Meteorological measurements at nuclear power plants

This Guide entered into force on 1 April 1991 and remains in force until further notice. The Guide replaces Guide YVL 7.5, issued on 14 May 1976.

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Authorisation

By virtue of section 55, second paragraph, point 3 of the Nuclear Energy Act (990/87) and section 29 of the Council of State Decision on the General Regulations for the Safety of Nuclear Power Plants (395/91) and section 11 of the Council of State Decision on the General Regulations for Emergency Response Arrangements at Nuclear Power Plants (397/91), the Finnish Centre for Radiation and Nuclear Safety issues detailed regulations concerning the safety of nuclear power plants.

The YVL Guides are rules an individual licensee or any other organization concerned shall comply with, unless the Finnish Centre for Radiation and Nuclear Safety has been presented with some other acceptable procedure or solution by which the safety level laid down in YVL Guides is achieved.

Translation. Original text in Finnish.

1 General

On-site meteorological measurements are necessary for evaluating atmospheric dispersion of gaseous effluents. Radiation doses in a plant's vicinity due to these effluents are calculated from the results of dispersion evaluations.

This Guide addresses the requirements for on-site meteorological measurement systems. Guide YVL 7.3 addresses atmospheric dispersion evaluations and calculation methods, Guide YVL 7.2 radiation dose calculations and Guide YVL 7.8 environmental data reporting.

2 On-site meteorological surveys

A general description of the regulatory control of nuclear power plants by the Finnish Centre for Radiation and Nuclear Safety is given in Guide YVL 1.1. A description of the local meteorological conditions and an on-site meteorological survey shall be included in a nuclear power plant's Preliminary Safety Analysis Report. The Report shall also include a plan for on-site meteorological measurements to be made during construction of the plant.

Meteorological measurements shall be commenced well in advance of a nuclear power plant's commissioning. A description of the local meteorological conditions which is based on measurements made over a minimum period of one year and on other available data, and also an updated meteorological site survey shall be included in the Final Safety Analysis Report. Data included in the Final Safety Analysis Report shall be complemented regularly on the basis of on-site measurements conducted during operation.

3 Requirements for meteorological measurement systems

3.1 Meteorological measurement objectives

On-site meteorological measurements are necessary to acquire data on the atmospheric dispersion of

- the releases of radioactive material discussed in the plant's safety analyses,
- releases during normal plant operation and
- releases during a nuclear power plant accident.

Safety analyses of nuclear power plant accidents are made to evaluate whether population exposure remains below the limits presented in the Council of State Decision on the General Regulations for the Safety of Nuclear Power Plants (395/91); also the adequacy of a nuclear power plant's safety systems is assessed by means of the safety analyses. Data available about on-site meteorological conditions are used in these analyses made already during plant design and construction. These data shall be complemented with on-site meteorological measurements. Based on measurements conducted during nuclear power plant operation it shall be ensured that the dispersion conditions postulated in the analyses are sufficiently conservative as regards the consequences of potential accidents, i.e. that the consequences are over-emphasized.

Meteorological measurements shall be conducted during nuclear power plant operation in such a way that the radiation exposure of the surrounding population can be assessed on the basis of recorded results and release data. Population dose limits are set forth in the aforementioned Council of State Decision.

Furthermore, a nuclear power plant's meteorological measurement system shall be designed to facilitate radiation dose assessment during a potential accident so that the assessment is based on data and estimates of the release and on real-time meteorological data. These assessments are necessary in the planning and execution of rescue services and in the evaluation of the timing of a potential controlled release of radioactive material.

3.2 General requirements for meteorological measurements during operation of nuclear power plants

On-site meteorological measurements which facilitate the establishment of temporary and long-term conditions of atmospheric dispersion shall be made during operation of nuclear power plants. Data on wind direction and speed, the structure of the mixing layer and precipitation shall be acquired by local measurements. The observations of meteorological stations in the plant's vicinity shall also be utilized in evaluating the dispersion of radioactive materials in the environment during transient and accident conditions.

The measurement system must remain operable in predictable, design basis ambient conditions and its power supply shall be ensured.

The meteorological data necessary in dispersion calculations and the quantities calculated on their basis shall be displayed in the nuclear power plant's control room. These data shall be processed and transmitted in a manner making them available real-time for the Finnish Centre for Radiation and Nuclear Safety and for the Finnish Meteorological Institute.

The data shall be so recorded that meteorological conditions which prevail at a certain point of time can be determined afterwards.

Detailed plans concerning the measurement system shall be submitted to the Finnish Centre for Radiation and Nuclear Safety for approval. In justifications included in the plans it shall be demonstrated that the aforementioned objectives can be achieved and requirements met by means of the system. The justification may take into account fixed radiation monitors located in the plant's vicinity indicating releases and the dispersion of radioactive materials during transient and accident conditions. The number of the system's monitoring stations shall also be justified.

4 Requirements for instruments

Meteorological measurements can be carried out using continuously operating measuring instruments mounted on a tower, a Doppler Sodar (Sound Detection and Ranging) system intended for weather measurement, or a combination thereof. The Doppler Sodar system generally facilitates meteorological measurements to a considerably higher level than tower measurements; when using this system, complementary tower measurements shall be performed close to ground level.

Acceptable instrument specifications are given in points 4.1 and 4.2 below. An example of the accuracy requirements for instruments is given in Appendix 1.

The instruments shall be regularly checked and tested in accordance with a programme prepared in advance. The results of the check-ups and tests and any information pertaining to instrument repair and maintenance shall be documented.

4.1 Meteorological tower measurements

The meteorological tower and sensors shall be placed in such a way that the nuclear power plant's buildings, the tower's structures and the surrounding terrain do not interfere with the measurement results. The tower is to be designed sufficiently high for acquiring representative wind values and for determining atmospheric turbulence or stability. The plume dispersion parameters used in atmospheric dispersion calculations are determined directly by turbulence measurements or indirectly by temperature, wind speed and direction fluctuation measurements.

Observations at the lowest level of meteorological measurement shall meet international requirements for synoptic observation. Air temperature, pressure and humidity, and precipitation and periods of precipitation are measured at 1 to 2 m above ground. Wind direction and speed are measured at a level of about 10 to 30 m, depending on the terrain.

The maximum measurement height shall be at least at the height of the power plant's main ventilation stack.

For turbulence measurements, the sensors are placed at a height of about 10 to 30 m, depending on the terrain, on both sides of the tower; the topmost sensor shall be placed above the tower.

For temperature and wind measurements the sensors shall be placed at the aforementioned heights and also at an intermediate measurement level.

Wind speed measurement instruments shall be placed on both sides of the tower and their sensors shall be fitted with a thermal element to ensure operation throughout the year. The temperature sensors are to be protected against the warming effect of solar radiation.

4.2 The Doppler Sodar system

The Doppler Sodar system shall be placed in an undisturbed location in the nuclear power plant's vicinity; it shall be sufficiently far from tall buildings and potential sound sources disturbing measurement.

The system calculates the wind components of the mixing layer; a measuring echo is used for the calculations which are made at least at every 50 m, up until the maximum height possible during each weather condition. The data are employed to determine wind direction and speed, wind direction fluctuation, the plume dispersion parameters for calculations and the height of a possible inversion layer.

State-of-the-art technical know-how shall be taken into account in the design and implementation of a Doppler Sodar-type acoustic measurement system; also the quality requirements for nuclear power plant systems and for their operation shall be met.

Where measurement requirements pertaining to synoptic observation are concerned, reference is made to point 4.1.

5 References

1 Atmospheric Dispersion in Nuclear Power Plant Siting, IAEA Safety Guide No 50-SG-S3, Vienna 1980

2 Techniques and Decision Making in the Assessment of Off-Site Consequences of an Accident in a Nuclear Facility, IAEA Safety Series No 86, Vienna 1987

3 Instrumentierung zur Ermittlung der Ausbereitung radioaktiver Stoffe in der Atmosphäre, KTA 1508, Fassung 9/88, Köln 1988

4 Guide to Meteorological Instruments and Methods of Observation, WMO Report No 8, Genova 1983

5 Report on meteorological measurement systems pertaining to nuclear power plants, an investigation ordered by the Finnish Centre for Radiation and Nuclear Safety from the Finnish Meteorological Institute, STUK-YTO-TR 25, 1991 (in Finnish)

Appendix

Accuracy requirements for instruments

Accuracy requirements for instrumentation mounted on a meteorological tower will be system-specific. When determining plume dispersion parameters by means of vertical temperature gradient and wind measurements, measurement accuracy in the laboratory environment shall be as follows:

Wind speed:	±0.2 m/s when wind speed < 2 m/s (starting speed of anemometer 0.4 m/s), ±5 % when wind speed < 2 m/s
Wind direction:	±5°
Temperature:	±0.15°C
Temperature difference:	±0.2°C/100 m
Precipitation:	±0.2 mm
Period of precipitation:	±1 min
Atmospheric pressure:	±0.3 hPa (mbar)
Relative humidity:	±5 %

When wind vanes are employed for calculating horizontal wind direction fluctuation, the accuracy of measurement is ±1°. When turbulence measurements are employed, the sensor's time constant is less than 0.5 s (wind direction and speed are determined at the aforementioned accuracy).

Wind direction sensors are checked on the tower with an accuracy of ±5°.

Temperature sensors and the temperature gradient measurement system are checked on the tower with an accuracy of ±0.3°C.

The tower's measuring channels are to be calibrated at least once a year.

Wind speed sensors are to be removed from the tower for calibration in a wind tunnel. If instrument adjustments or replacements are made in connection with the calibration, the records shall show the calibration readings of instruments removed from the tower and also of those to be mounted on the tower.

The Doppler Sodar system shall be directed with an accuracy of ±3°C.

The operation of the Doppler Sodar system shall be calibrated and the direction of the transmitter and receiver checked at least once a year.

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General guides

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YVL 1.1 The Finnish Centre for Radiation and Nuclear Safety as the regulatory authority in control of the use of nuclear energy, 27 Jan. 1992

YVL 1.2 Documents to be submitted to the Finnish Centre for Radiation and Nuclear Safety concerning the regulation of nuclear facilities, 22 May 1991 (in Finnish)

YVL 1.3 Mechanical components and structures of nuclear power plants. Inspection licenses, 25 March 1983

YVL 1.4 Quality assurance of nuclear power plants, 20 Sep. 1991

YVL 1.5 Reporting nuclear power plant operation to the Finnish Centre for Radiation and Nuclear Safety, 1 Jan. 1995 (in Finnish)

YVL 1.6 Nuclear power plant operator licensing, 3 March 1989

YVL 1.7 Duties important to nuclear power plant safety, personnel qualifications and training, 28 Dec. 1992 (in Finnish)

YVL 1.8 Repairs, modifications and preventive maintenance at nuclear facilities, 2 Oct. 1986

YVL 1.9 Quality assurance during operation of nuclear power plants, 13 Nov. 1991

YVL 1.11 Ydinvoimalaitosten käyttökokemusten hyödyntäminen, 22 Dec. 1994 (in Finnish)

YVL 1.13 Shutdowns at nuclear power plants, 9 Jan. 1995 (in Finnish)

YVL 1.15 Mechanical components and structures in nuclear installations, Construction inspection, 16 April 1984

Systems

YVL 2.1 Safety classification of nuclear power plant systems, structures and components, 22 May 1992

YVL 2.2 Transient and accident analyses for justification of technical solutions at nuclear power plants, 7 Oct. 1987

YVL 2.3 Preinspection of nuclear power plant systems, 14 Aug. 1975

YVL 2.4 Over-pressure protection and pressure control during disturbances in the primary circuit and steam generators of a PWR plant, 19 Sept. 1984

YVL 2.5 Pre-operational and start-up testing of nuclear power plants, 8 Jan 1991

YVL 2.6 Provision against earthquakes affecting nuclear facilities, 19 Dec. 1988

YVL 2.7 Failure criteria for the design of a light-water reactor, 6 April 1983

YVL 2.8 Probabilistic safety analyses (PSA) in the licensing and regulation of nuclear power plants, 18 Nov. 1987

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YVL 3.3 Supervision of the piping of nuclear facilities, 21 May 1984

YVL 3.4 Nuclear power plant pressure vessels. Manufacturing license, 15 April 1981

YVL 3.7 Pressure vessels of nuclear facilities. Commissioning inspection, 12 Dec. 1991

YVL 3.8 Nuclear power plant pressure vessels. Inservice inspections, 3 Dec. 1993 (in Finnish)

YVL 3.9 Nuclear power plant pressure vessels. Construction and welding filler materials, 6 Nov. 1978

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YVL 4.2 Steel structures for nuclear facilities, 19 Jan. 1987

YVL 4.3 Fire protection at nuclear facilities, 2 Feb. 1987

Other structures and components

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YVL 5.4 Supervision of safety relief valves in nuclear facilities, 3 June 1985

YVL 5.5 Supervision of electric and instrumentation systems and components at nuclear facilities, 7 June 1985

YVL 5.6 Ventilation systems and equipment for nuclear power plants, 23 Nov. 1993 (in Finnish)

YVL 5.7 Pumps at nuclear facilities, 23 Nov. 1993 (in Finnish)

YVL 5.8 Hoisting appliances and fuel handling equipment at nuclear facilities, 5 Jan. 1987

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YVL 6.2 Fuel design limits and general design criteria, 15 Feb. 1983

YVL 6.3 Supervision of fuel design and manufacture, 15 Sept. 1993

YVL 6.4 Supervision of nuclear fuel transport packages, 1 March 1984

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YVL 6.7 Quality assurance of nuclear fuel, 23 Nov. 1993

YVL 6.8 Handling and storage of nuclear fuel, 13 Nov. 1991 (in Finnish)

YVL 6.9 The national system of accounting for and control of nuclear material, 23 Nov. 1993 (in Finnish)

YVL 6.10 Reports to be submitted on nuclear materials, 23 Nov. 1993 (in Finnish)

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YVL 6.21 Physical protection of nuclear fuel transports, 15 Feb. 1988 (in Finnish)

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YVL 7.2 Evaluation of population doses in the environment of nuclear power plants, 12 May 1983

YVL 7.3 Evaluating the dispersion of radioactive releases from nuclear power plants under operating and in accident conditions, 12 May 1983

YVL 7.4 Nuclear power plant emergency plans, 12 May 1983

YVL 7.5 Meteorological measurements of nuclear power plants, 28 Dec. 1990

YVL 7.6 Monitoring of discharges of radioactive substances from nuclear power plants, 13 July, 1992

YVL 7.7 Programmes for monitoring radioactivity in the environment of nuclear power plants, 21 May 1982

YVL 7.8 Reporting radiological control of the environs of nuclear power plants to the Institute on Radiation Protection, 21 May 1982

YVL 7.9 Radiation protection of nuclear power plant workers, 14 Dec. 1992 (in Finnish)

YVL 7.10 Monitoring occupational exposure at nuclear power plants, 29 Aug. 1994 (in Finnish)

YVL 7.11 Radiation monitoring systems and equipment in nuclear power plants, 1 Feb. 1983

YVL 7.14 Action levels for protection of the public in nuclear power plant accidents, 26 May 1976

YVL 7.18 Radiation protection in design of nuclear power plants, 14 May 1981

Radioactive waste management

YVL 8.1 Disposal of reactor waste, 20 Sept. 1991

YVL 8.2 Exemption from regulatory control of nuclear wastes, 19 March 1992

YVL 8.3 Treatment and storage of radioactive waste at the nuclear power plants, 1 July 1985

The YVL-guides without any language marking are available both in English and Finnish.