

International Conference on Human and Organizational Aspects of Assuring Nuclear Safety Exploring 30 Years of Safety Culture

What Needs to be Changed based on Lessons Learned from Chernobyl.

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Obninsk

IAEA, Vienna, Austria 22–26 February 2016



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Fig.1 The presentation of safety culture (INSAG-4)





Fig. 2. Psychological aspects of the safety culture





Fig. 3. The «lesson» concept

Acknowledgement of negative event Understanding: what has happened, **how** it has happened and effort to understand **why** negative events are taking place

Organizational factors of industrial environment; Safety culture; Human values in work environment; Person psychology Psychophysiology features

Learning a lesson from an incident:

Forming **taboo** attitude prohibition to do (repeat) incorrect operation in future.

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Fig. 5. Systematic approach to manage nuclear power plant human resources 'Proanoz



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Fig.6. The Lessons Learned from Chernobyl, Human Factor's role.

The Chernobyl accident in 1986 resulted from the overlap of many circumstances, from politics and decision-making at the governmental level to reactor design drawbacks and wrong actions of the staff due to gaps in professional training programs and regulations.

"... in general the Chernobyl NPP 1986 staff is described as quite ordinary, mature, well-formed, consisting of qualified specialists at the level recognized in the country as satisfactory. The staff was no better, yet no worse than other NPPs teams. These conclusions indicate that failures and errors were made by the staff not because the Chernobyl NPP employees had some "outstanding" characteristics » [INSAG-7, p.39]).



Fig. 7. Comparison of average data in MMPI test sampling «NPP operating personnel reference» (78 people, 1986) and the Chernobyl NPP operating personnel sampling (19 people) in pre-accident period



- L, F, K scales evaluate reliability of results. Norm 50 T-points
- [1] health concerns.
- [2] tension, depression level.
- [3] ostentation, desire to impress.
- [4] inclination to neglect social norms.
- [5] masculinity, ascendance, inclination to leadership.

- [6] persistence, determination, suspiciousness.
- [7] hypochondria, self-doubt.
- [8] identity, emotional coldness and aloofness.
- [9] level of activeness, optimism, carelessness.
- [0] desire to control and limit contacts with public.



Fig. 8. Comparison of average data on R. Cattell16-ФЛО, «C» form, «NPP operating personnel» sampling (78 people, 1986) and the Chernobyl NPP operating personnel sampling (19 people, prior to the accident)



[A] emotions, sociability, responsiveness.

- [B] maturity, activeness of thinking.
- [C] emotional stability, self-control.
- [E] independence, ascendance.
- [F] relaxed behavior, activity.
- [G] scrupulosity, commitment to sense of duty, responsibility.
- [H] inclination to risk, fearlessness, vigor.
- [I] gentleness, sentimentality, sensitivity
- [L] elevated self-assessment, lack of trust, coldness.

[M] pragmatic attitude, realism, earthiness of interests.

- [N] reserve, ethics, gallantry of manners.
- [O] anxiety, tension, sensitivity.
- [Q1] flexibility of thinking, easy change of opinions.
- [Q2] autonomy, independence from the group.
- [Q3] behavior self-control, discipline, accounting for public opinion.
- V. Abramova 2016 IA[@4] adissatisfaction, anxiety, tension.

 $Confere \cite[MD] need for approval, desire to look better.$

Fig.9. The Lessons of global and national importance

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At the state level and the industry executive level the activities of specialists and executives having safetypriority competences to provide correctly legal support of the industry companies, to guarantee competent, scientifically-based decision-making regarding nuclear power development strategy in the country are envisaged. At this level of activities the requirements to feasible selection of sites for new NPP power units and construction quality are high. Special attention is paid to identifying preferences in the choice of the safest and most economical nuclear reactors for new projects viewing science and technology evolution within the future decades.

У OINPE MEPhI OSRC "Prognoz Рис. 10. The Lessons of individual importance level

Accident lessons have the following stages for every person:

- Getting information on accident event;
- Assessment of importance, role of accident event in production activities;
- Assessment of personality meaning regarding the accident event in further activities;
- Drawing up a psychological prohibition (taboo) to repeat conditions or actions resulting in accidents of this or other type;
- Memorizing and practical utilization of rules prohibiting to repeat conditions or actions resulting in accidents of similar or other type;
- Only actions elaborated on the basis of acquired lesson are allowed.



Fig. 11. Factors influencing the processes of **taboo** formation on execution improper actions in personnel behavior.



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Fig. 12. 30 years later: what should be changed

Accepting Strategies on Safety Culture and Organizational Factors Enhancement are urgent into two major strategic areas: retrospective and perspective.

In retrospective area positive achievements and negative experience – disorders in plant operation are studied. The main instrument in this activity is disorders analysis, as precursor events and factors in events. Direct (immediate) and root causes for disorders, corrective actions to prevent their re-occurrence and to prevent them in further on are identified.

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In retrospective area, negative experience manifests in disorders of a NPP operation due to technology, procedures or human factors deficiencies. However, any disorders in technology or procedures deficiencies are results from errors made either by NPP personnel directly, or people maintaining technology, procedures at the previous stages. Human factor is a part of all disorders.

The scale of disorders depends on time coincidence or on aligning a logical chain of objective conditions and facts regarding wrong actions, or manifestations of human error consequences (wrong decisions or actions) at previous stages.



Fig.14. 30 years later: what should be changed

<u>In retrospective</u> area, in the sense of organizational culture and safety culture human factor role is determined and maintained at every stage of life-cycle and creation /implementation of development policy and industry functioning. The following packages of works or stages can be singled out:

- providing for scientific studies and feasibility study of economic and technical development in the industry,
- analysis of human resources for the industry needs,
- setting forth development strategy, staff training,
- decision-making regarding the industry development,
 identifying tactic steps in its policy and strategy, adoption of
 programs on the industry development,

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Fig. 15. 30 years later: what should be changed

- identifying geographic locations for new industry facilities taking into account seismic, engineering-geological and demographic conditions,
- construction of the industry facilities,
- scientific theoretic development, equipment calculations and designing to ensure safe and high-performance operation of the industry facilities,
- equipment installation, adjustment and start-up, commissioning,
- operation, repairs and upgrade of facilities,
- extension of operating period, decommissioning of facilities.

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"^{Prognoz} <u>In perspective area</u> it is important to organize and to implement proper development projects for the whole industry development projects, and every company functioning projects on technical level and human behavior level. To organize production it is necessary to create optimum models of successfully operating technology and people, and rules on following those models with due regard to the accumulated experience in strategic and short-term (tactical) industry development plans.

Human behavior at all levels of responsibility represents the biggest modeling (or designing) difficulty. Methodology base of designing human behavior is constituted by the human sciences: psychology, sociology, ergonomics, economics and, of course, technical sciences, defining the contents and the essence of personnel activities, their role as a participant of technological process.^{V. Abramova 2016 IAEA Safety Culture Conference}

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Currently under the conditions of social and political instability in the world, development of the project on providing high organizational and safety culture in the nuclear industry worldwide is relevant.

The project should include the following:

- concept elaboration and creation of scientific-methodical complex to manage human factor risks in the nuclear power industry;

development of educational complex on formation of professional competences in human factor area, staff activities reliability, safety culture and organizational culture for higher education institutions training nuclear industry staff for and/or providing continued advanced training;
setting up a system of knowledge regarding personnel psychology to be applied in professional activities of equipment designers, specialists on technology operation and staff management at all stages of life-cycle in

nuclear organizations;



Fig. 18. Global Projects

-organizing educational-training complexes to form psychological readiness to work by every graduate in universities training staff for nuclear power organizations, to train and correct professionally important qualities - such as responsible work attitude, stress resistance, self-control, functional state self-regulation, other psychological professionally important personality traits and psychophysiological specifics;

- outfitting educational organizations, training centers with high-performance equipment, including usage of noncontact methods to obtain bio data aimed at training functional state self-regulation and self-control under stress circumstances.

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Global Projects

Correction of professional and educational standards is required to train specialists and engineers for NPPs aimed at achieving adequate ratio between these standards and staff training with due account for technical progress and safety culture:

 enhancement of professional training quality regarding future technical personnel within the academic period at universities/institutes to ensure high level of safety culture and organizational culture of production in the nuclear power organizations;

 enhancement of human resources management quality in the nuclear industry by means of improving professional training quality in higher-education institutions.

-setting up scientific-methodology base for advanced training departments in the system of post-graduate training, in training divisions of organizations and companies, in other organizations having potentially hazardous technologies.





Fig.20. The management of Human Factors Risks in concept of Safety culture enhancement of Nuclear Industry (generalization of many researchers opinions)







Fig. 21. Sources of risks to repeat failure events in NPP operation

The most frequent reasons for repeated similar failures are such circumstances as

- Deficiencies in organizing NPP operation and management
- Inadequate employee motivation

No smaller are the risks to repeat failures due to

- Hidden construction and installation errors
- Ergonomic and technology drawbacks of procedures, regulatory documents.

Deficiencies of professional training as well as professionally important personal qualities, functional state and ergonomic drawbacks of job places are most often the reasons for single failures.



Instructions.

Fig.22. Organization-functional structure, objectives and tasks of human factor risk management system.

Risk management system: Ensuring high organizational culture and safety culture



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Fig.23. The structure of performance professional successfulness of worker



Fig. 25. Principle scheme of professional reliability and OINPE MEPHI OSRC "Prognoz system (generalization of trade researchers opinions).

Feedback. Risks of a feedback absence

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Fig. 26. Why are important social security and NPP staff fare?

Socio-economic, socio-political upheavals, crises, the threat of unemployment, recession, lowering the standard of living and quality of life.

Whipping up the situation in communities of staff, the formation of protest motivations, aspirations to defend their rights

The deterioration of the socio-psychological climate, decrease of psycho-emotional state, psychosomatic disorders among employees.

The increase in the number of diseases, decreased performance and working capacity, abnormalities in attention, memory, thinking, coordination of movements.

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Fig.27. The amendments in educational standards for NPP personnel preparation.

Higher-education institutions curriculum and programs training staff for the nuclear power industry must have disciplines on psychological training, as well as on basic psychology application skills in further production activities. Educational standards must be adequate to professional personnel standards at particular departments and positions of the nuclear power companies and must contain educational materials of the following levels: -level of motives and psychological sets for safety priority in future NPP personnel system of values (creation of safety

culture);

 level of professional knowledge regarding psychology and psychophysiology, work capacity of a working person as an object in designing man-machine systems in future professional activity of a student;

Fig.28. The amendments in educational standards

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 level of professional psychological knowledge of a person as a member of working team (regarding management, leadership, group consolidation, group interaction, personnel success management, psychological climate and other issues);

- ergonomic level of job places, level of equipment and technologies, technical documentation (instructions, labor regulations, orders and others).

Within the human factor educational disciplines in NPP safety practical studies on organizational culture development, safety culture should be included, as well as basic psycho emotional state self-regulation trainings, selfcontrol and success self-assessment for students.

Enhancement of NPP Management System and Staff Success Assessment

Action Plan:

- 1. Professiogram analysis of NPP staff positions;
- 2. Development of professional competences for OAO «Energoatom» positions;
- 3. Development of professional standards;
- 4. Elaboration of staff success management methods for OAO «Energoatom».
- 5. Enhancement of analytical methods regarding staff wrong actions based on the developed professional standards

Objectives:

- Characteristics of labor costs and job requirements to the subjects of activities in NPP staff positions;
- Vocabulary of professional competences to enhance quality of job places for OAO «Energoatom» positions;
- Reference positions and professional standards in labor organization at NPP job places;
- Regulations, scales and methods to assess and stimulate success for optimization of OAO «Energoatom» labor remuneration system.
 - Quality enhancement of psychologists activities in commissions investigating NPP failure reasons.

Fig.29. Determination of error type in the level of psychological assessment in causal analysis of operational events

ΨFig.30.Some results of analysis of wrong personnelOSRC
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work on the NPP

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Lessons Things to Be Done (proposals) Sharing Experience.

- A) Based on the international experience and national experience from every country under the conference resolution:
- 1) To single out the learned lessons given in INSAGs
- 2) To identify positive experience of certain countries to be shared by other countries
- 3) To identify the experience that needs up-date. To prepare (propose) action plan.
- 4) To set up a working group to make proposals on
- organizing psychological support of NPP staff and nuclear facilities staff (trade psychological service)
- methodology of activities on NPP organizational and safety culture.

Ψ Lessons. Things to Be Changed ^{OINPE} ^{MEPhI} ^{OSRC} ^{"Prognoz} B) It is necessary to draft:

- 1) Recommendations to national leaders of the IAEA member states to support <u>scientific development and practical advancements</u> regarding human reliability and success in nuclear industry
- 2) To address the IAEA executives for approval to set up <u>a permanent</u> <u>IAEA division (group) on human factor</u>
- 3) To address the IAEA executives for support to open <u>international</u> <u>projects</u> on:
- psychology and ergonomics issues in setting forth professional standards for NPP jobs
- training of engineering and technical staff for NPP, elaboration and approval of educational standards and training programs including disciplines on staff reliability,
- -- development of methods and up-to-date techniques iπ training NPP operators to the required psychological qualities including non-contact biotechnologies.

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Thank you for your attention

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