

Formula 1

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Formula 2

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Formula 3

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Detailed Explanation

Induction heater duty (IH) is a specialized service condition defined in NEMA MG-1-2023 for motors driving induction heating equipment—e.g., induction furnaces, billet heaters, or hardening systems—where operation involves repeated short-duration high-torque (or high-current) bursts followed by cooling intervals. Unlike standard continuous-duty (S1) or intermittent-duty (S2–S8) classifications, IH duty explicitly accounts for the asymmetry between rapid resistive heating during on-time and slower convective/radiative cooling during off-time, requiring motor thermal modeling aligned with IEC 60034-1 Annex D principles but adapted for North American practice. The derating tables in MG-1-2023 Section 12.42 provide discrete multipliers (e.g., 0.75×, 0.85×, 0.95×) applied to the motor’s base continuous horsepower rating, based on empirically validated combinations of on-time (t_{on}), off-time (t_{off}), and duty cycle ratio ($t_{on} / (t_{on} + t_{off})$), with implicit assumptions about ambient temperature (40°C), enclosure type (TEFC), and insulation class (F or H). Engineers apply these tables during motor selection to ensure that cumulative thermal stress remains within safe limits over thousands of cycles—preventing hot-spot temperatures from exceeding insulation system endurance thresholds. Importantly, the tables assume sinusoidal current waveforms and do not cover non-sinusoidal drive effects (e.g., VFD-induced harmonics), necessitating additional derating or thermal modeling when inverters are used.

Key Components

#	Component
1	Duty Cycle Ratio ($t_{on} / (t_{on} + t_{off})$)
2	Thermal Time Constant-Based Derating Multipliers
3	Insulation Class and Ambient Temperature Assumptions

Applications

#	Application
1	Sizing induction-heater-driven pump or conveyor motors in metal heat-treating lines
2	Selecting motors for medium-frequency induction melting furnaces with 30–60 s on/off cycles
3	Validating thermal compliance of existing motors retrofitted into induction heating process control systems

Related Concepts

#	Concept
1	IEC 60034-1 Duty Types (S1–S10)
2	Motor Thermal Time Constant
3	Insulation Class (F/H) and Hot-Spot Temperature Limits

Tags

NEMA, induction heating, motor derating, thermal management, industrial electrification

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