STUK

GUIDE **YVL 5.3** / 28 APRIL 2008

NUCLEAR FACILITY VALVE UNITS

continues

As regards new nuclear facilities, this guide is valid as of 1 November 2008 until further notice. At operating nuclear facilities, and those under construction, this guide is enforced by a separate STUK decision. This guide replaces YVL 5.3 "Control of nuclear facility valves and their actuators", issued on 7 February 1991 and Guide YVL 5.4, "Control of nuclear facility safety valves", issued on 6 April 1995.

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Authorisation

By virtue of the below acts and regulations, the Finnish Radiation and Nuclear Safety Authority (STUK) issues detailed regulations that apply to the safe use of nuclear energy and to physical protection, emergency preparedness and safeguards:

- section 55 of the Nuclear Energy Act (990/1987)
- section 29 of the Government Decision (395/1991) on the safety of nuclear power plants
- section 13 of the Government Decision (396/1991) on the physical protection of nuclear power plants
- section 11 of the Government Decision (397/1991) on the emergency preparedness of nuclear power plants
- section 8 of the Government Decision (398/1991) on the safety of a disposal facility for reactor waste
- section 30 of the Government Decision (478/1999) on the safety of disposal of spent nuclear fuel.

Rules for application

The publication of a YVL guide does not, as such, alter any previous decisions made by STUK. It is only after having heard those concerned that STUK makes a separate decision on how a new or revised YVL guide applies to operating nuclear power plants, or those under construction, and to licensees' operational activities. The guides apply as such to new nuclear facilities.

When considering how new safety requirements presented in YVL guides apply to operating nuclear power plants, or to those under construction, STUK takes into consideration section 27 of the Government Decision (395/1991), which prescribes that *for further safety enhancement, action shall be taken which can be regarded as justified considering operating experience and the results of safety research, as well as the advancement of science and technology.*

If deviations are made from the requirements of the YVL guides, STUK shall be presented with some other acceptable procedure or solution by which the safety level set forth in the YVL guides is achieved.

Translation. Original text in Finnish.

1 Preface

This guide presents the requirements for a nuclear facility's valve units placed by STUK on the licensee and the procedures by which STUK oversees compliance with these requirements. This guide applies to all types of valve units, self-operated and actuated, in Safety Classes 1, 2 and 3 as follows:

- design and dimensioning
- manufacturing control, inspection and testing
- installation and commissioning
- maintenance, modifications and repairs.

The licensee shall have available corresponding procedures for the procurement, operation and maintenance of valve units in Safety Class 4 and Class EYT (non-nuclear).

2 Definitions

The following abbreviations and definitions are used in this guide:

hold point
: a notified inspection or test beyond which activities must not proceed without witnessing by STUK or a STUK-approved inspection organisation

non-serial
: order-specific, entirely new or modified from a component that has been in service

wearing spare parts
: spare parts and materials (seals, bearings, lubricants, etc.) replaced during preventive maintenance

major subcontractor
: a subcontractor who manufactures a structurally or functionally significant valve unit component

small valve
: a valve having a nominal size of DN50 or less

reference valve unit
: similar to the manufactured valve unit by construction, operating values and operating environment

serial
: manufactured in series (identical or similar materials, manufacturing methods, parts, structures and operating values) and have been in service

strategic spare parts
: replacement parts whose availability ensures operability of the valve unit (obturator, actuator, etc.)

design conditions
: design basis operational conditions, transients and accidents as well as design basis ambient conditions (temperature, humidity, radiation, pressure difference, fluid characteristics, etc.)

testing organisation
: performs non-destructive or destructive materials testing

product class
: based on the design work required for the valve unit, previous manufacturing volumes and operating experience, a product is classified as either serial or non-serial

valve unit
: a valve, an actuator, and parts and systems that form a structural or operational entity

witness point
: a notified inspection or test beyond which activities can proceed without witnessing by STUK or a STUK-approved inspection organisation.

3 Manufacturer, testing and inspection organisation

3.1 Manufacturer

Valve and actuator manufacturer must have

- competent and experienced personnel
- facilities and equipment for manufacturing as well as qualified manufacturing methods
- systematic procedures for assessing, selecting and supervising subcontractors
- references to valves and actuators with similar structures and operating parameters
- a management system that fulfils the requirements of Guide YVL 1.4 "Management systems for nuclear facilities".

The manufacturer or the subcontractor shall have STUK's approval in accordance with Guide YVL 3.4 "Approval of the manufacturer of nuclear pressure equipment" when they fabricate a valve unit's pressure-retaining structures by permanent joining, heat treatment or forming. The acceptability of the manufacturing methods of the

valve's other structures is assessed by STUK or a STUK-approved inspection organisation based on the valve construction plans and a possible audit at the manufacturer's premises.

The manufacturer shall submit the following documents to the licensee:

- documents for valve unit pre-inspection, as required in the construction plan
- manufacturing and inspection records
- requirements and instructions for valve unit installation, commissioning, operation, maintenance, condition monitoring in-service inspection and testing, and ageing management.

3.2 Testing and inspection organisation

The testing organisation and inspection organisation performing valve unit materials testing, and whose duties relate to the conformity assessment and approval of design and manufacturing, shall be STUK-approved in accordance with Guide YVL 1.3 "Mechanical components and structures of nuclear facilities. Approval of testing and inspection organisations".

4 General valve unit requirements

Valve unit design, dimensioning, manufacturing and fabrication, inspection and testing shall be based on generally used component and nuclear engineering standards [1–20].

The integrity of the valve unit's pressure retaining parts is to be maintained and the valve unit is to fulfil the system's operational requirements under design conditions for the duration of its design service life. This shall be demonstrated by calculations, tests and previous operational experience. Where separate strength calculations are not required, the dimensioning of pressure retaining structures or other load bearing structures shall be based on applicable standards.

Valve unit materials shall be applicable for their intended use. Material properties with their manufacturing tolerances must fulfil the requirements of design conditions and related phenomena such as fatigue, wearing, corrosion, cavitation and radioactivity of medium. The materials and welding filler materials of pressure retaining structures shall be approved and their material properties verified in accordance with Guide YVL 3.9 "Nuclear power plant pressure equipment. Construction and welding filler materials".

The valve unit shall fulfil the following requirements:

- It must have a design basis operating lifetime of at least 30 years, with the exception of wearing spare parts.
- The type of valve and actuator used shall be structurally and functionally suited for their intended application.
- Valve unit structure, location and process environment shall allow the performance of regular maintenance work, in-service inspection and testing.
- Valve unit condition monitoring shall be possible by direct or indirect measurement during operation. The condition monitoring of a Class 1 or 2 valve unit equipped with an electric actuator having functional safety significance shall be based on an analysis of the actuator's operational parameters and history data and be possible at the nuclear facility's main or local control room.
- Position data of valves shall be transmitted to the nuclear facility's main control room if it has safety significance.
- External leaks from a valve located in piping transferring radioactive liquid must be controllably led to a drain collection system.
- Valve shall be sized against actuator switch-off failure to maintain integrity, leaktightness or operability as specified in the design bases.
- Pressure relief valve settings must be sealable.

5 Valve specification

The licensee shall have a nuclear facility and safety class specific valve specification defining the general requirements for the nuclear facility's valve units as follows:

- design bases
- structural and functional dimensioning

- inspection plan
- inspection procedures
- manufacturer-related requirements.

Of the design bases and dimensioning, the following shall be presented: the design conditions of the nuclear facility's valve units; the requirements set for their materials, structures and functioning; and the component and nuclear engineering standards used in dimensioning.

The inspection plan shall define the inspections and testing to be performed on the valve unit's materials, structures and functioning during manufacturing, fabrication and factory acceptance tests. In the inspection procedures, the performance, scope and approval criteria of the most important inspections and tests shall be given.

Requirements pertaining to the manufacturer shall describe the requirements set for the quality management, previous nuclear facility experience, expertise and delivery references of the manufacturer of the valve and its actuator.

6 Construction plan

6.1 General requirements

The following information shall be given in the valve unit's construction plan:

- tag (KKS code or equivalent), safety class and product class
- manufacturer and testing organisation
- previous operating experience
- design bases
- dimensioning calculations
- technical specifications
- inspection plan
- inspection procedures
- spare parts.

In accordance with Guide YVL 1.2 "Documents pertaining to safety control of nuclear facilities", the licensee shall submit to STUK in three copies the construction plan they have approved. To a STUK-approved inspection organisation, a similarly approved plan shall be submitted using a procedure required by the organisation.

If the licensee proposes to replace the construction plan with a type document approved by a third party, the type document shall contain information corresponding to that given in the construction plan to such extent that evaluation of the valve's acceptability for its intended use is possible based on the information.

6.2 Manufacturer and testing organisation

If the valve unit's manufacturer or a major subcontractor is STUK-approved, the construction plan shall contain references to the relevant STUK decisions and their expiration dates. Otherwise, of manufacturers of Safety Class 1 and 2 valve units, the corporate structure (parent company/companies, design and manufacturing organisation), management system description, management system quality certificates, major subcontractors and previous references shall be given. Of manufacturers of Safety Class 3 valve units, at least the management system quality certificates and previous references shall be given.

For non-serial Safety Class 1 and 2 valve units, manufacturing and repair methods of importance and their qualification data shall be given.

As regards approval of testing organisations, the construction plan shall contain references to the relevant STUK decisions and their expiration dates. If the testing organisation is accredited, documents proving the accreditation submitted earlier to STUK for information shall be referred to.

6.3 Operating experience and type test data

The types, rated values, quantities, delivery years, purchasers and type test reports of reference valve units shall be given. When the construction or functioning of a valve unit differs from the reference valve units, information shall be given that makes it possible to evaluate the effect of the differences.

For Safety Class 1 and 2 reference valve units, operating experience data should include operating times and conditions with fault and maintenance history information.

6.4 Design bases

As the design bases, the requirements set for the valve unit by the system and the environment under design conditions shall be presented where applicable as follows:

- function in the system (stop valve, control valve, check valve, pilot valve, safety valve, rupture disc, blow down valve, etc.)
- dimensioning basis of flow capacity
- mechanical loadings and their combinations
  - design pressure and temperature
  - forces and torques exerted by actuator
  - limit switch failure
  - forces and torques exerted by piping
  - dynamic loadings (periodic operation, pressure and temperature transients)
  - external dynamic loadings (seismic event, aircraft impact, pressure wave)
- obturator pressure difference
- fluid properties
- ambient conditions (temperature, humidity, radiation, etc.)
- flow control range
- opening and closure time
- opening and closure pressure
- integrity, leaktightness and operability requirements under design conditions
- operating cycles and service life
- range and duration of supply voltage and frequency of electric actuator
- decontamination.

6.5 Dimensioning

6.5.1 General requirements

The design and dimensioning standards used shall be referred to.

Dimensioning calculations shall be presented covering initial data, calculation methods, visualised results, acceptance criteria and conclusions.

6.5.2 Calculations

Safety Class 1 and 2

For Safety Class 1 and 2 valve units, calculations, or equivalent studies, shall be given as follows:

- basic dimensioning
  - casing and nozzles
  - load path parts
  - pressure retaining or other load bearing structures
- fatigue analysis for structures subject to fatigue induced by alternate loading
- stress analysis and fast fracture analysis for pressure retaining main structures (applies to Safety Class 1 valve units, serial small-diameter valves excluded)
- contact stress calculations for sealing surfaces
- forces and torques exerted by obturator and sealing surfaces as initial data for actuator dimensioning.

Strength analysis requirements are presented in Guide YVL 3.5 “Ensuring the strength of pressure equipment at nuclear facilities”.

Safety Class 3

For Safety Class 3 non-serial valve units, basic dimensioning of casing and load path parts shall be presented. Calculations are not required for serial Safety Class 3 valve units unless required by their special construction or functioning.

6.6 Technical specifications

The following technical specifications for the valve unit shall be given, where applicable:

- assembly and sectional drawings
- flow capacity or or flow resistance (characteristic curve for control valve)
- part list and construction materials
- welding materials
- material specifications of major structural parts (Safety Classes 1 and 2)
- actuator design parameters, e.g. electric actuator’s rated voltage and current
- electric, hydraulic or pneumatic diagrams of valve actuator and control
- actuator enclosure, temperature rise and insulation classes
- torques and forces required by and allowed for the valve
- actuator torques (in case of switch-off failure, highest torque exerted by electric actuator with overvoltage and lowest torque with undervoltage)
- limit switches and settings
- position indicators
- fail-safe position.

Drawings shall present main dimensions, refer to the part list and material specifications and also indicate welded joints and hardfacings. The drawings shall also show the functioning of the valve unit as well as essential tolerances, clearances and plays.

6.7 Inspection plan

An inspection plan for the inspection and testing of the materials, structures and functioning of the valve unit shall be presented. It defines inspection and test steps as well as their supervision whose scope depends on the valve unit's safety significance. For the performance of the inspections and testing, the inspection plan shall refer to relevant inspection procedures and/or standards and include STUK or STUK-approved inspection organisation hold and witness points.

6.8 Inspection procedures

Procedures to inspect and test valve unit materials, structures and functioning shall be drawn up or applicable standards be used as such procedures. The inspection procedures shall include instructions, scope and approval criteria for the performance of the inspections and tests.

Inspection procedures shall be presented at least for hydrostatic and leaktightness tests, functional tests and in Safety Classes 1 and 2 for a valve's DT and NDT testing (material manufacturing and valve fabrication). A reference to the relevant decisions is adequate for inspection procedures approved by STUK earlier.

6.9 Spare parts

The construction plan shall define those wearing spare parts and strategic spare parts of the valve unit that are available, where necessary, at the nuclear facility or stored elsewhere for maintenance and repair work.

7 Inspections and testing

7.1 General requirements

The licensee shall ensure that the specified inspections and testing are performed on the materials, structures and functioning of the valve unit, and make it possible for STUK or a STUK-approved inspection organisation to oversee manufacturing as well as the inspections and testing in the scope they deem necessary.

The licensee shall arrange the valve unit's construction inspection as well as the other hold and witness points defined in the approved inspection plan or whose performance is otherwise required.

7.2 Construction inspection

In accordance with the principles set out in Guide YVL 1.15 "Mechanical components and structures in nuclear installations. Construction inspection", the construction inspections of valve units are intended to ensure that

- materials, manufacturing, fabrication, structures and functioning comply with the approved construction plan
- the scope of inspections and tests comply with the approved inspection plan and their results are acceptable.

In the construction inspection, the valve unit with part markings is visually inspected, the procurement and fabrication documentation is reviewed and appropriate tests witnessed. The tests to be witnessed are the valve unit's hydrostatic, leaktightness and functional tests. The valve is visually inspected assembled and disassembled in such a way that every Safety Class 1 and 2 valve unit and at least one valve unit in any batch of Safety Class 3 valve units is inspected disassembled after functional testing.

The procurement and fabrication documentation approved by those in charge and construction plans approved by STUK with their reference documents shall be available at the construction inspection.

The construction inspection of serial small-diameter valves is decided upon case-by-case at the licencee's request when a construction plan is submitted. A complete construction inspection is typically made on one valve only from a batch of identical valves.

7.3 Type test

The valve unit shall be tested in such a way that one or more valves per type are tested to demonstrate compliance with requirements. A type test may be replaced with information given in the

construction plan (records of previous type tests, good operating experience) that similarly demonstrates the compliance.

When a type test is required, valve unit structures and functioning shall be tested in conditions similar to design conditions in such a way that compliance with the requirements can be justifiably concluded from the test results. A type test procedure shall be drawn up that gives the test instructions, scope and acceptance criteria.

8 Installation

8.1 General requirements

Prior to installation, the licensee shall make an acceptance inspection to ensure that the valve units were delivered to the nuclear facility defect-free and are as specified in the construction plan. Records shall be kept of the acceptance inspection.

If installation includes fabrication, e.g. welded nozzles, the organisation installing the valve unit shall be STUK-approved in accordance with Guide YVL 3.4 "Approval of the manufacturer of nuclear pressure equipment".

8.2 Installation plan

The licensee shall draw up a valve unit installation plan containing the following information:

- installation procedure and drawings, incl. tightening of threads
- qualified welding procedures if installation includes welding
- inspection plan of installation.

Where necessary, the installation inspection plan shall include inspection steps for welding, alignment and other inspections to demonstrate acceptability of the valve unit's mechanical installation.

8.3 Installation inspection

The licensee shall arrange a visual inspection to demonstrate acceptability of the valve unit's mechanical installation. Reports of inspections specified in the installation inspection plan are also reviewed during the installation inspection.

9 Commissioning

9.1 General requirements

Manufacturers' instructions shall be followed during the valve unit's commissioning.

The licensee shall arrange a separate two-phased commissioning inspection of the valve unit whose first phase ensures the valve unit's trial run readiness and the second its readiness for operation. However, in case of a serial small-diameter valve, or a Safety Class 3 valve unit having a nominal size less than DN200, and if the system the valve unit belongs to is subject to a commissioning inspection, the licensee may demonstrate the valve unit's acceptable readiness for operation during the system's commissioning in accordance with Guide YVL 2.5 "The commissioning of a nuclear power plant".

Before the valve unit is put into service the licensee shall perform a commissioning inspection on its electric actuator in accordance with Guide YVL 5.2 "Electrical power systems and components at nuclear facilities".

If specific test equipment (a test bench, load relief device, etc.) are used for functional testing during the valve unit's commissioning, or later during in-service testing, a test procedure shall be drawn up, stating the operational principle of the test equipment, test performance, measuring tolerances and operator's qualification requirements.

9.2 Commissioning inspection

9.2.1 Phase 1

The licensee shall demonstrate during Phase 1 that the inspections and testing relating to the installed valve unit's electrical and I&C systems have been acceptably performed.

The licensee shall present a valve unit construction plan, a construction inspection protocol and an installation inspection protocol that have been approved. The manufacturer's commissioning procedures shall be presented as well.

9.2.2 Phase 2

The licensee shall perform a trial run during Phase 2 to demonstrate that the valve unit

fulfils the functional requirements as part of the system.

The licensee shall draw up for Phase 2 a valve unit trial run plan (incl. process arrangements, measured data, acceptance criteria, etc.). The licensee shall present the plan before Phase 2 is started.

10 Operation, maintenance and modifications

The licensee shall operate and maintain valve units in such a way that they fulfil their set requirements for the duration of their design lifetime. The licensee shall have in place procedures and plans for the operation and maintenance of the valve units (preventive maintenance, in-service inspection and testing, repairs). The procedures and plans shall be based on manufacturer requirements and recommendations as well as decisions given by authorities and shall be continually updated and developed based on accumulated operating experience.

Preventive maintenance shall be timed so that, by the next scheduled maintenance, the remaining service hours of wearing parts always exceed the designed uninterrupted operation period without maintenance. Approved construction plans shall be complied with in spare parts procurement.

The valve unit shall be periodically inspected and tested unless operability can be verified online by other means.

The licensee shall draw up construction, installation and trial run plans for repairs and modification and similarly arrange construction, installation and commissioning inspections. The plans and inspections shall, where applicable, correspond to those required for a new valve unit.

The licensee shall maintain a data acquisition system where documents on modifications and maintenance works are recorded, and shall ensure that they are at STUK's disposal on request.

The licensee shall have spare parts available for maintenance and repair work as defined in the valve unit construction plan.

11 Oversight by STUK

11.1 General

By the procedures described in this guide STUK oversees the nuclear facility's Safety Class 1, 2 and 3 valve units.

STUK oversees the appropriateness and implementation of procedures which the licensee has prepared to procure, operate and maintain the nuclear facility's Safety Class 4 and Class EYT valve units.

Upon the licensee's application STUK delegates, in accordance with Table 1, inspection of Safety Class 3 valve units to the inspection organisations it has approved for the purpose.

The licensee shall send a notification to STUK or a STUK-approved inspection organisation to perform inspections or supervise testing early enough before proposed date.

11.2 Valve specification

A nuclear facility specific valve specification shall be STUK-approved before the construction plans of valve units can be submitted for approval to STUK or a STUK-approved inspection organisation.

11.3 Construction plan

A valve unit's construction plan shall be licensee-approved before submission for approval to STUK or a STUK-approved inspection organisation and before manufacturing is started.

The construction plan shall be approved by STUK or a STUK-approved inspection organisation before the manufacturing of Safety Class 1 or 2 valve units (serial small-diameter valves excluded) or non-serial valve units. Manufacturing means here the manufacturing of a prefabricated or other part that essentially relates to the acceptability of the valve unit's structural or functional dimensioning.

The construction plan (or type documents) of a serial valve unit shall be approved by STUK or a STUK-approved inspection organisation before construction inspection if the valve unit is a small-diameter valve or belongs to Safety Class 3.

A STUK-approved system level design basis for the valve unit is a prerequisite for construction plan approval.

Table 1. General sharing of valve unit inspections (STUK and inspection organisation).

Safety Class	1	2	3
Design			
Valve specification	STUK	STUK	STUK
Construction plan	STUK	STUK	IO
Manufacturing and fabrication			
Construction inspection	STUK	STUK	IO
Installation			
Installation plan	STUK	STUK	IO
Installation inspection	STUK	STUK	IO
Commissioning*)			
Commissioning inspection, Phases 1 and 2	STUK	STUK	STUK
Trial run plan	STUK	STUK	STUK
Operation			
Plans for repairs and modifications; construction and installation inspection	STUK	STUK	IO
Commissioning inspection for repairs and modifications	STUK	STUK	STUK

STUK = The Finnish Radiation and Nuclear Safety Authority, IO = inspection organisation

*) the commissioning inspection of serial small-diameter valves or Safety Class 3 valves having a nominal size less than DN200 is conducted during system commissioning

11.4 Inspections and testing

STUK or a STUK-approved inspection organisation performs valve unit inspections and supervises tests (hold and witness points) that are defined in the approved inspection plan or whose performance is otherwise required.

When a type test is required, a test procedure shall be approved by STUK before the test.

The construction inspection shall be approved by STUK or a STUK-approved inspection organisation before the valve is installed.

11.5 Installation

The valve unit's installation plan shall be approved by STUK or a STUK-approved inspection organisation before installation is started.

The valve's installation inspection is performed by STUK or a STUK-approved installation organisation.

The installation inspection shall be approved by STUK or a STUK-approved inspection organisation before the valve unit is put into service.

11.6 Commissioning

STUK performs a separate two-phase commissioning inspection on the valve unit, or carries it out during the system's commissioning as stated earlier in the text. In the separate two-phase commissioning inspection

- the trial run plan shall be STUK-approved before the valve unit's trial run
- Phase 1 of the commissioning inspection shall be STUK-approved before Phase 2
- Phase 2 of the commissioning inspection shall be STUK-approved before the valve is put into service.

If special test equipment are used for testing during the valve unit's commissioning, the test procedure shall be STUK-approved.

11.7 Operation, maintenance and modifications

STUK oversees that the instructions and plans that are used for valve unit operation and maintenance are adequate and that they are complied with.

If special test equipment are used for valve unit in-service testing, the test procedure shall be STUK-approved.

Construction, installation and trial run plans for repairs and modifications shall be approved by STUK or a STUK-approved inspection organisation before entering a corresponding phase of the repair or modification.

The construction inspections of repairs or modifications, and of the strategic spare part procured for this purpose, shall be approved by STUK or a STUK-approved inspection organisation before installation.

The installation inspection of repairs or modifications shall be approved by STUK or a STUK-approved inspection organisation before the valve is put into service.

The commissioning inspection of repairs or modifications shall be STUK-approved before the valve is put into service.

12 References

1. 2004 ASME Boiler & Pressure Vessel Code, Section III, Division 1, Subsection NB Valve Design.
2. 2004 ASME Boiler & Pressure Vessel Code, Section III, Division 1, Subsection NC Valve Design.
3. SFS-EN 12266 “Industrial Valves. Testing of Valves”, Parts 1–2.
4. SFS-EN ISO 4126 “Safety Devices for Protection against excessive pressure”, Parts 1–7.
5. SFS-EN 764-7 + AC “Pressure Equipment”, Part 7: Safety systems for unfired pressure equipment”.
6. SFS-EN 593 “Industrial valves. Metallic butterfly valves”.
7. SFS-EN 1349 “Industrial process control valves”.
8. SFS-EN 1984 “Industrial valves. Steel gate valves”.
9. SFS-EN 12516 “Industrial valves. Shell design strength”, Parts 1–3.
10. SFS-EN 13397 ”Industrial valves. Diaphragm valves made of metallic materials”.
11. SFS-EN 13709 “Industrial valves. Steel globe and globe stop and check valves”.
12. SFS-EN 14341 “Industrial valves. Steel check valves”.
13. IEC 60534 ”Industrial process control valves”, Parts 1–8.
14. ASME OM CODE-2001 “Code for Operation and Maintenance of Nuclear Power Plants”, Subsection ISTC “In-service Testing of Valves in Light-Water Reactor Nuclear Power Plants”.
15. ASME QME-1-2002 “Qualification of Active Mechanical Equipment Used in Nuclear Power Plants”.
16. KTA 3504 “Elektrische Antriebe des Sicherheitssystems in Kernkraftwerken”.
17. IEC 60034 “Rotating electrical machines, rating and performance”.
18. IEC 71-1 “Insulation co-ordination, Definitions, principles and rules”.
19. IEC 71-2 “Insulation co-ordination, Application guide”.
20. IEC 60085 “Electrical insulation, Thermal classification”.