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HEAD OF STATE NUCLEAR POWER SAFETY INSPECTORATE

ORDER
ON THE APPROVAL OF NUCLEAR SAFETY GUIDELINES BST-1.5.1-2016 „THE EVALUATION OF COMPLIANCE WITH FREE RELEASE CRITERIA OF BUILDINGS AND SITE SURFACE OF NUCLEAR FACILITIES

20th of December 2016, No. 22.3-206
Vilnius

Pursuant to Part 3 of Article 31 of the Republic of Lithuania Law on Nuclear Power, Point 1 of Article 4 and Point 1 of Article 11 of the Republic of Lithuania Law on Nuclear Safety, point 75 and point 99 of the Nuclear Safety Requirements BSR-1.5.1-2019 “Decommissioning of Nuclear Facilities” approved by Order No. 22.3-216 by the Head of the State Nuclear Safety Inspectorate on 30th November 2015 “On the Approval of the Requirements to Decommissioning of Nuclear Facilities”:

1. **I approve** Nuclear Safety Guidelines BST-1.5.1-201 “The evaluation of compliance with free release criteria of buildings and site surface of nuclear facilities” (attached).
2. **I establish** that the present Order shall enter into force as of 1st May 2017.

Head Michail Demčenko

CONFIRMED by the
Head of State Nuclear Power
Safety Inspectorate
20/12/2016
Order No. 22.3-206

NUCLEAR SAFETY GUIDELINES BST-1.5.1-2016

THE EVALUATION OF COMPLIANCE WITH FREE RELEASE CRITERIA OF BUILDINGS AND SITE SURFACE OF NUCLEAR FACILITIES

SECTION I
GENERAL PROVISIONS

1. Nuclear safety guidelines BST-1.5.1-2016 'The evaluation of compliance with free release criteria of buildings and site surface of nuclear facilities' (further referred to as 'Guidelines') implements legislative requirements outlined in point 5.5 of the Guidelines and specifies the methodology for compliance with free release criteria evaluation of buildings and site surface (further referred to as 'site') of nuclear facilities (further referred to as 'NF').

2. An economic entity (further referred to as 'licensee') engaged in NF decommissioning, has to follow the Guidelines and possess a valid licence to carry out the decommissioning of NF.

3. The methodology of the evaluation of compliance with free release criteria defined in the Guidelines has to be followed during operations of NF, upon completion of dismantling of equipment, decontamination of structures in individual NF buildings and / or in premises, as well as in separate areas of the site.

4. The Guidelines cannot be applied when setting compliance with free release levels of materials, equipment, sub-surface (deeper than 15 cm) soil layer (except in the case stated in point 119 of the Guidelines) or surfaces underneath which are radioactive contaminated engineering networks.

SECTION II
REFERENCES

5. The Guidelines contain references to the following legislations:

5.1. Republic of Lithuania Law on Nuclear Energy;

5.2. Republic of Lithuania Law on Nuclear Safety;

5.3. Republic of Lithuania Law on Radiation Safety;

5.4. Republic of Lithuania Law on Radioactive Waste Management;

5.5. Nuclear safety requirements BSR-1.5.1-2015 'Decommissioning of nuclear facilities' confirmed by the head of State Nuclear Power Safety Inspectorate (further referred to as 'VATESI') on 30th November 2015, order No. 22.3-216 'On the approval of nuclear safety requirements BSR-1.5.1-2019 'Decommissioning of nuclear facilities'';

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5.6. Nuclear safety requirements BSR-1.9.2-2018 'Evaluation and application of materials and waste of radionuclide free release criteria, generated by nuclear activity with sources of ionising radiation', confirmed by the head of VATESI on 27th September 2011, order No. 22.3-90 'On the approval of nuclear safety requirements BSR-1.9.2-2018 'Evaluation and application of materials and waste of radionuclide free release criteria, generated by nuclear activity with sources of ionising radiation'';

Point changes:
No. 22.3-36, 2018-02-07, published TAR 2018-02-07, i. k. 2018-01926

5.7. The procedure of issuing of permits to carry out measurements and surveys of pollutants released into the environment by sources of pollution and pollutants in elements of environment, confirmed by minister of environment of Republic of Lithuania on 30th December 2004, order No. D1-711 'On the approval of the procedure of issuing of permits to carry out measurements and surveys of pollutants released into the environment by sources of pollution and pollutants in elements of environment';

5.8. Lithuanian hygiene standard HN 73:2001 'Main radiation safety standards' confirmed by minister of health of Republic of Lithuania on 21st December 2001, order No. 663 'On the approval of Lithuanian hygiene standard HN 73:2001 'Main radiation safety standards'.

SECTION III
DEFINITIONS

6. The following definitions shall apply to the Guidelines:

6.1. **Derived concentration guideline level –** a derived, radionuclide-specific activity concentration within a survey unit corresponding to the release criteria.

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6.2. **Ionising radiation detection limit** – the minimum detectable concentration of ionising radiation dose rate or surface activity levels.

6.3. **Background reference area** – geographical area from which representative reference measurements are performed for comparison with measurements performed in specific survey units. The background reference area is defined as an area built at the same time and possessing similar physical, chemical, radiological, and biological characteristics as the survey unit(s) being investigated but has not been contaminated by site activities (i.e. non-impacted).

6.4. **Survey unit of the final status radiological survey** – a physical area consisting of structure or land areas or specified size and shape, (i.e. NF site or a part thereof, NF building or a part thereof) for which a separate decision will be made as to whether or not that area exceeds the release criteria. This decision is made as a result of the final status radiological survey.

6.5. **Scanning** – an evaluation technique performed by moving a detection device for ionising radiation over a surface at a specified speed and distance above the surface to detect radiation.

6.6. **Scaling factor –** a factor derived from a mathematical relationship used in calculating the radioactivity of a difficult to measure key nuclide as determined from sampling and analysis data.

6.7. Other definitions applicable in the Guidelines are compliant with terms defined in legislations referred to in subpoints 5.1-5.8 of the Guidelines and other legislations of Republic of Lithuania regulating activities in the nuclear field.

SECTION IV
CLASSIFICATION OF NF BUILDINGS AND SITE, WITH RESPECT TO LEVELS OF RESIDUAL RADIOACTIVITY

7. NF buildings and NF site or a part thereof, with respect to ionising radiation effect and possibility of radioactive contamination, are classified as impacted or non-impacted by ionising radiation.

8. Buildings and site or a part thereof are considered as non-impacted NF building and non-impacted NF site or a part thereof when they comply with all the following conditions:

8.1. based on information collected during historical evaluation or earlier findings of radiological surveys, they have never had any contact with radioactive materials or materials containing radionuclides;

8.2. based on information collected during historical evaluation or earlier findings of radiological surveys, they have always been outside of a controlled zone.

9. Based on information collected during historical evaluation or earlier findings, NF building,

NF site or a part thereof are considered to be impacted by radionuclides if they are or can be contaminated with radionuclides or cannot be assigned as non-impacted by ionisation radiation because of one or more of the following conditions:

9.1. NF building currently is or was in the past assigned to a controlled zone;

9.2. NF building or a part thereof could have been impacted by neutron radiation;

9.3. nuclear and / or other radioactive materials were used in the NF building;

9.4. there is information (records, reports and / or other) that an unusual event took place in the NF building, during which radionuclides accessed or could have had access to the building;

9.5. radioactive materials and / or radioactive waste were kept, sorted, processed or otherwise handled in the NF building;

9.6. decontamination was carried out in the NF building, NF site or a part thereof;

9.7. based on NF site operation history, NF site or a part thereof could have been in the past or could currently be contaminated with radionuclides;

9.8. based on earlier information of radiological measurements, NF building, NF site or a part thereof could have been in the past or could currently be contaminated with radionuclides;

10. NF buildings and NF site or a part thereof impacted by radionuclides is classified into 3 classes by a licensee, based on levels of radionuclide contamination by the procedure outlined in the Guidelines:

10.1. Class 1 – any building on NF site impacted by radionuclides and NF site or a part thereof that could have been contaminated with radionuclides, and complying with at least one of the following conditions:

10.1.1. possible residual radioactivity;

10.1.2. residual radioactivity can be elevated in certain areas more than in other areas;

10.1.3. decontamination was carried out in an NF building, NF site or a part thereof;

10.1.4. lack of data for NF building or NF site to be classified as Class 2 or Class 3;

10.2. Class 2 – any buildings on NF site impacted by radionuclides and NF site or a part thereof that could have been contaminated with radionuclides, and complying with all the following conditions:

10.2.1. residual activity not very likely (taking into account, for example, historical evaluation, findings of radiological surveys and other objective circumstances);

10.2.2. little or no potential for areas of elevated radionuclide activity (taking into account, for example, historical evaluation, findings of radiological surveys and other objective circumstances);

10.2.3. measurement findings comply with free release criteria levels;

10.3. Class 3 – any buildings on NF site impacted by radionuclides and NF site or a part thereof that could have been contaminated with radionuclides, and complying with all the following conditions:

10.3.1. little or no potential for residual radioactivity and / or areas of elevated activity (taking into account, for example, historical evaluation, findings of radiological surveys, and other objective circumstances);

10.3.2. measurement findings do not exceed 10 percent of free release criteria levels stated in a legislation that was specified in subpoint 5.6 of the Guidelines, or 10 percent of conditional radioactive levels stated in a legislation that was specified in subpoint 5.6 of the Guidelines.

11. The whole NF site or a part thereof and NF buildings that could have been contaminated with radionuclides have to be assigned to Class 1, as long as there is no evidence to assign them to Class 2 or Class 3.

12. Assignment of NF buildings and NF site to non-impacted by radionuclides is specified at the final report of decommissioning of NF.

SECTION V
REQUIREMENTS FOR ECONOMIC ENTITITES CARRYING OUT MEASUREMENTS INDICATED IN THE GUIDELINES

13. An economic entity carrying out measurements indicated in the Guidelines has to possess

either a permit to carry out measurements in elements of environment of pollutants released into the environment by sources of pollution issued in accordance with legislation indicated in subpoint 5.7 of the Guidelines, or an accreditation certificate to perform radiological surveys of radionuclides in environmental components to define necessary parameters for specific free release evaluation issued by an accreditation body belonging to a European accreditation organisation.

SECTION VI
HISTORICAL SITE ASSESSMENT

14. An historical site assessment is carried out by a licensee and based on information about NF site and parts thereof, NF operating history, unusual events, NF buildings and their intended purposes, building structures, former and current equipment, and technological processes.

15. The objective of an historical site assessment is to assemble information to allow categorisation of NF site and NF buildings into impacted and non-impacted by radionuclides and taking into account the level of residual radioactivity, thereby assigning them into classes.

16. To conduct an historical site assessment all available information on NF has to be used:

16.1. descriptions and documents of operating technologies;

16.2. building plans, diagrams, drawings, and data on elements of building infrastructure contained within reinforced concrete constructions – piping, ventilation elements, various types of passages and so on;

16.3. data on workplaces, buildings, and environmental monitoring;

16.4. data on nuclear and other radioactive materials and radioactive waste management;

16.5. data on previous radiological measurements and studies;

16.6. data on radiological surveys by state and municipal institutions and / or bodies;

16.7. information about unusual events;

16.8. reports submitted to state and municipal institutions and / or offices;

16.9. transportation routes of nuclear and other radioactive materials and radioactive waste;

16.10. prevailing wind directions on NF site;

16.11. potential contamination sources on the leeward side of the NF site;

16.12. cases of NF site’s soil removal, arrival and transport;

16.13. NF site’s soil storage locations;

16.14. radioactive waste storage locations on NF site;

16.15. information about radioactive discharges accessing the environment;

16.16. records of meetings and interviews with current and former NF employees and personnel that carried out removal of consequences of accidents and incidents.

17. All information has to be collected during an historical site assessment, regardless of: changes to laws governing nuclear and radiation safety, licensee’s normative technical documentation, or the contradictory nature of information itself.

18. All information collected during historical evaluation has to be analysed and evaluated.

19. A preliminary evaluation of which ionising radiation (alpha, beta or gamma – including neutron exposure) has impacted a NF building and / or a part thereof, NF site and / or its territories, has to be conducted according to information about technological processes carried out in NF buildings. In respect to this, a preliminary evaluation of which areas could have been contaminated with radionuclides, what type of radionuclides and what chemical and physical properties of these radionuclides are, has to be conducted as well.

20. To evaluate contamination of short-lived radionuclides, it is necessary to take into account their possible entry time into NF site and NF building, and assess how much the contamination could have decreased due to self-fission of radionuclides.

21. A preliminary classification of NF buildings and NF site that are impacted by ionising radiation, and therefore possibly contaminated with radionuclides, is conducted according to results of the historical site assessment.

SECTION VII
SCOPING SURVEYS

22. To conduct scoping surveys, a scoping survey programme is formed. The results of historical surveys are utilised to compile scoping survey programmes.

23. Scoping surveys are conducted if during an historical site assessment, it is shown that a NF site or a NF building could have been contaminated with or were impacted by radionuclides.

24. Scoping surveys are conducted after an historical site assessment in a manner established in the Guidelines to collect more information in order to revise and specify the preliminary classification of NF buildings, and also to form a programme for characterisation surveys.

25. Objectives of scoping surveys:

25.1. to prepare data that will be used to develop a programme for characterisation survey;

25.2. to revise preliminary classification of NF buildings and NF site;

25.3. to establish a background reference area (that is non-impacted by ionising radiation and not contaminated with radionuclides, as well as being behind NF site perimeter) that could be used as background radiation or to determine unevenness of radionuclide distribution, if radionuclides are present in the background reference area.

26. Ionising radiation gamma dose rate in premises as well as floor and / or other surface general activity measurements are carried out during an execution of scoping surveys.

27. Detection limit of radiological surveys must be established during scoping surveys. Detection limit will be used to determine equipment and procedures of suitable sensitivity to prove that survey units of final status radiological survey comply with free release levels.

28. Measuring points have to be marked in coordinate systems drawn in blueprints;

29. If there are areas that do not comply with free release levels, they all have to be marked in the coordinate system.

30. Results of radiological measurements have to be expressed in same units as free release levels.

31. Results of scoping surveys are reported in such form and scope, which are sufficient to show that the objectives of a scoping survey are reached.

32. In a report of a scoping survey, a licensee has to meet requirements established in section X of the Guidelines, as well as the following information:

32.1. results of direct measurements of ionising radiation gamma dose rates near floors, walls, and ceiling surface of buildings;

32.2. results of direct measurements of general activity of surface contamination;

32.3. assessments of classes of radioactive waste;

32.4. measurement reports and drawings with marked measurement points.

33. If decommissioning, dismantling, radioactive waste management and other work required by the final decommissioning plan of the Nuclear Power Plant are not to be carried out on the basis of the results of the scoping radiological survey, and the data obtained during scoping surveys is chosen to be used as data for final status radiological surveys, the surveys must be conducted according to requirements established for final status radiological surveys within the Guidelines. The programmes of surveys must be submitted for consideration to VATESI under requirements specified in an article 97 of the legislation indicated in subpoint 5.5 of the Guidelines. A report also must be submitted under requirements defined in article 98 of the legislation indicated in subpoint 5.5 of the Guidelines.

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SECTION VIII
CHARACTERISATION SURVEYS

34. Characterisation surveys are conducted after scoping surveys. The main objectives of characterisation surveys are:

34.1. to assess composition and activity of radionuclides;

34.2. to collect information needed to decide on unconditional or conditional application of free release levels to NF building, NF site or a part thereof that are being investigated;

34.3. to collect data needed for technology selection and assessment of a possible decontamination process;

34.4. to obtain information to compose a programme for final status radiological survey.

35. A characterisation survey programme is compiled based on characterisation survey objectives, in accordance with the data of the historical site assessment, and revised according to results of scoping surveys.

36. Data on radionuclide distribution in NF buildings under investigation has to be obtained during characterisation surveys. Unevenness of radionuclide distribution have to be assessed. The number of measurement and sampling points during final status radiological survey have to be established based on this data.

37. Surface or specific gamma activities of surrogate radionuclides ^{60}Co and ^{137}Cs have to be measured during characterisation surveys, and survey units have to be scanned in order to determine areas of elevated residual radioactivity.

38. Analysis methods of characterisation surveys have to be chosen such that results could be provided in units which can express free release levels.

39. A radiological background of survey units must be defined before conducting characterisation surveys. Radiological background is equal to previously established radiological background of reference area. Radiological background is determined performing same radiological measurements of surface of background reference area as are used for survey units.

40. Measurement points have to be clearly specified using a coordinate system. Intervals in the coordinate system cannot be greater than 1-2 metres in buildings and 10-20 metres on site or part thereof.

41. All surface areas of elevated activity found during scanning, must be investigated in order to determine the greatest values of elevated surface general activity.

42. Results of research for each determined elevated surface general activity must be presented in a characterisation survey report.

43. Samples of floors, walls, and ceiling materials of NF buildings have to be taken when:

43.1. results of measurements show elevated radionuclide activity;

43.2. the ratio of surrogate nuclides needs to be determined;

43.3. in other cases, that are not determined in points 43.1, 43.2 – upon licensee's decision.

44. No less than two types of measurements (for example, surface scanning and testing of samples in laboratory) have to be conducted to determine distribution nature of radionuclide contamination.

45. Survey results have to be compared with free release levels. According to this comparison, survey units have to be categorised into these groups:

45.1. complying with free release levels;

45.2. not complying with free release levels.

46. Points of elevated activity found during surveys must be analysed fully and in detail. They can also be investigated further.

47. Based on results of characterisation surveys:

47.1. radionuclides and their distribution in NF buildings, NF site or parts thereof have to be determined;

47.2. ionising radiation gamma dose rate and activity of surrogate radionuclides ^{60}Co and ^{137}Cs have to be measured;

47.3. total activity of radionuclides has to be evaluated;

47.4. decontamination factor needed to achieve free release levels has to be established;

47.5. classification of NF buildings and NF site and parts thereof has to be revised;

47.6. data needed to prepare a decontamination description has to be collected;

47.7. data gathered to prepare a programme for final status radiological surveys has to be prepared.

48. Results of characterisation surveys are reported in such format and scope that is sufficient

to achieve objectives of characterisation surveys.

49. In a characterisation survey report a licensee has to provide information specified in section X of the Guidelines, as well as the following information:

49.1. a list of buildings and sites or parts thereof that are contaminated with radionuclides, their distribution and activity;

49.2. direct measurement results of ionisation radiation gamma dose rate;

49.3. measurement values of surrogate radionuclide activity;

49.4. assessment of radioactive waste quantities and classification;

49.5. measurement reports and drawings with marked points of measurement taking and sampling.

50. If decommissioning, dismantling, radioactive waste management and other work required by the final decommissioning plan of the Nuclear Power Plant are not to be carried out on the basis of the results of the characterisation radiological surveys, and the data obtained during characterisation surveys is chosen to be used as data for final status radiological surveys, the surveys must be conducted according to requirements established for final status radiological surveys within the Guidelines. The programmes of surveys must be submitted for consideration to VATESI under requirements specified in point 97 of the legislation indicated in subpoint 5.5 of the Guidelines. A report also must be submitted under requirements defined in articles 98 of the legislation indicated in subpoint 5.5 of the Guidelines.

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SECTION IX
FINAL STATUS RADIOLOGICAL SURVEYS

PART ONE
GENERAL PROVISIONS FOR COMPILATION OF FINAL STATUS RADIOLOGICAL SURVEY PROGRAMME

51. Final status radiological surveys always have to be conducted before making a decision to terminate radiation safety requirements for NF buildings, NF site or a part thereof.

52. Final status radiological surveys are conducted in accordance with a finals status radiological survey programme. The final status radiological survey programme is based on article 97 of the legislation specified in subpoint 5.5 of the Guidelines and coordinated with VATESI.

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53. Preparation stages of final status radiological survey programmes:

53.1. requirements for data quality received during surveys are formulated;

53.2. NF buildings and site under investigation are allocated to survey units of final status radiological survey based on previous results and classifications;

53.3. a number of samples and measurements needed to prove NF buildings and site compliance with free release levels is determined based on results of previously conducted radiological surveys and requirements of data quality established by the licensee.

53.4. the number of different types of measurements to be performed is determined, including combinations of discrete (spot) and continuous (scanning) measurements;

53.5. means to conduct technical surveys and measurements, which are used to obtain data satisfying quality requirements as is outlined in subpoint 53.1 of the Guidelines, are specified in a final status radiological survey programme.

54. During a final status radiological survey programme, in order to evaluate if survey units of final status radiological survey comply with free release levels according to a statistical method, a licensee has to:

54.1. determine decision error margin;

54.2. formulate null hypothesis (radionuclide activity of survey unit of final status radiological survey does not comply with free release levels).

55. The null hypothesis – 'radionuclide activity of survey unit of final status radiological survey does not comply with free release levels' – has to be approved or rejected in accordance with statistical tests.

56. The likelihood of acceptance of false approval rejection of null hypothesis has to be determined:

56.1. Firs type of error – unjustified rejection of null hypothesis. The probability of accepting this type of error is denoted α and its value is 0,05. In cases where, in view of the β value determined by the licensee, the limit of detection of ionizing radiation by the measuring and scanning devices, the complexity of the subject of the final status radiological surveys (its size, complexity of the building's surface and site relief, unevenness of distribution of contamination by radionuclides, complexity of decontamination, size of decontamination factor and other factors that may influence the results of the final status radiological surveys) it is likely that the inadequacy of the proposed measurements may lead to inadequate radiation protection, and VATESI may reasonably set a lower value for α.VATESI must determine the value of α according to provisions that α value is inversely proportional to the size of β, the higher limit of ionizing radiation detection of the measuring and scanning devices, the size of the area of the subject of the final status radiological surveys; also α value is lowered even more the more uneven terrain, the more unevenly distributed contamination by radionuclides, the more complex the decontamination and the higher the decontamination rate.

56.2. type II error – unfounded approval of null hypothesis. The likelihood of acceptance of this type of error is labelled β and is determined by a licensee during final status radiological survey programme.

57. These statistical tests have to be used in order to evaluate research results of a survey unit of final status radiological survey:

57.1. Wilcoxon Rank Sum (further referred to as WRS) test – when radionuclides that have to be evaluated are present in the background;

57.2. Sign test – when radionuclides that have to be evaluated are not present in the background.

58. If after conducting radiological measurements, radionuclides found to be present in background reference area are the same radionuclides that are present in a survey unit of final status radiological survey, then results obtained from both objects have to be compared using the WRS method. Measurement results are compared with free release levels. If results of any measurement do not comply with free release levels, then additional research of that area has to be conducted, notwithstanding results obtained with WRS test.

59. The objective of final status radiological survey is to prove that NF buildings and site under investigation comply with free release levels.

PART TWO
ALLOCATION OF NF BUILDINGS AND NF SITE TO SURVEY UNITS OF FINAL STATUS RADIOLOGICAL SURVEY

60. Before starting final status radiological surveys, all NF buildings and site under investigation have to be allocated to survey units of final status radiological survey according to classifications and following conditions:

60.1. each survey unit of final status radiological survey of NF site has to have clear parameters – walls, rivers, paths, fences and so on;

60.2. parts of survey unit of final status radiological survey must have similar histories of contamination, decontamination, demolition, radioactive waste management and other work required by the final decommissioning plan of the Nuclear Power Plant;

60.3. survey units of final status radiological surveys must be chosen so that unevenness of measurement results are as small as possible;

60.4. premises can be divided into several survey units of final status radiological survey. These survey units can belong to same or different classes;

60.5. several premises, except Class 1 premises, can be joined into one survey unit of final status radiological survey;

60.6. survey units of final status radiological survey are formed separately and individually for each of Class 1 premises.

61. In order to ensure that a sufficient number of measurements are carried out at each unit of final status radiological survey to evaluate the null hypothesis formulated in accordance with subpoint 54.2 of the Guidelines, the area of unit of the final status radiological survey must be determined:

61.1. an area of a survey unit of final status radiological survey of Class 1 cannot exceed 100 m^2 in buildings and 2000 m^2 on site;

61.2. area of a survey unit of final status radiological survey of Class 2 cannot exceed 1000 m^2 in buildings and 10 000 m^2 on site;

61.3. area of a survey unit of final status radiological survey of Class 3 is not limited.

62. Assignment of a building or site area to a specific survey unit of final status radiological survey has to be conducted in accordance with final status radiological survey programme. The number of data collection points, independent of area of survey unit of final status radiological survey, is determined by statistical methods. Each survey has to be allocated to a single area, which is equal to an area of survey unit of final status radiological survey divided by a number of data collection points.

63. Several survey units of final status radiological survey of the same class and possessing similar properties can be joined into a single large survey unit of final status radiological survey. In this case the overall measurement number and scanning area has to equal measurement numbers and scanning areas of separate survey units. The joining of survey units of final status radiological survey into a single larger survey unit is presented in final status radiological survey programme.

64. Floors of buildings and the lower part of walls can be allocated to Class 1 or Class 2. Ceilings and upper parts of walls can be allocated to a lower class respectively – Class 2 or Class 3. In case of upper or lower parts of walls being allocated to different classes, boundaries for survey units of final status radiological surveys are set at 2 metres above the floor.

PART THREE
BACKGROUND REFERENCE AREA

65. Selection of background reference area is conducted in accordance with the following conditions:

65.1. selected background reference area cannot be situated within NF site and it must not have been previously used for any activities related to potential effects of radioactive materials;

65.2. in cases when it is impossible to find background reference area outside NF site territory, Class 3 buildings or areas impacted by radioactive materials can be used as background reference area, if it is expected that the buildings or areas are free of residual radioactivity. Background reference area cannot be a part of a survey unit;

65.3. in cases when it is impossible to find background reference area corresponding to a survey unit, a part of a survey unit, which has no residual radioactivity, can be used as background reference area;

65.4. soil and woodland of background reference area of a survey unit of final status radiological survey located on site have to correspond to soil and woodland of the survey unit;

65.5. building materials of background reference area of a survey unit of final status radiological survey have to correspond to building materials of the survey unit. Background reference area chosen has to be built from materials of the same origin and / or same builder(s) as the NF building(s);

65.6.the same background reference area can be used for different survey units of final status radiological survey, which can be of different class and smaller than background reference area;

65.7. the size of background reference area should not be smaller than the size of survey unit of final status radiological survey;

65.8. in cases when background reference area of the same size as survey unit of final status radiological survey cannot be found, a smaller size background reference area can be used.

66. Number, locations and measurement methodology of background reference area are established in accordance with the following conditions:

66.1. if background reference area is used for a single survey unit of final status radiological survey, then the number of measurements is set in the order established in the Guidelines and is not lower than the number of measurements conducted in the survey unit;

66.2. if background reference area is used for several survey units of final status radiological survey, then the number of measurements cannot be lower than the number of measurements of a survey unit of final status radiological survey with the highest number of measurements, as is established within the Guidelines;

66.3. measurement locations in background reference area has to be evenly distributed and selected at random or systematically with the first measurement location selected at random;

66.4. measurement methodology and techniques conducted in background reference area have to correspond to measurement methodology and techniques of a survey unit of final status radiological survey.

PART FOUR
ESTABLISHEMENT OF DERIVED CONCENTRATION GUIDELINE LEVEL

67. Derived concentration guideline level (DCGL) of the survey unit of final status radiological survey is calculated in accordance with the following instructions:

67.1. DCGL is calculated for each survey unit of final status radiological survey;

67.2. if a survey unit of final status radiological survey contains only one radionuclide, then DCGL of this radionuclide complies with its free release levels;

67.3. if a survey unit of final status radiological survey contains a mixture of radionuclides and all of them are measured, then DCGL of all the radionuclides must be calculated. The DCGL of all radionuclides must comply with free release condition defined in article 8 of the legislation specified in subpoint 5.6 of the Guidelines;

67.4. if ratio activity of separate radionuclides is not known in gross activity, then the radionuclide with the lowest value of DCGL can be used;

67.5. if only general activity of alpha and beta is measured, not excluding separate types of radionuclides, then general DCGL C_{bendr} is measured using the following equation:

$$C_{bendr} = \frac{1}{\frac{f_1}{C_1}+\frac{f_2}{C_2}+\dots+\frac{f_n}{C_n}},$$

where C_{bendr} – general DCGL for all radionuclides, C_1 – DCGL of first radionuclide, f_1 – a part of first radionuclide activity in general measurement value, C_n – DCGL of nth radionuclide, f_n – a part of n^{th} radionuclide activity in general measurement value;

67.6. if scaling factor is determined in a survey unit of final status radiological survey, then DCGL is calculated only for surrogate radionuclides:

67.7. by estimating the activity of inferred radionuclides, DCGL of surrogate radionuclides is calculated according to the following equation:

$$C_{mbrna} = \frac{1}{\frac{1}{C_{brn}}+\frac{R_1}{C_1}+\dots+\frac{R_n}{C_n}},$$

where C_{brn} – DCGL of surrogate radionuclide, C_1– DCGL of first inferred radionuclide, C_n – DCGL of nth inferred radionuclide, R_1 –ratio of the first inferred radionuclide activity to surrogate radionuclide activity, R_n –ratio of n^{th} inferred radionuclide activity to surrogate radionuclide activity.

PART FIVE
CALCULATION OF RELATIVE CHANGE

68. Relative change (Δ/σ) is calculated using the following equation:

Δ/σ = (C – MTVR)/σ,

where C – DCGL, σ – standard deviation value, MTVR – expected mean value of radionuclide activity measurements, Δ – the difference between DCGL and the expected mean value of radionuclide activity measurements.

69. MTVR is determined under the following conditions:

69.1. determined MTVR value is equal to expected mean value of radionuclide activity measurements of survey unit of final status radiological survey;

69.2. if radionuclide activity measurements are not conducted, then MTVR value can be determined as half of DCGL value.

70. The difference between DCGL and expected mean value of radionuclide activity measurements (Δ) is calculated using the following equation:

$$\Delta = C - MTVR,$$

where C – DCGL, MVTR – expected mean value of radionuclide activity measurements.

71. Standard deviation value *(σ)* is calculated using previous measurements and in accordance with the following conditions:

71.1. if there is only one radionuclide, or only general alpha, beta or gamma emissions, or general alpha and beta emissions are measured, then the standard deviation value is calculated using the following equation:

$$\sigma = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(x_i - x_{vid})^2},$$

where n – a number of values used for calculation, X_i – values used for calculation, X_{vid} – average of those values;

71.2. if there are several types of radionuclides, standard deviation value *(σ)* is calculated using the following equation:

$$\sigma = \sqrt{\frac{{\sigma_1}^2}{{C_1}^2} + \frac{{\sigma_2}^2}{{C_2}^2} + \cdots + \frac{{\sigma_n}^2}{{C_n}^2}},$$

where σ_1 – standard deviation value of first radionuclide, σ_n –standard deviation value of n^{th} radionuclide, C_1 – DCGL of first radionuclide, C_n – DCGL of n^{th} radionuclide;

71.3. only data from measurements conducted in the same survey unit of final status radiological survey is used to calculate standard deviation value. Measurements must be conducted in the entire survey unit and the locations must be distributed equally;

71.4. a single standard deviation value can be set for all survey units of the same class, or a part thereof, if their surface physical, chemical, and biological properties are the same, and buildings are built from the same materials;

71.5. if radiological measurements have not been conducted, then additional measurements can be conducted in a survey unit of final status radiological survey, or by a decision of a licensee that conducting measurements is not necessary and σ value can be set at 0.3.

72. For a pair of WRS test objects, the relative change *(Δ / σ)* must be calculated for each object separately and the lower value used.

PART SIX
CALCULATION OF NUMBER OF MEASUREMENTS IN SURVEY UNIT OF FINAL STATUS RADIOLOGICAL SURVEY

73. The number of measurements *N* for each pair of objects (background reference area and survey unit of final status radiological survey) of WRS method is determined in one out of two approaches – calculated using equation described in point 74 of the Guidelines, or found in a table in Annex I. The number of measurements for each pair of VRSE test items N/2 is given in the table in Annex 1.

74. Equation to calculated number of measurements described in point 73:

$$N = \frac{\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2}{3 \cdot \left(P_r - 0.5\right)^2},$$

where N – number of measurements, $Z_{1-\alpha}$ and $Z_{1-\beta}$ – corresponding percentiles of selected decision error levels α and β respectively, P_r – probability that the difference in measurement results of any locations selected at random in a survey unit of final status radiological survey and any background reference area selected at random complies with free release levels.

75. When calculating the number of measurements in accordance with point 74 of the Guidelines, no less than 20 per cent of the calculated number of measurements must be added to ensure a sufficient amount of data to evaluate the null hypothesis formulated in subpoint 54.2 of the Guidelines.

76. Probability Pr value is found in a table in Annex 2. If calculated relative change Δ/σ is not found in the table in Annex II, then the lowest value in the table is always selected.

77. Percentiles $Z_{1-\alpha}$ and $Z_{1-\beta}$ are found in table in Annex 3.

78. When WRS test is being used, the measurements must be conducted in two objects – survey unit of final status radiological survey and background reference area. Number of measurements must be equal in both objects. Determined number of measurements must be divided by 2 and resulting quotient must be rounded upwards to the nearest whole number. Number of measurements is determined this way in each object.

79. Number of measurements necessary to conduct surveys with Sign test is determined by one out of two approaches – calculated using equation described in point 80 of the Guidelines, or found in a table in Annex 4.

80. Equation to calculated number of measurements described in point 79:

$$N = \frac{\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2}{4\left(Sign\ p - 0{,}5\right)^2}$$

where N – number of measurements, $Z_{1-\alpha}$ and $Z_{1-\beta}$ – corresponding percentiles of selected decision error levels α and β respectively, *Sign p* – calculated probability that measurement results of any at random selected areas of survey unit of final status radiological survey are lower than free release levels, when the median of measurements of a survey unit of final status radiological survey is close to the expected mean value of the radionuclide activity measurements.

81. Probability *Sign p* values are found in a table in Annex 5. If calculated relative change Δ/σ is not found in the table in Annex 5, then the lowest value in the table is always selected.

82. When calculating the number of measurements in accordance with point 80 of the Guidelines, no less than 20 per cent of the calculated number of measurements must be added to ensure a sufficient amount of data to evaluate the null hypothesis formulated in subpoint 54.2 of the Guidelines.

83. Percentiles $Z_{1-\alpha}$ and $Z_{1-\beta}$ values are found in a table in Annex 3.

84. If background reference area is equitable to zero and all measured activity of survey unit of final status radiological survey is assignable to contaminated radionuclides, then Sign method can be used instead of WRS method.

PART SEVEN
ESTABLISHMENT OF COORDINATE SYSTEM

85. A scaled drawing and reference coordinate system of a survey unit of final status radiological survey must be prepared. Maximum dimensions – length X and width Y – of a survey unit of final status radiological survey must be determined as well. Each measurement and sampling location must be identifiable in a selected coordinate system. Accurate identification and registration of all research points is an important component for final status radiological survey and ensures that all measurements can be repeated.

86. Intersections of lines in coordinate systems are not measurement locations.

87. First measurement location for Class 1 and Class 2 survey units of final status radiological survey must be selected at random from a set of 2 numbers (first – X, second – Y coordinates).

Distance between measurement locations L is calculated using the following equation:

87.1. if a grid of coordinate system is a triangle, then:

$$L = \sqrt{\frac{A}{0{,}866 \cdot n}}$$

;

87.2. if a grid of coordinate system is a square, then:

$$L = \sqrt{\frac{A}{n}}$$

,

where A – area of a survey unit of final status radiological survey, n – a number of research locations determined using statistical methods.

88. Research locations of Class 3 survey units of final status radiological survey must be determined at random. They are selected using a combination of 2 random numbers (first – X, second – Y coordinates). Random numbers are selected using a computer or from mathematical tables and must be distributed equally. Each number from a combination of 2 random numbers must be multiplied by respective dimensions of a survey unit of final status radiological survey. Measurement locations with coordinates that appear outside of a survey unit area of final status radiological survey must be changed to other measurement locations, which have been selected by the same means.

PART EIGHT
SELECTION OF MEAUREMENT LOCATIONS. MEASUREMENT IMPLEMENTATION

89. Additional non-statistical measurements must be conducted in areas of possibility of elevated residual radioactivity, which are selected in accordance with the following conditions:

89.1. in buildings – locations of floor drainage, former work locations and nearby locations of screws fastened to the floor, in cracks, crevices, seams and all other locations of elevated radionuclide activity;

89.2. on site – artificial trenches and mounds, animal burrows, locations of cargo handling, wharves, fences and locations of their former presence, areas of surface leakage accumulation and other locations of elevated radionuclide activity;

89.3. in locations of elevated radionuclide activity found during scanning.

90. Statistical control methods do not apply to surface scanning.

91. Detection area of measurement equipment cannot exceed 50% of DCGL for Class 1 and Class 2 final status radiological survey units, and for final status radiological survey units of Class 3 – cannot exceed 10% DCGL.

92. Detection area of scanning equipment cannot exceed DCGL for Class 1 and Class 2 final status radiological survey units, and cannot exceed 10% of DCGL for Class 3 final status radiological survey units.

93. Surface activity measurements of alpha, beta and gamma emissions must be conducted on surface of buildings and radiochemical laboratory tests of samples can be conducted.

94. Residual radioactivity measurements of site surface must be conducted by radiochemical tests of samples.

95. Samples of site surface must be homogenised through the entire layer of soil. Site surface is examined until the depth of 15 cm, therefore samples must be taken from 15 cm depth of soil level.

96. Scanning of building surfaces must be conducted by measuring alpha, beta or gamma emissions, scanning on site – by measuring gamma emissions.

97. The measurement locations for which the measurement results are used for statistical test in final status radiological survey unit area must be evenly distributed and selected at random or systematically with the first measurement location selected at random.

98. When residual radioactivity of a survey unit of final status radiological survey is not distributed equally, one of the methods described in point 57 of the Guidelines must be used to evaluate if radionuclide activity complies with free release levels. Small areas of elevated activity can

be found in a survey unit of final status radiological survey, which must be located and investigate by conducting surface scanning:

98.1. 100% of surface scanning of Class 1 survey units of final status radiological survey must be conducted;

98.2. 50% to 100% of floors and lower parts of walls surface scanning of Class 2 survey units of final status radiological survey and 10% to 50% of upper parts of walls surface and ceiling scanning must be conducted;

98.3. not less than 10% of surface scanning of Class 3 survey units of final status radiological survey must be performed of areas in locations selected at random, which must be distributed equally in a survey unit of final status radiological survey.

99. Measurement and sampling locations of Class 3 survey units of final status radiological survey must be distributed equally throughout the whole survey unit of final status radiological survey and selected according to point 88 of the Guidelines.

100. First measurement location for Class 1 and Class 2 survey units of final status radiological survey must be selected according to random number generator.

101. Coordinate systems must be established for all surfaces of survey units of final status radiological survey i.e., floors, walls, and ceilings.

102. Scanning of Class 3 survey unit of final status radiological survey and its results are evaluated using the following conditions:

102.1. if one or more locations are detected where scan results exceed 10% of the DCGL value, then an amendment to the final status radiological survey program must be submitted to VATESI;

102.2. if there is only one location referred to in subpoint 102.1, then decontamination of that location can be conducted and further final status radiological survey continued in this Class 3 final status radiological survey unit or, at the decision of the licensee, this Class 3 final status radiological survey unit must be reclassified to a higher class and the final status radiological survey must be performed in accordance with requirements of the higher class;

102.3. if there is more than one location referred to in subpoint 102.1, then the whole Class 3 final status radiological survey unit of final status radiological survey must be re-classified to a higher class and final status radiological survey must be conducted according to requirements of the higher class. Decontamination of new final status radiological survey units shall be conducted before starting new final status radiological surveys.

103. Results of scanning of Class 2 survey units of final status radiological survey are evaluated in accordance with the following conditions:

103.1. if one or more locations are detected where scan results exceed DCGL value, then an amendment to the final status radiological survey program must be submitted to VATESI;

103.2. if there is only one location referred to in subpoint 103.1, then decontamination of that location can be conducted and further final status radiological survey continued in this Class 2 final status radiological survey unit or, at the decision of the licensee, this Class 2 final status radiological survey unit must be reclassified to a higher class and the final status radiological survey must be performed in accordance with the requirements of the higher class;

103.3. if there is more than one location referred to in subpoint 103.1, then the whole Class 2 final status radiological survey unit of final status radiological survey must be re-classified to a higher class and final status radiological survey must be conducted according to requirements of the higher class. Decontamination of new final status radiological survey units must be conducted before starting new final status radiological surveys.

104. Results of scanning of Class 1 final status radiological survey units are evaluated in accordance with the following conditions:

104.1. if one or more locations are detected where scan results exceed DCGL value, then an amendment to the final status radiological survey program must be submitted to VATESI;

104.2. if there is only one location referred to in subpoint 104.1, then decontamination of that location can be conducted and further final status radiological survey continued in this Class 1 final status radiological survey unit;

104.3. if there is more than one location referred to in subpoint 104.1, then the decision about

further actions is made in accordance with results of statistical tests as specified in point 117 of the Guidelines.

PART NINE
EVALUATION OF MEASUREMENT RESULTS

105. Measurement data obtained during the final status radiological survey must be submitted in free release level values.

106. All individual measurements data must be compared with DCGL values to identify locations that do not comply with free release levels.

107. If there are areas that do not comply with free release levels, the licensee must decide on further action in accordance with point 117 of the Guidelines. The decision taken by the licensee is reflected in the VATESI final status radiological survey program submission.

108. Only at random and / or systemically selected measurements as per requirements of those tests are used for evaluation of statistical tests.

109. The licensee must verify that the number of measurements made is not less than the test requirements.

110. The average of measurement results must be calculated.

111. Measurement values of highest WRS test survey unit and lowest background reference area must be determined.

112. A survey unit of final status radiological survey does not comply with free release levels if the difference in averages between Sign test measurement results and WRS method measurement results of survey unit and background reference area is higher than maximum allowed surface activity values.

113. A survey unit of final status radiological survey does comply with free release levels and mathematical evaluations of statistical tests do not have to be conducted if all measurement values of a Sign test or a difference in WRS method measurement results between a highest value of a survey unit and a lowest value of background reference area are lower than DCGL values.

114. Mathematical evaluation of statistical tests must be conducted if the average of Sign test measurement values or a difference in averages between survey unit of final status radiological survey and background reference area of WRS method measurement results do not exceed DCGL values, but results from individual measurements or scans exceed this value.

115. Evaluation of Sign test results is conducted according to the following conditions:

115.1. overall number of measurements of statistical tests must be calculated;

115.2. the number of measurements with results that are lower than DCGL values S must be calculated;

115.3. the number of measurements with results that comply with DCGL values must be calculated. This number is used to lower the overall measurement number of statistical tests $N = N_0 - N_1$;

115.4. In the table in Annex 6 of the Guidelines, it must be checked that the S value exceeds the critical value. If the S value is above critical, then the null hypothesis must be rejected based on the results of the statistical test and a decision must be made in accordance with point 117 of the Guidelines regarding the locations where the measured or scanned results exceed DCGL activity. The decision taken by the licensee is reflected in the VATESI final status radiological survey program submission;

116. Evaluation of WRS test results is conducted in the following order:

116.1. DCGL value must be added to each background reference area measurement;

116.2. the background measurement results corrected in accordance with subpoint 116.1 of the Guidelines must be aggregated with results of the final status radiological survey measurement;

116.3. the results of a set of measurements made in accordance with subpoint 116.2 must be transcribed in sequence from lowest to highest and numbered. Each measurement result is assigned a rank, which is equal to its number. If several measurement results are of the same value, a rank assigned to them is equal to the average of their numbers;

116.4. a sum of background reference area measurement ranks W_r must be calculated;

116.5. In the table in Annex 7 of the Guidelines, it must be checked that the Wr value exceeds the critical value. If the Wr value is above critical, then the null hypothesis, formulated in accordance with subpoint 54.2 of the Guidelines must be rejected based on the results of the statistical test and a decision must be made in accordance with point 117 of the Guidelines regarding the locations where the measured or scanned results exceed DCGL activity. The decision made by the licensee is reflected in the VATESI final status radiological survey program submission;

117. If the number of measurement and scanning areas that exceed DCGL is equal to or lower than 5% of the number of measurement N of statistical tests and, based on the results of the statistical test, rejected the null hypothesis formulated in accordance with subpoint 54.2 of the Guidelines, then decontamination of areas that exceed DCGL and additional measurements of those areas can be conducted in coordination with VATESI according to alterations of final status radiological survey programme specified in point 54 of the Guidelines. If the number of such areas exceeds 5% of the number of measurements N of statistical tests, then the whole survey unit of final status radiological survey must be decontaminated and afterwards a new final status radiological survey of a Class 1 object must be conducted.

118. If the S value calculated under point 115 of the Guidelines is less than or equal to the critical value given in the table (Annex 6), or if the Wr value calculated under point 116 of the Guidelines is less than or equal to the critical value stated in the table (Annex 7) the results must be confirmed by the null hypothesis formulated in accordance with subpoint 54.2 of the Guidelines and the decontamination, radioactive waste management work must be performed on the final status radiological survey unit and must be followed by new final status radiological survey of the Class 1 final status radiological survey unit.

PART TEN
ADDITIONAL CONDITIONS TO CONDUCT FINAL STATUS RADIOLOGICAL SURVEY ACCORDING TO THE GUIDELINES

119. If sub-surface distribution of residual radioactivity is equal, then sub-surface soil layer can be examined in order specified in these Guidelines, and in accordance with the following conditions:

119.1. the number of measurements are determined by requirements of a Sign or WRS tests;

119.2. surface and sub-surface tests must be conducted separately, sampling places of both tests must be selected separately, and same samples cannot be used to conduct the tests;

119.3. if data obtained after an historical site assessment or radiological survey states that elevated radionuclide activity locations are possible in sub-surface soil layer, then the number of measurements must be increased so an area of elevated sub-surface activity locations is smaller than an area of 4 sampling locations.

120. These Guidelines do not apply to residual radioactivity measurements of bodies of water. If a body of water is placed within the larger survey unit of final status radiological survey, then sediment samples are taken from the bed of the body of water in measurement locations identified for that body of water, without regard to the water itself.

121. If residual radioactivity of rocks, crevices, rubble, debris and wreckage does not differ from surrounding areas of survey unit of final status radiological survey, they can be investigated in conjunction with the whole survey unit of final status radiological survey.

PART ELEVEN
REPORT OF FINAL STATUS RADIOLOGICAL SURVEY

122. A report of final status radiological survey is prepared and coordinated with VATESI in accordance with article 98 of legislation specified in subpoint 6.4 of the Guidelines.

Point changes:

No. 22.3-18, 2019-01-23, published TAR 2019-01-23, i. k. 2019-01022

123. Results of final status radiological survey must be reported in such form and scope that is sufficient to achieve the objectives of final status radiological survey and the data could be used to

conduct verification radiological survey of a survey unit of final status radiological survey. Verification radiological survey is intended to verify the accuracy of the conducted surveys.

124. Besides the information specified in section X of the Guidelines, in a report f final status radiological survey the following data must be provided:

124.1. description and locations of survey units of final status radiological surveys;

124.2. applied values of free release levels;

124.3. results of direct measurements of ionising radiation gamma dose;

124.4. results of surrogate radionuclide activity measurements;

124.5. results of measurements or samples taken:

124.6. distribution of residual radioactivity in survey units of final status radiological surveys;

124.7. drawings of survey units of final status radiological surveys with reference grid and marked points of measurements and sampling;

124.8. information necessary to conduct verification radiological survey of a survey unit of final status radiological survey;

124.9. information pertaining to determination of the number of measurements;

124.10. a protocol on how to determine the first measurement location in Class 1 and Class 2 survey units of final status radiological survey;

124.11. a protocol on selection of final status radiological survey measurement locations in Class 3 objects;

124.12. a report on calculation of the average of measurement results, median and standard deviation;

124.13. information pertaining to administering statistical tests (if they had been conducted).

125. An evaluation of whether a survey unit of final status radiological survey complies with free release levels must be submitted in a report of final status radiological survey.

SECTION X
REQUIREMENTS FOR RADIOLOGICAL SURVEY REPORTS

126. The licensee must provide the following information in all radiological survey reports:

126.1. references to all legislations on which basis the radiological survey was conducted;

126.2. radiological survey date;

126.3. initial radiological condition of survey units;

126.4. information about what radionuclides and parameters were measured;

126.5. descriptions of measurement methods;

126.6. information about what equipment and devices were used for measurements and their technical characteristics;

126.7. a detailed description of decontamination activities, control methods and means, raised objectives, and results achieved (if a decontamination of a survey unit had been conducted);

126.8. information about sources of the object’s radionuclide contamination;

126.9. information about radionuclide composition in residual radioactivity (if it had been determined), nuclide vector and its analysis;

126.10. information about radionuclide composition in residual radioactivity (if it had been determined), scaling factor and its analysis;

126.11. if radionuclide composition and scaling factor have not been determined, justification as to why they had not been determined;

126.12. classification of survey units;

126.13. basis for survey unit re-classification;

126.14. decontamination factor values of survey units, which are necessary to achieve free release levels (if it is evaluated);

126.15. other information characterising radiological state of an object;

126.16. findings of the surveys.

SECTION XI
FINAL PROVISIONS

127. Persons who violate provisions of the Guidelines must be held responsible according to the laws of the Republic of Lithuania.

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DETERMINATION OF THE MINIMUM NUMBER OF THE MEASUREMENTS N/2 OF THE WRS STATISTICAL TEST

Δ/σ	α = 0,01			
	β			
	0,01	0,025	0,05	0,1
0,1	5452	4627	3972	3278
0,2	1370	1163	998	824
0,3	614	521	448	370
0,4	350	297	255	211
0,5	227	193	166	137
0,6	161	137	117	97
0,7	121	103	88	73
0,8	95	81	69	57
0,9	77	66	56	47
1,0	64	55	47	39
1,1	55	47	40	33
1,2	48	41	35	29
1,3	43	36	31	26
1,4	38	32	28	23
1,5	35	30	25	21
1,6	32	27	23	19
1,7	30	25	22	18
1,8	28	24	20	17
1,9	26	22	19	16
2,0	25	21	18	15
2,25	22	19	16	14
2,5	21	18	15	13
2,75	20	17	15	12
3.0	19	16	14	12
3,5	18	16	13	11
4,0	18	15	13	11

	α = 0,025			
	β			
	0,01	0,025	0,05	0,1
0,1	4627	3870	3273	2646
0,2	1163	973	823	665
0,3	521	436	369	298
0,4	297	248	210	170
0,5	193	162	137	111
0,6	137	114	97	78
0,7	103	86	73	59
0,8	81	68	57	46
0,9	66	55	46	38
1,0	55	46	39	32
1,1	47	39	33	27
1,2	41	34	29	24
1,3	36	30	26	21
1,4	32	27	23	19
1,5	30	25	21	17
1,6	27	23	19	16
1,7	25	21	18	15
1,8	24	20	17	14
1,9	22	19	16	13
2,0	21	18	15	12
2,25	19	16	14	11
2,5	18	15	13	10
2,75	17	14	12	10
3.0	16	14	12	10
3,5	16	13	11	9
4,0	15	13	11	9
	α = 0,05			
	β			
	0,01	0,025	0,05	0,1
0,1	3972	3273	2726	2157
0,2	998	823	685	542
0,3	448	369	307	243

0,4	255	210	175	139
0,5	166	137	114	90
0,6	117	97	81	64
0,7	88	73	61	48
0,8	69	57	48	38
0,9	56	46	39	31
1,0	47	39	32	26
1,1	40	33	28	22
1,2	35	29	24	19
1,3	31	26	22	17
1,4	28	23	19	15
1,5	25	21	18	14
1,6	23	19	16	13
1,7	22	18	15	12
1,8	20	17	14	11
1,9	19	16	13	11
2,0	18	15	13	10
2,25	16	14	11	9
2,5	15	13	11	9
2,75	15	12	10	8
3.0	14	12	10	8
3,5	13	11	9	8
4,0	13	11	9	7
	$\alpha = 0,1$			
	β			
	0,01	0,025	0,05	0,1
0,1	3278	2646	2157	1655
0,2	824	665	542	416
0,3	370	298	243	187
0,4	211	170	139	106
0,5	137	111	90	69
0,6	97	78	64	49
0,7	73	59	48	37
0,8	57	46	38	29
0,9	47	38	31	24

1,0	39	32	26	20
1,1	33	27	22	17
1,2	29	24	19	15
1,3	26	21	17	13
1,4	23	19	15	12
1,5	21	17	14	11
1,6	19	16	13	10
1,7	18	15	12	9
1,8	17	14	11	9
1,9	16	13	11	8
2,0	15	12	10	8
2,25	14	11	9	7
2,5	13	10	9	7
2,75	12	10	8	6
3.0	12	10	8	6
3,5	11	9	8	6
4,0	11	9	7	6
	$\alpha = 0,25$			
	β			
	0,01	0,025	0,05	0,1
0,1	2268	1748	1355	964
0,2	570	440	341	243
0,3	256	197	153	109
0,4	146	112	87	62
0,5	95	73	57	41
0,6	67	52	40	29
0,7	51	39	30	22
0,8	40	31	24	17
0,9	32	25	20	14
1,0	27	21	16	12
1,1	23	18	14	10
1,2	20	16	12	9
1,3	18	14	11	8
1,4	16	13	10	7
1,5	15	11	9	7

1,6	14	11	8	6
1,7	13	10	8	6
1,8	12	9	7	5
1,9	11	9	7	5
2,0	11	8	7	5
2,25	10	8	6	4
2,5	9	7	6	4
2,75	9	7	5	4
3.0	8	6	5	4
3,5	8	6	5	4
4,0	8	6	5	4

The table shows the number of measurements required for the WRS test, including a 20 percent increase in accordance with the provisions of point 75 of the Nuclear Safety Guidelines BST-1.5.1-2016, „The evaluation of compliance with free release criteria of buildings and site surface of nuclear facilities“.

Nuclear Safety Guidelines BST-1.5.1-2016 'The evaluation of compliance with free release criteria of buildings and site surface of nuclear facilities'
Annex 2

VALUED OF *Pr* PROBABILITY

Δ/σ	P_r	Δ/σ	P_r
0,1	0,528182	1,4	0,838864
0,2	0,556223	1,5	0,855541
0,3	0,583985	1,6	0,871014
0,4	0,611335	1,7	0,885299
0,5	0,638143	1,8	0,898420
0,6	0,664290	1,9	0,910413
0,7	0,689665	2,0	0,921319
0,8	0,714167	2,25	0,944167
0,9	0,737710	2,5	0,961428
1,0	0,760217	2,75	0,974067
1,1	0,781627	3,0	0,983039
1,2	0,801892	3,5	0,993329
1,3	0,820978	4,0	0,997658

If the table does not contain the Δ/σ values calculated in accordance with point 68 of the Nuclear Safety Guidelines BST-1.5.1-2016, „The evaluation of compliance with free release criteria of buildings and site of nuclear facilities", then the nearest value in the table, lower than calculated value shall be used .

VALUES OF $Z_{1-\alpha}$ AND $Z_{1-\beta}$ PERCENTILES

α (or β)	$Z_{1-\alpha}$ (or $Z_{1-\beta}$)	α (or β)	$Z_{1-\alpha}$ (or $Z_{1-\beta}$)
0,005	2,576	0,1	1,282
0,01	2,326	0,15	1,036
0,015	2,241	0,2	0,842
0,025	1,960	0,25	0,674
0,05	1,645	0,3	0,524

DETERMINATION OF THE MINIMUM NUMBER OF THE MEASUREMENTS OF THE SIGN STATISTICAL TEST

Δ/σ	α = 0,01			
	β			
	0,01	0,025	0,05	0,1
0,1	4095	3476	2984	2463
0,2	1035	879	754	623
0,3	468	398	341	282
0,4	270	230	197	162
0,5	178	152	130	107
0,6	129	110	94	77
0,7	99	83	72	59
0,8	80	68	58	48
0,9	66	57	48	40
1,0	57	48	41	34
1,1	50	42	36	30
1,2	45	38	33	27
1,3	41	35	30	26
1,4	38	33	28	23
1,5	35	30	27	22
1,6	34	29	24	21
1,7	33	28	24	20
1,8	32	27	23	20
1,9	30	26	22	18
2,0	29	26	22	18
2,5	28	23	21	17
3,0	27	23	20	17
	α = 0,025			
	β			
	0,01	0,025	0,05	0,1
0,1	3476	2907	2459	1989

0,2	879	735	622	503
0,3	398	333	281	227
0,4	230	192	162	131
0,5	152	126	107	87
0,6	110	92	77	63
0,7	83	70	59	48
0,8	68	57	48	39
0,9	57	47	40	33
1,0	48	40	34	28
1,1	42	35	30	24
1,2	38	32	27	22
1,3	35	29	24	21
1,4	33	27	23	18
1,5	30	26	22	17
1,6	29	24	21	17
1,7	28	23	20	16
1,8	27	22	20	16
1,9	26	22	18	15
2,0	26	21	18	15
2,5	23	20	17	14
3.0	23	20	17	14
	$\alpha = 0,05$			
	β			
	0,01	0,025	0,05	0,1
0,1	2984	2459	2048	1620
0,2	754	622	518	410
0,3	341	281	234	185
0,4	197	162	136	107
0,5	130	107	89	71
0,6	94	77	65	52
0,7	72	59	50	40
0,8	58	48	40	32
0,9	48	40	34	27
1,0	41	34	29	23
1,1	36	30	26	21

1,2	33	27	23	18
1,3	30	24	21	17
1,4	28	23	20	16
1,5	27	22	18	15
1,6	24	21	17	14
1,7	24	20	17	14
1,8	23	20	16	12
1,9	22	18	16	12
2,0	22	18	16	12
2,5	21	17	15	11
3.0	20	17	14	11
	$\alpha = 0,1$			
	β			
	0,01	0,025	0,05	0,1
0,1	2463	1989	1620	1244
0,2	623	503	410	315
0,3	282	227	185	143
0,4	162	131	107	82
0,5	107	87	71	54
0,6	77	63	52	40
0,7	59	48	40	30
0,8	48	39	32	24
0,9	40	33	27	21
1,0	34	28	23	18
1,1	30	24	21	16
1,2	27	22	18	15
1,3	26	21	17	14
1,4	23	18	16	12
1,5	22	17	15	11
1,6	21	17	14	11
1,7	20	16	14	10
1,8	20	16	12	10
1,9	18	15	12	10
2,0	18	15	12	10
2,5	17	14	11	9

3.0	17	14	11	9
	α = 0,25			
	β			
	0,01	0,025	0,05	0,1
0,1	1704	1313	1018	725
0,2	431	333	258	184
0,3	195	150	117	83
0,4	113	87	68	48
0,5	75	58	45	33
0,6	54	42	33	23
0,7	41	33	26	18
0,8	34	26	21	15
0,9	28	22	17	12
1,0	24	18	15	11
1,1	21	17	14	10
1,2	20	15	12	9
1,3	17	14	11	8
1,4	16	12	10	8
1,5	15	12	10	8
1,6	15	11	9	6
1,7	14	11	9	6
1,8	14	11	9	6
1,9	14	10	9	6
2,0	12	10	8	6
2,5	12	10	8	5
3.0	12	9	8	5

The table shows the number of measurements required for the sign test, including a 20 percent increase in accordance with the provisions of point 82 of the Nuclear Safety Guidelines BST-1.5.1-2016, „The evaluation of compliance with free release criteria of buildings and site surface of nuclear facilities“.

VALUES OF *Sign p* PROBABILITY

Δ/σ	Sign p	Δ/σ	Sign p
0,1	0,539828	1,2	0,884930
0,2	0,579260	1,3	0,903199
0,3	0,617911	1,4	0,919243
0,4	0,655422	1,5	0,933193
0,5	0,691462	1,6	0,945201
0,6	0,725747	1,7	0,955435
0,7	0,758036	1,8	0,964070
0,8	0,788145	1,9	0,971284
0,9	0,815940	2,0	0,977250
1,0	0,841345	2,5	0,993790
1,1	0,864334	3,0	0,998650

If $\Delta/\sigma > 3,0$, then *Sign p* = 1,000000.

CRITICAL VALUES S FOR THE SIGN TEST

N	α							
	0,005	0,01	0,025	0,05	0,1	0,2	0,3	0,4
4	4	4	4	4	3	3	3	2
5	5	5	5	4	4	3	3	3
6	6	6	5	5	5	4	4	3
7	7	6	6	6	5	5	4	4
8	7	7	7	6	6	5	5	4
9	8	8	7	7	6	6	5	5
10	9	9	8	8	7	6	6	5
11	10	9	9	8	8	7	6	6
12	10	10	9	9	8	7	7	6
13	11	11	10	9	9	8	7	7
14	12	11	11	10	9	9	8	7
15	12	12	11	11	10	9	9	8
16	13	13	12	11	11	10	9	9
17	14	13	12	12	11	10	10	9
18	14	14	13	12	12	11	10	10
19	15	14	14	13	12	11	11	10
20	16	15	14	14	13	12	11	11
21	16	16	15	14	13	12	12	11
22	17	16	16	15	14	13	12	12
23	18	17	16	15	15	14	13	12
24	18	18	17	16	15	14	13	13
25	19	18	17	17	16	15	14	13
26	19	19	18	17	16	15	14	14
27	20	19	19	18	17	16	15	14
28	21	20	19	18	17	16	15	15
29	21	21	20	19	18	17	16	15
30	22	21	20	19	19	17	16	16
31	23	22	21	20	19	18	17	16
32	23	23	22	21	20	18	17	17
33	24	23	22	21	20	19	18	17
34	24	24	23	22	21	19	19	18
35	25	24	23	22	21	20	19	18
36	26	25	24	23	22	21	20	19
37	26	26	24	23	22	21	20	19
38	27	26	25	24	23	22	21	20
39	27	27	26	25	23	22	21	20
40	28	27	26	25	24	23	22	21
41	29	28	27	26	25	23	22	21
42	29	28	27	26	25	24	23	22
43	30	29	28	27	26	24	23	22
44	30	30	28	27	26	25	24	23
45	31	30	29	28	27	25	24	23
46	32	31	30	29	27	26	25	24

47	32	31	30	29	28	26	25	24
48	33	32	31	30	28	27	26	25
49	33	33	31	30	29	27	26	25
50	34	33	32	31	30	28	27	26

If *N* is bigger than 50, then *S* must be calculated using the following equation:

$$S = \frac{N}{2} + \frac{z}{2}\sqrt{N},$$

where $z - (1-\alpha)$ percentile whose meaning can be found in a table in Annex 3 of Nuclear Safety Guidelines BST-1.5.1-2016 'The evaluation of compliance with free release criteria of buildings and site surface of nuclear facilities', N – number of measurements whose results are not equal to the DCGL, S – critical value for measurement below the DCGL.

Wr CRITICAL CALUES OF WRS STATISTICAL TEST

m	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
2	α																			
	0,001	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35	37	39	41	43
	0,005	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35	37	39	40	42
	0,01	7	9	11	13	15	17	19	21	23	25	27	28	30	32	34	36	38	39	41
	0,025	7	9	11	13	15	17	18	20	22	23	25	27	29	31	33	34	36	38	40
	0,05	7	9	11	12	14	16	17	19	21	23	24	26	27	29	31	33	34	36	38
	0,1	7	8	10	11	13	15	16	18	19	21	22	24	26	27	29	30	32	33	35
m	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
3	α																			
	0,001	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	56	59	62	65
	0,005	12	15	18	21	24	27	30	32	35	38	40	43	46	48	51	54	57	59	62
	0,01	12	15	18	21	24	26	29	31	34	37	39	42	45	47	50	52	55	58	60
	0,025	12	15	18	20	22	25	27	30	32	35	37	40	42	45	47	50	52	55	57
	0,05	12	14	17	19	21	24	26	28	31	33	36	38	40	43	45	47	50	52	54
	0,1	11	13	16	18	20	22	24	27	29	31	33	35	37	40	42	44	46	48	50
m	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
4	α																			
	0,001	18	22	26	30	34	38	42	46	49	53	57	60	64	68	71	75	78	82	86
	0,005	18	22	26	30	33	37	40	44	47	51	54	58	61	64	68	71	75	78	81
	0,01	18	22	26	29	32	36	39	42	46	49	52	56	59	62	66	69	72	76	79
	0,025	18	22	25	28	31	34	37	41	44	47	50	53	56	59	62	66	69	72	75
	0,05	18	21	24	27	30	33	36	39	42	45	48	51	54	57	59	62	65	68	71
	0,1	17	20	22	25	28	31	34	36	39	42	45	48	50	53	56	59	61	64	67
m	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
5	α																			
	0,001	25	30	35	40	45	50	54	58	63	67	72	76	81	85	89	94	98	102	107
	0,005	25	30	35	39	43	48	52	56	60	64	68	72	77	81	85	89	93	97	101
	0,01	25	30	34	38	42	46	50	54	58	62	66	70	74	78	82	86	90	94	98

	0,025	25	29	33	37	41	44	48	52	56	60	63	67	71	75	79	82	86	90	94
	0,05	24	28	32	35	39	43	46	50	53	57	61	64	68	71	75	79	82	86	89
	0,1	23	27	30	34	37	41	44	47	51	54	57	61	64	67	71	74	77	81	84

m	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
6	α																			
	0,001	33	39	45	51	57	63	67	72	77	82	88	93	98	103	108	113	118	123	128
	0,005	33	39	44	49	54	59	64	69	74	79	83	88	93	98	103	107	112	117	122
	0,01	33	39	43	48	53	58	62	67	72	77	81	86	91	95	100	104	109	114	118
	0,025	33	37	42	47	51	56	60	64	69	73	78	82	87	91	95	100	104	109	113
	0,05	32	36	41	45	49	54	58	62	66	70	75	79	83	87	91	96	100	104	108
	0,1	31	35	39	43	47	51	55	59	63	67	71	75	79	83	87	91	94	98	102
m	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
7	α																			
	0,001	42	49	56	63	69	75	81	87	92	98	104	110	116	122	128	133	139	145	151
	0,005	42	49	55	61	66	72	77	83	88	94	99	105	110	116	121	127	132	138	143
	0,01	42	48	54	59	65	70	76	81	86	92	97	102	108	113	118	123	129	134	139
	0,025	42	47	52	57	63	68	73	78	83	88	93	98	103	108	113	118	123	128	133
	0,05	41	46	51	56	61	65	70	75	80	85	90	94	99	104	109	113	118	123	128
	0,1	40	44	49	54	58	63	67	72	76	81	85	90	94	99	103	108	112	117	121
m	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
8	α																			
	0,001	52	60	68	75	82	89	95	102	109	115	122	128	135	141	148	154	161	167	174
	0,005	52	60	66	73	79	85	92	98	104	110	116	122	129	135	141	147	153	159	165
	0,01	52	59	65	71	77	84	90	96	102	108	114	120	125	131	137	143	149	155	161
	0,025	51	57	63	69	75	81	86	92	98	104	109	115	121	126	132	137	143	149	154
	0,05	50	56	62	67	73	78	84	89	95	100	105	111	116	122	127	132	138	143	148
	0,1	49	54	60	65	70	75	80	85	91	96	101	106	111	116	121	126	131	136	141
m	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
9	α																			
	0,001	63	72	81	88	96	104	111	118	126	133	140	147	155	162	169	176	183	190	198
	0,005	63	71	79	86	93	100	107	114	121	127	134	141	148	155	161	168	175	182	188
	0,01	63	70	77	84	91	98	105	111	118	125	131	138	144	151	157	164	170	177	184
	0,025	62	69	76	82	88	95	101	108	114	120	126	133	139	145	151	158	164	170	176

	0,05	61	67	74	80	86	92	98	104	110	116	122	128	134	140	146	152	158	164	170
	0,1	60	66	71	77	83	89	94	100	106	112	117	123	129	134	140	145	151	157	162

m	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	α																			
	0,001	75	85	94	103	111	119	128	136	144	152	160	167	175	183	191	199	207	215	222
	0,005	75	84	92	100	108	115	123	131	138	146	153	160	168	175	183	190	197	205	212
10	0,01	75	83	91	98	106	113	121	128	135	142	150	157	164	171	178	186	193	200	207
	0,025	74	81	89	96	103	110	117	124	131	138	145	151	158	165	172	179	186	192	199
	0,05	73	80	87	93	100	107	114	120	127	133	140	147	153	160	166	173	179	186	192
	0,1	71	78	84	91	97	103	110	116	122	128	135	141	147	153	160	166	172	178	184
m	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	α																			
	0,001	88	99	109	118	127	136	145	154	163	171	180	188	197	206	214	223	231	240	248
	0,005	88	98	107	115	124	132	140	148	157	165	173	181	189	197	205	213	221	229	237
11	0,01	88	97	105	113	122	130	138	146	153	161	169	177	185	193	200	208	216	224	232
	0,025	87	95	103	111	118	126	134	141	149	156	164	171	179	186	194	201	208	216	223
	0,05	86	93	101	108	115	123	130	137	144	152	159	166	173	180	187	195	202	209	216
	0,1	84	91	98	105	112	119	126	133	139	146	153	160	167	173	180	187	194	201	207
m	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	α																			
	0,001	102	114	125	135	145	154	164	173	183	192	202	210	220	230	238	247	256	266	275
	0,005	102	112	122	131	140	149	158	167	176	185	194	202	211	220	228	237	246	254	263
12	0,01	102	111	120	129	138	147	156	164	173	181	190	198	207	215	223	232	240	249	257
	0,025	100	109	118	126	135	143	151	159	168	176	184	192	200	208	216	224	232	240	248
	0,05	99	108	116	124	132	140	147	155	165	171	179	186	194	202	209	217	225	233	240
	0,1	97	105	113	120	128	135	143	150	158	165	172	180	187	194	202	209	216	224	231
m	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	α																			
	0,001	117	130	141	152	163	173	183	193	203	213	223	233	243	253	263	273	282	292	302
	0,005	117	128	139	148	158	168	177	187	196	206	215	225	234	243	253	262	271	280	290
13	0,01	116	127	137	146	156	165	174	184	193	202	211	220	229	238	247	256	265	274	283
	0,025	115	125	134	143	152	161	170	179	187	196	205	214	222	231	239	248	257	265	274
	0,05	114	123	132	140	149	157	166	174	183	191	199	208	216	224	233	241	249	257	266

	0,1	112	120	129	137	145	153	161	169	177	185	193	201	209	217	224	232	240	248	256

m	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
14	α																			
	0,001	133	147	159	171	182	193	204	215	225	236	247	257	268	278	289	299	310	320	330
	0,005	133	145	156	167	177	187	198	208	218	228	238	248	258	268	278	288	298	307	317
	0,01	132	144	154	164	175	185	194	204	214	224	234	243	253	263	272	282	291	301	311
	0,025	131	141	151	161	171	180	190	199	208	218	227	236	245	255	264	273	282	292	301
	0,05	129	139	149	158	167	176	185	194	203	212	221	230	239	248	257	265	274	283	292
	0,1	128	136	145	154	163	171	180	189	197	206	214	223	231	240	248	257	265	273	282
m	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
15	α																			
	0,001	150	165	178	190	202	212	225	237	248	260	271	282	293	304	316	327	338	349	360
	0,005	150	162	174	186	197	208	219	230	240	251	262	272	283	293	304	314	325	335	346
	0,01	149	161	172	183	194	205	215	226	236	247	257	267	278	288	298	308	319	329	339
	0,025	148	159	169	180	190	200	210	220	230	240	250	260	270	280	289	299	309	319	329
	0,05	146	157	167	176	186	196	206	215	225	234	244	253	263	272	282	291	301	310	319
	0,1	144	154	163	172	182	191	200	209	218	227	236	246	255	264	273	282	291	300	309
m	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
16	α																			
	0,001	168	184	197	210	223	236	248	260	272	284	296	308	320	332	343	355	367	379	390
	0,005	168	181	194	206	218	229	241	252	264	275	286	298	309	320	331	342	353	365	376
	0,01	167	180	192	203	215	226	237	248	259	270	281	292	303	314	325	336	347	357	368
	0,025	166	177	188	200	210	221	232	242	253	264	274	284	295	305	316	326	337	347	357
	0,05	164	175	185	196	206	217	227	237	247	257	267	278	288	298	308	318	328	338	348
	0,1	162	172	182	192	202	211	221	231	241	250	260	269	279	289	298	308	317	327	336
m	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
17	α																			
	0,001	187	203	218	232	245	258	271	284	297	310	322	335	347	360	372	384	397	409	422
	0,005	187	201	214	227	239	252	264	276	288	300	312	324	336	347	359	371	383	394	406
	0,01	186	199	212	224	236	248	260	272	284	295	307	318	330	341	353	364	376	387	399
	0,025	184	197	209	220	232	243	254	266	277	288	299	310	321	332	343	354	365	376	387
	0,05	183	194	205	217	228	238	249	260	271	282	292	303	313	324	335	345	356	366	377
	0,1	180	191	202	212	223	233	243	253	264	274	284	294	305	315	325	335	345	355	365

m	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
18	α																			
	0,001	207	224	239	254	268	282	296	309	323	336	349	362	376	389	402	415	428	441	454
	0,005	207	222	236	249	262	275	288	301	313	326	339	351	364	376	388	401	413	425	438
	0,01	206	220	233	246	259	272	284	296	309	321	333	345	357	370	382	394	406	418	430
	0,025	204	217	230	242	254	266	278	290	302	313	325	337	348	360	372	383	395	406	418
	0,05	202	215	226	238	250	261	273	284	295	307	318	329	340	352	363	374	385	396	407
	0,1	200	211	222	233	244	255	266	277	288	299	309	320	331	342	352	363	374	384	395
m	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
19	α																			
	0,001	228	246	262	277	292	307	321	335	350	364	377	391	405	419	433	446	460	473	487
	0,005	227	243	258	272	286	300	313	327	340	353	366	379	392	405	419	431	444	457	470
	0,01	226	242	256	269	283	296	309	322	335	348	361	373	386	399	411	424	437	449	462
	0,025	225	239	252	265	278	290	303	315	327	340	352	364	377	389	401	413	425	437	450
	0,05	223	236	248	261	273	285	297	309	321	333	345	356	368	380	392	403	415	427	439
	0,1	220	232	244	256	267	279	290	302	313	325	336	347	358	370	381	392	403	415	426
m	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
20	α																			
	0,001	250	269	286	302	317	333	348	363	377	392	407	421	435	450	464	479	493	507	521
	0,005	249	266	281	296	311	325	339	353	367	381	395	409	422	436	450	463	477	490	504
	0,01	248	264	279	293	307	321	335	349	362	376	389	402	416	429	442	456	469	482	495
	0,025	247	261	275	289	302	315	329	341	354	367	380	393	406	419	431	444	457	470	482
	0,05	245	258	271	284	297	310	322	335	347	360	372	385	397	409	422	434	446	459	471
	0,1	242	254	267	279	291	303	315	327	339	351	363	375	387	399	410	422	434	446	458

If *n* or *m* is bigger than 20, then *Wr* must be calculated using the following equation:

$$W_r = \frac{m(n+m+1)}{2} + z\sqrt{\frac{nm(n+m+1)}{12}},$$

where *z – (1-α)* percentile whose meaning can be found in a table in annex III of nuclear safety guidelines BST-1.5.1-2016 ‘The evaluation of compliance with free release criteria of buildings and site surface of nuclear facilities’, *m* – measurement number in background reference area, *n* – measurement number in survey unit of final status radiological survey.

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Changes:

1.
State Nuclear Power Safety Inspectorate, Order
No. 22.3-36, 2018-02-07, published TAR 2018-02-07, i. k. 2018-01926
On the changes to approval of Nuclear Safety Guidelines BST-1.5.1-2016 ‘The evaluation of compliance with free release criteria of buildings and site surface of nuclear facilities’ approved by Order No. 22.3-206 by the Head of State Nuclear Safety Inspectorate on the 20th December 2016

2.
State Nuclear Power Safety Inspectorate, Order
No. 22.3-18, 2019-01-23, published TAR 2019-01-23, i. k. 2019-01022
On the changes to approval of Nuclear Safety Guidelines BST-1.5.1-2016 ‘The evaluation of compliance with free release criteria of buildings and site surface of nuclear facilities’ approved by Order No. 22.3-206 by the Head of State Nuclear Safety Inspectorate on the 20th December 2016