The Experience of Long Term Medical and Biophysical Control of Personnel Participating in Execution of Reconstructive Works at Object «Shelter» of Chernobyl NPP


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Object Shelter (OS) is a destroyed by out of project accident block № 4 of the Chornobyl NPP

- Is located on a earths surface,
- Is specially equipped and construction designed so that the long protected isolation of radioactive waste (RAW) from the hit of them in a biosphere was guaranteed
- In its present OS state it is necessary to characterize as a "place of superficial storage of unorganized RAW ("temporal depository of unorganized RAW, found in the stage of stabilization and reconstruction")".

1986  2004-2009 stabilization  20???
Main radiation hazards for personnel performing SIP-works at OS include external and internal exposure with the risk of transuranium radionuclides incorporation

- The work with these types of radionuclides sources is performed in sealed rooms (“hot chambers”) – with the use of remote manipulators. This practice results in a significant reduction of the dose levels of external exposure for personnel as well as the ability to reduce the potential for the contact with radioactive materials and therefore the potential for their incorporation in their body.

- Due to unique origin of Object Shelter, radiation-hygienic conditions at the work execution zones cannot be brought into compliance with the international safety standards. The work at OS will be performed under significant hazardous conditions.
Complex of additional biohazards:

- aggressive chemical aerosols, including welding aerosols
- high humidity and discomfort temperature mode at any time of the year
- absence of forced exchange ventilation system inside OS
- insufficient and artificial illumination
- presence of “confined space” factor in most of OS rooms
- altitude factor
- presence of debris and difficult access to workplaces under conditions of ionizing radiation
- influence of personal protective equipment
- psychoemotional stress
- synergetic effects of the complex influence of these hazard factors
The main objective of the SIP medical-biophysical program (BIOMED) is to provide radiation and general industrial security to personnel complying with Ukrainian legislation and the best international practice (ICRP, IAEA, UNSCEAR).

This was one of main requirements of Ministry of Health of Ukraine and UkrInvestExpertise for beginning of works at «object Shelter».
Stages of Construction Plan for the New Safe Confinement

Foundation

Pre-Assembly

Lifting Elements

Slide West

Cladding

Removing VT-2

Slide and test

In-Process

In-Process

This year

In-Process

This year

In-Process
Works on Arch construction
Works on Arch construction
Works on Arch construction
Main tasks of BIOMED Program are:

- Minimize the potential admission of personnel to work under extremely hazardous conditions that are not physically or mentally capable of performing the work. The legal basis for admission for work inside the Object Shelter and Local Zone.

- To ensure that radiation exposure (internal and external) does not result in long term diseases.

- To ensure that further occupational accidents do not occur because of the health of the workers. Specifically if an individual because of health reasons collapses during the performance of work the rescue efforts could lead to significant exposure to radiation and other hazardous conditions.

- To verify that individuals are not exposed to internal radiation doses because of the hazardous conditions of Object Shelter. Personnel Protective Means although can be effective it requires a discipline and training to ensure that the individuals are not exposed to internal contamination. The program objective is to ensure that there are a means to independently verify the personnel exposure risk.

- In the case of detection of internal contamination above a pre-set limit additional medical examinations will be conducted to ensure that the worker did no exceed the legal limits for radiation exposure (internal and external) and determine the capability of the worker to return to the work force at ChNPP.

- To provide emergency care in case of industrial or radiation accidents that may occur during the performance of the work.
Ensuring of safety of work

**Health safety**
- Check-in monitoring
- Individual examination
- Special monitoring
- Pre-shift monitoring
- Periodical monitoring
- Check-out monitoring

**Radiological safety**
- Monitoring of the external exposure dose
- Monitoring of the radiological parameters at the work place during work performance
- Monitoring of the internal exposure dose (biophysical monitoring)

**Conclusion on admission**
(non-admission) to work on SIP
ORGANIZATION of WORK

MANAGEMENT

Biophysical support
Bioassays controls
Biodosimetry

Clinical examinations
- Hematology
- Immunology
- Psychoneurology
- Ophthalmology
- ENT
- Pulmonology
- Cardiology
- Endocrinology
- Gastroenterology
- Oncology
- Urology
- Occupational Medicine

Laboratory examinations
- Biosample of blood and urine
- Hematology
- Citology
- Biochemistry
- Cellular immunity
- Immunoserology
- Immunoenzyme and radioimmunoe assay analysis
- Molecular Biology and Genetics
- Cytogenetics (FISH)

Instrumental Diagnostic
- Roentgenology and Radiology
- Electrophysiology
- Endoscopy
- Neurophysiology
- Ultrasound
- Respiratory lung functions
Check-in control

Routine control

Special control

Operational control

Check-out control

Sampling – SCRM Clinic, measurements - DpDos

Sampling – ChNPP on-site, measurement - DpDos

Sampling – SCRM Clinic, measurements - DpDos

Sampling – ChNPP on-site, measurement - DpDos

Sampling – SCRM Clinic, measurements - DpDos

Identification of events of an incorporation of radiomaterials, calculation of real individual internal doses (deeds) caused by these events over results of analysis of working conditions, WBC and bioassays measurements
Radiation Safety: External exposure

External exposure monitoring is provided by Radiation Safety Shop of ChNPP

Radiation situation, monitoring, personnel monitoring

Individual dose monitoring: Harshaw, and PD-3i (MGP)

Still problem issue:
Disposition of the source relative to the worker

(Geometry of the exposure)

Dose dependences;
Real and obtained by dosimeter dose
Quantitative Tests Used to Estimate Factors That Modify Biological Response at Low Dose

- Past radiation exposure
  - A – Former exposure above professional limits (e.g., former cleanup workers, military)
  - B – Former exposure in professional limits:
    - Nuclear industry
    - 30-kilometer Chornobyl exclusion zone
    - Previous activity as SIP worker
  - C – Previously non-exposed

- Estimation of individual Genetic dependent sensitivity to irradiation on the base of immunophenotyping

- Estimation of Nonradiation hazards (humidity, high/low temperature, vibration, dust)

- Immune dysfunctions, oxidative status

- Central nervous function and behaviour

- Lung function (oxygenation)
Number of medical controls for SIP workers during Oct 2004-Oct 2013

Total number of medical controls: 19434
Radiation Safety: External exposure

Total individual exposure dose of the candidates to be personnel for work at Object Shelter. The dose if formed by candidate previous practice activity.

![Graph showing external exposure doses of applicants from previous practice, mSv]
Main results of SIP Contractors personnel
Check-in medical control

Number of subjects - 19434
Admitted - 48,9% workers,
not admitted - 51,1%.

Structure of non-admissions
/contraindications for SIP works

- Exacerbated chronic diseases of digestive system: 20,5%
- Diseases of eye and adnexa: 8,7%
- Endocrine system diseases: 9,3%
- Respiratory system diseases and tuberculosis: 14,2%
- Diseases of nervous system, mental and behavioural disorders: 15%
- Other*: 52,4%

*Other category includes conditions that do not fit into the other classifications.
### Results of other types of control of the SIP Contractors personnel

<table>
<thead>
<tr>
<th>Med. Control</th>
<th>Admission</th>
<th>Non admission</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Periodical</td>
<td>2502</td>
<td>812</td>
<td>3314</td>
</tr>
<tr>
<td></td>
<td>(75.49%)</td>
<td>(24.51%)</td>
<td></td>
</tr>
<tr>
<td>Individual inspection</td>
<td>3070</td>
<td>983</td>
<td>4053</td>
</tr>
<tr>
<td></td>
<td>(75.74%)</td>
<td>(24.26%)</td>
<td></td>
</tr>
<tr>
<td>Special</td>
<td>1845 cases of possible overexposure in 783 subjects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check-out</td>
<td></td>
<td>615</td>
<td></td>
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</tbody>
</table>
Total effective dose of internal and external exposure of the personnel for the period of SIP work: 2004 till 2012

So high value of doses of external irradiation is conditioned by implementation of radiation-dangerous works for stabilizing of OS in 2006-2007, on which the special permission of MH of Ukraine was got at the observance of the basic requirement of HNRPUa-97 on limitation of individual doses of irradiation of personnel of category A at level no more than 50 mSv per/year on condition of not exceeding of dose in 100 mSv for any subsequent 5 years.
Radiation Safety: Internal exposure Biophysical control
Distribution of the internal exposure dose for the personnel who pass the program of special biophysical control (2004-2012)

4,1 (mSv)
Summary

- Work inside the Object Shelter presents unique challenges because it includes open sources of radionuclides (alpha emitters) and can be compared to “hot chambers” plus industrial hazards.

- The key problem is preserving health and safety of the SIP personnel during the execution of the work.

- The physical and psychological examination of the workers in accordance with the Ukrainian normative standards and best international practices have identified a significant impact to the availability of qualified workers for SIP works. Therefore both CHECKIN and CHECKOUT medical controls are needed to reduce the risk to all the personnel at “Object Shelter”.

- The initial training, discipline and initial supply of Personnel Protective Equipment were inadequate at the first stage of the work. Work was stopped and specific corrective actions taken to improve the safe working conditions at “Object Shelter”. Continuous enforcement and verification process is needed.
Summary (2)

- Providing of terms for providing of medical emergency-aid, especially specialized hospital and requires urgent biophysical control under strong control of regulators are needed.

- For maintenance of health and capacity of personnel the complex of health and rehabilitation measures is required by the account of the individual programs of treatment in the highly specialized medical facilities.

- The SIP medical-biological program Control is mandatory to ensure that all work performed at “Object Shelter” of the ChNPP under hazardous conditions is performed in a SAFE and CONTROLLED manner.