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NEMA Frames Application Manual

NEMA Frames Application Manual

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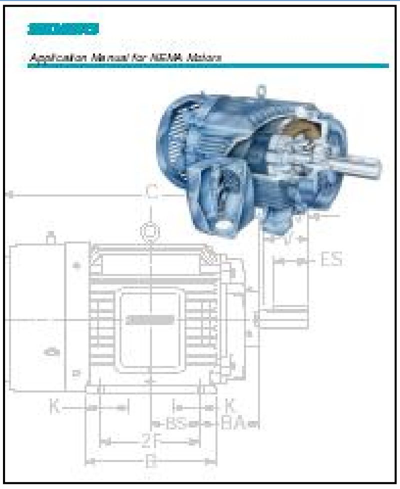

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Application Manual for NEMA Motors

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NEMA Frame TEFC Motors
600 Volts and Below
Product Range and Scope
By Frames Series

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<tr><th>HP/Speed</th><th>3600</th><th>1800</th><th>1200</th><th>900</th></tr>
<tr><td>1</td><td>-</td><td rowspan="3">-
140
-</td><td>140</td><td rowspan="2">-
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250</td></tr>
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-</td></tr>
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-</td></tr>
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440
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-</td></tr>
<tr><td>150</td></tr>
<tr><td>200</td></tr>
<tr><td>250</td><td>S440</td></tr>
<tr><td>300</td><td>S440</td><td>-</td></tr>
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-</td><td rowspan="2">-
-</td><td rowspan="2">-
-</td></tr>
<tr><td>400</td><td>-</td></tr>
</table>

Exact division between frames is dependent on motor voltage, service factor and efficiency options.

See Section 5, Part 1 and NEMA MG13 for further details, frame designations and enclosures.

Open Drip – Proof
Type RGE1 – 140 Through 400 Frames
Type RGE – 440 Frames

<table>
<tr><th>Basic Frame Size*</th><th>140</th><th>180</th><th>210</th><th>250</th><th>280</th><th>320</th><th>360</th><th>400</th><th>440</th></tr>
<tr><td>Bearings</td><td colspan="9">See Section 6</td></tr>
<tr><td>Bearing Bracket Material</td><td colspan="9">Cast Iron</td></tr>
<tr><td>Conduit Box Material</td><td colspan="7">Steel</td><td colspan="2">Cast Iron</td></tr>
<tr><td>Conduit Box Cover Gasket Material</td><td colspan="7">None</td><td colspan="2">Neoprene</td></tr>
<tr><td>Conduit Box Diagonally Split</td><td colspan="9">Yes</td></tr>
<tr><td>Eyebolt</td><td colspan="2">None</td><td colspan="7">Yes</td></tr>
<tr><td>Air Deflector Material</td><td colspan="7">Steel</td><td colspan="2">Plastic</td></tr>
<tr><td>Frame Material</td><td colspan="2">Steel</td><td colspan="7">Cast Iron</td></tr>
<tr><td>Internal Bearing Protection</td><td colspan="7">None</td><td colspan="2">Rotating Bearing Caps</td></tr>
<tr><td>Hardware</td><td colspan="9">Corrosion Resistant Zinc Plated Hex Head</td></tr>
<tr><td>Lead Terminals</td><td colspan="9">Yes</td></tr>
<tr><td>Lubrication Fittings</td><td colspan="9">Pipe Plugs – Inlet And Outlet</td></tr>
<tr><td>Nameplate Material</td><td colspan="9">Stainless Steel</td></tr>
<tr><td>Shaft Seal</td><td colspan="9">None</td></tr>
<tr><td>Voltage</td><td colspan="9">See Medallion Selection And Pricing Guide For Integral Horsepower AC Motors</td></tr>
<tr><td>Rotor</td><td colspan="9">Pressure Die Cast Aluminium With A Protective Coating On Outside Diameter</td></tr>
<tr><td>Insulation System</td><td colspan="9">Class F</td></tr>
</table>

*Example: 440 Means 444T, 444TS, 445T, 445TS, 447T, 447TS, 449T OR 449TS

Medallion™
Standard TEFC & Premium Efficiency TEFC
Type RGZP – 140 Through 440 Frames

<table>
<tr><th>Basic Frame Size*</th><th>140</th><th>180</th><th>210</th><th>250</th><th>280</th><th>320</th><th>360</th><th>400</th><th>440</th></tr>
<tr><td>Bearings</td><td colspan="9">See Section 6</td></tr>
<tr><td>Bearing Bracket Material</td><td colspan="4">Aluminum</td><td colspan="5">Cast Iron</td></tr>
<tr><td>Conduit Box Material</td><td colspan="4">Aluminum</td><td colspan="4">Steel</td><td>Cast Iron</td></tr>
<tr><td>Conduit Box Cover Gasket Material</td><td colspan="4">Neoprene</td><td colspan="4">None</td><td>Neoprene</td></tr>
<tr><td>Conduit Box Diagonally Split</td><td colspan="9">Yes</td></tr>
<tr><td>Conduit Box To Frame Gasket Material</td><td colspan="9">Neoprene</td></tr>
<tr><td>Condensation Drain</td><td colspan="7">Hole</td><td colspan="2">Combination T Slot Each Housing</td></tr>
<tr><td>Eyebolt</td><td colspan="2">Provisions For</td><td colspan="7">Yes</td></tr>
<tr><td>Fan Material</td><td colspan="9">Locked and Keyed Plastic</td></tr>
<tr><td>Fan Cover Material</td><td colspan="4">Steel</td><td colspan="3">Polypropylene</td><td colspan="2">Cast Iron</td></tr>
<tr><td>Frame Material</td><td colspan="9">Cast Iron</td></tr>
<tr><td>Internal Bearing Protection</td><td colspan="8">None</td><td>Stationary Brg Caps</td></tr>
<tr><td>Hardware</td><td colspan="4">Corrosion Resistant Zinc Plated</td><td colspan="5">Corrosion Resistant Zinc Plated Hex Head</td></tr>
<tr><td>Lead Terminals</td><td colspan="9">Yes</td></tr>
<tr><td>Lubrication Fittings</td><td colspan="4">None</td><td colspan="5">Pipe Plugs - Inlet and Outlet</td></tr>
<tr><td>Nameplate Material</td><td colspan="4">Aluminum</td><td colspan="5">Stainless Steel</td></tr>
<tr><td>Shaft Seal</td><td colspan="4">None</td><td colspan="5">Yes</td></tr>
<tr><td>Voltage</td><td colspan="9">See Medallion Selection & Pricing Guide for Integral Horsepower AC Motors</td></tr>
<tr><td>Rotor</td><td colspan="9">Pressure Die Cast Aluminum with a Protective Coating on Outside Diameter</td></tr>
<tr><td>Insulation System</td><td colspan="9">Class F</td></tr>
</table>

*Example: 440 Means 444T, 444TS, 445T, 445TS, 447T, 447TS, 449T OR 449TS

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Medallion™
TEFC Severe Duty
Type RGZPSD – 140 Through 440 Frames

Basic Frame Size*	**140**	**180**	**210**	**250**	**280**	**320**	**360**	**400**	**440**
Bearings	See Section 6								
Bearing Bracket Material	Cast Iron								
Conduit Box Material	Cast Iron								
Conduit Box Cover Gasket Material	Neoprene								
Conduit Box Diagonally Split	Yes								
Conduit Box To Frame Gasket Material	Neoprene								
Condensation Drain	Combination T Slot – Each Housing								
Eyebolt	Provisions For		Yes						
Fan Material	Locked And Keyed Plastic								
Fan Cover Material	Cast Iron								
Frame Material	Cast Iron								
Internal Bearing Protection	Stationary Bearing Caps				None			Stationary Bearing Caps	
Hardware	Corrosion Resistant Zinc Plated Hex Head								
Lead Terminals	Yes								
Lubrication Fittings	Zerk Fittings Inlet – Pipe Plugs Outlet				Pipe Plugs – Inlet And Outlet				
Nameplate Material	Stainless Steel								
Shaft Seal	Yes								
Voltage	See Medallion Selection And Pricing Guide For Integral Horsepower AC Motors								
Rotor	Pressure Die Cast Aluminium With A Protective Coating On Outside Diameter								
Insulation System	Class F								

*Example: 440 Means 444T, 444TS, 445T, 445TS, 447T, 447TS, 449T OR 449TS

Medallion™
TEFC Severe Duty Premium Efficiency
Type RGZESD – 140 Through 440 Frames

Basic Frame Size*	140	180	210	250	280	320	360	400	440	S449
Bearings	See Section 6									
Bearing Bracket Material	Cast Iron									
Conduit Box Material	Cast Iron									
Conduit Box Cover Gasket Material	Neoprene									
Conduit Box Diagonally Split	Yes									
Conduit Box To Frame Gasket Material	Neoprene									
Condensation Drain	Combination T Slot - Each Housing									
Eyebolt	Provisions For		Yes							
Fan Material	Locked And Keyed Plastic									Locked And Keyed Bronze
Fan Cover Material	Cast Iron									
Frame Material	Cast Iron									
Internal Bearing Protection	Stationary Cast Iron Bearing Caps									
Hardware	Corrosion Resistant Zinc Plated Hex Head									
Lead Terminals	Yes									
Lubrication Fittings	Zerk Fittings Inlet – Pipe Plugs Outlet				Pipe Plugs – Inlet And Outlet					
Nameplate Material	Stainless Steel									
Shaft Seal	Yes									
Voltage	See Medallion Selection And Pricing Guide For Integral Horsepower AC Motors									
Rotor	Pressure Die Cast Aluminum With A Protective Coating On Outside Diameter									
Insulation System	Class F									

*Example: 440 Means 444T, 444TS, 445T, 445TS, 447T, 447TS, 449T OR 449TS

Medallion™
TEFC IEEE 841 Chemical Industry Severe Duty Premium Efficiency
Type RGZESDX – 140 Through 440 Frames

Basic Frame Size*	**140**	**180**	**210**	**250**	**280**	**320**	**360**	**400**	**440**	**S449**
Bearings	See Section 6									
Bearing Bracket Material	Cast Iron									
Conduit Box Material	Cast Iron									
Conduit Box Cover Gasket Material	Neoprene									
Conduit Box Diagonally Split	Yes									
Conduit Box To Frame Gasket Material	Neoprene									
Condensation Drain	Special - Each Housing									
Eyebolt	Provisions For	Yes								
Fan Material	Locked And Keyed Plastic									Locked And Keyed Bronze
Fan Cover Material	Cast Iron									
Frame Material	Cast Iron									
Internal Bearing Protection	Stationary Cast Iron Bearing Caps									
Hardware	Corrosion Resistant Zinc Plated Hex Head									
Lead Terminals	Yes									
Lubrication Fittings	Zerk Fittings Inlet – Pipe Plugs Outlet				Pipe Plugs – Inlet And Outlet					
Nameplate Material	Stainless Steel									
Shaft Seal	Yes									
Voltage	See Medallion Selection And Pricing Guide For Integral Horsepower AC Motors									
Rotor	Pressure Die Cast Aluminum With A Protective Coating On Outside Diameter									
Insulation System	Class F									

*Example: 440 Means 444T, 444TS, 445T, 445TS, 447T, 447TS, 449T OR 449TS

Medallion™
TEFC Explosion – Proof Severe Duty Premium Efficiency
Type RGZZESD – 140 Through 440 Frames

Basic Frame Size*	**140**	**180**	**210**	**250**	**280**	**320**	**360**	**400**	**440**
Bearings	See Section 6								
Bearing Bracket Material	Cast Iron								
Conduit Box Material	Cast Iron								
Conduit Box Diagonally Split	Yes								
Condensation Drain	None							Yes	
Eyebolt	Provisions For		Yes						
Fan Material	Locked And Keyed Plastic								
Fan Cover Material	Cast Iron								
Frame Material	Cast Iron								
Internal Bearing Protection	Stationary Cast Iron Bearing Caps								
Hardware	Corrosion Resistant Zinc Plated Hex Head								
Lead Terminals	Yes								
Lead Seal Material	Epoxy Compound								
Lubrication Fittings	Zerk Fittings Inlet – Pipe Plugs Outlet				Pipe Plugs – Inlet And Outlet				
Nameplate Material	Stainless Steel								
Shaft Seal	Yes								
Voltage	See Medallion Selection An Pricing Guide For Integral Horsepower AC Motors								
Thermostats	Normally Closed								
Rotor	Pressure Die Cast Aluminum With A Protective Coasting On Outside Diameter								
Insulation System	Class F								

*Example: 440 Means 444T, 444TS, 445T, 445TS, 447T, 447TS, 449T OR 449TS

Motor Type Designations

Basic Design and Mechanical Features

RG	-	Open Drip-Proof (ODP)
RGZ	-	Totally Enclosed Fan Cooled (TEFC)
RGZZ	-	TEFC Explosion-proof and/or Dust Ignition proof

Electrical Features

E	-	Premium Efficiency
P	-	Epact Efficiency
T	-	NEMA Design C, High Starting Torque, Low Slip

Special Duty, Service or Configuration

SD	-	Severe Duty
F	-	Flange, Normally NEMA C or D Flange, Horizontal Mounted, Examples: RGF, RGZF.
V	-	Vertical, Normally Round Frame, Mounted Vertical by Flange (NEMA C, D or P), Examples: RGV, RGZV, RGZZV, etc.
IL	-	In-Line Pump, Vertical, Round Frame, P Flange, TEFC or Explosion-proof, RGZV-IL, etc.

Medallion™
TEFC Severe Duty Premium Efficiency
Type RGZESD – 140 Through 440 Frames

<table>
<tr><th>Basic Frame Size*</th><th>140</th><th>180</th><th>210</th><th>250</th><th>280</th><th>320</th><th>360</th><th>400</th><th>440</th><th>S449</th></tr>
<tr><td>Bearings</td><td colspan="10">See Section 6</td></tr>
<tr><td>Bearing Bracket Material</td><td colspan="10">Cast Iron</td></tr>
<tr><td>Conduit Box Material</td><td colspan="10">Cast Iron</td></tr>
<tr><td>Conduit Box Cover Gasket Material</td><td colspan="10">Neoprene</td></tr>
<tr><td>Conduit Box Diagonally Split</td><td colspan="10">Yes</td></tr>
<tr><td>Conduit Box To Frame Gasket Material</td><td colspan="10">Neoprene</td></tr>
<tr><td>Condensation Drain</td><td colspan="10">Combination T Slot - Each Housing</td></tr>
<tr><td>Eyebolt</td><td colspan="2">Provisions For</td><td colspan="8">Yes</td></tr>
<tr><td>Fan Material</td><td colspan="9">Locked And Keyed Plastic</td><td>Locked And Keyed Bronze</td></tr>
<tr><td>Fan Cover Material</td><td colspan="10">Cast Iron</td></tr>
<tr><td>Frame Material</td><td colspan="10">Cast Iron</td></tr>
<tr><td>Internal Bearing Protection</td><td colspan="10">Stationary Cast Iron Bearing Caps</td></tr>
<tr><td>Hardware</td><td colspan="10">Corrosion Resistant Zinc Plated Hex Head</td></tr>
<tr><td>Lead Terminals</td><td colspan="10">Yes</td></tr>
<tr><td>Lubrication Fittings</td><td colspan="4">Zerk Fittings Inlet – Pipe Plugs Outlet</td><td colspan="6">Pipe Plugs – Inlet And Outlet</td></tr>
<tr><td>Nameplate Material</td><td colspan="10">Stainless Steel</td></tr>
<tr><td>Shaft Seal</td><td colspan="10">Yes</td></tr>
<tr><td>Voltage</td><td colspan="10">See Medallion Selection And Pricing Guide For Integral Horsepower AC Motors</td></tr>
<tr><td>Rotor</td><td colspan="10">Pressure Die Cast Aluminum With A Protective Coating On Outside Diameter</td></tr>
<tr><td>Insulation System</td><td colspan="10">Class F</td></tr>
</table>

*Example: 440 Means 444T, 444TS, 445T, 445TS, 447T, 447TS, 449T OR 449TS

Medallion™
TEFC IEEE 841 Chemical Industry Severe Duty Premium Efficiency
Type RGZESDX – 140 Through 440 Frames

Basic Frame Size*	**140**	**180**	**210**	**250**	**280**	**320**	**360**	**400**	**440**	**S449**
Bearings	See Section 6									
Bearing Bracket Material	Cast Iron									
Conduit Box Material	Cast Iron									
Conduit Box Cover Gasket Material	Neoprene									
Conduit Box Diagonally Split	Yes									
Conduit Box To Frame Gasket Material	Neoprene									
Condensation Drain	Special - Each Housing									
Eyebolt	Provisions For		Yes							
Fan Material	Locked And Keyed Plastic									Locked And Keyed Bronze
Fan Cover Material	Cast Iron									
Frame Material	Cast Iron									
Internal Bearing Protection	Stationary Cast Iron Bearing Caps									
Hardware	Corrosion Resistant Zinc Plated Hex Head									
Lead Terminals	Yes									
Lubrication Fittings	Zerk Fittings Inlet – Pipe Plugs Outlet				Pipe Plugs – Inlet And Outlet					
Nameplate Material	Stainless Steel									
Shaft Seal	Yes									
Voltage	See Medallion Selection And Pricing Guide For Integral Horsepower AC Motors									
Rotor	Pressure Die Cast Aluminum With A Protective Coating On Outside Diameter									
Insulation System	Class F									

*Example: 440 Means 444T, 444TS, 445T, 445TS, 447T, 447TS, 449T OR 449TS

Medallion™
TEFC Explosion – Proof Severe Duty Premium Efficiency
Type RGZZESD – 140 Through 440 Frames

Basic Frame Size*	**140**	**180**	**210**	**250**	**280**	**320**	**360**	**400**	**440**
Bearings	See Section 6								
Bearing Bracket Material	Cast Iron								
Conduit Box Material	Cast Iron								
Conduit Box Diagonally Split	Yes								
Condensation Drain	None							Yes	
Eyebolt	Provisions For		Yes						
Fan Material	Locked And Keyed Plastic								
Fan Cover Material	Cast Iron								
Frame Material	Cast Iron								
Internal Bearing Protection	Stationary Cast Iron Bearing Caps								
Hardware	Corrosion Resistant Zinc Plated Hex Head								
Lead Terminals	Yes								
Lead Seal Material	Epoxy Compound								
Lubrication Fittings	Zerk Fittings Inlet – Pipe Plugs Outlet				Pipe Plugs – Inlet And Outlet				
Nameplate Material	Stainless Steel								
Shaft Seal	Yes								
Voltage	See Medallion Selection An Pricing Guide For Integral Horsepower AC Motors								
Thermostats	Normally Closed								
Rotor	Pressure Die Cast Aluminum With A Protective Coasting On Outside Diameter								
Insulation System	Class F								

*Example: 440 Means 444T, 444TS, 445T, 445TS, 447T, 447TS, 449T OR 449TS

Basic Motor Terminology and Theory

Motor Terminology

Air Gap – Opening between the stator and rotor.

Air Over – Motors designed for fan or blower service and cooled by the air stream from the driven fan or blower.

Altitude – General purpose motors are suitable for operation up to 3300 feet. Class F insulation is suitable to 9900 feet.

Ambient – The temperature of the space around the motor. Most motors are designed to operate in an ambient not over 40˚C (104˚F).

Amperes (amps) or A – Current flow at a specific load condition.

AFBMA – Anti-Friction Bearing Manufacturers Association – an organization of most bearing manufacturers that establishes standards for bearings.

Armature – See rotor.

Base – *Adapter Base or Conversion Base:* an adapter to convert current “T” frame motors (which are smaller) to older “U” frame motor mounting dimensions.
Slide base: an adjustable frame on which the motor sets. Used for belt drives to adjust belt tension.

Bearing Housing, End Bell or Bracket – Houses the bearing of motor and supports the rotor.

Breakaway Torque – See Locked Rotor Torque.

Breakdown Torque (BDT) – Pull Out Torque or Maximum Run Torque – usually is the maximum value of torque that a motor will develop without a sudden decrease in speed (breakdown).

Breather or Breather Drain – Plug type device to provide drainage of condensation or water from motor.

CSA – Canadian Standards Association sets standards and approves motor for use in Canada.

Conduit or Terminal Box – Contains the motor leads or terminals for connection to power source.

Current – Measured in amperes (amps).

Motor Terminology

Design or Design Letter – Letter assigned by NEMA to denote standard performance characteristics relating to torque, starting current and slip.

Drip Cover – Umbrella type cover used to keep water out of motor.

Duty Cycle – Standard is continuous duty, suitable for 24 hour per day operation. Some special motors may be rated for intermittent use (15 min., 30 min., etc.).

Efficiency – How effectively a motor converts electrical energy to mechanical energy.

Enclosure (ENCL) – Term used to describe motor housing. Common types are:

Drip-proof (ODP) or *Open Drip-proof* – Ventilation openings in bearing housings and some yokes placed so drops of liquid falling within an angle of 15° from vertical will not affect performance. Normally used indoors in fairly clean, dry locations.

Totally Enclosed Fan Cooled (TEFC) – Has an external fan to move cooling air over the motor. Suitable for outdoor and dirty locations.

Totally Enclosed Non-Ventilated (TENV) – Does not have external cooling fan but is dependent on radiation and convection for cooling.

Totally Enclosed Air Over (TEAO) – Special motor used to drive a fan blade. Has no external fan and is dependent on air stream of driven fan for cooling.

Explosion-proof – Motor designed to withstand an internal explosion of gas or vapor and not allow flame or explosion to escape. Generally TEFC but also built TENV in smaller horsepower ratings. Motors are labeled to meet UL and NEC requirements.

Frame or Frame Size – Generally refers to the NEMA Standardized dimensioning system. Also used to refer to the yoke or supporting structure for the stator parts.

Flange or Face – Specially machined drive end bearing housing with flat surface and bolt holes to provide easy mounting to driven equipment. Used extensively on pumps and gear reducers, NEMA flanges are designated by C, D or P and the letter will appear on the nameplate in the frame space, i.e. 256TC, etc.

Motor Terminology

Frequency – Hertz (HZ) Frequency in cycles per second of AC power; usually 60 Hz in U.S. and 50 Hz is common overseas.

Full-Load Amps (F.L.A.) – Current (Amps) drawn by motor operating at rated horsepower and voltage. Important for wire and control selection and is on the motor nameplate.

Hertz – See Frequency.

Horsepower – The output power rating of the motor shown on the nameplate.

Inrush Current – See Locked Rotor Amps.

Insulation – Generally refers to the maximum allowable operating temperature of the motor. Class A - 105°C, B - 130°C, F - 155°C, H - 180°C. The motor rise plus the ambient temperature should be equal to or less than the maximum allowable temperature for the insulation class.

KVA Code – Designated by a letter on the motor nameplate and indicates a range for values for locked rotor kva per horsepower.

Laminations – Slotted stampings or punchings of thin (0.018”-0.026”) electrical grade steels, stacked and joined together that contain the motor windings and form the magnetic “circuit” of a motor.

Locked Rotor Amps (L.R.A.) or Inrush Current – Line current drawn by a motor at starting or when nameplate voltage is applied and the rotor is not rotating (locked).

Locked Rotor Time or Stall Time – Time in seconds that a motor can withstand locked rotor (stalled) current without damage.

Locked Rotor Torque (L.R.T.) – Starting Torque or Breakaway Torque — The torque developed by the motor when starting or when stalled (rotor blocked).

Maximum Run Torque – See Breakdown Torque.

NEMA – *National Electrical Manufacturers Association* - an organization that develops voluntary standards of performance, dimensions, terminology, ratings and testing for motors.

Motor Terminology

NEMA Design Code – See Design

ODP – Open Drip Proof - See Enclosure.

Power Factor – In an AC motor is the ratio of the kilowatt input to the kva input and is usually expressed as a percentage.

Pull Out – See Breakdown.

Pull Up Torque – The minimum torque developed by the motor during acceleration from start to breakdown.

Rotor – The rotating element of a motor.

Service Factor – The amount a motor can be overloaded without damage or overheating. A motor with a 1.15 service factor can safely operate at 15% over the nameplate horsepower.

Stall Time – See Locked Rotor Time.

Starting Torque – See Locked Rotor Torque.

Stator – The stationary part of a motor that includes the stator laminations and windings.

Torque – The twisting or turning force produced by a motor and generally stated in lb.-ft.

UL – Underwriters Laboratories is an independent testing organization that sets safety standards for motors and other electrical equipment.

Basic Noise Theory

Introduction

Noise, sound power, sound pressure, Walsh-Healey Act., decibels, free field, “A” Scale and “C” Scale are all items appearing in motor specifications more and more frequently. The purpose of this article is to briefly define these terms and show their interrelationship.

Walsh–Healey Act

The Federal Government saw the need for keeping noise “pollution” within reasonable limits and also the need for limiting noise levels to “safe” values by current medical and acoustical standards. Therefore the Walsh-Healey Act was passed and amended the 1969 setting of these limits.

The limits are based on the hours per day human beings are exposed to the noise level. The acceptable levels range from a maximum of 155 dbA for 15 minutes to 90 dbA for 8 hours or more.

In order to understand what is required to meet this standard, it is first necessary to understand noise and its measurement.

Noise (Sound)

Sound is a physical disturbance which results in a sensation in the ear of the listener. It is usually the result of a mechanical vibration transferred to air and airborne to the ear of the listener.

If it is pleasing and acceptable to the ear of the listener it is called “sound.” If it is unpleasant an unwanted by the listener it is called “NOISE.” Sound emanating from a recording can be called “music” to a teenager while it is considered “noise” by his parents. Thus, individual judgment and difference between hearing sensitivity in individuals play a large part in the difference between sound and noise.

Cause of Sound

A particle moving back and forth in a specific pattern is said to be vibrating. The sequence of repeated movement is called periodic motion. Each unique sequence of motions is a cycle and the time required to move through one cycle is called the period. The FREQUENCY of the periodic motion is the number of cycles that occur per unit of time. This is usually measured in cycles per second or “HERTZ.” This vibrating motion causes the air particles near it to undergo vibration. This produces a variation in the normal atmospheric pressure. As the disturbance spreads, if it reaches the ear drum of a listener it will initiate vibrating motion of the ear drum and the listener experiences the sensation of sound.

Basic Noise Theory

Sound travels in a wave form at a constant speed of 1127 ft/second in air. This speed is not effected by the frequency. However, the particle velocity or the rate at which a given particle of air moves to and from when a sound wave passes is proportional to the frequency. Therefore, the frequency of the sound must be investigated when determining the effect of sound on the human ear.

Sound Pressure

When a sound wave is initiated it produces a fluctuation in the atmospheric pressure. This fluctuation in air pressure around the normal atmospheric pressure is called SOUND PRESSURE.

Normal atmospheric pressure is approximately 1 million dynes/cm^2. By definition 1 dyne/cm^2 is equal to 1 microbar. Therefore atmospheric pressure is approximately 1 million microbars. This is equal to 14.7 pounds per square inch which is the more common term we are used to seeing.

Microphones used in noise measurement are sensitive to sound pressure, hence sound pressure has enjoyed more popularity in the acoustical field.

Decibel and Sound Pressure Level

Sound pressure produce by different sources can vary over a wide range. Sound sources can cause pressure fluctuations as low as .0002 microbars or as high as 200 microbars. This represents a range of 200/.0002 or a million to one. Because of this extensive range it is more convenient to use logarithmic rather than linear scales in the acoustic field. Thus, values are expressed in SOUND PRESSURE LEVEL (SPL) rather than sound pressure.

The unit used to express this SPL is call a DECIBEL (db). It is a dimensionless unit which expresses logarithmically the ratio of the quantity under consideration (in this case sound rpessure) over a reference value of the same dimensions as the quantity.

By definition $$SPL = 20 \log_{10} \frac{P}{P_o} \text{ (db)}$$

where P = sound pressure in microbars produced by sound source
P_0 = reference pressure in microbars taken as 0.0002 microbars

.0002 Microbars was chosen as the reference level because it is the minimum sound pressure discernible by a sensitive human ear at 100 Hertz.

Basic Noise Theory

Sound Power

As mentioned previously, microphones used in recording sound are sensitive to sound pressure. The values recorded express the sound level of the area surrounding the equipment. However, they do not adequately express the energy produced by the generating source. The recorded sound levels are effected by the direction of the sound, the distance between the sound and the microphone and the acoustical properties of the room in which the measurement is taken. They will vary from a maximum in a reverberant room to a minimum in an atmosphere where sound waves are free to travel continuously away from the noise source in all directions (FREE FIELD).

Because of the inability to duplicate these variables everywhere the recorded data cannot be used for scientific analysis until it has been modified to compensate for these variables.

The modified data is called SOUND POWER which is defined as the total sound energy radiated by a source per unit of time.

Again, this is expressed as SOUND POWER LEVEL (PWL) in decibels. Mathematically it is expressed as follows:

$$PWL = 10 \log_{10} \frac{W}{W_o} \text{ (db)}$$

Where W = sound power in watts produced by sound source
W_o = reference power in watts taken as 10^{-12}

PWL provides data which the acoustic designer can use in determining the actual overall noise level at a given spot due to all noise generating sources.

“A” and “C” Scales

The human ear is not equally sensitive to all frequencies. Instead the human ear is more sensitive to higher frequencies and less responsive to lower frequencies. A 1000 Hz sound will appear much louder to the ear than a 100 Hz sound even though they both have the same sound level. Therefore in order to determine the effect of various frequencies it is necessary to determine the actual sound levels of these frequencies which appear to be equally “loud” to the human ear. This has been done through testing a large cross section of the human race.

BY plotting these results as a family of curves and smoothing out the irregularities it has been determined that “weighting networks” can be designed to approximate these values. Sound picked up by the microphone and passed through these networks will be recorded by the sound meter similar to the levels the ear thinks it hears. The two most commonly used are the “C” network and the “A” network.

Basic Noise Theory

The "C" network (or C Scale) represents a higher "loudness level" and has a relatively flat curve. It weights each frequency equally and therefore gives true values of sound levels eminating from the source. Hence it is use to record sound power levels.

The "A" network (or A Scale) represents a lower "loudness level." It discriminates primarily against the lower frequencies. Therefore it comes closest to the discrimination of the ear both for loudness of low level noises and to hearing damage risk from loud noises. This "A" Scale was selected by the Walsh-Healey Act as the basis for reporting overall sound pressure levels.

Broad Band and Third Octave

The average human ear can hear over a wide range of frequencies varying from 20 Hz to 16,000 Hz. In order to simplify calculations, this range is broken into 10 parts called "OCTAVE BANDS." Each band covers a 2 to 1 range or the higher frequency is twice the lower. In order to further simplify matters each band is generally referred to by its center (geometrically mean) frequency. In most cases the lowest and the highest band contribute very little valuable data and therefore are omitted. The 8 bands normally considered are as follows: 63 Hz, 125 Hz, 250 Hz, 500 Hz, 2000 Hz, 4000 Hz, 8000 Hz.

Laboratory equipment selects only the sound in the frequency band under consideration and records it exclusive of all other frequencies. Thus, the sound content from a source is available in 8 distinct bands for engineering analysis.

When engineering analysis requires more precise frequency data, equipment is available to further subdivide each octave into 3 parts. These are called "THIRD OCTAVES" which divide the full octave geometrically rather than arithmetically.

Basic Noise Theory

Conversions Between “A” and “C” Scales

The various frequencies are weighted differently for the”A” and “C” Scales. Therefore in order to convert from one scale to another each band of frequencies must be adjusted individually.

The following are the correction factors to convert from”C” Scale to “A” Scale.

Octave Band	Correction (db)
63	-26
125	-16
250	-9
500	-3
1000	0
2000	+1
4000	+1
8000	-1

The correction factors can only be used when converting between scales when both scales are on the same basis, either Sound Power or Pressure. They cannot be used for converting between Scales when one Scale is on Sound Power basis and the other Scale is on Sound Pressure basis.

Combining Sound Levels

Of major importance to the plant operators is the sound level at a specific spot in the plant, usually at the operator’s station. This can be determined if the sound levels are known from each generating source.

Keep in mind that sound levels are energy values and therefore they must be combined on an energy basis not arithmetically. Figure 1 is a chart which can be used for combining levels. It is self-explanatory.

Note that the maximum increase occurs when both sources have the same level. The maximum adder is 3 db.

Note also that when the difference is 10 or more the lower level adds very little and therefore the higher value is usually used.

This same method is used to determine the overall sound level if the individual octave band levels are known. The octave bands are combined two at a time using the results of previous combination with the next band level. The final answer is the overall level.

Combining Sound Levels to Obtain Over-All Level

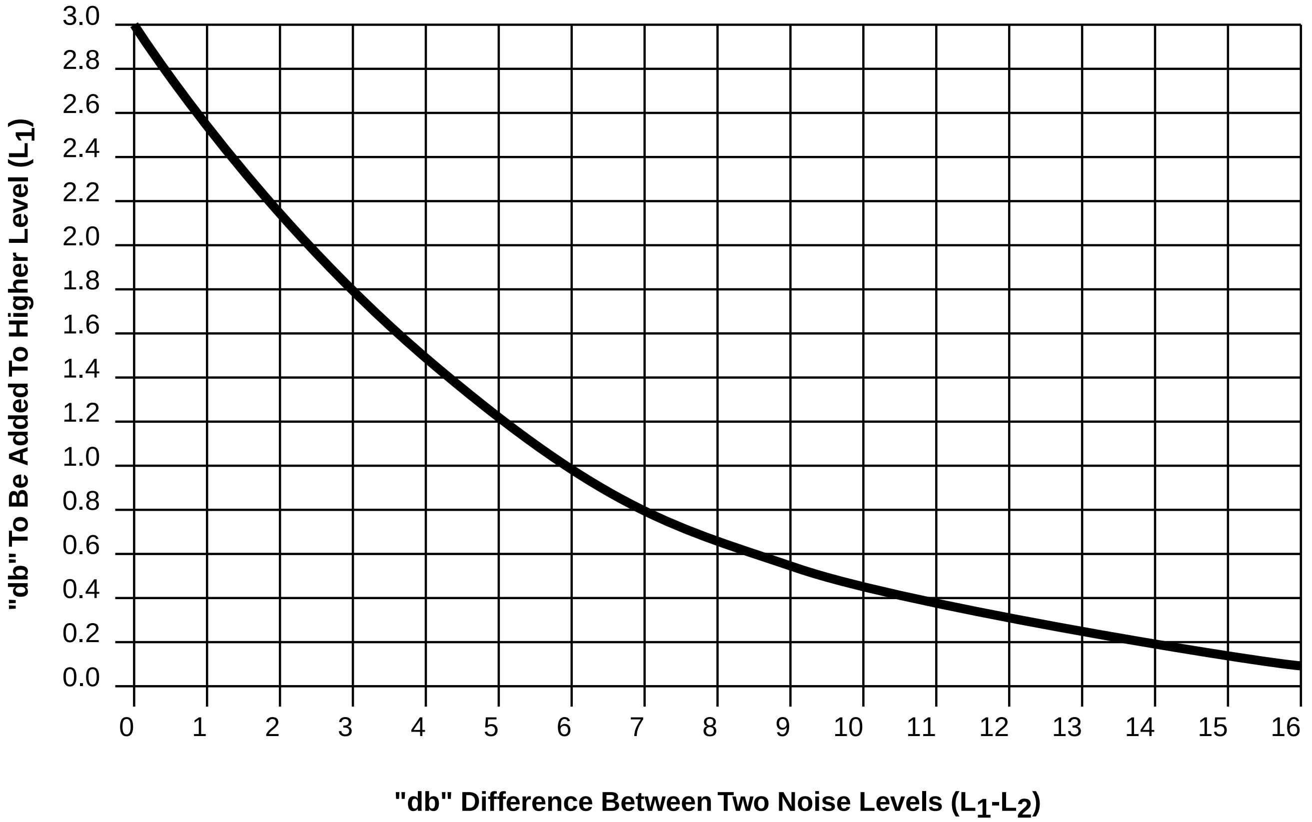


Figure 1

General Power Supply Variation

General

Induction motors will operate successfully under the following conditions of voltage and frequency variation, but not necessarily in accordance with the standards established for operating under rated conditions:

1. Where the variation in voltage does not exceed 10% above or below normal, with all phases balanced.
2. Where the variation in frequency does not exceed 5% above or below normal.
3. Where the sum of the voltage and frequency variations does not exceed 10% above or below normal (provided the frequency variation does not exceed 5%)

The approximate variations in motor performance, caused by these deviations from nameplate values, are discussed on the following pages.

The effect of electrical supply variations on motor performance should be considered when selecting and applying AC Induction motors. Variation in motor supply voltage and frequency may cause:

1. An increase in motor torque and/or speed which may be damaging to the driven machine.
2. A decrease in motor torque and/or speed which may cause a reduction in output of the driven machine.
3. Damage to the motor.

Although the AC Induction motor is designed to successfully operate when subjected to slight variations in power supply voltage and frequency, the performance (torque, speed, operating temperature, efficiency, power factor) is optimum when the power supply voltage and frequency are in accordance with the nameplate values.

Power supply variations may be classified into three categories:

1. Frequency variation from rated.
2. Unbalanced voltage between phases
3. Balanced phase voltage with voltage variation from rated value.

General Power Supply Variation

For ease of understanding, we shall consider the singular effect each of the preceding categories has on motor performance. In actual practice, it is common to simultaneously encounter a combination of two or more of the power supply variations listed in the preceding three categories, hence the combined effect will be the resultant of each singular effect; in other words, the effect of a particular variation will be superimposed upon the effect of another variation.

Unbalance Voltage Between Phases

General

The multiple phase AC induction motor is designed for use on a balanced voltage system, that is, the voltage in each phase is equal. When the voltage of each phase is unequal, a small rotating magnetic field is created. This magnetic field rotates in the opposite direction of the main magnetic field, therefore, it in effect is a “bucking” field causing induced voltages and resultant high currents. To determine the effect of unbalanced phase voltages on motor performance, it is necessary to express the voltage unbalance in percent as shown in the following formula:

$$\text{\% Volts Unbalance} = \frac{\text{Max. volts deviation from avg. volts}}{\text{avg. volts}} \times 100$$

Example:
Actual phase voltages at motor terminal of 3 phase motor are 236,229 and 225 volts.

$$\text{Average Voltage} = \frac{236 + 229 + 225}{3} = 230 \text{ volts}$$

Determine Maximum Voltage Deviation From Average Voltage

236 Volts	230 Volts	230 Volts
230 Volts	229 Volts	225 Volts
6	1	5

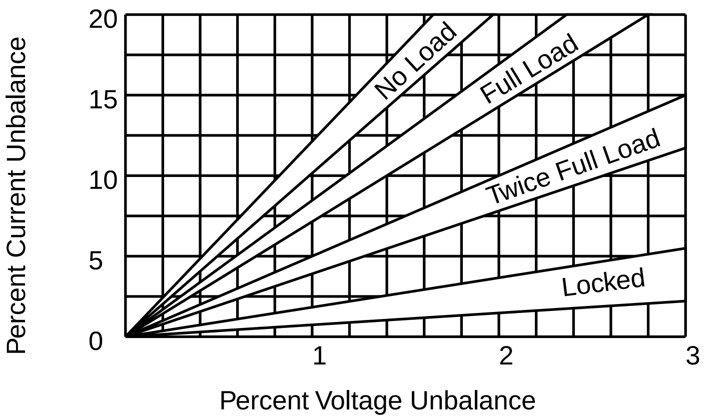
Maximum Voltage Deviation From Average Voltage = 6 Volts

$$\text{\% voltage unbalance} = \frac{6}{230} \times 100 = \underline{2.61\%}$$

General Power Supply Variation

Current

In general, a small voltage unbalance on any type of induction motor results in a considerably greater current unbalance. For a given voltage deviation, the current deviation is greatest at no load and decreases with loading with the least effect being exhibited under locked conditions. This phenomenon is conveniently shown in the following graph.



Full Load Speed

Unbalance phase voltage does not appreciably affect full load motor speed. There is a slight tendency for the full load speed to be reduced as the percentage of phase voltage unbalance increases.

Torque

Unbalanced phase voltages have little practical effect on AC induction motor torques.

$$\text{Torque with unbalanced phase voltage expressed as a percent of full load torque} = \text{Torque with balanced phase voltage expressed as a percent of full load torque} \times K \times \left[1 - \left(\frac{\%\ \text{voltage unbalance}}{100}\right)^2\right]$$

Where K = 1 for locked rotor torque (LRT) and 2 for breakdown torque (BDT).

General Power Supply Variation

Example:

Let locked rotor torque (balanced) = 150% of full load torque and voltage unbalance = 2.61%.

Torque with unbalanced phase voltage expressed as a percent of full load torque

$$= 150 \times 1 \times \left[1 - \left(\frac{2.61}{100}\right)^2\right] = 149.9\%$$

Motor Temperature

A small unbalanced phase voltage will cause a significant increase in motor temperature. Although there is no exact formula to determine the effect of voltage phase unbalance on temperature rise, laboratory tests indicate the percentage increase in motor temperature is approximately equal to twice the square of the percentage voltage unbalance. This can be expressed by the following formula:

$$\text{Temp. rise on unbalanced system} = \text{Temp. rise on balanced system} \times \left[1 + 2\,\frac{(\%\text{ voltage unbalance})^2}{100}\right]$$

Example:

Let the voltage unbalance = 2.61% and the full load motor temperature rise at balanced voltage be equal to 80°C.

$$\text{Temp. rise on unbalanced system} = 80°\text{C} \times \left[1 + \frac{2\,(2.61\%)^2}{100}\right]$$

$$\text{Temp. rise on unbalanced system} = 80°\text{C} \times 1.136 = 90.9°\text{C}$$

General Power Supply Variation

Efficiency

A marked reduction of motor efficiency results when unbalanced phase voltages exist. The increased currents caused by the reverse rotating “bucking magnetic field” cause a reduction in full load efficiency.

Power Factor

Full load power factor decreases as the degree of voltage unbalance increases.

Voltage Variation From Rated Value With Balanced Phase Voltages

Current

Three motor currents are often used when dealing with induction motors. They are: locked-rotor or starting, no-load and full-load current.

Locked rotor current varies nearly directly with the applied voltage; a 10% voltage increase results in approximately a 10% current increase.

No-load current consists primarily of magnetization current; this current establishes the magnetic field in the electrical steel within the motor. Increased applied voltages results in higher no-load currents; conversely, a reduction of no-load current results when the applied voltage is decreased. The degree of no-load or magnetization current change is a function of the motor design or geometry of electrical motor parts, type of materials used and degree of magnetic loading.

Full-load current is actually a summation of two currents; these are the no-load (magnetization) component and the load component of the full-load current.

As mentioned above, the no-load (magnetization) current increases with a voltage increase; the amount of increase is a function of the motor design.

The load component of the full-load current varies approximately inversely to the voltage variation. A voltage increase tends to result in a corresponding decrease in the load component of the full-load current. This phenomenon can be explained by considering the fact that electrical power is basically the product of voltage and current. Therefore, if the mechanical load of the motor remains constant, the electrical input power to the motor also remains nearly constant; hence the load component of the current is reduced when voltage is increased.

Since full-load current is the summation of both the no-load and load component currents, the manner in which the full load current varies with voltage depends on the way the two currents vary with voltage.

In general, the magnetizing (no-load) current of small motors is a large percent of the full load current. The motor magnetizing current increases when voltage is increased; hence an increase in impressed motor voltage on small AC induction motors causes an increase in full load current.

Voltage Variation From Rated Value With Balanced Phase Voltages

As the motor HP increases, the magnetizing current becomes a lesser percent of the total full load current; therefore, the full load current tends to decrease with increased voltage.

It should be noted that the magnetization (no-load) and load component currents are added vectorially.

Torque

Locked, pull-up (minimum) and breakdown torque vary approximately as the square of the applied voltage.

Motor Temperature

Motor temperature is predominately influenced by motor current; heating due to motor current is directly proportional to the square of the motor current.

A 10% increase or decrease in voltage form the nameplate voltage may increase motor heating, however, such an increase in heating will not exceed safe limits provided motor is operated at values of nameplate HP and ambient temperature or less.

Efficiency (Full-Load)

Efficiency is a measure of the amount of electrical power lost in the form of heat compared to the mechanical power delivered to the load. Higher motor currents cause higher motor temperatures which in turn result in a lower motor efficiency.

Power Factor (Full-Load)

Power factor is directly related to magnetization or no-load current. Higher voltages cause higher magnetization currents which in turn result in a lower power factor.

Speed (Full-Load)

Full-load speed increases slightly with a voltage increase.

Frequency Variation From Rated Value With Rated Balance Voltage Applied

Current

No-load, locked rotor and full-load current vary inversely with a change in applied frequency. The change in no-load and locked rotor current magnitude resulting from a change in frequency within ±5% of rated frequency is approximately 5% or less, whereas the change in full-load current is negligible.

Torque

Locked rotor, minimum pull up, and breakdown torques vary approximately inversely as the square of the frequency change.

Motor Temperature

Motor temperature is predominately influenced by motor current; heating due to the motor current is directly proportional to the square of the motor current. A 5% increase or decrease in frequency from the nameplate frequency may increase motor heating, however such an increase in heating will not exceed safe limits provided motor is operated at values of nameplate HP and ambient temperature or less.

Efficiency

Since a variance in frequency within ±5% of rated frequency has a negligible effect on full-load motor current, the effect of frequency change on full-load motor efficiency is also negligible.

Power Factor

An increase in applied frequency causes a reduction in the magnitude of the magnetizing current component of the full-load current which causes a slight increase in power factor.

Speed (Full-Load)

Since the full-load speed is directly proportional to frequency, a 5% frequency increase will result in a correspondent 5% increase in speed.

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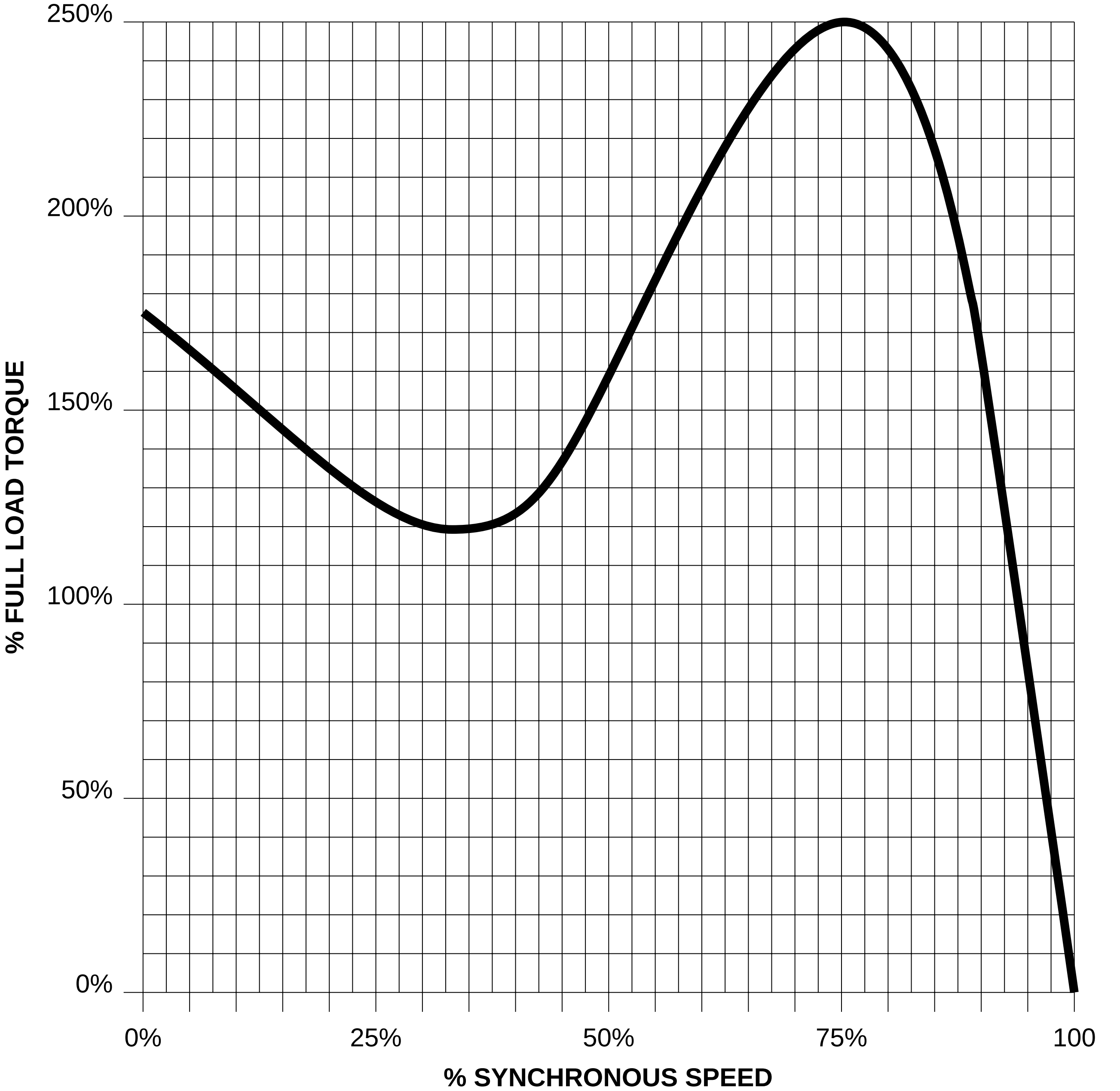
NEMA MG 1 Part 12 Torque

HP	1.5	**VOLTS**		**RPM**	3600	**TYPE**	
HZ	60	**PHASE**	3	**FRAME**		**NEMA**	B

TORQUE VS. SPEED



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Speed Torque Curves
NEMA MG 1 Part 12 Torque

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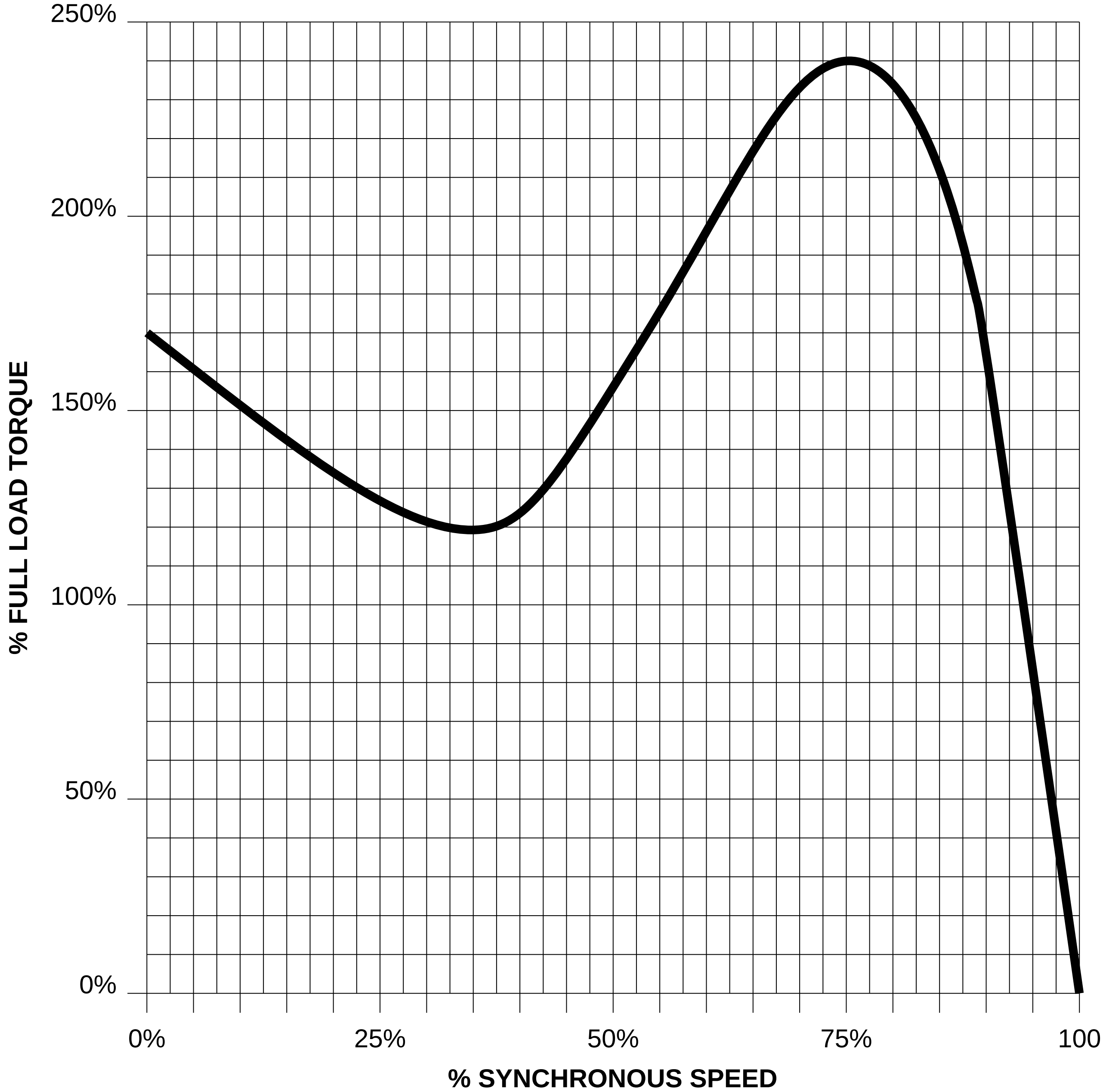
HZ	60	PHASE	3	FRAME		NEMA	B

TORQUE VS. SPEED



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NEMA MG 1 Part 12 Torque

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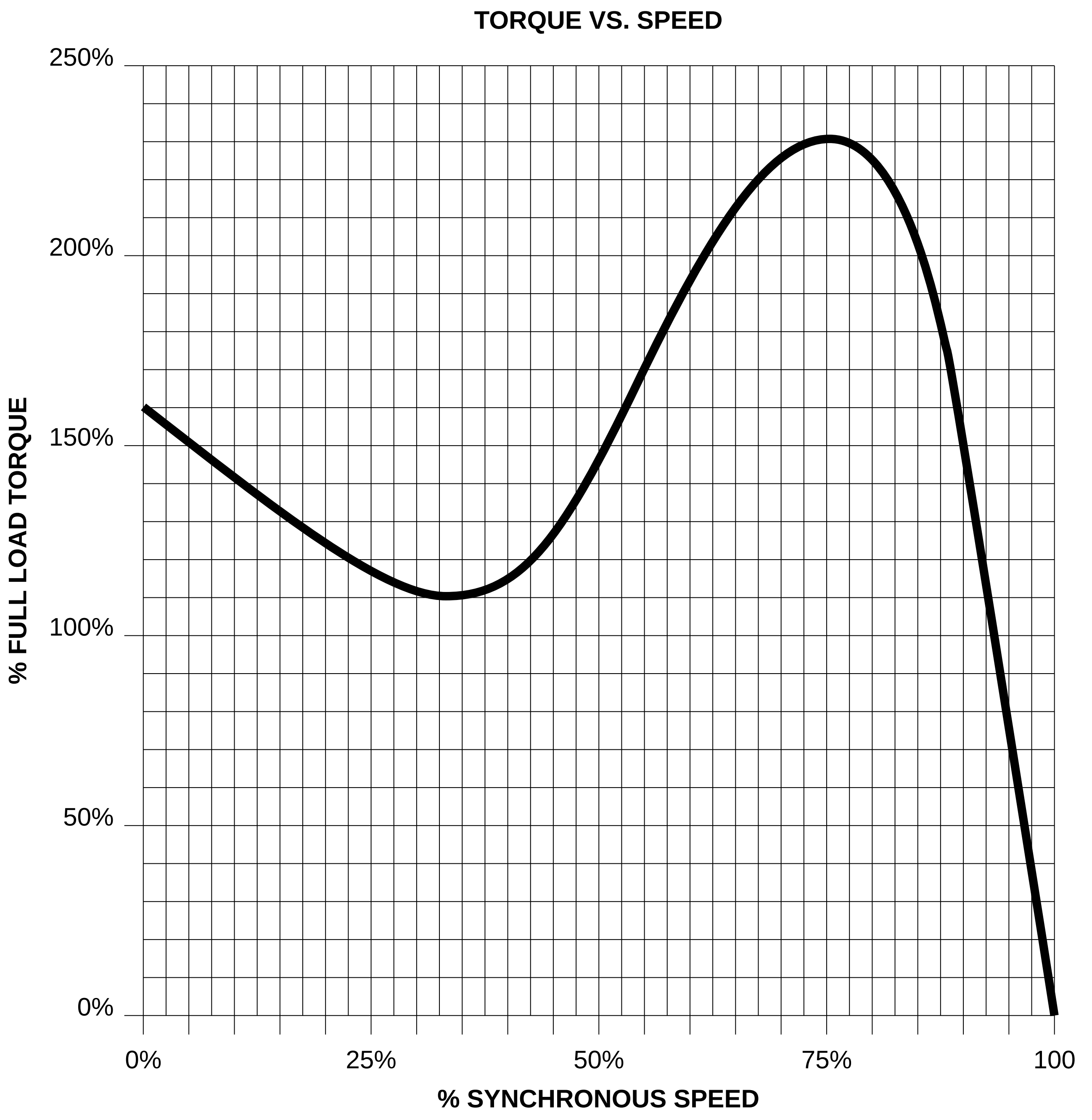

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Speed Torque Curves
NEMA MG 1 Part 12 Torque

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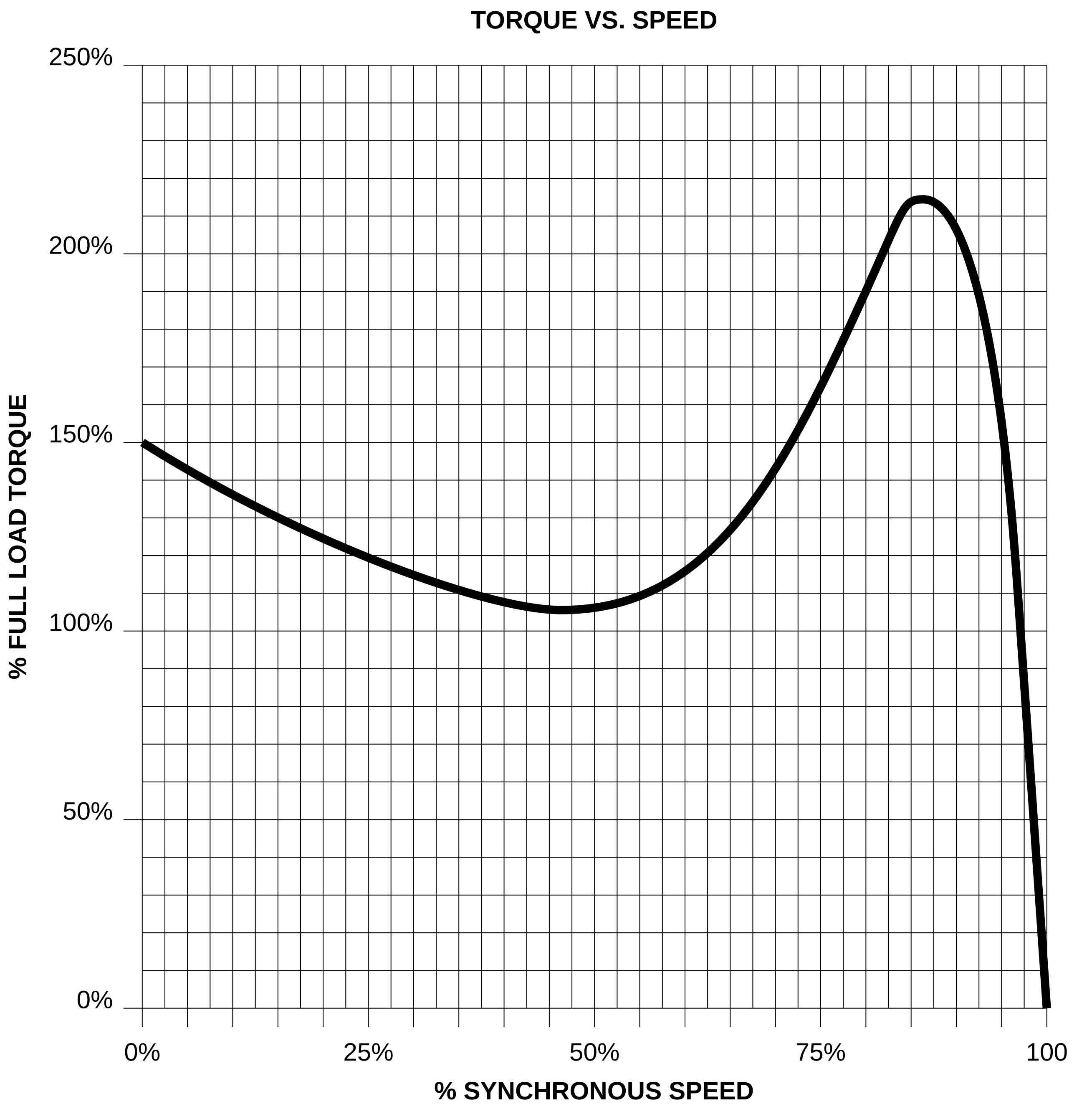

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Speed Torque Curves
NEMA MG 1 Part 12 Torque

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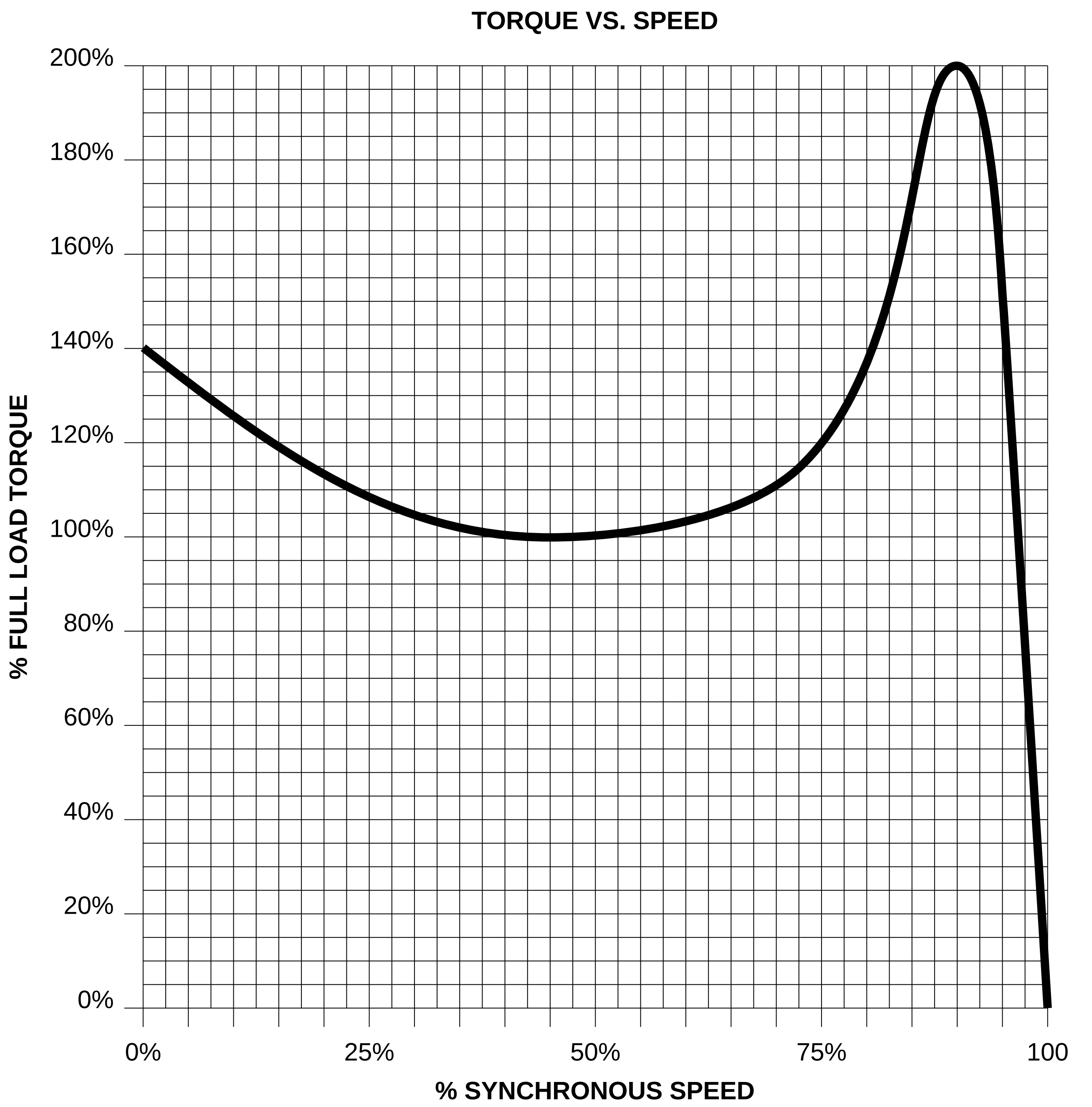

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Speed Torque Curves
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HP	10	VOLTS		RPM	3600	TYPE	
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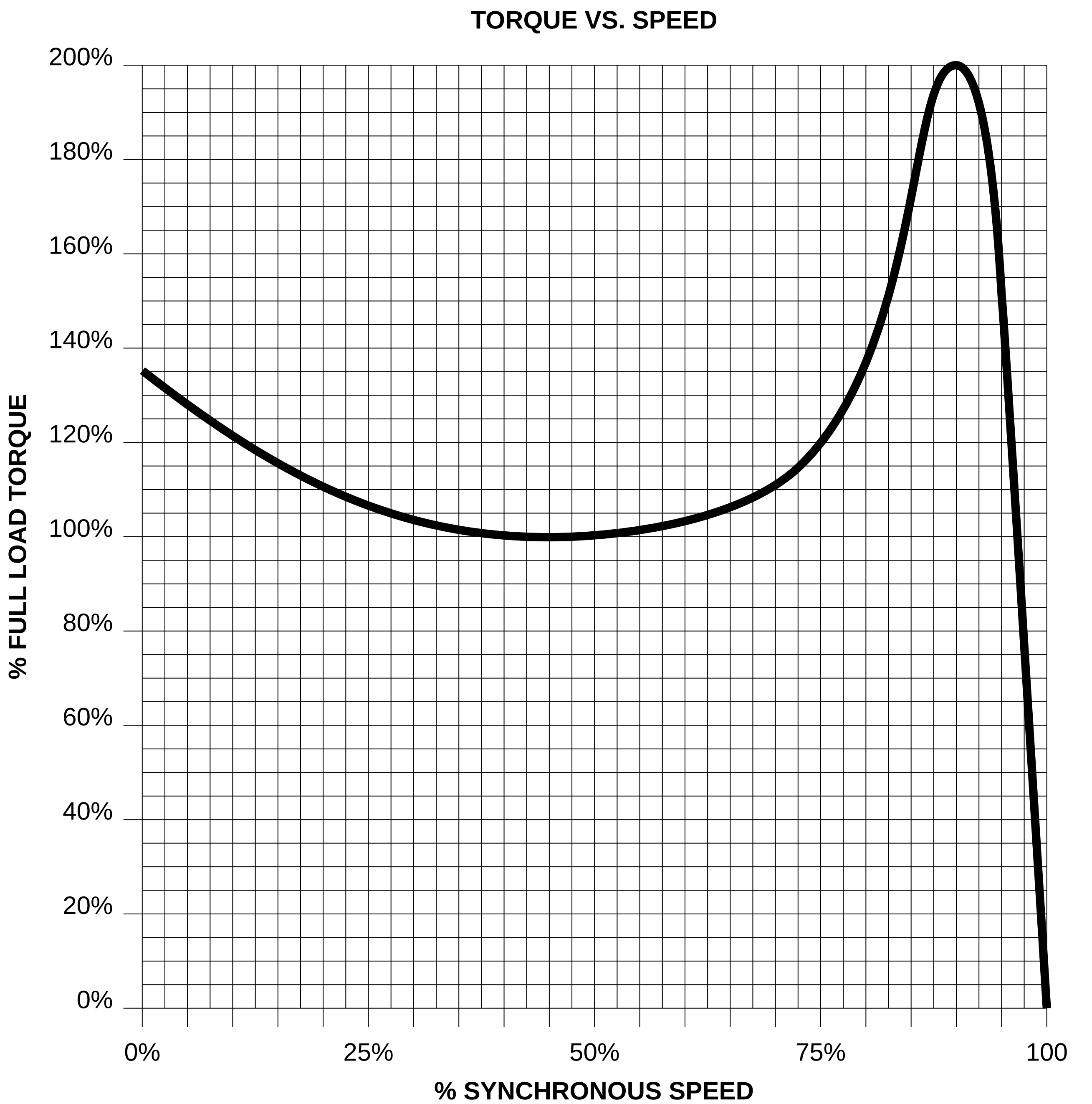

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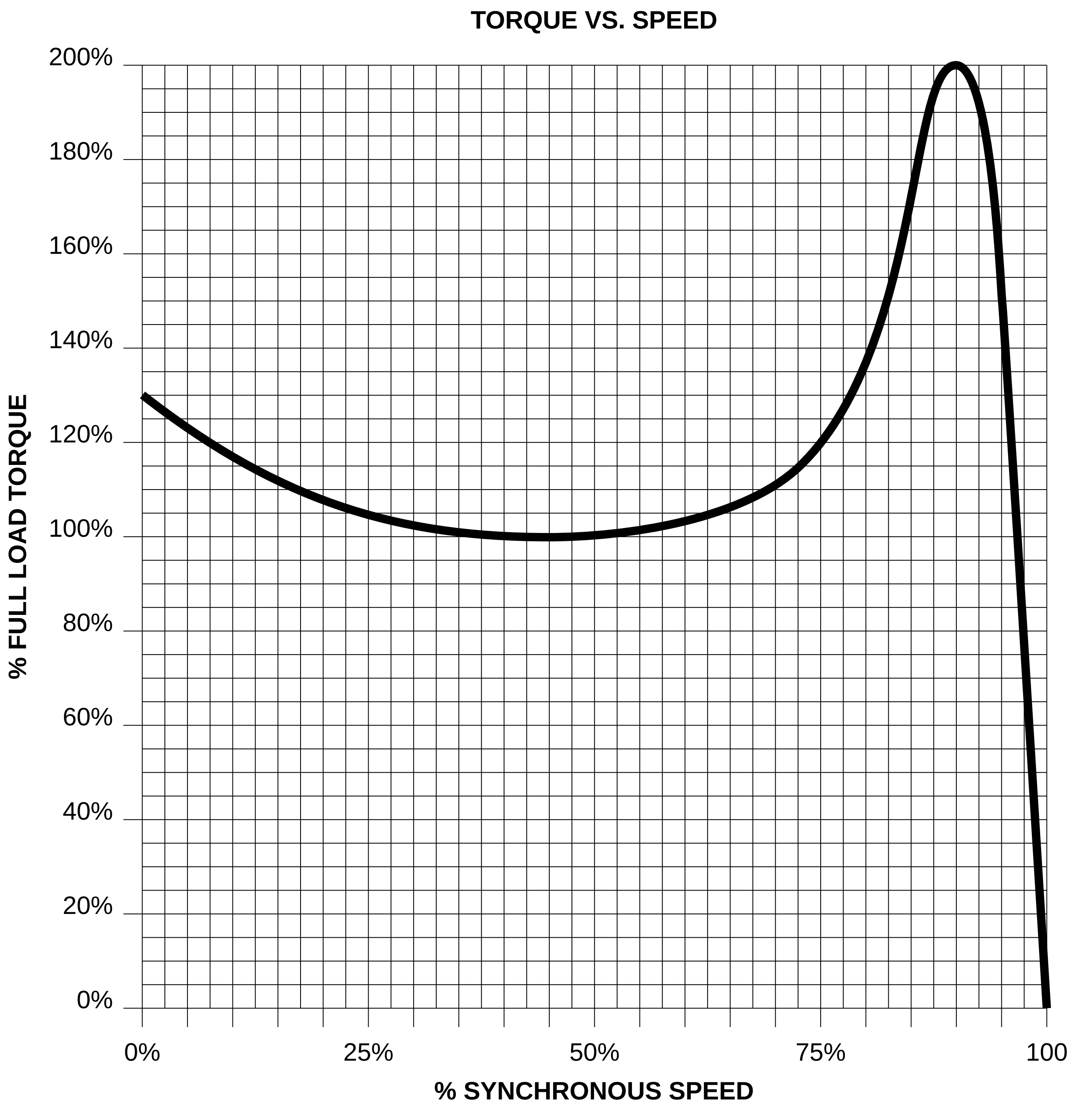
Speed Torque Curves
NEMA MG 1 Part 12 Torque

HP	15	VOLTS		RPM	3600	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



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Speed Torque Curves
NEMA MG 1 Part 12 Torque

HP	20	VOLTS		RPM	3600	TYPE	
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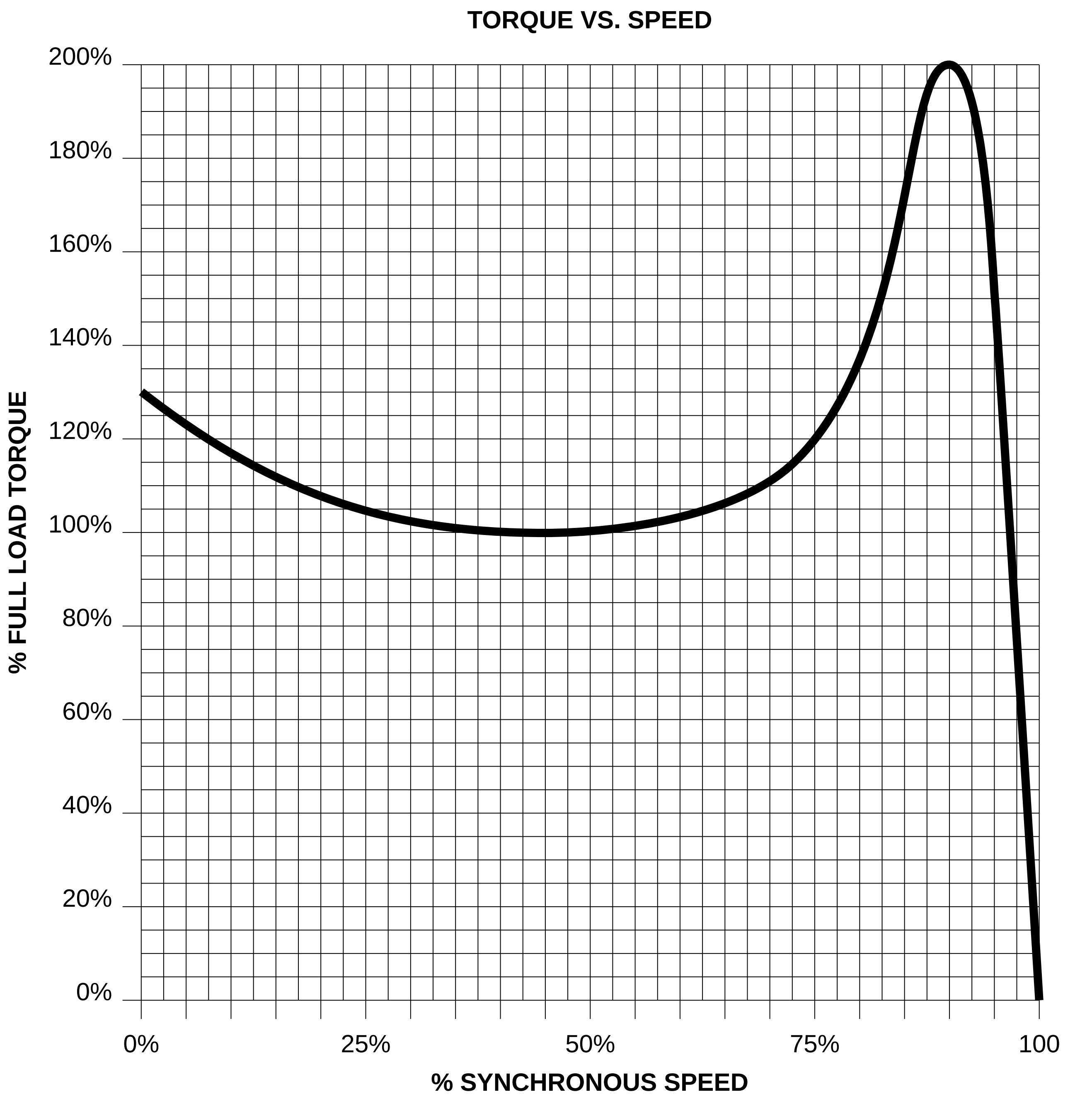

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Speed Torque Curves
NEMA MG 1 Part 12 Torque

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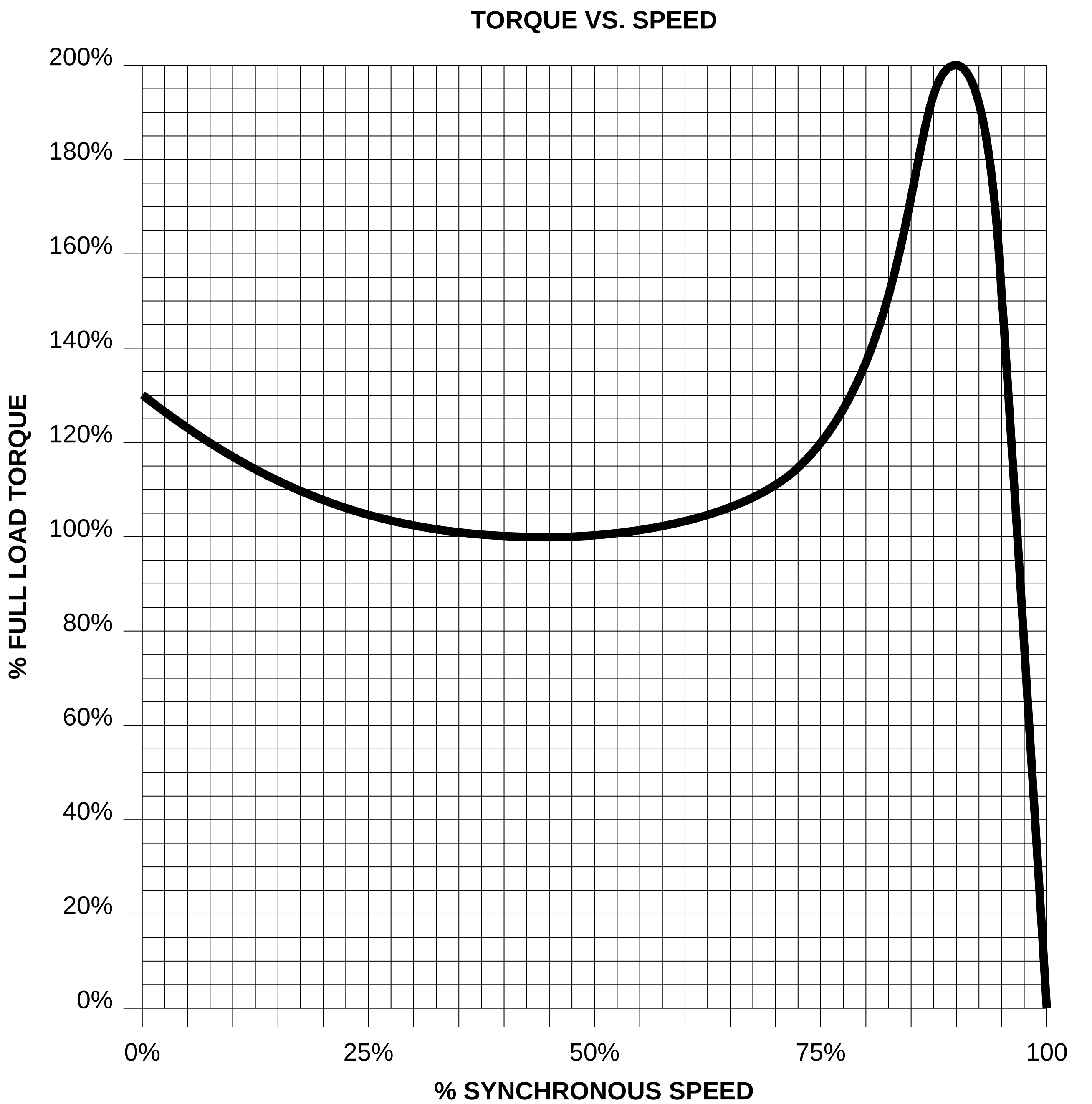

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Speed Torque Curves
NEMA MG 1 Part 12 Torque

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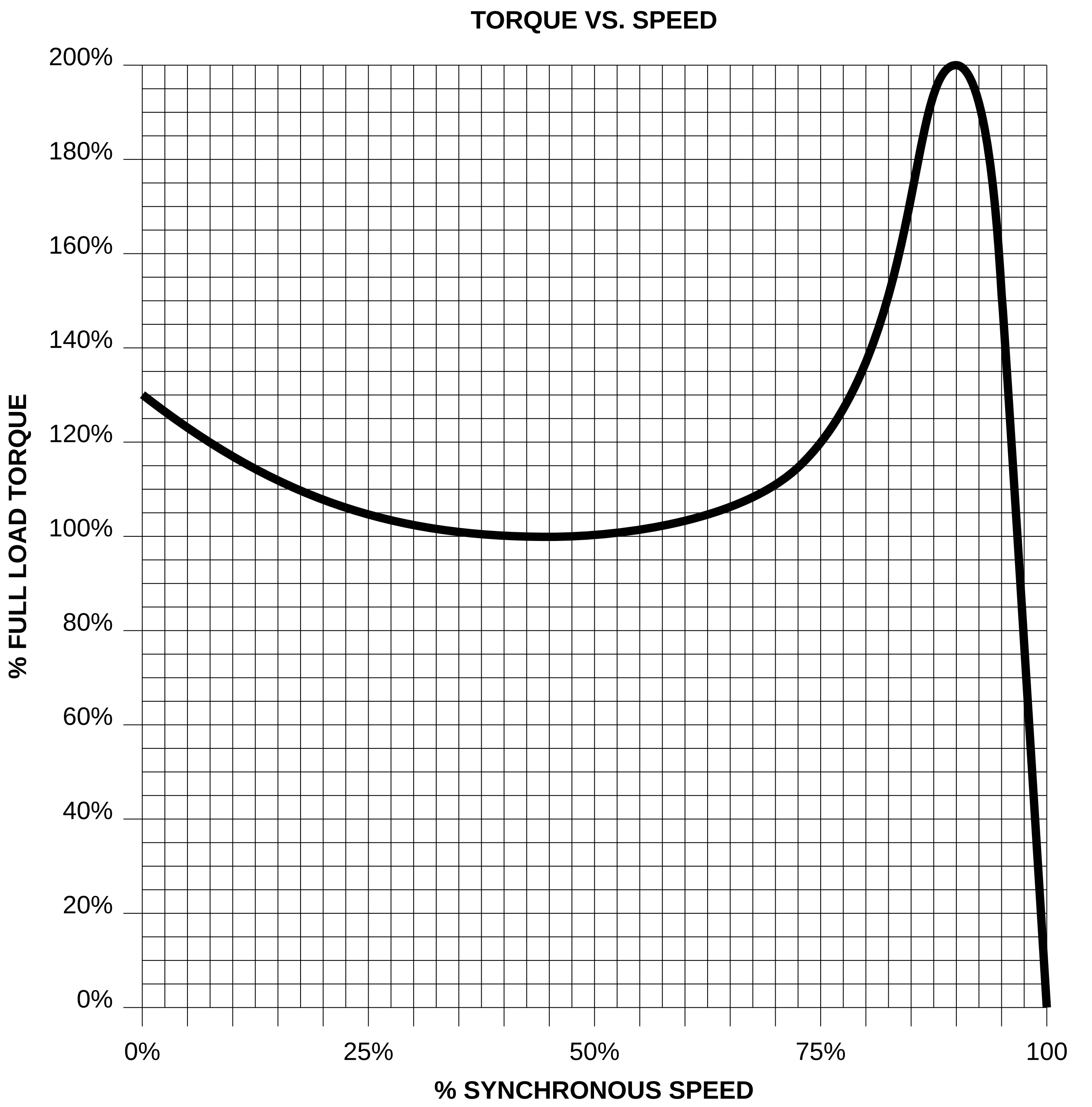
HZ	60	**PHASE**	3	**FRAME**		**NEMA**	B



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Speed Torque Curves
NEMA MG 1 Part 12 Torque

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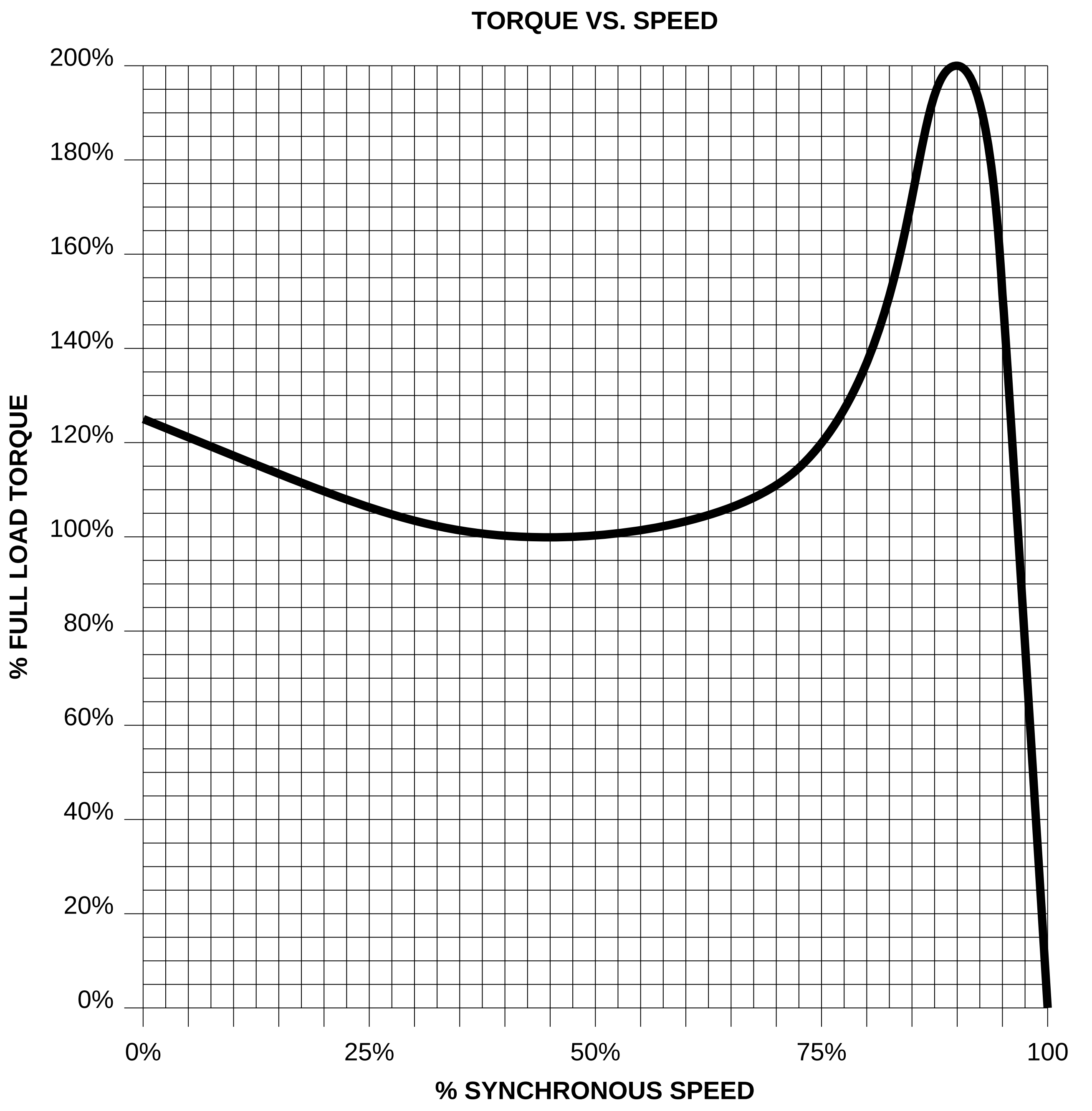

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Speed Torque Curves
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HP	50	VOLTS		RPM	3600	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B

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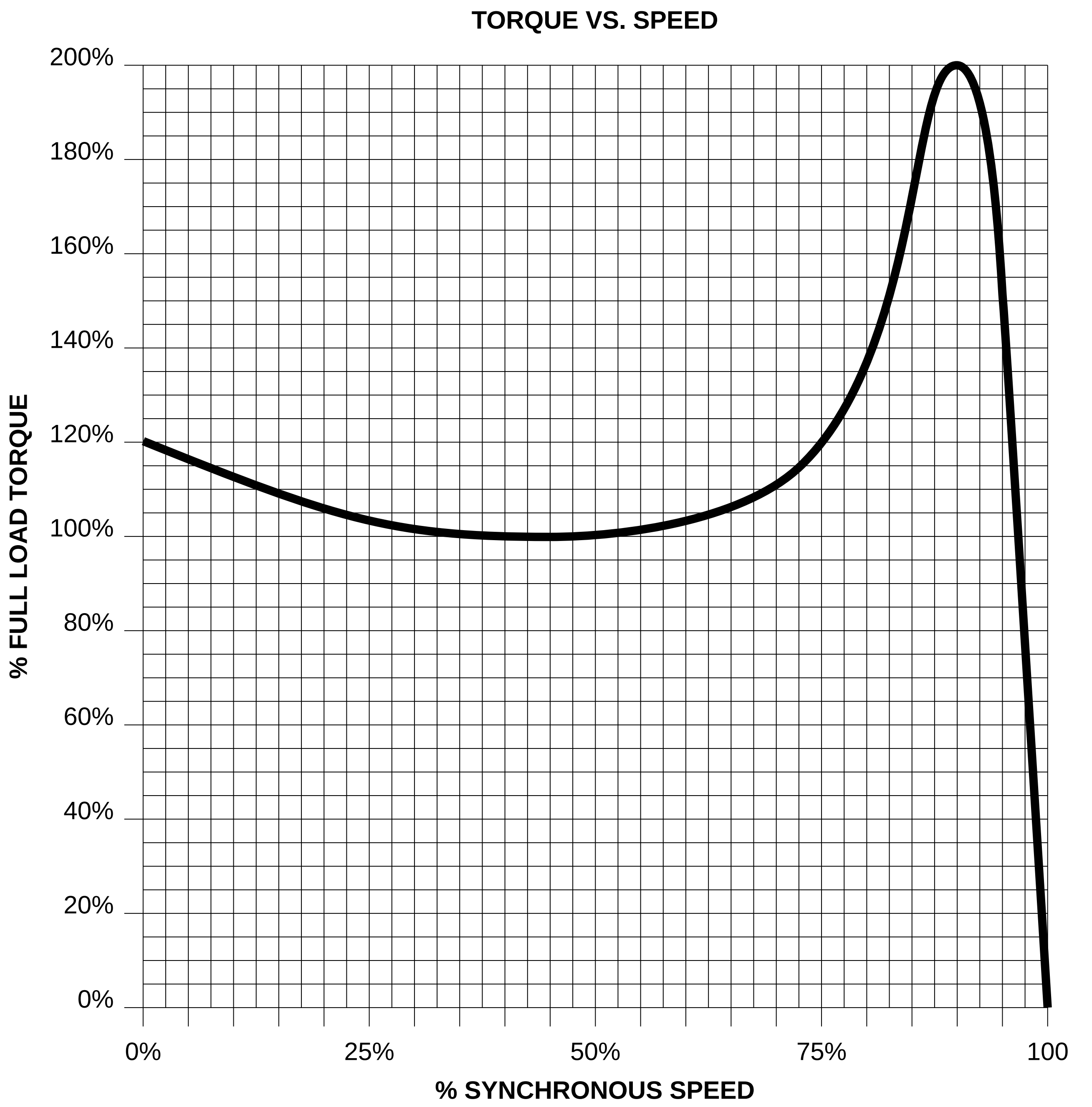
Speed Torque Curves
NEMA MG 1 Part 12 Torque

HP	60	**VOLTS**		**RPM**	3600	**TYPE**	
HZ	60	**PHASE**	3	**FRAME**		**NEMA**	B



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Speed Torque Curves
NEMA MG 1 Part 12 Torque

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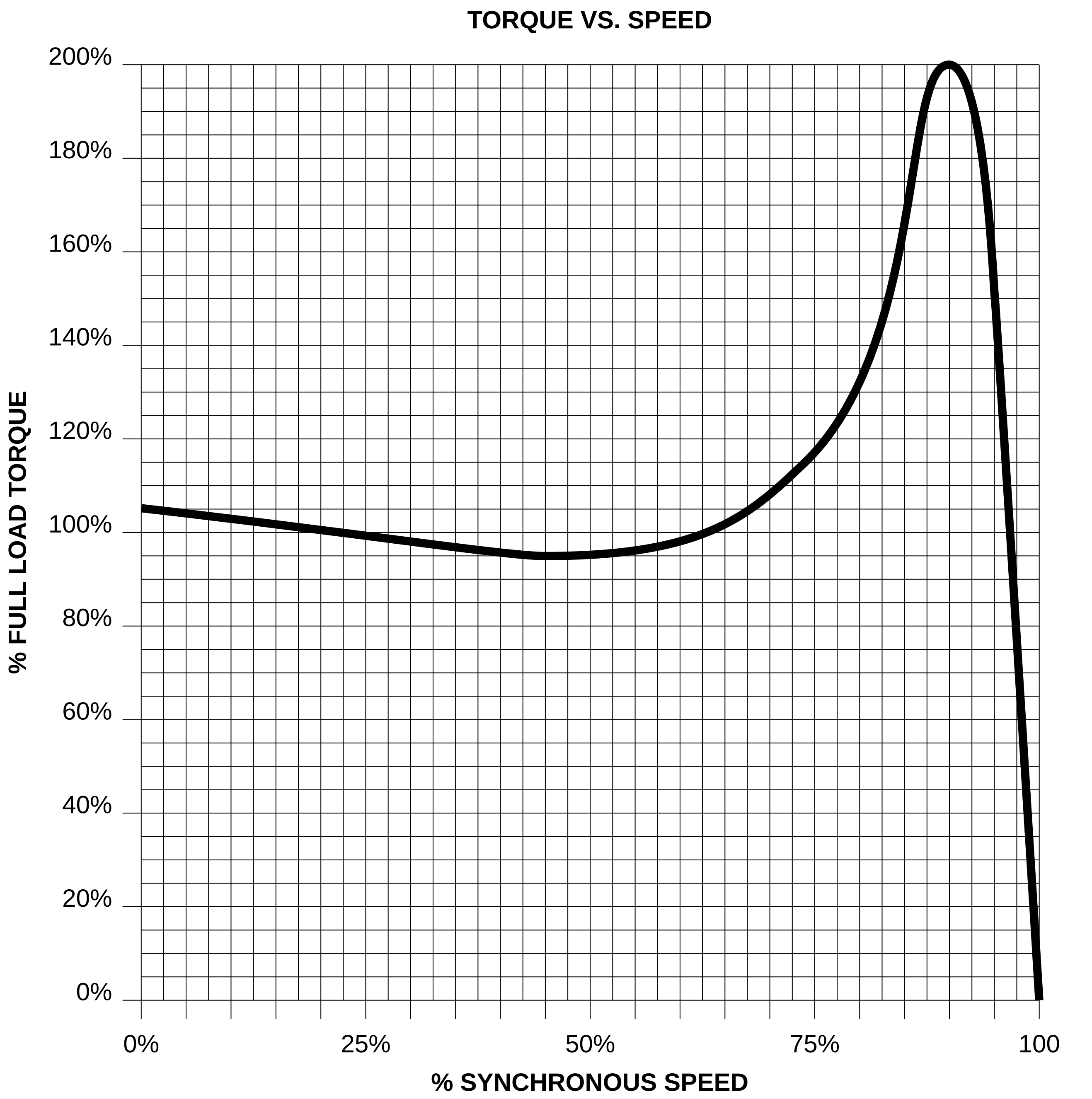
HZ	60	**PHASE**	3	**FRAME**		**NEMA**	B



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Speed Torque Curves
NEMA MG 1 Part 12 Torque

HP	100	VOLTS		RPM	3600	TYPE	
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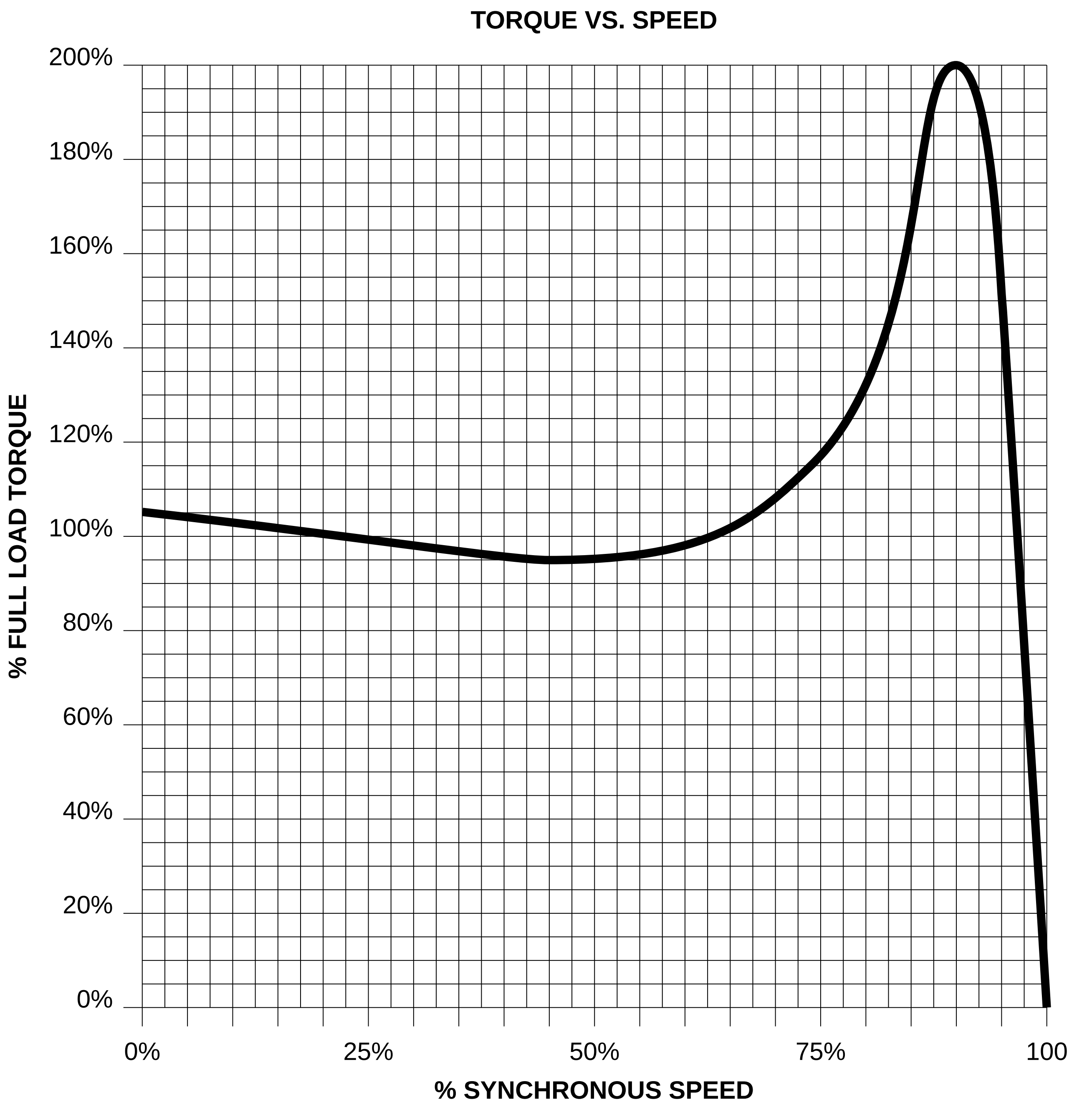
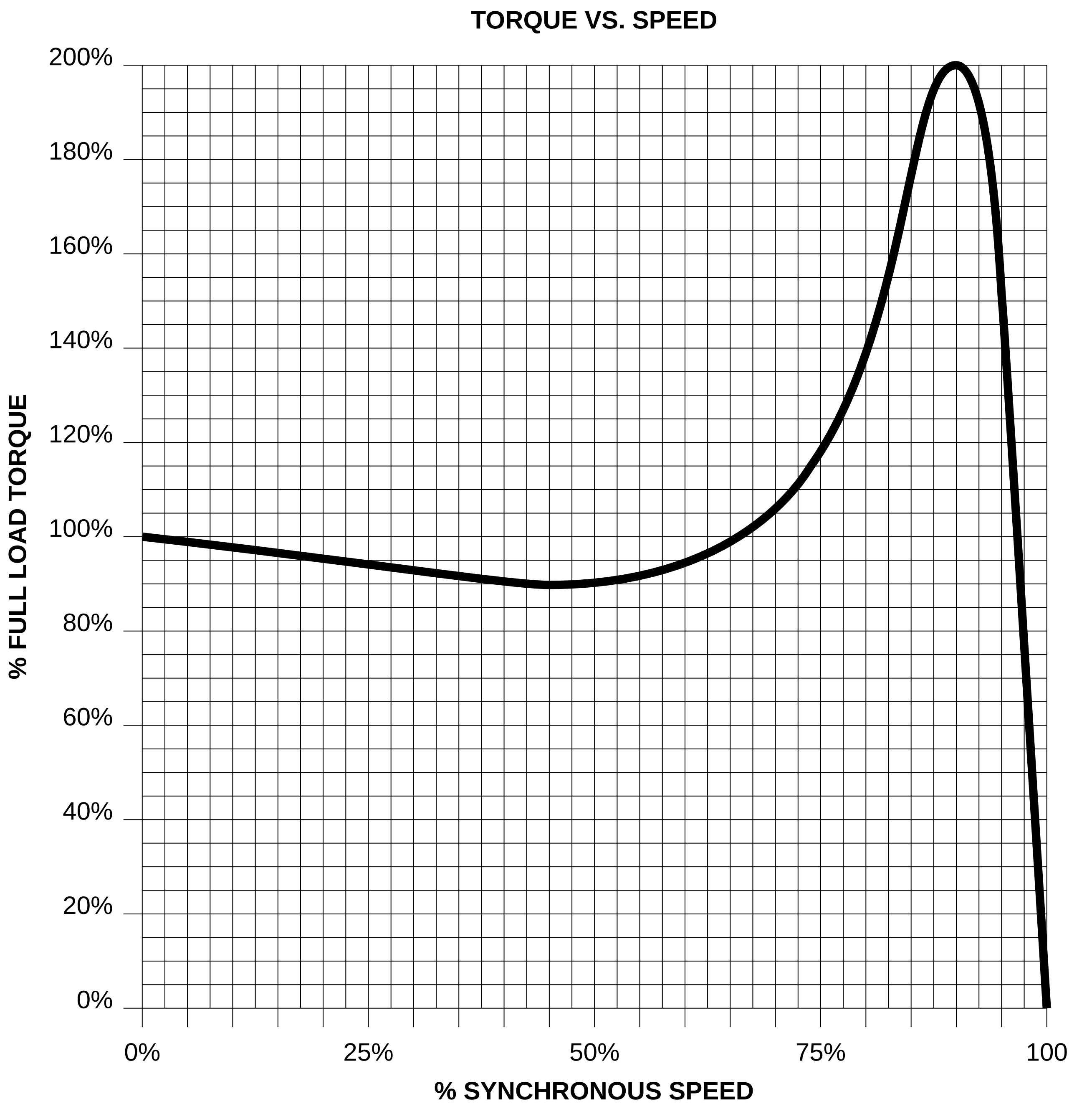


Customer:________________ PO #:________________ Order #:________________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

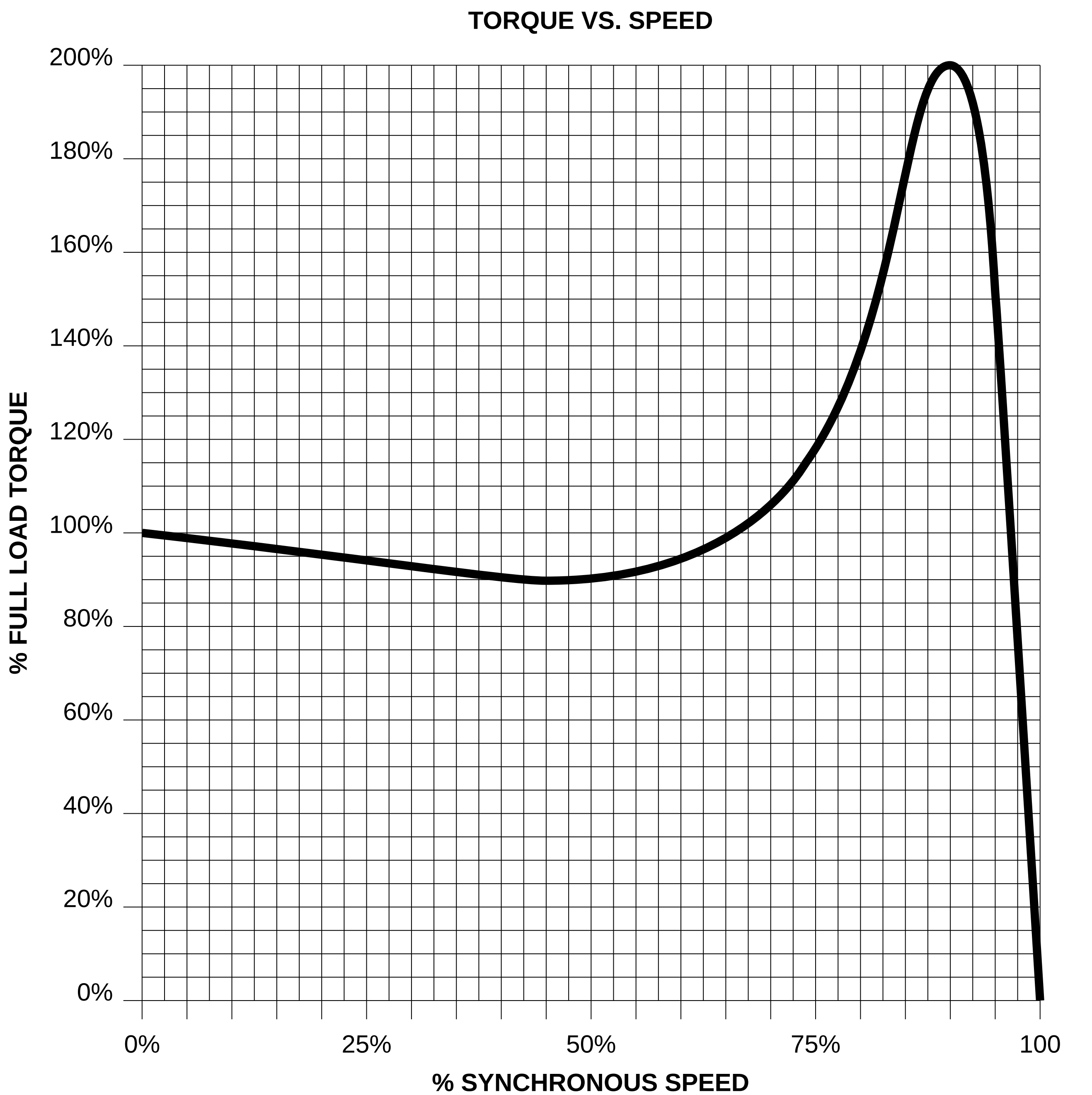
HP	125	VOLTS		RPM	3600	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:____________________ PO #:______________ Order #:______________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

HP	150	VOLTS		RPM	3600	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B

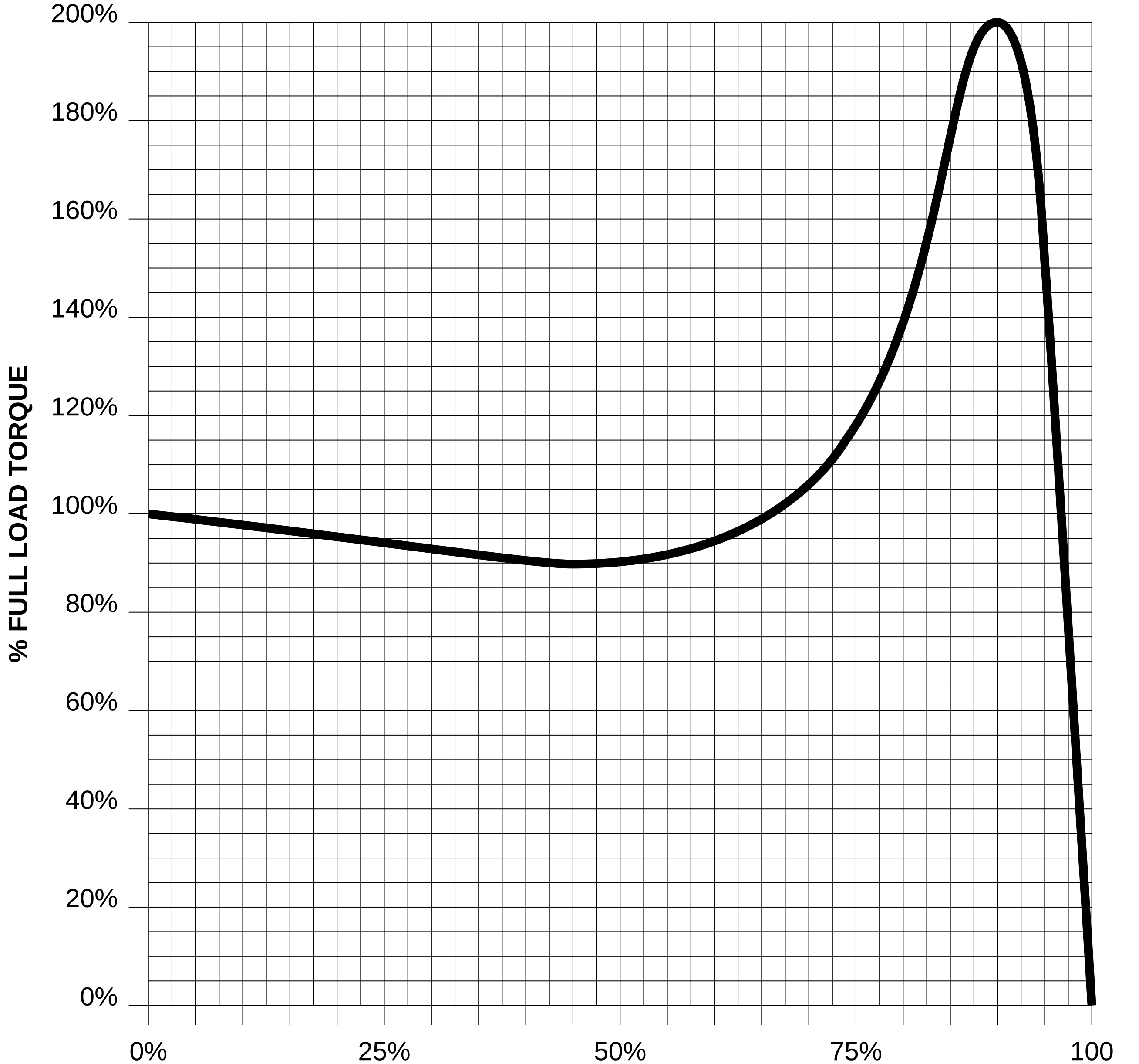


Customer:________________________ PO #:______________ Order #:________________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

HP	200	VOLTS		RPM	3600	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B

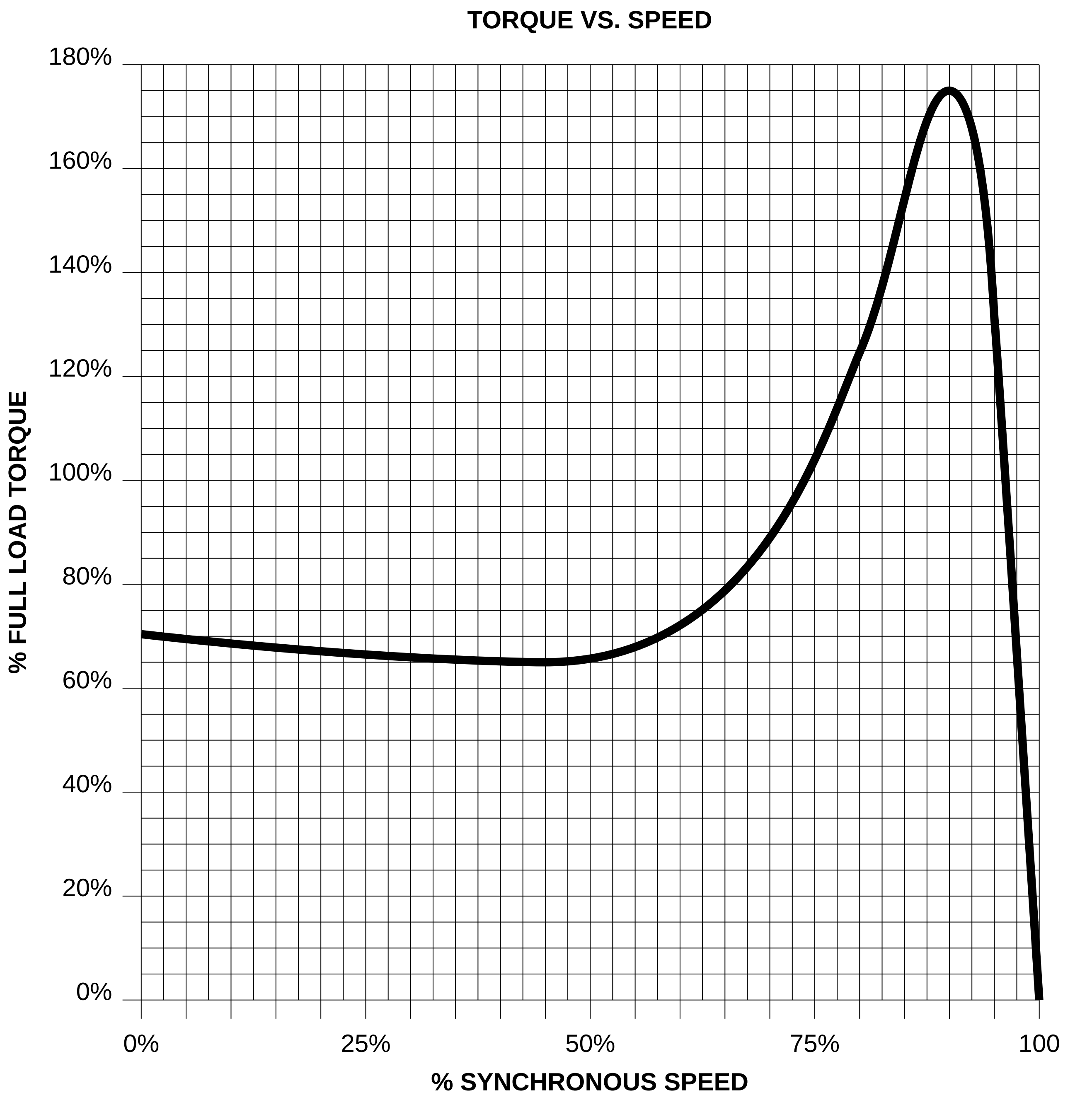
TORQUE VS. SPEED



Customer:________________ PO #:____________ Order #:____________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

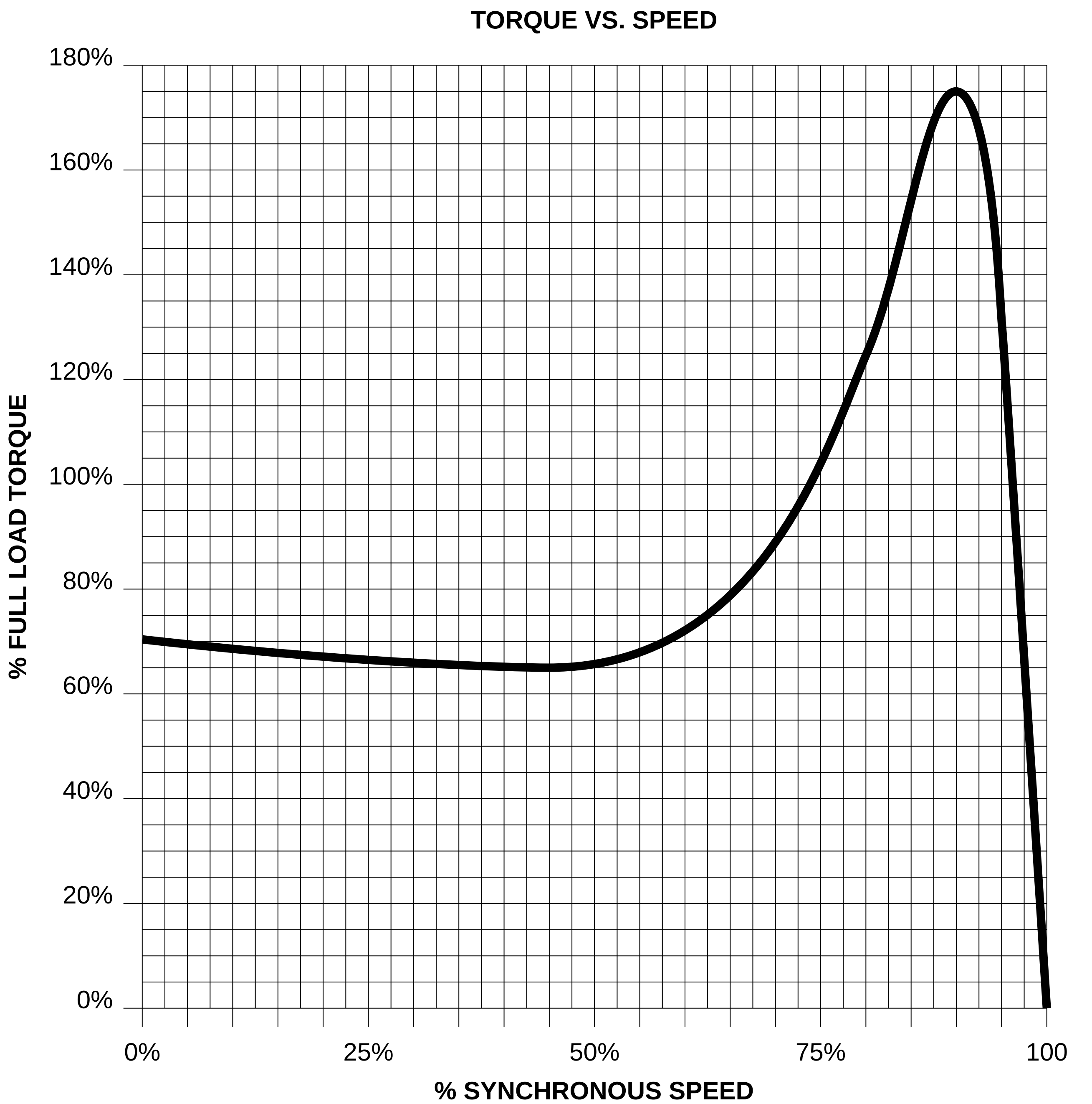
HP	250	VOLTS		RPM	3600	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:____________________ PO #:______________ Order #:______________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

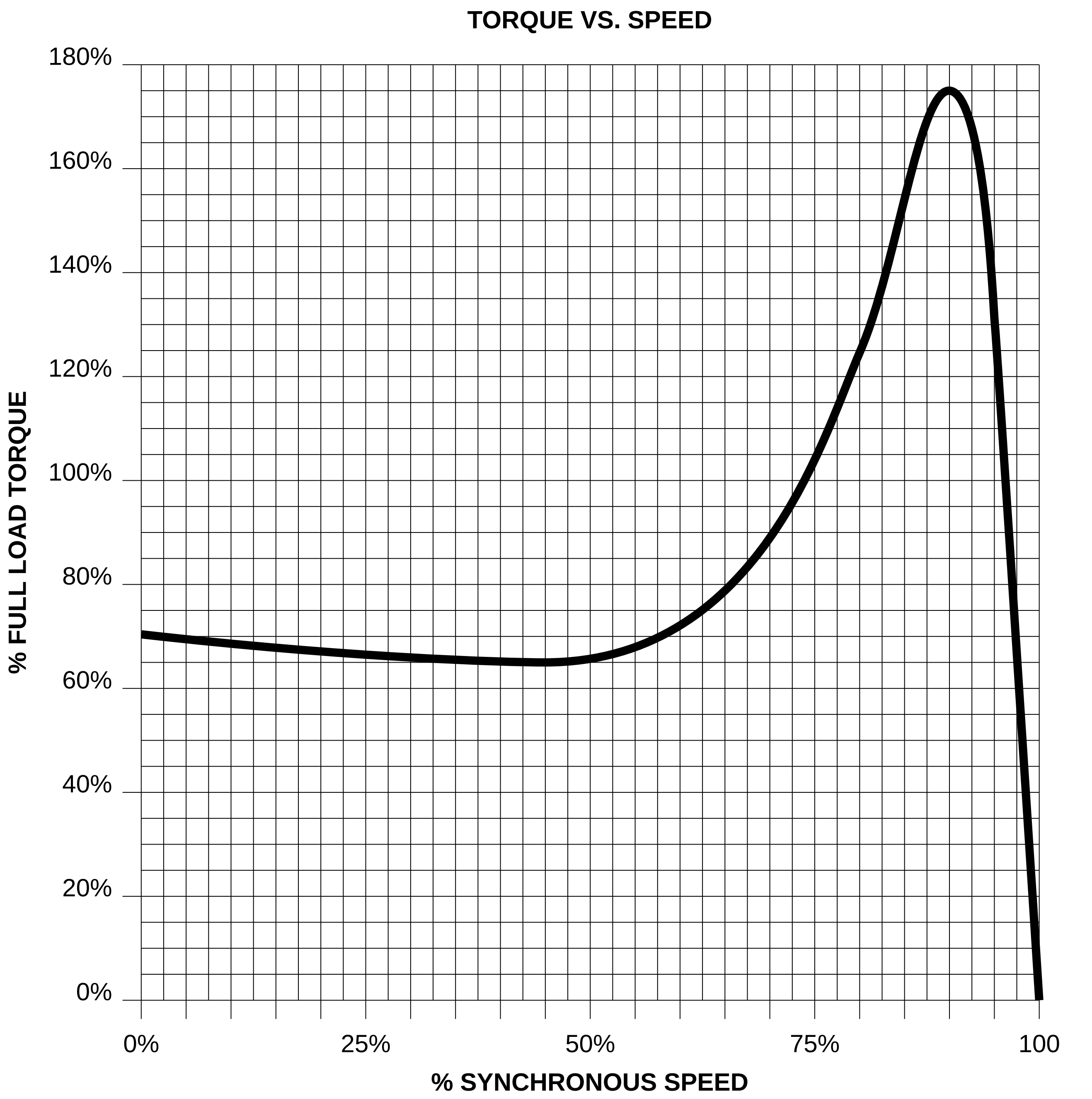
HP	300	VOLTS		RPM	3600	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:________________ PO #:____________ Order #:____________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

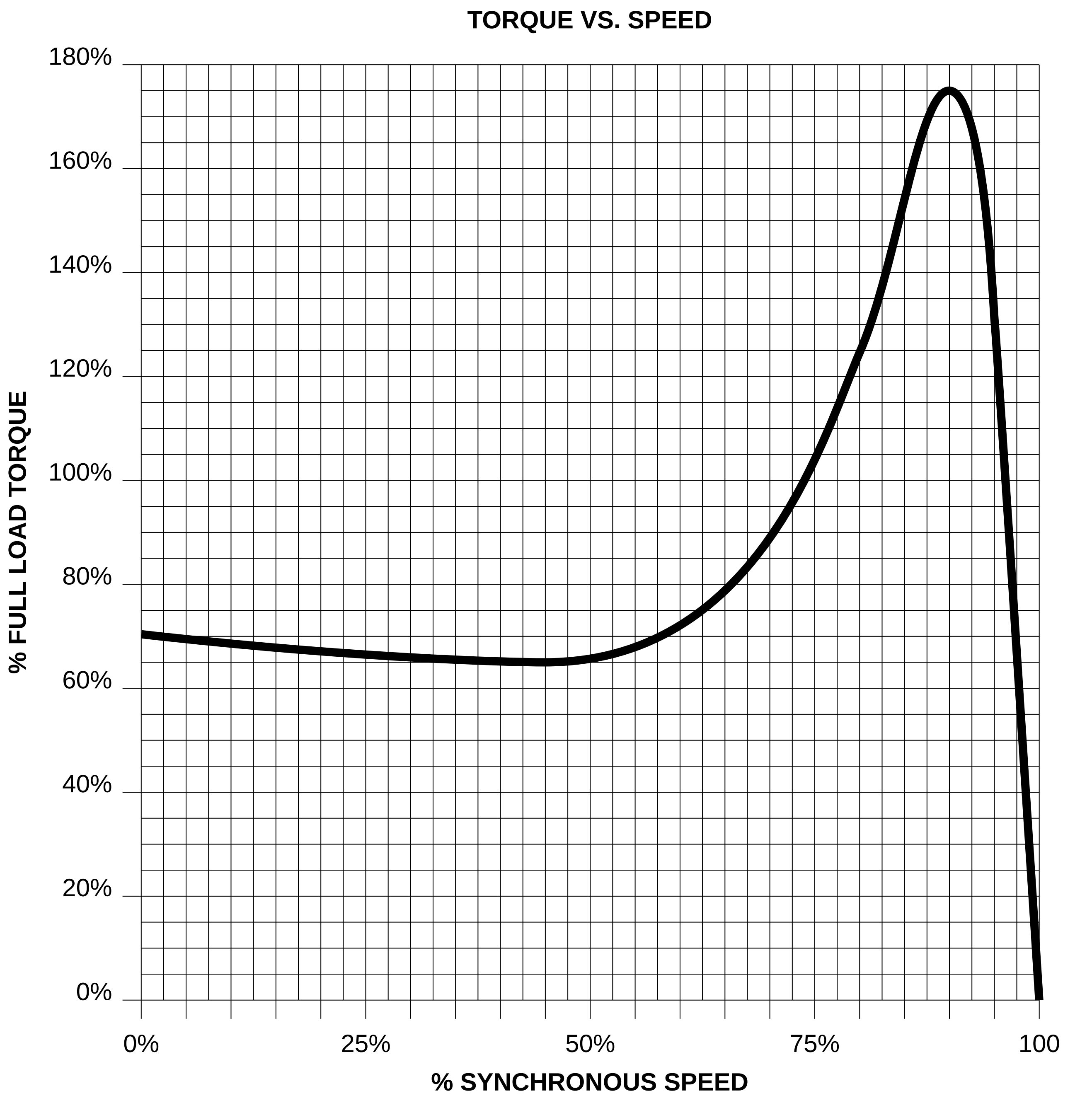
HP	350	VOLTS		RPM	3600	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:________________ PO #:________________ Order #:________________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

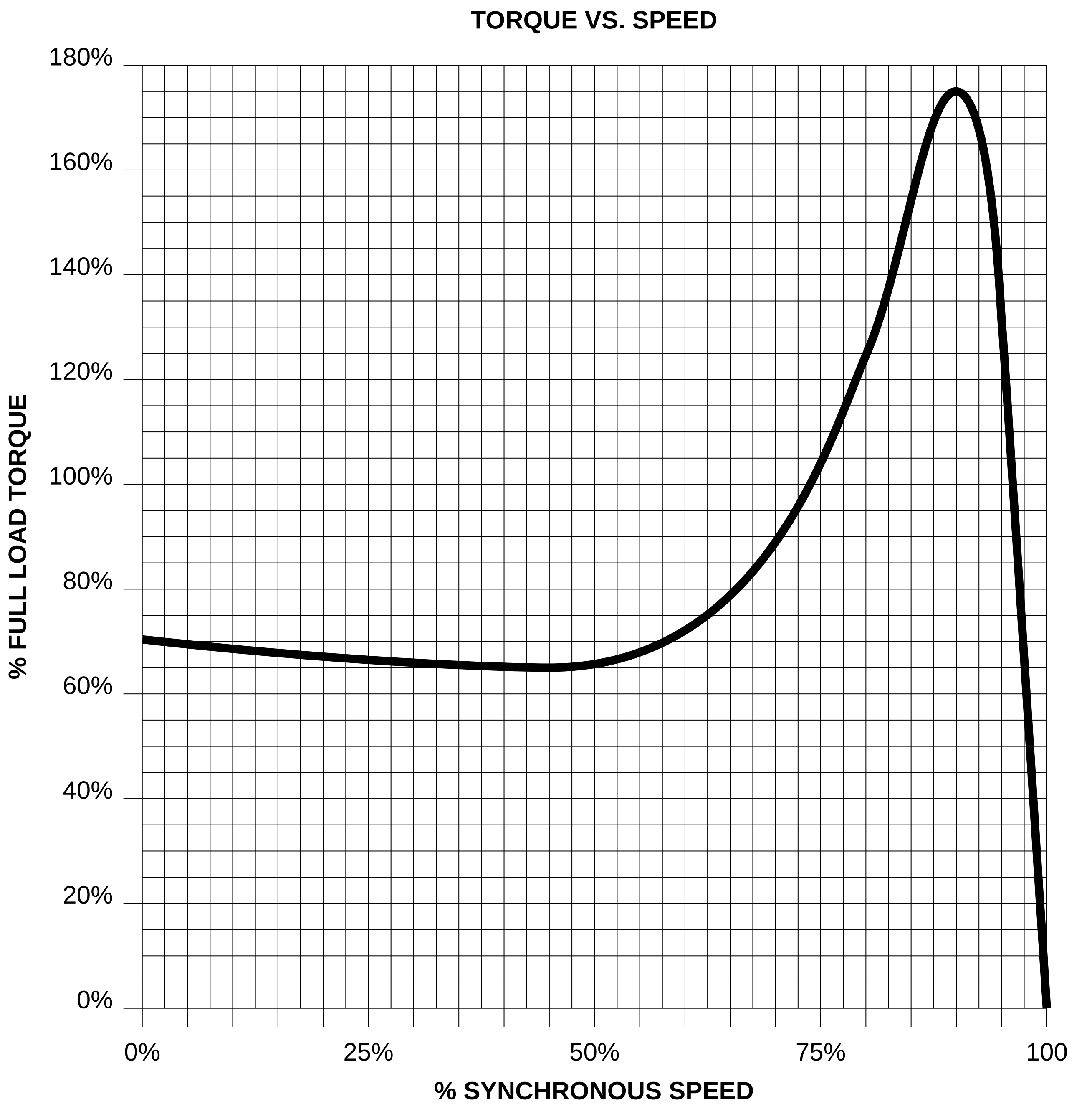
HP	400	VOLTS		RPM	3600	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:________________ PO #:________________ Order #:________________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

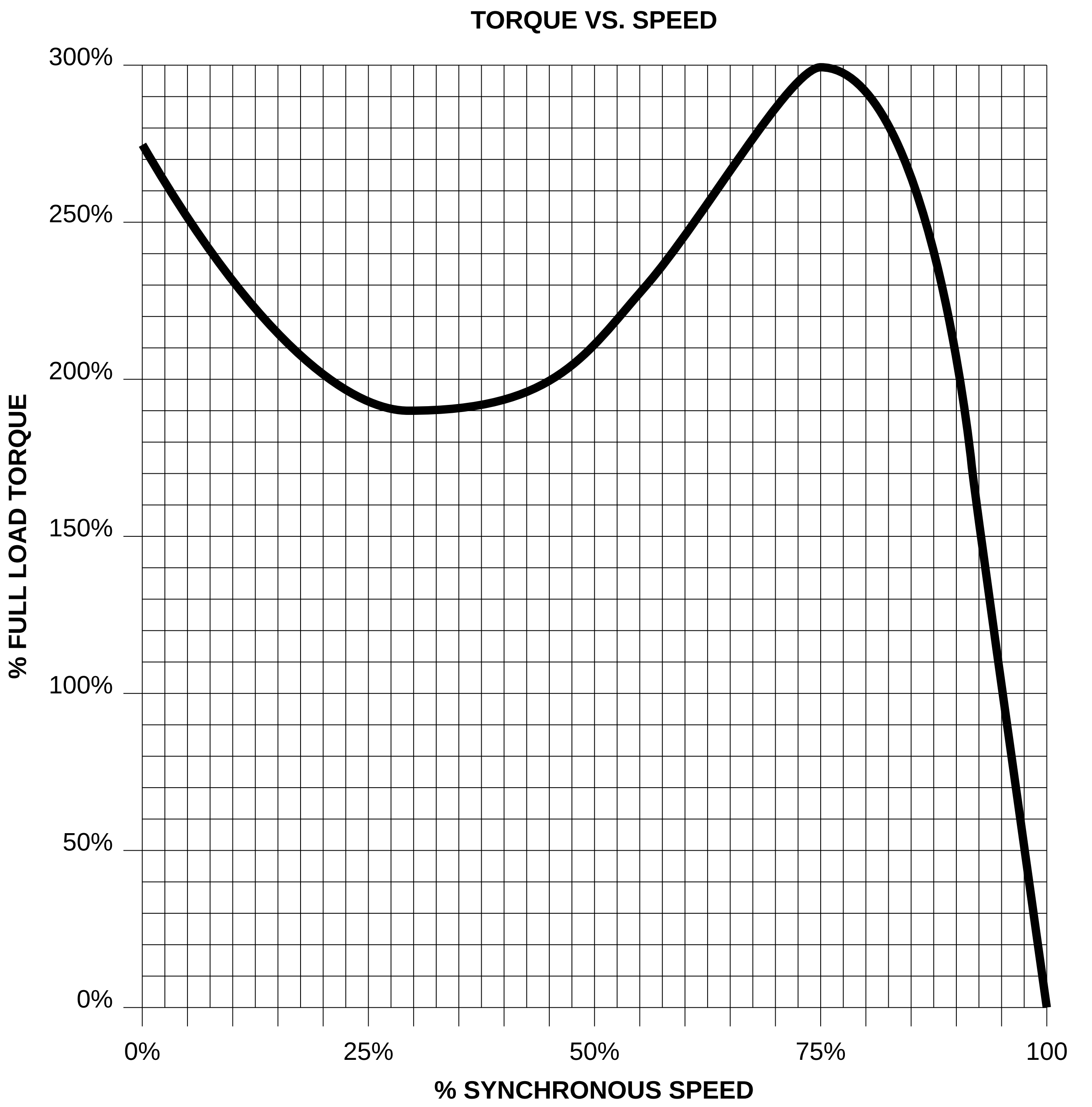
HP	450	VOLTS		RPM	3600	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:________________ PO #:__________ Order #:__________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

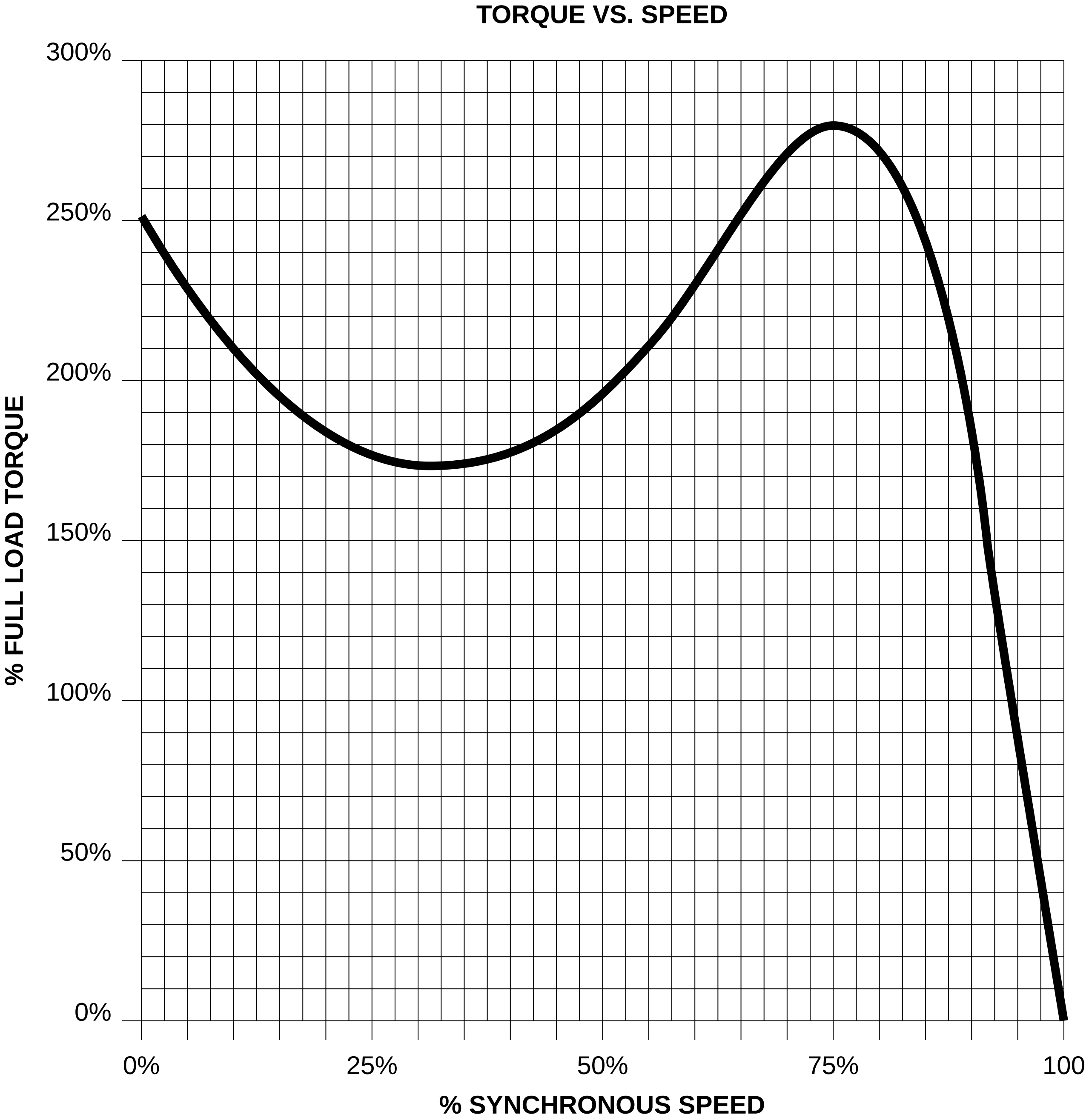
HP	1	VOLTS		RPM	1800	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:____________________ PO #:____________ Order #:____________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

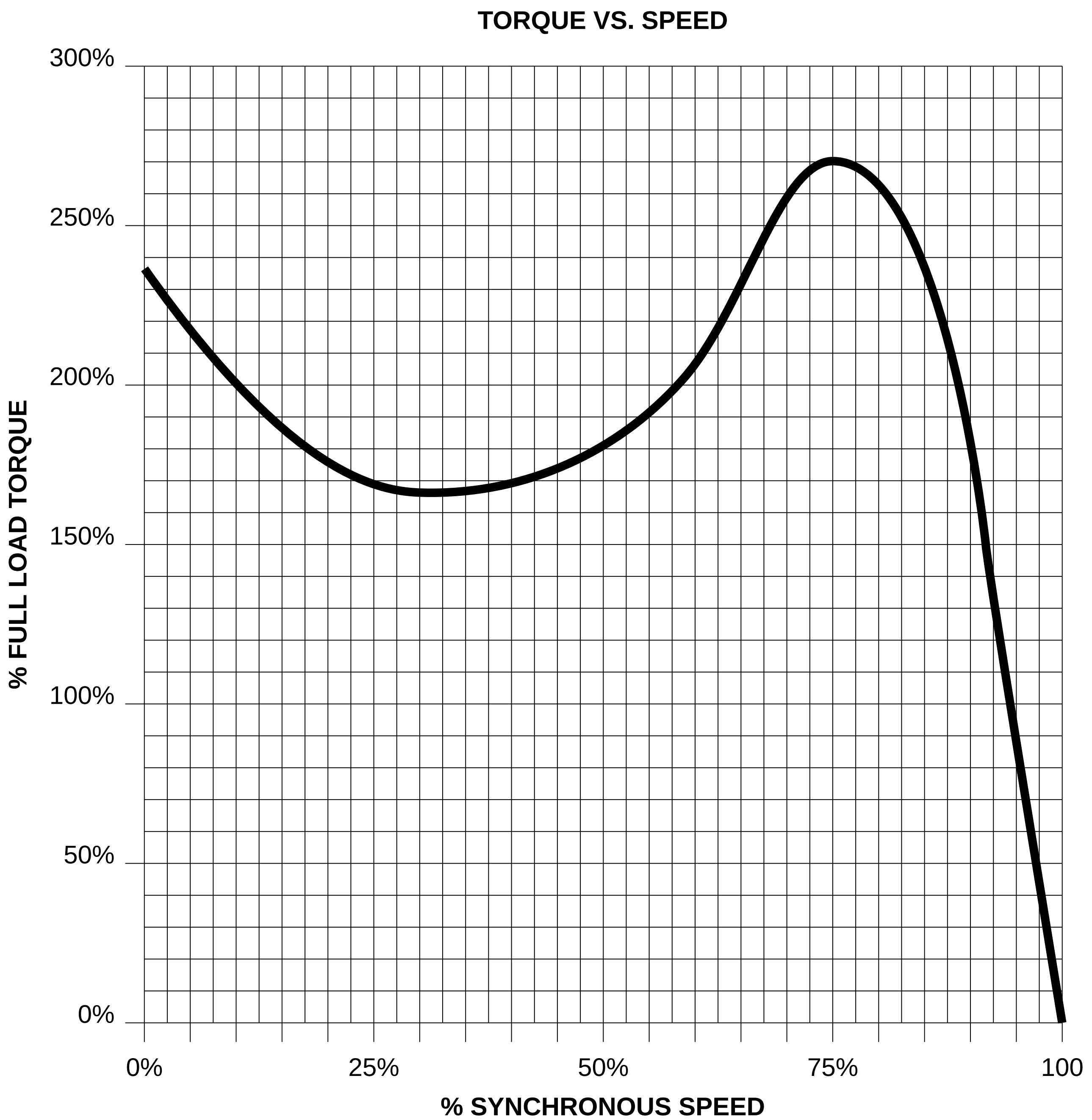
HP	1.5	VOLTS		RPM	1800	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:____________________ PO #:______________ Order #:______________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

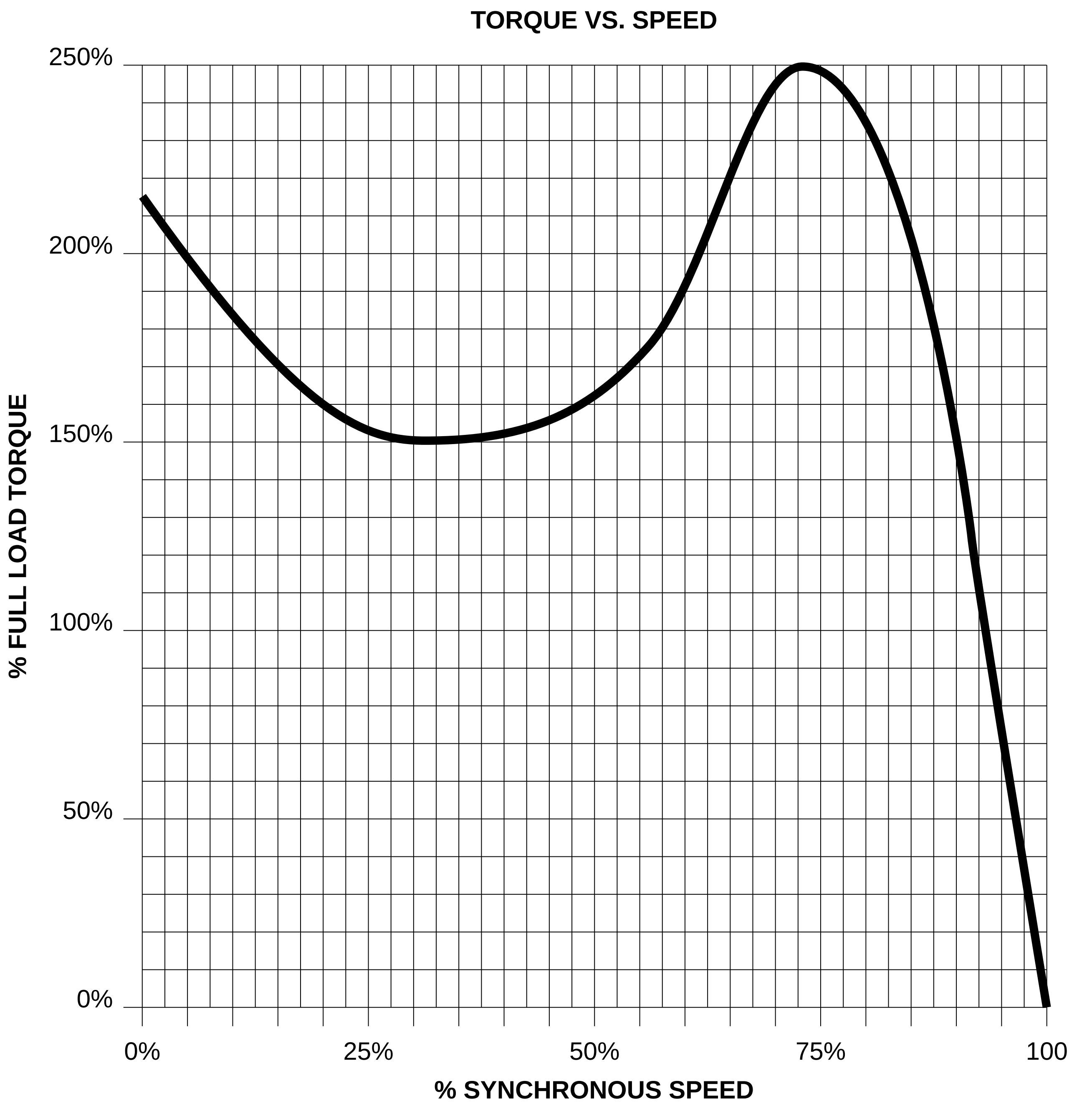
HP	2	**VOLTS**		**RPM**	1800	**TYPE**	
HZ	60	**PHASE**	3	**FRAME**		**NEMA**	B



Customer: ______________________ PO #: ______________ Order #: ______________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

HP	3	VOLTS		RPM	1800	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B

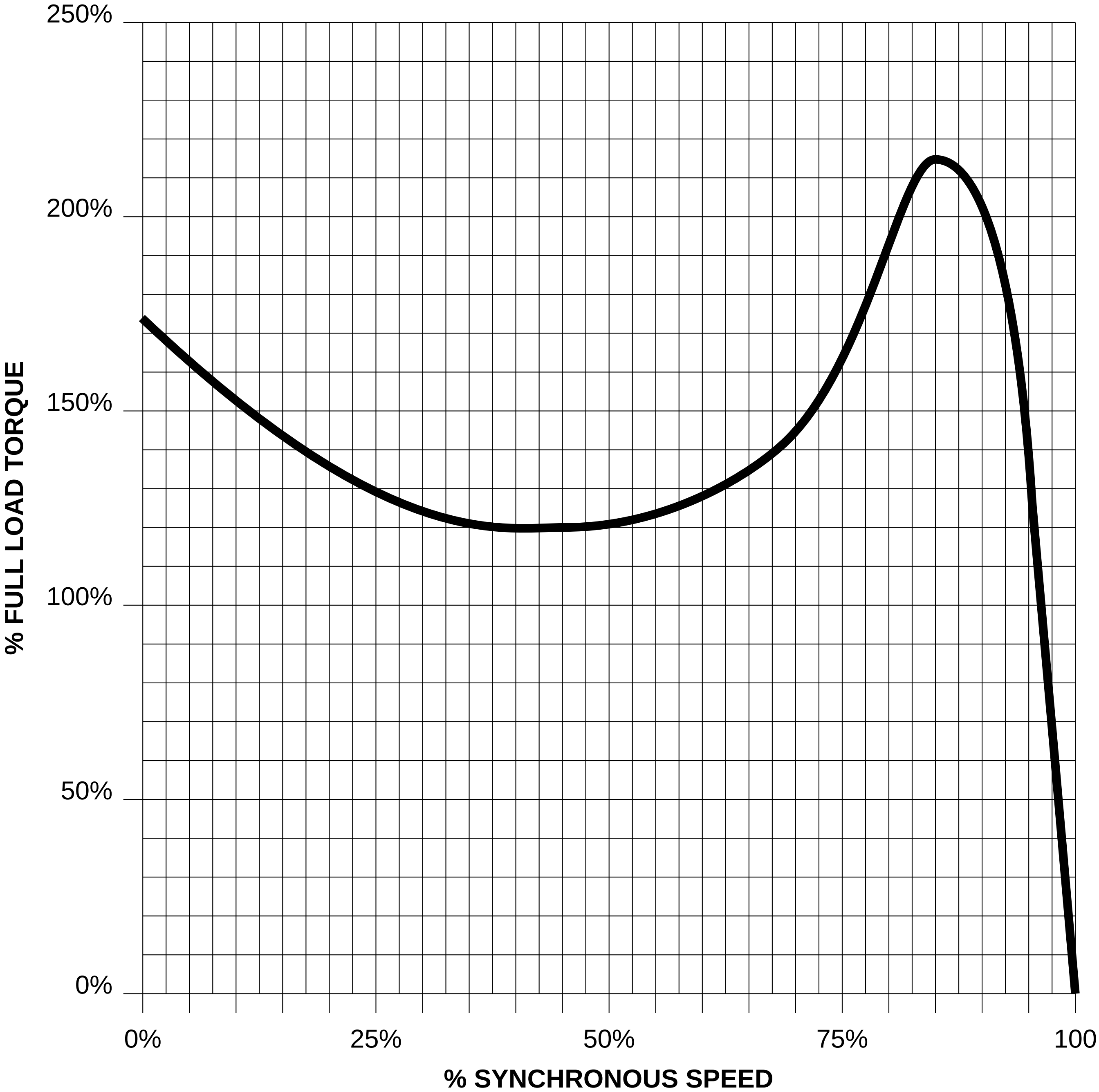


Customer:________________ PO #:__________ Order #:__________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

HP	5	VOLTS		RPM	1800	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B

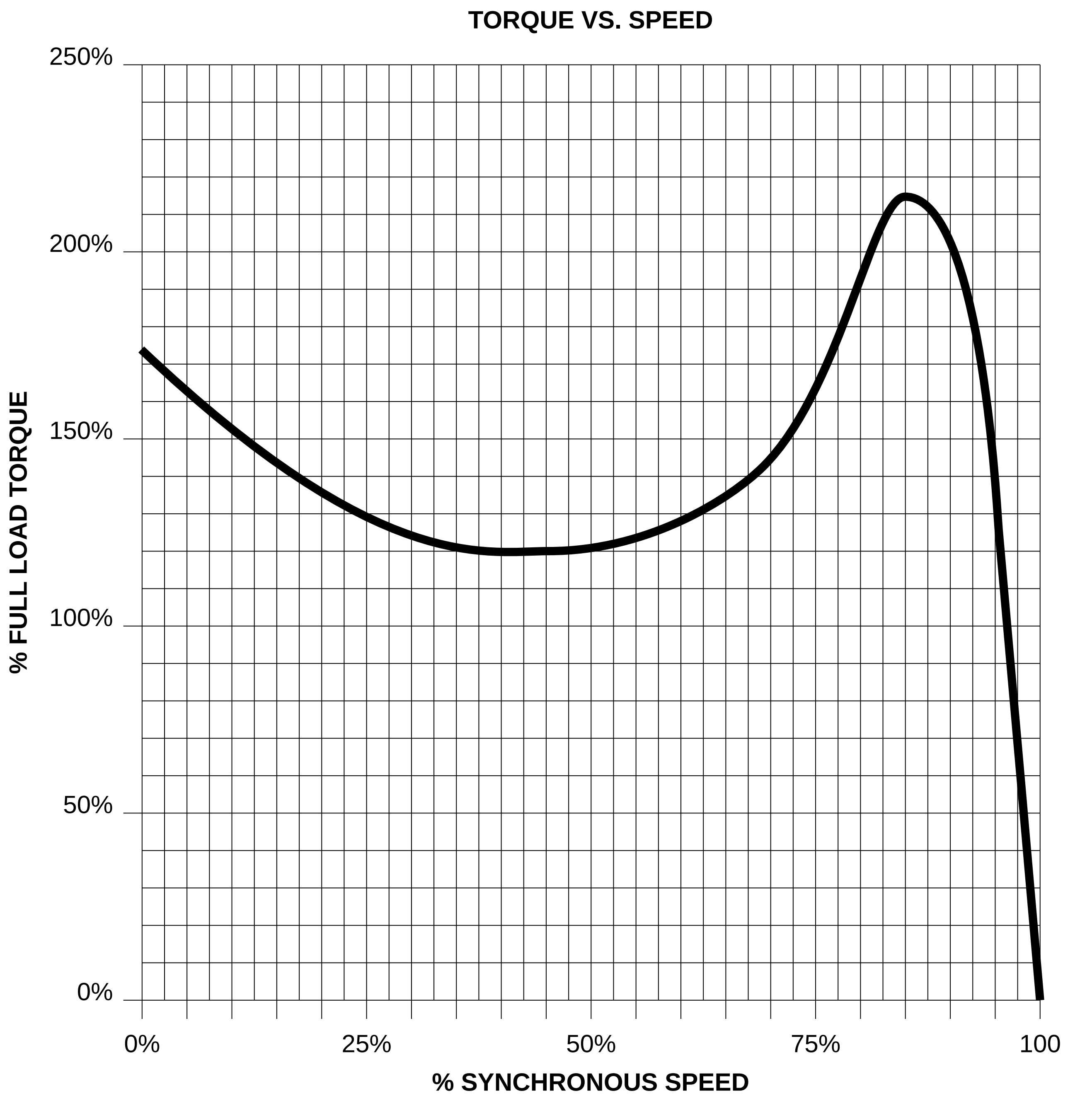
TORQUE VS. SPEED



Customer:____________________ PO #:____________ Order #:____________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

HP	7.5	VOLTS		RPM	1800	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B

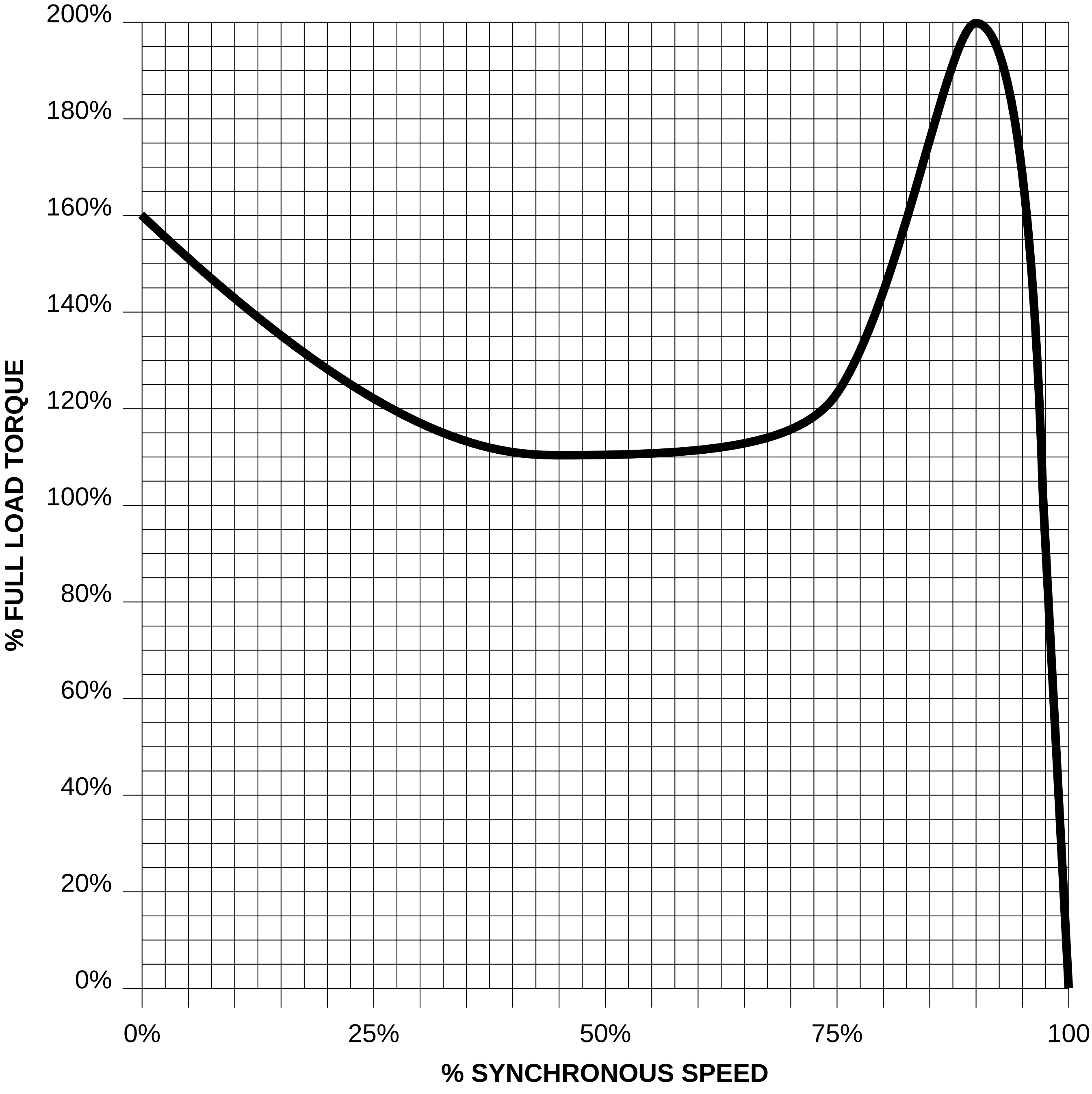


Customer:____________________ PO #:____________ Order #:____________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

HP	10	**VOLTS**		**RPM**	1800	**TYPE**	
HZ	60	**PHASE**	3	**FRAME**		**NEMA**	B

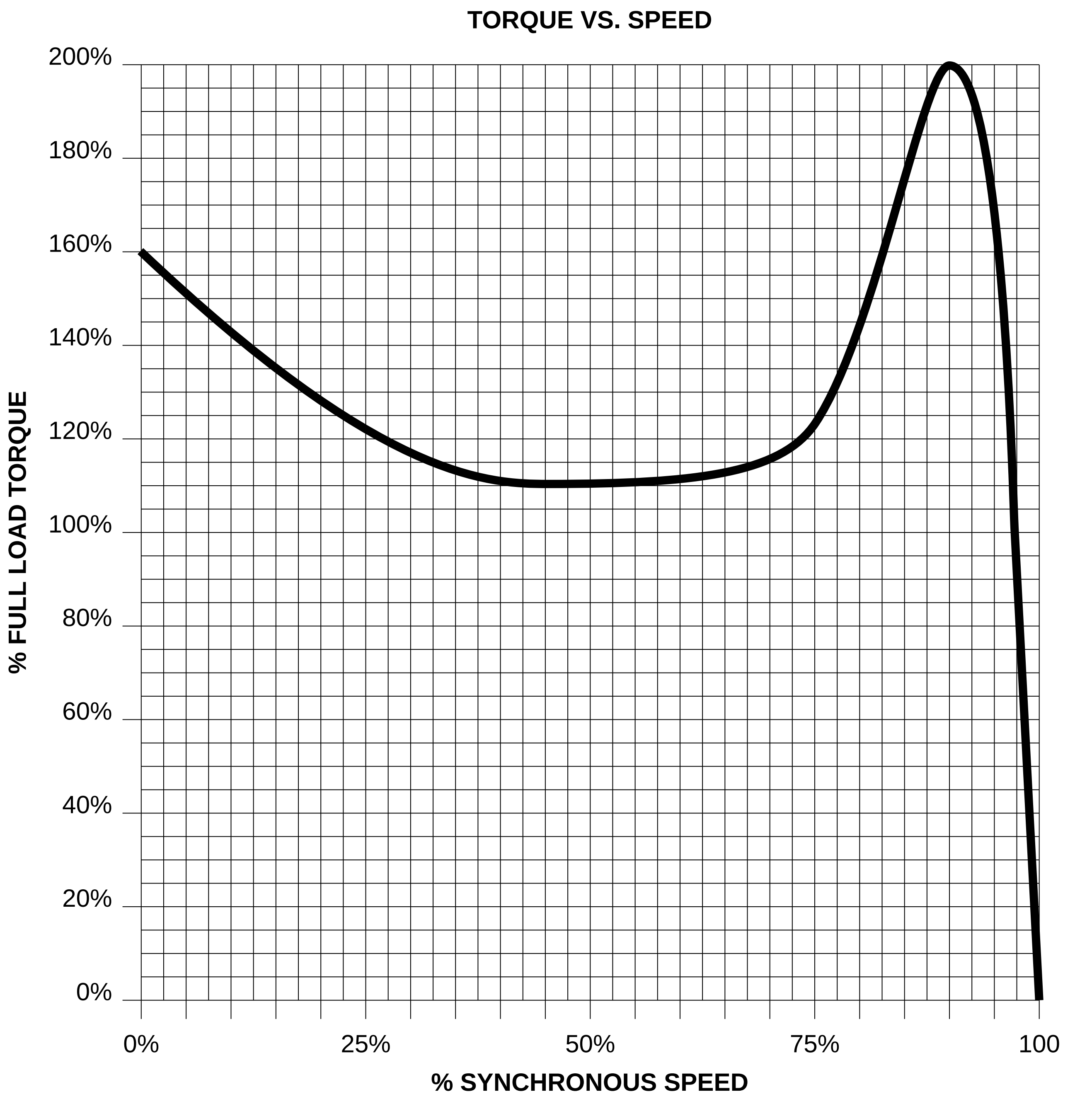
TORQUE VS. SPEED



Customer:________________________ PO #:____________ Order #:______________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

HP	15	VOLTS		RPM	1800	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B

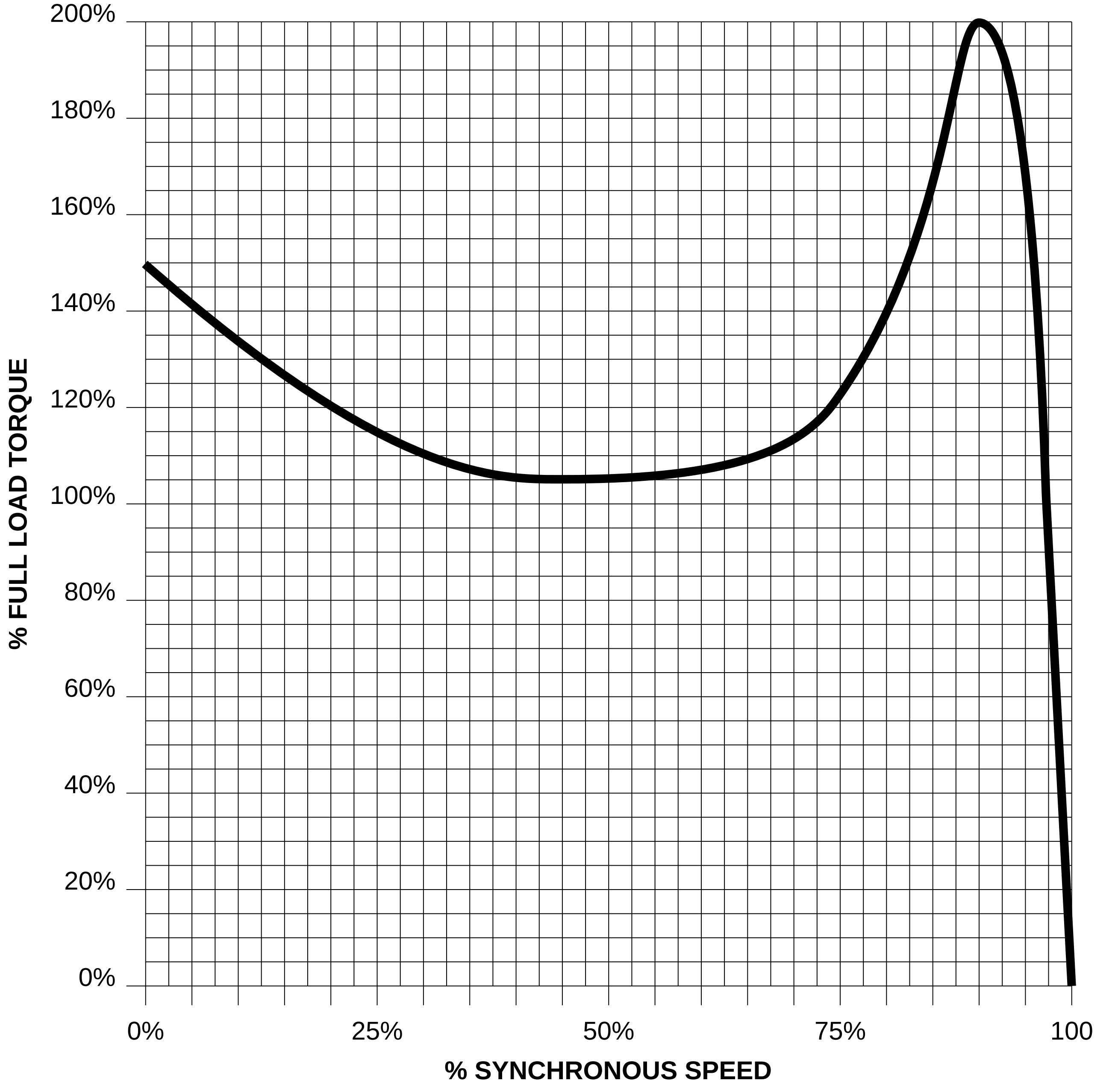


Customer: ______________________ PO #: ______________ Order #: ______________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

HP	20	VOLTS		RPM	1800	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B

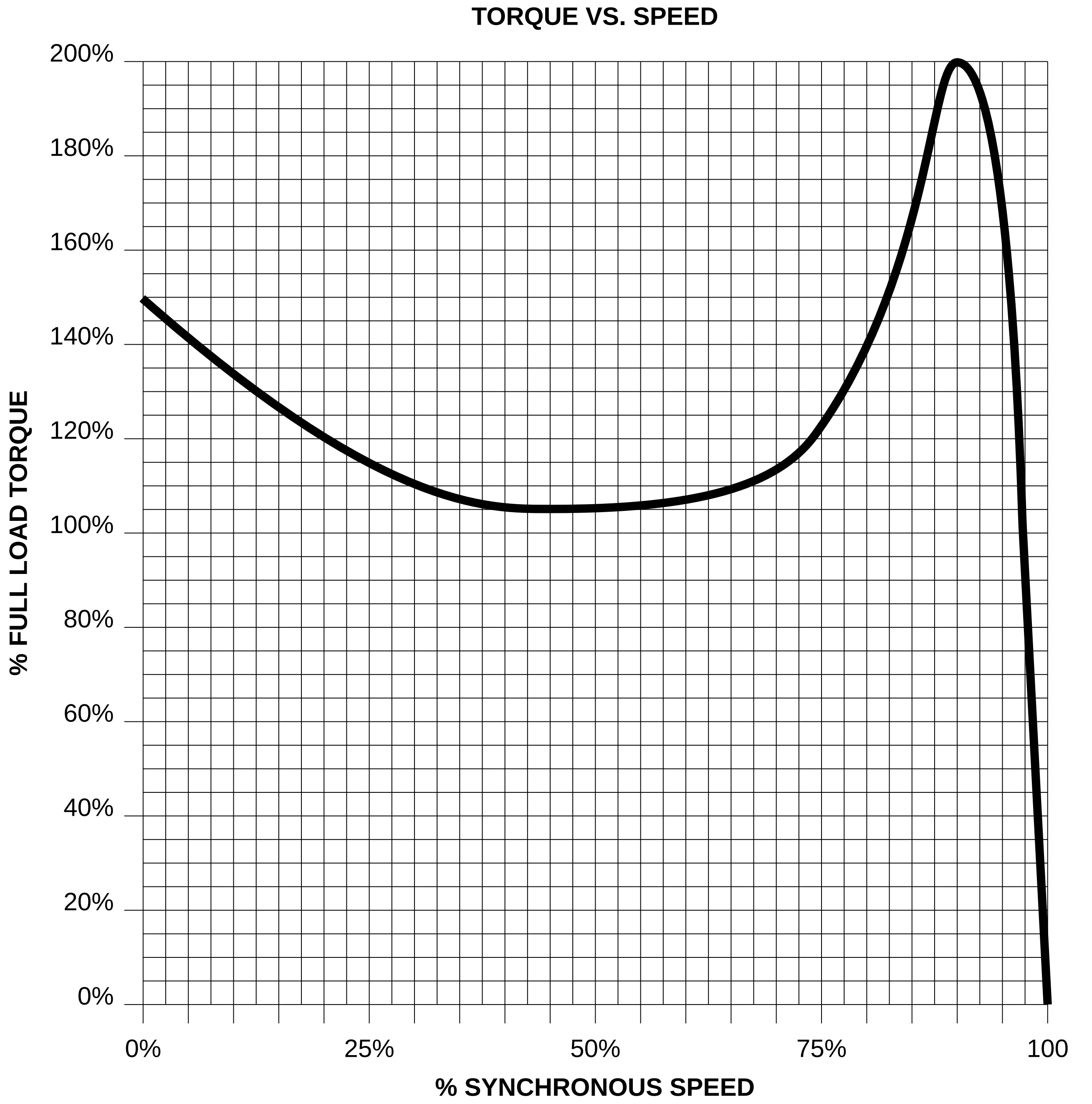
TORQUE VS. SPEED



Customer:____________________ PO #:____________ Order #:____________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

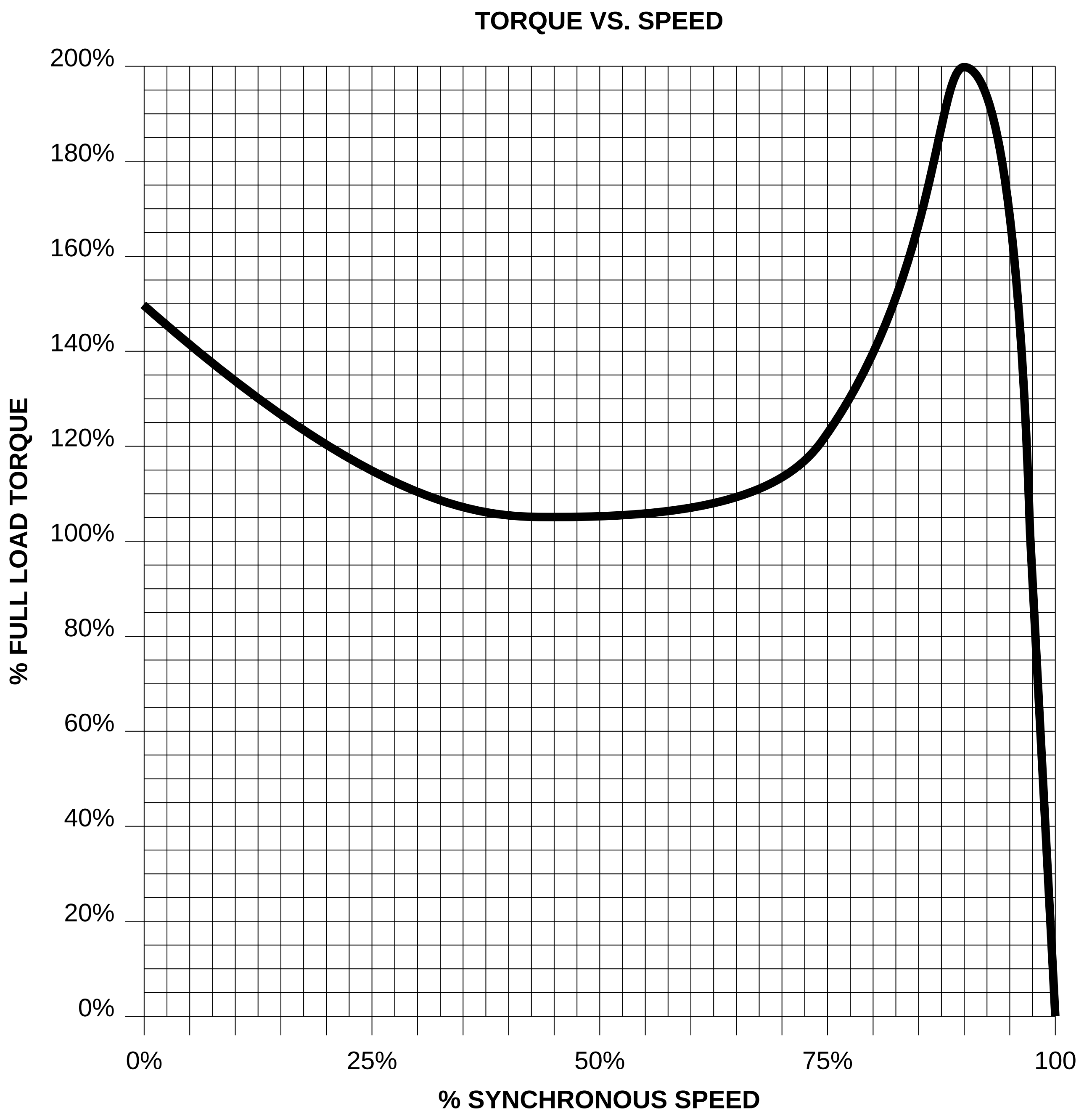
HP	25	VOLTS		RPM	1800	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer: ______________________ PO #: ______________ Order #: ______________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

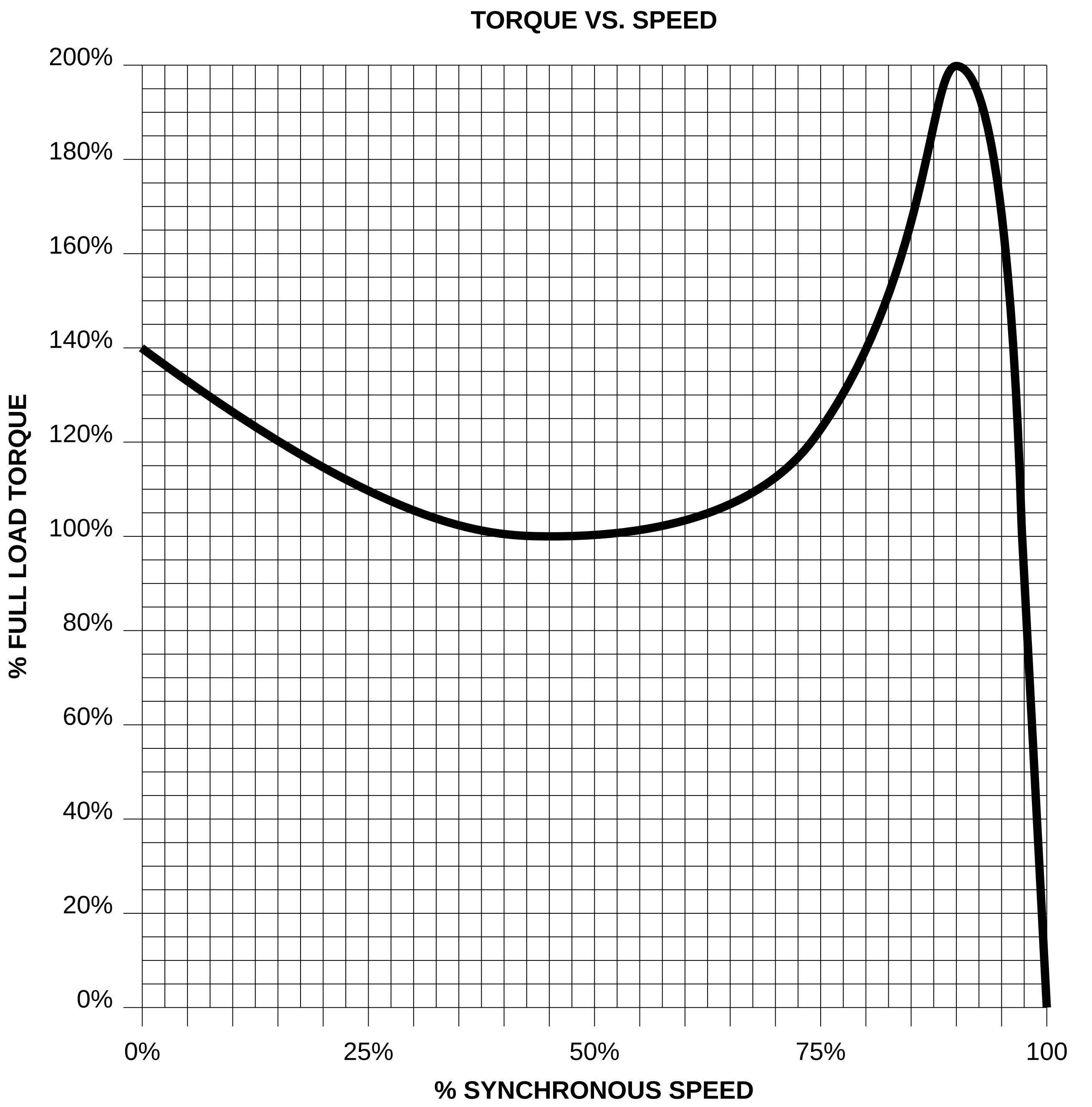
HP	30	VOLTS		RPM	1800	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:________________ PO #:________________ Order #:________________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

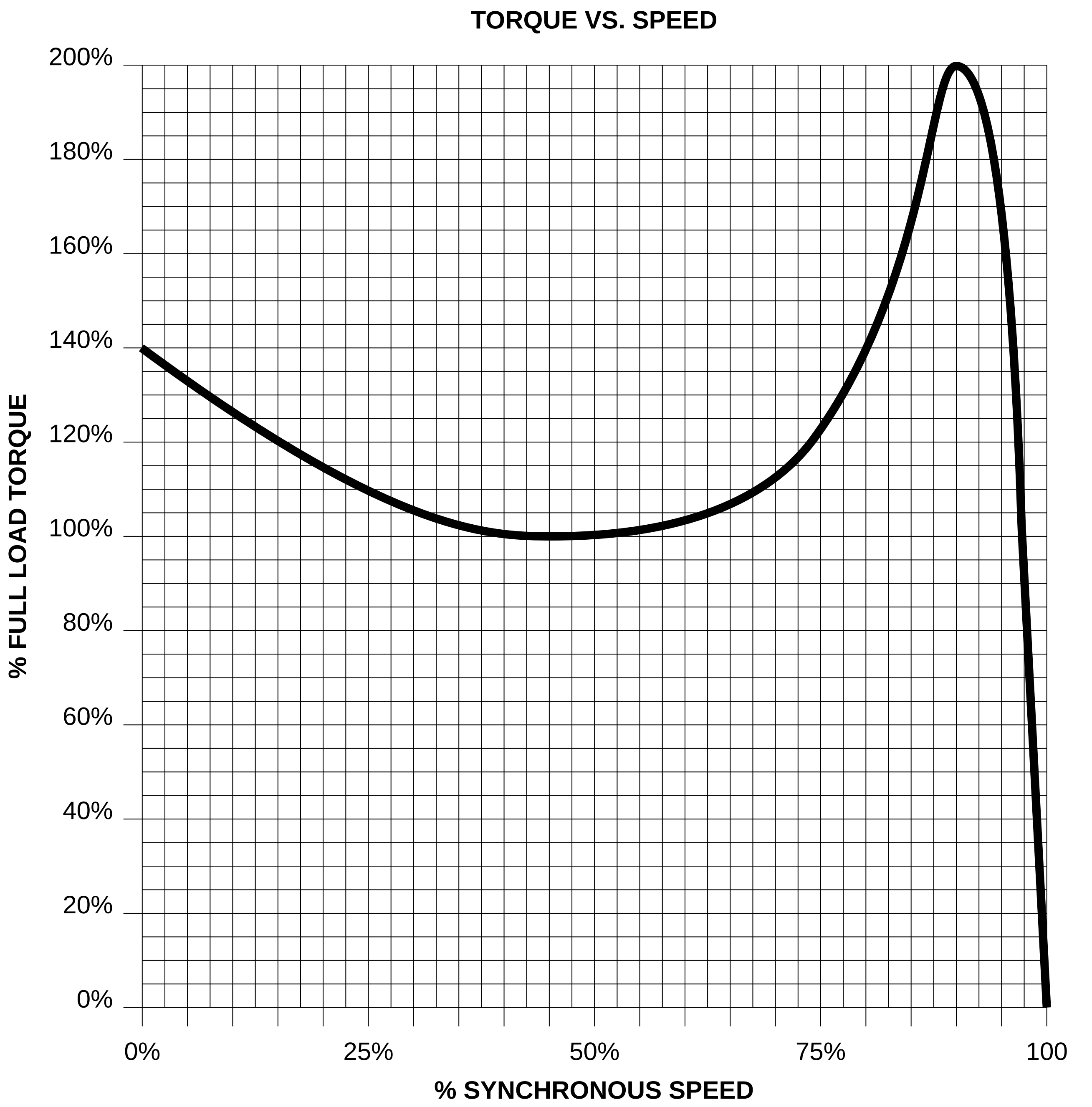
HP	40	VOLTS		RPM	1800	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:____________________ PO #:______________ Order #:________________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

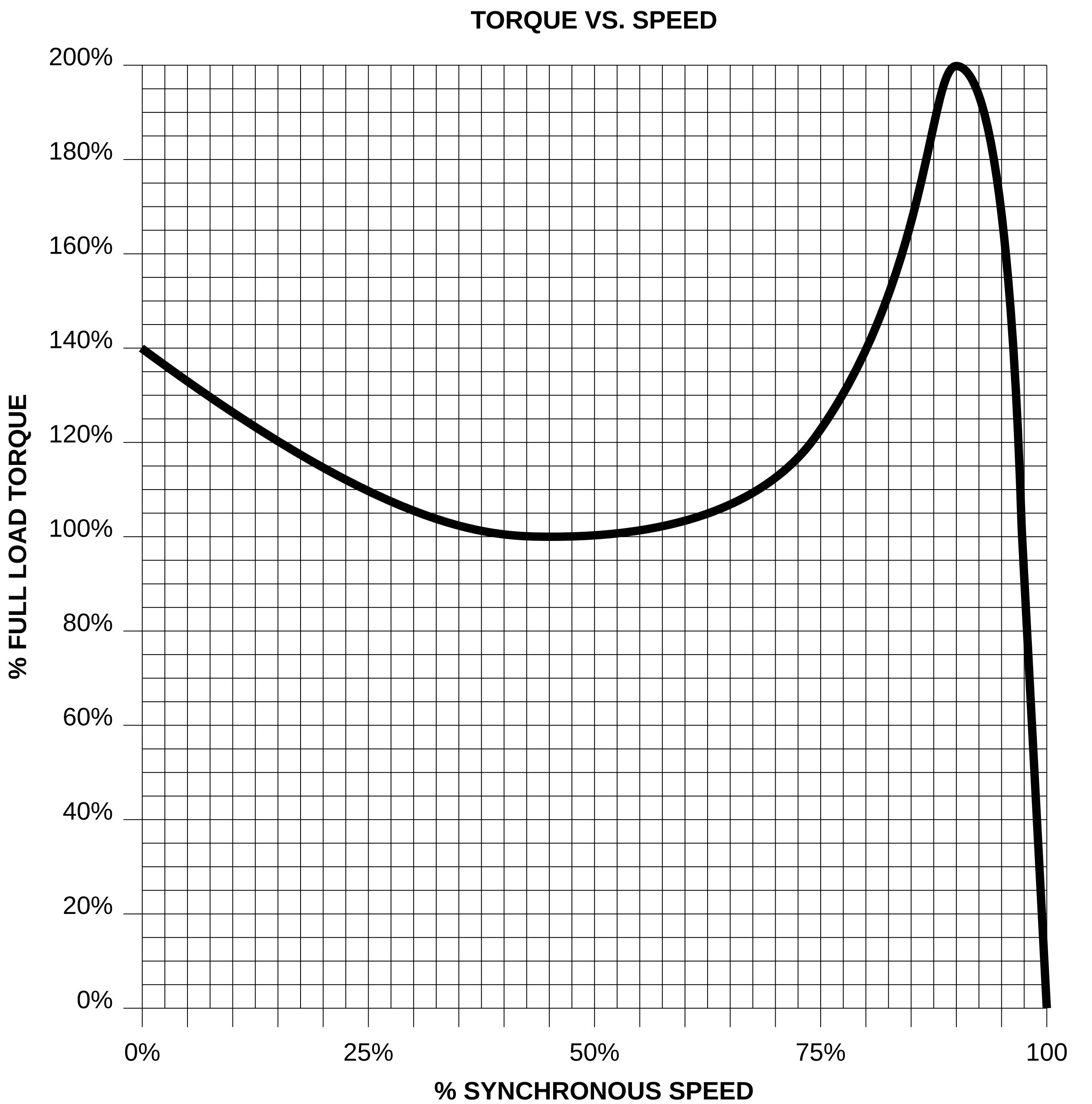
HP	50	VOLTS		RPM	1800	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:________________ PO #:__________ Order #:__________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

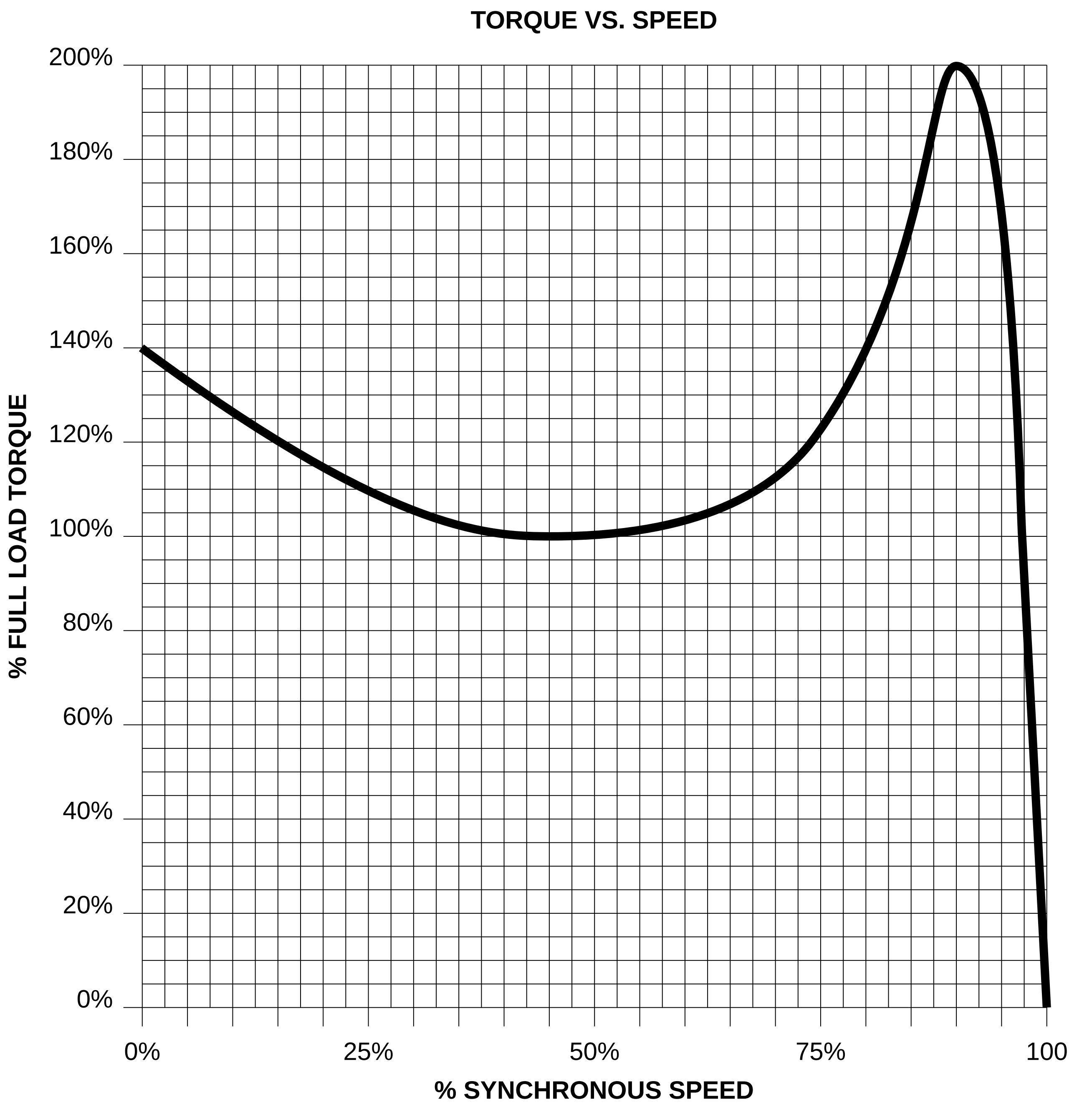
HP	60	VOLTS		RPM	1800	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:________________________ PO #:____________ Order #:______________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

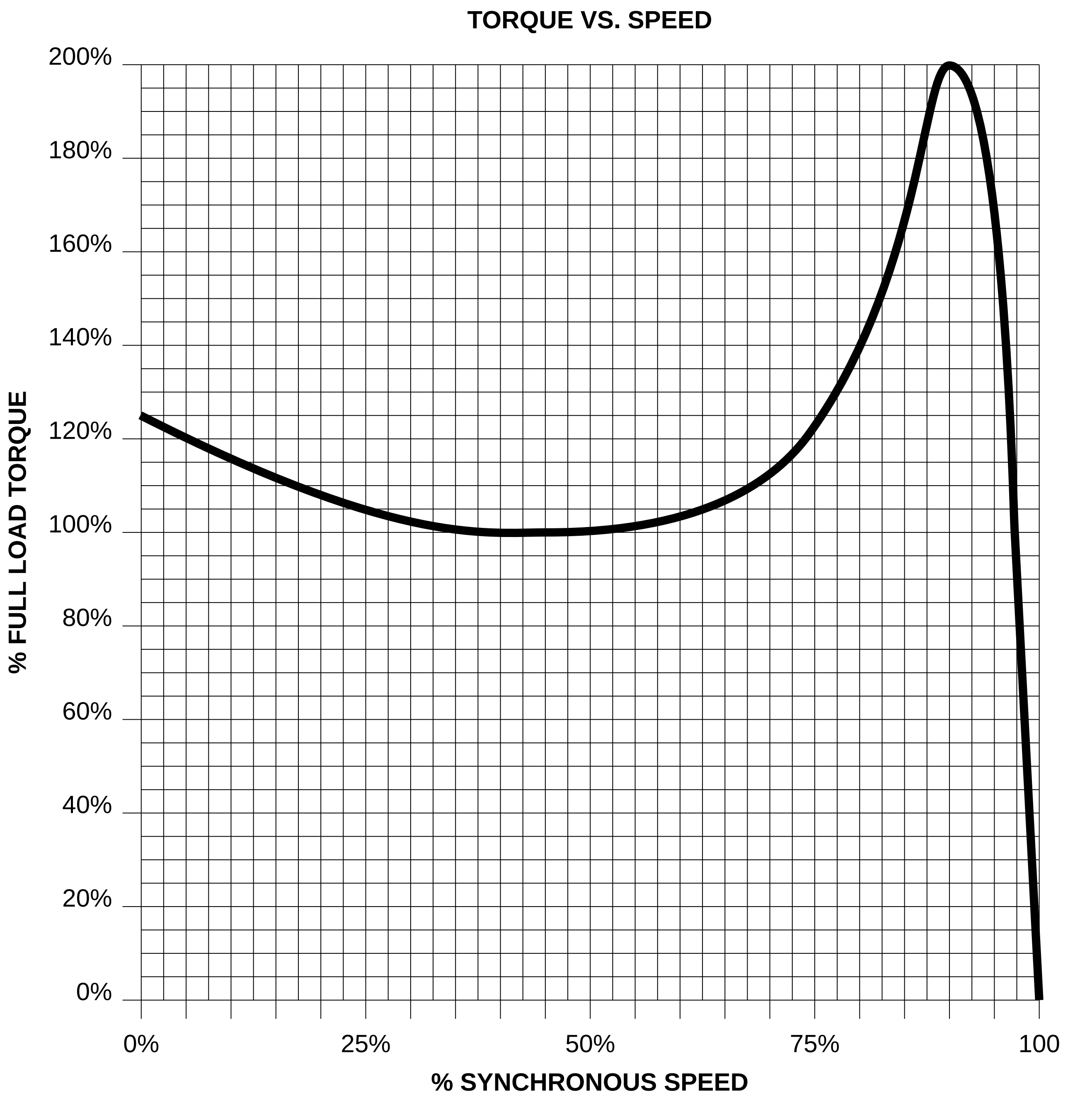
HP	75	VOLTS		RPM	1800	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:________________ PO #:________________ Order #:________________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

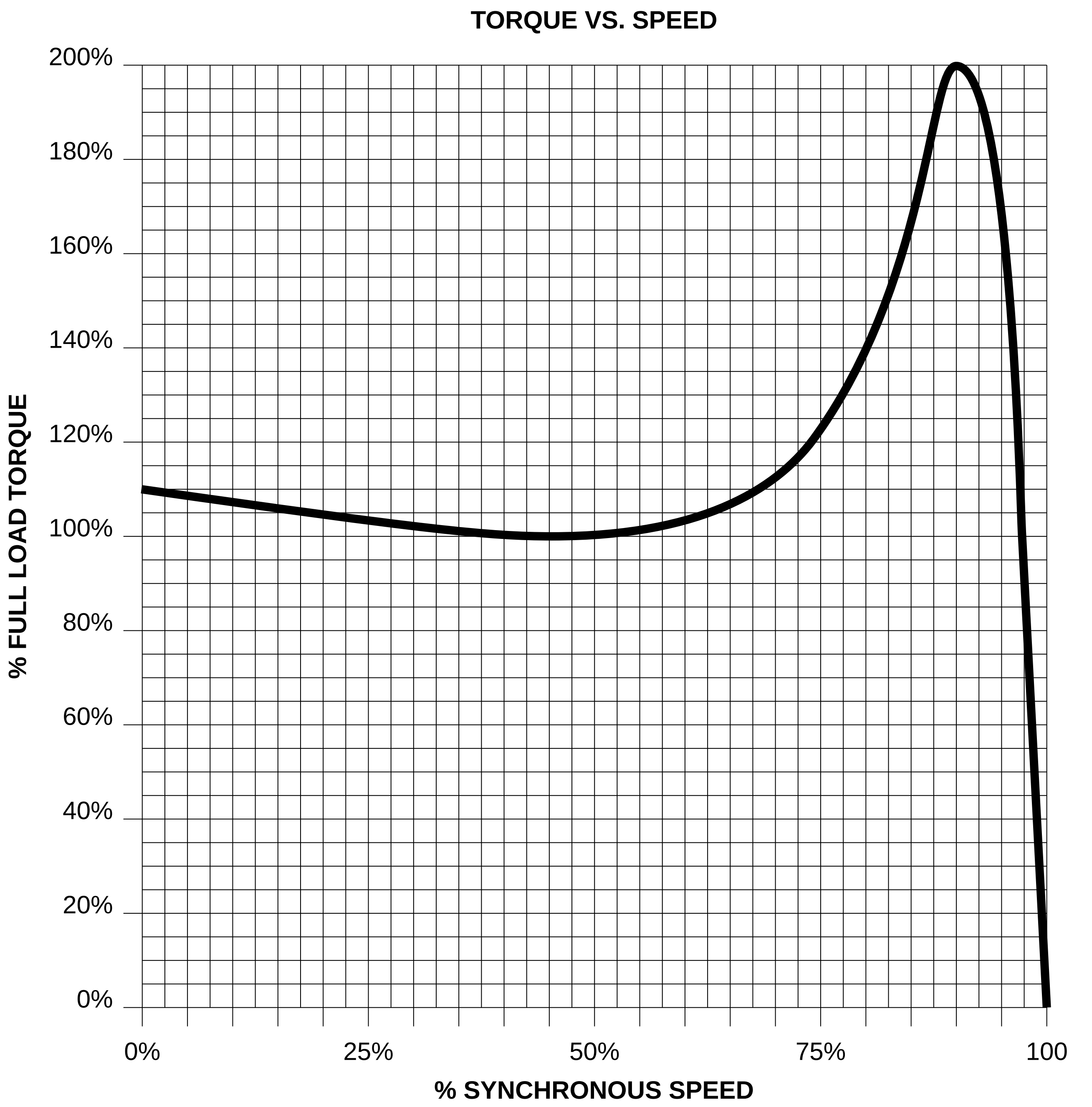
HP	100	VOLTS		RPM	1800	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:__________ PO #:__________ Order #:__________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

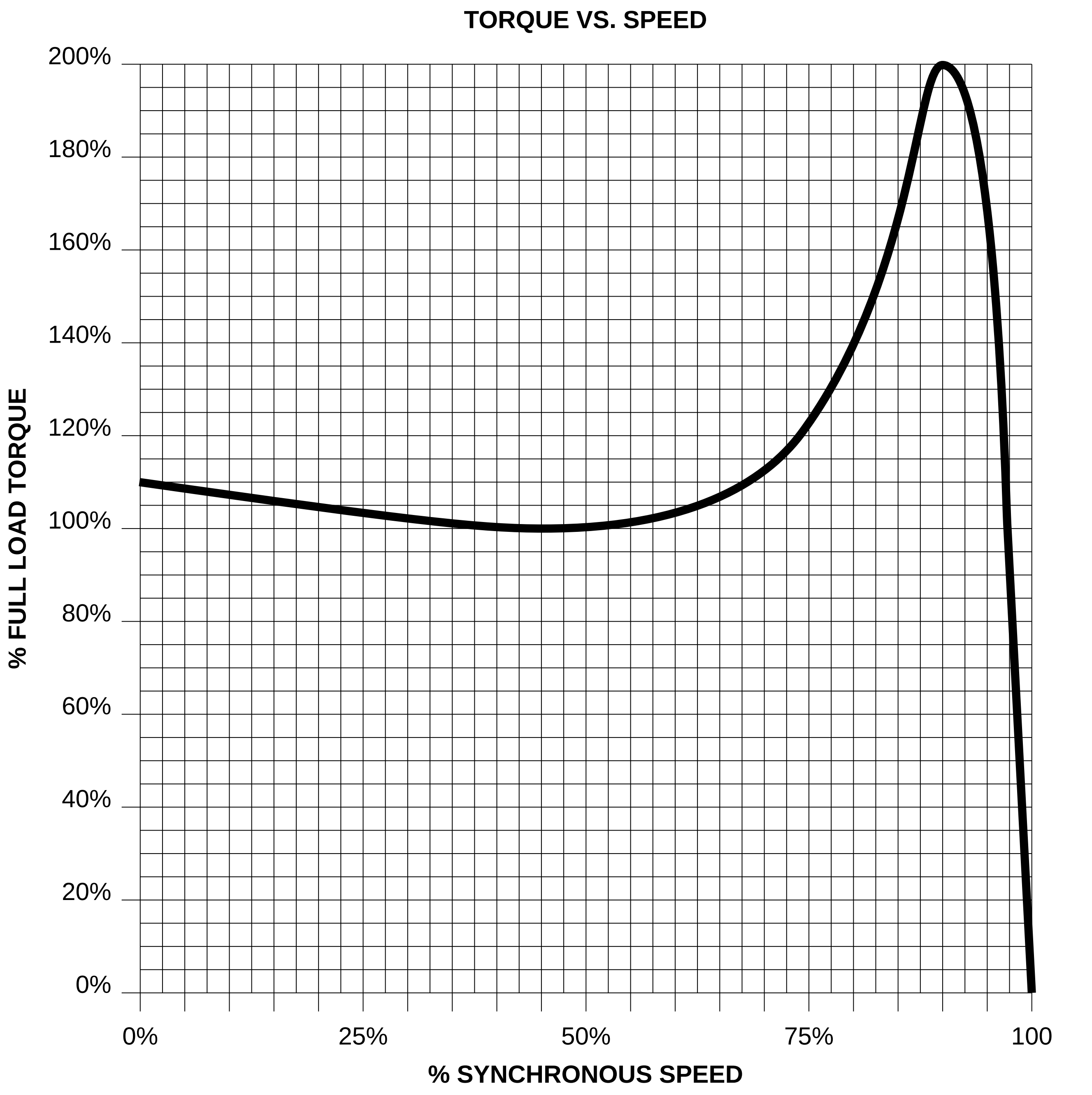
HP	125	VOLTS		RPM	1800	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:________________________ PO #:________________ Order #:________________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

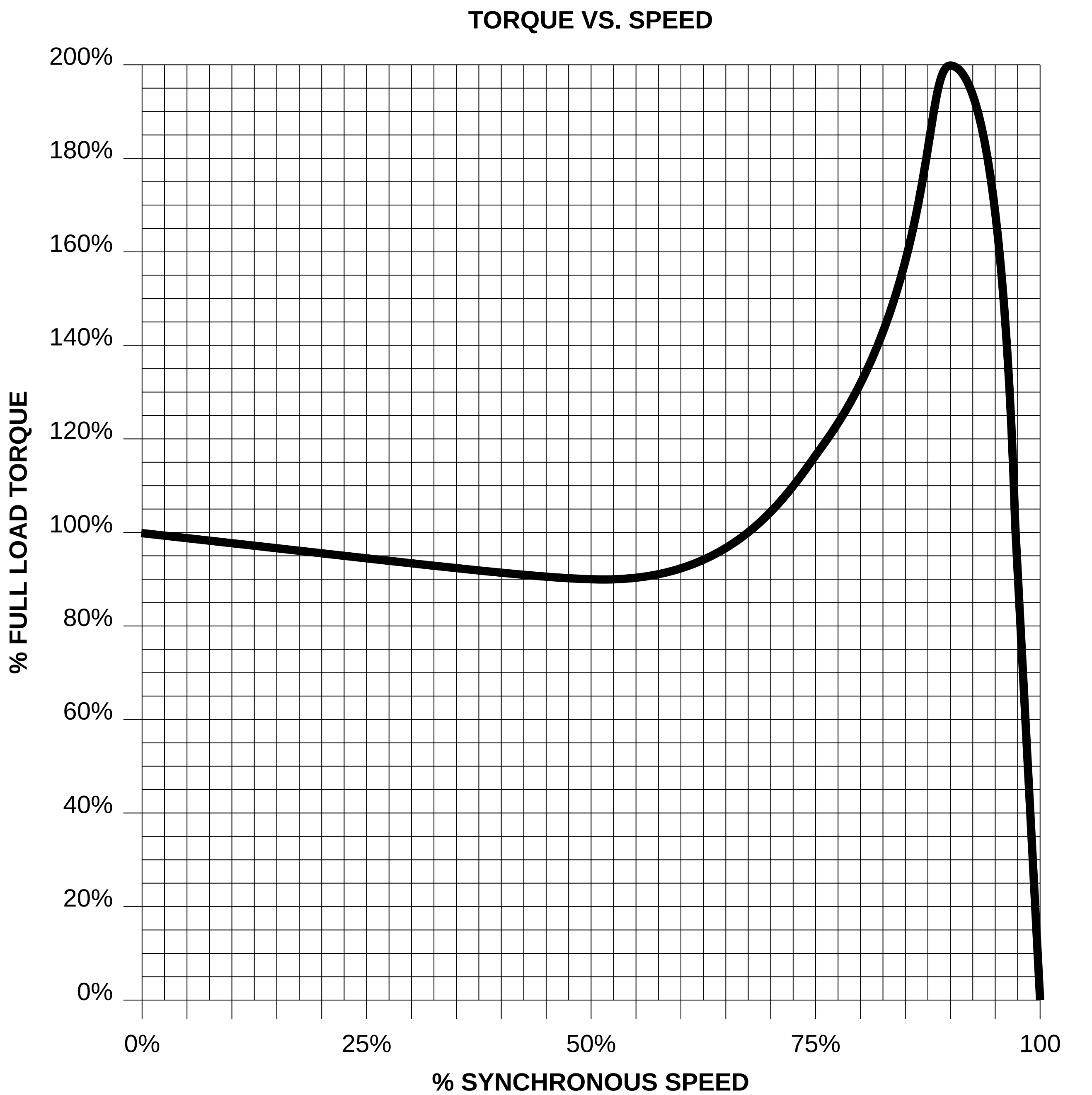
HP	150	VOLTS		RPM	1800	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:______________________ PO #:______________ Order #:________________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

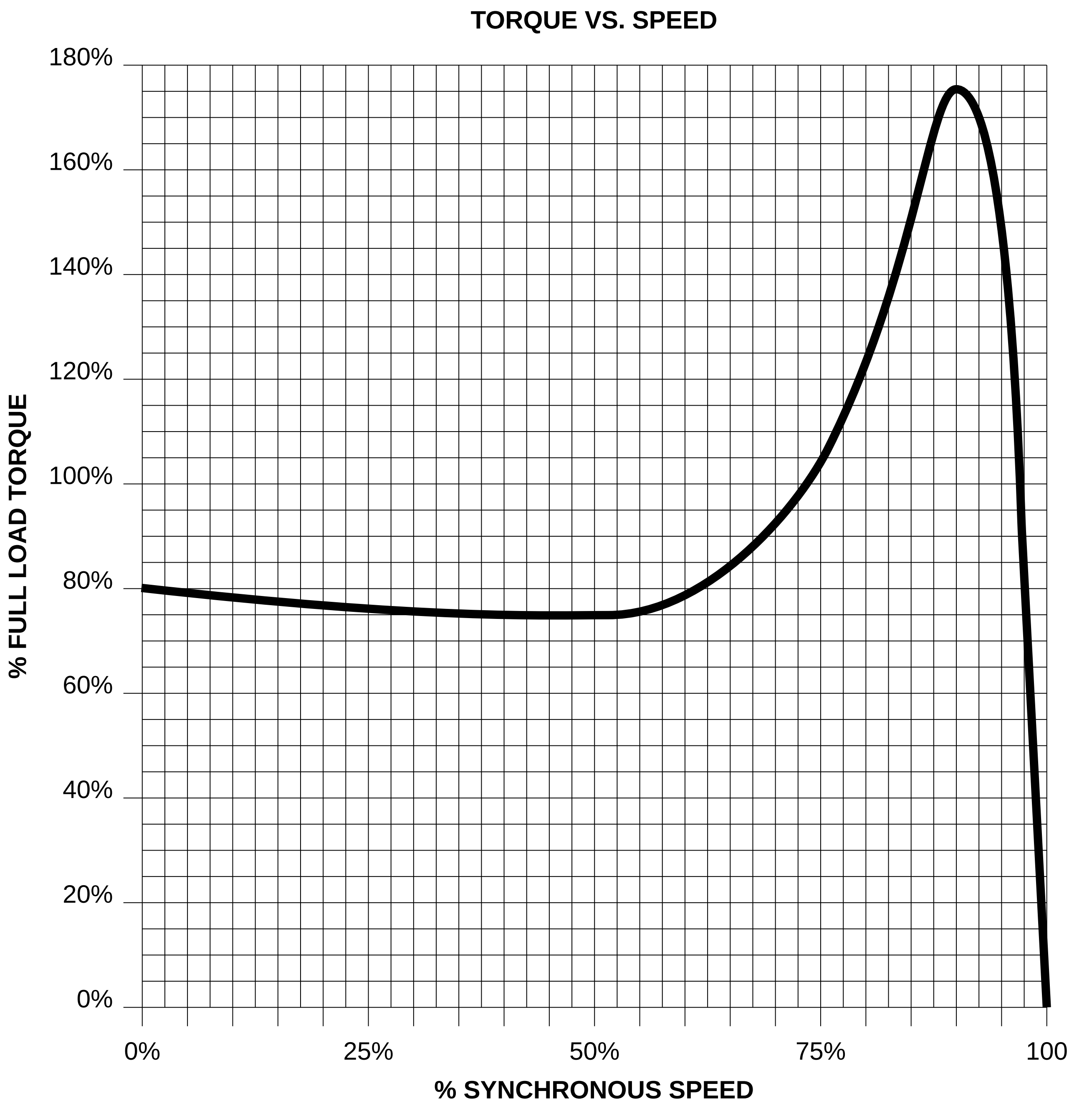
HP	200	VOLTS		RPM	1800	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:____________________ PO #:____________ Order #:____________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

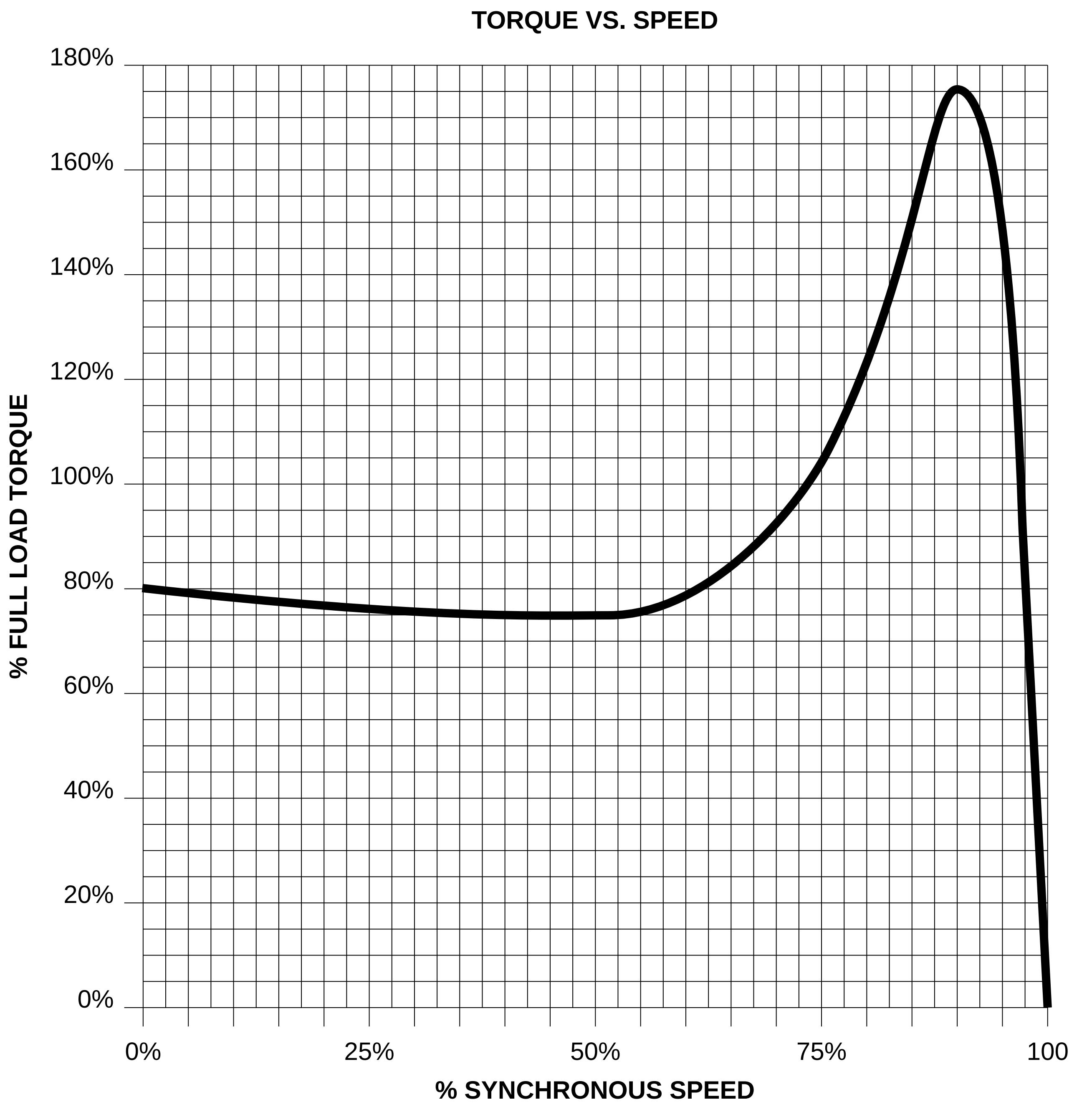
HP	250	VOLTS		RPM	1800	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:________________ PO #:________________ Order #:________________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

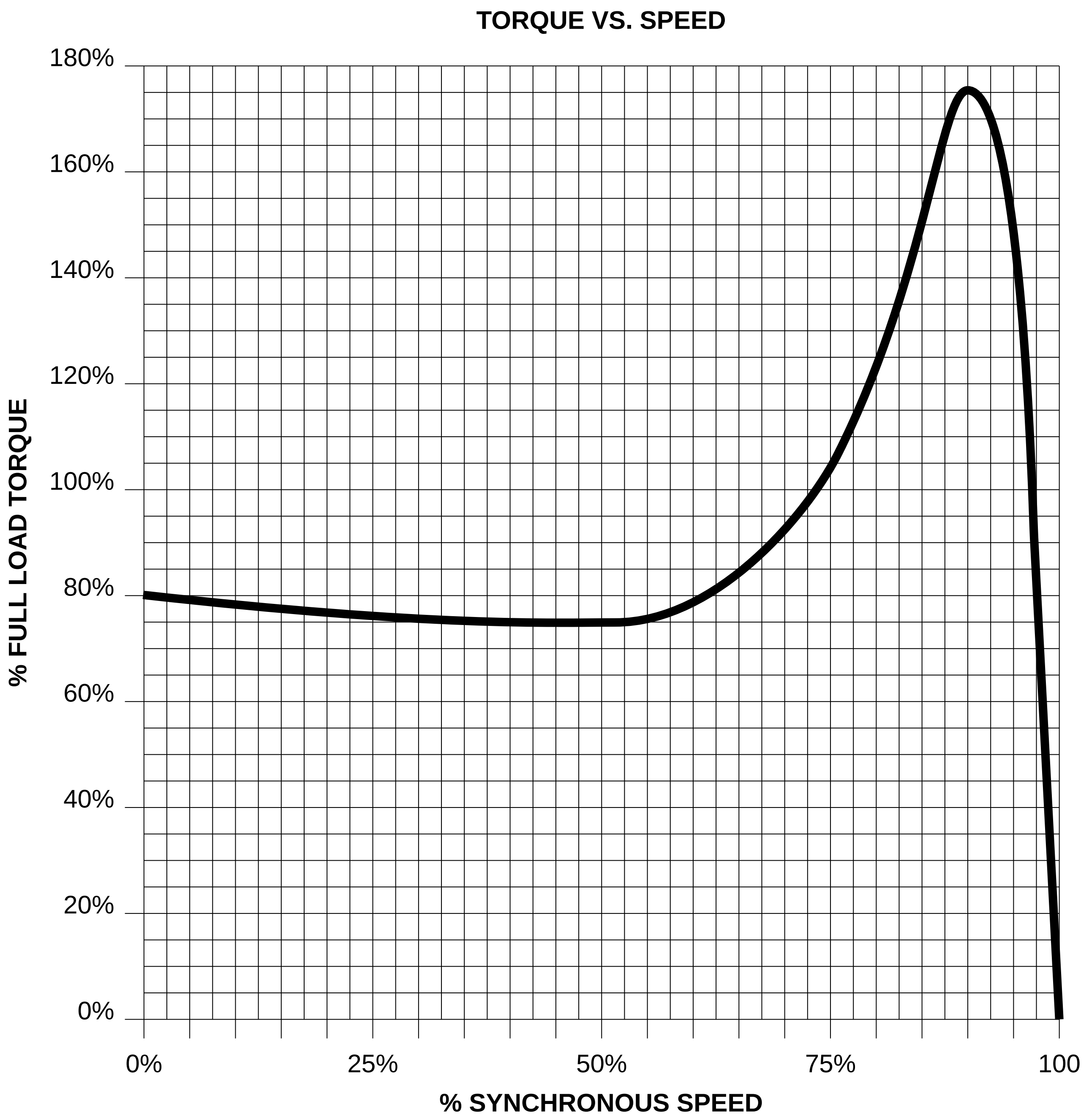
HP	300	VOLTS		RPM	1800	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:____________________ PO #:______________ Order #:______________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

HP	350	VOLTS		RPM	1800	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B

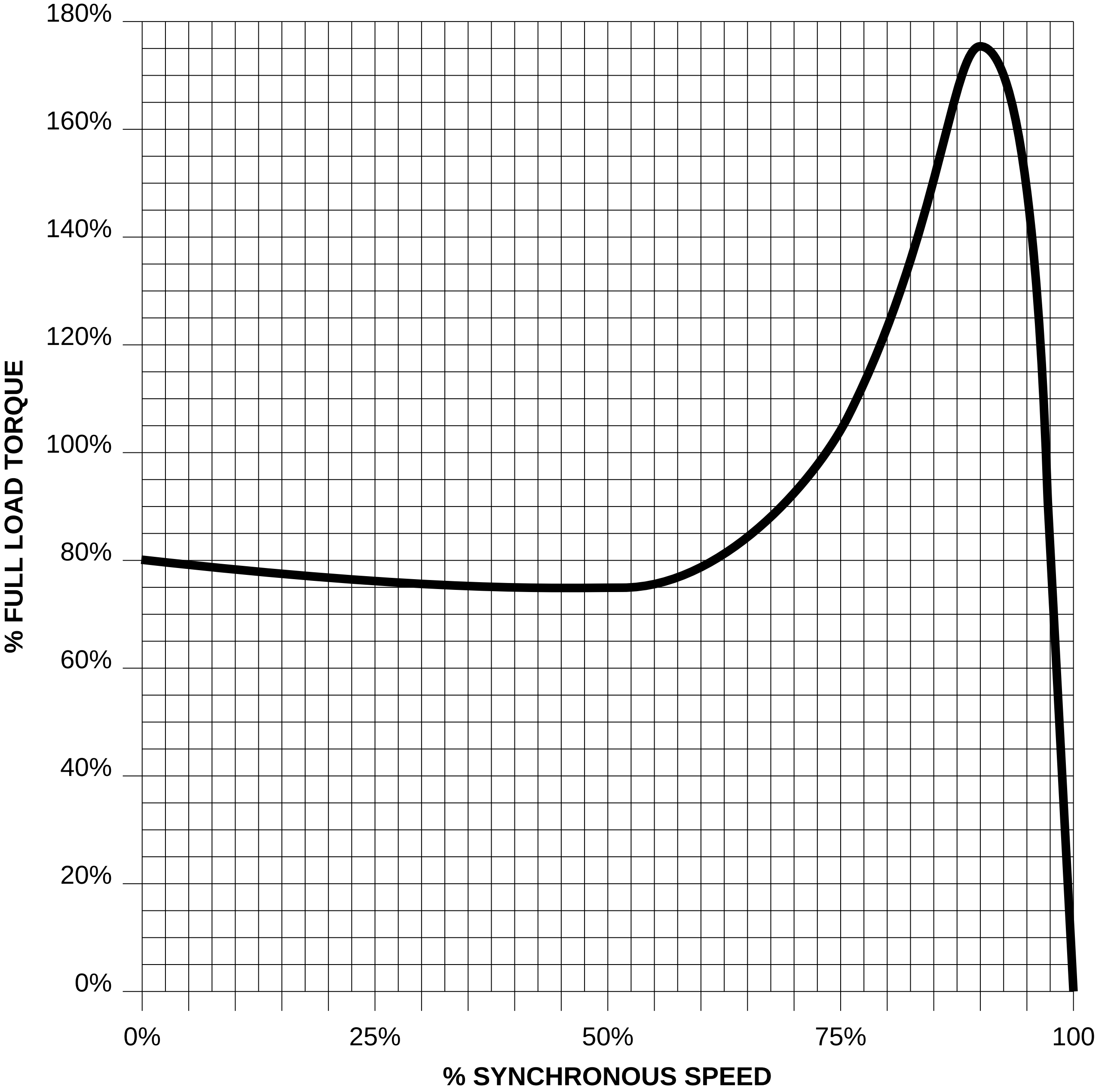


Customer:____________________ PO #:____________ Order #:____________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

HP	400	**VOLTS**		**RPM**	1800	**TYPE**	
HZ	60	**PHASE**	3	**FRAME**		**NEMA**	B

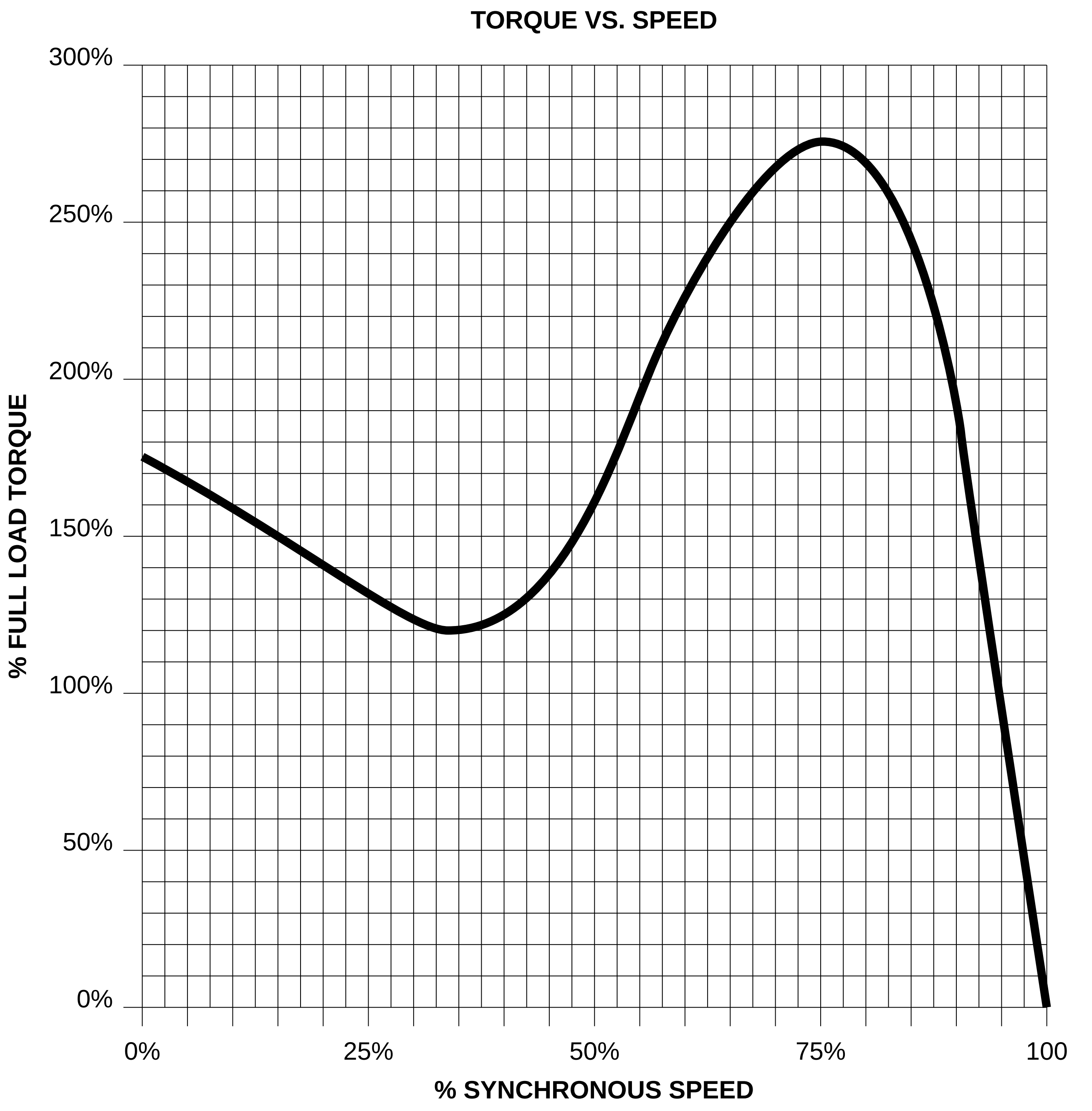
TORQUE VS. SPEED



Customer: ______________________ PO #: ______________ Order #: ______________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

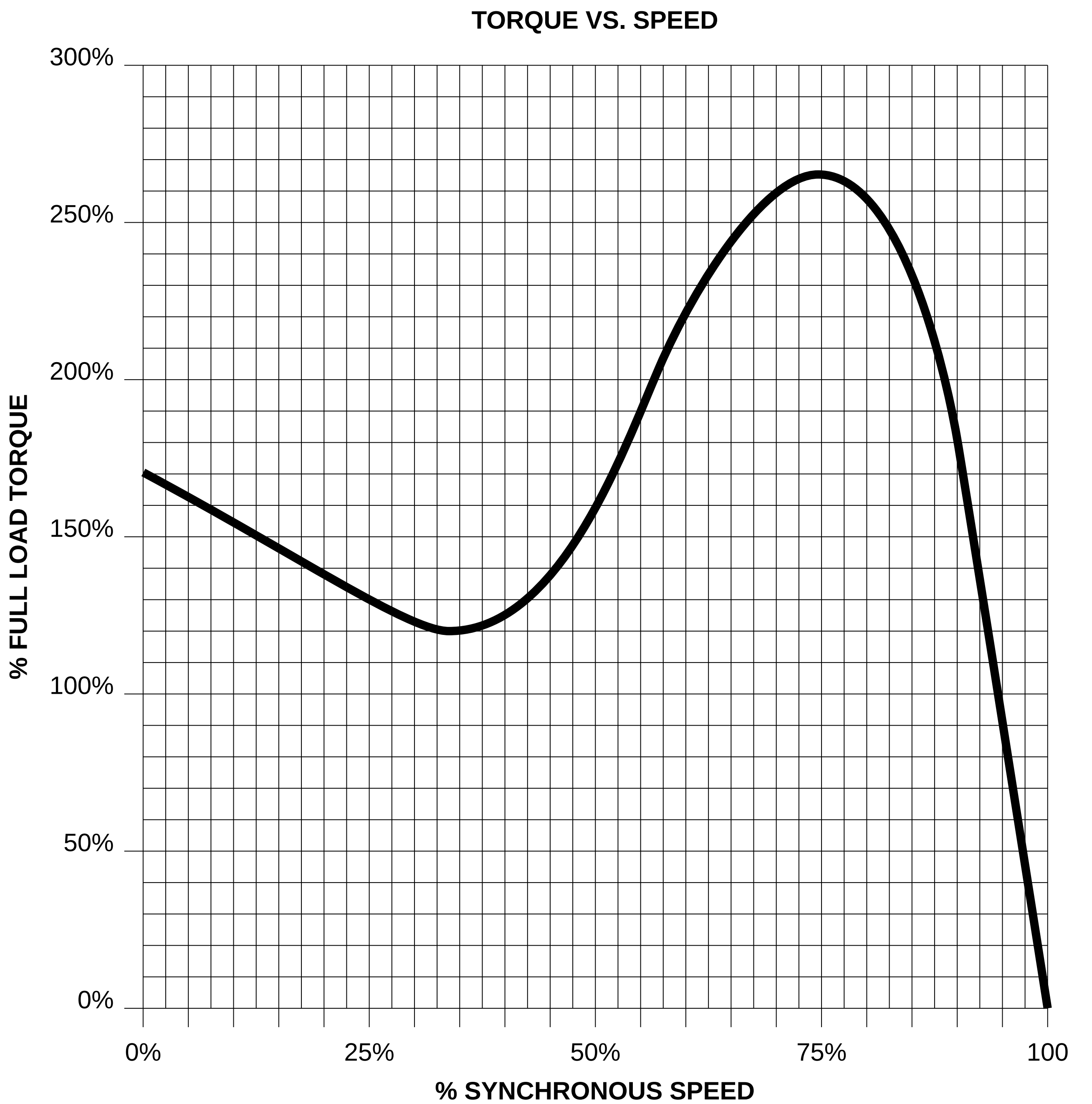
HP	0.75	VOLTS		RPM	1200	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:________________ PO #:________________ Order #:________________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

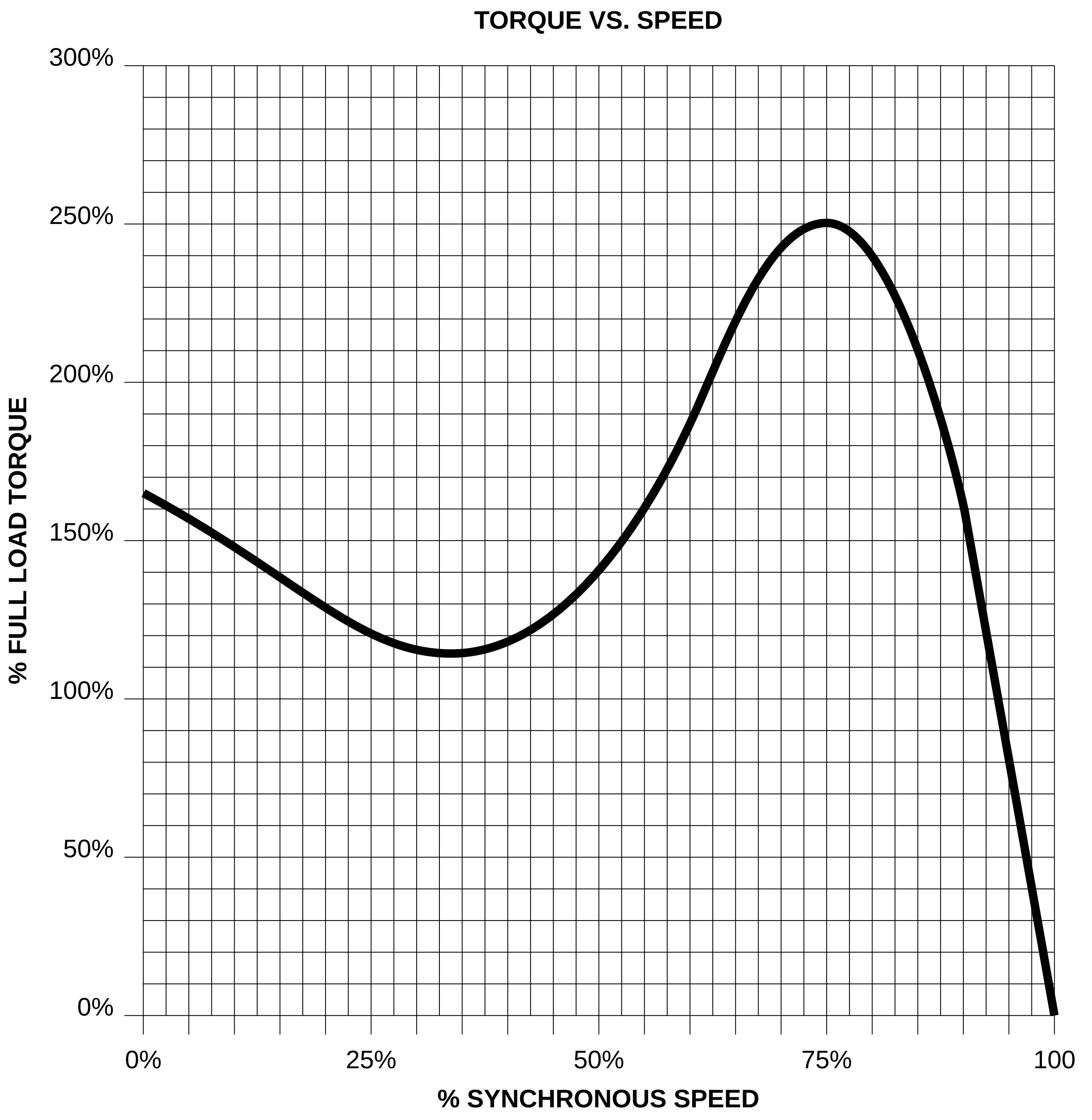
HP	1	VOLTS		RPM	1200	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:____________________ PO #:______________ Order #:______________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

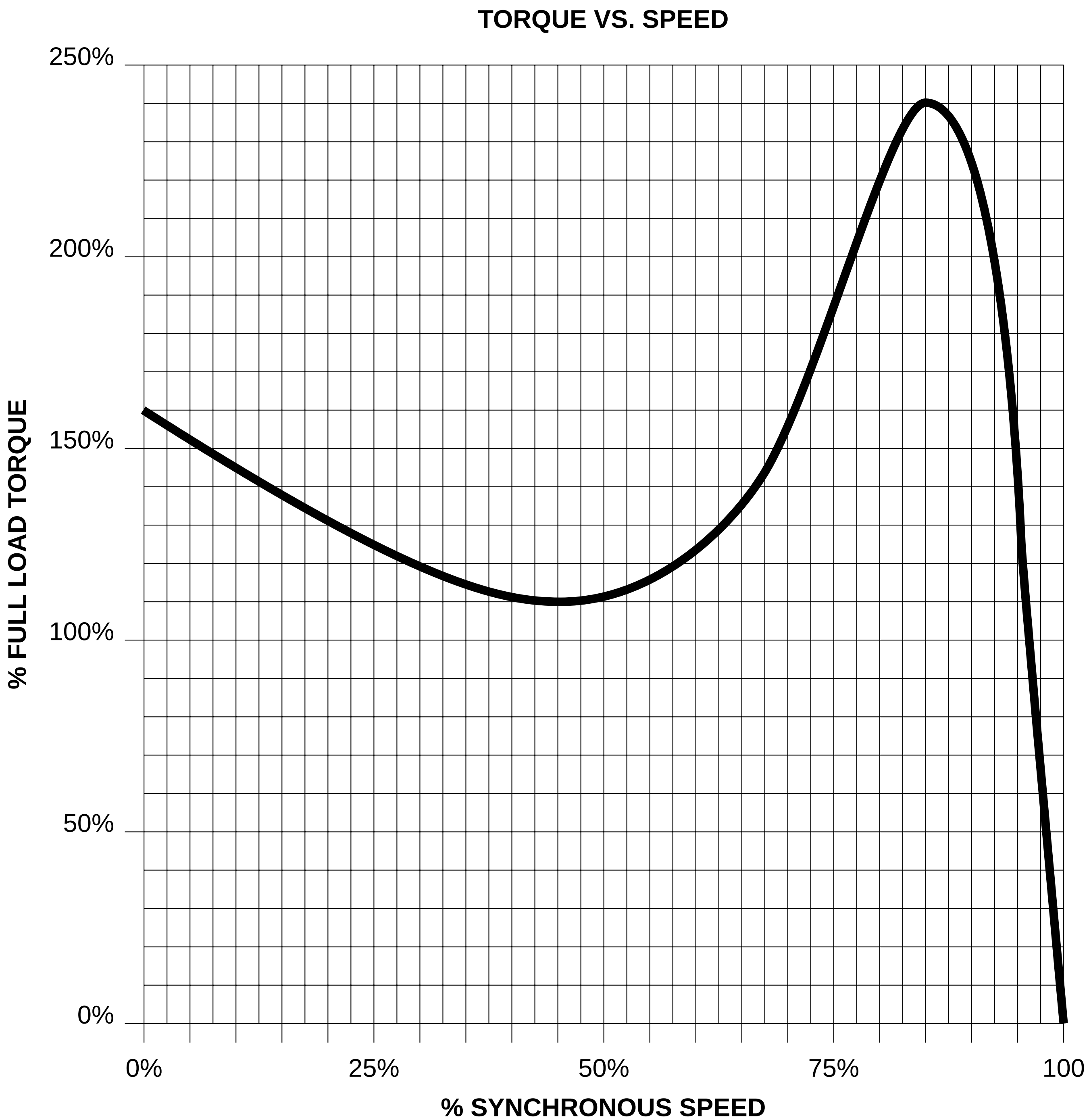
HP	1.5	VOLTS		RPM	1200	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:________________ PO #:________________ Order #:________________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

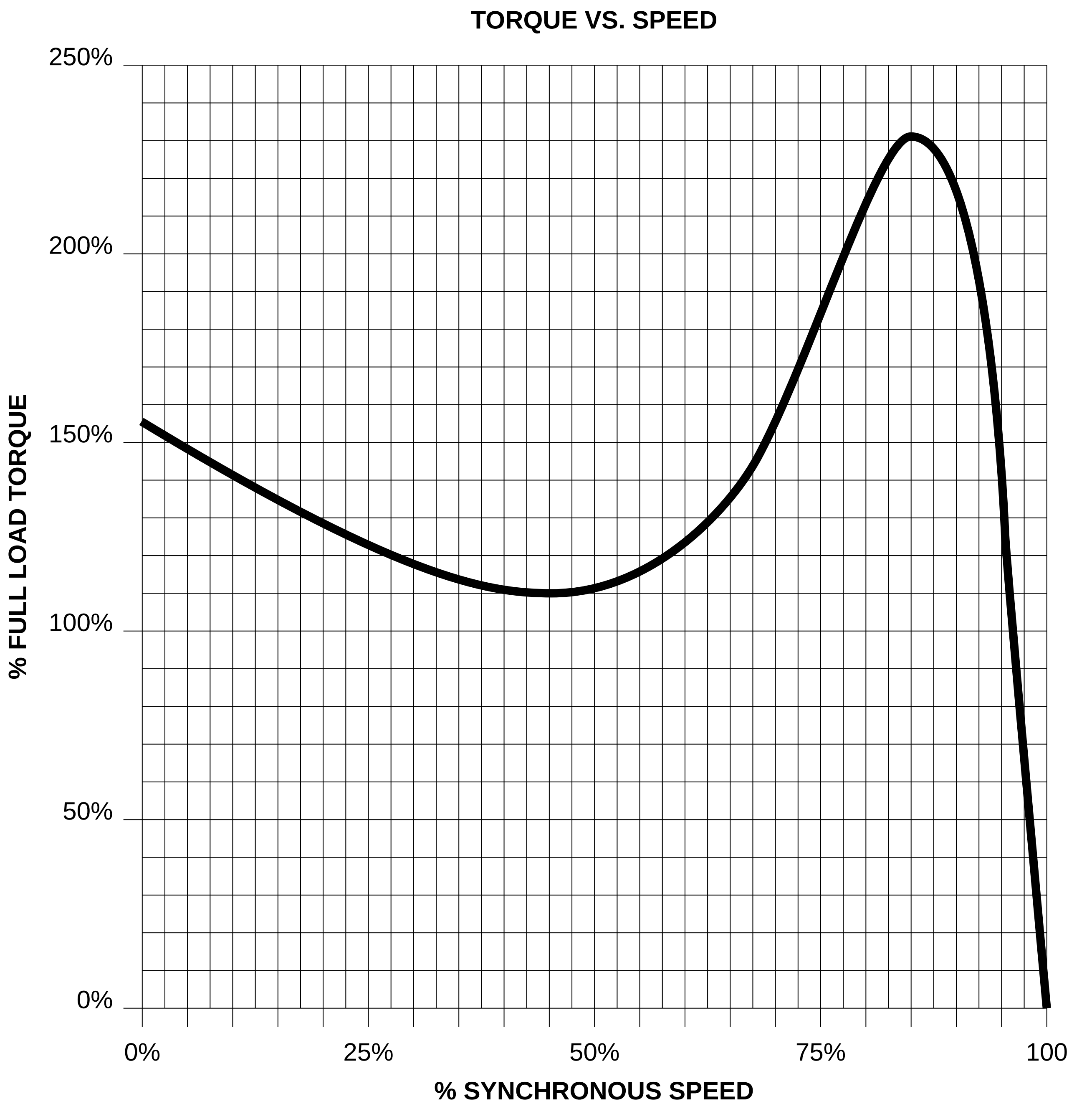
HP	2	VOLTS		RPM	1200	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:______________________ PO #:______________ Order #:______________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

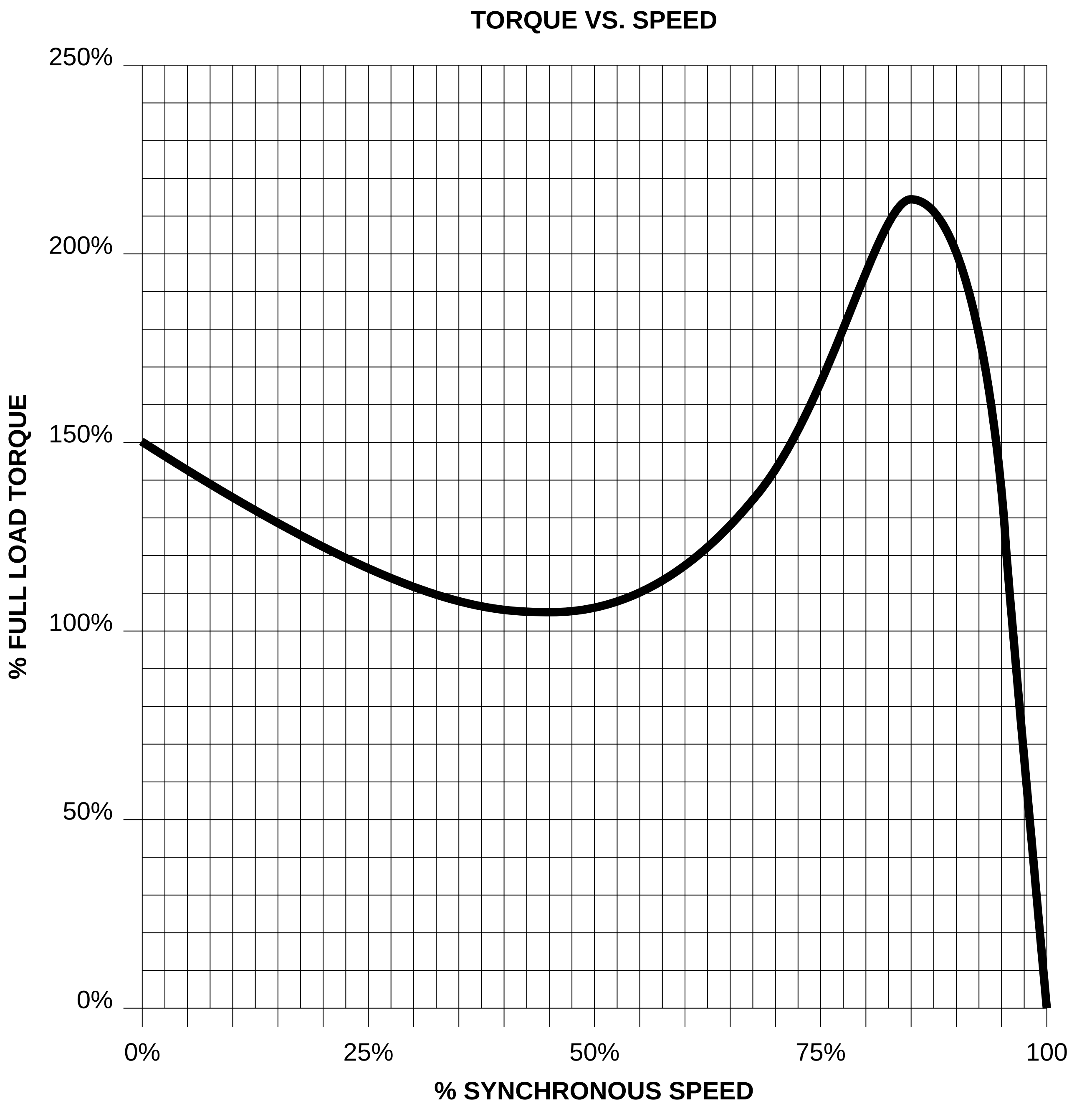
HP	3	VOLTS		RPM	1200	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:________________ PO #:________________ Order #:________________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

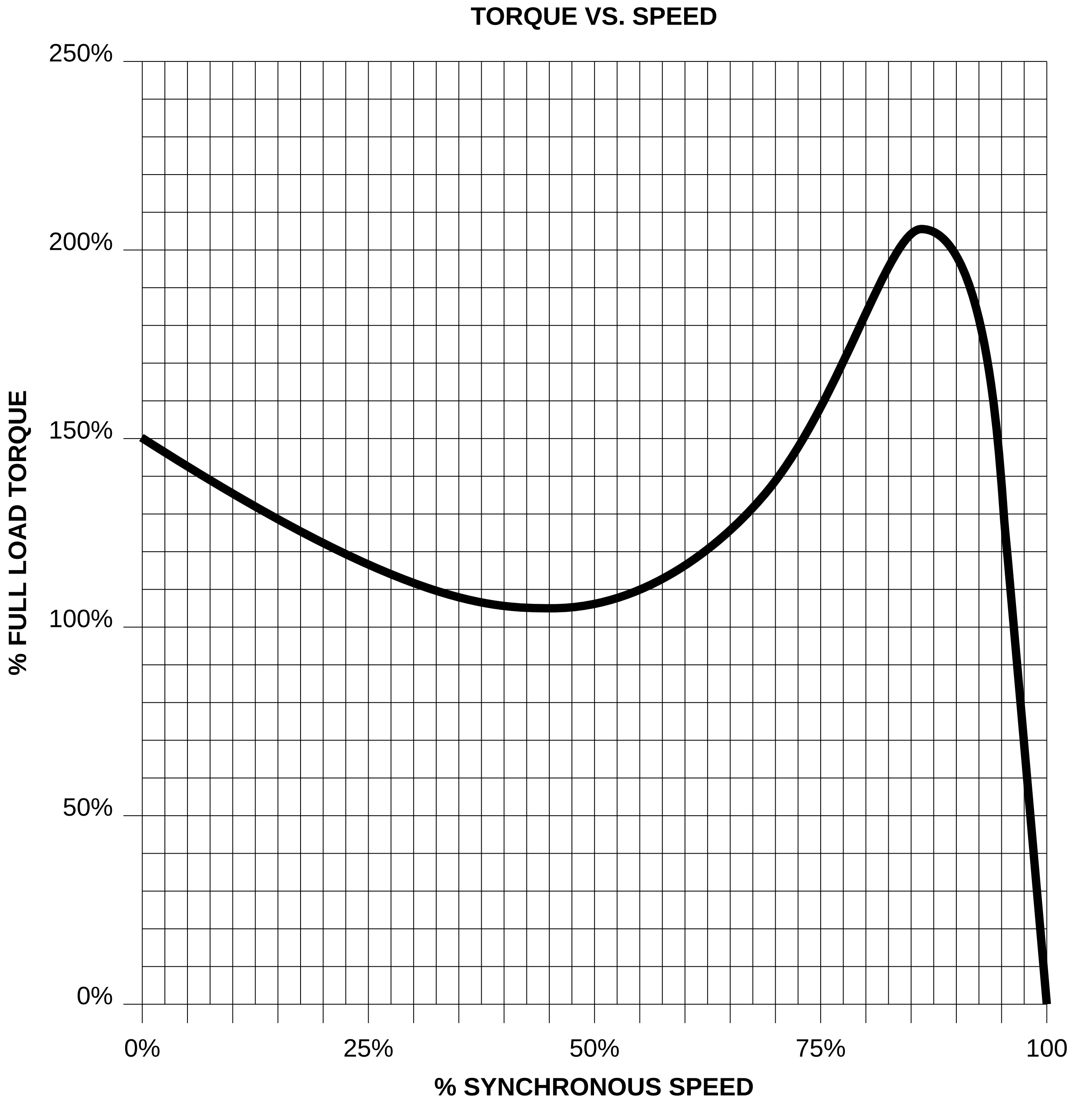
HP	5	VOLTS		RPM	1200	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:______________________ PO #:______________ Order #:______________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

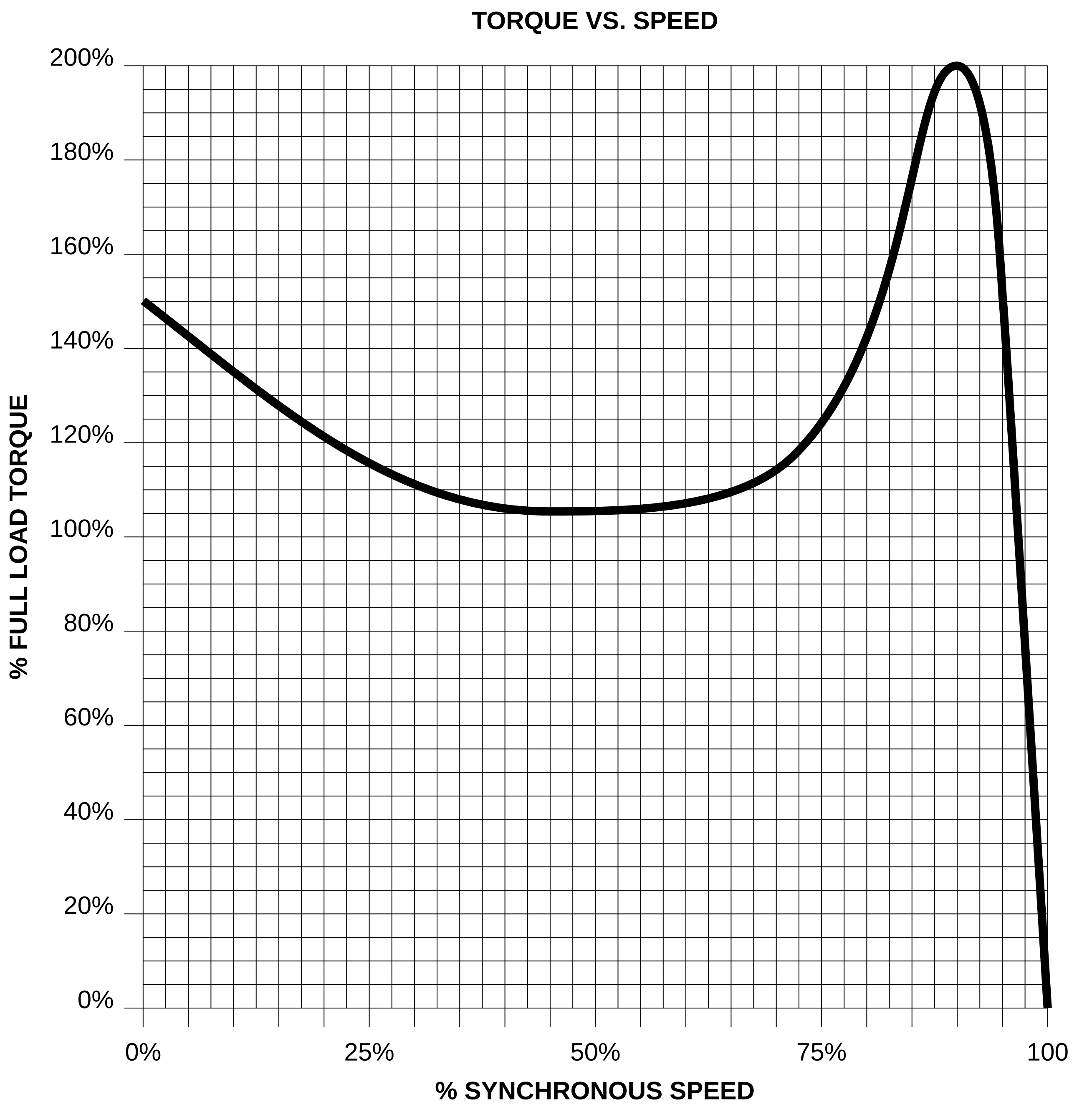
HP	7.5	VOLTS		RPM	1200	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:________________ PO #:________________ Order #:________________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

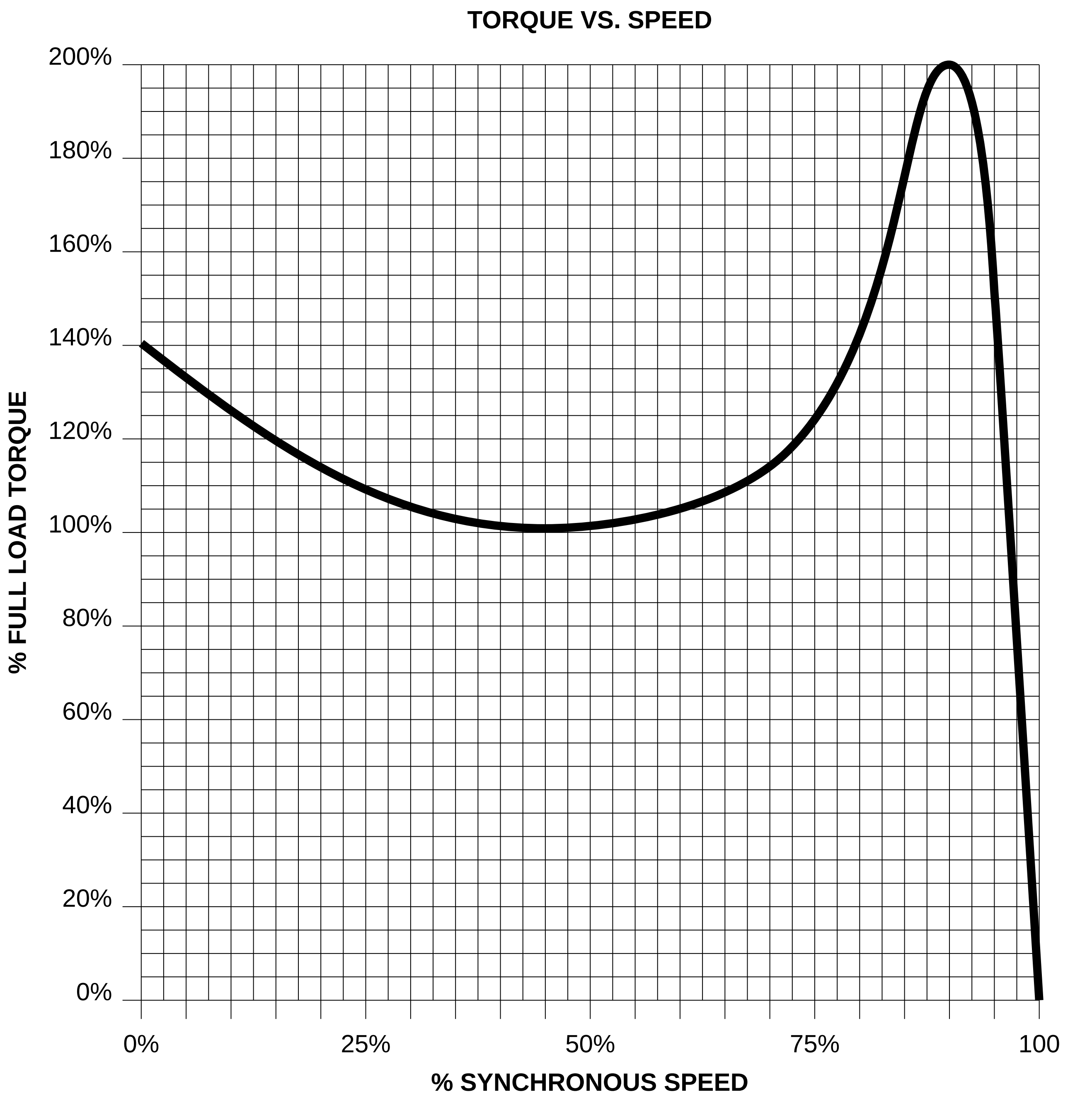
HP	10	VOLTS		RPM	1200	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer: ______________________ PO #: ______________ Order #: ______________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

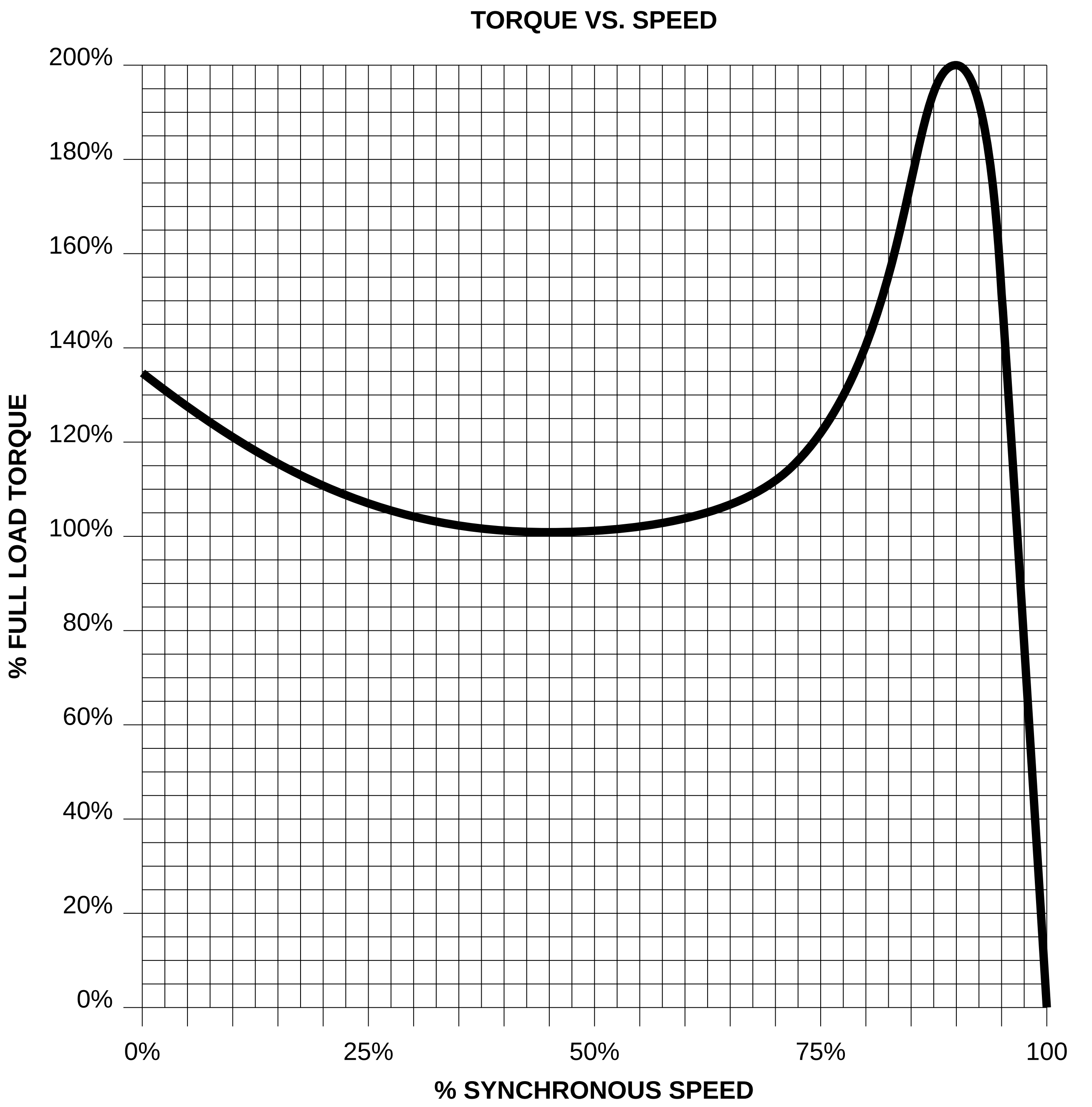
HP	15	VOLTS		RPM	1200	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:________________________ PO #:____________ Order #:______________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

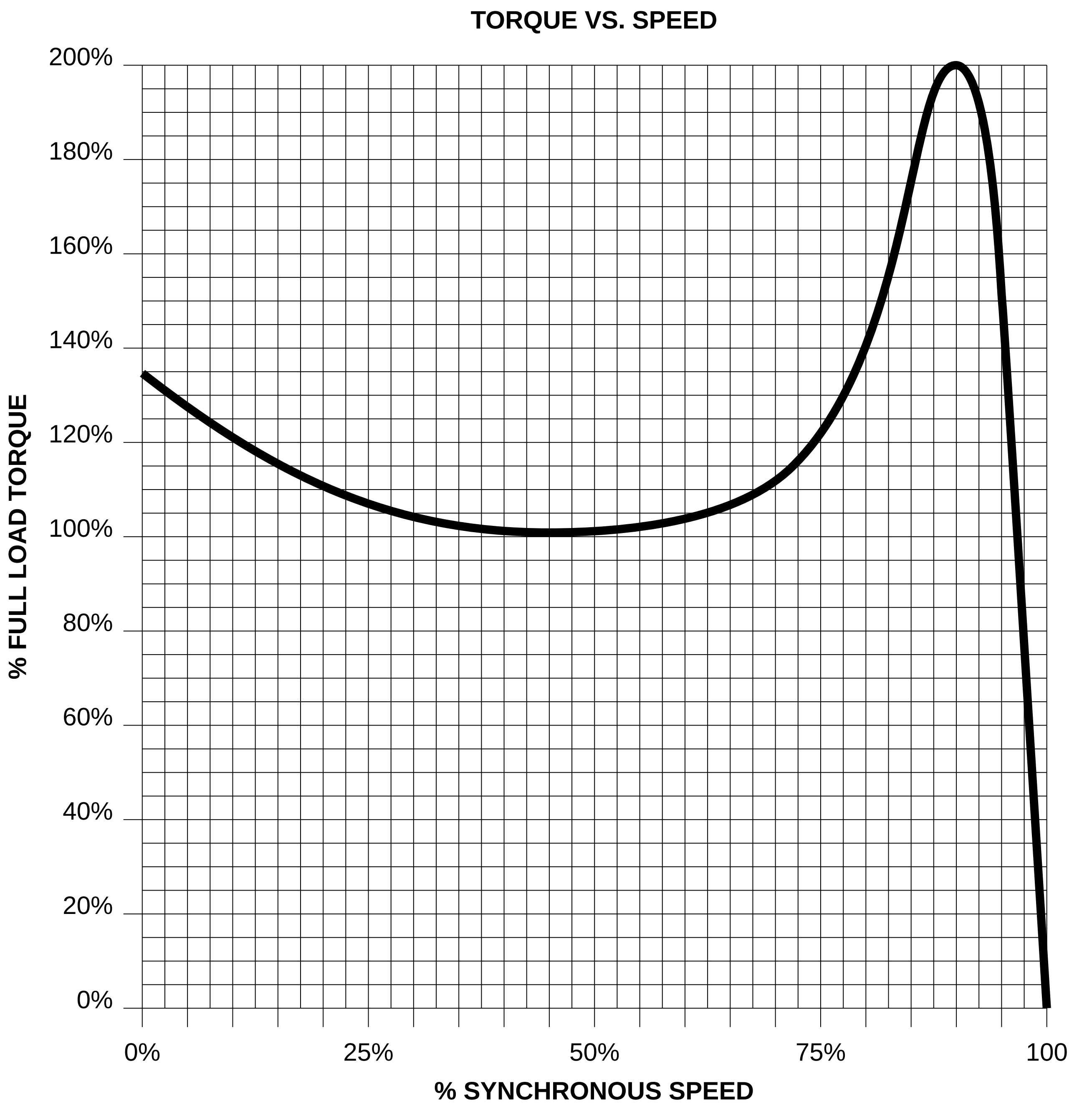
HP	20	VOLTS		RPM	1200	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer: ____________________ PO #: ____________ Order #: ______________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

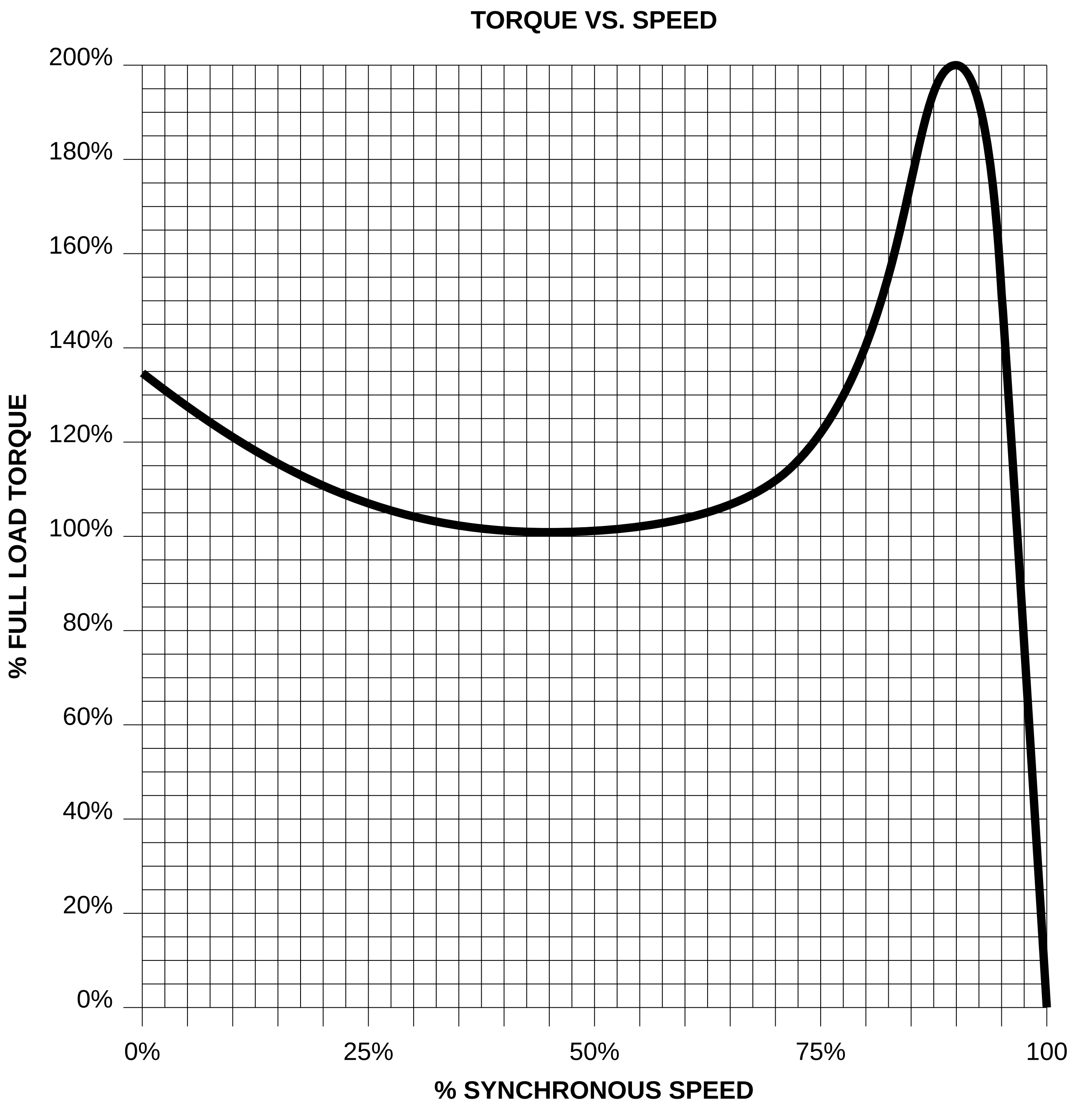
HP	25	VOLTS		RPM	1200	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer: ______________________ PO #: ______________ Order #: ______________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

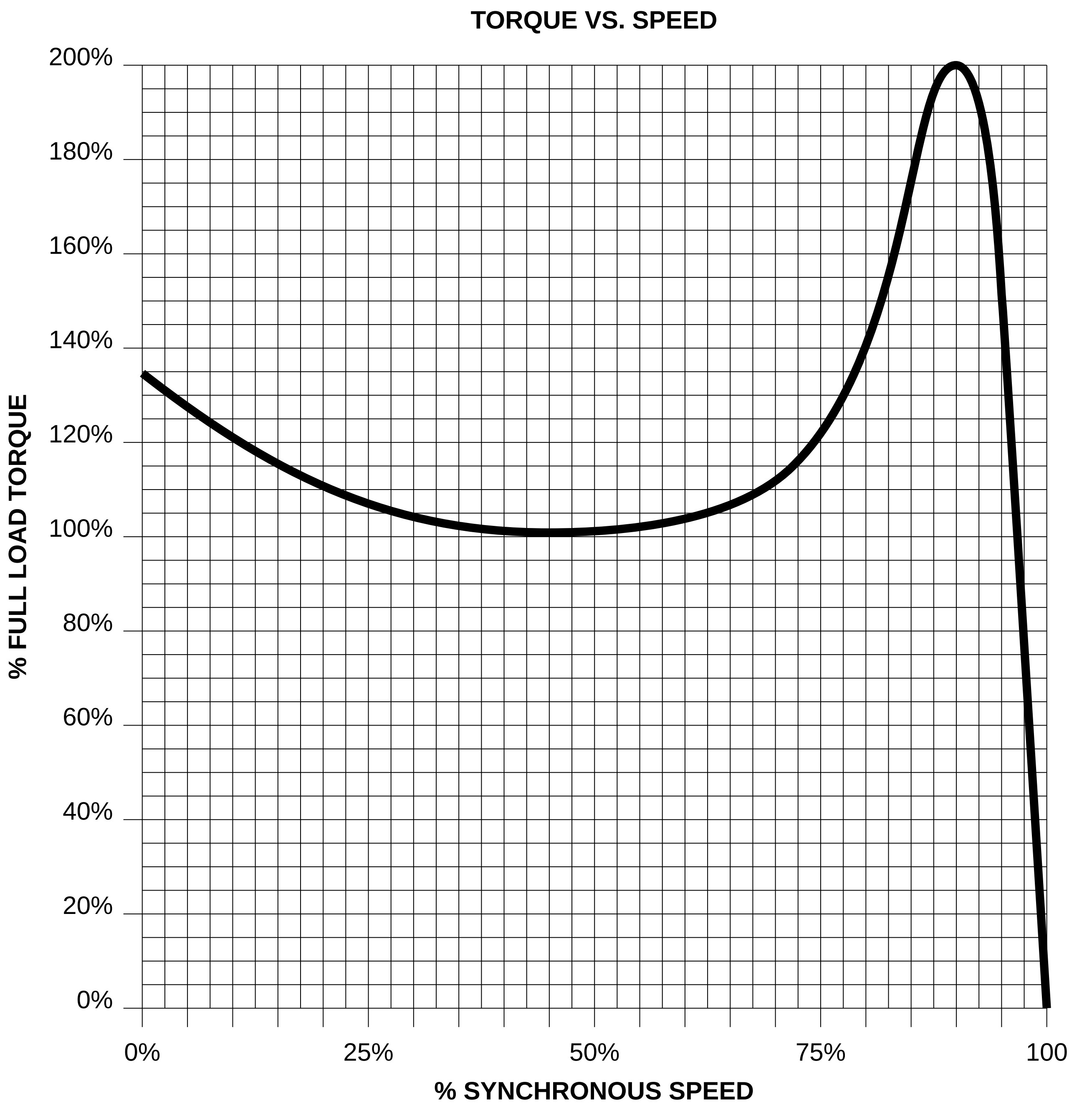
HP	30	VOLTS		RPM	1200	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:____________________ PO #:____________ Order #:____________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

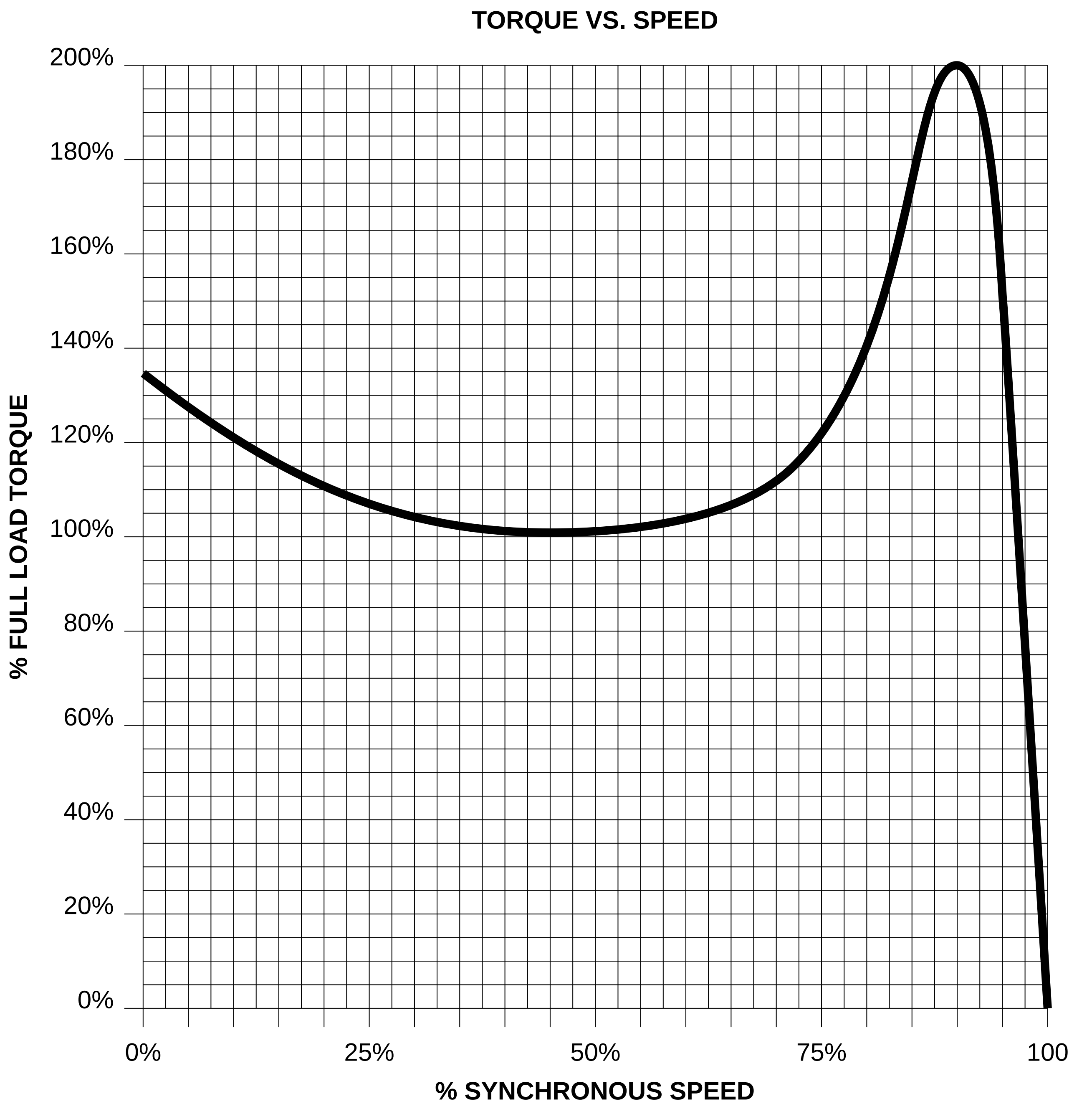
HP	40	VOLTS		RPM	1200	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer: ______________________ PO #: ______________ Order #: ______________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

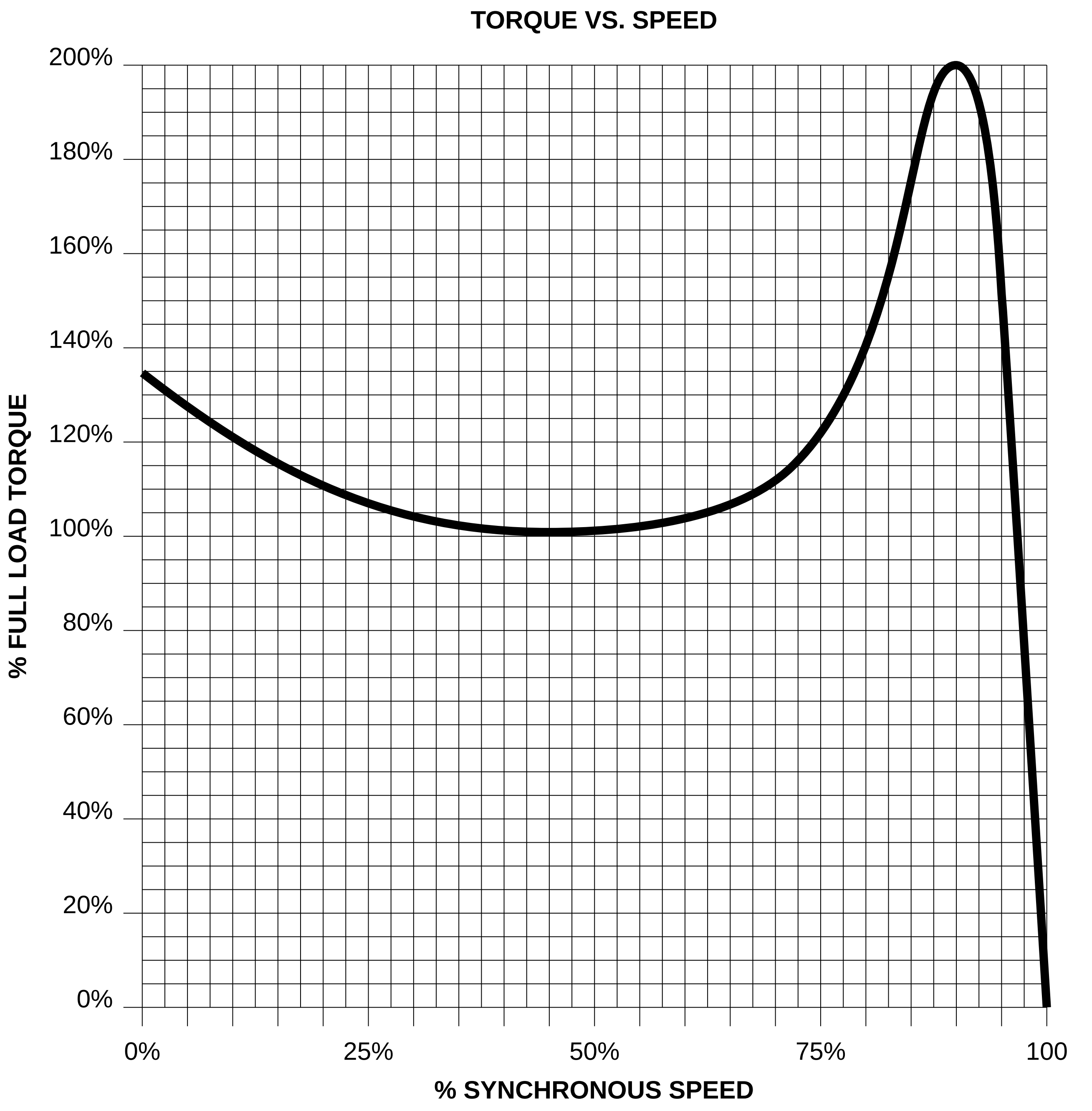
HP	50	VOLTS		RPM	1200	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:____________________ PO #:________________ Order #:________________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

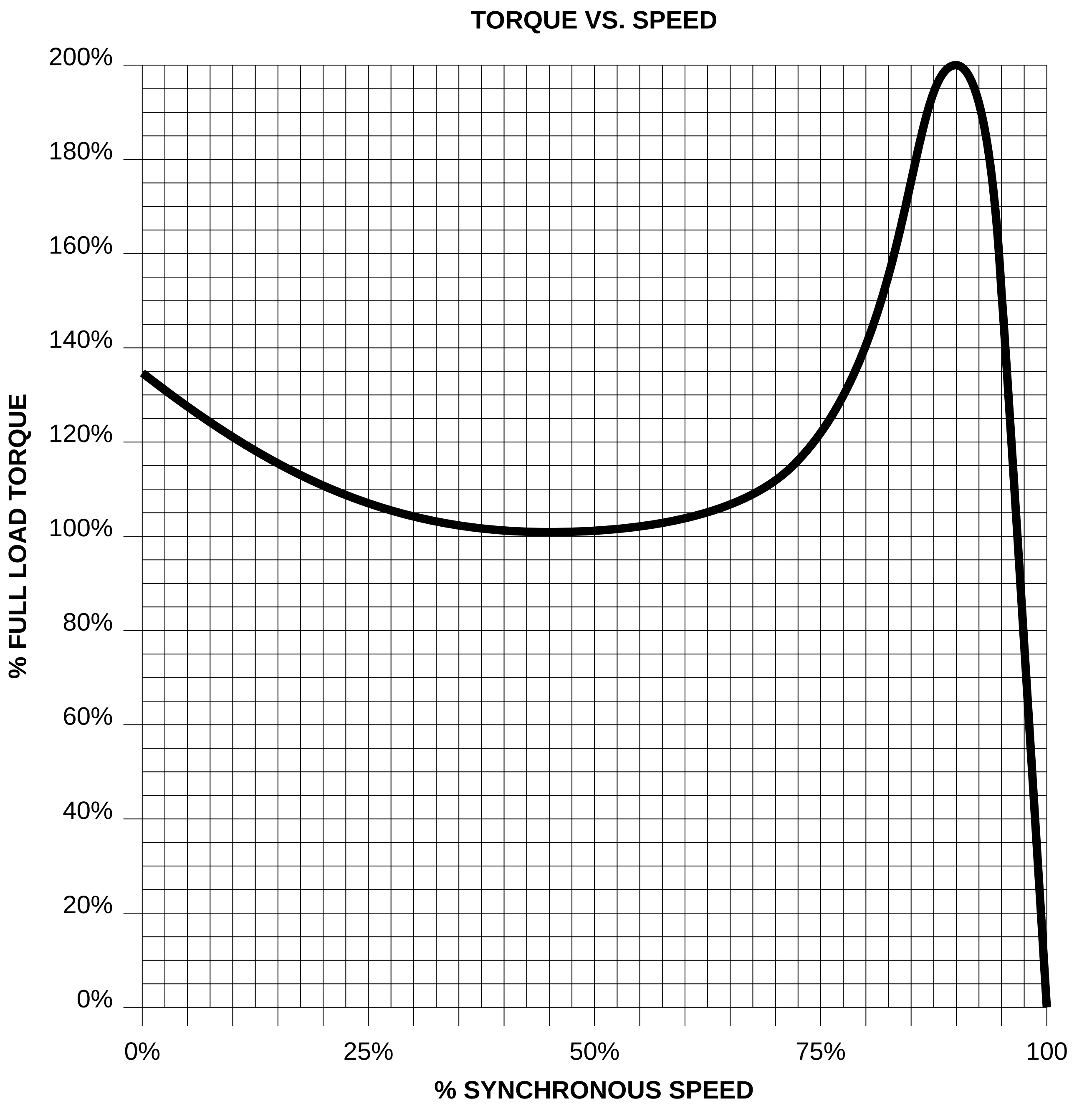
HP	60	VOLTS		RPM	1200	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer: ______________________ PO #: ______________ Order #: ______________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

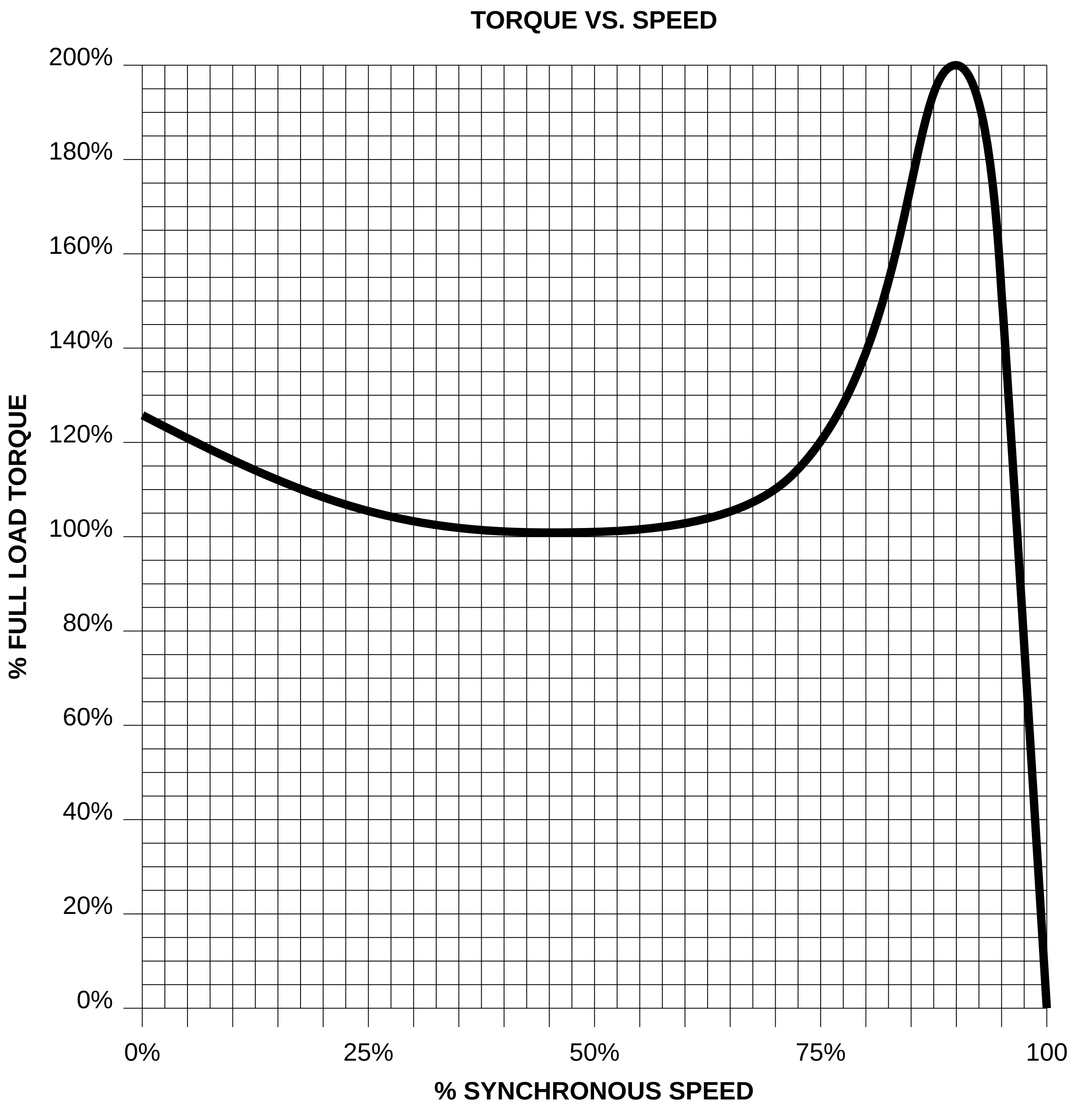
HP	75	VOLTS		RPM	1200	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:______________________ PO #:______________ Order #:______________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

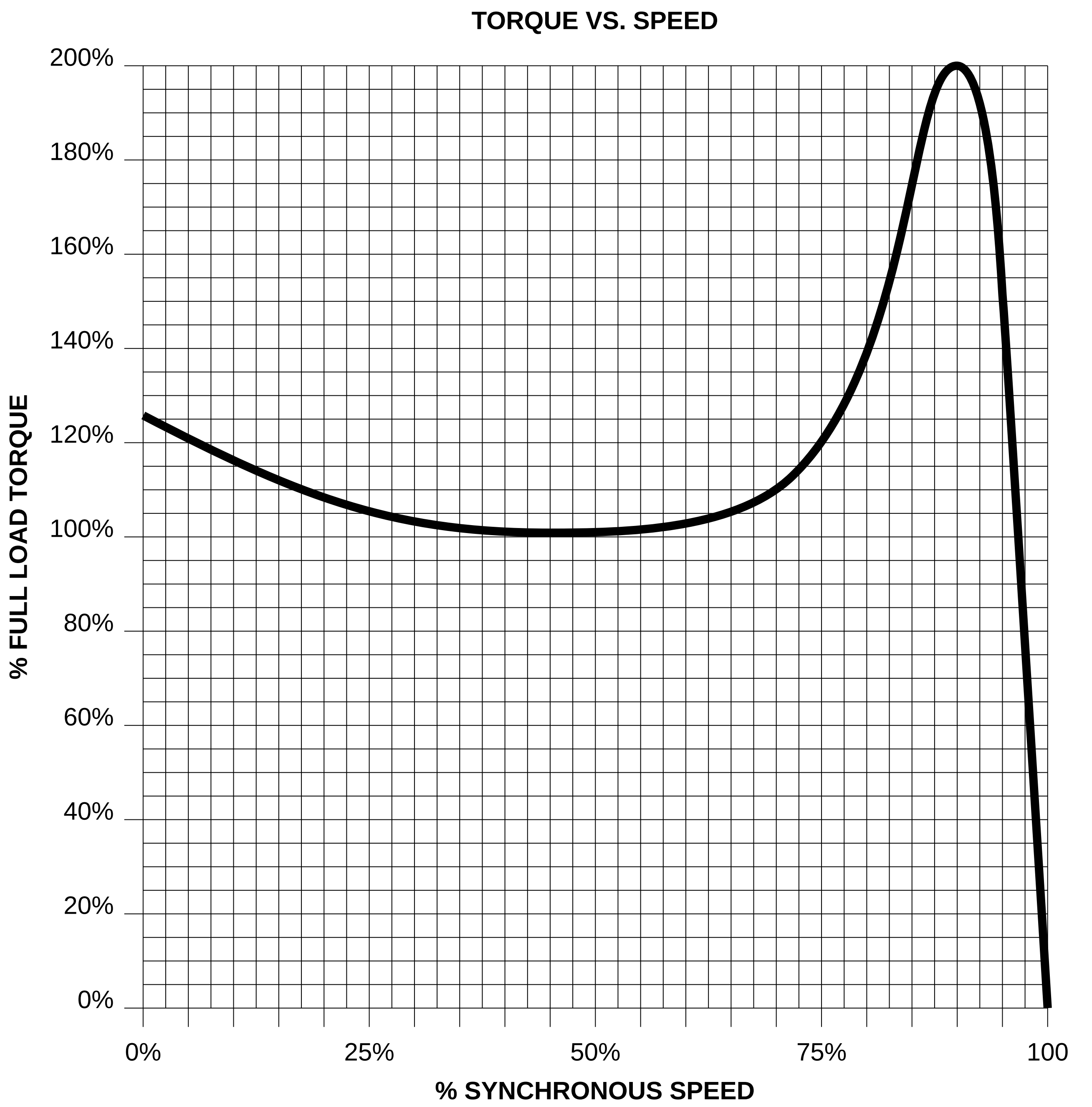
HP	100	VOLTS		RPM	1200	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:________________ PO #:________________ Order #:________________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

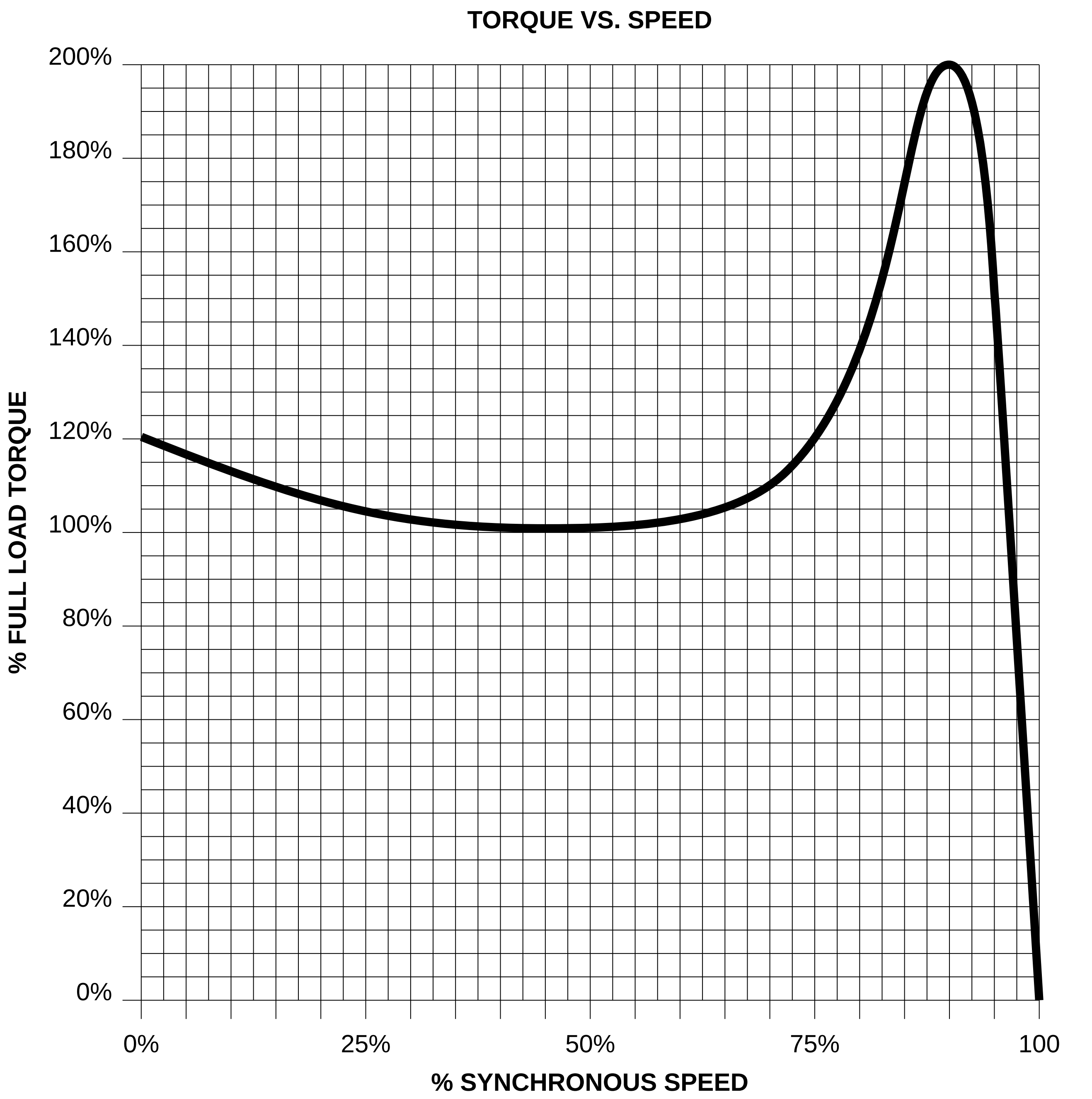
HP	125	VOLTS		RPM	1200	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:____________________ PO #:______________ Order #:______________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

HP	150	VOLTS		RPM	1200	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B

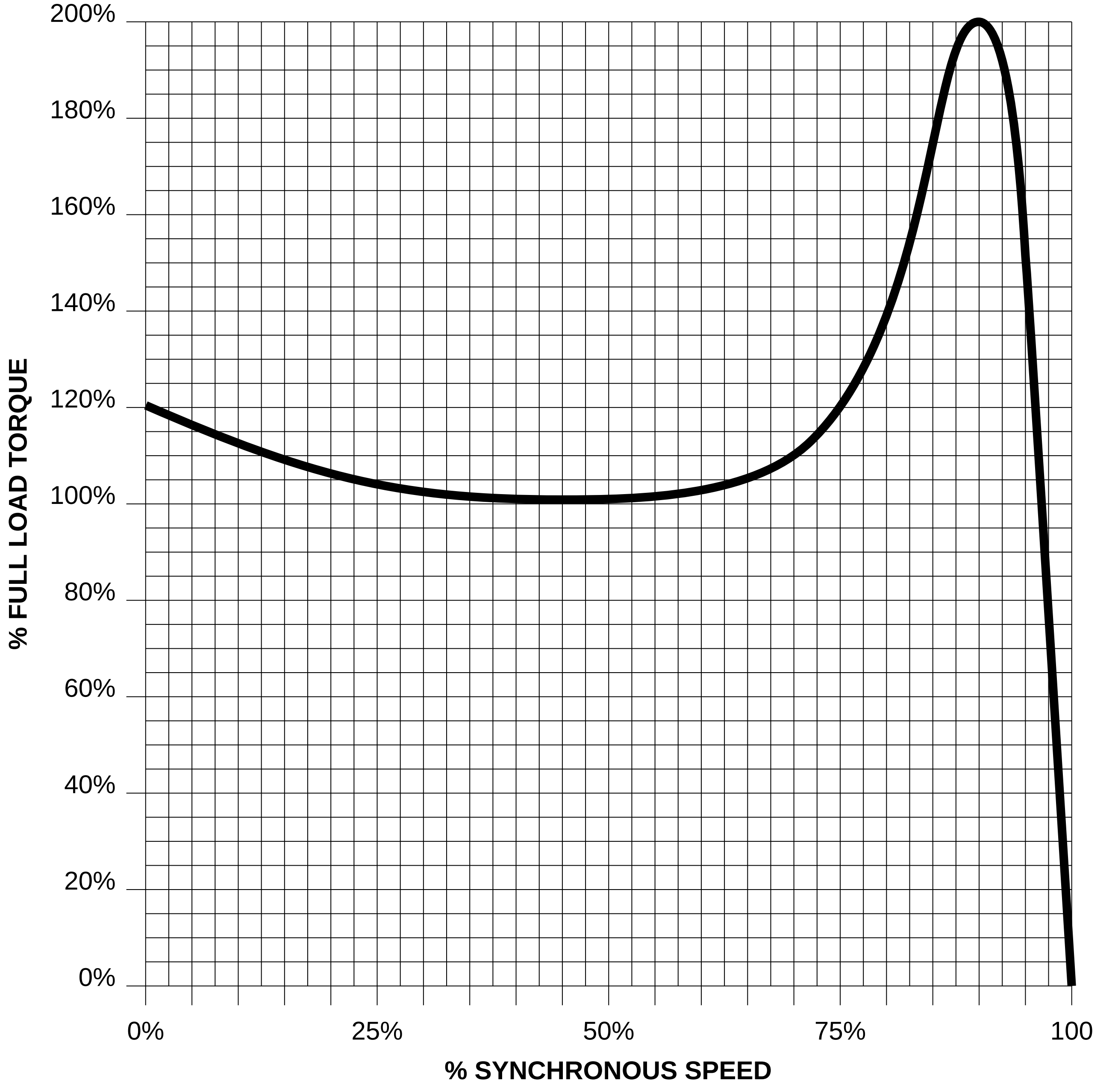


Customer:________________ PO #:________________ Order #:________________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

HP	200	**VOLTS**		**RPM**	1200	**TYPE**	
HZ	60	**PHASE**	3	**FRAME**		**NEMA**	B

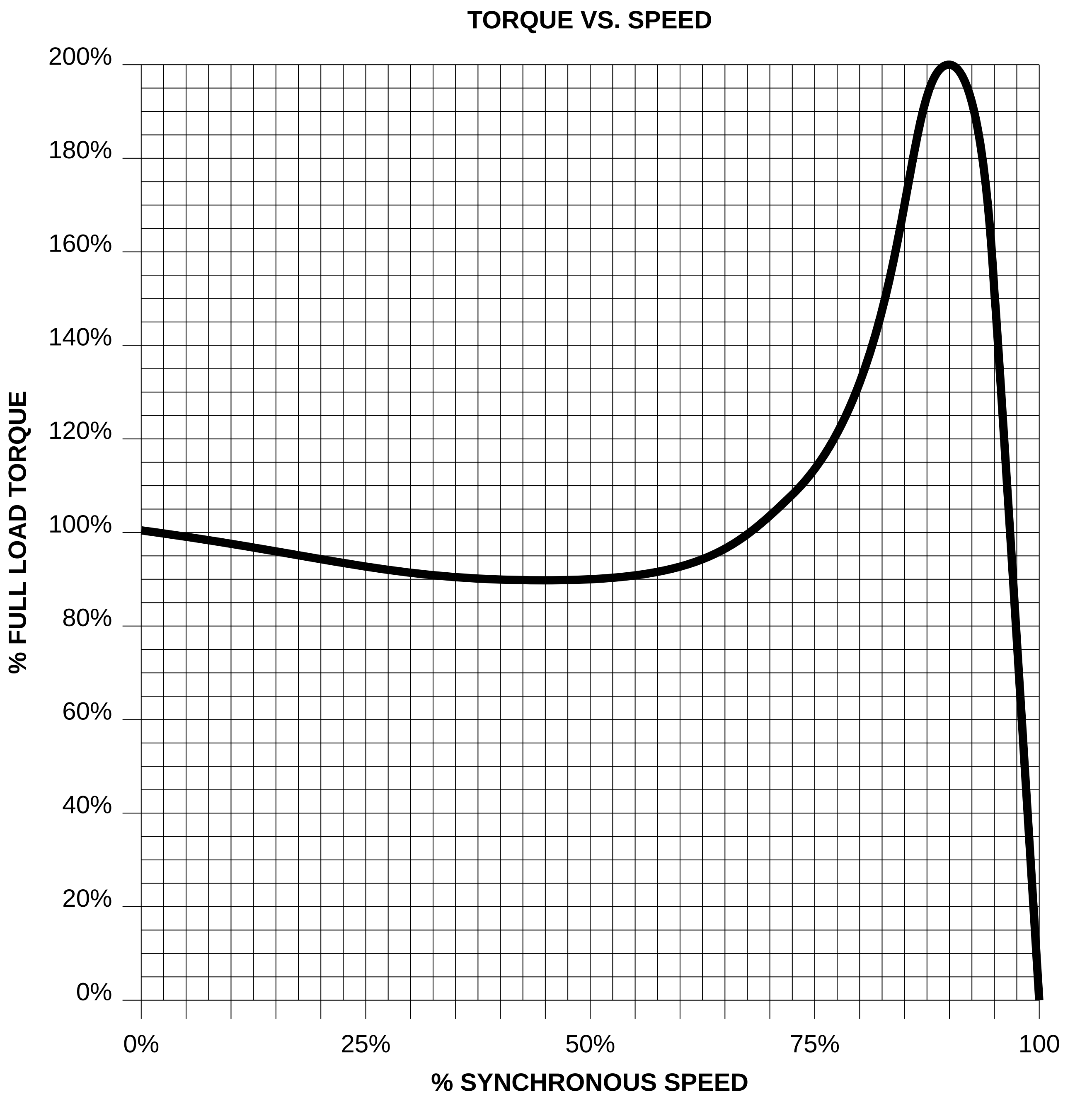
TORQUE VS. SPEED



Customer:________________________ PO #:______________ Order #:________________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

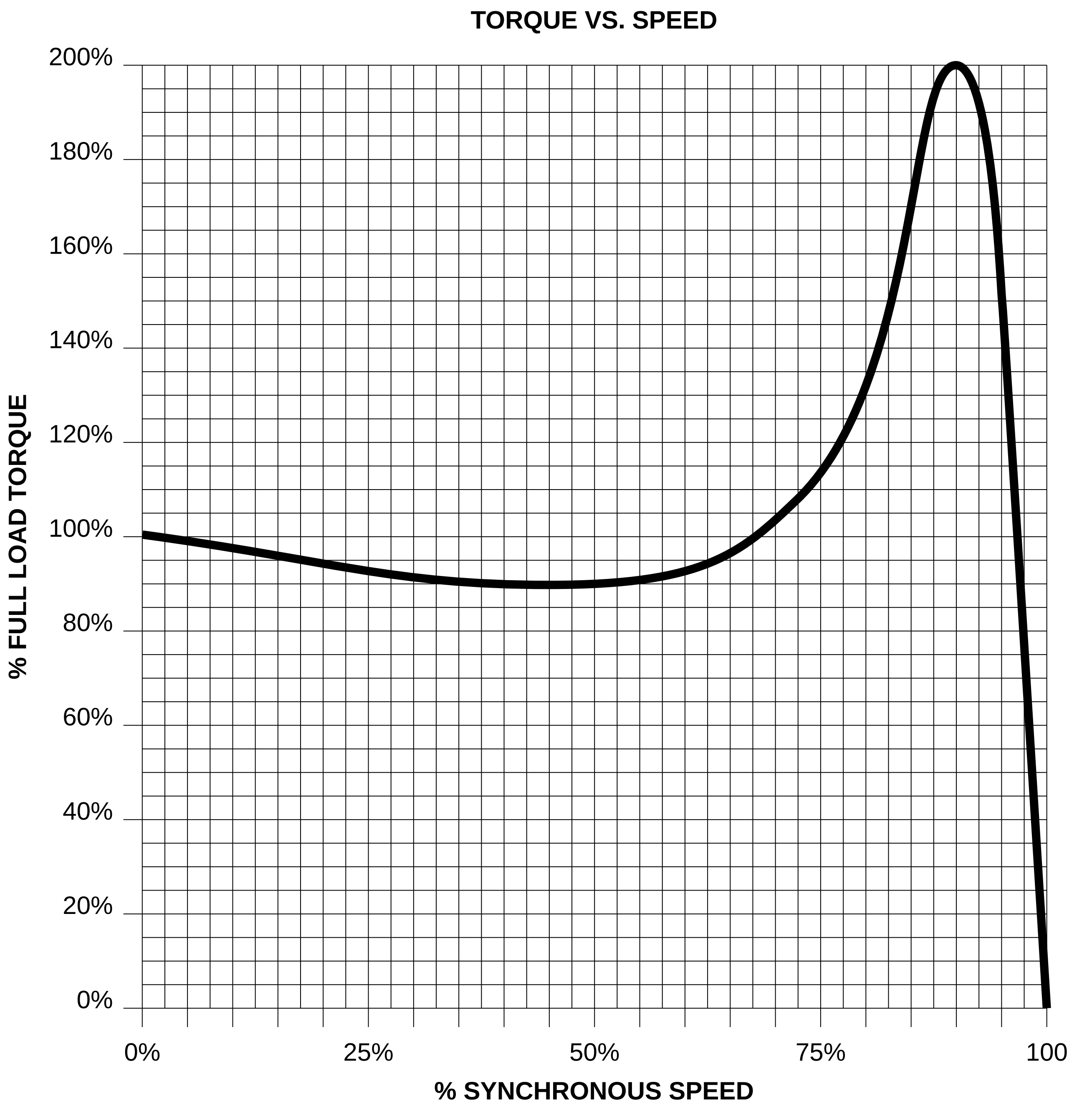
HP	250	VOLTS		RPM	1200	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:____________________ PO #:______________ Order #:______________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

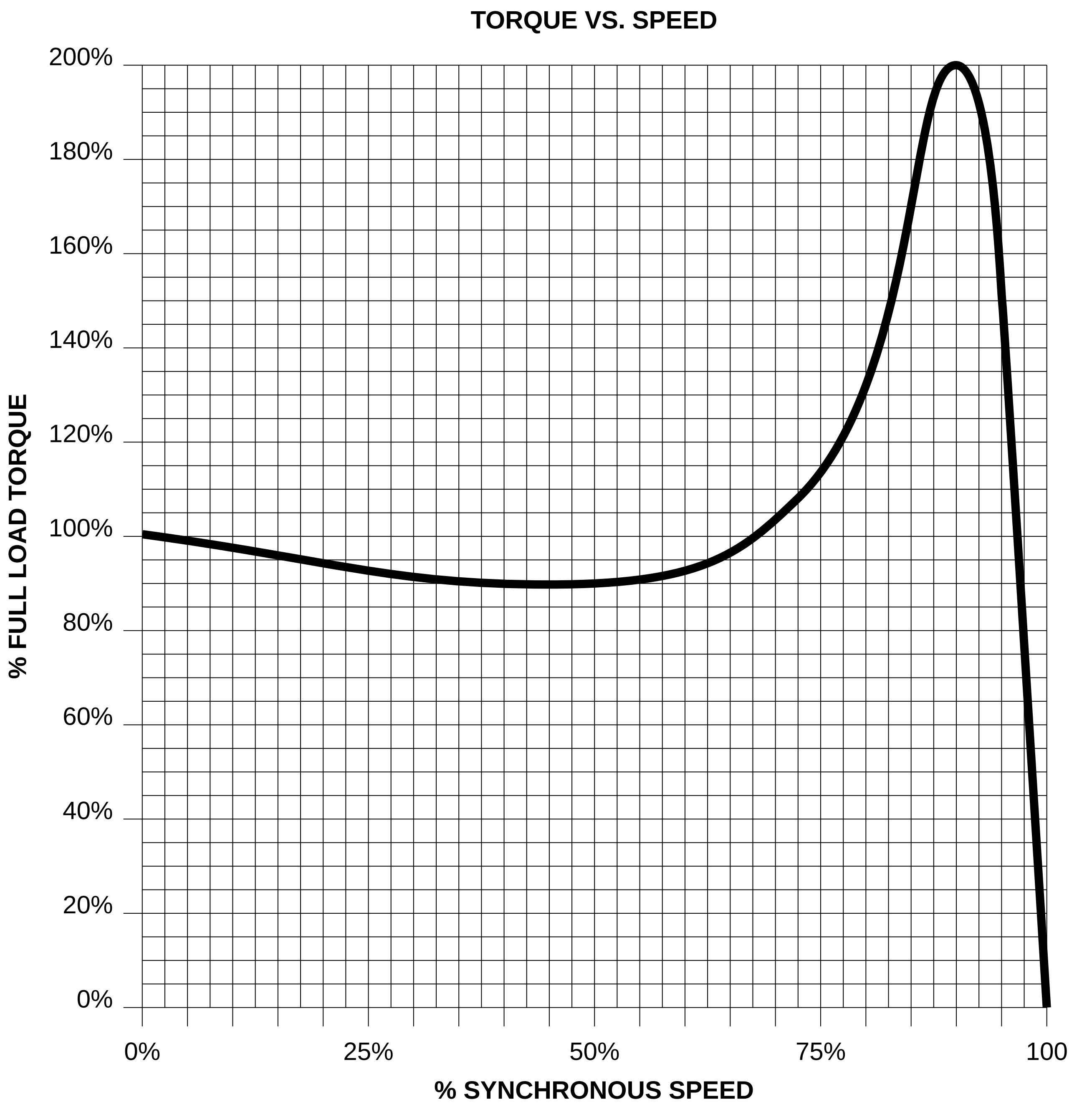
HP	300	VOLTS		RPM	1200	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:____________________ PO #:______________ Order #:______________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

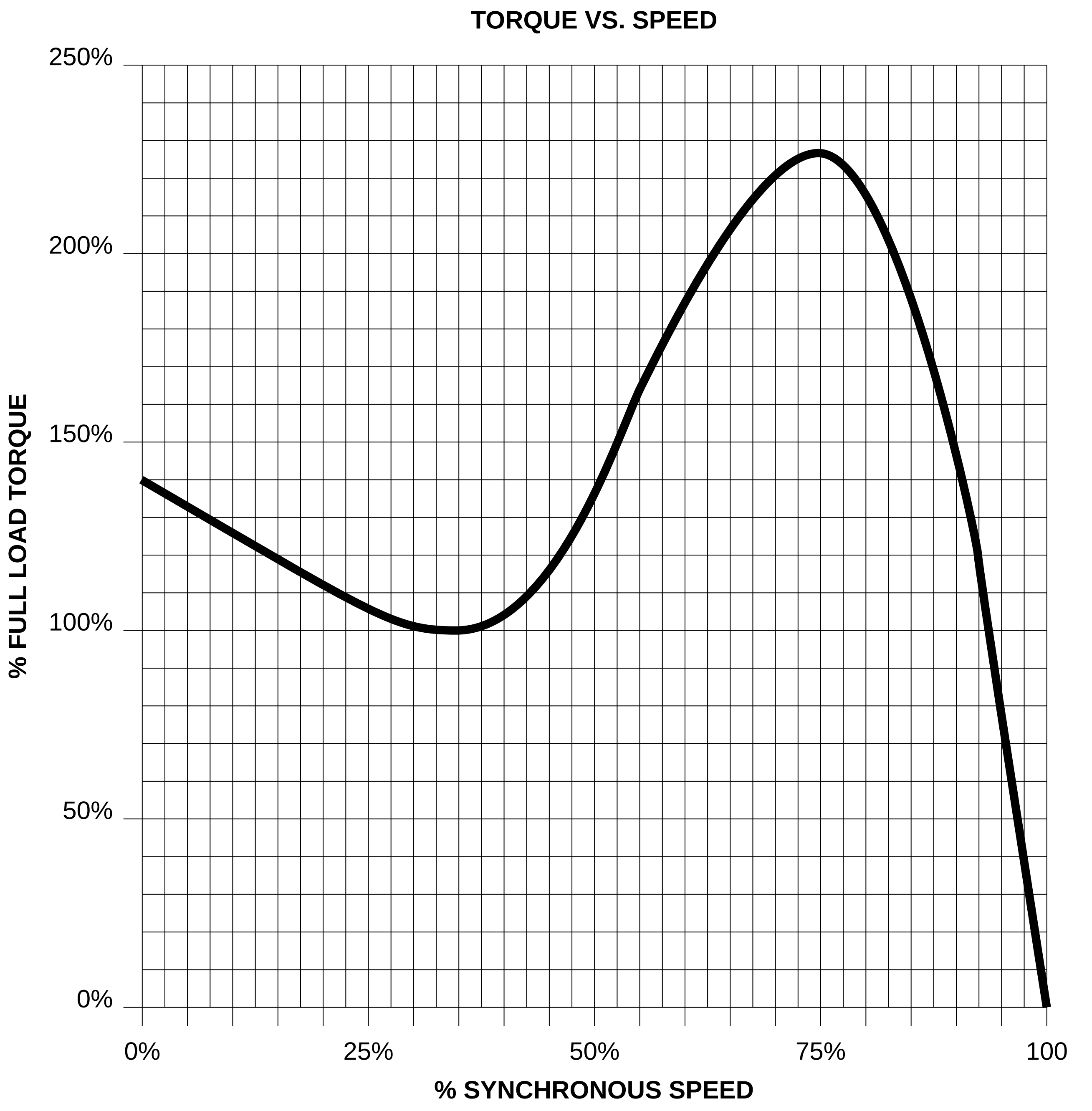
HP	350	VOLTS		RPM	1200	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer: ______________________ PO #: ______________ Order #: ______________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

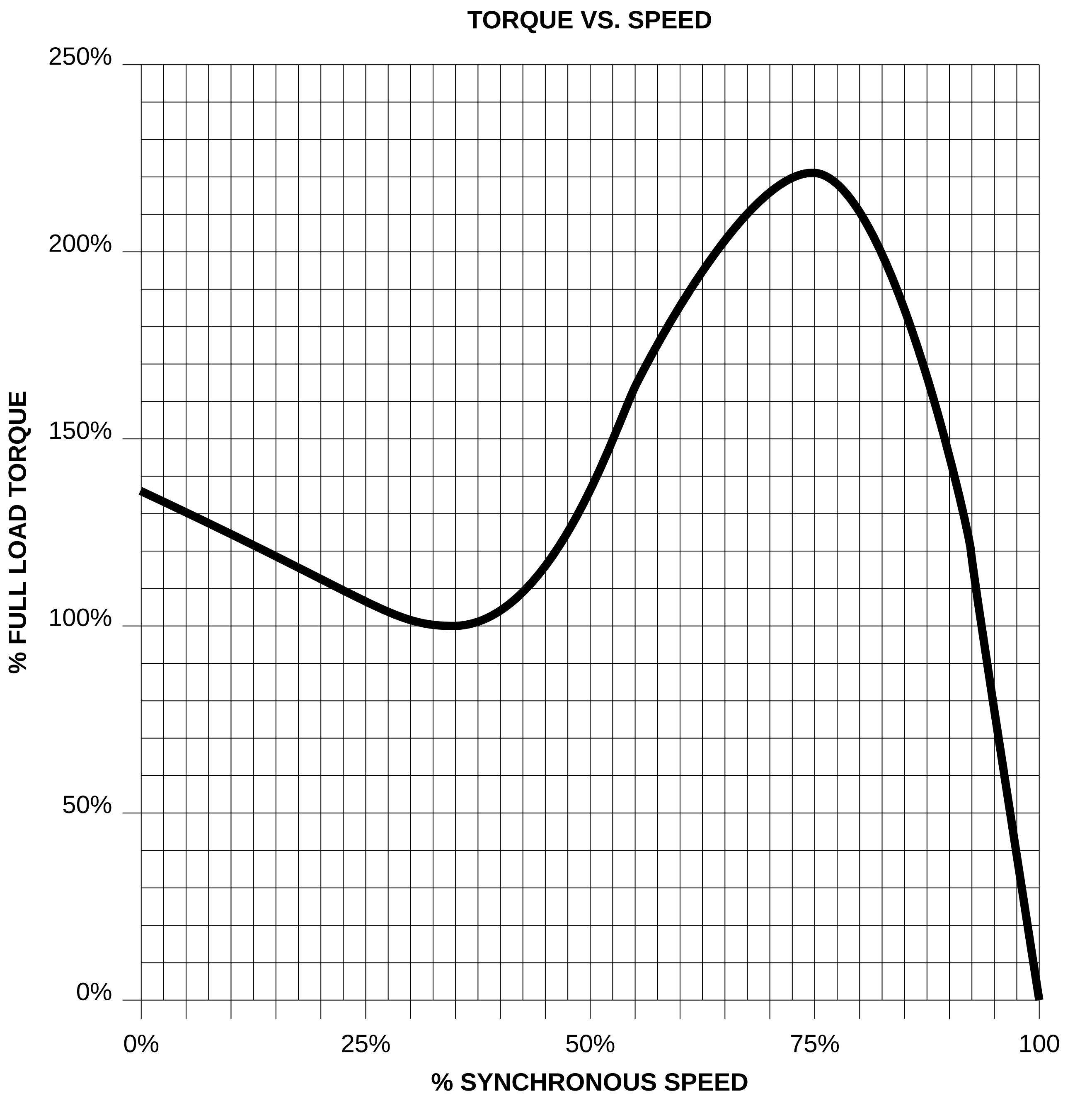
HP	0.5	VOLTS		RPM	900	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:________________ PO #:________________ Order #:________________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

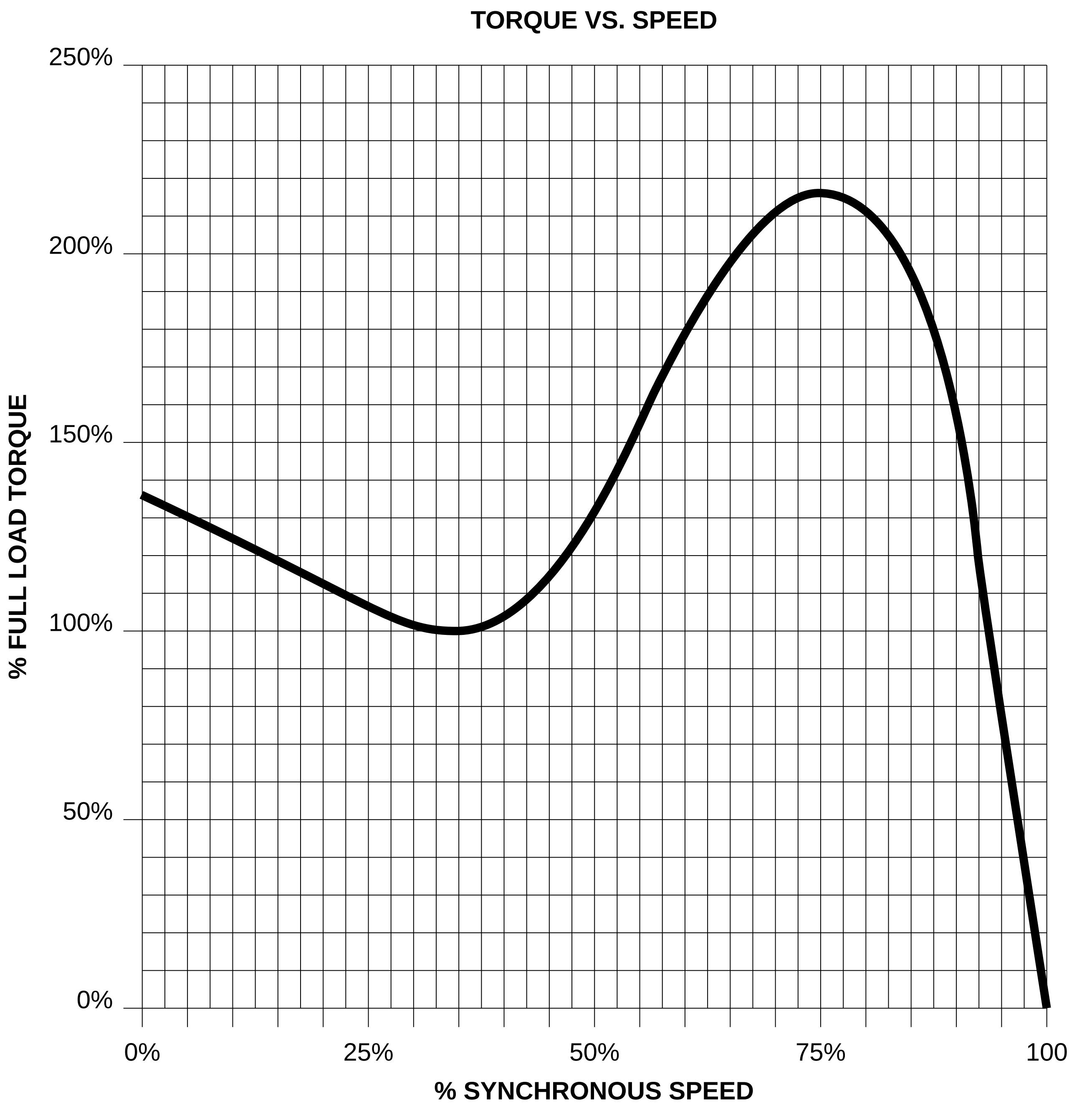
HP	0.75	VOLTS		RPM	900	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:__________ PO #:__________ Order #:__________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

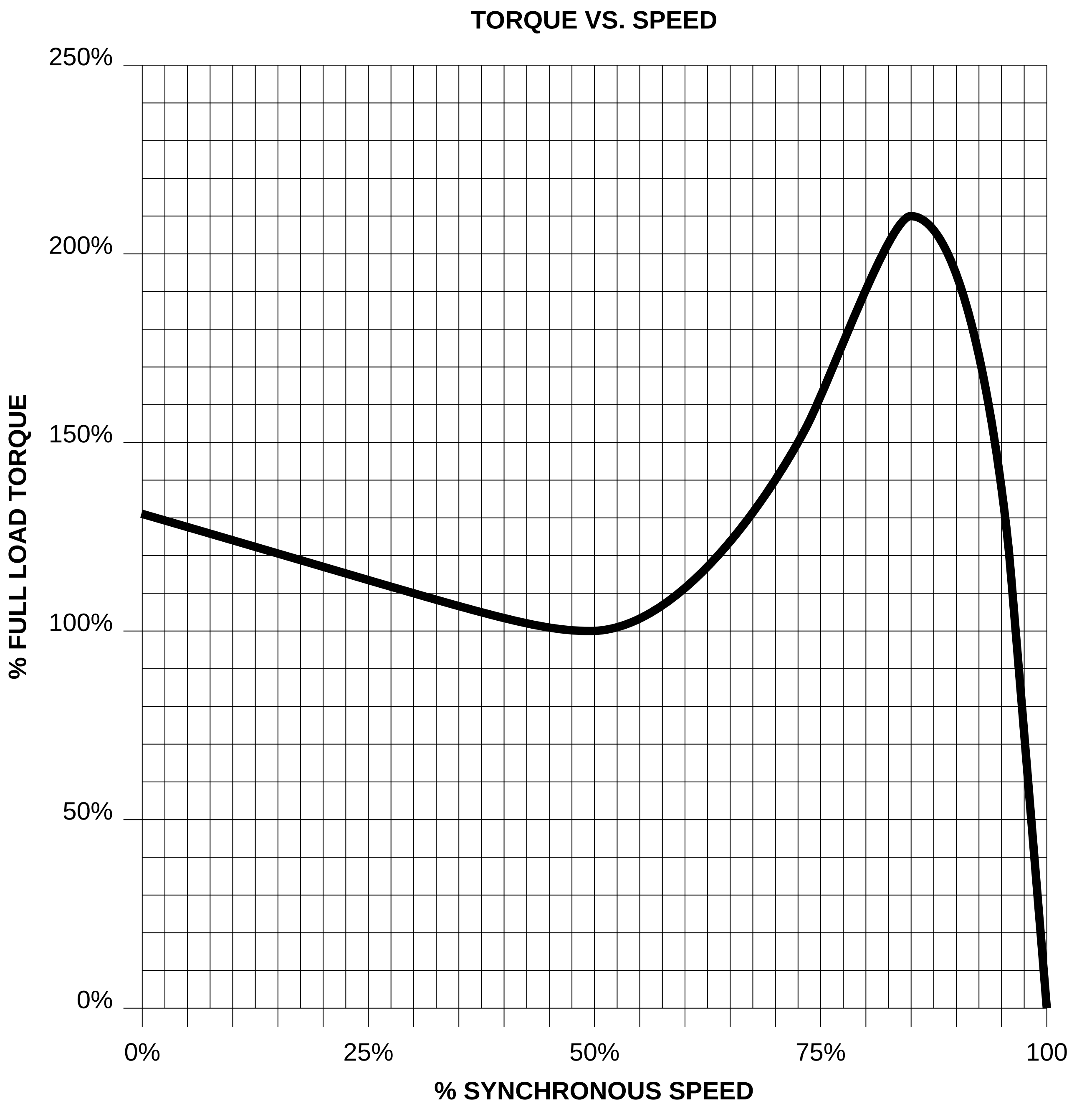
HP	1	VOLTS		RPM	900	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:____________________ PO #:______________ Order #:______________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

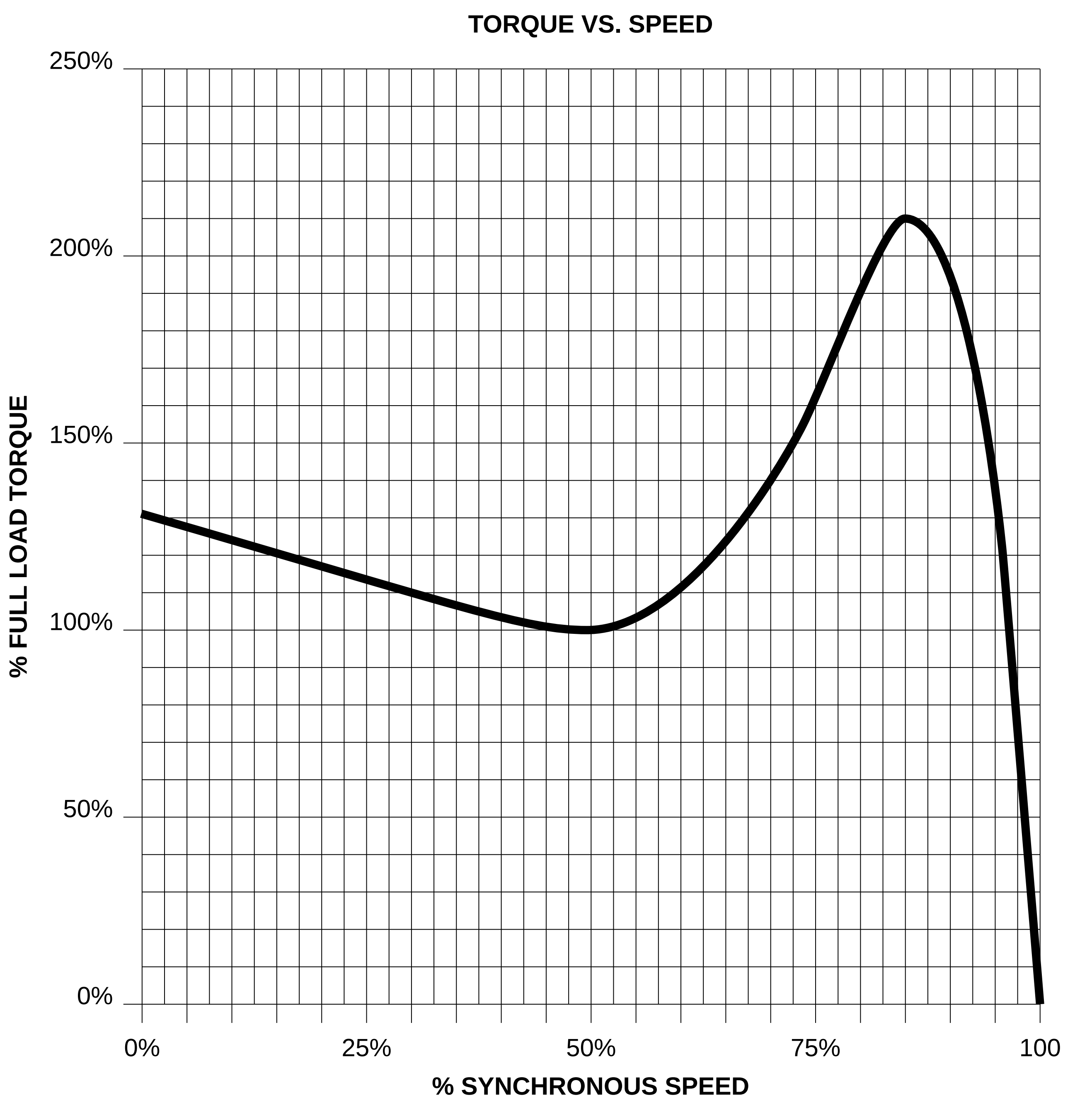
HP	1.5	VOLTS		RPM	900	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:____________________ PO #:______________ Order #:______________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

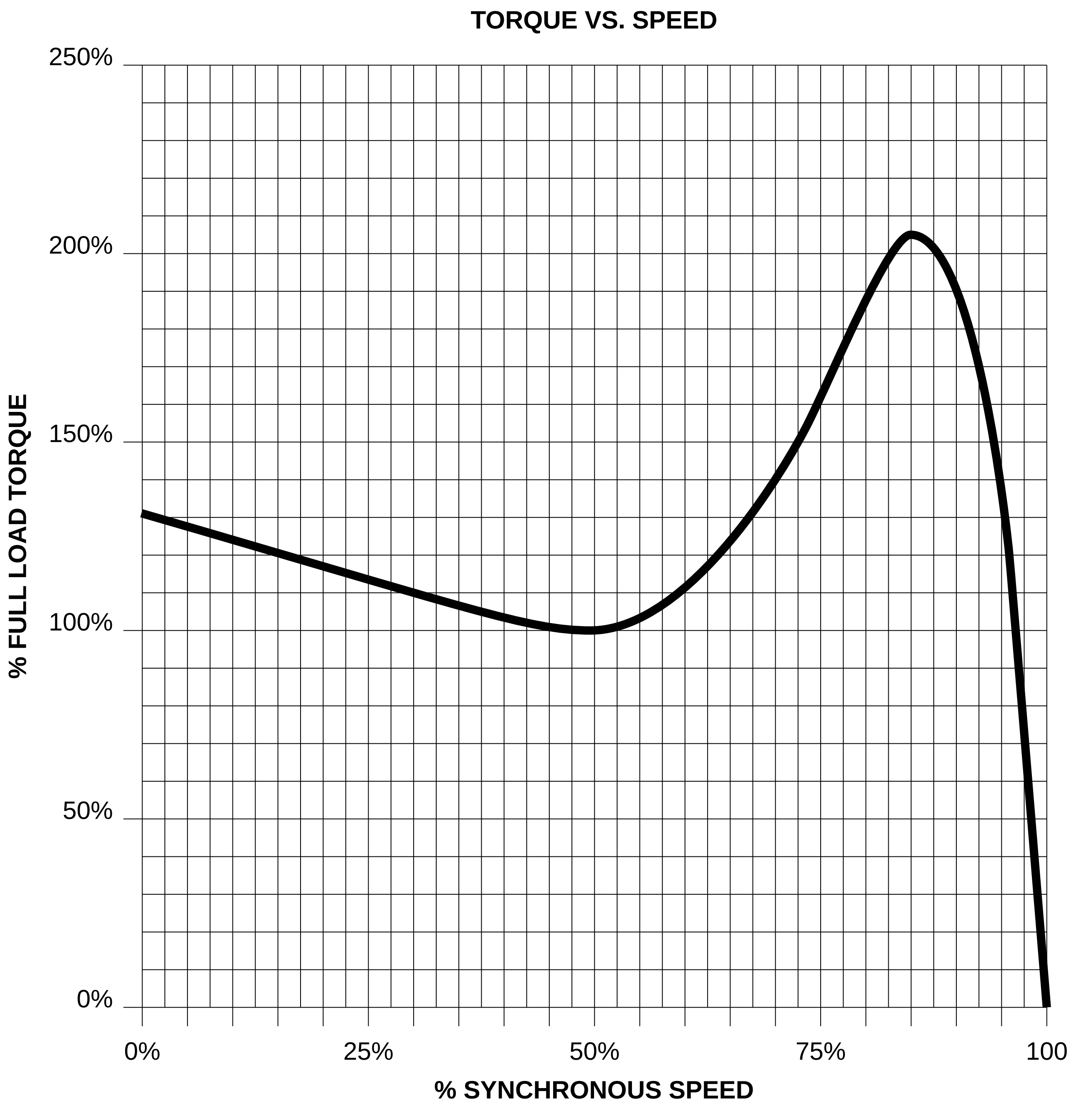
HP	2	VOLTS		RPM	900	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:__________________ PO #:____________ Order #:____________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

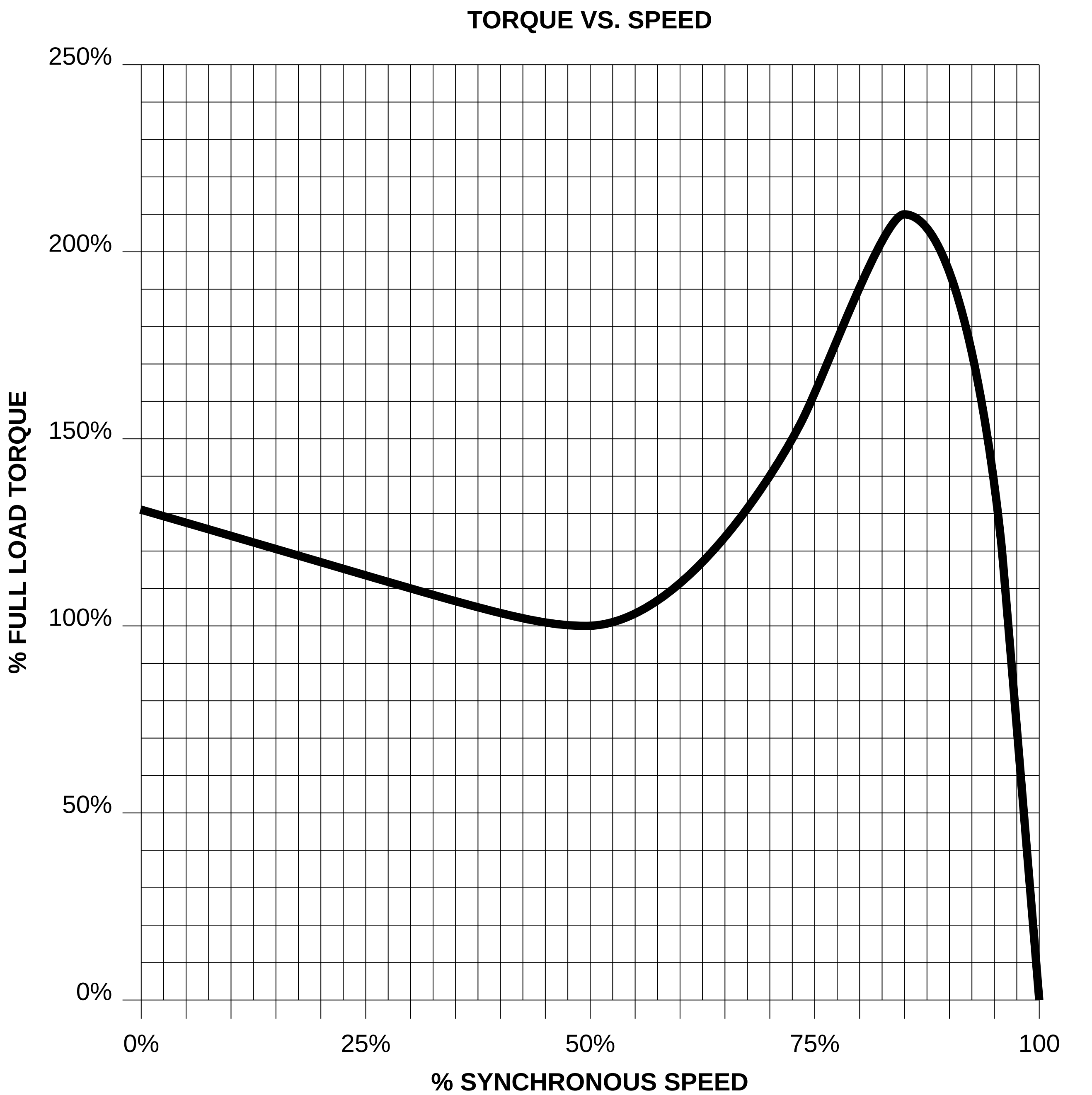
HP	3	VOLTS		RPM	900	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:________________________ PO #:____________ Order #:______________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

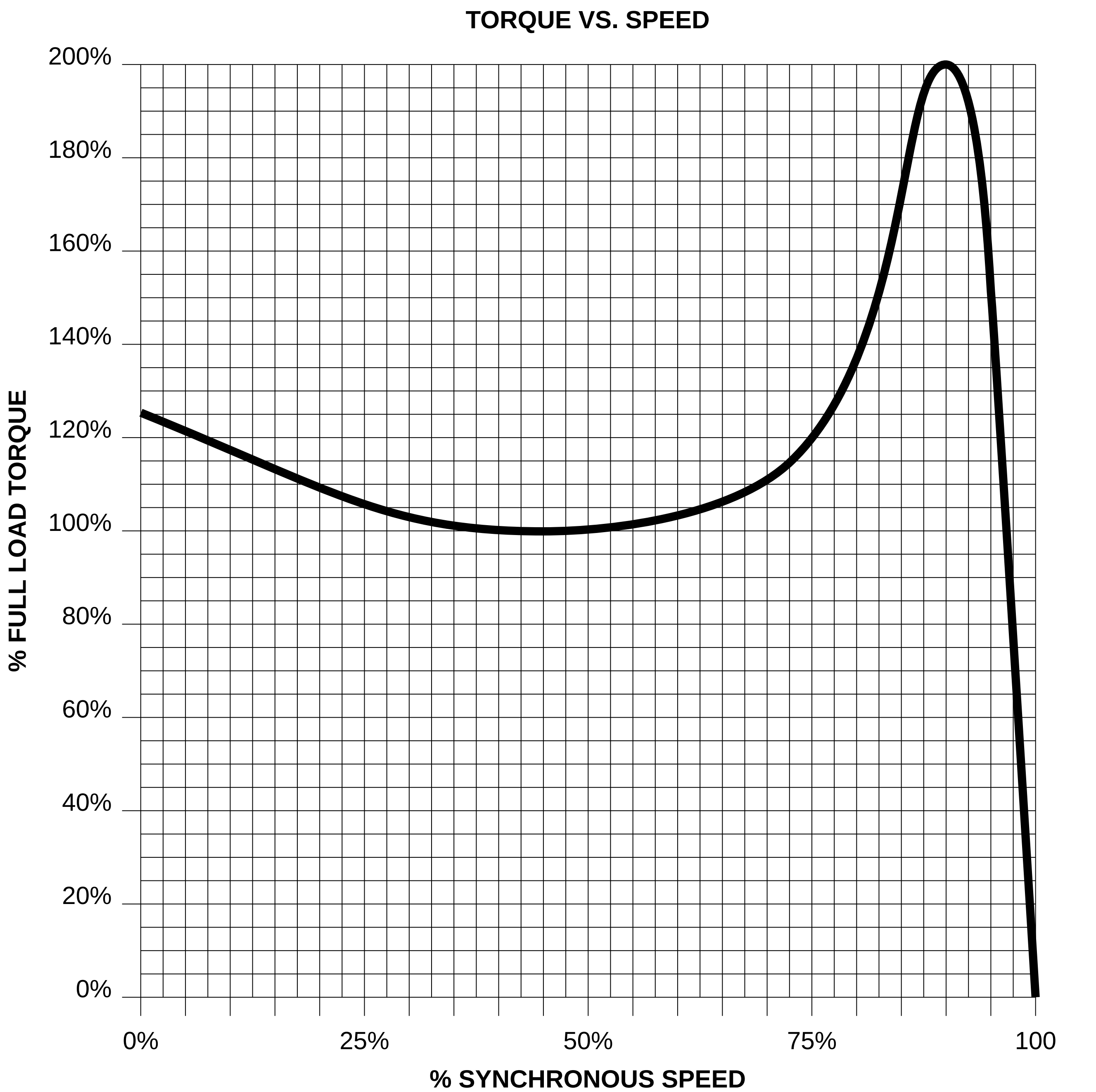
HP	5	VOLTS		RPM	900	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:____________________ PO #:_______________ Order #:_______________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

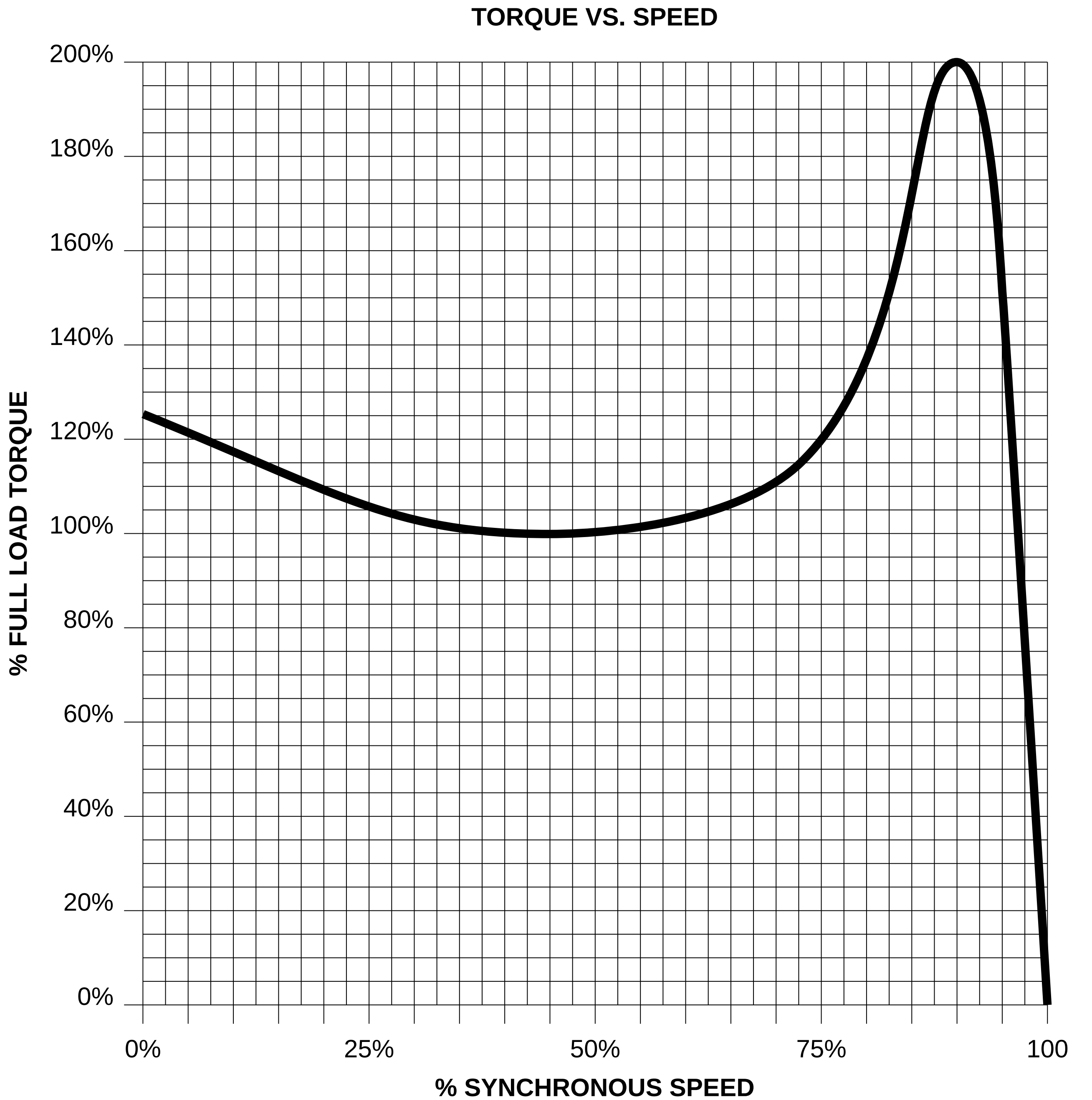
HP	7.5	VOLTS		RPM	900	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer: ______________________ PO #: ______________ Order #: ______________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

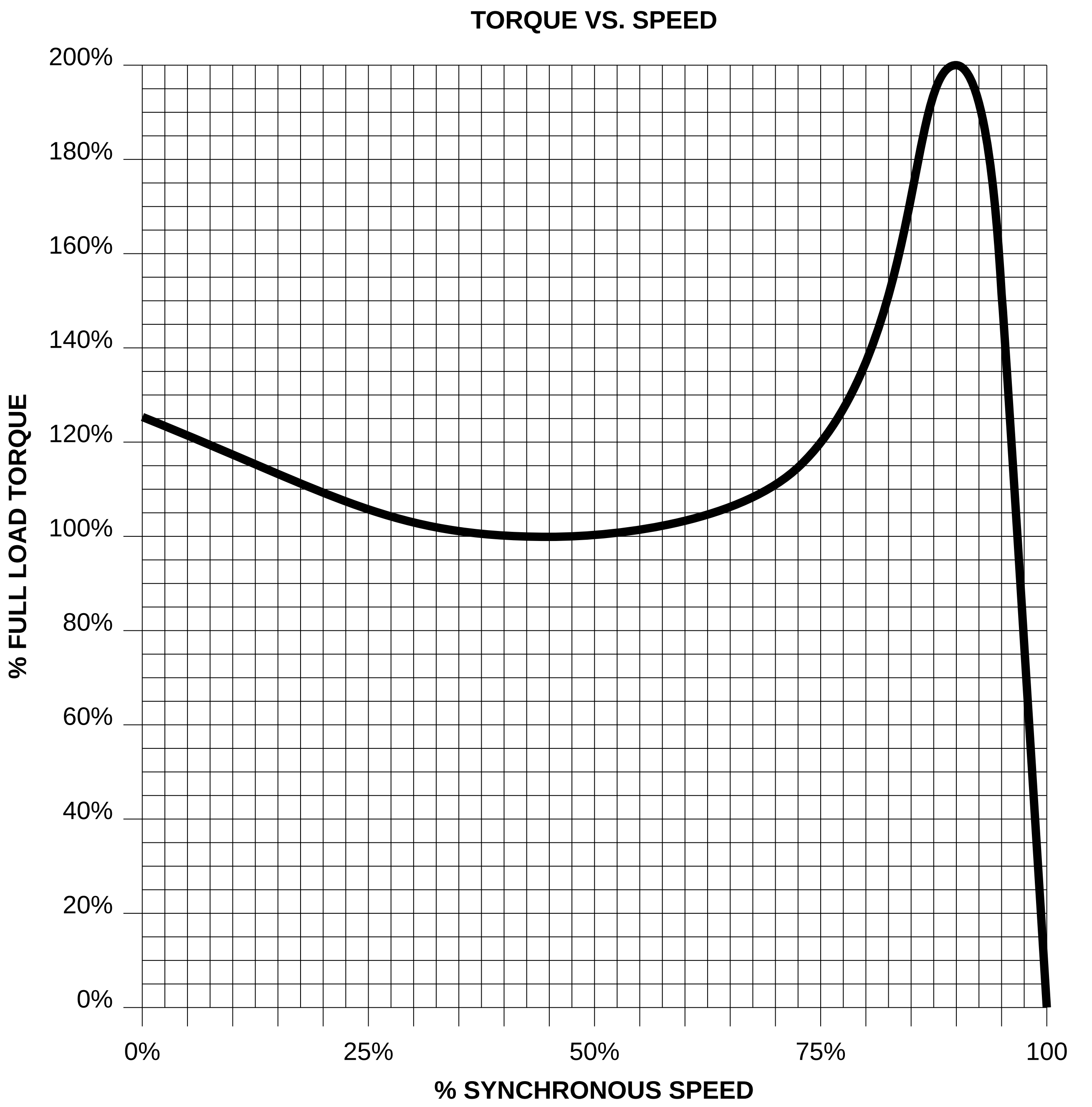
HP	10	VOLTS		RPM	900	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:__________________________ PO #:_______________ Order #:________________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

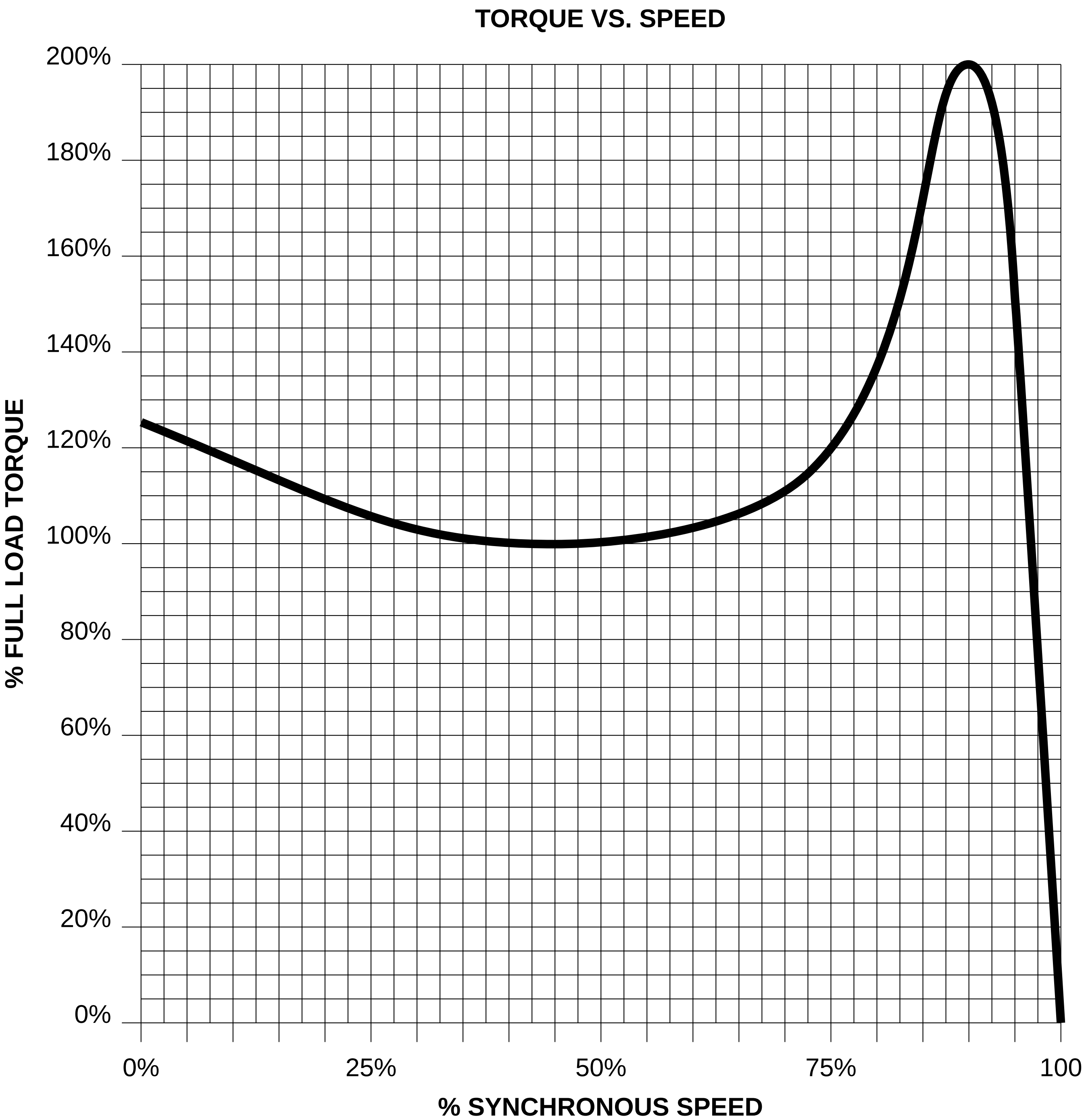
HP	15	VOLTS		RPM	900	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:________________ PO #:__________ Order #:__________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

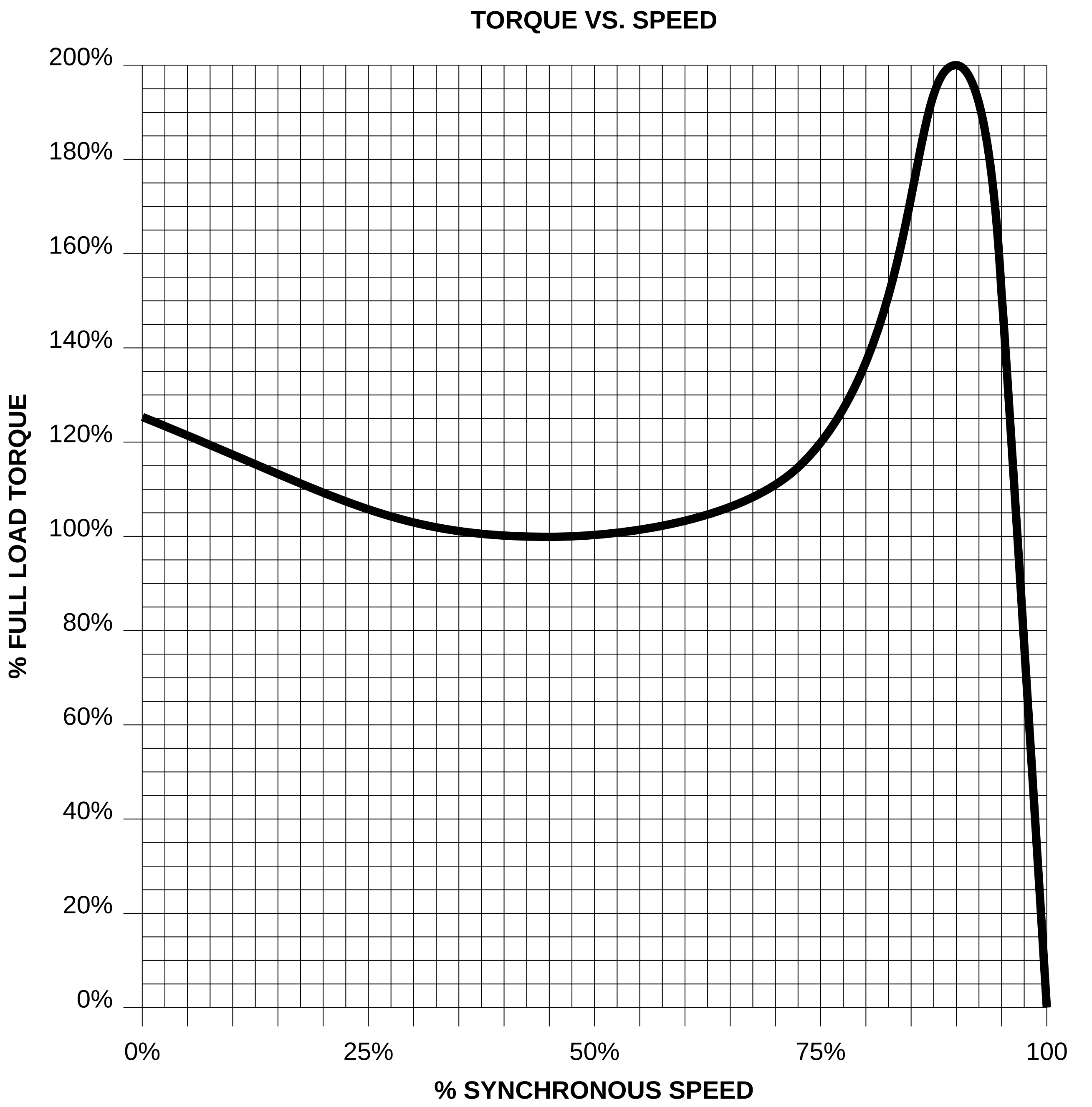
HP	20	VOLTS		RPM	900	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:________________________________ PO #:________________ Order #:____________________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

HP	25	VOLTS		RPM	900	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



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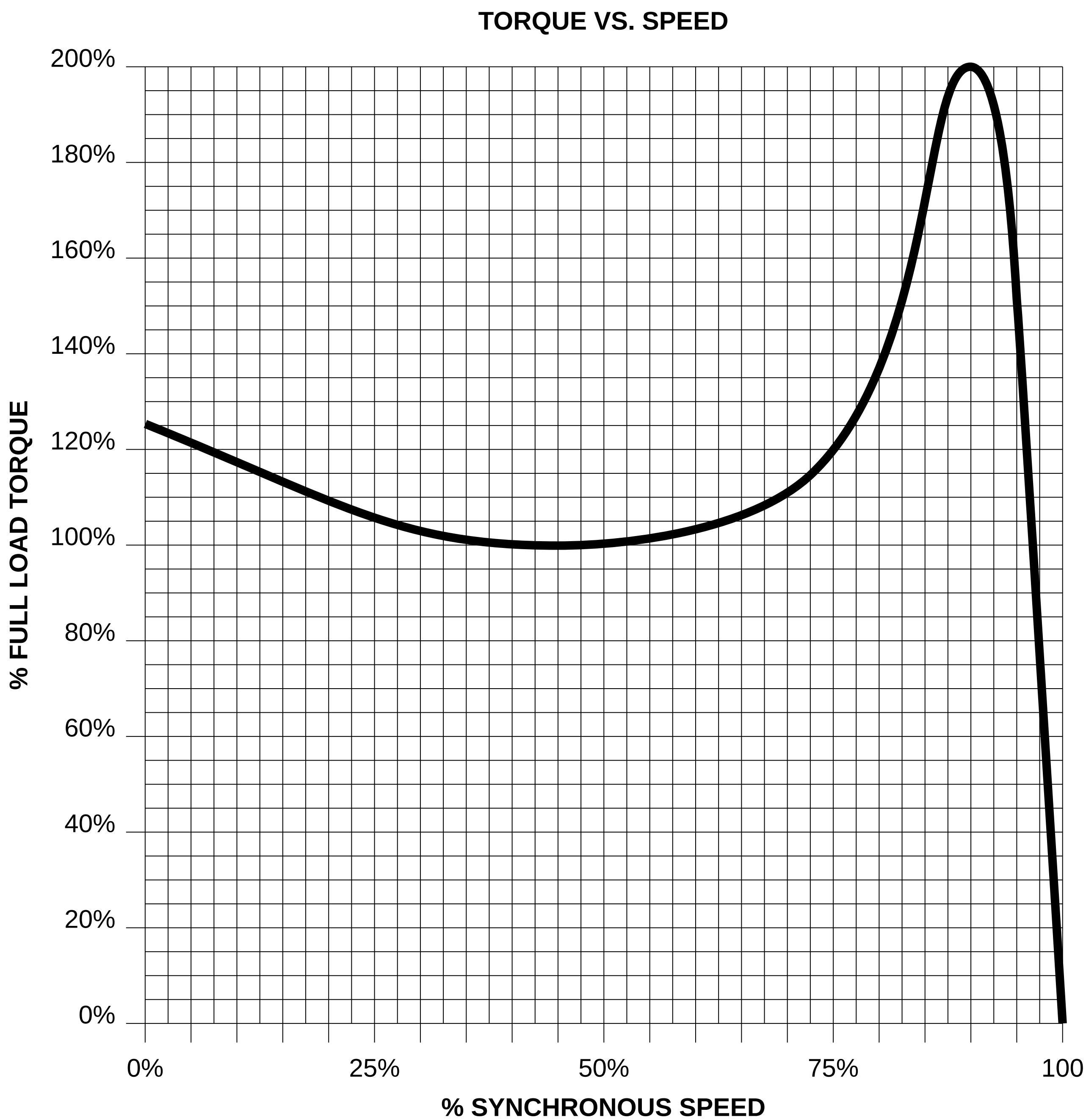
Speed Torque Curves
NEMA MG 1 Part 12 Torque

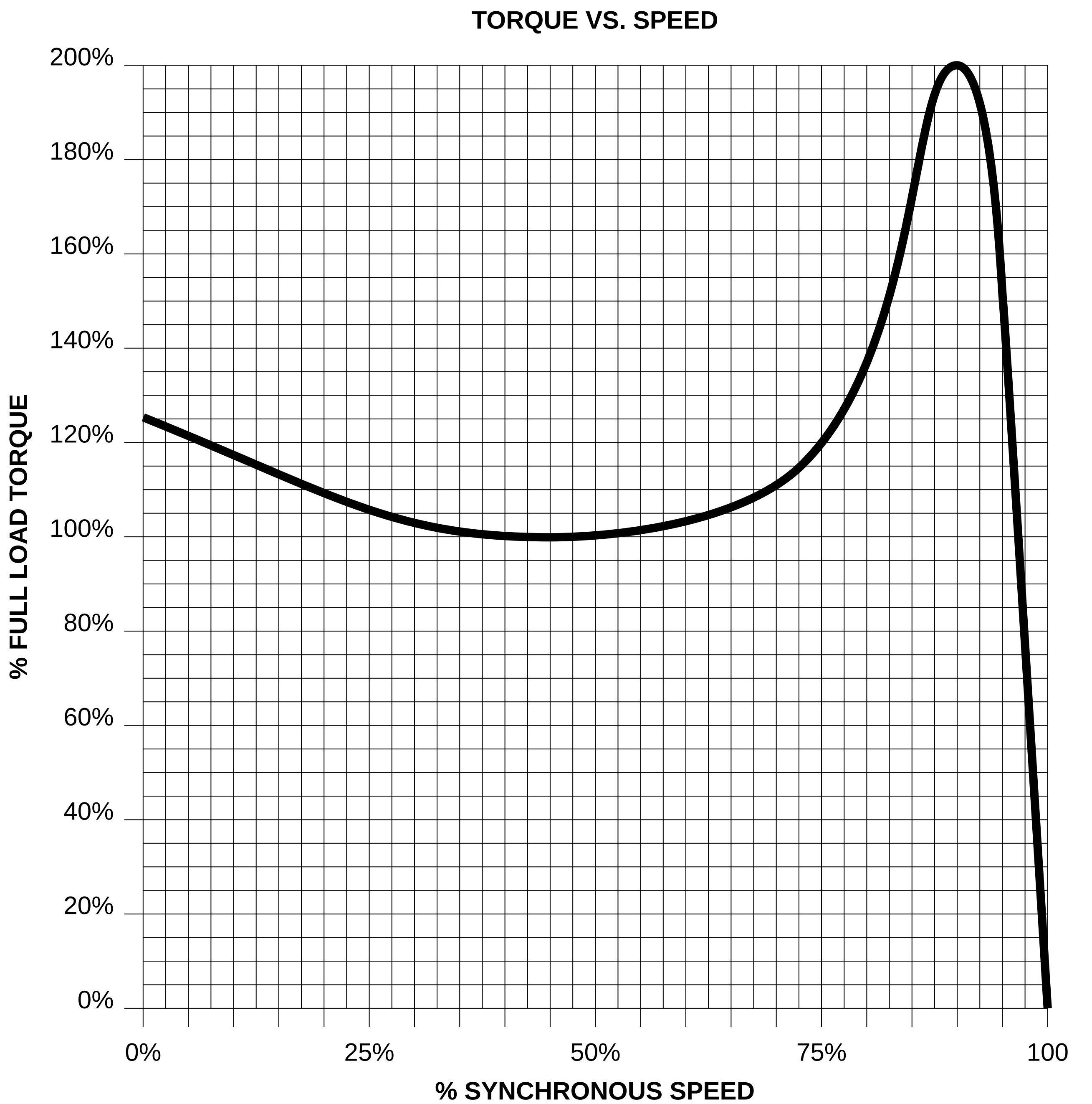
HP	30	VOLTS		RPM	900	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer: ______________________ PO #: ______________ Order #: ______________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

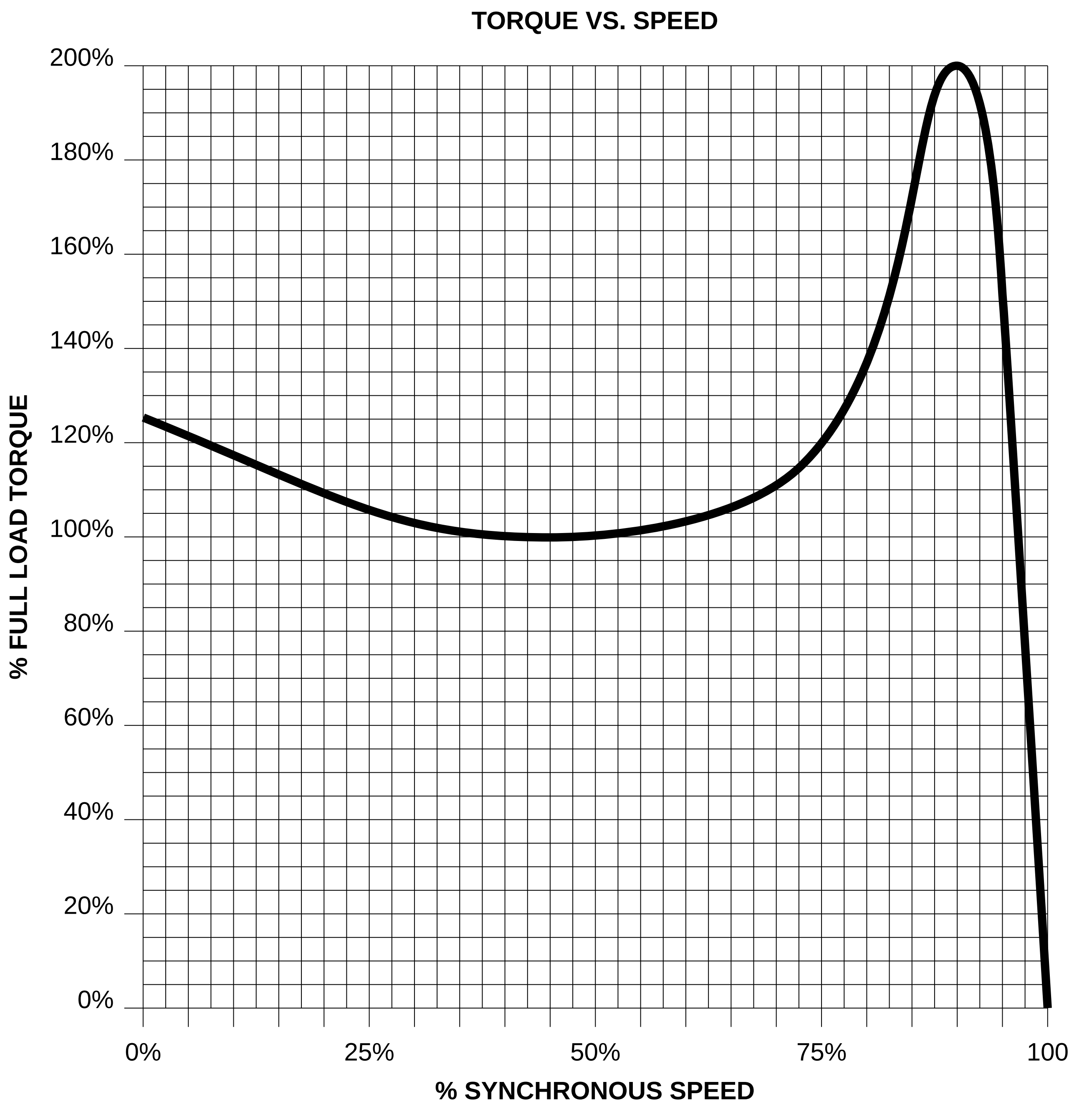
HP	40	VOLTS		RPM	900	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:______________________ PO #:______________ Order #:______________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

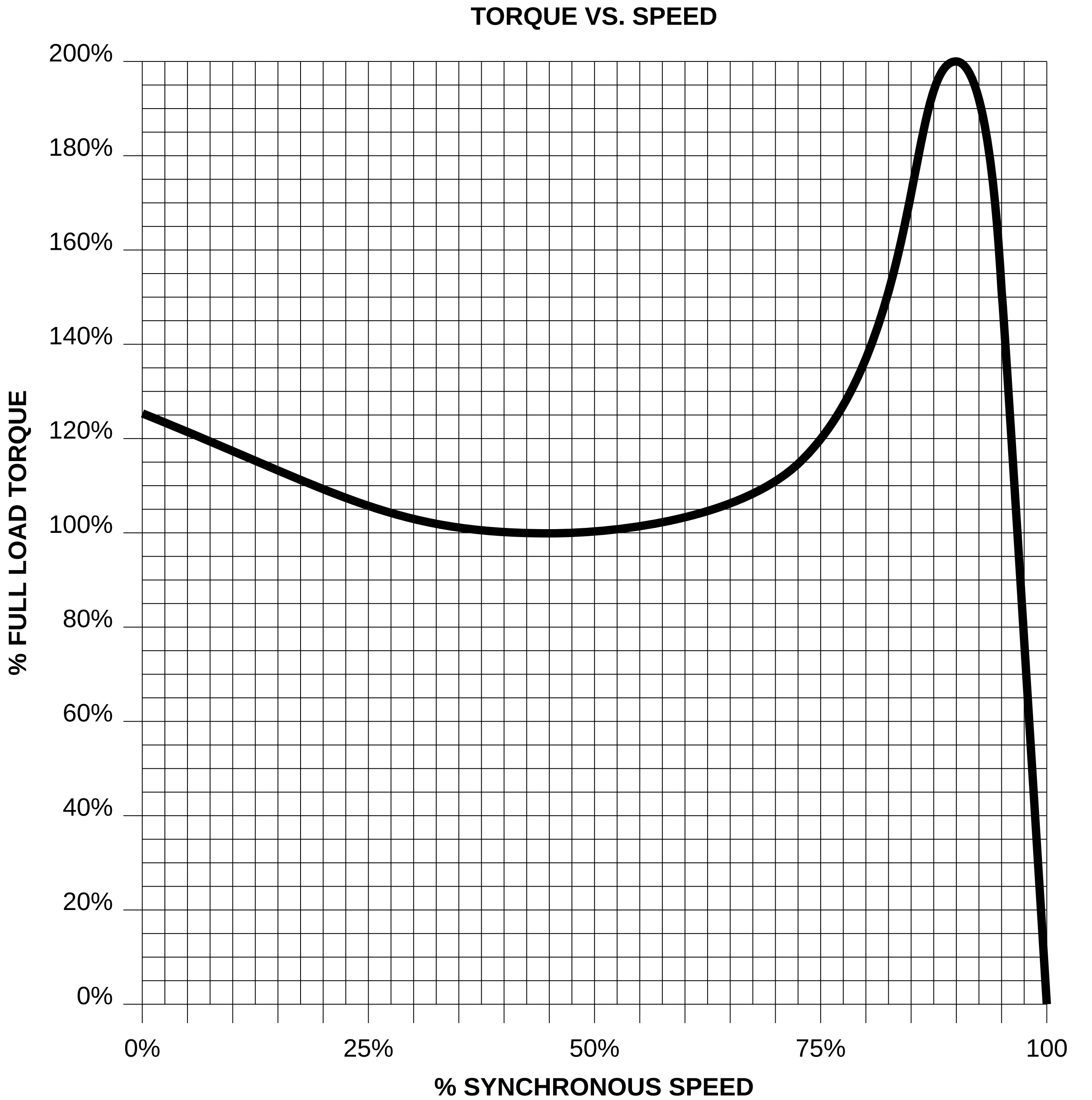
HP	50	VOLTS		RPM	900	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:________________ PO #:________________ Order #:________________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

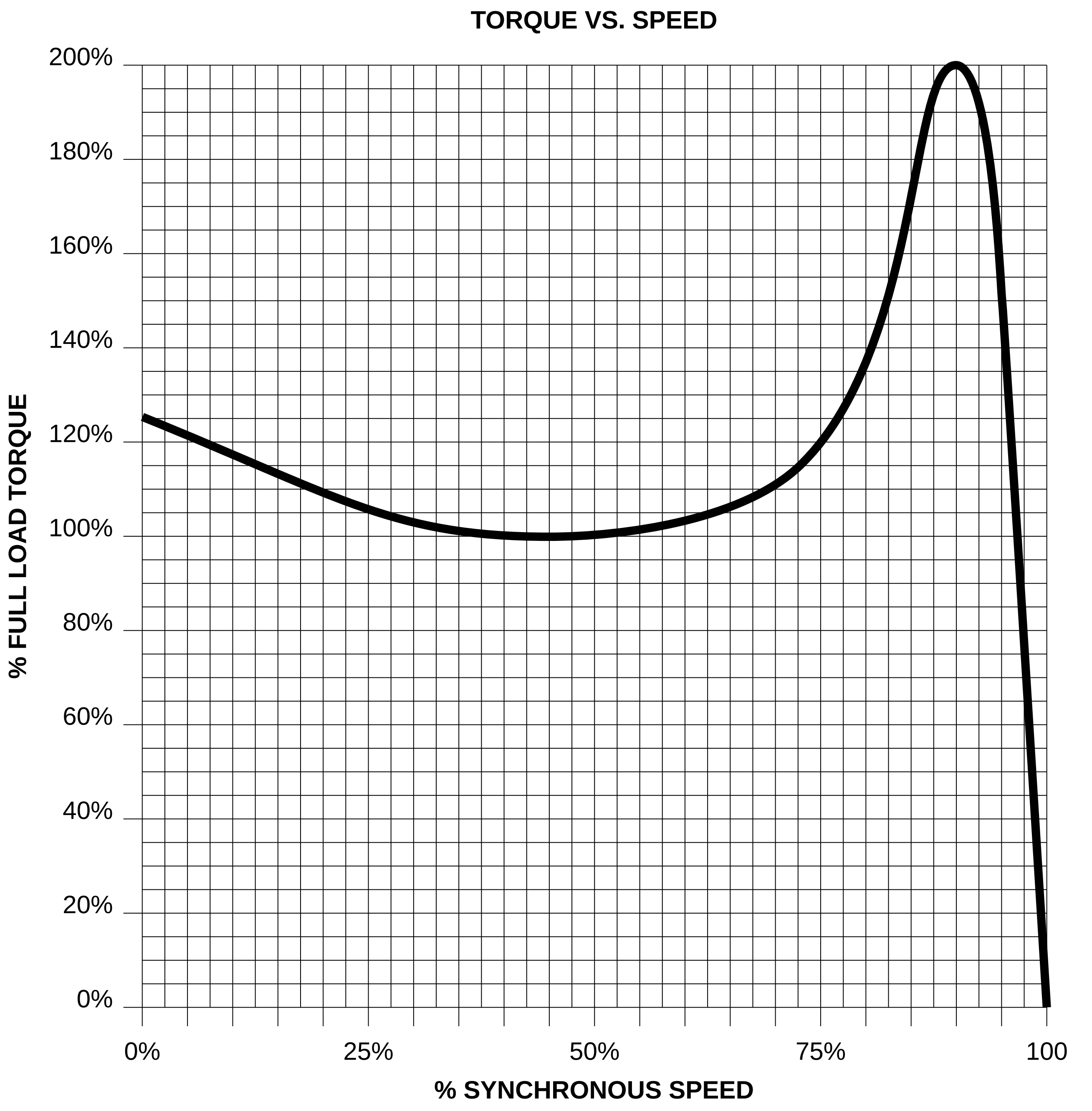
HP	60	VOLTS		RPM	900	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:__________________ PO #:____________ Order #:____________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

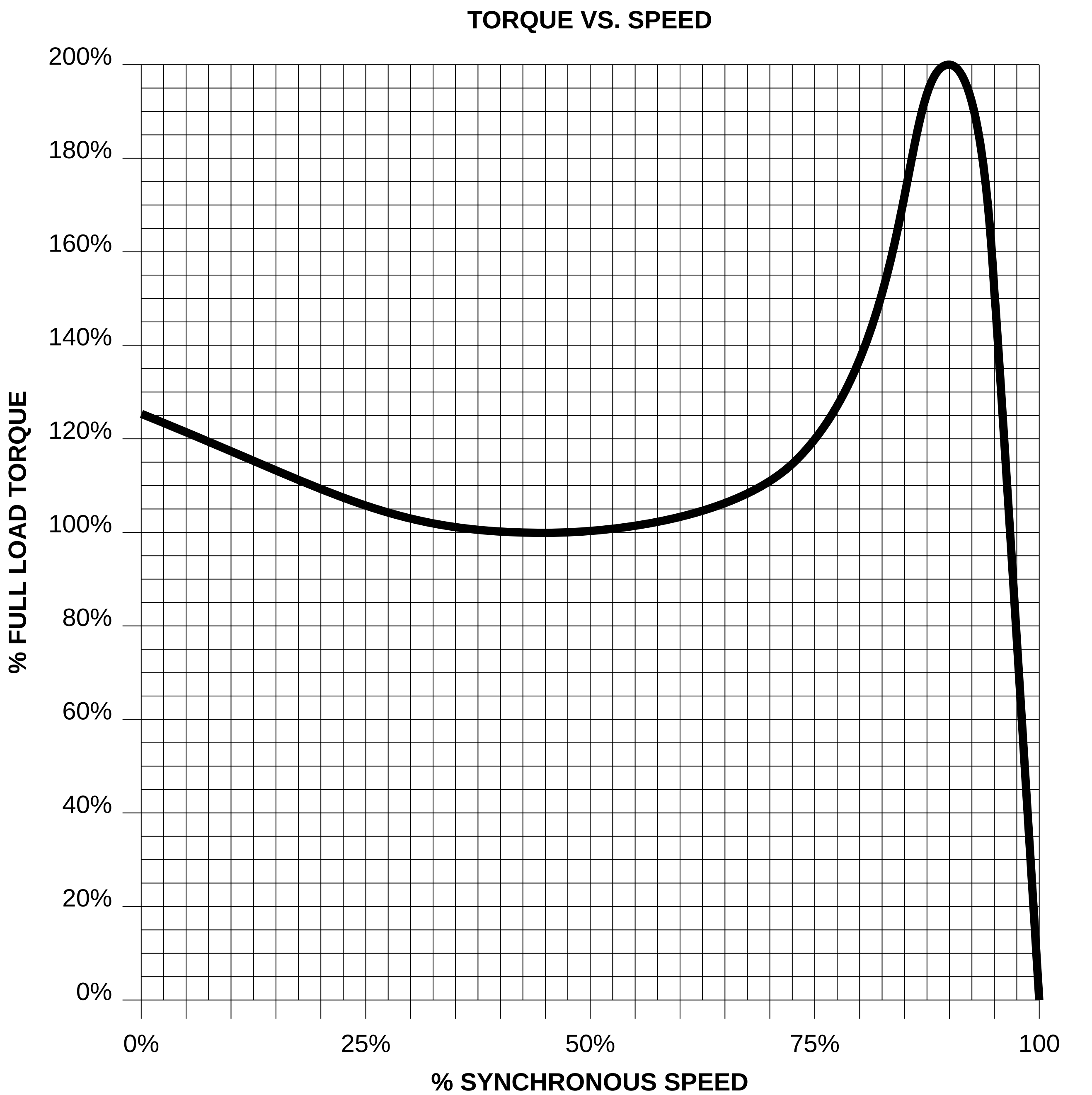
HP	75	VOLTS		RPM	900	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer: ______________________ PO #: ______________ Order #: ______________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

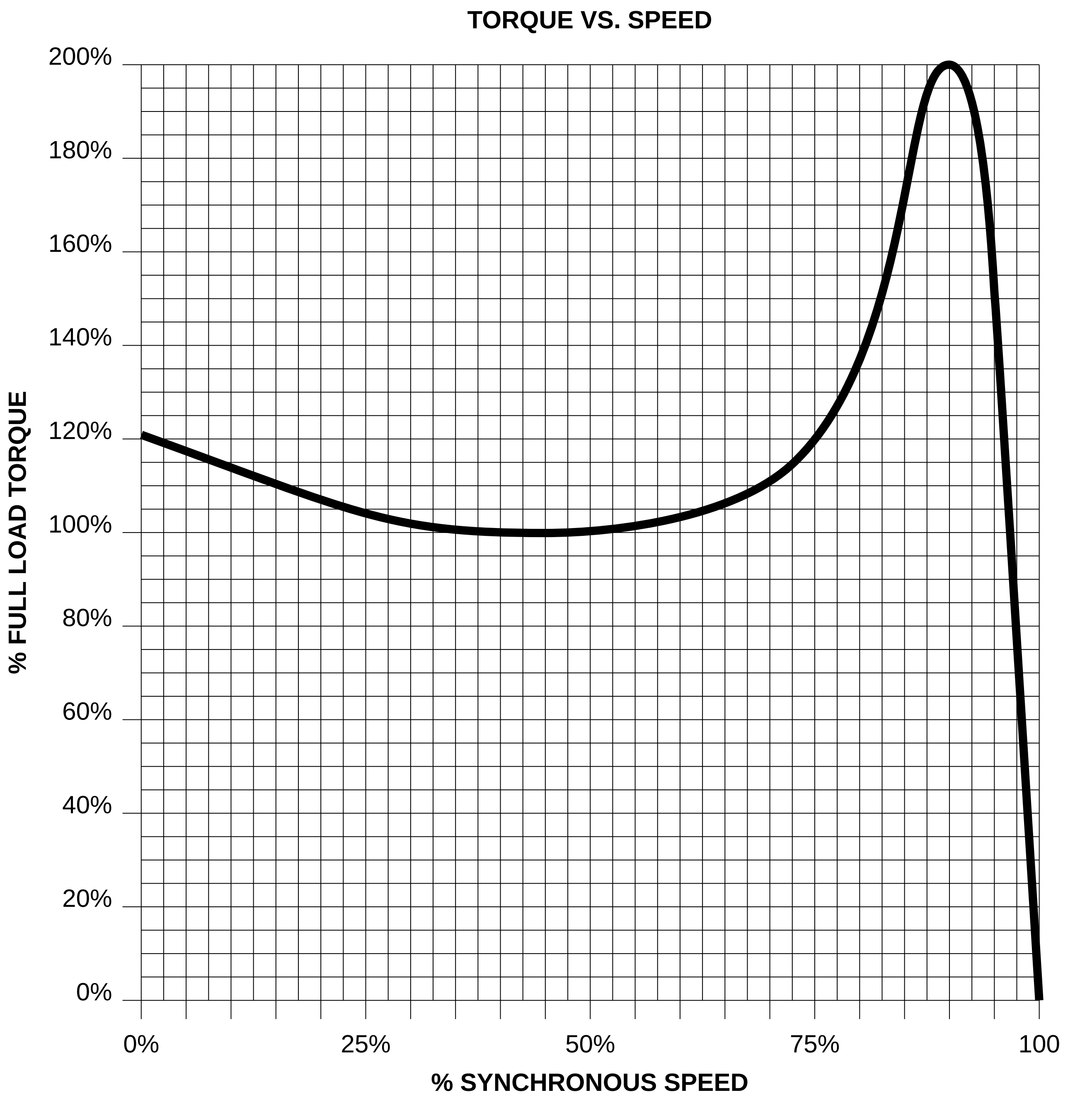
HP	100	VOLTS		RPM	900	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:________________________ PO #:______________ Order #:________________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

HP	125	VOLTS		RPM	900	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B

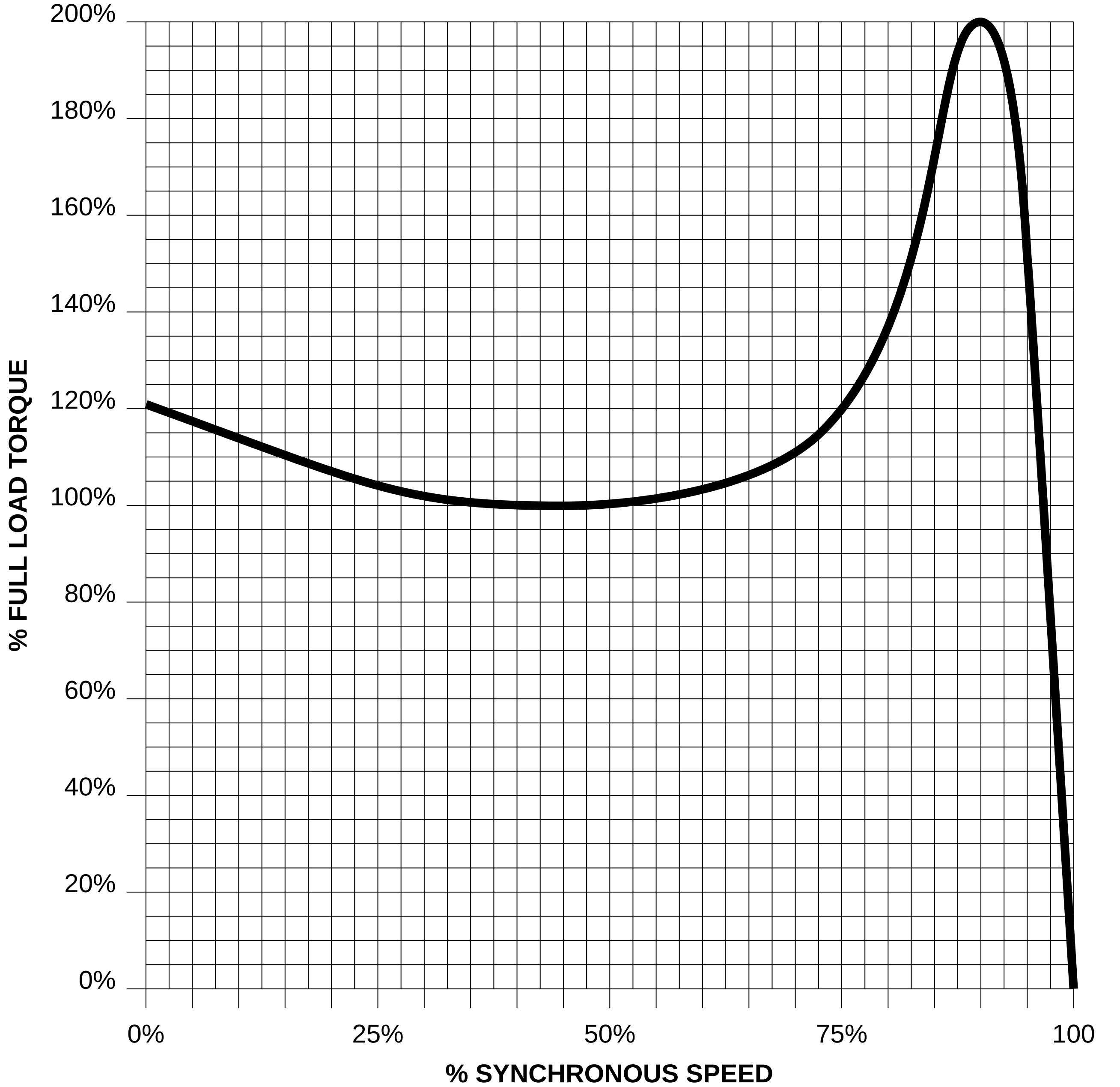


Customer:____________________ PO #:______________ Order #:______________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

HP	150	**VOLTS**		**RPM**	900	**TYPE**	
HZ	60	**PHASE**	3	**FRAME**		**NEMA**	B

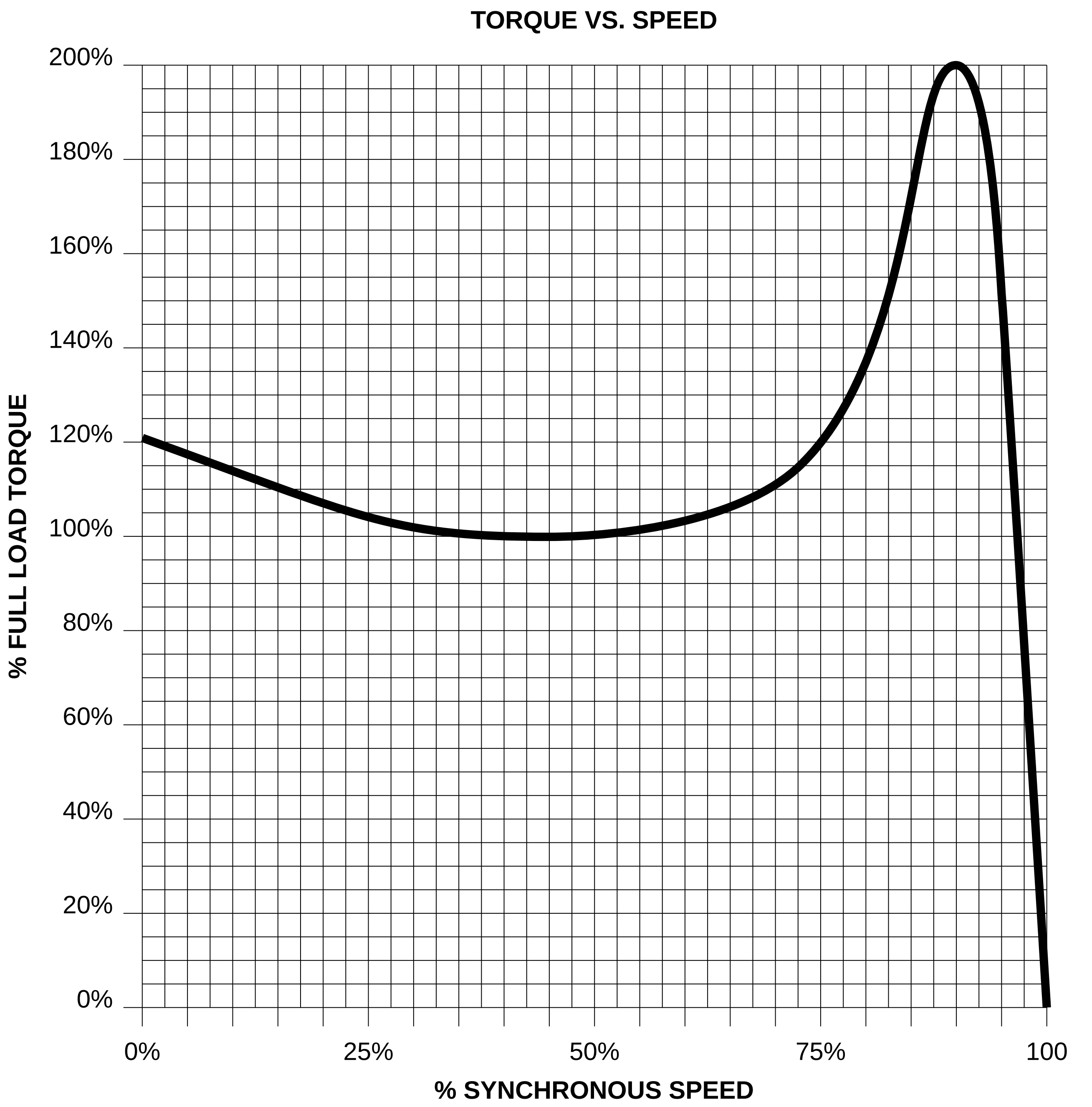
TORQUE VS. SPEED



Customer:____________________ PO #:____________ Order #:____________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

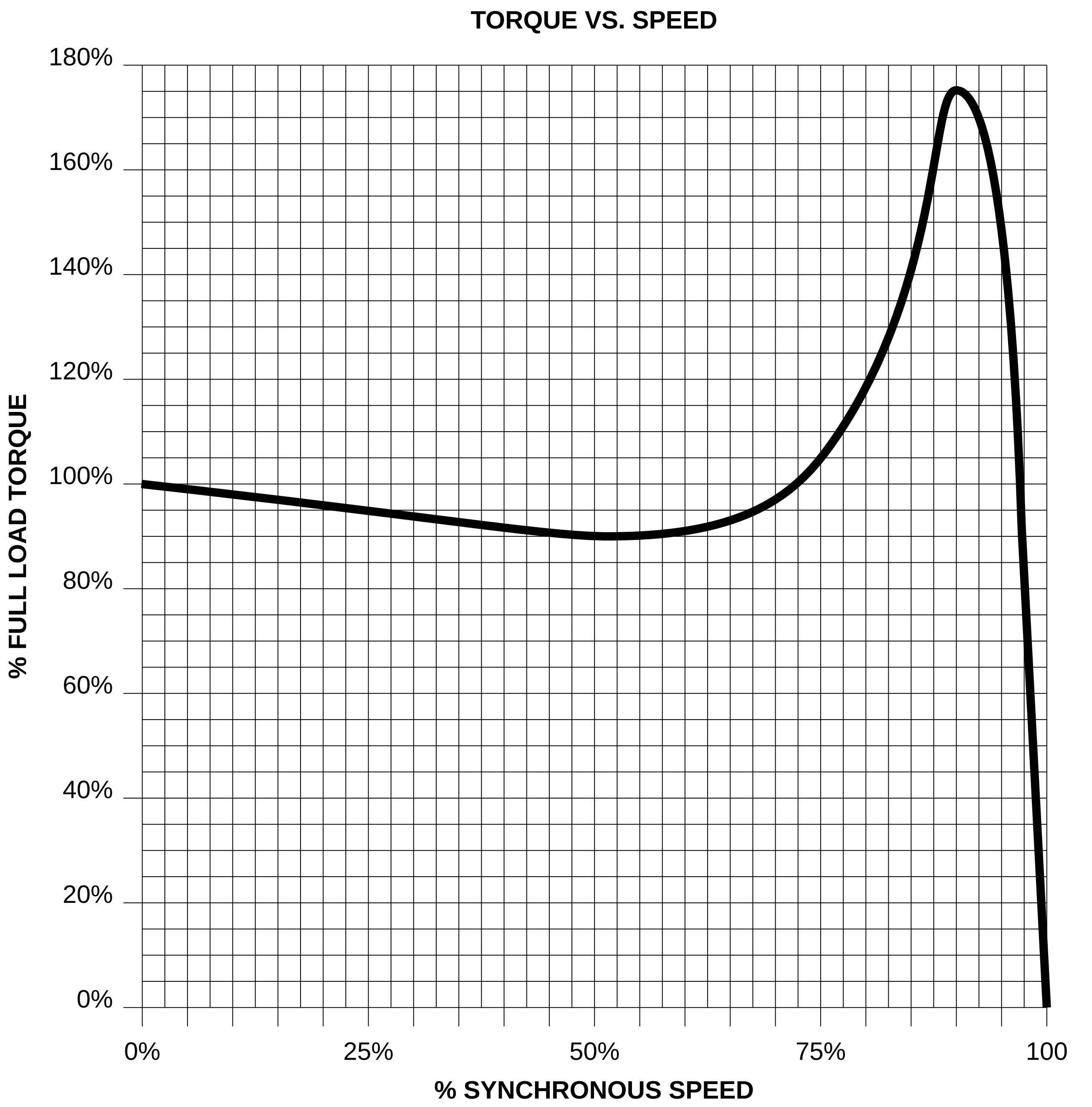
HP	200	VOLTS		RPM	900	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:________________________ PO #:______________ Order #:________________

Speed Torque Curves
NEMA MG 1 Part 12 Torque

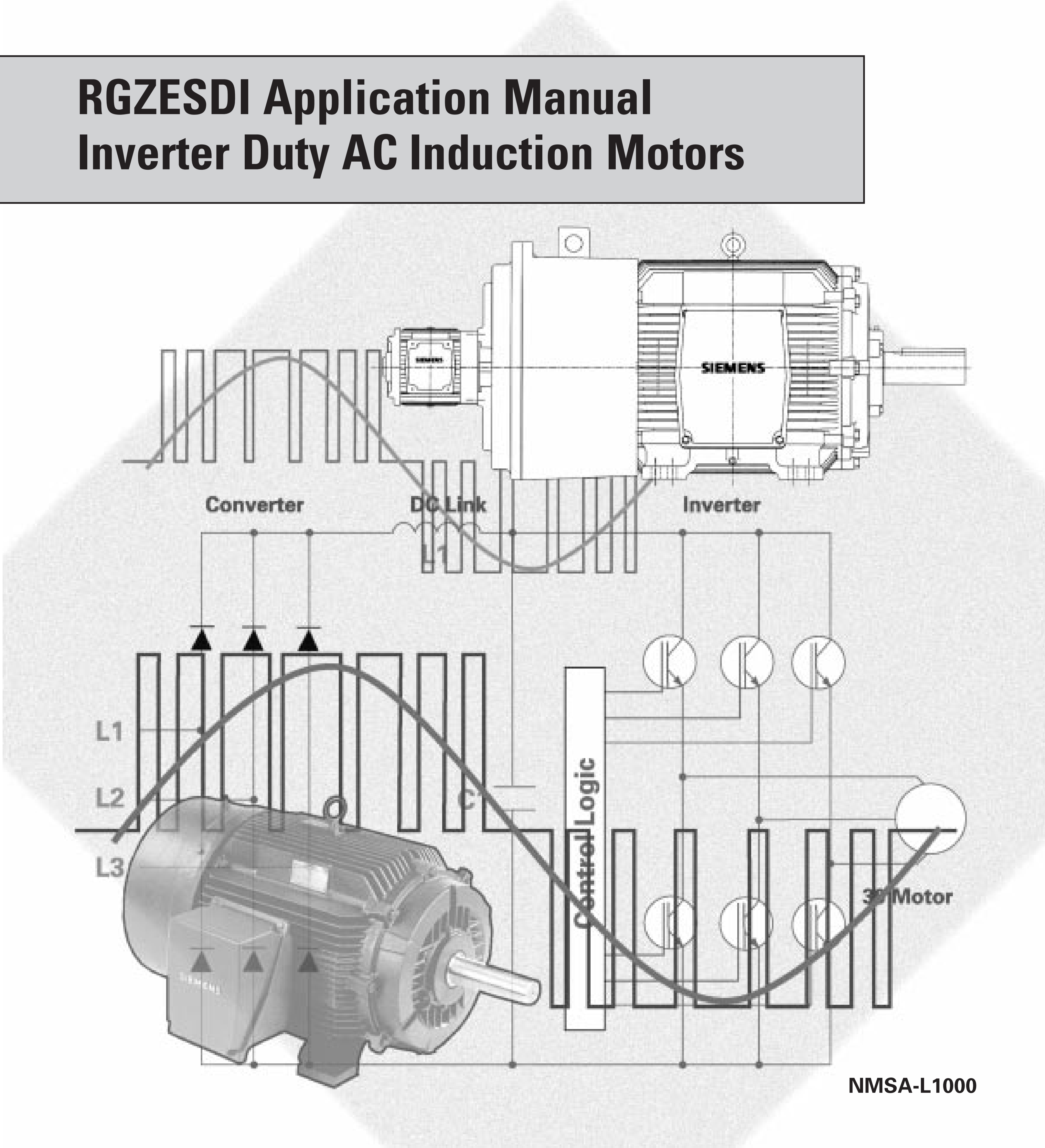
HP	250	VOLTS		RPM	900	TYPE	
HZ	60	PHASE	3	FRAME		NEMA	B



Customer:________________ PO #:________________ Order #:________________

SIEMENS

RGZESDI Application Manual
Inverter Duty AC Induction Motors



NMSA-L1000

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Stocked Low Voltage IEC Motors
Selection and Pricing Guide. . . . . Bulletin NMSP-L0200

SIEMENS

GENERAL INFORMATION

As a manufacturer of both variable speed drives and AC motors, Siemens has a superior understanding of their collective operation, application, and performance. The Inverter Duty Motors outlined in this publication are the result of an extensive testing program to establish guidelines for their typical utilization.

Siemens inverter-duty motors are rated for continuous operation in a 40° C ambient at altitudes up to 3300 feet above sea level. For specialized applications, such as non-standard ambient, intermittent or high duty cycles, high constant horsepower speed ranges (higher than those indicated), non-standard voltage or frequency, or other special conditions, please consult Siemens.

APPLICATION CONSIDERATIONS

Variable Torque Applications - From the perspective of motor cooling, AC motors are well suited to be used in adjustable speed variable torque applications, such as centrifugal fans or pumps. The torque characteristics of a variable torque load is such that the load falls off rapidly as the motor speed is reduced. The variable torque load eliminates the necessity to de-rate the motor due to excessive heat resulting from diminished motor cooling at reduced speeds. Variable Torque operation above base speed must be reviewed by Siemens.

Constant Torque Operation - Many general industrial machines, other than fans and pumps, are constant torque systems where the machine's torque requirement is independent of its speed. If the machine speed is doubled, its horsepower requirement doubles.

Vector drives can supply nearly ideal conditions to the motor resulting in better motor performance, cooler operation, and more precise speed regulation, especially at low speed ranges. A standard 4-pole 460V motor can be accurately controlled by this method to its synchronous speed of 1800 RPM.

RGZESDI Constant Torque motors provide full rated torque within their listed speed range, without exceeding their Class F temperature rating on PWM (pulse width modulated) inverter power. Ratings in this catalog are based on use with vector type IGBT inverters, set at a minimum 3 kHz switching frequency, and are designed for operation at 150% of rated torque for one minute, up to the base speed of the motor (overload capacity declines as the motor reaches maximum speed).

Constant Torque operation above base speed must be reviewed by Siemens.

Constant Horsepower Operation - AC motor controllers are also adaptable to constant horsepower operation. With this mode of operation, the Volts/Hz ratio is maintained to a specific frequency, normally 60 Hz. At this point, the voltage is "clamped" at a constant level while the frequency is adjusted further to achieve the desired maximum speed. The motor becomes "voltage starved" above the clamping point and torque decreases as speed increases, resulting in constant horsepower output. In constant horsepower applications, the drive provides conventional constant torque/variable horsepower operation up to 60 hertz. Above 60 hertz, the motor/drive provides constant horsepower, variable torque operation.

Constant Horsepower Speed Limits (see pg 28-29 chart)

Motor Frame	3600 RPM	1800 RPM	1200 RPM	900 RPM
143-184	5400	3600	2400	1800
213-256	5400	3600	2400	1800
284-286	4800	3000	2000	1500
324-326	4800	3000	2000	1500
364-365	4500	2700	1800	1350
404-405	3600	2700	1800	1350
444-445*	3600	2700	1800	1350
447-449*	3600	2400	1800	1350

*444-449 frame motors (1800 RPM and below) intended for belt duty are supplied with roller bearings. Consult sheave/belt supplier for maximum safe operating speeds.

Maximum Safe Mechanical Speed Limits
Direct Connected Loads
(Does not imply constant horsepower capability)

Motor Frame	3600 RPM	1800 RPM	1200 RPM
143-184	7200	5400	2700
213-256	5400	4200	2700
284-286	5400	3600	2700
324-326	4500	3600	2700
364-365	4500	2700	2700
404-445	3600	2700	1800
447-449	3600	2250	1800

CAUTION

Caution must be observed when applying standard motors for continuous low speed, constant torque operation. A standard motor's self-cooling capacity depends upon self-ventilation schemes that are greatly reduced at decreased operating speeds.

SIEMENS

WARRANTY

Siemens totally enclosed RGZESDI and explosion proof RGZZESD inverter-duty motors are warranted to be free from defects in materials and workmanship for a period of thirty-six (36) months from the date of manufacture. See also "Siemens Standard Terms and Conditions of Sale" for additional details.

Service
For warranty service on these motors, contact your nearest Siemens authorized service shop.

Accessories
Accessories, such as "C" face kits or encoders, can be added to stock motors in our Super Mod Center. Other common modifications, such as addition of space heaters, shaft seals or change to F2 assembly, are also available from the Super Mod Center. This facility provides a short lead-time on many popular modifications.

Optional Blowers
Low rotational speeds at constant torque loads, common in many vector applications, provide the motor with reduced ventilation. As a result, these motors are designed as Totally Enclosed Blower Cooled. Blowers are powered by a Siemens TENV, Severe Duty, 3 phase motor. Standard voltage is 230/460.

Optional Encoders
These electronic devices sense rotor speed and direction. A cable is connected from the encoder to the VFD. Various resolutions (pulses per revolution, PPR) are available. All encoders offer quadrature (direction sensing), with line driver output.

Service Factor
Standard service factor for RGZESDI motors is 1.0 on inverter power. RGZESDI motors are suitable for 1.15 service factor on sine wave power.

Thermal Protection
All RGZESDI motors are equipped with Class F normally closed thermostats for detection of overload conditions and/or excessive heating.

Insulation
Type RGZESDI inverter duty motors utilize an insulation system designed to meet the requirements of NEMA Part 31.

50 Hertz Power
Operation on 50 Hz sources limits the speed and voltage available for torque. Typically the next stronger motor, in larger frame is required for satisfactory application and performance.

CAUTION

It is the responsibility of the startup personnel during commissioning of the VFD/motor combination to properly tune the drive to the motor for the specific application. Application of motors which are not per the guidelines of this document may void the warranty, if they are not specifically approved by Siemens.

The RGZESDI Insulation System

BACKGROUND

More and more electric motors are being used with variable frequency drives (VFD) powered by insulated gate bipolar transistors or IGBT's. Typical considerations for load torque characteristics and low speed operation remain important in specifying a motor to ensure adequate cooling, but IGBT drives can introduce other elements. Due to the rapid switching rates of IGBT drives, the potential for long term detrimental effects on motor insulation exists if special measures are not taken. IGBT based PWM (pulse width modulated) drives generate high voltage spikes due to their high carrier frequencies and the short rise-time of their pulsed outputs.

In response to these concerns, Siemens has conducted research and testing to better understand the voltage stress environment in which our insulation system is expected to perform. The insulation system offered in the RGZESDI is designed and manufactured to operate with a variable frequency drive (VFD) for long motor life, high reliability, and superior performance.

UNDERSTANDING IGBT DRIVES

IGBT's have become the preferred power-switching device in modern drives because of their low cost and relative ease of manufacture. In addition, their high switching speed reduces losses while creating better motor current waveforms and improved overall dynamic performance as compared to earlier technologies. Most conventional voltage source VFD's rectify the sinusoidal AC voltage provided by the power utility and use switches (IGBTs) to create a pulse width modulated output (PWM). The drive sends out a train of rectangular shaped pulses to the motor via the motor lead cables. The height of the pulses is equal to the DC bus voltage.

Their widths and spacing, however, are varied or modulated in such a way as to provide an effective voltage similar to a sinusoidal voltage of the desired magnitude and frequency.

The drive sends out these pulses at a rate equal to the control carrier frequency. Modern VFD's typically utilize carrier frequencies in a range from 2-20 kHz meaning that the drive may be sending out as many as 20,000 pulses per second.

IGBTs used to produce these voltage pulses have very short turn on and turn off times and therefore, the pulses have very short rise and fall times. Rise time is defined in NEMA MG 1 Part 30 as the time required for the pulse to go from 10% to 90% of its steady state value. Today's VFD's produce pulses with rise times as low as .05 microseconds.

Voltage Spikes or Overshoots: Because of the IGBT's rapid rise time, a transient over-voltage of twice the DC bus voltage (or higher under unusual conditions) can occur each time a pulse reaches the motor terminals.

Several variables can affect the magnitude of the transient over-voltage including pulse rise time and magnitude; spacing of pulses; cable length; and motor and cable surge impedance. Installations having relatively small drives on long cables require added precautions, not only to assure the motor insulation is not over-stressed, but to also assure proper operation of the inverter.

Neutral Shift: Neutral shift is the voltage difference between the three-phase power source neutral of the VFD and the motor neutral. Its magnitude is a function of the total system design. The result of neutral shift is higher than normal line to ground voltages at the motor. In the case of typical voltage source drive, it can be as high as the DC bus voltage value, even without considering transient over-voltages.

Including transient over-voltages, the motor may be exposed to a peak line to ground voltage of 1.5 to 2 times the DC bus voltage. (Refer to NEMA MG1-Part 31.4.4.4.)

The RGZESDI Insulation System
Random-wound motor insulation components consist of stator wire insulation, phase insulation, slot or ground insulation, and impregnating varnish. These components must be carefully chosen for motors intended for use with adjustable speed drives, because of the factors outlined earlier. The RGZESDI motor uses an insulation system suitable for most common VFD applications.

Turn Insulation: As stated earlier, transient over-voltages can elevate the motor line-to-line voltage as high as twice the control DC bus voltage. The steep-fronted nature (rapid rise time or dv/dt) of these pulses cause them to be unevenly distributed throughout the winding. Thus, the first coil is exposed to higher voltages than the rest of the winding. This is why motors that are improperly applied to VFD's can be expected to fail most often across this first coil.

Unfortunately, with random windings, the first and last turn in a coil are sometimes placed near one another in the slot. This causes the entire coil voltage to be present between these two adjacent wires. When two conductors have a voltage between them, it becomes distributed within the insulation and in the air between their surfaces. If the voltage gradient in the air space between these conductors is beyond a certain critical value, a luminous discharge will take place due to the ionization of air. This discharge is known as corona (partial discharge). The critical voltage at which corona begins to take place is known as the corona inception voltage CIV. In order to obtain long motor service life, corona must be avoided as much as possible. However, simply avoiding corona is not enough to assure long life. Siemens has collected extensive data regarding the voltage pulse endurance characteristics of various magnet wire insulations, along with a detailed understanding of how the voltage pulses are distributed throughout the motor.

Armed with this information our engineers have designed the RGZESDI using a winding layout and wire type such that the expected voltage between any two wires is safely below a value that would result in unacceptable insulation life.

There are several insulation enhancements in the RGZESDI that offer reliable performance in inverter applications. Among them are improved wire film; optimized spacing of the insulation; low operating temperature; and use of our unique non-hygroscopic insulation system for superior resistance to the effects of humidity. Small air bubbles in the insulation have been nearly eliminated and crevices between adjacent turns have been minimized during varnishing. Siemens quality processes minimize the likelihood for these areas to become sites for partial discharges and accelerated insulation failure.

Phase Insulation: Phase insulation consists of slot center insulation and phase barrier insulation. The slot center insulation separates the top and bottom coils in a two layer three-phase winding. The phase barrier insulation is inserted between coils belonging to different phases in the winding end turns. Because of the high phase-to-phase voltages that are possible during operation from a PWM control, the thickness of these components has been increased over that utilized for sine wave operation.

Slot or ground insulation: As discussed earlier because of neutral shift and transient over-voltages, the ground insulation can be more severely stressed in VFD than in sine wave applications. For this reason ground insulation thickness has also been increased.

NEMA MG1-Part 31.4.4.2.

NEMA MG1, Parts 30 and 31 outline motor capabilities when used with VFD's for motors rated 600 volts or less. Part 30 requires that standard motors utilize an insulation system able to endure repeated voltage peaks of up to 1000 volts with rise times of 2 or more microseconds. Part 31 defines an inverter duty motor as having an insulation system able to withstand peaks of 3.1 times rated voltage with rise times of 0.1 or more microsecond.
The RGZESDI motor, specially designed for inverter duty applications, exceeds the insulation criteria specified NEMA MG 1, Part 31 and can be specified when a superior insulation is needed. As a manufacturer of both variable speed drives and AC motors, Siemens has a superior understanding of their collective operation, application, and performance.

MOTOR DESIGN

For a motor to be reliable in inverter duty applications it should be designed to keep internal operating temperatures at a minimum. Rotors should be free from voids to minimize current-flow resistance and excess heat generation.

The Siemens 4-Quadrant fin cooling design maximizes heat dissipation, and fans and blowers have been optimized for reliable ventilation. Tight tolerances and good mechanical contact guarantee thermal contact to external cooling surfaces. A built-in thermostat acts as an added measure against heat buildup or inadequate cooling.

The mechanical features of the RGZESDI make certain the motor will perform in the most demanding applications. Low vibration, cast iron construction - including cast iron inner bearing caps on all frame sizes - and Siemens dedication to quality, assure that every RGZESDI will provide reliable operation used with modern inverter power.

APPLICATION CONSIDERATIONS

- **Leave the commissioning of the VFD/motor combination to experienced startup personnel.**
- **Connect the thermostat leads to the control or alarm circuit of the VFD or control circuit.**
- **Connect the blower (if so equipped) per the wiring diagram supplied with the blower motor.**
- **Connect the encoder (if so equipped) per the wiring diagram supplied with the encoder.**
- **Refer any special applications (high or low ambient, high cyclic loading, special voltage or frequency, etc.) to Siemens.**
- **Specify an inverter with a carrier frequency selectable to a minimum of 3 KHz.**
- **Read the instruction manual supplied with the motor and VFD before applying power to the combination.**
- **Do not operate RGZESDI motors beyond 1.0 service factor on inverter power.**
- **Obtain the consent of Siemens Warranty Administration before performing any repair during the first 36 months of operation.**
- **Do not place power factor correction capacitors between the motor and VFD.**
- **Do not exceed speed parameters specified on the motor nameplate.**
- **Do not utilize excessively long cable lengths between the drive and motor. (See guidelines below.)**

Output Reactors/Cable Considerations

The output reactor is especially used to limit additional current spikes caused by the cable capacitances when long cables are used, i.e., it:

- Reduces the charge current spikes for long cables
- Reduces the voltage rate-of-change dv/dt at the motor terminals.

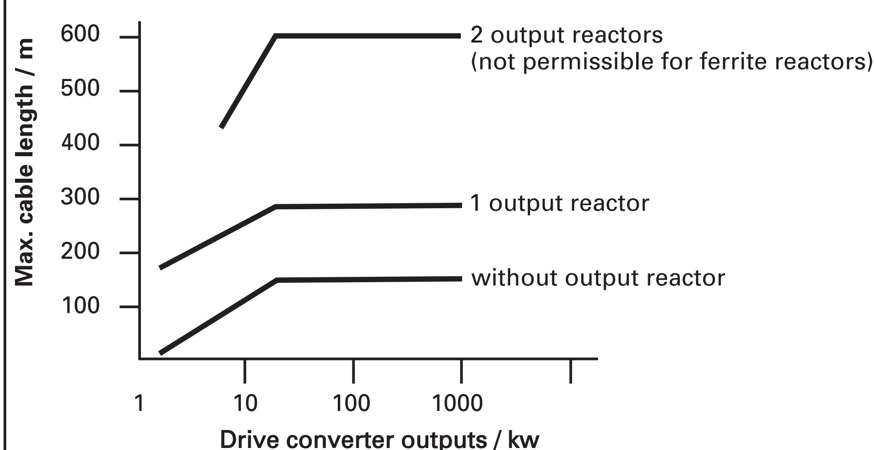
It does **not** reduce the magnitude of the transient voltage spikes at the motor terminals.

NOTE

The specified lengths are valid for unshielded cables; for shielded cables, these values must be reduced to 2/3.

If several motors are connected to a drive converter, the sum of the cables lengths of all the motor feeder cables must be less than the permissible cable length.

Output reactor design



Permissible cable lengths with and without output reactors

Refer to Performance Curves

The attached curves are provided to determine the suitability of type RGZESDI for applications with pulse width modulated (PWM) variable frequency drives. These curves apply only to Siemens type RGZESDI motors listed in Selection and Pricing Guide NMSP-L0700A. If the desired motor cannot be selected from the curves provided, refer the application to Siemens. Explosion proof motors can be applied in accordance to the curves on pages 30 and 31.

Information Needed for Motor Selection

Operating Speed Range: Minimum and maximum speeds must be determined prior to the selection of the motor. If operation is required above base speed (60 hertz rated speed), first ensure that constant horsepower (CHP) speeds are not exceeded.

Type of Load: Select from Variable Torque, Constant Torque, or Constant Horsepower.

The purpose of the calculations below is to determine pull-up torque and pull-up speed and plot these points on the curves provided. If these points fall beneath the curves, then acceptable application results.

$$\text{Speed}_L = \frac{\text{actual RPM}}{\text{nameplate RPM}}$$

$$\text{Torque}_L = \frac{\text{actual torque}}{\text{rated torque}} = \frac{\text{actual HP}}{\text{rated HP}}$$

$$\text{Rated torque} = \frac{\text{nameplate HP X 5252}}{\text{nameplate RPM}}$$

Constant Horsepower

For constant horsepower loads, the torque is proportional to the speed. The equation to calculate pull-up torque is:

$$= \frac{(\text{pull-up RPM}_{old}) \text{ X } (\text{pull-up torque}_{old})}{(\text{pull-up RPM}_{new})}$$

Calculate torque for each of the known speed points and plot these points on the attached graphs. If any point falls above the curve, the motor will overheat when used with a variable frequency drive for the type of load identified.

Constant Torque

For constant torque loads, where the calculated value of pull-up torque can be used for all speeds.

Example 1 - Constant Torque Loads

- *4 pole*
- *100 horsepower*
- *Constant torque to 20 Hz speed*
- *84 HP at nameplate RPM*
  (see curves page 17)

Point 1
1800 RPM @ 60 Hz

$$\text{Torque} = \frac{84}{100} \times 295 = 248$$

Point 2
600 RPM @ 20 Hz

Torque still 248

Since both points fall beneath the curve for a 4 pole 100 hp motor, this motor will function properly under VFD power for the application described.

Variable Torque

For variable torque loads, the torque is proportional to the square of the speed. The equation to calculate pull-up torque is:

$$= \frac{(\text{RPM}_{new})^2 \text{ X } (\text{Torque}_{old})}{(\text{RPM}_{old})^2}$$

Example 2 - Variable Torque

- *6 pole*
- *50 horsepower*
- *100 lb-ft load torque at 1180 RPM*
- *Variable torque down to zero speed*
  (see curves page 22)

Since torque varies as a square of the speed, only the highest speed point needs to be checked.

$$\text{Hz}_L = \frac{\text{actual RPM} \times 60}{\text{nameplate RPM}} = \frac{1180 \times 60}{1180} = 60$$

$$\text{Rated torque} = \frac{(\text{rated HP})\text{X}(5252)}{\text{rated RPM}} =$$

$$= \frac{(50)\ (5252)}{1180} = 223$$

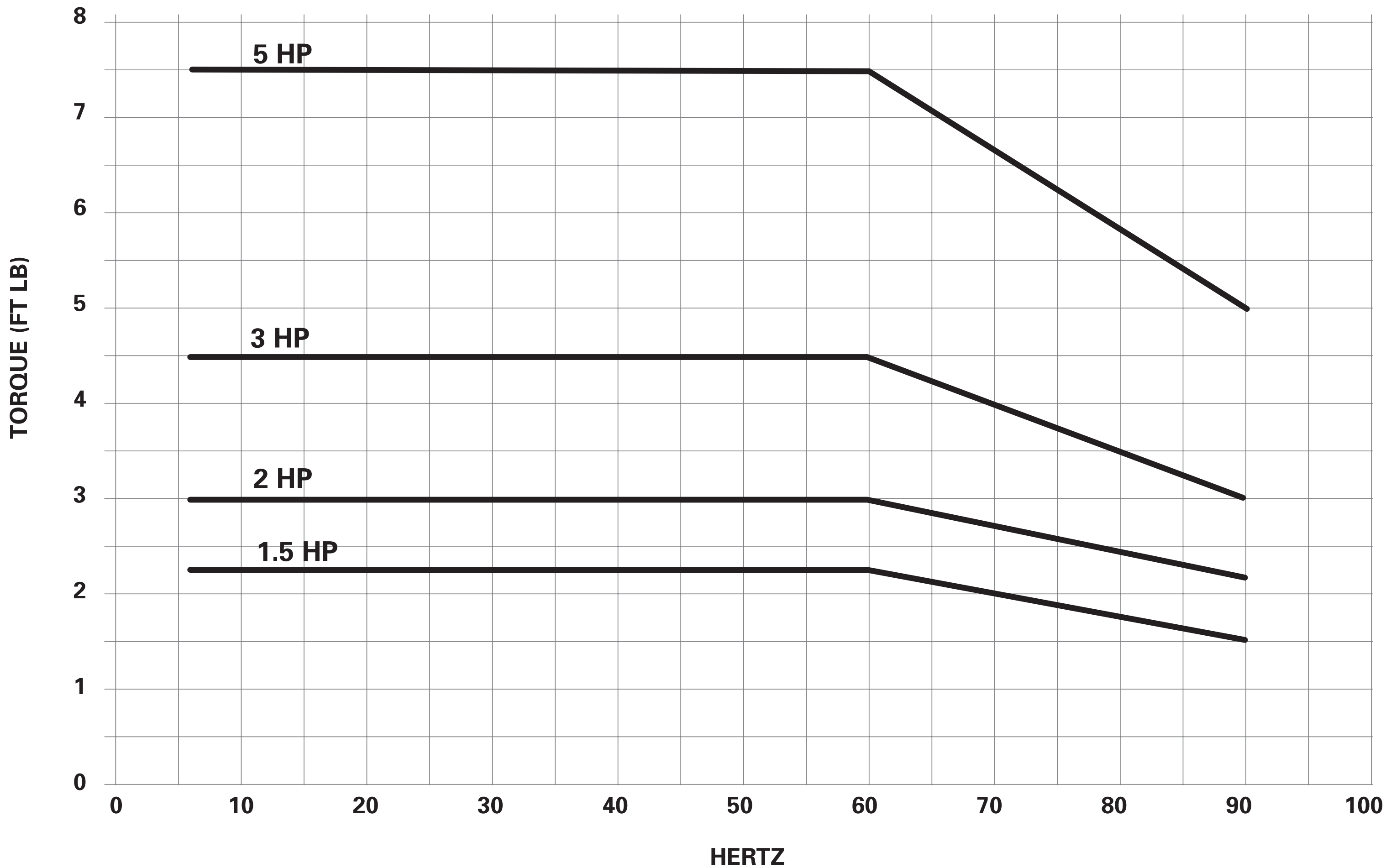
$$\text{Torque}_L = \frac{\text{actual}}{\text{torque}} = 100 \text{ lb-ft}$$

Since the highest speed point on this variable torque falls beneath the line, this motor will function properly under VFD power for the application described.

2-Pole
1.5 - 5 HP

INTERMITTENT OPERATION
Suitable for 150% of this torque
FOR ONE MINUTE MAXIMUM

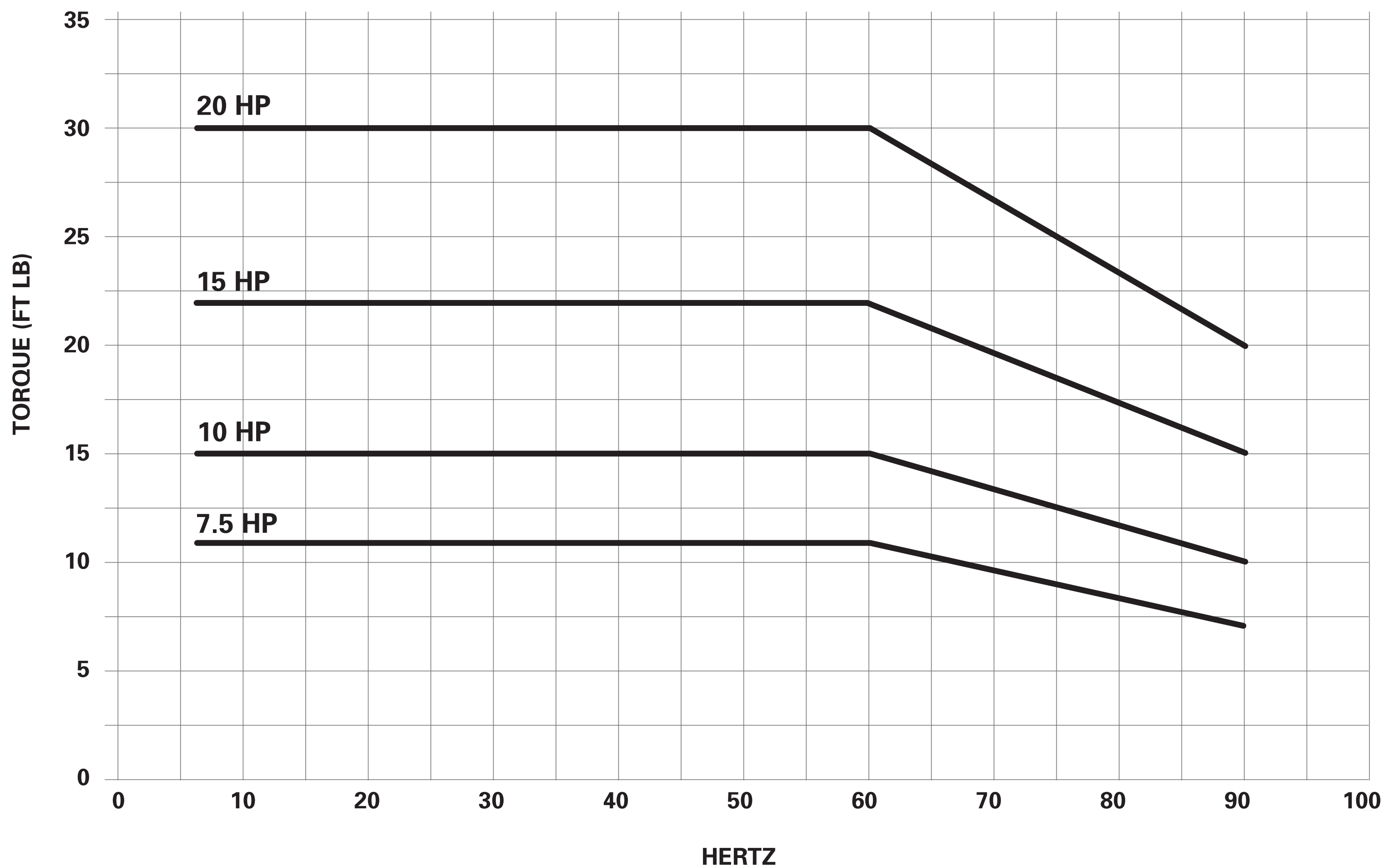
TORQUE vs FREQUENCY



2-Pole
7.5 - 20 HP

INTERMITTENT OPERATION
Suitable for 150% of this torque
FOR ONE MINUTE MAXIMUM

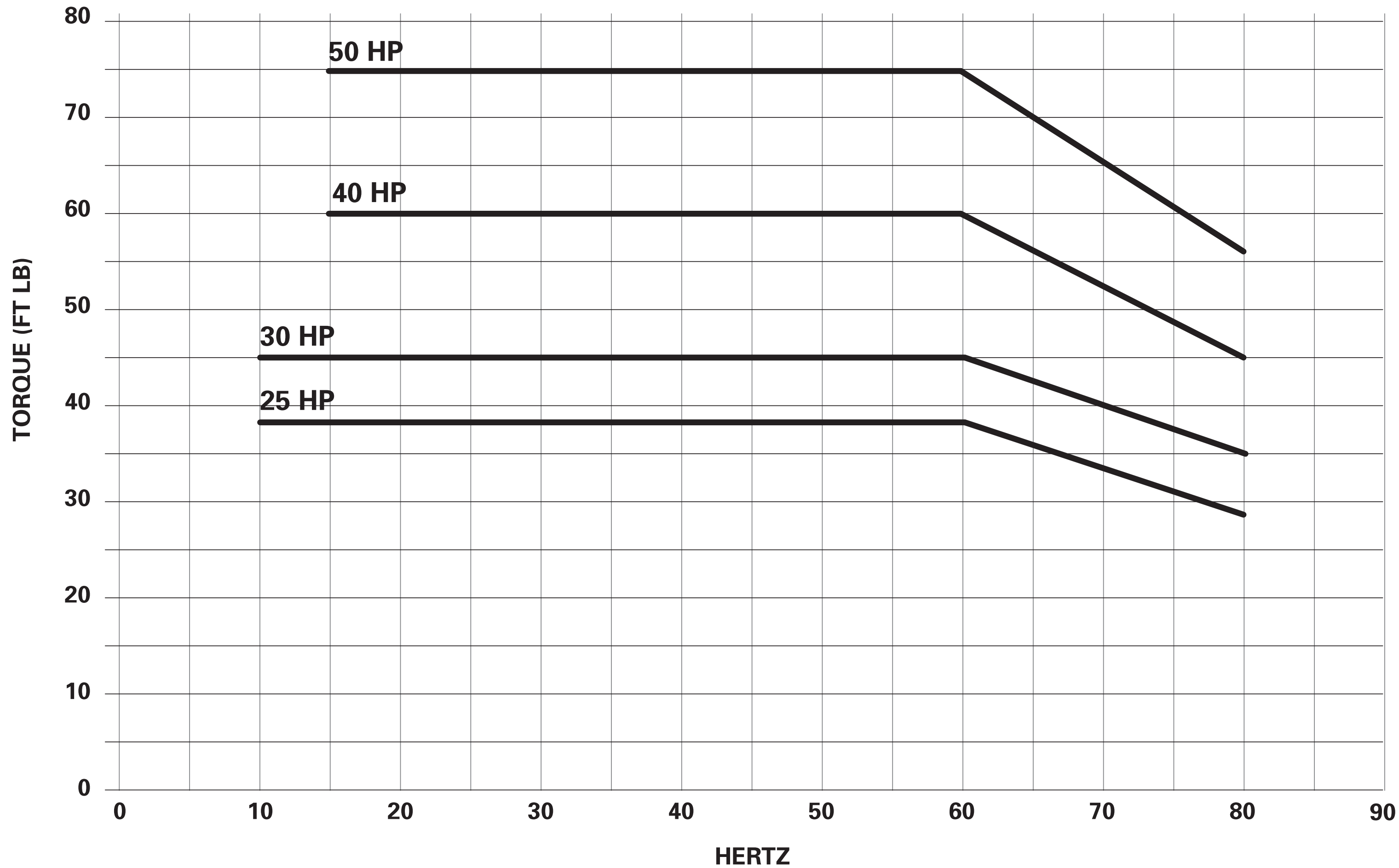
TORQUE vs FREQUENCY



2-Pole
25 - 50 HP

INTERMITTENT OPERATION
Suitable for 150% of this torque
FOR ONE MINUTE MAXIMUM

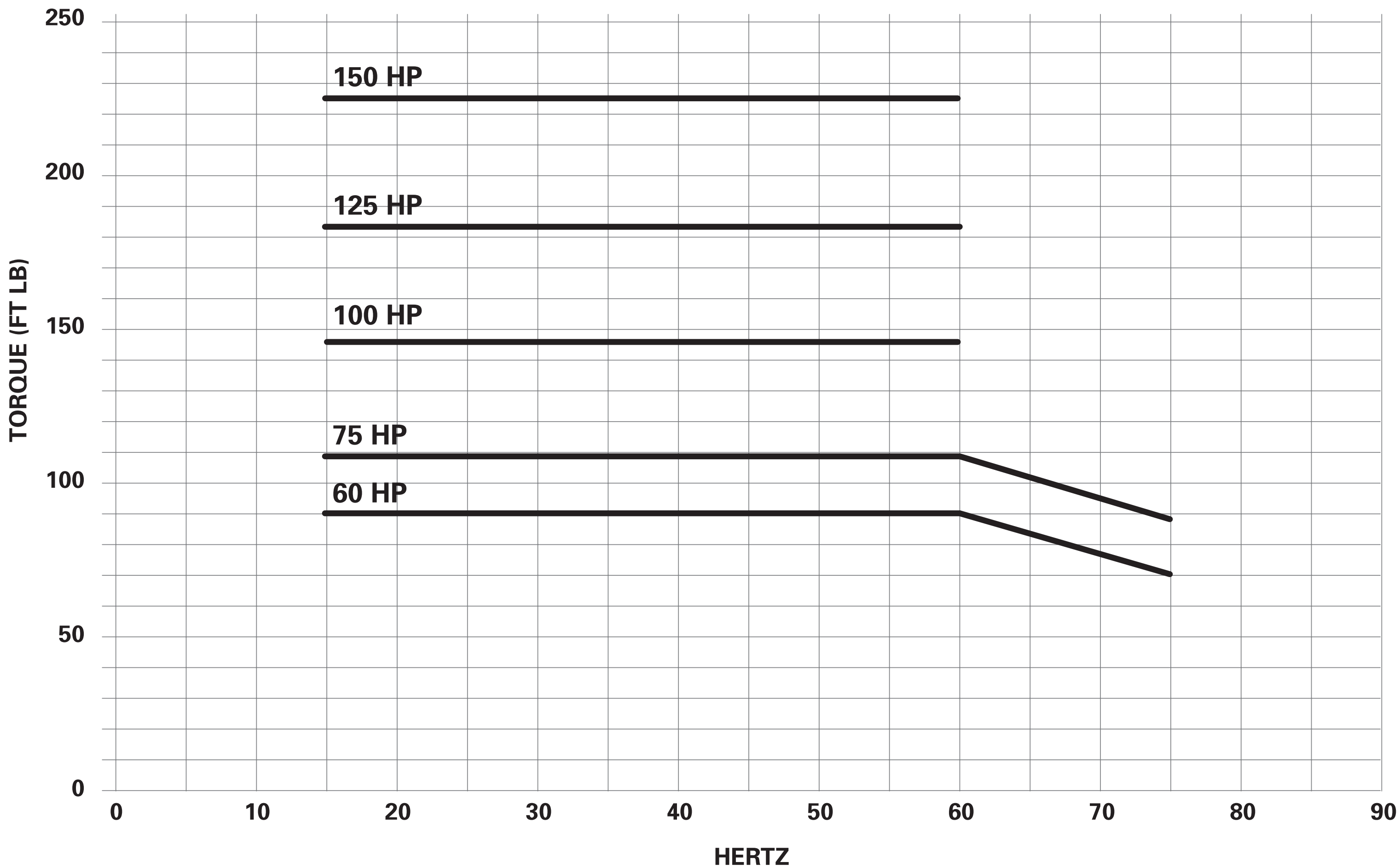
TORQUE vs FREQUENCY



2-Pole
60 - 150 HP

INTERMITTENT OPERATION
Suitable for 150% of this torque
FOR ONE MINUTE MAXIMUM

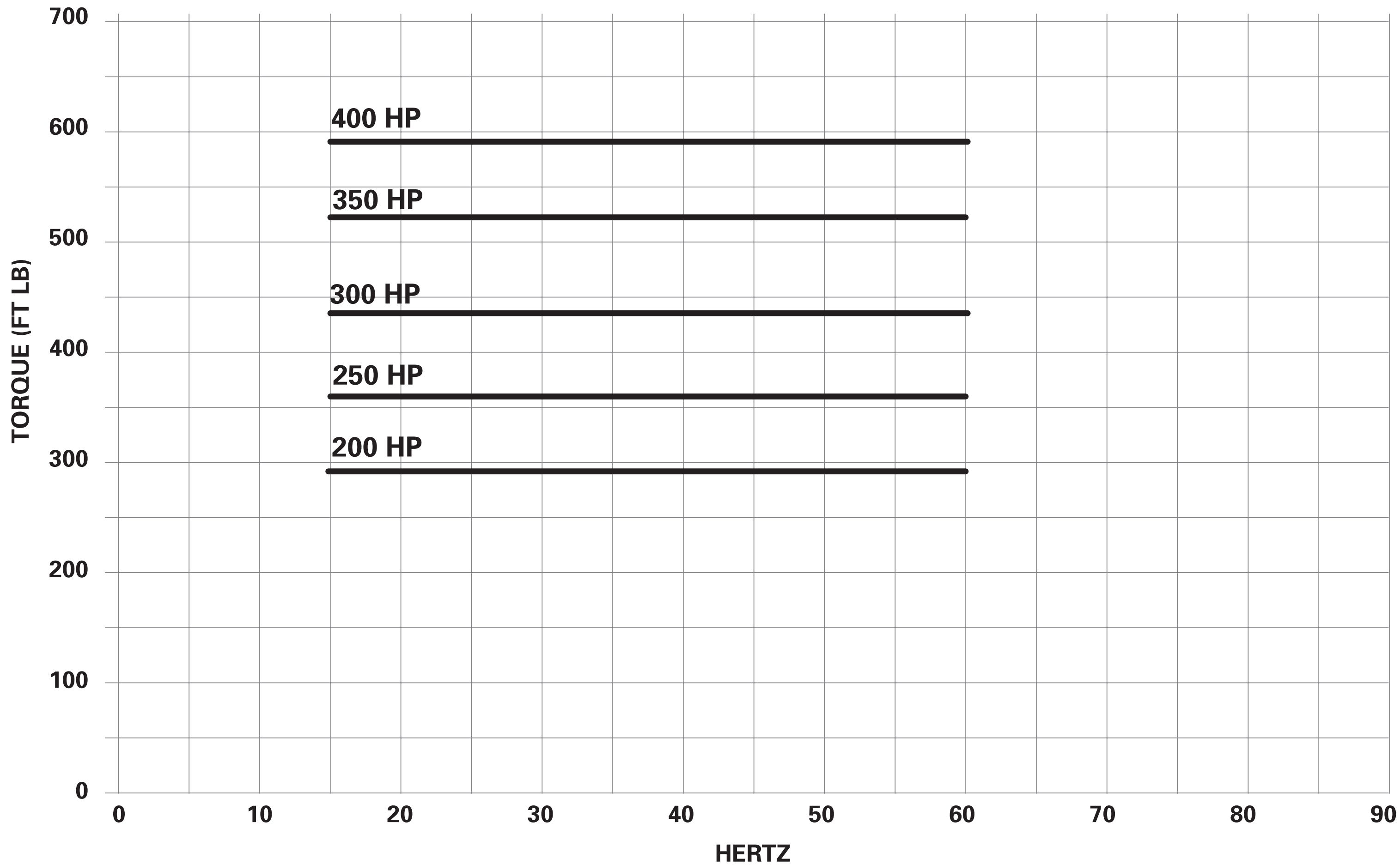
TORQUE vs FREQUENCY



2-Pole
200 - 400 HP

INTERMITTENT OPERATION
Suitable for 150% of this torque
FOR ONE MINUTE MAXIMUM

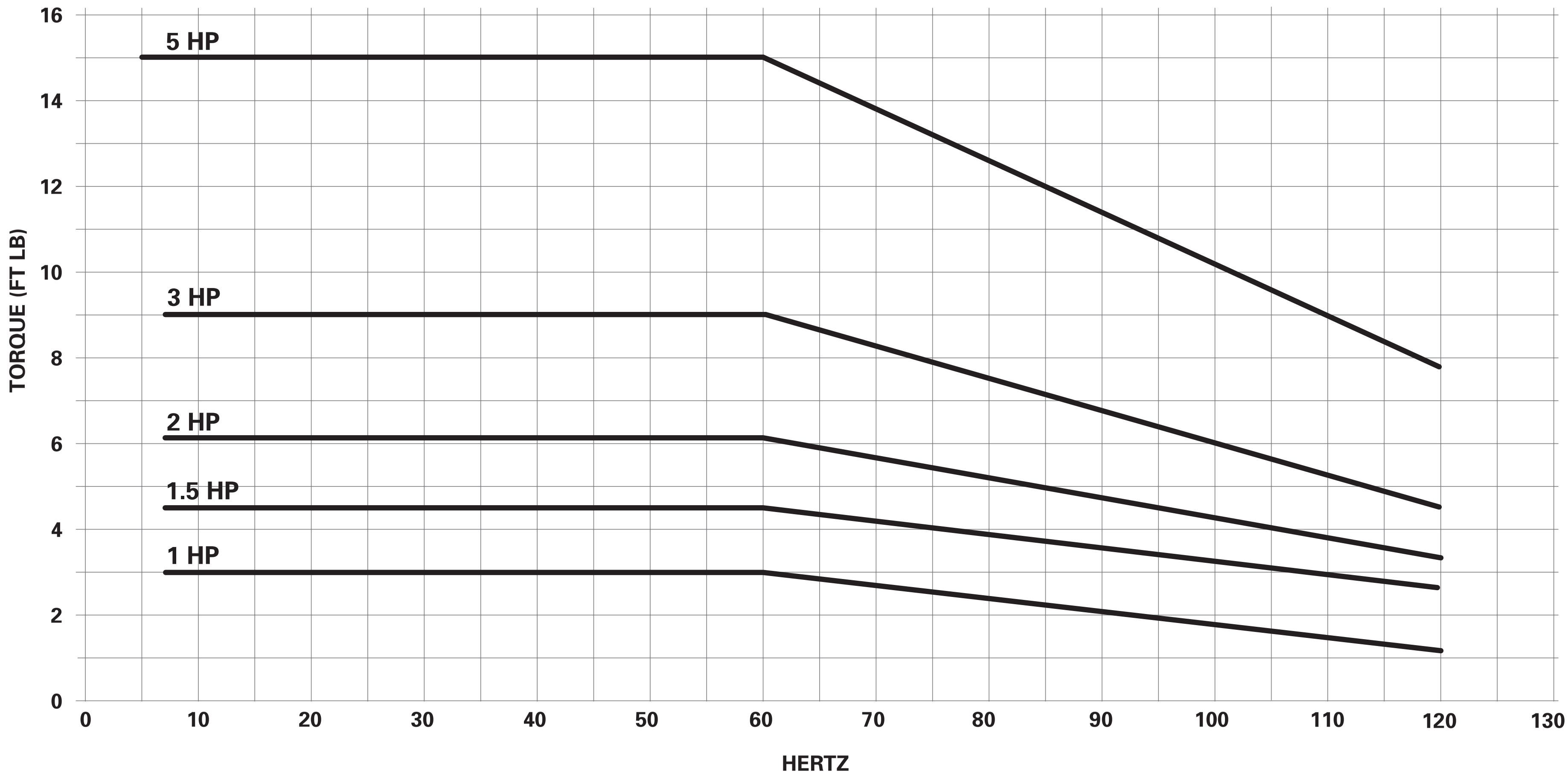
TORQUE vs FREQUENCY



4-Pole
1-5 HP

INTERMITTENT OPERATION
Suitable for 150% of this torque
FOR ONE MINUTE MAXIMUM

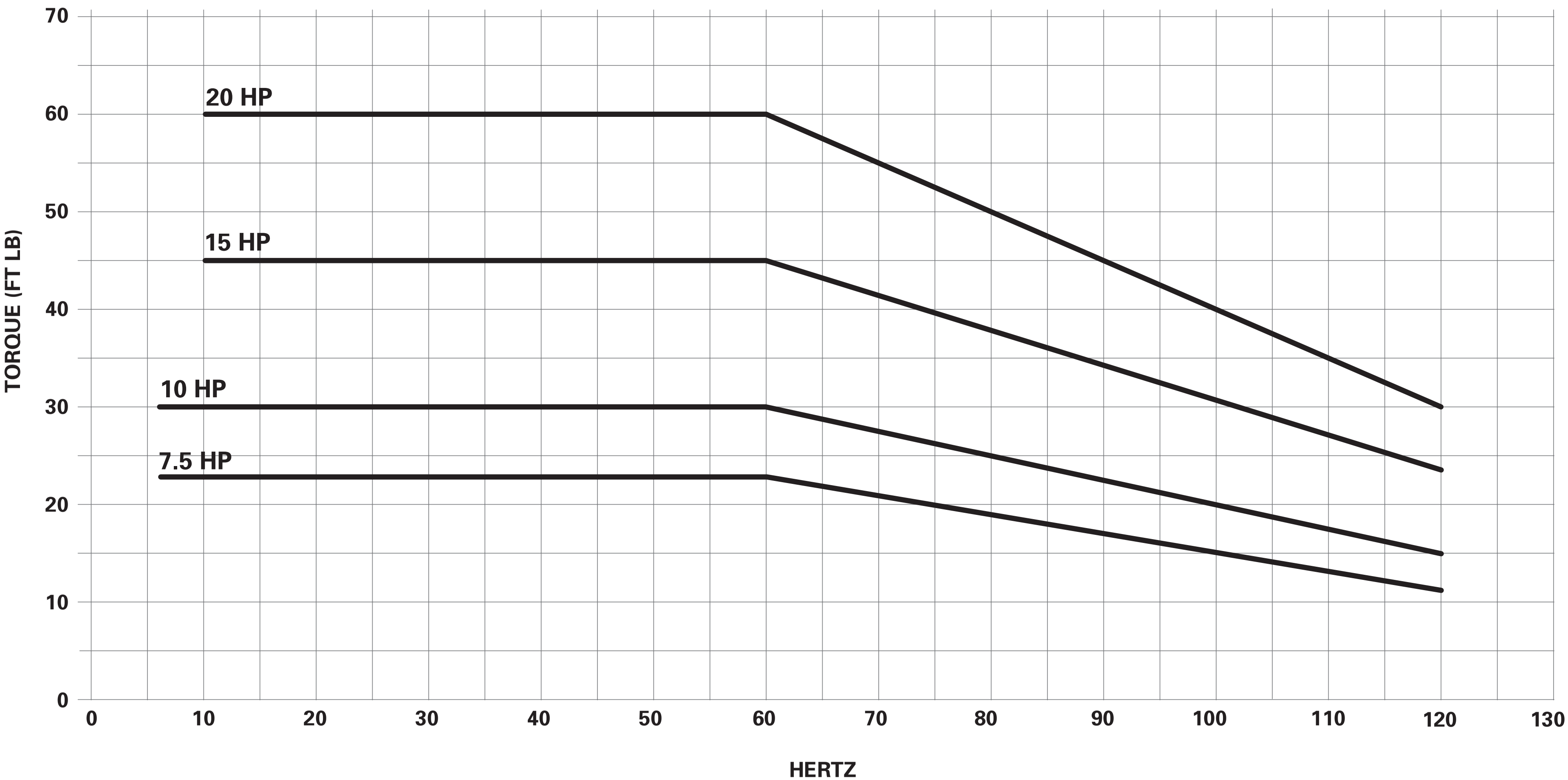
TORQUE vs FREQUENCY



4-Pole
7.5-20 HP

INTERMITTENT OPERATION
Suitable for 150% of this torque
FOR ONE MINUTE MAXIMUM

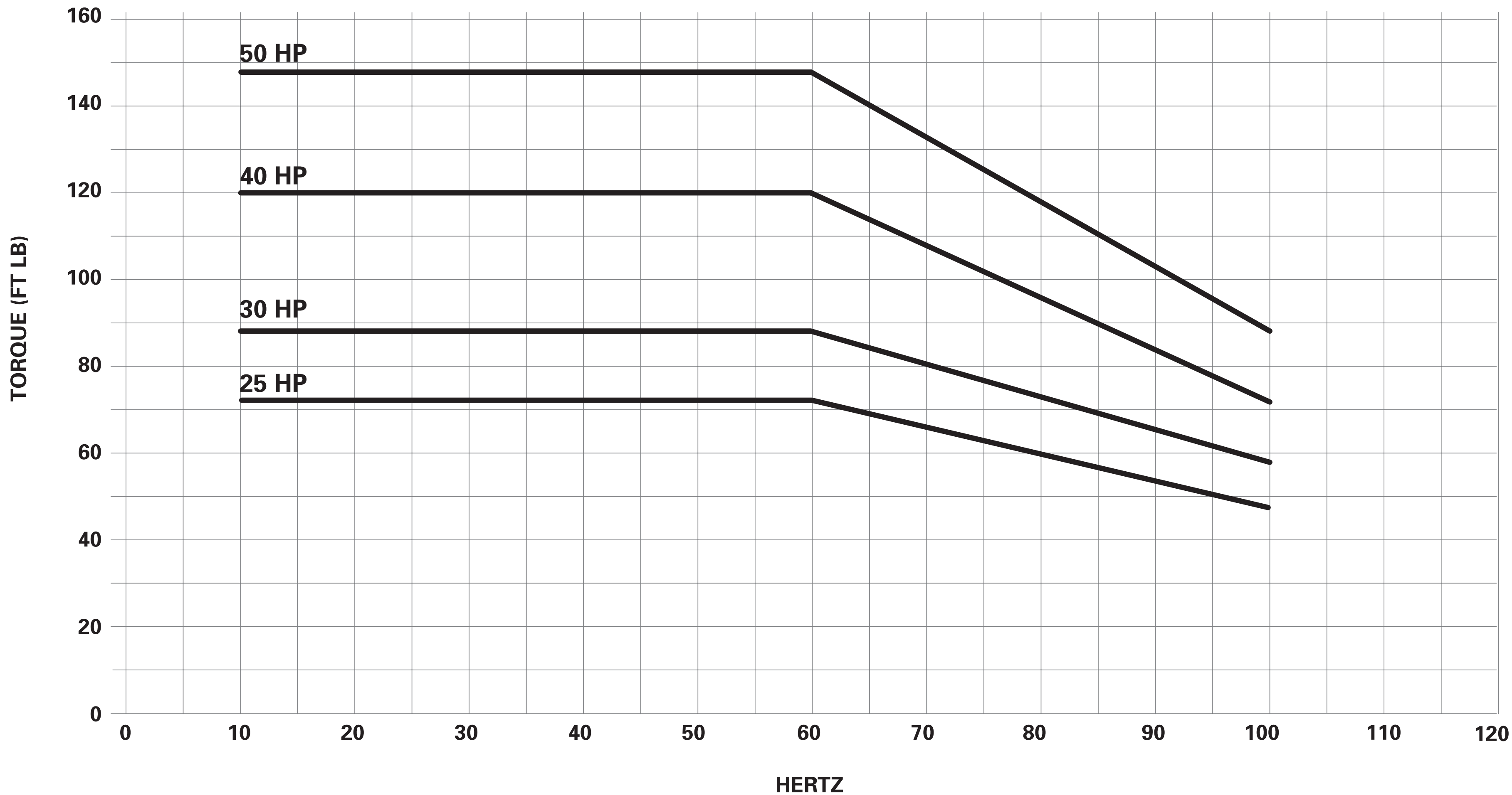
TORQUE vs FREQUENCY



4-Pole
25-50 HP

INTERMITTENT OPERATION
Suitable for 150% of this torque
FOR ONE MINUTE MAXIMUM

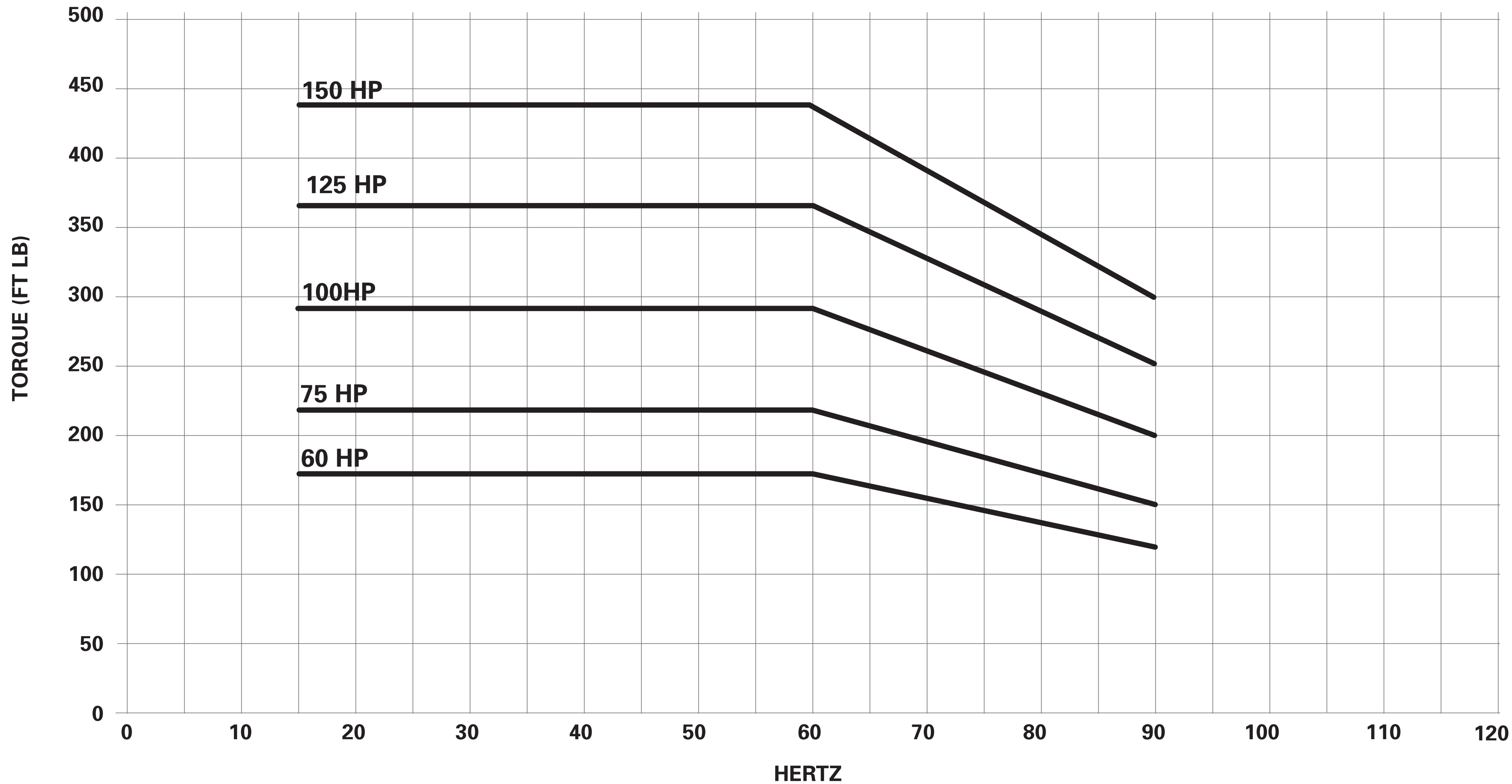
TORQUE vs FREQUENCY



4-Pole
60-150 HP

INTERMITTENT OPERATION
Suitable for 150% of this torque
FOR ONE MINUTE MAXIMUM

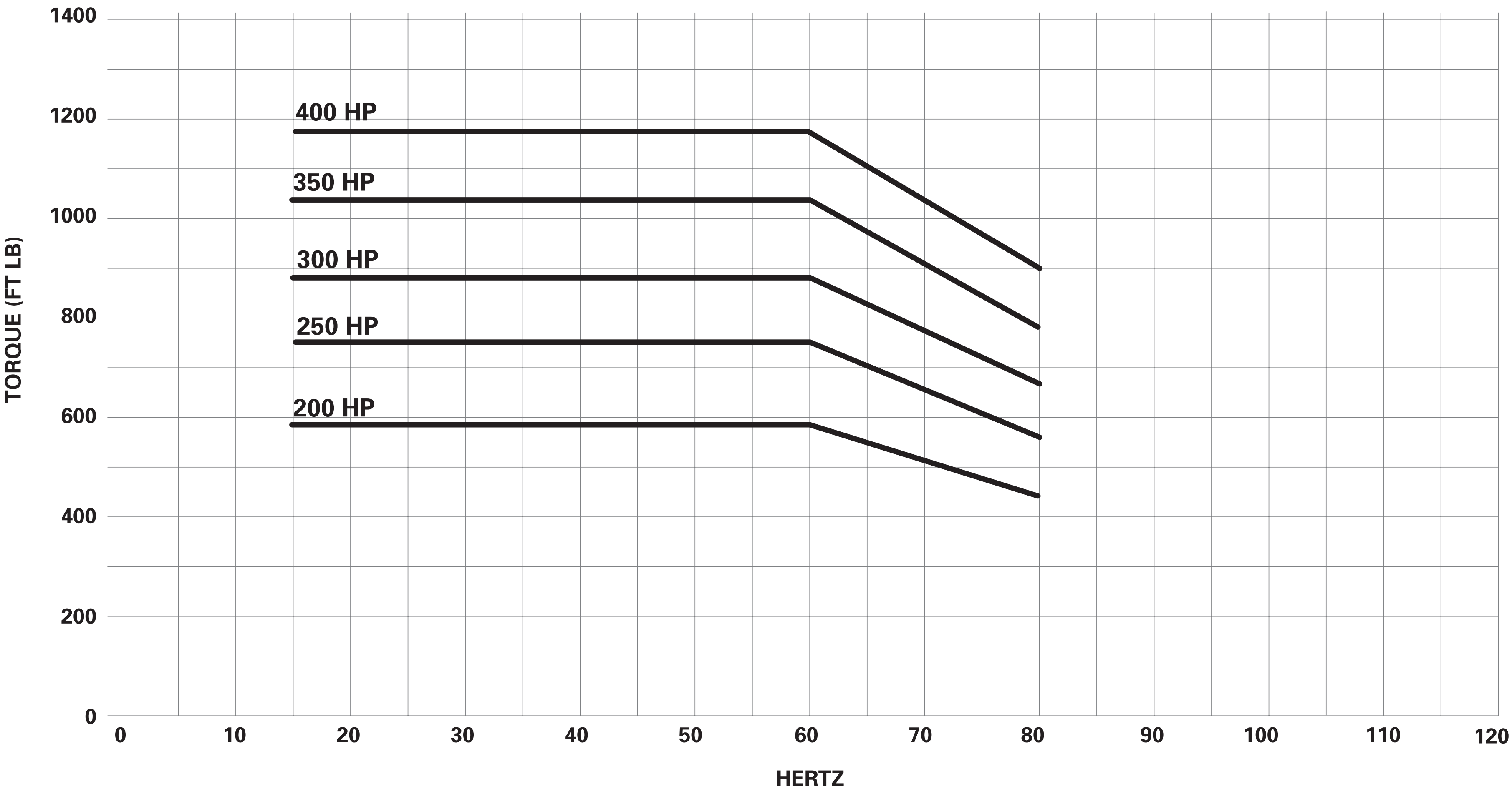
TORQUE vs FREQUENCY



4-Pole
200 - 400 HP

INTERMITTENT OPERATION
Suitable for 150% of this torque
FOR ONE MINUTE MAXIMUM

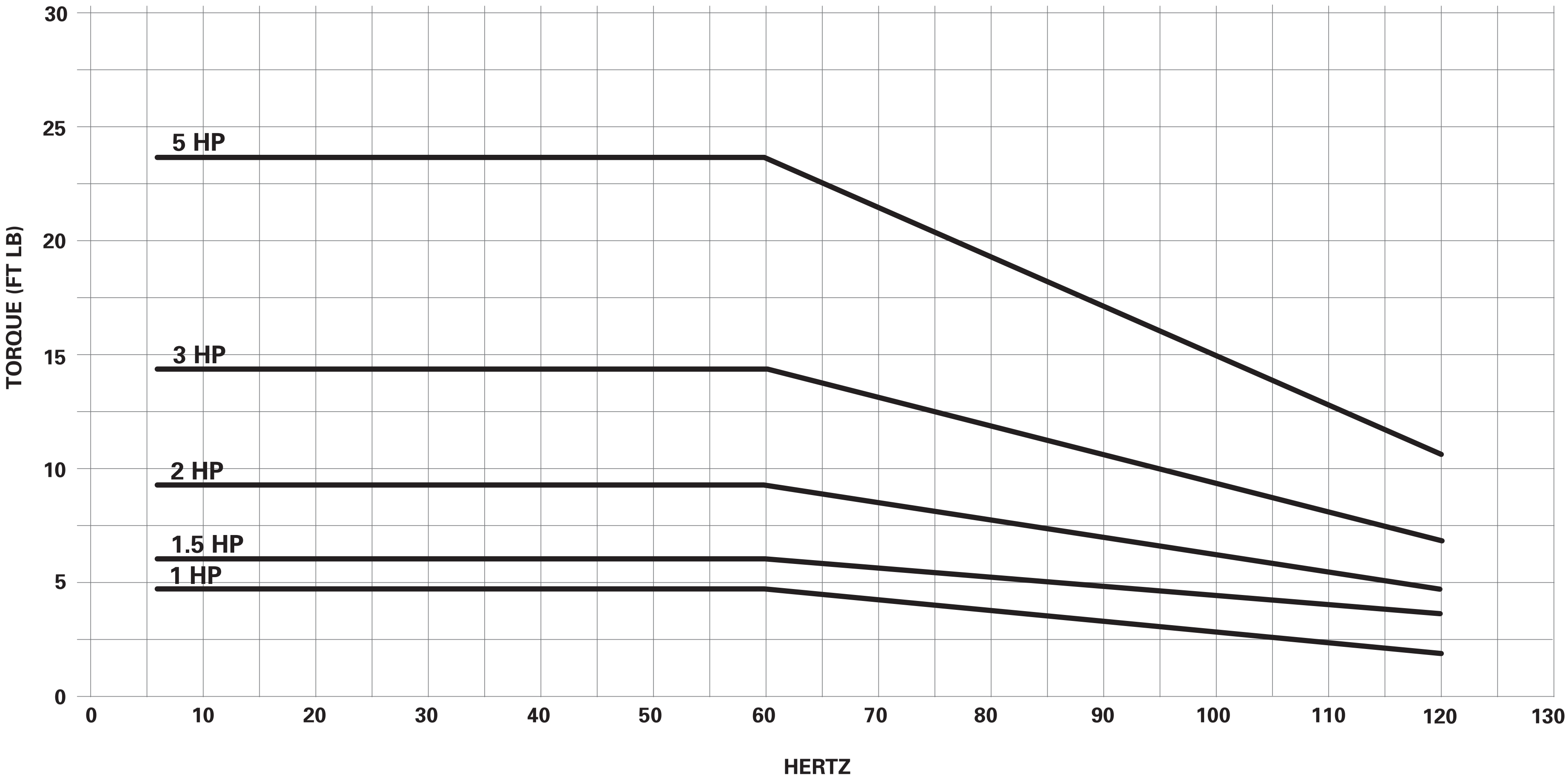
TORQUE vs FREQUENCY



6-Pole
1-5 HP

INTERMITTENT OPERATION
Suitable for 150% of this torque
FOR ONE MINUTE MAXIMUM

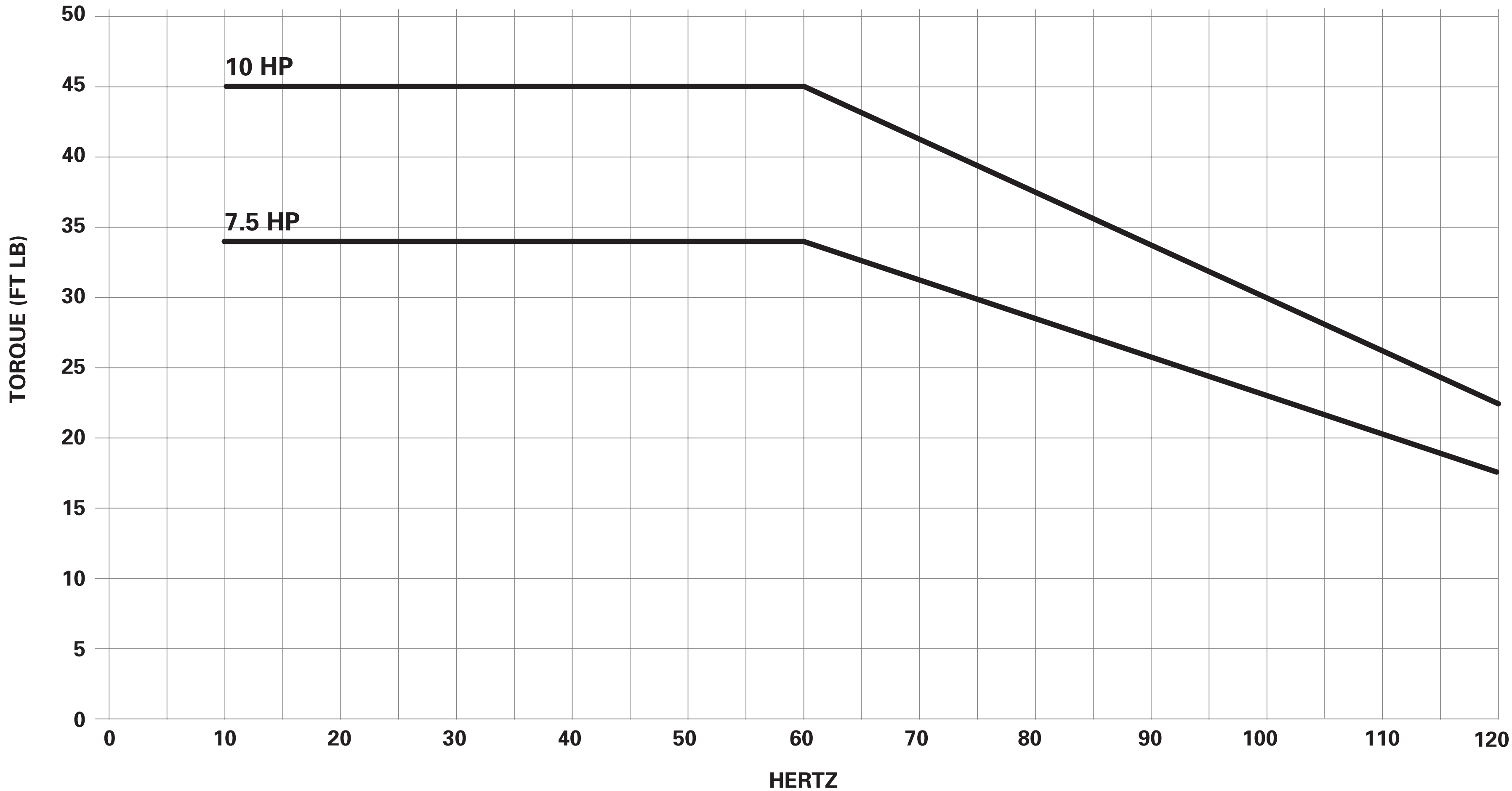
TORQUE vs FREQUENCY



6-Pole
7.5 - 10 HP

INTERMITTENT OPERATION
Suitable for 150% of this torque
FOR ONE MINUTE MAXIMUM

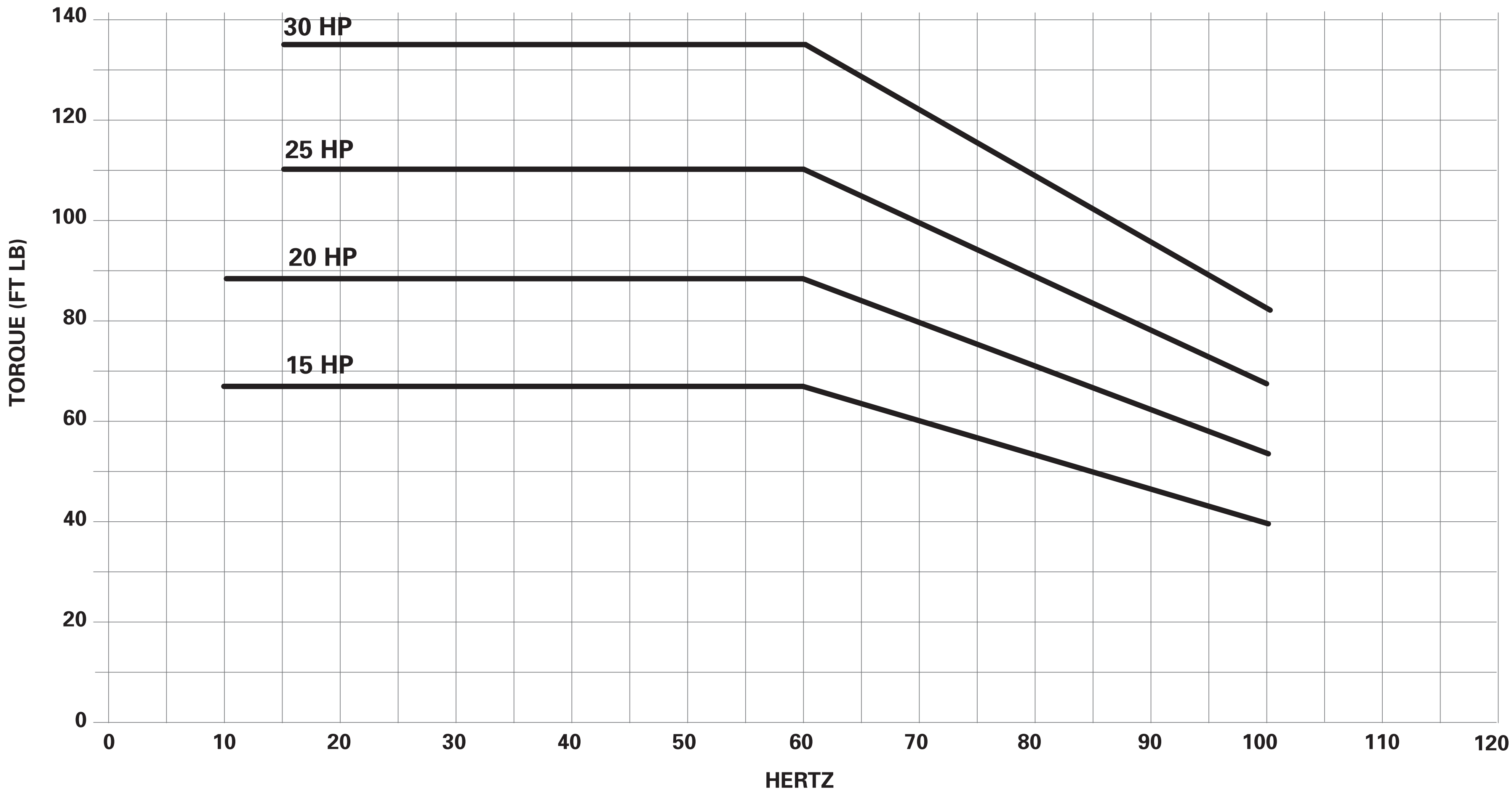
TORQUE vs FREQUENCY



6-Pole
15 - 30 HP

INTERMITTENT OPERATION
Suitable for 150% of this torque
FOR ONE MINUTE MAXIMUM

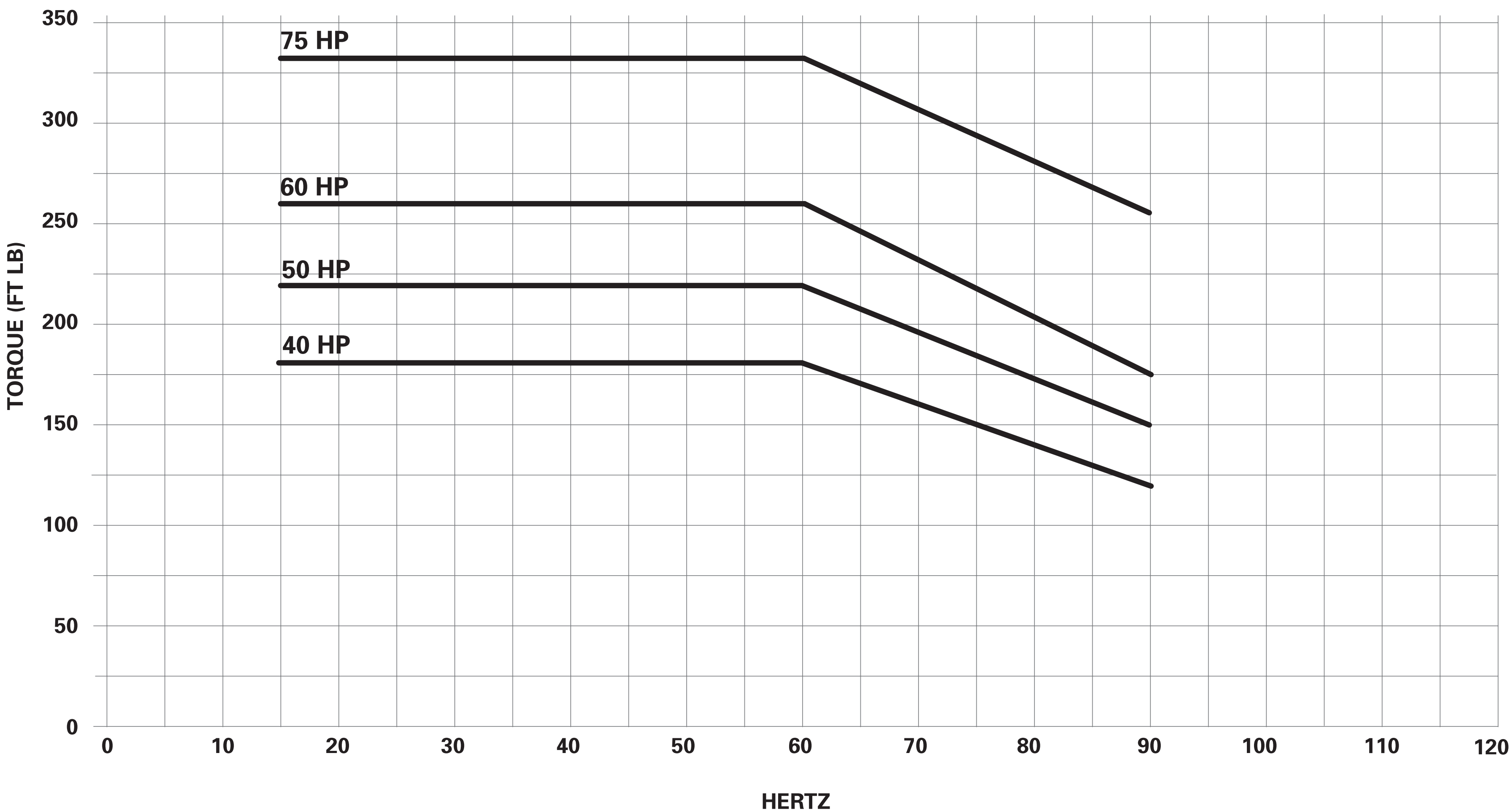
TORQUE vs FREQUENCY

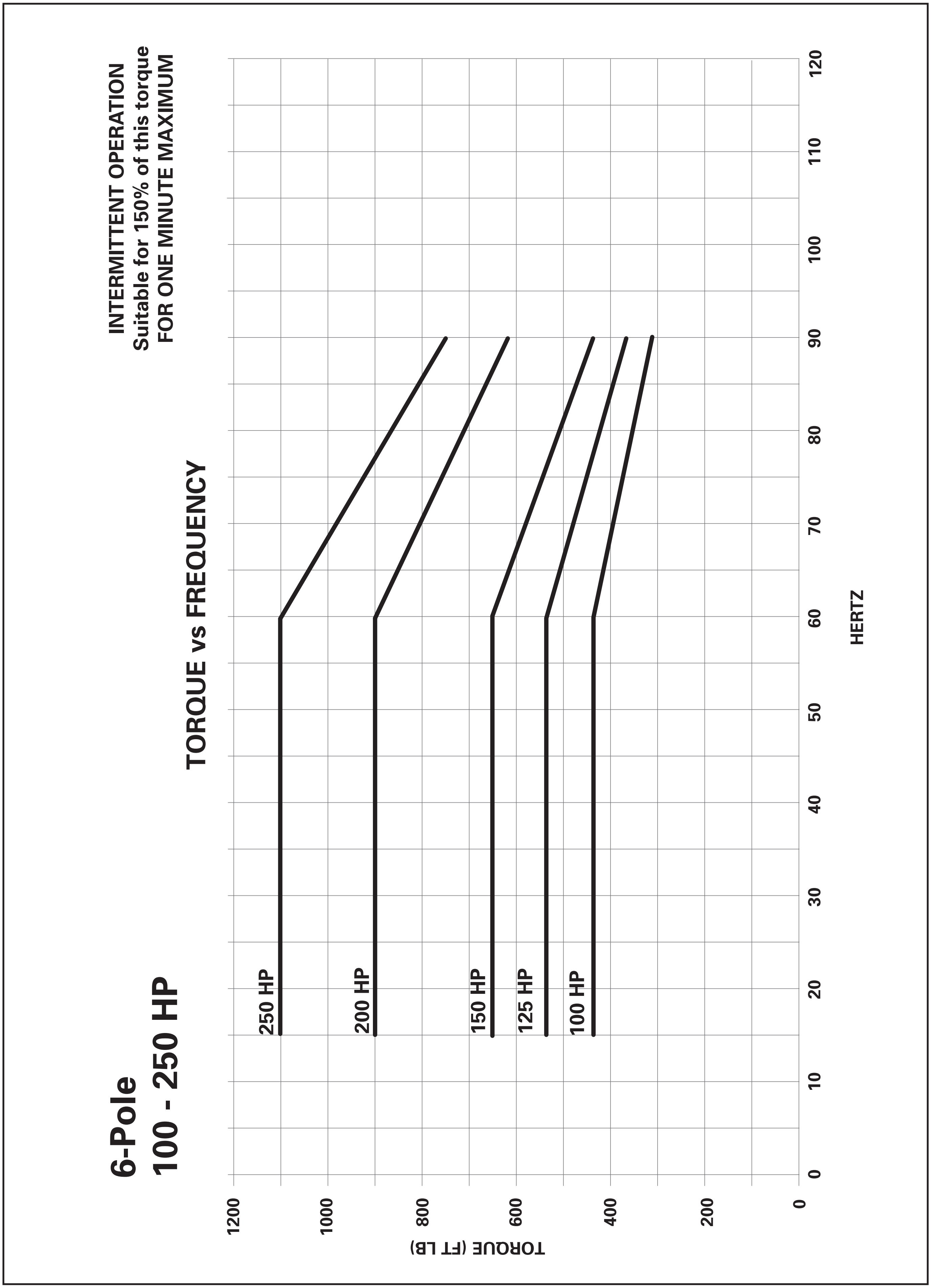


6-Pole
40 - 75 HP

INTERMITTENT OPERATION
Suitable for 150% of this torque
FOR ONE MINUTE MAXIMUM

TORQUE vs FREQUENCY

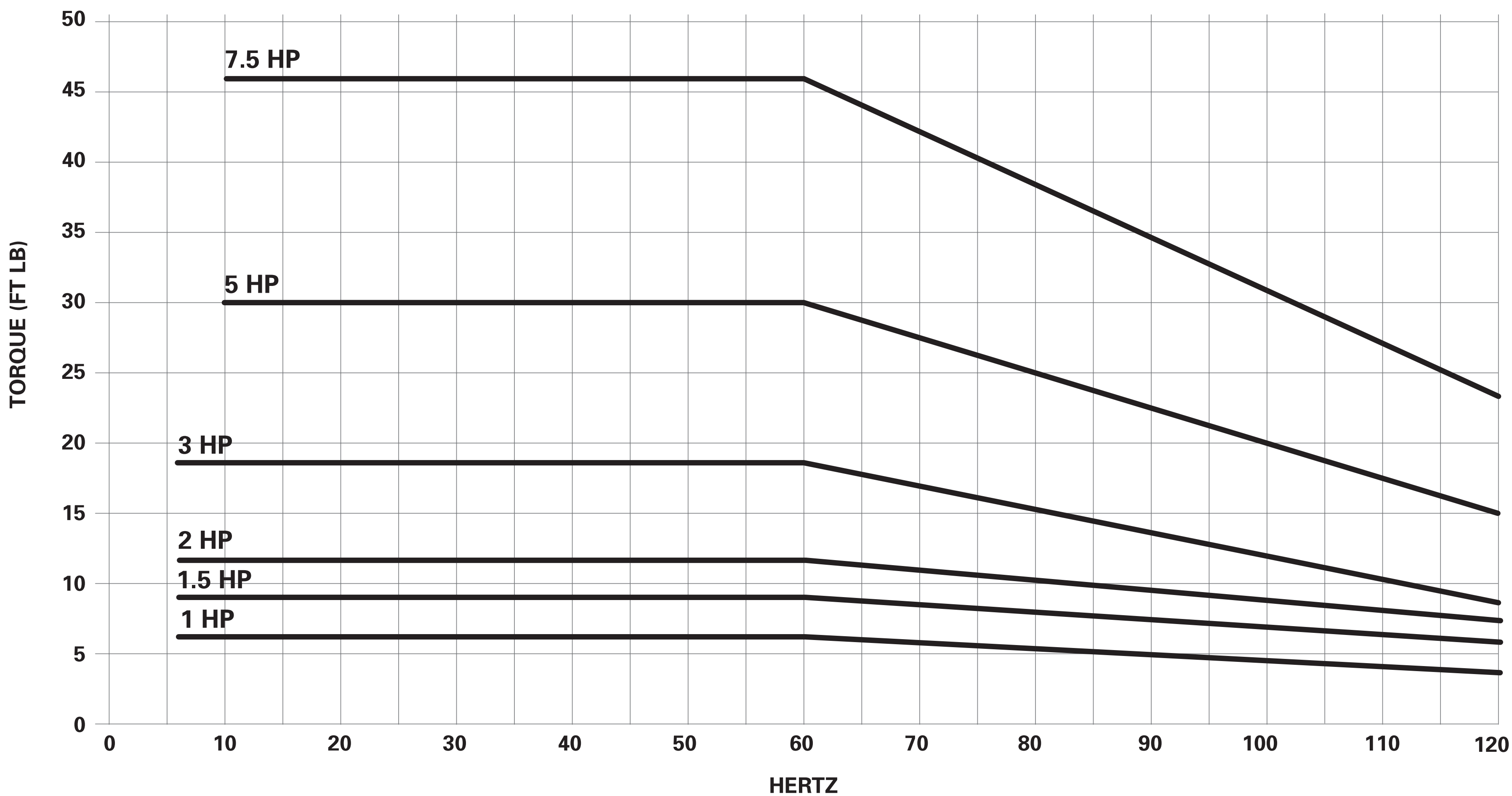



6-Pole
100 - 250 HP
TORQUE vs FREQUENCY
INTERMITTENT OPERATION
Suitable for 150% of this torque
FOR ONE MINUTE MAXIMUM
250 HP
200 HP
150 HP
125 HP
100 HP
TORQUE (FT LB)
1200
1000
800
600
400
200
0
HERTZ
0
10
20
30
40
50
60
70
80
90
100
110
120

8-Pole
1 - 7.5 HP

INTERMITTENT OPERATION
Suitable for 150% of this torque
FOR ONE MINUTE MAXIMUM

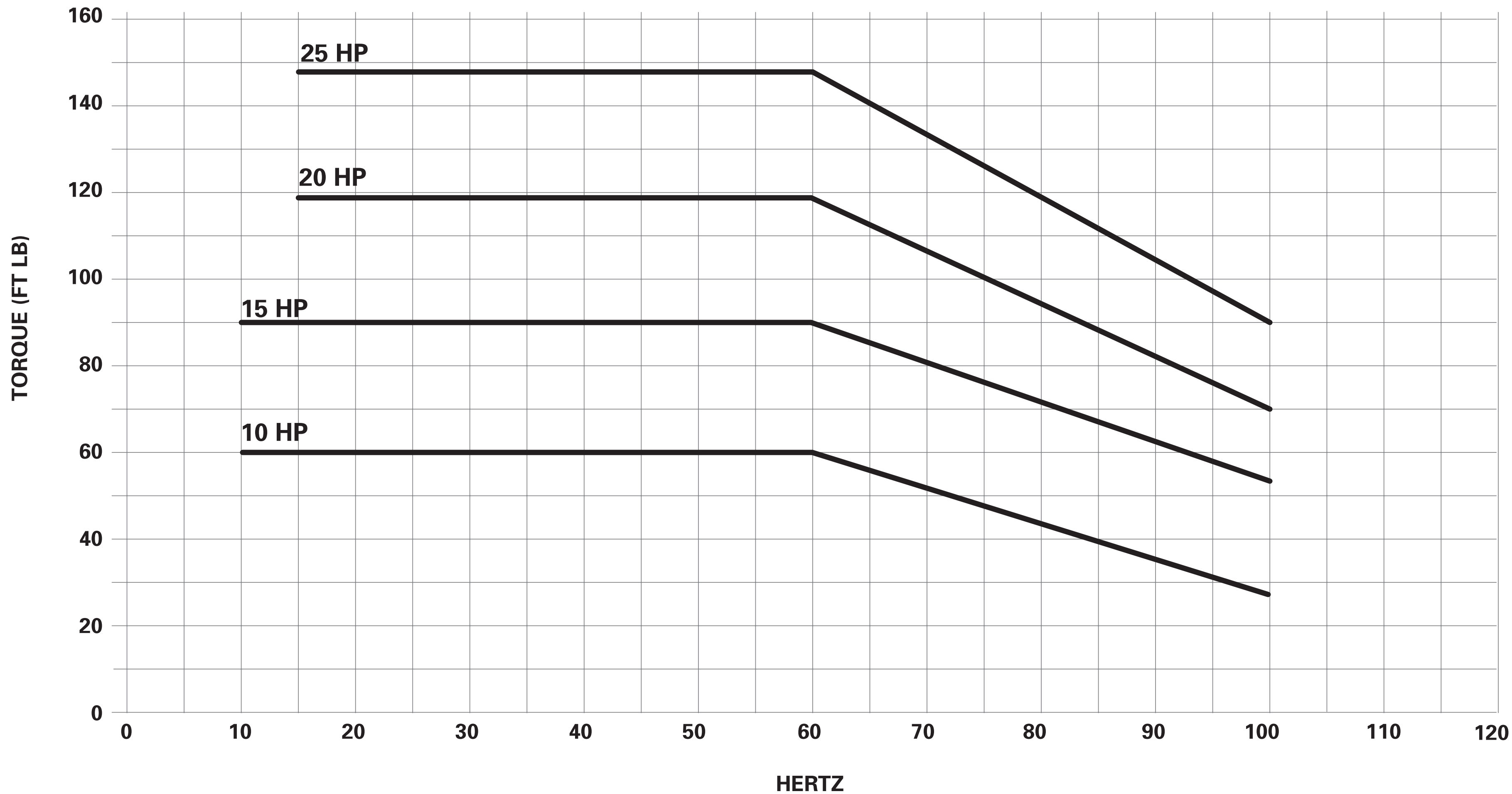
TORQUE vs FREQUENCY



8-Pole
10-25 HP

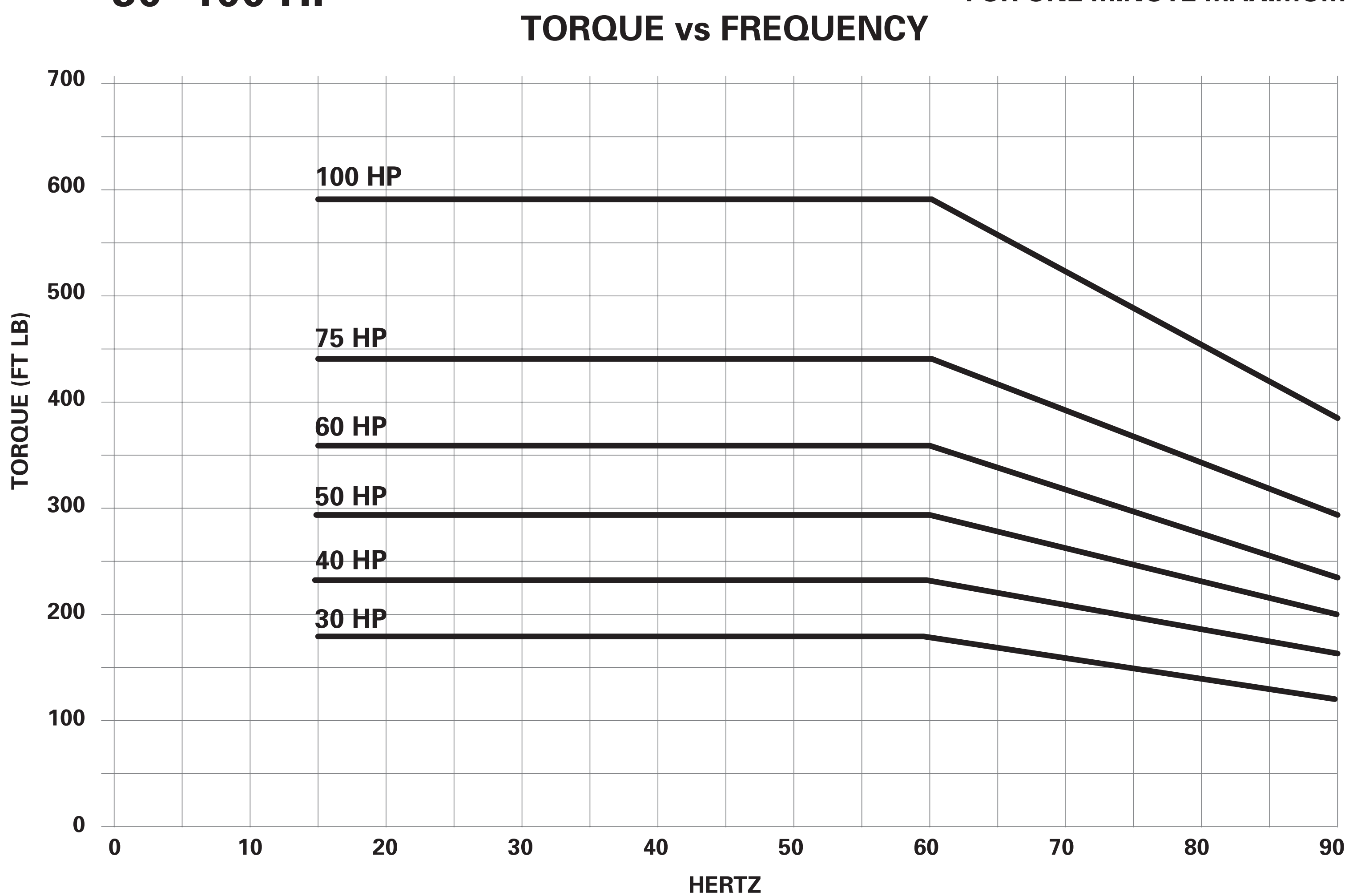
INTERMITTENT OPERATION
Suitable for 150% of this torque
FOR ONE MINUTE MAXIMUM

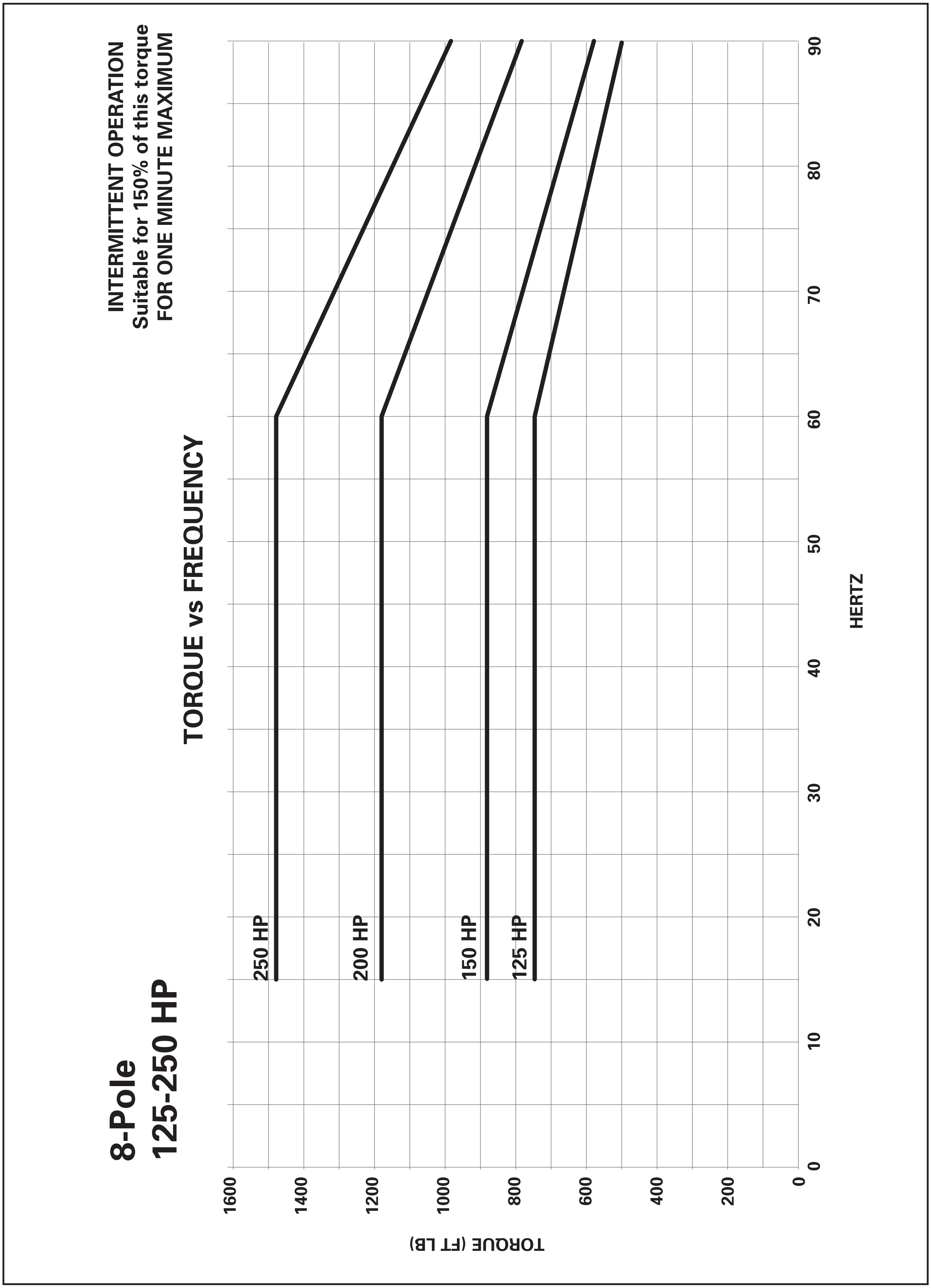
TORQUE vs FREQUENCY



8-Pole
30 -100 HP

INTERMITTENT OPERATION
Suitable for 150% of this torque
FOR ONE MINUTE MAXIMUM




8-Pole
125-250 HP
TORQUE vs FREQUENCY
INTERMITTENT OPERATION
Suitable for 150% of this torque
FOR ONE MINUTE MAXIMUM
250 HP
200 HP
150 HP
125 HP
TORQUE (FT LB)
1600
1400
1200
1000
800
600
400
200
0
HERTZ
0
10
20
30
40
50
60
70
80
90

Type RGZESDI Inverter Duty, Three Phase

Variable Torque Zero to Base Speed / Constant Torque Premium Efficiency

HP	RPM	Frame	Const. Torque Speed Range	FL RPM	F.L. Amps @ 460	NL Amps @ 460V	Nom. F.L. Eff.	F.L. Torque	Max. Torque Const. HP	Max. RPM Const. HP	Hp @ Min. Const. Torque	Ohms/Ph (Y equiv.) Circuit Parameters-25 degrees C X1	X2	XM	R1	R2
1	1800	143T	10:1	1745	1.5	1.1	82.5	3.0	1.5	3490	0.071	7.33	8.02	306	9.45	5.85
	1200	145T	10:1	1140	1.8	1.3	80.0	4.6	2.3	2280	0.053	7.47	6.54	214	12.50	8.68
	900	182T	10:1	860	1.9	1.2	78.5	6.1	3.1	1760	0.030	12.28	17.15	297	15.68	12.28
1.5	3600	143T	10:1	3485	2.0	0.9	82.5	2.3	1.2	5225	0.110	6.87	3.18	372	6.40	4.52
	1800	145T	10:1	1740	2.2	1.4	84.0	4.5	2.3	3480	0.103	4.94	5.27	199	6.98	4.37
	1200	182T	10:1	1160	2.3	1.5	85.5	6.8	3.4	2320	0.104	5.22	9.40	185	6.28	4.54
	900	184T	10:1	860	2.6	1.8	80.0	9.2	4.6	1760	0.09	8.31	12.02	202	8.31	12.08
2	3600	145T	10:1	3495	2.5	1.1	84.0	3.0	1.5	5240	0.146	4.87	2.45	286	4.59	3.56
	1800	145T	10:1	1735	2.9	1.9	84.0	6.1	3.0	3470	0.146	3.80	4.16	165	5.05	3.56
	1200	184T	10:1	1160	3.0	1.9	86.5	9.1	4.5	2320	0.139	3.59	7.37	145	4.26	3.43
	900	213T	10:1	865	3.3	2.2	82.5	12.0	6.0	1765	0.13	7.53	6.74	147	7.46	5.13
3	3600	182T	10:1	3510	3.6	1.7	86.5	4.5	2.3	5265	0.231	4.34	2.21	193	2.84	2.02
	1800	182T	10:1	1740	3.9	1.8	87.5	9.1	4.5	3480	0.208	2.98	4.54	146	3.13	2.62
	1200	213T	10:1	1165	4.0	2.3	87.5	14.0	6.8	2330	0.230	3.24	4.57	130	3.25	1.73
	900	215T	10:1	865	4.7	3.1	84.0	18.0	9.0	1765	0.19	5.66	5.287	118	5.23	3.87
5	3600	184T	10:1	3490	5.8	1.8	87.5	7.5	3.8	5235	0.360	2.62	1.54	135	1.86	1.40
	1800	184T	10:1	1730	6.5	3.2	87.5	15	7.6	3460	0.310	1.71	2.70	84.2	1.85	1.64
	1200	215T	10:1	1160	6.8	3.3	88.5	23	11.3	2320	0.340	2.01	2.91	86.8	1.99	1.23
	900	254T	6:1	865	7.5	4.1	86.5	30	15.0	1765	0.66	4.09	4.80	68.4	1.46	1.99
7.5	3600	213T	10:1	3515	8.8	3.4	88.5	11	7.5	5270	0.590	2.08	1.46	83.6	1.20	0.71
	1800	213T	10:1	1750	9.5	4.2	89.5	23	11.3	3500	0.560	1.27	2.48	63.2	1.03	0.75
	1200	254T	6:1	1170	9.8	4.5	90.2	34	16.8	2340	1.090	1.66	1.89	54.3	0.82	0.58
	900	256T	6:1	865	12	6.6	87.5	46	23.0	1765	1.0	3.00	3.69	56.1	0.91	1.47
10	3600	215T	10:1	3505	12	4.0	89.5	15	10.0	5255	0.760	1.67	1.27	74.0	0.97	0.60
	1800	215T	10:1	1750	13	5.4	89.5	30	15.0	3500	0.740	0.99	1.98	49.6	0.82	0.61
	1200	256T	6:1	1165	13	10.0	90.2	45	22.5	2330	1.42	1.41	1.71	52.1	0.68	0.53
	900	284T	6:1	875	15	9.1	91.0	60	36.0	1475	1.4	2.02	2.44	34.6	0.65	0.49
15	3600	254T	6:1	3530	17	5.0	90.2	22	15.0	5295	2.25	1.33	1.03	57.6	0.390	0.310
	1800	254T	6:1	1760	19	7.3	91.7	45	22.4	3520	2.2	0.85	1.61	38.5	0.380	0.340
	1200	284T	6:1	1175	20	10	91.0	67	40.0	1955	2.2	1.00	1.11	26.3	0.400	0.240
	900	286T	6:1	875	23	14	91.0	90	54.0	1475	2.1	1.34	1.68	23.8	0.380	0.330
20	3600	256T	6:1	3525	23	7.4	90.2	30	19.9	5285	3.0	0.95	0.80	40.3	0.300	0.270
	1800	256T	6:1	1755	26	9.1	91.7	60	29.9	3510	2.9	0.60	1.26	30.7	0.260	0.260
	1200	286T	6:1	1175	26	12	91.7	89	54.0	1955	3.0	0.77	0.93	22.9	0.290	0.210
	900	324T	4:1	860	31	18	91.0	119	71.0	1480	4.6	1.15	1.68	14.8	0.23	0.193
25	3600	284TS	6:1	3525	29	8	91.7	37	24.9	4700	3.7	0.55	1.14	38.5	0.270	0.210
	1800	284T	6:1	1765	29	13	93.0	74	49.7	2940	3.8	0.55	0.88	22.8	0.190	0.180
	1200	324T	4:1	1180	33	15	92.4	111	67.0	1965	5.9	0.67	0.65	16.1	0.170	0.150
	900	326T	4:1	880	38	22	90.2	149	89.0	1480	7.0	0.95	1.41	12.6	0.174	0.159
30	3600	286TS	6:1	3525	34	10	91.7	45	29.8	4700	4.5	0.42	0.98	33.8	0.200	0.170
	1800	286T	6:1	1765	35	15	93.0	89	59.6	2940	4.5	0.44	0.75	20.3	0.150	0.150
	1200	326T	4:1	1180	39	19	92.4	134	80.0	1965	7.1	0.56	0.56	13.9	0.150	0.130
	900	364T	4:1	885	47	26	91.0	178	119.0	1335	7.1	0.77	1.15	9.65	0.144	0.083

HP	RPM	Frame	Speed Range	FLR PM	F.L. Amps @ 460	NL Amps @ 460V	Nom. F.L. Eff.	F.L. Torque	Max. Torque Const. HP	Max. RPM Const. HP	Hp @ Min. Const. Torque	Ohms/Ph (Y equiv.) Circuit Parameters-25 degrees C X1	X2	XM	R1	R2
40	3600	324TS	6:1	3530	45	12	93.6	60	47.7	4705	9.4	0.33	0.60	22.6	0.088	0.100
	1800	324T	4:1	1770	47	15	93.6	119	79.2	2940	9.5	0.38	0.67	18.5	0.110	0.100
	1200	364T	4:1	1180	52	24	93.6	178	119.0	1770	9.5	0.41	0.70	11.6	0.100	0.070
	900	365T	4:1	885	63	36	91.7	237	158.0	1335	9.5	0.56	0.87	7.2	0.094	0.061
50	3600	326TS	4:1	3530	55	15	93.6	74	59.6	4705	11.8	0.25	0.49	18.8	0.072	0.083
	1800	326T	4:1	1770	58	18	93.6	148	98.9	2950	11.9	0.31	0.54	15.8	0.082	0.082
	1200	365T	4:1	1180	66	30	93.6	223	148.0	1770	11.9	0.32	0.58	10.4	0.081	0.058
	900	404T	4:1	880	67	28	91.7	297	198	1330	11.6	0.49	0.82	10.2	0.079	0.071
60	3600	364TS	4:1	3565	68	19	93.6	89	89	4455	14.6	0.30	0.56	14.8	0.066	0.054
	1800	364T	4:1	1775	71	21	93.6	178	118	2660	14.4	0.30	0.46	11.6	0.066	0.051
	1200	404T	4:1	1185	74	26	94.1	266	177	1775	14.0	0.35	0.58	10.8	0.049	0.033
	900	404T	4:1	880	67	28	91.7	356	237	1330	11.6	0.49	0.82	10.2	0.079	0.071
75	3600	365TS	4:1	3565	85	22	94.1	111	111	4455	18.2	0.20	0.46	12.8	0.045	0.041
	1800	365T	4:1	1775	87	27	94.1	222	148	2660	18.0	0.23	0.37	9.2	0.051	0.041
	1200	405T	4:1	1185	93	34	94.5	332	222	1775	18.0	0.26	0.45	8.4	0.035	0.025
	900	444T	4:1	885	94	37	93.0	445	297	1335	17.8	0.27	0.47	7.8	0.050	0.044
100	3600	405TS	4:1	3570	108	19	94.1	147	147	3570	24.4	0.21	0.32	16.0	0.034	0.015
	1800	405T	4:1	1780	113	30	94.5	295	197	2670	24.2	0.20	0.37	9.6	0.028	0.016
	1200	444T	4:1	1185	117	38	94.5	443	296	1775	24.1	0.17	0.35	7.3	0.026	0.016
	900	445T	4:1	885	123	48	94.1	593	395	1335	23.7	0.20	0.36	6.1	0.034	0.033
125	3600	444TS	4:1	3575	138	32	94.5	184	184	3575	30.7	0.14	0.27	8.8	0.018	0.010
	1800	444T	4:1	1785	143	42	95.0	368	245	2675	30.5	0.14	0.33	6.7	0.017	0.011
	1200	445T	4:1	1185	144	44	94.5	554	370	1775	30.1	0.14	0.29	6.2	0.020	0.013
	900	447T	4:1	885	152	54	93.6	742	495	1335	29.7	0.15	0.29	4.8	0.027	0.026
150	3600	445TS	4:1	3575	164	37	95.0	220	220	3575	36.7	0.10	0.21	7.2	0.012	0.007
	1800	445T	4:1	1785	170	45	95.8	441	294	2675	36.5	0.12	0.30	6.1	0.015	0.009
	1200	447T	4:1	1185	170	45	95.0	665	444	1775	36.1	0.13	0.28	6.1	0.017	0.012
	900	445T	4:1	885	186	72	94.1	890	593	1335	35.6	0.12	0.23	3.5	0.022	0.021
200	3600	447TS	4:1	3575	216	40	95.0	294	294	3575	49.0	0.087	0.20	7.0	0.010	0.006
	1800	447T	4:1	1785	225	60	95.8	588	471	2375	48.7	0.085	0.22	4.6	0.010	0.007
	1200	449T	4:1	1185	226	55	95.0	886	592	1775	48.1	0.092	0.21	4.8	0.013	0.009
	900	449T	4:1	885	241	101	94.5	1186	791	1335	47.4	0.10	0.19	3.1	0.018	0.018
250	3600	449TS	4:1	3570	267	45	95.4	368	368	3570	61.0	0.690	0.17	6.4	0.008	0.005
	1800	449T	4:1	1785	281	78	95.8	735	589	2380	60.9	0.064	0.18	3.7	0.007	0.005
	1200	449T	4:1	1185	280	75	95.0	1108	739	1775	60.2	0.076	0.18	3.8	0.010	0.008
	900	S449	4:1	885	303	111	94.5	1483	989	1335	59.3	0.110	0.11	2.7	0.009	0.012
300	3600	449TS	4:1	3575	323	68	95.8	441	441	3575	73.5	0.051	0.13	4.1	0.006	0.004
	1800	449T	4:1	1785	346	110	95.4	882	706	2380	73.1	0.052	0.141	2.7	0.007	0.004
	1200	S449	4:1	1185	335	90	95.0	1329	886	1775	72.1	0.092	0.091	3.2	0.007	0.008
350	3600	S449	4:1	3570	369	67	95.4	515	515	3570	85.3	0.064	0.062	4.2	0.005	0.004
	1800	S449	4:1	1785	390	115	95.8	1029	825	2380	85.3	0.066	0.079	2.4	0.004	0.004
	1200	S449	4:1	1185	396	133	95.0	1551	1034	1775	84.2	0.069	0.067	2.3	0.005	0.006
400	3600	S449	4:1	3570	418	80	95.4	588	588	3570	97.4	0.052	0.052	3.5	0.004	0.004
	1800	S449	4:1	1785	449	138	95.8	1176	942	2380	97.4	0.060	0.071	2.0	0.003	0.004

Efficiency Values are shown for 60 hertz sine wave power.

Note: Ratios shown apply to vector duty only. For volts/hertz operation, speed range is 4:1.

Type RGZESDI Inverter Duty, Three Phase

1000:1 Constant Torque Premium Efficiency

HP	RPM	Frame	Speed Range	FLR PM	F.L. Amps @ 460	NL Amps @ 460V	Nom. F.L. Eff.	F.L. Torque	Max. Torque Const. HP	Max. RPM Const. HP	Ohms/Ph (Y equiv.) Circuit Parameters-25 degrees C				
											X1	X2	XM	R1	R2
1	1800	145T	1000:1	1740	1.4	0.8	82.5	3.0	1.5	3490	7.12	8.21	335	11.28	7.59
1.5	1800	182T	1000:1	1740	2.0	1.0	84.0	4.5	2.2	3480	4.93	8.37	305	5.48	4.45
2	1800	182T	1000:1	1740	2.7	1.5	84.0	6.0	3.0	3470	3.70	6.07	209	4.32	3.57
3	1800	184T	1000:1	1740	4.2	2.2	87.5	9.0	4.5	3480	2.17	3.78	123	2.58	2.29
5	1800	213T	1000:1	1760	6.5	3.3	87.5	15.	7.5	3460	1.60	3.20	84	1.30	0.92
7.5	1800	254T	1000:1	1775	9.5	4.4	89.5	22.	11.1	3500	1.30	2.70	66	0.7	0.52
10	1800	256T	1000:1	1770	12.5	5.7	89.5	30.	15	3500	0.86	1.90	48	0.45	0.38
	1200	256T	1000:1	1165	13.0	10	90.2	45	22	2330	1.41	1.71	52	0.68	0.53
	900	287T	1000:1	875	15	9.1	91.0	60	36	1475	2.02	2.44	35	0.65	0.49
15	3600	254T	1000:1	3530	18	5.0	90.2	22	15	5295	1.33	1.03	57.6	0.390	0.310
	1800	254T	1000:1	1760	20	7.3	91.7	45	22	3520	0.85	1.61	38.5	0.380	0.340
	1200	284T	1000:1	1175	20	10	91.0	67	40	1955	1.00	1.11	26.3	0.400	0.240
	900	286T	1000:1	875	23	14	91.0	90	54	1475	1.34	1.68	23.8	0.38	0.33
20	3600	256T	1000:1	3525	23	7.4	90.2	30	20	5285	0.95	0.80	40.3	0.300	0.270
	1800	256T	1000:1	1755	27	9.1	91.7	60	30	3510	0.60	1.26	30.7	0.260	0.260
	1200	286T	1000:1	1175	26	12.0	91.7	89	54	1955	0.77	0.93	22.9	0.290	0.210
	900	324T	1000:1	880	31	18	91.0	119	71	1480	1.15	1.68	14.8	0.23	0.193
25	3600	284TS	1000:1	3525	29	8	91.7	37	25	4700	0.55	1.14	38.5	0.270	0.210
	1800	284T	1000:1	1765	29	13	93.0	74	50	2940	0.55	0.88	22.8	0.190	0.180
	1200	324T	1000:1	1180	33	15	92.4	111	67	1965	0.67	0.65	16.1	0.170	0.150
	900	287T	1000:1	880	38	22	90.2	149	89	1480	0.95	1.41	12.6	0.174	0.159
30	3600	286TS	1000:1	3525	34	9.5	91.7	45	30	4700	0.42	0.98	33.8	0.200	0.170
	1800	286T	1000:1	1765	35	15.0	93.0	89	60	2940	0.44	0.75	20.3	0.150	0.150
	1200	326T	1000:1	1180	39	19.0	92.4	134	80	1965	0.56	0.56	13.9	0.150	0.130
	900	364T	1000:1	885	47	26	91.0	178	119	1335	0.77	1.15	9.7	0.144	0.083
40	3600	324TS	1000:1	3530	46	12	93.6	60	48	4705	0.33	0.60	22.6	0.088	0.100
	1800	324T	1000:1	1770	47	15	93.6	119	79	2940	0.38	0.67	18.5	0.110	0.100
	1200	364T	1000:1	1180	52	24	93.6	178	119	1770	0.41	0.70	11.6	0.100	0.070
	900	365T	1000:1	885	63	36	91.7	237	158	1335	0.56	0.87	7.2	0.094	0.061
50	3600	326TS	1000:1	3530	55	15	93.6	74	60	4705	0.25	0.49	18.8	0.072	0.083
	1800	326T	1000:1	1770	58	18	93.6	148	99	2950	0.31	0.54	15.8	0.082	0.082
	1200	365T	1000:1	1180	66	30	93.6	223	148	1770	0.32	0.58	10.4	0.081	0.058
	900	404T	1000:1	880	67	28	91.7	297	198	1330	0.49	0.82	10.2	0.079	0.071
60	3600	364TS	1000:1	3565	68	19	93.6	89	89	4455	0.30	0.56	14.8	0.066	0.054
	1800	364T	1000:1	1775	71	21	93.6	178	118	2660	0.30	0.46	11.6	0.066	0.051
	1200	404T	1000:1	1185	72	26	94.1	266	177	1775	0.35	0.58	10.8	0.049	0.033
	900	405T	1000:1	880	78	30	91.7	356	237	1330	0.41	0.70	8.8	0.063	0.060

HP	RPM	Frame	Speed Range	FLR PM	F.L. Amps @ 460	NL Amps @ 460V	Nom. F.L. Eff.	F.L. Torque	Max. Torque Const. HP	Max. RPM Const. HP	Ohms/Ph (Y equiv.) Circuit Parameters-25 degrees C X1	X2	XM	R1	R2
75	3600	365TS	1000:1	3565	85	22	94.1	111	111	4455	0.20	0.46	12.8	0.045	0.041
	1800	365T	1000:1	1775	87	27	94.1	222	148.	2660	0.23	0.37	9.2	0.051	0.041
	1200	405T	1000:1	1185	87	34	94.5	332	222	1775	0.26	0.45	8.4	0.035	0.025
	900	444T	1000:1	885	94	37	93.0	445	297	1335	0.27	0.47	7.5	0.050	0.044
100	3600	405TS	1000:1	3570	110	19	94.1	147	147	3570	0.21	0.32	16	0.034	0.015
	1800	405T	1000:1	1780	113	30	94.5	295	197	2670	0.20	0.37	9.6	0.028	0.016
	1200	444T	1000:1	1185	115	38	94.5	443	296	1775	0.17	0.35	7.3	0.026	0.016
	900	445T	1000:1	885	123	48	94.1	593	395	1335	0.20	0.36	6.1	0.034	0.033
125	3600	444TS	1000:1	3575	136	32	94.5	184	184	3575	0.14	0.27	8.8	0.018	0.010
	1800	444T	1000:1	1785	143	42	95.0	368	245	2675	0.14	0.33	6.7	0.017	0.011
	1200	445T	1000:1	1185	144	44	94.5	554	370	1775	0.14	0.29	6.2	0.020	0.013
	900	447T	1000:1	885	152	54	93.6	742	495	1335	0.15	0.29	4.8	0.027	0.026
150	3600	445TS	1000:1	3575	160	37	95.0	220	220	3575	0.10	0.21	7.2	0.012	0.007
	1800	445T	1000:1	1785	169	45	95.8	441	294	2675	0.12	0.30	6.1	0.015	0.009
	1200	447T	1000:1	1185	169	45	95.0	665	444	1775	0.13	0.28	6.1	0.017	0.012
	900	447T	1000:1	885	186	72	94.1	890	593	1335	0.12	0.23	3.5	0.022	0.021
200	3600	447TS	1000:1	3575	208	40	95.0	294	294	3575	0.087	0.20	7.0	0.010	0.006
	1800	447T	1000:1	1785	223	60	95.8	588	421	2375	0.085	0.22	4.6	0.010	0.007
	1200	449T	1000:1	1185	222	55	95.0	886	592	1775	0.092	0.21	4.8	0.013	0.009
	900	449T	1000:1	885	241	101	94.5	1186	91	1335	0.10	0.19	3.1	0.018	0.018
250	3600	449TS	1000:1	3570	264	45	95.4	368	368	3570	0.690	0.17	6.4	0.008	0.005
	1800	449T	1000:1	1785	282	78	95.8	735	589	2380	0.064	0.18	3.7	0.007	0.005
	1200	449T	1000:1	1185	285	75	95.0	1108	739	1775	0.076	0.18	3.8	0.010	0.008
	900	S449	1000:1	885	303	111	94.5	1483	989	1335	0.11	0.11	2.7	0.009	0.012
300	3600	449TS	1000:1	3575	330	68	95.8	441	441	3575	0.051	0.13	4.1	0.006	0.004
	1800	449T	1000:1	1785	345	110	95.4	882	706	2380	0.052	0.141	2.7	0.007	0.004
	1200	S449	1000:1	1185	335	90	95.0	1329	886	1775	0.092	0.091	3.2	0.007	0.008
350	3600	S449	1000:1	3570	370	67	95.4	515	515	3570	0.064	0.062	4.2	0.005	0.004
	1800	S449	1000:1	1785	390	115	95.8	1029	825	2380	0.066	0.079	2.4	0.004	0.004
	1200	S449	1000:1	1185	396	133	95.0	1551	1034	1775	0.069	0.067	2.3	0.005	0.006
400	3600	S449	1000:1	3570	420	80	95.4	588	588	3570	0.052	0.052	3.5	0.004	0.004
	1800	S449	1000:1	1785	450	138	95.8	1176	942	2380	0.060	0.071	2.0	0.003	0.004

Efficiency Values are shown for 60 hertz sine wave power.

Note: Ratios shown apply to vector duty only. For volts/hertz operation, speed range is 4:1.

Type RGZZESD Inverter Duty, Three Phase

HP	RPM	Frame	Speed Range	FL RPM	F.L. Amps	NL Amps	Nom. F.L. Eff.	F.L. Torque	Max. Torque Const. HP	Max. RPM Const. HP	Hp @ Min. Const. Torque	Ohms/Ph (Y equiv.) Circuit Parameters-25 degrees C				
												X1	X2	XM	R1	R2
1	1800	145T	6:1	1760	1.7	1.4	83.6	3.0	1.5	3600	0.15	4.94	5.27	199	6.98	4.37
	1200	182T	6:1	1175	1.7	1.5	85.5	4.5	2.3	2400	0.15	5.22	9.40	185	6.28	4.54
	900	184T	6:1	870	1.9	1.2	78.5	6.1	3.0	1800	0.14	8.31	12.02	202	8.31	12.08
1.5	1800	145T	6:1	1750	2.5	1.9	84.0	4.5	2.3	3600	0.21	3.80	4.16	165	5.05	3.56
	1200	184T	6:1	1170	2.6	1.9	86.2	6.7	3.4	2400	0.22	3.59	7.37	145	4.26	3.43
	900	215T	6:1	870	2.8	1.8	80.0	9.2	4.5	1800	0.21	7.53	6.74	147	7.46	5.13
2	1800	145T	6:1	1765	3.0	1.8	87.5	5.9	3.0	3600	0.30	2.98	4.54	146	3.13	2.62
	1200	213T	6:1	1190	2.8	2.3	88.5	8.8	4.4	2400	0.30	3.24	4.57	130	3.25	1.73
	900	213T	6:1	870	3.5	2.2	82.5	12	5.9	1800	0.27	5.66	5.27	118	5.23	3.87
3	1800	184T	6:1	1755	4.6	3.2	87.5	9.0	4.5	3600	0.44	1.71	2.70	84.2	1.85	1.64
	1200	215T	6:1	1190	4.4	3.3	89.5	13.2	6.6	2400	0.48	2.01	2.91	86.8	1.99	1.23
	900	254T	6:1	880	5.5	3.1	84.0	18	8.8	1350	0.45	4.09	4.80	68.4	1.46	1.99
5	1800	213T	6:1	1760	7.3	4.2	89.5	14.9	7.5	3600	0.74	1.27	2.48	63.2	1.03	0.750
	1200	254T	6:1	1180	7.0	4.5	90.2	22.2	14.8	1800	0.76	1.66	1.89	54.3	0.820	0.580
	900	256T	6:1	870	9	4.1	86.5	30	15	1350	0.69	3.00	3.69	56.1	0.91	1.47
7.5	1800	215T	6:1	1760	10.7	5.4	89.5	22.4	11.2	3600	1.1	0.99	1.98	49.6	0.820	0.610
	1200	256T	6:1	1175	10.0	5.0	90.2	33.5	22.3	1800	1.1	1.41	1.71	52.1	0.680	0.530
	900	284T	6:1	880	12	6.6	87.5	46	30	1350	1.1	2.02	2.44	34.6	0.65	0.49
10	1800	254T	6:1	1770	13.7	7.3	91.7	29.7	19.8	2700	1.5	0.85	1.61	38.5	0.380	0.370
	1200	284T	6:1	1180	14.5	10.0	91.0	44.5	29.7	1800	1.5	1.00	1.11	26.3	0.400	0.240
	900	286T	6:1	885	17	9.1	91.0	60	39	1350	1.5	1.34	1.68	23.8	0.38	0.33
15	1800	256T	6:1	1765	20.4	9.1	91.7	44.6	29.7	2700	2.3	0.60	1.26	30.7	0.260	0.260
	1200	286T	6:1	1180	20.2	12.0	91.7	66.7	44.5	1800	2.3	0.77	0.93	22.9	0.290	0.210
	900	324T	6:1	885	25	14	91.0	90	59	1350	2.3	1.15	1.68	14.8	0.23	0.193
20	1800	284T	6:1	1770	24.0	13.0	93.0	59.3	39.5	2700	3.1	0.55	0.88	22.8	0.190	0.180
	1200	324T	6:1	1180	28.0	15.0	92.4	89.0	59.3	1800	3.1	0.67	0.65	16.1	0.170	0.150
	900	326T	6:1	885	33	18	91.0	119	79	1350	3.1	0.95	1.41	12.6	0.174	0.159
25	1800	286T	6:1	1770	30.0	15	93.0	74.2	49.5	2700	3.8	0.44	0.75	20.3	0.150	0.150
	1200	326T	6:1	1180	33.3	19	92.4	111	74.1	1800	3.8	0.56	0.56	13.9	0.150	0.130
	900	213T	6:1	885	33	18	91.0	119	79	1350	3.1	0.95	1.41	9.7	0.174	0.159
30	1800	224T	6:1	1775	36.3	15	93.6	88.7	59.1	2700	4.7	0.38	0.67	18.5	0.110	0.100
	1200	364T	6:1	1180	41.0	24	93.6	134	89.0	1800	4.6	0.41	0.70	11.6	0.100	0.070
	900	365T	6:1	890	52	26	91.0	178	118	1350	4.8	0.56	0.87	7.22	0.094	0.061
40	1800	326T	6:1	1775	47.5	18	93.6	118	78.9	2700	6.2	0.31	0.54	15.8	0.082	0.082
	1200	365T	6:1	1185	55	30	93.6	177	118	1800	6.2	0.32	0.58	10.4	0.081	0.058
	900	404T	6:1	885	53	36	91.7	237	157	1350	6.1	0.49	0.82	10.23	0.079	0.071
50	1800	364T	6:1	1775	60	21	93.6	148	98.6	2700	7.6	0.30	0.46	16.0	0.066	0.051
	1200	404T	6:1	1185	61	26	94.1	222	148	1800	7.8	0.35	0.58	10.8	0.049	0.033
	900	213T	6:1	885	66	28	91.7	297	197	1350	7.6	0.41	0.70	8.78	0.063	0.060

HP	RPM	Frame	Speed Range	FL RPM	F.L. Amps	NL Amps	Nom. F.L. Eff.	F.L. Torque	Max. Torque Const. HP	Max. RPM Const. HP	Hp @ Min. Const. Torque	Ohms/Ph (Y equiv.) Circuit Parameters-25 degrees C				
												X1	X2	XM	R1	R2
60	1800	365T	6:1	1775	71	27	94.1	177	118	2700	9.3	0.23	0.37	9.2	0.052	0.041
	1200	405T	6:1	1190	74	34	94.5	265	176	1800	9.6	0.26	0.45	8.4	0.035	0.025
	900	444T	6:1	890	77	30	91.7	356	235	1350	9.5	0.27	0.47	7.81	0.050	0.044
75	1800	405T	6:1	1780	86	30	94.5	221	147	2700	11.8	0.20	0.37	9.6	0.028	0.016
	1200	444T	6:1	1185	88	38	94.5	333	222	1800	11.7	0.17	0.35	7.3	0.026	0.016
	900	445T	6:1	890	95	37	93.0	445	294	1350	11.9	0.20	0.36	6.07	0.034	0.033
100	1800	444T	6:1	1785	118	42	95.0	294	196	2700	16.0	0.14	0.33	6.7	0.017	0.011
	1200	445T	6:1	1185	118	44	94.5	443	295	1800	15.6	0.14	0.29	6.2	0.020	0.013
	900	447T	6:1	890	124	48	94.1	593	392	1350	15.8	0.15	0.29	4.80	0.027	0.026
125	1800	445T	6:1	1785	143	45	95.8	368	245	2700	20.0	0.12	0.30	6.1	0.015	0.009
	1200	447T	6:1	1185	142	45	95.0	554	369	1800	19.5	0.13	0.28	6.1	0.017	0.012
	900	447T	6:1	890	159	54	93.6	742	490	1350	19.8	0.12	0.23	3.51	0.022	0.021
150	1800	447T	6:1	1785	171	60	95.8	441	294	2700	16.0	0.085	0.22	4.6	0.010	0.007
	1200	449T	6:1	1185	170	55	95.0	665	443	1800	23.4	0.092	0.21	4.8	0.013	0.009
	900	449T	6:1	890	186	72	94.1	890	588	1350	23.7	0.10	0.19	3.08	0.018	0.018
200	1800	449T	6:1	1785	223	78	95.8	588	392	2700	31.9	0.064	0.18	3.7	0.007	0.005
	1200	449T	6:1	1185	225	75	95.0	886	591	1800	31.2	0.076	0.18	3.8	0.010	0.008

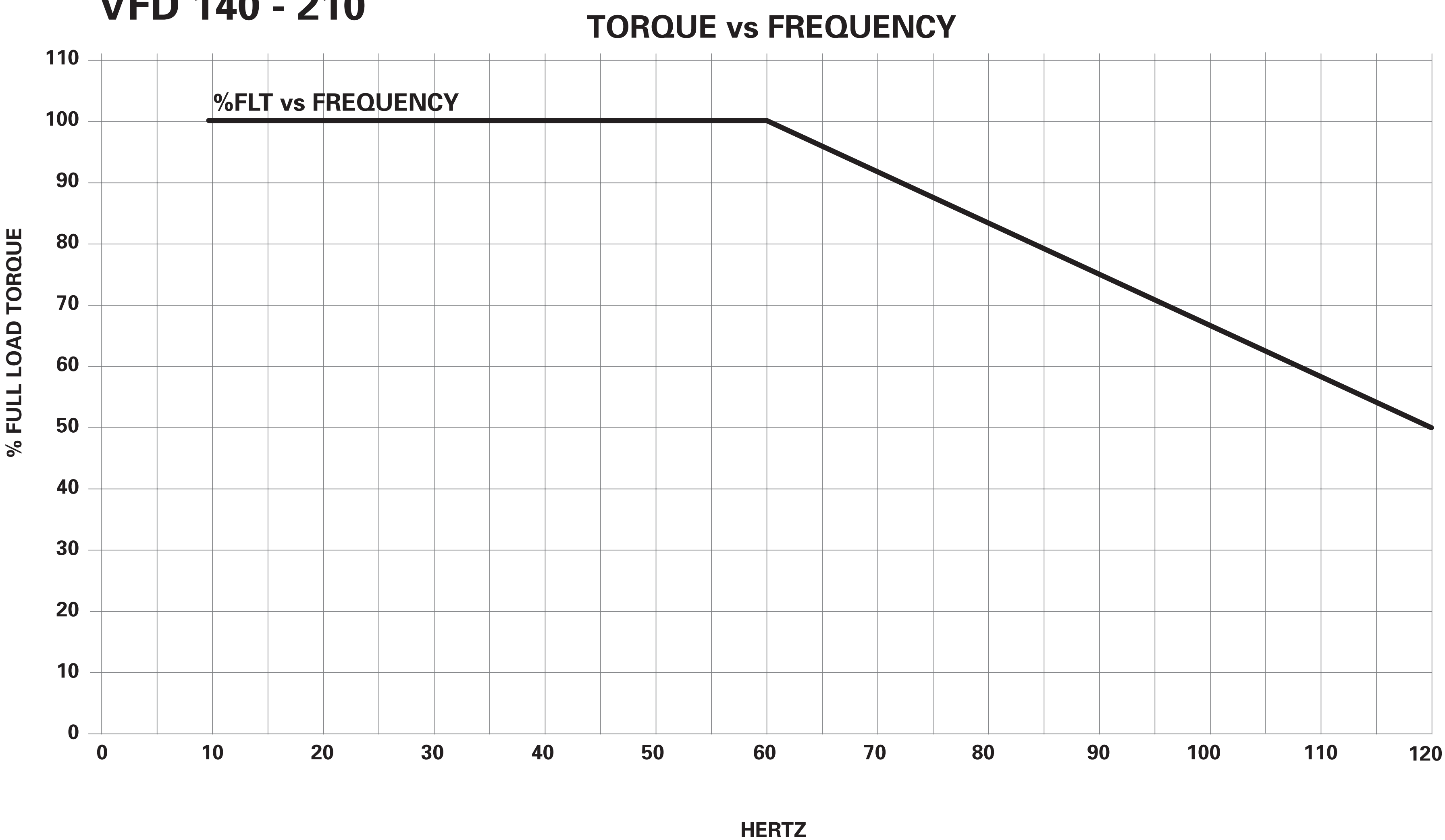
Notes

- Pounds x 4.448 = Newtons
  Newtons X .2248 = Pounds
- HP x .746 = KW
  KW x 1.341 = HP
- Torque (Lb. = Ft.) = $\frac{\text{HP X 5250}}{\text{RPM}}$
- Torque (Newton - meters):
  Nm x .7376 - Lb. - Ft.
  (Lb. Ft. x 1.356 = Nm)
- HP = $\frac{\text{Torque (Lb. - Ft.) x RPM}}{5250}$
- WK^2 (Inertia - Lb. $Ft.^2$) at motor Shaft =
  (Load RPM ÷ Mtr. F.L. RPM)^2 x Load WK^2
- Inertia (Kilogram - $meter^2$):
  kgm^2 x 23.73 = Lb. $Ft.^2$
  (Lb. $Ft.^2$ ÷ 23.73 = kgm^2)
  (Lb. $Ft.^2$ ÷ .042 = kgm^2)
- Power (Kilowatts):
  Kw x 1.341 = HP
  (HP ÷ 1.341 = Kw)
  (HP x .746 = Kw)
- Temperature:
  °C = 5/9 (°F - 32)
  °F = (9/5 x °C) + 32
- Performance Data Notes:

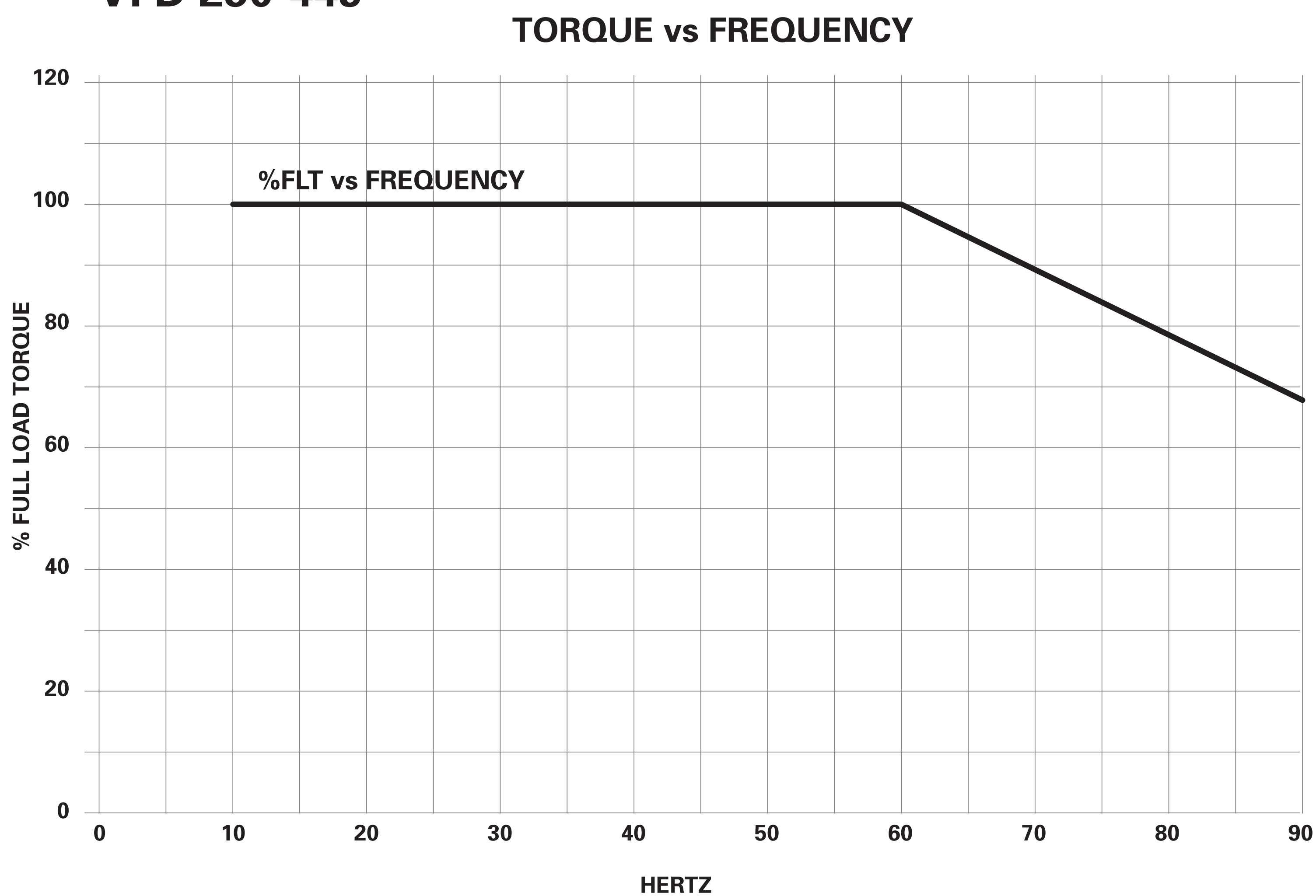
  To find amperes at various voltages:
  575 V Data = 460 V Amperes x .80
  230 V Data = 460 V Amperes x 2.0
  200 V Data = 460 V Amperes x 2.3
  (Amperes = Full Load, Locked Rotor and No Load Values - from data pages)

All other data (KVA Code, Efficiencies, Power Factors, Torques and Stall Times) remain same as 460 V Data (winding connections can change - rarely - with voltage designs).

RGZZESD
VFD 140 - 210



RGZZESD
VFD 250-449



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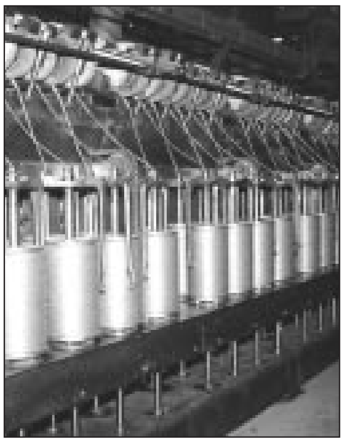
In addition to incorporating quality materials, each Siemens motor undergoes more than 100 separate quality inspections at the factory before it's good enough to be offered to you. Personal involvement and responsibility help put the extra reliability in Siemens motors. ISO 9001 certification assures our promise to you.



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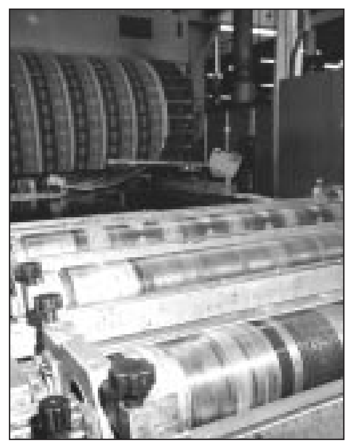

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Complete solutions rely on comprehensive product lines. Siemens motors are an integral part of a vast array of industrial products including variable speed drives, control and automation products, switchgear, motor control centers and power distribution equipment.

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Little Rock, AR 72206
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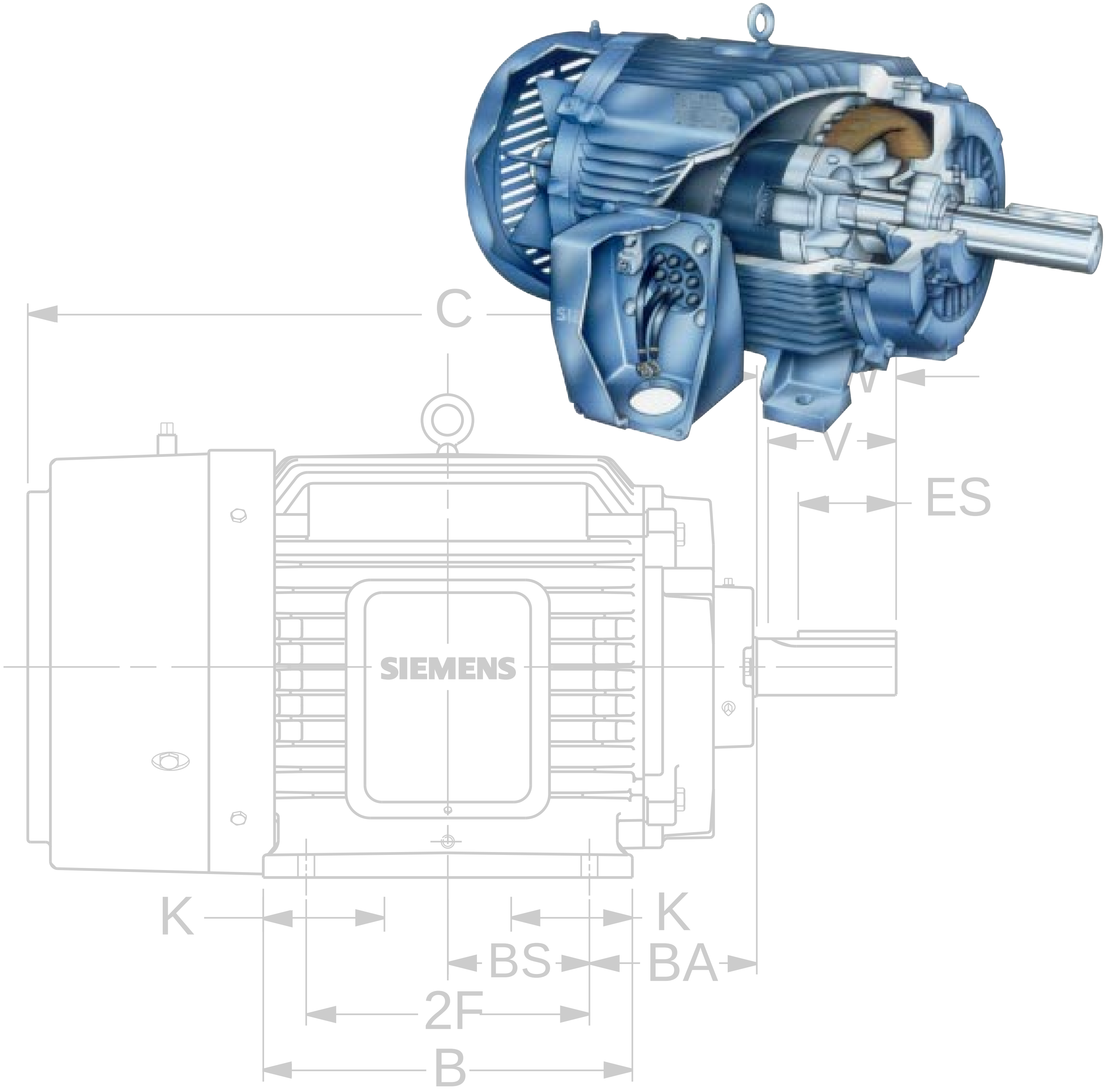
SIEMENS

Application Manual for NEMA Motors



NMCD-L4000-0897

SIEMENS

NEMA Frames Application Manual

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SIEMENS

Application Manual for NEMA Motors

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Special Applications and Information

National Electrical Manufacturers Association – NEMA

MG 1 – 1993

These standards provide practical information concerning performance, safety, test, construction and manufacturing of alternating-current and direct current motors and generators within the product scopes outlined in the applicable sections.

MG 1 – 1993 is divided in the following way:

Section I – General Standards Applying to All Machines
- Part 1 – Referenced Standards and Definitions
- Part 2 – Terminal Markings
- Part 3 – High Potential Tests
- Part 4 – Dimensions, Tolerances, and Mounting
- Part 5 – Classification by Degrees of Protection Provided by Enclosure
- Part 6 – Methods of Cooling (IC Code)
- Part 7 – Mechanical Vibration-measurement, Evaluation and Limits

Section II – Small and Medium Machines (up to 500 HP, 3600 RPM open-type machines)
- Part 10 – Ratings – AC and DC Motors
- Part 11 – Dimensions – AC and DC Small and Medium Machines
- Part 12 – Tests and Performance – AC and DC Motors
- Part 14 – Application Data – AC and DC Small and Medium Machines
- Part 15 – DC Generator Ratings
- Part 16 – Synchronous Generator – General Purpose
- Part 18 – Definite Purpose Machines

Section III – Large Machines (larger than 500 HP, 3600 RPM open-type machines)
- Part 20 – Induction Machines
- Part 21 – Synchronous Motors
- Part 22 – Synchronous Generators
- Part 23 – DC Motors
- Part 24 – DC Generators

Section IV – Performance Standards Applying to All Machines
- Part 30 – Application Considerations for Constant Speed Motors used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Variable Voltage or Variable Frequency Controls
- Part 31 – Definite-Purpose Inverter-Fed Motors

The motors manufactured at the Motors & Drives Division are designed and manufactured using applicable NEMA Standards as minimum criteria.

National Electrical Manufacturers Association – NEMA

MG 2 - 1989

This standard defines construction requirements of electric machines intended for use in circuits of 50 volts and higher and provides recommendations for their selection, installation, and use in such a manner as to provide for the practical safeguarding of persons and property.

MG 3 - 1974

This standard provides a method of estimating sound levels for installed rotating electrical machines.

MG 10 - 1994

This standard is an energy management guide for selection and use of fixed frequency AC squirrel-cage polyphase induction motors.

MG 13 - 1984

This standard covers frame assignments for single phase and polyphase integral HP induction motors.

The Institute of Electrical and Electronics Engineers - IEEE

The following IEEE Standards may be used in specifying NEMA frame size motors.

IEEE 112 - 1991 Test Procedures for Polyphase induction Motors and Generators

This standard covers instructions for conducting and reporting the more generally applicable and acceptable tests to determine the performance characteristics of polyphase induction motors and generators.

IEEE 85 - 1973 Test Procedure for Airborne Sound Measurements on Rotating Electric Machinery

This procedure defines approved methods for conducting tests and reporting results to effect the uniform determination of rotating electric machine sound under steady-state conditions with an accuracy of +3dB.

IEEE 45 - 1983 Practice for Electric Installations on Shipboard

These Marine Recommendations are to serve as a guide for the equipment of merchant vessels with an electric plant system and electric apparatus for lighting, signaling, communication, power and propulsion. They indicate what is considered good engineering practice with reference to safety of the personnel and of the ship itself as well as reliability and durability of the apparatus.

IEEE 117 - 1974 Test Procedure for Evaluation of Systems of Insulating Materials for Random-Wound AC Electric Machinery

This test procedure has been prepared to outline useful methods for the evaluation of systems of insulation for random wound stators of rotating electric machines. The purpose of this test procedure is to classify insulation systems in accordance with their temperature limits by test, rather than by chemical composition. The intention is to classify according to the recognized A, B, F and H categories.

The Institute of Electrical and Electronics Engineers - IEEE

IEEE 275 - 1992 Test Procedure for Evaluation of Systems of Insulating Materials for AC Electric Machinery Employing Form-Wound Pre-insulated Stator Coils

This test procedure has been prepared to outline useful methods for the evaluation of systems of insulation for form-wound stators of rotating electric machines. The purpose is the same as that stated for IEEE-117 above.

IEEE 841 - 1994 IEEE Standard for Chemical Industry Severe Duty TEFC Squirrel Cage Induction Motors Up to and Including 500 HP

The purpose of this standard is to define a specification that deals with mechanical and electrical performance, electrical insulation systems, corrosion protection, and electrical and mechanical testing for severe duty TEFC squirrel cage polyphase induction motors, up to and including 500 HP, for petroleum and chemical industry application. Many of the specified materials and components in this standard stem from experience with severely corrosive atmospheres and the necessity for safe, quiet, reliable, high-efficiency motors.

IEEE 323

IEEE 334

IEEE 344

These standards relate to Class 1E safety-related equipment for use in nuclear power generating stations. We do not manufacture motors to these standards.

American Petroleum Institute - API

API 541 - April 1995

This standard, together with applicable motor data sheets and job specifications, covers the requirements for form-wound squirrel cage induction motors 250 HP and larger for use in petroleum industry services.

NOTE: This standard is written with the intention of being a guideline for preparing specifications by a company for a specific job or project. We cannot build motors to this specification because it requires choices to be made whether certain paragraphs are applicable for the particular job.

API 610 - 1995

This specification covers centrifugal pumps for general refinery services.

Section 3.1 of the specification is a general guide to motor selection and requires motors for vertical pumps to have the thrust bearing at the top of the motor. The In-Line Vertical Pump Motors manufactured by the Motors & Drives Division do not meet all requirements of this specification.

Hazardous Location Classifications

Abstract

In spite of a lot of technical articles written on this subject, the complexities still remain. The main purpose of this paper is to simplify the complexities, the classification of these motors, and make it easier for the user to understand.

Classification

There are three main categories of classification:

1. Division
2. Class
3. Groups

Division: In real sense, it means location or area of the hazard.
There are only two types of divisions.

Division 1	Hazard can occur under normal conditions.
Division 2	Hazard can occur only under abnormal conditions.

Local safety authorities decide what are normal and abnormal conditions. Therefore, the first step is to contact local authorities to define the location if it is Division 1 or Division 2.

Class: Defines the type of hazard. There are three different classes.

Class I Consists of chemical gases or vapors in the environment, such as gasoline or acetylene.

Class II Consists of flammable dust in the environment, such as coke dust, grain dust, etc.

Class III Consists of flammable lint or fibers in the area, such as textile, saw dust, etc.

Hazardous Location Classifications

Groups: Defines the principal chemical gas, vapor or dust present in the environment. The term group comes from the various atmospheric mixtures which have been grouped together on the basis of their hazardous characteristics.

Groups A, B, C and D are always in the form of gas or vapor. Therefore, these groups can exist only under Class I category.

Groups E, F and G are always in the form of dust. Therefore, these group can exist only under Class II category.

Underwriters Laboratories Labeling

Underwriters Laboratories is the only safety agency recognized by National Electric Code for the approval of electric motors under hazardous locations.

It defines all the requirements for the manufactures to make these motors after Division, Class and Groups are defined by the user.

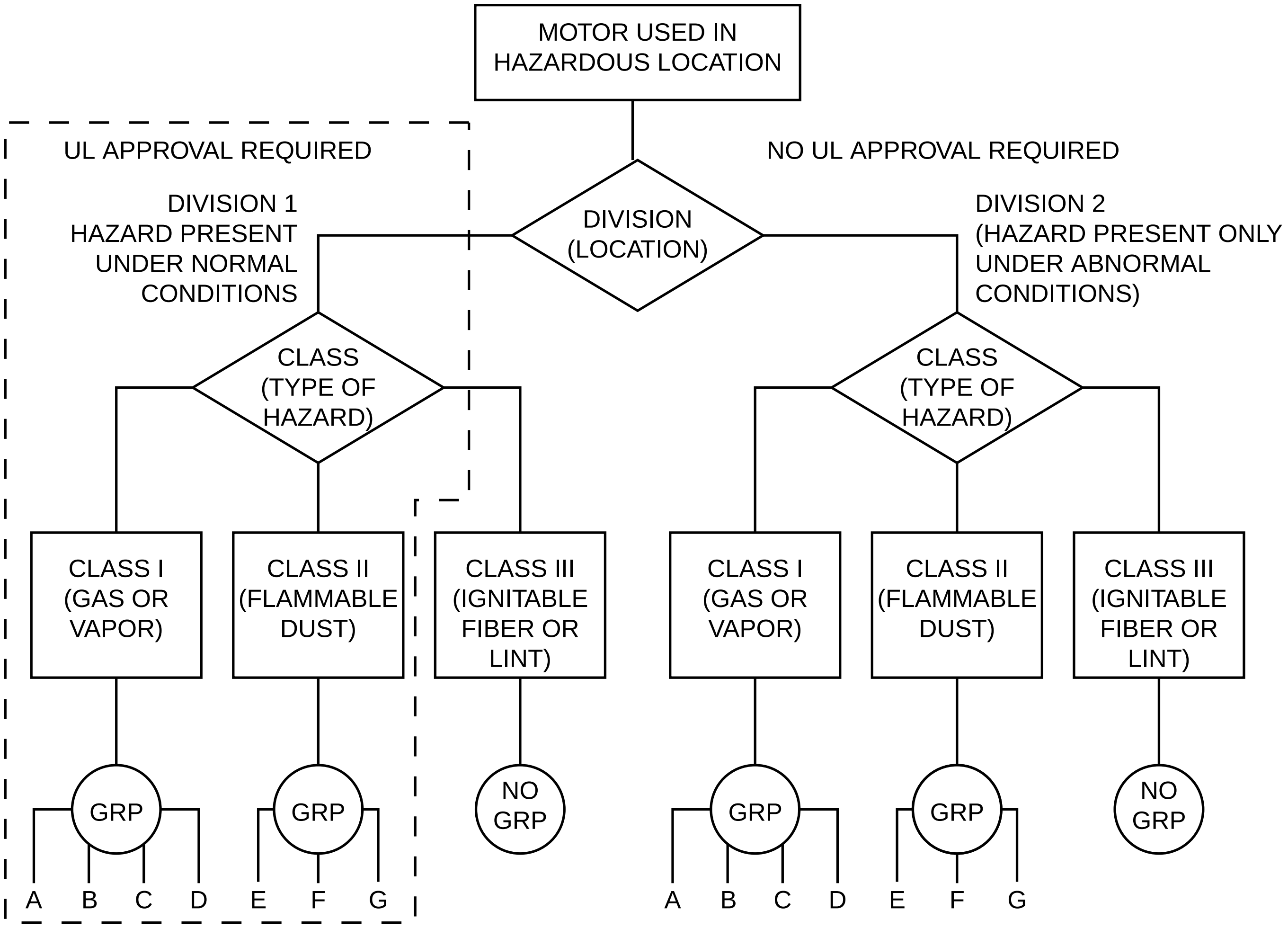
The following chart should help understanding where U.L. label is required.

U.L Requirements

	Class I	Class II	Class III
Division 1			
Division 2			

— Color indicates U.L. label required

Hazardous Location Classifications



IMD-T116(NEW)

Substances and Atmospheres Chart

Table I, Class I Substances and Atmospheres

Substance or Atmosphere	Minimum Ignition Temperature
Group A	
acetylene	303 C (581 F)
Group B	
butadiene	420 C (788 F)
ethylene oxide	429 C (804 F)
Group C	
acetaldehyde	175 C (347 F)
cyclopropane	500 C (932F)
diethyl ether	160 C (320 F)
ethylene	450 C (842 F)
isoprene	220 C (428 F)
unsymmetrical dimethyl hydrazine (UDMH) 1, 1-dimethyl hydrazine)	249 C (480 F)
Group D	
acetone	465 C (869 F)
acrylonitrile	481 C (898 F)
ammonia	498 C (928 F)
benzene	560 C (1040 F)
butane	405 C (761 F)
1-butane (butyl alcohol)	365 C (689 F)
2-butanol (secondary butyl alcohol)	405 C (761 F)
n-butyl acetate	425 C (797 F)
isobutyl acetate	421 C (790 F)
ethane	515 C (959 F)
ethanol (ethyl alcohol)	365 C (689 F)
ethyl acetate	427 C (800 F)
ethylene dichloride	413 C (775 F)
gasoline	280 C (536 F)
heptanes	215 C (419 F)
hexanes	225 C (437 F)
methane (natural gas)	540 C (1004 F)
methanol (methyl alcohol)	385 C (725 F)
3-methyl-1butanol (isoamyl alcohol)	350 C (662 F)
methyl ethyl ketone	516 C (960 F)
methyl isobutyl ketone	460 C (860 F)
2-methyl-propanol (isobutyl alcohol)	427 C (800 F)
2-methyl-2propanol (tertiary butyl alcohol)	480 C (896 F)
octanes	220 C (428 F)
petroleum naptha	288 C (550 F)
1-pentanol (amyl alcohol)	300 C (572 F)
propane	450 C (842 F)
1-propanol (propyl alcohol)	440 C (824 F)
2-propanol (isopropyl alcohol)	399 C (750 F)
propylene	460 C (860 F)
styrene	490 C (914 F)
vinyl acetate	402 C (756 F)
vinyl chloride	472 C (882 F)
xylenes	465 C (869 F)

Table II. Class II Substances
(*General Definitions* — Examples)

Group E

Metallic dusts
Dusts of aluminum, magnesium, their commercial alloys and other metals of similarly hazardous characteristics.

Group F

Electrically conducting non-metallic dusts
Coal dust, pulverized coal, pulverized coke, pulverized charcoal, carbon black and similar substances.

Group G

Electrically non-conducting dusts
Grain dusts, grain product dusts, pulverized sugar, pulverized starch, dried powdered potato, pulverized cocoa, pulverized spices, dried egg and milk powder, wood flour, oilmeal from beans and seeds, dried hay and other products producing combustible dust when dried or handled and other similar substances.

Table III. Class III Substances.
(No Groups Assigned)

Ignitable Fibers or Flyings

Rayon	Cotton
Sawdust	Sisal
Henequen	Istle
Jute	Hemp
Tow	Cocoa fiber
Oakum	Baled waste kapok
Spanish moss	Excelsior

(and other materials of similar nature)

Special Construction Features

1. Most are provided with thermal protectors.

2. Most are made of cast iron frame.

3. Conduit boxes of the motors going in Division 1 are specially sealed.

4. Class I motors have longer lap joints, tighter fits and longer flame paths so that if an explosion does occur in the motor, it’s contained in the motor and flames coming out through the joints are cooled enough to be extinguished. They may be bolted by hardened steel bolts.

5. Motors used in atmosphere of less than -25° C require still stronger construction features because of the extra stresses, also because of the increase in the density of the environment. The amount of energy required to cause an explosion is more but explosion is of much greater intensity. Standard explosion-proof motors are not useable below -25° C without special UL testing, approval and marking.

6. Class II motors have bearing dust seals.

7. Non-sparking fan made of aluminum, bronze or plastic is used to prevent possible friction sparks in case of any small stones or metal object getting into the air stream and bouncing off fan blades, and to prevent the build-up of static electrical charge which could generate a spark.

Special Information for User

U.L. does not offer any standards on Division 1 Class 1 Groups A and B.

U.L. does not offer any standards on Division 2 motors.

U.L. does not offer any standards on Class 3 motors.

U.L. does not offer any standards for motors used below ambients of -25° C, but will conduct individual tests at whatever low ambient is desired.

Motors rated at 3/4 HP and less may have internally mounted automatic thermal overload. Caution should be observed when applying these to the machinery as automatic thermal overload resets and starts the motor.

Motors rated at 1 HP and more may have thermostats on the windings which are pilot circuit devices only to be connected into the magnetic starter circuit.

Open motors can be used only in Division 2 location.

Operating temperature of space heaters must be considered when non-UL listed motors are applied in Division 2 locations. Any heater temperature below 200° C requires factory evaluation.

Conclusion

This paper provides the general everyday information. The user should be very careful about the special situations which are not covered by National Electric Code tables. The main limiting factor is the surface temperature of the motor which should always be below minimum ignition temperature of the environment. It should also be strong enough to contain any explosion inside.

Special Information for User

The latest revisions of the U.L. Standards are primarily additional safety features and in no way affect the safe operation of U.L. labeled motors now in use. The most significant change in the revised Standards is that all motors must bear a marking indicating maximum operating temperature. This change, in effect, further subdivides each of the existing U.L. groups.

The marking to show maximum surface operating temperature must be in either degrees, C or F, or by code, indicating the temperature range, i.e., a motor having a maximum surface operating temperature of 165˚ C may be marked 165˚ C or 329˚ F or coded T3B. All temperatures are on the highest temperature obtained in an ambient of 40˚ C (104˚ F) under all operating conditions, including overload, single-phasing and locked-rotor operation. National Electrical Code (1993) Article 500-3(d) lists the preferred markings in part as follows:

Maximum Temperature ˚C	˚F	Identification Number
280	536	T2A
260	500	T2B
230	446	T2C
215	419	T2D
200	392	T3
180	356	T3A
165	329	T3B
160	320	T3C
135	275	T4
120	248	T4A
100	212	T5
85	185	T6

Note that it is not possible to build every motor with every temperature code. Temperatures below 160˚C are not usually available. Consult factory for specific code availability.

Canadian Standards Association

Most motors sold and used in Canada require C.S.A. certification. This involves submitting design details and the testing of motors. Below is a tabulation of motors which are presently certified to C.S.A. standards. Auxiliary devices such as bearing RTD's and vibration switches are not included, and are to be submitted to C.S.A. for investigation and acceptance before they can be used on the motor.

I. Motors for Ordinary Location - C.S.A. Certification File No. LR 15721 (Domestic), LR 39020 (Mexico)

Type	Principle	Max HP	INS	Max Volts	Frames	PH	FREQ	NOTES
RG	Squirrel Cage	600	B,F	600	140T to 440T & TS	3	50,60	1
RGF	Squirrel Cage	600	B,F	600	140T to 440T	3	50,60	1,2,4
RGV	Squirrel Cage	600	B,F	600	140T to 440T	3	50,60	1,3,4
RGZ	Squirrel Cage	300	B,F	600	140T to 440T & TS	3	50,60	1
RGZF	Squirrel Cage	300	B,F	600	140T to 440T	3	50,60	1,2,4
RGZV	Squirrel Cage	300	B,F	600	140T to 440T	3	50,60	1,3,4
RGZV-IL	Squirrel Cage	300	B,F	600	213LP to 449LP 213LPH to 449LPH	3	60	1,3,4

Notes:

1. Types RG, RGF and RGV are drip-proof and Types RGZ, RGZF, RGZV and RGZVIL are TEFC motors. Other suffixes may be added to denote specific features such as high efficiency.
2. Horizontal with or without feet.
3. Vertical with or without feet.
4. Suffix letter C, D, or P may be added to frame designation denoting type of flange, and suffix letter Z denoting non-standard shaft extension.

Special Markings: All above motors are to be marked on the nameplate with the C.S.A. symbol, and code-dated with month and year of manufacture (e.g. "1281" means December 1981). Any warning labels must be bilingual (English-French).

All motors to have C.S.A. accepted ground terminal mounted inside the conduit box.

Canadian Standards Association

II. Motors for Hazardous Locations (DIV 1) - C.S.A. Certification File No. LR 36096 (Domestic), LR 39020 (Mexico)

These Motors are for Continuous or Intermittent Duty.

Hazardous Location Class or Group	Motor Type	Max RPM	INS	Max Volts	Frames	PH	Hertz
IC&D IIE, F&G	RGZZ	3600	B	600	143T TO 449T & TS	3	50,60
IC&D	RGZZ	3600	F	600	284T & TS & 449T & TS	3	50,60
ID	RGZZV-IL	3600	B	600	213LP & LPH to 449LP & LPH	3	60

Note: Designation RG is for basic AC motor type. Modifiers: ZZ (explosion-proof fan cooled), V (vertical with or without feet), F (horizontal flanged with or without feet), W (low noise), T (NEMA Design C: High starting torque low slip), H (NEMA Design D: High torque, high slip), -SD (with corrosion resistant modifications for severe duty), -IL (motor for In-Line Pumps). Flanged motors, vertical or horizontal, may have C, D, or P flange.

Special Marking

C.S.A. symbol on motor main nameplate and on UL Label. Date code for year and month of manufacture (e.g. “1281” means December 1981) on main nameplate. Bilingual warning labels in English and French.

All motors to have C.S.A. accepted ground terminal mounted inside the conduit box.

Requirements for motors not included in above two tables should be discussed with the factory. Where good business opportunities exist, special C.S.A. acceptance on a case basis can normally be obtained within a few months after the application is submitted to C.S.A. The investigation usually requires C.S.A. inspection of the motor, test data, and, sometimes, C.S.A. testing of motor components.

Standards Agencies' Addresses

To obtain catalogs or purchase standards, contact the appropriate organization below:

N.E.M.A.
1300 North 17th Street
Suite 1847
Rosslyn, Virginia 22209
Voice line: (703) 841-3200

IEEE
445 Hoes Lane
P.O. Box 1331
Piscataway, New Jersey 08855-1331
Voice line: (800) 678-4333
FAX line: (908) 981-9667

A.P.I.
2101 "L" Street, Northwest
Washington D.C. 20037
Voice line: (202) 682-8000

N.E.C.
National Fire Protection Association
1 Batterymarch Park
P.O. Box 9146
Quincy, Massachusetts 02269-9703
Voice line: (800) 344-3555

U.L.
333 Pfingsten Road
Northbrook, Illinois 60062-2096
Voice line: (847) 272-8800

C.S.A.
178 Rexdale Boulevard
Rexdale (Toronto)
Ontario, Canada
M9W 1R3
Voice line: (416) 747-4044
FAX line: (416) 747-2475

EG-Konformitätserklärung

No. 664.11 003.02 / 03.96

Bevollmächtigter:	Siemens Aktiengesellschaft Bereich Antriebs-, Schalt- und Installationstechnik Geschäftsgebiet Niederspannungsmotoren
Anschrift:	Siemensstrße 15 D-97615 Bad Neustadt a. d. Saale
Hersteller:	Siemens Energy & Automation, Inc. Industrial Products Division
Produktbezeichnug:	Drehstrom-Asynchronmotor mit Käfigläufer Typ RG, RGZ, RGZSD, RGZE, RGZESD, 1LA. RGF, RGZF, RGZFSD, RGZFE, & RGZFESD Shaft Height: 2.2 - 11.0 inches Outputs up to 450 HP

Das bezeichnete Produkt stimmt mit den Vorschriften folgender Europäischer Richtlinien überein:

73/23/EWG Richtlinie des Rates zur Angleichung der Rechtsvorschriften der Mitgliedstaaten betreffend elektrischer Betriebsmittel zur Verwendung innerhalb bestimmter Spannungsgrenzen, geändert durch RL 93/68/EWG des Rates

Die Übereinstimmung mit den Vorschriften dieser Richtlinien wird nachgewiesen durch die vollständige Einhaltung folgender Normen:

EN 60034-1 EN 60034-5 EN 60034-6 EN 60034-9 EN 60204-1

Erstmalige Anbringung der CE - Kennzeichnung: 96

Bad Neustadt, den 12.3.96

Paul-Heinz Rühr, Leiter des Vertriebs Niederspannungsmotoren

Manfred Bayer, Leiter des Produktmanagements

Diese Erklärung ist keine Zusicherung von Eigenschaften im Sinne der Produkthaftung.
Die Sicherheitshinweise der Produktdokumentation sind zu beachten.

EC declaration of conformity

No. 664.11 003.02 / 03.96

Authorized:	Siemens Aktiengesellschaft Bereich Antriebs-, Schalt- und Installationstechnik Geschäftsgebiet Niederspannungsmotoren
Address:	Siemensstrße 15 D-97615 Bad Neustadt a. d. Saale
Manufacturer:	Siemens Energy & Automation, Inc. Industrial Products Division
Product Description:	Three-Phase Induction Machine with Cage Rotor Typ RG, RGZ, RGZSD, RGZE, RGZESD, 1LA. RGF, RGZF, RGZFSD, RGZFE, & RGZFESD Shaft Height: 2.2 - 11.0 inches Outputs up to 450 HP

The named product is in conformity with the requirements of the following European Directive:

73/23/EWG Council Directive on the approximation of the laws of the Member States relating to electrical equipment for use within certain voltage limits, amended by Council Directive RL 93/68/EEC

Conformity with the requirements of these Directives is testified by complete adherence to me following standards:

EN 60034-1 EN 60034-5 EN 60034-6 EN 60034-9 EN 60204-1

CE symbol first displayed: 96

This Declaration does not give assurance of properties within the meaning of product liability.
The safety instructions provided in the product documentation must be observed.

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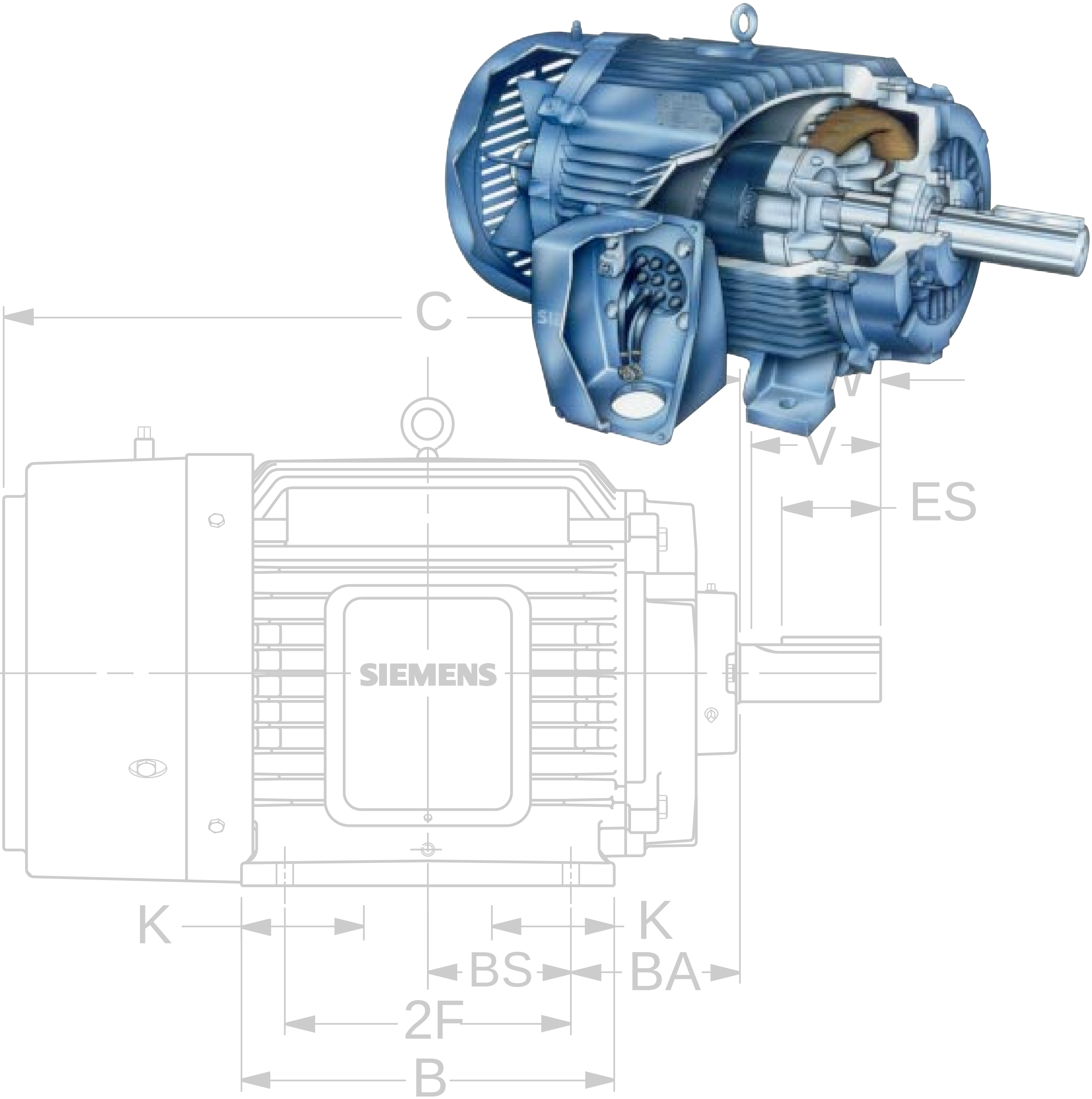
Application Manual for NEMA Motors



NMCD-L4000-0897

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NEMA Frames Application Manual

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Application Manual for NEMA Motors

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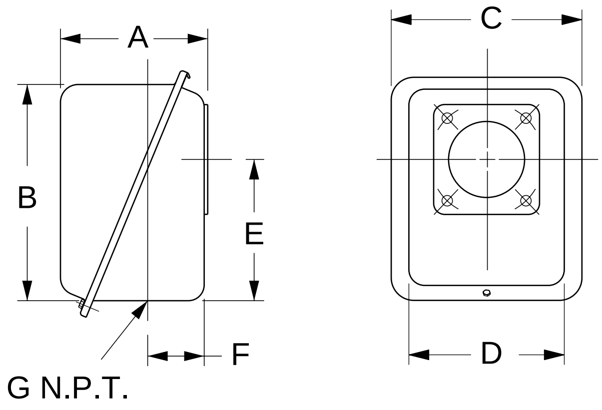
Mechanical Data

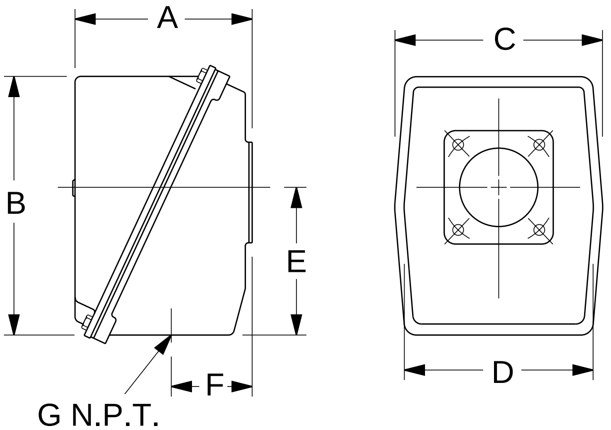
Standard Conduit Boxes — TEFC-standard duty — Type RGZP



Frame	External Dimensions (in)								Approx. internal volume (in^3)	no. of cover bolts
	A	B	C	D	E	F	G			
							NPT	Max. Cond.		
140	2.60	4.21	3.70	2.99	2.17	0.96	0.75		28	2
180	2.60	4.21	3.70	2.99	2.17	0.96	0.75		28	2
210	3.60	6.10	5.47	4.33	2.90	1.34	1.00		58	2
250	3.60	6.10	5.47	4.33	2.90	1.34	1.25		58	2
*280	5.12	7.69	6.50	5.50	5.00	2.00	-	2.00	189	1
*320	5.12	7.69	6.50	5.50	5.00	2.00	-	2.50	189	1
*360	7.19	9.38	7.00	6.00	6.25	3.38	-	3.00	316	1
*400	7.19	9.38	7.00	6.00	6.25	3.38	-	3.00	316	1
440	8.06	12.31	10.50	9.50	7.00	3.50	3.00		762	4

* 140-250 frames are cast aluminum, 280-400 frames have steel conduit boxes

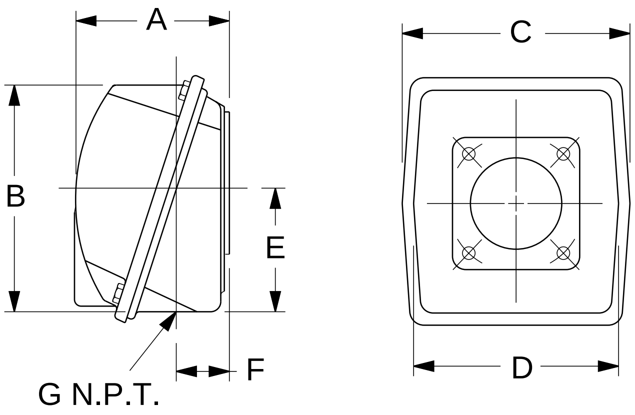
Standard Conduit Boxes — TEFC-severe duty — Types RGZPSD, RGZESD



Frame	External Dimensions (in)							Approx. internal volume (in^3)	no. of cover bolts
	A	B	C	D	E	F	G		
140	2.68	4.6	4.15	3.58	2.36	1.00	0.75	27	4
180	3.07	4.76	4.49	3.92	2.48	1.24	0.75	36	4
210	3.86	7.05	5.49	4.90	3.66	1.56	1.00	85	4
250	3.86	7.05	5.49	4.90	3.66	1.56	1.25	85	4
280	5.50	8.31	7.12	6.38	4.75	2.44	1.50	226	4
320	6.44	10.00	8.50	7.62	5.50	3.00	2.00	282	4
360	8.06	12.31	10.50	9.50	7.00	3.50	3.00	762	4
400	8.06	12.31	10.50	9.50	7.00	3.50	3.00	762	4
440	8.06	12.31	10.50	9.50	7.00	3.50	3.00	762	4
S449	10.19	15.70	13.50	12.50	8.50	5.00	4.00	1696	4

S449 is type RGZESD only

Standard Conduit Boxes — TEFC Explosion Proof — Types RGZZESD



Frame	External Dimensions (in)							Approx. internal volume (in^3)	no. of cover bolts
	A	B	C	D	E	F	G		
140	2.87	4.84	4.25	3.19	2.28	1.26	0.75	29	4
180	2.87	4.84	4.25	3.19	2.28	1.26	0.75	29	4
210	4.00	5.94	5.98	4.60	2.97	1.61	1.00	80	4
250	4.00	5.94	5.98	4.60	2.97	1.61	1.25	80	4
280	5.56	7.75	7.12	6.62	5.00	1.94	1.50	154	4
320	7.12	9.00	8.75	8.00	6.25	2.75	2.00	265	6
360	7.62	11.88	9.00	6.75	7.75	2.75	3.00	478	6
400	7.62	11.88	9.00	6.75	7.75	2.75	3.00	478	6
444	7.62	11.88	9.00	6.75	7.75	2.75	3.00	478	6
447	7.62	11.88	9.00	6.75	7.75	2.75	3.00	478	6
449	8.50	14.12	11.38	10.38	10.00	3.38	3.00	815	6

Standard Rotor Balance

The rotors of all motors are dynamically balanced in precision balancing machines to a degree that insures that the vibration measured on the bearing housing will be below the limits established by NEMA MG1-Part 7.

Speed RPM	NEMA Limits		Std. Siemens' Limits	
	Velocity in/sec	Displacement P-P Inches	Velocity in/sec	Displacement P-P Inches
3600	0.15	0.001 **	0.08	.0005 *
1800	0.15	0.0015 **	0.08	.0005 *
1200	0.15	0.002 **	0.08	.0005 *
900	0.12	0.0025 **	0.08	.0005 *

* For roller bearing motors axial limit is 0.001.

** This is not a present NEMA standard (was in previous standard MG1.12.06), but can be calculated based upon velocity and speed.

The above limits apply to motors on an elastic mounting per NEMA MG1-Part 7.06.1.

When required precision balance and extra precision balance are available, refer to factory for vibration levels and pricing.

Rotor Endplay Limits

The Medallion motor line features wavy (spring) washer loading which causes perceived endplay to be zero under normal operating conditions.

Under conditions of excessive thrust loading, some limited endplay due to compression of the wavy washer may be observed.

Standard Shaft Material

The standard shaft material supplied on motors is AISI (or SAE) 1045. It is a hot rolled, medium carbon, fine grain steel formed in round bars of special quality and straightness.

Typical Composition (%)
Carbon .45, Manganese .70, Phosphorus .007, Sulfur .025, Silicone .27

Tensile strength (PSI) 82,000 min.
Yield strength (PSI) 45,000 min.
Brinell 163 min.

Special steels including high strength and stainless are available on request. Refer to factory for pricing.

Standard Bearings for NEMA Frames — Horizontal Motors
Totally Enclosed Fan Cooled (TEFC) — Standard Duty — Severe Duty

Frame	TEFC — Standard Duty Type RGZ				TEFC — Standard Duty EPAct Efficiency Type RGZP				TEFC — EPAct Efficiency Severe Duty Type RGZPSD				TEFC — Premium Efficiency Severe Duty Types RGZESD, RGZESDX			
	Drive End		Opposite Drive End		Drive End		Opposite Drive End		Drive End		Opposite Drive End		Drive End		Opposite Drive End	
	AFBMA no.	Size	AFBMA no.	Size	AFBMA no.	Size	AFBMA no.	Size	AFBMA no.	Size	AFBMA no.	Size	AFBMA no.	Size	AFBMA no.	Size
143T - 145T	25BC02JEE3	6205	17BC02JEE3	6203	25BC02JP3	6205	17BC02JP3	6203	25BC02JP3	6205	25BC02JP3	6205	25BC02JP3	6205	25BC02JP3	6205
182T - 184T	30BC02JEE3	6206	20BC02JEE3	6204	30BC02JP3	6206	20BC02JP3	6204	30BC02JP3	6206	30BC02JP3	6206	30BC02JP3	6206	30BC02JP3	6206
213T - 215T	40BC02JEE3	6208	30BC02JEE3	6206	40BC02JP3	6208	30BC02JP3	6206	40BC02JP3	6208	40BC02JP3	6208	40BC02JP3	6208	40BC02JP3	6208
254T - 256T	45BC03JEE3	6209	40BC02JEE3	6208	45BC03JP3	6209	40BC02JP3	6208	45BC03JP3	6309	45BC03JP3	6309	45BC03JP3	6309	45BC03JP3	6309
284TS - 286TS	50BC03JPP3	6310	50BC02JPP3	6210	50BC03JP3	6310	50BC02JP3	6210	50BC03JP3	6310	50BC02JP3	6210	50BC03JP3	6310	50BC03JP3	6310
284T - 286T	50BC03JPP3	6310	50BC02JPP3	6210	50BC03JP3	6310	50BC02JP3	6210	50BC03JP3	6310	50BC02JP3	6210	50BC03JP3	6310	50BC03JP3	6310
324TS - 326TS	60BC03JPP3	6312	50BC02JPP3	6210	60BC03JP3	6312	50BC02JP3	6210	60BC03JP3	6312	50BC02JP3	6210	60BC03JP3	6312	60BC03JP3	6312
324T - 326T	60BC03JPP3	6312	50BC02JPP3	6210	60BC03JP3	6312	50BC02JP3	6210	60BC03JP3	6312	50BC02JP3	6210	60BC03JP3	6312	60BC03JP3	6312
364TS - 365TS	70BC03JPP3	6314	50BC02JPP3	6210	70BC03JP3	6314	50BC02JP3	6210	70BC03JP3	6314	50BC02JP3	6210	70BC03JP3	6314	70BC03JP3	6314
364T - 365T	70BC03JPP3	6314	50BC02JPP3	6210	70BC03JP3	6314	50BC02JP3	6210	70BC03JP3	6314	50BC02JP3	6210	70BC03JP3	6314	70BC03JP3	6314
404TS - 405TS	80BC03JPP3	6316	80BC03JPP3	6316	80BC03JP3	6316	80BC03JP3	6316	80BC03JP3	6316	80BC03JP3	6316	80BC03JP3	6316	80BC03JP3	6316
404T - 405T	80BC03JPP3	6316	80BC03JPP3	6316	80BC03JP3	6316	80BC03JP3	6316	80BC03JP3	6316	80BC03JP3	6316	80BC03JP3	6316	80BC03JP3	6316
444TS - 445TS	80BC03JPP3	6316	80BC03JPP3	6316	80BC03JP3	6316	80BC03JP3	6316	80BC03JP3	6316	80BC03JP3	6316	80BC03JP3	6316	80BC03JP3	6316
444T - 445T	90RU03M0	NU318	80BC03JPP3	6316	90RU03M0	NU318	80BC03JP3	6316	90RU03M0	NU318	80BC03JP3	6316	90RU03M0	NU318	80BC03JP3	6316
447TS - 449TS	80BC03JPP3	6316	80BC03JPP3	6316	80BC03JP3	6316	80BC03JP3	6316	80BC03JP3	6316	80BC03JP3	6316	80BC03JP3	6316	80BC03JP3	6316
447T - 449T	100RU03M0	NU320	80BC03JPP3	6316	100RU03M0	NU320	80BC03JP3	6316	100RU03M0	NU320	80BC03JP3	6316	100RU03M0	NU320	80BC03JP3	6316
S449SS	–	–	–	–	–	–	–	–	75BC03JP3	6315	75BC03JP3	6315	75BC03JP3	6315	75BC03JP3	6315
S449LS	–	–	–	–	–	–	–	–	100RU03M0	NU320	75BC03JP3	6315	100RU03M0	NU320	75BC03JP3	6315

Standard Bearings for NEMA Frames — Horizontal Motors
Open Drip-Proof and Explosion-Proof

Frame	Open Drip-Proof Types RGE1, RGE				Explosion-Proof Types RGZZESD			
	Drive End		Opposite Drive End		Drive End		Opposite Drive End	
	AFBMA no.	Size	AFBMA no.	Size	AFBMA no.	Size	AFBMA no.	Size
143T - 145T	25BC02JEE3	6205	25BC02JEE3	6205	25BC02JP3	6205	25BC02JP3	6205
182T - 184T	30BC02JEE3	6206	25BC02JEE3	6205	30BC02JP3	6206	30BC02JP3	6206
213T - 215T	40BC02JEE3	6208	30BC02JEE3	6206	40BC02JP3	6208	40BC02JP3	6208
254T - 256T	45BC03JEE3	6309	35BC02JEE3	6207	45BC03JP3	6309	45BC03JP3	6309
284TS - 286TS	45BC02JPP3	6209	45BC02JPP3	6209	50BC03JP3	6310	50BC03JP3	6310
284T - 286T	55BC03JPP3	6311	45BC02JPP3	6209	50BC03JP3	6310	50BC03JP3	6310
324TS - 326TS	55BC03JPP3	6311	55BC03JPP3	6311	60BC03JP3	6312	60BC03JP3	6312
324T - 326T	60BC03JPP3	6312	55BC03JPP3	6311	60BC03JP3	6312	60BC03JP3	6312
364TS - 365TS	55BC03JPP3	6311	55BC03JPP3	6311	70BC03JP3	6314	70BC03JP3	6314
364T - 365T	70BC03JPP3	6314	55BC03JPP3	6311	70BC03JP3	6314	70BC03JP3	6314
404TS - 405TS	65BC03JPP3	6313	65BC03JPP3	6313	80BC03JP3	6316	80BC03JP3	6316
404T - 405T	80BC03JPP3	6316	65BC03JPP3	6313	80BC03JP3	6316	80BC03JP3	6316
444TS - 445TS	65BC03JPP3	6313	65BC03JPP3	6313	80BC03JP3	6316	80BC03JP3	6316
444T - 445T	90BC03JPP3	6318	65BC03JPP3	6313	90RU03M0	NU318	80BC03JP3	6316
447TS - 449TS	65BC03JPP3	6313	65BC03JPP3	6313	80BC03JP3	6316	80BC03JP3	6316
447T - 449T	90RU03M0	NU318	65BC03JPP3	6313	100RU03M0	NU320	80BC03JP3	6316
S449SS	–	–	–	–	–	–	–	–
S449LS	–	–	–	–	–	–	–	–

Grease and Rulubricating Instructions

To assist our customers in securing trouble-free service from electric motors, Siemens uses double-shielded bearings on most NEMA size motors.

This type of bearing allows controlled migration of grease into the bearing, yet protects against overgreasing.

Replenishment grease for ball bearings should have a wide usable temperature range (-20°F to +350°F) and be made with a polyurea thickener and high quality oil with an NLGI #2 consistency. Chevron SRI #2 meets these requirements.

For roller bearing grease replenishment, use the grease recommended on the motor lubrication instruction plate.

Relubrication Frequency	Type of Service
6 months	normal-duty in relatively clean & dry environments
3 months	heavy-duty in dirty, dusty locations, high ambients, moisture laden atmosphere or increased vibration levels

Normal Lubrication Sequence

1. Stop the motor. Lock out the switch.

2. Thoroughly clean off and remove the grease inlet and drain pipe plugs from bearing housing.

3. Remove hardened grease from drains with stiff wire or rod.

4. Add grease to inlet until a small amount of new grease is forced out drain.

5. Remove excess grease from ports, replace inlet plugs and run motor 1/2 hour before replacing drain plugs.

6. Put motor back in operation.

Bearing Grease Capacity

Bearing Grease Capacity

Frame	Shaft End Bearing		Opposite End Bearing
	Direct Connected	Belted	
140T	0.2 oz.	0.2 oz.	0.2 oz.
180T	0.3	0.3	0.3
210T	1.6	1.6	1.6
250T	2.3	2.3	2.3
280T(S)	2.6	2.6	2.6
320T(S)	5.5	5.5	5.5
360T(S)	7.5	7.5	7.5
400T(S)	7.5	7.5	7.5
440T(S)	7.5	14.5	7.5

The grease capacity given is for that space in the bearing housing between the shield and the outside of the motor.

Standard Ball Bearings for NEMA Frames "P" Base — Vertical Motors
Totally Enclosed Fan Cooled (TEFC) and Explosion-Proof

Frame	Normal Thrust Types: RGZVESD, RGZZVESD				Medium Thrust Types: RGZVMTESD, RGZZVMTESD			
	Drive End		Opposite Drive End		Drive End		Opposite Drive End	
	AFBMA no.	Size	AFBMA no.	Size	AFBMA no.	Size	AFBMA no.	Size
143HP - 145HP	30BC02J3	6206	30BC02J3	6206	-	-	-	6203
182HP - 184HP	30BC02J3	6206	30BC02J3	6206	-	-	-	6204
213HP - 215HP	45BC02J3	6209	45BC03J3	6309	-	-	-	6206
254HP - 256HP	45BC03J3	6309	45BC03J3	6309	-	-	-	6208
284HP - 286HP	60BC03JP3	6312	50BC03JPP3	6310	60BC03JP3	6312	50BT03XXXDO 50BZ03K	7310 QJ310
324HP - 326HP	60BC03JP3	6312	60BC03JPP3	6312	60BC03JP3	6312	55BT03XXXDO 55BZ03K	7311 QJ311
364HP - 365HP	60BC03JP3	6312	70BC03JPP3	6314	60BC03JP3	6312	55BT03XXXDO 55BZ03K	7311 QJ311
404HP - 405HP	80BC03JPP3	6316	80BC03JPP3	6316	80BT03XXXD0	7316	80BC03JPP3	6316
444HP - 449HP (2 pole)	80BC03JPP3	6316	80BC03JPP3	6316	80BT03XXXD0	7316	80BC03JPP3	6316
444HP - 449HP (4 pole & slower)	90BC03JPP3	6318	80BC03JPP3	6316	90BT03XXXD0	7318	80BC03JPP3	6316

Standard Ball Bearings for NEMA Frames "P" Base — Vertical Motors
Totally Enclosed Fan Cooled (TEFC) and Explosion-Proof

Frame	Vertical In-Line Types: RGZVILESD, RGZZVILESD			
	Drive End		Opposite Drive End	
	AFBMA no.	Size	AFBMA no.	Size
143LP - 145LP	30BC02J3	6206	35BT03MR (duplex)	7306
182LP - 184LP	30BC02J3	6206	30BT03MR (duplex)	7306
213LP - 215LP	45BC02J3	6209	45BT03MR3 (duplex)	7309
254LP - 256LP	45BC03J3	6309	45BT03MR3 (duplex)	7309
284LP(H) - 286LP(H)	60BC03JP3	6312	50BT03JR (duplex)	7310
324LP - 326LP	60BC03JP3	6312	55BT03JR (duplex)	7311
364LP - 365LP	60BC03JP3	6312	55BT03JR (duplex)	7311
404LP - 405LP	80BC03JPP3	6316	55BT03JR (duplex)	7311
444LP - 445LP	80BC03JPP3	6316	55BT03JR (duplex)	7311

ABMA Nomenclature — Ball Bearings

Bearing Bore	Bearing Type	Dimension Series	Modifications			Fitup & Tolerance	
D D D	L L L	D D	L	LL*	L*	D**	D**

L designates a letter
D designates a digit

Tolerances
0 - Standard tolerances - ABEC 1
3 - More precision than 0 ABEC 3
5 - More precision than 3 - ABEC 5

Internal Clearances
0 - Standard fitup - AFBMA 0 or C/0
3 - Loose internal fitup - AFBMA 3 or C/3
4 - Looser than C/3 AFBMA 4 or C/4

Modifications (L*)
G - Snap ring and groove in outer race
D - Single bearing modified for duplex mounting

Column 2 or 3 Used for R, T, or U (LL*)
P - Single shielded - permanently fastened
PP - Double shielded - permanently fastened
E - Single sealed - permanently fastened
EE - Double sealed - permanently fastened
KK - Double labyrinth seals for cartridge bearings
R - Pair of bearings modified for duplex mounting - back to back
T - Pair of bearings modified for duplex mounting - in tandem
U - Pair of bearings modified for duplex mounting - face to face
X - None of the above - see footnote *
XX - None of the above - see footnote *

Type of Cage or Ball Retainer (L)
J - Standard - steel, sheet or strip form, centered by the balls
K - Bronze or brass, not sheet or strip, centered by one race
M - Bronze or brass, not sheet or strip, centered by the balls
D - Non-metallic (phenolic), centered by one race
X - Any type of cage
Y - Non-ferrous metal, sheet or strip form, center

Dimension Series
10 - Extra light, e.g. 6000 (SKF)
02 - Light, e.g. 6200 (SKF)
03 - Medium, e.g. 6300 (SKF)
32 - Light series wide cartridge type sealed bearings, e.g., 200-SZZC (SKF)
33 - Medium series with wide cartridge type sealed bearings, e.g., 300 SZZC (SKF)

Type of Ball bearing (2 or 3 Letters)
BC - Standard deep groove ball bearing, e.g. 6308 (SKF)
BL - Maximum capacity ball bearing with filling slot, e.g. 308M (SKF)
BT - Angular contact thrust bearing, e.g., 7313BE (SKF)

Bearing Bore in Millimeters (2 or 3 Digits)
e.g., 203 = 17, 204 = 20, 307 = 35, 222 = 110, i.e., the last two digits are multiplied by 5 to obtain the bore, excepting the 203 or 303 size bearing which is 17.

Example: 35BC02JPP3 - Standard deep groove, light series, standard steel cage, double shielded, loose fitup and standard tolerances 6207ZZC3 (SKF) or equivalent.
Example: SSBTO3JR - This is a pair of 7313BECB (SKF) angular contact bearings mounted back to back, standard fitup.
* The letters for columns 2, 3 and 4 of modifications are omitted if none are applicable. If column 4 is applicable but not 3, or 2 and 3, an X or XX is used in column 3, or 2 and 3, e.g., 35 BC02J03 or 35 BT03MXXD03
** If these three columns are omitted, standard fitup, tolerances, and greases are implied

Belted Service
Sheave Limitations for Standard Bearings and Shaft

Frame	Horsepower at Synchronous Speed, RPM				V-belt Sheave			
					Conventional A,B,C,D and E		Narrow 3V, 5V and 8V	
	3600	1800	1200	900	Min. Pitch Dia., in.	Max. Width	Min. Outside Dia., in.	Max. Width
143T	1 1/2	1	3/4	1/2	2.2	4 1/4	2.2	2 1/4
145T	2-3	1 1/2	1	3/4	2.4	4 1/4	2.4	2 1/4
182T	3	3	1 1/2	1	2.4	5 1/4	2.4	2 3/4
182T	5	-	-	-	2.6	5 1/4	2.4	2 3/4
184T	-	-	2	1 1/2	2.4	5 1/4	2.4	2 3/4
184T	5	-	-	-	2.6	5 1/4	2.4	2 3/4
184T	7 1/2	5	-	-	3.0	5 1/4	3.0	2 3/4
213T	7 1/2-10	7 1/2	3	2	3.0	6 1/2	3.0	3 3/8
215T	10	-	5	3	3.0	6 1/2	3.0	3 3/8
215T	15	10	-	-	3.8	6 1/2	3.8	3 3/8
254T	15	-	7 1/2	5	3.8	7 3/4	3.8	4
254T	20	15	-	-	4.4	7 3/4	4.4	4
256T	20-25	-	10	7 1/2	4.4	7 3/4	4.4	4
256T	-	20	-	-	4.6	7 3/4	4.4	4
284T	-	-	15	10	4.6	9	4.4	4 5/8
284T	-	25	-	-	5.0	9	4.4	4 5/8
286T	-	30	20	15	5.4	9	5.2	4 5/8
324T	-	40	25	20	6.0	10 1/4	6.0	5 1/4
326T	-	50	30	25	6.8	10 1/4	6.8	5 1/4
364T	-	-	40	30	6.8	11 1/2	6.8	5 7/8

For Horsepowers and frames larger than shown consult the Medallion™ selection and pricing guide for integral horsepower AC motors.

Information based upon the following:

1. Drive service factor of 1.6 maximum (using nameplate horsepower and speed) with the belts tightened to belt manufacturers' recommendations.
2. Maximum speed reduction of 5:1.
3. Center distance between sheaves approximately equal to the diameter of the larger sheave.
4. Sheave mounted 0.5" maximum from BA shaft shoulder.

For longer bearing life, minimum sheave diameters should be avoided, especially for fluctuating type loads.

Note: For limitations on flat belt pulley, spur and helical pinion and sprocket for chain drive, refer to NEMA Standards MG 1-14.07.2.

REFER TO FACTORY IF LIMITS EXCEED VALUES IN TABULATION.

Rotor Weights and Inertias

			Epact Efficiency Totally Enclosed Fan Cooled (TEFC) Types RGZP, RGZPSD		Premium Efficiency Totally Enclosed Fan Cooled (TEFC) Types RGZE, RGZESD, RGZZESD		Standard Efficiency Open Drip-Proof (ODP) Type RGE1	
HP	**RPM**	**Frame**	**Weight (lb)**	**Inertia (lb-ft²)**	**Weight (lb)**	**Inertia (lb-ft²)**	**Weight (lb)**	**Inertia (lb-ft²)**
0.75	1200	143T	7.4	0.05	8.0	0.06	11	0.11
0.75	900	145T	10	0.08	11	0.09	-	-
1	1800	143T	7.4	0.05	8.7	0.06	7.7	0.07
1	1200	145T	9.7	0.07	10	0.08	11	0.11
1	900	182T	12	0.11	14	0.14	-	-
1.5	3600	143T	7.4	0.05	8.9	0.07	11	0.11
1.5	1800	145T	7.5	0.05	9.1	0.06	11	0.11
1.5	1200	182T	12	0.11	14	0.14	18	0.28
1.5	900	184T	16	0.16	18	0.18	24	0.62
2	3600	145T	9.6	0.07	10	0.08	11	0.11
2	1800	145T	9.7	0.07	10	0.08	11	0.12
2	1200	184T	14	0.14	17	0.18	16	0.28
2	900	213T	23	0.32	23	0.32	30	0.76
3	3600	145T	-	-	-	-	12	0.13
3	3600	182T	10	0.09	12	0.11	-	-
3	1800	182T	12	0.11	14	0.14	15	0.23
3	1200	213T	22	0.28	27	0.39	24	0.45
3	900	215T	29	0.43	29	0.43	36	0.91
5	3600	182T	-	-	-	-	15	0.13
5	3600	184T	13	0.12	16	0.16	-	-
5	1800	184T	16	0.16	17	0.18	20	0.37
5	1200	215T	28	0.40	34	0.54	35	0.70
5	900	254T	46	0.94	50	1.1	53	1.8
7.5	3600	184T	-	-	-	-	18	0.19
7.5	3600	213T	27	0.32	32	0.43	-	-
7.5	1800	213T	27	0.39	31	0.50	30	0.56
7.5	1200	254T	44	0.95	60	1.4	59	2.2
7.5	900	256T	59	1.3	64	1.5	64	2.1
10	3600	213T	-	-	-	-	31	0.26
10	3600	215T	29	0.43	31	0.49	-	-
10	1800	215T	32	0.51	36	0.58	35	0.70
10	1200	256T	56	1.2	71	1.7	68	2.9
10	900	284T	81	2.6	86	2.8	83	3.6
15	3600	215T	-	-	-	-	38	0.38
15	3600	254T	56	1.2	56	1.2	-	-
15	1800	254T	46	0.9	57	1.3	59	1.3
15	1200	284T	73	2.2	81	2.6	97	5.0
15	900	286T	97	3.4	105	3.8	100	4.4

Rotor Weights and Inertias

			Epact Efficiency Totally Enclosed Fan Cooled (TEFC) Types RGZP, RGZPSD		Premium Efficiency Totally Enclosed Fan Cooled (TEFC) Types RGZE, RGZESD, RGZZESD		Standard Efficiency Open Drip-Proof (ODP) Type RGE1	
HP	**RPM**	**Frame**	**Weight (lb)**	**Inertia (lb-ft^2)**	**Weight (lb)**	**Inertia (lb-ft^2)**	**Weight (lb)**	**Inertia (lb-ft^2)**
20	3600	254T	-	-	-	-	59	0.63
20	3600	256T	57	1.2	58	1.3	-	-
20	1800	256T	59	1.3	71	1.7	68	1.7
20	1200	286T	86	2.8	97	3.3	115	6.1
20	900	324T	130	5.4	136	5.5	123	7.3
25	3600	256T	-	-	-	-	73	0.91
25	3600	284TS	59	1.3	75	1.9	-	-
25	1800	284T	76	2.4	86	2.8	73	2.5
25	1200	324T	110	4.1	121	4.9	137	9.1
25	900	326T	147	6.4	153	6.5	147	9
30	3600	284TS	-	-	-	-	64	1.6
30	3600	286TS	66	1.6	85	2.3	-	-
30	1800	286T	86	2.8	97	3.3	86	3.1
30	1200	326T	122	4.9	137	5.8	146	9.7
30	900	364T	189	11	192	11	180	17
40	3600	286TS	-	-	-	-	75	1.9
40	3600	324TS	90	2.6	105	3.3	-	-
40	1800	324T	111	4.2	119	4.7	117	5.7
40	1200	364T	184	11	184	11	176	14
40	900	365T	228	14	231	14	205	20
50	3600	324TS	-	-	-	-	95	3
50	3600	326TS	102	3.2	121	4.1	-	-
50	1800	326T	130	5.4	136	5.8	141	7.2
50	1200	365T	199	12	213	13.1	213.8	18
50	900	404T	299	25	304	26	299	25
60	3600	326TS	-	-	-	-	104	3.4
60	3600	364TS	120	4.3	130	5.0	-	-
60	1800	364T	156	8.3	173	9.6	161	10
60	1200	404T	263	21	284	23	263	21
60	900	405T	331	29	340	30	331	29
75	3600	364TS	-	-	-	-	132	5.2
75	3600	365TS	139	5.5	157	6.6	-	-
75	1800	365T	185	11	199	12	122	10
75	1200	405T	307	26	331	29	307	26
75	900	444T	400	40	400	40	400	40

Rotor Weights and Inertias

			Epact Efficiency Totally Enclosed Fan Cooled (TEFC) Types RGZP, RGZPSD		Premium Efficiency Totally Enclosed Fan Cooled (TEFC) Types RGZE, RGZESD, RGZZESD		Standard Efficiency Open Drip-Proof (ODP) Type RGE1, RGE	
HP	RPM	Frame	Weight (lb)	Inertia (lb-ft²)	Weight (lb)	Inertia (lb-ft²)	Weight (lb)	Inertia (lb-ft²)
100	3600	365TS	-	-	-	-	150	6.3
100	3600	405TS	216	11	232	12	-	-
100	1800	404T	-	-	-	-	243	18
100	1800	404TS	-	-	-	-	232	17
100	1800	405T	266	19	302	23	-	-
100	1200	444T	397	39	416	42	437	46
100	900	445T	487	53	487	53	487	53
125	3600	404TS	-	-	-	-	168	8.8
125	3600	444TS	263	17	281	19	-	-
125	1800	405TS	-	-	-	-	272	22
125	1800	405T	-	-	-	-	284	22
125	1800	444TS	348	32	375	35	-	-
125	1800	444T	367	32	390	36	-	-
125	1200	445T	465	49	503	54	518	58
125	900	447T	583	64	583	64	583	64
150	3600	405TS	-	-	-	-	185	10
150	3600	445TS	297	21	319	23	-	-
150	1800	445T	416	38	446	43	-	-
150	1800	444TS	-	-	-	-	336	32
150	1800	444T	-	-	-	-	357	32
150	1800	445TS	397	38	430	42	-	-
150	1200	445T	-	-	-	-	518	58
150	1200	447T	550	59	587	64	-	-
150	900	447T	626	70	626	70	619	70
200	3600	444TS	-	-	-	-	260	18
200	3600	447TS	371	28	392	30	-	-
200	1800	445TS	-	-	-	-	385	38
200	1800	447TS	501	50	529	54	-	-
200	1800	445T	-	-	-	-	407	38
200	1800	447T	526	51	549	54	-	-

Rotor Weights and Inertias

			Standard Efficiency Totally Enclosed Fan Cooled (TEFC) Types RGZ, RGZSD, RGZZSD		Premium Efficiency Totally Enclosed Fan Cooled (TEFC) Types RGZE, RGZESD, RGZZESD		Standard Efficiency Open Drip-Proof (ODP) Type RGE	
HP	**RPM**	**Frame**	**Weight (lb)**	**Inertia (lb-ft²)**	**Weight (lb)**	**Inertia (lb-ft²)**	**Weight (lb)**	**Inertia (lb-ft²)**
200	1200	447T	-	-	-	-	619	70
200	1200	449T	710	79	739	85	-	-
200	900	449T	764	88	764	88	710	82
250	3600	445TS	-	-	-	-	302	23
250	3600	449TS	456	35	486	38	-	-
250	1800	445TS	-	-	-	-	385	38
250	1800	445T	-	-	-	-	407	38
250	1800	449TS	623	64	645	67	-	-
250	1800	449T	648	64	670	67	-	-
250	1200	449T	701	79	739	85	758	88
300	3600	447TS		-	-	-	347	26
300	3600	449TS	456	35	484	38	-	-
300	1800	447TS	-	-	-	-	508	52
300	1800	447T	-	-	-	-	531	53
300	1800	449TS	623	64	645	67	-	-
300	1800	449T	648	64	670	67	591	61
350	3600	447TS	-	-	-	-	347	26
350	1800	447TS	-	-	-	-	-	-
350	1800	447T	-	-	-	-	531	53
400	3600	447TS	-	-	-	-	347	26
400	1800	449TS	-	-	-	-	-	-
400	1800	449T	-	-	-	-	569	58
450	3600	449TS	-	-	-	-	411	31
450	1800	449TS	-	-	-	-	-	-
450	1800	449T	-	-	-	-	-	-

Rotor Weights and Inertias

Premium Efficiency Super 449 Totally Enclosed Fan Cooled (TEFC)				
HP	**RPM**	**Frame**	**Weight (lb)**	**Inertia ($lb\text{-}ft^2$)**
350	3600	S449SS	527	43
400	3600	S449SS	561	48
350	1800	S449SS	684	74
400	1800	S449SS	684	74
350	1800	S449LS	711	75
400	1800	S449LS	711	75
300	1200	S449LS	839	106
350	1200	S449LS	839	106

Paint Process Standard — Little Rock Plant

Surface Preparation and Primer

1. Ferrous castings are blast cleaned in accordance with standard specification SSPC-SP-6.

2. Castings are immediately primed with a lead free alkyd base primer to a thickness of 2 to 3 mils.

3. Exterior surfaces are solvent cleaned as required to remove oil or other contaminants resulting from manufacturing or assembly operations.

Paint

Siemens standard finish paint consists of the following:

Epoxy modified acrylic air dry enamel.
Viscosity: 5--55 seconds No. 2 Zahn cup @ 77°F.
Fineness: 7 N.S. units Hegeman gage:
Adhension: 90% Cross-hatch test (tape)
Impact resistance: 40 inch pounds direct - No cracks
Composition: Lead and Chromate free

Color

Motor types RGZP-RGZPSD Gray, Types RGZESD, RGZZESD Dark Blue.

An optional paint system for extremely corrosive atmospheres is available.
Refer to your Siemens Representative.

Exposed Metal Surfaces

Exposed metal surfaces such as shafts are coated with rust preventative.

Packaging

A. Standard Domestic Packing - Horizontal Motors

Frames 140 - 180 - Motor packed in corrugated carton.

Frame 210 - 250 - Motor feet bolted to wooden base in corrugated carton with double wall corrugated liner.

Frames 280 - 440 -
Motor feet bolted to wooden skid:

Frames	Skid Sizes
280	26” X 33”
320	26” X 33”
360	31” X 37”
400	36” X 45”
444-445	54” X 40”
447-449	60” X 40”
Super 440	72” X 42”

Vertical P Base Motors 250 Frame and Larger - Bolted to wooden skids of sufficient height to clear shaft.

Round Frame Motors 140 through 280 Frames - Plastic wrapped and foamed into corrugated carton.

B. Motor shafts and exposed finished surfaces coated with an oil-type rust preventive (Exxon Rust-Ban 343 or equal).

C. Pallet Packing - Individually boxed motors 140 through 280 Frames on pallets 44” X 51”.

140 Frames - 10 per layer, 4 layers high
180 Frames - 8 per layer, 3 layers high
210 Frames - 6 per layer, 3 layers high
250 Frames - 4 per layer, 2 layers high
280 Frames - 4 per layer, 2 layers high

D. Export Packing when specified:

Shipments to Canada or Mexico same as Standard Domestic Packing per Item A.

Ocean and Air Shipment “Export Boxing” (charge per modification section of price book) is one motor per box wrapped in plastic and foamed in place in a solid wooden box.

Packaging Dimensions

Frame	Motor Type	Carton Dimensions (in)			Pallet Dimensions (in)	
		Height	Width	Depth	Width	Depth
143 - 145	Horizontal	14.5	11.5	9		
182 - 184	Horizontal	17	13.5	11.5		
213 - 215	Horizontal	21.5	16.5	15.25		
254 - 256	Horizontal	19	19.5	26		
284 - 286	Horizontal	—	—	—	26	33
324 - 326	Horizontal	—	—	—	26	33
364 - 365	Horizontal	—	—	—	31	37
404 - 405	Horizontal	—	—	—	36	45
444 - 445	Horizontal	—	—	—	54	40
447 - 449	Horizontal	—	—	—	60	40
Super 440	Horizontal	—	—	—	72	42
182 - 256	In-line Vertical	—	—	—	28	32
284 - 365	In-line Vertical	—	—	—	28	32
404 - 445	Vertical	—	—	—	40	40

3600 RPM - TEFC Enclosure - (See Note 1)

Premium Efficiency Motors										
HP	Frame	Overall Sound Pressure dBA	Overall Sound Power dBA	A-Weighted Sound Pressure Levels [dB(A)] @ 1 Meter Octave Band Center Frequencies [HZ] 125	250	500	1000	2000	4000	8000
	140	74	83	32	52	69	70	67	60	51
	180	82	90	41	58	75	77	77	68	57
	210	81	90	46	62	76	76	76	71	61
	250	83	93	53	65	77	78	77	71	61
	280	72	83	46	57	65	64	69	65	54
	320	77	87	43	56	68	68	70	74	54
	360	87	98	59	74	77	82	83	77	67
	400	80	91	51	67	72	74	74	72	61
	444	79	90	52	68	72	74	74	70	60
	445	79	90	50	67	71	74	74	70	59
200	447	83	94	55	69	74	78	79	72	63
250	449	82	94	54	69	73	78	78	72	63
300	449	91	103	63	77	81	88	86	80	71
350	S449	94	106	69	81	87	88	89	84	75
400	S449	*85	*97	61	76	78	78	78	74	66

* Directional Fan

Note 1 - IEEE 841 1994 specifies 90 dBA sound power
- Contact factory on specific rating

Standard Efficiency Motors										
HP	Frame	Overall Sound Pressure dBA	Overall Sound Power dBA	A-Weighted Sound Pressure Levels [dB(A)] @ 1 Meter Octave Band Center Frequencies [HZ] 125	250	500	1000	2000	4000	8000
	140	72	80	34	49	60	69	67	61	51
	180	80	88	42	57	67	73	78	70	58
	210	81	90	46	62	76	76	76	71	61
	250	84	93	49	64	73	77	80	76	69
	280	80	90	49	67	74	74	76	70	60
	320	80	90	49	67	74	75	76	69	59
	360	89	100	62	76	81	84	85	80	69
	400	84	94	56	70	78	79	78	75	67
	444	82	93	53	70	74	78	77	72	63
	445	82	93	53	70	74	78	77	72	63
200	447	91	102	64	77	82	87	86	80	70
250	449	91	102	64	77	82	87	86	80	70

1800 RPM - TEFC Enclosure - (See Note 1)

Premium Efficiency Motors										
HP	**Frame**	**Overall Sound Pressure dBA**	**Overall Sound Power dBA**	**A-Weighted Sound Pressure Levels [dB(A)] @ 1 Meter Octave Band Center Frequencies [HZ] 125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
	140	55	64	28	45	47	52	49	43	35
	180	63	72	33	51	54	60	58	48	39
	210	67	77	40	58	62	64	59	53	44
	250	72	83	49	60	67	68	66	63	50
	280	66	76	48	56	59	59	61	55	42
	320	70	80	40	51	61	60	68	54	41
	360	70	81	49	59	64	65	64	61	49
	400	67	77	44	57	61	62	60	59	48
	444	75	86	53	64	73	68	66	61	51
	445	73	84	54	64	70	67	66	58	49
200	447	74	85	51	63	70	67	68	60	50
250	449	75	86	57	61	71	69	67	59	50
300	449	84	95	67	73	79	79	75	67	58
350	S449	85	97	70	75	81	80	75	68	60
400	S449	84	96	67	73	79	80	76	69	61

Note 1 - IEEE 841 1994 specifies 90 dBA sound power
- Contact factory on specific rating

Standard Efficiency Motors										
HP	**Frame**	**Overall Sound Pressure dBA**	**Overall Sound Power dBA**	**A-Weighted Sound Pressure Levels [dB(A)] @ 1 Meter Octave Band Center Frequencies [HZ] 125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
	140	57	65	31	32	49	54	50	48	35
	180	65	74	37	44	51	64	55	48	35
	210	69	78	37	49	57	68	60	52	52
	250	74	84	41	52	62	73	64	59	51
	280	69	79	50	57	65	64	60	57	46
	320	73	83	52	58	69	68	65	61	49
	360	73	83	51	61	69	68	65	59	49
	400	75	86	56	65	70	71	68	61	53
	444	82	93	63	70	80	75	72	66	57
	445	81	92	60	69	78	75	72	65	56
200	447	79	91	59	67	77	73	69	62	52
250	449	79	91	62	67	77	73	70	64	55

1200 RPM - TEFC Enclosure - (See Note 1)

Premium Efficiency Motors										
HP	Frame	Overall Sound Pressure dBA	Overall Sound Power dBA	A-Weighted Sound Pressure Levels [dB(A)] @ 1 Meter Octave Band Center Frequencies [HZ] 125	250	500	1000	2000	4000	8000
	140	50	58	26	31	43	47	40	36	31
	180	54	63	35	36	46	52	47	41	31
	210	64	73	41	42	52	64	54	47	34
	250	67	77	46	50	64	61	57	46	39
	280	63	73	48	56	58	60	53	46	35
	320	68	78	36	47	55	65	64	48	36
	360	65	76	39	51	60	61	60	50	39
	400	66	77	48	58	61	62	57	48	39
	444	65	76	48	58	59	60	58	55	42
	445	66	77	46	58	61	61	59	56	41
150	447	64	75	45	55	59	60	57	50	42
200	449	64	76	48	56	59	59	57	53	41
250	449	79	90	54	64	68	69	71	76	68
300	S449	74	87	57	65	69	71	66	61	56
350	S449	75	87	59	66	71	70	65	61	55

Note 1 - IEEE 841 1994 specifies 90 dBA sound power
- Contact factory on specific rating

Standard Efficiency Motors										
HP	Frame	Overall Sound Pressure dBA	Overall Sound Power dBA	A-Weighted Sound Pressure Levels [dB(A)] @ 1 Meter Octave Band Center Frequencies [HZ] 125	250	500	1000	2000	4000	8000
	140	50	58	28	32	45	47	38	34	28
	180	57	66	33	33	47	54	53	36	31
	210	60	69	32	39	53	58	52	41	31
	250	68	78	44	50	63	65	59	51	42
	280	61	71	38	47	58	56	53	45	34
	320	65	76	45	55	62	59	57	50	38
	360	64	75	39	53	61	59	58	47	41
	400	68	78	47	59	60	66	59	49	38
	444	70	81	59	64	66	63	60	60	46
	445	70	80	49	60	65	65	60	60	46
150	447	69	80	50	58	64	64	60	53	47
200	449	67	78	49	57	63	61	59	50	43

Mechanical Modifications for Low Temperature TEFC Motors Only

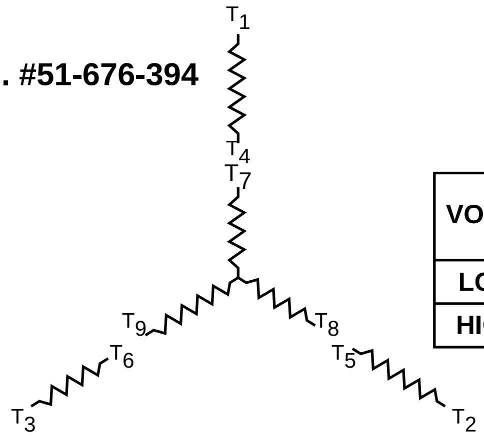
Temperature.	Grease Bearing & Housing	Anti-Friction Bearings	Shaft Material	Bearing Housing & Yoke
80°F				
40°F	Standard Chevron SRI#2	Standard Materials	Standard Hot-Rolled C-1045 Steel	Standard Cast Iron
0°F				
-20°				
-40°F	Mobil #28	Standard Materials Special Grease		
-65°F			Special Steel	
-90°F	Silicone Grease	Special Materials Grease	Special Stainless Steel	

Note: Below -65°F each application to be considered separately - Contact Factory.

Carbon steel eyebolts are used to -25°F, below -25°F Austenitic Stainless Steel Eyebolts must be used.

External Connection Diagrams - Single Speed

DWG. #51-676-394

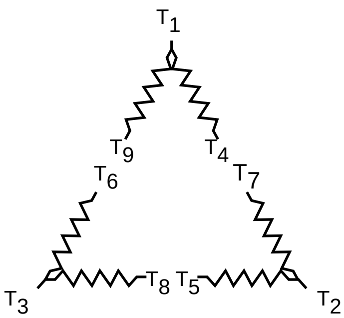


3 PHASE – 9 LEAD – WYE

VOLTS	LINES			CONNECTED TOGETHER	CONN.
	L1	L2	L3		
LOW	T_1 T_7	T_2 T_8	T_3 T_9	$T_4T_5T_6$	YY
HIGH	T_1	T_2	T_3	T_4 T_7 - T_5 T_8- T_6 T_9	Y

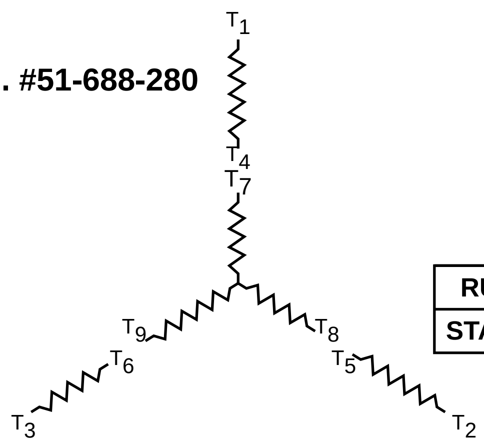
DWG. #51-676-397

3 PHASE – 9 LEAD – DELTA



VOLTS	LINES			CONNECTED TOGETHER	CONN.
	L1	L2	L3		
LOW	$T_1T_6T_7$	$T_2T_4T_8$	$T_3T_5T_9$		ΔΔ
HIGH	T_1	T_2	T_3	T_4 T_7 - T_5 T_8- T_6 T_9	Δ

DWG. #51-688-280



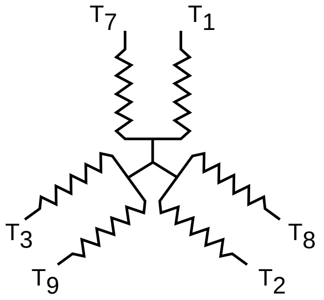
PART WINDING START
3 PHASE – 9 LEAD – WYE

	LINES			CONNECTED TOGETHER	CONN.
	L1	L2	L3		
RUN	T_1 T_7	T_2 T_8	T_3 T_9	$T_4T_5T_6$	YY
START	T_1	T_2	T_3	$T_4T_5T_6$	Y

External Connection Diagrams - Single Speed

DWG. #51-406-529

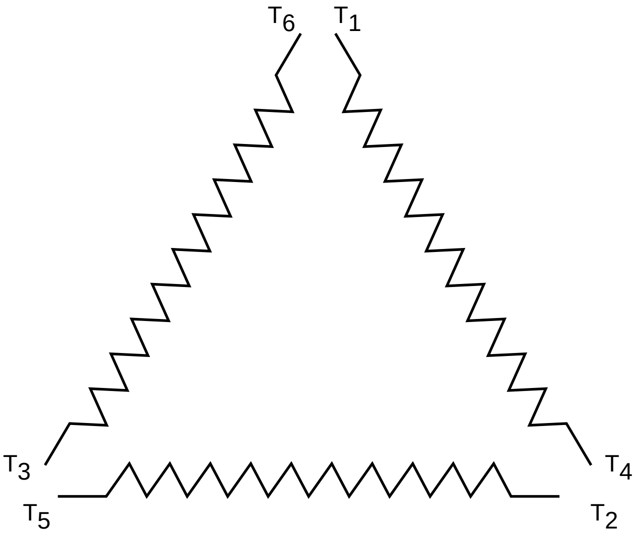
PART WINDING START
3 PHASE – 6 LEAD – WYE



LINES	L1	L2	L3	
START	T_1	T_2	T_3	$T_7T_8T_9$ OPEN
RUN	T_1 T_7	T_2 T_8	T_3 T_9	

DWG. #51-697-465

6 LEAD WYE DELTA START



	LINES			CONNECTED TOGETHER	CONN.
	L1	L2	L3		
START	T_1	T_2	T_3	$T_4T_5T_6$	Y
RUN	T_1 T_6	T_2 T_4	T_3 T_5		Δ

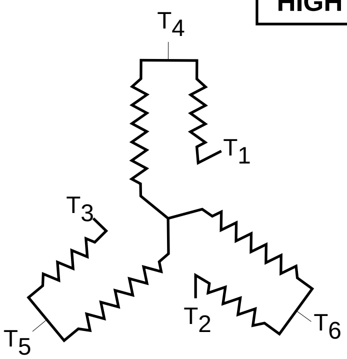
External Connection Diagrams - 2 Speeds

CLASS OF SERVICE AND DWG. NUMBER	SINGLE WINDING

#51-110-063

VARIABLE TORQUE

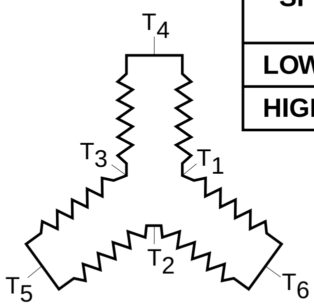
SPEEDS	LINES				CONN.
	L1	L2	L3		
LOW SPEED	T_1	T_2	T_3	T_4 T_5 T_6 OPEN	Y
HIGH SPEED	T_6	T_4	T_5	T_1 T_2 T_3 TOGETHER	YY



#51-110-060

CONSTANT TORQUE

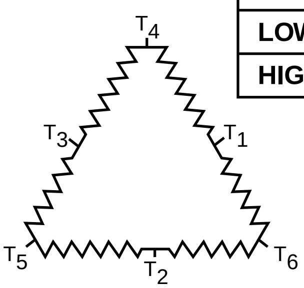
SPEEDS	LINES				CONN.
	L1	L2	L3		
LOW SPEED	T_1	T_2	T_3	T_4 T_5 T_6 OPEN	Δ
HIGH SPEED	T_6	T_4	T_5	T_1 T_2 T_3 TOGETHER	YY



#51-110-069

CONSTANT HORSE-POWER

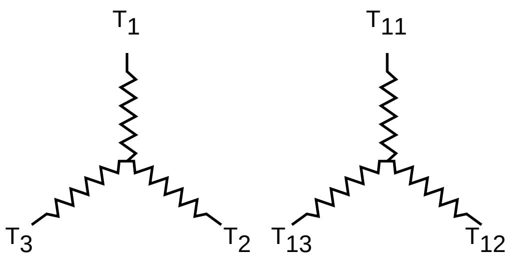
SPEEDS	LINES				CONN.
	L1	L2	L3		
LOW SPEED	T_1	T_2	T_3	T_4 T_5 T_6 OPEN	YY
HIGH SPEED	T_6	T_4	T_5	T_1 T_2 T_3 TOGETHER	Δ



External Connection Diagrams - 2 Speeds

CLASS OF SERVICE AND DWG. NUMBER	DOUBLE WINDING
#51-110-062 1) Variable Torque OR 2) Constant Torque OR 3) Constant Horse-power	3 PHASE – 6 LEAD – WYE

SPEEDS	LINES			OPEN	CONN.
	L1	L2	L3		
LOW SPEED	T_1	T_2	T_3	$T_{11} T_{12} T_{13}$	Y
HIGH SPEED	T_{11}	T_{12}	T_{13}	T_1 T_2 T_3	Y



Temperature Rise Standards

When operated at rated voltage and frequency, the temperature rise of the motor windings, above the ambient temperature should not exceed the values in the following table. Note that separate values are given for motors with a 1.0 service factor and 1.15 service factor. The values given in the table for 1.0 service factor are for motors operated at rated load or nameplate horsepower. The values given for 1.15 service factor are for motors operated at service factor load.

Maximum Winding Temperature Rise °C

	1.0 Service Factor				1.15 Service Factor		
Insulation Class	**A**	**B**	**F**	**H**	**A**	**B**	**F**
	60	80	105	125	70	90	115

Temperature rise values are by resistance method of determination.

Temperature rise values are based on a reference ambient temperature of 40°C.

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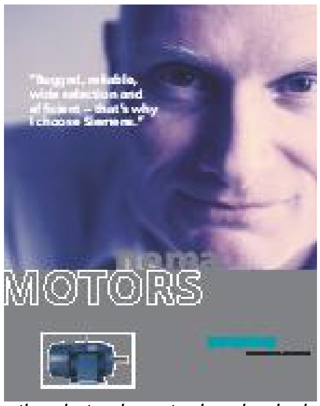
Siemens offers you more than just a motor, we offer the best value for your constant or variable-speed motor application.

In fact, Siemens is the number one provider of motors worldwide with global service and support second to none.



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Application support, availability, wide selection and uncompromising quality are ways we can help you receive optimum value for your motor investment. It's an investment that pays off through reliable operation, energy savings and long service life – day after day, year after year.

Wide Selection | The Right Efficiency | Customer Support | Quality | Availability | Modifications and Customization | Energy Efficiency

EPAct Efficiency | High Efficiency | NEMA Premium | Inverter Duty

Severe Duty TEFC Brake

Wide Selection

Providing value also means having the right motor for the job. At Siemens, we offer hundreds of motor types, sizes, ratings and modifications. And, as you read these words, we are adding to this list as part of our commitment to become your single source for motors.

Designed with "just-in-case" reliability at no extra cost is why we choose Siemens performance, operating efficiency and reliability.

The Right Efficiency for Your Application

To meet your cost of ownership and motor management needs, Siemens offers several levels of energy efficiency in many of its motors:

- EPAct
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When you're looking for a motor, look for a highly trained specialist to help you match the right motor to your specific needs. Siemens sales engineers share the knowledge, training and experience to help you solve performance or installation challenges to ensure that you will receive the best value for your investment.

Our customer service center takes pride in putting our customers first. Whether it's an expedited shipment, tracking your order, or making sure your motor is properly installed, these professionals won't be satisfied until you are.

Iron-clad Quality

The quality of our motors begins with the design experience we have gained through more than 100 years of manufacturing and applying motors.
We build on this experience every day with new designs that incorporate the latest materials and techniques to provide even higher levels of performance, operating efficiency and reliability.

These advanced motor designs are manufactured in a state-of-the-art ISO 9001 certified facility. Here, our manufacturing technicians subject each motor to more than 100 separate quality inspections before it leaves our plant. . . and before it is good enough to be offered to you.

Availability

Siemens has hundreds of distributor stocking locations throughout North America with a wide selection of NEMA motor sizes and ratings.

Motors are available same day from a local source you can trust. These distributors are supported by multiple stocking centers and our customer service centers in Little Rock and Cincinnati. Need something special? Our modification centers have complete motor modification capabilities to help you get the exact motor you need, when you need it.

Getting You the Exact Motor You Need is Our Specialty

Our Little Rock and Cincinnati motor stocking centers also are home to Siemens motor modification centers. These centers offer over 100 various modifications that can be made to a stock Siemens EPAct, High, or NEMA Premium™ efficiency motor, ensuring you will get the exact motor you need, when you need it.

Motor Modification Centers in Cincinnati and Little Rock

When a standard or modified motor won't do, ask us to build one exactly right for you. From special paint types and colors, NEMA Class H insulation and special frequency – to auxiliary blower motors, multi-speed motors, and ambient temperatures from -40º C to 70º C – we can provide the exact motor you need.

Optimum Efficiency and Optimum Durability –
Siemens IEEE 841 Motors

Looking for maximum durability and operating efficiency in severe operating environments? Here it is, the Siemens line of IEEE 841 motors.
These motors exceed IEEE 841 standards that include:

- Low noise: under 90 dBA
- Longer winding life: meets or exceeds NEMA MG-1 Part 31 standards for variable frequency operation
- Minimum vibration: 0.06 inchesper-second peak velocity
- Increased energy efficiency: meets or exceeds NEMA Premium™ efficiency standards
- Protected electrical connections: meets NEMA and IEEE 841 standards
- Longer bearing life: meets IP 55 standards
- Maintenance: easily regreaseable bearings with grease relief
- Structural integrity: close tolerance cast iron construction throughout
- Plus, Siemens IEEE 841 motors are backed by a five-year warranty.

Motor Efficiency – Good for Our Environment

According to the U.S. Department of Energy, industrial electric motors use over one-half of the nation's total power consumption from fossil fuel plants in the process of converting electrical power to mechanical energy. In converting fossil fuel into electricity, these plants produce greenhouse gasses that are adversely affecting our environment.

By reducing electric motor energy consumption, these fossil fuel plants will not have to produce as much energy, therefore lowering greenhouse gas emissions.

Motor Efficiency – Good for Your Bottom Line

These motors can also consume 50 to 60 times their initial purchase price in energy costs during their service life. With this in mind, it makes good economic sense to carefully examine the return-on-investment your motor will provide during its service life.

More on NEMA Premium efficiency motors from Siemens

In this example, a 50 HP, 1800 RPM motor can save $1,520 in energy costs over five years.

Just think of the energy savings that can be achieved when you have multiple motors operating 24-7 in your facility.

Siemens – A Proud Sponsor of *Motor Decisions Matter*

Newer energy efficient motors are designed to reduce energy consumption through the use of advanced materials, more copper, and tighter tolerances. As a result, they are more costly to manufacture and buy, but pay for themselves through energy savings. As a member of the *Motor Decisions Matter* campaign, Siemens encourages motor users to develop a motor management plan to take advantage of the energy savings available through the use of energy efficient motors. More information about the *Motor Decisions Matter* campaign is available from your Siemens representative or by visiting the *Motor Decisions Matter* website: www.motorsmatter.org

Siemens Motors and Drives – Perfect Harmony

Performance-matched, variable-speed motors and drives from Siemens make perfect sense. They are designed to work together for faster selection, start-up, long-term reliability, and performance. Whether your application requires variable torque capability to operate pumps or fans, constant torque operation for conveyors, hoists or winches, or low-speed constant torque operation in hostile environments – there's a Siemens motor and drive combination available for you. Siemens Drives Community Page

Siemens inverter duty motors meet IEEE and NEMA standards for variable frequency operation, and feature our unique NEMA Class F insulation system to virtually eliminate concerns about harmonic and corona damage.

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Success stories from Siemens

NEMA Premium

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Calendar of Events

→June 26-29, 2005 EASA Convention Nashville, TN

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External Load Inertia Capability, Wk^2 [lb-ft^2]

MOTOR HP	SYNCHRONOUS SPEED AND ENCLOSURE							
	3600 RPM		1800 RPM		1200 RPM		900 RPM	
	ODP	TEFC	ODP	TEFC	ODP	TEFC	ODP	TEFC
0.75	-	-	-	-	20	20	46	47
1	-	-	12	12	24	24	60	63
1.5	4.2	4.2	17	17	45	45	90	95
2	4.5	4.5	23	23	60	60	115	150
3	5	6.5	35	35	85	87	180	240
5	8	11	55	55	145	150	300	400
7.5	13	18	80	80	230	240	430	600
10	20	26	105	105	310	350	540	730
15	30	41	200	220	460	530	820	1100
20	45	53	250	270	610	750	1100	1400
25	55	68	305	340	770	950	1350	1700
30	65	83	375	420	920	1150	1580	1990
40	85	107	480	540	1200	1600	2100	2500
50	120	150	580	680	1520	1750	2890	3020
60	155	180	650	800	1710	1930	3460	3800
75	200	240	790	920	2150	2410	4300	4700
100	250	250	1000	1250	2870	3150	5570	6250
125	300	310	1260	1570	3480	3880	6790	7800
150	350	380	1450	1900	4010	4490	8140	9300
200	425	500	1850	2550	5100	5950	11250	12400
250	525	600	2280	3150	6380	7130	13570	15400
300	600	695	2750	3520	7310	8420	-	-
350	685	800	3410	4100	-	9900	-	-
400	765	900	3900	4670	-	-	-	-
450	860	-	-	-	-	-	-	-

NOTES:

1. Locked rotor and breakdown torques are per NEMA design A and B for general purpose motors.
2. Class F insulation with standard service factor and temperature rise.
3. Rated voltage and frequency applied.
4. During acceleration period, connected load torque varies as the square of the speed and equal to rated torque at rated speed.
5. Two consecutive cold starts or one start with motor at rated temperature.

Insulation System
600 Volts and Lower
Class B and Class F

Slot Liner:	100 % fill polyester fiber - polyester film - polyester fiber laminate (DMD).
Magnet Wire:	Round random wound cooper conducters with heavy terephthalic polyetser coating and Amide-Imide overcoat (200˚C).
Coil Separator:	100% fill polyester fiber - polyester film - polyester fiber laminate (DMD).
Slot Wedges:	Formed aromatic polyamide or 100% treated polyester fiber - polyester film - polyester fiber or polyester glass laminate.
Sleeving:	Acrylic coated glass sleeving impregnated with varnish or aromatic polyamide - polyester film sleeving.
Tie Cord:	Heat shrinkable polyester.
Phase Insulation:	100% fill polyester fiber - polyester film - polyester fiber laminate or varnished glass cloth.
Varnish:	100% solids polyester resin.
Leads:	Cross linked polymeric or Teflon.

Insulation System
600 Volts and Lower
Class H

Slot Liner: Nomex laminate - polyester film - Nomex laminate (NMN)

Magnet Wire: Round random would copper conductors with heavy terephthalic polyester coating and Amide-Imide overcoat (200°C).

Coil Seperator: Nomex laminate - polyester film - Nomex laminate (NMN).

Slot Wedges: Formed aromatic polyamide (Nomex) or silicone glass laminate.

Sleeving: Flexible silicone rubber treated fiberglass sleeving.

Tie Cord: Heat shrinkable polyester.

Phase: Aromatic polyamide (Nomex) fiber paper.

Varnish: 100% solids polyester resin.

Leads: Silicone rubber or Teflon.

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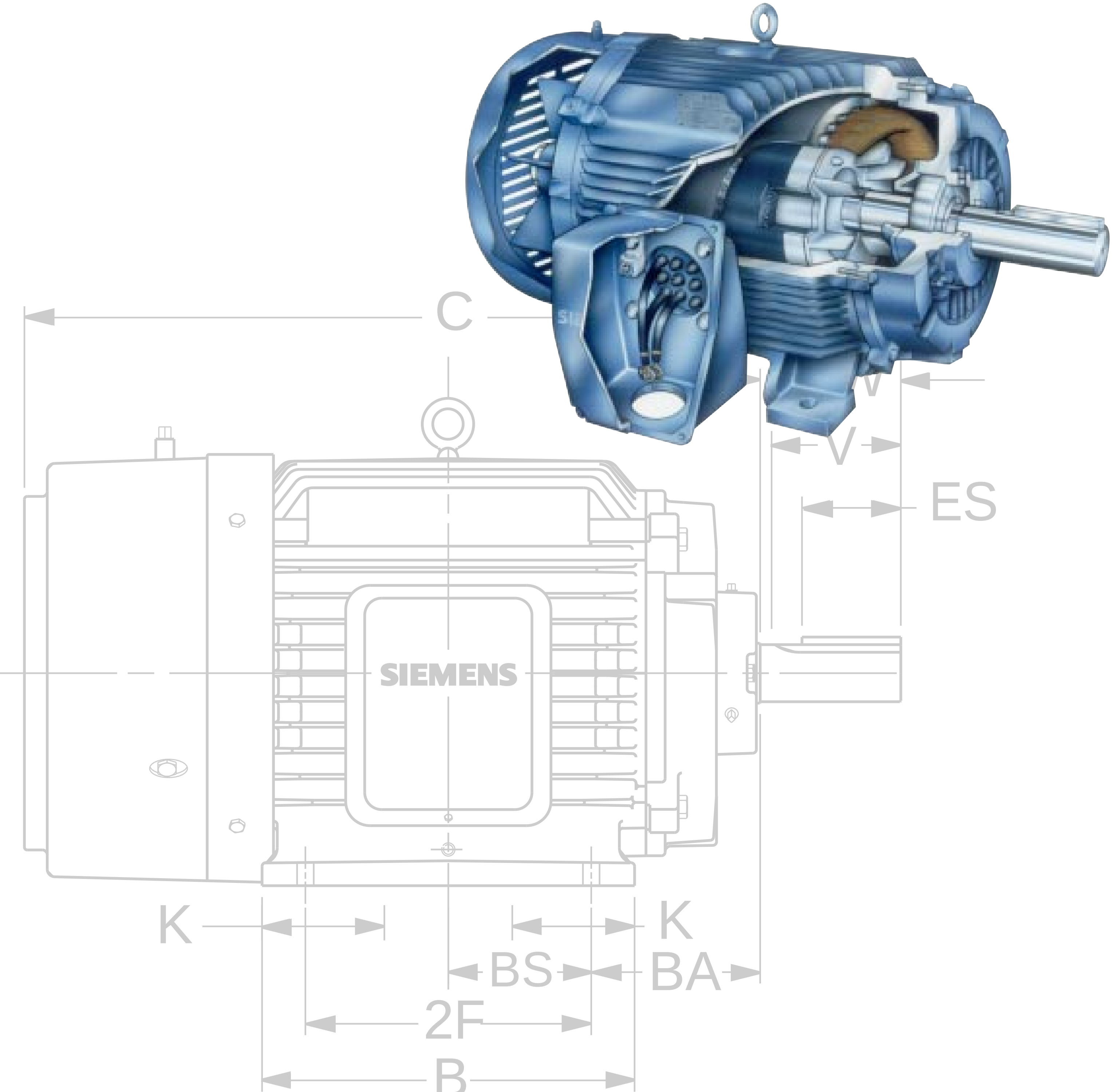
Application Manual for NEMA Motors



NMCD-L4000-0897

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NEMA Frames Application Manual

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Application Manual for NEMA Motors

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Tests

Standard Commercial Test

Standard Commercial Tests per IEEE 112 are performed on all motors and include the following tests:

1. No-load readings of current at rated voltage and frequency. For 50 Hz motors, these readings may be taken at 60 Hz.

2. Check excessive vibration and bearing noise.

3. Measurement of winding resistance at room temperature.

4. Dielectric test - AC voltage of 2304 is applied for one second. (460 v. Motors)

5. Measurement of single phase locked rotor current at one-fourth the rated voltage.

6. Thermostats (klixons) are checked for continuity of circuit.

7. Space heaters wattage is measured with rated voltage applied across heater terminals.

Test reports are made only when specified on the order.

Complete Tests

Complete tests are performed only when specified and include the following:

1. Winding resistance is measured at room temperature.

2. Motor is run no-load at rated voltage with current and watts measured.

3. Full-load heat run includes the following readings and measurements.
   a. Currents and voltages in all phases with amp meter and volt meter.
   b. Input watts with watt meter.
   c. Full-load speed is measured.
   d. Thermocouple temperatures are measured in the following locations:
      - Yoke
      - Winding
      - Rear bearing hub
      - Ambient air
   e. Efficiency is determined by dynamometer per IEEE 112 (MG1-12.58.1).
   f. Power factor is calculated.
   g. Winding resistance is measured immediately after shutdown.

4. Dielectric test - AC voltage applied at 2304 volts for 1 second. (460 v. Motors)

5. Locked rotor current and torque are measured.

6. Breakdown torque is measured.

7. Check for excessive vibration and bearing noise.

8. Thermostats (klixons) are checked for circuit continuity.

9. Space heater ratings are verified.

10. Test reports are submitted.

Noise Tests

Noise tests are coinducted per IEEE No. 85 - “Test Procedure for Airborne Sound Measurements on Rotating Electric Machinery” using a microphone in a test environment of a free field over a reflecting plane.

Test measurements recorded are overall and 7 octave levels of sound pressure readings at 11 prescribed points plus ambient at overall and 7 octave levels.

Overall A-weighted Sound Power and Sound Pressure at a reference distance of 1 meter are computed from data recorded.

All noise tests are performed at the Little Rock Plant.

Accuracy is within a ±3 dB.

Siemens 2005 Contractor's Edge Program

Siemens 2005 Contractor Advantage Rewards Program

Siemens 2004 Contractor Council

Siemens Carolina Residential Contractor Council

Key local contractors from the North and South Carolina area attended a dinner and trade show hosted by Residential Marketing and the Carolinas Sales Team. They provided valuable input on ways to improve existing products, participated in a preview session to discuss new products and exchange information on market conditions. These events will continue throughout the year to solicit valuable feedback and reinforce business relationships with the market place.

Image at the left: *Siemens Product Manager, Jon Pickens (right), discusses Siemens products with a contractor and Sales Manager, Rick Brooks (center).*

Image at the left: *Market Development Manager, Kirk Brown (center), explains the features and benefits of using Siemens products.*

Builder's Circle Program

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Residential Electrical Product Information

- AC Disconnects
- Circuit Breakers
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- Meter Sockets
- Multi-Family Metering
- Power Outlet Panels
- Surge Protection