MISSION REPORT

IAEA MISSION ON PARTIAL COLLAPSE OF TURBINE HALL ROOF OF UNIT 4

Chernobyl NPP, Ukraine
03–07 June 2013

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Review of activities performed by ChNPP and analyses of perspective causes of the Unit 4 turbine roof failure.

Chernobyl NPP, Ukraine

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IAEA MISSION REPORT

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IAEA MISSION REPORT

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SUMMARY

This report presents an overview of the main findings, observations, acknowledgements and recommendations for improvement identified by the IAEA Mission on partial collapse of Turbine Hall Roof of Unit 4 at Chernobyl NPP. IAEA Mission Team have reviewed activities performed by ChNPP and analyses of perspective causes of the Unit 4 turbine roof failure

This report highlights 12 areas of important progress (acknowledgments) to date and offers recommendations on 14 points where the Mission Team felt that current practices could be improved. The acknowledgments and recommendations cover three separate areas that IAEA Mission was focused on or on Turbine Hall Structural Issues, Radiological Considerations and Management response to the event. Each of these separate areas is further divided in distinct topics that are presented in the Summary and the Body text of the Report.

Acknowledgements and recommendations on these separate areas are summarized as follows:

3.1. Turbine Hall Structural Issues

3.1.2 Description of structures of the turbine hall roof

Acknowledgement 1
ChNPP has successfully completed stabilization measures at adjacent unstable Sarcophagus structures few years ago. Without these measures the risks of further consequences could have been higher.

Recommendation 1 – Design documentation

It would be prudent to try (again) to obtain full set of as-build design drawings and design calculations from the Designers of Record from 1983 and designer of construction of additional roof performed in 1988 (possibly with involvement of the General Designer - VNIPIET Institute from St. Petersburg). Such design information would significantly contribute to the completeness of actual data required for the further analysis of the turbine hall roof stability and understanding of the conditions impacting on engineering estimate of the life cycle.

3.1.3. Maintenance of structures, ageing management (pre-event)

Acknowledgement 2
ChNPP has developed and implemented a periodic inspection procedure for the subject structure and procedures of instrumental (geodesic) measurements. Periodic inspection and instrumental measurements had been and are currently performed with a due diligence and in accordance with established procedures.

Recommendation 2 – Maintain and ensure safety
ChNPP is encouraged to maintain and improve further the health and safety measures allowing safe performance of activities at the site both in terms of physical and radiological safety of workers. In that respect it is recommended to revisit categorization of building structures that accounts for both physical and radiological risks in terms of workplace health and safety and that has an explicit designation of structures where safety cannot be established definitively.

3.1.4. Post-event activities of ChNPP staff in relation to structural health of subject structure

Acknowledgement 3
ChNPP civil engineering staff and plant management have implemented the corrective measures identified during performed investigation in a fast and professional manner. There are further measures related directly to the collapse event that are in due process of being subcontracted to external organizations (e.g. KSK Consortium).

Acknowledgement 4
ChNPP civil engineering staff has provided a quick response, due internal investigation was carried out following the applicable Standard for Damaged Structures of Ukraine [19] and initiated part of the further evaluation concerning the local structural health and building envelope restoration options in the area of collapse (in preliminary report stage).

Recommendation 3 – Continued structural monitoring
It is recommended to continue with currently implemented structural monitoring measures like geodetic observations, until results from initiated measures for better determination of the Turbine Hall structural health are available.

3.1.5. Causes of collapse

Recommendation 4 – Re-evaluation of uniform risk distribution among structures

Based on the recent experience that unplanned structural failure in buildings is not only a theoretical risk, but can be a real event, it is recommended to perform a systematic review with involvement of specialized organizations of all potentially weak structures at the site to confirm their technical status, remaining life and whether there is a presence of condition(s) that can prevent detection of serious deterioration of structural health (e.g. due to inaccessible structural elements). Such action would result in re-assessment of possible risks arising from such structures and identification of mitigating measures in addressing these risks , if it is needed.

3.1.6 Ageing management and interface with safe confinement project

Recommendation 5- Ageing Management and Interface with New Safe Confinement Project

Consider establishment of proactive visible aging managing program for relevant unit 4 structures as an important management tool. Level of scrutiny applied to each structure should follow graded risk-informed approach. Aging management program should be clear and implemented in a transparent way to support also specifically the strategy for life cycle of the Turbine Hall roof with regard to timing of NSC and to determine the needs, available options for their realisation in the process of concluding the life of the structure.

Recommendation 6 – Establishment of strategy to determine structure life-cycle

Consider development of comprehensive strategy for assessment of life cycle options for the Turbine Hall roof structure. The strategy should be such that it will minimize risks and potential adverse impacts on NSC project (with focus on workers safety to manage the concerned structures before, during and after completion of the NSC and workers safety for completion of the NSC).

3.2. Radiological Considerations

Acknowledgement 5

It was clearly reflected that CHNPP is highly committed to the enhancement of radiation protection and implementation of individual radiation management, the examination and implementation of measures for reduction of dose optimized for work activities, and the rationalization of protective measures. The evacuation was performed according to the emergency instruction ensuring suitable individual external monitoring following it by relevant internal exposure control.

Acknowledgement 6

Following the collapse of the roof comprehensive radiation monitoring program was initiated and performed in the Turbine Hall and also in the vicinity of the buildings. The dose rate, surface contamination monitoring and the air concentration measurements were performed systematically ensuring the radiological safety on the site. The monitoring program is being performed every day controlling continuously the radiological conditions.

Recommendation 7-Application of ventilated masks in special situations

As a measure to improve the working conditions during the work inside the turbine hall buildings the IAEA team suggests considering usage of ventilated masks with particulate filters. Use of such enhanced protective equipment should be considered in accordance with ALARA principle and optimum dose management.

3.3. Radiological impact - releases

Recommendation 8-Fixing the dust in Turbine Hall

As a measure to prevent the discharge of radioactive materials following a potential roof collapse, the IAEA team suggests considering to fix dispersible contamination in the turbine hall building. This may significantly contribute to reducing the risk of internal exposure of workers preparing the foundations close to the turbine hall building.

3.4 Management response to the Event

3.4.1 Event reporting and immediate response

Acknowledgement 7

The existence of an accident and emergency response provisions as part of the management system that worked in the default case is a remarkable achievement. The response was undertaken in a coordinated and professional manner. It is positively noted that eventually concerned areas were rapidly evacuated, no workers or people were injured and concrete measures taken.

Acknowledgement 8

The IAEA mission experts acknowledge the quick initiation of result oriented activities to analyze in depth the reasons of the abnormal event, to analyze the status of turbine hall constructions conditions and to manage the abnormal event consequences with defined objectives and responsibilities. The special acknowledgement is due to further efforts of ChNPP to dispatch consolidated information within short terms to third parties.

Acknowledgement 9

The timely initiation of parallel and complementary efforts to analyze the abnormal events by different experts and organizations which contributes to double check, consolidation and transparency is considered as another element of strong objective based management.

Acknowledgement 10

IAEA Team acknowledge the efforts taken by ChNPP to manage the abnormal event consequences such that the important safety relevant core process at ChNPP to convert unit 4 into safe ecological conditions (SIP project) will not be further delayed

Recommendation 9- Procedures for handling inconsistent information

ChNPP shall review its possibilities to avoid uncontrolled information through different and unofficial channels. To the extent the latter cannot be avoided, possible procedures to handle confusing and inconsistent information floating around shall be reviewed and considered.

Recommendation 10 – Continue successful completion of SIP project

IAEA expert team encourages ChNPP to continue the activities to manage structural and radiological risks such that the SIP as important mission (core process) will be successfully accomplished as soon as possible.

3.4.2 Further event response

Acknowledgment 11

The IAEA mission experts acknowledge the quick initiation of result oriented activities to analyze in depth the reasons of the abnormal event, to analyze the status of turbine hall conditions and to manage the abnormal event consequences with defined objectives and responsibilities

Recommendation 11 – Decision making procedure

The IAEA mission experts recommends to consider the use of the existing and anticipated investigation results to develop substantiated decision procedures (substantiation should include an evaluation of dose uptake and other risks of possible activities to be implemented with the gain of safety for on-going or planned activities in future.)

Recommendation 12 – Active communication about Unit 4

Consider to maintain active stakeholder involvement (information, participation where appropriate or useful in result discussion and decision processes) in the overall framework of converting the Unit 4 site into safe ecological situation.

3.4.3 Stakeholder involvement & Communication

Acknowledgement 12

The Team acknowledges that the ChNPP have recognized the importance of appropriate stakeholder involvement and communication and the timely communication to third parties using internet through own website. The team further acknowledges the efforts of ChNPP with regard to communicate and involve stakeholder in decision processes (e.g. invitation for information and discussion of recent development, preparation of donor assemblies)

Recommendation 13 – Active communication

The team encourages ChNPP to communicate also in future consolidated findings and development to third parties and to consider stakeholder involvement in decision processes. Any works in the vicinity and possibly impacting the NSC projects are followed by many external stakeholders. With regard to delays and cost increases already occurred they may have concerns regarding the impact and consequences of the partial turbine hall roof collapse.

Recommendation 14 – Sharing present report

Thus the conclusions of this assessment should be shared with the relevant parties (including Nuclear Regulatory Authority and local authorities) and stakeholders, with the double purpose to enhancing coordination among the different players in the mentioned processes and to helping in the tasks for filling up the gaps with the expectations of the public.

1. BACKGROUND, OBJECTIVES AND SCOPE OF THE MISSION

1.1. BACKGROUND

The segment of Unit 4 Turbine Hall roof collapsed at 2:03PM, February 12, 2013. The controlling authority from Chernobyl Nuclear Power Plant (ChNPP) has immediately withdrawn the SSE ChNPP and Joint Venture "NOVARKA" personnel who were performing activities at Unit 4, Unit 4 Industrial site and Unit 4 Local Zone. The initial engineering and radiological survey was initiated immediately to better understand what has happen. At 6 p.m. information on occurrence classified as abnormal event was distributed to a duty officer of State Nuclear Regulatory Inspectorate of Ukraine, a duty officer of State Exclusion Zone Administration, Security Service of Ukraine and Head of State Inspectorate on Nuclear Safety at the ChNPP. The initial engineering-radiological survey to determine the building structures condition and radiation condition was completed in the meanwhile. The radiation monitoring conducted, including monitoring along personnel access routes and in the premises of personnel permanent stay revealed that the reference levels were not exceeded.

A series of parallel and complementary action were taken to analyze further the event and possible consequences of the event, including:

- Appointment of an (ad hoc) expert group of specialists from ChNPP and NIISK to perform investigation of the event.
- Engagement of engineering personnel to analyze the causes of ChNPP Unit 4 Turbine Hall roof section collapse along axes 50-52/А-Б and elaborate the recommendations for restoration of the collapsed roof section
- Initiation of an additional expert group composed by external competent institutions for an independent analysis of the event of 12.02.2012.
- Development of plan of corrective actions by the ChNPP Management with explicit formulation of objectives, timing and responsibilities, that took into account comments received from the Regulatory Body SNRIU [5]

The request to IAEA Technical Cooperation Department to assist ChNPP with investigation of the event in the framework of UKR 9030 project in accordance within defined objectives has been submitted in April, 2013 .

1.2. OBJECTIVE

The objective of the IAEA mission is to provide an independent and impartial review of the activities performed by ChNPP and to analyze perspective causes of the Unit 4 turbine roof failure. In particular, it is intended to provide the mission report in accordance with the following three objectives:

1. Evaluation of design information related to roof, maintenance program for it, inspection program, ageing management program, organization in the plant related to roof maintenance and relevance of plant procedures. The separate task will be to evaluate any

investigative report that is done by the plant staff or by independent engineering organizations;

2) Radiological impact of consequences, damage to the stability to the rest of the roof, possible risks to workers at the plant and its contractors, management response to the incident;

3) Evaluation of engineering technical alternatives (studies and proposals) to mitigate consequences of the roof damage, management action related to implementation of engineering alternatives.

1.3. SCOPE OF THE MISSION

The scope covers the following main areas:

- Turbine Hall Structural Issues (prior event, during event, current and longer term);
- Radiological Considerations and Impact of the roof collapse;
- Review of the Management System in ChNPP procedures related to the event;
- Management Actions related to response to the event.

The mission team had opportunity to listen the presentations on the event prepared by ChNPP, to visit the Turbine Hall, to perform interviews with responsible staff of ChNPP and to review documents that were made available to the team [1-19]

2. CONDUCT OF THE MISSION

The mission was conducted by a team composed of three IAEA and four international experts well recognized in this domain. The mission was conducted from 03 June through 07 June 2013.

The first day were devoted to presentations by ChNPP on all issues related to mission [1-4]. The second day was dedicated to the visit of Turbine Hall to observe the damage and the overall condition of the structure and to better understand radiological constrains. It was followed by discussion of generic and specific issues related to the event and existing constrains to different options for roof.. The issues related to eventual dismantlement of turbine hall roof and synchronization with the other on-going work at the site was also discussed. The IAEA team specific groups met with ChNPP officials and experts on all corresponding issues (e.g. structural, radiological and management actions). On the third and fourth day IAEA mission team prepared the first draft of the report for discussion with the experts from ChNPP. The draft report has been discussed with the Counterpart in the panel session as well as within specific expert groups. On the fifth day of the mission the preliminary report was presented to the Director General and submitted to the ChNPP. The final report is due in a month or before July 7, 2013.

3. MAIN CONCLUSIONS AND RECOMMENDATIONS

3.1. TURBINE HALL STRUCTURAL ISSUES

3.1.1. DESCRIPTION OF EVENT

The collapse of the part of the Chernobyl NPP’s Unit 4 Turbine Hall roof in axes 50-52 has occurred 12.02.2013 (Figure 1). The survey conducted after the collapse showed that the failure of the truss along gridline 50 (Figure 2) was the cause of the collapse. Truss failure resulted in the collapse of the hinged wall roof panels and additional roof constructions, installed in 1988 above the roof originally constructed in 1983.

During the roof truss failure, its bearing node on the deaerator stack structure on row B side wasn’t destroyed. As a result, the fallen roof truss is partially supported and hanging to the deaerator stack structure.

Figure 1 Turbine Building outside view of area of collapsed wall and roof section

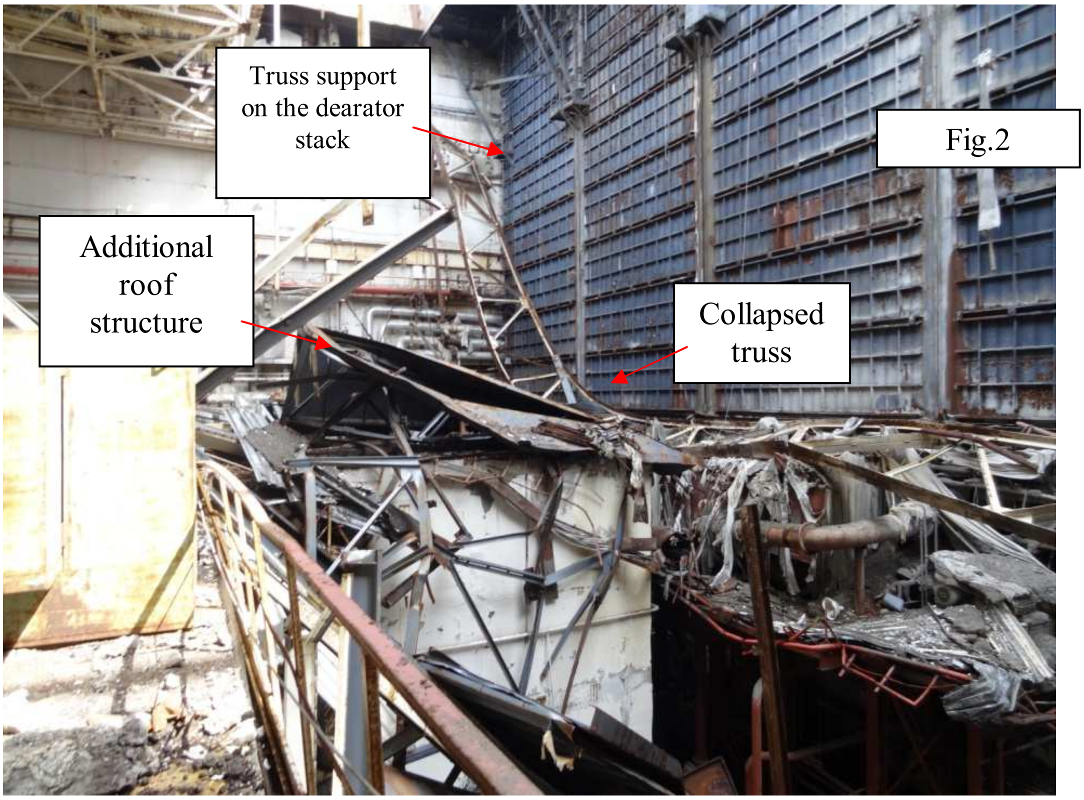

Figure 2 Turbine Building inside view of main floor area under collapsed roof section

Collapsed roof truss was connected with bracings on the bottom chord with trusses in axes 52. During failure its junctions with bracings were destroyed (Fig. 3)

Along with the roof collapse complete or partial collapse of wall panels (~ 20 pieces) occurred in the zone of fallen roof truss support on a column along gridline A. Part of these panels collapsed to the ground, some panels were stuck in unstable position, partly relying on neighboring structures. Another part of the unstable panels has been removed by plant's personnel using the jib crane. Part of the unstable panels were not accessible for the crane due to close location of spatial structure supporting additional "high" roof, built over an intensively damaged roof area of the Turbine Hall after the accident from 26.04.1986.

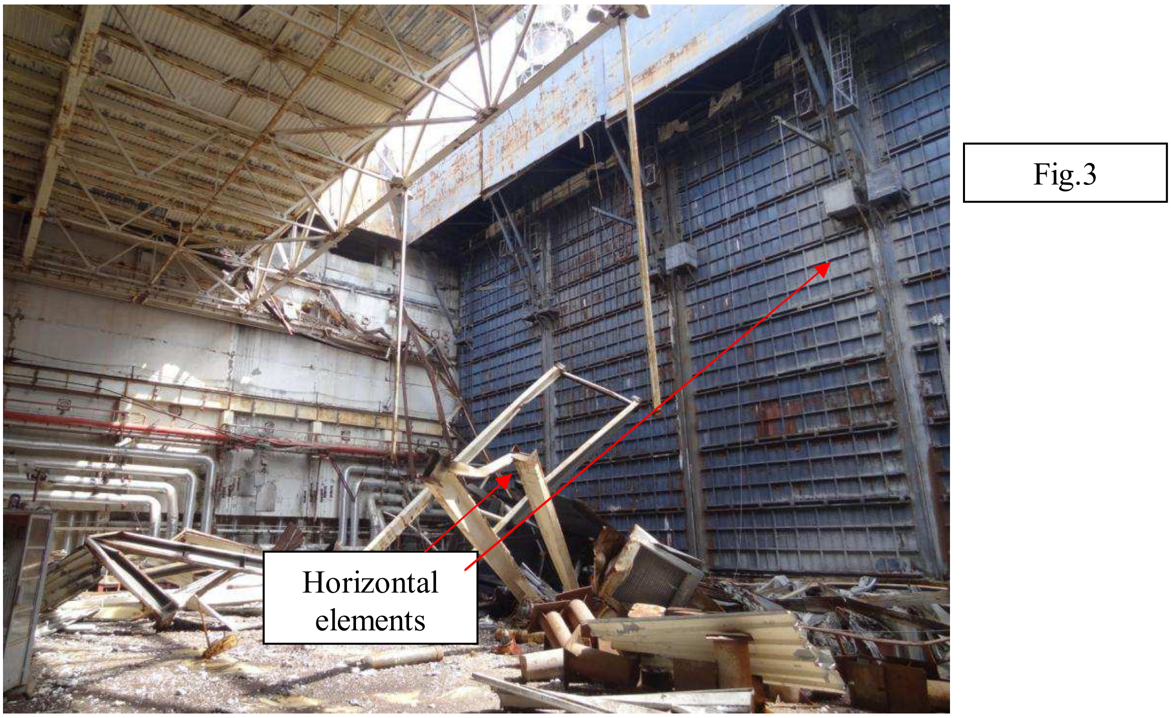

Figure 3 Turbine Building view of area of collapsed roof section

Figure 4 Turbine Building view from outside of wall panel failure in "high" roof zone next to gridline 50

3.1.2 DESCRIPTION OF STRUCTURES OF THE TURBINE HALL ROOF

ChNPP Unit 4 Turbine Hall is part of the main building of Chernobyl NPP generation II part (Fig. 5).

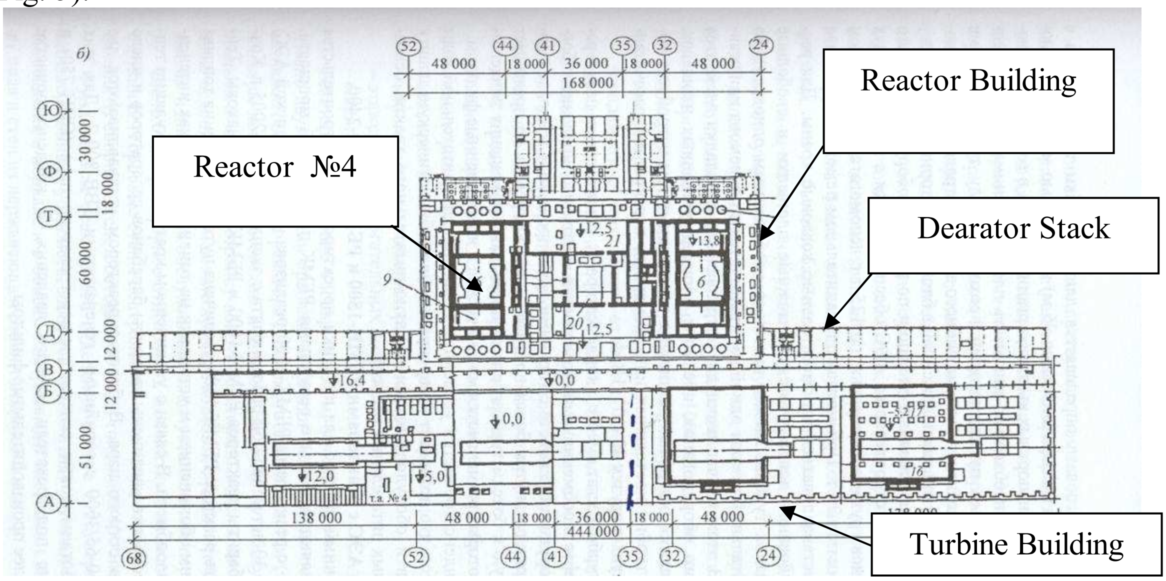

Figure 5 Plan view ChNPP main structures, part II (Units 3 and 4)

In accordance with the original design Chernobyl NPP main building includes a rigid block of the reactor compartment with adjacent contiguous volumes of the deaerator stack and Turbine Hall. The deaerator stack has a frame structure and is made of reinforced concrete. The Turbine Hall is a long span framed structure. The Turbine Hall span is 51 m long. Length of the Turbine Hall is 408 meters. It should be noted that, although from an architectural point of view, the Turbine Hall is perceived as a single building, but from structural point of view, it is divided into separate blocks, each of which is an integral structural system. This solution significantly reduces the impact of one damaged part of the Turbine Hall to the others. Along row A Turbine Hall roof steel pitched trusses are supported on steel columns (Figure 6). Along row B the trusses are supported on corbels, part of deaerator stack reinforced concrete precast columns.

The turbine hall roof considered in this report has also an additional roof (double roofing) in axis from 36 to 40 and from 50 to 68 of Unit 4 roof. In addition the Unit 4 Turbine Hall roof construction between the axes 41- 50 is considered as the critical building construction which has a special roof (third roof). This particular part of turbine hall roof is one of 17+8 specially important “Object Shelter” structures that went to thorough assessment and inspections to ensure that it will retain its functionality within 15 years.

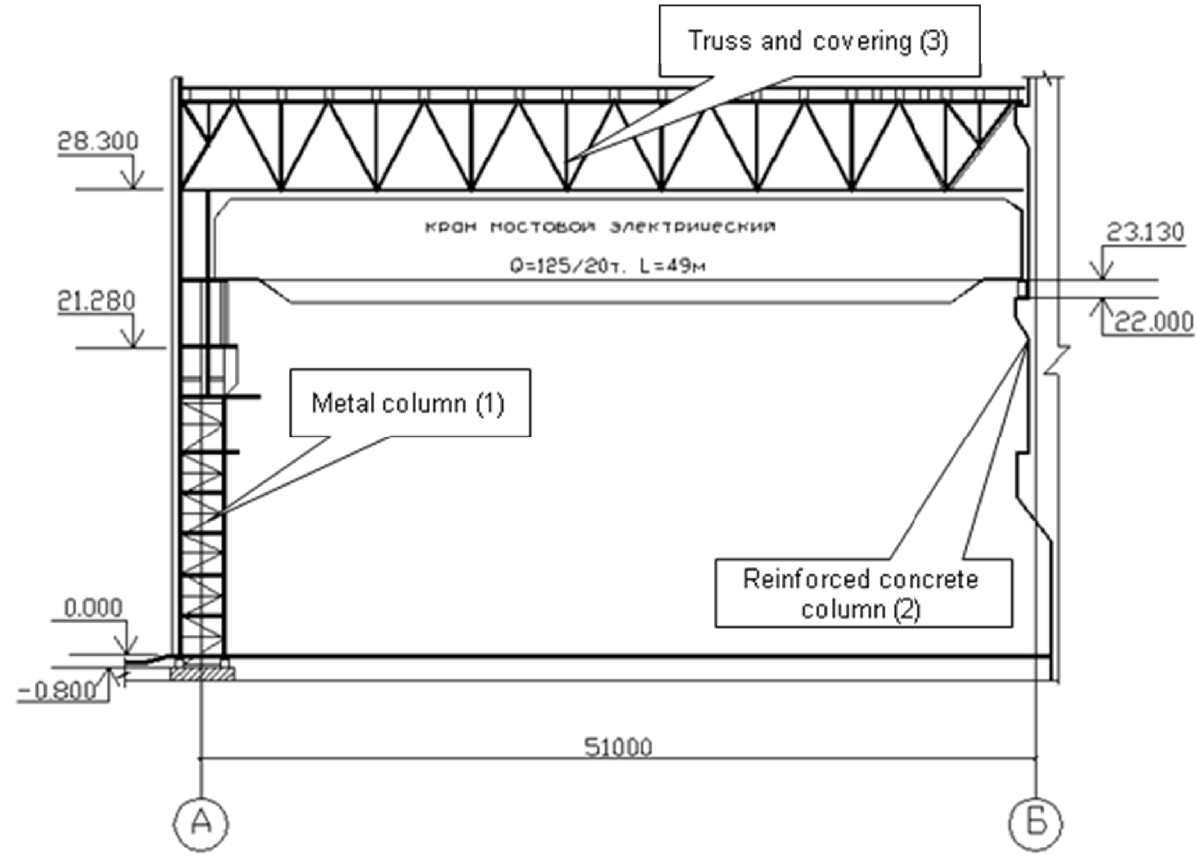

Figure 6 Section of ChNPP part II (Units 3 and 4) Turbine Building

It should be noted, that the original ChNPP design documentation is not available at the plant, since it has been withdrawn and wasn't returned during investigation of accident causes 1986. This has been duly documented by ChNPP and poses a serious obstacle to further evaluate the load bearing capacity of the structure [9]. The missing design documentation circumstance seriously complicates organization of survey of the condition of ChNPP building structural/ components. General Designer (1983) of Chernobyl NPP Turbine Hall was VNIPIET Institute from St. Petersburg.

During the 26.04.1986 accident not only Reactor Building, but also some Deaerator Stack and Turbine Hall structural elements were seriously damaged (Figure 7).

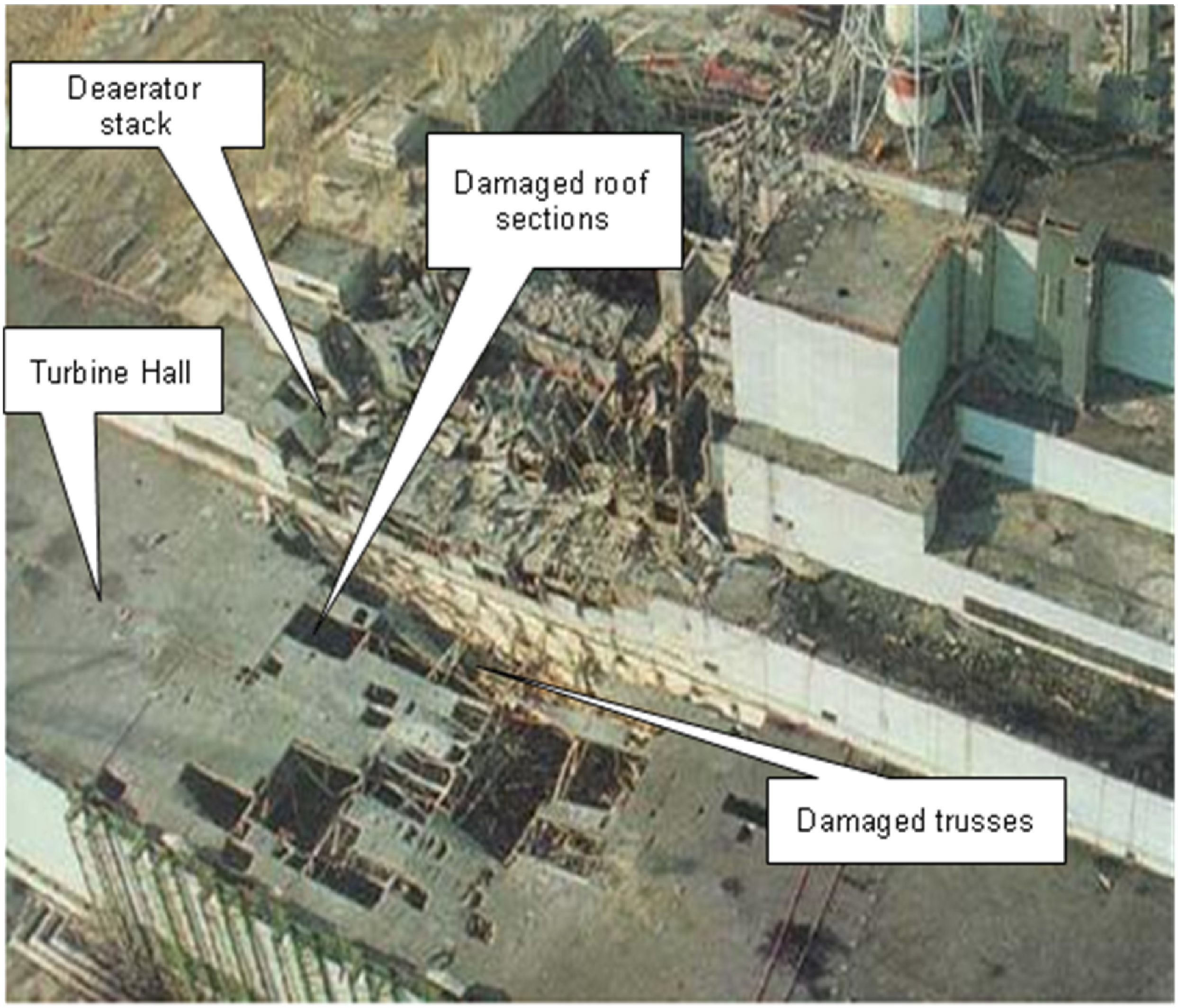

Figure 7 Damages to ChNPP generation II structures (Units 3 and 4) as a result of the accident

The Turbine Hall roof was not only damaged, but also highly contaminated with radioactive particles ejected during reactor explosion. The Deaerator stack structures (Fig. 8), being the supporting structures for the Turbine Hall roof trusses were significantly damaged at places. Especially seriously were damaged the roof elements in gridlines 40-50, i.e. in the area closely adjacent to Unit 4 Reactor Building.

During the post-accidental work and the Shelter Object construction (1986-1988), it was decided to reinforce the damaged Turbine Hall structures in order to ensure its stability. For that reason an additional roof over existing one was put in place between gridlines 36-40 and 50-68 . Also separation walls between Unit 3 and Unit 4 have been built along gridlines 41 and 50 and new (third) roof has been built in that zone (“high” roof area).

Figure 8 Deaerator stack structure damages

Additional roof in Unit 4 Turbine Hall consists of two parts: additional "high" roof between gridlines 40-50 and additional "low" roof between gridlines 50-68 and 36-40. The collapse happened in the area of "low" roof junction to the "high" roof on the grid lines 50-52.

Additional "high" roof is built in the area of very intensive damages. In this zone, it was not possible to rely on the bearing capacity of damaged roof trusses and columns. In this regard, in the Turbine Hall in axes 41 and 49 monolithic reinforced concrete walls were built. New trusses were installed on the walls on which "high" roof was placed.

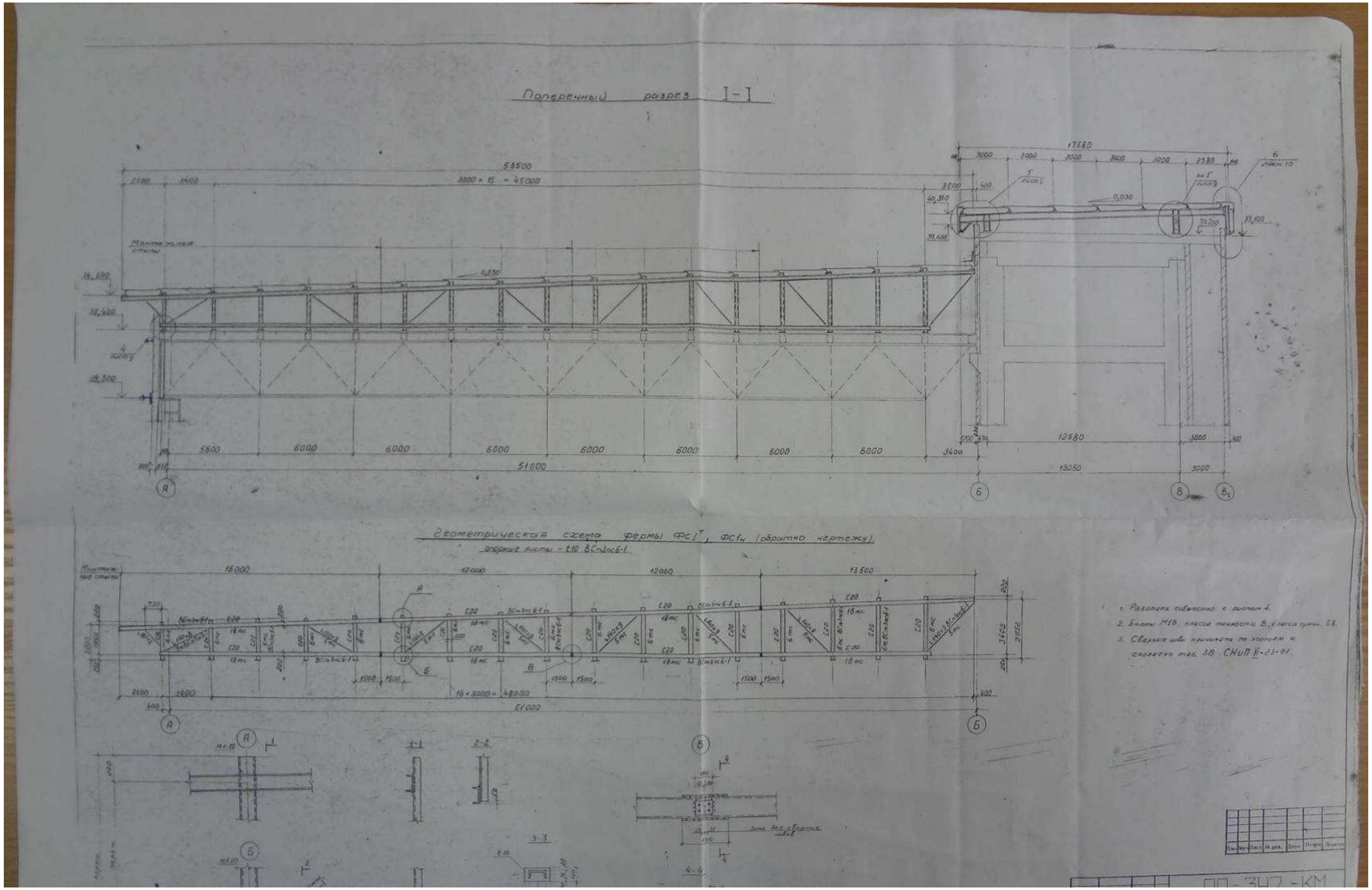

Figure 9 Transverse section of second roof structure in “low” roof area

Additional "low" roof was arranged in the area, where the damage severity was less. In this zone original trusses have been kept as the supporting structures for covering. New construction has been installed on the axes of these trusses above the existing roof slab, which included additional metal frames, on which the roof of flat steel sheets stacked overlap has been arranged (Figure 9). In the longitudinal direction the joints between the sheets has been arranged using the roofing iron strips. Also, junction of additional "low" roof to the deaerator stack was covered using the flat strip. There is no data about presence of moisture-proof seals or other means for roofing sheets sealing.

The design calculations that should establish the availability of structural resource to support the second roof and whether this included any reduction of original design snow load are unknown.

Acknowledgement 1

ChNPP has successfully completed stabilization measures at adjacent unstable Sarcophagus structures few years ago. Without these measures the risks of further consequences could have been higher.

Recommendation 1 – Design documentation

It would be prudent to try (again) to obtain full set of as-build design drawings and design calculations from the Designers of Record from 1983 and designer of construction of additional roof performed in 1988 (possibly with involvement of the General Designer - VNIPIET Institute from St. Petersburg). Such design information would significantly contribute to the completeness of actual data required for the further analysis of the turbine hall roof stability and understanding of the conditions impacting onengineering estimate of the life cycle.

3.1.3. MAINTENANCE OF STRUCTURES (PRE-EVENT)

ChNPP is managing all building structures at site. The activities for inspection, maintenance and repairs related to each structure are determined based on its importance (e.g. use), and the radiological environment (e.g radiation safety). The Turbine Building (TB), is the part of the Shelter Object structures, where inspection is defined in the “Provision Nr. 81P-S on engineering survey of industrial buildings and facilities” under item 9 [14]. However, TB particular gridlines 36-40 and 50-68, are not part of the 17+8 structures that are identified in Appendix 13 of “Provision Nr. 81P-S on engineering survey of industrial buildings and facilities” [14]. Because of that the inspections that are carried out once a year are limited to the outside of the structure, caused by absence of access to supporting units and justified by criteria for avoidance of radiation doses. The lack of safe physical access rout to the space between the two roofs and high radiation levels on the roof and inside the subject part of turbine building have led to reduced level of inspection such that it does not allow to properly establish the building condition (e.g. presence of impermeable building envelope, condition of structural elements and connections) which would allow to have reasonable confidence for availability of sufficient load carrying capacity. The subject part of turbine building is envisaged

as structure with no functional requirements for the Shelter object, other than it provides limited confinement of radioactive debris from the time of accident (1986), that are present on the original roof and in the building (due to penetrations through the roof).

Due to such determination and in compliance with "*Provision Nr. 81P-S on engineering survey of industrial buildings and facilities"* [14], there was no need to perform detail technical investigation to determine the period for which performance can be maintained or to follow prescribed activities to verify structural conditions as it was required for 17+8 essential structures listed in Appendix 13 of reference [14].

There has been a project initiated by ChNPP, commenced before February 12, 2013, to evaluate and develop conceptual proposal for construction of end walls along gridlines 39 and 65 as part of hermetic enclosure of New Safe Confinement (NSC). This project included verification of the structural condition in the expected area of work in Turbine Hall (i.e. gridlines 39 to65). Building institute consortium "KSK" is performing this work.

Acknowledgement 2
ChNPP has developed and implemented a periodic inspection procedure for the subject structure and procedures of instrumental (geodesic) measurements. Periodic inspection and instrumental measurements had been and are currently performed with a due diligence and in accordance with established procedures.

Recommendation 2 – Maintain and ensure safety
ChNPP is encouraged to maintain and improve further the health and safety measures allowing safe performance of activities at the site both in terms of physical and radiological safety of workers. In that respect it is recommended to revisit categorization of building structures that accounts for both physical and radiological risks in terms of workplace health and safety and that has an explicit designation of structures where safety cannot be established definitively.

3.1.4. POST-EVENT ACTIVITIES OF CHNPP RELATED TO STRUCTURAL HEALTH OF SUBJECT STRUCTURE

Immediately after the event an engineering and radiological inspection was performed to determine the conditions at site of collapse and facts relevant to understanding of collapse causes. The inspection results were documented in *"Act of investigation of the incident, occurred 12 February, 2013 at 2.03 at Turbine Hall building"* [9].

The corrective actions initiated or considered by ChNPP are as follows:

- Restore the confining structure to prevent the spread of radioactive substances release into environment and penetration of precipitation to inside the turbine hall building premises, as stipulated in the *"Report on abnormal event investigation on a partial collapse in axes 48-52 and a part of roofing over the Shelter Object Turbine Hall in axes 50-52(A-B)"* which was issued 25 February 2013 [8].
- Perform a survey of Unit 4 Turbine Hall structures involving Kyiv Institute "Energoproekt" (KIEP), Research Institute of Building Structures, Shymanovsky Research Institute "Stalkonstruktsiya", Institute for NPP Safety Problems) as

stipulated in the preliminary report on "*Analysis of Turbine Hall structures collapse in axes 50-52 and development of proposals to technical solutions on restoration of roofing sections"* [7].

- Proceed with additional geodetic observation over the deformed structures of Turbine Hall in accordance with separately prepared additional program to receive reliable data on state of these building structures. Although these structures are not currently included into the list of "responsible structures" (17+8) in accordance with established criteria on degree of impact on nuclear and radiation safety, lack of their integrity can still lead to localizing facility contour integrity violation. This measure is already implemented and was also stipulated in the preliminary report as per reference [7].
- In order to avoid overloading of the construction, to dismantle damaged wall panels on row A between the axes 52 - 46 in two phases: within the first phase to dismantle the wall plates between axis 50-52 and in axis 48 and within the second phase to remove all other plates after detailed survey [8].
- In order to obtain reliable data about constructions, which are not critical, but can lead to the loss of confinement, in addition to the scope of specified 9 geodesic surveillance to perform geodesic monitoring of the Turbine Hall constructions movement and deformation with periodicity of 4 cycles per year untill NSC construction completion. This measure which was stipulated in [8] is already implemented
- In order to obtain reliable data about the actual technical condition of constructions, similar to damaged, to perform a survey of ChNPP Units 1, 2, 3 and 4 Turbine Hall constructions with involvement of a specialized organization as stipulated [8].
- In order to obtain reliable data on subsidence and deformation of bearing constructions of other ChNPP buildings and constructions, to perform 2 cycles of geodesic survey of these B and C subsidence and deformation as stipulated in [8].

Consequently a work order [10] was issued to a competent organisation (KSK consortium) for the work scope as follows:

1. Develop the program for surveying the state of the Turbine Hall structures within the collapse area along axes 50-52;
2. Develop the Safe Work Execution Program for investigating the state of the Turbine Hall structures along axes 50-52;
3. Study the design documents for the Turbine Hall structures and the additional post-accident roofing along axes 49-53/А-Б, and the available video and photo materials; perform the visual examination of the structural collapse area to determine the possible causes of the structural collapse.
4. Elaborate the recommendations regarding technical solutions for restoration of the collapsed roof section along axes 50-52/А-Б and the wall along axis A.
5. Elaborate the proposals regarding specification of design criteria for limitation of the force impacts on the OS Turbine Hall structures considering timeframes for commissioning of the New Safe Confinement (NSC).

A preliminary report with analytical investigation on possible reasons for collapse and with conceptual options for roof restoration and their evaluation has been delivered to ChNPP [7].

In addition, ChNPP has a plan (in process of approval) that includes measures for proper structural investigation of TB, gridlines 36-40 and 51-68 [5].

ChNPP has identified the causes that have led to the collapse:

- Damages occurred during the accident in 1986
- Redundant deformations and stresses in the collapsed truss elements
- Metal corrosion
- Displacement of the additional block roof from the places of support up to 500 mm
- Load on the covering trusses from segments of additional block roof exceeded design loading
- Absence of heating, ventilation and penetration of atmospheric precipitation

Provisions and planning of the remaining life of the structure are very much dependent on coordination with New Safe Confinement (NSC) project. This includes taking into consideration risks and potential impact on NSC activities that have to be executed in Turbine Hall or within the zone of potential impact. Decisions made within NSC project have to consider findings from the structural evaluation of subject structure and vice versa decisions on the future of subject structure shall consider design solutions that are made in NSC project (e.g. selected design and construction of NSC end walls).

The presented investigation in preliminary report from KSK consortium [7] in general confirms the conclusions of ChNPP own investigation. It also studies the options for roof restoration in the area of collapse. From review of provided information and interview of ChNPP staff it was confirmed that selection of Option 1 is properly identified by ChNPP staff as the most feasible. Measures for further structural investigation are properly being put in place.

Acknowledgement 3
ChNPP civil engineering staff and plant management have implemented the corrective measures identified during performed investigation in a fast and professional manner. There are further measures related directly to the collapse event that are in due process of being subcontracted to external organizations (e.g. KSK Consortium).

Acknowledgement 4
ChNPP civil engineering staff has provided a quick response, due internal investigation was carried out following the applicable Standard for Damaged Structures of Ukraine [19] and initiated part of the further evaluation concerning the local structural health and building envelope restoration options in the area of collapse (in preliminary report stage).

Recommendation 3 – Continued structural monitoring
It is recommended to continue with currently implemented structural monitoring measures like geodetic observations, until results from initiated measures for better determination of the Turbine Hall structural health are available.

3.1.5. CAUSES OF COLLAPSE (IAEA MISSION)

As a result of discussions with Chernobyl NPP experts, study of available design and operational documentation, as well as on-site review of the damaged structures it can be concluded that the collapse of ChNPP II generation Turbine Hall roof structures was the result of the complex causes. The main reasons should be classified as follows:

A. Absence of a full-scale surveillance of the technical state of building constructions due to absence of access ways to bearing constructions and high doses to the personnel. In addition, the Turbine Hall constructions were considered as not critical in terms of the radiological consequences of their collapse. As a result, the Supervision Service hasn’t information about development of the hazardous processes, which can lead to the loss of their load-bearing capacity. In particular there was no information on the status of the trusses support units.

B. Water leakages through the roof as a result of which the steel roof structures corrosion developed. These leakages in the form of ice deposits have been revealed by Chernobyl NPP personnel, investigated the causes of the incident. In the available materials there is no information about presence of the sealing of additional roof sheets junctions.

C. It should be noted that the Turbine Hall constructions were designed assuming an operation inside the heated building. That determined accepted requirements to frost-resistance for reinforced concrete constructions, and to anti-corrosion coating for metal constructions. During last 27 years Turbine Hall building wasn’t heated and variations of temperature/humidity inside are close to variation in temperature/humidity outside. Due to condensation and air exchanges humidity in the Turbine Hall was reaching up to 100%. Changes of temperature and humidity had to lead to reduction of the life of structures due to fostering of corrosion processes.

D. Damages occurred for the collapsed truss during the accident on 26.04.1986. Deaerator stack column, on which this farm was relayed, during the accident was displaced on about 800 mm in the Turbine Hall direction. This displacement could cause the bending of truss chords, additional stresses and damage of its supporting units.

E. Fact that, in principal, collapsed truss was working in relatively more adverse conditions. This truss is a marginal truss of the "low" additional roof and was located at the place of "low" roof junction to "high" roof. At this place in case of snowfalls "snow bag" is formed, that fosters water ingress and causes increase of snow load on the truss. Furthermore, the marginal truss, as distinct from ordinary trusses is under asymmetric load as covering is adjacent to it on one side only. Asymmetric load causes additional effort and twisting deformations of truss.

F. During erection of reinforced concrete wall in axis 49 covering plates, installed on trusses in axis 48-50 and connections on the level of the bottom chord were removed. That resulted in asymmetric transfer of loads on truss in axis 50, that

wasn't taken into account during by truss design calculations. Besides, constructive solutions, ensuring truss stability in axis 50, as marginal, wasn't stipulated and realized. After installation of additional covering blocks loading from their self-weight on the existing covering is about 70 kgf/m2, which is comparable to the normative value of design limit for a snow load for Turbine Hall roof. That additional load significantly reduced bearing strength margin in trusses elements

G. Installation of additional roof structures was fulfilled in the period of the accident in conditions of high radiation by using of remote processes. Therefore additional roof structures were positioned not fully accurate relatively existing trusses. Transfer of load from additional roof to the nodes of existing trusses was not in any cases provided. This leads to bending of upper truss chords, as well as to increasing of efforts in same truss elements

Recommendation 4 – Re-evaluation of uniform risk distribution among structures

Based on the recent experience that unplanned structural failure in buildings is not only a theoretical risk, but can be a real event, it is recommended to perform a systematic review with involvement of specialized organizations of all potentially weak structures at the site to confirm their technical status, remaining life and whether there is a presence of condition(s) that can prevent detection of serious deterioration of structural health (e.g. due to inaccessible structural elements). Such action would result in re-assessment of possible risks arising from such structures and identification of mitigating measures in addressing these risks , if it is needed.

3.1.6 AGEING MANAGEMENT AND INTERFACE WITH SAFE CONFINEMENT PROJECT (NSC)

An aging management program would be useful tool to determine the needs and strategy for concluding the life of the structure of Turbine hall gridlines 36-40, 50-68.
The key criteria that a successful ageing management program for a building structure should satisfy are as follows:

- Structure safety and physical functions, and components of structure that play a key role in maintaining these functions, have been identified and documented
- Pertinent ageing mechanisms that may impact the structure's safety functions have been identified, evaluated, and documented (e.g. corrosion)
- Conditions that may influence the rate of degradation of structure components are maintained within design or prescribed limits
- Surveillance programme is sufficient to ensure timely detection of any ageing process (or processes), adverse environmental conditions, and their potential effects
- Acceptance criteria have been established to determine need for, type of, and timing of corrective actions. (This may include specified limits for impact of various degradation factors on a component's functional and performance requirements. Although they generally will be somewhat plant specific, design specifications, industry

codes and standards, regulatory requirements, and industry experience provide sources for development of such acceptance criteria.)

• Methods and criteria have been established to evaluate results obtained from in-service inspection and monitoring that would enable a determination of whether:

-Current condition of structure complies with acceptance criteria

-Estimated future performance, based on trending of historical data or application of service life models in conjunction with reliability-based techniques indicates continued compliance with acceptance criteria

-Ambient environmental parameters and applied loads, together with their trends, are within established operating limits

• Options for remedial measures are defined and understood

Besides the difficulties of Shelter Object site conditions and lack of international specific guidance for ageing management for passive and damaged structures like Unit 4 Turbine Hall most of these key criteria are applicable assuming that graded risk-informed approach is applied and followed to satisfy site specific needs and limitations. The ultimate goal is to ensure physical and radiological safety at site through a site-specific ageing management program.

It is also understood that due to the delays of the Shelter Implementation Plan (SIP), and construction of NSC the original concept to timely remove risky structures that might collapse by demolishment of unstable parts under a new safe confinement may be compromised by:

- further ageing leading to further collapse events before the new safe confinement structures completion
- further ageing leading to further collapse events during the new safe confinement structures completion
- by endangering or further delaying the SIP through such collapse events.

Because of these risks, it would be worthwhile to consider first development of comprehensive strategy for assessment of life cycle options for the Turbine Hall roof structure. Main element to consider in such strategy is that the roof structure may become obsolete when Turbine Hall becomes covered by the NSC in which either organized demolishment or uncontrolled further collapse events would be contained. With this boundary condition the strategy could evaluate the near term dismantling of turbine hall roof versus continued temporary preservation of the subject structure (or parts of it) to adopt an optimized approach. Such optimized approach should be based on the survey of Turbine Hall constructions already initiated and the analysis and determination of safe options by respecting the necessary near term completion of NSC as part of the structure management strategy. The strategy development process should consider stages to allow for iterative evaluation and implementation of ALARA principles for field related activities. After strategy goals are set, ageing management program that has the necessary measures for achieving the strategy goals should be established.

Recommendation 5- Ageing Management and Interface with New Safe Confinement Project

Consider establishment of proactive visible aging managing program for relevant unit 4 structures as an important management tool. Level of scrutiny applied to each structure should

follow graded risk-informed approach. Aging management program should be clear and implemented in a transparent way to support also specifically the strategy for life cycle of the Turbine Hall roof with regard to timing of NSC and to determine the needs, available options for their realisation in the process of concluding the life of the structure.

Recommendation 6 – Establishment of strategy to determine structure life-cycle

Consider development of comprehensive strategy for assessment of life cycle options for the Turbine Hall roof structure. The strategy should be such that it will minimize risks and potential adverse impacts on NSC project (with focus on workers safety to manage the concerned structures before, during and after completion of the NSC and workers safety for completion of the NSC).

3.2. RADIOLOGICAL CONSIDERATIONS

By the discussion with radiation protection managements and the presented monitoring team's results can be concluded that radiation protection personnel are very committed to ensure high level of radiation safety. The presentations and reports made available contributed in high extent to evaluate the radiological situation after the roof collapse. The walk-trough on the site, especially in the Turbine Hall further enhanced to get a bright picture about the event and its consequences. The main findings can be summarised as following:

- During the collapse of the roof the workers in the vicinity of the Turbine Hall were suitable equipped by personal dosimeters (EPD, TLD) and by personal protective equipment (mask, overall, overshoes etc.). The workers in New Safe Confinement (NSC) were also properly equipped by mask and personal dosimeters.
- Following the collapse of the roof the workers (from NOVARKA and SSE CHNPP) in the vicinity of Turbine House and at NSC were immediately evacuated from the zone following the Emergency Instructions (SIP-N-SA-22-F91__-MPL-013-03 Annex I) for evacuation.
- Personal monitoring at the changing facilities during evacuation didn't show personal contamination neither on skin nor on protecting clothing.
- By the EPD results the external exposure values were below the daily established levels.
- Detailed internal personal monitoring (by Whole Body Counter -WBC) was performed on the following days on workers and the monitoring team (including 37 members). The results showed that the incorporations of Cs-137 were much below the level established for normal situations (12 kBq).
- Summarising the internal exposures: 30 persons exposure from Cs-137 was less than 2 mSv, 5 persons internal exposure from inhalation was in the range of 2- 4

mSv. It was noted that some line managers had the highest exposure during the inspection efforts.

- By the “Schedules Measures Log” (No. 134 RB-35) the dose rate values and alpha beta contamination values were below the reference values in the premises.

- According to the reading of automated monitoring system it was also confirmed that the dose rate values did not exceed the reference levels.

- The dose rate and surface contamination measurements were completed by air concentration measurement (for Cs-137 and Am-241) on 38 point of the site. It follows from the results that the increase of airborne activity in the SO premises was short – timed and it was resulted from wall panels and partly from light roof collapse of Unit 4 Turbine Hall. Following the results of scheduled air monitoring in the SO Local Zone as of February 13 and 14, no reference level for beta and alpha long – lived nuclides mixture volumetric activity was exceeded in general.

- The monitoring program is being performed every day controlling the dose rate, surface contamination and air contamination.

- Dose rate measurements were performed during the walk through and good agreement was found with the results of the monitoring team.

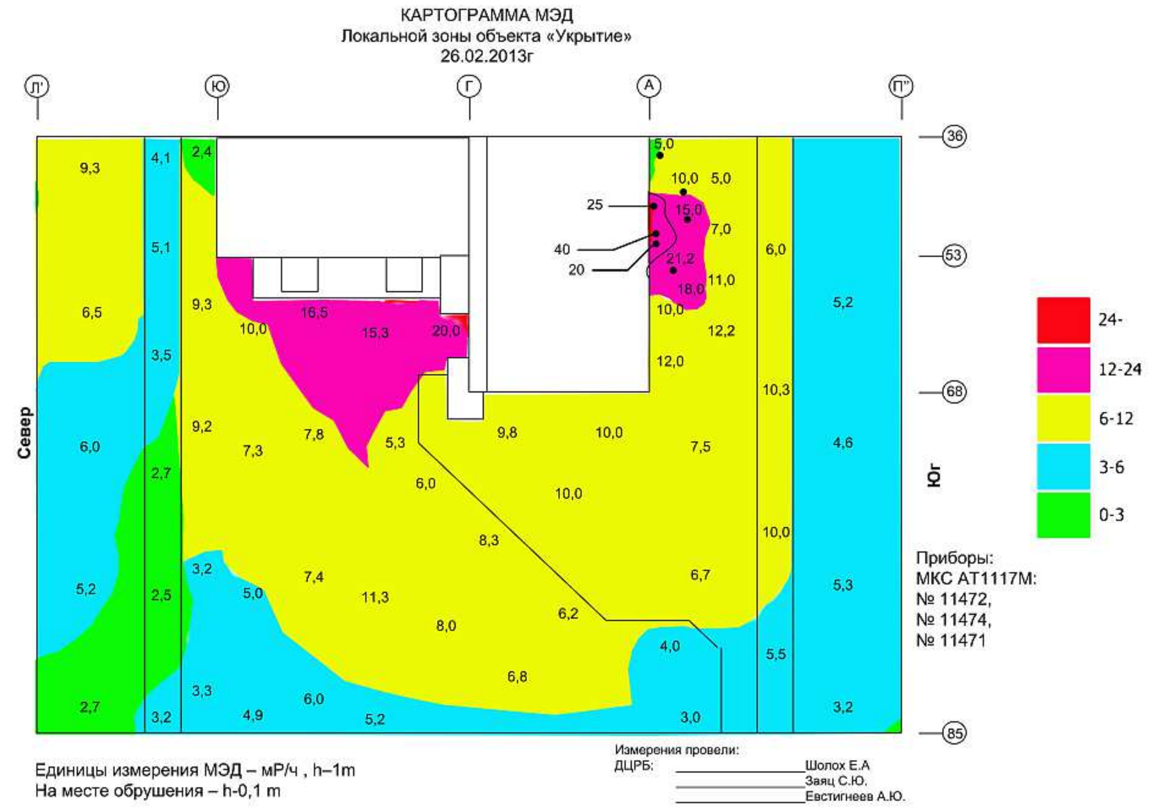

Figure 10

An additional measure to improve the working conditions during the work inside the turbine hall buildings (such as already used for works in other highly contaminated areas at ChNPP), could be use of vented masks with particulate filters. This may contribute to reducing the possibility of internal exposure and to increase work efficiency and related reduction of the time spent in the high-radiation zone. An illustration below indicate vented mask that is light weight and easy to carry.

Figure 11 Example of ventilated masks

Acknowledgement 6

It was clearly reflected that CHNPP is highly committed to the enhancement of radiation protection and implementation of individual radiation management, the examination and implementation of measures for reduction of dose optimized for work activities, and the rationalization of protective measures. The evacuation was performed according to the emergency instruction ensuring suitable individual external monitoring following it by relevant internal exposure control.

Acknowledgement 7

Following the collapse of the roof comprehensive radiation monitoring program was initiated and performed in the Turbine Hall and also in the vicinity of the buildings. The dose rate, surface contamination monitoring and the air concentration measurements were performed systematically ensuring the radiological safety on the site. The monitoring program is being performed every day controlling continuously the radiological conditions.

Recommendation 7-Application of vented masks in special situations

As a measure to improve the working conditions during the work inside the turbine hall buildings the IAEA team suggests considering usage of vented masks with particulate filters. Use of such enhanced protective equipment should be considered in accordance with ALARA principle and optimum dose management.

3.3. RADIOLOGICAL IMPACT - RELEASES

After roof collapse radioactive aerosols were discharged into the environment what was confirmed by air monitoring measurements. Due to this discharge the radiological consequences can be summarised as following:

- The dose rate and surface contamination did not exceed the reference values.
- According to the reading of automated monitoring system it was also confirmed that the dose rate values did not exceed the reference levels.
- By the EPD results the external exposure values were below the daily established levels.
- It follows from the monitoring results that the increase of airborne activity in the SO premises was short – timed resulted in incorporation of radioactive caesium. The results showed that the incorporations of Cs-137 were much below the level established for normal situations, but improving the protective equipment in similar situations would contribute to the further reduce of the individual and collective doses according to the ALARA principle.
- By the “Schedules Measures Log” (No. 134 RB-35) the dose rate values and alpha beta contamination values were below the reference values in the premises.
- After finishing of the short-timed release of radioactive aerosols the radioactive air concentration level was not exceeded.

Decrease radiological impacts of potential further collapses of turbine hall roof

To prevent the discharge of radioactive materials following a potential roof collapse, it is suggested to fix aerosols in the turbine house. This may significantly contribute to reducing the risk of internal exposure of workers preparing the foundations close to the turbine house even if other segments or the whole turbine hall roof collapse.

Recommendation 8-Fixing the dust in Turbine Hall

As a measure to prevent the discharge of radioactive materials following a potential roof collapse, the IAEA team suggests considering to fix dispersible contamination in the turbine hall building. This may significantly contribute to reducing the risk of internal exposure of workers preparing the foundations close to the turbine hall building.

3.4 MANAGEMENT RESPONSE TO THE EVENT

3.4.1 EVENT REPORTING AND IMMEDIATE RESPONSE

Information received and discussed:

In compliance with the Ukrainian regulation ChNPP has implemented specific provisions and procedures for emergency and accident response as well as for reporting. Evidence for these provisions and procedures were given by copies of specific documents ("Instruction Nr. 42 E-CEOU(NBK) on procedure of personnel actions in case of emergencies and accidents at the Shelter Object" [13], "Provision Nr. 9P-S for procedure of investigation and accounting of violations and malfunctions of Chernobyl NPP operation" [15], "Order n° 39 on amendments to regulation for procedure of investigation and accounting of violations in operations of NPPs" [16], "Technical Regulation Nr. 1 R-OU of Chernobyl NPP reactor unit 4 Shelter Object" [17], "Plan Nr. 32P-S on emergency and accident response" [18]).

According to the implemented procedures the contractor working in the area adjacent to the abnormal event location informed the Shift Supervisor at Radiation Shop (14h03) who informed at 14h04 the Plant Shift Supervisor and initiated immediate response action: withdrawal of personnel from the area and immediate inspection of the area which were performed timely (14h10-14h30). At 14h30 the abnormal event area was barricaded, adjacent access ways of workers checked, workers sent to fully body check, power line in the abnormal event area shut down, automated dose recording and aerosol measurement data checked. All available and date confirmed that dose limits and aerosol contamination were within regulated thresholds.

A first fact finding report was given and discussed at a meeting to the chief engineer at 16h30 and classification performed: "abnormal event with radiological consequences (aerosols) without violation of operational parameters."

"Notification on abnormal event at ChNPP unit 4" [11] was prepared and sent to SNRIU (regulatory authority) at 18h00. The notification was also published at ChNPP web-site, including in English.

At 18h40 Chief Engineer approved the decree on informing the personnel in terms of assurance of general industrial and radiation safety due to the partial collapse of SO Turbine hall roof-Notwithstanding with the above, out of existing provisions diverging and inconsistent information from Chernobyl employees seem to have been dispatched publically. Also other Ukrainian organization seems to have taken action and communication with inadequate information which had not their source official ChNPP communication routes.

Acknowledgement 8

The existence of an accident and emergency response provisions as part of the management system that worked in the default case is a remarkable achievement. The response was undertaken in a coordinated and professional manner. It is positively noted that eventually concerned areas were rapidly evacuated, no workers or people were injured and concrete measures taken.

Acknowledgement 9

The IAEA mission experts acknowledge the quick initiation of result oriented activities to analyze in depth the reasons of the abnormal event, to analyze the status of turbine hall constructions conditions and to manage the abnormal event consequences with defined objectives and responsibilities. The special acknowledgement is due to further efforts of ChNPP to dispatch consolidated information within short terms to third parties.

Acknowledgement 10

The timely initiation of parallel and complementary efforts to analyze the abnormal events by different experts and organizations which contributes to double check, consolidation and transparency is considered as another element of strong objective based management.

Acknowledgement 11

IAEA Team acknowledge the efforts taken by ChNPP to manage the abnormal event consequences such that the important safety relevant core process at ChNPP to convert unit 4 into safe ecological conditions (SIP project) will not be further delayed

Recommendation 9- Procedures for handling inconsistent information

ChNPP shall review its possibilities to avoid uncontrolled information through different and unofficial channels. To the extent the latter cannot be avoided, possible procedures to handle confusing and inconsistent information floating around shall be reviewed and considered.

Recommendation 10 – Continue successful completion of SIP project

IAEA expert team encourages ChNPP to continue the activities to manage structural and radiological risks such that the SIP as important mission (core process) will be successfully accomplished as soon as possible.

3.4.2 FURTHER EVENT RESPONSE

A series of parallel and complementary action were taken to analyze further the event and possible consequences of the event, including:

- Appointment of an (ad hoc) expert group (Committee) of specialists from ChNPP and NIISK to perform investigation of the event. The report “ACT of investigation of the incident, occurred 12 February, 2013 at 2.03 at Turbine Hall building, block "G" SSE

"Chernobyl NPP" second generation“ [9] is submitted on 22nd February 2013 to management of ChNPP.

- Engagement of engineering personnel to analyze the causes of ChNPP Unit 4 Turbine Hall roof section collapse along axes 50-52/А-Б and elaborate the recommendations for restoration of the collapsed roof section. The “Report on abnormal event investigation on a partial collapse in axes 48-52 and a part of roofing over the Shelter Object Turbine Hall in axes 50-52 between rows (A-B)” [8]
- Initiation of an additional expert group composed by external competent institutions for an independent analysis of the event of 12.02.2012. A preliminary report on “Analysis of Turbine Hall structures collapse in axes 50-52 and development of proposals to technical solutions on restoration of roofing sections” [7] was submitted on 7th March 2013
- Development of a “Plan of measures on mitigating the consequences of unit 4 Turbine Hall roof collapse and reducing potential risks for the existing structures and personnel” [5] by the ChNPP Management with explicit formulation of objectives, timing and responsibilities, that took into account comments received from the Regulatory Body (SNRIU).

Acknowledgment 12

The IAEA mission experts acknowledge the quick initiation of result oriented activities to analyze in depth the reasons of the abnormal event, to analyze the status of turbine hall conditions and to manage the abnormal event consequences with defined objectives and responsibilities

Recommendation 11 – Decision making procedure

The IAEA mission experts recommends to consider the use of the existing and anticipated investigation results to develop substantiated decision procedures (substantiation should include an evaluation of dose uptake and other risks of possible activities to be implemented with the gain of safety for on-going or planned activities in future.)

Recommendation 12 – Active communication about Unit 4

Consider to maintain active stakeholder involvement (information, participation where appropriate or useful in result discussion and decision processes) in the overall framework of converting the Unit 4 site into safe ecological situation.

3.4.3 STAKEHOLDER INVOLVEMENT & COMMUNICATION

The issues surrounding stakeholder involvement and communication in the course of implementation of the SIP and decommissioning programme is one of the challenges that the ChNPP is dealing with. ChNPP as budget organisation and using support from third parties

(e.g. foreign Donors) knows that stakeholder involvement and communication is a tool to bridge the gap of difference of thinking and perspectives in a process of mutual understanding and to maintain or foster support.

When stakeholder involvement and communication are conducted in a way that people's anxieties and concerns are properly addressed, the support from state budget as well as from third parties is considerably facilitated.

Acknowledgement 13
The Team acknowledges that the ChNPP have recognized the importance of appropriate stakeholder involvement and communication and the timely communication to third parties using internet through own website. The team further acknowledges the efforts of ChNPP with regard to communicate and involve stakeholder in decision processes (e.g. invitation for information and discussion of recent development, preparation of donor assemblies)

Recommendation 13 – Active communication
The team encourages ChNPP to communicate also in future consolidated findings and development to third parties and to consider stakeholder involvement in decision processes. Any works in the vicinity and possibly impacting the NSC projects are followed by many external stakeholders. With regard to delays and cost increases already occurred they may have concerns regarding the impact and consequences of the partial turbine hall roof collapse.

Recommendation 14 – Sharing present report
Thus the conclusions of this assessment should be shared with the relevant parties (including Nuclear Regulatory Authority and local authorities) and stakeholders, with the double purpose to enhancing coordination among the different players in the mentioned processes and to helping in the tasks for filling up the gaps with the expectations of the public.

3.5 RECORD OF IAEA MISSION DOCUMENTS

Nr	Type	Comment
1	Presentation: Organization of Control over Condition of Shelter Object Building Structures, ChNPP – Mr. Khavrus, Mr. Svitus, 3 June	Electronic file in English and in Russian
2	Presentation: Turbine Hall of the 2-nd generation. Main constructional solutions, implemented after 1986, , ChNPP – Mr. Khavrus, Mr. Svitus, 3 June	Electronic file in English
3	Presentation: Abnormal event of 12.02.2013, ChNPP – Mr. Kondratenko	Electronic file in English
4	Presentation: Radiation monitoring for consequences of abnormal event of 12.02.2013, ChNPP – Mr. Novikov, 3 June 2013	Electronic file in Russian
5	Plan of measures on mitigating the consequences of unit 4 Turbine Hall roof collapse and reducing potential risks for the existing structures and personnel (revision taking account the comments of SCNRIU, Ref. N° 24-18/2447 of 21.05.2013), ChNPP dated 31.05.2013	Hardcopy in Russian
6	Regulation Nr. 40 E-S on information activity at ChNPP dated 22.05.2013	Electronic file in Russian
7	Preliminary report “Analysis of Turbine Hall structures collapse in axes 50-52 and development of proposals to technical solutions on restoration of roofing sections, KSK consortium, dated 7.3.2013	Electronic file in Russian
8	Report on abnormal event investigation on a partial collapse in axes 48-52 and a part of roofing over the Shelter Object Turbine Hall in axes 50-52 between rows “A-B”, ChNPP, dated 25.02.2013	Electronic file in English
9	ACT of investigation of the incident, occurred 12 February, 2013 at 2.03 at Turbine Hall building, block "G" SSE "Chernobyl NPP" second generation of the State Agency for Exclusion zone Management, ChNPP, dated 22.02.2013	Electronic file in English
10	Home Office Support Request Nr. SIP09-2-001 – HOSR-024 on engagement of the Client Engineer Home Office engineering personnel to analyze the causes of ChNPP Unit 4 Turbine Hall roof section collapse along axes 50-52/А-Б and elaborate the recommendations for restoration of the collapsed roof section, SIP-PMU, date unknown	Electronic file in English and Russian
11	Notification on abnormal event at ChNPP unit 4, ChNPP dated 12.02.2013	Electronic file in Russian
12	Provision Nr. 22P-S on procedure of information communication, ChNPP dated 28.01.2013	Hardcopy in Russian
13	Instruction Nr. 42 E-CEOU(NBK) on procedure of personnel actions in case of emergencies and accidents at the Shelter Object, ChNPP, dated	Hardcopy in Russian

	09.01.2013	
14	Provision Nr. 81P-S on engineering survey of industrial buildings and facilities, ChNPP, dated 2012	Electronic file in Russian
15	Provision Nr. 9P-S for procedure of investigation and accounting of violations and malfunctions of Chernobyl NPP operation, ChNPP dated 07.12.2011	Hardcopy in Russian
16	Order n° 39 on amendments to regulation for procedure of investigation and accounting of violations in operations of NPPs, SNRIU dated 20.04.2011 (published official gazette of Ukraine 2011, N° 40)	Hardcopy in Ukrainian
17	Technical Regulation Nr. 1 R-OU of Chernobyl NPP reactor unit 4 Shelter Object, ChNPP, dated 29.03.2011	Hardcopy in Russian
18	Plan Nr. 32P-S on emergency and accident response, ChNPP dated 2005	Electronic file package with 29 files in Russian
19	Standards for Damaged Structures of Ukraine (DBN B 1.1-2-95) , State Commission of Ukraine for building and architecture, dated 1995	Electronic file in Ukrainian

APPENDIX I - MISSION PROGRAMME

Program for IAEA Mission on Root Cause Analysis of Turbine Hall Roof Collapse at ChNPP Ukraine, Slavutich, 2013-06-03 - 2013-06-07

02 June 2013 – arrival at Boryspil International Airport, moving to Slavutich, accommodation

Monday, June 03, ChNPP

Time	Activities
07:40	Leaving Slavutich for ChNPP by electric train
08:30	Passing through a Whole Body Counter (WBC) at the entry
09.30 – 12.00	Plenary session
	Welcome speech
	Discussion of Mission goals and detailed agenda
	Introduction of the participants
	ChNPP presentation on the event, organization of investigation, causes, etc.
12:00 – 12.30	Lunch
12:30 – 15:20	Plenary session continues ChNPP presentation on organization of maintenance and inspection of building structures
15:55	Leaving ChNPP

Tuesday, June 04, ChNPP

Time	Activities
07:40	Leaving Slavutich for ChNPP by electric train
09:00 – 12:00	Visiting the Unit 4 turbine hall. Examination of the event area
12:00 – 12:30	Lunch
12:30 – 15:20	Work of the experts in distinct groups or independently. Review of the documents, talking to the ChNPP personnel

15:55	Leaving ChNPP

Wednesday, June 05, ChNPP

Time	Presentation / Activities
07:40	Leaving Slavutich for ChNPP by electric train
09.00 – 12.00	Work of the experts in distinct groups or independently. Review of the documents, talking to the ChNPP personnel
12:00 – 12:30	Lunch
12:30 – 15:20	Work of the experts continues

Thursday, June 06, Slavutich, Training Center

Time	Activities
08:30 – 12.00	Work of the experts on the preliminary report
12:00 – 13:30	Lunch
13:30 – 17:00	Work on the preliminary report continues

Friday, June 07, ChNPP

Time	Activities
07:40	Leaving Slavutich for ChNPP by electric train
09:00 – 12:00	Presentation and discussion of the preliminary report
12:00 – 12:30	Lunch
12:30 – 13:00	Passing through a Whole Body Counter (WBC) at the exit
13:00	Leaving for Kiev

APPENDIX II - LIST OF PARTICIPANTS

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A.2 ChNPP

List of Participants from ChNPP

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