STÁTNÍ ÚŘAD PRO JADERNOU BEZPEČNOST

CZECH REPUBLIC

ASSESSMENT OF THE SET OF OPERATIONAL AND SAFETY INDICATORS (PBU) FOR THE YEAR 2024

CONTENTS:

A. INTRODUCTION

The State Office for Nuclear Safety (SÚJB) performs, pursuant to Article I, paragraph 4 of Act No. 21/1993 Coll. of the Czech National Council, state administration and supervision in the Czech Republic in the use of nuclear energy and ionizing radiation in accordance with Act No. 28/1984 Coll., which was replaced on July 1, 1997, by Act No. 18/1997 Coll. and, in the area of nuclear safety requirements, replaced on January 1, 2017, by the currently valid Act No. 263/2016 Coll., according to which the SÚJB strives to ensure the highest possible level of safety through its activities. The focus of supervision lies in inspections of the operator's facilities and the evaluation and assessment of activities related to nuclear safety and radiation protection, as well as the systematic evaluation of their results. In order to objectively evaluate nuclear safety and radiation protection and identify trends, the SÚJB annually assesses the level of nuclear safety and radiation protection achieved at the Dukovany and Temelín nuclear power plants using a set of **operational** safety indicators (PBU).

The foundations for this set of indicators were laid in the late 1990s. Over the years and with the experience gained, the set **of operational** safety indicators has undergone many minor and major changes in terms of its name, structure, and responsibilities.

Since the late 20th century, the set has been structured into four stable areas in which the level of nuclear safety and radiation protection of nuclear power plant operation is assessed. These areas are as follows:

Area 1 – Events,

Area 2 – Operation of safety systems,

Area 3 – Barrier integrity,

Area 4 – Radiation protection.

A list of all assessed indicators, including their definitions, is provided in Annex 1.

Responsibility for collecting data for PBU assessment, processing and evaluation is delegated to a designated inspector at the local office of the State Office for Nuclear Safety at the Dukovany and Temelín nuclear power plants and at the Regional Centers in Brno and České Budějovice. The designated inspector at the headquarters in Prague is responsible for coordinating all activities, including the final editing and publication of results, commenting on data, estimating possible trends and further development of individual indicators, and making related proposals for possible activities of the SÚJB for the next period, with the aim of preventing any unfavorable trends in the development of the indicator.

In 2004, requirements were established for the operator of the Temelín NPP and updated in 2005 for the Dukovany NPP for the submission of operational data for the purposes of PBU evaluation, specifying what data should be submitted to the SÚJB, how often, where and in what form. The data transmitted in this way then constitutes about 70% of the input data for PBU evaluation, with the remaining 30% being obtained through the SÚJB inspectors' own control activities.

By signing the "Agreement on communication between ČEZ, a. s., and the SÚJB on events subject to legislative requirements," the criteria for "Reported Events" for both NPPs were unified on

February 7, 2007, and since 2007, the evaluation of Area 1 indicators has been based on the same definition at both NPPs. This agreement was subsequently transformed in 2013 into safety instruction BN-JB-1.1, revision 1 – Use of operating experience at nuclear facilities, which was followed until the end of 2020. In January 2021, the SÚJB issued new guidance BN-JB-5.2, rev.0, which replaced guidance BN-JB-1.1 from 2013.

In 2015, the SÚJB issued internal directive VDS 089/2016 – "SÚJB activities related to the preparation of the PBU report", which describes in detail the activities, deadlines, and responsibilities of individual SÚJB inspectors in the preparation of this document.

The results of the PBU assessment in the form of graphs for the past calendar year 2024 are again presented in Annexes 2 and 3. The individual graphs are commented on in the following sections of this document. In order to identify trends in the development of a given indicator, the graphs always show its values for the last six consecutive years, i.e., in this case, the period from 2019 to the recently completed year 2024 for the Dukovany and Temelín NPPs. In some cases, the graphs represent local values in the form of sums or averages of block values. For the inoperability of the most important safety systems, values are given at the level of individual safety systems for each unit, and values are also given at the level of each unit for the tightness of barriers.

Periodic integral leak tests of hermetic spaces (PERIZ/OZIK at EDU and PERZIK at ETE), i.e., leak tests of one of the barriers to prevent the release of radioactive substances into the environment, are designed to systematically check the tightness of the hermetic spaces of the EDU units and the containment at ETE. PERIZ / OZIK tests were systematically launched on all four blocks at EDU in 2001, and since 2011, PERIZ / OZIK tests have been performed every two years, with even blocks tested in even years and odd blocks in odd years. Periodic integral leak tests of PERZIK hermetic spaces at ETE determine the leak tightness of the ETE containment, and PERZIK tests are performed every four years.

B. EVALUATION OF THE SET OF OPERATIONAL AND SAFETY INDICATORS FOR THE DUKOVANY NPP

This section of the report contains an evaluation of individual indicators for monitored areas of operation at the Dukovany NPP, with graphical representations provided in Appendix 2.

The current graphical representation shows the last six years of operation.

In general and in summary, the evaluation of the set of EDU operational and safety indicators for 2024 shows that the overall level of nuclear safety in electricity generation at the Dukovany Nuclear Power Plant continues to be maintained at a very good level. The operation of all four units of the Dukovany NPP, including planned shutdowns for fuel replacement, always proceeded according to the pre-approved operating schedule for 2024. Individual units were shut down for fuel replacement and general repairs in 2024 during the following periods:

- Unit 1 of the EDU: August 16 to October 24, 2024 – 69.4 days
- Unit 2 EDU May 24–August 3, 2024 – 70.3 days
- 3rd EDU unit January 19–April 3, 2024 – 74.5 days
- 4th EDU block 24 December 2024 – 4 March 2025 – 70.8 days

The following text evaluates individual PBUs in groups according to their classification into relevant areas.

Area 1 – Events

This area is evaluated by the following groups of indicators:

1.A – Reported events

1.B – Operation of protective and limiting systems

1.C – Reduction in performance

1.D – Limits and conditions

Group 1.A – Reported events

The basic data for evaluating Group 1.A indicators is the number of events reported in 2024, i.e., events that correspond to the specifications in Table 2 of Safety Instruction BN-JB-5.2.

Indicator 1.A.1 – Number of incidents reported to the JB supervisory authority (Chart 1.A.1 – marked "RE"). In 2019, the number of events rose significantly to a record high of 68. In 2020, the number of events reported to the authority fell slightly to 65, and in 2021, the number of events reported to the SÚJB continued to decline to 52 events. In 2022, the RE value even fell by half, with only 26 events reported to the SÚJB, and this trend was repeated in 2023, when the number of events reported to the SÚJB was 27. Last year, in 2024, the number of events reported to the authority increased slightly to 35 reported events. However, it can be stated that this indicator fluctuates around the long-term average of 44 reported events per year, with minor fluctuations related to the operation of the units.

Safety-significant events (Graph 1.A.1 – marked BSE, SSE), classified according to the INES scale, were reported to the SÚJB in 2021, only 2 events in 2022, and in 2023 this figure increased to 5 events, and last year, in 2024, a total of 7 safety-significant events were reported. With the exception of one event last year, all of these events were classified as INES = 0. The event that occurred last year in 2024 and was rated INES = 2 was an event that occurred at Unit 3 on January 11, 2024, and was designated PNČ 124137 (event number 1/24/3) – Unreliability of Spinline process units after tester connection, unplanned LaP pumping with $N_{(R)}$reduction according to LaP rule 1.4.4.

A total of 6 other events were classified as INES = 0. They occurred on:

- 12 March 2024 (event number 8/24/9) on Unit 4, when LaP 3.3.8 was violated on all units on the PAMS1 device due to failure to perform PK5 at the required time (PNČ 130384).
- March 29, 2024 (event number 9/24/7) on Unit 3, when a power failure occurred during the ÚZNVS test and the required actions were not performed – violation of LPP 3.3.2 D1 on Units 3 and 4 (PNČ 131941).
- April 15, 2024 (event number 11/24/3) on Unit 3, when the RLS HO-3 was repeatedly activated due to the loss of P_{HPK}measurement while searching for the cause of mutual interference between cards RA673 x RA670 (PNČ 133399, 134654)
- April 24, 2024 (event number 12/24/3) on unit 3, when a fault occurred on the PC Tester during the 3PPU3 test on the Tester SP3 device and PI 015/24 was not complied with (PNČ 134760).
- October 4, 2024 (event number 25/24/1) on Unit 1, when LaP 3.5.2.1 B1 was violated due to insufficient unlocking of drive 1TH21D01 caused by human error (PNČ 149574).
- 22 November 2024 (event number 34/24/2) on Unit 2, when a violation of LaP occurred on the 2nd RB on device 2CV88S20,22 (PNČ 154268).

Graph 1.A.1 Reported events in relation to previous years shows that the number of safety-significant events is stable, i.e. 6 events rated INES = 0 or 1. In 2022, this figure fell to 2, and in 2023 there were 5 events rated INES = 0, while last year, in 2024, the figure rose to a total of 7. Given the low number of registered events, these are small numbers, but the graph shows that the values are around the above-mentioned average of 6 events without any trends indicating a significant deterioration.

Statistics on the number of reported events for individual units (number of BSE (Bellow Scale Events) and SSE (Safety Significant Events) – see Graph 1.A.1,a,b) indicate how many such events occurred at individual units. In 2024, since the start of PBU evaluation, the situation at Unit 3 seems to have deteriorated, with a total of 4 events out of 7 occurring this year. However, in 2021, Unit 1 was in a similar situation, but then returned to the average.

Indicator 1.A.2 – Human factor (Chart 1.A.2) expresses the number of events reported to the SÚJB in which human influence (HF) was identified and, at the same time, the proportion of human error in the occurrence of events reported to the SÚJB (RE) expressed as a percentage (HFI). The indicator is general and does not distinguish between the human factor of the operator and that of supplier organizations. The graph shows that the development in the area of human error, both in terms of the number of events and the HFI index, has long been around the statistical average of 36 reported events and 17% HF influence. In 2019, the number of incidents with human influence decreased to 18, only to rise again to 42 in 2020 and increase slightly to 44 in 2021. In 2022, it fell again to 31 and in 2023 rose again to 48 reported incidents with human factors. Last year, in 2024, the upward trend continued, rising to 69 reported incidents with human factors, which represented 24% of HF impact.

Group 1.B – Performance of protective and limiting systems

The first indicator in this group shows the number of unplanned rapid reactor shutdowns. The summary results of this indicator are shown in Graph 1.B.1,2, and the block values are shown in Graph 1.B.1,2a.

The last time one of the Dukovany nuclear reactors had to be shut down manually was in 2005, and the last automatic shutdown occurred in 2010 on Unit 4. In 2019, HO1 was also manually activated on Unit 1 due to the activation of ESFAS "HNK rupture, HVK (event +034/2019/1) caused by incorrect handling by OSO. In 2022, no such event occurred on any of the EDU units. Last year, in 2023, there was another rapid shutdown of Unit 3 since 2019, on December 22, 2023, when, in accordance with the applicable operating regulations, the RTS was activated during operation due to a temperature effect caused by the failure of the TG32 turbogenerator due to the action of the electrical differential protection on 3SP50 (event number 25/23/3). In 2024, there were no unplanned manual reactor shutdowns.

In 2024, as in the previous 13 years, there were no unplanned rapid automatic reactor shutdowns.

As already stated in previous PBU assessment reports, as part of the SKŘ renewal, the HO 2 functions were partially replaced by reactor protection (rapid automatic shutdown) and partially by a new RLS system, which also replaced the former HO 3 and HO 4 protections. Graph 1.B.3-5 now shows the number of RLS-3 and RLS-4 activations. As can be seen from the graph, after 2017, when there were no RLS-3 or RLS-4 activations, there were 3 RLS-3 activations and 5 RLS-4 activations in 2018, In 2019, there were a total of 4 RLS-4 activations, all of which involved HRK cartridge failure, and in 2020, there were only 2 RLS-4 activations, both on the 3rd block, but only HRK cartridge failure was signaled, and the HRK cartridges themselves did not fail. In 2023, as in the previous two years, 2021 and 2022, there were no RLS-3 or RLS-4 activations. Last year, in 2024, there were two RLS-3 activations, both on the third unit, when on April 15, 2024, event PNČ 133399 occurred – Short-term activation of RLS HO-3 during loss of P_{HPK} during the search for the cause of mutual interference between cards RA673 x RA670, and on April 26, 2024, event PNČ 134654 – Activation of RLS HO-3 due to loss of measurement reliability of all P_{HPK}sensors. However, no fundamental conclusions can be drawn from the statistics for this indicator, as these are rather random events and therefore statistics of very small random numbers. Nevertheless, in recent years, the number of RLS-3 and RLS-4 actions appears to be on a downward trend.

Indicator 1.B.6 – "Failures of regulatory authorities" has been at zero since 2018, when the last two such events occurred, meaning that there has not been a single failure of a regulatory authority in the EDU in the last six years.

Group 1.C – Performance reduction

This group includes only indicator 1.C.1 “Unplanned performance reductions” UCLF. It is expressed as the ratio of the mean value of unplanned performance reductions (technical failure rate) to the reference performance in the monitored period, expressed as a percentage.

In 2019, this indicator was 5.79. This was due to the unplanned shutdown of Unit 2 for a leak at PG26 associated with the phasing out of Unit 2. Another contributor in 2019 was the reduction in the output of Units 3 and 4 due to the failure of BQDV3,4. In 2020, this indicator fell by almost five times, and in 2021 and 2022, this trend stabilized, with values from 2020 to 2023 (1.28, 0.92, 1.19 and 0.62) and the value for last year 2024 even fell to a quarter of the value of 0.12. It is therefore clear that the values of the indicator are currently very low and are mainly due to short unplanned shutdowns or reductions in output for various operational reasons.

Group 1.D – Limits and conditions for safe operation

In 2020, there were two violations of the Limits and Conditions for Safe Operation, which is a basic operating document approved by the SÚJB. In 2021, there was one violation of the LaP, in 2022 no violations of the LaP were recorded, but in 2023 there were four violations of the LaP and last year, in 2024, there were as many as seven violations of the LaP (see Chart 1.D.1). The following events were classified as violations of the LaP:

- On March 12, 2024, a failure to comply with the 36-month inspection frequency for PK5 LP 3.3.8 for PAMS1, MK 40 was detected on Unit 2. The last calibration of the T BSVP measurement was performed on Unit 2 on September 17, 2020. Four LaP violations are therefore recorded (one for each RB) – PNČ 130384.
- On March 29, 2024, it was found that LPP 3.3.2 status D1 had not been initiated and that the required activity was not being performed at the specified frequency of 8 hours on blocks 3 and 4 due to the inoperability of the measurement of the volume activity of liquids from the heating steam evaporators. The channel stopped measuring on March 27 at 6:20 p.m. in connection with the ÚZNVS test on the 3rd block, when the evaporator TR was in operation – PNČ 131941.
- On September 29, 2024, at 6:53 p.m., pump 1TH21D01 was incorrectly released before the transition to R6 performed at 8:52 p.m. On October 4, 2024, at 8:34 a.m., the pump did not start when requested to perform a test run, at which point a LaP violation occurred on October 4, 2024, i.e., registration month 10/24 – PNČ 149574.
- On 22 November 24, a control switchover was detected for RČA 2VC88S20 and 2VC88S22 – the control key from 2VC88S20 controls 2VC88S22 and vice versa. The incorrect connection occurred in GO 2 block during the implementation of IA 8028, when the required activities were not performed in accordance with LP 3.6.3 A1. This was therefore a violation of LaP by the transition of block 2 to Mode 4 on 27. 7. 2024 at 19:41. – PNČ 154268.

The objective of the indicator "Number of forced actions initiated according to LaP" (Chart 1.D.2) is to provide a comprehensive overview of the number of equipment statuses and parameters that deviate from the safety guarantees provided by LaP. The indicator therefore summarises the number of all reactor shutdowns by protective systems; equipment states or technological parameter states which, according to LaP, necessitate the transition of the unit to a higher sequence number MODE; and also LaP VIOLATIONS, if actions to initiate the transition were taken. In 2019 and 2020, there were no forced initiations of actions according to the LaP. In 2021, there was one forced initiation of an action in accordance with LaP, when, as part of an event at Unit 1, an unsuccessful ELS3 test was performed due to a fault in the coupling of the pump of the emergency system insert 1TF60D01, resulting in the subsequent unplanned pumping of LPP 3.5.2.1. In the following years, 2022 to 2024, there were again no actions that were forced by the requirements in LaP.

The value of indicator 1.D.3 "Temporary changes in LaP" rose slightly in 2018, but then fell below the values of all previous three years in 2019 and last year, 2020, with this trend becoming even more pronounced in the following years, 2021 to 2024. The reason for the higher values of this parameter in 2018 to 2020 and the use of temporary changes in LaP was mainly the drainage of individual TVD systems related to the implementation of OP No. 73/2018, the inspection and repair of welded joints, and the replacement of measuring screens on TVDs on TQ23,43,63W0 coolers. Other temporary changes to LaP were related to the implementation of investment project 7129 – Addition of a third cooling circuit to BSVP (TG17 system). This was followed in 2019 and then in 2020 by investment projects No. 7129 – Installation of the 3rd BSVP cooling pump and project No. 7429 – Replacement of TVD supply and return manifolds for HVAC. However, previous experience was used here and the implementation was carried out with lower temporary LaP changes. These projects were then implemented in 2021, resulting in a significant decrease in this parameter. Last year, 2022, there was only one unplanned LaP change, which was related to the implementation of a new fire extinguishing system for Unit 2 as part of the implementation of JMA 6683 – Replacement of stable halon fire extinguishing equipment (SHHZ), 9082 – Modification of the EPS detection and control part to PoE and PřE, and 9084 – Installation of additional ventilation systems on PoE and PřE. After the implementation of these measures, which undoubtedly increase nuclear safety, the temporary LaP change indicator decreased significantly to values in the order of units, which indicates a reduction in equipment failure rates. All temporary LaP changes are always thoroughly reviewed by the authorities and, if they meet all legislative requirements, subsequently approved. This ensures that only measures that increase the nuclear safety of the units are implemented.

The value of indicator 1.D.4 "LaP drawdown" expresses the total number of hours of LaP drawdown in a year per unit. On the one hand, it is related to the above-mentioned indicator of permitted temporary changes to LaP, but it is also related to the operation of the unit and the condition of its equipment, when the unit, during operation and unexpected events, enters the area of limits and conditions that are still permitted and safe, i.e. into the area of time-limited limit and condition drawdown, where the unit operator must take the prescribed measures within the limits and conditions to bring the deviating parameter back within the limits and conditions of the given safe limits. In 2019, the value of this parameter fell to 1/3 of the 2018 level. In 2020, the value of this indicator returned to the 2018 level, and in 2021, the value increased slightly compared to 2020, only to rise by more than an order of magnitude in 2022, with this value persisting into 2023. This increase of more than an order of magnitude in 2022 and 2023 was related to the implementation of new fire extinguishing systems as part of JMA 6683, 9082, and 9084. During the implementation of this measure, which undoubtedly greatly increased nuclear safety, it was not possible to simultaneously operate the fire extinguishing sections and EPS according to the "old LaP" that had not yet been reconstructed and the fire extinguishing sections and EPS according to the "new LaP" that had already been reconstructed. For these reasons, there was also a significant increase in the "LaP pumping" parameter compared to previous years. Last year, in line with forecasts following the implementation of these measures, the value decreased rapidly and returned to the values of previous years, i.e., to the equilibrium average value of around 2,500, which is determined by the use of this parameter, mainly as a result of the required operational checks. The high value of this indicator in 2022 and 2023 was related to the higher utilization of permitted temporary changes to LaP for the implementation of the above-mentioned actions. However, in terms of long-term impact on nuclear safety, the implementation of these measures, for which the SÚJB issues its consent decisions, has an indisputably positive impact on nuclear safety for the further operation of the EDU.

Area 2 - Operation of safety systems

The evaluation of the operation of safety systems is based on groups of indicators:

2.A – Non-operability of safety systems

2.B – Safety system failure

Group 2.A – Non-operability of safety systems

This group is monitored using five main indicators. Their evaluation results in values related to a unit (general or fictitious) safety system at the site – site values. These results are further broken down into sub-indicators to the level of individual safety systems at the site, i.e., system values.

The first indicator in group 2.A, "BS non-operability" (SSU, graph 2.A.1), characterizes the total downtime. It shows that the average downtime of a single security system (SS) in 2019 decreased compared to the previous years 2018 to 2014, only to return to the 2017 level in 2020 and 2021. In 2022, there was a more than tenfold decrease from 0.0124 to 0.006, and this decrease continued in 2023. Last year, in 2024, there was only a slight increase. From the perspective of overall monitoring over a longer period of time, the graph shows that the value of this parameter fluctuates significantly from year to year, but does not exceed 0.014, which still indicates the very good quality of EDU safety systems, where the SSU indicator of BS type non-operability is mainly influenced by BS non-operability due to the implementation of tests prescribed by limits and conditions. The fluctuation of the parameter to higher values and its fluctuations in individual years are caused by the non-operability of these systems due to the implementation of projects approved by the authority to improve the quality of safety systems as part of increasing nuclear safety.

The graphs of sub-indicators for individual safety systems (2.A.1a-g) show that the graphs for individual BS copy the course of the previous summary graph 2.A.1, which is entirely logical and correct. In previous years, the increase in this parameter was always associated with the use of LaP for the reconstruction of the TVD system piping, where the failure of this system always led to the loss of cooling of the connected BS, i.e., also to their inoperability. In 2018 and 2019, there were shorter periods of LaP drawdown for reconstruction, which is why there was a slight decrease in this parameter for all BS in these years, and in 2020 and 2021, the value of this parameter returned to the expected average values. In 2022 to 2024, the value for all BS will be at its minimum, as no reconstruction work was carried out on any BS that would have rendered them inoperable.

The values of the indicator for the average duration of a single non-operational period of a fictitious unit BS (Chart 2.A.2) also correspond completely to the values of the individual sub-indicators (Chart 2.A.2a-g) and correspond to the aforementioned renovations at BS (TVD and BS renovations) in previous years (2020 to 2021). After completing investment projects, which always increase nuclear safety, the operator strives to ensure that the average downtime of the BS is limited to the time required for operational checks prescribed in the LaP and that the system is otherwise always operational. This parameter will approach this value in 2022 to 2024, which is why the value of this parameter in these years is the lowest in its entire monitoring history.

Chart 2.A.3 – "BS downtime frequency," which shows the frequency of BS downtime over the last six years, fully confirms the above findings from Charts 2.A.1 to 2.A.2. The values in the graph are again fully consistent with the above and relate to the implementation of work on the reconstruction of the TVD pipeline, work on connecting the TG17 cooling system to the BSVP (in 2018), the continuation of these activities in 2019 and 2020, and the completion of the activities in 2021. Each increase in the graph is always due to the implementation of one of the investment projects at the BS, which is duly approved by the SÚJB and which, after implementation, increases the JB. This effect is evident in systems where the SÚJB approved a change in LaP for the implementation of these measures (non-operability of TVD linked to the non-operability of the TJ, TH, and TQ safety systems, SHNPG, and connection of the TG17 system). For other BSs not affected by approved LaP changes, the value shows stable average values (sub-indicators in Chart 2.A.3a-g). Since no investment measures related to the drawdown of BS inoperability were carried out on any BS between 2022 and 2024, the value for these years is historically the lowest and is only approximated by the inoperability of BS systems due to the implementation of PK prescribed in LaP.

The graph for indicator 2.A.4, “Type-specific BS inoperability,” and similarly graph 2.A.4a-g "Type NPSCH of individual BS" shows that in the last three years, BS non-operability has been caused mainly by prescribed BS tests, i.e. the performance of PK prescribed in connection with the LaP approved by the authority, which verify the readiness of these systems. The graphs show that BS non-operational status due to faults and other reasons has been minimized in the last three years. In 2024, as in 2022 and 2023, the highest component is the schedule. The graph is therefore fully consistent with these findings.

In the STUR indicator chart "Standardized type non-operability" (Chart 2.A.5), which represents the ratio of all three types of non-operability, and in Chart 2.A.5a-g “Standardized type of non-operability of individual BS in 2024”, the “schedule” component again predominates in the monitored period, as was fully expected. The non-operability of BS systems due to the performance of PK prescribed in LaP contributes most to the HMG value. Another, no longer permanent, contribution to its level is the BS non-operability in connection with the implementation of planned activities, such as the reconstruction of the TVD piping and the commissioning of a new, third cooling system for the TG 17 storage pool in previous years. In 2024, higher values are recorded on PG power supply systems (HNPG and SHNPG), which were undergoing reconstruction work. This work is proceeding according to schedule in connection with changes to the LaP approved in advance by the authorities. If there is increased BS downtime due to the approved schedule, this is not a sign of an unfavorable permanent trend, but has usually been associated with the implementation of an investment project approved by the authorities, leading to a permanent increase in JB.

Group 2.B – Failure of safety systems

The indicator "Number of BS failures at start-up" (graph 2.B.1) shows that after a successful year in 2022, when there were no BS failures on any EDU block at start-up, there was one such event in 2023, which was classified as a minor event MV70/23. The event occurred on October 25, 2023, during an ELS test on the 3rd division on the 1st RB. After performing a back-up (ZZ), a signal "DG not ready for automatic operation" appeared on the BD. For this reason, unplanned drawing of limits and conditions LPP 3.7.2 A1 was initiated and the required action was taken in accordance with the relevant limit condition. The cause of the event was a fault in the circuit breaker control switch and a fault signal due to a burnt relay coil, which is used to signal the status of the switch for DG3 to the PAMS2 system. After replacing the faulty relay, the ELS test was performed without any faults. Currently, there is no increasing trend in the failure rate of the affected relay type; this was the first failure of this relay in the 6 kV switchgear superstructure. All safety system faults are always properly rectified and then successfully tested. In 2024, there were again no BS failures. Given the number of tests performed on all blocks of these systems, the values in the graph are still very low and indicate the high reliability of these devices.

The graph showing the "BS start-up system unreliability" indicator (graph 2.B.2) simply copies the previous graph in relative values based on the number of system start-ups and is used to compare the reliability of the different systems. In 2021, there were three BS start failures, which slightly increased the values in the graph for the DG and REA ZNII systems. In 2023, there was only one BS start failure. In 2022 and last year, 2024, there were no such failures. This confirms the above statement that, given the number of tests of these systems running on all units, the values are still very low, indicating the high reliability of all BS systems.

These facts are subsequently reflected in indicators 2.B.3 and 2.B.4, which monitor the behavior of safety systems during operation. Based on historical monitoring, it can be stated that in 2020, 2021, and last year, 2023, there was always one failure during operation on the DG system. The failure in 2021 occurred on February 17, 2021, on Unit 1 due to a fault in the coupling of the pump inserted in the emergency systems circuit 1TF60D01, which are common to both the TH and TQ systems (event designated as V15). The failure of safety systems during operation in 2023 occurred on the DG (see above significant event MV70/23 "DG not ready for automatic operation") and on Unit 3 of the EDU on the TJ system on pump 3TJ61D01, event designated as V21/23 "High temperature of pump bearing 3TJ61D01" on August 31, 2023, when, during operation of pump 3TJ61D01 as part of DG 9 testing after an oil change, a rapid increase in the temperature of the front pump bearing occurred in the 34th minute, to which OPO correctly shut down 3TJ61D01 without undue delay, thereby initiating unplanned pumping of LPP 3.5.2.1 A1, followed by the required action in accordance with the relevant limit condition. Last year, on April 12, 2024, at 3:58 a.m. on RB3 at 3SHNČ2, a fault was detected on the SHNČ2 pump during the ELS III test. This was a seal leak – fault V10–133269, which caused the pump to shut down during the ELS test due to a pump fault. The fault was repaired and the test was then successfully repeated. Despite these minor operational events, the graphs show that all BS equipment on all EDU units is in good condition, which testifies to the high reliability of all BS systems.

Area 3 – Barrier tightness

Barrier integrity is assessed using a group of indicators:

3.A – Nuclear fuel

3.B – Hermetic enclosure

Group 3.A – Nuclear fuel

The condition of nuclear fuel is monitored by the indicator “Fuel reliability” (FRI, graph 3.A.1) and the indicator “Number of leaking (discarded) fuel assemblies” (graph 3.A.2). The formula for calculating fuel reliability is based on empirical relationships, and in practice, three levels of FRI values are assessed:

- more than 19 Bq/g – the active zone (AZ) is highly likely to contain leakage(s),
- less than 19 Bq/g – AZ most likely does not contain any leaky fuel,
- values lower than 0.04 Bq/g are corrected to the limit value of 0.04 Bq/g due to the limited validity of empirical relationships.

A comparison of the graphs for these two indicators clearly shows their correlation. Annual FRI values at the Dukovany NPP have been very low for a long time. In 2018, the highest FRI value of 0.59 Bq/g was again detected in Unit 1. In 2019, the highest FRI value of 0.71 Bq/g was also recorded at Unit 1, and in 2020, the highest FRI value was again at Unit 1, but reduced to 0.45 Bq/g. In 2021, the highest FRI value was again on block 1, but again reduced to FRI 0.34 Bq/g. In 2022, the highest FRI value was again on block 1, at the same value of FRI 0.34 Bq/g, In 2023, the highest FRI value was again on Unit 1, where it increased to 0.60 Bq/g, and last year, in 2024, the FRI coefficient was again highest on Unit 1, where it increased to 0.87 Bq/g. These increased values are related to microscopic leaks in the fuel cladding, where temperature effects on the fuel cause a slight "blow-off" of gases from the fuel. However, the values are still very low and do not indicate fuel leakage. On the contrary, the graphs show very high fuel assembly leak tightness. This is fully confirmed by the following graph 3.A.2, showing the "Number of leaking fuel assemblies." Both graphs show that in the last seven years, the values have been well below the level that would indicate leaking fuel, and therefore no leaking fuel assemblies were identified in 2024. It should be reiterated here that, since the start of operation of all EDU units, only seven leaky (discarded) fuel assemblies have been stored in the BSVP.

Group 3.B – Hermetic envelope

Indicator 3.B.1 assesses the tightness of hermetic spaces based on the results of periodic integral tests (PERIZ / OZIK). The operator's efforts to systematically improve the tightness of EDU blocks began on all four blocks in 2001, and since then, with a few minor deviations, the tightness of the blocks has improved or fluctuated around very acceptable values. Since 2011, PERIZ / OZIK tests have been carried out at intervals of two cycles, with even-numbered blocks tested in even years and odd-numbered blocks in odd years. Since 2018, a different philosophy has been adopted for PERIZ testing, namely that the tests are carried out according to a uniform HVB construction standard, with PERIZ tests being carried out on HVB I in even years and on HVB II in odd years, at a frequency of one PERIZ/OZIK test per two cycles. PERIZ/OZIK tests can only be performed when the unit is shut down for VP and GO. In 2021, a PERIZ leak test was performed on Unit 3, and in 2022, PERIZ leak tests were performed on Units 1, 3, and 4. In 2023, PERIZ / OZIK tests were performed on units 1, 2, and 4. Last year, in 2024, PERIZ / OZIK tests were performed on units 1, 2, and 3.

During the PERIZ / OZIK test, the integrity of the airtight spaces is verified by gradually pressurizing them to 50 kPa for 8 hours, and then the measured value is extrapolated to the design overpressure of 150 kPa. By measuring and extrapolating the values measured in 2022, the tightness of the hermetic spaces of Unit 1 was determined to be 7.128% / 24 h, which is a slight deterioration compared to the previous test (in 2020 it was 6.786% / 24 h). Despite all efforts made in this regard, Unit 1 has consistently been the worst performing unit in these tests. In 2022, a value of 4.036%/24 h was measured on the third block, which is a slight improvement compared to the previous test (in 2021, it was 4.415%/24 h), and a value of 1.756%/24 h was measured on the fourth block, which is a slight improvement compared to the previous test (in 2021, it was 1.9%/24 h). 24 h, which is a slight improvement compared to the previous test (in 2020 it was 1.9% / 24 h). On the contrary, the fourth block shows historically the lowest values in this test. Since 2018, PERIZ tests have been carried out in even years at HVBI and in odd years at HVBII. In 2023, an out-of-sequence test of the tightness of hermetic spaces was performed on Unit 1 with a result of 7.508%/24 h, which is a slight deterioration compared to 2022 and again confirmed that Unit 1 is the worst unit in this respect in the long term, despite all the efforts made in this regard. Tests of the tightness of hermetic spaces were then carried out as scheduled on Unit 2 with a result of 3.407%/24 h (a slight improvement compared to 2020) and on Unit 4 with a result of 1.946%/24 h (a slight deterioration compared to 2022).

Last year, in 2024, an unscheduled leak test was performed on the hermetic spaces of Unit 3, with a result of 3.997%/24 h, which is a slight improvement compared to 2022 (4.036%/24 h). Leak tests on the hermetic spaces of Unit 1 were then carried out as scheduled, with a result of 7.481% / 24 h, which is a slight improvement compared to 2023, when the value was 7.508% / 24 h, and on Unit 2 with a result of 3.432% / 24 h – compared to 2023, this is a slight improvement of 3.407% / 24 h.

Once again, it has been confirmed that, despite all the efforts made in this regard, the first block is the worst block in the long term. However, all specifically measured data and subsequently extrapolated values of the periodic integral leak test of hermetic spaces (PERIZ / OZIK) are well below the permissible limit value of 13% / 24 h. The highest, and therefore worst, PERIZ test values measured to date were recorded in 2023 on Unit 1, at 7.508%/24 hours. However, it is clear that even this historically worst measured value is only about half of the permissible value. The values measured on all other units were always lower. All measured values are within the expected range based on previous years, i.e., they mirror the tightness of previous years and demonstrate the continued good tightness of the hermetic spaces of all EDU units.

Area 4. Radiation protection

This area is assessed by the following groups of indicators:

4. A – Radiation workers

4. B – Radioactive discharges

Group 4. A – Radiation workers

The indicator "Collective effective dose per unit" (Chart 4.A.1) monitors the collective effective dose of all radiation workers converted to one unit. In 2024, the indicator concerned 961 radiation workers at NPPs and 1,794 radiation workers at suppliers. A higher value corresponds to the length of outages and the scope of work performed. The total collective effective dose for four EDU units is shown separately for NPP workers and suppliers in Chart 4.A.2. It shows that radiation workers employed by contractors contribute significantly to the total collective effective dose (85% in 2024), as they perform the majority of maintenance activities during unit outages on a contractual basis.

The division of activities between NPP workers and contractors is also reflected in the "Average individual effective dose" indicator (Figure 4.A.3). The "maximum individual effective dose" for NPP workers in 2024 increased due to the increased frequency of certain checks (Chart 4.A.4). In general, the values for 2024 correspond to the scope of work performed. None of the workers exceeded the dose optimization limit of 10 mSv per year set by the NPP operator.

During 2024, one radiation worker was specially decontaminated under medical supervision (Graph 4.A.5).

Group 4. B – Radioactive discharges

The operational status of the Dukovany NPP in terms of radioactive discharges is assessed by the indicators "Discharges to the air" and "Discharges to watercourses." These two indicators are supplemented by five sub-indicators for air discharges and two sub-indicators for discharges into watercourses, which supplement and refine the information on discharges in terms of individual main contributors.

Graph 4.B.1 "Effective dose from air emissions" for the indicator "Air emissions" represents the radiation exposure of a representative person obtained by calculation from an authorized model for the current release of radionuclides into the air and the current meteorological situation in the assessed year 2024. In the long-term trend, the exposure of a representative person from air discharges shows a steady state.

The activities of individual contributors – radioactive rare gases, radioactive aerosols, radioactive iodine isotopes, radiocarbon, and tritium – are shown in graphs 4.B.1a – 4.B.1e. Unlike the effective dose, whose value also depends on the specific conditions of air emissions in the year under review, data on the released activity of individual components can be used to directly compare individual years and monitor their development over time. In 2024, no significant changes from the long-term trend were recorded for any of the monitored components.

Graph 4.B.2 "Effective dose from discharges into watercourses" for the indicator "Discharges into watercourses" represents the exposure of a representative person, calculated from an authorized model for the current discharge of radionuclides into watercourses and the current hydrological situation in the year under review. The effective dose from discharges into watercourses is therefore influenced not only by the amount of radionuclides discharged, but also by the average flow rate in the Jihlava River in 2024, which was 4.59 m3/s at the Mohelno reservoir profile.

The activities of individual contributors – liquid tritium and activated and fission products (AŠP) – are shown in graphs 4.B.2a and 4.B.2b. Unlike the effective dose, whose value also depends on the specific hydrological conditions of the watercourse in a given year, data on the released activity of the above-mentioned components can be used for direct comparison between individual years and to monitor their development over time. In 2024, no significant changes from the long-term trend were recorded for any of the monitored components.

In conclusion, based on the above results of the indicators in the area of "Radiation Protection," it can be stated that radiation protection at the EDU is ensured. The indicators assessing the radiation doses of radiation workers fluctuate due to the scope of work during shutdowns. The maximum annual individual effective doses do not exceed the dose optimization limit set by the operator.

Emissions to the air and water are kept at a low level. The authorized limit for the effective dose of a representative person from air emissions of 6 µSv was drawn from 0.5% in 2024. The effective dose of a representative person from water emissions in 2024 was 36% of the authorized limit of 6 µSv.

C. EVALUATION OF THE SET OF OPERATIONAL AND SAFETY INDICATORS FOR THE TEMELÍN NPP

This section presents an evaluation of individual indicators monitored in the Temelín NPP, with graphical representations provided in Appendix 3.

The year 2024 is already the 22nd year in which the operation of the Temelín Nuclear Power Plant has been evaluated using operational and safety indicators. Statistically, this is already a long period of time, during which it is possible to reliably perform statistical comparisons similar to those performed at EDU.

Based on the course of operation and evaluation of the set of operational and safety indicators for 2024, it can be stated that the overall level of nuclear safety in electricity generation at the Temelín NPP continues to be maintained at a high level. The operation of all units of the Temelín Nuclear Power Plant, including planned outages for fuel replacement and general repairs on both units, proceeded according to schedule and without significant problems. The shutdown schedules were adhered to. Due to the issue of increased turbine generator vibration, Unit 1 was not used to regulate unit output in accordance with the requirements of the ČEPS dispatch center.

The individual units were shut down for fuel replacement and general repairs in 2024 during the following periods:

- Unit 1 ETE April 5, 2024 ÷ June 11, 2024 – 66.87 days
- 2nd unit ETE October 11, 2024 ÷ December 6, 2024 – 55.55 days.

Area 1 – Events

The area evaluates the following groups of indicators:

1.A – Evaluated events

1.B – Effectiveness of protective and limiting systems

1.C – Reduction in performance

1.D – Limits and conditions

Group 1.A – Evaluated events

Since 2007, as is the case at EDU, the basis for evaluating Group 1.A indicators has been the number of Reportable Events (RE), which were originally specified in the "Communication Agreement" instead of the previously used Safety-Related Events (SRE), which were specified in the safety instruction BN-JB-1.1 – Use of Operating Experience at Nuclear Installations, according to which the procedure was followed until the end of 2020. Since January 2021, a new instruction for the use of operating experience, BN-JB-5.2, has been in force.

Indicator 1.A.1 "Events assessed" shows the number of reported significant events (marked RE in the graph) over the last six years. In 2018, the number of reported significant events reached 183. In 2019, this parameter fell to a total of 85 reported significant events, and the decline continued in 2020, when 40 significant events were reported. In 2021, the number of reported incidents rose slightly to a total of 49, and in 2022, the number of reported incidents fell again to 41. In 2023, the number of reported incidents rose again to 73. Last year, in 2024, the number of reported incidents fell slightly to 61. As can be seen, the parameter fluctuates around a median value of 58, which is related to the less than ideal and precise definition of what this parameter should include. However, efforts are being made to refine this definition through experience and practice. BSE (Below Scale Events) and SSE (Safety Significant Events) are defined more precisely, and therefore the variation in their values over the years is much lower.

The number of events in graph 1.A.1 "Evaluated events" classified according to INES 0 (marked BSE in the graph) is around the long-term average of 7. Historically, the lowest BSE value in the last 10 years was in 2022, when only 4 events were rated INES 0. However, these are small numbers, and therefore higher fluctuations can be expected.

During 2024, the following 11 significant events occurred at ETE, but they were classified as INES 0 at worst. These events occurred on the following dates:

- January 9, 2024 – event at Unit 1 designated PNČ 124048/24 – 1VF60 – deterioration of TVD flow through exchanger 1TQ30W01,
- January 17, 2024 – event at Unit 1 designated PNČ 124536/24 – Failure of 1BAa from HZO field 12, followed by failure of TG and HCČ2,
- January 18, 2024 – event on Unit 2 marked with PNČ 124657/24 – Clogging of heat exchanger 2TQ30W01,
- March 15, 2024 – event on Unit 1 marked with PNČ 130812/24 – Missing part of check valve 1VF30S05 – shutdown of HVB1,
- April 20, 2024 – event on Unit 1 marked with PNČ 135978/24 – 1GO24 – Leaky PS after campaign U1C21,
- May 25, 2024 – event on Unit 1 marked with PNČ number 137082/24 – 1GO24 – leak during TZ I. O. at P = 5.56 MPa,
- June 3, 2024 – event on Unit 1 marked with PNČ number 137782/24 – PoKo No. 4 Handling of nuclear material in SČP,
- 7 June 2024 – event at Unit 2 marked with PNČ No. 138215/24 – VTH TG SC71 failure, TG2 failure, HCČ 1, 3, 4, manual LSd,
- June 20, 2022 – event marked with PNČ 139985/24 – Shutdown of TG2 (high vibration), effective LSd,
- August 11, 2024 – event at Unit 2 marked with PNČ 144074/24 – ETE HVB2 – 2TQ10L003 measurement inoperable,
- 13 August 2024 – event marked with PNČ 144282/24 – Short circuit at switchboard 2BC/a, ROR action.

The number of events rated INES 1 at ETE (marked SSE in Chart 1.A.1 “Rated events”) is also very low, which indicates that nuclear safety is at a high level. When monitoring the SSE parameter, it should be noted that in 2018 there was one event rated INES 1 (event No. 153/18/2 – “Leakage in route 2VB20Z201.1 – violation of LaP A.3.6.2B”, which occurred at Unit 2 of the ETE on November 6, 2018). In 2019, there were no events at the ETE that were rated INES 1. In 2020, two events were classified by the authority as INES 1. The first event rated INES 1 (PNČ 20645/20 – "Failure of HVB1 (LSd) due to RCLS failure and LaP violation on May 15, 2020") was the shutdown of Unit 1 from 80% Nnom by the limiting system caused by communication failures on the data bus and simultaneous violation of limits and conditions by the unit control room operating personnel during the subsequent resolution of the event. The second event (PNČ 13755/20 – "Discrepancy between material certificates and the actual quality of metallurgical material" dated February 25, 2020) classified as INES 1 was the use of unsuitable metallurgical material on equipment at the Temelín NPP. This event was classified as INES 1, the same as the Dukovany NPP, as the causes of the discovery of deliveries of unsuitable material were identical. Between 2021 and 2024, there were no events classified as INES= 1.

Graph 1.A.1a,b shows events rated according to INES by individual units. The development of events according to their severity (rated according to the INES scale) for the period under review is around the expected values, comparable to Western nuclear units. However, it is clear from the graph that these are "small number statistics," so unfortunately, each event can have a relatively high impact.

As part of monitoring the Human Factors Events indicator (Chart 1.A.2), a total of 26 events out of a total of 61 significant events occurred in 2024, the root cause of which was determined to be human factors, representing 43%. In 2023, there were a total of 25 events out of a total of 73 significant events whose root cause was determined to be human factor, representing 34%. In 2022, there were a total of 21 events out of a total of 41 significant events whose root cause was determined to be human factor, representing 51%. In 2021, there were a total of 28 events out of a total of 49 events whose root cause was determined to be human factor, representing 57%. In 2020, a total of 32 events out of a total of 40 evaluated events were caused by human factor, representing 80%. Graph 1.A.2 shows a downward trend over the last three years in both incidents involving human factors and the influence of human factors on the occurrence of incidents. Last year, the influence of human factors increased slightly again, but whether this is an upward trend or just a statistical fluctuation will become apparent in the coming years.

Historically, the highest share of human factors in reported incidents for the entire period monitored for this parameter was in 2020, when it reached 80%. Since then, the share of human factors in reported incidents has been declining for three consecutive years. After evaluating this factor in 2020, the operator increased the intensity and effectiveness of staff training aimed specifically at reducing the impact of the LF. There was also stricter and more consistent evaluation of the root causes of events, with a focus on the impact of the human factor. The human factor plays a very significant role in NPP events worldwide, and it is therefore essential to continue to monitor its impact in detail. The operator should make increasing efforts to eliminate the human factor through better training of operating personnel and better supervision of activities, thereby reducing the overall number of events. The coming years will show whether this trend of reducing the influence of the LF can be maintained in the years to come. In view of the above, in 2024, the SÚJB should continue to focus with at least the same or even greater intensity on inspecting the implementation of the highest possible quality of personnel training and continue to monitor and evaluate this training.

Group 1.B – Operation of protective and limiting systems

Over the past 11 years, there has been no unplanned ROR (rapid reactor shutdown based on root causes in the PRPS system) at ETE, nor has there been any reactor shutdown due to LS(d) activation (see Graphs 1.B.1, 2, and 1.B.1, 2a). there was only one ROR activation on Unit 1 in 2020. The event occurred on May 15, 2020, at 00:46 (PNČ 20645/20 – "HVB1 (LSd) failure due to RCLS malfunction – communication failure of cabinet 1JZ33E531A and LaP violation). Due to its significance and LaP violation, the event was rated as INES 1. Last year, in 2024, there were two manual and two automatic rapid reactor shutdowns, i.e., four ROR activations. These were the following events:

- On January 31, 2024, at 00:09, the reactor was shut down due to an increase in hydrogen leakage from SP01D001. After a previous smooth reduction in reactor power, a transition to R3 Manual LS(d), manual ROR according to 2TCD003 part A was performed – without entering TC007.
- On March 17, 2024, at 14:55, the HVB1 reactor was shut down in Unit 1 due to the transfer of the unit to MODE 3 and subsequently to MODE 5 with regard to the pumping times of the relevant limit conditions associated with activities on the important technical water 1VF30. After a previous smooth reduction in reactor power, a transition to R3 was performed. Manual LS(d), manual ROR according to 1TCD003 part A – no entry into TC007.
- On June 7, 2024, at 05:11:44, there was a failure of VTH TG SC71, shutdown of TG2, and activation of LSc+a on Unit 2. This was followed by problems with the feed heads due to high Δp caused by high TBN2 speeds. Furthermore, LSa was activated due to low levels in PG4 and later also in PG2 (L < 210 cm and falling), and after the situation worsened further, LSd was manually activated from 11.4% output on the instructions of VRB.
- On August 13, 2024, at 11:17 a.m., a block outage occurred on Unit 2 due to ROR activation because of "power input 3 of 4 HCČ < 50%" and "flow in 3 of 4 loops < 90%." The cause of the event was a short circuit at the 2BC/a switchboard – event 144282).

The limiting system of other types (a, b, c) was activated a total of six times in 2020, including three activations of LS(a), one activation of LS(b), and two activations of LS(c). In 2021, there were only four occurrences, including three LS(a) activations and one LS(c) activation. LS(a) was activated on Unit 1 on May 23, 2021, at 5:17 by manually reducing the power using the LS(a) button due to high TG vibration, and the second time again on May 23, 2021, at 6:48 by manually reducing the power using the LS(a) button due to high TG vibration. The third activation of LS(a) occurred on the second unit on June 20, 2021, at 1:21 from the signal "MEZ II – closure of the input to the TG NT part" – closure of 2SE05S301 from the SPP technological protection (level control failure in 2RN81B001 L), while the power was reduced from 100% to below 38% N_{nom} . The limiting system was activated a total of 7 times in 2022, of which 2 were LS(c) activations and 5 were LS(b) activations. In 2023, other types of limiting systems (a, b, c) were also activated a total of 7 times, including 6 LS(a) activations and 1 LS(b) activation. Last year, in 2024, the limiting system of other types (a, b, c) was triggered a total of 22 times, of which 17 were LS(a) and 5 were LS(c). The values determined in 2024 in the LS(a) section increased significantly, but this value is related to the multiple effects of LS(a) and LS(c) within the above-mentioned 4 LS(d) effects. In the coming years, this value is likely to return to normal so that it does not deviate significantly and remains within the expected values for LS(a), LS(b) and LS(c). From a long-term perspective, it can be said that these are small numbers, so the increased values found in 2024 should not yet be interpreted as a trend. This will only become clear in the coming years, but a return to the expected values for LS(a), LS(b) and LS(c) is more likely.

The LS(d) limiting system (i.e., all cartridges falling into AZ) has not been triggered manually by the operator even once in the last eight years. Automatic triggering occurred in 2020, with two automatic interventions on Unit 1. In the following year, 2021, there was also one automatic activation of the LS(d) limiting system on Unit 2. The event occurred on June 23, 2021, with the root cause being "no KČ in operation." The cause of the entire event was a storm that knocked down the V052 power line pylons, followed by the activation of the "HAZR" protection and the failure of all operating KČs – the event has the number 50793. In 2022 and 2023, there were no activations of the LS(d) limitation system. Last year, there were a total of four incidents involving the activation of the LS(d) limitation system, one automatic (2nd block on August 13, 2024, ROR HVB2 – short circuit in switchgear 2BC/a – PNČ144282) and three manual interventions.

For better clarity, all activations of the LS(a) to LS(d) limiting systems in 2024 on the ETE (a total of 26 LS activations occurred in 14 events) are listed below as follows:

- On 17 January 2024 – HVB1 – **LS(a+c), LS(a)** – PNČ124536 - Failure of substation 1BAa (ZO activation during measurement Riz 1SD11D001), resulting in failure of HCČ1 and activation of LSa+c (target power 50%). Outage of HCČ2 from LPg2, activation of LSa.
- On 31 January 2024 – HVB2 – **LS(d) manual** – PNČ125476 – HVB2 – leak 2ST01W001 with H2 leak into the engine room. DP 2B124/02/01, shutdown for repair of hydrogen cooler leak.
- On 1 March 2024 – HVB2 – **LS(a)+c, LS(a) manual** – PNČ129195 - Rapid increase in vibration behind NT3 at the rear, **LS(a) RUČ** power reduction initiated**,** entry into TC0006/1 cap 1.0. 1:19 Increase in vibration behind NT3 above 10 mm/s, manual shutdown of TG using the emergency button, **LS(a+c)** intervention below 40%.
- On 17 March 2024 – HVB1 – **LS(d) manual ROR** – PNČ 130812 - Shutdown of unit for repair of ZK 1VF30S05.
- On 7 June 2024 – HVB2 – **LS(a+c) automatic, LS(d) manual** – PNČ 138215 – HVB2 failure shutdown – TG failure due to VTHTG shutdown due to a fault.
- On June 14, 2024 – HVB1 – **LS(a) manual, LS(a+c)** – PNČ139506 – **LS(a**) and subsequently LSa+c – Shutdown of TG1 due to high vibration.
- On 20 June 2024 – HVB2 – **LS(d)** – PNČ139985 – LSd activated due to no TBN in operation
- On 26 June 2024 – HVB1 – **LS(a+c)** – PNČ 140581 – Sudden increase in temperature 1RL12T017 from 46 degrees to 138 degrees (max. 150 degrees). TBN2 failure – LS(a+c) activated.
- On 15 July 2024 – HVB2 – **LS(a) manual, LS(a) automatic** – PNČ 141924 – TG2 shut down due to high vibration, **manual LS(a)**, TG shut down using the emergency button. **Automatic activation of LS(a)**.
- On 16 July 2024 – HVB1 – **LS(a)** – PNČ142143 – **LS(a)** activated at target value 38% due to failure of ½ of pumps 1VC01D002.
- On 29 July 2024 – HVB2 – **LS(a) manual**, **LS(a) automatic** – PNČ143196 – TG2 vibration
- On 27 September 2024 – HVB2 – **LS(a) manual, LS(a) automatic** – PNČ148934 – Shutdown of TG2 (high vibration)
- On 14 December 2024 – HVB2 – **LS(a) manual, LS(a) automatic** – PNČ156281 – Rapid increase in bearing support vibration and TG rotor vibration
- On 31 December 2024 – HVB2 – **LS(a) manual** – PNČ157099 – Reduction of TG2 output by 700 MWe to stabilize vibrations

Group 1.C – Power reduction

The value of "Unplanned power reductions" (Chart 1.C.1), which is expressed as the ratio of the average value of unplanned power reductions (technical failure rate) to the reference power in the monitored period in percent, compared to 2015, when it reached a historic high of 32.2, there was a gradual but significant decline to 0.37 in 2022. Its increase in 2023 to 1.58 and last year, 2024, to 5.65 is mainly related to turbine vibration issues.

Group 1.D – Limits and conditions for safe operation

Graph 1.D.1 “LaP violations” shows that there was one LaP violation in 2018 (event No. 153/18/2 at Unit 2 on November 6, 2018, “Leak in route 2VB20Z201.1 – LaP violation in LPP A.3.6.2B”, rated INES 1), in 2019, as in 2016 and 2017, there were no LaP violations, but in 2020 there were two LaP violations. The first case was an event on May 15, 2020, PNČ 20645/20 – "HVB1 (LSd) failure due to RCLS malfunction – communication failure of cabinet 1JZ33E531A and LaP violation, where a total of three operating limit conditions (A.3.1.5B, A.3.1.6B, and A.3.9.2) were violated. The second LaP violation occurred on September 21, 2020, when the LPP for hermetic seals (A.3.6.2A) was violated. – LaP violation. There were also two LaP violations in 2021, the first event marked PNČ 42633/21 dated March 22, 2021 2021 in relation to both blocks, i.e. two LaP violations, when it was found and confirmed by the external company KLIKA BP that complete monthly and annual PKs were not being performed in accordance with LaP B.3.7.6 because KLIKA employees did not have the necessary access authorization via KV130 and 230. In 2022, there was a single LaP violation on September 10, 2022 – a violation of LPP A.3.3.2 and A.3.7.2 in connection with a failure to perform an activity in the event of a steam leak on ND HVB2 – event marked PNČ 85009. In 2023, there were again no incidents involving LaP violations. Last year, in 2024, there was one LaP violation. The breach was the failure to perform activities A.1.1 on August 8, 2024, as part of incident PNČ 144074 – breach of LaP HVB2 for LPP nd A.3.3.3, status A – post-accident monitoring system – PAMS – not measuring 2TQ10L003.

The LaP violation indicator is a very important indicator in terms of nuclear safety, as LaPs are one of the basic documents for safe operation and are therefore approved by the authorities. Therefore, any violation of LaP is always of fundamental importance for nuclear safety. The license holder is also aware of this and therefore strives to minimize this indicator. It is not easy to evaluate the graph, as it is a "small number statistic," meaning that even a single event can have a "relatively high value." The number of LaP violations in the graphs for the last six years is random and occurs at an acceptably low frequency.

Graph 1.D.2 – "Enforced initiation of actions according to LaP" tells us that even in 2024, the sixth year, no such action has been taken. The last such recorded event (No. 153/18/2) was recorded in the graph in 2018 after 12 previous years in which no other event requiring action (transition to a mode with a higher serial number based on the requirements of the Limits and Conditions enforced by the technological state of the equipment or parameters) occurred.

Chart 1.D.3 – “Temporary changes to LaP” is defined as the number of temporary changes to LaP approved by the authority that were used during the operation of a nuclear power plant. These are mostly temporary changes to LaP necessary for the implementation of an investment project that increases nuclear safety after implementation. For example, in 2022, one request for a temporary change to the LaP was made for Unit 2, issued as 2TPI2022/031 for the implementation of investment projects involving the reconstruction of TVD2 and the overhaul of VTKS2, TG12, which was approved by SÚJB Decision No. 19342/2022 of July 28, 2022, as a temporary change to document 2TL001. In 2021, there were two requests for temporary changes to LaP. The first case involved a temporary change to 1TL001R7/DZ04 as part of the "Implementation of TVSA-T nuclear fuel, mod.2," which was approved by SÚJB Decision No. 8538/2021 of April 15, 2021, as a temporary change until the next revision of document 1TL001. The second case was a temporary change to 1TL001R7/DZ06 – for the implementation of investment projects E623, E771, F255, and G266, supplemented by additional operational activities on shut-down equipment during the TVD (1V321) outage planned for October 2021. The temporary change was approved by SÚJB Decision No. 16232/2021 of July 16, 2021, as a temporary change until the next revision of document 1TL001. In 2023, two changes were approved by the authority, namely a temporary change to LaP 1TL001 issued as 1TPI2023/017 for planned activities within the shutdown of TVD Division 3, approved by SÚJB Decision No. 11234/2023 dated April 28, 2023, as a temporary amendment to document 1TL001. The second temporary amendment to LaP 2TL001 for Unit 2 was issued as 2TPI2023/015 for planned activities within the shutdown of the TVD Division 3 and was approved by SÚJB Decision No. 11235/2023 of April 28, 2023, as a temporary amendment to document 2TL001. Last year, in 2024, the authority also approved two changes, namely a temporary change to LaP 2TL001 issued as 2TPI2024/005 for Unit 2 for the performance of activities on important technical water systems (repair of flap 2VF30S05 and cleaning of exchanger 2TQ30W01, repair of flap 2VF20S05 and performance of activities on the 1st division of the TVD ETE system (2VF10)) – approved by SÚJB decision No. 12510/2024 of 7 May 2024 as a temporary change to document 2TL001. The second temporary change to LaP 1TL001 approved by the authority was a change issued as 1TPI2024/003 for Unit 1, approved by SÚJB Decision No. 12511/2024 of 9 May 2024 for the shutdown of the first division of the TVD ETE system (1VF10) for the implementation of investment projects H158, H159, F254, G007, G280, G490, G491, G840, I766. It is therefore clear that temporary changes to LaP are used to implement investment projects which, once implemented, increase nuclear safety.

The "LaP utilization" indicator (Chart 1.D.4) reached 6,641 hours in 2022, which is a slight increase compared to 2021, when it reached 6,491 hours. In 2023, there was a further significant increase to 11,628 hours. Last year, in 2024, the value fell slightly to 11,194 hours. However, this is all justifiable, as this indicator is defined as the sum of all LaP usage times in hours (averaged value per block). Since there were no requests for temporary changes to LaP in 2020, the value of this parameter in 2020 is the sum of the times required for LaP use only to perform the system tests prescribed in LaP, which is the state that every power plant would prefer to achieve. However, in 2021, two temporary changes to LaP were implemented to increase nuclear safety, which is why this indicator was higher in 2021 than in 2020. Also in 2022, investment projects E623, E771, F255 and G266 were implemented, which involved the use of LaP approved by the authorities. In 2023 and last year, 2024, the indicator was higher than in 2022, as two temporary LaP changes were applied to TVD to increase nuclear safety (see above). And since a change in LaP for TVD and work on TVD systems is always associated with the operability, or in this case the inoperability, of safety systems that are cooled by TVD, the use of LPP for TVD also resulted in the use of LPP for these related systems.

Parameters monitoring limits and conditions for safe operation are an important indicator of the nuclear safety status of each unit, as a violation of LaP is always a very significant event from a nuclear safety perspective. All events involving a violation of LaP are therefore analyzed in great detail, investigated, evaluated, and corrective measures are taken to prevent recurrence. Therefore, both the operator and the SÚJB place great emphasis on correctly and specifically formulated and then fully implemented corrective measures (UNO), which are imposed after each event has been investigated in order to prevent not only the recurrence of the event, but also the possible occurrence of a similar event on another system. All of this is then checked by the SÚJB at the end of the investigation as part of feedback checks.

Area 2 – Operation of safety systems

The evaluation of the operation of safety systems is based on the following groups of indicators:

2.A – Non-operability of safety systems

2.B – Failure of safety systems

Group 2.A – Non-operability of safety systems

This group is monitored using five main indicators, which result in values for the unit (general) safety system at the site – site values. These results are further broken down into sub-indicators to the level of individual safety systems, i.e. system values.

The first indicator in group 2.A – "BS unavailability" (SSU, graph 2.A.1) saw a slight increase in 2023 and again in 2024 compared to 2022, but there is a logical explanation for this increase. It is related to a temporary change in LaP approved by the authority and the non-operability of the TVD system, on which planned activities were carried out as part of nuclear safety improvements during the shutdown of TVD on Units 1 and 2. As mentioned above, the change in the LaP for the TVD and work on the TVD systems is always linked to the operability or, in this case, the inoperability of the safety systems cooled by the TVD. Therefore, in 2023 and 2024, this indicator increased both overall and for individual safety systems (see Graph 2.A.1 and Graphs 2.A.1.a – g). However, the value does not deviate unexpectedly or significantly and seems to fully correspond to the fact that temporary changes to the LaP were drawn on the units to carry out actions on the TVD, which increases nuclear safety for the future. Ideally, for this indicator, no LaP changes should be used for investment projects and there should be no unplanned unit outages. Then the main contribution to the BS's unavailability would be its unavailability during the testing and trials within the limits and conditions of the prescribed tests. This status was almost achieved at ETE in 2019. And that is the goal of every power plant.

The indicator "Average BS downtime" – ASTU (Chart 2.A.2) showed a slight increase in 2023 and last year 2024 compared to the previous three years. This again corresponds to the above information on the use of temporary LaP changes for safety systems to implement measures for future nuclear safety improvements.

Graph 2.A.2a-g shows the values for individual safety systems. This graph shows that the value is significantly lower for hydroaccumulator (HA) systems, as no TVD system is required for HA operability and therefore temporary changes to LaP for TVD are not reflected in HA operability. In the coming years, these values are expected to stabilize at levels related only to non-operability due to prescribed tests and inspections of BS equipment.

FSSU indicator – "BS downtime frequency" (number of downtimes of a single general BS route per 1,000 hours of required uptime, graph 2.A.3) was the lowest in the last six years in 2023 (value of 1.22), but rose again last year to 1.52. Here, too, this increase is in line with the implementation of IA on the TVD of both units. From a temporal perspective, it can be said that this parameter has been declining since 2016, but as can be seen from the graph, its value fluctuates around a median value of 1.45. The stabilization of this parameter around this value indicates good maintenance and condition of the BS equipment. The parameter monitors the frequency of BS downtime and its minimum value occurs when the parameter reaches a value related to BS downtime solely due to prescribed tests and inspections on the equipment.

Another indicator in this group is "BS type unavailability" (SSU(T) – Chart 2.A.4). This local indicator expresses the ratio of the total downtime of a unit BS for the corresponding reason to the time when its availability was required. Since January 1, 2007, the Office has distinguished and recorded planned and unplanned non-operability. Planned non-operability continues to include all long-term (annual) planned measures to ensure that systems can perform tests prescribed by the LaP document, or long-term planned repairs of systems and equipment. Everything else is considered unplanned non-operational status. As can be seen from the graph, unplanned non-operational status has changed only minimally in recent years, in connection with the occurrence of events – BS equipment failures that occur in a given year. In recent years, the SSU(T) value has shown a slight downward trend, with only a slight increase in 2022 due to the unplanned shutdown of pump 1TX30D01 to adjust the oil levels of the rear bearings (oil overflow, replacement of the oil seal between the bearing assemblies) and detected leaks in the 2QD11W01 cooler on the TVD side and oil during 2GV operation (excluding DGS operation). In 2023, no such events occurred, and therefore the parameter returned to the values of the previous years 2018 to 2021. In 2022, the value increased, but in 2023 it decreased again, and last year, in 2024, the parameter rose slightly again due to two unexpected failures of the M40-05 card on measurement 1TQ13F001 (PNČ 123605, PNČ 123605).

Planned downtime in 2024 increased slightly again compared to 2023, but this increase in 2024 was due to the implementation of planned actions on TVD, which were carried out. The values in the graph fully correspond to this. The parameter is within the limits resulting from planned and implemented actions on BS.

Chart 2.A.4a-g – The type of non-operational availability of individual BSs in 2024 again demonstrates all the above-mentioned connections with the implementation of planned measures on TVD. The graph shows that activities in the TVD route divisions and the associated permitted use of LaP had the same impact on all emergency BSs that were also inoperable during the implementation period of the actions. Once again, a significantly lower value can be seen for HA, whose operability is not dependent on the TVD system.

The STUR indicator (Chart 2.A.5) shows the ratio of the two types of BS unavailability specified above in relative terms. In 2022, as in previous years, the value of unplanned BS downtime remained around the median value of 0.32, which indicates that there are no increased unplanned BS outages and that BS maintenance remains at a very good level. In 2023, this parameter decreased significantly, which is due to the fact that the numerator of the ratio – the total downtime of BS for the relevant reason – was completely minimized in 2023, and the denominator of the ratio – the total downtime of the system – was extended due to the measures taken in 2023. In 2024, the value returned to the expected values of previous years. Graphs 2.A.5a-g show this ratio for individual systems in 2024 and are fully consistent with the previous summary graph 2.A.5.

Group 2.B – Failure of safety systems

In 2024, there were no failures of safety systems at the DGS. The last failure occurred in 2021 on October 7, 2021, at Unit 2, when the 2DGS3 was shut down by overspeed protection during a 3-minute test run (event PNČ 58936/21). The second BS failure in 2021 occurred on October 21, 2021, at Unit 2, when pump 2TQ22D01 failed to start during the APS2 test (event PNČ 58936/21). In 2020, there was one failure of the safety systems (on the DGS) on February 16, 2020, when DGS2 was shut down by protection after start-up and its subsequent start-up was blocked. Such events are classified as start-up failures – see Graph 2.B.1 and Graph 2.B.2. In 2019, as in 2018, there were no failures of safety systems during start-up, and the last such event occurred in 2017, when this event was recorded for "slow DG start-up" (connection time of 10.123 seconds was longer than the required 10 seconds). As can be seen, these are random occurrences and therefore statistics based on small numbers, but there has been no significant increase in the values of this parameter throughout the period of monitoring.

As for the other two graphs in this group (Graph 2.B.3 and Graph 2.B.4) monitoring safety systems during operation, in 2024, as in the previous years 2021 to 2023, there were no failures during operation. In 2020, there was only one such event, namely on August 31, 2020, when DGS2 was shut down, which is recorded in Graph 2.B.3 and Graph 2.B.4 as system unreliability during operation.

In general, it can be stated, and the graphs in this group also confirm this, that the reliability of safety systems remains at a very high level. BS failures are rare, which testifies to the good maintenance of these systems and their high reliability. If a BS malfunction occurs, it is always investigated in detail, the cause of the event is identified, and then measures are taken to prevent a similar event from recurring. After repair, the system is always fully tested, as these are important systems related to nuclear safety.

Area 3 – Barrier integrity

The barrier integrity is assessed using a group of indicators:

3.A – Nuclear fuel

3.B – Containment

Group 3.A – Nuclear fuel

The condition of nuclear fuel is monitored by the indicator “Fuel reliability” (FRI, graph 3.A.1) and the indicator “Number of leaking (discarded) fuel assemblies” (graph 3.A.2). The formula for calculating fuel reliability is based on empirical relationships, and in practice, three levels of FRI values are assessed:

- more than 19 Bq/g – the active zone (AZ) is highly likely to contain leakage(s),
- less than 19 Bq/g – AZ most likely does not contain any leaky fuel,
- all calculated FRI values less than 0.04 Bq/g are corrected to the limit value of 0.04 Bq/g due to the limited validity of empirical relationships.

In 2024, the 14th campaign ended on Unit 1 and the 13th campaign ended on Unit 2 with new TVSA-T fuel. The FRI values on individual units remained significantly lower in 2024 than in 2020 and 2021. For Unit 1, the values decreased from 56.21 Bq/g in 2021 to 11.49 Bq/g in 2022, 7.39 Bq/g in 2023, and 6.23 Bq/g in 2024. For block 2, there was a decrease from 1.31 Bq/g in 2021 to 1.17 Bq/g in 2022, 1.04 Bq/g in 2023, and 1.26 Bq/g in 2024 – see graph 3.A.1.

The distribution of FRI throughout the calendar year 2024 is shown in Graph 3.A.1a for both units. These values correspond to only four leaky fuel assemblies detected in Unit 1. In both 2022 and 2023, only one leaky fuel assembly was detected in Unit 1. In 2021, a total of five leaky fuel assemblies were detected, all on Unit 1, where the FRI values were much higher than on Unit 2 – see Figures 3.A.2 and 3.A.2a below. During planned outages, all fuel assemblies are removed from the active zone and inspected. The probable cause of the leaks appears to be excessive deflection of the fuel rods and the resulting interaction between the rods and the structural elements of the fuel assemblies, where minor leaks occur. The leaky fuel assemblies detected in 2021 were older versions (modification 1); newer versions (modification 2) no longer exhibit leaks on the fuel rods, as shown in the graphs for this parameter. The current condition of the fuel, or rather its leaks, do not affect increased dosing by personnel. Due to the indicated leaks, all leaking fuel assemblies are always replaced with new ones and the leaking fuel assemblies are stored in the spent fuel storage pool. It should be noted here that statistically, the leakage of fuel assemblies is around the expected average values comparable to the global standard.

Group 3.B – Hermetic envelope

There is only one indicator for the tightness of the hermetic envelope, which is shown in Graph 3.B.1 and evaluates the tightness of the ETE containment based on the results of the PERZIK test. PERZIK tests are performed every four years.

The last tests on Unit 1 were carried out in 2015, when a value of 0.1232% was measured. The next test on Unit 1 was then carried out four years later, between April 17 and April 20, 2019. This PERZIK test on Unit 1 found a value of 0.134%. Another test on Unit 1 was carried out again after four years, in 2023, between May 22 and May 24, 2023, and a value of 0.161% was measured. The permissible value for this parameter is 0.4%, so despite a slight increase, the value measured in 2023 is only 40.25%, less than half the permissible value.

The last tests on Unit 2 were carried out in 2017, when a value of 0.1537% was measured. After four years, a PERZIK test was carried out on Unit 2 in 2021, between August 15 and August 18, with a result of 0.1513%, which represents only 37.8% of the permitted value. The tightness of the hermetic envelope on Unit 2 improved slightly in 2021 compared to 2017. Last year, in 2024, a PERZIK test was performed on Unit 2 between November 24 and November 26, 2024, and the measured value – the leakage rate, extrapolated to the design overpressure at LOCA, i.e. 400 kPa, is 0.1387% mass leakage per 24 hours, which is slightly better than the previous two tests.

The next PERZIK test is now scheduled to take place in 2025 on Unit 1. As mentioned above, the measured leakages show very good results in all cases. The graph shows that, despite a slight previous deterioration on Unit 1, the tightness of the containment envelope for both units remains good. This is in line with project expectations and international experience.

Area 4. Radiation protection

This area is assessed by the following groups of indicators:

4. A – Radiation workers

4. B – Radioactive discharges

Group 4. A – Radiation workers

The indicator "Collective effective dose per unit" (Chart 4.A.1) monitors the average collective effective dose of radiation workers converted to one unit. In 2024, this indicator concerned 876 radiation workers at NPPs and 1,793 radiation workers at suppliers. The indicator “Collective effective dose” (Chart 4.A.2) monitors the total collective effective dose ETE separately for NPP workers and supplier workers. Increased collective effective doses in some years are due to the greater volume and structure of work in the controlled area during shutdowns. In 2024, there was an increase in both the collective and average individual effective doses. There was also an increase in the “Maximum individual effective dose” indicator (Chart 4.A.4), which corresponds to the above-mentioned scope of work performed in the CP. None of the workers exceeded the dose optimization limit of 10 mSv per year set by the NPP operator.

In 2024, no radiation worker had to undergo special decontamination (see Graph 4.A.5).

Group 4.B – Radioactive discharges

The operating status of the Temelín NPP in terms of radioactive discharges is assessed by the indicators "Discharges to the air" and "Discharges to watercourses." These two indicators are supplemented by five sub-indicators for air discharges and two sub-indicators for water discharges, which provide additional information on discharges in terms of individual main contributors.

Graph 4.B.1 "Effective dose from air discharges" for the indicator "Air discharges" represents the radiation exposure of a representative person, calculated from an authorized model for the current discharge of radionuclides into the air and the current meteorological situation in the year under review. In recent years, this indicator has remained at fractions of the annual authorized limit of 10 µSv for air discharges set by the State Office for Nuclear Safety. In 2024, as in previous years, this indicator reached a value of 0.02 µSv.

The activities of individual contributors – radioactive noble gases, radioactive aerosols, radioactive iodine isotopes, radiocarbon, and tritium – are shown in Figures 4.B.1a to 4.B.1e. Unlike the effective dose, whose value also depends on the specific conditions of the dispersion of emissions into the air in the assessed year 2024, data on the released activity of individual components can be used to directly compare individual years and to monitor developments over time. Compared to recent years, a decrease can be observed in iodine isotopes (Figure 4.B.1c), radioactive rare gas emissions (Figure 4.B.1a) and tritium emissions (Figure 4.B.1e). Emissions of C-14 (Graph 4.B.1d) and radioactive aerosols (Graph 4.B.1b) have remained stable in recent years within normal variations. These changes have had virtually no impact on the effective dose from air discharges, which remains well below the SÚJB authorized limit for air discharges.

Chart 4.B.2 "Effective dose from discharges into watercourses" for the indicator "Discharges into watercourses" represents the radiation exposure of a representative person, calculated from the authorized model for the current discharge of radionuclides into watercourses and the current hydrological situation in the year under review. The annual authorized limit for discharges into watercourses is 4 µSv. In 2024, the effective dose from discharges into watercourses was 0.40 µSv, the same as in the previous year.

The activities of individual contributors – liquid tritium and fission products (FP) – are shown in graphs 4.B.2a and 4.B.2b. Unlike the effective dose, whose value also depends on the specific hydrological conditions of the watercourse in a given year, data on the discharged activity of the above-mentioned components can be used to directly compare individual years and monitor their development over time. In the case of tritium discharges, a slight upward trend can be observed.

Based on the results of the indicators in the area of "Radiation Protection," it can be concluded that radiation protection at the ETE is at a high level. The indicators evaluating the doses of radiation workers show long-term stable values, fluctuating only as a result of the scope of work during outages. The maximum annual individual effective doses are also relatively low.

Emissions to the air and water are kept at very low levels. The authorized limit for the effective dose to a representative person from emissions to the air of 10 µSv was used at the ETE in 2024 at a level of 0.2%, similar to recent years. The effective dose to a representative person from discharges into watercourses reached 10.0% of the authorized limit of 4 µSv in 2024, the same as in 2023.

The course of individual indicators in 2024 for the Temelín NPP therefore clearly shows that nuclear and radiation safety at this site is at a level typical for NPPs with pressurized water reactors.

D. CONCLUSION

The evaluation of individual operational and safety indicators and their trends following the so-called "welds case," which was a problem with proving the quality of welded joints from 2015 – 2016 at both sites and the resulting investigation of their actual quality, any necessary repairs and the associated extension of unit outages, is now a thing of the past, and all operational and safety indicators at both the EDU and ETE nuclear power plants have returned to their expected average values.

In terms of trends in individual operational and safety indicators, it can be stated that there was no significant deterioration in any of the monitored indicators in 2024 and that all monitored and evaluated parameters are within the expected ranges and statistical error margins, especially if the parameter in question falls within the limits of "small numbers" statistics. In such cases, even a small ("even just one") change can significantly affect the movement of the parameter in question, and its impact may appear significant, However, in this case, it is important to realize that if even one event per year can affect a given parameter multiple times, the parameter must be evaluated in the context of several consecutive years. Such parameters include, for example, BS failure during operation or BS failure during operation. In this respect, 2024 was one of the more successful years, but in 2021, for example, the parameter BS failure during operation (see graphs 2B) had a significant impact. However, when monitoring these parameters over consecutive years, it can be seen that any parameter can "fly off," but if this is not a trend over several years, it is due to the random nature of the process and the subsequent evaluation of small numbers. However, if any parameter shows an increased or sustained growth, it is necessary to look at the parameter and the equipment to which it relates in more detail, analyze the entire situation, and then take measures to ensure that the parameter or the equipment returns to the expected average values. In 2024, only two parameters on the ETE appear to be suspicious, namely parameter 1.B – Effect of protective and limiting systems (Graph 1.B.1,2 and Graph 1.B.3-5) and the parameter "Unplanned power reductions" (Graph 1.C.1). The effectiveness of protective and limiting systems rose from zero last year to 4, and there was also a significant increase in "Unplanned power reductions" last year, with this parameter reaching a historic high of 32.2 in 2015. However, from 2017 to 2022, this parameter decreased, returning to the expected average values of previous years to a long-term average of 0.93. Its increase in 2023 to 1.58 and last year in 2024 to 5.65 is most closely related to turbine vibrations, which do not pose a significant problem in terms of nuclear safety.

Both the authority and the operator investigate all safety-related incidents in detail, rectify any faults and, in addition, take corrective measures to prevent similar incidents from occurring, even on similar equipment throughout the power plant. The correctness of this "feedback" process is also closely monitored by the SÚJB.

In addition to the good condition of the equipment, its operational readiness and reliability during operation, well-trained, high-quality and reliable personnel are equally important for the safe operation of both nuclear power plants. Only the harmony between technology and its operators can guarantee the reliable and, above all, safe operation of nuclear power plants. For this reason, it is necessary to continue to pay attention to both the quality of technology and the quality of training and education of operational personnel.

In order to ensure the continued safe operation of Czech nuclear power plants, in 2025 the SÚJB will continue to focus intensively on inspections of the condition, ageing and reliability of equipment, as well as on the training and practices of personnel. The Authority will continue to require the operator to constantly emphasize to each employee that the quality of their work significantly affects not only the number of incidents, but also, and in particular, nuclear and radiation safety.

The evaluation of operational and safety indicators at both nuclear power plants for 2024 shows that almost all evaluated indicators were within the usual expected values in all evaluated areas, and that a high level of nuclear safety and radiation protection was maintained during energy production at **both the Dukovany** and **Temelín nuclear power plants** in 2024.

E. ABBREVIATIONS

AŠP	activated and fission products
AZ	reactor core
BL	safety limit
BS	security system
BSVP	spent fuel storage pool
ČEZ	Czech Energy Works
DG	diesel generator
DKP	lower end position
DKV	lower limit switch
E	individual effective dose
EDU	Dukovany Nuclear Power Plant
ETE	Temelín Nuclear Power Plant
GO	general overhaul
HA	hydro accumulator
HMG	schedule
HP	hermetic spaces
HN PG	emergency power supply system for steam generators (EDU)
HO	emergency reactor protection
HRK	emergency and control cartridge
HUA	main shut-off valve
INES	International Nuclear Event Scale
IO	primary circuit
JB	nuclear safety
NPP	nuclear power plant
LI	site inspector of the State Office for Nuclear Safety and Protection
LS (a,b,c,d)	limitation system (various functions)
LaP	Limits and conditions
LPP	Limiting condition for operation
NT	low-pressure system

NOS	setting of protective systems
OKJZ	nuclear facility inspection department
OROPC	fuel cycle radiation protection department
OZIK	repeated containment integrity test
PG	parogenerator
PBU	Operational safety indicator(s)
PERIZ	Periodic integral test of hermetic spaces
PERZIK	periodic containment integrity test
PRPS	primary reactor protection system
PSA	atmospheric venting station
RB	reactor block
RC	regional center SÚJB
REAZNII	automatic mode of the category II secured power supply system
ROR	rapid reactor shutdown
RTS	reactor trip system
S	collective effective dose
SAOZ (SHCHAZ)	emergency cooling system AZ
SHN PG	super emergency power supply system for steam generators (EDU)
SKŘ	control and monitoring system
SW	software
SZB	safety assurance system
TJ	high-pressure emergency refilling system AZ
TH	low-pressure emergency refill system AZ
TQ	EDU shower system / AZ emergency cooling systems and ETE containment shower system
TX	PG emergency power supply system (ETE)
VP	fuel replacement
VT	high-pressure system
ZIK	containment integrity test
ZKOB	protection and interlock tests

F. APPENDIX No. 1

LIST OF OPERATIONAL AND SAFETY INDICATORS USED BY SÚJB

Area 1 – Events

Group/Indicator	Indicator name	Graph label	Graph title	Note
1.	**Reported / Evaluated events**			EDU/ETE
1.	Number of reported events – RE (Reportable Events)	1.A.1	Reported events – RE	EDU/ETE ***B1***
1.A.1a	Number of INES events > 0 - SSE (Safety Significant Events)	1.A.1a,b	Events according to INES – block values	***B1.1***
1.A.1b	Number of INES events = 0 – BSE (Below Scale Events)	1.A.1a,b	Events according to INES – block values	***B1.2***
1.A.2	Human error – HF, HFI	1.A.2	Human factor	***B2***
1.	**The effect of protective and limiting systems**			
1.B.1	Unplanned rapid automatic shutdown of the reactor – US (Unplanned Scram)	1.B.1,2 1.B.1,2a	Unplanned rapid reactor shutdowns Block values ROR	***P***
1.B.2	Manual rapid reactor shutdown – USM (Unplanned Scram Manual)	1.B.1,2 1.B.1,2a	Unplanned rapid **reactor** shutdowns Block values ROR	***P***
1.B.3	Automatic reduction of reactor power by HO-2 / LS (c) - APR2 (Automatic Power Reduction)	1.B.3-5	Automatic reduction/limitation of reactor power	EDU/ETE ***P2***
1.B.4	Automatic reduction of reactor power by HO-3 / LS (a) – APR3 (Automatic Power Reduction)	1.B.3-5	Automatic reactor power reduction/limitation	EDU/ETE ***P2***
1.B.5	Automatic reactor power limitation by HO-4 / LS (b) – APL4 (Automatic Power limitation)	1.B.3-5	Automatic reactor power reduction/limitation	EDU/ETE ***P2***
1.B.6	Control rod drop – CRD (Control Rod Drop)	1.B.6	Control rod drops	EDU
1.B.6	Action of the type d limiting system – LS(d)	1.B.6,7 + 1.B6,7a	Effect of LS type d + Block values of LS type d effect	ETE ***P2***
1.B.7	Manual action of the type d limiting system – LS(d)	1.B.6,7 + 1.B6,7a	LS type d action + Block values of LS type d action	ETE ***P2***
1.	**Power reduction**			
1C.1	Unplanned performance reduction - UCLF	1C.1	Unplanned performance reductions	

Group/Indicator	Indicator name	Graph label	Graph title	Note
1.D	**Limits and conditions for safe operation**			
1.D.1	Number of violations of limits and conditions – VLC (Violation of Limits and Conditions)	1.D.1	Violation of LaP	***B3.1***
1.D.2	Number of forced actions initiated according to LaP – AILCR (Actions Induced by L&C Requirements)	1.D.2	Actions according to LaP	***B3.3***
1.D.3	Number of temporary changes LaP- ELC (Exemptions from L&C)	1.D.3	Temporary changes to LaP	***B3.2***
1.D.4	Drawing of L&C Limits and Conditions	1.D.4	Drawing of LaP	

Area 2 - Operation of safety systems

Group/Indicator	Indicator name	Graph label	Graph name	Note
2.	**Safety system failure**			
2.A.1	BS – SSU (Safety System Unavailability)	2.A.1	Local BS unavailability value	
	BS system unavailability – SSU_s (Safety System Unavailabilities)	2.A.1a-g	DG, TJ, TH, TQ, HA, HN PG, SHN PG unavailability / DG, TQx1, TQx2, TQx3, TQx4, HA, TX unavailability	EDU/ETE ***R1 - R5***
2.	Average BS unavailability time - ASTU (Average System Time Unavailability)	2.A.2	Average BS downtime	
	System average BS downtime – $ASTU_S$ (Average System Time Unavailabilities)	2.A.2a-g	Average downtime of individual BS	
2.A.3	Frequency of BS unavailability – FSSU (Frequency of Safety System Unavailability)	2.A.3	Frequency of BS downtime	
	System frequency of BS unavailability - $FSSU_S$ (Frequency of Safety System Unavailabilities)	2.A.3a-g	Frequency of individual BS failures	

Group/Indicator	Indicator name	Graph label	Graph name	Note
2.A.4	Type of BS unavailability - SSU(T) (Type of SSU)	2.A.4	Type of BS non-operability	
	System type non-operability BS - $SSU(T)_S$ (Type of SSU_S)	2.A.4a-g	Type of individual BS non-operability in 200x	
2.A.5	Standardized type of BS non-operability - STUR	2.A.5	Standard type non-operability of BS	
	System standard type unavailability BS - $STUR_S$ (Relative System Type Unavailabilities)	2.A.5a-g	Standardized type unavailability of individual BS in 200x	
2.	**Failure of safety systems**			
2.B.1	Number of BS failures at start-up - NSF_s (Number of Starting Failures)	2.B.1	System failure at start-up	***R6.1***
2.B.2	BS start unreliability - SU_s (Starting Unreliability)	2.B.2	System unreliability at start-up	
2.B.3	Number of BS failures during operation - NRF_s (Number of Running Failures)	2.B.3	System failure during operation	***R6.2***
2.B.4	BS running unreliability - RU_s (Running Unreliability)	2.B.4	System unreliability during operation	

Area 3 - Barrier integrity

Group/Indicator	Indicator name	Graph designation	Graph name	Note
3.	**Nuclear fuel**			
3.A.1	Nuclear fuel reliability - FRI (Fuel Reliability Index)	3.A.1	Fuel reliability	***P4.1***
3.A.2	Number of leaking fuel assemblies – NLFA (Number of Leak Fuel Assemblies)	3.A.2	Number of leaking fuel assemblies	***P4.2***
3.	**Hermetic envelope**			
3.B.1	Results of PERIZ/PERZIK blocks - L_e (Leak)	3.B.1	PERIZ/PERZIK results	EDU/ETE ***P6***

Area 4 - Radiation protection

Group/Indicator	Indicator name	Graph label	Graph name	Note
4.	**Personnel**			
4.A.1	Collective Effective Dose per Unit – S_U	4.A.1	Collective effective dose per unit	
4.A.2	Collective effective dose for nuclear power plant personnel and suppliers to the nuclear power plant - S (Collective Effective Dose)	4.A.2	Collective effective dose	
4.A.3	Average individual effective dose of nuclear power plant personnel and suppliers to the nuclear power plant - E_{avg}(Collective Effective Dose per Capita)	4.A.3	Average individual effective dose	
4.A.4	Maximum individual effective dose received by one nuclear power plant worker and one nuclear power plant supplier worker - E_{max} (Maximum Individual Effective Dose)	4.A.4	Maximum individual effective dose	
4.A.5	Number of workers with special decontamination - NWSD (Number of Workers with Special Decontamination)	4.A.5	Number of workers specially decontaminated	
4.B	**Radioactive discharges**			
4.B.1	Emissions into the air - E	4.B.1	Effective dose from emissions to air	
	Total activity of radioactive noble gas discharges	4.B.1a	Radioactive noble gas discharges	
	Total activity of radioactive aerosol emissions	4.B.1b	Radioactive aerosol emissions	
	Total activity of radioactive iodine isotope emissions	4.B.1c	Emissions of radioactive isotopes of iodine	
	Total activity of C-14 discharge	4.B.1d	C-14 discharges	
	Total activity of gaseous tritium discharge	4.B.1e	Tritium gas releases	
4.B.2	Discharges into watercourses - E	4.B.2	Effective dose from discharges into watercourses	
	Total activity of liquid tritium discharge	4.B.2a	Liquid tritium	

Group/Indicator	Indicator name	Graph label	Graph name	Note
			discharges	
	Total activity of liquid discharge of activated and fission products	4.B.2b	Liquid effluent of activated and fission products	

Note:

1) A note without a symbol means that the same indicators are used for both EDU and ETE
2) if only EDU or only ETE is indicated in the note, the indicator is used only at the relevant location, which means that the indicator is specific to the given NPP and a different indicator is used for the other NPP or no indicator is used at all
3) EDU/ETE is specified in the note – indicator for EDU/indicator for ETE
4) the designation in italics in the note indicates a link to indicators contained in the agreement between SÚJB and ČEZ on a common set of indicators, where the letter indicates the area assessed (***P*** - Operational Continuity, ***R*** - Operational Risk, B - Access to Safety), unless this designation is specified, the indicator has not been included in the joint set of indicators of SÚJB and ČEZ

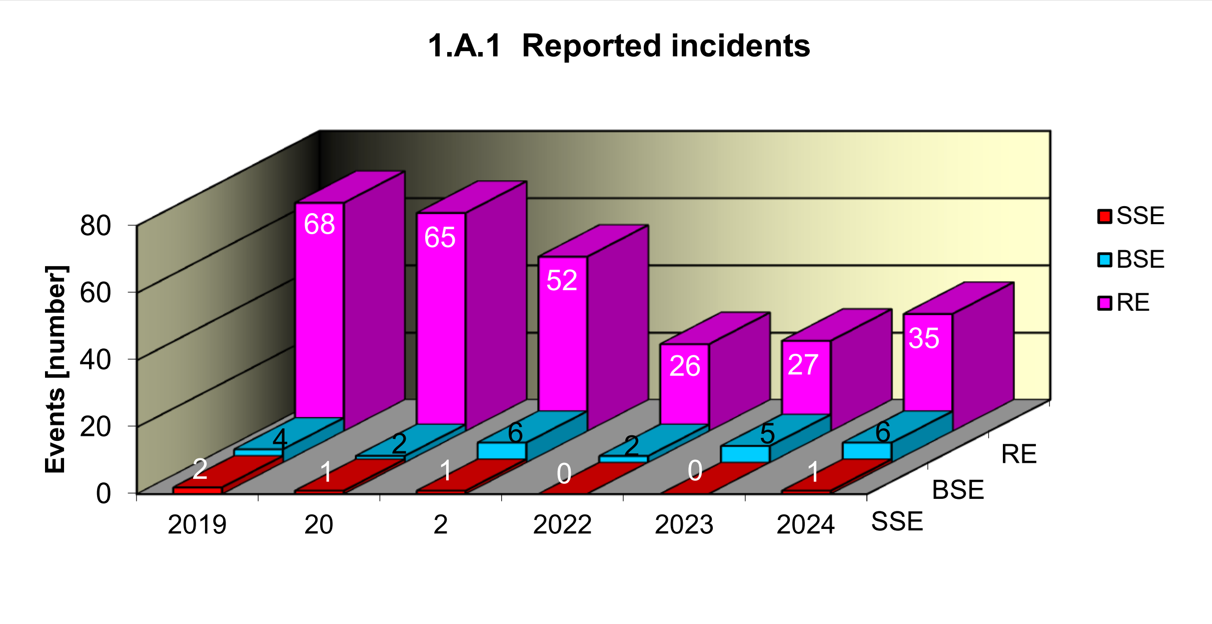
G. APPENDIX No. 2

RESULTS OF THE EVALUATION OF THE SET OF OPERATIONAL AND SAFETY INDICATORS IN 2024 FOR DUKOVANY

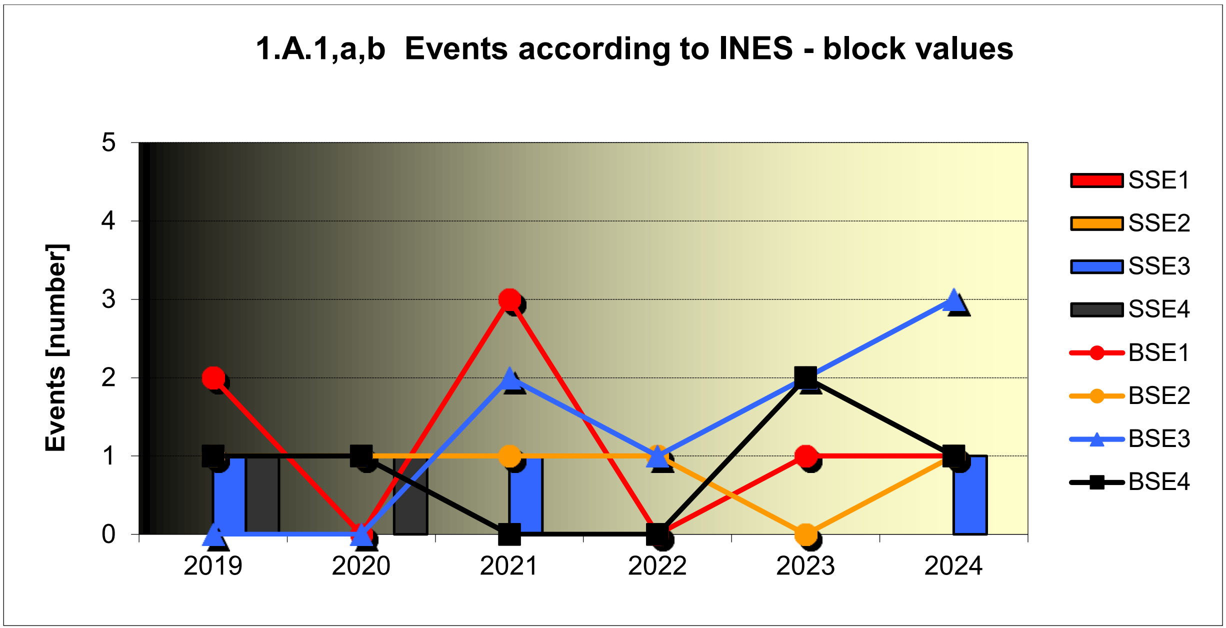
1. Events

1.A Reported events

Indicator graph 1.A.1 tracks the development of the number of reported events (RE), including their classification according to the INES scale into significant events (SSE, INES > 0) and events below the scale (BSE, INES 0).



Graphs 1.A.1a and 1.A.1b compare the block numbers of events assessed according to INES.



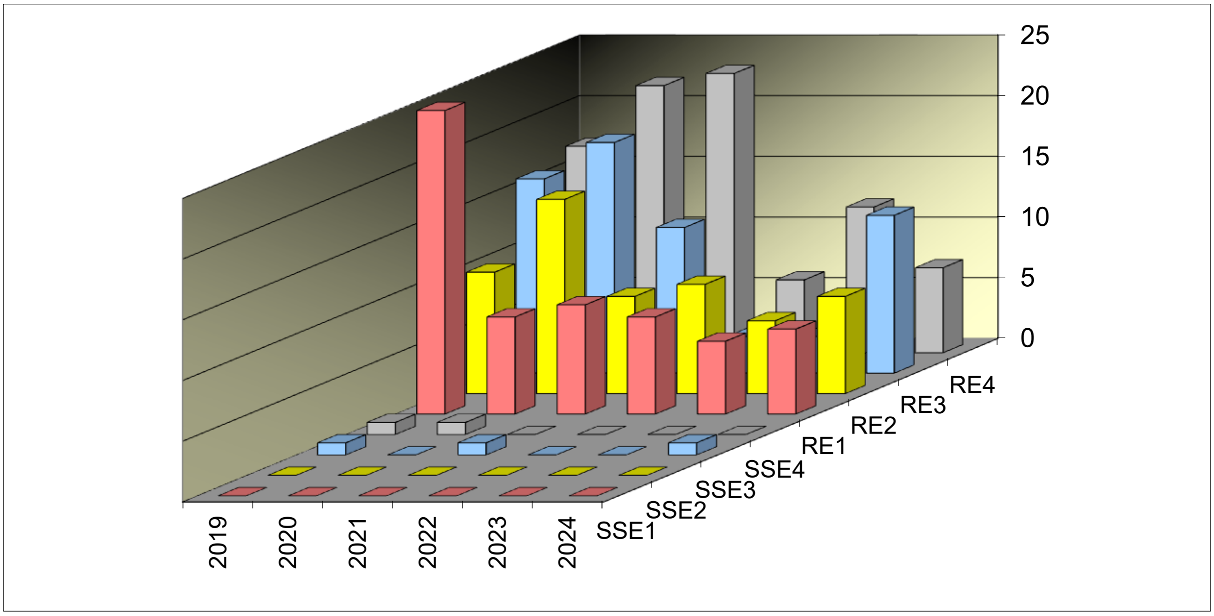
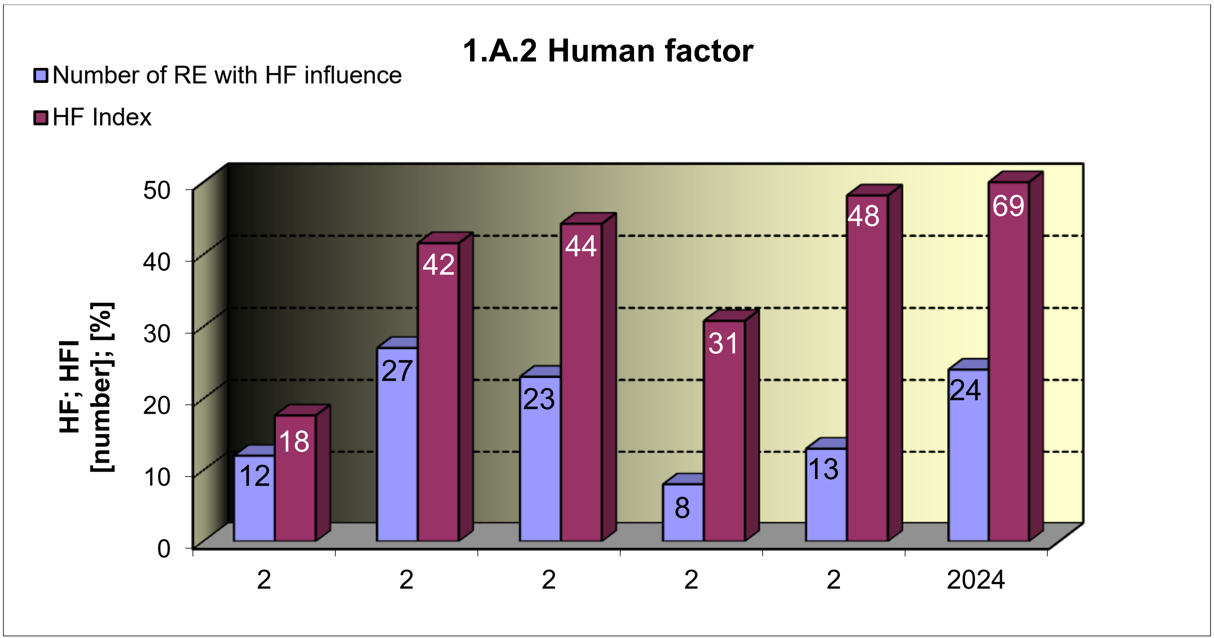
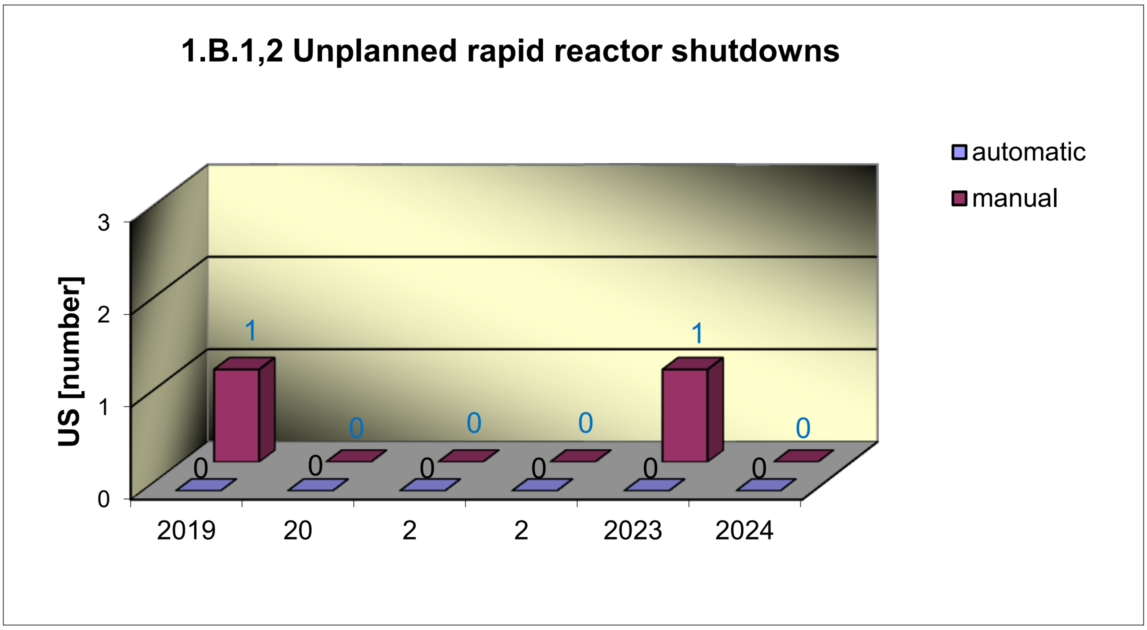


Chart 1.A.2 assesses the influence of human factors on the occurrence of reported events. The indicator is expressed by the number of events with human influence (HF) and its percentage share (HFI).

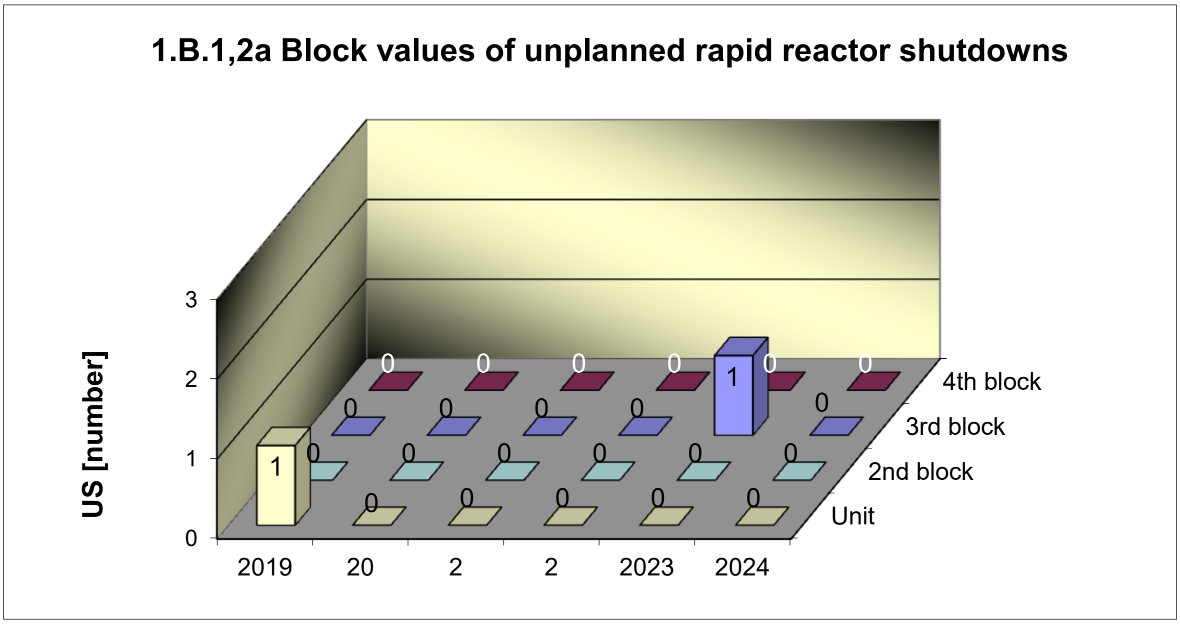


1.B Effectiveness of protective and limiting systems

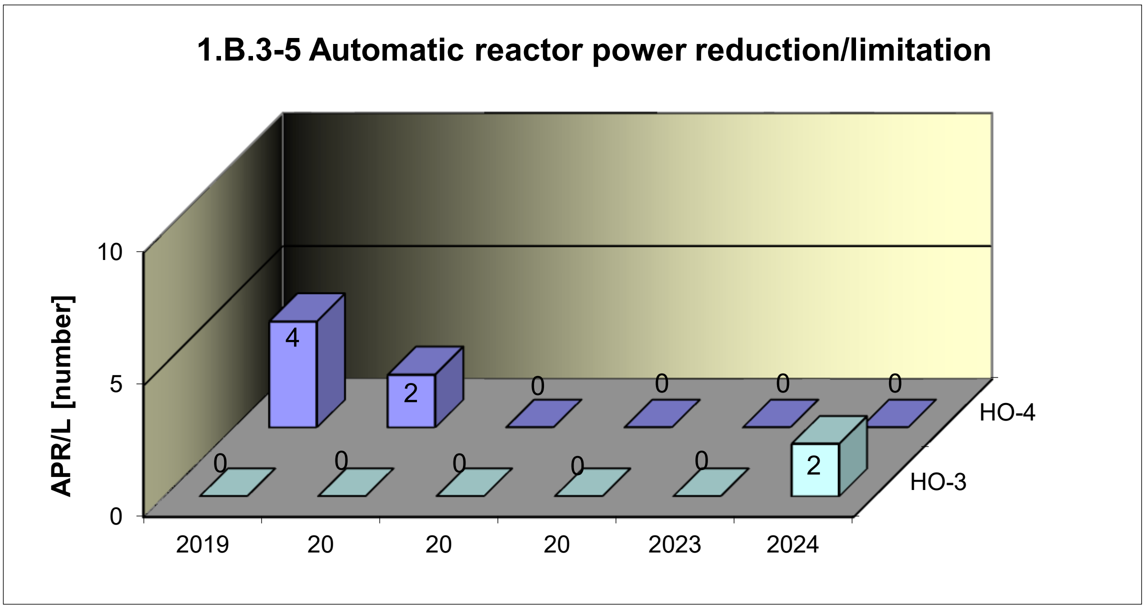
Graphs 1.B.1 and 1.B.2 summarize the total number of unplanned rapid reactor shutdowns (US) (reactor in MODE 1 or 2) with a distinction between manual shutdown and automatic incorporation. Unplanned means that the rapid shutdown was not an expected part of a planned test.



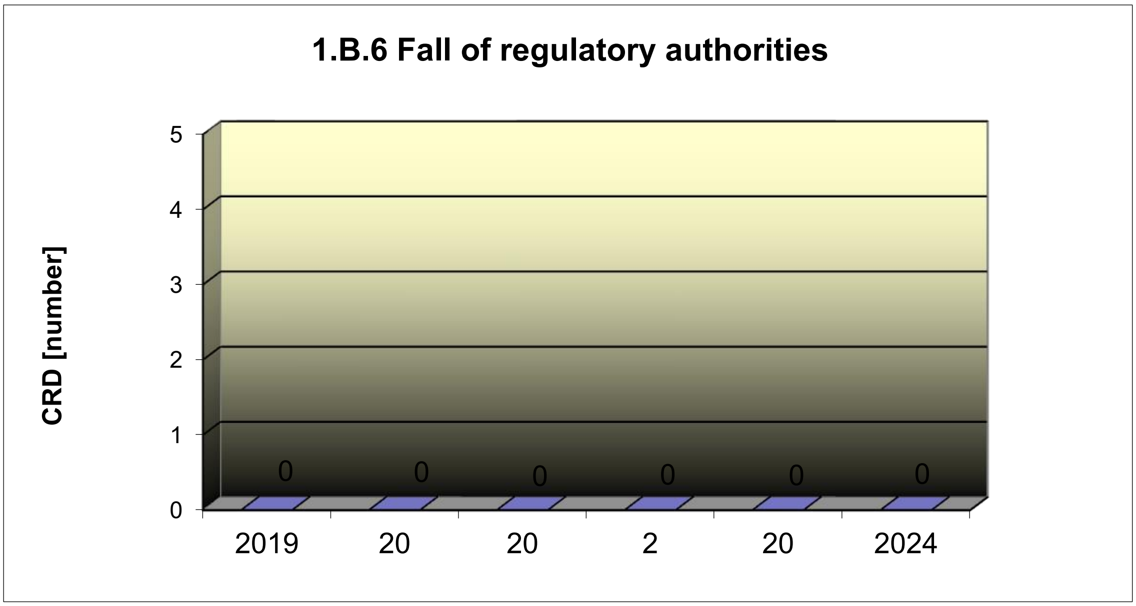
Graph 1.B.1,2a compares the block numbers of unplanned rapid reactor shutdowns (US), including manual ones.



The combined graph of indicators 1.B.3-5 shows the number of unplanned safety protection activations (APR/L) HO-2, HO-3, and HO-4.

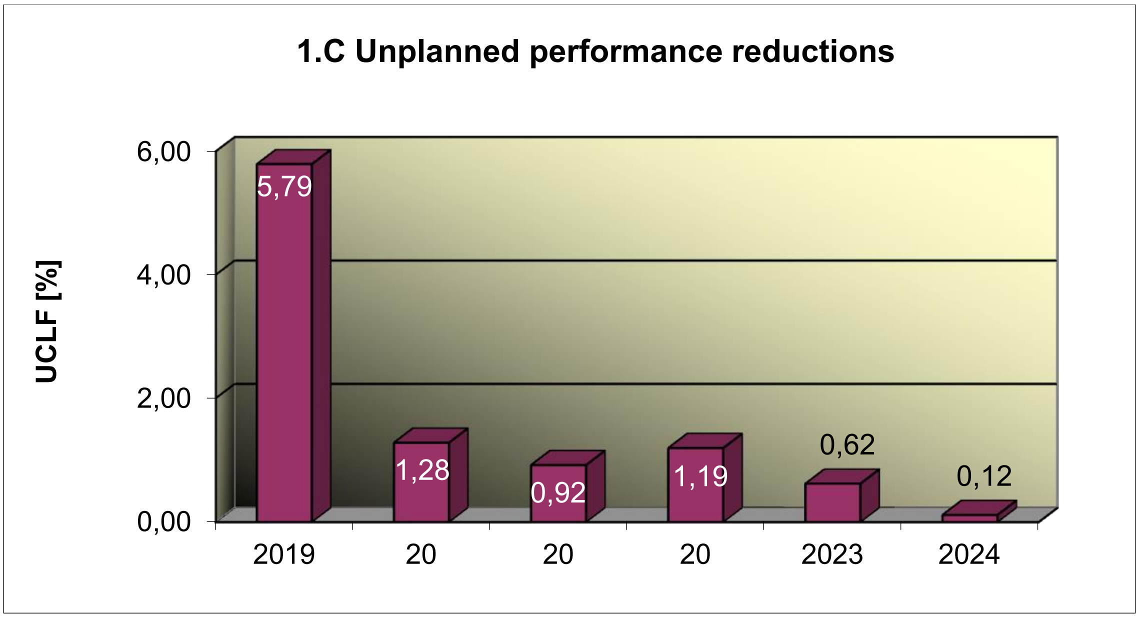


Graph 1.B.6 shows the development of the number of control rod drop (CRD) events.



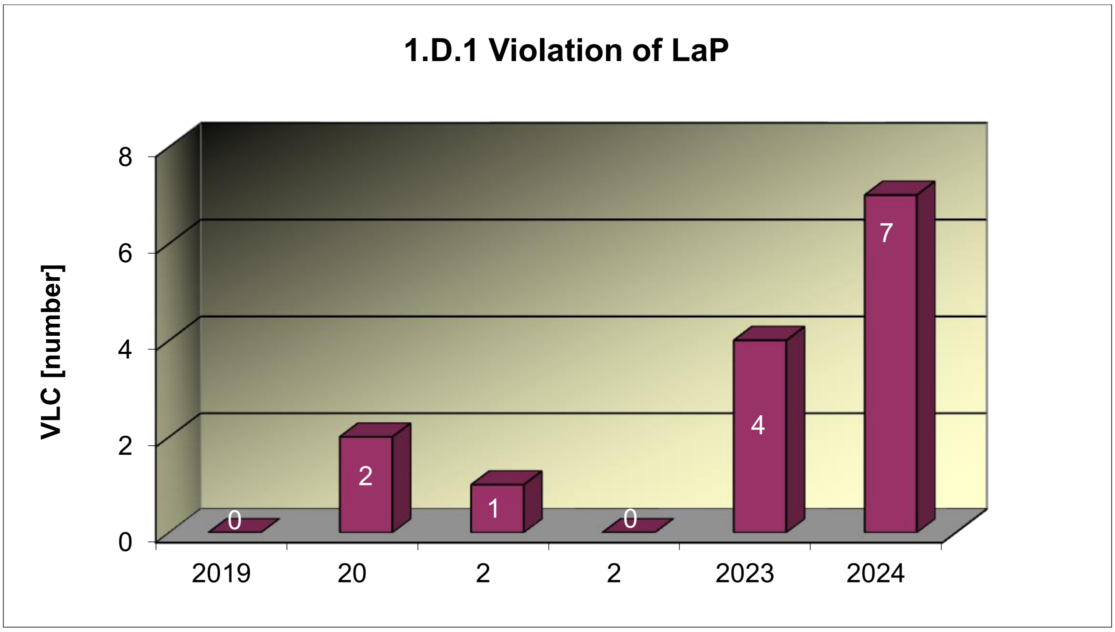
1.C Power reduction

Graph 1.C.1 tracks the trend in unplanned power reductions (UCLF).

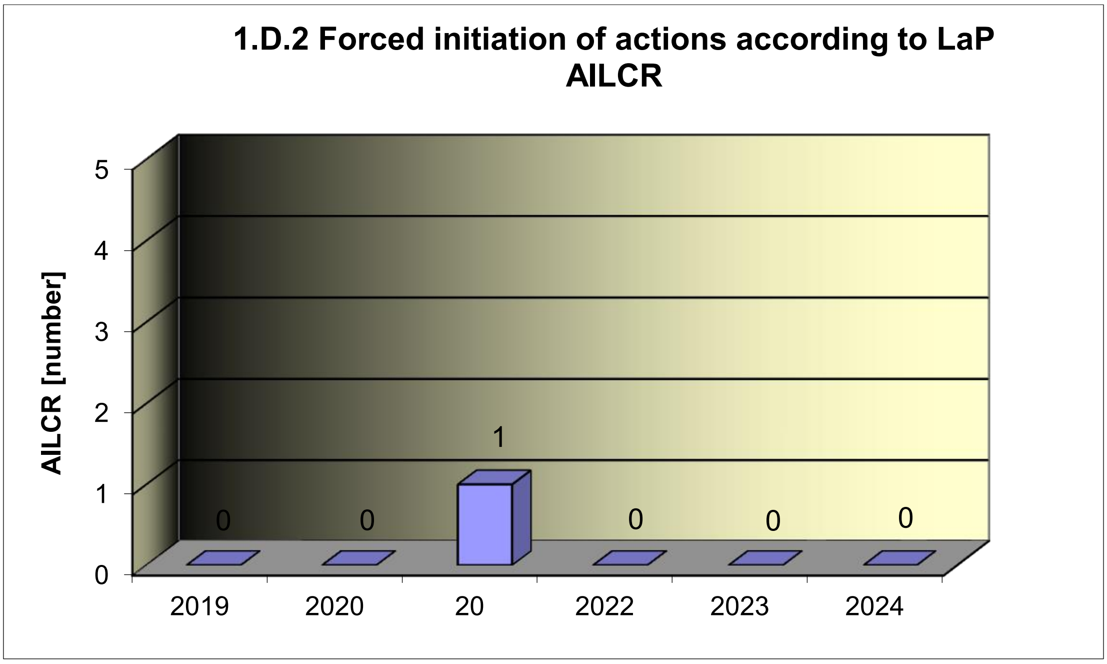


1.D Limits and conditions for safe operation

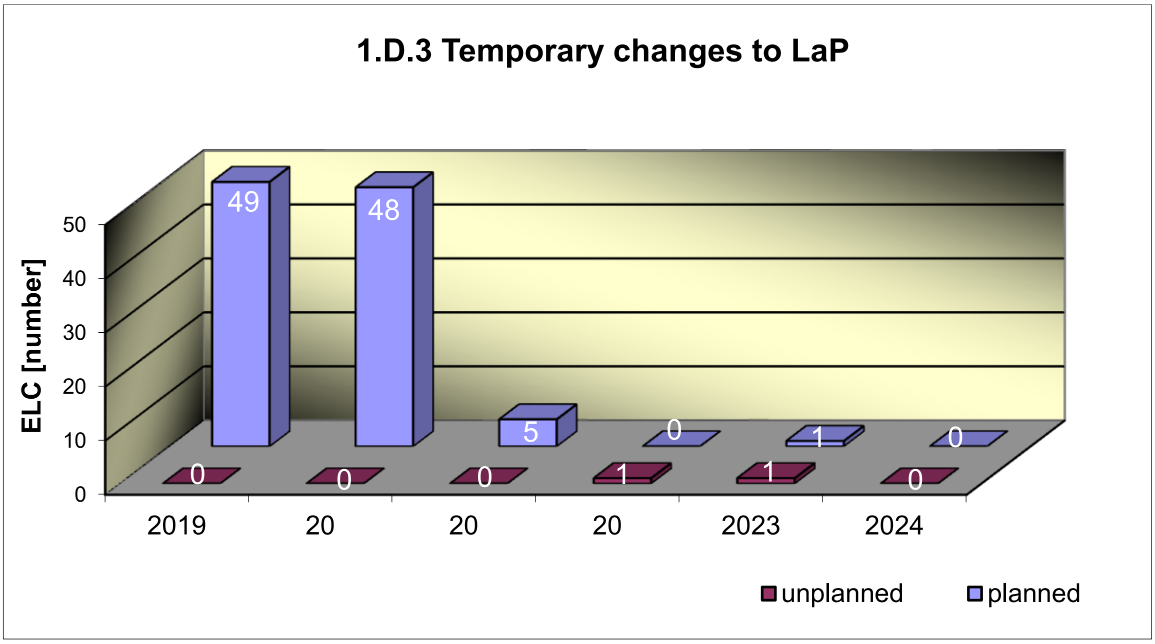
Graph 1.D.1 summarizes the number of LaP violations (VLC) detected by the supervisory authority or reported to the supervisory authority by the NPP operator.



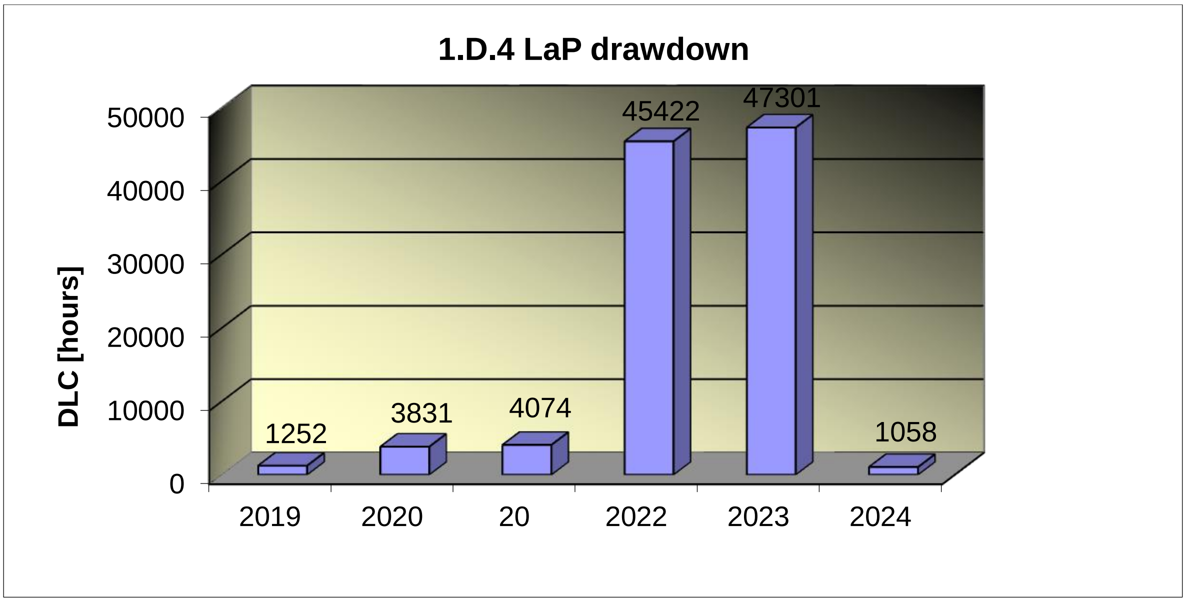
Graph 1.D.2 shows the number of all equipment status or parameter-induced transitions of a unit to a higher sequence number mode in accordance with LaP requirements (AILCR).



Graph 1.D.3 summarizes the number of planned and unplanned temporary LaP changes (ELC) approved by the supervisory authority, including those requested, approved by the SÚJB, but not used for various reasons.



Graph 1.D.4 summarizes the number of hours of LaP utilization in all unit modes (DLC).



2. Operation of safety systems

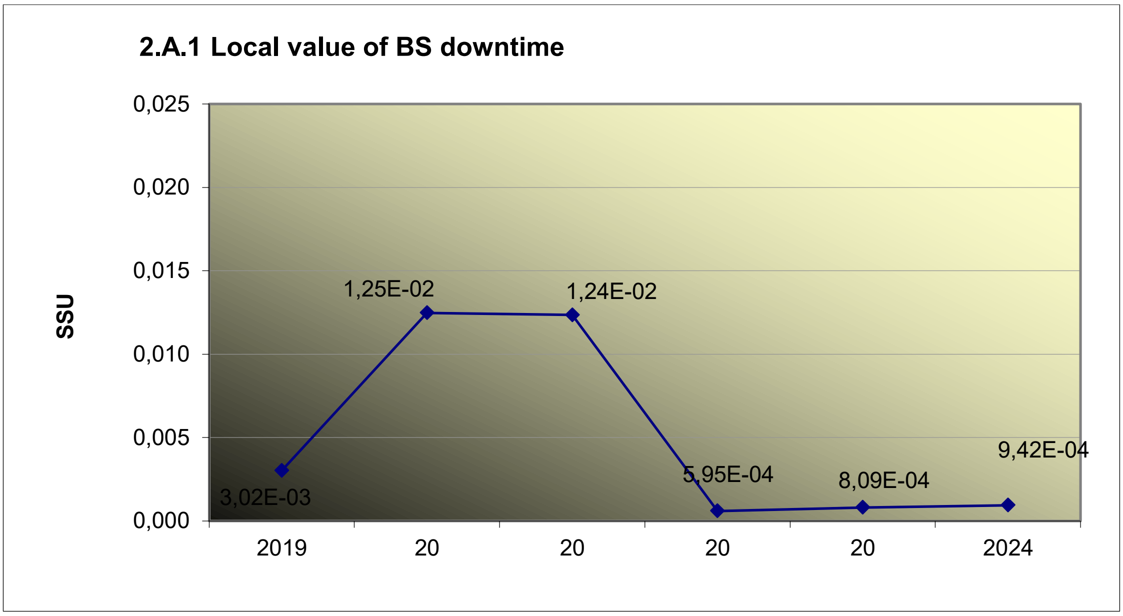
Area 2 monitors and evaluates the operability of the following safety systems (BS) in group A:

- diesel generators DG
- AZ high-pressure emergency refilling system TJ
- low-pressure emergency refuelling system AZ TH
- shower system TQ
- hydroaccumulators HA
- emergency power supply system for steam generators HN PG
- PG super emergency power supply system SHN PG

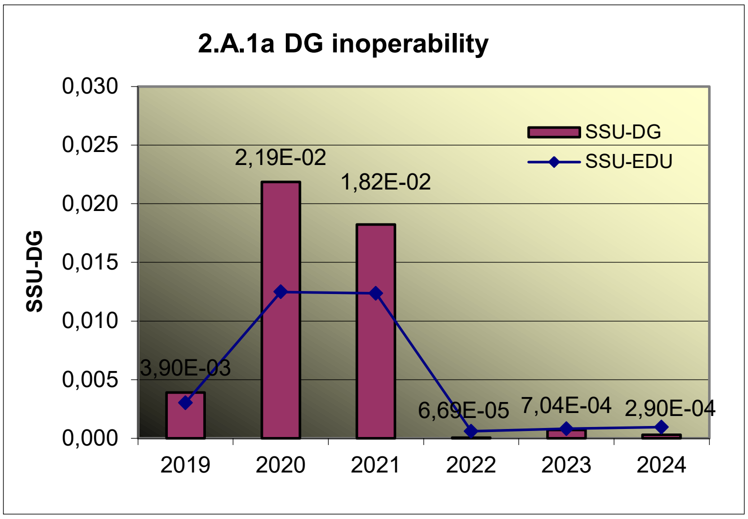
and in group B, failure of DG, REAZNII (category II automatic secure power supply mode), SHN PG, TJ, TH, and TQ during start-up and operation.

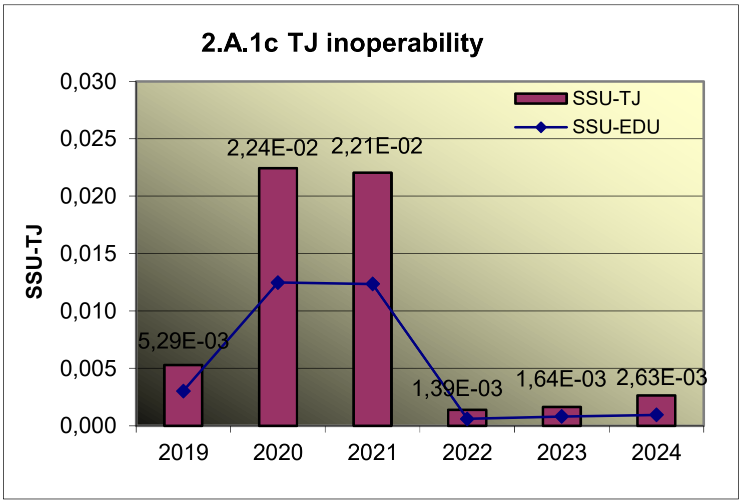
2.A Non-operability of safety systems

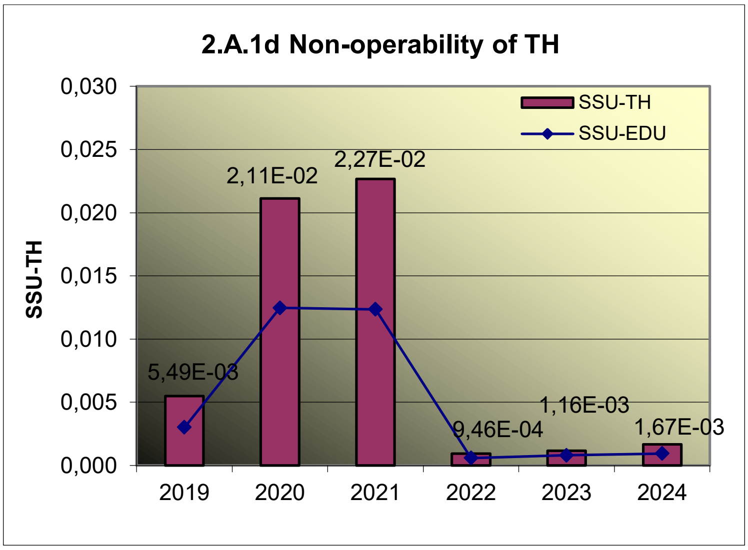
Graph 2.A.1 shows the local value of the non-operability of the "unit – general" safety system (SSU), which is given by the average value of the non-operability of all monitored safety systems at the site.

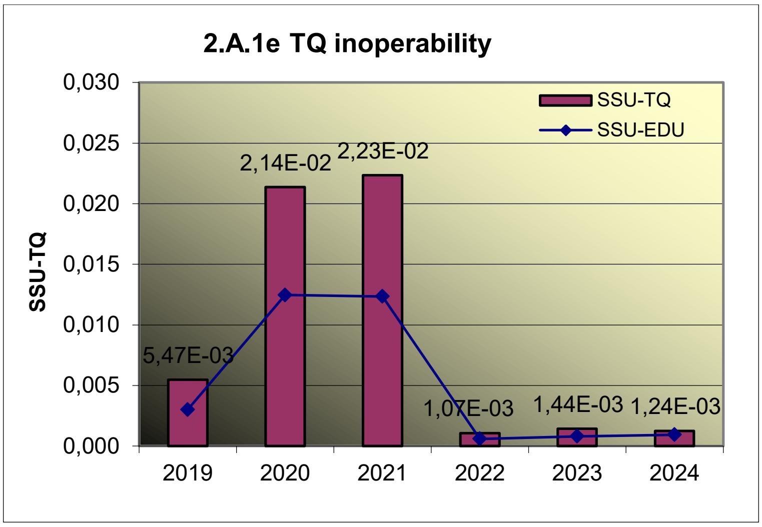


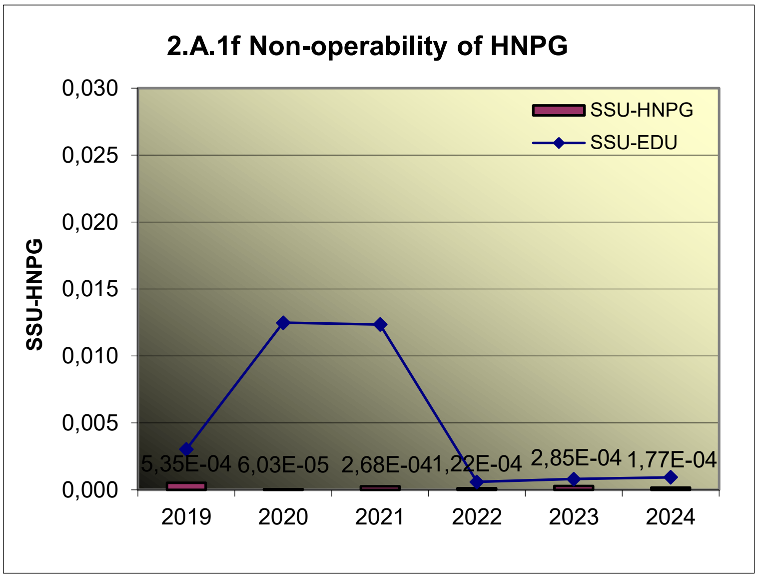
The non-operability of individual BS (SSU_S) - graphs 2.A.1.a – g, is defined as the ratio of the total non-operability time of the evaluated BS to the total time during which its operability was required. These combined graphs also show the ratio of the non-operational time of a given BS to the "general" BS of the site.

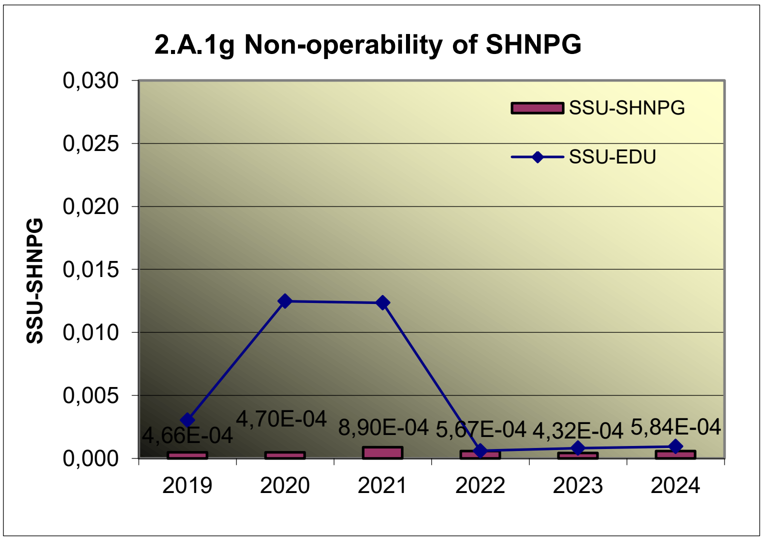




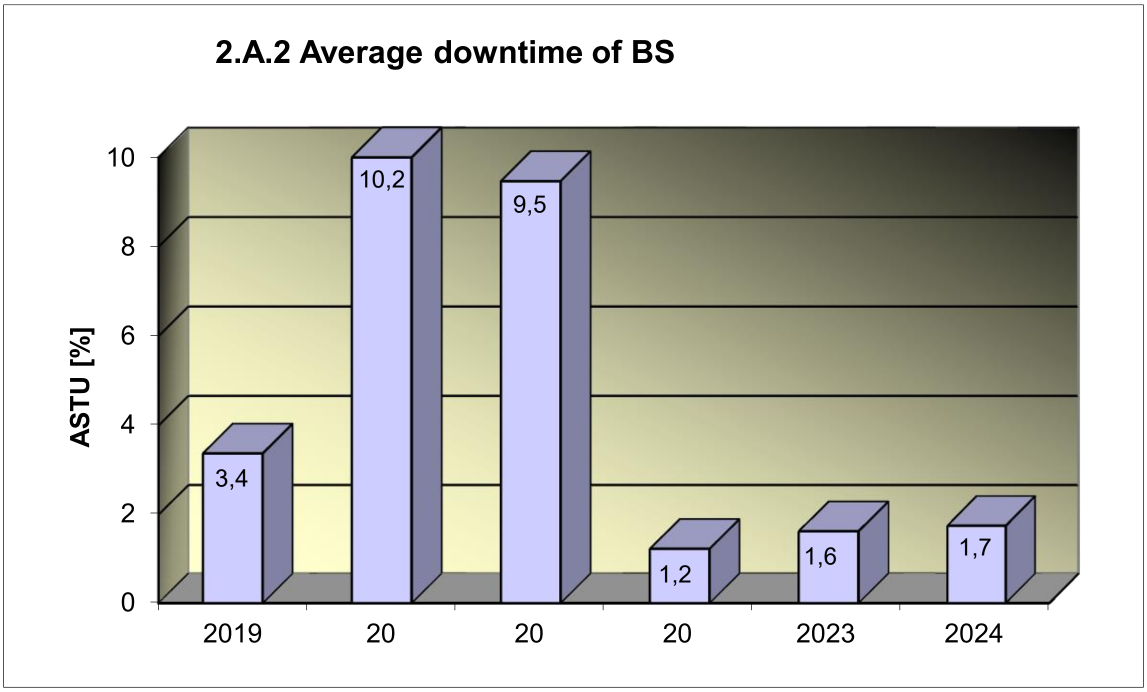



2.A.1e TQ inoperability
SSU-TQ
SSU-EDU
SSU-TQ
0,030
0,025
0,020
0,015
0,010
0,005
0,000
5,47E-03
2,14E-02
2,23E-02
1,07E-03
1,44E-03
1,24E-03
2019
2020
2021
2022
2023
2024

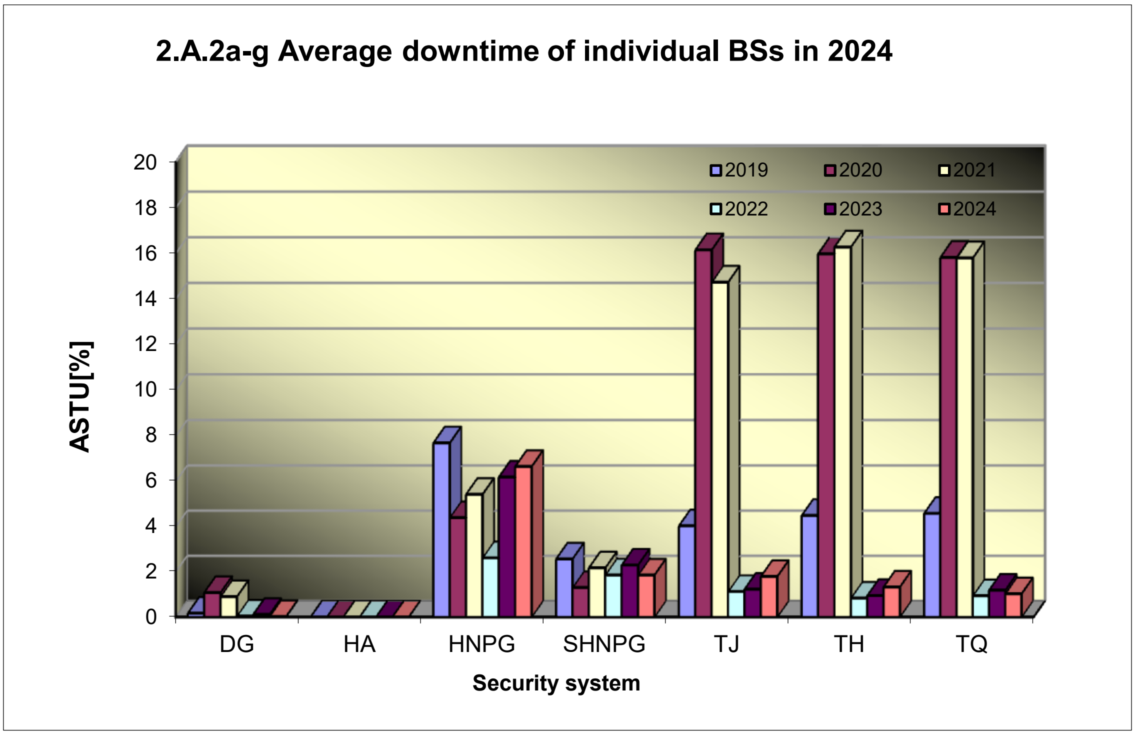

2.A.1f Non-operability of HNPG
SSU-HNPG
SSU-EDU
SSU-HNPG
0,030
0,025
0,020
0,015
0,010
0,005
0,000
5,35E-04
6,03E-05
2,68E-04
1,22E-04
2,85E-04
1,77E-04
2019
2020
2021
2022
2023
2024


2.A.1g Non-operability of SHNPG
SSU-SHNPG
SSU-EDU
SSU-SHNPG
0,030
0,025
0,020
0,015
0,010
0,005
0,000
4,66E-04
4,70E-04
8,90E-04
5,67E-04
4,32E-04
5,84E-04
2019
2020
2021
2022
2023
2024

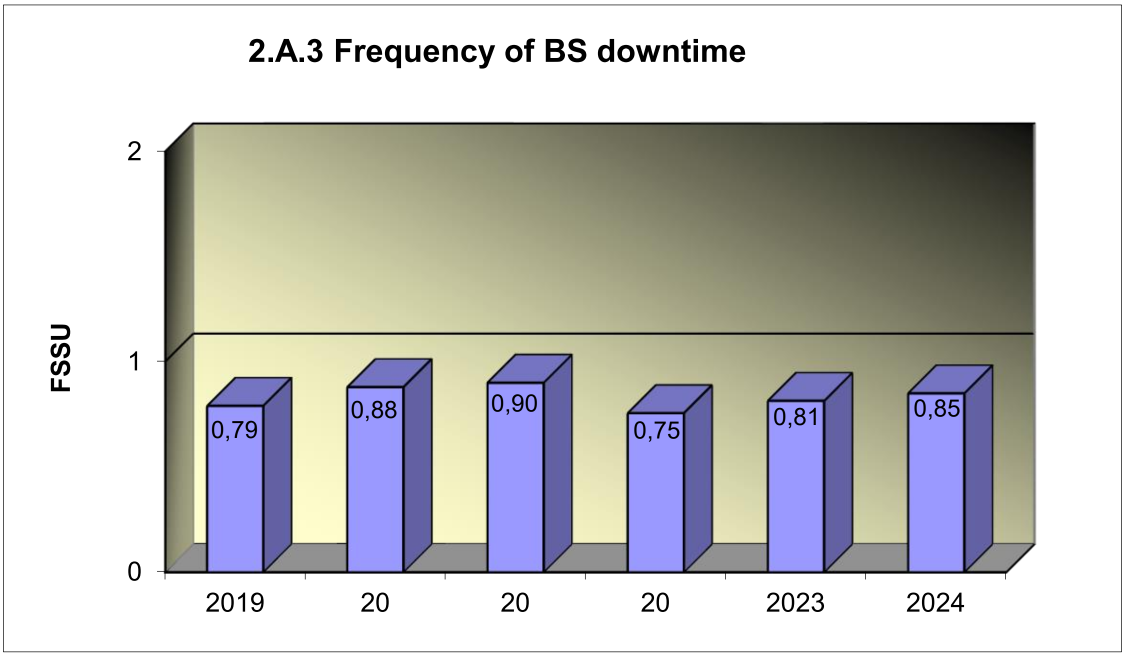
Graph 2.A.2 shows the average downtime of the "unit – general" safety system at the location (ASTU), which is given by the ratio of the average downtime of one BS to the single downtime allowed in LaP.



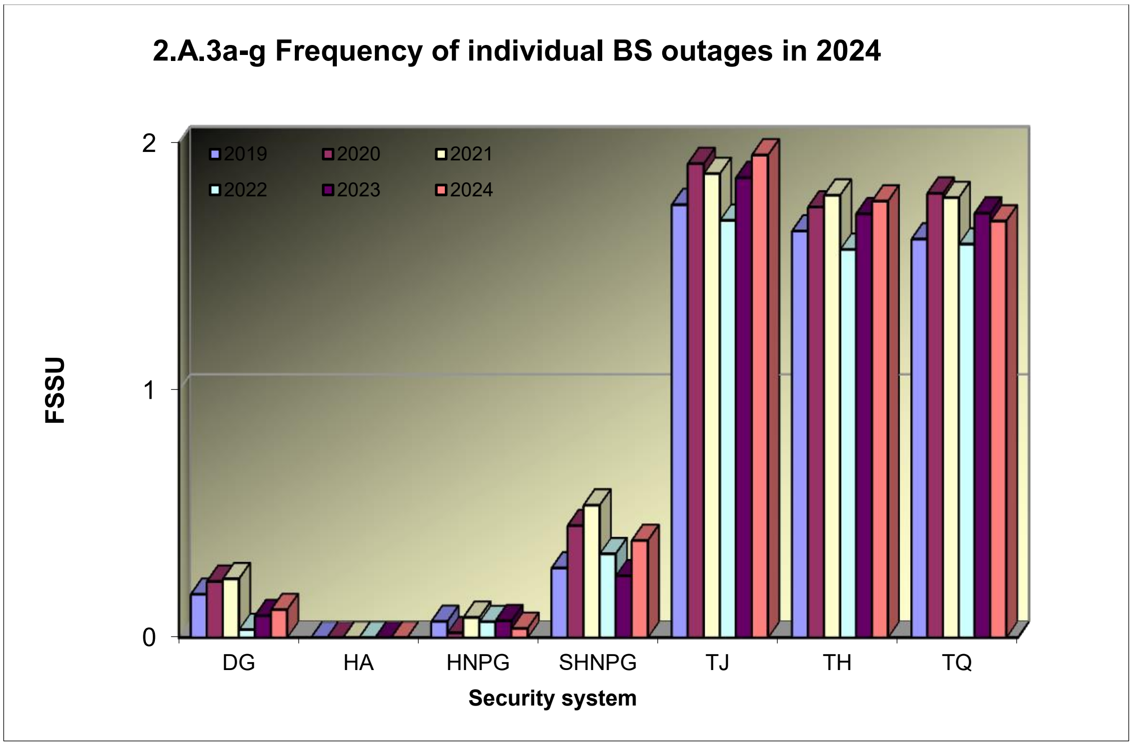
Graphs 2.A.2a-g show the ASTU system values.



Graph 2.A.3 expresses the total number of "unit-general" BS outages at a site per thousand hours of required availability (FSSU).

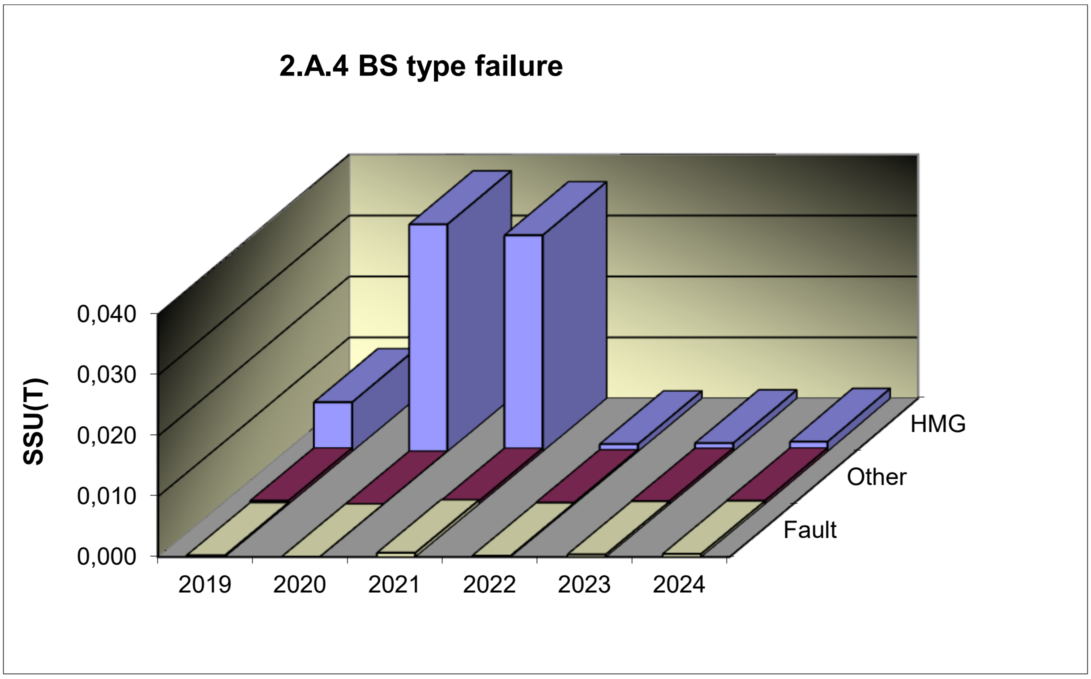


Graph 2.A.3a-g shows the development of FSSU values by system.

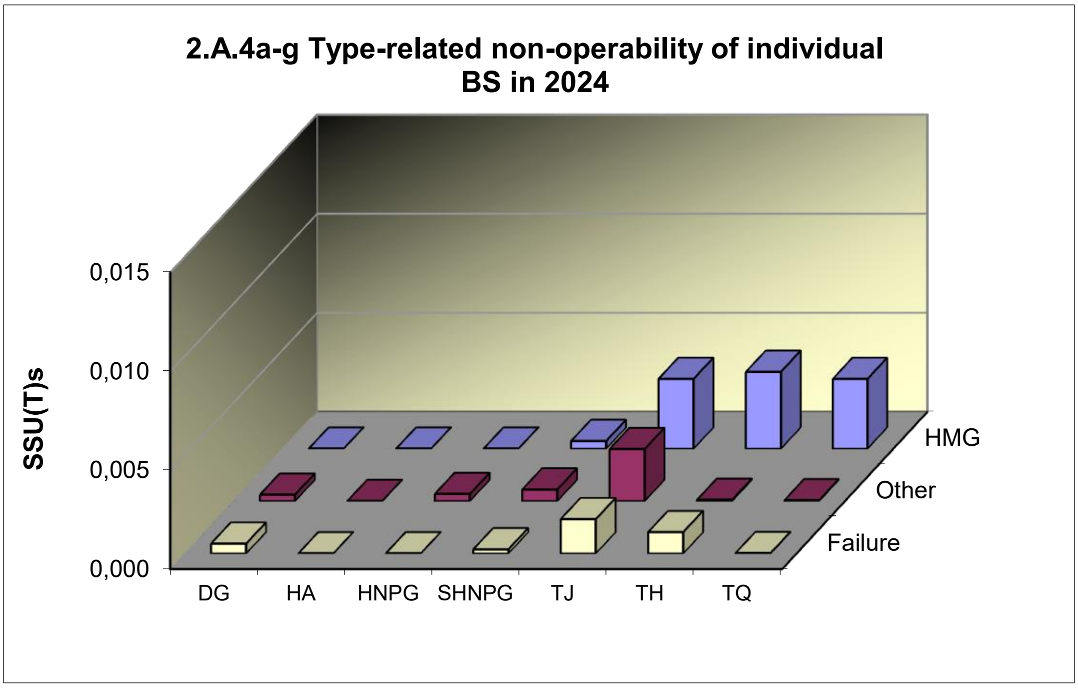


Graph 2.A.4 shows the ratio of the total downtime of "unit-general" BS for the relevant reason to the total time when system availability was required - SSU(T).

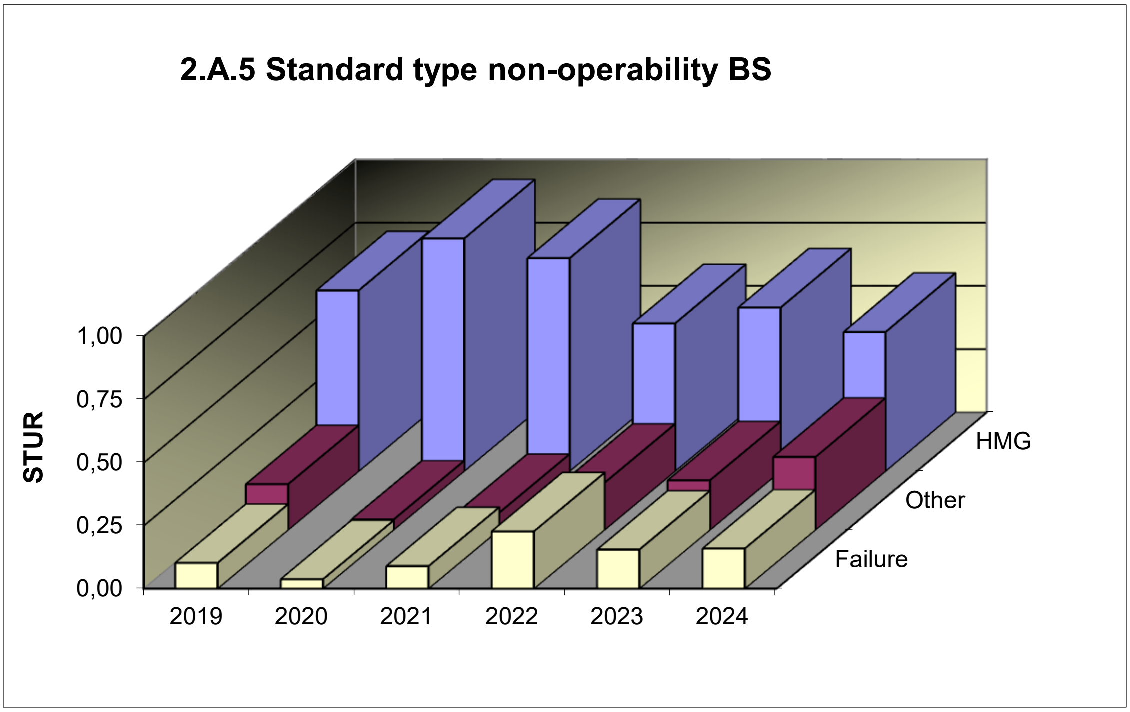
Three types of downtime are distinguished.



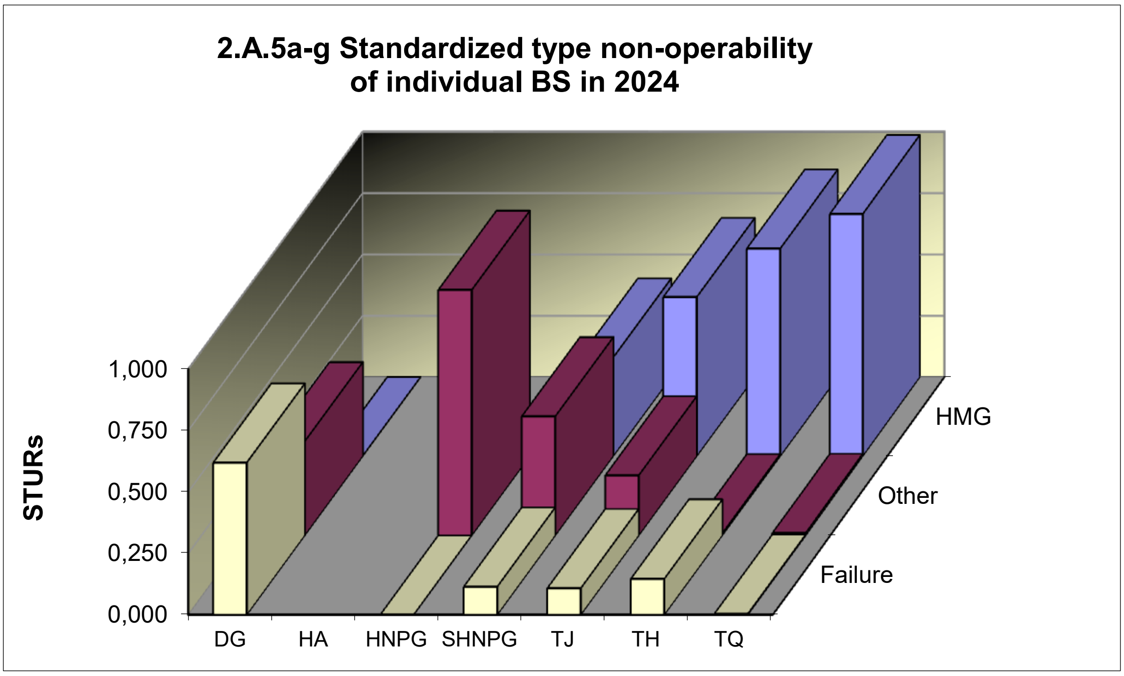
Graph 2.A.4a-g shows the system values of SSU(T) in 2024.



Graph 2.A.5 shows the ratio of the total downtime of BS for the relevant reason (see Graph 2.A.4 for reasons for downtime) to the total system downtime – STUR.

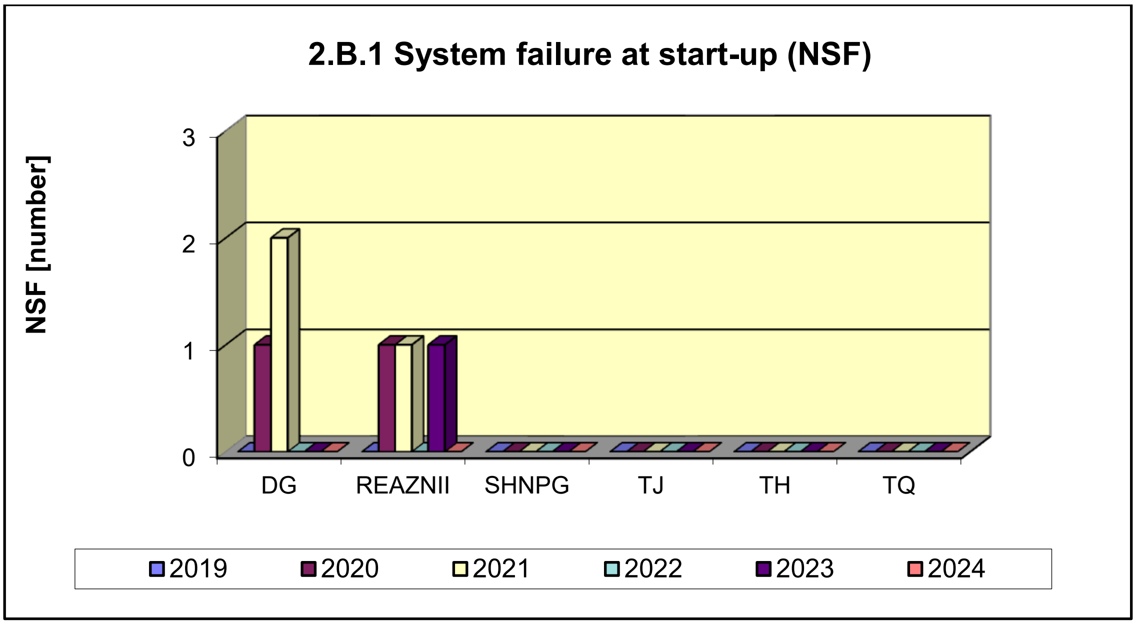


Graph 2.A.5a-g shows the system values of STUR in 2024.

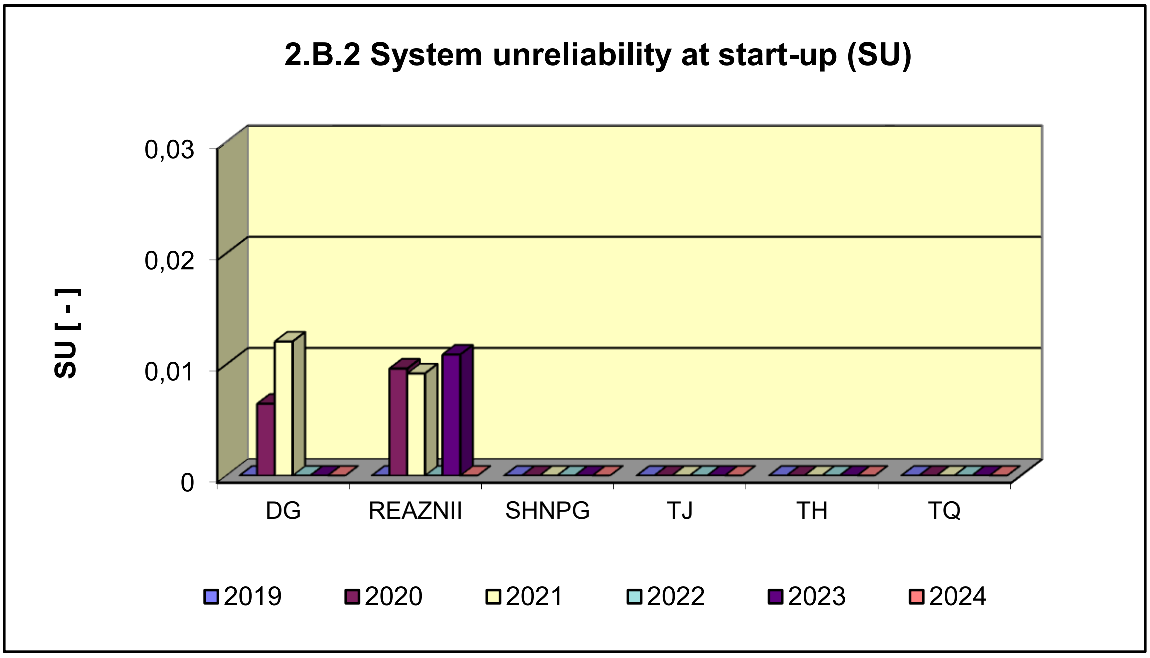


2.B Safety system failures

Chart 2.B.1 shows the number of BS failures at start-up (NSF), i.e. situations where the relevant system or unit does not reach its nominal operating characteristics after the start command or fails (shuts down) within 30 minutes of start-up.



Graph 2.B.2 shows the ratio of the number of start failures to the total number of BS starts (SU) in a given period (so-called start unreliability).



Graph 2.B.3 shows the number of BS failures during operation (NRF), which is the number of cases where the relevant system, drive or unit fails and is shut down from operation at nominal operating characteristics for more than 30 minutes after start-up.

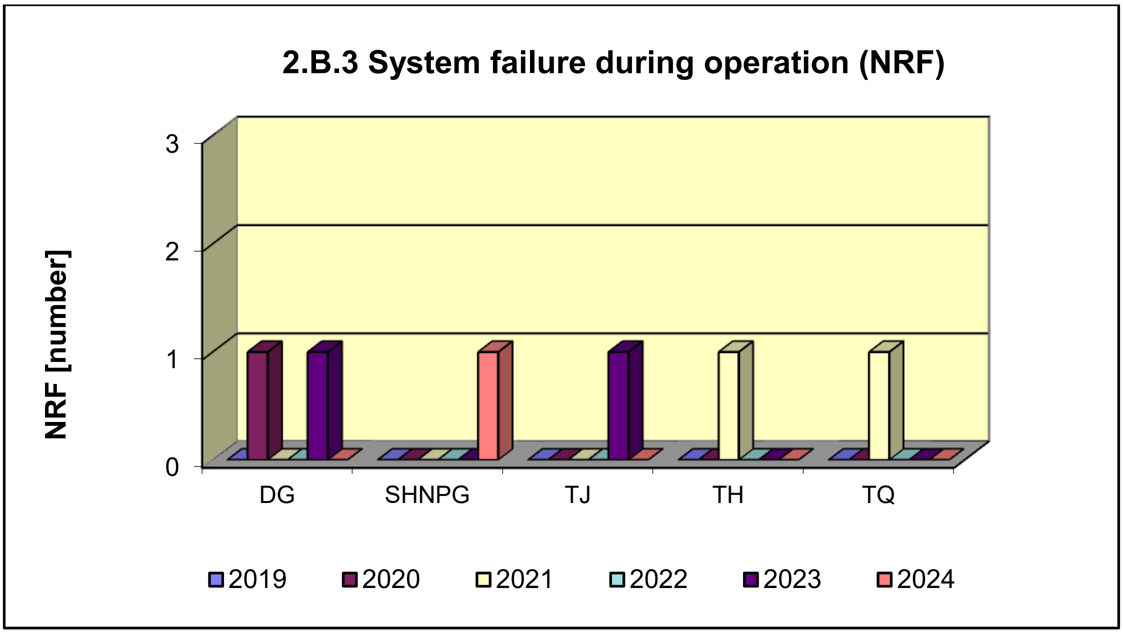
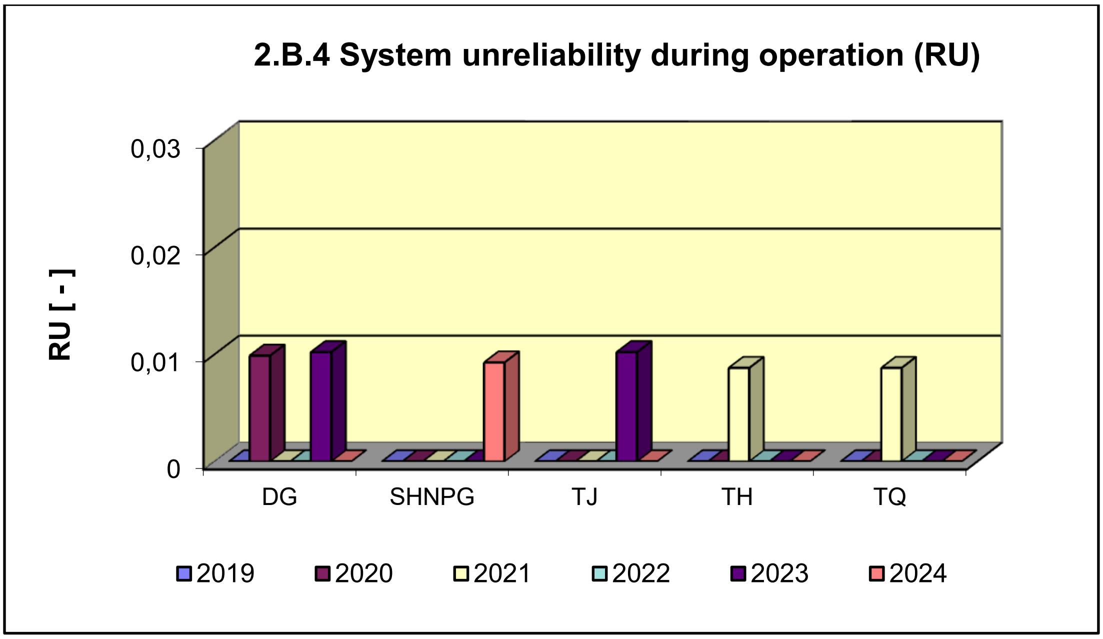


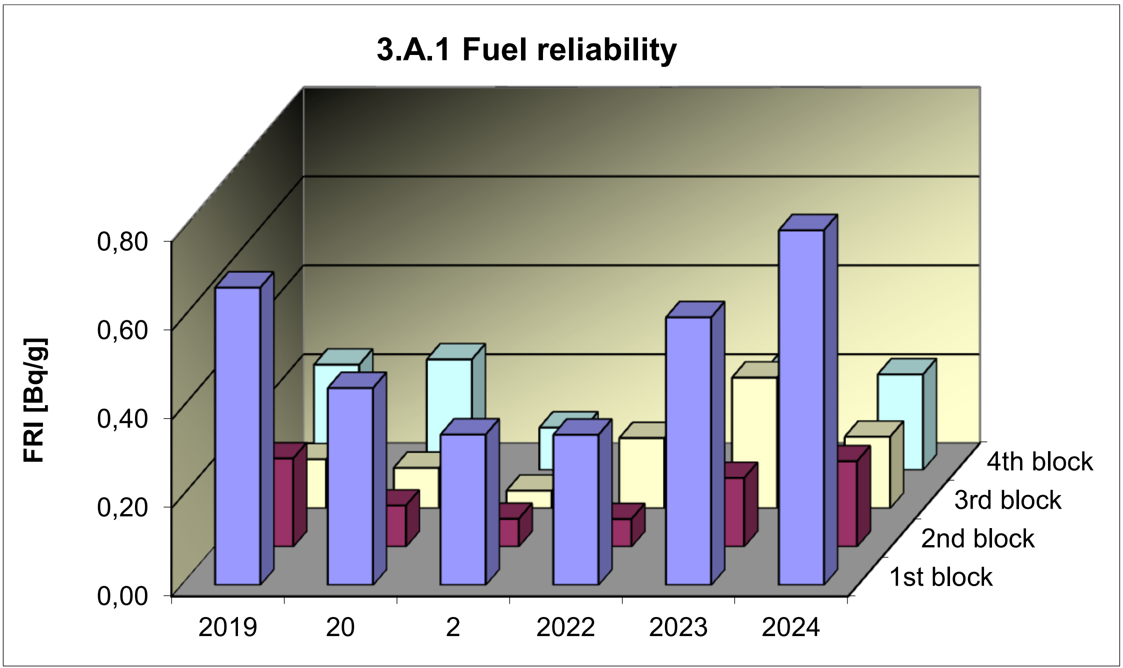
Chart 2.B.4 shows the ratio of the total number of breakdowns during operation to the total number of hours run (RU) when its operational availability is required.



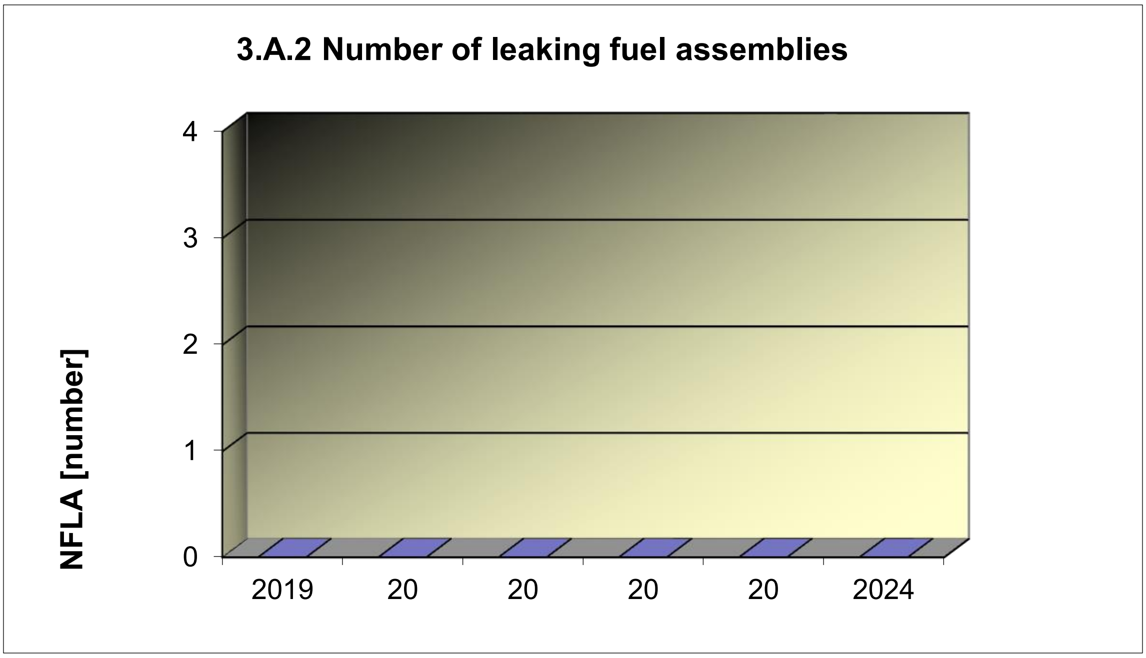
3. Barrier integrity

3.A Nuclear fuel

Graph 3.A.1 monitors the reliability of fuel in individual units using the FRI factor. An FRI value of≤ 19Bq/g indicates that the active zone is highly unlikely to contain any stable fuel defects.

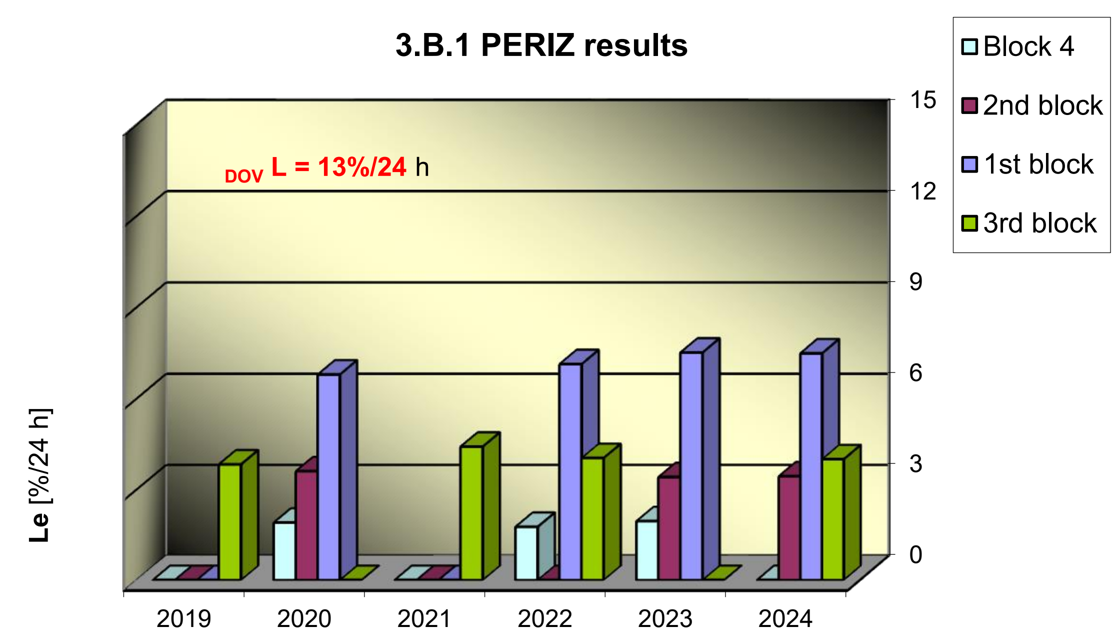


Graph 3.A.2 shows the number of leaky fuel elements that had to be taken out of service due to unacceptable leakage.



3.B Hermetic envelope

Graph 3.B.1 shows the results for PERIZ blocks (L_e), i.e. the results of leak tests of hermetic spaces performed at an overpressure of 150 kPa with a holding time of 24 hours. Extrapolated results are given for tests at lower pressures and holding times. Starting in 2011, the tests are performed every two years, alternating between odd and even blocks.

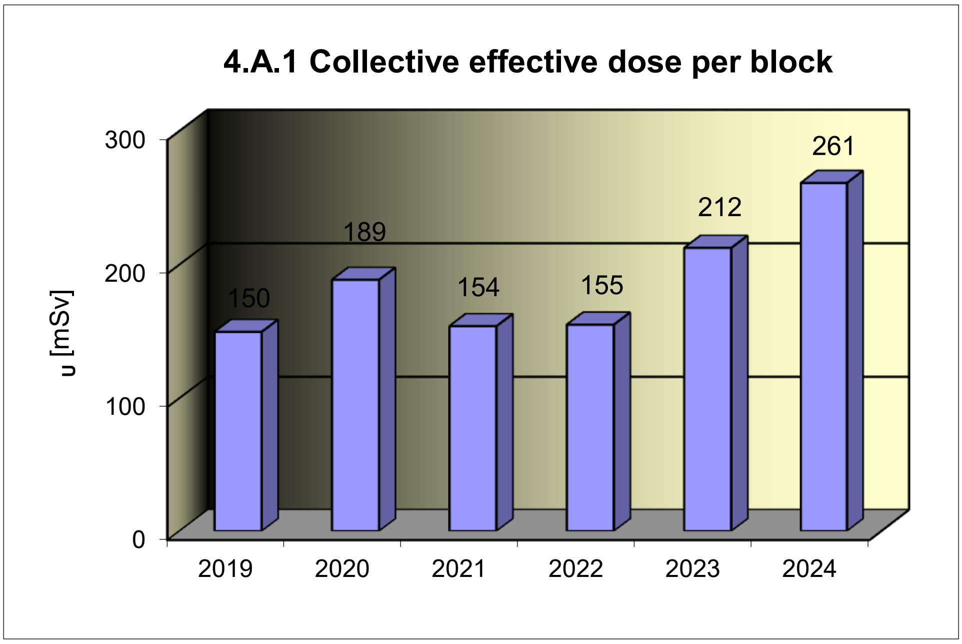


*) Since 2011, PERIZ testing has been conducted once every two years;
since 2018, PERIZ tests have been conducted in even years at HVBI and in odd years at HVBII

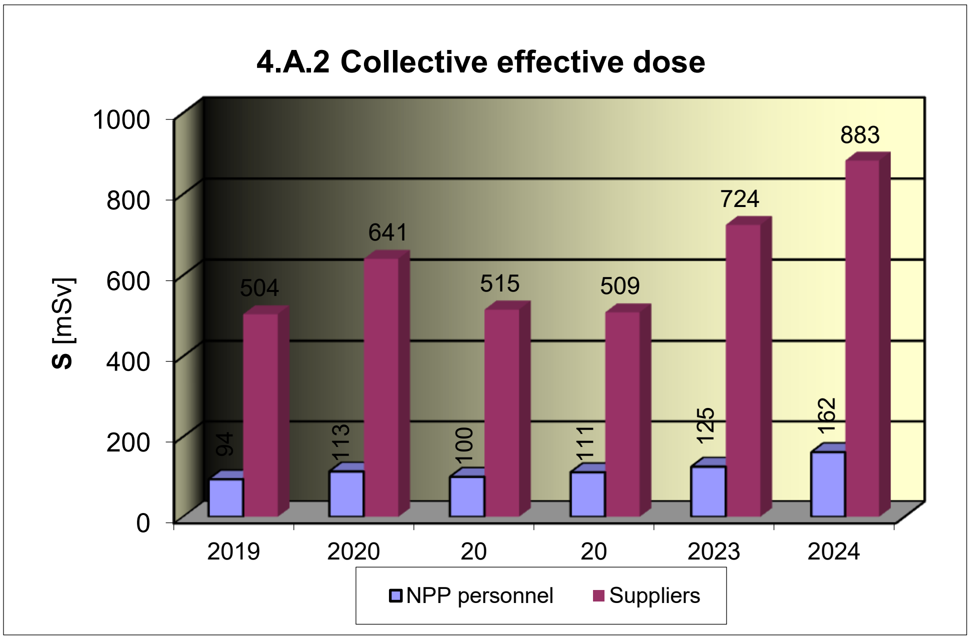
4. Radiation protection

4.A Radiation workers

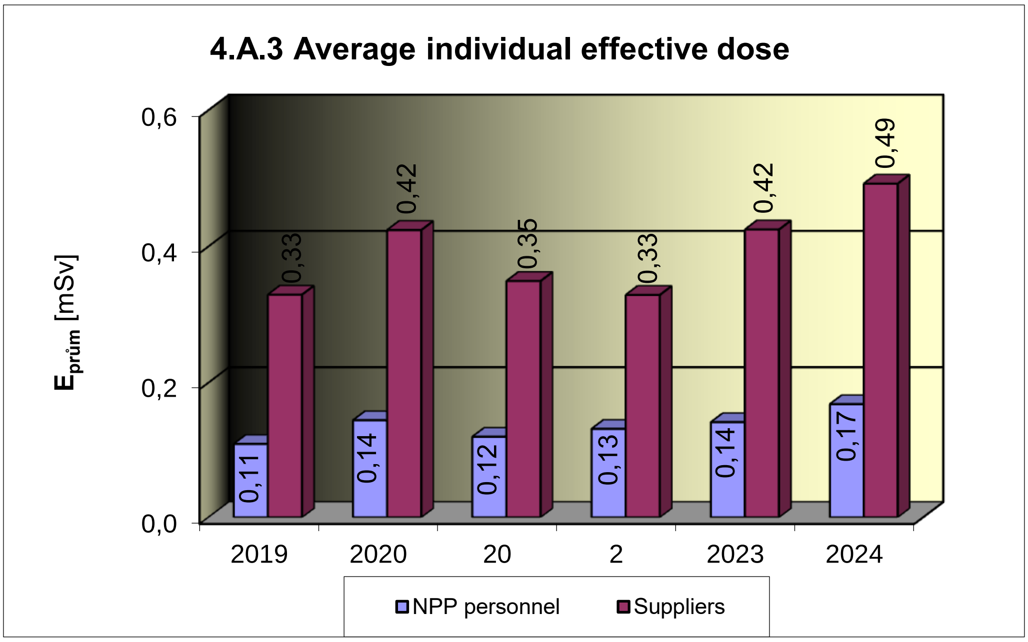
Graph 4.A.1 shows the collective effective dose, which is given by the total external whole-body dose received by radiation workers at the NPP and suppliers during the monitored period, per operating unit.



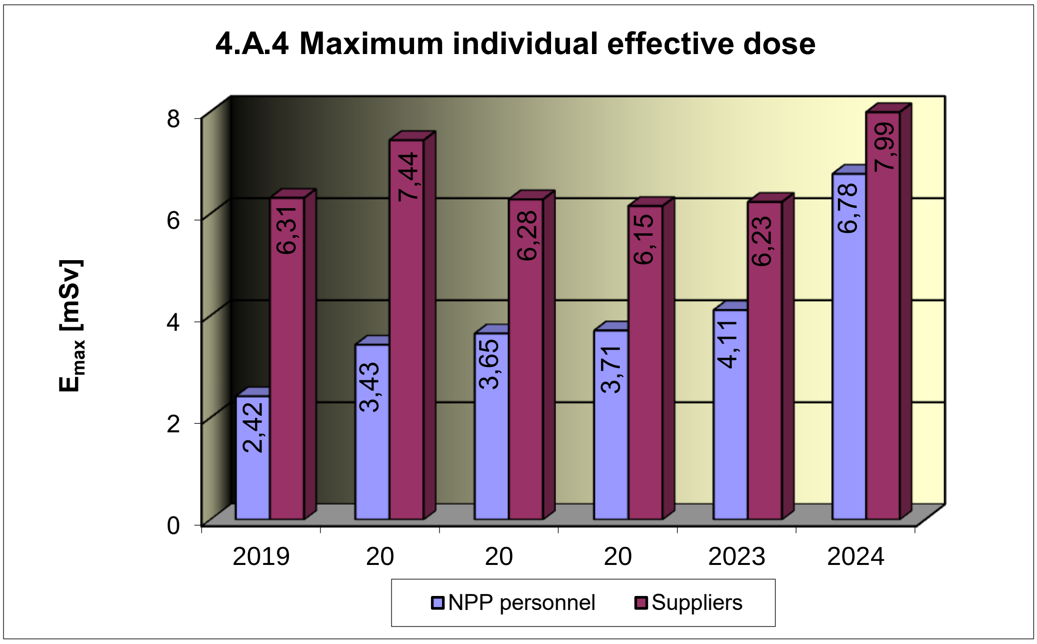
Graph 4.A.2 shows the collective effective dose, which is given by the total external whole-body dose received by radiation workers at NPPs and suppliers during the monitored period.



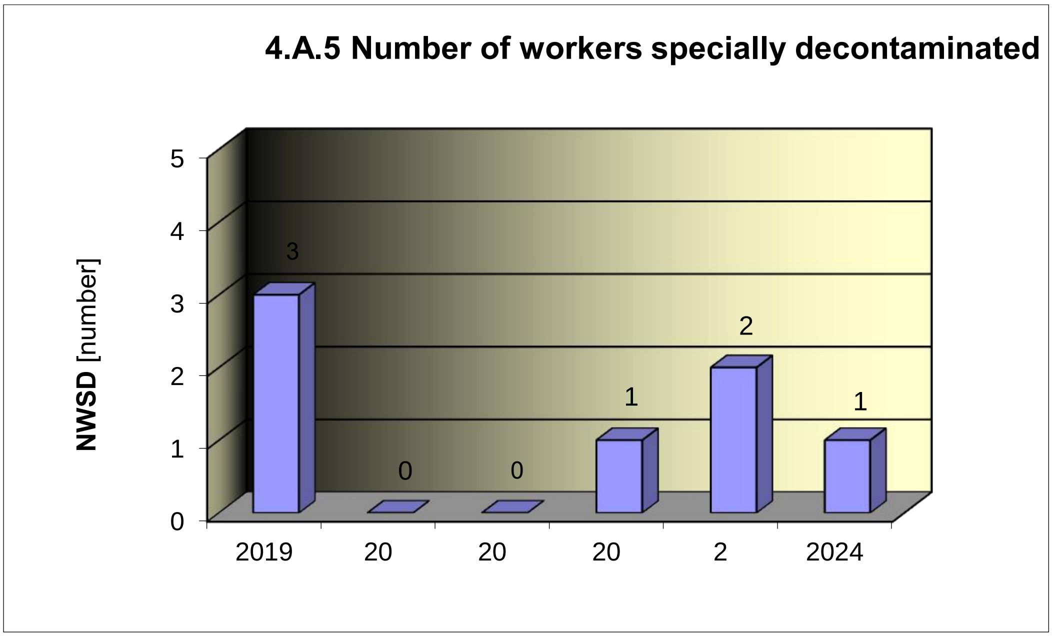
Graph 4.A.3 shows the average individual effective dose, which is given by the total external whole-body dose received by radiation workers at NPPs and suppliers during the monitored period, expressed as a value per radiation worker.



Graph 4.A.4 shows the maximum individual effective dose, which is given by the total external whole-body dose received by one specific NPP employee and one specific contractor employee during the monitored period.

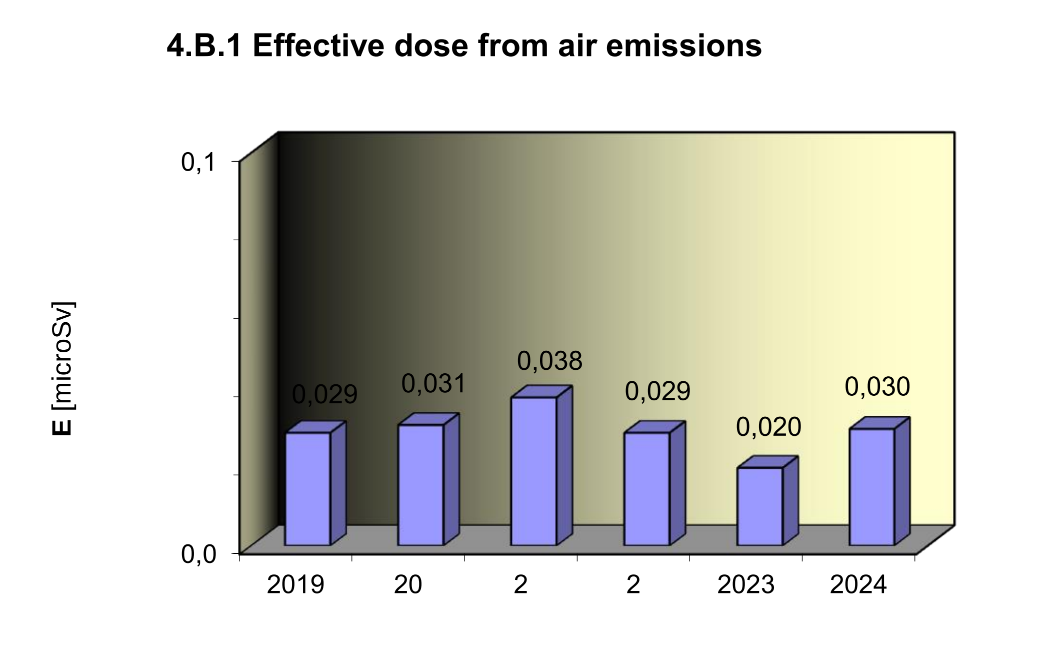


Graph 4.A.5 shows the number of radiation workers (NPP and contractors) who underwent special decontamination under medical supervision.

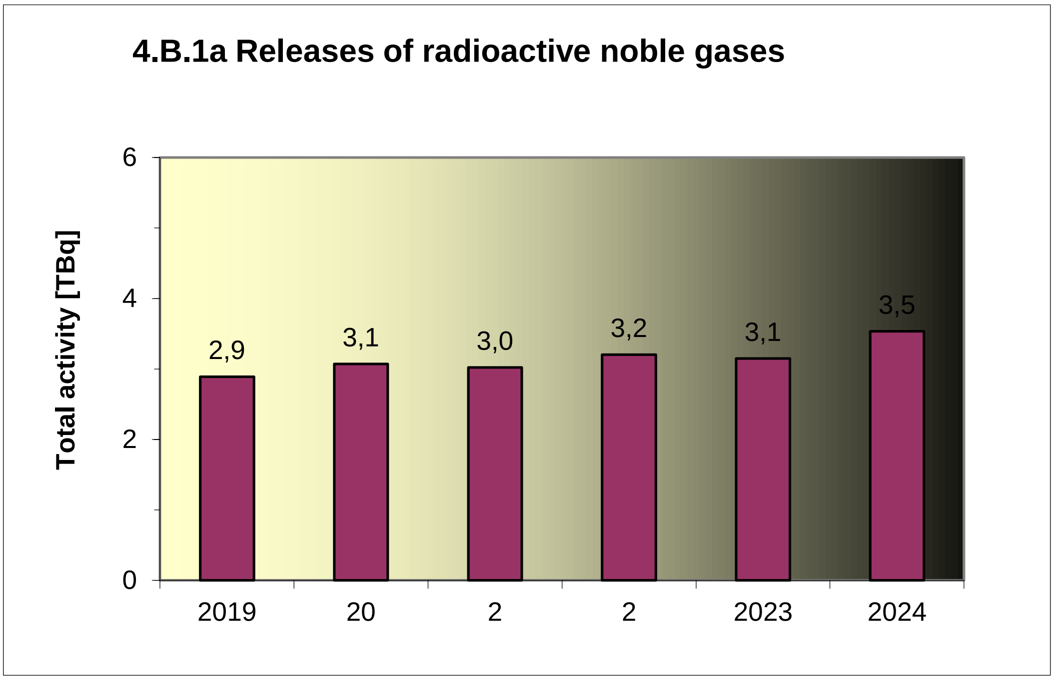


4.B Radioactive discharges

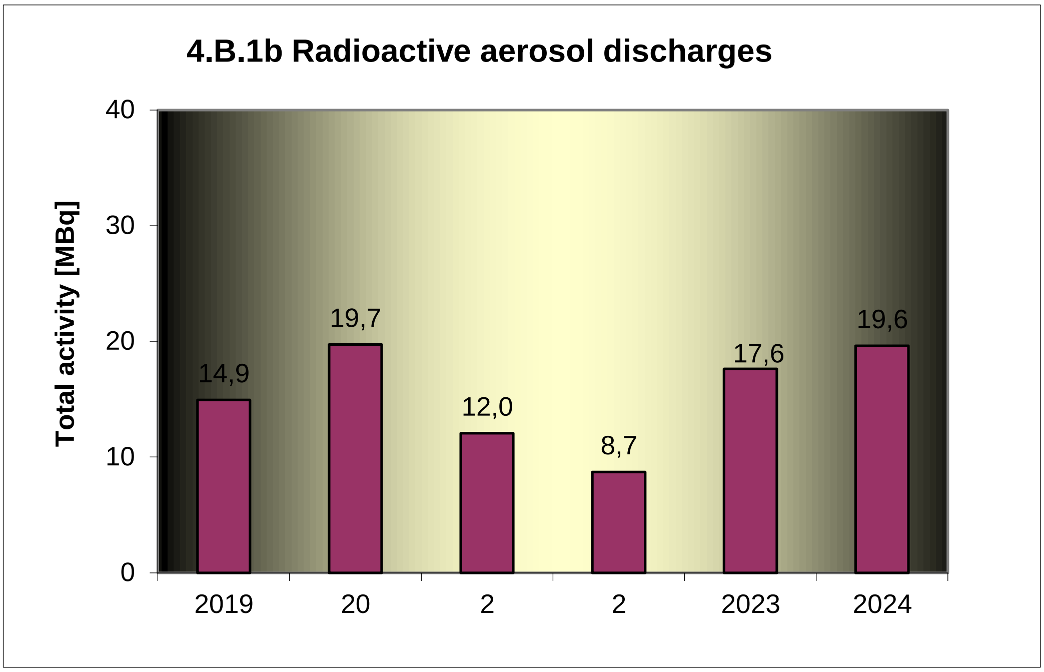
Graph 4.B.1 shows the effective dose calculated for a representative person as a result of discharges from the NPP into the air.



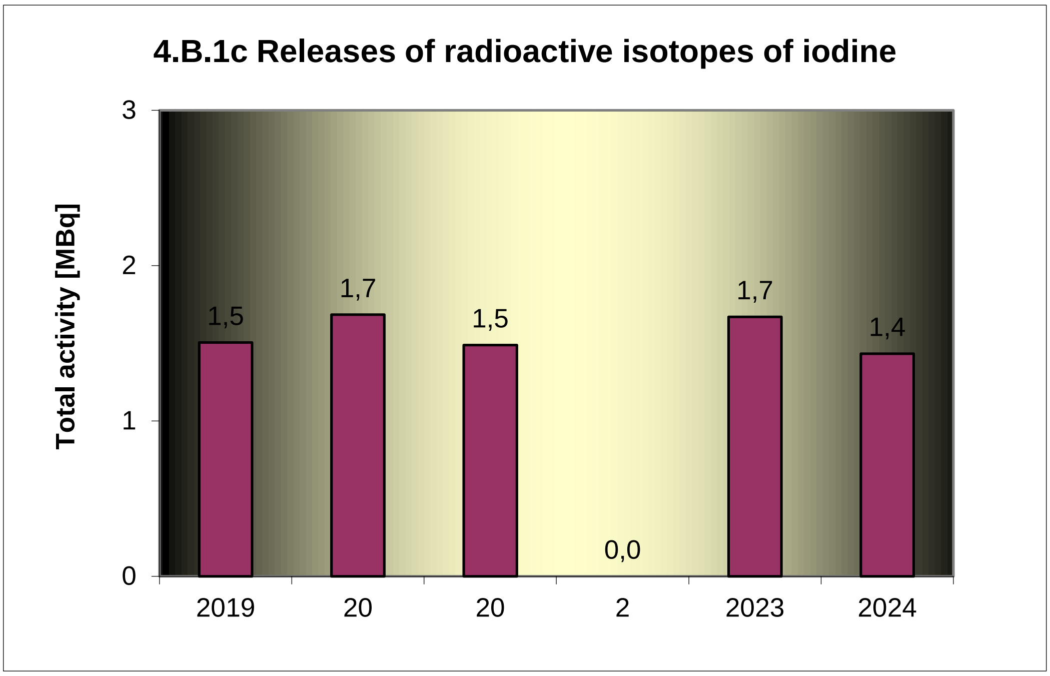
Graph 4.B.1a shows the total activity of radioactive noble gas discharges from NPPs.



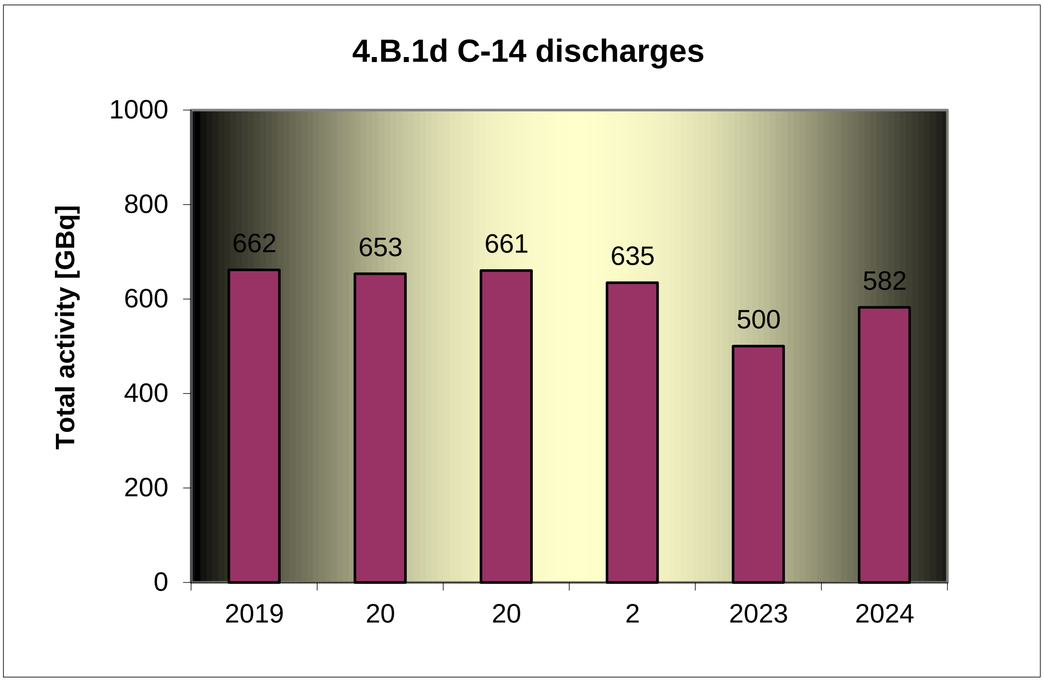
Graph 4.B.1b shows the total activity of radioactive aerosol discharges from NPPs.



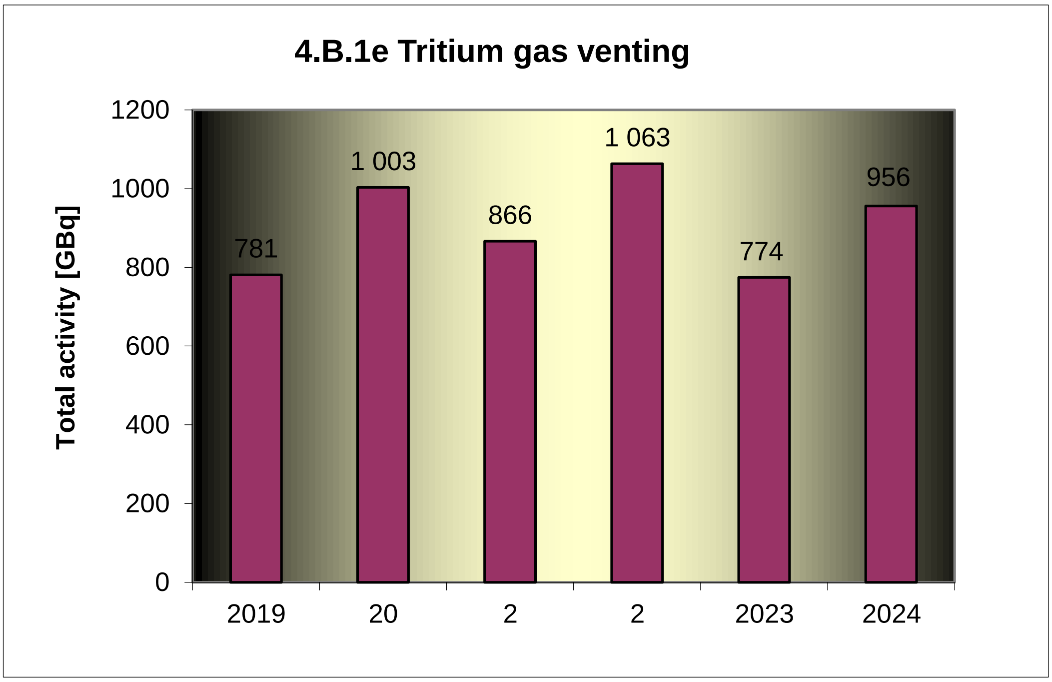
Graph 4.B.1c shows the total activity of radioactive iodine isotope discharges from NPPs.



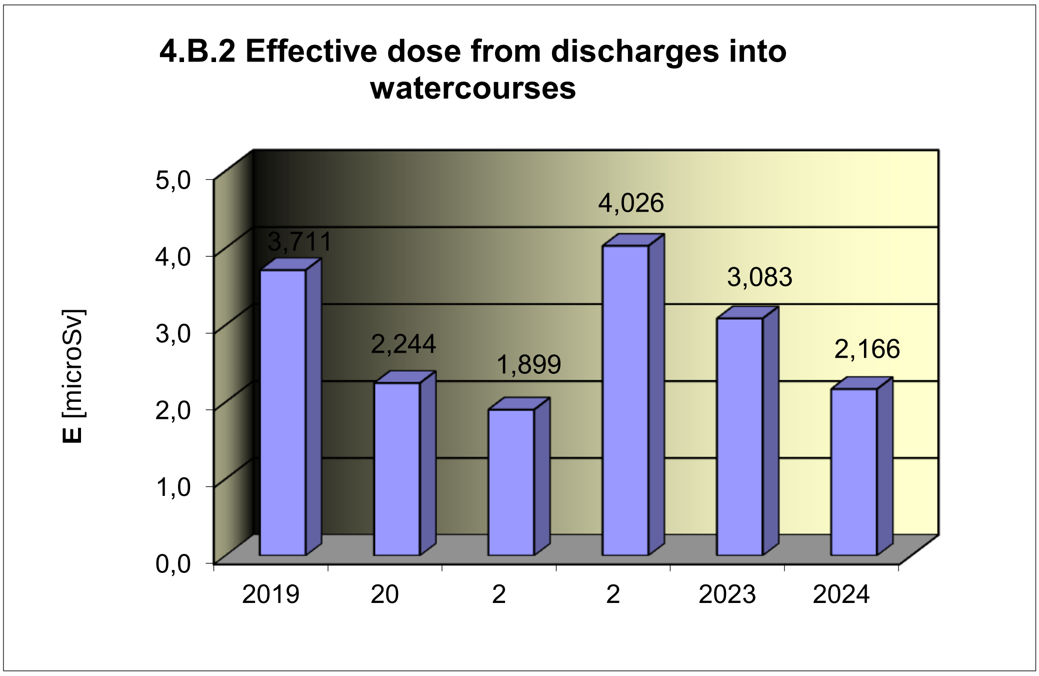
Graph 4.B.1d shows the total activity of C-14 radioisotope emissions from nuclear power plants.



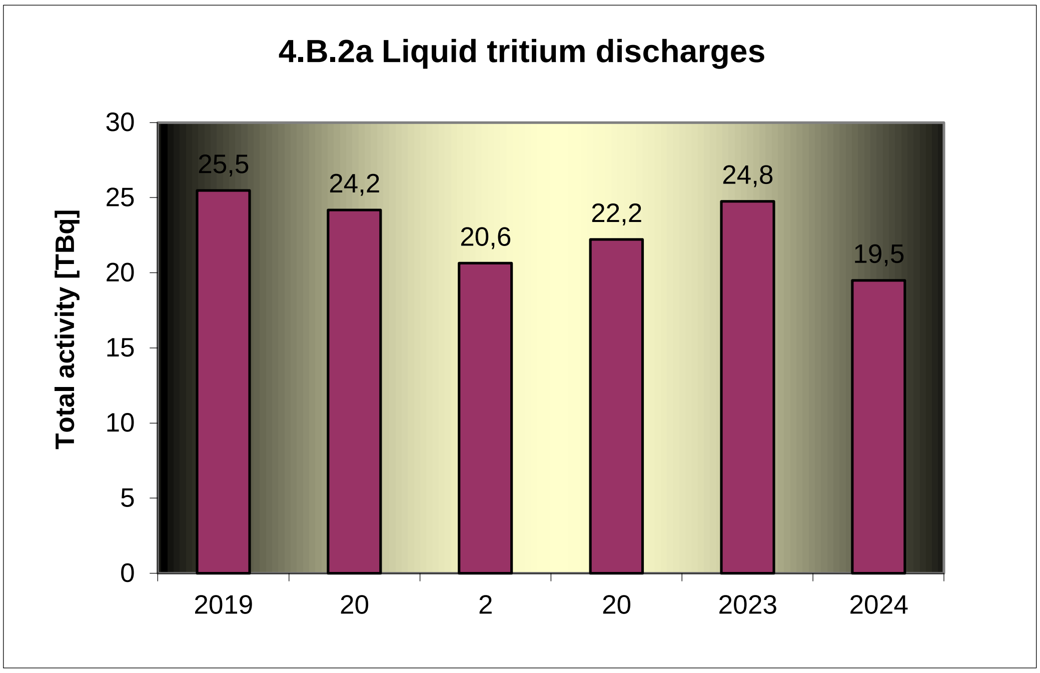
Graph 4.B.1e shows the total activity of gaseous tritium emissions from NPPs.



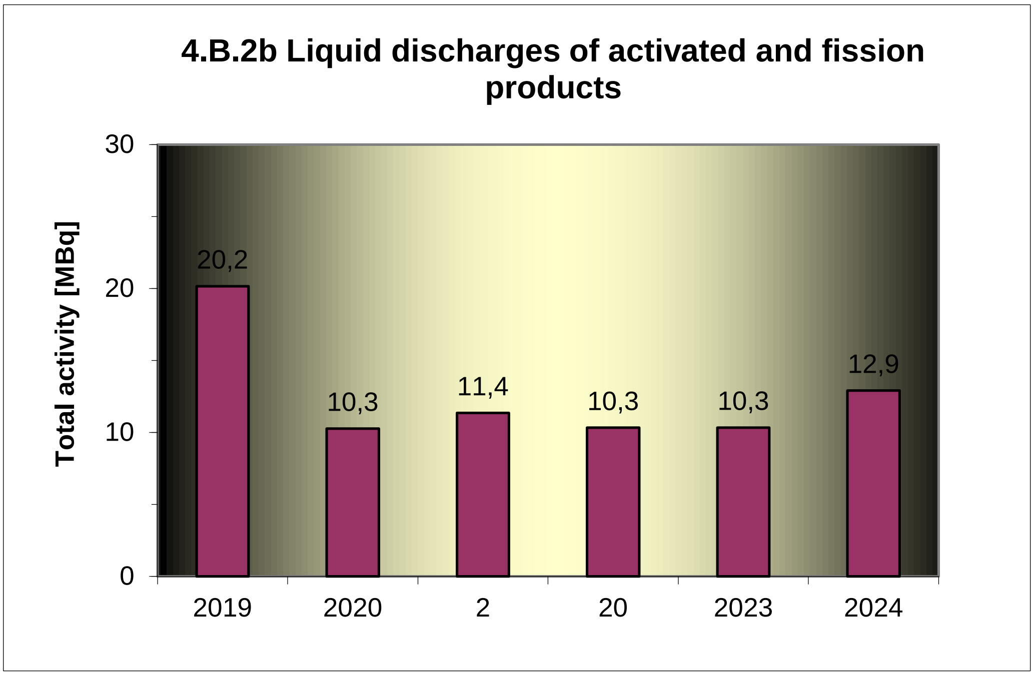
Graph 4.B.2 shows the effective dose calculated for a representative person as a result of discharges from NPPs into watercourses.



Graph 4.B.2a shows the total activity of liquid tritium discharges from nuclear power plants.



Graph 4.B.2b shows the total activity of liquid discharges of activated and fission products from the NPP.



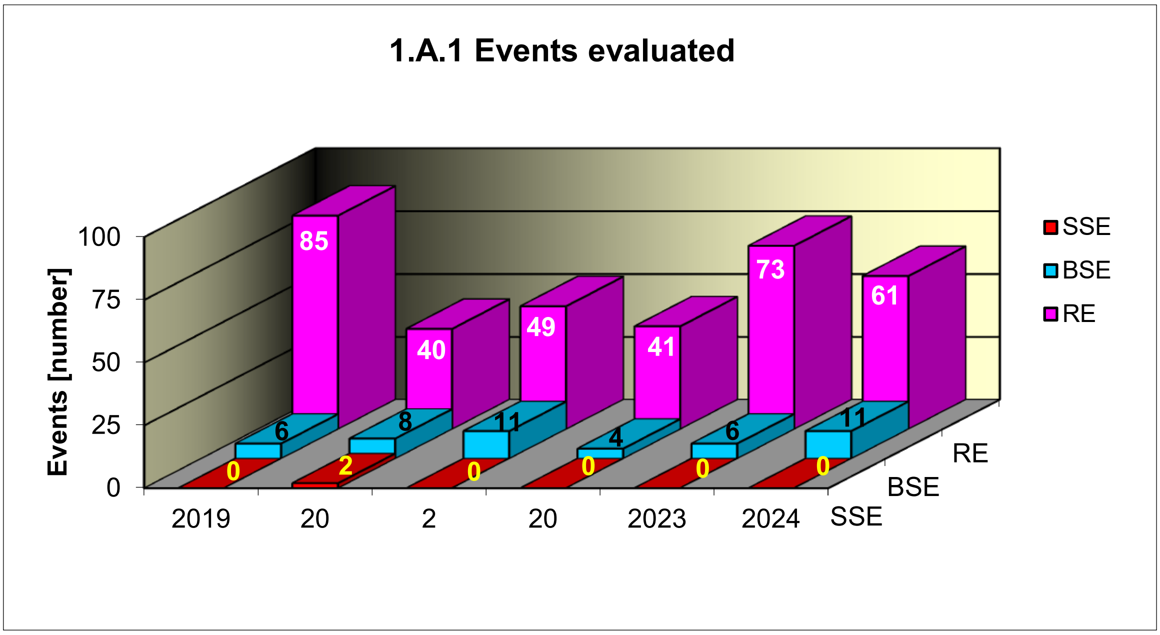
H. APPENDIX No. 3

RESULTS OF THE EVALUATION OF THE SET OF OPERATIONAL AND SAFETY INDICATORS IN 2024 FOR THE TEMELÍN NPP

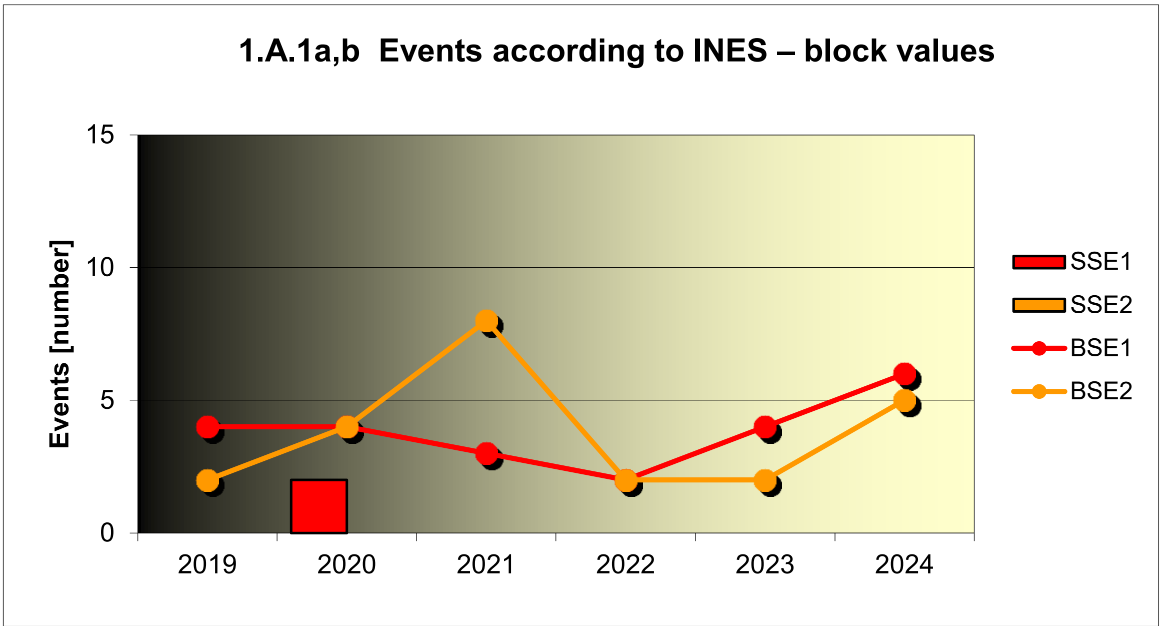
1. Events

1.A Evaluated events

Indicator graph 1.A.1 tracks the development of the number of evaluated events (RE), including their classification according to the INES scale into significant events (SSE, INES > 0) and events below the scale (BSE, INES 0).



Graphs 1.A.1a and 1.A.1b compare the number of events assessed according to INES by unit.



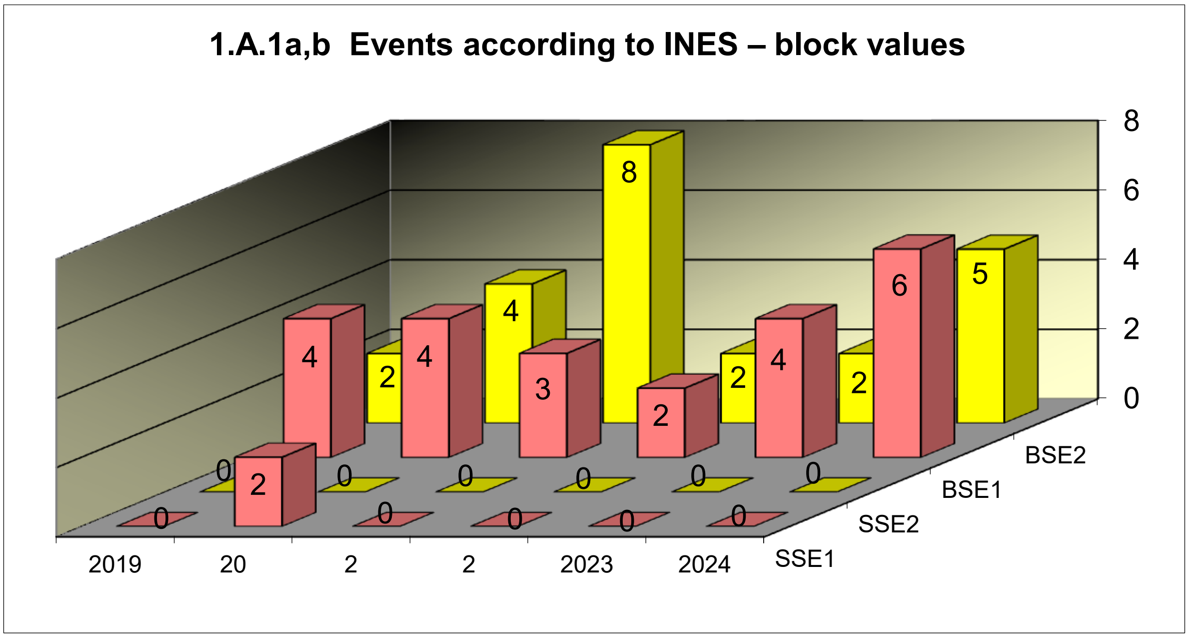
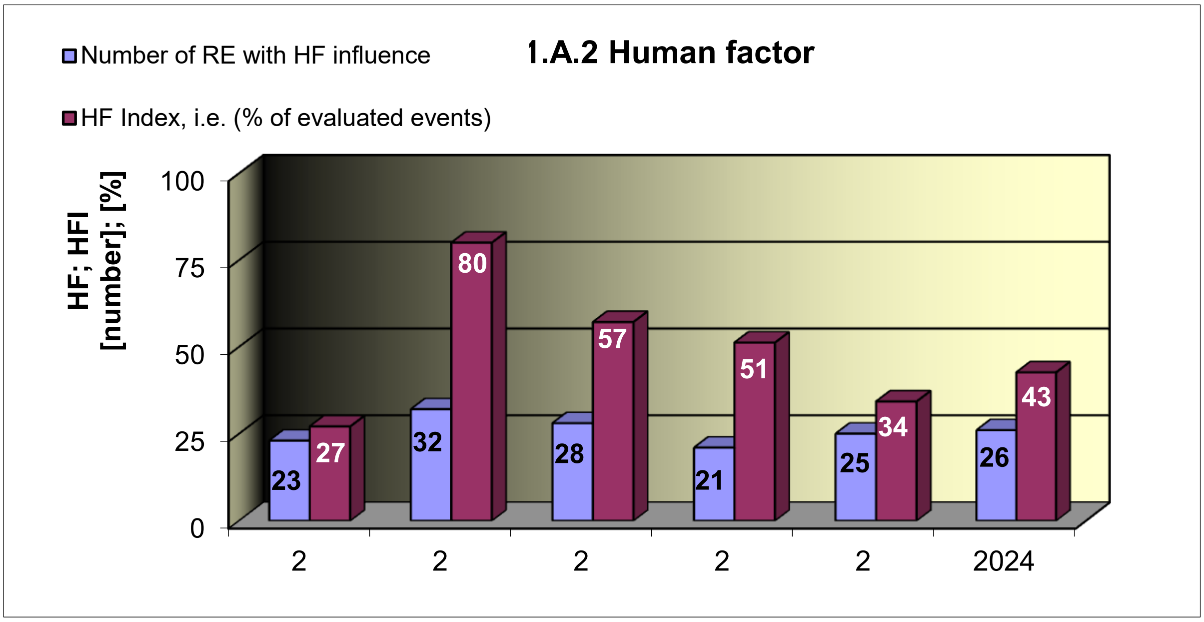
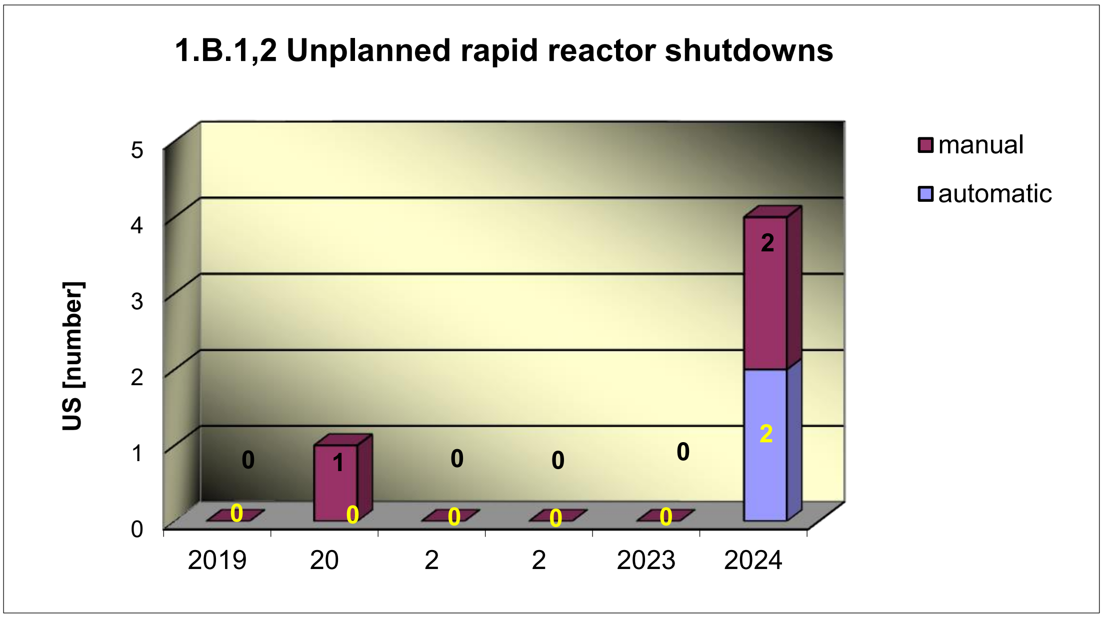


Chart 1.A.2 assesses the impact of human factors on the occurrence of reported events (until 2006 on the occurrence of safety events – SRE, INES ≥ 0). The indicator is expressed by the number of events with human factors (HF) and their percentage share (HFI).

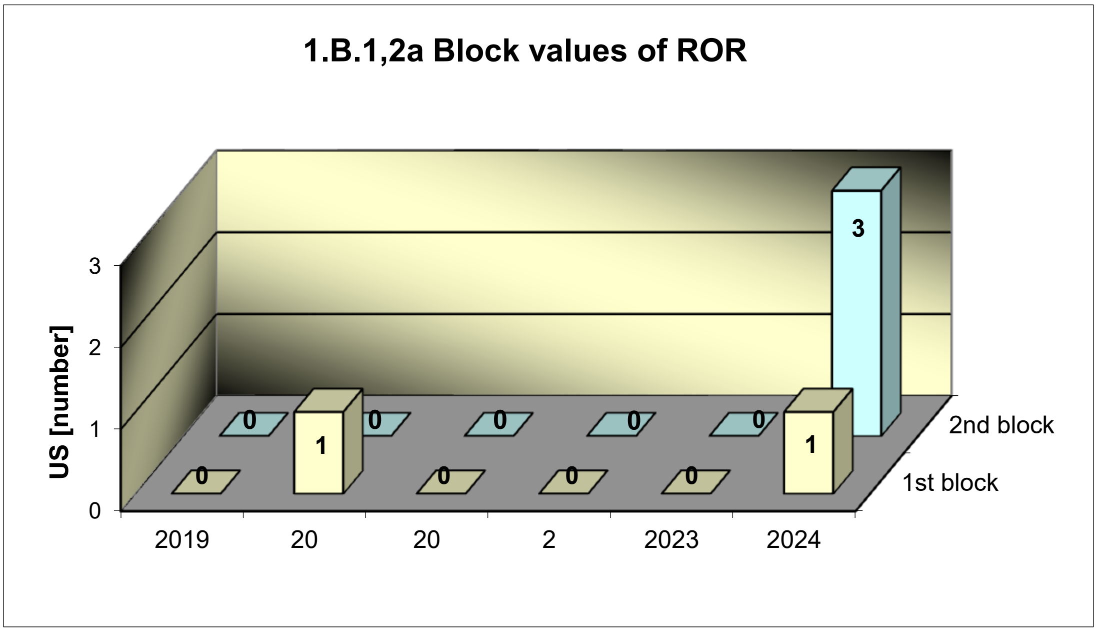


1.B Effectiveness of protective and limiting systems

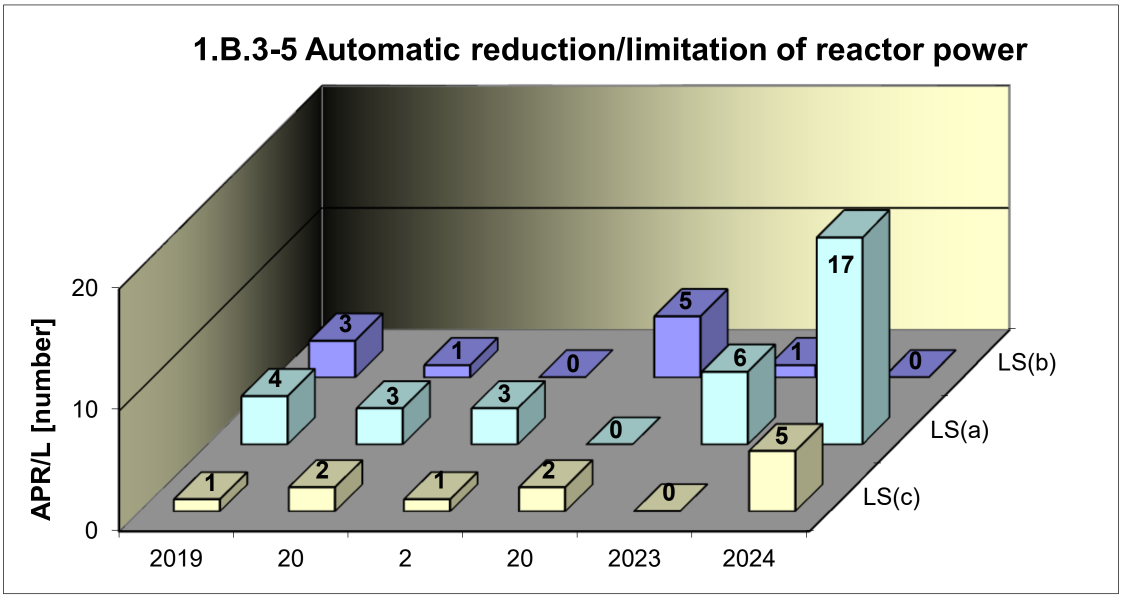
Graph 1.B.1,2 summarizes the total number of unplanned rapid reactor shutdowns (US) (reactor in MODE 1 or 2) with a distinction between manual shutdown and automatic incorporation. Unplanned means that the rapid shutdown was not an expected part of a planned test.



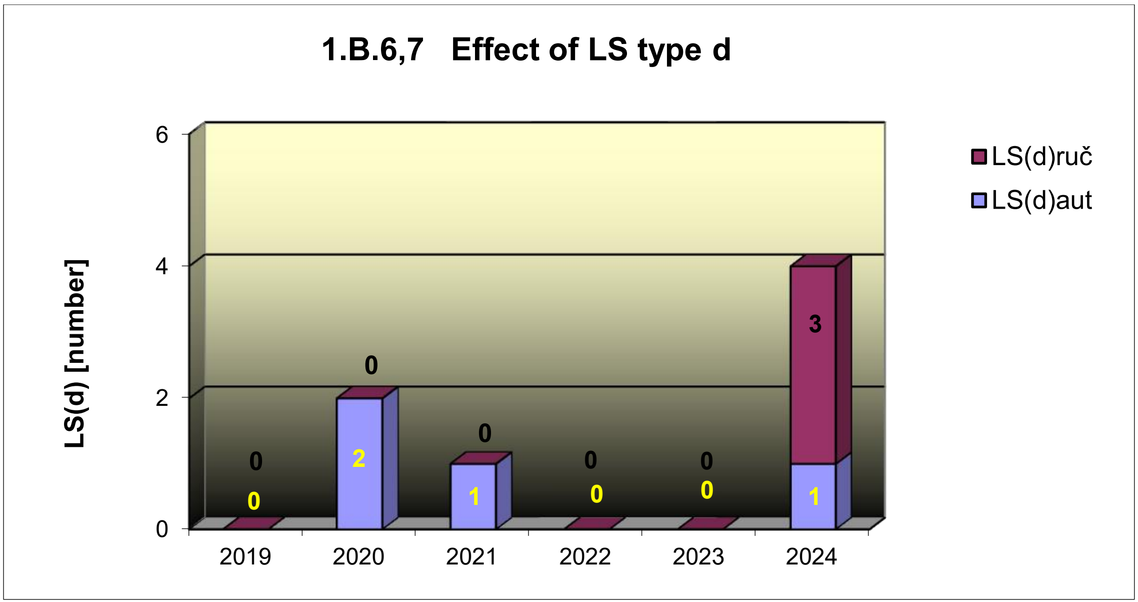
Graph 1.B.1,2a compares the number of unplanned rapid reactor shutdowns (US), including manual shutdowns, by unit.



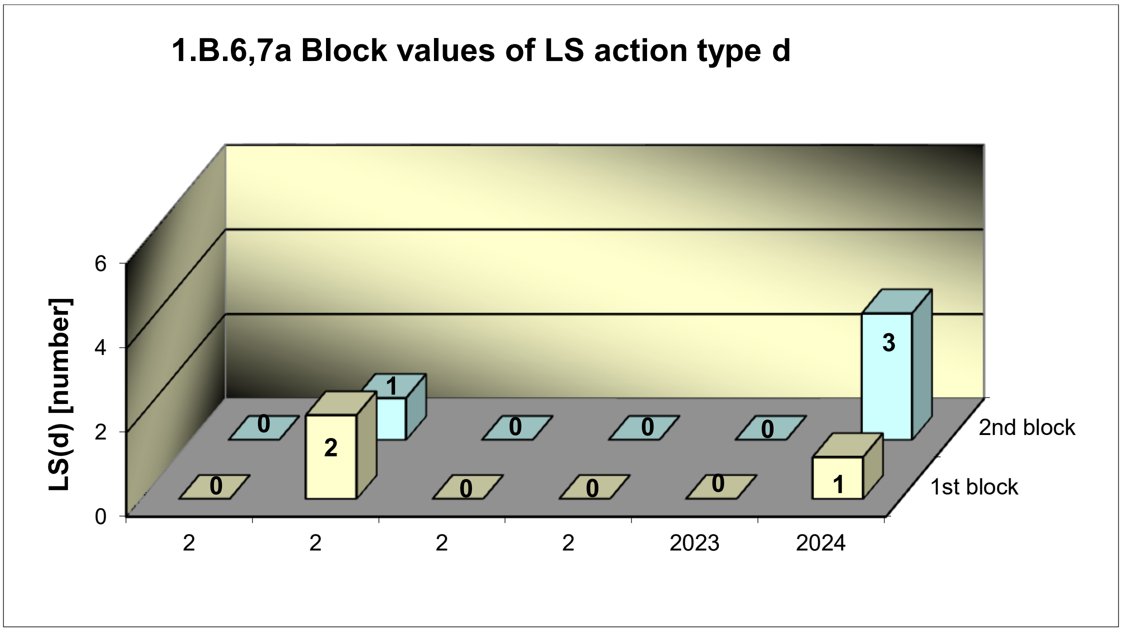
The combined graph of indicators 1.B.3-5 shows the number of unplanned LS activations of types a, b, and c.



Graph 1.B.6,7 summarizes the total number of unplanned rapid reactor shutdowns caused by LS(d) (reactor in MODE 1 or 2) with a distinction between manual shutdown and automatic integration. Unplanned means that the rapid shutdown was not an expected part of the planned test.

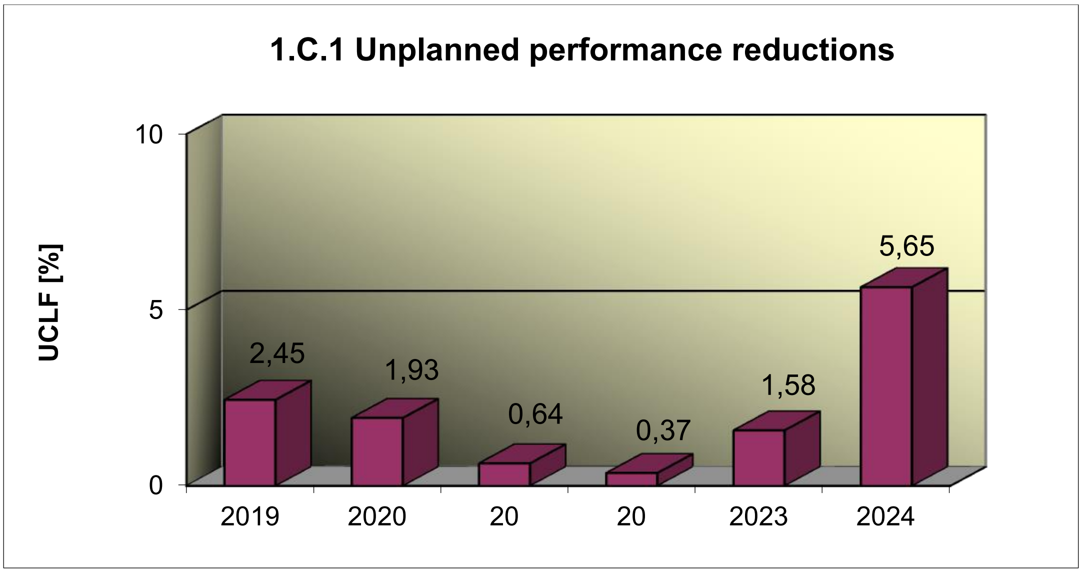


Graph 1.B.6,7a compares the block numbers of unplanned rapid reactor shutdowns, including manual LS(d) actions.



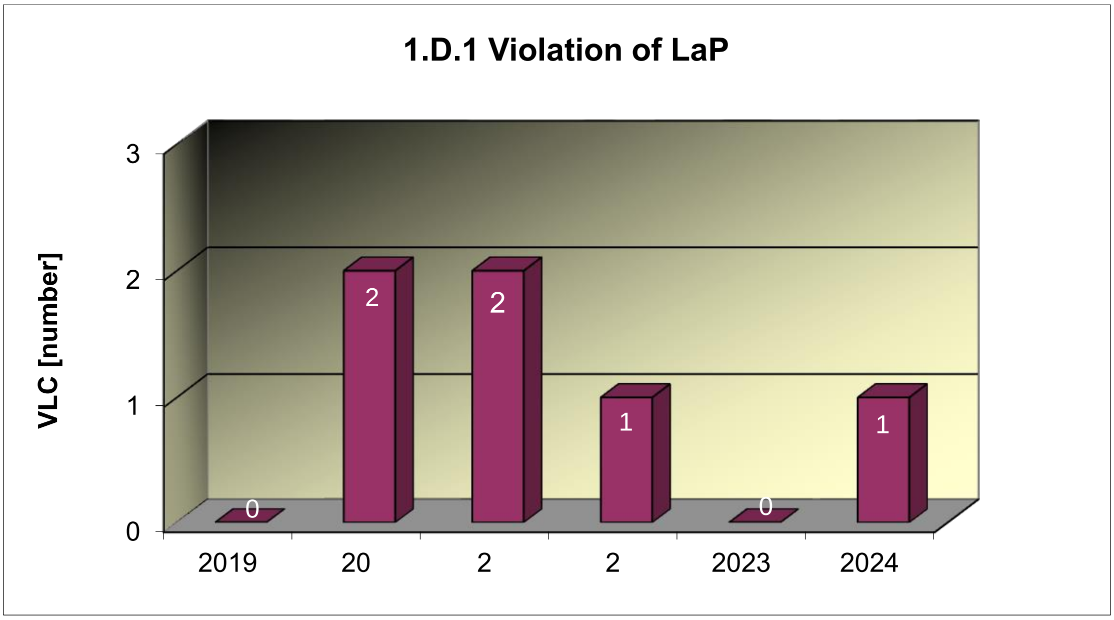
1.C Power reduction

Graph 1.C.1 shows the trend of unplanned power reductions (UCLF).

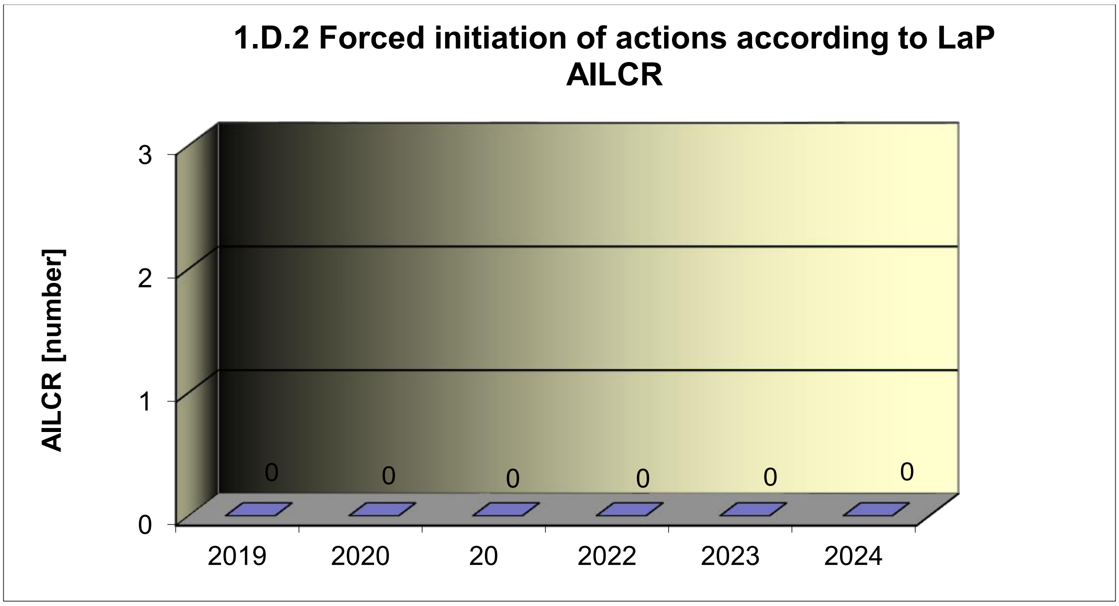


1.D Limits and conditions for safe operation

Graph 1.D.1 summarizes the number of LaP violations (VLC) detected by the regulatory authority or reported to the regulatory authority by the NPP operator.



Graph 1.D.2 shows the number of all equipment status or parameter-induced initiations of a unit transition to a higher sequence number mode in accordance with LaP requirements (AICLR).



Graph 1.D.3 summarizes the number of planned and unplanned temporary LaP changes (ELC) approved by the supervisory authority, including those requested, approved by the SÚJB, but not used for various reasons.

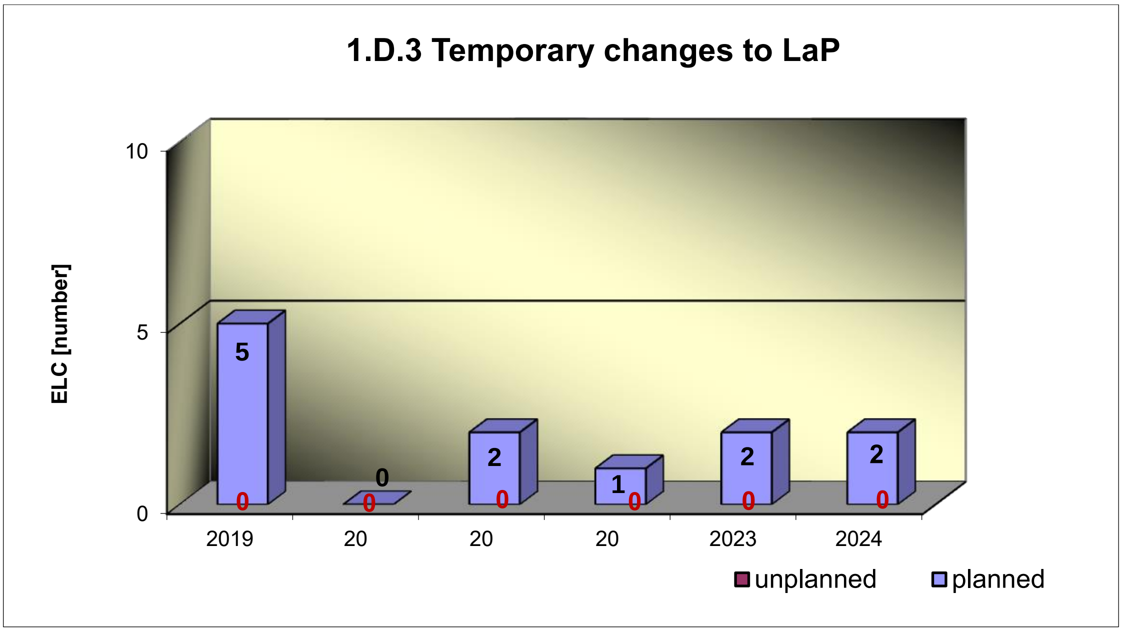
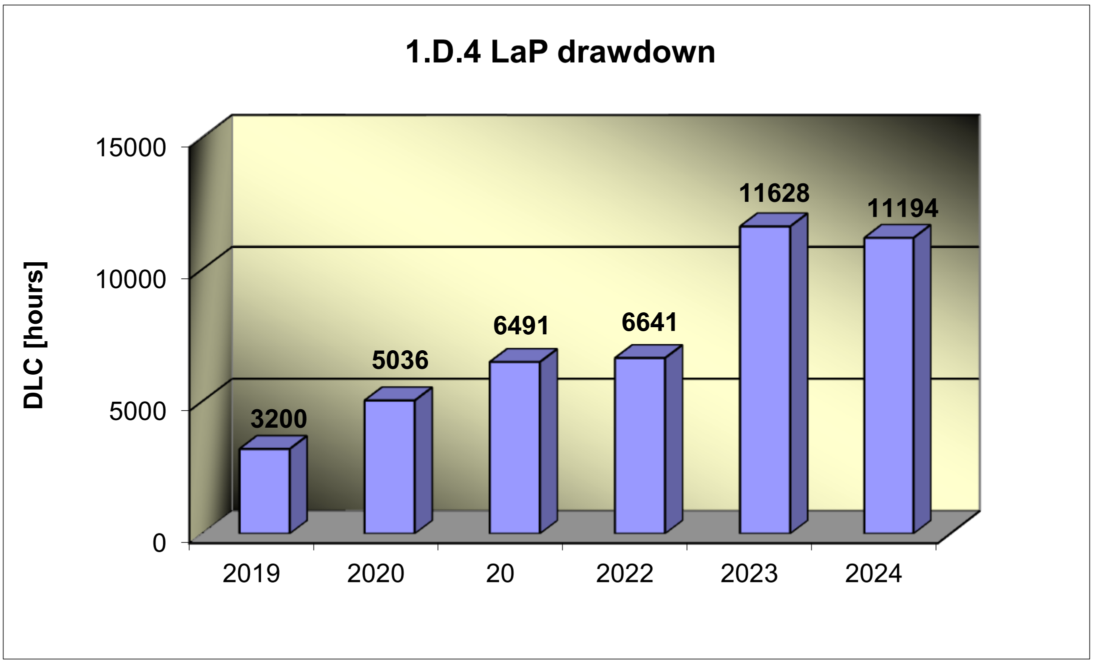


Chart 1.D.4 summarizes the number of hours of LaP utilization in all unit modes (DLC).



2. Operation of safety systems

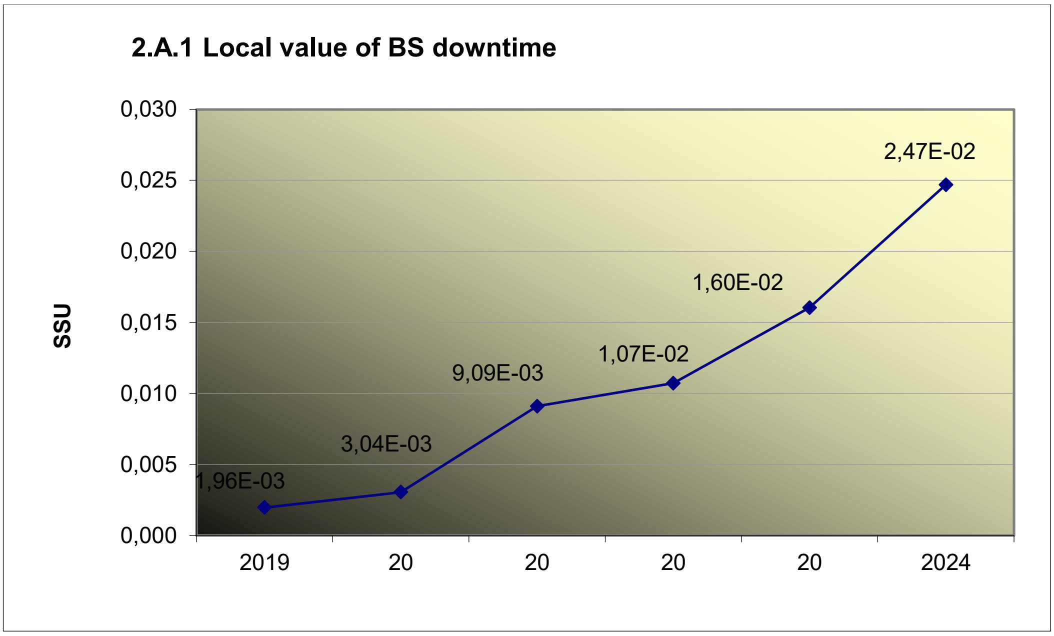
Area 2 monitors and evaluates the operability of the following safety systems (BS) in group A:

- system diesel generators **DGS**
- shower system **TQx1**
- low-pressure AZ emergency replenishment system **TQx2**
- high-pressure emergency refill system AZ **TQx3**
- emergency boron injection system **TQx4**
- hydraulic accumulators **HA**
- PG emergency power supply system **TX**

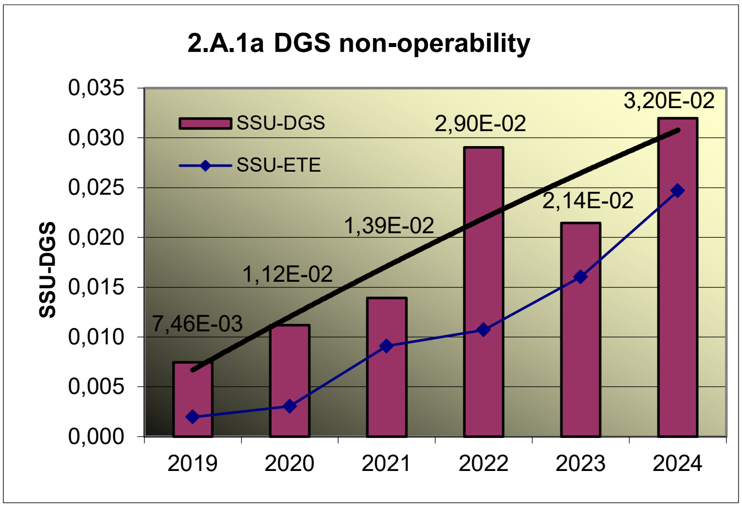
and in group B, failure of DG, TQx1, TQx2, TQx3, TQx4, and TX during start-up and operation.

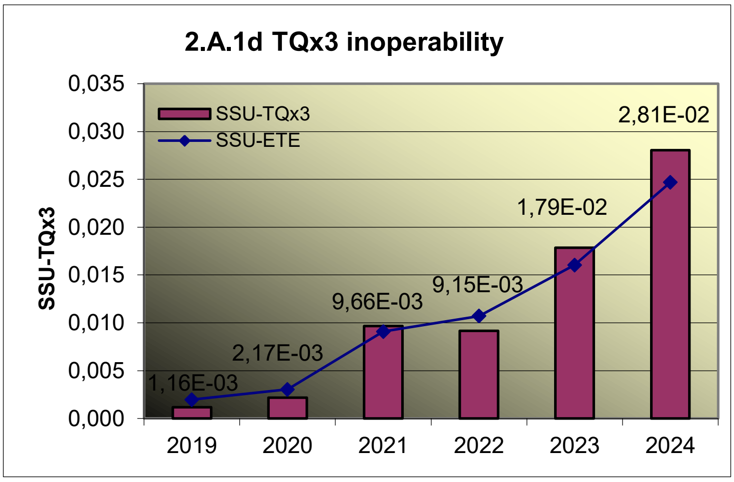
2.A Non-operability of safety systems

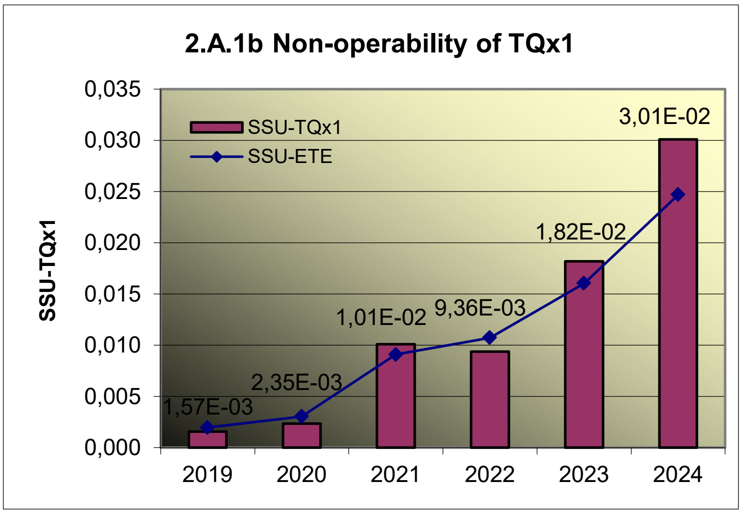
Graph 2.A.1 shows the local value of the non-operability of the "unit – general" safety system (SSU), which is given by the average value of the non-operability of all monitored safety systems at the site.

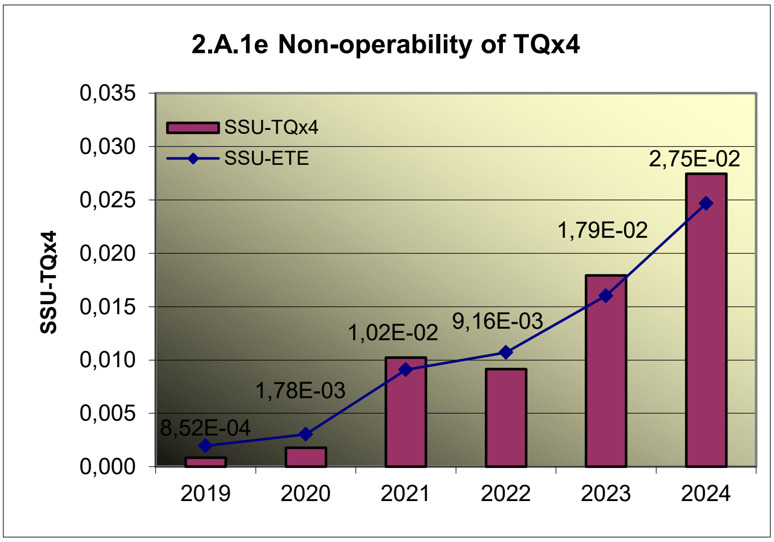


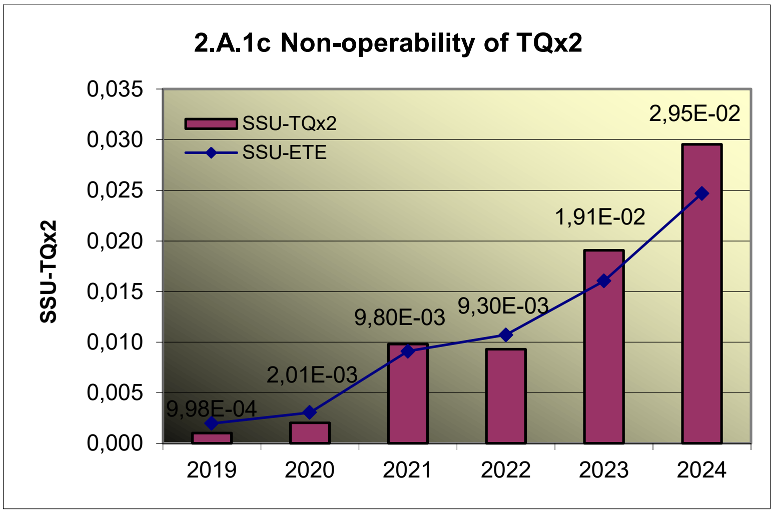
The non-operability of individual BS (SSU_S) – graphs 2.A.1.a – g – is defined as the ratio of the total non-operability time of the evaluated BS to the total time during which its operability was required. These combined graphs also show the ratio of the non-operational time of a given BS to the "general" BS of the site.

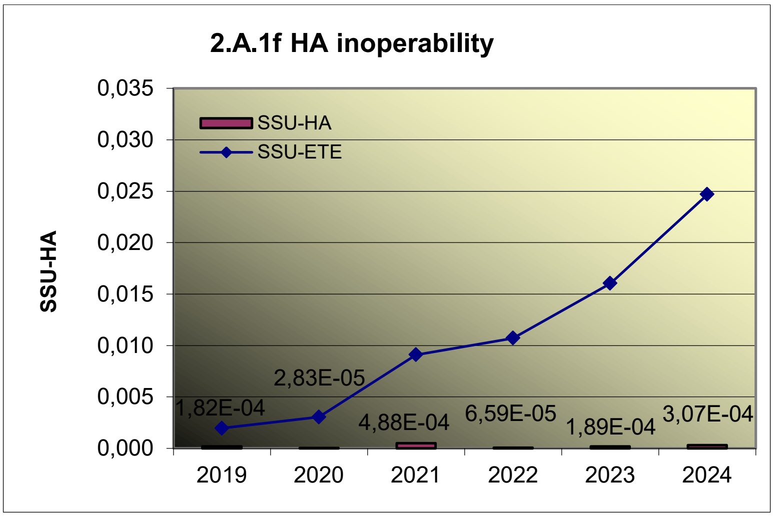







2.A.1e Non-operability of TQx4
SSU-TQx4
SSU-ETE
SSU-TQx4
0,035
0,030
0,025
0,020
0,015
0,010
0,005
0,000
8,52E-04
1,78E-03
1,02E-02
9,16E-03
1,79E-02
2,75E-02
2019
2020
2021
2022
2023
2024


2.A.1c Non-operability of TQx2
SSU-TQx2
SSU-ETE
SSU-TQx2
0,035
0,030
0,025
0,020
0,015
0,010
0,005
0,000
9,98E-04
2,01E-03
9,80E-03
9,30E-03
1,91E-02
2,95E-02
2019
2020
2021
2022
2023
2024


2.A.1f HA inoperability
SSU-HA
SSU-ETE
SSU-HA
0,035
0,030
0,025
0,020
0,015
0,010
0,005
0,000
1,82E-04
2,83E-05
4,88E-04
6,59E-05
1,89E-04
3,07E-04
2019
2020
2021
2022
2023
2024

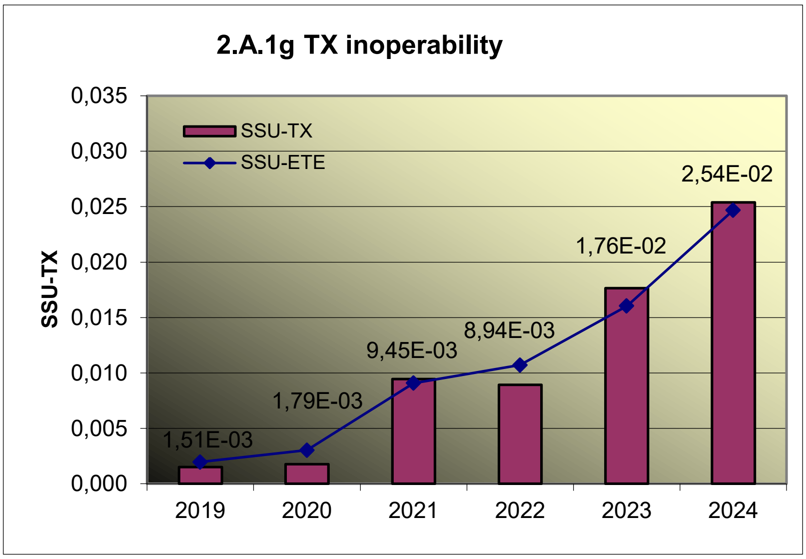
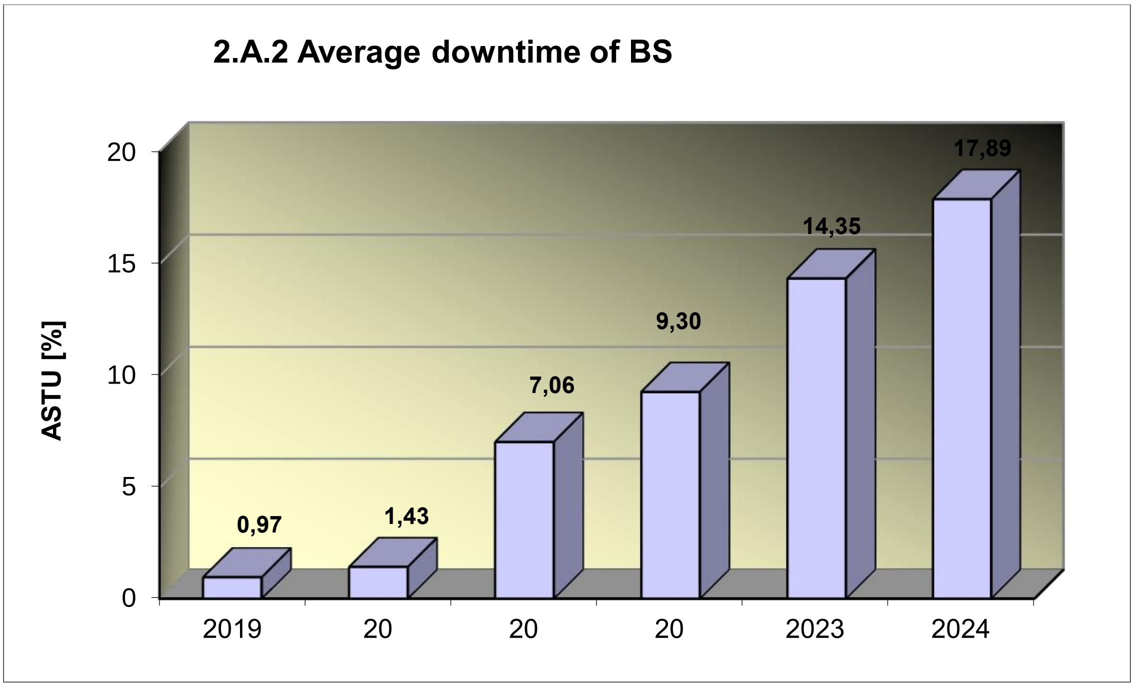
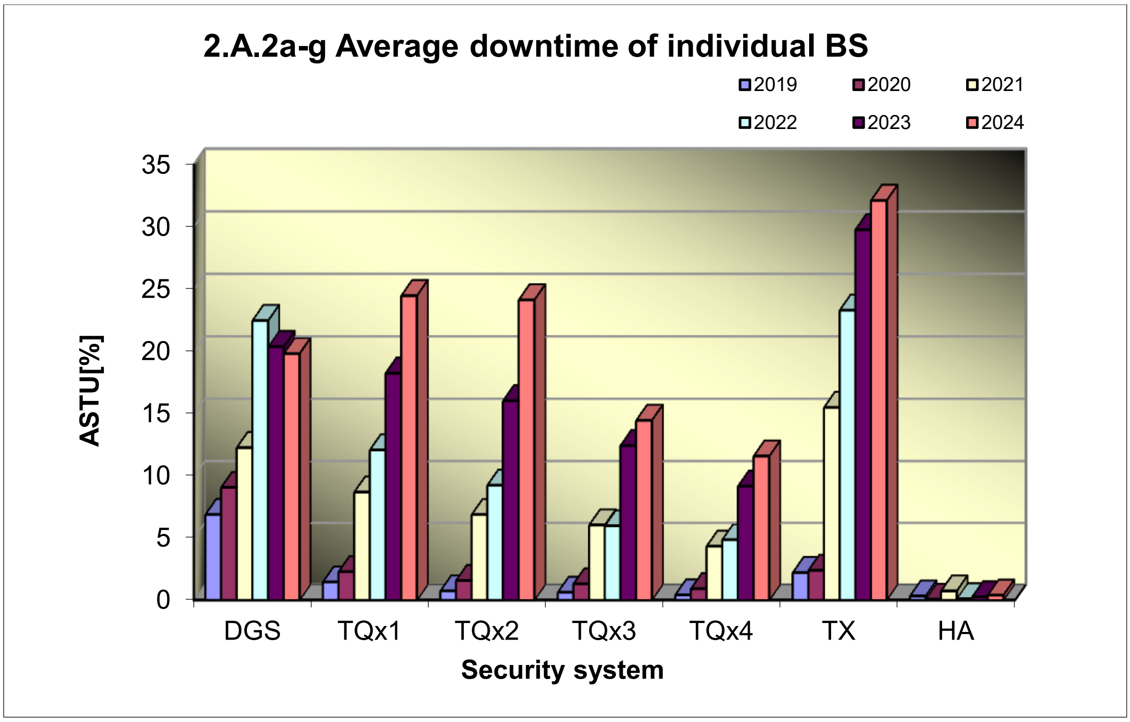

2.A.1g TX inoperability
SSU-TX
SSU-ETE
SSU-TX
0,035
0,030
0,025
0,020
0,015
0,010
0,005
0,000
1,51E-03
1,79E-03
9,45E-03
8,94E-03
1,76E-02
2,54E-02
2019
2020
2021
2022
2023
2024

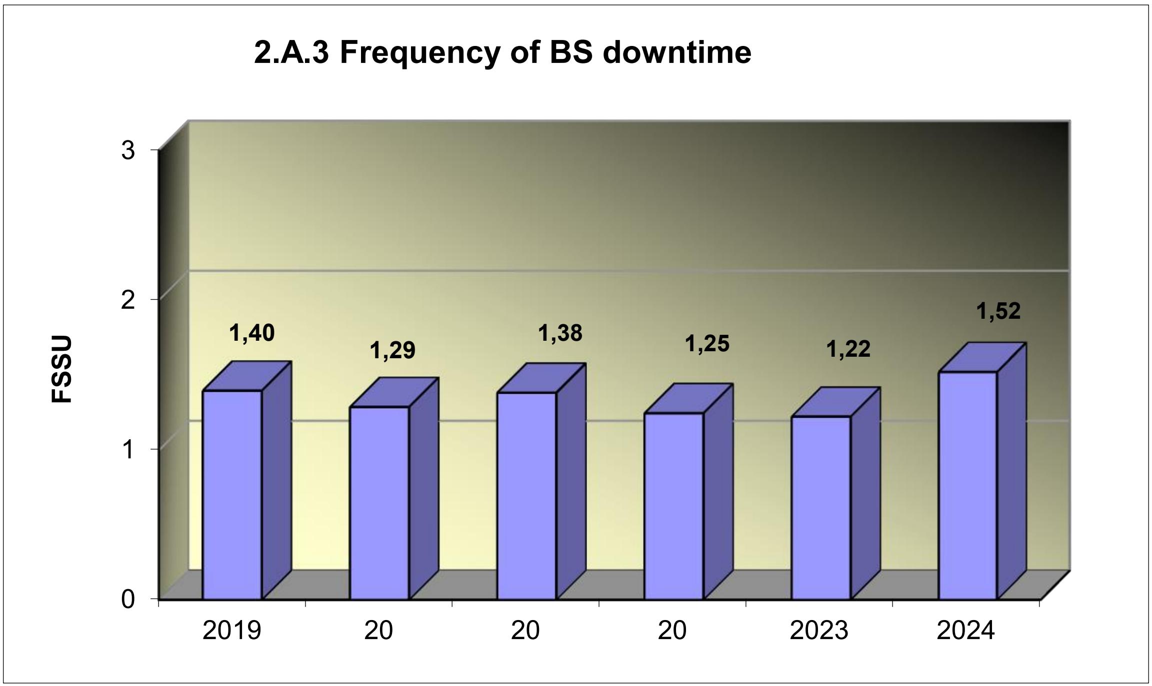
Chart 2.A.2 shows the average downtime of a "unit-general" safety system at a site (ASTU), which is given by the ratio of the mean downtime of a BS to the single downtime allowed in LaP.



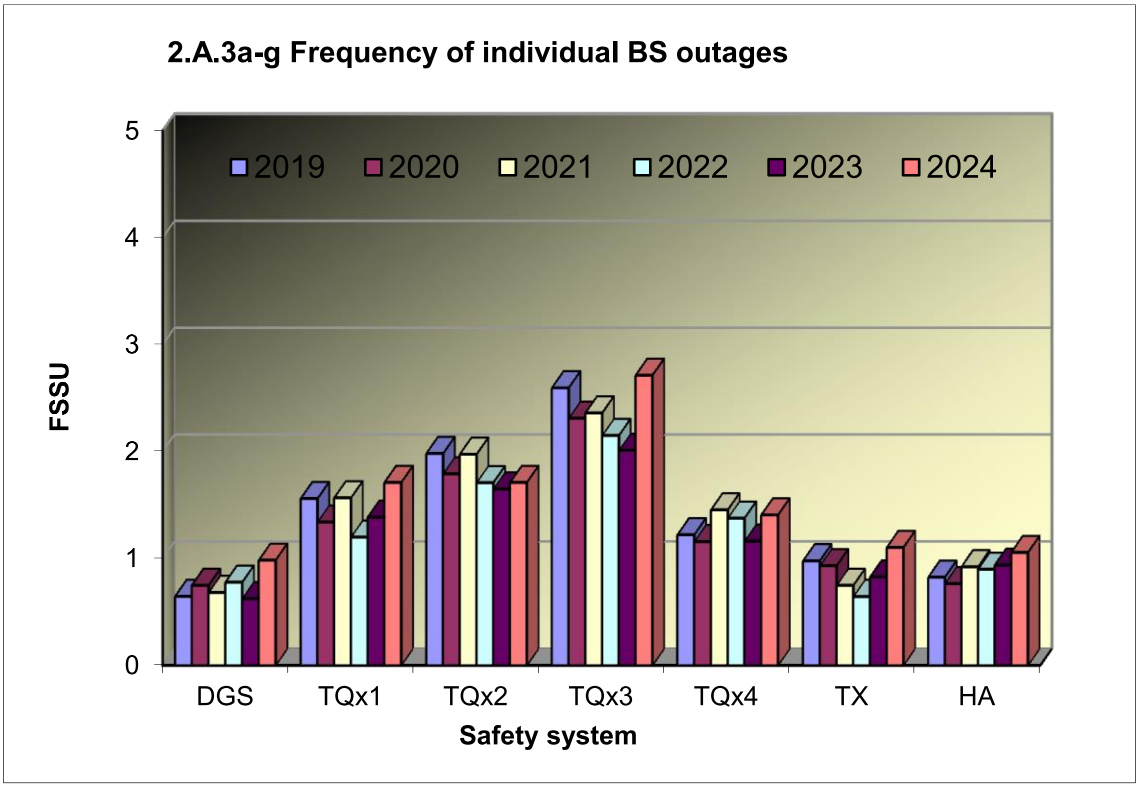
Graph 2.A.2a-g shows the ASTU system values.



Graph 2.A.3 shows the total number of "unit-general" BS outages at a site per thousand hours of required availability (FSSU).

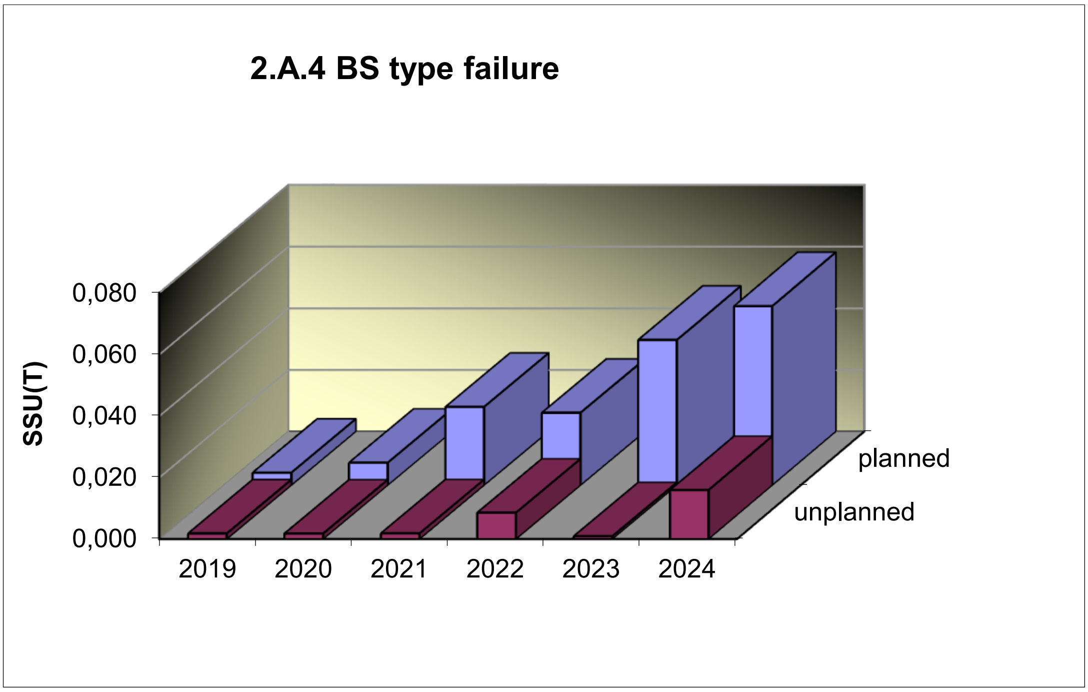


Graph 2.A.3a-g shows the development of FSSU values by system.

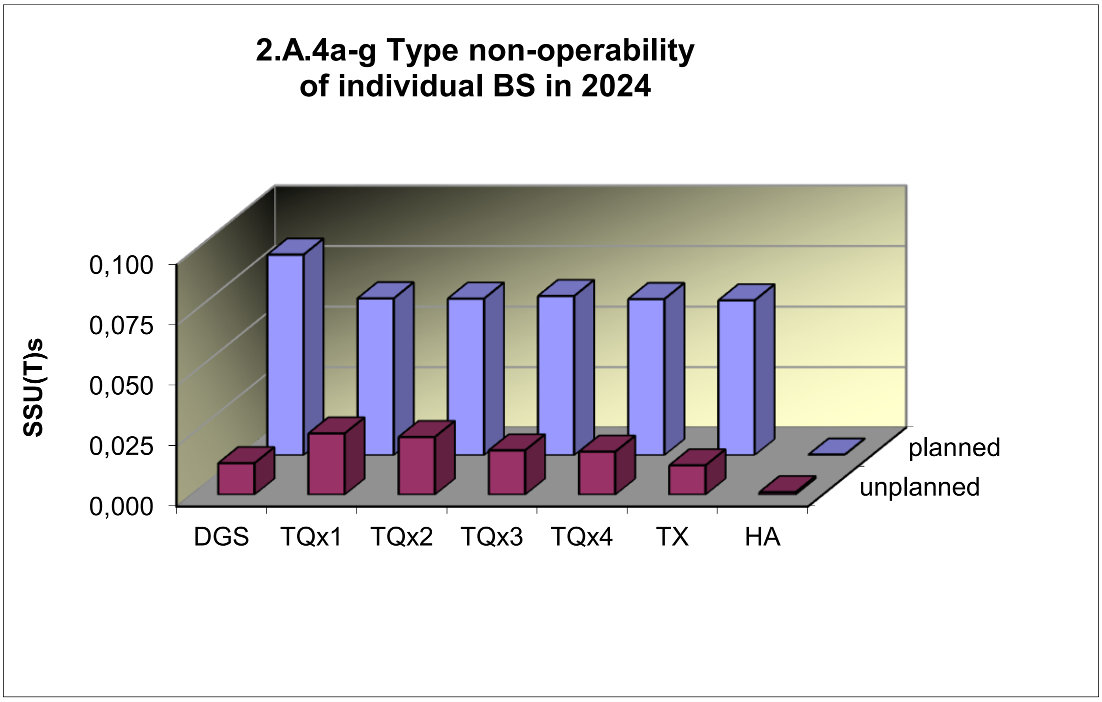


Graph 2.A.4 shows the ratio of the total downtime of "unit-general" BS for the relevant reason to the total time when system availability was required - SSU(T).

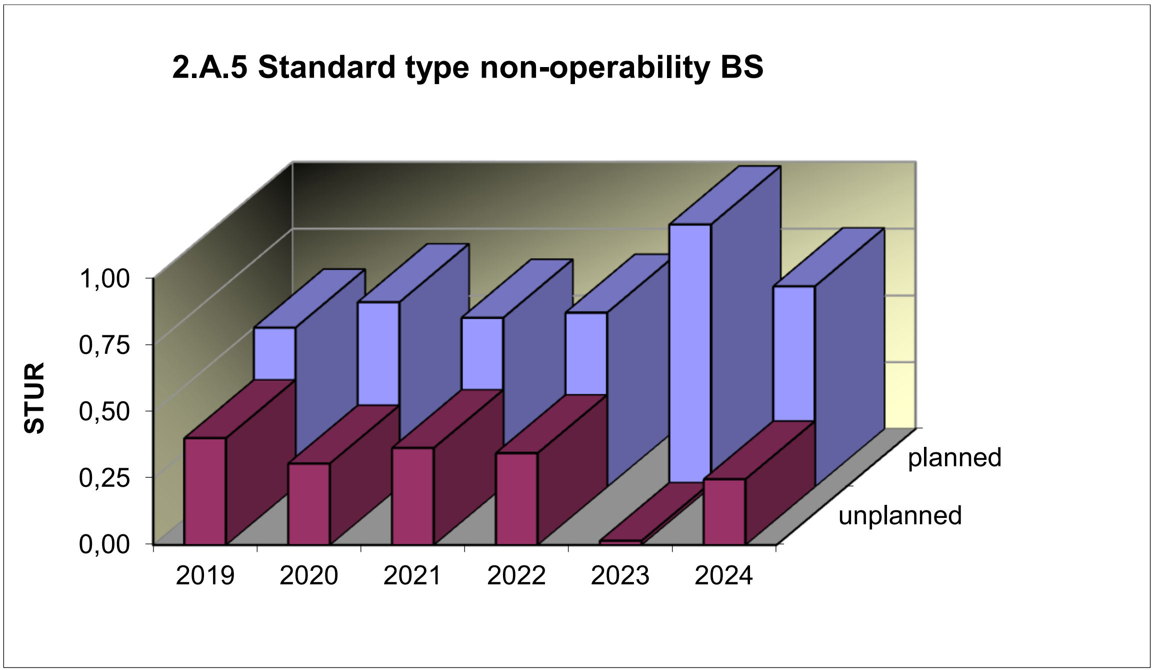
Three types of non-operability are distinguished.



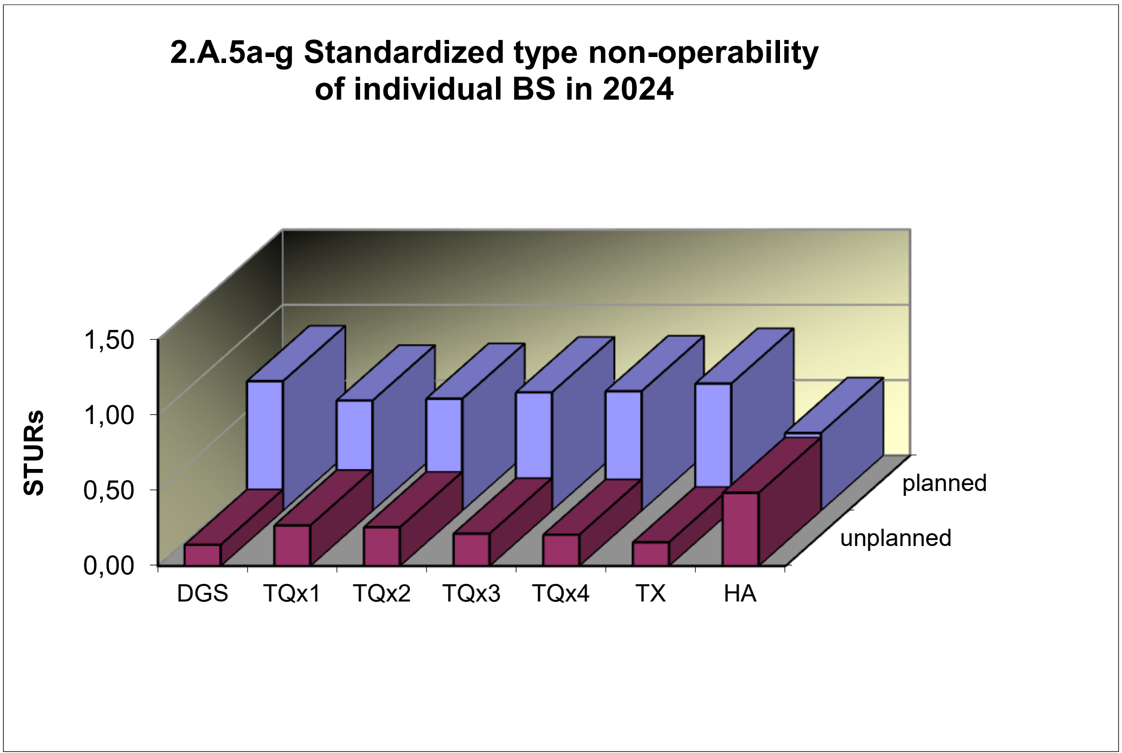
Graph 2.A.4a-g shows the system values of SSU(T) in 2024.



Graph 2.A.5 shows the ratio of the total downtime of BS for the relevant reason (see Graph 2.A.4 for reasons for downtime) to the total downtime of the system – STUR.

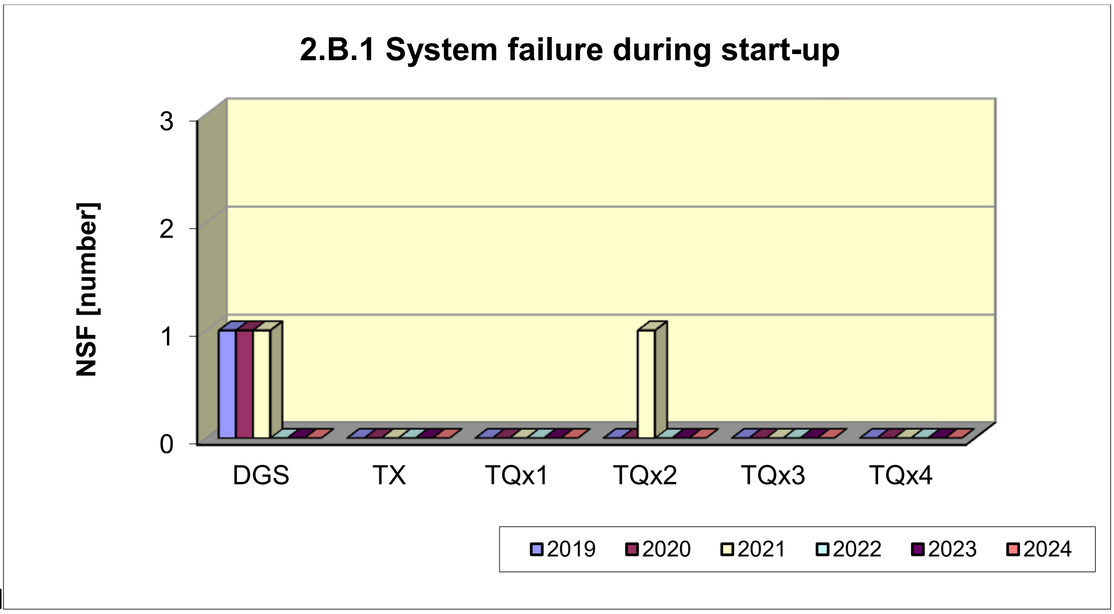


Graph 2.A.5a-g shows the system values of STUR in 2024.

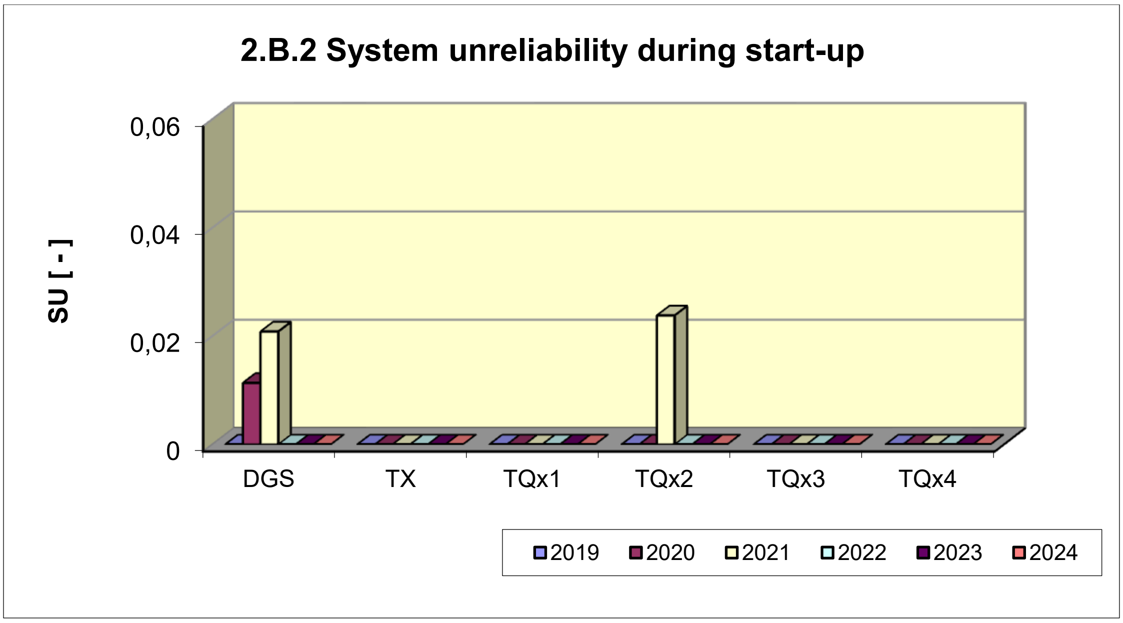


2.B Safety system failures

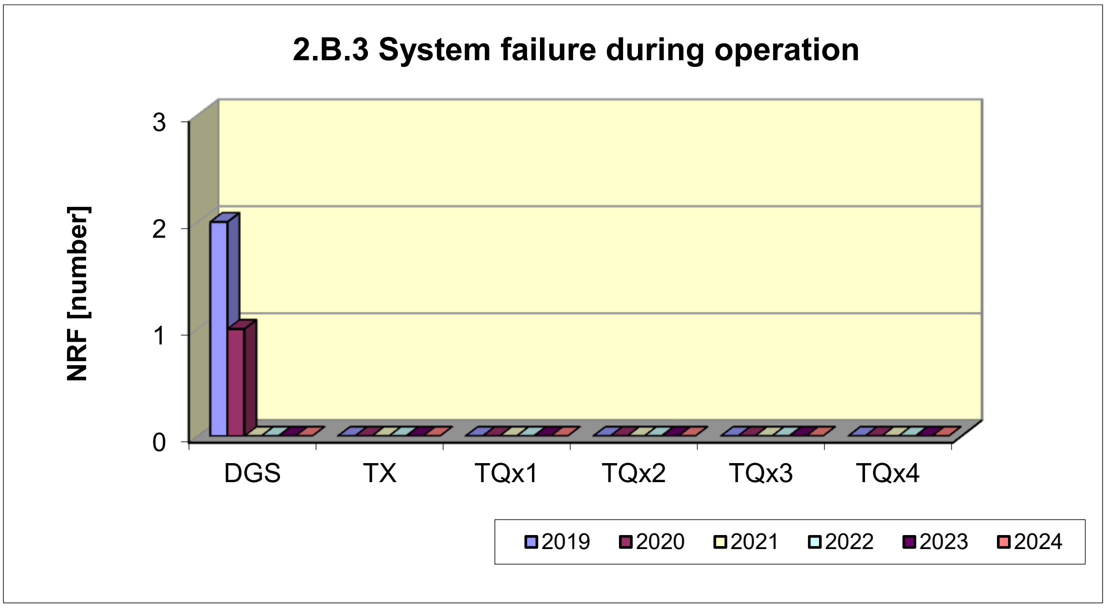
Graph 2.B.1 shows the number of BS failures at start-up (NSF), i.e. situations where the relevant system or unit does not reach its nominal operating characteristics after the start command or fails (shuts down) within 30 minutes of start-up.



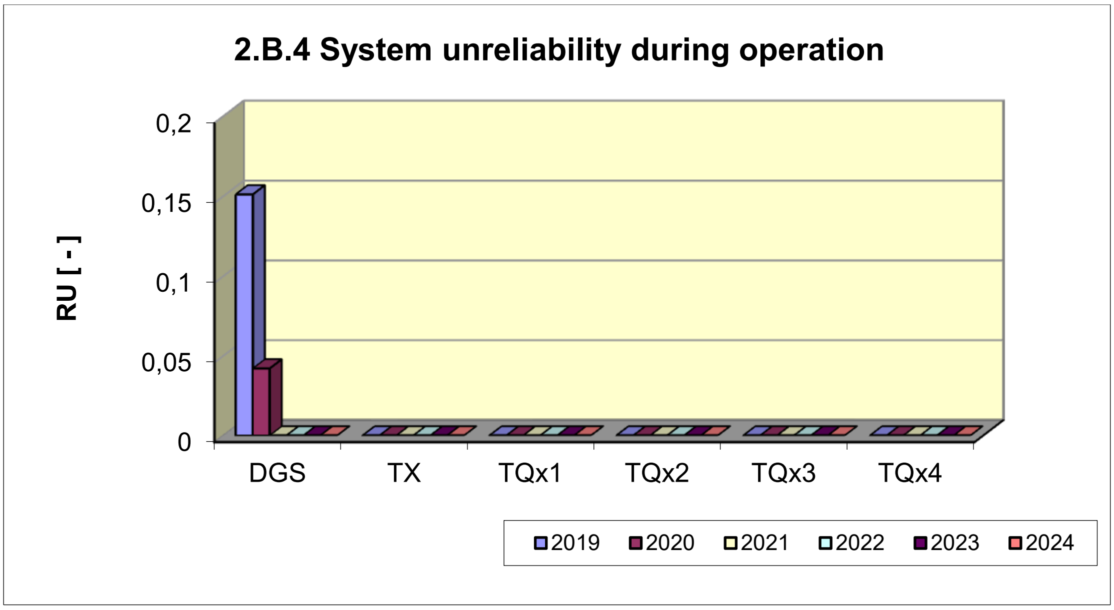
Graph 2.B.2 shows the ratio of the number of start failures to the total number of BS starts (SU) in a given period (so-called start unreliability).



Graph 2.B.3 shows the number of BS failures during operation (NRF), which is the number of cases when the relevant system, drive or unit fails and is shut down from operation at nominal operating characteristics for a period longer than 30 minutes after start-up.



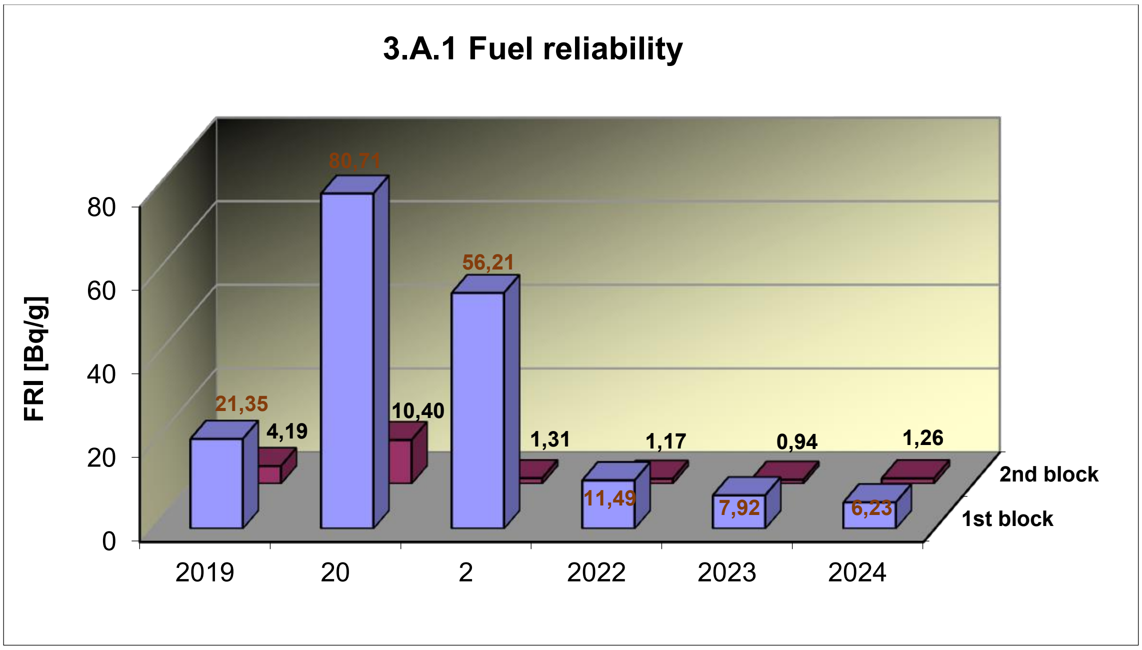
Graph 2.B.4 shows the ratio of the total number of failures during operation to the total number of hours run (RU) when its operability is required.



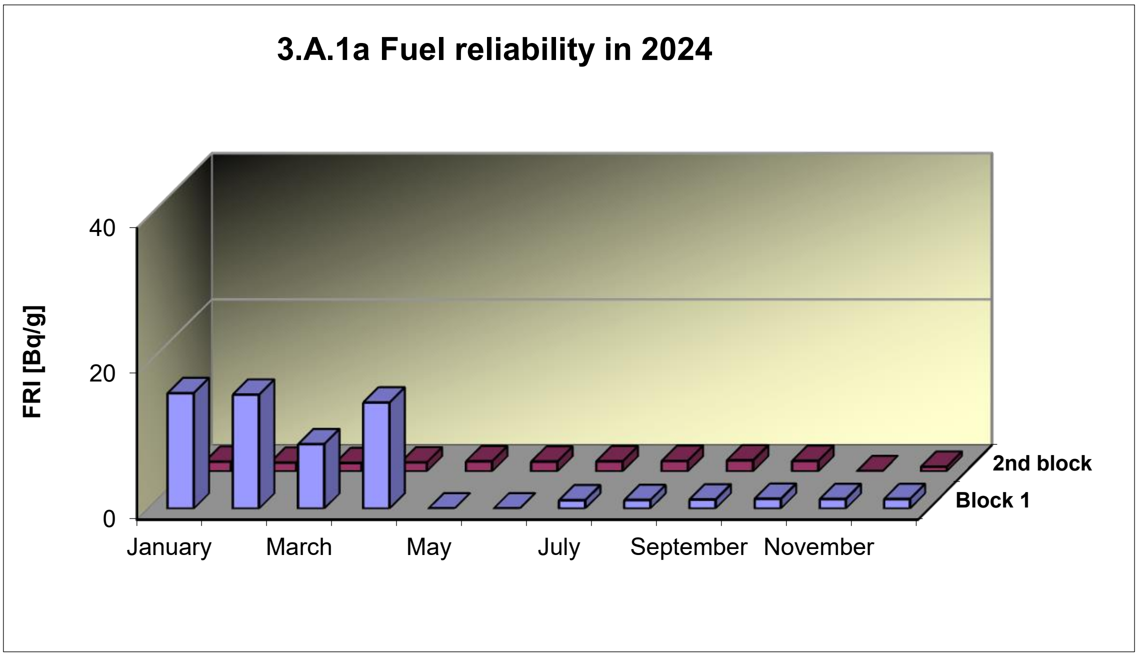
3. Barrier tightness

3.A Nuclear fuel

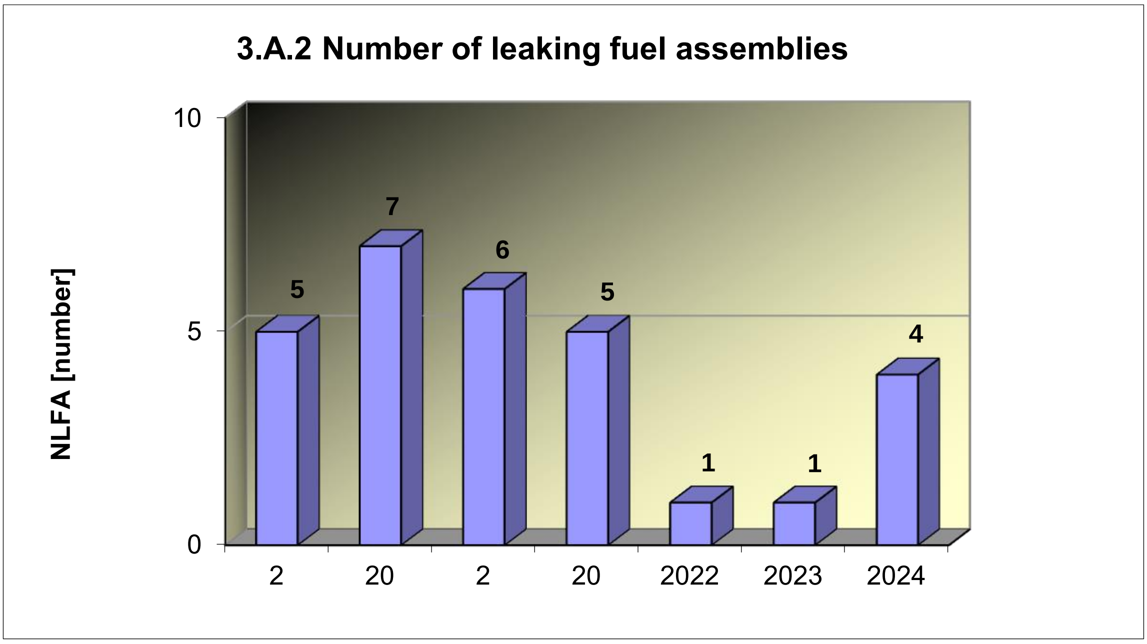
Graph 3.A.1 monitors the reliability of fuel in individual units using the FRI factor. An FRI value of≤ 19 Bq/g indicates that the active zone is highly unlikely to contain any stable fuel defects.



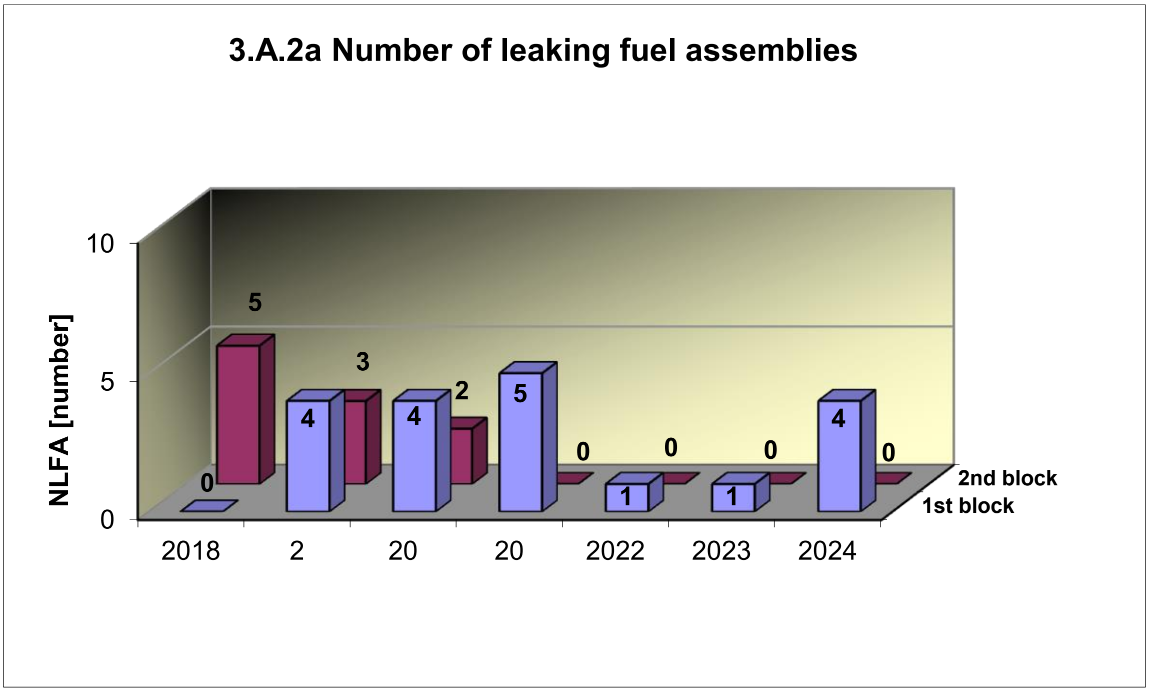
Graph 3.A.1a shows the FRI factor over the course of 2024 for individual units at the Temelín NPP.



Graph 3.A.2 shows the number of leaky fuel assemblies that were found to be leaky and subsequently repaired or removed from the core due to leakage.

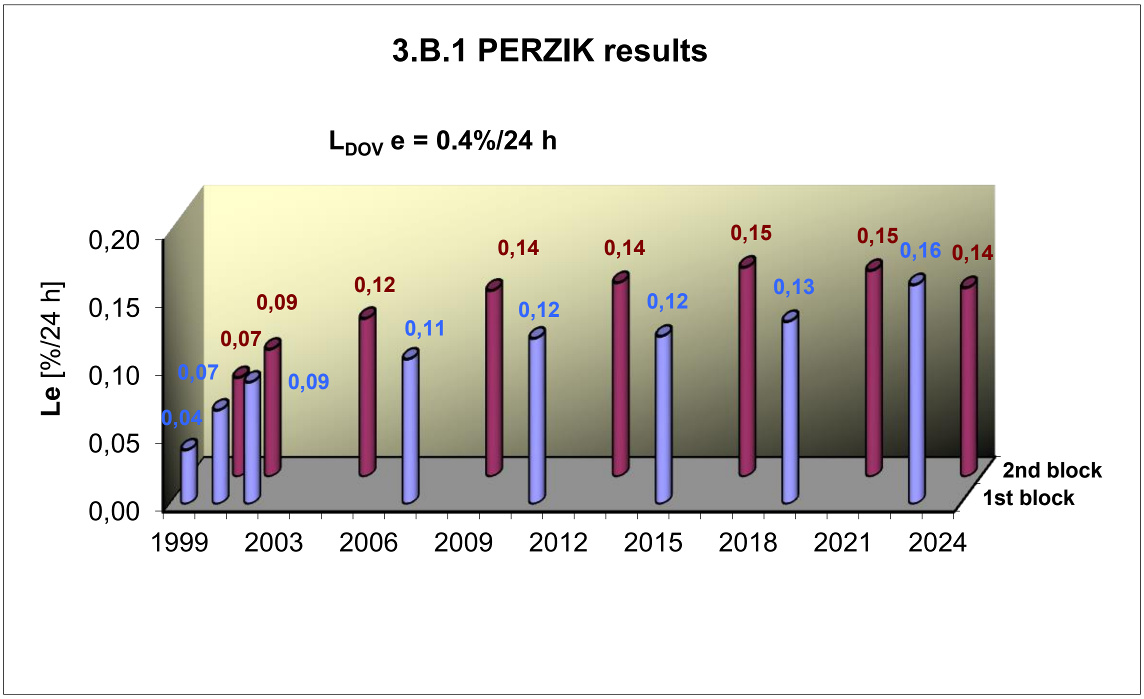


Graph 3.A.2a shows the number of leaking fuel assemblies by unit.



3.B Hermetic envelope

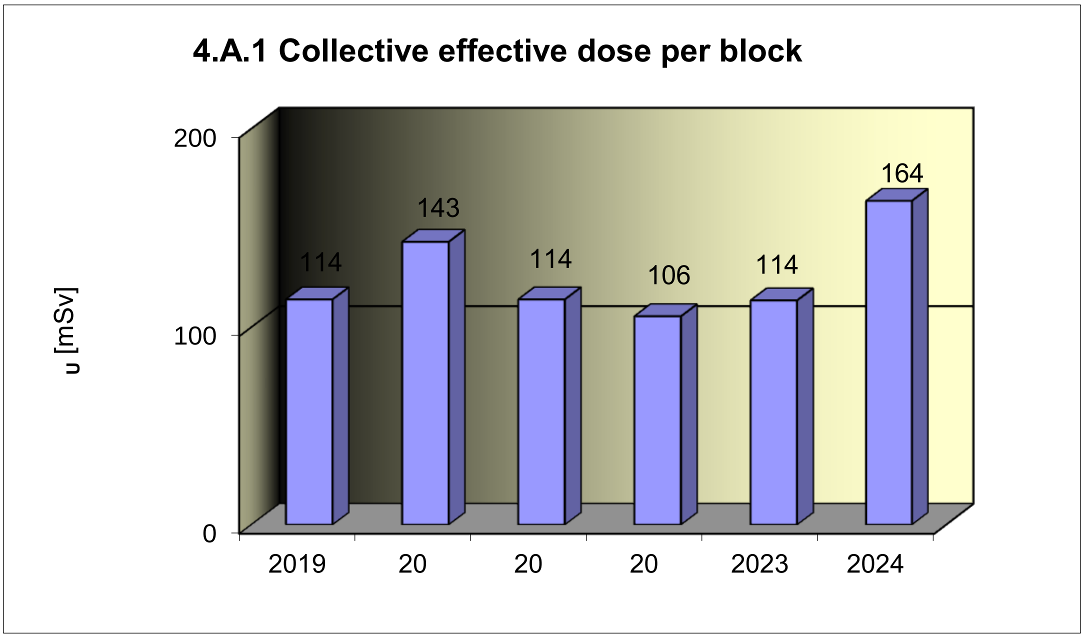
Graph 3.B.1 shows the results of PERZIK tests (L_e), i.e. the results of leak tests of hermetic spaces performed at an overpressure of 400 kPa with a holding time of 24 hours at ZIK, and for OZIK and PERZIK tests at a lower pressure of 70 kPa with a holding time of 24 hours, the extrapolated results are given.



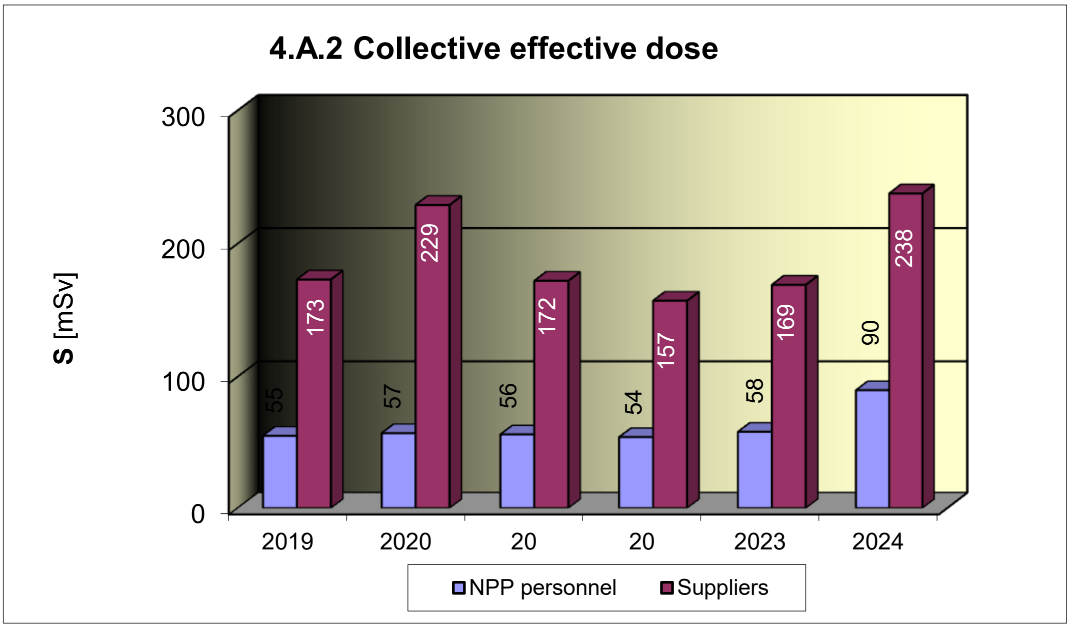
4. Radiation protection

4.A Radiation workers

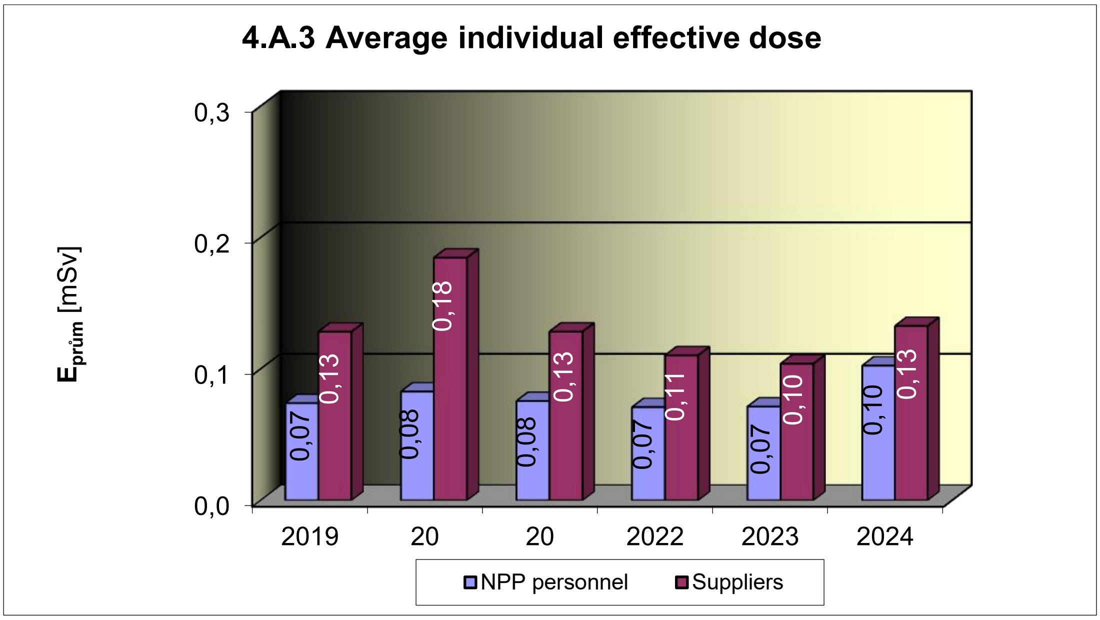
Graph 4.A.1 shows the collective effective dose, which is given by the total external whole-body dose received by radiation workers at the NPP and suppliers during the monitored period, per operating unit.



Graph 4.A.2 shows the collective effective dose, which is given by the total external whole-body dose received by radiation workers at NPPs and suppliers during the monitored period.



Graph 4.A.3 shows the average individual effective dose, which is given by the total external whole-body dose received by radiation workers at NPPs and suppliers during the monitored period, expressed as a value per radiation worker.



Graph 4.A.4 shows the maximum individual effective dose, which is given by the total external whole-body dose received by one specific NPP employee and one specific supplier employee during the monitored period.

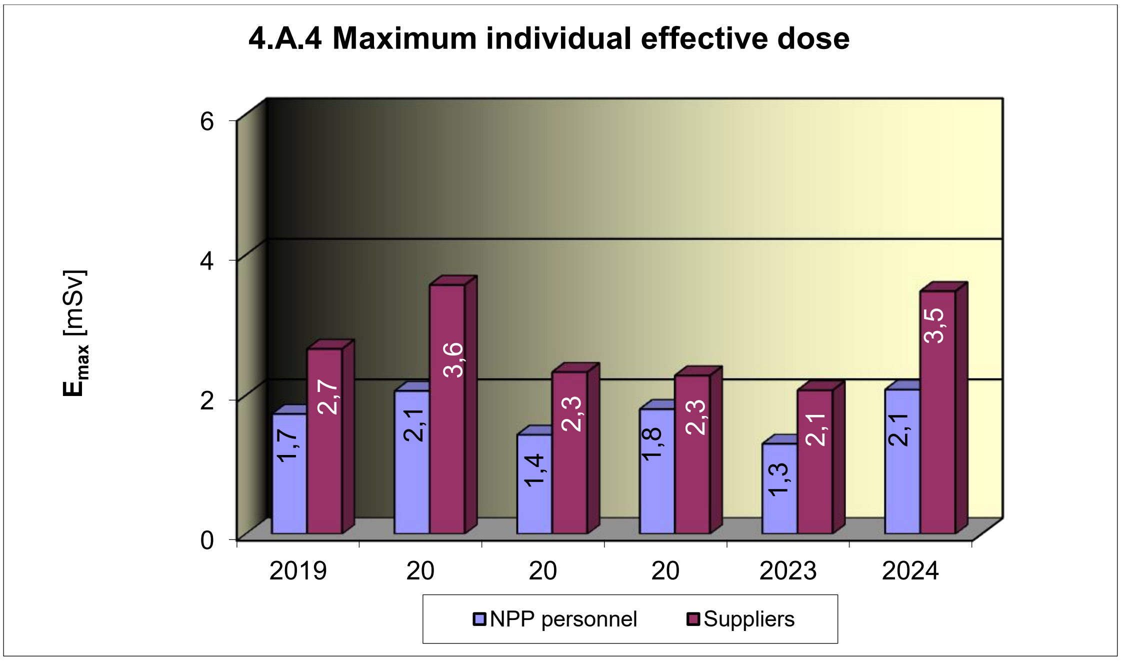
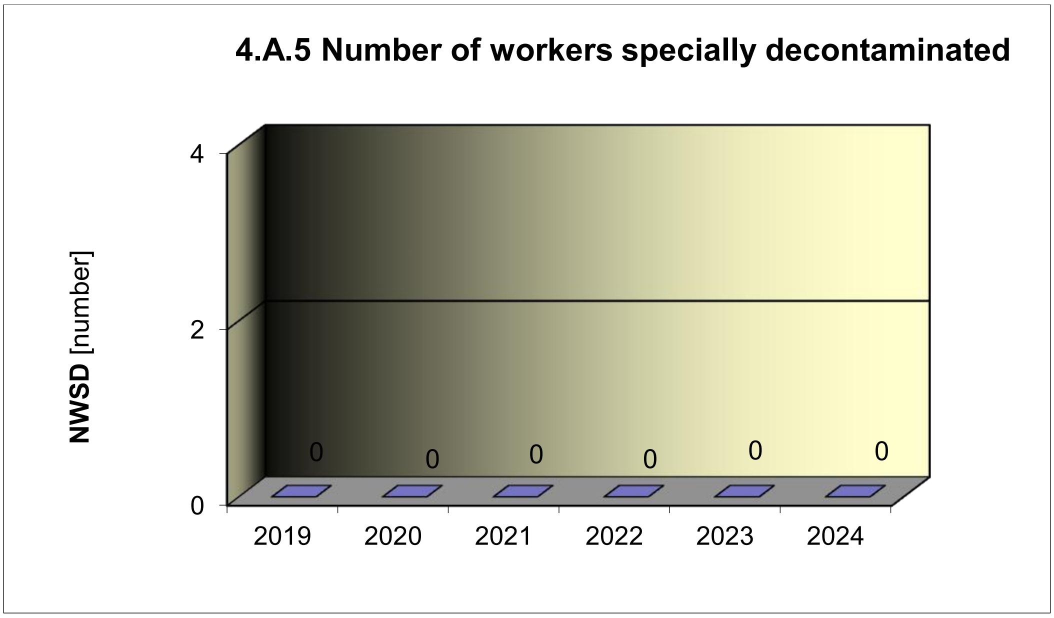
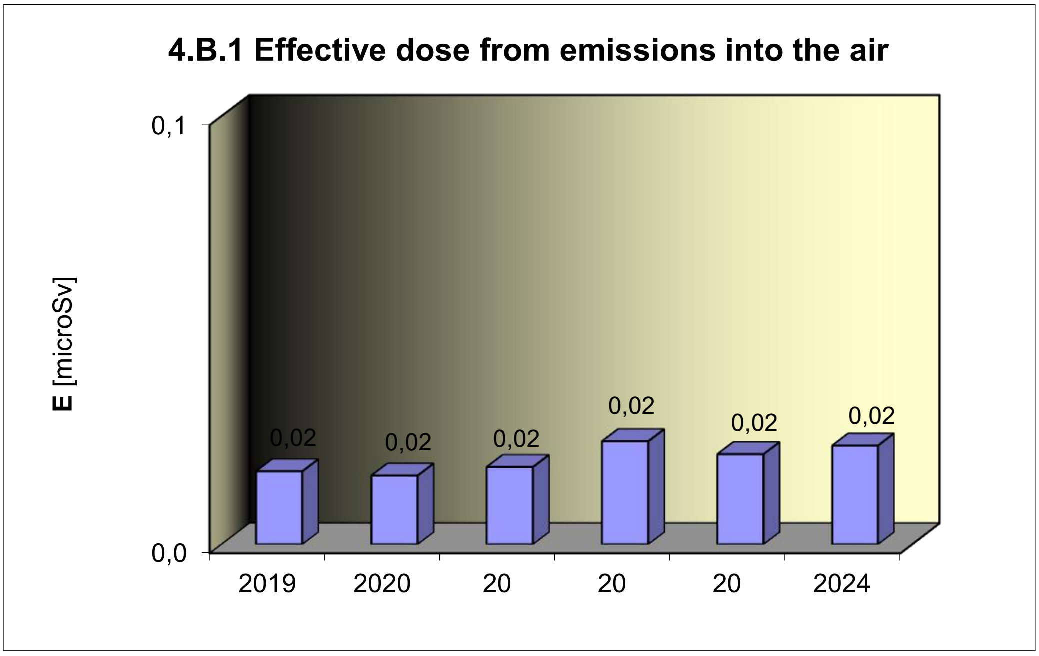


Chart 4.A.5 shows the number of radiation workers (NPP and contractors) who underwent special decontamination under medical supervision.

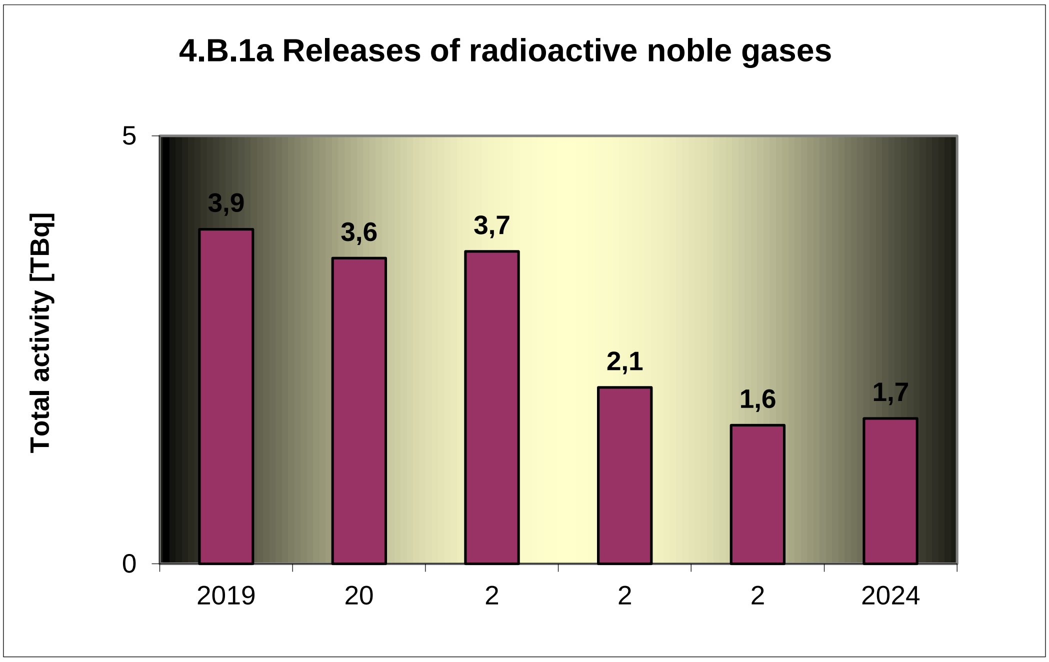


4.B Radioactive discharges

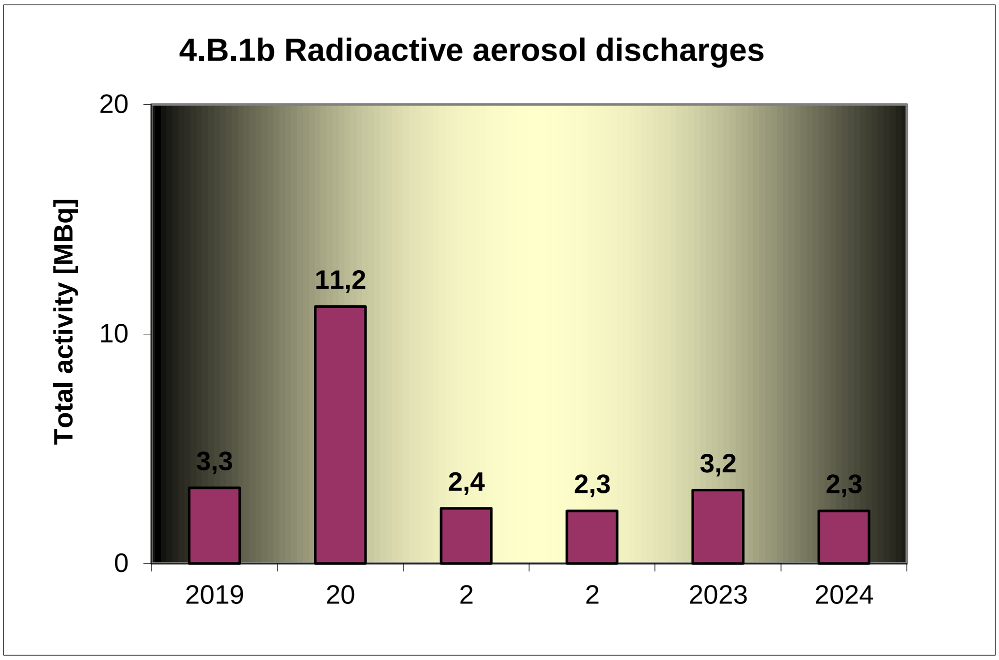
Graph 4.B.1 shows the effective dose calculated for a representative person as a result of discharges into the air from nuclear power plants.



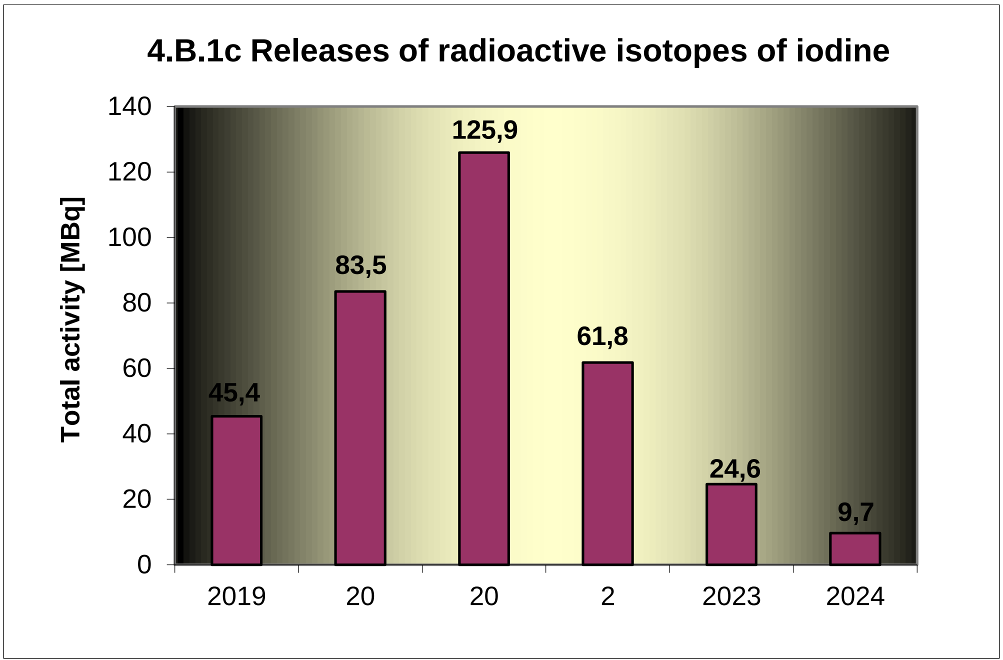
Graph 4.B.1a shows the total activity of radioactive rare gas discharges from NPPs.



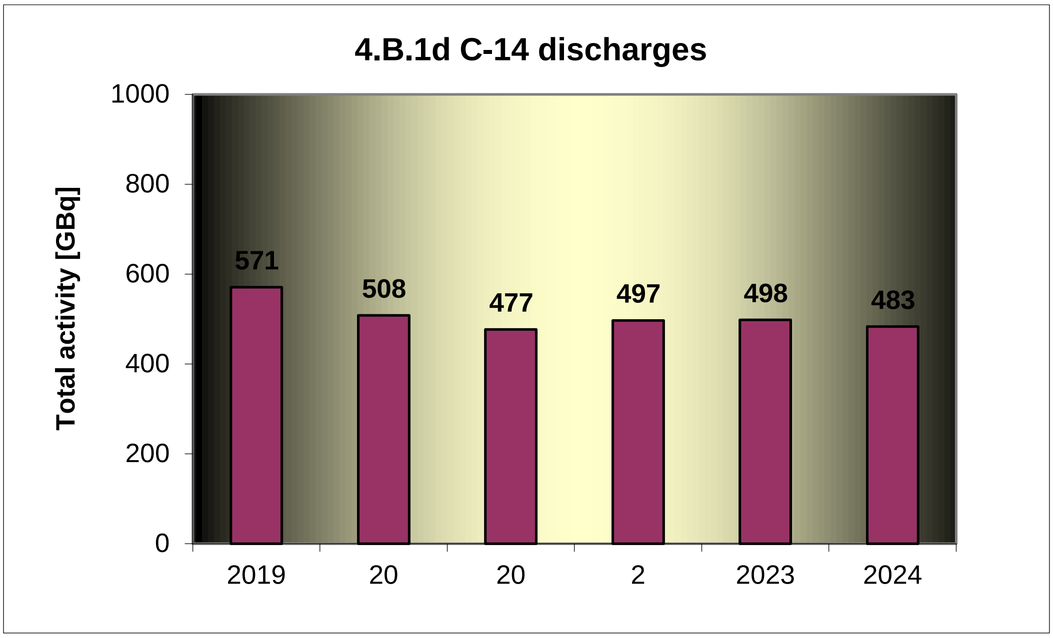
Graph 4.B.1b shows the total activity of radioactive aerosol discharges from NPPs.



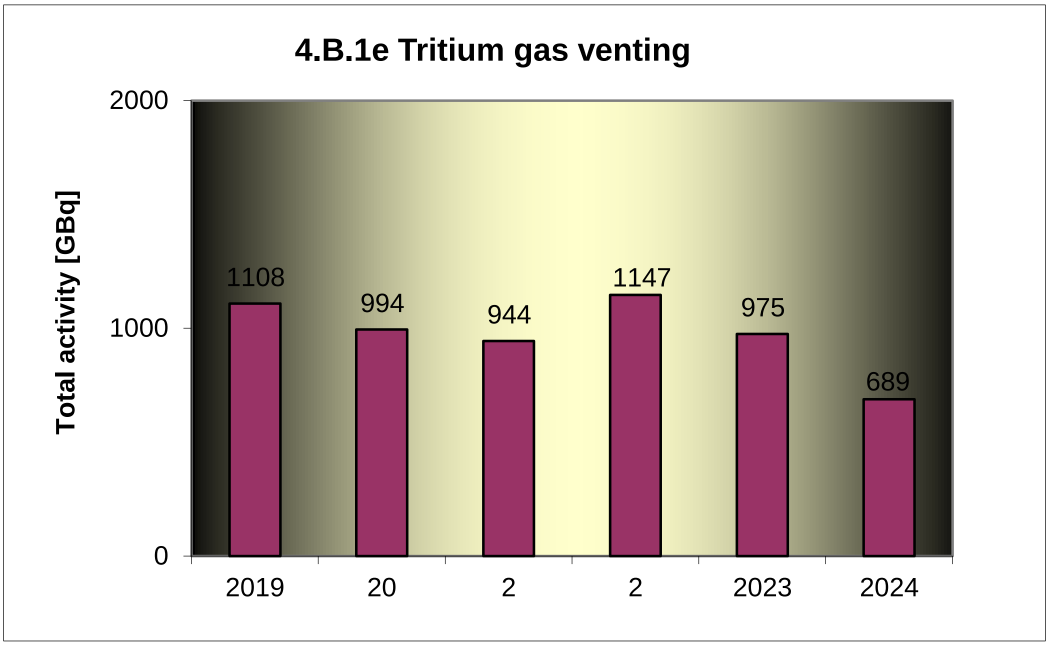
Graph 4.B.1c shows the total activity of radioactive iodine isotope discharges from NPPs.



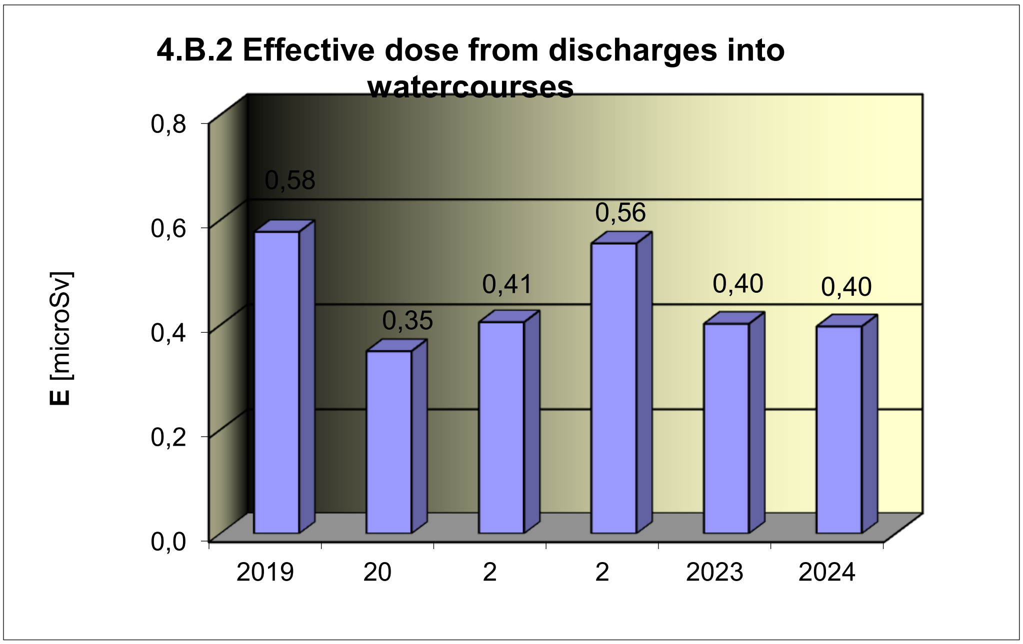
Graph 4.B.1d shows the total activity of C-14 radioisotope discharges from NPPs.



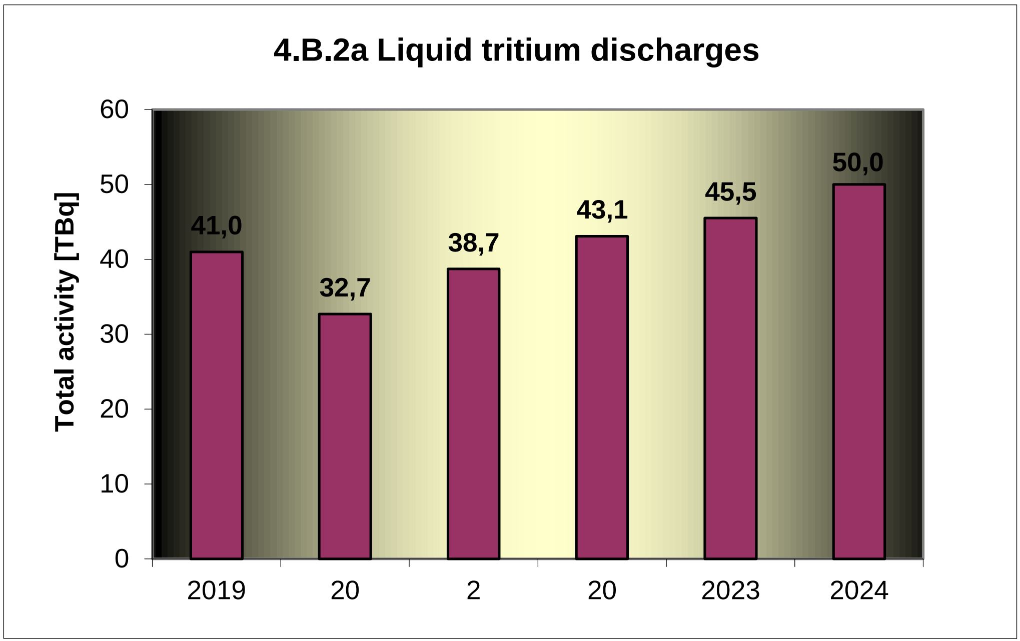
Graph 4.B.1e shows the total activity of gaseous tritium emissions from NPPs.



Graph 4.B.2 shows the effective dose calculated for a representative person as a result of discharges into watercourses from nuclear power plants.



Graph 4.B.2a shows the total activity of liquid tritium discharges from NPPs.



Graph 4.B.2b shows the total activity of liquid discharges of activated and fission products from nuclear power plants.