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BRITISH STANDARD 2613 : 1970

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METRIC UNITS

SPECIFICATION FOR

THE ELECTRICAL PERFORMANCE OF ROTATING ELECTRICAL MACHINES

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SPECIFICATION FOR

THE ELECTRICAL PERFORMANCE OF ROTATING ELECTRICAL MACHINES

BS 2613 : 1970

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Second revision May, 1970.

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The Institution desires to call attention to the fact that this British Standard does not purport to include all the necessary provisions of a contract.

A complete list of British Standards, numbering over 5000, fully indexed and with a note of the contents of each, will be found in the British Standards Yearbook, price £1. The BS Yearbook may be consulted in many public libraries and similar institutions.

This standard makes reference to the following British Standards:

BS 205. Glossary of terms used in electrical engineering.
BS 269. Rules for methods of declaring efficiency of electrical machinery (excluding traction motors).
BS 358. Method for the measurement of voltage with sphere-gaps (one sphere earthed).
BS 2725. Memorandum on the measurement of cooling medium temperature when testing electrical machines, transformers and other electrical apparatus.
BS 2757. Classification of insulating materials for electrical machinery and apparatus on the basis of thermal stability in service.
BS 2960. Dimensions of 3-phase electric motors.
BS 3979. Dimensions of electric motors (metric series).
BS 4296. Methods of test for determining synchronous machine quantities.
BS 4362. Rotating electrical machinery.

British Standards are revised, when necessary, by the issue either of amendment slips or of revised editions. It is important that users of British Standards should ascertain that they are in possession of the latest amendments or editions.

The following BSI references relate to the work on this standard:
Committee reference ELE/1/1 Draft for comment 68/9230

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CO-OPERATING ORGANIZATIONS

The Electrical Industry Standards Committee under whose supervision this British Standard was prepared consists of representatives from the following Government departments and scientific and industrial organizations:

Associated Offices' Technical Committee
*Association of Consulting Engineers
Association of Mining Electrical and Mechanical Engineers
*Association of Supervisory and Executive Engineers
*British Electrical and Allied Manufacturers' Association
*British Railways Board
British Radio Equipment Manufacturers' Association
*Crown Agents for Oversea Governments and Administrations
Department of Employment and Productivity
Electric Cable Makers' Confederation
Electric Lamp Industry Council
Electric Light Fittings Association
Electrical Contractors' Association (Incorporated)
Electrical Contractors' Association of Scotland
Electrical Research Association
*Electricity Council, the Central Electricity Generating Board and the Area Boards in England and Wales
Electronic Engineering Association
*Engineering Equipment Users' Association
Institution of Electrical Engineers
Ministry of Technology
Ministry of Defence
*Ministry of Defence, Army Department
*Ministry of Defence, Navy Department
Ministry of Power
*Ministry of Public Building and Works
Municipal Passenger Transport Association (Incorporated)
National Inspection Council for Electrical Installation Contracting
National Physical Laboratory (Ministry of Technology)
*Oil Companies Materials Association
Post Office
Public Transport Association (Incorporated)
*South of Scotland Electricity Board

The Government departments and scientific and industrial organizations marked with an asterisk in the above list, together with the following, were directly represented on the Committee entrusted with the preparation of this British Standard:

Association of Electrical Machinery Trades
British Approvals Service for Electrical Equipment for Flammable Atmospheres
British Internal Combustion Engine Manufacturers' Association
Confederation of British Industry
Electrical Power Engineers' Association
Engineer Surveyors' Association
Gas Council
High Commission of India
Lloyd's Register of Shipping
London Transport Board
Machine Tool Trades Association
National Coal Board

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BRITISH STANDARD SPECIFICATION FOR

THE ELECTRICAL PERFORMANCE OF ROTATING ELECTRICAL MACHINES

FOREWORD

This British Standard has been prepared under the authority of the Electrical Industry Standards Committee, and it revises, expands and supersedes the 1957 edition of BS 2613. This edition is based upon the seventh edition of Publication 34-1 issued by the International Electrotechnical Commission. There are, however, a number of differences between this British Standard and IEC Publication 34-1; such differences include data on starting characteristics, a subject not at present covered by the IEC Recommendation. Turbine-type machines are not dealt with in this standard.

When making a firm enquiry for an electrical machine within the scope of this standard, the intending purchaser should provide, or make available, all particulars of the service conditions which affect the design, testing, performance and operation of the machine. The information should be provided as listed and itemized in Appendix A. It is listed in two parts; the first part being general information applicable to all types of machines, the second part applying to the particular type of machine required.

Where optional requirements are included in this standard they should be agreed at the time of enquiry and attention directed to the appropriate clauses containing such requirements.

When ordering a machine the purchaser should make available all particulars of the service conditions which affect the design, testing, performance and operation of the machine together with any optional requirements included in this standard. Alternatively he should confirm such data as may have been previously provided with an enquiry to ensure that the basis for the design, manufacture and testing of the machine is correctly established.

The term 'synchronous condenser' has been used in previous editions of BS 2613 although deprecated in BS 205: 1943, 'Glossary of terms used in electrical engineering', which gives 'synchronous capacitor' as the preferred term. The term 'synchronous compensator' has also been used increasingly in recent years in the United Kingdom for the same machine. Each of these terms appears to have disadvantages but, for the time being, and for the purposes of this standard, all three are considered to have the same meaning. It is expected that the revision of the 1943 edition of BS 205 will recommend one specific term for future use and that this will be taken into account in the next revision of this standard.

Attention is drawn to certain other standards, listed below, which may apply when machines are required for particular applications. The rating plates of machines built to comply with these standards indicate the number of the relevant British Standard.

BS 170. Electrical performance of fractional horsepower electric motors and generators.

BS 173. Rotating electrical machines for use on road and rail vehicles.

BS 638. Arc welding plant, equipment and accessories.

BS 741. Flameproof electric motors for conveyors, coalcutters, loaders and similar purposes for use in mines.

BS 1608. Electrically-driven refrigerant condensing units.

BS 1727. Motors for battery-operated vehicles.

BS 2949. Rotating electrical machines for use in ships.

BS 5000 Pt 16. Motors for use in Division 2 areas*.

BS 5000 Pt 2. Electrical performance and characteristics of turbo-type electrical machines*.

It is intended that the requirements of this standard will eventually be incorporated in a comprehensive British Standard for rotating electrical machinery. As this will inevitably take time to complete, and because the provisions of this standard are urgently required by industry, it has been decided to issue this edition as a revision of BS 2613.

SPECIFICATION

1. SCOPE

1.1 SCOPE

This British Standard specifies requirements for rotating electrical machines without limitation of output or voltage. It does not include machines intended for particular applications, e.g. machines for use in ships, air transport or traction vehicles, and fractional horsepower and turbine-type machines, for which reference should be made to the appropriate British Standards where these exist.

All the machines are assigned a class of rating, specified in Section 3, associated with a method of cooling, (see 2.2).

* In course of preparation.

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2. GENERAL

2.1 GENERAL TERMS*

For the purposes of this standard the definitions given in Appendix B apply.

2.2 CLASSIFICATION OF COOLING METHODS AND TYPES OF ENVIRONMENTAL PROTECTION

A cooling method and type of protection for any machine within the scope of this standard shall be recommended by the manufacturer unless otherwise specified by the purchaser. Standard cooling methods are classified and listed in BS 4362†.

Since the assignment of a rating (see Section 3) to a machine is dependent on the method of cooling and, in some cases, on the type of protection, where parts of the cooling system are external to the machine such that the quantities or velocities of coolant flow can be affected by external conditions the coolant quantities shall be specified with the rating. For gas cooled machines the gas pressure(s) shall be related to the rated output(s) and shall be indicated on the rating plate.

3. DUTY AND RATING

3.1 GENERAL

The declaration of duty should be made by the purchaser as accurately as possible. In certain cases, where the load does not vary or where it varies in a predeterminable manner, it may be declared numerically or with the aid of time-sequence graphs of the variable quantities. Where the true time-sequence is indeterminate a fictitious time-sequence, not less onerous than the true one, shall be nominated or selected from the duty-types listed in 3.2.

The assignment of a rating shall be made by the manufacturer to signify the capabilities of the machine. Irrespective of whether the machine carries an indication of the duty-type, as described in 3.2, it shall carry a plate giving the values of the quantities assigned to it by the manufacturer in accordance with the definition of rating given in Appendix B. In addition, since electrical machines have a time-rate of temperature rise and since the rise of temperature in accordance with this standard is limited, a qualifying term shall precede the term 'rating' to give an indication of the duration for which the machine may be run at the assigned values while complying with this standard. Where a machine is manufactured for general purposes, it shall be capable of supplying its rating indefinitely and the qualifying term shall signify this. Where a machine is manufactured with the intention that it will be used to supply varying loads or loads including periods of no-load or periods where the machine will be in a state of 'rest and de-energized' the qualifying term shall signify this.

* For the use of the term 'synchronous condenser' see Foreword.

† BS 4362, 'Rotating electrical machinery', Section A3, 'Classification of methods of cooling' (In course of preparation.)

Since the rating is assigned to the machine by the manufacturer from his knowledge, experience and best estimate, and since a certain maintenance period on site is usually agreed, it will normally be sufficient to test a machine, where a test is required, to an equivalent rating. In cases, however, where a purchaser wishes to have the machine tested to the actual or estimated duty, this should be arranged by agreement between the manufacturer and the purchaser.

3.2 DUTY-TYPES AND DESIGNATION

The duty-types are designated as follows:

- S1 Continuous running duty-type (see Fig. 1)
- S2 Short-time duty-type (see Fig. 2)
- S3 Intermittent periodic duty-type (see Fig. 3)
- S4 Intermittent periodic duty-type with starting (see Fig. 4)
- S5 Intermittent periodic duty-type with electric braking (see Fig. 5)
- S6 Continuous operation duty-type (see Fig. 6)
- S7 Continuous operation duty-type with electric braking (see Fig. 7)
- S8 Continuous operation duty-type with related load/speed changes (see Fig. 8)

The duty-type is normally designated by the abbreviations S1, S2, etc. For duty-types which include a period of starting, a period of braking, or a period of speed changing, the motor stored energy constant (H_m) and the load stored energy constant (H_l), both referring to rated speed, shall be stated and marked on the rating plate. The stored energy relationship may be given in the form of a factor of inertia (FI) which is the ratio $\frac{H_m + H_l}{H_m}$

For the duty-type S2, the abbreviation is followed by an indication of the duration of the duty. For duty-types S3 and S6 the abbreviations are followed by the cyclic duration factor:

Examples: S2 60 min
S3 25 %
S6 40 %

For duty-types S4 and S5 the abbreviation is followed by the indication of the cyclic duration factor, the motor stored energy constant (H_m) and the load stored energy constant (H_l) or the factor of inertia (FI).

Examples: S4 25 % H_m 2 H_l 4
S4 25 % H_m 2 FI 3

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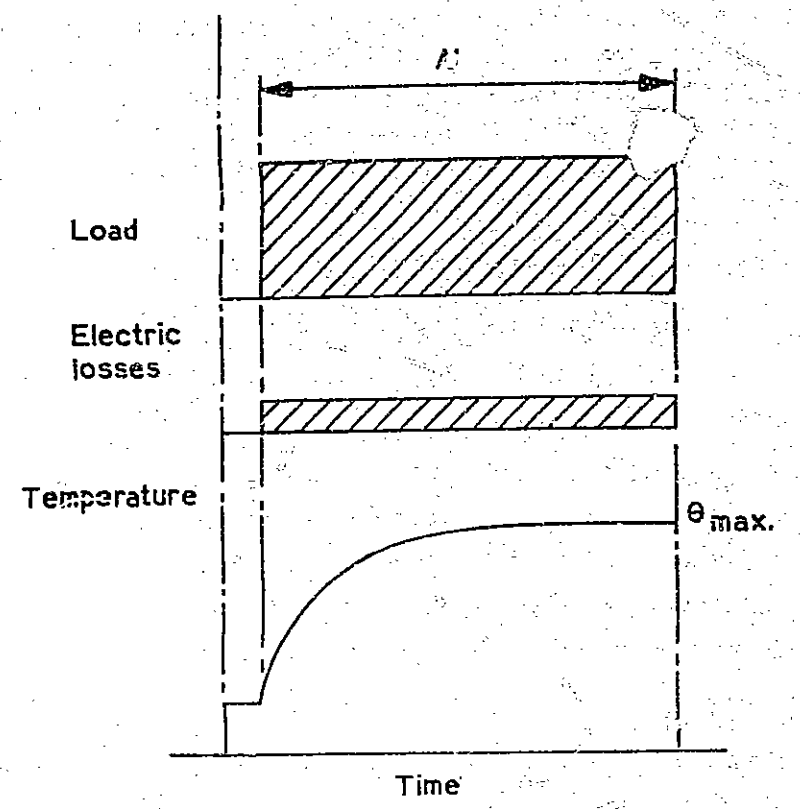
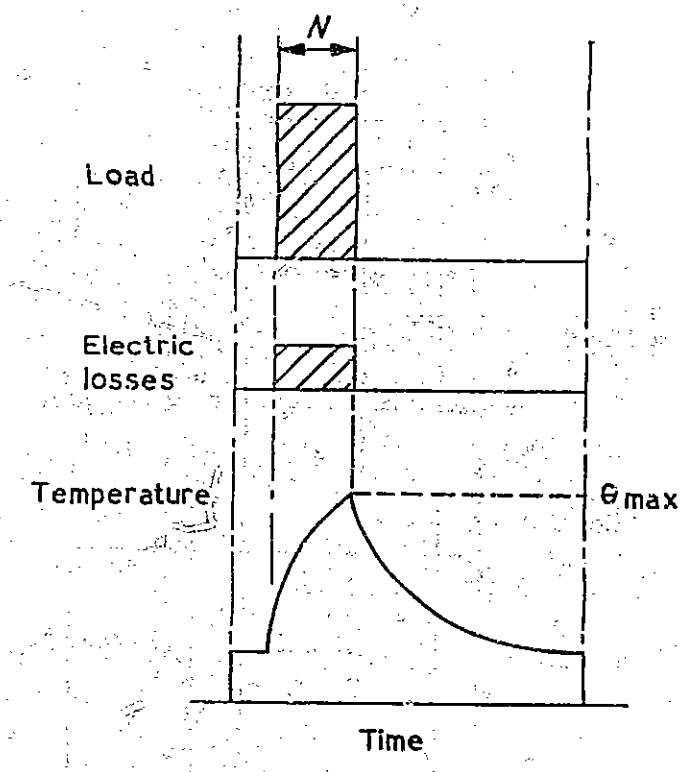


θ_{max} = Maximum temperature attained
N = Operation under rated condition

Fig. 1. Continuous running duty. Duty-type S1



N = Operation under rated condition
θ_{max} = Maximum temperature attained during the duty cycle

Fig. 2. Short time duty. Duty-type S2

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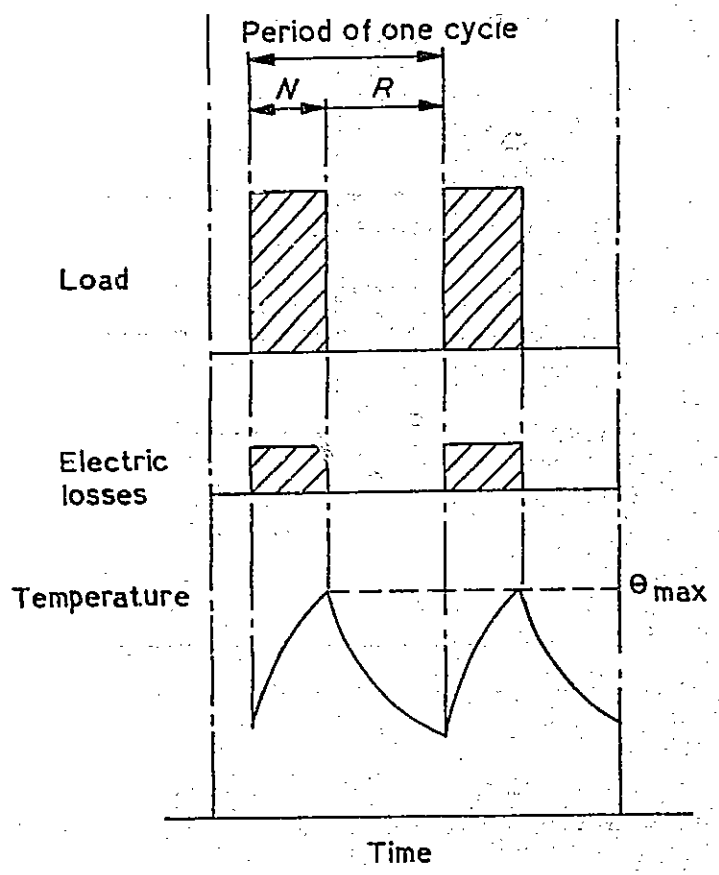
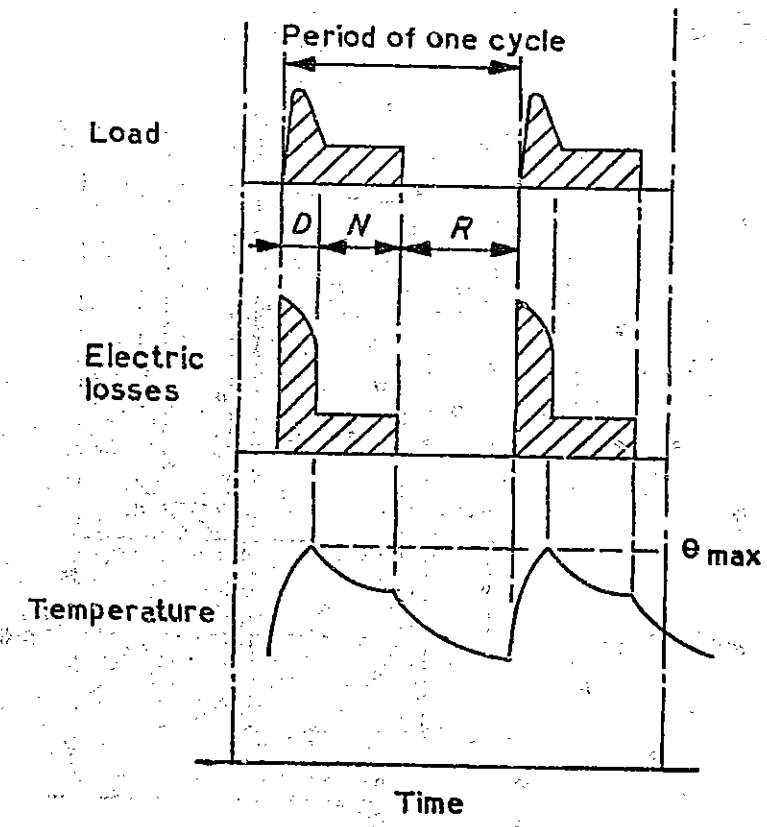


N = Operation under rated condition
R = At rest and de-energized
Θ_{max} = Maximum temperature attained during the duty cycle

$$\text{Cyclic duration factor} = \frac{N}{N+R}$$

Fig. 3. Intermittent periodic duty. Duty-type S3



D = Starting
N = Operation under rated condition
R = At rest and de-energized
Θ_{max} = Maximum temperature attained during the duty cycle

$$\text{Cyclic duration factor} \frac{D+N}{D+N+R}$$

Fig. 4. Intermittent periodic duty with starting. Duty-type S4

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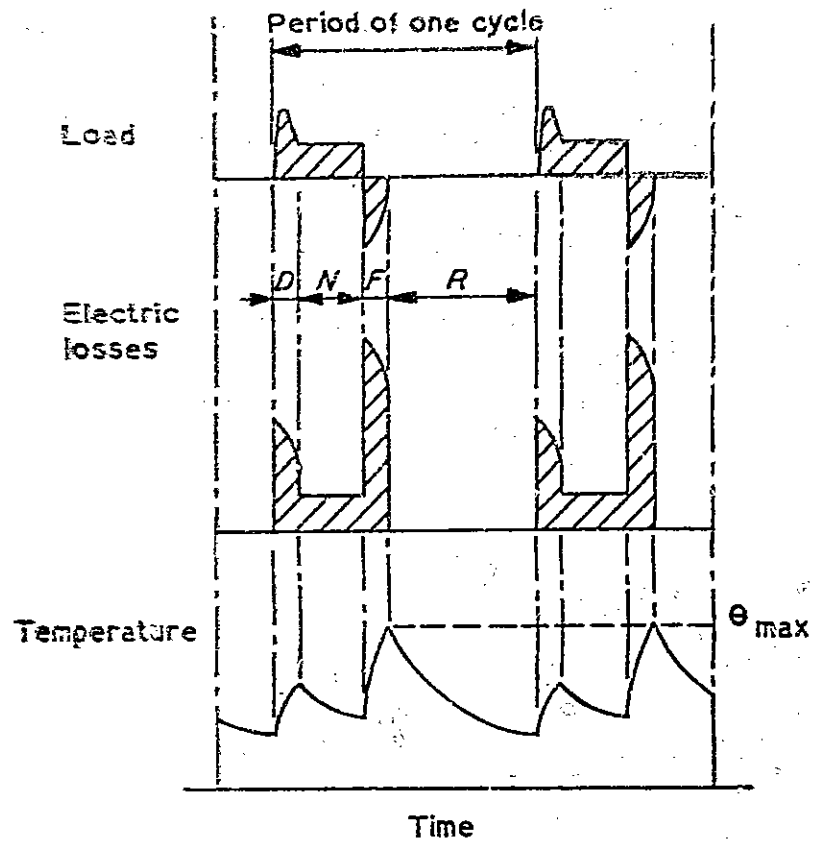
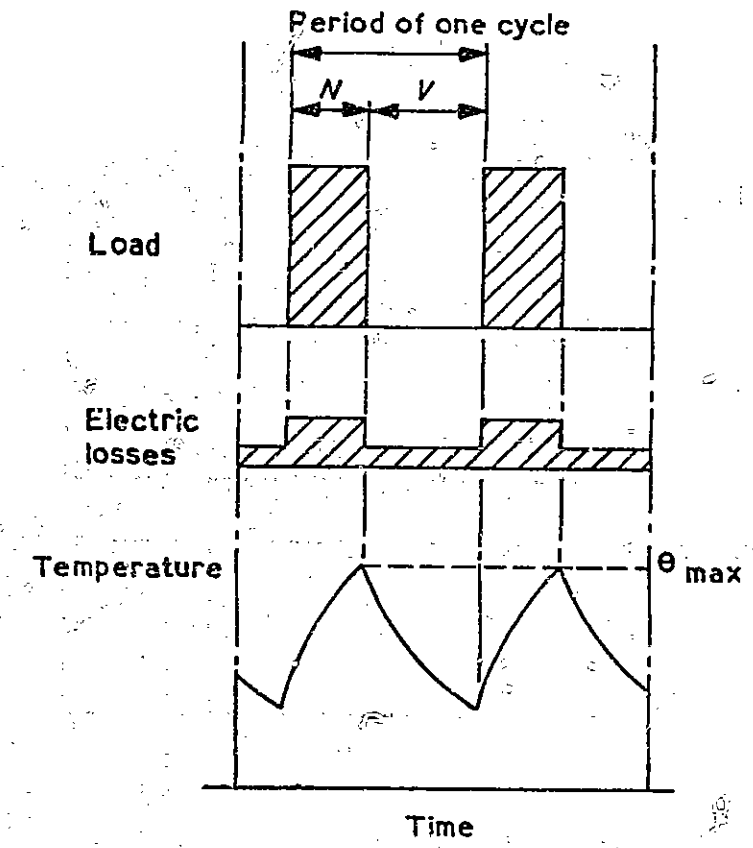


D = Starting
N = Operation under rated condition
F = Electric braking
R = At rest and de-energized
θ_{max} = Maximum temperature attained during the duty cycle

$$\text{Cyclic duration factor} = \frac{D + N + F}{D + N + F + R}$$

Fig. 5. Intermittent periodic duty with electric braking. Duty-type S5



N = Operation under rated condition
V = Operation on no load
θ_{max} = Maximum temperature attained during the duty cycle

$$\text{Cyclic duration factor} = \frac{N}{N + V}$$

Fig. 6. Continuous operation duty. Duty-type S6

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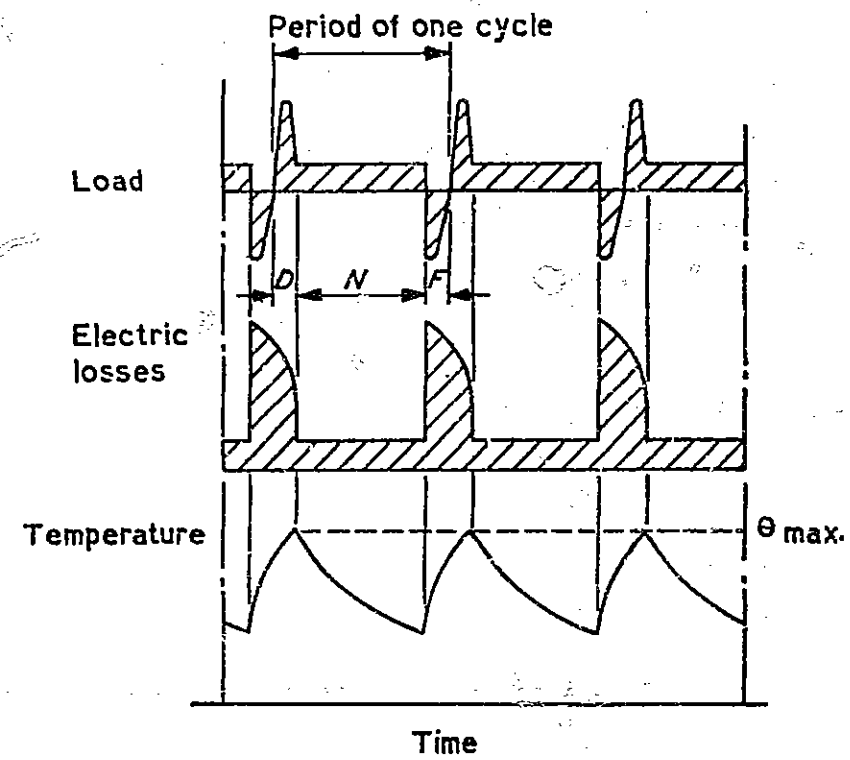
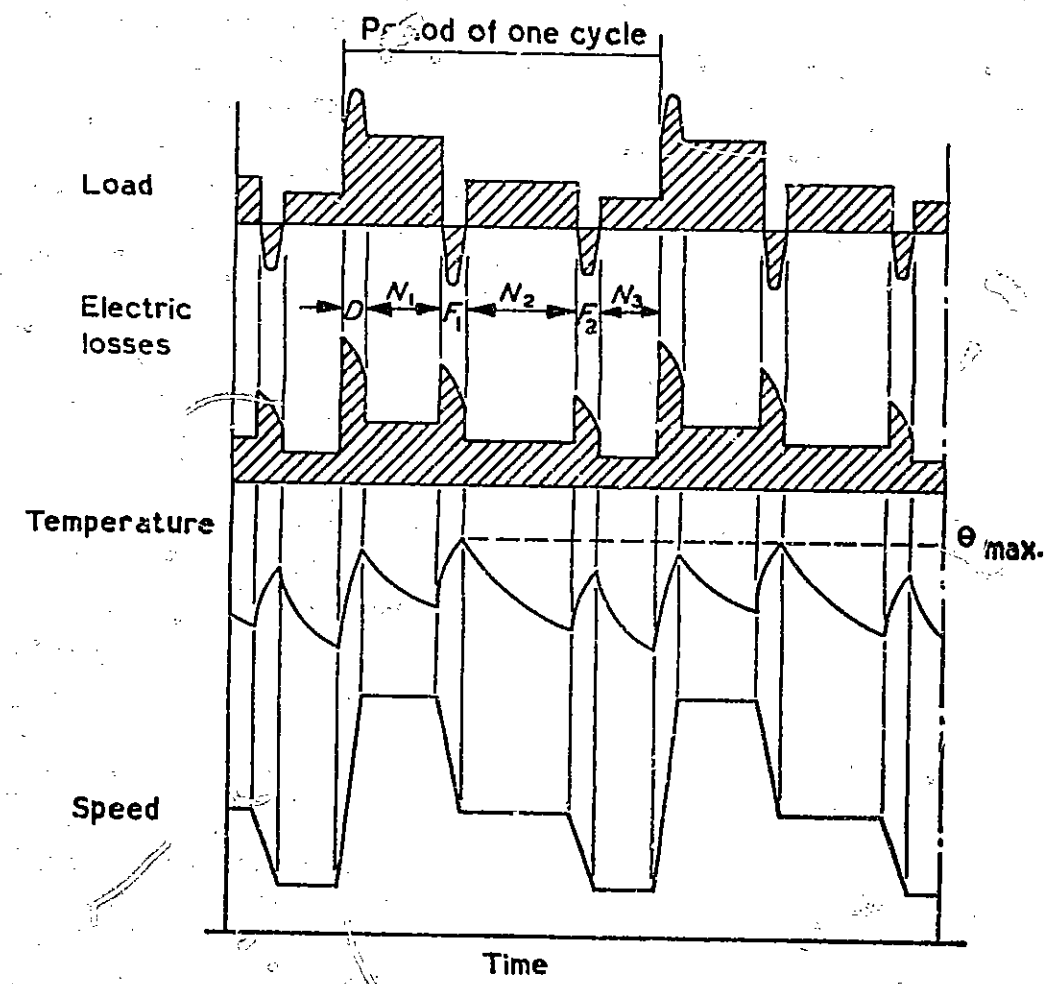


D = Starting
N = Operation under rated condition
F = Electric braking
θ_{max} = Maximum temperature attained during the duty cycle
Cyclic duration factor = 1

Fig. 7. Continuous operation duty with electric braking. Duty-type S7



F_1 F_2 = Electric braking
D = Acceleration
N_1 N_2 N_3 = Operation under rated conditions
θ_{max} = Maximum temperature attained during the duty cycle
Cyclic duration factors =

$$\frac{D + N_1}{D + N_1 + F_1 + N_2 + F_2 + N_3}$$

$$\frac{F_1 + N_2}{D + N_1 + F_1 + N_2 + F_2 + N_3}$$

$$\frac{F_2 + N_3}{D + N_1 + F_1 + N_2 + F_2 + N_3}$$

Fig. 8. Continuous operation duty with related load/speed changes. Duty-type S8

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For duty-type S7 the abbreviation is followed by the motor stored energy constant (H_m) and the load stored energy constant (H_l), or the factor of inertia (FI).

Examples: S7 H_m 1 H_l 5
or S7 H_m 1 FI 6

For duty-type S8 the abbreviation is followed by the motor stored energy constant (H_m) and the load stored energy constant (H_l), or the factor of inertia (FI), together with the load, speed and cyclic duration factor for each steady speed condition.

Examples:

S8	H_m 1	H_l9	24 kW	740 rev/min	25 %
	H_m 1	H_l9	60 kW	1460 rev/min	25 %
	H_m 1	H_l9	45 kW	980 rev/min	40 %
or S8	H_m 1	FI 10	24 kW	740 rev/min	25 %
	H_m 1	FI 10	60 kW	1460 rev/min	25 %
	H_m 1	FI 10	45 kW	980 rev/min	40 %

3.3 CLASSES OF RATING

In assigning the rating the manufacturer shall select one of the following rating classes:

3.3.1 Maximum continuous rating (MCR). The statement of the load and conditions, assigned to the machine by the manufacturer, at which the machine may be operated for an unlimited period while complying with the requirements of this standard.

3.3.2 Short time rating (STR). The statement of the load time and conditions, assigned to the machine by the manufacturer, at which the machine may be operated for a limited period, starting at the ambient temperature while complying with the requirements of this standard. The preferred times for short time ratings are 10, 30, 60 and 90 minutes.

3.3.3 Equivalent continuous rating (ECR)*. The statement of the load and conditions, assigned to the machine for test purposes by the manufacturer, at which the machine may be operated until thermal equilibrium is reached and which is considered to be equivalent to one of the duty-types listed in 3.2 while complying with the requirements of this standard.

* Equivalent continuous rating is not the same as maximum continuous rating.

3.3.4 Duty-type rating (DTR). The statement of the loads and conditions, assigned to the machine by the manufacturer, at which the machine may be operated on duty-cycles while complying with the requirements of this standard.

The following items are required to determine the rating:

motor stored energy constant H_m
load stored energy constant H_l, (or factor of inertia FI)
duration of cyclic rating
cyclic duration factor.

Ratings of this class, if applied, shall correspond to one of the duty-types S3 to S8 described in 3.2.

The time for a duty-cycle shall be 10 minutes and the cyclic duration factor shall be one of the following values:

15 % 25 % 40 % 60 %

3.4 ASSIGNMENT OF RATINGS

Ratings shall be assigned in accordance with the requirements of Section 3 and together with the relevant information included in 3.3 shall be marked on the rating plate in accordance with the requirements of Section 10.

Machines with multiple ratings shall comply with this standard in all respects at each rating.

Where reactors or capacitors are connected between the machine terminals and the busbars and are regarded as an integral part of the machine the ratings shall refer to the busbar terminals of the reactor or capacitor.

If reactors or capacitors are connected, reference shall be made to this on the rating plate.

3.5 OUTPUT RATINGS

In this standard, where a reference is made in terms of rated output, the reference to W (or VA)* shall be taken to mean W for d.c. generators, d.c. motors and a.c. motors, and VA for a.c. generators and synchronous condensers.

3.5.1 D.C. generators. The rated output of d.c. generators shall be expressed in watts (W)

3.5.2. A.C. generators. The rated output of a.c. generators shall be the apparent electric power expressed in volt-amperes (VA) together with the power factor; or the real power expressed in watts (W).

3.5.3 Motors. The rated output available at the motor shaft shall be expressed in watts (W).

* Large outputs may be expressed in kW or MW.

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