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Cranes — Classification —

Part 1: General

Appareils de levage à charge suspendue — Classification —

Partie 1: Généralités

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 96, *Cranes*, Subcommittee SC 10, *Design principles and requirements*.

This third edition of ISO 4301-1 constitutes a technical revision of ISO 4301-1:1986, which is provisionally retained as it specifies another approach to the classification of cranes that will continue to be used within the industry for some time. See also Annex B.

ISO 4301 consists of the following parts, under the general title *Cranes — Classification*:

— *Part 1: General*

— *Part 2: Mobile cranes*

— *Part 3: Tower cranes*

— *Part 4: Jib cranes*

— *Part 5: Overhead travelling and portal bridge cranes*

Introduction

Cranes play a part in the handling of materials by raising and moving loads the mass of which is within their rated capacity. However, there may be wide variations in their duty. The design of the crane has to take account of the duty in terms of conditions of service, in order to reach an appropriate level of safety and useful life which is in line with the purchaser's requirements.

Classification serves as a reference framework between purchaser and manufacturer, by which a particular appliance can be matched to the intended service. It also is the system used to provide a means of establishing rational bases for the design of structures and machinery.

Cranes — Classification —

Part 1:
General

1 Scope

This part of ISO 4301 establishes a general classification of cranes and mechanisms based on the service conditions, mainly expressed by the following:

— the total number of working cycles to be carried out during the specified design life of the crane;

— the load spectrum factor which represents the relative frequencies of loads to be handled;

— the average displacements.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 4306 (all parts), *Cranes — Vocabulary*

3 Definitions

For the purposes of this document, the terms and definitions given in ISO 4306 apply.

4 Symbols

The main symbols used in this document are given in Table 1.

Table 1 — Main symbols

Symbol	Description
A	Classes for group classification
C	Total number of working cycles
D	Classes for average displacement
K_p	Load spectrum factor
K_{cp}	Load effect spectrum factor of components
P [P]	Individual load magnitudes (load levels) of the crane [classes]
Q_p	Classes Q of load spectrum factors K_p
Q_{cp}	Classes Q of load effect spectrum factor K_{cp} of components
U	Classes of total numbers of working cycles C

5 Use of classification

5.1 General

Classification has two applications in practice (see 5.2 and 5.3), which although related can be regarded as separate objectives.

Determination of an appropriate life requires consideration of economic, technical and environmental factors, and should have regard to the influence of obsolescence.

5.2 Use of classification for commercial specification

The classification is applied by the purchaser and the manufacturer of a crane and/or load lifting attachments, between which agreement is necessary on the duty of the crane. The classification thus agreed is intended for contractual and technical reference purposes.

It is also used to specify the service conditions of cranes, load lifting attachments, or components which are designed for serial manufacture and allows such items to be selected in accordance with their intended use.

The specified classification shall be documented in the crane manuals.

5.3 Use of classification in the design

The second purpose of classification is to provide a basis for the designer to build up his analysis of the design and to verify that the crane or component is capable of achieving the intended life under the specified service conditions of the particular application.

As a person skilled in crane technology, the designer takes the specified service conditions, either provided by the purchaser or predetermined by the manufacturer (as is the case in the design of serial equipment), and incorporates them into the assumptions on which his analysis is based, having regard to all other factors which influence the proportioning of components.

Crane operation gives rise to stress or load histories in crane structures and components (e.g. wire ropes, slewing bearings, or wheels and rails). These histories may be classified for the particular component. The method of determining this classification is set out in the appropriate standards, e.g. for structures in ISO 20332.

6 Classification of crane duty for the crane as a whole

6.1 General

Crane duties are determined by the following parameters:

a) the total number of working cycles during the design life;

b) the relative frequencies of loads to be handled (load spectrum, state of loading);

c) the average displacements.

When the classified ranges of parameters are used, the design shall be based on the maximum values of the parameters within the specified classes. Use of an intermediate value for a parameter is permissible, but in that case this design value shall be determined and indicated instead of the class.

6.2 Total number of crane working cycles

For the purpose of classification, a crane working cycle is a sequence of movements which commences when the crane is ready to hoist the load and ends when the crane is ready to hoist the next load within the same task. A task, r, can be characterized by a specific combination of crane configuration and sequence of intended movements.

In certain specific tasks for which cranes are used, for example, bulk unloading by grab, the number of cycles can readily be derived from a knowledge of the total number of working hours and the number of operating cycles per hour. In other cases, for example, mobile cranes, the number is less easy to determine because the crane is used in a variety of duties and it becomes necessary to estimate suitable values on the basis of experience. The total number of working cycles, C, is the sum total of all working cycles during the design life of the crane.

The total number of crane working cycles during the design life of a crane can be separated into the numbers of working cycles corresponding to several typical tasks.

The total number of crane working cycles is related to the frequency of use (e.g. daily) and the intended life (in years) of the crane. For convenience, the range of the total number of crane working cycles has been divided into 10 classes of utilization in Table 2.

Table 2 — Classes U of total numbers of crane working cycles, C

Class of utilization	Total number of crane working cycles, C
U_0	$C \leq 1{,}6 \times 10^4$
U_1	$1{,}6 \times 10^4 < C \leq 3{,}15 \times 10^4$
U_2	$3{,}15 \times 10^4 < C \leq 6{,}3 \times 10^4$
U_3	$6{,}3 \times 10^4 < C \leq 1{,}25 \times 10^5$
U_4	$1{,}25 \times 10^5 < C \leq 2{,}5 \times 10^5$
U_5	$2{,}5 \times 10^5 < C \leq 5 \times 10^5$
U_6	$5 \times 10^5 < C \leq 1 \times 10^6$
U_7	$1 \times 10^6 < C \leq 2 \times 10^6$
U_8	$2 \times 10^6 < C \leq 4 \times 10^6$
U_9	$4 \times 10^6 < C \leq 8 \times 10^6$

6.3 State of loading

The load spectrum factor, K_p, is one of the parameters used to specify the duty of the crane by describing the different net loads to be handled during the working movements. The load spectrum factor takes into account the number of times a load of a particular magnitude, in relation to the rated capacity of the crane, is lifted.

Six nominal values of load spectrum factor are listed in Table 3, each numerically representative of a corresponding nominal state of loading.

Where details of the numbers and masses of loads to be handled during the design life of the crane are not known, the selection of an appropriate nominal state of loading shall be agreed between the manufacturer and purchaser.

Alternatively, where precise details are available of the magnitudes of the loads and the number of times these will be handled during the design life of the crane, the load spectrum factor for a task may be calculated as follows.

The load spectrum factor, K_p, is given by Formula (1):

$$K_p = \sum \left[\frac{C_i}{C_T} \times \left(\frac{P_i}{P_{max}} \right)^m \right] \quad (1)$$

where

C_i represents the average number of load cycles which occur at the individual load levels, = C_1, C_2, C_3... C_n;

C_T is the total of all the individual load cycles at all load levels, = $\Sigma\, C_i = C_1 + C_2 + C_3... + C_n$;

P_i represents the individual load magnitudes (load levels), = P_1, P_2, P_3... P_n

P_{max} is the heaviest load (rated load for hoists) that may be handled by the crane or its mechanism;

m = 3.

Expanded, Formula (1) becomes:

$$K_p = \frac{C_1}{C_T} \times \left(\frac{P_1}{P_{max}} \right)^3 + \frac{C_2}{C_T} \times \left(\frac{P_2}{P_{max}} \right)^3 + \frac{C_3}{C_T} \times \left(\frac{P_3}{P_{max}} \right)^3 + \cdots + \frac{C_n}{C_T} \times \left(\frac{P_n}{P_{max}} \right)^3 \quad (2)$$

Where there are several tasks, r, a value K_p for all tasks is obtained from

$$K_p = \sum_r \frac{C_r}{C_{Tr}} \times K_{pr} \times \left(\frac{P_{max,r}}{P_{max}} \right)^3 \quad (3)$$

where the subscript, r, indicates the value for the respective task r.

The load spectrum factor for the crane is then established by matching the calculated load spectrum factor to the closest (higher) nominal value of K_p in Table 3.

Table 3 — Classes Q_p of load spectrum factors, K_p

State of loading	Load spectrum factor K_p	Remarks on the use of crane
Q_p0	$K_p \leq 0{,}031\ 3$	Cranes which hoist usually very light loads and the rated load very rarely
Q_p1	$0{,}031\ 3 < K_p \leq 0{,}062\ 5$	
Q_p2	$0{,}062\ 5 < K_p \leq 0{,}125$	Cranes which hoist the rated load occasionally and, normally, light loads
Q_p3	$0{,}125 < K_p \leq 0{,}25$	Cranes which hoist the rated load fairly frequently and, normally, moderate loads
Q_p4	$0{,}25 < K_p \leq 0{,}50$	Cranes which hoist the rated load frequently and, normally, heavy loads
Q_p5	$0{,}50 < K_p \leq 1{,}00$	Cranes which are regularly loaded close to the rated load
NOTE The classes Q_p differ from the classes Q of ISO 4301-1:1986.		

6.4 Group classification

Having determined the class of utilization from Table 2 and the state of loading from Table 3, they can be combined into a single group classification for the crane as a whole. The group classification is determined from Table 4.

Table 4 — Classes A for group classification

Classes Q_p and load spectrum factor K_p		Classes U and total number of work cycles									
Class Q_p	Design value of load spectrum factor K_p	U_0 $1,6 \times 10^4$	U_1 $3,15 \times 10^4$	U_2 $6,3 \times 10^4$	U_3 $1,25 \times 10^5$	U_4 $2,5 \times 10^5$	U_5 $5,0 \times 10^5$	U_6 $1,0 \times 10^6$	U_7 $2,0 \times 10^6$	U_8 $4,0 \times 10^6$	U_9 $8,0 \times 10^6$
Q_p0	0,031 3	A03	A02	A01	A0	A1	A2	A3	A4	A5	A6
Q_p1	0,062 5	A02	A01	A0	A1	A2	A3	A4	A5	A6	A7
Q_p2	0,125 0	A01	A0	A1	A2	A3	A4	A5	A6	A7	A8
Q_p3	0,250 0	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9
Q_p4	0,500 0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
Q_p5	1,000 0	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11

Where the Q_p and U classes are not specified and only the A class is given, the design calculations shall be based on the number of full load cycles, C_f, as given in the Table 5.

Table 5 — Design basis by classes

A-class	Design number of full load cycles, i.e. $K_p = 1$ C_f
A03	500
A02	1 000
A01	2 000
A0	4 000
A1	8 000
A2	16 000
A3	31 500
A4	63 000
A5	125 000
A6	250 000
A7	500 000
A8	1 000 000
A9	2 000 000
A10	4 000 000
A11	8 000 000

6.5 Average displacements

6.5.1 General

The fatigue design of detailed components requires the values of the stress histories to be determined.

For drive systems, there is a direct proportional relation between number of stress cycles and the displacement, between travel distance and rotation of wheels or shafts or between hook path and number of wire rope bendings.