussion of the question, whether we need fast breeders or not since this discussion is really under way among a wide public and it is not sufficiently qualified in its nature and it just does harm to the national economy by slowing down of the necessary energy program and it is now time to stop the discussion of this question. Today, unfortunately, I heard that you are having a revision of the question of whether the fast breeders are necessary or not for the development of the energy program. This is the comment I wanted to make.

Dr. SMITH: There was a comment, I think, in connection with FFTF on remote inspection of welds. This is an important question for fast reactors which wish to operate for 30 or, I think, 40 years, which Mr. Yevick mentioned. What sort of inspection had Mr. Yevick in mind here? Is this initial inspection, inspection after 20 years operation and how is this inspection done?

Dr. YEVICK: It appears at the present time inspection is visual utilizing a television camera. I have not heard of any plans for FFTF to use other inspection means. The under sodium scanning device which will be tried out in the FFTF will be of some help internally, but mainly as a scanner for obstructions and not an inspection device.

Dr. SMITH: On the SLSF you mentioned, I think, that there have been two tests carried out. I do not think that I have heard the results of the second test. Were there any particular interesting points?

Dr. YEVICK: The primary objective of experiment P2 was to investigate the consequences of a hypothetical unprotected FTR flow coastdown accident caused by the abrupt loss of all pumping power. Mode of element failure, fuel motion (dispersion and slumping), extent of fuel-coolant interaction, and coolant response were among areas of particular importance addressed by this test of nearly fresh (0.5% Bu) fuel in a high power FTR subassembly. The start-of-life simulation permitted an investigation of these phenomena without influence from the presence of high-pressure plenum fission gas. Simulation of the flow coastdown at start of life provided information that will be supplemented by the P3 and P5 tests with progressively larger numbers of fuel pins. The information gained will also provide a basis for assessment of the significance of certain nonprototypic conditions in the TREAT experiments.

The P2 subassembly is a 19 element bundle of FTR type fuel elements.

The P2 test results show:

1. A slow boilout of sodium from the fueled section compared with a predicted rapid expulsion,

2. A small net flow maintained through the test section after boilout indicating either no clad blockage or incomplete blockage at both ends of the bundle, and

3. An incomplete voiding of the upper bundle indicated by thermocouple data.

The results of the posttest analyses indicate that the contributing factors causing the slow boilout of sodium in the P2 safety test are:

1. Different test conditions than TREAT tests which result in earlier boiling and a higher pump head at the onset of boiling.

2. Radial incoherences in bundle temperatures and void fraction due to the larger P2 bundle size.

3. A radial heat loss from the upper P2 bundle to the sodium bypass resulting in void condensation and hence a lower two phase pressure drop.

Mr. VAUTREY: I would like to ask Mr. Yevick if he could send his results of the second SLSF test to us because we would be very interested in this. I don't know if you are going to distribute them to everybody here?

Dr. YEVICK: I will distribute them to the IWGFR. P3A test was inserted into the Engineering Test Reactor in July and the final P3A transient is scheduled for mid-August. The P3A transient is a stop-action transient in which fuel in various stages of melting will be "captured" to determine the fission gas distribution within the pins.

Dr. KESSLER: There is a program under discussion which is called SAREF and this program has been revised during the last year and has been broken into several parts, for instance an improvement of TREAT and the question is, is the budget for this new program assured now?.

Dr. YEVICK: Programs such as SAREF and FFTF will continue. SAREF consists of three parts: use EBR2 as a safety facility, second improve TREAT, and third a separate facility with a fairly large transient capability. International cooperation in the U.S. SAREF program is a goal. We will proceed with the SAREF program.

Mr. LARRIMORE: Has a view developed on heterogeneous cores for large LMFBRs?.

Dr. YEVICK: The optimization conference to be held by the BNES will include papers on this subject. Abstracts have been provided to BNES.

Dr. SMITH: I do find myself confused by the American situation and I suspect other people do as well, in one sense if there is not to be reprocessing in the States and if the budget for PLBR is stopped it seems very little sense in continuing with FFTF and SAREF. I do not think I expect an answer to this but it does seem to be an illogical position we are in at the moment.

Dr. YEVICK: The U.S. will have to redevelop its objectives for longer range programs.

Dr. DAUNERT: Gentlemen, I have the feeling that there are lots of questions of this kind which could be put to Dr. Yevick - he is not able to give us a sufficient answer today. I think we will hear what happens in the next few weeks in the United States as soon as information is available.

3. Discussion of Dr. Tomabechi's presentation

Dr. DAUNERT: Before starting the discussion about the Japanese presentation I would like to give Mr. Tomabechi the opportunity to make a correction to his paper which was announced before the break for lunch.

Dr. TOMABECHI: On page five, paragraph four, there is one sentence that is missing. I would like to correct it like this: The results of this experiment indicated that although about 10% of the original sodium was released into the atmosphere, only about 3% of the iodine originally contained in the sodium was released into the atmosphere. All I wanted to say was: this experiment indicated about 10% of the sodium was released into the atmosphere. However, only 3% of the iodine, originally contained in the sodium, was released into the atmosphere.

Mr. VAUTREY: I would like to ask Mr. Tomabechi for some details which perhaps were given already, but on which I haven't been able to consult my documents. Could he remind us about the JOYO fuel?. What are the basic characteristics of it, that is the linear power, the burn-up scheduled, the maximum cladding temperature and the diameter of the pins?

Dr. TOMABECHI: Certainly I can give you the information. For the time being we are allowed to attain fuel burn-up only to to 25 000 MWD/ton, and thermal power is limited to 50 MW. At 50 MW the maximum linear power is 214 watts per centimetre. The size of the pin: diameter of pellets - 5.4, cladding thickness - .35, outer diameter - 6.3, pitch - 7.6, all in millimetres. What else do you need?.

Mr. VAUTREY: The maximum cladding temperature.

Dr. TOMABECHI: I don't think I have the figure with me at the moment. However, I can tell you the criteria. The criteria is that the maximum cladding temperature should not reach beyond the 650°C with thermal power of 75 MW. So at 50 megawatts, the figure must be very low. The maximum cladding temperatures at 75 MW and 50 MW are 629°C and 542°C respectively.

Dr. WELCH: Could Mr. Tomabechi tell us please if there is any consideration being given in Japan to the design of large commercial reactor beyong MONJU?.

Dr. TOMABECHI: At the moment we are authorised only to conduct major experiment for up to MONJU prototype reactor. However, there are certain activities going on in connection with the follow-on large reactor. We are making a preliminary study on a 1000 MWe reactor.

Dr. SMITH: Could I ask whether there is any planning for reprocessing and developing in general fast reactor fuel cycle in Japan?.

Dr. TOMABECHI: Yes. We are planning to start the R & D work for reprocessing. According to the present programme by 1985 we will have a kind of a pilot scale small plant for the reprocessing of fast reactor fuel. We are thinking particularly about spent fuel from experimentsl reactor, "JOYO" and prototype reactor "MONJU".

Dr. KESSLER: On page 5 you report about the NaK loop. My question is whether you have any application of NaK within the JOYO or MONJU?.

Dr. TOMABECHI: We have no intention of applying NaK to JOYO at the moment. However, there is a possibility to use NaK for MONJU. Of course we don't like to have a core-catcher. It has not been seriously envisaged to use NaK for cooling a core-catcher but there are other possibilities to use NaK, for instance, for cold traps.

Dr. DAUNERT: Thank you Mr. Tomabechi. We all hope that you will be successful in commissioning JOYO in time.

4. Discussion of Dr. Smith's presentation

Dr. DAUNERT: It was very interesting for me in the context of CFR that there are certain requests made by the utility side to be met before the acceptance of the fast breeder system. I felt utilities asked for the demonstration of a closed fuel cycle. But it makes no commercial sense to close a fuel cycle if there is not a sufficient amount of installed capacity. Have you any idea, Mr. Smith, or could you give additional comments on how to solve this problem?.

Dr. SMITH: This is a very difficult problem and there is much discussion and argument in the UK. The fast reactor is dependent on having a short turn-round of its fuel. If you do not achieve a short turn-round of the fuel you find you use more uranium, at least for a very large number of years, than you do with thermal reactors. On the other hand, at the time when fast reactors are first introduced there will be no need for rapid reprocessing since the countries concerned are likely to have sufficient plutonium in stock to keep fast reactors running for some years. The reprocessing people would prefer to delay any studies of short term reprocessing, because they say the problem is difficult enough even if long cooling times of 5 years or more are adopted. On the other hand the utilities say why should we buy this station only to find out later that it is not possible to reprocess the fuel in less than five years and, therefore, the system does not do what you claim it will do. We have not resolved this problem: we are arguing about it.

Dr. DAUNERT: Please let me know if you find a solution.

Dr. KESSLER: With regard to the fuel cycle you give a number of 0.75 years for the out of core time. This is 270 days and I suppose that you have about 140 or 150 days cooling time and the remainder of 121/130 days is for transportation, refabrication and so on?.

Dr. SMITH: Yes, it is 140 days cooling - that includes the transport to the reprocessing plant and waiting in the reprocessing plant buffer store. From that to reprocessing and refabrication of the fuel back into the reactor we estimate the remainder of the time will bring it up to the 9 months. It is not crucial exactly to achieve 9 months. That happens to be the number we use in our economic studies. If it were a year or a bit longer this would still be acceptable but it would not be acceptable for it to become 2 or 3 years.

Dr. KESSLER: Again in the context of the fuel cycle you talk about different methods for fuel fabrication and especially about the so-called wet process, the gel process, and you also talk about a fully remote fabrication process with low waste, low plutonium hold-up and so on. Is this the present position and could this become a reference case for your fuel fabrication?.

Dr. SMITH: Unfortunately, we don't have a large-scale fabrication and reprocessing plant so these represent thoughts. It is clear from the operation of the Windscale plant that one of the problems is plutonium dust, this is the reason why gel plant is attractive and a lot of the work being done is towards the development of such a process. This is all development work at this stage.

Dr. WELCH: I think that as Dr. Smith has said the problem at the moment with our fuel plant is dust. One can either reduce the amount of dust or reduce the hazard from the dust by complete remote control or go to a wet process which deals with the dust but produces other problems. We are building an experimental gel plant and we will be trying that out to see how it functions in comparison with the dry plant.

Dr. KESSLER: The remote fabrication process - has this anything to do with a relatively high spontaneous neutron radiation of the higher actinides?.

Dr. WELCH: Yes, there is a higher radiation from the fuel which is recycled and we believe and have believed for a long time that one has to demonstrate that the fuel will go around the complete cycle at least twice before you say you have proved a fast reactor fuel cycle. To go through once is relatively easy - the second time requires different plant or better plant.

Dr. DAUNERT: In the context of materials development you mention that you now found special material for the replacement of the super heaters in PFR. Have you any idea when this will take place?. Are these under fabrication?.

Dr. SMITH: These are virtually just at the point of letting a contract. I am not sure if the contract has been let or not but it will in any event take some time to fabricate new tube bundles.

5. Discussion of Mr. Vautrey's presentation

Dr. TOMABECHI: You mentioned that you are going to install a device for detecting failed fuel pins and I heard from the translation that it is a sniffing device. My question is could you elaborate a little bit on the method to detect the failed pins and my second question is where are you going to install it, in the reactor core of RAPSODIE or somewhere else?

Mr. VAUTREY: I think the translation was not a bad one. This is what is really involved. As you know, in PHENIX we have a much more sophisticated instrumentation above the core which allows us to detect a faulty assembly, which does not exist in RAPSODIE, at least in the reactor with its normal installation. I ought to remind you that at the time when RAPSODIE was constructed we set up a device to detect the delayed neutrons on the sodium and also to measure the fission products in the gas circuits. These installations have developed, we have added to them and completed them and this is being done gradually during the course of the years. When RAPSODIE was initially designed it was quite modest because our knowledge and experience did not allow us to do any better than this. However, all the installations which we have, I must say were extremely efficient and we are able to detect especially well a faulty assembly, either through tagging gas or through fission gases which escape and allow us to have an idea as to the age of the assembly, its length of stay in pile, also due to the samplings which are taken either in gas or sodium in different circuits. We also have geographical localization, due to the fact that one or another detectors is influenced by say the position of the fault assembly in the core. This is why we have different installations through which people who are used to this kind of work are usually able to quite quickly detect a failed assembly. There are cases, of course, where there are doubts and when we are forced for example, we have some, maybe 3, 4 or 5 assemblies which are suspect and we carry out displacements to try to give more precise detection. We have now an additional detecting device. We have called this the sniffing cask - it is really a cask which sniffs. It is a device, a kind of cask which is placed like a cask car to unload a fuel assembly. We pull a little inside the cask a suspect fuel assembly and through the adjoining circuits we detect whether this suspect assembly really is releasing fission gases or not. It is not a permanent device.

Dr. TOMABECHI: I understand you are going to reach from the top of the rotating plug down to a sub-assembly and take some kind of gas which comes out from the sub-assembly. Is this correct?.

Mr. VAUTREY: It is a sub-assembly which we take out partly from the sodium in order to allow slight heating. We have checked that the conditions were such that the heating of the assembly was not excessive.

Dr. SMITH: I would like to ask about SUPER-PHENIX. You mentioned that you discharged the fuel elements without any internal storage. I would like to know what is the maximum decay heat of an element which you discharge and how the elements cooled during the discharge.

Mr. VAUTREY: It is discharged one or two days following the close-down and I think that the power envisaged in the discharge system is roughly 30 kilowats. I am quoting the figure by memory and I am not absolutely certain.

Dr. SMITH: How is the element cooled?. Is it in a bucket of sodium, is it gas cooling or sodium cooling?.

Mr. VAUTREY: The assembly is in fact in a bucket of sodium but the cooling is purely through gas and we are seriously studying in detail the cooling of the sodium vessel.

Dr. KESSLER: I would like to ask a question on two numbers you have given on page 15. Perhaps I need only a little bit more explanation but you have indicated for the cladding a swelling rate for the diameter $\Delta D/D$ of 5% and then you have mentioned for the Hexagonal tube 1.6% over the plates. Are those two numbers due to different material or is it just a different geometry which has to be taken into account?.

Mr. VAUTREY: I am not quite certain about the reply to this. However, the cladding deformation in diameter and the deformation of the hexagonal tube are two different problems, first of all because the pressures are not the same. Regarding the question of the deformation of the cladding, we have overall deformation of the cladding and the pressures are not at all the same in the two cases so the behaviour is different.

Dr. SMITH: There are some more questions I would like to ask. First of all on the question of fuel cycles for the series of stations about which you are talking, the ones following SUPER-PHENIX, what studies and plans are you making for reprocessing and refabricating fuel and what fuel plants are you proposing to build?.

Mr. VAUTREY: For the time being as to SUPER-PHENIX, the fabrication of the fuel is going to be in Cadarache in the same workshop which fabricated the RAPSODIE and PHENIX fuel, the capacity of which was extended to 20 tons per year. The reprocessing of SUPER-PHENIX can only be done in the Hague on the pilot facility called HAO (high oxide activity). This is an old reprocessing pilot facility to which we have added a head-end to allow for the reprocessing of the oxide fuel, light-water fuel with high activity and the fuel of the fast reactors. There is a question both for reprocessing and refabrication. It is also a question of an installation which basically speaking are not specific, which are not adapted that is to say to a large capacity and corresponding to a large chain of plants. At present we are studying both with respect to reprocessing and refabricating on a preliminary basis, factories, the capacities of which will be at least 100 tons per year or 200/250 tons per year. These are factories or plants which will be adapted to covering the requirements of a chain of fast reactors of 6,000÷10,000 electric megawatts. This is what is planned to be carried out at the time when the programme of Electricité de France is going to develop and after SUPER-PHENIX will be carried out in series, as our Soviet colleague said.

Dr. SMITH: On the head-end plant at the Hague and on these 100 ton and 200 ton per year plants, what cooling time before the head-end treatment are you planning?. How long before you can put it into the plant?.

Mr. VAUTREY: I think it is less than one year.

Dr. SMITH: For both the existing head-end plant and the future ones which you are planning?.

Mr. VAUTREY: Yes.

Dr. SMITH: The problem I have is the kind of criticality problems you will get in a light-water reactor reprocessing plant and so on - How do you overcome them by more dilution just?.

Mr. VAUTREY: Yes, the head-end is made both for high activity light-water reactor and fast reactor fuel. In any case by dilution.

Dr. SMITH: In the question of the size of the later fast reactors, SUPER-PHENIX 2 and so on, which you mentioned as being 1800 megawatts electric, what turbine size is that, is that 1 turbine or 2 turbines and 'though I believe you have not finally decided on this, what are your reasons for going to a very big station?.

Mr. VAUTREY: I must say that it is mainly a tendency of some people and I think just saying that the fast breeder plants because they have no pressure are more adaptable or have much more possibility for greater power than light-water reactors but this value I think has no real meaning up to now.

Dr. DAUNERT: May I comment on this. I think we had the same situation in Germany. I remember during the 9th AGM we told you that the original approach for the size of SNR-2 was up to 2000 MWe. The power of 2 000 MWe was envisaged because utilities always like to have as large stations as possible if they are large utilities because of a better commercial behaviour. In any case you need in the order of 100/120 people to run the reactor and this does not enlarge if you go from 1 200 to 2 000 megawatts.

Dr. SMITH: There are some contrary views on this. With the increase in size the reloading time goes up in an unfavourable manner and in addition the maintenance time for things like turbines also increases and the effect of all general maintenance problems may mean that you do not get as much benefit as is at first thought.

Dr. DÄUNERT: I think, Mr. Smith, it is not so much the question of a turbine. Anyway if you go to 1 800 or beyond this for the time being you need two parallel turbines and so far this is not the problem. It is very interesting for me to hear the other aspect, the time out of order for reloading and it is the first time I heard that anyone made calculations about this. Could you comment a little bit more on this?.

Dr. SMITH: We have done a simple sum of preparation time plus an equal time per sub-assembly and this does tend to favour the smaller sizes because you have the whole reactor shut down while you are removing one fuel element essentially unless you could develop a method for changing fuel elements two at a time. There is some viewpoint in the UK that 1 300 megawatts is already too large, and people would like to go to a smaller size, that it does seem clear that there is a fairly large penalty in going down from 1 200 to say 600 megawatts in cost but I think that the cost benefit in going up from 1 200 to 1 800 or 2 000 may not be very great. There are certainly bigger problems in designing the reactor.

Prof. PIERANTONI: In Italy, as far as I know, one of the reasons that ENEL is in favour of large power stations is due to the fact that it became more difficult to find a place for a nuclear power station and the experience we got is quite funny. People think in terms of a number of units, not on the total power so in Italy we have foreseen to have a maximum 4 unit in one side, independent from 600 or 1 2000 megawatts. This, I think, is a quite important reason in order to increase the power because the number of sites which will be allowed for the nuclear power station will not be very large placed in an evenly populated country like Italy.

Dr. DÄUNERT: I think this is the experience with us all. The amount of trouble with public acceptance is not proportional to the power of the station.

Dr. INYUTIN: I have a question to Dr. Smith. Could you clarify please what you meant speaking about 1 200 or 1 300 megawatts is too large a size. Do you mean a nuclear plant or a turbine one?.

Dr. SMITH: I was thinking of the size of the reactor for CFR. The reference design is actually 1 320 megawatts gross which feeds two 660 turbines which gives you roughly 1 250 megawatts net. Since we have not yet started constructing the station that gives an opportunity to people to ask whether that is the best size, and I was merely saying that it is the view of some people that the reactor's size could be smaller with some advantage and certainly from a safety point of view there are considerable advantages in smaller reactors. They don't have such large positive sodium void coefficients and in addition the strength of the containment seems to go up relative to the size of the HCDA's, though both are smaller. So I see safety advantages in small reactors. We have some safety difficulties with 1 300 megawatt size. These will be more difficult with 1 800 megawatts and still more difficult with larger stations.

Mr. CICOGNANI: Just a short comment which is in connection with Mr. Smith's point. This factor of sodium coefficients could really lead towards a heterogeneous core concept and this could be a point in favour of such a concept.

Dr. SMITH: We are studying heterogeneous cores in the UK only really because of safety reasons, not because of better uranium utilization, 'though some heterogeneous cores at which we have looked had better utilization. I was going to ask Mr. Vautrey what sort of heterogenous core he has in mind for subsequent stations but I imagine that is not yet fixed. We in the UK have not yet identified a heterogeneous core which we consider suitable and safe for use in CFR.

Mr. VAUTREY: I must say that we are also studying different possibilities and I think it is too early to give results. We are thinking of what we call purely radial heterogeneous core or radial-axial. Radial means some fertile part in the centre and other fertile parts around and radial-axial means that some sub-assembly could have a fertile part between two fissile parts but this is being studied.

Dr. SMITH: If I could comment on this. We have looked at these type of cores. Difficulties we have found with the radial cores are first of all a difficulty in finding a place to put instruments to measure the flux because the instruments on the outside of the core are not sensitive to what goes on in the middle of the core. Another difficulty is that emerging from the top of the core are jets of sodium of different temperatures which may cause thermo-cycling problems. They seem to be more sensitive to fuel management problems as the power will shift from zone to zone very easily. The Doppler coefficient in general we find to be lower. Another point is with the axial layers. We have found in some conditions that you can get an increase in reactivity by voiding the fertile part as a result of the increase in coupling between the layers. So you have to design it rather carefully and you also have to be careful about fuel slumping - fuel melting and so on. The general experience with a number of cores at which we have looked is that they looked good to start with but the more work you do the worse they get.

Are you concerned at all about the different temperatures of the sodium on the above core structure?.

Mr. VAUTREY: Yes, that could be a problem.

Dr. DÄUNERT: I think, gentlemen, lots of things have to be done in this direction and it will be a good idea to have a specialist meeting on this topic in future.

Dr. KESSLER: Since the UK has definite steels chosen for the primary circuit and heat exchangers, what are the reference steels for the primary circuit and evaporators for the SUPER-PHENIX?. The UK has reported that they go to 316 steel for the CFR primary circuit and to 9CR 1Mo ferritic steel for the CFR evaporators, super-heaters and steam generators.

Mr. VAUTREY: As you know, alloy INCOLOY will be used for SUPER-PHENIX steam generators and for primary circuit - some kind of 316 steel. After the SUPER-PHENIX we are looking carefully to iron-chromium ferritic steels, which we call the EM-12, for steam generators.

6. Discussion of Prof. Pierantoni's presentation

Dr. DÄUNERT: I have a question just for clarification because I did not get it during your presentation. You gave some figures about your plans for nuclear and fossil capacity to be installed until 1985. Would you please repeat these figures?.

Prof. PIERANTONI: In Italy we are now facing more difficulties with building a fossil power station than a nuclear power station. This is due to the fact that the nuclear power station is approved by the government at the initial level whereas the fossil power station is approved at the local level. Taking into account these difficulties, we plan to have in Italy in 1985,65 000 MWe including 4 000 MWe nuclear power stations already decided. This is necessary to compare with 25 000 MWe peak demand which we had in 1976 and also this figure may be compared with about 40 000 MWe installed which we had last year. I think it is interesting to know that 4 000 MWe decided in September 1973 during the oil crisis are still to be located. Two of them were not accepted by the local government and are awaiting a solution and two of them were accepted by the local government at the regional level. Now we are facing a strong anti-nuclear campaign carried out by the friends of fields, the friends of the flowers and some other associations like these. On the one hand if you decide in Italy to have a nuclear power station you must decide on the so-called long term housing planning for ten km. radius. This puts a lot of limitation on housing around the nuclear power station because this plan can only be changed by the representative of the central government. This law was introduced in order to avoid what happened in Casaccia, where after the approval of an area for a big nuclear centre, we had about 40 000 people living near the centre because there were no regulations.

Dr. SMITH: You mentioned some large joint tests on sodium fires on "Esmeralda" which has to be made at Cadarache. How large are the fires you are contemplating in these tests?.

Prof. PIERANTONI: I don't remember exactly. I think probably 40 m^3. It costs a lot of money.

Dr. DÄUNERT: I remember in one of the presentations, I think it was yours, Mr. Vautrey, yesterday we heard the figure about the amount of sodium which can be used in this facility but personally I don't remember.

Prof. PIERANTONI: The "Esmeralda" experiment is still under design. I think there is probably still no definite figure for the amount of sodium which will be burned. I will send all the information as soon as possible about this facility which will be quite a large one.

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7. Discussion of Drs. Däunert's and Kessler's presentation

Dr. SMITH: On page 14 Dr. Kessler mentioned that energy conversion factors in fuel-sodium interactions were in the range of 0.02 to 0.025%. Could you say anything about what this really means?. In particular, maybe only part of the fuel actually took part in the interaction. Is this calculated on the basis of the total fuel present or the efficiency of the interaction for that part of the fuel which actually interacted?.

Dr. KESSLER: First I have to explain a little bit about the experiment. There are one or seven pin bundles, the length of the fuel pins is about 30 cm, half of the fuel is molten and has the possibility to interact with the surrounding sodium. What is then done is one takes the whole loop geometry and calculates the increase of mechanical energy of this flowing loop system obtained from the increases in pressure and sodium velocity and certain interfaces which can be set on the loop. This increase in mechanical energy is then related to the total amount of fuel as it has been done in earlier times for the TREAT experiments. It is the same system and from those calculations we receive these energy conversion factors.

Dr. SMITH: On the question on the increasing flow rate from 6m/sec to 8 or 9m/sec (this is on page 16), what is the limiting criteria for flow rate?. Is this cavitation, noise, damage or what are you seeking as an upper limit?.

Dr. KESSLER: The experiments have been done in a rather big test facility, the so-called RSB at Bensberg, with a piping diameter of about 600 mm. One has increased the velocity from the normal SNR-300 reference velocity to almost a factor of two higher. One has then investigated all determining parameters like cavitation on the pump impellers etc. Within the range of velocity increase no real limitations have been found and it would be possible to go to higher velocities.

Dr. DÄUNERT: Mr. Smith, we cannot give you the final answer because we do not have the final results yet but I would like to illustrate what we are now aiming to do. This part of the work in Bensberg is part of the SNR-2 work. The first analysis of the cost break down of the SNR-2 reference design told us that in the order of 20% of the costs are related to piping, especially valves and armatures. So we try to find out if we can reduce the piping diameter and therefore the tremendous costs of the valves from 600 mm diameter to smaller dimensions. The first step is to go to 350 mm and the mentioned velocities of sodium correspond to this diameter but these experiments are not finished. Finally the results should be fitted back in the design of the SNR-2.

Dr. SMITH: Perhaps I can just add a comment. This problem does not apply so much to the tank design where we have much less primary piping, but we have been concerned particularly with pump impeller design to keep the cavitation noise down as far as possible. That is probably a more stringent limitation than cavitation damage in order that we can apply an acoustic detection. Otherwise there is always an advantage in going up in sodium velocity, particularly in a core itself. Perhaps I could ask if Mr. Vautrey has any comments on this point?.

Mr. VAUTREY: I fully endorse what Mr. Smith has said. On one hand in the pool type design the problem of the primary pipes almost does not arise, and I must say that we are also examining the question for the secondary circuits of increasing perhaps the speed of sodium to reduce the diameter for reasons of economy. In the primary circuit, however, we are studying the problem of cavitation in the entry of the core very carefully. In this case studies have to be not only theoretical but have to apply above all to a given type of design because the emergence of cavitation does creat difficulties for any detection of sound noise in the core of the reactor.

Now I would like to put a question. Is the existence of core catcher considered in Germany as a final choice?. This question is a very controversial one, especially in the US but this question is far away from being a clear one and has supporters. What do you think about this from your part?.

Dr. DÄUNERT: I will try to give you an answer and if it is necessary Dr. Kessler will add some comments. The final decision to have a core catcher or not is to be made in the course of the licensing procedure. At the time being there is no formal decision by the licencing body that it is necessary to have a core catcher for the SNR-300. All discussions we have had indicate to us that there is a very high probability that the licencing authorities would put such a request on SNR-300.

We started, therefore, with an approach which will give us an opportunity to install a core catcher later on but now we have reached a point where we have to make a decision whether to install a core catcher or not. In parallel design work on the core catcher was done and discussed also with the licencing authorities and if you ask me for my personal guess I would tell you it is very probable that we will have the request of the licencing authorities to install the core catcher.

Dr. KESSLER: I would just confirm what Dr. Däunert said. Our work is going on at SNR. R & D programme and engineering is done as if the core catcher would be inserted, and all the delays during the last year were due to the fact that new problems, which were not in a normal R & D programme, like the irradiation behaviour of insulating materials, materials properties for concrete insulating materials, also thermodynamic properties and so on, had to be investigated and agreed with the licencing authorities. Then the problem of vapour generation from concrete at higher temperatures in the range of 200°C had to be solved which means work is going on as if the core catcher would be in. We also initiated work, before I asked yesterday Dr. Tomabechi, on NaK circuits. NaK circuit is supposed to be the cooling system for the core catcher. It is some kind of provisional work going on in case one is finally decided upon.

Mr. LARRIMORE: Is the core catcher question, therefore, not going to affect the schedule for the SNR-300?.

Dr. DÄUNERT: The core catcher question has affected the time schedule of the SNR-300 very hardly. Just to give you an impression of the kind of discussions which are going on: the first discussion between the licencing authorities and the manufacturers led to the provisional design to how such a thing could look like. Then the licencing authorities studied the first design and asked for redundancy of the cooling of the core catcher. The problem due to the specific construction of the cooling system was that you can have a redundancy of diverse system, which cannot be replaced later on, only as long as both systems are available. It is now a question for the government to take over the risk to stop the operation of SNR-300 if one system fails, although it is not needed because then the conditions of the licence are not fulfilled any longer.

Mr. CICOGNANI: I would like to ask you about the SNR fuel. Do you foresee to fabricate fuel assembly elements and then to ship them into the reactor or do you foresee some kind of inside assembling of pin bundles?.

Dr. KESSLER: For KNK-2 and SNR-300 it is foreseen that the fuel pellets and the fuel rods are fabricated by ALKEN at Hanau or by Belgo-Nucléaire at Desel, Belgium. The assembling is again done by Belgo-Nucléaire at Desel for full fuel elements and on the German side by ALKEM. It was foreseen to be done by AVU but it is done by ALKEM because of the Pu licence and so on. This means the fabrication of the fuel bundles at the fabrication plant and shipment to the reactor.

Dr. SMITH: Do you have any plans for developing the reprocessing to complete the fuel cycle for fast reactors?.

Dr. DÄUNERT: It is one of the topical items which we have under internal discussion, but may be Mr. Kessler could give you a short comment on the state-of-art and what we have reached up to now. You know that we had discussions with the UK and also with France to reprocess especially the SNR-300 fuel but it is not a concept for the future.

Dr. KESSLER: As Dr. Däunert said this is under internal discussion. As it stands now we have studies of reprocessing work in Karlsruhe in a small facility, the so called Milli Facility which can reprocess one kg/day. This facility is not foreseen and not capable to reprocess fuel of KNK-2 or SNR-300. On the reprocessing side for fast breeders work has decreased during the last two years, because we had to increase work on light water reactor reprocessing. As to the possibilities to reprocess SNR-300 and KNK-2 fuel in the FRG; in principle, we would have the WAK facility at Karlsruhe, which is a 30-50 ton facility for light water reactor fuel. Most experts in Germany think that this possibility is not feasible at the moment. On the other hand there are definite plans to ship the SNR-300 fuel over to France and reprocess it there.

8. Discussion of Mr. Balz's presentation

Dr. DAUNERT: I think it was a very impressive report. First progress was made indeed on the basis of specific work to come together in the frame of the European Community.

Dr. SMITH: In talking on research and safe handling of Pu and so on, have you given in the CEC, or are you proposing to give, any thought to transport problems?. It seems to me there are special transport problems of fast reactor fuels which perhaps should be tackled by international organizations. I believe we had one specialist meeting some years ago on this topic.

Mr. BALZ: In the frame of a Commission's R&D programme on plutonium recycle in light water reactors, the impact on the environment of plutonium transport under normal and accidental conditions is considered. R&D is also done in order to decrease that impact, e.g. development of a large transport cask for plutonium in oxide form. To some extent, this work is of interest for the LMFBR fuel cycle.

Dr. TOMABECHI: On page 8 you said that an entirely new technique had made it possible to measure vapour pressures of selected fuel materials at temperatures up to 5000 K and so forth. Do you know what kind of technique you are using to heat up the fuel samples?.

Mr. BALZ: Yes, the samples are heated by a double-intensity laser pulse heating technique with power densities of the order of MW/cm2. The laser equipment developed at the Karlsruhe Establishment of J.R.C. has a well focused beam with a single transversal mode in a well defined power distribution profile. The temperature measurements with nano-second time resolution are obtained by a high-speed multi-wave length pyrometer.

Mr. LARRIMORE: In view of the discussion of the ANS initiative on safety guidelines is there any written document on the work of this Safety Working Group which describes the accomplishments today and which could be made available?.

Mr. BALZ: It is a rather difficult question. Of course there are documents but we have a special classification system inside the Safety Working Group and documents are generally not given outside the Group without special permission. Coming back to the question of safety guidelines we have not yet reached the stage at which guidelines are already written down. We are just discussing them. I think during the next month we could perhaps reach the stage where we are able to have the first version of some guidelines.

Mr. LARRIMORE: I was referring to a more general statement of what is being attempted rather than the restricted details. Is there any open piece of paper which describes the scope?.

Mr. BALZ: I think a paper is probably not existing but could be prepared

Dr. DAUNERT: Mr. Larrimore, the difficulty to give you an exact answer to your question lies in the following explanation. This action started under the headline that we should try to come to a harmonization of the licensing procedures in Europe at the end. There is a necessity in Europe for some harmonization because we are such small countries that facilities installed on the borderline are also affecting the neighbouring country. My personal feeling why this action was so successful up to now is that it was started in a way of a workshop. All those groups are installed but from my knowledge there is no paper explaining what they are doing and at what they are aiming, as you wish. Maybe Mr. Balz could consider to find a paper more from the beginning which is always valid to give you a more broad answer to your question. Could you try to do so, Mr. Balz?.

Mr. BALZ: O.K.

9. Discussion of Dr. Royen's presentation

Dr. SMITH: I have a comment rather than a question. We did some years ago decide that in order to avoid duplication of meetings, particularly specialists' meetings, we would leave to CREST which is now CSNI, I believe, the organization of specialists' meetings on almost all fast reactor safety topics. This avoids us having clashes with the liquid metal boiling group which is now disappearing, with the fuel-coolant interaction group and so on. This is, I think, a fairly satisfactory arrangement but not all our members are represented on CSNI. I just wonder if we wanted to continue this arrangement.

Dr. DAUNERT: I do not think necessarily the members of the IWGFR but what about the member countries?. In our case I know that we are represented on the CSNI. I am not informed but may be Mr. Royen can answer this question.

Dr. ROYEN: In fact all countries represented here, except USSR, are represented on CSNI directly; of course there may be some co-ordination problems but this is one of the reasons for us to participate in IWGFR meetings for instance so as to be able to inform CSNI of the plans of this group and see what can be done.

Dr. SMITH: I am wondering in the case of meetings such as the fuel-coolant interaction studies and possible meetings of that type whether the USSR should or could be invited to these meetings.

Dr. ROYEN: There is no principle problem. We have had participation of Soviet experts in a number of meetings through the IAEA. The only practical problem is that specialists' meetings of CSNI are decided towards the end of November to be arranged within the next 12 months; co-ordination with the IAEA and eastern European countries usually takes some time and because of that it is rather impractical to have arrangements like this on a continuing basis. It is easier for symposiums for instance where we have a 2 year plan with the IAEA or things like that.

Dr. DAUNERT: I have a strong feeling that we should try to find a solution maybe with the help of the Agency to avoid overloading the duties of this Working Group because the safety of the fast breeders becomes a so large area and needs so detailed knowledge that I personally would prefer to go ahead in the way we did it up to now. The question is and this is a question to the Agency, how we could solve the problem of the non-member countries of OECD. Could it be a practical way to organize joint specialists' meetings as we have in other cases. I remember for instance a joint GCFR meeting to give the possibility to the Soviet Union for instance to participate.

Mr. LARRIMORE: I think that there has to be a specific case in which there is a specific interest in order that the Agency should bother trying to do something. We have this in the physics meeting which we hope NEACRP will coordinate and we have already arranged that the scientists in Obninsk are working on this so I think it is not very easy to discuss this in general terms. I think that as a specific case arises if the organisers know that Soviet scientists are interested in working in the field and have reason to believe that they would like to attend I think we could do something but it is a little hard to know how to talk about it generally.

Dr. DÄUNERT: I believe that we should recommend to the Agency in the context of this Salzburg meeting that the Agency should continue in the near future to take over activities in the field of fast breeder safety also and would it not be worthwhile to postpone this problem and connect it with the discussions of such activities of the Agency and up to that point leave it as it is?.

Dr. ROYEN: Also I think that we should not over-stress CSNI sponsorship of specialists' meetings although it is a fact that the committee sponsors a number of specialists' meetings. The work of the committee will probably increase in the future and there will be more activities done through very small groups of experts. Our specialists' meetings have a tendency to become too large because most of our countries have an immediate or long term interest in nuclear safety and because of that we have problems to restrict the number of participants in these meetings. In order to do more efficient work we more and more adopt the method of using small groups of experts who report to specialists' meetings after 2 or 3 years which in that case are more of an information exchange type.

Dr. SMITH: On the point you have just raised what you need to do surely is to restrict the number of people per country rather than necessarily the number of countries attending but I didn't wish to take away the sponsorship of these meetings from CSNI because I feel, as the Chairman said, if we try to organize all these meetings we would be over-loaded in this Group. Therefore, I am happy with the arrangement but perhaps I should ask the USSR to comment on this since they know through this Group what meetings are planned. If they could perhaps indicate if they are interested in attending any of these meetings and some method could be found to issue an invitation should they show interest in any particular meeting. I think that it would be a satisfactory interim measure but it does seem to me that meetings, such as FCI meetings, are very important and we shouldn't deliberately exclude one of our members with a prototype fast reactor from these meetings.

Dr. DÄUNERT: Before asking for a comment from the Soviet delegation let us see what we have up to now. We have an installed activity inside OECD but there is no distinct activity inside the Agency. We discussed whether it would be worthwhile to have an activity inside the Agency but this is not settled up to now and not finally discussed. In the meantime by having a member of OECD in this group all the information about the on-going activities and Specialists' Meetings are given to members here in this group. In special cases we can try to find solutions to make it possible to participate but this could not be decided here by this group. We can give recommendations which have to be agreed upon by the Agencies. So far I think the best we can do in respect to the mandate of our group is to give the best information which is possible and this is done by participation of an OECD member in our group opening the possibility also for the Soviet Union to try to participate in these meetings but I see no official way at the time being to make decisions on the participation here in this group. I think this is beyond our mandate. Would you like to comment, Mr. Inyutin.

Dr. INYUTIN: Thank you. I would like to thank the members of the Working Group for their kind regard and interest in the participation of Soviet experts in various meetings on fast reactor problems. In those cases where we have had meetings under joint sponsorship of the OECD and the IAEA no problems arose in any connection and Soviet experts in fact did take part in these meetings. The last example of this is the meeting which took place here in Vienna in October 1976 under the title "Differential and Integral Nuclear Data Requirements for Shielding Calculations". Another example of the sort of interaction that takes place between the OECD experts and Soviet experts has been the activity of magnetohydrodynamic generators. Having this list of meetings to be held by the OECD we will be able to express wishes to participate in a particular meeting or meetings. In principle we could inform the Agency of this, specifically the Scientific Secretary of the present Group, Mr. Khodarev. The Agency could perhaps ask the OECD what it thinks about the possible participation of Soviet specialists. In the event of an affirmative reply from the OECD the Soviet specialists would be pleased to take part in such meetings.

The official procedure appears to be rather cumbersome, rather unwieldy. I am not sure whether all things will go smoothly but it seems to me that this is the sole avenue, the sole possibility of involving Soviet scientists in expert meetings sponsored by the OECD.

Mr. LARRIMORE: On the basis of that perhaps I could get you off the subject with the following suggestion. We are just now in the Agency reviewing the 1978 programme of NEA and I could put in, if you wish, a comment under the paragraphs on the CSNI activity firstly of a reminder of what Dr. Smith said that the IWGFR has adopted the policy of leaving the organization of specialists' meetings in the area of fast reactors largely to the CSNI. Could we remind them of this and we could mention the interest from both sides in certain cases in the participation of countries outside the OECD in the meetings on fast reactor safety, particularly from the Soviet Union and to suggest that the Agency be willing to, as it has in other cases, insist in getting the information and the invitations to these countries if the CSNI and the NEA will choose to give us this opportunity. Would that be a good idea?.

Dr. ROYEN: I think I have noted all that was said here and I will transmit it to NEA and CSNI. We would have to ask for special permission from CSNI for every meeting to ask if they agree to invite IAEA and non-member countries to participate. I do not wish to raise false hope just now but we will do our best.

Dr. DÄUNERT: To arrange joint meetings between the different agencies is a matter for the Agency and not of this group. We would appreciate if these two bodies, the IAEA and the NEA could contact one another and try to find solutions. At that point all responsibility of this group ends.

Dr. ROYEN: We have regular contact with IAEA. In fact we have our annual coordination meeting and other meetings but I wanted to stress that in our case it is not enough. We need more consultation.

Dr. DÄUNERT: Let me say it in another way. We here have all agreed to give all the information to all the members who are present here - that is one thing. Secondly, we agreed that we would not like to incorporate in this group also the large field of reactor safety and it is up to responsible agencies and persons to see if it is worthwhile to come to closer contacts between different organizations.