ЯДЕРНА ФІЗИКА ТА ЕНЕРГЕТИКА / NUCL. PHYS. AT. ENERGY 23 (2022) 245-254 ISSN 1818-331X

УДК 621.039.76 https://doi.org/10.15407/jnpae2022.04.245

O. V. Mykhailov[1,]*, M. V. Saveliev[1,2], R. L. Godun[1], V. V. Avgustov[1]

[1] *Institute for Safety Problems of Nuclear Power Plants, National Academy of Sciences of Ukraine, Chornobyl, Kyiv region, Ukraine*
[2] *Institute of Mathematical Machines and Systems Problems, National Academy of Sciences of Ukraine, Kyiv, Ukraine*

*Corresponding author: o.mikhailov@ispnpp.kiev.ua

LONG-TERM TEMPERATURE DYNAMICS AT THE PERIPHERALS ON NUCLEARLY HAZARDOUS CLUSTERS OF FUEL-CONTAINING MATERIALS LOCATED IN ROOM 305/2 OF THE “SHELTER” OBJECT BEFORE AND AFTER NEW SAFE CONFINEMENT INSTALLATION INTO A DESIGN POSITION

A brief overview of data of automated temperature monitoring systems at the periphery of nuclearly hazardous clusters of fuel-containing materials (FCM NHC) and analytical materials regarding the study of its dynamics at various monitoring points before and after installation of New Safe Confinement (NSC) into its design position, is presented. The characterization of revealed dominant trends in temperature time characteristics underway in the observation period from 1991 to 2015 and the reasons influencing their formation at various distances from FCM NHC boundaries in room 305/2, are addressed. The importance of the work of an expert research system (ERS), which functionally supplemented the existing nuclear safety monitoring system (NSMS) of CHNPP “Shelter” Object (SO) installed instead of decommissioned information and measuring system (IMS “Finish”) and other autonomous FCM monitoring systems, is highlighted. A critical analysis of the state of current temperature monitoring around the FCM clusters is provided, and a conclusion about the need to improve the existing monitoring network is made.

Keywords: Chornobyl NPP, “Shelter” Object, New Safe Confinement, nuclearly hazardous clusters, fuel-containing materials, temperature, automated monitoring system.

1. Introduction

According to state-of-the-art concepts, nuclearly hazardous clusters of fuel-containing materials (FCM NHC) produced at the accident’ active stage of Unit 4 of Chornobyl Nuclear Power Plant (ChNPP) are characterized by the highest concentration of fissile materials (FM) [1]. Just under the core of the former reactor, two areas of intensive concrete ablation of a sub-reactor slab (SRS) in the southeastern quadrant of room 305/2, are located. Based on information on material and energy balance, the estimates were carried out, which show that the most hazardous FCM cluster is located in the “southern” part of 305/2 and can contain up to 18 ± 5 t of uranium [2]. After the installation of New Safe Confinement (NSC) into the design position, the phenomena of steady growth in neutron flux density (NFD) were recorded by the measuring channels of the Nuclear Safety Monitoring System (NSMS), whose sensors are located in close vicinity to FCM NHC boundaries [3, 4]. Such behavior is completely in line with the hypothesis put forward in the past, and the results of special theoretical studies demonstrate that the observable phenomenon may be caused by the increase in the effective neutron multiplication factor in the NHC environment [5]. As a part of the implementation of the conservative approach to providing the NSC nuclear safety and to reduce the hypothetical risks of self-sustaining chain reaction in NHC environment, a range of measures was proposed. The key action here is to improve the monitoring efficiency of FCM clusters [5 - 7]. In particular, by improving the current monitoring of FCM clusters with a network of temperature sensors, which are, practically, out of service owing to technically obsolete equipment, degradation of boreholes, through which the monitoring was carried out, and the use of a number of boreholes for more priority monitoring of NFD and exposure dose rate (EDR). The objective of this work is to review the main results of long-term monitoring of FCM temperature in the SRS of ChNPP Unit 4 and to present some analytical materials devoted to temperature dynamics analysis before and after NSC installation in its design position.

2. FCM temperature monitoring and analysis of its dynamics before NSC installation

Extremely high radiation fields, blockages of ChNPP Unit 4 fragments, and “fresh” concrete, which was poured inside the emergency Unit during “Shelter” Object (SO) construction made it impossible to solve the problems regarding the study of the state of the emergency reactor in order to detect and localize the FCM at the early stages of accident mitigation. This led to the idea of deploying a network of survey boreholes from relatively accessible Unit 4 rooms in the direction of the destroyed reactor shaft. Between 1988 and 1992, more than 100 boreholes of various lengths and diameters were equipped, and instruments were installed in them to measure the NFD, ERD, and temperature, as well as photo- and video cameras [8, 9]. These measures enabled assessing the internal destructions of the reactor, defining the state of Unit structures, and determining the main FCM clusters. At the initial stages of the monitored FCM state, the temperature was measured by the sensors based on thermal resistors. Later, such sensors were replaced by temperature probes with thermocouples, which showed better reliability under conditions inside the SO aggressive environment [10]. Fig. 1 demonstrates the results of a temperature measurement performed along a range of boreholes in 1988 [10]. The above illustration clearly shows how sharply the concrete temperature in the borehole changes when the sensor moves from its mouth to FCM NHC boundaries. Based on the obtained experimental data, a cartogram of temperature fields distribution at +9.1 elevation of the SO building was built, which clearly demonstrated the presence of two powerful heat sources hidden in the SRS concrete (see Fig. 1). Such heat sources can be located inside the SO FCM with high FM content only.

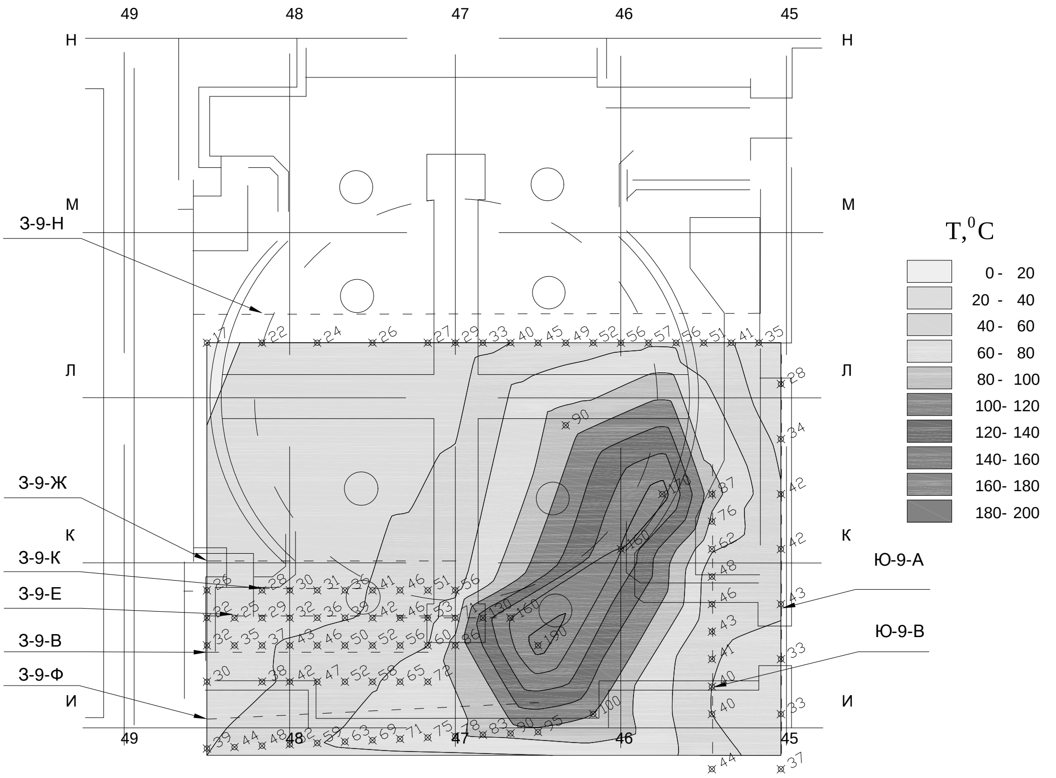

Fig. 1. Distribution of temperature fields in SRS concrete around the areas of localized nuclearly hazardous clusters in room 305/2 (November 1988). The borehole legends are given in Russian-language original designation.

In 1990, the Information Monitoring System (IMS) “Finish” was created and put into operation. It launched systematic monitoring of FCM state, including the temperature measurements around the NHC localization areas. The monitoring network provided a survey of FCM state at 64 places (points of control – PC) located at different elevations of SO building [8]. In December 1998, IMS “Finish” was split into two autonomous systems: IMS “Finish-I” and IMS “Finish-R”. The operation of IMS “Finish-I” was carried out in irregular session mode, and the IMS “Finish-R” was operated in routine monitoring mode. Fig. 2 schematically shows the temperature monitoring network around FCM NHC localization areas, which were a part of the above systems. The network of sensors was located in the boreholes between the elevations +8.8 - +9.3, on the metal sheathing of the ceiling of the steam distribution corridor (SDC) in rooms 210/5 and 210/6 (elevation +8.0) and at elevation +12.0. The obtained dataset enabled studying the long-term dynamics of concrete temperature at different distances from FCM NHC boundaries (Fig. 3), to reveal the differences in the form of its manifestation and to estimate the values of temperature gradients forming heat fluxes in different azimuthal directions from FCM cooling boundaries (Table 1) [11, 12].

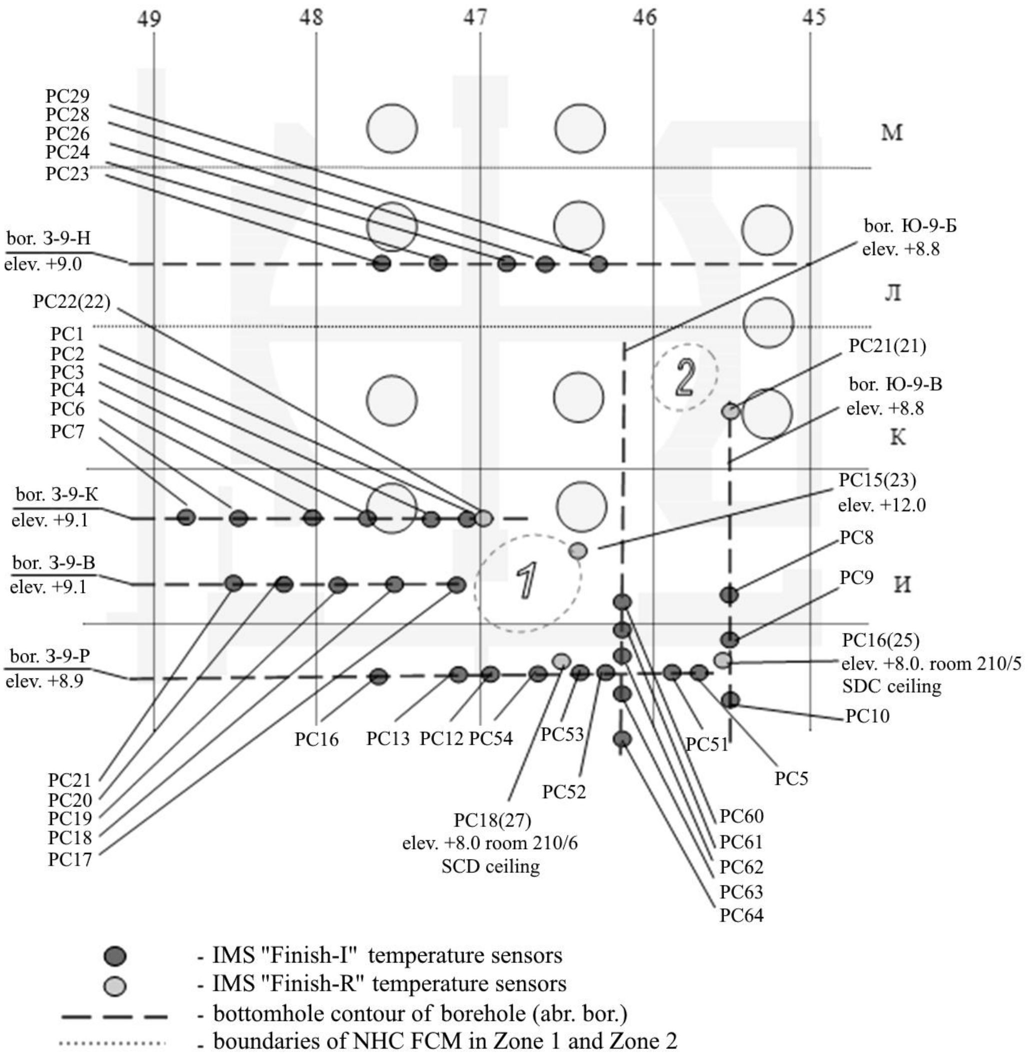

Fig. 2. Scheme of the layout of temperature sensors (PC) at NHC periphery in projection onto the plane of +9.1 elevation (10.02.2010) [12]. Marks “1” and “2” correspond to Zone 1 and Zone 2.

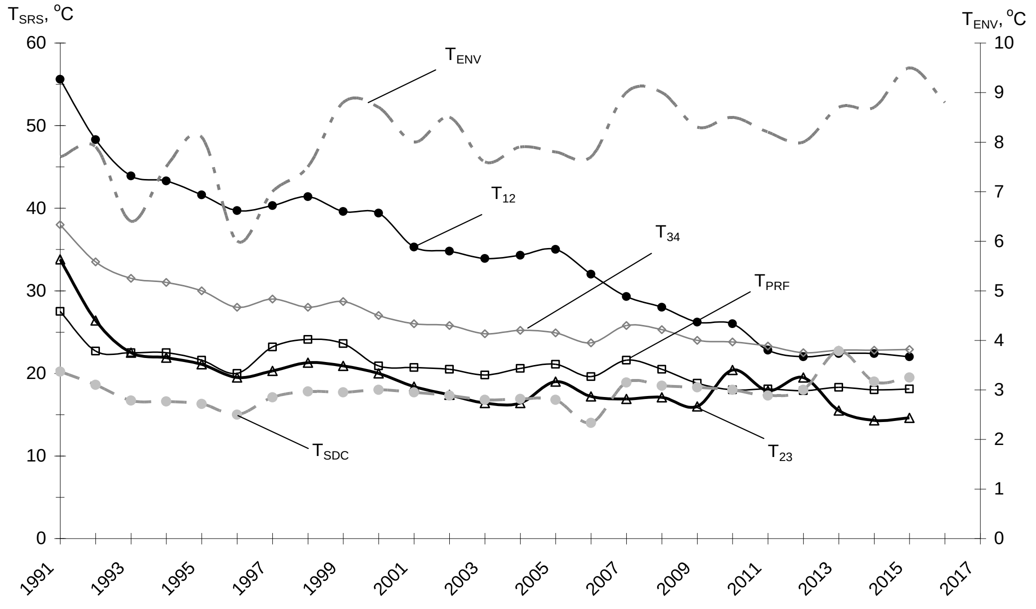

Fig. 3. Dynamics of temperature in SRS concrete at different distances from FCM NHC boundaries against the background of average environmental temperature fluctuations (T_{ENV}). Legends: T_{12} and T_{34} – temperature at 1 - 2 m and 3 - 4 m distances from Zone 1 boundaries (elevation +9.1); T_{23} – temperature at 2 - 3 m distance from Zone 2 boundaries (elevation +8.8); T_{PRF} – temperature at more than 8 m distance from Zone 1 boundaries (elevation +9.1); T_{SDC} – temperature of SDC ceiling (elevation +8.0) [12].

Table 1. **Results of evaluated temperature gradients according to 2008 - 2013 data [12]**

Compared monitoring points	Average gradient, ºC
Environment – CH (elevation +34.5)	+0.05 (± 15 %)
CH - reactor shaft (elevation +12.0)	+3.0 (± 45 %)
CH - SRS at 3 - 4 m distance from Zone 1 (elevation +9.1)	+15.8 (± 15 %)
CH - SRS at 2 - 3 m distance from Zone 2 (elevation +8.8)	+9.7 (± 20 %)
CH - SRS at 8 - 13 m distance from Zone 1 (elevation +8.8 - 9.1)	+7-11 (± 20 %)
CH - SDC ceiling (elevation +8.0)	+9.9 (± 15%)
SRS (elevation +8.9, ~ 5 m distance from Zone 1) – SDC ceiling (elevation +8.0)	–0.3 (± 10 %)
SRS (elevation +8.8, ~ 8 m distance from Zone 1) – SDC ceiling (elevation +8.0)	–1.8 (± 10 %)

Note. CH – Central Hall. The variability of the average gradient is indicated in brackets.

It was stated that the observable temperature dependences at various locations were the result of the continuous heat transfer process, which is triggered by the temperature difference between FCM NHC and atmospheric air. The concrete and the rest part of SO building, including the reactor shaft and Central Hall space, are the single intermediate media dissipating thermal energy into the environment [12].

The results of retrospective assessment of long-term dynamics of concrete temperature in monitoring points, which most representatively reflect various conditions for the formation of SRS thermal mode around the FCM NHC, have clearly demonstrated the presence of following stable trends. For a long time (up to 1998), the highest temperature gradients had been remained in the concrete (Fig. 4), which provided intensive heat removal from the FCM surface and dissipation of thermal energy generated inside the FM into the environment. By 2009, the heat release effect from the FM had decreased to such an extent that at more than 8-m distance, concrete temperature changes became negligible (see Table 1). An exception was the direction of heat dissipation from SRS lower part to SDC ceiling, where a weak tendency to increase in temperature was present (see Fig. 3).

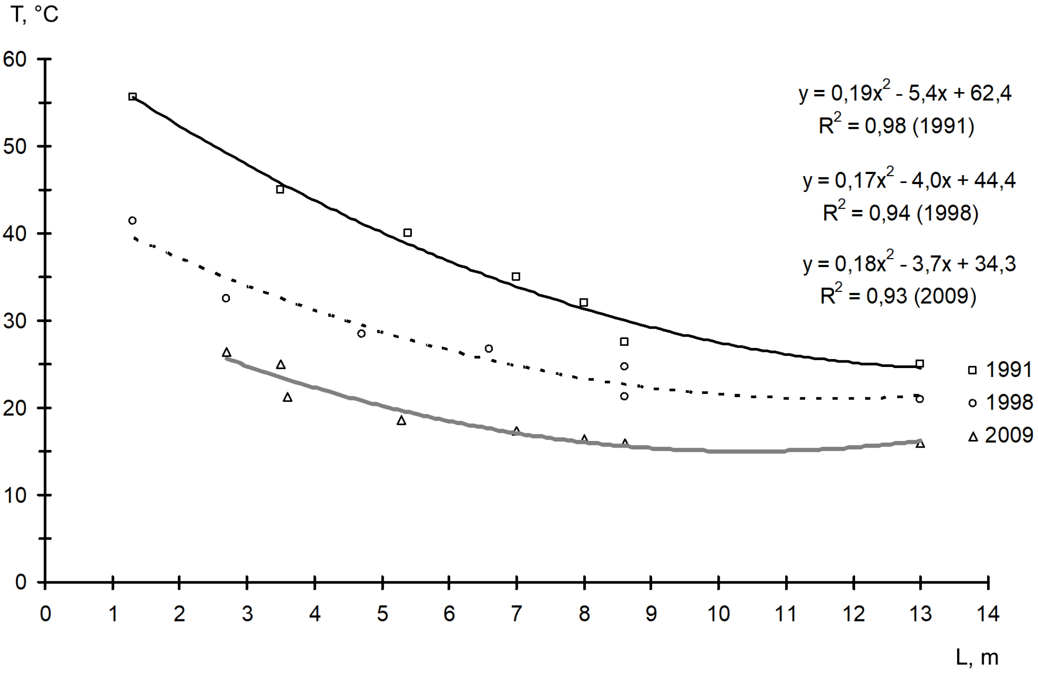

Fig. 4. Dependence of temperature in SRS concrete at the distance to FCM NHC border in Zone 1 [12].

The detailed analysis of data obtained for the 2007 - 2010 period also revealed the presence of the following features in temperature dynamics. Against the background of the stable tendency towards the recurrence of alternation of temperature minimums and maximums during the same calendar periods, its dynamics differed in different boreholes. On the whole, two main types of it were identified: Type A – with a smooth nature of temperature change in the radial direction (Fig. 5); Type B – with the presence of random sawtooth “emissions” of large amplitude from 4.3 to 8.3 °C, simultaneously observed along the entire depth of borehole (Fig. 6) [11].

The time dependences of type A were observed in dry boreholes, type B – in boreholes periodically flooded with water coming from an area having a higher temperature, than the concrete. In the absence of other heat sources, the FM clusters only could be such an area. When moving along the borehole towards its mouth, the water is cooled down. The temperature drop was estimated at values within the range of 0.8 to 1.2 °C/m.

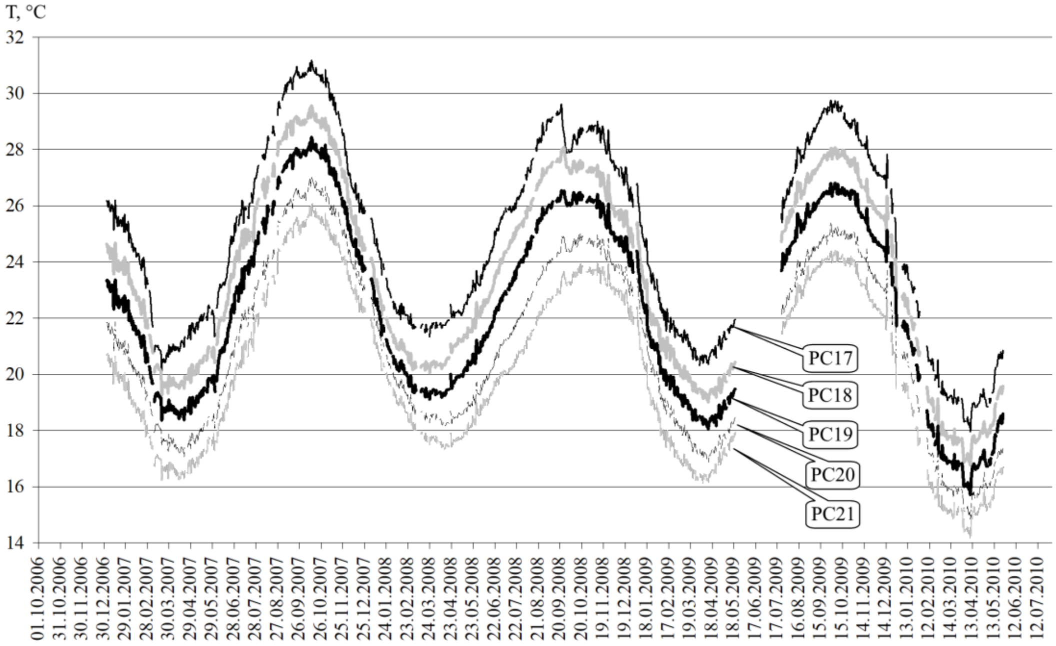

Fig. 5. An example of temperature dynamics of SRS concrete in a dry borehole (type A) [11].

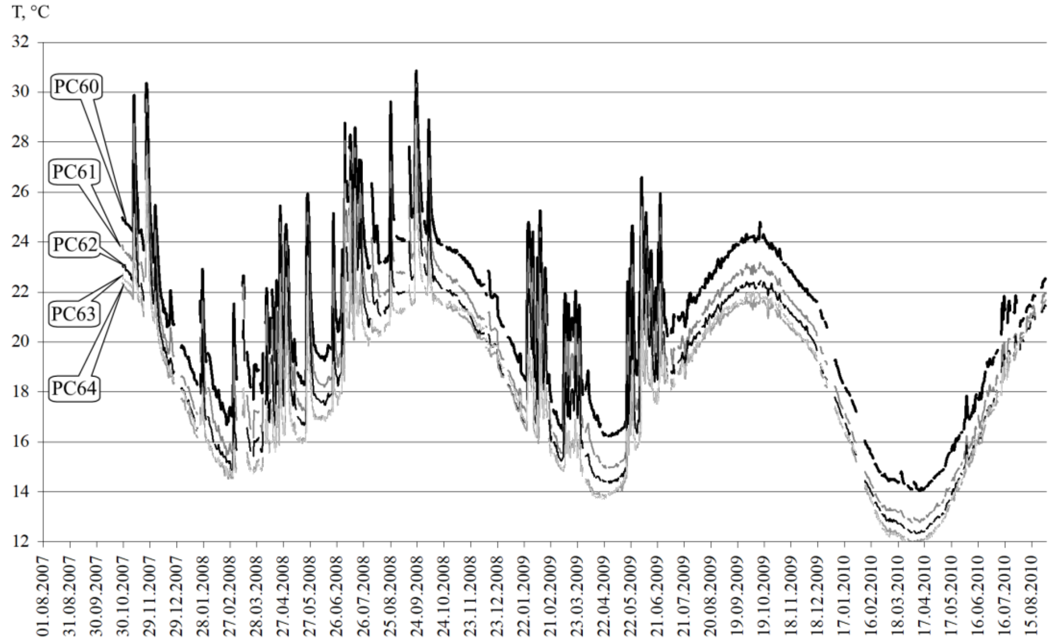

Fig. 6. An example of temperature dynamics of SRS concrete during periodic flooding of the borehole with water (type B) [11].

The data processed in [11] allowed for obtaining very important information, which was subsequently used to refine the previously estimated neutron-physical parameters of FCM NHC. Namely, in the concrete around the FCM, temperature gradients that are stable over observable time, provide necessary thermodynamic conditions for continuous heat removal from the isothermal surface of a powerful and stable source of thermal radiation within the area of FCM NHC localization.

The temperature dynamics of B type identified for boreholes at elevation +8.8 testifies that the heat source in Zone 1 was sunk in the water, whose level is not lower than this elevation. The presence of "splashes" in temperature dynamics and seasonal fluctuations of their amplitude has proven that the water level within the heat source area was constantly replenished due to atmospheric precipitation.

The amplitude of temperature "splashes" in its absolute value carries the information about the temperature gradient magnitude existing between the layer of thermally destroyed concrete and the outside surface of FCM cluster. The coincidence of average temperature at the points situated at approximately the same distance from the heat source boundary but belonging to different elevations (+8.0 and +8.9), indicates that FCM cluster surface is close to cylindrical, and differs slightly from its model form, which is used to calculate FM neutron-physical parameters in Zone 1.

Thus, before the installation of NSC in its design position, temperature distribution at FCM NHC periphery corresponded fully to the theory of heat fluxes continuity in a homogeneous medium during the transition from one isothermal surface to another, which has a large area at a radial distance from the heat source. The regularity in temperature drop with distance (see Fig. 4) was broken only for sensors located far from the cluster periphery (more than 10 m) and installed near the mouth of boreholes entering the SO rooms adjacent to room 305/2. It was found that the observed deviation from the dominant trend was caused by the influence of forced space heating, which was regularly used in the SO. The above influence manifested in the form of a systematic rise in the recorded temperature by 0.5 - 2.0 °C [12].

In 2009, in connection with the preparation for the installation and commissioning of a new nuclear safety monitoring system (NSMS), a large number of measuring sensors of IMS "Finish-I" were dismantled. Underway the work, a number of boreholes (З-9-К, З-9-В, and З-9-Ж), whose bottom holes came closest to "southern" FCM NHC boundaries, were cased with pipes in order to protect them from degradation and to permit the installation of NSMS sensors. In the next years, up to 2015, the vast majority of IMS "Finish" temperature sensors were also dismantled due to expired service life and malfunctions under extreme environments.

The detailed analysis of data obtained by IMS "Finish" during its operation period revealed the presence of the following features in time dependences of temperature drop around FCM NHC. It was found that the rate of temperature drop near Zone 1 is significantly less than near Zone 2, where decay dynamics of residual heat release (RHR) power of ChNPP Unit 4 spent fuel is generally reproduced [12]. To explain the discovered phenomenon, a hypothesis was proposed that the temperature dynamics was influenced by an additional heat source (AHS) concentrated directly in the FM environment.

The results obtained during the research [2] confirmed AHS presence in Zone 1 epicentre and made it possible to estimate its parameters more. Fig. 7 shows the results of temperature dynamics reassessment around FCM NHC boundaries against the background of RHR power drop and fluctuations in mean annual environmental temperature. As Fig. 8 demonstrates, AHS impact on the thermal mode of SRS concrete is expressed in maintaining a higher level of heat release from FCM NHC zone (Q_{sum}) as compared to the calculated value typical for RHR (Q_{RHR}) only. As it turned out, AHS contribution to the total heat release from the Zone 1 is characterized by a trend toward gradual increase.

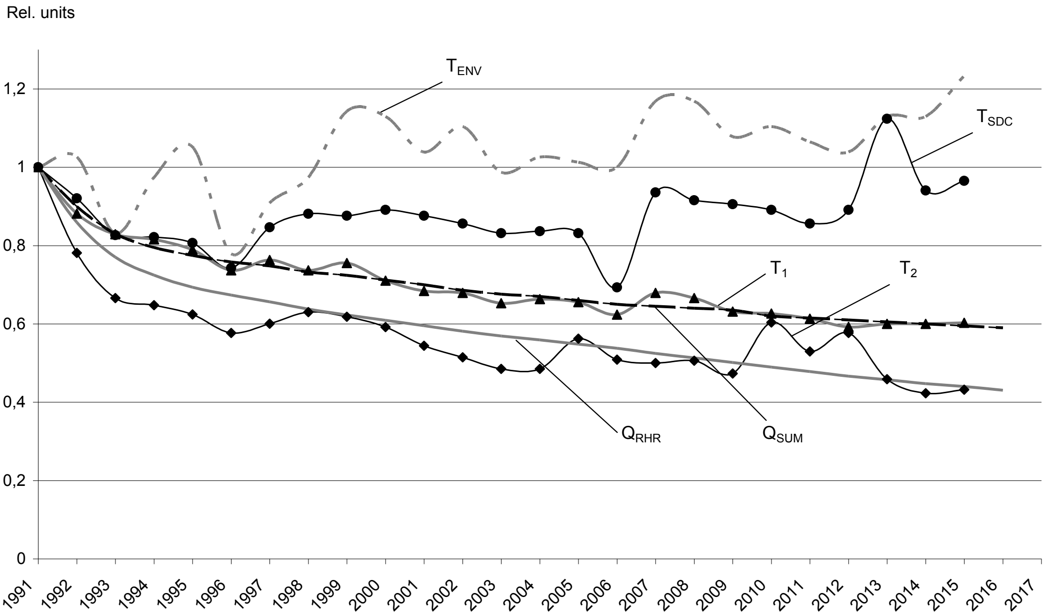

Fig. 7. The SRS concrete temperature dynamics near FCM NHC boundaries against the background of fuel RHR drop (Q_{RHR}) and fluctuations in environmental temperature (T_{ENV}). Legends: T_{SDC} – temperature in steam distribution corridor; T_1 – temperature near Zone 1 boundaries; T_2 – temperature near Zone 2 boundaries; Q_{SUM} – drop trend for the power of total heat release from Zone 1.

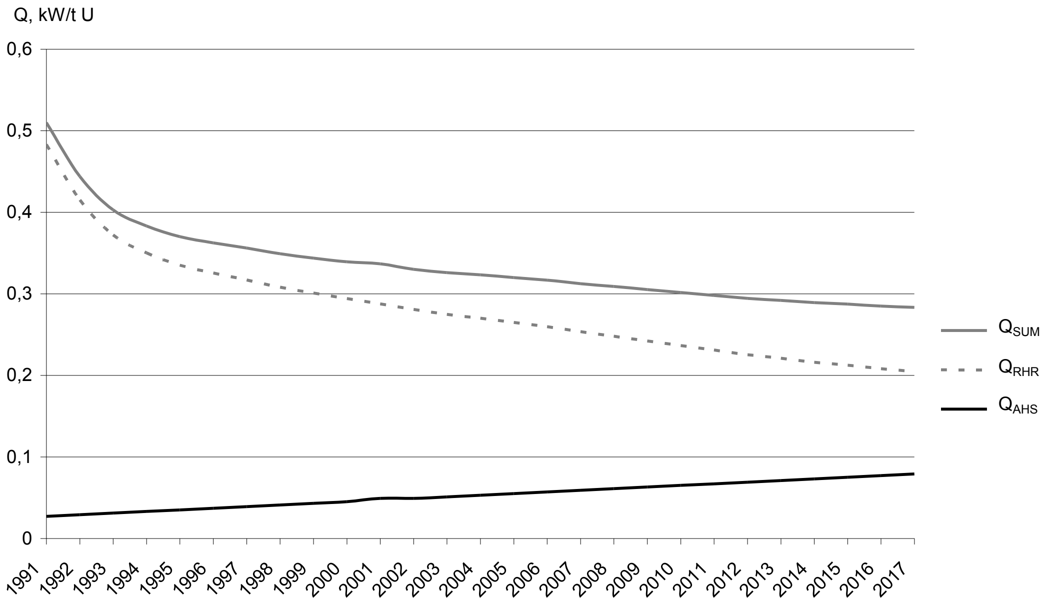

Fig. 8. Estimation of power of the additional source of heat release (Q_{AHS}), which partially compensates for fuel RHR drop. Legends Q_{SUM} and Q_{RHR} correspond to Fig. 7.

Based on the data obtained and the calculated value of spent nuclear fuel RHR (0.208 kW/t), the power of the heat source hidden under black LFCM layers and concrete cast in 1986 in the southeastern quadrant of room 305/2 was estimated at 5.1 ± 1.4 kW (November 2016) [2].

3. FCM temperature monitoring and analysis of its dynamics after NSC installation

The IMS “Finish” was decommissioned in 2016 after almost 26 years of continuous operation. At present, the NSMS is a single regular system destined for monitoring the nuclear safety of the NSC-SO Complex, however, in line with the design [7], it does not include temperature sensors. In 2017, it was decided to create an expert research system (ERS) based on the equipment that was previously a part of IMS “Finish”, one of whose functions was to monitor the temperature at FCM NHC periphery. The work to create the ERS was entrusted to the Institute for Safety Problems of NPP of the National Academy of Sciences of Ukraine. In 2019, the ERS was commissioned and partially compensated for almost completely lost temperature control after IMS “Finish” decommission [5 - 7].

To date, the ERS units integrate a network of measuring channels based on five-link thermocouple probes mounted in the boreholes, which were previously used in the IMS “Finish”, and thermal resistors installed on SDC ceiling (rooms 210/5 and 210/6). The layout of sensors (marked as PC) and information about monitored areas are given in Table 2. If we compare the coordinates of ERS sensors network given in Table 2, we can conclude that newly replaced some previous sensors, which were a part of IMS “Finish” network (see Fig. 2). This gives reason to believe that SRS temperature monitoring in eastward from Zone 1 boundaries has been restored, although to a much lesser extent than before.

Table 2. **Coordinates of installed ERS temperature sensors (PC)**

No. PC	Monitored room	Borehole*	Coordinates of temperature sensors		
			Elevation, m	Axis	Row
5	304/3	З-9-Р	+8.9	46_{-1600}	И$_{-2000}$
6	304/3	З-9-Р	+8.9	46_{-600}	И$_{-2000}$
7	305/2	Ю-12-109	+13.1	46_{-1100}	И$_{+3400}$
8	304/3	Ю-12-109	+12.9	46_{-1200}	И$_{+1900}$
11	304/3	Ю-9-В	+8.8	45_{+2700}	И$_{+1100}$
12	304/3	Ю-9-В	+8.8	45_{+2700}	И$_{-1100}$
13	305/2	Ю-9-Б	+8.8	46_{+700}	И$_{+900}$
14	304/3	Ю-9-Б	+8.8	46_{+700}	И$_{-300}$
21	305/2	Ю-9-В	+8.8	45_{+2700}	К$_{+2200}$
23	305/2	Ю-12-83	+12.0	46_{+2800}	К$_{-3000}$
25	ПРК	Ю-9-Г	+6.5	46_{-3000}	И$_{-1800}$
26	ПРК	Ю-9-Г	+6.5	45_{+1500}	И$_{-1800}$
27	ПРК	Ю-9-Г	+6.5	45_{+2900}	И$_{-1800}$

* Legend of boreholes and coordinates are given in Russian-language original designation [6].

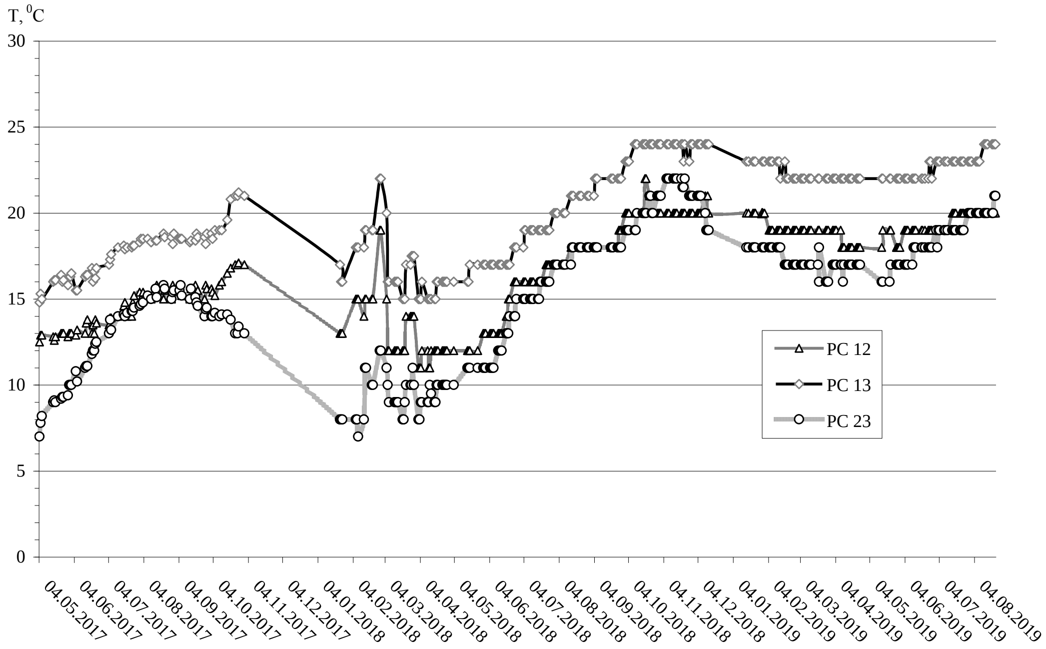

Fig. 9. SRS concrete temperature dynamics on FCM NHC periphery (Zone 1) according to data from PC 12, PC 13, and PC 23 sensors of ERS [6].

Fig. 9 shows an example of measurement data obtained using the ERS, which covers the period of temperature monitoring at FCM NHC periphery both before and after NSC installation into its design position. PC 12 and PC 13 of ERS replaced PC 9 and PC 60, which were previously a part of the monitoring network of IMS “Finish”. This gives grounds to carry out a comparative analysis of measurement results with earlier obtained data. As can be seen in Fig. 9, the values of temperature gradients in SRS concrete and between SRS and reactor shaft (PC 23) are still preserved. According to the data of [6], when approaching FCM NHC cluster boundaries, the temperature grows up by several degrees.

4. Conclusions

During the operation period of automated temperature monitoring systems, a large amount of measurement data has been accumulated. The analysis of monitoring results enabled identifying the main trends in SRS concrete temperature dynamics around FCM NHC boundaries, explaining the differences in its manifestation forms at different monitoring points, detecting and quantifying the parameters of additional heat sources, whose influence manifested in the form of more moderate temperature drop as compared to estimated decay of residual heat release power of ChNPP Unit 4 spent fuel.

For a long time (until 1998), high-temperature gradients had been remaining in the SRS concrete, which provided intense heat removal from the FCM surface and dissipation into the environment of thermal energy generated in FM cluster areas. Over time, the absolute value of temperature gradients has decreased. However, from year to year, the temperature mode retained the following features. The temperature in Central Hall of destroyed Unit 4, with a calendar shift in one month, repeated almost completely the environmental temperature. As for SRS concrete and the ceiling of the steam distribution corridor are concerned, the dynamics observed were synchronous with minimum temperatures in March - April, and the maximum ones in September - October. As a result, the calendar shift of SRS concrete temperature from the temperature in the central zone made two months, and from the environment – three months.

After the NSC was installed in its design position, the previous picture of the temperature field's distribution inside the SO was broken. However, as the data recorded at ERS monitoring points show when approaching the FM cluster boundaries, the temperature gradient of several degrees is still preserved, which creates needed conditions for heat dissipation from FCM NHC zones into the rooms adjacent to room 305/2.

It should be noted that the rejection of regular temperature monitoring in the “Shelter's” nuclear safety monitoring system was a mistake made at the stage when design requirements for the NSMS were developed. Temperature monitoring remains a reliable additional source of information regarding the FCM state. Currently, attention should be paid to improving the network of temperature monitoring points with the ability to measure temperature throughout all available boreholes. In addition, it is necessary to consider the possibility of retrofitting the boreholes used for NSMS with temperature sensors installed directly behind the NSMS sensors for the purpose of temperature monitoring in the area of installation of NFD and EDR detectors. Such an approach is technically possible owing to the geometrical shapes of the NSMS sensors and the space available in casing pipes inside the boreholes. However, it will require technical and organizing changes in the current procedures of maintaining the NSMS sensors.

The participation in writing this article provided by Valentyn Bezmylov, Leading Engineer of ISP NPP NRSD, is gratefully acknowledged by the authors.

REFERENCES

1. V.O. Krasnov et al. *Object “Ukryttya”: 30 Years After the Accident*: A monograph (Chornobyl: Institute for Safety Problems of Nuclear Power Plants, 2016) 512 p. (Ukr)
2. O.V. Mikhajlov, A.O. Doroshenko. Update results about dynamics of under-reactor slab temperature and total heat extraction from the zone of localization of nuclearly hazardous clusters in room 305/2 of the Chernobyl NPP Object “Ukryttya”. Problemy Bezpeky Atomnyh Electrostantsii i Chornobylia (Problems of Nuclear Power Plants' Safety and of Chornobyl) 29 (2017) 105. (Rus)
3. E.D. Vysotsky, R.L. Godun, A.O. Doroshenko. The dynamics of neutron activity and subcriticality of a nuclear-dangerous cluster in the conditions of NSC-SO complex. Problemy Bezpeky Atomnyh Electrostantsii i Chornobylia (Problems of Nuclear Power Plants' Safety and of Chornobyl) 30 (2018) 78. (Rus)
4. V.A. Krasnov, R.L. Godun. The state of fuel-containing materials inside the NSC “Arka” and problems connected with the ensuring of their nuclear and radiation safety. Problemy Bezpeky Atomnyh Electrostantsii i Chornobylia (Problems of Nuclear Power Plants' Safety and of Chornobyl) 32 (2019) 22. (Rus)
5. R. Godun et al. The research of changing of the neutrons’ effective multiplication factor after the construction of NSC-SO complex. In: Fourth International Conference on Nuclear Decommissioning and Environment Recovery, Proc., Slavutych, Ukraine, April 24 - 26, 2019 (Chernigiv: ChNTU, 2019) p. 45.
6. R. Godun et al. The perspectives of using of ERS for the improving of monitoring’s efficiency of the subcriticality of FCM clusters inside the NSC-SO Complex. In: Fourth International Conference on Nuclear Decommissioning and Environment Recovery, UNIDECO 19, Proc., Slavutych, Ukraine, April 24 - 26, 2019 (Chernigiv: ChNTU, 2019) p. 48. (Rus)
7. R.L. Godun, A.O. Doroshenko, D.O. Muliar. The efficiency assessment of the state system of nuclear safety control of NSC-SO. Voprosy Atomnoj Nauki i Tekhniki (Problems of Atomic Science and Technology) 2(126) (2020) 71.
8. A.A. Kljuchnikov et al. “*Shelter*” *Object: 1986 - 2006*: A monograph (Chornobyl: Institute for Safety Problems of Nuclear Power Plants, 2006) 168 p. (Rus)
9. Ye.D. Vysotskii et al. Analysis of access paths to agglomeration of fuel-containing materials in object “Shelter” room 305/2. Part 2. Research boreholes at under-reactor plate. Preprint IPB AES NAN of Ukraine 11-2 (Chornobyl, 2011) 36 p. (Rus)
10. E.D. Visotskiy, A.A. Kluchnikov, V.A. Krasnov. Localization of nuclear-dangerous accumulations of fuel-containing materials. Problemy Bezpeky Atomnyh Electrostantsii i Chornobylia (Problems of Nuclear Power Plants' Safety and of Chornobyl) 7 (2007) 66. (Rus)
11. E.D. Vysotskiy, O.V. Mikhailov. Temperature anomalies in zones of critical mass risk. Problemy Bezpeky Atomnyh Electrostantsii i Chornobylia (Problems of Nuclear Power Plants' Safety and of Chornobyl) 16 (2011) 101. (Rus)
12. E.D. Vysotsky, O.V. Mikhailov, A.O. Doroshenko. Dynamics of under-reactor slab temperature on the background of fuel afterheat decrease within critical mass risk zones. Problemy Bezpeky Atomnyh Electrostantsii i Chornobylia (Problems of Nuclear Power Plants' Safety and of Chornobyl) 22 (2014) 76. (Rus)

О. В. Михайлов[1,*], М. В. Савельєв[1,2], Р. Л. Годун[1], В. В. Августов[1]

[1] Інститут проблем безпеки атомних електростанцій НАН України,
Чорнобиль, Київська обл., Україна,
[2] Інститут проблем математичних машин та систем НАН України, Київ, Україна

*Відповідальний автор: o.mikhailov@ispnpp.kiev.ua

ДОВГОТРИВАЛА ДИНАМІКА ТЕМПЕРАТУРИ НА ПЕРИФЕРІЇ ЯДЕРНО-НЕБЕЗПЕЧНИХ СКУПЧЕНЬ ПАЛИВМІСНИХ МАТЕРІАЛІВ, ЛОКАЛІЗОВАНИХ У ПРИМІЩЕННІ 305/2 ОБ’ЄКТА «УКРИТТЯ», ДО ТА ПІСЛЯ ВСТАНОВЛЕННЯ НОВОГО БЕЗПЕЧНОГО КОНФАЙНМЕНТУ У ПРОЕКТНЕ ПОЛОЖЕННЯ

Представлено огляд результатів обробки даних автоматизованих систем моніторингу температури на периферії ядерно-небезпечних скупчень паливовмісних матеріалів (ЯНС ПВМ) та аналізу її динаміки в різних точках моніторингу до та після встановлення Нового Безпечного Конфайнменту Об’єкта «Укриття» (НБК ОУ) Чорнобильської АЕС у його проектне положення. Розглянуто характеристику виявлених домінуючих трендів поведінки температури за період спостережень з 1991 по 2015 рр. та факторів, що впливають на її формування на різних відстанях від зон локалізації ЯНС ПВМ у приміщенні 305/2. Проаналізовано дані, отримані експертною дослідницькою системою, яка після виведення із експлуатації інформаційно-вимірювальної системи «Фініш» функціонально доповнила нову систему контролю ядерної безпеки (СКЯБ) НБК ОУ. Надано критичний аналіз стану сучасного моніторингу температури навколо ЯНС ПВМ та зроблено висновок про необхідність розширення існуючої мережі моніторингу.

Ключові слова: Чорнобильська АЕС, об’єкт «Укриття», новий безпечний конфайнмент, ядерно-небезпечні скупчення, паливовмісні матеріали, температура, автоматизована система моніторингу.

Надійшла/Received 01.11.2022