



Translation

**HOISTING APPLIANCES AND FUEL HANDLING EQUIPMENT
AT NUCLEAR FACILITIES**

CONTENTS

page

1	GENERAL	3
2	CONSTRUCTION PLAN	4
	2.1 Manufacturer	5
	2.2 Design bases	6
	2.3 Materials	7
	2.4 Dimensioning	8
	2.4.1 Strength calculations	8
	2.4.2 Dimensioning of electrical and instrumentation compo- nents	9
	2.5 Drawings	10
	2.5.1 Assembly drawings	10
	2.5.2 Electrical and instrumenta- tion system drawings	10
	2.6 Quality control program	11
	2.7 Other descriptions	13
3	SUPERVISION OF FABRICATION AND CONSTRUCTION INSPECTION	13
	3.1 Supervision of fabrication	13
	3.2 Construction inspection	13
4	COMMISSIONING INSPECTION	14
	4.1 Verification of installation and inspection status	14
	4.2 Supervision of operational tests	15

Helsinki 1987
Government Printing Centre

ISBN 951-47-0395-2
ISSN 0783-2400

5	INSERVICE INSPECTION	16
6	REPAIRS AND MODIFICATIONS	16
7	SPARE PARTS	17
8	BIBLIOGRAPHY	17

1 GENERAL

This guide is followed by the Finnish Centre for Radiation and Nuclear Safety (STUK) in regulating hoisting and handling equipment Class 3 at nuclear facilities. The classification criteria are given in Guide YVL 2.1 /2/. According to Guide YVL 2.1, the Safety Classes 1 and 2 do not include hoisting or handling equipment. The cranes in Class EYT (non-nuclear) are not regulated by STUK. The regulatory measures undertaken by STUK do not replace the surveillance over hoisting and handling equipment required by the National authorities for Labour Protection and the Electrical Inspectorate.

The guide is applied, e.g. to following equipment:

- reactor building overhead cranes,
- hoisting appliances at nuclear fuel storages,
- fuel handling machines,
- other hoisting appliances, which because of nuclear safety aspects are classified in Safety Class 3,
- load-bearing devices connected with the above equipment, such as replaceable hoisting tools and auxiliary lifting devices.

The hoisting and handling equipment without safety classification, located outside the nuclear facilities, are regulated in connection with transports of nuclear fuel in accordance with Guide 6.5 /3/.

The regulating of hoisting and handling equipment comprises the following stages:

- handling of preliminary and final safety analysis reports
- inspection of the construction plan
- supervision of fabrication and construction inspection
- supervision of initial start-up and commissioning inspection

- inservice inspections
- supervision of repairs and modifications.

In the preliminary safety analysis report or its reference documents, which are handled in connection with the construction permit application, are given the following data concerning hoisting and handling equipment:

- type; design criteria, such as rated load, operating range of the lifting attachment three-dimensionally,
- types (electrical, pneumatic or other) and intended use of power supplies,
- environmental conditions, and
- eventual special features, such as instruments for radiation monitoring, safe handling of critical loads (see 2.2 below) and seismic design requirements.

The auxiliary systems or parts of them in the hoisting and handling equipment structures are inspected as part of the construction plan.

2 CONSTRUCTION PLAN

The construction plan of the hoisting and handling equipment shall be submitted to STUK.

The construction plan shall comprise information on following items:

- manufacturer
- design criteria
- materials
- dimensioning
- drawings
- quality control program
- other necessary information.

The construction plans are submitted to STUK in accordance with Guide YVL 1.2 /4/ and provided with a division of items according to this guide. However, the applicant can put forward his own proposal for the combination of construction plan documents.

The contents and scope of the construction plan documents shall be matched to the structural solutions and the duty classification of the equipment.

Changes in the construction plan shall be submitted to and are handled by STUK in the same manner as the construction plan. A minor deviation from the construction plan may be accepted at the construction inspection on the basis of a mutual deviation report approved by the separate parties.

2.1 Manufacturer

The manufacturer of the hoisting and handling equipment shall give an account of his technical and administrative qualifications for manufacturing the hoisting and handling equipment described in the construction plan. The project organization shall be described and confirmed by the company management with following specifications:

- definitions of duties
- competences and responsibilities
- quality assurance arrangements.

The description shall include information on the procedures the manufacturer will follow in order to supervise the subcontractors who participate in the fabrication or quality control of the load-bearing members of the hoisting and handling equipment or other components important to safety. The manufacturer's quality control department or the external inspection agency and its testing personnel conducting the quality control shall be approved by STUK, as per Guide 1.3 /5/.

The persons responsible for the design and fabrication shall be designated separately for each piece of hoisting and handling equipment.

As deemed necessary, STUK performs audits at the factory to assess the competence of the manufacturer.

2.2. Design bases

The design data shall provide information required for inspection the structural solutions, material selection, strength calculations, quality control program and operational test schemes, as well as assessment of operational safety, concerning the hoisting and handling equipment. Any deviation from the data given in the original safety analysis report shall be given separately.

The cranes shall be designed and fabricated to standards SFS 4696 /6/ and SFS 4697 /7/. The cranes in Safety Class 3 are considered equal to cranes handling dangerous materials.

The hoisting and handling equipment, in which a failure may cause a possibility of a considerable radiation exposure at or in the vicinity of the nuclear facility, shall be accomplished by adding safety features to the structures, as well as adding safety devices and protective systems, so that the load-bearing components in handling of critical loads can be considered single-failure-proof. See NUREG-0554 /8/.

The fuel handling machines shall be able to move fuel safely from one place to another in the pool water that protects from radiation. The reliability of the hoisting mechanism shall conform to the requirements for the handling of critical loads.

Guidelines for design details are given, e.g. in publications:

- KTA 3902 /9/ provides the requirements for the design of the different types of hoisting appliances at nuclear facilities.
- Standard ANSI/ANS-57.1-1980 /10/ provides the design requirements for light water reactor fuel handling systems.

2.3 Materials

In the construction material data it shall be described the applicability of the construction materials to their intended use and presented the criteria for their approval.

The description shall, in the first place, comprise material data for all load-bearing or load-moving components and parts welded to them. The choice of construction materials shall be based on SFS standards dealing with selection criteria for hoisting appliance materials, or other standards that set forth comparable requirements for material quality. In addition, in defining the selection criteria for construction materials, the manufacturer shall also observe the requirements presented in the safety regulations and instructions the National Board of Labour Protection has at each time validated for hoisting appliances.

The material data shall include a list of base materials and welding filler materials giving the numbers of the parts in question (reference to drawings) and standard markings of the materials.

Steel materials shall be deoxidized. Grey pig iron shall not be used in the load-bearing members of the hoisting mechanism and its brakes.

The testing and sampling methods and the extent they are applied shall be defined on the basis of the type of the

construction material, service conditions and dimensioning.

2.4 Dimensioning

By means of analyses of the construction plan, it shall be verified that the equipment and each piece of it conforms to the requirements set forth as its design bases. The accounts in question are:

- dimensioning concerning strength to verify the endurance of the different parts in supposed load conditions,
- dimensioning criteria for the electrical and instrumentation components to verify their applicability to the designed equipment.

2.4.1 Strength calculations

The document shall be of one entity describing how the presented dimensioning has been reached as a result of the load combinations and material properties. The document shall be sufficiently detailed (references to standards) to make it possible to estimate the accuracy of the calculation method used and the fulfilment of the dimensioning requirements.

The dimensioning of the hoisting and handling equipment shall be based on classification of the appliance and the mechanism as a whole according to Standards SFS 4020 /11/ and SFS 4300 /12/. Class of utilization and state of loading of the appliance, as well as the classified service life and load factor of the mechanism shall be defined by means of load spectrum analysis.

The dimensioning concerning strength shall be performed in accordance with Standards SFS /11 - 26/, which are given as reference sources in the bibliography. In so called handling of critical loads, the cranes shall conform to the strength requirements according to paragraph 2.2 above.

The dimensioning of auxiliary lifting devices according to Standard SFS 4696 /6/ shall be in accordance with the resolution of the National Board of Labour Protection 356/059/74, 27 March 1974 /27/ and requirements set forth in Standards SFS 3804 /28/, SFS 4646 /29/ and SFS 5082 /30/.

The fatigue analysis of a hoisting and handling equipment part shall be given if, considering the points of discontinuity, points of stress concentration and classification of the part, there is any reason to suspect that the load on the part is fatiguing.

The dimensioning is also approved performed in accordance with standards FEM or ISO equivalent to the SFS standards in question. The application of the universal principles of strength of materials is also accepted.

When the strength analyses are executed with a computer a description of the programs shall be given completed, when necessary, with test run results of the programs to make it possible to assess the applicability of the program and the reliability of the results obtained. The input values entered, the functional elements and the default values used, as well as the interpretation of the results, shall be given in a short summary report.

2.4.2 Dimensioning of electrical and instrumentation components

The electrical and instrumentation components for the hoisting and handling equipment shall be dimensioned so that reliable operation is achieved and overloading is avoided in all normal service conditions. The structure and the electrical installations of the hoisting and handling equipment shall conform to the requirements set forth in the Electrical Inspectorate's Bulletin T43 /31/.

2.5 Drawings

2.5.1 Assembly drawings

The purpose of the drawings is to show the assembly and details of the structure in such a way that the dimensions, fabrication and operation of the hoisting and handling equipment can be seen in sufficient detail.

The drawings shall show, among other things:

- assembly data with part and material lists,
The assembly drawings shall also show the placement of the control equipment,
- the dimensions and shapes used in the dimensioning with permissible tolerances,
- locations and dimensions of joints,
- coating and surface finish of materials,
- hydraulic and pneumatic system schemes,
- location drawings showing the operating range and restrictions on motions of the hoisting appliance,
- walkways and service platforms to the extent as given in Standard SFS 4697 /7/,
- locations of markings set forth in Standard SFS 4696 /6/ and the rules for hoisting appliances nr. 22 /32/ compiled by the Ministry for Social Affairs and Health.

2.5.2 Electrical and instrumentation system drawings

For the inspection of the electrical and instrumentation apparatus for the hoisting and handling equipment STUK shall be furnished with the following documents:

- functional description of the control systems,
- primary circuit diagram for electrical power supplies showing the power supply to the electrical devices and the equipment necessary for controlling and regulating them,
- motor circuit diagram showing the electrical power

- supply to each motor,
- control circuit diagram showing in detail the design of the control circuits of the electrical equipment,
- logic diagram showing the operating principle of the control systems in different service conditions,
- regulating system circuit diagram showing the regulating principle of the systems,
- technical specification of the electric and instrumentation system equipment.

2.6 Quality control program

The quality control program shall include information on the quality control measures applied to the design, fabrication, installation and operational tests of the hoisting and handling equipment, including inspection procedures. The quality control of construction materials, welds, coatings, installation and completed structures shall be given part-specific.

The program includes:

- numbering of each part and welded joint in accordance with the drawings,
- name and quantity of the part,
- standard symbol of the construction materials and the weld filler materials and the type of required material certificate,
- wire rope splice validating test,
- division of the quality control measures in accordance with the item division in the inspection instructions,
- program for procedure tests.

If an inspection is included in the plan, it shall be indicated at which manufacturing stage it is carried out and which parties will perform the inspection/testing or

supervise it. The quality control program for installation may be submitted to STUK later.

Inspection rules shall be given for inspection and supervisory measures associated with the design, fabrication, installation and operational tests of the hoisting and handling equipment. The inspection rules shall include the inspection procedure, scope of the inspection, inspection requirements and reporting procedure concerning the inspection. In particulars may be referred to standards or safety regulations and instructions issued and validated by the authorities regulating hoisting appliances.

The most general quality control measures given in the inspection rules may be grouped as follows:

- review of the construction plans,
- identification, marking and certificates of materials,
- sampling in material testing and/or inspection
- destructive testing,
- non-destructive testing,
- supervision of procedure tests,
- the competence of welders as given in Standard SFS 2218 /33/ or in other comparable manner,
- supervision of welding,
- supervision of heat treatment,
- supervision of surface finishing or coating,
- inspection of electric and instrumentation component installations,
- measurement of technical data and properties of the electric and instrumentation components,
- operational tests of the electric and instrumentation systems,
- checking for dimensions,
- load testing and operational tests.

The load testing given in the inspection rules shall be performed in accordance with the requirements set forth

in the standards used in the dimensioning. The rules for load testing and operational tests shall, in the first place, conform to the requirements set forth in Standard SFS 4261 /34/.

2.7 Other descriptions

In this description are given other circumstances associated with the construction plan of the hoisting appliance. Such are the description of fabrication and installation, loading and dimensioning requirements for crane tracks, or references to documents providing the requirements. In addition, special aspects related to the structure and functional components, such as accident conditions in the containment and fire, are described in this paragraph.

3 SUPERVISION OF FABRICATION AND CONSTRUCTION INSPECTION

3.1 Supervision of fabrication

STUK supervises the fabrication of hoisting and handling equipment in Safety Class 3 by performing audits at the manufacturer's factory and the installation site. The inspectors of STUK shall be given an opportunity to familiarize themselves with the factory organization, the manufacturing processes and quality control procedures at the factory. For the audits STUK shall be furnished with the preliminary manufacturing schedule of the hoisting and handling equipment.

3.2 Construction inspection

The construction inspection is performed on all hoisting and handling equipment in Safety Class 3 according to Guide 1.15 /35/. This guide is also applied to crane tracks mounted on buildings. Load testing may be performed in connection with the operational tests.

4 COMMISSIONING INSPECTION

Any piece of equipment this guide is applied to must not be commissioned before an inspector employed by STUK has approved it at the commissioning inspection.

The commissioning inspection is performed after the equipment, the stops or interlocks on its pathways, the auxiliary systems (power supplies, controlling, safety and communication equipment) and auxiliary structures are completely installed and the construction of its pathways is inspected.

The person responsible for the operation of the equipment and the personal needed for the operational tests shall be at present at the inspection. A request for a commissioning inspection shall be sent to STUK in good time before the intended date of inspection. The commissioning inspection is divided into two phases; verification and supervision of operational tests.

4.1 Verification of installation and inspection status

In the verification it is ensured that the construction plan of the installed equipment has been approved and the construction inspection completed and the associated qualifications have been met. In addition, a review is carried out of the placement and pathway stops of the equipment and the acceptability of the construction inspections of the pathways.

During the verification of the hoisting and handling equipment the inspector from STUK shall be presented with an inspection book containing:

- document list,
 - covering letters and front leaves of the documents,
 - resolutions and letters sent by the Finnish Centre for Radiation and Nuclear Safety
 - inspection protocols,
-

- written accounts on inspector's notes,
- design data of the equipment,
- assembly drawings,
- list of accessories with references.

During the verification the representative of STUK shall also be presented with an approved construction plan and a written account of the fulfilment of the conditions in a conditional decision, as well as preliminary plans for supervision of the service condition and maintenance of the equipment.

At a later date, the inspection book shall be supplemented with inspection protocols and, as for the supervision of operation, with significant result material concerning repairs, modifications and design work or with summaries of and references to this material. A database should be kept of accomplished maintenance measures.

4.2 Supervision of operational tests

A operational test program is prepared for the hoisting and handling equipment containing data on operational tests and load testing. The operational test program shall be approved by STUK before the tests are initiated.

The instructions for load testing and operational tests shall primarily conform to requirements for load testing and test operation set forth in Standard SFS 4261 /34/.

The operational tests are performed to verify the ability of the equipment to perform as designed. During the operational tests, it may be checked that the requirements for certain technical values are met, e.g. quantities measurable after installation (electric quantities, safety clearances etc.).

Operation in all parts of the operating range and the limits of the operating range shall be tested in the most unfavourable loading conditions, if no other procedure is given in the operational test program.

The operational test measures shall be entered in a protocol with an unequivocal description of the test situation, accomplished tests with test results and the acceptability of the results.

5 INSERVICE INSPECTION

The inservice inspection programs shall be submitted to STUK in good time before the hoisting and handling equipment is commissioned at the nuclear facility. The program for inservice inspections shall show:

- intervals and extent of the inspections,
- standards and other regulations applied,
- inspection personnel
- the preparation of the the item to be inspected for inspection,
- inspection rules and reporting procedure.

The inservice inspection intervals and the extent of the inspections shall be defined in view of the intended use and loading frequencies of the hoisting and handling equipment.

STUK supervises the above mentioned inservice inspections, as deemed necessary.

6 REPAIRS AND MODIFICATIONS

Requirements concerning repairs and modifications at nuclear facilities during operation are presented in Guide YVL 1.8 /36/.

7 SPARE PARTS

The construction plan of the hoisting and handling equipment is also valid for spare parts. All changes shall be submitted to STUK individually. The construction inspection of the spare parts is conducted in the same extent as the inspection of the original parts.

8 BIBLIOGRAPHY (E English translation available)

- /1/ E STUK Guide YVL 1.1, "The Institute of Radiation Protection as the supervising authority of nuclear power plants", 1976
 - /2/ E STUK Guide YVL 2.1, "Safety Classification of nuclear power plant systems, structures and components", 1982
 - /3/ E STUK Guide YVL 6.5, "Supervision of nuclear fuel transport", 1984
 - /4/ E STUK Guide YVL 1.2, "Formal requirements for the documents to be submitted to the Institute of Radiation Protection", 1976
 - /5/ E STUK Guide YVL 1.3, "Mechanical components and structures of nuclear power plants. Inspection licenses", 1983
 - /6/ E SFS 4696, "Cranes. Safety code".
 - /7/ E SFS 4697, "Cranes. Safety clearances, walkways and service platforms".
 - /8/ E NUREG-0554, "Single-failure-Proof Cranes for Nuclear Power Plants", U.S.N.R.C., 1979
 - /9/ KTA 3902, "Auslegung von Hebezeugen in Kernkraftwerken", Fassung 11/83
 - /10/ E ANSI/ANS-57.1-1980, "Design Requirements for Light Water Reactor Fuel Handling Systems", ANS, 1980
 - /11/ E SFS 4020, "Rules for the design of hoisting appliances. Steel structures".
 - /12/ E SFS 4300, "Rules for the design of hoisting appliances. Mechanisms".
-

- /13/ E SFS 4021, "Hoisting appliances. Harmonisation of the classifications of structures and mechanisms".
- /14/ E SFS 4022, "Rules for the design of hoisting appliances. Calculation of loads due to acceleration of horizontal motions".
- /15/ E SFS 4023, "Rules for the design of hoisting appliances. Joints using high-strength bolts with controlled tightening".
- /16/ E SFS 4024, "Rules for the design of hoisting appliances. Stress in welded joints".
- /17/ E SFS 4025, "Rules for the design of hoisting appliances. Checking structural members subject to gripping and buckling".
- /18/ E SFS 4026, "Rules for the design of hoisting appliances. Checking structural members subject to fatigue".
- /19/ E SFS 4027, "Tolerances of cranes and tracks".
- /20/ E SFS 4104, "Cranes and lifting appliances. Steel wire ropes. Dimensioning".
- /21/ E Rules for the design of hoisting appliances. Determination of permissible stresses in mechanism components subjected to fatigue".
- /22/ E SFS 4407, "Hoisting appliances. Choice of brakes".
- /23/ E SFS 4691, "Rope attachments. Wire-rope sockets".
- /24/ E SFS 4764, "Lifting hooks. Mechanical properties. Load capacities. Stresses and materials".
- /25/ E SFS 4765, "Lifting hooks. Shank hooks with a point. Forgings".
- /26/ E SFS 4766, "Lifting hooks. Shank hooks with a point. Cylindral shank or shank with a thread".
- /27/ E 356/059/74,27.3.1974, "Resolution of the National Board of Labour Protection concerning the regulations followed in the loading and unloading of vessels, and their application to craning services".
- /28/ SFS 3804, "Lifting straps. Slings and strops from natural or man made fibres".

- /29/ SFS 4646, "Flat worn webbing slings made of man-made fibre".
- /30/ SFS 5082, Wire rope slings for general purposes. Characteristics and specifications".
- /31/ SETI t43-82, "Electrical Accessories in Cranes", 1982-10.
- /32/ Safety Guide Nr. 22 "Cranes, guidelines for suppliers, assemblers and users (Rules for Cranes), the Ministry of Social Affairs and Health", 1975.
- /33/ E SFS 2218, "Welding. Qualification of welders".
- /34/ E SFS 4261, "Test of the hoisting appliances under overload conditions".
- /35/ E Guide YVL 1.15, "Mechanical components and structures in nuclear installations, Construction inspection", STUK 1984
- /36/ E Guide YVL 1.8, "Repairs, modifications and preventive maintenance in nuclear facilities", STUK 1986.

In the event of any differences in interpretation of this guide, the Finnish version shall take precedence over this translation.