DRAFT INTERNATIONAL STANDARD ISO/DIS 8568

ISO/TC **108**/SC **6** Secretariat: **GOST R**

Voting begins on **2002-06-06** Voting terminates on **2002-11-06**

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

Mechanical shock — Testing machines — Characteristics and performance

[Revision of first edition (ISO 8568:1989)]

Chocs mécaniques — Machines d'essai — Caractéristiques et performance

ICS 17.160

In accordance with the provisions of Council Resolution 15/1993 this document is circulated in the English language only.

Conformément aux dispositions de la Résolution du Conseil 15/1993, ce document est distribué en version anglaise seulement.

To expedite distribution, this document is circulated as received from the committee secretariat. ISO Central Secretariat work of editing and text composition will be undertaken at publication stage.

Pour accélérer la distribution, le présent document est distribué tel qu'il est parvenu du secrétariat du comité. Le travail de rédaction et de composition de texte sera effectué au Secrétariat central de l'ISO au stade de publication.

THIS DOCUMENT IS A DRAFT CIRCULATED FOR COMMENT AND APPROVAL. IT IS THEREFORE SUBJECT TO CHANGE AND MAY NOT BE REFERRED TO AS AN INTERNATIONAL STANDARD UNTIL PUBLISHED AS SUCH.

IN ADDITION TO THEIR EVALUATION AS BEING ACCEPTABLE FOR INDUSTRIAL, TECHNOLOGICAL, COMMERCIAL AND USER PURPOSES, DRAFT INTERNATIONAL STANDARDS MAY ON OCCASION HAVE TO BE CONSIDERED IN THE LIGHT OF THEIR POTENTIAL TO BECOME STANDARDS TO WHICH REFERENCE MAY BE MADE IN NATIONAL REGULATIONS.

Contents

Page

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 8568 was prepared by Technical Committee ISO/TC 108, *Mechanical vibration and shock*, Subcommittee SC 6, *Vibration and shock generating systems*.

This second edition cancels and replaces the first edition (ISO 8568:1989) which has been technically revised.

Annexes A to D are for information only.

Mechanical shock — Testing machines — Characteristics and performance

1 Scope

This International Standard gives guidlines for describing characteristics, performance parameters and methods of inspection of shock-testing machines. It is intended to ensure that the potential user of a particular shock machine is provided with an adequate description of the characteristics of the machine and to give guidance for the selection of such machines.

This International Standard is applicable to the shock-testing machines that are used for demonstrating or evaluating the effect of shock conditions representative of the service environment in accordance with IEC 60068 Standard series and also for diagnostic testing. The purpose of the shock test is to reveal mechanical weakness and/or degradation in specified performance. It may also be used to determine the structural integrity of a test specimen or as a means of quality control.

Machines used for metal working, forming, etc. are not covered in this International Standard.

Several techniques for generating the desired shock motion are discussed. Both simple-pulse and complex transients may be produced. The simulation of transients can be achieved by control of the test with a specified shock spectrum.

Environmental shock test requirements frequently occur in conjunction with vibration test requirements. Vibration generators can be used when frequency, acceleration, velocity change and displacement requirements for the specified shock are within the capabilities of the machine. Making use of test equipment and fixtures already on hand or justified for vibration testing alone has obvious economic advantages for environmental test laboratories. Characteristics of vibration generating equipment are covered in ISO 5344, ISO 6070 and ISO 8626.

NOTE Annex A gives description of pulse-shaping devices. Annex B defines methods of application of the shock response spectra. Annex C considers a method of evaluating the possibility of use a vibration generator for producing a shock pulse. Annex D deals with the methods of measurement of some characteristics in inspection methods (or procedures) of shock testing machines.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 2041:1990, *Mechanical vibration and shock — Vocabulary.*

ISO 5344:1980, *Electrodynamic test equipment for generating vibration — Methods of describing equipment characteristics.*

ISO 5347 (all parts), *Methods for the calibration of vibration and shock pick-ups.*

ISO 5348:1987, *Mechanical vibration and shock — Mechanical mounting of accelerometers.*

ISO 6070:1981, *Auxiliary tables for vibration generators — Methods of describing equipment characteristics.*

ISO 8626:1989, *Servo-hydraulic test equipment for generating vibration — Methods of describing equipment characteristics.*

ISO 16063 (all parts), *Methods for the calibration of vibration and shock transducers.*

IEC 60068-1:1988, *Environmental testing — Part 1: General and guidance*.

IEC 60068-2-27:1987, *Environmental testing — Part 2: Tests — Test Ea and guidance: Shock.*

3 Terms and definitions

For the purposes of this International Standard, the terms and definitions given in ISO 2041 and the following apply.

3.1
shock-testing machine
a physical assembly that generates the shock and applies it to the test specimen, as well as all auxiliary power, cooling, control, pulse shaping, and monitoring equipment necessary to form a complete system. Shock-testing machines can be classified as specially designed shock generators and vibration generators of electrodynamic and servo-hydraulic types used in a shock mode

3.2
check point
a fixing point nearest to the centre of the table surface of the shock testing machine, unless there is a fixing point having a more rigid connection to the table, in which case the latter point shall be used

4 General

4.1 Performance of a shock-testing machine

Performance of a shock-testing machine is based on a relatively slow accumulation of energy used to reproduce a shock and its consequent discharge in an energy transducing device for a short period of time.

At this conditions the mean value of the shock force is more than the mean value of the force applied to the impacting mass between the shocks in so many times as the mean shock duration is less than the time interval between the shocks.

The energy needed to create a shock may be achieved by the work against gravity (in free-fall machines) or, if the shock has to be in a direction other than downwards or if the free-fall machine does not provide enough velocity change, the necessary potential energy may be supplied by elastic cords, springs or hydraulic and pneumatic means.

The shock can also be achieved by releasing compressed gas, by explosives or by transfer of momentum from one moving mass to another.

4.2 Principles used in shock-testing machine

According to the principle used free-fall (gravity-activated) or accelerated shock-testing machines or gas guns, explosive guns, hydraulic and pneumatically driven shock-testing machines are classified.

Electrodynamic and servo-hydraulic test equipment for generating vibration is also used for shock testing. These machines can generate classical shock waveforms (half-sine, trapezoidal, saw-tooth, etc.) as well as arbitrary waveforms which have the required shock response spectra produced by means of digital control, but generally have limited velocity and displacement capability. Method of maintaining the above limitations is briefly treated in annex C of this International Standard.

The shock pulse - either a single-pulse or a transient vibration - is produced by a shock pulse-shaping device mounted either on the table or carriage, on the reaction mass, or on both. A wide selection of pulse shapes can be produced depending on how the kinetic energy is transferred by pulse-shaping devices. Annex A gives some guidelines on selection of pulse-shaping devices.

Pulse-shaping devices can be used in a rebounding or non-rebounding mode. Usually the device for attaching a test specimen is initially accelerated and a shock is produced during the rebound of the test specimen. Sometimes (for large masses or when the initial acceleration of test specimen is undesirable) a reaction mass or a hammer can be initially accelerated and the shock is produced as a result of the impact between the reaction mass and a device for attaching a test specimen. This mode is classified as a non-rebound one and it consumes approximately twice the impact velocity and up to four times the accumulated energy and the deflection of the pulse-shaping device.

As an alternative to the shaping of the shock pulse, for electrodynamic or servo-hydraulic vibration generators the shock spectrum of the impulse to be applied to the specimen may be shaped to be similar to a test shock spectrum.

4.3 Shock-testing classification

4.3.1 Shock pulse reproduction

The classic shock pulse shapes in accordance with IEC 60068-2-27 standard are generated, with additional pre-pulse and post-pulse shaping to limit velocity and displacement. The amplitude of the pre-pulse and post-pulse shapes is limited to a small fraction of the primary pulse amplitude.

4.3.2 Shock response spectrum reproduction

A brief, low level oscillatory transient impulse is typically applied to the specimen. The shock response spectrum is measured, compared with the desired shock response spectrum, and the difference used to modify the shape of the next impulse. Typically this process is repeated several times until the desired shock spectrum is achieved, then an input transient impulse of the desired level is applied to the specimen. The desired shock spectrum may be either standardised (one of the shock spectra of annex B) or the shock spectrum of a field environment.

4.4 Constitution of a shock-testing machine

A shock-testing machine consists of:

— a rigid table or carriage with means of attaching test specimens and shock pulse-shaping devices;

— a set of guides that control the movement of the carriage;

— a means for storing the potential energy necessary for imparting the shock, such as provisions for hoisting or preloading springs and cords attached to the carriage;

— a means for securing the carriage at a selected drop height or position, prior to initiation of the shock pulse;

— release mechanism;

— a reaction mass or base upon which the carriage impacts;

— a pulse-shaping and rebound braking system or a mean to generate and control the shock spectra;

— control equipment;

— shock-measuring system;

— auxiliary power, cooling and the other equipment, as required.

5 Specification of shock-testing machine

The motion of the table or carriage may be specified by shock spectra and/or time-history parameters. Where applicable, data, together with tolerances, shall be given for the following items.

a) Available pulse shapes.

b) The maximum velocity change.

c) The maximum displacement.

d) Range of reproducible shock-pulse peak accelerations.

e) Initial or pre-pulse acceleration and final or post-pulse acceleration.

f) Range of shock-pulse duration.

g) Minimum and maximum frequencies of produced shock spectrum.

h) Shock spectrum flatness and number of lines resolved in shock spectrum.

i) Maximum drop height, preload pressure or charge.

j) Tare weight of table or carriage and total moving mass.

k) Maximum stiffness, strength and damping of the table or carriage.

l) Natural frequencies of the table or carriage.

m) Natural frequencies of the machine on its foundation.

n) Required pressure and volume of gas and liquids.

o) Quantities and flow rates of fluid or gas for the operation of the machine.

p) Type of rebound braking system and braking force.

q) Size and overall dimensions of the machine and its parts, especially the table or carriage and its accessories.

r) Dimensions, weight and mounting method of reaction masses and floor loading requirements.

s) Maximum size and mass of test specimen.

t) Mounting facilities for test specimen and transducers.

u) Number of shocks (shock pulses) possible per unit time, or alternatively, minimum period between two shocks.

v) Specification of the used shock-measuring system.

w) Centre of gravity of table, plus effect of any off centre load.

x) Acceptable range of environmental conditions, i.e. temperature, humidity, etc.

6 Requirements for shock-testing machines

6.1 General

The performance of shock-testing machine shall be defined and specified by the manufacturer.

Detailed installation, operation and maintenance instruction manuals shall be provided by the manufacturer.

Instructions shall include requirements for periodic inspection, maintenance and lubrication of the equipment. The signs of wear of replaceable components and possible structural failure shall be described by the manufacturer. Appropriate steps shall be proposed for reconditioning deteriorated pulse-shaping devices and repairing leaks in the pneumatic and hydraulic systems.

The application and mounting of test specimens, adapter plates and fixtures to the table or carriage shall be thoroughly described. The effects on the test of eccentric or faulty loading of the carriage shall be explained.

Installation dimensions shall include adequate working room, overhead clearances and walk-ways around the equipment.

The electrical power requirements shall be stated. The normal operation of the machine shall not cause any interference in the power network that might affect the test monitoring instrumentation.

If a shock-testing machine operates by means of compressed gases or fluids then adequate seals shall be used to prevent blow-out of gases or fluids during the test. All sections of barrels, cylinders and piping shall be designed with an adequate safety factor. The maximum expected pressures produced throughout the worst case test shall be considered.

6.2 Safety requirements

The overall machine design and installation shall provide sufficient safety and protect personnel from flying objects if the equipment or test specimen fails structurally.

Guns shall be located in restricted remote areas with adequate blast-proof enclosures for the protection of personnel. The maximum gas pressures external to the gun and sound pressure levels shall be specified.

The table or carriage, piston or sabot shall be securely retained and fixed when being made ready for testing. The table or carriage shall be prevented from striking the reaction mass while personnel are assembling pulse-shaping devices.

The release or firing shall only be possible on command. The release mechanism shall be fail-safe and it shall be impossible to accidentally activate the release mechanism, for example by providing two simultaneously activated switches; one of which is lockable.

Gases which are likely to be compressed during testing shall not present any risk of spontaneous combustion by self-ignition.

It should be considered that shock-testing machines can be used for human exposure testing and should therefore have proven reliability and safety. For such machines, the table or carriage shall be accessible immediately after the impact so that the human subject can be released quickly.

Protection shall be provided to protect humans from electrical terminals.

6.3 Table or carriage

The table or carriage (piston, sabot, spigot or tubes) and all accessories used for movement of the test specimen during the shock test shall be designed for maximum stiffness, strength and damping.

The means of attaching a test specimen and the limits of torque to be applied to the fixing screws shall be indicated.

In the case of test tables, it shall be stated whether or not they are fitted with replaceable threaded inserts and whether they are recessed or raised. All test specimen mounting surfaces shall be geometrically flat and of minimum roughness and the applicable tolerances shall be stated. If the surface is fitted with recessed inserts, the flatness of the whole surface shall be indicated for normal reference atmospheric conditions (see IEC 60068-1:1978, chapter 5). If replaceable raised inserts are provided the resulting co-planarity of the insert surfaces shall be given, based on the thickness tolerance of the insert flanges and the flatness of the insert mounting surface.

The maximum torque to be applied to replaceable inserts during installation shall be stated along with the types of materials being mated.

A dimensioned drawing or diagram shall be provided giving all dimensions of the table or carriage, the dimensions and positional tolerances of the inserts and the material from which they are made.

The maximum permissible torque and axial force that may be applied to the inserts shall be stated, along with the required perpendicularity of the test specimen fixing screws with respect to the mounting surface.

6.4 Hoisting or pre-loading

The free-fall and the accelerated shock-testing machines and machines that use a hammer or a pendulum shall be supplied with mechanisms for hoisting and pre-loading the carriage to a predetermined drop height or tension, for example by means of a built-in height- or angle-measuring scale with a residual indicator. The precision of the drop height or pre-load setting shall be specified together with tolerances. The machine shall be fitted with devices to stop the carriage automatically or to indicate to the operator when the carriage has reached a predetermined drop height or pre-load. The manufacturer shall specify the maximum drop height or pre-load.

If the test has to be aborted, it shall be possible to disarm the machine and safely lower the table or carriage.

6.5 Braking systems

Shock-testing machines should be equipped with adequate braking systems. Braking may be achieved by mechanical, electrical, pneumatic or hydraulic devices; shock-absorbing materials or parachutes may be employed on devices that are in free trajectory and shall be recovered with minimum damage.

The design of the braking system shall ensure that minimum vibration is super-imposed on the pulse trace and that shock tests can be limited to a single pulse.

Acceleration limits for braking shall be given by the manufacturer together with information on the braking force required for controlled braking. The magnitude of acceleration applied during braking should not exceed 25 % of that applied during the test pulse.

A shock-testing machine not equipped with braking system should be adequately marked and by other means prevented from causing damage.

6.6 Reaction mass

If a reaction mass is used, it shall be a large and rigid structure by comparison with the table or carriage.

The resonance of the reaction mass shall have sufficiently high frequencies to avoid distortion of the shortest shock pulse duration for which the machine is rated.

Seismically-suspended reaction masses can be used. They can be installed where the shock has to be isolated from the surroundings and where reduced dynamic floor loading is required. They can also be used in order to control the recoil motion of the shock table or carriage by momentum transfer to the reaction mass.

The manufacturer shall provide or recommend dimensions, weights and ratio between the moving mass including the test specimen and the reaction mass, together with mounting methods.

6.7 Shock pulse-shaping devices and methods

The springs, impact pads and pulse programmers or generators used for controlling the shock pulse, i.e. the pulse shape, duration and acceleration, depend on the dynamic force-deflection characteristics of the pulse-shaping device.

If two or more masses are involved in a momentum exchange, the shock motion of each mass shall be taken into consideration in the design of the shock pulse-shaping device.

Any special equipment needed to form the pulse-shaping devices, for example moulds for making lead forms, shall also be specified. A guide for choosing shock-shaping devices is the subject of Annex A of this International Standard.

Similarly, a special electronic shock synthesising controller typically is used to generate the input signal to an electrodynamic or servo-hydraulic vibration generator used to generate a shock impulse (see Annex B).

7 Inspection of a shock-testing machine

7.1 General

A procedure shall be specified for performing a shock calibration test for periodic evaluation of system performance. A periodic check of the test equipment characteristics shall be carried out in accordance with the specified control method or manual.

Calibration interval of shock-tasting machine shall be defined by the manufacturer and can be changed by the user depending on constancy of characteristics to be certified and intensity of shock-testing machine use with time.

7.2 Inspection procedure

The following operations shall be carried out during the inspection procedure.

a) Preliminary inspection of a shock-testing machine operation.

b) Metrological examination of the following shock-pulse parameters for each test operating mode of a shock-testing machine:

   1) range of peak accelerations;

   2) range of shock-pulse durations;

   3) available pulse shapes;

   4) ratio of superimposed oscillations in the time history of shock accelertaion.

c) Metrological examination of a dimensionless shock spectrum for those test operating modes, which are declared by the manufacturer.

d) Determination of instability of peak accelerations or the values of a dimensionless shock spectrum reproduction for shock-testing machines for repetitive shocks as well as for shock-testing machines which do not have a built-in measuring system.

e) Determination of number of shocks (shock pulses) possible per unit time for shock-testing machines for repetitive shocks.

f) Determination of nonuniformity of shock acceleration along the table or carriage.

g) Determination of relative transverse shock acceleration reproduced by shock-testing machine.

