ANNEX 6 Evaluation of the Safety Performance Indicators Set
(year 2021)

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A. INTRODUCTION

State Office for Nuclear Safety (SUJB) executes the state administration and supervision of the utilisation of nuclear power and ionising radiation in order to assure achieving a required safety level. As the focus of the supervision consists in the evaluation and assessment of nuclear safety related activities and their results, SÚJB annually evaluates an achieved level of nuclear safety of operation of Dukovany NPP and Temelín NPP by using Safety Performance Indicators.

The Safety Performance Indicators evaluate four areas of the NPP operation:

1. Events,
2. Safety Systems Performance,
3. Barriers Integrity,
4. Radiation Protection.

The evaluation results of Safety Performance Indicators in the form of graphs for the monitored period (2016 – 2021 for Dukovany NPP and 2016 – 2021 for Temelín NPP) are given in appendices. The graphs mostly represent local values in the form of sum totals or averages of the unit values. Only for Safety System Unavailability, the indicated values are also at the level of the systems and for Barriers Integrity at the unit level.

Input data for the evaluation were acquired both from documents submitted by the operator and by SÚJB supervisory activities at Dukovany NPP and Temelin NPP.

B. EVALUATION OF THE SET OF SAFETY PERFORMANCE INDICATORS FOR DUKOVANY NPP

This section includes an evaluation of particular indicators of the monitored areas of operation of Dukovany NPP and their graphic representation is shown in Annex – Part I.

After 2016, almost all operational safety indicators were in a way "distorted" by serious findings in the area of poor documentation of welds and subsequent necessary inspection and possible repairs within the so-called "welds case"; for that reason, the shutdowns were prolonged at all units. In 2017, the operation of all units began to return to the usual tracks and in 2018 the length of outages returned to the expected values from the years before 2016. SÚJB informed about the bad evidence of welds by ČEZ for the first time in September 2015, and as a result of this case, large financial losses were incurred by ČEZ, due to the long-term shutdown of the units, and criminal cases were filed in this case, which were subject to investigation by the police in 2018.

In general, the evaluation of the set of operational safety indicators of Dukovany NPP for 2021 shows that the overall achieved status of nuclear safety in electricity production at Dukovany NPP is still maintained at a very high level.

In the following, the individual Safety Performance Indicators are grouped according to their classification in the respective areas.

1. Events

Group 1.A – Reportable events

The basic data for the evaluation of indicators of Group 1.A is the number of reported events in 2021, i.e. events that conform to the specifications in Table 2 of the Safety Guide on Nuclear Safety 1.1.

Indicator 1.A.1 - The number of events reported to the nuclear safety regulatory authority (graph 1.A.1) has been around the long-term mean value of 55 reported events per year in recent years. In the monitoring history, in 2015, resp. 2016 this indicator decreased to 49 resp. up to minimum of 41 reported events. This was due to prolonged shutdowns due to the 'welds' cause. In 2017, 56 events were reported to SÚJB and in 2018, 48 events were reported. In 2019, the number of events increased to 68 and in 2020 the number of events reported to the Office decreased to 65. In 2021, 52 events were reported to SÚJB. The value of the year 2021 shows a downward trend started in 2020. However, this parameter should also be focused on during the next evaluation. With a more significant increase in 2019 and taking into account the value in the following years 2020 and 2021, the long-term mean value has returned to the long-term 52 reported events.

In 2018, no events were rated at EDU by INES = 1. The final evaluation of Event 56/17, which occurred on Unit 2 diesel generators in 2017 and the issue of last year's Safety Performance Indicators File Evaluation, has not yet been resolved, was eventually rated INES = 0.

In 2018, a total of 7 events (events 6, 8, 10, 25, 33, 39, and 45) were evaluated at the

Dukovany NPP with INES = 0. The two events (events no. 20 and 58) have not yet been finally decided whether to rate them or to be assessed as events outside the INES scale.

A total of 7 safety-significant events, classified according to the INES scale, were reported to SÚJB in 2020 and 2021. Six of them were rated INES = 0, one event, marked 56837(ZV38)/21/3, was rated INES = 1. In this event, on 2 September 2021, on Unit 3, the limit condition (LP 3.5.2.1) was violated by failing to perform the required actions in time when an increased oil level was detected in the rear bearing of the high-pressure emergency pump 3TJ61D01, caused by the penetration of media from the inserted circuit 3TF60 – event marked as V38.

Indicator 1.A.2 - Human failure (Chart 1.A.2) through the HFI index reflects the proportion of human failure in the total number of reported events. The development in the area of human failure in both the number of events and the HFI index has long been consistent with the average number of events reported. In 2018, the number of human-caused events reached a value of 35, thus returning to the expected values, and in 2019, the number of human-caused events even decreased to a value of 18, to rise again to a value of 42 in 2020 and slightly increased also in 2021 to a value of 44. From the graph it appears that this is a fluctuation of values. As regards the percentage increase in the number of all relevant events with the influence of the human factor in 2019 from 12 % to 27 % in 2020 and last year's reduction to 23 %, it can also be evaluated as a fluctuation of monitored values, from which it cannot be unequivocally stated that there are more or less frequent operator errors. The increased number of human factor influence may be due to the fact that the licensee tries to determine the root causes better and more precisely when investigating the events. If there are any trends, they will probably show only in the next few years.

Group 1.B – Actuation of the protection and limitation systems

Results of the indicator "Unplanned Unit Scrams" are shown on graph 1.B.1,2.

A Dukovany NPP reactor had to be manually shut down for the last time in 2005 and the last automatic shutdown of the reactor occurred in Unit 4 in 2010.

In 2019, manual activation of HO 1 also occurred on Unit 1 due to activation of ESFAS "Rupture of HNK, HVK (event +034/2019/1) caused by incorrect handling of operator of secondary circuit. In 2020 and 2021, no such event occurred on any EDU Units.

In 2021, as in the previous 10 years, there was no unplanned fast automatic shutdown of the reactor.

During the first phase of I&C renewal, the HO 2 functions were partially repLaPed by reactor protection (fast automatic shutdown) and partly by a new RLS system which repLaPed the previous HO 3 and HO 4 protections. Graph 1.B.3-5 thus shows the number of actuations of RLS -3 and RLS-4. As can be seen from the graph, after 2017, when there was no actuation of RLS-3 protection and no actuation of RLS-4, in 2018 there were 2 actuations of RLS-3 and 4 actuations of RLS-4 and 5 actuations of RLS-4. In 2019, there were in total 4 actuations of RLS-4, it was always a HRK assembly failure and in 2020 there were only 2 actuations of RLS-4, in both cases on Unit 3, when there was only signalling of the failure of the HRK assemblies; the actual failure of the HRK assemblies did not occur. In 2021 there was no actuation of RLS-3 and RLS-4. It is still difficult to draw any conclusions from the statistics of this indicator, as these are rather random events, and thus the statistics of very small random numbers, however, over the last 3 years it appears that the number of actuations of RLS-3 and RLS-4 has a decreasing trend.

Group 1.D – Limits and Conditions

Compared to 2017, when there were a total of 4 violations of Limits and Conditions at Dukovany NPP, there were no LaP violations in 2018 or 2019. In 2020, there were 2 violations of this basic operational document, and last year 2021 there was only 1 violation of LaP (see graph 1.D.1). As already mentioned above, this violation of LaP in 2021 occurred within the event marked V38 and this event was rated INES = 1. It occurred on 2 September 2021 at Unit 3 (violation of limit condition LP 3.5.2.1) due to the failure to carry out the required actions when an increased oil level was detected in the rear bearing of the high-pressure emergency pump 3TJ61D01, caused by the penetration of media from the inserted circuit 3TF60.

2. Safety Systems Performance

Group 2.A – Safety System Unavailability

The group is monitored by means of indicator "Safety System Unavailability" for specific safety systems, see graphs 2.A.1.a – g.

From the graphs of sub-indicators for individual systems (2.A.1a-g) it can be seen that in recent years the increase of this parameter was connected with non-meeting[1] the Limits and Conditions after the reconstruction of the ESW system piping. In 2018, there were shorter periods of non-meeting[1] Limits and Conditions for reconstruction, and therefore in 2018 there was also a slight decrease of this parameter for all BSs. In the years 2018 and 2019, there were shorter periods of non-meeting LaP for reconstructions, and therefore in these years there was also a slight decrease in this parameter for all BSs, and in 2020 and last year 2021, the value of this parameter returned to the expected average values.

Group 2.B – Failure of safety systems

According to the indicator “Starting Failures of Safety System” (graph 2.B.1), in 2021, three starting failures of SS occurred at all units. These were events that occurred on 17 February 2021 at Unit 1 - a failed test of ELS3 (event marked V15), on 5 September 2021 at Unit 2 - when a short circuit occurred on pump motor 2TH60D01 during the 2ELS3 test (event marked as V37) and on 19 September 2020 on Unit 3 - during the 3ELS1 test, a failure was identified on DG7, when it was shut down by overspeed protection due to a sensor failure (event marked as V44).

3. Barriers Integrity

Group 3.A – Nuclear fuel

The condition of nuclear fuel is monitored by the indicator "Fuel Reliability Index" (FRI, graph 3.A.1) and the indicator "The Number of Leaky Fuel Assemblies" (graph 3.A.2).

The fuel reliability formula is based on the empirical formulas and its results thus must be considered in terms of possible failure load. In practice, two or three levels of the values of the Fuel reliability factor are assessed:

- more than 19 Bq/g – the reactor core contains, with great probability, one to two defects;
- less than 19 Bq/g – the reactor core does not contain, with great probability, any fuel defect; all design values of the Fuel

[1] and at the same time implementing corrective measures

– reliability factor less than 0.04 Bq/g are just corrected to the limit 0.04 Bq/g by reason of limited operation of the empirical formulas.

Out of the comparison the graphs of these two indicators their interconnection is apparent. Annual values FRI factor at Dukovany NPP very low long-term.

Group 3.B – Containment

The graph of indicator 3.B.1 assesses the tightness of hermetic areas through the results of the periodic integral test (PERIZ/OZIK). The operator's effort to systematically improve the tightness of EDU units started in all four units already in 2001 and from that year on, the block tightness has improved or oscillated around very acceptable values with a few minor variations. Since 2011, PERIZ/OZIK tests have been carried out with an interval of 2 years, even blocks in even years and odd blocks in odd years. From 2018 onwards, another philosophy of conducting PERIZ tests according to the unified HVB was carried out, such that in the even year the PERIZ tests were carried out on HVB I (Units 1 +2), in the odd year on HVB II (Units 3+4). In 2018, tightness tests were carried out at Units 1 and 2. In 2021, by measuring and extrapolating the measured values, the tightness value of the hermetic spaces of Unit 3 was determined to be 4.415% / 24h, which is a slight deterioration compared to the previous test (in 2019 it was 3.826% / 24h), however, it is the expected value and oscillating around the mean value.

4. Radiation Protection

Group 4.A – Staff

The indicator "Collective Effective Dose per Unit" (graph 4.A.1) monitors collective effective dose of NPP staff, suppliers and visitors converted per one unit.

In 2021, the indicator concerned 834 NPP radiation workers and 1476 suppliers' radiation workers. The value corresponds to the length of outages and the extent of work performed. The total collective effective dose for 4 EDU units is shown separately for NPP personnel and suppliers in graph 4.A.2. It shows that the collective effective dose of NPP radiation workers is stable at around 10% and that around 90% (2021 84%) is the collective effective dose of supplier radiation workers, which is due to the fact that overhauls are carried out by contracted supply activities.

The division of activities between NPP and supplier personnel is also reflected in the indicators “Average Individual Effective Dose” (Graph 4.A.3) and “Maximum Individual Effective Dose” (Graph 4.A.4). The values for 2021 correspond to the extent of work performed. None of the employees exceeded the dose optimization limit of 10 mSv per year.

During 2021, no worker had to be specially decontaminated (graph 4.A.5).

Group 4.B – Radioactive Releases

The indicators "Gaseous Releases" and "Liquid Releases" evaluate the operation of Dukovany NPP in terms of radioactive releases.

Graph 4.B.1 "Effective dose from gaseous releases" for the indicator "gaseous releases" represents the exposure of a representative person obtained by calculation from an authorized model for the current discharge of radionuclides into the atmosphere and the current

meteorological situation in the evaluated year 2021. In the long-term trend, the exposure of a representative person from discharges to the atmosphere shows a steady state.

Graph 4.B.2 “Effective dose from Liquid releases” for the indicator “Liquid releases” represents the exposure of a representative person obtained by calculation from an authorized model for the current discharge of radionuclides into the watercourse and the current hydrological situation in the year under review. The effective dose from discharges to watercourses is therefore influenced by the average flow rate in the Jihlava River in 2018, which was below the long-term average due to warm weather and therefore this value is slightly increased in 2021.

EVALUATION OF THE SET OF SAFETY PERFORMANCE INDICATORS FOR TEMELIN NPP

This section includes an evaluation of particular indicators of the monitored areas of Temelin NPP operation and their graphic representation is shown in Annex – Part II.

The year 2021 is already the 19th year, when the operation of the Temelín Nuclear Power Plant is also evaluated using operational safety indicators. Statistically, this is a period when it is already possible to reliably perform a similar statistical comparison as at EDU.

1. Events

Group 1.A – Related events

Since 2007, as in EDU, the number of Reportable Events (RE) that were originally specified by the "Communication Agreement" instead of the previously used Safety-Related Events (SRE) and that have been specified since 2013 in the safety guide BN-JB-1.1 (Utilization of operational experience on nuclear installations, which is currently being followed) has been taken as the basis for evaluating Group 1.A indicators. Since January 2020, a new instruction for the use of operational experience, namely BN-JB-5.2, has been applied.

Indicator 1.A.1 "Evaluated events" indicates the number of reported significant events (marked RE in the graph) over the last 6 years. The long-term history of monitoring this indicator shows that the lowest number of reported significant events (i.e. 35 – the minimum since the start of operation) was recorded in 2013. In 2016, compared to 2015, the number of reported events increased by 9 to a total of 52 reported significant events and in 2017, the number of reported events returned to 43. In 2018, the number of reported significant events increased significantly to the highest value ever of 183. In 2019, the value of this parameter dropped 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 events increased slightly to a total of 49. The parameter ranges in a rather wide range of values, which is related to a not entirely ideal and precise definition of what to include under the reporting parameter. However, the effort is to refine this definition over time and practice.

The number of events in chart 1.A.1 “Related events” classified by INES = 0 (marked BSE in the chart) increased by 2 to 16 in 2016 compared to 2015 and then decreased to 8 in 2017, and in 2018 the number of decreased again to only 5. In 2019, the number increased again by one to 6. In 2020, the number increased again by 2 to 8, and in 2021, 11 events were rated INES = 0. Historically the lowest ever value for the last 10 years is the value from 2018 (5 INES 0 events).

The number of events rated INES = 1 at Temelín NPP (marked as SSE in the chart 1.A.1 “Related Events”) was zero in 2016 and 2017, in 2018 there was one event rated INES = 1. It was Event No. 153/18/2 - “Leakage of route 2VB20Z201.1 - violation of Limits and Conditions A.3.6.2B”, which occurred at Unit 2 of the Temelín NPP on 6 November 2018.

In 2019, there was no event at ETE that was evaluated as INES = 1. In 2020, the Office classified 2 events as INES = 1. The first event rated as INES = 1 (PNČ 20645/20 – "Outage HVB1 (LSd) as a result of an RCLS failure and a violation of the LaP dated 15 May 2020) was the shutdown of Unit 1 from 80% of the Nnom by the limitation system caused by malfunctions in communication on the data bus and at the same time a violation of Limits and conditions by the operative staff of the control room during the subsequent resolution of the event.

The second event (PNČ 13755/20 – "Contradiction between material certificates and the actual quality of metallurgical material" dated 25 February 2020) classified as INES = 1 was the use of unsuitable metallurgical material at the Temelín NPP facilities. Thus, the event is classified as INES = 1, in line with the Dukovany NPP. Last year 2021, there were a total of 8 safety-significant events, classified according to the INES scale. All these events were classified as INES = 0, possibly outside the INES scale. No event in 2021 was classified as INES = 1 and higher on the ETE.

Group 1.B – Actuation of the protection and limitation systems

Similarly, in the previous 8 years and in 2021, there was no unplanned ROR (reactor scram on the basis of primary causes in PRPS system) and no shutdown of the reactor by LS (d), see graph 1.B.1,2 and graph 1.B.1,2a.

After the previous 8 years, when there was no unplanned ROR actuation at ETE (fast reactor shutdown based on primary causes in the PRPS system) or reactor shutdown due to actuation of LS(d), see graph 1.B.1,2 and graph 1.B.1 ,2a., in 2020 there was one actuation of ROR on Unit 1. The event occurred, as stated above, on 15 May 2020 at 12:46 a.m. (PNČ 20645/20 - "HVB1 (LSd) failure due to RCLS failure - 1JZ33E531A box communication failure and LaP violation).

Group 1.D – Limits and Conditions

In 2018, as mentioned above, on November 6, 2018, there was one violation of LaP on Unit 2. It was event no. 153/18/2 - "Leak of route 2VB20Z201.1 - violation of LaP in LPP A.3.6.2B", which for these reasons was also rated INES = 1 (see Graph 1.D.1 Violation of the Limits and Conditions).

In 2019, as in 2016 and 2017, there were no LaP violations and in 2020 there were 2 LaP violations. In the first case, it was the already described event (PNČ 20645/20 - "HVB1 (LSd) failure due to RCLS failure - 1JZ33E531A box communication failure and LaP violation) dated 5/15/2020, when a total of 3 limit conditions of operation were violated (A.3.1.5B, A.3.1.6B and A.3.9.2). The second LaP violation occurred on 21/09/2020, when the LPP for Hermetic Closures (A.3.6.2A) was violated - see graph 1.D.1 - Violation of LaP In 2021, there were 2 violations of LaP - see above the event marked with number 42633, when on 22 March 2021 in relation to both Units (i.e. 2 violations of LaP) it was detected and by the external company KLIKA BP confirmed that the full monthly and annual operating controls according to LaP B.3.7.6 are not carried out due to the fact that the employees of the KLIKA company do not have access authorization via KV130 and 230, which they need.

2. Safety Systems Performance

Group 2.A – Safety System Unavailability

The „BS Unavailability" increased in 2021 compared to the year 2020, however, the value does not deviate significantly from the expected average value of previous years. It fully corresponds with the fact that SÚJB approved temporary modifications of LaP on the Unit to carry out actions on TVD, for the future strengthening of nuclear safety, which led to non-meeting of LaP. The main contribution to the inoperability of the BS is its inoperability from the period of its testing and trials within the limits and conditions of the prescribed tests. Achieving this state was in 2020, and that is the goal of every power plant.

Group 2.B – Failure of safety systems

In 2021, there was one failure of the safety systems at DGS on 7 October 2021 on Unit 2, when the 2DGS3 was shut down by the overspeed protection during the 3-min run test - see event number 58936 above. The second BS failure occurred on 21 October 2021 on unit 2, when the 2TQ22D01 pump did not start during the APS2 test, see event number 58936 above. In 2020, there was one failure of the safety systems (on DGS) on 16 February 2020, when after start-up DGS2 was stopped by protection and was blocked from its next start. Such events are evaluated as start failures - see chart 2.B.1 and chart 2.B.2. In 2019, as in 2018, there was no failure of safety systems at start, and the last such event occurred in 2017, when this event was recorded for "slow DG start" (connection time of 10.123 sec. was longer than the required 10 sec.).

3. Barriers Integrity

Group 3.A – Nuclear fuel

The state of nuclear fuel is monitored by the indicator "Fuel Reliability Index" (FRI, graph 3.A.1) and the indicator "The Number of Leaky Fuel Assemblies" (graph 3.A.2).

In 2021, the 11th campaign ended on Unit 1 and the 10th campaign on Unit 2 with the new TVSA-T fuel. The FRI values on individual Units decreased in 2021 compared to the previous year 2020 on both Units. For Unit 1 there was a reduction from 80.71 Bq/g in 2020 to 56.21 Bq/g in 2021 and for Unit 2 it was a decrease from 10.40 Bq/g in 2020 to 1.31 Bq/ g – see graph 3.A.1. The distribution of FRI during the entire calendar year 2021 is shown for both Units on graph 3.A.1a. The values correspond to the detected total of 5 leaking fuel elements on Unit 1, where the FRI values were much higher than on Unit 2 - see the following graphs 3.A.2, 3.A.2a. During the planned shutdowns, all fuel assemblies were taken out of the active zone and their checks were carried out, during which leaks were detected in a total of 5 fuel elements on Unit 1. No leaking fuel element was detected on Unit 2 in 2021, and the far lower value of the FRI parameter also corresponds to this.

Group 3.B – Containment

In this group, there is only one indicator, which evaluates the results of the Periodic integral tightness testing, tightness condition of hermetic areas in graph 3.B.1.

PERZIK tests are carried out with a period of 4 years and last performed in 2015 on Unit 1, where the measured value was 0.1232% of the permitted 0.4%, and in 2017, it was performed on Unit 2, where the measured value was 0, 1357%. Therefore, after 4 years, in 2019, on 17 – 20 April 2019, the PERZIK test was performed on Unit 1, where a value of 0.134% was measured. Last year 2021, the 5th PERZIK test for L 400kPa was carried out on 15 – 18 August 2021 in sequence for L 400kPa on Unit 2 with a result of 0.151%. The measured leakage shows very good results in both cases, which are only less than one third of the permitted value. In addition, the graph shows that the tightness of the containment is consistently good. This corresponds to the design expectations and international experience.

4. Radiation Protection

Group 4.A – Staff

The indicator "Collective Effective Dose per Unit" (graph 4.A.1) monitors collective effective dose of NPP staff, suppliers and visitors converted per one unit. In 2021, this indicator concerned 742 NPP radiation workers and 1341 supplier radiation workers. The indicator "Collective Effective Dose" (graph 4.A.2) monitors total collective effective dose of Temelin NPP in distribution of NPP staff and suppliers. Increased collective effective doses in some

years are due to the increased volume of work in the controlled area during outages. In 2021, there was a slight decrease in the collective and average individual effective dose for this reason.

There was also a slight decrease in the indicator “Maximum Individual Effective Dose” (Graph 4.A.4) for both personnel and suppliers, which corresponds to the above-mentioned decrease in the volume of work in the controlled area. However, none of the employees exceeded the dose optimization limit of 10 mSv per year.

In 2021, no radiation worker had to be specially decontaminated (see graph 4.A.5).

Group 4.B – Radioactive Releases

Graph 4.B.1 "Gaseous Releases - Committed Effective Dose" represents the exposure of individuals from the most exposed population group acquired by calculation from the authorized model for current radionuclide effluent to the air and the current meteorological situation in the evaluated year. In recent years, this indicator has remained at fractions of the annual authorized limit of SÚJB, which is 40 μSv for gaseous releases. In 2021, this indicator reached 0.02 μSv.

Graph 4.B.2 "Liquid Releases - Committed Effective Dose" represents the exposure of individuals from the most exposed population group acquired from the authorized model for current radionuclide effluent to the stream and the current hydrological situation in the evaluated year.

The annual authorized limit for liquid releases is 3 μSv. In 2021, 0.41 μSv was released, which is 20% of the authorized limit.

C. CONCLUSION

From all the above information and evaluation of the results of monitoring of individual areas of the particular Safety Indicators, it shows that this file provides a good overview of the state and provision of nuclear safety and radiation protection during operation of all EDU and Temelín NPP units.

From the values of the individual Safety Indicators of monitored parameters, no parameter inexplicably deviated from its expected value in 2021. In general, all parameters compared to 2020 were within the statistical error around the mean value and, unless there was a slight improvement, there was no unexplained deterioration in any of the parameters.

D. ABBREVIATIONS:

AŠP	Activated and fission products
AZ	Reactor core
BL	Safety limit
BS	Safety system
BSVP	Spent fuel storage pool
ČEZ	Business name of the Czech utility - joint stock company ČEZ, a. s.
DG	Diesel generator
E	Individual effective dose

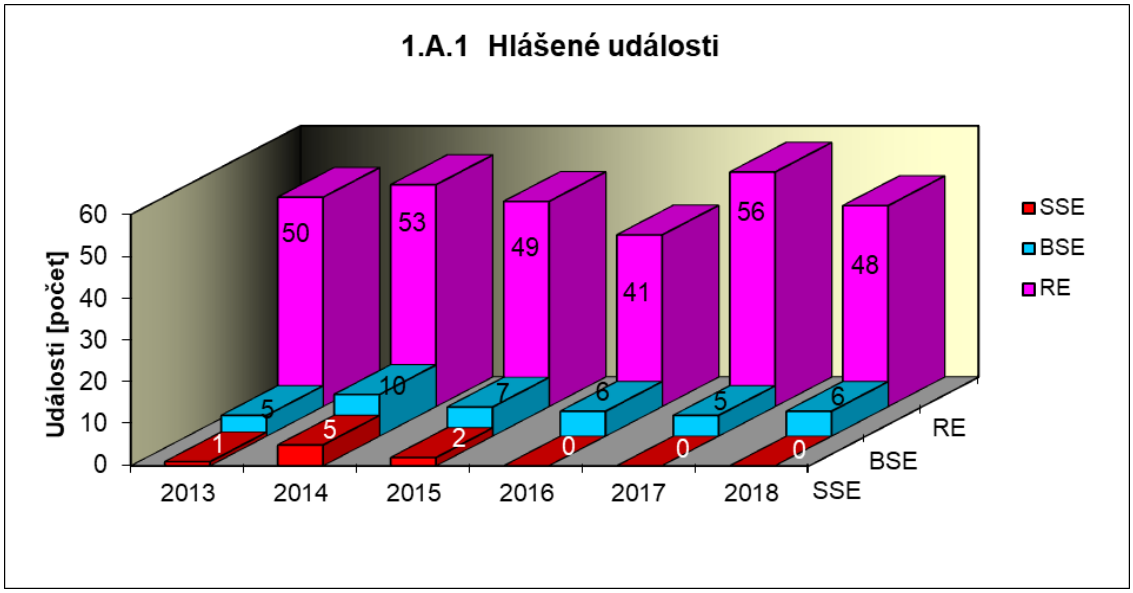
EDU	Dukovany nuclear power plant
ETE	Temelin nuclear power plant
GO	Overhaul
HA	Hydro-accumulator
HMG	Time schedule
HP	Hermetic premises
HN PG	Steam generator auxiliary feed-water system (Dukovany NPP)
INES	International Nuclear Event Scale
JB	Nuclear safety
JE	Nuclear power plant
LIJB	SÚJB local inspectors
LS (a,b,c,d)	Limitation system (various actuation functions)
LaP (L&C)	Limits and Conditions
LPP	Limiting condition for operation
NT	Low-pressure system
NOS	Protection system setting
OKJZ	Nuclear installation inspection section
OROPC	Fuel cycle radiation protection section
OZIK	Repetitive containment integrity test
PG	Steam generator
PBU	Safety indicator(s)
PERIZ	Periodic integral tightness testing
PERZIK	Periodic containment integrity test
PRPS	Primary reactor protection system
RB	Reactor unit
RC	Regional center
REAZNII	Automatics of emergency power system – category II
ROR	Reactor scram
S	Collective effective dose
SAOZ (SHCHAZ)	Emergency core cooling system
SHN PG	Steam generator emergency feed-water system (Dukovany NPP)
SW	Software
SZB	Safety assurance system
TJ	High-pressure emergency core cooling system
TH	Low-pressure emergency core cooling system
TQ	Dukovany NPP spray system / Temelin NPP emergency core cooling systems and spray system
TX	Emergency steam generator feedwater system (Temelin NPP)
VT	High-pressure system
ZIK	Structural over-pressure test
ZKOB	Safeguards and protection testing

1. Significant Events NPP Dukovany

1.A Reportable events

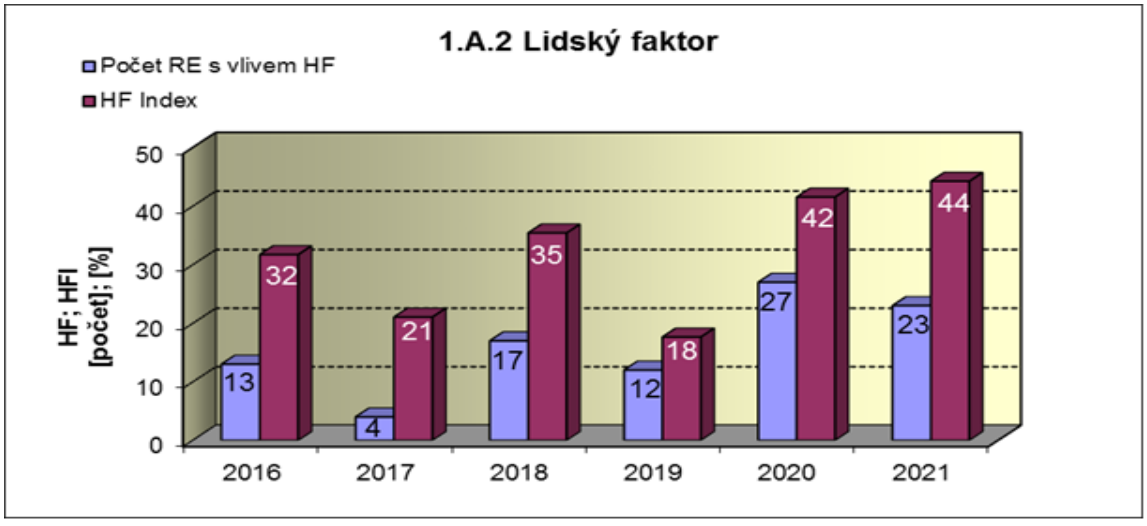
Graph of indicator 1.A.1 monitors the development of number of reportable events (RE) including its division according to the evaluation of the International Nuclear Event Scale (INES) into significant events (SSE, INES > 0) and the below scale events (BSE, INES = 0).

1.A.1 Number of Reportable Events



Events [number]

Graph 1.A.2 evaluates the influence of the human factor upon occurrence of reportable events. The indicator is expressed by the number of the reportable events with an influence of human factor (HF) and its percentage share (HFI).



1.A.2 Human Factor

HF, HFI [number]

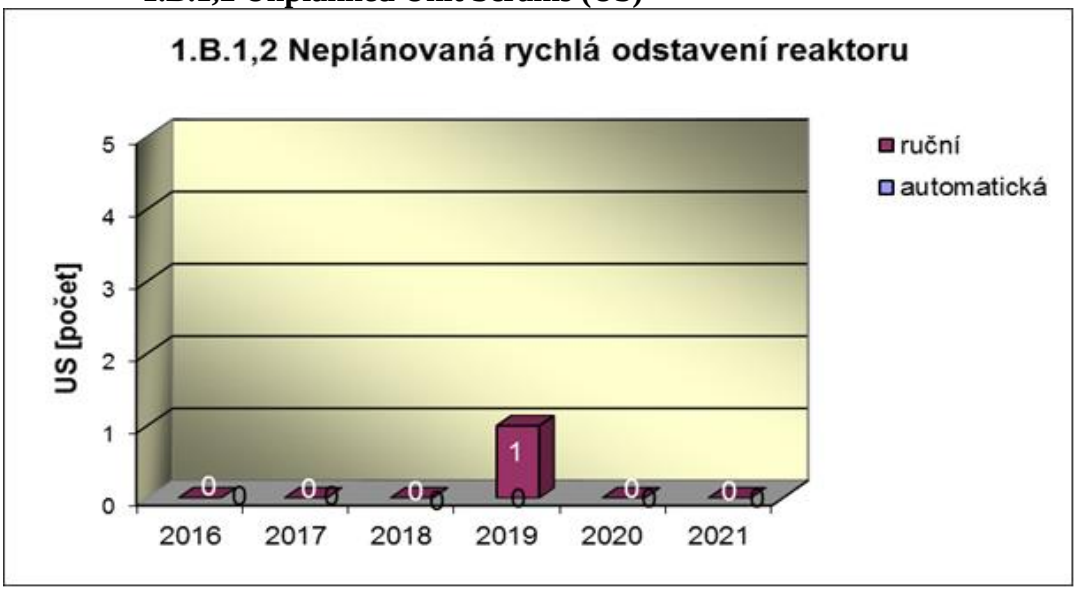
Number of reportable events with HF influence

HF Index

1.B Actuation of the protection and limitation systems

Graph 1.B.1,2 summarises the total number of unplanned unit scrams (US) (reactor in MODE 1 or 2) with resolution of manual and automatic shutdown. The term unplanned means that the scram was not an expected part of the planned test.

1.B.1,2 Unplanned Unit Scrams (US)



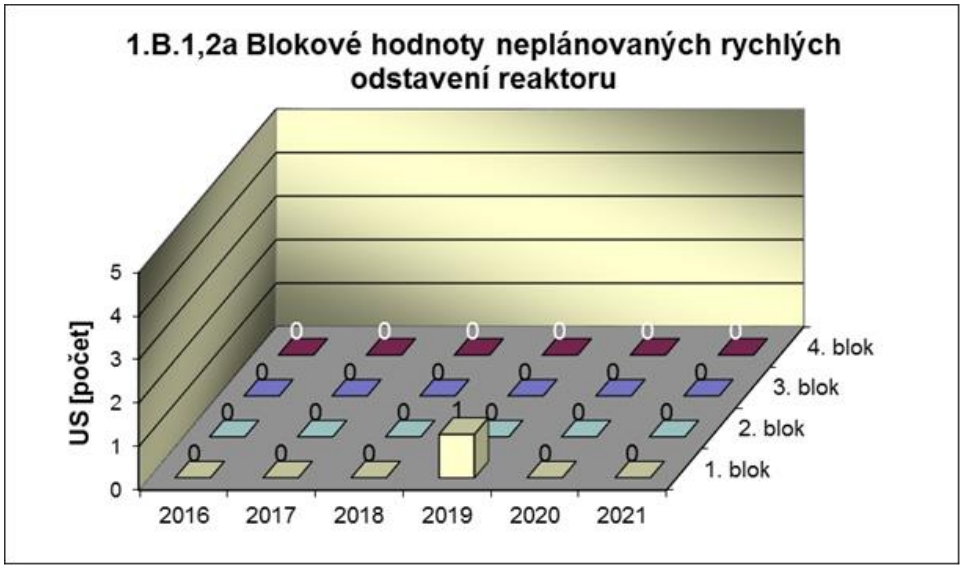
US [number]

manual

automatic

Graph 1.B.1,2a compares unit values of unplanned reactor shutdowns, including manual.

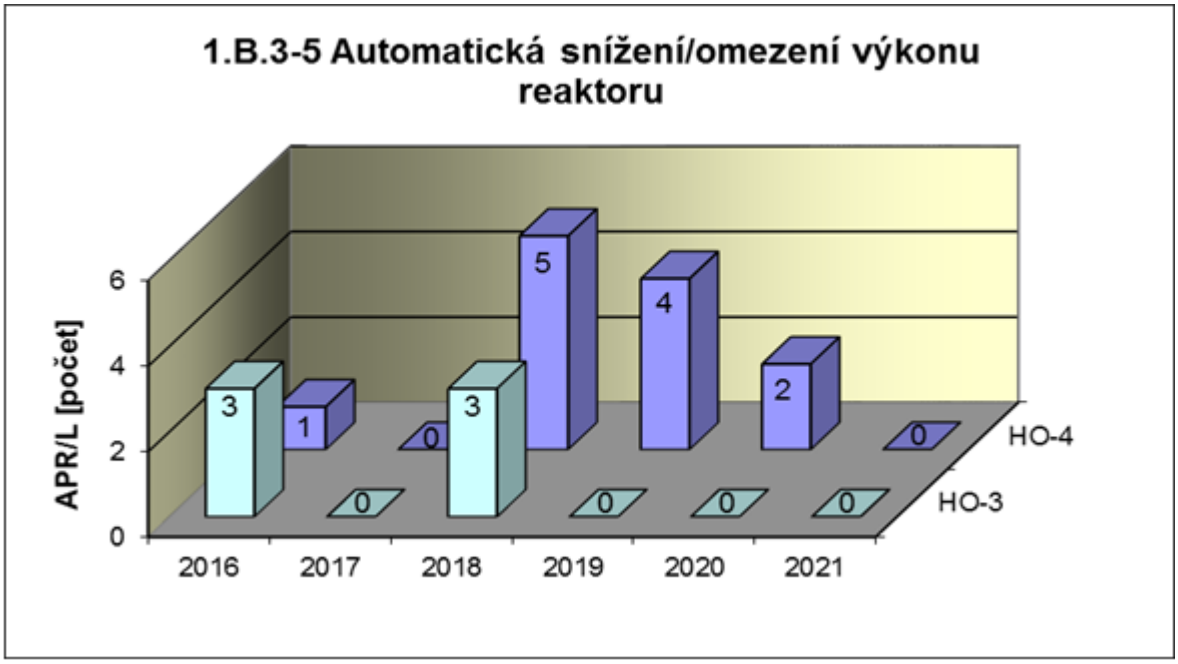
1.B.1,2a Unplanned Unit Scrams – Unit Values



US [number]
Units 1 - 2

A common graph of indicators 1.B.3-5 presents the number of unplanned automatic power reduction (APR) by emergency protection of the 2nd – 4th type (HO-2, HO-3 a HO-4).

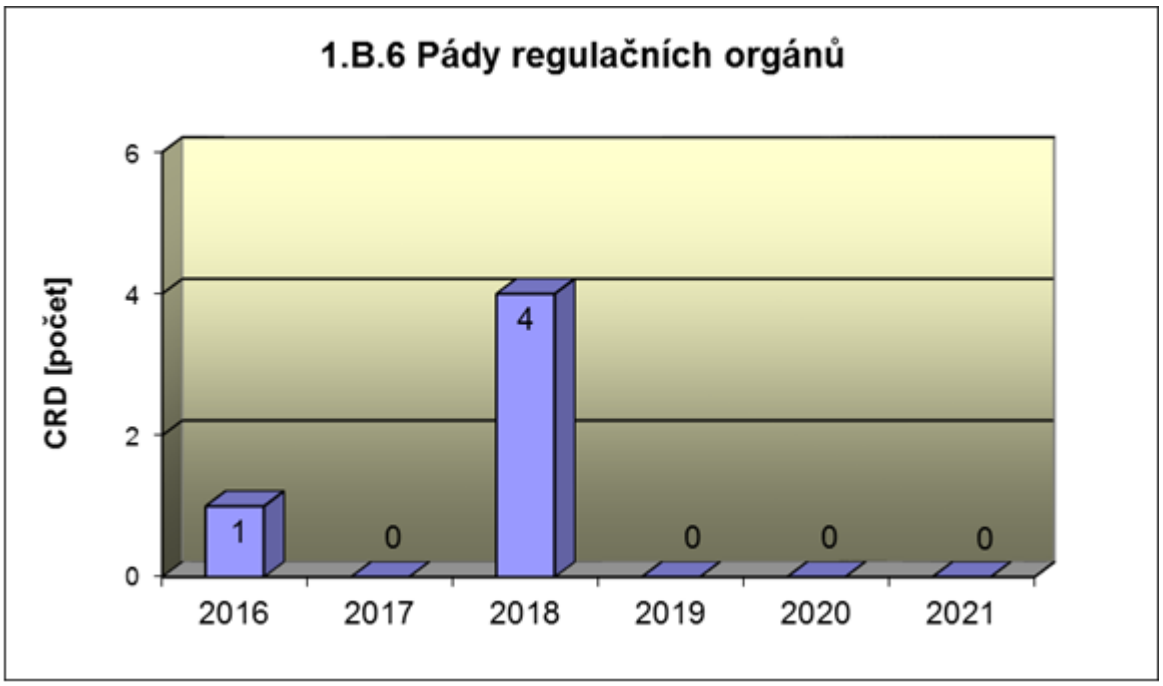
1.B.3-5 Automatic Power Reduction/Limitation



APR/L [number] / year / type

Graph 1.B.6 presents the development of the number of control rod drops (CRD).

1.B.6 Control Rod Drops

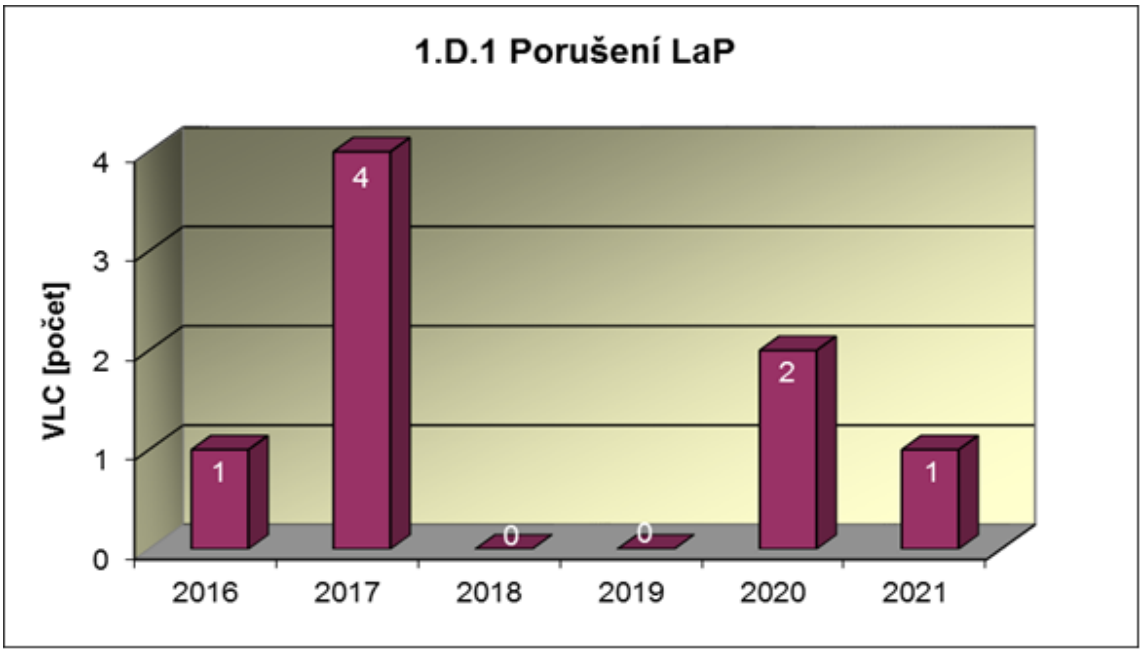


CRD [number]

1.D Limits and Conditions

Graph 1.D.1 summarises violations of the Limits and Conditions (VLC) detected by the Regulatory body or reported to the Regulatory body by the licensee.

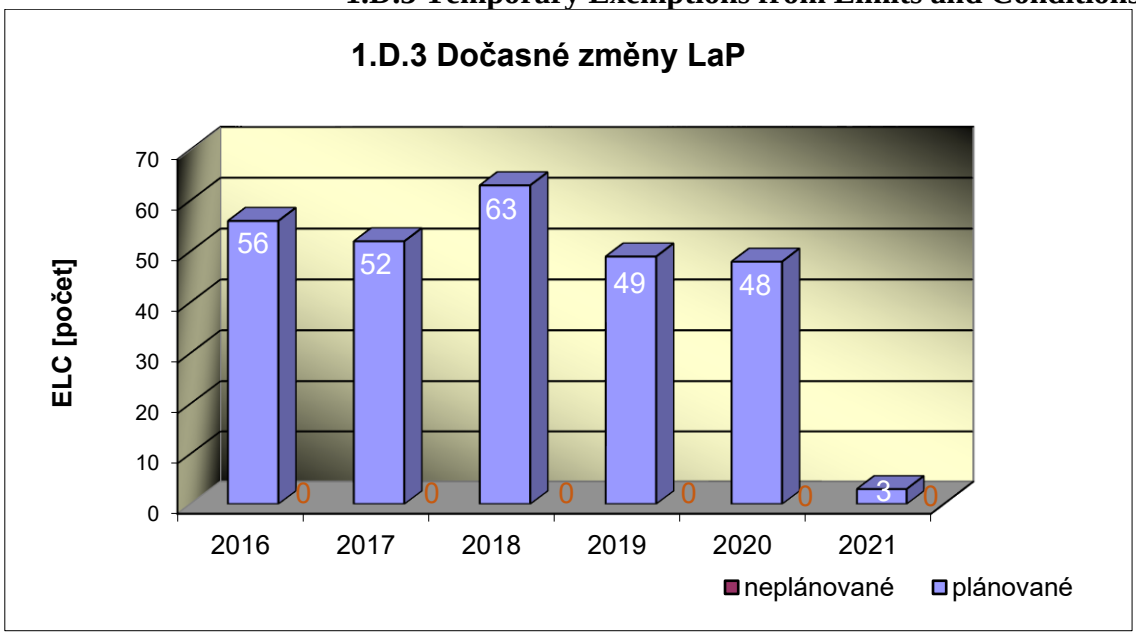
1.D.1 Violation of Limits and Conditions



VLC [number]

Graph 1.D.3 summarises the number of planned and unplanned exemptions from the Limits and Conditions (ELC) approved by the Regulatory body including those requiring SUJB approval and however not drawn for various reasons.

1.D.3 Temporary Exemptions from Limits and Conditions



ELC *[number]*
unplanned
planned

2. Safety Systems Performance

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

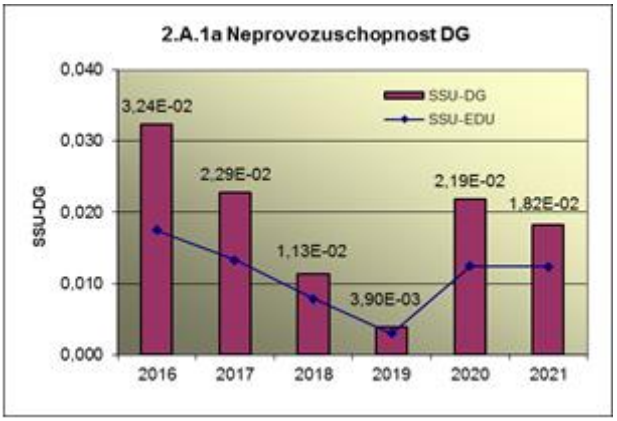
- diesel generators	**DG**
- high pressure emergency core cooling system	**TJ**
- low pressure emergency core cooling system	**TH**
- spray system	**TQ**
- hydro-accumulators	**HA**
- steam generator auxiliary feed-water system	**HN PG**
- steam generator emergency feed-water system	**SHN PG**

and in group B failure of diesel generator (DG), high pressure emergency core cooling system (TJ), low pressure emergency core cooling system (TH) and spray system (TQ) in starting and operation.

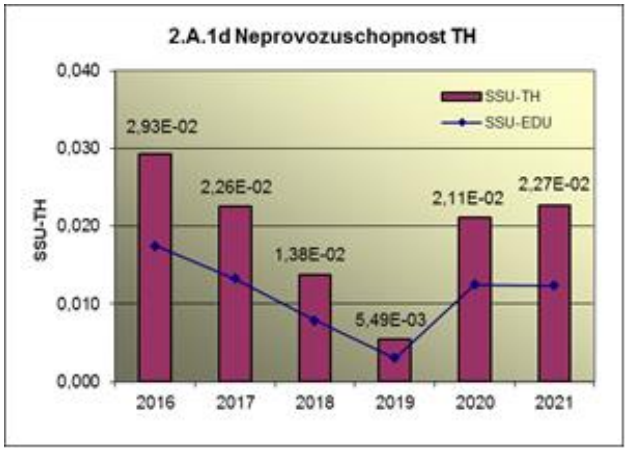
2.A Safety system unavailability

Unavailability of particular safety systems (SSU_S) - graphs 2.A.1.a – g, is defined as the ratio of the total time of unavailability of an evaluated safety system to the total time when its availability was required. In addition, these combined graphs express the ratio of unavailability of respective safety system to the "general" safety system of the site.

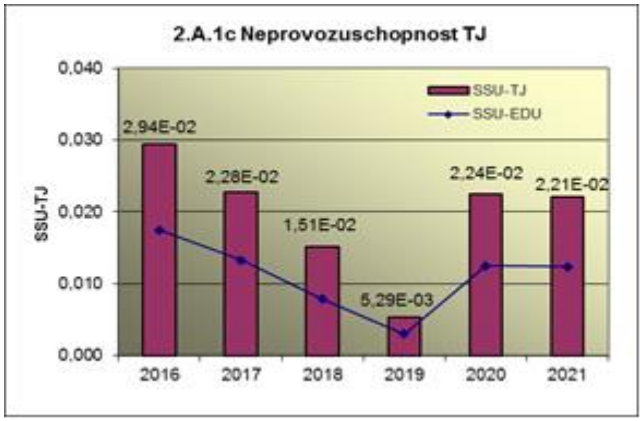
2.A.1a DG Unavailability



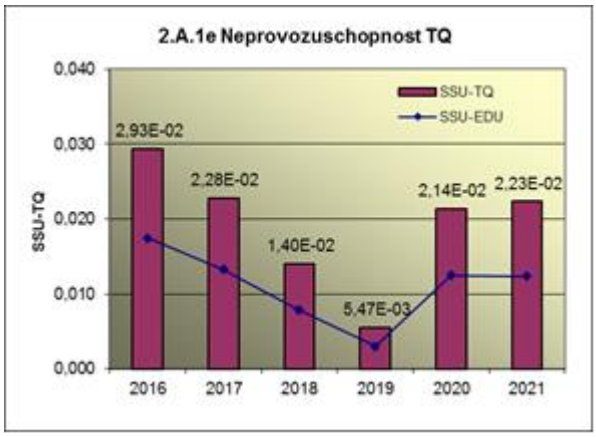
2.A.1d TH Unavailability



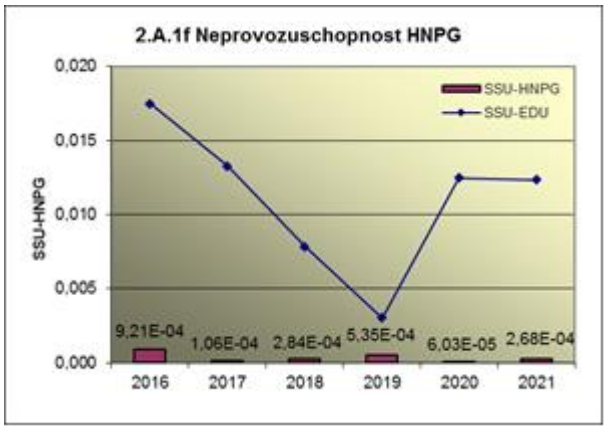
2.A.1c TJ Unavailability



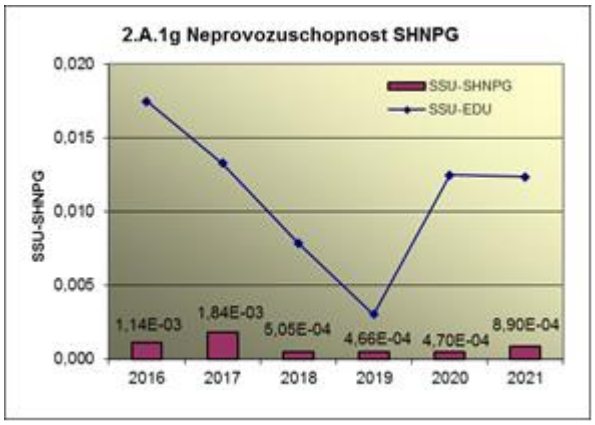
2.A.1e TQ Unavailability



2.A.1f HNPG Unavailability



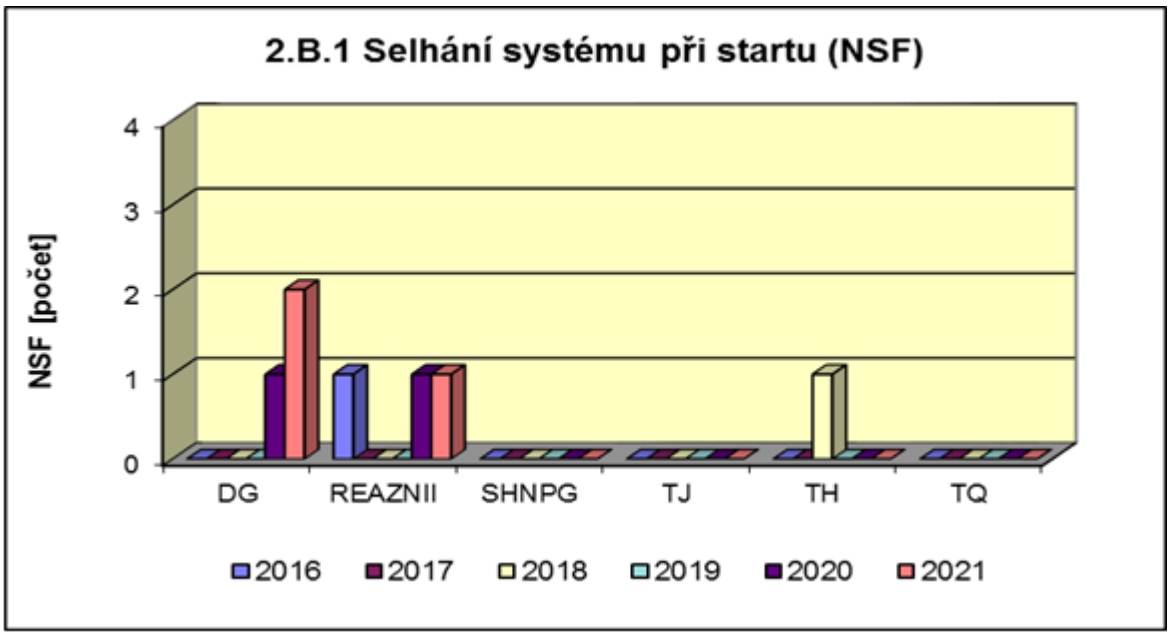
2.A.1g SHNPG Unavailability



2.B.1 Failure of safety systems

Graph 2.B.1 indicates the number of starting failures of the safety system (NSF), i.e. the state when the respective system, possibly set after the command to start, does not achieve nominal performance characteristic or its failure (shutdown) occurs within 30 minutes after its start.

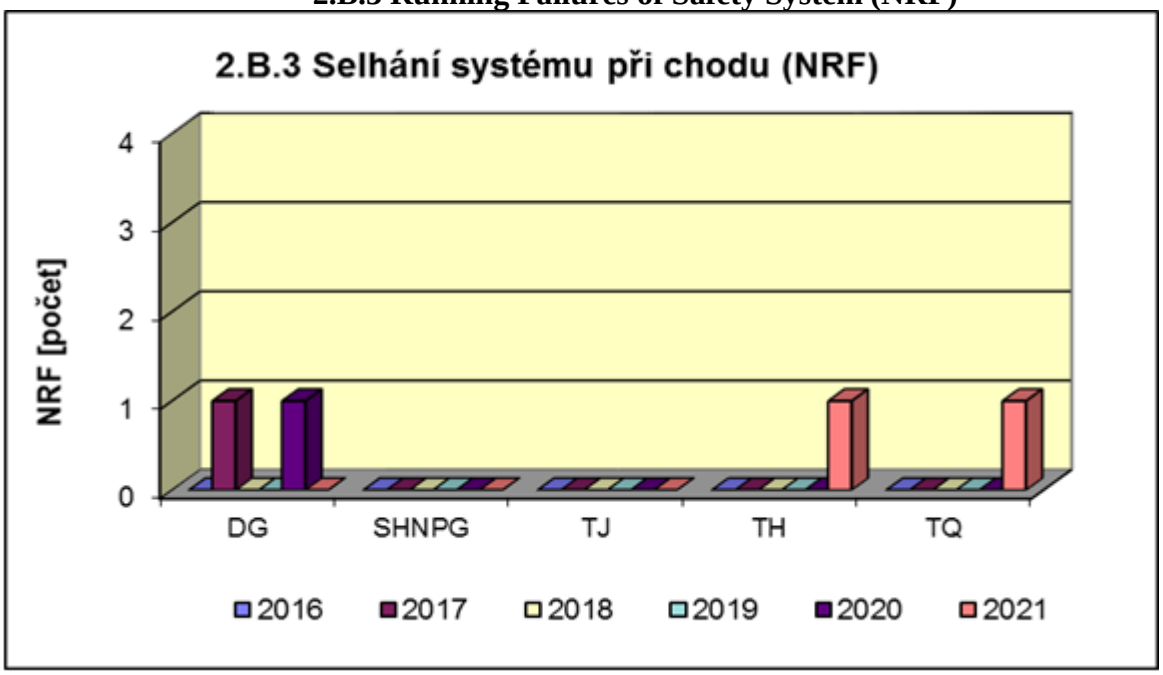
2.B.1 Starting Failures of Safety System (NSF)



NSF [number]

Graph 2.B.3 indicates the number of running failures of safety system (NRF), i.e. the number of states when failure shut down of respective system, drive, possibly set occurs at nominal performance characteristics for the time exceeding 30 minutes since its starting.

2.B.3 Running Failures of Safety System (NRF)



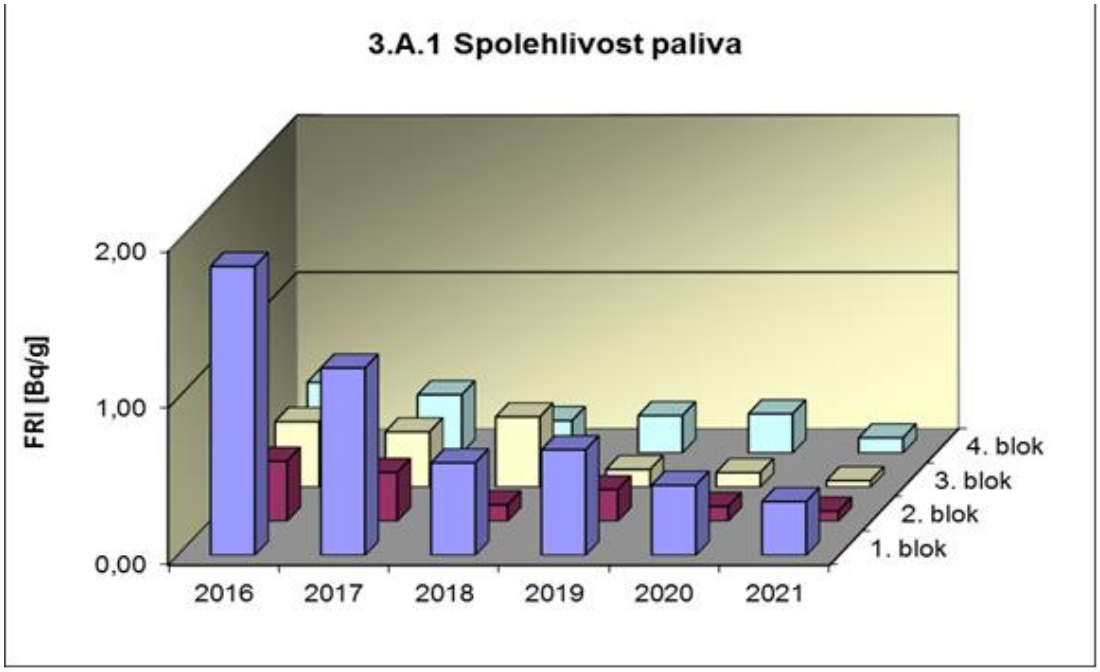
NRF [number]

3. Barriers Integrity

3.A Nuclear fuel

Graph 3.A.1 monitors fuel reliability of particular units through the values of FRI - Fuel reliability index. The value FRI ≤ 19Bq/g expresses that reactor core most likely does not contain any steady fuel defects.

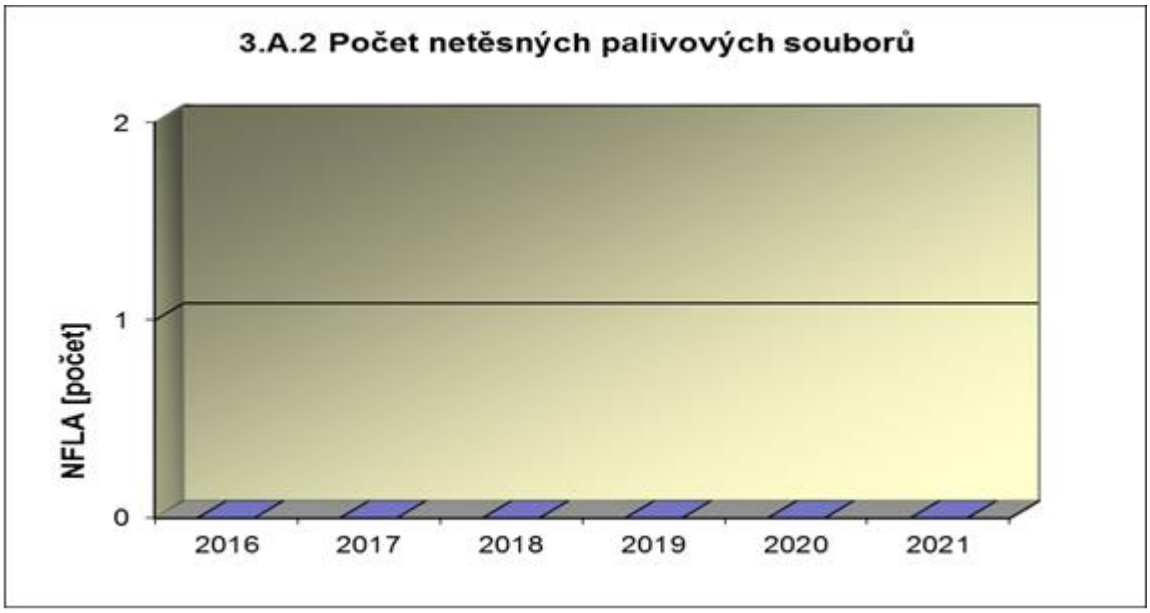
3.A.1 Fuel Reliability



Units 1 - 4

Graph 3.A.2 indicates the number of leaky fuel assemblies (NLFA) that had to be put out of operation due to their inadmissible leakage.

3.A.2. Number of Leaky Fuel Assemblies



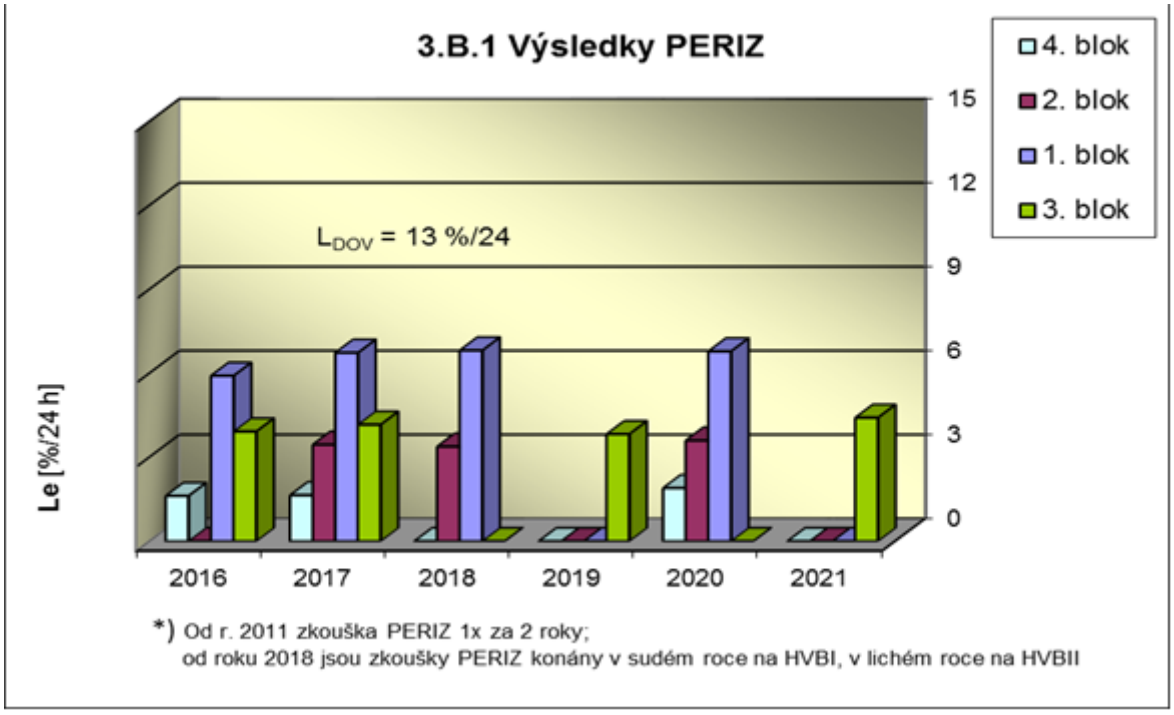
NFLA [number]

3.B Containment

Graph 3.B.1 states the results of Containment periodic integral tightness testing (L_e), i.e. the results of leakage tests of hermetic areas executed by overpressure 150 kPa lasting 24 hours. Extrapolated results are included for the tests with a lower pressure and dwell.

From 2011 – unit testing period = 1x/2 years.

3.B.1 Results of Containment Periodic Integral Tightness Testing



Units 1 – 4

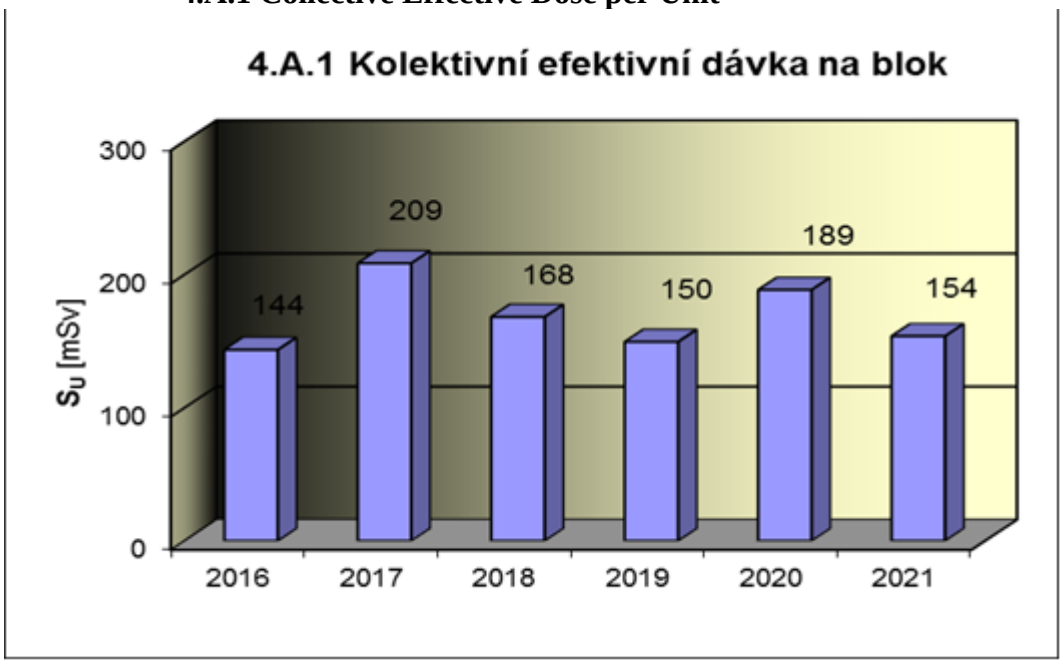
**) Since 2018 the testing PERIZ is performed in even-numbered years at Units 1+ 2 and in odd-numbered years at Units 3+4*

4. Radiation Protection

4.A Staff

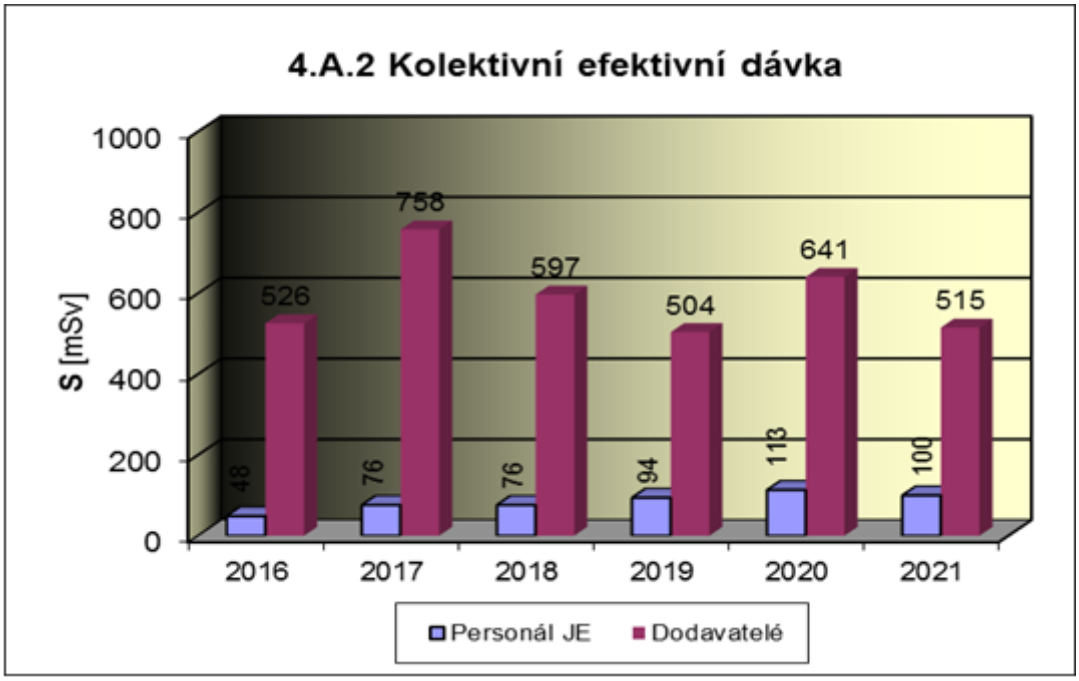
Graph 4.A.1 indicates collective effective dose (CED) received by the staff of NPP (including suppliers and visitors) during monitored period, measured by basic film dosimeters and expressed by mean value per unit.

4.A.1 Collective Effective Dose per Unit



Graph 4.A.2 indicates collective effective dose received by the staff of NPP and suppliers during monitored period, measured by basic film dosimeters.

4.A.2 Collective Effective Dose

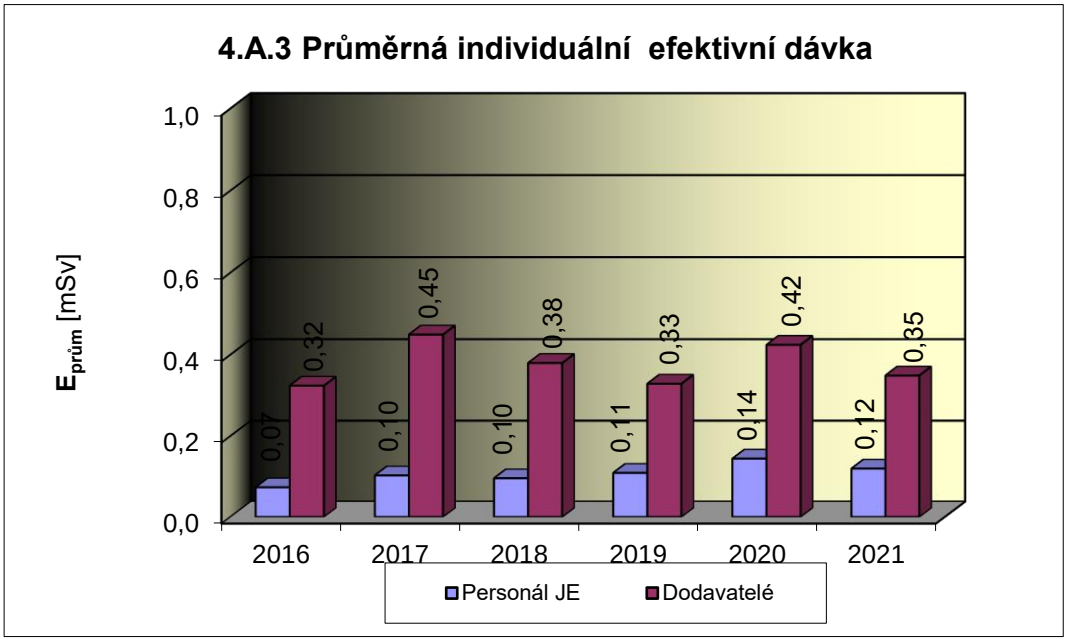


NPP Staff

Suppliers

Graph 4.A.3 indicates specific collective effective dose received by the staff of NPP and suppliers during monitored period, measured by basic film dosimeters and express by value per one radiation worker.

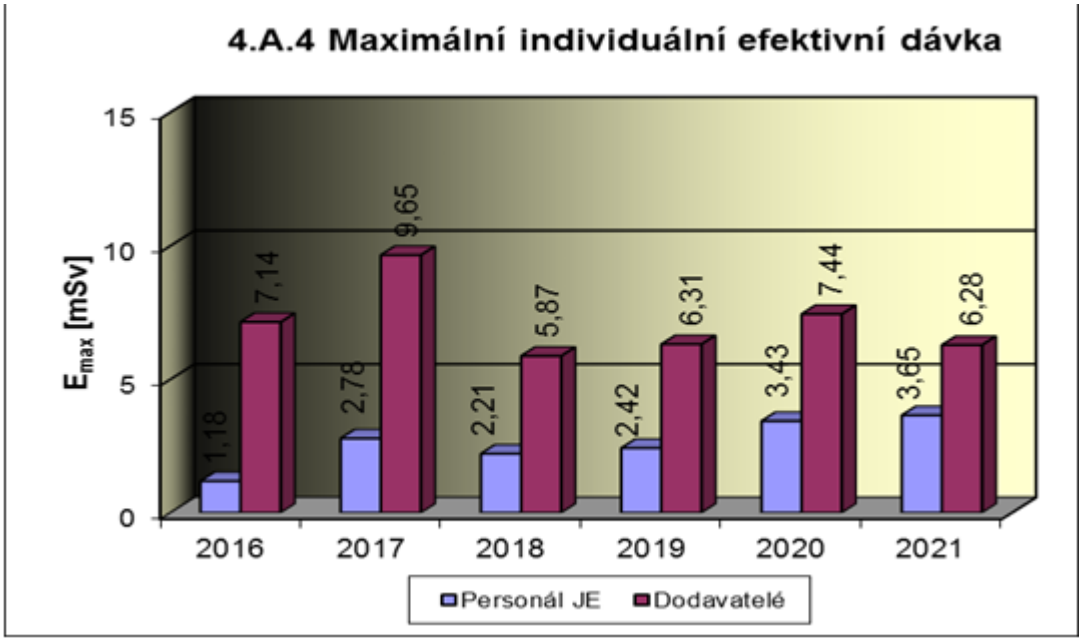
4.A.3 Specific Collective Dose per Capita



NPP Staff
Suppliers

Graph 4.A.4 indicates maximum individual effective dose received by one particular employee of NPP and one particular employee of supplier during monitored period, measured by basic film dosimeters.

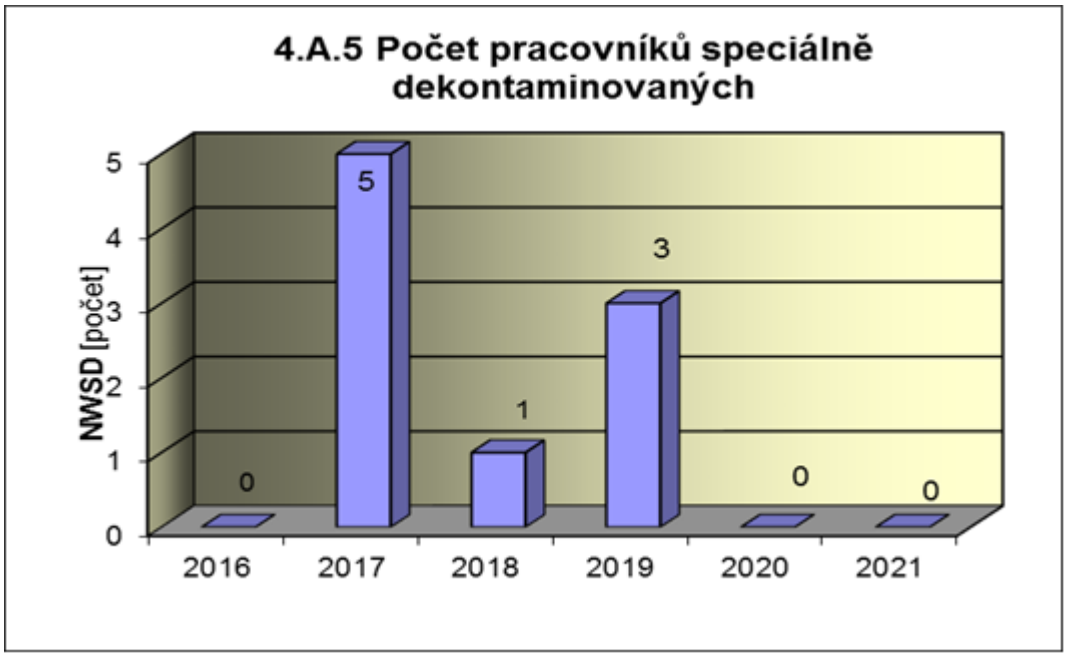
4.A.4 Maximum Individual Effective Dose



NPP Staff
Suppliers

Graph 4.A.5 indicates number of workers (NPP and suppliers) subjected to a special decontamination under medical supervision.

4.A.5 Number of Workers with Special Decontamination

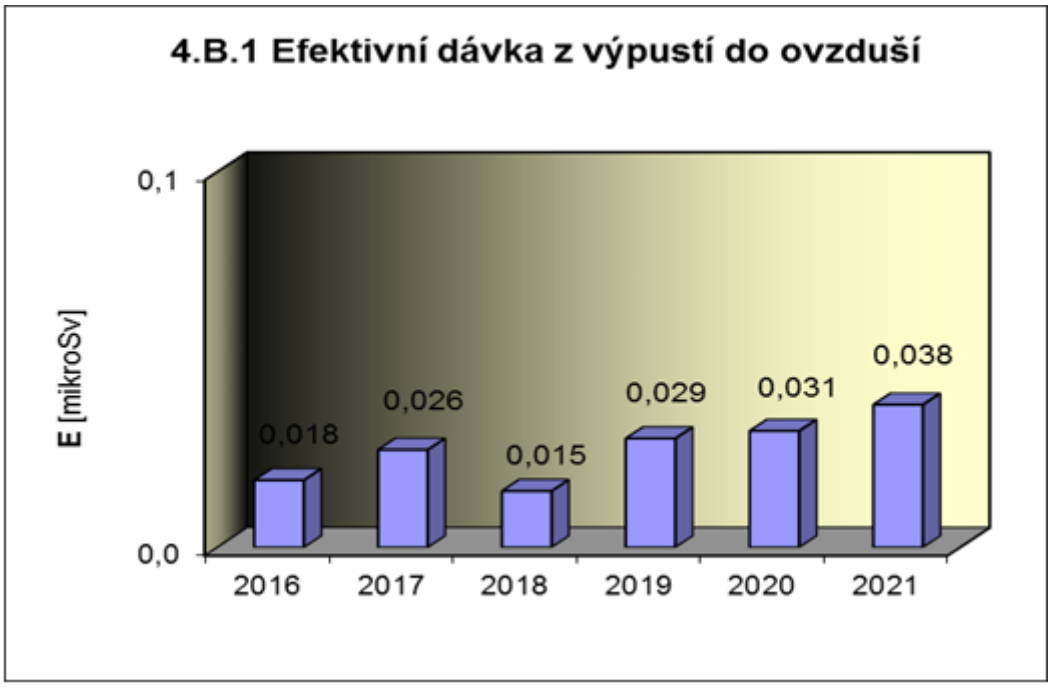


NWSD [number]

4.B Radioactive Releases

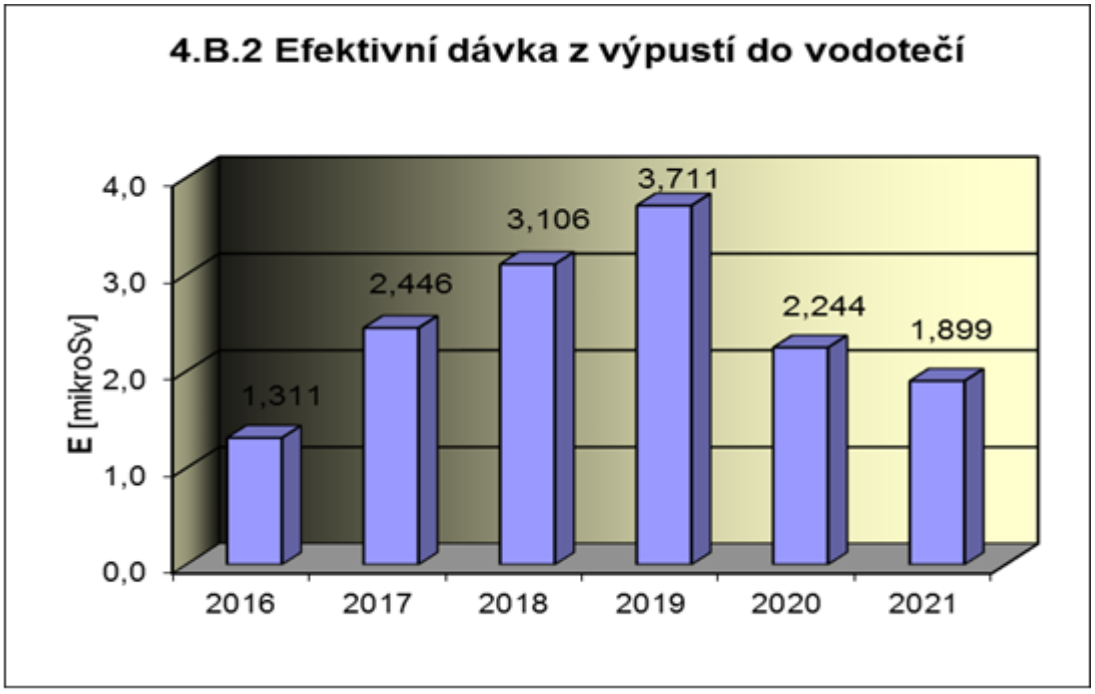
Graph 4.B.1 indicates the committed effective dose for an individual, which arises from radioactive gaseous releases from NPP.

4.B.1 Gaseous Releases – Committed Effective Doses



Graph 4.B.2 indicates the committed effective dose for an individual, which arises from radioactive liquid releases from NPP.

4.B.2 Liquid Releases – Committed Effective Doses

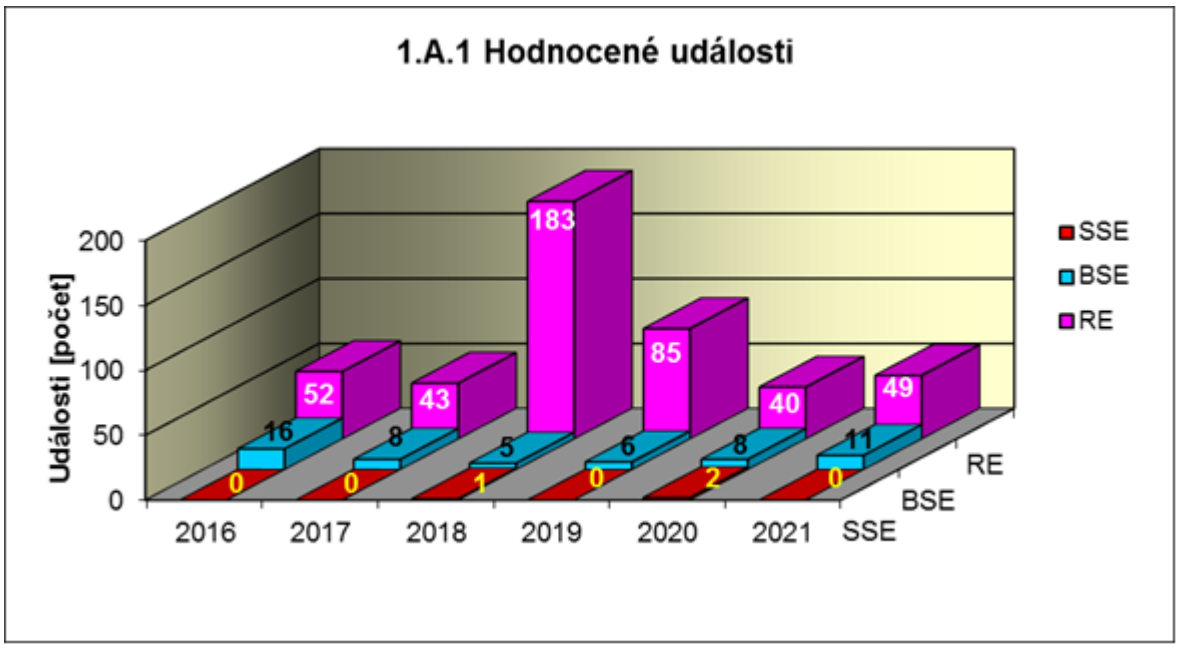

4.B.2 Efektivní dávka z výpustí do vodotečí
E [mikroSv]
4,0
3,0
2,0
1,0
0,0
1,311
2,446
3,106
3,711
2,244
1,899
2016
2017
2018
2019
2020
2021

1. Significant Events NPP Temelin

1.A Related events

Graph of indicator 1.A.1 monitors the development of the number of related events (RE) including their division according to the evaluation of the International Nuclear Event Scale (INES) into significant events (SSE, INES > 0) and the below scale events (BSE, INES = 0).

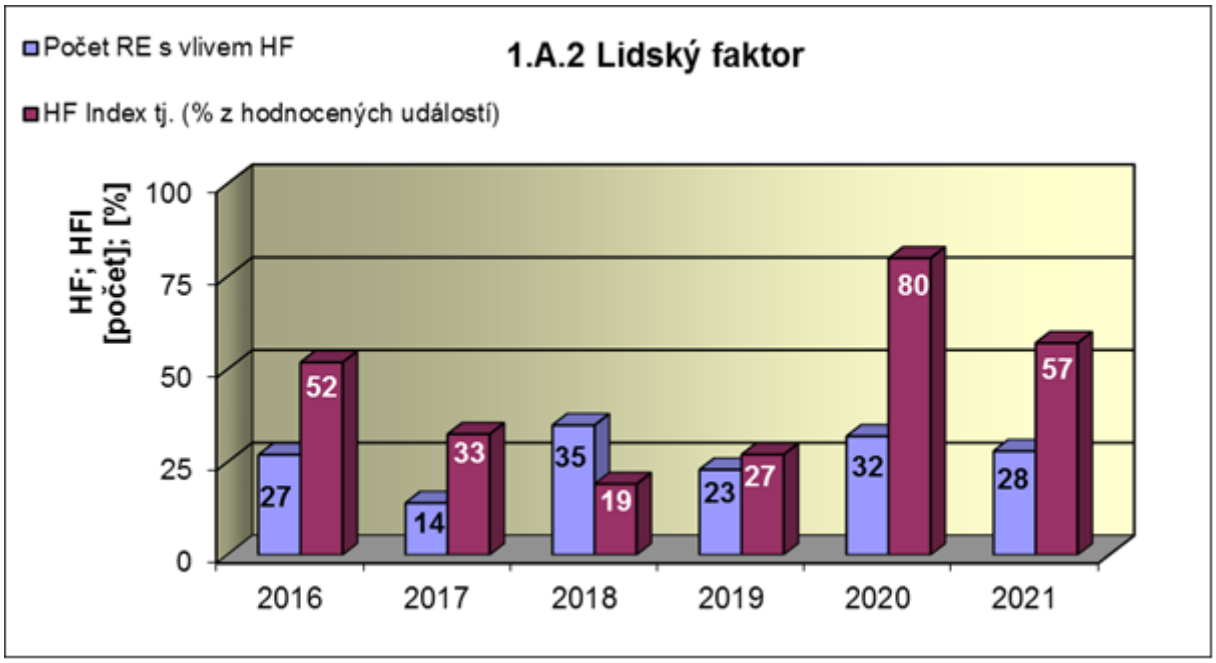
1.A.1 Related Events



Events [number]

Graph 1.A.2 evaluates the influence of the human factor upon occurrence of safety related events. The indicator is expressed by the number of the safety-related events with an influence of human factor (HF) and its percentage share (HFI).

1.A.2 Human Factor

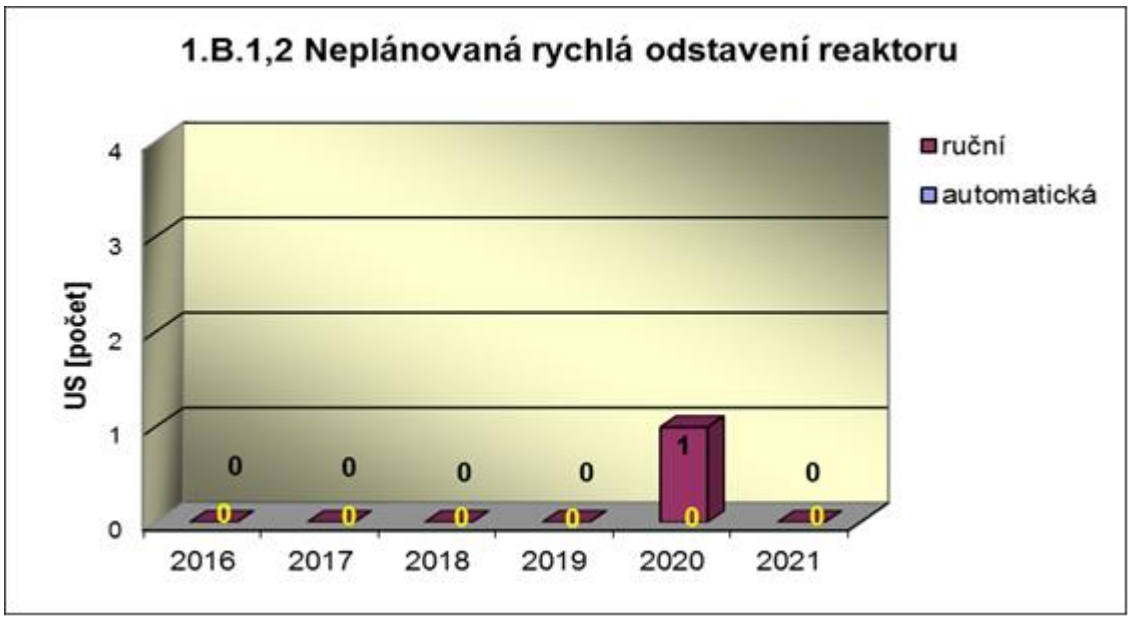


HF, HFI [number]
Number of RE with HF influence
HF Index [% from evaluated events]

1.B Actuation of the protection and limitation systems

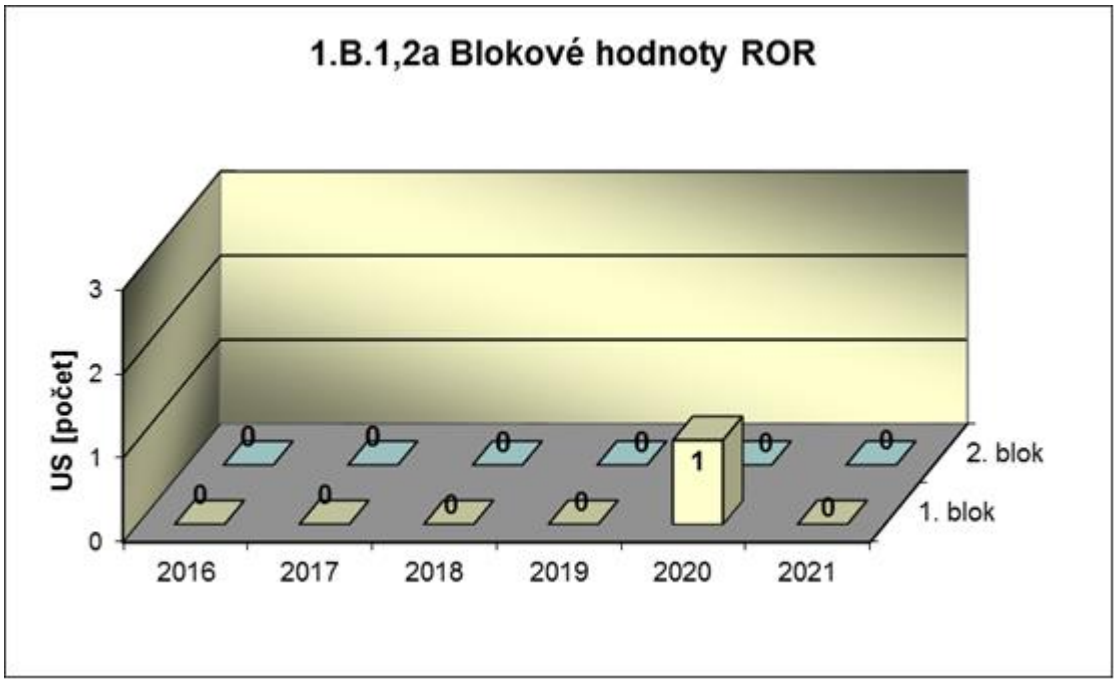
Graph 1.B.1,2 summarises the total number of unplanned unit scrams (US) (reactor in MODE 1 or 2) with resolution of manual and automatic shutdown. The term "unplanned" means that the scram was not an expected part of the planned test.

1.B.1,2 Unplanned Unit Scrams (US)



US [number]
manual
automatic

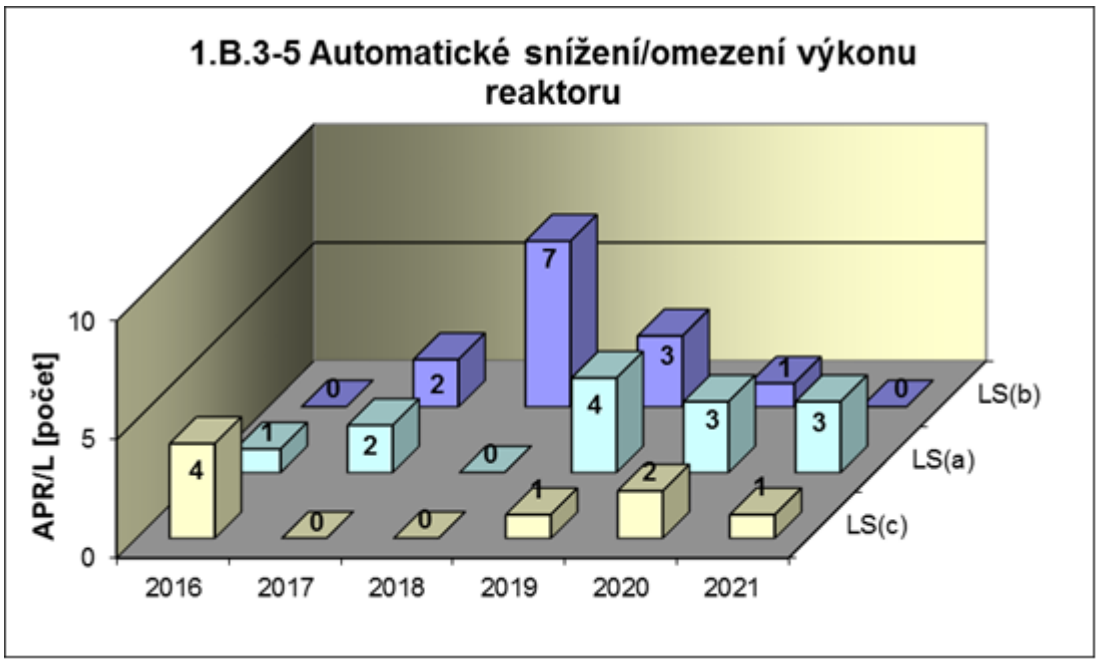
1.B.1,2 a Unplanned Unit Scrams – Unit Values



US [number] / year / unit 1 – 2

A common graph of indicators 1.B.3-5 indicates the number of limitation system (LS) incorporation with a, b, c types.

1.B.3-5 Automatic Power Reduction / Limitation

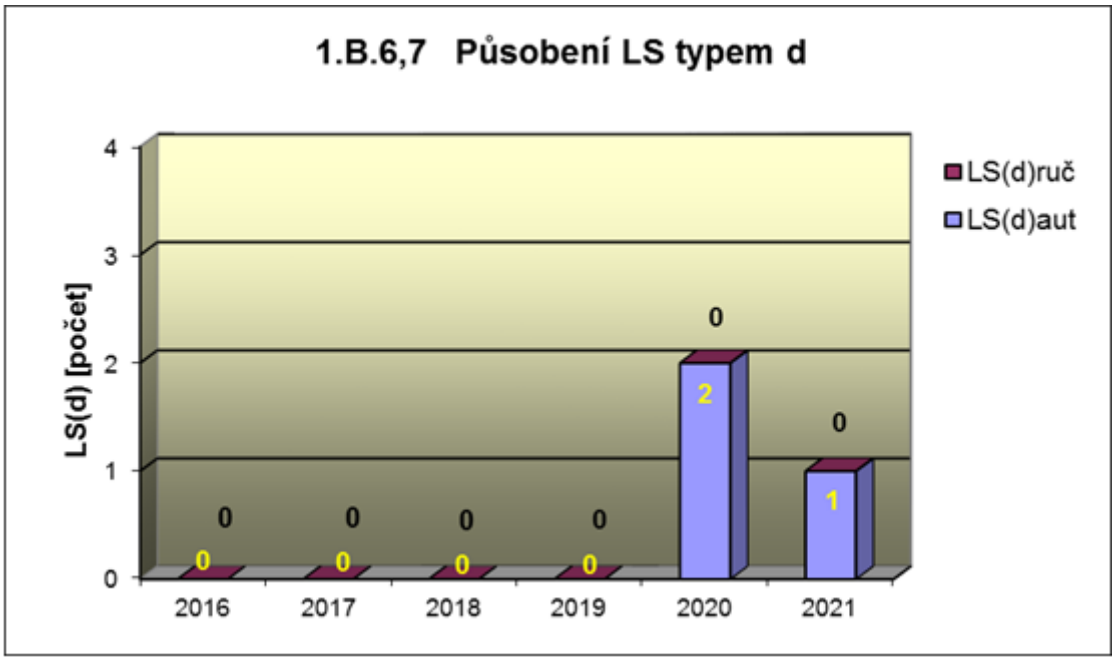


APR/L [number]

Graph 1.B.6,7 summarises the total number of unplanned reactor scrams with action of the limitation system (LS(d)) (reactor in MODE 1 or 2) with resolution of manual and automatic

shutdown. The term “unplanned” means that the scram was not an expected part of the planned test.

1.B.6,7 Limitation Systems function (d) Actuation

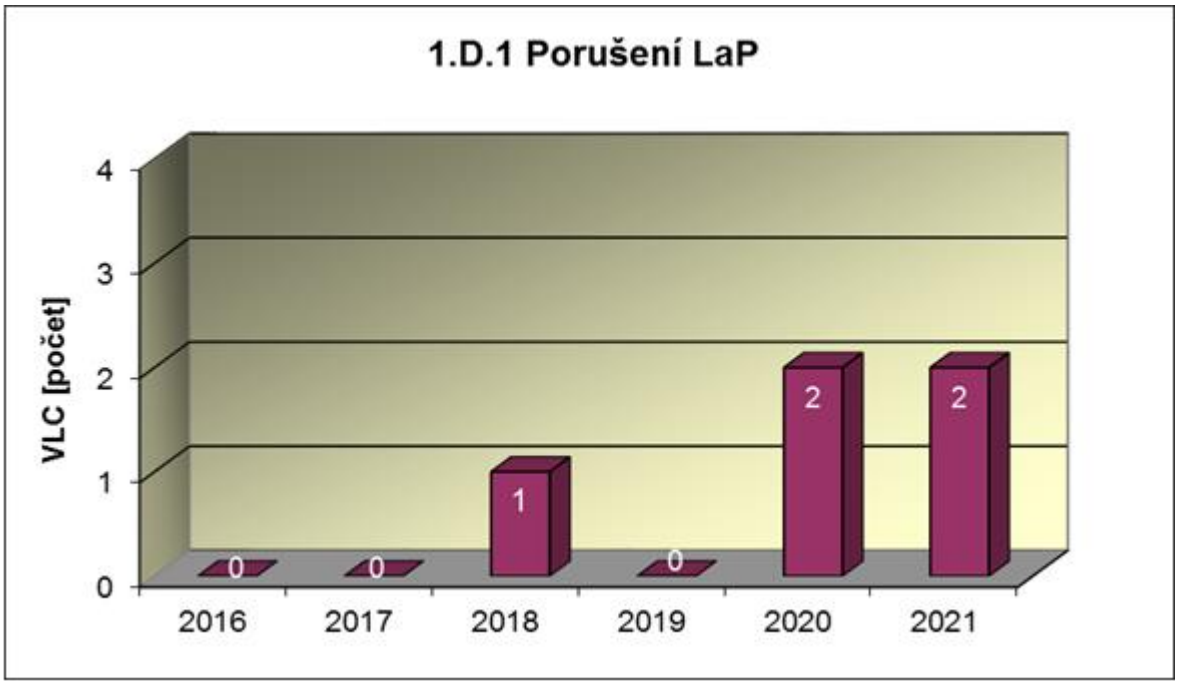


LS(d) [number]
LS manual
LS automatic

1.D Limits and Conditions

Graph 1.D.1 summarises violations of the Limits and Conditions (VLC) detected by the Regulatory body or reported to the Regulatory body by the licensee.

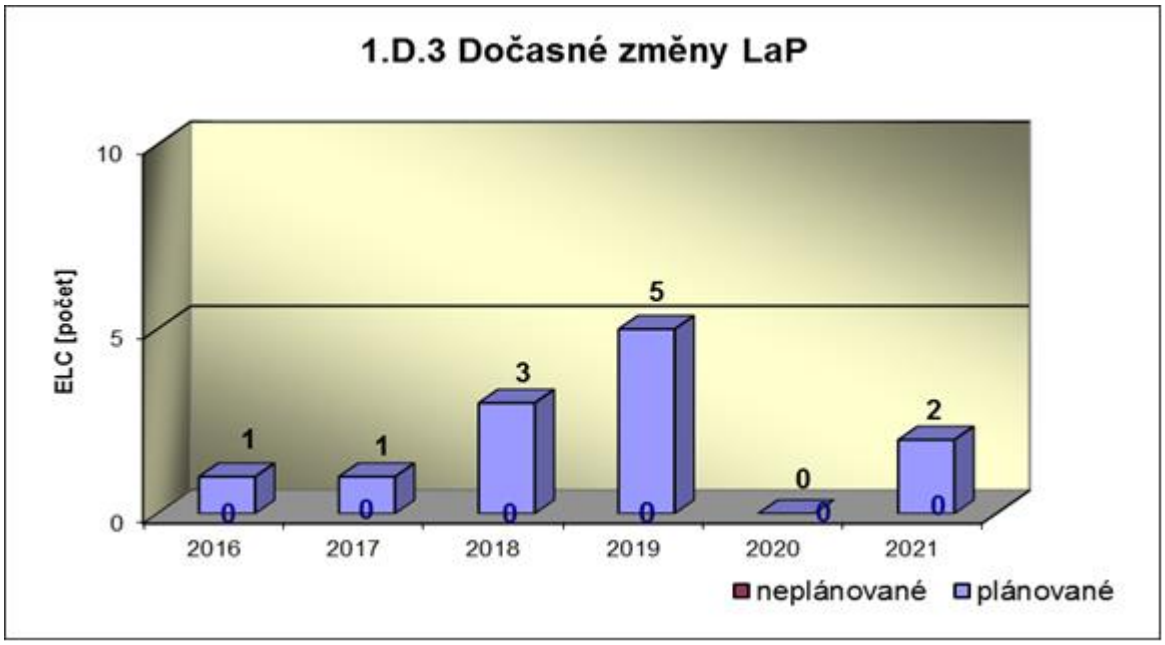
1.D.1 Violation of Limits and Conditions



VLC [number]

Graph 1.D.3 summarises the number of planned and unplanned exemptions from the Limits and Conditions (ELC) approved by the Regulatory body including those requiring SUJB approval and however not drawn for various reasons.

1.D.3 Temporary Exemptions from Limits and Conditions



ELC [number]
unplanned
planned

2. Safety Systems Performance

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

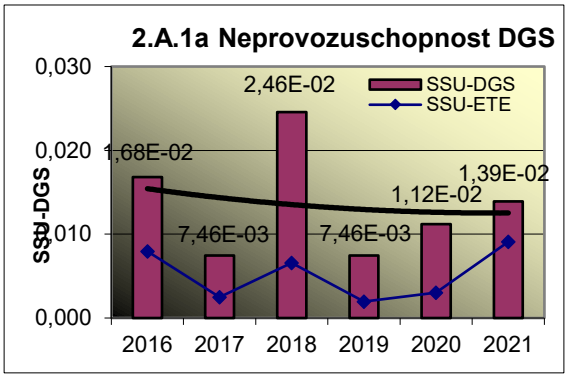
- system diesel generators	**DGS**
- spray system	**TQx1**
- low pressure emergency core cooling system	**TQx2**
- high pressure emergency core cooling system	**TQx3**
- boric acid emergency injection system	**TQx4**
- hydro-accumulators	**HA**
- steam generator emergency feed-water system	**TX**

and in group B failure of diesel generator (DG), spray system (TQx1), low pressure emergency core cooling system (TQx2), high pressure emergency core cooling system (TQx3), boric acid emergency injection system (TQx4) in starting and operation.

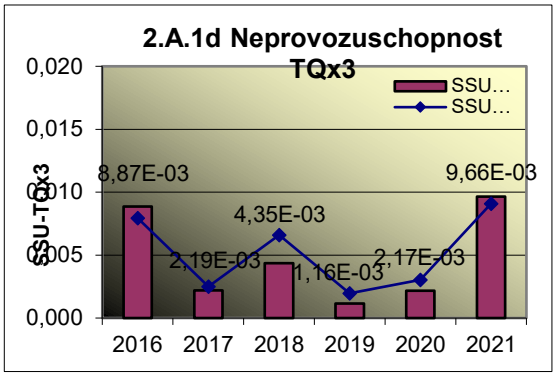
2.A Safety system unavailability

Unavailability of particular safety systems (SSUs) - graphs 2.A.1.a – g, is defined as the ratio of the total time of unavailability of an evaluated safety system to the total time when its availability was required. In addition, these combined graphs express the ratio of unavailability of respective safety system to the "general" safety system of the site.

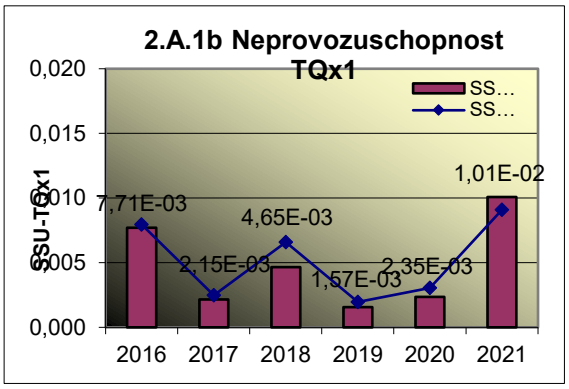
2.A.1a DGS Unavailability



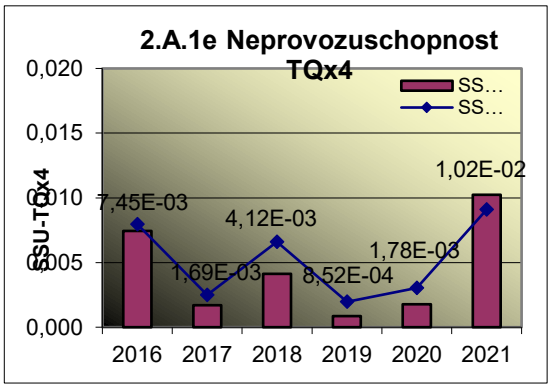
2.A.1d TQx3 Unavailability



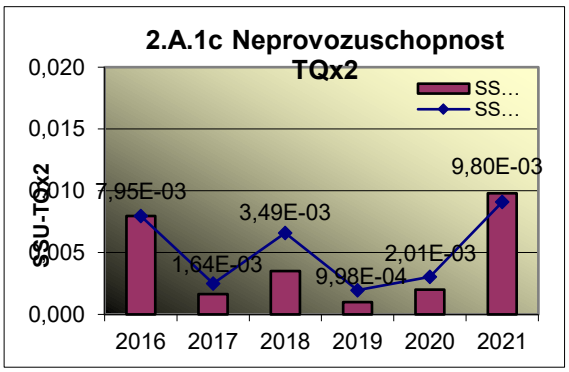
2.A.1b TQx1 Unavailability



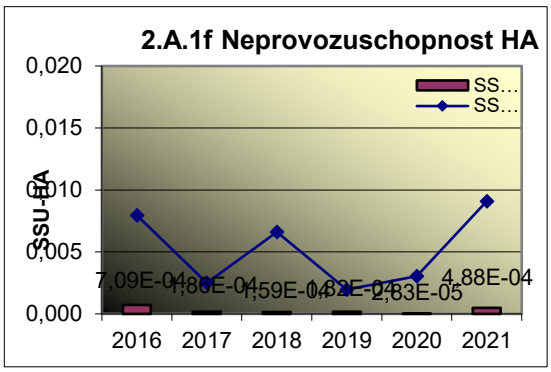
2.A.1e TQx4 Unavailability



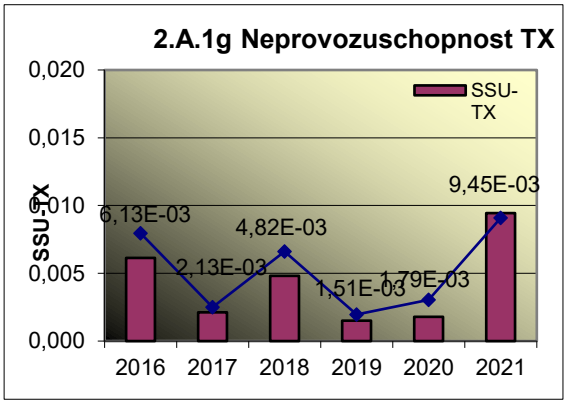
2.A.1c TQx2 Unavailability



2.A.1f HA Unavailability



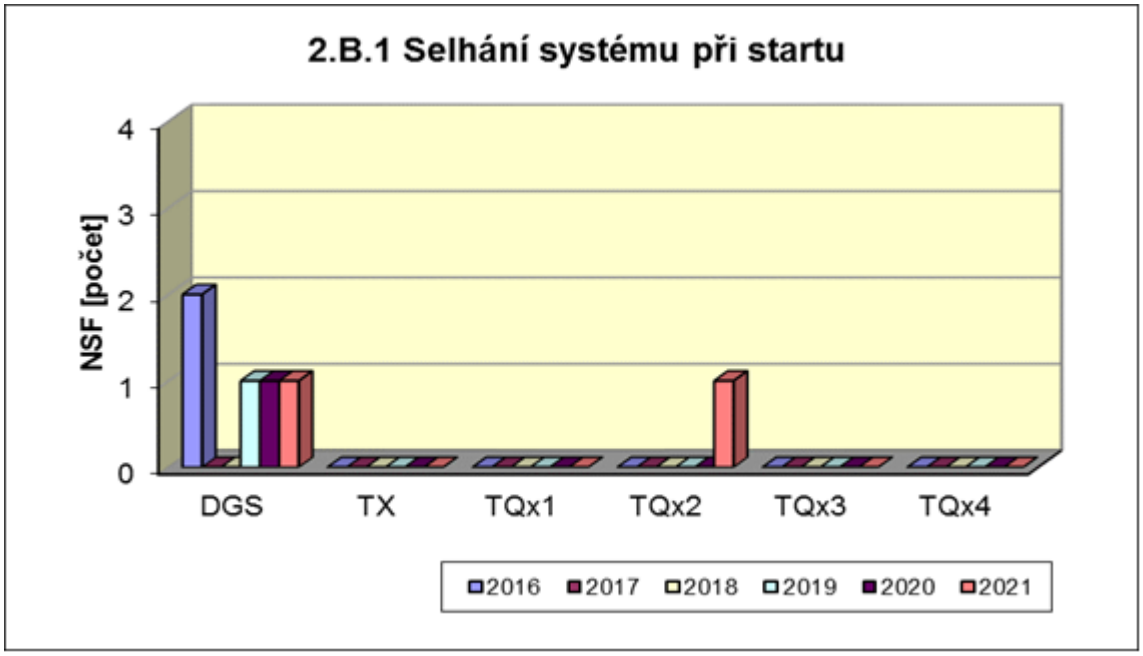
2.A.1g TX Unavailability



2.B Failure of safety systems

Graph 2.B.1 indicates the number of starting failures of the safety system (NSF), i.e. the state when the respective system, possibly set after the command to start, does not achieve nominal performance characteristic or its failure (shutdown) occurs within 30 minutes after its start.

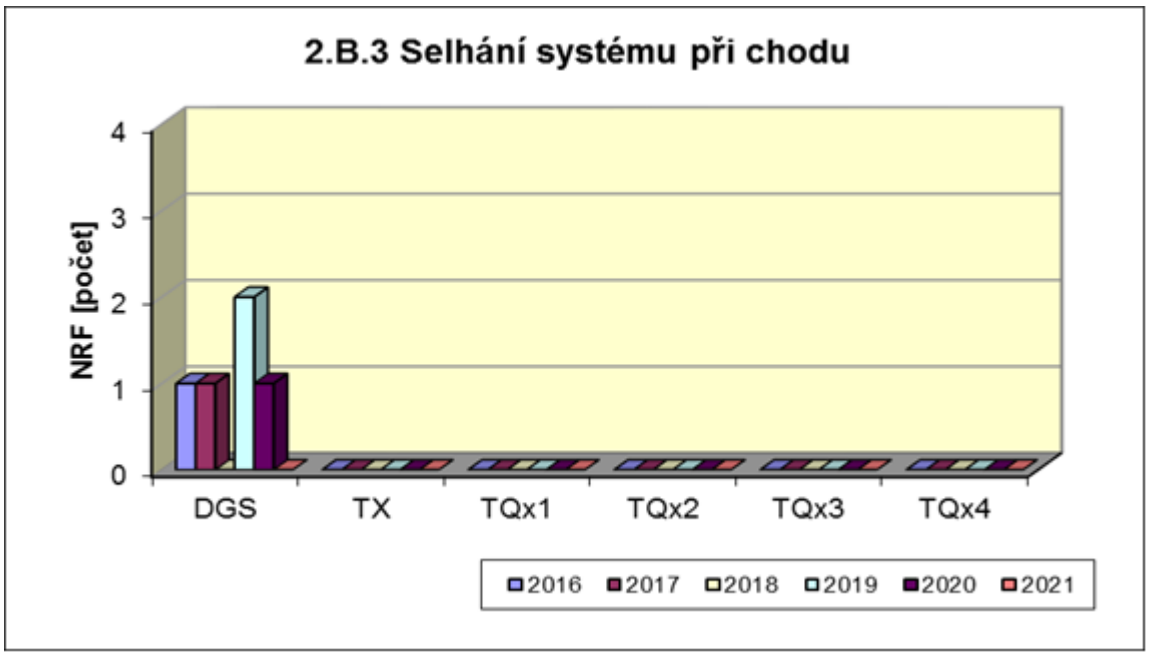
2.B.1 Starting Failures of Safety System



NSF [number]

Graph 2.B.3 indicates the number of running failures of safety system (NRF), i.e. the number of states when failure shut down of respective system, drive, possibly set occurs at nominal performance characteristics for the time exceeding 30 minutes since its starting.

2.B.3 Running Failures



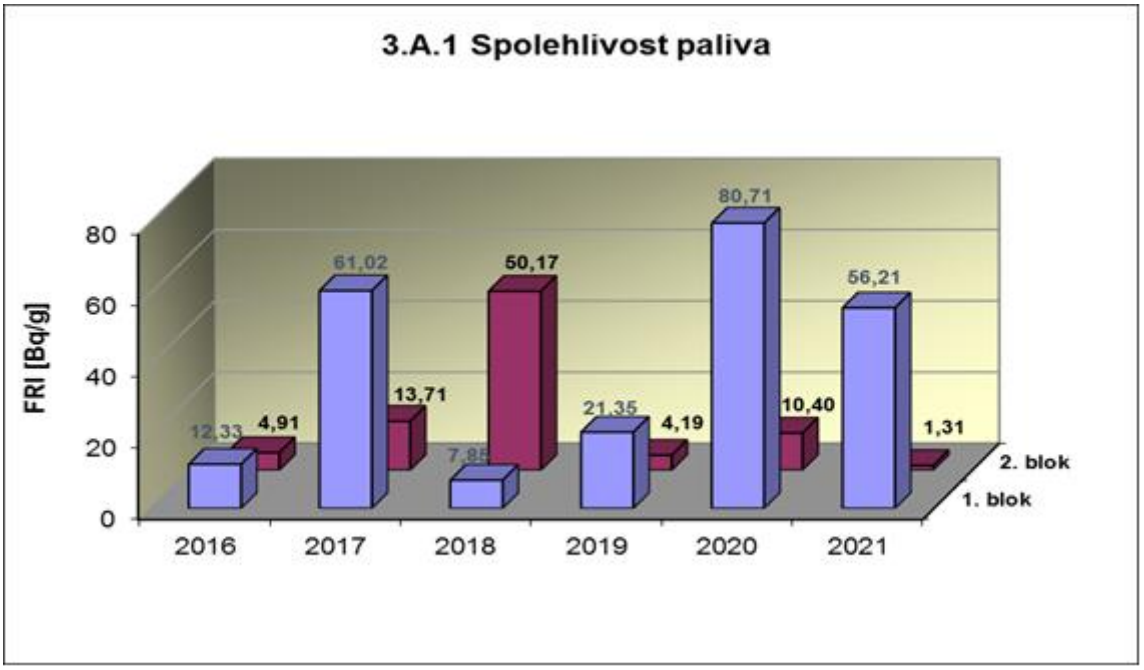
NRF [number]

3. Barriers integrity

3.A Nuclear fuel

Graph 3.A.1 monitors fuel reliability of particular units through the values of FRI - Fuel reliability index. The value FRI ≤ 19Bq/g expresses that reactor core most likely does not contain any steady fuel defects.

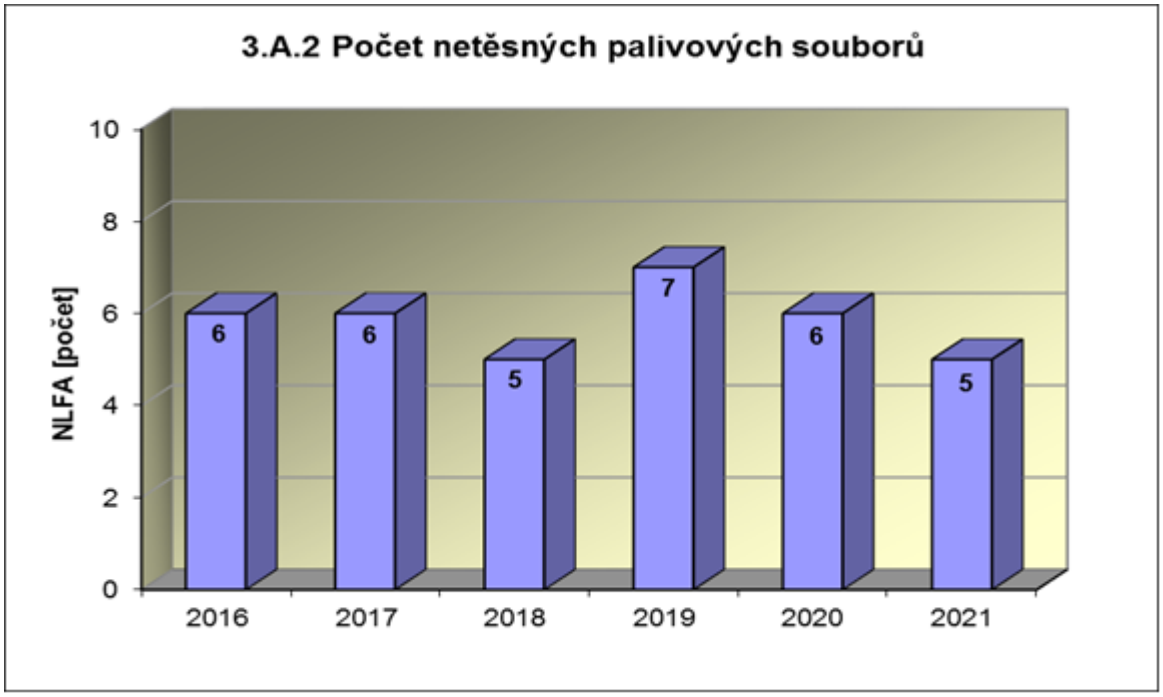
3.A.1 Fuel Reliability



Units 1 - 2

Graph 3.A.2 indicates the number of leaky fuel assemblies (NLFA) that had to be put out of operation due to their inadmissible leakage.

3.A.2 Number of Leaky Fuel Assemblies

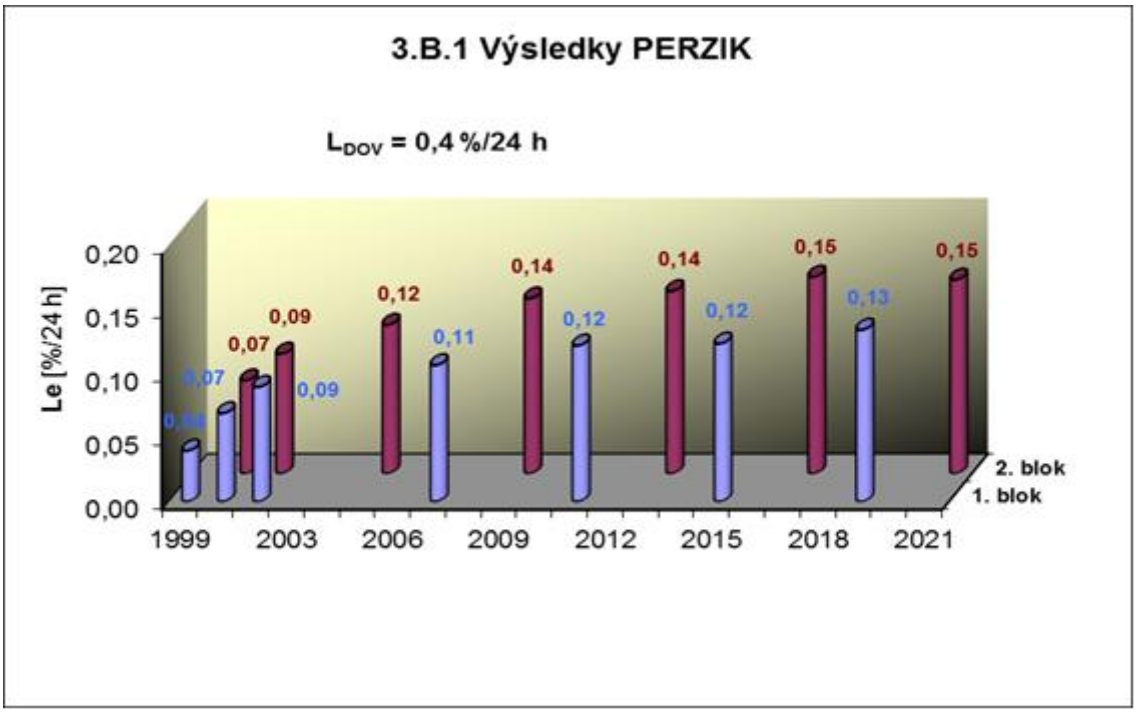

3.A.2 Počet netěsných palivových souborů
NLFA [počet]
10
8
6
4
2
0
6
6
5
7
6
5
2016
2017
2018
2019
2020
2021

NLFA [number]

3.B Containment

Graph 3.B.1 states the results of Containment periodic integral tightness testing (L_e), i.e. the results of leakage tests of hermetic areas executed by overpressure 400 kPa lasting 24 hours during Containment integrity testing and extrapolated results are stated for Containment integrity repeated testing and Containment integrity periodic testing with lower pressure of 70 kPa and dwell.

3.B.1 Results of Containment Periodic Integral Tightness Testing



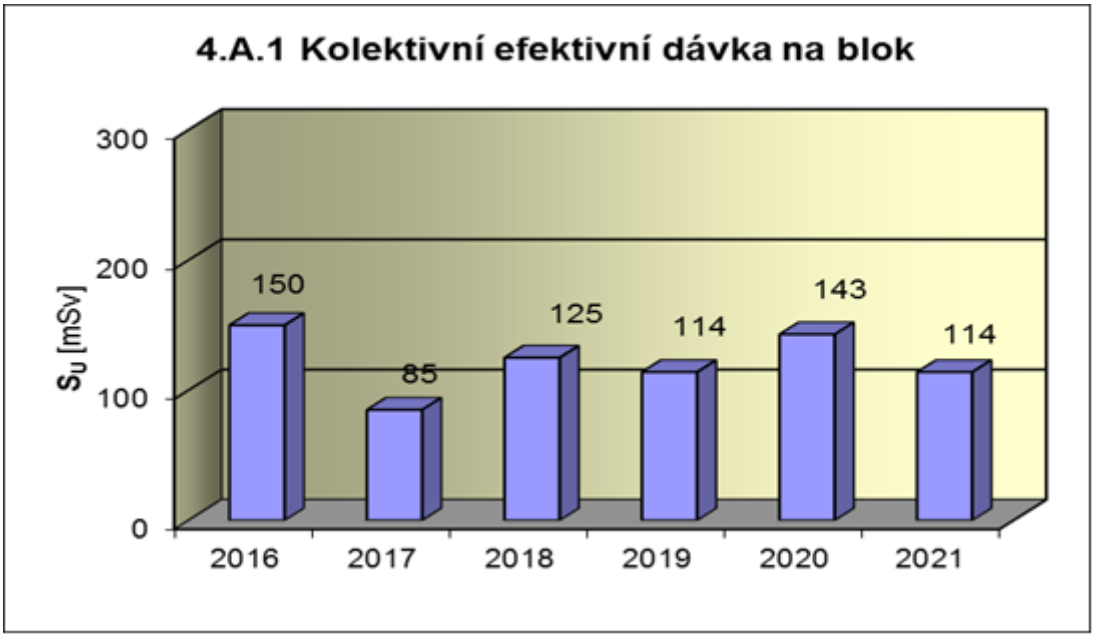
Units 1 – 2

4. Radiation Protection

4.A Staff

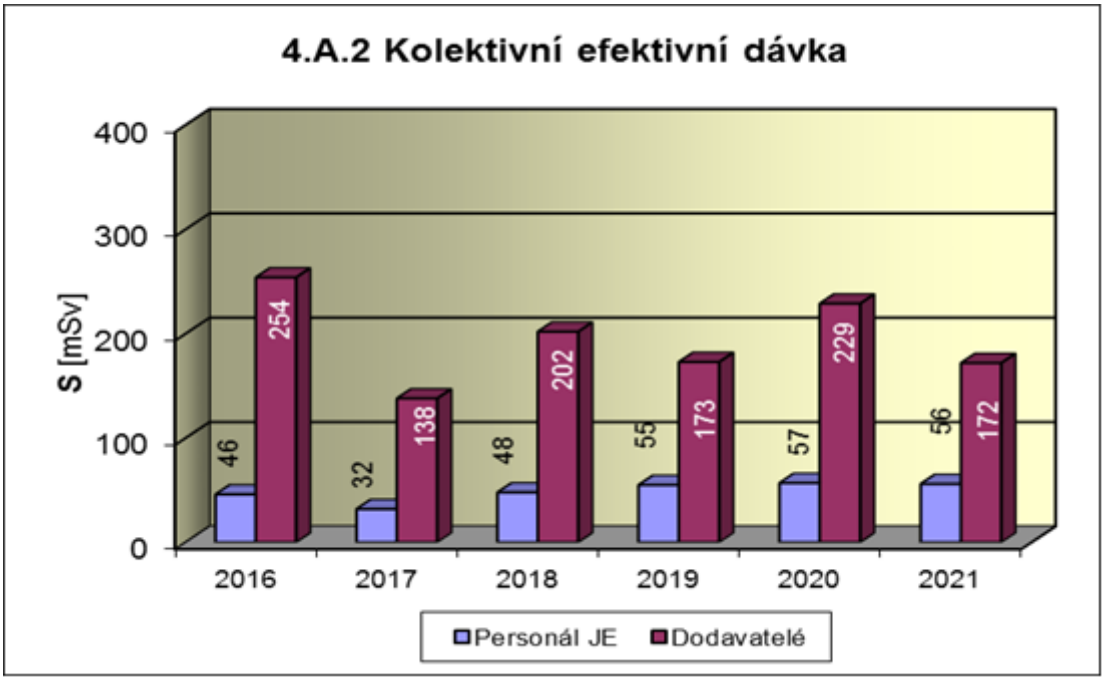
Graph 4.A.1 indicates collective effective dose (CED) received by the staff of NPP (including suppliers and visitors) during monitored period, measured by basic film dosimeters and expressed by mean value per unit.

4.A.1 Collective Effective Dose per Unit



Graph 4.A.2 indicates collective effective dose received by the staff of NPP and suppliers during monitored period, measured by basic film dosimeters.

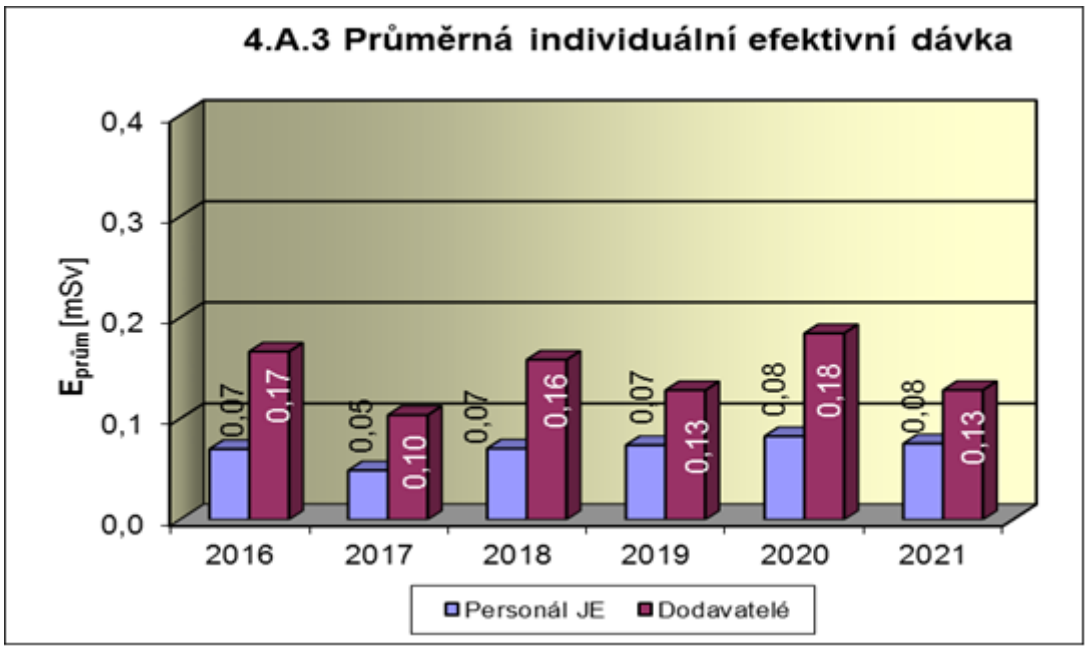
4.A.2 Collective Effective Dose



NPP Staff
Suppliers

Graph 4.A.3 indicates specific collective effective dose received by the staff of NPP and suppliers during monitored period, measured by basic film dosimeters and express by value per one radiation worker.

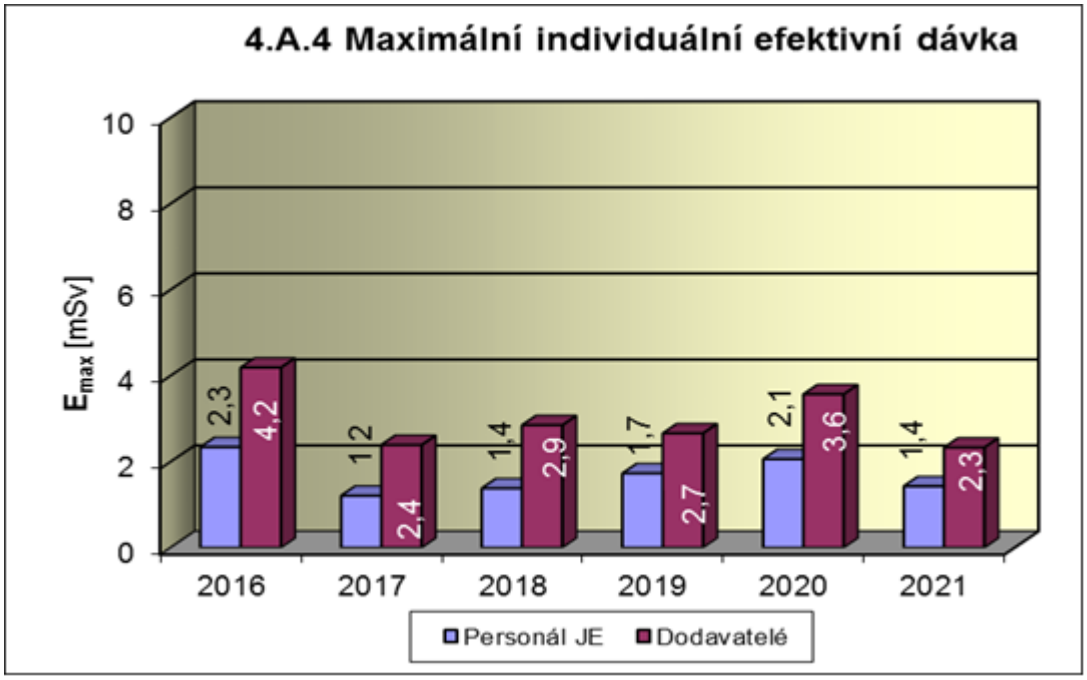
4.A.3 Specific Collective Dose per Capita



NPP Staff
Suppliers

Graph 4.A.4 indicates maximum individual effective dose received by one particular employee of NPP and one particular employee of supplier during monitored period, measured by basic film dosimeters.

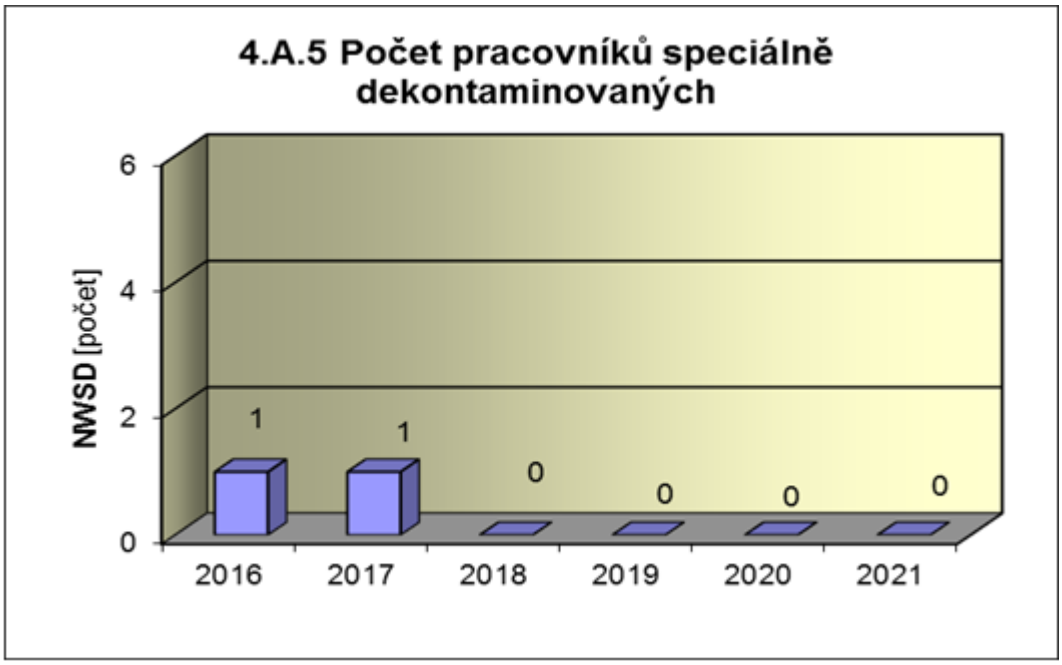
4.A.4 Maximum Individual Effective Dose



NPP Staff
Suppliers

Graph 4.A.5 indicates number of workers (NPP and suppliers) subjected to a special decontamination under medical supervision.

4.A.5 Number of Workers with Special Decontamination

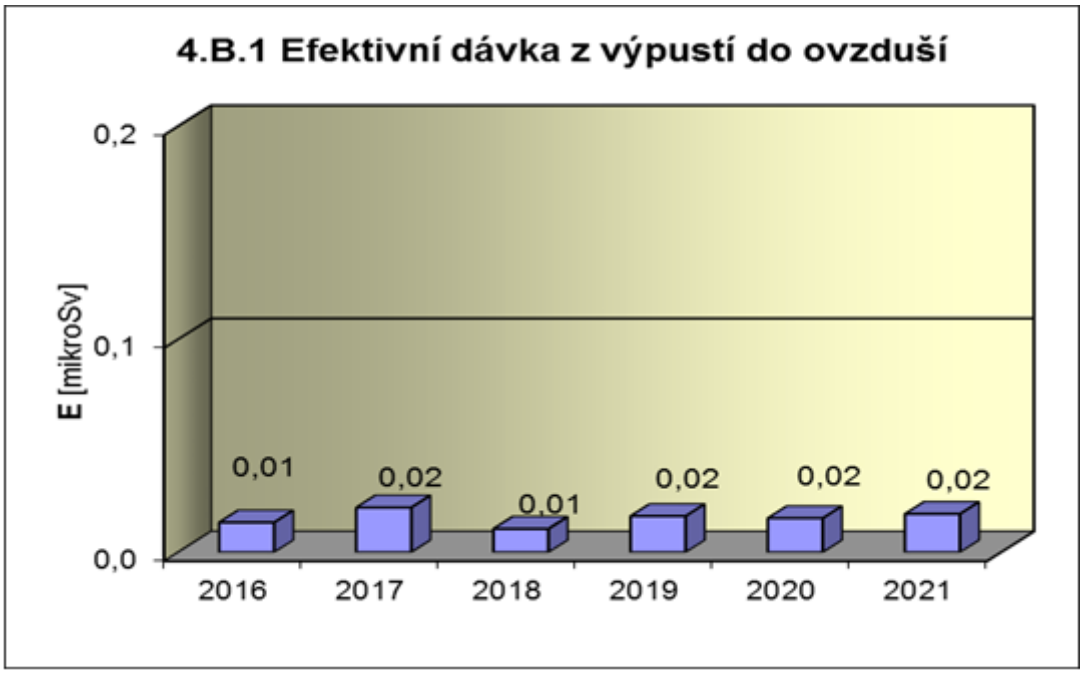


NWSD [number]

4.B Radioactive Releases

Graph 4.B.1 indicates the committed effective dose for an individual, which arises from radioactive gaseous releases from NPP.

4.B.1 Gaseous Releases – Committed Effective Doses



Graph 4.B.2 indicates the committed effective dose for an individual, which arises from radioactive liquid releases from NPP.

4.B.2 Liquid Releases – Committed Effective Doses