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INTERNATIONAL ATOMIC ENERGY AGENCY

REPORT OF THE

IPERS

(INTERNATIONAL PEER REVIEW SERVICE)

PRE-REVIEW WORKSHOP

FOR THE

ZAPOROZHYE, UNIT 5

NUCLEAR POWER PLANT

PROBABILISTIC SAFETY ASSESSMENT

IN

VIENNA, AUSTRIA

12 to 16 June 1995

DIVISION OF NUCLEAR SAFETY

NUCLEAR SAFETY REVIEW WORKSHOP

UNDER TC PROJECT (RER/9/035)
DIVISION OF TECHNICAL CO-OPERATION PROGRAMMES

PREAMBLE

This report presents the results of the IAEA international peer review services (IPERS) pre-review workshop held in Vienna, 12 to 16 June 1995, which reviewed the status of the present version of the Probabilistic Safety Assessment (PSA) for the Zaporozhye, Unit 5, nuclear power plant.

Distribution of the IPERS report is left to the discretion of the Ukrainian Government; this includes the removal of any initial restrictions. The IAEA makes the report available only with the permission declared by the Ukrainian Government.

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INTERNATIONAL PEER REVIEW SERVICE

FOR THE ZAPOROZHYE, UNIT 5 PROBABILISTIC SAFETY ASSESSMENT

Report of the Pre-Review (12 to 16 June 1995)

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1. INTRODUCTION

Currently a Level 1 PSA for the Zaporozhye NPP, Unit 5, in the Ukraine is being carried out by a team of specialists at the power plant supported by organizations in Russia. The reference unit is of the WWER-1000 (V-320) reactor type, Table 1 contains the important plant characteristics. The IAEA has been requested to organize a pre-review of this PSA to review the current state of the work and to make recommendations for the continuation of the study.

For that purpose the IAEA organized a one week Consultants Meeting to pre-review the PSA for the Zaporozhye Unit 5 NPP during the period of 12 to 16 June 1995 in Vienna. The meeting was conducted as a review workshop with participants from the Ukrainian PSA team, external PSA experts from Germany and Spain and a IAEA review team leader, see Appendix A for the Agenda of the meeting and Appendix B for the list of participants. The pre-review was conducted according to the IPERS review guidelines [1] and using the related IAEA PSA procedures, mainly [2]. The meeting was supported by the Technical Co-operation Regional Support Programme, RER/9/035, "Support for Nuclear Safety in Central and Eastern Europe" and by the "Extrabudgetary Programme on the Safety of WWER and RBMK Plants" of the IAEA.

At present the PSA is in an intermediate stage and comprises the following initiating event categories from the old, 1992, list of initiators:

- LOCAs
- SG tube or collector header break (only available in a draft version)
- Failure of heat removal via the secondary cooling circuit
- Loss of electric power supply

Furthermore the following events have been analyzed:

- Heat removal failure for the spent fuel storage pond
- Fuel handling accidents

Figure 1 summarizes the present stage of completion of the study.

Because of the limited documentation and the short time available for the review meeting only a cursory review of technical items was possible mainly by interviewing and discussion with the participants from the Ukrainian PSA team. In particular it was not possible to thoroughly consider all the technical issues raised during the review meeting.

Table 1. Main Characteristics of the Zaporozhye Unit 5 NPP

REACTOR, Type: pressurized water WWER-1000, Manufacturer: Production Amalgamation Izhorsky Plant, Leningrad	
Power, MWth (MWe)	3000 (1000)
Loops	4
Primary circuit pressure, MPa	16.0
Coolant temperature inlet (outlet), °C	289 (322)
Average fuel enrichment, %	3.3 - 4.4
Mass of fuel in the core, t	75.0
Average power density (core), kW/l	111.0
Equivalent diameter of the core, m	3.12
Core height, m	3.55
Burnup, MWd/t	
for two-year operating period	27000
for three-year operating period	40000
Reactor vessel dimensions (Height, outer Dia.), m	10.88, 4.51
Reactor vessel wall thickness, mm	190
STEAM GENERATOR, Type: horizontal PGW-1000, Manufacturer: Production Amalgamation-Atommash S.Ordjonikidze machine building plant, Podolsk	
Steam output, t/h	1469
Steam temperature, °C	287.5
Steam pressure, MPa	6.4
Feedwater temperature, °C	223
Heat exchange area, m^2	5200
TURBINE, Type: K-1000-60/1500-2, Manufacturer: S.M.Kirov Production Amalgmation Kharkovsky Turbine Plant	
Rated power, MW	1100
Live steam conditions:	
pressure, MPa	6.0
temperature, °C	274.3
Steam flow under rated operating conditions, t/h	5795
Rotor speed, RPM	1500
Estimated pressure in condenser, kPa	3.9
Number of extraction stages	7
GENERATOR, Type: TWW-1000-4YE, Manufacturer: S.M.Kirov Production	
Rated output power, MW	1000
Terminal voltage, kV	24
Power factor	0.9
Rotor speed, RPM	1500
Cooling	hydrogen-water
TRANSFORMER, Type:single-phase ORZ-417000/750, Manufacturer: Production Amalgamation Zaporozhtransformator	
Number of transformers per unit	3
Capacity, MVA	417
Voltage, kV	787/24

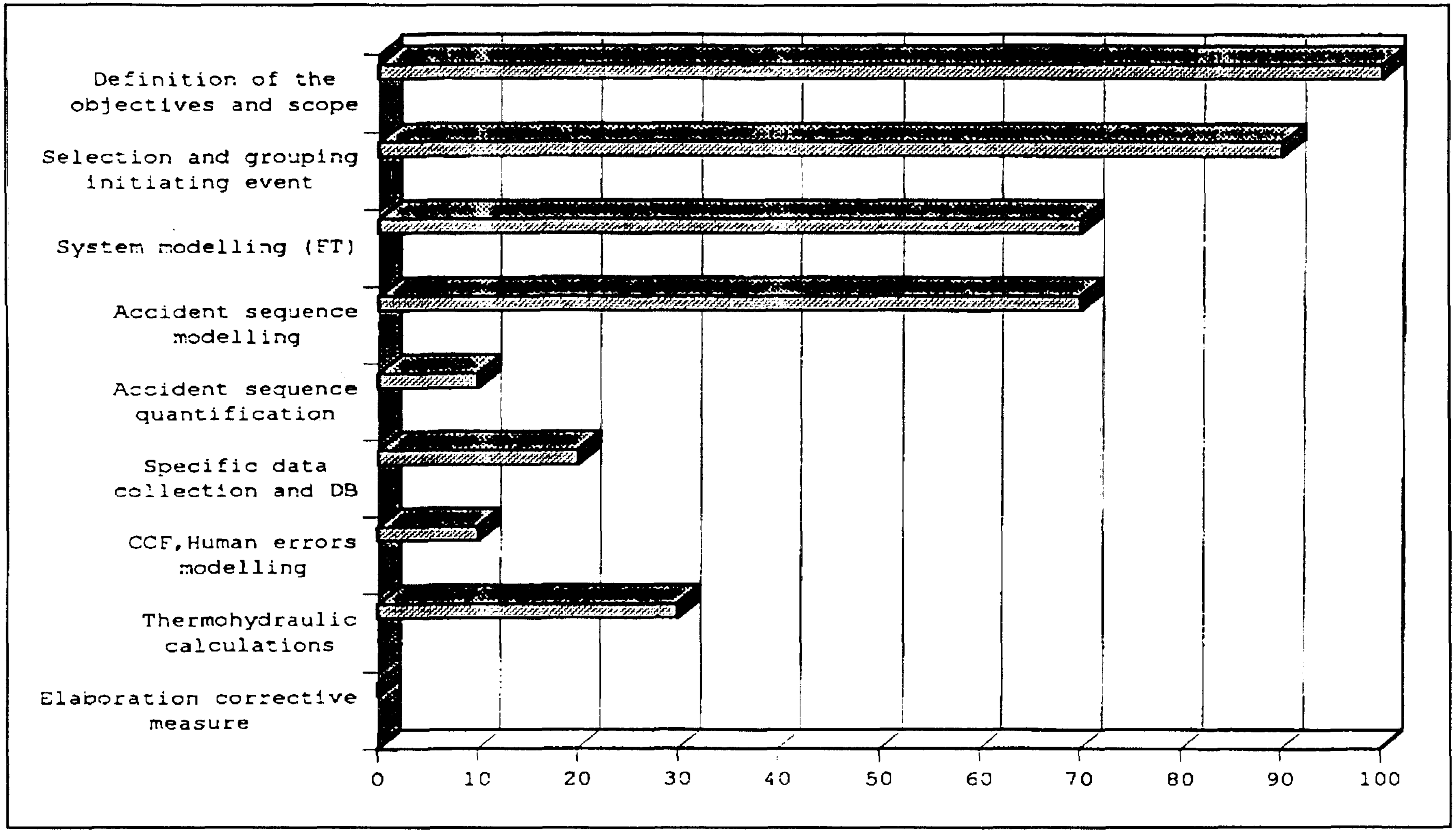

Figure 1. Level of Completeness of the Level 1 PSA Project

2. PSA STATUS AND DETAILED COMMENTS

2.1. MANAGEMENT AND ORGANIZATION

2.1.1. Definition of the objectives of the PSA

The general objectives of the PSA for the Zaporozhye NPP are defined as follows:

- To assess the current level of safety of the Zaporozhye NPP. The reference plant selected for the PSA is Unit 5, see also short description of major differences between the Zaporozhye units at the end of this section.

- To identify design weaknesses and to support the decision making process with regard to plant improvements.

- To support improvement and development of operation and emergency procedures.

- To support the development of emergency plans for the public.

These general objectives are regarded as appropriate and they correspond to the objectives envisaged for many other NPPs. The differences between the units were discussed during the review meeting regarding the selection of the reference plant, Unit 5. Basically all the 6 units correspond to the standard WWER-1000 (V-320) design. The main differences between the units are the following:

- Spray ponds are used as the ultimate heat sink for the service water systems. The main waterguides which connect the units to the spray ponds are shared by the Units 1, 2, 3, 4 and Units 5, 6 respectively.

- Units 5 and 6 are equipped with two additional diesel generators to provide power for the auxiliary feedwater pumps, the make-up system and other equipment.

- For Units 5 and 6 mainly equipment (e.g. pressurizer safety/relief valves) of Russian origin is used, whereas for Units 1, 2 ,3 and 4 some equipment from other manufacturers was installed.

Unit 6 is not yet operational, it is at present in the commissioning stage.

2.1.2. Definition of the scope of the PSA

The general scope of the PSA is defined as follows:

(A) Data collection and evaluation process for component reliability parameters and initiating events assessment based on specific experience data from the operational units (this part of the study is called PSA Level 0).

(B) PSA Level 1 for internal and external initiating events, full power and low power and shutdown operational conditions.

(C) PSA Level 2

A "plant freeze status" has been defined as of 1992 for consideration in the study. The broad scope of the study is appreciated by the reviewers. However it is strongly recommended to concentrate the current effort to the data collection and evaluation process (A) and to the Level 1, full power PSA for internal initiating events. Priorities are recommended accordingly as follows:

First priority: Component and initiating event data collection in the plant and Level 1, full power PSA for internal initiating events.

Second priority: Level 1 PSA (full power) for internal fires and floods.

Third priority: PSA Level 1 for low power and shutdown operational conditions.

Fourth priority: Level 2 PSA.

The envisaged program for a systematic human reliability data collection and evaluation program based on simulator experiments at Zaporozhye is regarded by the reviewers as very important and valuable. Due to the significant effort involved in such investigation it requires a careful definition and thorough documentation. It is recommended by the reviewers to consider the large experience made during the last ten years in similar efforts performed in France, Hungary and the USA. This experience includes methodologies, techniques and tools for data collection and evaluation and the methods used to transfer the data to modelling of human actions in the PSA.

2.1.3. Project management

At the plant a PSA group coordinates the PSA work, organizes and conducts the data collection and evaluation program. The group provides to the outside contractors the necessary plant information and feedback by reviewing and commenting the study.

The main contractor for the PSA work is Atomenergoproekt in Moscow with support from Gidropress (Moscow) and from the Kurchatov Institute. The contract for the PSA contains the steps to be performed, the conditions and deliverables. In general terms it also contains specifications for the methods to be used and regarding know-how transfer to the plant. It is recommended that:

(A) The study documentation delivered to the plant should be as complete as possible in order to make all steps fully traceable and to allow future updating. The documentation should include all background information and a description of underlaying assumptions.

(B) The current effort is concentrated according to the priorities as described in the previous paragraph.

(C) All software tools used for the study are made available for the PSA team at the plant.

2.1.4. Selection of methods and establishment of procedures

It appears that selection of methods and establishment of procedures is only defined in general terms. It is understood that the main contractor is responsible for these items. It is recommended that a complete and traceable documentation of the methods and procedures implemented and used by the main contractor is made available for each PSA step or task.

2.1.5. Training of the team

The PSA team at the plant has been trained in PSA techniques, methodologies and techniques. Further PSA know-how transfer is performed during the conduct of the project. To support further development of expertise it is recommended that members of the Zaporozhye PSA team participate in the related IAEA activities, such as meetings, training courses and workshops in the PSA area.

2.1.6. Establishment of a quality assurance programme and interactive peer review

As part of the PSA project the PSA reports and other deliverables are reviewed by the PSA team and other technical staff at the plant. High level reviews are envisaged to be performed by the Ukrainian safety authority.

The reviewers recommend to perform as soon as possible a detailed IAEA IPERS peer review of past, ongoing and future PSA tasks and steps. This review should also involve staff from the main contractor, Atomenergoproekt, Moscow, and of the subcontractors Gidropress and Kurchatov Institute, if needed. An extended summary report in English and the original PSA documentation should be available for such review. It is understood that an agreement with the external contractors is necessary for such review.

2.2. COMPILATION OF PLANT INFORMATION, ACCIDENT INITIATORS AND SAFETY FUNCTIONS

2.2.1. Familiarization with the plant and information gathering

The main purpose of this task is to provide the PSA team with the necessary information to develop the PSA and that the PSA model reflects the as built design of the plant as closely as possible. The main PSA work is performed by specialists from Atomenergoproekt, Moscow, based on the original design documentation supported by visits to the plant and exchange of information with the PSA team at the plant.

Plant operational data such as test, maintenance data and procedures are only available at the plant. This information is provided to the PSA staff at Atomenergoproekt by the plant PSA team.

Regarding supporting thermohydraulic analyses for success criteria evaluation and event sequence development, it appears that the main knowledge is available at the PSA consortium in Russia (Atomenergoproekt, Gidropress and Kurchatov Institute). It was stated by the Zaporozhye PSA team that steps are underway to acquire some capability in this area at the plant.

Limited easily accessible information on cable routings seems to be accessible at the plant. It also appears that no systematic update has been made for the plant documentation regarding plant modifications performed by plant staff since start-up of Unit 5. Therefore it might be that the PSA is not fully representative to the as built design. The reviewers would make the following suggestions in this connection:

(1) All parties involved in the PSA work should agree on a framework and procedure to ensure that the necessary information is available to all organizations involved.

(2) Information on all plant modifications should be made available in a systematic way for the plant PSA team including a reference to the original design. This allows the PSA team to analyze the impact of such modifications on PSA models to ensure that the PSA represents the plant as built.

2.2.2. Determination and selection of plant operating states

As part of the definition of the PSA scope it was stated that the PSA is intended to include full power and low power and shutdown operational conditions. The usual way of proceeding for a PSA is to first perform the PSA for full power operating conditions and afterwards to extend the PSA to low power and shutdown states using the analyses and information from the full power PSA as far as possible. The initiating events list presented in the review contains a limited number of initiating events for shutdown conditions intended to be analyzed, although no screening of the impact of such events has been made. The reviewers would like to make the following suggestions in this connection:

(1) A screening type of assessment should be made regarding the impact of initiators for operating modes other than power operating conditions. This screening can be based on qualitative arguments in many cases.

(2) Given the plants ability to be operated at reduced power with only three or two loops, a technical judgment is suggested to assess the risk significance of initiating events occurring during such conditions. This judgment should be made in comparison with full power operation and should include consideration of technical specifications and thermohydraulic analyses to ensure that the PSA for full power conditions is conservative with regard to reduced power

conditions. In such way the reduced power conditions can be regarded to be covered by the full power analysis.

2.2.3. Definition of core damage states or other consequences

At the present stage of the PSA no attempt has been made to define core or plant damage states other than one core damage state which is defined by the usual criteria such as the 1200 °C limit for cladding temperature. In contrast to this an attempt is made to define different safe or success conditions. The reviewers would like to make the following suggestion in this connection:

(1) In order to keep the models as simple as possible and to avoid unnecessary modelling efforts, the distinction of safe (or success) sequences into different end state categories should only be done if this is required for the PSA objectives.

2.2.4. Selection of initiating events

Regarding initiating events (nongrouped initiating events) and grouped initiating events or initiating event categories two different lists were presented for the meeting. The first list, dated 1992, contains the following initiating events (which appear to be initiating event categories):

- Large LOCA
- Medium LOCA
- Small LOCA
- Short duration LOOP (loss of offsite power)
- Long duration LOOP
- Loss of secondary side heat sink
- Main steam line break
- Steam generator tube rupture and collector header break

This list was used for the PSA work up to now, however, only limited insights with regard to the principles of grouping were available. The reviewers believe that the list is incomplete, in particular regarding transients, secondary side breaks and interfacing systems LOCAs (loss of coolant accidents directly to outside of the containment). The second list, dated 1993, compiled for the future work looks more complete with regard to raw (nongrouped) initiating events and event categories. Regarding grouping of initiating events into initiating event categories the reviewers suggest that this grouping is done in a consistent manner using the principles described for example in the IAEA Level 1 guideline [2]. Also the grouping should be thoroughly documented, including a description of the primary initiating events, together with their probability, the definition of initiating event categories and the rationale for grouping individual raw initiating events into categories. Due to the limited time and information available during the review a thorough review of these items was not possible. Nevertheless the general impression is that the newer list represents a more complete list of initiating events for the Zaporozhye PSA. It is suggested to use a systematic approach for the identification of initiators, including:

- Use of FMEA (failure mode and effects analysis) or fault tree modelling for common cause initiating events. Common cause initiating events are events which may impact on the availability of systems required after the initiating event. A typical example is the failure of the service water system.

- Detailed evaluation of events from operational experience to identify plant specific circumstances.

Existing gaps in thermohydraulic analyses to support initiating event grouping, evaluation of success criteria and event sequence development should either be filled with new analyses or engineering considerations.

The reviewers would like to make following suggestions in this connection:

(1) A complete and systematic list of raw (nongrouped) initiating events should be established. Grouping principles for each individual initiator should be documented.

(2) As indicated in the paragraph about selection of plant operational states a screening type of analysis should be conducted for the initiators to be considered for low power and shutdown conditions to see whether the initiators are representative for these conditions and whether they contribute or not to the plant risk.

(3) Plant operational experience should be taken into account regarding initiating events identification including consideration of plant specific features.

It appears that a screening type of assessment for the internal hazards such as internal fires and floods based on ZNPP operational experience has been carried out partly, but was not considered in detail during the review. This assessment should be completed taking into account actual, as built plant arrangements.

2.2.5. Determination of safety functions

The safety functions at the system level have been defined in the PSA. The reviewers suggest to start determination of safety functions at the global plant level, first, to identify alternative ways of fulfilling specific functions by systems, and second, to document the principles for the allocation of systems to functions.

2.2.6. Assessment of function/system relationships

Regarding grouping of initiating events one of the main characteristics usually considered are the required safety system functions, front line systems and related support and supply systems. It is therefore recommended to support the grouping of initiating events with a set of tables which indicate the following relations:

(a) safety functions for each initiating event and the front line systems performing the functions,

(b) the front line systems required,

(c) support and supply systems,

(d) dependencies between front line and support systems at the level of redundancies or trains, and

(e) dependencies between support and supply systems.

2.2.7. Assessment of plant system requirements

Success criteria for the initiating event categories as defined in the 1992 list have been defined in terms of front line systems. During the meeting it was not possible to review thermohydraulic analyses supporting these success criteria. For the new list of initiating events (1993) and for the related initiating event categories success criteria were not available. The reviewers would like to make the following suggestions in this connection:

(1) A formal documentation of success criteria for frontline systems should be established for each initiator. This should include a reference to thermohydraulic analyses or engineering assessments to support the development of the criteria. This not only improves traceability of the study, but also would allow independent review of this part of the PSA.

(2) As indicated above, dependency tables for frontline and support/supply systems should be established, in particular to identify the implications of common cause initiating events.

2.2.8. Grouping of the initiating events

For the 1992 list of initiating event groups no formal process of grouping of raw initiating events to event categories was documented. A more systematic process of grouping appears to be performed for the newer initiating event list, dated 1993. However, as indicated above the grouping of initiating events should be subject to a more thorough review to check completeness, consistency and to ensure that dependencies between initiators and mitigating systems have been addressed in an adequate manner. A thorough review of the 1993 list of initiating events and of the grouping into initiating event categories is recommended.

2.3. ACCIDENT SEQUENCE MODELLING

2.3.1. Event sequence modelling

It appears that the approach followed for event sequence modelling is changed at present following the availability of analysis tools. The approach now selected seems to be the small event tree, large fault tree technique. Due to the present preliminary status of the PSA and due to the limited documentation a thorough review of event sequence development was not possible. The following comments were made regarding this area:

- The distinction made for success sequence end states into different success categories appears not to be necessary for the PSA objectives. The approach makes the event trees more complicated and the analysis effort might be diverted to sequences which are not significant for the plant risk.

- Certain sequences in the event trees contain human actions that seem to require complex and nonplanned activities. If these human actions have the character of recovery actions it is usual practice not to treat them in the event trees but at the level of minimal cutsets because only in this way the conditions and potential dependencies can be accounted in an adequate way.

- The timing for sequences is important and sometimes decisive for success or failure. Because no thermohydraulic analyses were available for the review it was not possible to judge whether the timing considerations are adequately performed for the sequences.

- No consideration of the implications of containment behavior was visible in the study. Containment behavior for example may impact on emergency core cooling during the injection phase for a large LOCA or the suction head for recirculation could be reduced which could fail the recirculation pumps.

The reviewers propose the following suggestions in this connection:

(1) A detailed review of event trees should be performed taking into account supporting documentation and analyses and focusing on dominant core damage sequences.

(2) Event trees should be simplified and should not include headings only needed to differentiate between different success end states.

2.3.2. System modelling

It is envisaged at present to use the RISK SPECTRUM program in place of the original system analysis software used at Atomenergoproekt (VNF and COCOFAN). In this connection the format of the event logic will be changed to the small event tree, large fault tree technique.

As a valuable preparation for fault tree analysis, up to now more than 30 frontline and support systems were modelled with FMEA (failure mode and effects analysis). The fault tree for the high pressure injection system was available for review. A short check of this fault tree stimulated the following comments:

- It would be desirable to develop and use a guideline for fault tree construction. Such guideline could enhance the completeness and consistency of the fault tree models, especially when fault trees for different systems are developed by different persons.

- The RISK SPECTRUM program allows to include CCFs in a comparatively easy manner with a special program option. Lists of minimal cutsets are a valuable tool for the identification of CCF component groups and for discussion of CCF impacts.

- Failure of the check valves TQ13S18 and TQ13S19 should be considered in the fault tree for the high pressure injection system.

- The fault tree contains basic events for the unavailability of trains due to maintenance. Plant specific data should be used to quantify these events.

- The definition of CCF component groups is unclear. Some check valves are considered in a CCF group, some are not, see for example TQ13S20 and TQ13S25. Consistent principles should be used for the identification of CCF groups including consideration of different failure modes for the same components.

2.3.3. Human performance analysis

Human reliability analysis (HRA) is a central part of any PSA, in particular for plants with general operating and emergency procedures. Regarding the HRA process the IAEA recommends the use of the SHARP procedure, see IAEA Level 1 guideline [2], p. 54. The SHARP procedure describes the major steps of the HRA process but does not specify the individual modelling and quantification of HIs (human interactions) and HEPs (human error probabilities). Detailed documentation of the HRA process steps is strongly recommended. As a good practice for the first step of the HRA process (identification of human interactions) the use of ESDs (event sequence diagrams) including operator actions is recommended. Essential for human performance analysis is that it is performed in a consistent manner and that it is thoroughly documented.

2.3.4. Qualitative dependence analysis

Functional dependencies which exist due to the dependency of the function of a system or component on other systems or components are usually modelled explicitly. In the study a frontline - support system dependency matrix at the level of systems has been developed to support fault tree construction. A support - support system dependency matrix is currently in preparation. It seems that all functional dependencies are explicitly modelled in the fault trees. For the new modelling approach with RISK SPECTRUM it should be checked that the information from the dependency matrices has actually been transferred to the fault trees. Therefore, it would be preferable to establish the dependency matrices on the train level in place of system level.

Dependencies which cannot be explicitly modelled are usually handled with a CCF model. CCF analysis can be divided into a qualitative and a quantitative assessment. For the qualitative analysis it seems to be important that:

- all failure modes are taken into consideration,
- the appropriate size of the CCF component groups is justified,
- the success criteria to be considered for CCF component groups are exactly stated,
- the reasons why specific components are not included in a CCF group are justified.

The CCF model used in the study is the MGL (multiple greek letter) model which represents a state-of-the-art model. The basic difficulty, in particular for higher order CCFs, is to estimate reasonably applicable model parameters because so far no WWER specific data is available in this field.

2.3.5. Classification of accident sequences into plant damage states

For the extension of the PSA to Level 2 the parameters characterizing the plant damage states (PDSs) should be defined.

2.4. DATA ASSESSMENT AND PARAMETER ESTIMATION

2.4.1. Assessment of the frequency of initiating events

The present estimates for initiating event frequencies have been based on generic data. No justification regarding use of a specific source or regarding the adequacy of the generic information was available. No attempt has been made to establish and use a correspondence between plant operational experience and the initiating event categories. It is recommended to:

(1) Clearly document the process of initiating event frequency estimation including sources used and assumptions made.

(2) Take into account plant specific experience as much as possible and available.

2.4.2. Assessment of component reliability and assessment of common cause failure probabilities

The preliminary results are derived using generic data for the component reliability parameters. It is planned to use also plant specific data in future. In this connection the reliability group of the NPP evaluated the available operational data for selected components from the period of 1989 to 1992 using all kind of data sources at the plant. The results were handed over to the PSA group at Atomenergoproekt in Moscow. The information contained the component code, the number of the considered components in all the 5 Zaporozhye units, the number of demands respectively exposure time and the number of failures.

Regarding reliability parameters for components and systems it is recommended

- to list all the generic sources and to reference them where used,

- to precisely describe the process of selecting specific data for each type of component including a justification,

- to ensure that the component boundaries used for the generic data matches those assumed for the components in the plant specific assessment,

- to describe the process of collecting and evaluating plant specific data in detail. This should include assumptions, judgement and techniques to bridge incomplete or missing information.

- to consider all the important component failure modes in the assessment of plant specific data,

- to extend the plant specific data collection and evaluation to maintenance and test unavailabilities and for repair times.

For CCF modelling the MGL model is used. Basis for the estimation of parameters is US operating experience. Using the methods described in NUREG/CR-4780 "pseudo plant specific" parameters are estimated. These methods allow for example to adapt the generic experience data to systems with a different number of redundancies by a method named mapping-up or mapping-down, depending on the number of redundancies in the original and the target system at the plant, respectively. The application of these methods and related assumptions should be documented in detail for each component type and failure mode.

2.4.3. Assessment of human error probabilities

At present it seems that human error probabilities are estimated based on the development of logic human error trees, generic data and data gained from simulator experiments at the Novovoronezh NPP. Due to the limited information available during the meeting no review of these techniques could be performed.

The envisaged program for a systematic human reliability data collection and evaluation program based on simulator experiments at Zaporozhye is regarded by the reviewers as very important and valuable. Due to the significant effort involved in such investigation it requires a careful definition and thorough documentation. It is recommended by the reviewers to consider the large experience made during the last ten years in similar efforts performed in France, Hungary and the USA. This experience includes methodologies, techniques and tools for data collection and evaluation and the methods used to transfer the data to modelling of human actions in the PSA.

Essential for the assessment of human error probabilities is that the assessment is made in a consistent way and that it is thoroughly documented.

2.5. ACCIDENT SEQUENCE QUANTIFICATION

Quantification of the PSA models is currently performed with tools developed by Atomenergoproekt. It is envisaged to use the RISK SPECTRUM software in future. In this connection it is recommended that the PSA team at the plant is provided with the software used for the study in order to take full profit from the information contained in the PSA and for updating the PSA in future.

At present the PSA is in an intermediate stage and comprises the following initiating event categories from the 1992 (old) list of initiators:

- LOCAs
- SG tube or collector header break (only available in a draft version)
- Failure of heat removal via the secondary cooling circuit
- Loss of electric power supply

Furthermore the following events have been analyzed:

- Heat removal failure for the spent fuel storage pond
- Fuel handling accidents

Due to this preliminary status of the PSA the CDF (core damage frequency) values given in the summary report must therefore be regarded as preliminary as well.

2.6. DOCUMENTATION OF THE ANALYSIS: DISPLAY AND INTERPRETATION OF RESULTS

At present the following documentation is available at the plant:

- An extended list of grouped initiating events

- A description of methods regarding initiating events parameter estimation and data analysis based on ZNPP data

- Lists of summarized plant specific failure data for selected components

- A description of the following initiating event categories and corresponding event trees (in Russian):

    - Loss of coolant accidents
    - Loss of offsite electric power
    - Loss of heat removal via the secondary side

- A description of the fault trees (in Russian)

- A screening type of assessment for the internal hazards, contractor documents (Atomenergoproekt)

- A summary of the current results (corresponding to the working material [3]) presented in the review meeting

It is recommended to establish a concept for the documentation of the study, for example following the IAEA Level 1 guidelines [2]. The documentation should make the study traceable in all aspects and should contain all background information and assumptions.

The documentation needs for the proposed extended review are described in Paragraph 2.1.6.

3. CONCLUSIONS

The effort of the PSA group at the Zaporozhye NPP to carry out the PSA for the Zaporozhye Unit 5 plant is appreciated, as well as the open minded discussions which were possible during the pre-review meeting. The PSA team at the plant has already gained significant competence in the PSA areas. In particular it is appreciated that it is envisaged to make the PSA as plant specific as possible by means of the data collection and evaluation program at the plant.

The review team made a number of detailed comments, recommendations and suggestions which are contained in Section 2 of this report, for further consideration by the PSA team. The main general recommendations can be summarized as follows:

(1) Priorities are recommended for the further work as follows:

First priority: Component and initiating event data collection in the plant and Level 1, full power PSA for internal initiating events.

Second priority: Level 1 PSA (full power) for internal fires and floods.

Third priority: PSA Level 1 for low power and shutdown operational conditions.

Fourth priority: Level 2 PSA.

(2) The reviewers recommend to perform as soon as possible a detailed IAEA IPERS peer review of past, ongoing and future PSA tasks and steps. This review should also involve staff from the main contractor, Atomenergoproekt, Moscow, and of the subcontractors Gidropress and Kurchatov Institute, if needed. An extended summary report in English and the original PSA documentation should be available for such review. It is understood that an agreement with the external contractors is necessary for such review.

(3) The documentation delivered by the contractors to the PSA team at the plant for all the steps and tasks of the PSA should be as complete as possible including background information and assumptions. The documentation should allow to completely understand

and trace all the analyses. The documentation for a Level 1 PSA for example is described in detail in the IAEA PSA Level 1 guidelines [2].

(4) The PSA team at the plant has been trained in PSA techniques, methodologies and techniques. Further PSA know-how transfer is performed during the conduct of the project. To support further development of expertise it is recommended that members of the Zaporozhye PSA team participate in the related IAEA activities, such as meetings, training courses and workshops in the PSA area.

4. REFERENCES

[1] IAEA, IPERS guidelines for the international peer review service, second revised edition, (in print), IAEA, 1995

[2] IAEA, Procedures for conducting probabilistic safety assessments of nuclear power plants (Level 1), IAEA Safety Series No. 50-P-4, IAEA, 1992

[3] WORKING MATERIAL (Summary Report) for the pre-review workshop of the preliminary PSA Zaporozhye NPP, Vienna, Austria, 12-16 June 1995, prepared by the Zaporozhye PSA team.

Appendix A: AGENDA OF THE MISSION

Monday, 12 June 1995

(1) Welcome address and introduction (IAEA)

(2) Discussion of the objectives, scope and purpose of the pre-review workshop

Tuesday, 13 June 1995

(1) Description of the reference nuclear power plant, overview on the PSA (PSA team), discussion

(2) Review and discussion of the summary report

(3) Pre-review workshop

Wednesday, 14 June 1995

(1) Pre-review workshop

Thursday, 15 June 1995

(1) Pre-review workshop

(2) Drafting of the pre-review conclusions and report

(3) Heurigen (19:00 h)

Friday, 16 June 1995

(1) Drafting of the pre-review conclusions and report, discussion

Appendix B: LIST OF PARTICIPANTS

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