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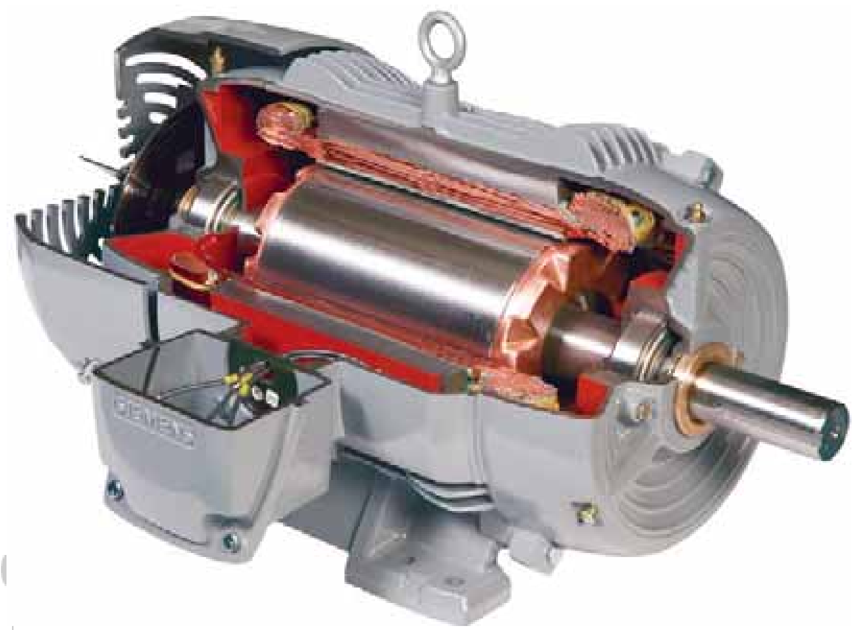
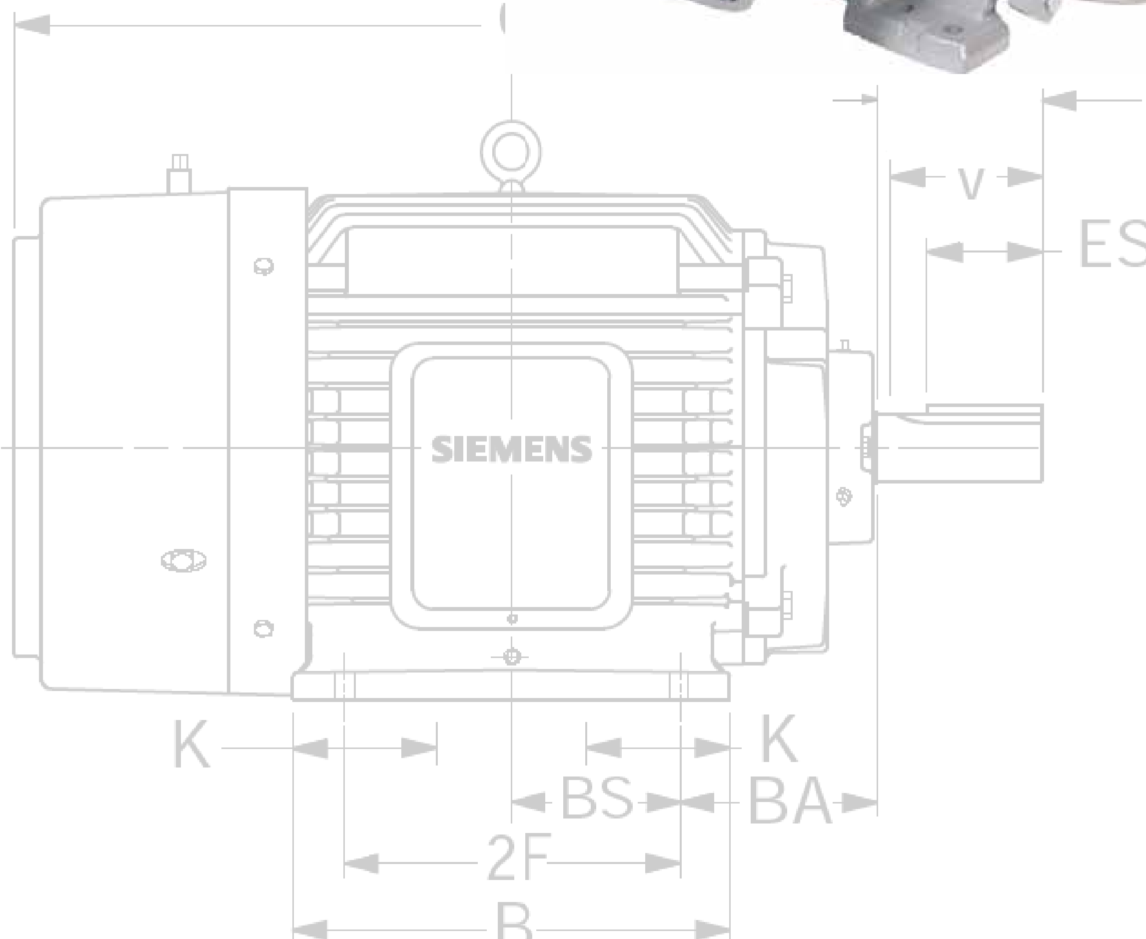
Application Manual for NEMA Motors





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NEMA Frame TEFC Motors
600 Volts and Below
Product Range and Scope by Frame Size

	SPEED				
HP	**3600**	**1800**	**1200**	**900**	**720**
1	143	143	145	182	
1.5	143	145	182	184	
2	145	145	184	213	
3	182	182	213	215	
5	184	184	215	254	
7.5	213	213	254	256	
10	215	215	256	284	
15	254	254	284	286	
20	256	256	286	324	
25	284	284	324	326	
30	286	286	326	364	
40	324	324	364	365	
50	326	326	365	404	
60	364	364	404	405	444
75	365	365	405	444	445
100	405	405	444	445	447
125	444	444	445	447	449
150	445	445	447	447	449
200	447	447	449	449	
250	449	449	449	S449	
300	449	447	S449		
350	S449	S449			
400	S449	S449			

NEMA Frame ODP Motors
600 Volts and Below
Product Range and Scope by Frame Size

HP	SPEED 3600	1800	1200	900
1		143	145	
1.5	143	145	182	
2	145	145	184	
3	145	182	213	
5	182	184	215	
7.5	184	213	254	
10	213	215	256	
15	215	254	284	
20	254	256	286	
25	256	284	324	
30	284	286	326	
40	286	324	364	
50	324	326	365	
60	326	364	404	
75	364	365	405	
100	365	404	444	445
125	404	405	445	447
150	405	444	447	447
200	444	445	447	449
250	445	445	449	
300	447	447	449	
350	447	447		
400	449	449		
500	449	449		

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DP10
Open Drip Proof

Electrical Data	**Enclosure**	**General Purpose - ODP**
	Efficiency	High
	HP Range	1-500
	Frame Size	140-440
	Frequency	60 Hertz
	Power	3 - Phase
	Voltage	208-230/460 to 100HP (400 frame) 460 only 100HP (440 frame) and above
	Service Factor (sine wave)	1.15
	Electrical Design	NEMA design B
	Stator Windings	Copper - Random Wound
	Insulation	Class F, meets NEMA MG1-2003, Part 31 (140-400) and Part 30 (440)
	Temperature Rise (sine wave)	Class B @ 1.0SF, Class F @ 1.15SF
	Warranty	18 Months
echanical Data	**Frame**	Cast Iron
	End Shields	Cast Iron
	Conduit Box	140-400 Steel 440 Cast Iron
	Lead Seal Gasket	Neoprene
	Fan Cover	Not Applicable
	Cooling Fan	Not Applicable
	Rotor	Die Cast Aluminum
	Shaft	High Strength Carbon Steel (C1045)
	Bearing Type	140-280 Lubricated for Life 320-440 Double Shielded
	Bearing Inner Cap	320-440 Stationary Bearing Caps
	Shaft Seal / Slinger	
	Lubrication	140-400 Lithium 440 Polyurea
	Lube Inlet Fittings	320-440 Alemite
	Lube Relief Fittings	Plug
	Condensation Drain	
	Hardware	Zinc Plated
	Lifting Eyebolt	180-440 Included
	Nameplate	Stainless Steel - Engraved
	Paint	Epoxy Enamel RAL 7030 Grey
	Vibration	0.15 IPS

RGZP
General Purpose - TEFC

Electrical Data	**Enclosure**	General Purpose - TEFC
	Efficiency	High
	HP Range	1-200
	Frame Size	140-440
	Frequency	60 Hertz
	Power	3 - Phase
	Voltage	230/460 460 only 100HP and above
	Service Factor (sine wave)	1.15
	Electrical Design	NEMA design B
	Stator Windings	Copper - Random Wound
	Insulation	Class F, meets NEMA MG1-2003, Part 30
	Temperature Rise (sine wave)	Class B @ 1.0SF, Class F @ 1.15SF
	Warranty	18 Months
Mechanical Data	**Frame**	Cast Iron
	End Shields	140-250 Aluminum 280-440 Cast Iron
	Conduit Box	140-250 Aluminum 280-400 Steel, 440 Cast Iron
	Lead Seal Gasket	Neoprene
	Fan Cover	140-365 Polycarbonate 400-440 Cast Iron
	Cooling Fan	Bi-directional, Polypropylene
	Rotor	Die Cast Aluminum
	Shaft	High Strength Carbon Steel (C1045)
	Bearing Type	140-250 Double Shielded 280-440 Single Shielded
	Bearing Inner Cap	440 Stationary Bearing Caps
	Shaft Seal / Slinger	280-440 V-Ring Slinger DE
	Lubrication	140-250 Lubricated for Life 280-440 Polyurea
	Lube Inlet Fittings	280-440 Alemite
	Lube Relief Fittings	280-440 Plug
	Condensation Drain	140-360 Hole 400-440 T-Drain
	Hardware	Zinc Plated
	Lifting Eyebolt	140-180 Provisions 210-440 Included
	Nameplate	Aluminum - Engraved
	Paint	Epoxy Enamel - RAL 7030 Grey
	Vibration	0.08 IPS

RGZPSD
Severe Duty - TEFC

Electrical Data	**Enclosure**	Severe Duty - TEFC
	Efficiency	High
	HP Range	1-200
	Frame Size	140-440
	Frequency	60 Hertz
	Power	3 - Phase
	Voltage	230/460 460 only 100HP and above
	Service Factor (sine wave)	1.15
	Electrical Design	NEMA design B
	Stator Windings	Copper - Random Wound
	Insulation	Class F, meets NEMA MG1-2003, Part 30
	Temperature Rise (sine wave)	Class B @ 1.0SF, Class F @ 1.15SF
	Warranty	18 Months
Mechanical Data	**Frame**	Cast Iron
	End Shields	Cast Iron
	Conduit Box	Cast Iron
	Lead Seal Gasket	Neoprene
	Fan Cover	Cast Iron
	Cooling Fan	Bi-directional, Polypropylene
	Rotor	Die Cast Aluminum
	Shaft	High Strength Carbon Steel (C1045)
	Bearing Type	Single Shielded
	Bearing Inner Cap	400-440 Stationary Bearing Caps
	Shaft Seal / Slinger	140-250 Shaft Seal DE 280-440 V-Ring Slinger
	Lubrication	Polyurea
	Lube Inlet Fittings	Alemite
	Lube Relief Fittings	Plug
	Condensation Drain	T-Drain
	Hardware	Zinc Plated
	Lifting Eyebolt	140-180 Provisions 210-440 Included
	Nameplate	Stainless Steel - Engraved
	Paint	Epoxy Enamel RAL 7030 Grey
	Vibration	0.08 IPS

RGZESD
Severe Duty – TEFC

Electrical Data	**Enclosure**	Severe Duty - TEFC
	Efficiency	High
	HP Range	1-400
	Frame Size	140-S440
	Frequency	60 Hertz
	Power	3 - Phase
	Voltage	230/460 460 only 25HP and above
	Service Factor (sine wave)	1.15
	Electrical Design	NEMA design B
	Stator Windings	Copper - Random Wound
	Insulation	Class F, meets NEMA MG1-2003, Part 31
	Temperature Rise (sine wave)	Class B @ 1.0SF, Class F @ 1.15SF
	Warranty	3 Years
Mechanical Data	**Frame**	Cast Iron
	End Shields	Cast Iron
	Conduit Box	Cast Iron
	Lead Seal Gasket	Neoprene
	Fan Cover	Cast Iron
	Cooling Fan	140-440 Bi-directional, Polypropylene S440 Locked & Keyed Bronze
	Rotor	Die Cast Aluminum
	Shaft	High Strength Carbon Steel (C1045)
	Bearing Type	Single Shielded
	Bearing Inner Cap	Stationary Bearing Caps
	Shaft Seal / Slinger	140-250 Shaft Seal DE 280-440 V-Ring Slinger DE
	Lubrication	Polyurea
	Lube Inlet Fittings	Alemite
	Lube Relief Fittings	Plug
	Condensation Drain	T-Drain
	Hardware	Zinc Plated
	Lifting Eyebolt	140-180 Provisions 210-440 Included
	Nameplate	Stainless Steel - Engraved
	Paint	Epoxy Enamel RAL 7030 Grey
	Vibration	0.08 IPS

RGZZESD
Hazardous Duty – TEFC

Electrical Data	**Enclosure**	Hazardous Duty - TEFC
	Efficiency	High
	HP Range	1-300
	Frame Size	140-440
	Frequency	60 Hertz
	Power	3 - Phase
	Voltage	230/460 460 only 25HP and above
	Service Factor (sine wave)	1
	Electrical Design	NEMA design B
	Stator Windings	Copper - Random Wound
	Insulation	Class F
	Temperature Rise (sine wave)	Class B @ 1.0SF
	Warranty	3 Years
Mechanical Data	**Frame**	Cast Iron
	End Shields	Cast Iron
	Conduit Box	Cast Iron
	Lead Seal Gasket	
	Fan Cover	Cast Iron
	Cooling Fan	Bi-directional, Polypropylene
	Rotor	Die Cast Aluminum
	Shaft	High Strength Carbon Steel (C1045)
	Bearing Type	Single Shielded
	Bearing Inner Cap	Stationary Bearing Caps
	Shaft Seal / Slinger	140-250 Shaft Seal DE 280-440 V-Ring Slinger DE
	Lubrication	Polyurea
	Lube Inlet Fittings	Alemite
	Lube Relief Fittings	Plug
	Condensation Drain	400-440 Only
	Hardware	Zinc Plated
	Lifting Eyebolt	140-180 Provisions 210-440 Included
	Nameplate	Stainless Steel - Engraved
	Paint	Epoxy Enamel - RAL 7030 Grey
	Vibration	0.08 IPS

RGZESDI
Severe/Inverter Duty – TEFC

Electrical Data	**Enclosure**	Severe / Inverter Duty - TEFC
	Efficiency	High
	HP Range	1-400
	Frame Size	140-S440
	Frequency	60 Hertz
	Power	3 - Phase
	Voltage	460
	Service Factor (sine wave)	1.15 (sine wave), 1.0 (VFD)
	Electrical Design	NEMA design B (except for derates)
	Stator Windings	Copper - Random Wound
	Insulation	Class F, meets NEMA MG1-2003, Part 31
	Temperature Rise (sine wave)	Class B @ 1.0SF & Class F @ 1.15SF
	Warranty	3 Years
Mechanical Data	**Frame**	Cast Iron
	End Shields	Cast Iron
	Conduit Box	Cast Iron
	Lead Seal Gasket	Neoprene
	Fan Cover	Cast Iron
	Cooling Fan	Bi-directional, Polypropylene
	Rotor	Die Cast Aluminum
	Shaft	High Strength Carbon Steel (C1045)
	Bearing Type	Single Shielded
	Bearing Inner Cap	Stationary Bearing Caps
	Shaft Seal / Slinger	140-250 Shaft Seal DE 280-440 V-Ring Slinger DE
	Lubrication	Polyurea
	Lube Inlet Fittings	Alemite
	Lube Relief Fittings	Plug
	Condensation Drain	T-Drain
	Hardware	Zinc Plated
	Lifting Eyebolt	140-180 Provisions 210-440 Included
	Nameplate	Stainless Steel - Engraved
	Paint	Epoxy Enamel - RAL 7030 Grey
	Vibration	0.06 IPS

RGZZESDI
Hazardous/Inverter Duty – TEFC

Electrical Data	**Enclosure**	Hazardous / Inverter Duty - TEFC
	Efficiency	High
	HP Range	1-200
	Frame Size	140-440
	Frequency	60 Hertz
	Power	3 - Phase
	Voltage	460
	Service Factor (sine wave)	1
	Electrical Design	NEMA design B (except for derates)
	Stator Windings	Copper - Random Wound
	Insulation	Class F, meets NEMA MG1-2003, Part 31
	Temperature Rise (sine wave)	Class B @ 1.0SF
	Warranty	3 Years
Mechanical Data	**Frame**	Cast Iron
	End Shields	Cast Iron
	Conduit Box	Cast Iron
	Lead Seal Gasket	
	Fan Cover	Cast Iron
	Cooling Fan	Bi-directional, Polypropylene
	Rotor	Die Cast Aluminum
	Shaft	High Strength Carbon Steel (C1045)
	Bearing Type	Single Shielded
	Bearing Inner Cap	Stationary Bearing Caps
	Shaft Seal / Slinger	140-250 Shaft Seal DE 280-440 V-Ring Slinger DE
	Lubrication	Polyurea
	Lube Inlet Fittings	Alemite
	Lube Relief Fittings	Plug
	Condensation Drain	400-440 Only
	Hardware	Zinc Plated
	Lifting Eyebolt	140-180 Provisions 210-440 Included
	Nameplate	Stainless Steel - Engraved
	Paint	Epoxy Enamel - RAL 7030 Grey
	Vibration	0.06 IPS

RGZEESD
Severe Duty – TEFC

Electrical Data	**Enclosure**	Severe Duty - TEFC
	Efficiency	NEMA Premium
	HP Range	1-400
	Frame Size	140-S440
	Frequency	60 Hertz
	Power	3 - Phase
	Voltage	230/460 460 only 25HP and above
	Service Factor (sine wave)	1.15
	Electrical Design	NEMA design B (except as noted)
	Stator Windings	Copper - Random Wound
	Insulation	Class F, meets NEMA MG1-2003, Part 31
	Temperature Rise (sine wave)	Class B @ 1.0SF, Class F @ 1.15SF
	Warranty	3 Years
Mechanical Data	**Frame**	Cast Iron
	End Shields	Cast Iron
	Conduit Box	Cast Iron
	Lead Seal Gasket	Neoprene
	Fan Cover	Cast Iron
	Cooling Fan	140-440 Bi-directional, Polypropylene S440 Locked & Keyed Bronze
	Rotor	Die Cast Aluminum
	Shaft	High Strength Carbon Steel (C1045)
	Bearing Type	Single Shielded
	Bearing Inner Cap	Stationary Bearing Caps
	Shaft Seal / Slinger	V-Ring Slinger DE & ODE
	Lubrication	Polyurea
	Lube Inlet Fittings	Alemite
	Lube Relief Fittings	Plug
	Condensation Drain	T-Drain
	Hardware	Zinc Plated
	Lifting Eyebolt	140-440 Included
	Nameplate	Stainless Steel - Engraved
	Paint	Epoxy Enamel - RAL 7030 Grey
	Vibration	0.08 IPS

RGZEESDX
Severe Duty – TEFC

Electrical Data	**Enclosure**	Severe Duty / IEEE 841 (2001) - TEFC
	Efficiency	NEMA Premium
	HP Range	1-400
	Frame Size	140-S440
	Frequency	60 Hertz
	Power	3 - Phase
	Voltage	460
	Service Factor (sine wave)	1.15
	Electrical Design	NEMA design B (except as noted)
	Stator Windings	Copper - Random Wound
	Insulation	Class F, meets NEMA MG1-2003, Part 31
	Temperature Rise (sine wave)	Class B @ 1.0SF, Class F @ 1.15SF
	Warranty	5 Years
Mechanical Data	**Frame**	Cast Iron
	End Shields	Cast Iron
	Conduit Box	Cast Iron
	Lead Seal Gasket	Neoprene
	Fan Cover	Cast Iron
	Cooling Fan	140-440 Bi-directional, Polypropylene S440 Locked & Keyed Bronze
	Rotor	Die Cast Aluminum
	Shaft	High Strength Carbon Steel (C1045)
	Bearing Type	Single Shielded
	Bearing Inner Cap	Stationary Bearing Caps
	Shaft Seal / Slinger	Inpro/Seal® Bearing Isolator DE & ODE
	Lubrication	Polyurea
	Lube Inlet Fittings	Alemite
	Lube Relief Fittings	Pressure Relief
	Condensation Drain	T-Drain
	Hardware	Zinc Plated
	Lifting Eyebolt	140-440 Included
	Nameplate	Stainless Steel - Embossed
	Paint	Epoxy Enamel - RAL 7030 Grey
	Vibration	0.06 IPS

HSRGZVESD
Vertical Hollow Shaft, High Trust – TEFC

Electrical Data	**Enclosure**	Severe Duty - TEFC
	Efficiency	High
	Thrust	High
	HP Range	25-250
	Frame Size	284TP-449TP
	Frequency	60 Hertz
	Power	3 - Phase
	Voltage	230/460 460 only 100HP and above
	Service Factor (sine wave)	1.15
	Electrical design	NEMA design B
	Stator Windings	Copper - Random Wound
	Insulation	Class F, meets NEMA MG1-2003, Part 31
	Temperature Rise (sine wave)	Class B @ 1.0SF, Class F @ 1.15SF
	Warranty	3 Years
Mechanical Data	**Frame**	Cast Iron
	End Shields	Cast Iron
	Conduit Box	Oversized Cast Iron
	Lead Seal Gasket	Neoprene
	Fan Cover	Cast Iron
	Cooling Fan	284-449TP Bi-directional, Polypropylene
	Drip cover	Steel
	Rotor	Die Cast Aluminum
	Shaft	Hollow - High Strength Carbon Steel (C1045)
	Bearing Type (DE)	284-449TP open ball bearing
	Bearing Type (ODE)	284-449TP angular contact thrust bearing
	Bearing Inner Cap	Stationary Bearing Caps
	Shaft Seal / Slinger	284-449TP V-Ring Slinger
	Lubrication	Polyurea
	Lube Inlet Fittings	Alemite
	Lube Relief Fittings	Plug
	Condensation Drain	T-Drain
	Hardware	Zinc Plated
	Lifting Lugs	284-449TP Included
	Nameplate	Stainless Steel - engraved
	Paint	Epoxy Enamel - RAL 7030 Grey
	Vibration	0.08 IPS

RGZVESD
Vertical Solid Shaft, Normal Trust – TEFC

Electrical Data	**Enclosure**	Severe Duty - TEFC
	Efficiency	High
	Thrust	Normal
	HP Range	1-250
	Frame Size	143HP-449HP
	Frequency	60 Hertz
	Power	3 - Phase
	Voltage	230/460 460 only 25HP and above
	Service Factor (sine wave)	1.15
	Electrical design	NEMA design B
	Stator Windings	Copper - Random Wound
	Insulation	Class F, meets NEMA MG1-2003, Part 31
	Temperature Rise (sine wave)	Class B @ 1.0SF, Class F @ 1.15SF
	Warranty	3 Years
Mechanical Data	**Frame**	Cast Iron
	End Shields	Cast Iron
	Conduit Box	Oversized Cast Iron
	Lead Seal Gasket	Neoprene
	Fan Cover	Cast Iron
	Cooling Fan	143-449HP Bi-directional, Polypropylene
	Drip cover	Steel
	Rotor	Die Cast Aluminum
	Shaft	Solid - High Strength Carbon Steel(C1045)
	Bearing Type (DE)	143-256HP open ball bearing 284-365HP single shielded ball bearing 404-405HP double shielded ball bearing 444-449HP open ball bearing
	Bearing Type (ODE)	143-365HP open ball bearing 404-405HP double shielded ball bearing 444-449HP single shielded ball bearing
	Bearing Inner Cap	Stationary Bearing Caps
	Shaft Seal / Slinger	143-256HP Shaft Seal 284-365HP None 404-449HP V-Ring Slinger
	Lubrication	Polyurea
	Lube Inlet Fittings	Alemite
	Lube Relief Fittings	Plug
	Condensation Drain	T-Drain
	Hardware	Zinc Plated
	Lifting Lugs	143-449HP Included
	Nameplate	Stainless Steel - engraved
	Paint	Epoxy Enamel - RAL 7030 Grey
	Vibration	0.08 IPS

RGZZVESD
Vertical Solid Shaft, Normal Trust – TEFC P-Base – Hazardous Duty

Electrical Data	**Enclosure**	Hazardous Duty - TEFC
	Efficiency	High
	Thrust	Normal
	HP Range	1-250
	Frame Size	143HP-449HP
	Frequency	60 Hertz
	Power	3 - Phase
	Voltage	230/460 460 only 25HP and above
	Service Factor (sine wave)	1.0
	Electrical design	NEMA design B
	Stator Windings	Copper - Random Wound
	Insulation	Class F
	Temperature Rise (sine wave)	Class B @ 1.0SF
	Warranty	3 Years
Mechanical Data	**Frame**	Cast Iron
	End Shields	Cast Iron
	Conduit Box	Oversized Cast Iron
	Lead Seal Gasket	None
	Fan Cover	Cast Iron
	Cooling Fan	143-449HP Bi-directional, Polypropylene
	Drip cover	Steel
	Rotor	Die Cast Aluminum
	Shaft	Solid - High Strength Carbon Steel(C1045)
	Bearing Type (DE)	143-256HP open ball bearing 284-365HP single shielded ball bearing 404-405HP double shielded ball bearing 444-449HP open ball bearing
	Bearing Type (ODE)	143-365HP open ball bearing 404-405HP double shielded ball bearing 444-449HP single shielded ball bearing
	Bearing Inner Cap	Stationary Bearing Caps
	Shaft Seal / Slinger	143-256HP Shaft Seal 284-365HP None 404-449HP V-Ring Slinger
	Lubrication	Polyurea
	Lube Inlet Fittings	Alemite
	Lube Relief Fittings	Plug
	Condensation Drain	U.L. Listed (404-449HP only)
	Hardware	Zinc Plated
	Lifting Lugs	143-449HP Included
	Nameplate	Stainless Steel - engraved
	Paint	Epoxy Enamel - RAL 7030 Grey
	Vibration	0.08 IPS

RGZVMTESD
Vertical Solid Shaft, Medium Trust – TEFC P-Base

Electrical Data	**Enclosure**	Severe Duty - TEFC
	Efficiency	High
	Thrust	Medium
	HP Range	1-250
	Frame Size	143HP-449HP
	Frequency	60 Hertz
	Power	3 - Phase
	Voltage	230/460 460 only 25HP and above
	Service Factor (sine wave)	1.15
	Electrical design	NEMA design B
	Stator Windings	Copper - Random Wound
	Insulation	Class F, meets NEMA MG1-2003, Part 31
	Temperature Rise (sine wave)	Class B @ 1.0SF, Class F @ 1.15SF
	Warranty	3 Years
Mechanical Data	**Frame**	Cast Iron
	End Shields	Cast Iron
	Conduit Box	Oversized Cast Iron
	Lead Seal Gasket	Neoprene
	Fan Cover	Cast Iron
	Cooling Fan	143-449HP Bi-directional, Polypropylene
	Drip cover	Steel
	Rotor	Die Cast Aluminum
	Shaft	Solid - High Strength Carbon Steel(C1045)
	Bearing Type (DE)	143-256HP open ball bearingbearing 284-365HP double shielded ball bearing 404-449HP angular contact thrust bearing
	Bearing Type (ODE)	143-256HP angular contact thrust bearing 284-365HP angular contact thrust bearing and four-point ball bearing 404-449HP double shielded ball bearing
	Bearing Inner Cap	Stationary Bearing Caps
	Shaft Seal / Slinger	143-256HP Shaft Seal 284-365HP None 404-449HP V-Ring Slinger
	Lubrication	Polyurea
	Lube Inlet Fittings	Alemite
	Lube Relief Fittings	Plug
	Condensation Drain	T-Drain
	Hardware	Zinc Plated
	Lifting Lugs	143-449HP Included
	Nameplate	Stainless Steel - engraved
	Paint	Epoxy Enamel - RAL 7030 Grey
	Vibration	0.08 IPS

RGZZVMTESD
Vertical Solid Shaft, Medium Trust – TEFC P-Base – Hazardous Duty

Electrical Data	**Enclosure**	Hazardous Duty - TEFC
	Efficiency	High
	Thrust	Medium
	HP Range	1-250
	Frame Size	143HP-449HP
	Frequency	60 Hertz
	Power	3 - Phase
	Voltage	230/460 460 only 25HP and above
	Service Factor (sine wave)	1.0
	Electrical design	NEMA design B
	Stator Windings	Copper - Random Wound
	Insulation	Class F
	Temperature Rise (sine wave)	Class B @ 1.0SF
	Warranty	3 Years
Mechanical Data	**Frame**	Cast Iron
	End Shields	Cast Iron
	Conduit Box	Oversized Cast Iron
	Lead Seal Gasket	None
	Fan Cover	Cast Iron
	Cooling Fan	143-449HP Bi-directional, Polypropylene
	Drip cover	Steel
	Rotor	Die Cast Aluminum
	Shaft	Solid - High Strength Carbon Steel(C1045)
	Bearing Type (DE)	182-256LP open ball bearing 284-449LP double shielded ball bearing
	Bearing Type (ODE)	143-256HP angular contact thrust bearing 284-365HP angular contact thrust bearing and four-point ball bearing 404-449HP double shielded ball bearing
	Bearing Inner Cap	Stationary Bearing Caps
	Shaft Seal / Slinger	143-256HP Shaft Seal 284-365HP None 404-449HP V-Ring Slinger
	Lubrication	Polyurea
	Lube Inlet Fittings	Alemite
	Lube Relief Fittings	Plug
	Condensation Drain	U.L. Listed (404-449HP only)
	Hardware	Zinc Plated
	Lifting Lugs	143-449HP Included
	Nameplate	Stainless Steel - engraved
	Paint	Epoxy Enamel - RAL 7030 Grey
	Vibration	0.08 IPS

RGZVILESD
Vertical Solid Shaft, In-Line Trust – TEFC P-Base

Electrical Data	**Enclosure**	Severe Duty - TEFC
	Efficiency	High
	Thrust	In-Line
	HP Range	3-250
	Frame Size	182LP-449LP
	Frequency	60 Hertz
	Power	3 - Phase
	Voltage	230/460 460 only 25HP and above
	Service Factor (sine wave)	1.15
	Electrical design	NEMA design B
	Stator Windings	Copper - Random Wound
	Insulation	Class F, meets NEMA MG1-2003, Part 31
	Temperature Rise (sine wave)	Class B @ 1.0SF, Class F @ 1.15SF
	Warranty	3 Years
Mechanical Data	**Frame**	Cast Iron
	End Shields	Cast Iron
	Conduit Box	Oversized Cast Iron
	Lead Seal Gasket	Neoprene
	Fan Cover	Cast Iron
	Cooling Fan	182-449LP Bi-directional, Polypropylene
	Drip cover	Cast Iron
	Rotor	Die Cast Aluminum
	Shaft	Solid - High Strength Carbon Steel(C1045)
	Bearing Type (DE)	182-256LP open ball bearing 284-449LP double shielded ball bearing
	Bearing Type (ODE)	182-449LP duplex angular contact thrust bearing
	Bearing Inner Cap	Stationary Bearing Caps
	Shaft Seal / Slinger	182-256LP Shaft Seal 284-365LP None 404-449LP V-Ring Slinger
	Lubrication	Polyurea
	Lube Inlet Fittings	Alemite
	Lube Relief Fittings	Plug
	Condensation Drain	T-Drain
	Hardware	Zinc Plated
	Lifting Lugs	182-449LP Included
	Nameplate	Stainless Steel - engraved
	Paint	Epoxy Enamel - RAL 7030 Grey
	Vibration	0.08 IPS

RGZZVILESD
Vertical Solid Shaft, In-Line Trust – TEFC P-Base – Hazardous Duty

Electrical Data	**Enclosure**	Hazardous Duty - TEFC
	Efficiency	High
	Thrust	In-Line
	HP Range	3-250
	Frame Size	182LP-449LP
	Frequency	60 Hertz
	Power	3 - Phase
	Voltage	230/460 460 only 25HP and above
	Service Factor (sine wave)	1.0
	Electrical design	NEMA design B
	Stator Windings	Copper - Random Wound
	Insulation	Class F
	Temperature Rise (sine wave)	Class B @ 1.0SF
	Warranty	3 Years
Mechanical Data	**Frame**	Cast Iron
	End Shields	Cast Iron
	Conduit Box	Oversized Cast Iron
	Lead Seal Gasket	None
	Fan Cover	Cast Iron
	Cooling Fan	182-449LP Bi-directional, Polypropylene
	Drip cover	Cast Iron
	Rotor	Die Cast Aluminum
	Shaft	Solid - High Strength Carbon Steel(C1045)
	Bearing Type (DE)	
	Bearing Type (ODE)	182-449LP duplex angular contact thrust bearing
	Bearing Inner Cap	Stationary Bearing Caps
	Shaft Seal / Slinger	182-256LP Shaft Seal 284-365LP None 404-449LP V-Ring Slinger
	Lubrication	Polyurea
	Lube Inlet Fittings	Alemite
	Lube Relief Fittings	Plug
	Condensation Drain	U.L. Listed (404-449LP only)
	Hardware	Zinc Plated
	Lifting Lugs	182-449LP Included
	Nameplate	Stainless Steel - engraved
	Paint	Epoxy Enamel - RAL 7030 Grey
	Vibration	0.08 IPS

GP10A
General Purpose - TEFC

Electrical Data	**Enclosure**	General Purpose - TEFC
	Efficiency	High
	HP Range	1-20
	Frame Size	143T-256T
	Frequency	60 Hertz
	Power	3 - Phase
	Voltage	208-230/460 & 575
	Service Factor (sine wave)	1.15
	Electrical Design	NEMA design B
	Stator Windings	Copper - random wound
	Insulation	Class F, meets NEMA MG1-2003, Part 31
	Temperature Rise (sine wave)	Class B @ 1.0SF, Class F @ 1.15SF
	Warranty	18 Months
Mechanical Data	**Frame**	Cast aluminum with bolted feet
	End Shields	Cast aluminum
	Conduit Box	Cast aluminum
	Lead Seal Gasket	Neoprene (o-rings)
	Fan Cover	Plastic
	Cooling Fan	Bi-directional - polypropylene
	Rotor	Die cast aluminum
	Shaft	High strength carbon steel (C1045)
	Bearing Type	Lubricated for life Non-regreasable
	Bearing Inner Cap	No
	Shaft Seal / Slinger	V-ring slinger - DE only
	Lubrication	Polyurea
	Lube Inlet Fittings	NA
	Lube Relief Fittings	NA
	Condensation Drain	Drain holes - lowest point (2)
	Hardware	Zinc plated
	Lifting Eyebolt	Motors > 75 lbs
	Nameplate	Aluminum - engraved
	Paint	Epoxy enamel - RAL 7030 Grey
	Vibration	0.15 IPS

GP10
General Purpose - TEFC

Electrical Data	**Enclosure**	General Purpose - TEFC
	Efficiency	High
	HP Range	1-20
	Frame Size	143T-256T
	Frequency	60 Hertz
	Power	3 - Phase
	Voltage	208-230/460 & 575
	Service Factor (sine wave)	1.15
	Electrical Design	NEMA design B
	Stator Windings	Copper - random wound
	Insulation	Class F, meets NEMA MG1-2003, Part 31
	Temperature Rise (sine wave)	Class B @ 1.0SF, Class F @ 1.15SF
	Warranty	18 Months
Mechanical Data	**Frame**	Cast iron
	End Shields	Cast iron
	Conduit Box	Cast aluminum
	Lead Seal Gasket	Neoprene
	Fan Cover	Plastic
	Cooling Fan	Bi-directional - polypropylene
	Rotor	Die cast aluminum
	Shaft	High strength carbon steel (C1045)
	Bearing Type	Lubricated for life Non-regreasable
	Bearing Inner Cap	No
	Shaft Seal / Slinger	V-ring slinger - DE only
	Lubrication	Polyurea
	Lube Inlet Fittings	NA
	Lube Relief Fittings	NA
	Condensation Drain	Drain holes - lowest point (2)
	Hardware	Zinc plated
	Lifting Eyebolt	Motors > 75 lbs
	Nameplate	Aluminum - engraved
	Paint	Epoxy enamel - RAL 7030 Grey
	Vibration	0.15 IPS

SD10
Severe Duty - TEFC

Electrical Data	**Enclosure**	Severe Duty - TEFC
	Efficiency	High
	HP Range	1-20
	Frame Size	143T-256T
	Frequency	60 Hertz
	Power	3 - Phase
	Voltage	208-230/460 & 575
	Service Factor (sine wave)	1.15
	Electrical Design	NEMA design B
	Stator Windings	Copper - random wound
	Insulation	Class F, meets NEMA MG1-2003, Part 31
	Temperature Rise (sine wave)	Class B @ 1.05F, Class F @ 1.15SF
	Warranty	3 Years
Mechanical Data	**Frame**	Cast iron
	End Shields	Cast iron
	Conduit Box	Cast iron
	Lead Seal Gasket	Neoprene
	Fan Cover	Cast iron
	Cooling Fan	Bi-directional - polypropylene
	Rotor	Die cast aluminum
	Shaft	High strength carbon steel (C1045)
	Bearing Type	Double Shielded Regreasable inlet & outlet
	Bearing Inner Cap	Cast iron
	Shaft Seal / Slinger	V-ring slinger - DE and ODE
	Lubrication	Polyurea
	Lube Inlet Fittings	Alemite
	Lube Relief Fittings	Plug
	Condensation Drain	T - drains - lowest point (2)
	Hardware	Zinc plated
	Lifting Eyebolt	Motors > 75 lbs
	Nameplate	Stainless steel - engraved
	Paint	Epoxy enamel - RAL 7030 Grey
	Vibration	0.08 IPS (2, 4, 6 pole) 0.06 IPS (8 pole)

GP100A
General Purpose - TEFC

Electrical Data	**Enclosure**	General Purpose - TEFC
	Efficiency	Exceeds NEMA Premium
	HP Range	1-20
	Frame Size	143T-256T
	Frequency	60 Hertz
	Power	3 - Phase
	Voltage	208-230/460 & 575
	Service Factor (sine wave)	1.15
	Electrical Design	NEMA design B
	Stator Windings	Copper - random wound
	Insulation	Class F, meets NEMA MG1-2003, Part 31
	Temperature Rise (sine wave)	Class B @ 1.0SF, Class F @ 1.15SF
	Warranty	18 Months
Mechanical Data	**Frame**	Cast aluminum with bolted feet
	End Shields	Cast aluminum
	Conduit Box	Cast aluminum
	Lead Seal Gasket	Neoprene (o-ring)
	Fan Cover	Plastic
	Cooling Fan	Bi-directional - polypropylene
	Rotor	Die cast copper
	Shaft	High strength carbon steel (C1045)
	Bearing Type	Lubricated for life Non-regreasable
	Bearing Inner Cap	No
	Shaft Seal / Slinger	V-ring slinger - DE only
	Lubrication	Polyurea
	Lube Inlet Fittings	NA
	Lube Relief Fittings	NA
	Condensation Drain	Drain holes - lowest point (2)
	Hardware	Zinc plated
	Lifting Eyebolt	Motors > 75 lbs
	Nameplate	Aluminum - engraved
	Paint	Epoxy enamel - RAL 7030 Grey
	Vibration	0.15 IPS

GP100
General Purpose - TEFC

Electrical Data	**Enclosure**	General Purpose - TEFC
	Efficiency	Exceeds NEMA Premium
	HP Range	1-20
	Frame Size	143T-256T
	Frequency	60 Hertz
	Power	3 - Phase
	Voltage	208-230/460 & 575
	Service Factor (sine wave)	1.15
	Electrical Design	NEMA design B
	Stator Windings	Copper - random wound
	Insulation	Class F, meets NEMA MG1-2003, Part 31
	Temperature Rise (sine wave)	Class B @ 1.0SF, Class F @ 1.15SF
	Warranty	18 Months
Mechanical Data	**Frame**	Cast iron
	End Shields	Cast iron
	Conduit Box	Cast aluminum
	Lead Seal Gasket	Neoprene
	Fan Cover	Plastic
	Cooling Fan	Bi-directional - polypropylene
	Rotor	Die cast copper
	Shaft	High strength carbon steel (C1045)
	Bearing Type	Lubricated for life Non-regreasable
	Bearing Inner Cap	No
	Shaft Seal / Slinger	V-ring slinger - DE only
	Lubrication	Polyurea
	Lube Inlet Fittings	NA
	Lube Relief Fittings	NA
	Condensation Drain	Drain holes - lowest point (2)
	Hardware	Zinc plated
	Lifting Eyebolt	Motors > 75 lbs
	Nameplate	Aluminum - engraved
	Paint	Epoxy enamel - RAL 7030 Grey
	Vibration	0.15 IPS

SD100
Severe Duty - TEFC

Electrical Data	**Enclosure**	Severe Duty - TEFC
	Efficiency	Exceeds NEMA Premium
	HP Range	1-20
	Frame Size	143T-256T
	Frequency	60 Hertz
	Power	3 - Phase
	Voltage	208-230/460 & 575
	Service Factor (sine wave)	1.15
	Electrical Design	NEMA design B
	Stator Windings	Copper - random wound
	Insulation	Class F, meets NEMA MG1-2003, Part 31
	Temperature Rise (sine wave)	Class B @ 1.0SF, Class F @ 1.15SF
	Warranty	3 Years
Mechanical Data	**Frame**	Cast iron
	End Shields	Cast iron
	Conduit Box	Cast iron
	Lead Seal Gasket	Neoprene
	Fan Cover	Cast iron
	Cooling Fan	Bi-directional - polypropylene
	Rotor	Die cast copper
	Shaft	High strength carbon steel (C1045)
	Bearing Type	Double Shielded Regreasable inlet & outlet
	Bearing Inner Cap	Cast iron
	Shaft Seal / Slinger	V-ring slinger - DE and ODE
	Lubrication	Polyurea
	Lube Inlet Fittings	Alemite
	Lube Relief Fittings	Plug
	Condensation Drain	T-drains - lowest point (2)
	Hardware	Zinc plated
	Lifting Eyebolt	Motors > 75 lbs
	Nameplate	Stainless steel - engraved
	Paint	Epoxy enamel - RAL 7030 Grey
	Vibration	0.08 IPS

SD100 IEEE841
Severe Duty / IEEE841 (2001) - TEFC

Electrical Data	**Enclosure**	Severe Duty / IEEE 841 (2001) - TEFC
	Efficiency	Exceeds NEMA Premium
	HP Range	1-20
	Frame Size	143T-256T
	Frequency	60 Hertz
	Power	3 - Phase
	Voltage	460 & 575
	Service Factor (sine wave)	1.15
	Electrical Design	NEMA design B
	Stator Windings	Copper - random wound
	Insulation	
	Temperature Rise (sine wave)	Class B @ 1.0SF, Class F @ 1.15SF
	Warranty	5 Years
Mechanical Data	**Frame**	Cast iron
	End Shields	Cast iron
	Conduit Box	Cast iron
	Lead Seal Gasket	Neoprene
	Fan Cover	Cast iron
	Cooling Fan	Bi-directional - polypropylene
	Rotor	Die cast copper, Alum. for 8 pole motors
	Shaft	High strength carbon steel (C1045)
	Bearing Type	Single Shielded Regreasable inlet & outlet
	Bearing Inner Cap	Cast iron
	Shaft Seal / Slinger	Inpro/Seal® Bearing Isolator DE & ODE
	Lubrication	Polyurea
	Lube Inlet Fittings	Alemite
	Lube Relief Fittings	Pressure relief
	Condensation Drain	T-drains - lowest point (2)
	Hardware	Zinc plated
	Lifting Eyebolt	Motors > 75 lbs
	Nameplate	Stainless steel - embossed
	Paint	Epoxy enamel - RAL 7030 Grey
	Vibration	0.06 IPS

SIEMENS

Application Manual for NEMA Motors

Section 2

Motor Theory

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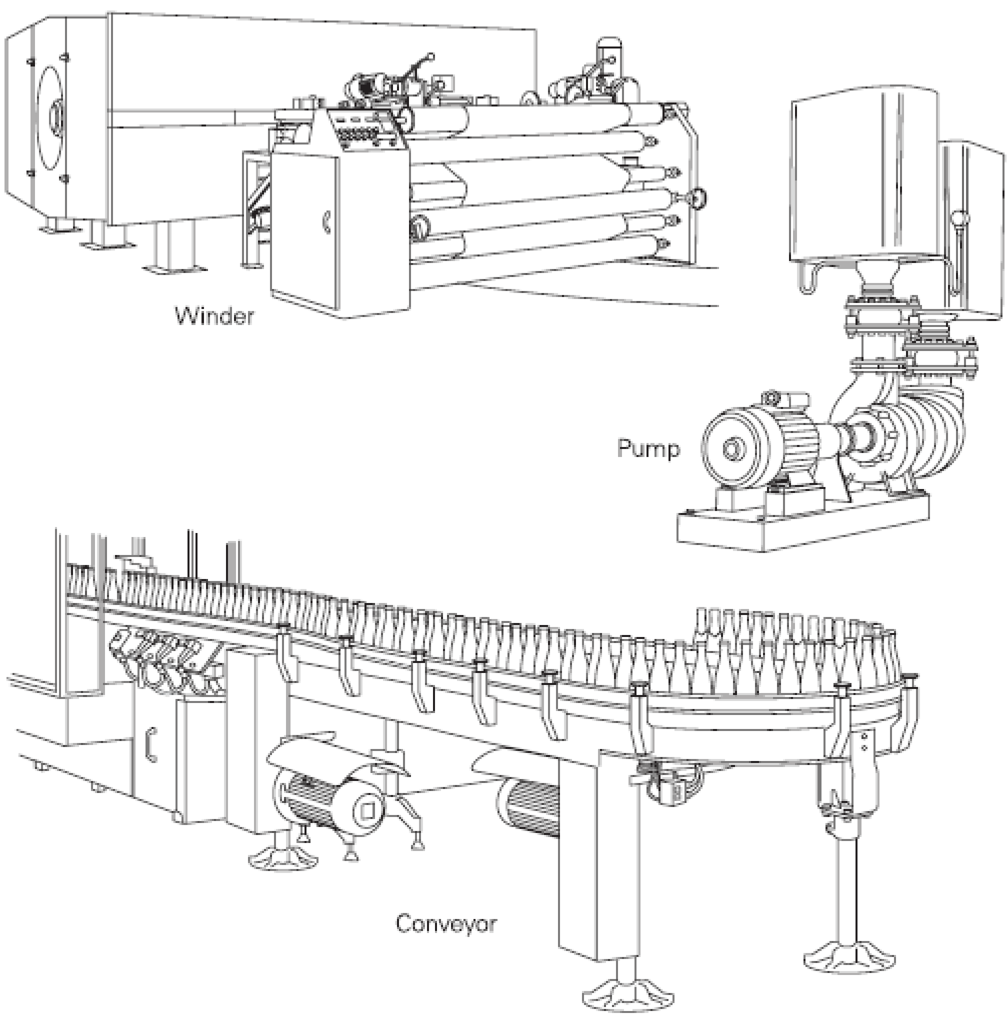
Motor Basics

AC motors are used worldwide in many residential, commercial, industrial, and utility applications. Motors transform electrical energy into mechanical energy. An AC motor may be part of a pump or fan, or connected to some other form of mechanical equipment such as a winder, conveyor, or mixer. AC motors are found on a variety of applications from those that require a single motor to applications requiring several motors. Siemens manufactures a wide variety of motors for various applications. The material presented in this course will help in selection of a motor for a specific application.



NEMA

Throughout this course reference is made to the National Electrical Manufacturers Association (NEMA). NEMA sets standards for a wide range of electrical products, including motors. NEMA is primarily associated with motors used in North America. The standards developed represent general industry practices and are supported by manufacturers of electrical equipment. These standards can be found in NEMA Standard Publication No. MG 1. Some large AC motors may not fall under NEMA standards. These motors are built to meet the requirements of a specific application. These are referred to as above NEMA motors.

IEC

The International Electrotechnical Commission (IEC) is another organization responsible for motor standards. IEC standards are a group of recommended electrical practices developed by committees from participating IEC countries. These standards are different than NEMA standards. IEC standards are associated with motors used in many countries, including motors used in North America. These standards can be found in IEC 34-1-16. Motors which meet or exceed these standards are referred to as IEC motors.

Force and Motion

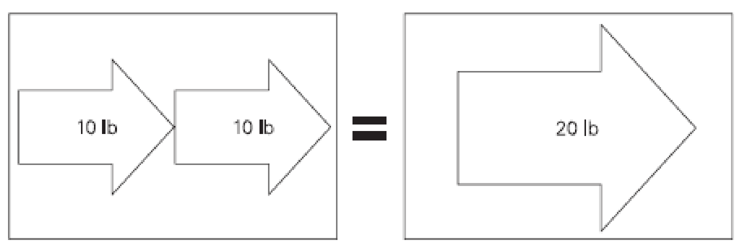
Before discussing AC motors it is necessary to understand some of the basic terminology associated with motor operation. Many of these terms are familiar to us in some other context. Later in the course we will see how these terms apply to AC motors.

Force

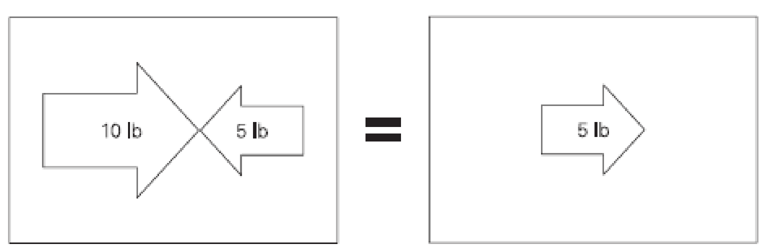
In simple terms, a force is a push or a pull. Force may be caused by electromagnetism, gravity, or a combination of physical means.

Net force

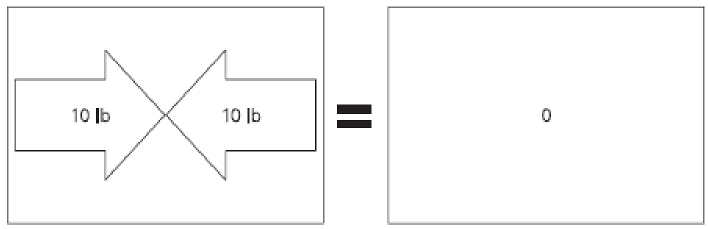
Net force is the vector sum of all forces that act on an object, including friction and gravity. When forces are applied in the same direction they are added. For example, if two 10 pound forces are applied in the same direction the net force would be 20 pounds.



If 10 pounds of force is applied in one direction and 5 pounds of force is applied in the opposite direction, the net force would be 5 pounds and the object would move in the direction of the greater force.



If 10 pounds of force is applied equally in both directions, the net force would be zero and the object would not move.



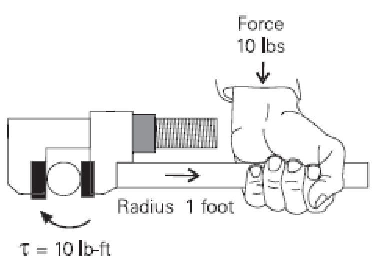
Torque

Torque is a twisting or turning force that causes an object to rotate. For example, a force applied to the end of a lever causes a turning effect or torque at the pivot point.

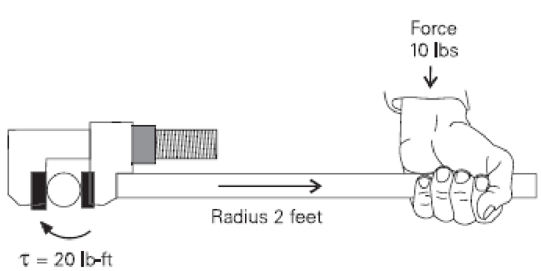
Torque (τ) is the product of force and radius (lever distance).

τ = Force x Radius

In the English system torque is measured in pound-feet (lb-ft) or pound-inches (lb-in). For example, if 10 lbs of force is applied to a lever 1 foot long the resulting torque would be 10 lb-ft.



An increase in force or radius would result in a corresponding increase in torque. Increasing the radius to two feet, for example, results in 20 lb-ft of torque.



Speed

An object in motion travels a distance in a given time. Speed is the ratio of the distance traveled and the time it takes to travel the distance.

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

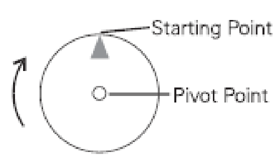
Linear Speed

The linear speed of an object determines how long it takes the object to get from point A to point B. Linear speed is usually expressed in a form that combines units of distance divided by units of time such as meters per second (m/s). For example, if the distance between point A and point B were 10 meters, and it took 2 seconds to travel the distance, the speed would be 5 m/s.

Linear Motion

Angular (Rotational) Speed

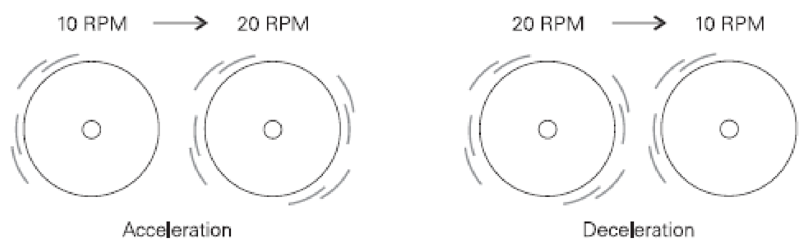
The angular speed of a rotating object determines how long it takes a given point on the object to make one complete revolution from its starting point. Angular speed is often expressed in revolutions per minute (RPM). An object that makes ten complete revolutions in one minute, for example, has a speed of 10 RPM.



Rotational Motion

Acceleration

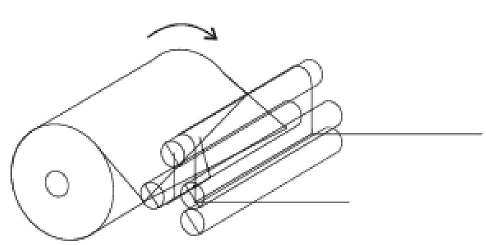
An object can change speed. An increase in speed is called acceleration. Acceleration occurs only when there is a change in the force acting upon the object. An object can also change from a higher to a lower speed. This is known as deceleration (negative acceleration). A rotating object, for example, can accelerate from 10 RPM to 20 RPM, or decelerate from 20 RPM to 10 RPM.



Inertia

Mechanical systems are subject to the law of inertia. The law of inertia states that an object will tend to remain in its current state of rest or motion unless acted upon by an external force. This property of resistance to acceleration/deceleration is referred to as the moment of inertia. The English system of measurement is pound-feet squared ($lb\text{-}ft^2$).

If we look at a continuous roll of paper, for example, we know that when the roll is stopped it would take a certain amount of force to overcome the inertia of the roll to get it rolling. The force required to overcome this inertia can come from a source of energy such as a motor. Once rolling, the paper will continue unwinding until another force acts on it to bring it to a stop.



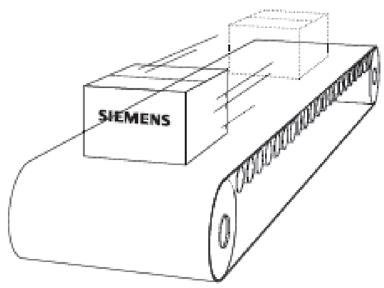
Friction

Any system in motion has losses that drain energy from the system. The law of inertia is still valid, however, because the system will remain in motion at constant speed if energy is added to the system to compensate for the losses. In the previous illustration, for example, these losses include:

- Friction applied to motor and driven equipment bearings
- Wind losses in the motor and driven equipment
- Friction between material on winder and rollers

Work

Whenever a force of any kind causes motion, work is accomplished. For example, work is accomplished when an object on a conveyor is moved from one point to another.



Work is generally expressed in foot-pounds and is defined by the product of the net force (F) applied and the distance (d) moved. If twice the force is applied, twice the work is done. If an object moves twice the distance, twice the work is done.

$$W = F \times d$$

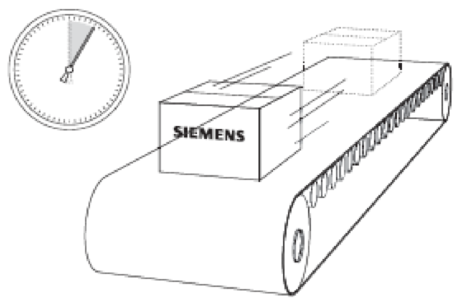
Power

Power is the rate of doing work, or work divided by time.

$$\text{Power} = \frac{\text{Force} \times \text{Distance}}{\text{Time}}$$

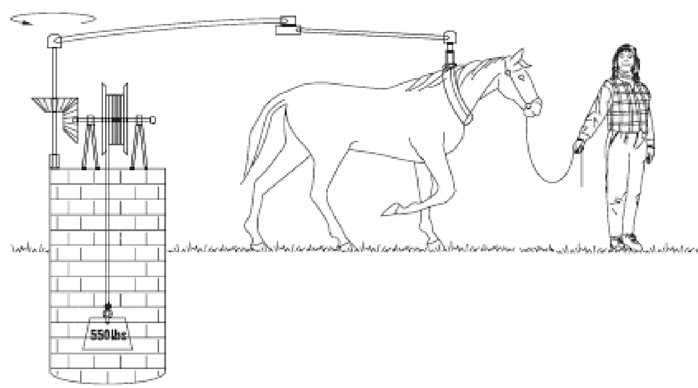
$$\text{Power} = \frac{\text{Work}}{\text{Time}}$$

In other words, power is the amount of work it takes to move the package from one point to another point, divided by the time.



Horsepower

Power can be expressed in foot-pounds per second, but is often expressed in horsepower (HP). This unit was defined in the 18th century by James Watt. Watt sold steam engines and was asked how many horses one steam engine would replace. He had horses walk around a wheel that would lift a weight. He found that a horse would average about 550 foot-pounds of work per second. One horsepower is equivalent to 550 foot-pounds per second or 33,000 foot-pounds per minute.



The following formula can be used to calculate horsepower when torque (in lb-feet) and speed are known. An increase of torque, speed, or both will cause an increase in horsepower.

$$HP = \frac{T \times RPM}{5250}$$

Horsepower and Kilowatts

AC motors manufactured in the United States are generally rated in horsepower (HP). Equipment manufactured in Europe is generally rated in kilowatts (KW). Horsepower can be converted to kilowatts with the following formula:

$$KW = .746 \times HP$$

For example, a 25 HP motor is equivalent to 18.65 KW.

$$18.65\ KW = .746 \times 25\ HP$$

Kilowatts can be converted to horsepower with the following formula:

$$HP = 1.341 \times KW$$

The power formula for a single-phase system is:

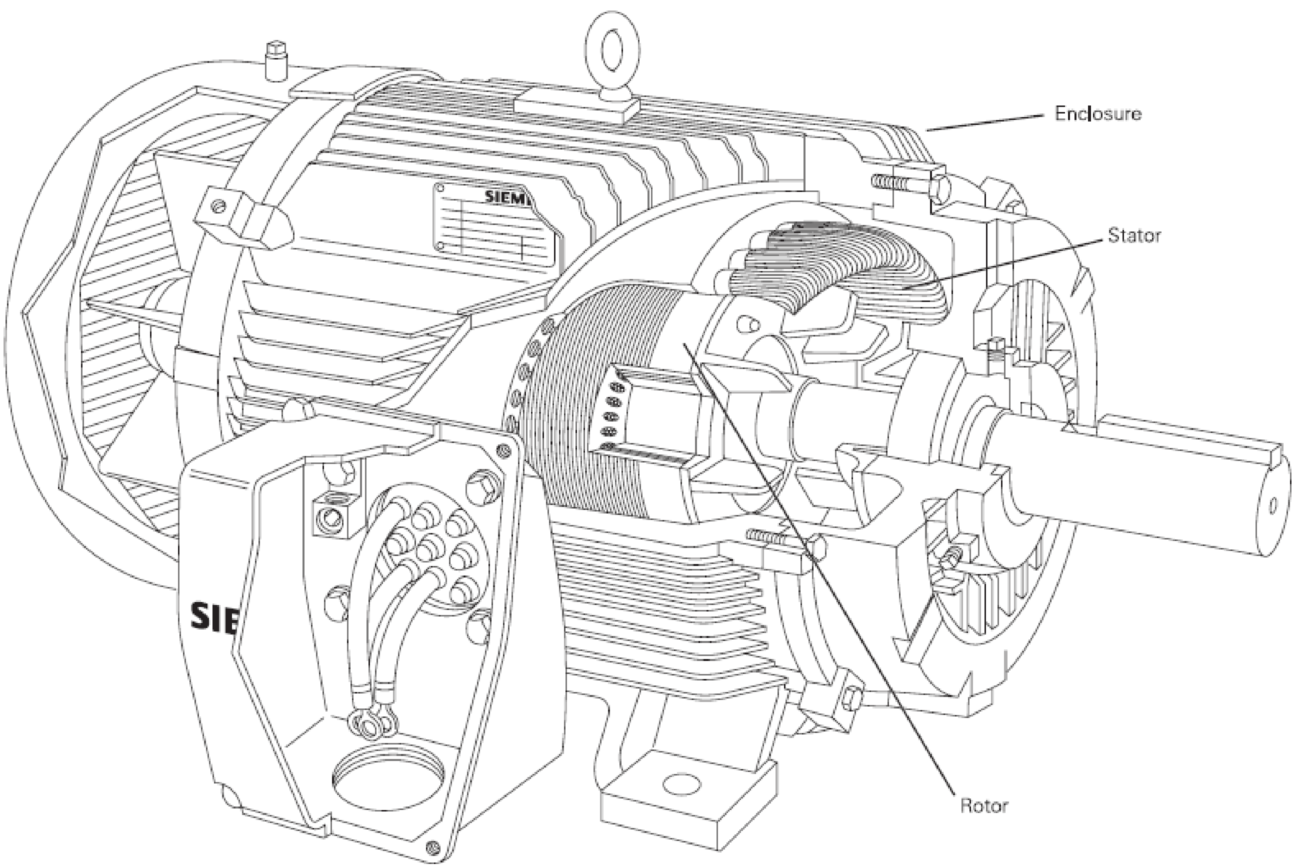
$$KW = \frac{V \times I \times PF}{1000}$$

The power formula for three-phase power is:

$$KW = \frac{V \times I \times PF \times 1.732}{1000}$$

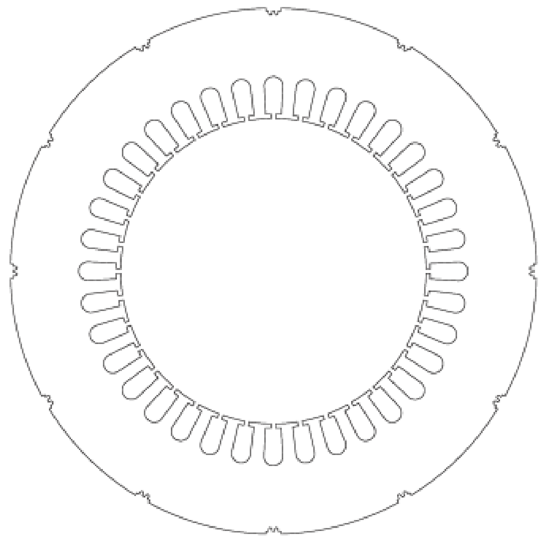
AC Motor Construction

AC induction motors are commonly used in industrial applications. The following motor discussion will center around three-phase, 460 VAC, asynchronous, induction motors. An asynchronous motor is a type of motor where the speed of the rotor is less than the speed of the rotating magnetic field. This type of motor is illustrated below. The three basic parts of an AC motor are the rotor, stator, and enclosure.



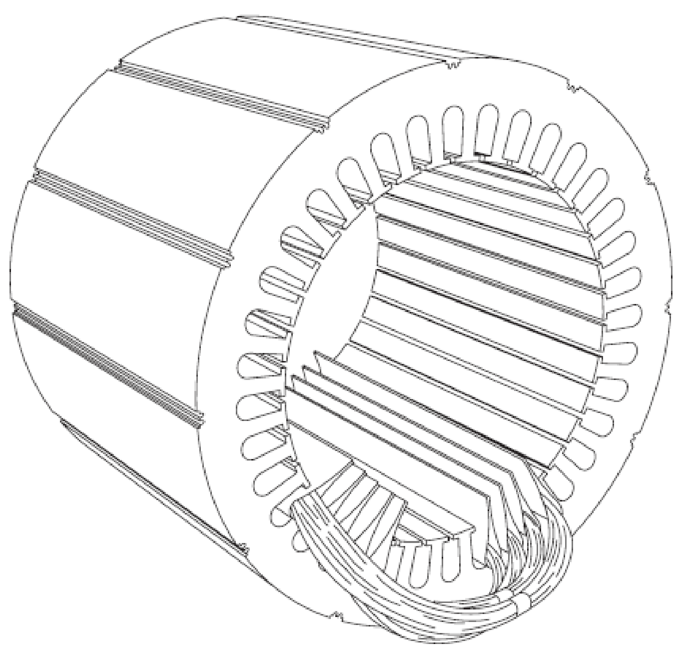
Stator Construction

The stator and the rotor are electrical circuits that perform as electromagnets. The stator is the stationary electrical part of the motor. The stator core of a NEMA motor is made up of several hundred thin laminations.

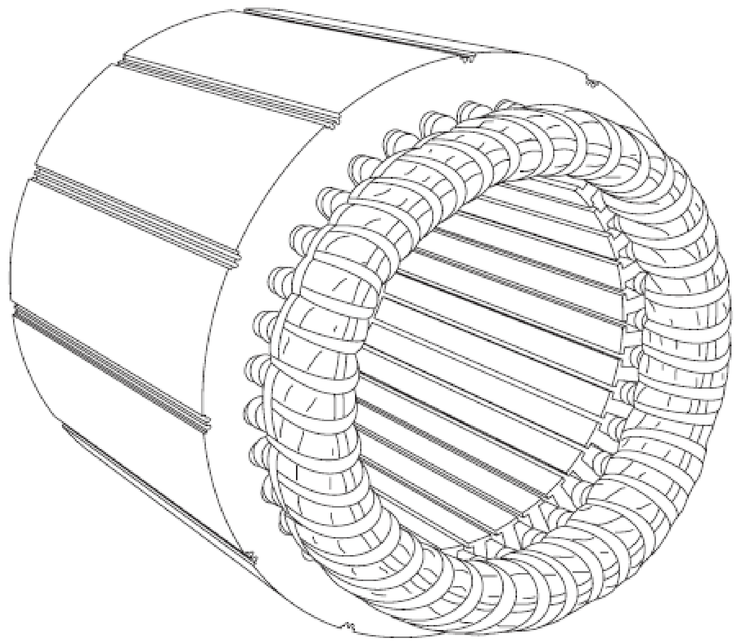


Stator Windings

Stator laminations are stacked together forming a hollow cylinder. Coils of insulated wire are inserted into slots of the stator core.

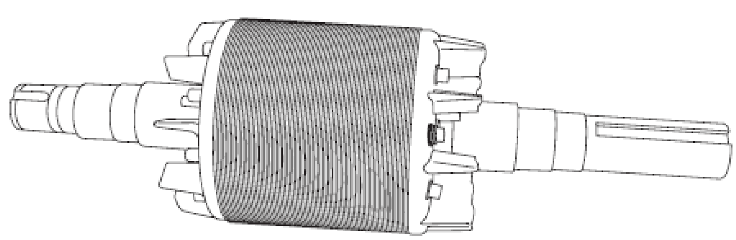


Each grouping of coils, together with the steel core it surrounds, form an electromagnet. Electromagnetism is the principle behind motor operation. The stator windings are connected directly to the power source.

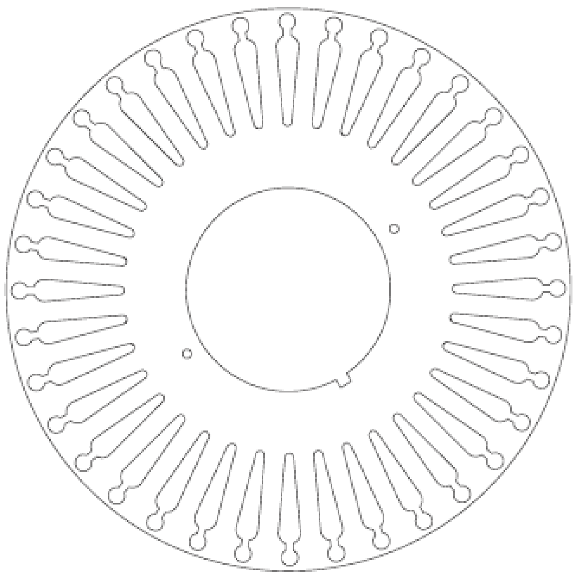


Rotor Construction

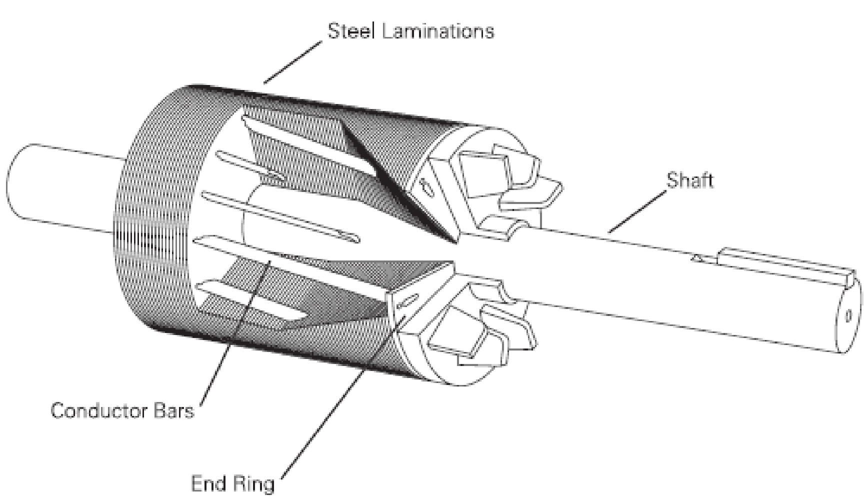
The rotor is the rotating part of the electromagnetic circuit. The most common type of rotor is the "squirrel cage" rotor. Other types of rotor construction will be mentioned later in the course. The construction of the squirrel cage rotor is reminiscent of rotating exercise wheels found in cages of pet rodents.



The rotor consists of a stack of steel laminations with evenly spaced conductor bars around the circumference.

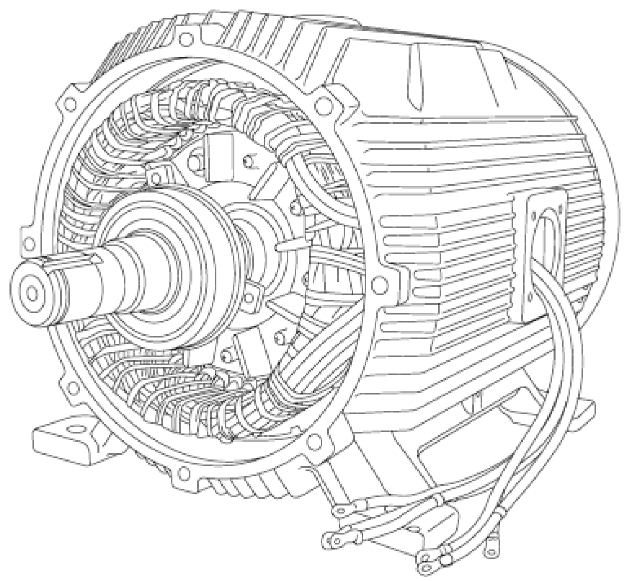


The laminations are stacked together to form a rotor core. Aluminum is die cast in the slots of the rotor core to form a series of conductors around the perimeter of the rotor. The conductor bars are mechanically and electrically connected with end rings. The rotor core mounts on a steel shaft to form a rotor assembly.

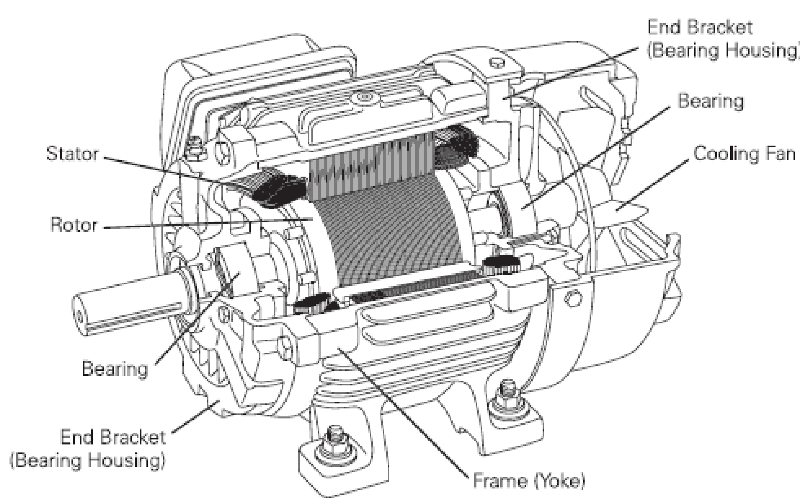


Enclosure

The enclosure consists of a frame (or yoke) and two end brackets (or bearing housings). The stator is mounted inside the frame. The rotor fits inside the stator with a slight air gap separating it from the stator. There is no direct physical connection between the rotor and the stator.

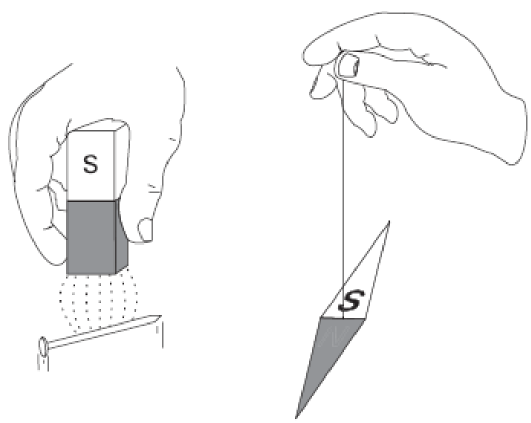


The enclosure also protects the electrical and operating parts of the motor from harmful effects of the environment in which the motor operates. Bearings, mounted on the shaft, support the rotor and allow it to turn. A fan, also mounted on the shaft, is used on the motor shown below for cooling.



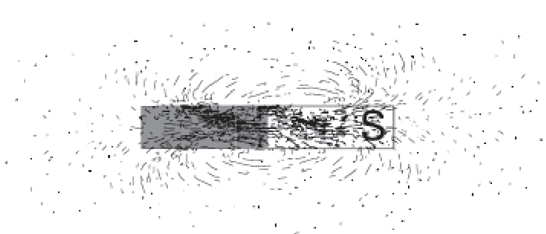
Magnetism

The principles of magnetism play an important role in the operation of an AC motor. All magnets have two characteristics. They attract and hold metal objects like steel and iron. If free to move, like the compass needle, the magnet will assume roughly a north-south position.

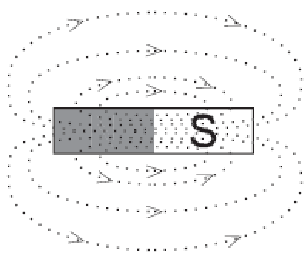


Magnetic Lines of Flux

We know that a magnet attracts an iron or steel object by an invisible force. The magnet's invisible force is called lines of flux. These lines of flux make up an invisible magnetic field. Every magnet has two poles, one north pole and one south pole. Invisible magnetic lines of flux leave the north pole and enter the south pole. While the lines of flux are invisible, the effects of magnetic fields can be made visible. When a sheet of paper is placed on a magnet and iron filings loosely scattered over it, the filings will arrange themselves along the invisible lines of flux.

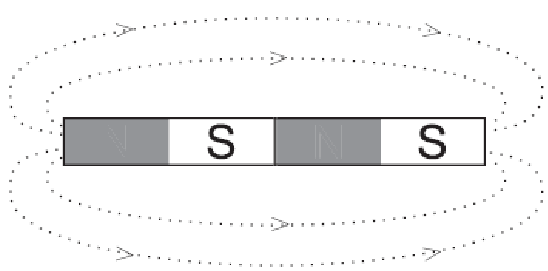


By drawing lines the way the iron filings have arranged themselves, the following illustration is obtained. Magnetic lines of flux always form closed loops, leaving the north pole and entering the south pole. They return to the north pole through the magnet.



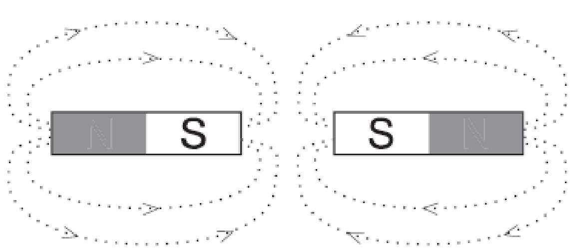
Unlike Poles Attract

The polarity of the magnetic field affects the interaction between magnets. For example, when the opposite poles of two magnets are brought within range of each other the lines of flux combine and tend to pull or attract the magnets.



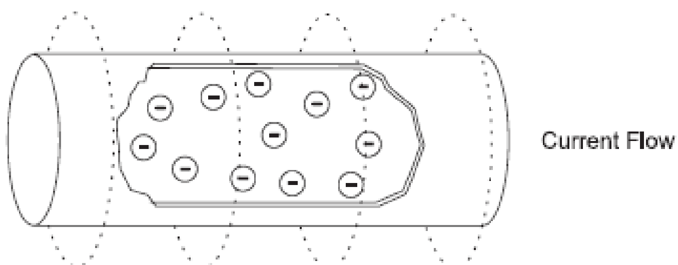
Like Poles Repel

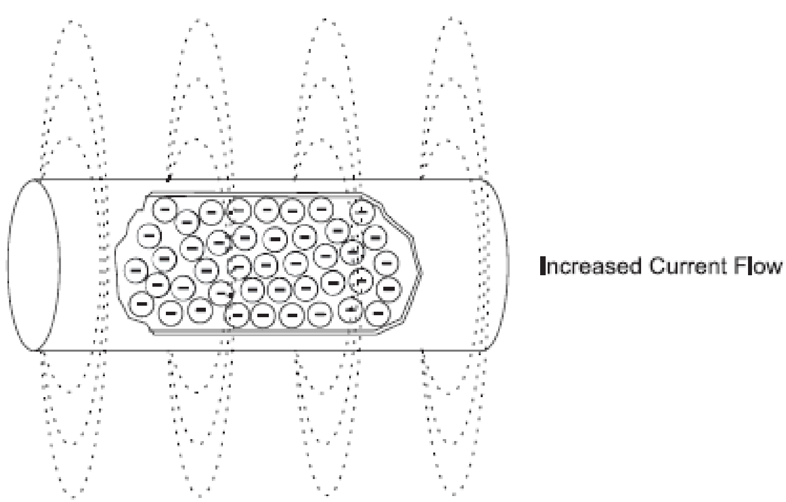
When poles of like polarity of two magnets are brought within range of each other the lines of flux produce a force that tends to push or repel the magnets. For this reason it is said that unlike poles attract and like poles repel. The attracting and repelling action of the magnetic fields is important in the operation of AC motors.



Electromagnetism

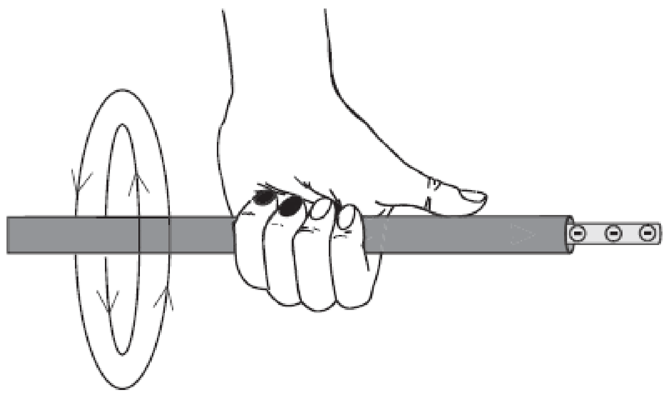
When current flows through a conductor a magnetic field is produced around the conductor. The magnetic field is made up of lines of flux, just like a natural magnet. The size and strength of the magnetic field will increase and decrease as the current flow strength increases and decreases.



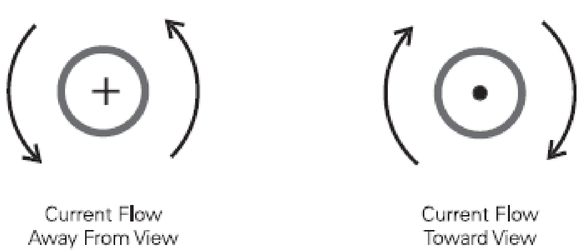


Left-Hand Rule for Conductors

A definite relationship exists between the direction of current flow and the direction of the magnetic field. The left-hand rule for conductors demonstrates this relationship. If a current-carrying conductor is grasped with the left hand with the thumb pointing in the direction of electron flow, the fingers will point in the direction of the magnetic lines of flux.

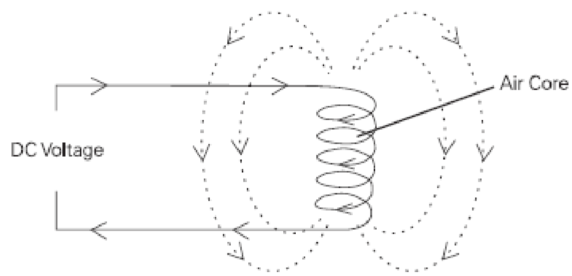


In the following illustration it can be seen that when the electron flow is away from the viewer (indicated by the plus sign) the lines of flux flow in a counterclockwise direction around the conductor. When the electron flow reverses and current flow is towards the viewer (indicated by the dot) the lines of flux reverse direction and flow in a clockwise direction.



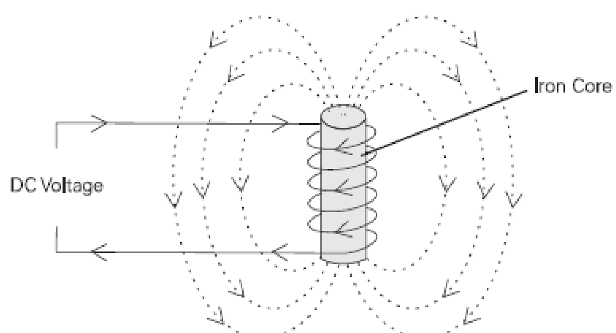
Electromagnet

An electromagnet can be made by winding the conductor into a coil and applying a DC voltage. The lines of flux, formed by current flow through the conductor, combine to produce a larger and stronger magnetic field. The center of the coil is known as the core. In this simple electromagnet the core is air.



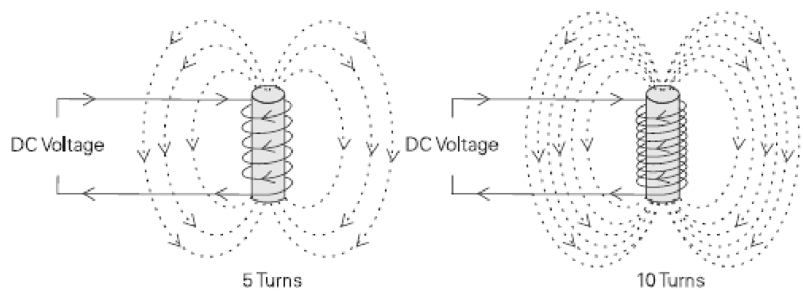
Adding an Iron Core

Iron is a better conductor of flux than air. The air core of an electromagnet can be replaced by a piece of soft iron. When a piece of iron is placed in the center of the coil more lines of flux can flow and the magnetic field is strengthened.



Number of Turns

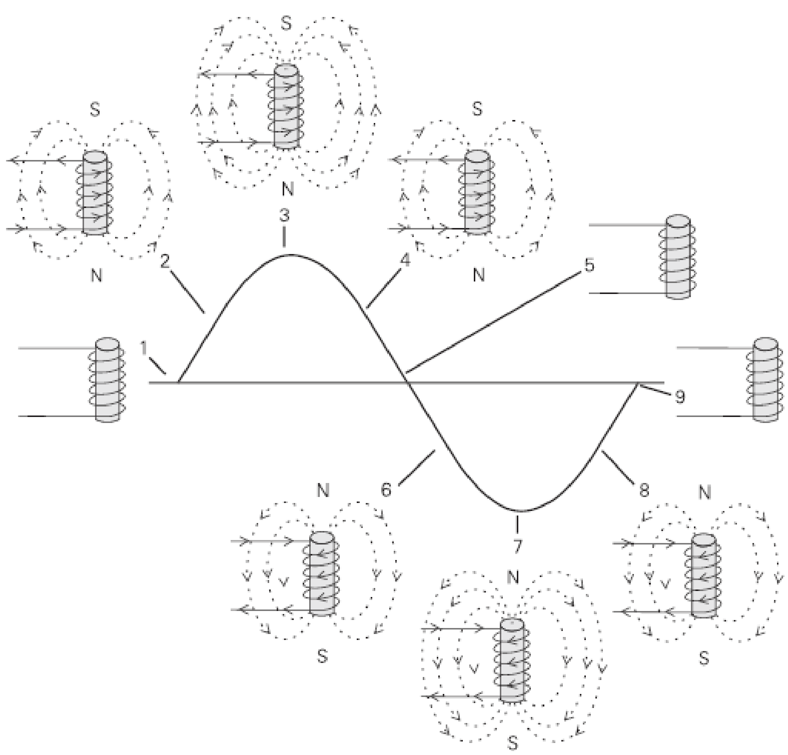
The strength of the magnetic field in the DC electromagnet can be increased by increasing the number of turns in the coil. The greater the number of turns the stronger the magnetic field.



Changing Polarity

The magnetic field of an electromagnet has the same characteristics as a natural magnet, including a north and south pole. However, when the direction of current flow through the electromagnet changes, the polarity of the electromagnet changes. The polarity of an electromagnet connected to an AC source will change at the same frequency as the frequency of the AC source. This can be demonstrated in the following illustration.

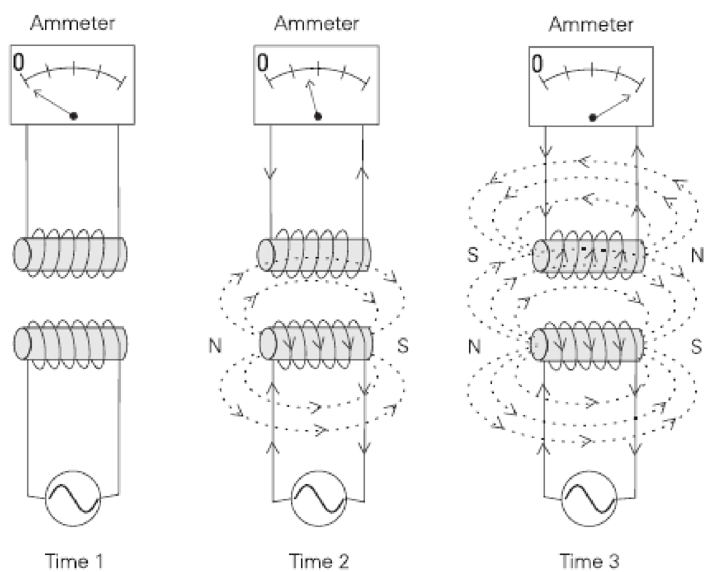
At Time 1 current flow is at zero. There is no magnetic field produced around the electromagnet. At Time 2 current is flowing in a positive direction. A magnetic field builds up around the electromagnet. The electromagnet assumes a polarity with the south pole on the top and the north pole on the bottom. At Time 3 current flow is at its peak positive value. The strength of the electromagnetic field is at its greatest value. At Time 4 current flow decreases and the magnetic field begins to collapse, until Time 5 when current flow and magnetic field are at zero. Current immediately begins to increase in the opposite direction. At Time 6 current is increasing in a negative direction. The polarity of the electromagnetic field has changed. The north pole is now on top and the south pole is on the bottom. The negative half of the cycle continues through Times 7 and 8, returning to zero at Time 9. This process will repeat 60 times a second with a 60 Hz AC power supply.



Induced Voltage

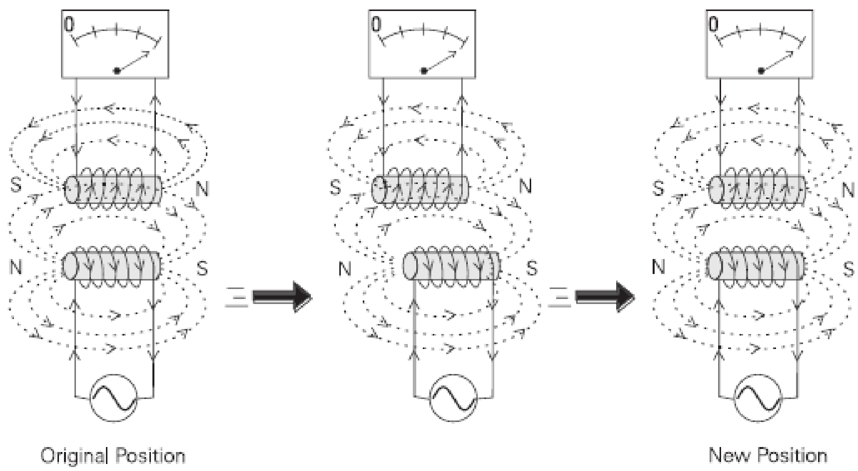
A conductor moving through a magnetic field will have a voltage induced into it. This electrical principle is used in the operation of AC induction motors. In the following illustration an electromagnet is connected to an AC power source. Another electromagnet is placed above it. The second electromagnet is in a separate circuit. There is no physical connection between the two circuits.

At Time 1 voltage and current are zero in both circuits. At Time 2 voltage and current are increasing in the bottom circuit. A magnetic field builds up in the bottom electromagnet. Lines of flux from the magnetic field building up in the bottom electromagnet cut across the top electromagnet. A voltage is induced in the top electromagnet and current flows through it. At Time 3 current flow has reached its peak. Maximum current is flowing in both circuits. The magnetic field around the coil continues to build up and collapse as the alternating current continues to increase and decrease. As the magnetic field moves through space, moving out from the coil as it builds up and back towards the coil as it collapses, lines of flux cut across the top coil. As current flows in the top electromagnet it creates its own magnetic field.



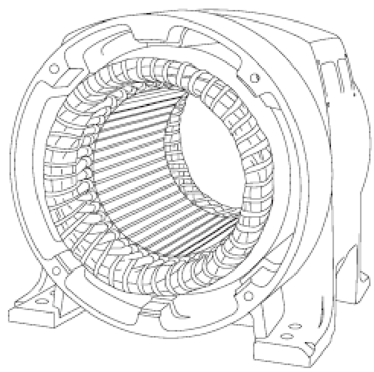
Electromagnetic Attraction

The polarity of the magnetic field induced in the top electromagnet is opposite the polarity of the magnetic field in the bottom electromagnet. Since opposite poles attract, the top electromagnet will follow the bottom electromagnet when it is moved.



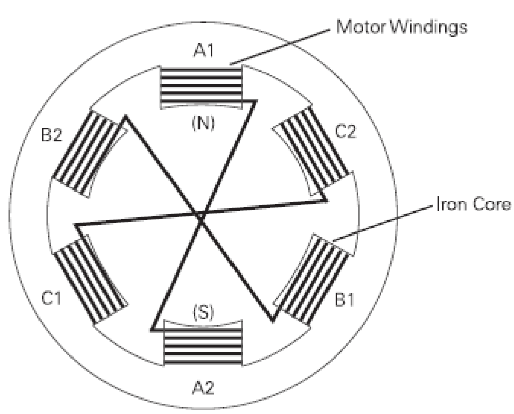
Developing a Rotating Magnetic Field

The principles of electromagnetism explain the shaft rotation of an AC motor. Recall that the stator of an AC motor is a hollow cylinder in which coils of insulated wire are inserted.



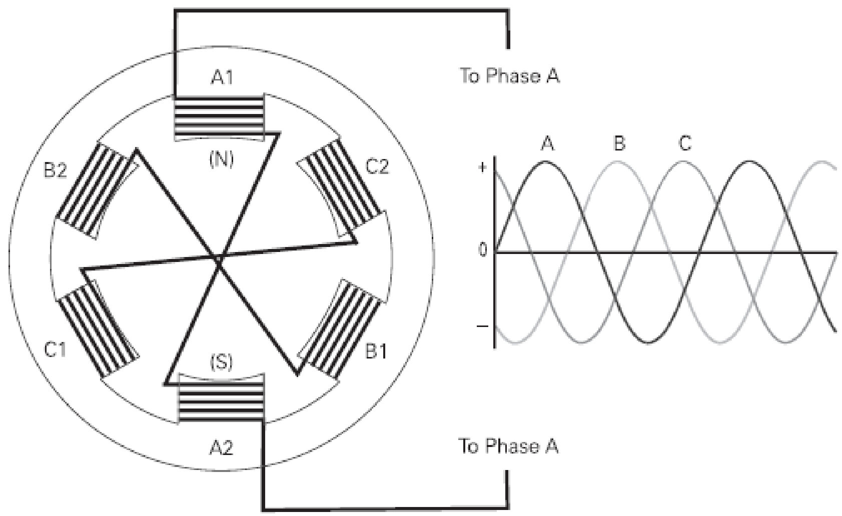
Stator Coil Arrangement

The following schematic illustrates the relationship of the coils. In this example six coils are used, two coils for each of the three phases. The coils operate in pairs. The coils are wrapped around the soft iron core material of the stator. These coils are referred to as motor windings. Each motor winding becomes a separate electromagnet. The coils are wound in such a way that when current flows in them one coil is a north pole and its pair is a south pole. For example, if A1 were a north pole then A2 would be a south pole. When current reverses direction the polarity of the poles would also reverse.

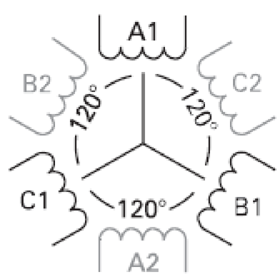


Power Supply

The stator is connected to a 3-phase AC power supply. In the following illustration phase A is connected to phase A of the power supply. Phase B and C would also be connected to phases B and C of the power supply respectively.



Phase windings (A, B, and C) are placed 120° apart. In this example, a second set of three-phase windings is installed. The number of poles is determined by how many times a phase winding appears. In this example, each phase winding appears two times. This is a two-pole stator. If each phase winding appeared four times it would be a four-pole stator.



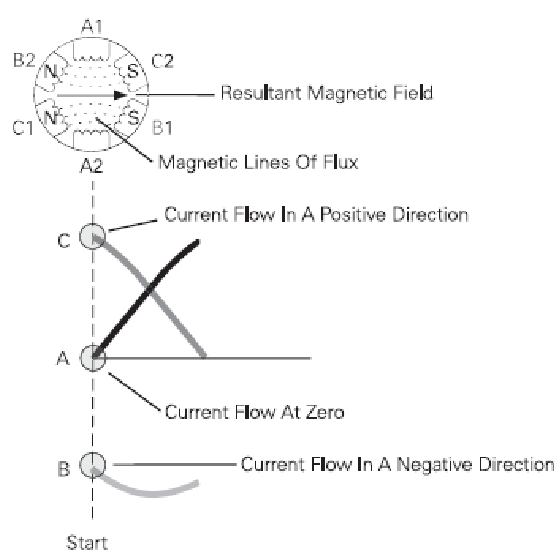
2-Pole Stator Winding

When AC voltage is applied to the stator, current flows through the windings. The magnetic field developed in a phase winding depends on the direction of current flow through that winding. The following chart is used here for explanation only. It will be used in the next few illustrations to demonstrate how a rotating magnetic field is developed. It assumes that a positive current flow in the A1, B1 and C1 windings result in a north pole.

Winding	Current Flow Direction	
	Positive	**Negative**
A1	North	South
A2	South	North
B1	North	South
B2	South	North
C1	North	South
C2	South	North

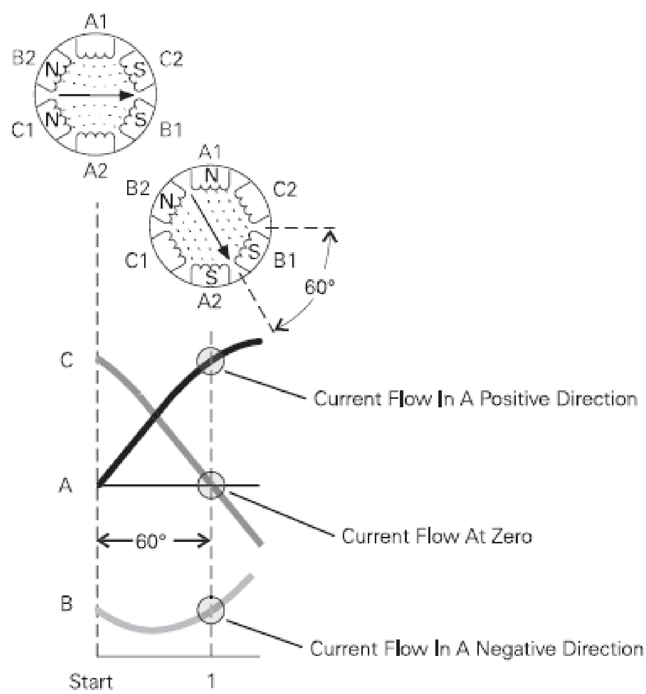
Start

It is easier to visualize a magnetic field if a start time is picked when no current is flowing through one phase. In the following illustration, for example, a start time has been selected during which phase A has no current flow, phase B has current flow in a negative direction and phase C has current flow in a positive direction. Based on the above chart, B1 and C2 are south poles and B2 and C1 are north poles. Magnetic lines of flux leave the B2 north pole and enter the nearest south pole, C2. Magnetic lines of flux also leave the C1 north pole and enter the nearest south pole, B1. A magnetic field results, as indicated by the arrow.



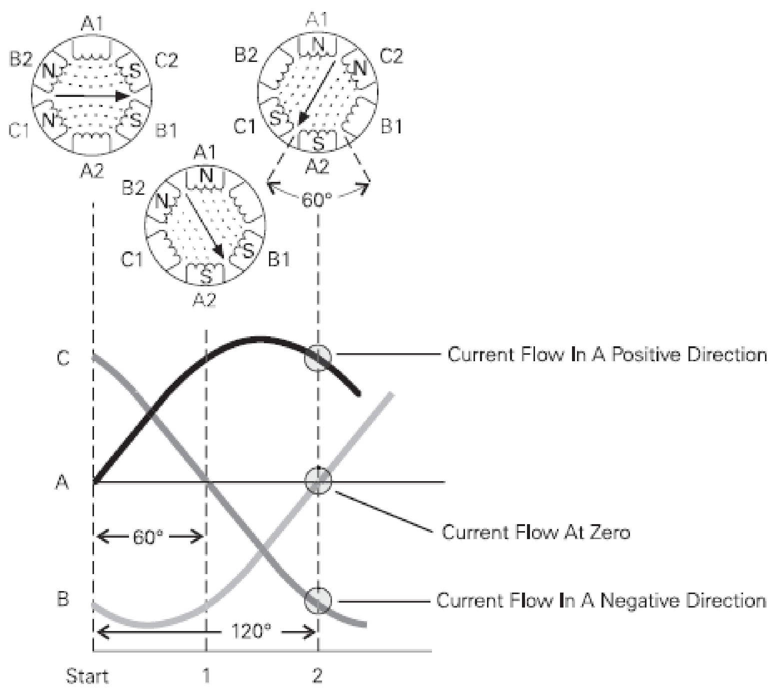
Time 1

If the field is evaluated at 60° intervals from the starting point, at Time 1, it can be seen that the field will rotate 60°. At Time 1 phase C has no current flow, phase A has current flow in a positive direction and phase B has current flow in a negative direction. Following the same logic as used for the starting point, windings A1 and B2 are north poles and windings A2 and B1 are south poles.



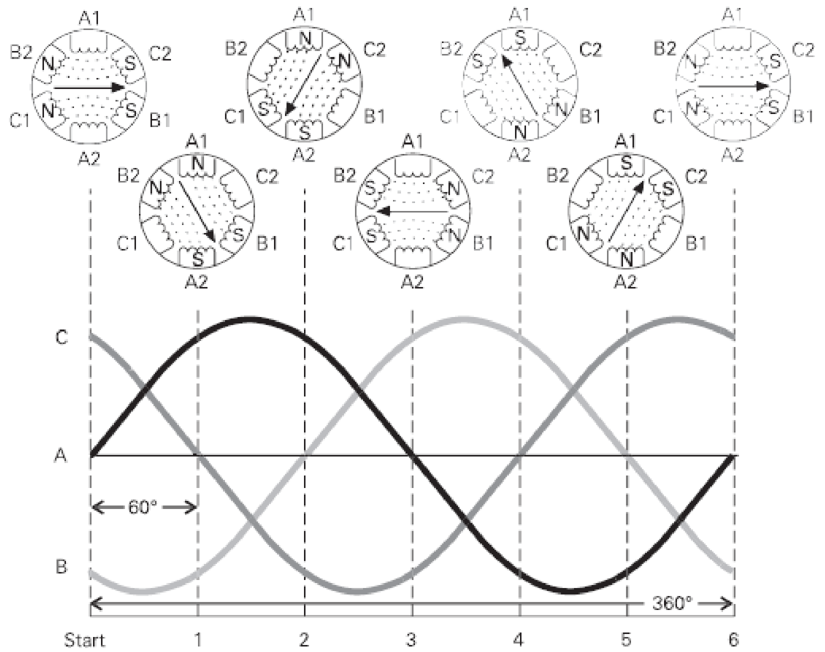
Time 2

At Time 2 the magnetic field has rotated 60°. Phase B has no current flow. Although current is decreasing in phase A it is still flowing in a positive direction. Phase C is now flowing in a negative direction. At start it was flowing in a positive direction. Current flow has changed directions in the phase C windings and the magnetic poles have reversed polarity.



360° Rotation

At the end of six such time intervals the magnetic field will have rotated one full revolution or 360°. This process will repeat 60 times a second on a 60 Hz power supply.



Synchronous Speed

The speed of the rotating magnetic field is referred to as synchronous speed (Ns). Synchronous speed is equal to 120 times the frequency (F), divided by the number of poles (P). The synchronous speed for a two-pole motor operated at 60 Hz, for example, is 3600 RPM.

$$N_s = \frac{120F}{P} \Rightarrow N_s = \frac{120 \times 60}{2} \Rightarrow N_s = 3600 \text{ RPM}$$

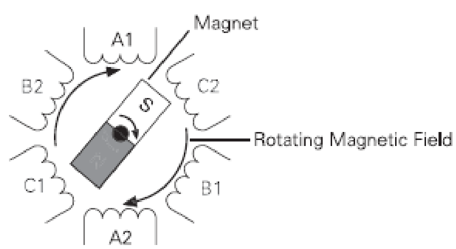
Synchronous speed decreases as the number of poles increase. The following table shows the synchronous speed at 60 Hz for the corresponding number of poles.

No. of Poles	Synchronous Speed
2	3600
4	1800
6	1200
8	900
10	720

Rotor Rotation

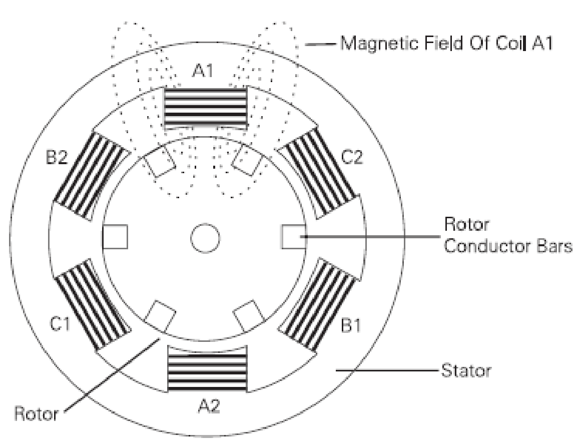
Permanent Magnet

To see how a rotor works, a magnet mounted on a shaft can be substituted for the squirrel cage rotor. When the stator windings are energized a rotating magnetic field is established. The magnet has its own magnetic field that interacts with the rotating magnetic field of the stator. The north pole of the rotating magnetic field attracts the south pole of the magnet, and the south pole of the rotating magnetic field attracts the north pole of the magnet. As the rotating magnetic field rotates, it pulls the magnet along causing it to rotate. This design, used on some motors, is referred to as a permanent magnet synchronous motor.

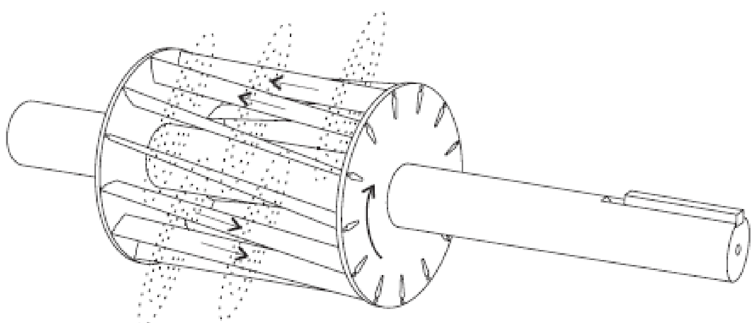


Induced Voltage Electromagnet

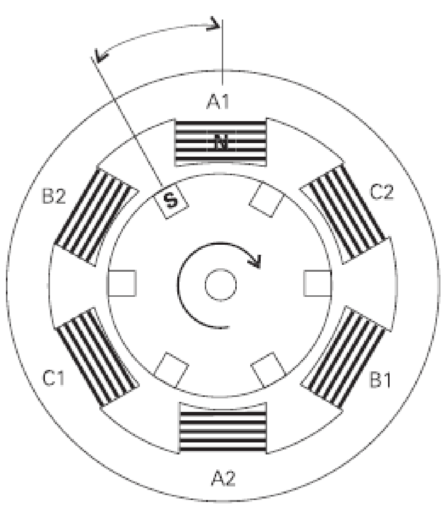
The squirrel cage rotor acts essentially the same as the magnet. When power is applied to the stator, current flows through the winding, causing an expanding electromagnetic field which cuts across the rotor bars.



When a conductor, such as a rotor bar, passes through a magnetic field a voltage (emf) is induced in the conductor. The induced voltage causes a current flow in the conductor. Current flows through the rotor bars and around the end ring. The current flow in the conductor bars produces magnetic fields around each rotor bar. Recall that in an AC circuit current continuously changes direction and amplitude. The resultant magnetic field of the stator and rotor continuously change. The squirrel cage rotor becomes an electromagnet with alternating north and south poles.



The following drawing illustrates one instant in time during which current flow through winding A1 produces a north pole. The expanding field cuts across an adjacent rotor bar, inducing a voltage. The resultant magnetic field in the rotor tooth produces a south pole. As the stator magnetic field rotates the rotor follows.



Slip

There must be a relative difference in speed between the rotor and the rotating magnetic field. If the rotor and the rotating magnetic field were turning at the same speed no relative motion would exist between the two, therefore no lines of flux would be cut, and no voltage would be induced in the rotor. The difference in speed is called slip. Slip is necessary to produce torque. Slip is dependent on load. An increase in load will cause the rotor to slow down or increase slip. A decrease in load will cause the rotor to speed up or decrease slip. Slip is expressed as a percentage and can be determined with the following formula.

$$\% \text{ Slip} = \frac{N_S - N_R}{N_S} \times 100$$

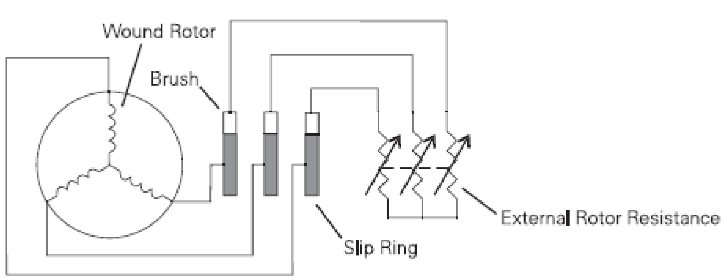
For example, a four-pole motor operated at 60 Hz has a synchronous speed (N_S) of 1800 RPM. If the rotor speed at full load is 1765 RPM (N_R), then slip is 1.9%.

$$\% \text{ Slip} = \frac{1800 - 1765}{1800} \times 100$$

$$\% \text{ Slip} = 1.9\%$$

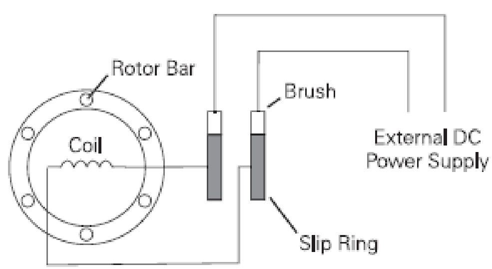
Wound Rotor Motor

The discussion to this point has been centered on the more common squirrel cage rotor. Another type is the wound rotor. A major difference between the wound rotor motor and the squirrel cage rotor is the conductors of the wound rotor consist of wound coils instead of bars. These coils are connected through slip rings and brushes to external variable resistors. The rotating magnetic field induces a voltage in the rotor windings. Increasing the resistance of the rotor windings causes less current flow in the rotor windings, decreasing speed. Decreasing the resistance allows more current flow, speeding the motor up.



Synchronous Motor

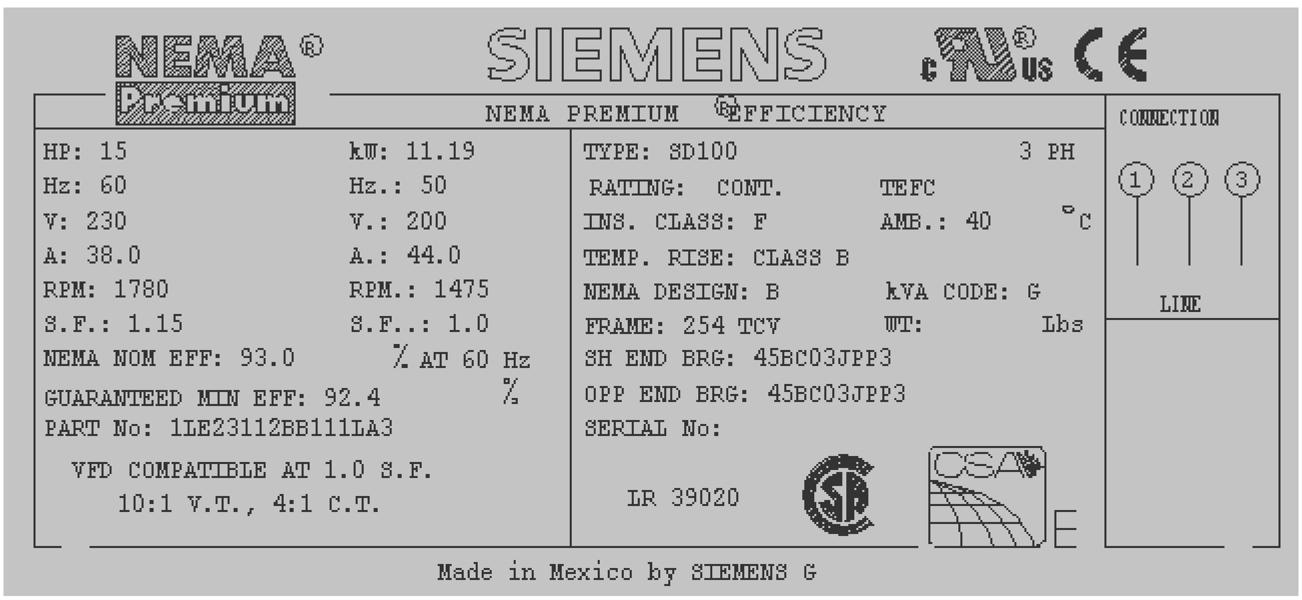
Another type of AC motor is the synchronous motor. The synchronous motor is not an induction motor. One type of synchronous motor is constructed somewhat like a squirrel cage rotor. In addition to rotor bars coil windings are added. The coil windings are connected to an external DC power supply by slip rings and brushes. On start AC is applied to the stator and the synchronous motor starts like a squirrel cage rotor. DC is applied to the rotor coils after the motor reaches maximum speed. This produces a strong constant magnetic field in the rotor which locks in step with the rotating magnetic field. The rotor turns at the same speed as synchronous speed (speed of the rotating magnetic field). There is no slip. Variations of synchronous motors include a permanent magnet rotor. The rotor is a permanent magnet and an external DC source is not required. These are found on small horsepower synchronous motors.



Motor Specifications

Nameplate

The nameplate of a motor provides important information necessary for selection and application. Below is the nameplate of a sample 15 horsepower AC motor. Specifications are given for the load and operating conditions as well as motor protection and efficiency.



Voltage and Amps

AC motors are designed to operated at standard voltages and Frequencies. This motor is designed for use on 230 VAC 60Hz and 200VAC 50Hz. Full load current for this motor is 38 amps (60Hz) and 44 amps (50Hz).

RPM

Base speed is the nameplate speed, given in RPM, where the motor develops rated horsepower at rated voltage and frequency. It is an Indication of how fast the output shaft will turn the connected equipment when fully loaded with proper voltage and frequency applied.

The base speed of this motor is 1780 RPM (60Hz) and 1475 RPM (50Hz). It is known that the synchronous speed of a 4-pole motor is 1800 RPM. When fully loaded there will be 1.1% slip. If the connected equipment is operating at less than full load, the output speed (RPM) will be slightly higher than nameplate.

% Slip = (1800-1780) x 100% / 1800

% Slip = 1.1

Service Factor

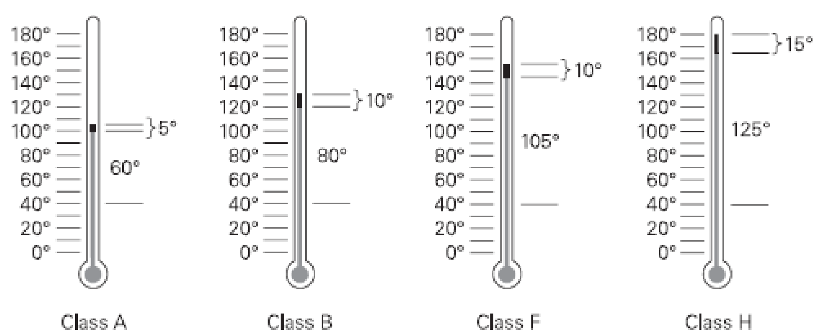
A motor designed to operate at its nameplate horsepower rating has a service factor of 1.0. This means the motor can operate at 100% of its rated horsepower. Some applications may require a motor to exceed the rated horsepower. In these cases a motor with a service factor of 1.15 can be specified. The service factor is a multiplier that may be applied to the rated power. A 1.15 service factor motor can be operated 15% higher than the motor's nameplate horsepower. The 15 HP motor with a 1.15 service factor, for example, can be operated at 22.5 HP. It should be noted that any motor operating continuously at a service factor greater than 1 will have a reduced life expectancy compared to operating it at its rated horsepower. In addition, performance characteristics, such as full load RPM and full load current, will be affected.

Class Insulation

The National Electrical Manufacturers Association (NEMA) has established insulation classes to meet motor temperature requirements found in different operating environments. The four insulation classes are A, B, F, and H. Class F is commonly used. Class A is seldom used. Before a motor is started, its windings are at the temperature of the surrounding air. This is known as ambient temperature. NEMA has standardized on an ambient temperature of 40° C, or 104° F within a defined altitude range for all motor classes.

DUTY	CONT	40 °C AMB.
CLASS INSUL	F	

Temperature will rise in the motor as soon as it is started. Each insulation class has a specified allowable temperature rise. The combination of ambient temperature and allowed temperature rise equals the maximum winding temperature in a motor. A motor with Class F insulation, for example, has a maximum temperature rise of 105° C when operated at a 1.0 service factor. The maximum winding temperature is 145° C (40° ambient plus 105° rise). A margin is allowed to provide for a point at the center of the motor's windings where the temperature is higher. This is referred to as the motor's hot spot.



Class A
60° C Rise
5° C Hot Spot

Class B
80° C Rise
10° C Hot Spot

Class F
105° C Rise
10° C Hot Spot

Class H
125° C Rise
15° C Hot Spot

The operating temperature of a motor is important to efficient operation and long life. Operating a motor above the limits of the insulation class reduces the motor's life expectancy. A 10° C increase in the operating temperature can decrease the motor's insulation life expectancy as much as 50%.

Motor Design

The National Electrical Manufacturers Association (NEMA) has established standards for motor construction and performance. NEMA design B motors are most commonly used.

NEMA DESIGN	B

Efficiency

AC motor efficiency is expressed as a percentage. It is an indication of how much input electrical energy is converted to output mechanical energy. The nominal efficiency of this motor is 93.0%. The higher the percentage the more efficiently the motor converts the incoming electrical power to mechanical horsepower. A 15 HP motor with 93.0% efficiency would consume less energy than a 15 HP motor with an efficiency rating of 83%. This can mean a significant savings in energy cost. Lower operating temperature, longer life, and lower noise levels are typical benefits of high efficiency motors.

NEMA Motor Characteristics

Standard Motor Designs

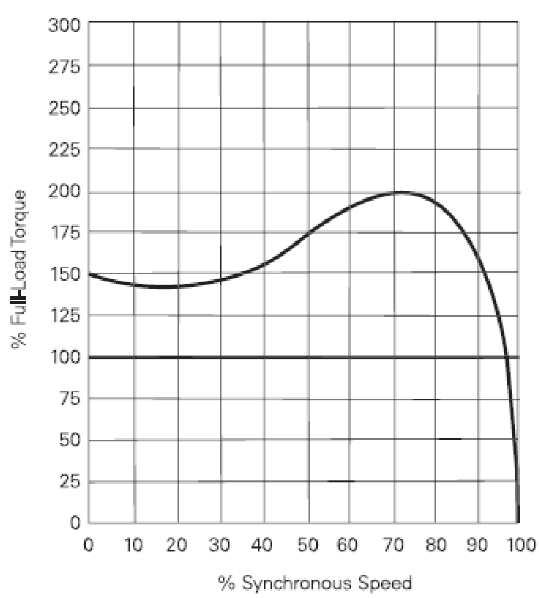
Motors are designed with certain speed-torque characteristics to match speed-torque requirements of various loads. The four standard NEMA designs are NEMA A, NEMA B, NEMA C, and NEMA D. NEMA A is not used very often. NEMA B is most commonly used. NEMA C and NEMA D are used for specialized applications. A motor must be able to develop enough torque to start, accelerate and operate a load at rated speed. Using the sample 30 HP, 1765 RPM motor discussed previously, torque can be calculated by transposing the formula for horsepower.

$$HP = \frac{T \times RPM}{5250}$$

$$T = \frac{HP \times 5250}{RPM} \qquad T = \frac{30 \times 5250}{1765} \qquad T = 89.2 \text{ Lb-Ft}$$

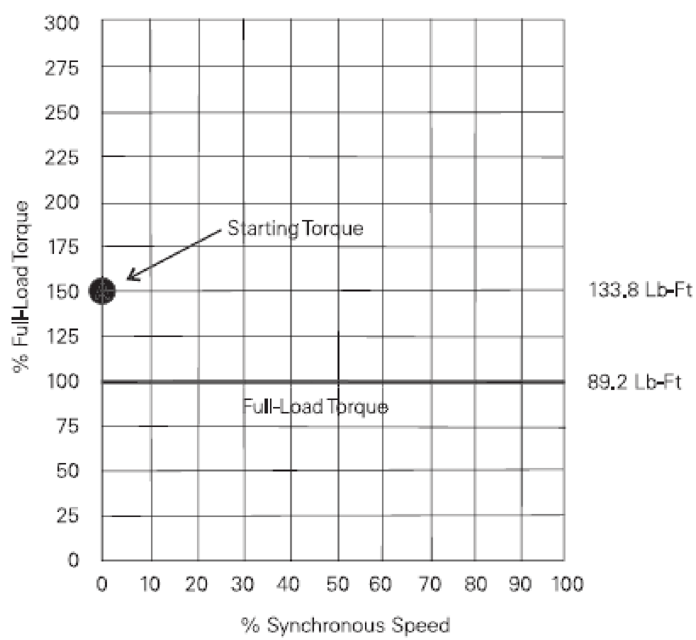
Speed-Torque Curve for NEMA B Motor

A graph, like the one shown below, shows the relationship between speed and torque the motor produces from the moment of start until the motor reaches full-load torque at rated speed. This graph represents a NEMA B motor.



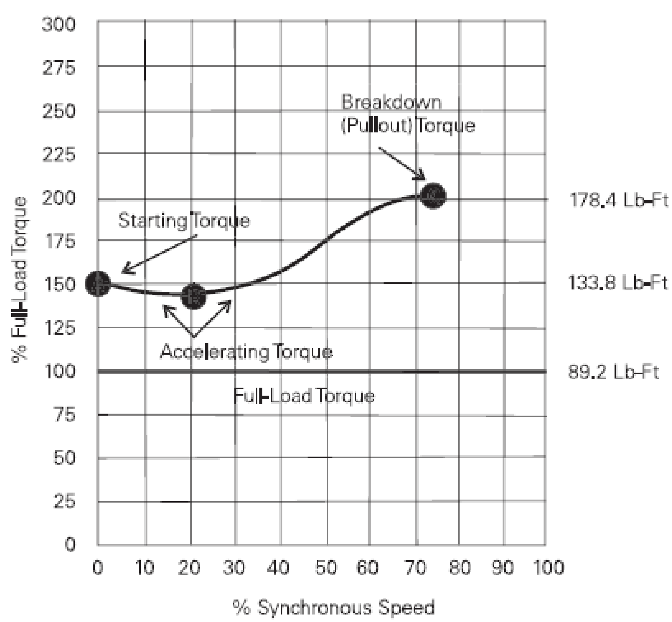
Starting Torque

Starting torque (point A on the graph) is also referred to as locked rotor torque. This torque is developed when the rotor is held at rest with rated voltage and frequency applied. This condition occurs each time a motor is started. When rated voltage and frequency are applied to the stator there is a brief amount of time before the rotor turns. At this instant a NEMA B motor develops approximately 150% of its full-load torque. A 30 HP, 1765 RPM motor, for example, will develop approximately 133.8 Lb-Ft of torque.



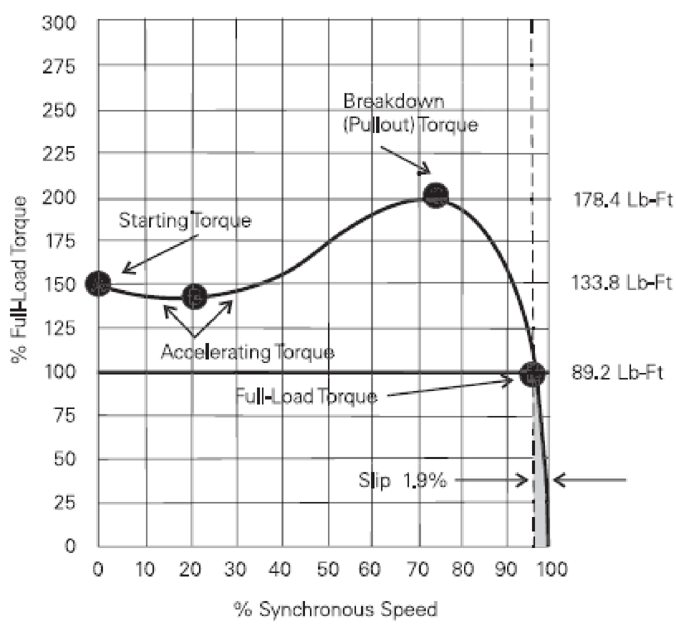
Accelerating and Breakdown Torque

The magnetic attraction of the rotating magnetic field will cause the rotor to accelerate. As the motor picks up speed torque decreases slightly until it reaches point B on the graph. As speed continues to increase from point B to point C torque increases until it reaches it's maximum at approximately 200%. This torque is referred to as accelerating or pull up torque. Point C is the maximum torque a motor can produce. At this point a 30 HP motor will develop approximately 178.4 Lb-Ft of torque. If the motor were overloaded beyond the motor's torque capability, it would stall or abruptly slow down at this point. This is referred to as breakdown or pullout torque.



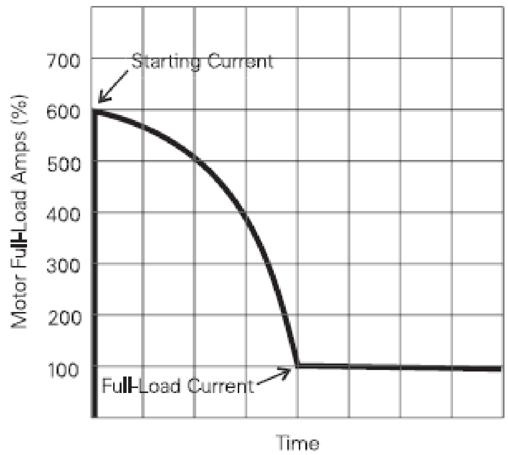
Full-Load Torque

Torque decreases rapidly as speed increases beyond breakdown torque (point C), until it reaches full-load torque at a speed slightly less than 100% synchronous speed. Full-load torque is the torque developed when the motor is operating with rated voltage, frequency and load. The speed at which full-load torque is produced is the slip speed or rated speed of the motor. Recall that slip is required to produce torque. If the synchronous speed of the motor is 1800 RPM and the amount of slip is 1.9%, the full-load rated speed of the motor is 1765 RPM. The full-load torque of the 1765 RPM 30 HP motor is 89.2 Lb-Ft. NEMA design B motors are general purpose single speed motors suited for applications that require normal starting and running torque such as conveyors, fans, centrifugal pumps, and machine tools.



Starting Current and Full-Load Current

Starting current is also referred to as locked rotor current, and is measured from the supply line at rated voltage and frequency with the rotor at rest. Full-load current is the current measured from the supply line at rated voltage, frequency and load with the rotor up to speed. Starting current is typically 600-650% of full-load current on a NEMA B motor. Starting current decreases to rated full-load current as the rotor comes up to speed.

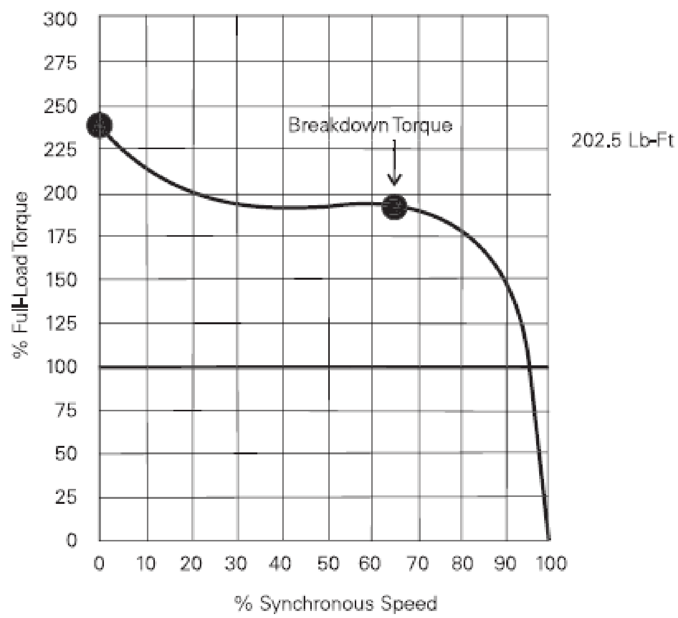


NEMA A Motor

NEMA sets limits of starting (locked rotor) current for NEMA design B motors. When special load torque or load inertia requirements result in special electrical designs that will yield higher locked rotor current (LRA), NEMA design A may result. This designation also cautions the selection of motor control components to avoid tripping protective devices during longer acceleration times or higher than normal starting current.

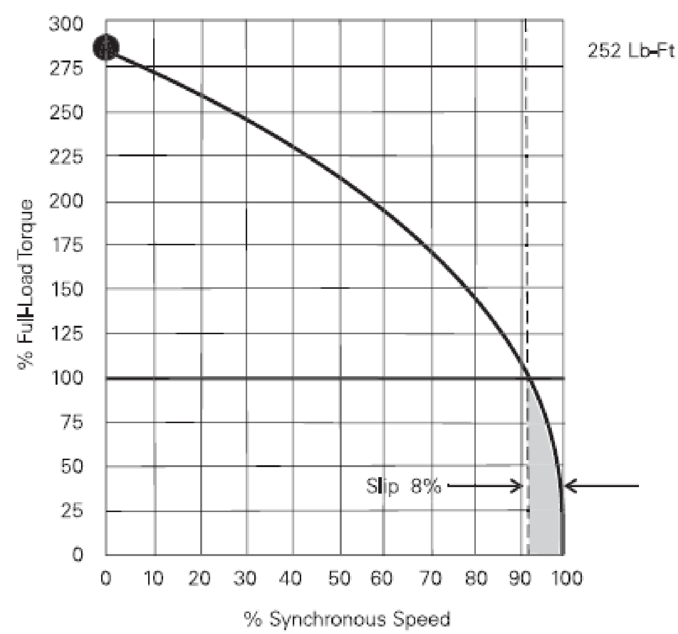
NEMA C Motor

Starting torque of a NEMA design C motor is approximately 225%. A NEMA C, 1765 RPM, 30 HP motor will develop approximately 202.5 Lb-Ft of starting torque. Hard to start applications such as plunger pumps, heavily loaded conveyors, and compressors require this higher starting torque. Slip and full-load torque are about the same as a NEMA B motor. NEMA C applies to single speed motors from approximately 5 HP to 200 HP.



NEMA D Motor

The starting torque of a NEMA design D motor is approximately 280% of the motor's full-load torque. A NEMA D, with a full-load rated speed of 1765 RPM, 30 HP motor will develop approximately 252 Lb-Ft of starting torque. Very hard to start applications, such as punch presses, cranes, hoists, and oil well pumps require this high starting torque. NEMA D motors have no true breakdown torque. After initial starting torque is reached torque decreases until full-load torque is reached. NEMA D motors typically are designed with 5 to 8% slip or 8 to 13% slip.



Multispeed and ASD (Adjustable Speed Drive)

These specialized motor designs are uniquely designed or selected to specific load requirements. NEMA design classifications are not applicable to these specialized motors.

Soft Starts

Various special configurations of motor controls are selected when starting/accelerating torques must be more accurately controlled, or when starting current must be limited. In the cases of part winding start or wye-delta start, the motor windings must be designed with unique connections for the special controls. In cases such as reduced voltage autotransformer or electronic soft starts, relatively standard motors may be approved for these special applications.

Derating Factors

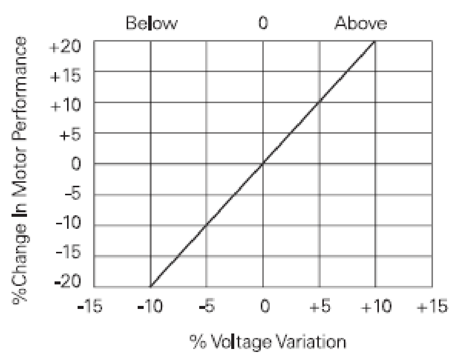
Several factors can effect the operation and performance of an AC motor. These need to be considered when applying a motor.

Voltage Variation

AC motors are designed to operate on standardized voltages and frequencies. The following table reflects NEMA standards.

Standardized Voltages/Frequencies	
60 Hz	**50 Hz**
115 VAC	380 VAC
220 VAC	400 VAC
230 VAC	415 VAC
460 VAC	220/380 VAC
575 VAC	

A small variation in supply voltage can have a dramatic affect on motor performance. In the following chart, for example, when voltage is 10% below the rated voltage of the motor, the motor has 20% less starting torque. This reduced voltage may prevent the motor from getting its load started or keeping it running at rated speed. A 10% increase in supply voltage, on the other hand, increases the starting torque by 20%. This increased torque may cause damage during startup. A conveyor, for example, may lurch forward at startup. A voltage variation will cause similar changes in the motor's starting amps, full-load amps, and temperature rise.



Frequency

A variation in the frequency at which the motor operates causes changes primarily in speed and torque characteristics. A 5% increase in frequency, for example, causes a 5% increase in full-load speed and a 10% decrease in torque.

Frequency Variation	% Change Fl. Load Speed	% Change Starting Torque
+5%	+5%	-10%
-5%	-5%	+11%

Altitude

Standard motors are designed to operate below 3300 feet. Air is thinner and heat is not dissipated as quickly above 3300 feet. Most motors must be derated for altitude. The following chart gives typical horsepower derating factors, but the derating factor should be checked for each motor. A 50 HP motor operated at 6000 feet, for example, would be derated to 47 HP, providing the 40°C ambient rating is still required.

Altitude	Derating Factor
3300 - 5000	0.97
5001 - 6600	0.94
6601 - 8300	0.90
8301 - 9900	0.86
9901 - 11,500	0.82

50 HP X 0.94 = 47 HP

Ambient Temperature

The ambient temperature may also have to be considered. The ambient temperature may be reduced from 40°C to 30°C at 6600 feet on many motors. A motor with a higher insulation class may not require derating in these conditions.

Ambient Temperature (°C)	Maximum Altitude (Feet)
40	3300
30	6600
20	9900

AC Motors and AC Drives

Many applications require the speed of an AC motor to vary. The easiest way to vary the speed of an AC induction motor is to use an AC drive to vary the applied frequency. Operating a motor at other than the rated frequency and voltage has an effect on motor current and torque.

Volts per Hertz

A ratio exists between voltage and frequency. This ratio is referred to as volts per hertz (V/Hz). A typical AC motor manufactured for use in the United States is rated for 460 VAC and 60 Hz. The ratio is 7.67 volts per hertz. Not every motor has a 7.67 V/Hz ratio. A 230 Volt, 60 Hz motor, for example, has a 3.8 V/Hz ratio.

$$\frac{460}{60} = 7.67 \text{ V/Hz} \qquad \frac{230}{60} = 3.8 \text{ V/Hz}$$

Flux (Φ), magnetizing current (I_M), and torque are all dependent on this ratio. Increasing frequency (F) without increasing voltage (E), for example, will cause a corresponding increase in speed. Flux, however, will decrease causing motor torque to decrease. It can be seen that torque ($T = k\Phi I_W$) is directly affected by flux (Φ). Torque is also affected by the current resulting from the applied load, represented here by I_W. Magnetizing current (I_M) will also decrease. A decrease in magnetizing current will cause a corresponding decrease in stator or line (I_S) current. These decreases are all related and greatly affect the motor's ability to handle a given load.

$$\Phi \approx \frac{E}{F}$$

$$T = k\Phi I_W$$

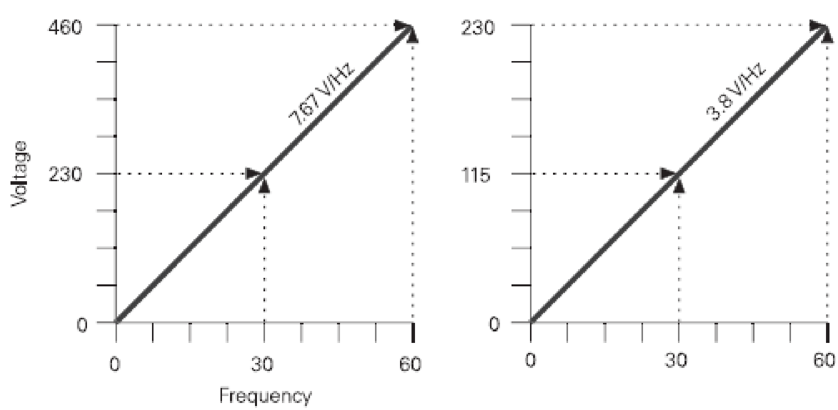
$$I_M = \frac{E}{2\pi F L_M}$$

Constant Torque

AC motors running on an AC line operate with a constant flux (Φ) because voltage and frequency are constant. Motors operated with constant flux are said to have constant torque. Actual torque produced, however, is determined by the demand of the load.

$T = k\Phi Iw$

An AC drive is capable of operating a motor with constant flux (Φ) from approximately zero (0) to the motor's rated nameplate frequency (typically 60 Hz). This is the constant torque range. As long as a constant volts per hertz ratio is maintained the motor will have constant torque characteristics. AC drives change frequency to vary the speed of a motor and changes voltage proportionately to maintain constant flux. The following graphs illustrate the volts per hertz ratio of a 460 volt, 60 Hz motor and a 230 volt, 60 Hz motor. To operate the 460 volt motor at 50% speed with the correct ratio, the applied voltage and frequency would be 230 volts, 30 Hz. To operate the 230 volt motor at 50% speed with the correct ratio, the applied voltage and frequency would be 115 volts, 30 Hz. The voltage and frequency ratio can be maintained for any speed up to 60 Hz. This usually defines the upper limits of the constant torque range.



$\frac{460}{60} = 7.67\ V/Hz$ $\frac{230}{60} = 3.8\ V/Hz$

$\frac{230}{30} = 7.67\ V/Hz$ $\frac{115}{30} = 3.8\ V/Hz$

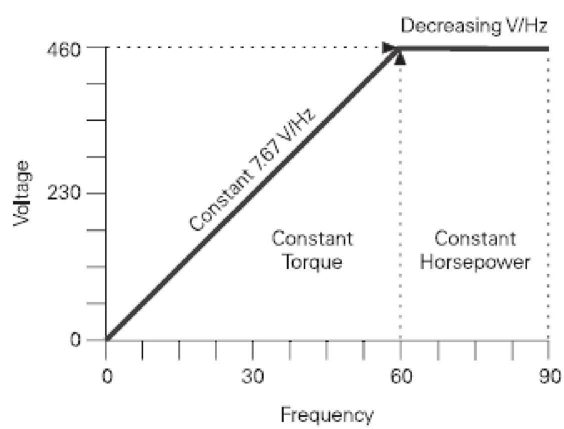
Constant Horsepower

Some applications require the motor to be operated above base speed. The nature of these applications requires less torque at higher speeds. Voltage, however, cannot be higher than the rated nameplate voltage. This can be illustrated using a 460 volt, 60 Hz motor. Voltage will remain at 460 volts for any speed above 60 Hz. A motor operated above its rated frequency is operating in a region known as a constant horsepower. Constant volts per hertz and torque is maintained up to 60 Hz. Above 60 Hz the volts per hertz ratio decreases, with a corresponding decrease in torque.

Frequency	V/Hz
30 Hz	7.67
60 Hz	7.67
70 Hz	6.6
90 Hz	5.1

Flux (Φ) and torque (T) decrease:

$$\Phi \approx \frac{E}{F} \qquad T = k\Phi I_w$$

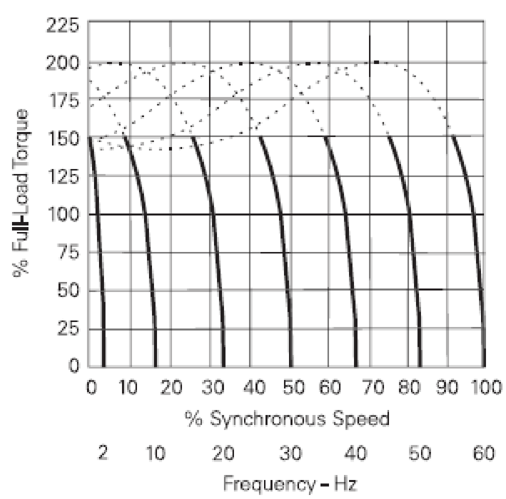


Horsepower remains constant as speed (N) increases and torque decreases in proportion. The following formula applies to speed in revolutions per minute (RPM).

$$\text{HP (remains constant)} = \frac{\text{T (decreases)} \times \text{N (increases)}}{5250}$$

Reduced Voltage and Frequency Starting

A NEMA B motor that is started by connecting it to the power supply at full voltage and full frequency will develop approximately 150% starting torque and 600% starting current. AC drives start at reduced voltage and frequency. The motor will start with approximately 150% torque and 150% current at reduced frequency and voltage. The torque/speed curve shifts to the right as frequency and voltage are increased. The dotted lines on the torque/speed curve illustrated below represent the portion of the curve not used by the drive. The drive starts and accelerates the motor smoothly as frequency and voltage are gradually increased to the desired speed. An AC drive, properly sized to a motor, is capable of delivering 150% torque at any speed up to speed corresponding to the incoming line voltage. The only limitations on starting torque are peak drive current and peak motor torque, whichever is less.



Some applications require higher than 150% starting torque. A conveyor, for example, may require 200% rated torque for starting. If a motor is capable of 200% torque at 200% current, and the drive is capable of 200% current, then 200% motor torque is possible. Typically drives are capable of producing 150% of drive nameplate rated current for one (1) minute. If the load requires more starting torque than a drive can deliver, a drive with a higher current rating would be required. It is appropriate to supply a drive with a higher continuous horsepower rating than the motor when high peak torque is required.

Selecting a Motor

AC drives often have more capability than the motor. Drives can run at higher frequencies than may be suitable for an application. Above 60 Hz the V/Hz ratio decreases and the motor cannot develop 100% torque. In addition, drives can run at low speeds, however, self-cooled motors may not develop enough air flow for cooling at reduced speeds and full load. Each motor must be evaluated according to its own capability before selecting it for use on an AC drive.

Harmonics, voltage spikes, and voltage rise times of AC drives are not identical. Some AC drives have more sophisticated filters and other components designed to minimize undesirable heating and insulation damage to the motor. This must be considered when selecting an AC drive/motor combination. Motor manufacturers will generally classify certain recommended motor selections based on experience, required speed range, type of load torque, and temperature limits.

Distance Between Drive and Motor

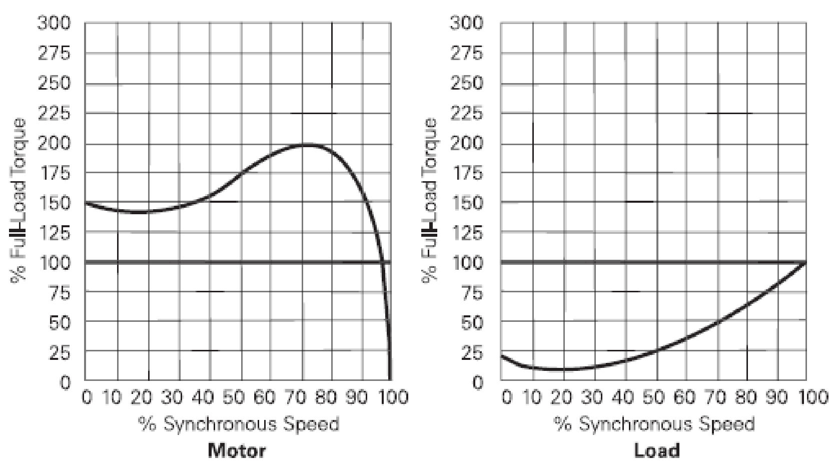
Distance from the drive to the motor must also be taken into consideration. All motor cables have line-to-line and line-to-ground capacitance. The longer the cable, the greater the capacitance. Some types of cables, such as shielded cable or cables in metal conduit, have greater capacitance. Spikes occur on the output of AC drives because of the charging current in the cable capacitance. Higher voltage (460 VAC) and higher capacitance (long cables) result in higher current spikes. Voltage spikes caused by long cable lengths can potentially shorten the life of the AC drive and motor. When considering an application where distance may be a problem, contact your local Siemens representative.

Service Factor on AC Drives

A high efficiency motor with a 1.15 service factor is recommended when used on an AC drive. Due to heat associated with harmonics of an AC drive, the 1.15 service factor is reduced to 1.0.

Matching AC Motors to the Load

One way to evaluate whether the torque capabilities of a motor meet the torque requirements of the load is to compare the motor's speed-torque curve with the speed-torque requirements of the load.



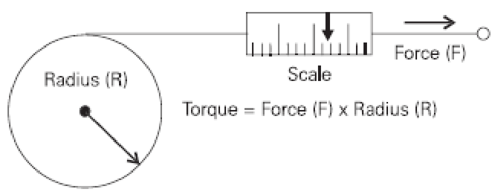
Load Characteristics Tables

To find the torque characteristics a table, similar to the partial one shown below, can be used. NEMA publication MG 1 is one source of typical torque characteristics.

Load Description	Load Torque as % Full-Load Drive Torque		
	Break-away	Accel-erating	Peak Running
Actuators:			
Screw-down (rolling mills)	200	150	125
Positioning	150	110	100
Agitators			
Liquid	100	100	100
Slurry	150	100	100
Blowers, centrifugal:			
Valve closed	30	50	40
Valve open	40	110	100
Blowers, positive displacement, rotary, bypassed	40	40	100
Calenders, textile or paper	75	110	100

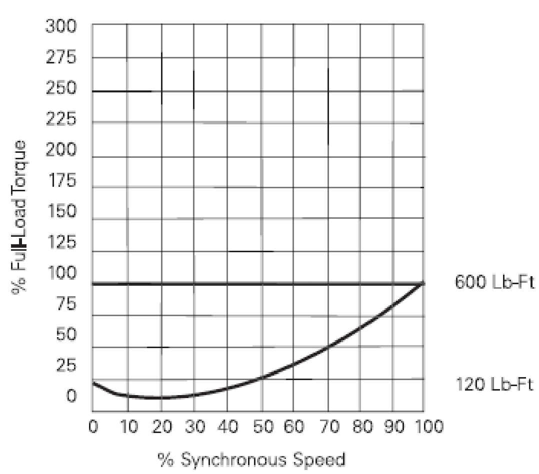
Calculating Load Torque

The most accurate way to obtain torque characteristics of a given load is from the equipment manufacturer. A simple experiment can be set up to show how torque of a given load can be calculated. In the following illustration a pulley is fastened to the shaft of a load. A cord is wrapped around the pulley with one end connected to a spring scale. The torque can be calculated by pulling on the scale until the shaft turns and noting the reading on the scale. The force required to turn the shaft, indicated by the scale, times the radius of the pulley equals the torque value. It must be remembered that the radius is measured from the center of the shaft. If the radius of the pulley and shaft were 1 foot, for example, and the force required to turn the shaft were 10 pounds, the torque requirement is 10 Lb-Ft. The amount of torque required to turn the connected load can vary at different speeds.

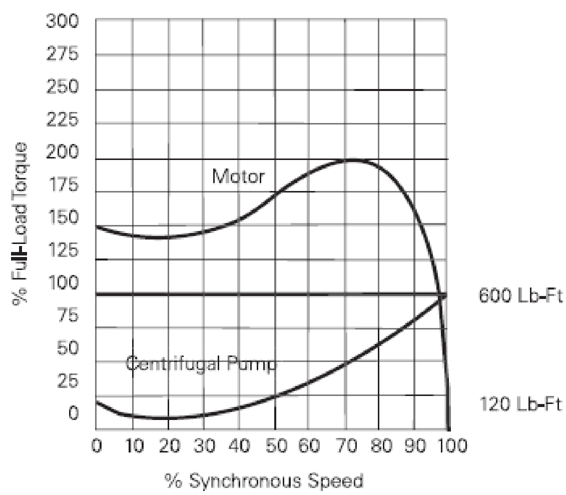


Centrifugal Pump

At any point during acceleration and while the motor is operating at full-load speed, the amount of torque produced by the motor must always exceed the torque required by the load. In the following example a centrifugal pump has a full-load torque of 600 Lb-Ft. This is equivalent to 200 HP. The centrifugal pump only requires approximately 20% of full-load torque to start. The torque dips slightly after it is started and then increases to full-load torque as the pump comes up to speed. This is typically defined as a variable torque load.

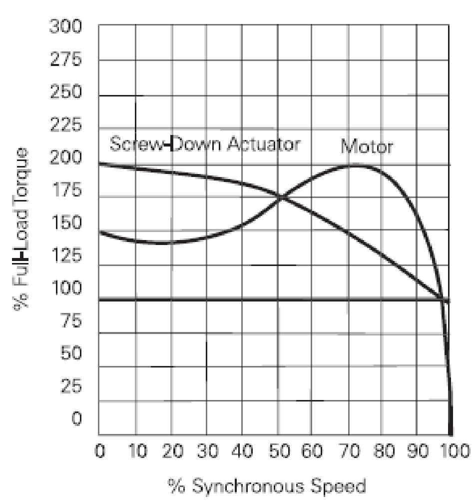


A motor has to be selected that can start and accelerate the centrifugal pump. By comparing a 200 HP NEMA B motor curve to the load curve, it can be seen that the motor will easily start and accelerate the load.

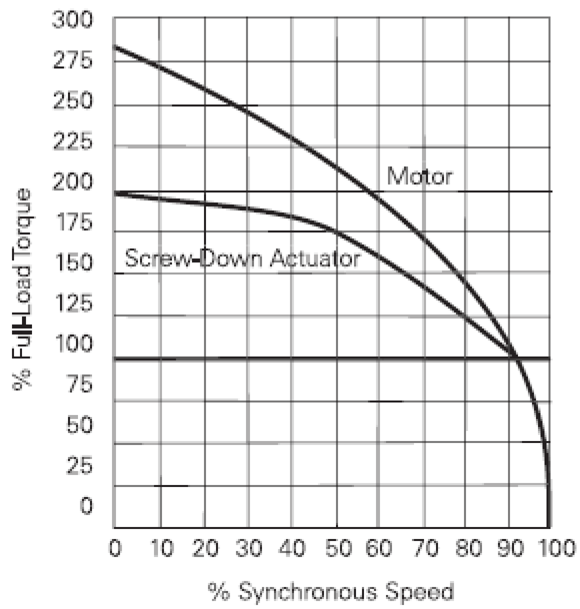


Screw Down Actuator

In the following example a screw down actuator is used. The starting torque of a screw down actuator is approximately 200% of full-load torque. Comparing the load's requirement (200%) with the NEMA design B motor of equivalent horsepower, it can be seen that the load's starting torque requirement is greater than the motor's capability (150%). The motor, therefore, will not start and accelerate the load.



One solution would be to use a higher horsepower NEMA B motor. A less expensive solution might be to use a NEMA D motor of the same horsepower requirements as the load. A NEMA D motor would easily start and accelerate the load.



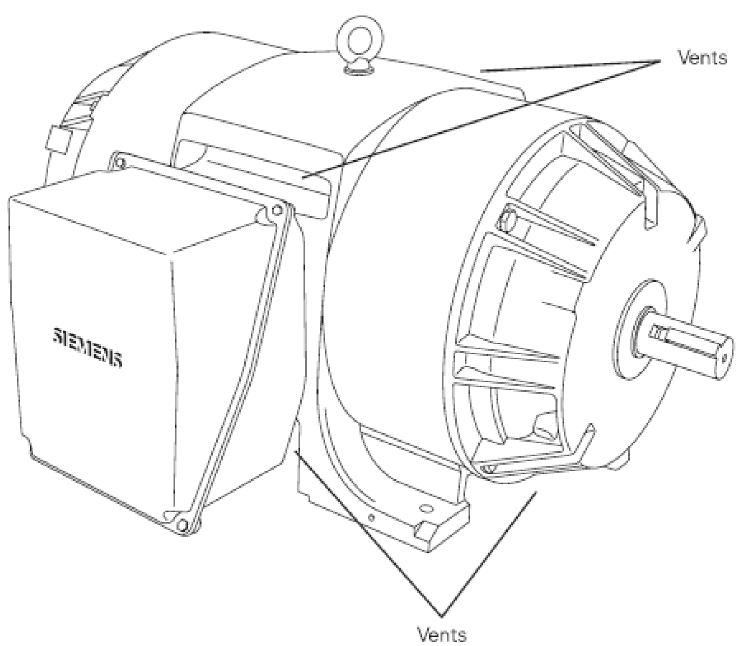
The motor selected to drive the load must have sufficient torque to start, accelerate, and run the load. If, at any point, the motor cannot produce the required torque the motor will stall or run in an overloaded condition. This will cause the motor to generate excess heat and typically exceed current limits causing protective devices to remove the motor from the power source. If the overload condition is not corrected, or the proper motor installed, the existing motor will eventually fail.

Enclosures

Recall that the enclosure provides protection from contaminants in the environment in which the motor is operating. In addition, the type of enclosure affects the cooling of the motor. There are two categories of enclosures: open and totally enclosed.

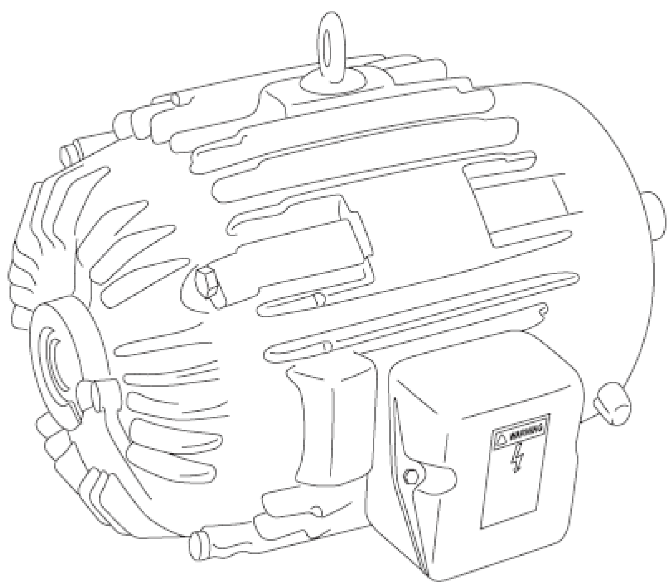
Open Drip Proof (ODP)

Open enclosures permit cooling air to flow through the motor. The rotor has fan blades that assist in moving the air through the motor. One type of open enclosure is the drip proof enclosure. The vent openings on this type of enclosure prevent liquids and solids falling from above at angles up to 15° from vertical from entering the interior of the motor and damaging the operating components. When the motor is not in the horizontal position, such as mounted on a wall, a special cover may be necessary to protect it. This type of enclosure can be specified when the environment is free from contaminates.



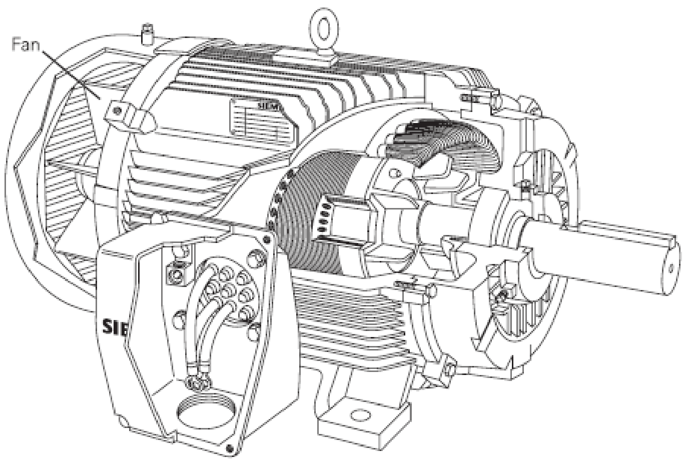
Totally Enclosed Non-Ventilated (TENV)

In some cases air surrounding the motor contains corrosive or harmful elements which can damage the internal parts of a motor. A totally enclosed motor enclosure restricts the free exchange of air between the inside of the motor and the outside. The enclosure is not airtight, however, and a seal at the point where the shaft passes through the housing keeps out water, dust, and other foreign matter that could enter the motor along the shaft. The absence of ventilating openings means all heat dissipates through the enclosure by means of conduction. Most TENV motors are fractional horsepower. TENV motors are used, however, for larger horsepower special applications. For larger horsepower applications the frame is heavily ribbed to help dissipate heat more quickly. TENV motors can be used indoors and outdoors.



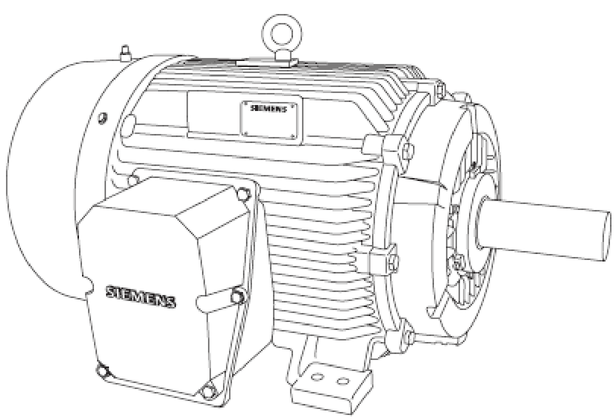
Totally Enclosed Fan Cooled (TEFC)

The totally enclosed fan-cooled motor is similar to the TENV except an external fan is mounted opposite the drive end of the motor. The fan provides additional cooling by blowing air over the exterior of the motor to dissipate heat more quickly. A shroud covers the fan to prevent anyone from touching it. With this arrangement no outside air enters the interior of the motor. TEFC motors can be used in dirty, moist, or mildly corrosive operating conditions. TEFC motors are more widely used for integral HP applications.



Explosion Proof (XP)

The explosion proof motor enclosure is similar in appearance to the TEFC, however, most XP enclosures are cast iron. The application of motors used in hazardous locations is subject to regulations and standards set by regulatory agencies such as the *National Electrical Code®* and Underwriters Laboratories for XP motors used in the United States.



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Hazardous Environments

Although you should never specify or suggest the type of location, it is important to understand regulations that apply to hazardous locations. It is the user's responsibility to contact local regulatory agencies to define the location as Division I or II and to comply with all applicable codes. There are two divisions.

Division I

Hazardous materials are normally present in the atmosphere. A division I location requires an explosion proof motor.

Division II

Atmosphere may become hazardous as result of abnormal conditions. This may occur if, for example, a pipe breaks that is the conduit for a hazardous chemical.

Classes and Groups

Once the location is defined as hazardous the location is further defined by the class and group of hazard. Class I, Groups A through D are chemical gases or liquids such as gasoline, acetone, and hydrogen. Class II, Groups E, F, and G include flammable dust, such as coke or grain dust. Class III is not divided into groups. It includes all ignitable fibers and lints such as clothing fiber in textile mills.

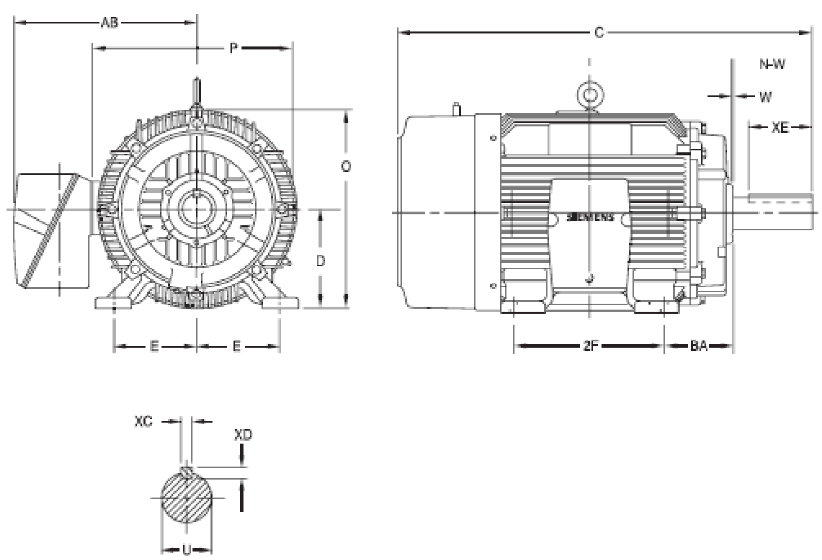
Class I	Class II	Class III
Groups A-D Gasses and Liquids	Groups E-G Flammable Dust	Ignitable Fibers
Gasoline Acetone Hydrogen	Coke Dust Grain Dust Metalic Dust	Rayon Jute

In some cases it may be necessary for the user to define the lowest possible ignition temperature of the hazardous material to assure the motor complies with all applicable codes and requirements.

Mounting

NEMA Dimensions

NEMA has standardized frame size motor dimensions. Standardized dimensions include bolt hole size, mounting base dimensions, shaft height, shaft diameter, and shaft length. Existing motors can be replaced without reworking the mounting arrangement. New installations are easier to design because the dimensions are known. Letters are used to indicate where a dimension is taken. For example, the letter "C" indicates the overall length of the motor. The letter "E" represents the distance from the center of the shaft to the center of the mounting holes in the feet. The actual dimensions are found by referring to a table in the motor data sheet and referencing the letter to find the desired dimension.

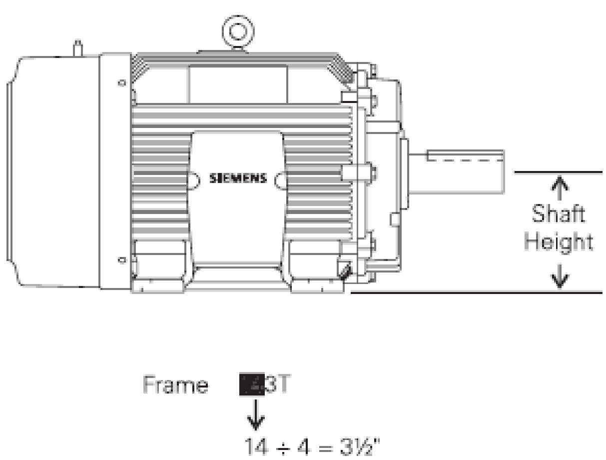


NEMA divides standard frame sizes into two categories: fractional and integral. Fractional frame sizes are designated 48 and 56 and include primarily horsepower ratings of less than one horsepower. Integral or medium horsepower motors are designated by frame sizes ranging from 143T to 445T. A "T" in the motor frame size designation of integral horsepower motors indicates the motor is built to current NEMA frame standards. Motors built prior to 1966 have a "U" in the motor frame size designation, indicated they are built to previous NEMA Standards.

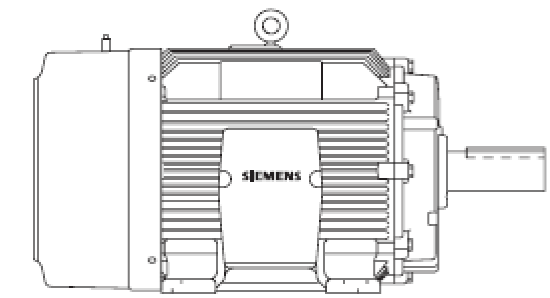
143T = Current NEMA Standards

326U = Previous NEMA Standards

The frame size designation is a code to help identify key frame dimensions. The first two digits, for example, are used to determine the shaft height. The shaft height is the distance from the center of the shaft to the mounting surface. To calculate the shaft height divide the first two digits of the frame size by 4. In the following example a 143T frame size motor has a shaft height of 3½ inches (14 ÷ 4).



The third digit in the integral "T" frame size number is the NEMA code for the distance between the center lines of the mounting bolt holes in the feet of the motor.

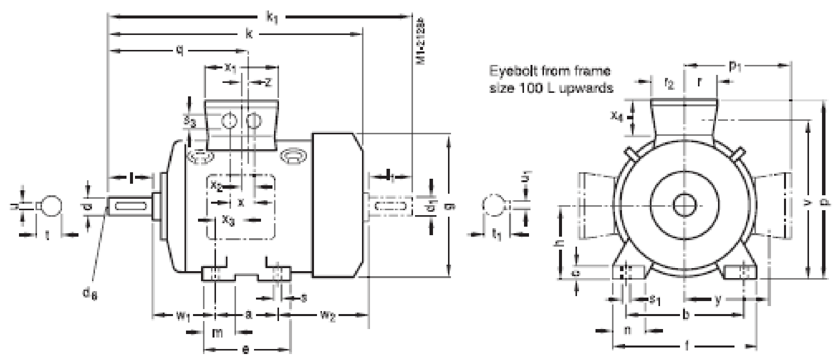


The dimension is determined by matching the third digit in the frame number with a table in NEMA publication MG-1. It can be seen that the distance between the center lines of the mounting bolt holes in the feet of a 143T frame is 4.00 inches.

Frame Number Series	Third/Fourth Digit In Frame Number					
	D	1	2	3	4	5
140				4.00	4.50	4.50
160	4.00	3.50	4.00	4.50	5.00	5.00
180	4.50	4.00	4.50	5.00	5.50	5.50
200	5.00	4.50	5.00	5.50	6.50	6.50
210	5.25	4.50	5.00	5.50	6.25	6.25
220	5.50	5.00	5.50	6.25	6.75	6.75
250	6.25	5.50	6.25	7.00	8.25	8.25
280	7.00	6.25	7.00	8.00	9.50	9.50
320	8.00	7.00	8.00	9.00	10.50	10.50

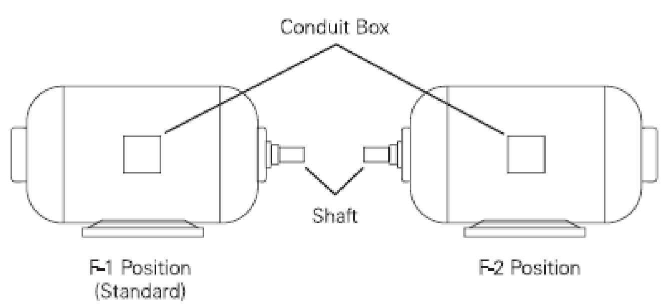
IEC Dimensions

IEC also has standardized dimensions which differ from NEMA. Many motors are manufactured using IEC dimensions. IEC dimensions are shown in the following drawing.

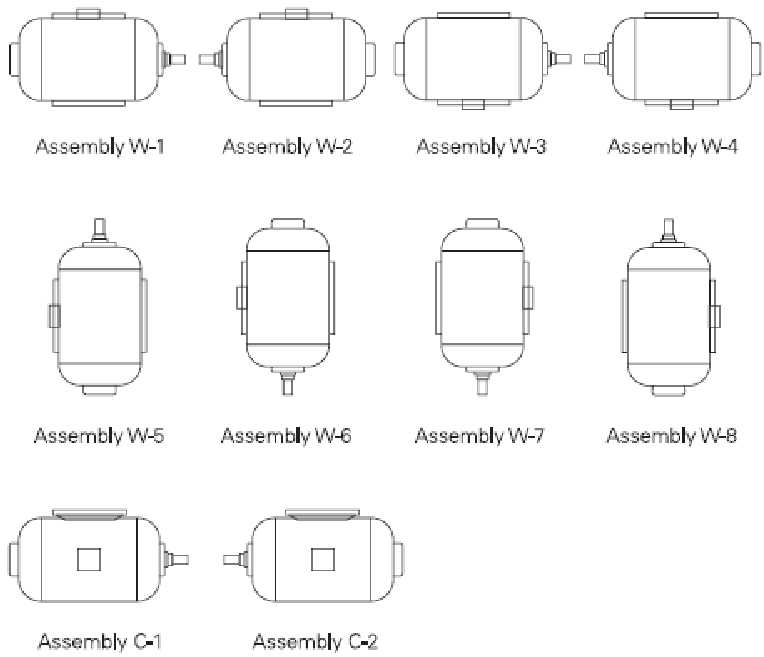


Mounting Positions

The typical floor mounting positions are illustrated in the following drawing, and are referred to as F-1 and F-2 mountings. The conduit box can be located on either side of the frame to match the mounting arrangement and position. The standard location of the conduit box is on the left-hand side of the motor when viewed from the shaft end. This is referred to as the F-1 mounting. The conduit opening can be placed on any of the four sides of the box by rotating the box in 90° steps.

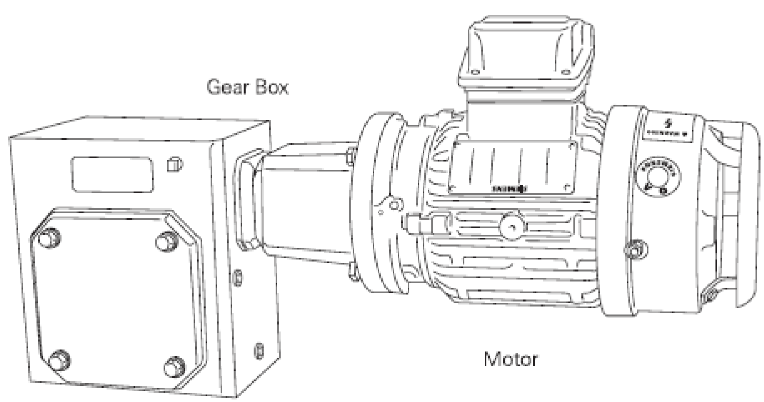


With modification the foot-mounted motor can be mounted on the wall and ceiling. Typical wall and ceiling mounts are shown in the following illustration. Wall mounting positions have the prefix "W" and ceiling mounted positions have the prefix "C."



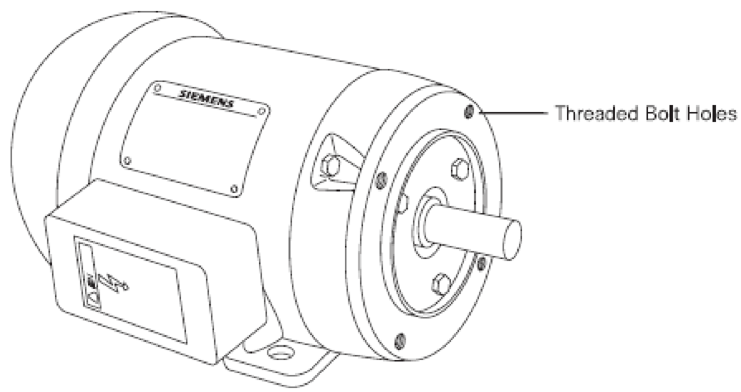
Mounting Faces

It is sometimes necessary to connect the motor directly to the equipment it drives. In the following example a motor is connected directly to a gear box.



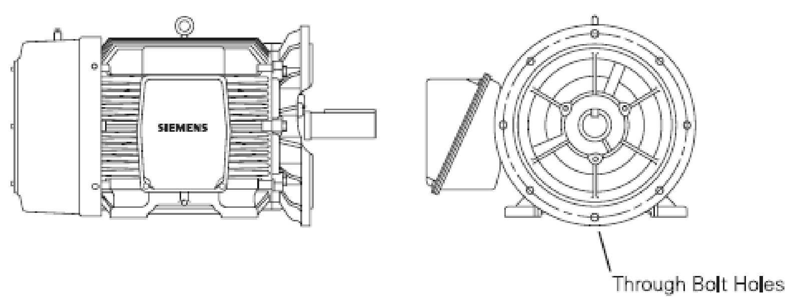
C-face

The face, or the end, of a C-face motor has threaded bolt holes. Bolts to mount the motor pass through mating holes in the equipment and into the face of the motor.



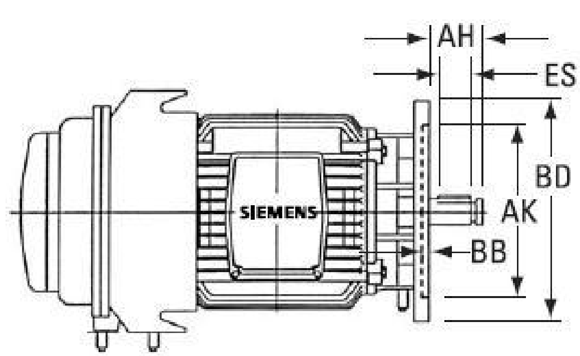
D-flange

The bolts go through the holes in the flange of a D-flange motor and into threaded mating holes of the equipment.



P-base

The bolts go thru the holes in the flange of a P-base motor and into threaded mating holes of the equipment (usually a pump).



Noise Theory

Introduction

This section is intended to describe the information, data and terms used when discussing or measuring noise produced by rotating electrical machines. Among reasons for making a noise analysis are: checking for compliance with a specification, code, ordinance or acoustical criterion, as in user acceptance testing; or to obtain information on exposure of personnel or equipment to noise, as in a sound survey. Noise analysis supplies data necessary to rate the machine according to its acoustic power output, establish sound control measures or predict sound pressure levels produced by the machine in a given enclosure or environment.

Also included is an IEEE paper titled "Noise in Induction Motors - Causes and Treatment." It is included to explain the possible causes of noise in an induction motor, and how they can be predicted and reduced.

In addition, an IEEE paper titled "Specifying And Measuring The Noise Level Of Electric Motors In Operation" is included to explain the new testing procedure using the sound intensity method.

Definitions And Terminology

Noise (Sound)

Sound is a physical disturbance that results in a sensation in the ear of the listener. It is usually the result of a mechanical vibration transferred to the air and then 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 and unwanted by the listener it is called "NOISE". Sound emanating from a recording can be "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.

Noise Theory

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 eardrum of a listener it will initiate vibration motion of the eardrum and the listener will experience the sensation of sound.

Sound travels in a waveform at a constant speed of 1127 ft./second in air. This speed is not affected by the frequency. However, the particle velocity or the rate at which a given particle of air moves about 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 per cm2. By definition 1 dyne per cm2 is equal to 1 microbar or to .10 Pascals. Therefore, atmospheric pressure is approximately 1 million microbars or 105 Pascals. 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.

Level

In acoustics, a level is the logarithm of the ratio of a quantity to a reference quantity of the same kind. The base of the logarithm, reference quantity and kind of level must be specified.

Noise Theory

Decibel and Sound Pressure Level

Sound pressure produced by different sources can vary over a wide range. Sound sources can cause pressure fluctuations as low as .0002 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 (Lp) rather than in sound pressure.

The unit used to express this Lp is called DECIBEL (dB). It is a dimensionless unit that expresses logarithmically the ratio of the quantity under consideration (in this case sound pressure) to a reference value of the same dimensions as the quantity. 0.0002 microbars was chosen as the reference level because it is the minimum sound pressure discernible by a sensitive human ear at 1000 Hertz.

By definition;

$$Lp = 20 \log_{10} \frac{P}{P} (\text{dB})$$

Where; P = sound pressure in microbars produced by sound source
Po = reference pressure in microbars taken as .002 microbars
which is equal to .002 dynes/cm^2 or 20x10^{-6} Pascals

Sound Power

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 affected 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 sound pressure level recorded 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.

Noise Theory

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

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

$$Lw = 10\log_{10}\frac{W}{W_0} \text{ (dB)}$$

Where; *W* = sound power in watts produced by sound source
*W*o = Reference power taken as 10-12watts or 1 Pico watt
(see ANSI S1.8-1964).

"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 level. Therefore, in order to determine the effect of various frequencies it is necessary to determine the actual sound levels of these frequencies that appear to be equally "loud" to the human ear. This has been done through testing a large cross section of the population.

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. The sound meter can record sound picked up by the microphone and passed through these weighing networks. This is similar to the levels that the ear thinks it hears. The two most commonly used are the "C" network and the "A" network.

The "C" network (or C Scale) represents a higher "loudness level" and has a relatively flat curve. It weighs each frequency equally and therefore gives true values of sound levels emanating from the source.

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. The Walsh-Healey Act selected this “A” Scale as the basis for reporting overall sound pressure levels.

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 Sound 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.

Band Level

Band level is the total level of all noise in a specified frequency band.

Narrow Band

A narrow band is generally defined as a band of frequencies whose width is not less than one percent or more than eight percent of the band center frequency.
Application Manual for Above NEMA Motors Noise Theory

Noise Theory

Band Center Frequency

Band center frequency is the geometric mean between the extreme frequencies of the band.

$$f_c = \sqrt{f_h * f_l}$$

f_c = the band center frequency

Where; f_h = high frequency limit of the band
f_l = low frequency limit of the band

Free Field Over a Reflective Plane

Free field conditions exist when sound from the source can travel freely and continuously away from the source and in which the effects of the boundaries are negligible over the region of interest. In this environment the sound pressure level decreases 6 dB each time the distance from the source is doubled.

Broad Band, Octave Band, and Third Octave

The average human ear can hear over a wide range of frequencies varying from 20Hz to 16,000Hz. In order to simplify calculations this range is broken into ten parts called "OCTAVE BANDS". Each band covers a 2 to 1 range of frequencies. 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 bands normally considered are with center frequencies as follows: 63Hz, 125Hz, 250Hz, 500Hz, 1000Hz, 2000Hz, 4000Hz, and 8000Hz.

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 distinct bands for engineering analysis.

Noise Theory

When engineering analysis requires more detailed frequency data, equipment is available to further subdivide each octave into three parts. These are called "ONE-THIRD OCTAVES" which divide the full octave geometrically rather than arithmetically. A one-third octave is a bandwidth in which the ratio of extreme frequencies is equal to the cube root of 2 or 1.260.

Sometimes it is of interest to study discrete frequencies of sound. Equipment is also available to measure the sound level of any such pure tones that might emanate from a sound source.

Anechoic Room

An anechoic room is one constructed so that all the sound striking the boundaries of the room is absorbed. This is also called a Free Field room.

Reverberant Room

A reverberant room is an enclosure in which all the surfaces have been made as sound reflective as possible. In a reverberant room the measured sound pressure level is independent of the distance from the source and is essentially constant when measured beyond the near field region.

Airborne Noise

Airborne noise is undesired sound in the air. This is the noise that is received by the ear of the observer.

Structure borne Noise

Structure borne noise is undesired vibration in or of solid bodies such as machinery, foundations or structures.

Frequencies for Acoustical Measurements

Until 1960 the variety of frequencies used for acoustical measurements made comparison of results inconvenient. The 1960 issue of the American Standard of Preferred Frequencies S1.6-1960 establishes an octave center frequency series based on multiples of 1000 cycles per second. This simplification affords a maximum number of center frequencies common to both the octave band series and the one-third octave band series.

Noise Theory

Preferred Frequencies For Acoustical Measurements

Octave Band Edge Frequencies	Octave Band Center Frequency
45/90	63
90/180	125
180/355	250
355/710	500
710/1400	1000
1400/2800	2000
2800/5600	4000
5600/11200	8000

Sound Pressure vs. Sound Power

The definitions of sound pressure level, sound power level and vibration acceleration level are of academic interest only. Sound level instruments are calibrated to read or record sound pressure levels directly in dB. Sound power is obtained only by calculation from measured values of sound pressure levels. Sound pressure levels are useful in determining the noise level of an area surrounding a piece of equipment. They do not, however, adequately express the noise produced by the equipment itself. Sound pressure levels are influenced by the room environment, by the presence of other sound sources and by the distance and location of the microphone. For the same source, they will be highest in a reverberant room and lowest under anechoic or free field conditions. It is evident then, that sound pressure levels can never be repeated or duplicated except under identical test conditions.

Sound power of a source is the total sound energy radiated by the source per unit of time. It is then essentially independent of the environment in which the source is located or distance from the source. Sound power is the only basic measure of the acoustic properties of a machine, and every effort should be made to encourage expression of noise test results and noise limit specifications in terms of sound power levels.

In a free field over a reflecting plane, sound pressure can be converted to sound power by the following formula:

$$L_W = L_p + 10\text{Log}_{10} \frac{2\pi r^2}{1.0}$$

r = radius from the center of the motor at which the pressure was measured in meters.

Noise Theory

Combining Sound Levels

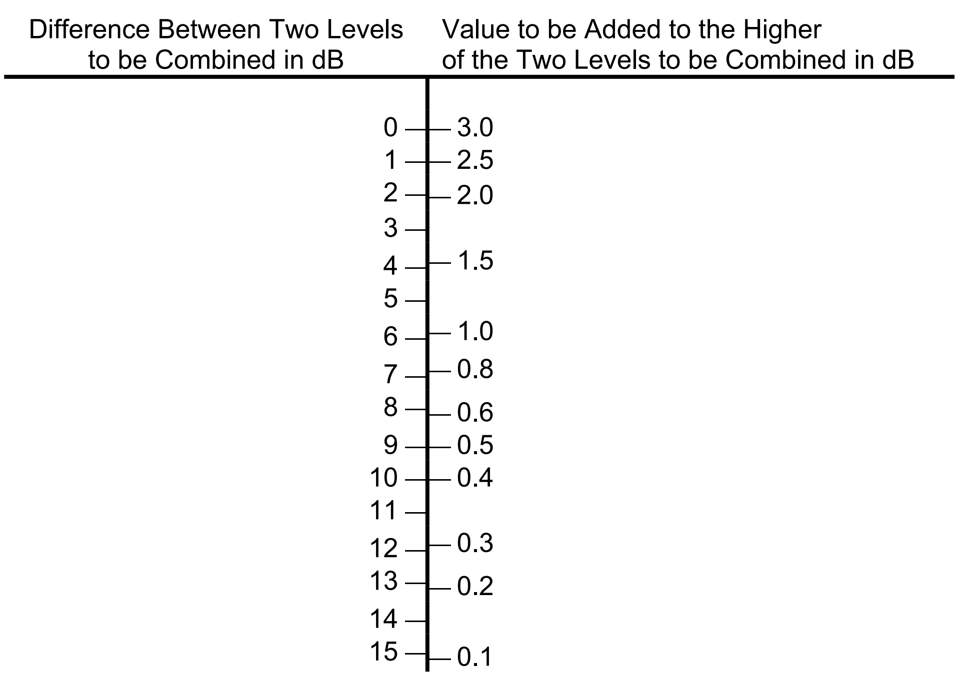
Of major importance to the plant operators is the sound pressure level at a specific spot in the plant, usually at the operator's station. This can be determined if the sound levels are known from each generating source.

Keep in mind that sound levels are energy values and therefore they must be combined on an energy basis not arithmetically. Knowing the sound level of each source, one can calculate the sum total, using the following chart, or the following formula.

$$LP = 10\log_{10}\left[\text{antilog}_{10}\frac{Lp(1)}{10} + \text{antilog}_{10}\frac{Lp(2)}{10} + \cdots + \text{antilog}_{10}\frac{Lp(n)}{10}\right]$$

Lp = total sound pressure level or total sound level.
Lp(1) = level in decibels of the first measurement.
Lp(n) = level in decibels in the nth measurement.

dB Adjustments for Combining Sound Sources



Noise Theory

For example, assume a motor at 80 dBA and a compressor at 82 dBA is installed together. The difference is 2 dBA; therefore, the overall noise will be 84.1 dBA (82 + 2.1 increase). Assume a duplicate unit is now installed right next to the first unit. Combine that new unit (84.1 dBA) with the existing unit (84.1 dBA). The difference is zero; therefore, the result of the two units will be 87.1 dBA. If a third unit is now added, you combine 87.1 with an 84.1. The difference is 3 dBA, which results in a 1.75 dBA increase, for a total of 88.85. A fourth unit would result in an increase of about 1.25 dBA overall, or a total of just over 90 dBA, which is a 6 dBA increase over the original single unit.

Each 3 dBA increase represents a doubling of the sound level at the operator's station; that is, 83 dBA is approximately twice as loud as 80 dBA.

Note that when the difference between two pieces of equipment is greater than 10 dBA, there is virtually no change in the overall level caused by adding the quieter machine.

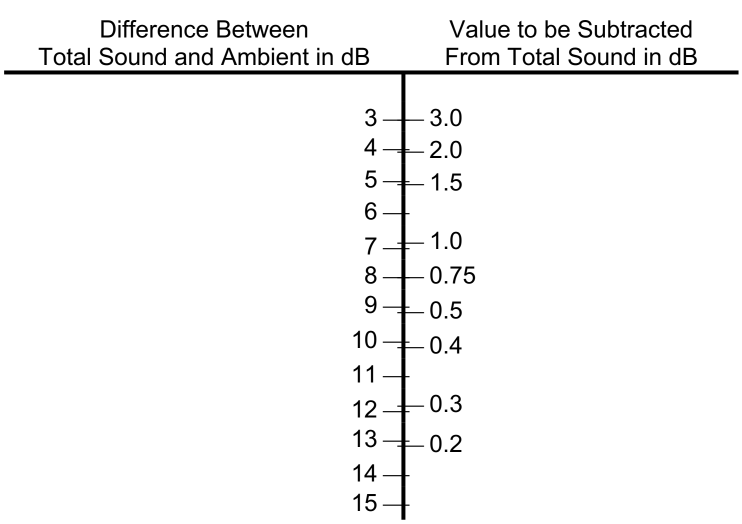
The chart shown previously can also be used to determine the overall sound level of a motor when the individual octave bands are known. The bands are combined two at a time, using the result of the previous combination with the next band level. For example, assume a motor has a following spectrum:

Octave Band:	125	250	500	1000	2000	4000	8000
A Scale Sound Level:	80	86	84	88	85	80	70

Following similar calculations gives an overall level of 92.6 dBA.

The following chart shows adjustments to estimate the sound coming from a source in a plant location.

For example, if the sound level in the plant with the motor operating is 90 dBA, and with the motor shut down is 86 dBA, then the sound level of the motor above would be 87.8 dBA (90 - 2.2).



Noise Theory

Effect of Distance

In a free field where sound from a point source can spread out equally in all directions, the sound pressure decreases with distance. Tests have proven that the product of pressure times the distance is a constant. Noise levels at other distances can be calculated from the following:

$$L_{p2} = L_{p1} + 20\,\mathrm{Log}_{10}\frac{r^1}{r^2}$$

Where: L_{p1} = sound pressure at distance r^1
L_{p2} = sound pressure at distance r^2
r^1 and r^2 are radius from the center of the motor

On a motor four feet wide, three feet from the surface would have an $r = \frac{4}{2} + 3 = 5$. Five feet from the surface would have an r = 7. The values for r^1 and r^2 can be in either meters or feet.

Noise Theory

Testing

All testing and calculations are made in strict accordance with the latest issues of "American Standard Method for the Physical Measurement of Sound" and with IEEE No. 85 "Test Procedure for Airborne Noise Measurements on Rotating Electric Equipment." Complete Octave, Third Octave and Narrow Band results are not required on every study. Sufficient information only is developed to satisfy the requirements of the problem or situation.

Sound Intensity Method of Noise Testing

We have developed the procedure and acquired the equipment to conduct sound intensity testing of motors under load. This enables accurate determination of the sound power level produced by loaded motors. This method is available upon request. Industry standards have not yet been fully established for this method, but we are working closely with ANSI, IEEE and IEC to establish these standards. To understand this approach, see the IEEE article "Specifying And Measuring The Noise Level Of Electric Motors In Operation".

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 in 1969 setting 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 115 dBA for 15 minutes to 90 dBA for 8 hours or more.

These levels are overall levels as measured on the "A" Scale of a standard sound level meter at slow response.

Noise Theory

NEMA Noise Levels

NEMA has published overall sound power levels that should not be exceeded by polyphase squirrel-cage motors. It should be recognized that the distribution of noise as a function of frequency affects the acceptance of sound and that machines with the same overall sound level can have different noise qualities.

Low Noise Machines

Modifications are usually necessary if a machine is to be classified as having low noise. Most of the work done to lower noise levels is aimed at sound absorption or a reduction in vibration of mechanical components in frequencies most sensitive to the ear. Under usual conditions in the area near a machine a 1.0-decibel change in noise level is about the minimum that can be detected by the average individual. On this basis, a 1.0 dB reduction would hardly be important. A reduction of 3 dB is usually significant and 6 dB is certainly worthwhile.

Airborne noise produced by a motor can be attenuated by treatment with sound absorbing materials. Directional fans and careful attention to airflow and velocity can be expected to result in considerable noise reduction at the fundamental and harmonics of the blade passing frequency.

Different types of machines require different methods of noise reduction depending upon their construction. Noise can be caused by anyone, or all, of several sources. Magnetic forces varying periodically, turbulent airflow and fan configuration, mechanical unbalance and bearings, fits and friction forces and the mounting arrangement on a base or structure can all be potential sources. Each must be considered individually to make sure that its contribution to the total noise level of the motor is as small as possible.

Noise Theory

Customer Specification

Our customers usually express their noise limit specifications to us in terms of overall sound pressure level or sound power level at no load.

Since the speech interference level is defined as the arithmetic average of the sound pressure level of the noise in each of the octave bands 710 to 1400 Hz, 1400 to 2800 Hz, and 2800 to 5600 Hz, specifications will be in terms of full octave band sound pressure levels when this is the prime consideration.

When the user is concerned with the noise radiated by a machine in relation to other sources of noise in the same areas, he might well specify octave band sound power or pressure levels.

Sound power levels are always related to sound pressure levels that would exist under free field conditions. Using sound power, it is possible for the user to predict the sound pressure levels that will exist in the space environment in which the machine will ultimately be used. Overall sound pressure or sound power level can also be computed. As far as testing procedure is concerned, however, the type of specification is immaterial since the results can easily be converted.

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

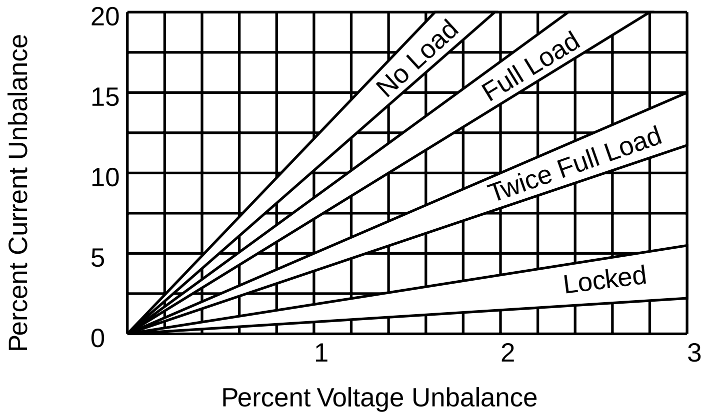
Maximum Voltage Deviation From Average Voltage = 6 Volts

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

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.

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

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.

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

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

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.

Motor Terminology

AC (ALTERNATING CURRENT) - The commonly available electric power supplied by an AC generator and is distributed in single- or three-phase forms. AC current changes its direction of flow (cycles).

AC MOTOR - A motor (see Motor definition) operating on AC current that flows in either direction (AC current). There are two general types: induction and synchronous.

ACTIVE IRON - The amount of steel (iron) in the stator and rotor of a motor. Usually the amount of active iron is increased or decreased by lengthening or shortening the rotor and stator (they are generally the same length).

AIR GAP - The space between the rotating (rotor) and stationary (stator) members in an electric motor.

AIR PRESSURE SWITCH - Used on motors with blowers to measure the difference in pressure across the filter to detect a clogged filter.

AIR TEMPERATURE SWITCH - A device used with an air hood motor to detect the temperature of the exhausted air. When used in this manner an air temperature switch will detect blockage in the cooling air system or long-term motor overload.

ALTITUDE - The atmospheric altitude (height above sea level) at which the motor will be operating; NEMA standards call for an altitude not exceeding 3,300 feet (1,000 meters). As the altitude increases above 3,300 feet and the air density decreases, the air's ability to cool the motor decreases. For higher altitudes, higher grades of insulation or motor derating are required. DC motors require special brushes for operation at high altitudes.

AMBIENT TEMPERATURE - The temperature of the surrounding cooling medium, such as gas or liquid, which comes into contact with the heated parts of the motor. The cooling medium is usually the air surrounding the motor. The standard NEMA rating for ambient temperature is not to exceed 40^{o}C.

ANTI-FRICTION BEARING - An anti-friction bearing is a bearing utilizing rolling elements between the stationary and rotating assemblies.

ARMATURE - The portion of the magnetic structure of a DC or universal motor which rotates.

ARMATURE CURRENT, AMPS - Rated full load armature circuit current.

ARMATURE INDUCTANCE, mH - Armature inductance in milli-henries (saturated).

ARMATURE REACTION - The current that flows in the armature winding of a DC motor tends to produce magnetic flux in addition to that produced by the field current. This effect, which reduces the torque capacity, is called armature reaction and can effect the commutation and the magnitude of the motor's generated voltage.

ARMATURE RESISTANCE, OHMS - Armature resistance is measured in ohms at 25^{o} C (cold).

AXIAL THRUST - The force or loads that are applied to the motor shaft in a direction parallel to the axis of the shaft (Such as from a fan or pump.).

BACK END OF A MOTOR - The back end of a normal motor is the end that carries the coupling or driving pulley (NEMA). This is sometimes called the drive end (D.E.), pulley end (P.E.) etc.

BASE SPEED, RPM - The speed in revolutions per minute (RPM) which a DC motor develops at rated armature and field voltage with rated load applied.

BEARINGS - Bearings reduce friction and wear while supporting rotating elements. When used in a motor, they must provide a relatively rigid support for the output shaft. (See pages x and y). Bearings act as the connection point between the rotating and stationary elements of a motor. There are various types such as roller, ball, sleeve (journal) and needle. Ball bearings are used in virtually all types and sizes of electric motors. They exhibit low friction loss, are suited for high speed operation and are compatible with a wide range of temperatures. There are various types of ball bearings such as open, single shielded and sealed.

BEARING LIFE - Rating life, L_{10} (B_{10}), is the life in hours or revolutions in which 90% of the bearings selected will obtain or exceed. Median life (average life), L_{50} (B_{50}), is the life in hours or revolutions in which 50% of the bearings selected will obtain or exceed.

BRAKES - An external device or accessory that brings a running motor to a standstill and/or holds a load. Can be added to a motor or incorporated as part of it.

BRAKING TORQUE - The torque required to bring a motor down to a standstill. The term is also used to describe the torque developed by a motor during dynamic braking conditions.

BREAK AWAY TORQUE - (See Locked Rotor Torque.)

BREAKDOWN TORQUE - The maximum torque a motor will develop at rated voltage without a relatively abrupt drop or loss in speed.

BRUSH - A piece of current conducting material (usually carbon or graphite) which rides directly on the commutator of a commutated motor and conducts current from the power supply to the armature windings.

CE - This designation shows that a product such as a motor or control meets European Standards for safety and environmental protection. A CE mark is required for products used in most European countries, and is designated as:

CE

CIV (CORONA INCEPTION VOLTAGE) - The minimum voltage amount that begins the process of ionization (corona) of motor windings.

CSA - Canadian Standards Association like U.L., sets specific standards for products used in Canada. The CSA mark is:

SA

"C" FLANGE OR C-FACE - A type of flange used with close-coupled pumps, speed reducers and similar equipment where the mounting holes in the flange are threaded to receive bolts. Normally the "C" flange is used where a pump or similar item is to be connected on the motor. The "C" type flange is a NEMA standard design and available with or without feet.

CANOPY (DRIP COVER) - A protective cover placed on the top of a motor being mounted vertically to protect it from liquids or solids that might drop onto the motor (functions as an umbrella for the motor).

CAPACITOR - A device which, when connected in an alternating-current circuit, causes the current to lead the voltage in time phase. The peak of the current wave is reached ahead of the peak of the voltage wave. This is the result of the successive storage and discharge of electric energy used in single phase motors to start, or in three-phase motors for power factor correction.

CAPACITOR MOTOR - A single-phase induction motor with a main winding arranged for direct connection to the power source, and an auxiliary winding connected in series with a capacitor. There are three types of capacitor motors:

- **capacitor start**, in which the capacitor phase is in the circuit only during starting
- **permanent-split capacitor**, which has the same capacitor and capacitor phase in the circuit for both starting and running

- **two-value capacitor motor**, in which there are different values of capacitance for starting and running.

CAPACITOR START - The capacitor start single-phase motor is basically the same as the split phase start, except that it has a capacitor in series with the starting winding. The addition of the capacitor provides better phase relation and results in greater starting torque with much less power input. As in the case of the split phase motor, this type can be reversed at rest, but not while running unless special starting and reversing switches are used. When properly equipped for reversing while running, the motor is much more suitable for this service than the split phase start since it provides greater reversing ability at less watts input.

CENTRIFUGAL CUTOUT SWITCH - A centrifugally operated automatic mechanism used in conjunction with split phase and other types of single-phase induction motors. Centrifugal cutout switches will open or disconnect the starting winding when the rotor has reached a predetermined speed and reconnect it when the motor speed falls below it. Without such a device, the starting winding would be susceptible to rapid overheating and subsequent burnout.

CLUTCH - A mechanical device for engaging and disengaging a motor. It is often used when many starts and stops are required.

COGGING - A term used to describe non-uniform angular velocity. It refers to rotation occurring in jerks or increments rather than smooth motion. When an armature coil enters the magnetic field produced by the field coils, it tends to speed up and slow down when leaving it. This effect becomes apparent at low speeds. The fewer the number of coils, the more noticeable it can be.

COIL (STATOR OR ARMATURE) - The electrical conductors wound into the core slot, electrically insulated from the iron core. These coils are connected into circuits or windings, which carry independent current. It is these coils that carry and produce the magnetic field when the current passes through them.
There are two major types:

- **"Mush" or "random" wound**, round wire found in smaller and medium motors where coils are randomly laid in slot of stator core
- **Formed coils** of square wire individually laid in, one on top of the other, to give an evenly stacked layered appearance.

COMMUTATOR - A cylindrical device mounted on the armature shaft and consisting of a number of wedge-shaped copper segments arranged around the shaft (insulated from it and each other). The motor brushes ride on the periphery of the commutator and electrically connect and switch the armature coils to the power source.

COMPOUND WOUND DC MOTORS - Designed with both a series and shunt field winding, the compound motor is used where the primary load requirement is heavy starting torque and variable speed is not required (See Paralleling). Also used for parallel operation. The load must tolerate a speed variation from full load to no-load. Industrial machine applications include large planers, boring mills, punch presses, elevators and small hoists.

CONDUCTOR - A material such as copper or aluminum which offers low resistance or opposition to the flow of electric current.

CONDUIT BOX - The metal container usually on the side of the motor where the stator (winding) leads are attached to leads going to the power supply.

CONSTANT HP (HORSEPOWER) - A designation for variable speed motors used for loads requiring the same amount of horsepower regardless of their motor speed during a normal operation.

CONSTANT TORQUE - Refers to loads with horsepower requirements that change linearly at different speeds. Horsepower varies with the speed, i.e., 2/1 HP at 1800/900 RPM (seen on some two-speed motors). Applications include conveyors, some crushers and constant-displacement pumps.

CONSTANT SPEED - A DC motor which changes speed only slightly from a no-load to a full-load condition. For AC motors, these are synchronous motors.

CORE - The iron portion of the stator and rotor made up of cylindrical laminated electric steel. The stator and rotor cores are concentric and separated by an air gap, with the rotor core being the smaller of the two and inside to the stator core.

CORONA - This is the electrical discharge breakdown of a winding through the application of excessive voltage.

COUNTER ELECTROMOTIVE FORCE (CEMF) - The induced voltage in a motor armature caused by conductors moving through or “cutting” field magnetic flux. This induced voltage opposes the armature current and tends to reduce it.

COUPLING - The mechanical connector joining the motor shaft to the equipment to be driven.

CURRENT - This time rate of flow of electrical charge and is measured in amps (amperes).

CYCLES PER SECOND (HERTZ) - One complete reverse of flow of alternating current per rate of time. (A measure of frequency.) 60 Hz (cycles per second) AC power is common throughout the US and 50 Hz is common in many foreign countries.

"D" FLANGE - A special end shield with untapped holes for through bolts in the flange. It is primarily used for mounting the motor to gear boxes or bulkheads. They are available in frame sizes 143T through 445T.

DC (DIRECT CURRENT) - A current that flows only in one direction in an electric circuit. It may be continuous or discontinuous and it may be constant or varying.

DC MOTOR - A motor using either generated or rectified DC power (see Motor). A DC motor is often used when adjustable-speed operation is required.

DEFINITE PURPOSE MOTOR - A definite purpose motor is any motor design listed and offered in standard ratings with standard operating characteristics but with special mechanical features for use under service conditions other than usual or for use on a particular type of application (NEMA).

DUAL VOLTAGE - Some motors can operate on two different voltages, depending upon how it is built and connected. The voltages are either multiples of two or the $\sqrt{3}$ of one another.

DUTY CYCLE - The relationship between the operating and rest times or repeatable operation at different loads. A motor which can continue to operate within the temperature limits of its insulation system after it has reached normal operating (equilibrium) temperature is considered to have a continuous duty (CONT.) rating. A motor which never reaches equilibrium temperature but is permitted to cool down between operations, is operating under intermittent (INT) duty. Conditions such as a crane and hoist motor are often rated 15 or 30 minute intermittent duty.

DYNAMOMETER - A device which places a load on the motor to accurately measure its output torque and speed by providing a calibrated dynamic load. Helpful in testing motors for nameplate information and an effective device in measuring efficiency.

DESIGN A, B, C, D – FOR AC MOTORS - NEMA has standard motor designs with various torque characteristics to meet specific requirements posed by different application loads. The design "B" is the most common design.

DIMENSIONS - NEMA has standard frame sizes and dimensions designating the height of the shaft, the distance between mounting bolt holes and various other measurements. Integral AC motor NEMA sizes run from 143T-445T, and the center of the shaft height in inches can be figured by taking the first two digits of the frame number and dividing it by 4.

Fractional horsepower motors, for which NEMA spells out dimensions, utilize 42, 48 and 56 frames. The shaft height in inches can be established by dividing the frame number by 16.

DRIP-PROOF GUARDED - A drip-proof machine with ventilating openings guarded (with screens) as in a guarded motor.

DRIP-PROOF MOTOR - An open motor in which the ventilating openings are so constructed that drops of liquid or solid particles falling on it, at any angle not greater than 15 degrees from the vertical, cannot enter either directly or by striking and running along a horizontal or inwardly inclined surface.

DUAL TORQUE - A dual speed motor with torque values that vary with speed (as the speed changes the horsepower remains constant).

EDDY CURRENT - Localized currents induced in an iron core by alternating magnetic flux. These currents translate into losses (heat) and their minimization is an important factor in lamination design.

EFFICIENCY - The efficiency of a motor is the ratio of electrical input to mechanical output. It represents the effectiveness with which the motor converts electrical energy into mechanical energy. NEMA has set up codes, which correlate to specific nominal efficiencies. A decrease in losses (the elements keeping the motor from being 100% efficient) of 10% constitutes an upward improvement of the motor of one code on the NEMA table. Each nominal efficiency has a corresponding minimum efficiency number.

ELECTRICAL DEGREE - A unit of measurement of time as applied to alternating current. One complete cycle equals 360 electrical degrees. One cycle in a rotating electrical machine is accomplished when the rotating field moves from one pole to the next pole of the same polarity. There are 360 electrical degrees in this time period. Therefore, in a two pole machine there are 360 degrees in one revolution, and the electrical and mechanical degrees are equal. In a machine with more than two poles, the number of electrical degrees per revolution is obtained by multiplying the number of pairs of poles by 360.

ELECTRICAL TIME CONSTANT (FOR DC MOTORS) - The ratio of electrical inductance to armature resistance. Electrical time constant in seconds defined as Electrical

$$TC = (L_a \times I_a) / \text{Hot IR voltage drop}$$

Where L_a is the armature circuit inductance in henries and I_a is the rated full load armature current.

ELECTRICAL UNBALANCE - In a three-phase supply, where the voltages of the three different phases are not exactly the same. Measured as a percent of unbalance.

ELECTROMOTIVE FORCE (EMF) - A synonym for voltage, usually restricted to generated voltage.

ENCAPSULATED WINDING - A motor which has its winding structure completely coated with an insulating resin (such as epoxy). This construction type is designed for exposure to more severe atmospheric conditions than the normal varnished winding.

ENCLOSURE - The housing or frame of the motor:

ODG ....Open Drip-Prof, Guarded
ODG-FV...........Open Drip-Proof, Force Ventilated
ODG-SV...........Open Drip-Proof, Separately Ventilated
ODP.................Open Drip-Proof
HP...................Vertical P-Base, Normal Thrust
LP ....Vertical P-Base, Medium Thrust, Extended Thrust
Prot.................Protected
TEAO...............Totally-Enclosed, Air-Over
TEBC...............Totally-Enclosed, Blower-Cooled
TECACA...........Totally-Enclosed, Closed Circuit, Air to Air
TEDC-A/A ....Totally-Enclosed, Dual Cooled, Air to Air
TEDC-Q/W ......Totally-Enclosed, Dual Cooled, Air to Water
TEFC ....Totally-Enclosed, Fan-Cooled
TENV...............Totally-Enclosed, Non-Ventilated
TETC ....Totally-Enclosed, Tube Cooled
TEWAC............Totally-Enclosed, Water/Air Cooled
TEXP ....Totally-Enclosed, Explosion-Proof
IP-22...............Open Drip-Proof (IEC Standard)
IP-44...............Totally-Enclosed (IEC Standard)
IP-54...............Splash Proof (IEC Standard)
IP-55...............Washdown (IEC Standard)
WPI ....Weather Protected, Type I
WPII ....Weather Protected, Type II
XP ....Explosion-Proof

ENDSHIELD - The part of the motor housing which supports the bearing and acts as a protective guard to the electrical and rotating parts inside the motor. This part is frequently called the “end bracket” or “end bell.”

EXPLOSION-PROOF ENCLOSURE - A totally enclosed enclosure, which is constructed to withstand an explosion of a specified gas, vapor or dust which, may occur within it. Should such an explosion occur, the enclosure would prevent the ignition or explosion of the gas or vapor which may surround the motor enclosure. These motors are listed with Underwriter’s Laboratories.

EXPLOSION-PROOF-HAZARDOUS LOCATIONS

- **DIVISION I** – Locations in which ignitable concentrations of flammable or combustible material exist and come in contact with the motor.
- **DIVISION II** – Locations in which ignitable concentrations of flammable or combustible material exist but are contained within closed systems or containers and normally would not come in contact with the motor.

EXPLOSION-PROOF-U.L. CLASSIFICATIONS

- **CLASS I** – Those in which flammable gasses or vapors are or may be present in the air in quantities sufficient to product explosive or ignitable mixtures.

  Group C – Atmospheres containing ethyl or ether vapors.

  Group D – Atmospheres containing gasoline, hexane, benzine, butane, propane, alcohol, acetone, benzol, lacquer solvent vapors, natural gas, etc.

- **CLASS II** – Those which are hazardous because of the presence of combustible dust.

  Group E – Atmospheres containing metal dust, including aluminum, magnesium, or their commercial alloys.

  Group F – Atmospheres containing carbon black, charcoal, coal or coke dust.

  Group G – Atmospheres containing flour, starch, grain or combustible plastics or chemical dusts.

EXTERNALLY VENTILATED - A motor using an external cooling system. This is required in applications where the motor's own fan will not provide sufficient cooling. These cooling systems are used in certain duty cycle applications, with slow speed motors, or in environments with extreme dirt. Often a duct with an external blower is used to bring clean air into the motor's air-intake.

FIELD - A term commonly used to describe the stationary (stator) member of a DC motor. The field provides the magnetic field with which the mechanically rotating (armature or rotor) member interacts.

FIELD WEAKENING - The introduction of resistance in series with the shunt wound field of DC motor to reduce the voltage and current which weakens the strength of the magnetic field and thereby increases the motor speed.

FLANGE - Mounting endshield with special rabbets and bolt holes for mounting such equipment as pumps and gear boxes to the motor or for overhanging the motor on the driven machine. *(see "C" flange and "D" flange).*

FLUX - The magnetic field which is established around an energized conductor or permanent magnet. The field is represented by flux lines creating a flux pattern between opposite poles. The density of the flux lines is a measure of the strength of the magnetic field.

FORM FACTOR - A figure of merit which indicates how much rectified current departs from pure (non-pulsating) DC. A large departure from unity form factor (pure DC) increases the heating effect of the motor and reduces brush life. Mathematically, form factor is the ratio of the root-mean square (rms) value of the current to the average (av) current or I_{rms} /I_{av}.

FORM WOUND - A type of coil in which each winding is individually formed and placed into the stator slot. A cross sectional view of the winding would be rectangular. Usually form winding is used on high voltage (2300 volts and above) and large motors (449T and above). Form winding allows for better insulation on high voltage than does random (mush) winding.

FRACTIONAL-HORSEPOWER MOTOR (FHP) - A motor usually built in a frame smaller than that having a continuous rating of one horsepower, open construction, at 1700 - 1800 rpm. Within NEMA frame sizes, FHP encompasses the 42, 48 and 56 frames. (In some cases the motor rating does exceed one horsepower, but the frame size categorizes the motor as a fractional). The height in inches from the center of the shaft to the bottom of the base can be calculated by dividing the frame size by 16.

FRAME - The supporting structure for the stator parts of an AC motor. In a DC motor, the frame usually forms a part of the magnetic coil. The frame also determines mounting dimensions *(see Frame Size).*

FRAME SIZE - Refers to a set of physical dimensions of motors as established by NEMA. These dimensions include critical mounting dimensions. NEMA 48 and 56 frame motors are considered fractional horsepower sizes even though they can exceed one horsepower. NEMA 143T to 449T is considered integral horsepower AC motors and 5000 series and above are called large motors. *(For definition of letters following frame number, see Suffixes).*

FREQUENCY - The rate at which alternating current makes a complete cycle of reversals. It is expressed in cycles per second. In the U.S., 60 cycles (Hz) is the standard while in other countries 50 Hz (cycles) is common. The frequency of the AC current will affect the speed of a motor *(See Speed.)*

FRONT END OF A MOTOR - The front end of a normal motor is the end opposite the coupling or driving end (NEMA). This is sometimes called the opposite drive end (ODE.) or commutator end (C.E).

FULL-LOAD CURRENT - The current flowing through the line when the motor is operating at full-load torque and full-load speed with rated frequency and voltage applied to the motor terminals.

FULL-LOAD TORQUE - That torque of a motor necessary to produce its rated horsepower at full-load speed, sometimes referred to as running torque.

GEARHEAD - The portion of a gearmotor, which contains the actual gearing which, converts the basic motor speed to the rated output speed.

GEARMOTOR - A gearhead and motor combination to reduce the speed of the motor to obtain the desired speed or torque.

GENERAL PURPOSE MOTOR - A general-purpose motor is any motor having a NEMA "B" design, listed and offered in standard ratings, with standard operating characteristics and mechanical construction for use under usual service conditions without restriction to a particular application or type of application (NEMA).

GROUNDED MOTOR - A motor with an electrical connection between the motor frame and ground.

GUARDED MOTOR - An open motor in which all openings giving direct access to live or rotating parts (except smooth shafts) are limited in size by the design of the structural parts or by screens, grills, expanded metal, etc., to prevent accidental contact with such parts. Such openings shall not permit the passage of a cylindrical rod 1/2-inch in diameter.

HEAT EXCHANGER - A device which will transfer the heat from inside the motor to another medium, through a radiator type heat exchanger.

HERTZ (Hz) - One cycle per second (as in 60 Hz which is 60 cycles per second).

HORSEPOWER (HP) - The measure of rate of work. One horsepower is equivalent to lifting 33,000 pounds to a height of one foot in one minute. The horsepower of a motor is expressed as a function of torque and speed. For motors the following approximate formula may be used:

$$HP = (T \times RPM) / 5252$$

where HP = horsepower, T = torque (in. lb- ft.), and
RPM = revolutions per minute.

HYSTERESIS LOSS - The resistance offered by materials to becoming magnetized (magnetic orientation of molecular structure). This results in energy being expended and corresponding loss. Hysteresis loss in a magnetic circuit is the energy expended to magnetize and demagnetize the core.

IDENTIFICATION - In most instances, the following information will help identify a motor:

1. Frame designation (actual frame size in which the motor is built).
2. Horsepower, speed, design and enclosure.
3. Voltage, frequency and number of phases of power supply.
4. Class of insulation and time rating.
5. Application

INDUCTANCE - The characteristic of an electric circuit by which varying current in it produces a varying magnetic field which causes voltages in the same circuit or in a nearby circuit.

INDUCTION MOTOR - An induction motor is an alternating current motor in which the primary winding on one member (usually the stator) is connected to the power source and a secondary winding or a squirrel-cage secondary winding on the other member (usually the rotor) carries the induced current. There is no physical electrical connection to the secondary winding, its current is induced.

INERTIAL LOAD - A load (flywheel, fan, etc.) which tends to cause the motor shaft to continue to rotate after the power has been removed (stored kinetic energy). If this continued rotation cannot be tolerated, some mechanical or electrical braking means must be applied. This application may require a special motor due to the energy required to accelerate the inertia. Inertia is measured in either lb-ft^2 or oz-in^2.

Inertia reflected to the shaft of the motor= $(\text{Load RPM})^2$ / Motor RPM

INSULATOR - A material which tends to resist the flow of electric current (paper, glass, etc.). In a motor the insulation serves two basic functions:

1. Separates the various electrical components from one another
2. It protects itself and the electrical components from attack of contaminants and other destructive forces.

INSULATION SYSTEM - Five specialized elements are used, which together constitute the motor"s INSULATION SYSTEM. The following are typical in an AC motor:

1. TURN-TO-TURN INSULATION between separate wires in each coil. Usually enamel to random wound coils of smaller motors – tape on “form wound” coils of larger motors.

2. PHASE-TO-PHASE INSULATION between adjacent coils in different phase groups. A separate sheet material on smaller motors – not required on form wound coils because the tape also performs this function.

3. PHASE-TO-GROUND INSULATION between windings as a whole and the “ground” or metal part of the motor. A sheet material, such as the liner used in stator slots, provides both di-electric and mechanical protection.

4. SLOT WEDGE to hold conductors firmly in the slot.

5. IMPREGNATION to bind all the other components together and fill in the air space. A total impregnation, applied in a fluid form and hardened, provides protection against contaminants.

INSULATION CLASS - Since there are various ambient temperature conditions a motor might encounter and different temperature ranges within which motors run and insulation is sensitive to temperature; motor insulation is classified by the temperature ranges at which it can operate for a sustained period of time. There are four common classes:.

*(Including Ambient and 110° Hot Spot)
When a motor insulation class is labeled on the nameplate, the total insulation system is capable of sustained operation at the
above temperature.

INTERMITTENT DUTY - A requirement of service that demands operation for alternate intervals of (1) load and no load; or (2) load and rest; (3) load, no load and rest; such alternative intervals being definitely specified.

INTERPOLES - An auxiliary set of field poles carrying armature current to reduce the field flux caused by armature reaction in a DC motor.

INVERTER - An electronic device that converts fixed frequency and fixed voltages to variable frequency and voltage. Enables the user to electrically adjust the speed of an AC motor.

I^2R - Losses due to current flowing in a conductor caused by resistance (equals the current squared times the resistance).

J SECONDS (DC MOTORS) - J is the per unit moment of inertia. It is defined as the time in seconds to accelerate the motor armature to rated base speed using rated full load torque.

$$J = (WR^2 \times \text{Base RPM (seconds)}) / (308 \times \text{Rated Torque})$$

JACKSCREW - A device used for leveling the positioning of a motor. These devices are adjustable screws that fit on the base or motor frame. Also a device for removing endshields from a motor assembly.

KILOWATT (kW) - Since the watt is a relatively small unit power, the kilowatt – (kW) 1,000 watts – is used where larger units of power measurement are desirable.

LAMINATIONS - The steel portion of the rotor and stator cores make up a series of thin laminations (sheets) which are stacked and fastened together by cleats, rivets or welds. Laminations are used instead of a solid piece in order to reduce eddy-current losses.

LARGE MOTORS - Usually refers to AC motors with 5000 series frames and above or DC motors with 500 series frames and larger.

LOAD - The burden imposed on a motor by the driven machine. It is often stated as the torque required to overcome the resistance of the machine it drives. Sometimes "load" is synonymous with "required power."

LOCKED ROTOR CURRENT - Steady state current taken from the line with the rotor at standstill (at rated voltage and frequency). This is the current seen when starting the motor and load.

LOCKED ROTOR TORQUE - The minimum torque that a motor will develop at rest for all angular positions of the rotor (with rated voltage applied at rated frequency).

LOSSES - A motor converts electrical energy into a mechanical energy and in so doing, encounters losses. These losses are all the energy that is put into a motor and not transformed to usable power but are converted into heat causing the temperature of the windings and other motor parts to rise.

LUBRICATION - In order to reduce wear and avoid overheating certain motor components lubrication is required (application of an oil or grease). The bearings are the major motor component requiring lubrication (as per manufacturer's instructions). Excess lubrication can however damage the windings and internal switches, etc.

MAGNETIC POLARITY - It is a fundamental principle of a winding that adjacent poles must be wound to give opposite magnetic polarity. This does not mean that the coils actually have to be wound in this direction before being placed into the stator. It does mean that the winding must be connected so that, if the current proceeds through one pole in a clockwise direction, it must proceed through the next pole in a counterclockwise direction. This principle is used to determine the correctness of connection diagrams.

MEDIUM MOTORS - Motors in NEMA 143T to 449T frames.

MEGGER TEST - A measure of an insulation system's resistance. This is usually measured in megohms and tested by passing a high voltage at low current through the motor windings and measuring the resistance of the various insulation systems.

MOTOR - A device that takes electrical energy and converts it into mechanical energy to turn a shaft.

MULTI-SPEED MOTORS - A motor wound in such a way that varying connections at the starter can change the speed to a predetermined speed. The most common multispeed motor is a two-speed although three and four-speeds are sometimes available. Multispeed motors can be wound with two sets of windings or one winding. They are also available with constant torque, variable torque or constant horsepower.

NAMEPLATE - The plate on the outside of the motor describing the motor horsepower, voltage, speed efficiency, design, enclosure, etc.

NAVY SERVICE "A" - Motors designed to meet requirements of MIL M-17059 or MIL M-17060 for high shock and service and are essential to the combat effectiveness of a ship. These motors are usually made of nodular iron.

N.E.C. TEMPERATURE CODE ("T" CODE) - A National Electrical Code index for describing maximum allowable "skin" (surface) temperature of a motor under any normal or abnormal operating conditions. The "T" codes are applicable to U.L. listed explosion-proof motors. The skin temperature shall not exceed the minimum ignition temperature of the substances to be found in the hazardous location. The "T" code designations apply to motors and other types of electrical equipment subject to hazardous location classification.

NEMA - The National Electrical Manufacturers Association is a nonprofit organization organized and supported by manufacturers of electric equipment and supplies. NEMA has set standards for:

- Horsepower ratings
- Speeds
- Frame sizes and dimensions
- Standard voltages and frequencies with allowable variations
- Service factors

- Torque
- Starting current & KVA
- Enclosures

NEMA I - *(See Weather Protected Machine, Type I.)*
NEMA II - (See Weather Protected Machine, Type II.)

NODULAR IRON (DUCTILE IRON) - Special cast iron with a crystalline formation, which makes it capable of handling high shock.

OIL MIST LUBRICATION-DRY SUMP - A method for lubricating anti-friction bearings, which utilizes oil, dispersed on an air stream. The mist is exhausted from the bearing housing so as not to permit oil to accumulate.

OIL MIST LUBRICATION-WET SUMP - Similar to Oil Mist Lubrication – Dry Sump, except that a pool of oil is developed in the bearing chamber. This oil pool will continue to supply oil to the bearing in the event that the oil mist is interrupted and is fed from a source outside the bearing housing such as a constant level oiler.

OPEN BEARING - A ball bearing that does not have a shield, seal or guard on either of the two sides of the bearing casing.

OPEN EXTERNALLY-VENTILATED MACHINE - A machine which is ventilated with external air by means of a separate motor-driven blower mounted on machine enclosure.

OPEN PIPE-VENTILATED MACHINE - An open machine except that openings for admission of ventilating air are so arranged that inlet ducts or pipes can be connected to them. Air may be circulated by means integral with machine or by means external to and not a part of the machine. In the latter case, this machine is sometimes known as a separately- or force-ventilated machine.

OPEN (PROTECTED) MOTOR - A motor having ventilating openings which permit passage of external cooling air over and around the windings. The term “open machine,” when applied to large apparatus without qualification, designates a machine having no restriction to ventilation other than that necessitated by mechanical construction.

“P” BASE - A special mounting similar to “D” flange except with a machined fit tenon recessed instead of protruding. Usually found on pumps.

PARALLELING - When two or more DC motors are required to operate in parallel – that is, to drive a common load while sharing the load equally among all motors – they should have speed-torque characteristics which are identical. The greater the speed droop with load, the easier it becomes to parallel motors successfully. It follows that series motors will operate in parallel easier than any other type. Compound motors, which also have drooping speed characteristics (high regulation), will generally parallel without special circuits or equalization. It may be difficult to operate shunt or stabilized-shunt motors in parallel because of their nearly constant speed characteristics. Modifications to the motor control must sometimes be made before these motors will parallel within satisfactory limits.

PART WINDING START MOTOR - Is arranged for starting by first energizing part of the primary winding and subsequently energizing the remainder of this winding in one or more steps. The purpose is to reduce the initial value of the starting current drawn or the starting torque developed by the motor. A standard part winding start induction motor is arranged so that one-half of its primary winding can be energized initially and subsequently the remaining half can be energized, both halves then carry the same current.

PERMANENT MAGNET SYNCHRONOUS
(HYSTERESIS SYNCHRONOUS) - A motor with magnets embedded into the rotor assembly, which enable the rotor to align itself with the rotating magnetic field of the stator. These motors have zero slip (constant speed with load) and provide higher torque, efficiency and draw less current than comparable reluctance synchronous motors.

PHASE - Indicates the space relationships of windings and changing values of the recurring cycles of AC voltages and currents. Due to the positioning (or the phase relationship) of the windings, the various voltages and currents will not be similar in all aspects at any given instant. Each winding will lead or lag another in position. Each voltage will lead or lag another voltage in time. Each current will lead or lag another current in time. The most common power supplies are either single- or three-phase (with 120 electrical degrees between the three phases).

PLUG REVERSAL - Reconnecting a motor's winding in reverse to apply a reverse braking torque to its normal direction of rotation while running. Although it is an effective dynamic braking means in many applications, plugging produces more heat than other methods and should be used with caution.

POLARIZATION TEST - A ratio of one-minute megger test *(see Megger Test)* to ten minute megger test. Used to detect contaminants in winding insulation done typically on high voltage V.P.I. motors, which are tested by water immersion.

POLES - In an AC motor, refers to the number of magnetic poles in the stator winding. The number of poles determines the motor's speed. *(See Synchronous Speed).* In a DC motor, refers to the number of magnetic poles in the motor. They create the magnetic field in which the armature operates (speed is not determined by the number of poles).

POLYPHASE MOTOR - Two- or three-phase induction motors have their windings, one for each phase, evenly divided by the same number of electrical degrees. Reversal of the two-phase motor is accomplished by reversing the current through either winding. Reversal of a three-phase motor is accomplished by interchanging any two of its connections to the line. Polyphase motors are used where a polyphase (three-phase) power supply is available and is limited primarily to industrial applications.

Starting and reversing torque characteristics of polyphase motors are exceptionally good. This is due to the fact that the different windings are identical and, unlike the capacitor motor, the currents are balanced. They have an ideal phase relation, which results in a true rotating field over the full range of operation from locked rotor to full speed.

POWER CODE - Identifies the type of power supply providing power to a DC motor. Frequency, voltage, and type of rectifier configuration.

POWER FACTOR - A measurement of the time phase difference between the voltage and current in an AC circuit. It is represented by the cosine of the angle of this phase difference. For an angle of 0 degrees, the power factor is 100% and the volt/amperes of the circuit are equal to the watts (this is the ideal and an unrealistic situation). Power factor is the ration of Real Power-kW to total kVA or the ratio of actual power (watts) to apparent power (volt amperes).

PRIMARY WINDING - The winding of a motor, transformer or other electrical device which is connected to the power source.

PROTECTIVE RELAY - The principal function of a relay is to protect service from interruption, or to prevent or limit damage to apparatus.

PULL-IN TORQUE - The maximum constant torque, which a synchronous motor will accelerate into synchronism at, rated voltage and frequency.

PULL-UP TORQUE - The minimum torque developed by an AC motor during the period of acceleration from zero to the speed at which breakdown occurs. For motors, which do not have a definite breakdown torque, the pull-up torque is the minimum torque developed during the process of achieving rated speed.

R – R - (r bar) is the per unit armature circuit resistance using counter emf as a base:

R = Hot IR voltage drop, where Terminal volts-(Hot IR voltage drop)

and

Hot IR voltage drop = (Rated 1a x Hot Arm. Cir. Resistance) +2.0 (Brush drop) volts.

RPM (REVOLUTIONS PER MINUTE) - The number of times per minute the shaft of the motor (machine) rotates. This is a function of design and the power supply.

RANDOM WOUND - The standard type of stator winding used in motors under 1,000 volts. The coils are random wound with round wire as opposed to flat form wound coils.

RTD (RESISTANCE THERMAL DETECTORS)

WINDING RTD A resistance device used to measure temperature change in the motor windings to detect a possible over heating condition. These detectors are embedded into the winding slot and their resistance varies with temperature.

BEARING RTD A probe used to measure bearing temperature to detect an overheating condition. The RTD's resistance varies with the temperature of the bearings.

REACTANCE (INDUCTIVE) - The characteristic of a coil when connected to alternating current, which causes the current to lag the voltage in time phase. The current wave reaches its peak later than the voltage wave reaches its peak.

REFLECTIVE WAVE - Reflective waves can occur in variable-speed motor applications when the drive and motor are placed a considerable distance apart. The combination of long lead (cable) lengths and the fast switching semiconductors in the drive can cause voltage spikes at the motor's terminals. These spikes can cause the motor's insulation to deteriorate.

RELAY - A device that is operative by a variation in the conditions of one electric circuit to effect the operation of other devices in the same or another electric circuit.

RELUCTANCE - The characteristic of a magnetic material which resists the flow of magnetic lines of force through it.

RELUCTANCE SYNCHRONOUS MOTOR - A synchronous motor with a special rotor design which directly lines the rotor up with the rotating magnetic field of the stator, allowing for no slip under load. Reluctance motors have lower efficiencies, power factors and torques than their permanent magnet counterparts.

RESISTANCE - The degree of obstacle presented by a material to the flow of electric current is known as resistance and is measured in ohms (Ω).

RESILIENT MOUNTING - A suspension system or cushioned mounting designed to reduce the transmission of normal motor noise and vibration to the mounting surface. This type of mounting is typically used in fractional horsepower motors for fans and blowers.

REVERSING - Unless otherwise specified, a general-purpose DC motor is reversible. A DC motor can be reversed by changing the polarity of the field or the armature, but not both. When rapid reversing is necessary, the armature circuit is reversed. In some cases, it is advantageous to reverse the field connections of shunt motors, since the controls have to handle much less current, especially on large motors, than do armature-circuit contactors. An AC motor is reversed by reversing the connections of one leg on three-phase power or by reversing the leads on single phase.

ROLLER BEARING - A special bearing system with cylindrical rollers capable of handling belted applications too large for standard ball bearings.

ROTATING MAGNETIC FIELD - The force created by the stator once power is applied to it that causes the rotor to turn.

ROTOR - The rotating member of an induction motor made up of stacked laminations. A shaft running through the center and a squirrel cage made in most cases of aluminum, which holds the laminations together, and act as a conductor for the induced magnetic field. The squirrel cage is made by casting molten aluminum into the slots cut into each lamination.

SCREENS - Are protection which can be placed over openings in the fan cover on a fan-cooled motor or ventilation openings of a protected motor to help keep out large particles and/or animals, but not block ventilation.

SECONDARY WINDING - Winding which is not connected to the power source, but which carries current induced in it through its magnetic linkage with the primary winding.

SERIES DC MOTORS - Where high starting torques are required for a DC motor, the series motor is used. The load must be solidly connected to the motor and never decrease to zero to prevent excessive motor speeds. The load must tolerate wide speed variations from full load to light load. Typical areas of application are industrial trucks, hoists, cranes and traction duty.

SERVICE FACTOR (SF) –

1.When used on a motor nameplate, a number which indicates how much above the nameplate rating a motor can be loaded without causing serious degradation (i.e., a 1.15 SF can produce 15% greater torque than the 1.0 SF rating of the same motor).

2.When used in applying motors or gearmotors, a figure of merit, which is used to “adjust”, measured loads in an attempt to compensate for conditions which are difficult to measure or define. Typically, measured loads are multiplied by service factors (experience factors) and the result in an “equivalent required torque” rating of a motor or gearmotor.

SHORT-CIRCUIT - A defect in a winding which causes part of the normal electrical circuit to be bypassed. This frequently results in reducing the resistance or impedance to such an extent as to cause overheating of the winding and subsequent burnout.

SHAFT - The rotating member of the motor which protrudes past the bearings for attachment to the driven apparatus.

SHUNT WOUND DC MOTORS - Integral-horsepower shunt motors are used where the primary load requirements are for minimum speed variation from full load to no-load and/or constant horsepower over an adjustable speed range at constant potential. Shunt motors are suitable for average starting torque loads. Typical applications include individual drives for machine tools such as drills and lathes, and centrifugal fans and blowers which are regulated by means of the discharge opening.

SKEW - Arrangement of laminations on a rotor or armature to provide a slight angular pattern of their slots with respect to the shaft axis. This pattern helps to eliminate low speed cogging effects in an armature and minimize induced vibration in a rotor as well as reduce associated noise. It can also help to increase starting torque.

SLEEVE BEARINGS - A type of bearing with no rolling elements, where the motor shaft rides on a film of oil.

SLIP - The difference between the speed of the rotating magnetic field (which is always synchronous) and the rotor in a non-synchronous induction motor is known as slip. It is expressed as a percentage of synchronous speed. Slip generally increases with an increase in torque.

SPACE HEATER - Small resistance heater units mounted in a motor that are energized during motor shutdown to prevent condensation of moisture in the motor windings.

SPECIAL PURPOSE MOTOR - Motor with special operating characteristics or special mechanical construction, or both, designed for a particular application and not falling within the definition of a general purpose or definite purpose motor.

SPLASH-PROOF MOTOR - An open motor in which the ventilating openings are so constructed that drops of liquid or solid particles falling on it, or coming toward it in a straight line at any angle not greater than 100 degrees from the vertical, cannot enter either directly or by striking and running along a surface of the motor.

SPLIT PHASE START - Motors, which employ a main winding and an auxiliary winding, called the starting winding. The windings are unlike and thereby “split” the single phase of the power supply by causing a phase displacement between the currents of the two windings thus producing a rotating field. After the motor has attained approximately 75% of rated speed, the starting winding is automatically disconnected by means of a centrifugal switch or by a relay. The motor then continues to run on a single oscillating field, which in conjunction with the rotation of the rotor, results in a rotating field effect. Since there is no rotating field, after the starting winding is de-energized, the rotation cannot be changed until the motor has come to rest or at least slowed down to the speed at which the automatic switch closes. Special starting switches are available as well as special reversing switches which have a means for shunting the open contracts of the automatic switch while the motor is running and thus permits the split phase motor to be reversed while rotating. This type of starting is found typically on single phase fractional motors.

SPEED - The speed of the motor refers to the RPM's (revolutions per minute) of the shaft. For a three-phase AC motor the synchronous speed =

120 x frequency / # of poles

Where the frequency is measured in Hertz (or cycles per second). The number of poles are a function of design.

STABILIZED SHUNT-WOUND MOTOR - A stabilized shunt-wound motor is a direct-current motor in which the shunt field circuit is connected either in parallel with the armature circuit or to a separate source of excitation voltage and which also has a light series winding added to prevent a rise in speed or to obtain a slight reduction in speed with increase in load.

STANDARDS ORGANIZATIONS

ABS - American Bureau of Shipping
ANSI -American National Standards Institute
API - American Petroleum Institute
BASEEFA - British Approval Service for Electrical Equipment in Flammable Atmospheres
BISSC - Baking Industry Standards Committee
CE - Compliance to European Standards
CSA - Canadian Standards Association
EPACT1997 - U.S. Energy Policy Act
IEC - International Electrotechnical Commission
IEEE - Institute of Electrical and Electronics Engineers
ISO - International Standards Organization
MIL - Military Specifications
MSHA - U.S. Mining, Safety, Health Administration
NAFTA - North American Free Trade Agreement
NEC - National Electric Code
NEMA - National Electrical Manufacturers Association
UL - Underwriter's Laboratories
UR - Underwriter's Laboratories Recognized

USDA - U.S. Department of Agriculture
USCG - U.S. Coast Guard

STARTING CURRENT - Amount of current drawn at the instant a motor is energized--in most cases much higher than the required for running. Same as locked rotor current.
STARTING TORQUE - The torque or twisting force delivered by a motor at the instant it is energized. Starting torque is often higher than rated running or full load torque.

STATOR - That part of an AC induction motor's magnetic structure which does not rotate. It usually contains the primary winding. The stator is made up of laminations with a large hole in the center in which the rotor can turn; there are slots in the stator in which the windings for the coils are inserted.

STRESS CONES - A physical protection placed over the external connections point on medium and high voltage motor leads. Stress cones are used to avoid dielectric breakdown of motor leads in the vicinity of the external connection. Stress cones generally require an oversized conduit box on large motors.

SUFFIXES TO NEMA FRAMES - Letter suffixes sometimes follow the NEMA frame size designations. Some of these suffixes, according to NEMA standards, have the following meanings:

FRACTIONAL HORSEPOWER MOTORS

C - Face mounting
G - Gasoline pump motor
H - Indicates a frame having a larger "F" dimension
J - Jet pump motor
Y - Special mounting dimensions (see manufacturer)
Z - All mounting dimensions are standard except the shaft extension

INTEGRAL HORSEPOWER MOTORS

A - DC motor or generator
C – C-Face mounting on drive end
D – D-Flange mounting on drive end
P - Vertical hollow and solid shaft motors with P-Base flange
HP - Vertical solid shaft motors with P-Base flange (normal thrust)
JM - Close-coupled pump motor with C-Face mounting and special shaft extensions
JP - Close-coupled pump motor with C-Face mounting and special long shaft extension
LP - Vertical solid shaft motors with P-Base flange (medium thrust)
S - Standard short shaft for direct connection
T - Standardized shaft --"T" frame
V - Vertical mounting
Y - Special mounting dimensions
Z - All mounting dimensions standard except shaft Extension

SURGE PROTECTION - A capacitor device usually mounted in the conduit box to flatten the voltage surges that may occur as a result of lighting or a power supply surge (short-period peak). These surges can result in more than twice the rated voltage going to the windings and in turn cause winding damage.

SYNCHRONOUS MOTOR - A motor which operates at a constant speed up to full load. The rotor speed is equal to the speed of the rotating magnetic field of the stator – there is no slip. There are two major synchronous motor types: reluctance and permanent magnet. A synchronous motor is often used where the exact speed of a motor must be maintained.

SYNCHRONOUS SPEED - The speed of the rotating magnetic field set up by the stator winding of an induction motor. In a synchronous motor, the rotor locks into step with the rotating magnetic field and the motor is said to run at synchronous speed. Approximately the speed of the motor in revolutions per minute(RPM) with no load on it is equal to:

120 x Frequency / # of poles

“T” FRAME - Current NEMA designation identifying AC induction motor frames. (NEMA has dimension tables which offer standard frame measurements.) Replaced the previous standard “U” frame in 1965.

TACHOMETER - A small generator normally used as a rotational speed sensing device. Tachometers are typically attached to the output shaft of DC or AC adjustable-speed motors requiring close speed regulation. The tachometer feeds its signal to a control which adjusts its output to the DC or AC motor accordingly (called “closed loop feedback” control).

TEMPERATURE - Has direct effect on motor life when considering life expectancy. The following application considerations that affect a motor’s operating temperature should be taken into account:

1) Bearings
2) Lubricants
3) Duty Cycle
4) Radial Loading
5) Axial Loading
6) Mounting
7) Enclosure
8) Ambient Temperature
9) Ventilation

As a general rule, each 10oC increase in total temperature over the maximum permissible to the motor’s insulation system, reduces its life by half. Bearing or gear lubricant life is reduced by half for every 25°F (approximately 14°C) increase in temperature. Heat eventually causes deterioration of most lubricants and seals leading to leakage and increased friction.

"T" (TEMPERATURE CODES)

(See N.E.C. Temperature Codes.)

TEMPERATURE RISE - Some of the electrical energy losses inherent in motors are converted to heat causing some of the motor parts to heat up when the motor is running. The heated parts are at a higher temperature than the air surrounding them which causes a rise above room (ambient) temperature. It is important to match the proper motor and insulation system (NEMA temp. codes) to the expected ambient temperature. If a motor has been built with greater than 1.0 service factor, then it can operate at a temperature somewhat higher than the motor's rated operating temperature. In all cases, the actual insulation thermal capability usually is higher than the motor's operating temperature to allow for any excessive heat areas. This is called hot spot allowance. *(see Insulation Systems for NEMA standard temperature codes).* Each temperature code has an associated temperature rise which when added to the ambient and hot spot should not exceed the temperature handling of the insulation system.

TEMPERATURE TESTS - Tests conducted to determine the temperature rise of certain parts of a motor above the ambient temperature, when operating under specific conditions.

TESTS

ROUTINE

A routine test is a basic test done in the factory to the requirements of NEMA MG1, paragraph 12.51 and IEEE-112-1978. It includes the following measurements: no load current/watts; winding resistance; and high potential test.

COMPLETE

A complete test is a test which meets the requirements of IEEE-112-1978. It includes the tests conducted in a Routine Test as well as a full-load heat run; no-load current and watts determination of torques; efficiencies at 125, 100, 75, 50 and 25 percent of full load; power factor at 125, 100, 75, 50 and 25 percent of full load.

WITNESS

A witness test is a test performed with a customer representative present.

NOISE

A test performed to verify the motor sound level, conducted in accordance with IEEE-85. The tests are performed under no-load conditions in sound room.

THERMAL PROTECTOR (INHERENT) - An inherent overheating protective device which is responsive to motor temperature and when properly applied to a motor, protects the motor against dangerous overheating due to overload or failure to start. This protection is available with either manual or automatic reset.

THERMISTOR – THERMALLY SENSITIVE RESISTOR - A semiconductor used to measure temperature that can be attached to an alarm or meter to detect motor overheating.
THERMOCOUPLE – THERMAL DETECTION DEVICE - A temperature detecting device made of two dissimilar metals which generates a voltage as a function of temperature. Thermocouples can be attached to a meter or alarm to detect overheating of motor windings or bearings.

THERMOSTAT - Units applied directly to the motor's windings which senses winding temperature and may automatically break the circuit in an overheating situation.

TORQUE - Turning force delivered by a motor or gearmotor shaft, usually expressed in

lb-ft = (HP x 5252) / RPM = full load torque

TOTALLY-ENCLOSED ENCLOSURE - A motor enclosure, which prevents free exchange of air between the inside and the outside of the enclosure but is not airtight. Different methods of cooling can be used with this enclosure.

TOTALLY-ENCLOSED AIR-TO-AIR COOLED MACHINE - A totally enclosed machine cooled by circulating internal air through a heat exchanger which in turn, is cooled by circulating external air. Provided with an air-to-air heat exchanger for cooling ventilating air and fan or fans integral with rotor shaft or separate, for circulating external air.

TOTALLY-ENCLOSED FAN-COOLED ENCLOSURE - Provides for exterior cooling by means of a fan(s) integral with the machine, but external to the enclosed parts.

TOTALLY-ENCLOSED NON-VENTILATED ENCLOSURE - Has no provisions for external cooling of the enclosed parts. The motor is cooled by heat radiation from the exterior surfaces to the surrounding atmosphere.

TOTALLY-ENCLOSED PIPE VENTILATED MACHINE - A totally-enclosed machine except for openings arranged so inlet and outlet ducts or pipes may be connected to them for the admission and discharge of ventilating air. Air may be circulated by means integral with the machine or by means external to and not a part of the machine. In latter case, these machines shall be known as separately-forced-ventilated machines.

TOTALLY-ENCLOSED WATER AIR-COOLED MACHINE - A totally-enclosed machine cooled by circulating air which in turn, is cooled by circulating water. Provided with water-cooled heat exchanger for cooling ventilating air and fan or fans, integral with rotor shaft or separate, for circulating ventilating air.

TRANSFORMER - A device which converts electrical power (alternating current) to electrical power of a different voltage. In this device, both primary and secondary windings are usually stationary and are wound on a common magnetic core.

THRUST BEARINGS - Special bearings used to handle higher than normal axial forces exerted on the shaft of the motors as is the case with some fan or pump blade mountings.

TUBE COOLED - A motor in which heat is dissipated by air-to-air heat exchange

"U" FRAME - A previously used NEMA designation indicating frame size and dimension (prior to 1965 the standard frame sizes per horsepower rating).

U.L. (UNDERWRITER'S LABORATORY) - An independent testing organization, which examines and tests - devices, systems and materials with particular reference to life, fire and casualty hazards. It develops standards for motors and controls used in hazardous locations through cooperation with manufacturers. U.L. has standards and tests for explosion-proof and dust ignition-proof motors, which must be met and passed before application of the U.L. label. UL also has a recognized component mark for Canada and the US:

c UR US

VACUUM DEGASSED BEARINGS - Vacuum degassing is a process used in the purifying of steel for ball bearings ensuring a very dense and consistent bearing surface. This results in a longer lasting superior bearing.

VARIABLE TORQUE - A multi-speed motor used on loads with torque requirements, which vary with speed as with some centrifugal pumps and blowers. The horsepower varies as the square of the speed.

VERTICAL MOTOR - A motor being mounted vertically (shaft up or down) as in many pump applications.

VERTICAL "P" BASE MOTOR - A vertical motor with a special mounting face conforming to NEMA design "P" and with a ring groove on the shaft.

VOLTAGE - The force that causes a current to flow in an electrical circuit. Analogous to pressure in hydraulics, voltage is often referred to as electrical pressure. The voltage of a motor is usually determined by the supply to which it is attached. NEMA requires that motor be able to carry its rated horsepower at nameplate voltage plus or minus 10% although not necessarily at the rated temperature rise.

VOLTAGE DROP - Loss encountered across a circuit impedance from power source to applicable point (motor) caused by the resistance in conductor. Voltage drop across a resistor takes the form of heat released into the air at the point of resistance.

WK^2 (MOMENT OF INERTIA) - The moment of inertia is expressed as Wk^2 in terms of pound-feet

squared. It is the product, the weight of the object in pounds and the square of the radius of gyration in feet. If the application is such that the motor is driving through a pulley or gear so that the driven equipment is operating at a higher or lower speed than the rotor, it is necessary to calculate the inertia reflected to the motor shaft. This is an equivalent Wk^2 (reflected to motor shaft) = Wk^2 based on the speed (rpm) of the motor.

Wk^2 (reflected to motor shaft) =

$$Wk^2 \text{ (driven equipment) x (driven equipment rpm/motor rpm)}^2$$

WATT - The amount of power required to maintain a current of one ampere at a pressure of one volt. Most motors are rated in Kwatt equal to 1,000 watts. One horsepower is equal to 746 watts.

WEATHER-PROTECTED MACHINE
TYPE I (WPI) weather-protected machine is an open machine with its ventilating passages so constructed as to minimize the entrance of rain, snow and airborne particles to the electric parts. Its ventilating openings are constructed to prevent the passage of a cylindrical rod 3/4 inch in diameter.

WEATHER-PROTECTED MACHINE
TYPE II (WPII) have, in addition to the enclosure defined for a Type I weather-protected machine, its ventilating passages at both intake and discharge so arranged that high velocity air and airborne particles blown into the machine by storms or high winds can be discharged without entering the internal ventilating passages leading directly to the electric parts of the machine itself. The normal path of the ventilating air which enters the electric parts of the machines are arranged by baffling or through a separate housing to provide at least three abrupt changes in direction, none of which shall be less than 90^o. In addition, an area of low velocity not exceeding 600 feet per minute shall be provided in the intake air path to minimize the possibility of moisture or dirt being carried into the electric parts of the machine.

WOUND ROTOR INDUCTION MOTOR - A wound rotor induction motor is an induction motor in which the secondary circuit consists of polyphase winding or coils with terminals that are either short circuited or closed through suitable circuits. A wound rotor motor is sometimes used when high breakdown torque and soft start or variable-speed operation are required.

WYE-DELTA STARTING - A method for starting a motor at rated voltage but drawing locked rotor current and producing reduced locked rotor torque to provide lower starting torque than a straight delta connection. Once the load and motor have been started, the wiring will switch from the wye connection to a delta connection in which mode it must run and deliver full torque.

SIEMENS

Application Manual for NEMA Motors

Section 3

Collateral Material

Page

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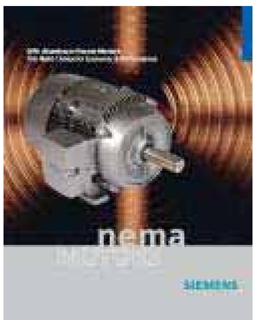
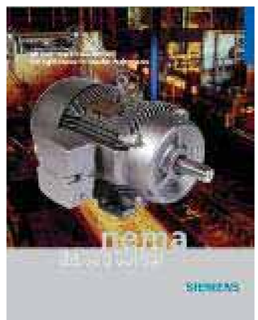
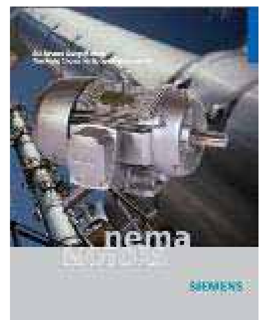
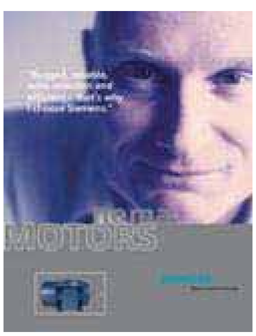
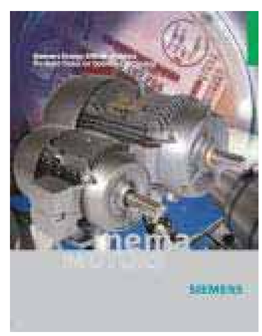
Part 2	**Features at a Glance**	**2**
Part 3	**Technical Publications**	**3**

Collateral Material
NEMA Motor Brochures

GPA Aluminum Motors   GP Cast Iron Frame Motors   SD Severe Duty Motors





RG Series Motors   RGZEESD Motors   Energy Efficient Motors

http://www2.sea.siemens.com/Products/Electric-Motors/NEMA-AC-Motors/Pre-Sales-Information-Brochures.htm

Collateral Material
NEMA Motor Features at a Glance

GPA, GP & SD Motors

DP & RG Motors

Vertical P-Base Motors

http://www2.sea.siemens.com/Products/Electric-Motors/NEMA-AC-Motors/Pre-Sales-Information-Brochures.htm

Collateral Material
Technical Publications

General Purpose Motors

DP10 - Open Drip Proof

GP10A - TEFC, EPAct, Aluminum

GP10 - TEFC, EPAct, Cast Iron

GP100A - TEFC, NEMA Premium, Aluminum

GP100 - TEFC, NEMA Premium, Cast Iron

RGZP - TEFC, EPAct, Cast Iron

Severe Duty Motors

SD10 - EPAct

SD100 - NEMA Premium

SD100 IEEE841 - NEMA Premium,

RGZESD - EPAct

RGZEESD - NEMA Premium

RGZEESDX - NEMA Premium, IEEE 841

Hazardous Duty (Explosion Proof) Motors

RGZZESD - EPAct

Inverter Duty Motors

RGZESDI - EPAct

RGZZESDI - EPAct, XP

Vertical P-Base Motors

RGZVESD - Solid Shaft, Normal Thrust

RGZVILESD - Solid Shaft, In-Line Thrust

HSRGZVESD - Hollow Shaft, High Thrust

RGZZVESD - Solid Shaft, Normal Thrust, XP

RGZZVILESD - Solid Shaft, In-Line Thrust, XP

Definite Purpose Motors

RGZESD - Multi-Speed

RGZEAD - Automotive Duty

RGZTESD - Design C

http://www2.sea.siemens.com/Products/Electric-Motors/NEMA-AC-Motors/Pre-Sales-Information-Product+Pages.htm

SIEMENS

Application Manual for NEMA Motors

Section 4

Dimensional Drawings

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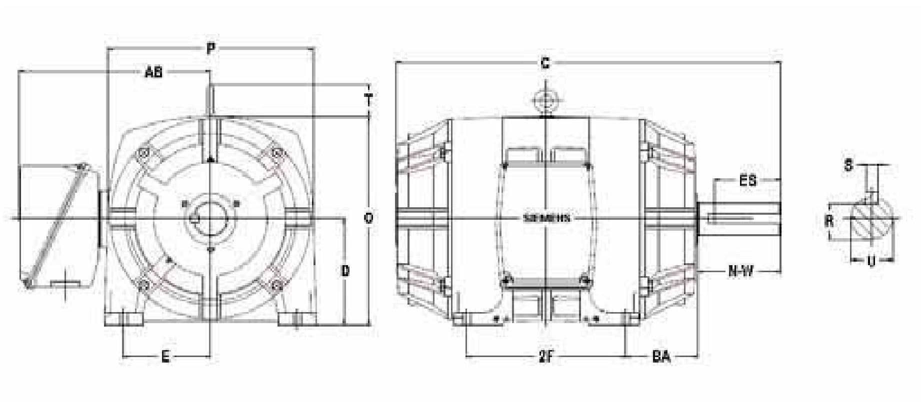
Dimensional Drawings
General Purpose ODP Motors
DP10

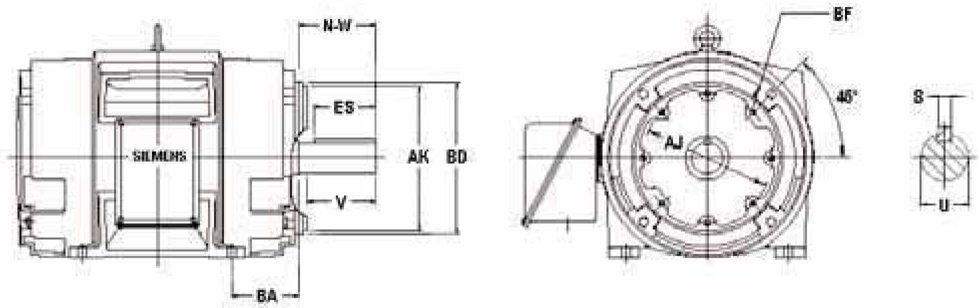


Frame	S	R	ES	C	D	E	2F	BA	N-W	O	T	P	AB	U
143T	0.188	0.771	1.375	10.53	3.50	2.75	4.0	2.25	2.25	7.54	-	6.81	6.3	0.875
145T	0.188	0.771	1.375	11.5	3.50	2.75	5.0	2.25	2.25	7.54	-	6.81	6.3	0.875
182T	0.250	0.986	1.75	12.53	4.50	3.75	4.5	2.75	2.75	9.17	1.63	8.7	7	1.125
184T	0.250	0.986	1.75	13.53	4.50	3.75	5.5	2.75	2.75	9.17	1.63	8.7	7	1.125
213T	0.312	1.201	2.375	15.85	5.25	4.25	5.5	3.5	3.38	10.82	1.63	10.55	8.19	1.375
215T	0.312	1.201	2.375	17.38	5.25	4.25	7.0	3.5	3.38	10.82	1.63	10.55	8.19	1.375
254T	0.375	1.416	2.875	20.67	6.25	5	8.25	4.25	4	12.54	2.01	12.8	10.83	1.625
256T	0.375	1.416	2.875	22.4	6.25	5	10	4.25	4	12.54	2.01	12.8	10.83	1.625
284T	0.500	1.591	3.25	23.82	7	5.5	9.5	4.75	4.62	14.57	2.36	14.76	13.18	1.875
284TS	0.375	1.416	1.875	22.45	7	5.5	9.5	4.75	3.25	14.57	2.36	14.76	13.18	1.625
286T	0.500	1.591	3.25	25.32	7	5.5	11	4.75	4.62	14.57	2.36	14.76	13.18	1.875
286TS	0.375	1.416	1.875	23.95	7	5.5	11	4.75	3.25	14.57	2.36	14.76	13.18	1.625
324T	0.5	1.845	3.875	26.26	8	6.25	10.5	5.25	5.25	16.34	2.36	16.69	14.09	2.125
324TS	0.5	1.591	2	24.76	8	6.25	10.5	5.25	3.75	16.34	2.36	16.69	14.09	1.875
326T	0.5	1.845	3.875	27.76	8	6.25	12	5.25	5.25	16.34	2.36	16.69	14.09	2.125
326TS	0.5	1.591	2	26.26	8	6.25	12	5.25	3.75	16.34	2.36	16.69	14.09	1.875
364T	0.625	2.021	4.25	29.13	9	7	11.25	5.88	5.88	18.26	2.79	18.31	14.81	2.375
364TS	0.5	1.591	2	27	9	7	11.25	5.88	3.75	18.26	2.79	18.31	14.81	1.875
365T	0.625	2.021	4.25	30.13	9	7	12.25	5.88	5.88	18.26	2.79	18.31	14.81	2.375
365TS	0.5	1.591	2	28	9	7	12.25	5.88	3.75	18.26	2.79	18.31	14.81	1.875
404T	0.75	2.45	5.625	33.1	10	8	12.25	6.62	7.25	20.24	3.54	20.24	20.08	2.875
404TS	0.5	1.845	2.75	30.1	10	8	12.25	6.62	4.25	20.24	3.54	20.24	20.08	2.125
405T	0.75	2.45	5.625	34.6	10	8	13.75	6.62	7.25	20.24	3.54	20.24	20.08	2.875
405TS	0.5	1.845	2.75	31.6	10	8	13.75	6.62	4.25	20.24	3.54	20.24	20.08	2.125
444T	0.875	2.88	6.88	39.89	11	9	14.5	7.5	8.5	21.62	3.54	21.25	19.85	3.375
444TS	0.625	2.021	3	36.12	11	9	14.5	7.5	4.75	21.62	3.54	21.25	19.85	2.375
445T	0.875	2.88	6.88	39.89	11	9	16.5	7.5	8.5	21.62	3.54	21.25	19.85	3.375
445TS	0.625	2.021	3	36.12	11	9	16.5	7.5	4.75	21.62	3.54	21.25	19.85	2.375
447T	0.875	2.88	6.88	43.39	11	9	20	7.5	8.5	21.69	3.54	21.38	22	3.375
447TS	0.625	2.021	3	39.62	11	9	20	7.5	4.75	21.69	3.54	21.38	22	2.375
449T	0.875	2.88	6.88	48.4	11	9	25	7.5	8.5	21.75	3.54	21.5	22	3.375
449TS	0.625	2.021	3	44.62	11	9	25	7.5	4.75	21.75	3.54	21.5	22	2.375

440 frame motors have 8 holes footprint

Dimensions in Inches
Dimensions are for reference only

Dimensional Drawings
General Purpose ODP Motors
DP10 – C Face with feet

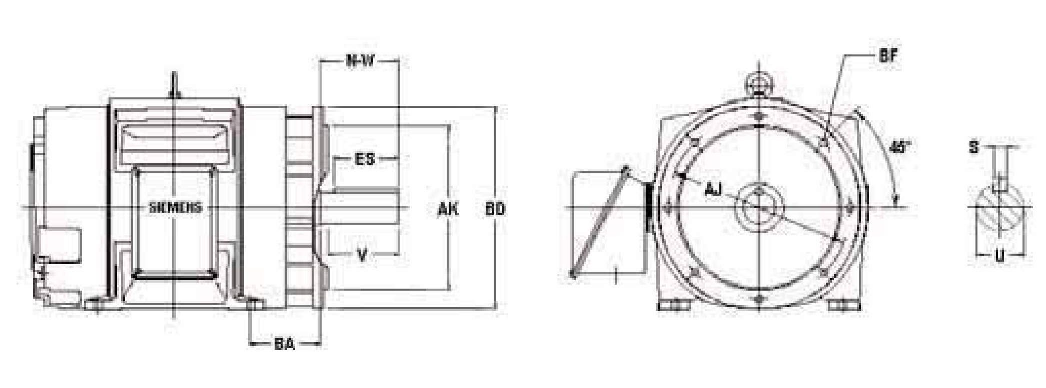


Frame	BD	AJ	AK	U	N-W	V	BA	ES	S	BF#	BF DIA
143TC	6.5	5.875	4.5	0.875	2.25	1.88	2.25 (1)	1.41	0.188	4	3/8”-16NC
145TC	6.5	5.875	4.5	0.875	2.25	1.88	2.25 (1)	1.41	0.188	4	3/8”-16NC
182TC	9	7.25	8.5	1.125	2.75	2.50	2.75 (1)	1.81	0.25	4	1/2”-13NC
184TC	9	7.25	8.5	1.125	2.75	2.50	2.75 (1)	1.81	0.25	4	1/2”-13NC
213TC	9	7.25	8.5	1.375	3.38	3.12	3.5 (1)	2.44	0.312	4	1/2”-13NC
215TC	9	7.25	8.5	1.375	3.38	3.12	3.5 (1)	2.44	0.312	4	1/2”-13NC
254TC	10	7.25	8.5	1.625	4.00	3.75	4.25 (1)	2.91	0.375	4	1/2”-13NC
256TC	10	7.25	8.5	1.625	4.00	3.75	4.25 (1)	2.91	0.375	4	1/2”-13NC
284TC	11	9	10.5	1.875	4.62	4.38	4.75	3.25	0.5	4	1/2”-13NC
284TSC	11	9	10.5	1.625	3.25	3.00	4.75	1.88	0.375	4	1/2”-13NC
286TC	11	9	10.5	1.875	4.62	4.38	4.75	3.25	0.5	4	1/2”-13NC
286TSC	11	9	10.5	1.625	3.25	3.00	4.75	1.88	0.375	4	1/2”-13NC
324TC	13	11	12.5	2.125	5.25	5.00	5.25	3.88	0.5	8	5/8”-11NC
324TSC	13	11	12.5	1.875	3.75	3.50	5.25	2.00	0.5	8	5/8”-11NC
326TC	13	11	12.5	2.125	5.25	5.00	5.25	3.88	0.5	8	5/8”-11NC
326TSC	13	11	12.5	1.875	3.75	3.50	5.25	2.00	0.5	8	5/8”-11NC
364TC	13	11	12.5	2.375	5.88	5.62	5.88	4.25	0.625	8	5/8”-11NC
364TSC	13	11	12.5	1.875	3.75	3.50	5.88	2.00	0.5	8	5/8”-11NC
365TC	13	11	12.5	2.375	5.88	5.62	5.88	4.25	0.625	8	5/8”-11NC
365TSC	13	11	12.5	1.875	3.75	3.50	5.88	2.00	0.5	8	5/8”-11NC
404TC	13	11	12.5	2.875	7.25	7.00	6.62	5.63	0.75	8	5/8”-11NC
404TSC	13	11	12.5	2.125	4.25	4.00	6.62	2.75	0.5	8	5/8”-11NC
405TC	13	11	12.5	2.875	7.25	7.00	6.62	5.63	0.75	8	5/8”-11NC
405TSC	13	11	12.5	2.125	4.25	4.00	6.62	2.75	0.5	8	5/8”-11NC
444TC	16.77	14	16	3.375	8.50	8.25	7.5	6.88	0.875	8	5/8”-11NC
444TSC	16.77	14	16	2.375	4.75	4.50	7.5	3.00	0.625	8	5/8”-11NC
445TC	16.77	14	16	3.375	8.50	8.25	7.5	6.88	0.875	8	5/8”-11NC
445TSC	16.77	14	16	2.375	4.75	4.50	7.5	3.00	0.625	8	5/8”-11NC
447TC	16.77	14	16	3.375	8.50	8.25	7.5	6.88	0.875	8	5/8”-11NC
447TSC	16.77	14	16	2.375	4.75	4.50	7.5	3.00	0.625	8	5/8”-11NC
449TC	16.77	14	16	3.375	8.50	8.25	7.5	6.88	0.875	8	5/8”-11NC
449TSC	16.77	14	16	2.375	4.75	4.50	7.5	3.00	0.625	8	5/8”-11NC

(1) Not according to NEMA standard.

Dimensions in Inches
Dimensions are for reference only

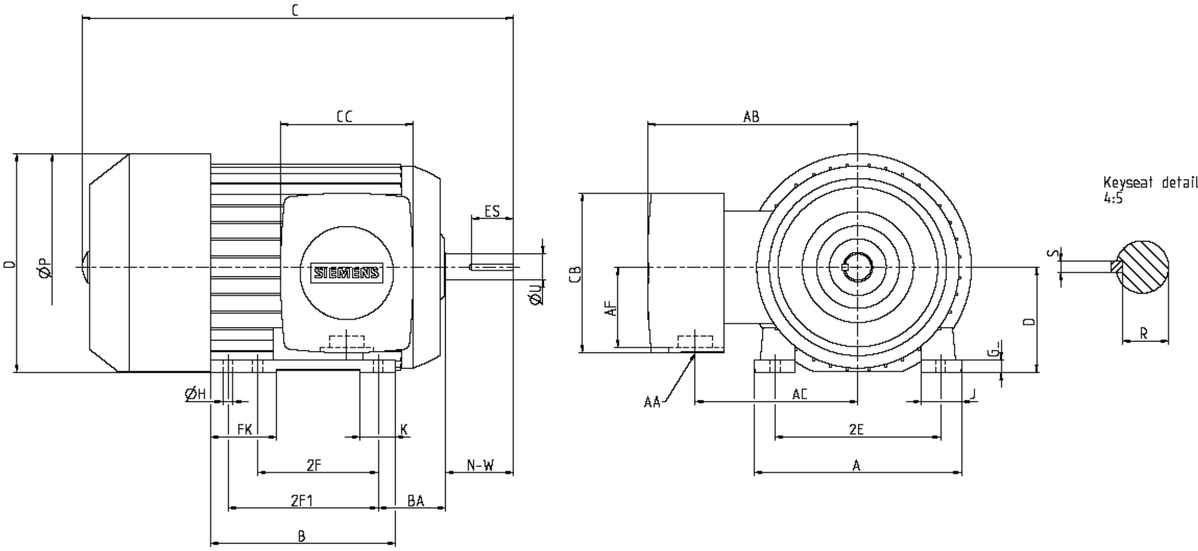
Dimensional Drawings
General Purpose ODP Motors
DP10 – D Flange with feet



Frame	BD	AJ	AK	U	N-W	V	BA	ES	S	BF#	BF DIA
444TD	22	20	18	3.375	8.50	8.25	7.5	6.88	0.875	8	5/8”-11NC
444TSD	22	20	18	2.375	4.75	4.50	7.5	3.00	0.625	8	5/8”-11NC
445TD	22	20	18	3.375	8.50	8.25	7.5	6.88	0.875	8	5/8”-11NC
445TSD	22	20	18	2.375	4.75	4.50	7.5	3.00	0.625	8	5/8”-11NC
447TD	22	20	18	3.375	8.50	8.25	7.5	6.88	0.875	8	5/8”-11NC
447TSD	22	20	18	2.375	4.75	4.50	7.5	3.00	0.625	8	5/8”-11NC
449TD	22	20	18	3.375	8.50	8.25	7.5	6.88	0.875	8	5/8”-11NC
449TSD	22	20	18	2.375	4.75	4.50	7.5	3.00	0.625	8	5/8”-11NC

Dimensions in Inches
Dimensions are for reference only

Dimensional Drawings
General Purpose TEFC Motors – Cast Aluminum Frame
GP10A / GP100A – Foot Mount



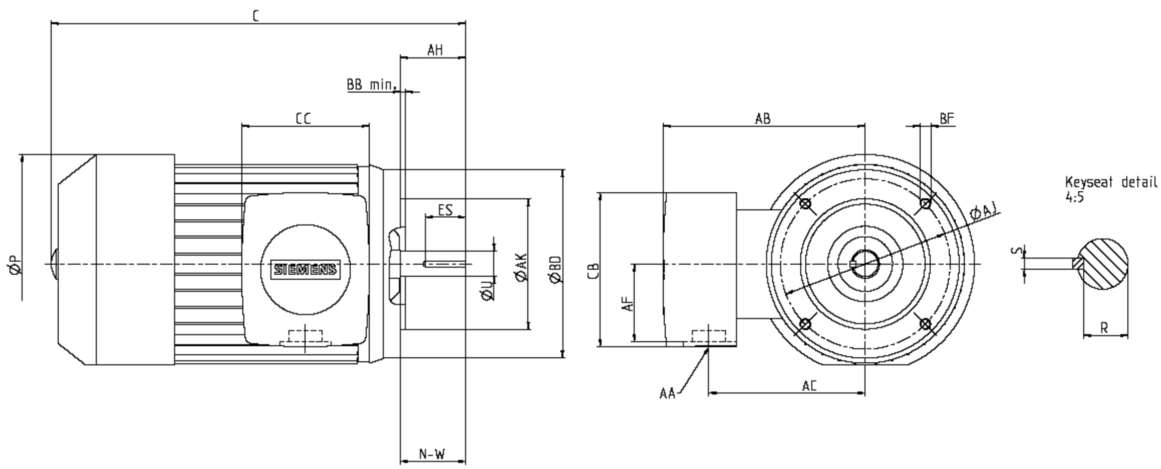
Frame	C	D	2E	2F	2F1	N-W	0	P	U	AB	BA	Key seat R	Key seat S	ES
143T	14.37	3.5	5.5	4		2.25	7.28	7.56	0.875	7	2.25	0.771	0.188	1.41
145T	14.37	3.5	5.5		5	2.25	7.28	7.56	0.875	7	2.25	0.771	0.188	1.41
182T(1)	15.69	4.5	7.5	4.5		2.75	8.87	8.74	1.125	6.94	2.75	0.986	0.25	1.81
182T(2)	16.68	4.5	7.5	4.5		2.75	8.87	8.74	1.125	6.94	2.75	0.986	0.25	1.81
184T(1)	15.69	4.5	7.5		5.5	2.75	8.87	8.74	1.125	6.94	2.75	0.986	0.25	1.81
184T(2)	16.68	4.5	7.5		5.5	2.75	8.87	8.74	1.125	6.94	2.75	0.986	0.25	1.81
213T(3)	18.68	5.25	8.5	5.5		3.38	10.41	10.31	1.375	8.27	3.5	1.201	0.312	2.44
213T(4)	20.65	5.25	8.5	5.5		3.38	10.41	10.31	1.375	8.27	3.5	1.201	0.312	2.44
215T(3)	18.68	5.25	8.5		7	3.38	10.41	10.31	1.375	8.27	3.5	1.201	0.312	2.44
215T(4)	20.65	5.25	8.5		7	3.38	10.41	10.31	1.375	8.27	3.5	1.201	0.312	2.44
254T(5)	23.8	6.25	10	8.25		4	12.43	12.36	1.625	9.35	4.25	1.416	0.375	2.91
254T(6)	26.16	6.25	10	8.25		4	12.43	12.36	1.625	9.35	4.25	1.416	0.375	2.91
256T(5)	23.8	6.25	10		10	4	12.43	12.36	1.625	9.35	4.25	1.416	0.375	2.91
256T(6)	26.16	6.25	10		10	4	12.43	12.36	1.625	9.35	4.25	1.416	0.375	2.91

- Optional 4.5 inches "AK" is available for 182/184TC frame motors.

(1) All GP10A Motors except 5HP, 1800RPM & 1.5HP, 900RPM.
(2) All GP100A Motors and 5HP, 1800RPM & 1.5HP, 900RPM GP10A Motors.
(3) All GP10A Motors except 10HP, 3600RPM & 10HP, 1800RPM.
(4) All GP100A Motors and 10HP, 3600RPM & 10HP, 1800RPM GP10A Motors.
(5) All GP10A Motors.
(6) All GP100A Motors

Dimensions in Inches
Dimensions are for reference only

Dimensional Drawings
General Purpose TEFC Motors – Cast Aluminum Frame
GP10A / GP100A – C Face



Frame	C	D	2E	2F	2F1	N-W	0	P	U	AB	BA	Key seat R	Key seat S	Key seat ES
143T	14.37	3.5	5.5	4		2.25	7.28	7.56	0.875	7	2.25	0.771	0.188	1.41
145T	14.37	3.5	5.5		5	2.25	7.28	7.56	0.875	7	2.25	0.771	0.188	1.41
182T(1)	15.69	4.5	7.5	4.5		2.75	8.87	8.74	1.125	6.94	2.75	0.986	0.25	1.81
182T(2)	16.68	4.5	7.5	4.5		2.75	8.87	8.74	1.125	6.94	2.75	0.986	0.25	1.81
184T(1)	15.69	4.5	7.5		5.5	2.75	8.87	8.74	1.125	6.94	2.75	0.986	0.25	1.81
184T(2)	16.68	4.5	7.5		5.5	2.75	8.87	8.74	1.125	6.94	2.75	0.986	0.25	1.81
213T(3)	18.68	5.25	8.5	5.5		3.38	10.41	10.31	1.375	8.27	3.5	1.201	0.312	2.44
213T(4)	20.65	5.25	8.5	5.5		3.38	10.41	10.31	1.375	8.27	3.5	1.201	0.312	2.44
215T(3)	18.68	5.25	8.5		7	3.38	10.41	10.31	1.375	8.27	3.5	1.201	0.312	2.44
215T(4)	20.65	5.25	8.5		7	3.38	10.41	10.31	1.375	8.27	3.5	1.201	0.312	2.44
254T(5)	23.8	6.25	10	8.25		4	12.43	12.36	1.625	9.35	4.25	1.416	0.375	2.91
254T(6)	26.16	6.25	10	8.25		4	12.43	12.36	1.625	9.35	4.25	1.416	0.375	2.91
256T(5)	23.8	6.25	10		10	4	12.43	12.36	1.625	9.35	4.25	1.416	0.375	2.91
256T(6)	26.16	6.25	10		10	4	12.43	12.36	1.625	9.35	4.25	1.416	0.375	2.91

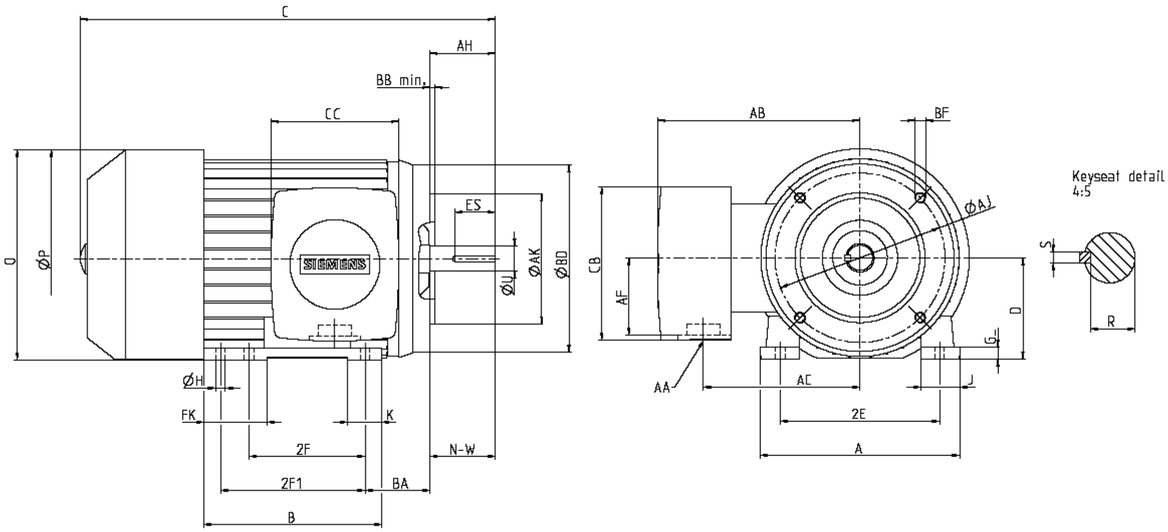
C - Face					
Frame	AH	AJ	AK	BD	BF
143T	2.12	5.875	4.5	6.6	3/8-16
145T	2.12	5.875	4.5	6.6	3/8-16
182T(1)	2.62	7.25	8.5*	8.9	1/2-13
182T(2)	2.62	7.25	8.5*	8.9	1/2-13
184T(1)	2.62	7.25	8.5*	8.9	1/2-13
184T(2)	2.62	7.25	8.5*	8.9	1/2-13
213T(3)	3.12	7.25	8.5	8.9	1/2-13
213T(4)	3.12	7.25	8.5	8.9	1/2-13
215T(3)	3.12	7.25	8.5	8.9	1/2-13
215T(4)	3.12	7.25	8.5	8.9	1/2-13
254T(5)	3.75	7.25	8.5	9.3	1/2-13
254T(6)	3.75	7.25	8.5	9.3	1/2-13
256T(5)	3.75	7.25	8.5	9.3	1/2-13
256T(6)	3.75	7.25	8.5	9.3	1/2-13

- Optional 4.5 inches "AK" is available for 182/184TC frame motors.

(1) All GP10A Motors except 5HP, 1800RPM & 1.5HP, 900RPM.
(2) All GP100A Motors and 5HP, 1800RPM & 1.5HP, 900RPM GP10A Motors.
(3) All GP10A Motors except 10HP, 3600RPM & 10HP, 1800RPM.
(4) All GP100A Motors and 10HP, 3600RPM & 10HP, 1800RPM GP10A Motors.
(5) All GP10A Motors.
(6) All GP100A Motors

Dimensions in Inches
Dimensions are for reference only

Dimensional Drawings
General Purpose TEFC Motors – Cast Aluminum Frame
GP10A / GP100A – C Face with feet



												Key seat		
Frame	C	D	2E	2F	2F1	N-W	0	P	U	AB	BA	R	S	ES
143T	14.37	3.5	5.5	4		2.25	7.28	7.56	0.875	7	2.25	0.771	0.188	1.41
145T	14.37	3.5	5.5		5	2.25	7.28	7.56	0.875	7	2.25	0.771	0.188	1.41
182T(1)	15.69	4.5	7.5	4.5		2.75	8.87	8.74	1.125	6.94	2.75	0.986	0.25	1.81
182T(2)	16.68	4.5	7.5	4.5		2.75	8.87	8.74	1.125	6.94	2.75	0.986	0.25	1.81
184T(1)	15.69	4.5	7.5		5.5	2.75	8.87	8.74	1.125	6.94	2.75	0.986	0.25	1.81
184T(2)	16.68	4.5	7.5		5.5	2.75	8.87	8.74	1.125	6.94	2.75	0.986	0.25	1.81
213T(3)	18.68	5.25	8.5	5.5		3.38	10.41	10.31	1.375	8.27	3.5	1.201	0.312	2.44
213T(4)	20.65	5.25	8.5	5.5		3.38	10.41	10.31	1.375	8.27	3.5	1.201	0.312	2.44
215T(3)	18.68	5.25	8.5		7	3.38	10.41	10.31	1.375	8.27	3.5	1.201	0.312	2.44
215T(4)	20.65	5.25	8.5		7	3.38	10.41	10.31	1.375	8.27	3.5	1.201	0.312	2.44
254T(5)	23.8	6.25	10	8.25		4	12.43	12.36	1.625	9.35	4.25	1.416	0.375	2.91
254T(6)	26.16	6.25	10	8.25		4	12.43	12.36	1.625	9.35	4.25	1.416	0.375	2.91
256T(5)	23.8	6.25	10		10	4	12.43	12.36	1.625	9.35	4.25	1.416	0.375	2.91
256T(6)	26.16	6.25	10		10	4	12.43	12.36	1.625	9.35	4.25	1.416	0.375	2.91

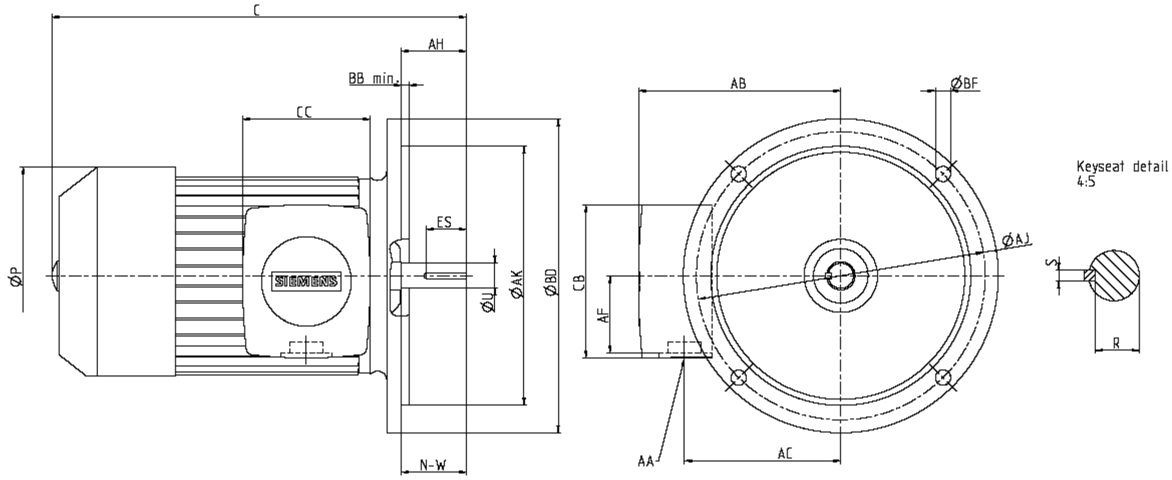
	C - Face				
Frame	AH	AJ	AK	BD	BF
143T	2.12	5.875	4.5	6.6	3/8-16
145T	2.12	5.875	4.5	6.6	3/8-16
182T(1)	2.62	7.25	8.5*	8.9	1/2-13
182T(2)	2.62	7.25	8.5*	8.9	1/2-13
184T(1)	2.62	7.25	8.5*	8.9	1/2-13
184T(2)	2.62	7.25	8.5*	8.9	1/2-13
213T(3)	3.12	7.25	8.5	8.9	1/2-13
213T(4)	3.12	7.25	8.5	8.9	1/2-13
215T(3)	3.12	7.25	8.5	8.9	1/2-13
215T(4)	3.12	7.25	8.5	8.9	1/2-13
254T(5)	3.75	7.25	8.5	9.3	1/2-13
254T(6)	3.75	7.25	8.5	9.3	1/2-13
256T(5)	3.75	7.25	8.5	9.3	1/2-13
256T(6)	3.75	7.25	8.5	9.3	1/2-13

- Optional 4.5 inches "AK" is available for 182/184TC frame motors.

(1) All GP10A Motors except 5HP, 1800RPM & 1.5HP, 900RPM.
(2) All GP100A Motors and 5HP, 1800RPM & 1.5HP, 900RPM GP10A Motors.
(3) All GP10A Motors except 10HP, 3600RPM & 10HP, 1800RPM.
(4) All GP100A Motors and 10HP, 3600RPM & 10HP, 1800RPM GP10A Motors.
(5) All GP10A Motors.
(6) All GP100A Motors

Dimensions in Inches
Dimensions are for reference only

Dimensional Drawings
General Purpose TEFC Motors – Cast Aluminum Frame
GP10A / GP100A – D Flange



												Key seat		
Frame	C	D	2E	2F	2F1	N-W	0	P	U	AB	BA	R	S	ES
143T	14.37	3.5	5.5	4		2.25	7.28	7.56	0.875	7	2.25	0.771	0.188	1.41
145T	14.37	3.5	5.5		5	2.25	7.28	7.56	0.875	7	2.25	0.771	0.188	1.41
182T(1)	15.69	4.5	7.5	4.5		2.75	8.87	8.74	1.125	6.94	2.75	0.986	0.25	1.81
182T(2)	16.68	4.5	7.5	4.5		2.75	8.87	8.74	1.125	6.94	2.75	0.986	0.25	1.81
184T(1)	15.69	4.5	7.5		5.5	2.75	8.87	8.74	1.125	6.94	2.75	0.986	0.25	1.81
184T(2)	16.68	4.5	7.5		5.5	2.75	8.87	8.74	1.125	6.94	2.75	0.986	0.25	1.81
213T(3)	18.68	5.25	8.5	5.5		3.38	10.41	10.31	1.375	8.27	3.5	1.201	0.312	2.44
213T(4)	20.65	5.25	8.5	5.5		3.38	10.41	10.31	1.375	8.27	3.5	1.201	0.312	2.44
215T(3)	18.68	5.25	8.5		7	3.38	10.41	10.31	1.375	8.27	3.5	1.201	0.312	2.44
215T(4)	20.65	5.25	8.5		7	3.38	10.41	10.31	1.375	8.27	3.5	1.201	0.312	2.44
254T(5)	23.8	6.25	10	8.25		4	12.43	12.36	1.625	9.35	4.25	1.416	0.375	2.91
254T(6)	26.16	6.25	10	8.25		4	12.43	12.36	1.625	9.35	4.25	1.416	0.375	2.91
256T(5)	23.8	6.25	10		10	4	12.43	12.36	1.625	9.35	4.25	1.416	0.375	2.91
256T(6)	26.16	6.25	10		10	4	12.43	12.36	1.625	9.35	4.25	1.416	0.375	2.91

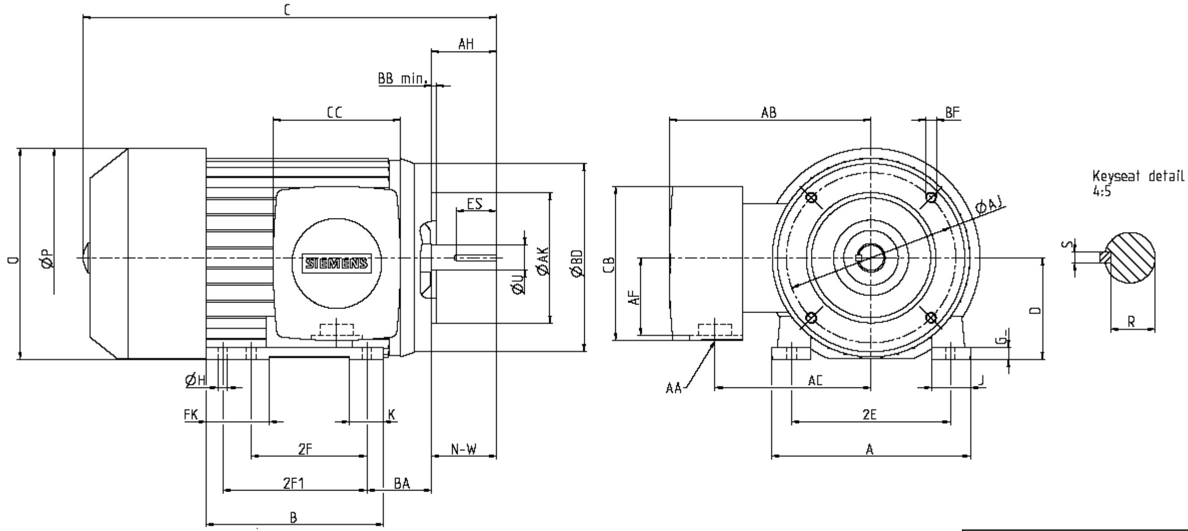
D - Flange					
Frame	AH	AJ	AK	BD	BF
143T	AH	AJ	AK	BD	BF
145T	2.25	10	9	10.9	0.53
182T(1)	2.25	10	9	10.9	0.53
182T(2)	2.75	10	9	11	0.53
184T(1)	2.75	10	9	11	0.53
184T(2)	2.75	10	9	11	0.53
213T(3)	2.75	10	9	11	0.53
213T(4)	3.38	10	9	10.9	0.53
215T(3)	3.38	10	9	10.9	0.53
215T(4)	3.38	10	9	10.9	0.53
254T(5)	3.38	10	9	10.9	0.53
254T(6)	4	12.5	11	13.9	0.81
256T(5)	4	12.5	11	13.9	0.81
256T(6)	4	12.5	11	13.9	0.81

- Optional 4.5 inches "AK" is available for 182/184TC frame motors.

(1) All GP10A Motors except 5HP, 1800RPM & 1.5HP, 900RPM.
(2) All GP100A Motors and 5HP, 1800RPM & 1.5HP, 900RPM GP10A Motors.
(3) All GP10A Motors except 10HP, 3600RPM & 10HP, 1800RPM.
(4) All GP100A Motors and 10HP, 3600RPM & 10HP, 1800RPM GP10A Motors.
(5) All GP10A Motors.
(6) All GP100A Motors

Dimensions in Inches
Dimensions are for reference only

Dimensional Drawings
General Purpose TEFC Motors – Cast Aluminum Frame
GP10A / GP100A – D Flange with feet



												Key seat		
Frame	C	D	2E	2F	2F1	N-W	0	P	U	AB	BA	R	S	ES
143T	14.37	3.5	5.5	4		2.25	7.28	7.56	0.875	7	2.25	0.771	0.188	1.41
145T	14.37	3.5	5.5		5	2.25	7.28	7.56	0.875	7	2.25	0.771	0.188	1.41
182T(1)	15.69	4.5	7.5	4.5		2.75	8.87	8.74	1.125	6.94	2.75	0.986	0.25	1.81
182T(2)	16.68	4.5	7.5	4.5		2.75	8.87	8.74	1.125	6.94	2.75	0.986	0.25	1.81
184T(1)	15.69	4.5	7.5		5.5	2.75	8.87	8.74	1.125	6.94	2.75	0.986	0.25	1.81
184T(2)	16.68	4.5	7.5		5.5	2.75	8.87	8.74	1.125	6.94	2.75	0.986	0.25	1.81
213T(3)	18.68	5.25	8.5	5.5		3.38	10.41	10.31	1.375	8.27	3.5	1.201	0.312	2.44
213T(4)	20.65	5.25	8.5	5.5		3.38	10.41	10.31	1.375	8.27	3.5	1.201	0.312	2.44
215T(3)	18.68	5.25	8.5		7	3.38	10.41	10.31	1.375	8.27	3.5	1.201	0.312	2.44
215T(4)	20.65	5.25	8.5		7	3.38	10.41	10.31	1.375	8.27	3.5	1.201	0.312	2.44
254T(5)	23.8	6.25	10	8.25		4	12.43	12.36	1.625	9.35	4.25	1.416	0.375	2.91
254T(6)	26.16	6.25	10	8.25		4	12.43	12.36	1.625	9.35	4.25	1.416	0.375	2.91
256T(5)	23.8	6.25	10		10	4	12.43	12.36	1.625	9.35	4.25	1.416	0.375	2.91
256T(6)	26.16	6.25	10		10	4	12.43	12.36	1.625	9.35	4.25	1.416	0.375	2.91

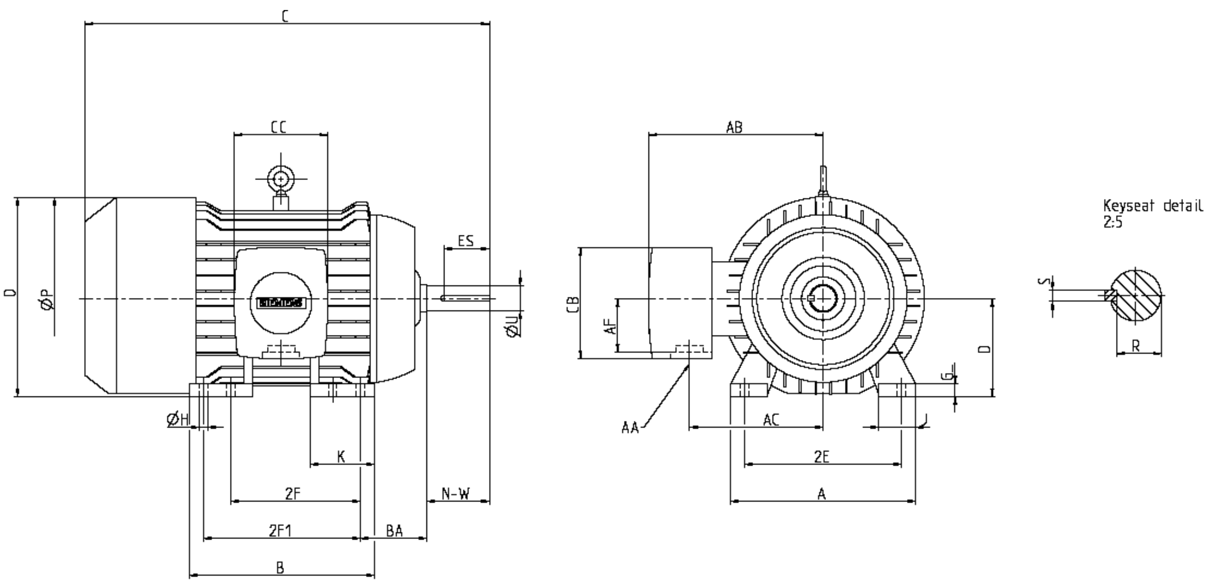
D - Flange					
Frame	AH	AJ	AK	BD	BF
143T	AH	AJ	AK	BD	BF
145T	2.25	10	9	10.9	0.53
182T(1)	2.25	10	9	10.9	0.53
182T(2)	2.75	10	9	11	0.53
184T(1)	2.75	10	9	11	0.53
184T(2)	2.75	10	9	11	0.53
213T(3)	2.75	10	9	11	0.53
213T(4)	3.38	10	9	10.9	0.53
215T(3)	3.38	10	9	10.9	0.53
215T(4)	3.38	10	9	10.9	0.53
254T(5)	3.38	10	9	10.9	0.53
254T(6)	4	12.5	11	13.9	0.81
256T(5)	4	12.5	11	13.9	0.81
256T(6)	4	12.5	11	13.9	0.81

- Optional 4.5 inches "AK" is available for 182/184TC frame motors.

(1) All GP10A Motors except 5HP, 1800RPM & 1.5HP, 900RPM.
(2) All GP100A Motors and 5HP, 1800RPM & 1.5HP, 900RPM GP10A Motors.
(3) All GP10A Motors except 10HP, 3600RPM & 10HP, 1800RPM.
(4) All GP100A Motors and 10HP, 3600RPM & 10HP, 1800RPM GP10A Motors.
(5) All GP10A Motors.
(6) All GP100A Motors

Dimensions in Inches
Dimensions are for reference only

Dimensional Drawings
General Purpose TEFC Motors – Cast Iron Frame
GP10 / GP100 – Foot Mount

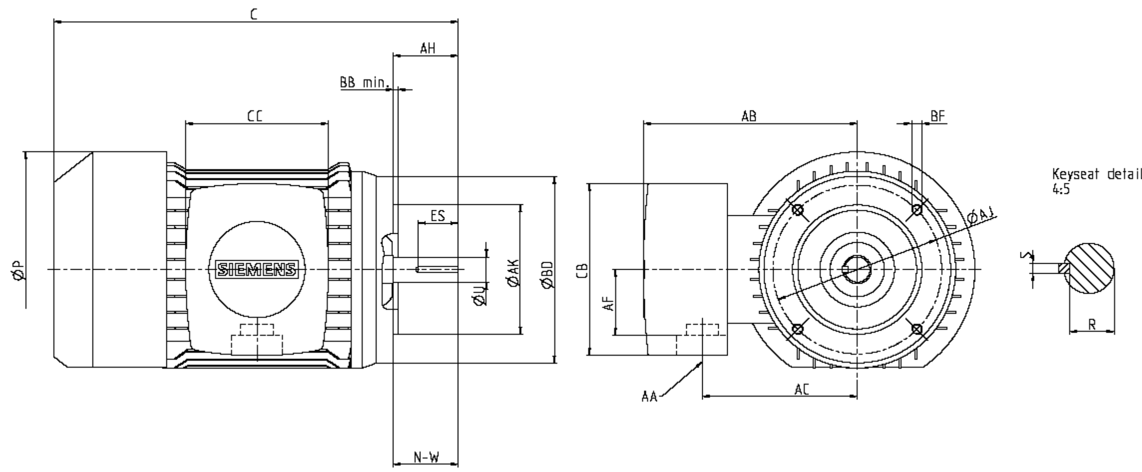


												Key seat		
Frame	C	D	2E	2F	2F1	N-W	0	P	U	AB	BA	R	S	ES
143T	14.4	3.5	5.5	4		2.25	7.5	7.6	0.875	6.9	2.25	0.771	0.188	1.41
145T	14.4	3.5	5.5		5	2.25	7.5	7.6	0.875	6.9	2.25	0.771	0.188	1.41
182T	16.7	4.5	7.5	4.5		2.75	11.1	9.6	1.125	7.8	2.75	0.986	0.25	1.81
184T	16.7	4.5	7.5		5.5	2.75	11.1	9.6	1.125	7.8	2.75	0.986	0.25	1.81
213T	20.7	5.25	8.5	5.5		3.38	10.66	10.7	1.375	9.45	3.5	1.201	0.312	2.44
215T	20.7	5.25	8.5		7	3.38	10.66	10.7	1.375	9.45	3.5	1.201	0.312	2.44
254T	26.16	6.25	10	8.25		4	12.75	12.91	1.625	10.197	4.25	1.416	0.375	2.91
256T	26.16	6.25	10		10	4	12.75	12.91	1.625	10.197	4.25	1.416	0.375	2.91

- Optional 4.5 inches "AK" is available for 182/184TC frame motors.

Dimensions in Inches
Dimensions are for reference only

Dimensional Drawings
General Purpose TEFC Motors – Cast Iron Frame
GP10 / GP100 –C Face



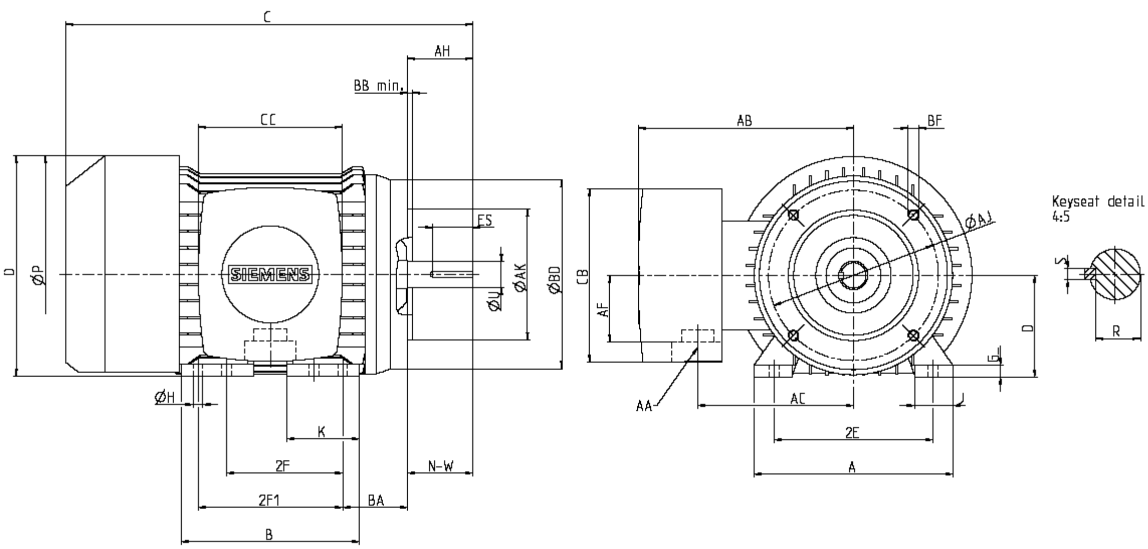
Frame	C	D	2E	2F	2F1	N-W	0	P	U	AB	BA	Key seat R	Key seat S	Key seat ES
143T	14.4	3.5	5.5	4		2.25	7.5	7.6	0.875	6.9	2.25	0.771	0.188	1.41
145T	14.4	3.5	5.5		5	2.25	7.5	7.6	0.875	6.9	2.25	0.771	0.188	1.41
182T	16.7	4.5	7.5	4.5		2.75	11.1	9.6	1.125	7.8	2.75	0.986	0.25	1.81
184T	16.7	4.5	7.5		5.5	2.75	11.1	9.6	1.125	7.8	2.75	0.986	0.25	1.81
213T	20.7	5.25	8.5	5.5		3.38	10.66	10.7	1.375	9.45	3.5	1.201	0.312	2.44
215T	20.7	5.25	8.5		7	3.38	10.66	10.7	1.375	9.45	3.5	1.201	0.312	2.44
254T	26.16	6.25	10	8.25		4	12.75	12.91	1.625	10.197	4.25	1.416	0.375	2.91
256T	26.16	6.25	10		10	4	12.75	12.91	1.625	10.197	4.25	1.416	0.375	2.91

C – Face					
Frame	AH	AJ	AK	BD	BF
143T	2.12	5.875	4.5	6.6	3/8-16
145T	2.12	5.875	4.5	6.6	3/8-16
182T	2.62	7.25	8.5*	8.9	1/2-13
184T	2.62	7.25	8.5*	8.9	1/2-13
213T	3.12	7.25	8.5	8.9	1/2-13
215T	3.12	7.25	8.5	8.9	1/2-13
254T	3.75	7.25	8.5	9.3	1/2-13
256T	3.75	7.25	8.5	9.3	1/2-13

- Optional 4.5 inches "AK" is available for 182/184TC frame motors.

Dimensions in Inches
Dimensions are for reference only

Dimensional Drawings
General Purpose TEFC Motors – Cast Iron Frame
GP10 / GP100 – C Face with feet



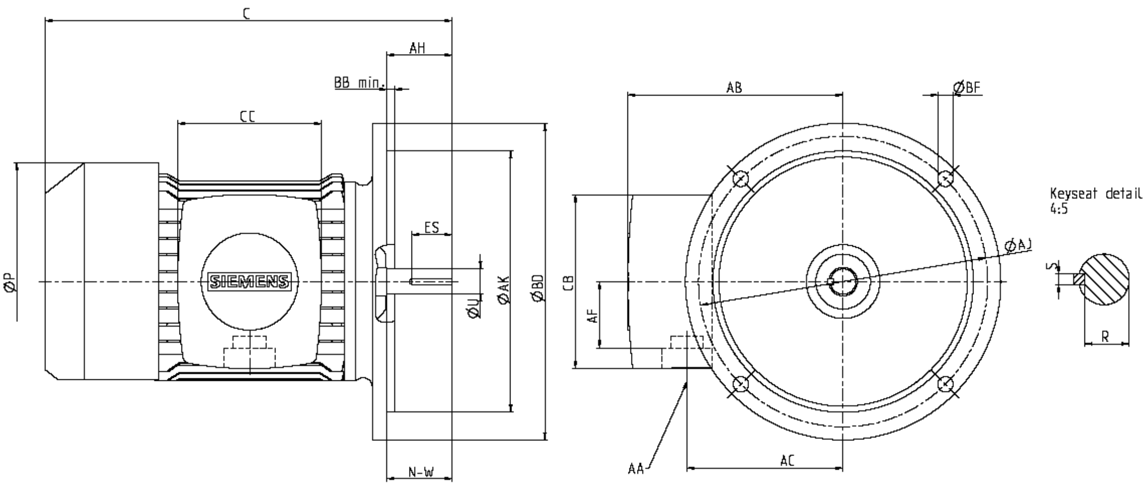
												Key seat		
Frame	C	D	2E	2F	2F1	N-W	0	P	U	AB	BA	R	S	ES
143T	14.4	3.5	5.5	4		2.25	7.5	7.6	0.875	6.9	2.25	0.771	0.188	1.41
145T	14.4	3.5	5.5		5	2.25	7.5	7.6	0.875	6.9	2.25	0.771	0.188	1.41
182T	16.7	4.5	7.5	4.5		2.75	11.1	9.6	1.125	7.8	2.75	0.986	0.25	1.81
184T	16.7	4.5	7.5		5.5	2.75	11.1	9.6	1.125	7.8	2.75	0.986	0.25	1.81
213T	20.7	5.25	8.5	5.5		3.38	10.66	10.7	1.375	9.45	3.5	1.201	0.312	2.44
215T	20.7	5.25	8.5		7	3.38	10.66	10.7	1.375	9.45	3.5	1.201	0.312	2.44
254T	26.16	6.25	10	8.25		4	12.75	12.91	1.625	10.197	4.25	1.416	0.375	2.91
256T	26.16	6.25	10		10	4	12.75	12.91	1.625	10.197	4.25	1.416	0.375	2.91

C - Face					
Frame	AH	AJ	AK	BD	BF
143T	2.12	5.875	4.5	6.6	3/8-16
145T	2.12	5.875	4.5	6.6	3/8-16
182T	2.62	7.25	8.5*	8.9	1/2-13
184T	2.62	7.25	8.5*	8.9	1/2-13
213T	3.12	7.25	8.5	8.9	1/2-13
215T	3.12	7.25	8.5	8.9	1/2-13
254T	3.75	7.25	8.5	9.3	1/2-13
256T	3.75	7.25	8.5	9.3	1/2-13

- Optional 4.5 inches "AK" is available for 182/184TC frame motors.

Dimensions in Inches
Dimensions are for reference only

Dimensional Drawings
General Purpose TEFC Motors – Cast Iron Frame
GP10 / GP100 – D Flange



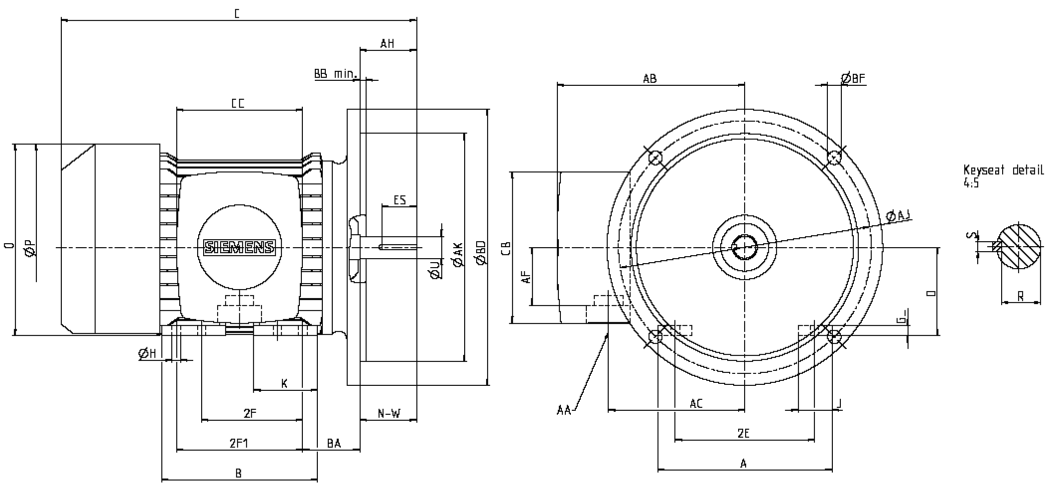
												Key seat		
Frame	C	D	2E	2F	2F1	N-W	0	P	U	AB	BA	R	S	ES
143T	14.4	3.5	5.5	4		2.25	7.5	7.6	0.875	6.9	2.25	0.771	0.188	1.41
145T	14.4	3.5	5.5		5	2.25	7.5	7.6	0.875	6.9	2.25	0.771	0.188	1.41
182T	16.7	4.5	7.5	4.5		2.75	11.1	9.6	1.125	7.8	2.75	0.986	0.25	1.81
184T	16.7	4.5	7.5		5.5	2.75	11.1	9.6	1.125	7.8	2.75	0.986	0.25	1.81
213T	20.7	5.25	8.5	5.5		3.38	10.66	10.7	1.375	9.45	3.5	1.201	0.312	2.44
215T	20.7	5.25	8.5		7	3.38	10.66	10.7	1.375	9.45	3.5	1.201	0.312	2.44
254T	26.16	6.25	10	8.25		4	12.75	12.91	1.625	10.197	4.25	1.416	0.375	2.91
256T	26.16	6.25	10		10	4	12.75	12.91	1.625	10.197	4.25	1.416	0.375	2.91

D - Flange					
Frame	AH	AJ	AK	BD	BF
143T	2.25	10	9	10.9	0.53
145T	2.25	10	9	10.9	0.53
182T	2.75	10	9	11	0.53
184T	2.75	10	9	11	0.53
213T	3.38	10	9	10.9	0.53
215T	3.38	10	9	10.9	0.53
254T	4	12.5	11	13.9	0.81
256T	4	12.5	11	13.9	0.81

- Optional 4.5 inches "AK" is available for 182/184TC frame motors.

Dimensions in Inches
Dimensions are for reference only

Dimensional Drawings
General Purpose TEFC Motors – Cast Iron Frame
GP10 / GP100 – D Flange with feet



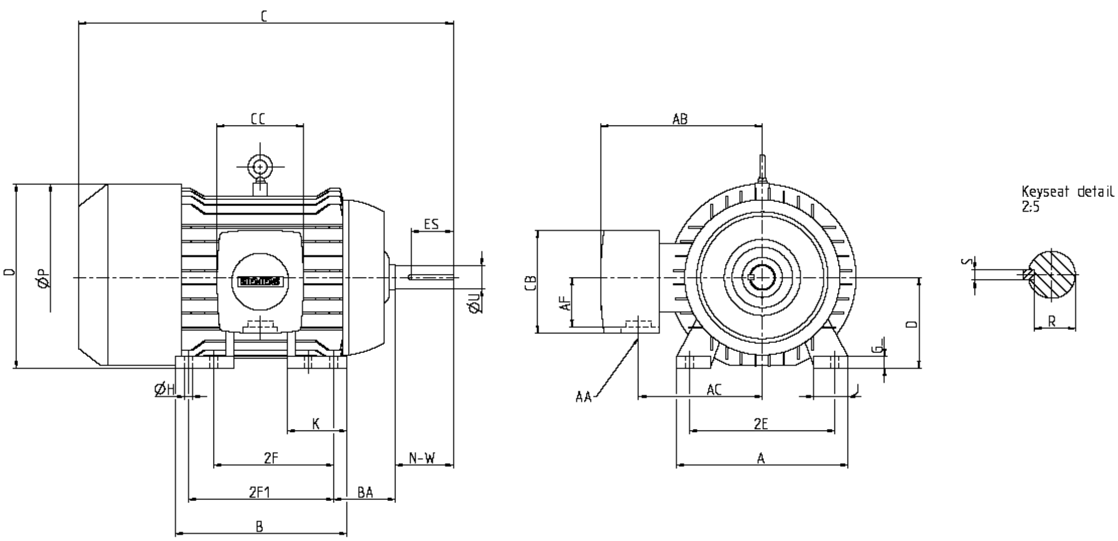
												Key seat		
Frame	C	D	2E	2F	2F1	N-W	0	P	U	AB	BA	R	S	ES
143T	14.4	3.5	5.5	4		2.25	7.5	7.6	0.875	6.9	2.25	0.771	0.188	1.41
145T	14.4	3.5	5.5		5	2.25	7.5	7.6	0.875	6.9	2.25	0.771	0.188	1.41
182T	16.7	4.5	7.5	4.5		2.75	11.1	9.6	1.125	7.8	2.75	0.986	0.25	1.81
184T	16.7	4.5	7.5		5.5	2.75	11.1	9.6	1.125	7.8	2.75	0.986	0.25	1.81
213T	20.7	5.25	8.5	5.5		3.38	10.66	10.7	1.375	9.45	3.5	1.201	0.312	2.44
215T	20.7	5.25	8.5		7	3.38	10.66	10.7	1.375	9.45	3.5	1.201	0.312	2.44
254T	26.16	6.25	10	8.25		4	12.75	12.91	1.625	10.197	4.25	1.416	0.375	2.91
256T	26.16	6.25	10		10	4	12.75	12.91	1.625	10.197	4.25	1.416	0.375	2.91

D - Flange					
Frame	AH	AJ	AK	BD	BF
143T	2.25	10	9	10.9	0.53
145T	2.25	10	9	10.9	0.53
182T	2.75	10	9	11	0.53
184T	2.75	10	9	11	0.53
213T	3.38	10	9	10.9	0.53
215T	3.38	10	9	10.9	0.53
254T	4	12.5	11	13.9	0.81
256T	4	12.5	11	13.9	0.81

- Optional 4.5 inches "AK" is available for 182/184TC frame motors.

Dimensions in Inches
Dimensions are for reference only

Dimensional Drawings
General Purpose TEFC Motors – Cast Iron Frame
SD10 / SD100 – Foot mount

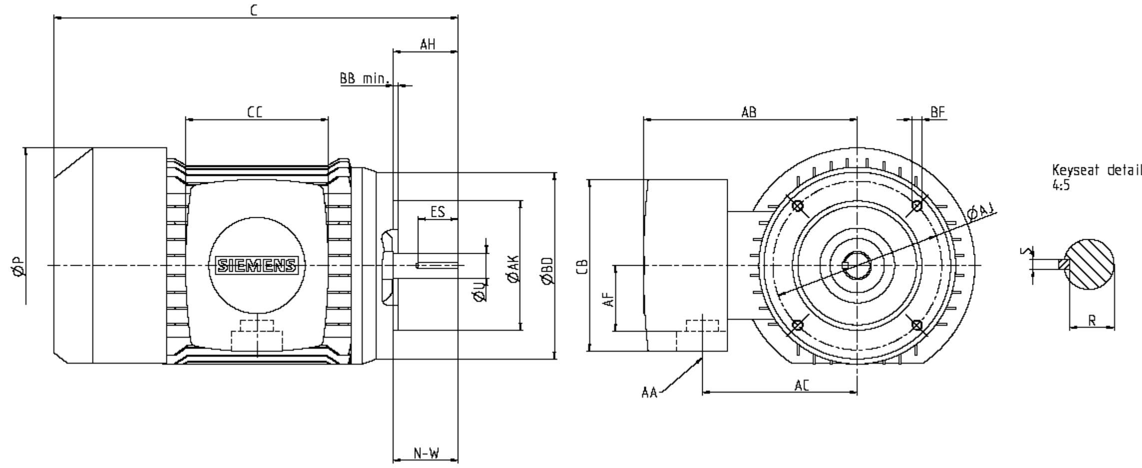


												Key seat		
Frame	C	D	2E	2F	2F1	N-W	0	P	U	AB	BA	R	S	ES
143T	14.15	3.5	5.5	4		2.25	7.5	8.2	0.875	7.4	2.25	0.771	0.188	1.41
145T	14.15	3.5	5.5		5	2.25	7.5	8.2	0.875	7.4	2.25	0.771	0.188	1.41
182T	16.4	4.5	7.5	4.5		2.75	11.1	9.6	1.125	8.2	2.75	0.986	0.25	1.81
184T	16.4	4.5	7.5		5.5	2.75	11.1	9.6	1.125	8.2	2.75	0.986	0.25	1.81
213T	20.2	5.25	8.5	5.5		3.38	10.66	10.7	1.375	10.39	3.5	1.201	0.312	2.44
215T	20.2	5.25	8.5		7	3.38	10.66	10.7	1.375	10.39	3.5	1.201	0.312	2.44
254T	25.77	6.25	10	8.25		4	12.75	12.91	1.625	11.14	4.25	1.416	0.375	2.91
256T	25.77	6.25	10		10	4	12.75	12.91	1.625	11.14	4.25	1.416	0.375	2.91

- Optional 4.5 inches "AK" is available for 182/184TC frame motors.
- (1) Not according to NEMA standard for SD100 IEEE841 motors due to inpro/seal bearing insolator.

Dimensions in Inches
Dimensions are for reference only

Dimensional Drawings
General Purpose TEFC Motors – Cast Iron Frame
SD10 / SD100 – C Face



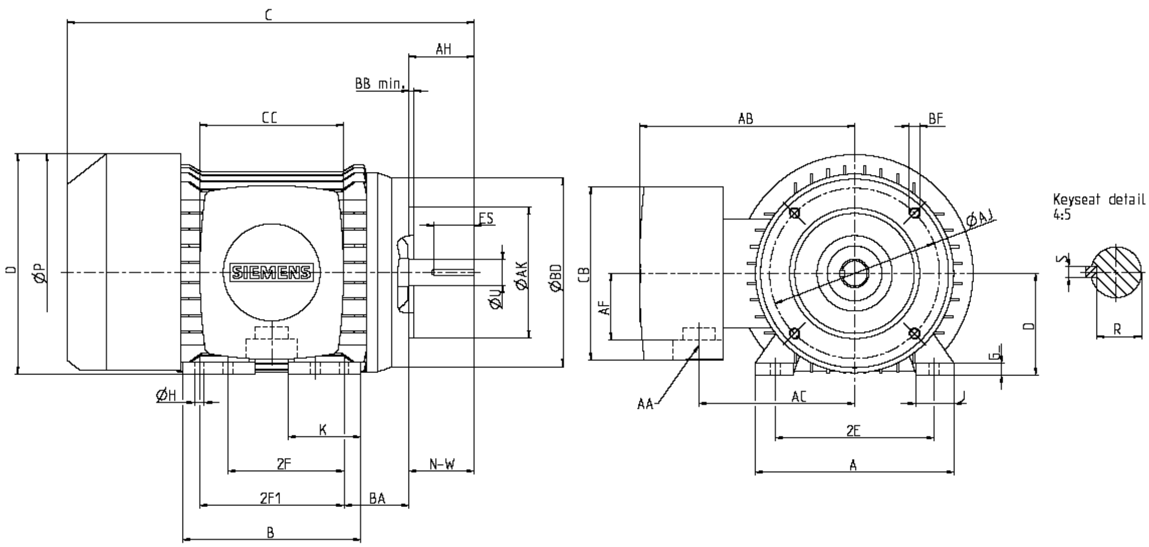
												Key seat		
Frame	C	D	2E	2F	2F1	N-W	0	P	U	AB	BA	R	S	ES
143T	14.15	3.5	5.5	4		2.25	7.5	8.2	0.875	7.4	2.25	0.771	0.188	1.41
145T	14.15	3.5	5.5		5	2.25	7.5	8.2	0.875	7.4	2.25	0.771	0.188	1.41
182T	16.4	4.5	7.5	4.5		2.75	11.1	9.6	1.125	8.2	2.75	0.986	0.25	1.81
184T	16.4	4.5	7.5		5.5	2.75	11.1	9.6	1.125	8.2	2.75	0.986	0.25	1.81
213T	20.2	5.25	8.5	5.5		3.38	10.66	10.7	1.375	10.39	3.5	1.201	0.312	2.44
215T	20.2	5.25	8.5		7	3.38	10.66	10.7	1.375	10.39	3.5	1.201	0.312	2.44
254T	25.77	6.25	10	8.25		4	12.75	12.91	1.625	11.14	4.25	1.416	0.375	2.91
256T	25.77	6.25	10		10	4	12.75	12.91	1.625	11.14	4.25	1.416	0.375	2.91

C – Face					
Frame	AH	AJ	AK	BD	BF
143T	6.6	3/8-16	2.25	10	9
145T	6.6	3/8-16	2.25	10	9
182T	8.9	1/2-13	2.75	10	9
184T	8.9	1/2-13	2.75	10	9
213T	8.9	1/2-13	3.38	10	9
215T	8.9	1/2-13	3.38	10	9
254T	9.3	1/2-13	4	12.5	11
256T	9.3	1/2-13	4	12.5	11

- Optional 4.5 inches "AK" is available for 182/184TC frame motors.
- (1) Not according to NEMA standard for SD100 IEEE841 motors due to inpro/seal bearing insolator.

Dimensions in Inches
Dimensions are for reference only

Dimensional Drawings
General Purpose TEFC Motors – Cast Iron Frame
SD10 / SD100 – C Face with feet



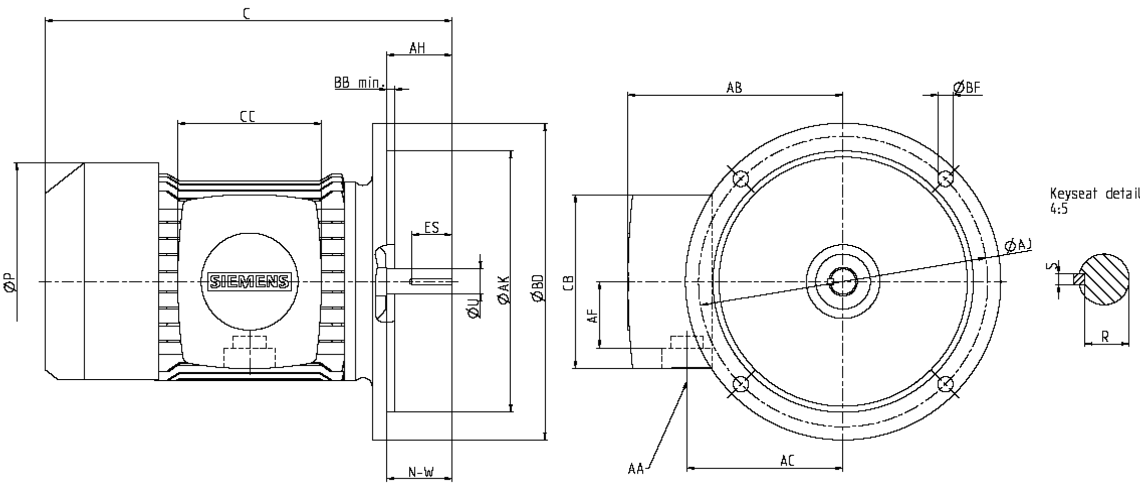
												Key seat		
Frame	C	D	2E	2F	2F1	N-W	0	P	U	AB	BA	R	S	ES
143T	14.15	3.5	5.5	4		2.25	7.5	8.2	0.875	7.4	2.25	0.771	0.188	1.41
145T	14.15	3.5	5.5		5	2.25	7.5	8.2	0.875	7.4	2.25	0.771	0.188	1.41
182T	16.4	4.5	7.5	4.5		2.75	11.1	9.6	1.125	8.2	2.75	0.986	0.25	1.81
184T	16.4	4.5	7.5		5.5	2.75	11.1	9.6	1.125	8.2	2.75	0.986	0.25	1.81
213T	20.2	5.25	8.5	5.5		3.38	10.66	10.7	1.375	10.39	3.5	1.201	0.312	2.44
215T	20.2	5.25	8.5		7	3.38	10.66	10.7	1.375	10.39	3.5	1.201	0.312	2.44
254T	25.77	6.25	10	8.25		4	12.75	12.91	1.625	11.14	4.25	1.416	0.375	2.91
256T	25.77	6.25	10		10	4	12.75	12.91	1.625	11.14	4.25	1.416	0.375	2.91

C – Face					
Frame	AH	AJ	AK	BD	BF
143T	6.6	3/8-16	2.25	10	9
145T	6.6	3/8-16	2.25	10	9
182T	8.9	1/2-13	2.75	10	9
184T	8.9	1/2-13	2.75	10	9
213T	8.9	1/2-13	3.38	10	9
215T	8.9	1/2-13	3.38	10	9
254T	9.3	1/2-13	4	12.5	11
256T	9.3	1/2-13	4	12.5	11

- Optional 4.5 inches "AK" is available for 182/184TC frame motors.
- (1) Not according to NEMA standard for SD100 IEEE841 motors due to inpro/seal bearing insolator.

Dimensions in Inches
Dimensions are for reference only

Dimensional Drawings
General Purpose TEFC Motors – Cast Iron Frame
SD10 / SD100 – D Flange



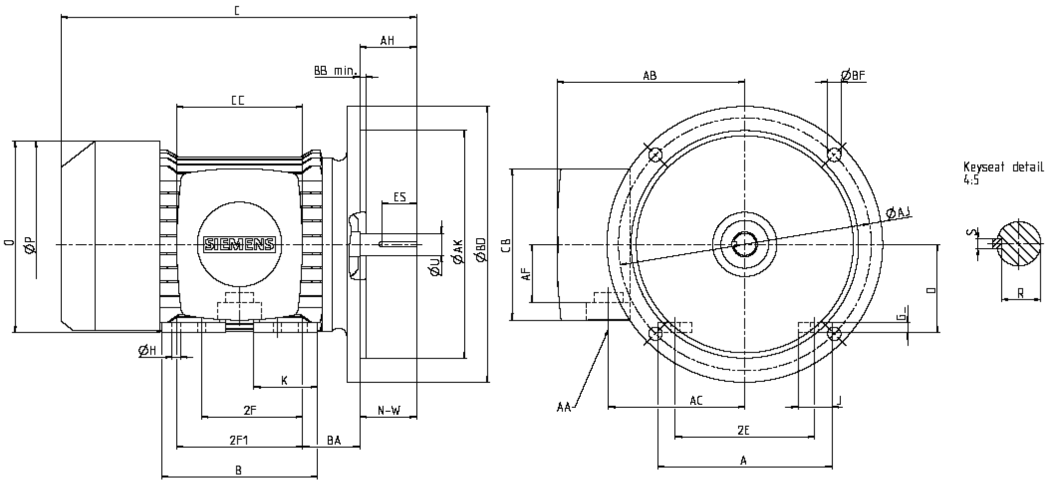
Frame	C	D	2E	2F	2F1	N-W	0	P	U	AB	BA	Key seat R	Key seat S	Key seat ES
143T	14.15	3.5	5.5	4		2.25	7.5	8.2	0.875	7.4	2.25	0.771	0.188	1.41
145T	14.15	3.5	5.5		5	2.25	7.5	8.2	0.875	7.4	2.25	0.771	0.188	1.41
182T	16.4	4.5	7.5	4.5		2.75	11.1	9.6	1.125	8.2	2.75	0.986	0.25	1.81
184T	16.4	4.5	7.5		5.5	2.75	11.1	9.6	1.125	8.2	2.75	0.986	0.25	1.81
213T	20.2	5.25	8.5	5.5		3.38	10.66	10.7	1.375	10.39	3.5	1.201	0.312	2.44
215T	20.2	5.25	8.5		7	3.38	10.66	10.7	1.375	10.39	3.5	1.201	0.312	2.44
254T	25.77	6.25	10	8.25		4	12.75	12.91	1.625	11.14	4.25	1.416	0.375	2.91
256T	25.77	6.25	10		10	4	12.75	12.91	1.625	11.14	4.25	1.416	0.375	2.91

	D - Flange				
Frame	AH	AJ	AK	BD	BF
143T	10.9	0.53	0.771	0.188	1.41
145T	10.9	0.53	0.771	0.188	1.41
182T	11	0.53	0.986	0.25	1.81
184T	11	0.53	0.986	0.25	1.81
213T	10.9	0.53	1.201	0.312	2.44
215T	10.9	0.53	1.201	0.312	2.44
254T	13.9	0.81	1.416	0.375	2.91
256T	13.9	0.81	1.416	0.375	2.91

- Optional 4.5 inches "AK" is available for 182/184TC frame motors.
- (1) Not according to NEMA standard for SD100 IEEE841 motors due to inpro/seal bearing insolator.

Dimensions in Inches
Dimensions are for reference only

Dimensional Drawings
General Purpose TEFC Motors – Cast Iron Frame
SD10 / SD100 – D Flange with feet



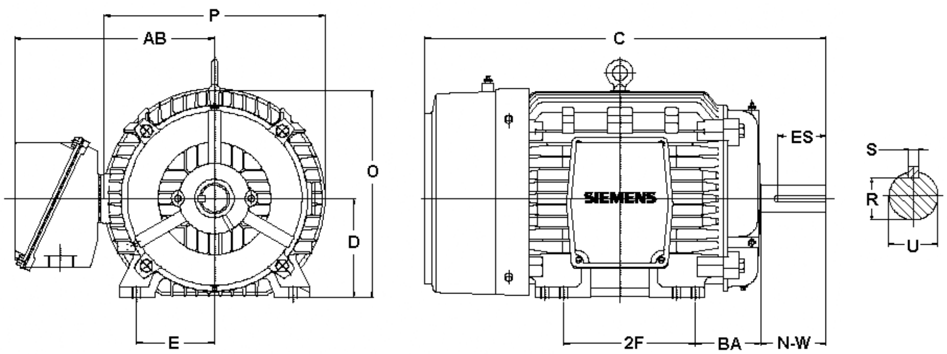
												Key seat		
Frame	C	D	2E	2F	2F1	N-W	0	P	U	AB	BA	R	S	ES
143T	14.15	3.5	5.5	4		2.25	7.5	8.2	0.875	7.4	2.25	0.771	0.188	1.41
145T	14.15	3.5	5.5		5	2.25	7.5	8.2	0.875	7.4	2.25	0.771	0.188	1.41
182T	16.4	4.5	7.5	4.5		2.75	11.1	9.6	1.125	8.2	2.75	0.986	0.25	1.81
184T	16.4	4.5	7.5		5.5	2.75	11.1	9.6	1.125	8.2	2.75	0.986	0.25	1.81
213T	20.2	5.25	8.5	5.5		3.38	10.66	10.7	1.375	10.39	3.5	1.201	0.312	2.44
215T	20.2	5.25	8.5		7	3.38	10.66	10.7	1.375	10.39	3.5	1.201	0.312	2.44
254T	25.77	6.25	10	8.25		4	12.75	12.91	1.625	11.14	4.25	1.416	0.375	2.91
256T	25.77	6.25	10		10	4	12.75	12.91	1.625	11.14	4.25	1.416	0.375	2.91

D - Flange					
Frame	AH	AJ	AK	BD	BF
143T	10.9	0.53	0.771	0.188	1.41
145T	10.9	0.53	0.771	0.188	1.41
182T	11	0.53	0.986	0.25	1.81
184T	11	0.53	0.986	0.25	1.81
213T	10.9	0.53	1.201	0.312	2.44
215T	10.9	0.53	1.201	0.312	2.44
254T	13.9	0.81	1.416	0.375	2.91
256T	13.9	0.81	1.416	0.375	2.91

- Optional 4.5 inches "AK" is available for 182/184TC frame motors.
- (1) Not according to NEMA standard for SD100 IEEE841 motors due to inpro/seal bearing insolator.

Dimensions in Inches
Dimensions are for reference only

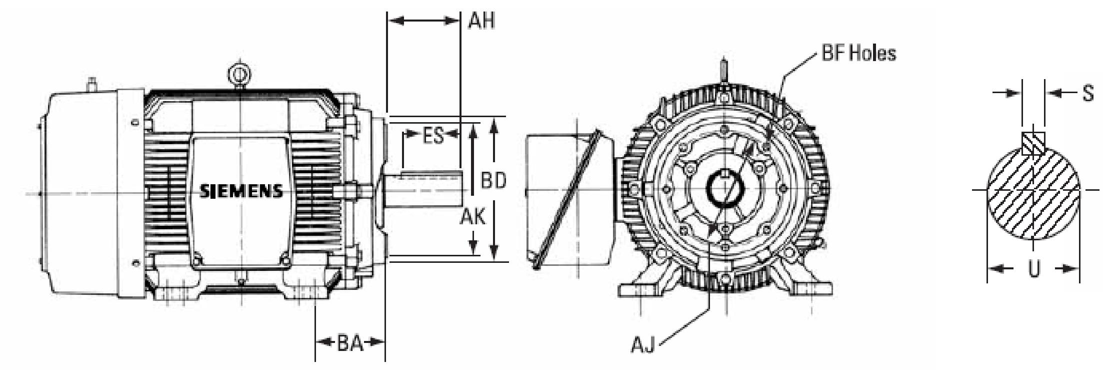
Dimensional Drawings
Hazardous Duty – TEFC Motors
RGZP / RGZPSD / RGZESD / RGZTESD / RGZZESD



Frame	S	R	ES	C	D	E	2F	BA	N-W	O	P	AB	U
143T	.188	.77	1.38	12.2	3.50	2.75	4	2.25	2.25	6.93	7.7	6.46	.875
145T	.188	.77	1.38	13.3	3.50	2.75	5	2.25	2.25	6.93	7.7	6.46	+.0000 –.0005
182T	.250	.99	1.75	14.2	4.50	3.75	4.50	2.75	2.75	8.86	9.7	7.36	1.125
184T	.250	.99	1.75	15.2	4.50	3.75	5.50	2.75	2.75	8.86	9.7	7.36	+.0000 –.0005
213T	.313	1.20	2.38	18.0	5.25	4.25	5.50	3.50	3.38	10.62	11.2	9.02	1.375
215T	.313	1.20	2.38	19.1	5.25	4.25	7	3.50	3.38	10.62	11.2	9.02	+.0000 –.0005
254T	.375	1.42	2.88	22.3	6.25	5	8.25	4.25	4	12.62	13.4	9.92	1.625
256T	.375	1.42	2.88	24.1	6.25	5	10	4.25	4	12.62	13.4	9.92	+.000 –.001
284T	.500	1.59	3.25	27.4	7	5.50	9.50	4.75	4.63	14.19	15.5	13.4	1.875
286T	.500	1.59	3.25	28.9	7	5.50	11	4.75	4.63	14.19	15.5	13.4	+.000 –.001
284TS	.375	1.42	1.88	26.0	7	5.50	9.50	4.75	3.25	14.19	15.5	13.4	1.625
286TS	.375	1.42	1.88	27.5	7	5.50	11	4.75	3.25	14.19	15.5	13.4	+.000 –.001
324T	.500	1.85	3.88	32.0	8	6.25	10.50	5.25	5.25	15.94	17.1	15.75	2.125
326T	.500	1.85	3.88	32.0	8	6.25	12	5.25	5.25	15.94	17.1	15.75	+.000 –.001
324TS	.500	1.59	2	30.0	8	6.25	10.50	5.25	3.75	15.94	17.1	15.75	1.875
326TS	.500	1.59	2	30.0	8	6.25	12	5.25	3.75	15.94	17.1	15.75	+.000 –.001
364T	.625	2.02	4.25	34.2	9	7	11.25	5.88	5.88	17.81	18.5	17.69	2.375
365T	.625	2.02	4.25	34.2	9	7	12.25	5.88	5.88	17.81	18.5	17.69	+.000 –.001
364TS	.500	1.59	2	32.1	9	7	11.25	5.88	3.75	17.81	18.5	17.69	1.875
365TS	.500	1.59	2	32.1	9	7	12.25	5.88	3.75	17.81	18.5	17.69	+.000 –.001
404T	.750	2.45	5.63	39.5	10	8	12.25	6.625	7.25	19.90	19.6	17.50	2.875
405T	.750	2.45	5.63	39.5	10	8	13.75	6.625	7.25	19.90	19.6	17.50	+.000 –.001
404TS	.500	1.85	2.75	36.5	10	8	12.25	6.625	4.25	19.90	19.6	17.50	2.125
405TS	.500	1.85	2.75	36.5	10	8	13.75	6.625	4.25	19.90	19.6	17.50	+.000 –.001
444T	.875	2.88	6.88	45.6	11	9	14.50	7.50	8.50	21.9	21.7	19.94	3.375
445T	.875	2.88	6.88	45.6	11	9	16.50	7.50	8.50	21.9	21.7	19.94	+.000 –.001
444TS	.625	2.02	3	41.8	11	9	14.50	7.50	4.75	21.9	21.7	19.94	2.375
445TS	.625	2.02	3	41.8	11	9	16.50	7.50	4.75	21.9	21.7	19.94	+.000 –.001
447T	.875	2.88	6.88	49.1	11	9	20	7.50	8.50	21.9	21.8	19.94	3.375
447TS	.625	2.02	3	45.4	11	9	20	7.50	4.75	21.9	21.8	19.94	2.375
449T	.875	2.88	6.88	54.1	11	9	25	7.50	8.50	21.9	21.8	22.00	3.375
449TS	.625	2.02	3	50.3	11	9	25	7.50	4.75	21.9	21.8	22.00	2.375
S449LS	.875	3.13	7.5	67.1	11	9	25	7.50	9.12	23.4	25.4	23.01	3.625
S449SS	.625	2.28	3.5	67.1	11	9	25	7.50	5.25	23.4	25.4	23.01	2.625

Dimensions in Inches
Dimensions are for reference only

Dimensional Drawings
Hazardous Duty – TEFC Motors
RGZP / RGZPSD / RGZESD / RGZTESD / RGZZESD
C Face, without feet

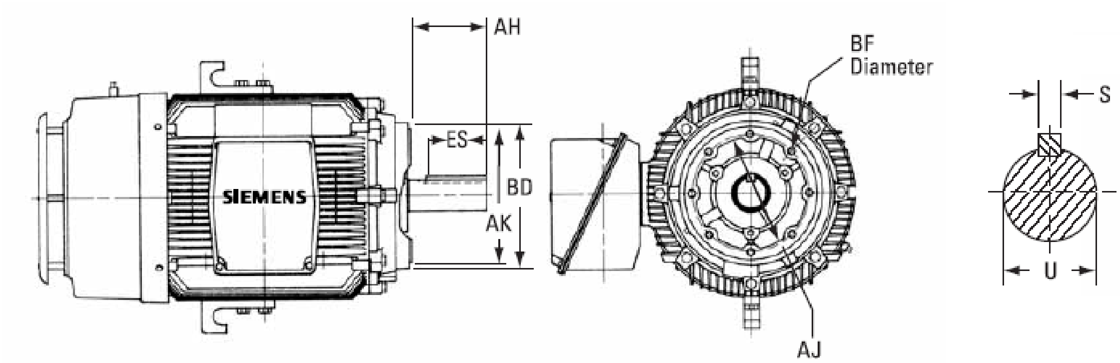


Frame	BD	AJ	AK	U	AH	ES	S	BF#	BF DIA
143/5TC	6.50	5.875	4.5	0.875	2.12	1.41	.188	4	***
182/4TC	9.00*	7.250*	8.5*	1.125	2.62	1.78	.250	4	***
213/5TC	9.00	7.250	8.5	1.375	3.12	2.41	.312	4	***
254/6TC	10.00	7.250	8.5	1.625	3.75	2.91	.375	4	***
284/6TC	10.75	9.000	10.5	1.875	4.38	3.25	.500	4	***
284/6TSC	10.75	9.00	10.5	1.625	3.00	1.88	.380	4	***
324/6TC	12.75	11.00	12.5	2.125	5.00	3.88	.500	4	***
324/6TSC	12.75	11.00	12.5	1.875	3.50	2.00	.500	4	***
364/5TC	12.75	11.00	12.5	2.375	5.62	4.25	.625	8	***
364/5TSC	12.75	11.00	12.5	1.875	3.50	2.00	.500	8	***
404/5TC	13.50	11.00	12.5	2.875	7.00	5.62	.750	8	***
404/5TSC	13.50	11.00	12.5	2.125	4.00	2.75	.500	8	***
444/5TC	16.62	14.00	16.0	3.375	8.25	6.88	.875	8	***
444/5TSC	16.62	14.00	16.0	2.375	4.50	3.00	.625	8	***
447TC	16.62	14.00	16.0	3.375	8.25	6.88	.875	8	***
447TSC	16.62	14.00	16.0	2.375	4.50	3.00	.625	8	***
449TC	16.62	14.00	16.0	3.375	8.25	6.88	.875	8	***
449TSC	16.62	14.00	16.0	2.375	4.50	3.00	.625	8	***

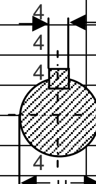
* Optional 4.5 inches “AK” (See 143/5TC) is available for 182/4 TC.
***Tap for 449TC to 324TC = .625 - 11. For 286TC to 182TC = .500 - 13. 140TC = .375 - 16 NC.
Drip Cover dimension (when used) - max 3 inches.

Dimensions in Inches
Dimensions are for reference only

Dimensional Drawings
Hazardous Duty – TEFC Motors
RGZP / RGZPSD / RGZESD / RGZTESD / RGZZESD
C Face, without feet



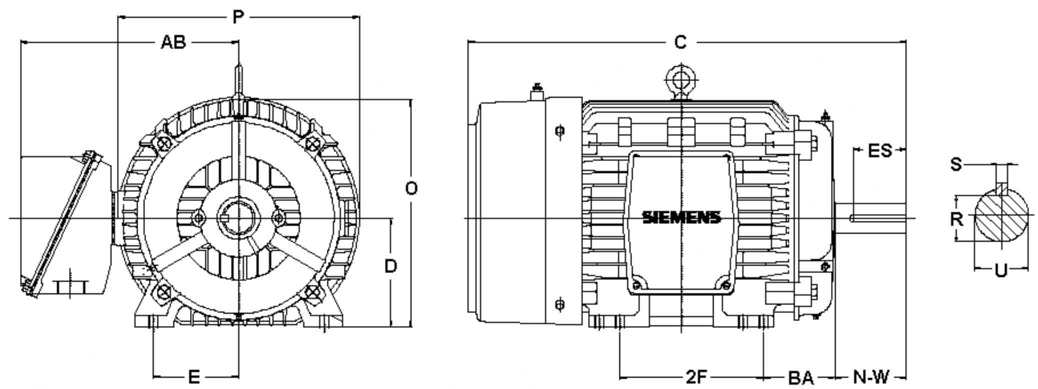
Frame	BD	AJ	AK	U	AH	ES	S	BF#	BF DIA
143/5TC	11.00	10.0	9	.875	2.25	1.41	.188	4	.530
182/4TC	11.00	10.0	9	1.125	2.75	1.78	.250	4	.530
213/5TC	11.00	10.0	9	1.375	3.38	2.41	.310	4	.530
254/6TC	14.00	12.5	11	1.625	4.00	2.91	.375	4	.812
284/6TC	13.88	12.5	11	1.875	4.62	3.25	.500	4	.812
284/6TSC	13.88	12.5	11	1.625	3.25	1.88	.375	[illegible]	.812
324/6TC	17.88	16.0	14	2.125	5.25	3.88	.500	[illegible]	.812
324/6TSC	17.88	16.0	14	1.875	3.75	2.00	.500	4	.812
364/5TC	17.88	16.0	14	2.375	5.88	4.25	.620	4	.812
364/5TSC	17.88	16.0	14	1.875	3.75	2.00	.500	4	.812
404/5TC	21.88	20.0	18	2.875	7.25	5.62	.750	8	.812
404/5TSC	21.88	20.0	18	2.125	4.25	2.75	.500	8	.812
444/5TC	21.88	20.0	18	3.375	8.50	6.88	.875	8	.812
444/5TSC	21.88	20.0	18	2.375	4.75	3.00	.625	8	.812
447TC	21.88	20.0	18	3.375	8.50	6.88	.875	8	.812
447TSC	21.88	20.0	18	2.375	4.75	3.00	.625	8	.812
449TC	21.88	20.0	18	3.375	8.50	6.88	.875	8	.812
449TSC	21.88	20.0	18	2.375	4.75	3.00	.625	8	.812



Drip Cover dimension (when used) - max 3 inches.

Dimensions in Inches
Dimensions are for reference only

Dimensional Drawings
Automotive Duty – TEFC U Frame Motors
RGZEAD

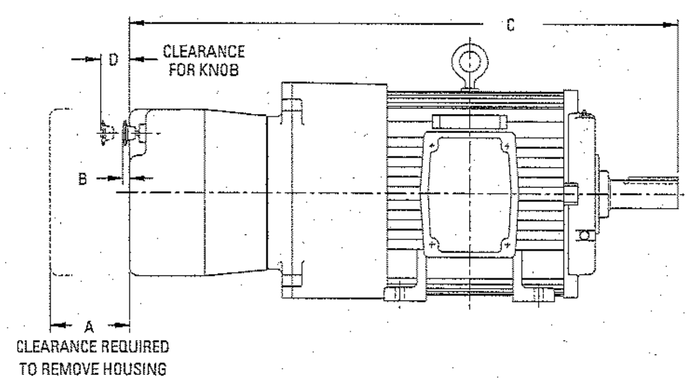


Frame	S	R	ES	C	D	E	2F	BA	N-W	O	P	AB	U
182	0.188	0.771	1.41	14.3	4.5	3.75	4.5	2.75	2.25	9	9	8	0.875
184	0.188	0.771	1.41	15.35	4.5	3.75	5.5	2.75	2.25	9	9	8	0.875
213	0.25	0.986	2.04	17.8	5.25	4.25	5.5	3.5	3	10.62	10.63	9.4	1.125
215	0.25	0.986	2.04	19.3	5.25	4.25	7	3.5	3	10.62	10.63	9.4	1.125
254U	0.312	1.201	2.8	22.9	6.25	5	8.25	4.25	3.75	12.62	12.65	10.65	1.375
256U	0.312	1.201	2.8	24.61	6.25	5	10	4.25	3.75	12.62	12.65	10.65	1.375
284U	0.375	1.416	3.74	27.6	7	5.5	9.5	4.74	4.88	14.27	14.38	13.39	1.625
286U	0.375	1.416	3.74	29.2	7	5.5	11	4.74	4.88	14.27	14.38	13.39	1.625
324S	0.375	1.416	1.875	29.48	8	6.25	10.5	5.25	3.25	15.9	15.82	15.5	1.625
326S	0.375	1.416	1.875	29.48	8	6.25	12	5.25	3.25	15.9	15.82	15.5	1.625
324U	0.5	1.591	4.24	31.86	8	6.25	10.5	5.25	5.62	15.9	15.82	15.5	1.875
326U	0.5	1.591	4.24	31.86	8	6.25	12	5.25	5.62	15.9	15.82	15.5	1.875
364U	0.5	1.845	5	34.69	9	7	11.25	5.88	6.38	17.81	17.66	17.94	2.125
364US	0.75	1.591	2	32.06	9	7	11.25	5.88	3.75	17.81	17.66	17.94	1.875
365U	0.5	1.845	5	34.69	9	7	12.25	5.88	6.38	17.81	17.66	17.94	2.125
365US	0.75	1.591	2	32.06	9	7	12.25	5.88	3.75	17.81	17.66	17.94	1.875
404U	0.625	2.021	5.5	39.28	10	8	12.25	6.62	7.125	19.6	19.56	18.38	2.375
404US	0.5	1.845	2.75	36.4	10	8	12.25	6.62	4.25	19.6	19.56	18.38	2.125
405U	0.625	2.021	5.5	39.28	10	8	13.75	6.62	7.125	19.6	19.56	18.38	2.375
405US	0.5	1.845	2.75	36.4	10	8	13.75	6.62	4.25	19.6	19.56	18.38	2.125
444U	0.75	2.45	7	45.64	11	9	14.5	7.5	8.62	21.8	21.75	19.63	2.875
445U	0.75	2.45	7	45.64	11	9	16.5	7.5	8.62	21.8	21.75	19.63	2.875

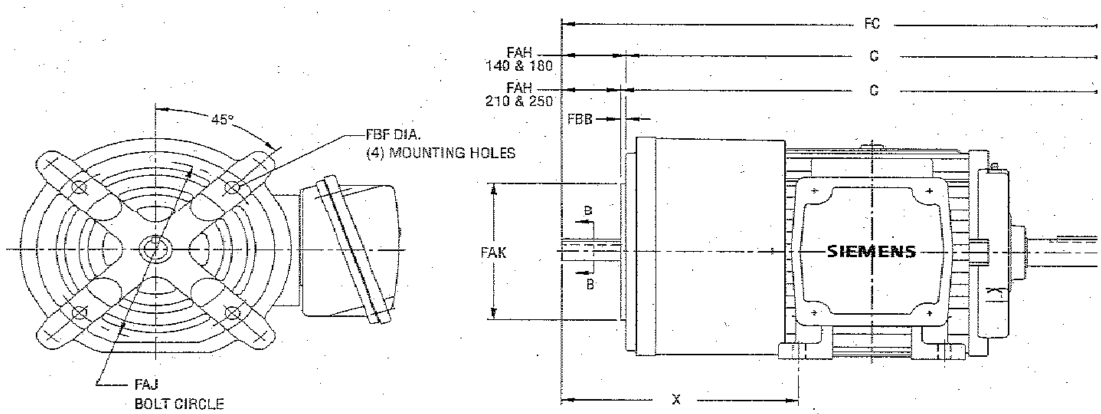
All of the above motors have 8 holes footprint except 182 to 286 frames.

Dimensions in Inches
Dimensions are for reference only

Dimensional Drawings
Severe Duty – TEFC Brake & Brake Ready Motors
RGZESDB / RGZESBR



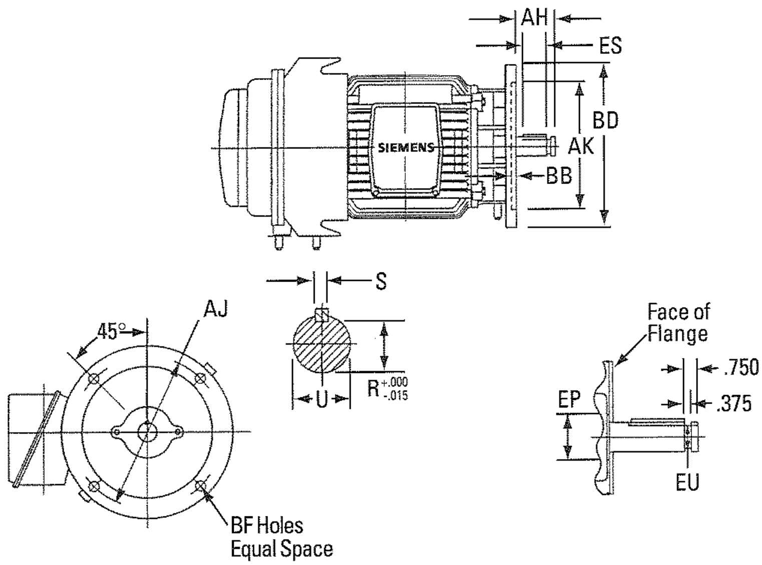
Frame	A	B	C	D	Brake Size Lbs. Ft
143T	2.94	—	17.28	—	6
145T	2.94	—	18.74	—	10
182T	2.94	—	20.28	—	15
184T	2.94	—	21.28	—	20
213T	4.69	.4	26.56	1.3	35
215T	4.69	.4	28.56	1.3	50
254T	4.69	.4	32.58	1.3	75
256T	4.69	.4	34.82	1.3	105
284T	4.69	.4	37.50	1.3	50
284T	4.69	.4	37.50	1.3	75
286T	4.69	.4	39.00	1.3	75
286T	4.69	.4	39.50	1.3	105
324T	4.69	.4	42.50	1.3	105
324T	6.00	—	45.00	1.4	175
326T	4.69	.4	42.5	1.3	105
326T	6.00	—	45.20	1.4	230
364T	6.00	—	48.50	1.4	330
365T	6.00	—	48.50	1.4	330



Frame	C	FC	X	FAH	FAJ	FAK	FBB	FR	FS	FU	Brake Size Lbs .Ft
143T	13.22	15.03	6.53	1.81	5.88	4.50	.16	.517	.188	.625	6
145T	14.22	16.03	6.53	1.81	5.88	4.50	.16	.517	.188	.625	10
182T	15.77	18.03	8.03	2.26	5.88	4.50	.16	.771	.188	.875	15
184T	16.77	19.03	8.03	2.26	5.88	4.50	.16	.771	.188	.875	20
213T	19.11	21.87	9.50	2.76	7.25	8.50	—	.986	.250	1.125	35
215T	20.61	23.37	9.50	2.76	7.25	8.50	—	.986	.250	1.125	50
254T	24.65	28.05	11.55	3.40	7.25	8.50	—	1.201	.312	1.375	75
256T	26.40	29.80	11.55	3.40	7.25	8.50	—	1.201	.312	1.375	105
284T	29.42	31.75	12.88	2.33	7.25	8.50	—	1.201	.312	1.375	105
286T	30.92	33.25	12.88	2.33	7.25	8.50	—	1.201	.312	1.375	105

Dimensions in Inches
Dimensions are for reference only

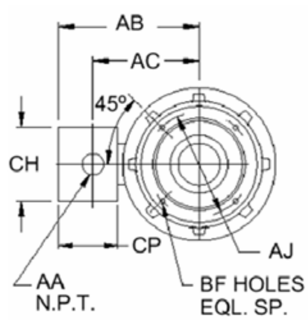
Dimensional Drawings
Severe & Hazardous Duty – Vertical P Base (VSS) Motors
RGZVESD / RGZVMTESD /RGZVILESD
RGZZVESD / RGZZVMTESD / RGZZVILESD

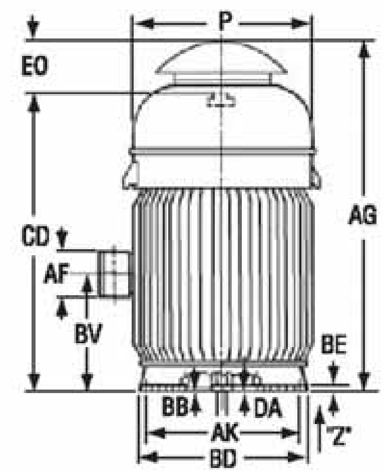


Frame		U	ES	EU	EP	AH	AJ	AK	BB	BD	BF	R	S
143LP	145LP	1.125	1.25	0.875	1.160	2.75	9.12	8.25	0.19	10.00	.438	0.986	.250
182LP	184LP	1.125	1.25	0.875	1.160	2.75	9.12	8.25	0.19	10.00	.438	0.986	.250
213LP	215 LP	1.625	1.25	1.250	1.770	2.75	9.12	8.25	0.19	10.00	.438	1.416	.375
254LP	256LP	1.625	1.25	1.250	1.770	2.75	9.12	8.25	0.19	10.00	.438	1.416	.375
84LPH	286LPH	2.125	3.00	1.750	2.360	4.50	14.75	13.50	0.25	16.50	.688	1.845	.500
324LP	326 LP	2.125	3.00	1.750	2.360	4.50	14.75	13.50	0.25	16.50	.688	1.845	.500
364LP	365LP	2.125	3.00	1.750	2.380	4.50	14.75	13.50	0.25	16.50	.688	1.845	.500
404LP	405LP	2.125	3.00	1.750	2.999	4.50	14.75	13.50	0.25	16.38	.688	1.845	.500
444LP	445LP	2.125	3.00	1.750	2.999	4.50	14.75	13.50	0.25	16.38	.688	1.845	.500
447LP	449LP	2.125	3.00	1.750	2.999	4.50	14.75	13.50	0.25	16.38	.688	1.845	.500
143HP	145HP	0.875	1.25	0.688	1.160	2.75	9.12	8.25	0.19	10.00	.438	0.771	.188
182HP	184HP	1.125	1.25	0.875	1.160	2.75	9.12	8.25	0.19	10.00	.438	0.986	.250
213HP	215HP	1.125	1.25	0.875	1.380	2.75	9.12	8.25	0.19	10.00	.438	0.986	.250
254HP	256HP	1.125	1.25	0.875	1.770	2.75	9.12	8.25	0.19	10.00	.438	0.986	.250
284HP	286HP	1.125	1.25	0.875	2.360	2.75	9.12	8.25	0.19	10.00	.438	0.986	.250
84HPH	286HPH	1.625	3.00	1.250	2.360	4.50	14.75	13.50	0.25	16.50	.688	1.416	.375
324HP	326HP	1.625	3.00	1.250	2.360	4.50	14.75	13.50	0.25	16.50	.688	1.416	.375
364HP	365HP	1.625	3.00	1.250	2.360	4.50	14.75	13.50	0.25	16.50	.688	1.416	.375
404HP	405HP	1.625	3.00	1.250	2.999	4.50	14.75	13.50	0.25	16.38	.688	1.416	.375
444HP	445HP	2.125	3.00	1.750	2.999	4.50	14.75	13.50	0.25	16.38	.688	1.845	.500
447HP	449HP	2.125	3.00	1.750	2.999	4.50	14.75	13.50	0.25	16.38	.688	1.845	.500

Dimensions in Inches
Dimensions are for reference only

Dimensional Drawings
Severe & Hazardous Duty – Vertical P Base (VHS) Motors
HSRGVZVESD



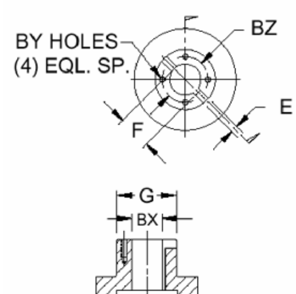


Frame	P	AA (npt)	AB	AC	AF	AG	AJ	AK	BD	BF (dia)	BF #Holes	BV	CD	CH	CP	EO	Wt. (lbs)
284TP	14.1	1.5	11.2	9.2	8.23	30.5	9.125	8.25	10	0.44	4	6.02	25.1	6.85	3.66	5.7	462
286TP	14.1	1.5	11.2	9.2	8.23	30.5	9.125	8.25	10	0.44	4	6.02	26.6	6.85	3.66	5.7	488
324TP	15.8	2	12.5	10.2	9.68	32.6	14.75	13.5	16.5	0.69	4	7	31	7.87	4.41	4.1	653
326TP	15.8	2	12.5	10.2	9.68	32.6	14.75	13.5	16.5	0.69	4	7	31	7.87	4.41	4.1	671
364TP	17.7	3	15.3	12.1	11.53	37.6	14.75	13.5	16.5	0.69	4	8.15	34.8	9.21	6.22	4.6	957
365TP	17.7	3	15.3	12.1	11.53	37.6	14.75	13.5	16.5	0.69	4	8.15	34.8	9.21	6.22	4.6	1188
404TP	19.8	3	17	13.9	11.53	43.1	14.75	13.5	16.5	0.69	4	8.5	40	9.21	6.22	6.4	1518
405TP	19.8	3	17	13.9	11.53	43.1	14.75	13.5	16.5	0.69	4	8.5	40	9.21	6.22	6.4	1518
444TP	22.2	3	19.94	15.06	12.31	49.54	14.75	13.5	19.8	0.69	4	16.75	43.2	10.5	9	6.34	1826
445TP	22.2	3	19.94	15.06	12.31	49.54	14.75	13.5	19.8	0.69	4	16.75	43.2	10.5	9	6.34	1870
447TP	22.2	3	19.94	15.06	12.31	53.04	14.75	13.5	19.8	0.69	4	20.25	46.7	10.5	9	6.34	2475
449TP	22.2	3	19.94	15.06	12.31	58.04	14.75	13.5	19.8	0.69	4	25.25	51.7	10.5	9	6.34	2750

Detail of Drive Coupling

							Stock motors	
Frame	BX	BY (tap)	BZ	E	F	G	HP	RPM
284	1.001	10-32NF	1.375	0.250	1.141	2.52	25	1800
286	1.001	10-32NF	1.375	0.250	1.141	2.52	30	1800
324	1.188	0.250-20NC	1.75	0.250	1.328	2.87	40	1800
326	1.188	0.250-20NC	1.75	0.250	1.328	2.87	50	1800
364-365	1.188	0.250-20NC	1.75	0.250	1.328	2.87	60,75	1800
364-365	1.501	0.250-20NC	2.125	0.375	1.679	2.87		
364-365	1.251	0.250-20NC	1.75	0.375	1.424	2.87		1800
364-365	1.001	10-13NF	1.375	0.250	1.124	2.87		
364-365	1.438	0.250-20NC	2.125	0.375	1.615	2.87	100	1800
404-405	1.251	0.250-20NC	1.75	0.375	1.424	2.87		
404-405	1.438	0.250-20NC	2.125	0.375	1.615	2.87		
404-405	1.688	0.250-20NC	2.5	0.375	1.869	3.62		
404-405	1.188	0.250-20NC	1.75	0.250	1.328	2.52		
404-405	1.501	0.250-20NC	2.125	0.375	1.679	2.87		
444-449	1.688	0.250-20NC	2.5	0.375	1.901	2.52	*	1800

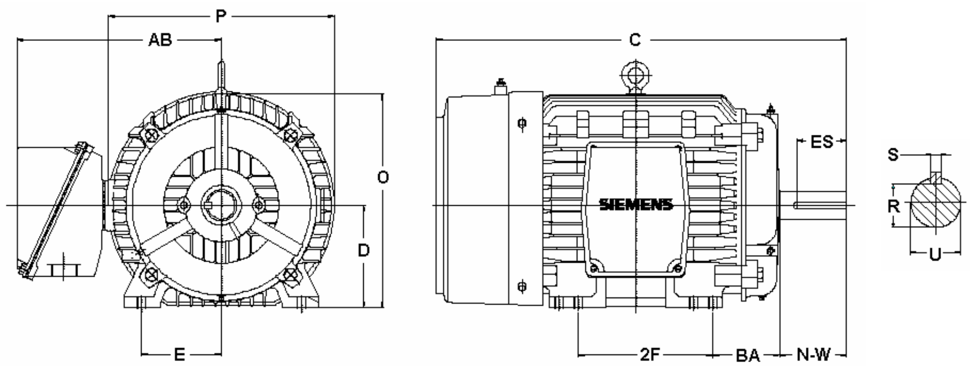
* 125, 150 200 & 250 HP



DETAIL OF
DRIVE COUPLING

Dimensions in Inches
Dimensions are for reference only

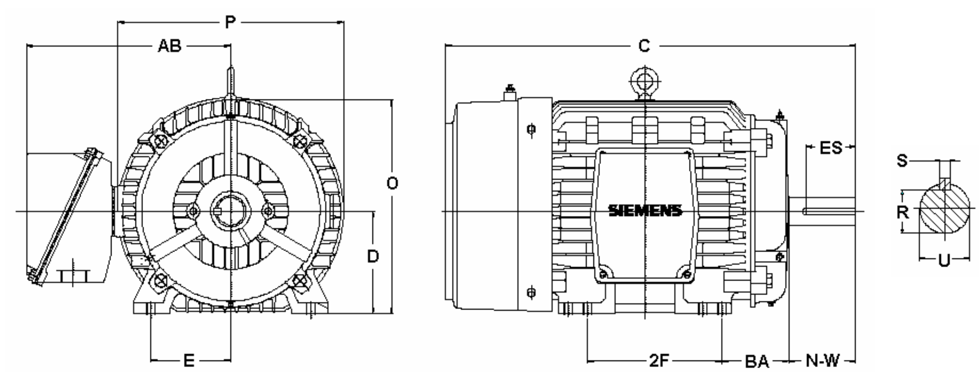
Dimensional Drawings
Severe Duty – TEFC Motors
RGZEESD 140 – 360 Frames



Frame	Poles	S	R	ES	C	D	E	2F	BA	N-W	O	P	AB	U	Wt. (lbs)
143T	2,4,6	0.188	0.771	1.41	13.97	3.50	2.75	4.0	2.25	2.25	7.56	8.11	7.05	0.875	45
145T	2,4,6	0.188	0.771	1.41	13.97	3.50	2.75	5.0	2.25	2.25	7.56	8.11	7.05	0.875	55
182T	2	0.250	0.986	1.78	14.8	4.50	3.75	4.5	2.75	2.75	9	9	8	1.125	85
182T	4,6	0.250	0.986	1.78	16.22	4.50	3.75	4.5	2.75	2.75	9.74	10.83	8.58	1.125	85
184T	2	0.250	0.986	1.78	15.9	4.50	3.75	5.5	2.75	2.75	9	9	8	1.125	100
184T	4,6	0.250	0.986	1.78	16.22	4.50	3.75	5.5	2.75	2.75	9.74	10.83	8.58	1.125	100
213T	2	0.312	1.201	2.41	18.15	5.25	4.25	5.5	3.5	3.38	10.43	10.63	9.4	1.375	130
213T	4,6	0.312	1.201	2.41	20.27	5.25	4.25	5.5	3.5	3.38	11.35	12.2	10.63	1.375	130
215T	2	0.312	1.201	2.41	19.7	5.25	4.25	7.0	3.5	3.38	10.43	10.63	9.4	1.375	162
215T	4,6	0.312	1.201	2.41	20.27	5.25	4.25	7.0	3.5	3.38	11.35	12.2	10.63	1.375	162
254T	2	0.375	1.416	2.91	23.15	6.25	5	8.25	4.25	4	12.33	12.65	10.65	1.625	250
254T	4,6	0.375	1.416	2.91	25.83	6.25	5	8.25	4.25	4	13.34	14.37	11.62	1.625	250
256T	2	0.375	1.416	2.91	24.85	6.25	5	10	4.25	4	12.33	12.65	10.65	1.625	295
256T	4,6	0.375	1.416	2.91	25.83	6.25	5	10	4.25	4	13.34	14.37	11.62	1.625	295
284T	4,6	0.500	1.591	3.25	29.38	7	5.5	9.5	4.75	4.625	14.87	15.82	14.3	1.875	380
286T	4,6	0.500	1.591	3.25	29.38	7	5.5	11	4.75	4.625	14.87	15.82	14.3	1.875	450
284TS	2	0.375	1.416	1.88	26	7	5.5	9.5	4.75	3.25	14.27	14.38	13.39	1.625	380
284TS	4,6	0.375	1.416	1.88	28.01	7	5.5	9.5	4.75	3.25	14.87	15.82	14.33	1.625	380
286TS	2	0.375	1.416	1.88	27.5	7	5.5	11	4.75	3.25	14.27	14.38	13.39	1.625	450
286TS	4,6	0.375	1.416	1.88	28.01	7	5.5	11	4.75	3.25	14.87	15.82	14.33	1.625	450
324T	4,6	0.5	1.845	3.88	32.07	8	6.25	10.5	5.25	5.25	16.66	17.66	15.99	2.125	565
326T	4,6	0.5	1.845	3.88	32.07	8	6.25	12	5.25	5.25	16.66	17.66	15.99	2.125	565
324TS	2	0.5	1.591	2	30	8	6.25	10.5	5.25	3.75	15.9	15.82	15.5	1.875	565
324TS	4,6	0.5	1.591	2	30.57	8	6.25	10.5	5.25	3.75	16.66	17.66	15.99	1.875	565
326TS	2	0.5	1.591	2	30	8	6.25	12	5.25	3.75	15.9	15.82	15.5	1.875	565
326TS	4,6	0.5	1.591	2	30.57	8	6.25	12	5.25	3.75	16.66	17.66	15.99	1.875	565
364T	4,6	0.625	2.021	4.25	35.53	9	7	11.25	5.88	5.88	18.48	19.56	18.57	2.375	830
365T	4,6	0.625	2.021	4.25	35.53	9	7	12.25	5.88	5.88	18.48	19.56	18.57	2.375	830
364TS	2	0.5	1.591	2	32.06	9	7	11.25	5.88	3.75	17.81	17.66	17.94	1.875	830
364TS	4,6	0.5	1.591	2	33.4	9	7	11.25	5.88	3.75	18.48	19.56	18.57	1.875	850
365TS	2	0.5	1.591	2	32.06	9	7	12.25	5.88	3.75	17.81	17.66	17.94	1.875	830
365TS	4,6	0.5	1.591	2	33.4	9	7	12.25	5.88	3.75	18.48	19.56	18.57	1.875	850

Dimensions in Inches
Dimensions are for reference only

Dimensional Drawings
Dimensional Drawings
Severe Duty – TEFC Motors
RGZEESD 440 Frames

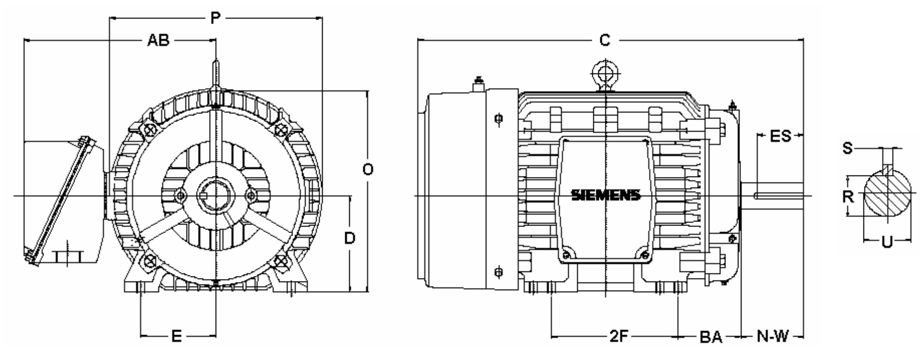


Frame	Poles	S	R	ES	C	D	E	2F	BA	N-W	O	P	AB	U	Wt. (lbs)
404T		0.75	2.45	5.63	39.4	10	8	12.25	6.62	7.25	19.6	19.56	18.38	2.875	1100
405T		0.75	2.45	5.63	39.4	10	8	13.75	6.62	7.25	19.6	19.56	18.38	2.875	1250
404TS		0.5	1.845	2.75	36.4	10	8	12.25	6.62	4.25	19.6	19.56	18.38	2.125	1100
405TS		0.5	1.845	2.75	36.4	10	8	13.75	6.62	4.25	19.6	19.56	18.38	2.125	1250
444T		0.875	2.88	6.88	45.58	11	9	14.5	7.5	8.5	21.8	21.75	19.63	3.375	1620
445T		0.875	2.88	6.88	45.58	11	9	16.5	7.5	8.5	21.8	21.75	19.63	3.375	1740
444TS		0.625	2.021	3.05	41.82	11	9	14.5	7.5	4.75	21.8	21.75	19.63	2.375	1620
445TS		0.625	2.021	3.05	41.82	11	9	16.5	7.5	4.75	21.8	21.75	19.63	2.375	1740
447T		0.875	2.88	6.88	49	11	9	20	7.5	8.5	22	21.75	19.63	3.375	2000
447TS		0.625	2.021	3.05	45.26	11	9	20	7.5	4.75	22	21.75	19.63	2.375	2000
449T		0.875	2.88	6.88	54	11	9	25	7.5	8.5	22	21.75	22	3.375	2300
449TS		0.625	2.021	3.05	50.3	11	9	25	7.5	4.75	22	21.75	22	2.375	2300
S449LS		0.875	3.134	7.5	63.6	11	9	25	7.5	9.12	23.3	24.6	23	3.625	3050
S449SS		0.625	2.275	3.5	59.8	11	9	25	7.5	5.25	23.3	24.6	23	2.625	3050
S449SS	*	0.625	2.275	3.5	63.2	11	9	25	7.5	5.25	23.3	24.6	23	2.625	3050

* Only for 400HP, 2 Pole
All of the above motors have 8 hole footprints except 182 to 286 frames (2 pole only) and S449 frames

Dimensions in Inches
Dimensions are for reference only

Dimensional Drawings
Severe Duty – TEFC Motors – IEEE 841
RGZEESDX 140 – 320 Frames

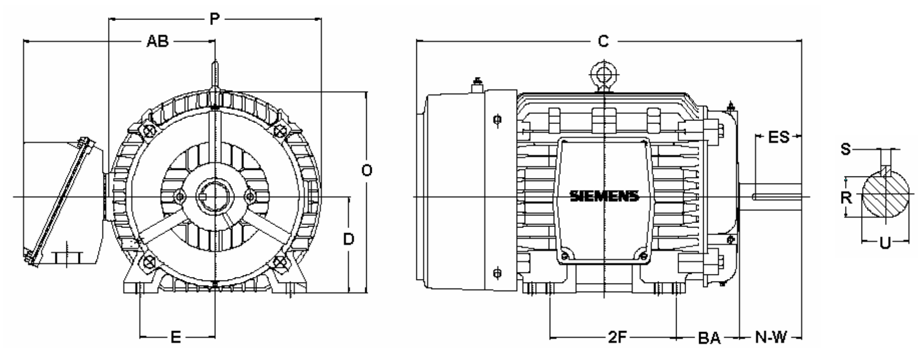


Frame	Poles	S	R	ES	C	D	E	2F	BA(1)	N-W(1)	O	P	AB	U
143T	2,4,6,8	0.188	0.771	1.41	13.97	3.50	2.75	4.0	2.73	1.77	7.42	8.11	7.05	0.875
145T	2,4,6,8	0.188	0.771	1.41	13.97	3.50	2.75	5.0	2.73	1.77	7.42	8.11	7.05	0.875
182T	2,8	0.250	0.986	1.78	14.8	4.50	3.75	4.5	3.03	2.46	9	9	8	1.125
182T	4,6	0.250	0.986	1.78	16.22	4.50	3.75	4.5	3.03	2.46	9.74	10.83	8.58	1.125
184T	2,8	0.250	0.986	1.78	15.9	4.50	3.75	5.5	3.03	2.46	9	9	8	1.125
184T	4,6	0.250	0.986	1.78	16.22	4.50	3.75	5.5	3.03	2.46	9.74	10.83	8.58	1.125
213T	2,8	0.312	1.201	2.41	18.15	5.25	4.25	5.5	4	2.88	10.43	10.63	9.4	1.375
213T	4,6	0.312	1.201	2.41	20.27	5.25	4.25	5.5	4.03	2.85	11.35	12.2	10.63	1.375
215T	2,8	0.312	1.201	2.41	19.7	5.25	4.25	7.0	4	2.88	10.43	10.63	9.4	1.375
215T	4,6	0.312	1.201	2.41	20.27	5.25	4.25	7.0	4.03	2.85	11.35	12.2	10.63	1.375
254T	2,8	0.375	1.416	2.91	23.15	6.25	5	8.25	4.7	3.55	12.33	12.65	10.65	1.625
254T	4,6	0.375	1.416	2.91	25.83	6.25	5	8.25	4.78	3.47	13.34	14.37	11.62	1.625
256T	2,8	0.375	1.416	2.91	24.85	6.25	5	10	4.7	3.55	12.33	12.65	10.65	1.625
256T	4,6	0.375	1.416	2.91	25.83	6.25	5	10	4.78	3.47	13.34	14.37	11.62	1.625
284T	8	0.500	1.591	3.25	27.4	7	5.5	9.5	5.2	4.17	14.27	14.38	13.39	1.875
284T	4,6	0.500	1.591	3.25	29.38	7	5.5	9.5	5.29	4.09	14.87	15.82	14.3	1.875
286T	8	0.500	1.591	3.25	28.9	7	5.5	11	5.2	4.17	14.27	14.38	13.39	1.875
286T	4,6	0.500	1.591	3.25	29.38	7	5.5	11	5.29	4.09	14.87	15.82	14.3	1.875
284TS	2,8	0.375	1.416	1.88	26	7	5.5	9.5	5.2	2.8	14.27	14.38	13.39	1.625
284TS	4,6	0.375	1.416	1.88	28.01	7	5.5	9.5	5.28	2.72	14.87	15.82	14.33	1.625
286TS	2,8	0.375	1.416	1.88	27.5	7	5.5	11	5.2	2.8	14.27	14.38	13.39	1.625
286TS	4,6	0.375	1.416	1.88	28.01	7	5.5	11	5.28	2.72	14.87	15.82	14.33	1.625
324T	8	0.5	1.845	3.88	31.5	8	6.25	10.5	5.75	4.75	15.9	15.82	15.5	2.125
324T	4,6	0.5	1.845	3.88	32.07	8	6.25	10.5	5.8	4.69	16.66	17.66	15.99	2.125
326T	8	0.5	1.845	3.88	31.5	8	6.25	12	5.75	4.75	15.9	15.82	15.5	2.125
326T	4,6	0.5	1.845	3.88	32.07	8	6.25	12	5.8	4.69	16.66	17.66	15.99	2.125
324TS	2	0.5	1.591	2	30	8	6.25	10.5	5.75	3.25	15.9	15.82	15.5	1.875
324TS	4,6	0.5	1.591	2	30.57	8	6.25	10.5	5.75	3.25	16.66	17.66	15.99	1.875
326TS	2	0.5	1.591	2	30	8	6.25	12	5.75	3.25	15.9	15.82	15.5	1.875
326TS	4,6	0.5	1.591	2	30.57	8	6.25	12	5.75	3.25	16.66	17.66	15.99	1.875

(1) Not according to NEMA standard
All of the above motors have 8 holes footprint except 182 to 286 frames (2 & 8 pole) and S449 frames

Dimensions in Inches
Dimensions are for reference only

Dimensional Drawings
Severe Duty – TEFC Motors – IEEE 841
RGZEESDX 360 – 400 Frames

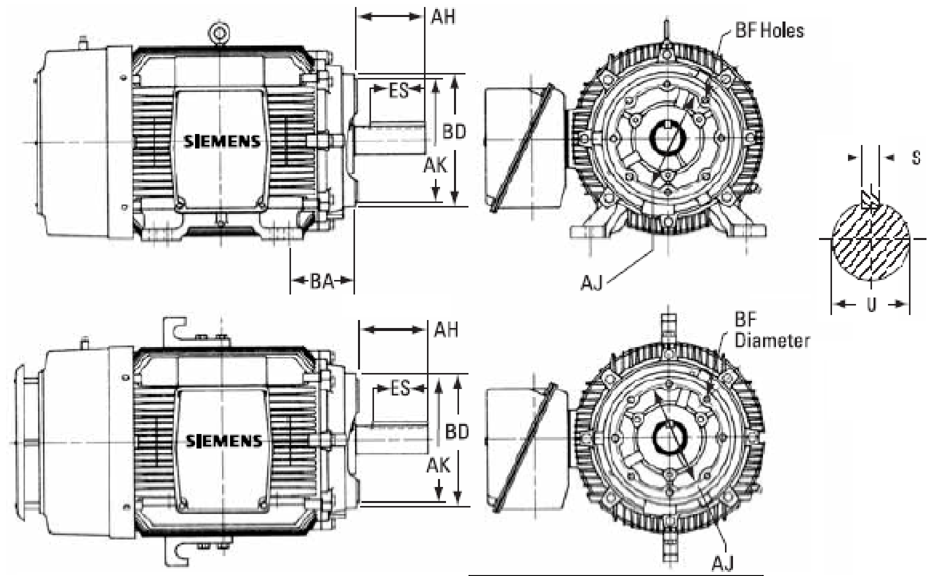


Frame	Poles	S	R	ES	C	D	E	2F	BA(1)	N-W(1)	O	P	AB	U
364T	8	0.625	2.021	4.25	34.19	9	7	11.25	6.31	5.44	17.81	17.66	17.94	2.375
364T	4,6	0.625	2.021	4.25	35.53	9	7	11.25	6.35	5.4	18.48	19.56	18.57	2.375
365T	8	0.625	2.021	4.25	34.19	9	7	12.25	6.31	5.44	17.81	17.66	17.94	2.375
365T	4,6	0.625	2.021	4.25	35.53	9	7	12.25	6.35	5.4	18.48	19.56	18.57	2.375
364TS	2	0.5	1.591	2	32.06	9	7	11.25	6.31	3.31	17.81	17.66	17.94	1.875
364TS	4,6	0.5	1.591	2	33.4	9	7	11.25	6.35	3.28	18.48	19.56	18.57	1.875
365TS	2	0.5	1.591	2	32.06	9	7	12.25	6.31	3.31	17.81	17.66	17.94	1.875
365TS	4,6	0.5	1.591	2	33.4	9	7	12.25	6.35	3.28	18.48	19.56	18.57	1.875
404T		0.75	2.45	5.63	39.4	10	8	12.25	7.1	6.78	19.6	19.56	18.38	2.875
405T		0.75	2.45	5.63	39.4	10	8	13.75	7.1	6.78	19.6	19.56	18.38	2.875
404TS		0.5	1.845	2.75	36.4	10	8	12.25	7.38	3.5	19.6	19.56	18.38	2.125
405TS		0.5	1.845	2.75	36.4	10	8	13.75	7.38	3.5	19.6	19.56	18.38	2.125
444T		0.875	2.88	6.88	45.58	11	9	14.5	7.9	8.1	21.8	21.75	19.63	3.375
445T		0.875	2.88	6.88	45.58	11	9	16.5	7.9	8.1	21.8	21.75	19.63	3.375
444TS		0.625	2.021	3.05	41.82	11	9	14.5	8.25	4	21.8	21.75	19.63	2.375
445TS		0.625	2.021	3.05	41.82	11	9	16.5	8.25	4	21.8	21.75	19.63	2.375
447T		0.875	2.88	6.88	49	11	9	20	7.96	8.03	22	21.75	19.63	3.375
447TS		0.625	2.021	3.05	45.26	11	9	20	8.25	4	22	21.75	19.63	2.375
449T		0.875	2.88	6.88	54	11	9	25	7.96	8.03	22	21.75	22	3.375
449TS		0.625	2.021	3.05	50.3	11	9	25	8.25	4	22	21.75	22	2.375
S449LS		0.875	3.134	7.5	63.6	11	9	25	7.95	8.67	23.3	24.6	23	3.625
S449LS	**	0.875	3.134	7.5	66.7	11	9	25	7.95	8.67	23.3	24.6	23	3.625
S449SS		0.625	2.275	3.5	59.8	11	9	25	8.16	4.59	23.3	24.6	23	2.625
S449SS	*	0.625	2.275	3.5	63.2	11	9	25	8.16	4.59	23.3	24.6	23	2.625

(1) Not according to NEMA standard
* Only for 400HP, 2 Pole
** Only for 300, 350 & 400HP, 4 Pole
All of the above motors have 8 holes footprint except 182 to 286 frames (2 & 8 pole) and S449 frames

Dimensions in Inches
Dimensions are for reference only

Dimensional Drawings
Severe Duty – TEFC Motors – IEEE 841
RGZEESD / RGZEESDX 140 – 320 Frames
C Face with and without feet

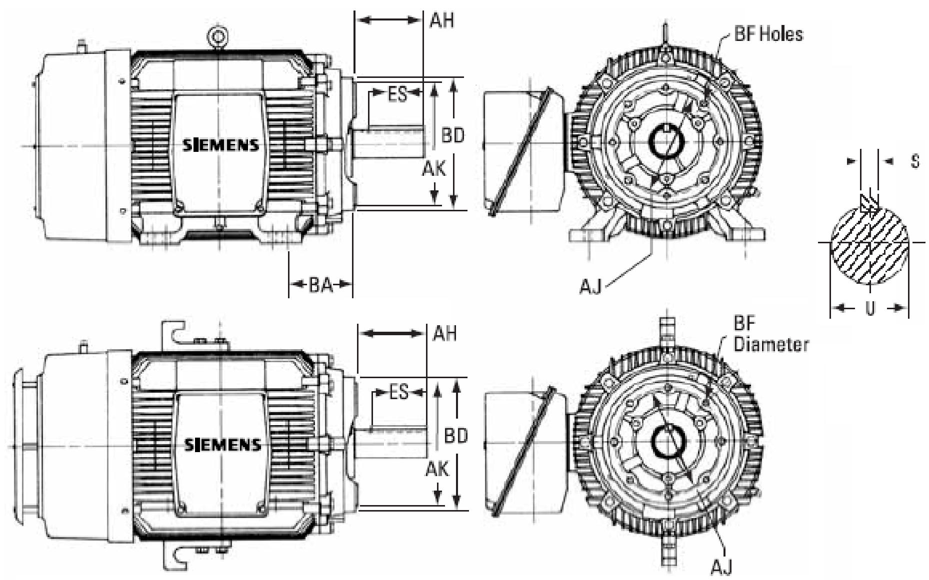


							RGZEESD	RGZEESDX				
Frame	**Poles**	**BD**	**AJ**	**AK**	**U**	**AH**	**BA**	**BA[1]**	**ES**	**S**	**BF#**	**BF DIA**
143TC	2,4,6	6.5	5.875	4.5	0.875	1.96	2.25 [1]	2.73	1.41	0.188	4	3/8"-16NC
145TC	2,4,6	6.5	5.875	4.5	0.875	1.96	2.25 [1]	2.73	1.41	0.188	4	3/8"-16NC
182TC	2	9	7.25	8.5	1.125	2.62	2.75 [1]	3.03	1.78	0.25	4	1/2"-13NC
182TC	4,6	9	7.25	8.5	1.125	2.62	2.75 [1]	3.03	1.78	0.25	4	1/2"-13NC
182TCH	2	6.5	5.875	4.5	1.125	2.62	2.75 [1]	3.03	1.78	0.25	4	1/2"-13NC
182TCH	4,6	6.5	5.875	4.5	1.125	2.62	2.75 [1]	3.03	1.78	0.25	4	1/2"-13NC
184TC	2	9	7.25	8.5	1.125	2.62	2.75 [1]	3.03	1.78	0.25	4	1/2"-13NC
184TC	4,6	9	7.25	8.5	1.125	2.62	2.75 [1]	3.03	1.78	0.25	4	1/2"-13NC
184TCH	2	6.5	5.875	4.5	1.125	2.62	2.75 [1]	3.03	1.78	0.25	4	1/2"-13NC
184TCH	4,6	6.5	5.875	4.5	1.125	2.62	2.75 [1]	3.03	1.78	0.25	4	1/2"-13NC
213TC	2	9	7.25	8.5	1.375	3.12	3.5 [1]	4	2.41	0.312	4	1/2"-13NC
213TC	4,6	9	7.25	8.5	1.375	3.12	3.5 [1]	4.03	2.41	0.312	4	1/2"-13NC
215TC	2	9	7.25	8.5	1.375	3.12	3.5 [1]	4	2.41	0.312	4	1/2"-13NC
215TC	4,6	9	7.25	8.5	1.375	3.12	3.5 [1]	4.03	2.41	0.312	4	1/2"-13NC
254TC	2	10	7.25	8.5	1.625	3.75	4.25 [1]	4.7	2.91	0.375	4	1/2"-13NC
254TC	4,6	10	7.25	8.5	1.625	3.75	4.25 [1]	4.78	2.91	0.375	4	1/2"-13NC
256TC	2	10	7.25	8.5	1.625	3.75	4.25 [1]	4.7	2.91	0.375	4	1/2"-13NC
256TC	4,6	10	7.25	8.5	1.625	3.75	4.25 [1]	4.78	2.91	0.375	4	1/2"-13NC
284TC	4,6	11.25	9	10.5	1.875	4.38	4.75	5.2	3.25	0.5	4	1/2"-13NC
286TC	4,6	11.25	9	10.5	1.875	4.38	4.75	5.29	3.25	0.5	4	1/2"-13NC
284TSC	2	11.25	9	10.5	1.625	3	4.75	5.2	1.88	0.375	4	1/2"-13NC
284TSC	4,6	11.25	9	10.5	1.625	3	4.75	5.28	1.88	0.375	4	1/2"-13NC
286TSC	2	11.25	9	10.5	1.625	3	4.75	5.2	1.88	0.375	4	1/2"-13NC
286TSC	4,6	11.25	9	10.5	1.625	3	4.75	5.28	1.88	0.375	4	1/2"-13NC
324TC	4,6	14	11	12.5	2.125	5	5.25	5.75	3.88	0.5	4	5/8"-11NC
326TC	4,6	14	11	12.5	2.125	5	5.25	5.8	3.88	0.5	4	5/8"-11NC

(1) Not according to NEMA standard
Drip Cover dimension (when used)--max. 3 inches

Dimensions in Inches
Dimensions are for reference only

Dimensional Drawings
Severe Duty – TEFC Motors – IEEE 841
RGZEESD / RGZEESDX 320 – 449 Frames
C Face with and without feet

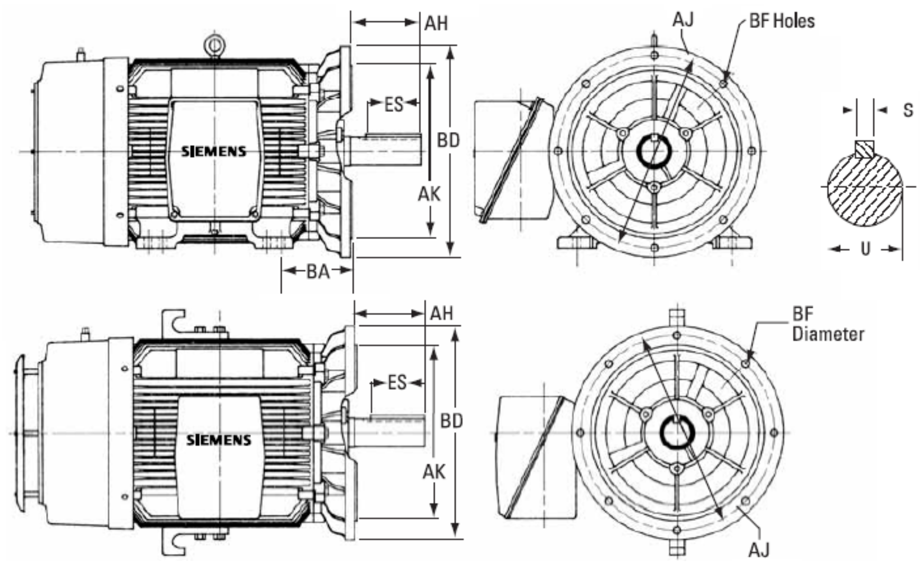


							RGZEESD	RGZEESDX				
Frame	Poles	BD	AJ	AK	U	AH	BA	BA(1)	ES	S	BF#	BF DIA
324TSC	2	14	11	12.5	1.875	3.5	5.25	5.75	2	0.5	4	5/8"-11NC
324TSC	4,6	14	11	12.5	1.875	3.5	5.25	5.75	2	0.5	4	5/8"-11NC
326TSC	2	14	11	12.5	1.875	3.5	5.25	5.75	2	0.5	4	5/8"-11NC
326TSC	4,6	14	11	12.5	1.875	3.5	5.25	5.75	2	0.5	4	5/8"-11NC
364TC	4,6	12.75	11	12.5	2.375	5.63	5.88	6.31	4.25	0.625	8	5/8"-11NC
365TC	4,6	12.75	11	12.5	2.375	5.63	5.88	6.35	4.25	0.625	8	5/8"-11NC
364TSC	2	14	11	12.5	1.875	3.5	5.88	6.31	2	0.5	8	5/8"-11NC
364TSC	4,6	12.75	11	12.5	1.875	3.5	5.88	6.35	2	0.5	8	5/8"-11NC
365TSC	2	14	11	12.5	1.875	3.5	5.88	6.31	2	0.5	8	5/8"-11NC
365TSC	4,6	12.75	11	12.5	1.875	3.5	5.88	6.35	2	0.5	8	5/8"-11NC
404TC		15.5	11	12.5	2.875	7	6.62	7.1	5.63	0.75	8	5/8"-11NC
405TC		15.5	11	12.5	2.875	7	6.62	7.1	5.63	0.75	8	5/8"-11NC
404TSC		15.5	11	12.5	2.125	4	6.62	7.38	2.75	0.5	8	5/8"-11NC
405TSC		15.5	11	12.5	2.125	4	6.62	7.38	2.75	0.5	8	5/8"-11NC
444TC		18	14	16	3.375	8.25	7.5	7.9	6.88	0.875	8	5/8"-11NC
445TC		18	14	16	3.375	8.25	7.5	7.9	6.88	0.875	8	5/8"-11NC
444TSC		18	14	16	2.375	4.5	7.5	8.25	3.05	0.625	8	5/8"-11NC
445TSC		18	14	16	2.375	4.5	7.5	8.25	3.05	0.625	8	5/8"-11NC
447TC		18	14	16	3.375	8.25	7.5	7.96	6.88	0.875	8	5/8"-11NC
447TSC		18	14	16	2.375	4.5	7.5	8.25	3.05	0.625	8	5/8"-11NC
449TC		18	14	16	3.375	8.25	7.5	7.96	6.88	0.875	8	5/8"-11NC
449TSC		18	14	16	2.375	4.5	7.5	8.25	3.05	0.625	8	5/8"-11NC

(1) Not according to NEMA standard
Drip Cover dimension (when used)--max. 3 inches
S449 frame motors are only available with feet.

Dimensions in Inches
Dimensions are for reference only

Dimensional Drawings
Severe Duty – TEFC Motors – IEEE 841
RGZEESD / RGZEESDX 140 – 320 Frames
D Flange with and without feet

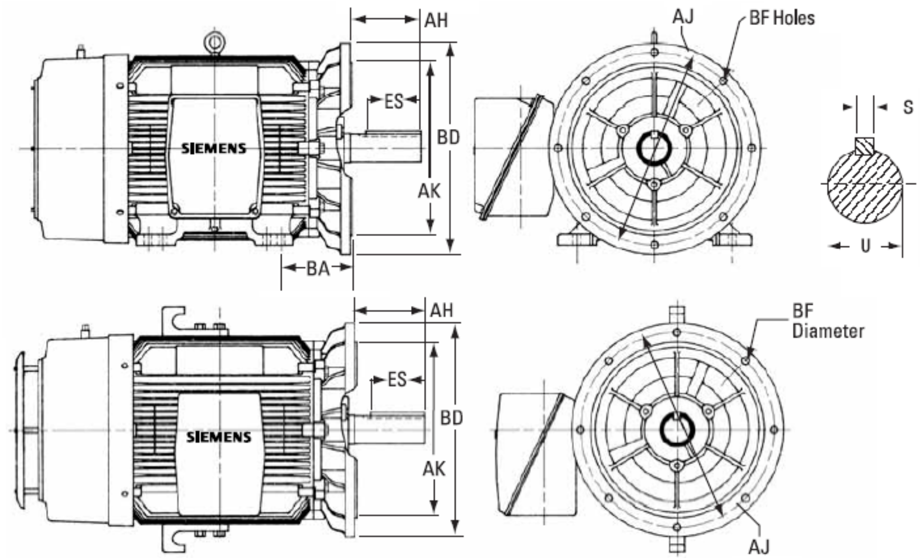


Frame	Poles	BD	AJ	AK	U	AH	RGZEESD BA	RGZEESDX BA(1)	ES	S	BF#	BF DIA
143TD	2,4,6	11	10	4.5	0.875	2	2.25 (1)	2.73	1.41	0.188	4	0.53
145TD	2,4,6	11	10	9	0.875	2	2.25 (1)	2.73	1.41	0.188	4	0.53
182TD	2	11	10	9	1.125	2.5	2.75 (1)	3.03	1.78	0.25	4	0.53
182TD	4,6	11	10	9	1.125	2.5	2.75 (1)	3.03	1.78	0.25	4	0.53
184TD	2	11	10	9	1.125	2.5	2.75 (1)	3.03	1.78	0.25	4	0.53
184TD	4,6	11	10	9	1.125	2.5	2.75 (1)	3.03	1.78	0.25	4	0.53
213TD	2	11	10	9	1.375	3.13	3.5 (1)	4	2.41	0.312	4	0.53
213TD	4,6	11	10	9	1.375	3.13	3.5 (1)	4.03	2.41	0.312	4	0.53
215TD	2	11	10	9	1.375	3.13	3.5 (1)	4	2.41	0.312	4	0.53
215TD	4,6	11	10	9	1.375	3.13	3.5 (1)	4.03	2.41	0.312	4	0.53
254TD	2	14	12.5	11	1.625	3.75	4.25 (1)	4.7	2.91	0.375	4	0.81
254TD	4,6	14	12.5	11	1.625	3.75	4.25 (1)	4.78	2.91	0.375	4	0.81
256TD	2	14	12.5	11	1.625	3.75	4.25 (1)	4.7	2.91	0.375	4	0.81
256TD	4,6	14	12.5	11	1.625	3.75	4.25 (1)	4.78	2.91	0.375	4	0.81
284TD	4,6	14	12.5	11	1.875	4.37	4.75	5.2	3.25	0.5	4	0.81
286TD	4,6	14	12.5	11	1.875	4.37	4.75	5.29	3.25	0.5	4	0.81
284TSD	2	14	12.5	11	1.625	3	4.75	5.2	1.88	0.375	4	0.81
284TSD	4,6	14	12.5	11	1.625	3	4.75	5.28	1.88	0.375	4	0.81
286TSD	2	14	12.5	11	1.625	3	4.75	5.2	1.88	0.375	4	0.81
286TSD	4,6	14	12.5	11	1.625	3	4.75	5.28	1.88	0.375	4	0.81
324TD	4,6	18	16	14	2.125	5	5.25	5.75	3.88	0.5	4	0.81
326TD	4,6	18	16	14	2.125	5	5.25	5.8	3.88	0.5	4	0.81

(1) Not according to NEMA standard
Drip Cover dimension (when used)--max. 3 inches

Dimensions in Inches
Dimensions are for reference only

Dimensional Drawings
Severe Duty – TEFC Motors – IEEE 841
RGZEESD / RGZEESDX 320 – 449 Frames
D Flange with and without feet

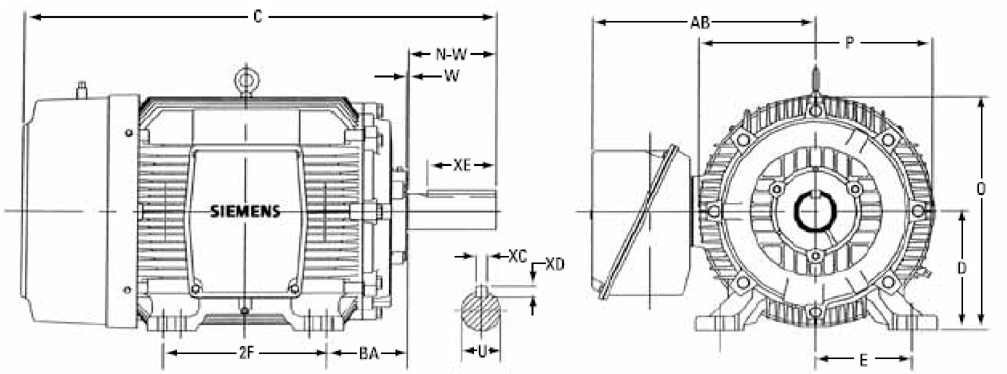


							RGZEESD	RGZEESDX				
Frame	Poles	BD	AJ	AK	U	AH	BA	BA(1)	ES	S	BF#	BF DIA
324TSD	2	18	16	14	1.875	3.5	5.25	5.75	2	0.5	4	0.81
324TSD	4,6	18	16	14	1.875	3.5	5.25	5.75	2	0.5	4	0.81
326TSD	2	18	16	14	1.875	3.5	5.25	5.75	2	0.5	4	0.81
326TSD	4,6	18	16	14	1.875	3.5	5.25	5.75	2	0.5	4	0.81
364TD	4,6	18	16	14	2.375	5.63	5.88	6.31	4.25	0.625	4	0.81
365TD	4,6	18	16	14	2.375	5.63	5.88	6.35	4.25	0.625	4	0.81
364TSD	2	18	16	14	1.875	3.5	5.88	6.31	2	0.5	4	0.81
364TSD	4,6	18	16	14	1.875	3.5	5.88	6.35	2	0.5	4	0.81
365TSD	2	18	16	14	1.875	3.5	5.88	6.31	2	0.5	4	0.81
365TSD	4,6	18	16	14	1.875	3.5	5.88	6.35	2	0.5	4	0.81
404TD		22	20	18	2.875	7	6.62	7.1	5.63	0.75	4	0.81
405TD		22	20	18	2.875	7	6.62	7.1	5.63	0.75	4	0.81
404TSD		22	20	18	2.125	4	6.62	7.38	2.75	0.5	4	0.81
405TSD		22	20	18	2.125	4	6.62	7.38	2.75	0.5	4	0.81
444TD		22	20	18	3.375	8.25	7.5	7.9	6.88	0.875	8	0.81
445TD		22	20	18	3.375	8.25	7.5	7.9	6.88	0.875	8	0.81
444TSD		22	20	18	2.375	4.5	7.5	8.25	3.05	0.625	8	0.81
445TSD		22	20	18	2.375	4.5	7.5	8.25	3.05	0.625	8	0.81
447TD		22	20	18	3.375	8.25	7.5	7.96	6.88	0.875	8	0.81
447TSD		22	20	18	2.375	4.5	7.5	8.25	3.05	0.625	8	0.81
449TD		22	20	18	3.375	8.25	7.5	7.96	6.88	0.875	8	0.81
449TSD		22	20	18	2.375	4.5	7.5	8.25	3.05	0.625	8	0.81
S449LSD		22	20	18	3.625	8.25	7.5	7.95	7.5	0.875	8	0.81
S449SSD		22	20	18	2.625	4.5	7.5	8.16	3.5	0.625	8	0.81

(1) Not according to NEMA standard
Drip Cover dimension (when used)--max. 3 inches
S449 frame motors are only available with feet.

Dimensions in Inches
Dimensions are for reference only

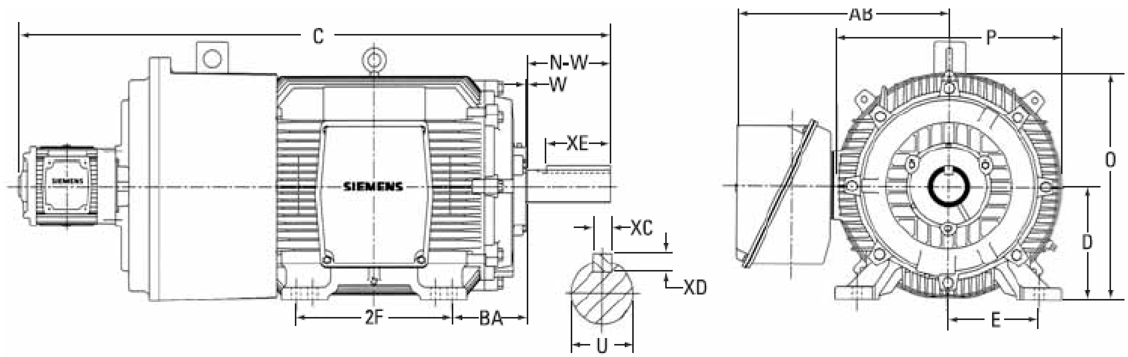
Dimensional Drawings
Severe & Hazardous Duty – TEFC Motors
RGZESDI / RGZZESDI
Fan Cooled



Frame	XC	XD	XE	C	D	E	2F	BA	N-W	O	P	W	AB	U
143T	0.188	0.188	1.3	12.2	3.50	2.75	4.00	2.25	2.25	7.2	7.7	0.13	6.7	0.875
145T	0.188	0.188	1.3	13.7	3.50	2.75	5.00	2.25	2.25	7.2	7.7	0.13	6.7	-0.0005
182T	0.250	0.250	1.8	14.8	4.50	3.75	4.50	2.75	2.75	9.0	9.4	0.13	8.0	1.125
184T	0.250	0.250	1.8	15.8	4.50	3.75	5.50	2.75	2.75	9.0	9.4	0.13	8.0	-0.0005
213T	0.313	0.313	2.3	18.2	5.25	4.25	5.50	3.50	3.38	10.5	10.8	0.13	9.4	1.375
215T	0.313	0.313	2.3	19.6	5.25	4.25	7.00	3.50	3.38	10.5	10.8	0.13	9.4	-0.0005
254T	0.375	0.375	2.8	23.0	6.25	5.00	8.25	4.25	4.00	12.6	13.4	0.13	10.7	1.625
256T	0.375	0.375	2.8	24.8	6.25	5.00	10.00	4.25	4.00	12.6	13.4	0.13	10.7	-0.001
284T	0.500	0.500	3.2	27.4	7.00	5.50	9.50	4.75	4.63	14.3	15.5	0.13	13.4	1.875
286T	0.500	0.500	3.2	28.9	7.00	5.50	11.00	4.75	4.63	14.3	15.5	0.13	13.4	-0.001
284TS	0.375	0.375	1.8	27.5	7.00	5.50	9.50	4.75	3.25	14.3	15.5	0.13	13.4	1.625
286TS	0.375	0.375	1.8	27.5	7.00	5.50	11.00	4.75	3.25	14.3	15.5	0.13	13.4	-0.001
324T	0.500	0.500	3.8	31.5	8.00	6.25	10.50	5.25	5.25	16.0	17.1	0.13	15.5	2.125
326T	0.500	0.500	3.8	31.5	8.00	6.25	12.00	5.25	5.25	16.0	17.1	0.13	15.5	-0.001
324TS	0.500	0.500	2.0	30.0	8.00	6.25	10.50	5.25	3.75	16.0	17.1	0.13	15.5	1.875
326TS	0.500	0.500	2.0	30.0	8.00	6.25	12.00	5.25	3.75	16.0	17.1	0.13	15.5	-0.001
364T	0.625	0.625	4.2	34.2	9.00	7.00	11.25	5.88	5.88	17.8	18.4	0.38	18.0	2.375
365T	0.625	0.625	4.2	34.2	9.00	7.00	12.25	5.88	5.88	17.8	18.4	0.38	18.0	-0.001
364TS	0.500	0.500	2.0	32.1	9.00	7.00	11.25	5.88	3.75	17.8	18.4	0.38	18.0	1.875
365TS	0.500	0.500	2.0	32.1	9.00	7.00	12.25	5.88	3.75	17.8	18.4	0.38	18.0	-0.001
404T	0.750	0.750	5.6	39.5	10.0	8.00	12.25	6.625	7.25	19.9	19.6	0.13	18.7	2.875
405T	0.750	0.750	5.6	39.5	10.0	8.00	13.75	6.625	7.25	19.9	19.6	0.13	18.7	-0.001
404TS	0.500	0.500	2.7	36.5	10.0	8.00	12.25	6.625	4.25	19.9	19.6	0.13	18.7	2.125
405TS	0.500	0.500	2.7	36.5	10.0	8.00	13.75	6.625	4.25	19.9	19.6	0.13	18.7	-0.001
444T	0.875	0.875	6.8	45.6	11.0	9.00	14.50	7.5	8.50	21.9	21.7	0.13	20.0	3.375
445T	0.875	0.875	6.8	45.6	11.0	9.00	16.50	7.5	8.50	21.9	21.7	0.13	20.0	-0.001
444TS	0.625	0.625	3.0	41.8	11.0	9.00	14.50	7.5	4.75	21.9	21.7	0.13	20.0	2.375
445TS	0.625	0.625	3.0	41.8	11.0	9.00	16.50	7.5	4.75	21.9	21.7	0.13	20.0	-0.001
447T	0.875	0.875	6.8	49.1	11.0	9.00	20.00	7.50	8.50	21.9	21.8	0.13	20.0	3.375
447TS	0.625	0.625	3.0	45.4	11.0	9.00	20.00	7.50	4.75	21.9	21.8	0.13	20.0	2.375
449T	0.875	0.875	6.8	54.1	11.0	9.00	25.00	7.50	8.50	21.9	21.8	0.13	20.0	3.375
449TS	0.625	0.625	3.0	50.3	11.0	9.00	25.00	7.50	4.75	21.9	21.8	0.13	20.0	2.375
S449LS	0.875	0.875	7.5	63.7	11.0	9.00	25.00	7.50	9.12	23.4	25.4	0.13	23.0	3.625
S449SS	0.625	0.625	3.5	59.8	11.0	9.00	25.00	7.50	5.25	23.4	25.4	0.13	23.0	2.625

Dimensions in Inches
Dimensions are for reference only

Dimensional Drawings
Severe Duty – TEBC Motors
RGZESDI
Blower Cooled – With or without Encoder



Frame	XC	XD	XE	C	D	E	2F	BA	N-W	O	P	W	AB	U
254T	0.375	0.375	2.81	38.0	6.25	5.00	8.25	4.25	4.00	12.6	13.4	0.13	10.7	1.625
256T	0.375	0.375	2.81	39.8	6.25	5.00	10.00	4.25	4.00	12.6	13.4	0.13	10.7	-0.001
284T	0.500	0.500	3.25	41.7	7.00	5.50	9.50	4.75	4.63	14.3	15.5	0.13	13.4	1.875
286T	0.500	0.500	3.25	43.2	7.00	5.50	11.00	4.75	4.63	14.3	15.5	0.13	13.4	-0.001
284TS	0.375	0.375	1.88	40.3	7.00	5.50	9.50	4.75	3.25	14.3	15.5	0.13	13.4	1.625
286TS	0.375	0.375	1.88	41.8	7.00	5.50	11.00	4.75	3.25	14.3	15.5	0.13	13.4	-0.001
324T	0.500	0.500	3.88	45.9	8.00	6.25	10.50	5.25	5.25	16.0	17.1	0.13	15.5	2.125
326T	0.500	0.500	3.88	45.9	8.00	6.25	12.00	5.25	5.25	16.0	17.1	0.13	15.5	-0.001
324TS	0.500	0.500	2.00	44.4	8.00	6.25	10.50	5.25	3.75	16.0	17.1	0.13	15.5	1.875
326TS	0.500	0.500	2.00	44.4	8.00	6.25	12.00	5.25	3.75	16.0	17.1	0.13	15.5	-0.001
364T	0.625	0.625	4.25	48.6	9.00	7.00	11.25	5.88	5.88	17.8	18.4	0.38	18.0	2.375
365T	0.625	0.625	4.25	48.6	9.00	7.00	12.25	5.88	5.88	17.8	18.4	0.38	18.0	-0.001
364TS	0.500	0.500	2.00	46.5	9.00	7.00	11.25	5.88	3.75	17.8	18.4	0.38	18.0	1.875
365TS	0.500	0.500	2.00	46.5	9.00	7.00	12.25	5.88	3.75	17.8	18.4	0.38	18.0	-0.001
404T	0.750	0.750	5.63	53.0	10.00	8.00	12.25	6.625	7.25	19.9	19.6	0.13	18.7	2.875
405T	0.750	0.750	5.63	53.0	10.00	8.00	13.75	6.625	7.25	19.9	19.6	0.13	18.7	-0.001
404TS	0.500	0.500	2.75	50.0	10.00	8.00	12.25	6.625	4.25	19.9	19.6	0.13	18.7	2.125
405TS	0.500	0.500	2.75	50.0	10.00	8.00	13.75	6.625	4.25	19.9	19.6	0.13	18.7	-0.001
444T	0.875	0.875	6.88	78.5	11.00	9.00	14.50	7.5	8.50	21.9	21.7	0.13	20.0	3.375
445T	0.875	0.875	6.88	78.5	11.00	9.00	16.50	7.5	8.50	21.9	21.7	0.13	20.0	-0.001
444TS	0.625	0.625	3.00	74.8	11.00	9.00	14.50	7.5	4.75	21.9	21.7	0.13	20.0	2.375
445TS	0.625	0.625	3.00	74.8	11.00	9.00	16.50	7.5	4.75	21.9	21.7	0.13	20.0	-0.001
447T	0.875	0.875	6.88	82.0	11.00	9.00	20.00	7.50	8.50	21.9	21.8	0.13	20.0	3.375
447TS	0.625	0.625	3.00	78.3	11.00	9.00	20.00	7.50	4.75	21.9	21.8	0.13	20.0	2.375
449T	0.875	0.875	6.88	87.1	11.00	9.00	25.00	7.50	8.50	21.9	21.8	0.13	20.0	3.375
449TS	0.625	0.625	3.00	83.2	11.00	9.00	25.00	7.50	4.75	21.9	21.8	0.13	20.0	2.375
S449LS	0.875	0.875	7.50	100.0	11.00	9.00	25.00	7.50	9.12	23.4	25.4	0.13	23.0	3.625
S449SS	0.625	0.625	3.50	96.1	11.00	9.00	25.00	7.50	5.25	23.4	25.4	0.13	23.0	2.625

Dimensions in Inches
Dimensions are for reference only

SIEMENS

Application Manual for NEMA Motors

Section 5

Electrical Information

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NEMA Motor Frame Assignments – Type DP10 Open Drip-Proof
High Efficient
*208 - 230 / 460 Volt, 3 Phase, 60Hz thru 100 HP (400 frame)
460 Volt, 100 HP (440 frame) and above
Class B Temperature Rise 80°C 1.0 S.F.

	RPM			
	3600	**1800**	**1200**	**900**
HP				
0.5				-
0.75			143T	-
1		143T	145T	-
1.5	143T	145T	182T	-
2	145T	145T	184T	-
3	145T	182T	213T	-
5	182T	184T	215T	-
7.5	184T	213T	254T	-
10	213T	215T	256T	-
15	215T	254T	284T	-
20	254T	256T	286T	-
25	256T	284T	324T	-
30	284TS	286T	326T	-
40	286TS	324T	364T	-
50	324TS	326T	365T	-
60	326TS	364T	404T	-
75	364TS	365T	405T	-
100	365TS	404T	444T	445T
125	404TS	405T	445T	447T
150	405TS	444T	445T (1)	447T (1)
200	444TS	445T	447T (1)	449T (1)
250	445TS	445T (1)	449T (1)	
300	447TS	447T (1)	449T (1)	
350	447TS	447T (1)		
400	449TS (1)	449T (1)		
450	449TS (1)			
500	449TS (1)			

*575 Volt available 440 frames only

NEMA Motor Frame Assignments – Type RGE1 / RGE Open Drip-Proof High Efficient

*230 / 460 Volt, 3 Phase, 60Hz

Class B Temperature Rise 80°C 1.0 S.F., 90°C 1.15 S.F.

	RPM			
	3600	**1800**	**1200**	**900**
HP				
0.5				-
0.75			143T	-
1		143T	145T	-
1.5	143T	145T	182T	-
2	145T	145T	184T	-
3	145T	182T	213T	-
5	182T	184T	215T	-
7.5	184T	213T	254T	-
10	213T	215T	256T	-
15	215T	254T	284T	-
20	254T	256T	286T	-
25	256T	284T	324T	-
30	284TS	286T	326T	-
40	286TS	324T	364T	-
50	324TS	326T	365T	-
60	326TS	364T	404T	405T
75	364TS	365T	405T	444T
100	365TS	404T	444T	445T
125	404TS	405T	445T	447T
150	405TS	444T	445T (1)	447T (1)
200	444TS	445T	447T (1)	449T (1)
250	445TS	445T (1)	449T (1)	
300	447TS	447T (1)	449T (1)	
350	447TS	447T (1)		
400	449TS (1)	449T (1)		
450	449TS (1)			

(1) Class F Insulation 1.15 Service Factor (115° at 1.15 S.F.)

*575 Volt available 404T – 449T

NEMA Motor Frame Assignments – Type GP10A / GP10 / SD10 Totally Enclosed Fan Cooled
High Efficient
208 - 230 / 460 Volt, 3 Phase, 60Hz
Class B Temperature Rise 80°C 1.0 S.F.

	RPM			
	3600	**1800**	**1200**	**900**
HP				
1	143T	143T	145T	182T
1.5	143T	145T	182T	184T
2	145T	145T	184T	213T
3	182T	182T	213T	215T
5	184T	184T	215T	254T
7.5	213T	213T	254T	256T
10	215T	215T	256T	
15	254T	254T		
20	256T	256T		

NEMA Motor Frame Assignments – Type RGZP(SD) Totally Enclosed Fan Cooled High Efficient
230 / 460 Volt, 3 Phase, 60Hz thru 75 HP
460 or 575 Volt, 3 Phase 60Hz 100 HP and above
Class B Temperature Rise 80°C 1.0 S.F.

	RPM			
	3600	1800	1200	900
HP				
0.5				143T
0.75			143T	145T
1		143T	145T	182T
1.5	143T	145T	182T	184T
2	145T	145T	184T	213T
3	182T	182T	213T	215T
5	184T	184T	215T	254T
7.5	213T	213T	254T	256T
10	215T	215T	256T	284T
15	254T	254T	284T	286T
20	256T	256T	286T	324T
25	284TS	284T	324T	326T
30	286TS	286T	326T	364T
40	324TS	324T	364T	365T
50	326TS	326T	365T	404T
60	364TS	364T	404T	405T
75	365TS	365T	405T	444T
100	405TS	405T	444T	445T
125	444TS	444T	445T	447T
150	445TS	445T	447T	447T
200	447TS	447T	449T	449T
250				
300				
350				
400				
450				

NEMA Motor Frame Assignments – Type GP100A / GP100 / SD100 Totally Enclosed Fan Cooled
NEMA Premium® Efficient
208 - 230 / 460 Volt, 3 Phase, 60Hz
Class B Temperature Rise 80°C 1.0 S.F.

	RPM		
	3600	**1800**	**1200**
HP			
1	143T	143T	145T
1.5	143T	145T	182T
2	145T	145T	184T
3	182T	182T	213T
5	184T	184T	215T
7.5	213T	213T	254T
10	215T	215T	256T
15	254T	254T	
20	256T	256T	

NEMA Motor Frame Assignments – Type SD100 IEEE 841 Totally Enclosed Fan Cooled NEMA Premium® Efficient
460 Volt, 3 Phase, 60Hz
Class B Temperature Rise 80°C 1.0 S.F.

	RPM			
	3600	**1800**	**1200**	**900**
HP				
1	143T	143T	145T	182T
1.5	143T	145T	182T	184T
2	145T	145T	184T	213T
3	182T	182T	213T	215T
5	184T	184T	215T	254T
7.5	213T	213T	254T	256T
10	215T	215T	256T	
15	254T	254T		
20	256T	256T		

NEMA Motor Frame Assignments – Type RGZESD Totally Enclosed Fan Cooled High Efficient

230 / 460 Volt or 460 Volt , 3 Phase, 60Hz thru 20 HP
460 or 575 Volt, 3 Phase 60Hz 25 HP and Above
Class B Temperature Rise 80^{o}C 1.0 S.F

	RPM			
	3600	**1800**	**1200**	**900**
HP				
0.5				143T
0.75			143T	145T
1		143T	145T	182T
1.5	143T	145T	182T	184T
2	145T	145T	184T	213T
3	182T	182T	213T	215T
5	184T	184T	215T	254T
7.5	213T	213T	254T	256T
10	215T	215T	256T	284T
15	254T	254T	284T	286T
20	256T	256T	286T	324T
25	284TS	284T	324T	326T
30	286TS	286T	326T	364T
40	324TS	324T	364T	365T
50	326TS	326T	365T	404T
60	364TS	364T	404T	405T
75	365TS	365T	405T	444T
100	405TS	405T	444T	445T
125	444TS	444T	445T	447T
150	445TS	445T	447T	447T
200	447TS	447T	449T	449T
250	449TS	449T	449T	S449LS
300	449TS	449T	S449LS	
350	S449SS	S449LS	S449LS	
400	S449SS	S449LS		

NEMA Motor Frame Assignments – Type RGZEESD Totally Enclosed Fan Cooled NEMA Premium® Efficient

230 / 460 Volt or 460 Volt , 3 Phase, 60Hz thru 20 HP
460 or 575 Volt, 3 Phase 60Hz 25 HP and Above
Class B Temperature Rise 80^{o}C 1.0 S.F

	RPM		
	3600	**1800**	**1200**
HP			
0.5			
0.75			
1	143T	143T	145T
1.5	143T	145T	182T
2	145T	145T	184T
3	182T	182T	213T
5	184T	184T	215T
7.5	213T	213T	254T
10	215T	215T	256T
15	254T	254T	284T
20	256T	256T	286T
25	284TS	284T	324T
30	286TS	286T	326T
40	324TS	324T	364T
50	326TS	326T	365T
60	364TS	364T	404T
75	365TS	365T	405T
100	405TS	405T	444T
125	444TS	444T	445T
150	445TS	445T	447T
200	447TS	447T	449T
250	449TS	449T	449T
300	449TS	449T	S449LS
350	S449SS	S449LS	
400	S449SS	S449LS	

NEMA Motor Frame Assignments – Type RGZEESDX Totally Enclosed Fan Cooled NEMA Premium® Efficient

460 Volt , 3 Phase, 60Hz (575 Volt Available)

Class B Temperature Rise 80^{o}C 1.0 S.F

	RPM			
	3600	**1800**	**1200**	**900**
HP				
0.5				
0.75				
1	143T	143T	145T	182T
1.5	143T	145T	182T	184T
2	145T	145T	184T	213T
3	182T	182T	213T	215T
5	184T	184T	215T	254T
7.5	213T	213T	254T	256T
10	215T	215T	256T	284T
15	254T	254T	284T	286T
20	256T	256T	286T	324T
25	284TS	284T	324T	326T
30	286TS	286T	326T	364T
40	324TS	324T	364T	365T
50	326TS	326T	365T	404T
60	364TS	364T	404T	405T
75	365TS	365T	405T	444T
100	405TS	405T	444T	445T
125	444TS	444T	445T	447T
150	445TS	445T	447T	449T
200	447TS	447T	449T	S449LS
250	449TS	449T	449T	S449LS
300	449TS	S449LS	S449LS	
350	S449SS	S449LS		
400	S449SS	S449LS		

NEMA Motor Frame Assignments – Type RGZZESD Totally Enclosed Fan Cooled
230 / 460 Volt or 460 Volt , 3 Phase, 60Hz thru 20 HP
460 or 575 Volt, 3 Phase 60Hz 25 HP and Above
Class B Temperature Rise 80^{o}C 1.0 S.F

	RPM			
	3600	**1800**	**1200**	**900**
HP				
0.5				143T
0.75			143T	145T
1		143T	145T	182T
1.5	143T	145T	182T	184T
2	145T	145T	184T	213T
3	182T	182T	213T	215T
5	184T	184T	215T	254T
7.5	213T	213T	254T	256T
10	215T	215T	256T	284T
15	254T	254T	284T	286T
20	256T	256T	286T	324T
25	284TS	284T	324T	326T
30	286TS	286T	326T	364T
40	324TS	324T	364T	365T
50	326TS	326T	365T	404T
60	364TS	364T	404T	405T
75	365TS	365T	405T	444T
100	405TS	405T	444T	445T
125	444TS	444T	445T	447T
150	445TS	445T	447T	447T
200	447TS	447T	449T	449T
250	449TS	449T	449T	
300	449TS	449T		

NEMA Motor Frame Assignments – Type RGZESDI Totally Enclosed Fan Cooled
460 Volt, 3 Phase, Variable or 4:1 Constant Torque

	RPM			
	3600	**1800**	**1200**	**900**
HP				
0.5				
0.75				
1		143T*	145T*	182T*
1.5	143T*	145T*	182T*	184T*
2	145T*	145T*	184T*	213T*
3	182T*	182T*	213T*	215T*
5	184T*	184T*	215T*	254T**
7.5	213T*	213T*	254T**	256T**
10	215T*	215T*	256T**	284T**
15	254T**	254T**	284T**	286T**
20	256T**	256T**	286T**	324T
25	284TS**	284T**	324T	326T
30	286TS**	286T**	326T	364T
40	324TS**	324T	364T	365T
50	326TS	326T	365T	404T
60	364TS	364T	404T	405T
75	365TS	365T	405T	444T
100	405TS	405T	444T	445T
125	444TS	444T	445T	447T
150	445TS	445T	447T	447T
200	447TS	447T	449T	449T
250	449TS	449T	449T	S449LS
300	449TS	449T	S449LS	
350	S449SS	S449LS	S449LS	
400	S449SS	S449LS		

*10:1 constant torque speed range

**6:1 constant torque speed range

NEMA Motor Frame Assignments – Type RGZESDI Totally Enclosed Fan Cooled
460 Volt, 3 Phase, 10:1 Constant Torque

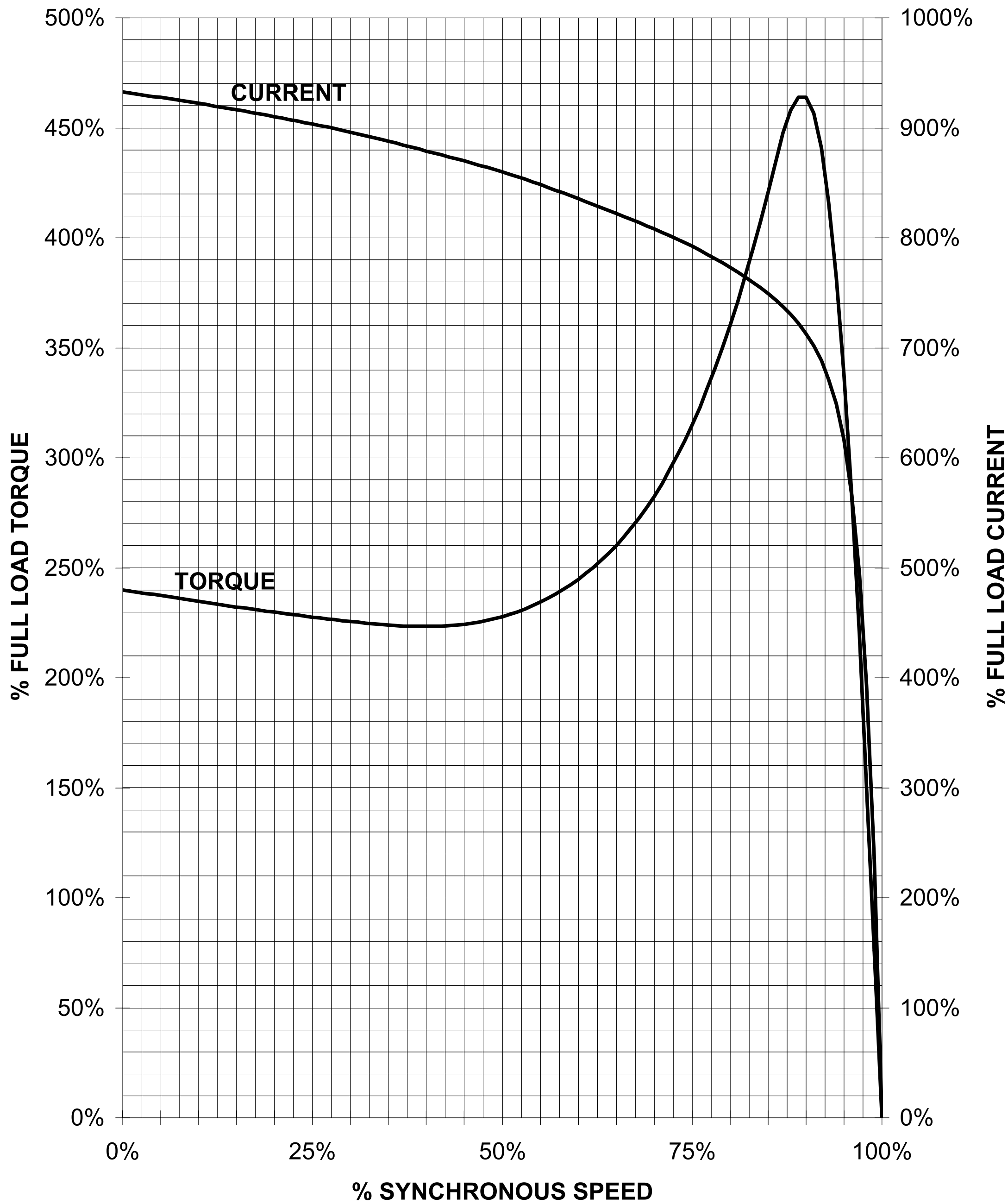
	RPM			
	3600	**1800**	**1200**	**900**
HP				
0.5				
0.75				
1		143T	145T	182T
1.5	143T	145T	182T	184T
2	145T	145T	184T	213T
3	182T	182T	213T	215T
5	184T	184T	215T	254T
7.5	213T	213T	256T	284T
10	215T	215T	284T	2864T
15	256T	256T	286T	324T
20	284TS	284T	324T	326T
25	286TS	286T	326T	364T
30	324TS	324T	364T	365T
40	326TS	326T	365T	404T
50	364TS	326T	404T	405T
60	365TS	365T	405T	444T
75	405TS	405T	444T	445T
100	444TS	444T	445T	447T
125	445TS	445T	447T	447T
150	447TS	447T	449T	449T
200	449TS	449T	449T	
250	449TS	449TS	S449SS	
300	S449SS	S449SS		
350	S449SS	S449LS		

NEMA Motor Frame Assignments – Type RGZZESDI Totally Enclosed Fan Cooled
460 Volt , 3 Phase, 6:1 Variable or Constant Torque

	RPM			
	3600	**1800**	**1200**	**900**
HP				
1	143T	145T	182T	184T
1.5	145T	145T	184T	213T
2	182T	145T	213T	215T
3	184T	184T	215T	254T
5	213T	213T	254T	256T
7.5	215T	215T	256T	284T
10	254T	254T	284T	286T
15	256T	256T	286T	324T
20	284TS	284T	324T	326T
25	286TS	286T	326T	364T
30	324TS	324T	364T	365T
40	326TS	326T	365T	404T
50	364TS	364T	404T	405T
60	365TS	365T	405T	444T
75	405TS	405T	444T	445T
100	444TS	444T	445T	447T
125	445TS	445T	447T	449T
150	447TS	447T	449T	449T
200	449TS	449T	449T	

HP	1	VOLTS	460	RPM	3600	TYPE	GP10
HZ	60	PHASE	3	FRAME	143T	NEMA	B

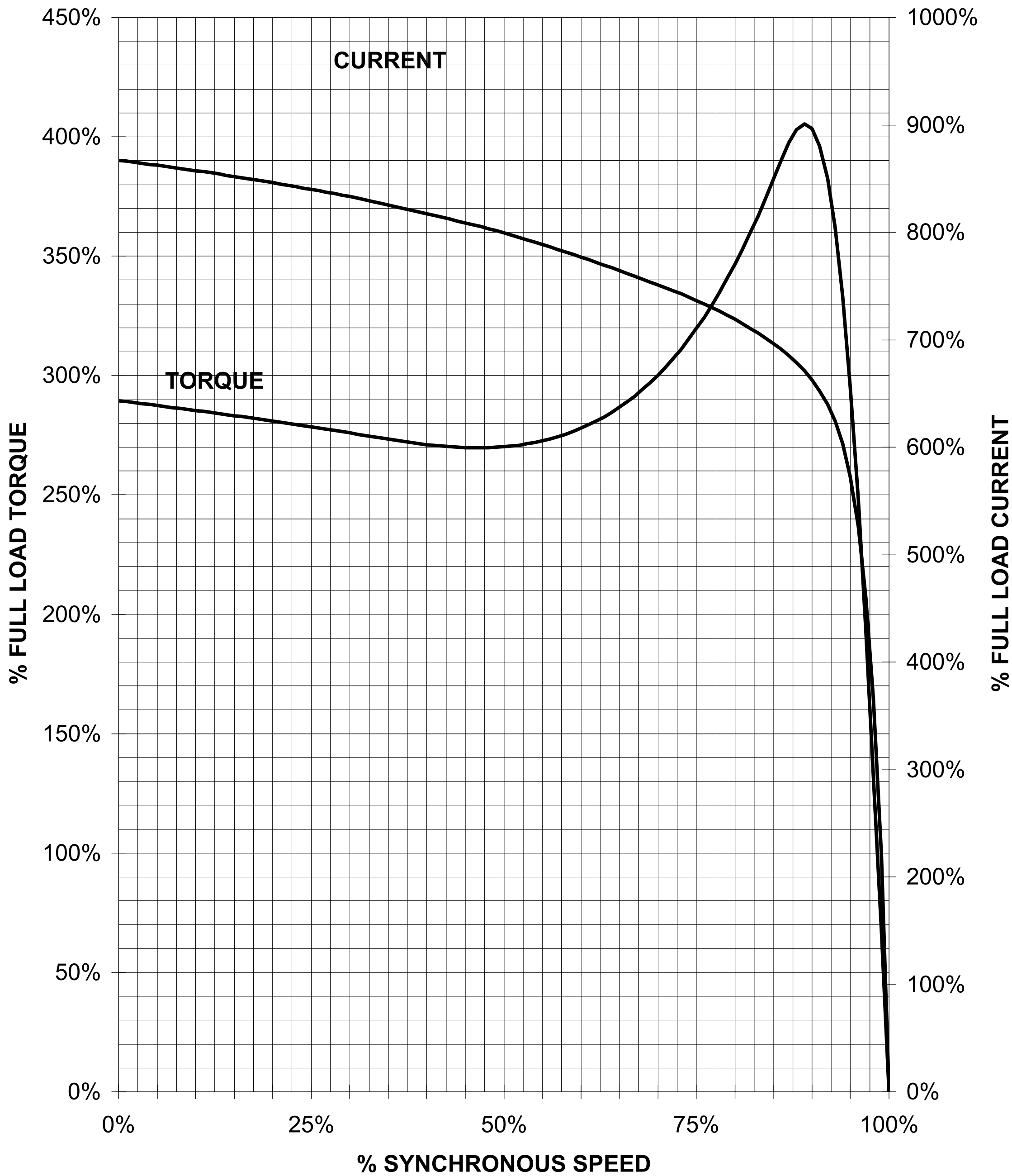
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1	VOLTS	460	RPM	1800	TYPE	GP10
HZ	60	PHASE	3	FRAME	143T	NEMA	B

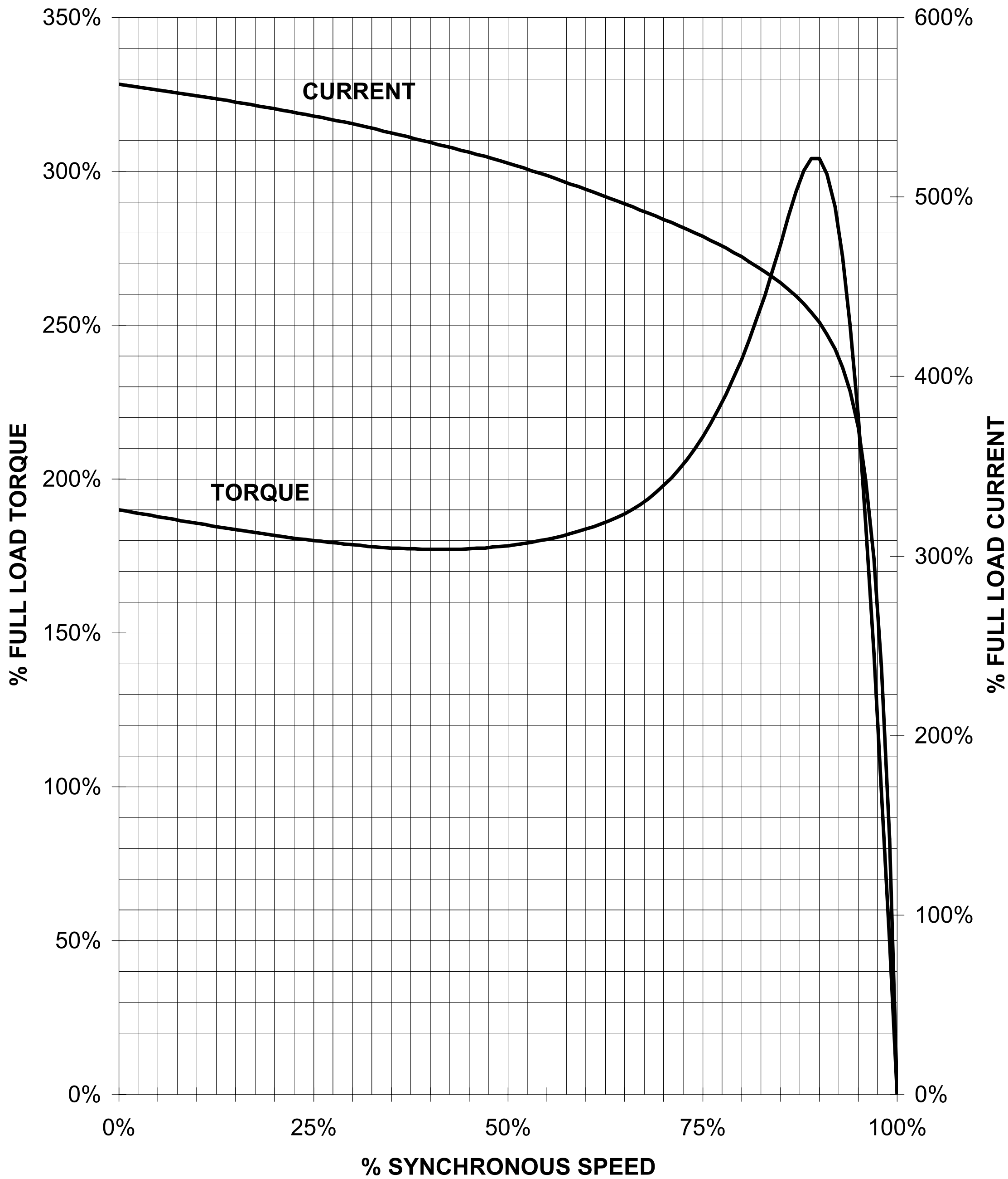
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1	VOLTS	460	RPM	1200	TYPE	GP10
HZ	60	PHASE	3	FRAME	145T	NEMA	B

TORQUE & CURRENT VS. SPEED

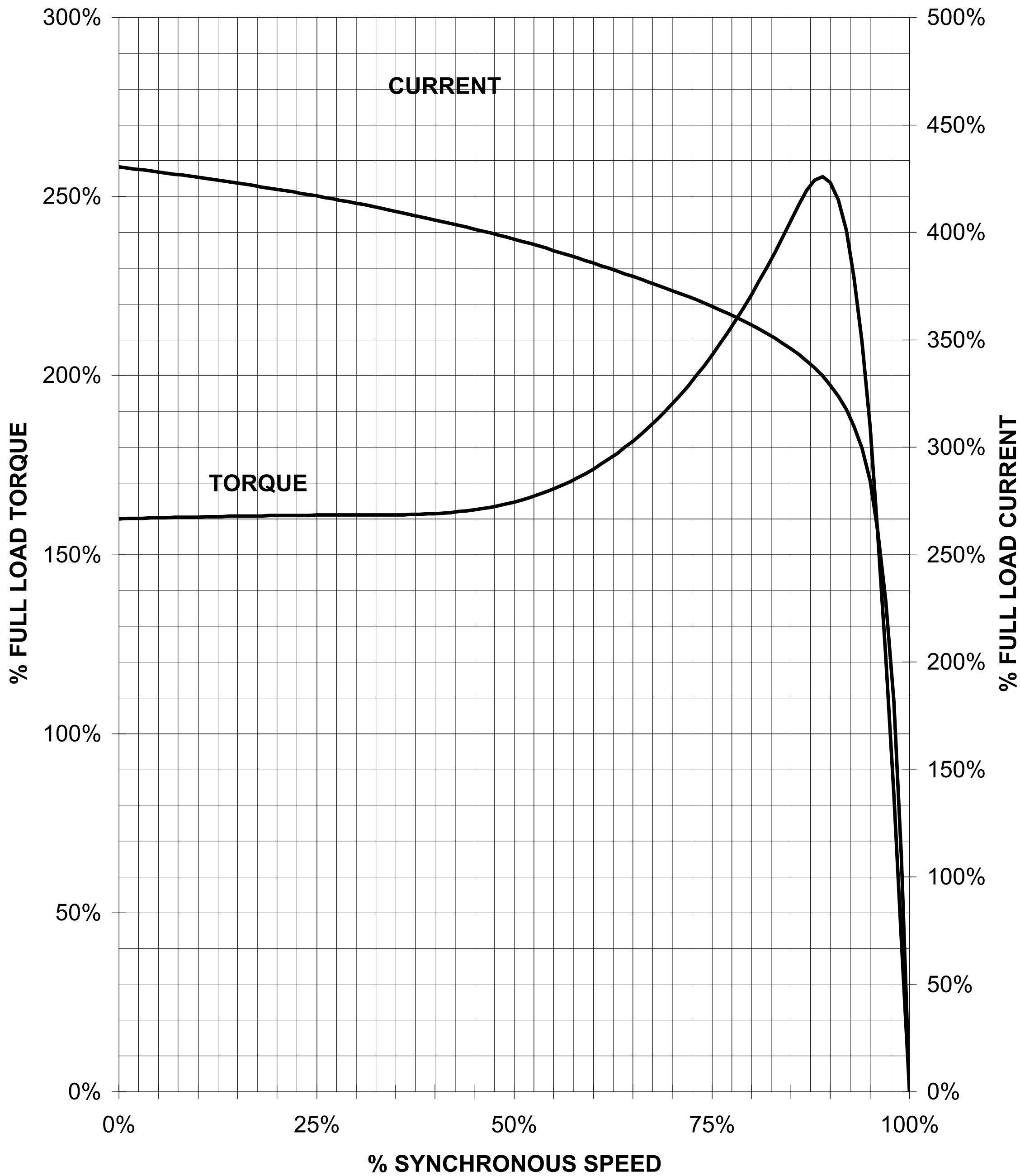


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	1	VOLTS	460	RPM	900	TYPE	GP10
HZ	60	PHASE	3	FRAME	182T	NEMA	B

TORQUE & CURRENT VS. SPEED

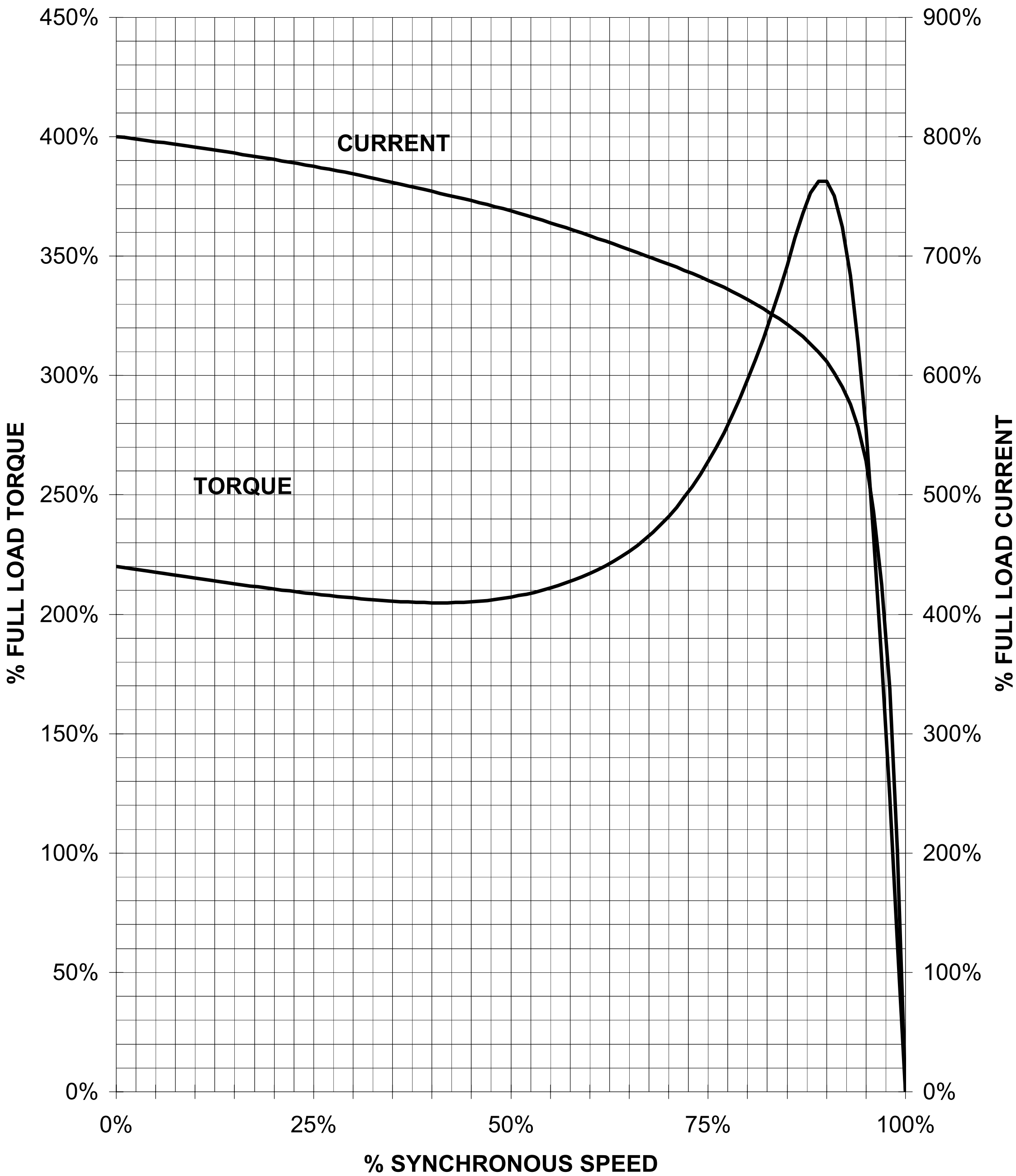


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	1.5	VOLTS	460	RPM	3600	TYPE	GP10
HZ	60	PHASE	3	FRAME	182T	NEMA	B

TORQUE & CURRENT VS. SPEED

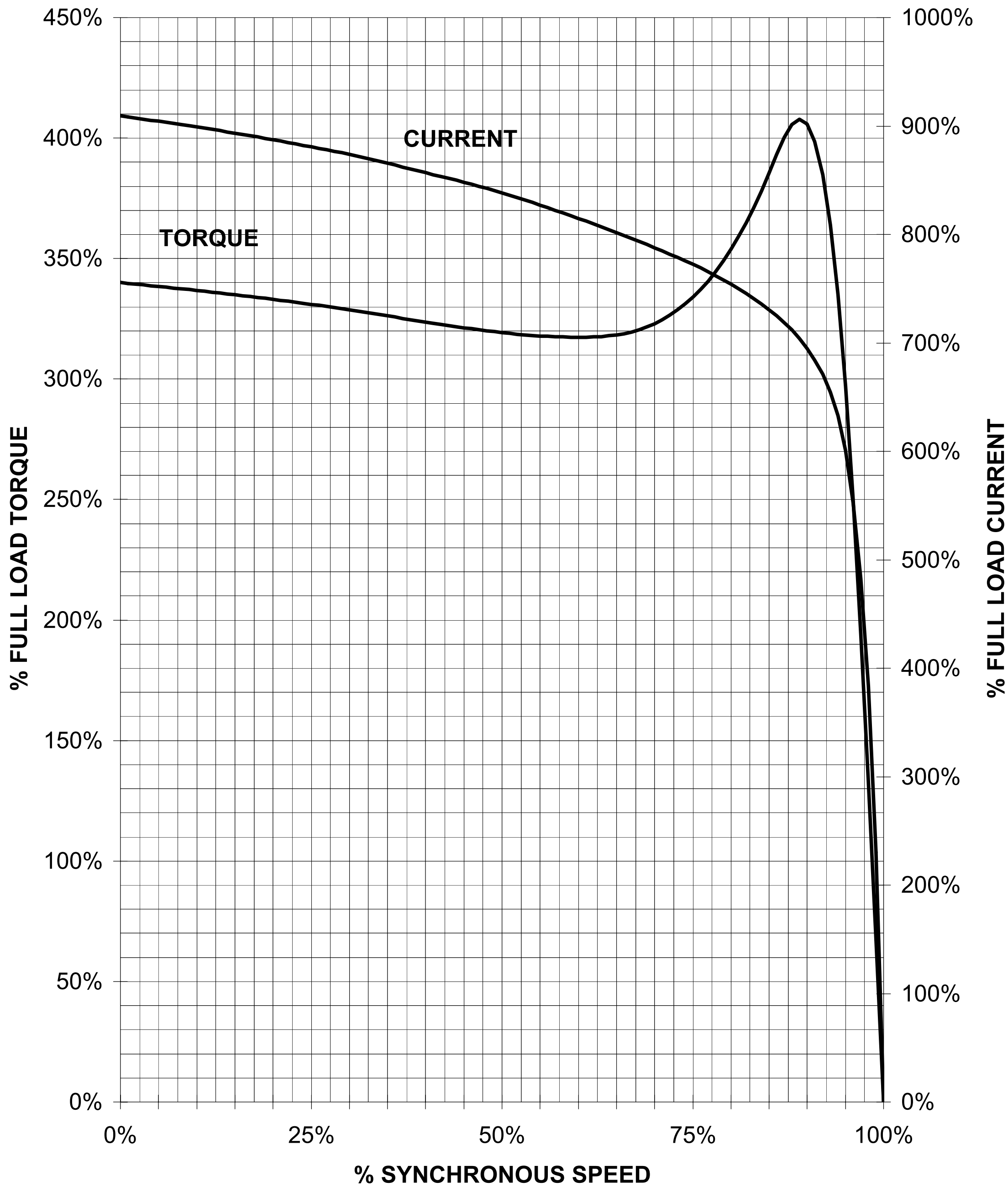


Customer: **PO No.:** **Order No.:**

Application Manual for NEMA Motors

HP	1.5	VOLTS	460	RPM	1800	TYPE	GP10
HZ	60	PHASE	3	FRAME	145T	NEMA	B

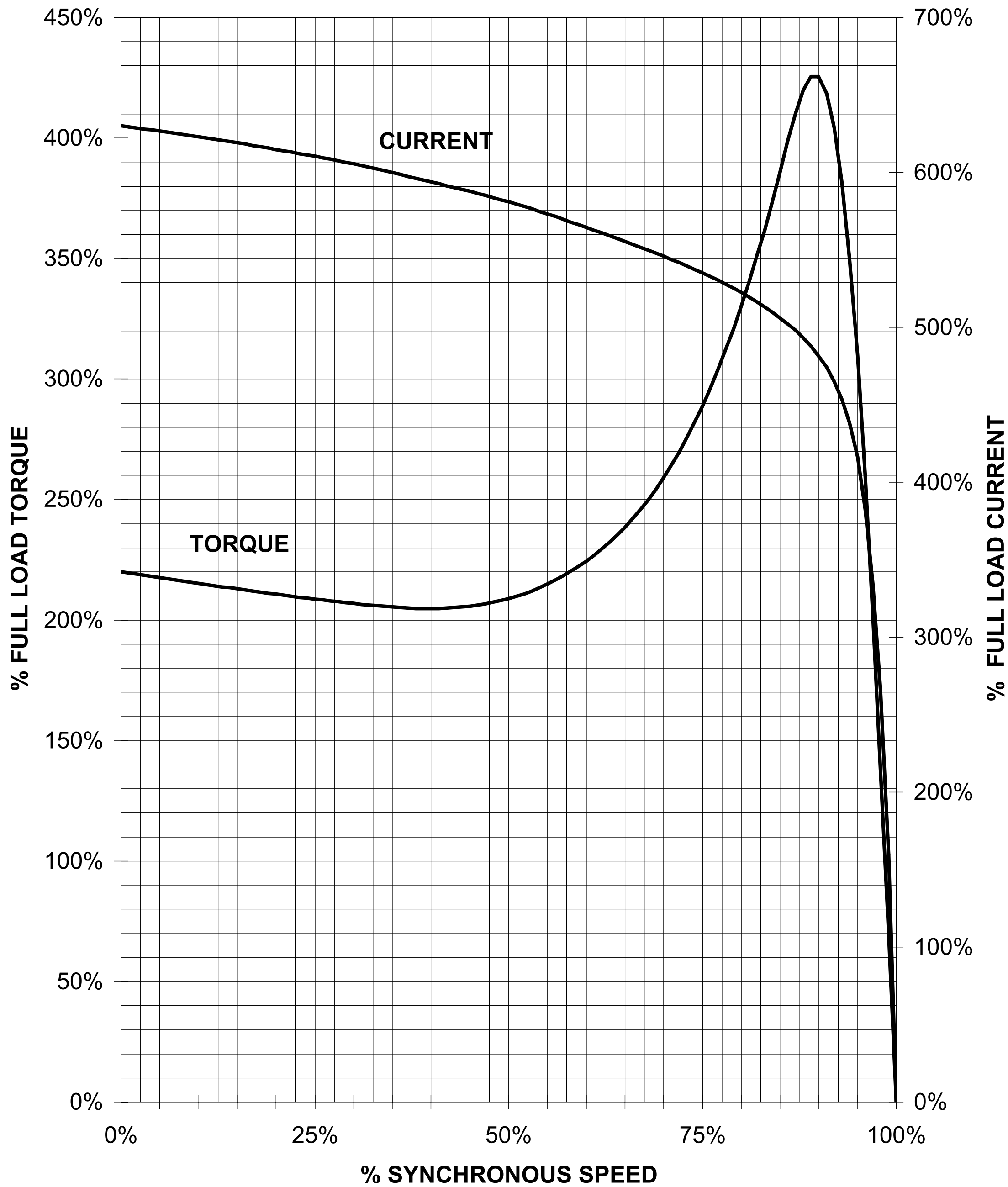
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1.5	VOLTS	460	RPM	1200	TYPE	GP10
HZ	60	PHASE	3	FRAME	182T	NEMA	B

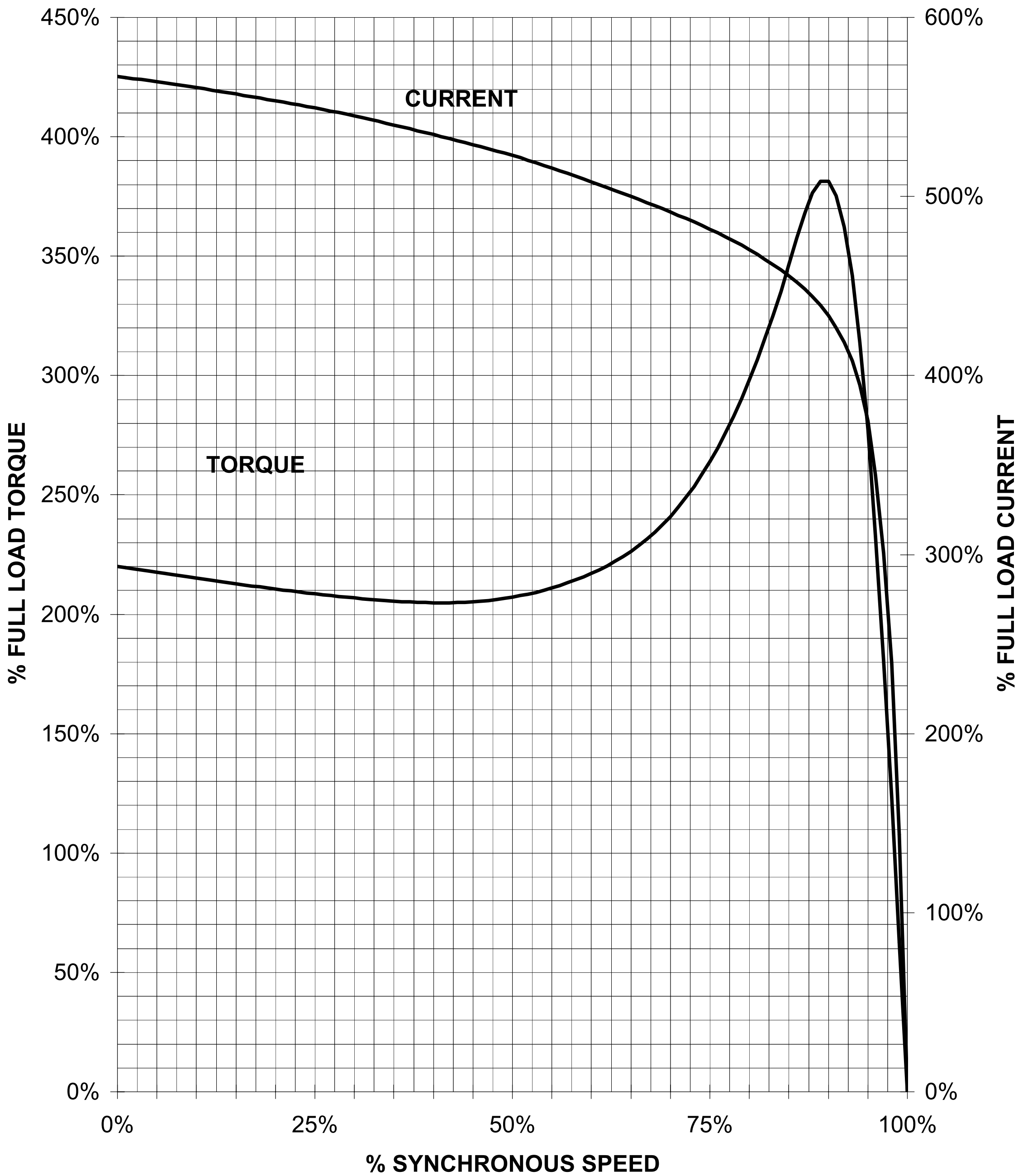
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1.5	VOLTS	460	RPM	900	TYPE	GP10
HZ	60	PHASE	3	FRAME	184T	NEMA	B

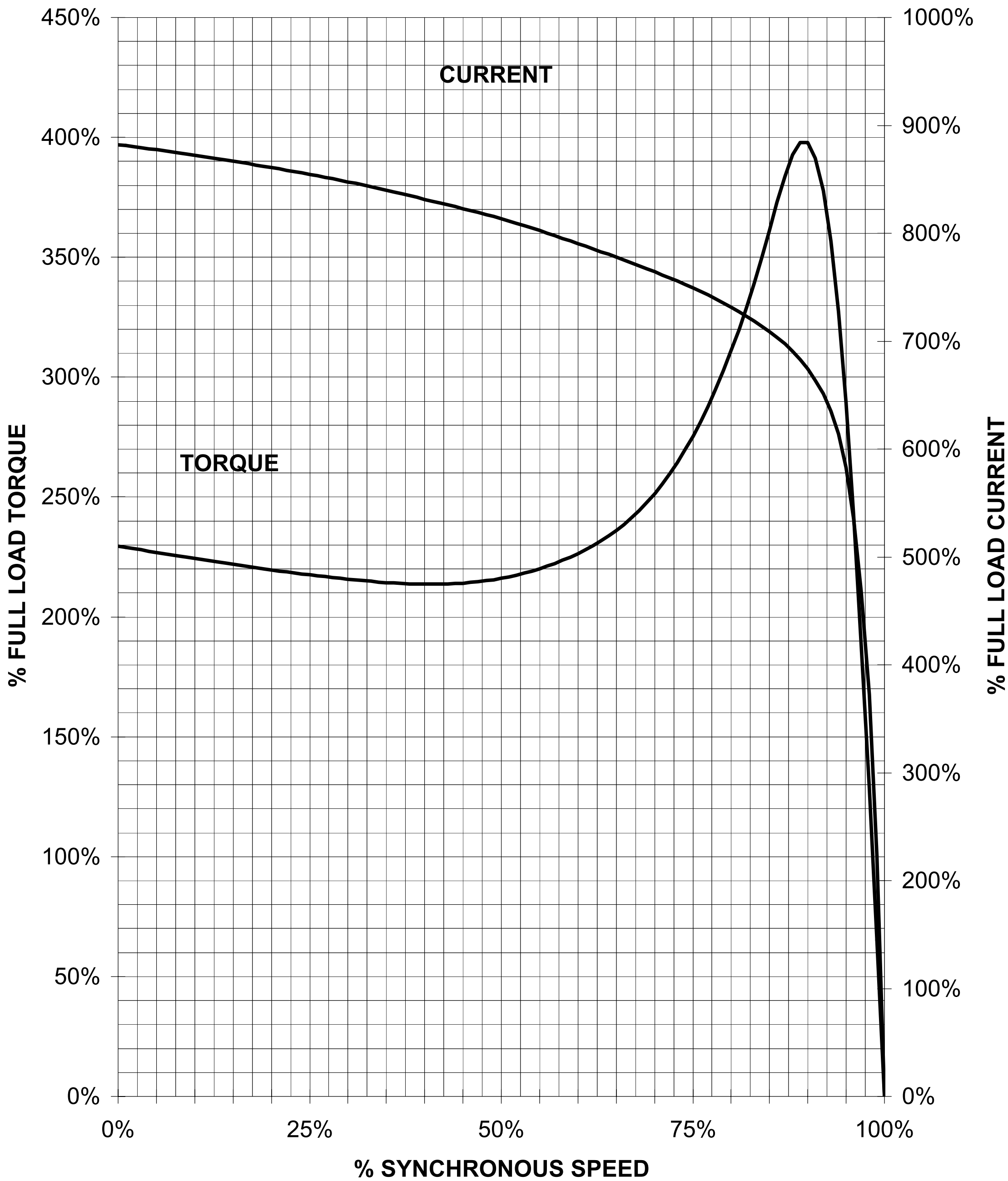
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	2	VOLTS	460	RPM	3600	TYPE	GP10
HZ	60	PHASE	3	FRAME	145T	NEMA	B

TORQUE & CURRENT VS. SPEED

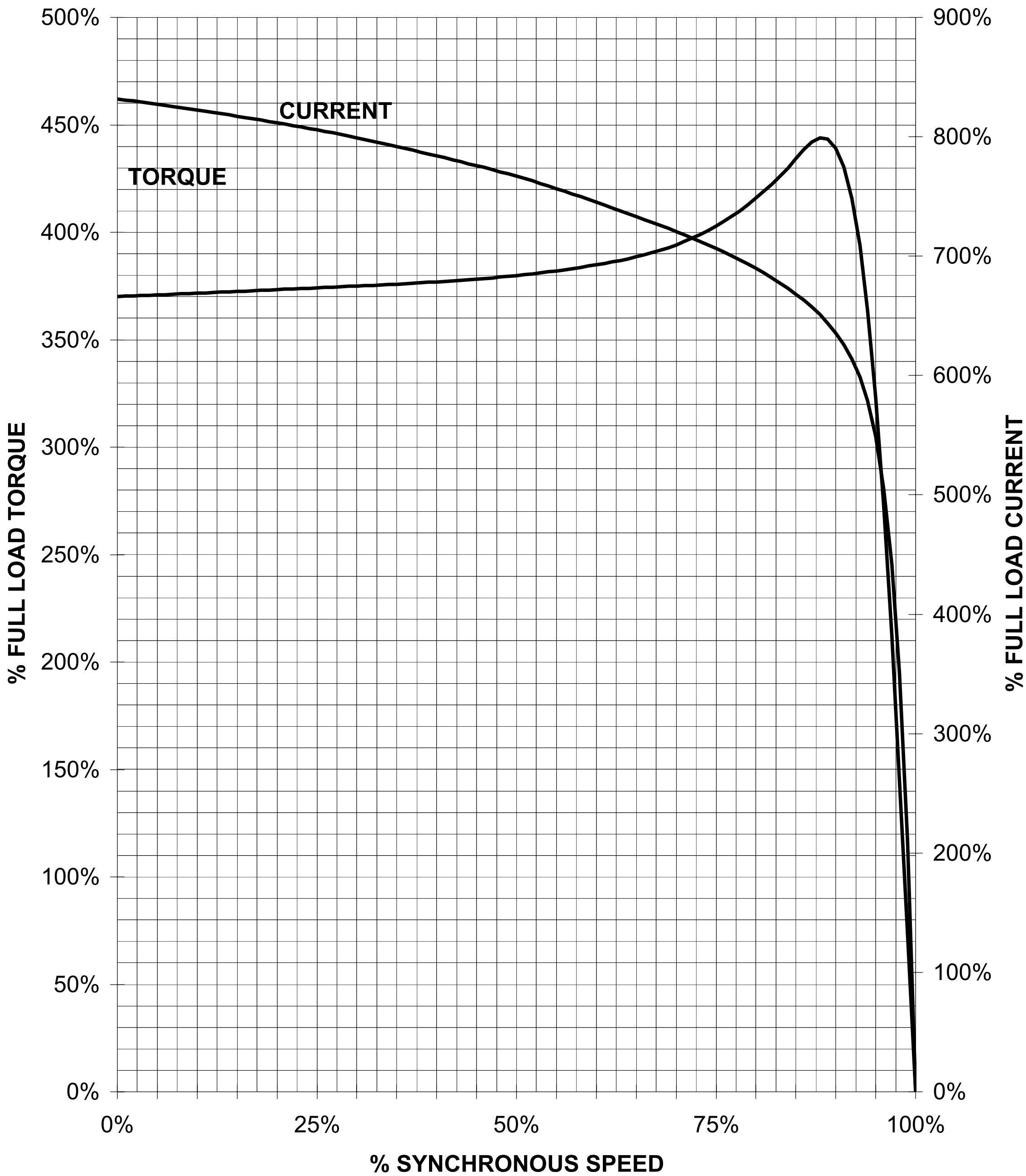


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	2	VOLTS	460	RPM	1800	TYPE	GP10
HZ	60	PHASE	3	FRAME	145T	NEMA	B

TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

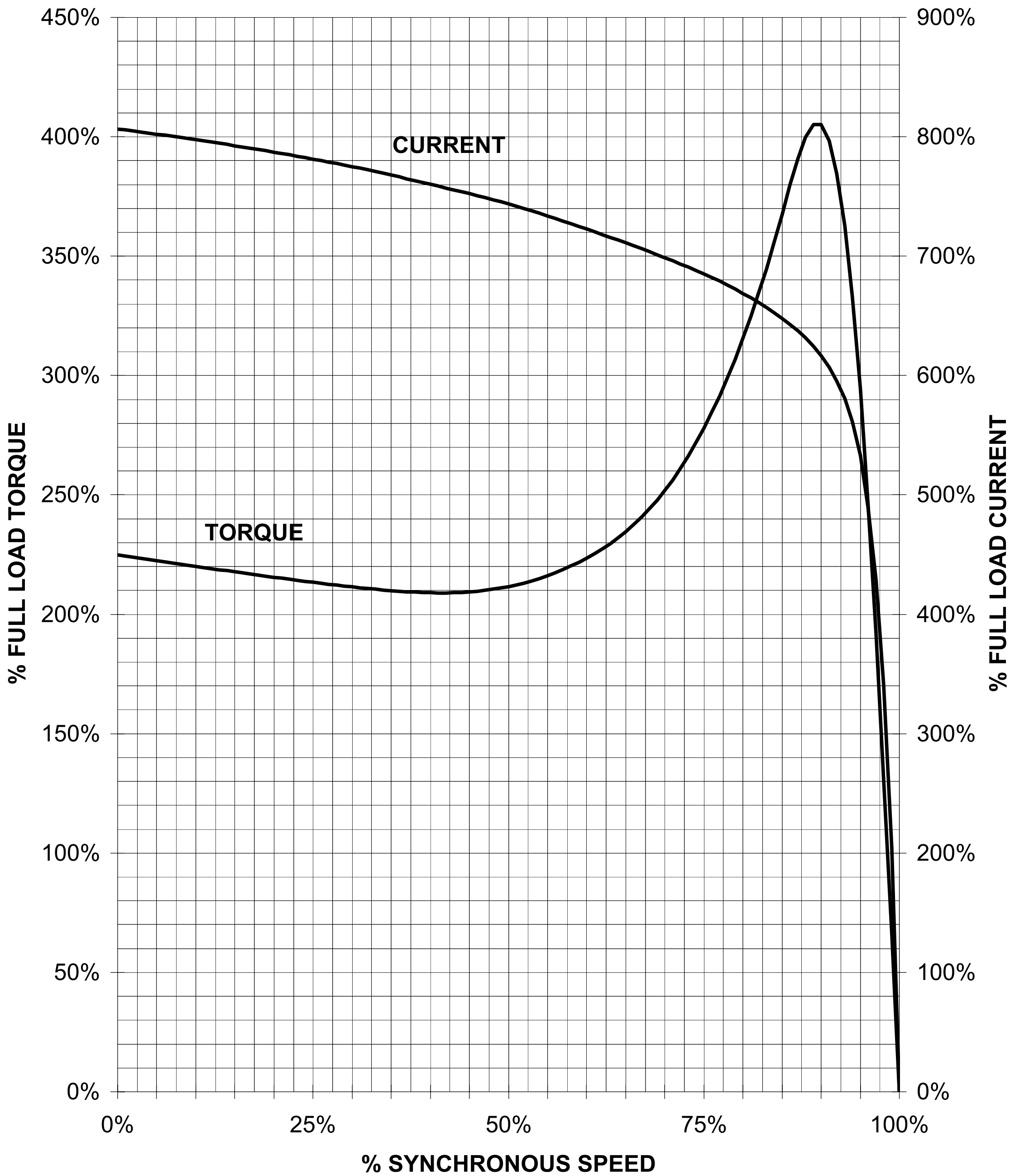
PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

SIEMENS

Application Manual for NEMA Motors

HP	2	VOLTS	460	RPM	1200	TYPE	GP10
HZ	60	PHASE	3	FRAME	184T	NEMA	B

TORQUE & CURVE VS. SPEED

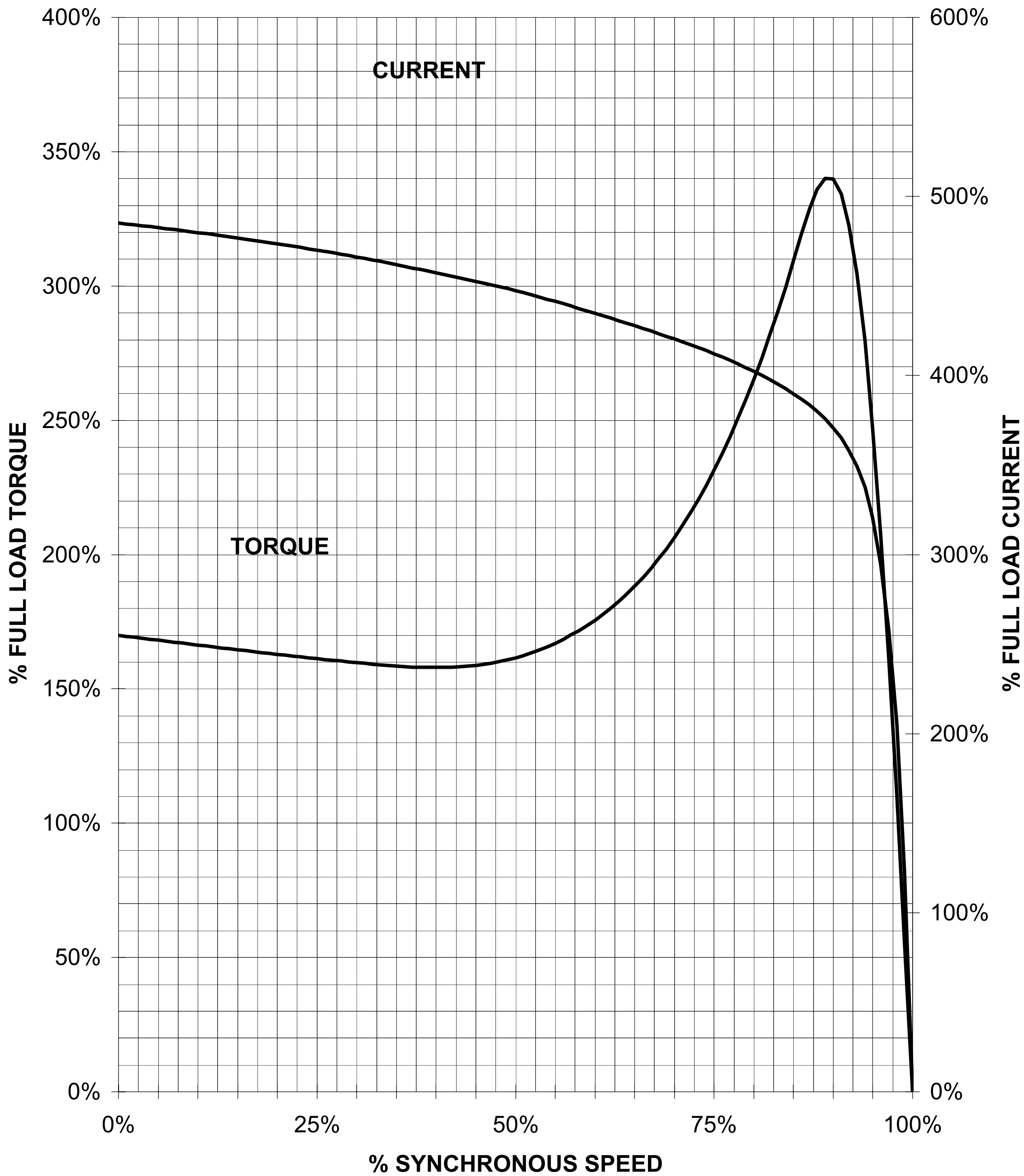


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	2	VOLTS	460	RPM	900	TYPE	GP10
HZ	60	PHASE	3	FRAME	213T	NEMA	B

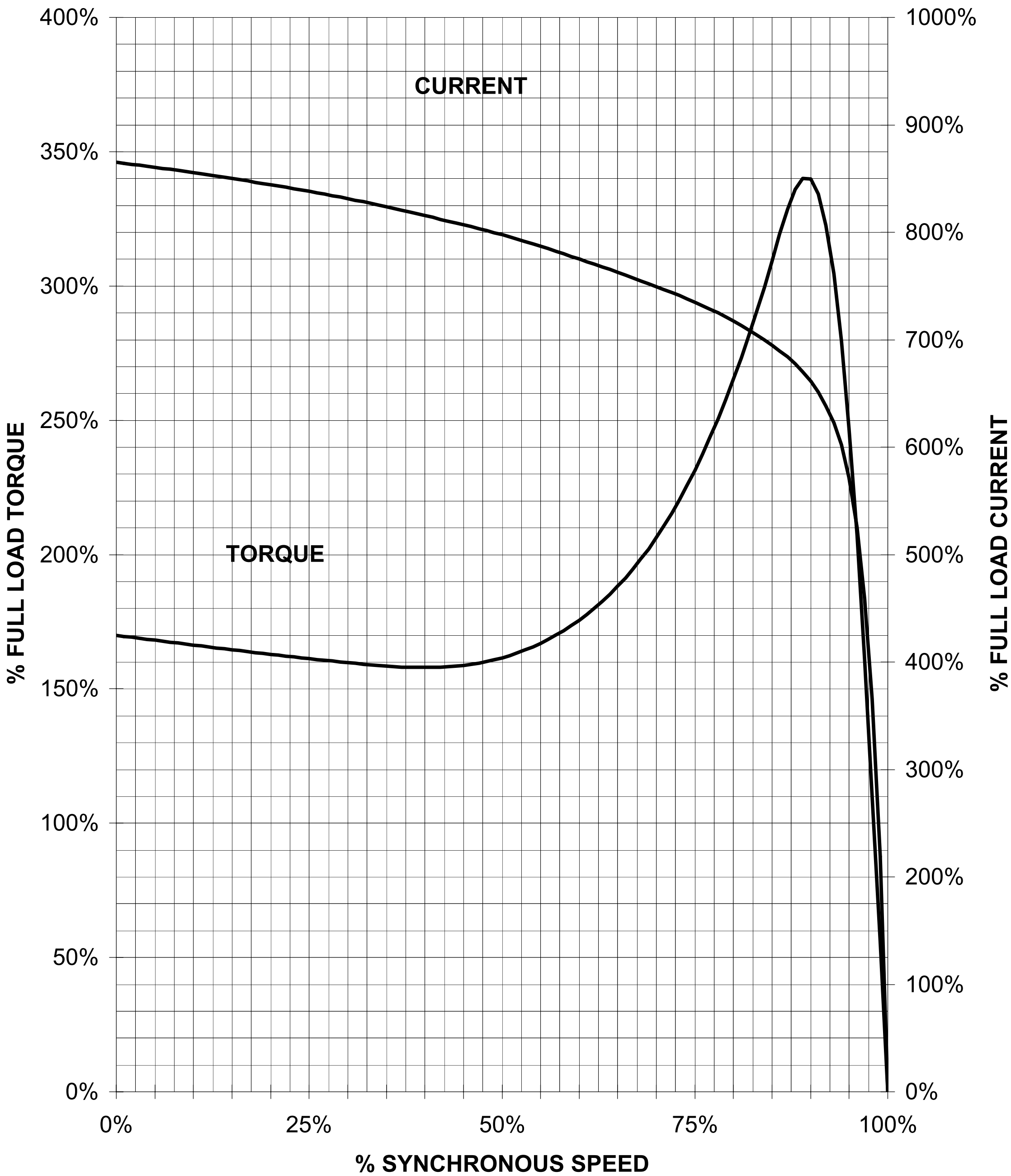
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	3	VOLTS	460	RPM	3600	TYPE	GP10
HZ	60	PHASE	3	FRAME	182T	NEMA	B

TORQUE & CURRENT VS. SPEED

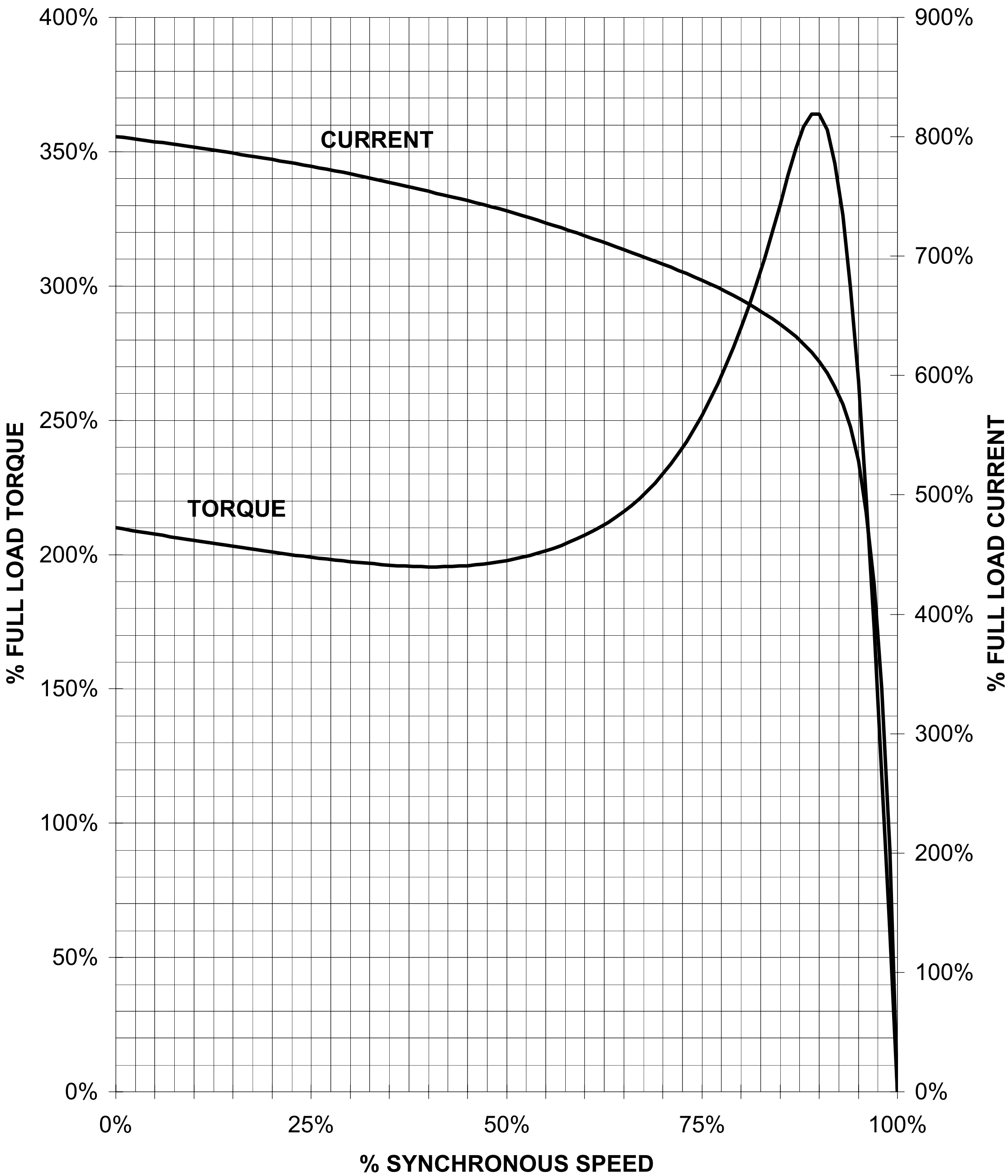


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	3	VOLTS	460	RPM	1800	TYPE	GP10
HZ	60	PHASE	3	FRAME	182T	NEMA	B

TORQUE & CURRENT VS. SPEED

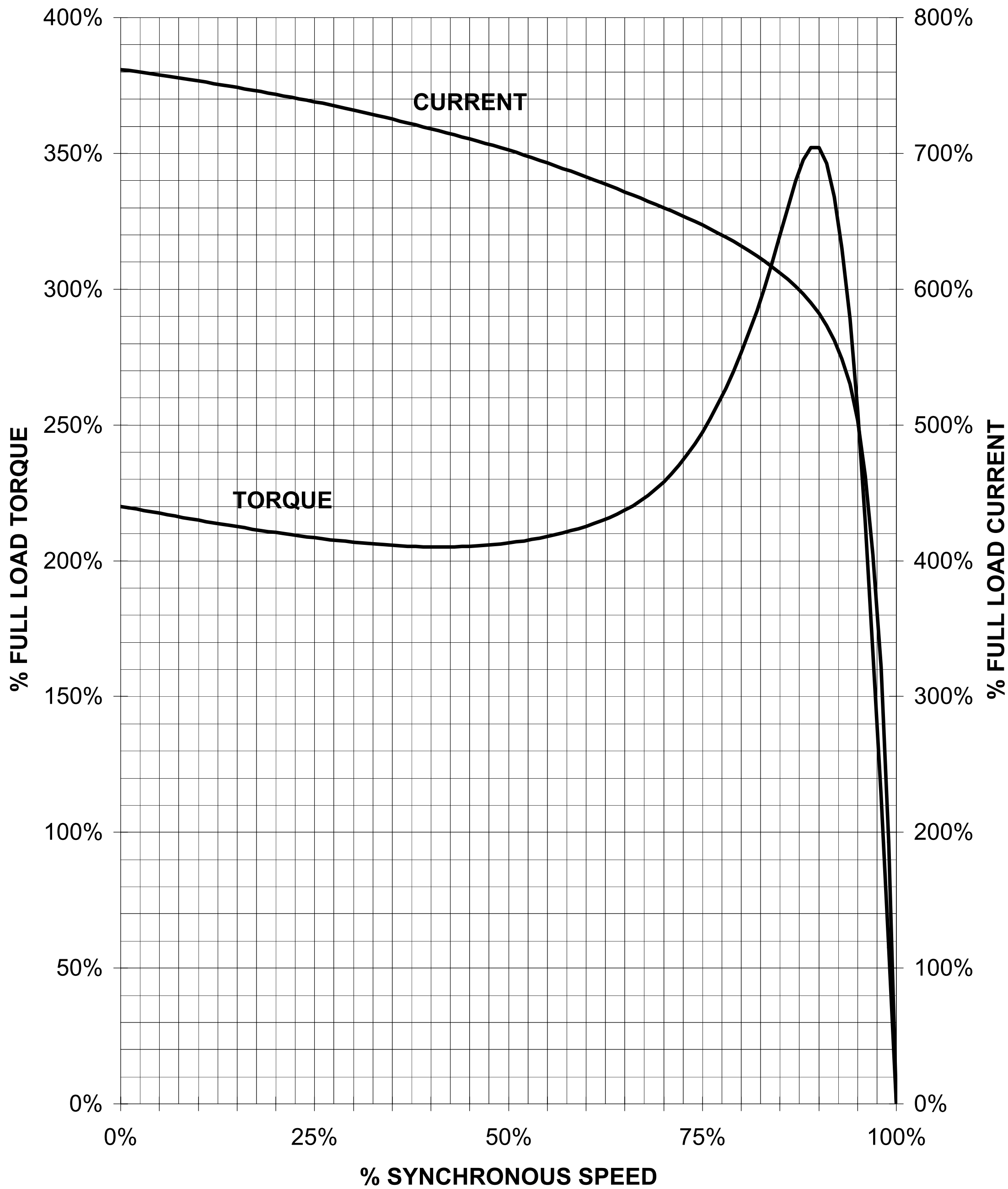


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	3	VOLTS	460	RPM	1200	TYPE	GP10
HZ	60	PHASE	3	FRAME	213T	NEMA	B

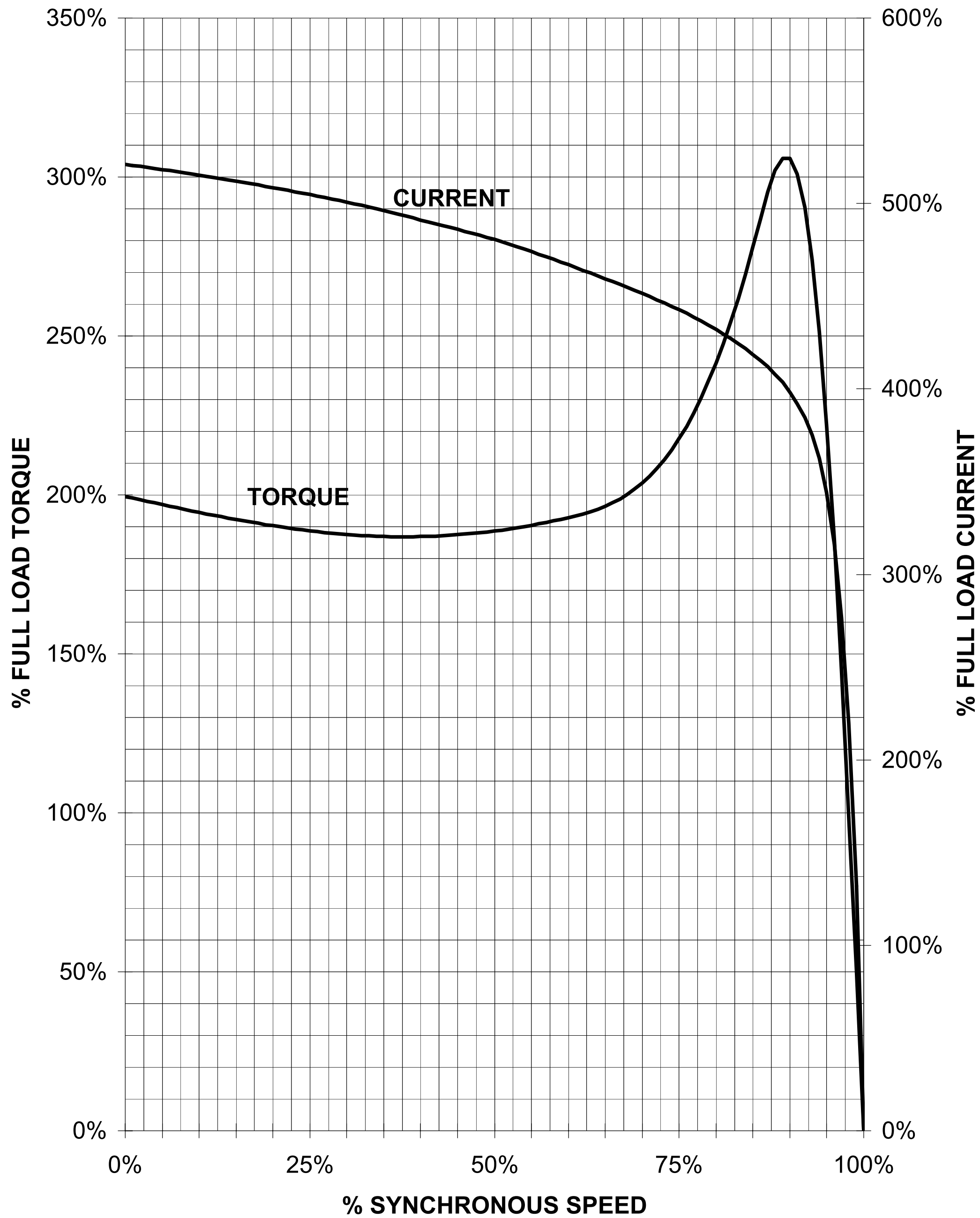
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	3	VOLTS	460	RPM	900	TYPE	GP10
HZ	60	PHASE	3	FRAME	215T	NEMA	B

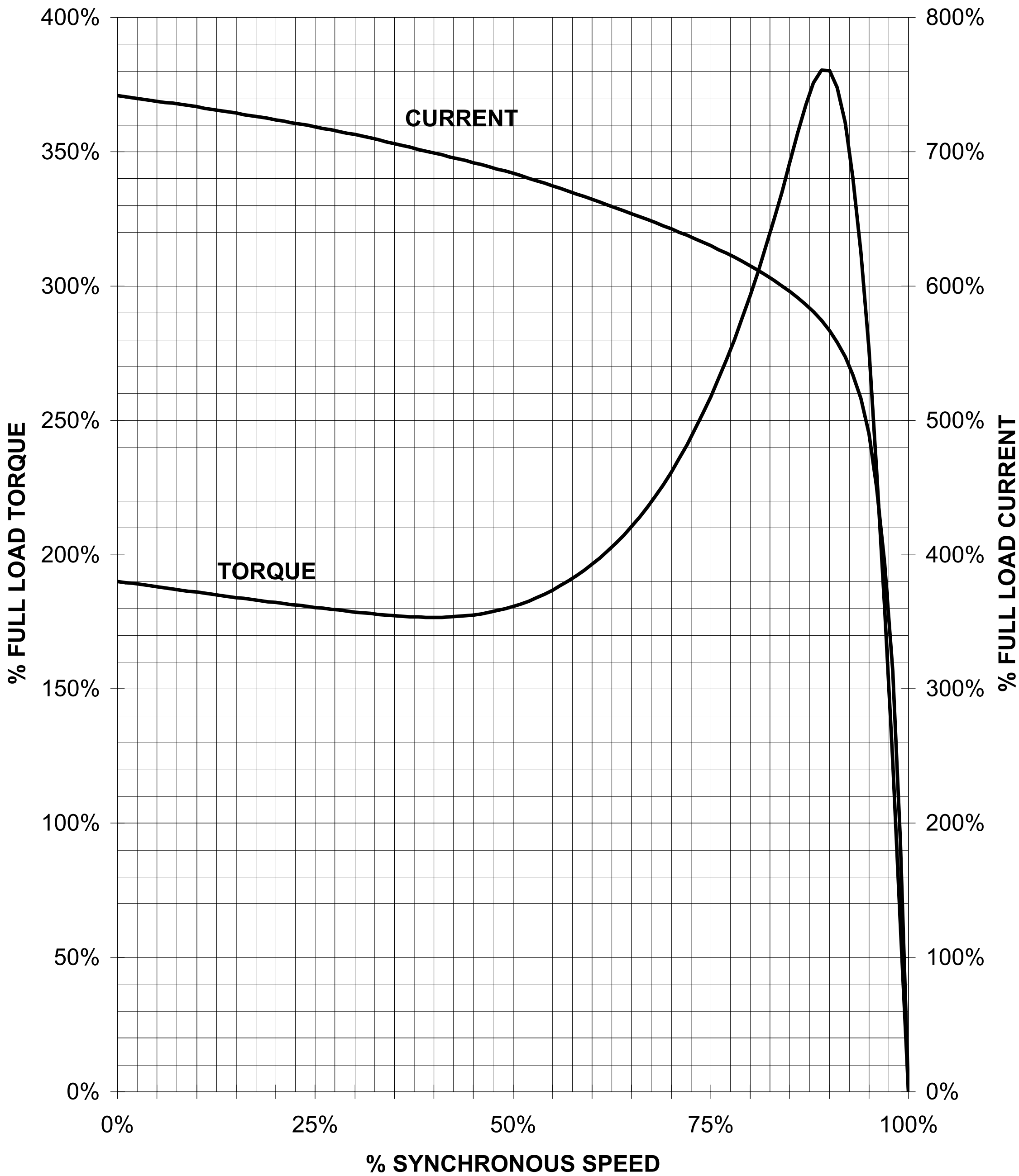
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	5	VOLTS	460	RPM	3600	TYPE	GP10
HZ	60	PHASE	3	FRAME	184T	NEMA	B

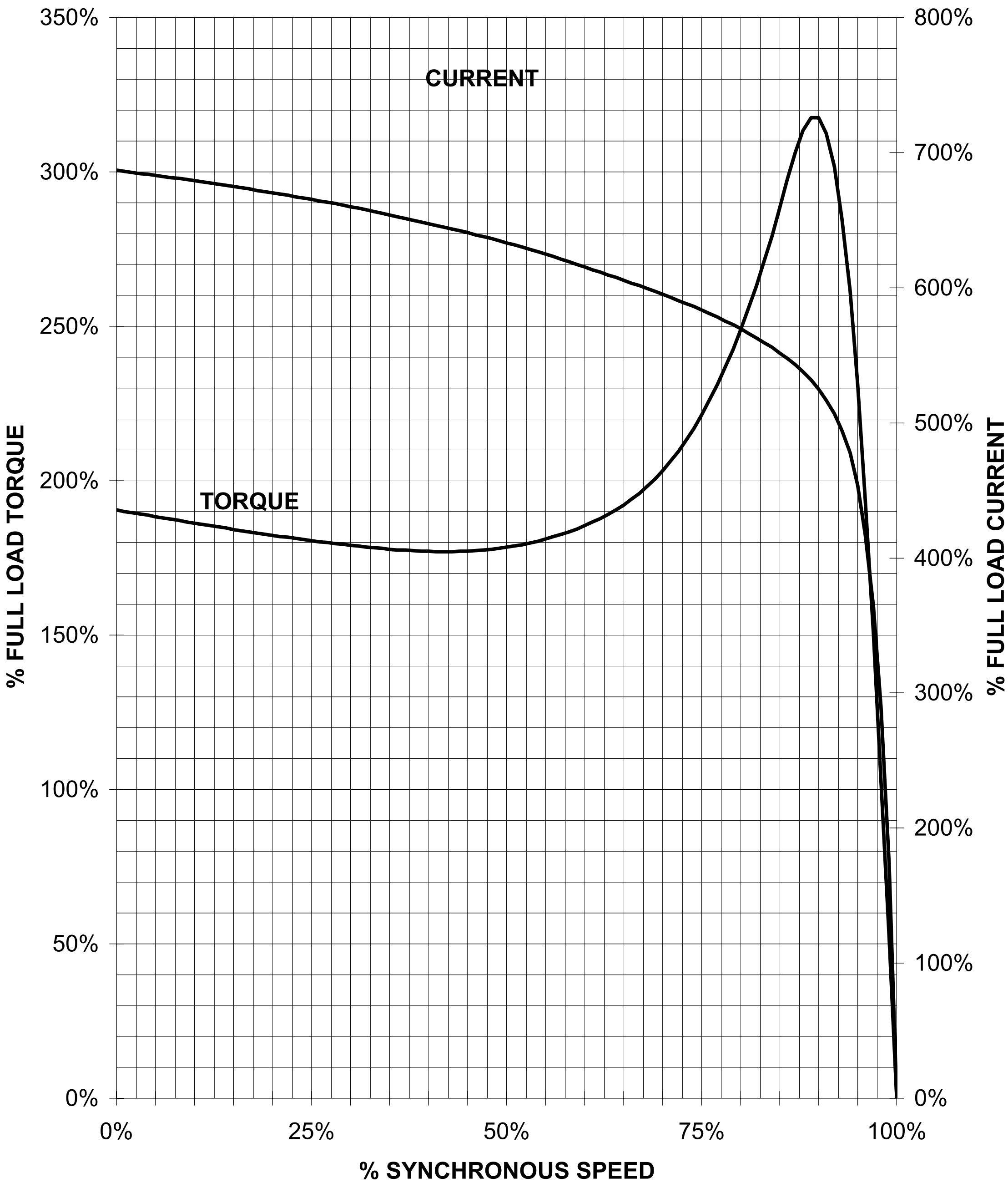
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	5	VOLTS	460	RPM	1800	TYPE	GP10
HZ	60	PHASE	3	FRAME	184T	NEMA	B

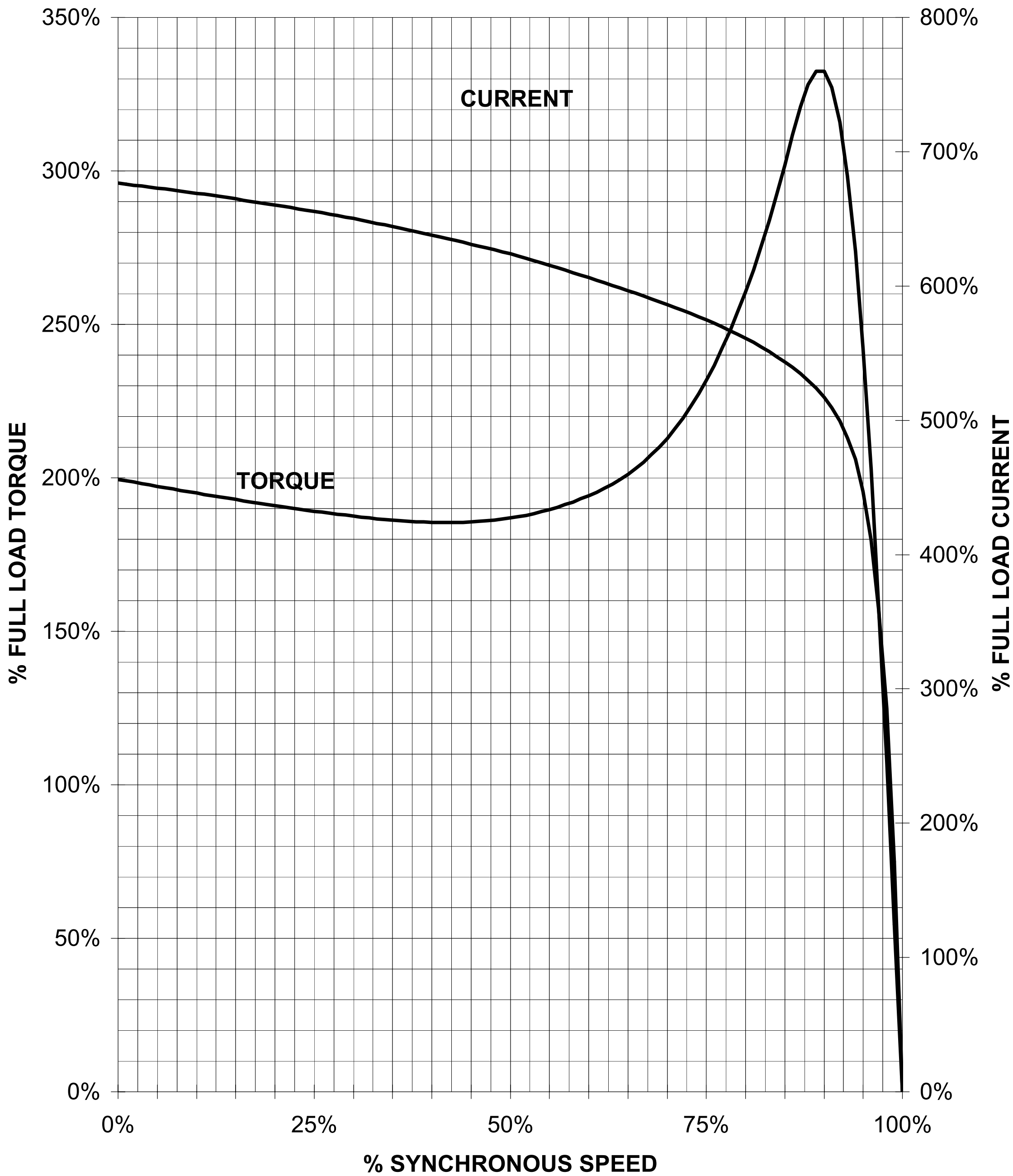
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	5	VOLTS	460	RPM	1200	TYPE	GP10
HZ	60	PHASE	3	FRAME	215T	NEMA	B

TORQUE & CURRENT VS. SPEED

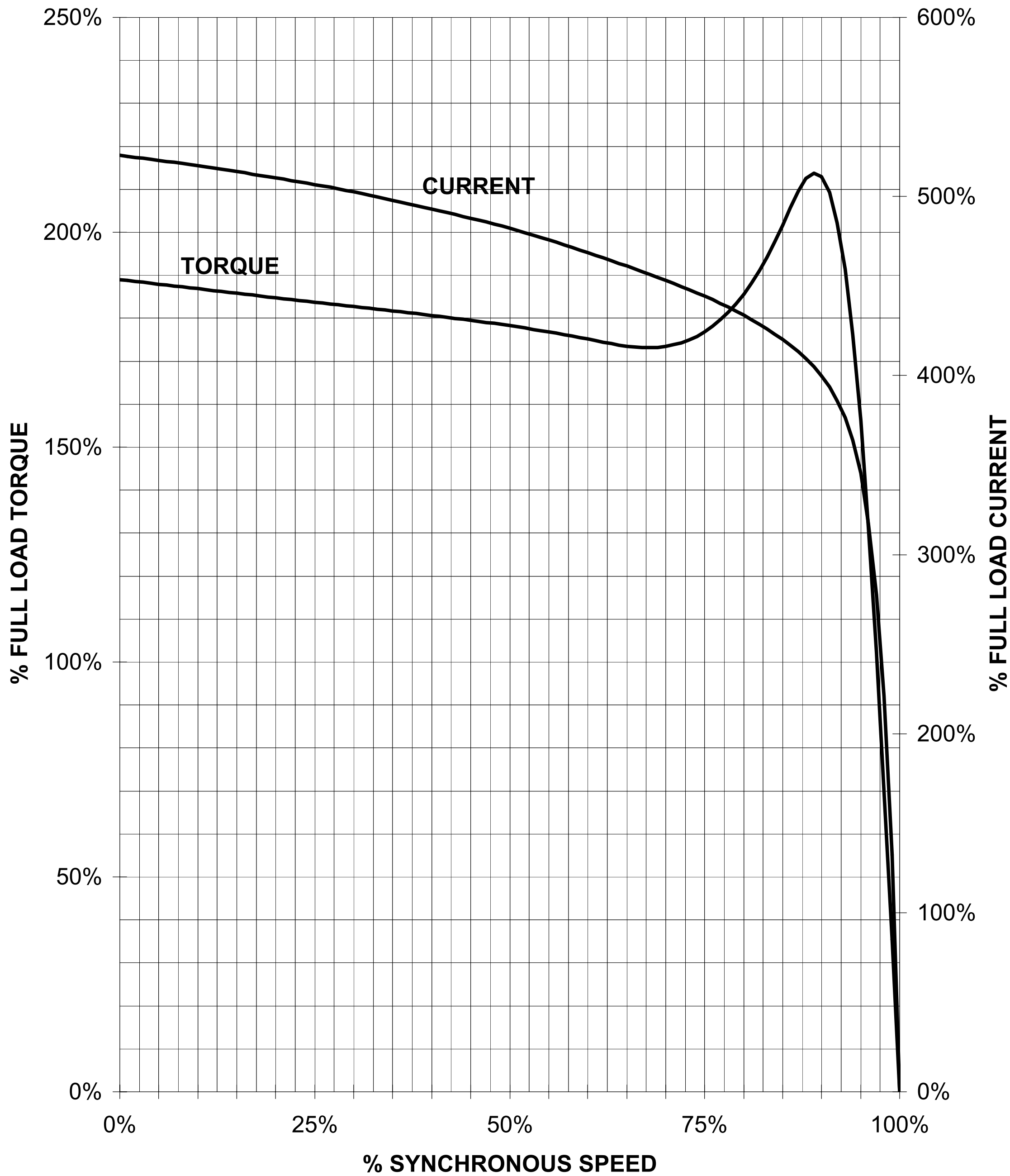


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	5	VOLTS	460	RPM	900	TYPE	GP10
HZ	60	PHASE	3	FRAME	254T	NEMA	B

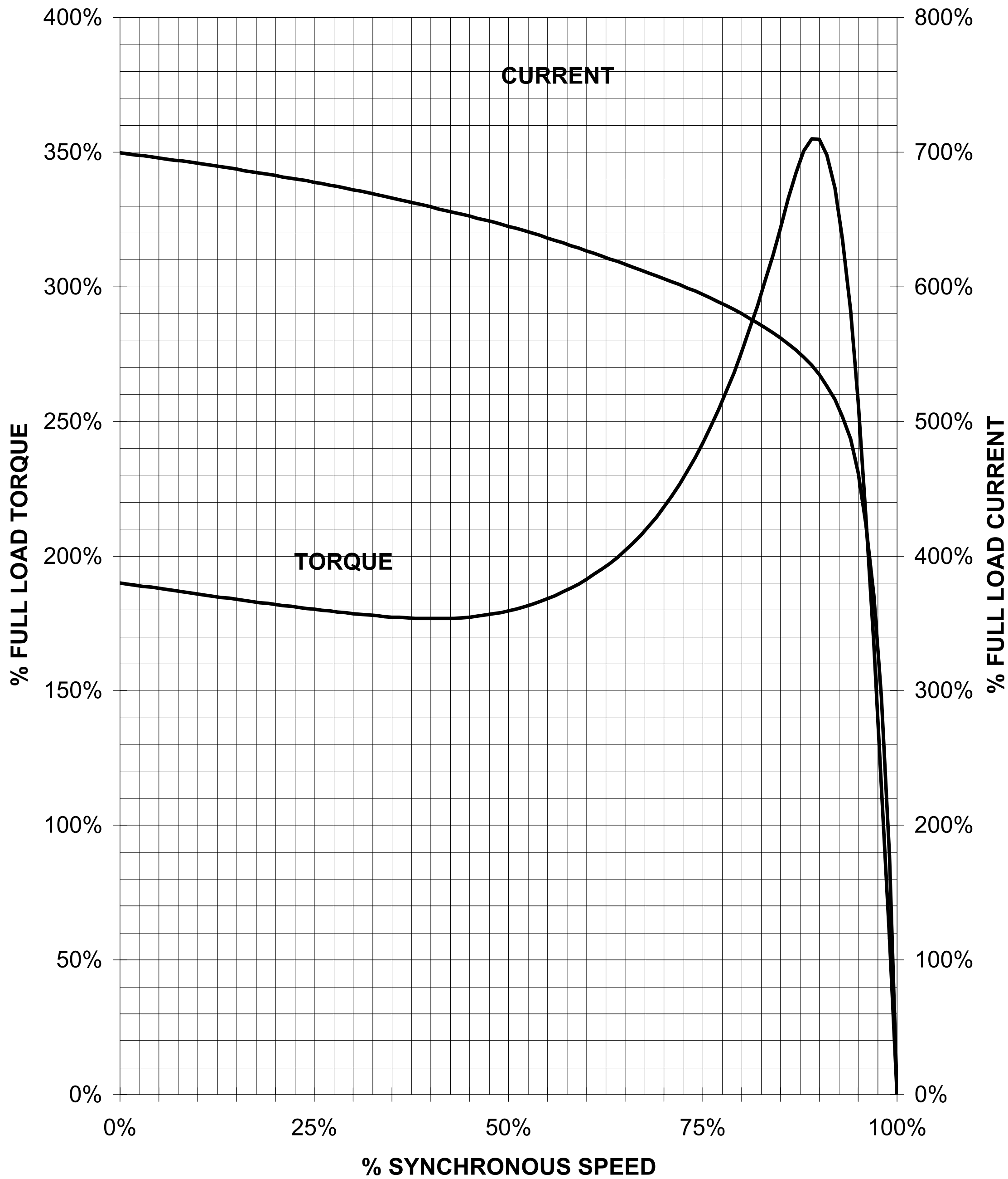
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	7.5	VOLTS	460	RPM	3600	TYPE	GP10
HZ	60	PHASE	3	FRAME	213T	NEMA	B

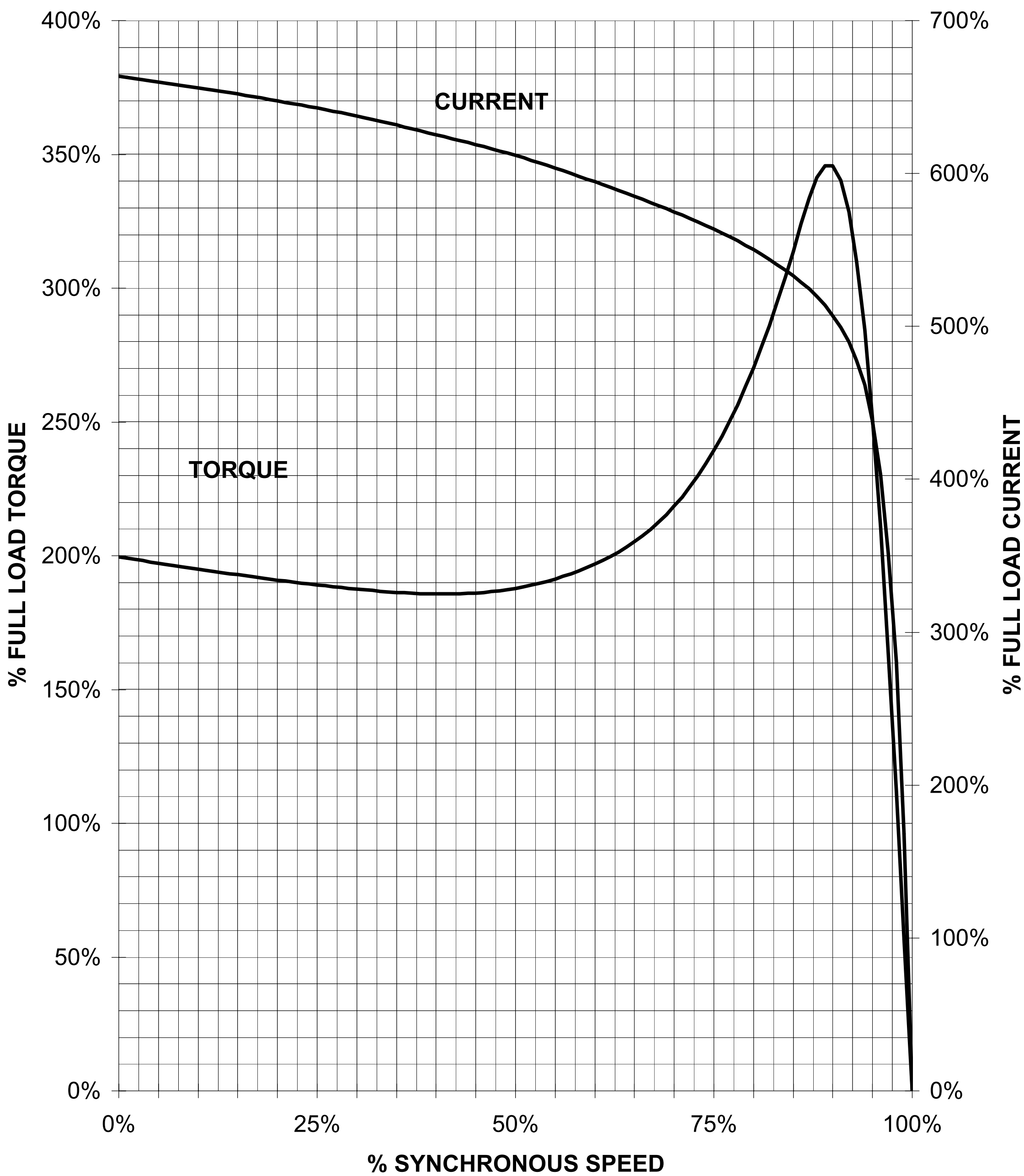
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	7.5	VOLTS	460	RPM	1800	TYPE	GP10
HZ	60	PHASE	3	FRAME	213T	NEMA	B

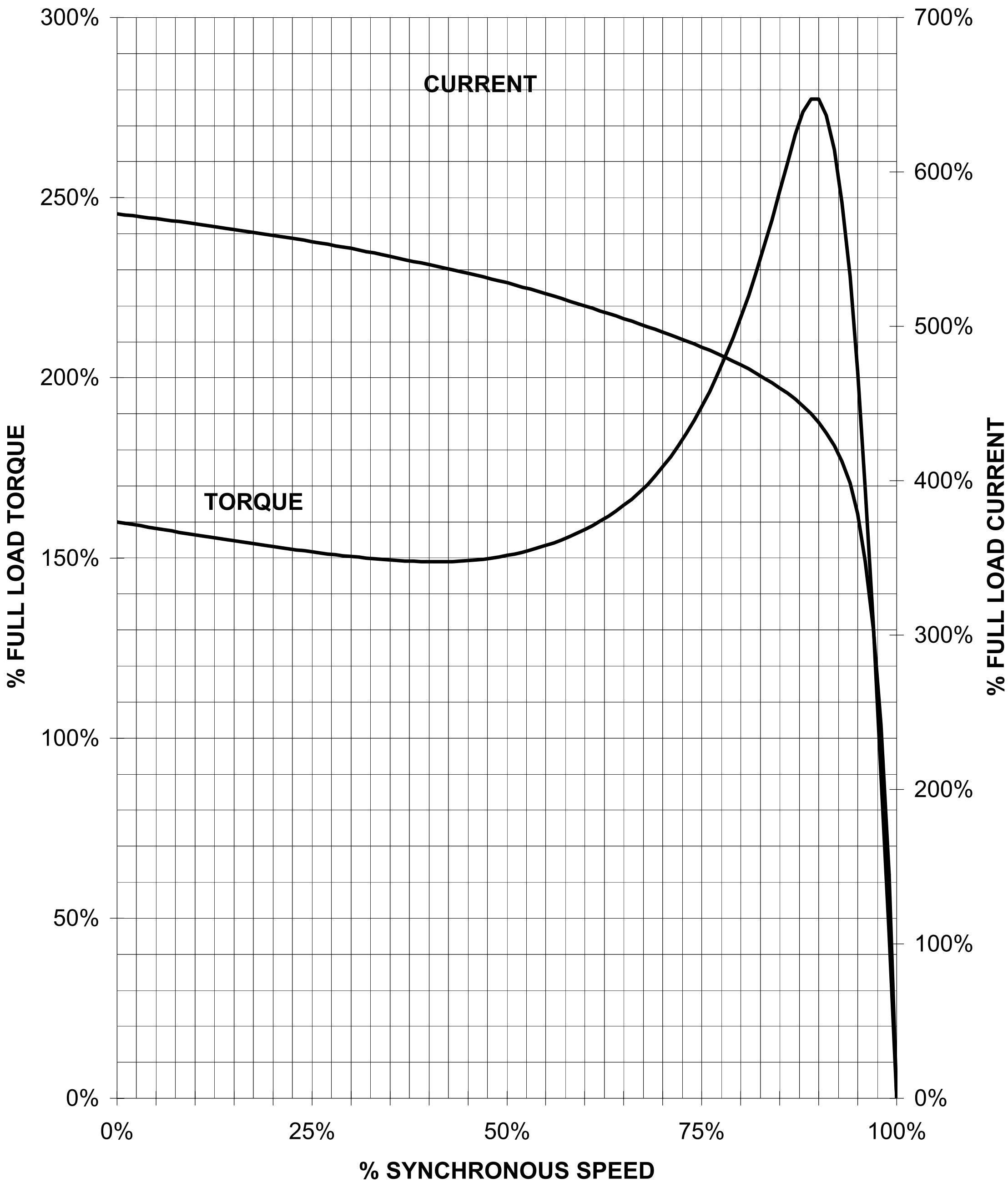
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	7.5	VOLTS	460	RPM	1200	TYPE	GP10
HZ	60	PHASE	3	FRAME	254T	NEMA	B

TORQUE & CURRENT VS. SPEED

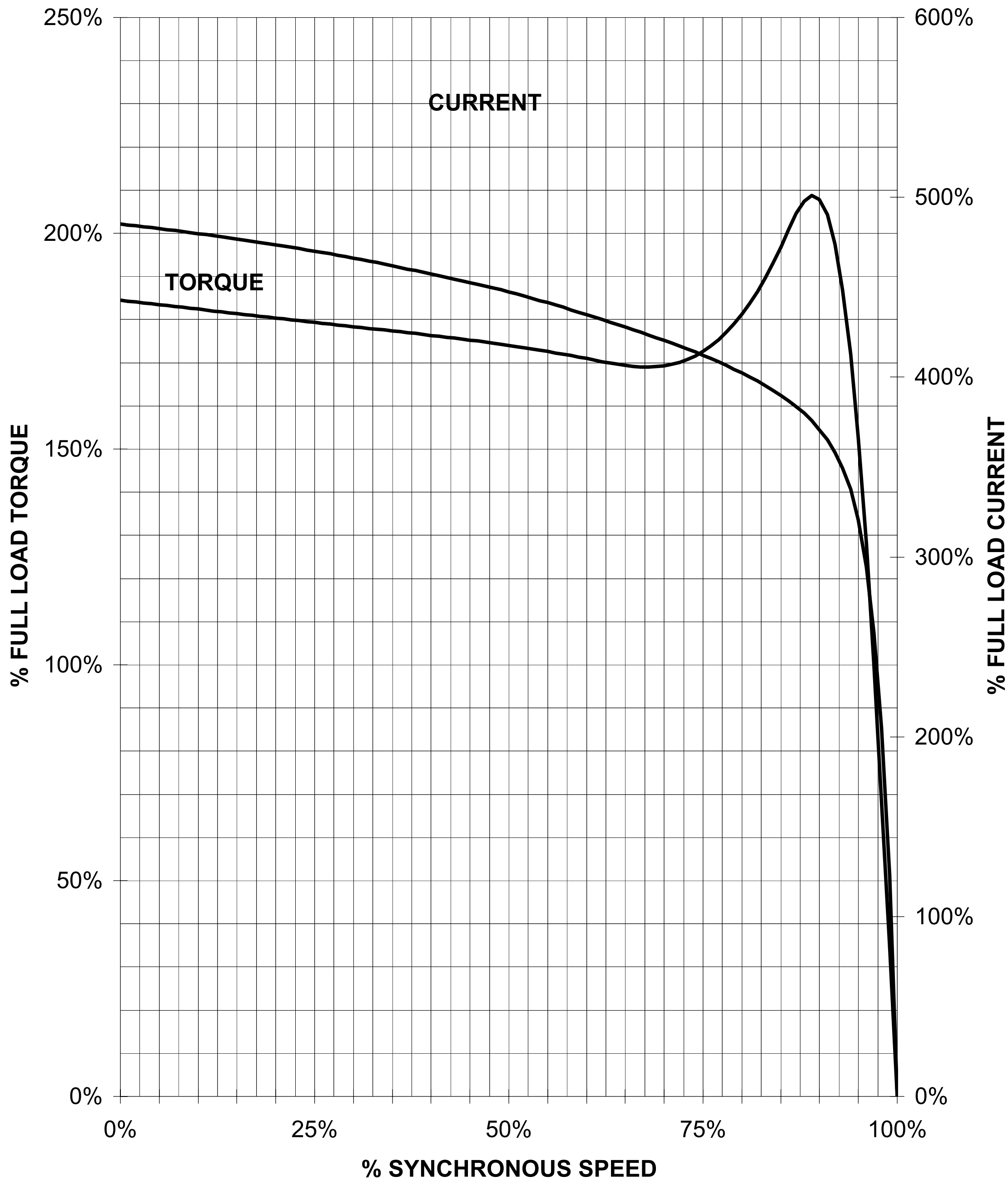


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	7.5	VOLTS	460	RPM	900	TYPE	GP10
HZ	60	PHASE	3	FRAME	256T	NEMA	B

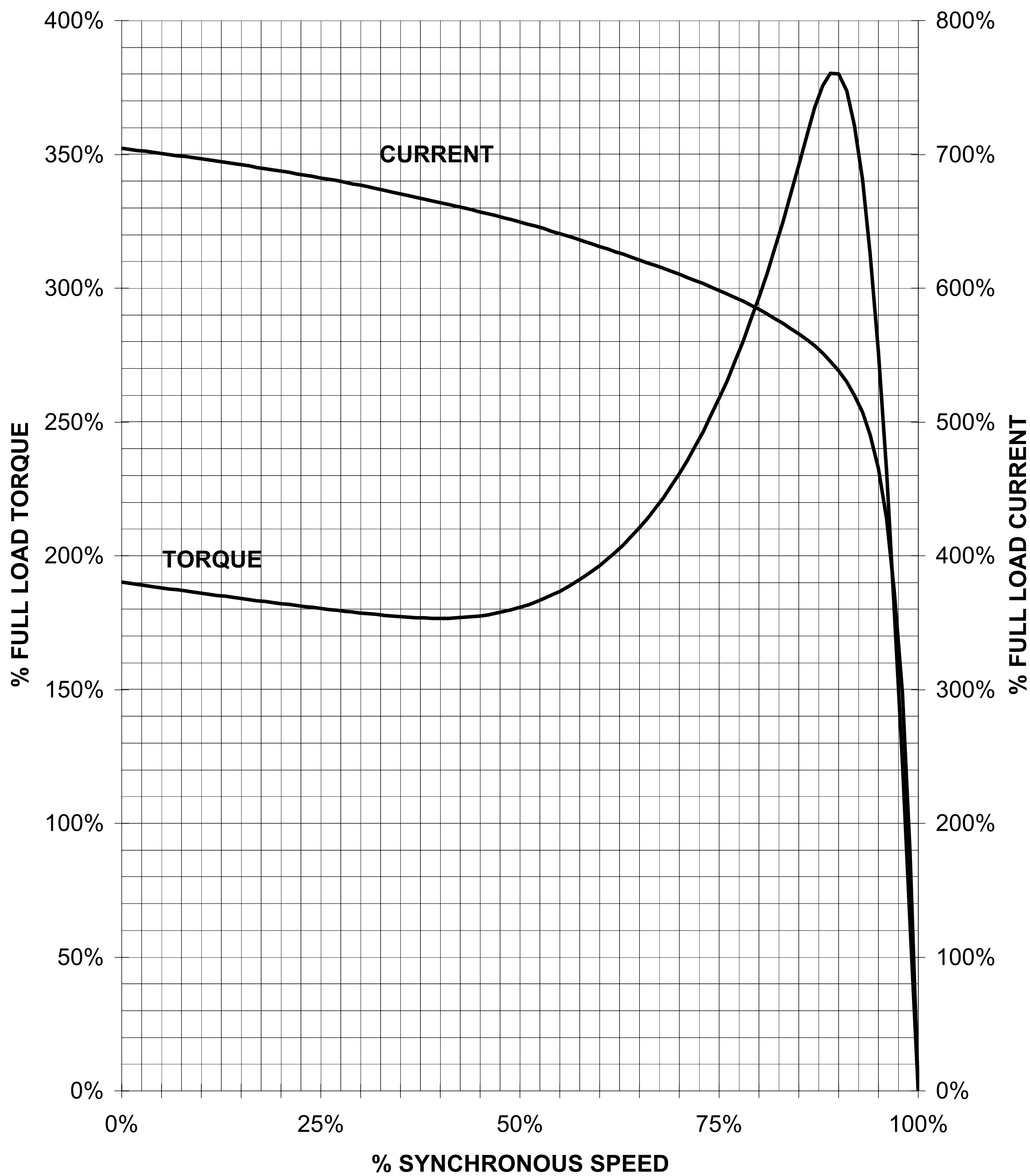
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	10	VOLTS	460	RPM	3600	TYPE	GP10
HZ	60	PHASE	3	FRAME	215T	NEMA	B

TORQUE & CURRENT VS. SPEED

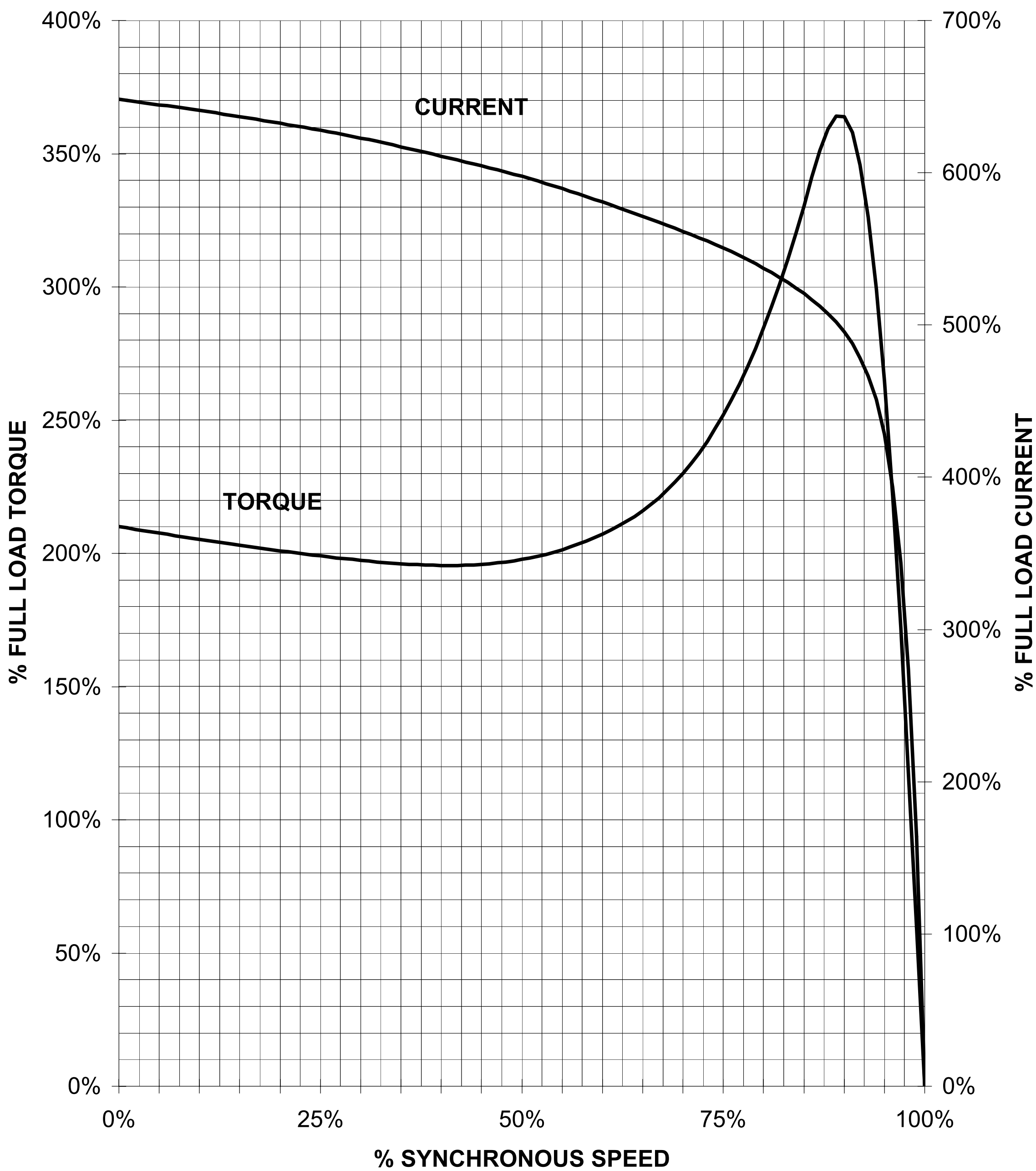


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	10	VOLTS	460	RPM	1800	TYPE	GP10
HZ	60	PHASE	3	FRAME	215T	NEMA	B

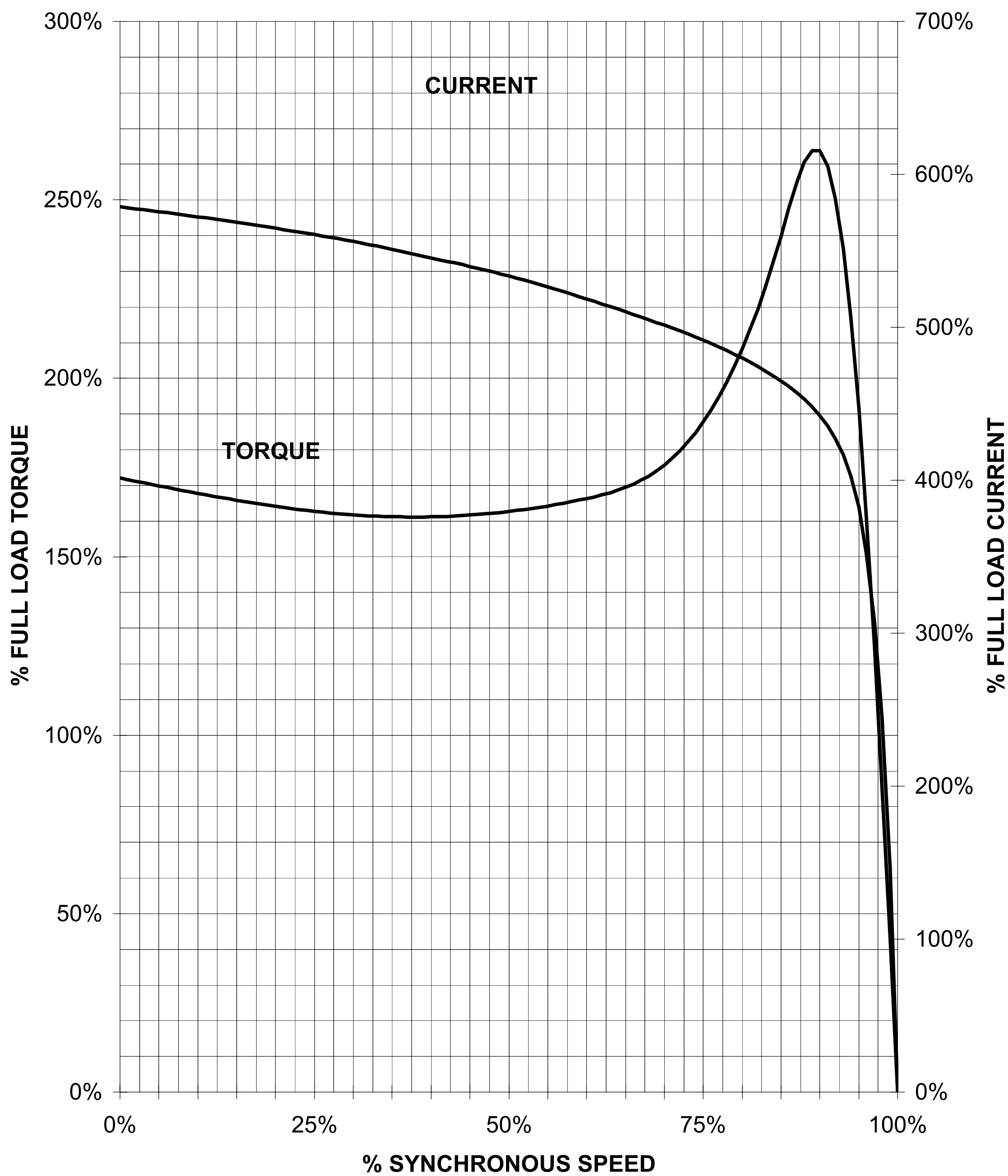
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	10	VOLTS	460	RPM	1200	TYPE	GP10
HZ	60	PHASE	3	FRAME	256T	NEMA	B

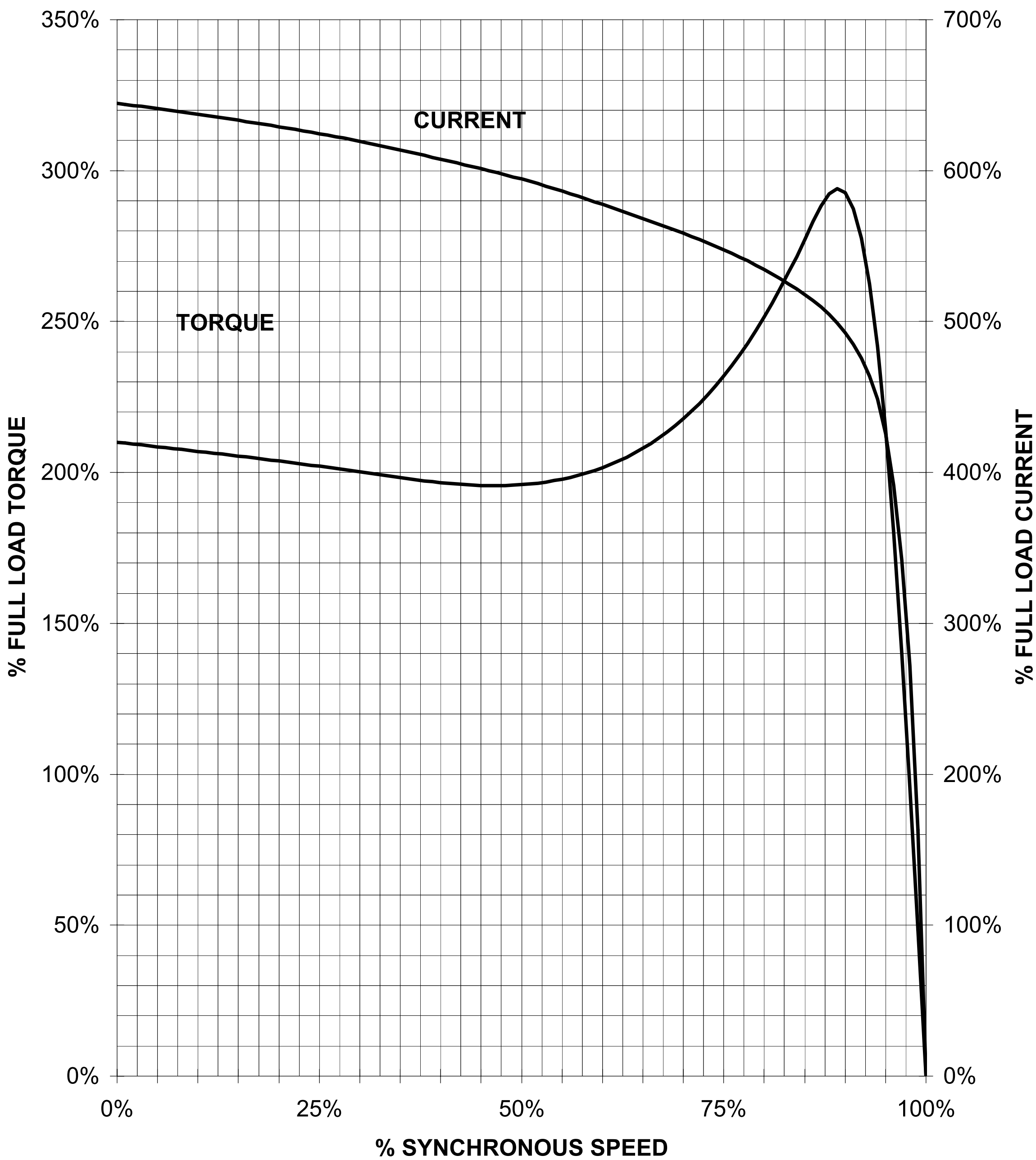
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	15	VOLTS	460	RPM	3600	TYPE	GP10
HZ	60	PHASE	3	FRAME	254T	NEMA	B

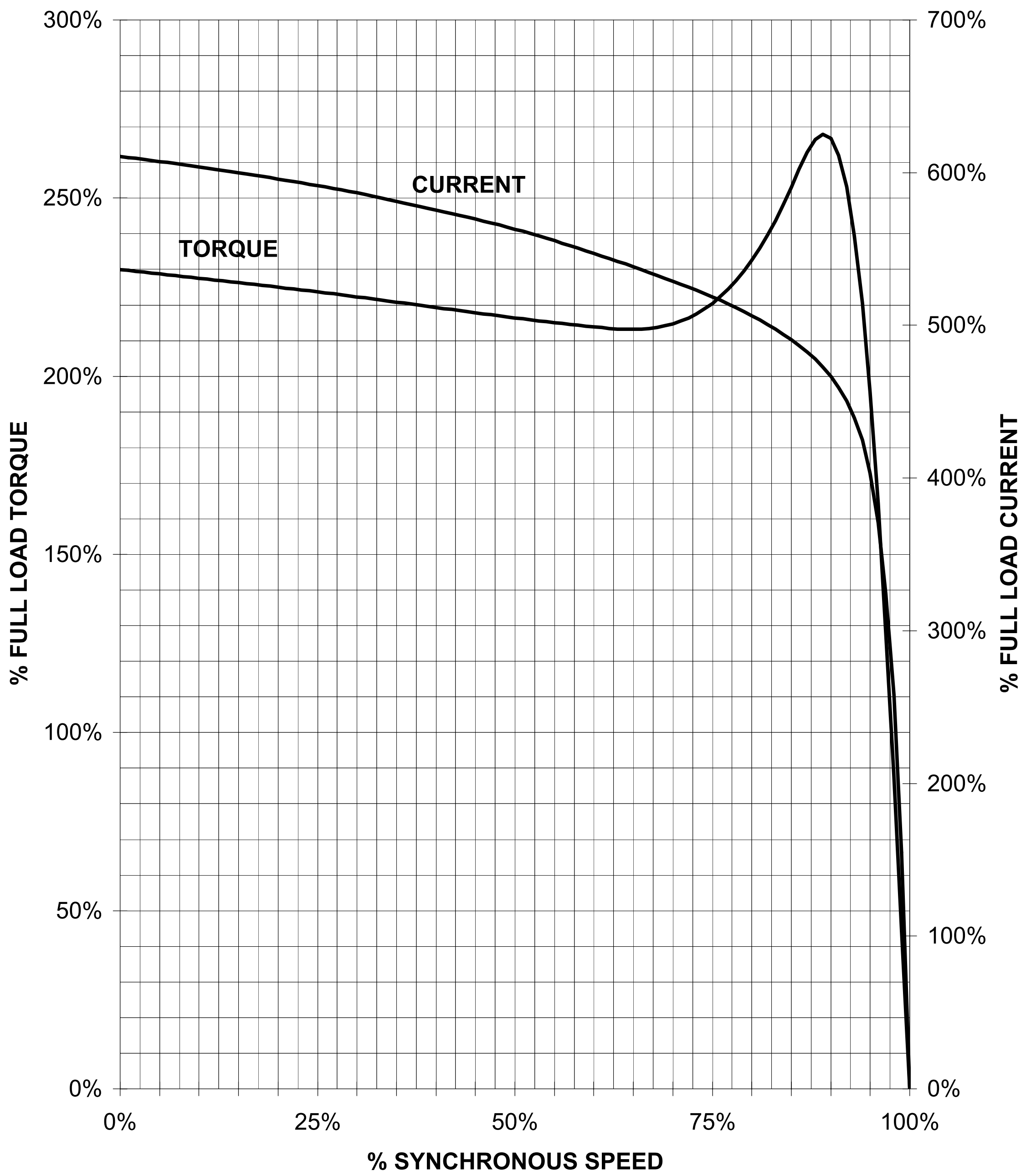
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	15	VOLTS	460	RPM	1800	TYPE	GP10
HZ	60	PHASE	3	FRAME	254T	NEMA	B

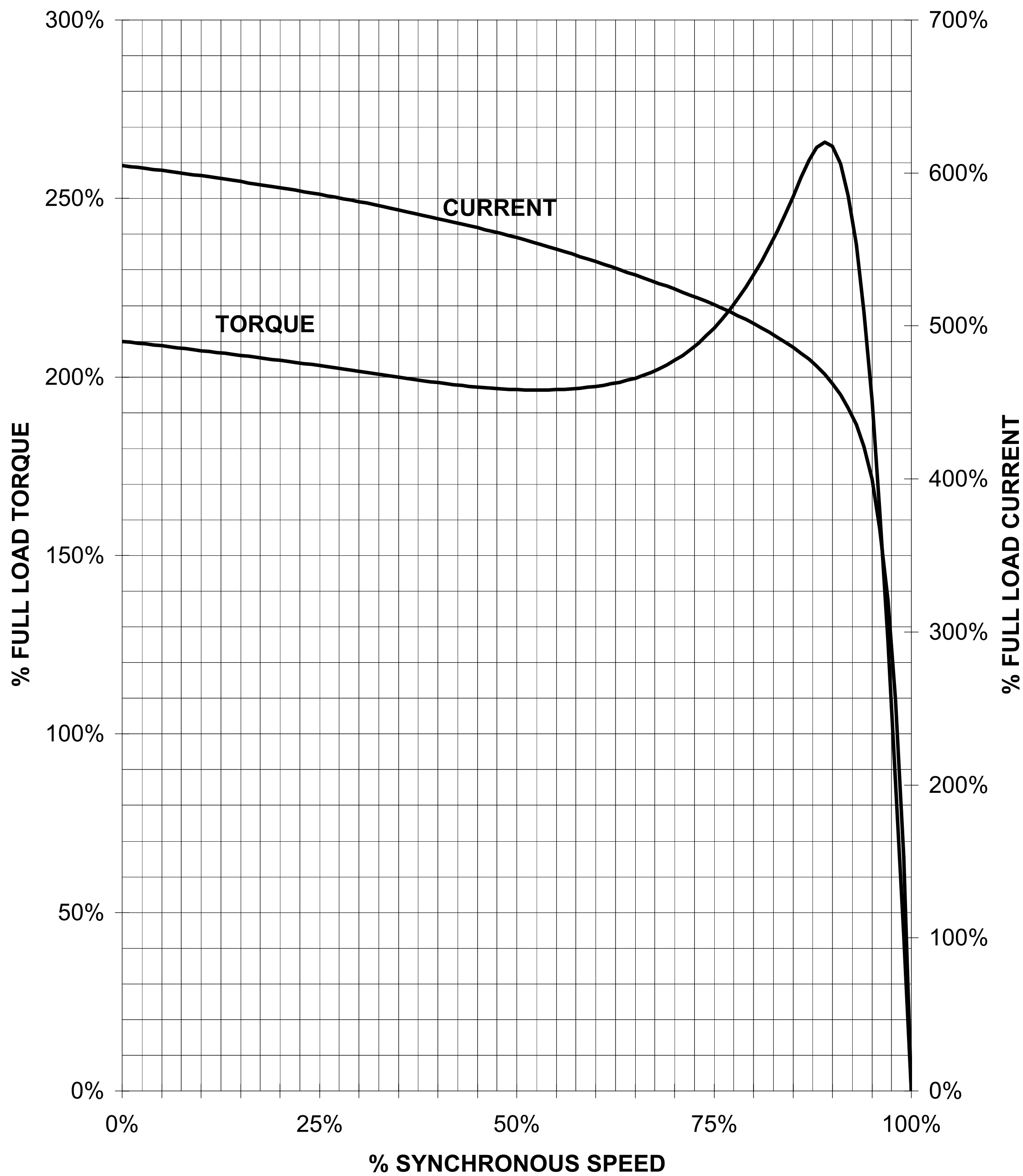
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	20	VOLTS	460	RPM	3600	TYPE	GP10
HZ	60	PHASE	3	FRAME	256T	NEMA	B

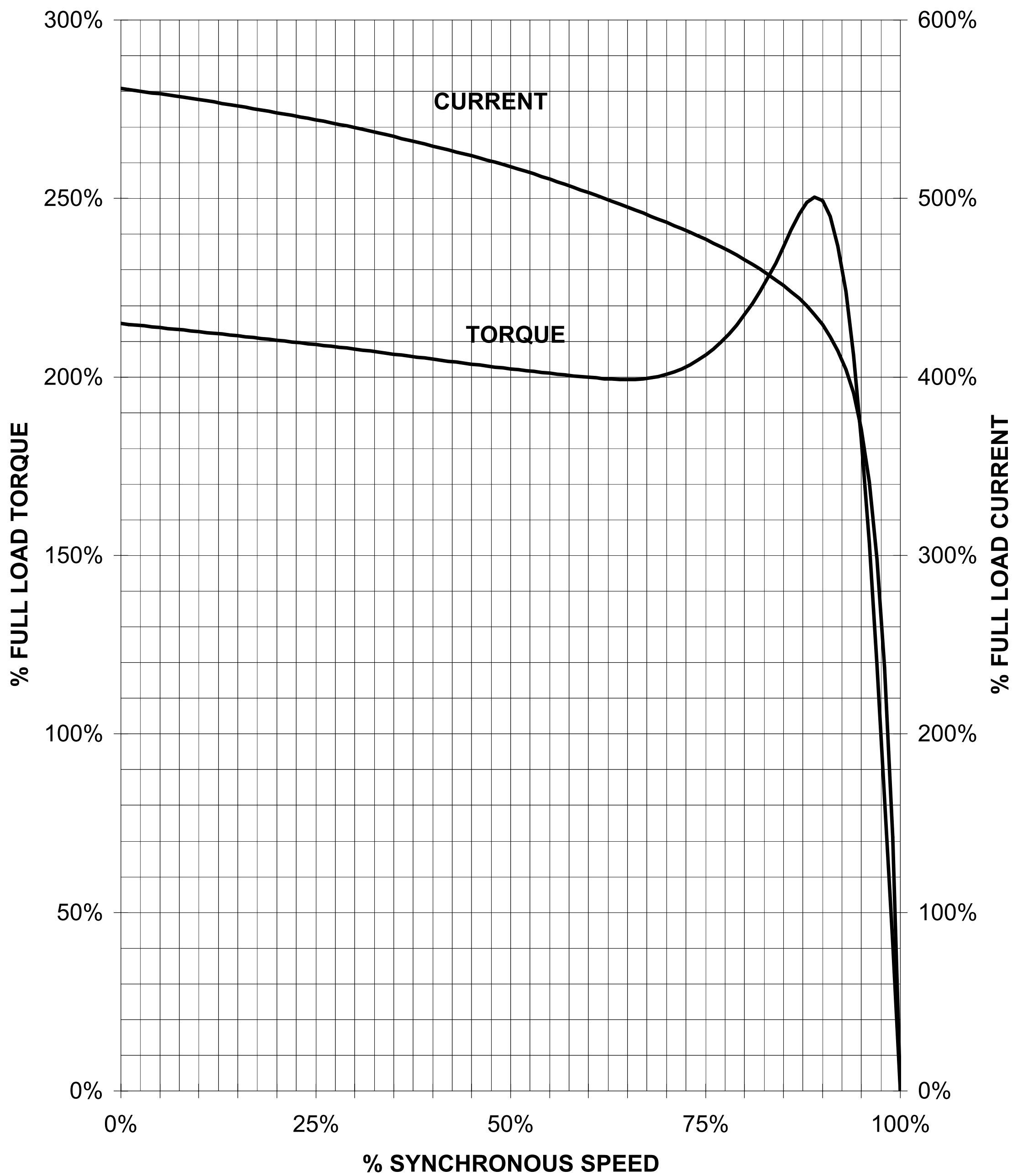
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	20	VOLTS	460	RPM	1800	TYPE	GP10
HZ	60	PHASE	3	FRAME	256T	NEMA	B

TORQUE & CURRENT VS. SPEED

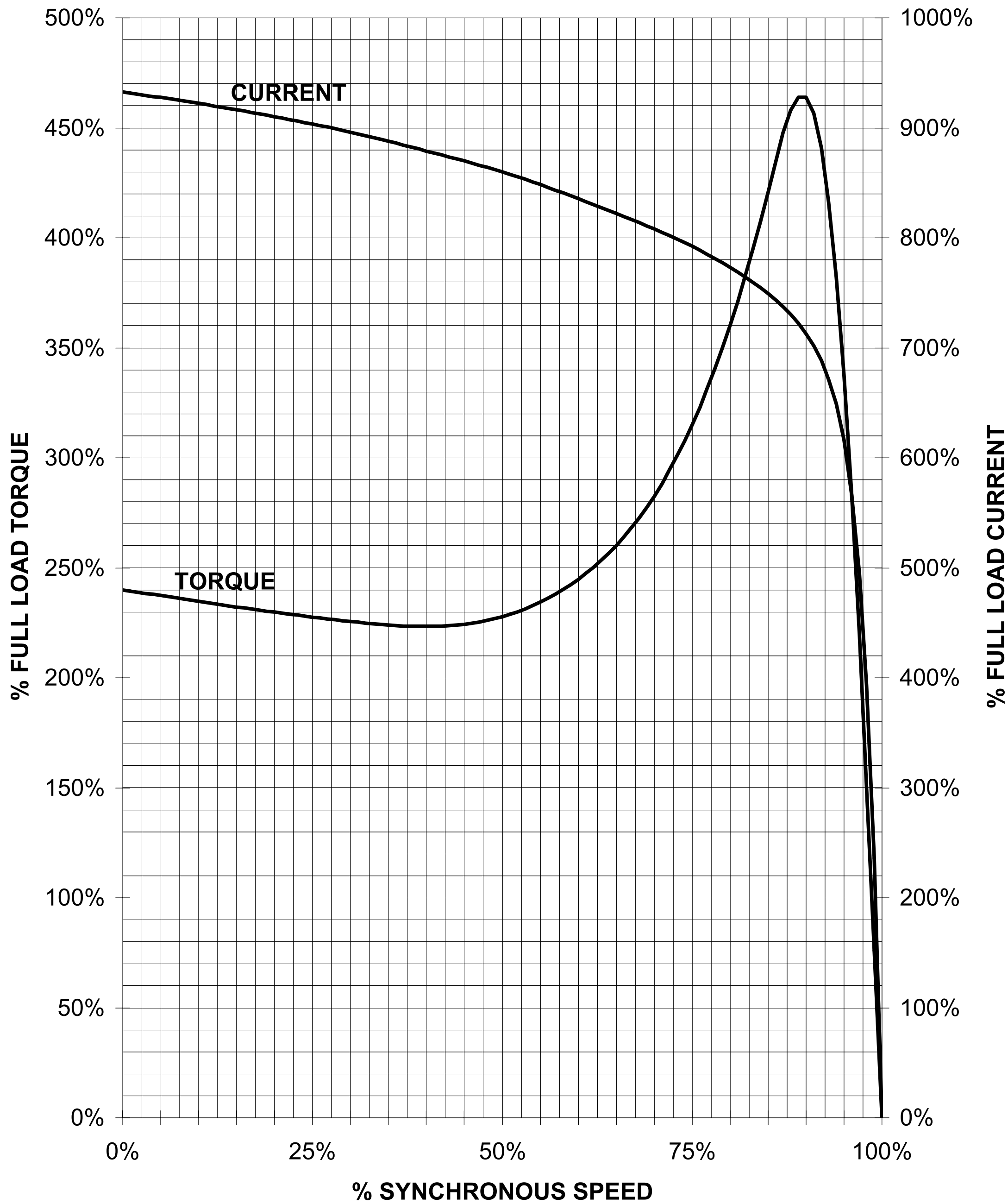


Customer: **PO No.:** **Order No.:**

Application Manual for NEMA Motors

HP	1	VOLTS	460	RPM	3600	TYPE	GP10A
HZ	60	PHASE	3	FRAME	143T	NEMA	B

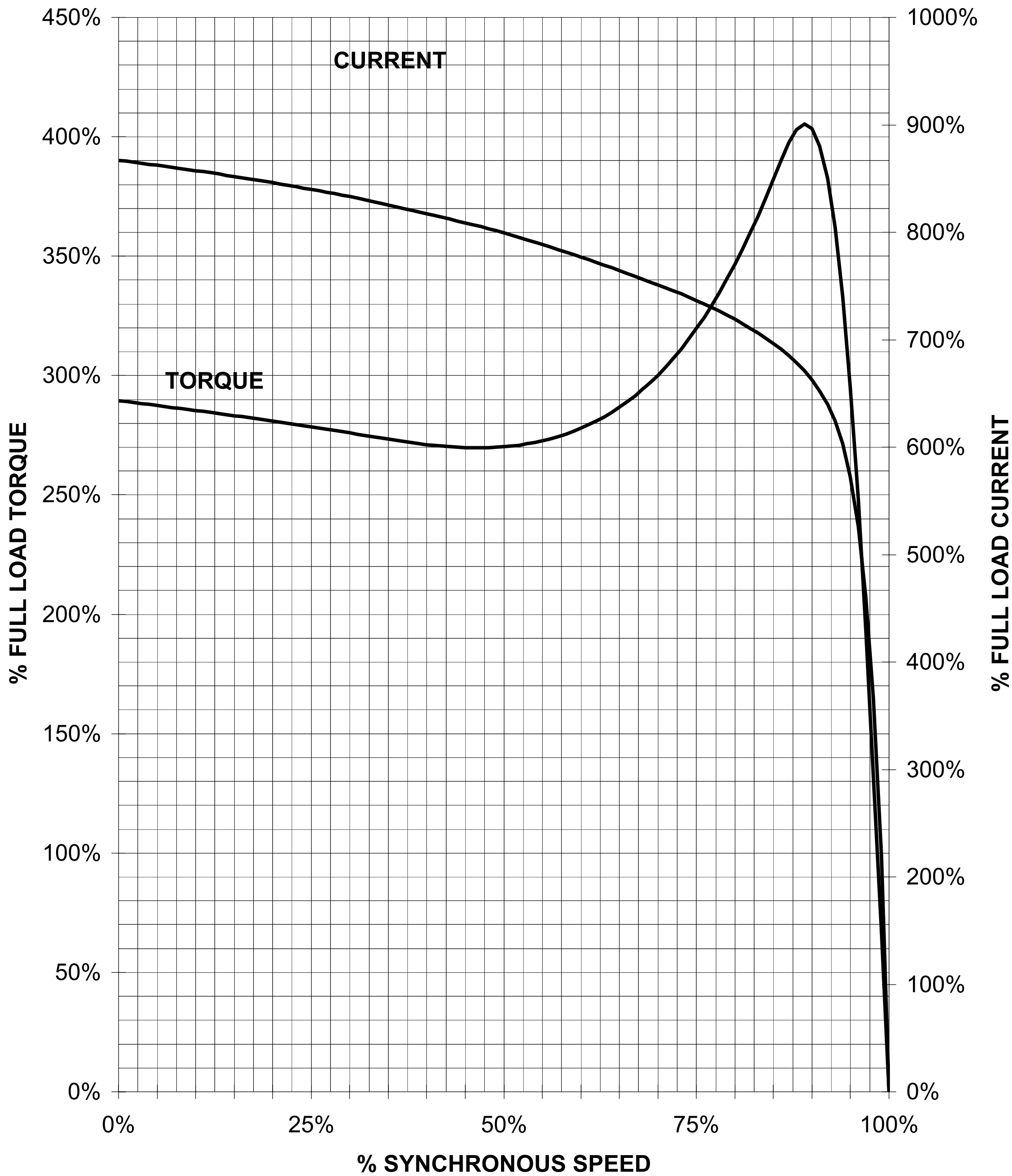
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1	VOLTS	460	RPM	1800	TYPE	GP10A
HZ	60	PHASE	3	FRAME	143T	NEMA	B

TORQUE & CURRENT VS. SPEED

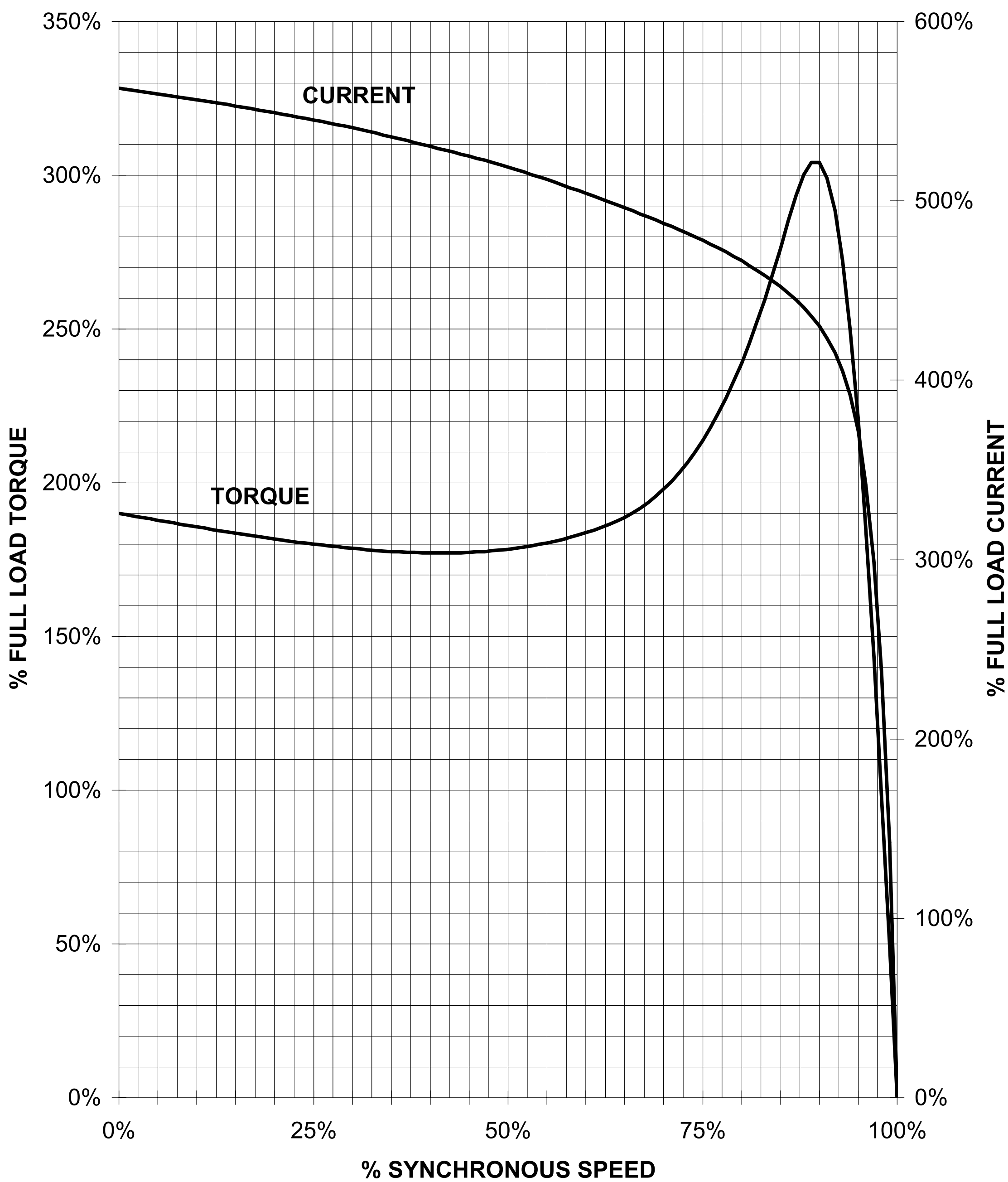


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	1	VOLTS	460	RPM	1200	TYPE	GP10A
HZ	60	PHASE	3	FRAME	145T	NEMA	B

TORQUE & CURRENT VS. SPEED

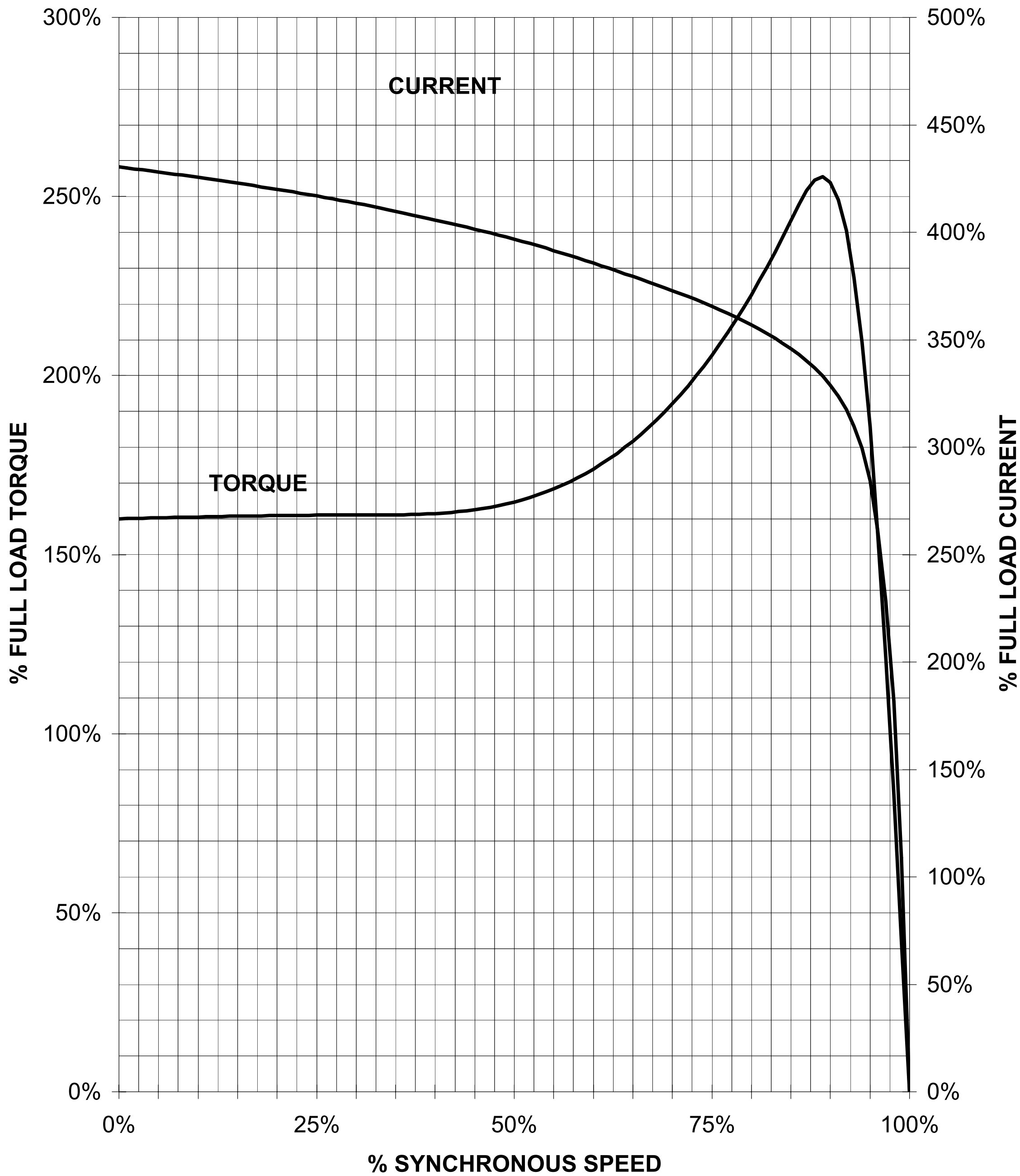


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	1	VOLTS	460	RPM	900	TYPE	GP10A
HZ	60	PHASE	3	FRAME	182T	NEMA	B

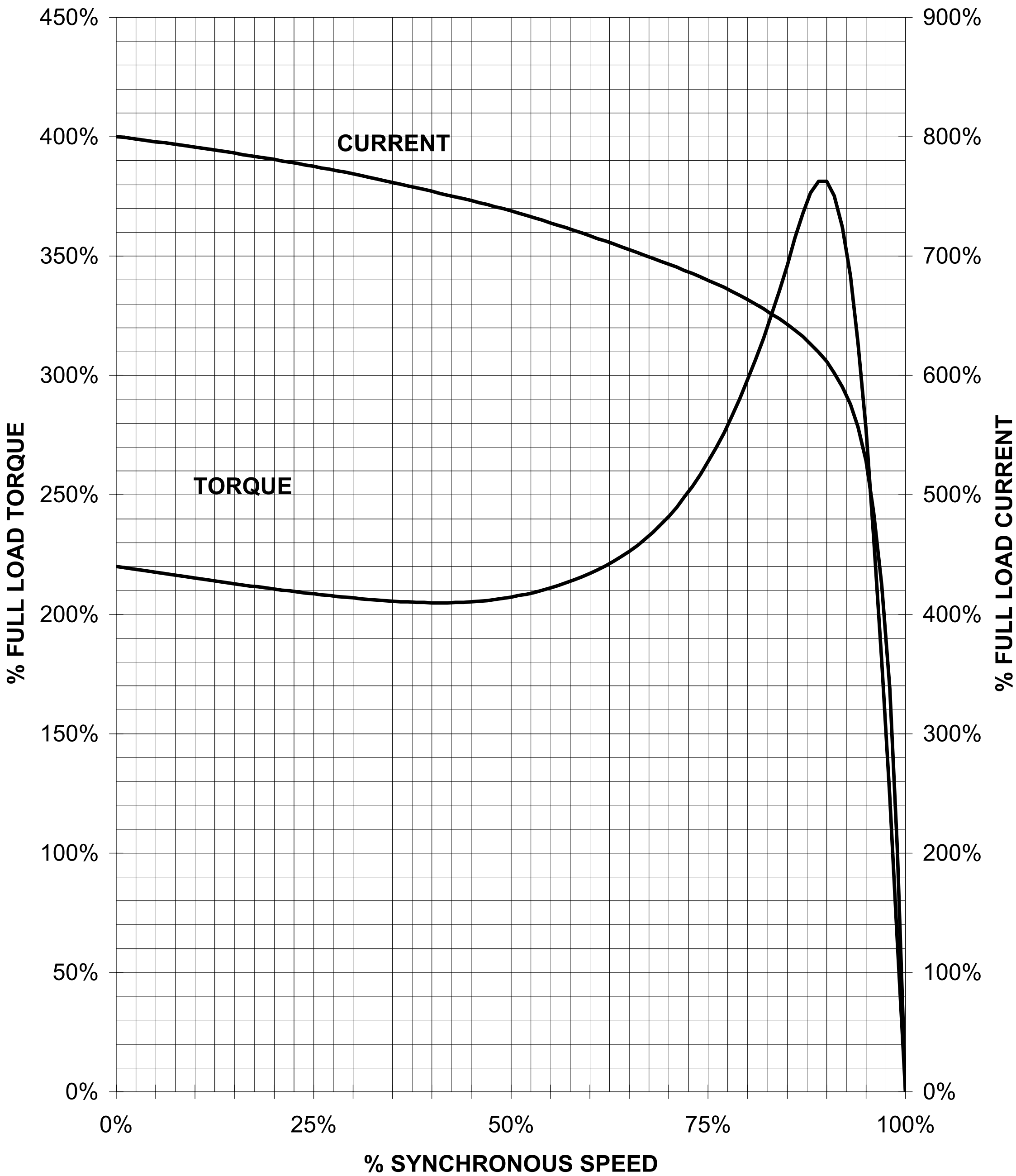
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1.5	VOLTS	460	RPM	3600	TYPE	GP10A
HZ	60	PHASE	3	FRAME	182T	NEMA	B

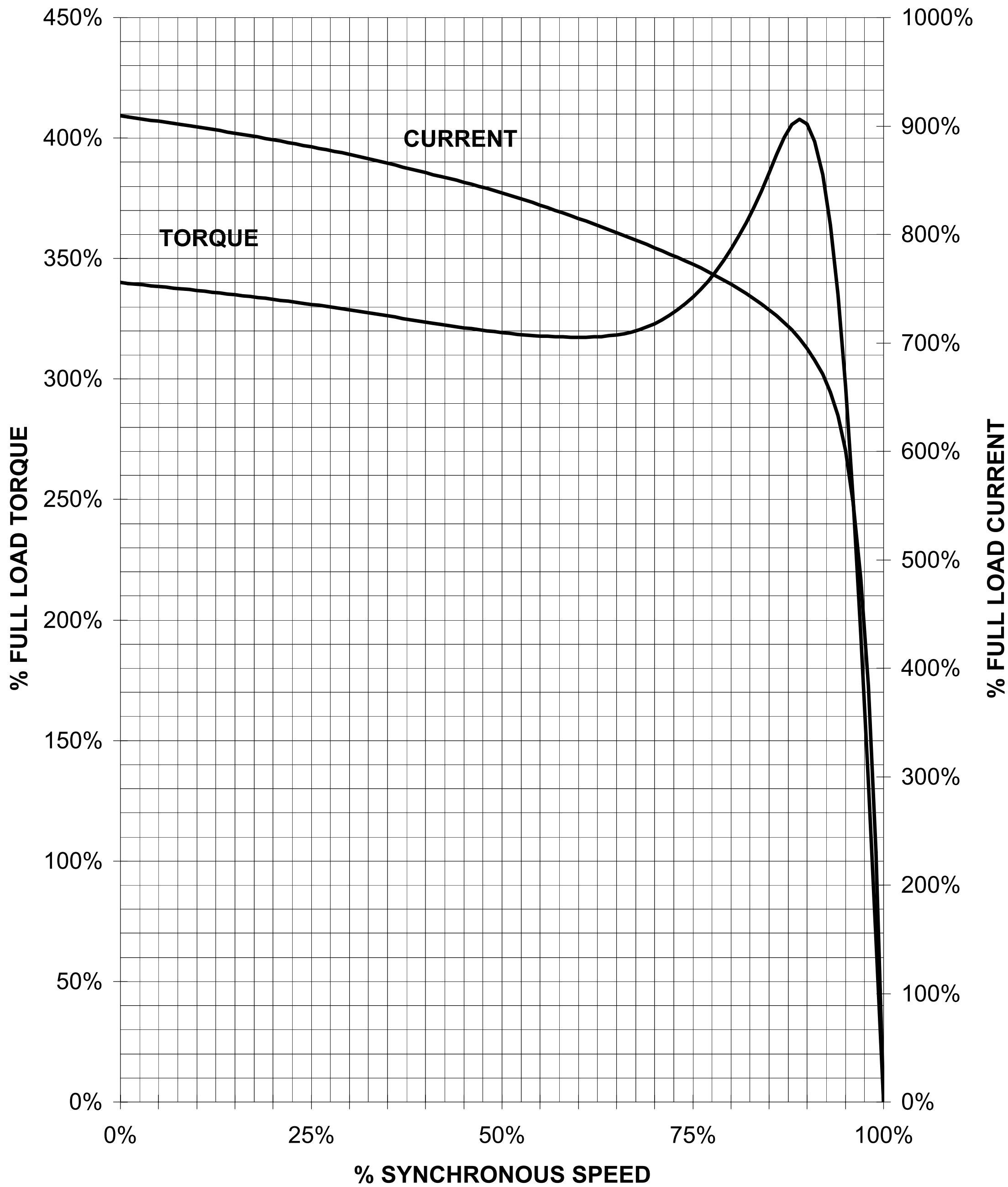
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1.5	VOLTS	460	RPM	1800	TYPE	GP10A
HZ	60	PHASE	3	FRAME	145T	NEMA	B

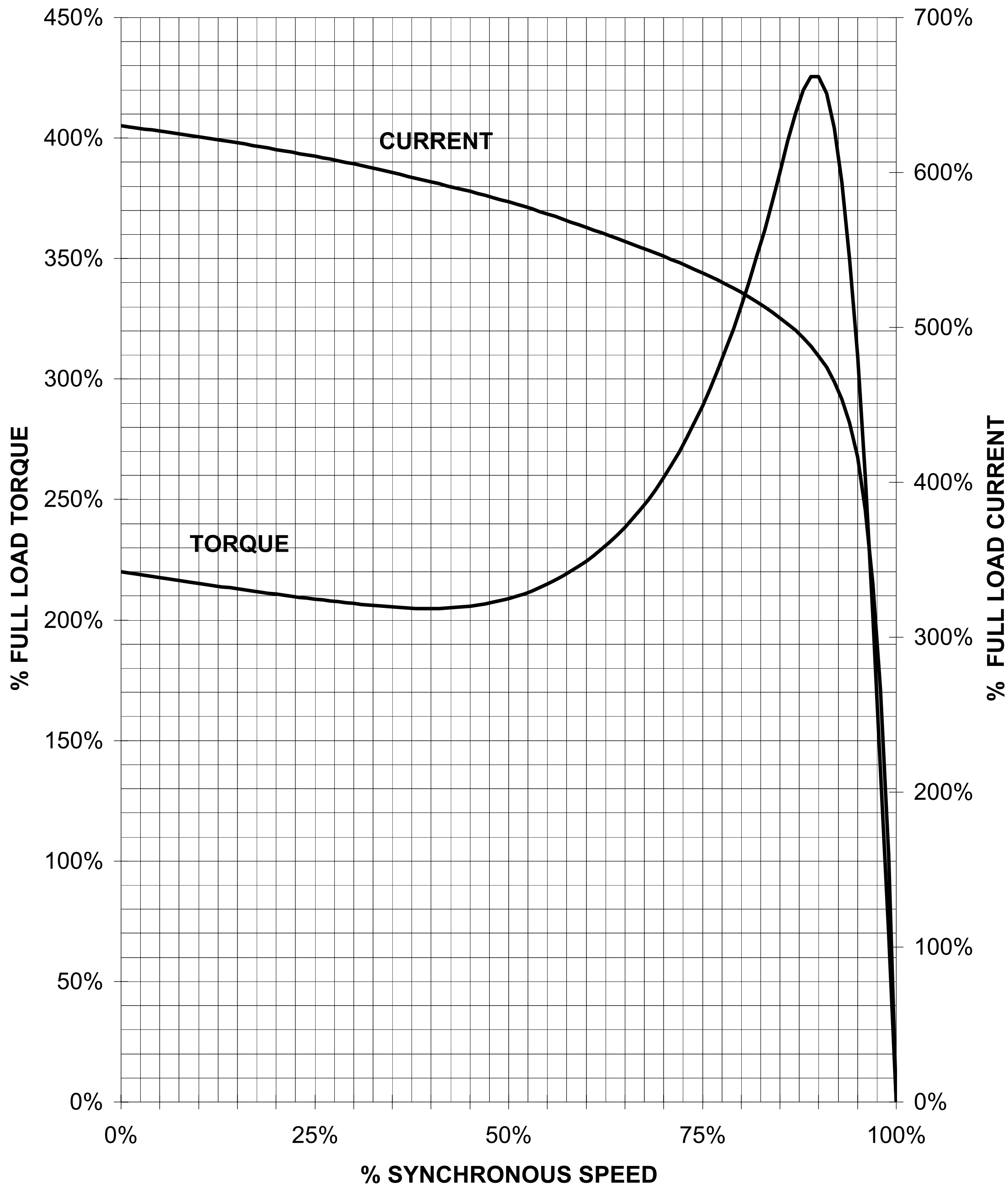
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1.5	VOLTS	460	RPM	1200	TYPE	GP10A
HZ	60	PHASE	3	FRAME	182T	NEMA	B

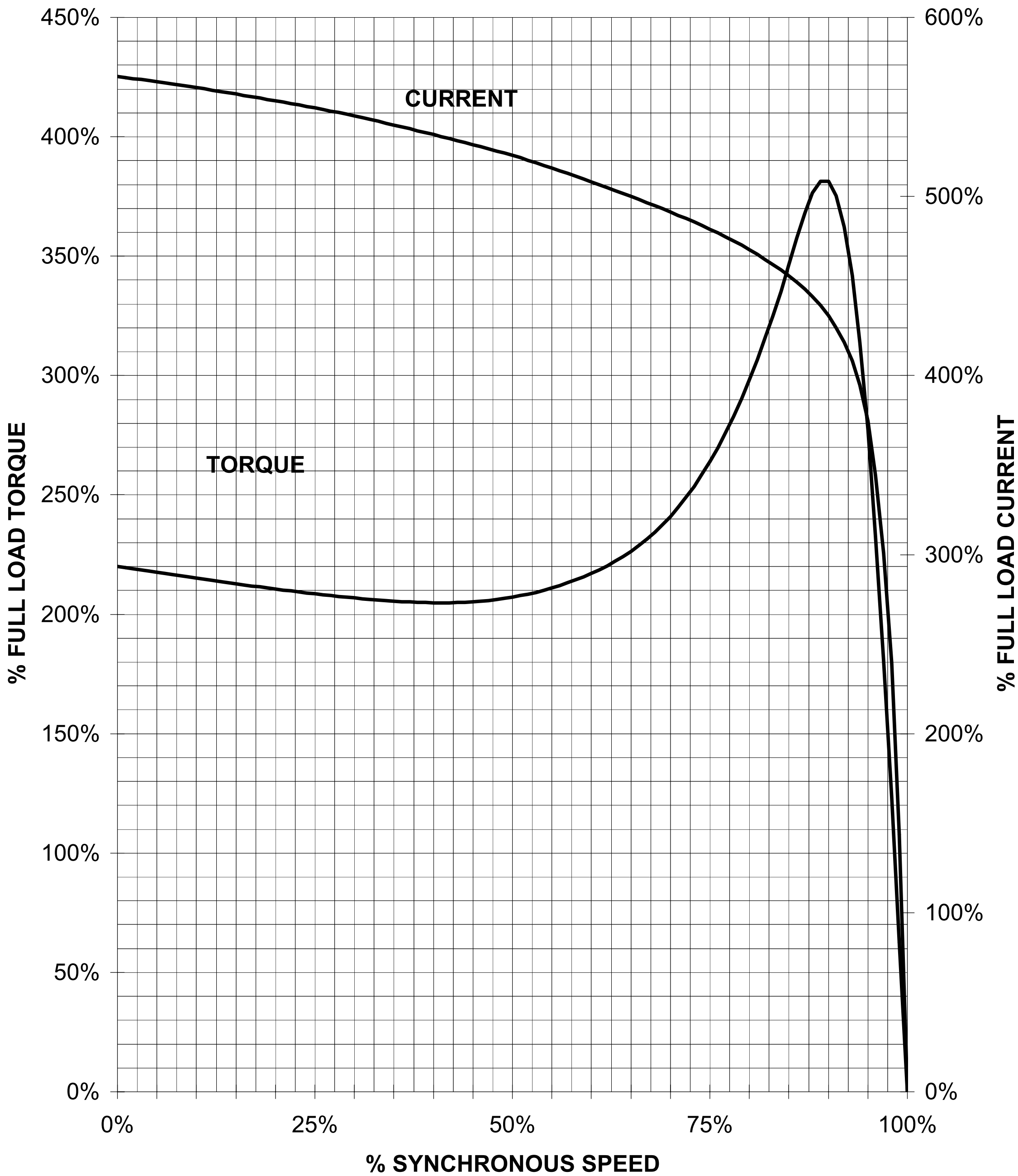
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1.5	VOLTS	460	RPM	900	TYPE	GP10A
HZ	60	PHASE	3	FRAME	184T	NEMA	B

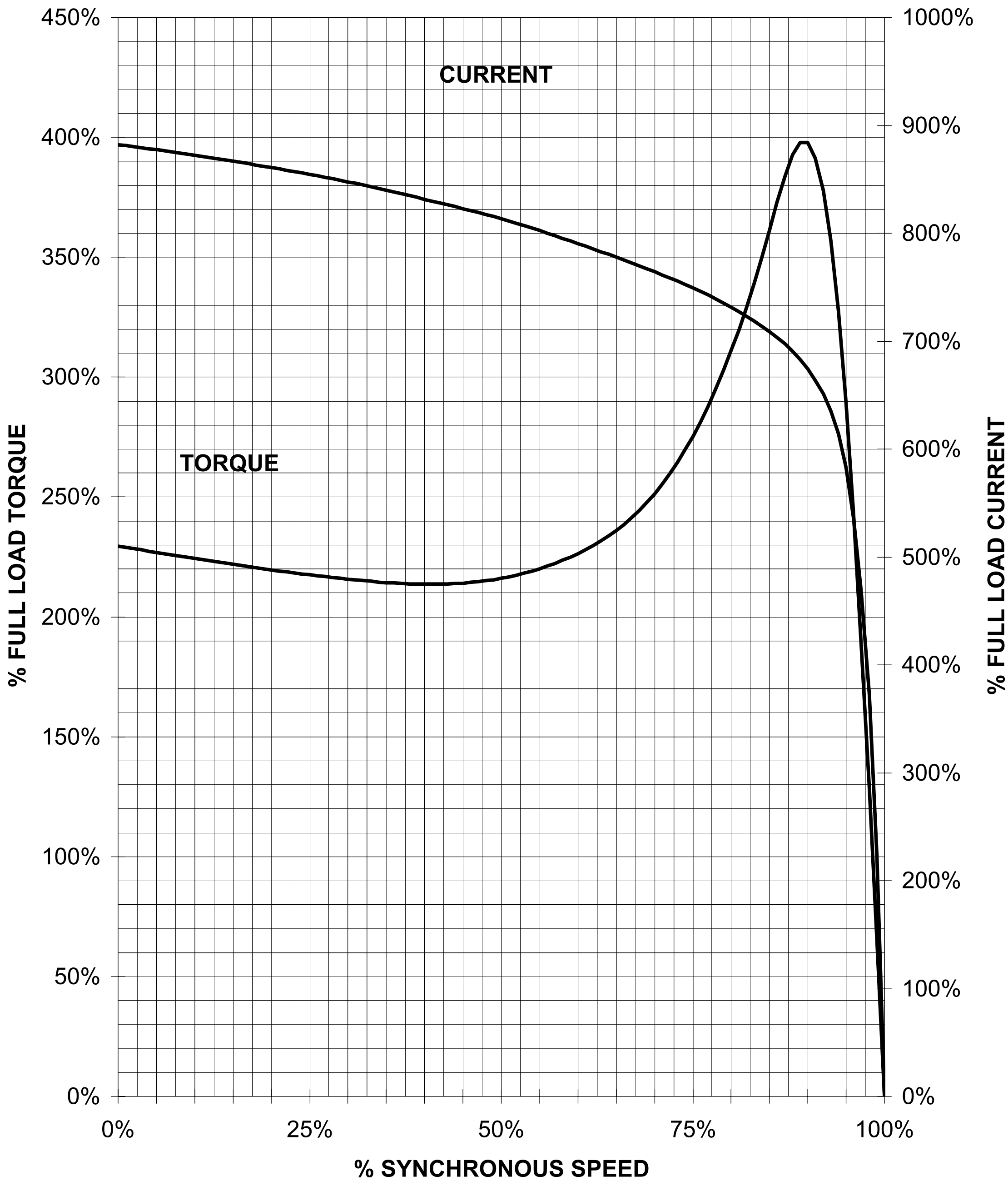
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	2	VOLTS	460	RPM	3600	TYPE	GP10A
HZ	60	PHASE	3	FRAME	145T	NEMA	B

TORQUE & CURRENT VS. SPEED



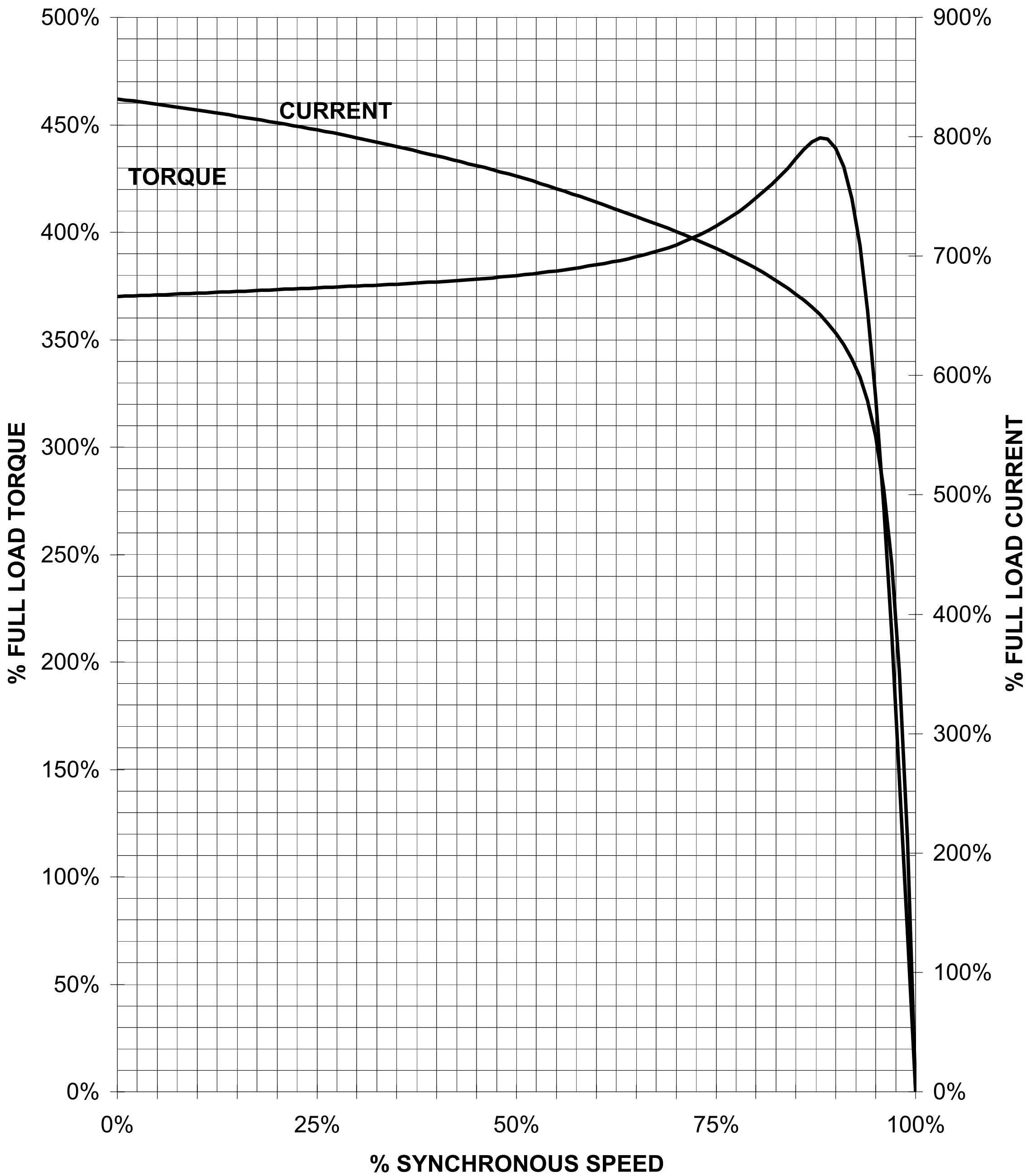
Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

Application Manual for NEMA Motors

HP	2	VOLTS	460	RPM	1800	TYPE	GP10A
HZ	60	PHASE	3	FRAME	145T	NEMA	B

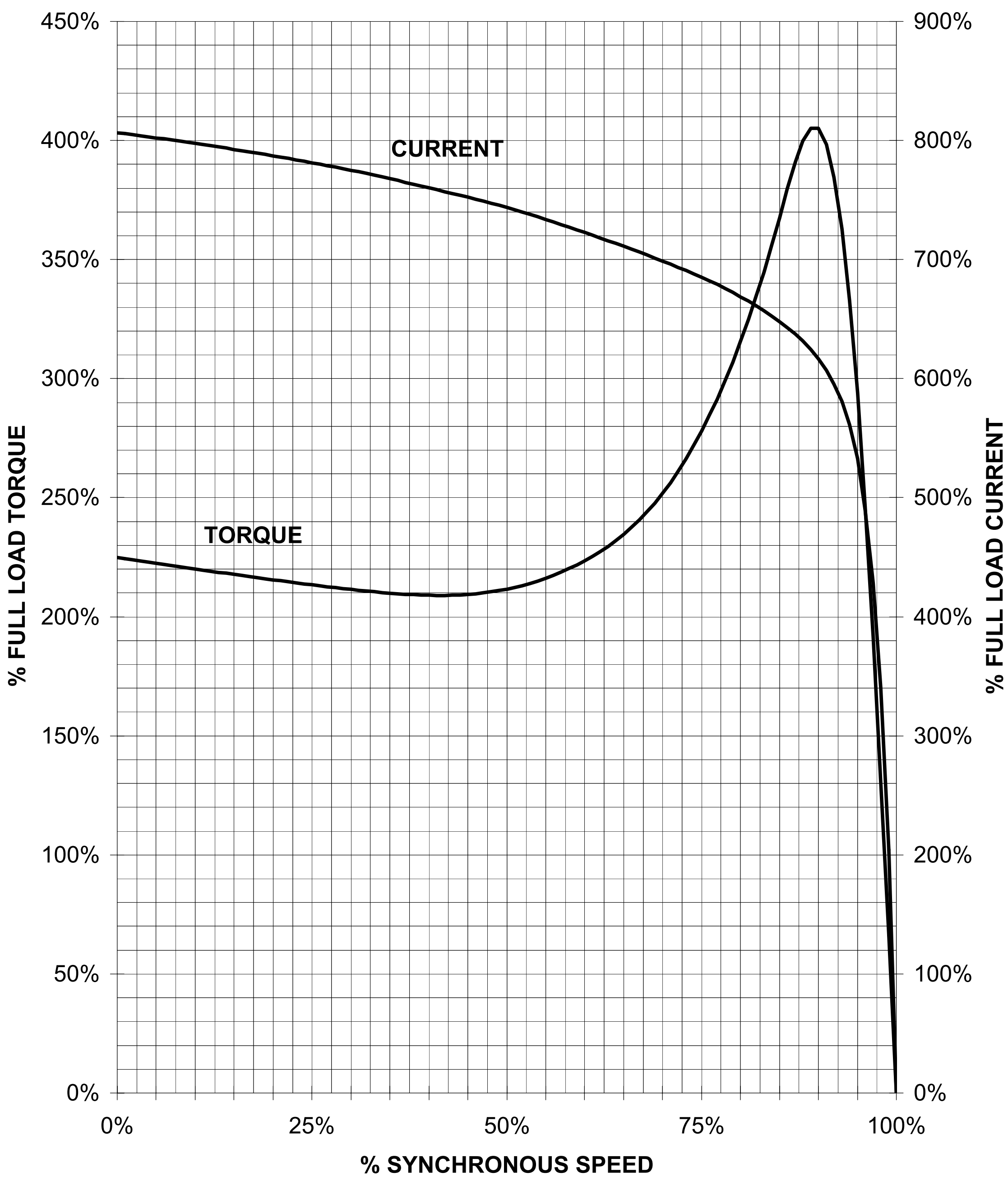
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	2	VOLTS	460	RPM	1200	TYPE	GP10A
HZ	60	PHASE	3	FRAME	184T	NEMA	B

TORQUE & CURVE VS. SPEED

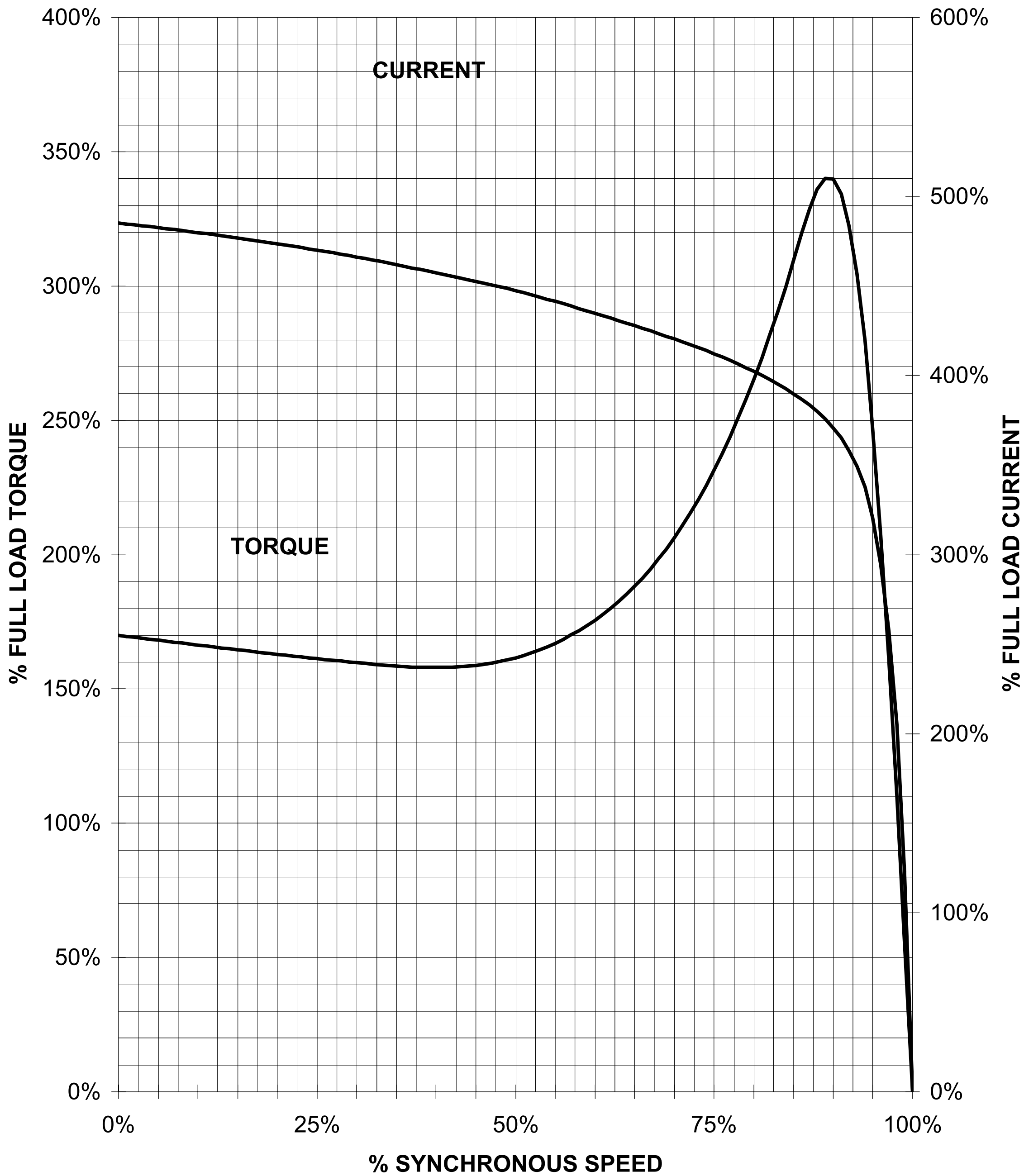


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	2	VOLTS	460	RPM	900	TYPE	GP10A
HZ	60	PHASE	3	FRAME	213T	NEMA	B

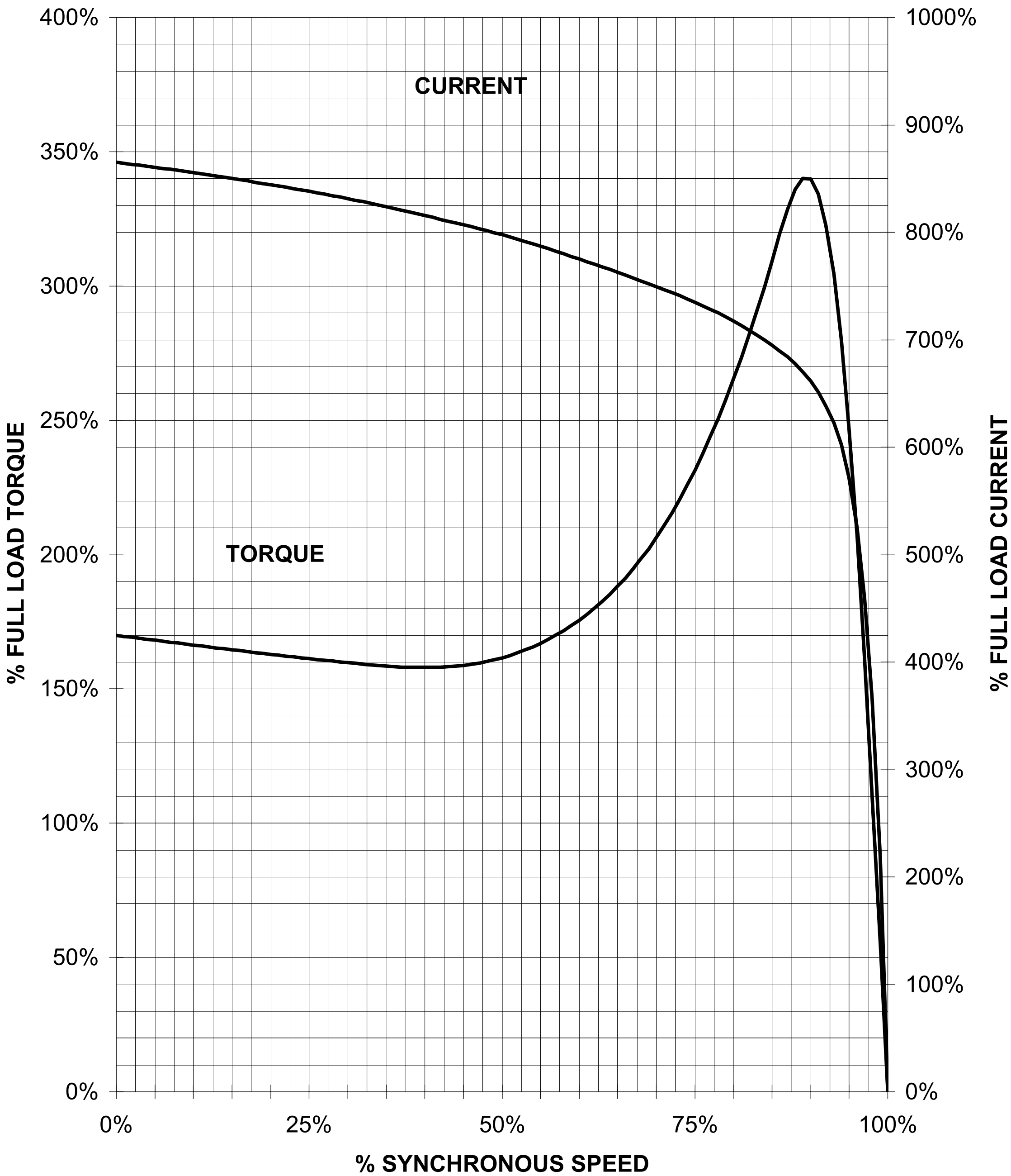
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	3	VOLTS	460	RPM	3600	TYPE	GP10A
HZ	60	PHASE	3	FRAME	182T	NEMA	B

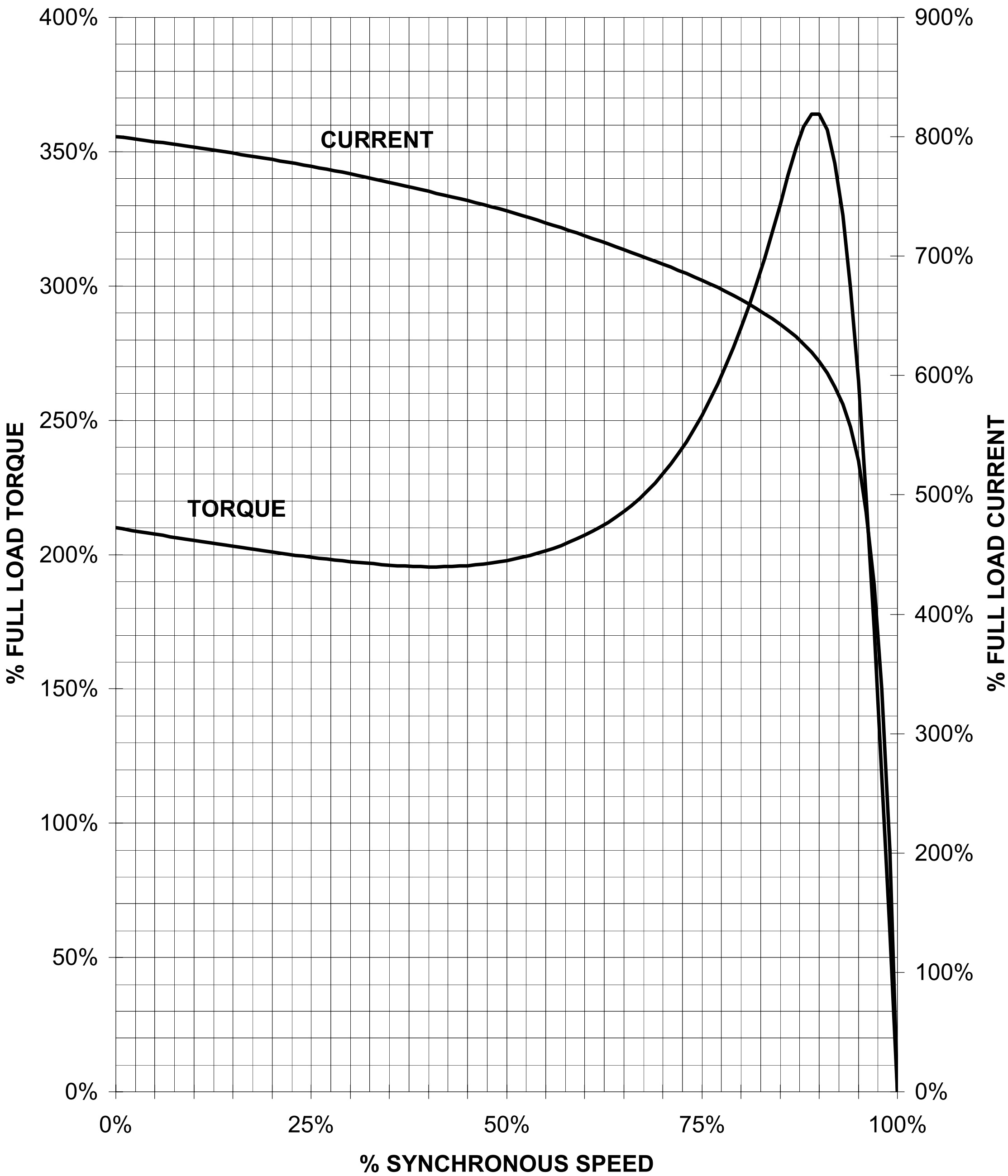
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	3	VOLTS	460	RPM	1800	TYPE	GP10A
HZ	60	PHASE	3	FRAME	182T	NEMA	B

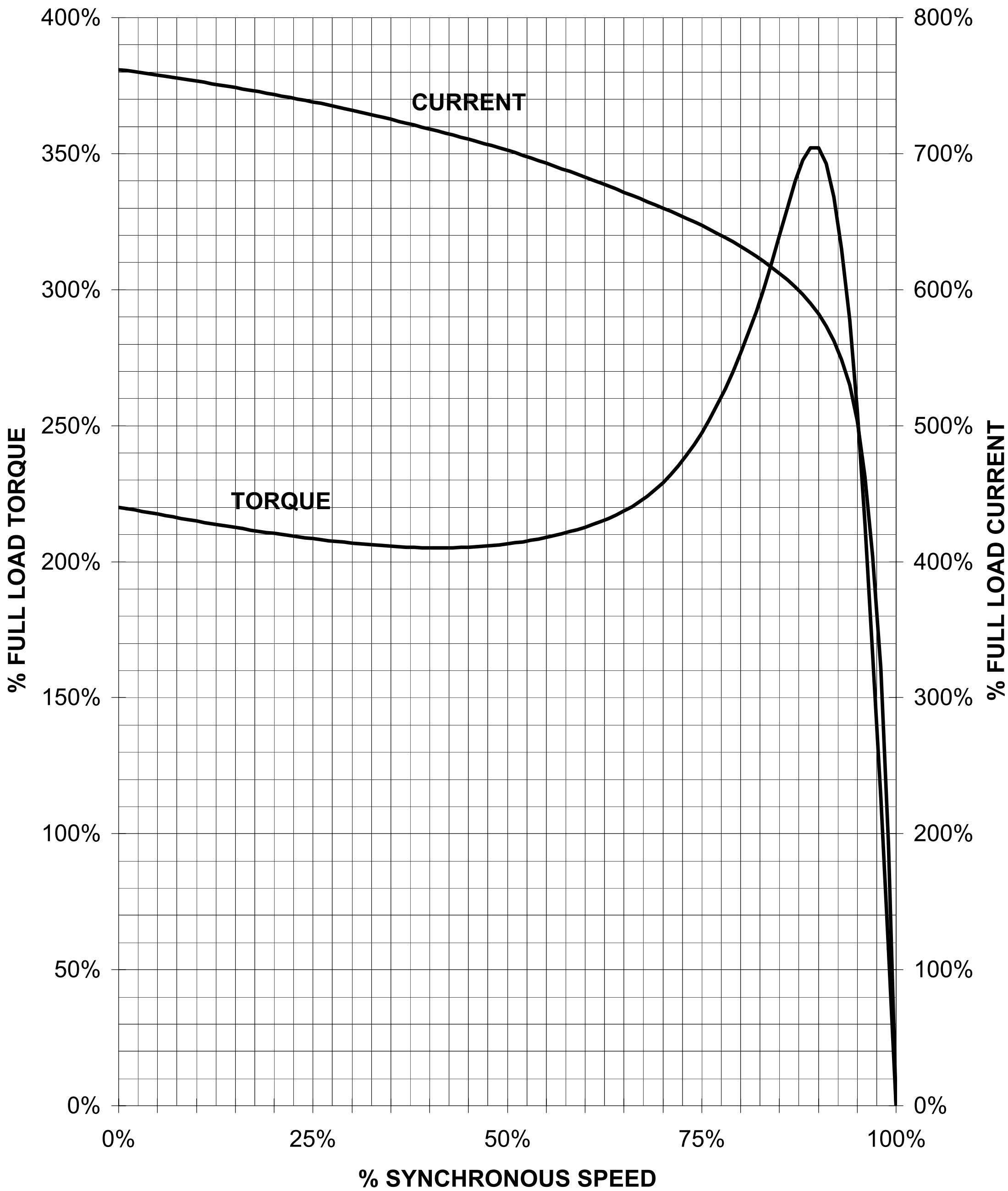
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	3	VOLTS	460	RPM	1200	TYPE	GP10A
HZ	60	PHASE	3	FRAME	213T	NEMA	B

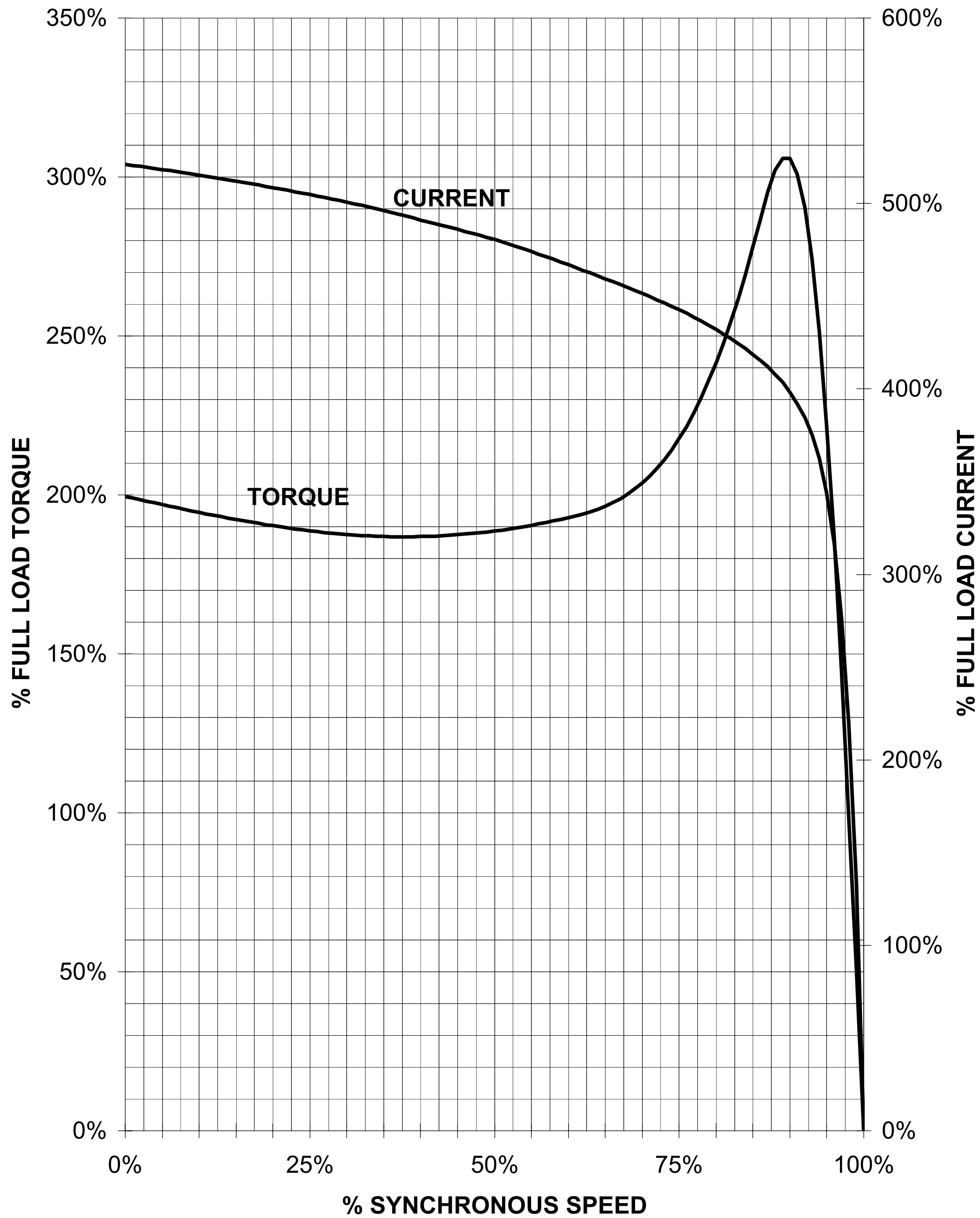
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	3	VOLTS	460	RPM	900	TYPE	GP10A
HZ	60	PHASE	3	FRAME	215T	NEMA	B

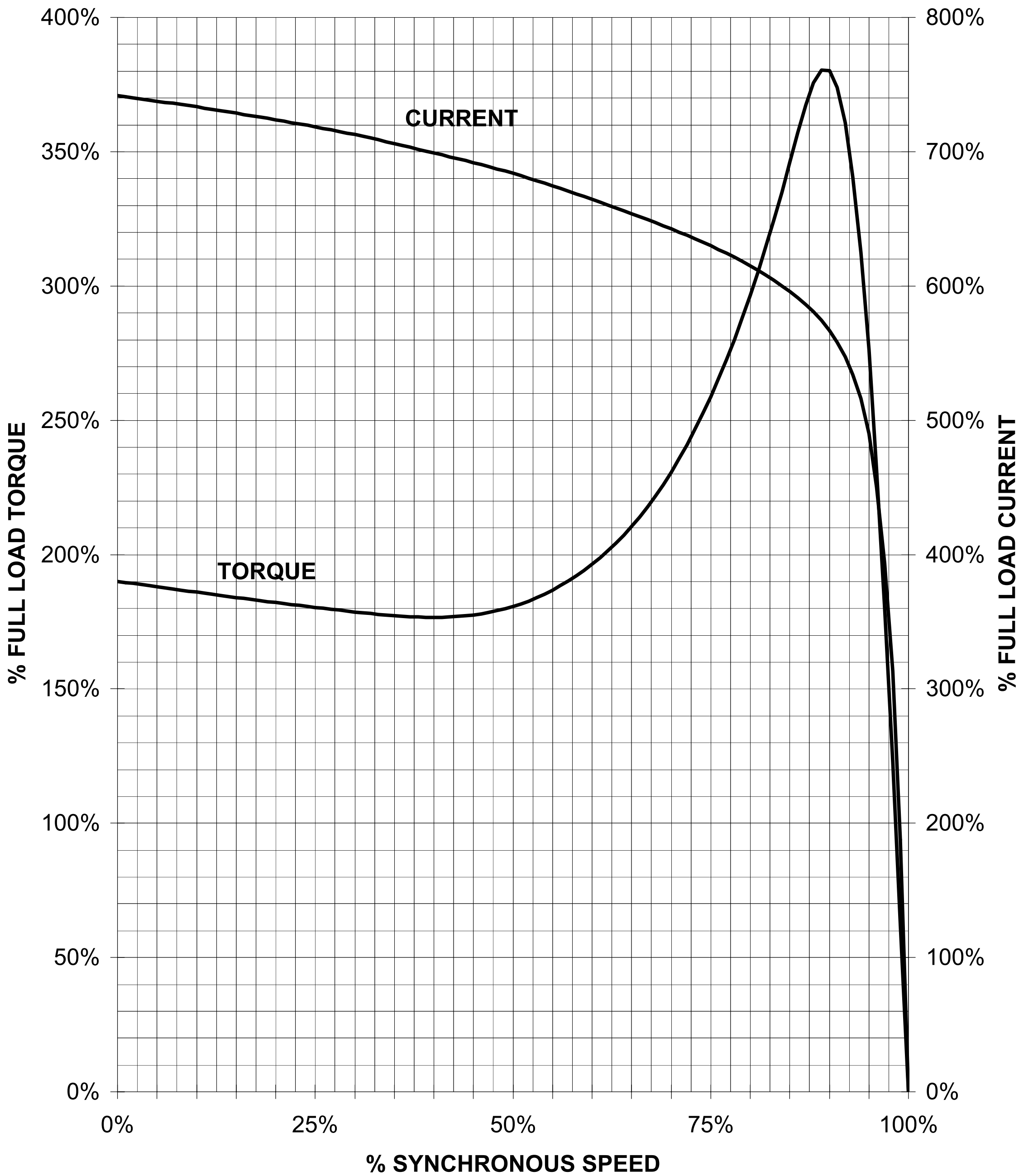
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	5	VOLTS	460	RPM	3600	TYPE	GP10A
HZ	60	PHASE	3	FRAME	184T	NEMA	B

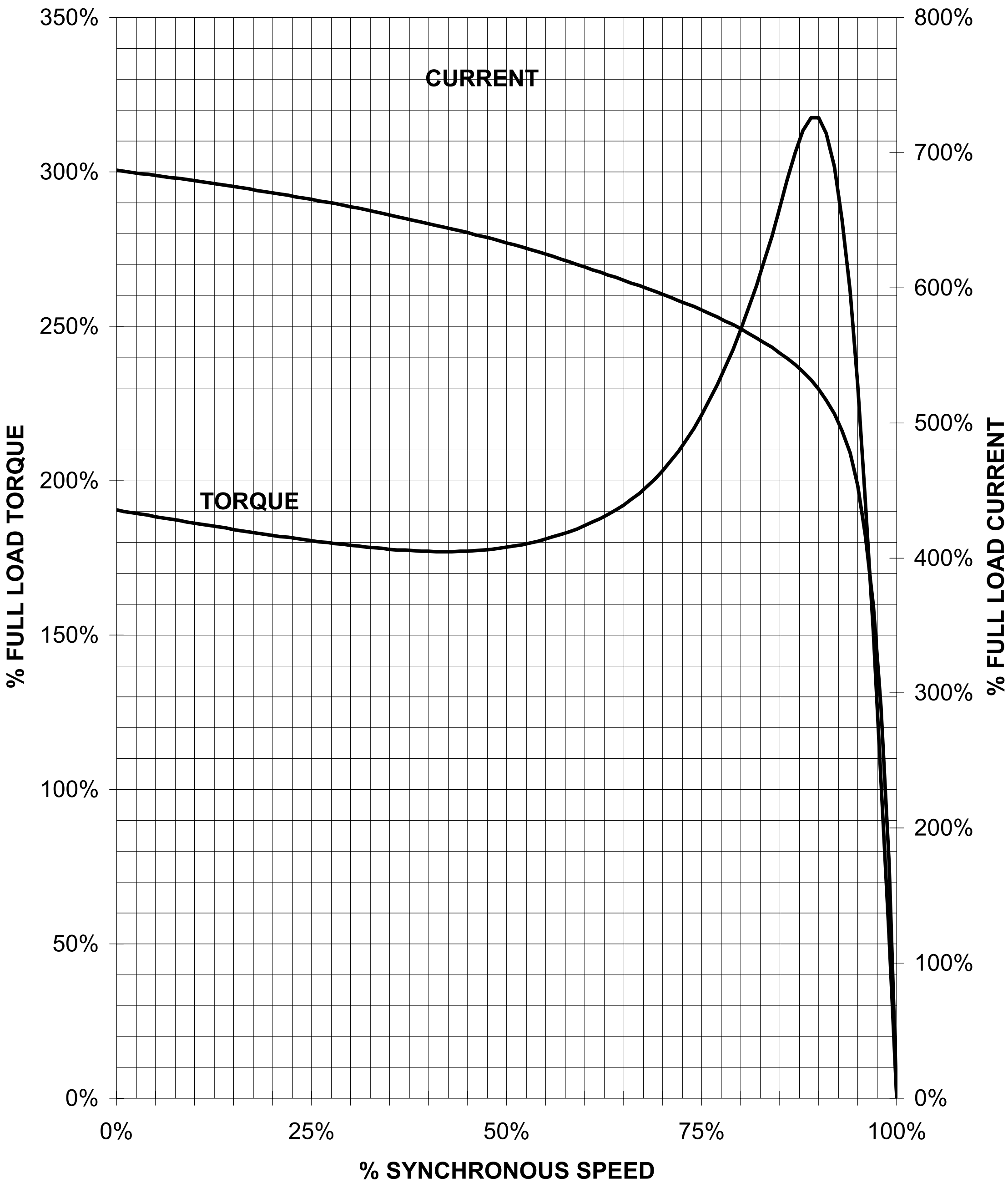
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	5	VOLTS	460	RPM	1800	TYPE	GP10A
HZ	60	PHASE	3	FRAME	184T	NEMA	B

TORQUE & CURRENT VS. SPEED

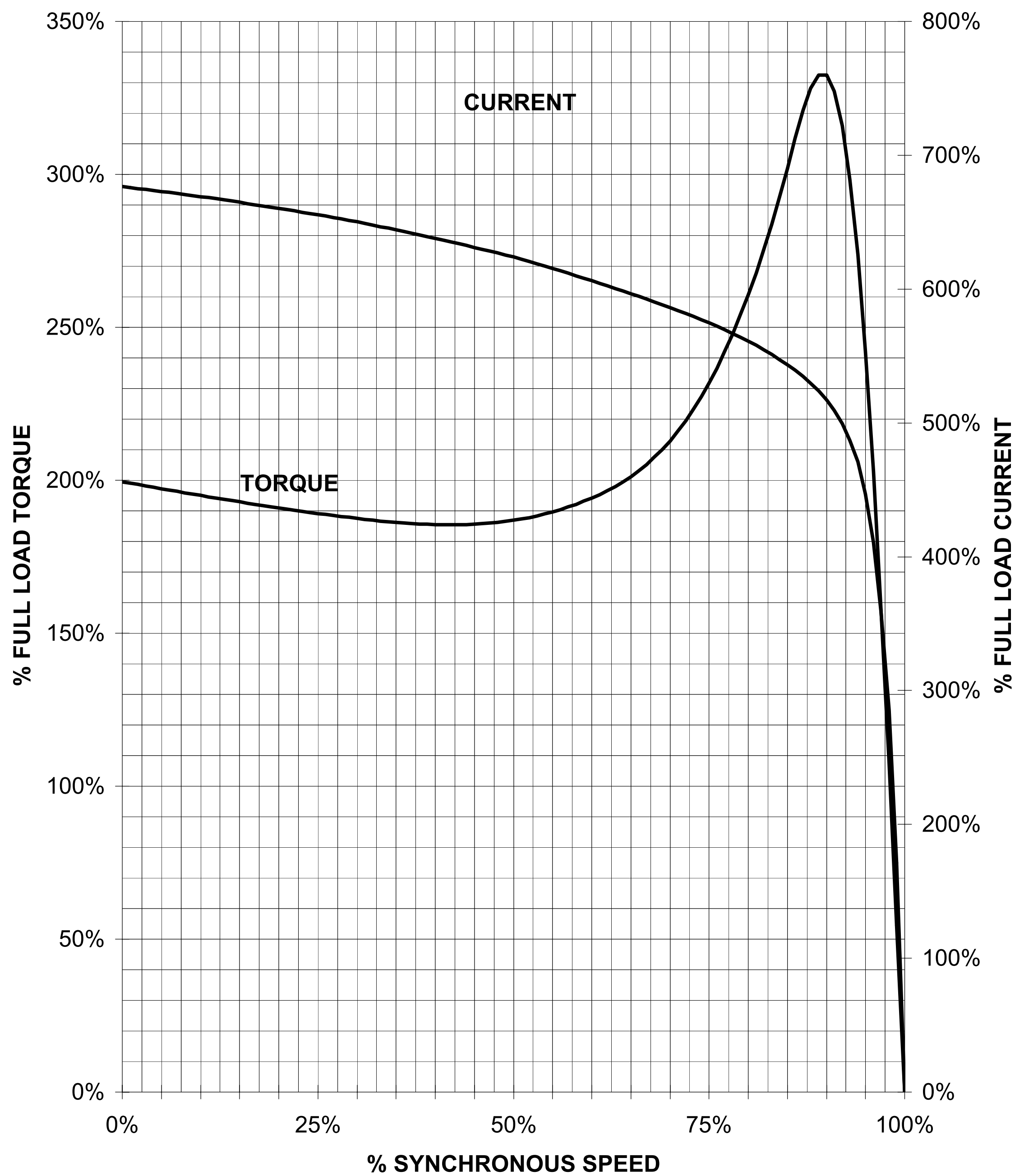


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	5	VOLTS	460	RPM	1200	TYPE	GP10A
HZ	60	PHASE	3	FRAME	215T	NEMA	B

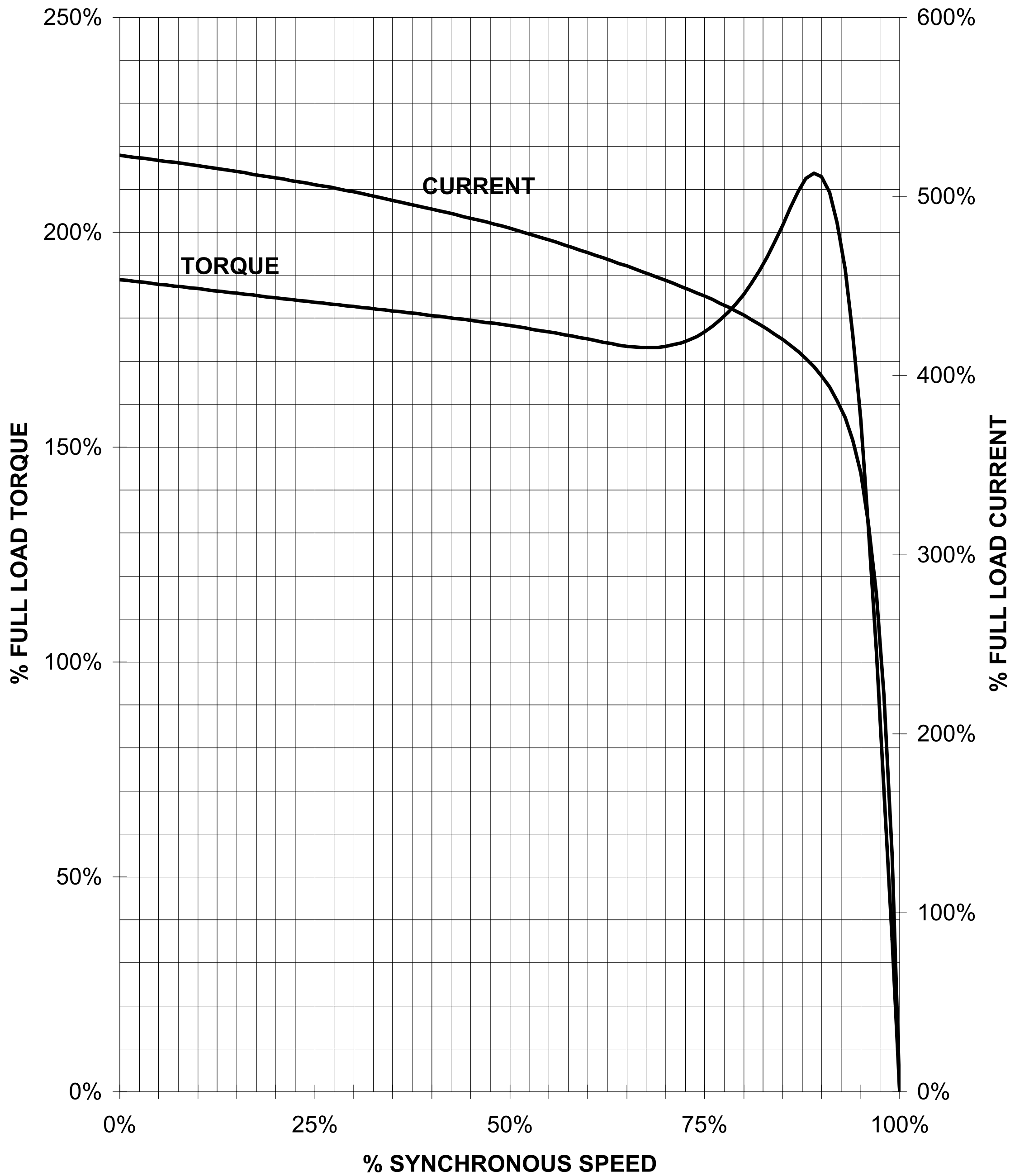
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	5	VOLTS	460	RPM	900	TYPE	GP10A
HZ	60	PHASE	3	FRAME	254T	NEMA	B

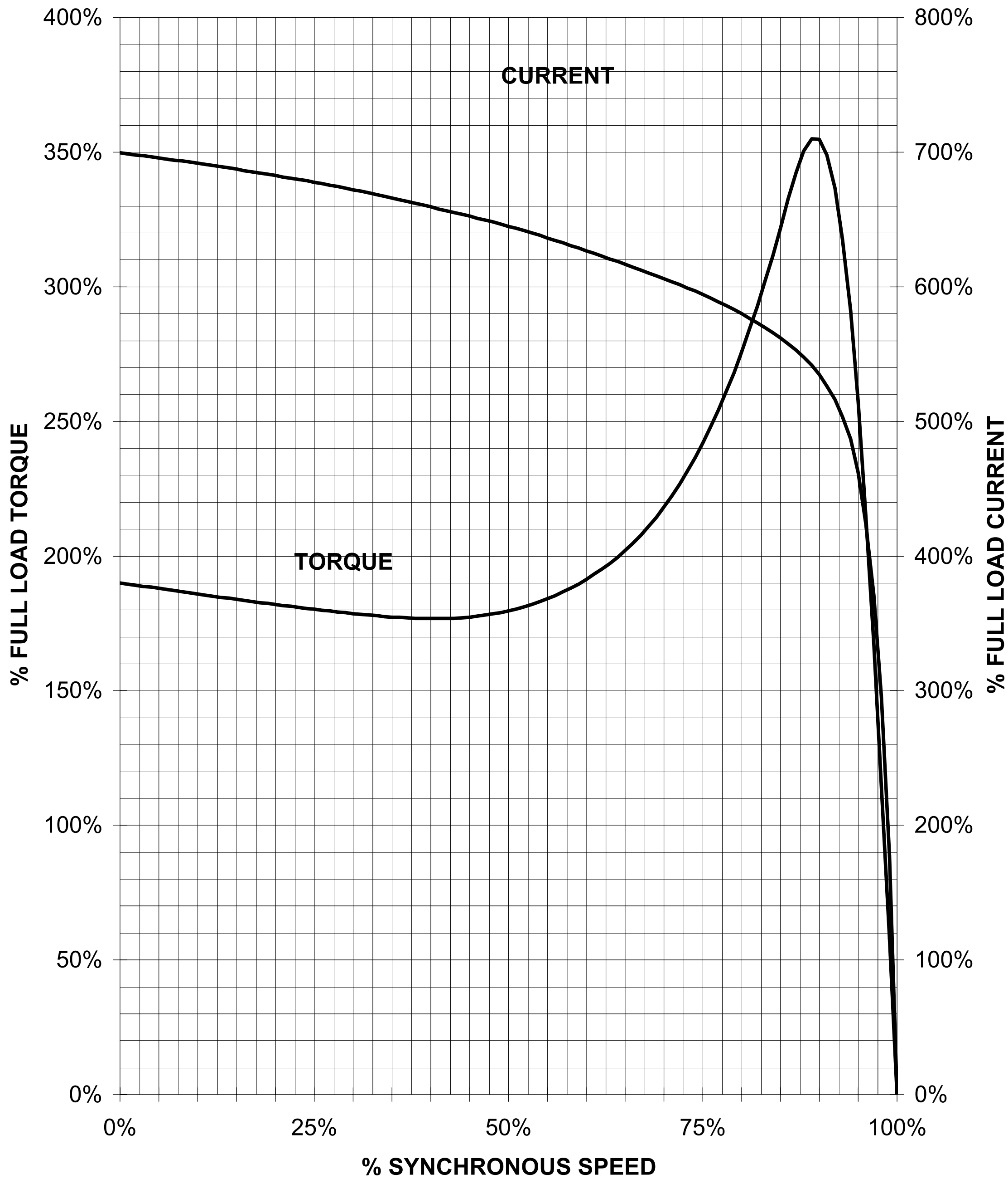
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	7.5	VOLTS	460	RPM	3600	TYPE	GP10A
HZ	60	PHASE	3	FRAME	213T	NEMA	B

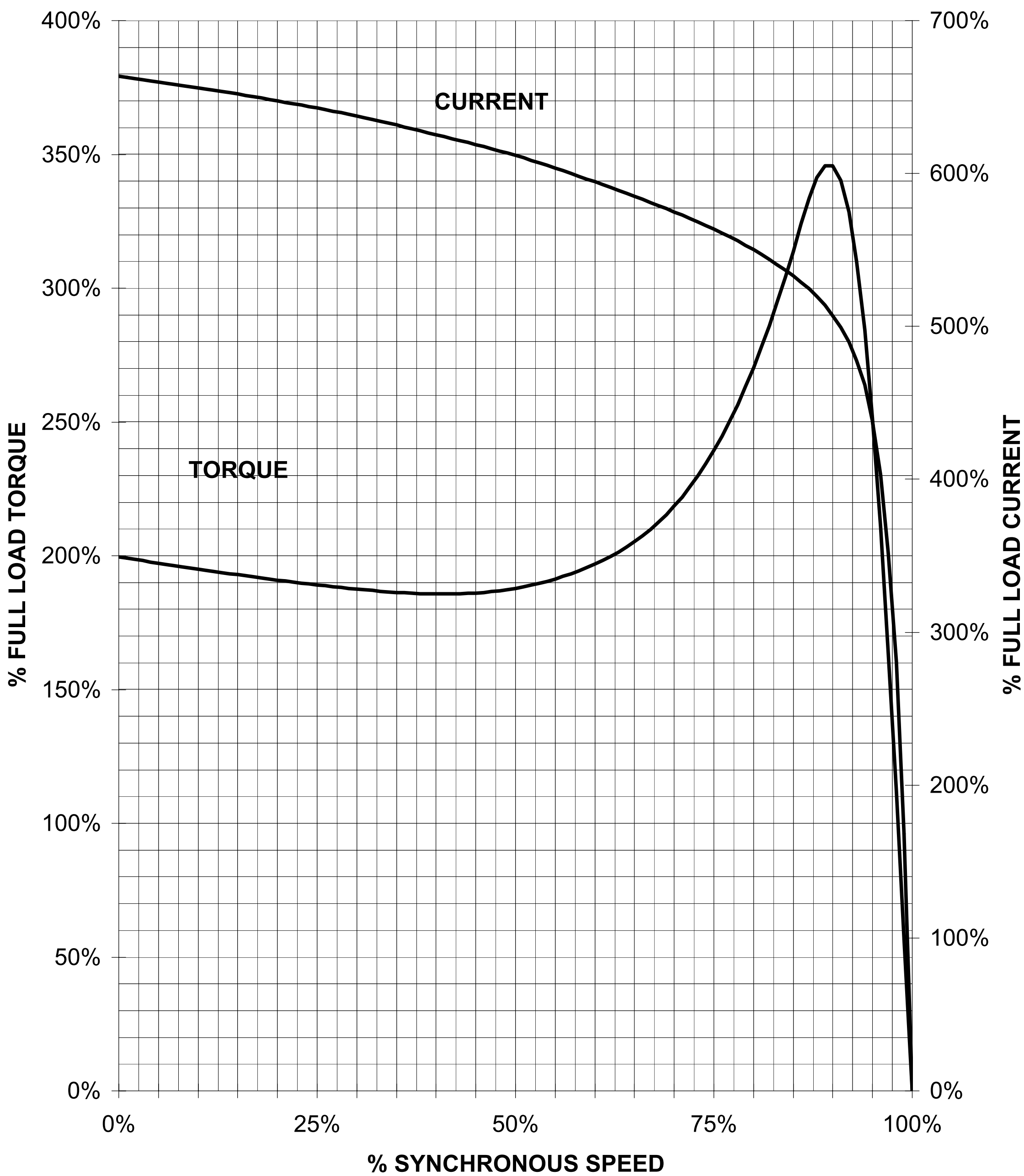
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	7.5	VOLTS	460	RPM	1800	TYPE	GP10A
HZ	60	PHASE	3	FRAME	213T	NEMA	B

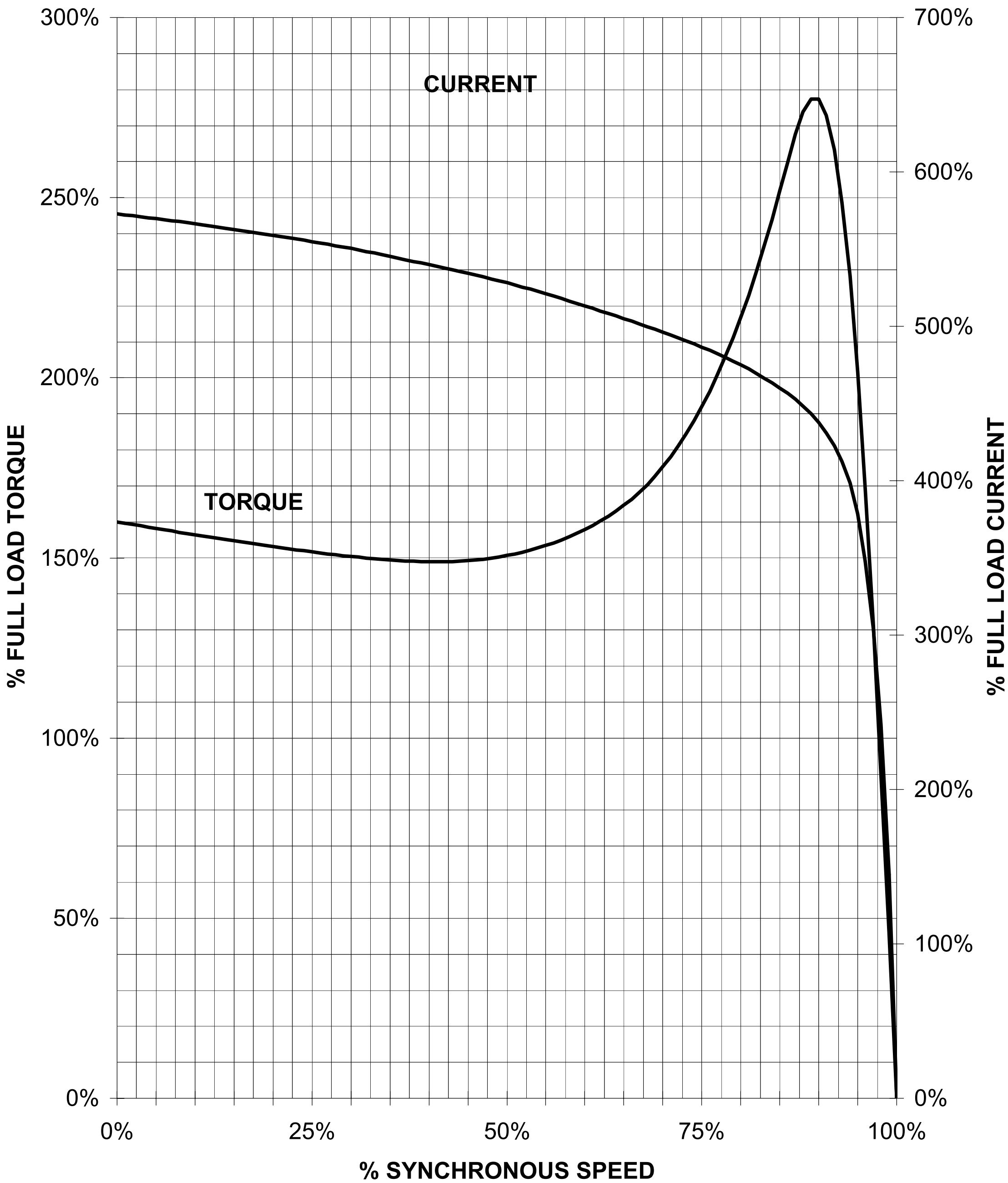
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	7.5	VOLTS	460	RPM	1200	TYPE	GP10A
HZ	60	PHASE	3	FRAME	254T	NEMA	B

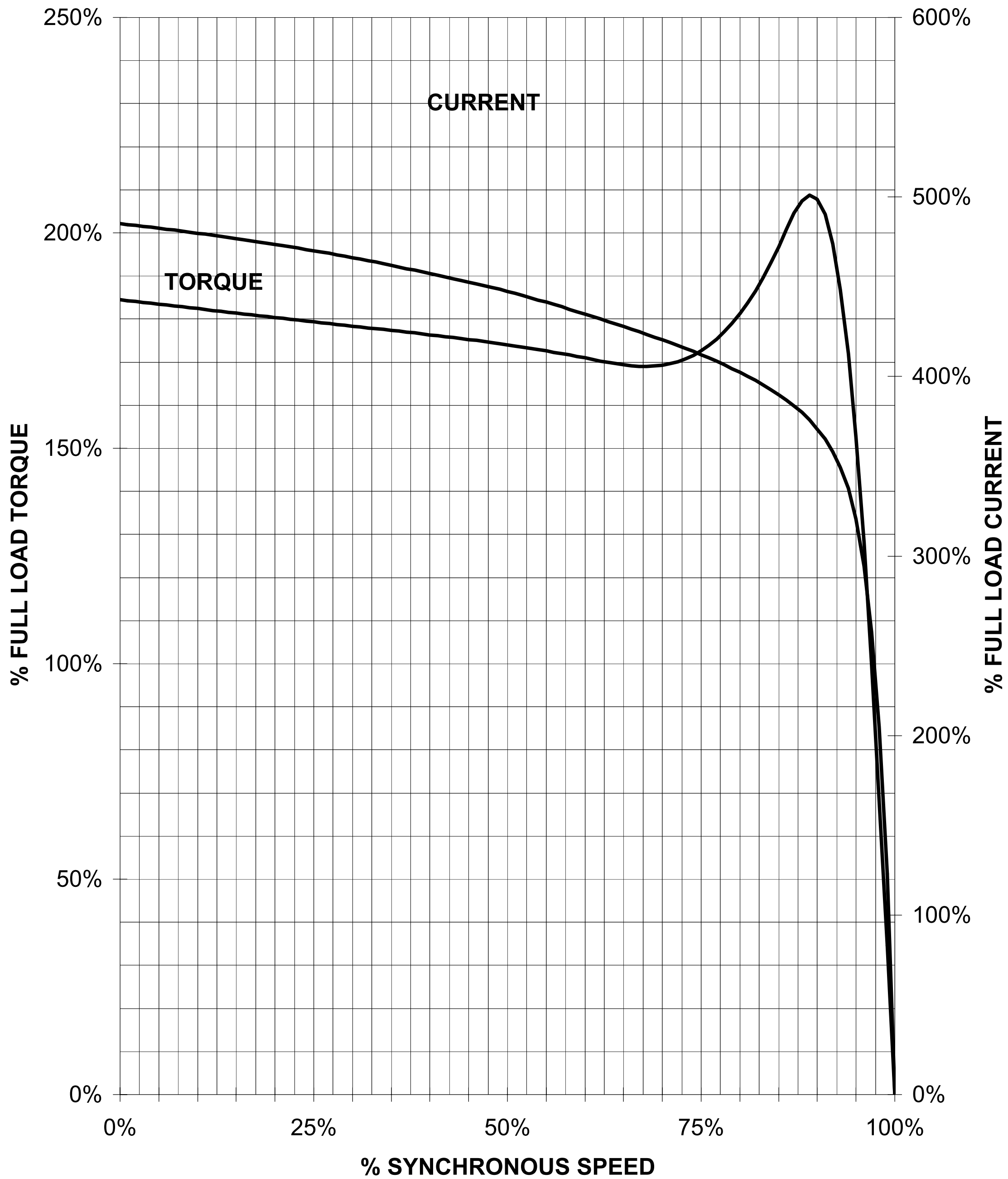
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	7.5	VOLTS	460	RPM	900	TYPE	GP10A
HZ	60	PHASE	3	FRAME	256T	NEMA	B

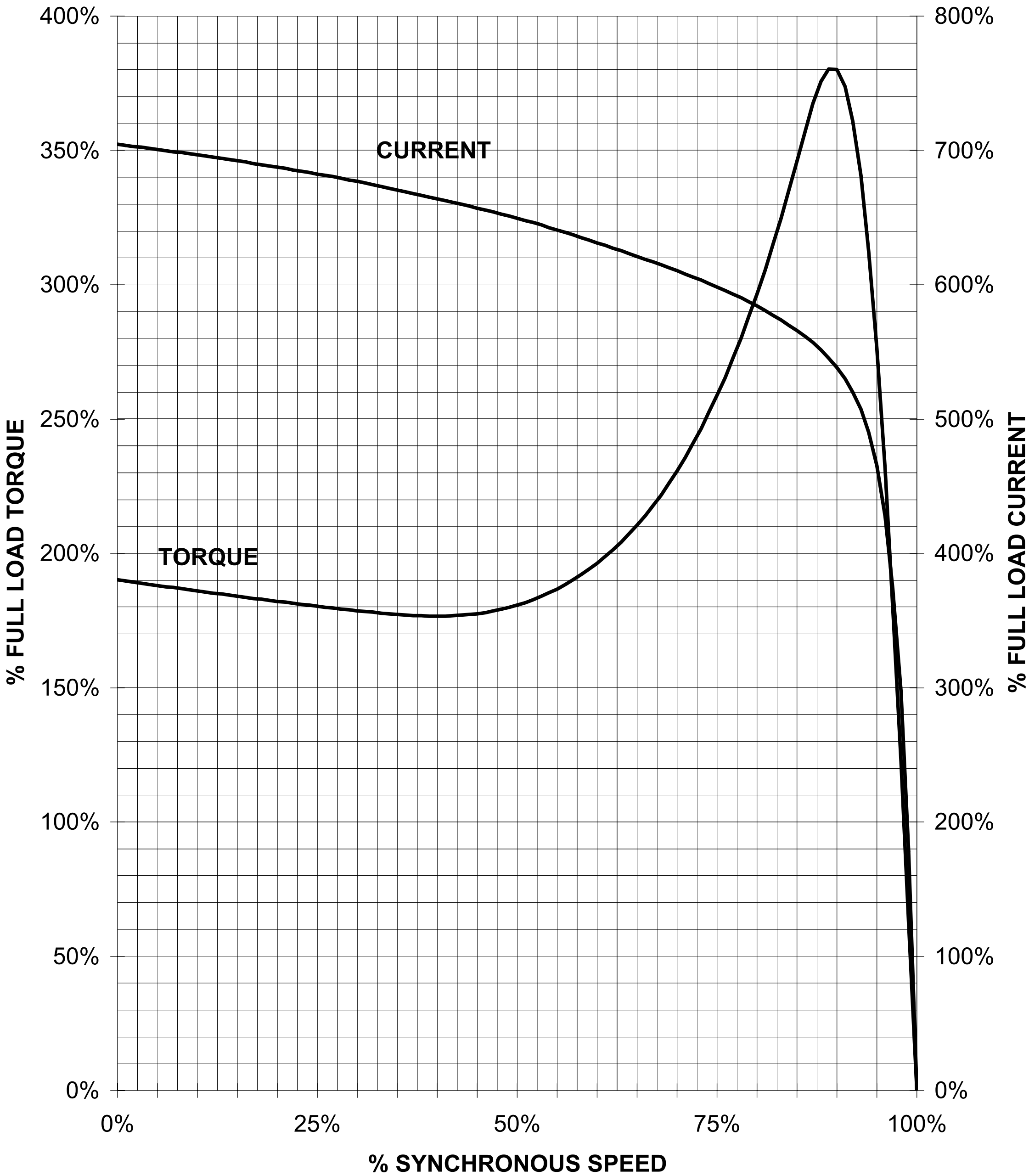
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	10	VOLTS	460	RPM	3600	TYPE	GP10A
HZ	60	PHASE	3	FRAME	215T	NEMA	B

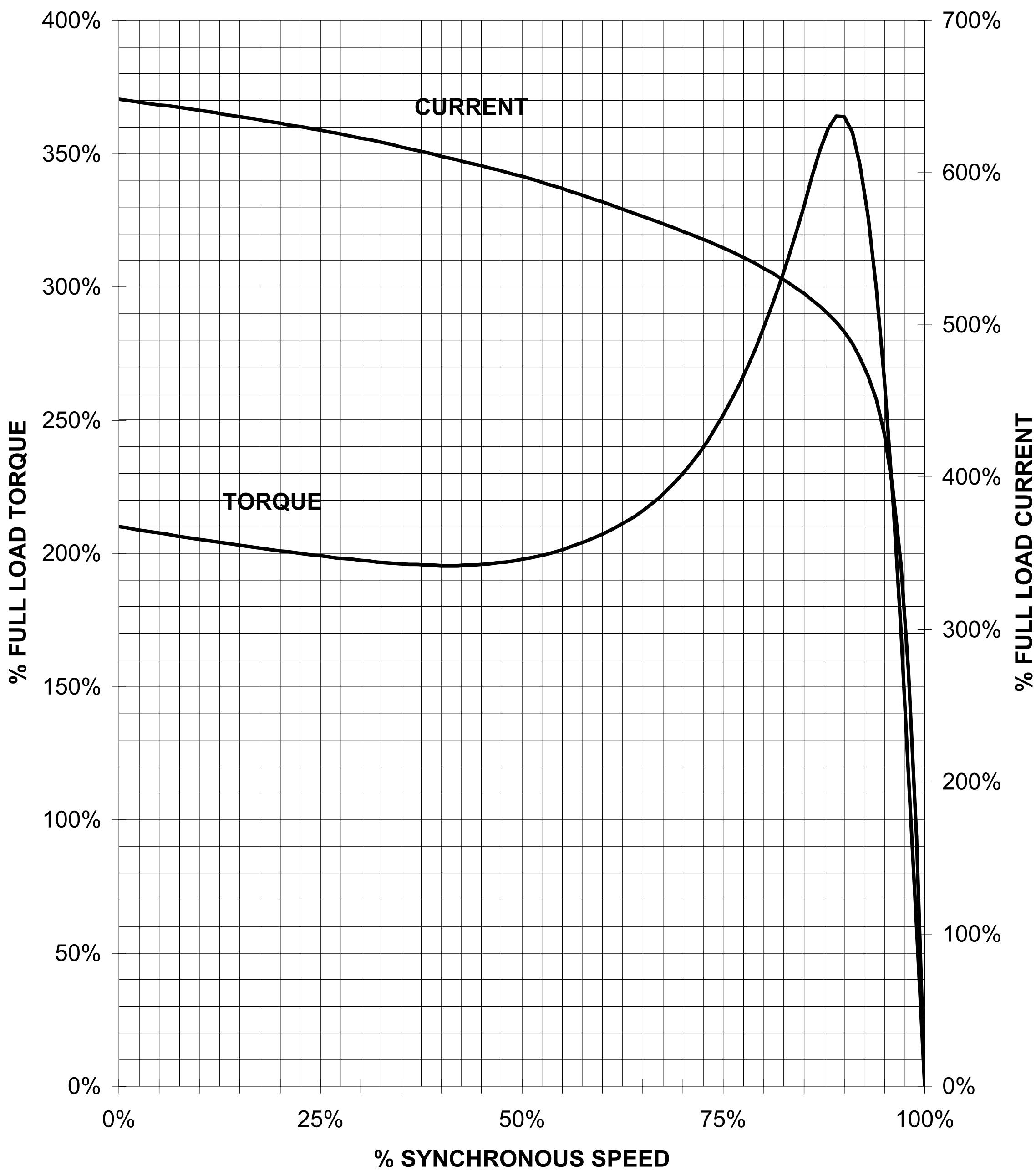
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	10	VOLTS	460	RPM	1800	TYPE	GP10A
HZ	60	PHASE	3	FRAME	215T	NEMA	B

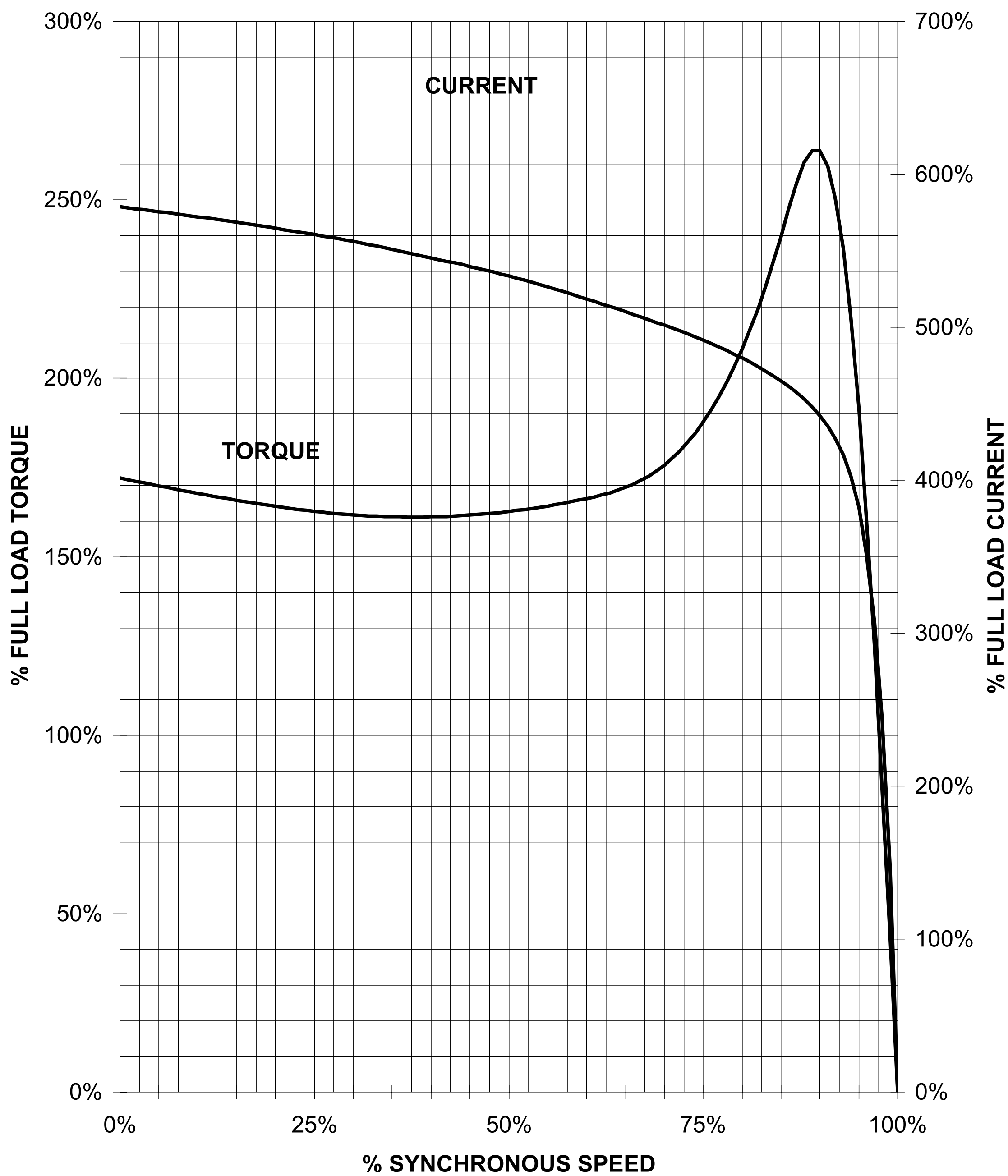
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	10	VOLTS	460	RPM	1200	TYPE	GP10A
HZ	60	PHASE	3	FRAME	256T	NEMA	B

TORQUE & CURRENT VS. SPEED

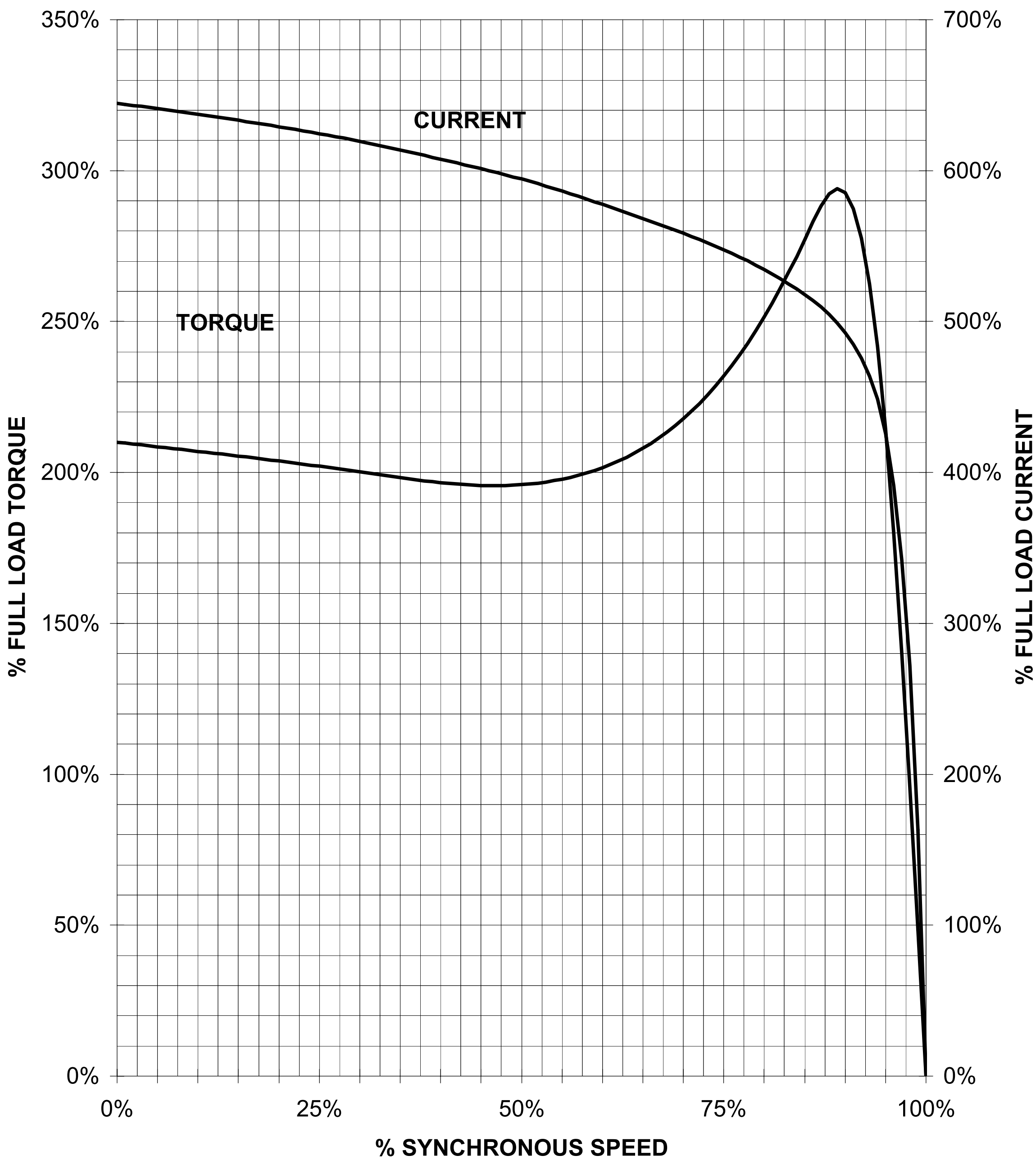


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	15	VOLTS	460	RPM	3600	TYPE	GP10A
HZ	60	PHASE	3	FRAME	254T	NEMA	B

TORQUE & CURRENT VS. SPEED

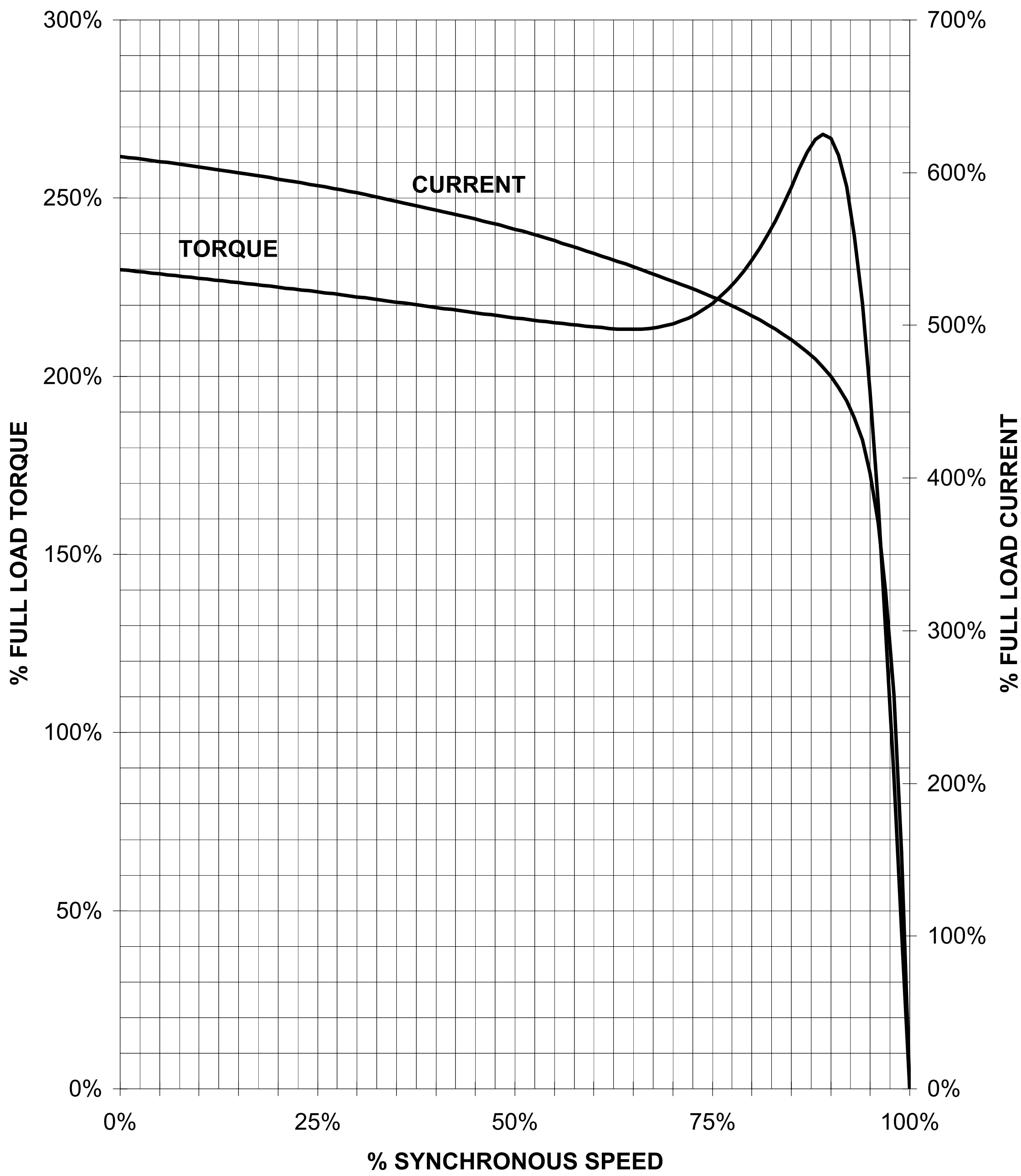


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	15	VOLTS	460	RPM	1800	TYPE	GP10A
HZ	60	PHASE	3	FRAME	254T	NEMA	B

TORQUE & CURRENT VS. SPEED

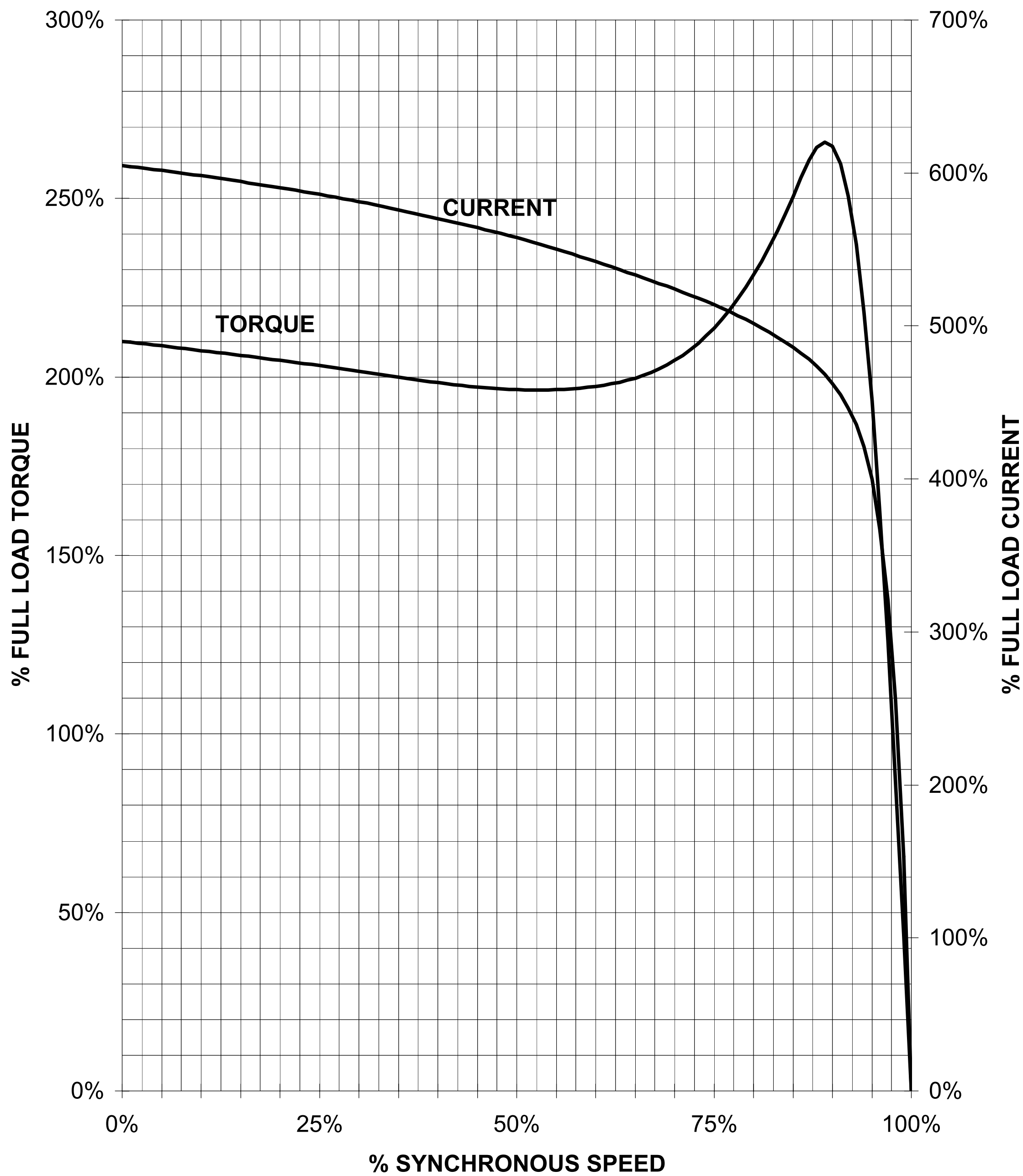


Customer: **PO No.:** **Order No.:**

Application Manual for NEMA Motors

HP	20	VOLTS	460	RPM	3600	TYPE	GP10A
HZ	60	PHASE	3	FRAME	256T	NEMA	B

TORQUE & CURRENT VS. SPEED

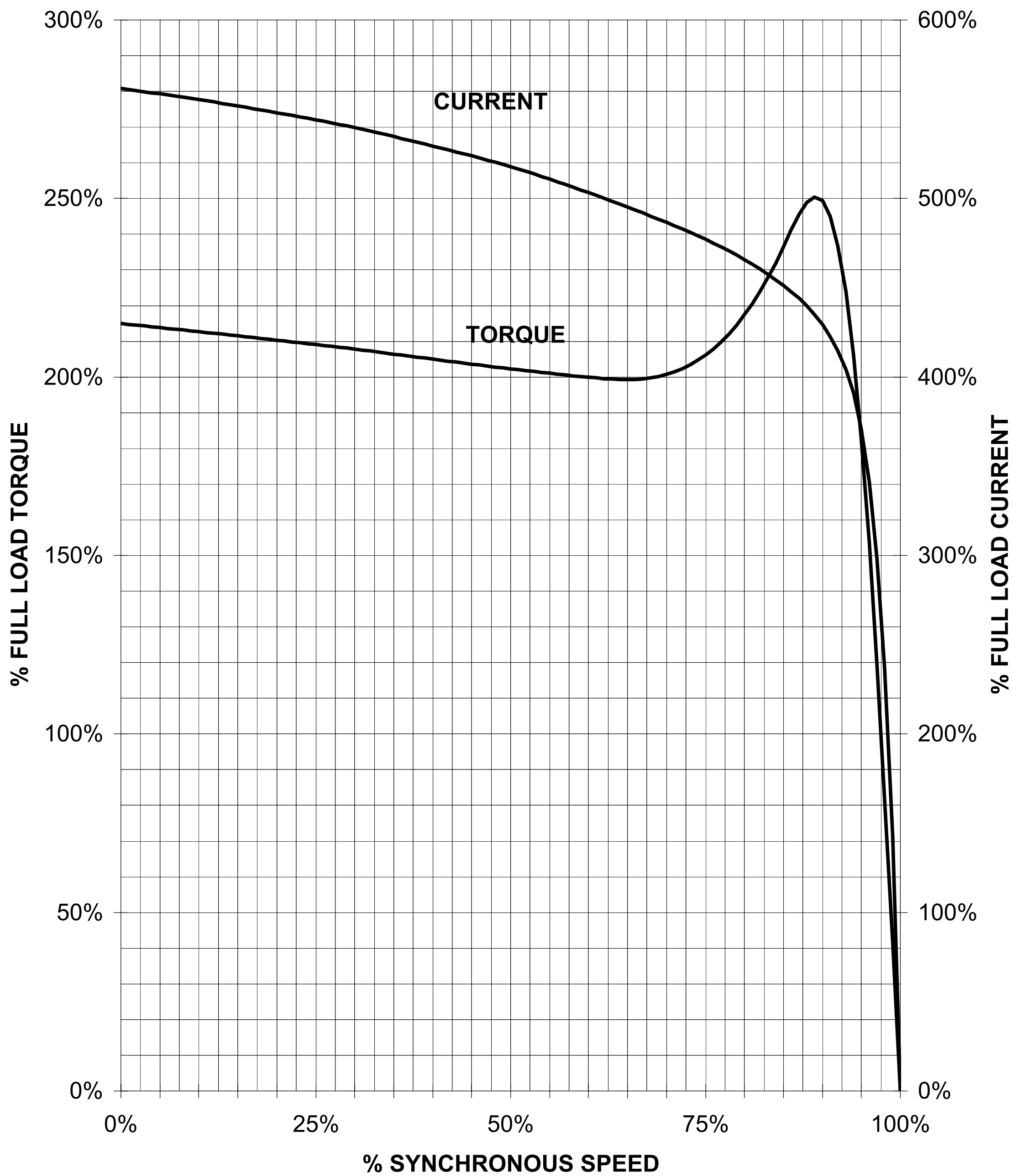


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	20	VOLTS	460	RPM	1800	TYPE	GP10A
HZ	60	PHASE	3	FRAME	256T	NEMA	B

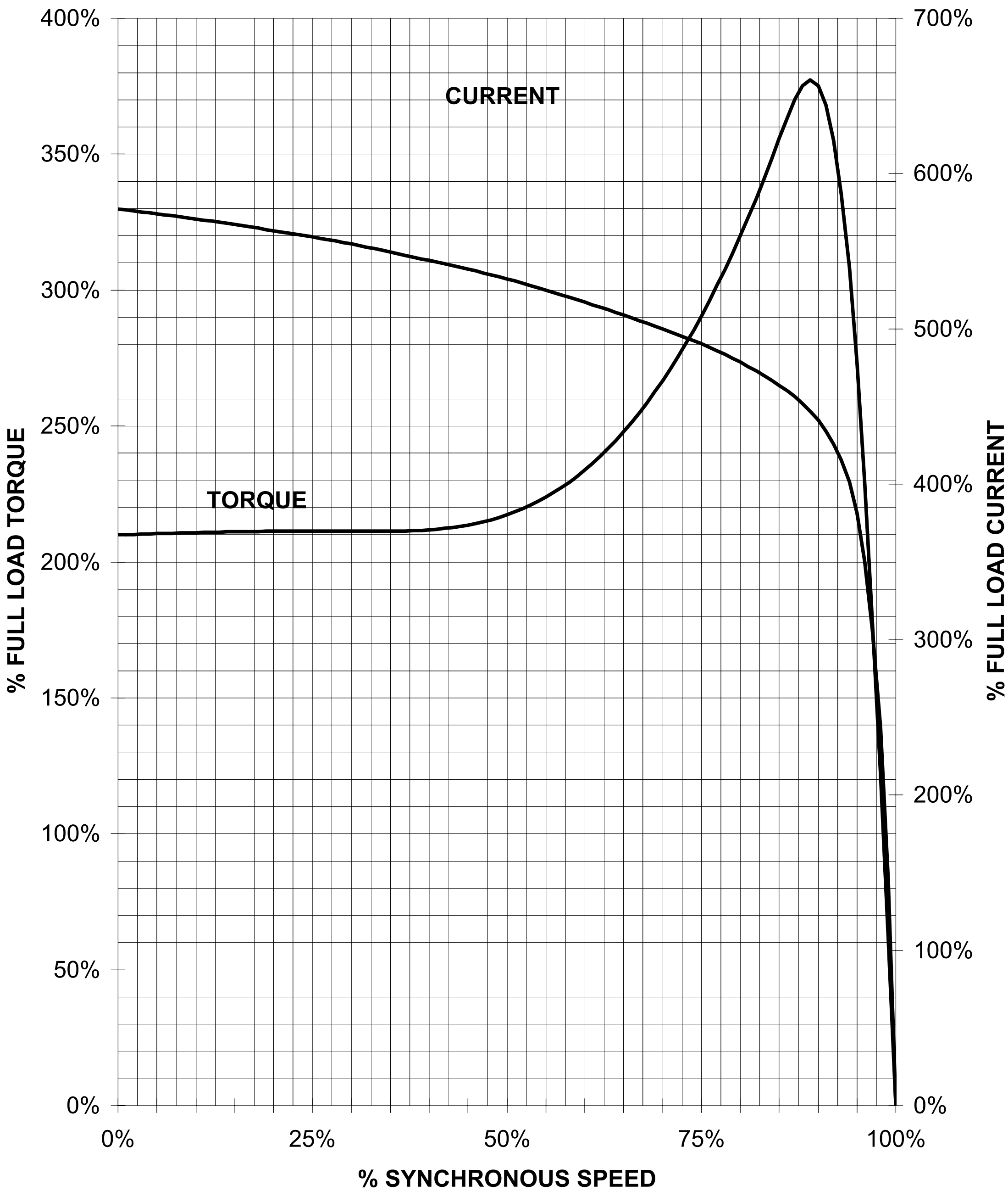
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1	VOLTS	460	RPM	3600	TYPE	GP100
HZ	60	PHASE	3	FRAME	143T	NEMA	B

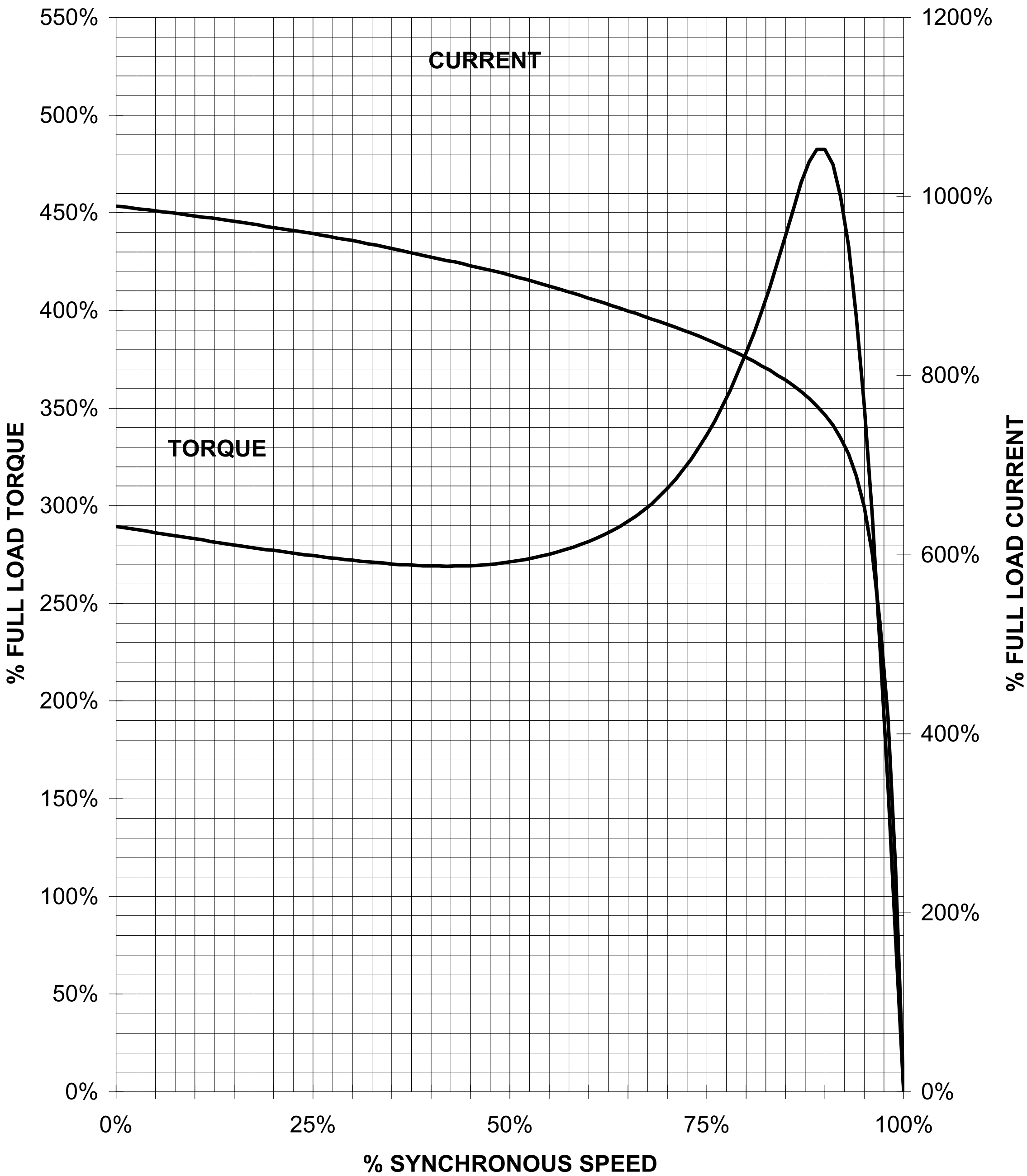
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1	VOLTS	460	RPM	1800	TYPE	GP100
HZ	60	PHASE	3	FRAME	143T	NEMA	B

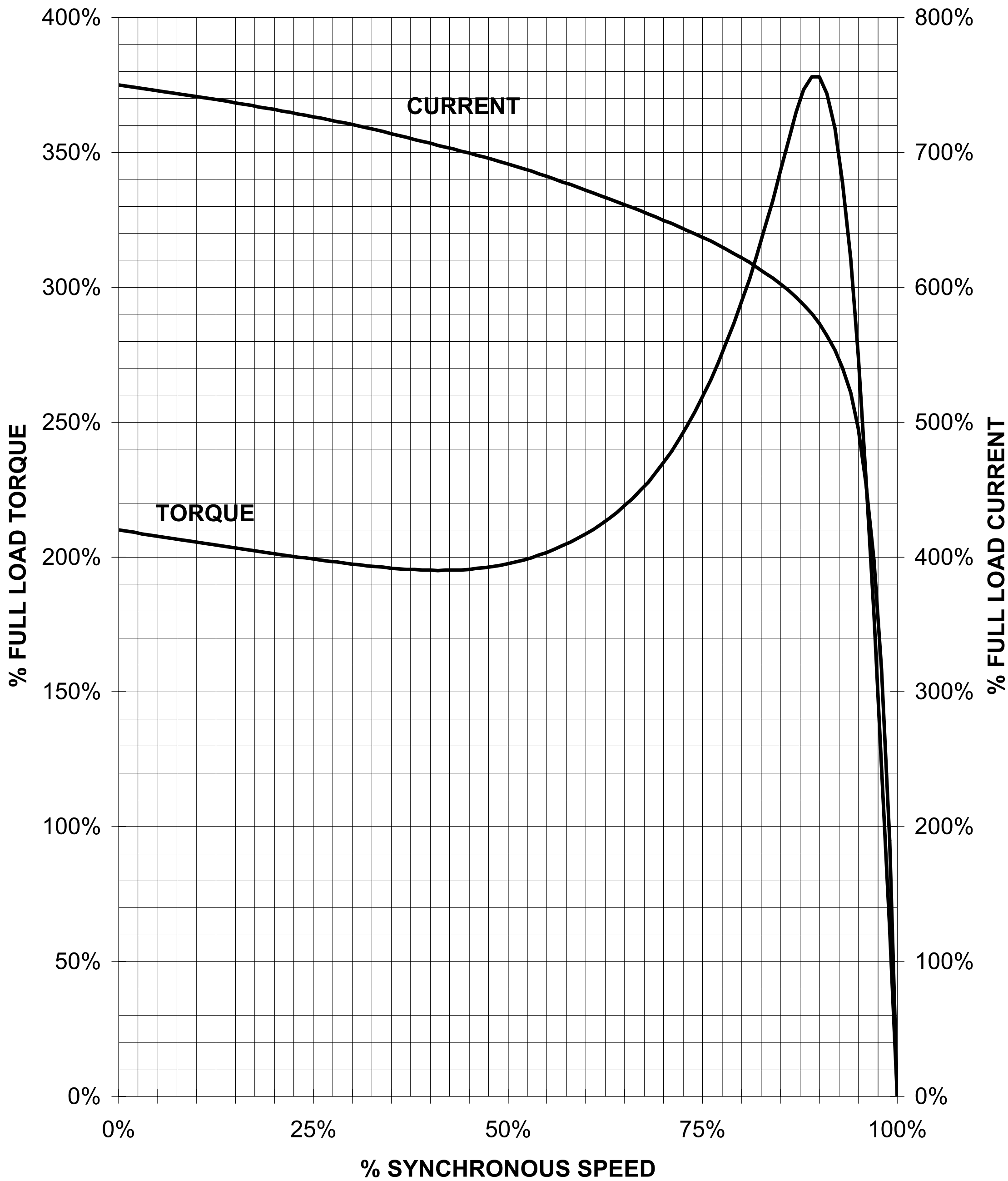
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1	VOLTS	460	RPM	1200	TYPE	GP100
HZ	60	PHASE	3	FRAME	145T	NEMA	B

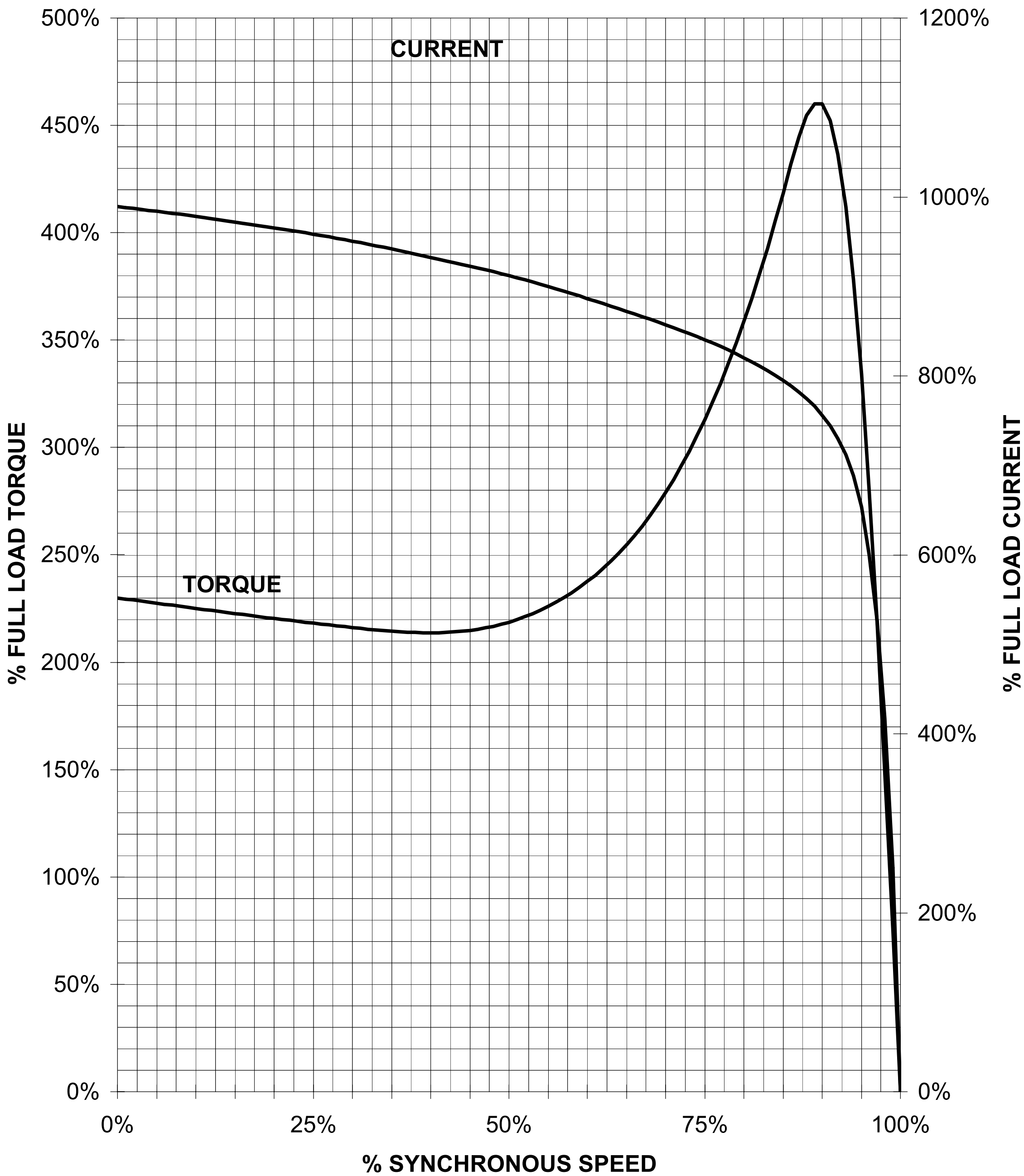
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1.5	VOLTS	460	RPM	3600	TYPE	GP100
HZ	60	PHASE	3	FRAME	143T	NEMA	B

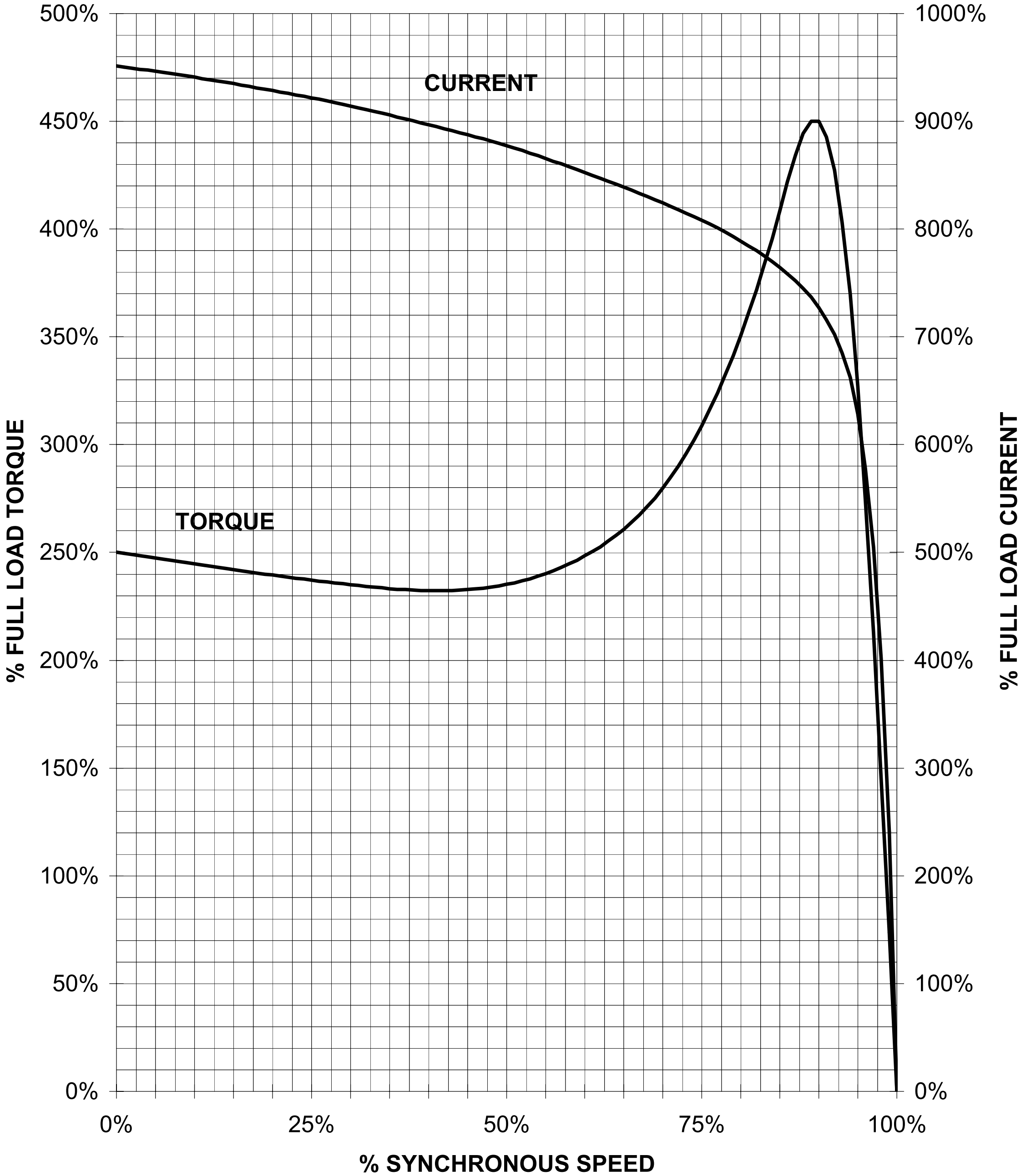
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1.5	VOLTS	460	RPM	1800	TYPE	GP100
HZ	60	PHASE	3	FRAME	145T	NEMA	B

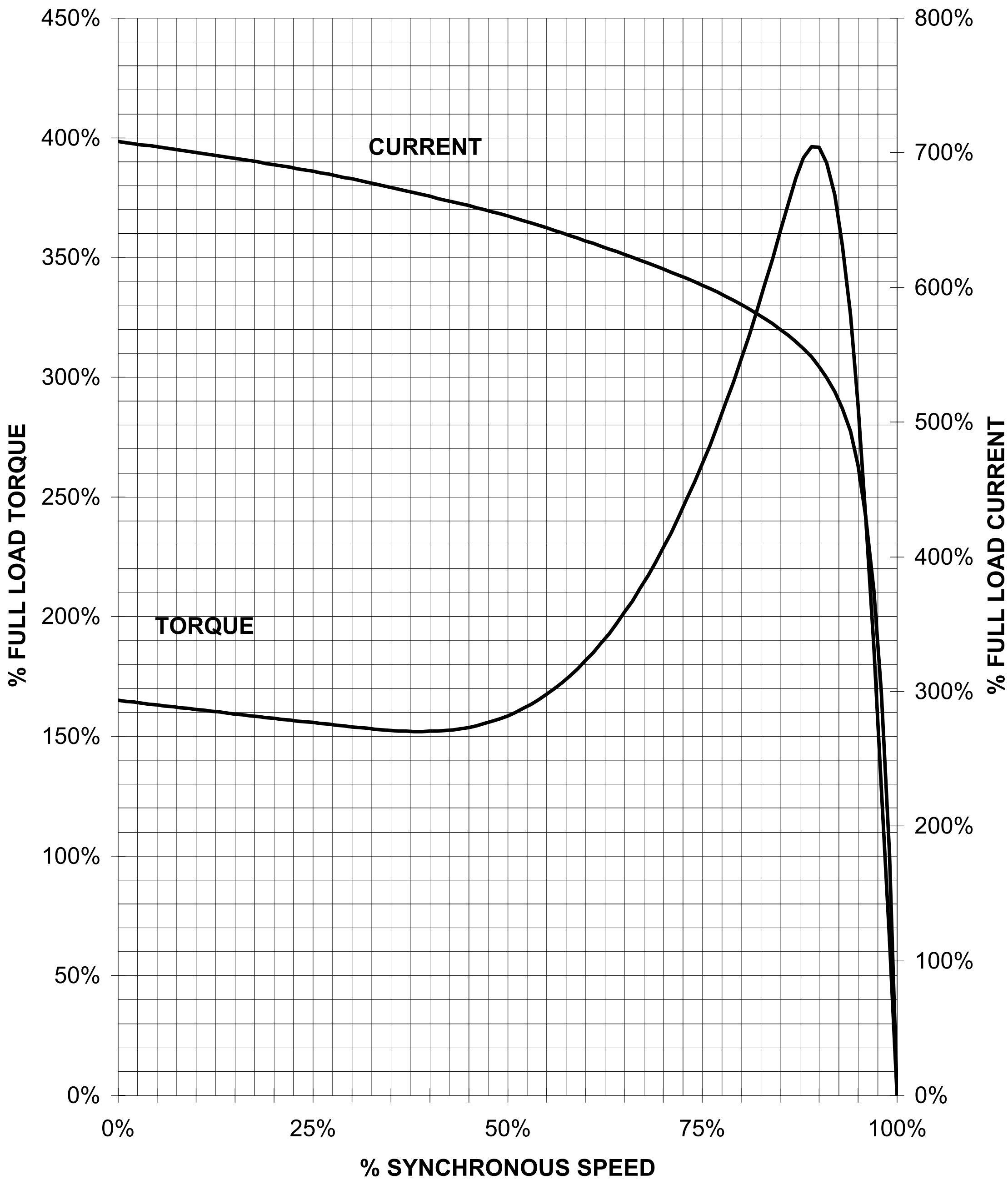
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1.5	VOLTS	460	RPM	1200	TYPE	GP100
HZ	60	PHASE	3	FRAME	182T	NEMA	B

TORQUE & CURRENT VS. SPEED

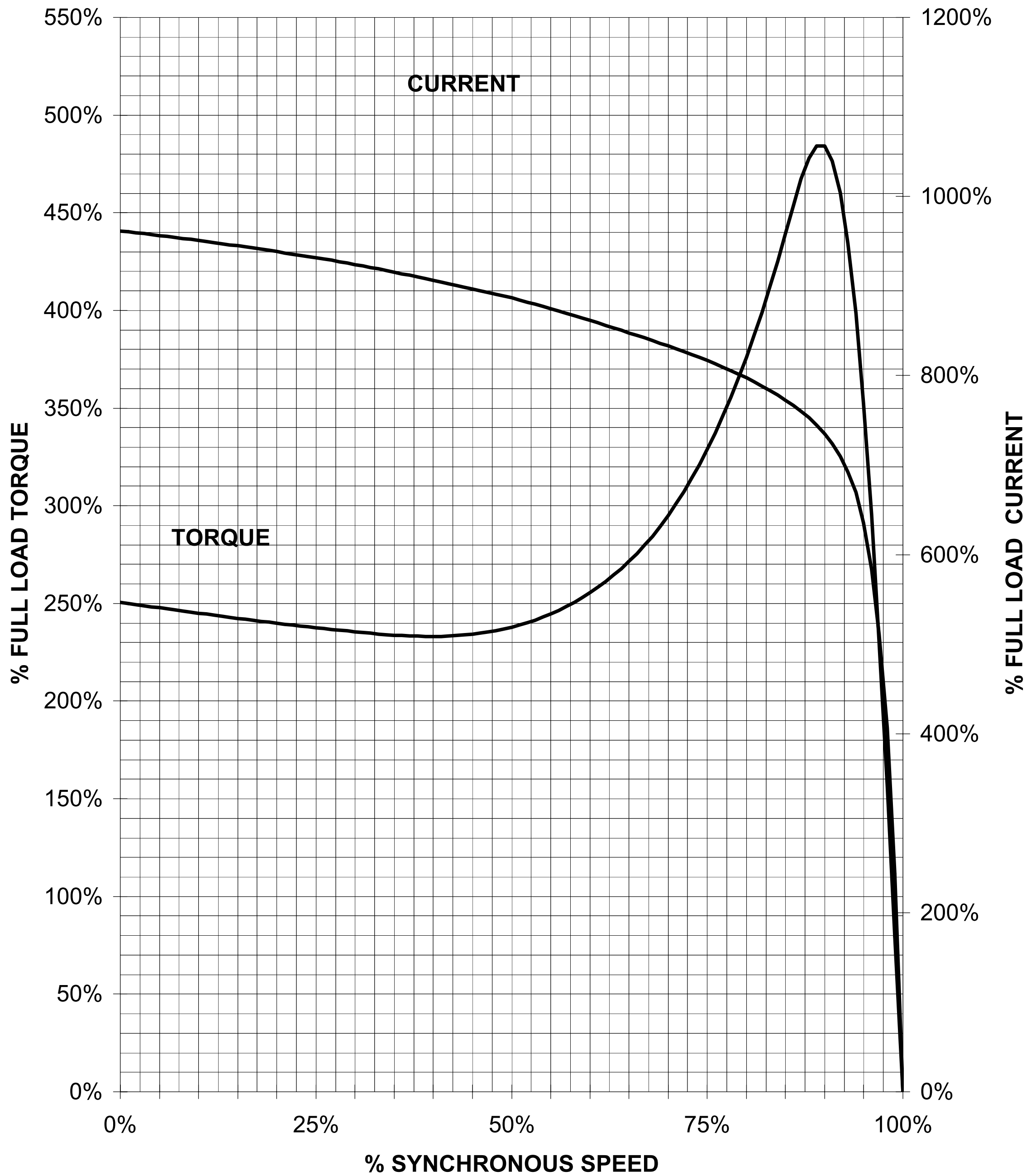


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	2	VOLTS	460	RPM	3600	TYPE	GP100
HZ	60	PHASE	3	FRAME	145T	NEMA	B

TORQUE & CURRENT VS. SPEED

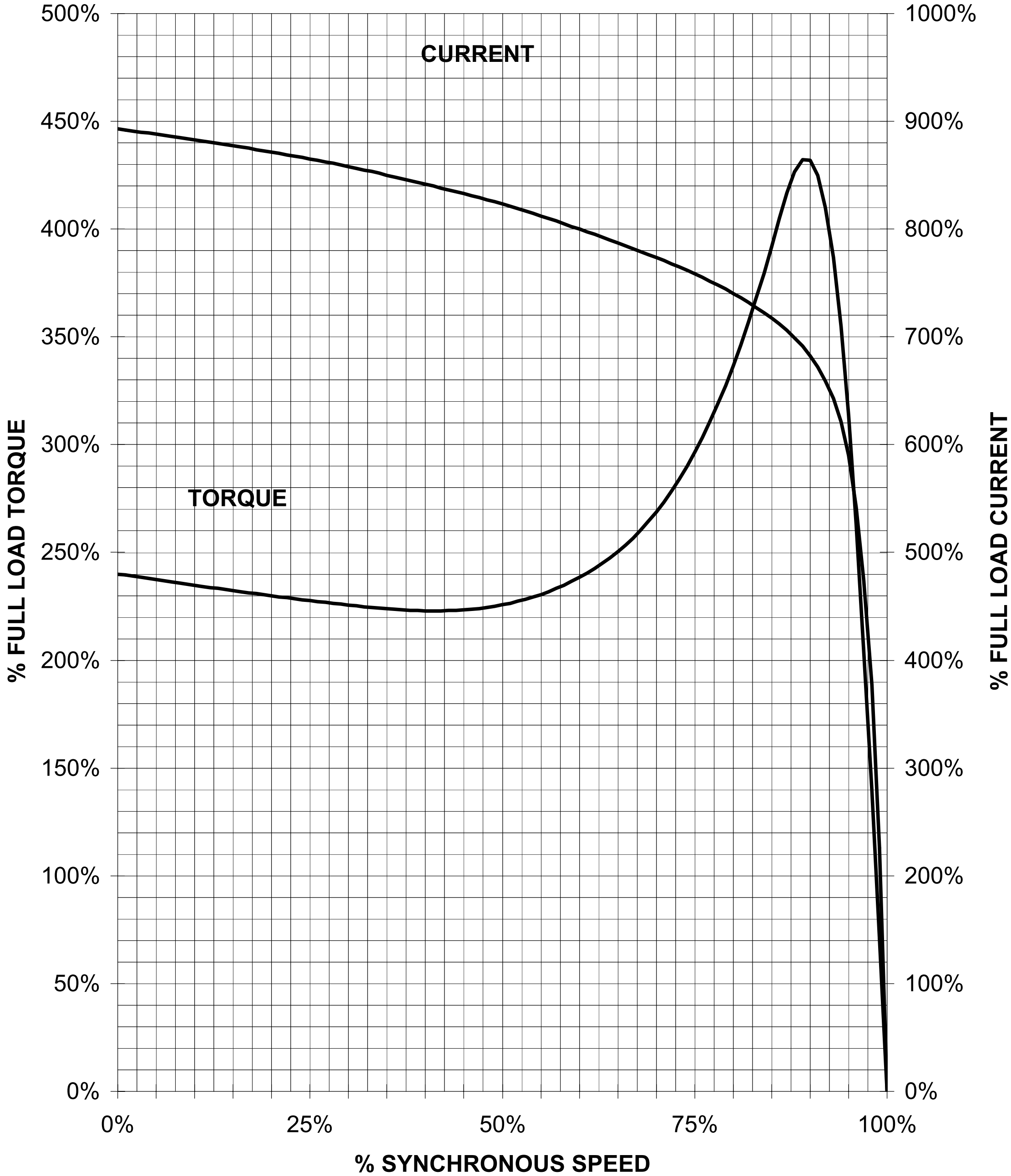


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	2	VOLTS	460	RPM	1800	TYPE	GP100
HZ	60	PHASE	3	FRAME	145T	NEMA	B

TORQUE & CURRENT VS. SPEED

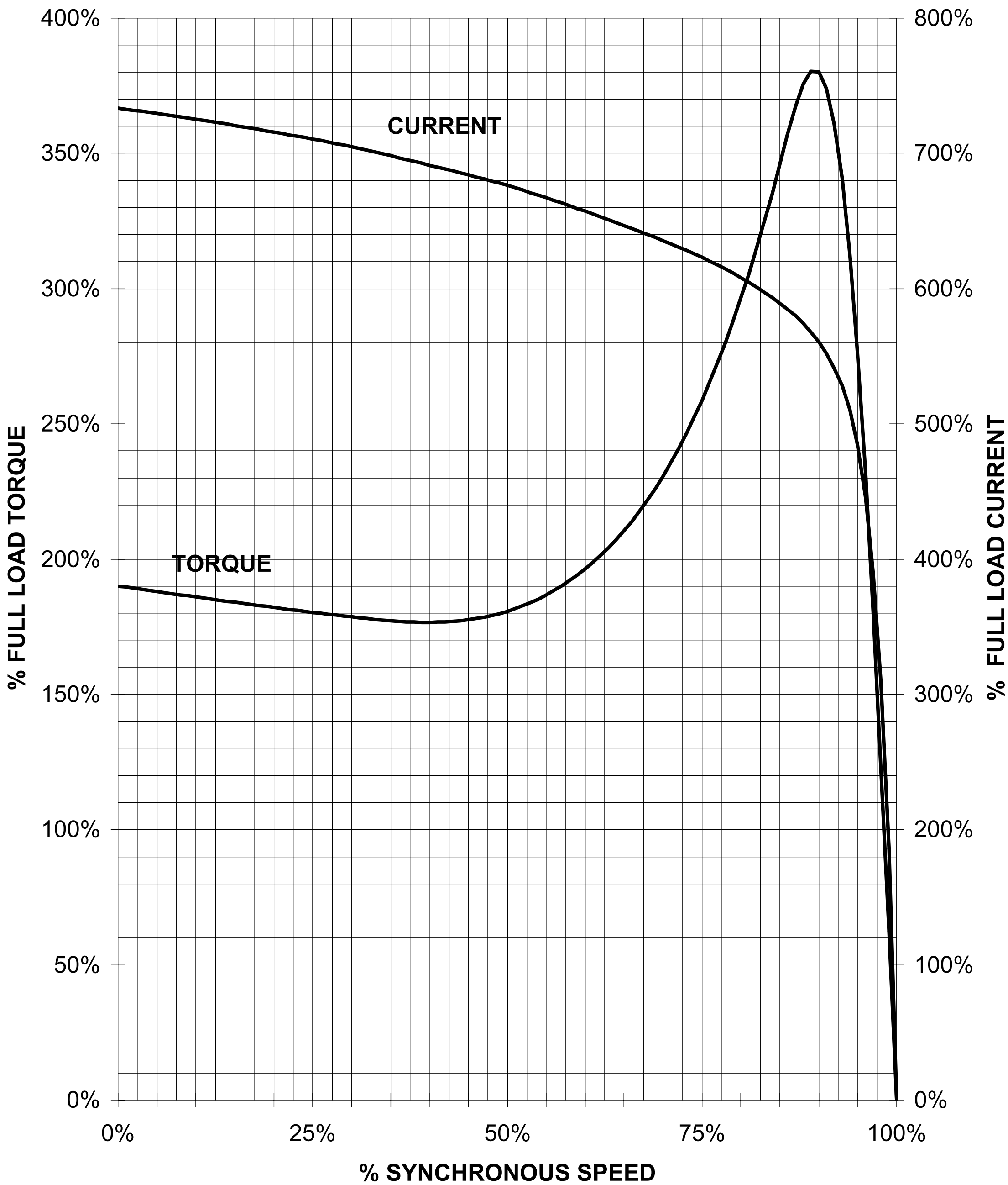


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	2	VOLTS	460	RPM	1200	TYPE	GP100
HZ	60	PHASE	3	FRAME	184T	NEMA	B

TORQUE & CURRENT VS. SPEED

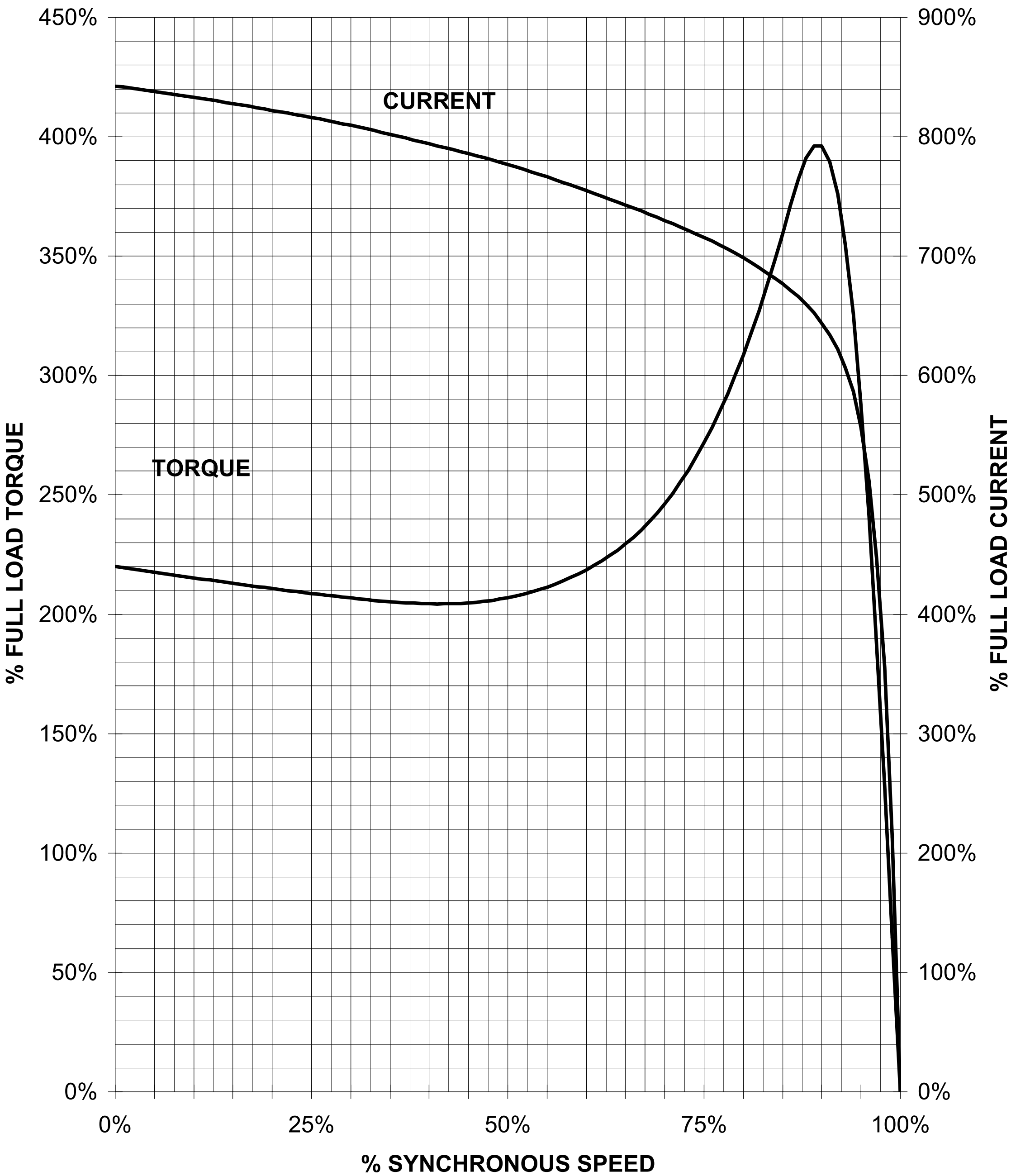


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	3	VOLTS	460	RPM	3600	TYPE	GP100
HZ	60	PHASE	3	FRAME	182T	NEMA	B

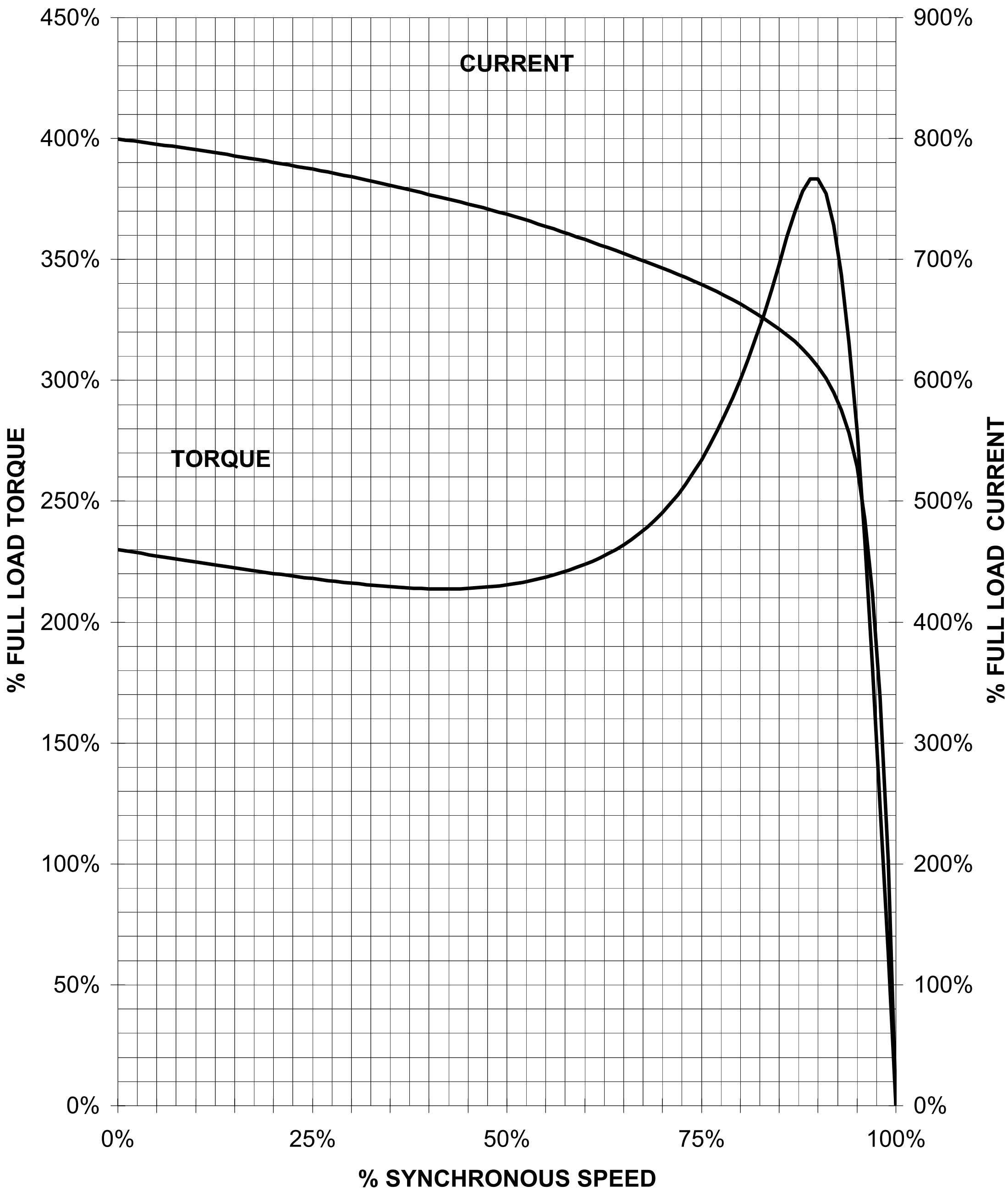
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	3	VOLTS	460	RPM	1800	TYPE	GP100
HZ	60	PHASE	3	FRAME	182T	NEMA	B

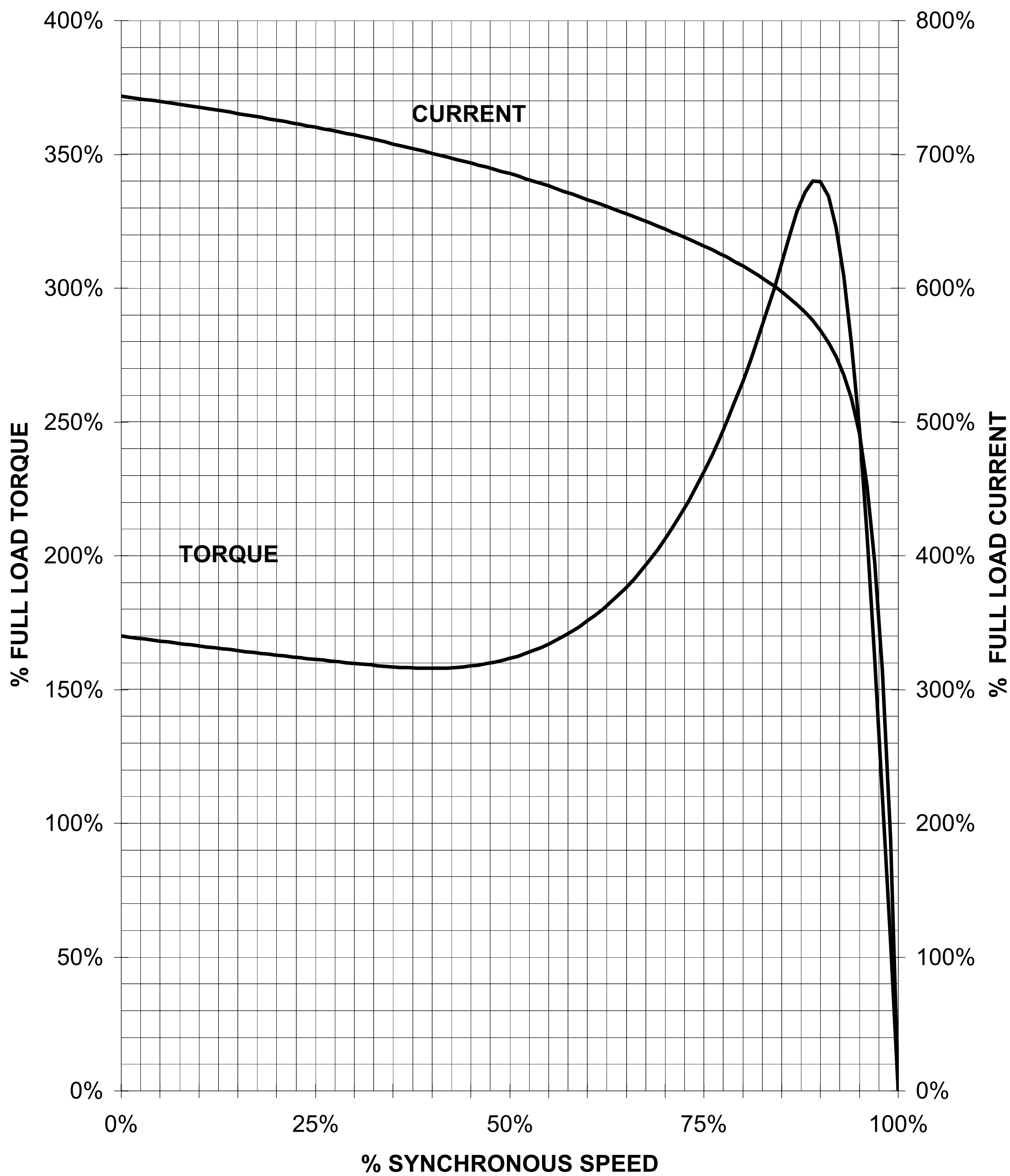
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	3	VOLTS	460	RPM	1200	TYPE	GP100
HZ	60	PHASE	3	FRAME	213T	NEMA	B

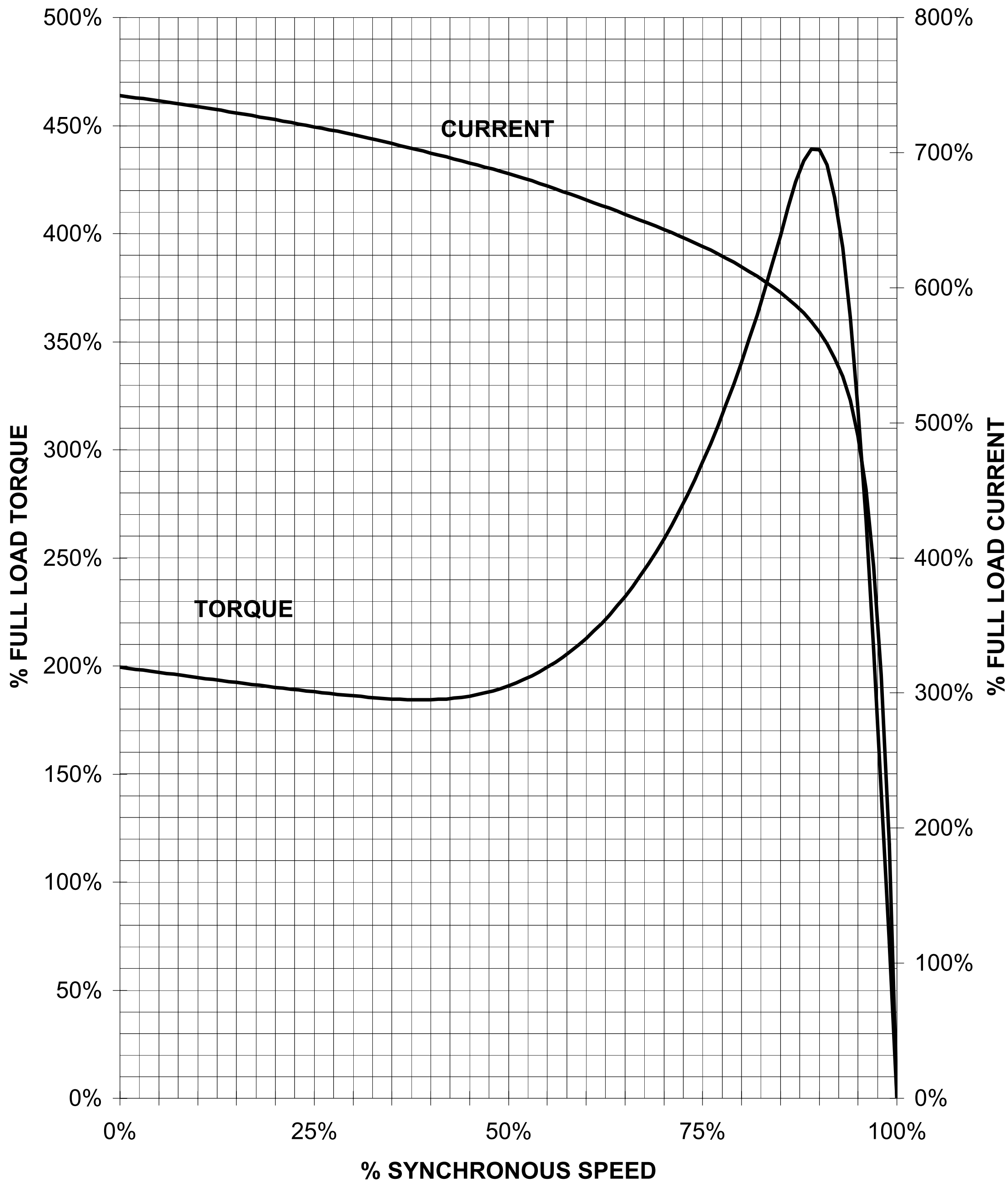
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	5	VOLTS	460	RPM	3600	TYPE	GP100
HZ	60	PHASE	3	FRAME	184T	NEMA	B

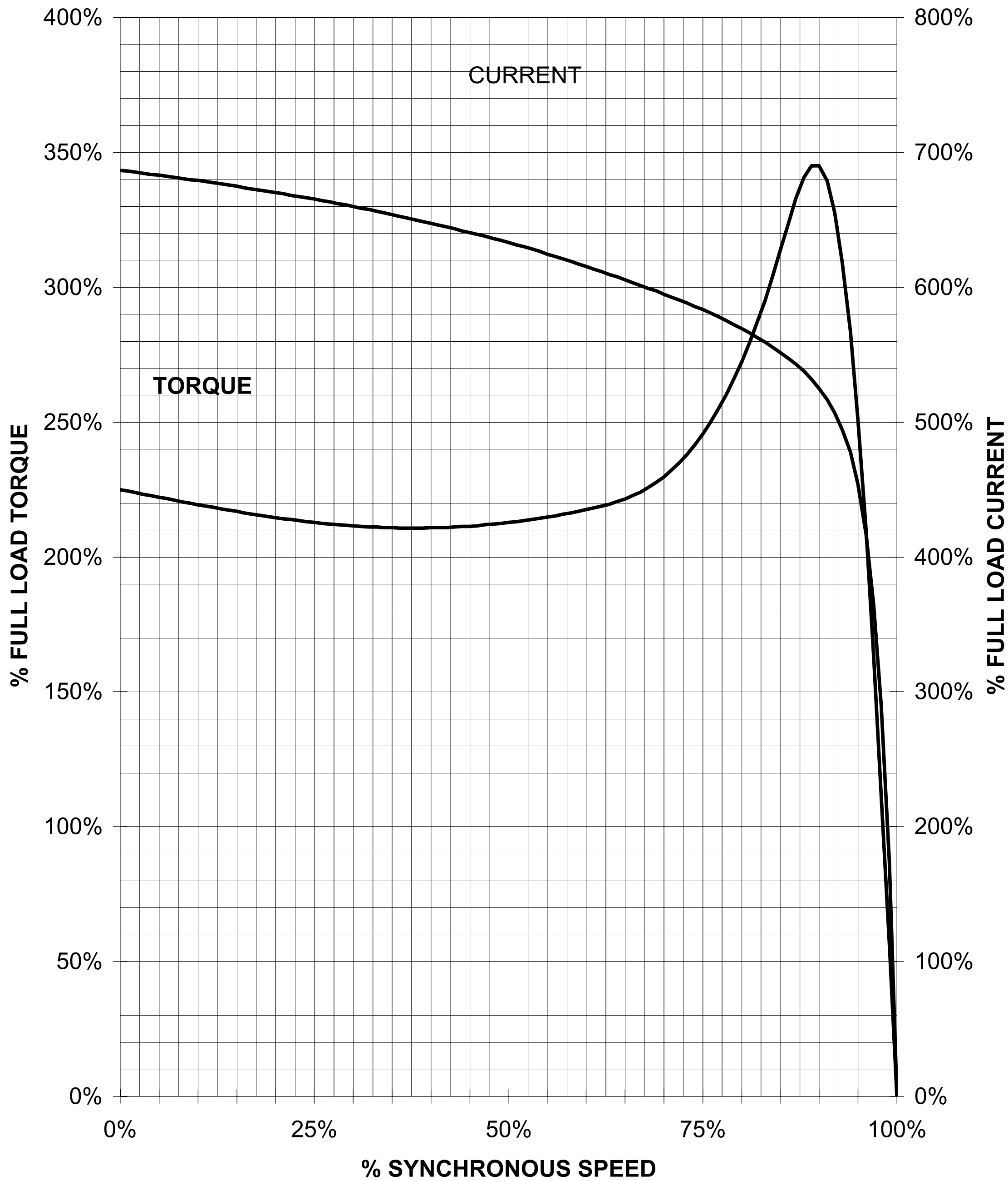
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	5	VOLTS	460	RPM	1800	TYPE	GP100
HZ	60	PHASE	3	FRAME	184T	NEMA	B

TORQUE & CURRENT VS. SPEED

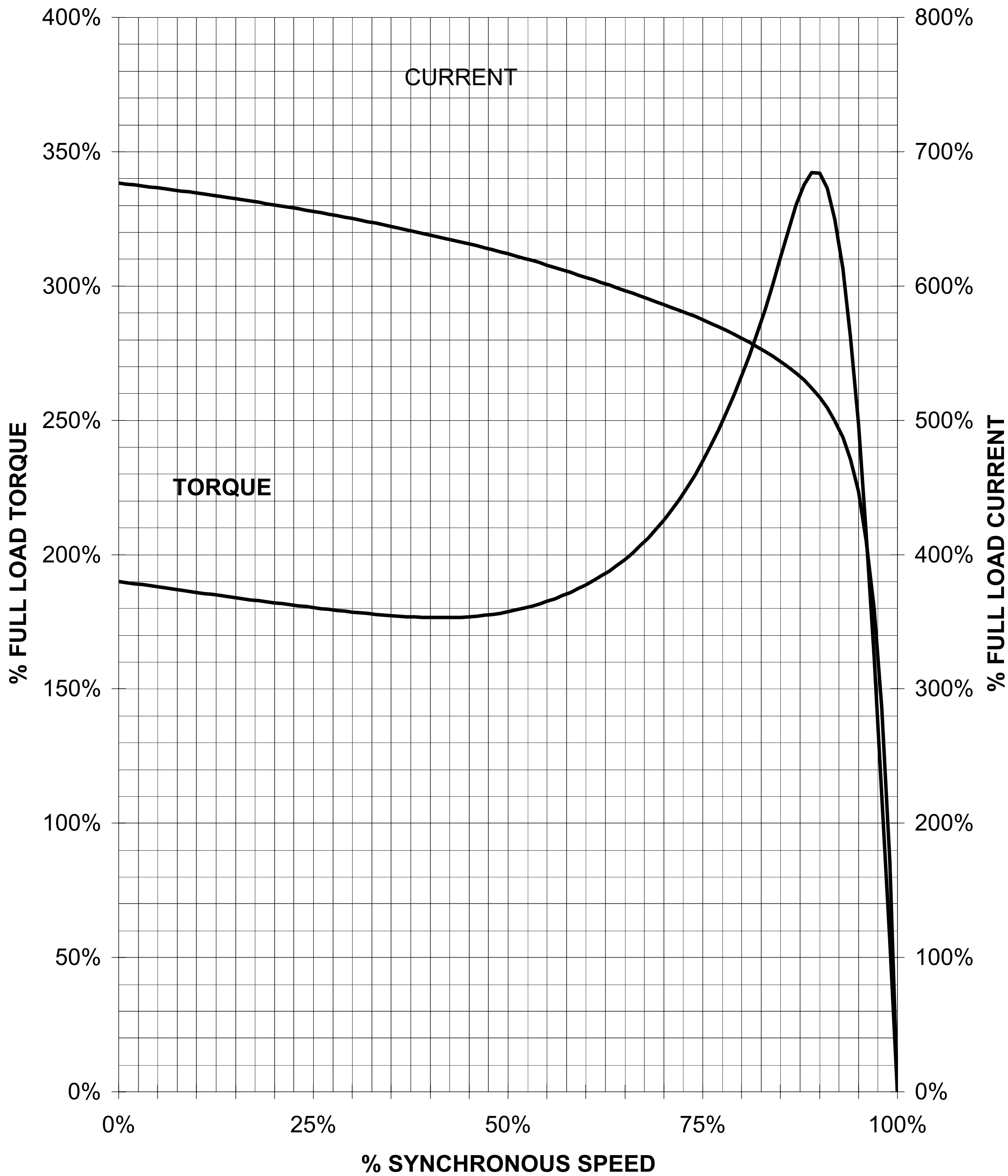


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	5	VOLTS	460	RPM	1200	TYPE	GP100
HZ	60	PHASE	3	FRAME	215T	NEMA	B

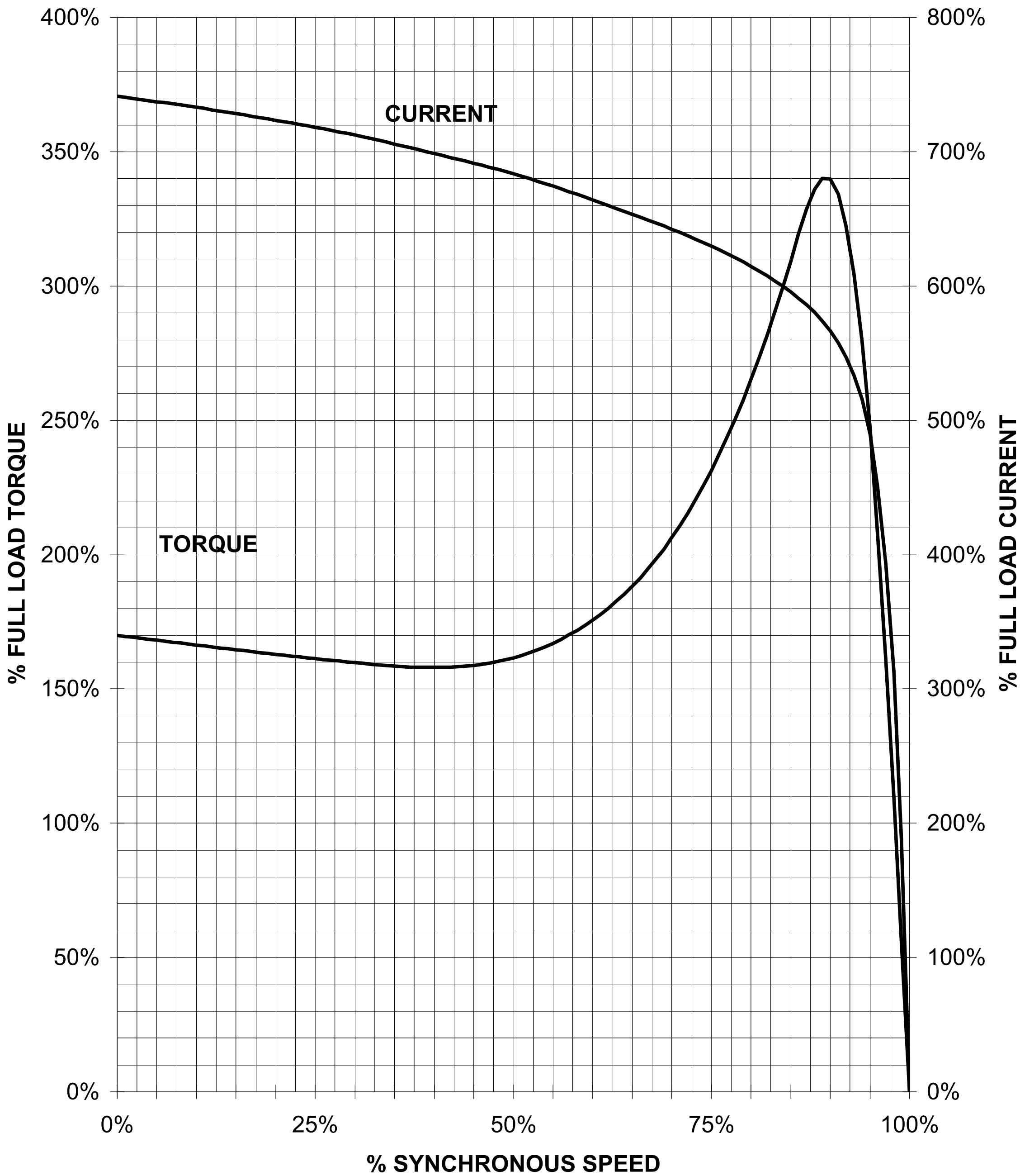
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	7.5	VOLTS	460	RPM	3600	TYPE	GP100
HZ	60	PHASE	3	FRAME	213T	NEMA	B

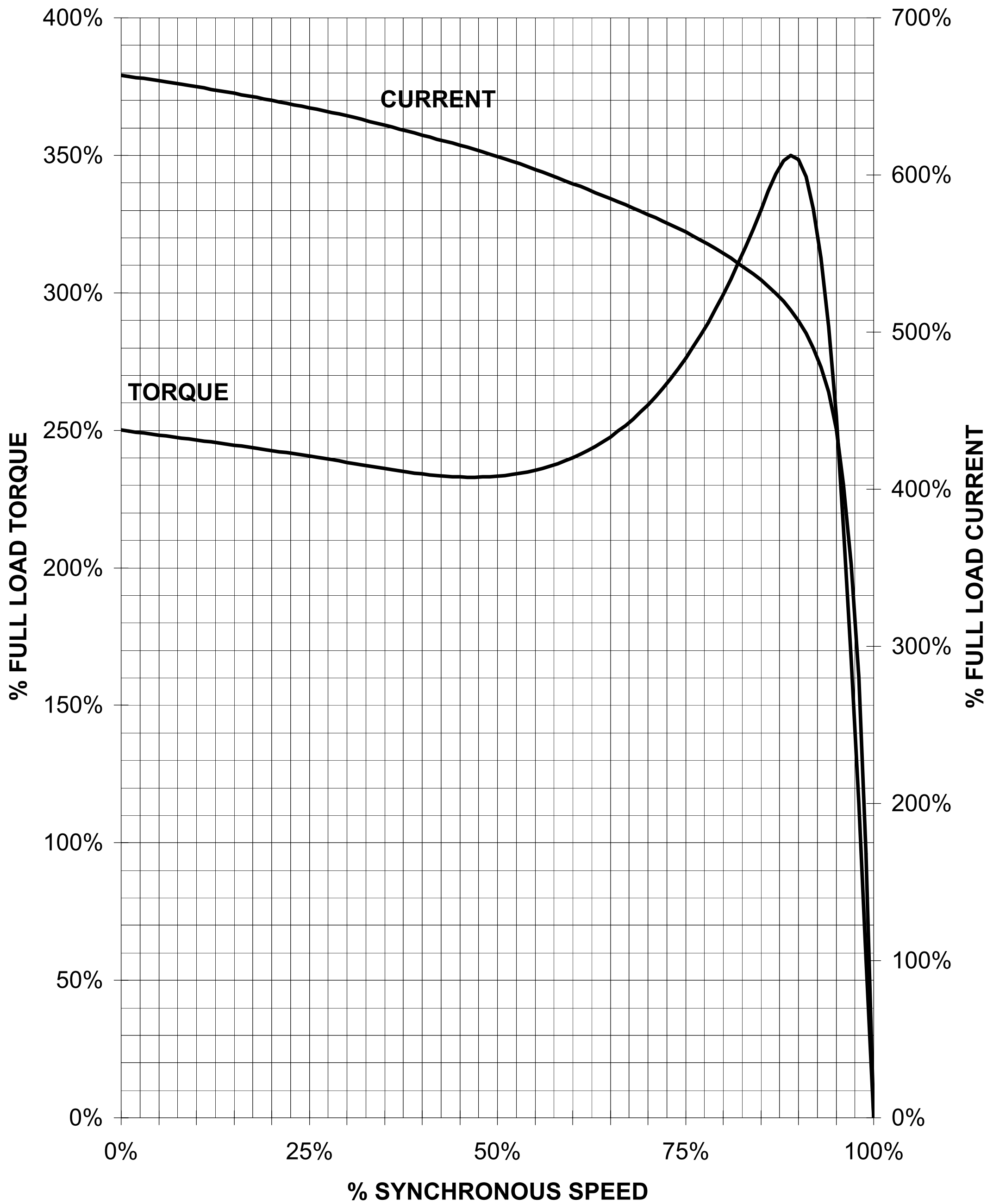
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	7.5	VOLTS	460	RPM	1800	TYPE	GP100
HZ	60	PHASE	3	FRAME	213T	NEMA	B

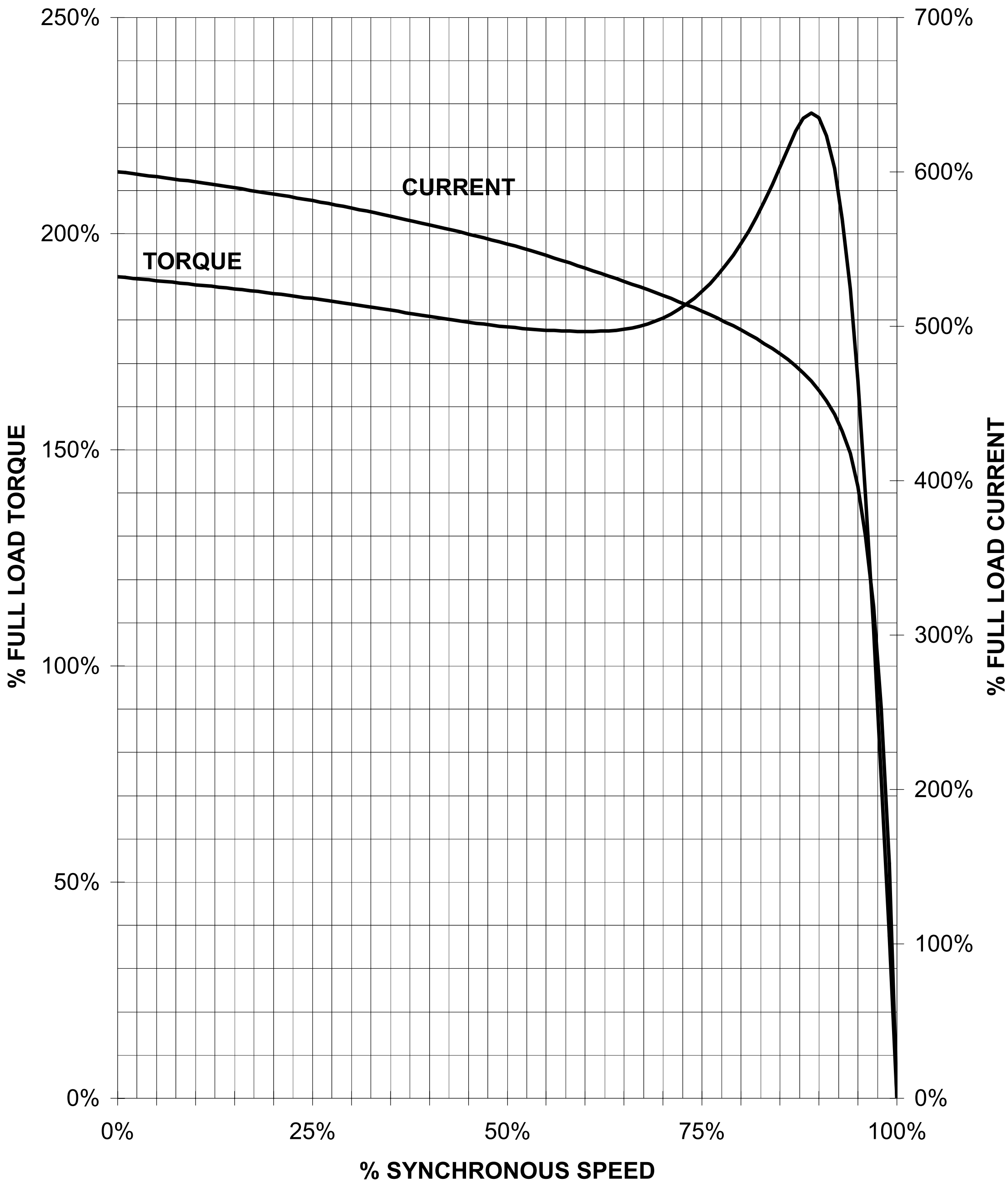
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	7.5	VOLTS	460	RPM	1200	TYPE	GP100
HZ	60	PHASE	3	FRAME	254T	NEMA	B

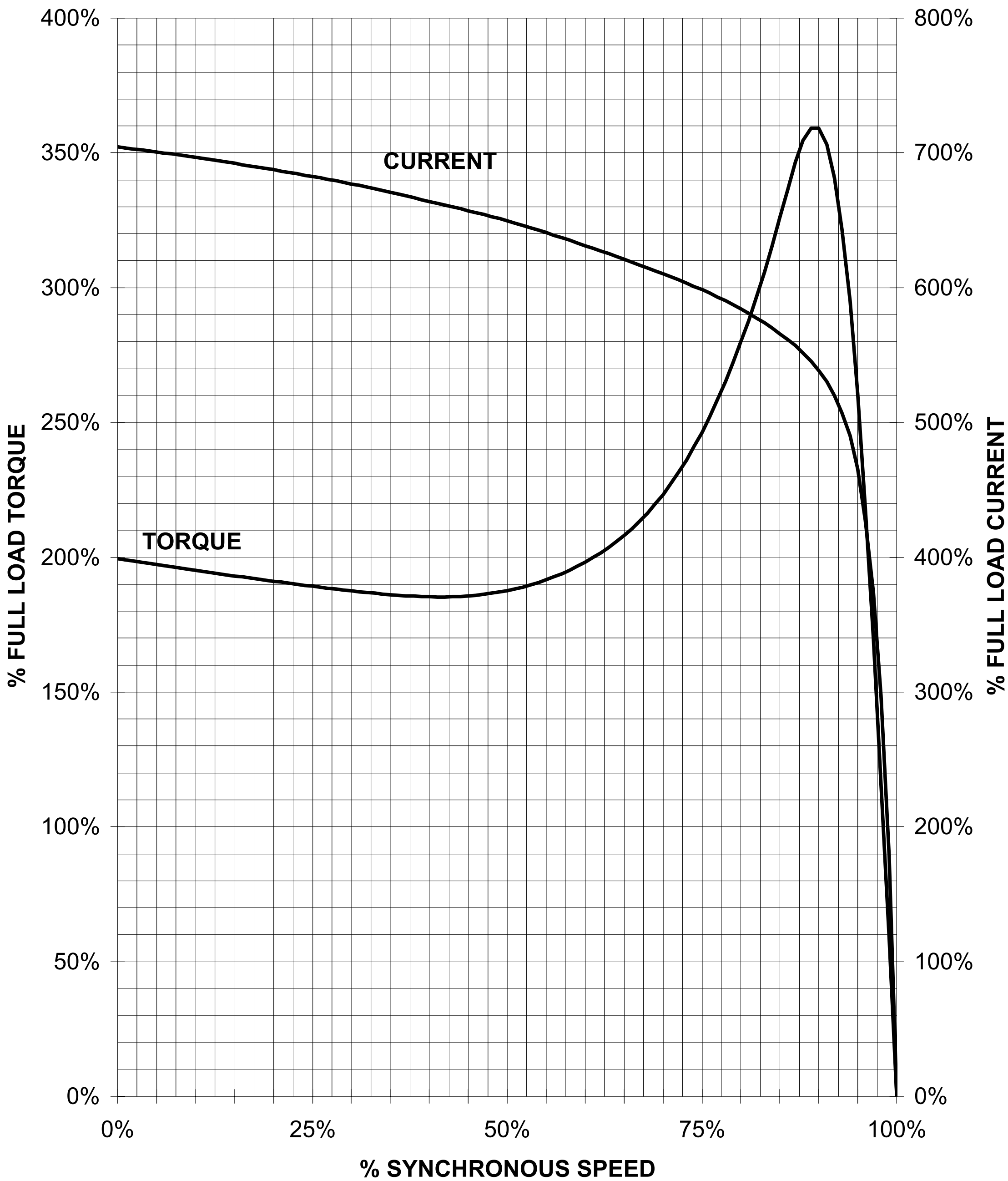
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	10	VOLTS	460	RPM	3600	TYPE	GP100
HZ	60	PHASE	3	FRAME	215T	NEMA	B

TORQUE & CURRENT VS. SPEED

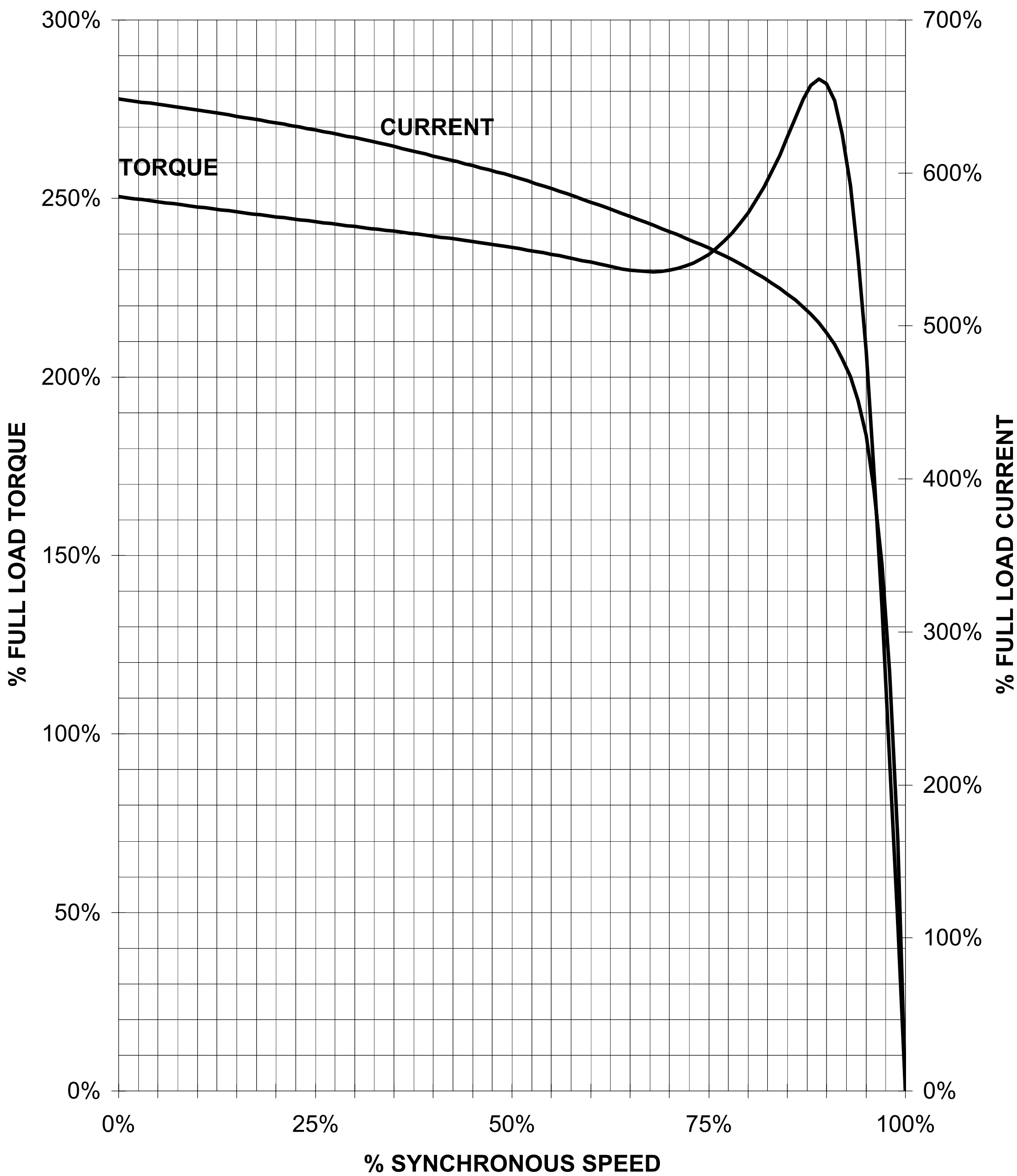


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	10	VOLTS	460	RPM	1800	TYPE	GP100
HZ	60	PHASE	3	FRAME	215T	NEMA	B

TORQUE & CURRENT VS. SPEED

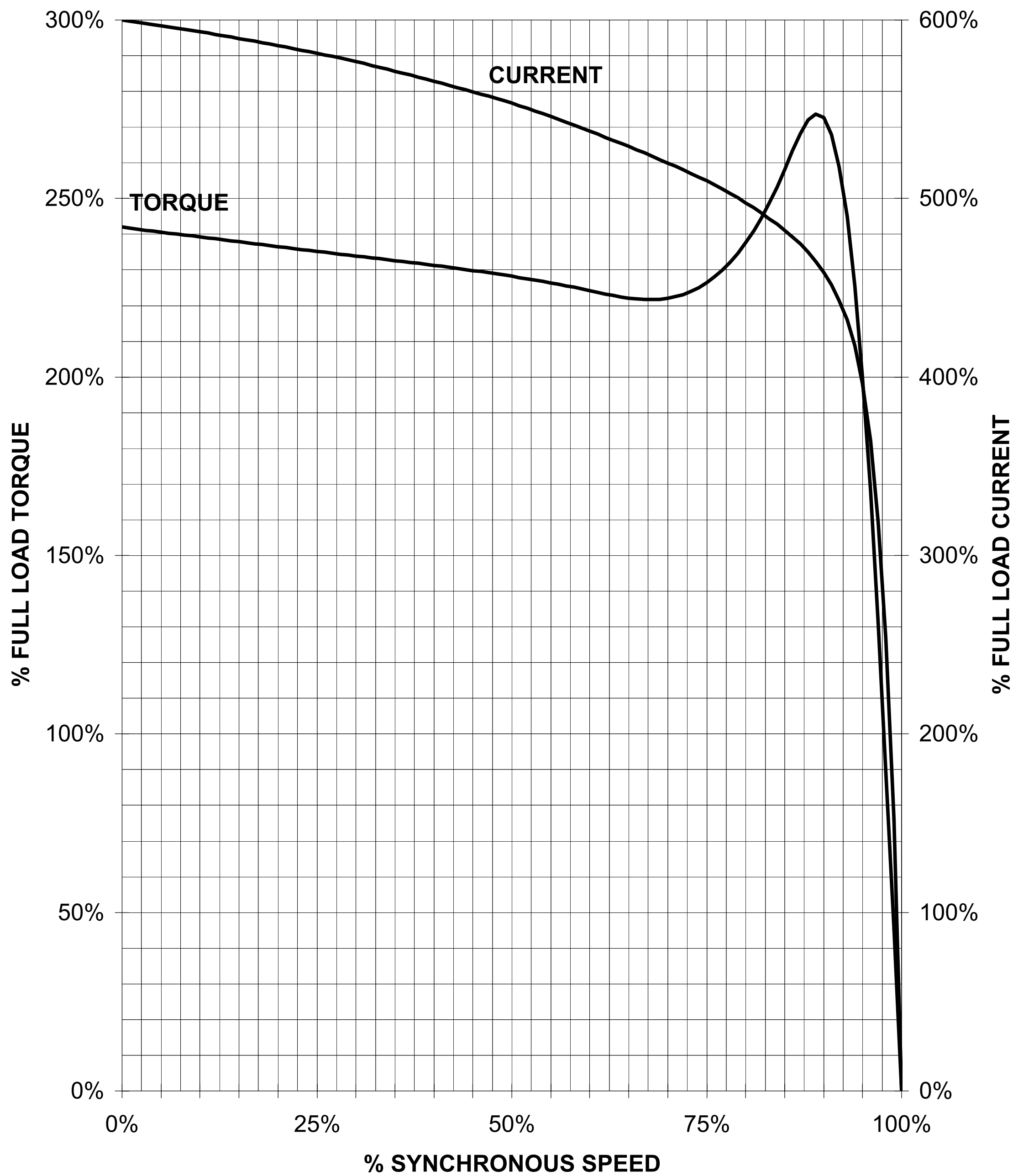


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	10	VOLTS	460	RPM	1200	TYPE	GP100
HZ	60	PHASE	3	FRAME	256T	NEMA	B

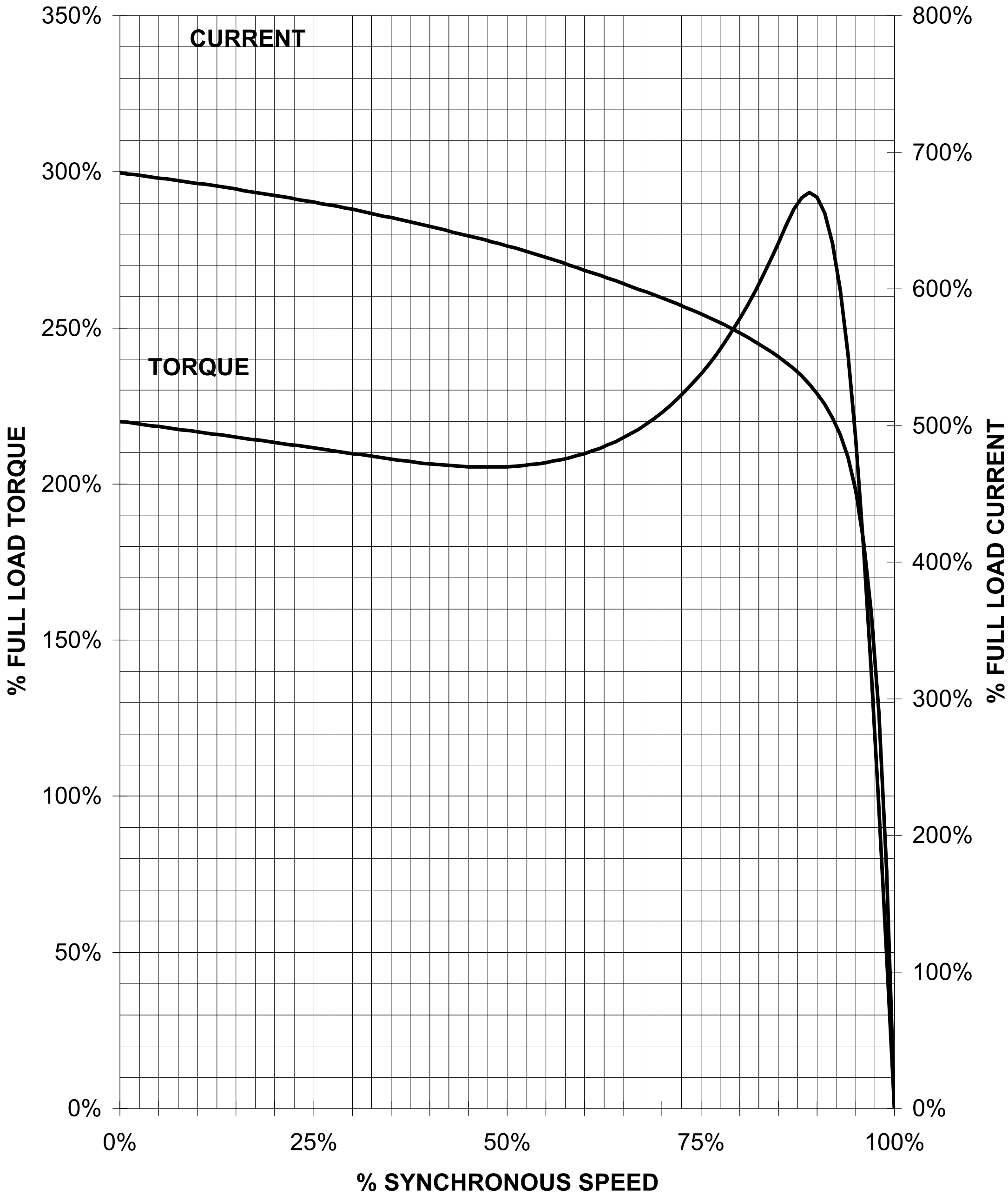
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	15	VOLTS	460	RPM	3600	TYPE	GP100
HZ	60	PHASE	3	FRAME	254T	NEMA	B

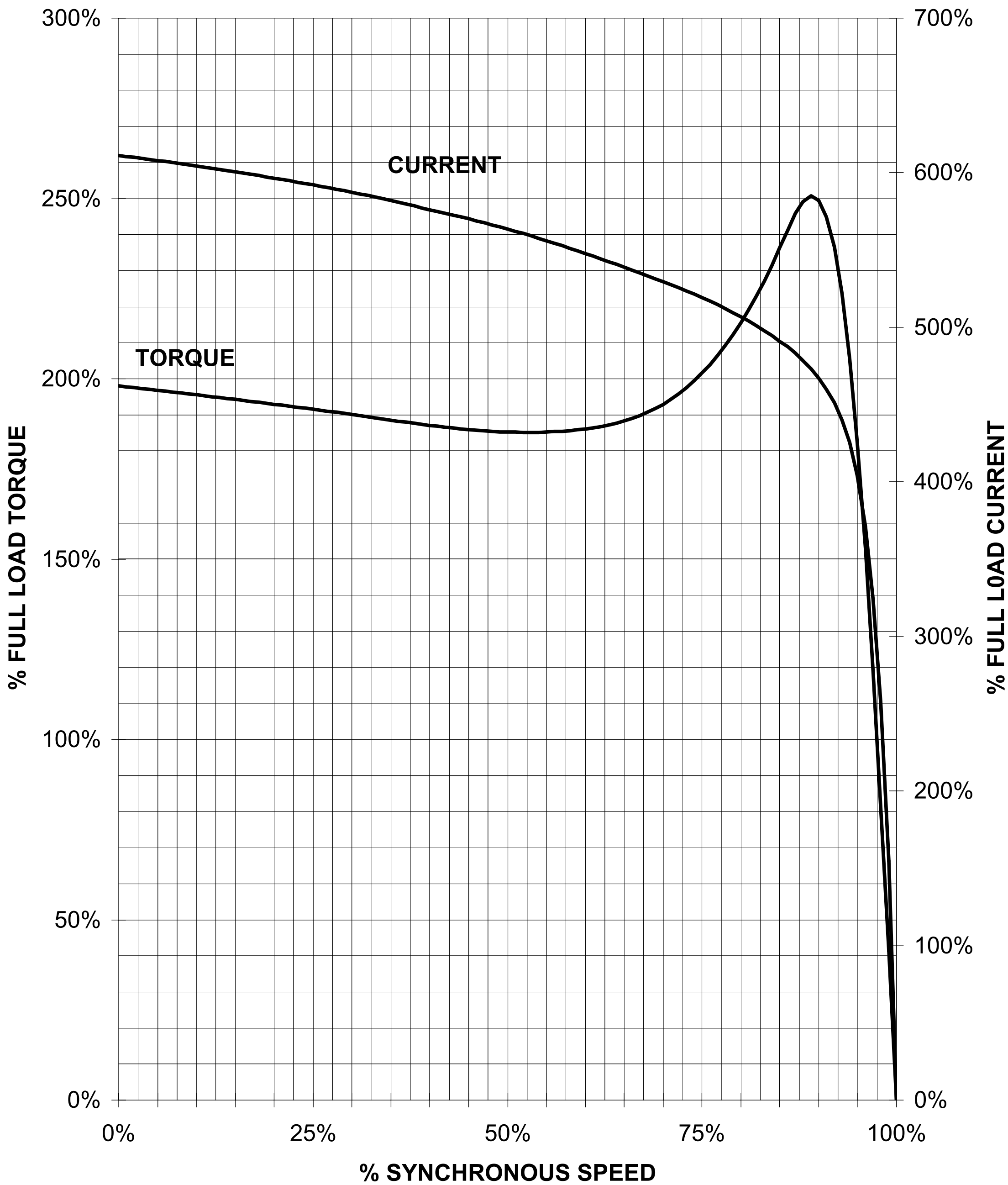
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	15	VOLTS	460	RPM	1800	TYPE	GP100
HZ	60	PHASE	3	FRAME	254T	NEMA	B

TORQUE & CURRENT VS. SPEED

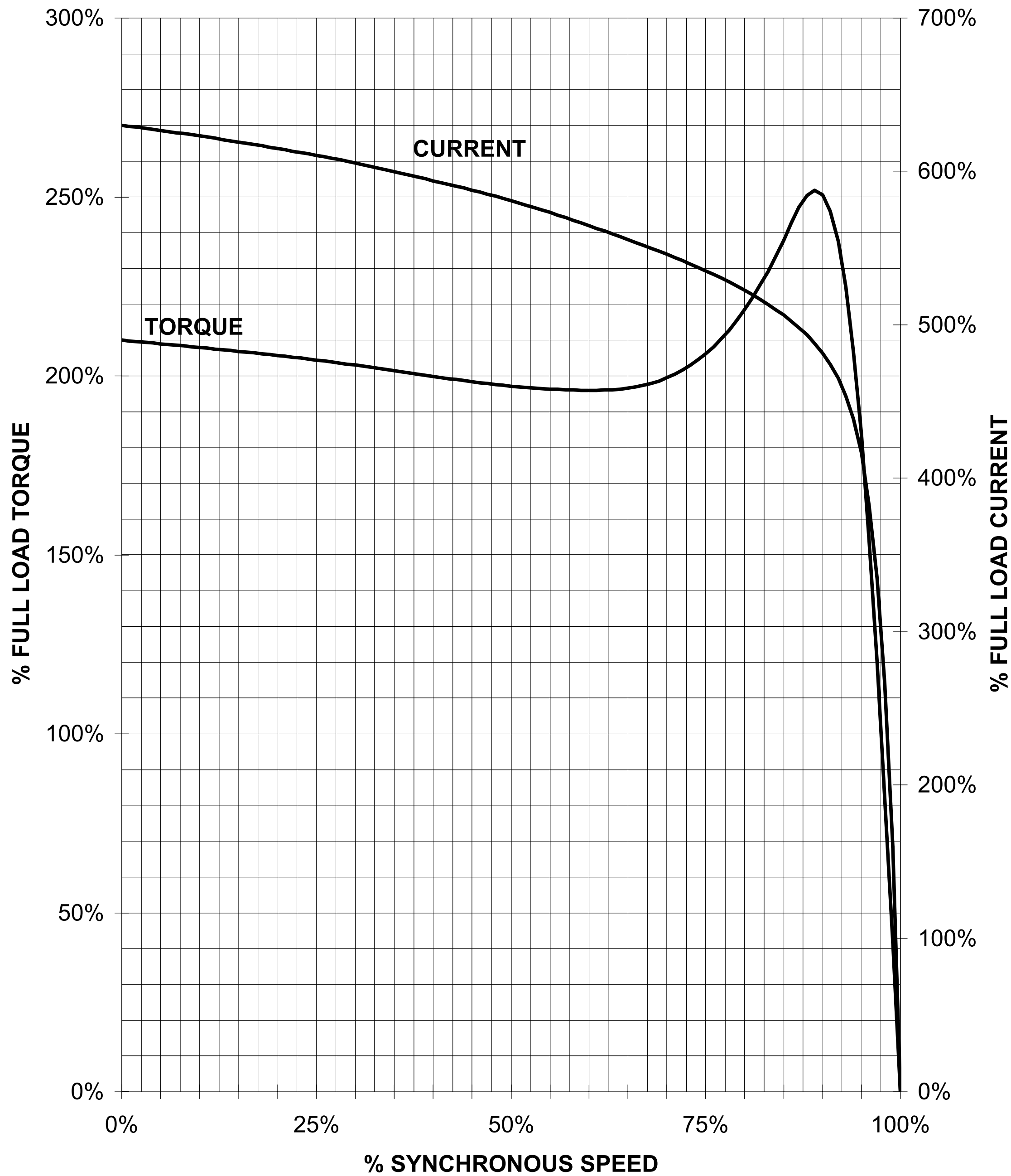


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	20	VOLTS	460	RPM	3600	TYPE	GP100
HZ	60	PHASE	3	FRAME	256T	NEMA	B

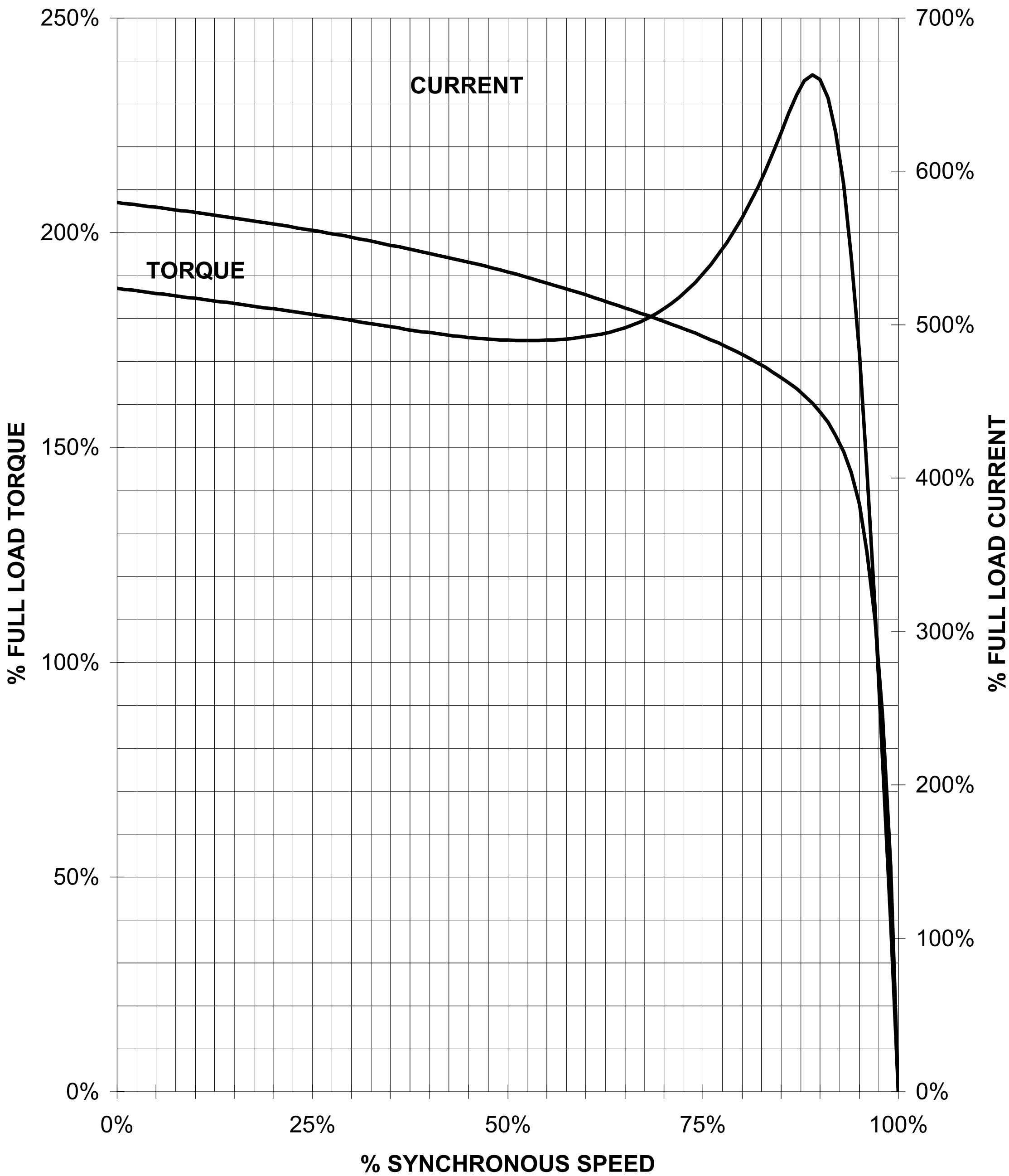
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	20	VOLTS	460	RPM	1800	TYPE	GP100
HZ	60	PHASE	3	FRAME	256T	NEMA	B

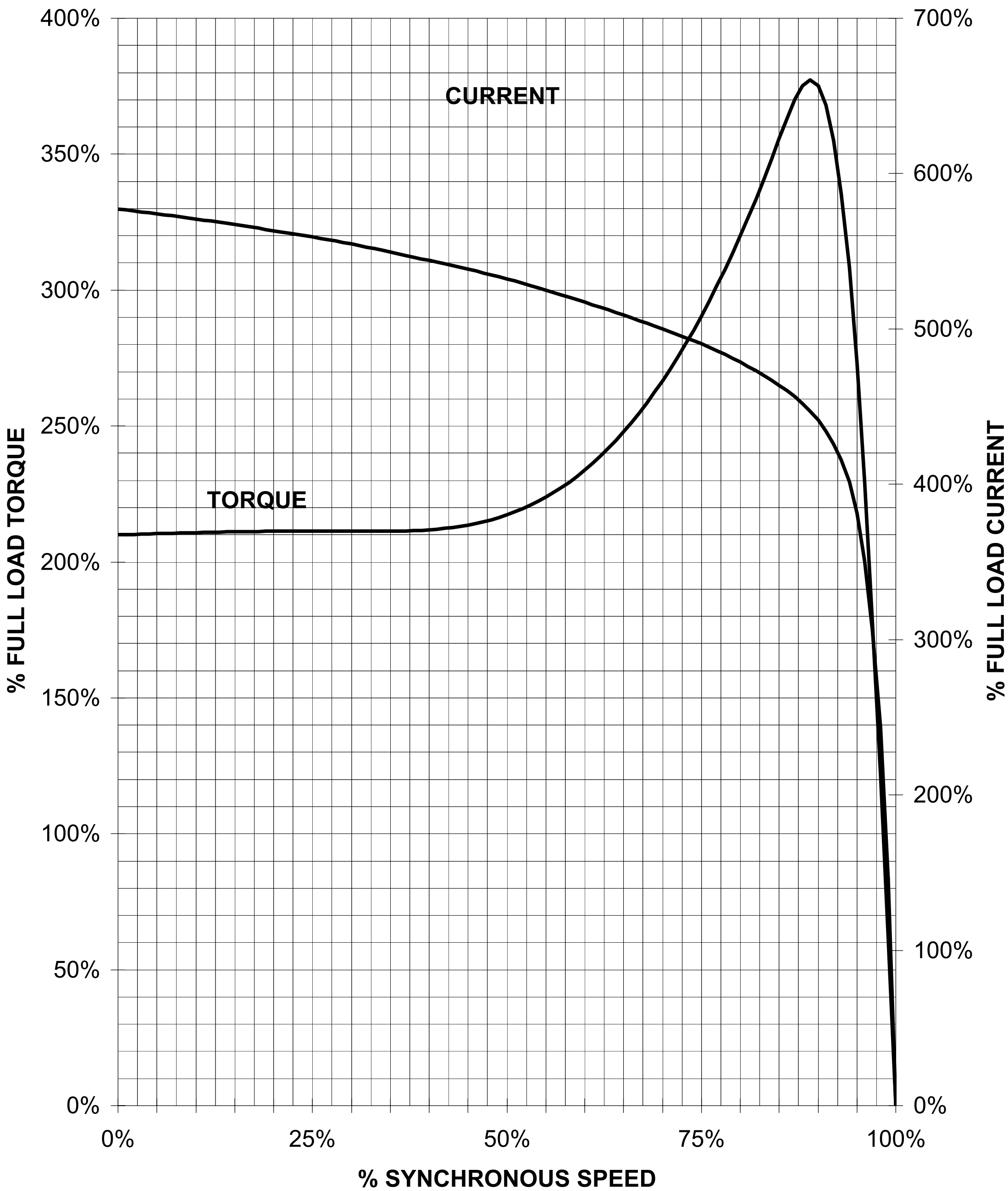
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1	VOLTS	460	RPM	3600	TYPE	GP100A
HZ	60	PHASE	3	FRAME	143T	NEMA	B

TORQUE & CURRENT VS. SPEED

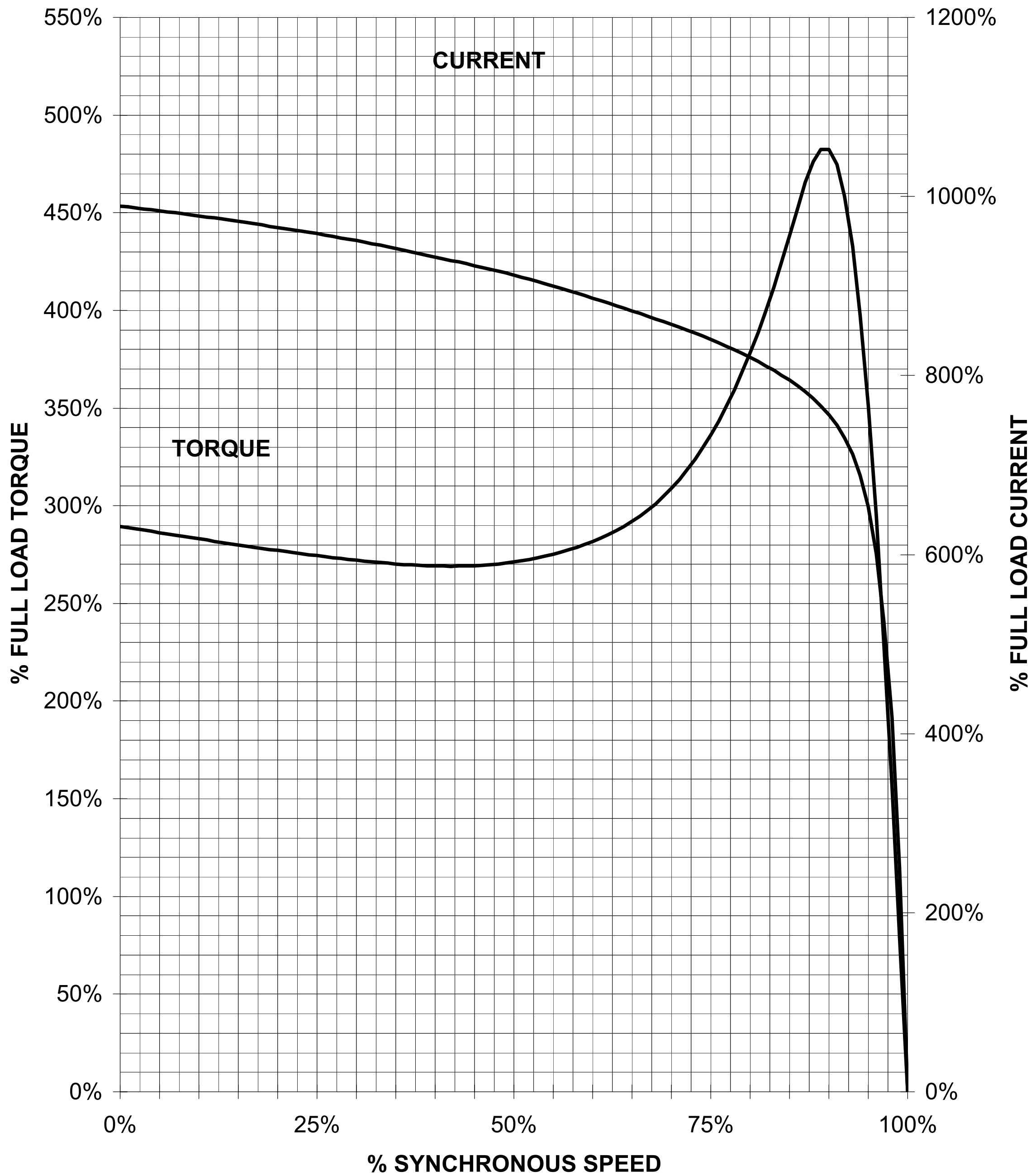


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	1	VOLTS	460	RPM	1800	TYPE	GP100A
HZ	60	PHASE	3	FRAME	143T	NEMA	B

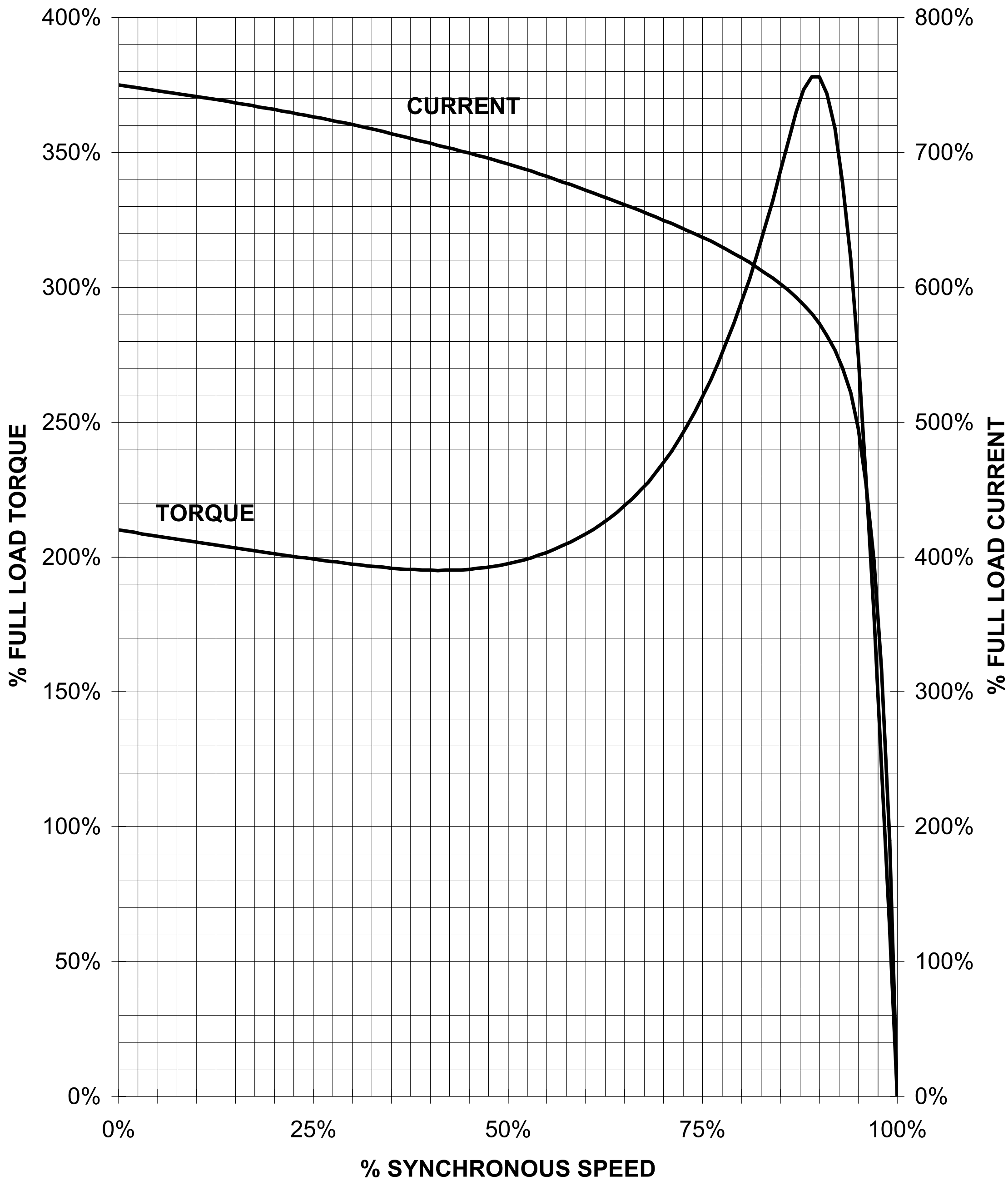
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1	VOLTS	460	RPM	1200	TYPE	GP100A
HZ	60	PHASE	3	FRAME	145T	NEMA	B

TORQUE & CURRENT VS. SPEED

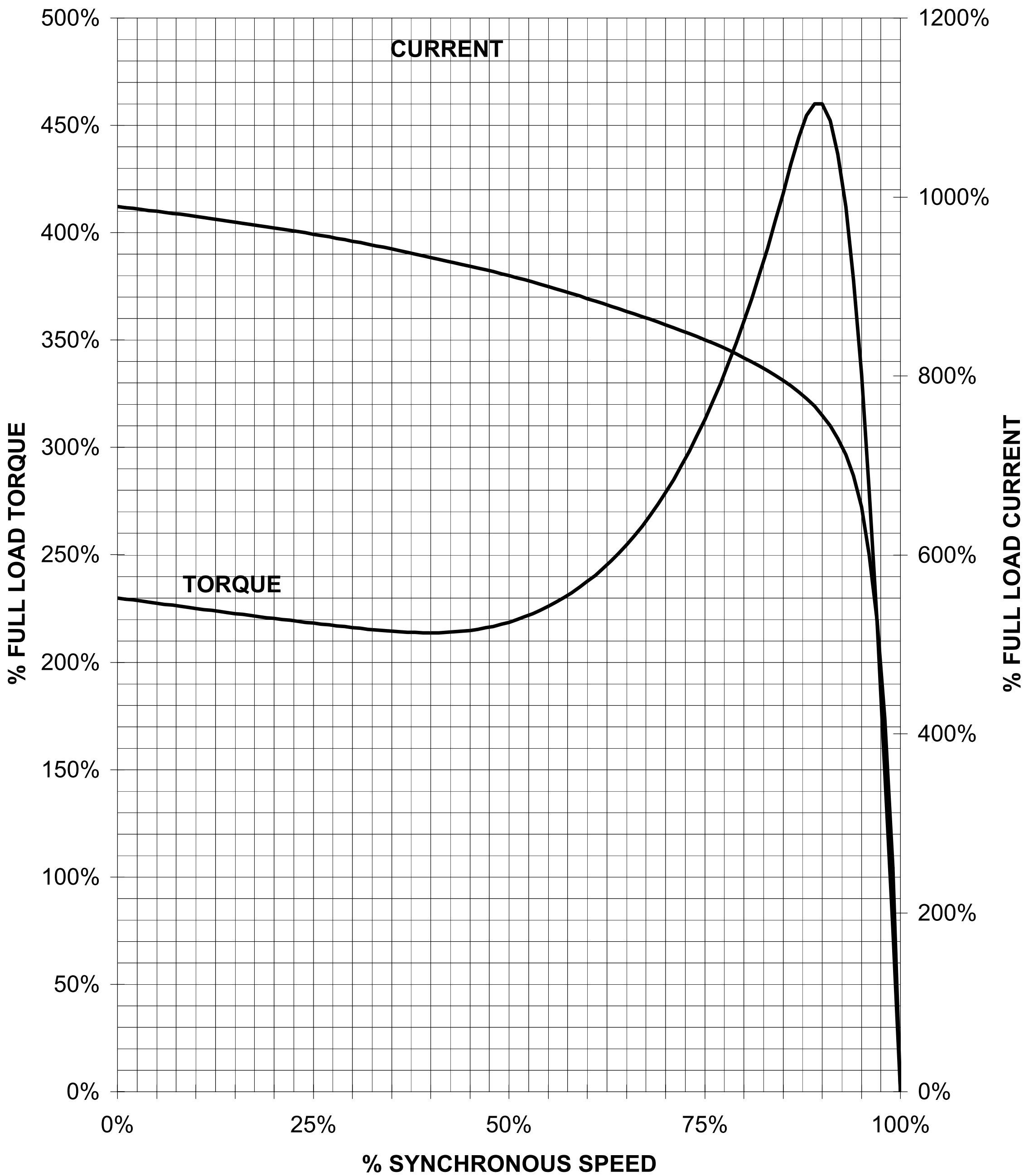


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	1.5	VOLTS	460	RPM	3600	TYPE	GP100A
HZ	60	PHASE	3	FRAME	143T	NEMA	B

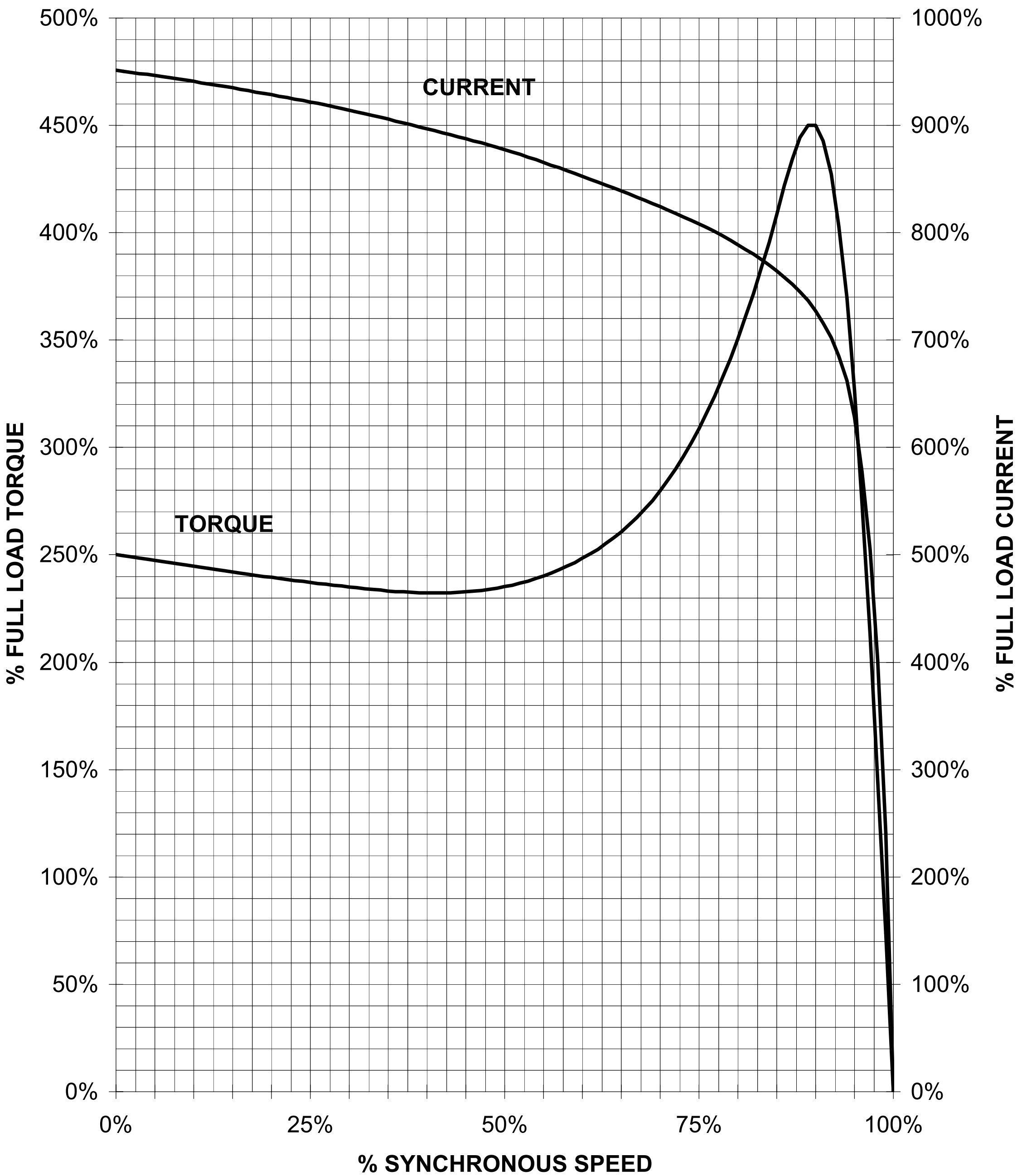
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1.5	VOLTS	460	RPM	1800	TYPE	GP100A
HZ	60	PHASE	3	FRAME	145T	NEMA	B

TORQUE & CURRENT VS. SPEED



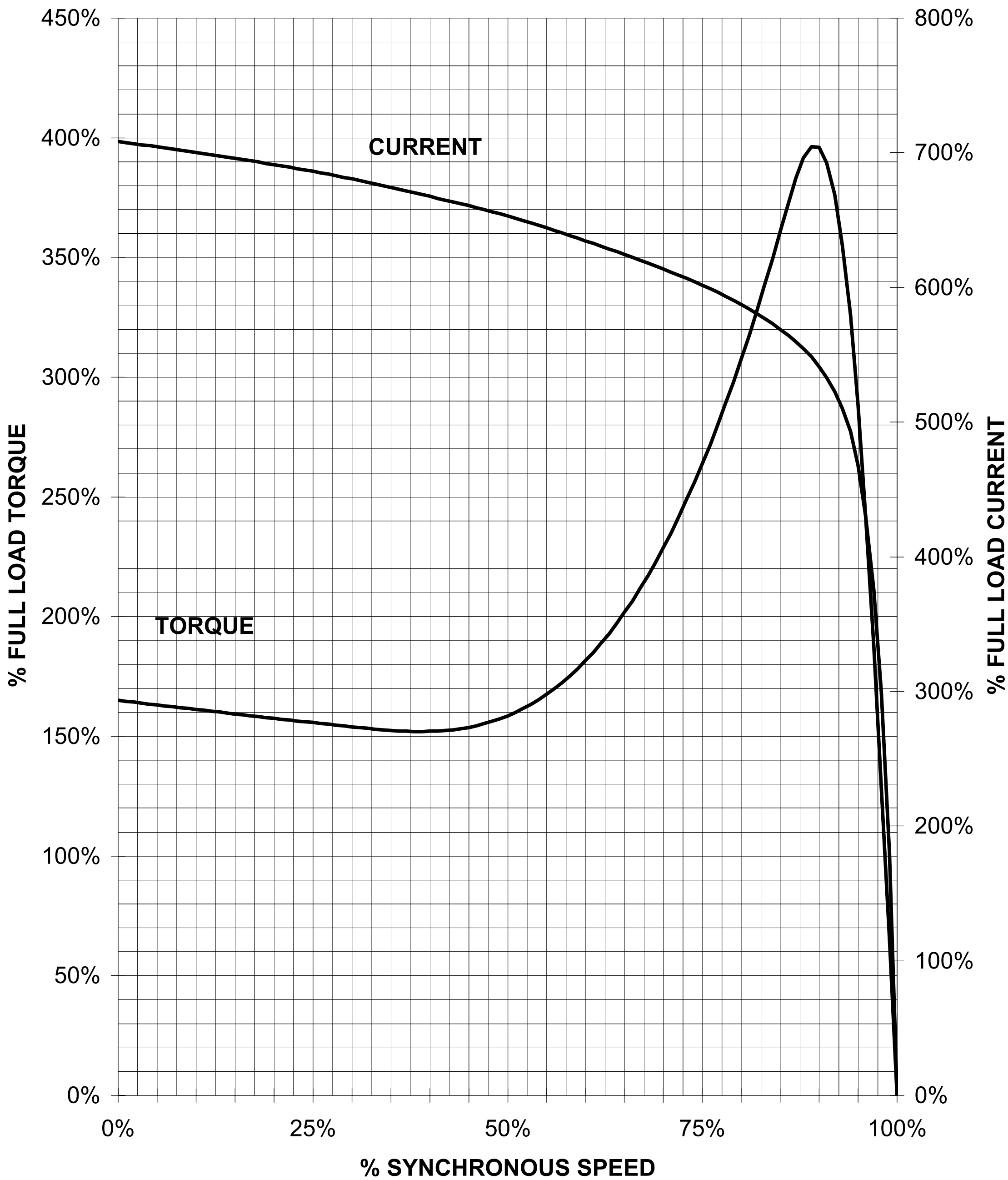
Customer: **PO No.:** **Order No.:**

SIEMENS

Application Manual for NEMA Motors

HP	1.5	VOLTS	460	RPM	1200	TYPE	GP100A
HZ	60	PHASE	3	FRAME	182T	NEMA	B

TORQUE & CURRENT VS. SPEED



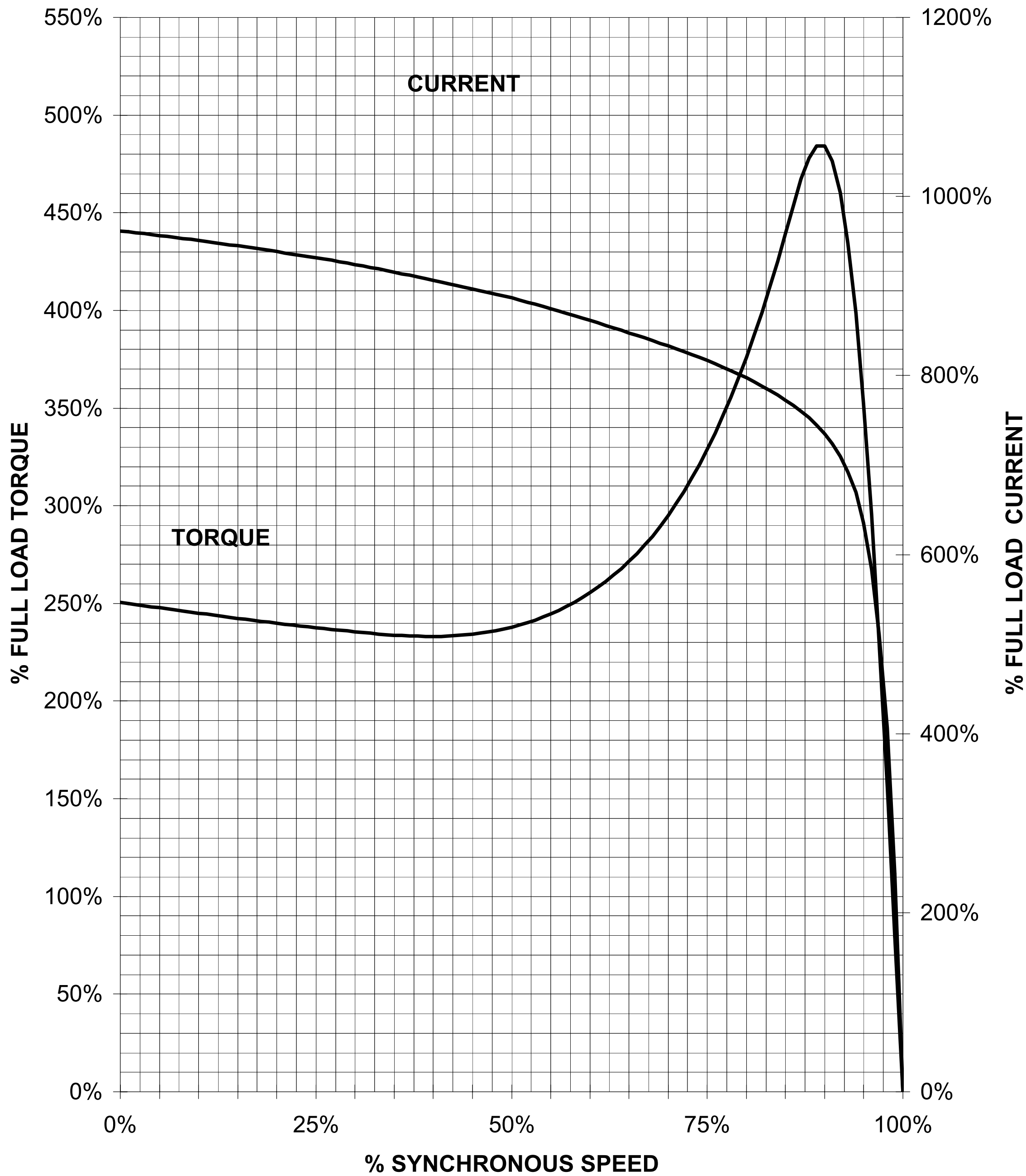
Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

Application Manual for NEMA Motors

HP	2	VOLTS	460	RPM	3600	TYPE	GP100A
HZ	60	PHASE	3	FRAME	145T	NEMA	B

TORQUE & CURRENT VS. SPEED

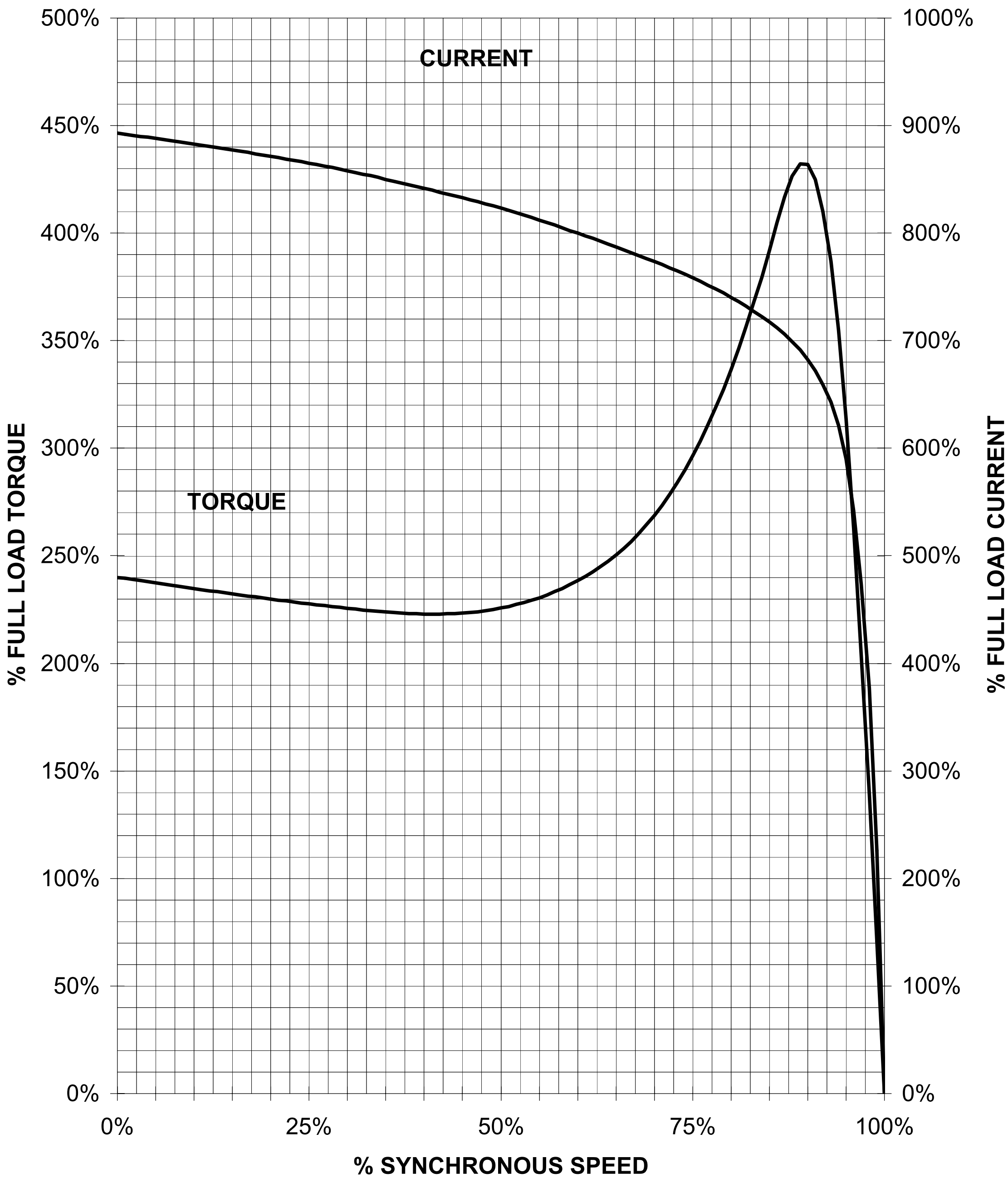


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	2	VOLTS	460	RPM	1800	TYPE	GP100A
HZ	60	PHASE	3	FRAME	145T	NEMA	B

TORQUE & CURRENT VS. SPEED

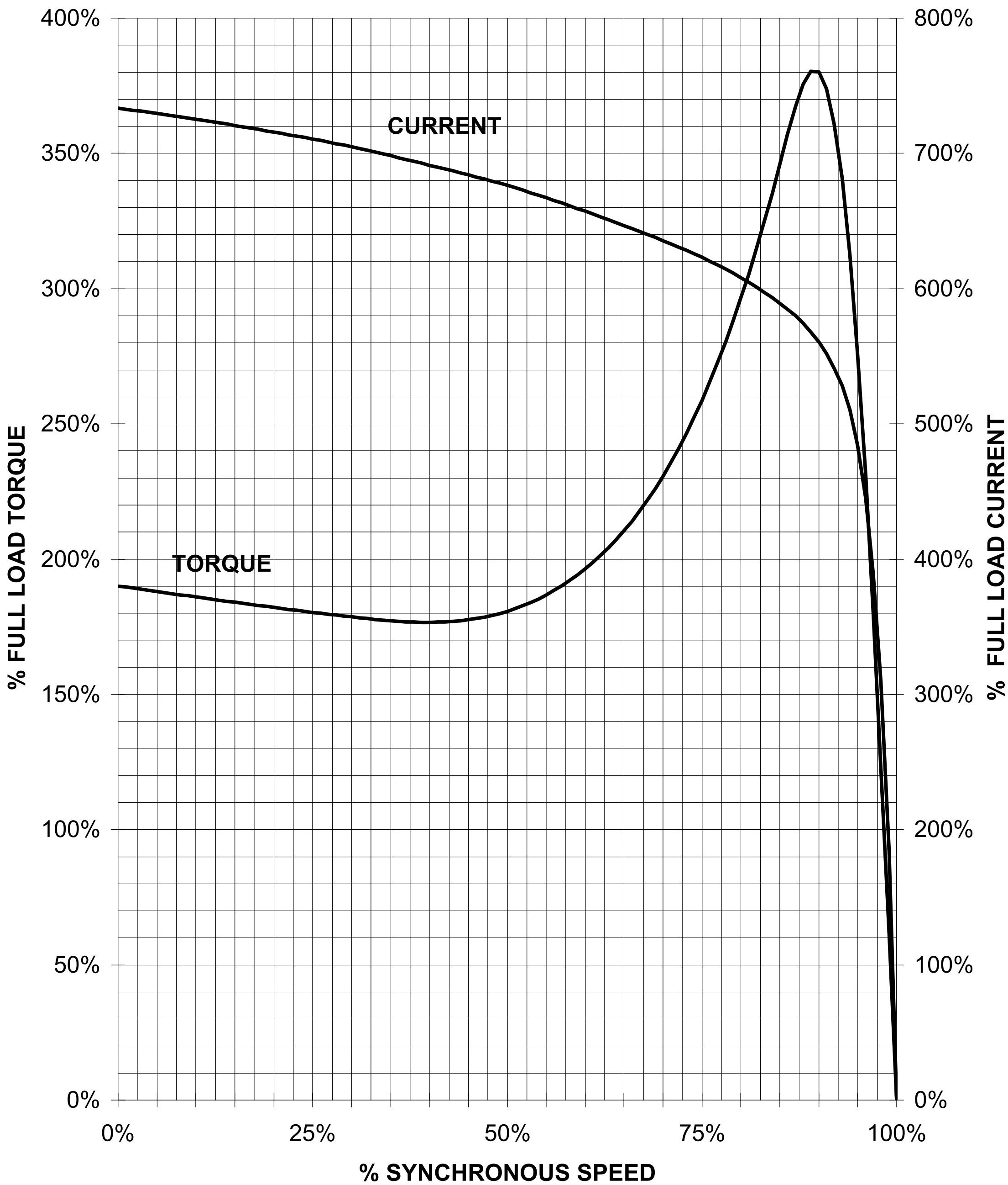


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	2	VOLTS	460	RPM	1200	TYPE	GP100A
HZ	60	PHASE	3	FRAME	184T	NEMA	B

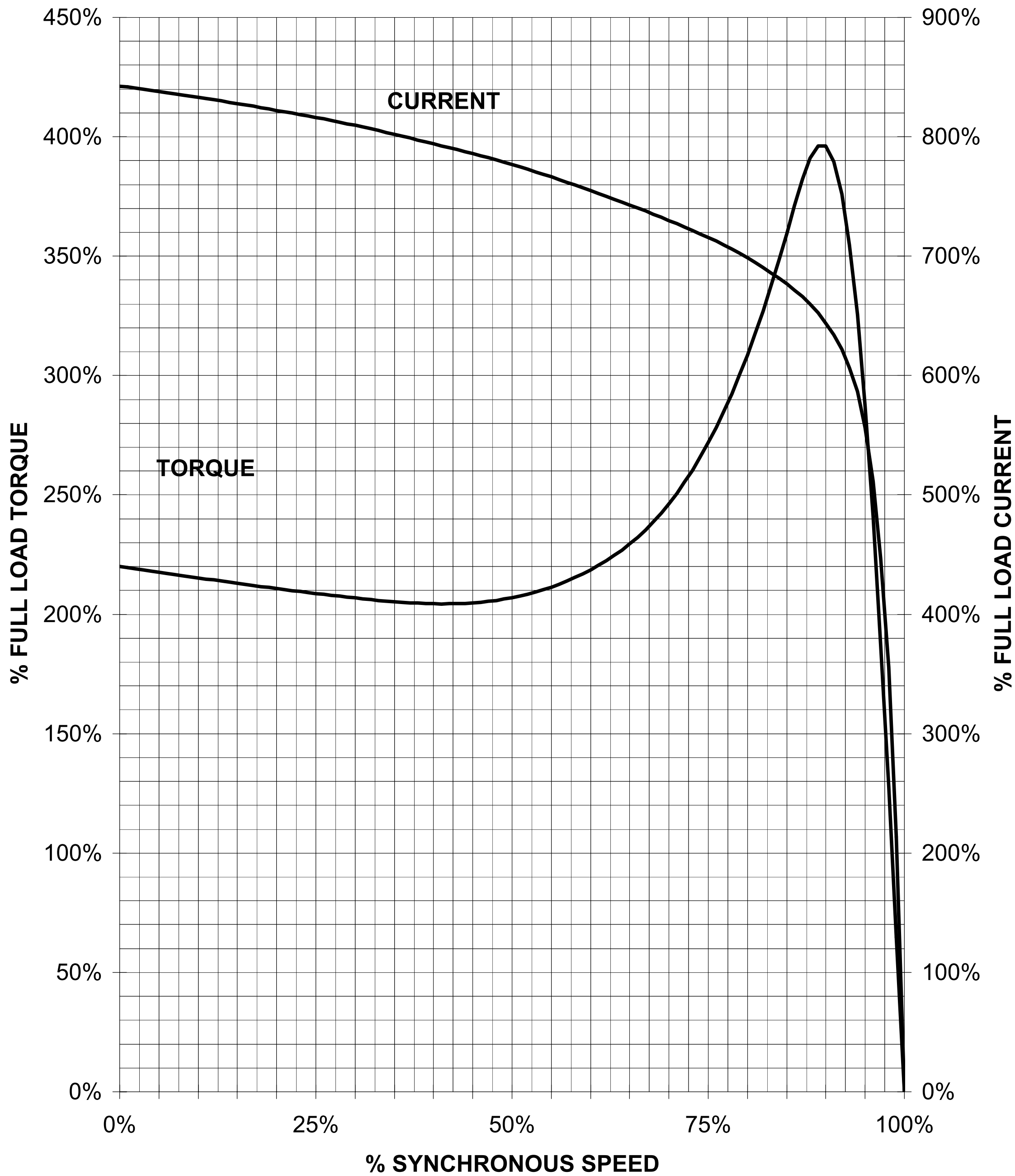
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	3	VOLTS	460	RPM	3600	TYPE	GP100A
HZ	60	PHASE	3	FRAME	182T	NEMA	B

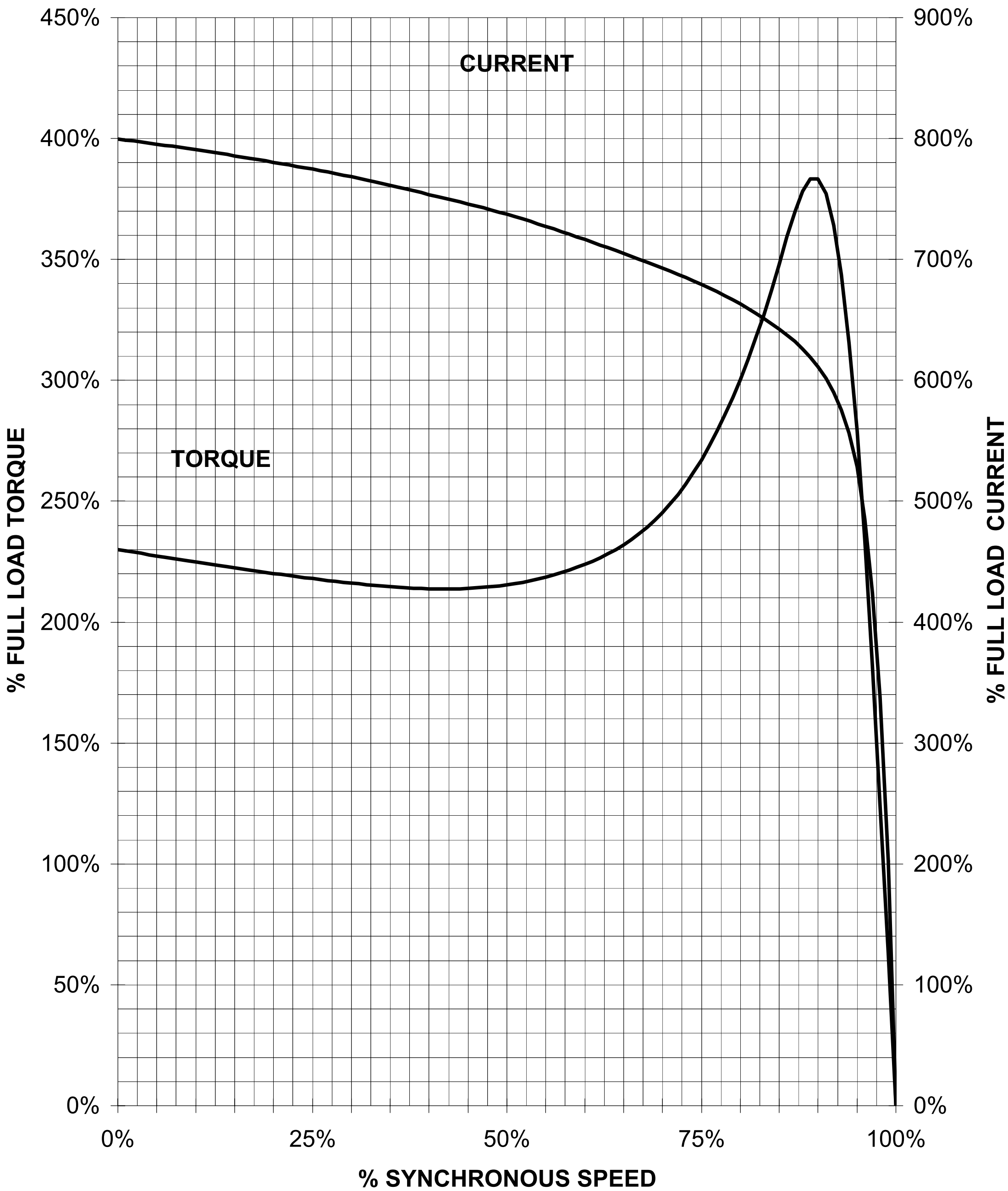
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	3	VOLTS	460	RPM	1800	TYPE	GP100A
HZ	60	PHASE	3	FRAME	182T	NEMA	B

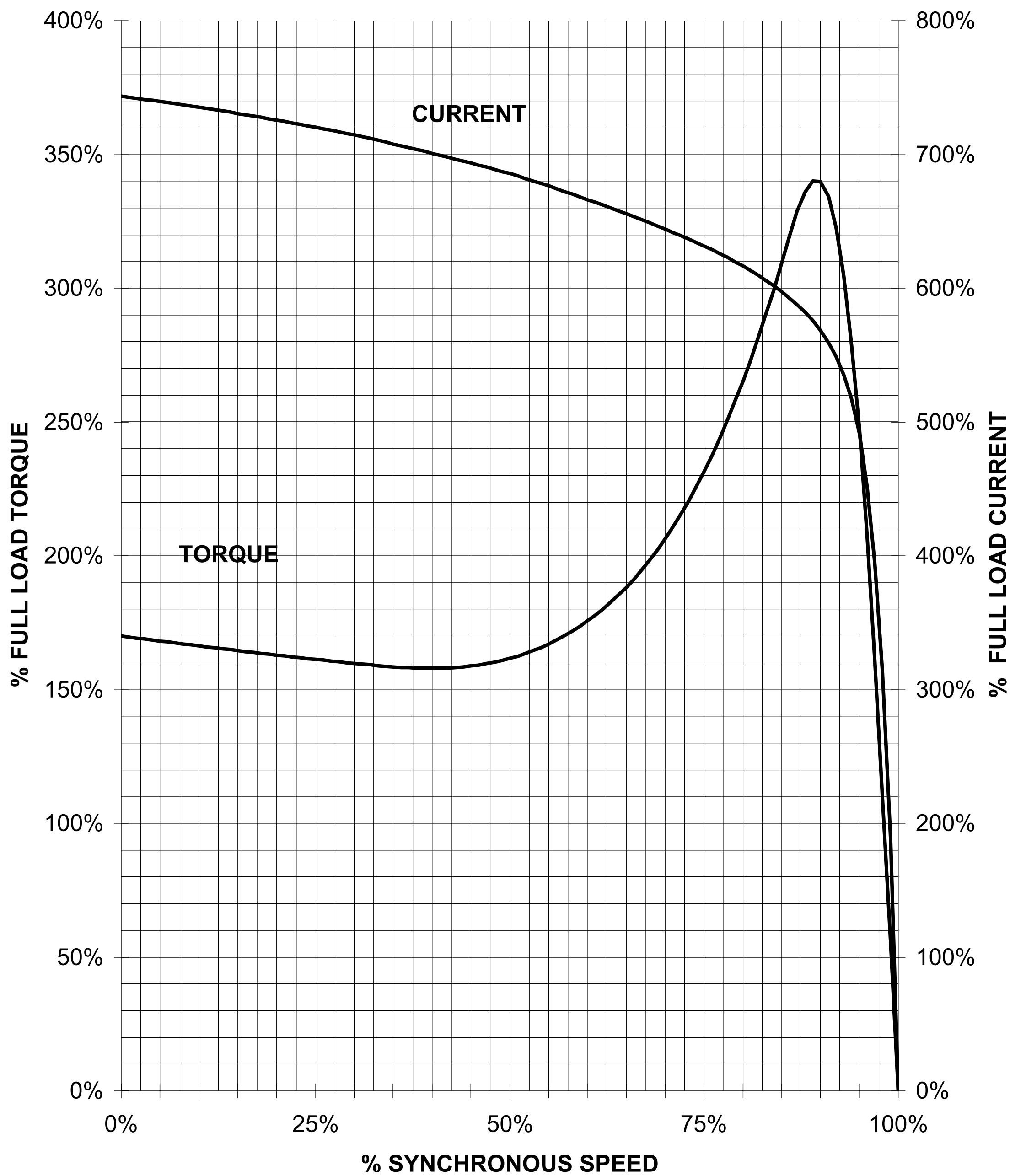
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	3	VOLTS	460	RPM	1200	TYPE	GP100A
HZ	60	PHASE	3	FRAME	213T	NEMA	B

TORQUE & CURRENT VS. SPEED

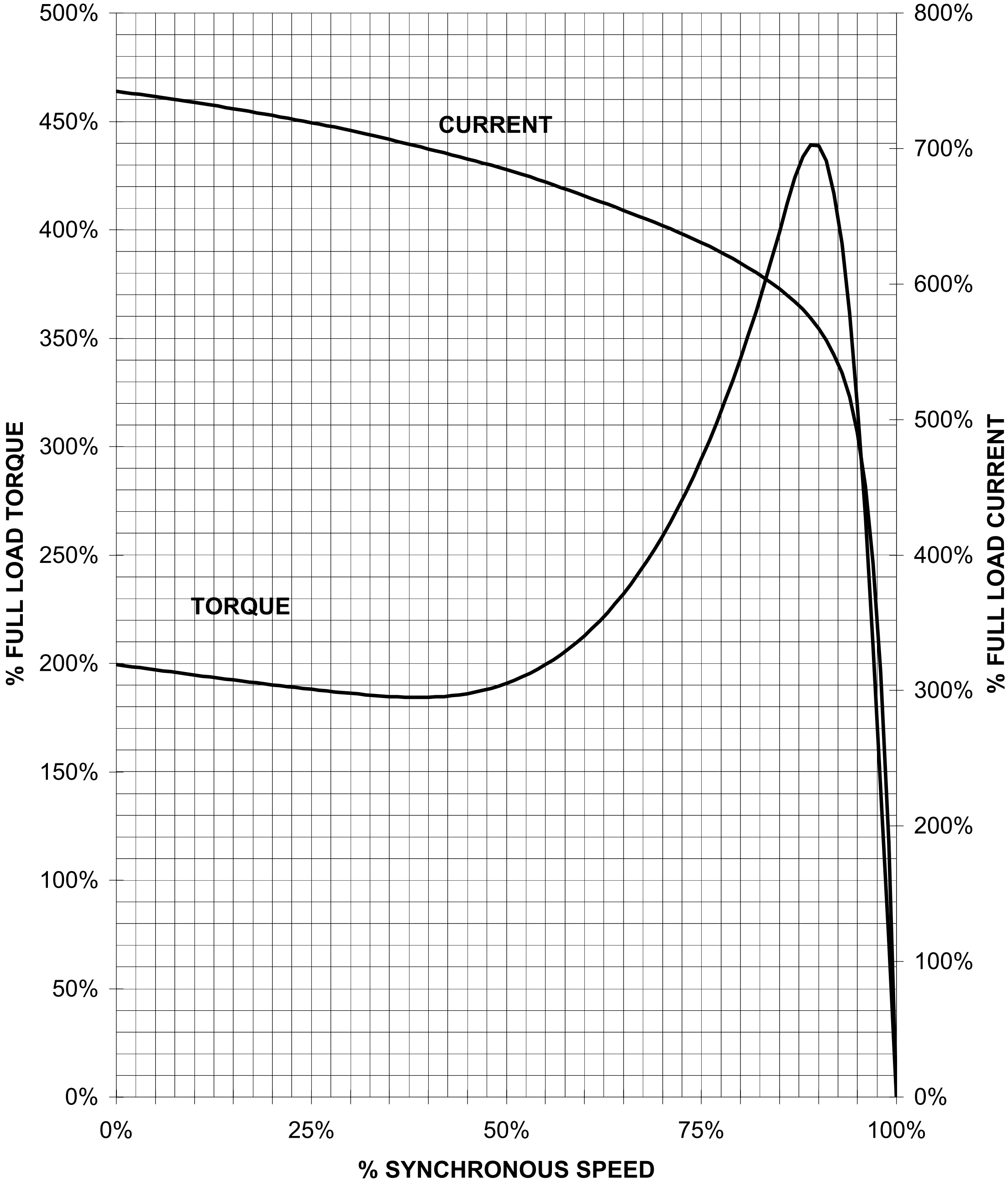


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	5	VOLTS	460	RPM	3600	TYPE	GP100A
HZ	60	PHASE	3	FRAME	184T	NEMA	B

TORQUE & CURRENT VS. SPEED

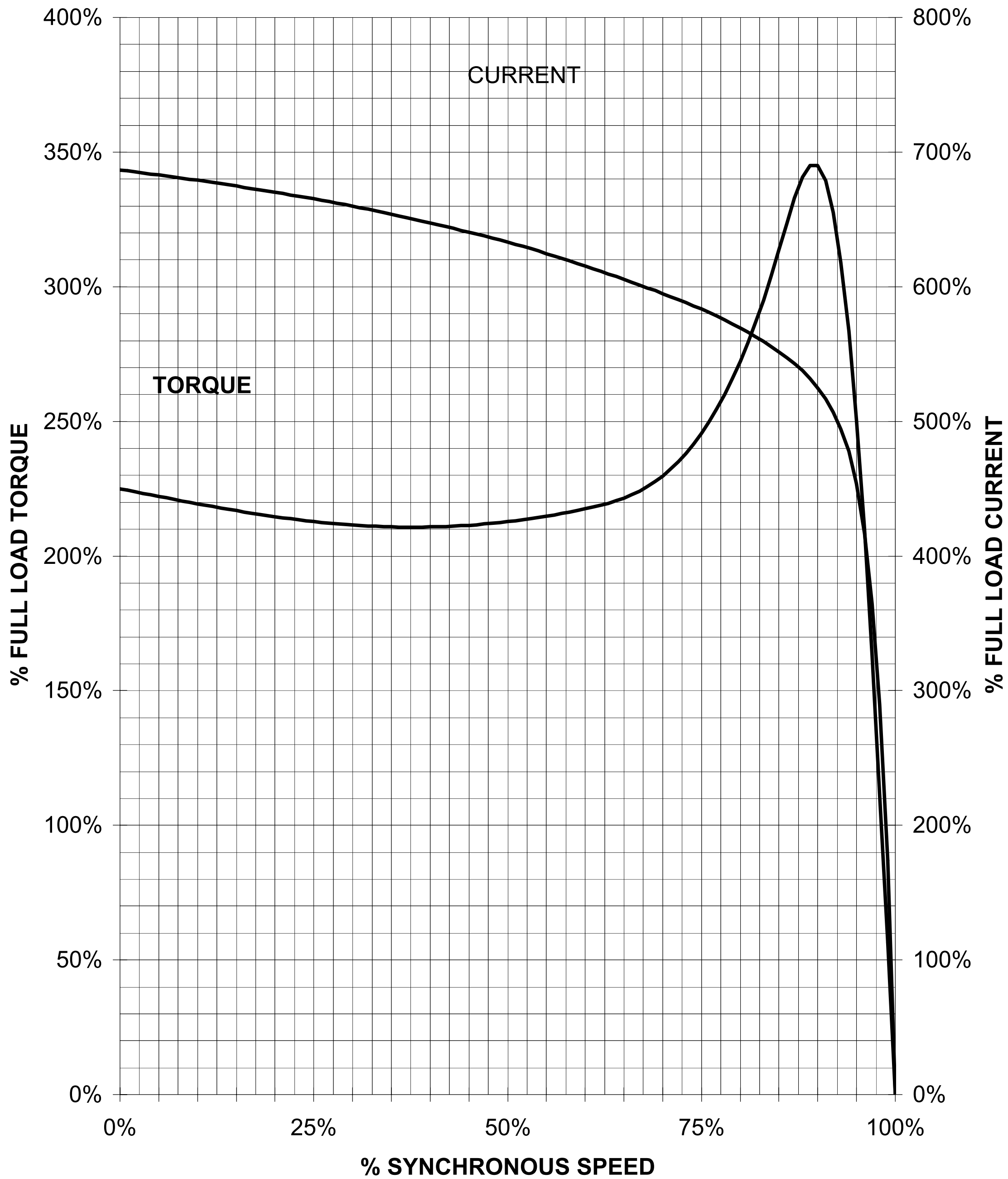


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	5	VOLTS	460	RPM	1800	TYPE	GP100A
HZ	60	PHASE	3	FRAME	184T	NEMA	B

TORQUE & CURRENT VS. SPEED

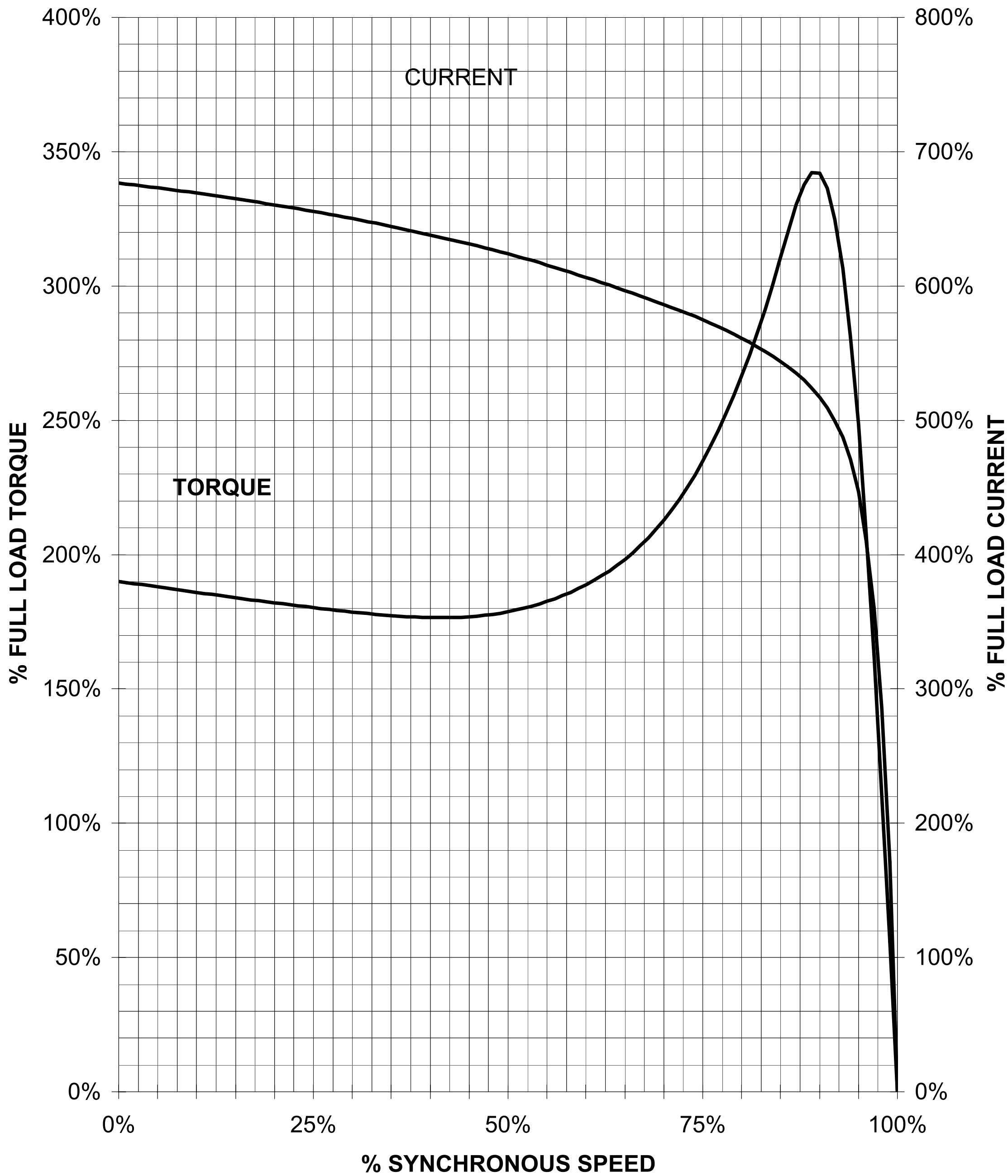


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	5	VOLTS	460	RPM	1200	TYPE	GP100A
HZ	60	PHASE	3	FRAME	215T	NEMA	B

TORQUE & CURRENT VS. SPEED

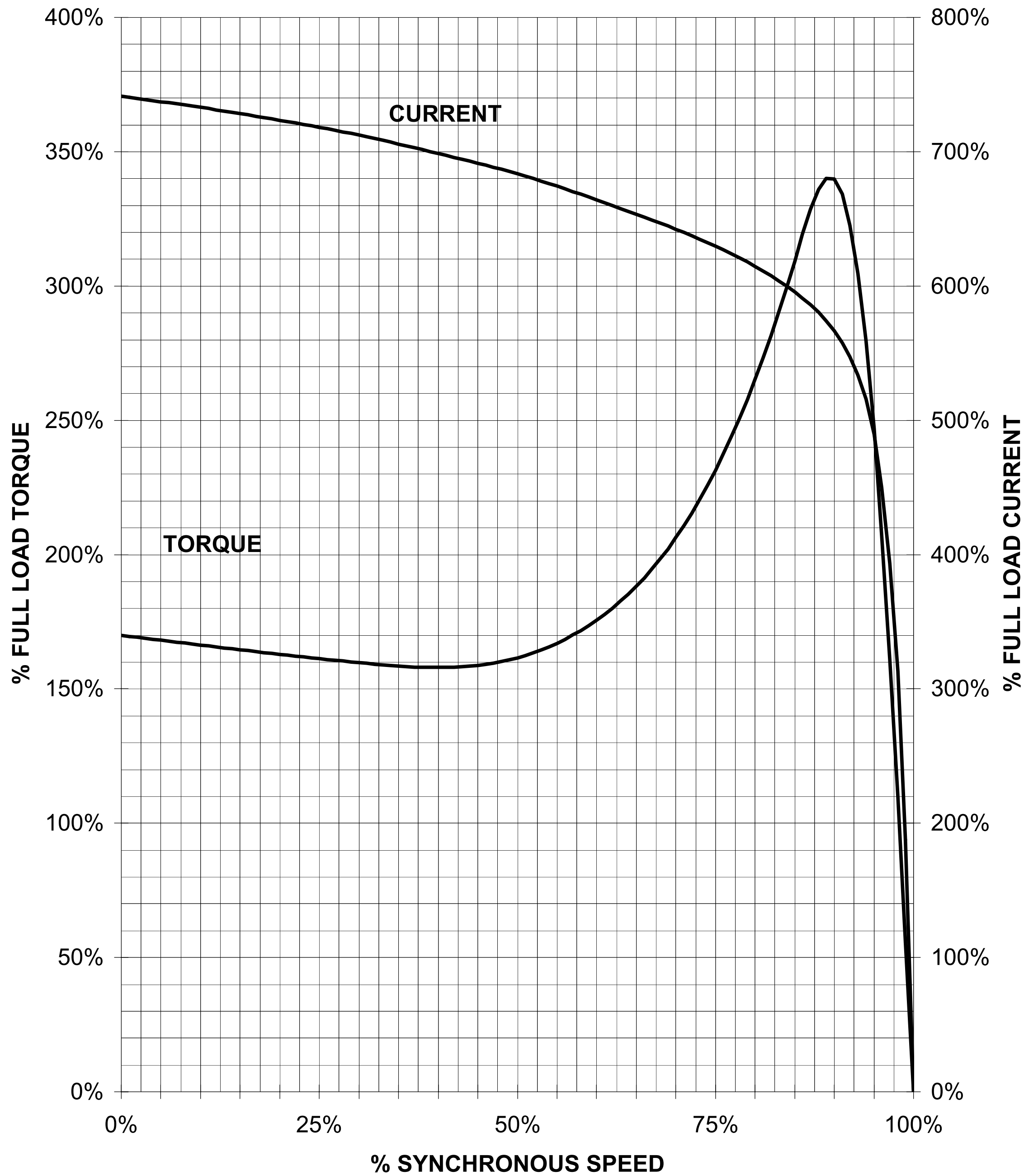


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	7.5	VOLTS	460	RPM	3600	TYPE	GP100A
HZ	60	PHASE	3	FRAME	213T	NEMA	B

TORQUE & CURRENT VS. SPEED

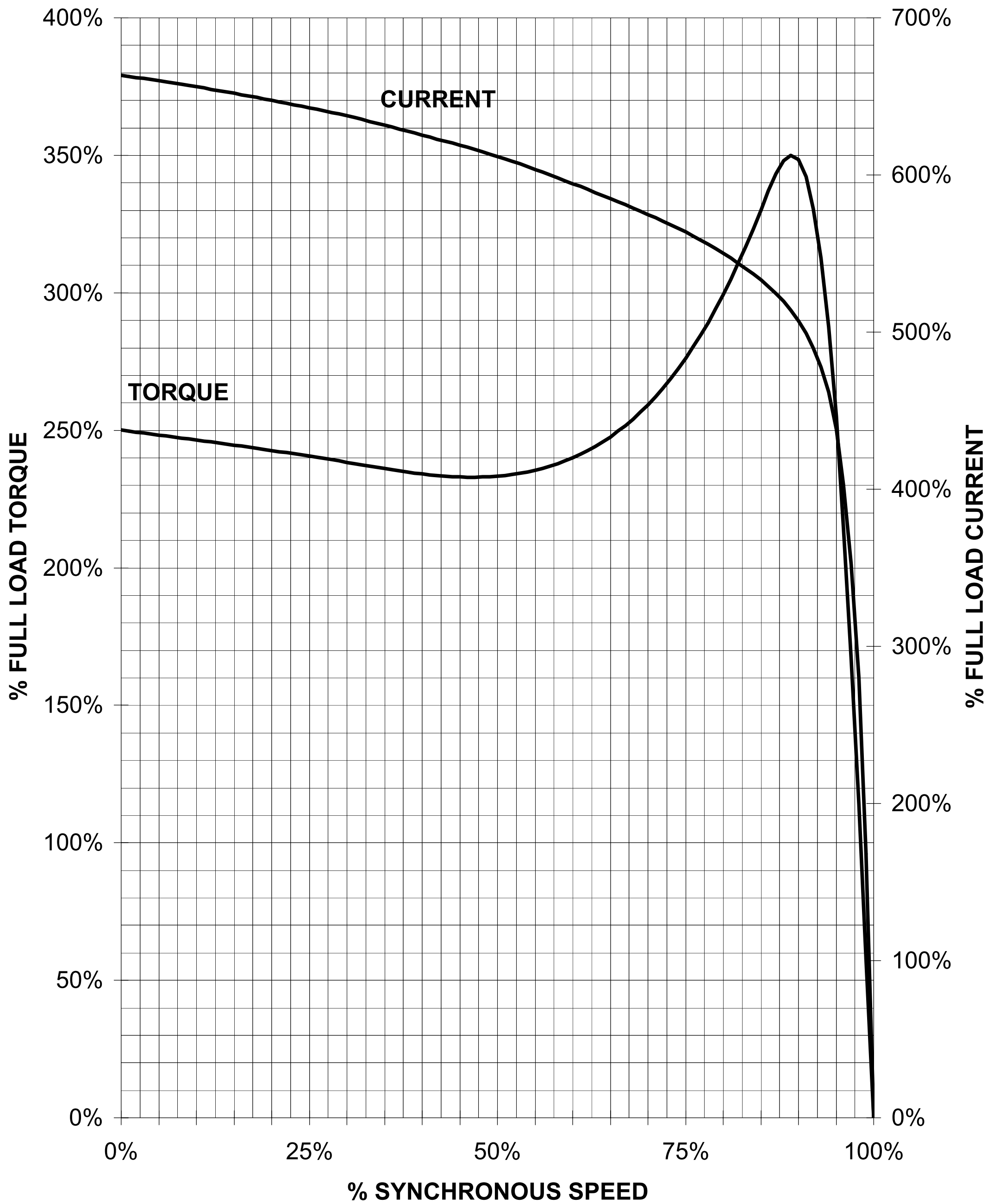


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	7.5	VOLTS	460	RPM	1800	TYPE	GP100A
HZ	60	PHASE	3	FRAME	213T	NEMA	B

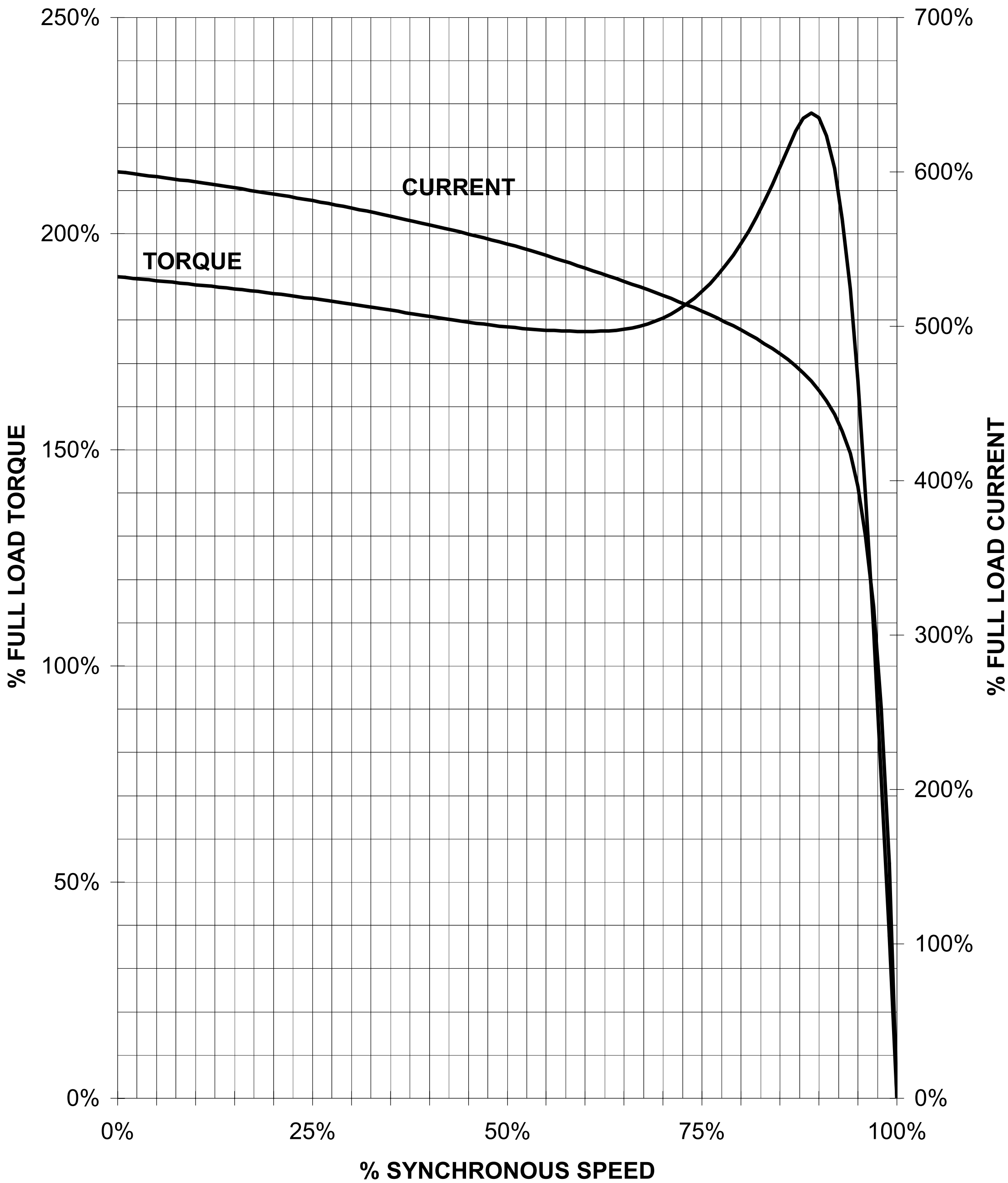
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	7.5	VOLTS	460	RPM	1200	TYPE	GP100A
HZ	60	PHASE	3	FRAME	254T	NEMA	B

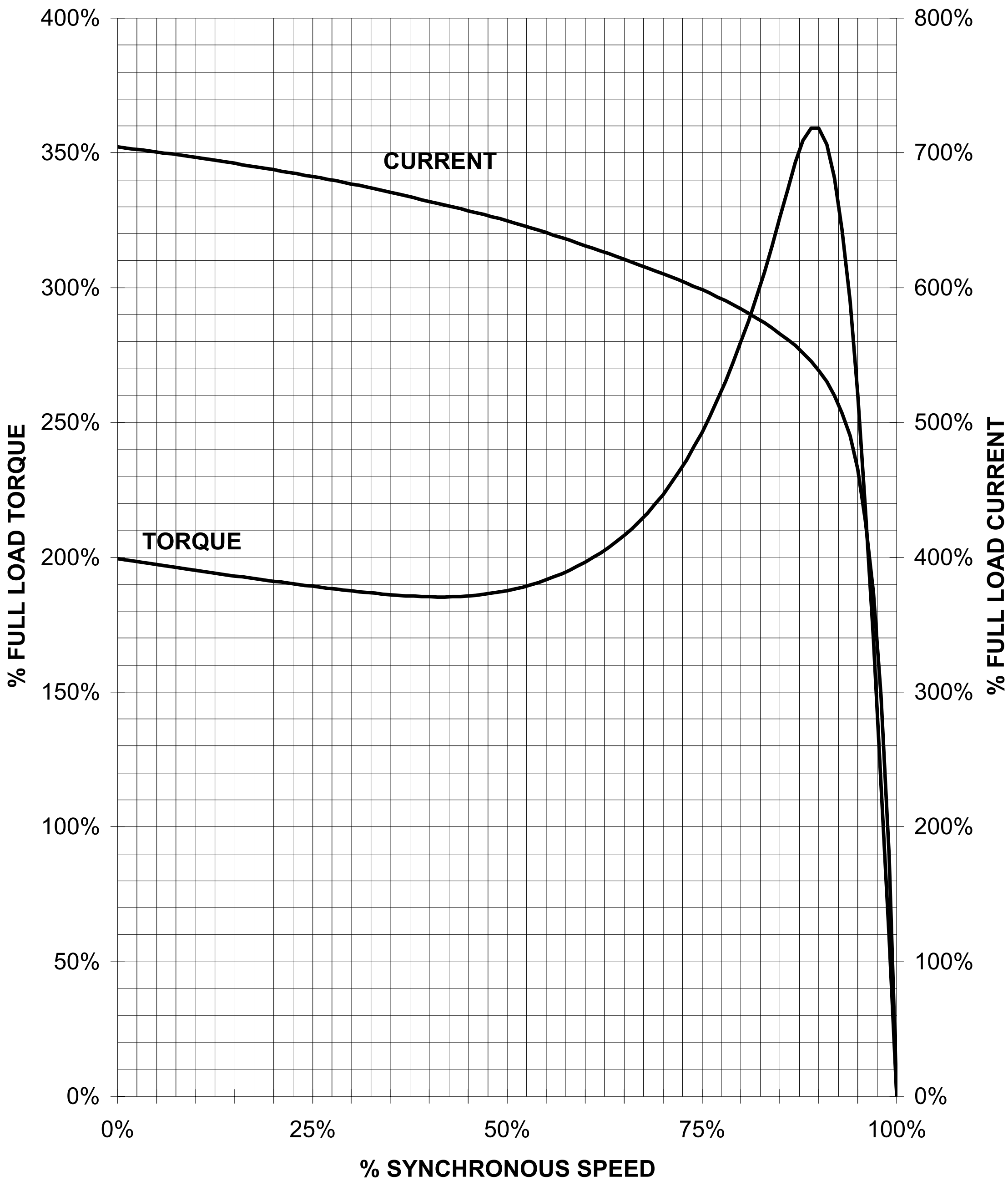
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	10	VOLTS	460	RPM	3600	TYPE	GP100A
HZ	60	PHASE	3	FRAME	215T	NEMA	B

TORQUE & CURRENT VS. SPEED

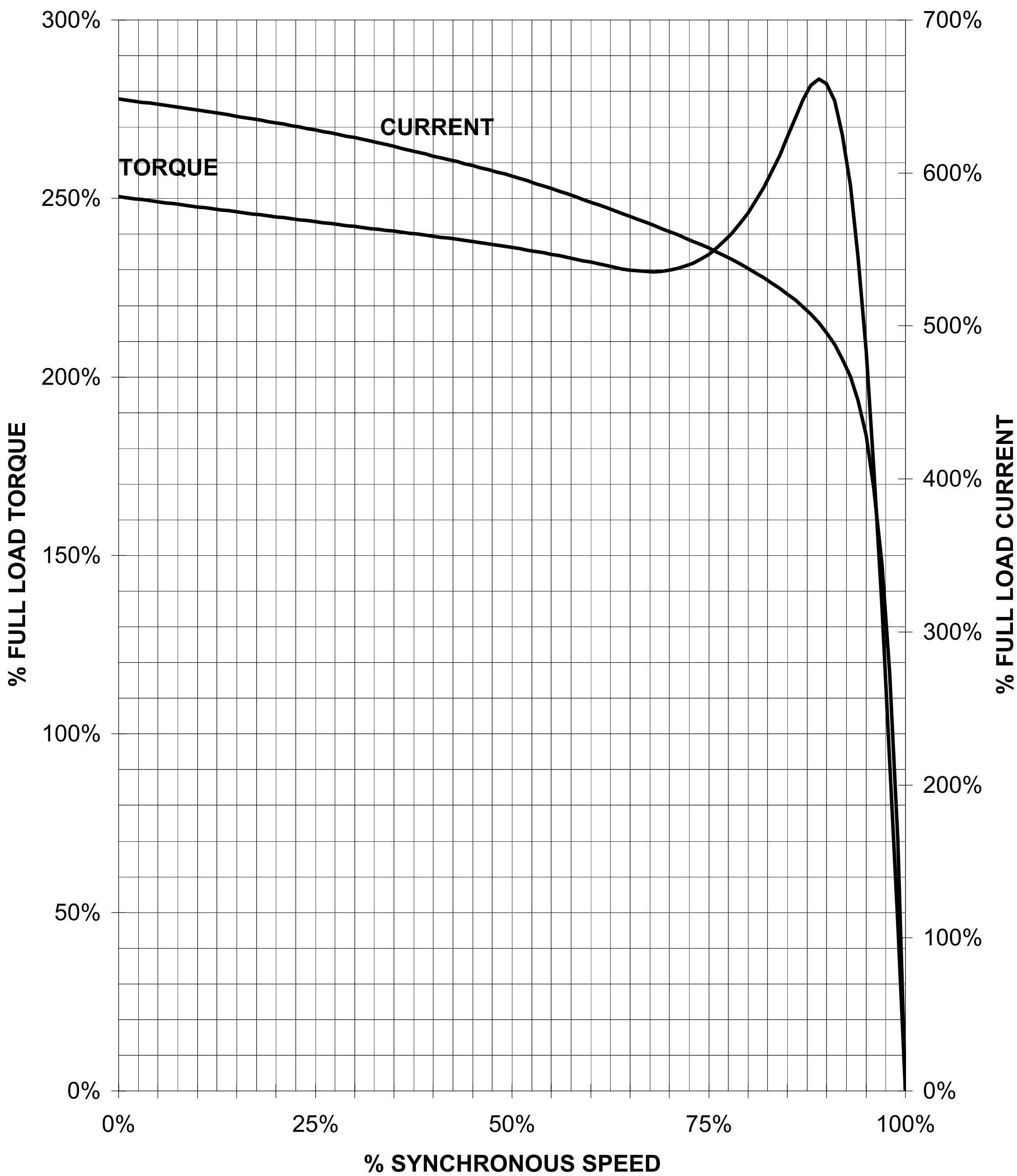


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	10	VOLTS	460	RPM	1800	TYPE	GP100A
HZ	60	PHASE	3	FRAME	215T	NEMA	B

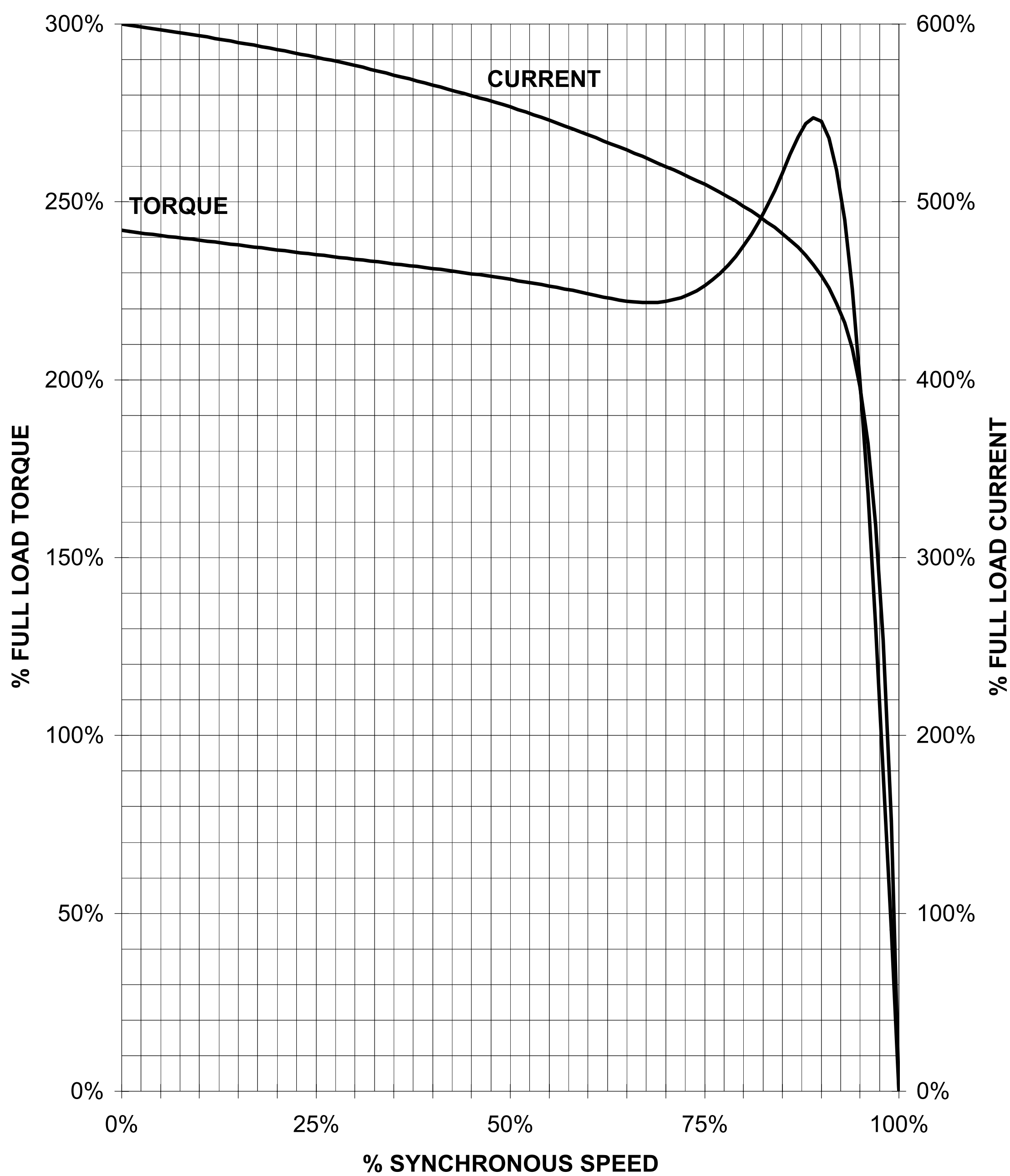
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	10	VOLTS	460	RPM	1200	TYPE	GP100A
HZ	60	PHASE	3	FRAME	256T	NEMA	B

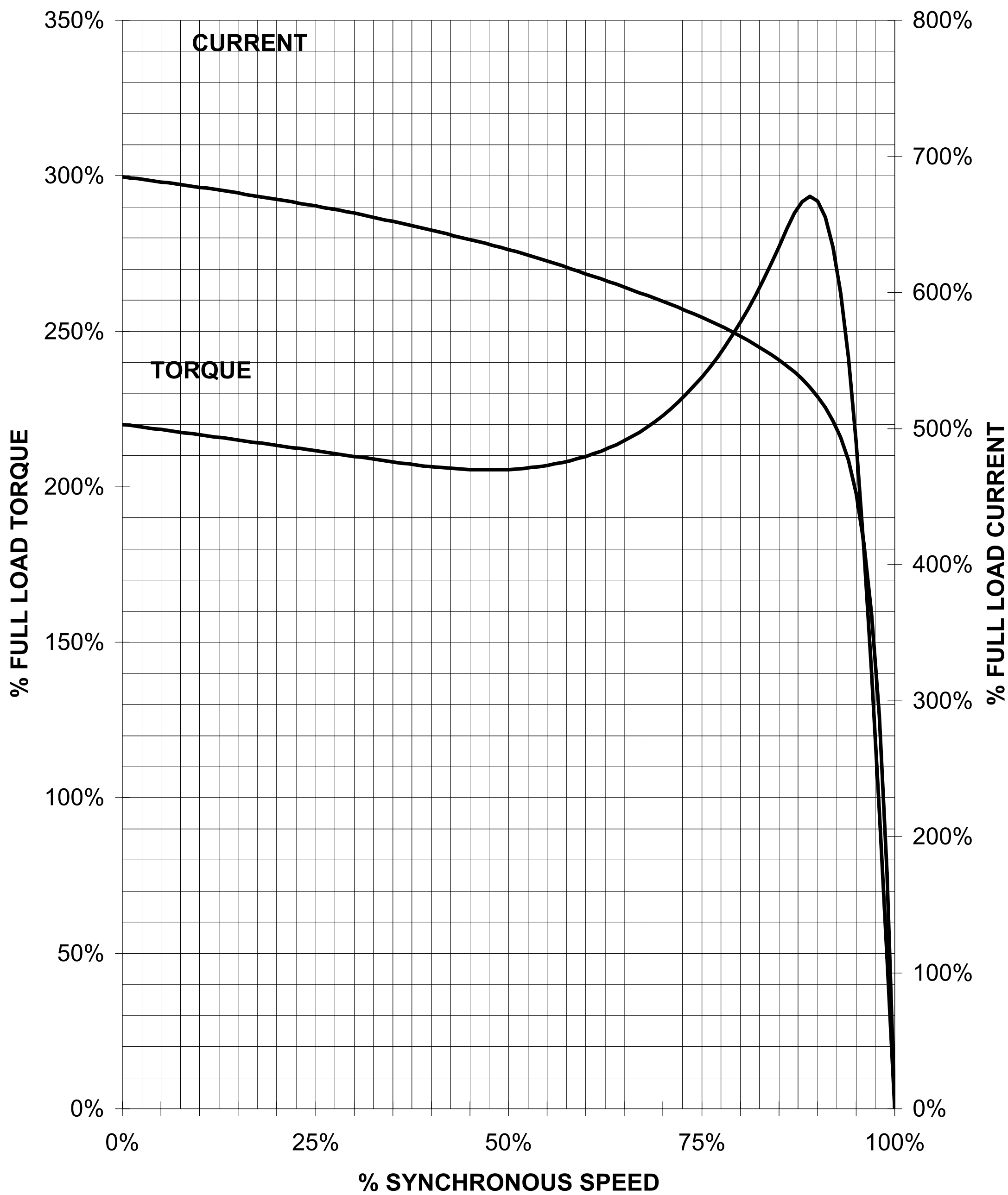
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	15	VOLTS	460	RPM	3600	TYPE	GP100A
HZ	60	PHASE	3	FRAME	254T	NEMA	B

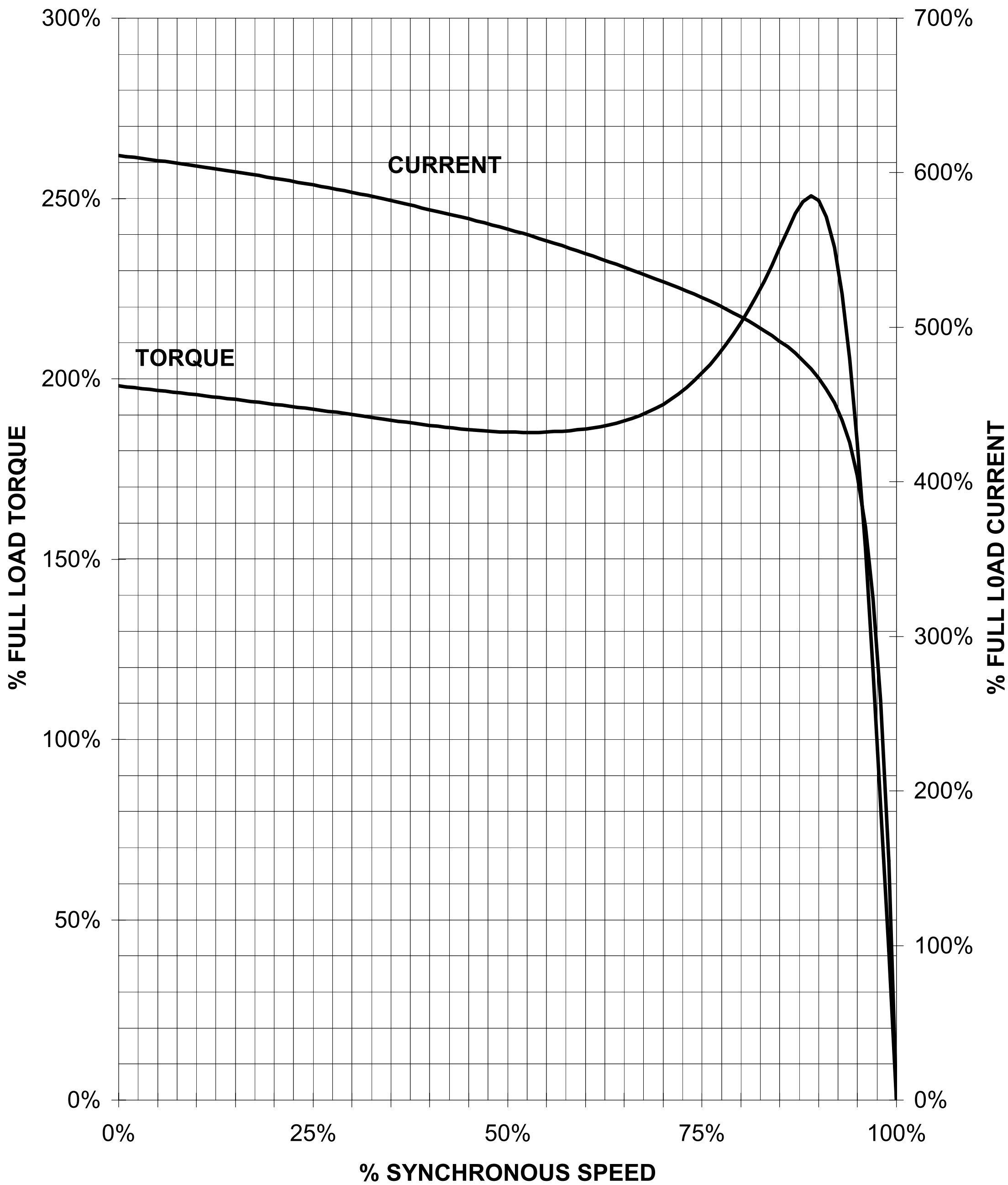
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	15	VOLTS	460	RPM	1800	TYPE	GP100A
HZ	60	PHASE	3	FRAME	254T	NEMA	B

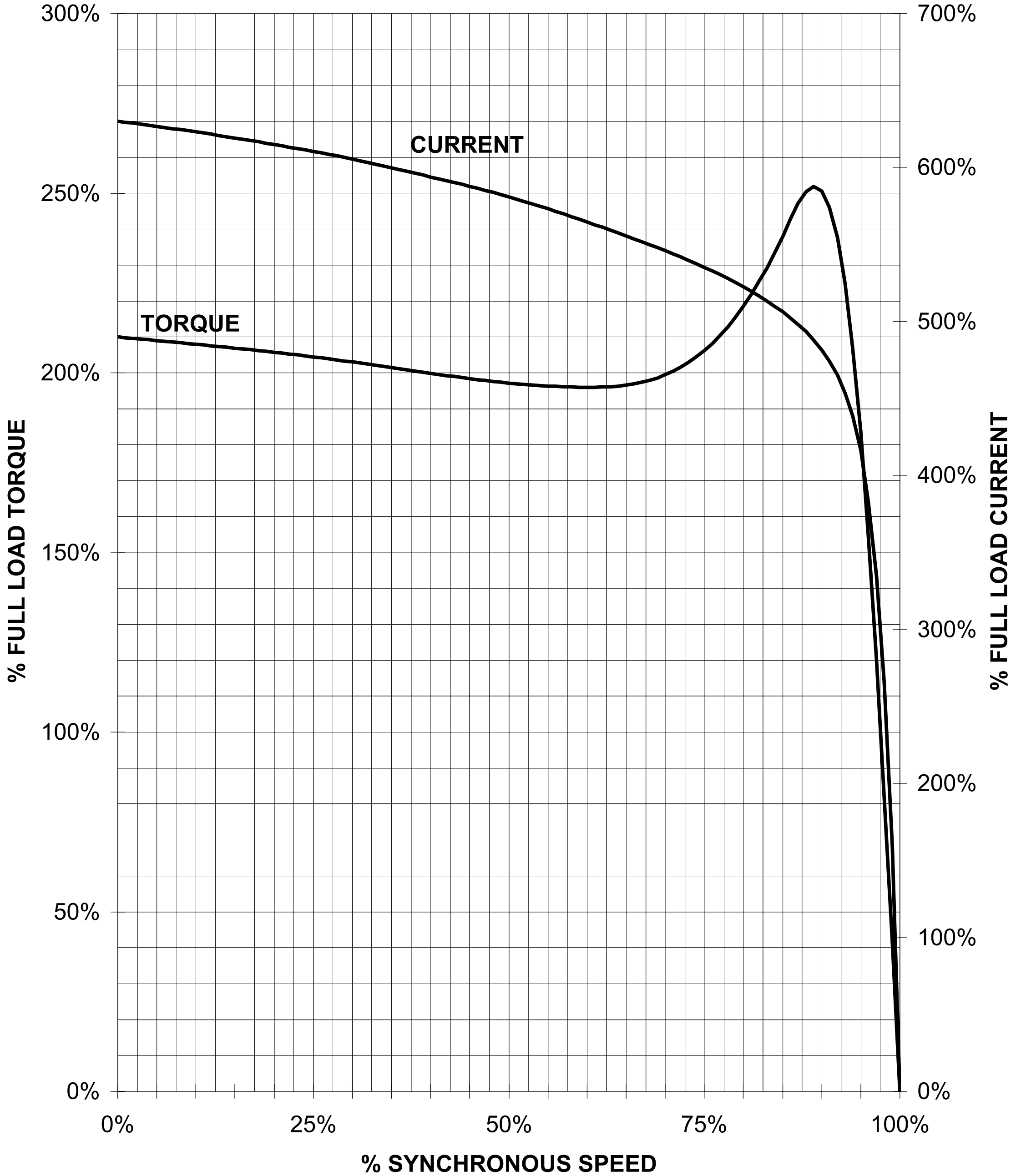
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	20	VOLTS	460	RPM	3600	TYPE	GP100A
HZ	60	PHASE	3	FRAME	256T	NEMA	B

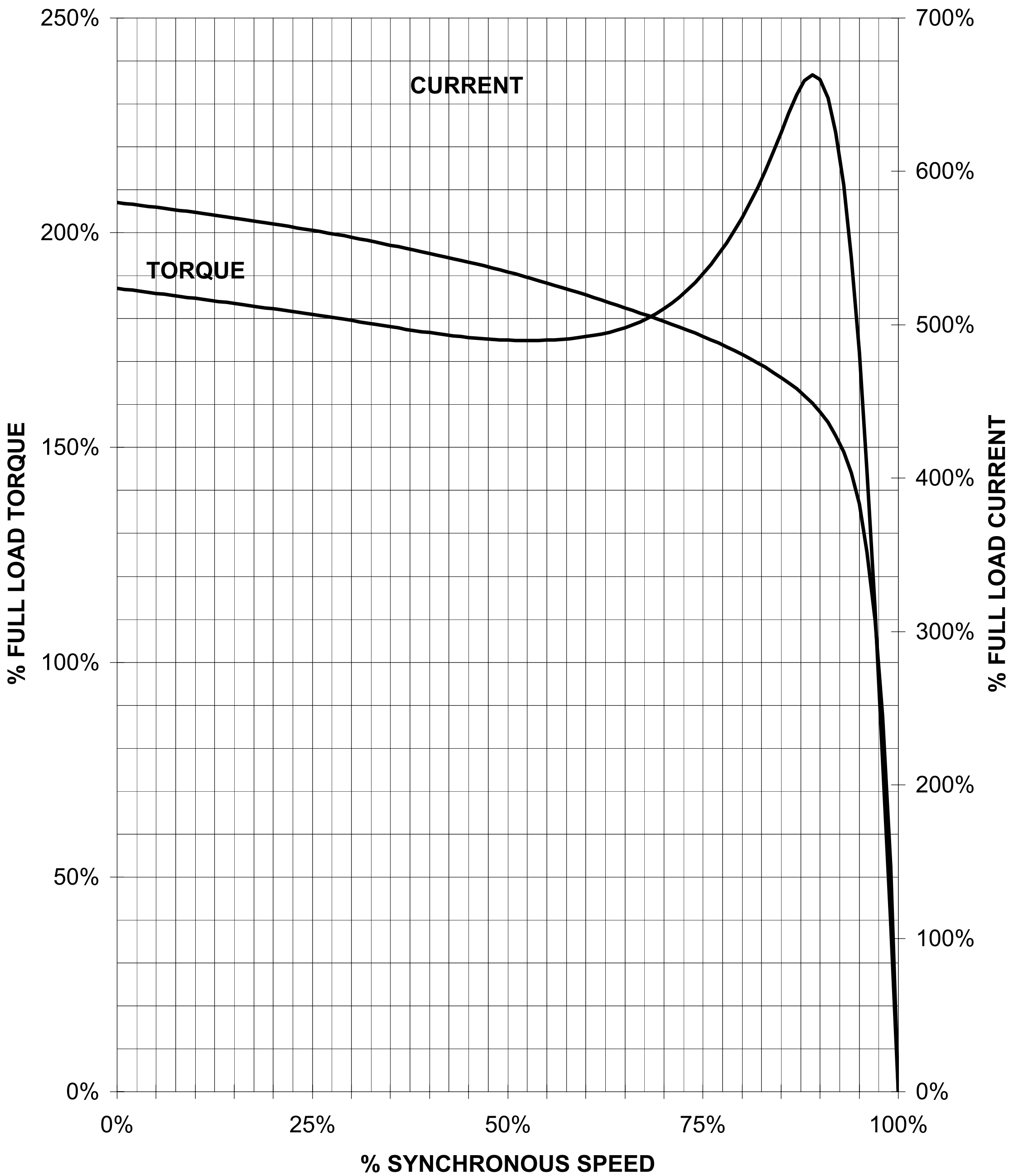
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	20	VOLTS	460	RPM	1800	TYPE	GP100A
HZ	60	PHASE	3	FRAME	256T	NEMA	B

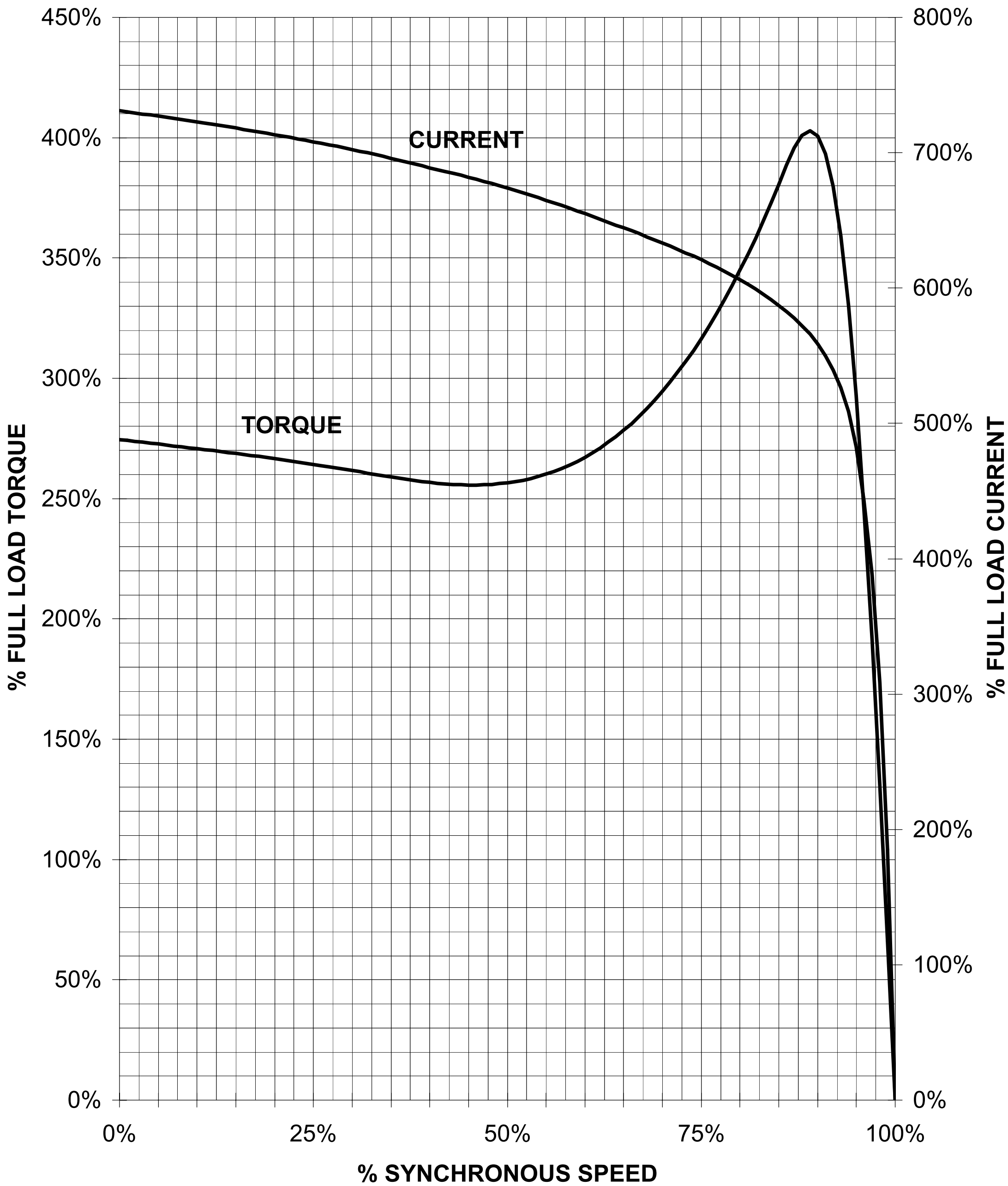
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1	VOLTS	230/460	RPM	1800	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	143T	NEMA	B

TORQUE & CURRENT VS. SPEED

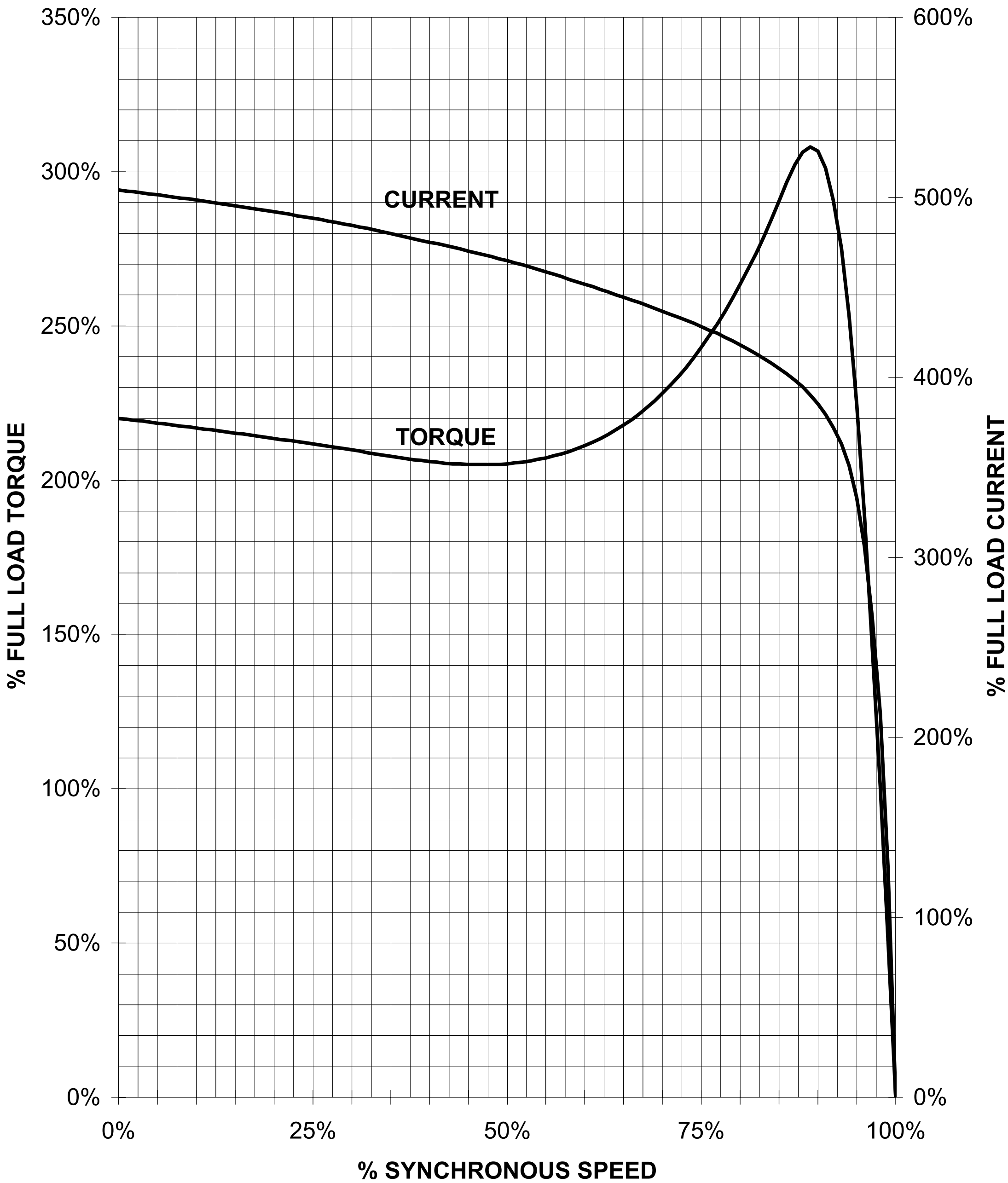


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	1	VOLTS	230/460	RPM	1200	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	145T	NEMA	B

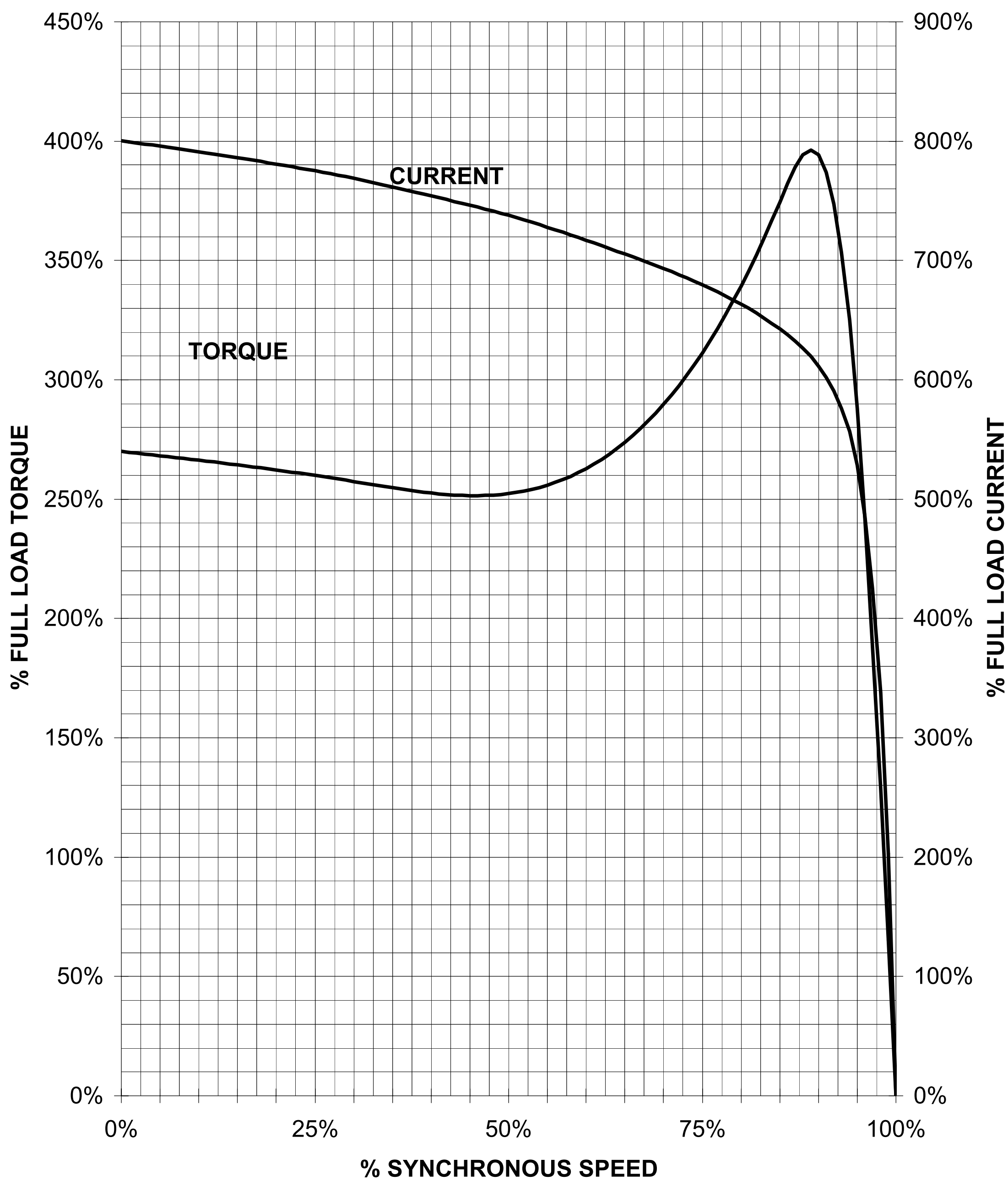
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP 1.5	VOLTS 230/460	RPM 3600	TYPE RGZEESD
HZ 60	PHASE 3	FRAME 143T	NEMA B

TORQUE & CURRENT VS. SPEED

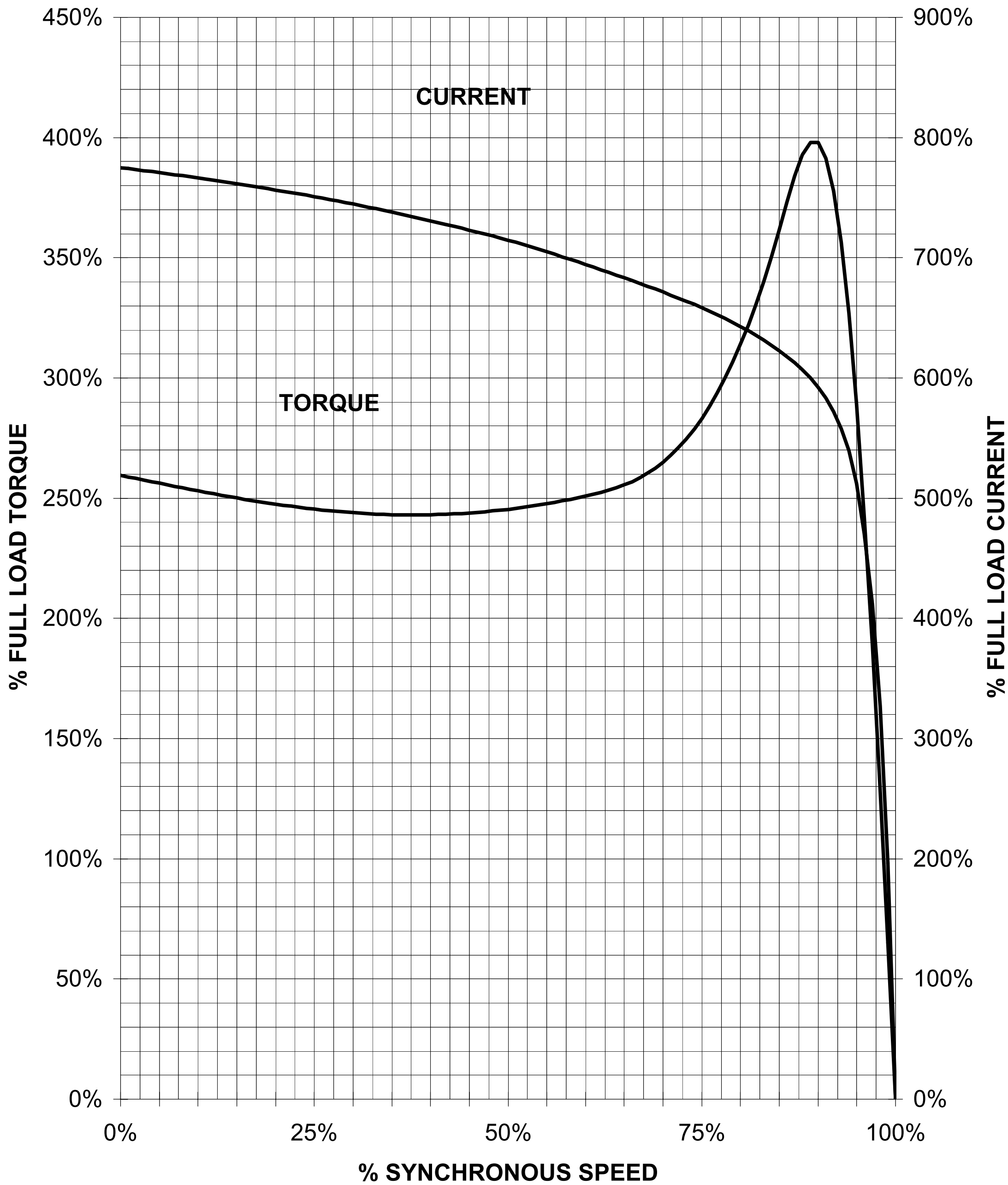


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	1.5	VOLTS	230/460	RPM	1800	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	145T	NEMA	B

TORQUE & CURRENT VS. SPEED



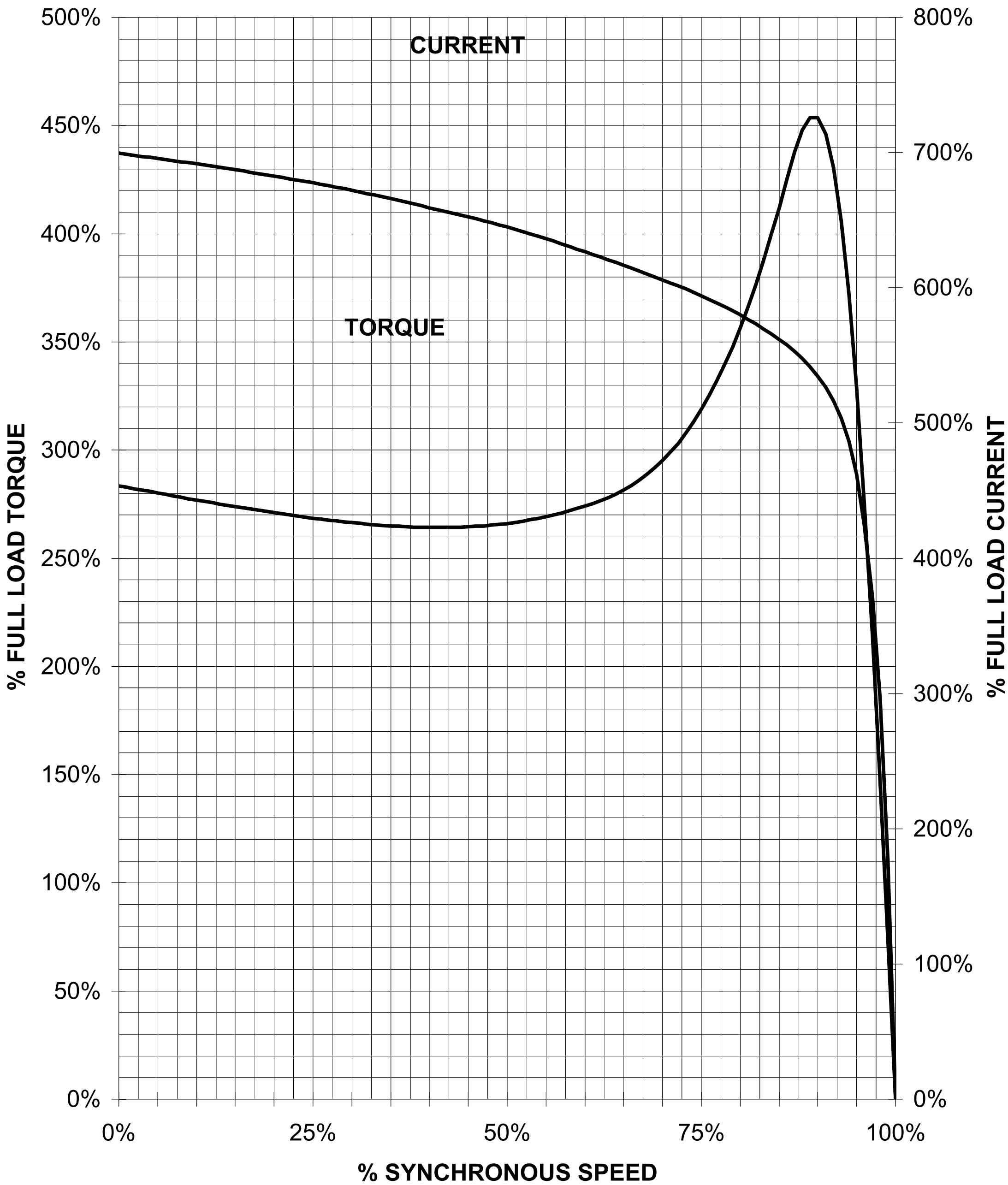
Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP 1.5 VOLTS 230/460 RPM 1200 TYPE RGZEESD

HZ 60 PHASE 3 FRAME 182T NEMA B

TORQUE & CURRENT VS. SPEED

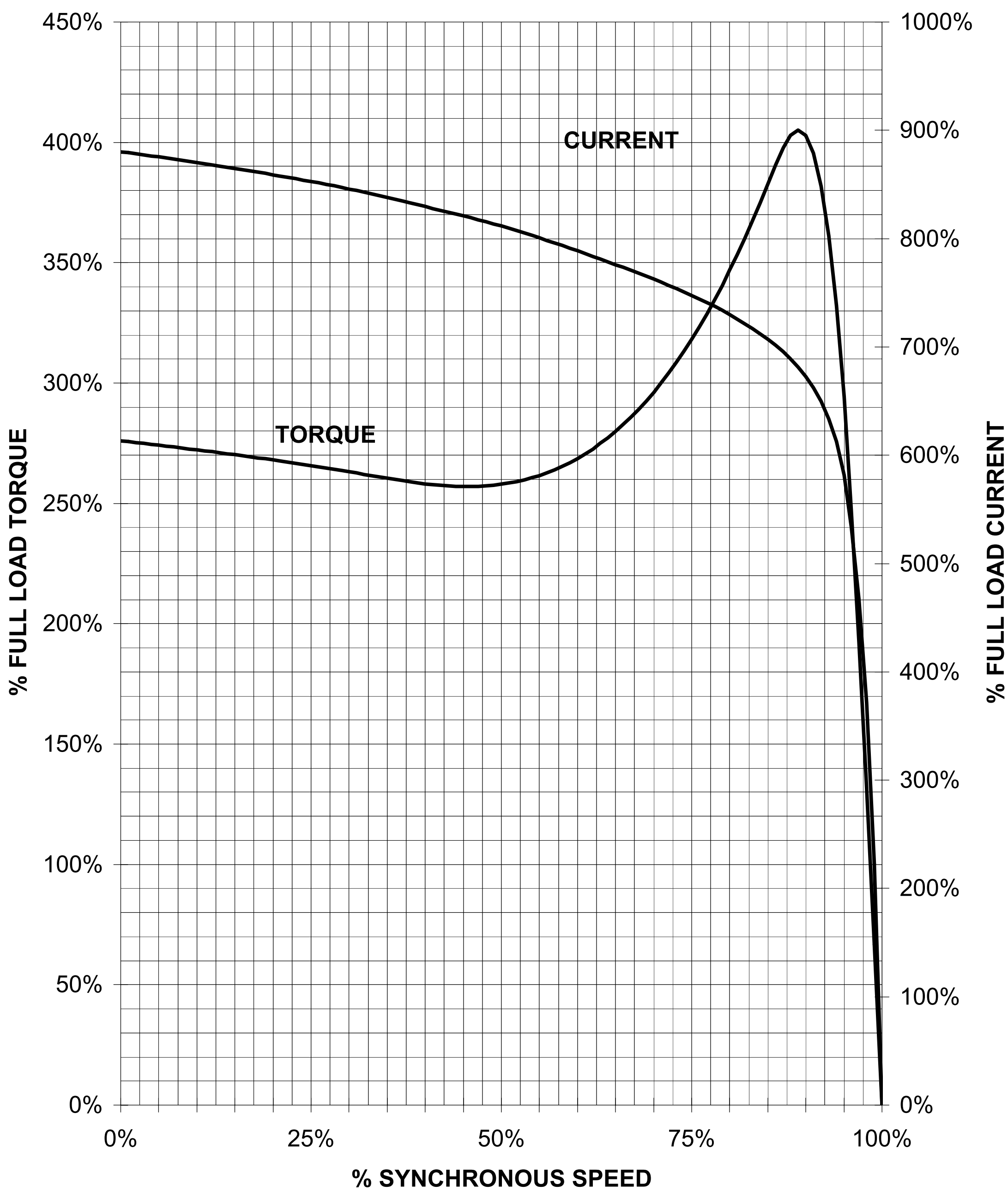


Customer: **PO No.:** **Order No.:**

Application Manual for NEMA Motors

HP	2	VOLTS	230/460	RPM	3600	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	145T	NEMA	B

TORQUE & CURRENT VS. SPEED

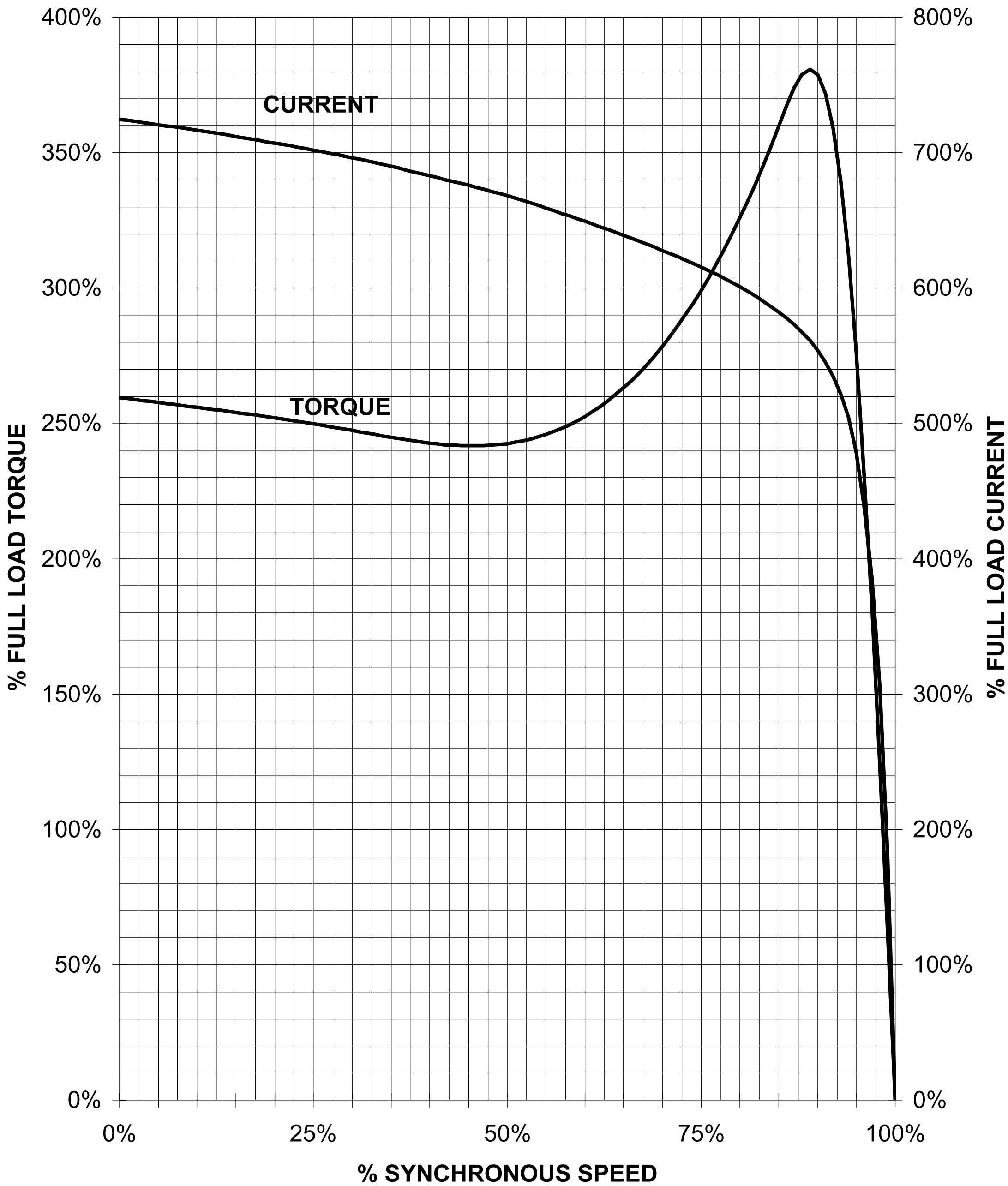


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	2	VOLTS	230/460	RPM	1800	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	145T	NEMA	B

TORQUE & CURRENT VS. SPEED

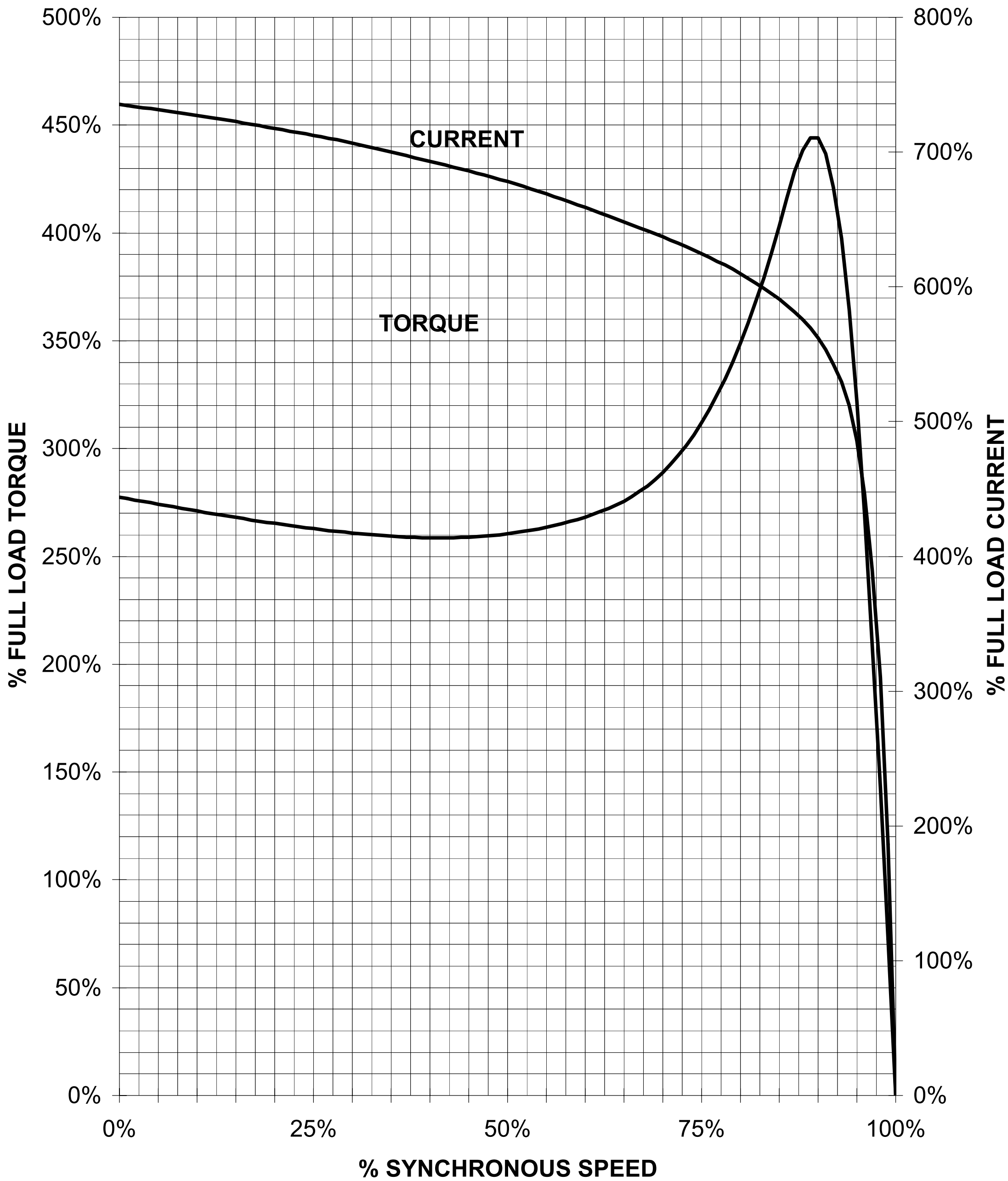


Customer: **PO No.:** **Order No.:**

HP 2 VOLTS 230/460 RPM 1200 TYPE RGZEESD

HZ 60 PHASE 3 FRAME 184T NEMA B

TORQUE & CURRENT VS. SPEED

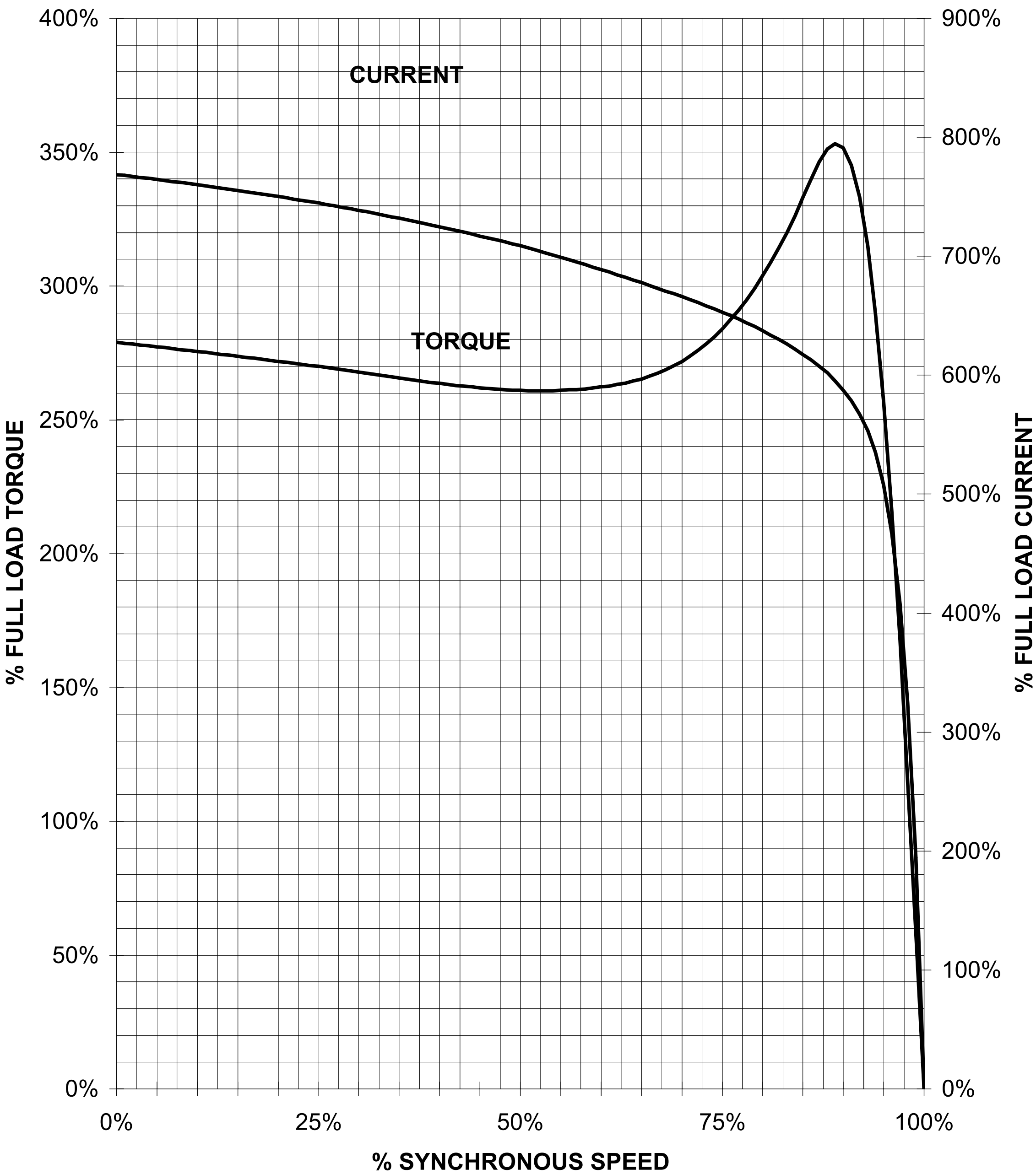


Customer: **PO No.:** **Order No.:**

Application Manual for NEMA Motors

HP	3	VOLTS	230/460	RPM	3600	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	182T	NEMA	B

TORQUE & CURRENT VS. SPEED

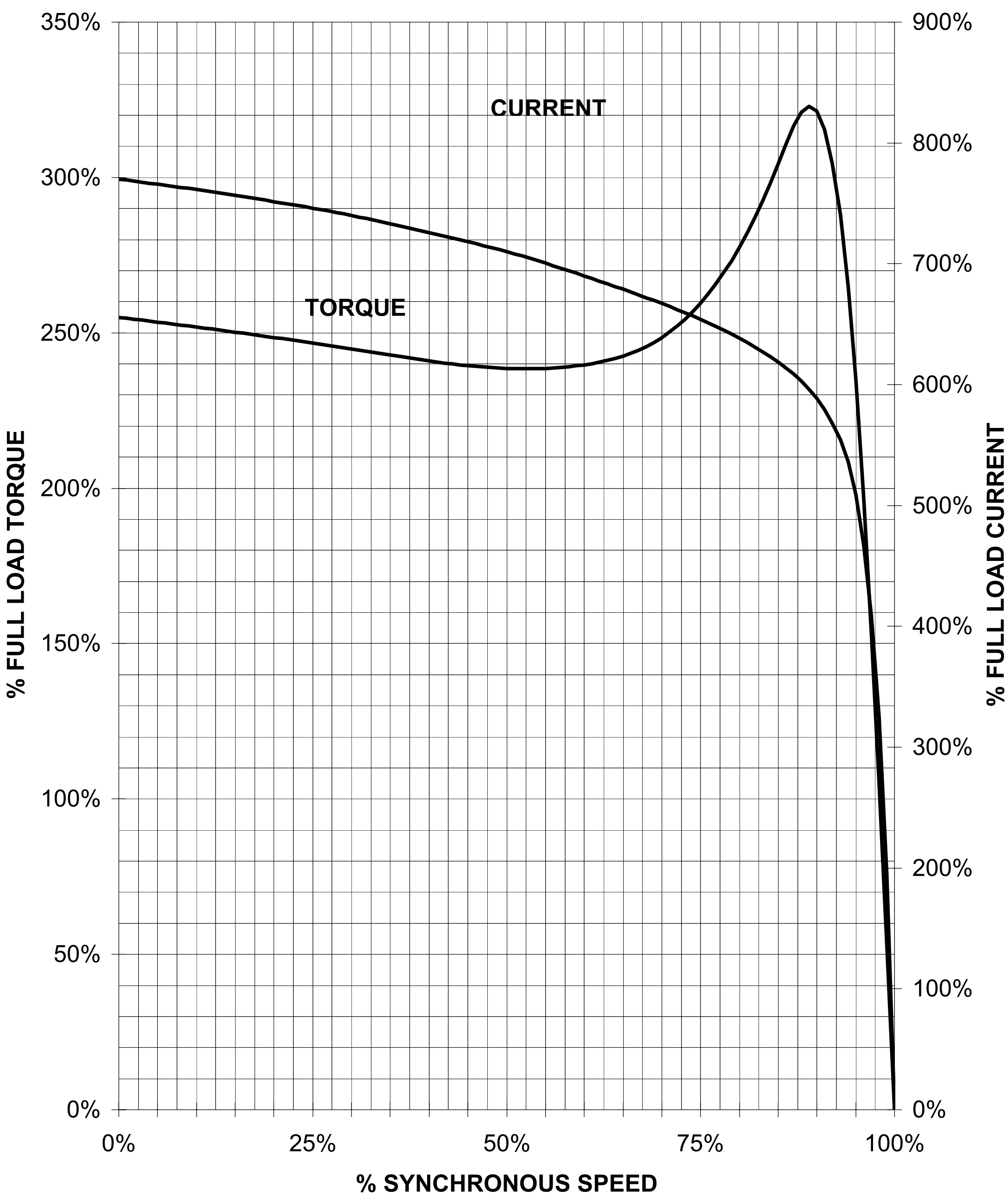


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	3	VOLTS	230/460	RPM	1800	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	182T	NEMA	B

TORQUE & CURRENT VS. SPEED



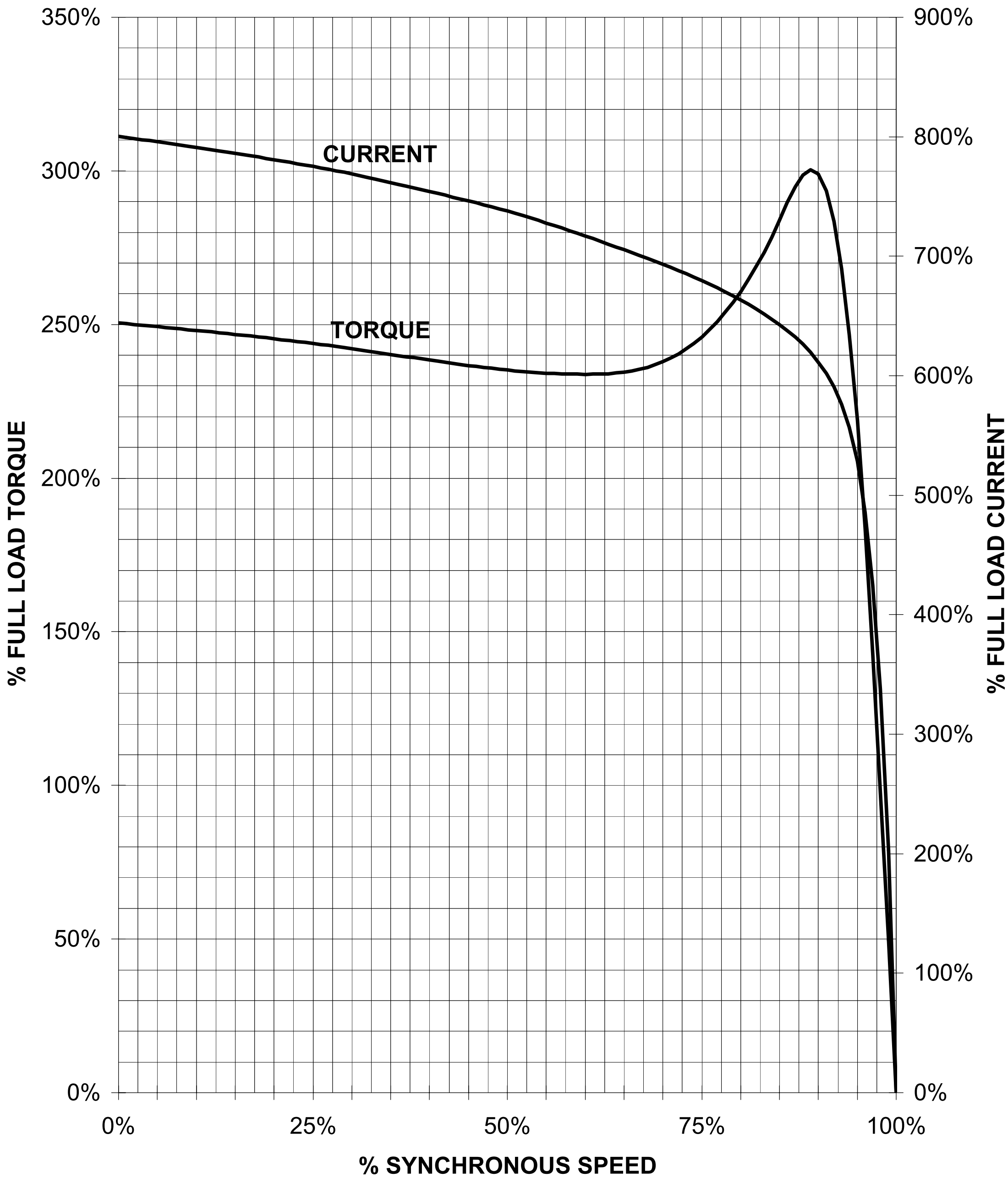
Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP 3 VOLTS 230/460 RPM 1200 TYPE RGZEESD

HZ 60 PHASE 3 FRAME 213T NEMA B

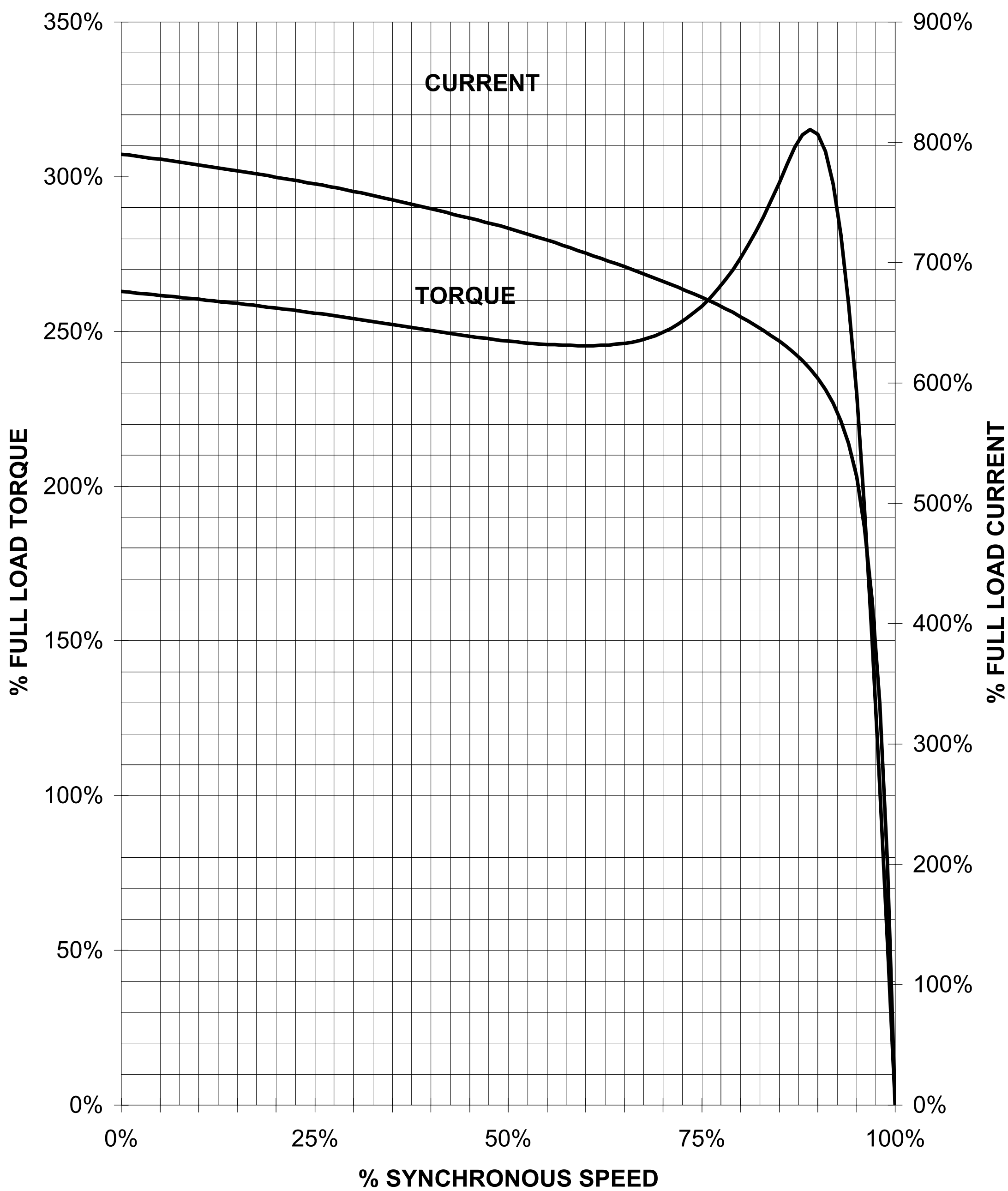
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	5	VOLTS	230/460	RPM	3600	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	184T	NEMA	B

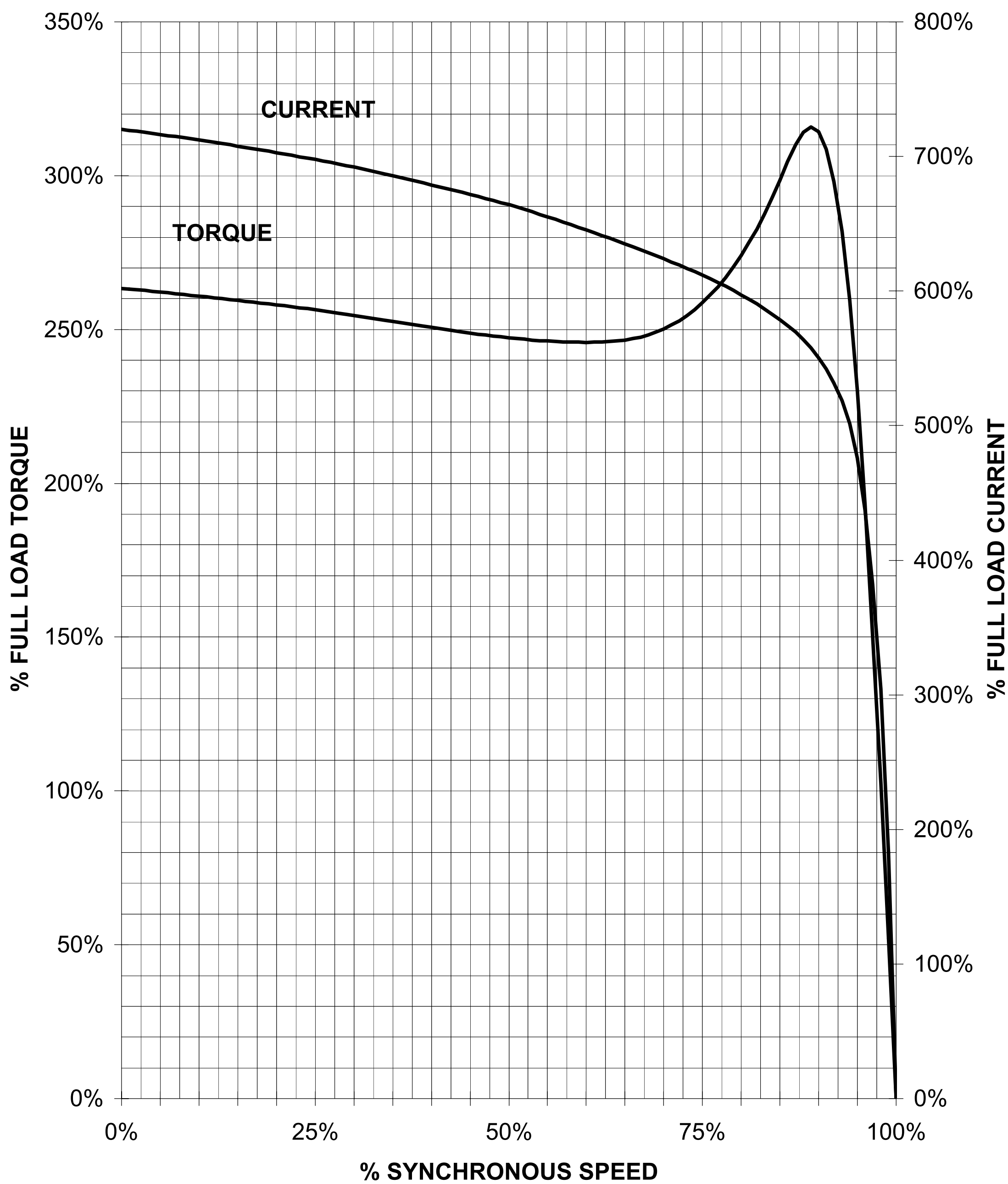
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	5	VOLTS	230/460	RPM	1800	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	184T	NEMA	B

TORQUE & CURRENT VS. SPEED

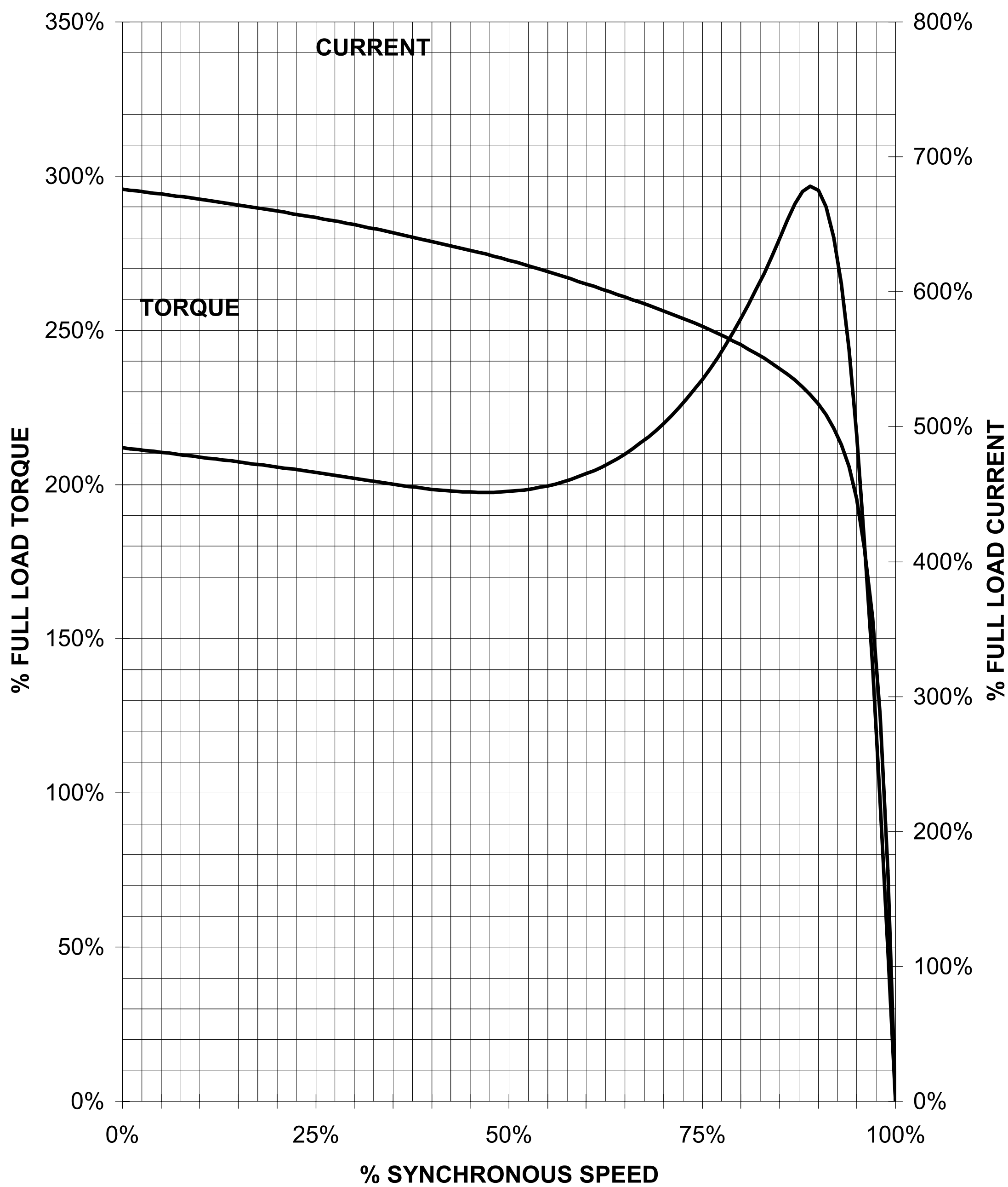


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	5	VOLTS	230/460	RPM	1200	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	215T	NEMA	B

TORQUE & CURRENT VS. SPEED

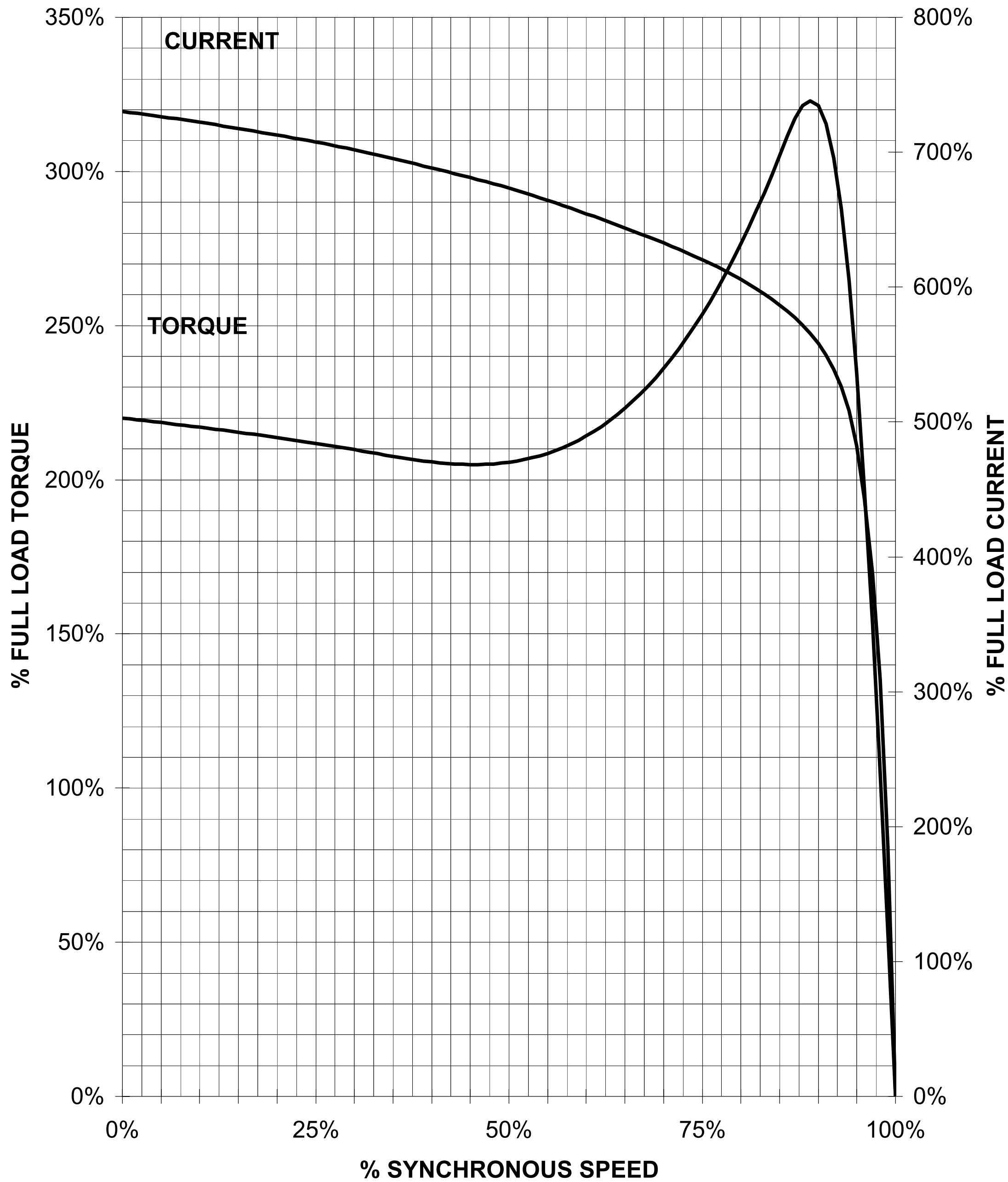


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	7.5	VOLTS	230/460	RPM	3600	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	213T	NEMA	B

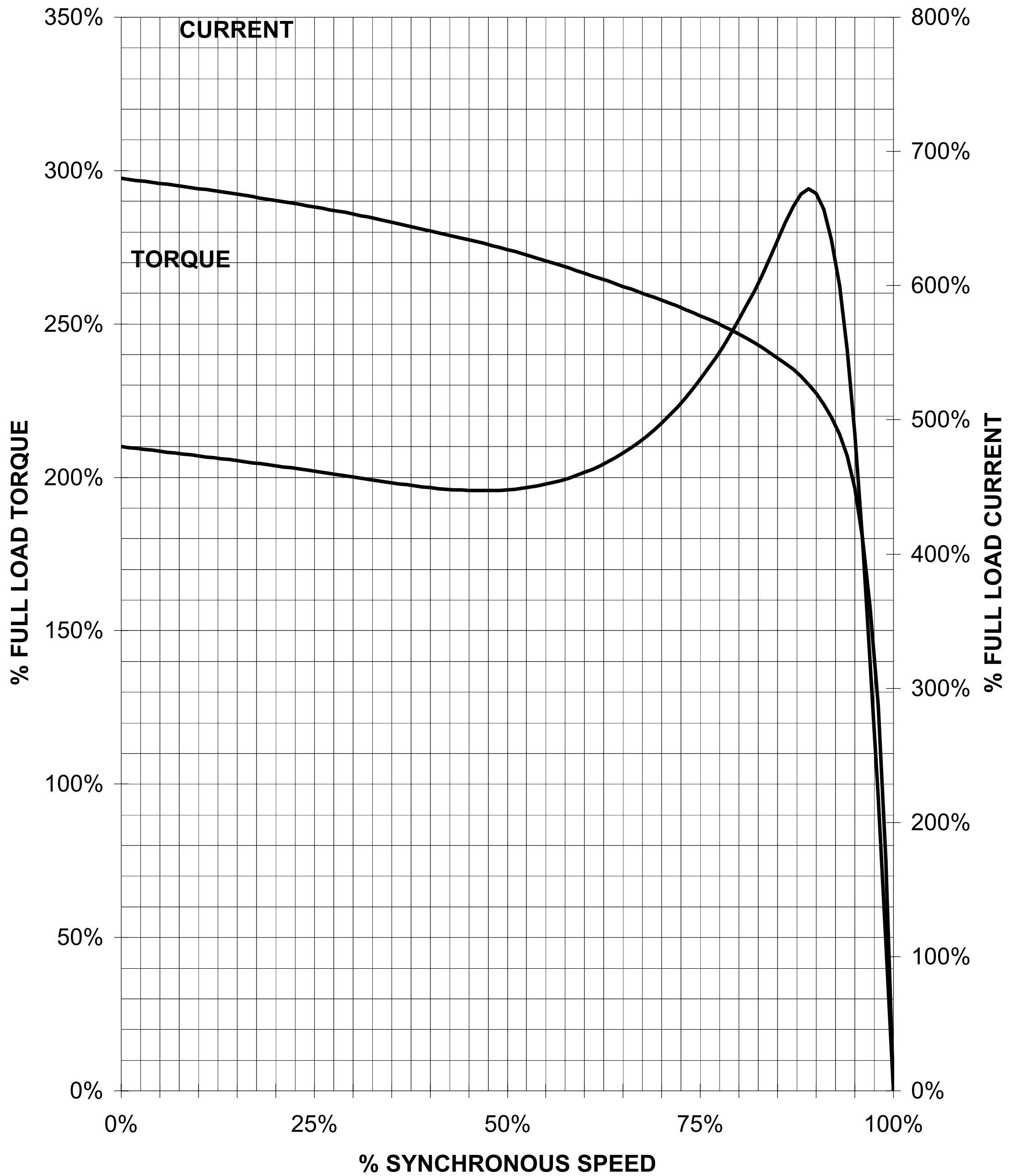
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	7.5	VOLTS	230/460	RPM	1800	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	213T	NEMA	B

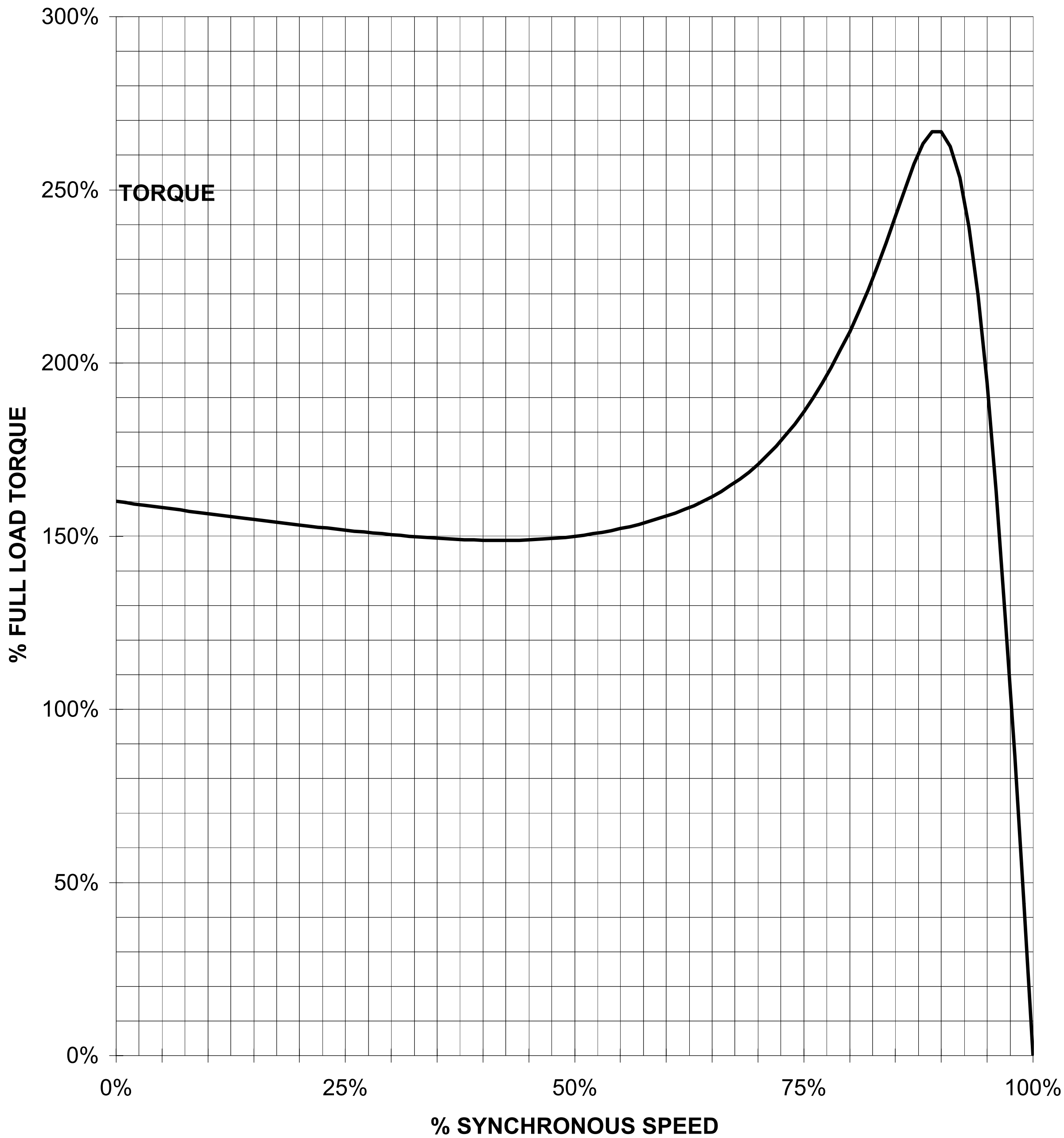
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	7.5	VOLTS	230/460	RPM	1200	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	254T	NEMA	B

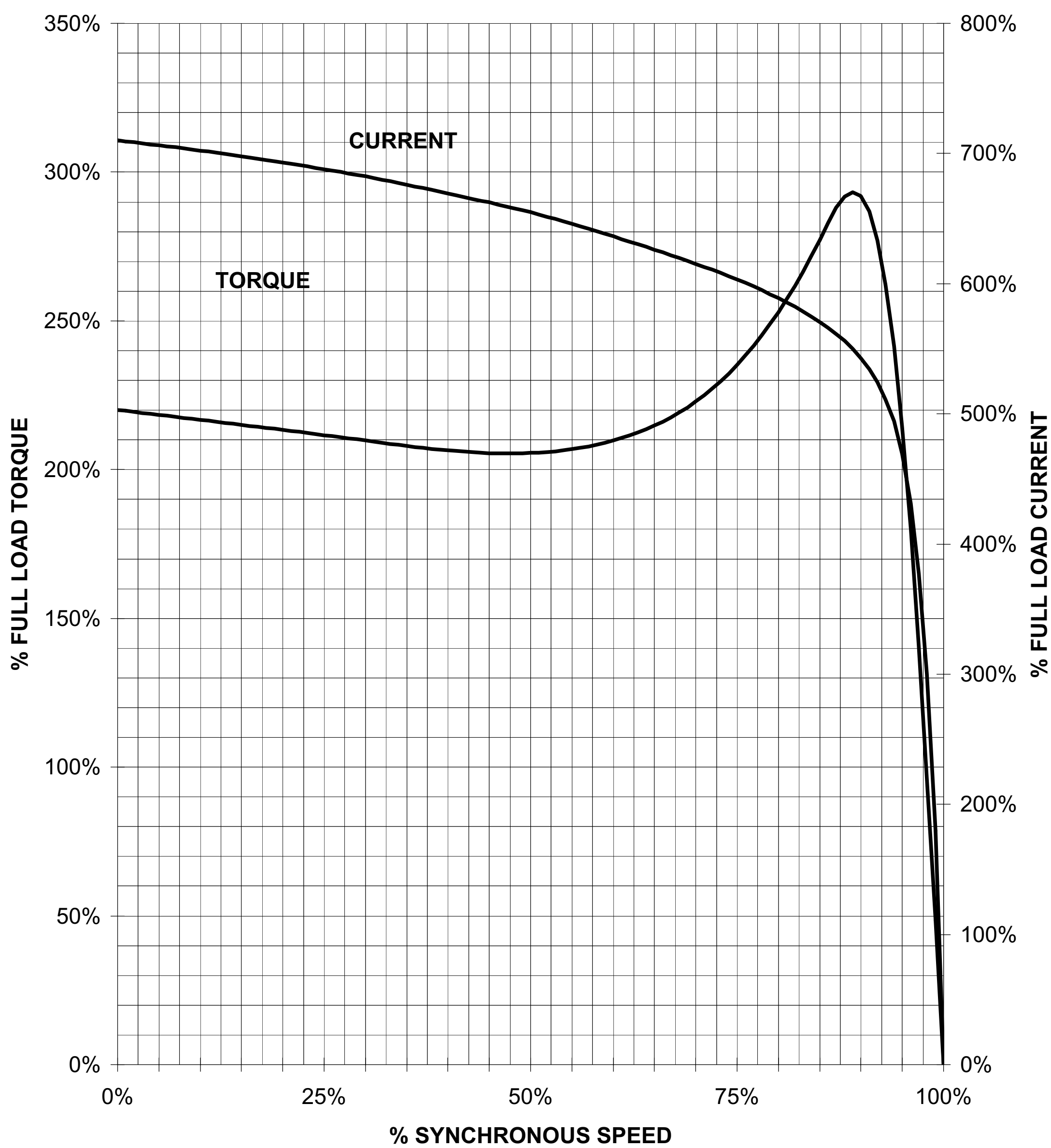
TORQUE VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	10	VOLTS	230/460	RPM	3600	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	215T	NEMA	B

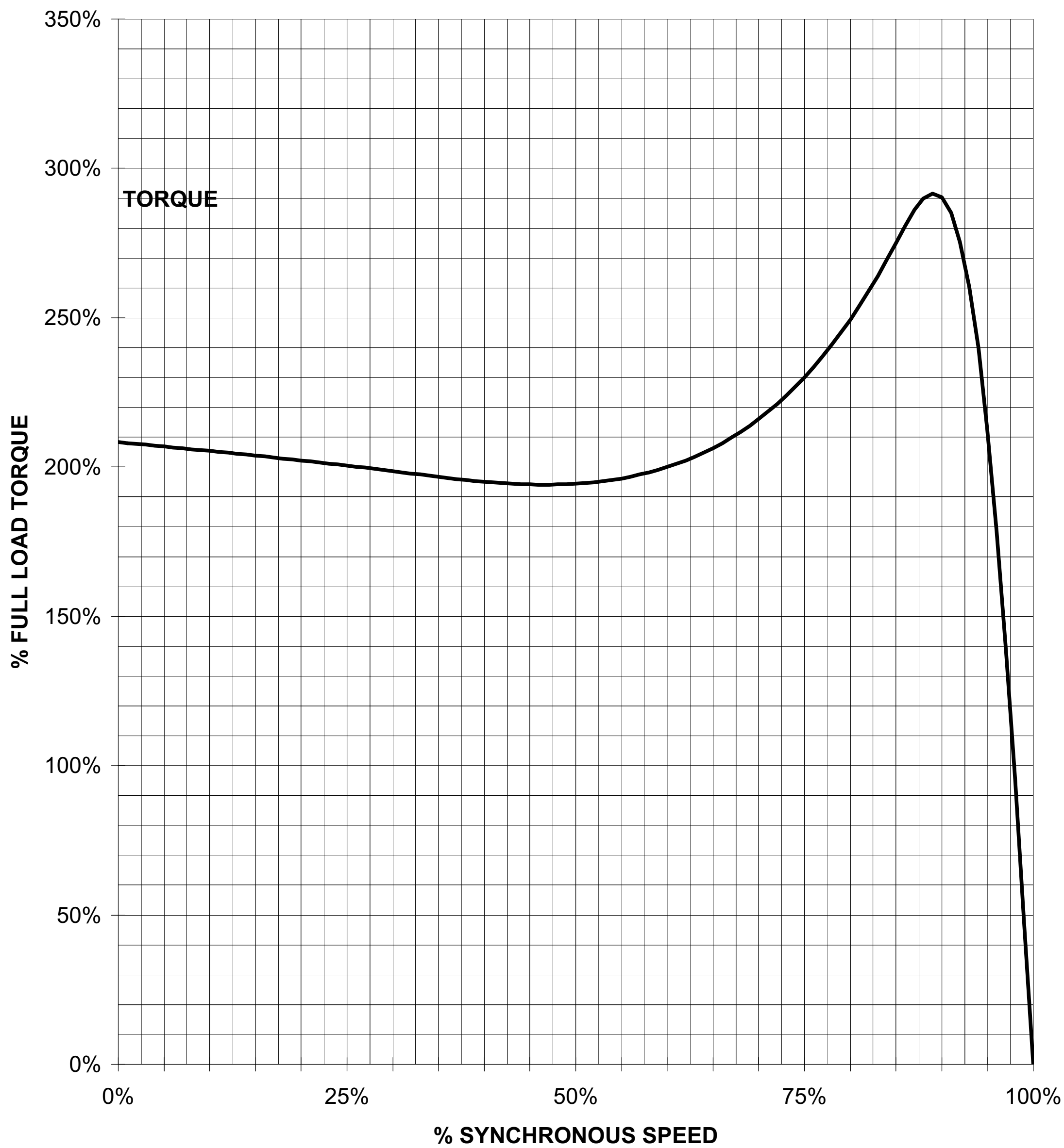
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	10	VOLTS	230/460	RPM	1800	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	215T	NEMA	B

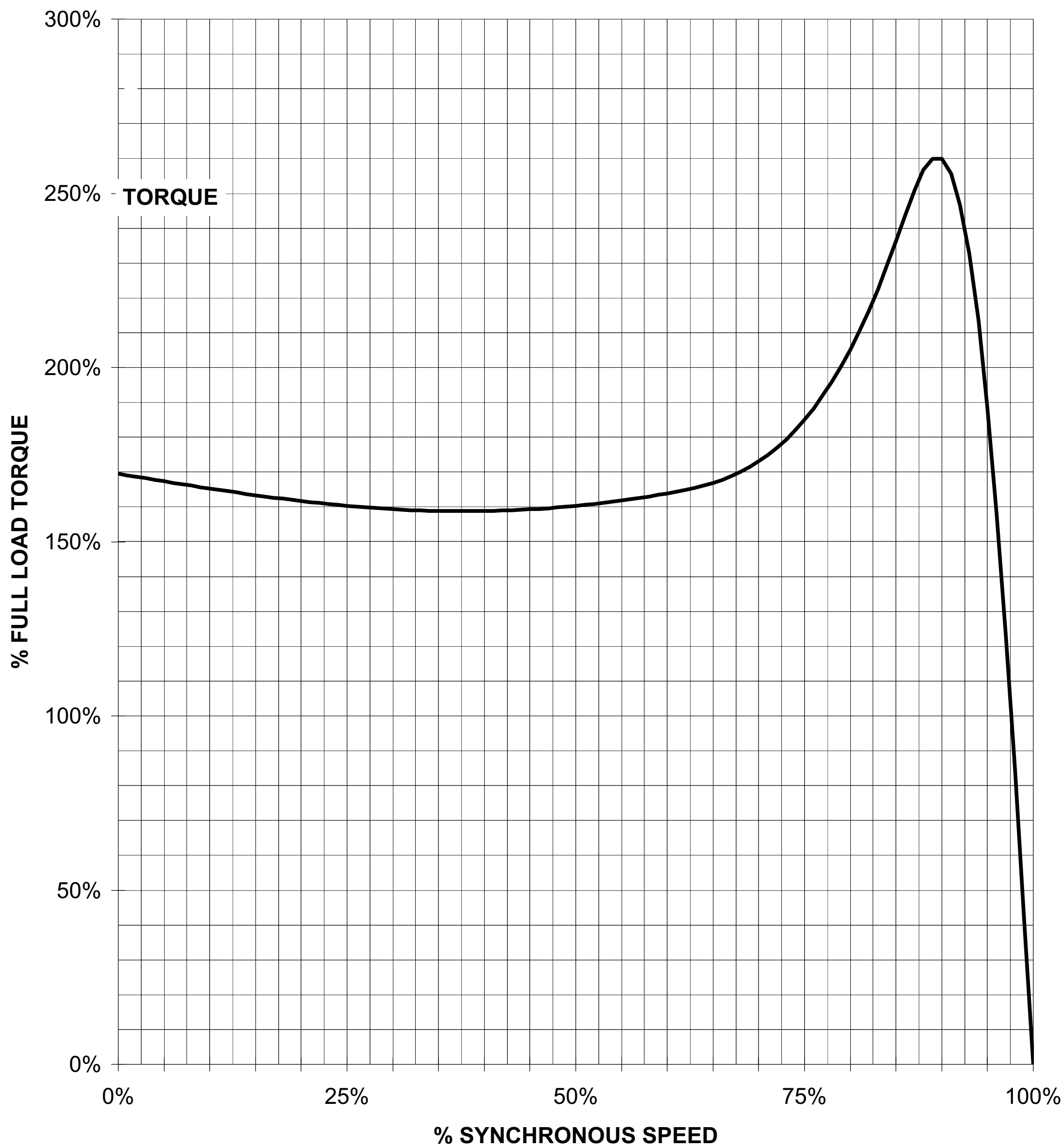
TORQUE VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	10	VOLTS	230/460	RPM	1200	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	256T	NEMA	B

TORQUE VS. SPEED

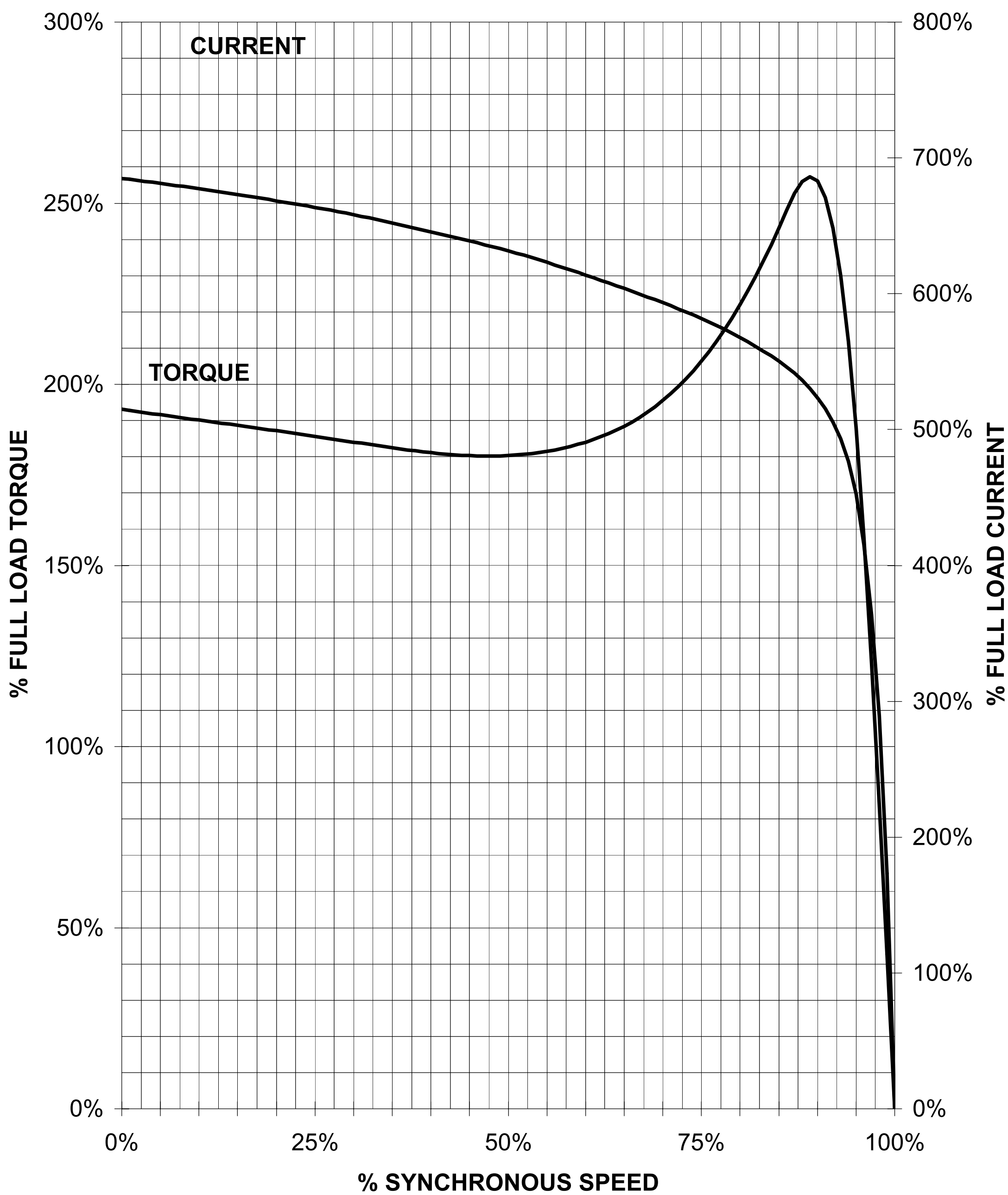


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	15	VOLTS	230/460	RPM	3600	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	254T	NEMA	B

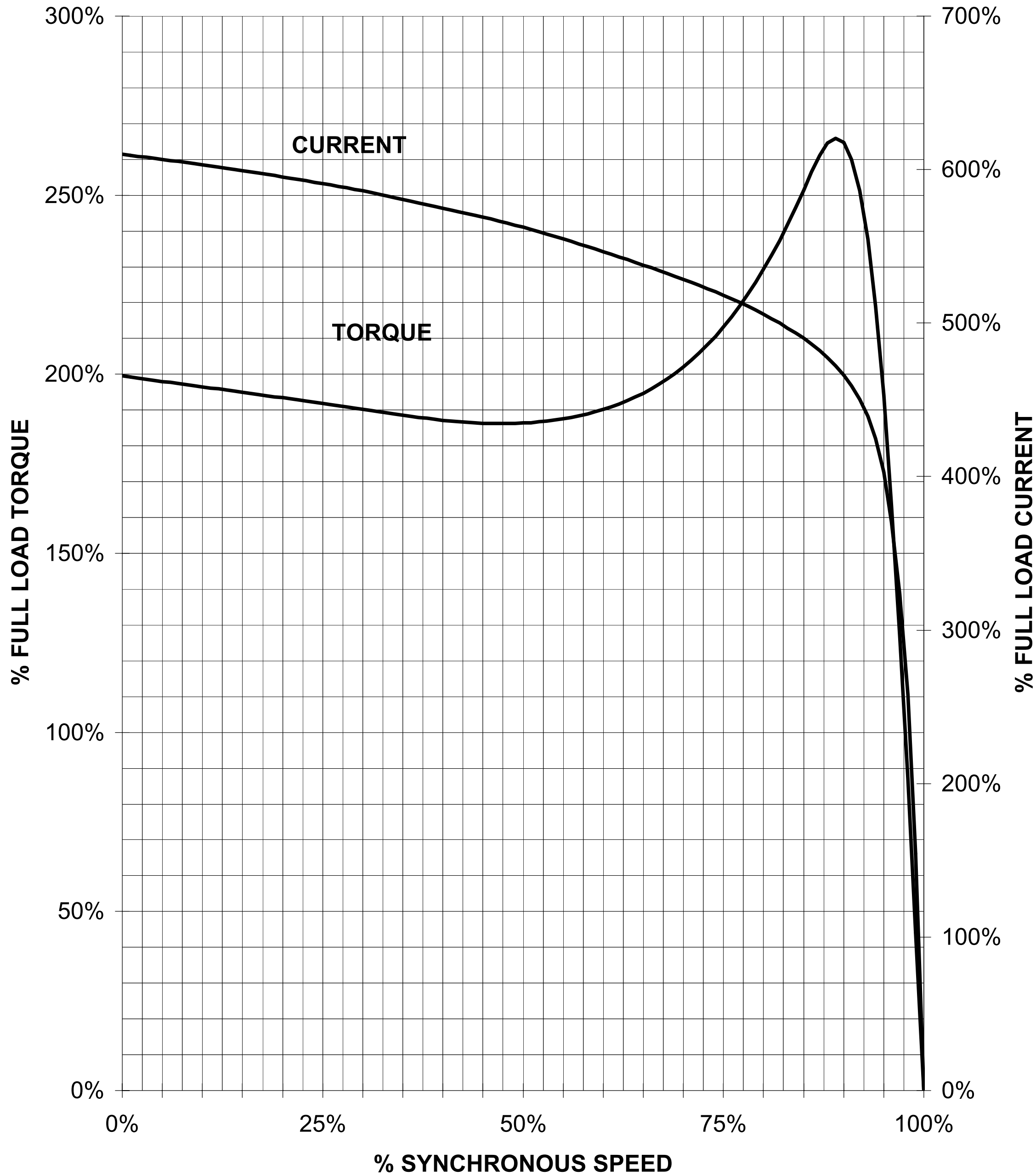
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	15	VOLTS	230/460	RPM	1800	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	254T	NEMA	B

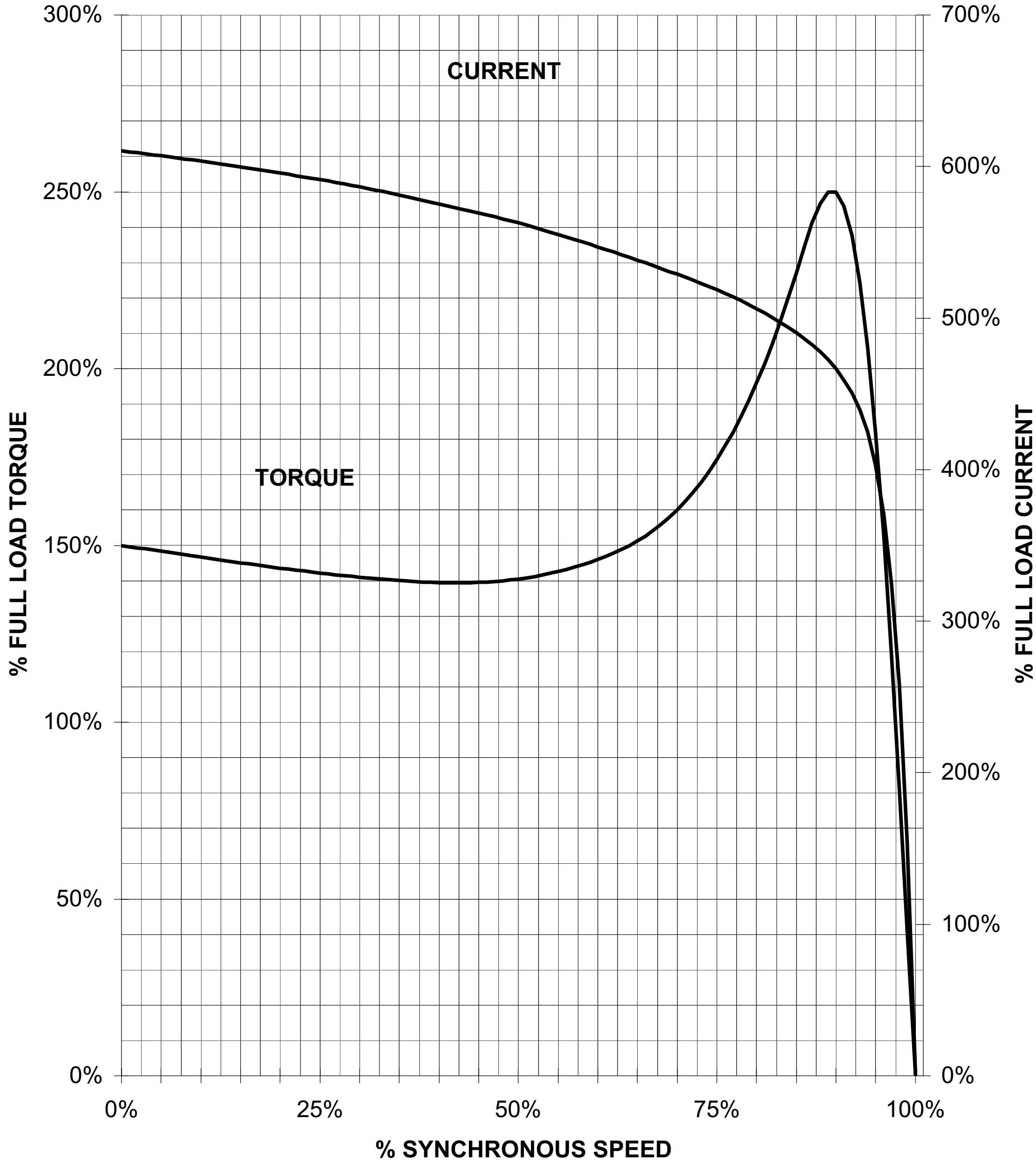
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	15	VOLTS	230/460	RPM	1200	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	284T	NEMA	B

TORQUE AND CURRENT VS. SPEED

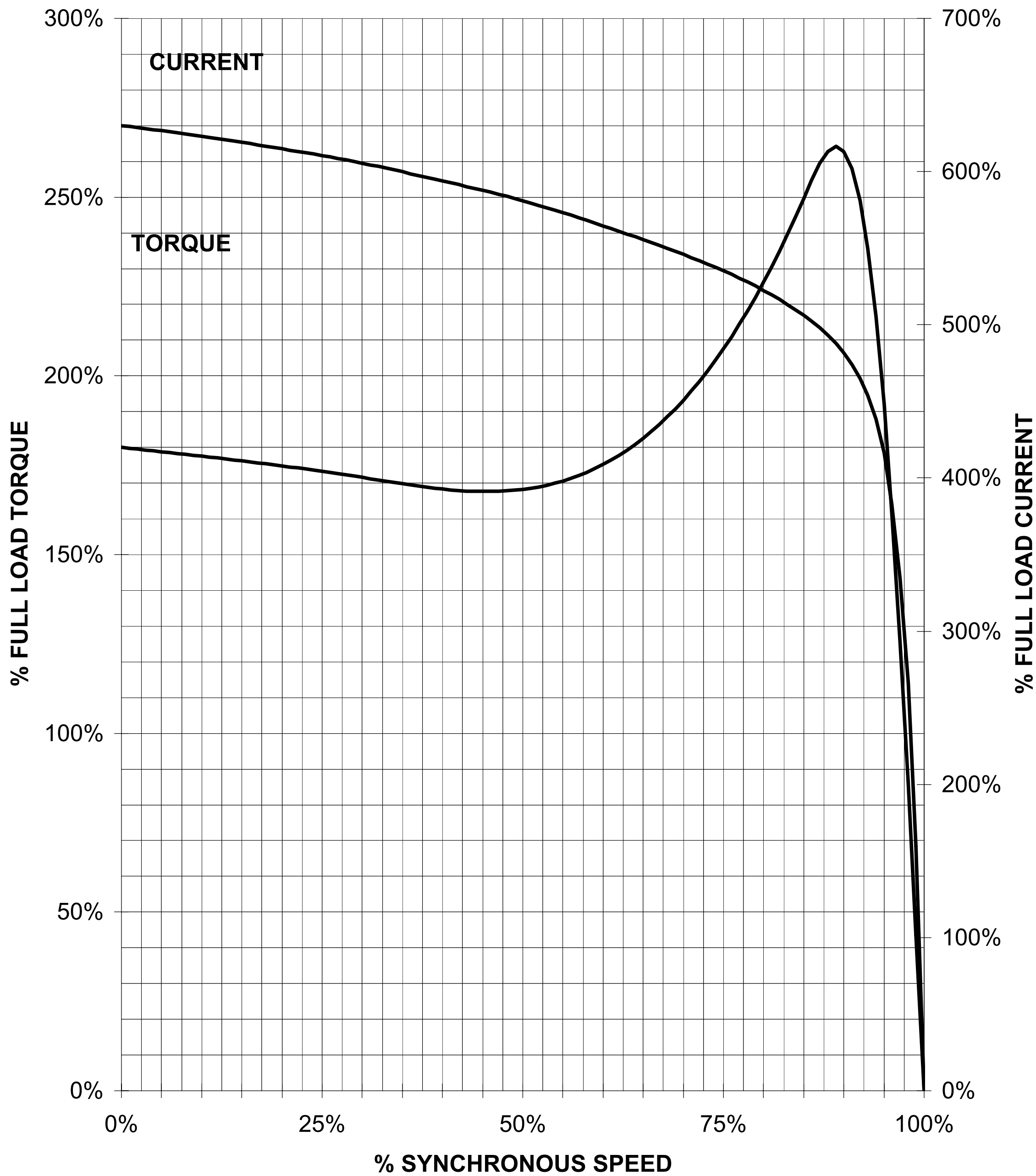


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	20	VOLTS	230/460	RPM	3600	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	256T	NEMA	B

TORQUE & CURRENT VS. SPEED

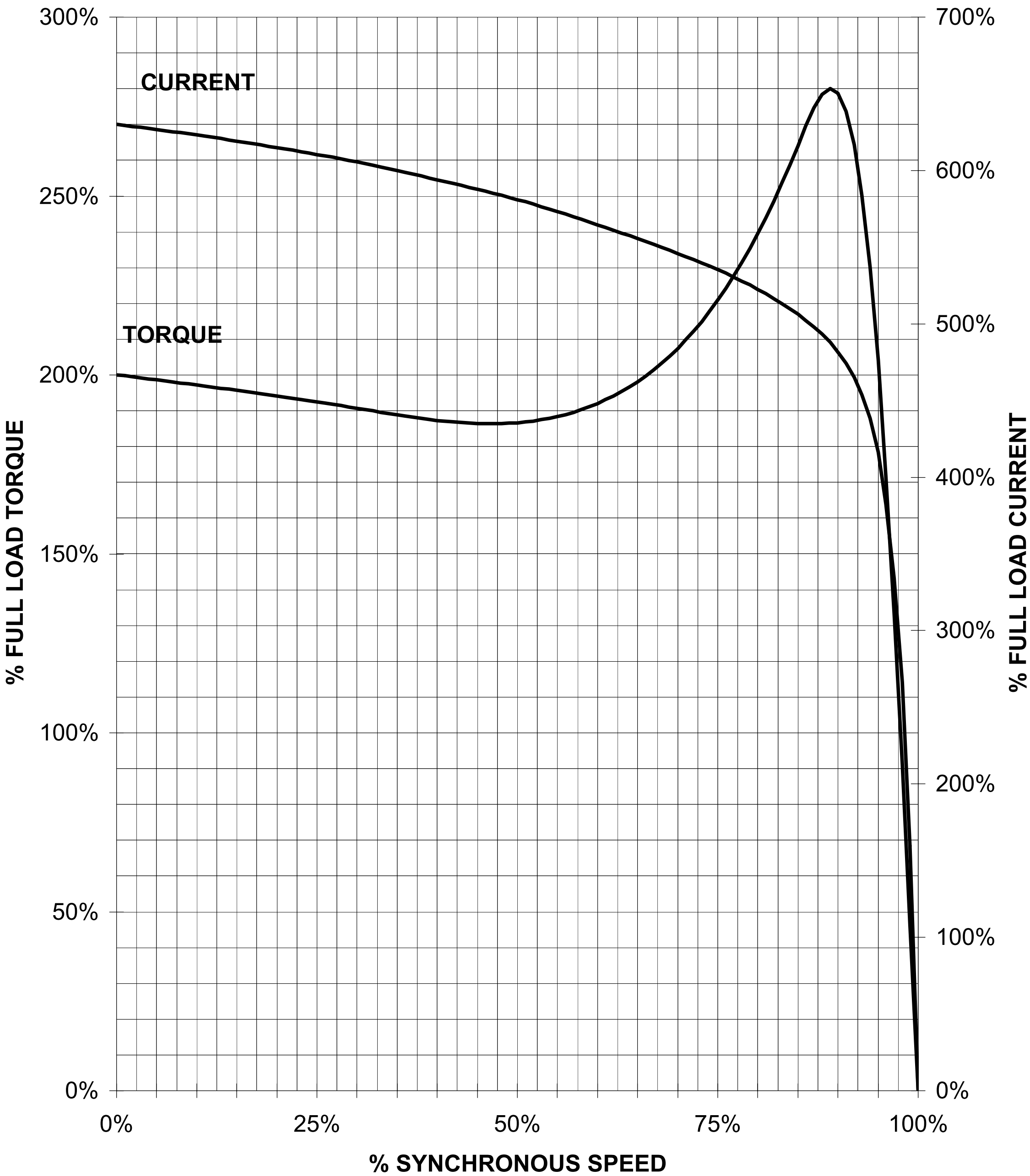


Customer: **PO No.:** **Order No.:**

HP 20 VOLTS 230/460 RPM 1800 TYPE RGZEESD

HZ 60 PHASE 3 FRAME 256T NEMA B

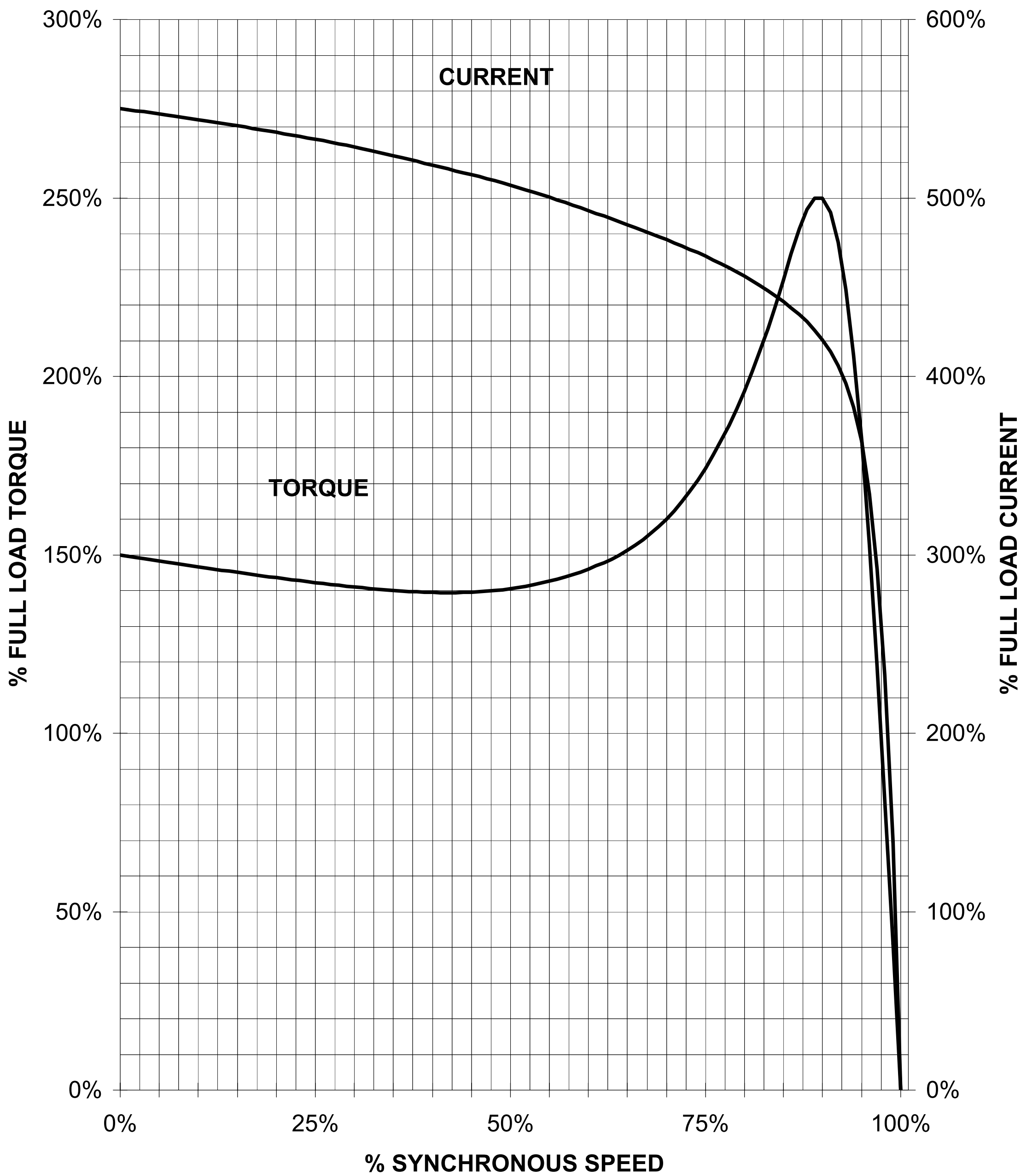
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	20	VOLTS	230/460	RPM	1200	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	286T	NEMA	B

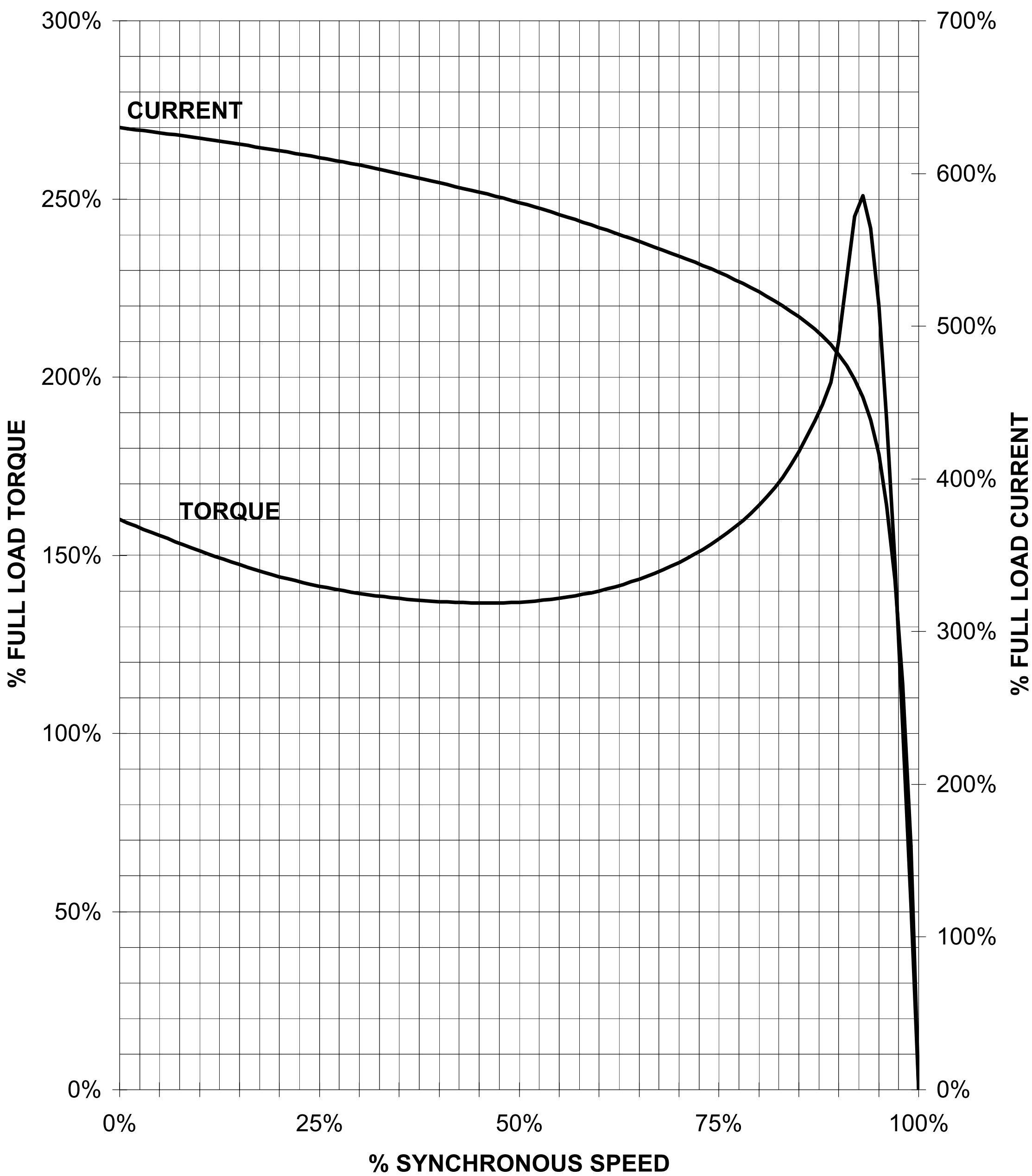
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP 25	VOLTS 460	RPM 3600	TYPE RGZEESD
HZ 60	PHASE 3	FRAME 284TS	NEMA B

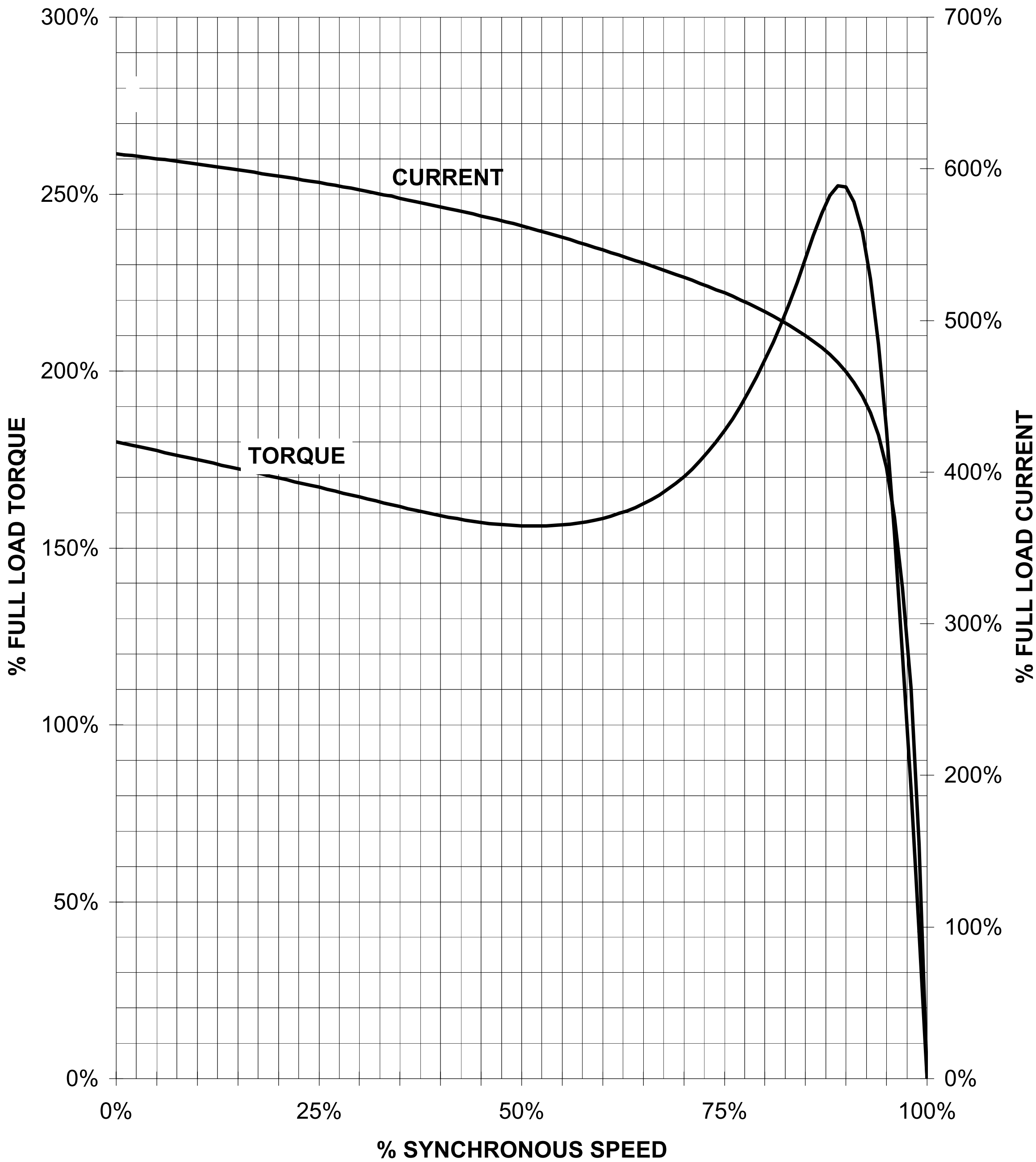
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	25	VOLTS	460	RPM	1800	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	284T	NEMA	B

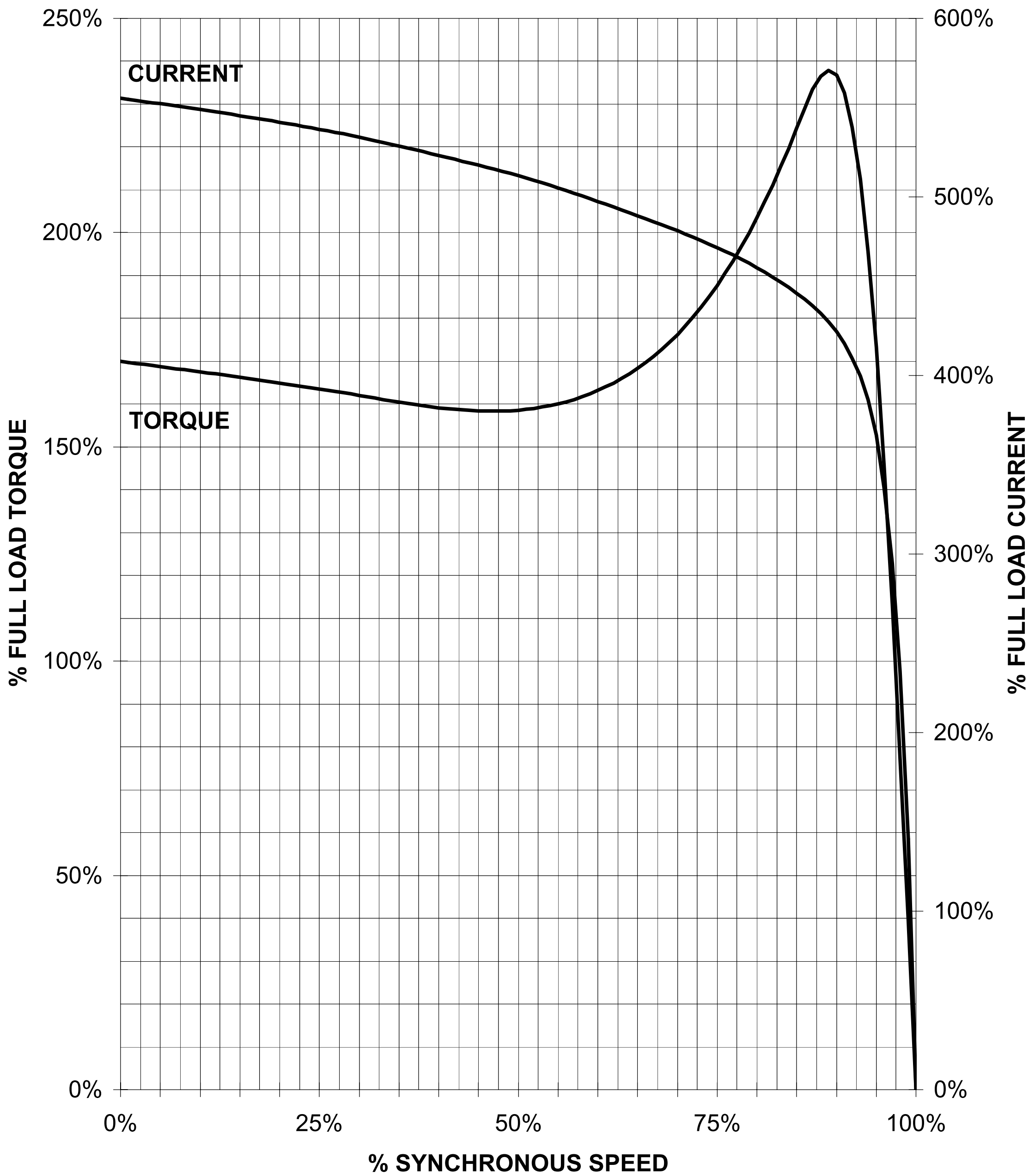
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	25	VOLTS	230/460	RPM	1200	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	324T	NEMA	B

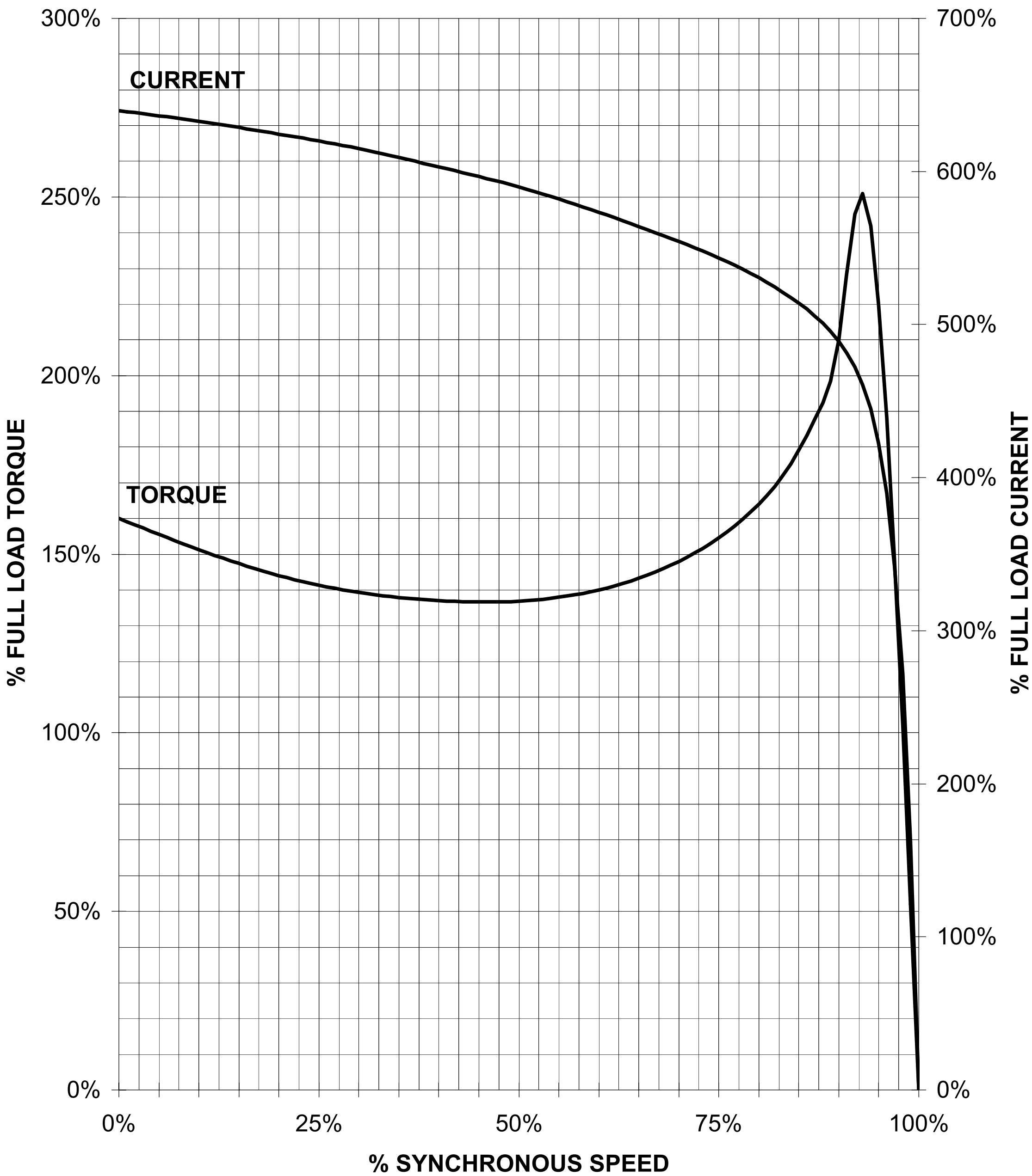
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	30	VOLTS	230/460	RPM	3600	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	286TS	NEMA	B

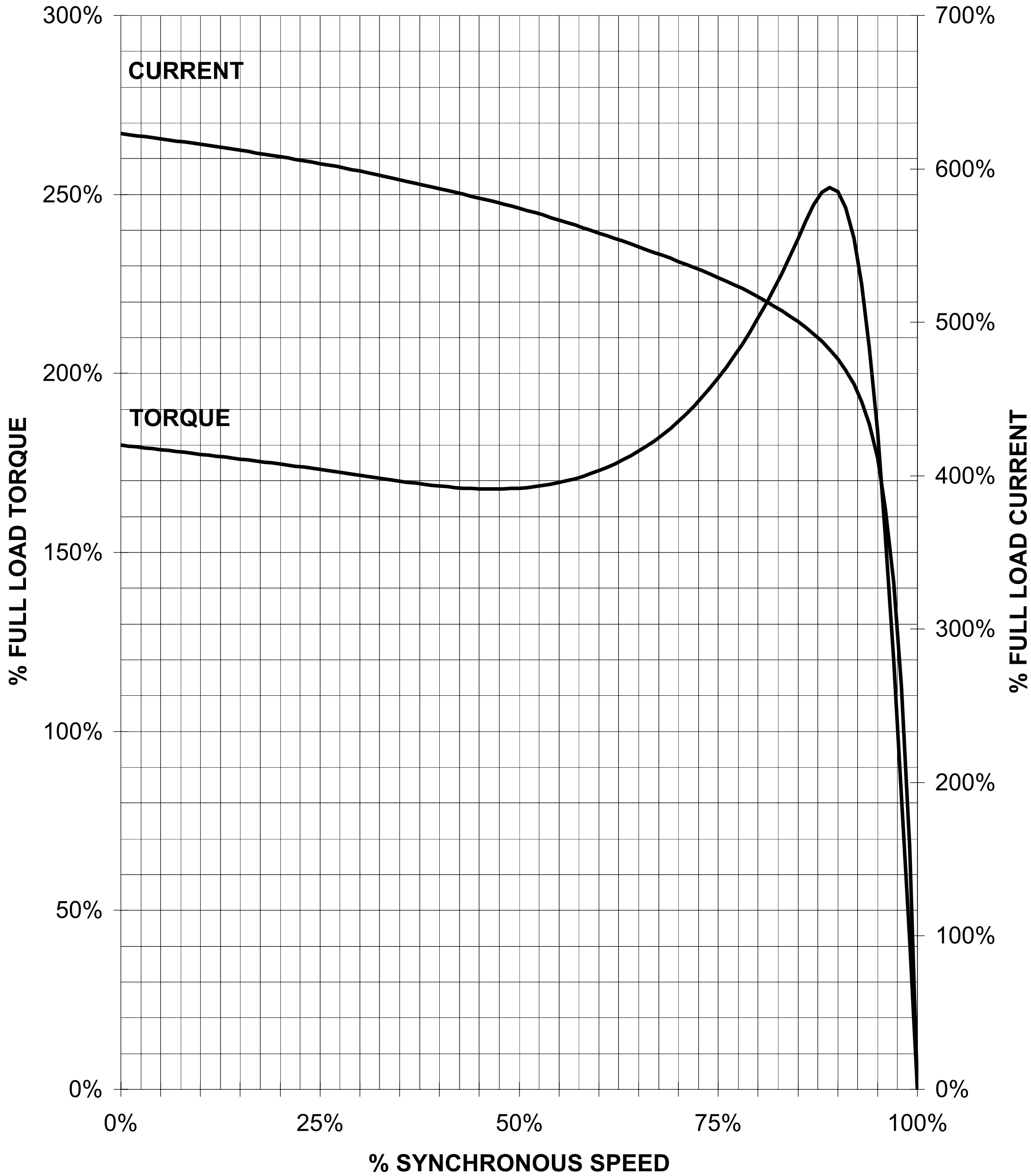
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	30	VOLTS	460	RPM	1800	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	286T	NEMA	B

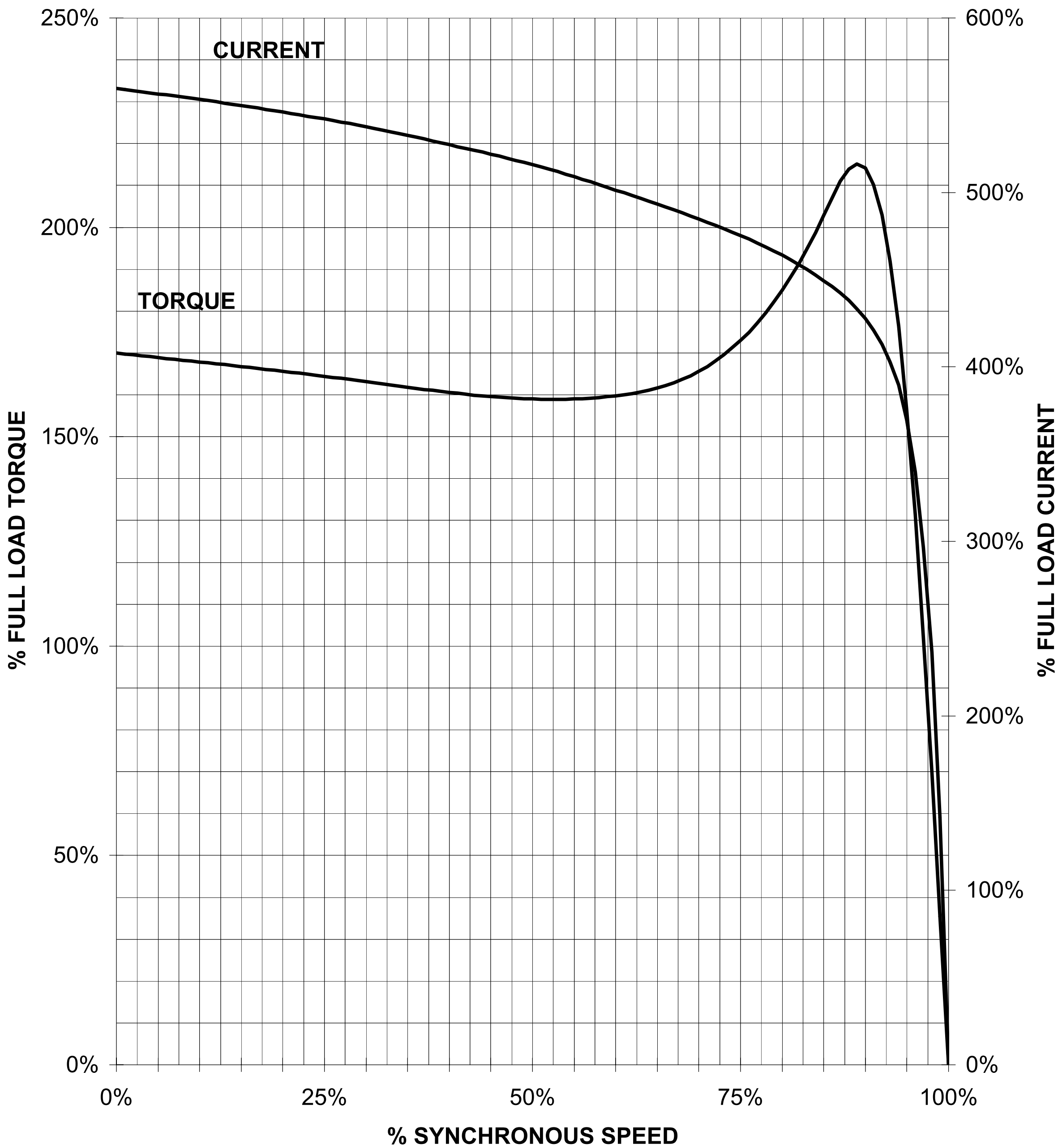
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	30	VOLTS	460	RPM	1200	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	326T	NEMA	B

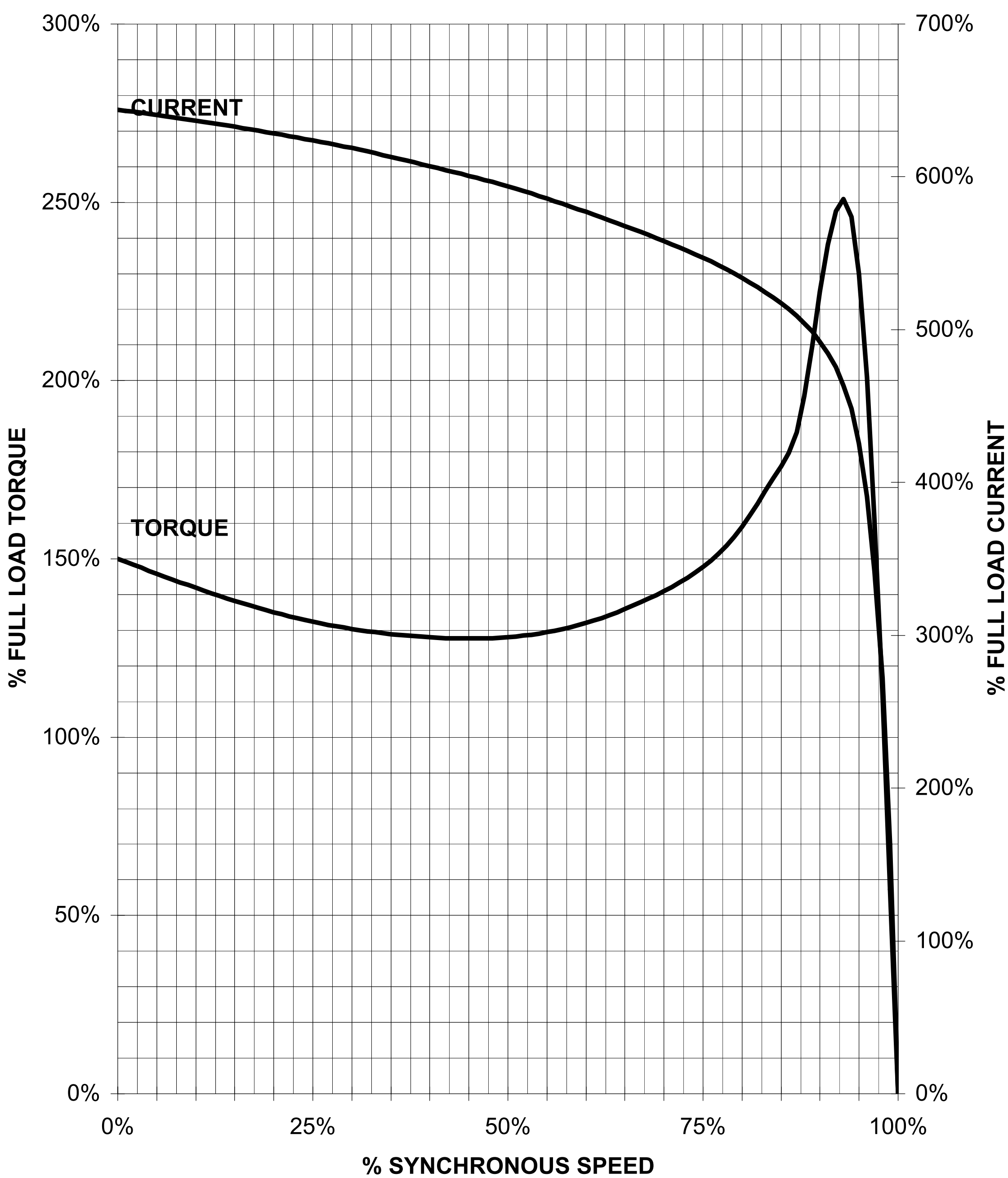
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	40	VOLTS	460	RPM	3600	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	324TS	NEMA	B

TORQUE AND CURRENT VS. SPEED

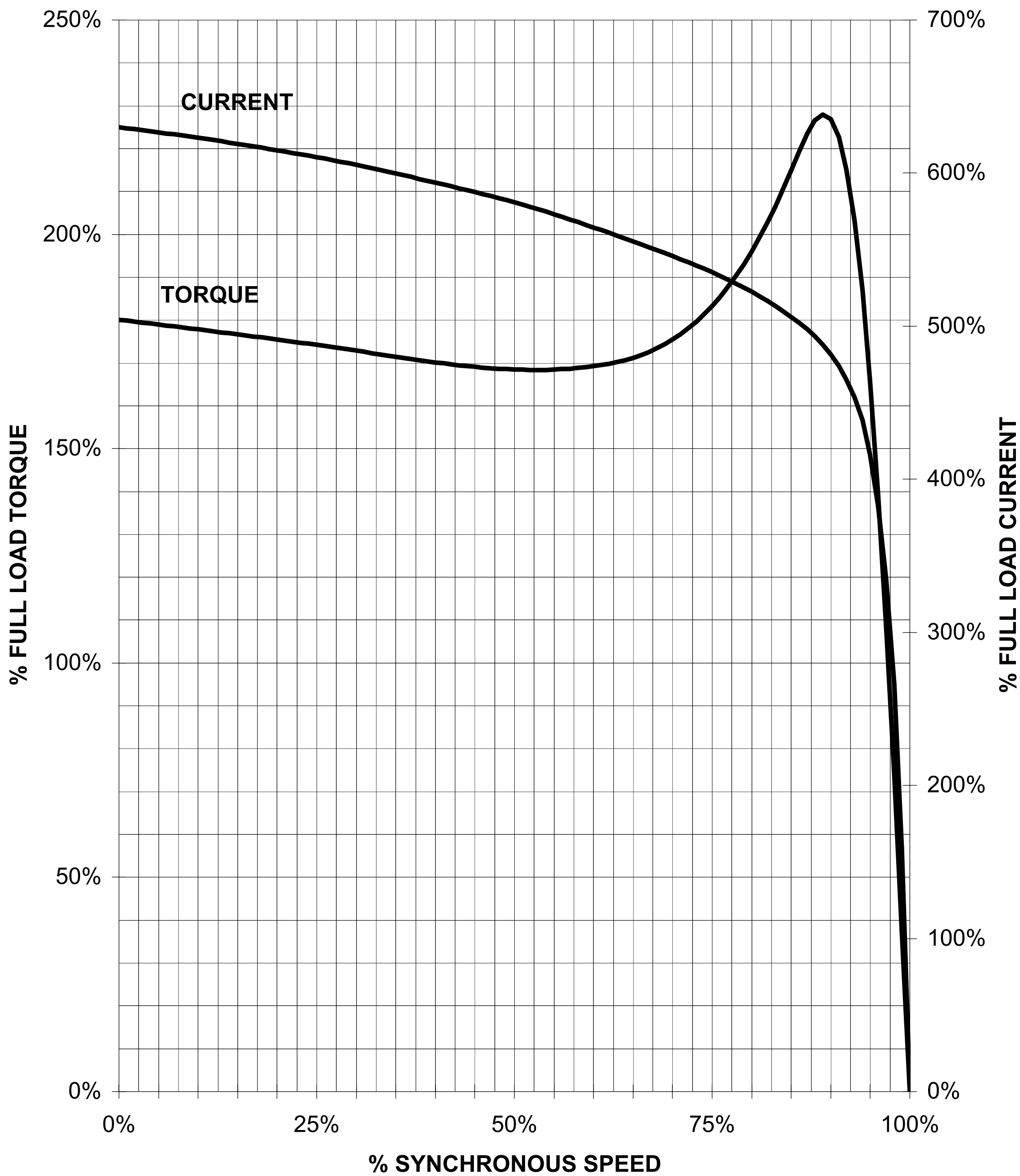


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	40	VOLTS	460	RPM	1800	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	324T	NEMA	B

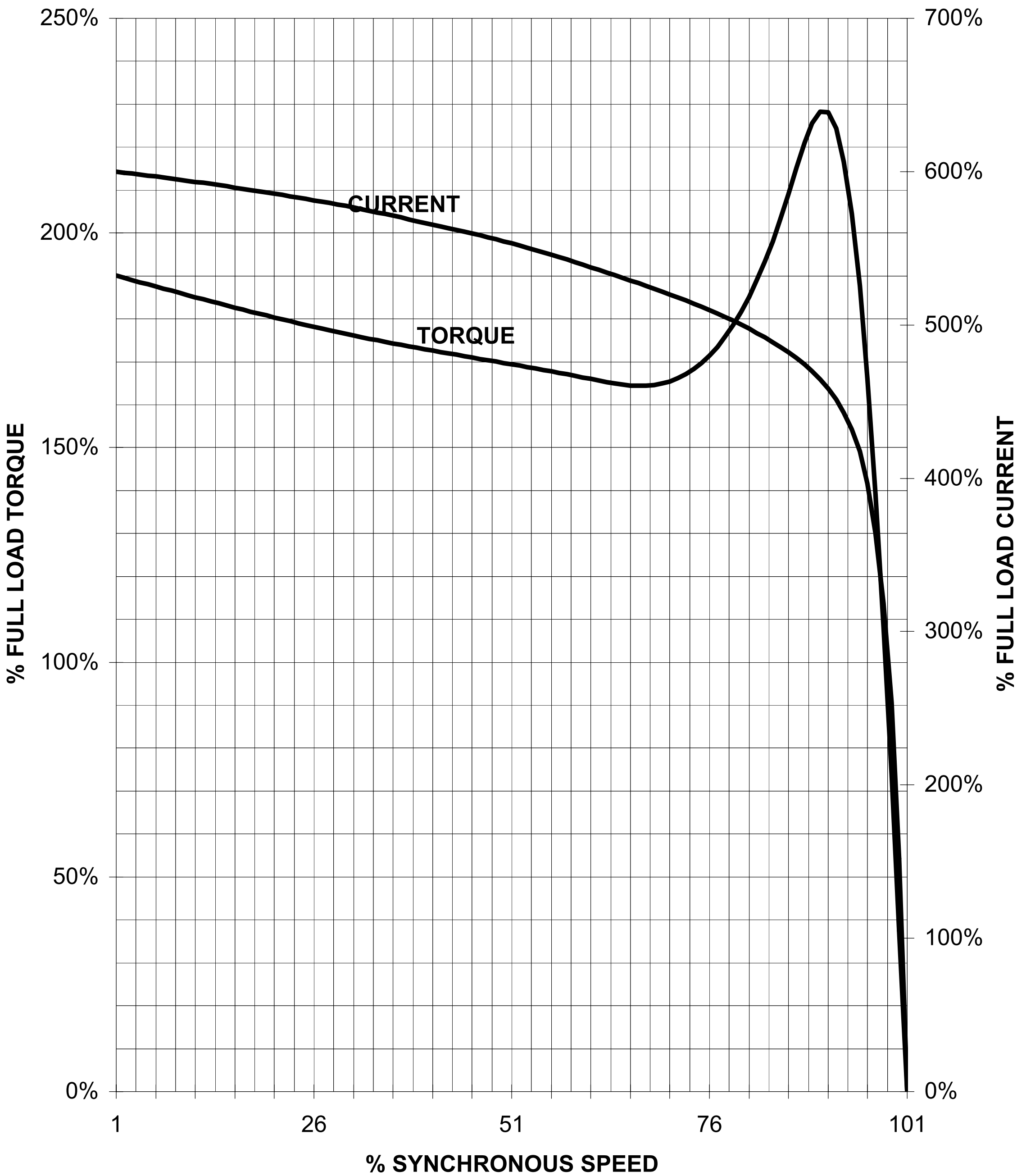
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	40	VOLTS	460	RPM	1200	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	364T	NEMA	B

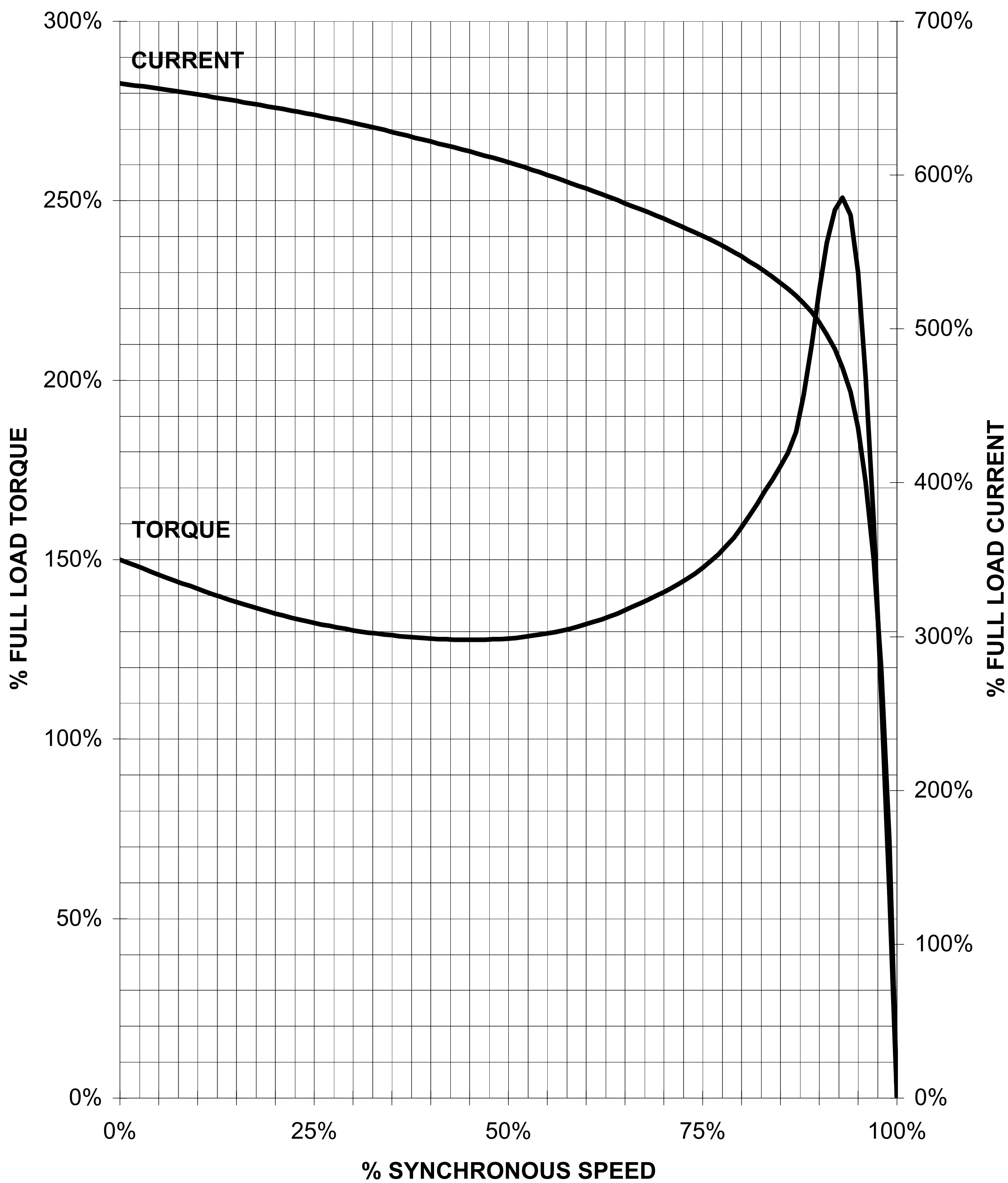
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	50	VOLTS	460	RPM	3600	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	326TS	NEMA	B

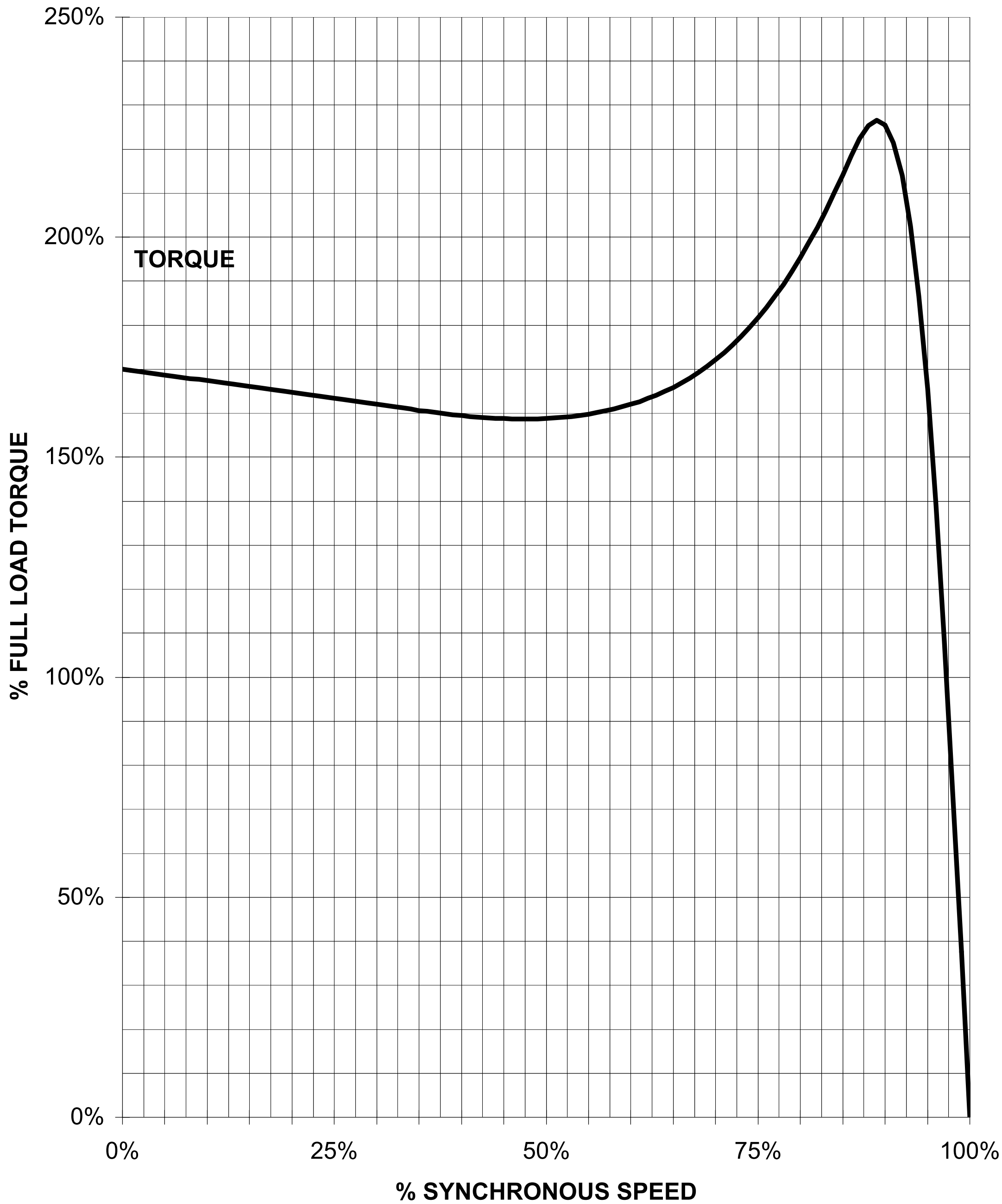
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	50	VOLTS	460	RPM	1800	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	326T	NEMA	B

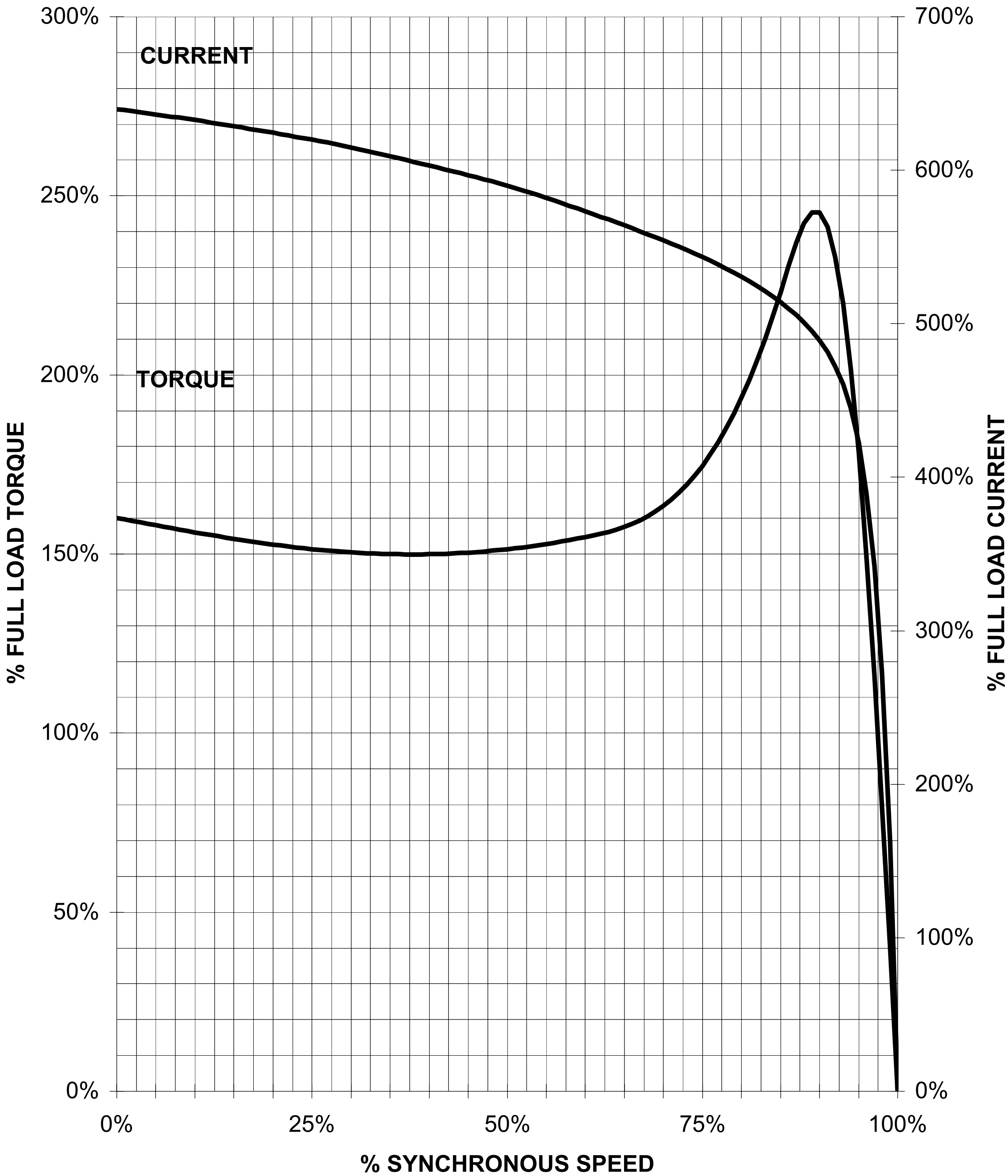
TORQUE VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	60	VOLTS	460	RPM	3600	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	364TS	NEMA	B

TORQUE AND CURRENT VS. SPEED

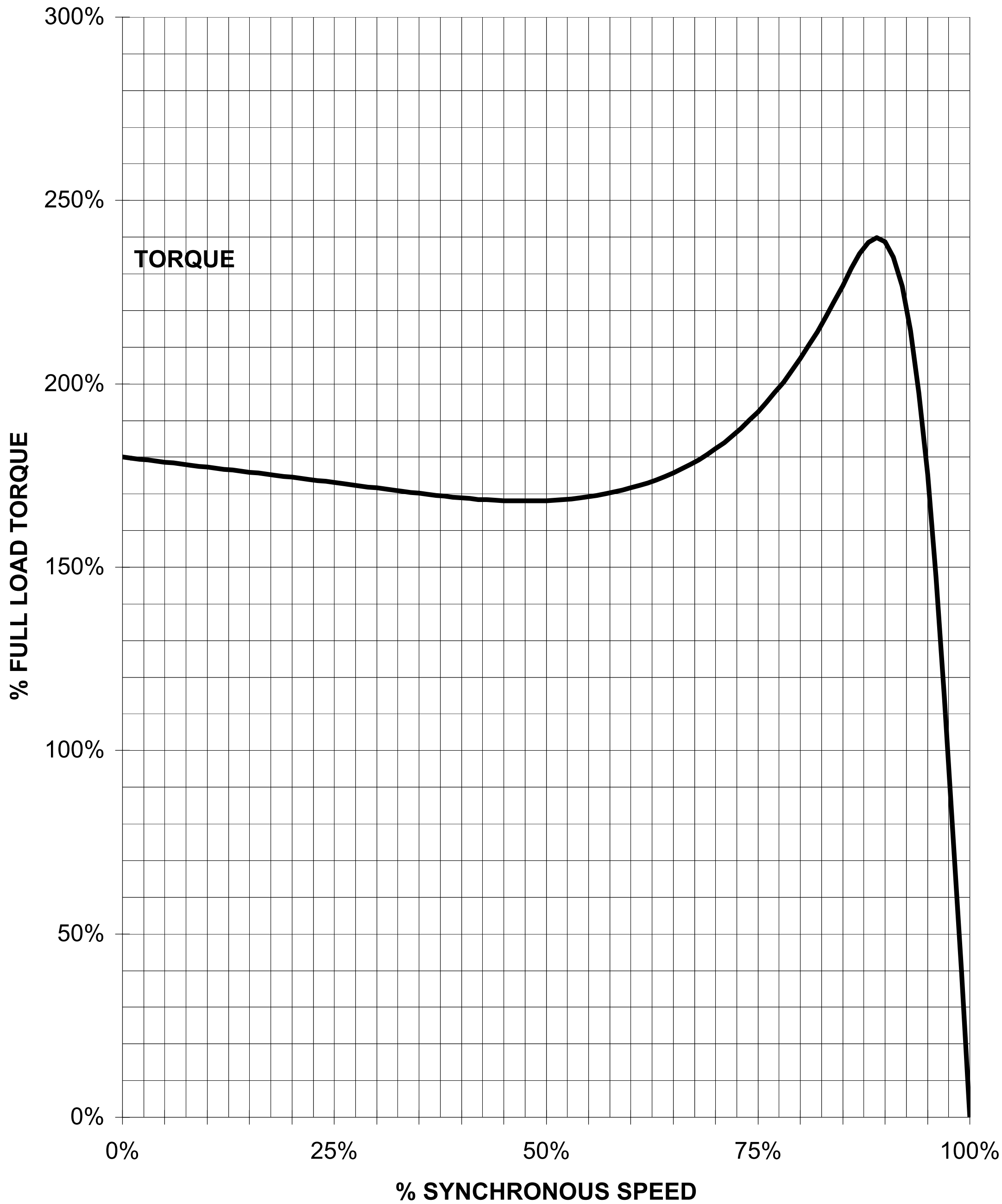


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	60	VOLTS	460	RPM	1800	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	364T	NEMA	B

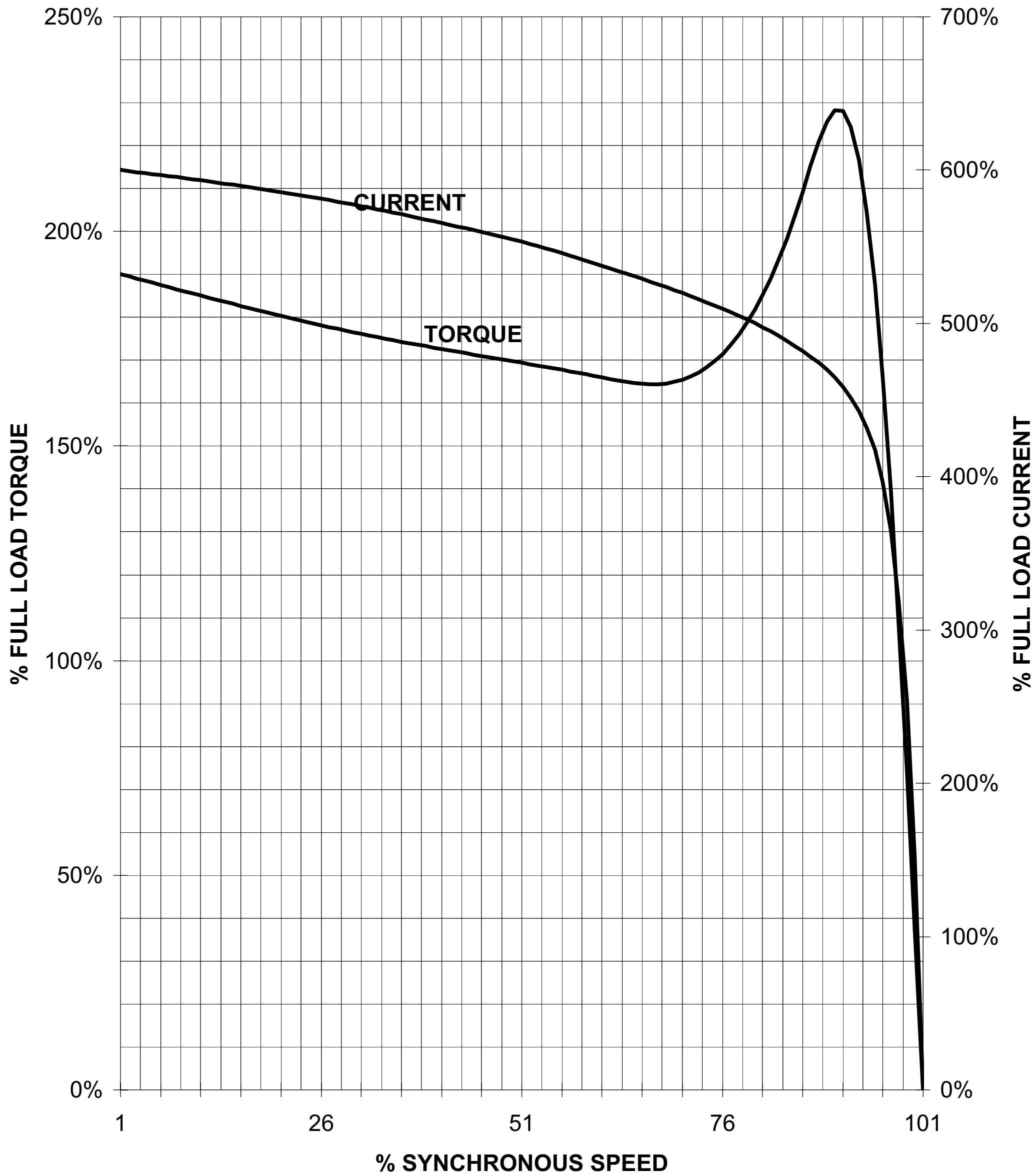
TORQUE VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	50	VOLTS	460	RPM	1200	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	365T	NEMA	B

TORQUE AND CURRENT VS. SPEED

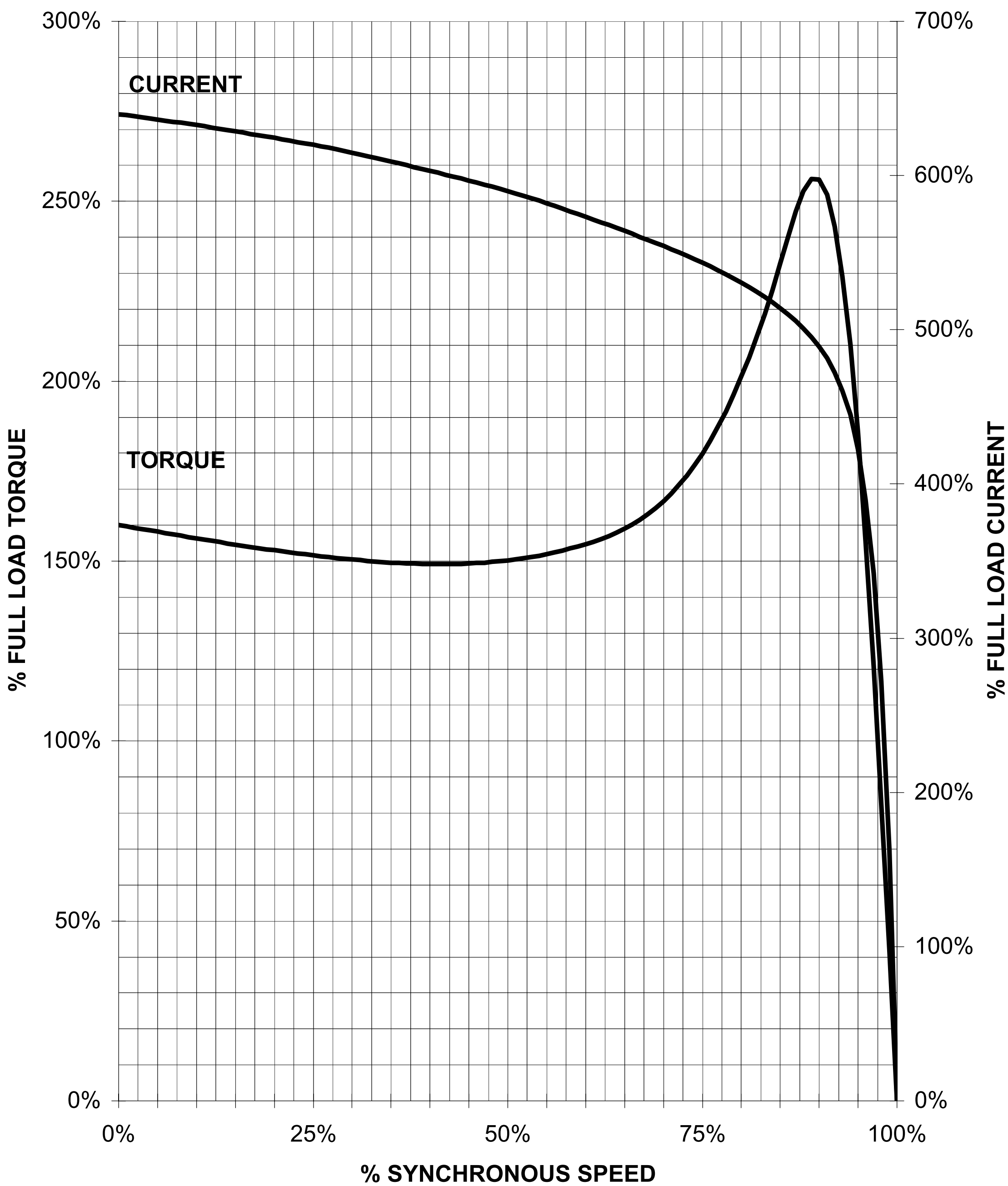


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	75	VOLTS	460	RPM	3600	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	365TS	NEMA	B

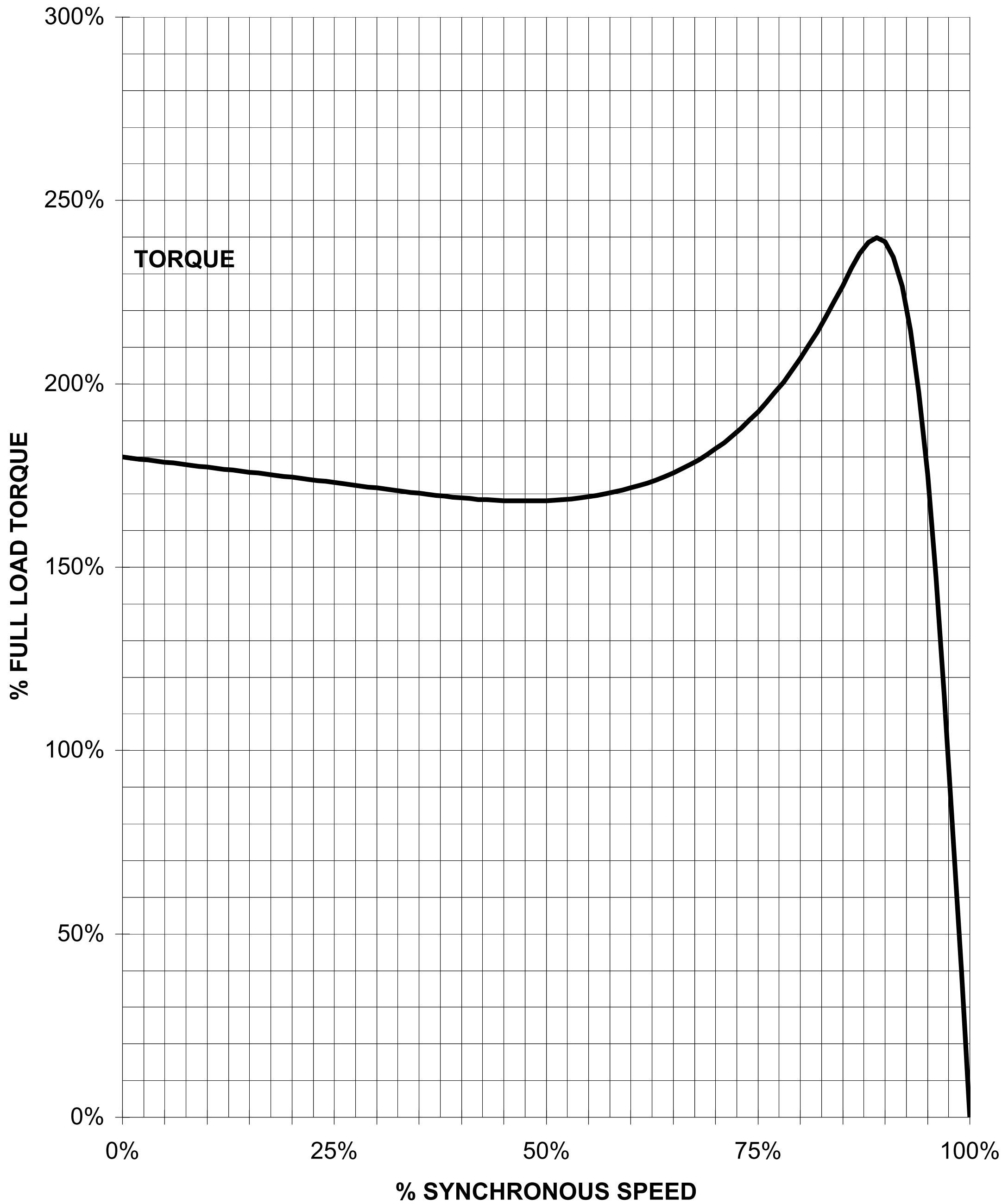
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	75	VOLTS	460	RPM	1800	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	365T	NEMA	B

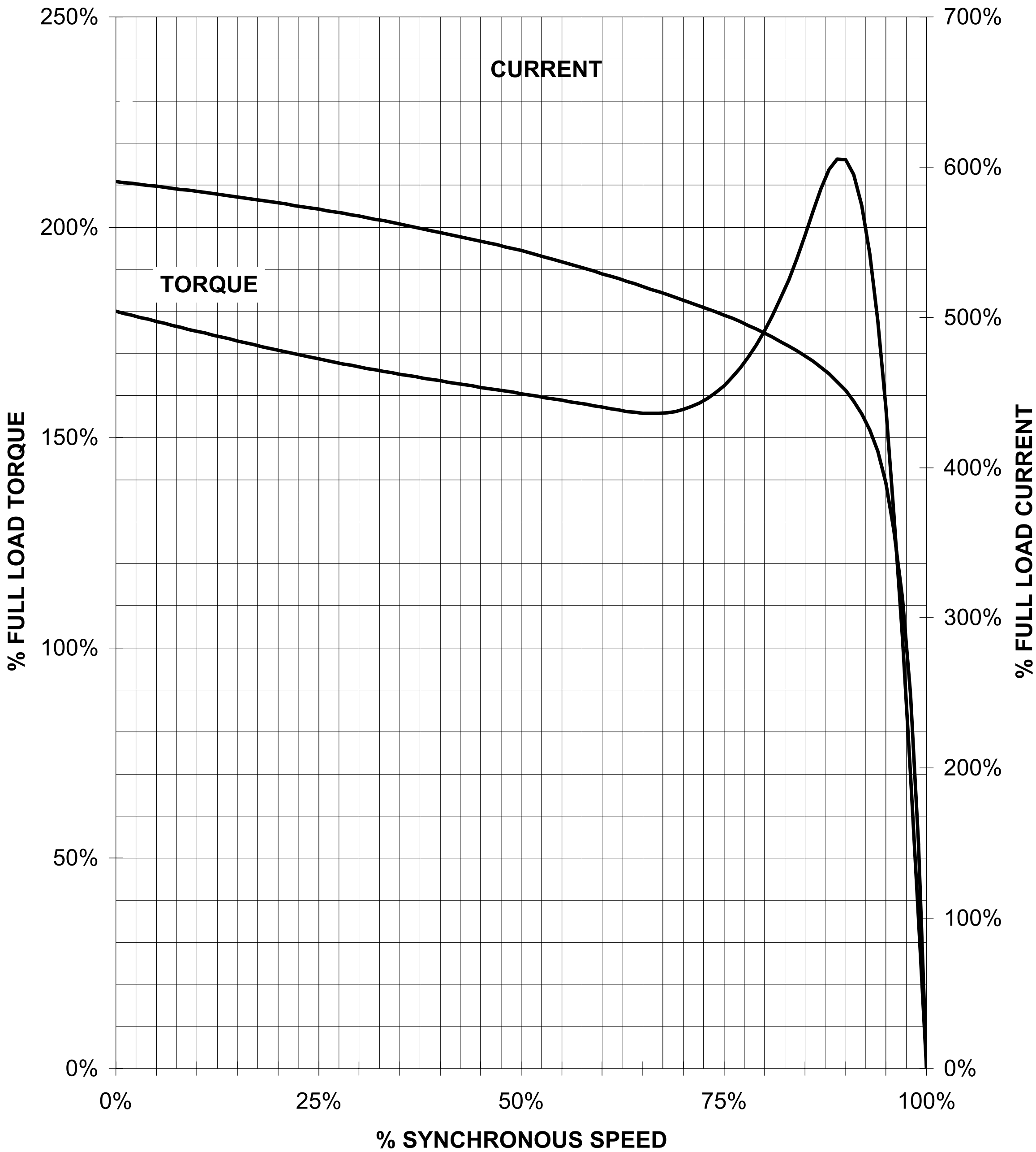
TORQUE VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	75	VOLTS	460	RPM	1200	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	405T	NEMA	B

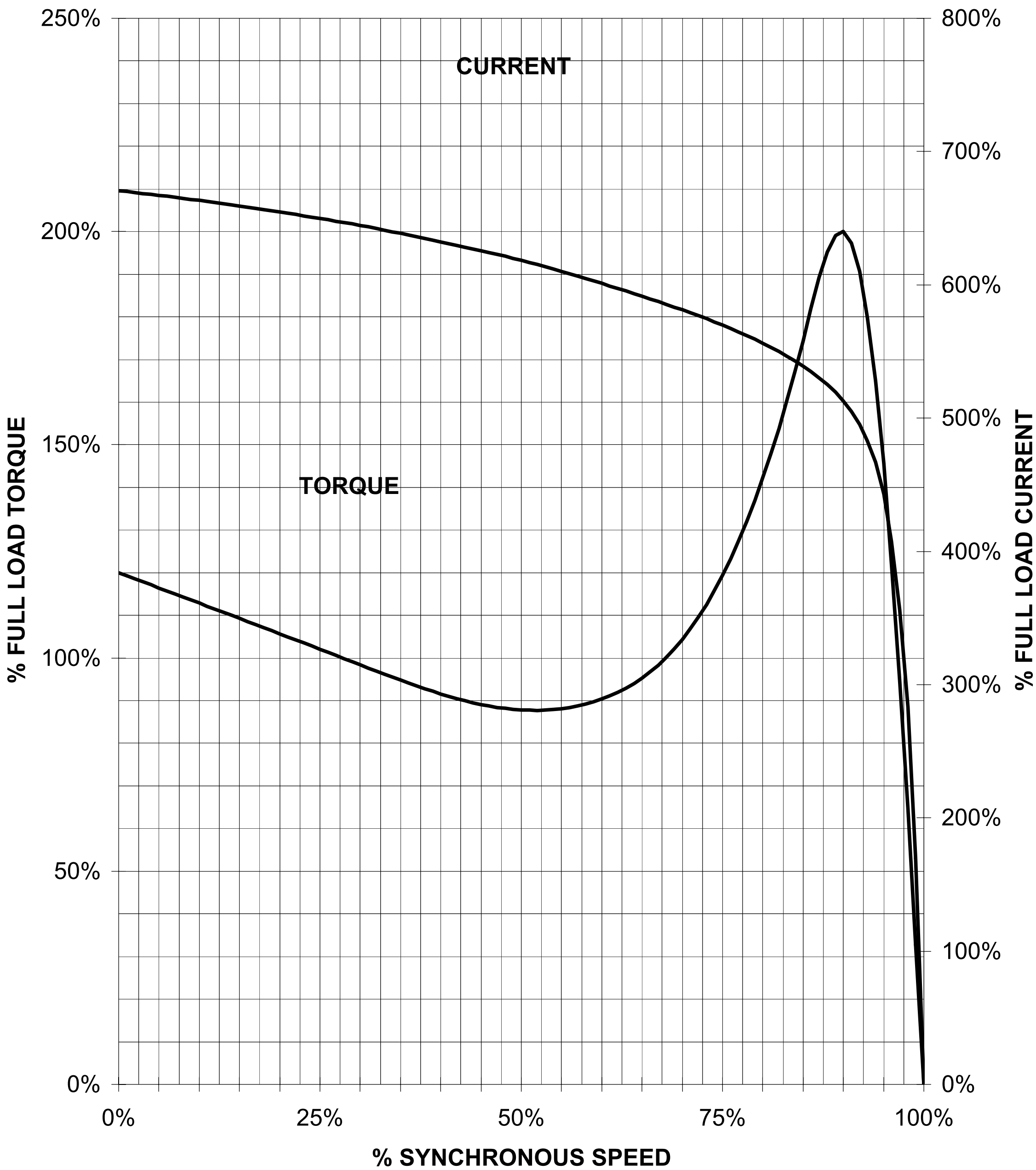
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	100	VOLTS	460	RPM	3600	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	405TS	NEMA	B

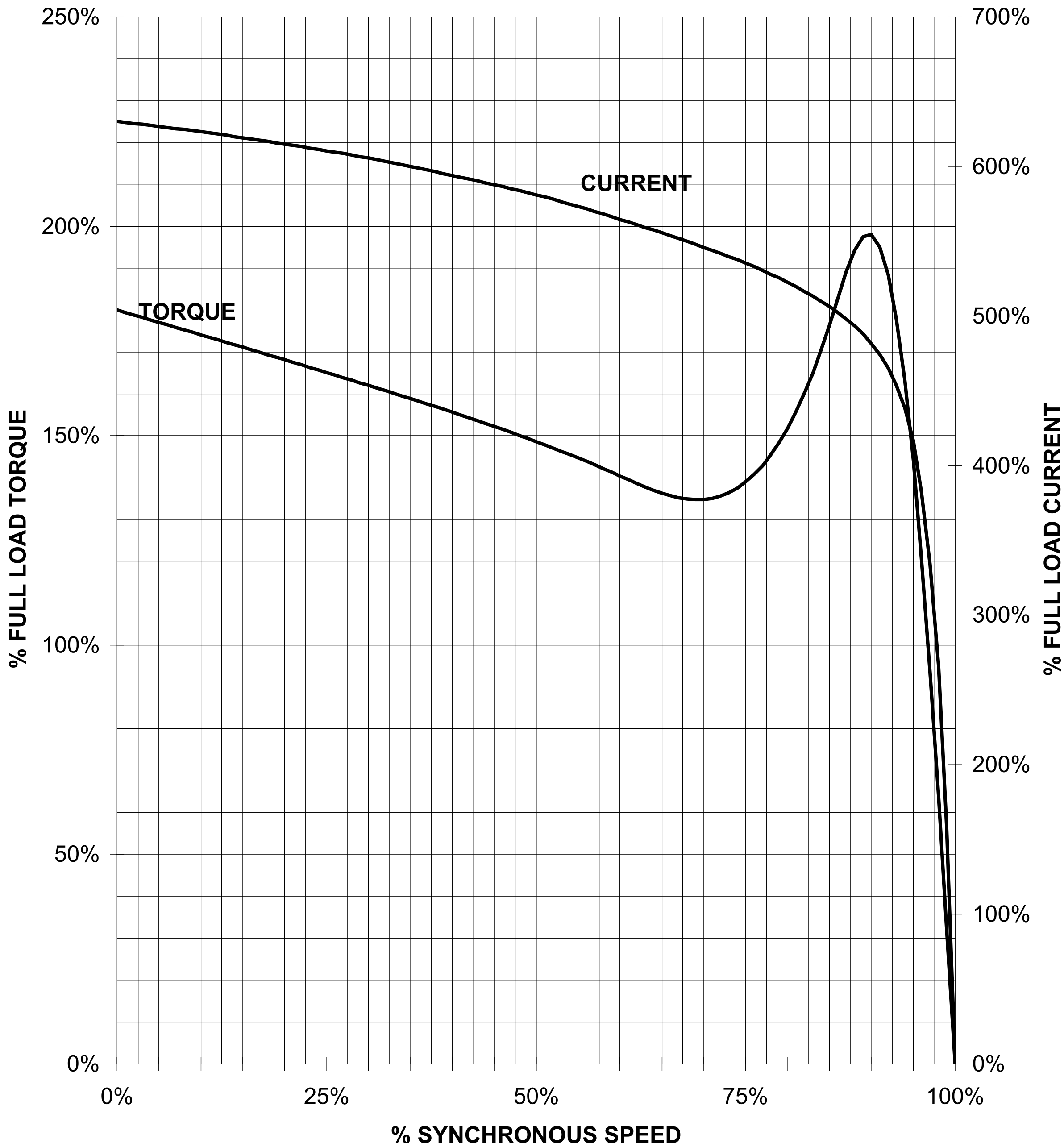
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	100	VOLTS	460	RPM	1800	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	405TS	NEMA	B

TORQUE & CURRENT VS. SPEED

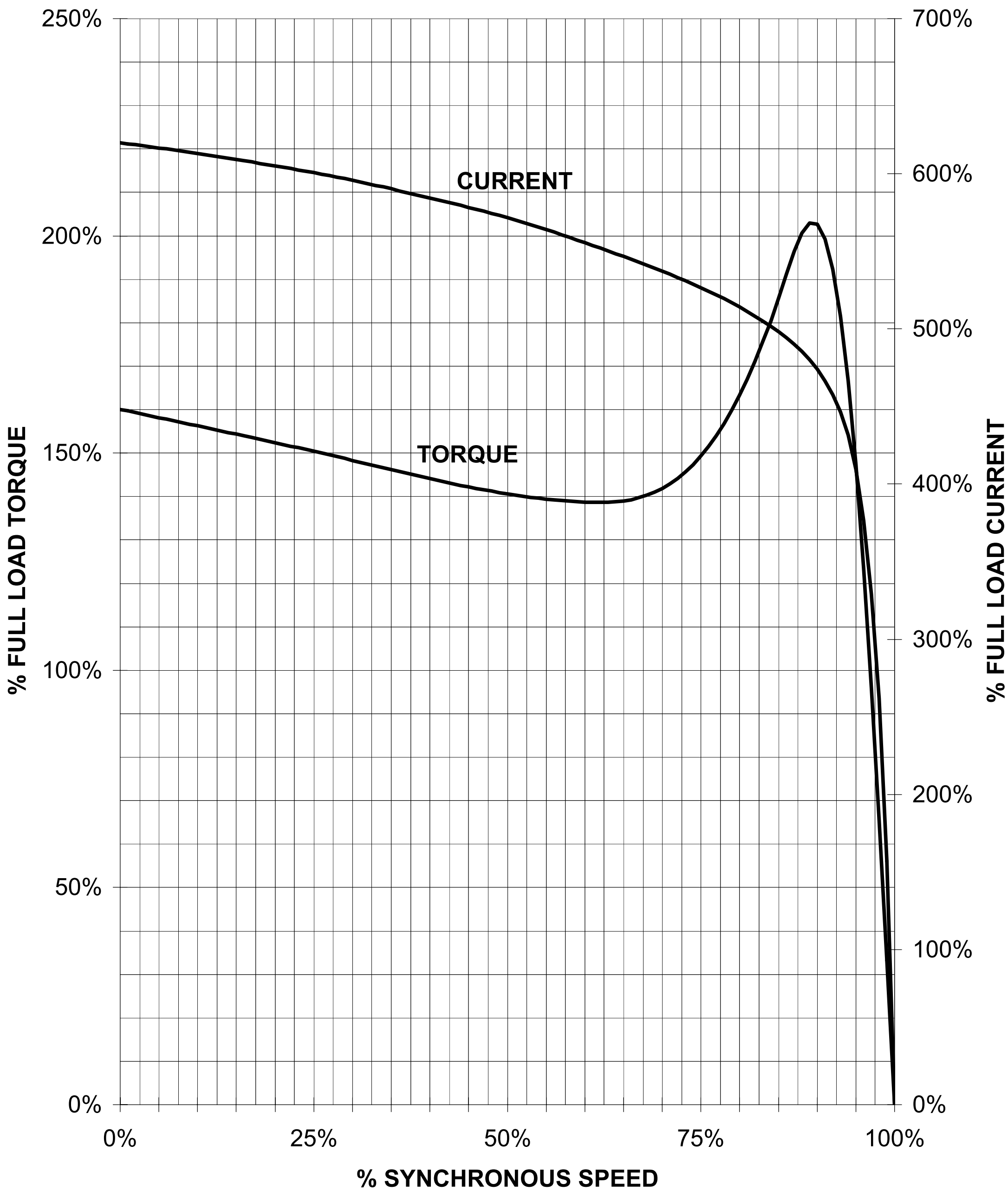


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	100	VOLTS	460	RPM	1200	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	444T	NEMA	B

TORQUE & CURRENT VS. SPEED



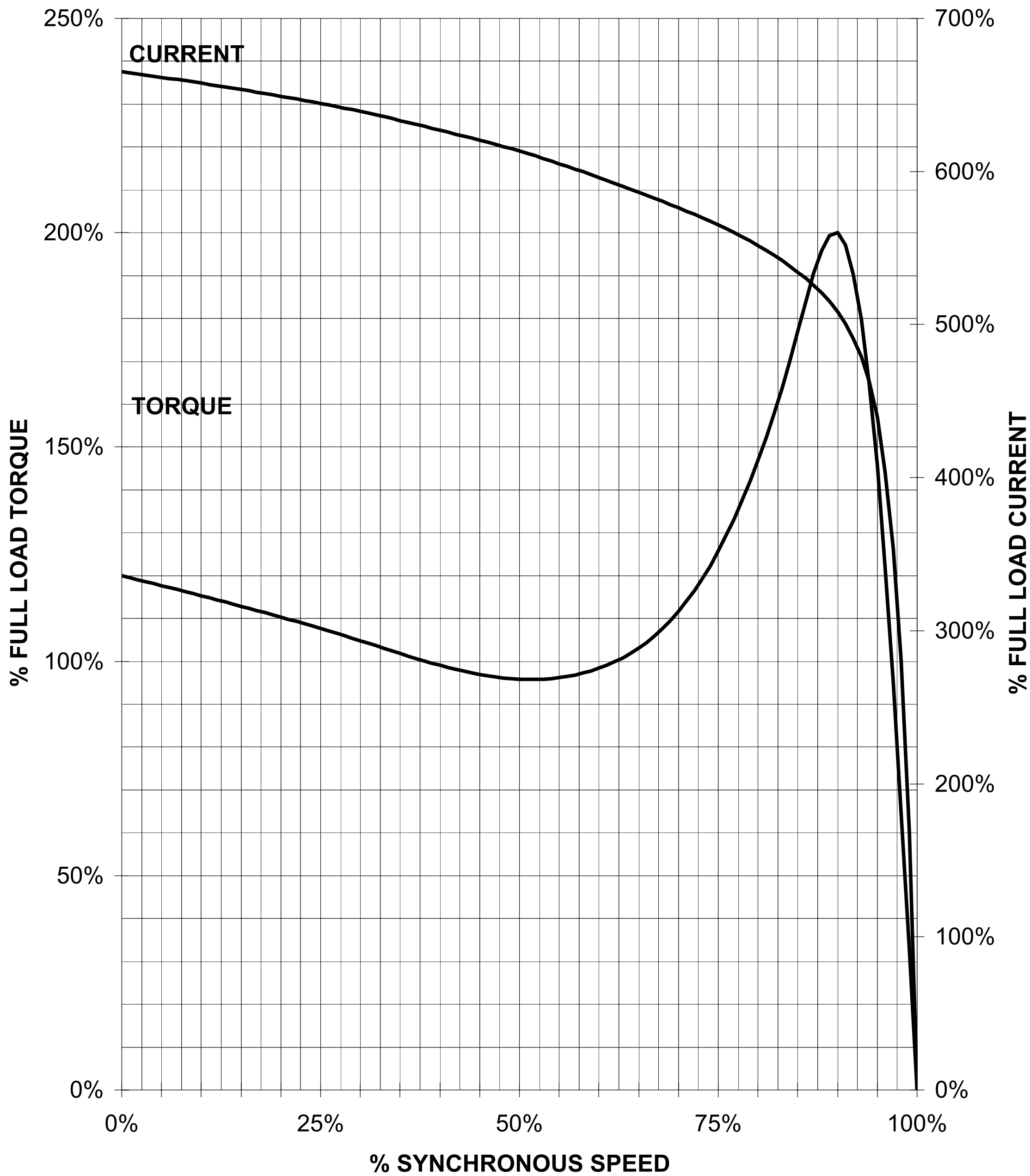
Customer: **PO No.:** **Order No.:**

SIEMENS

Application Manual for NEMA Motors

HP	125	VOLTS	460	RPM	3600	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	444TS	NEMA	B

TORQUE AND CURRENT VS. SPEED



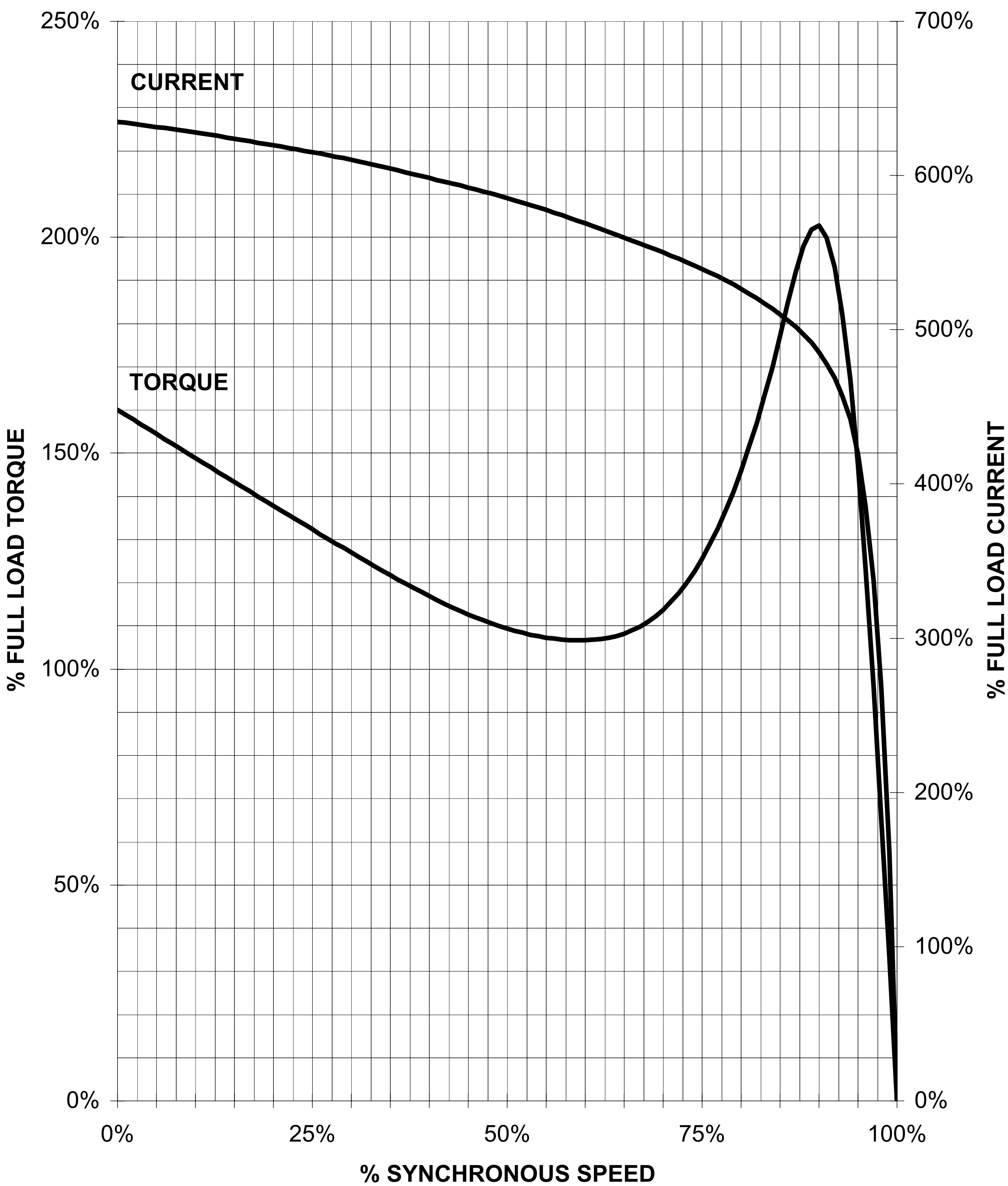
Customer: **PO No.:** **Order No.:**

SIEMENS

Application Manual for NEMA Motors

HP	125	VOLTS	460	RPM	1800	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	444TS	NEMA	B

TORQUE AND CURRENT VS. SPEED

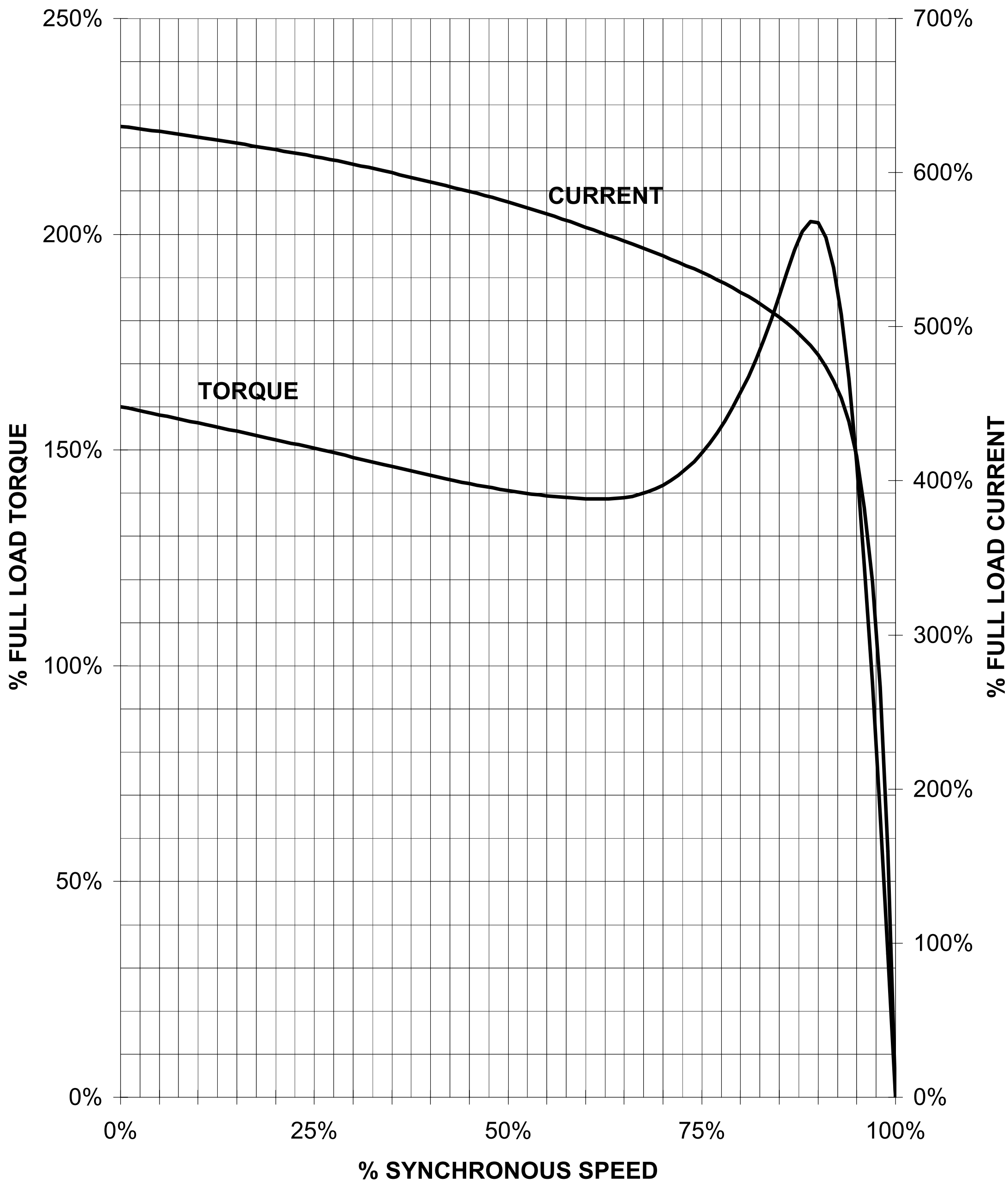


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	125	VOLTS	460	RPM	1200	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	445T	NEMA	B

TORQUE & CURRENT VS. SPEED



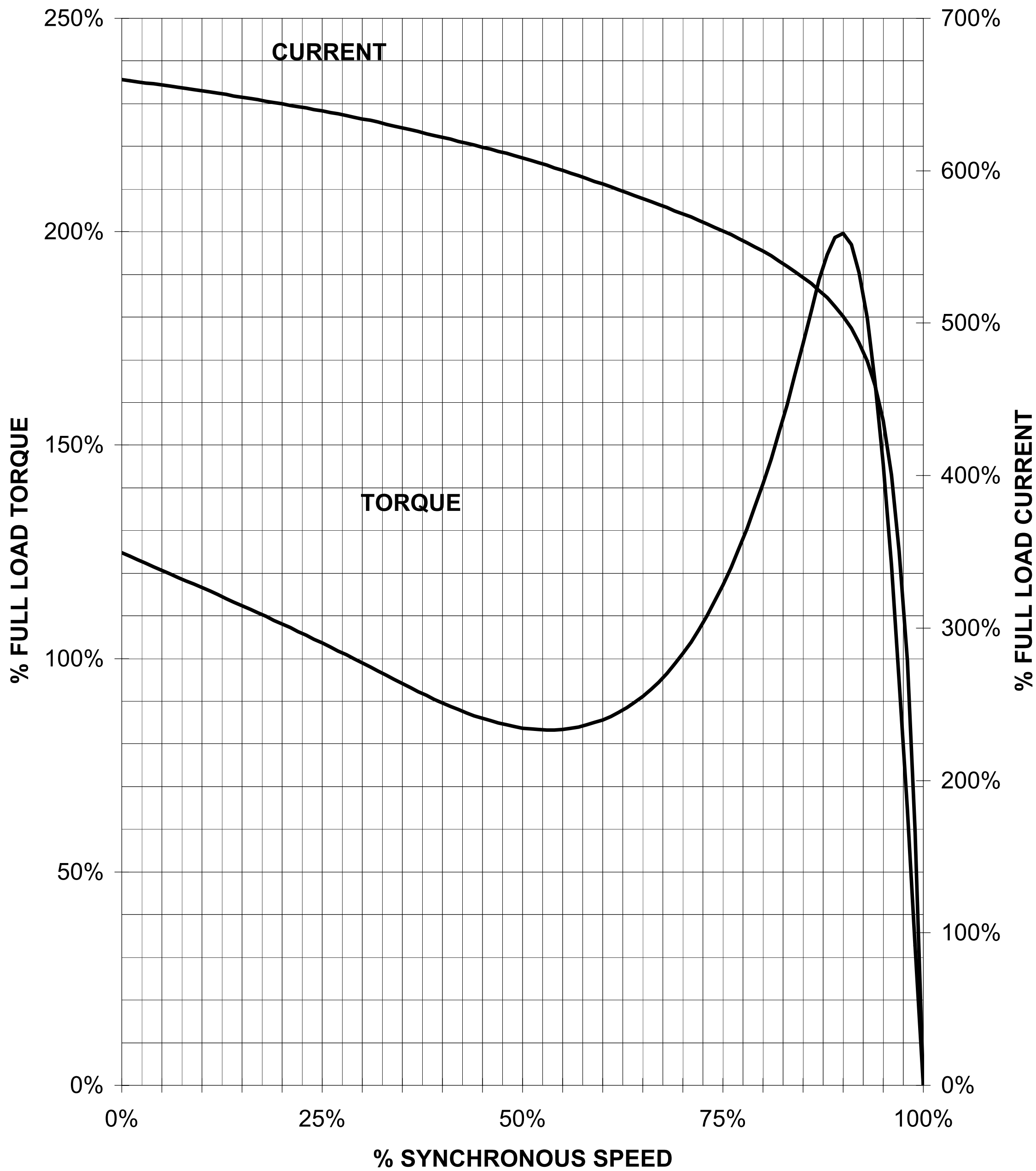
Customer: **PO No.:** **Order No.:**

Application Manual for NEMA Motors

HP 150 VOLTS 460 RPM 3600 TYPE RGZEESD

HZ 60 PHASE 3 FRAME 445TS NEMA B

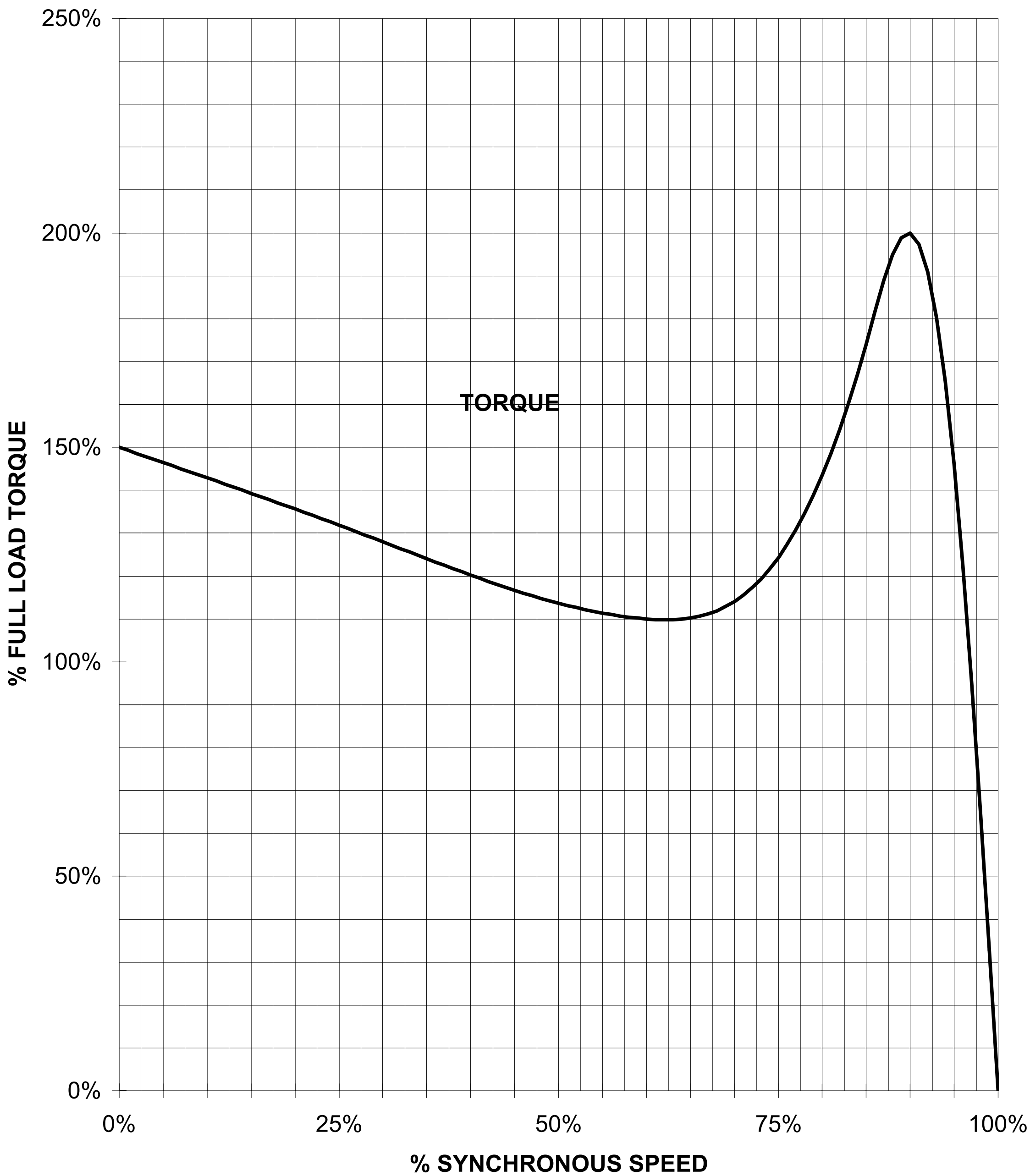
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	150	VOLTS	460	RPM	1800	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	445T	NEMA	B

TORQUE VS. SPEED



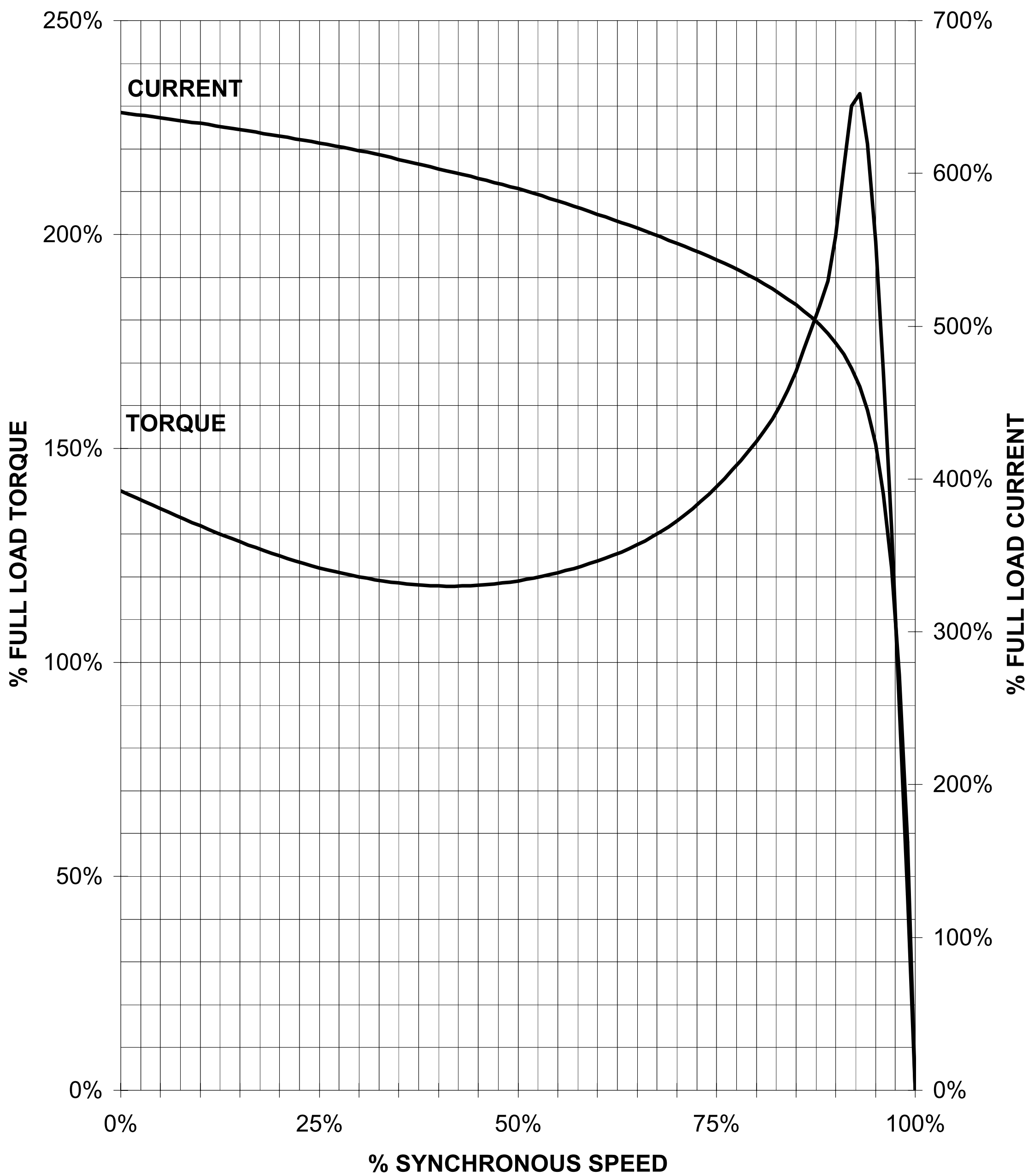
Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP 150 VOLTS 460 RPM 1200 TYPE RGZEESD

HZ 60 PHASE 3 FRAME 447T NEMA B

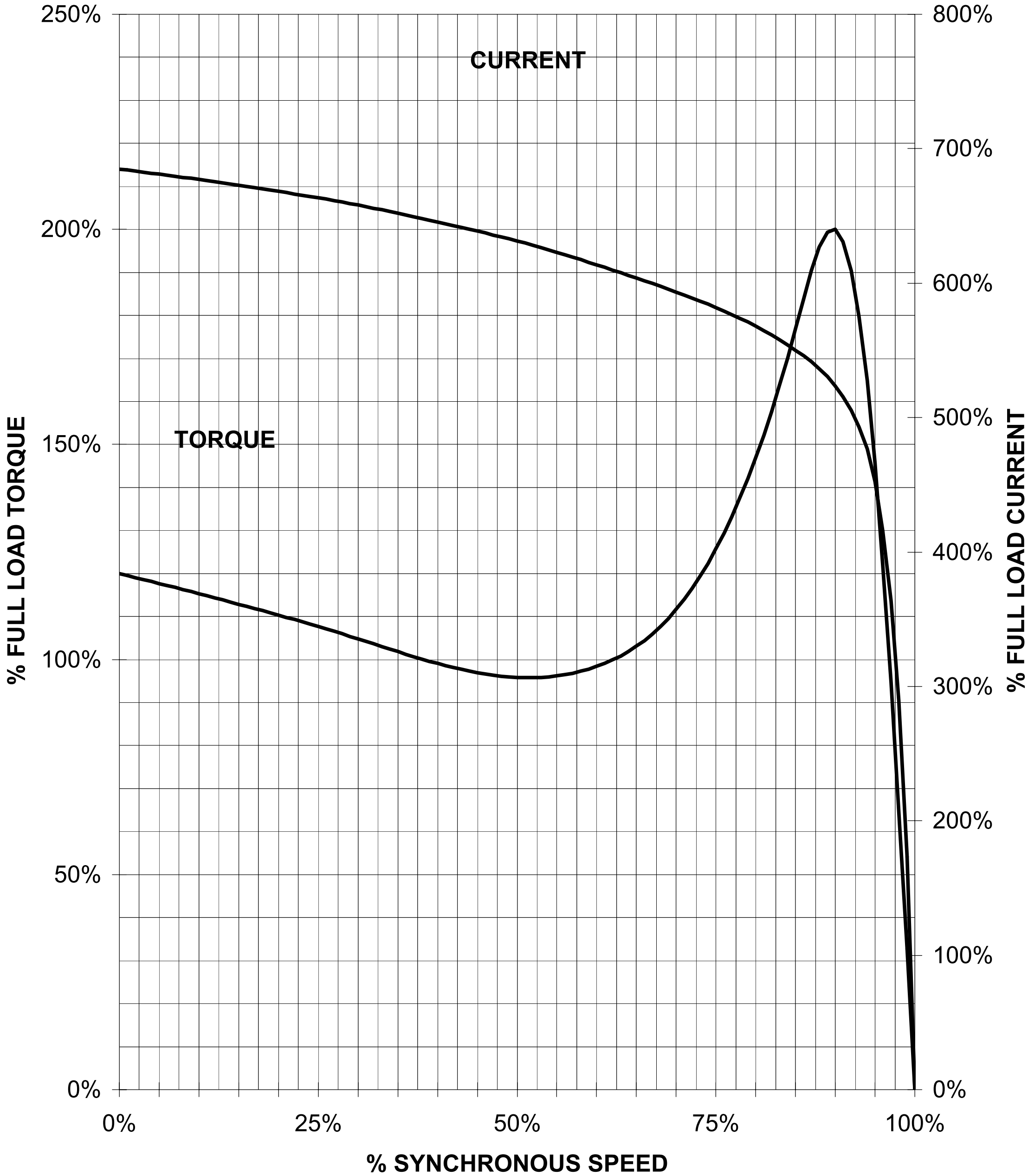
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	200	VOLTS	460	RPM	3600	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	447TS	NEMA	B

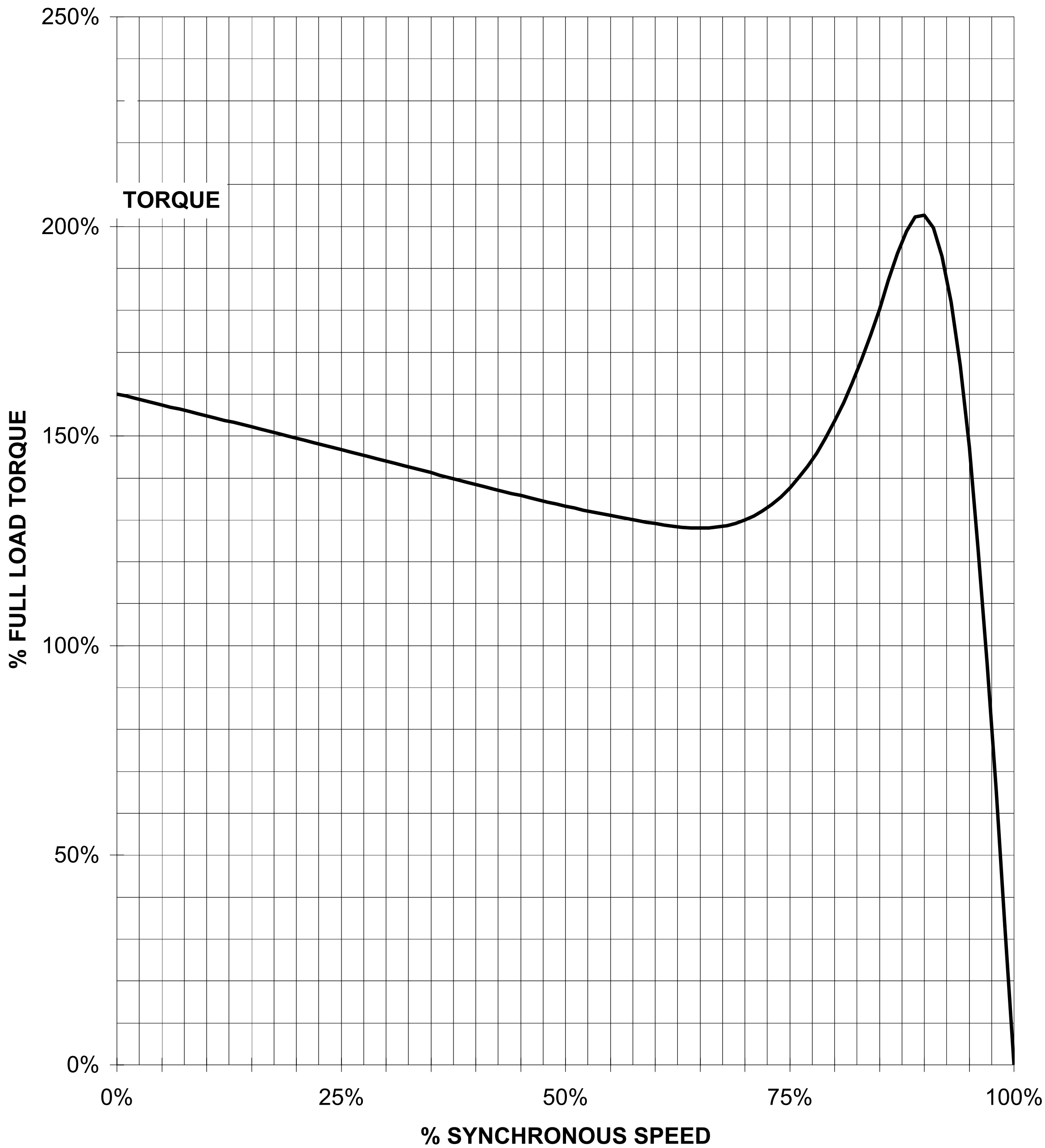
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	200	VOLTS	460	RPM	1800	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	447T	NEMA	B

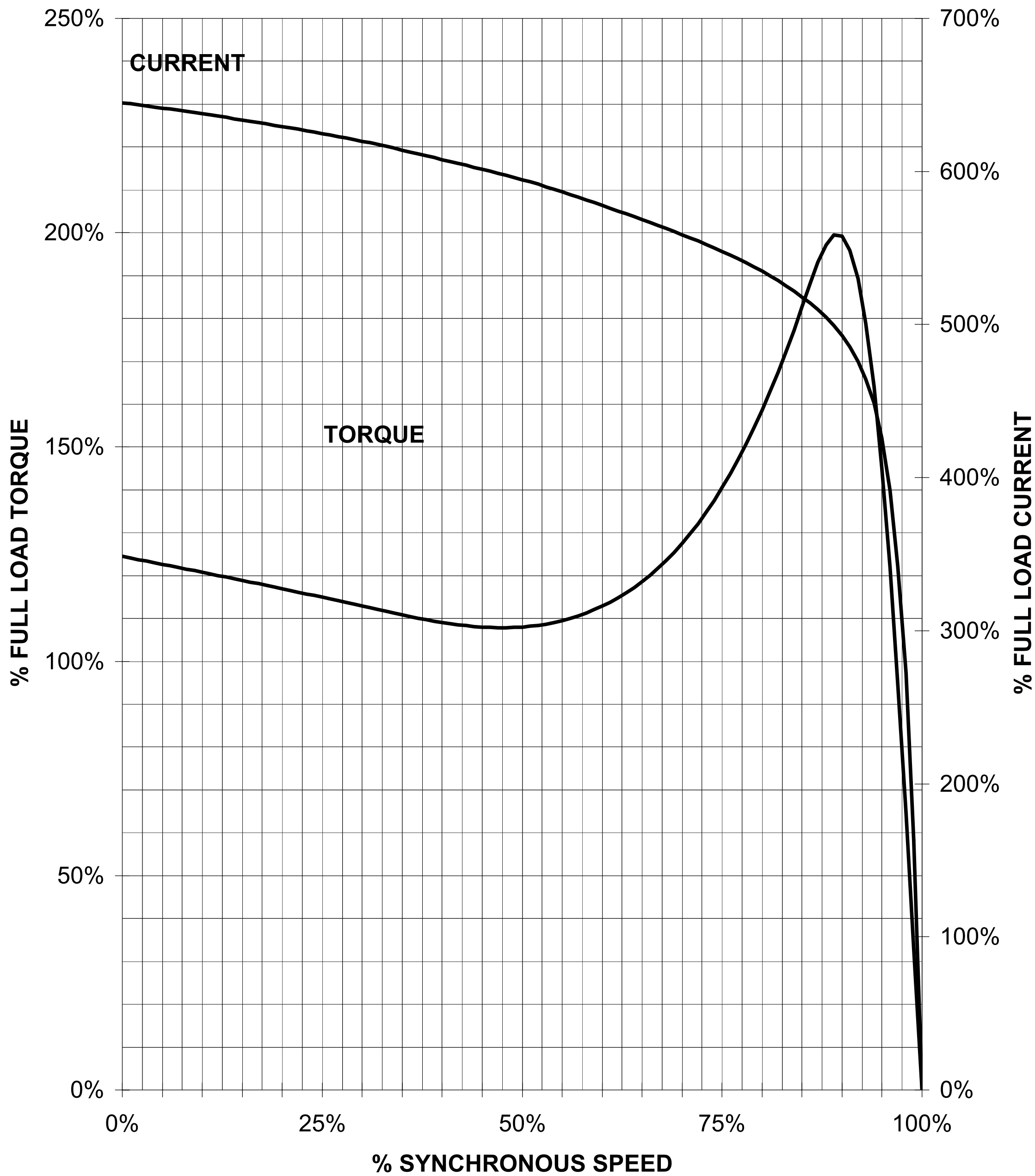
TORQUE VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	200	VOLTS	460	RPM	1200	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	449TS	NEMA	B

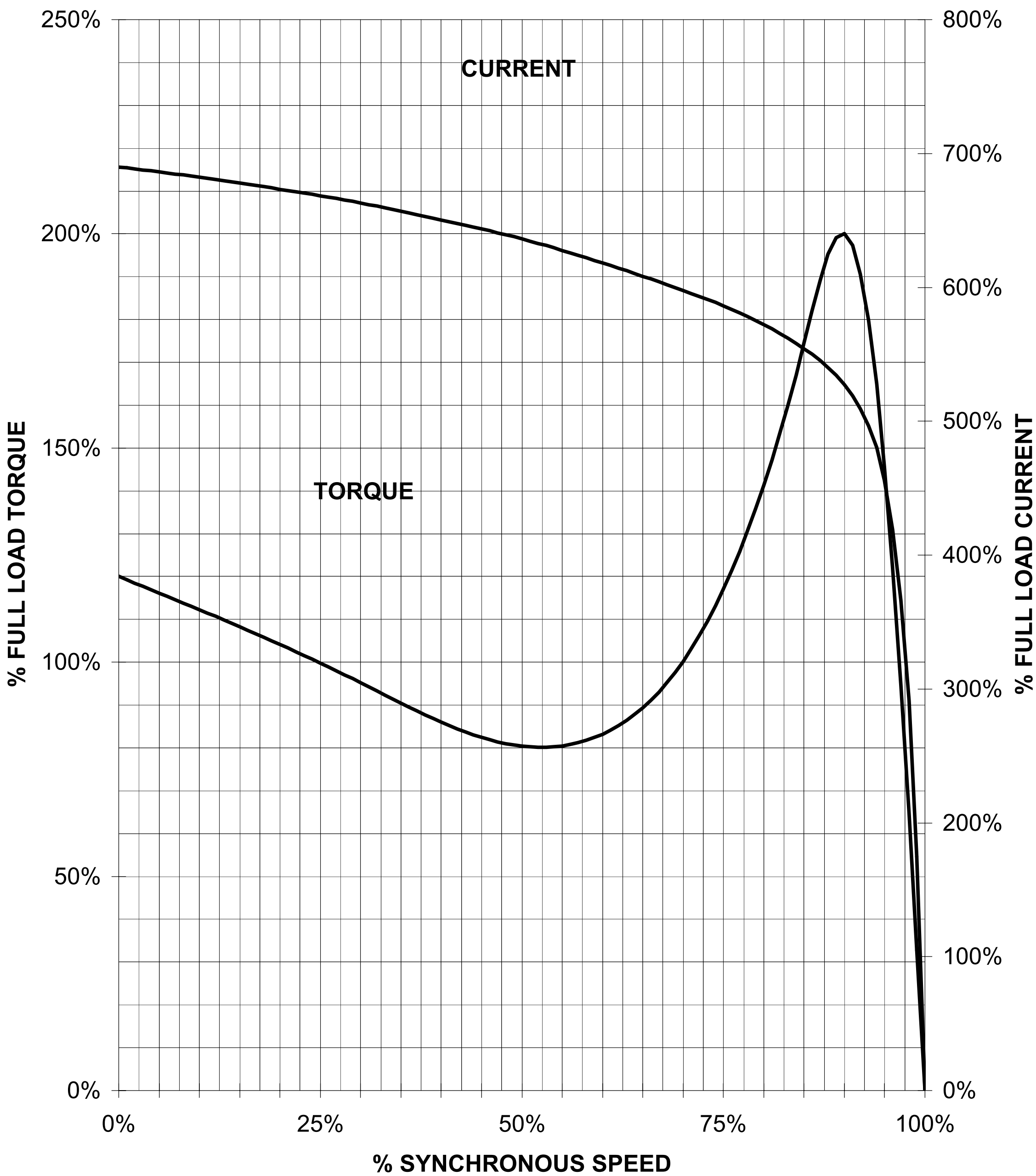
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	250	VOLTS	460	RPM	3600	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	449TS	NEMA	B

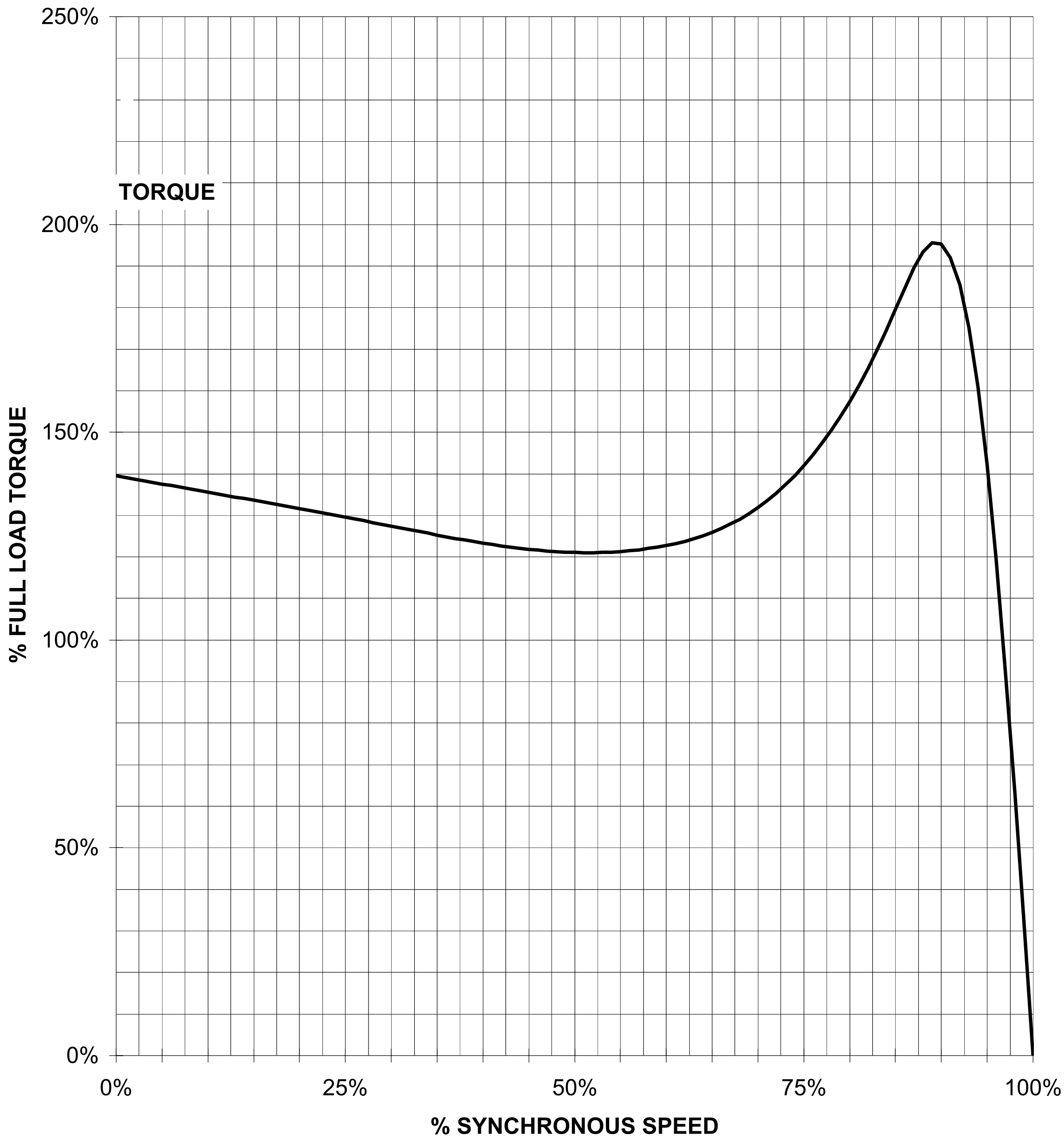
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	250	VOLTS	460	RPM	1800	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	449TS	NEMA	A

TORQUE VS. SPEED

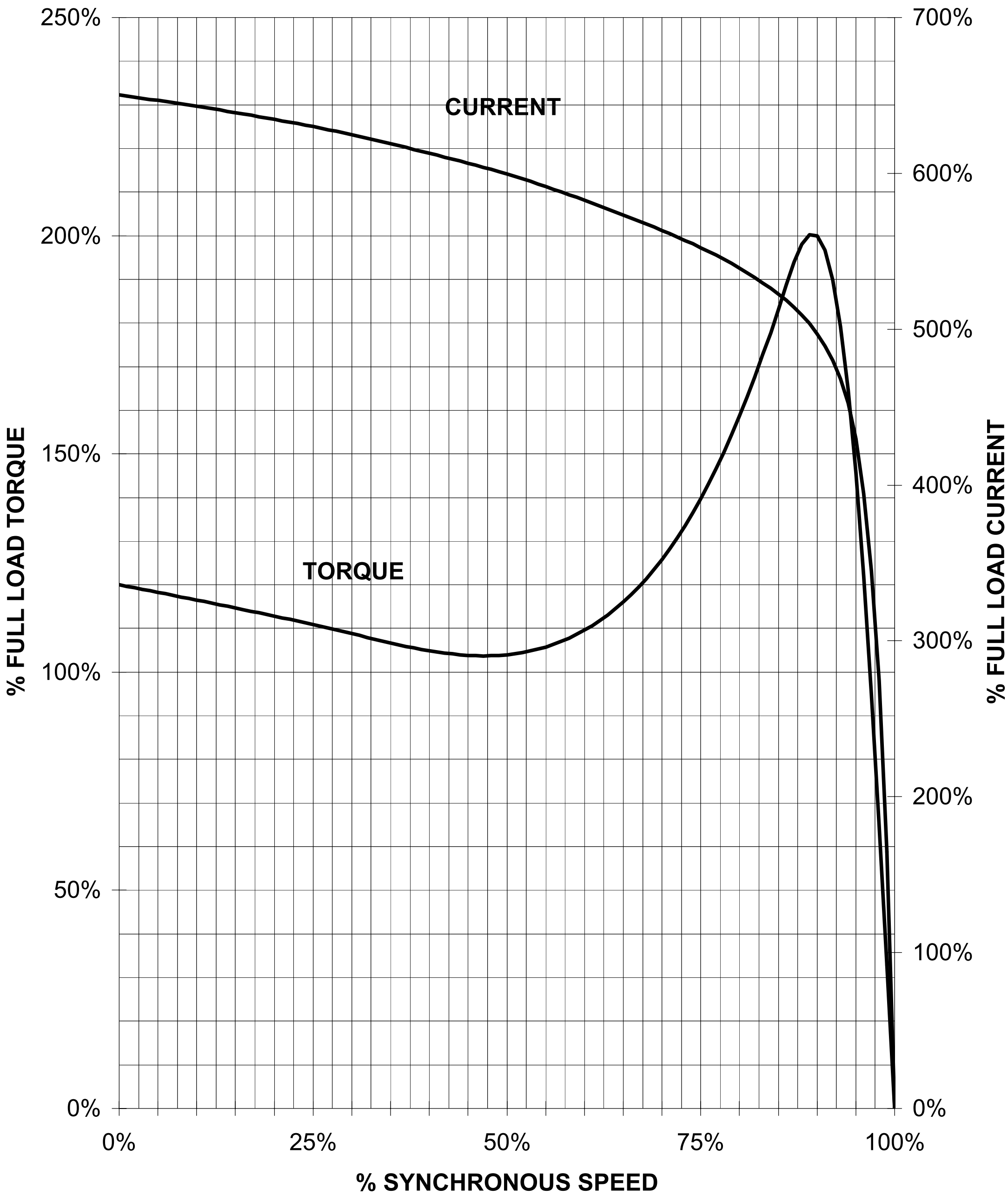


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	250	VOLTS	460	RPM	1200	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	449TS	NEMA	A

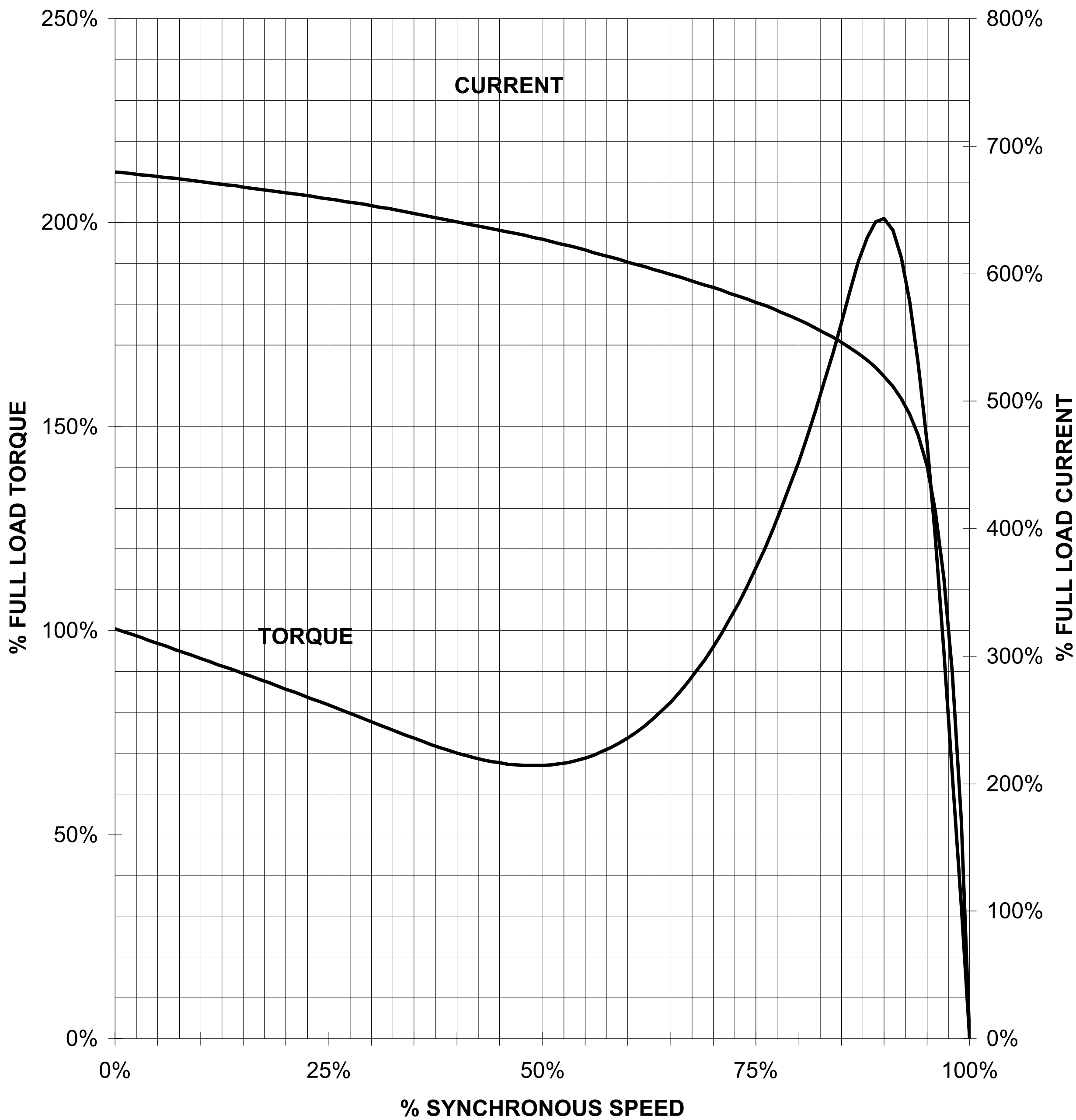
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	300	VOLTS	460	RPM	3600	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	449TS	NEMA	B

TORQUE & CURRENT VS. SPEED

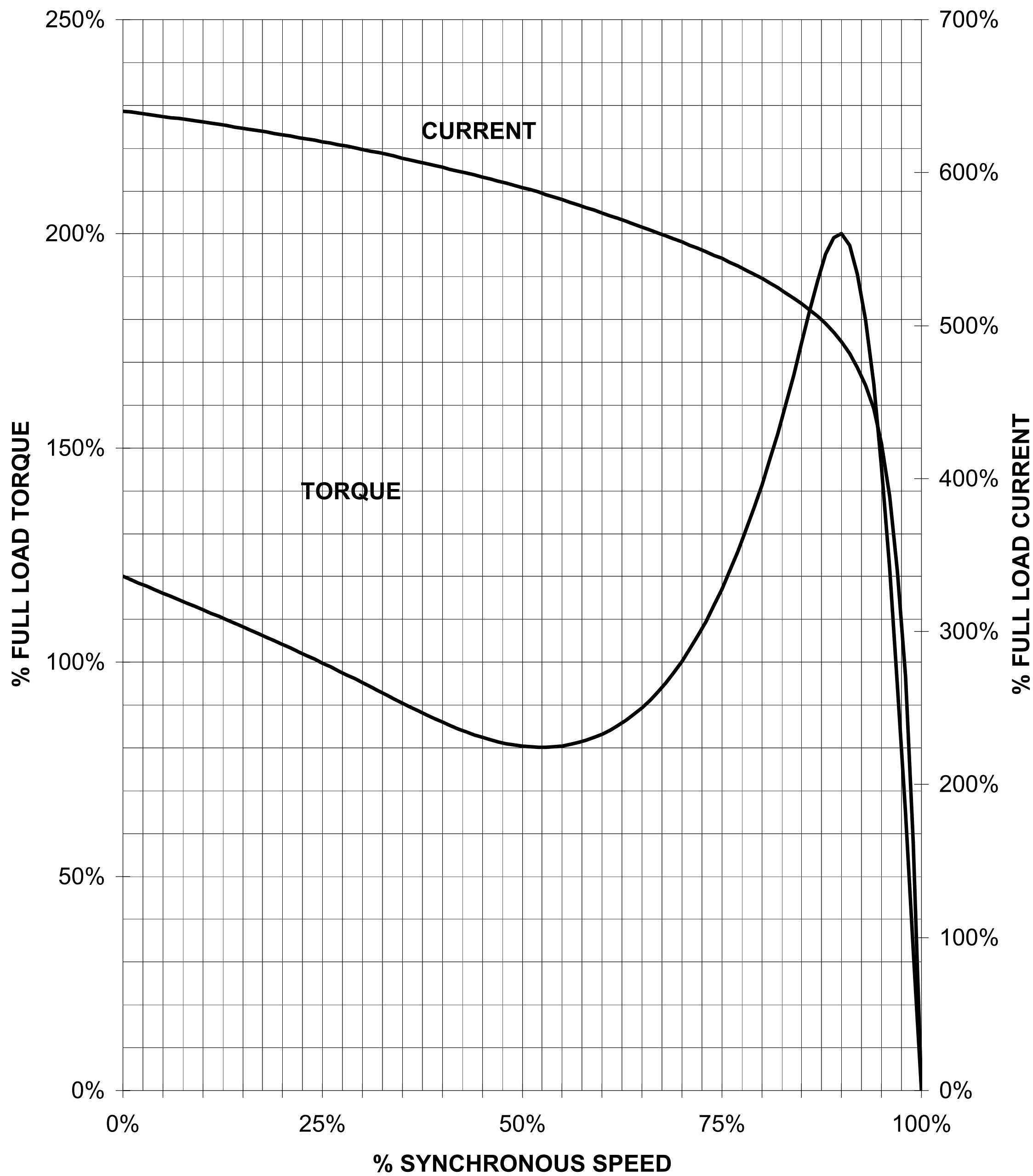


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	300	VOLTS	460	RPM	1800	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	449TS	NEMA	A

TORQUE & CURRENT VS. SPEED

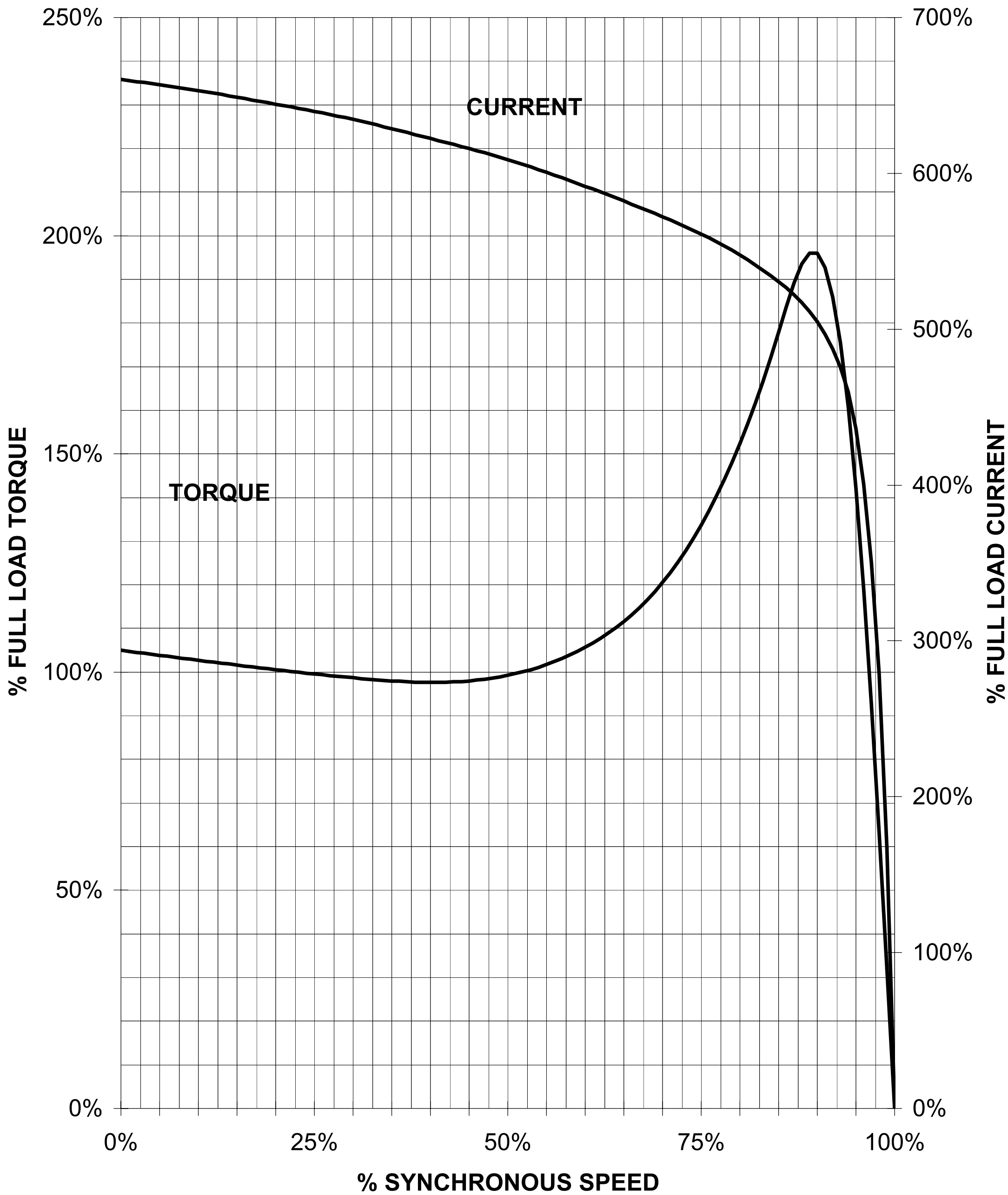


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	300	VOLTS	460	RPM	1200	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	S449	NEMA	A

TORQUE & CURRENT VS. SPEED

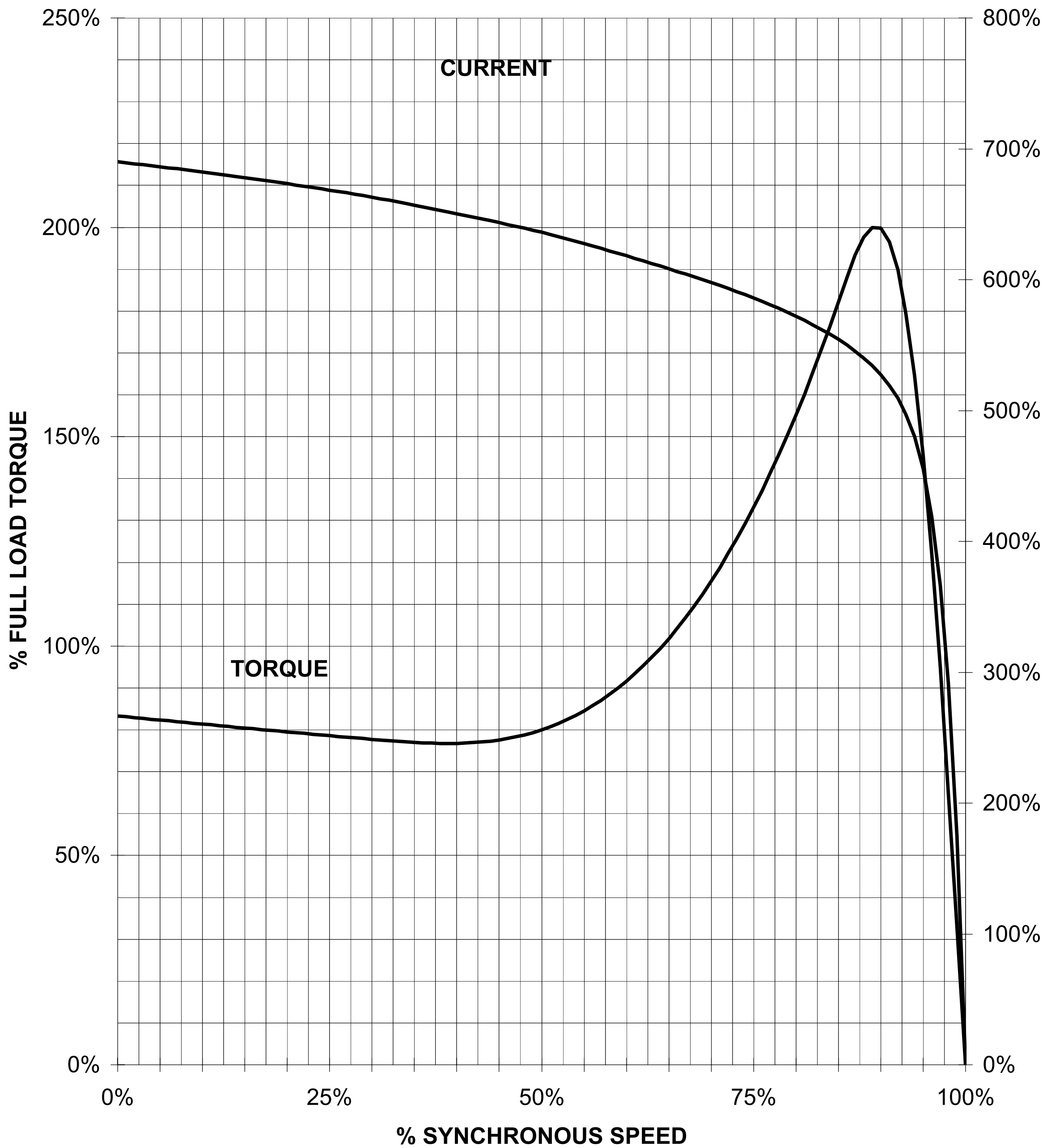


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	350	VOLTS	460	RPM	3600	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	S449SS	NEMA	B

TORQUE & CURRENT VS. SPEED

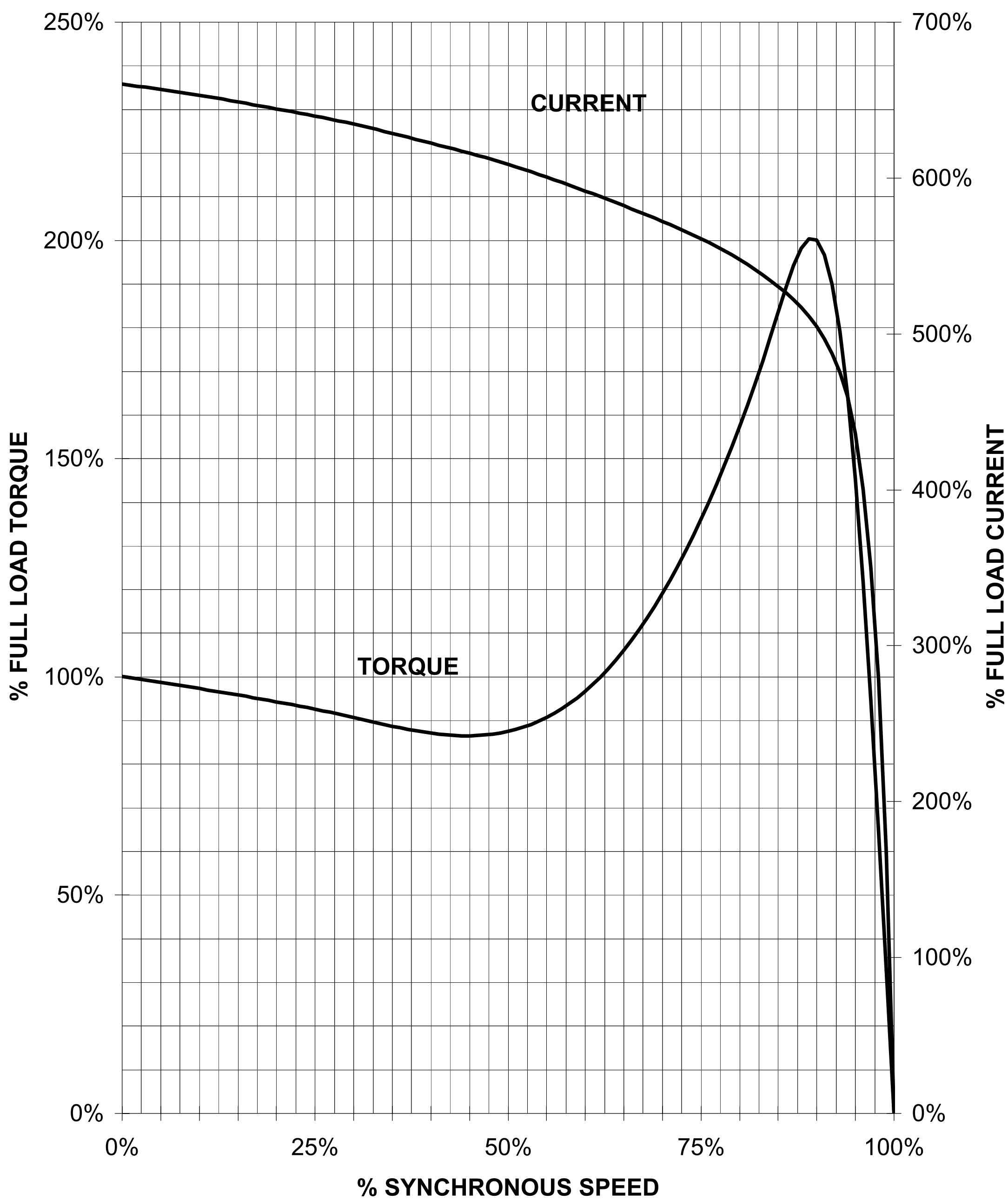


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	350	VOLTS	460	RPM	1800	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	S449	NEMA	B

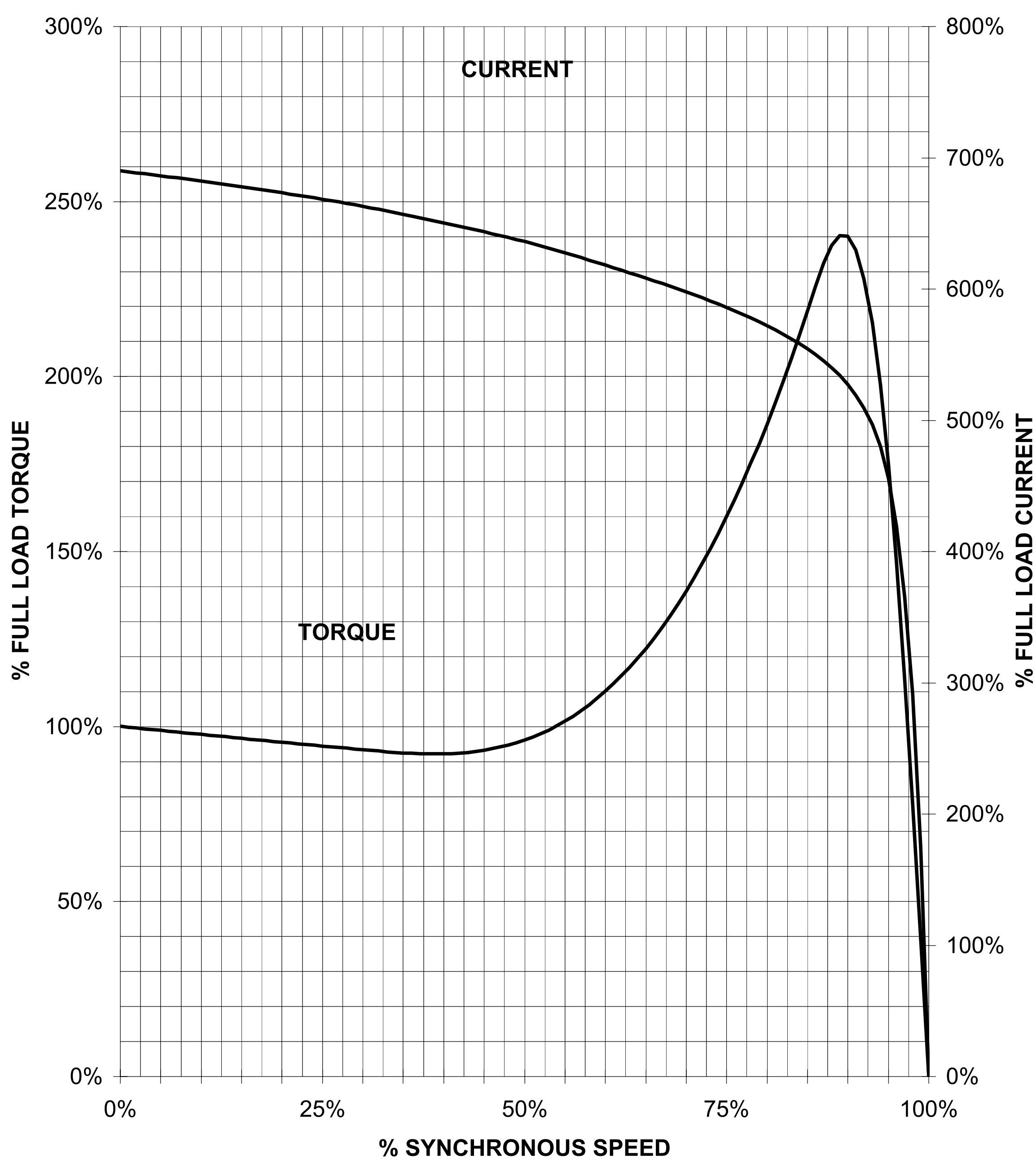
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	400	VOLTS	460	RPM	3600	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	S449SS	NEMA	B

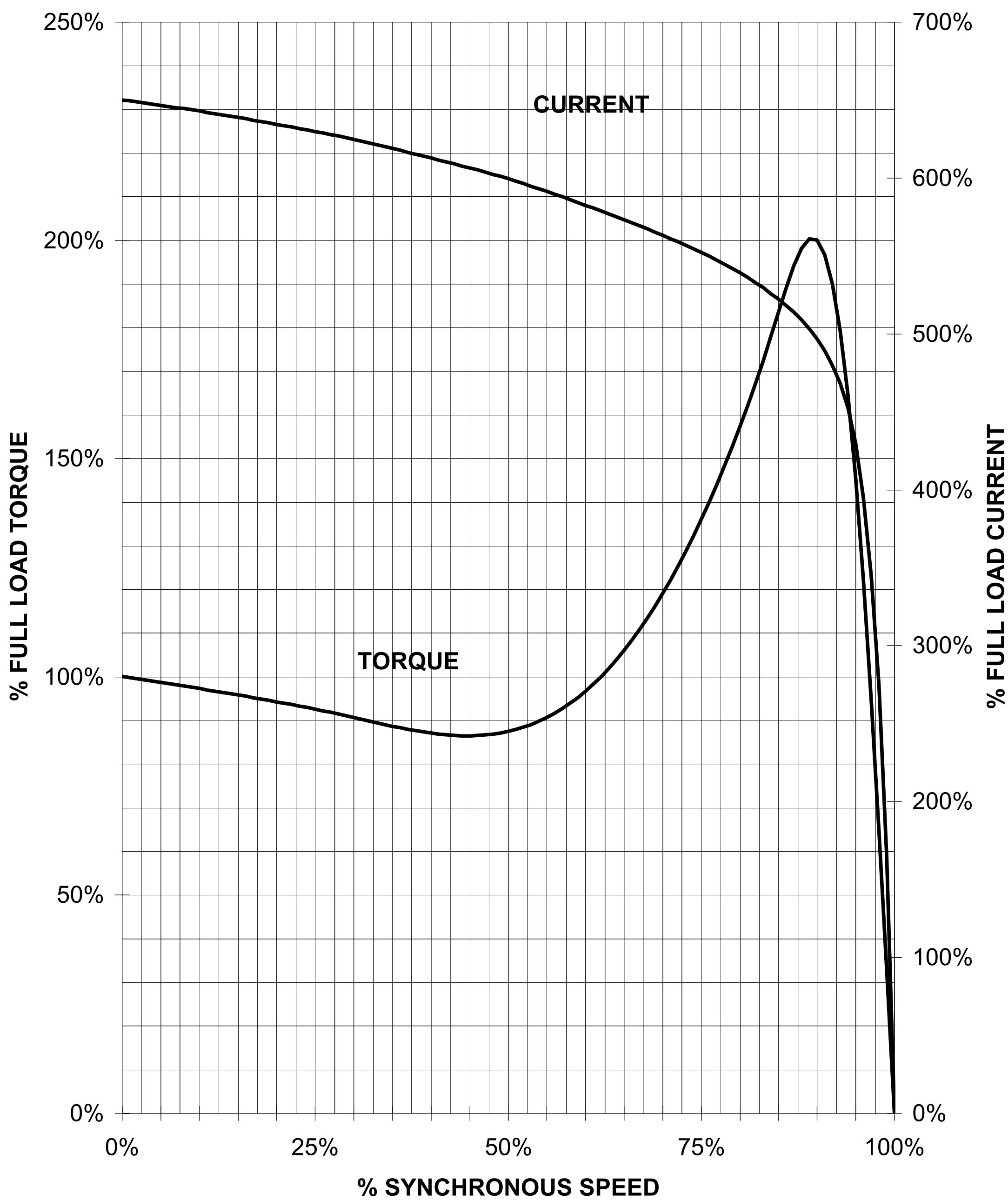
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	400	VOLTS	460	RPM	1800	TYPE	RGZEESD
HZ	60	PHASE	3	FRAME	S449	NEMA	B

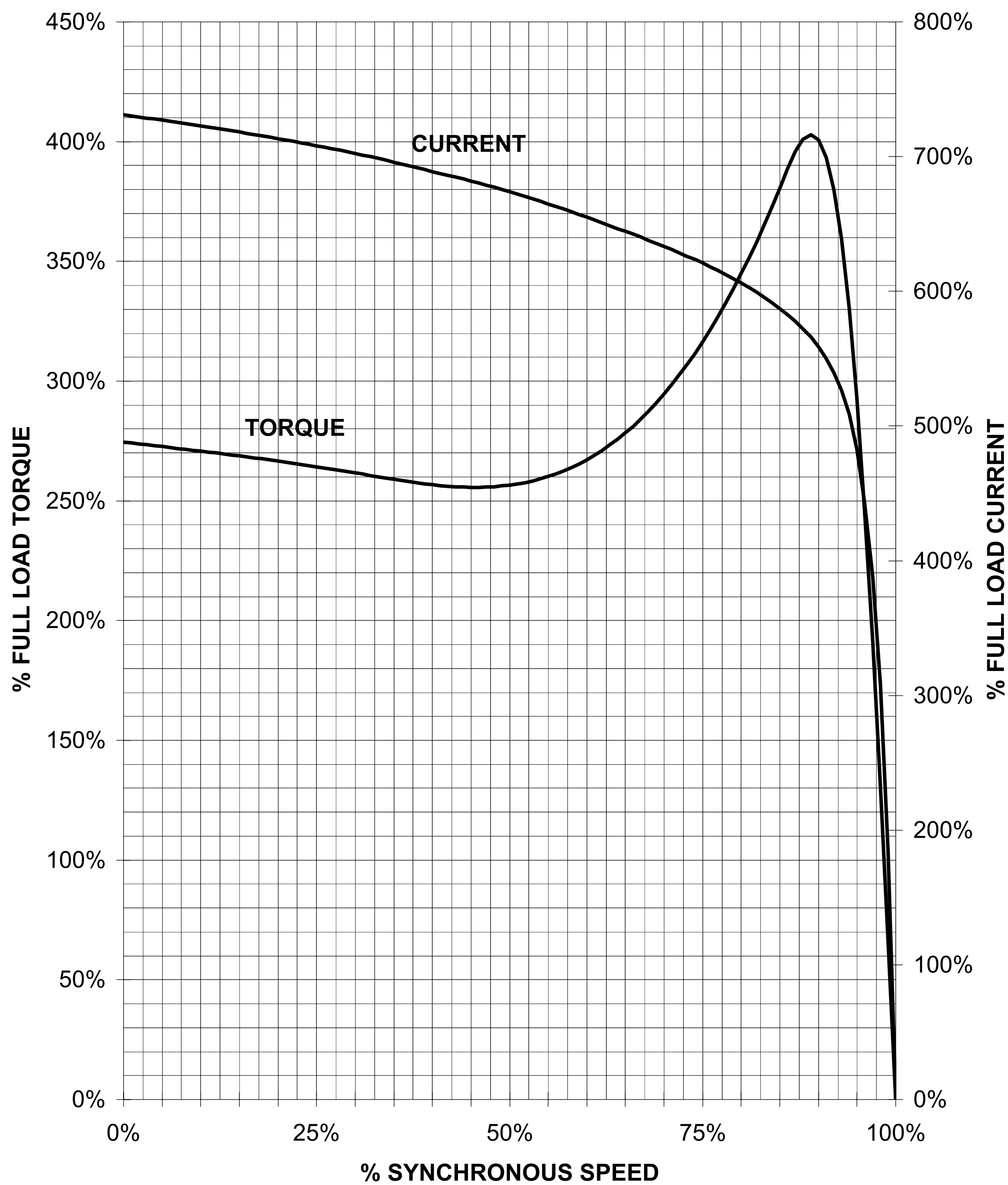
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1	VOLTS	460	RPM	1800	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	143T	NEMA	B

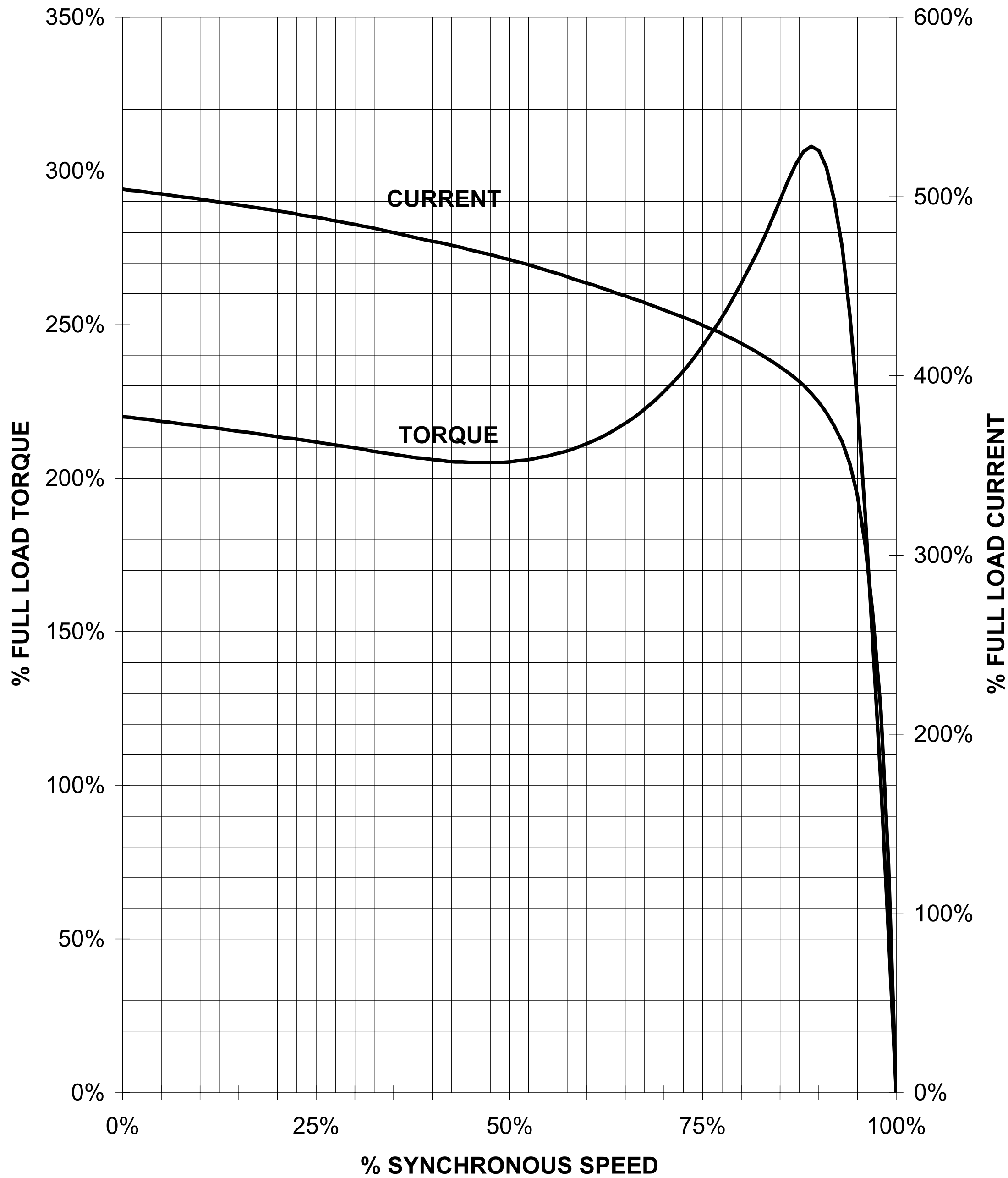
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1	VOLTS	460	RPM	1200	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	145T	NEMA	B

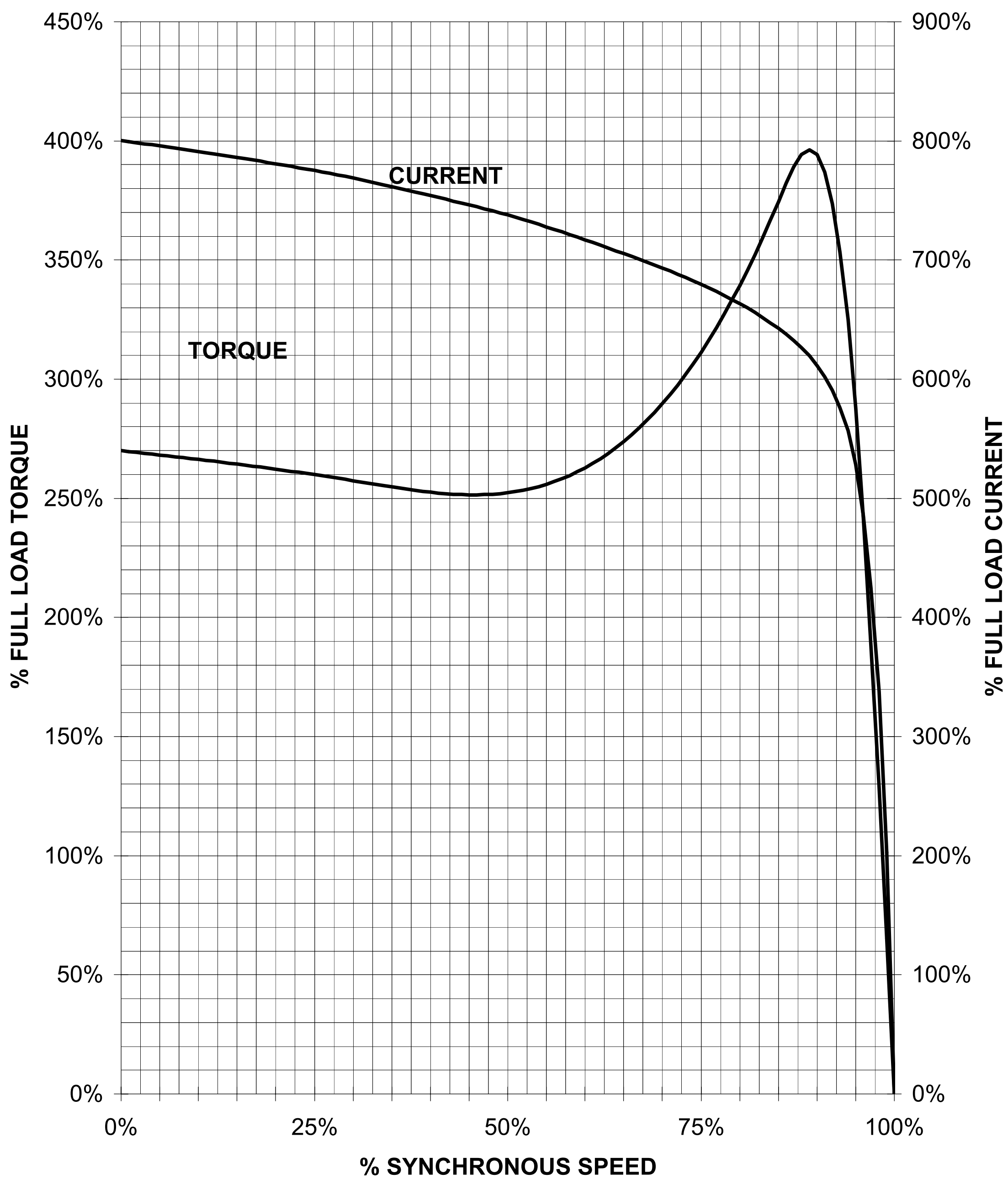
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1.5	VOLTS	460	RPM	3600	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	143T	NEMA	B

TORQUE & CURRENT VS. SPEED



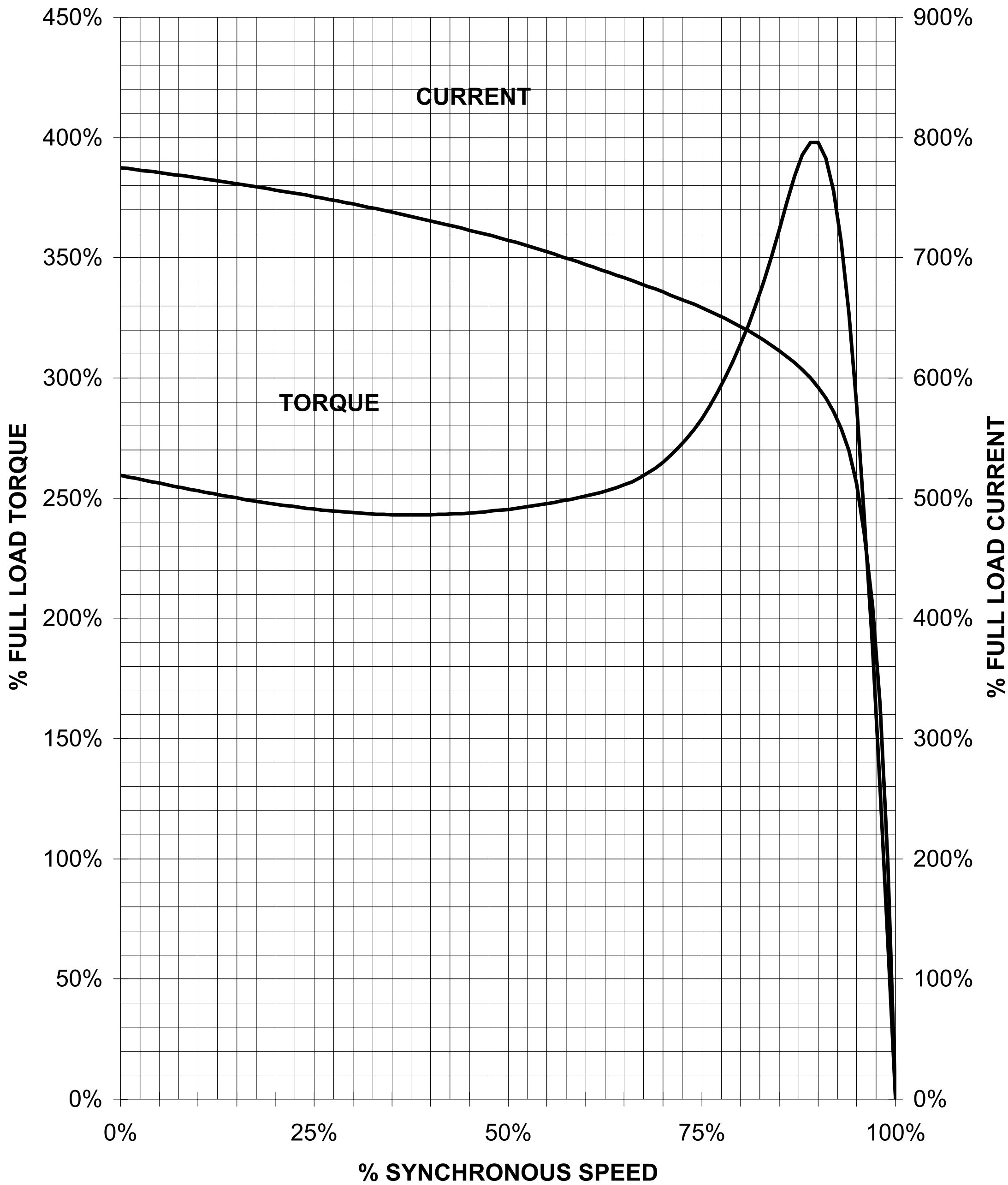
Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP 1.5 VOLTS 460 RPM 1800 TYPE RGZEESDX

HZ 60 PHASE 3 FRAME 145T NEMA B

TORQUE & CURRENT VS. SPEED

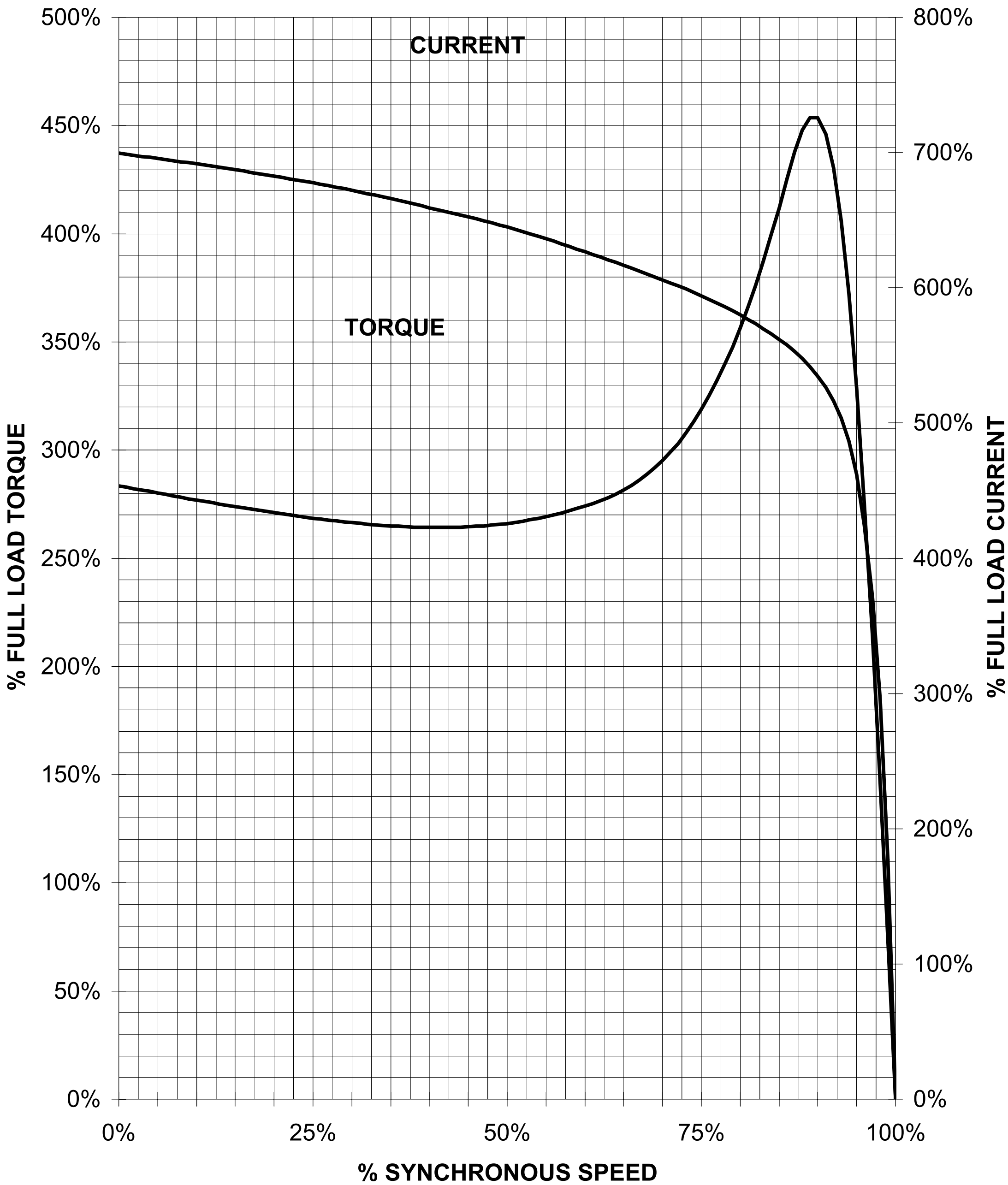


Customer: **PO No.:** **Order No.:**

Application Manual for NEMA Motors

HP	1.5	VOLTS	460	RPM	1200	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	182T	NEMA	B

TORQUE & CURRENT VS. SPEED

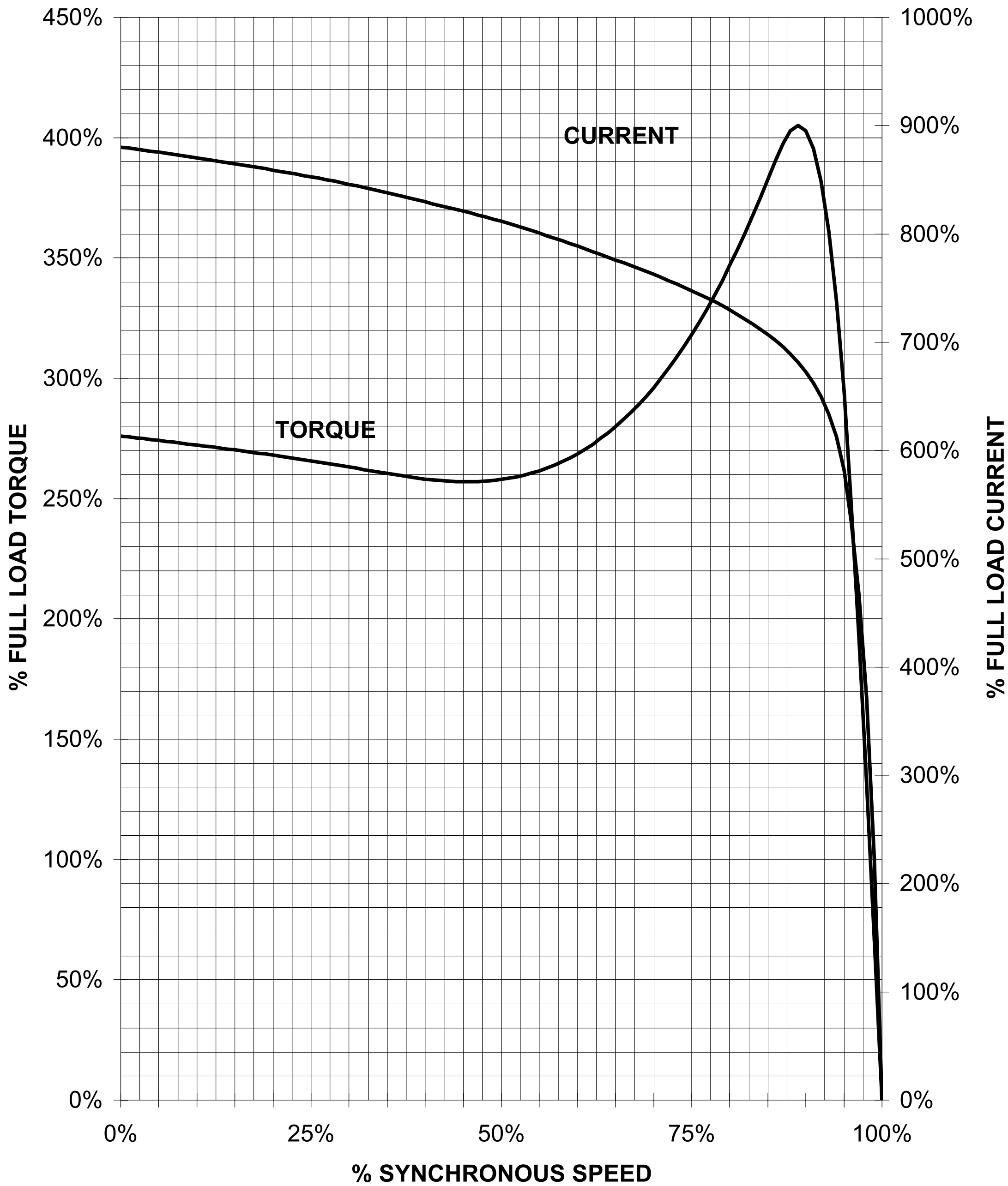


Customer: **PO No.:** **Order No.:**

HP 2 VOLTS 460 RPM 3600 TYPE RGZEESDX

HZ 60 PHASE 3 FRAME 145T NEMA B

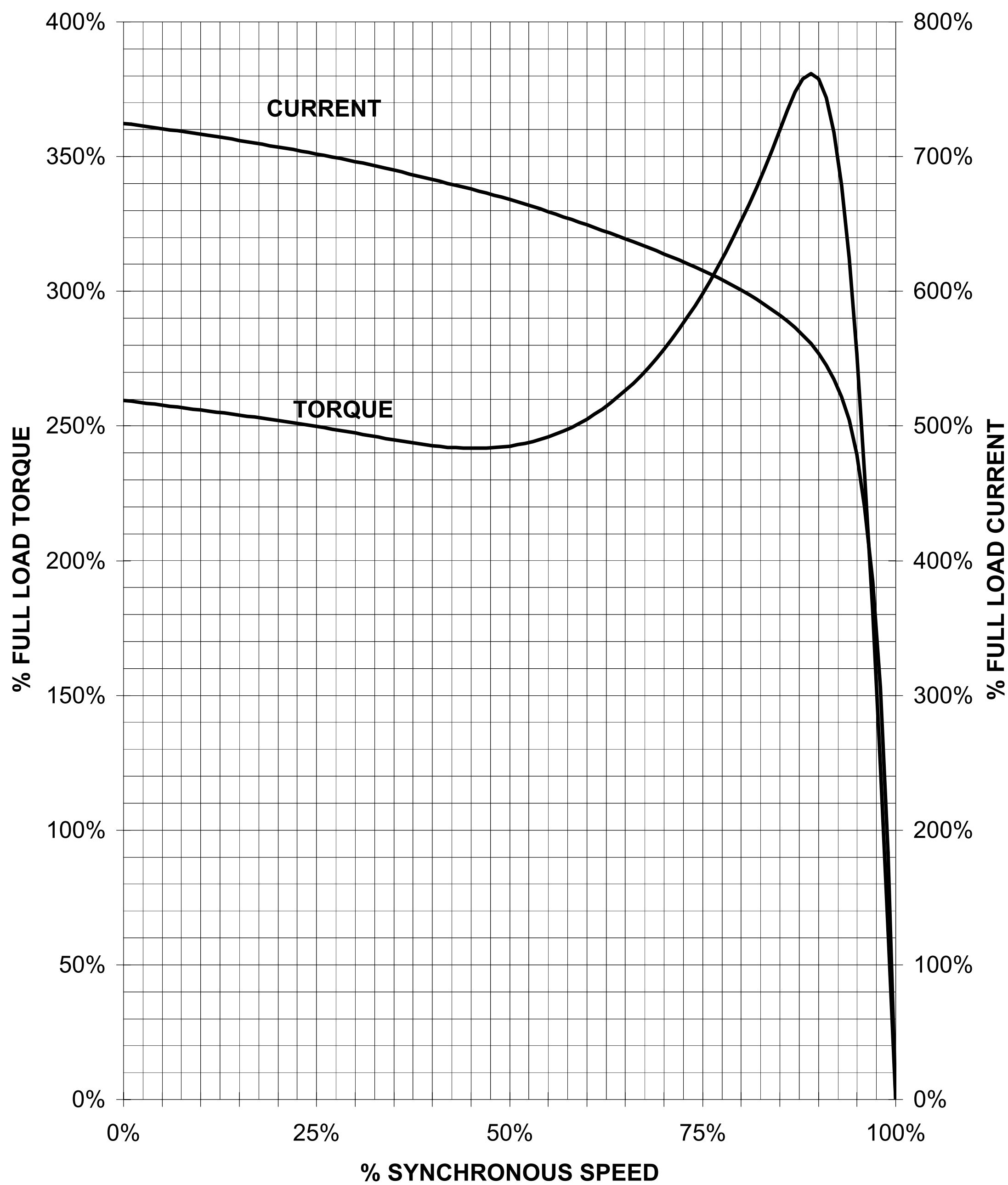
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	2	VOLTS	460	RPM	1800	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	145T	NEMA	B

TORQUE & CURRENT VS. SPEED

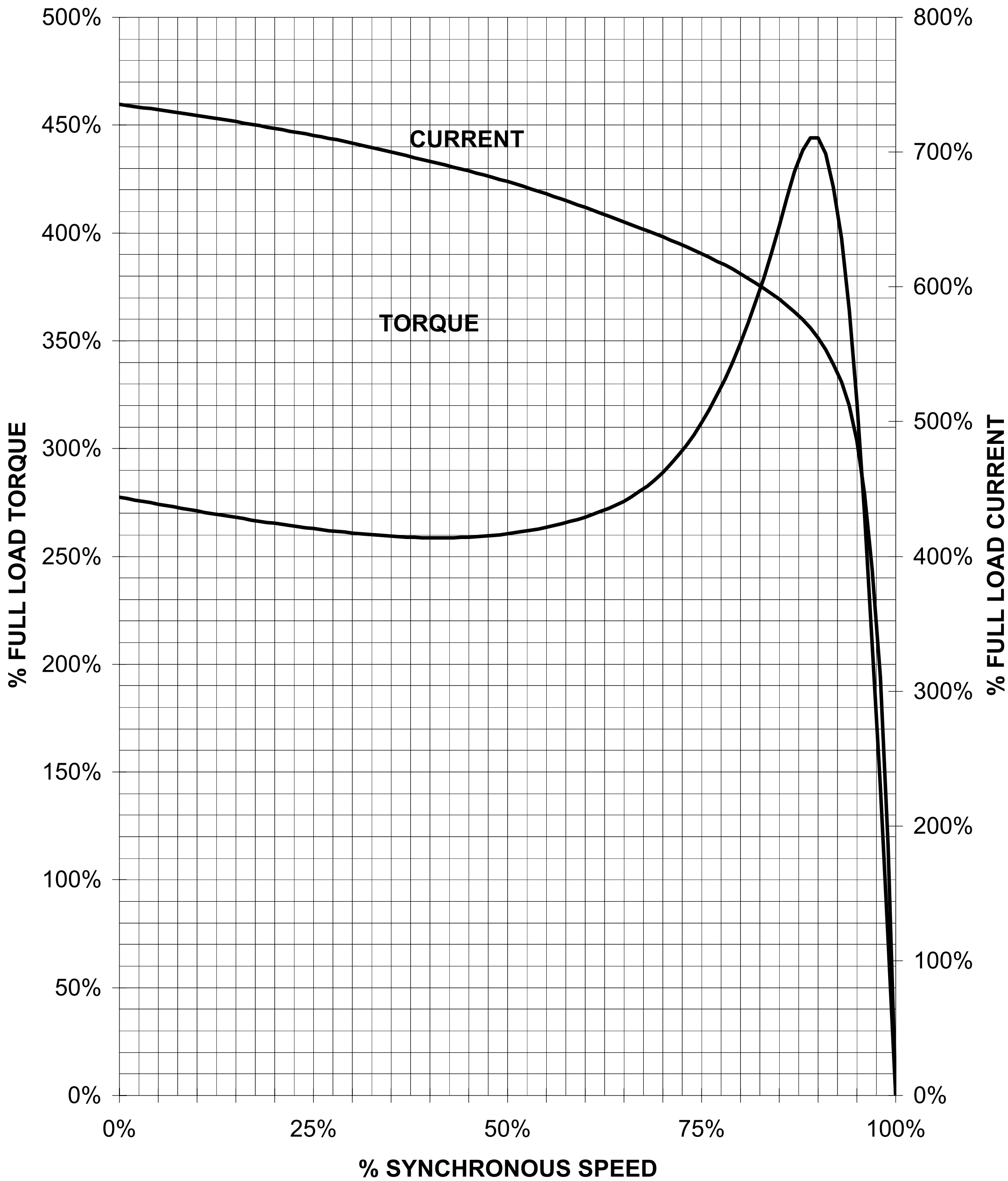


Customer: **PO No.:** **Order No.:**

HP 2 VOLTS 460 RPM 1200 TYPE RGZEESDX

HZ 60 PHASE 3 FRAME 184T NEMA B

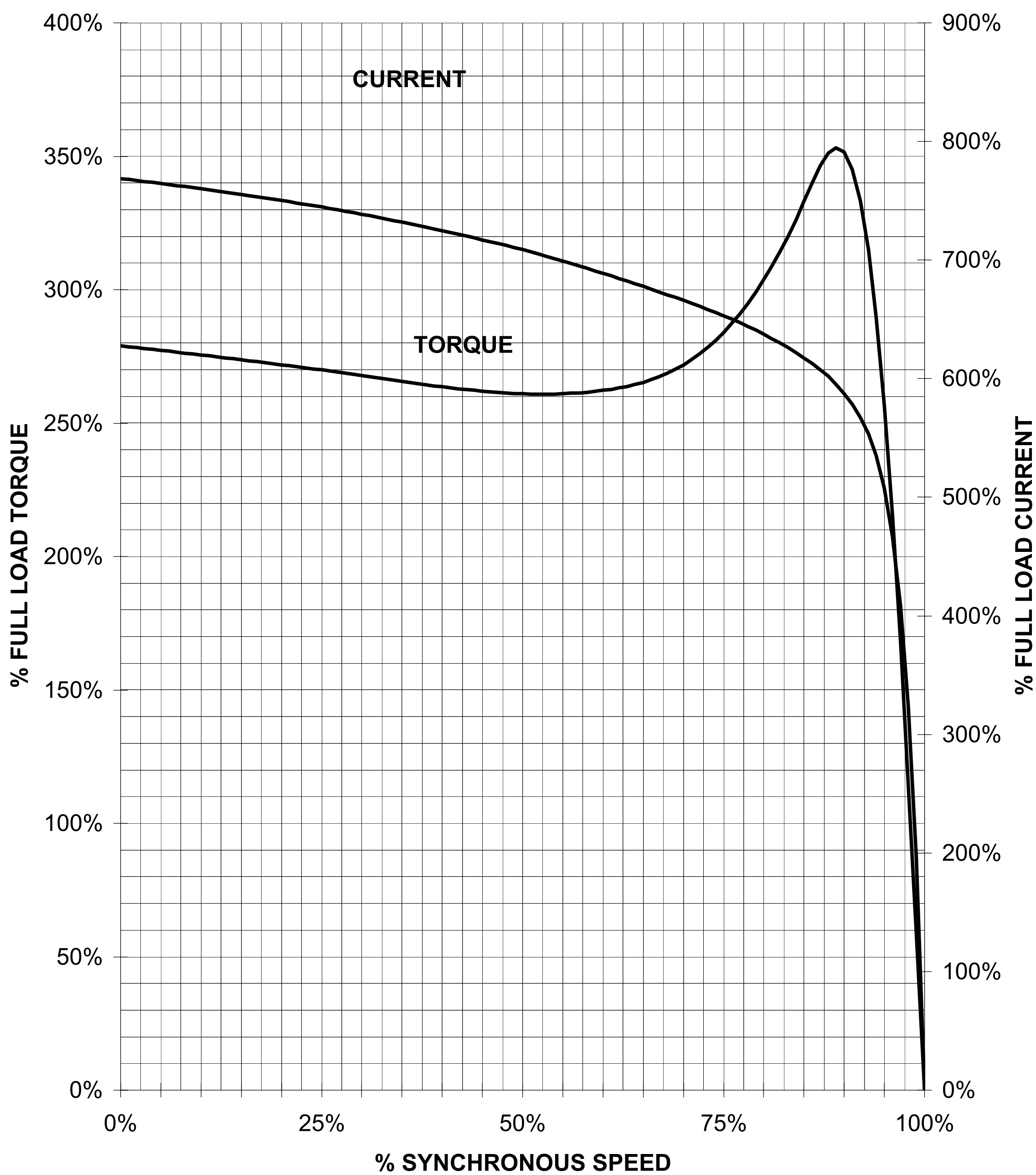
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	3	VOLTS	460	RPM	3600	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	182T	NEMA	B

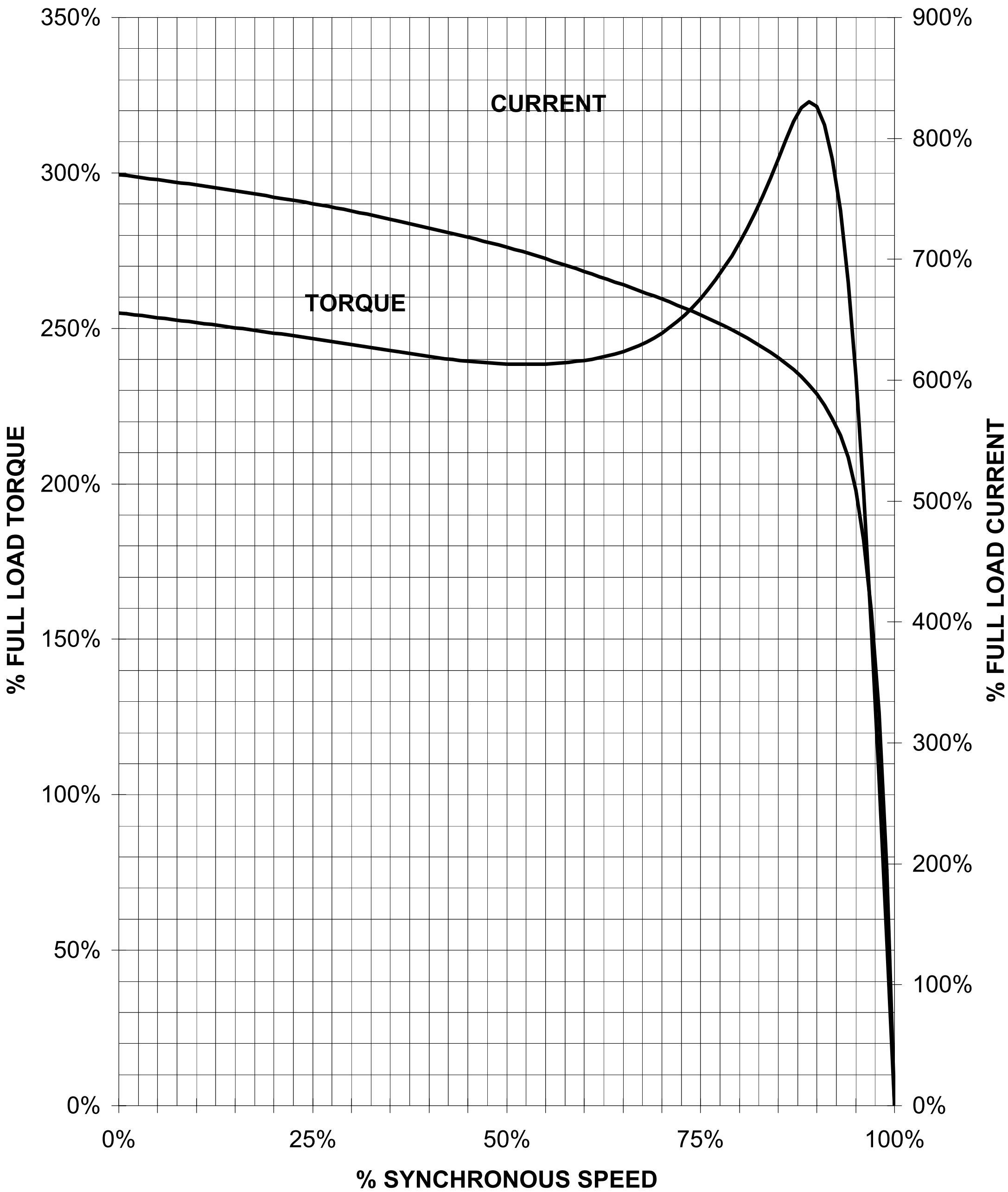
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP 3	VOLTS 460	RPM 1800	TYPE RGZEESDX
HZ 60	PHASE 3	FRAME 182T	NEMA B

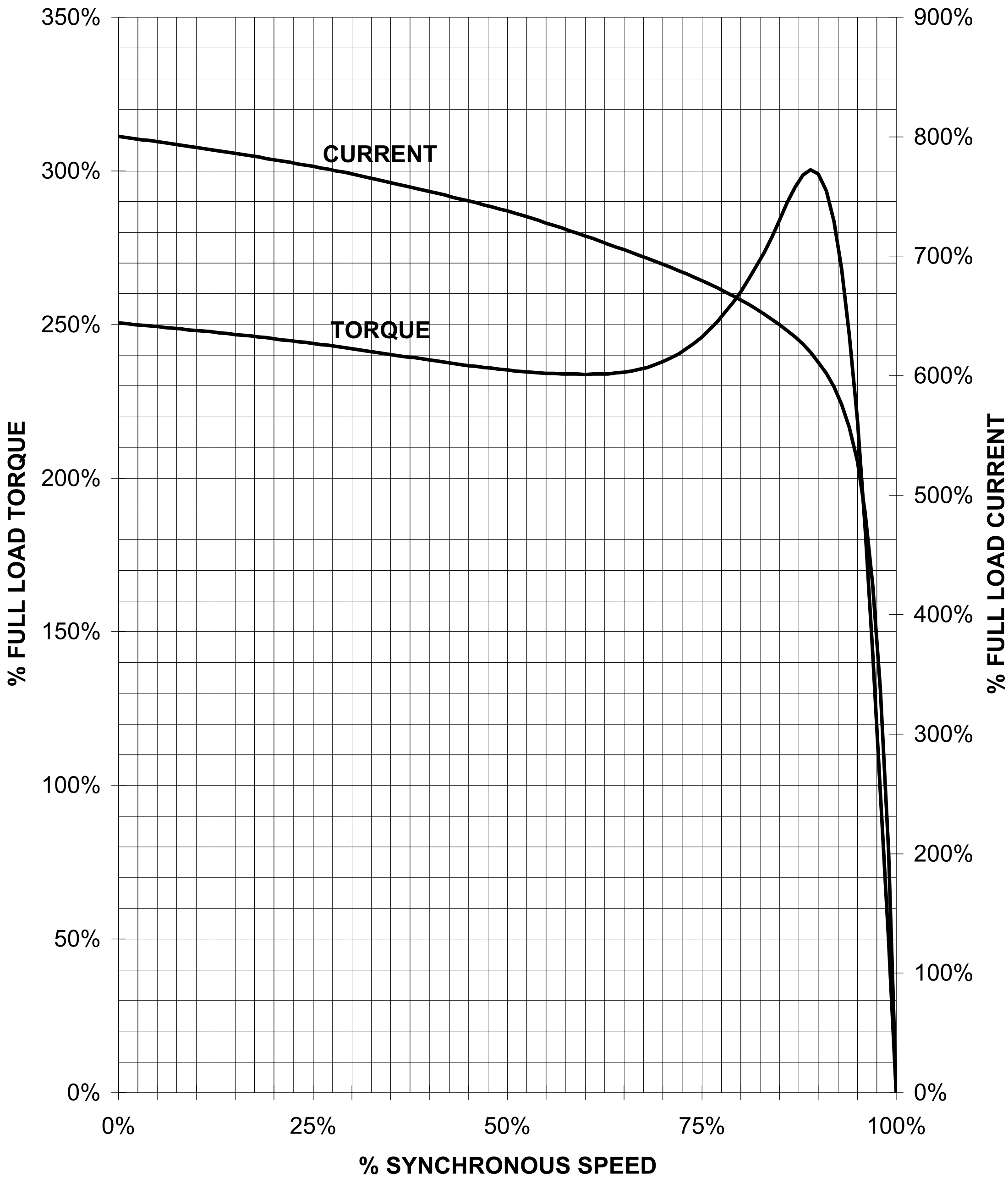
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	3	VOLTS	460	RPM	1200	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	213T	NEMA	B

TORQUE & CURRENT VS. SPEED

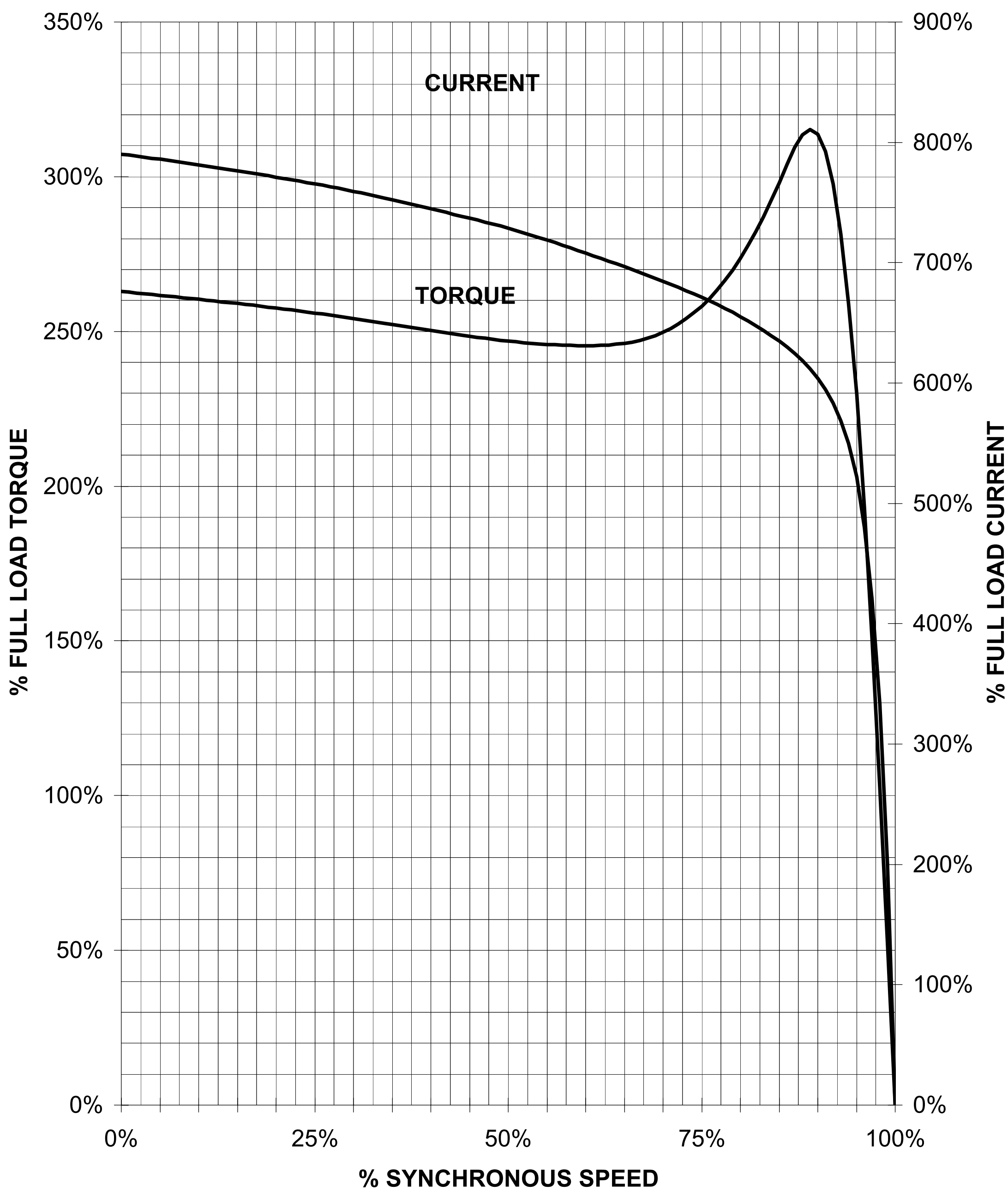


Customer: **PO No.:** **Order No.:**

HP 5 VOLTS 460 RPM 3600 TYPE RGZEESDX

HZ 60 PHASE 3 FRAME 184T NEMA B

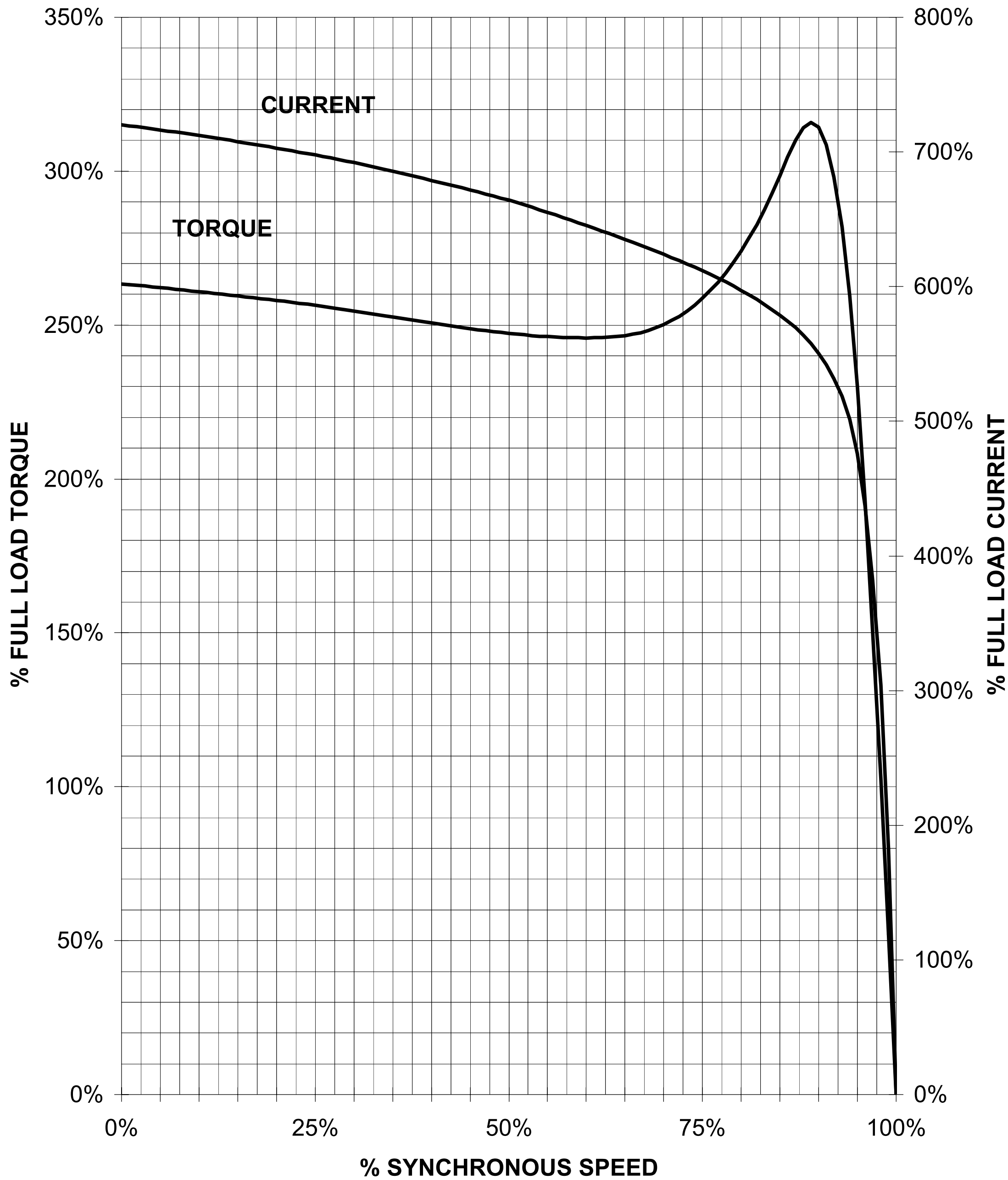
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	5	VOLTS	460	RPM	1800	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	184T	NEMA	B

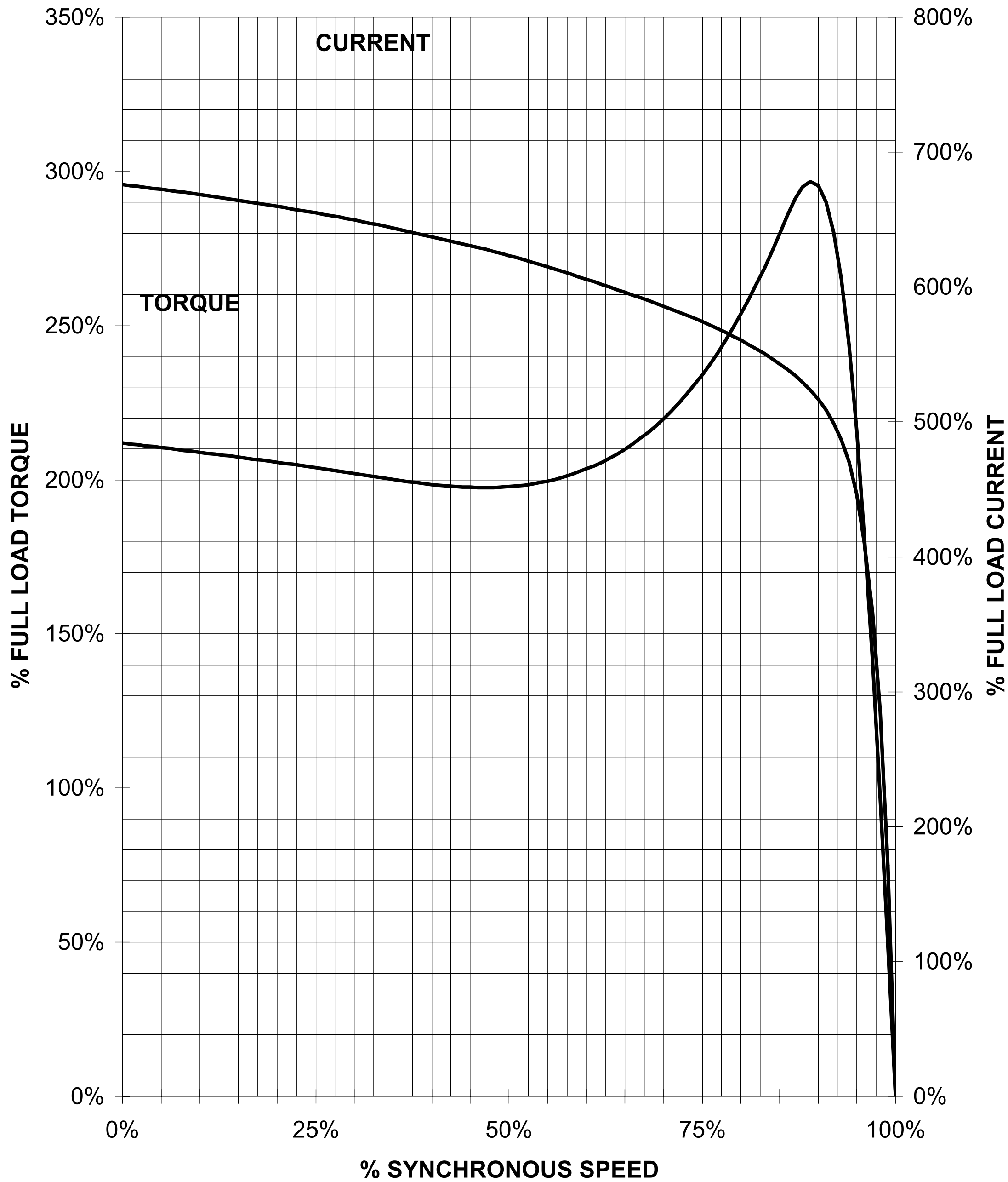
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	5	VOLTS	460	RPM	1200	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	215T	NEMA	B

TORQUE & CURRENT VS. SPEED

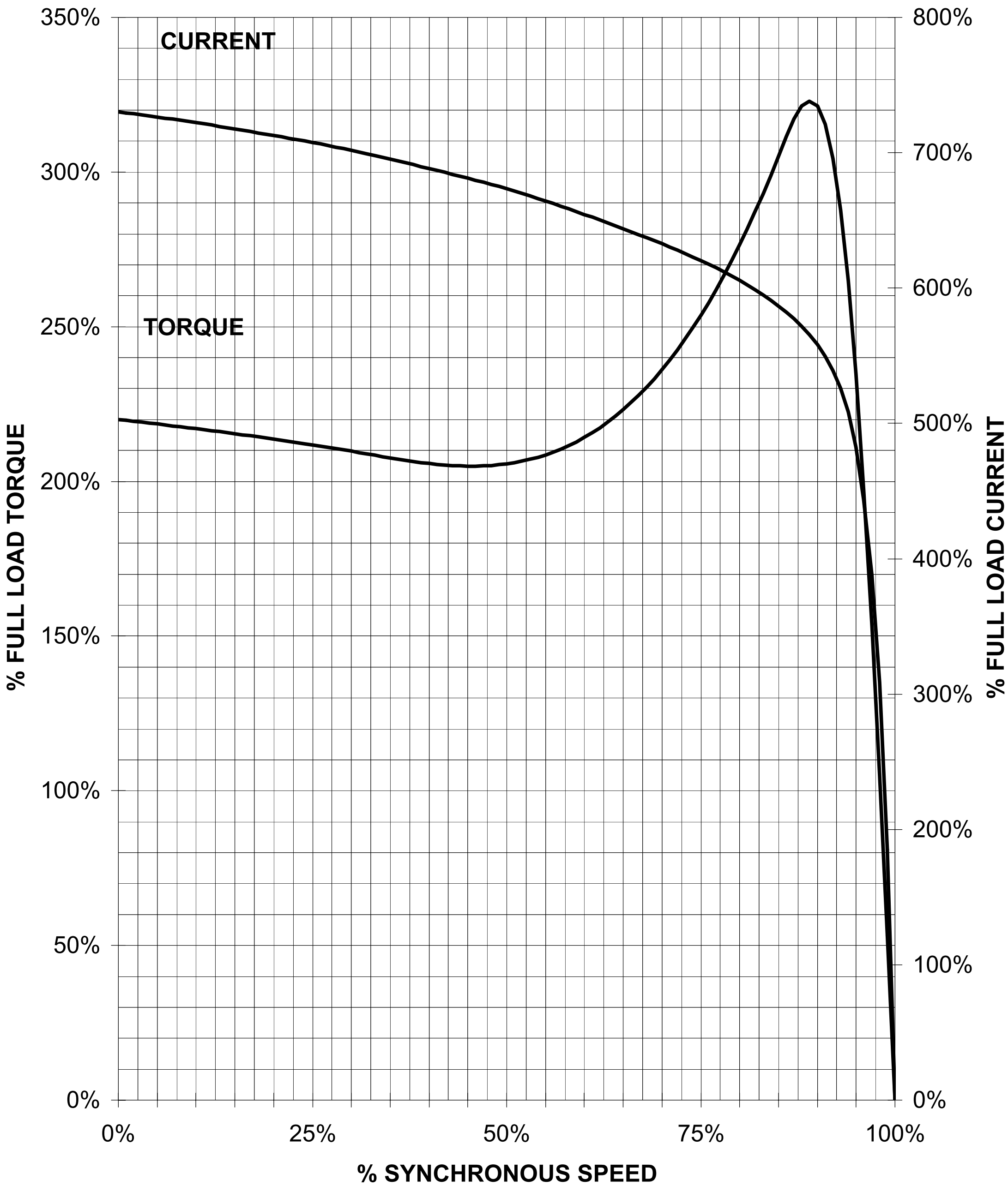


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	7.5	VOLTS	460	RPM	3600	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	213T	NEMA	B

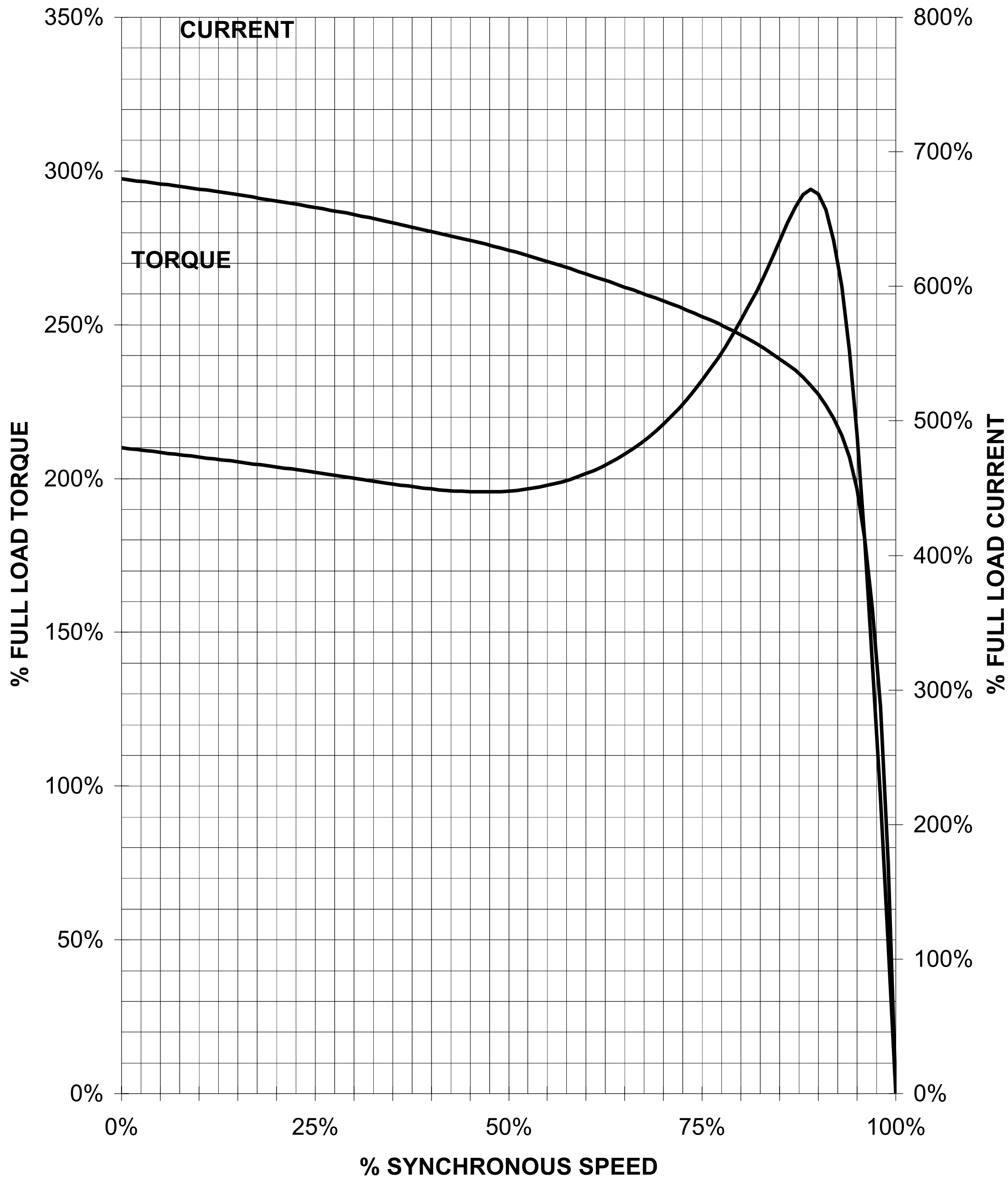
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	7.5	VOLTS	460	RPM	1800	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	213T	NEMA	B

TORQUE & CURRENT VS. SPEED

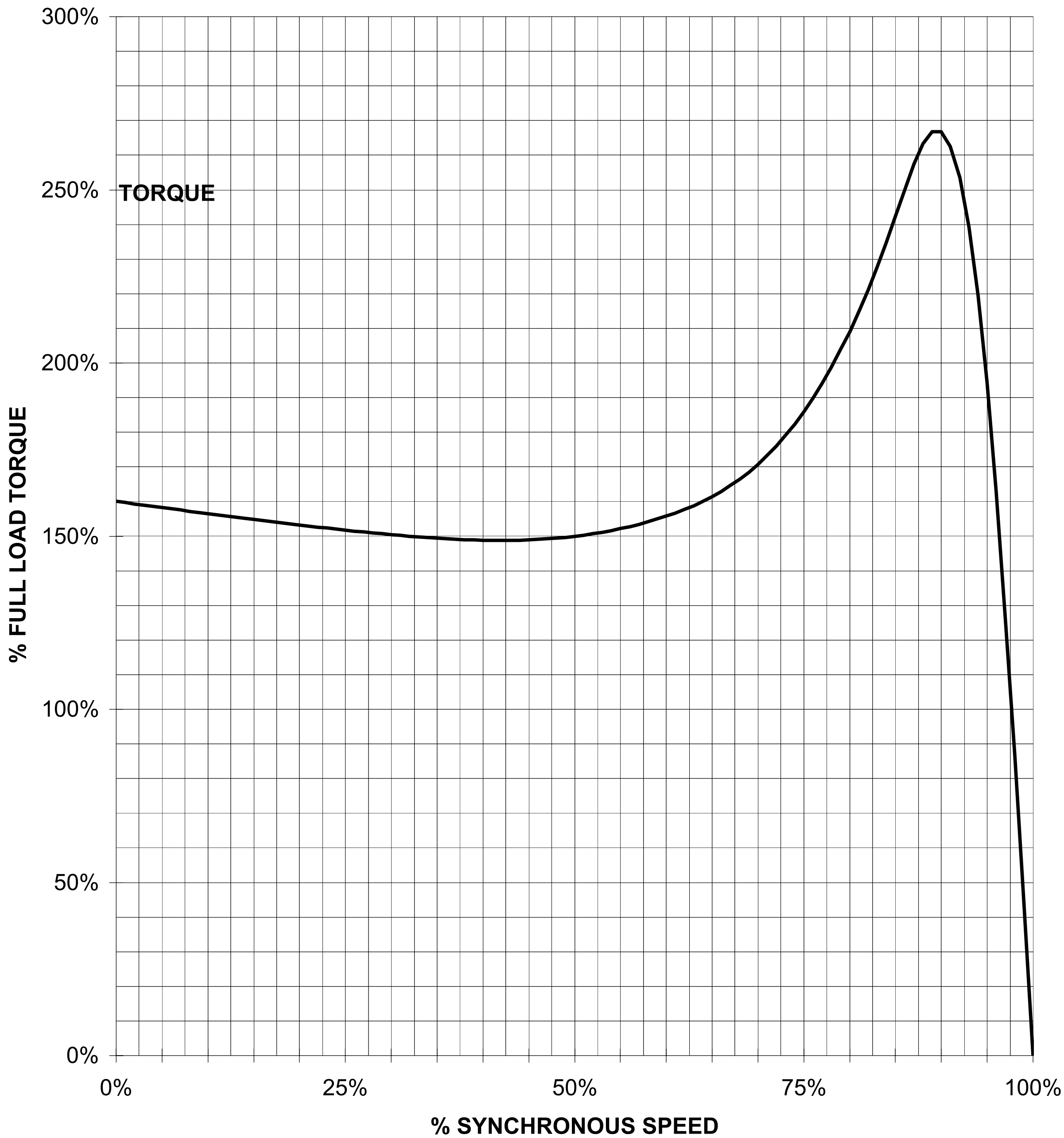


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	7.5	VOLTS	460	RPM	1200	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	254T	NEMA	B

TORQUE VS. SPEED



Customer:

PO No.:

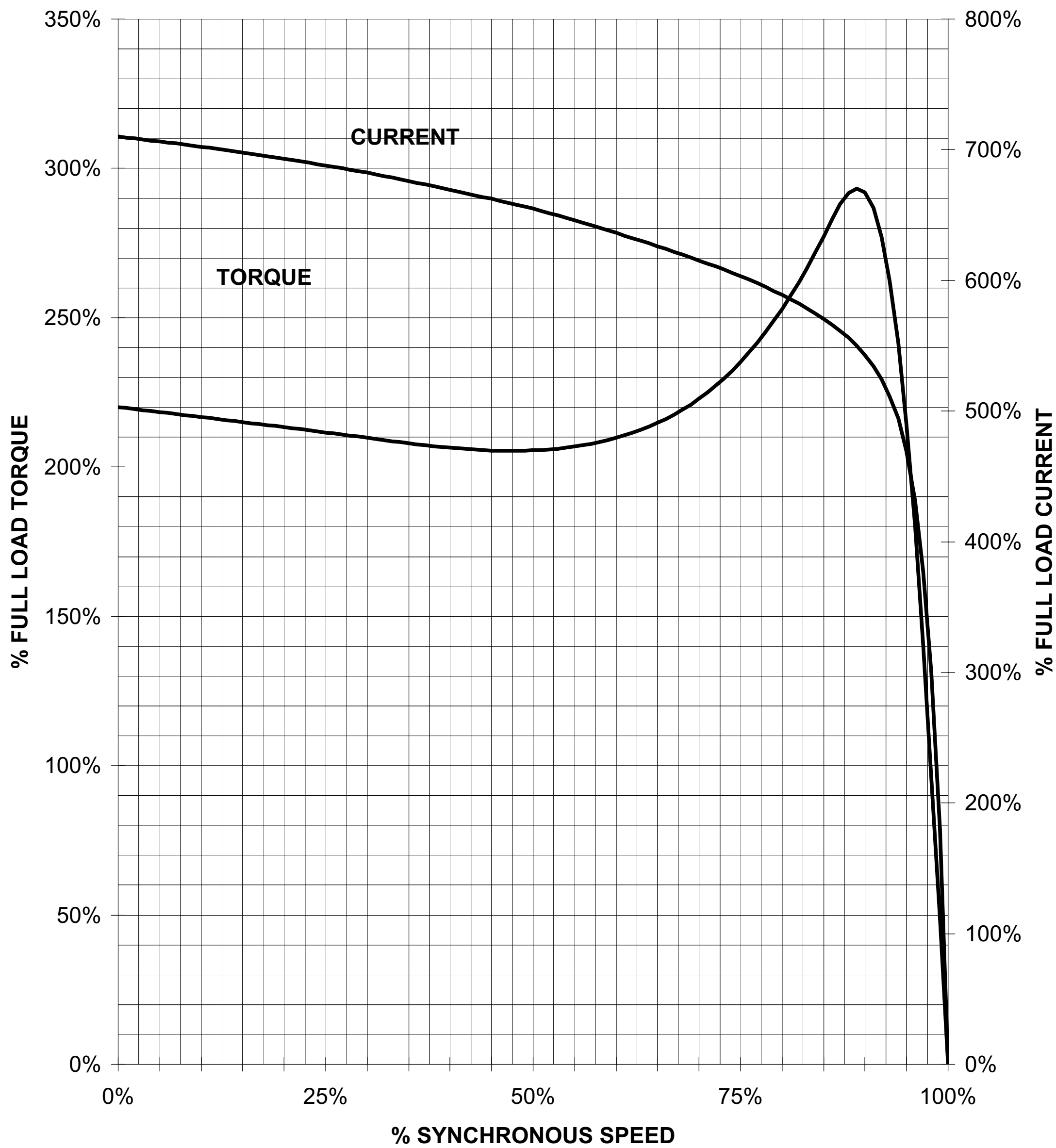
Order No.:

SIEMENS

Application Manual for NEMA Motors

HP	10	VOLTS	460	RPM	3600	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	215T	NEMA	B

TORQUE & CURRENT VS. SPEED



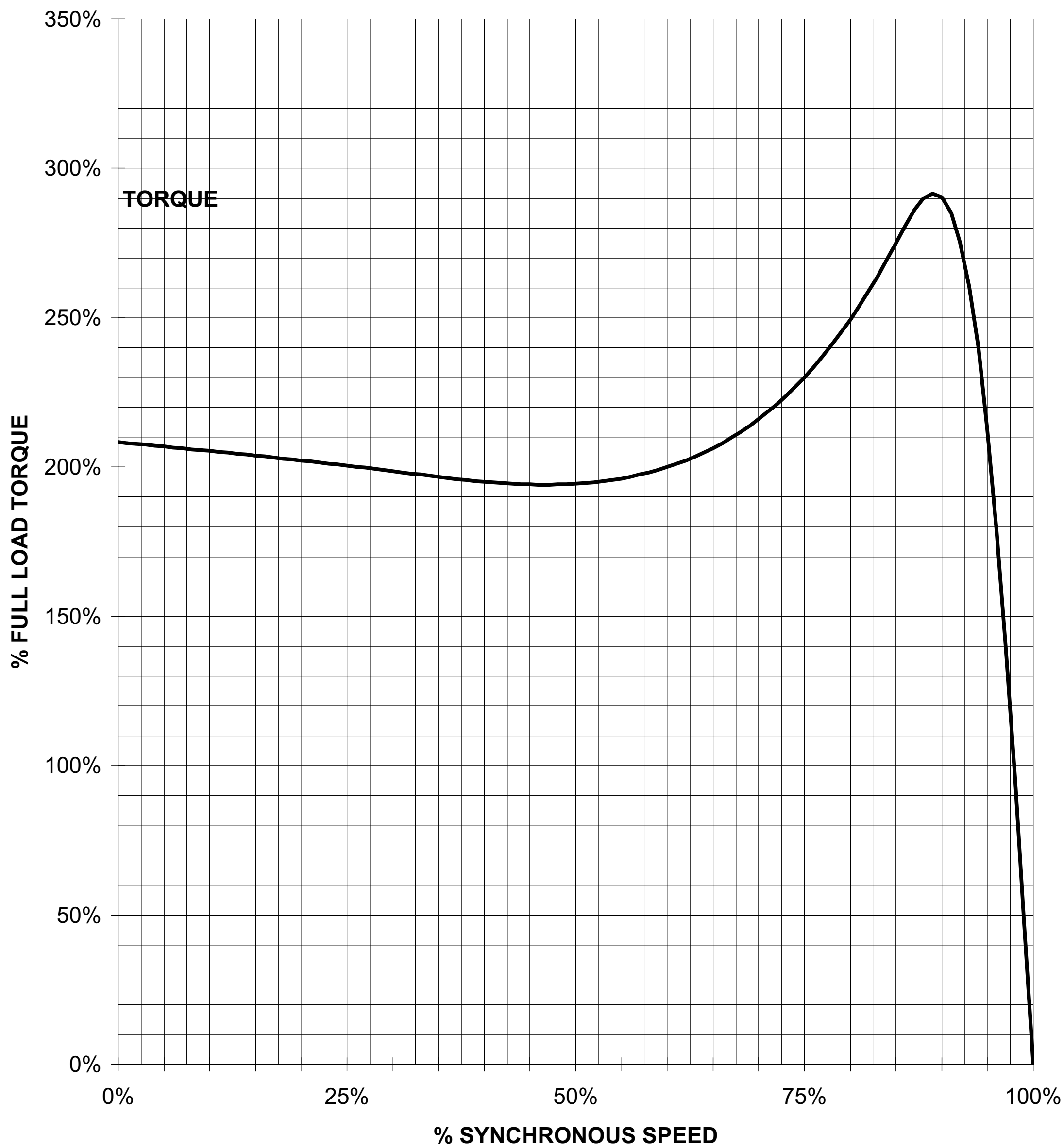
Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP 10 VOLTS 460 RPM 1800 TYPE RGZEESDX

HZ 60 PHASE 3 FRAME 215T NEMA B

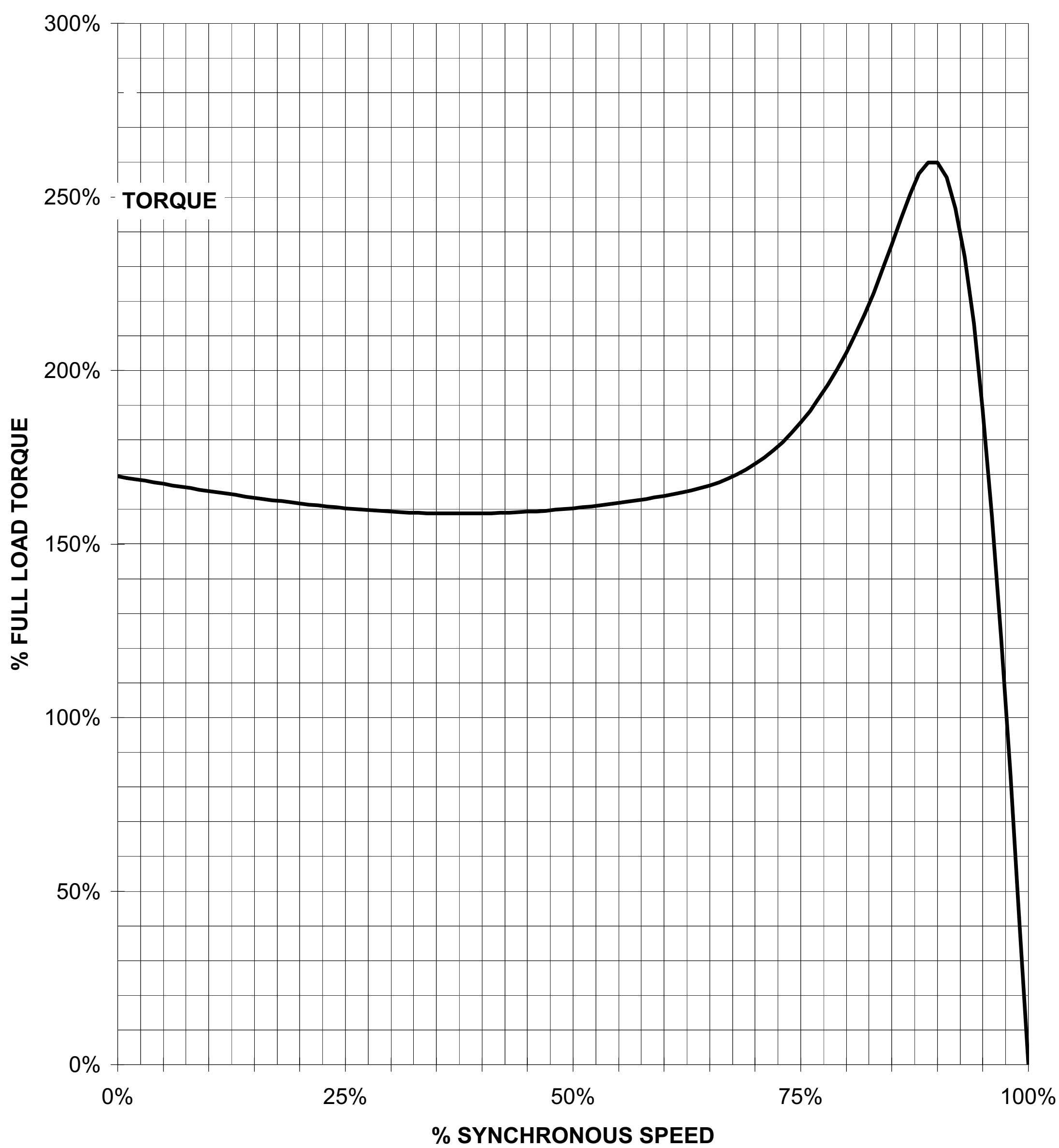
TORQUE VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	10	VOLTS	460	RPM	1200	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	256T	NEMA	B

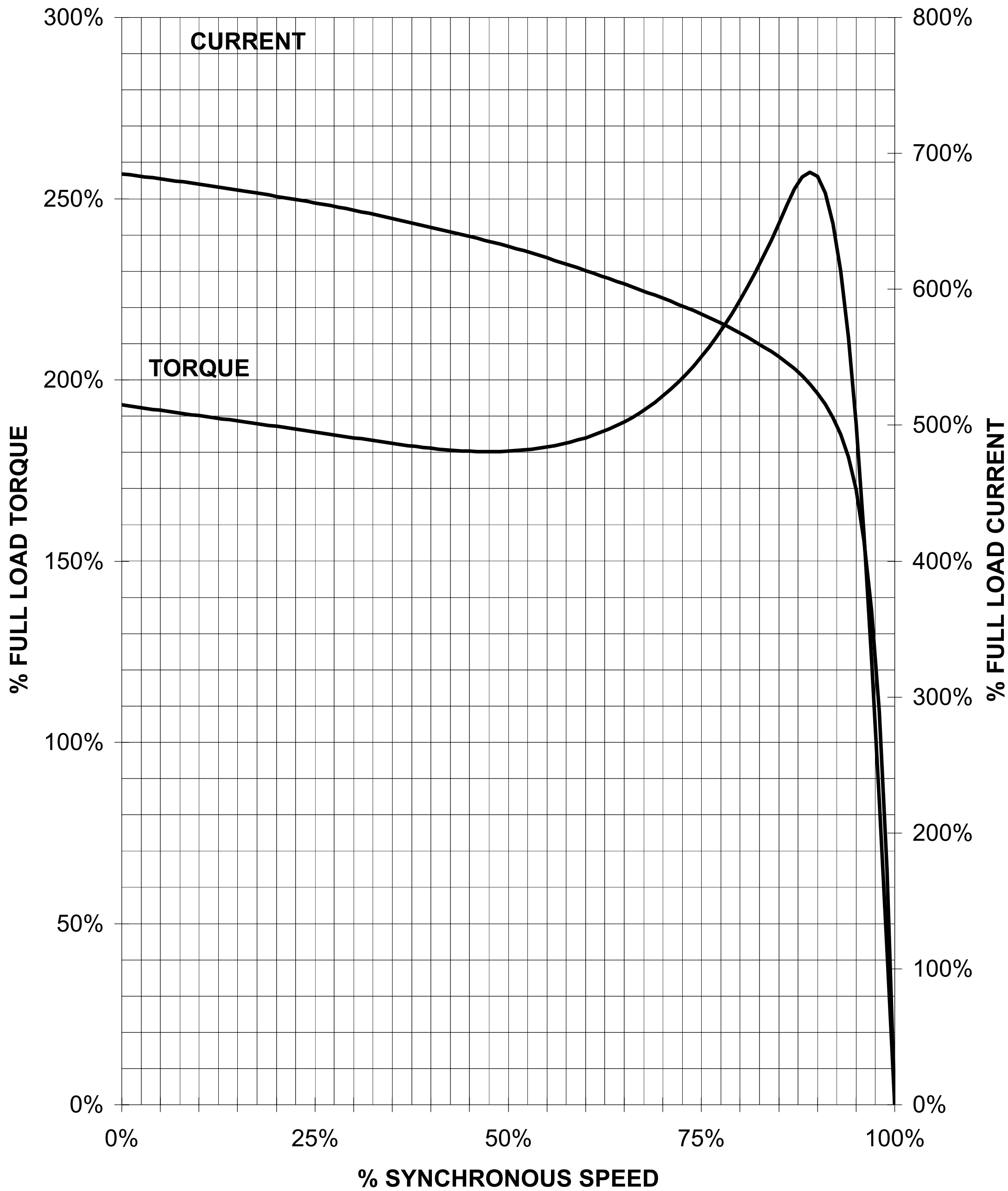
TORQUE VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	15	VOLTS	460	RPM	3600	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	254T	NEMA	B

TORQUE & CURRENT VS. SPEED

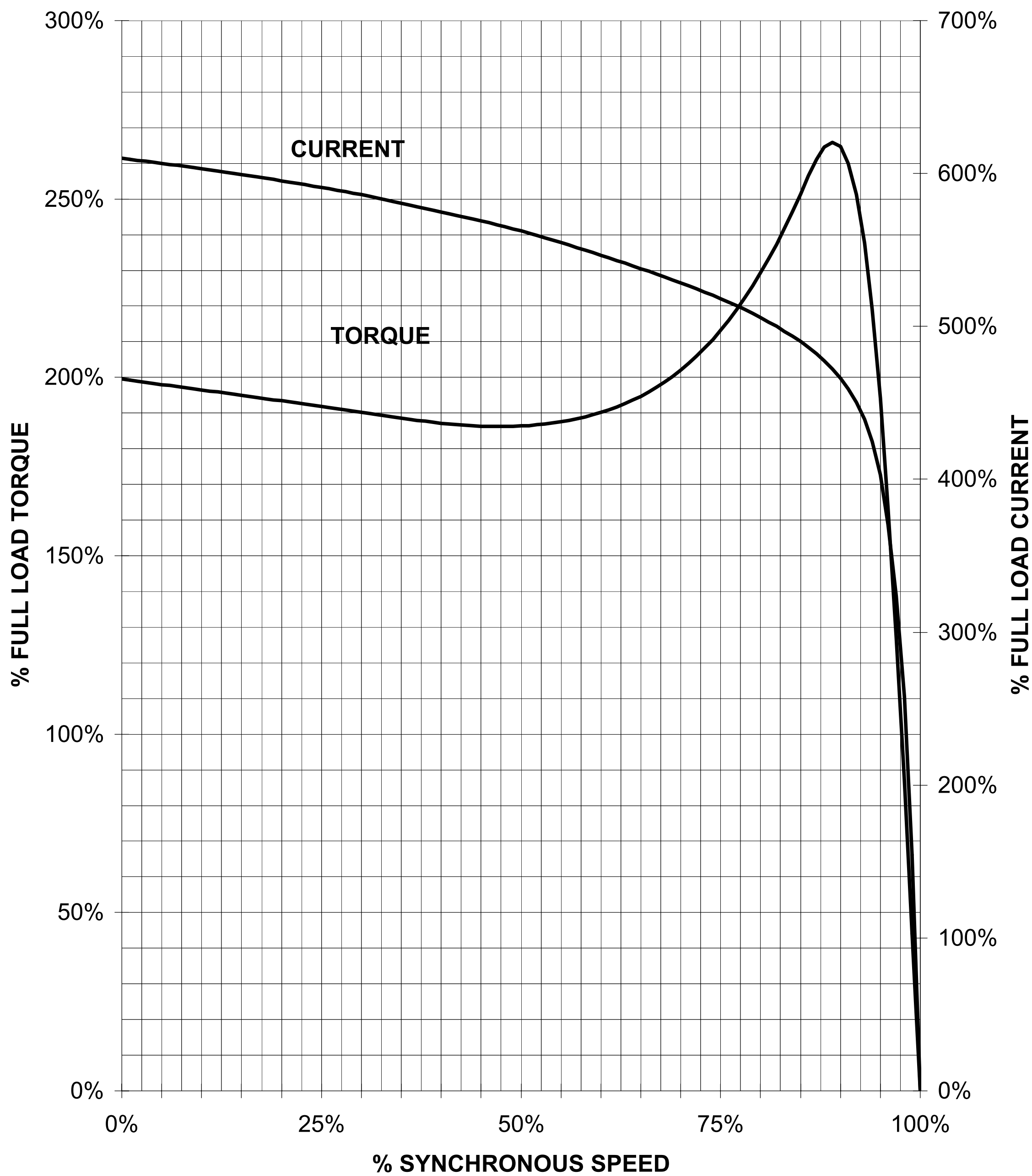


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	15	VOLTS	460	RPM	1800	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	254T	NEMA	B

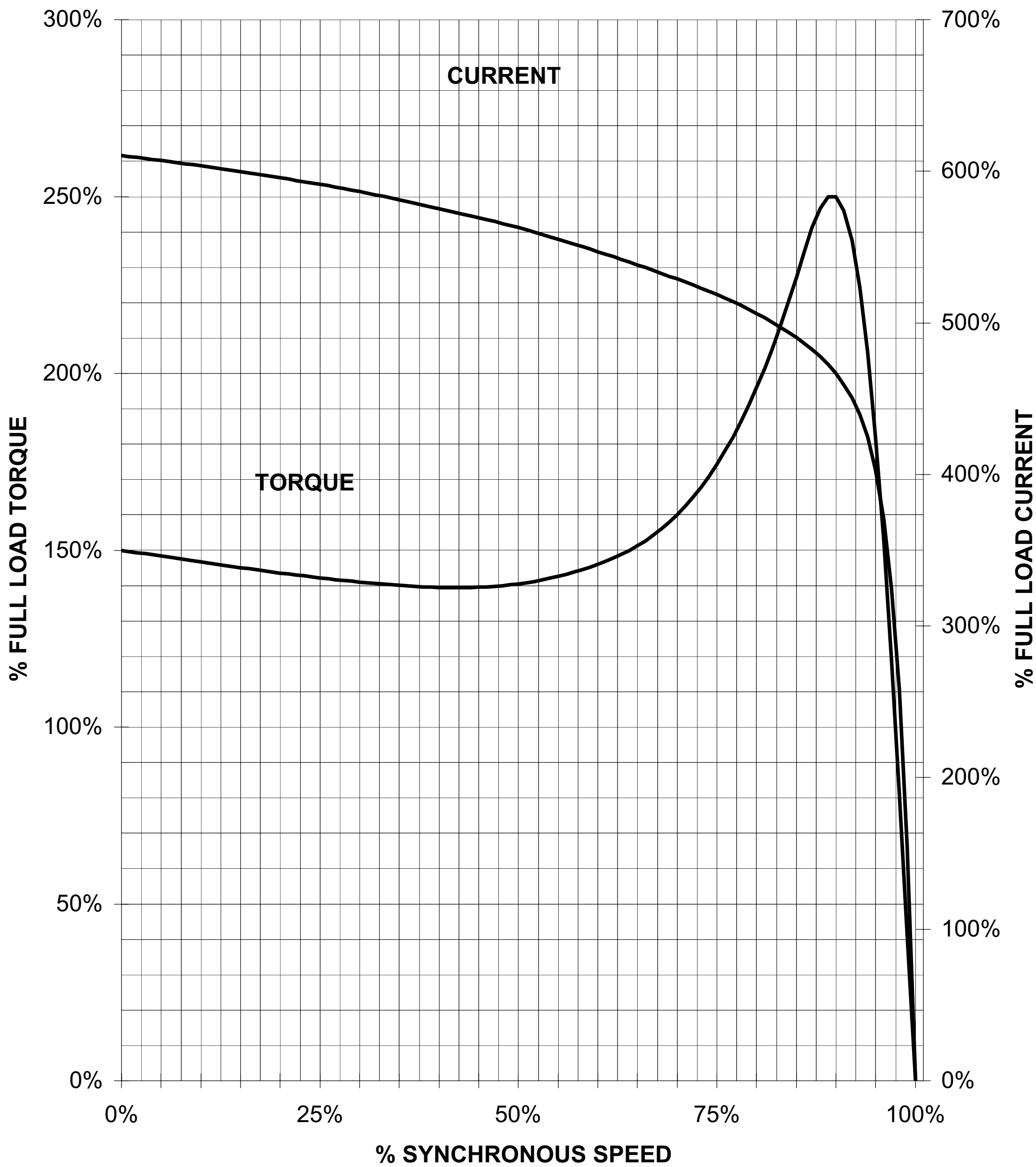
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	15	VOLTS	460	RPM	1200	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	284T	NEMA	B

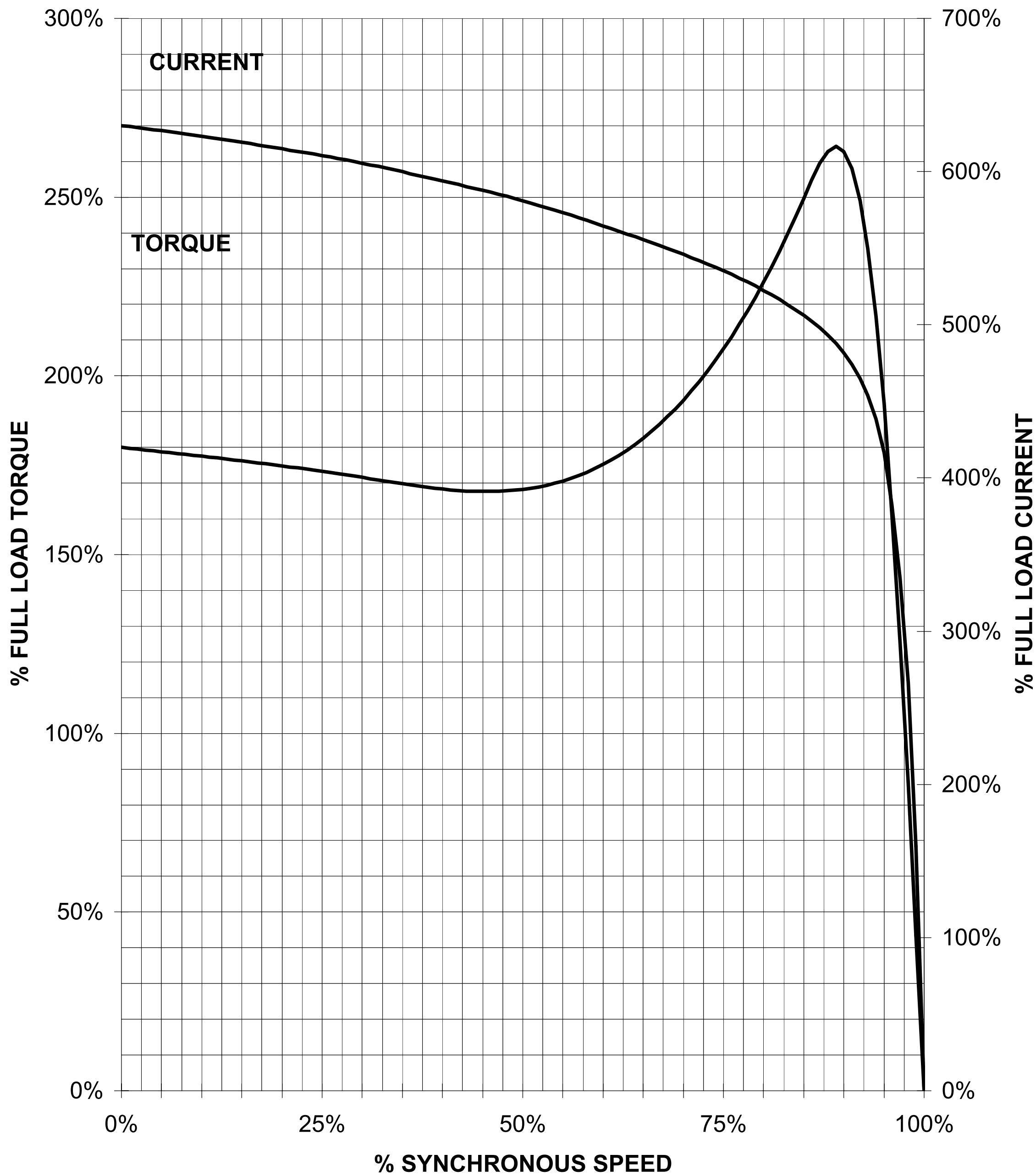
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	20	VOLTS	460	RPM	3600	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	256T	NEMA	B

TORQUE & CURRENT VS. SPEED



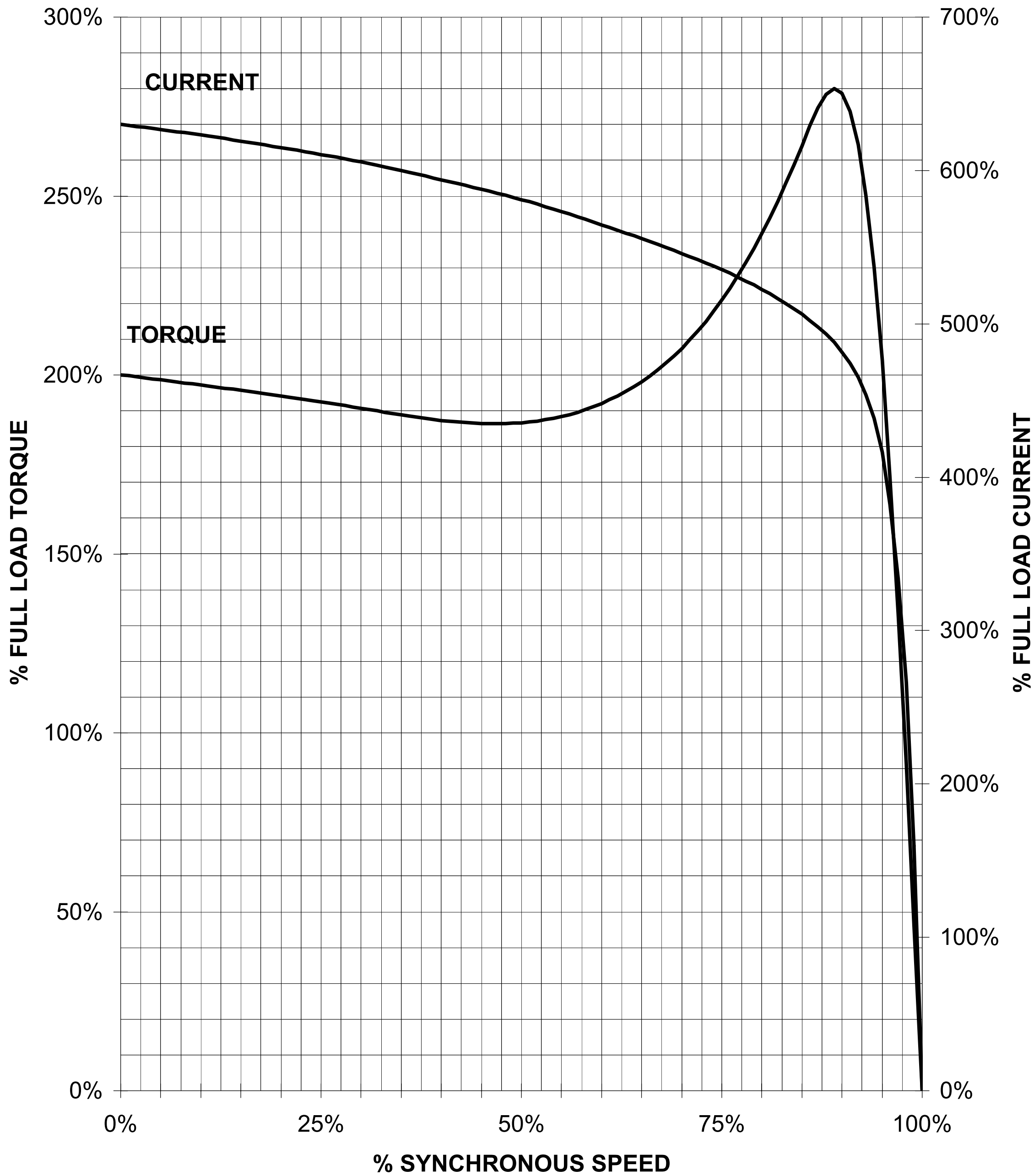
Customer: **PO No.:** **Order No.:**

SIEMENS

Application Manual for NEMA Motors

HP	20	VOLTS	460	RPM	1800	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	256T	NEMA	B

TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

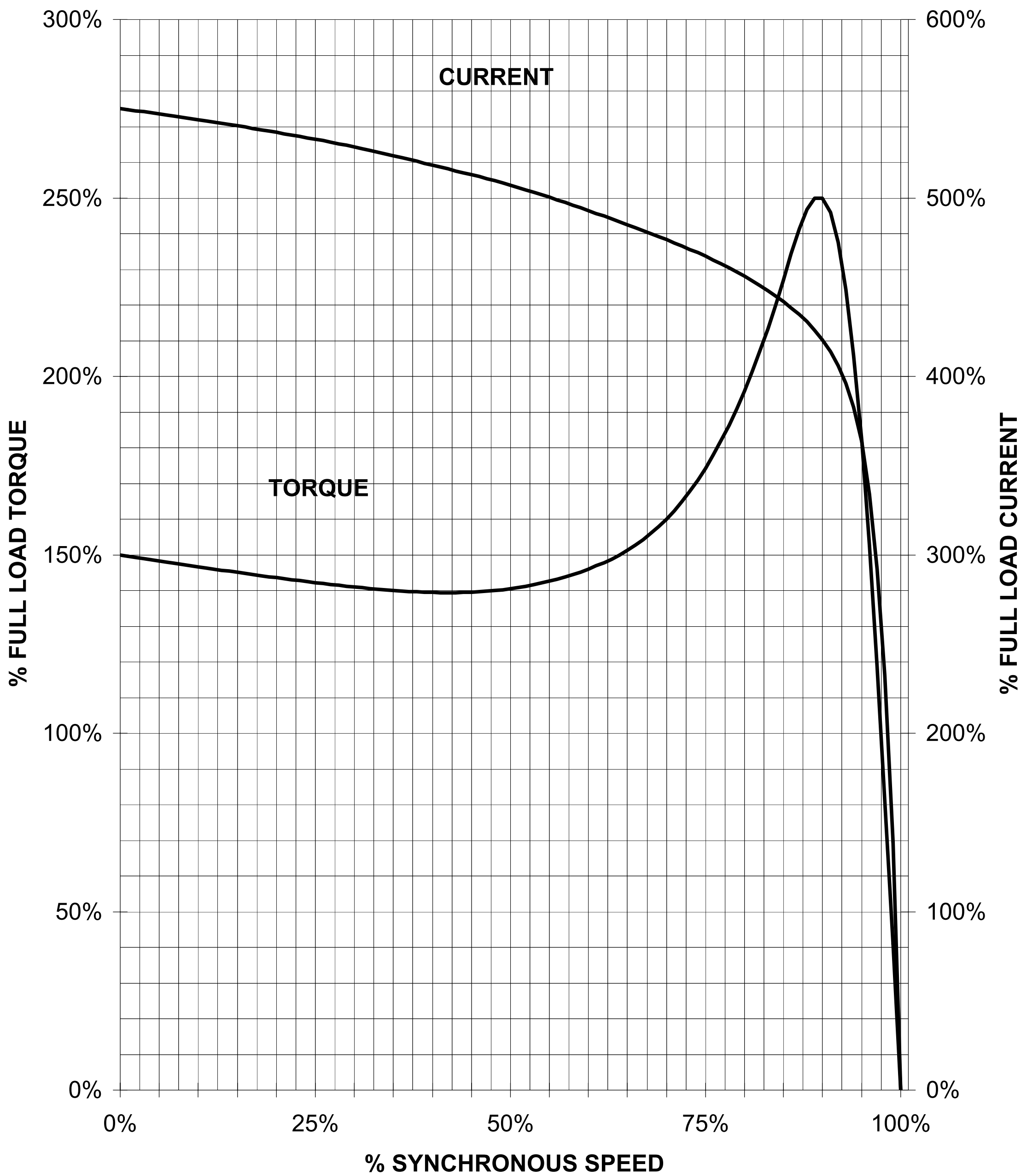
PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

Application Manual for NEMA Motors

HP 20 VOLTS 460 RPM 1200 TYPE RGZEESDX

HZ 60 PHASE 3 FRAME 286T NEMA B

TORQUE AND CURRENT VS. SPEED

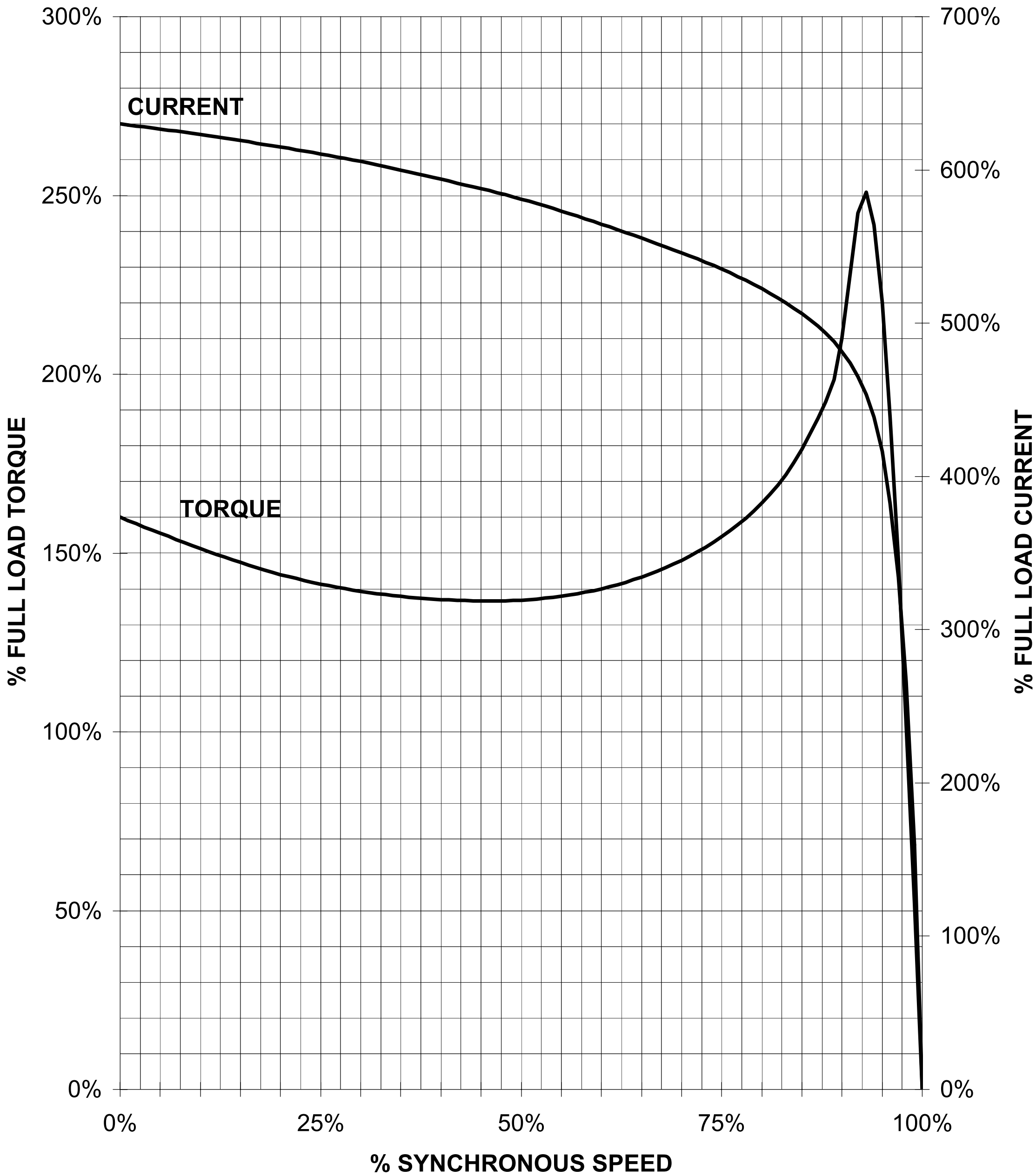


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	25	VOLTS	460	RPM	3600	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	284TS	NEMA	B

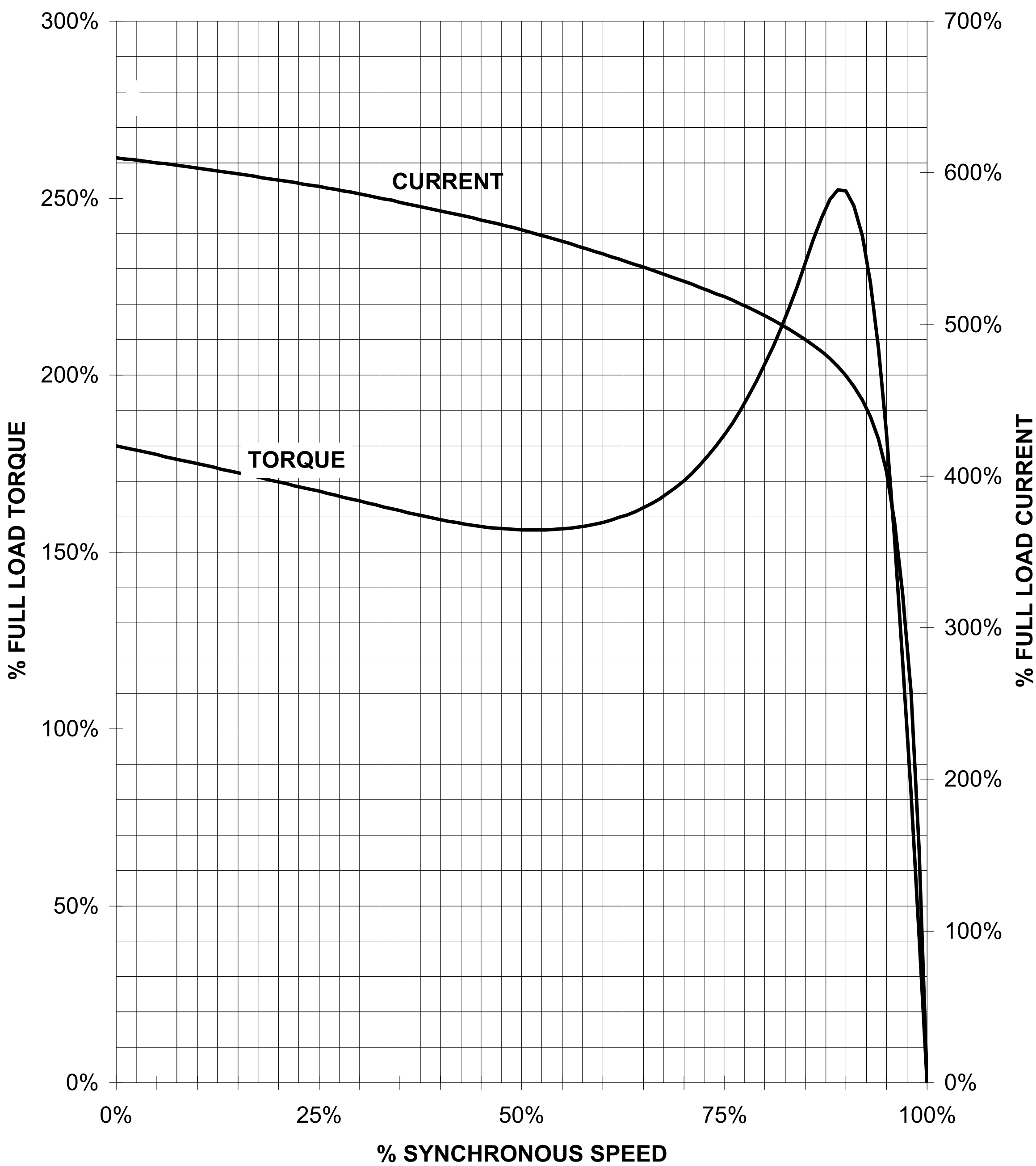
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	25	VOLTS	460	RPM	1800	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	284T	NEMA	B

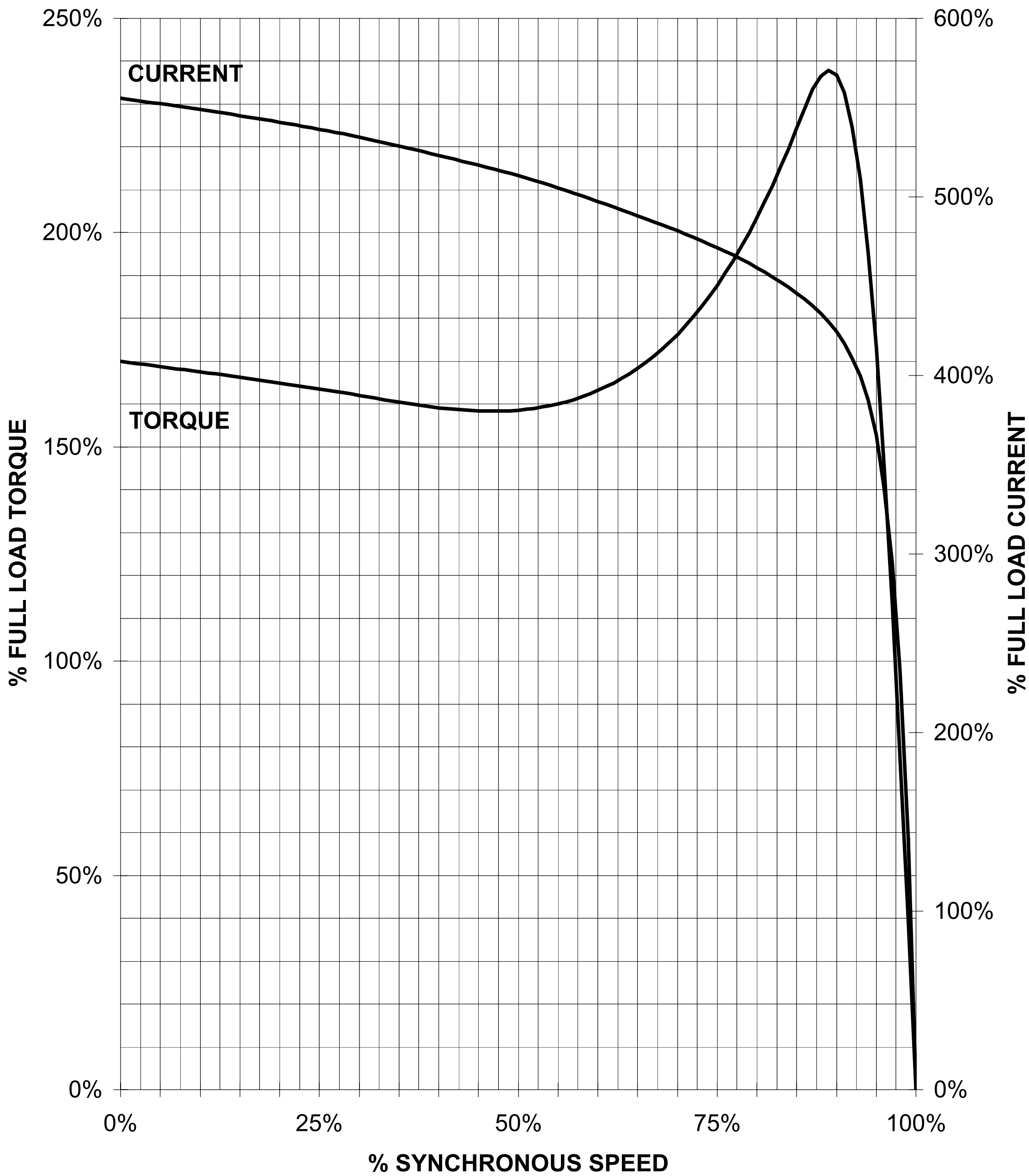
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	25	VOLTS	460	RPM	1200	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	324T	NEMA	B

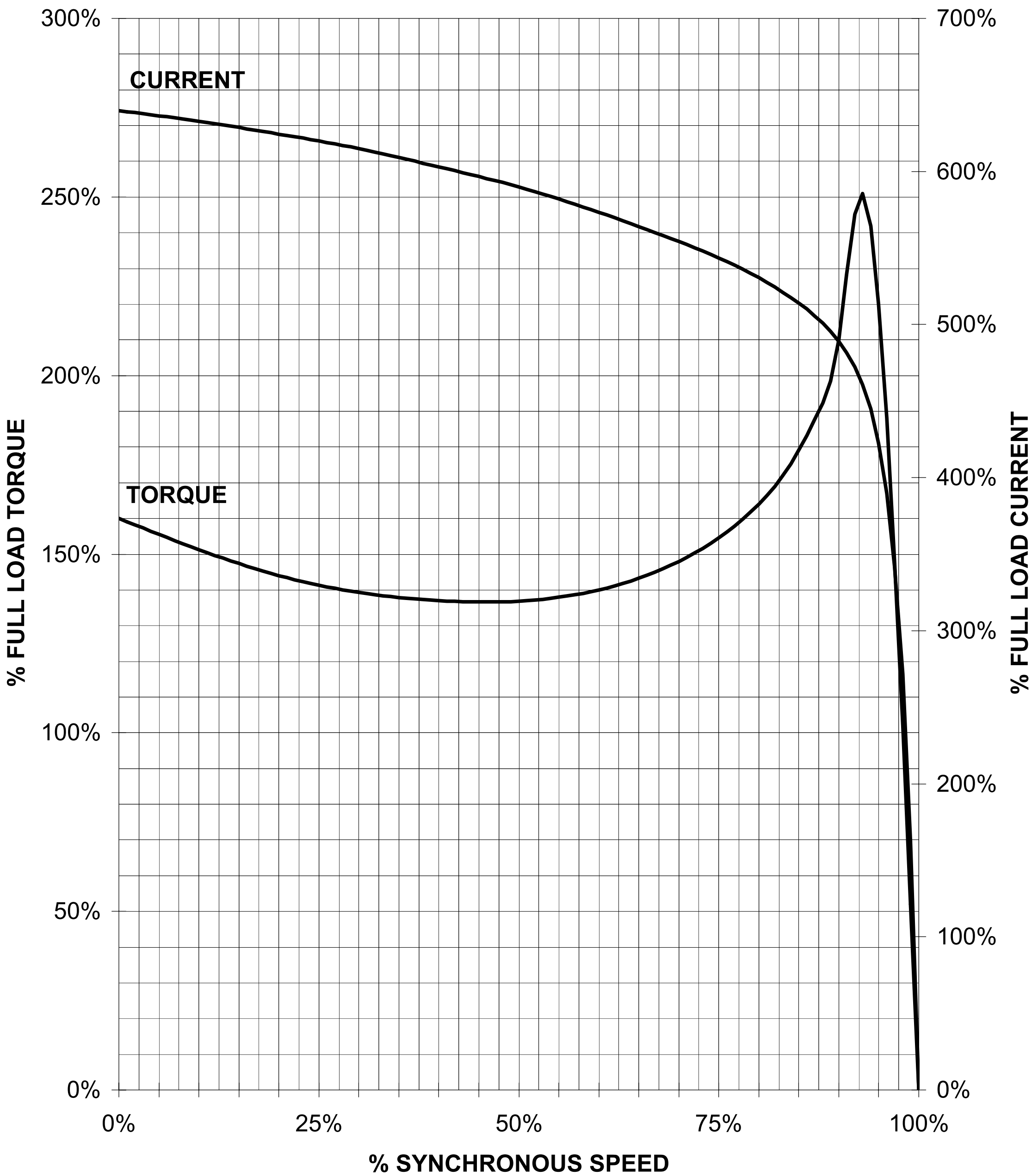
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	30	VOLTS	460	RPM	3600	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	286TS	NEMA	B

TORQUE AND CURRENT VS. SPEED

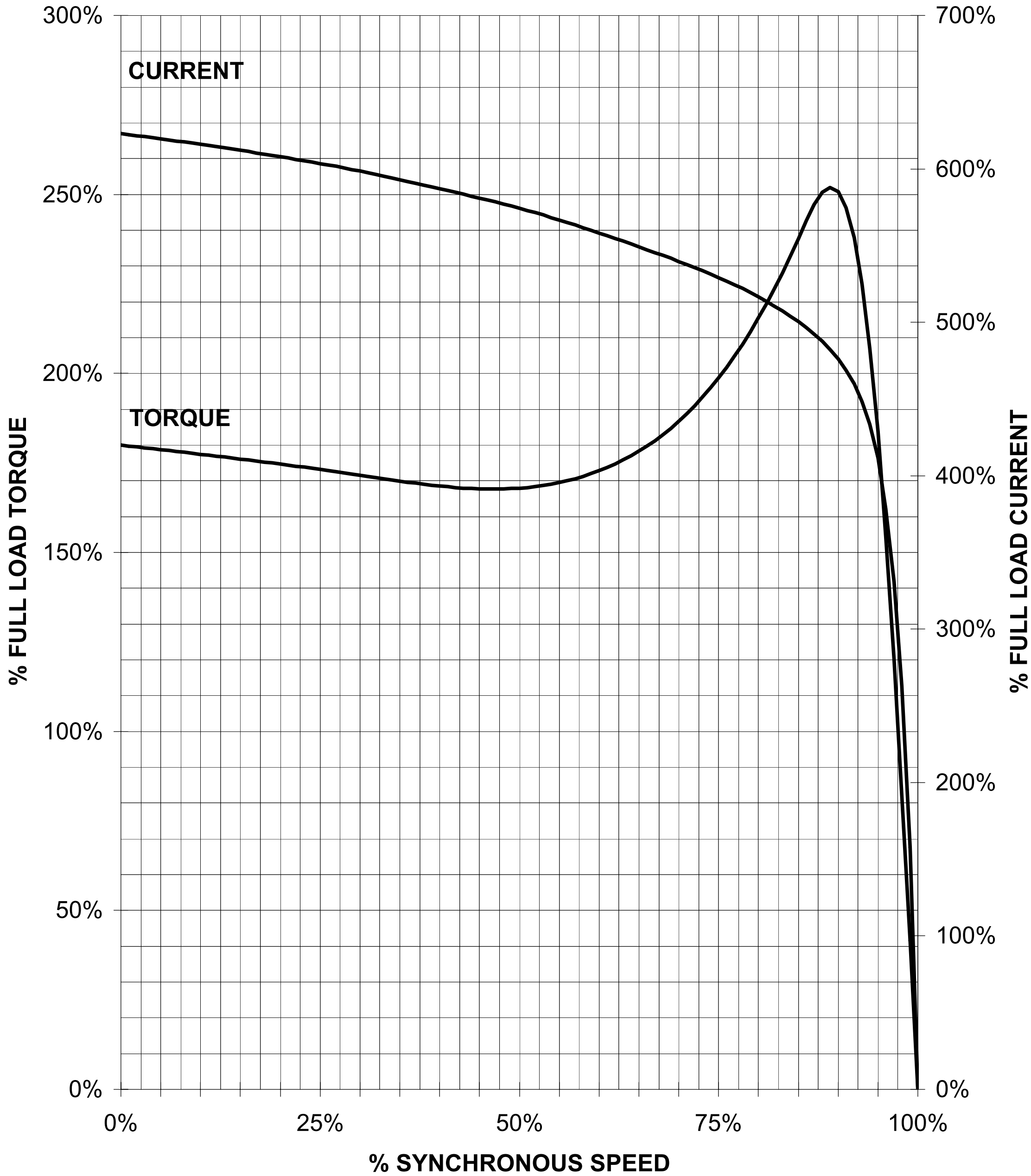


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	30	VOLTS	460	RPM	1800	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	286T	NEMA	B

TORQUE AND CURRENT VS. SPEED

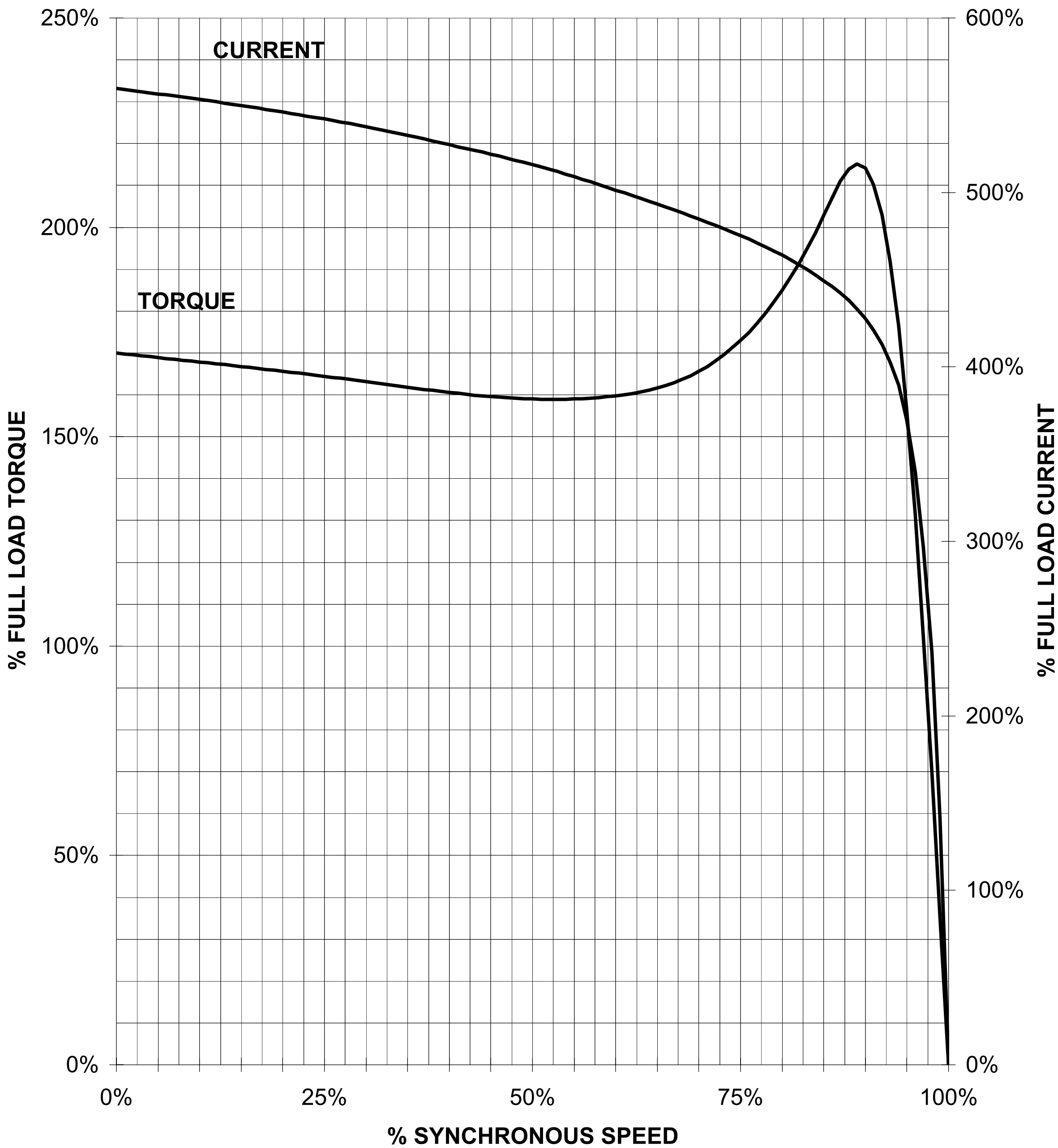


Customer: **PO No.:** **Order No.:**

HP 30 VOLTS 460 RPM 1200 TYPE RGZEESDX

HZ 60 PHASE 3 FRAME 326T NEMA B

TORQUE & CURRENT VS. SPEED



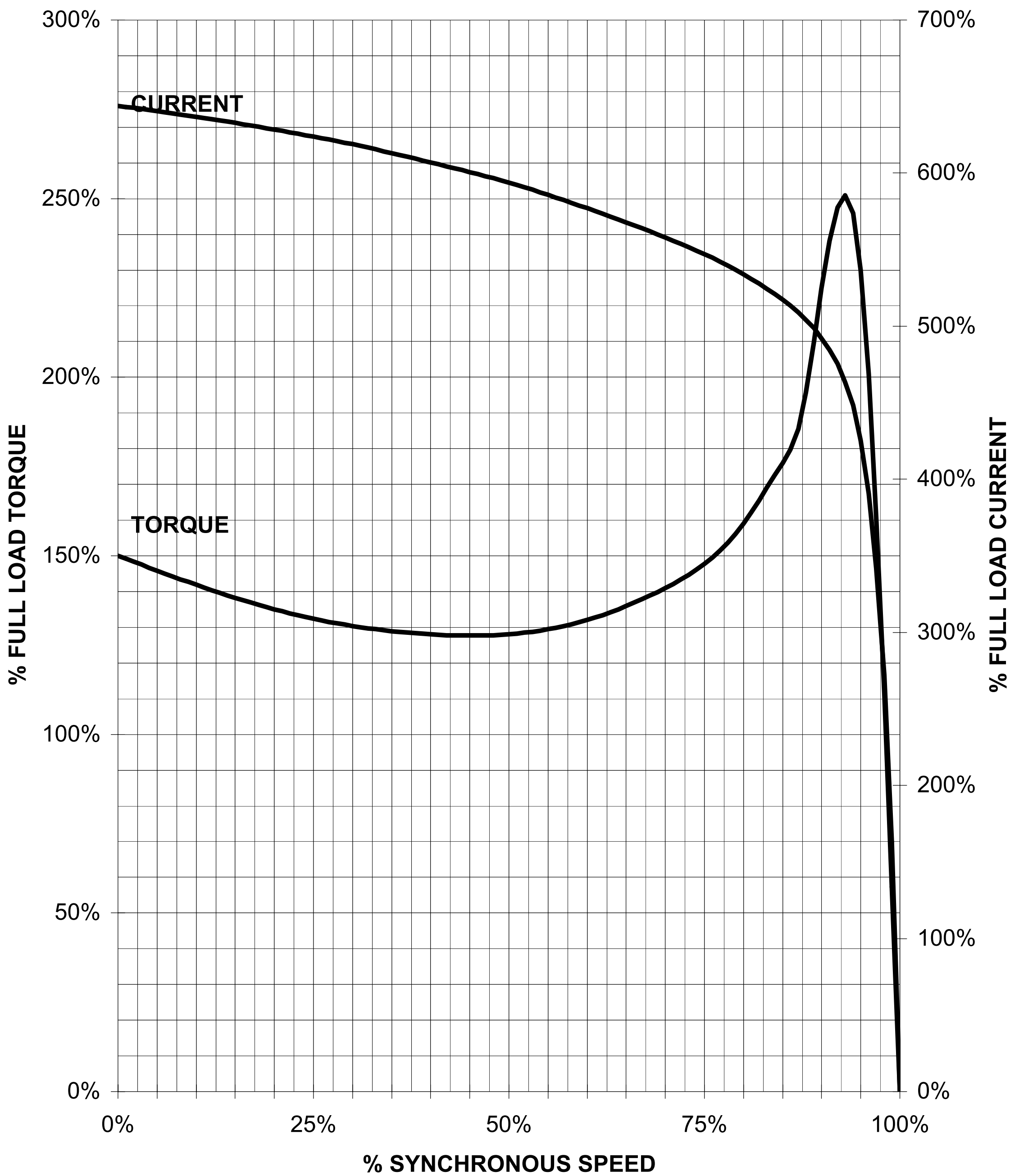
Customer: **PO No.:** **Order No.:**

SIEMENS

Application Manual for NEMA Motors

HP	40	VOLTS	460	RPM	3600	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	324TS	NEMA	B

TORQUE AND CURRENT VS. SPEED

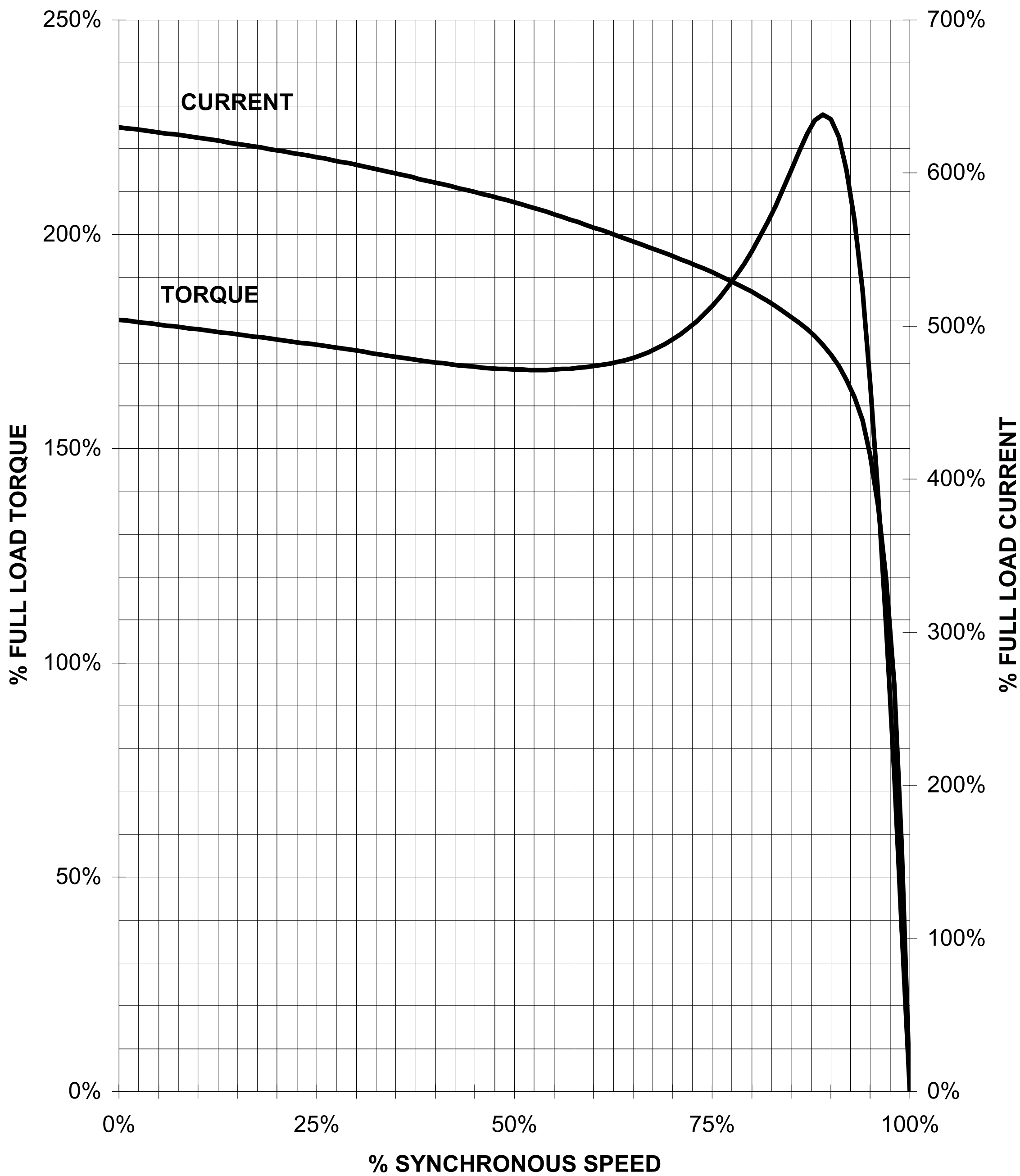


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	40	VOLTS	460	RPM	1800	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	324T	NEMA	B

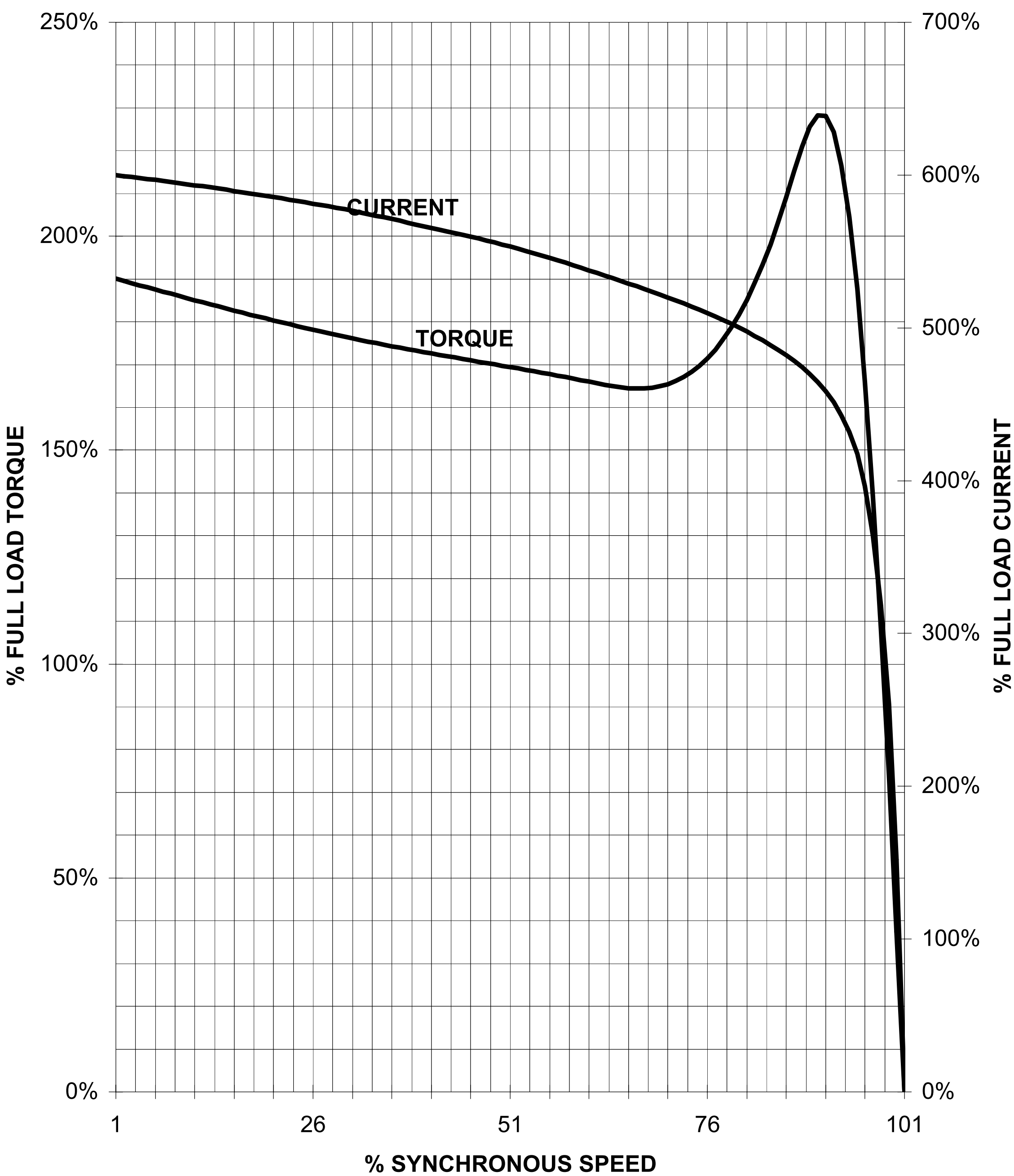
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	40	VOLTS	460	RPM	1200	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	364T	NEMA	B

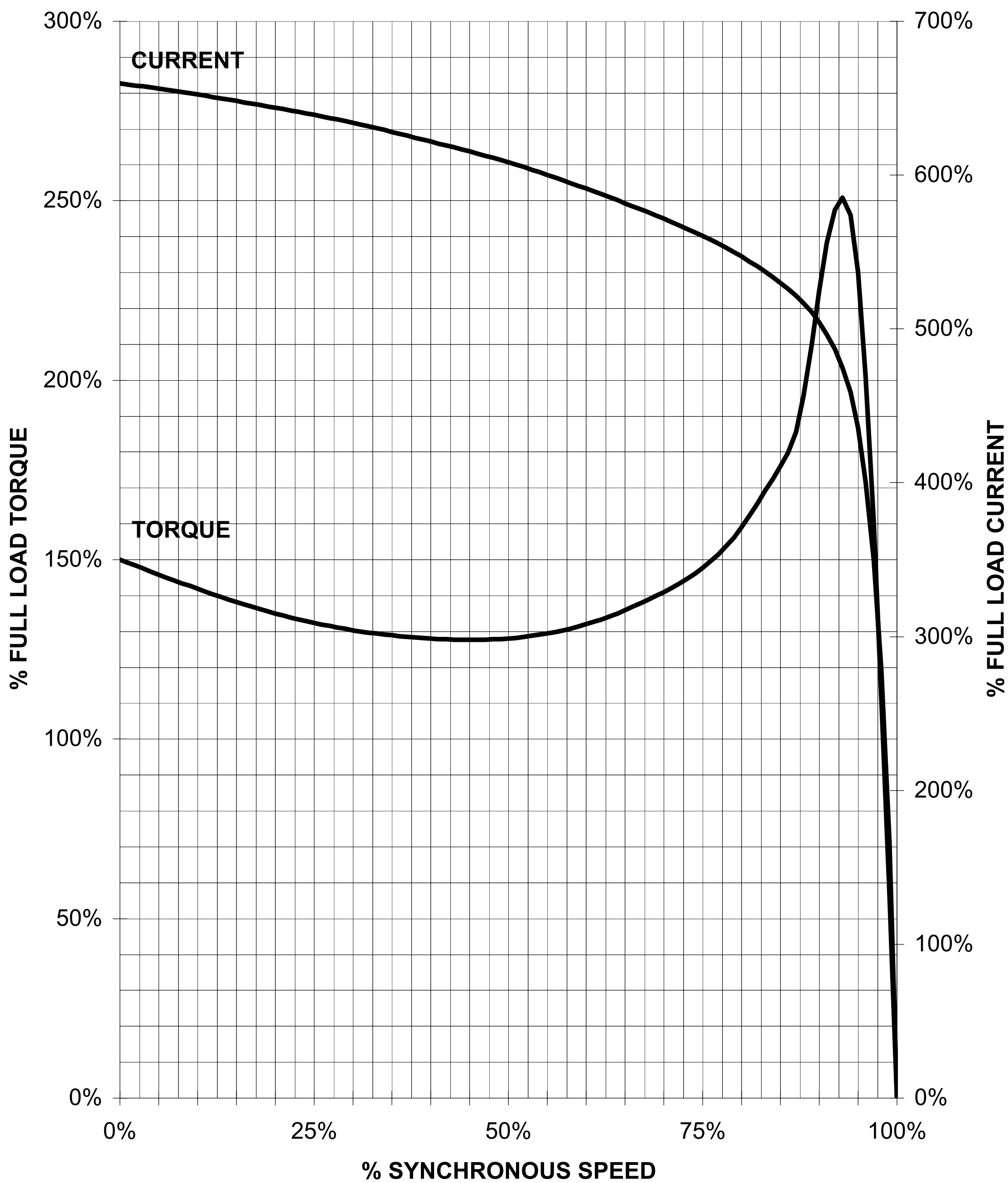
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	50	VOLTS	460	RPM	3600	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	326TS	NEMA	B

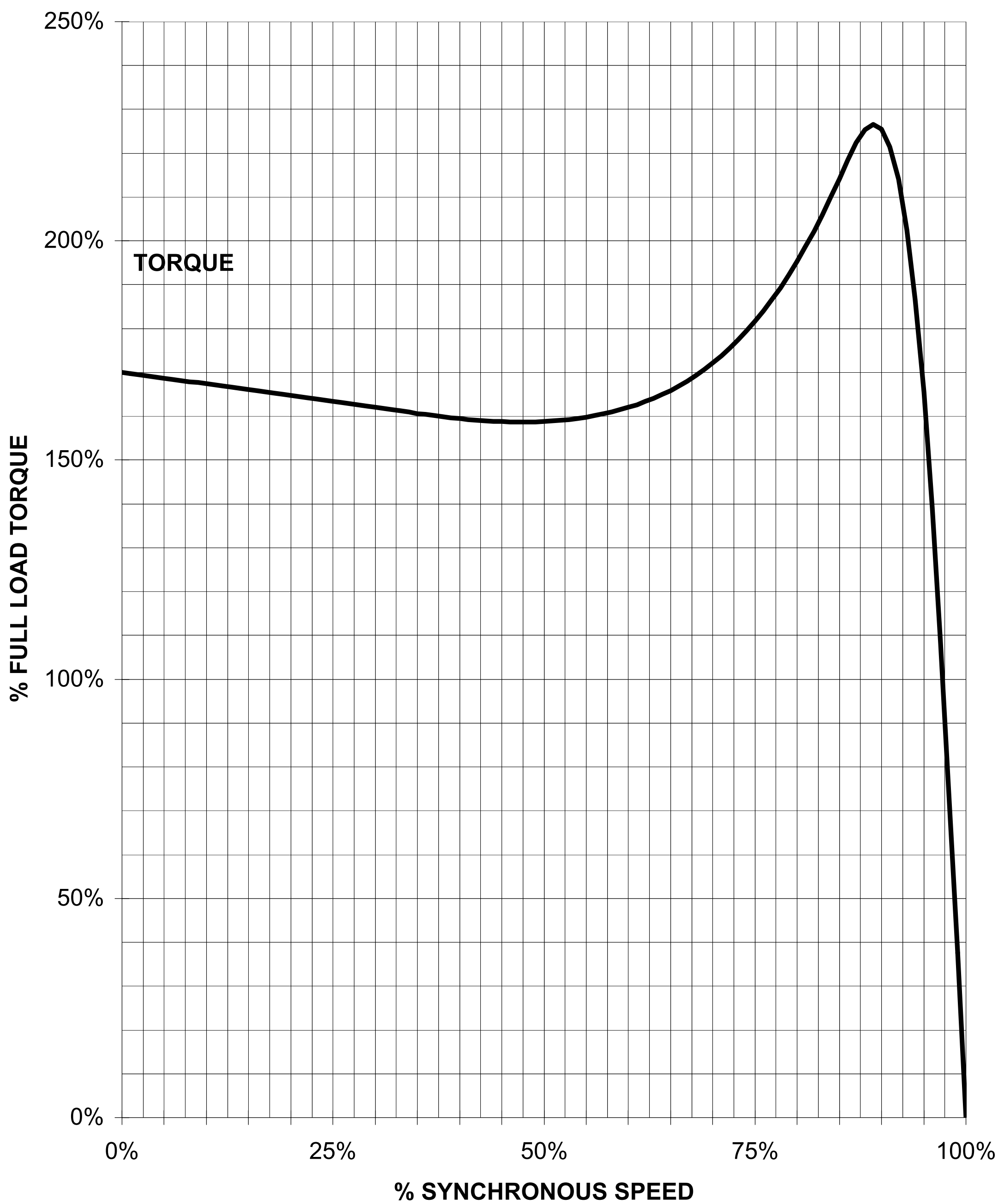
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	50	VOLTS	460	RPM	1800	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	326T	NEMA	B

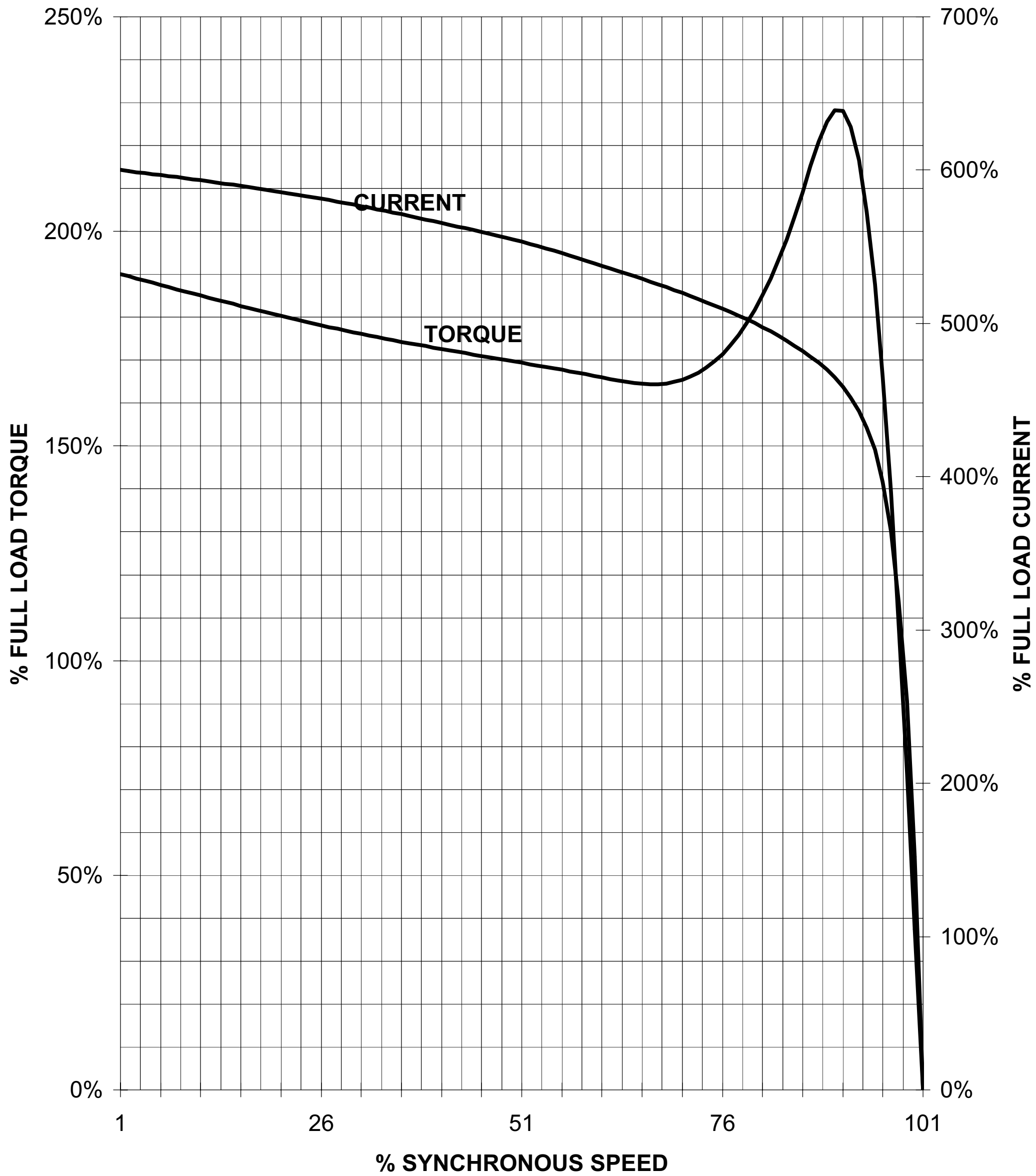
TORQUE VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	50	VOLTS	460	RPM	1200	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	365T	NEMA	B

TORQUE AND CURRENT VS. SPEED

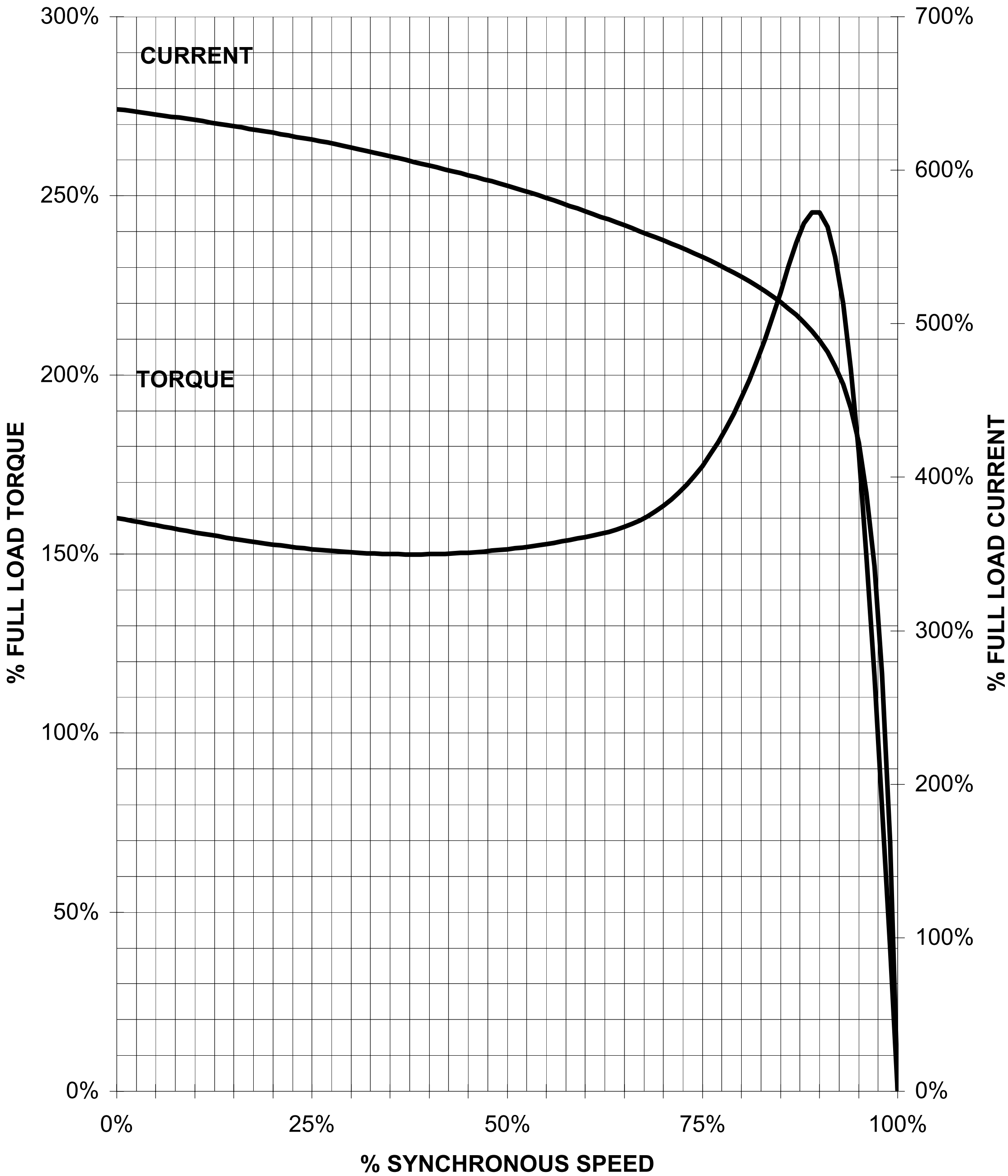


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	60	VOLTS	460	RPM	3600	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	364TS	NEMA	B

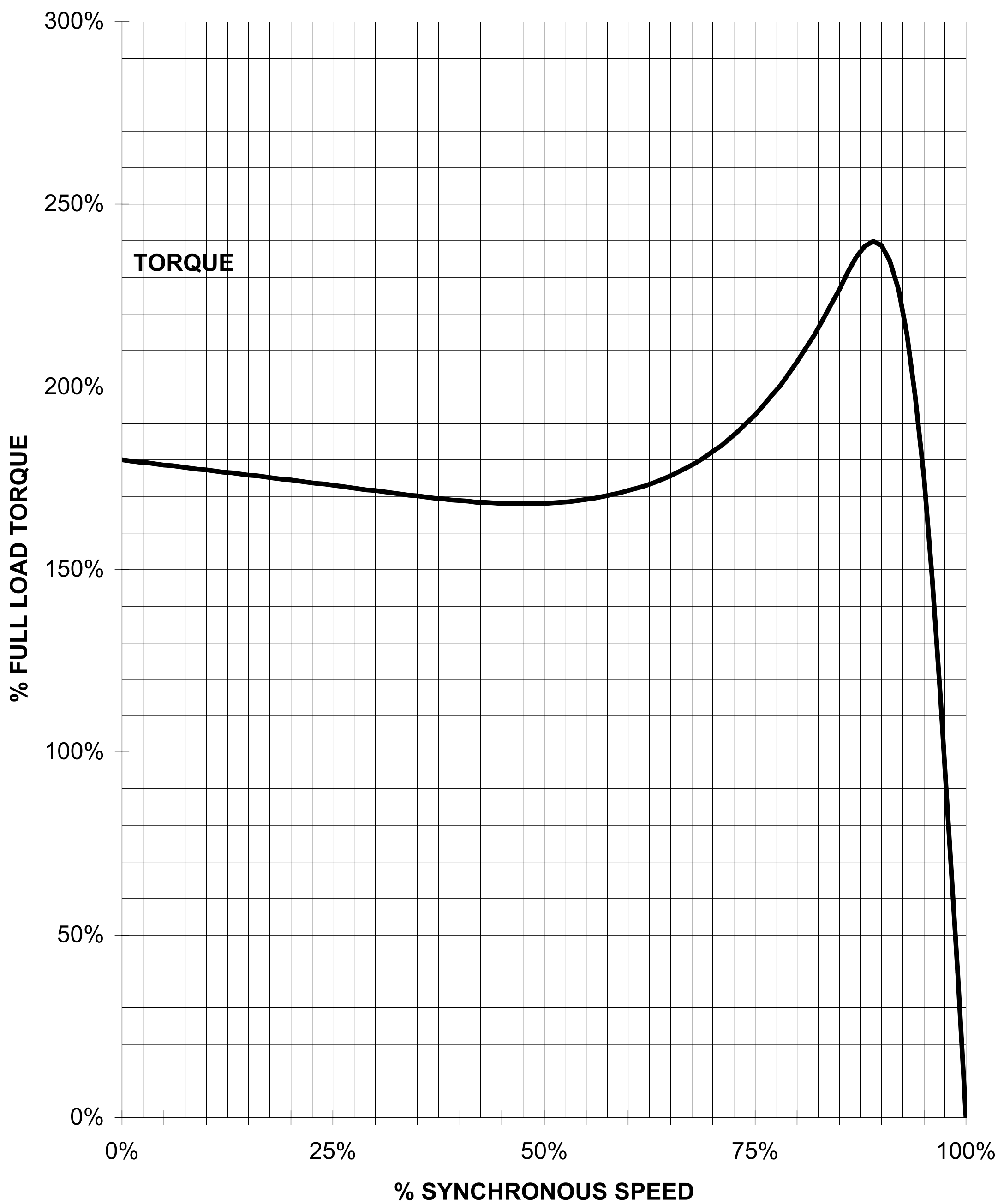
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	60	VOLTS	460	RPM	1800	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	364T	NEMA	B

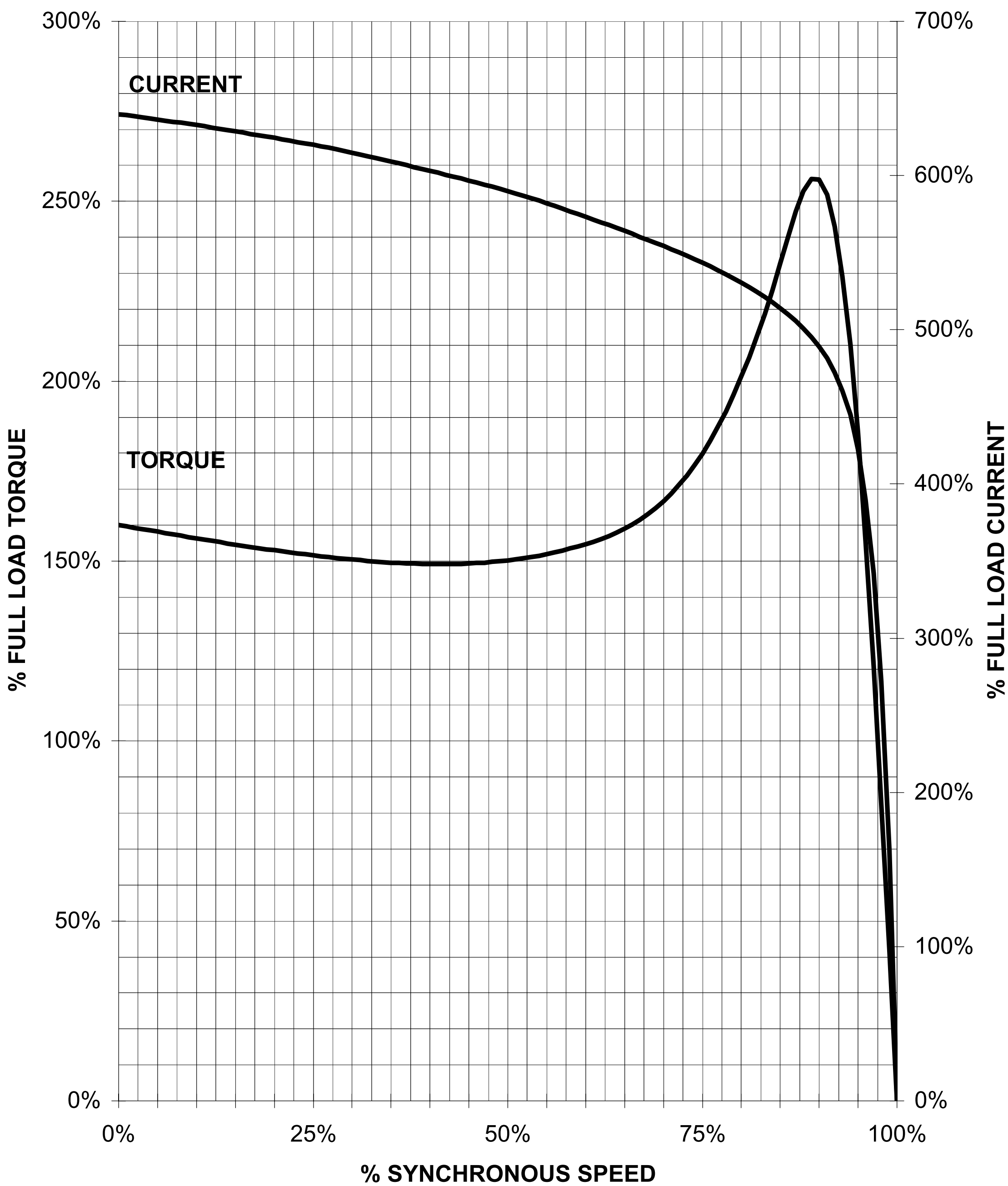
TORQUE VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	75	VOLTS	460	RPM	3600	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	365TS	NEMA	B

TORQUE AND CURRENT VS. SPEED

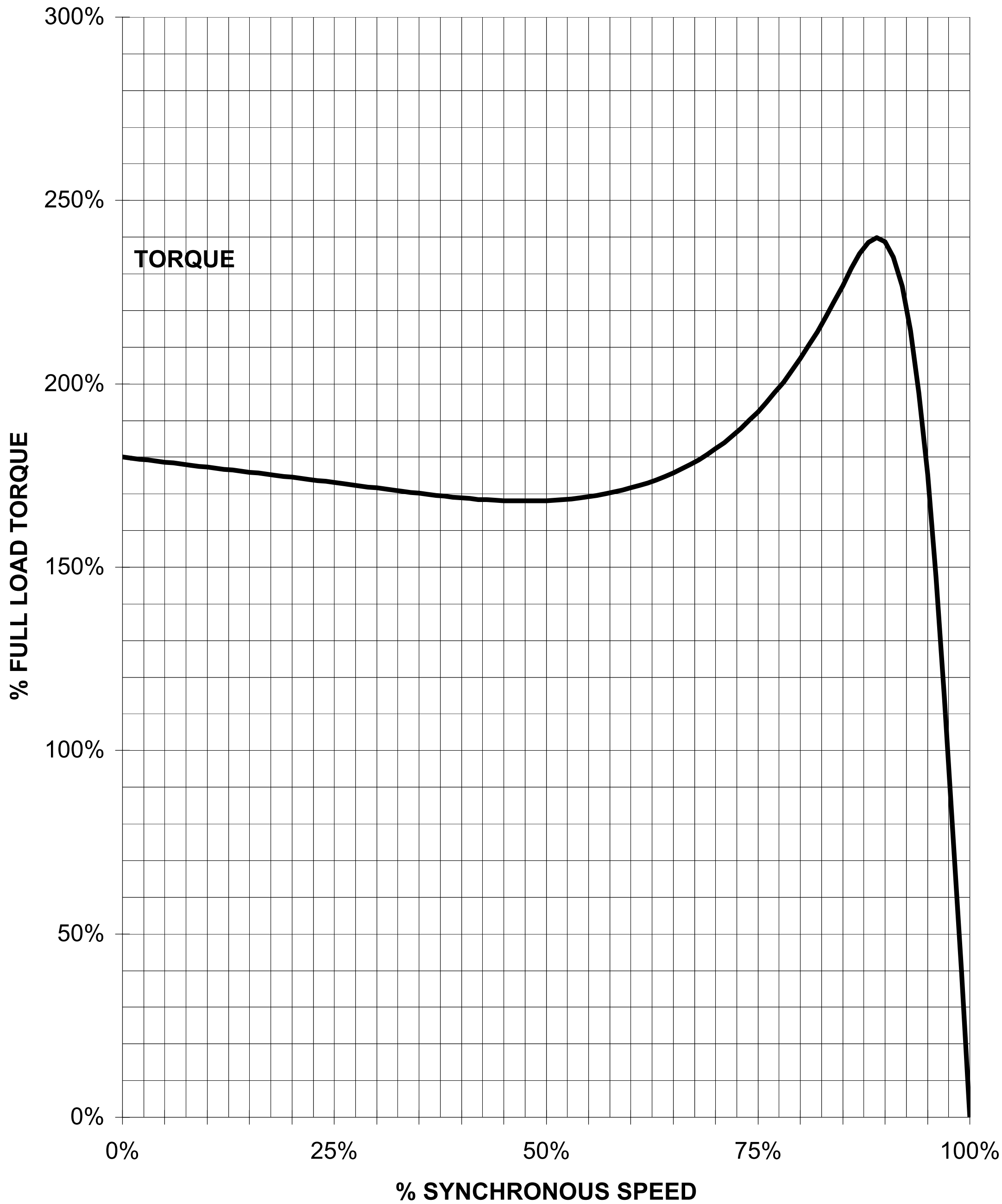


Customer: **PO No.:** **Order No.:**

Application Manual for NEMA Motors

HP	75	VOLTS	460	RPM	1800	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	365T	NEMA	B

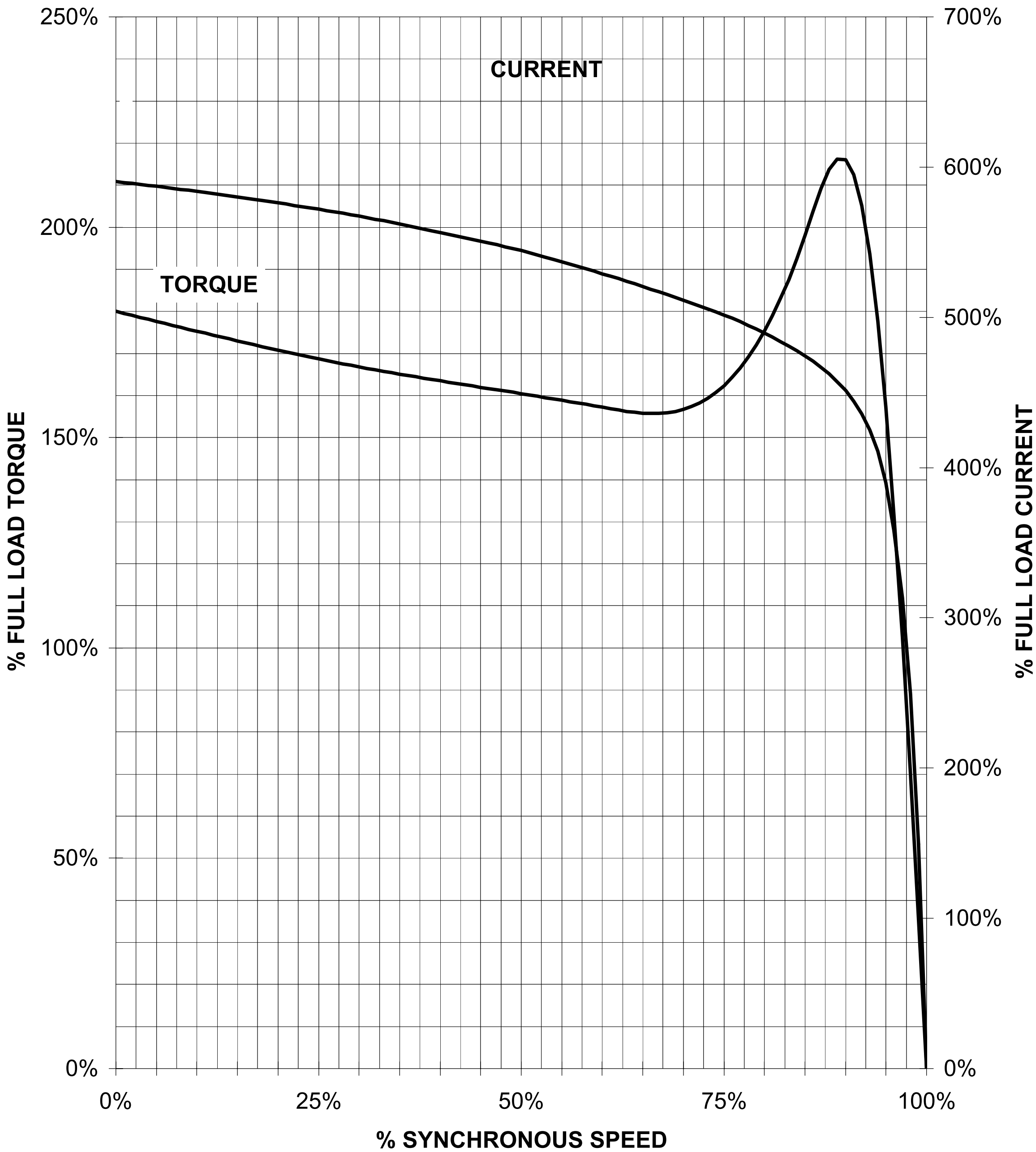
TORQUE VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	75	VOLTS	460	RPM	1200	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	405T	NEMA	B

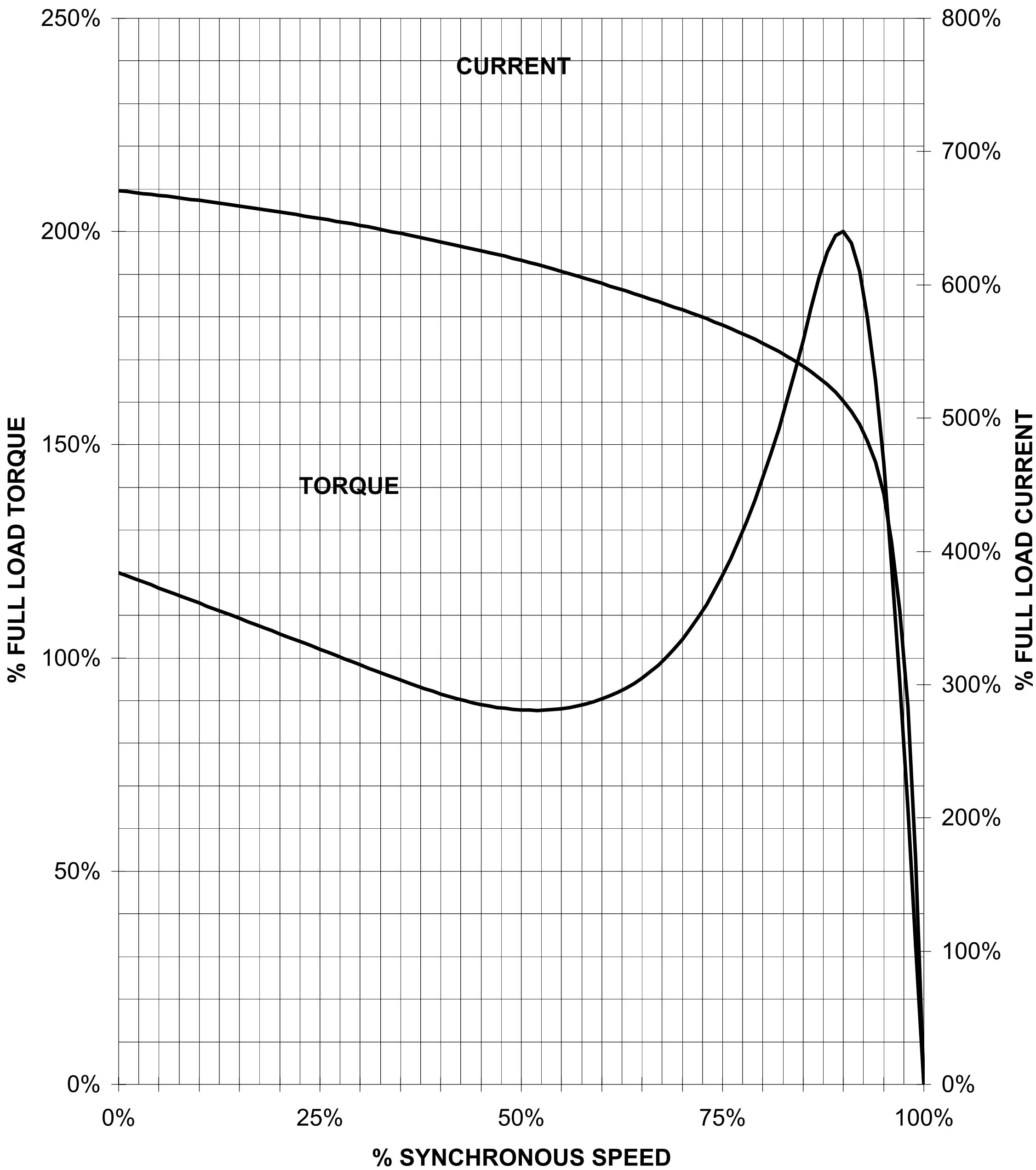
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	100	VOLTS	460	RPM	3600	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	405TS	NEMA	B

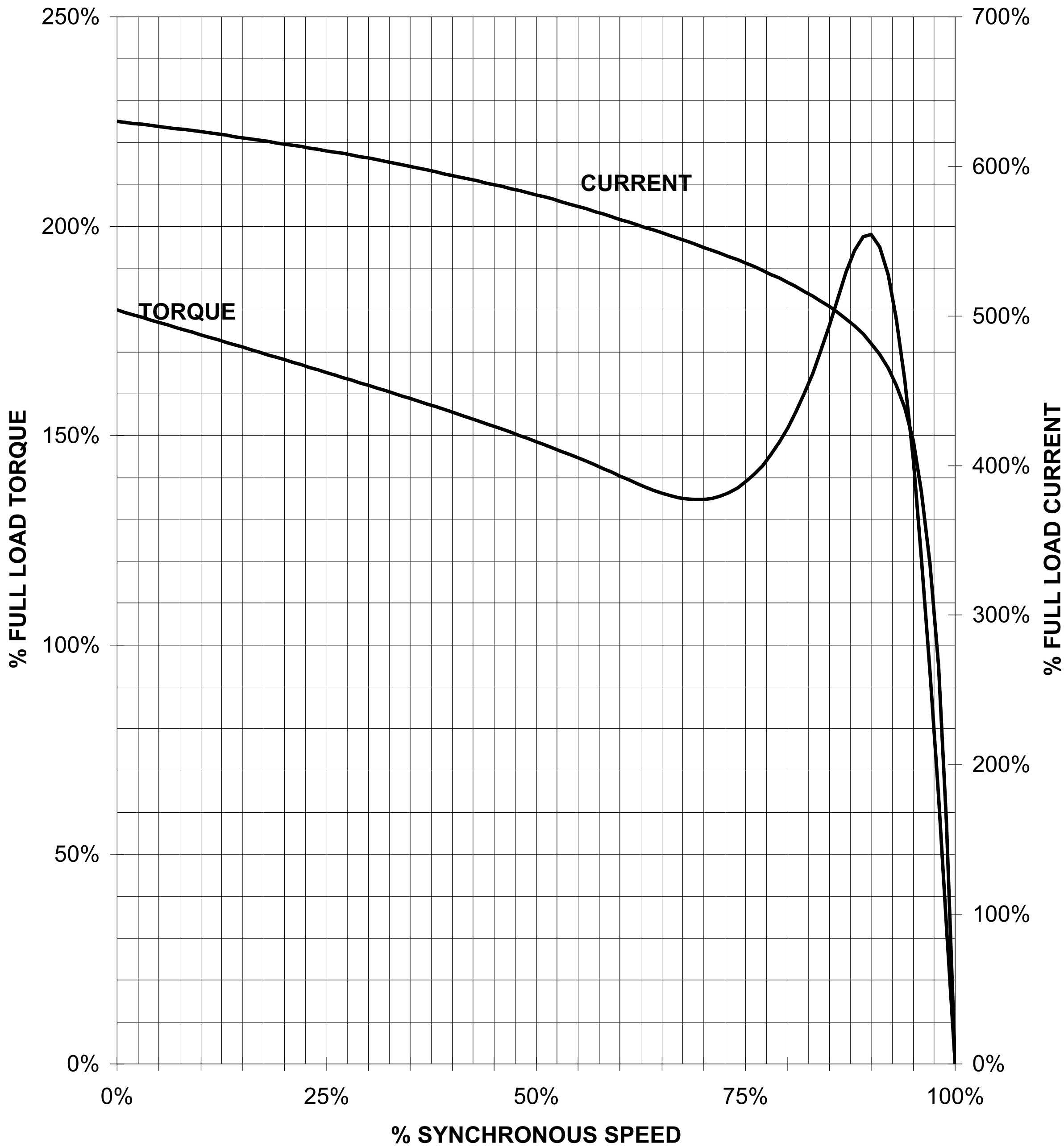
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	100	VOLTS	460	RPM	1800	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	405TS	NEMA	B

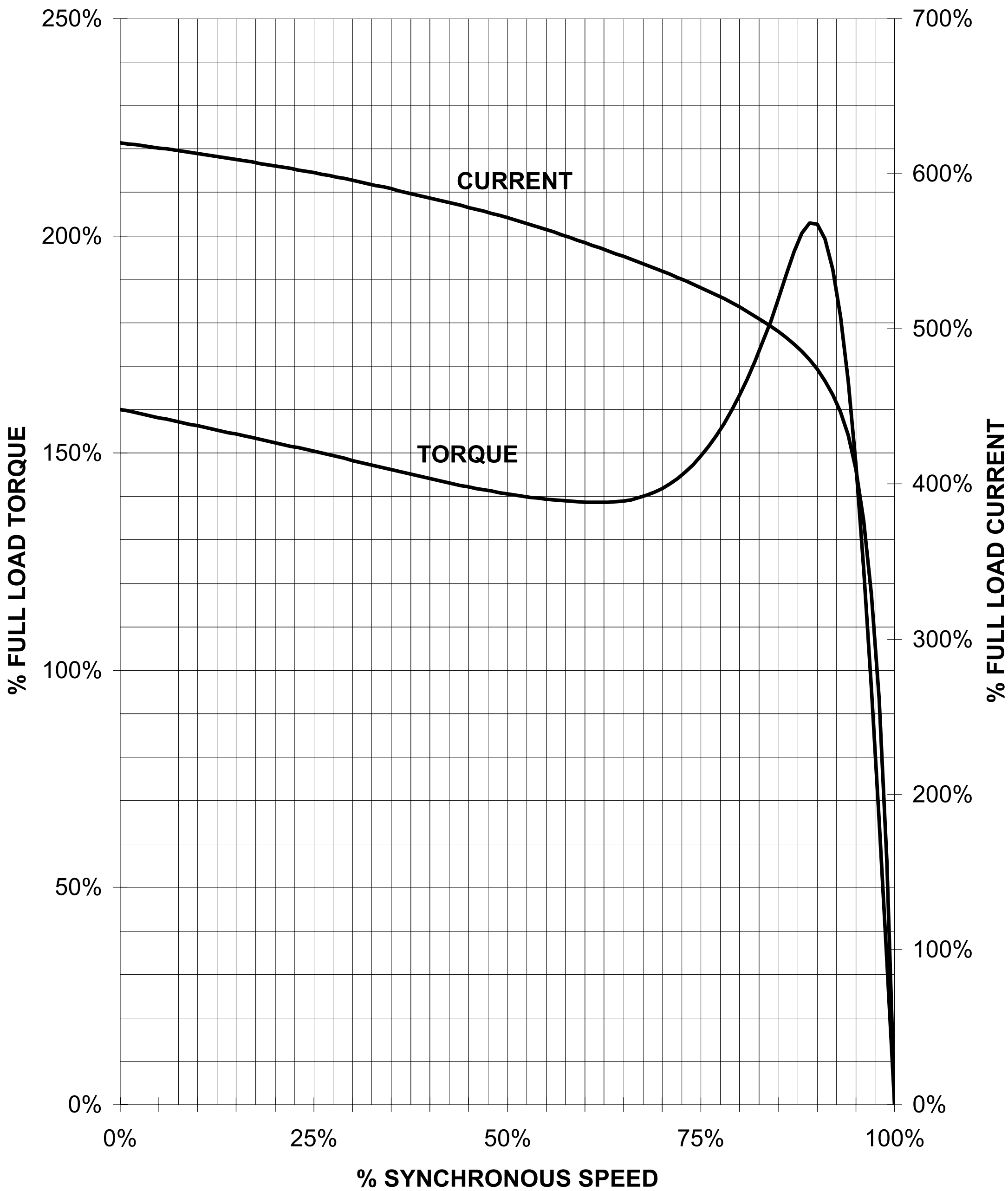
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	100	VOLTS	460	RPM	1200	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	444T	NEMA	B

TORQUE & CURRENT VS. SPEED

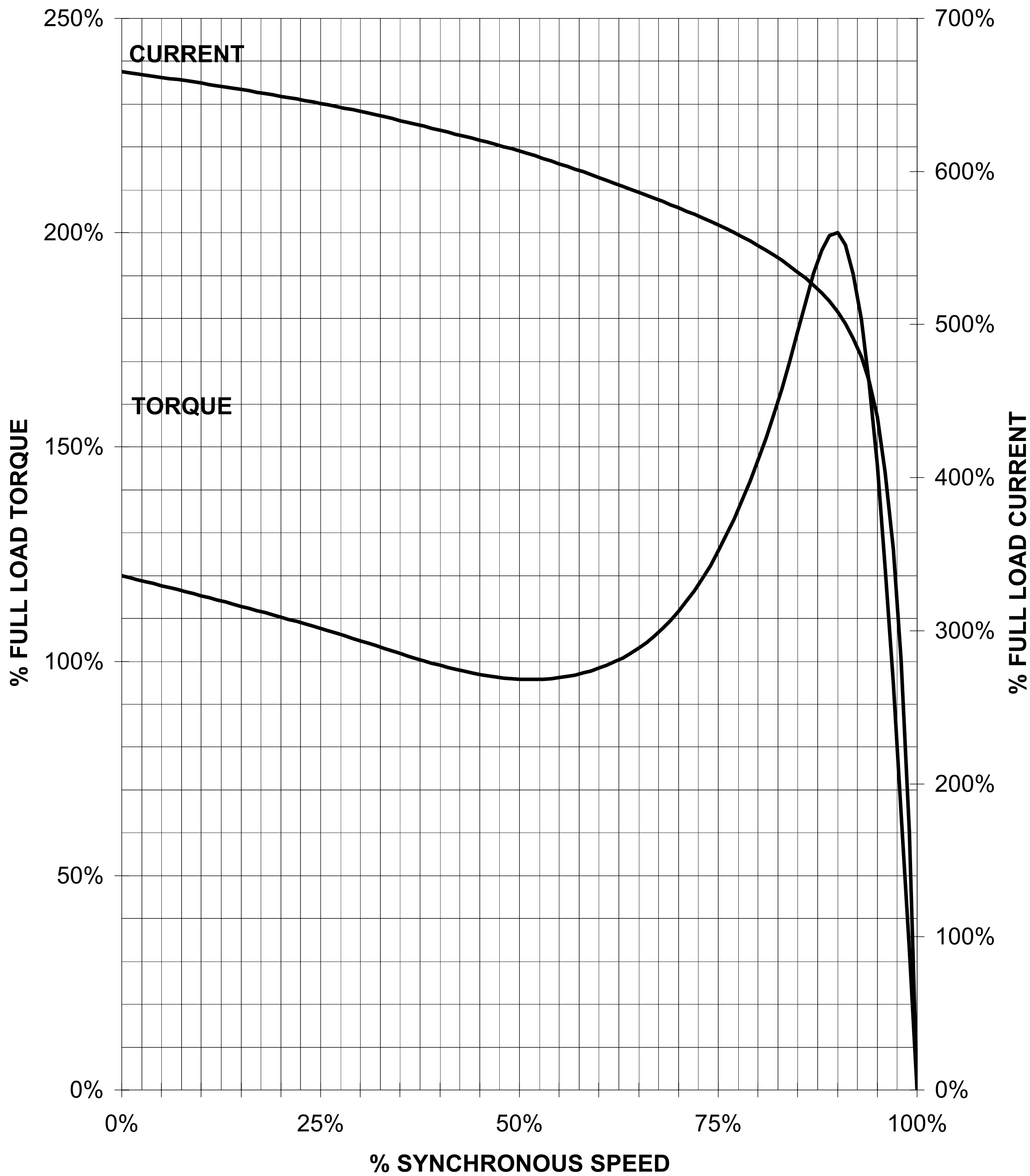


Customer: **PO No.:** **Order No.:**

HP 125 VOLTS 460 RPM 3600 TYPE RGZEESDX

HZ 60 PHASE 3 FRAME 444TS NEMA B

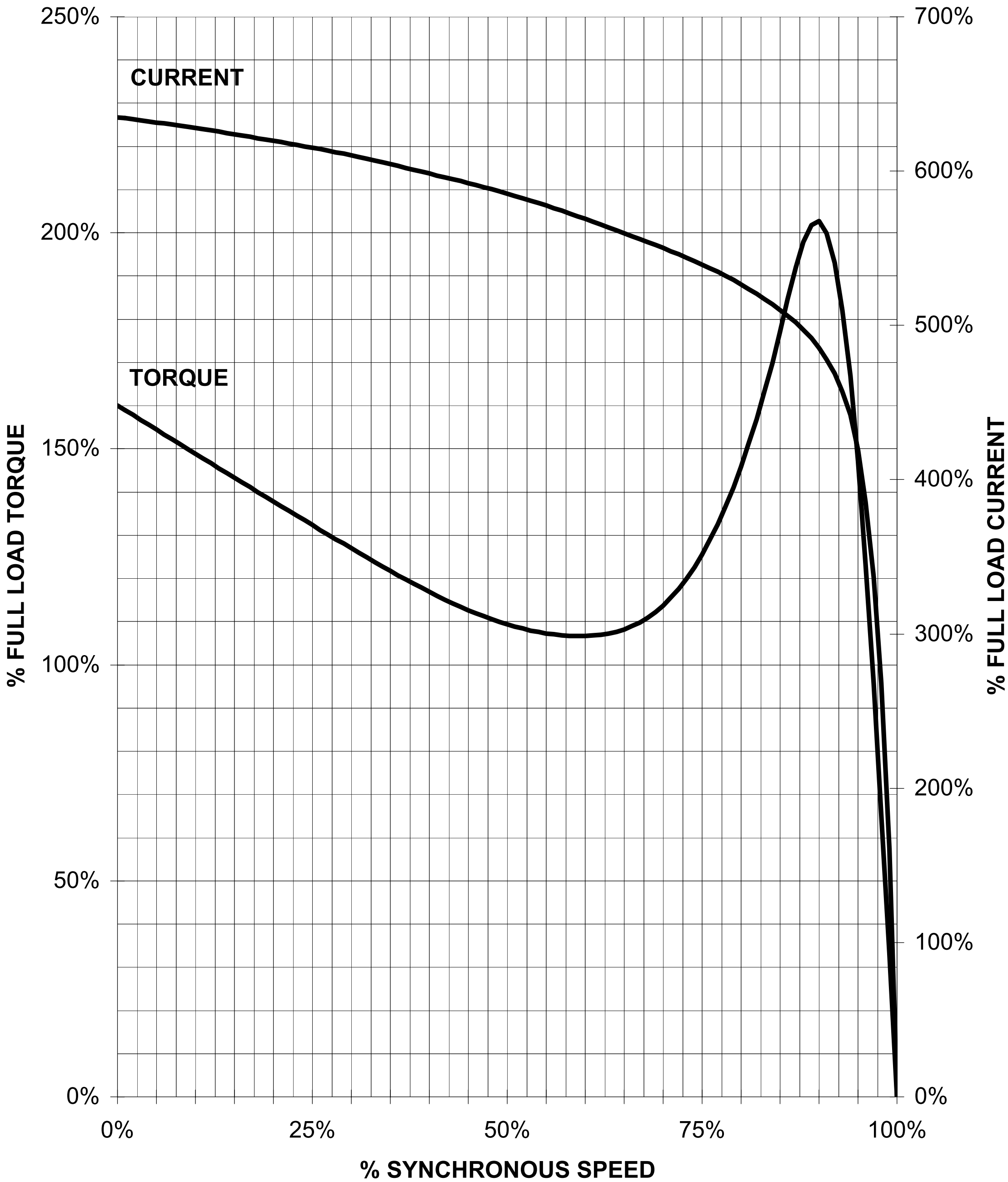
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	125	VOLTS	460	RPM	1800	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	444TS	NEMA	B

TORQUE AND CURRENT VS. SPEED

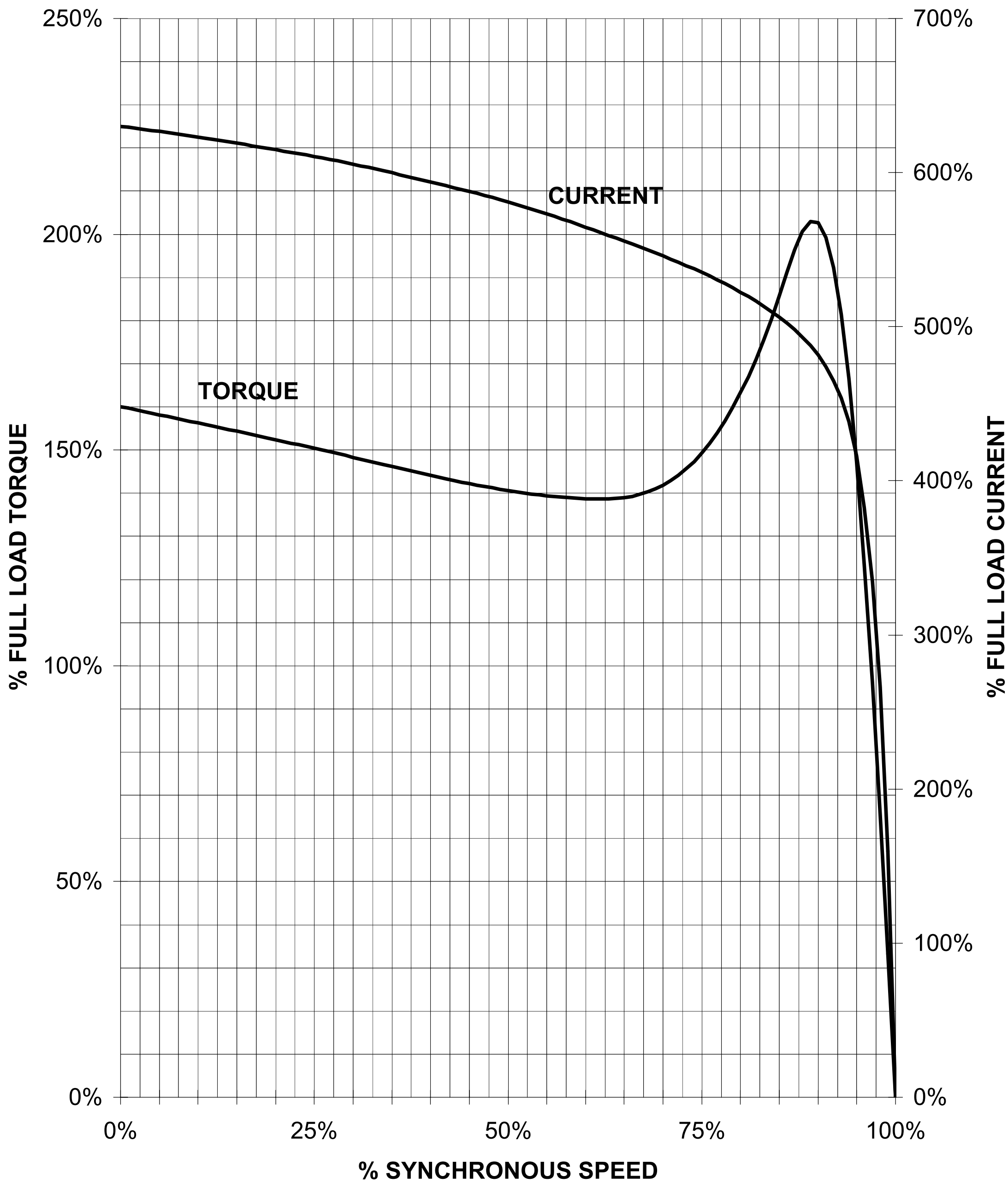


Customer: **PO No.:** **Order No.:**

HP 125 VOLTS 460 RPM 1200 TYPE RGZEESDX

HZ 60 PHASE 3 FRAME 445T NEMA B

TORQUE & CURRENT VS. SPEED

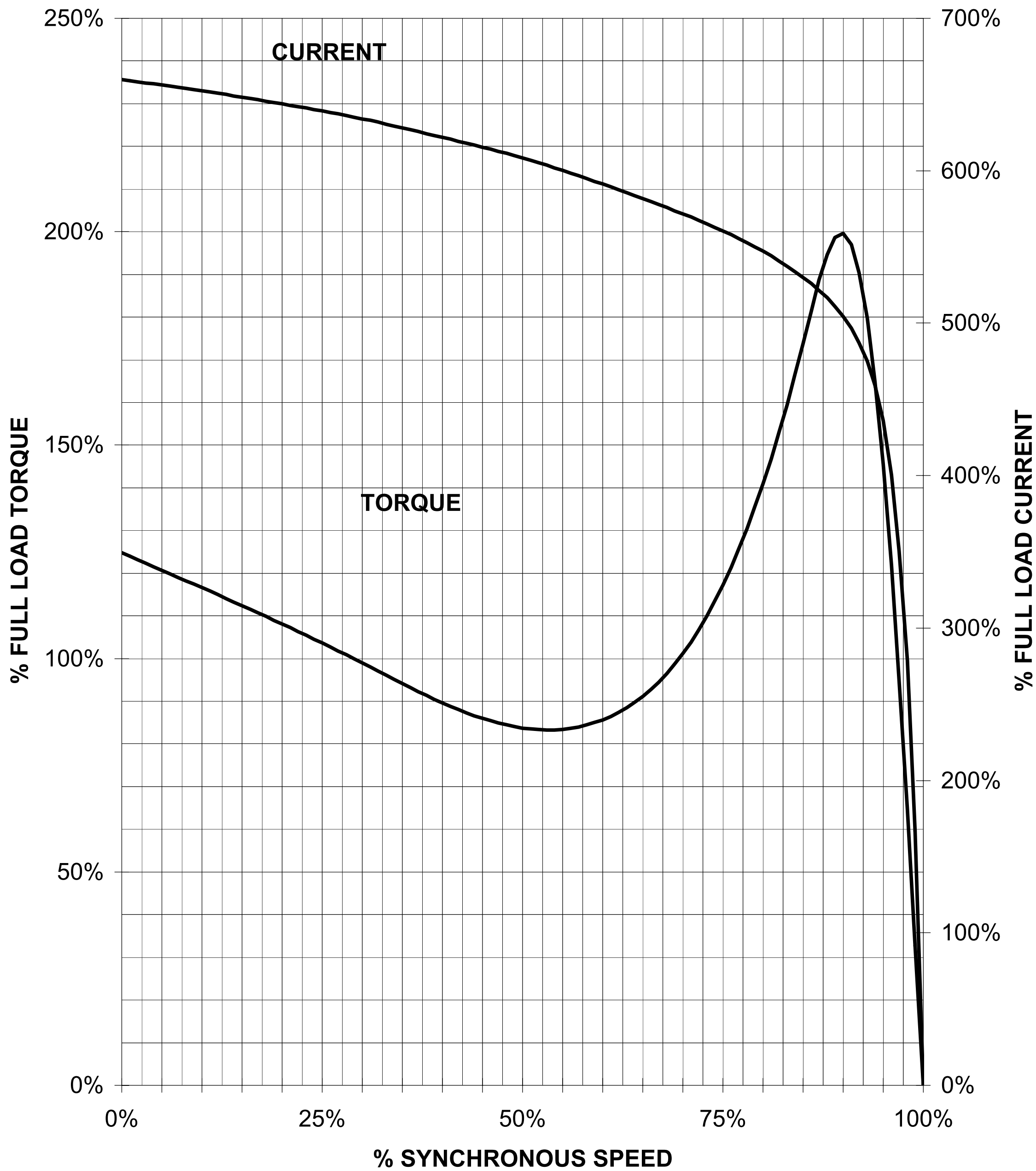


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	150	VOLTS	460	RPM	3600	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	445TS	NEMA	B

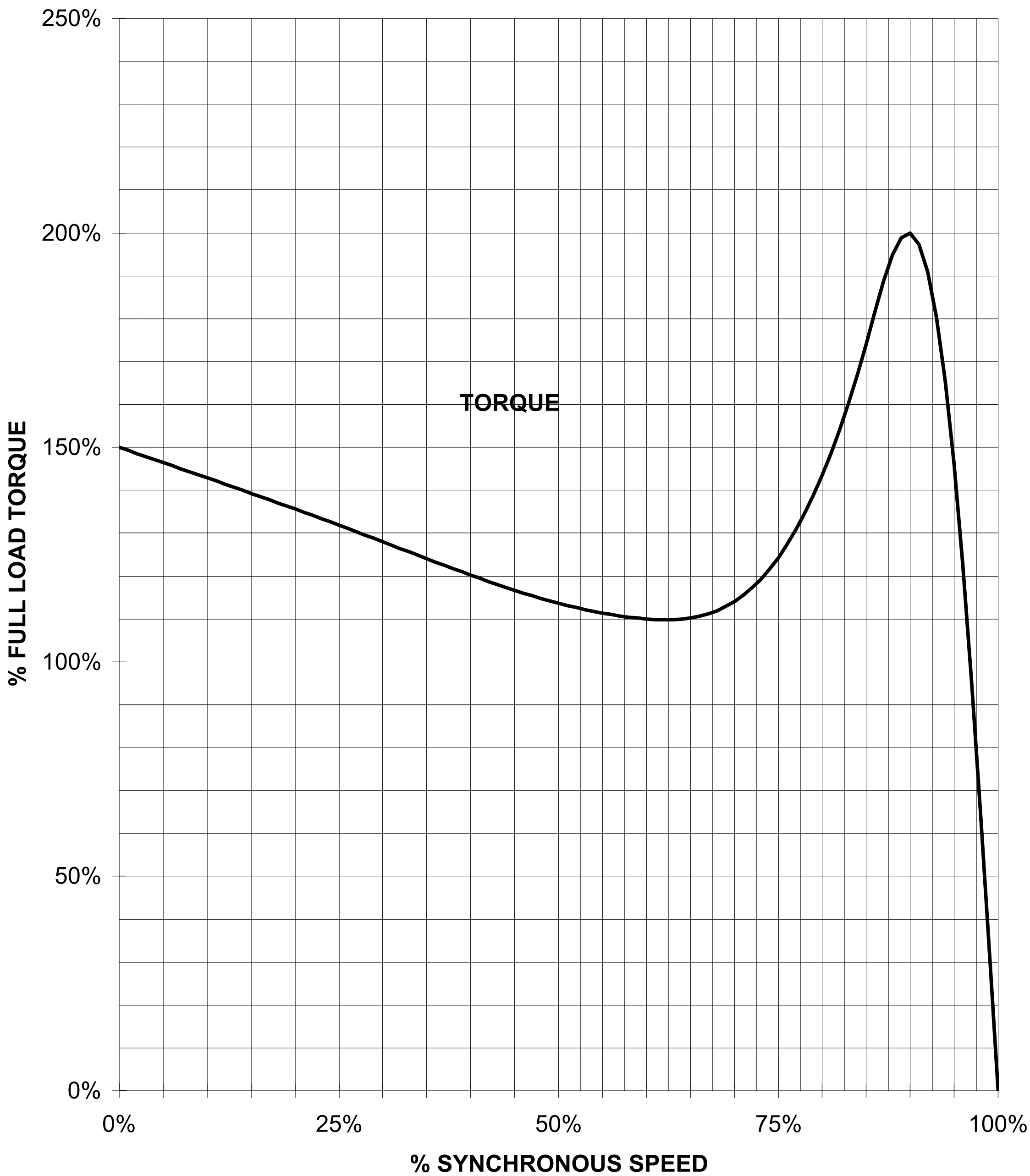
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	150	VOLTS	460	RPM	1800	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	445T	NEMA	B

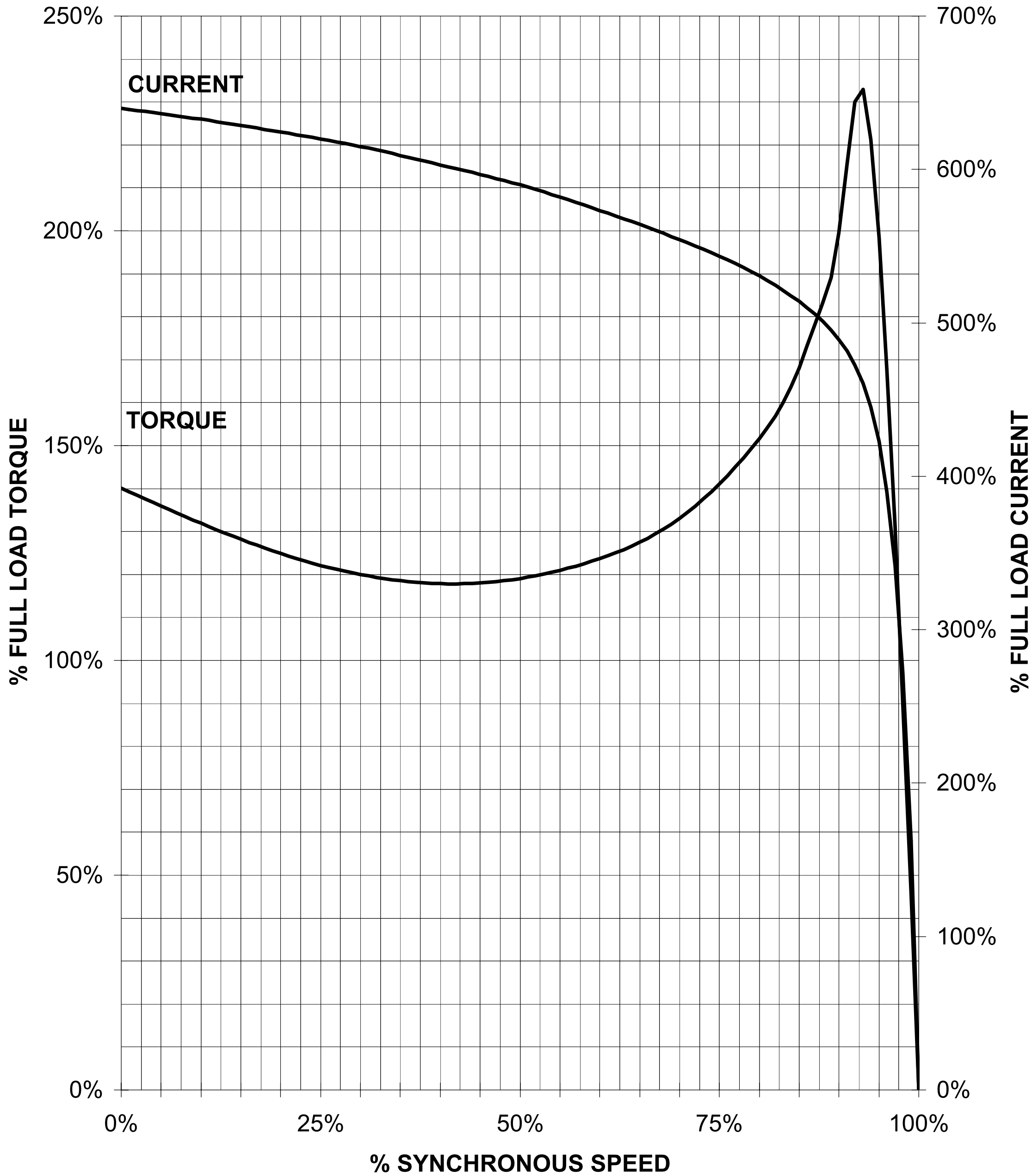
TORQUE VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	150	VOLTS	460	RPM	1200	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	447T	NEMA	B

TORQUE AND CURRENT VS. SPEED

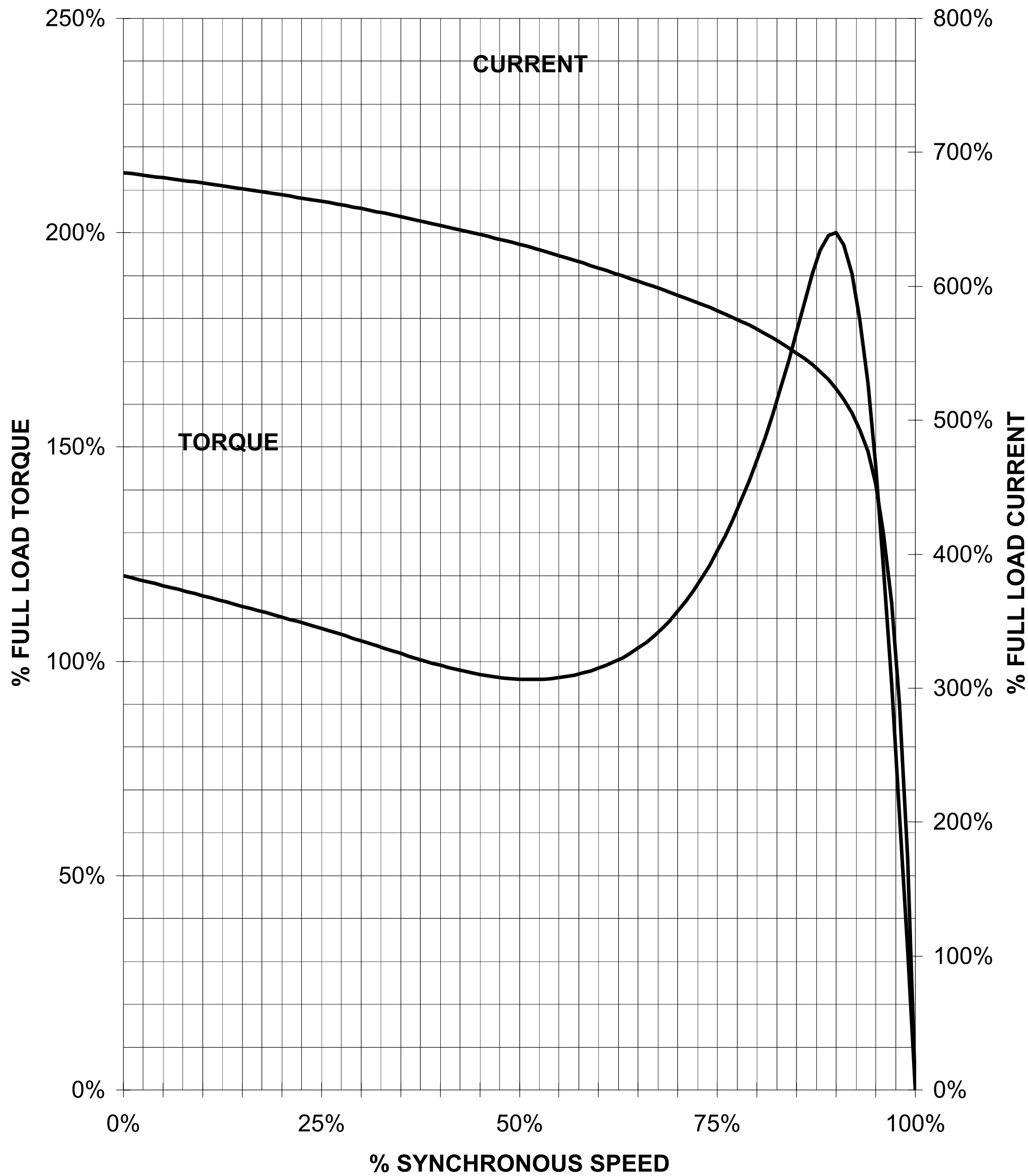


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	200	VOLTS	460	RPM	3600	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	447TS	NEMA	B

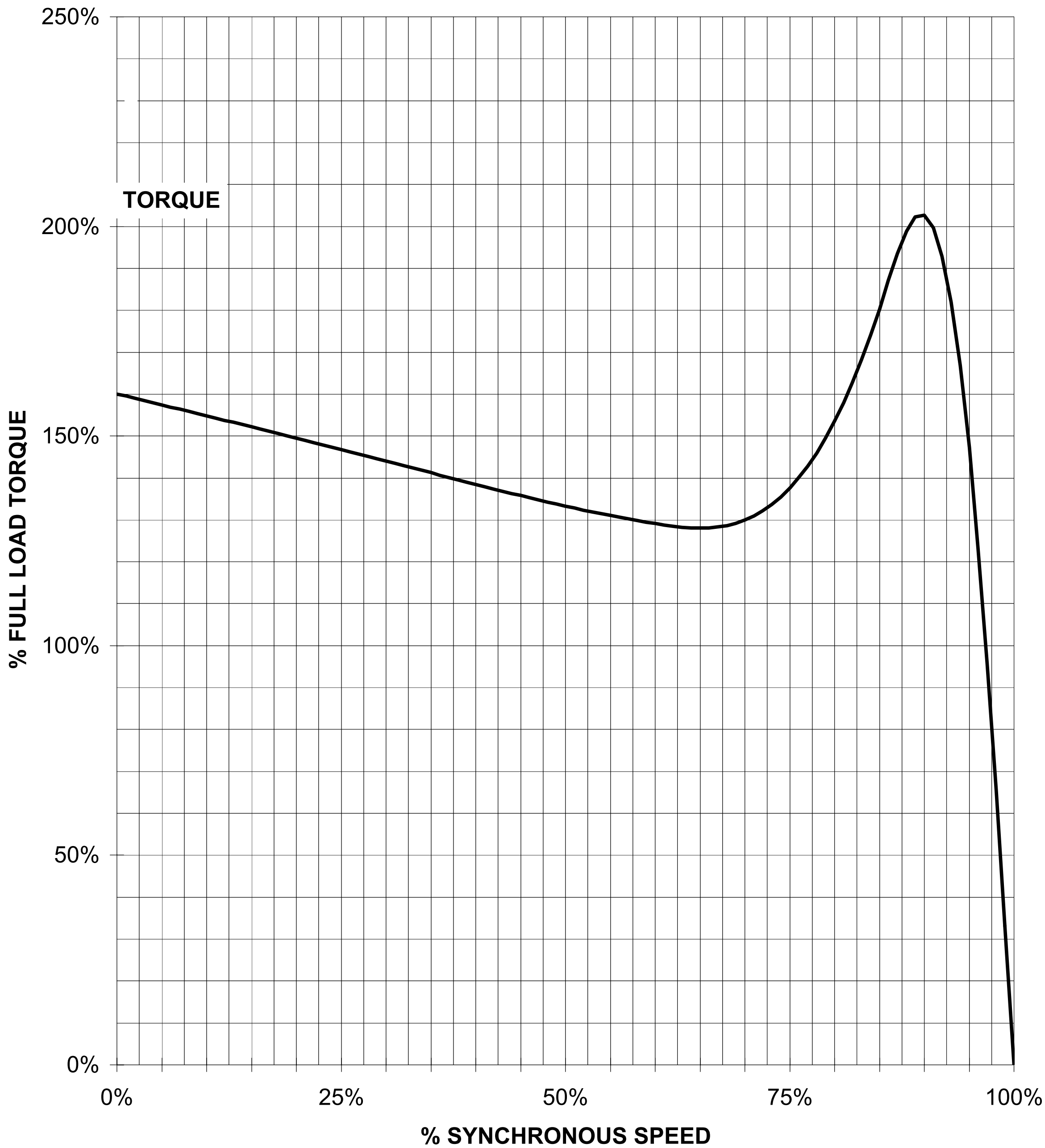
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	200	VOLTS	460	RPM	1800	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	447T	NEMA	B

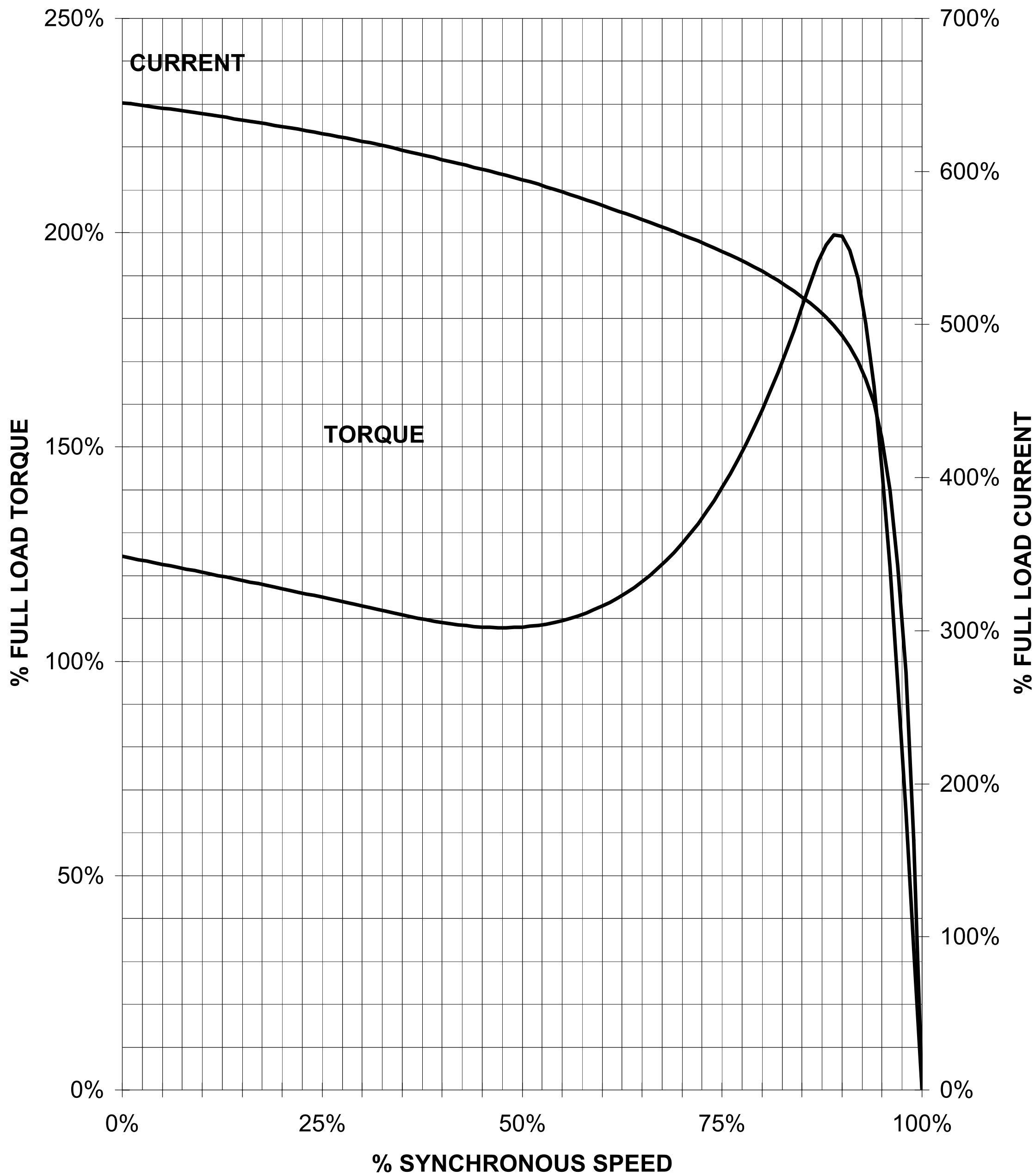
TORQUE VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	200	VOLTS	460	RPM	1200	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	449TS	NEMA	B

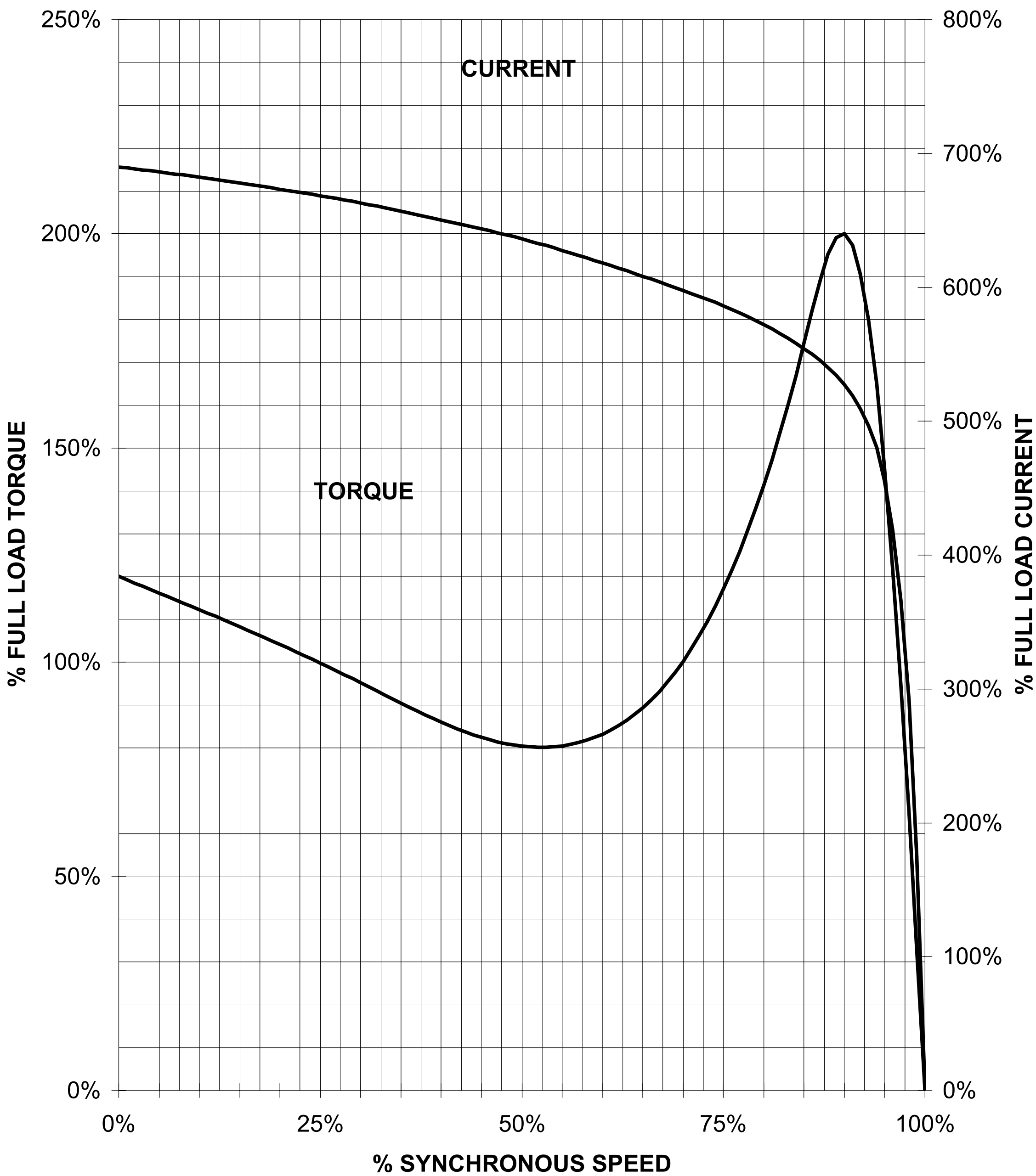
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	250	VOLTS	460	RPM	3600	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	449TS	NEMA	B

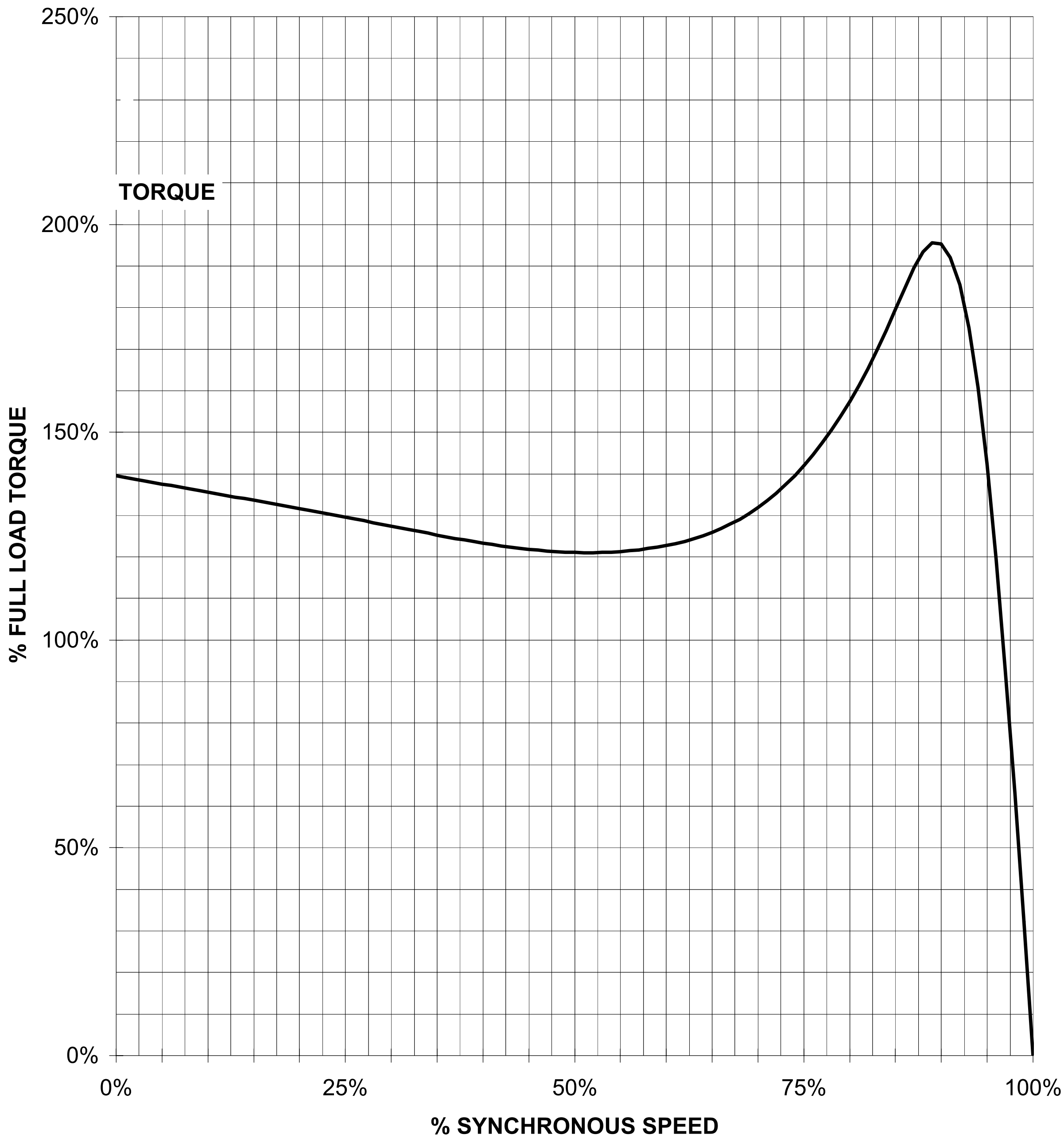
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	250	VOLTS	460	RPM	1800	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	449TS	NEMA	A

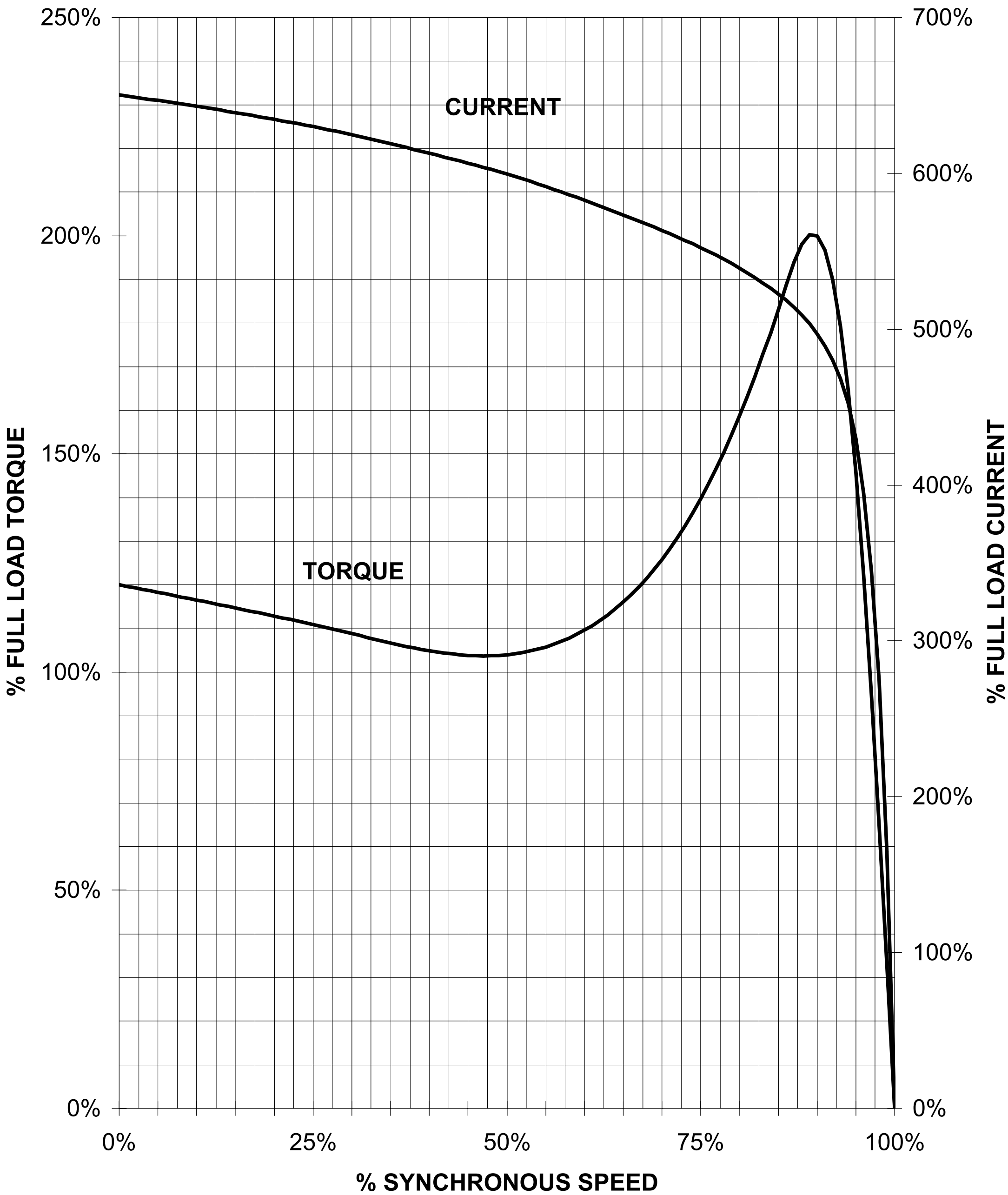
TORQUE VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	250	VOLTS	460	RPM	1200	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	449TS	NEMA	A

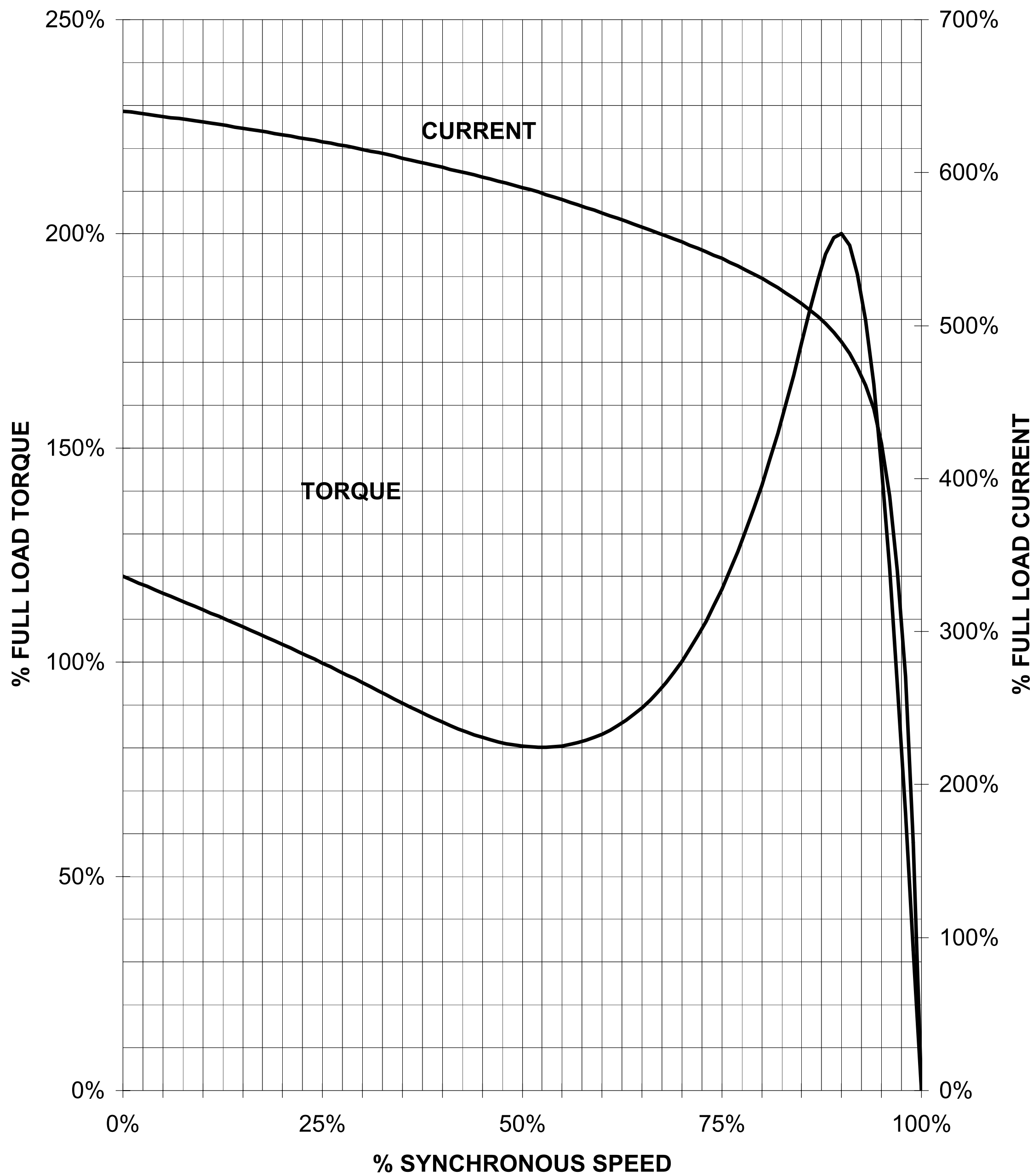
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	300	VOLTS	460	RPM	1800	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	S449	NEMA	A

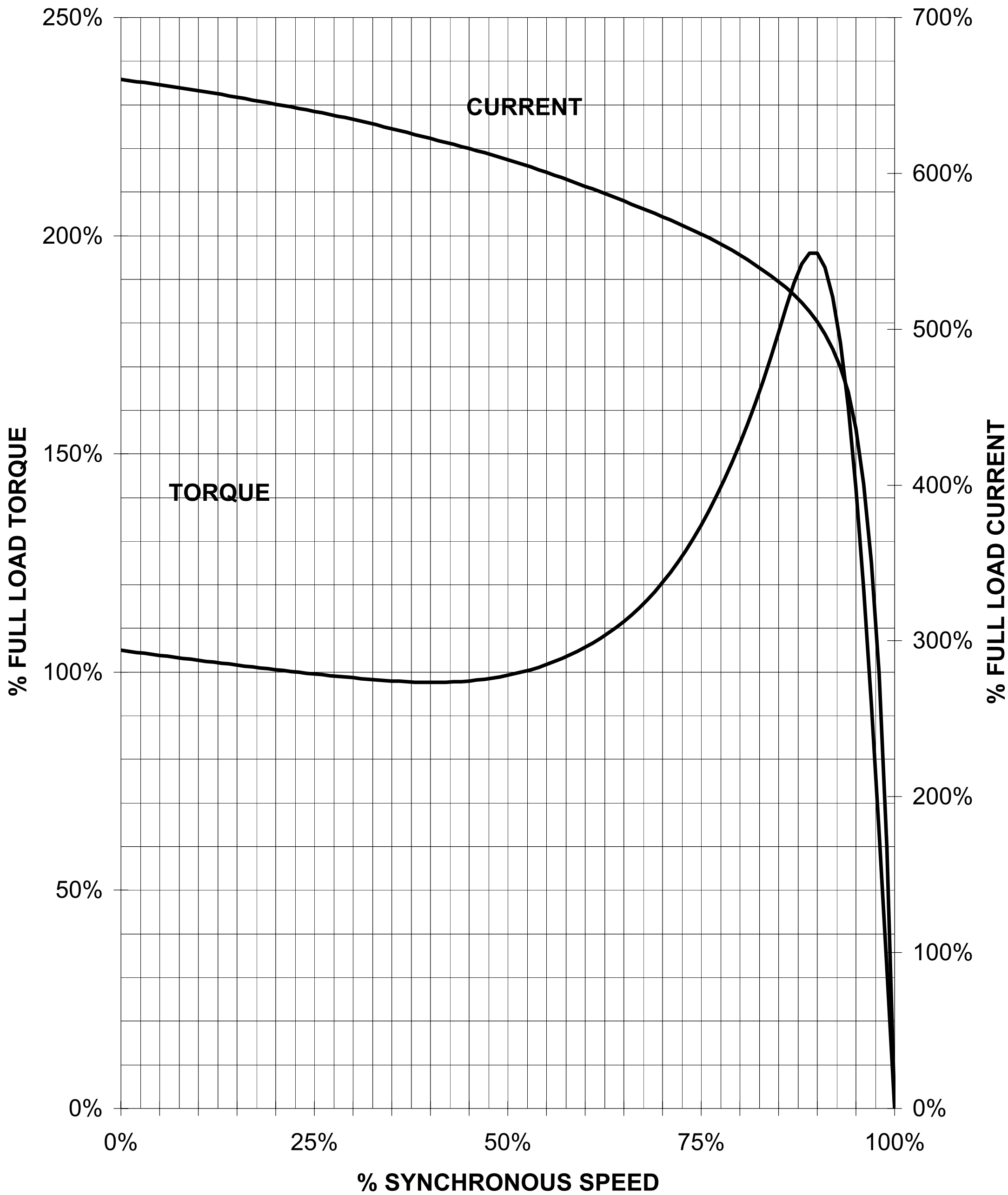
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	300	VOLTS	460	RPM	1200	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	S449	NEMA	A

TORQUE & CURRENT VS. SPEED

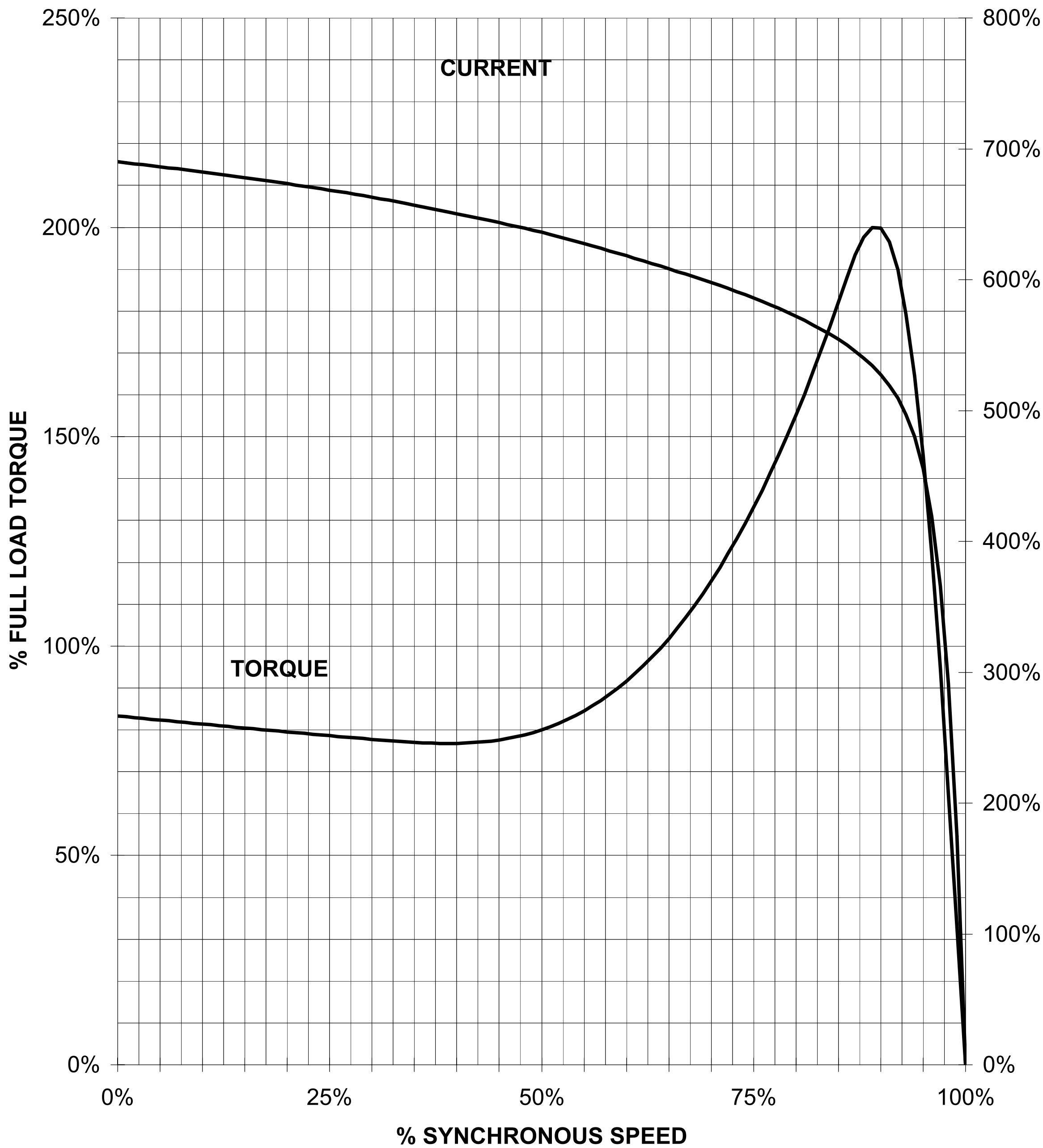


Customer: **PO No.:** **Order No.:**

HP 350 VOLTS 460 RPM 3600 TYPE RGZEESDX

HZ 60 PHASE 3 FRAME S449SS NEMA B

TORQUE & CURRENT VS. SPEED

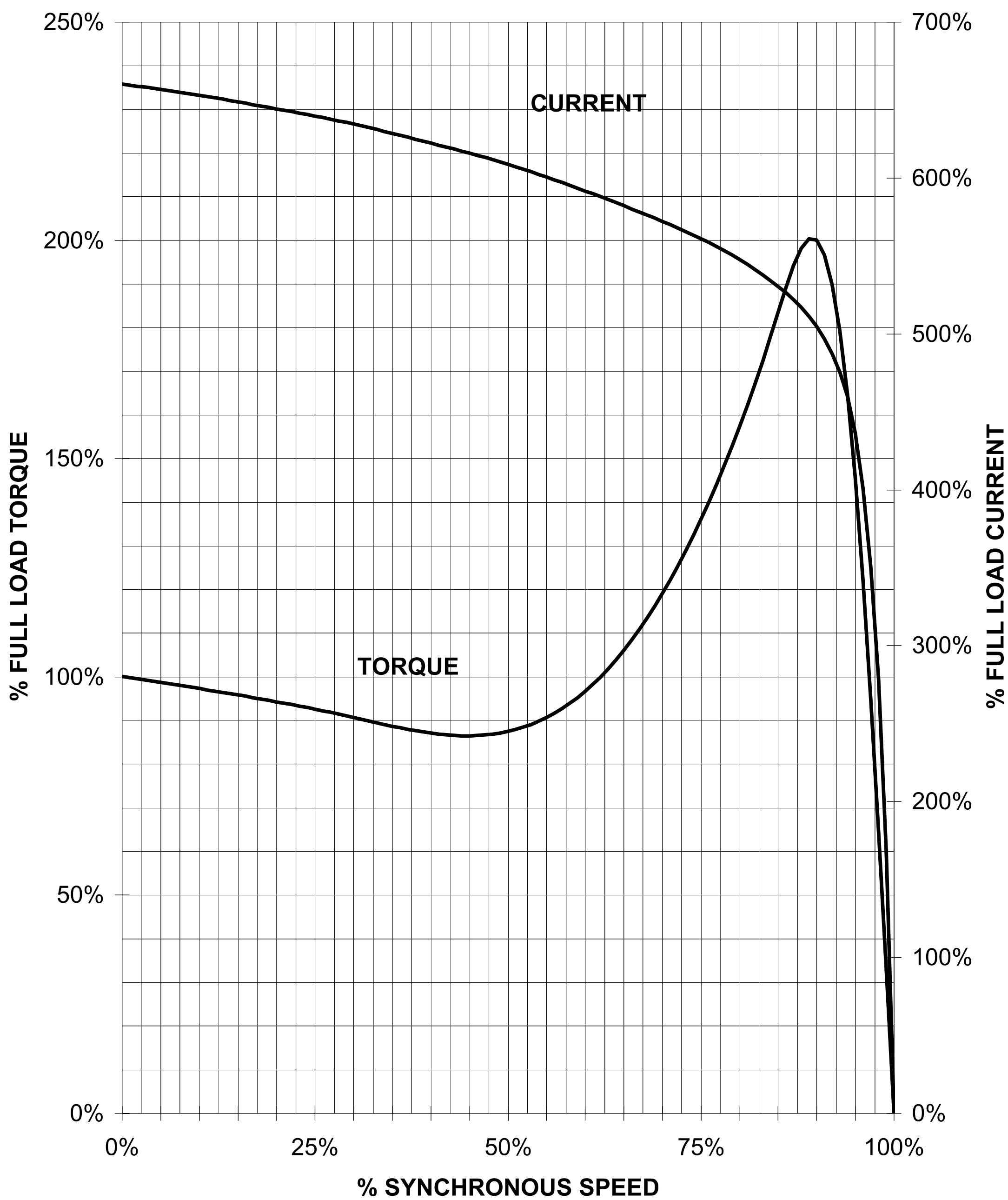


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	350	VOLTS	460	RPM	1800	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	S449	NEMA	B

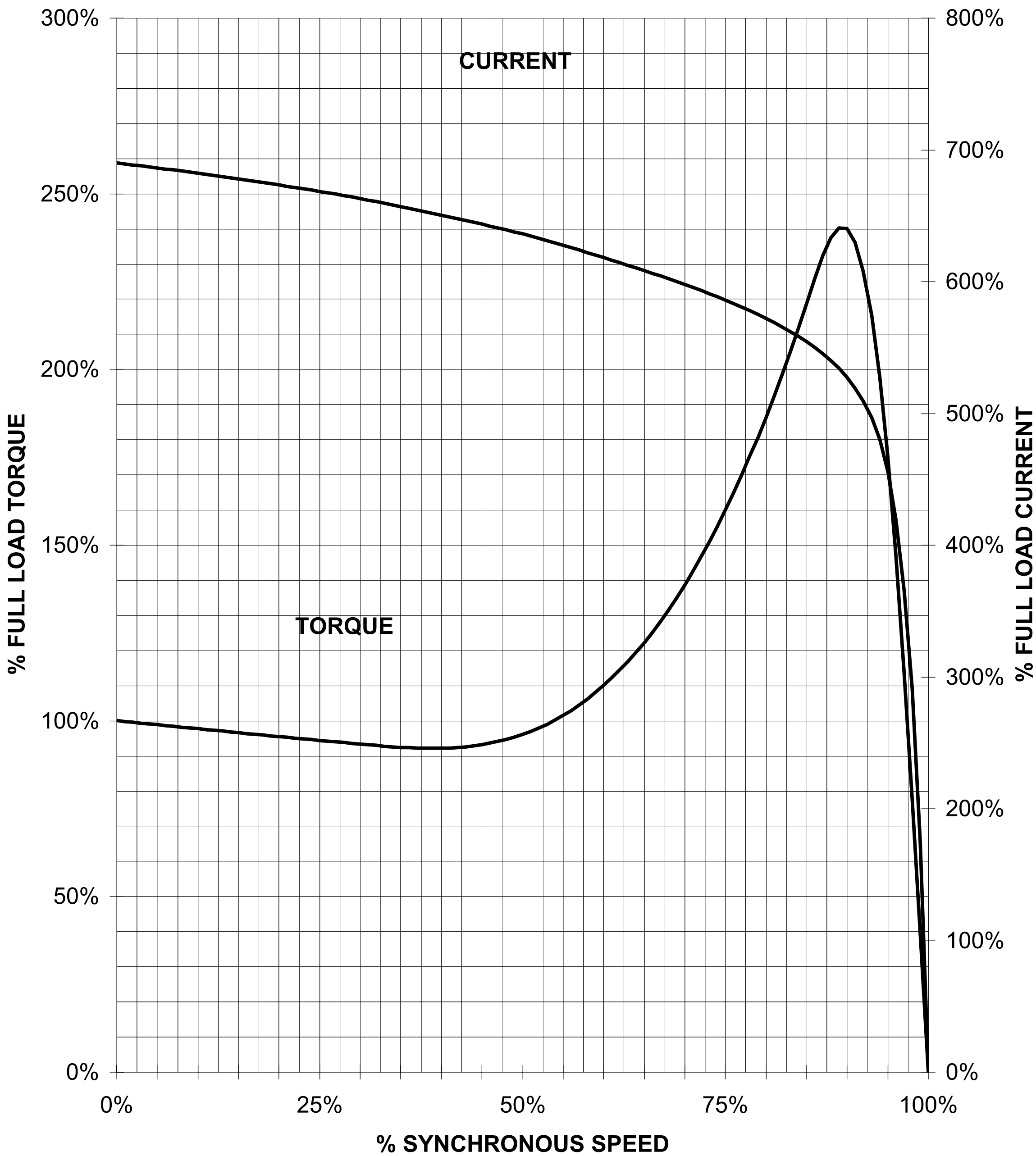
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	400	VOLTS	460	RPM	3600	TYPE	RGZEESDX
HZ	60	PHASE	3	FRAME	S449SS	NEMA	B

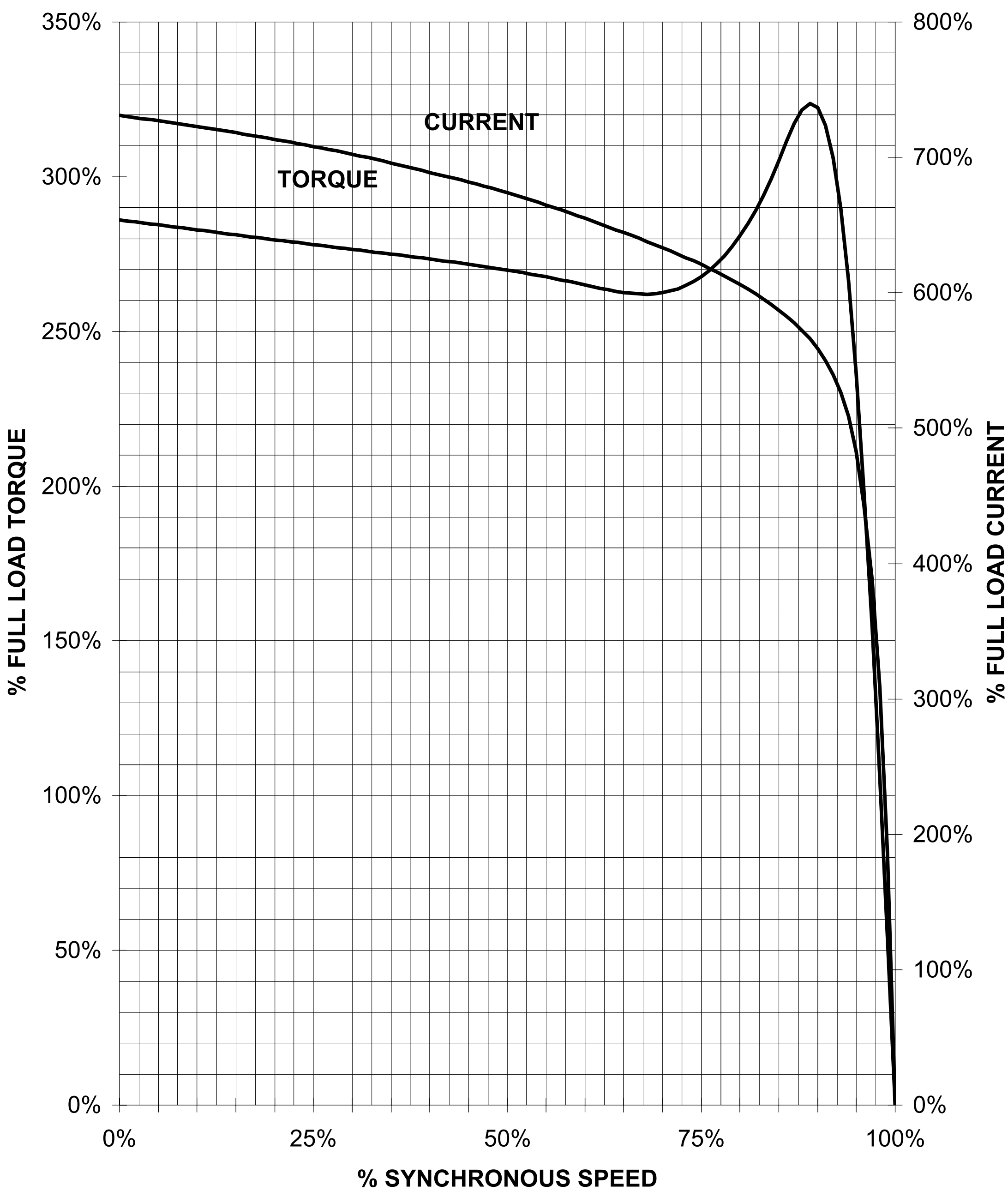
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1	VOLTS	230/460	RPM	1800	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	143T	NEMA	B

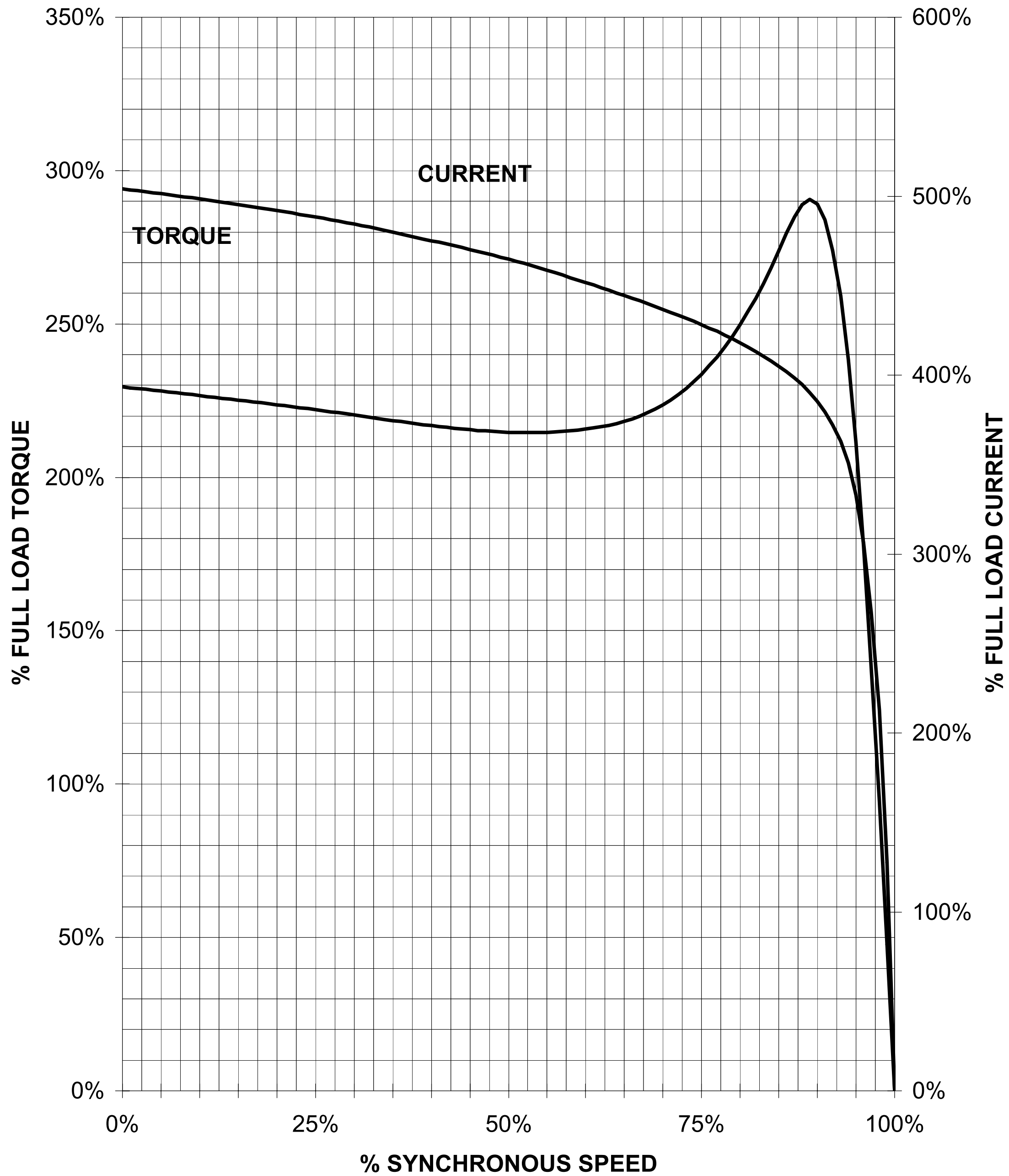
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1	VOLTS	230/460	RPM	1200	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	145T	NEMA	B

TORQUE & CURRENT VS. SPEED

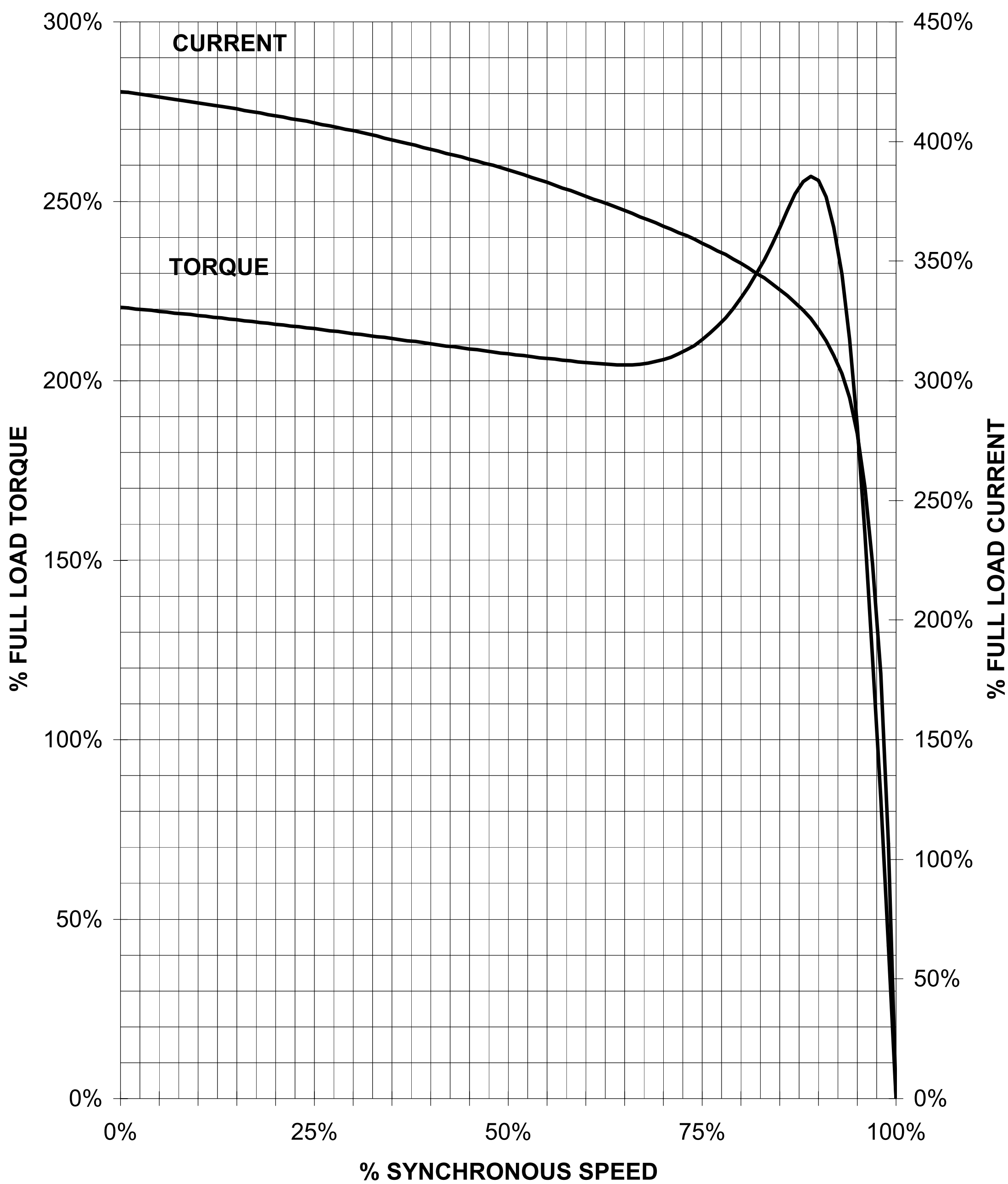


Customer: **PO No.:** **Order No.:**

HP 1 VOLTS 230/460 RPM 900 TYPE RGZESD

HZ 60 PHASE 3 FRAME 182T NEMA B

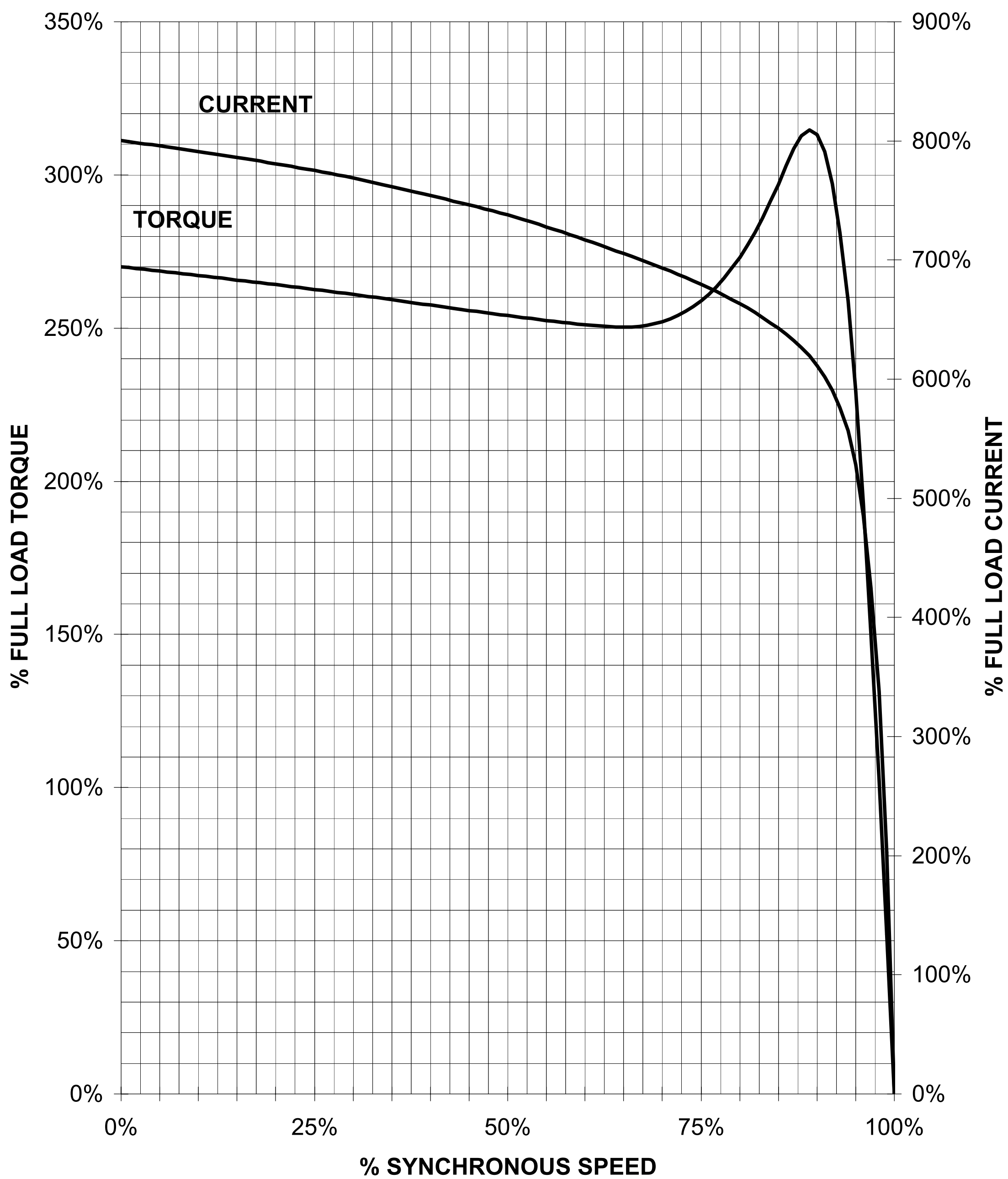
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1.5	VOLTS	230/460	RPM	3600	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	143T	NEMA	B

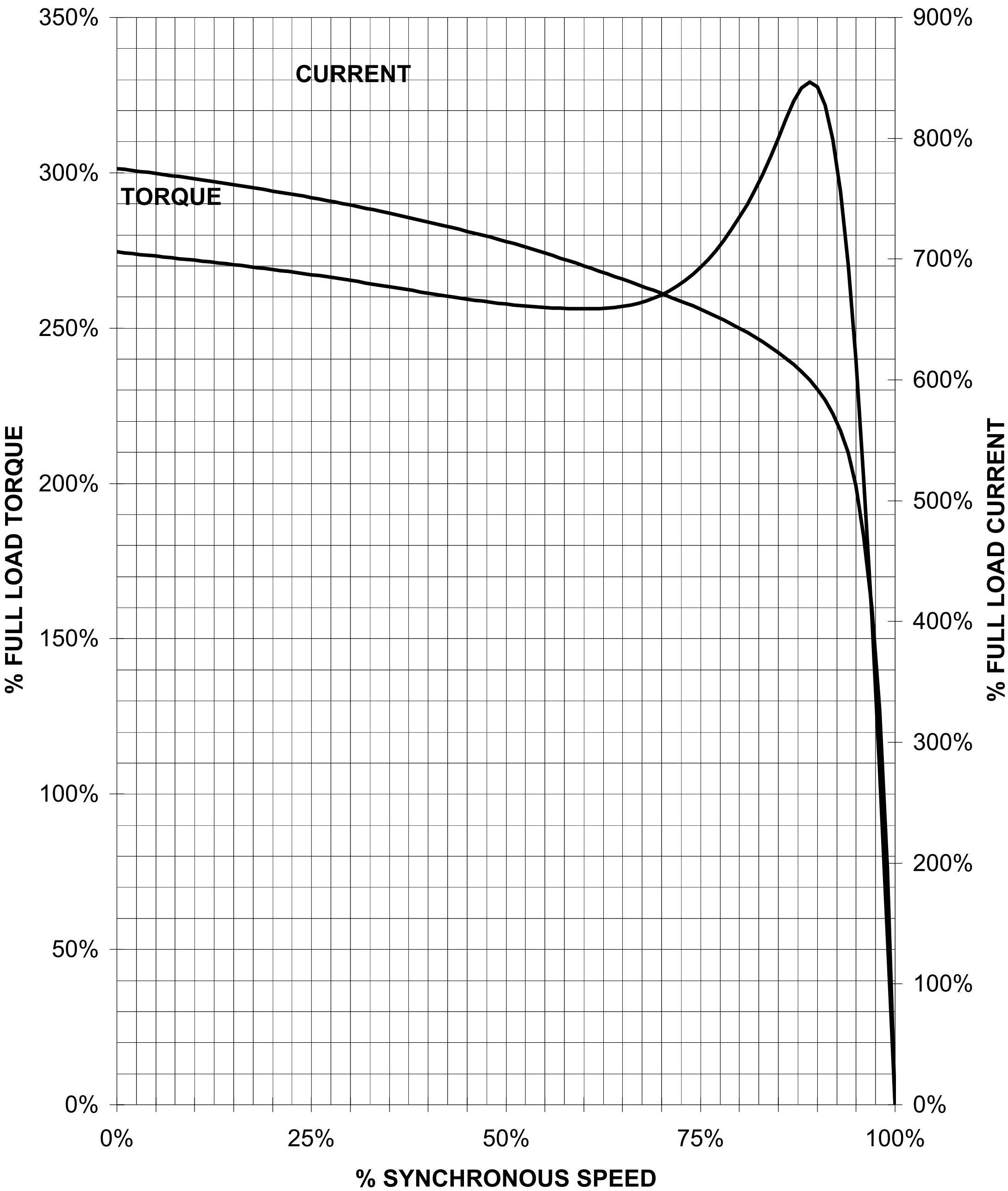
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1.5	VOLTS	230/460	RPM	1800	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	145T	NEMA	B

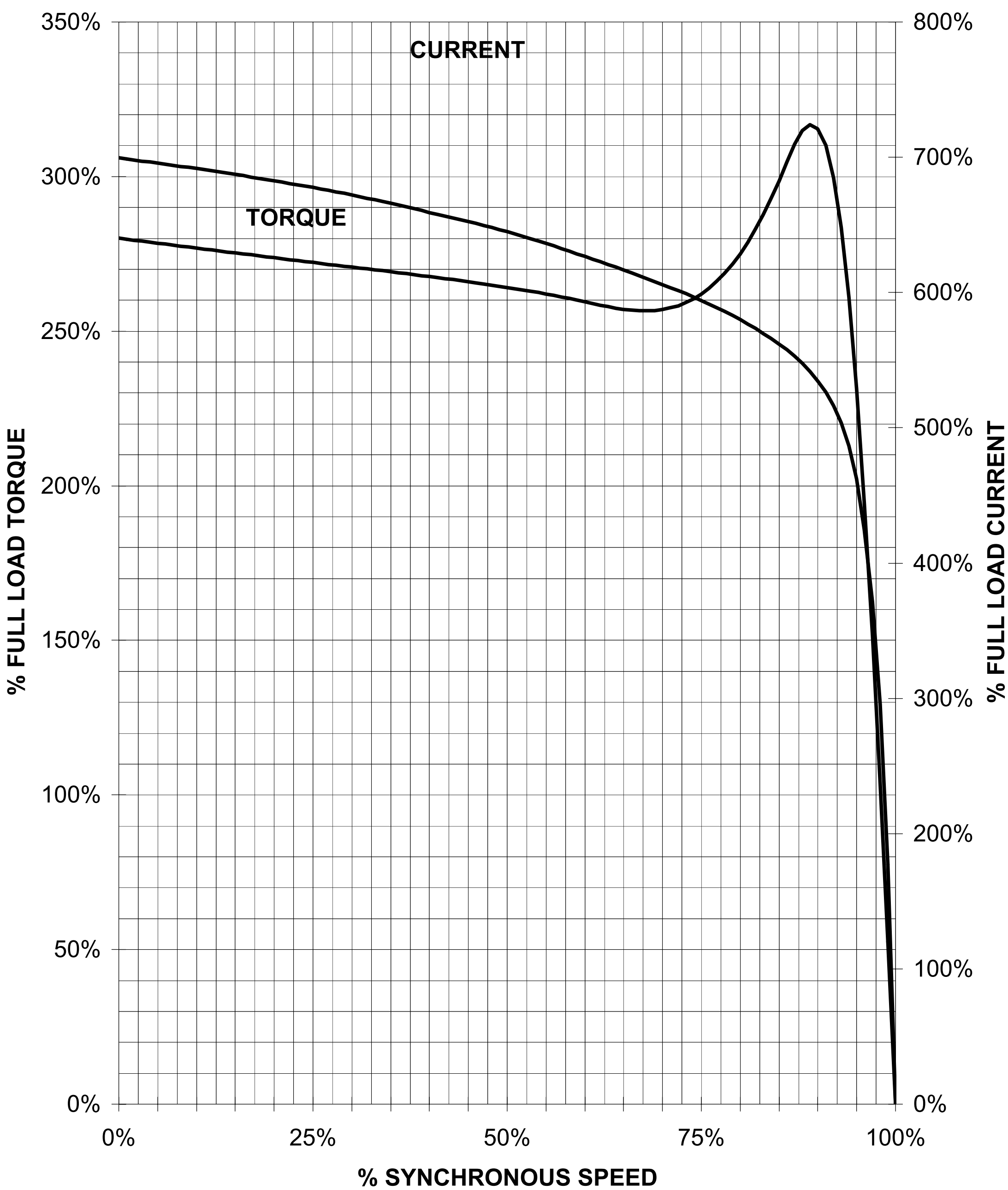
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1.5	VOLTS	230/460	RPM	1200	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	182T	NEMA	B

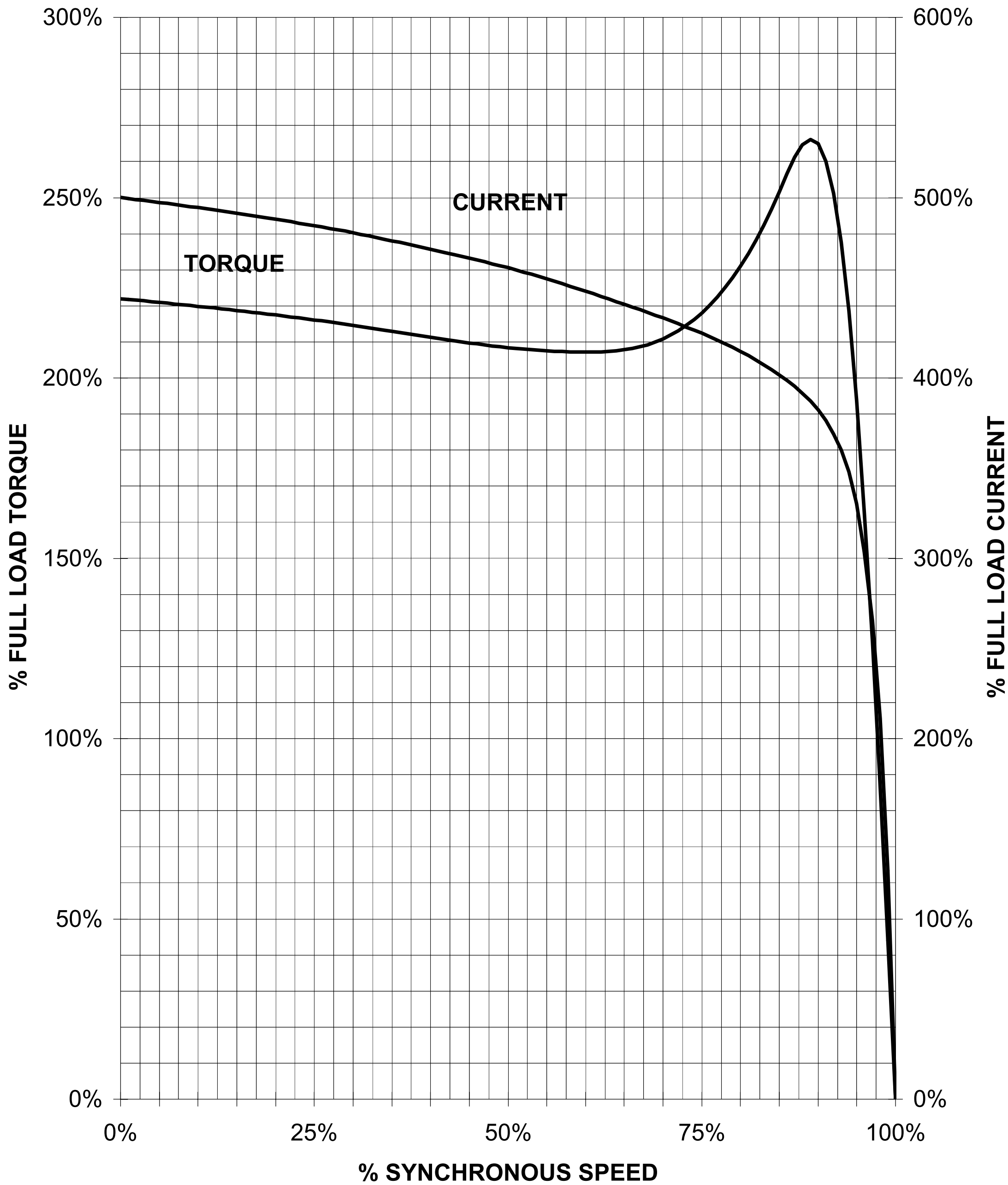
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1.5	VOLTS	230/460	RPM	900	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	184T	NEMA	B

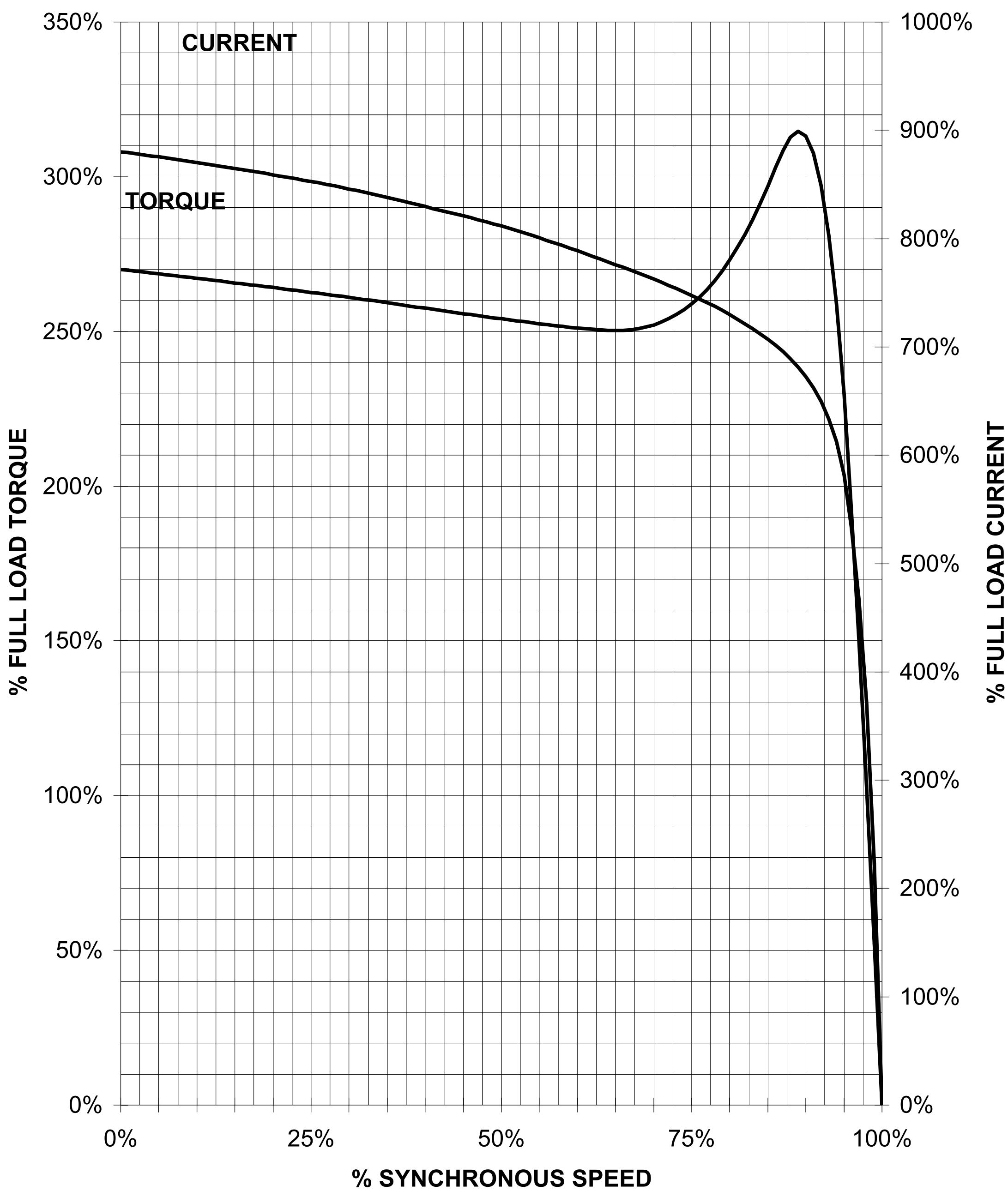
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	2	VOLTS	230/460	RPM	3600	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	145T	NEMA	B

TORQUE & CURRENT VS. SPEED

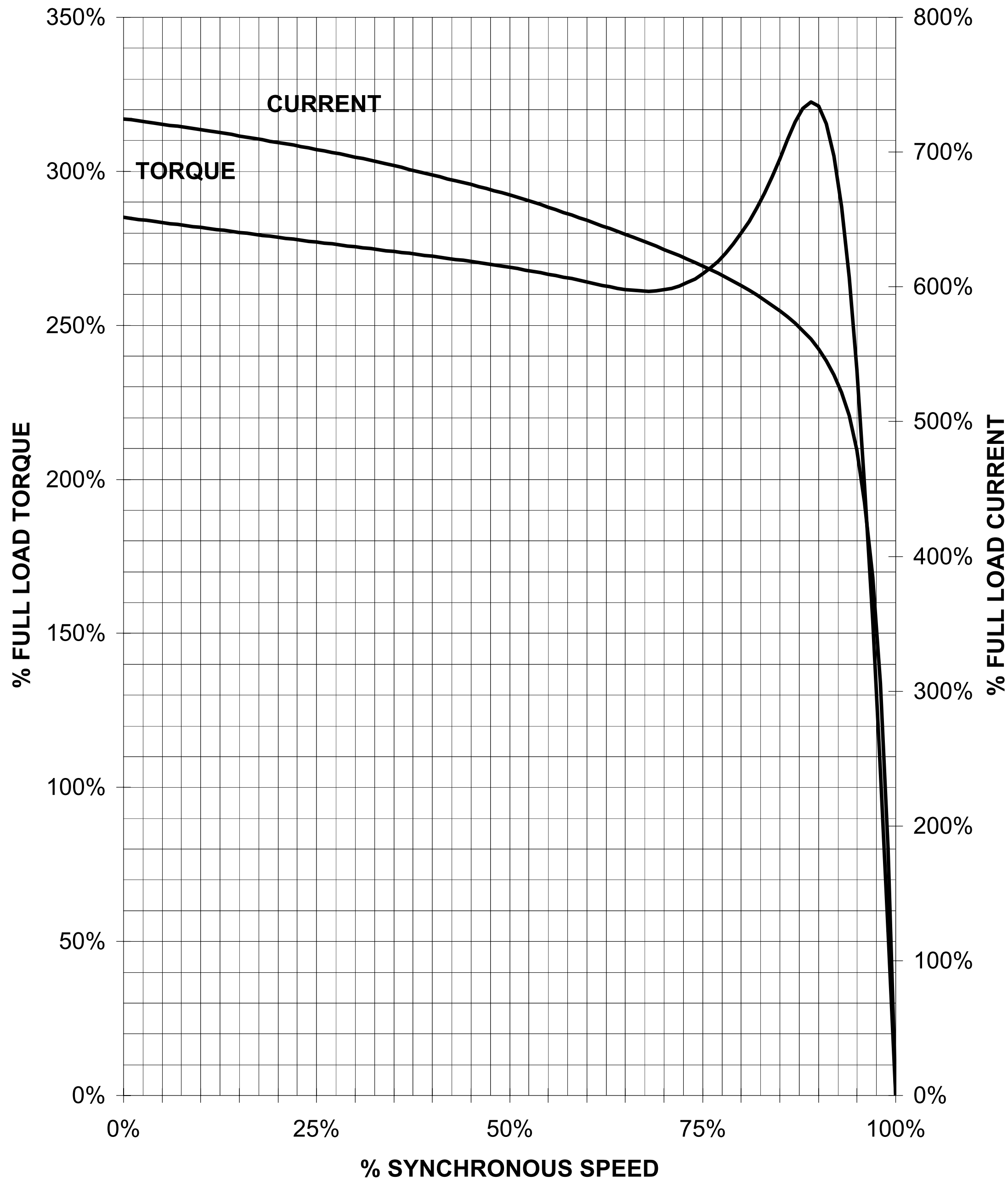


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	2	VOLTS	230/460	RPM	1800	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	145T	NEMA	B

TORQUE & CURRENT VS. SPEED

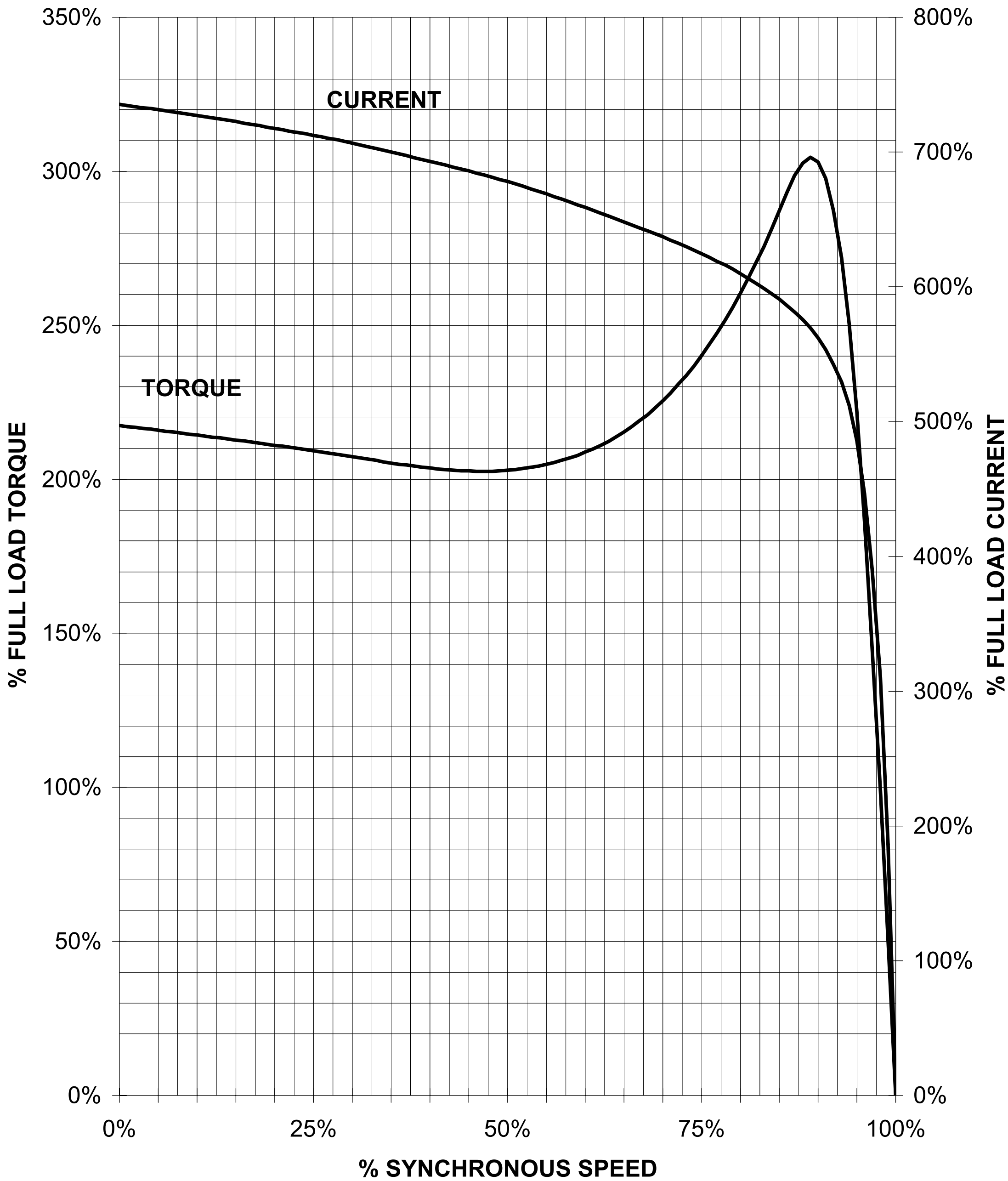


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	2	VOLTS	230/460	RPM	1200	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	184T	NEMA	B

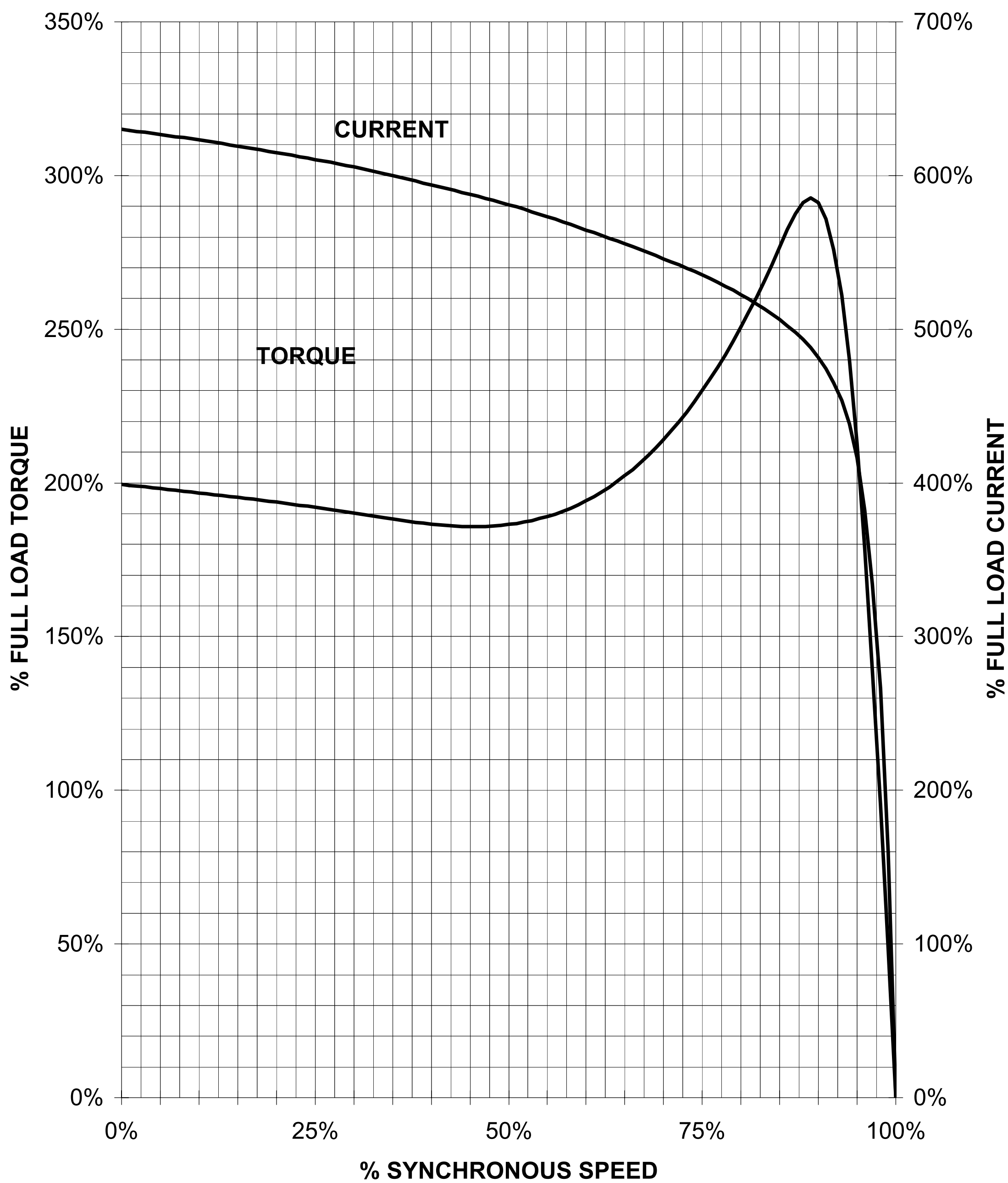
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	2	VOLTS	230/460	RPM	900	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	213T	NEMA	B

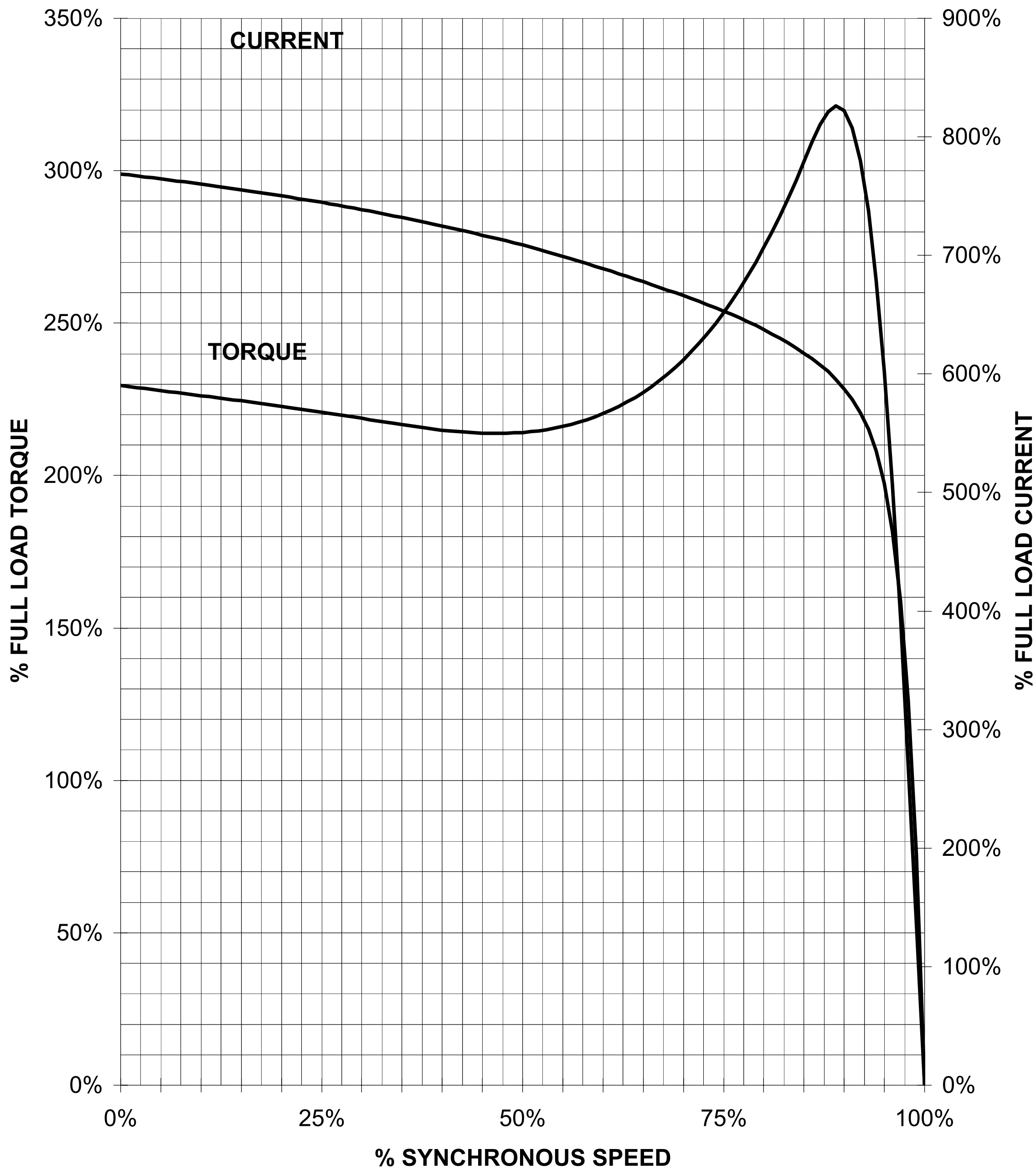
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	3	VOLTS	230/460	RPM	3600	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	182T	NEMA	B

TORQUE & CURRENT VS. SPEED

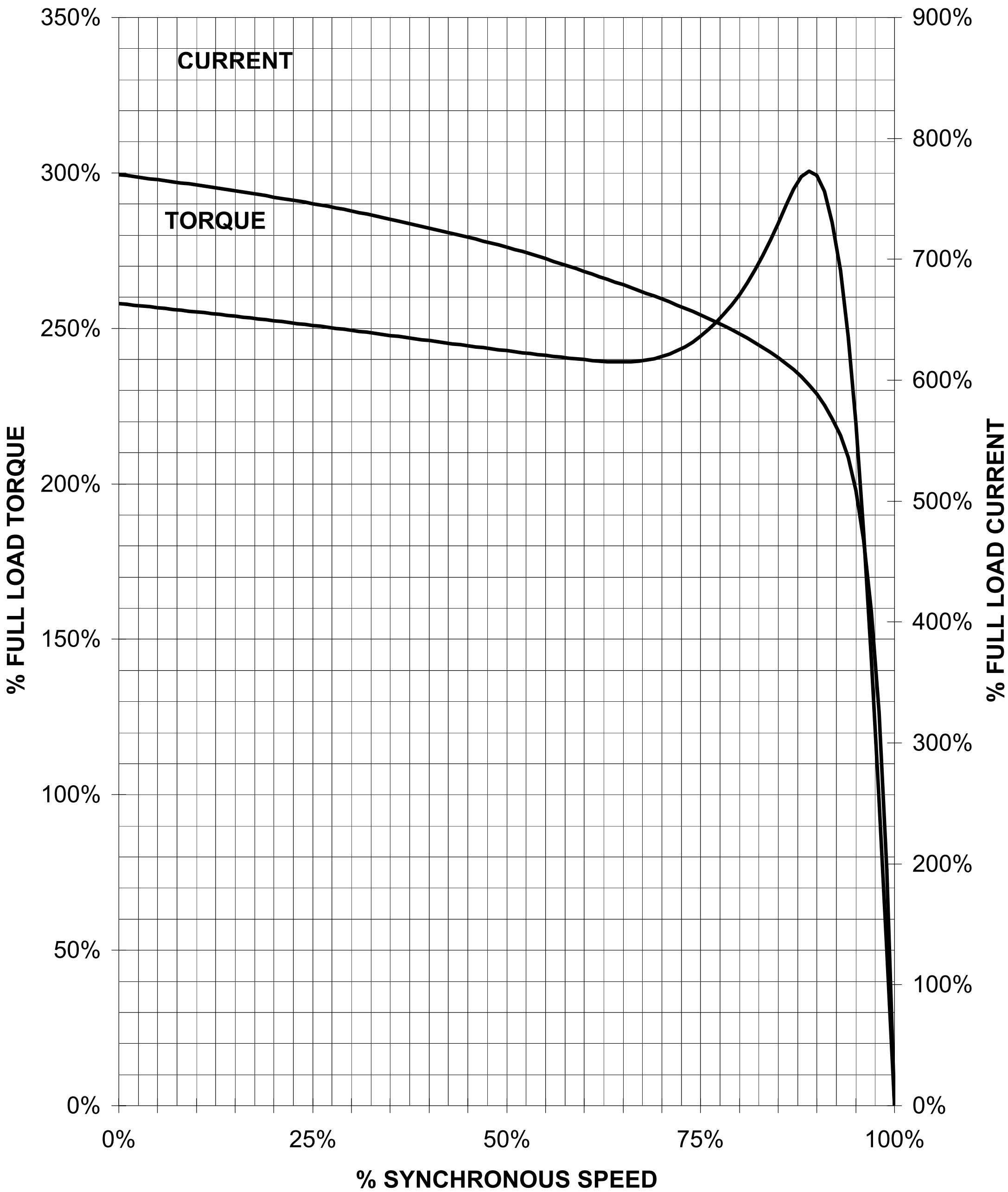


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	3	VOLTS	230/460	RPM	1800	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	182T	NEMA	B

TORQUE & CURRENT VS. SPEED

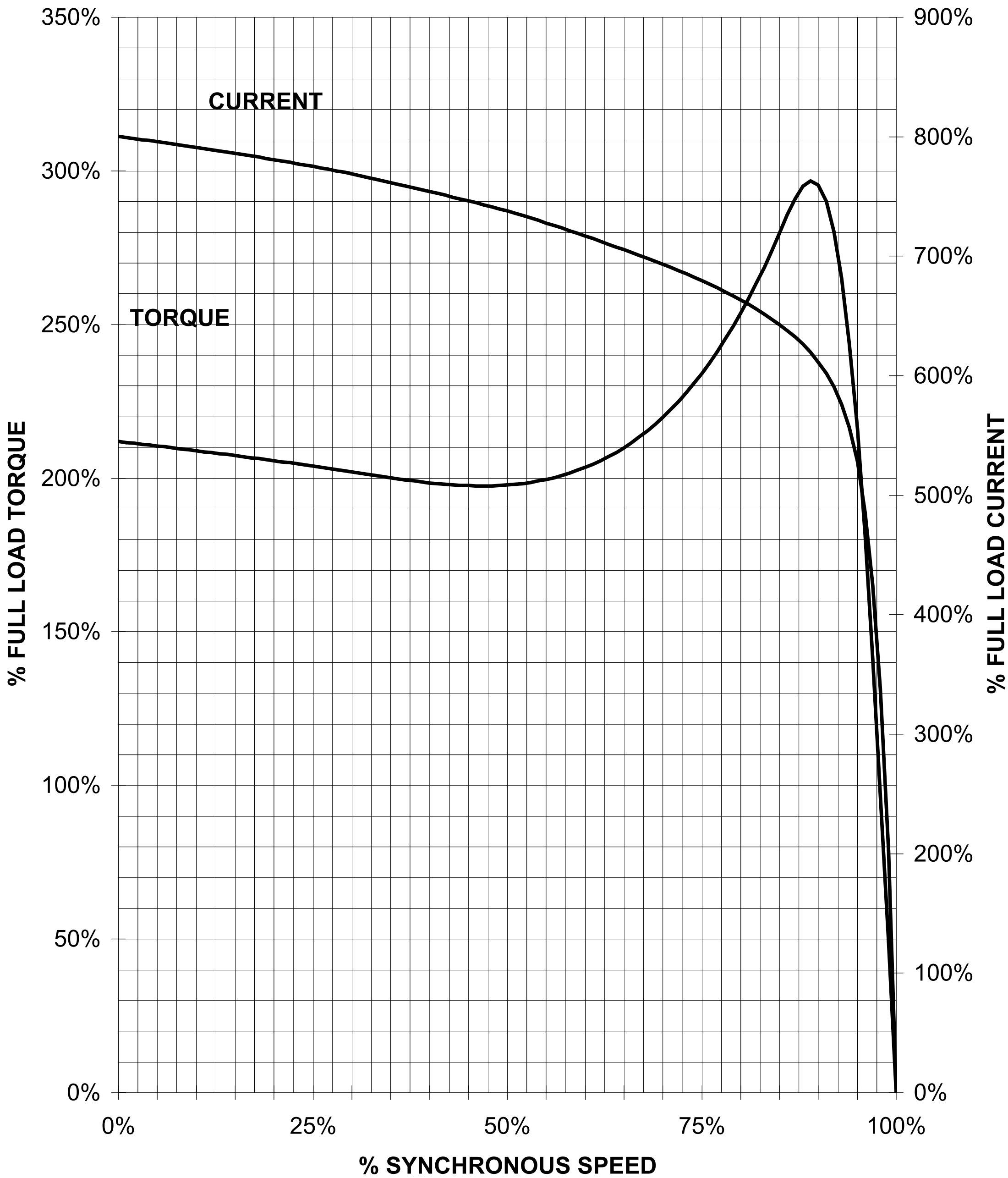


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	3	VOLTS	230/460	RPM	1200	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	213T	NEMA	B

TORQUE & CURRENT VS. SPEED

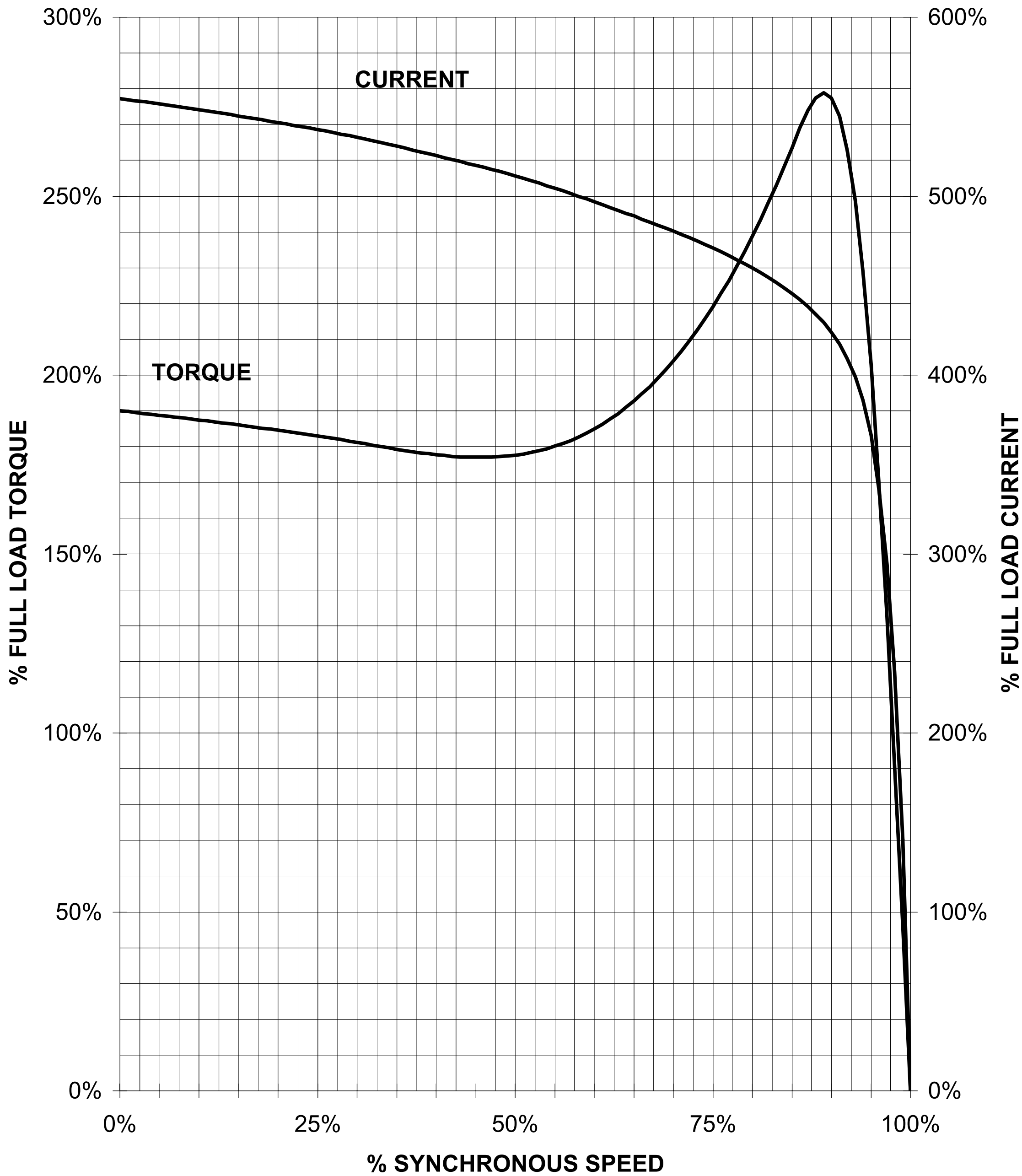


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	3	VOLTS	230/460	RPM	900	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	215T	NEMA	B

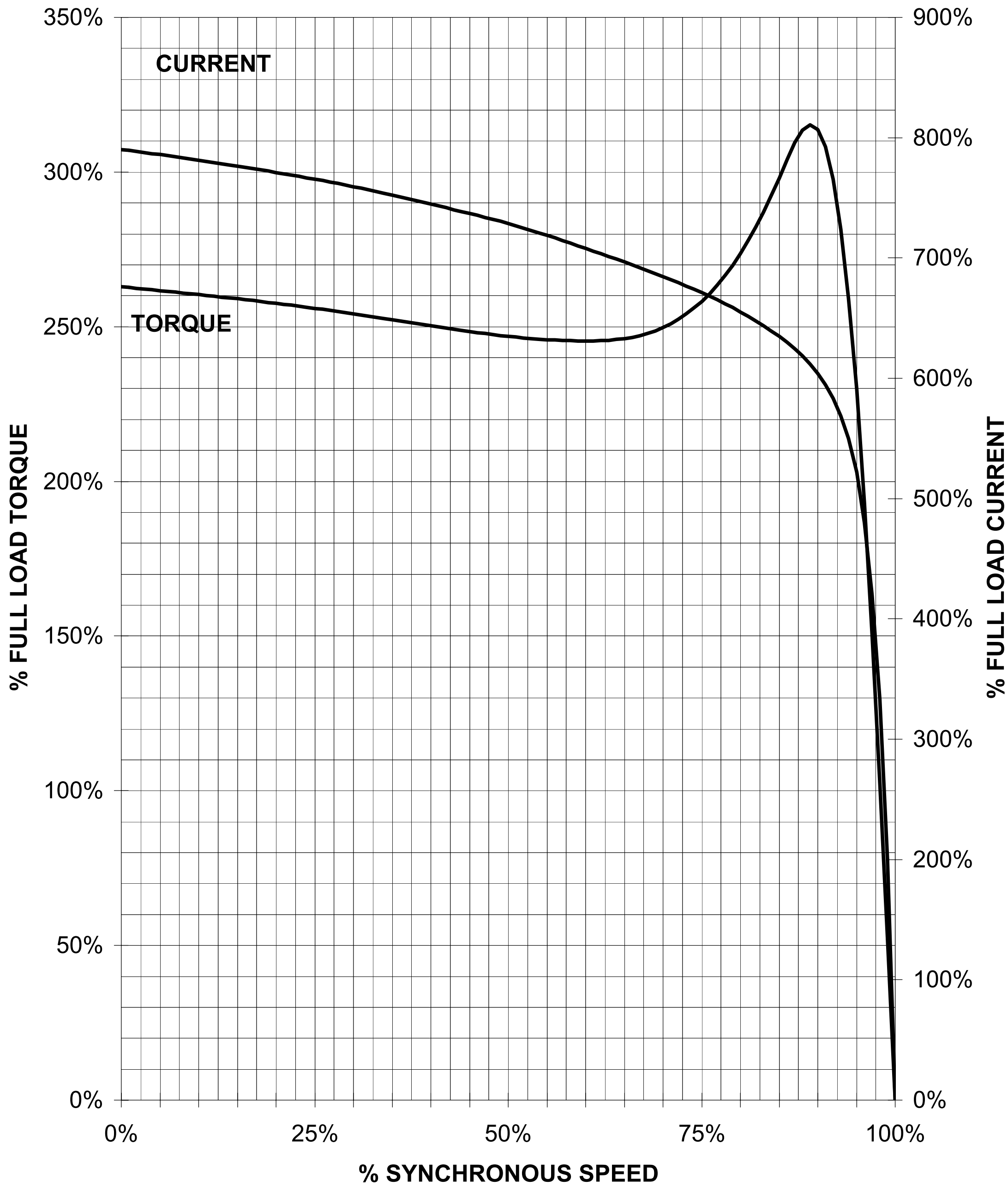
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	5	VOLTS	230/460	RPM	3600	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	184T	NEMA	B

TORQUE & CURRENT VS. SPEED

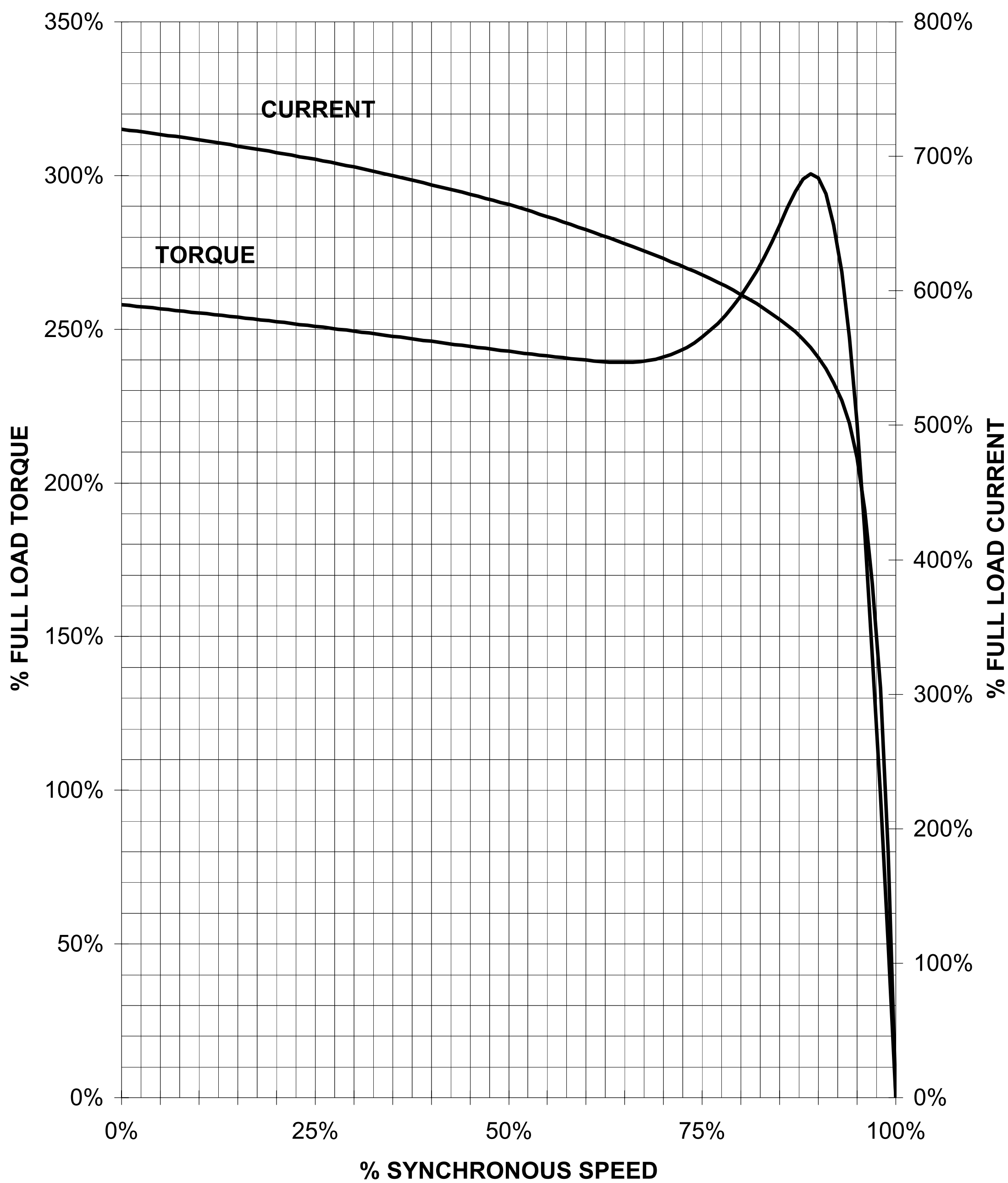


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	5	VOLTS	230/460	RPM	1800	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	184T	NEMA	B

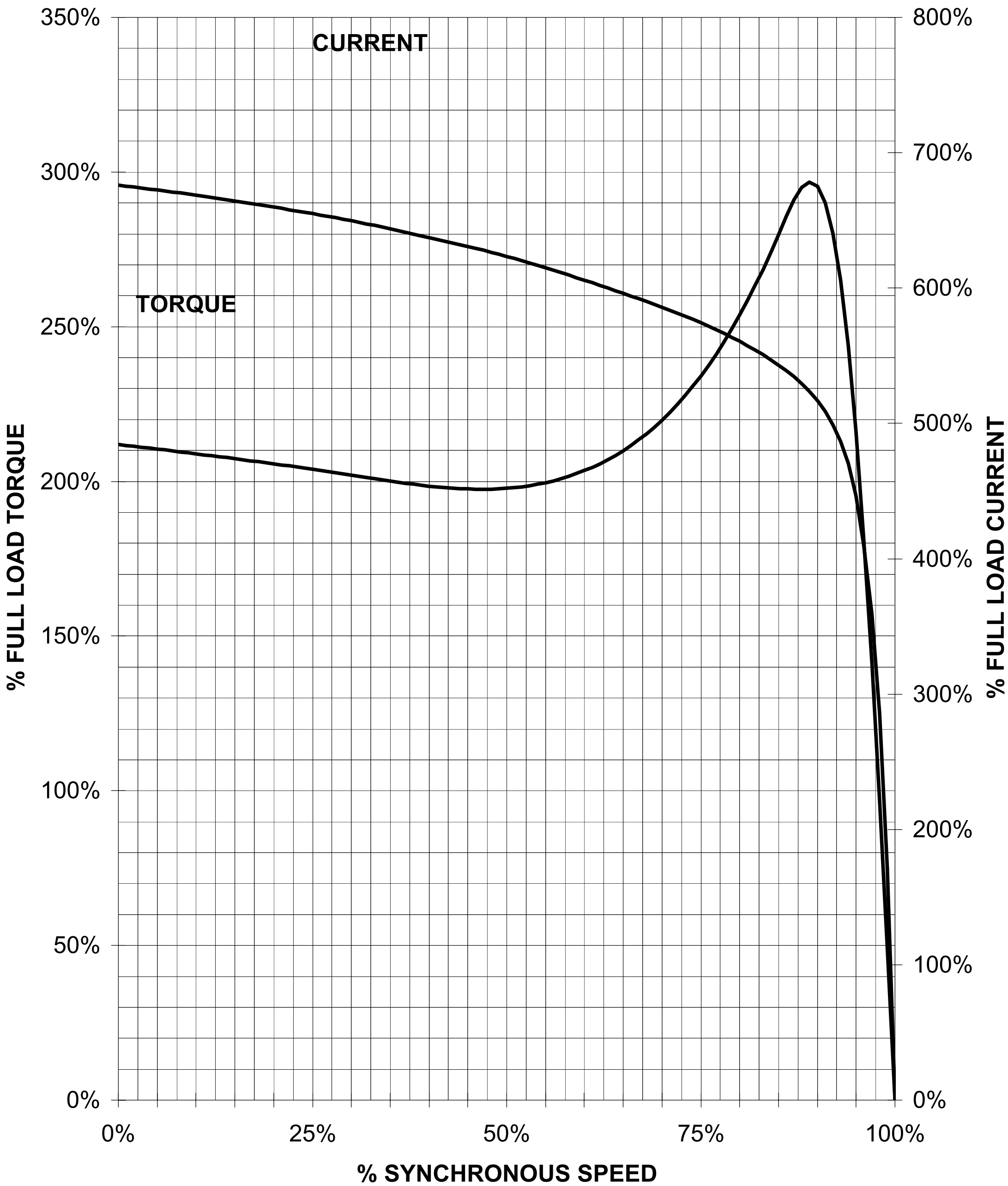
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP 5	VOLTS 230/460	RPM 1200	TYPE RGZESD
HZ 60	PHASE 3	FRAME 215T	NEMA B

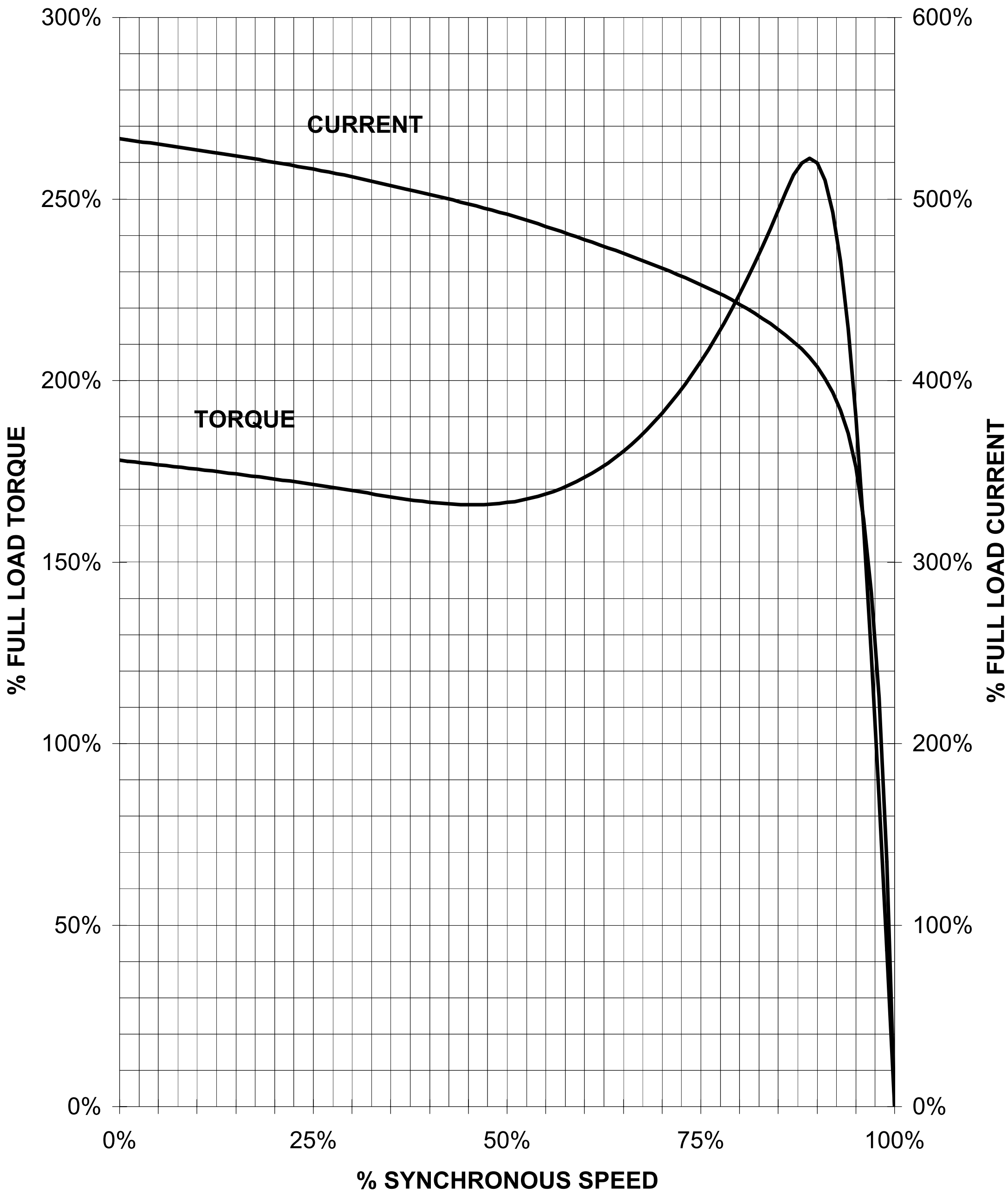
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	5	VOLTS	230/460	RPM	900	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	254T	NEMA	B

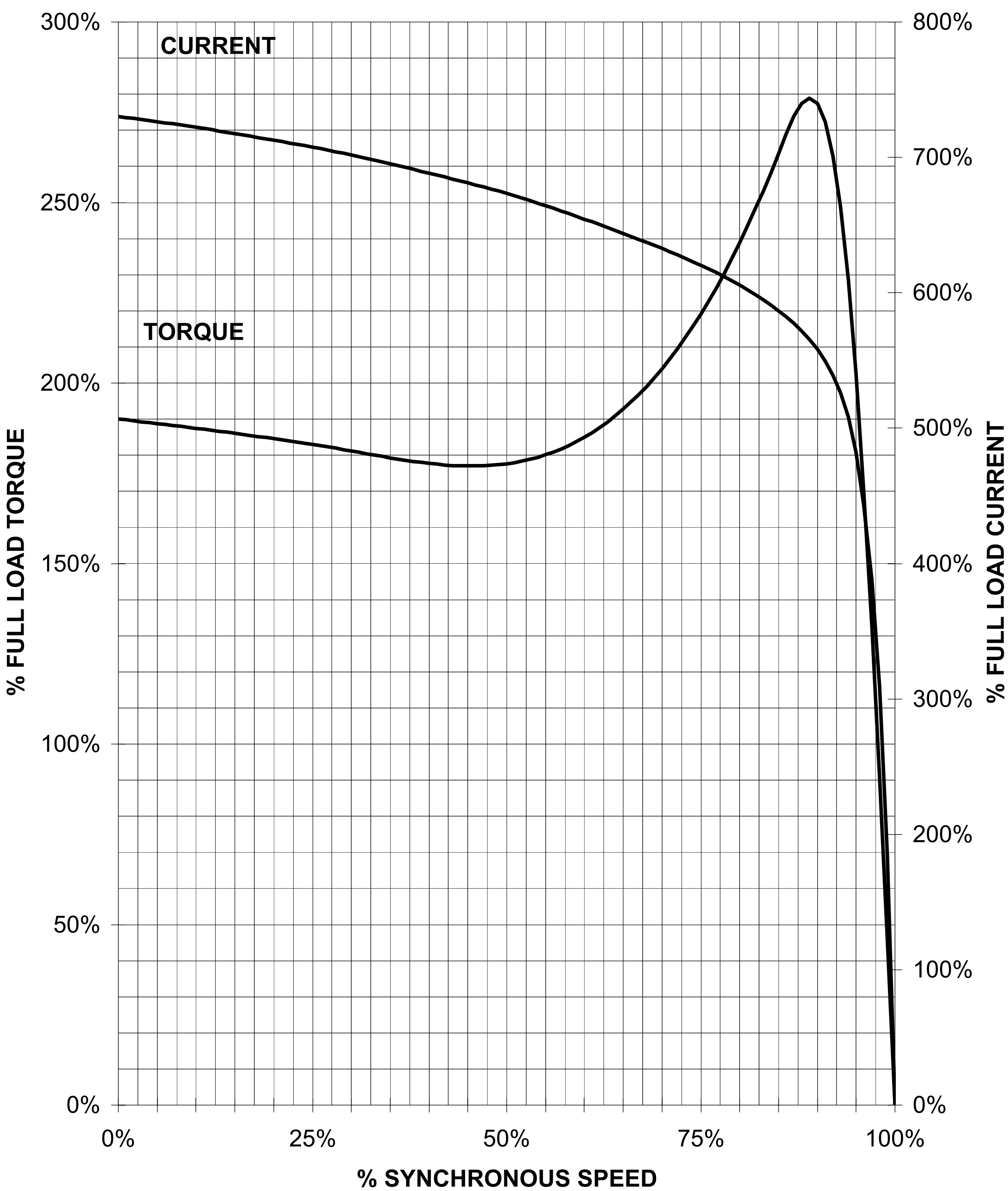
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	7.5	VOLTS	230/460	RPM	3600	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	213T	NEMA	B

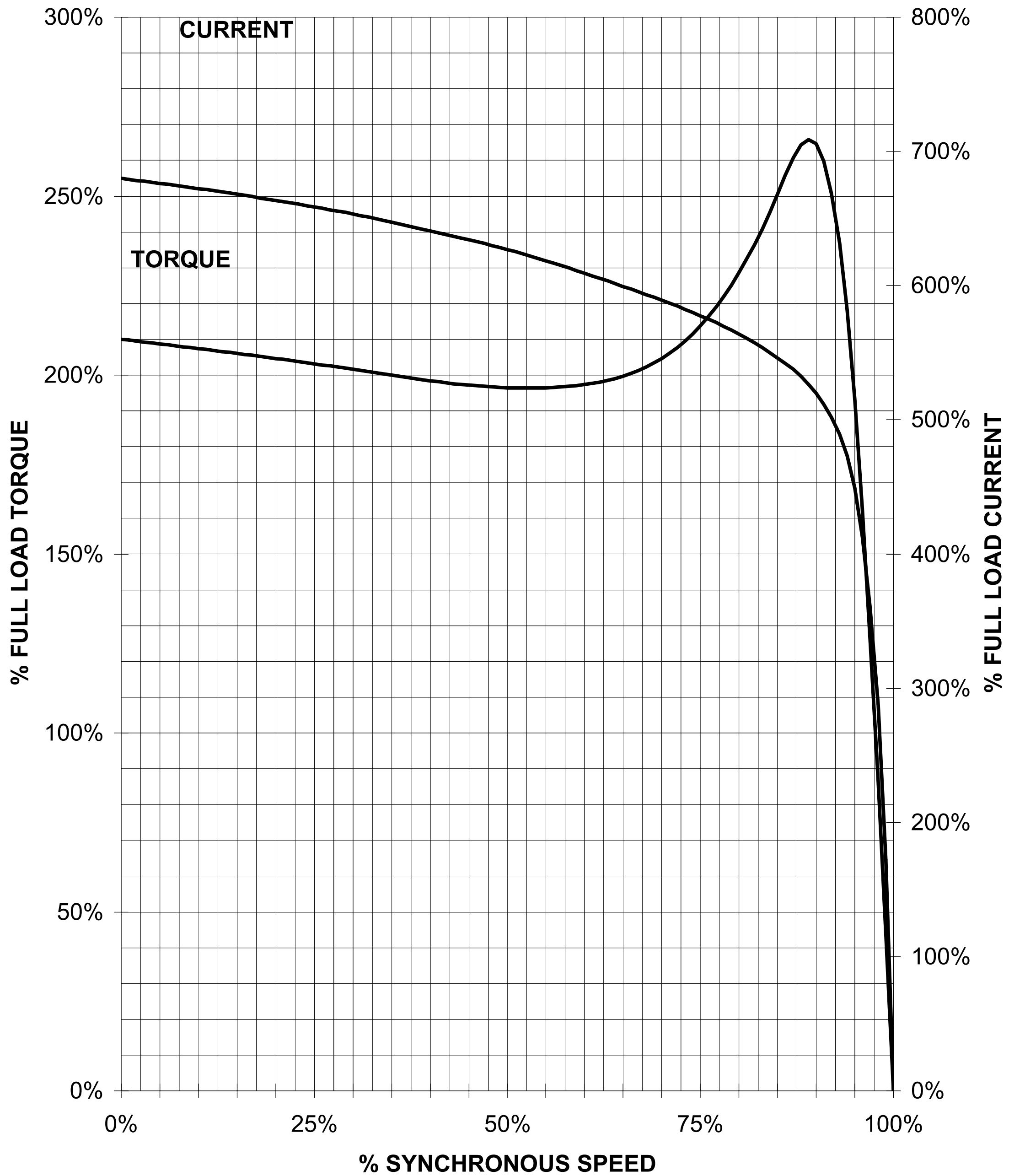
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	7.5	VOLTS	230/460	RPM	1800	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	213T	NEMA	B

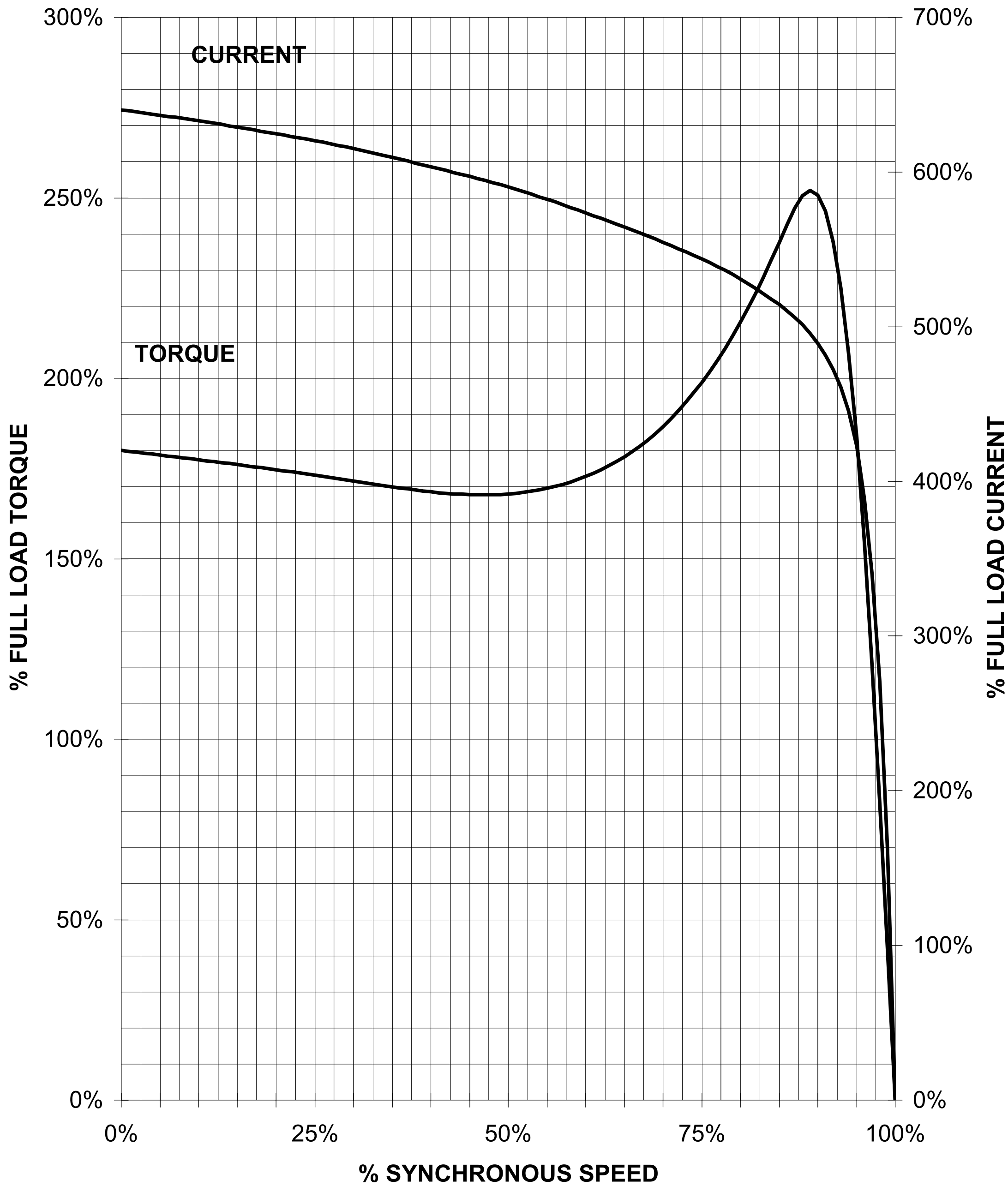
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	7.5	VOLTS	230/460	RPM	1200	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	254T	NEMA	B

TORQUE & CURRENT VS. SPEED

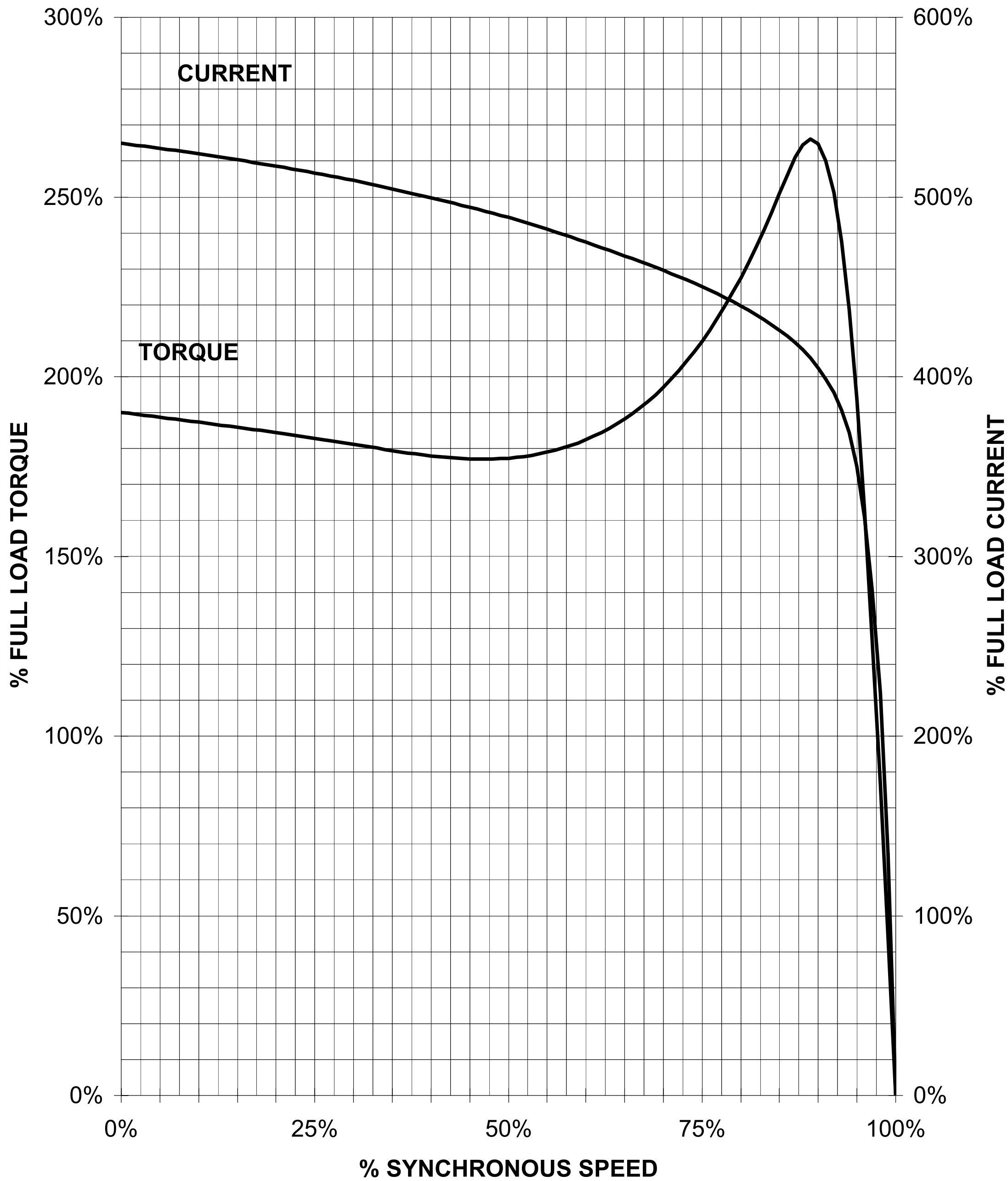


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	7.5	VOLTS	230/460	RPM	900	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	256T	NEMA	B

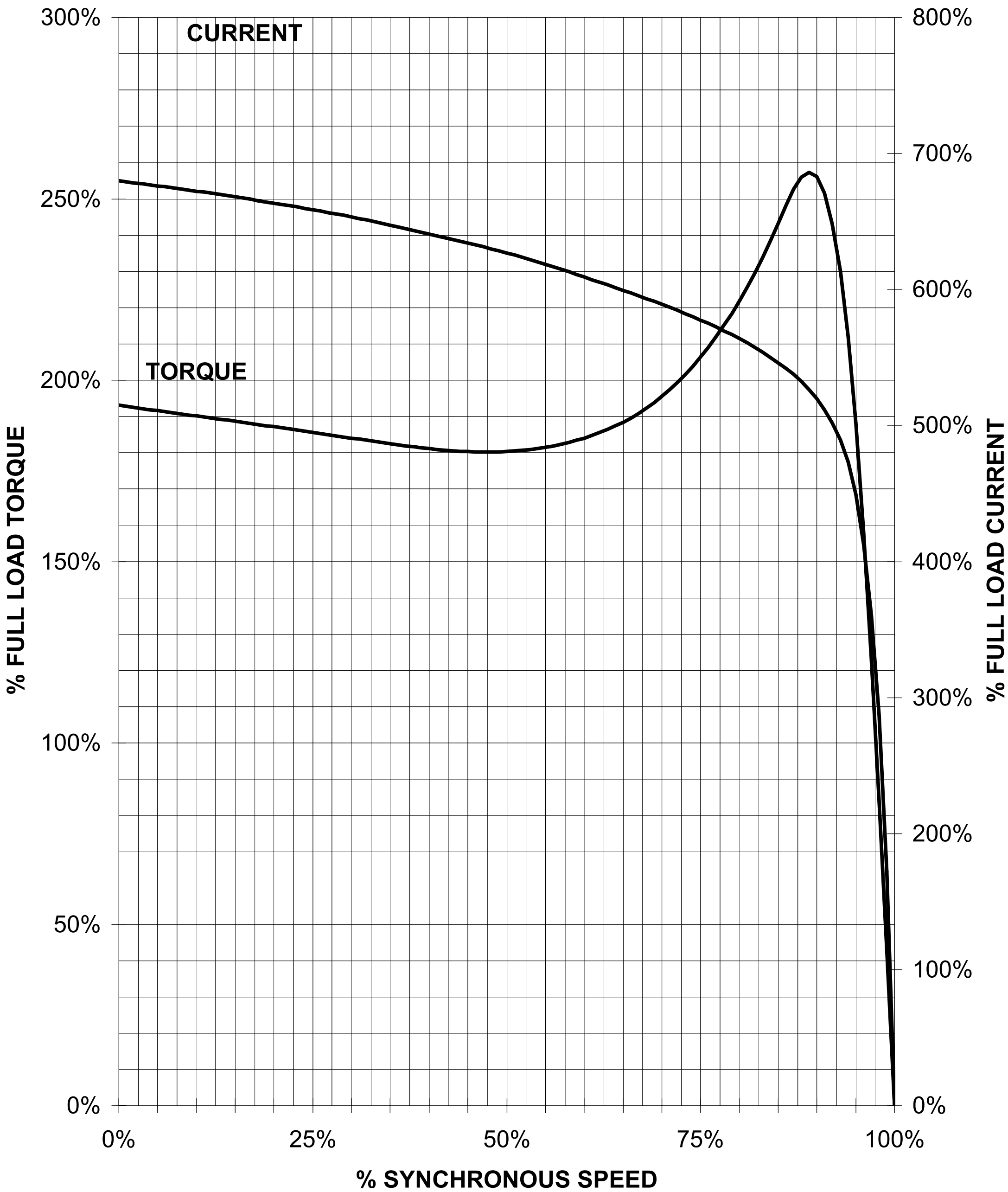
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	10	VOLTS	230/460	RPM	3600	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	215T	NEMA	B

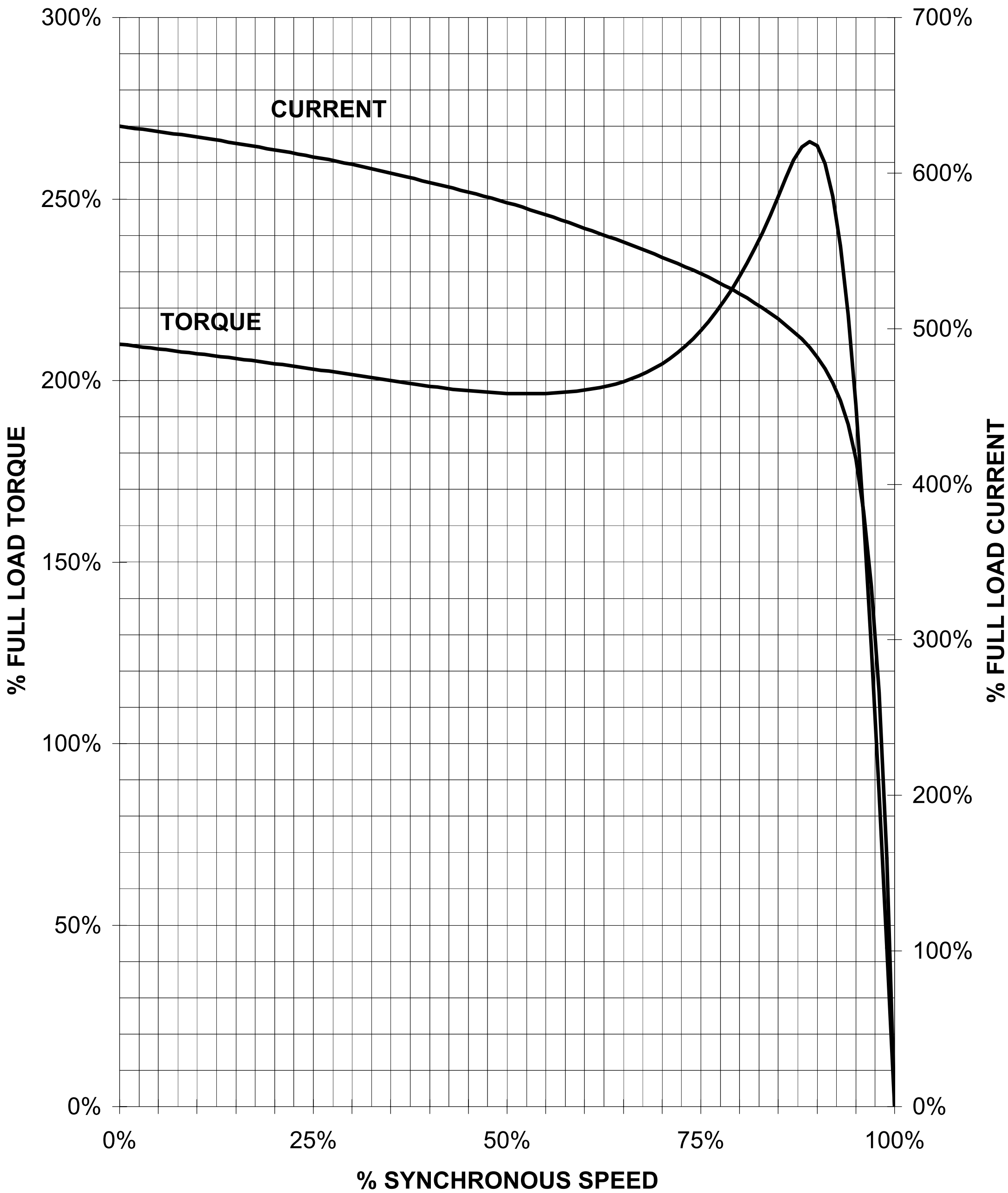
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	10	VOLTS	230/460	RPM	1800	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	215T	NEMA	B

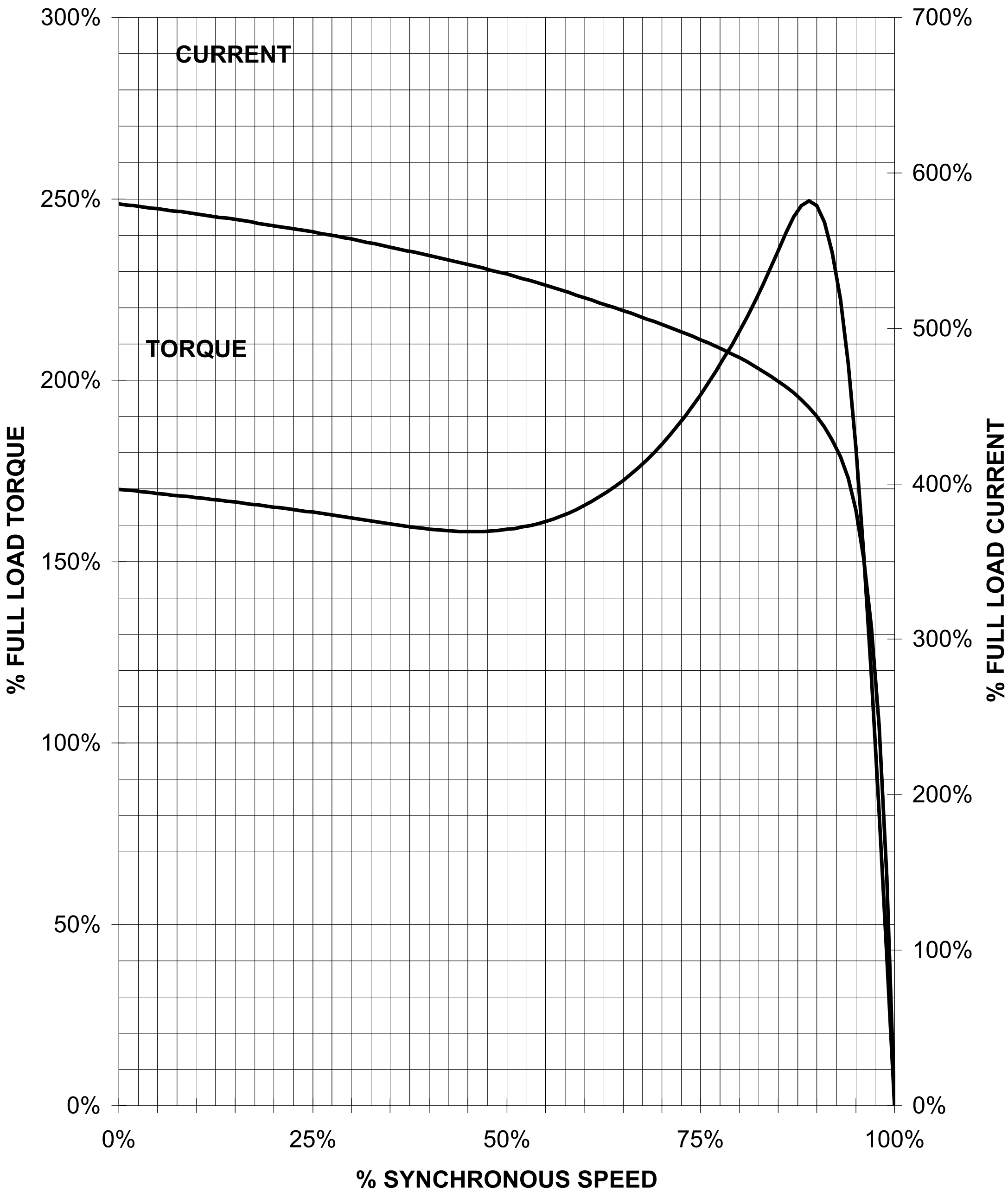
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	10	VOLTS	230/460	RPM	1200	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	256T	NEMA	B

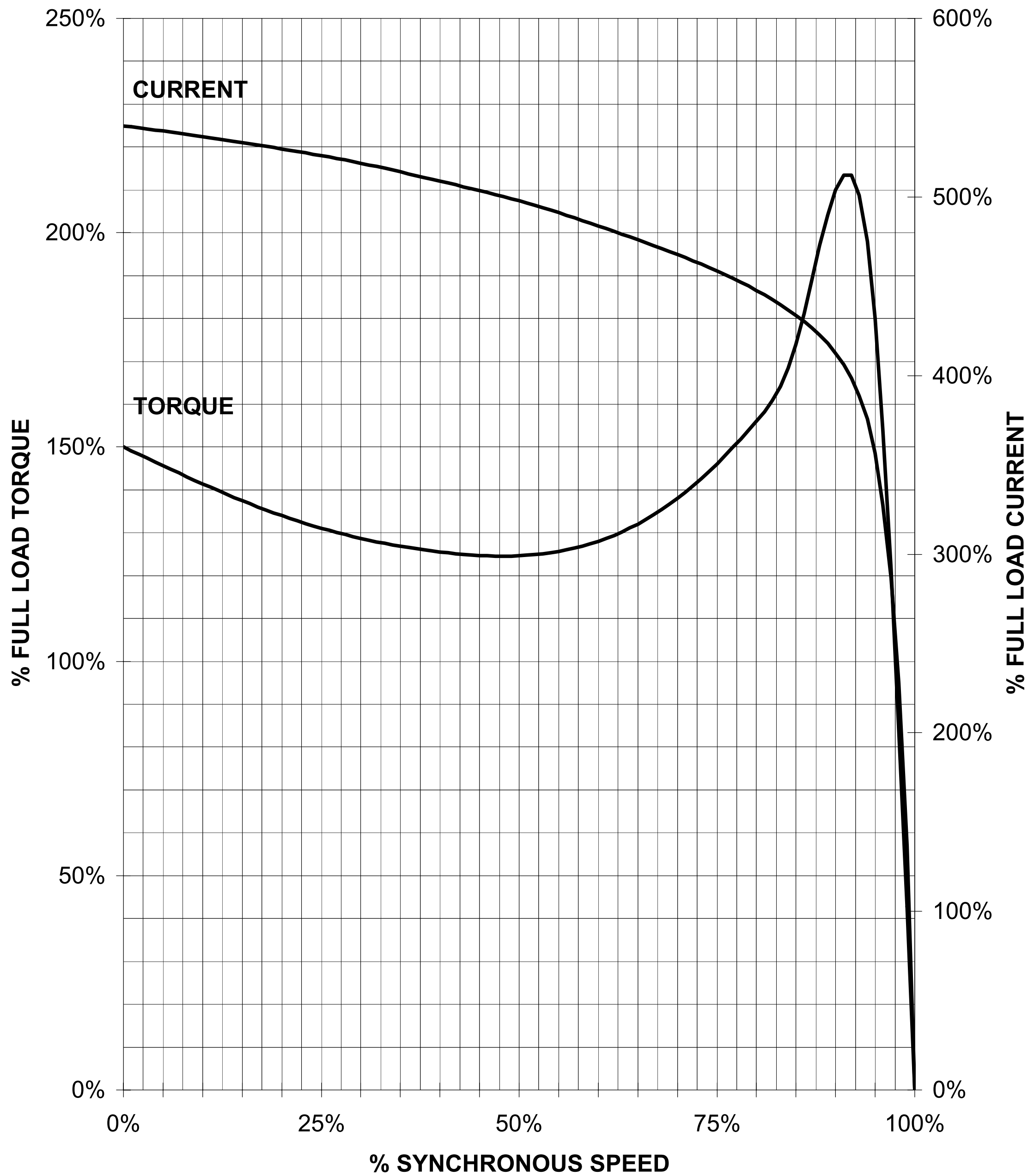
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	10	VOLTS	230/460	RPM	900	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	284T	NEMA	B

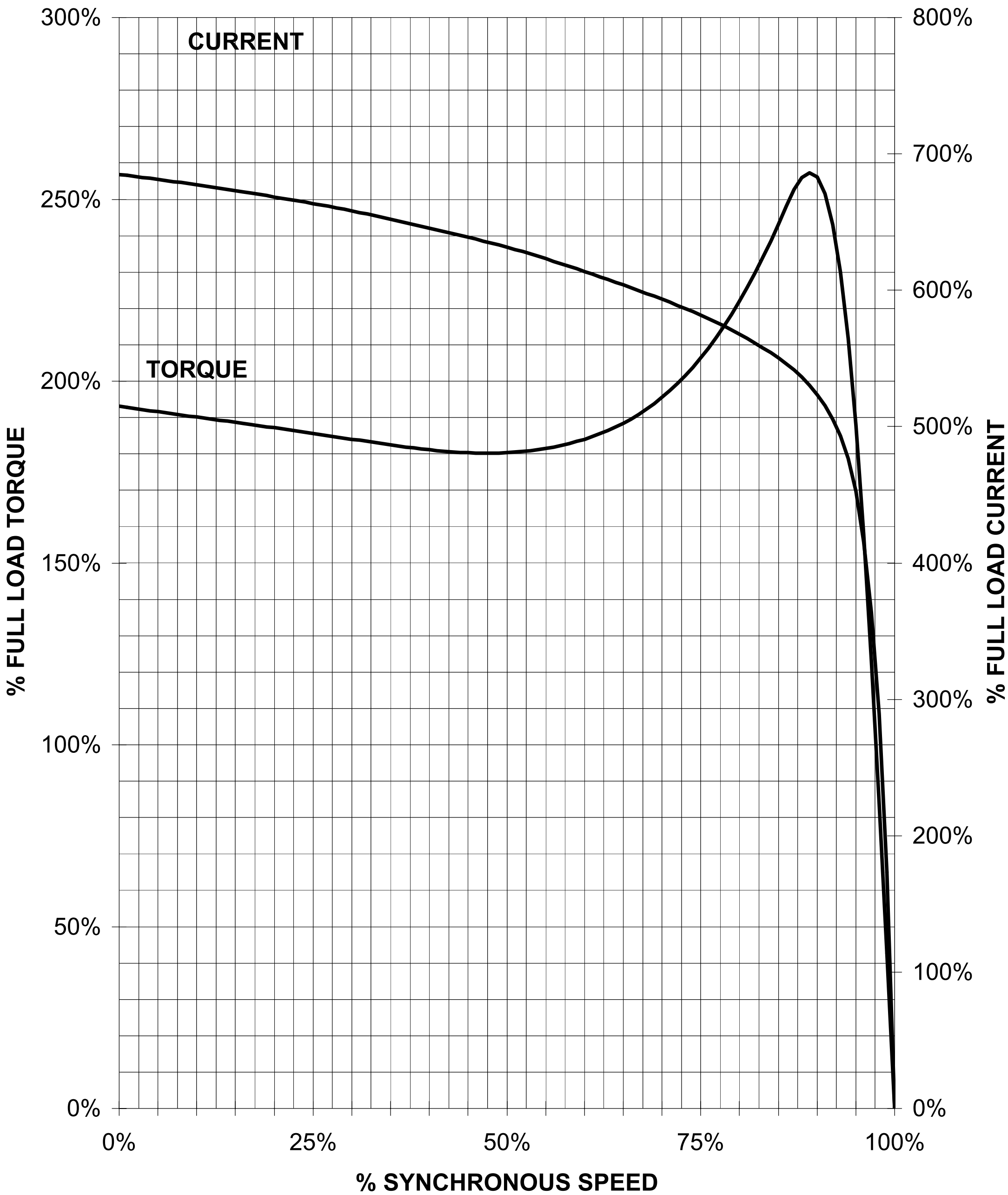
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	15	VOLTS	230/460	RPM	3600	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	254T	NEMA	B

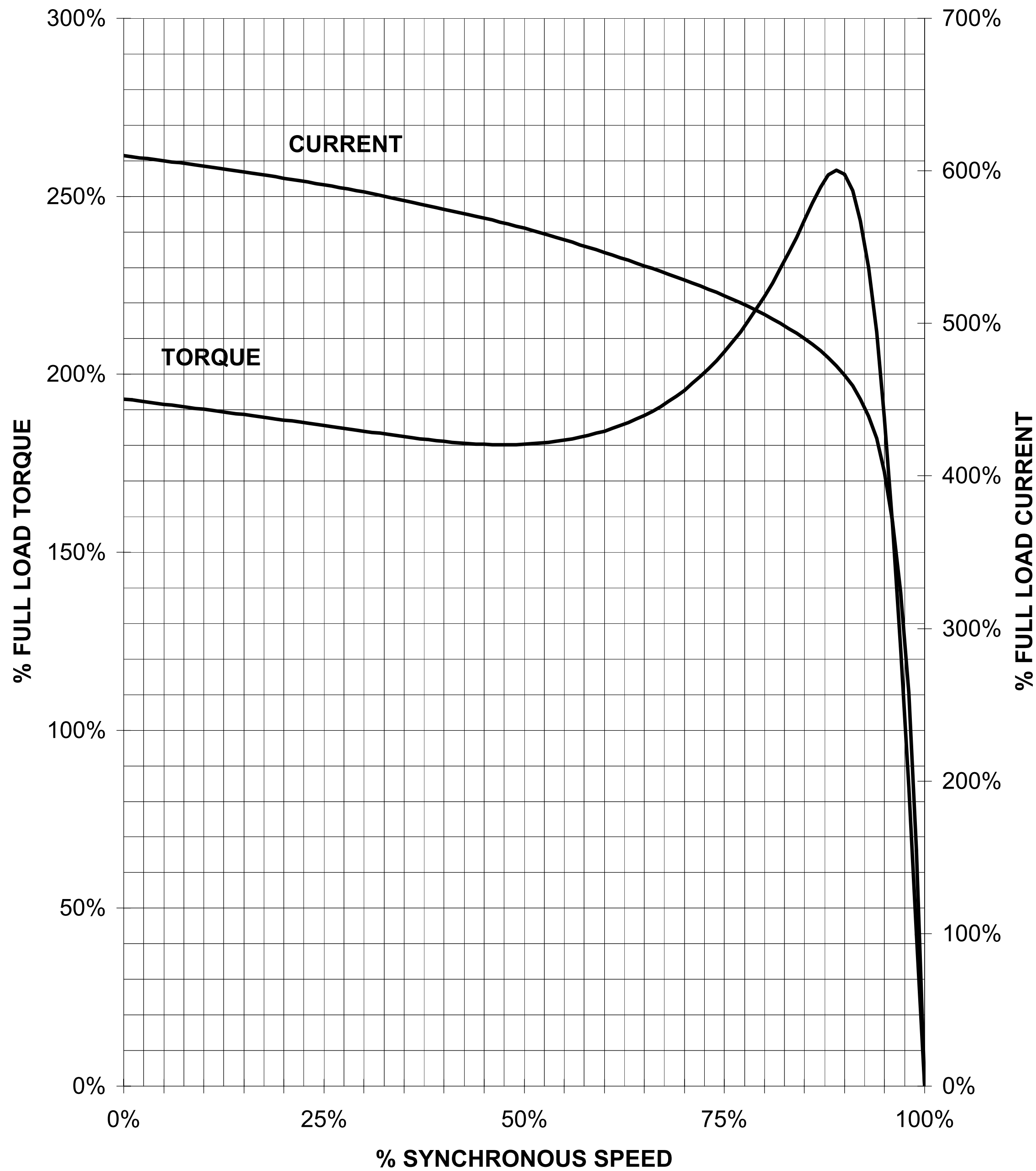
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	15	VOLTS	230/460	RPM	1800	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	254T	NEMA	B

TORQUE & CURRENT VS. SPEED

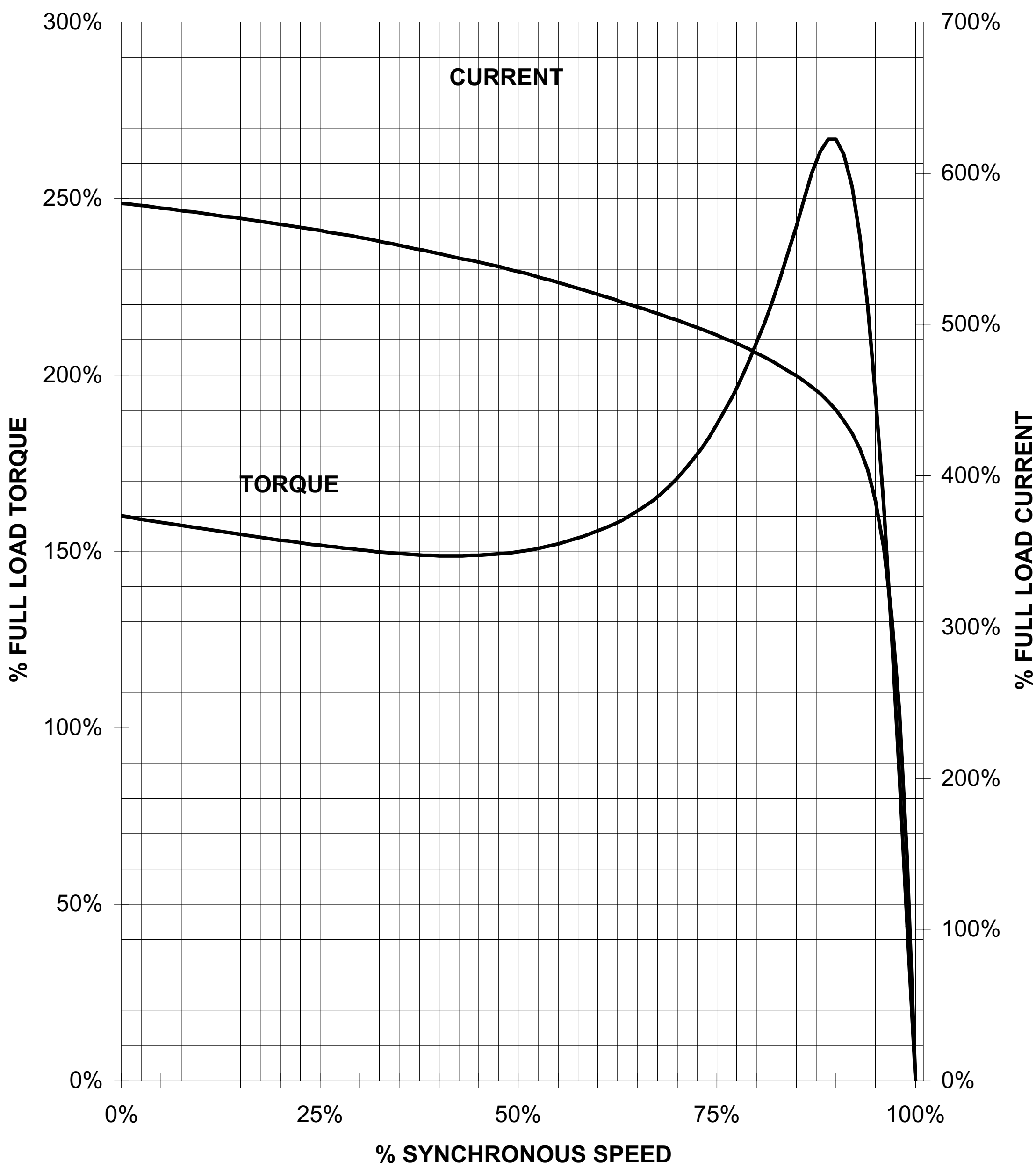


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	15	VOLTS	230/460	RPM	1200	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	284T	NEMA	B

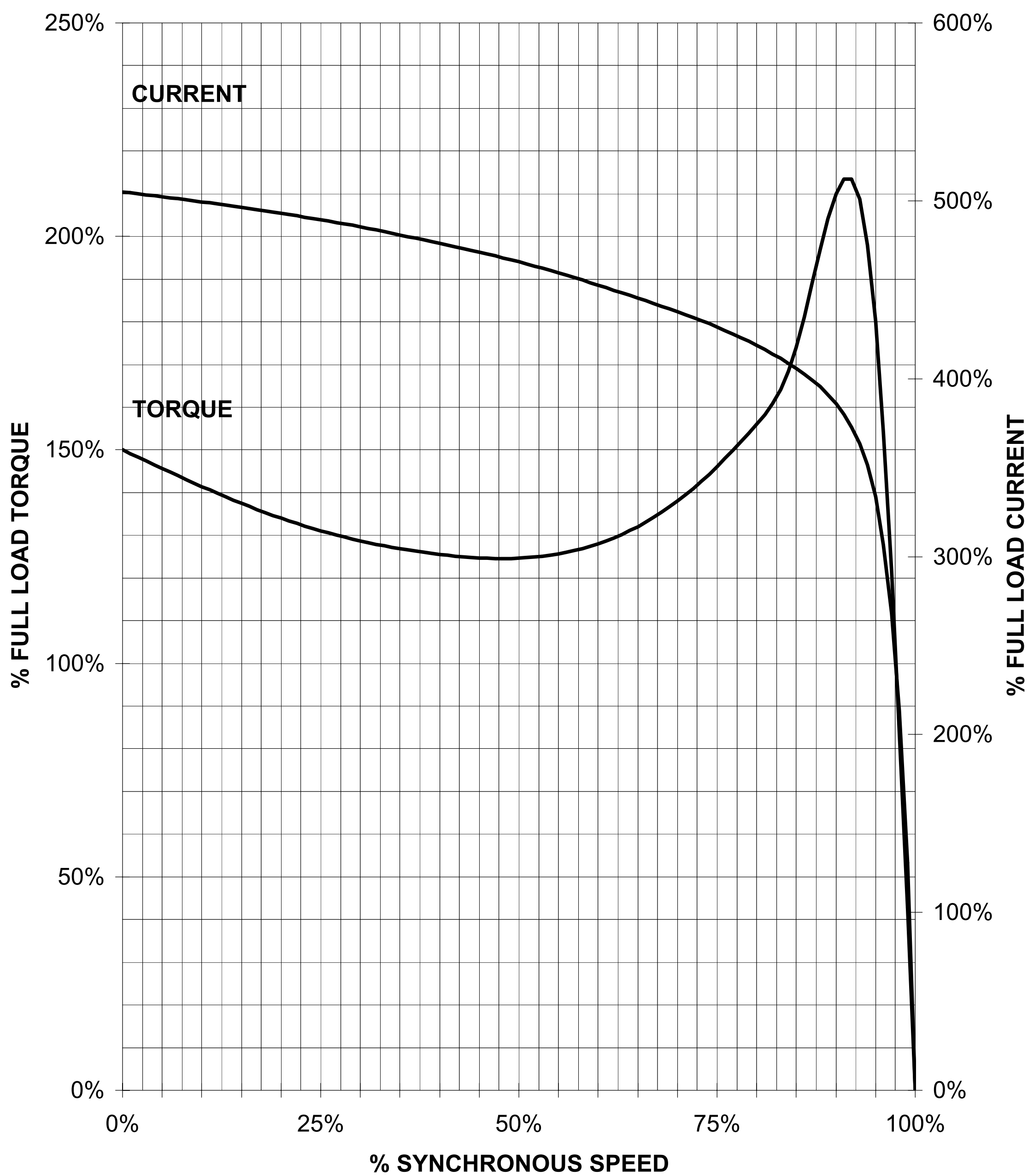
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	15	VOLTS	230/460	RPM	900	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	286T	NEMA	B

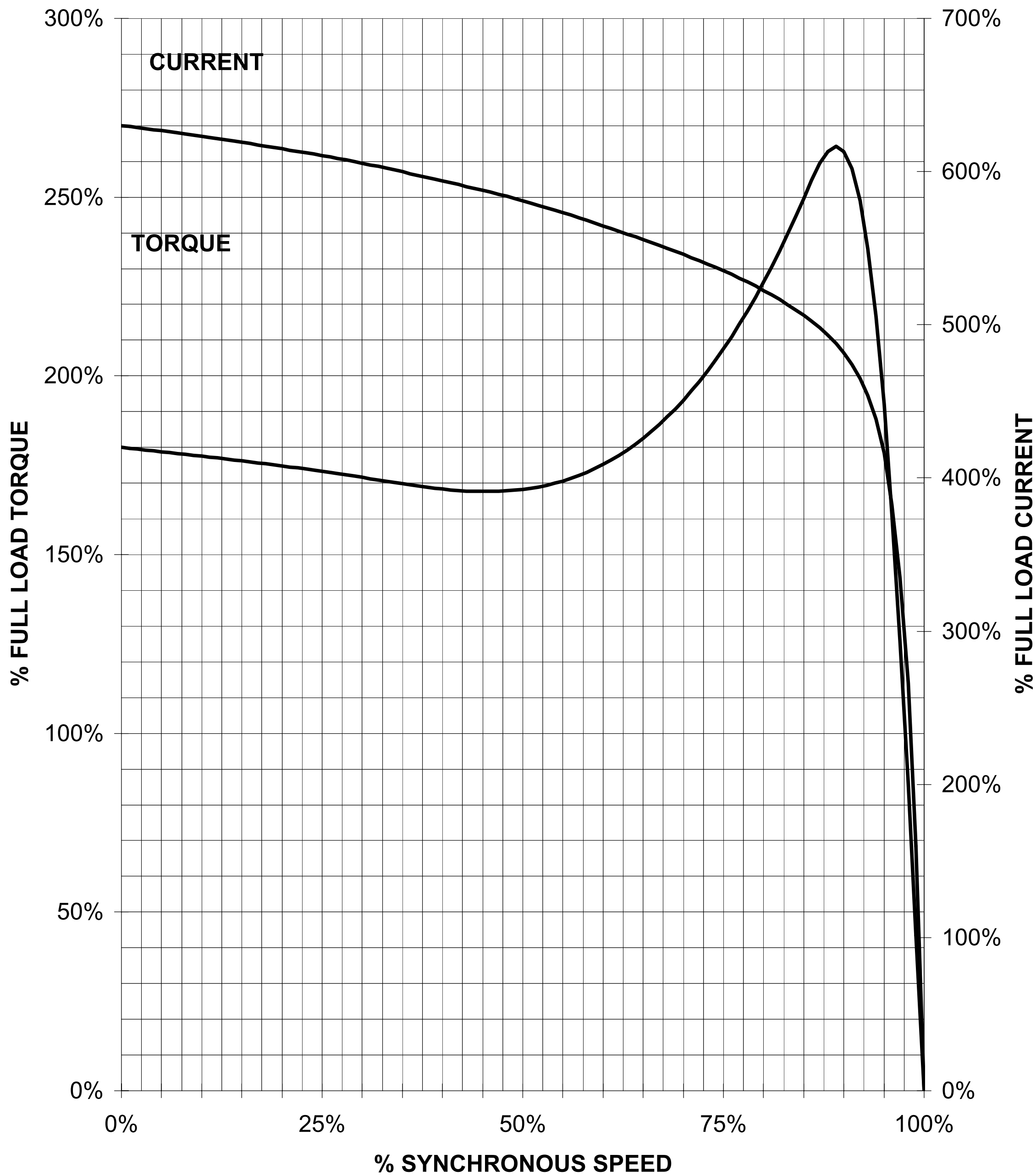
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	20	VOLTS	230/460	RPM	3600	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	256T	NEMA	B

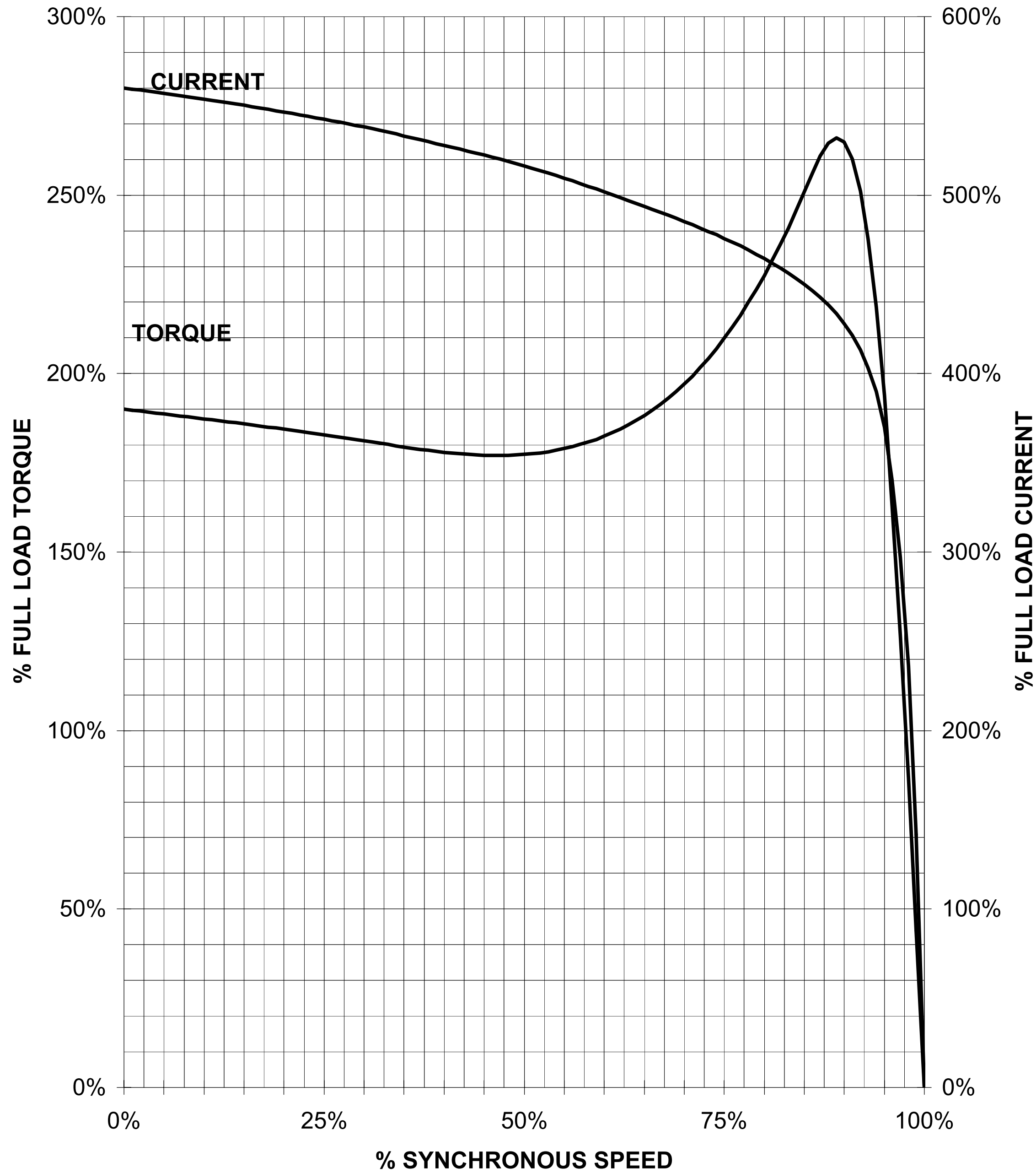
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	20	VOLTS	230/460	RPM	1800	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	256T	NEMA	B

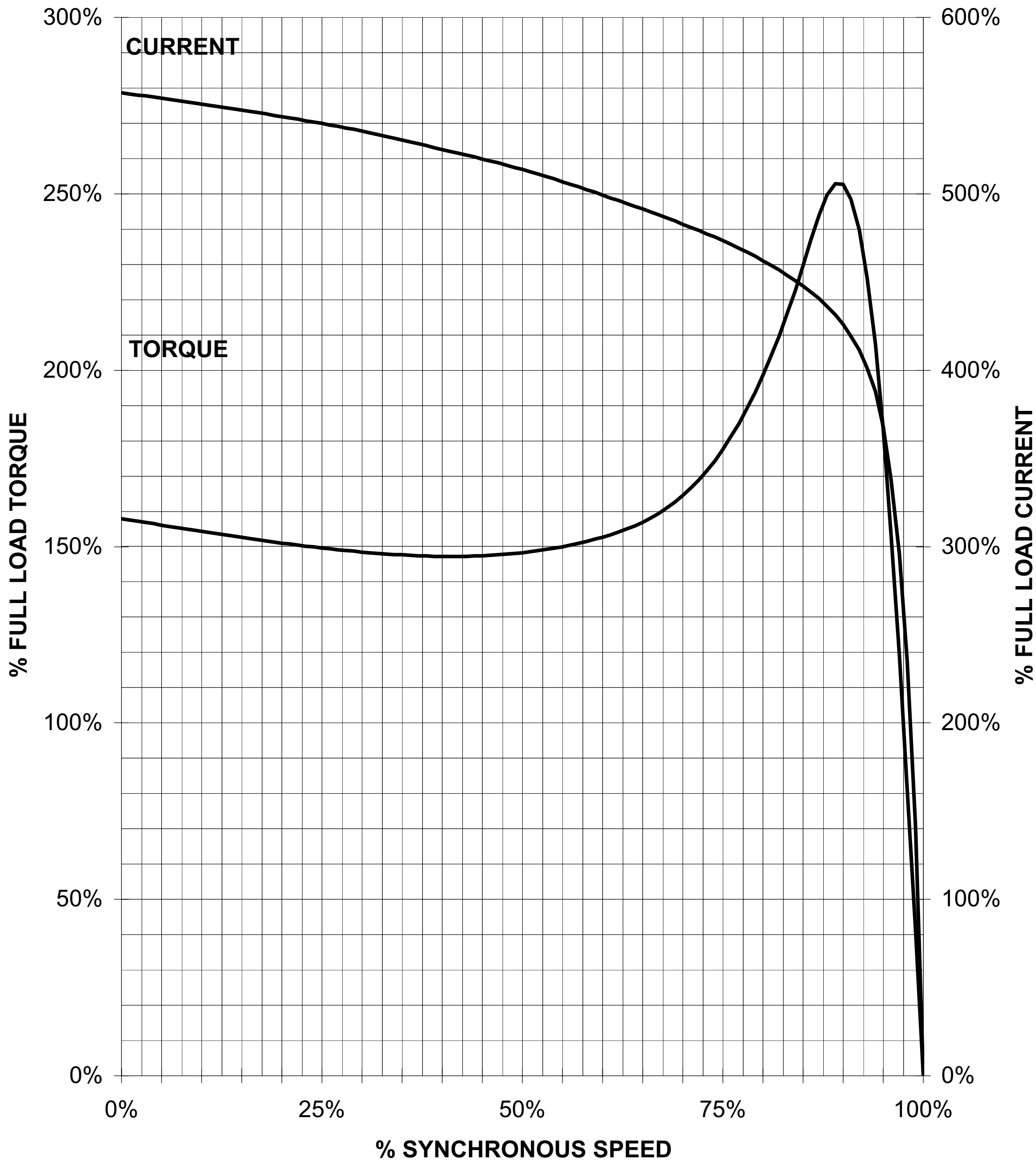
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	20	VOLTS	230/460	RPM	1200	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	286T	NEMA	B

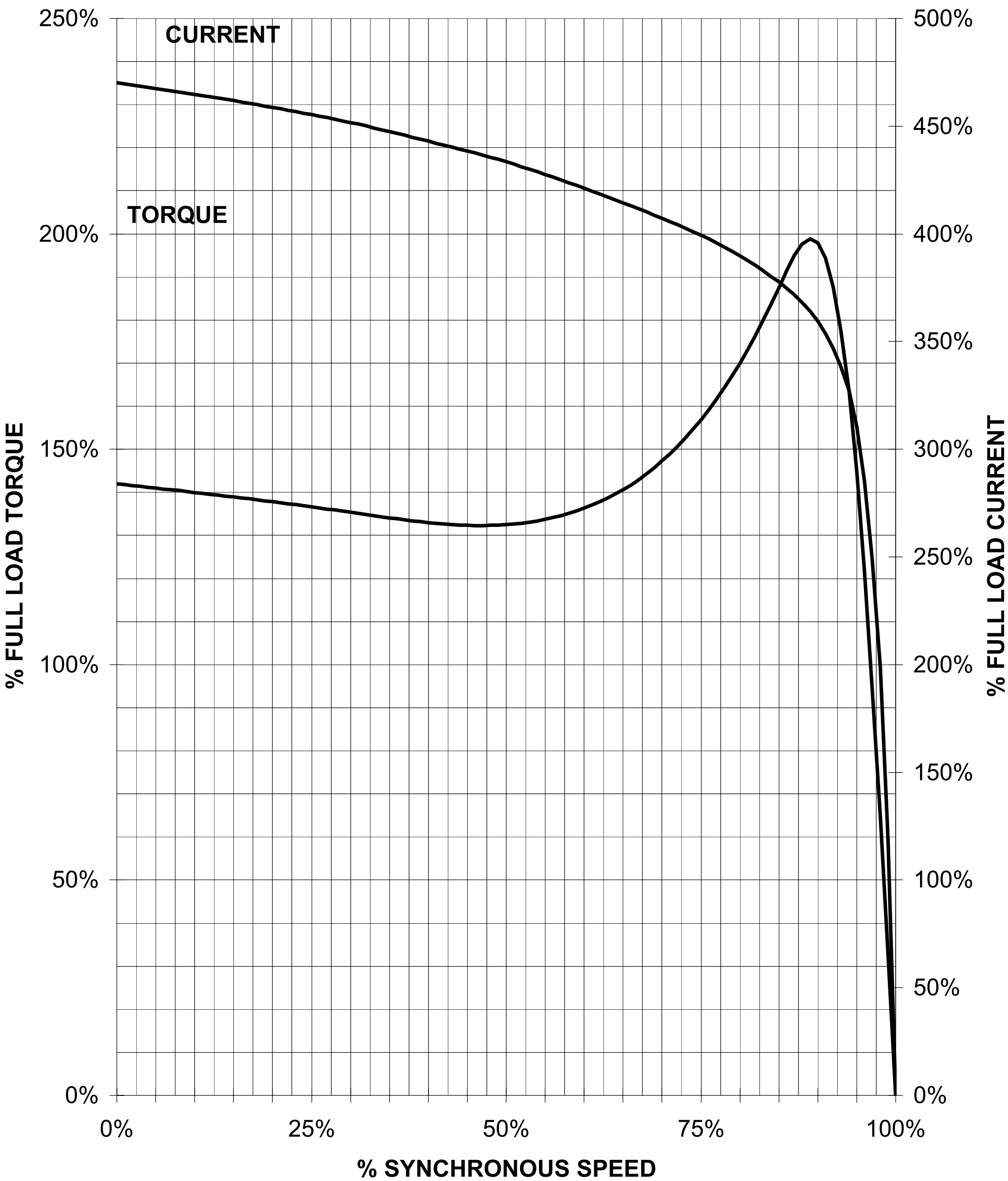
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	20	VOLTS	230/460	RPM	900	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	324T	NEMA	B

TORQUE & CURRENT VS. SPEED



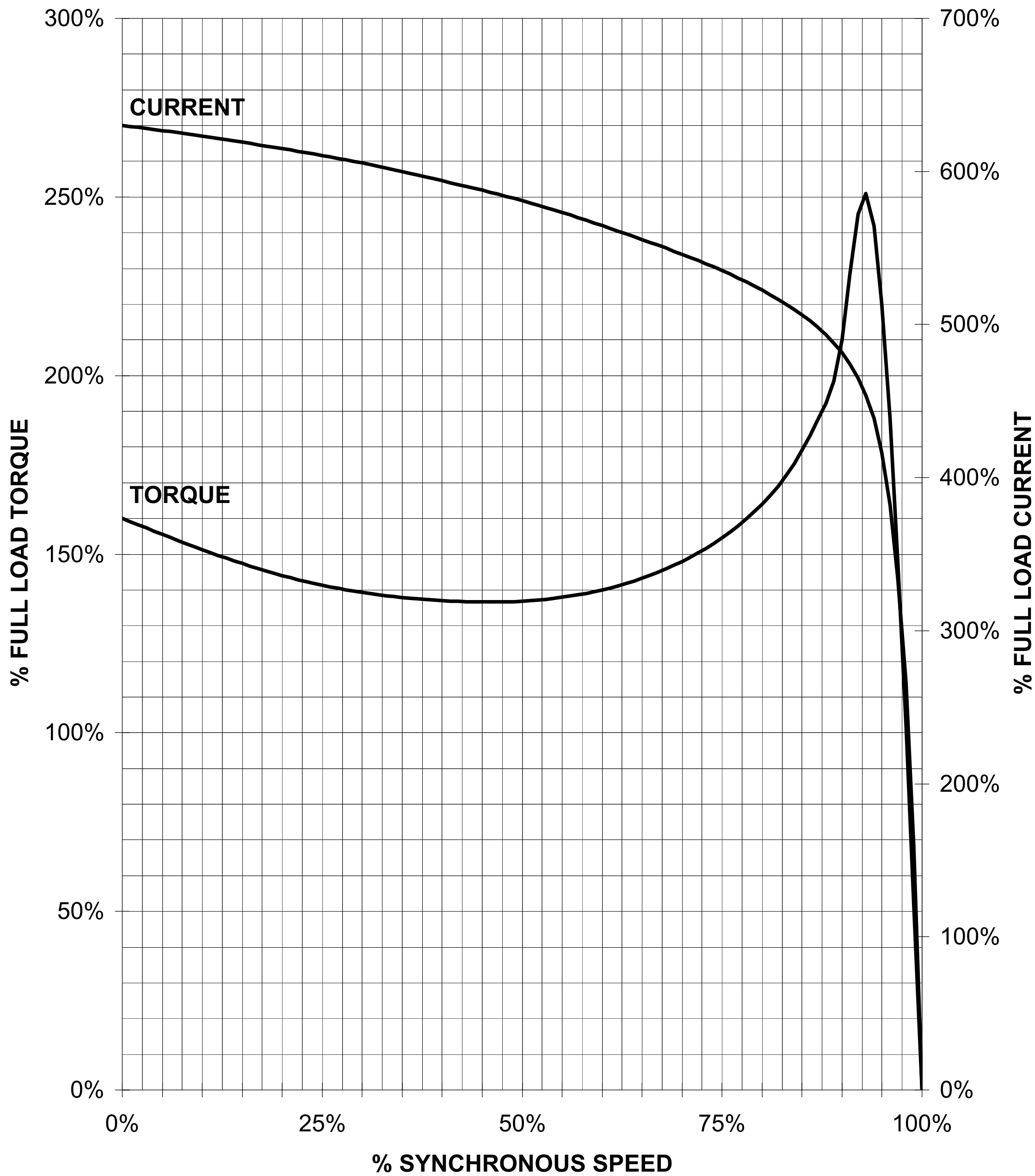
Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

Application Manual for NEMA Motors

HP	25	VOLTS	460	RPM	3600	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	284TS	NEMA	B

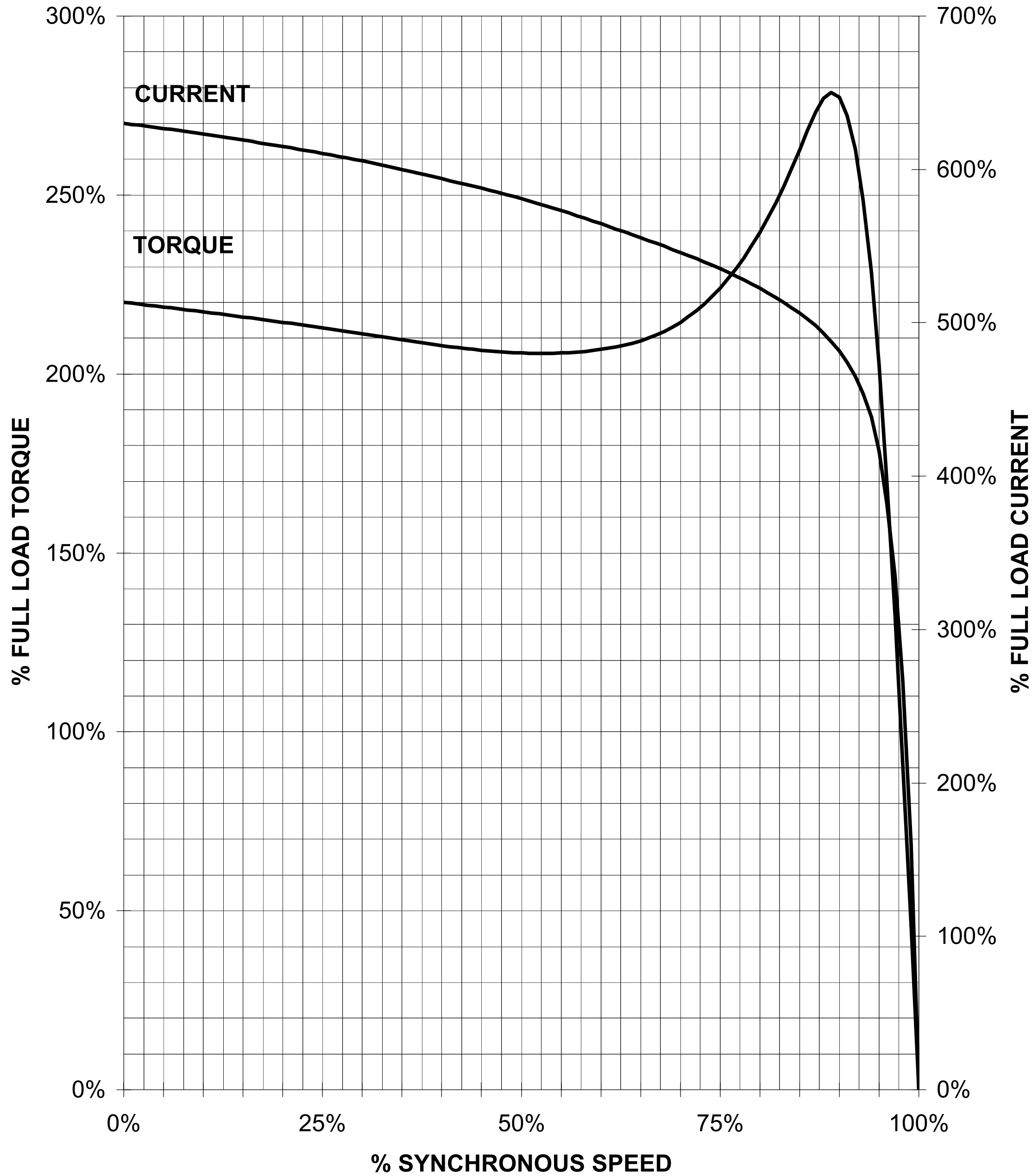
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	25	VOLTS	460	RPM	1800	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	284T	NEMA	B

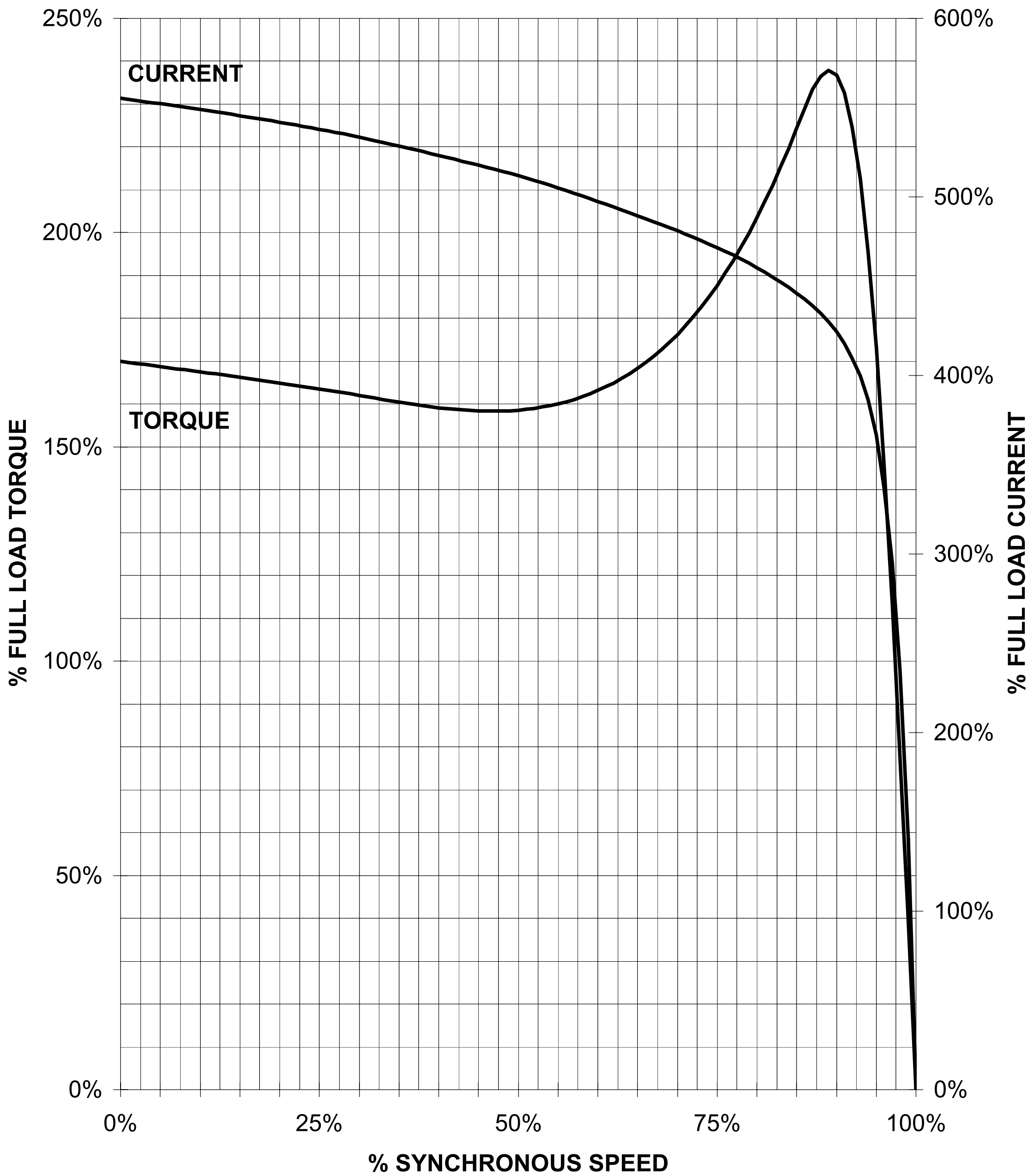
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	25	VOLTS	460	RPM	1200	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	324T	NEMA	B

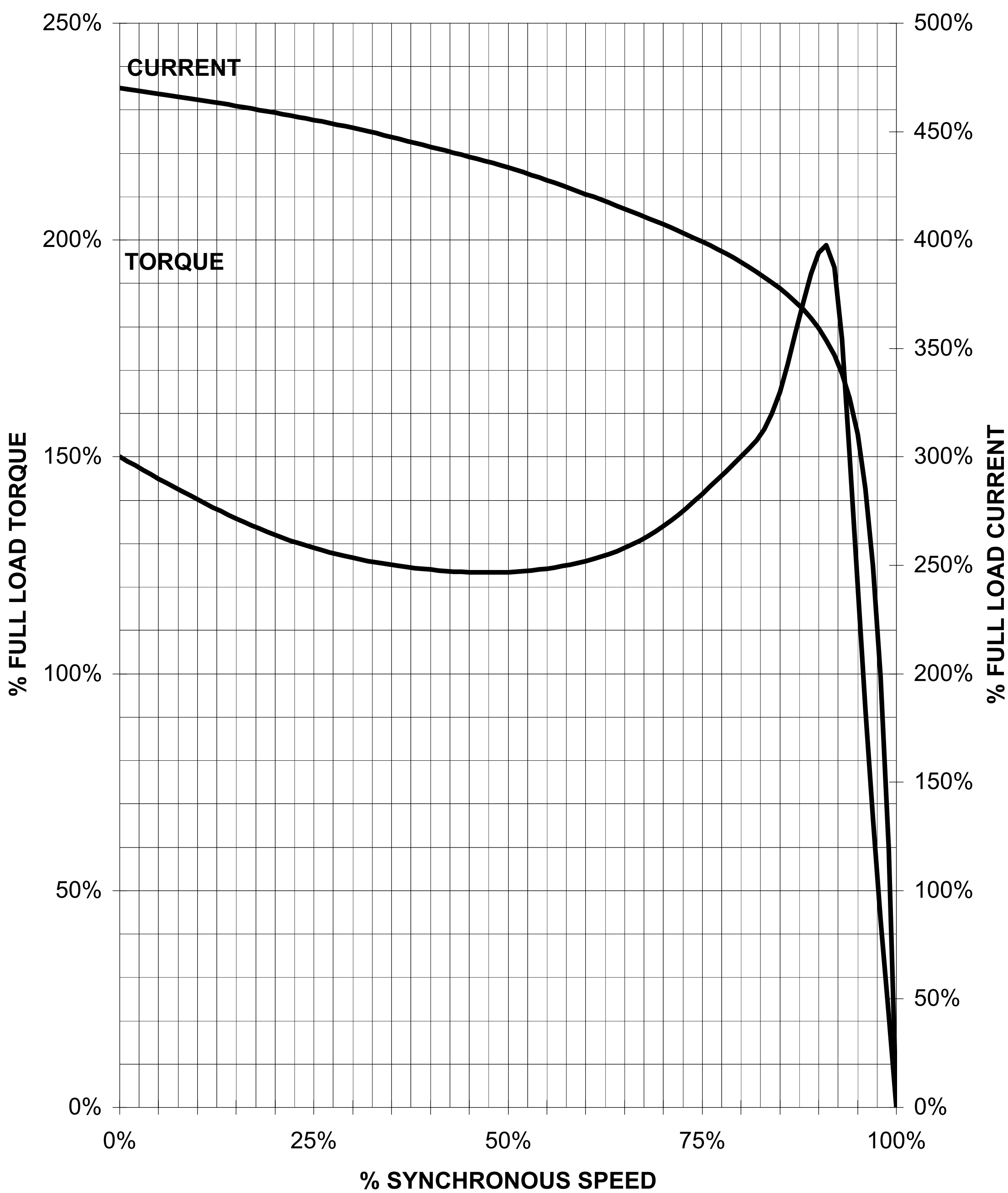
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	25	VOLTS	460	RPM	900	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	326T	NEMA	B

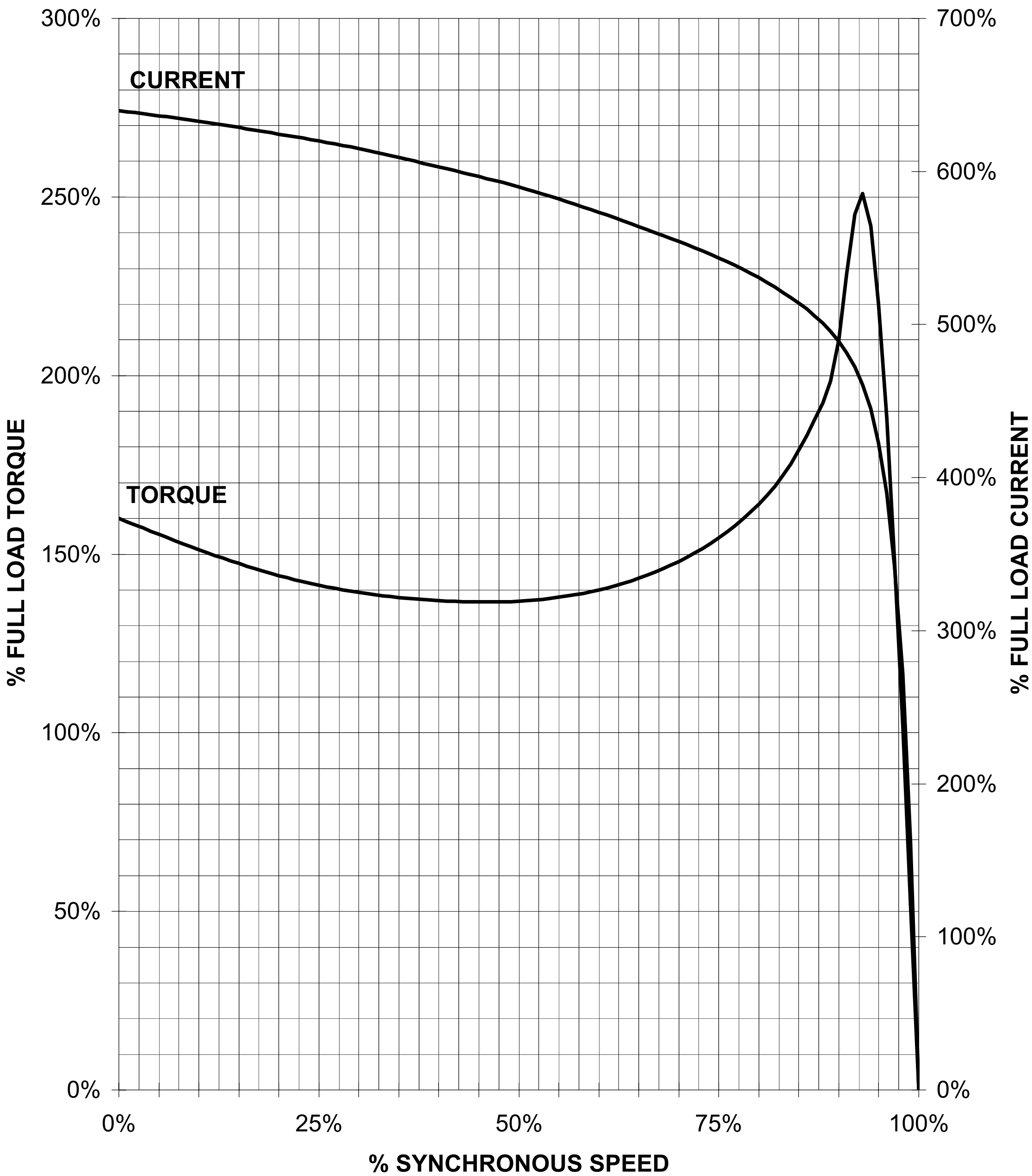
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	30	VOLTS	460	RPM	3600	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	286TS	NEMA	B

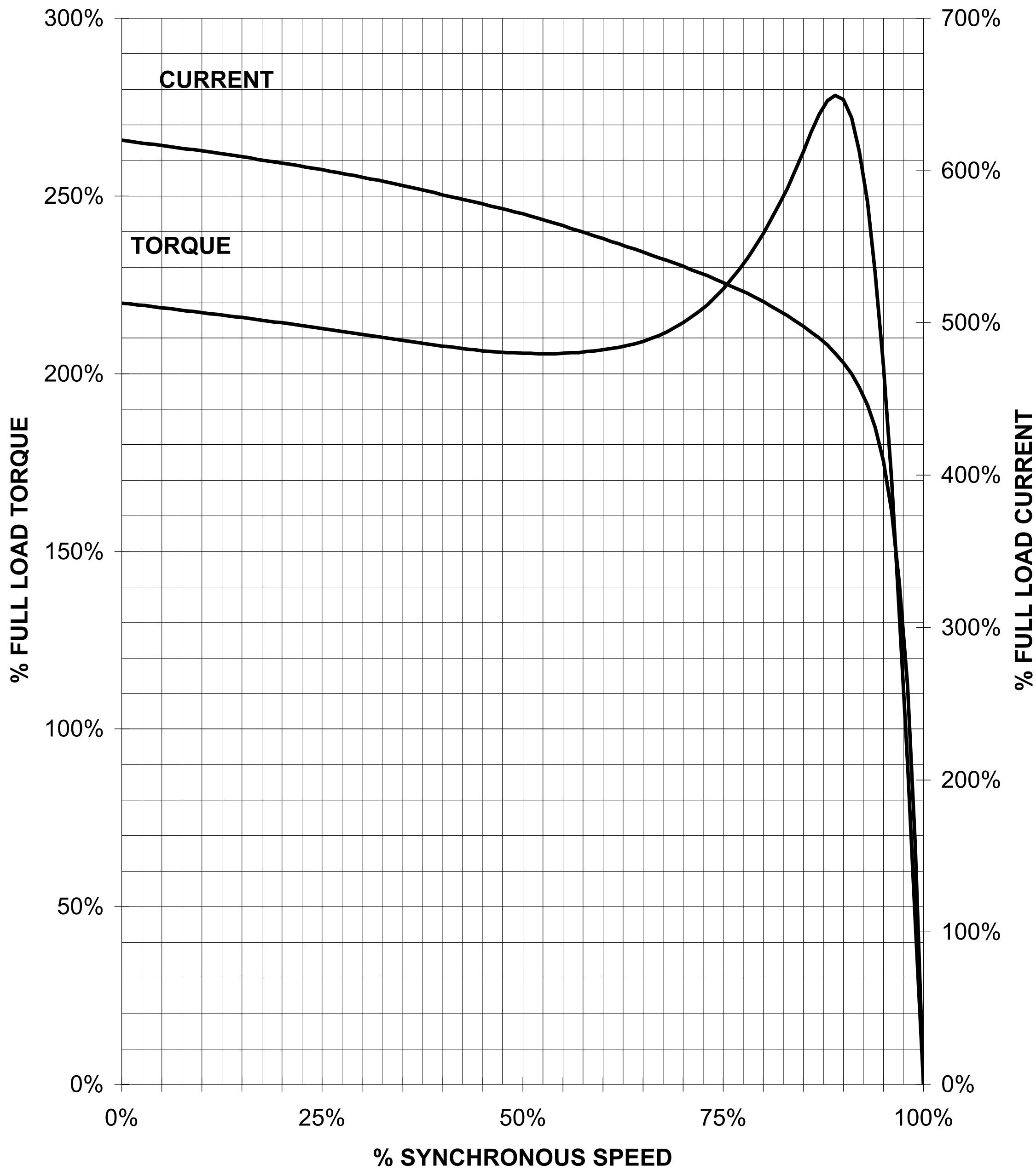
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	30	VOLTS	460	RPM	1800	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	286T	NEMA	B

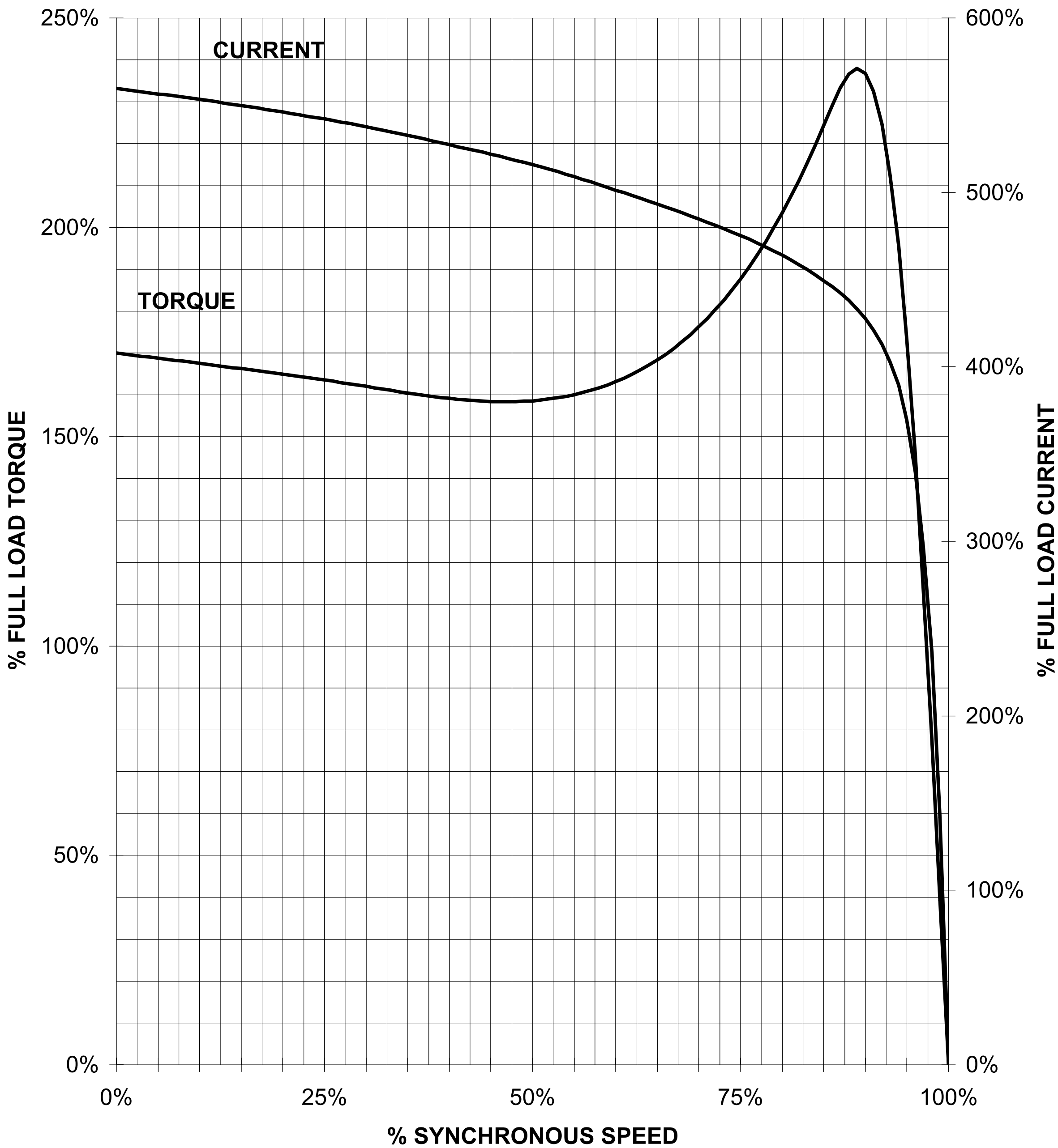
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	30	VOLTS	460	RPM	1200	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	326T	NEMA	B

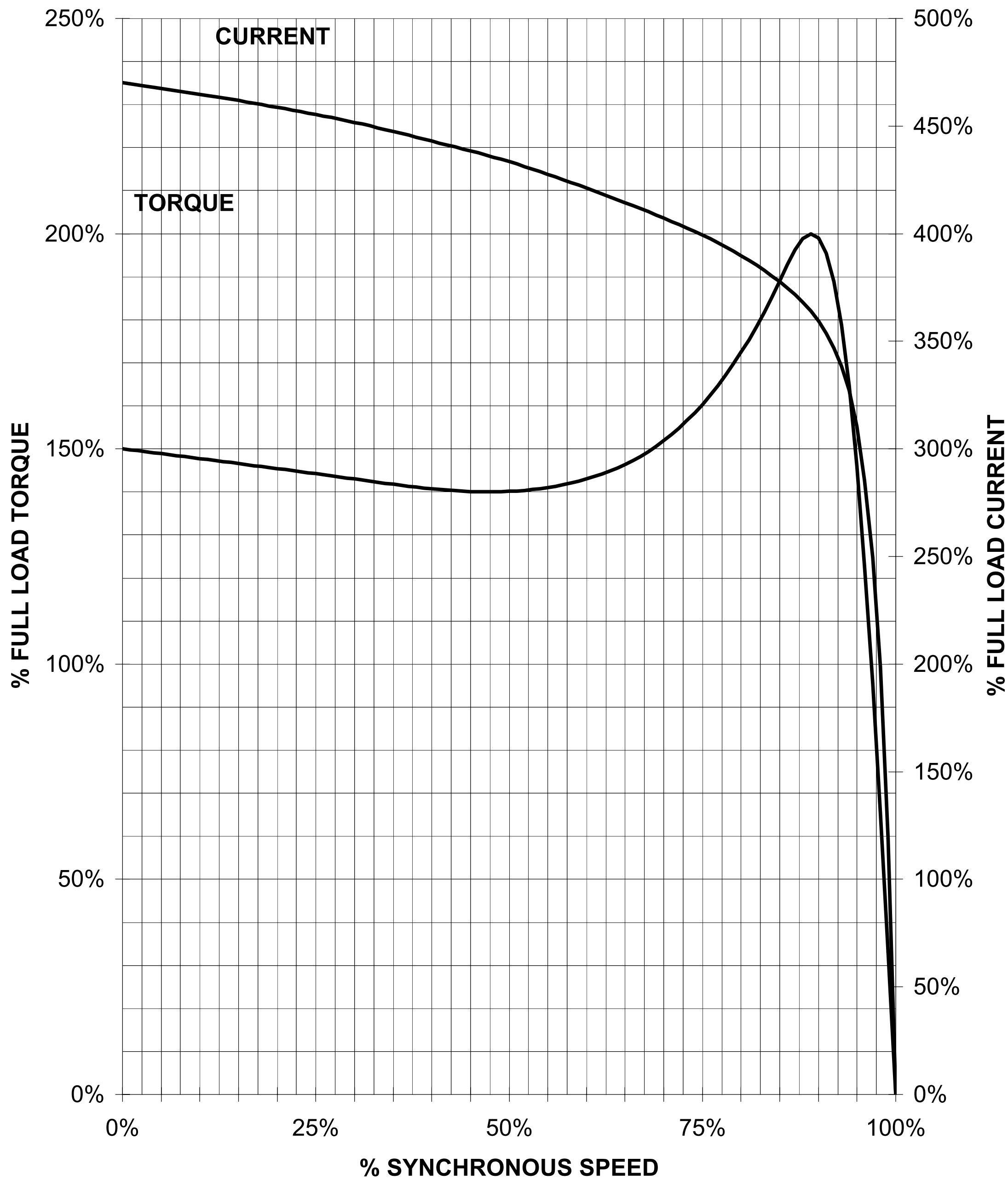
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	30	VOLTS	460	RPM	900	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	364T	NEMA	B

TORQUE & CURRENT VS. SPEED

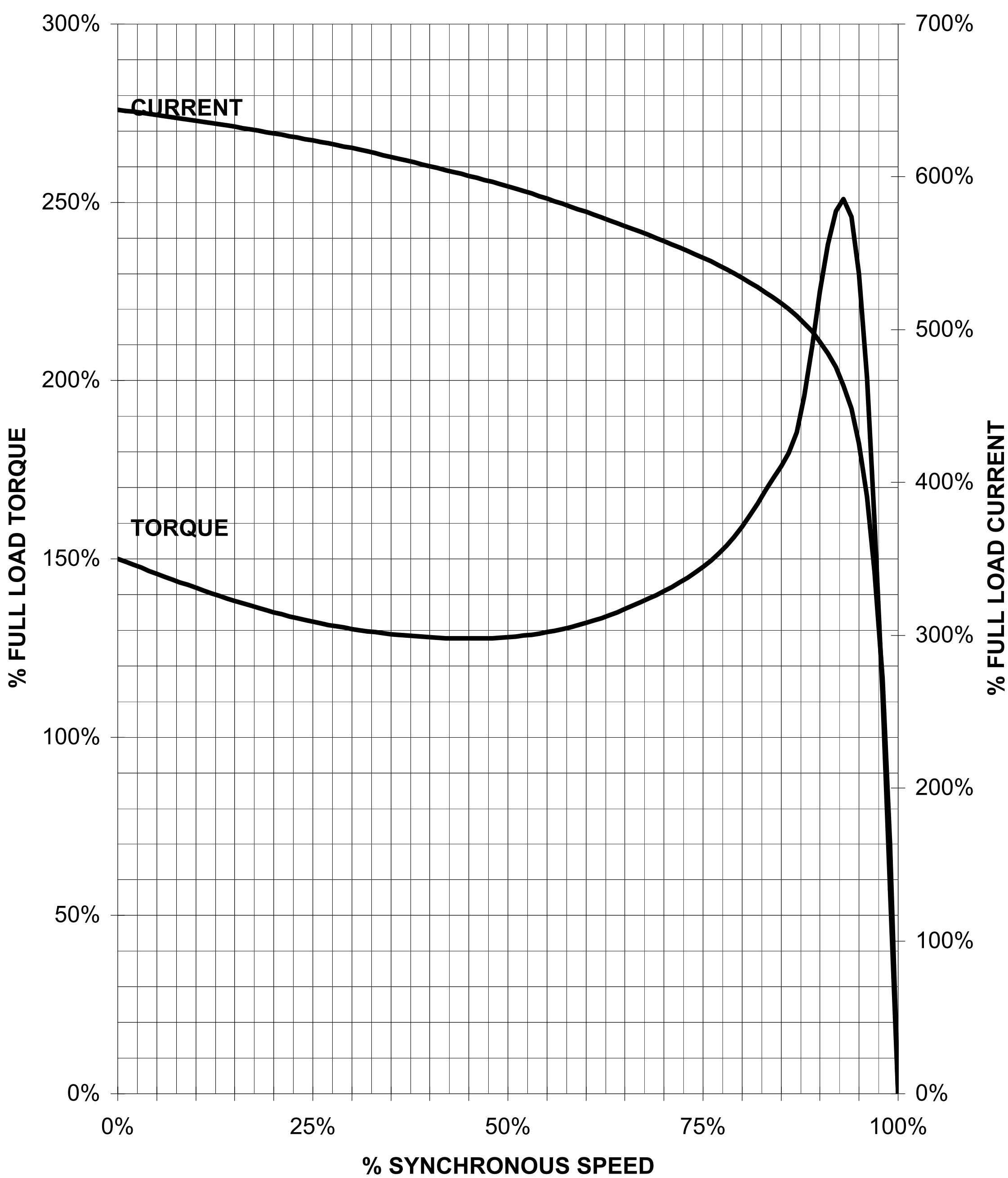


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	40	VOLTS	460	RPM	3600	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	324TS	NEMA	B

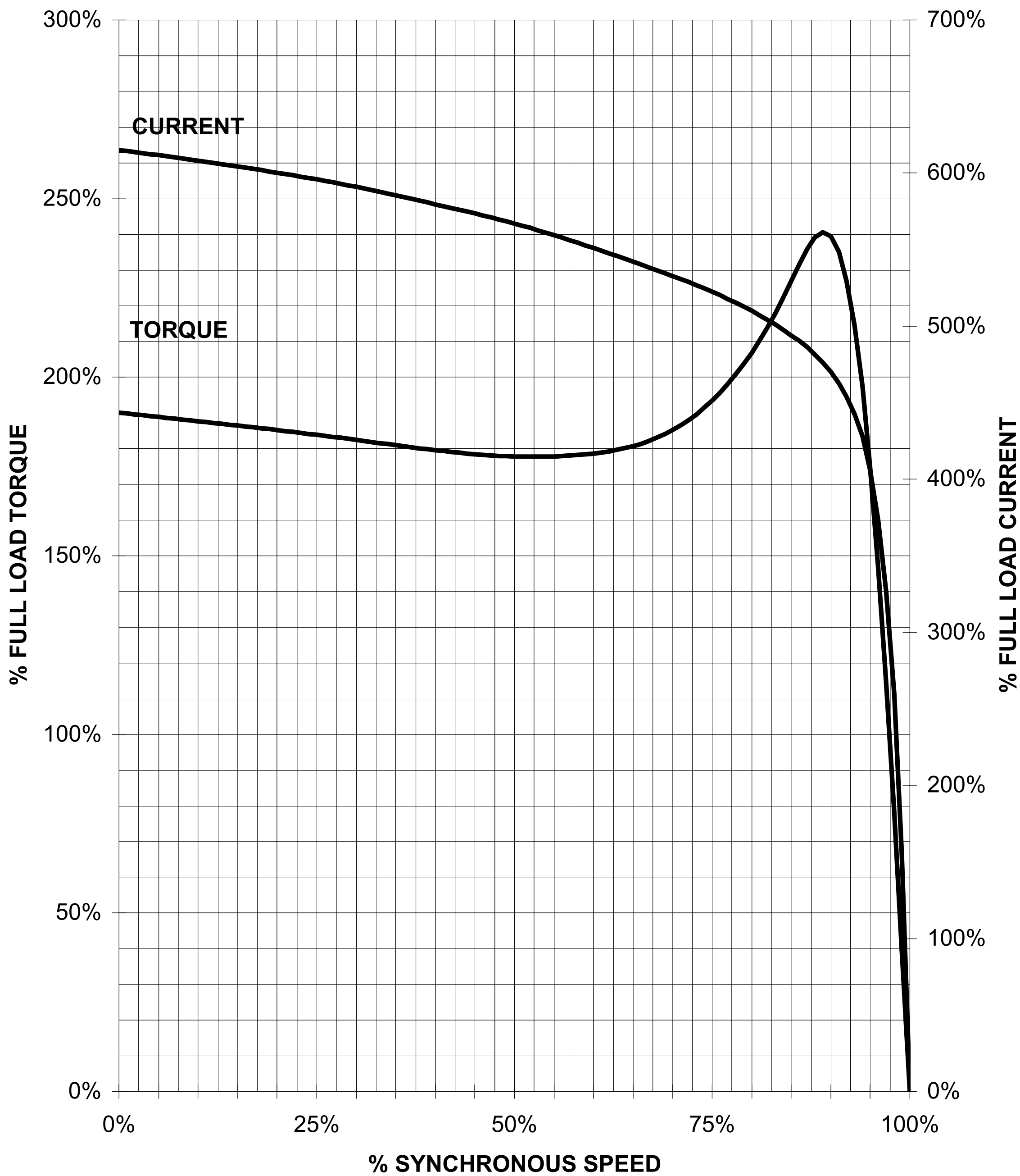
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	40	VOLTS	460	RPM	1800	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	324T	NEMA	B

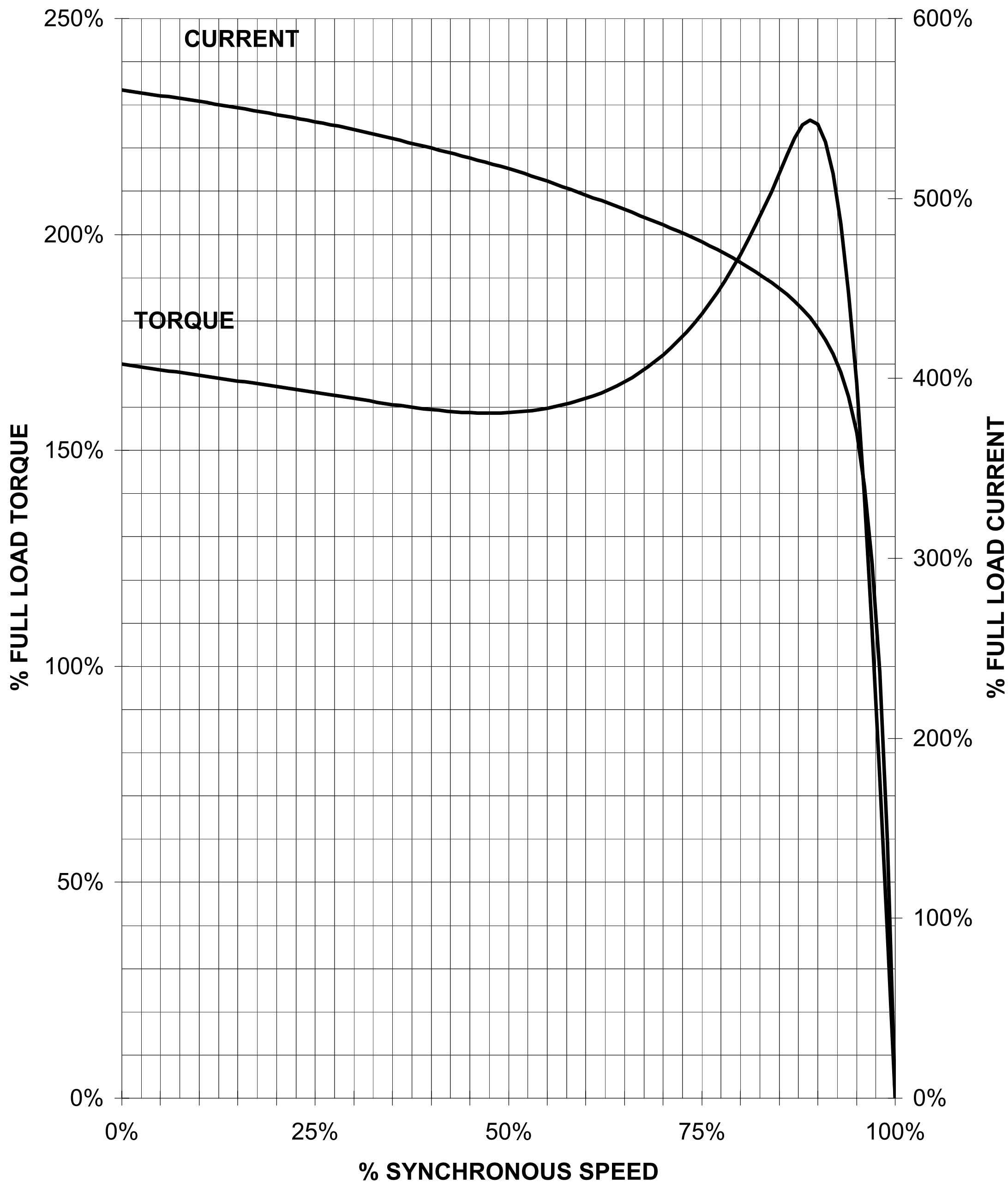
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	40	VOLTS	460	RPM	1200	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	364T	NEMA	B

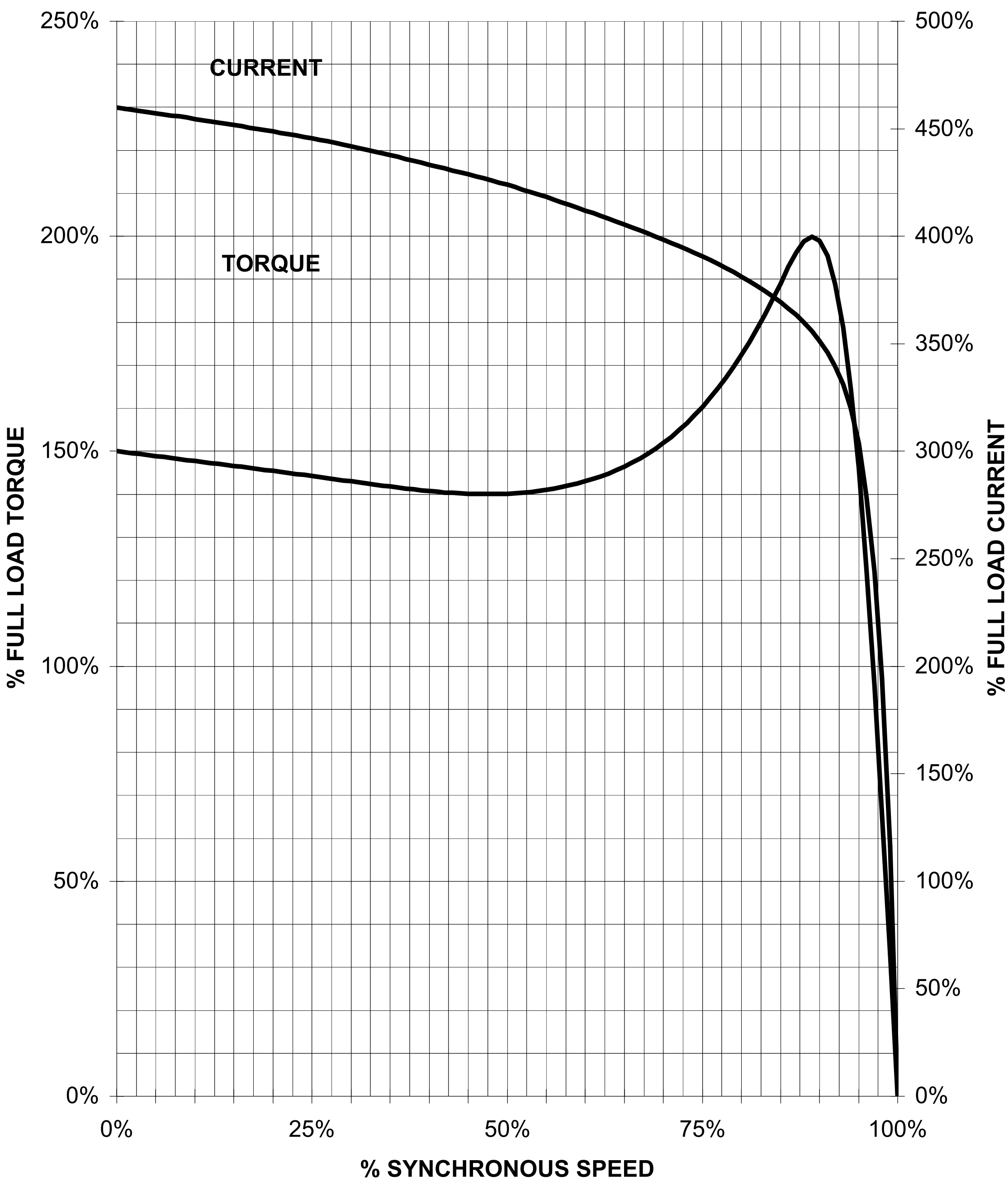
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	40	VOLTS	460	RPM	900	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	365T	NEMA	B

TORQUE AND CURRENT VS. SPEED

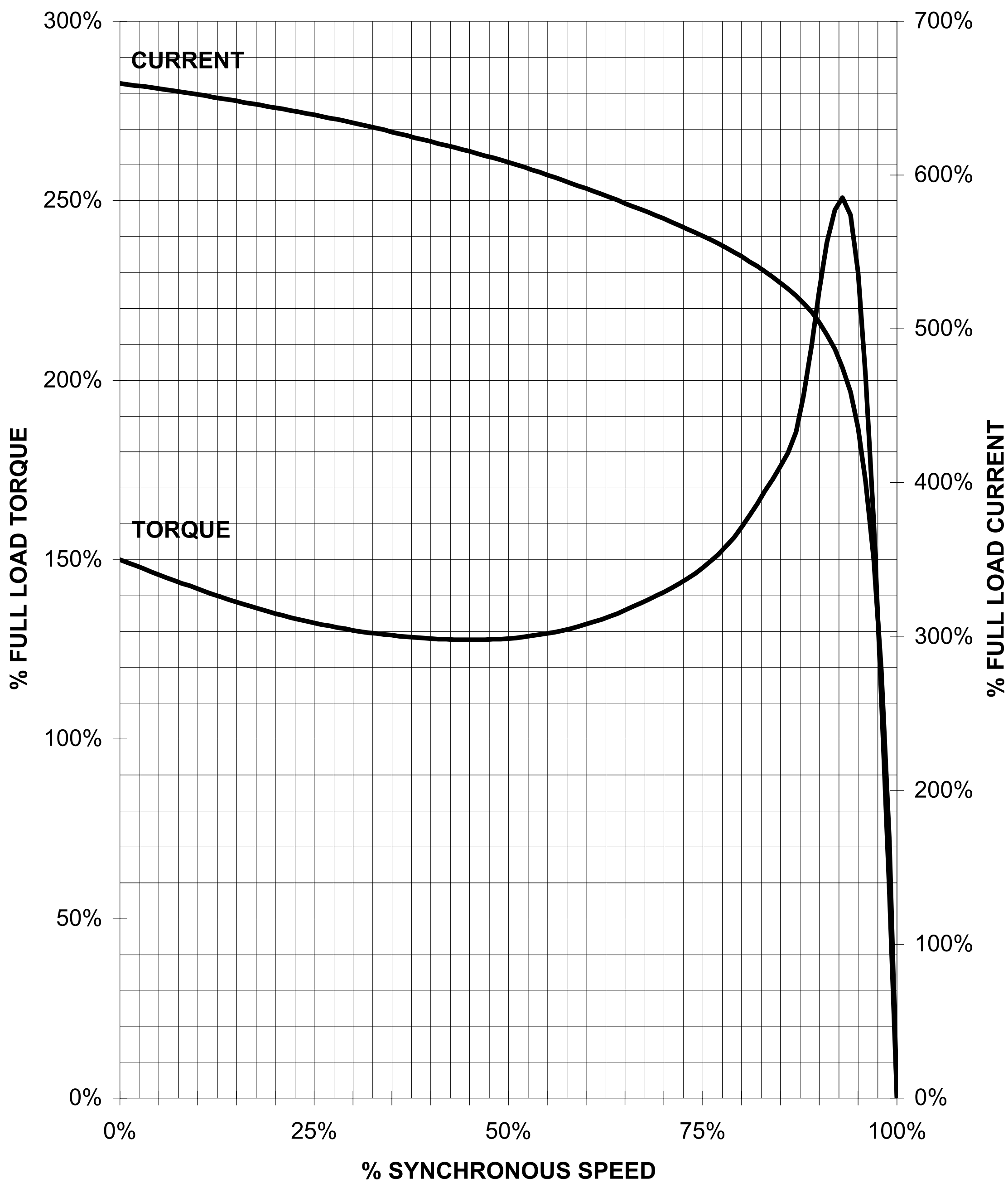


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	50	VOLTS	460	RPM	3600	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	326TS	NEMA	B

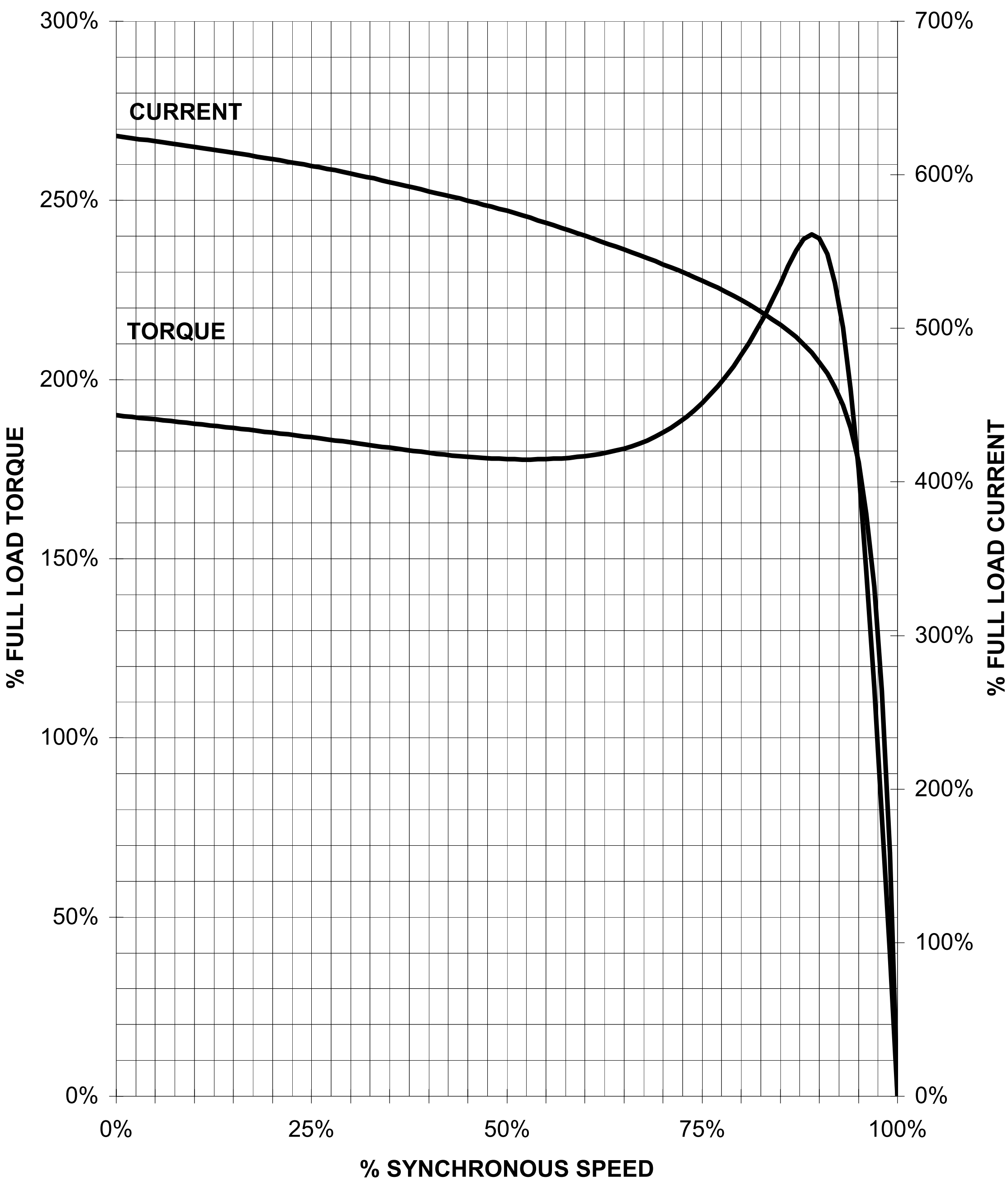
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	50	VOLTS	460	RPM	1800	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	326T	NEMA	B

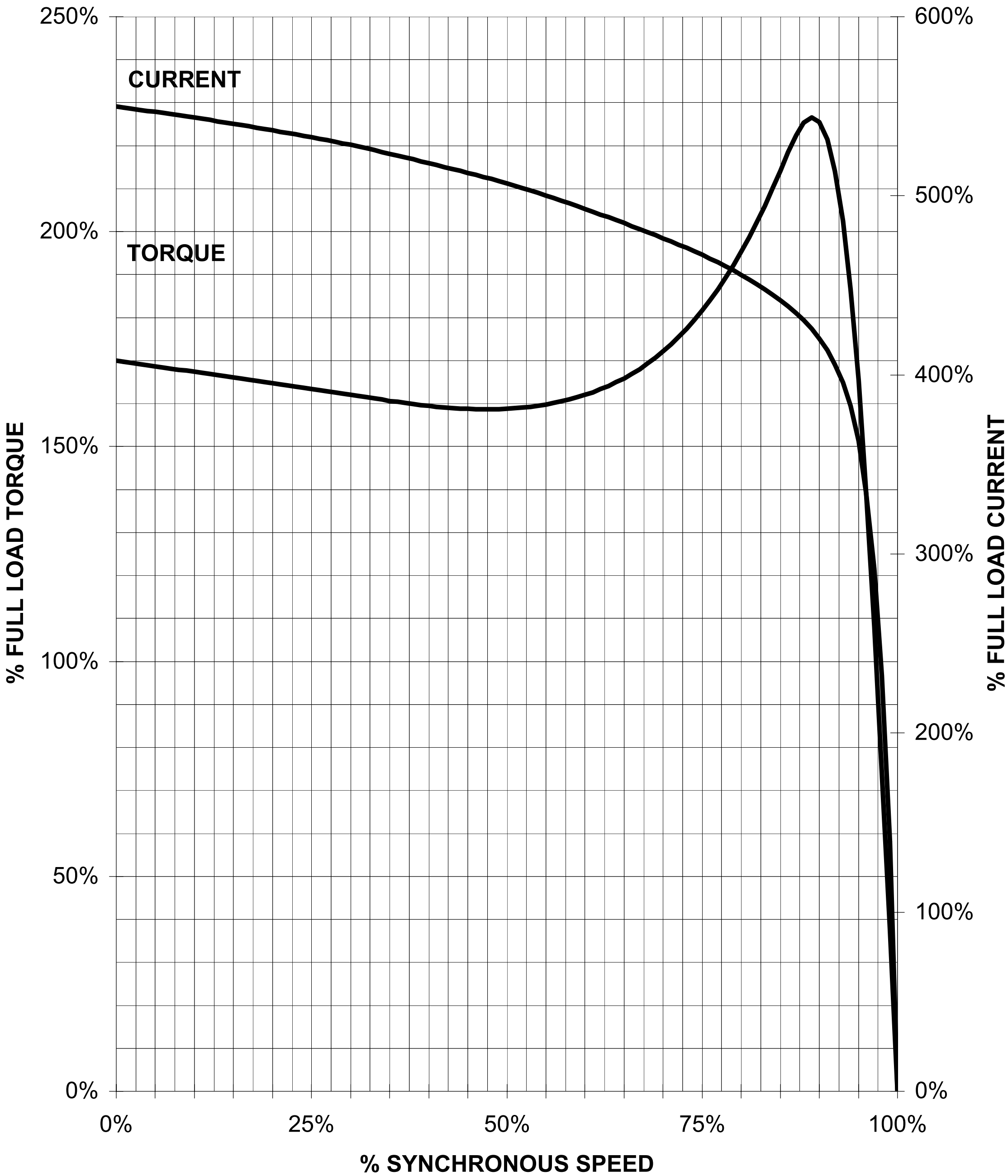
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	50	VOLTS	460	RPM	1200	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	365T	NEMA	B

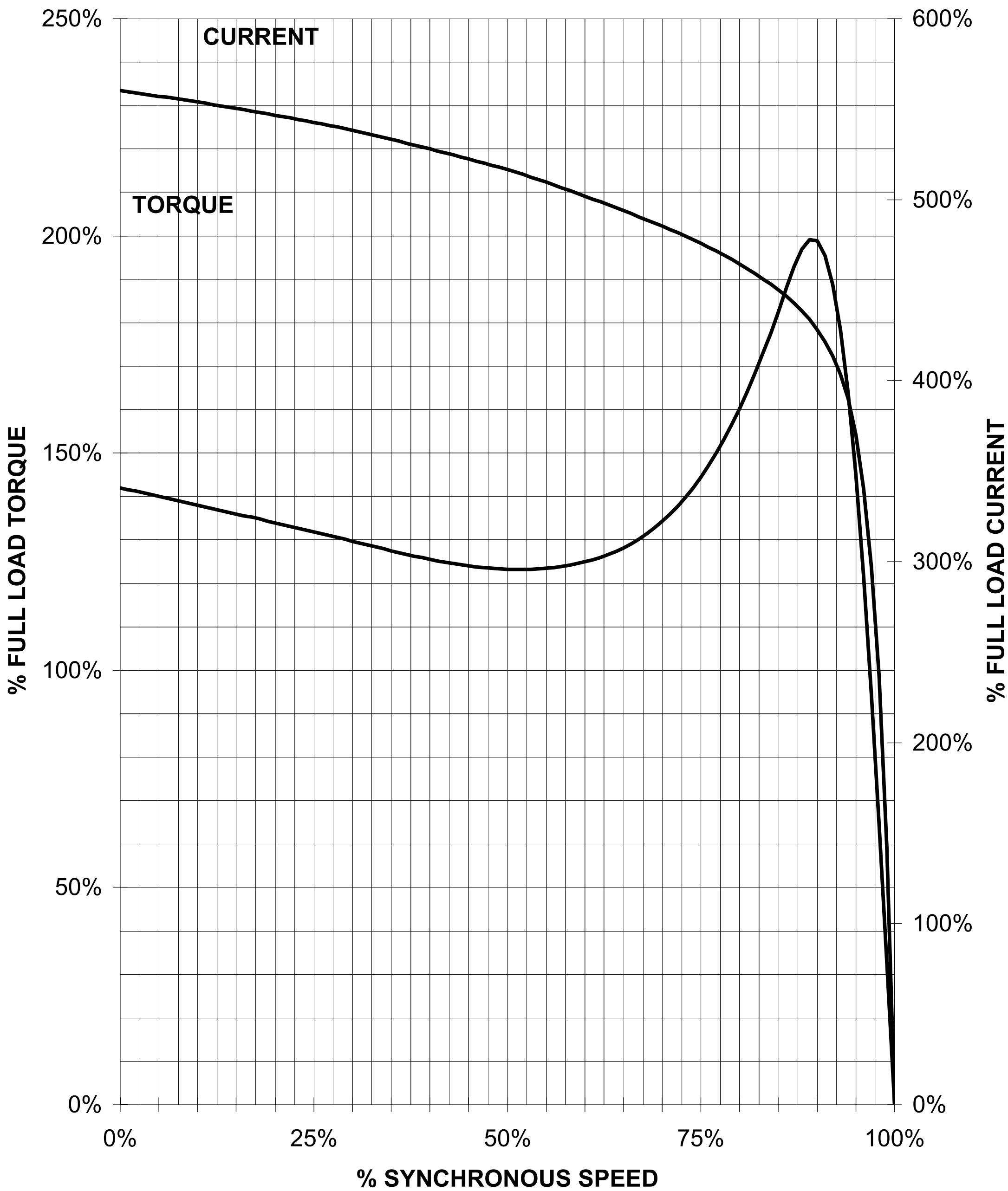
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	50	VOLTS	460	RPM	900	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	404T	NEMA	B

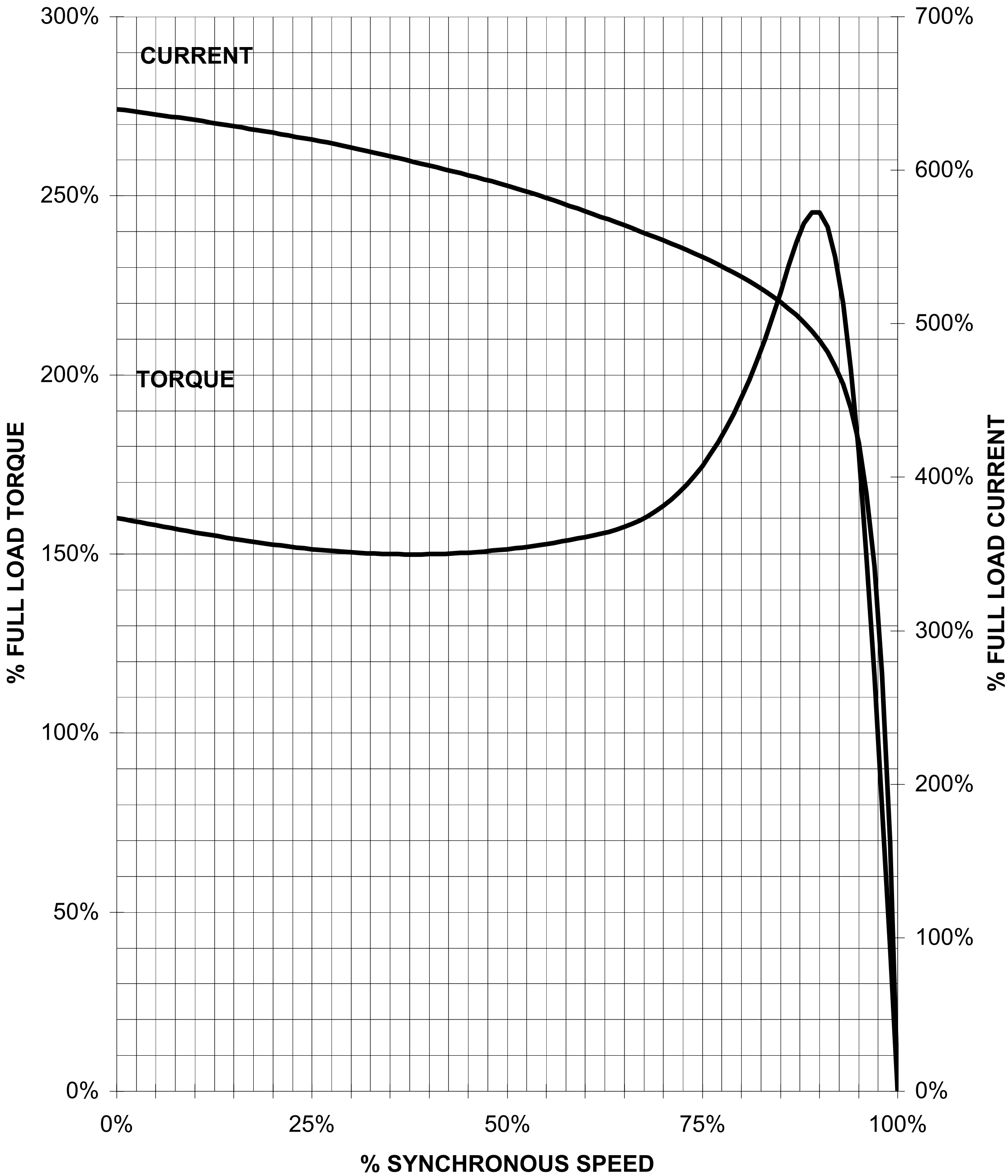
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	60	VOLTS	460	RPM	3600	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	364TS	NEMA	B

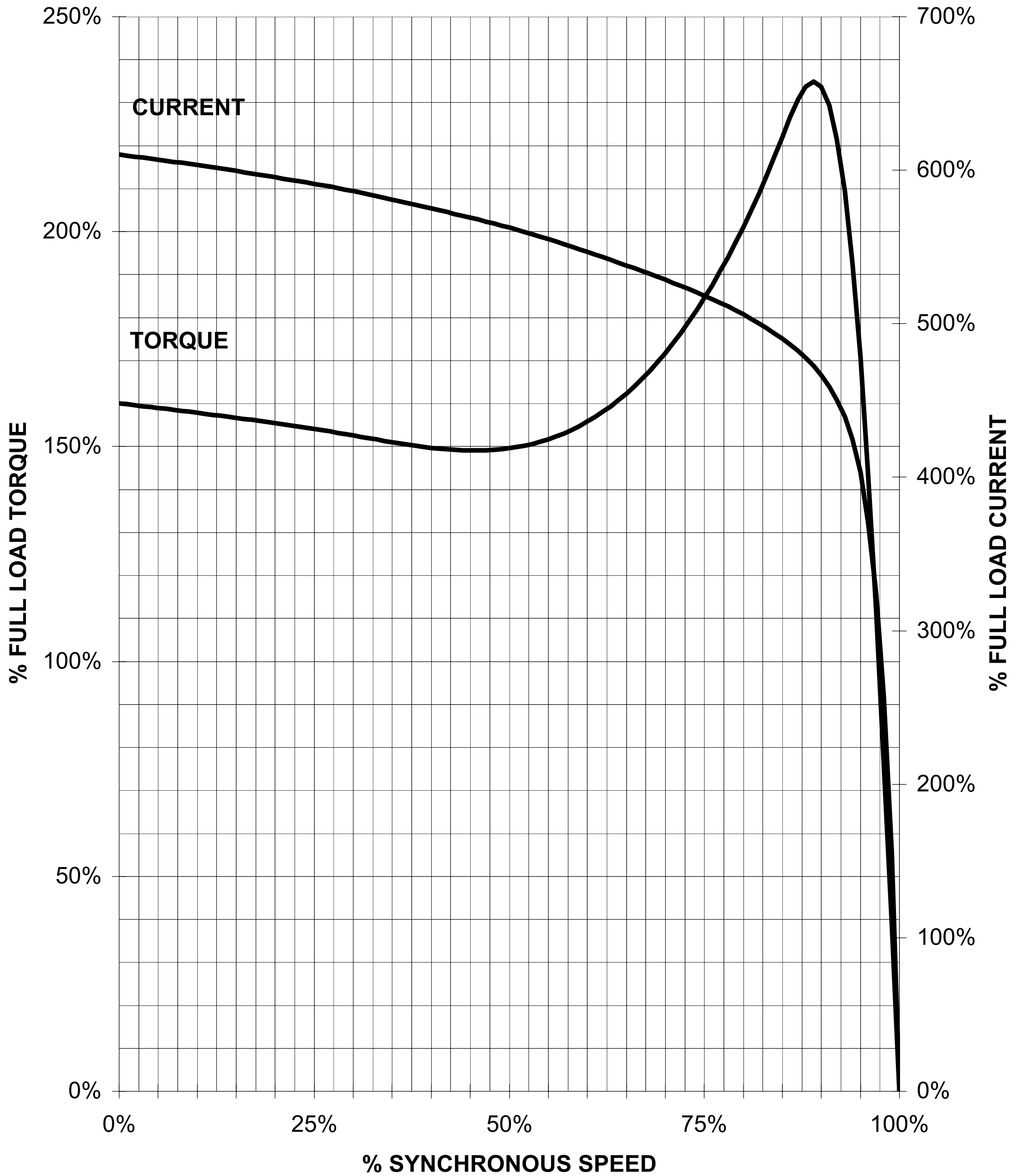
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	60	VOLTS	460	RPM	1800	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	364T	NEMA	B

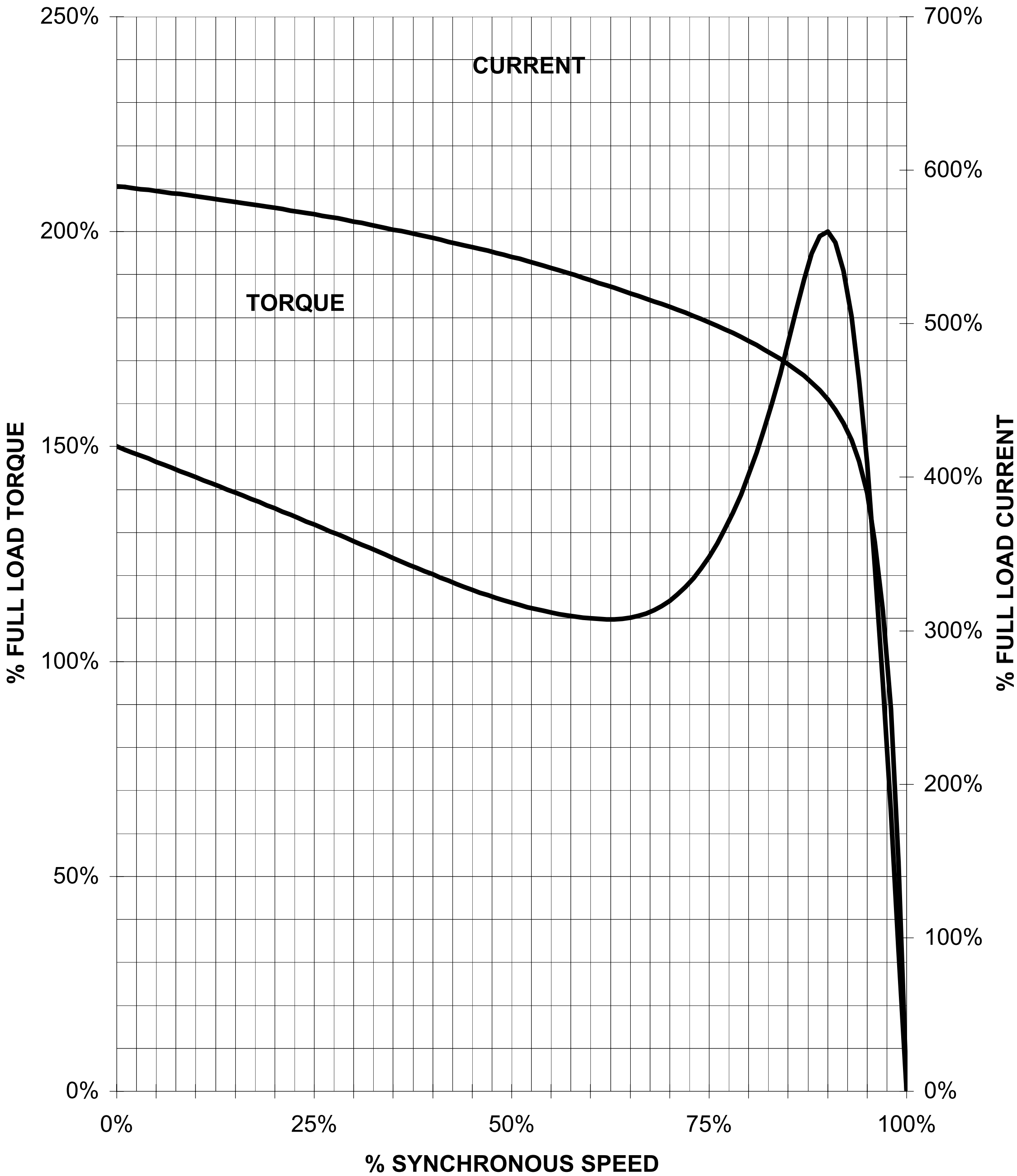
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	60	VOLTS	460	RPM	1200	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	404T	NEMA	B

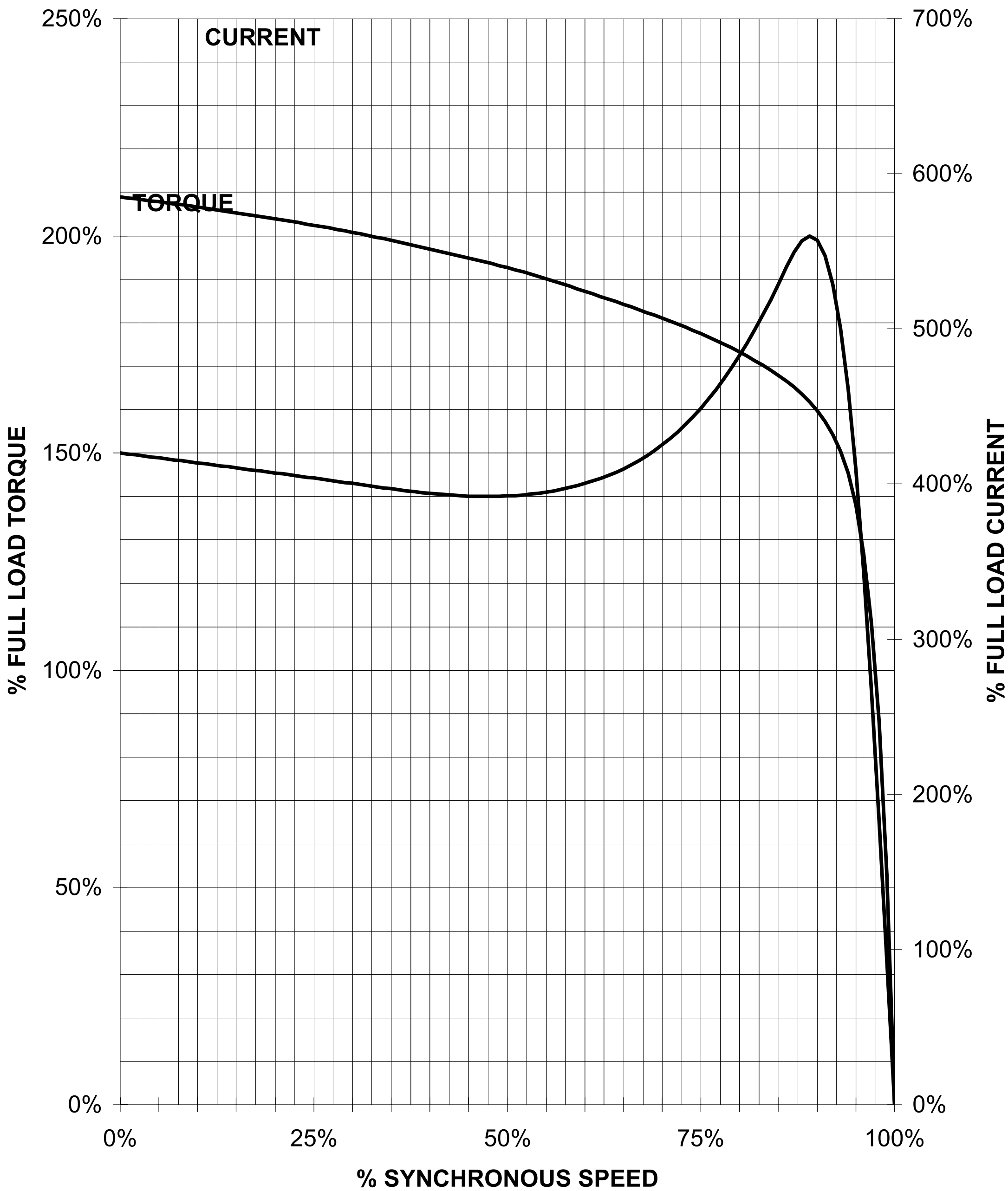
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	60	VOLTS	460	RPM	900	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	405T	NEMA	B

TORQUE & CURRENT VS. SPEED



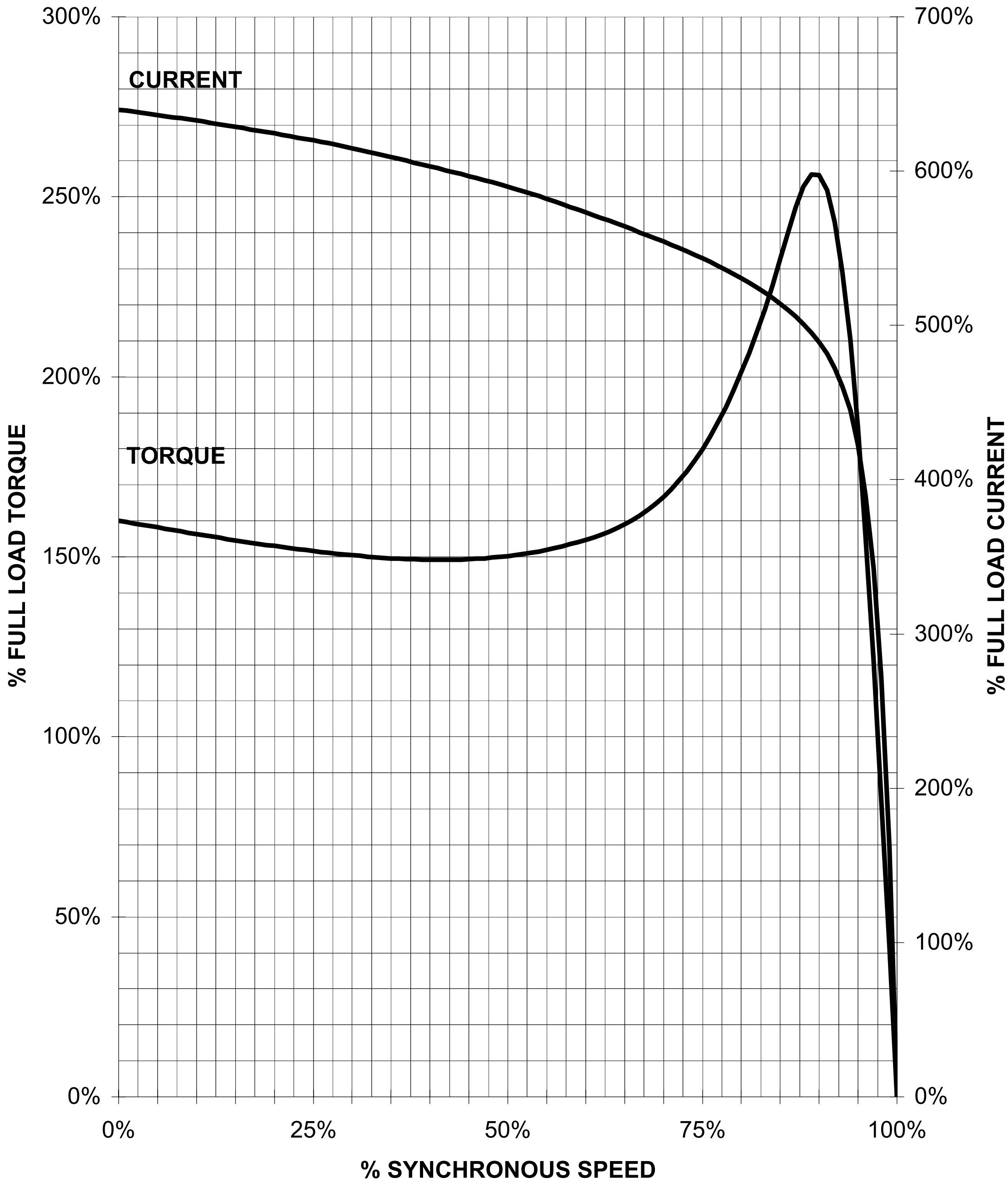
Customer: **PO No.:** **Order No.:**

SIEMENS

Application Manual for NEMA Motors

HP	75	VOLTS	460	RPM	3600	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	365TS	NEMA	B

TORQUE AND CURRENT VS. SPEED

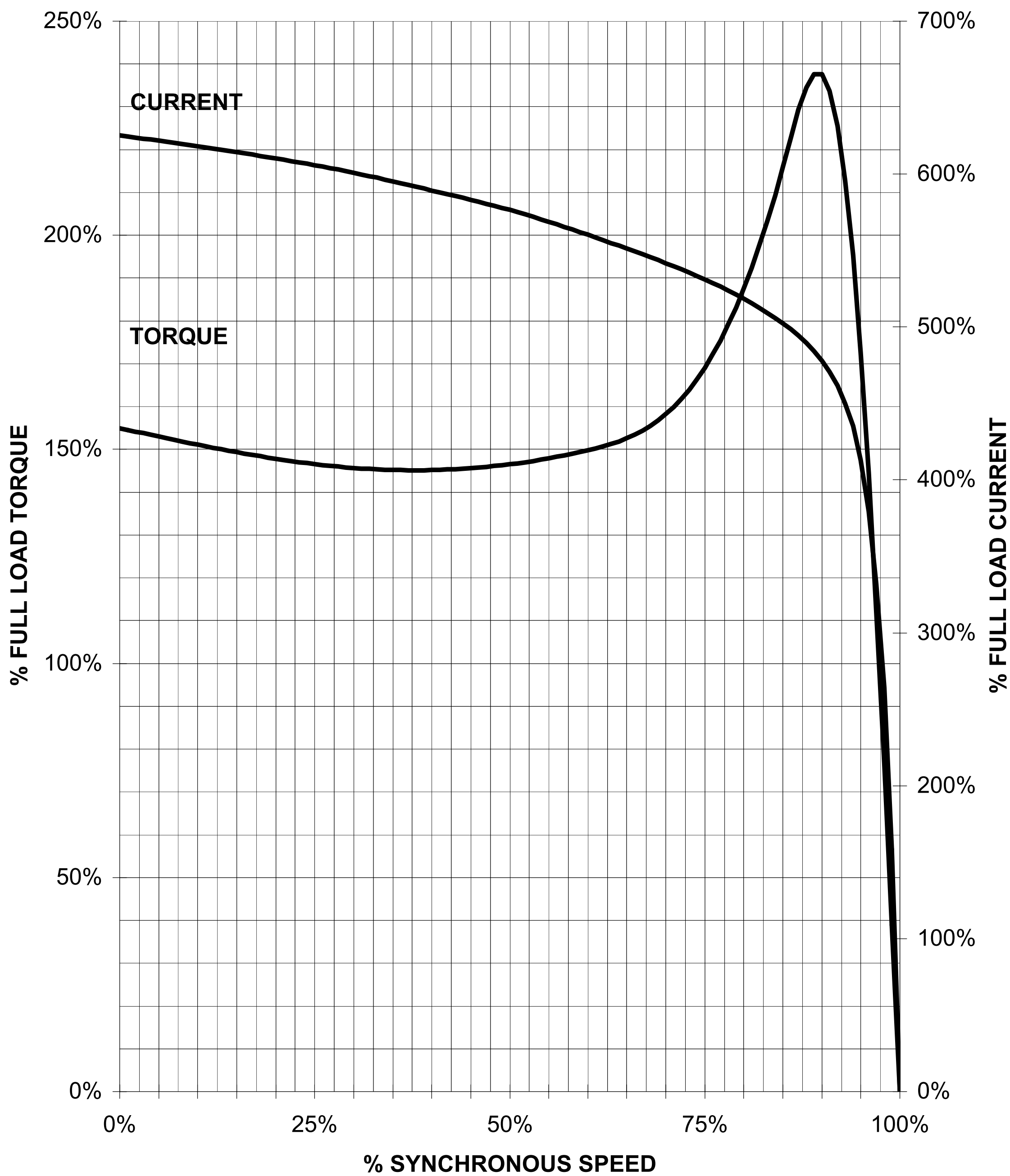


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	75	VOLTS	460	RPM	1800	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	365T	NEMA	B

TORQUE AND CURRENT VS. SPEED

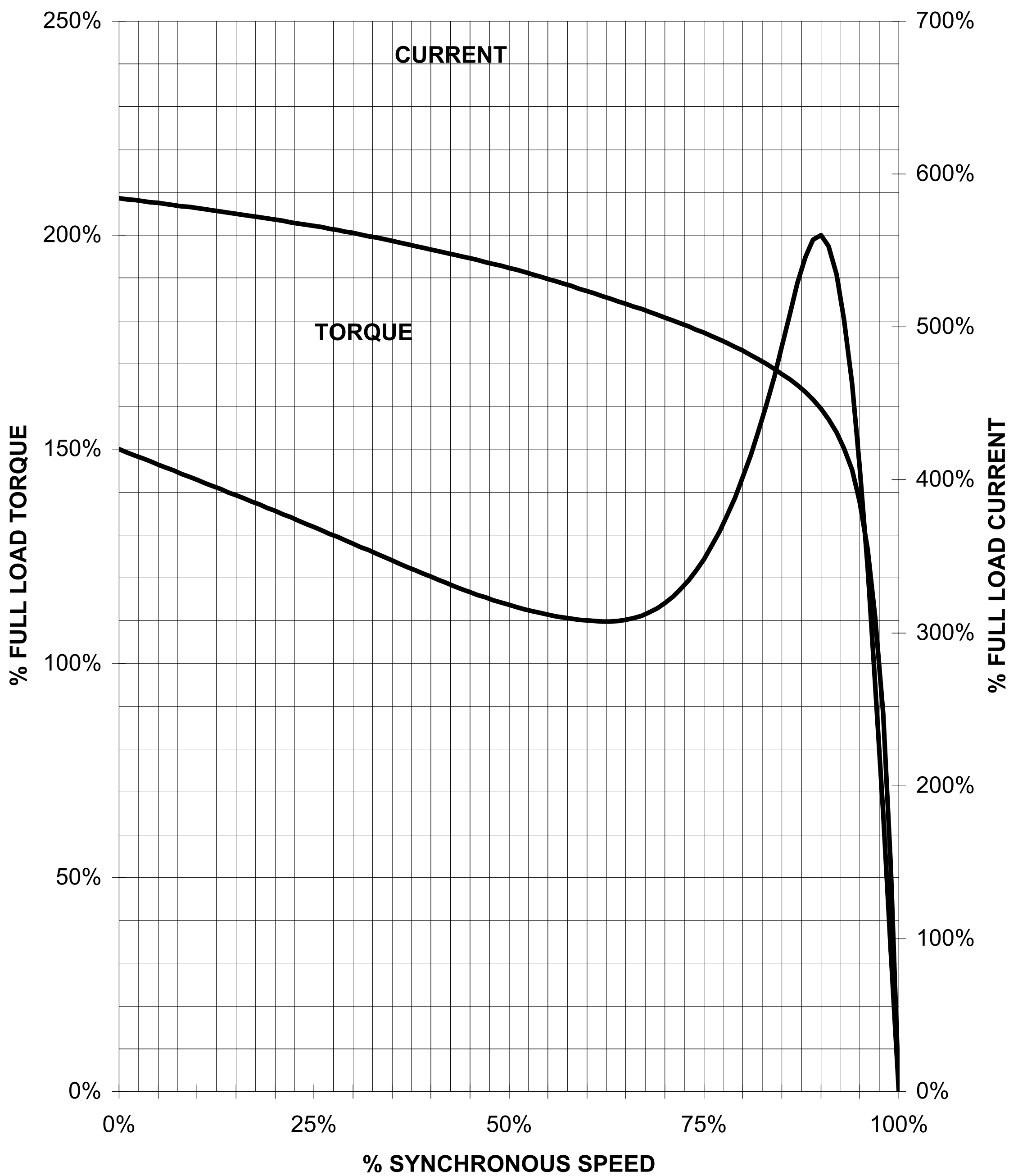


Customer: **PO No.:** **Order No.:**

Application Manual for NEMA Motors

HP	75	VOLTS	460	RPM	1200	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	405T	NEMA	B

TORQUE AND CURRENT VS. SPEED

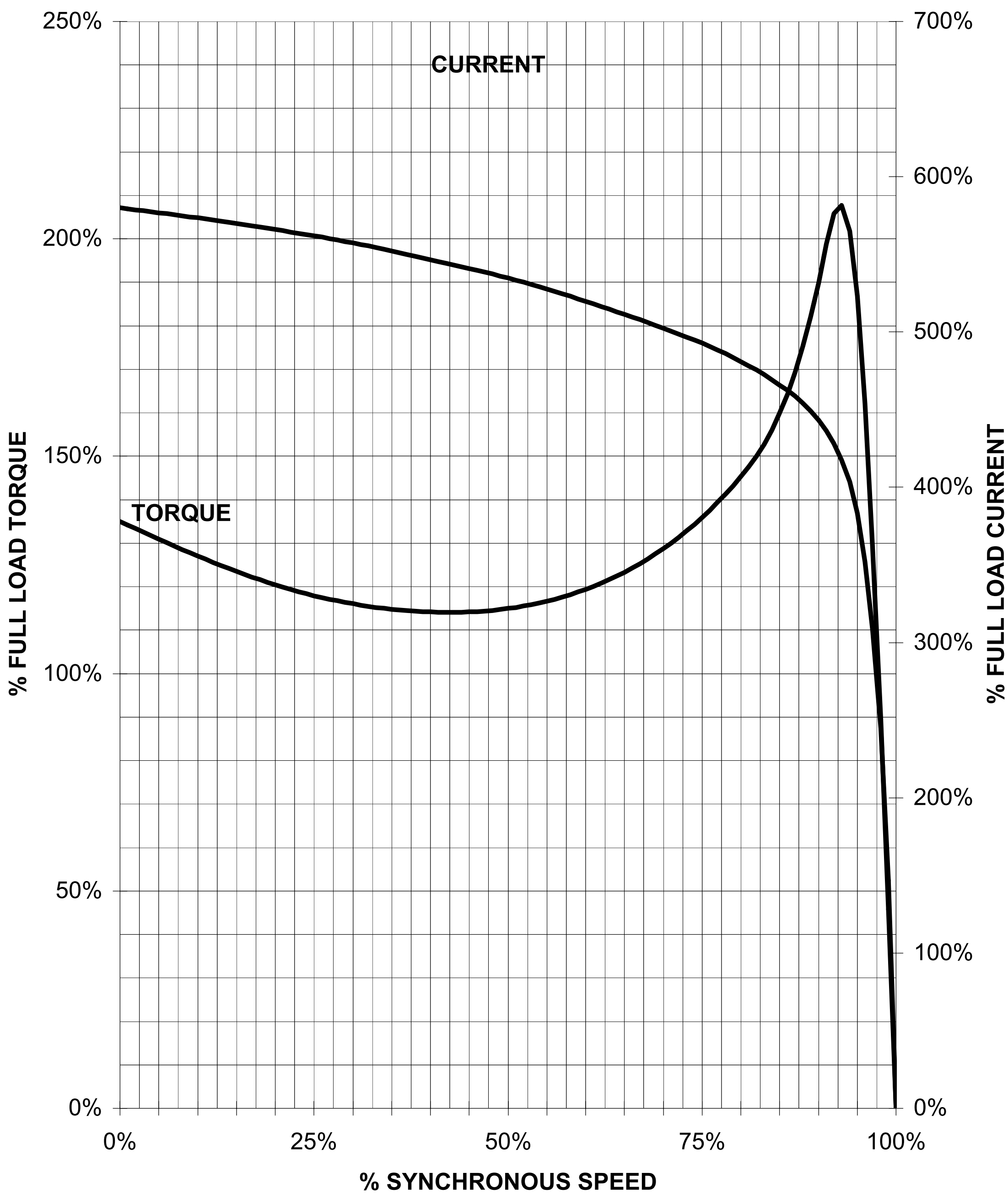


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	75	VOLTS	460	RPM	900	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	444T	NEMA	B

TORQUE AND CURRENT VS. SPEED

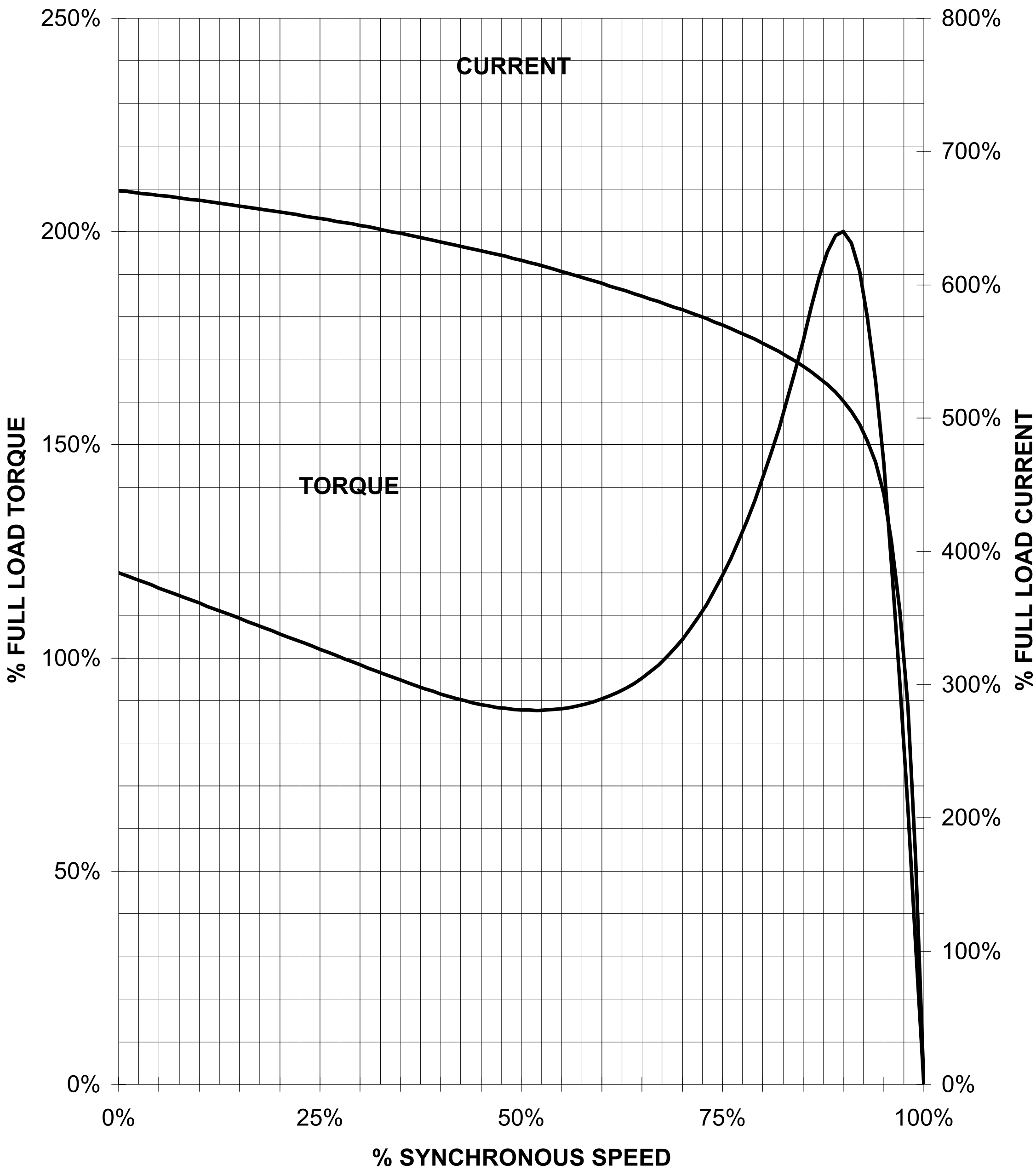


Customer: **PO No.:** **Order No.:**

Application Manual for NEMA Motors

HP	100	VOLTS	460	RPM	3600	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	405TS	NEMA	B

TORQUE AND CURRENT VS. SPEED

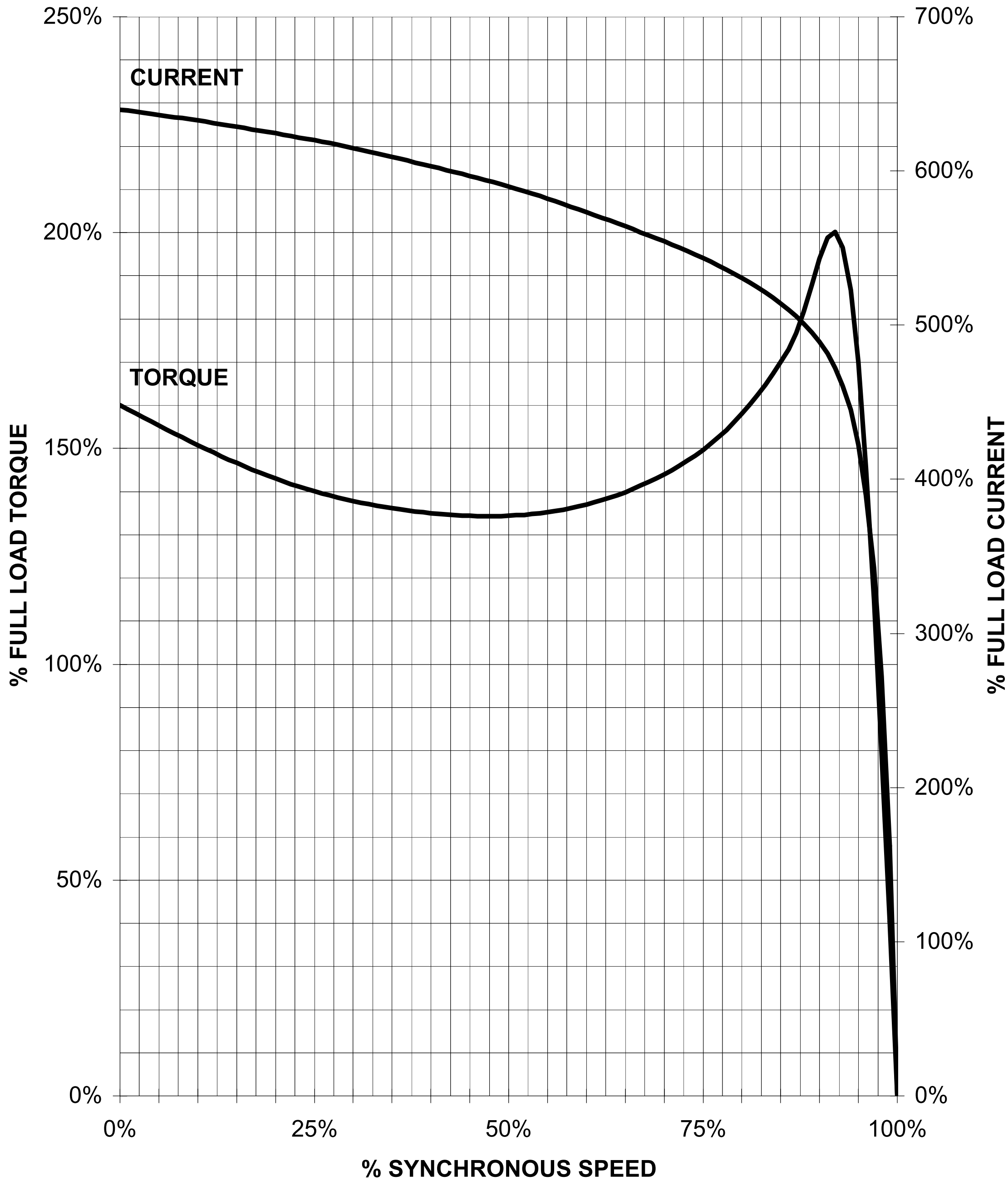


Customer: **PO No.:** **Order No.:**

Application Manual for NEMA Motors

HP	100	VOLTS	460	RPM	1800	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	405T	NEMA	B

TORQUE AND CURRENT VS. SPEED

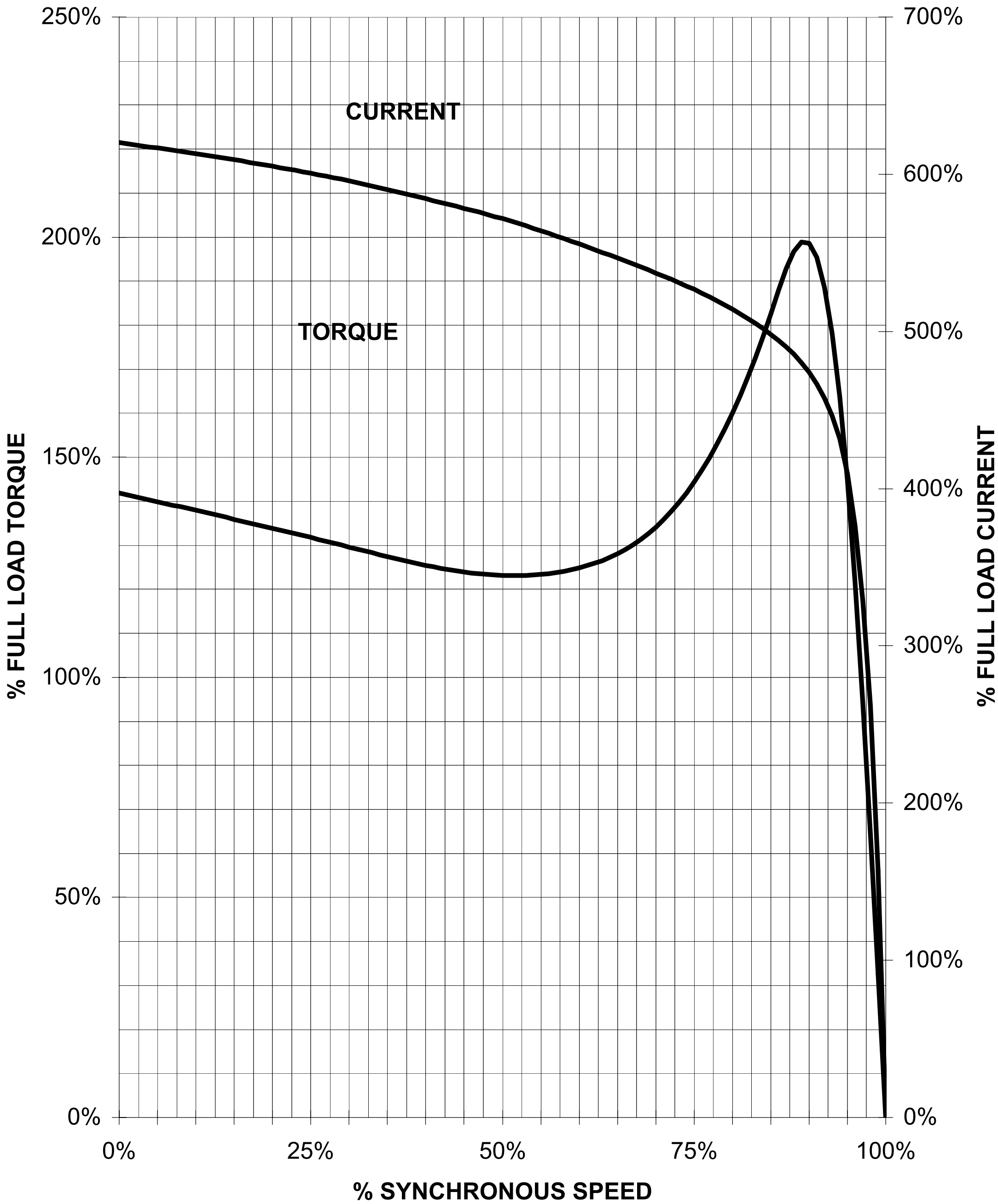


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	100	VOLTS	460	RPM	1200	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	444TS	NEMA	B

TORQUE & CURRENT VS. SPEED

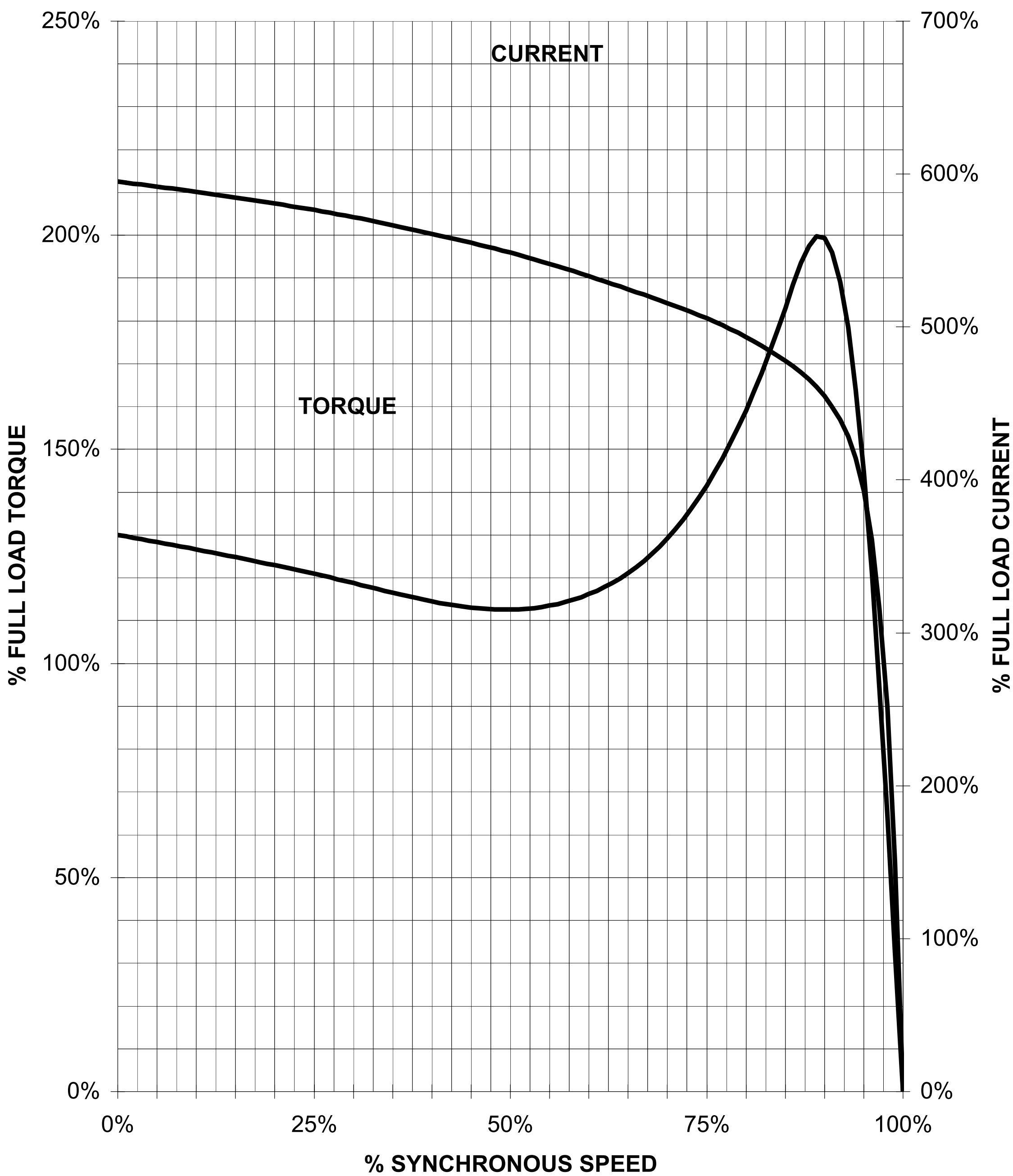


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	100	VOLTS	460	RPM	900	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	445T	NEMA	B

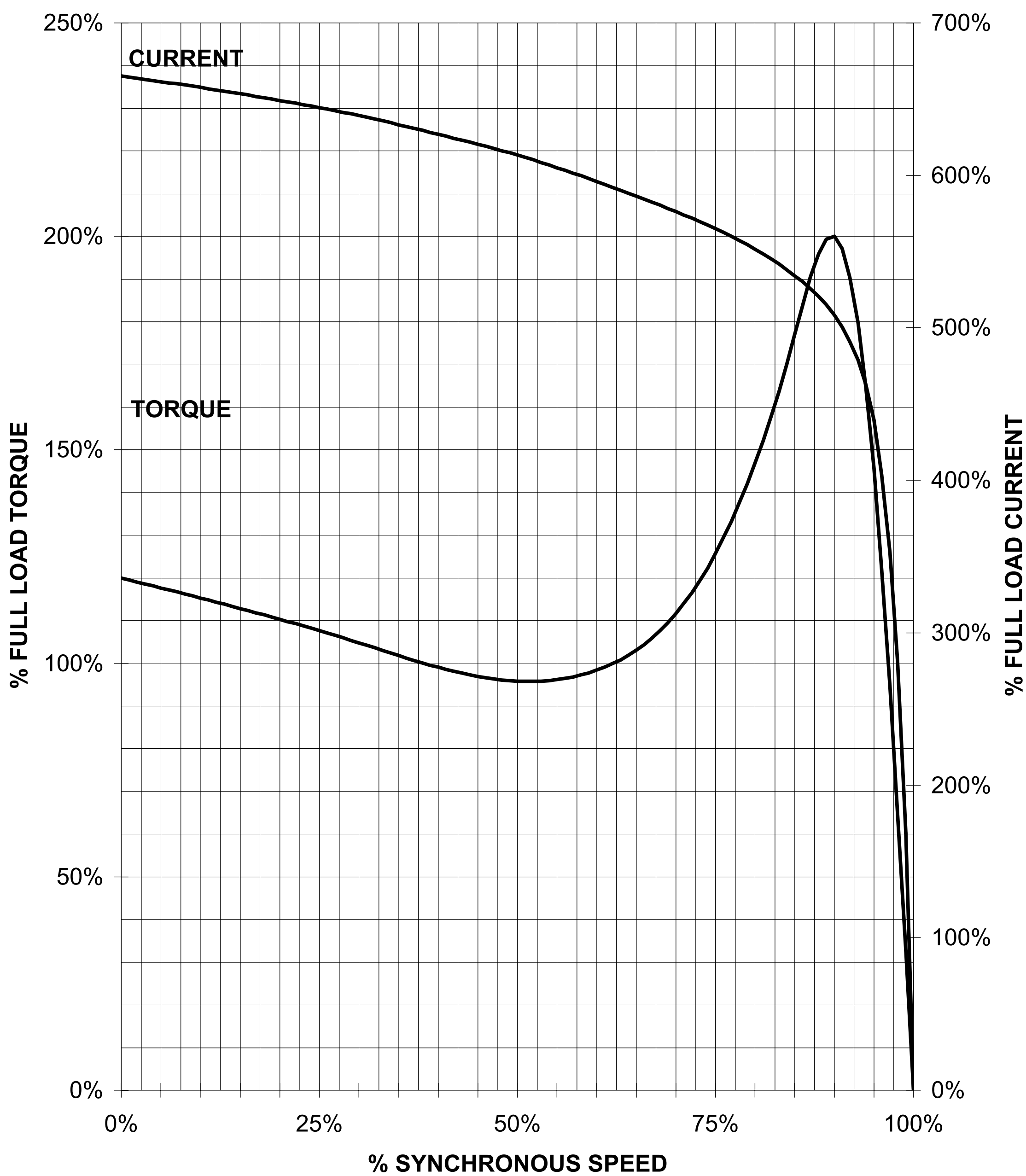
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	125	VOLTS	460	RPM	3600	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	444TS	NEMA	B

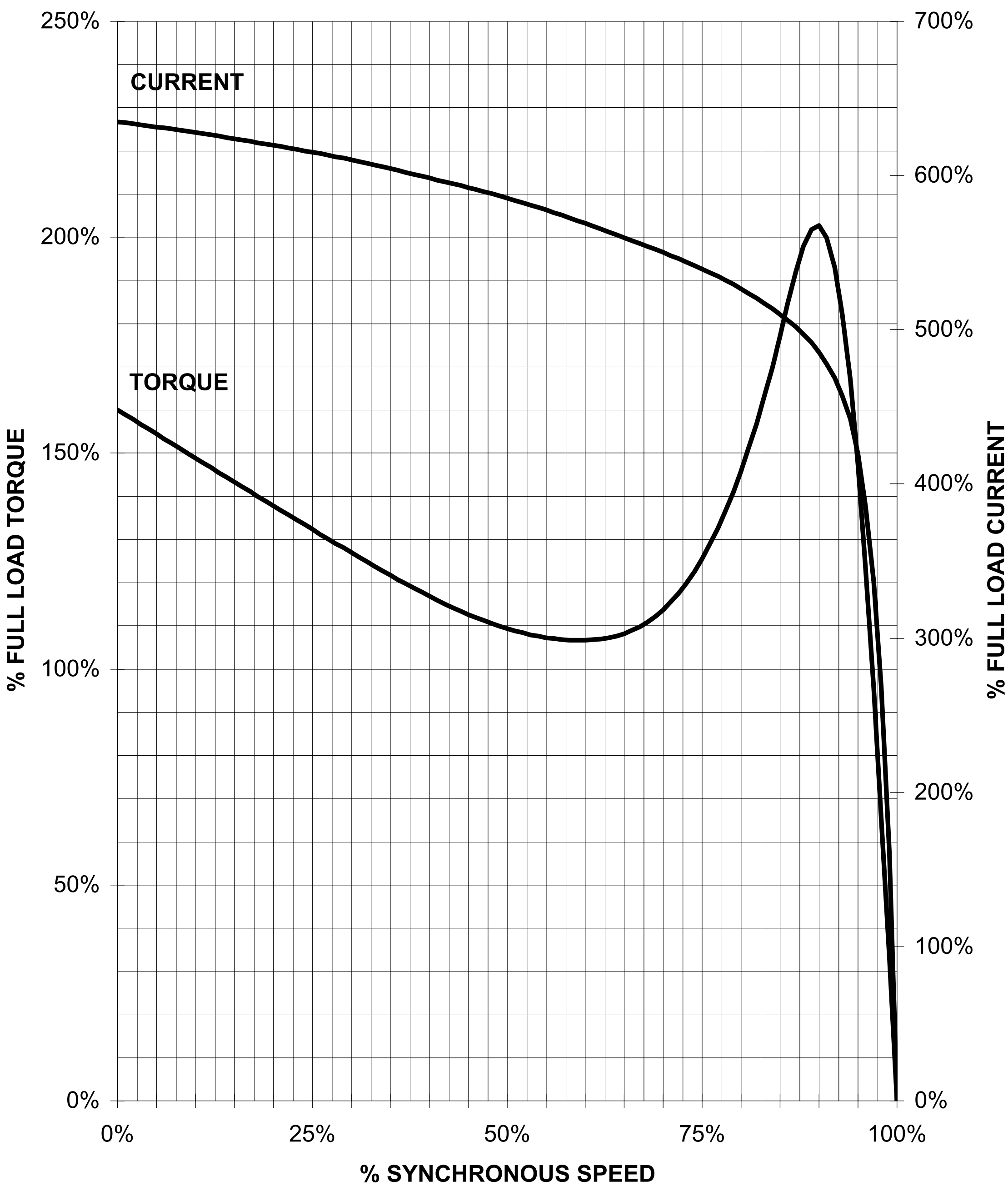
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	125	VOLTS	460	RPM	1800	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	444T	NEMA	B

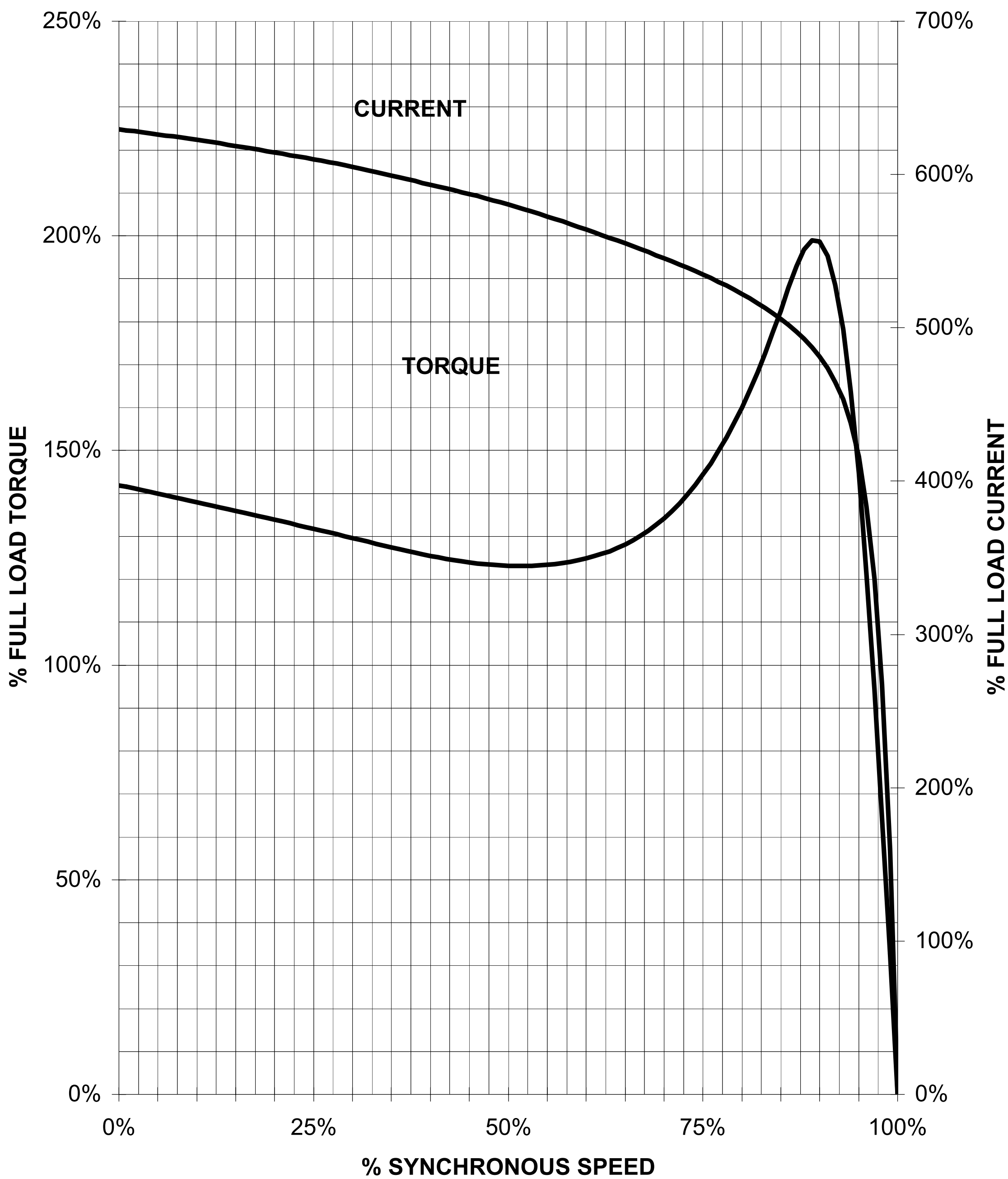
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	125	VOLTS	460	RPM	1200	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	445T	NEMA	B

TORQUE AND CURRENT VS. SPEED

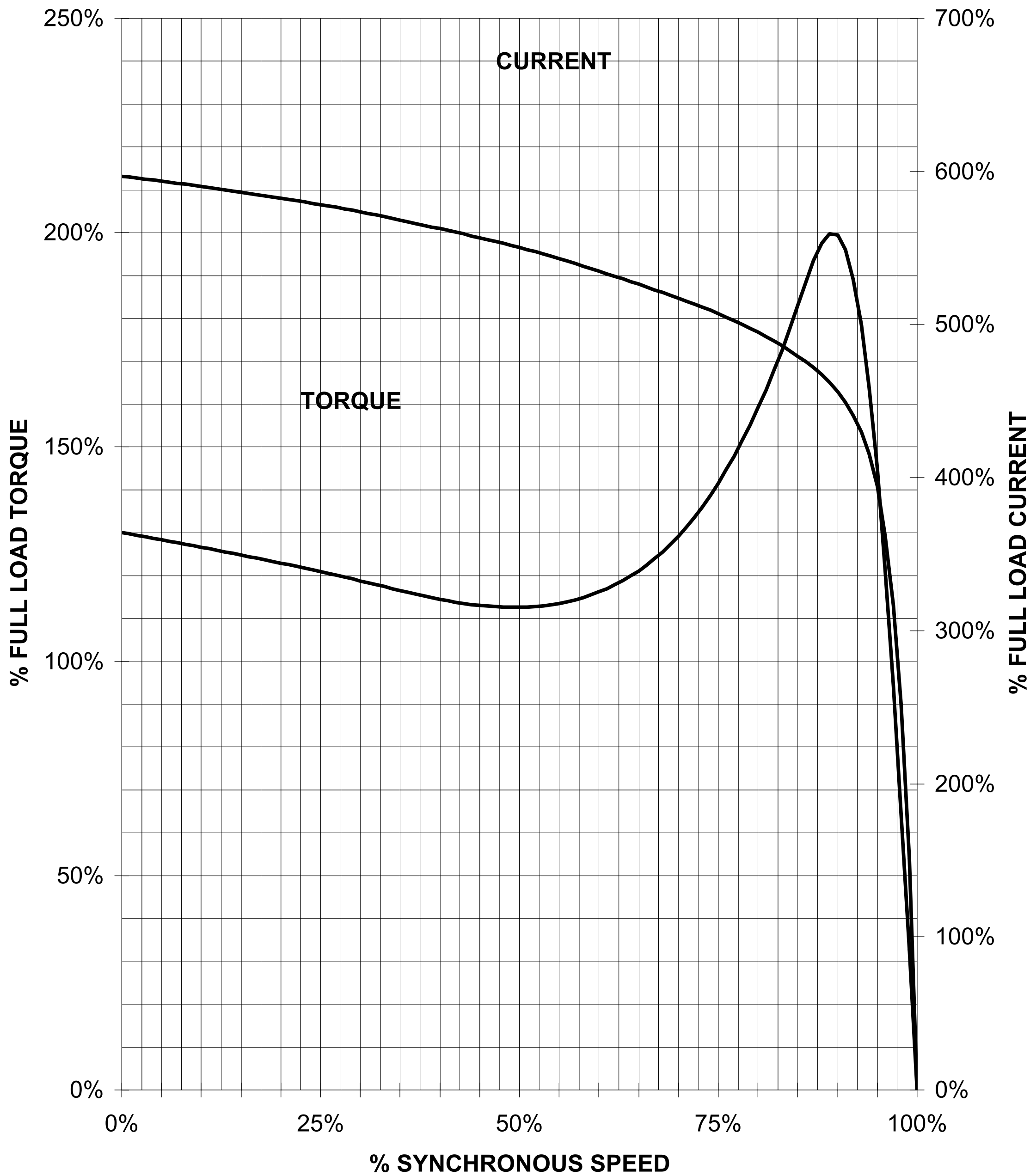


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	125	VOLTS	460	RPM	900	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	447T	NEMA	B

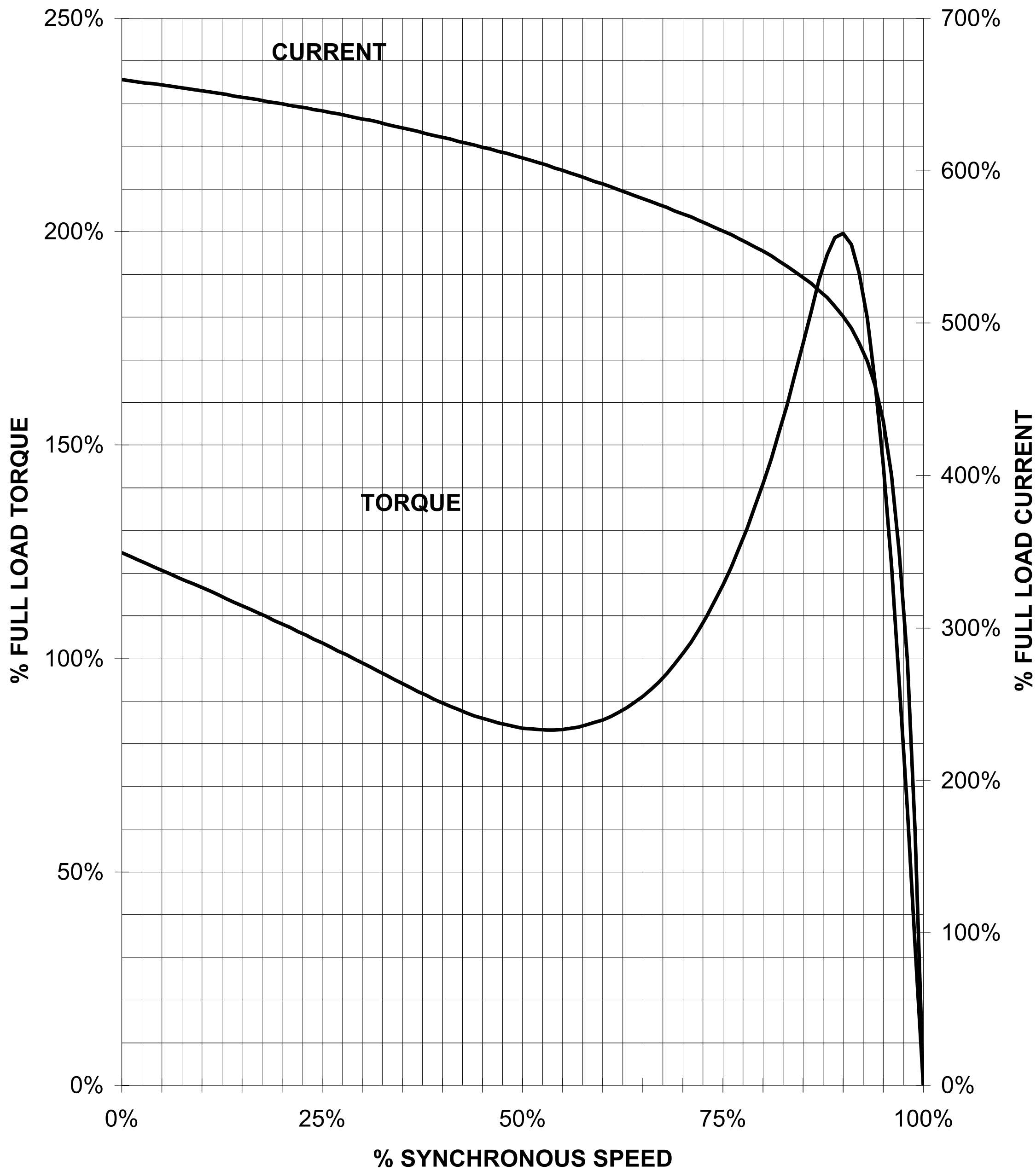
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	150	VOLTS	460	RPM	3600	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	445TS	NEMA	B

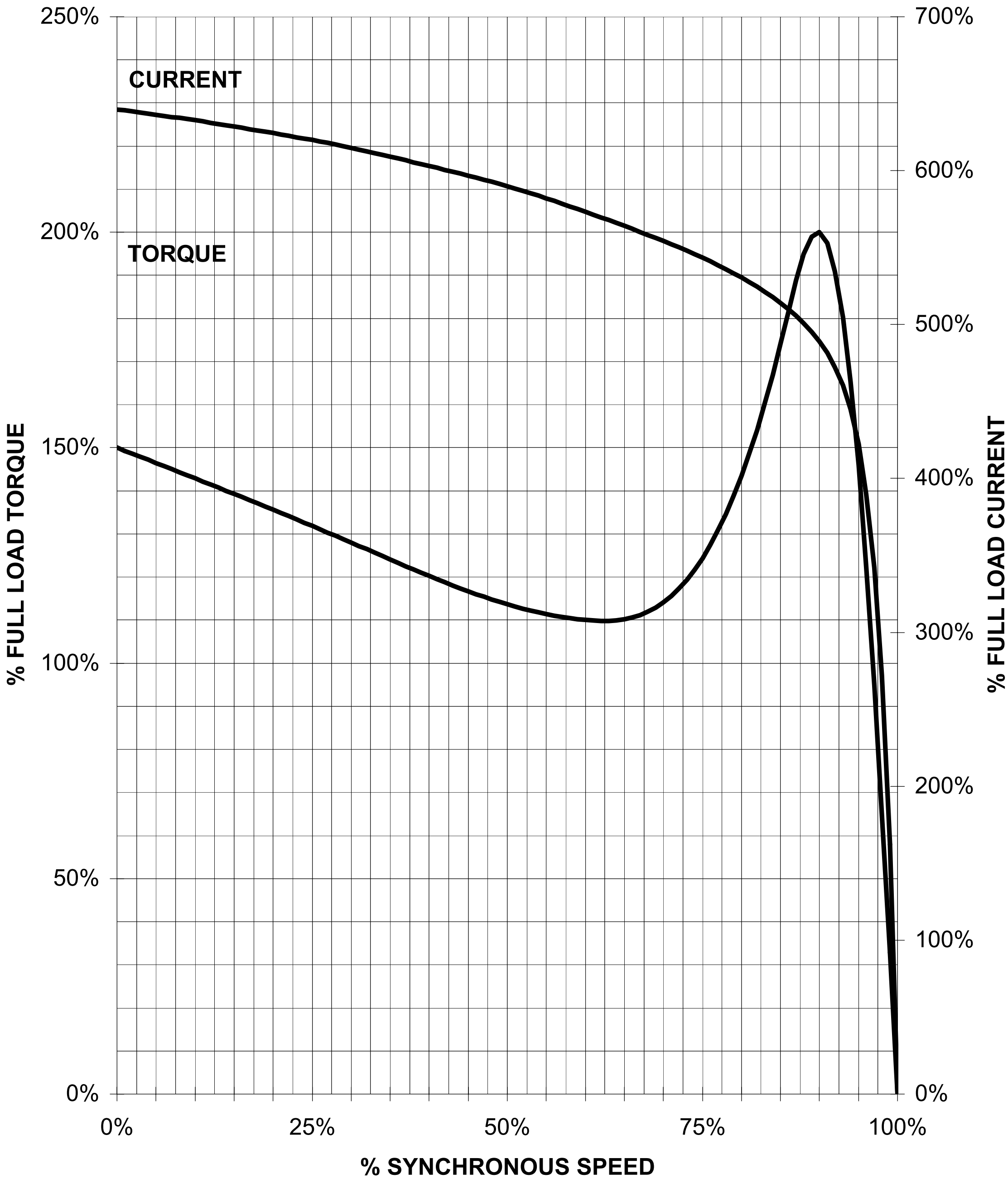
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	150	VOLTS	460	RPM	1800	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	445T	NEMA	B

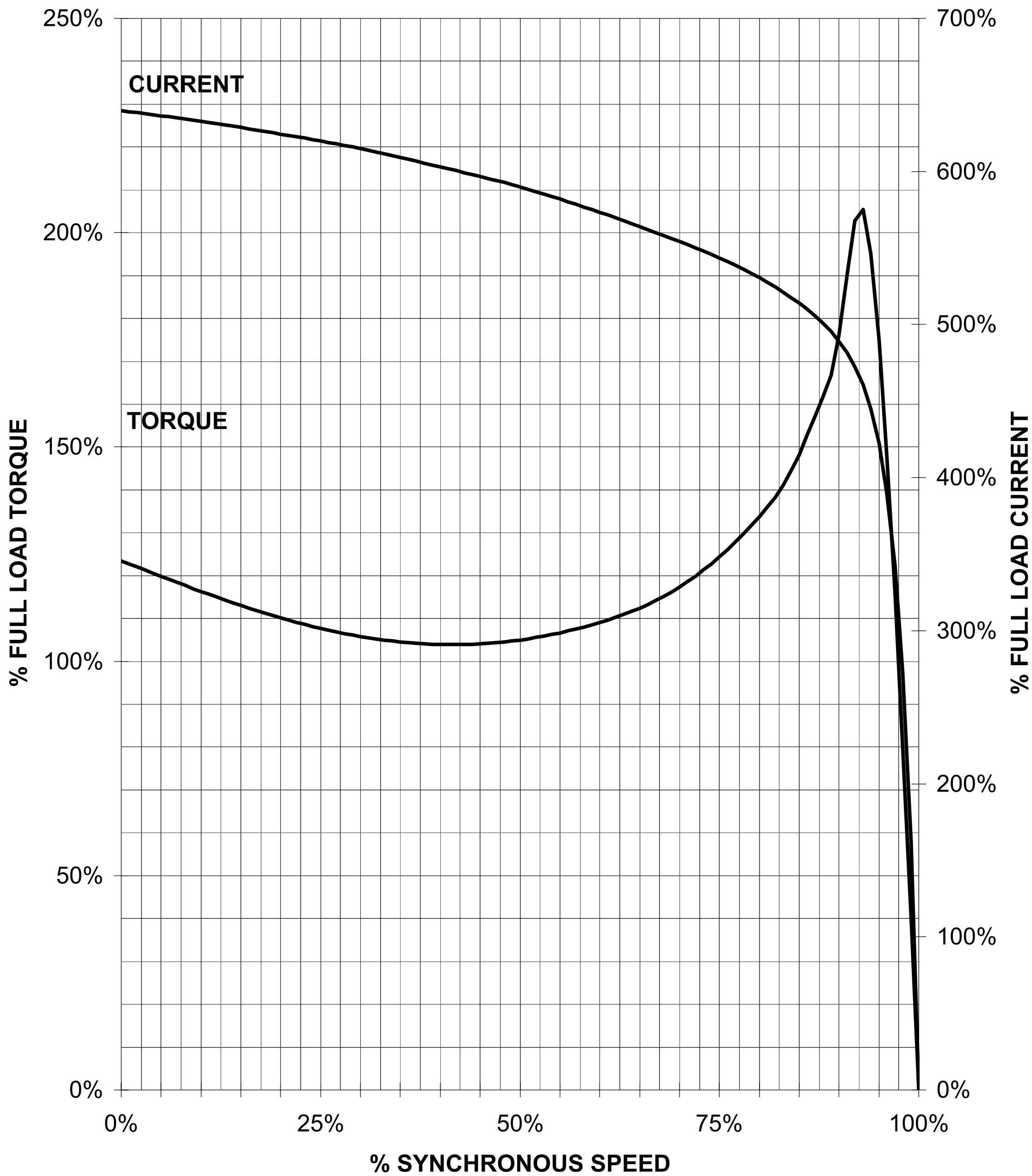
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	150	VOLTS	460	RPM	1200	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	447T	NEMA	B

TORQUE AND CURRENT VS. SPEED

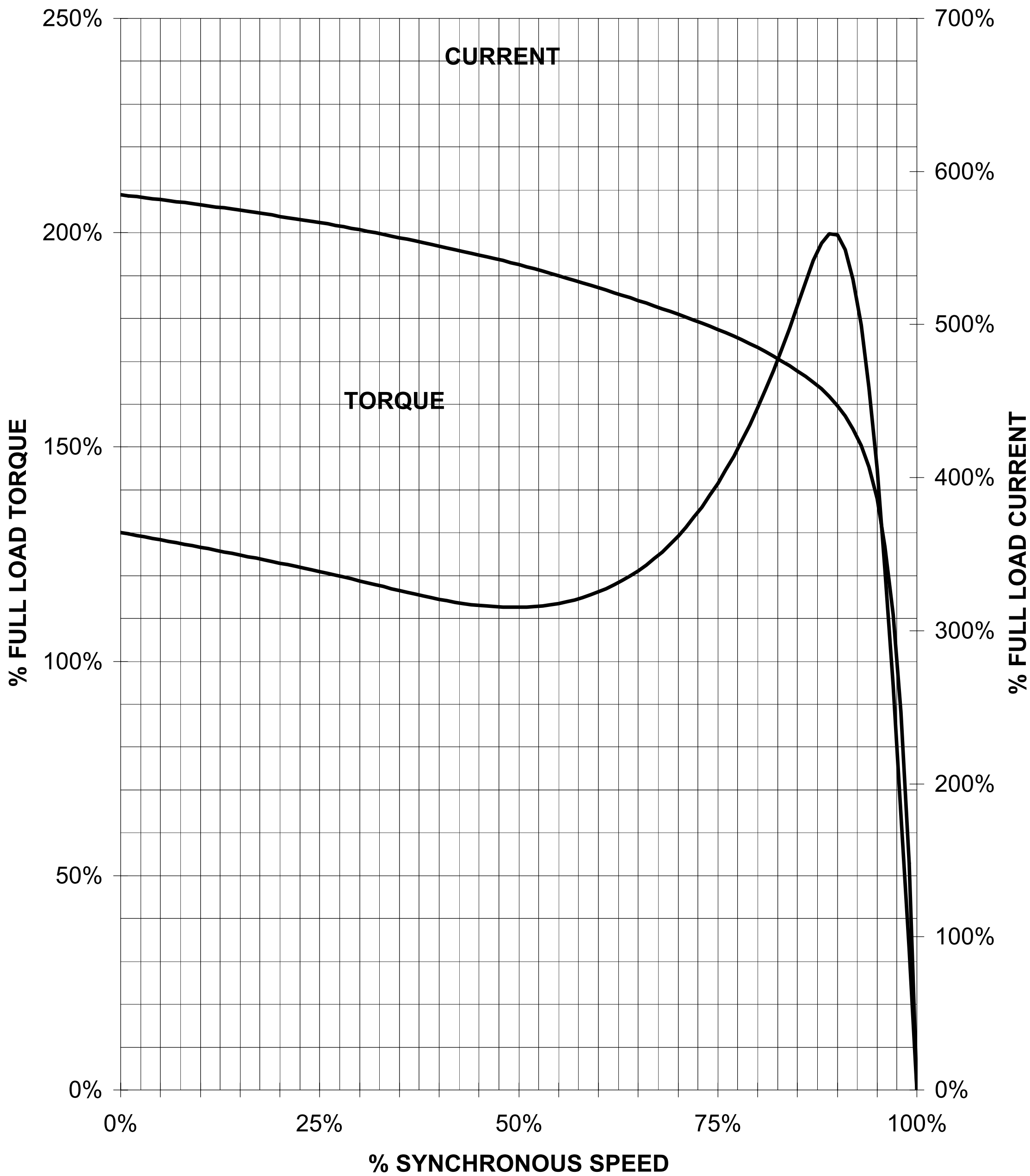


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	150	VOLTS	460	RPM	900	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	447T	NEMA	B

TORQUE AND CURRENT VS. SPEED



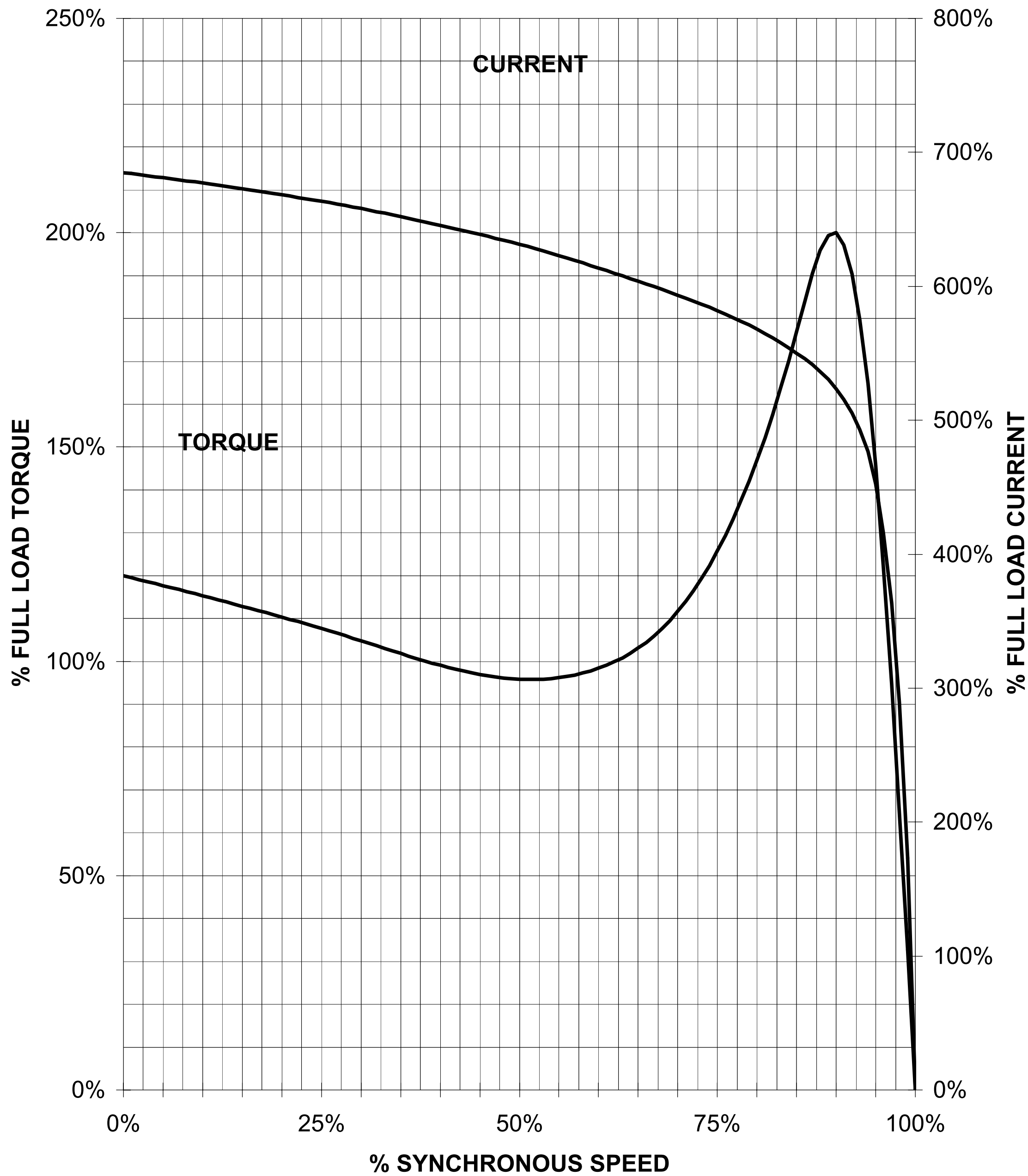
Customer: **PO No.:** **Order No.:**

Application Manual for NEMA Motors

HP 200 VOLTS 460 RPM 3600 TYPE RGZESD

HZ 60 PHASE 3 FRAME 447TS NEMA B

TORQUE AND CURRENT VS. SPEED

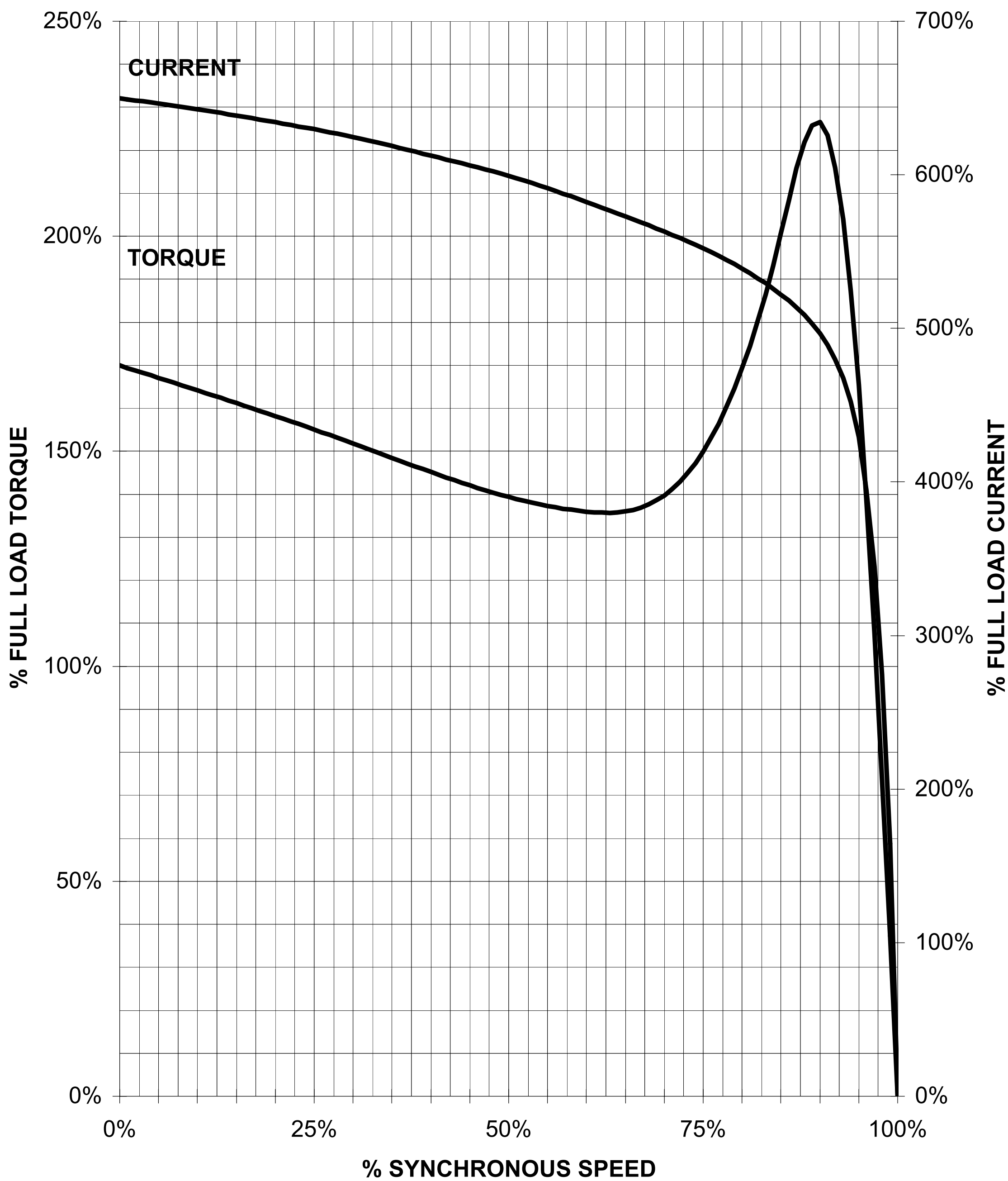


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	200	VOLTS	460	RPM	1800	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	447T	NEMA	B

TORQUE AND CURRENT VS. SPEED

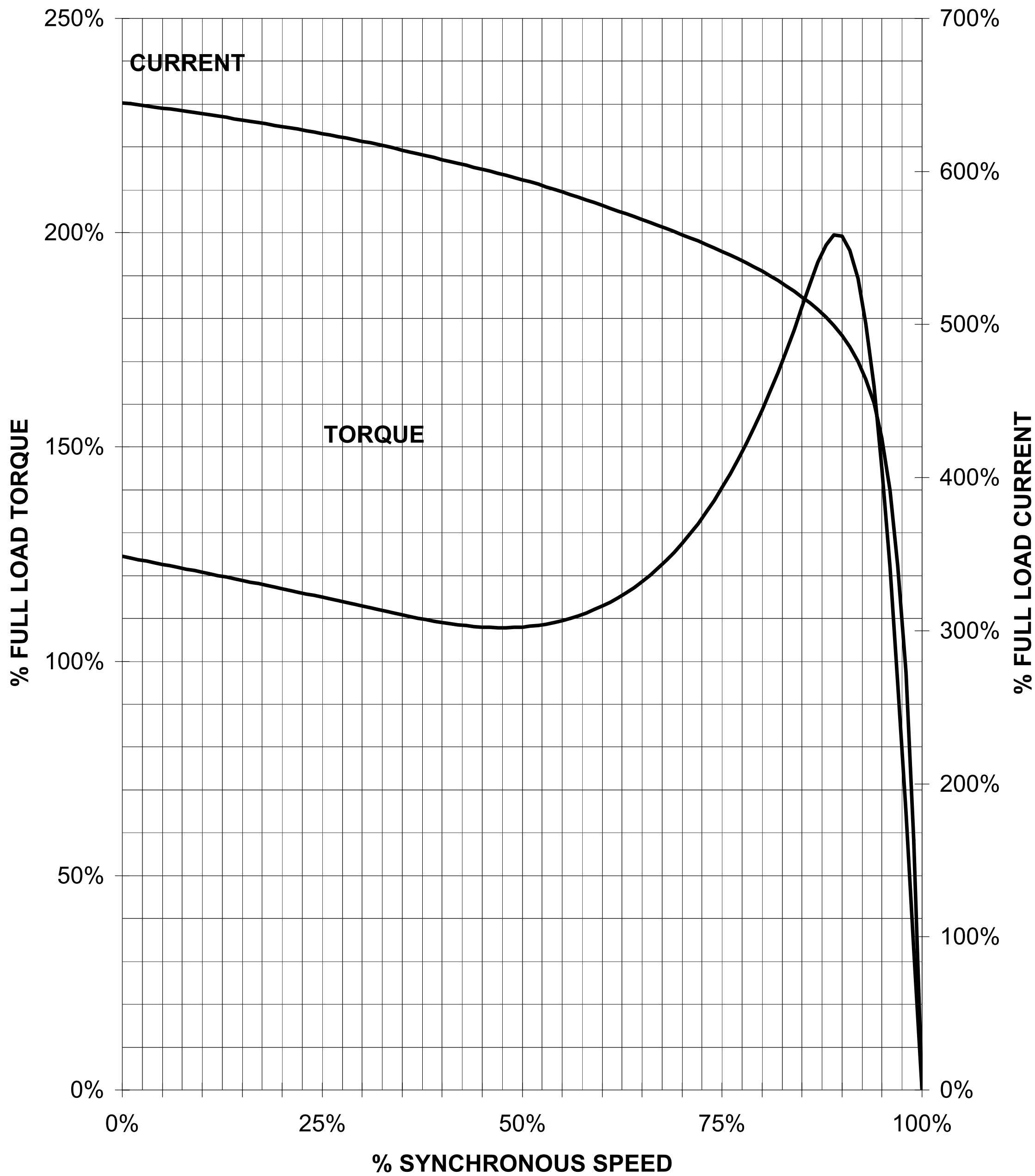


Customer: **PO No.:** **Order No.:**

Application Manual for NEMA Motors

HP	200	VOLTS	460	RPM	1200	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	449T	NEMA	B

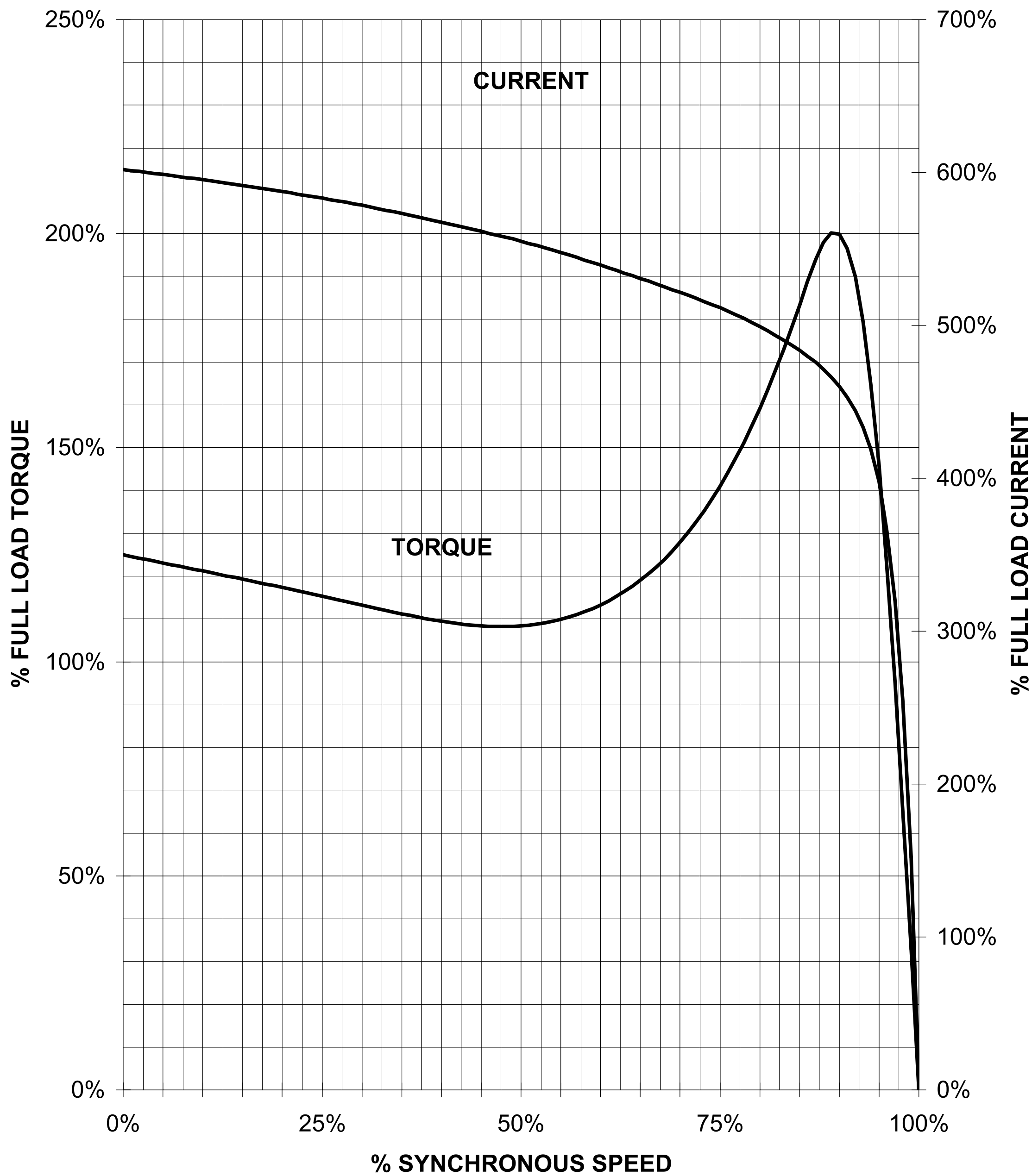
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	200	VOLTS	460	RPM	900	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	449T	NEMA	B

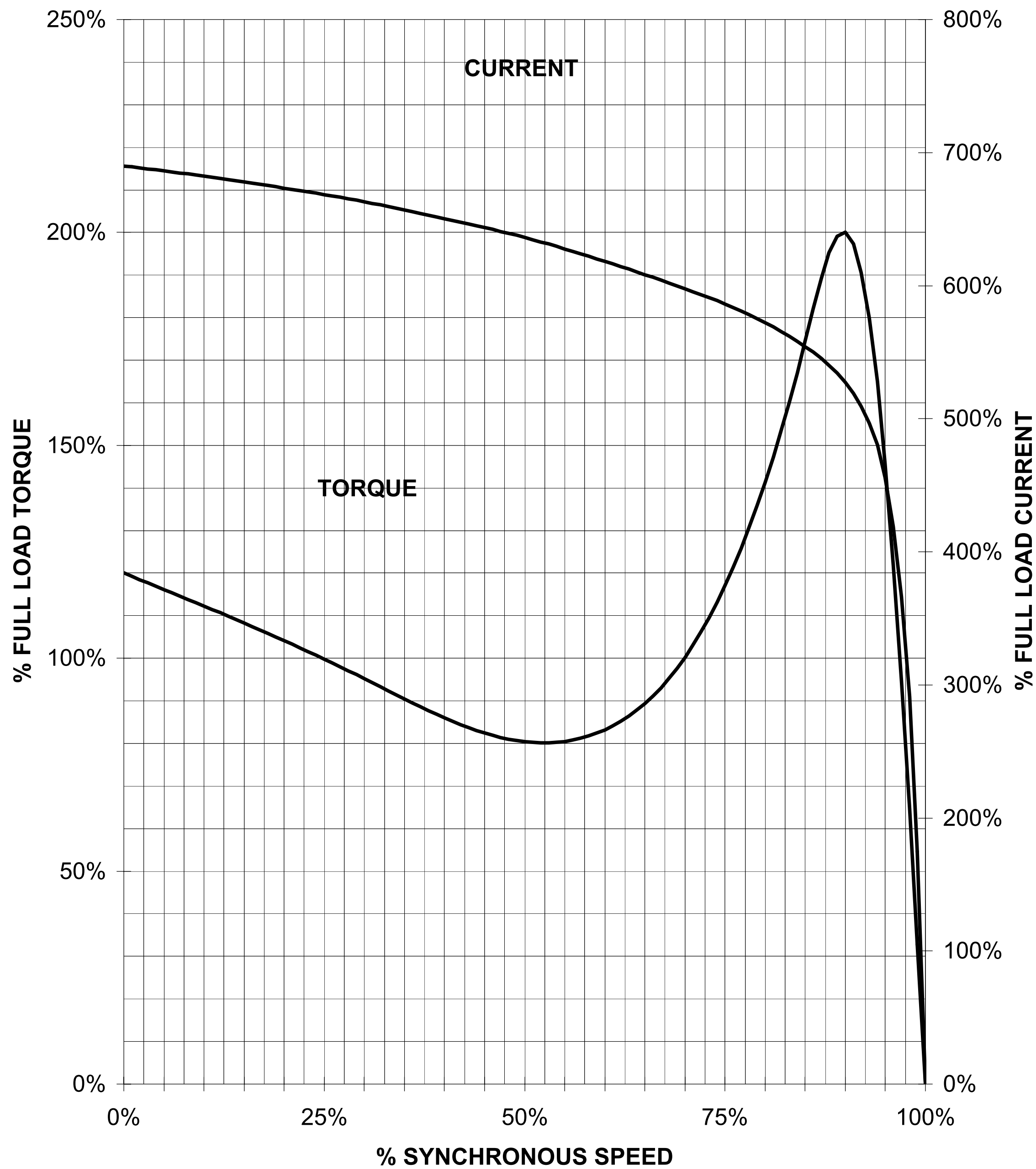
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	250	VOLTS	460	RPM	3600	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	449TS	NEMA	B

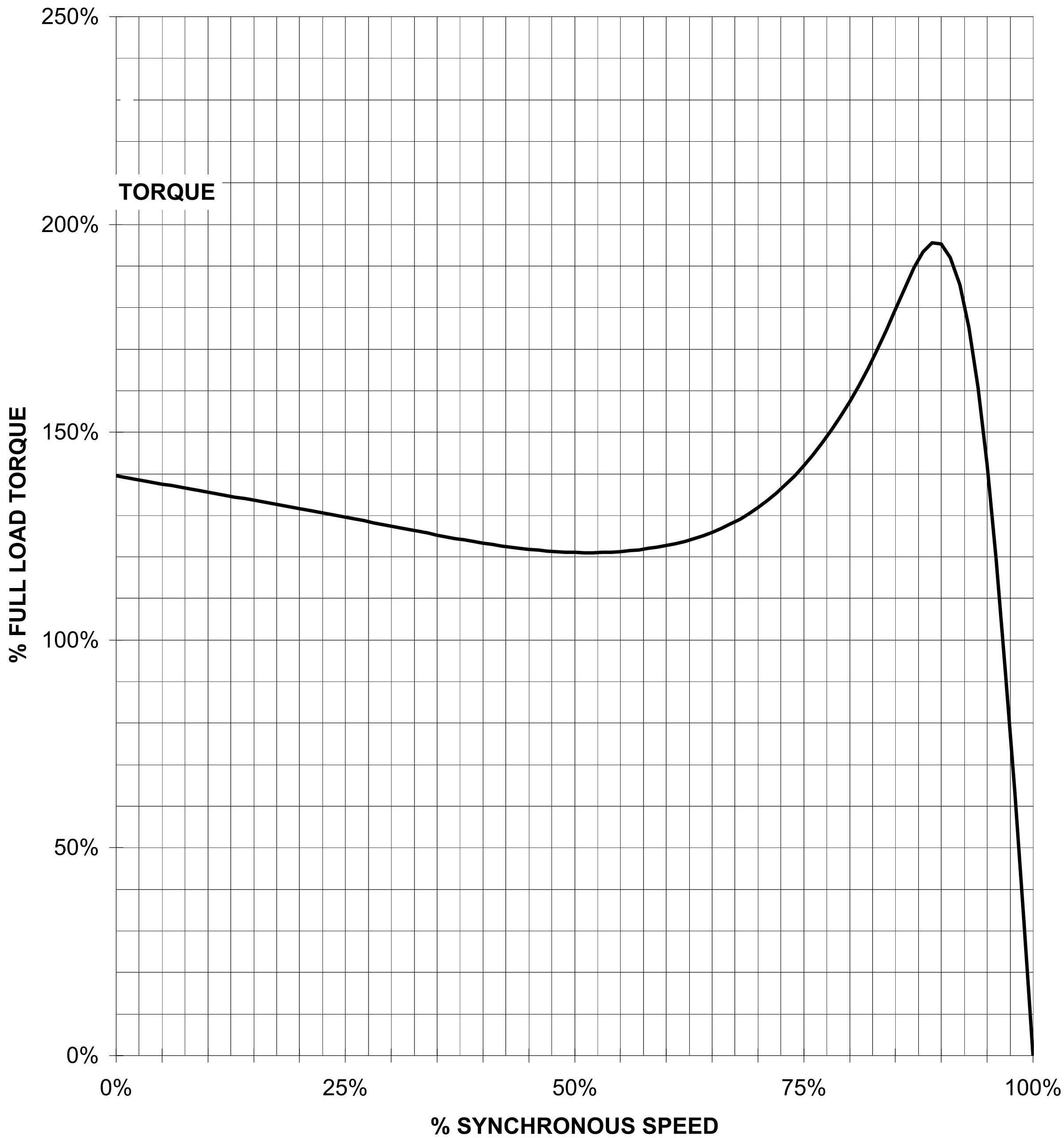
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	250	VOLTS	460	RPM	1800	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	449TS	NEMA	B

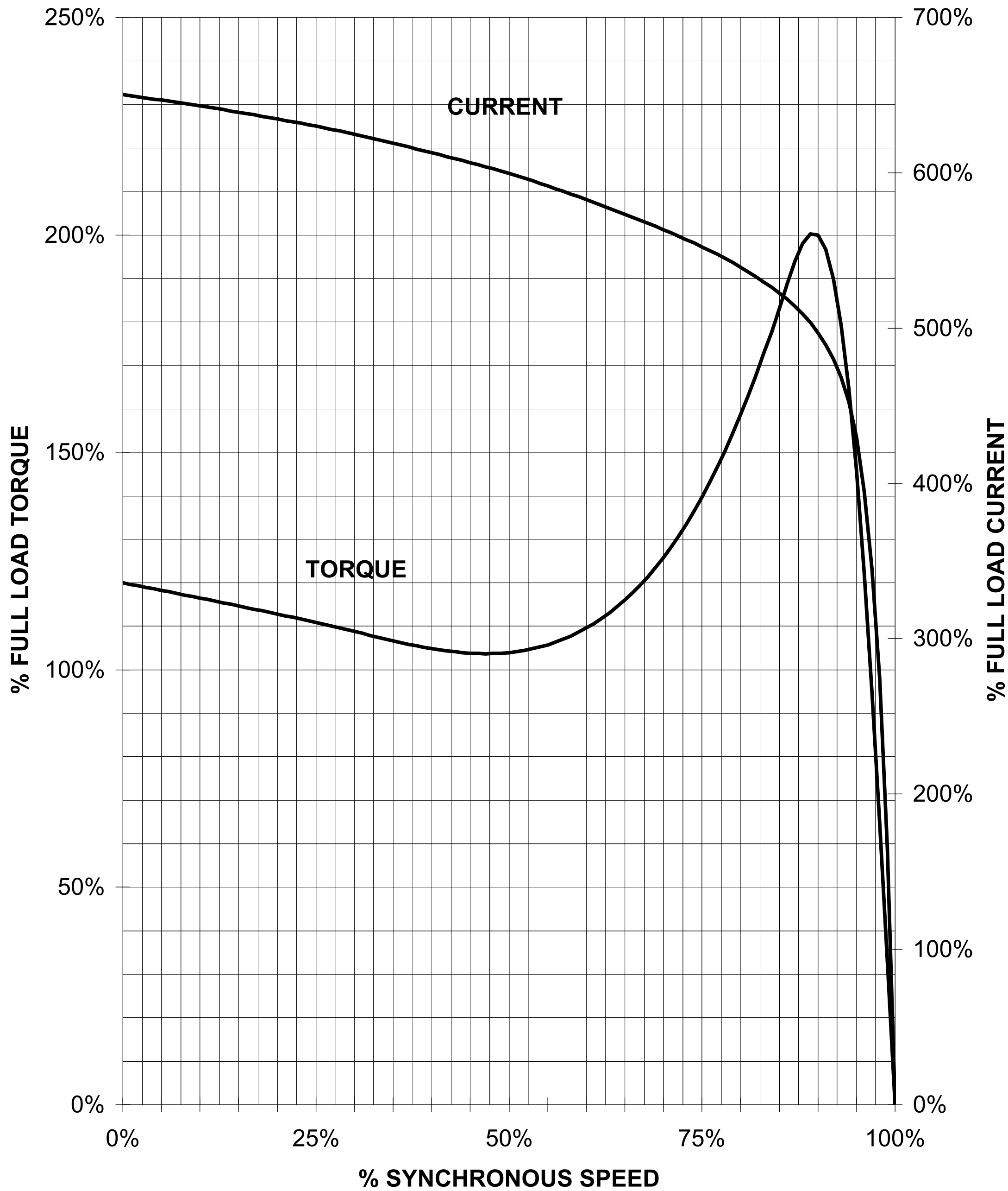
TORQUE VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	250	VOLTS	460	RPM	1200	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	449TS	NEMA	B

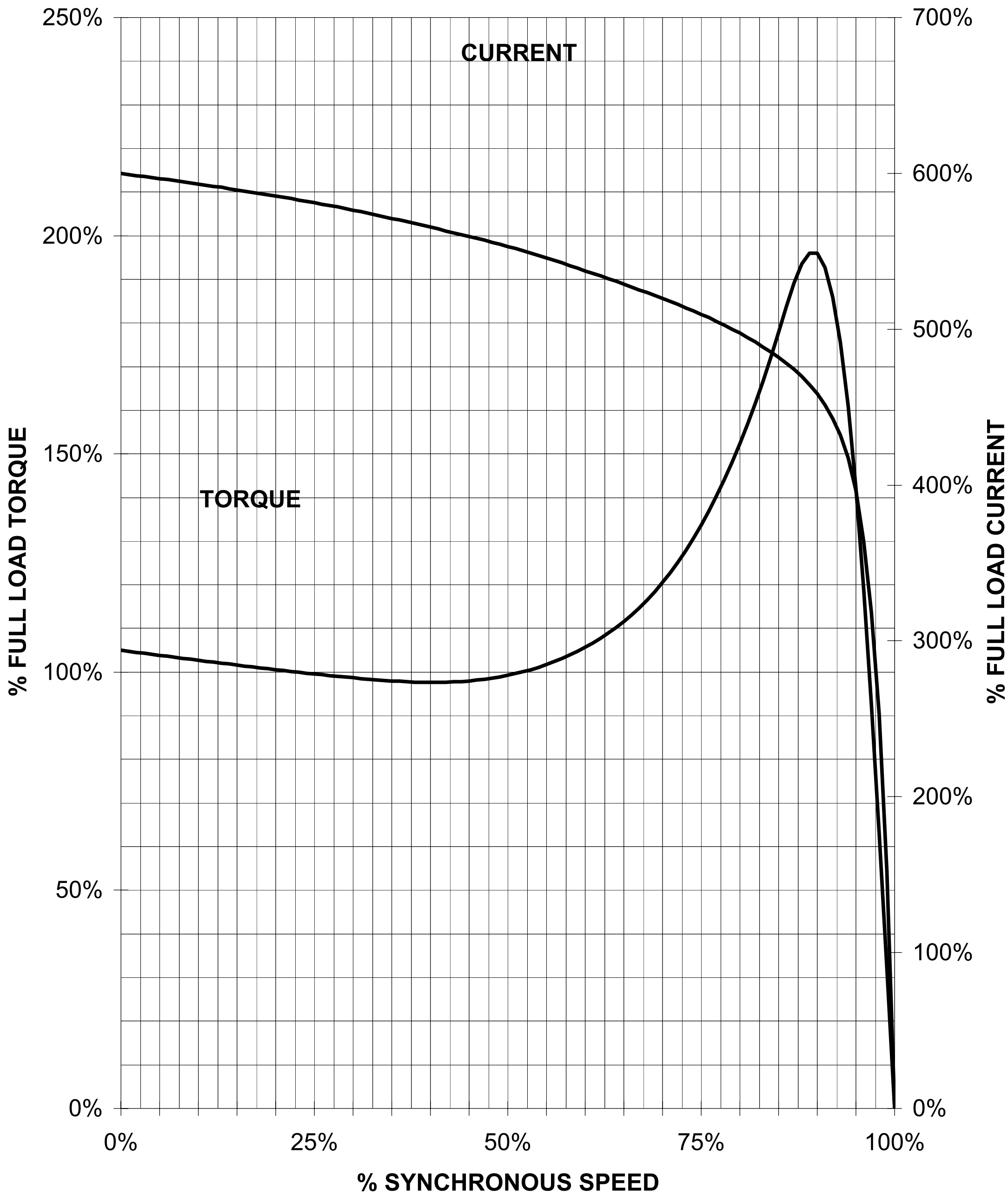
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	200	VOLTS	460	RPM	900	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	S449	NEMA	B

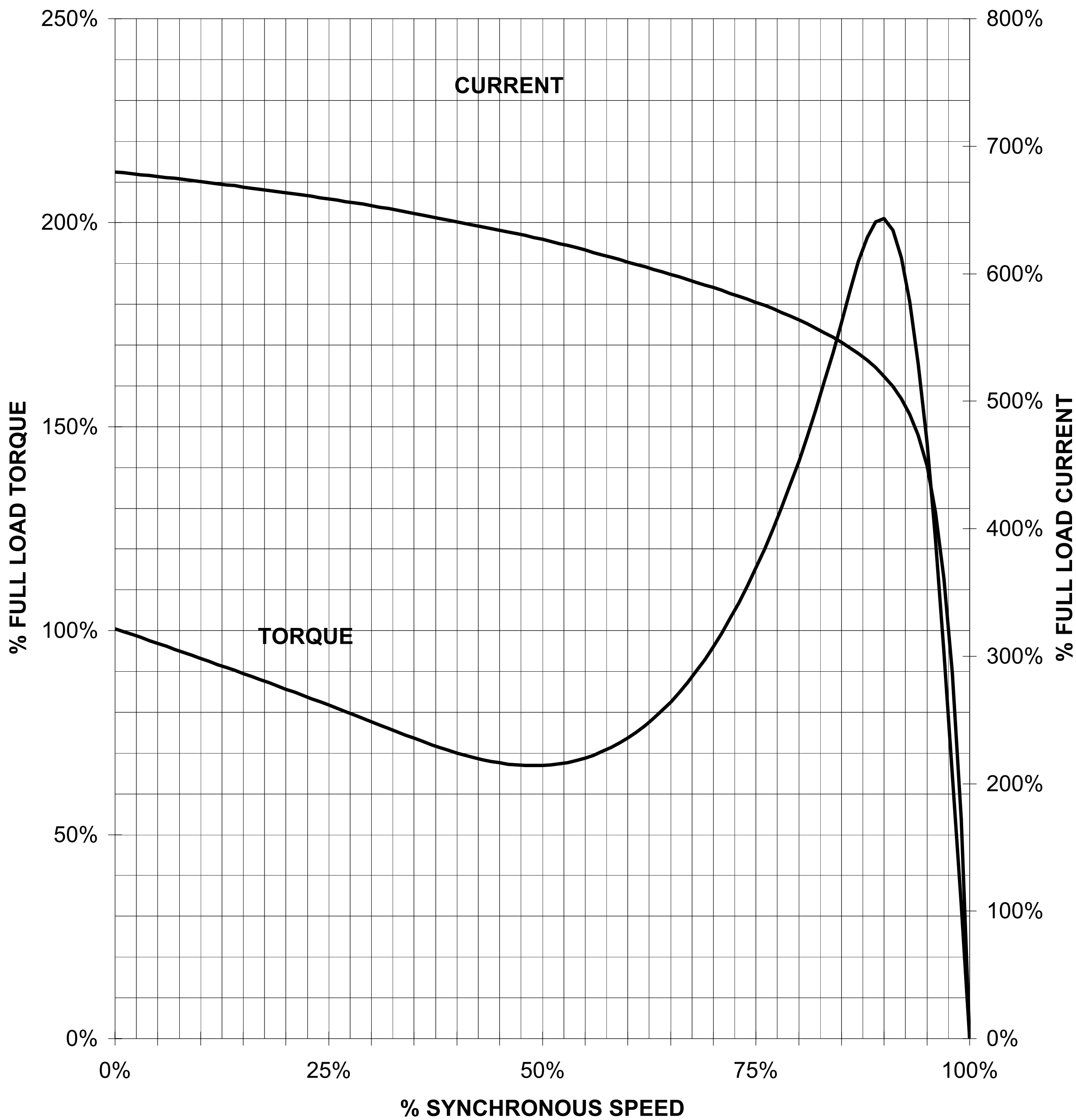
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	300	VOLTS	460	RPM	3600	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	449TS	NEMA	B

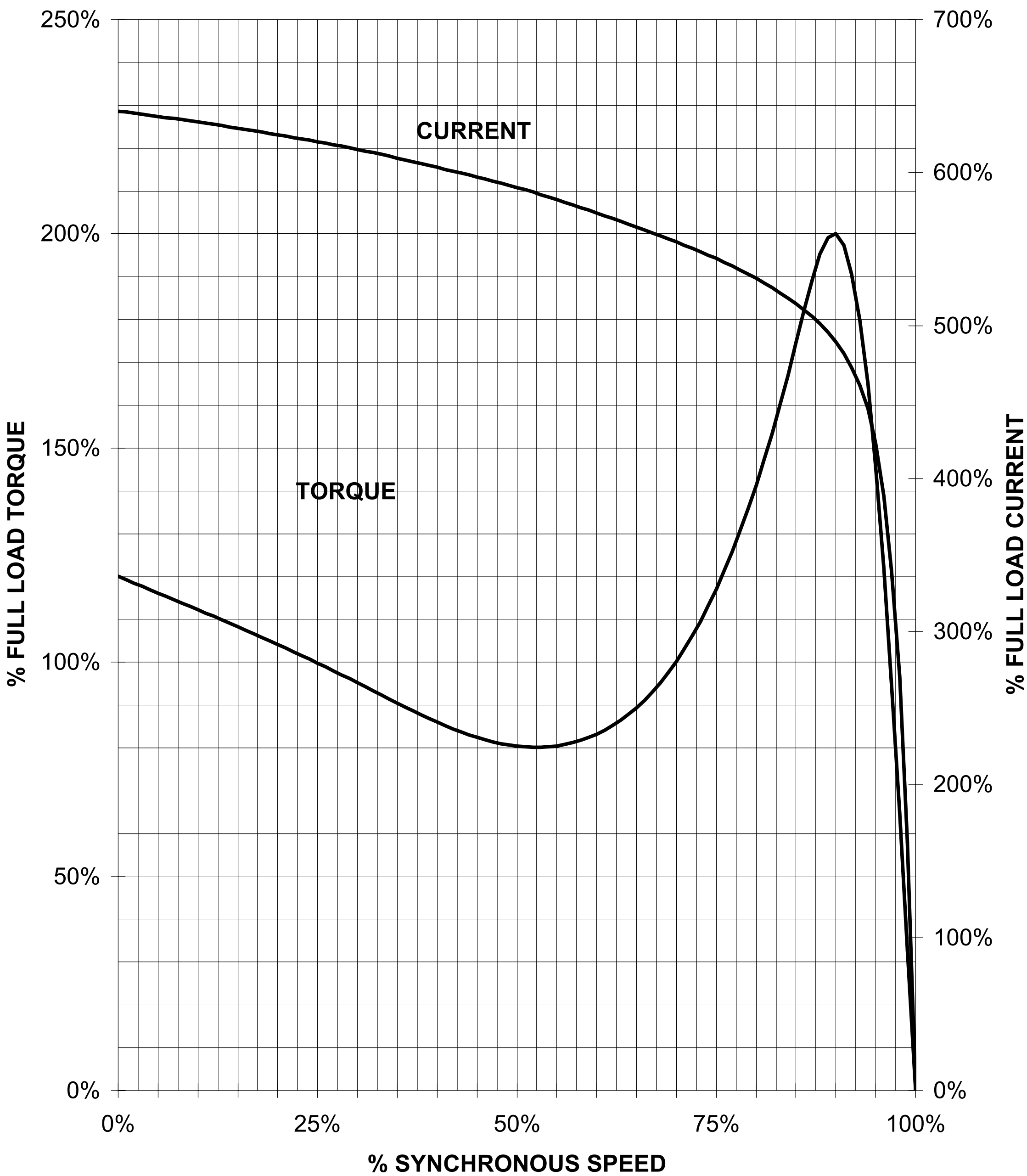
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	300	VOLTS	460	RPM	1800	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	449TS	NEMA	B

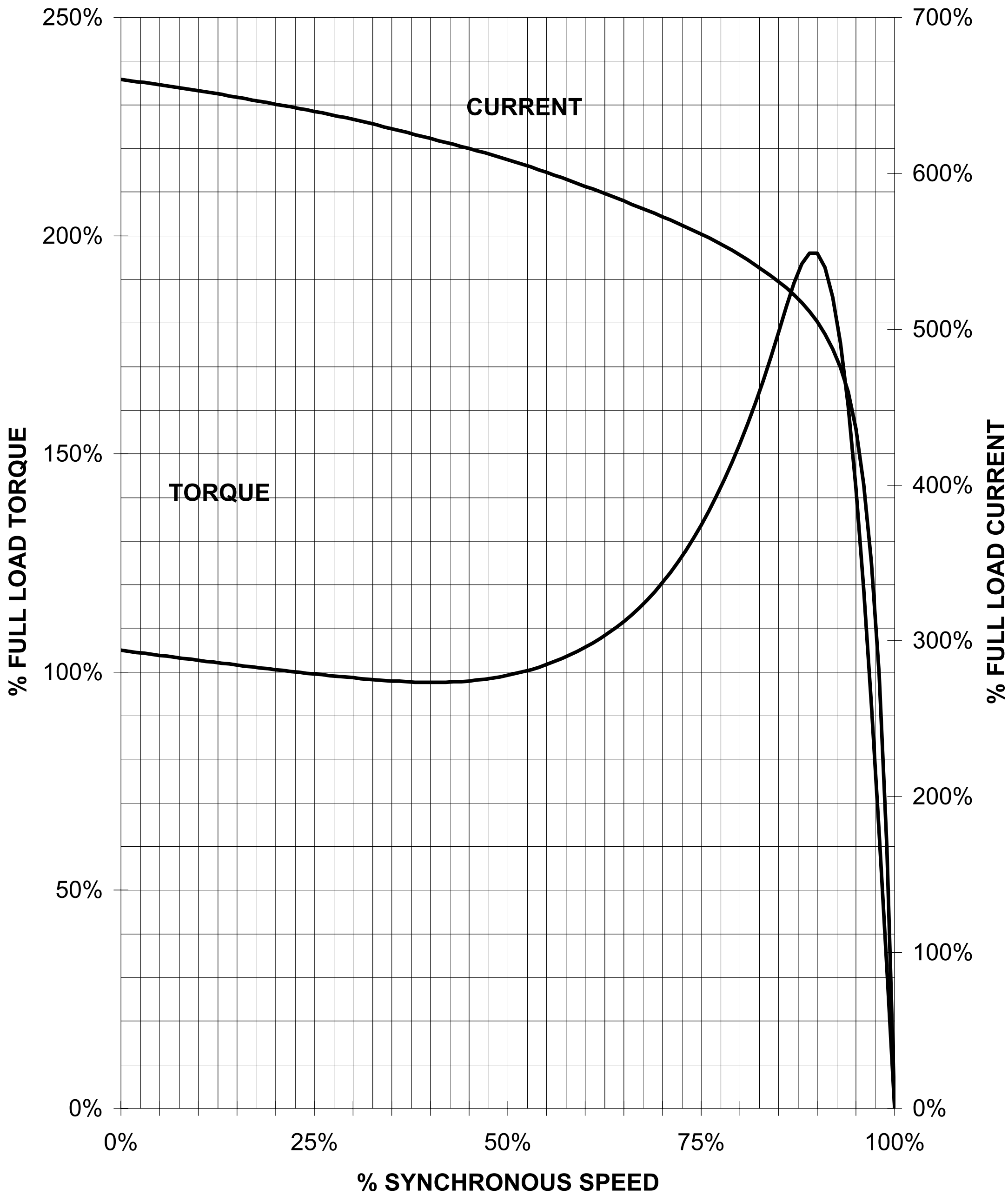
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	300	VOLTS	460	RPM	1200	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	S449	NEMA	B

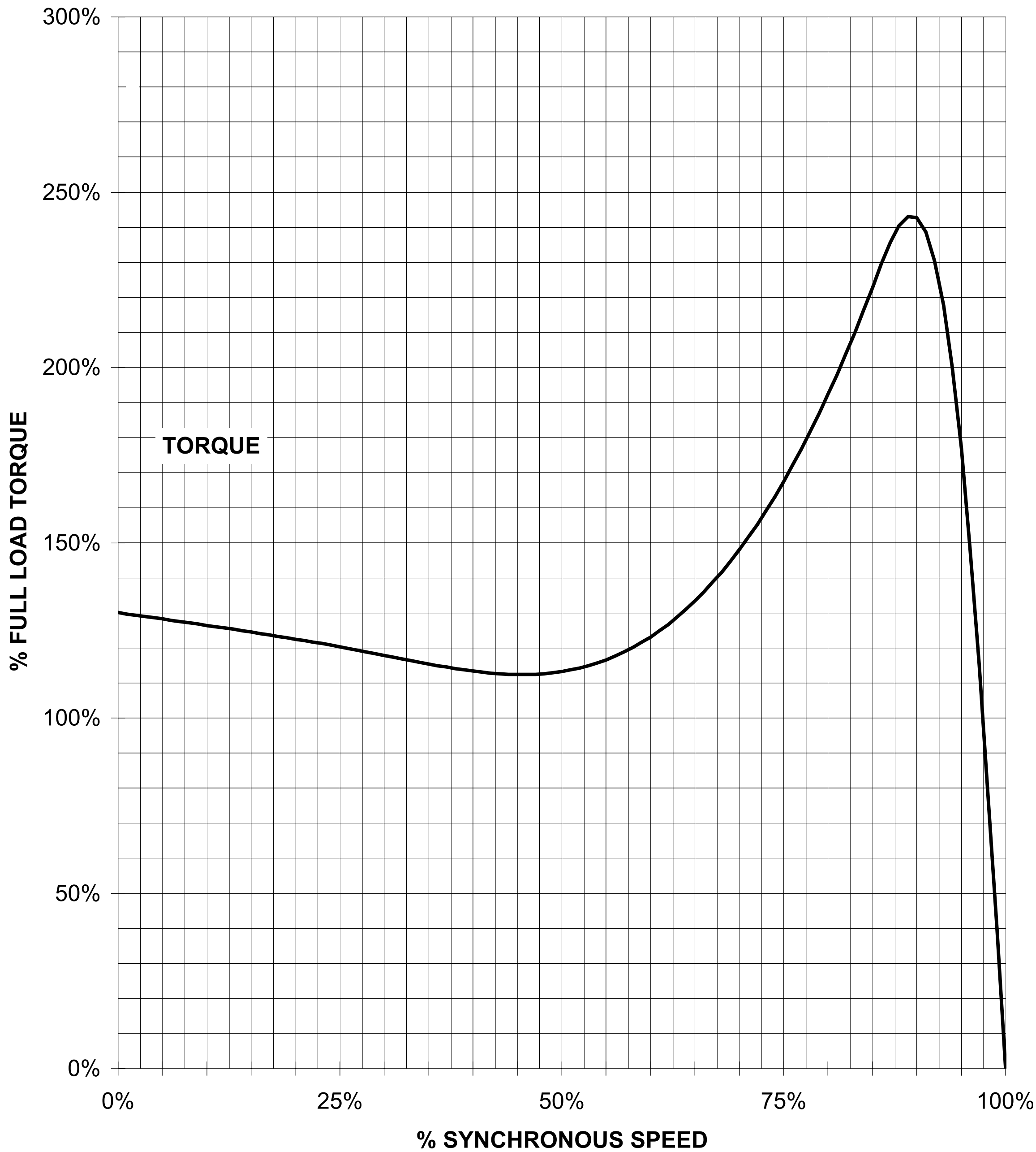
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	300	VOLTS	460	RPM	1800	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	S449SS	NEMA	B

TORQUE VS. SPEED

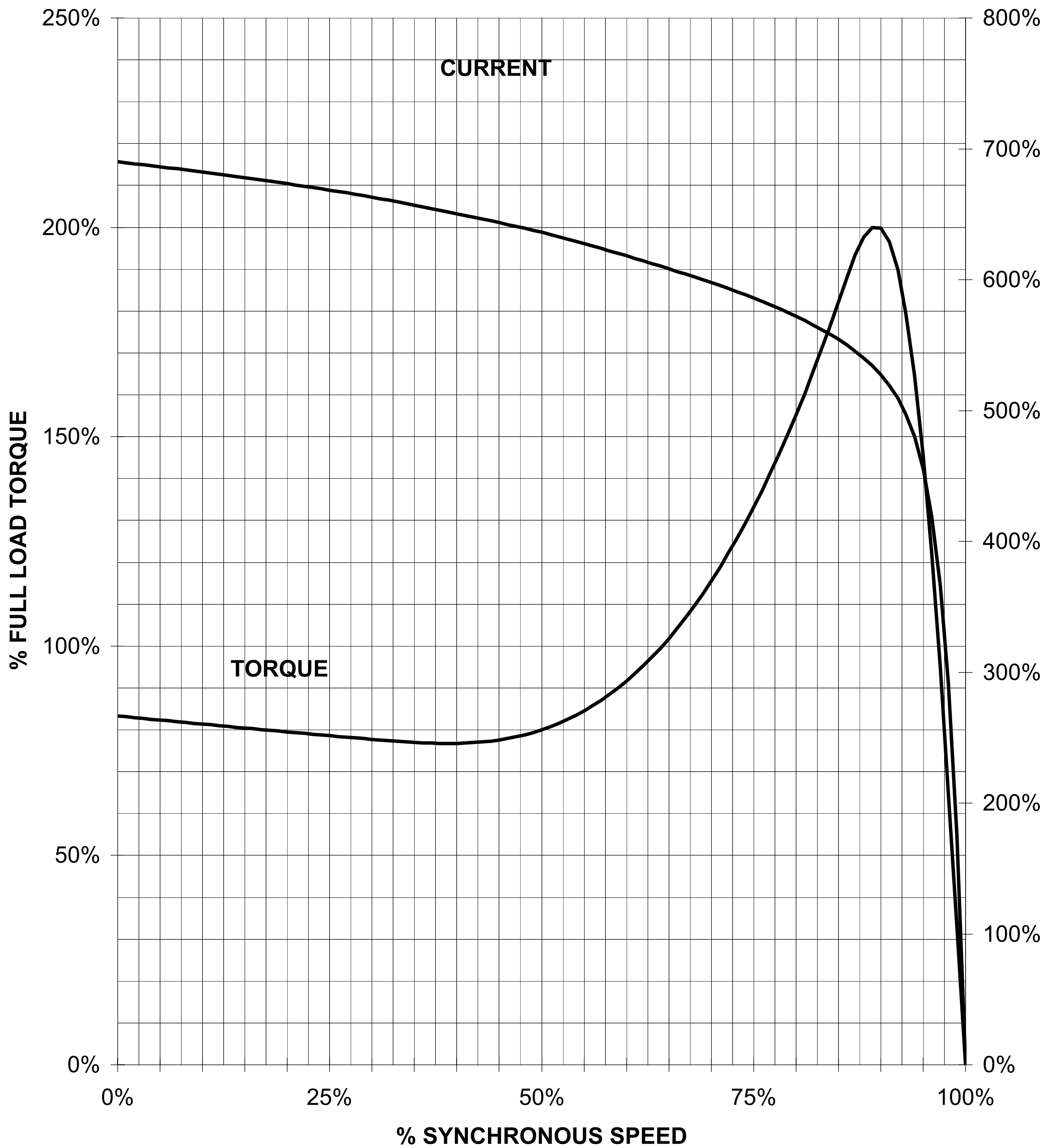


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	350	VOLTS	460	RPM	3600	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	S449SS	NEMA	B

TORQUE & CURRENT VS. SPEED

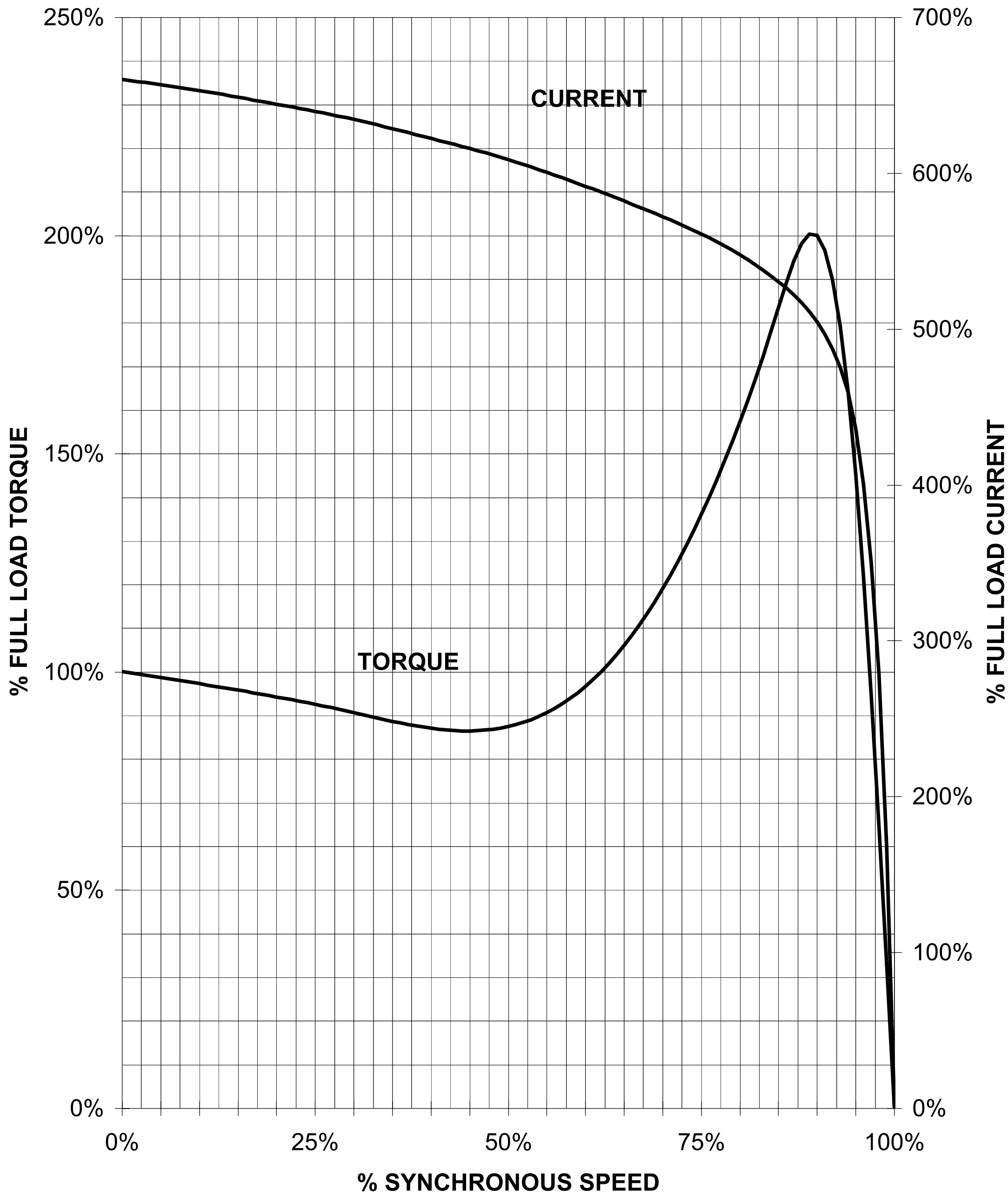


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	350	VOLTS	460	RPM	1800	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	S449	NEMA	B

TORQUE & CURRENT VS. SPEED



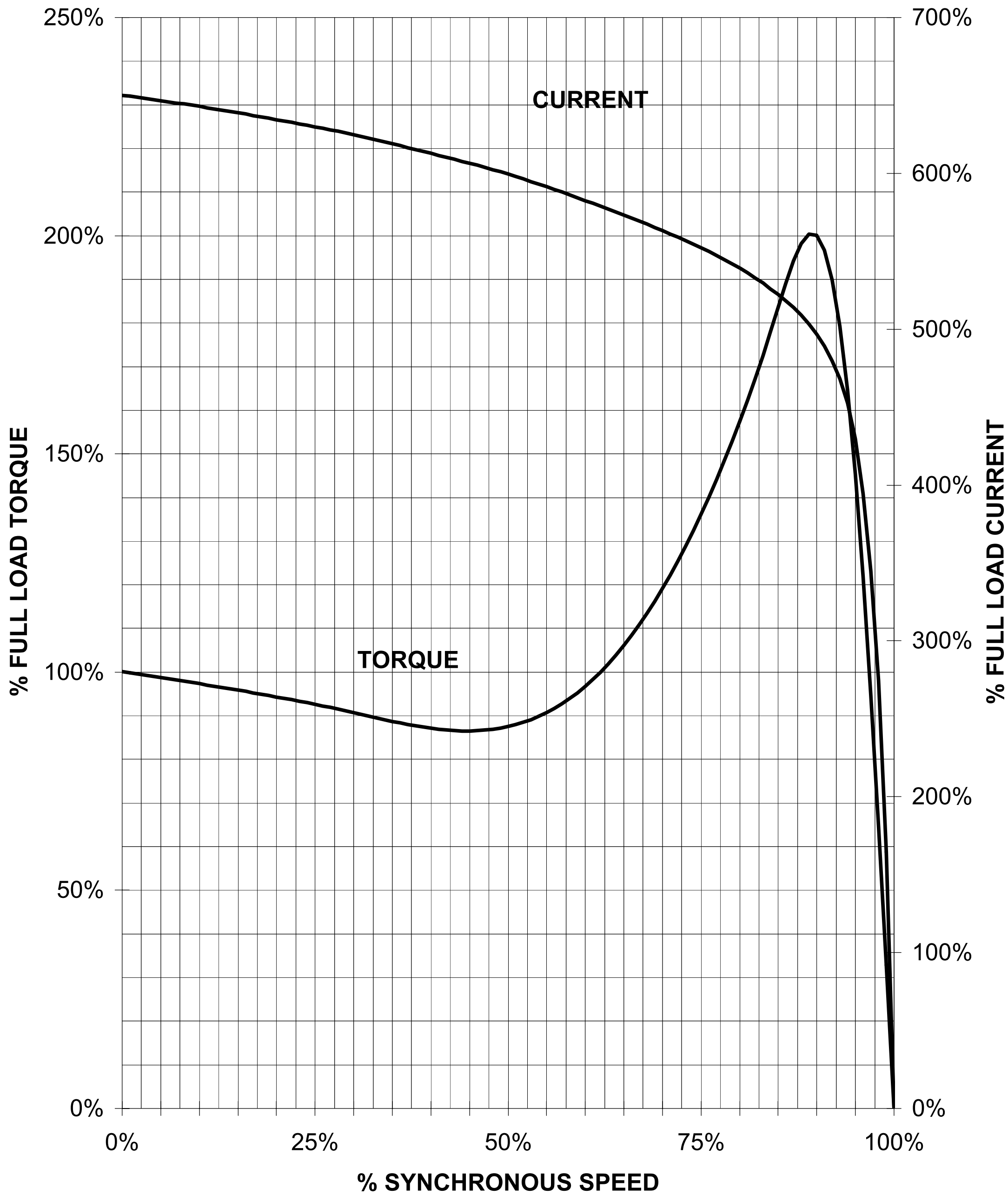
Customer: **PO No.:** **Order No.:**

CUSTOMER: ____________________ PO#: ____________________ ORDER#: ____________________

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	350	VOLTS	460	RPM	1200	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	S449	NEMA	B

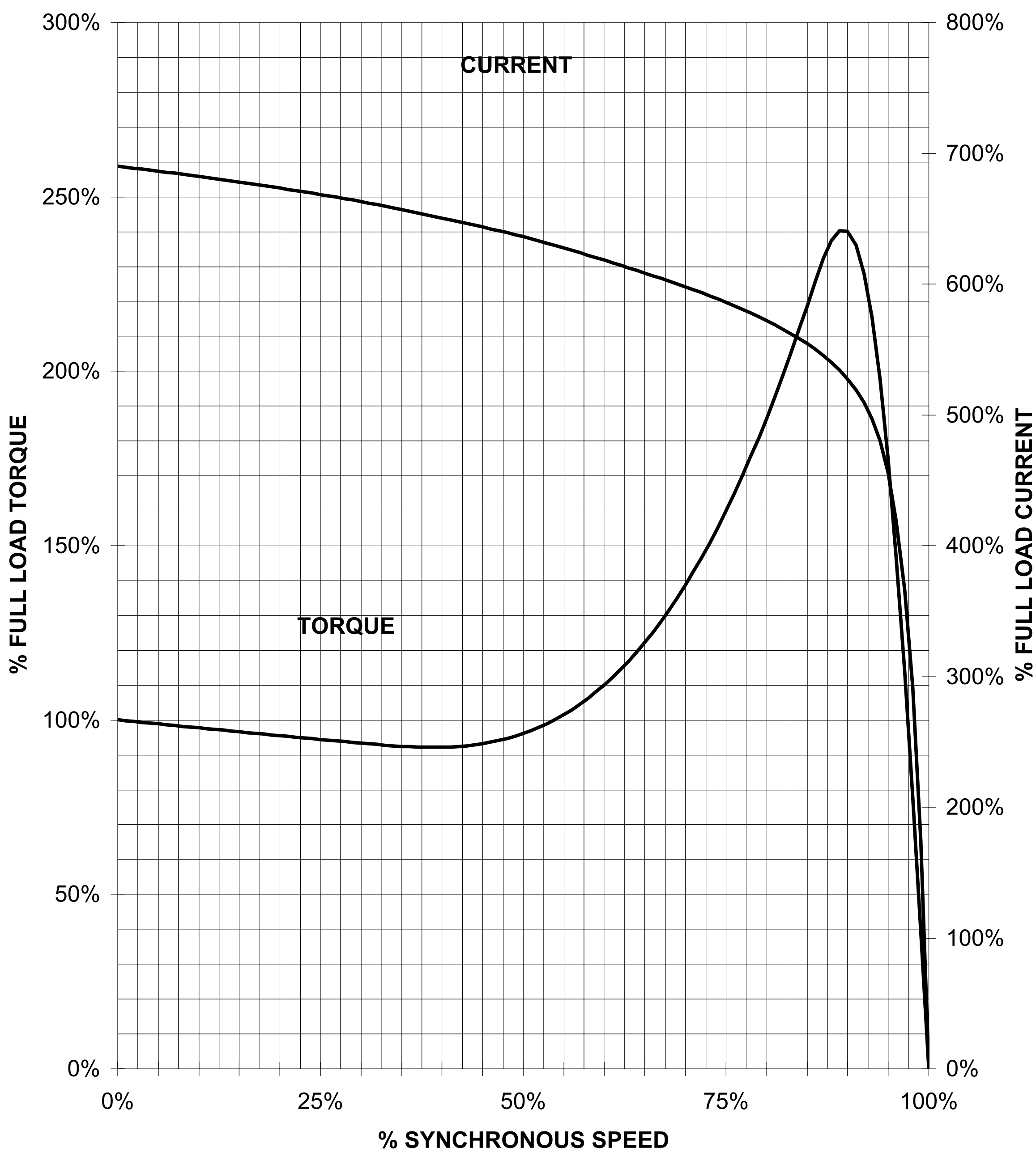
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	400	VOLTS	460	RPM	3600	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	S449SS	NEMA	B

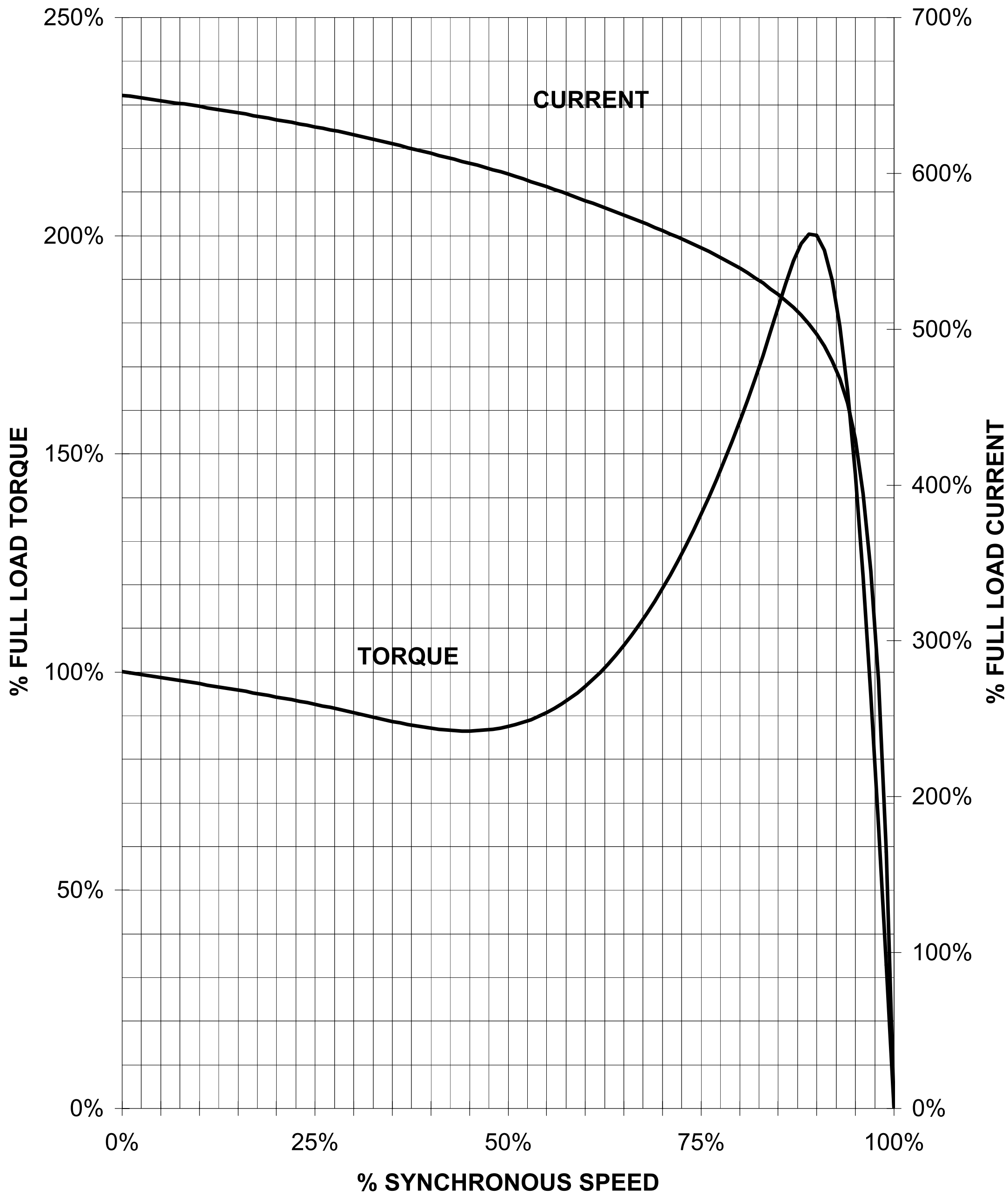
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	400	VOLTS	460	RPM	1800	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	S449	NEMA	B

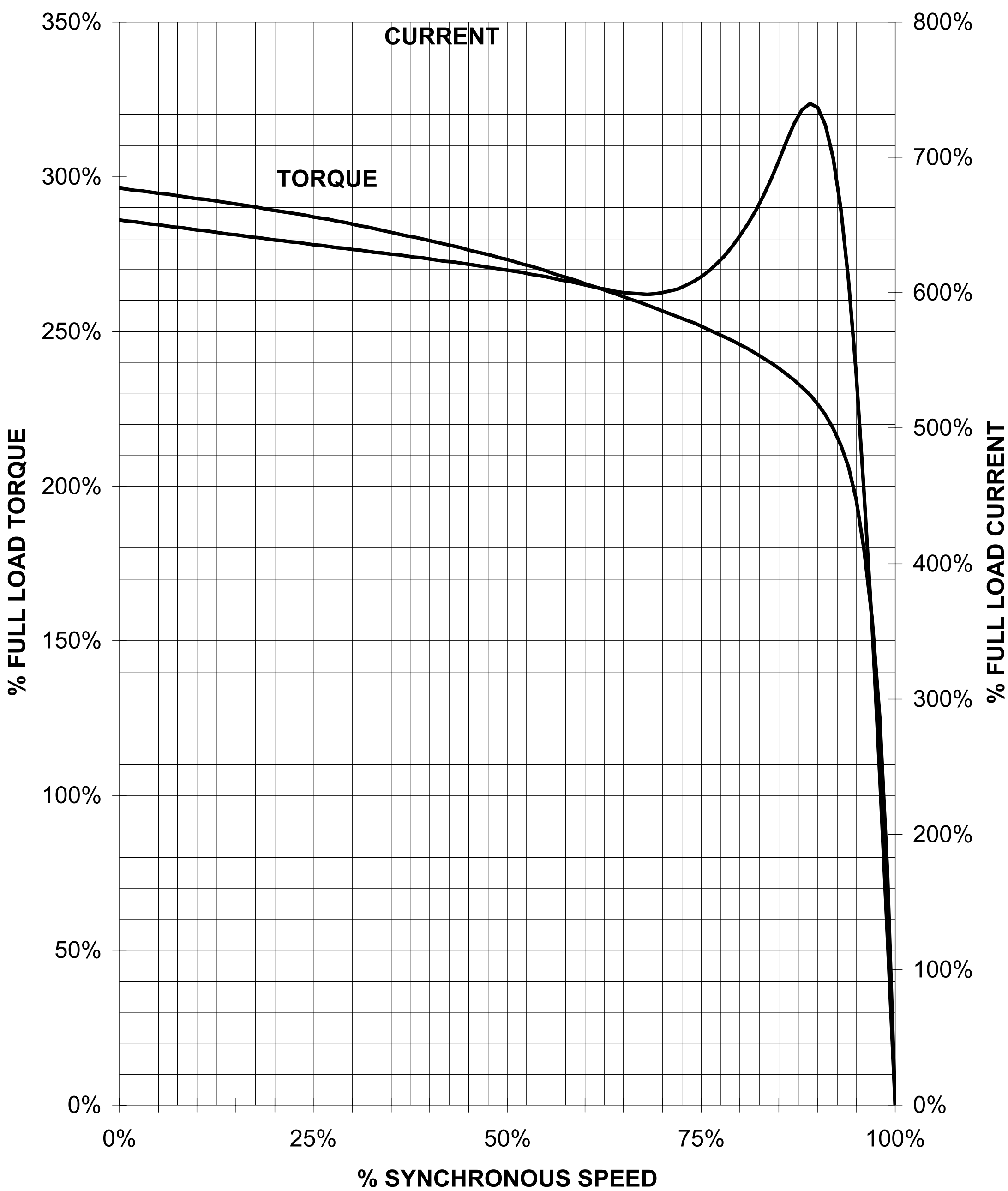
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1	VOLTS	230/460	RPM	1800	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	143T	NEMA	B

TORQUE & CURRENT VS. SPEED

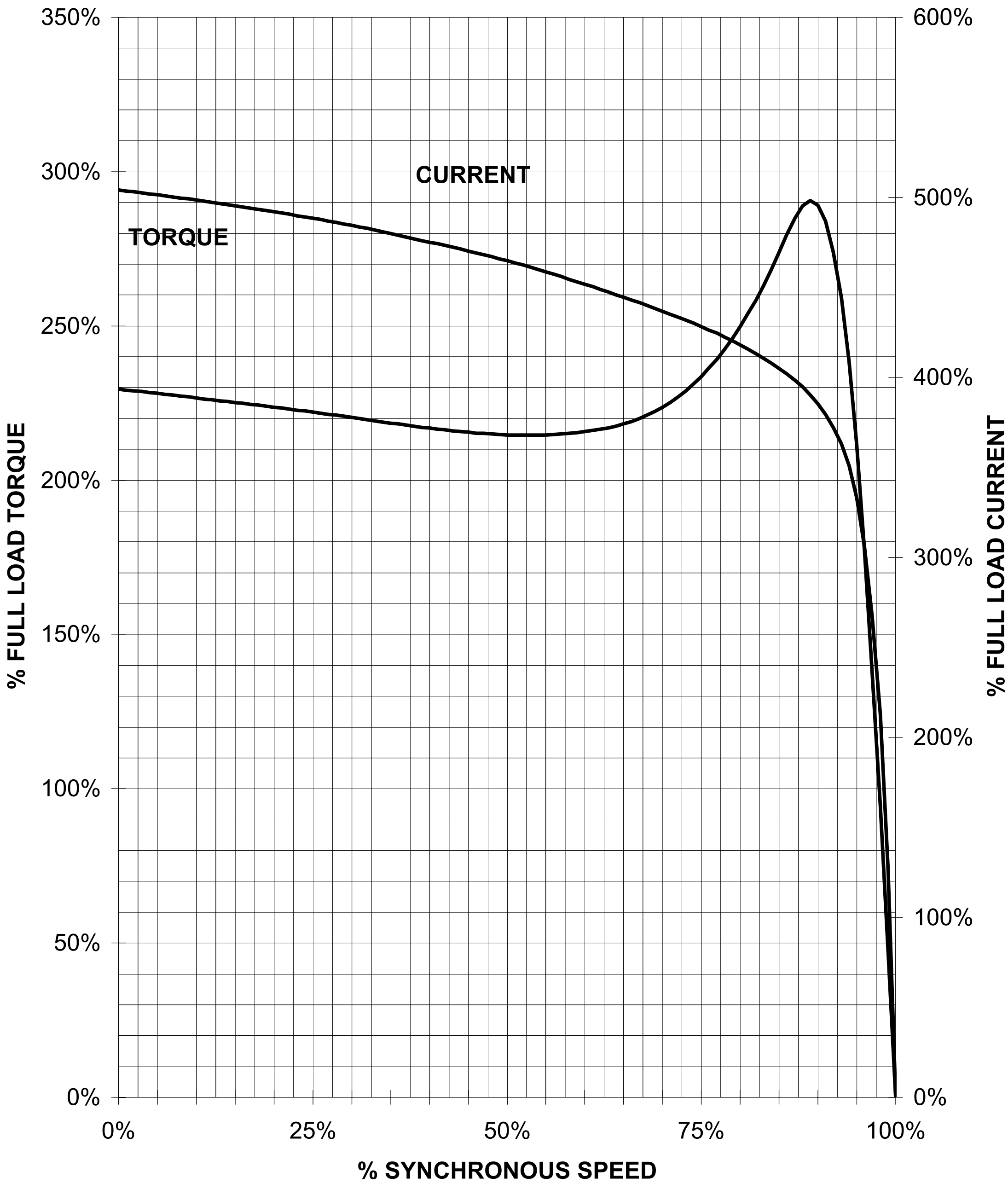


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	1	VOLTS	230/460	RPM	1200	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	145T	NEMA	B

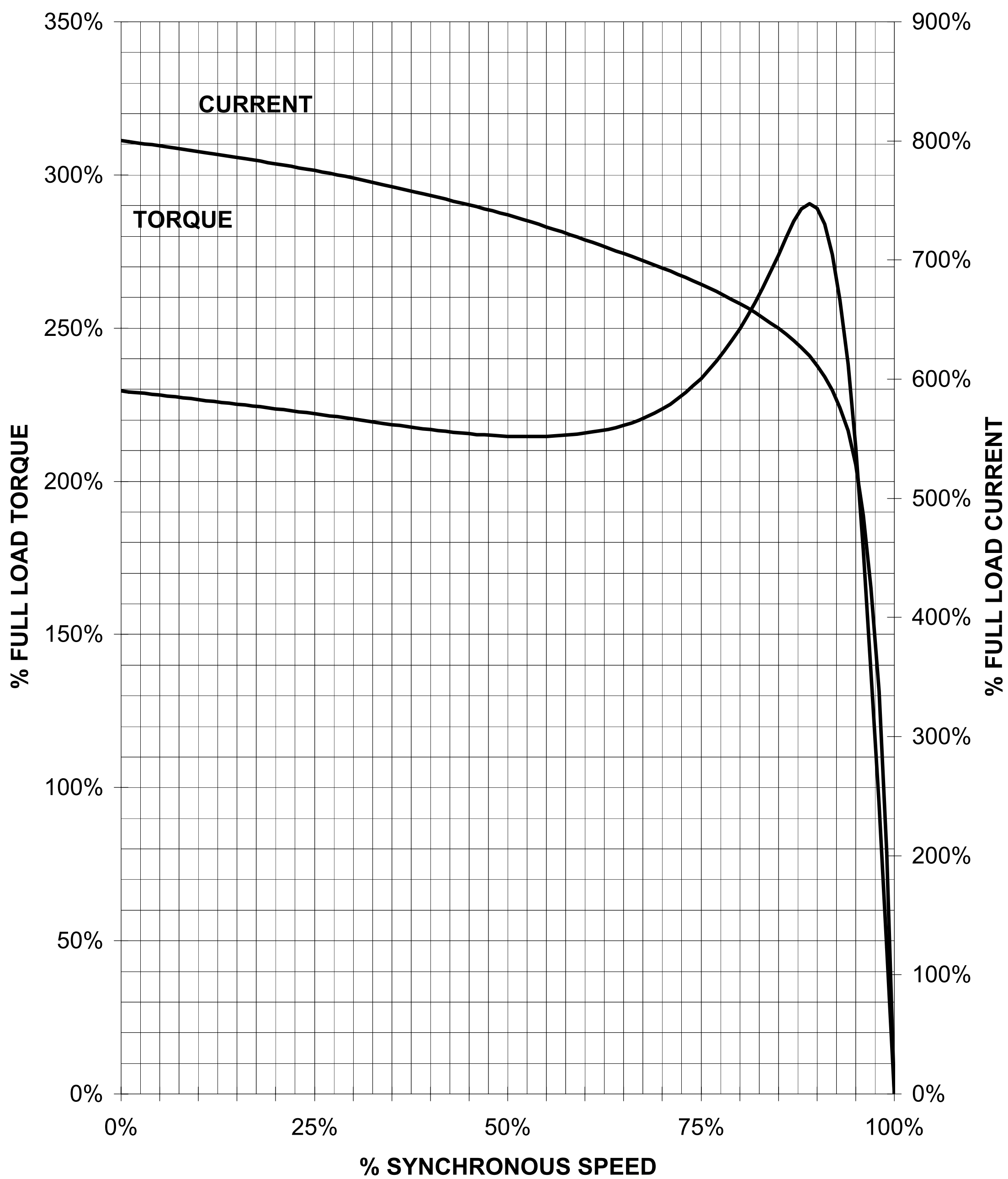
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1.5	VOLTS	230/460	RPM	3600	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	143T	NEMA	B

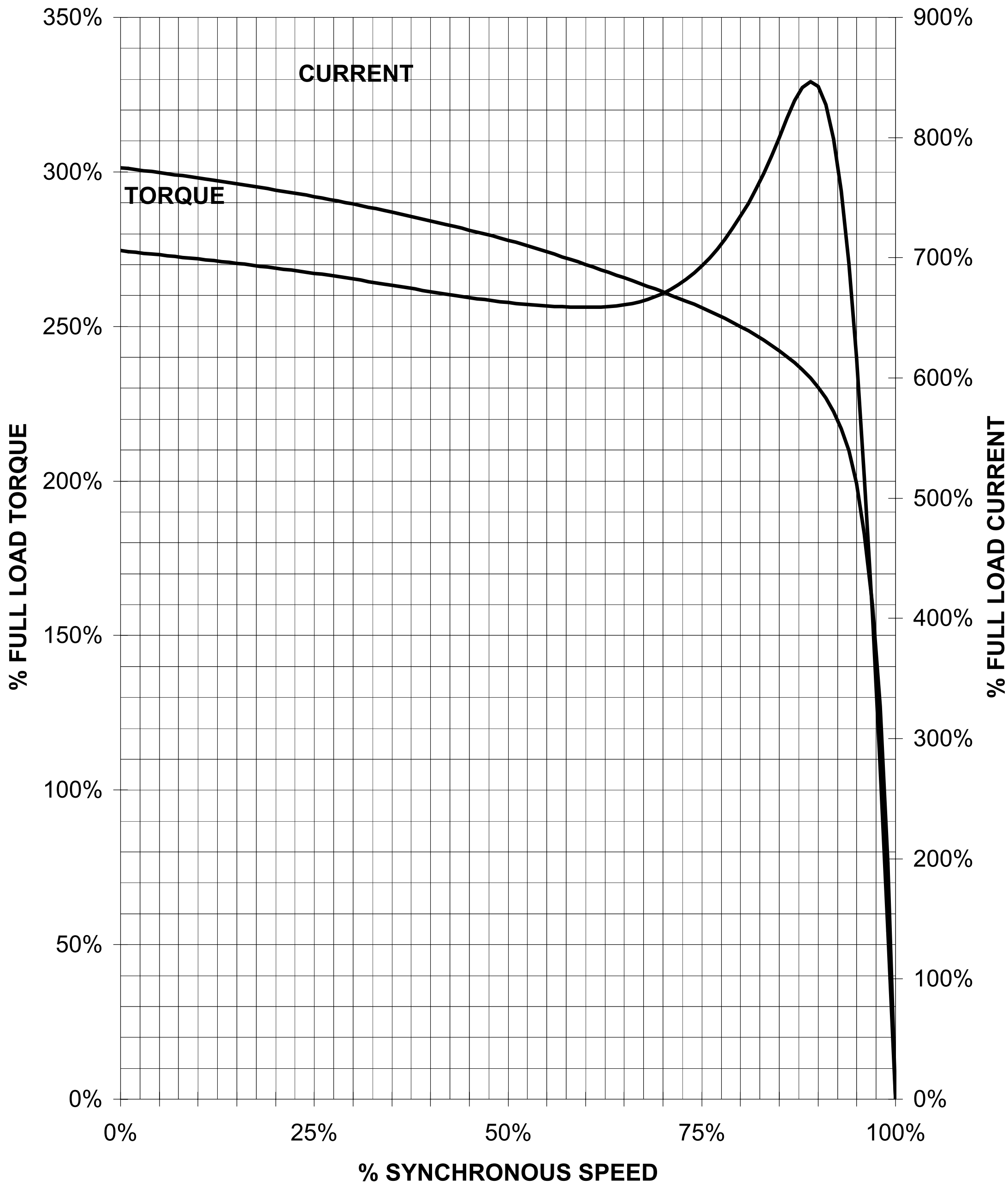
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1.5	VOLTS	230/460	RPM	1800	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	145T	NEMA	B

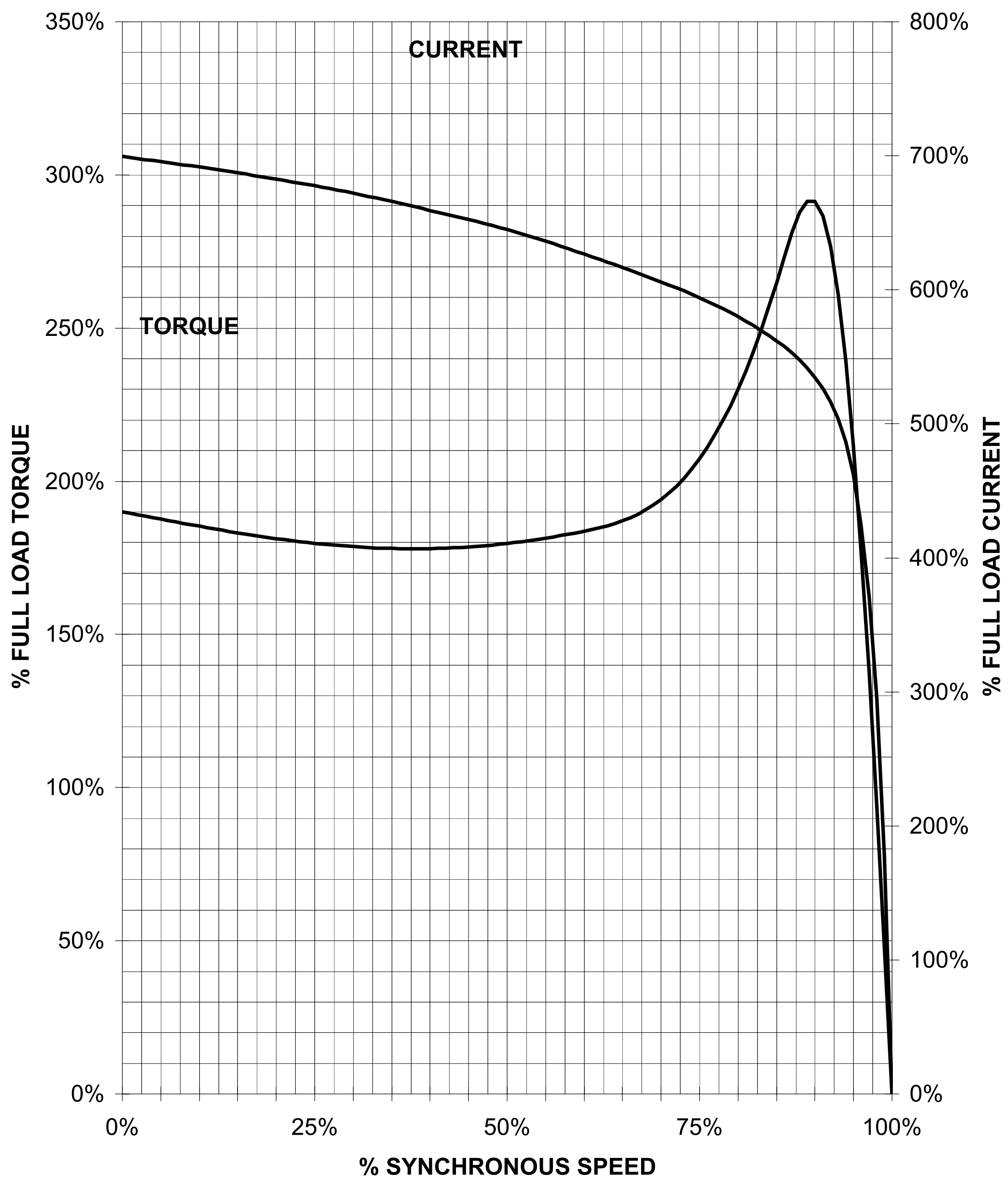
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1.5	VOLTS	230/460	RPM	1200	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	182T	NEMA	B

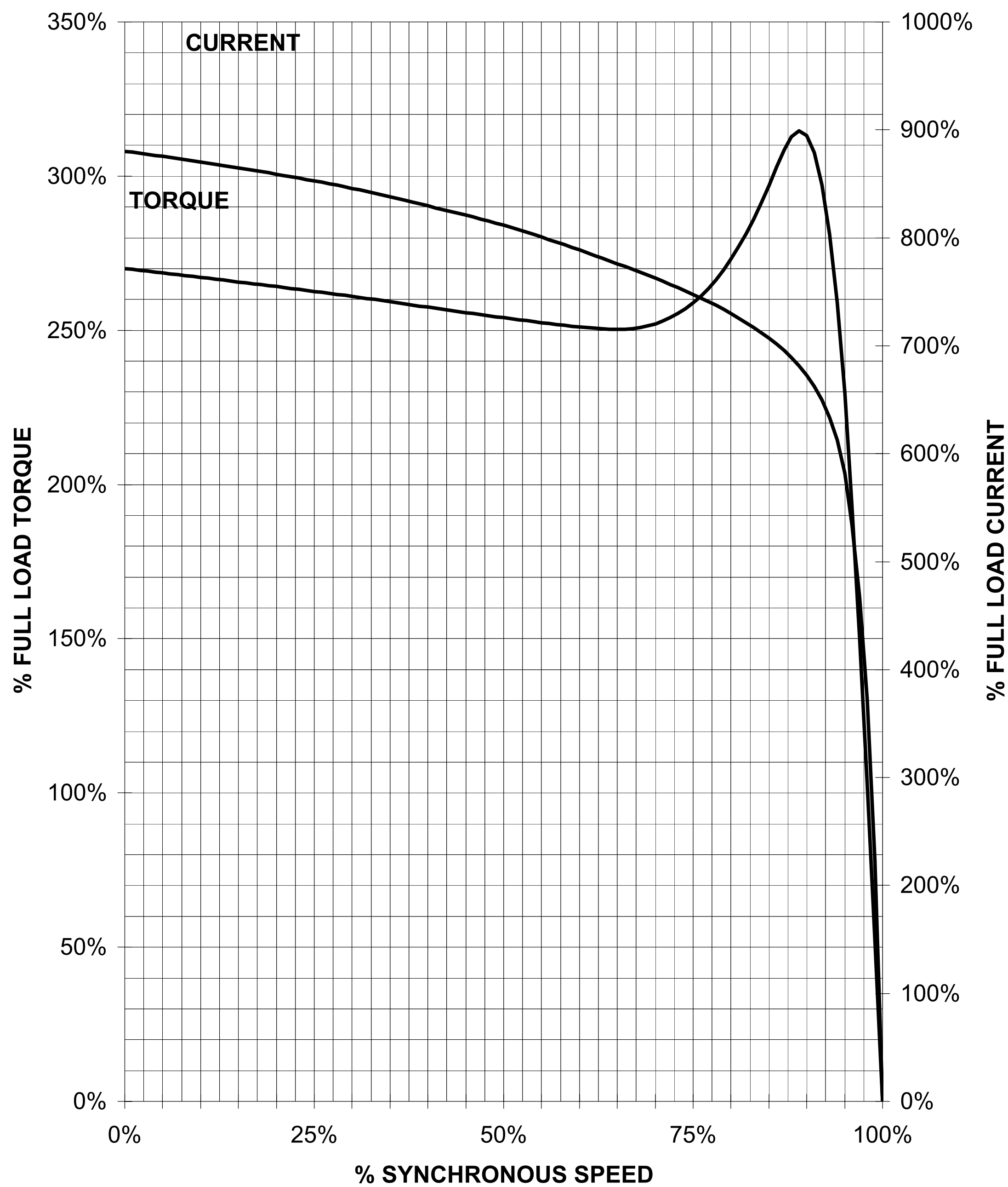
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	2	VOLTS	230/460	RPM	3600	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	145T	NEMA	B

TORQUE & CURRENT VS. SPEED

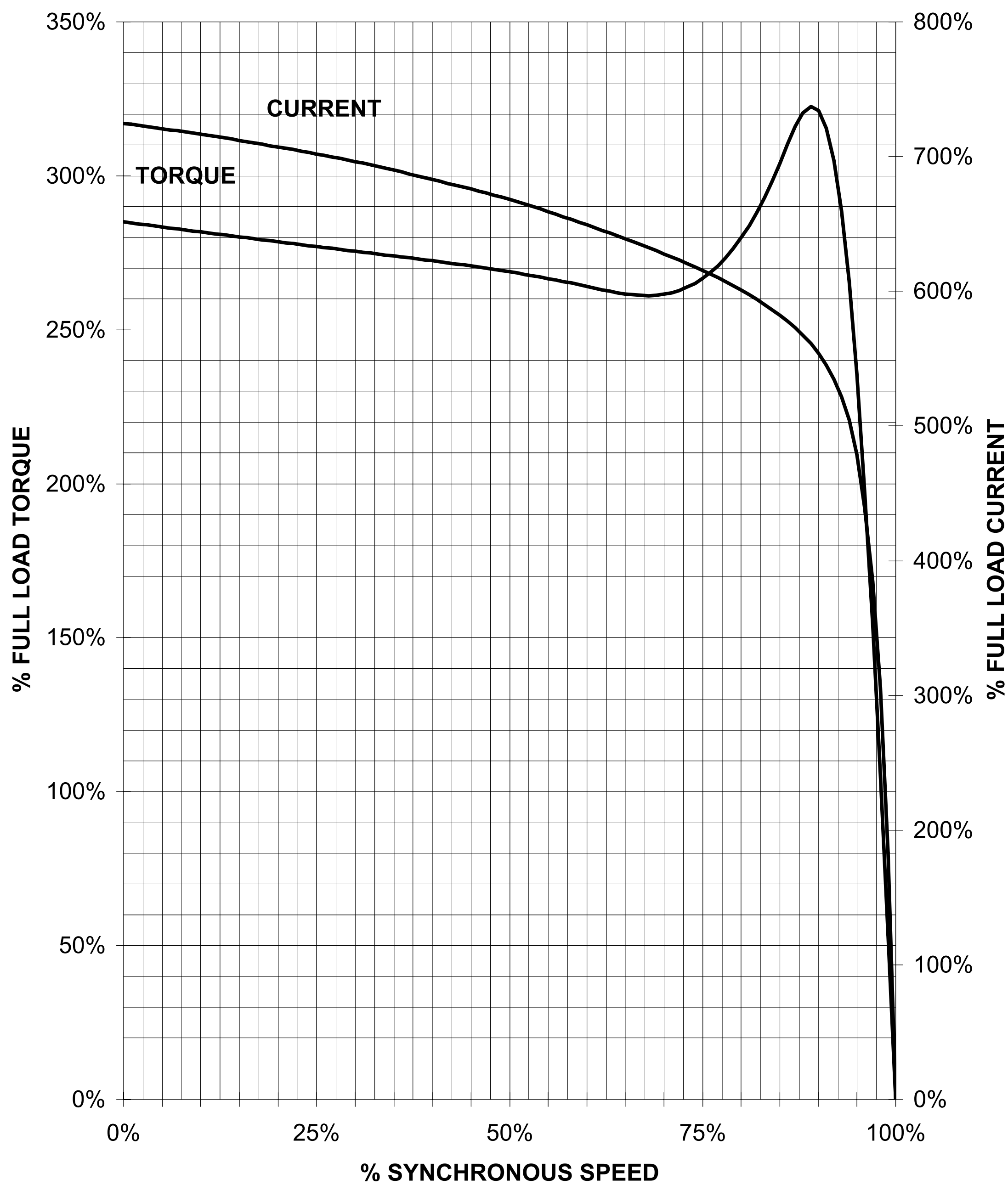


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	2	VOLTS	230/460	RPM	1800	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	145T	NEMA	B

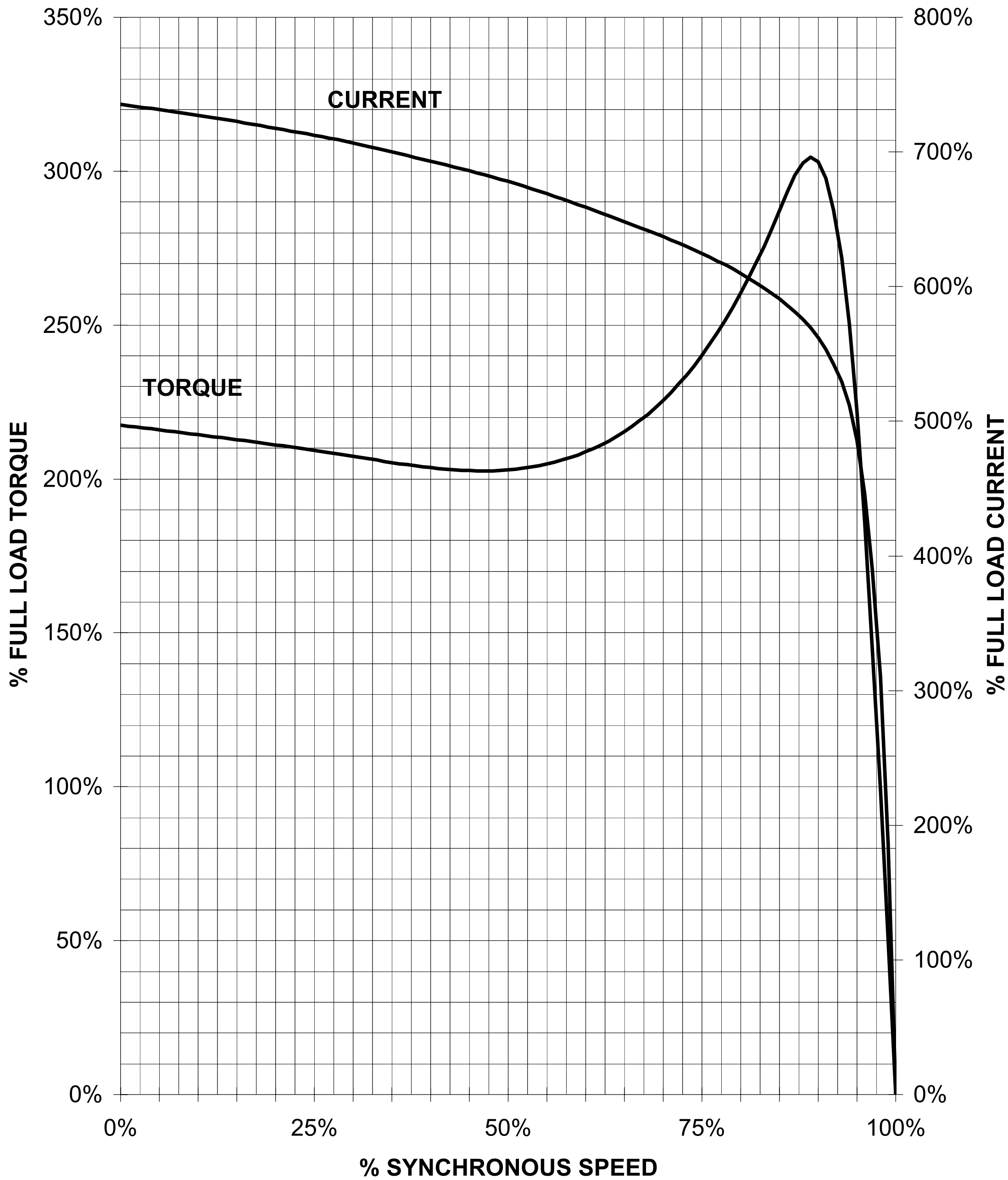
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	2	VOLTS	230/460	RPM	1200	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	184T	NEMA	B

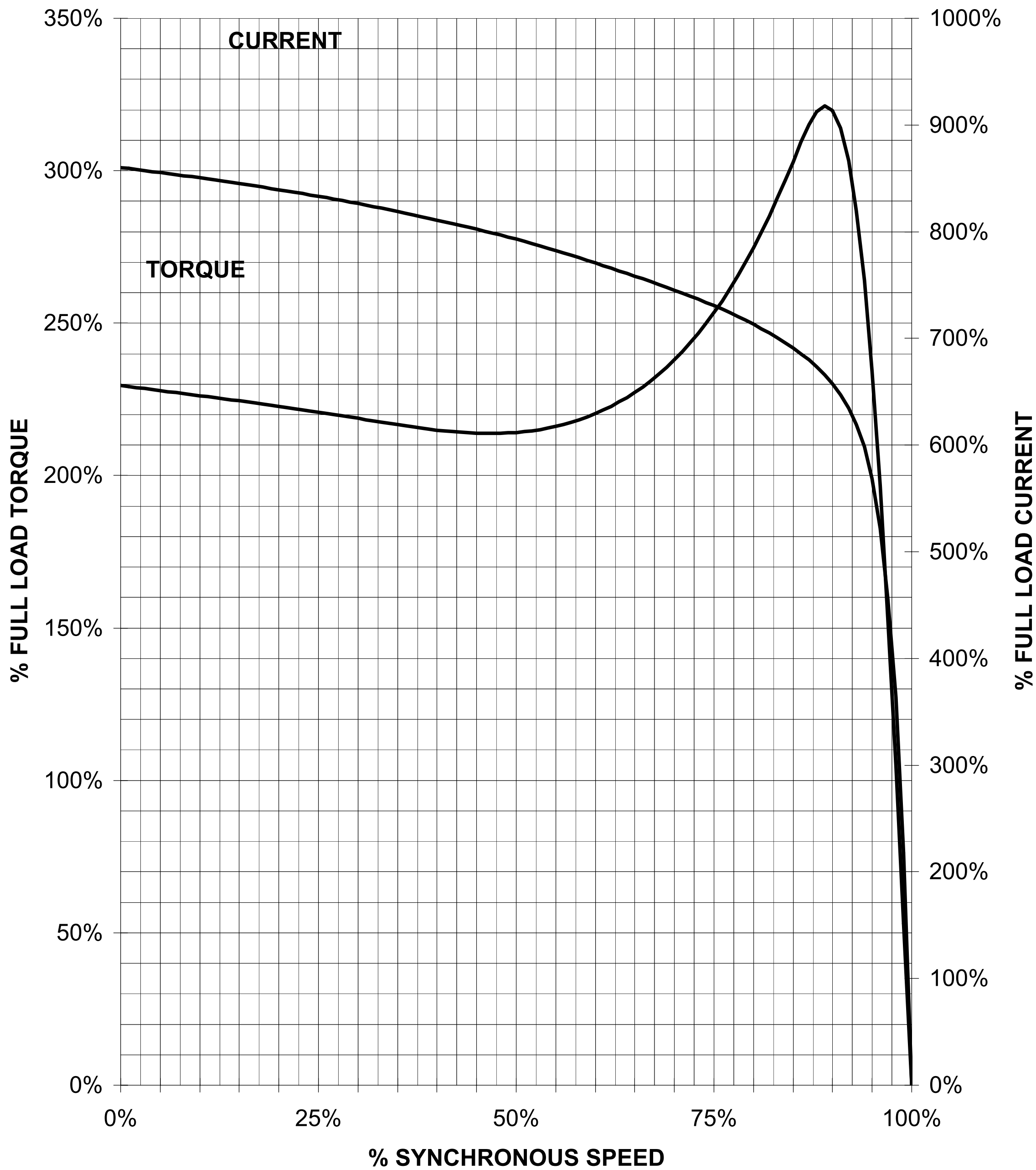
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	3	VOLTS	230/460	RPM	3600	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	182T	NEMA	B

TORQUE & CURRENT VS. SPEED

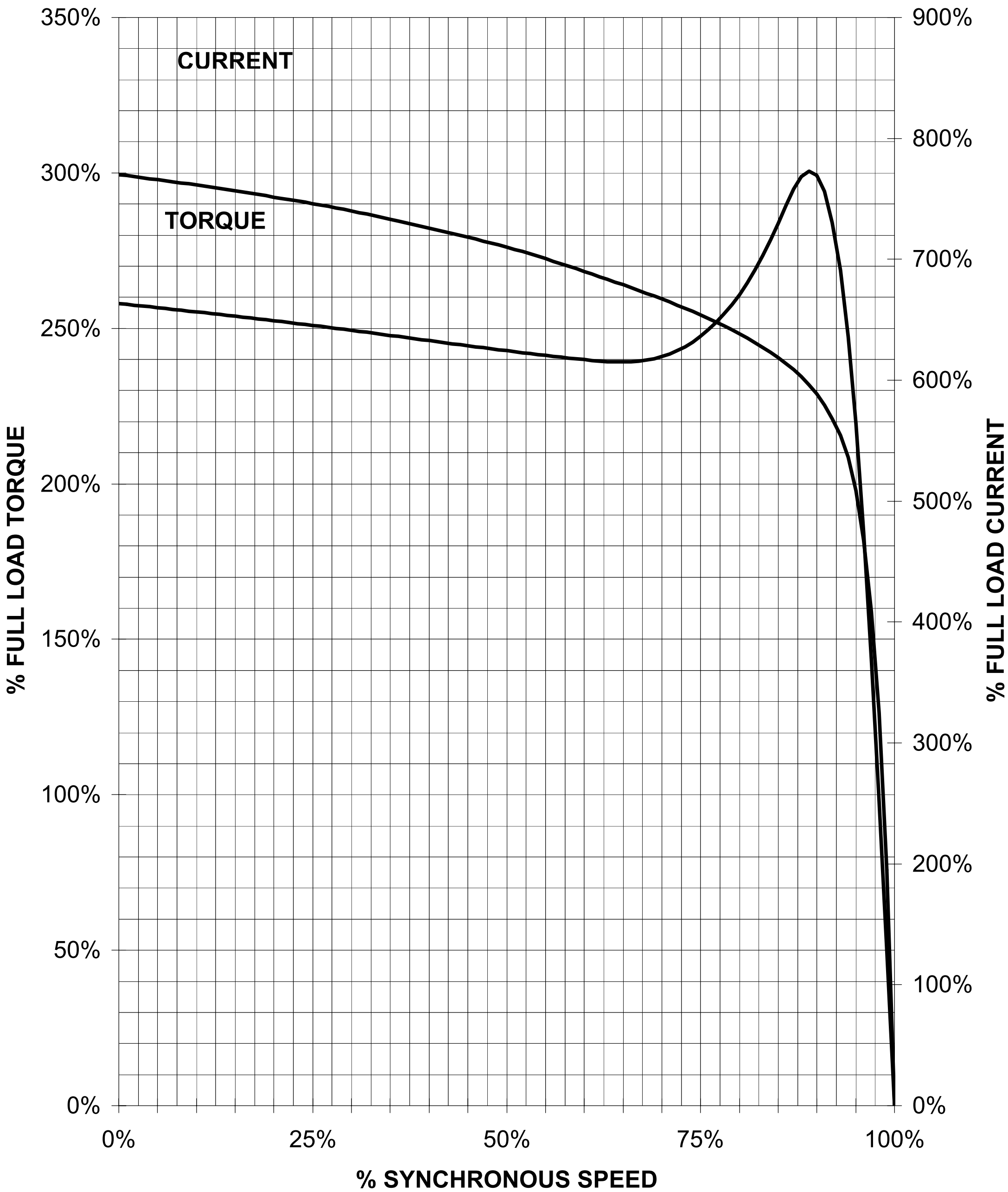


Customer: **PO No.:** **Order No.:**

HP 3 VOLTS 230/460 RPM 1800 TYPE RGZP(SD)

HZ 60 PHASE 3 FRAME 182T NEMA B

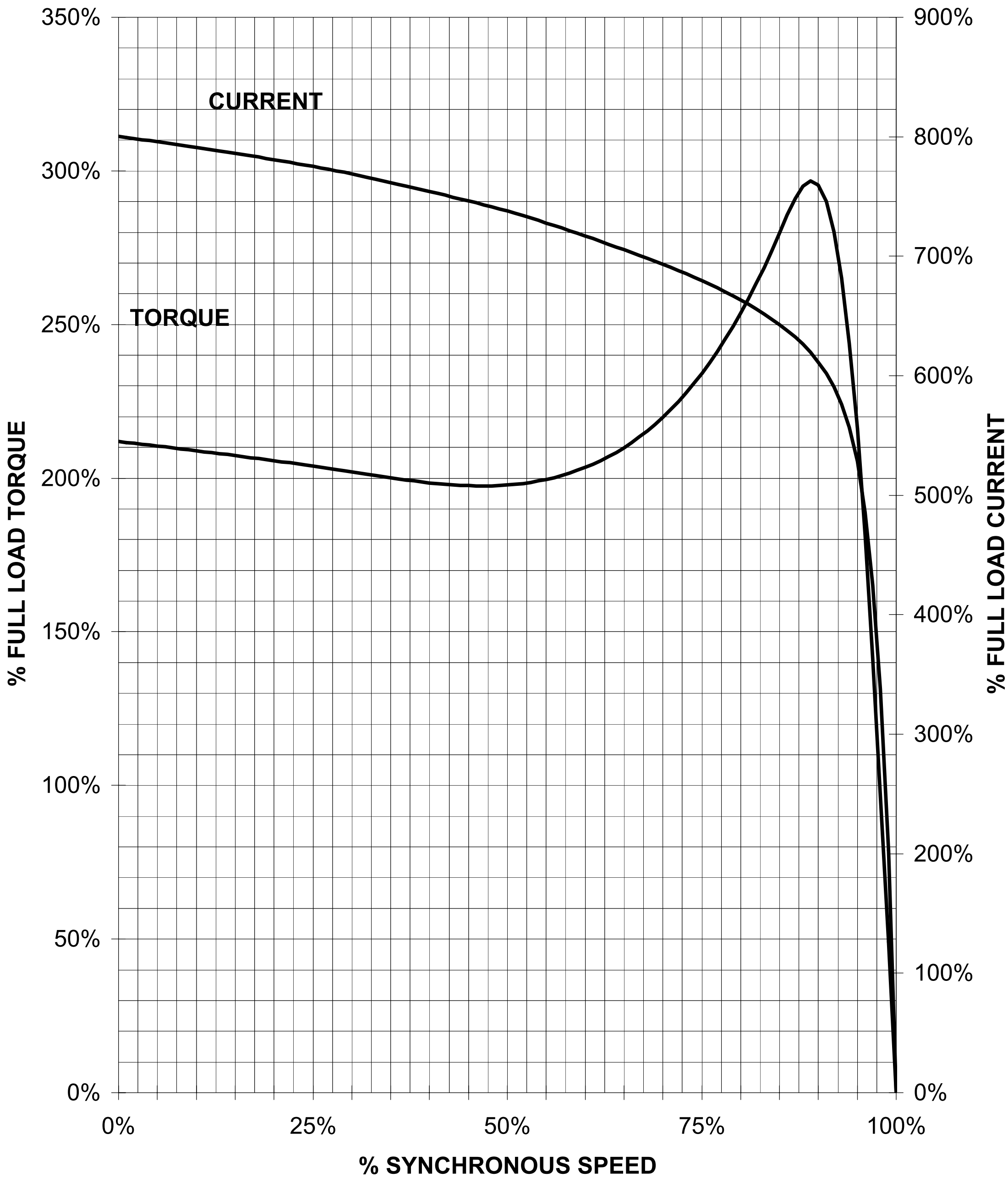
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	3	VOLTS	230/460	RPM	1200	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	213T	NEMA	B

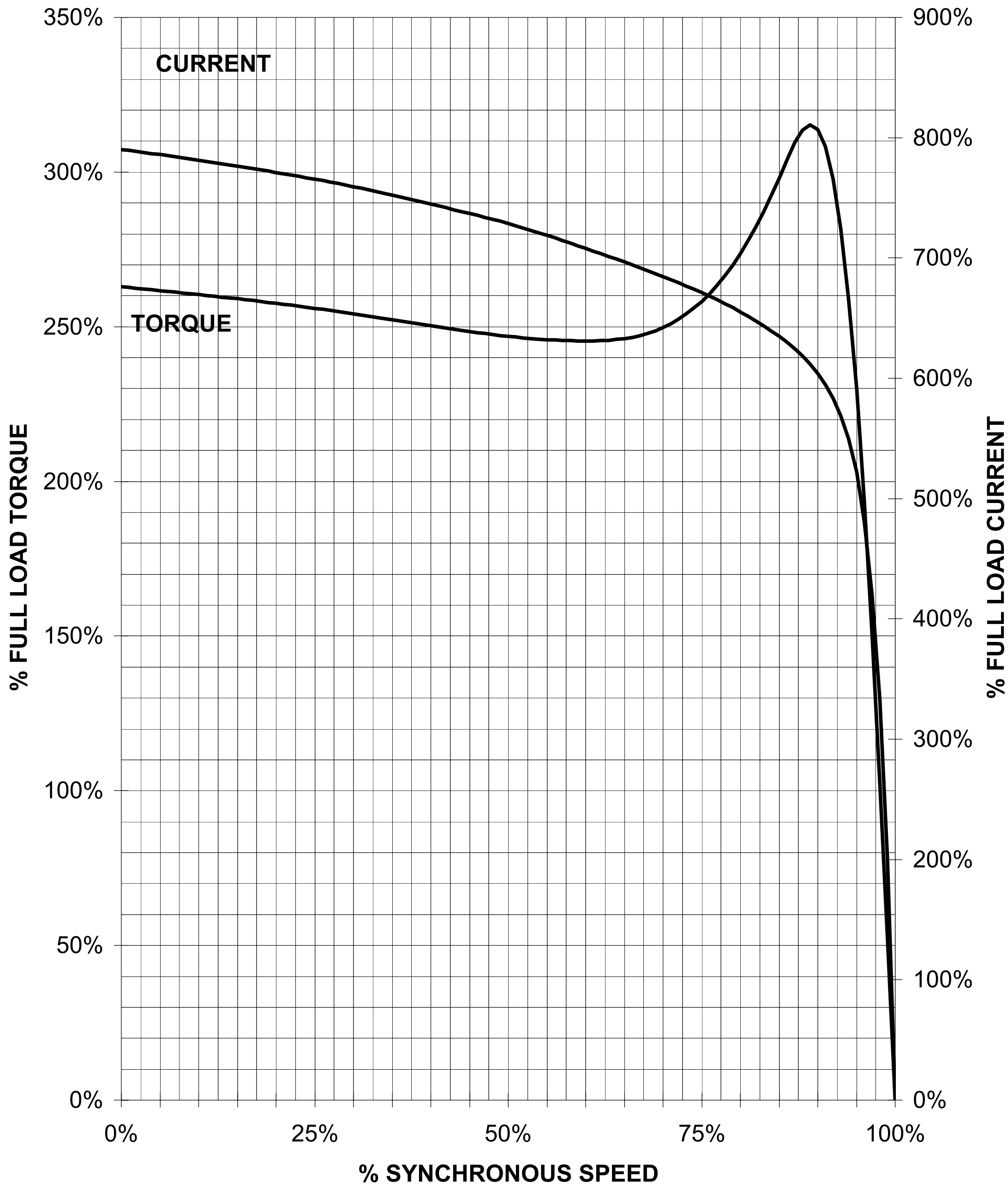
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	5	VOLTS	230/460	RPM	3600	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	184T	NEMA	B

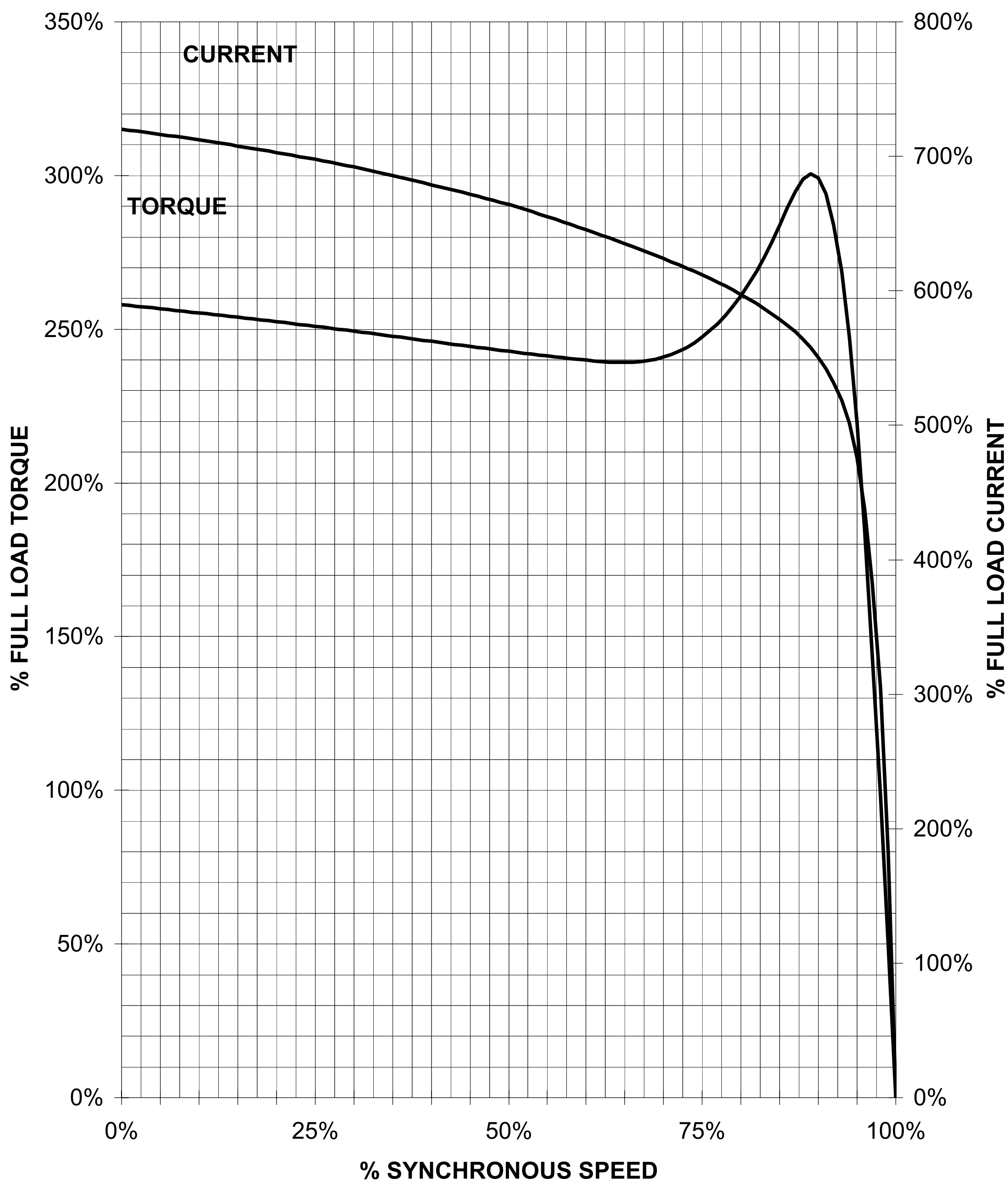
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP 5	VOLTS 230/460	RPM 1800	TYPE RGZP(SD)
HZ 60	PHASE 3	FRAME 184T	NEMA B

TORQUE & CURRENT VS. SPEED



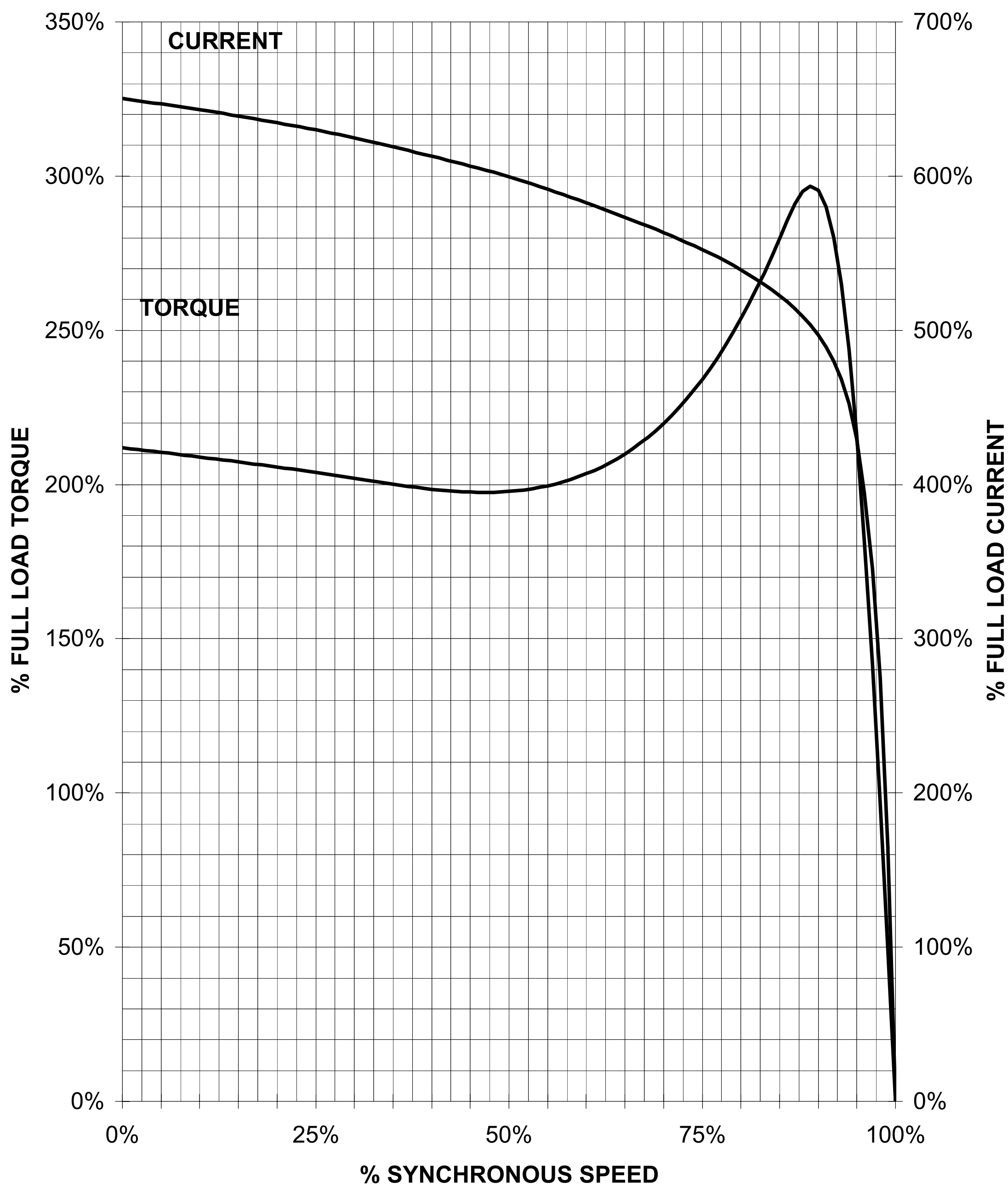
Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

Application Manual for NEMA Motors

HP	5	VOLTS	230/460	RPM	1200	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	215T	NEMA	B

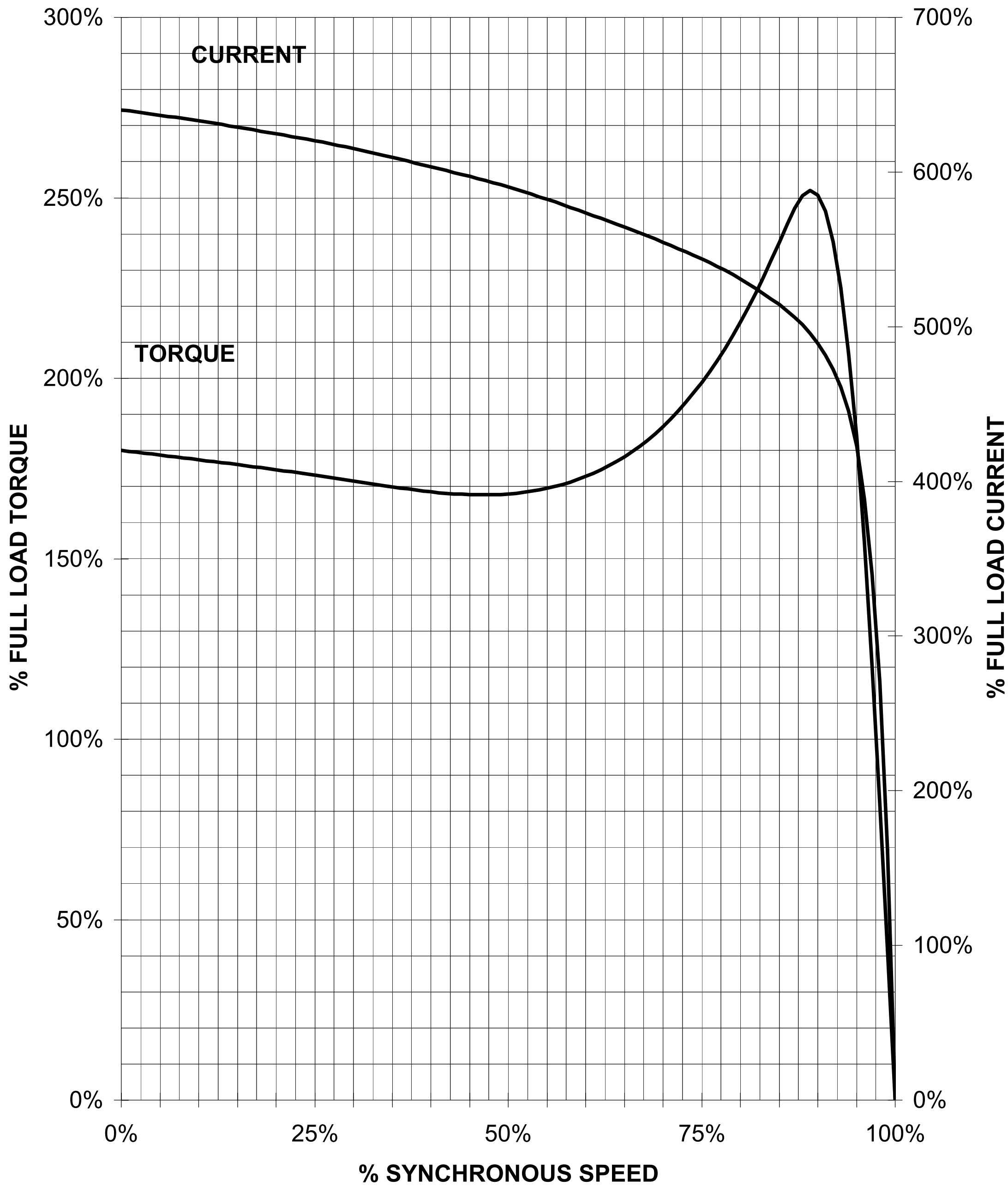
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	7.5	VOLTS	230/460	RPM	1200	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	254T	NEMA	B

TORQUE & CURRENT VS. SPEED

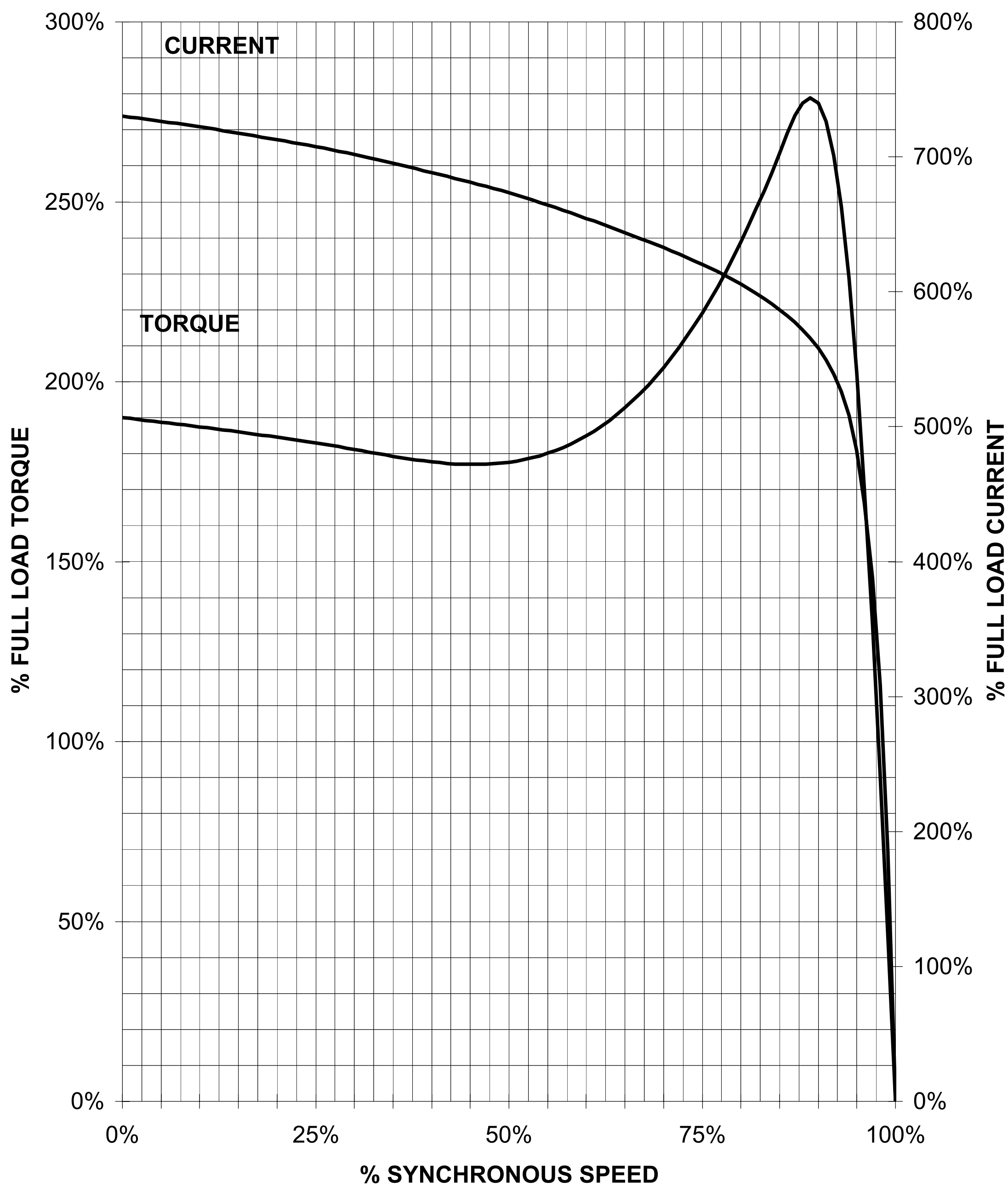


Customer: **PO No.:** **Order No.:**

HP 7.5 VOLTS 230/460 RPM 3600 TYPE RGZP(SD)

HZ 60 PHASE 3 FRAME 213T NEMA B

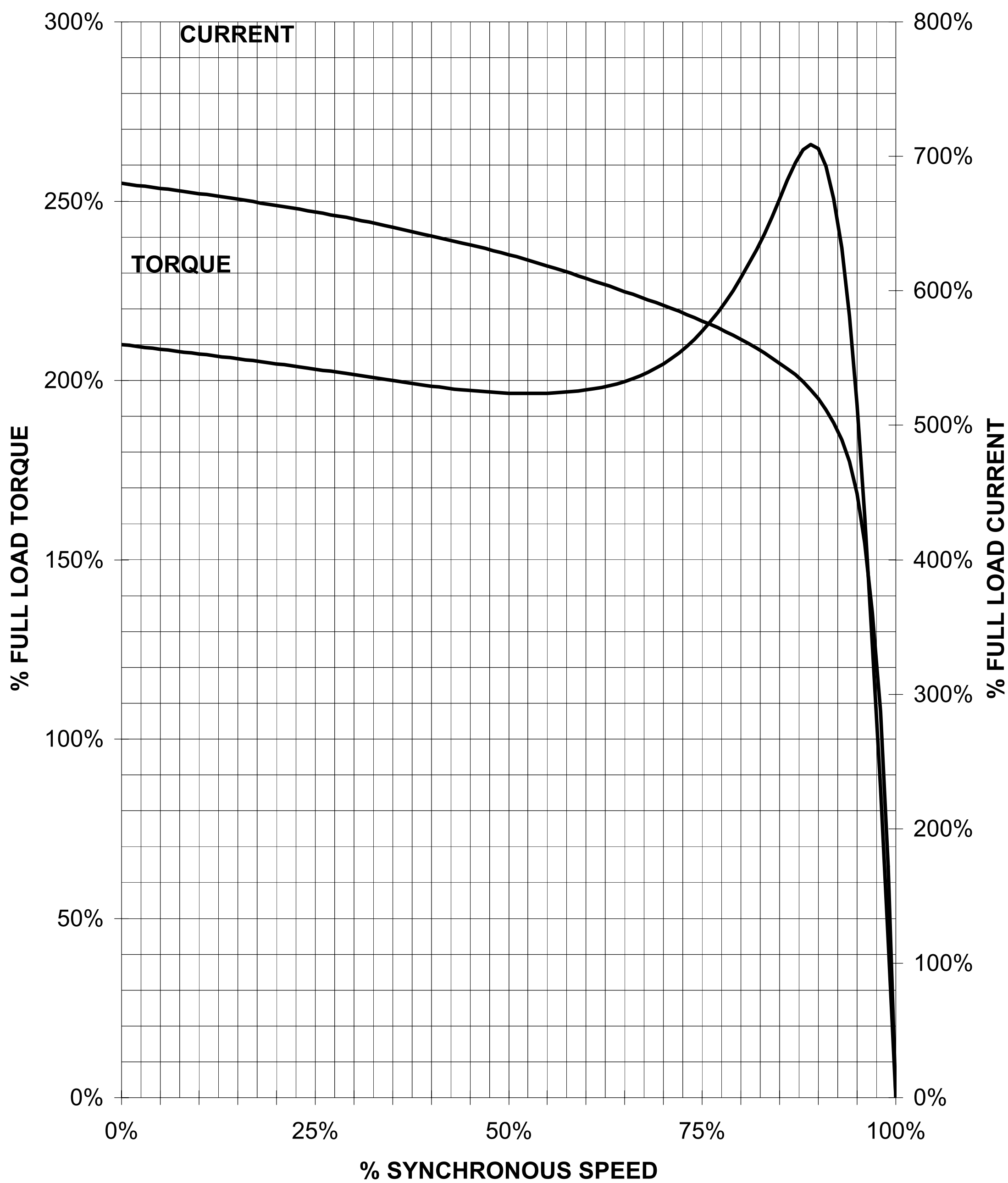
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	7.5	VOLTS	230/460	RPM	1800	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	213T	NEMA	B

TORQUE & CURRENT VS. SPEED

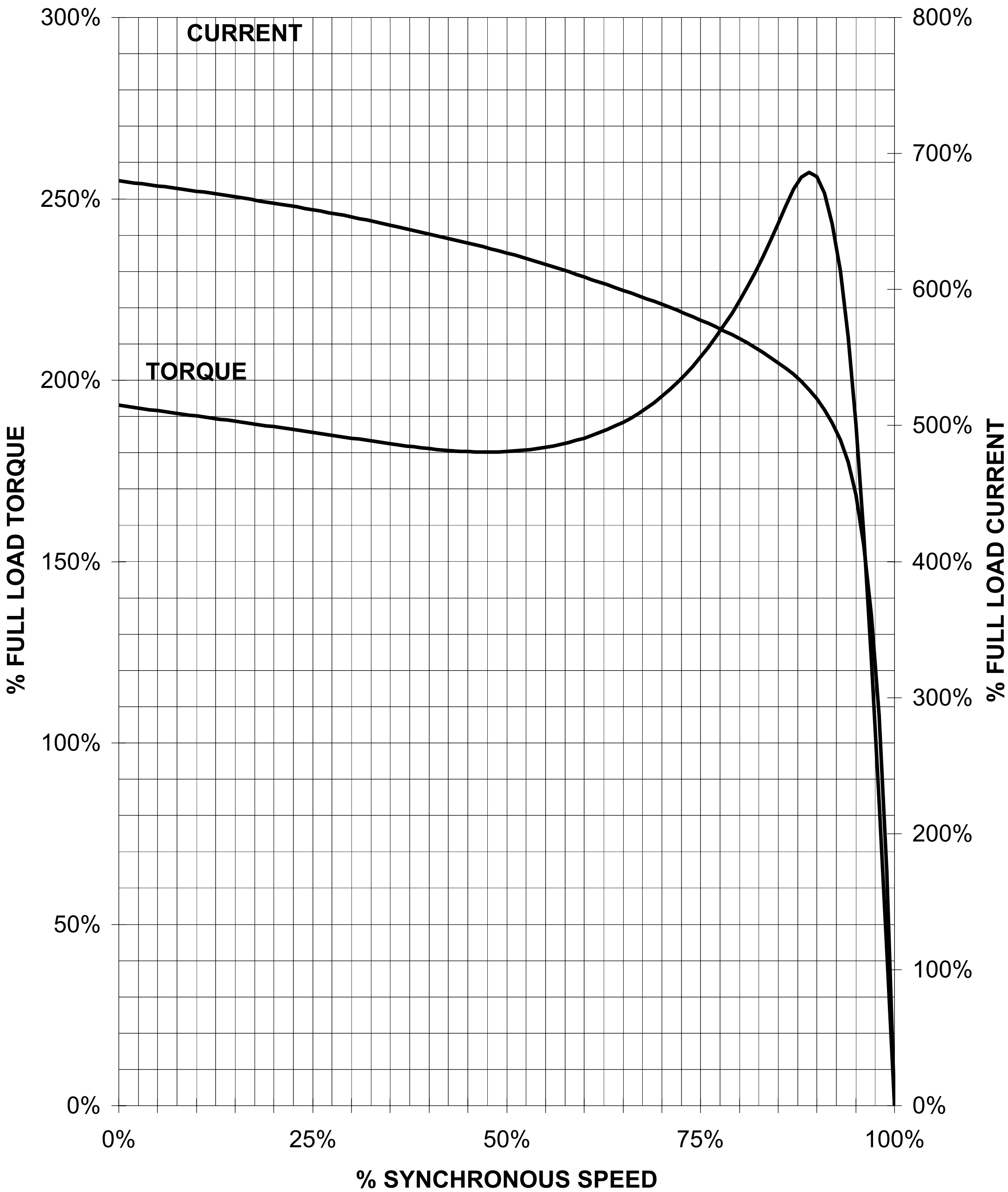


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	10	VOLTS	230/460	RPM	3600	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	215T	NEMA	B

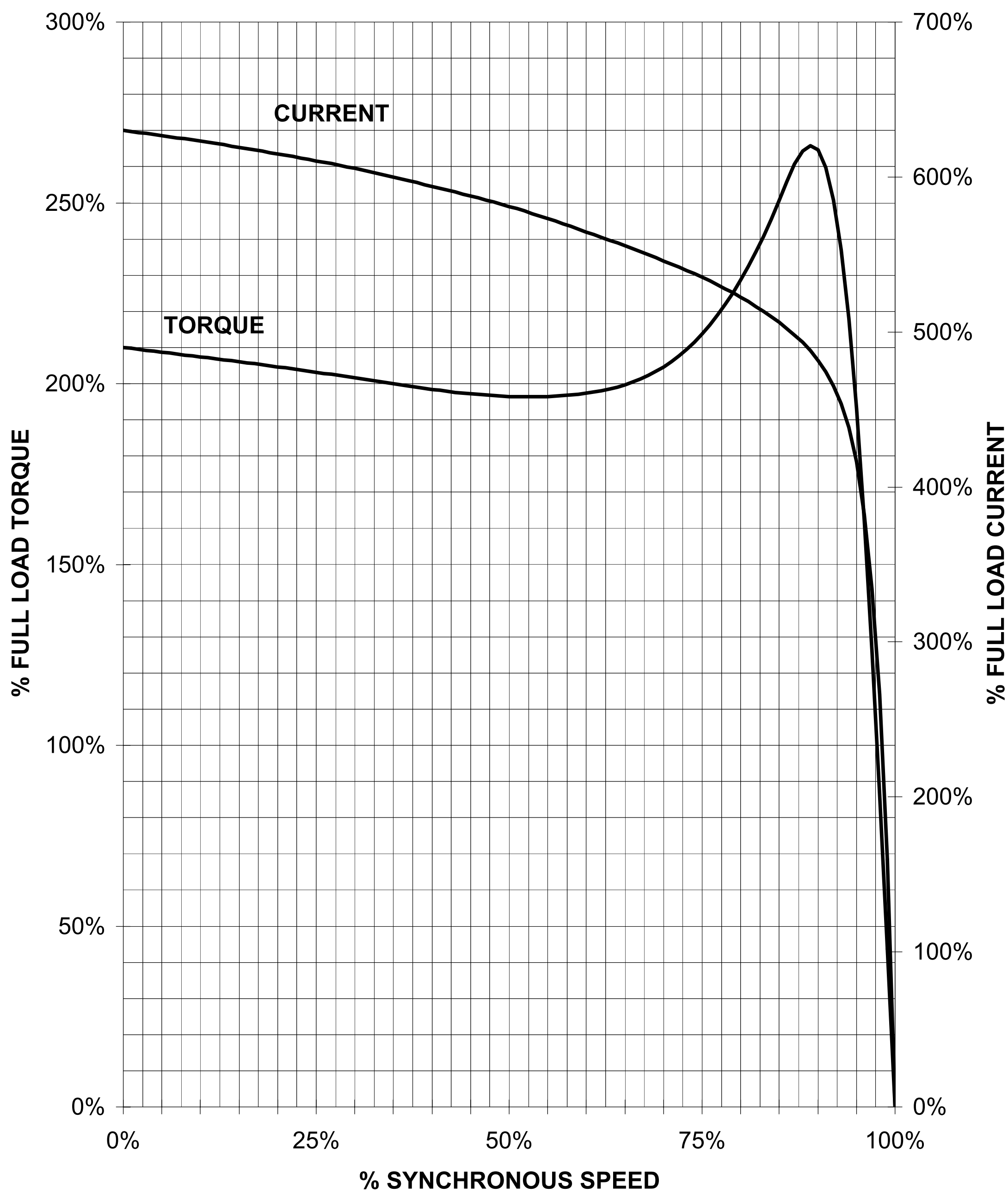
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	10	VOLTS	230/460	RPM	1800	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	215T	NEMA	B

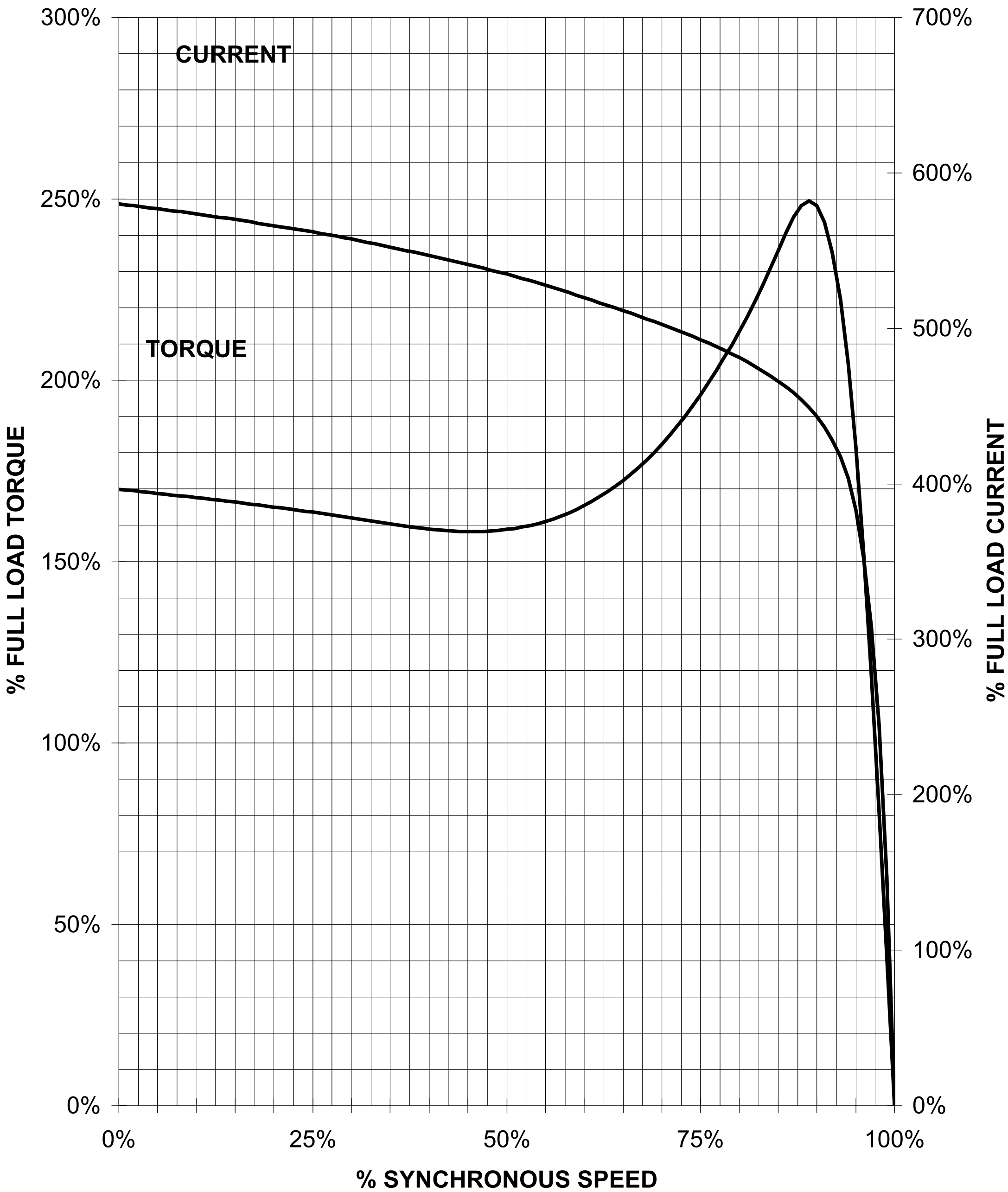
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	10	VOLTS	230/460	RPM	1200	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	256T	NEMA	B

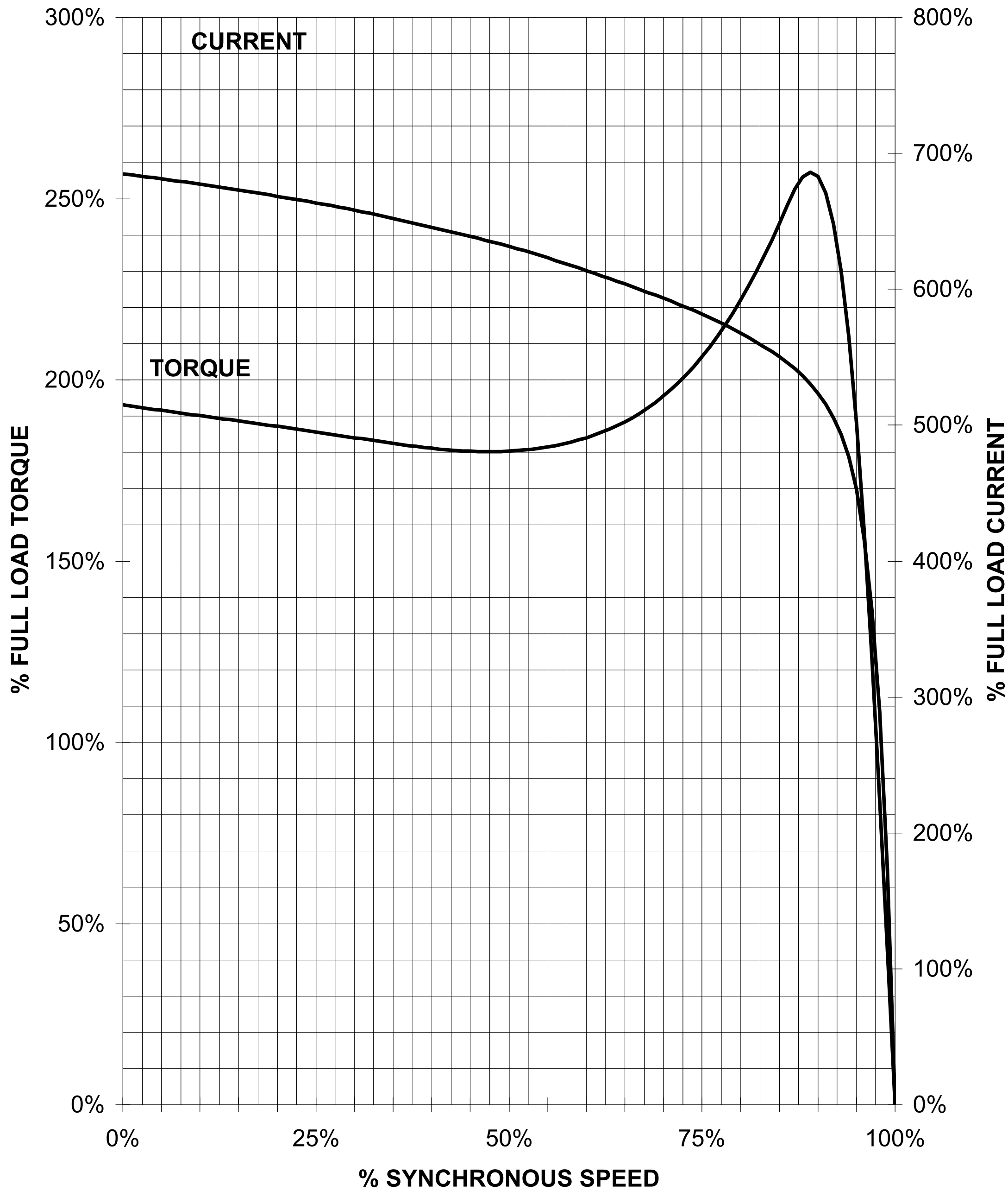
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	15	VOLTS	230/460	RPM	3600	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	254T	NEMA	B

TORQUE & CURRENT VS. SPEED

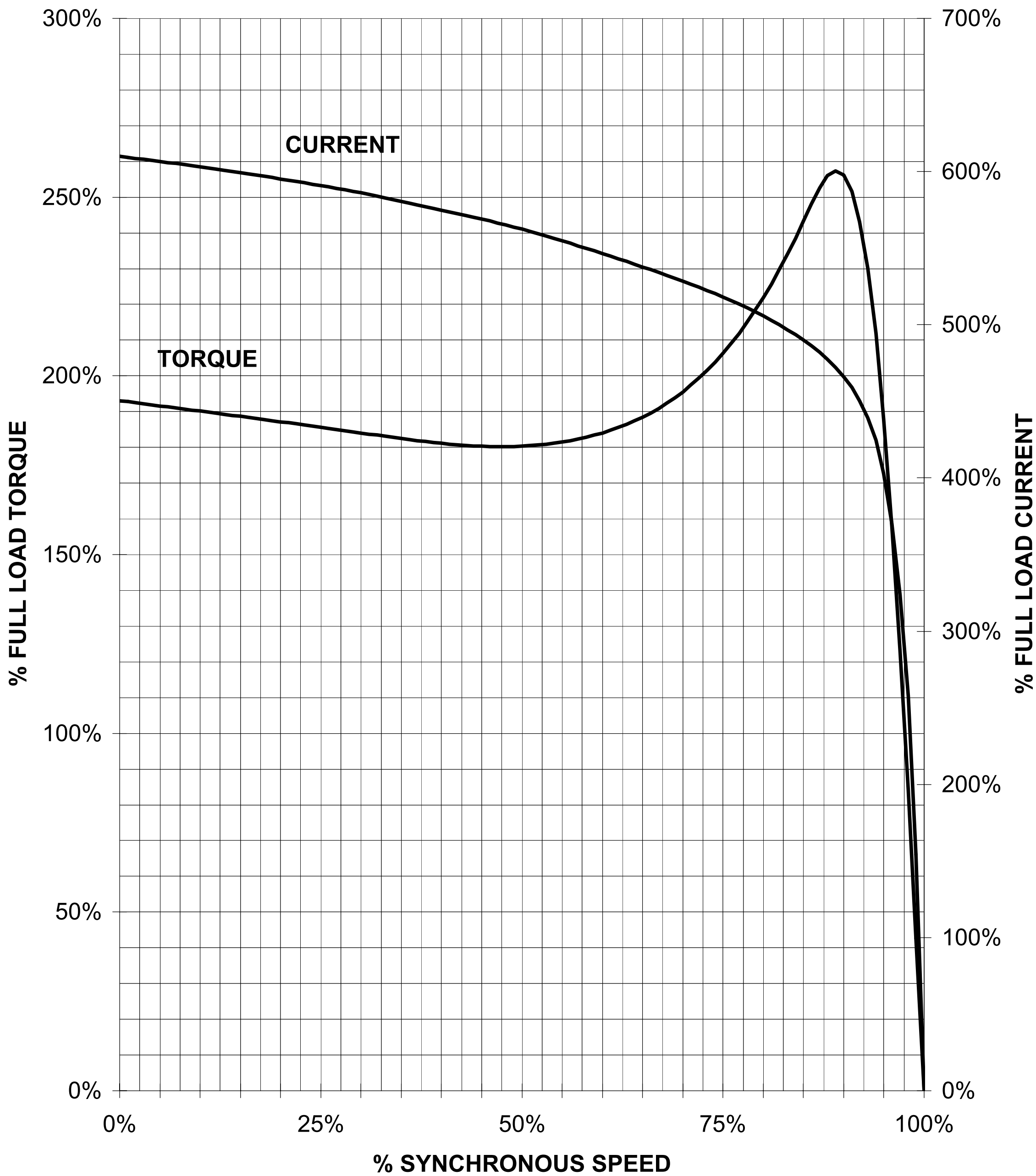


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	15	VOLTS	230/460	RPM	1800	TYPE	RGZPSD
HZ	60	PHASE	3	FRAME	254T	NEMA	B

TORQUE & CURRENT VS. SPEED



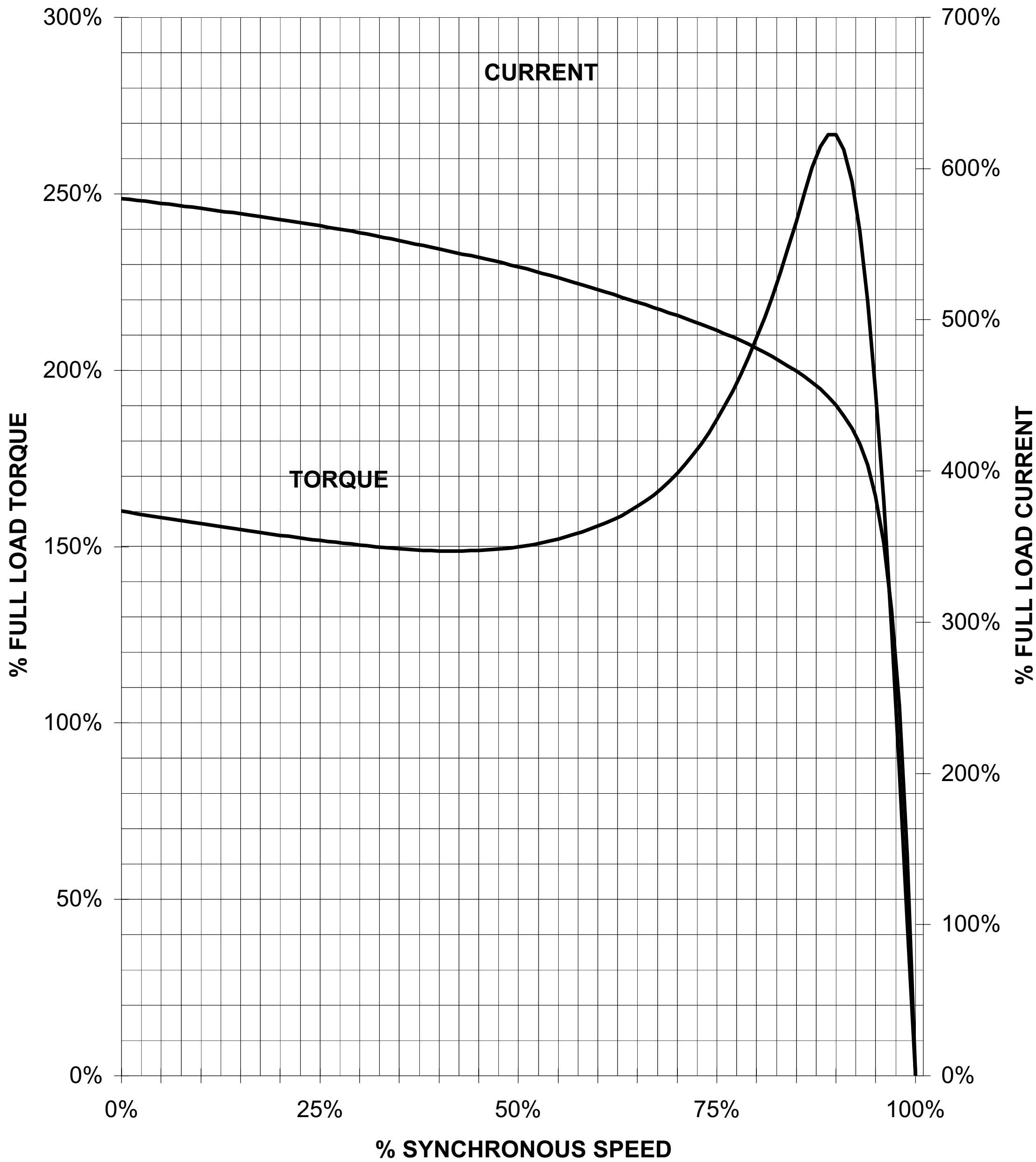
Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP 15 VOLTS 230/460 RPM 1200 TYPE RGZP(SD)

HZ 60 PHASE 3 FRAME 284T NEMA B

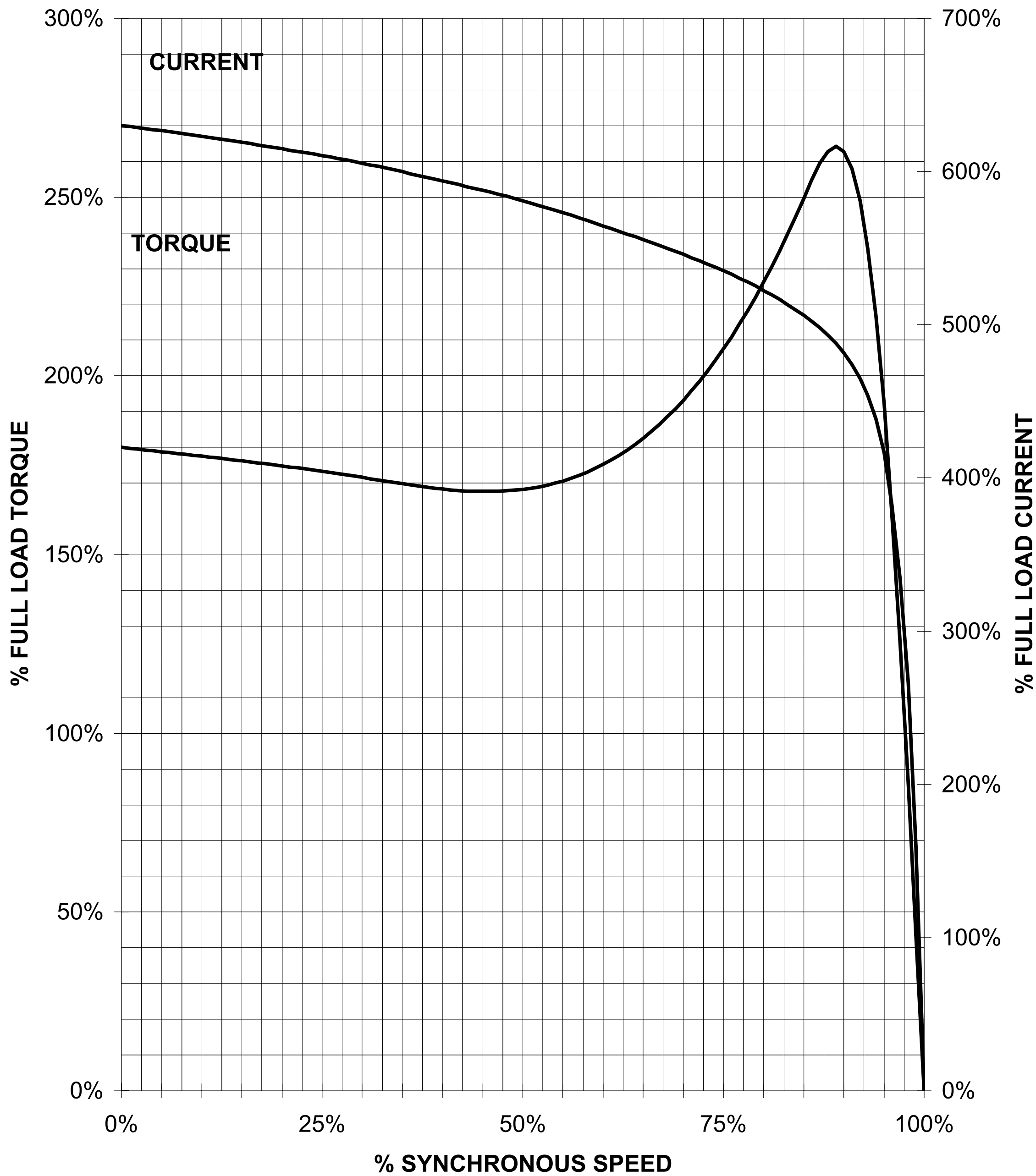
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	20	VOLTS	230/460	RPM	3600	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	256T	NEMA	B

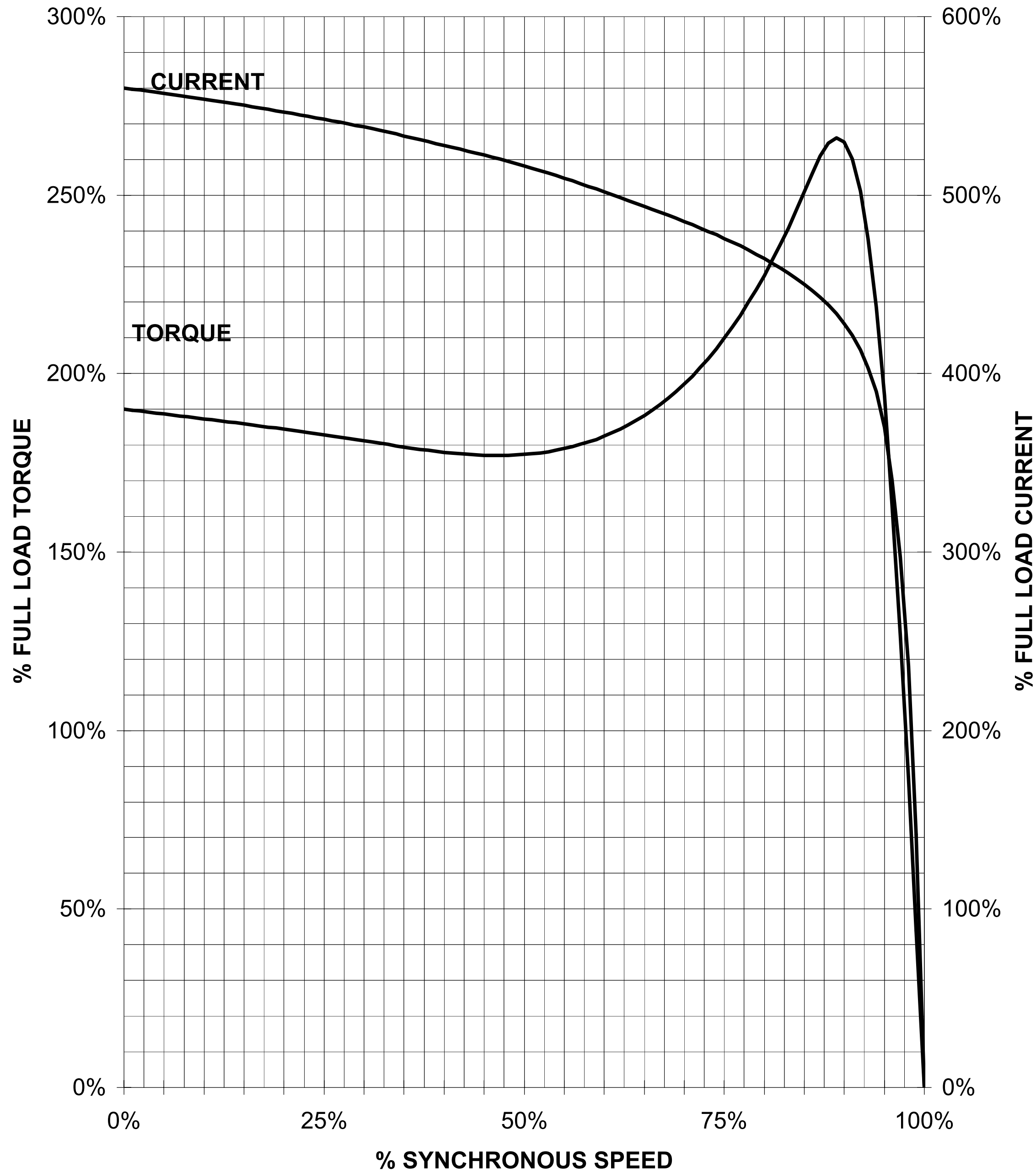
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	20	VOLTS	230/460	RPM	1800	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	256T	NEMA	B

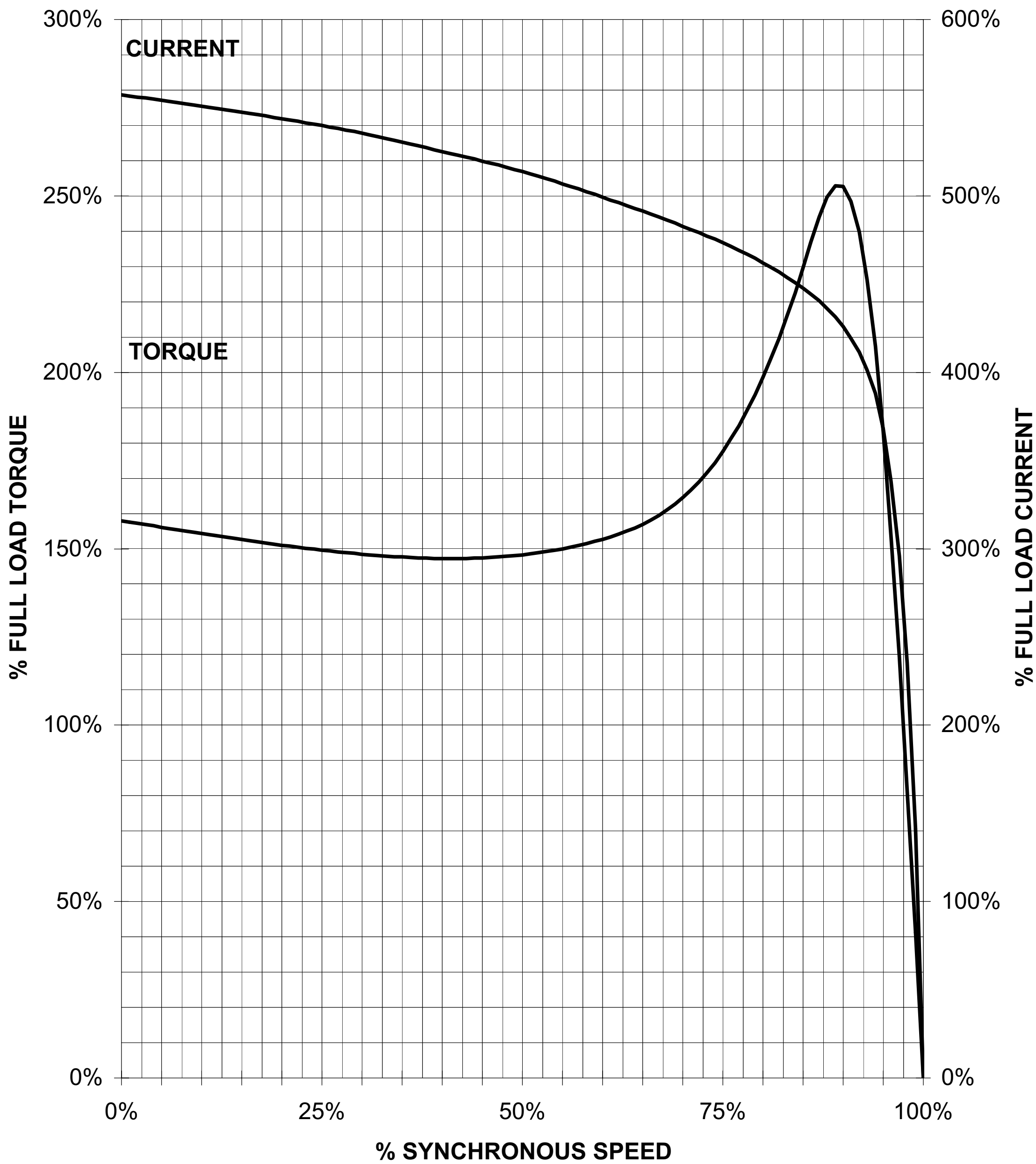
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	20	VOLTS	230/460	RPM	1200	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	286T	NEMA	B

TORQUE AND CURRENT VS. SPEED



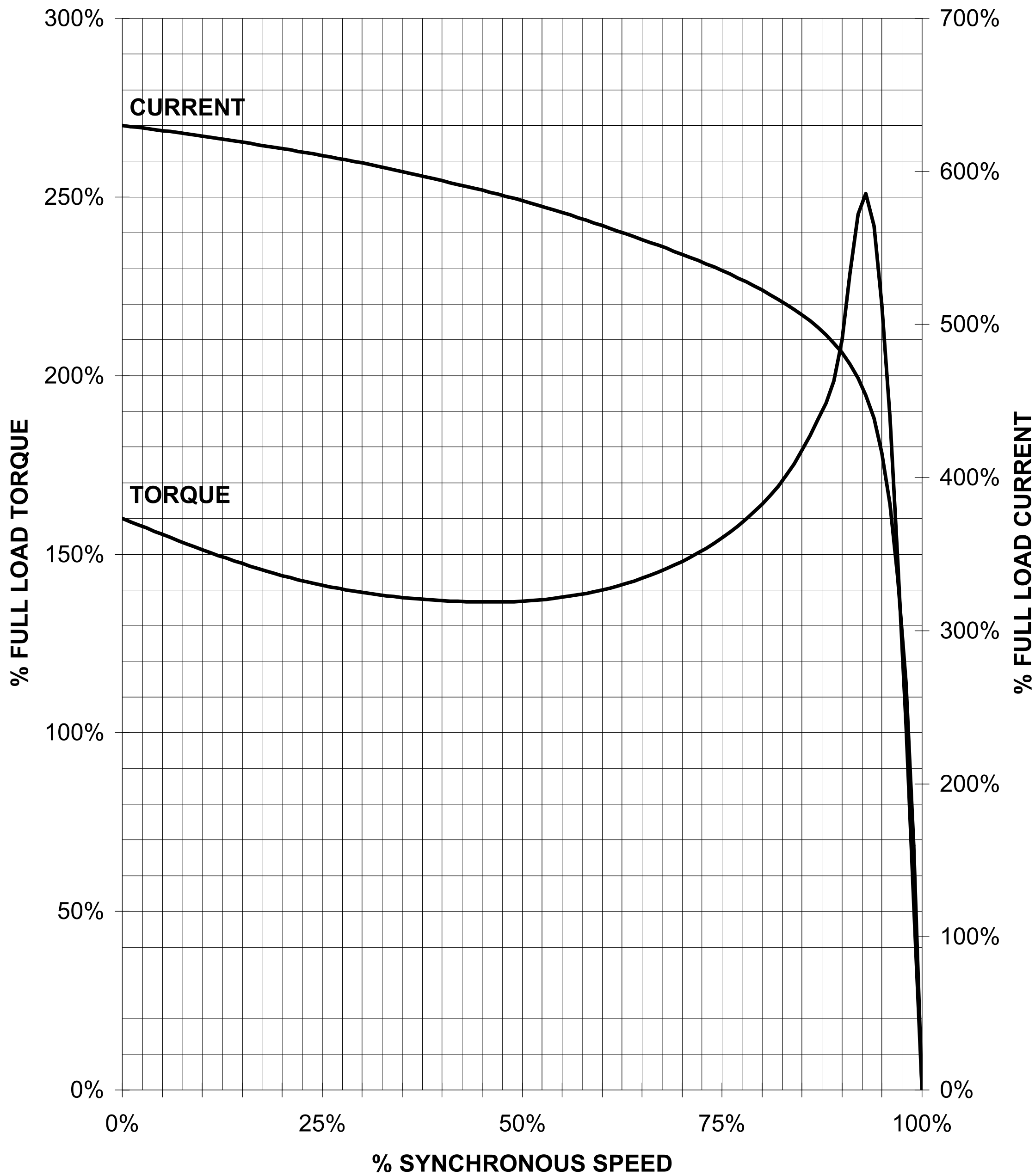
Customer: **PO No.:** **Order No.:**

Application Manual for NEMA Motors

HP 25 VOLTS 460 RPM 3600 TYPE RGZP(SD)

HZ 60 PHASE 3 FRAME 284TS NEMA B

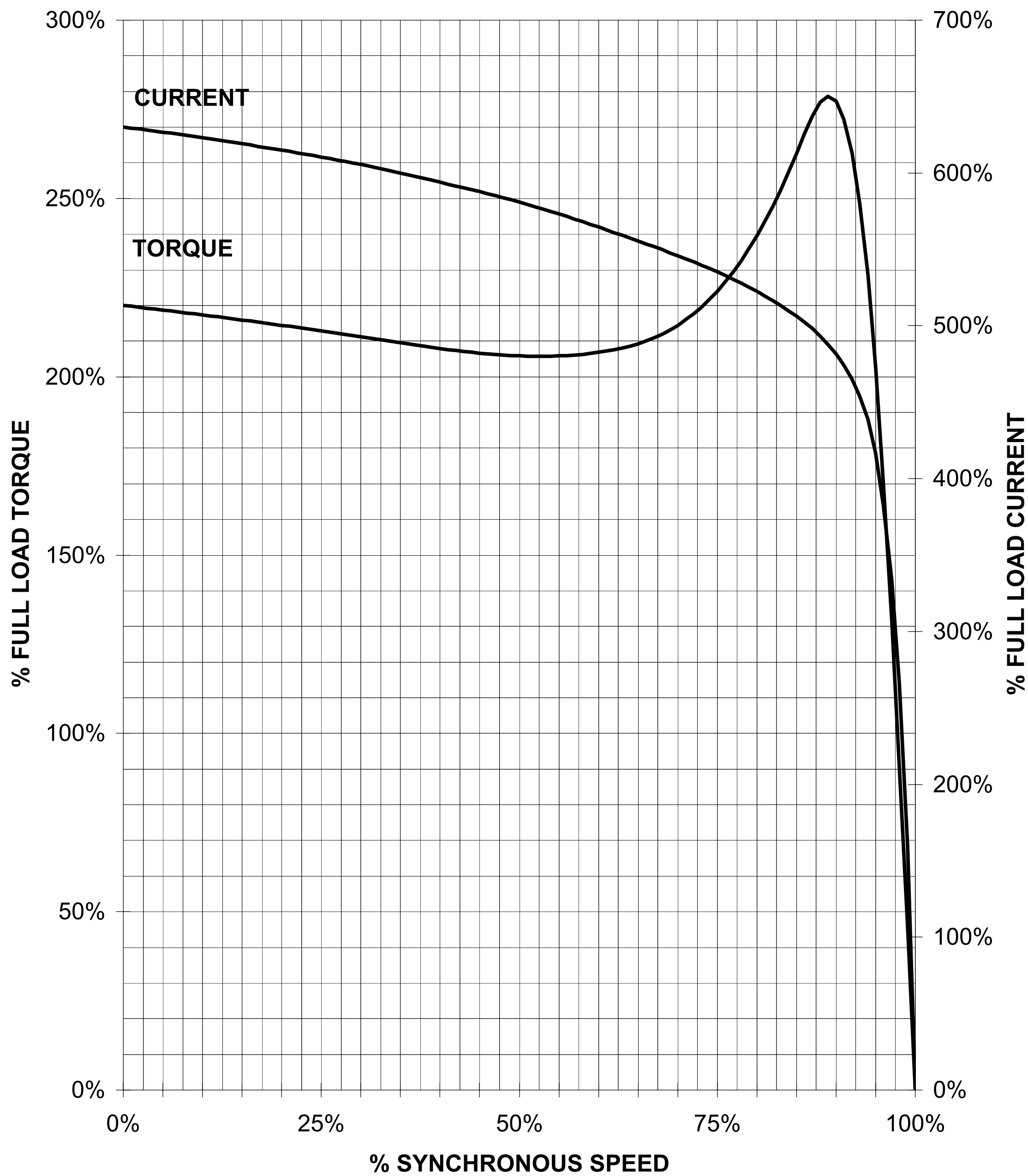
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	25	VOLTS	460	RPM	1800	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	284T	NEMA	B

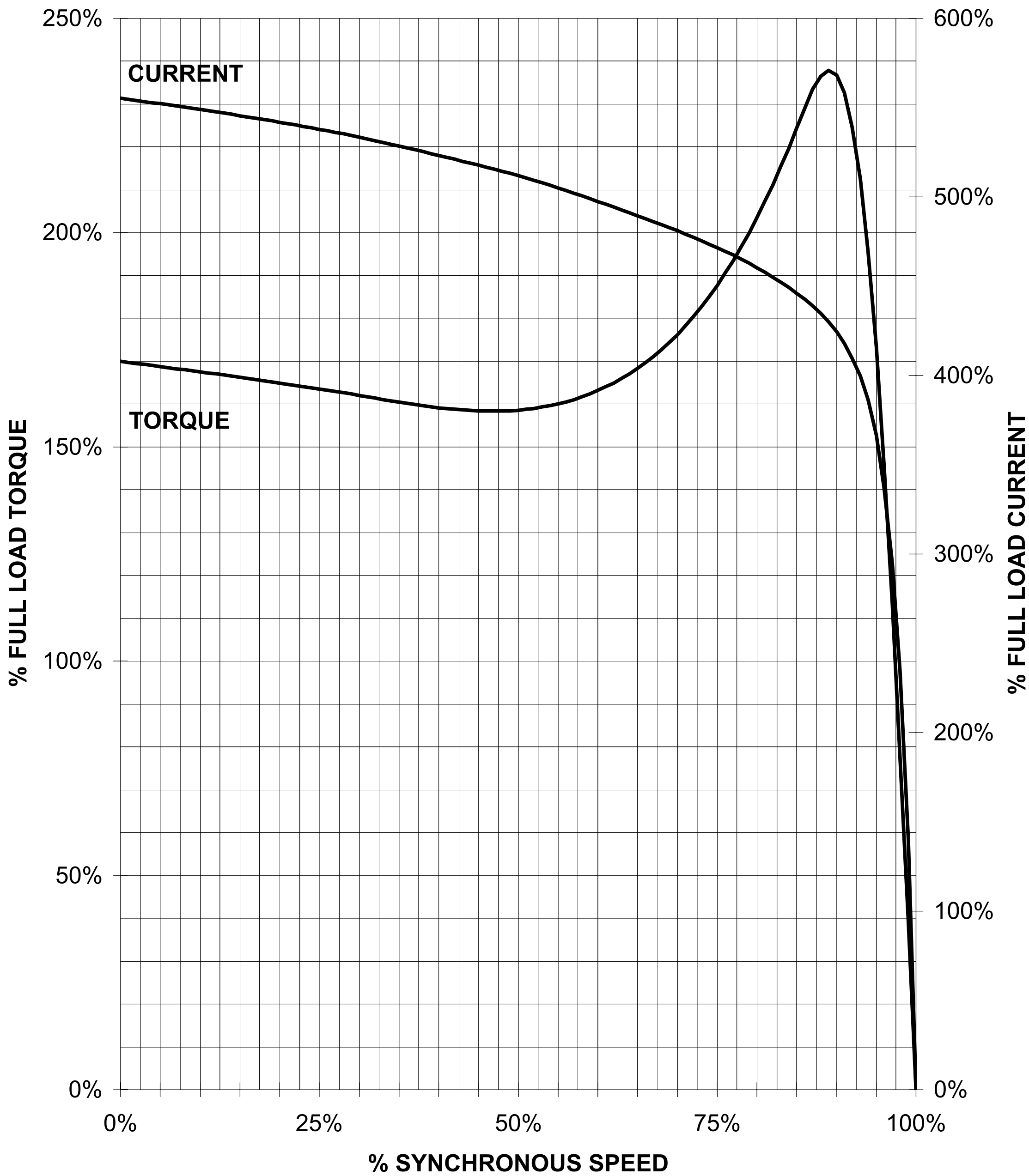
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	25	VOLTS	460	RPM	1200	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	324T	NEMA	B

TORQUE AND CURRENT VS. SPEED



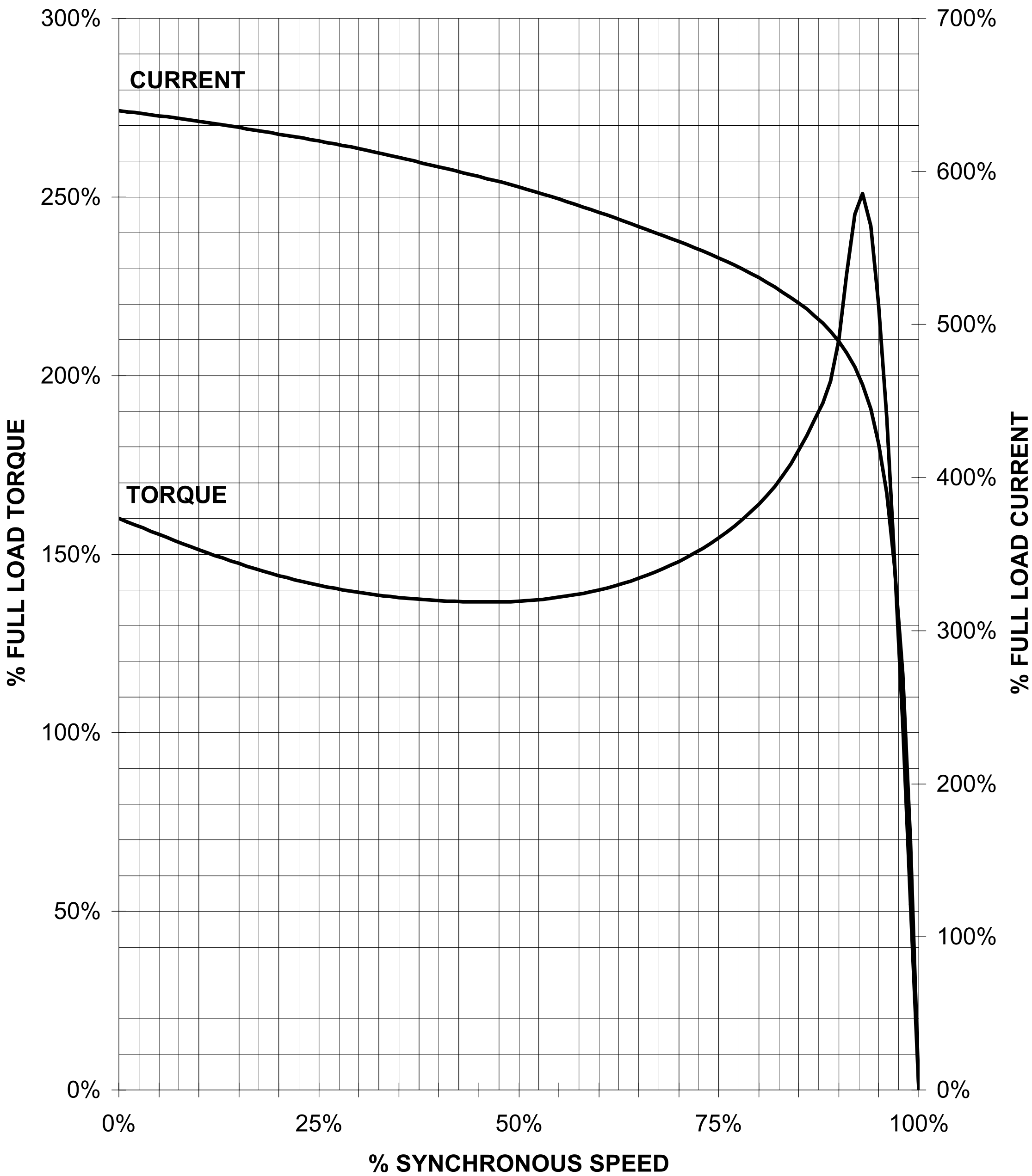
Customer: **PO No.:** **Order No.:**

Application Manual for NEMA Motors

HP 30 VOLTS 460 RPM 3600 TYPE RGZP(SD)

HZ 60 PHASE 3 FRAME 286TS NEMA B

TORQUE AND CURRENT VS. SPEED

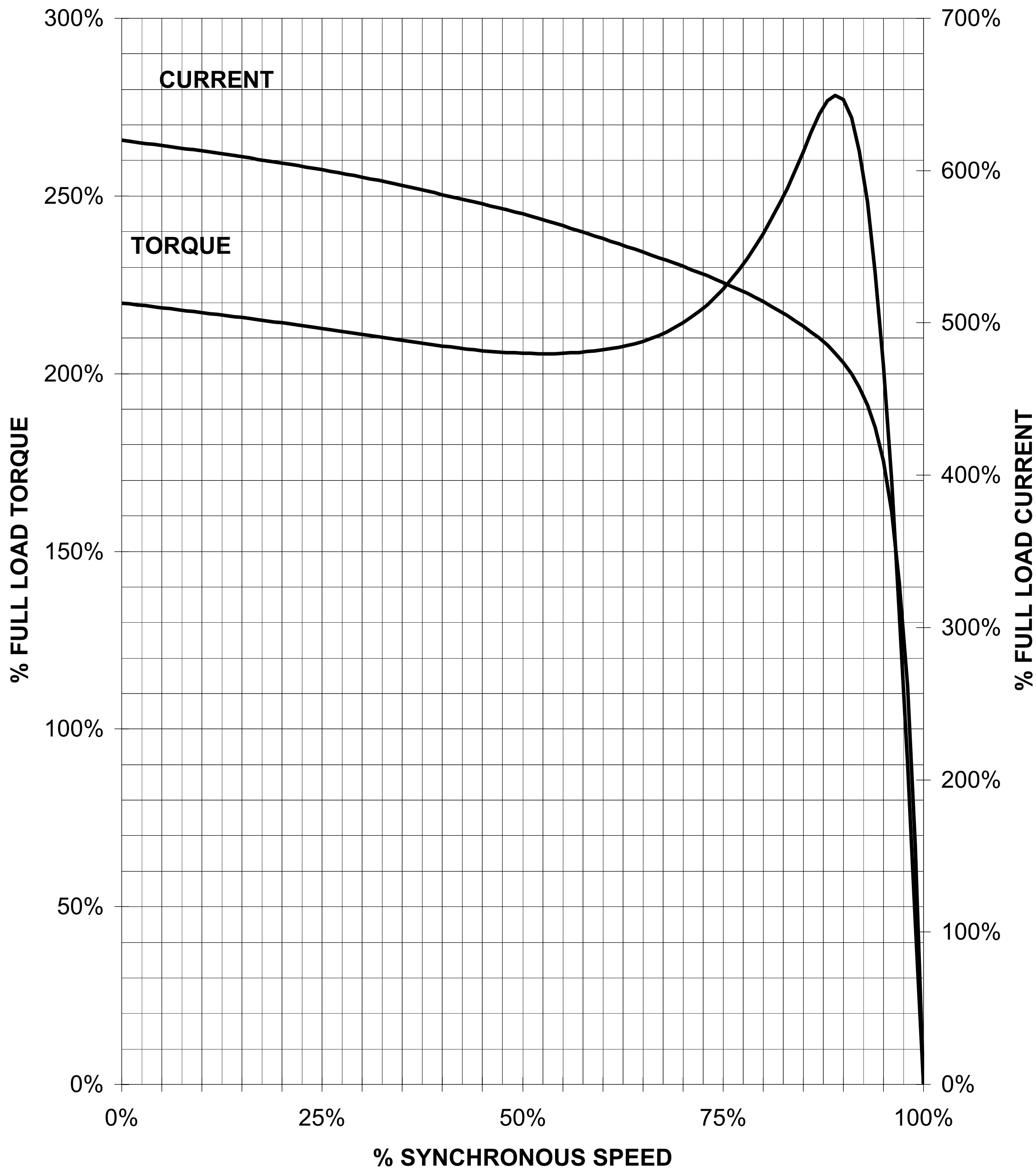


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	30	VOLTS	460	RPM	1800	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	286T	NEMA	B

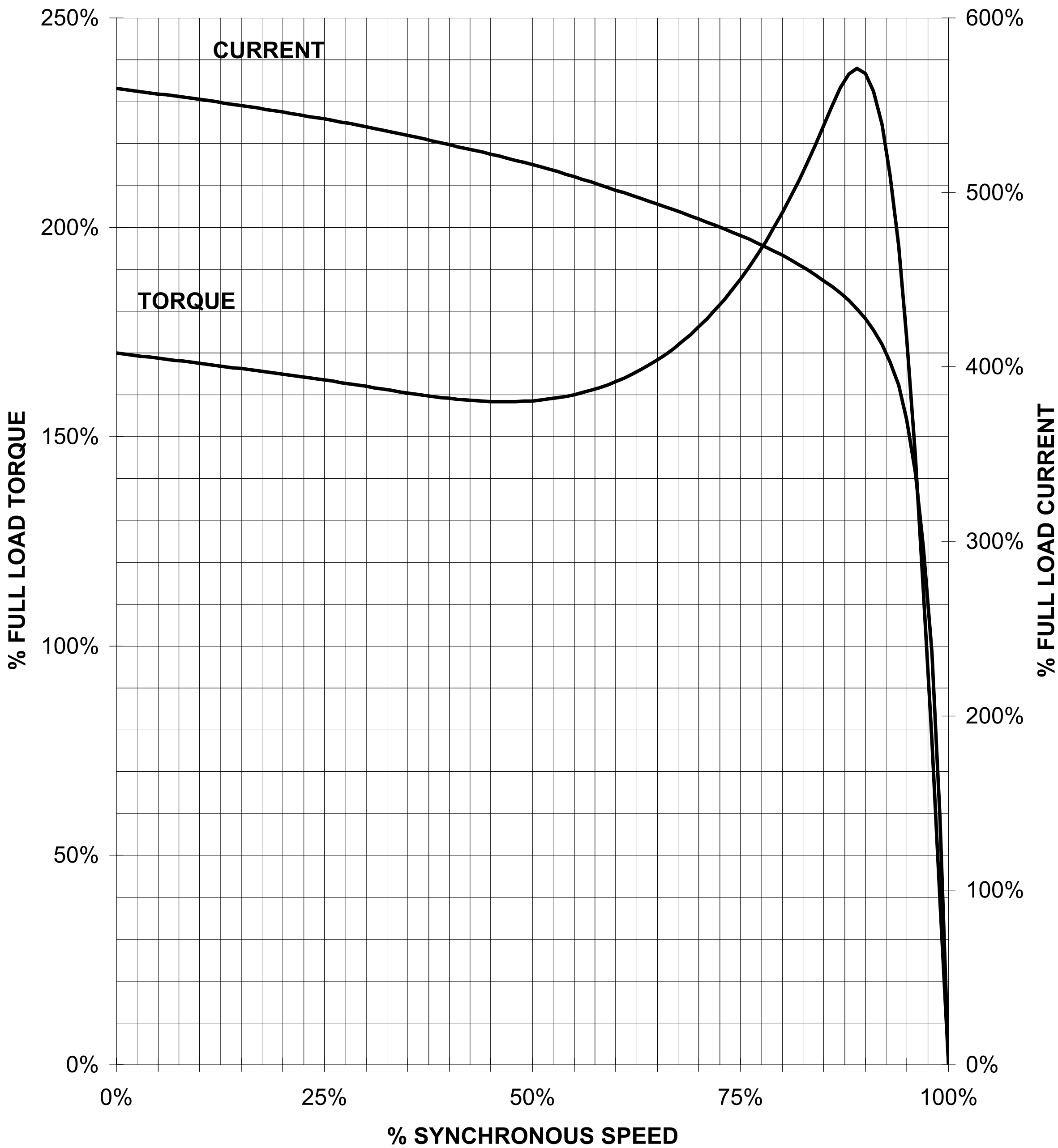
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	30	VOLTS	460	RPM	1200	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	326T	NEMA	B

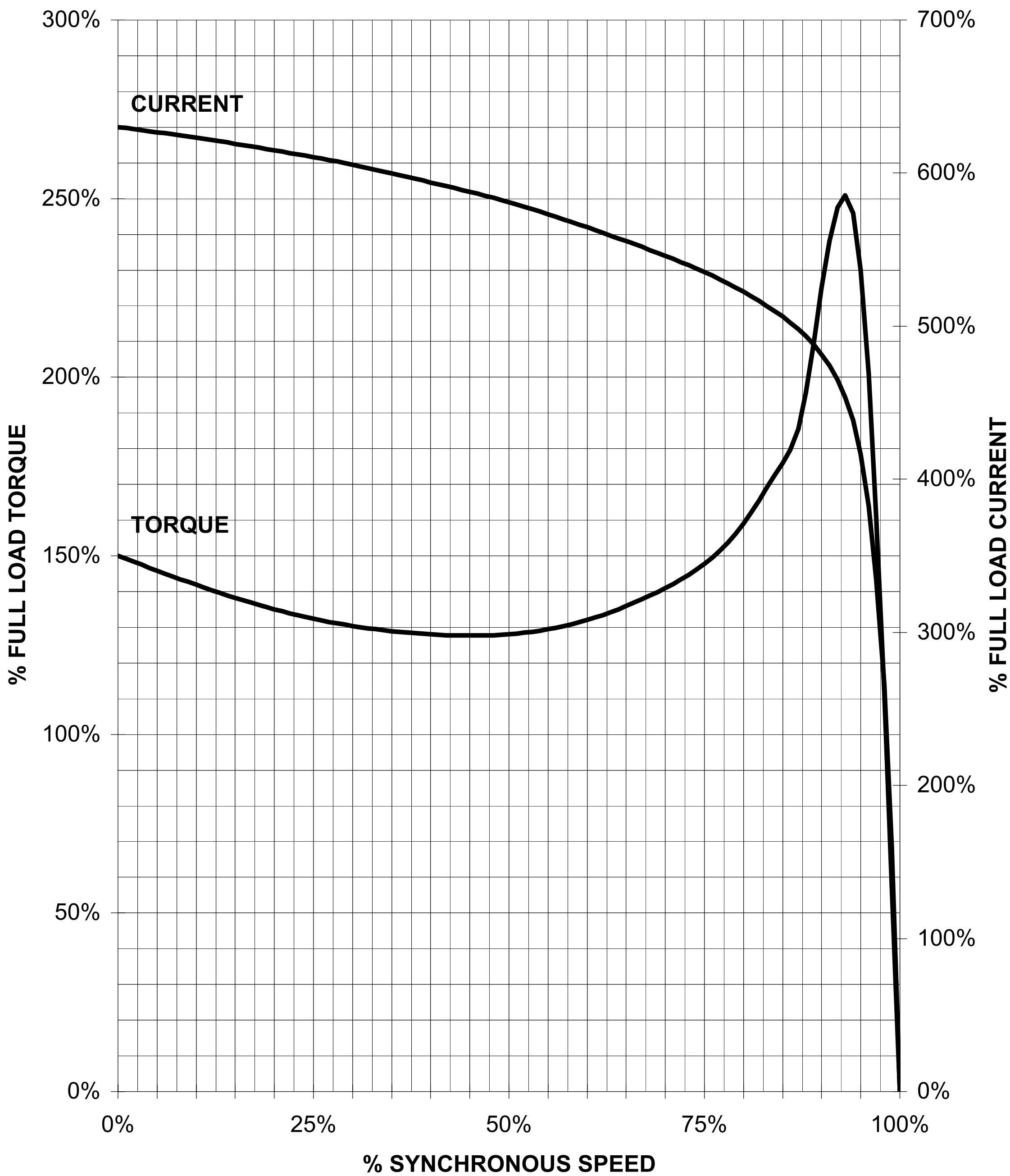
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	40	VOLTS	460	RPM	3600	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	324TS	NEMA	B

TORQUE AND CURRENT VS. SPEED

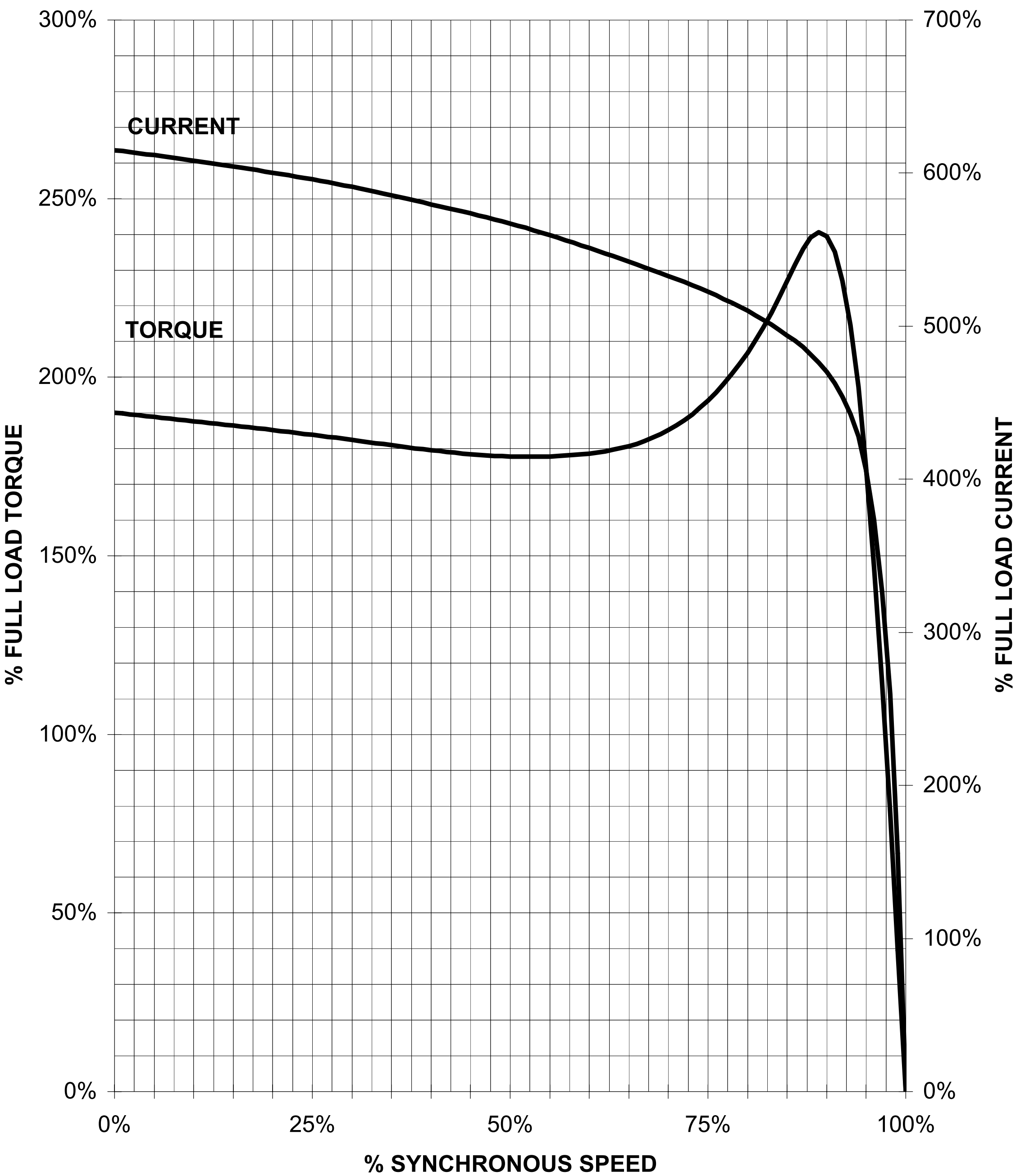


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	40	VOLTS	460	RPM	1800	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	324T	NEMA	B

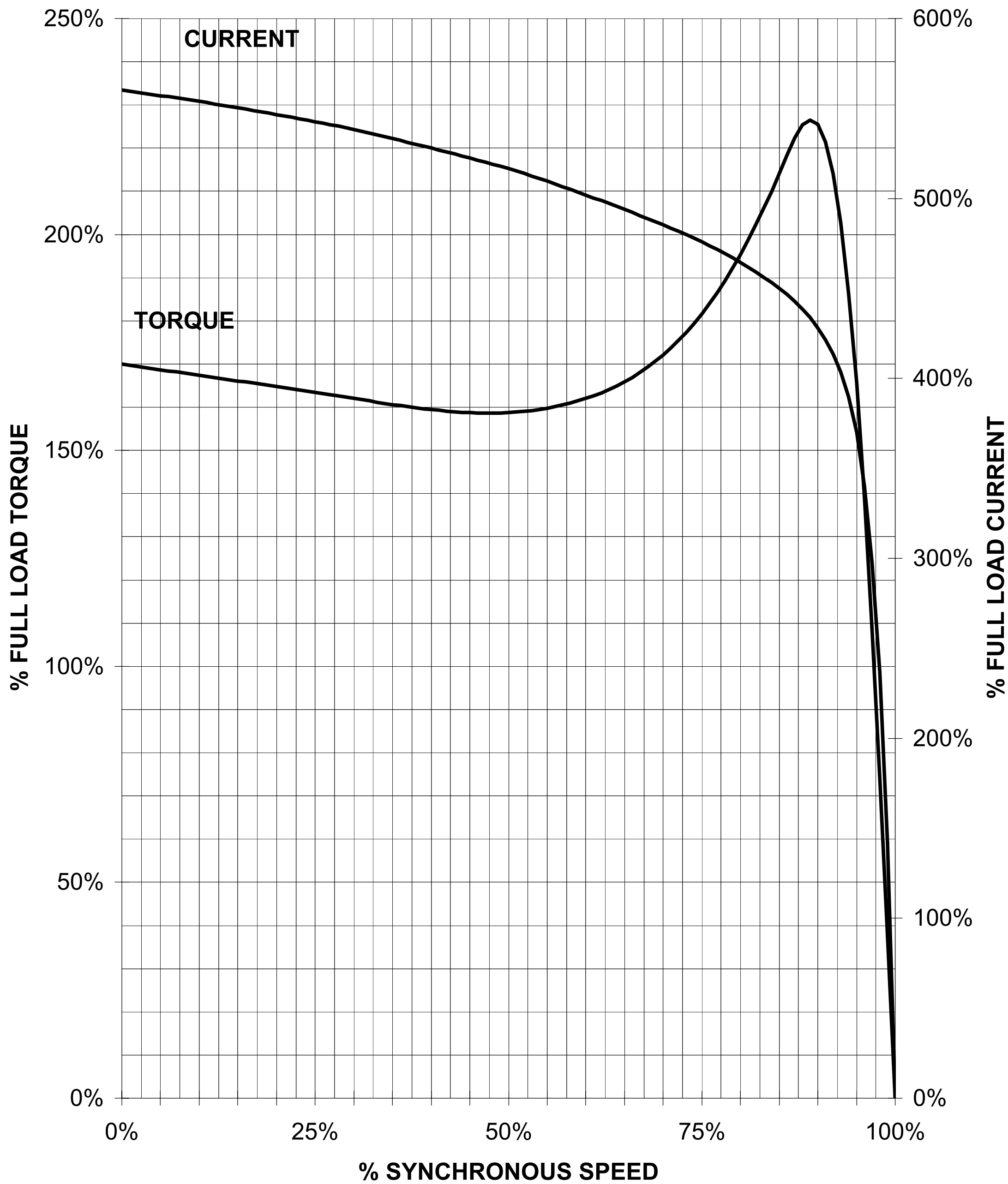
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	40	VOLTS	460	RPM	1200	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	364T	NEMA	B

TORQUE & CURRENT VS. SPEED

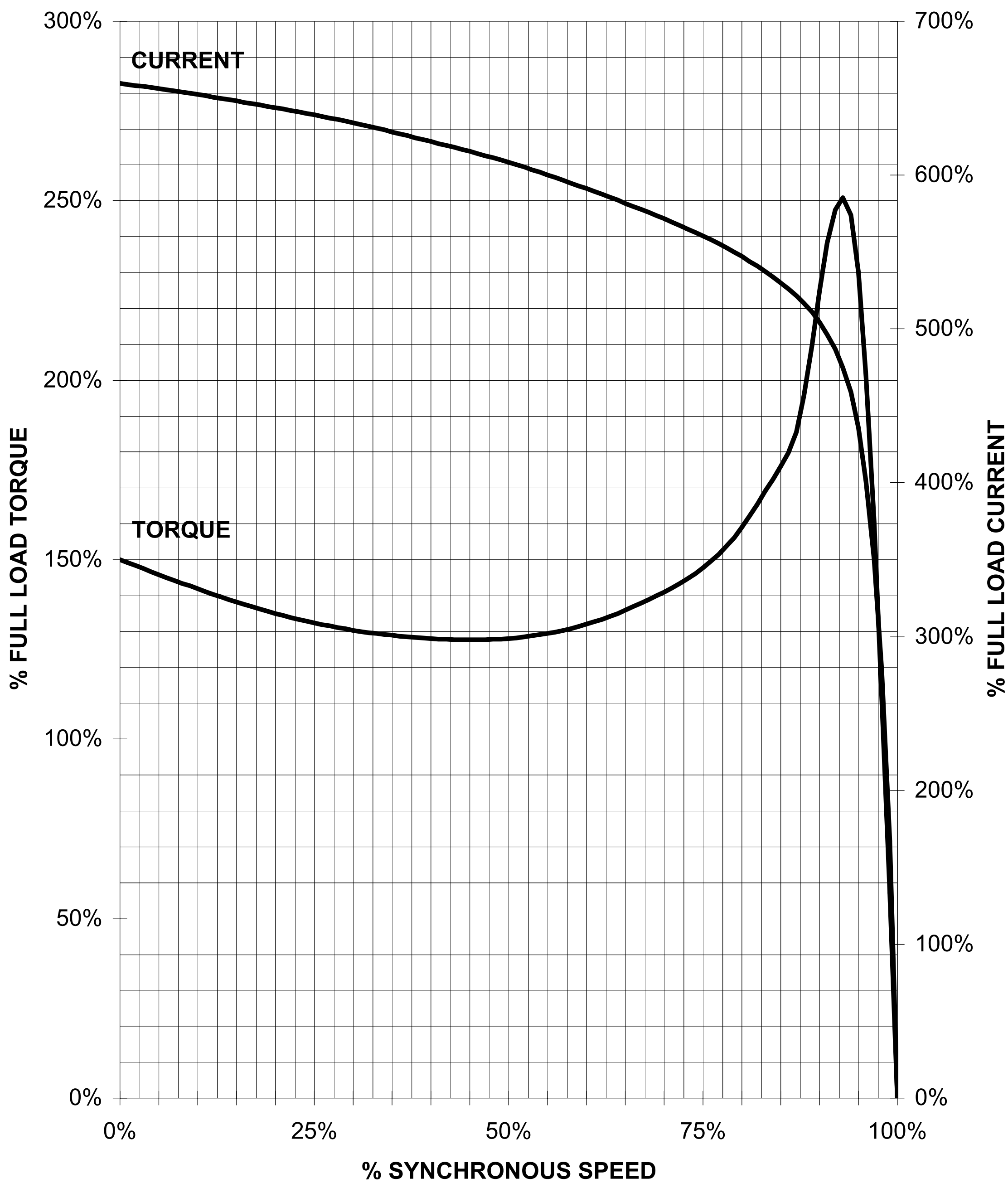


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	50	VOLTS	460	RPM	3600	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	326TS	NEMA	B

TORQUE AND CURRENT VS. SPEED

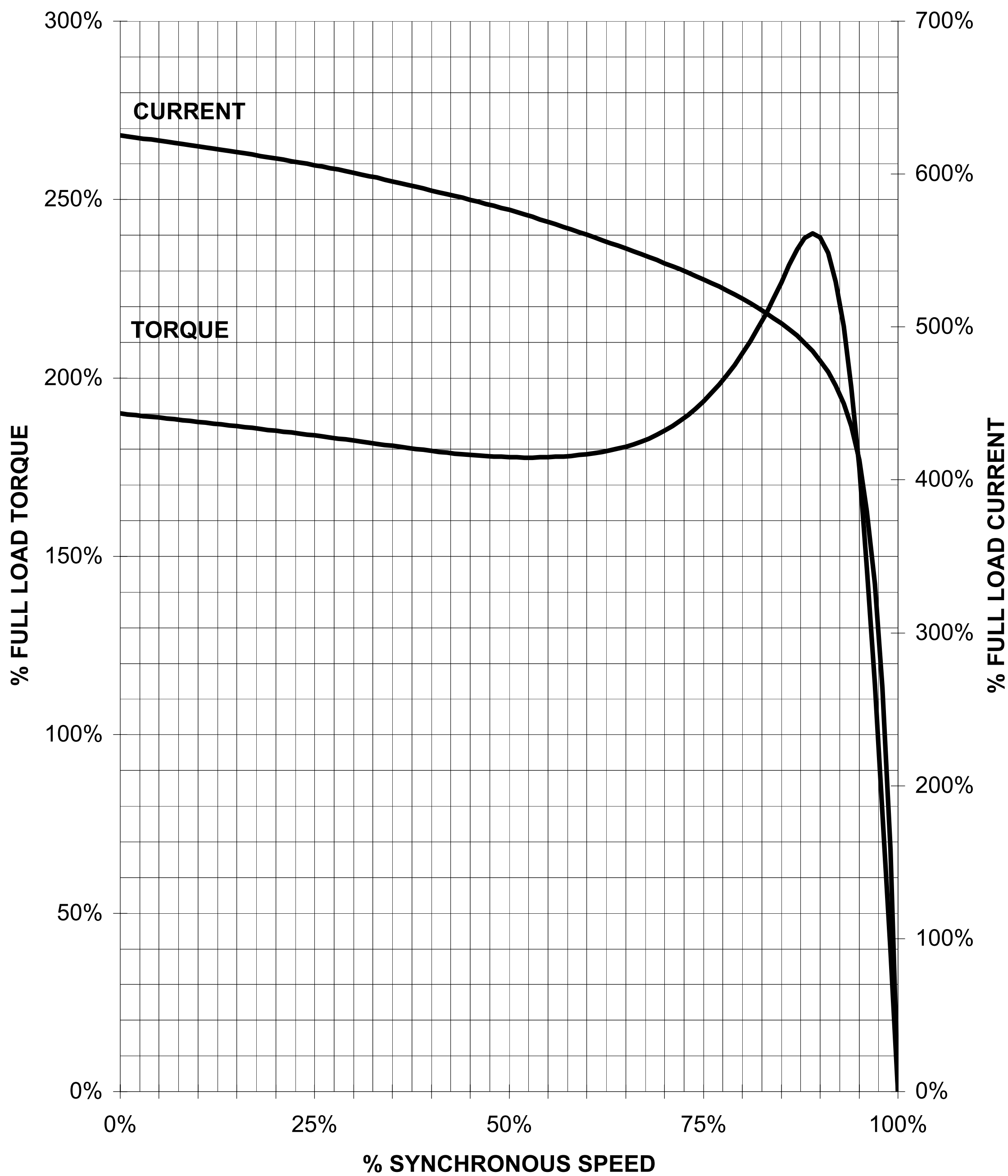


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	50	VOLTS	460	RPM	1800	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	326T	NEMA	B

TORQUE AND CURRENT VS. SPEED

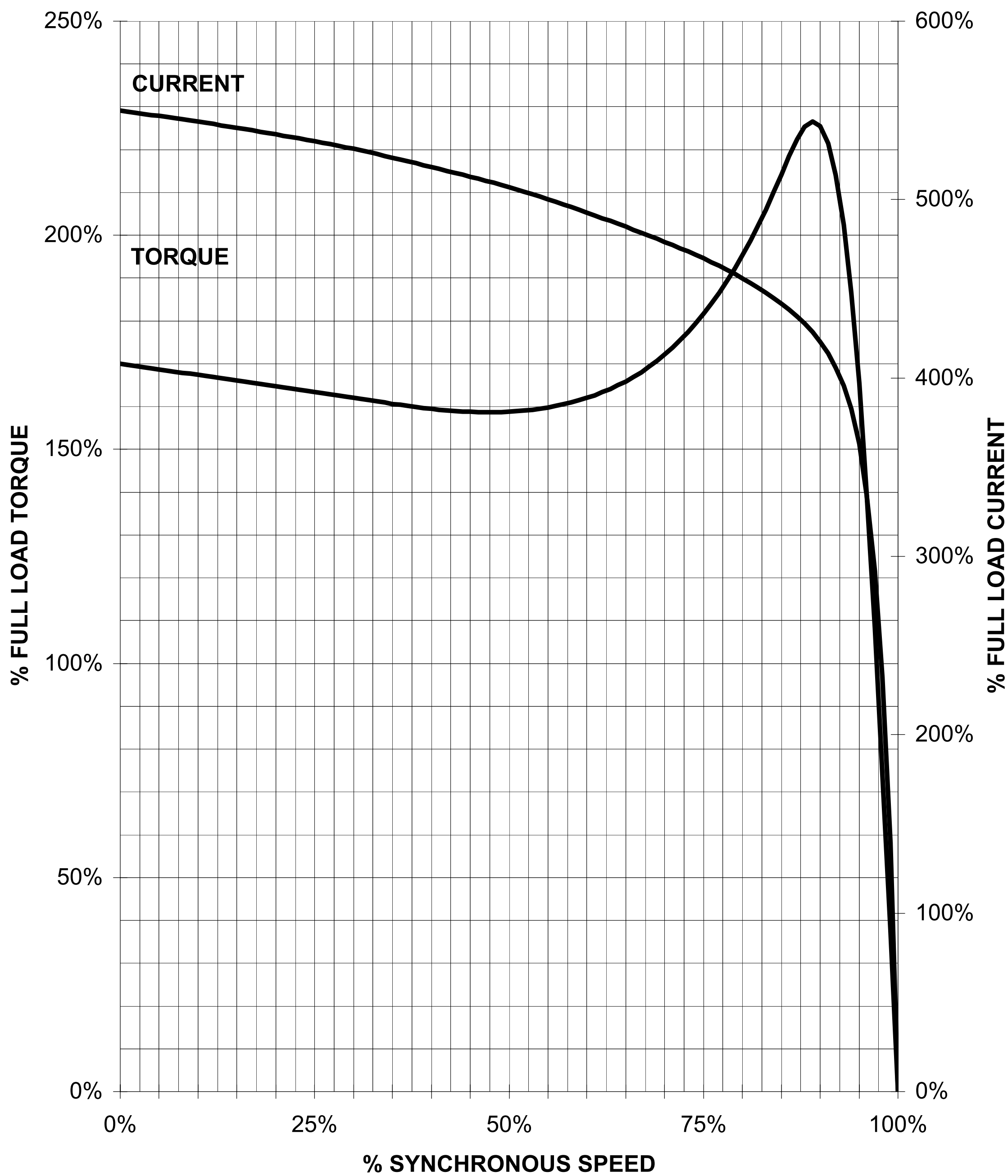


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	50	VOLTS	460	RPM	1200	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	365T	NEMA	B

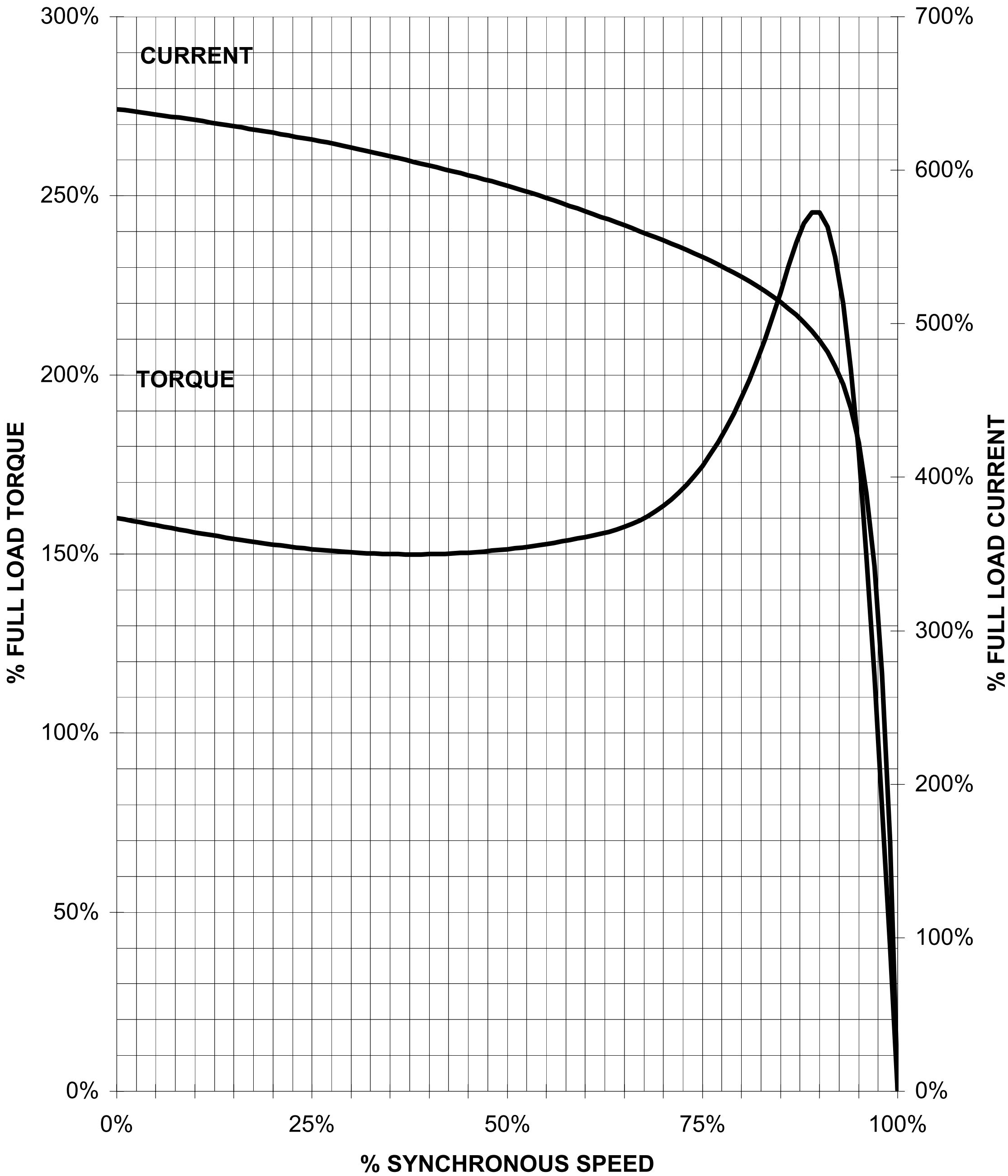
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	60	VOLTS	460	RPM	3600	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	364TS	NEMA	B

TORQUE AND CURRENT VS. SPEED

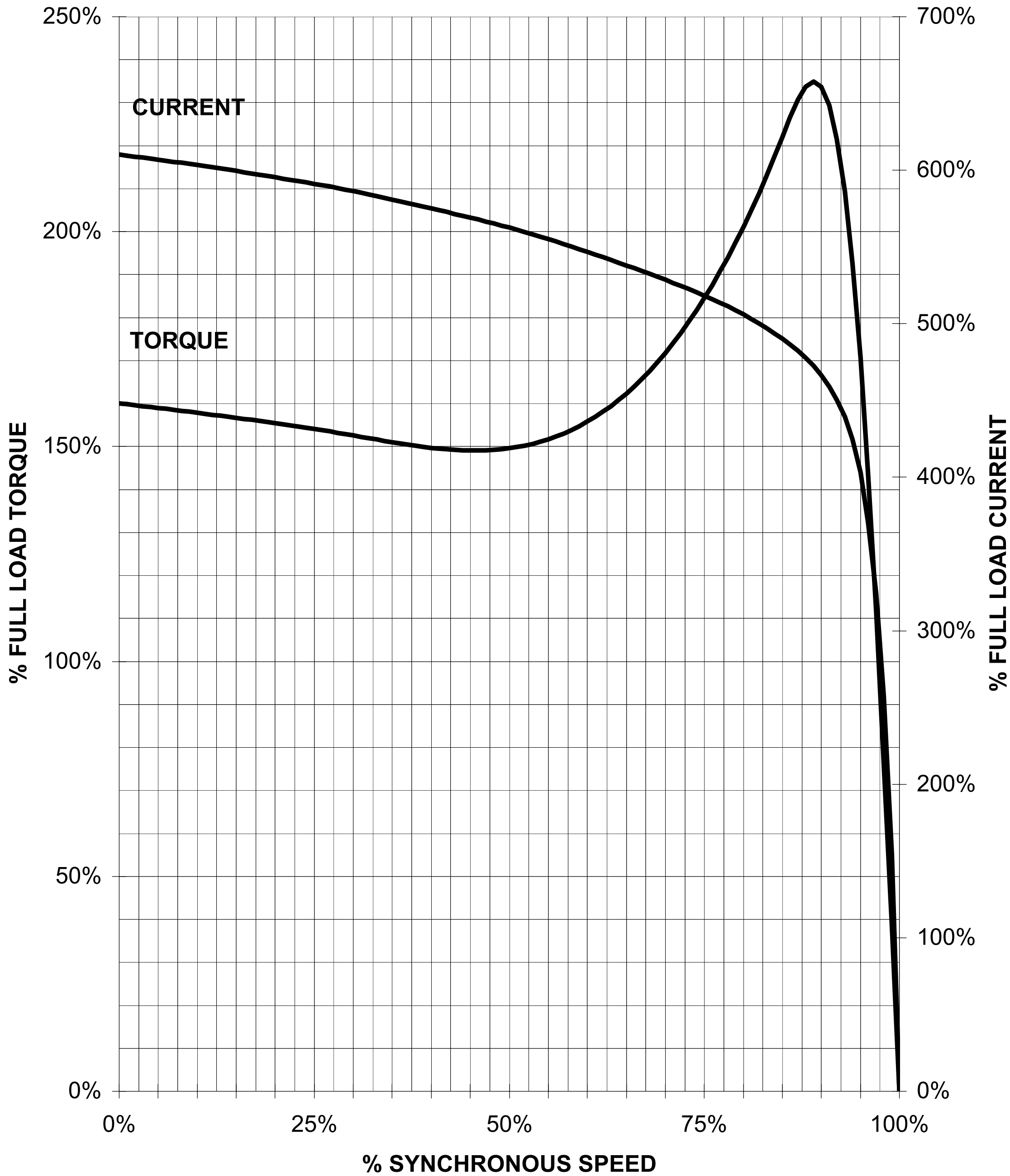


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	60	VOLTS	460	RPM	1800	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	364T	NEMA	B

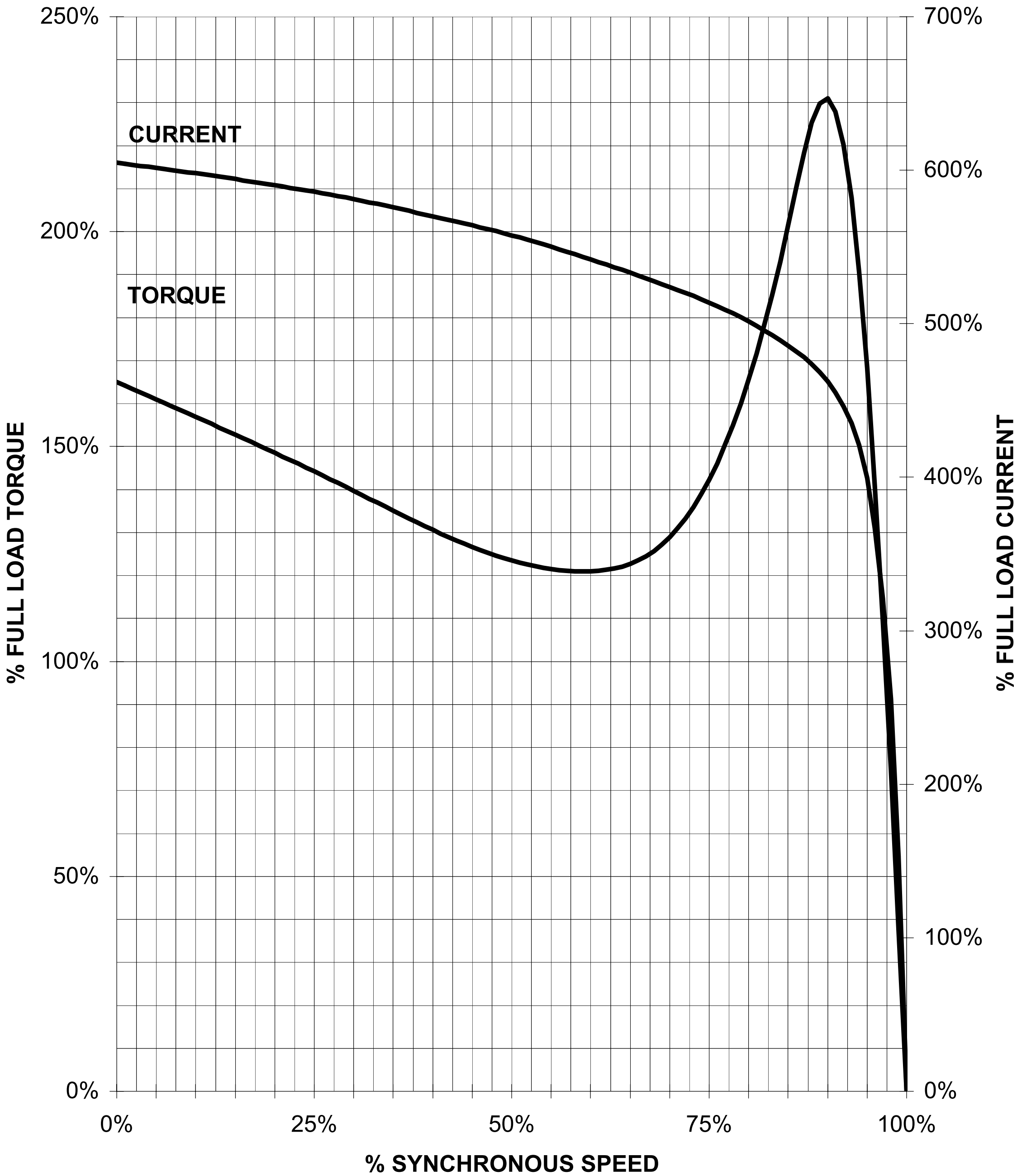
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	60	VOLTS	460	RPM	1200	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	404T	NEMA	B

TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

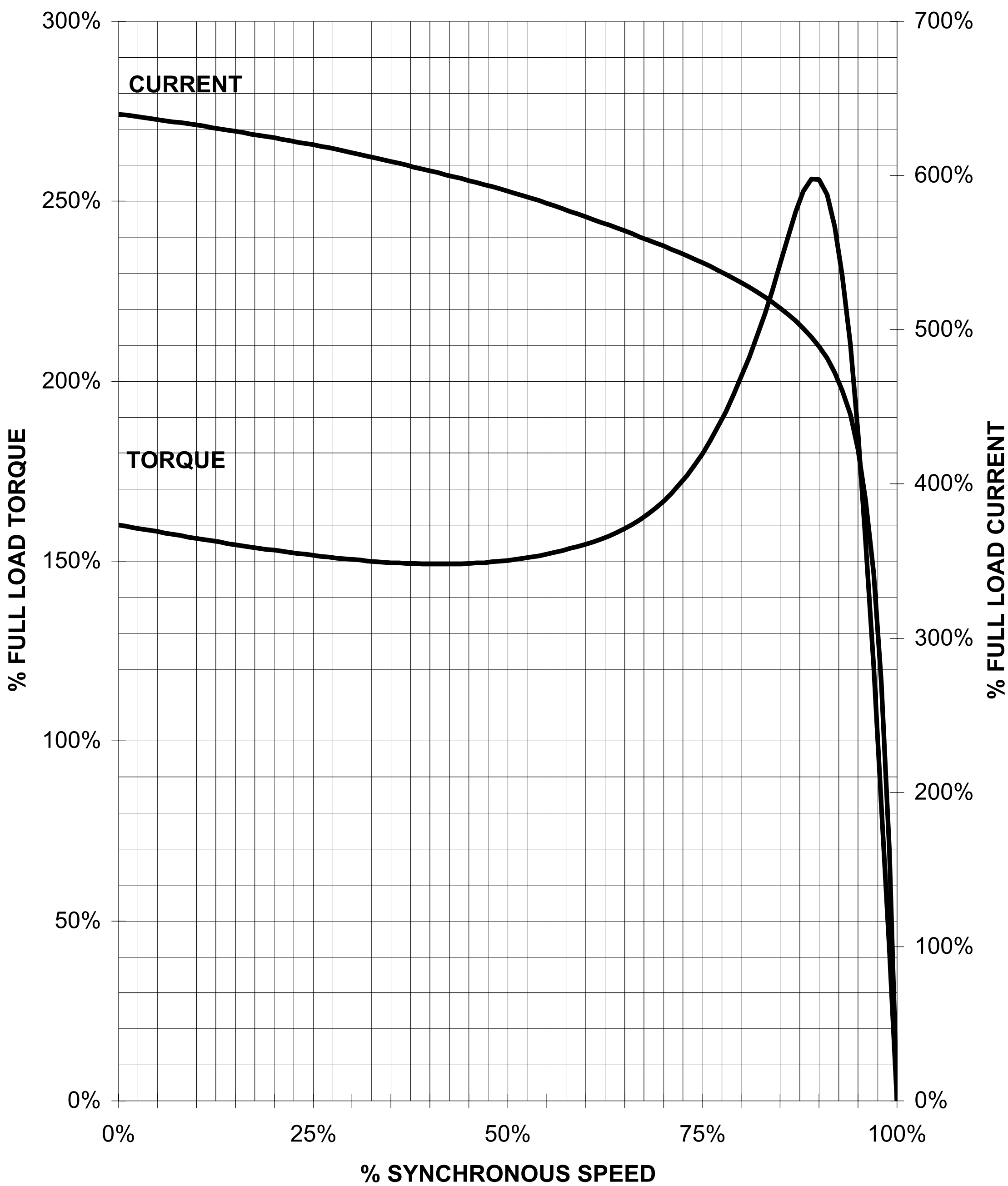
PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

SIEMENS

Application Manual for NEMA Motors

HP	75	VOLTS	460	RPM	3600	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	365TS	NEMA	B

TORQUE AND CURRENT VS. SPEED

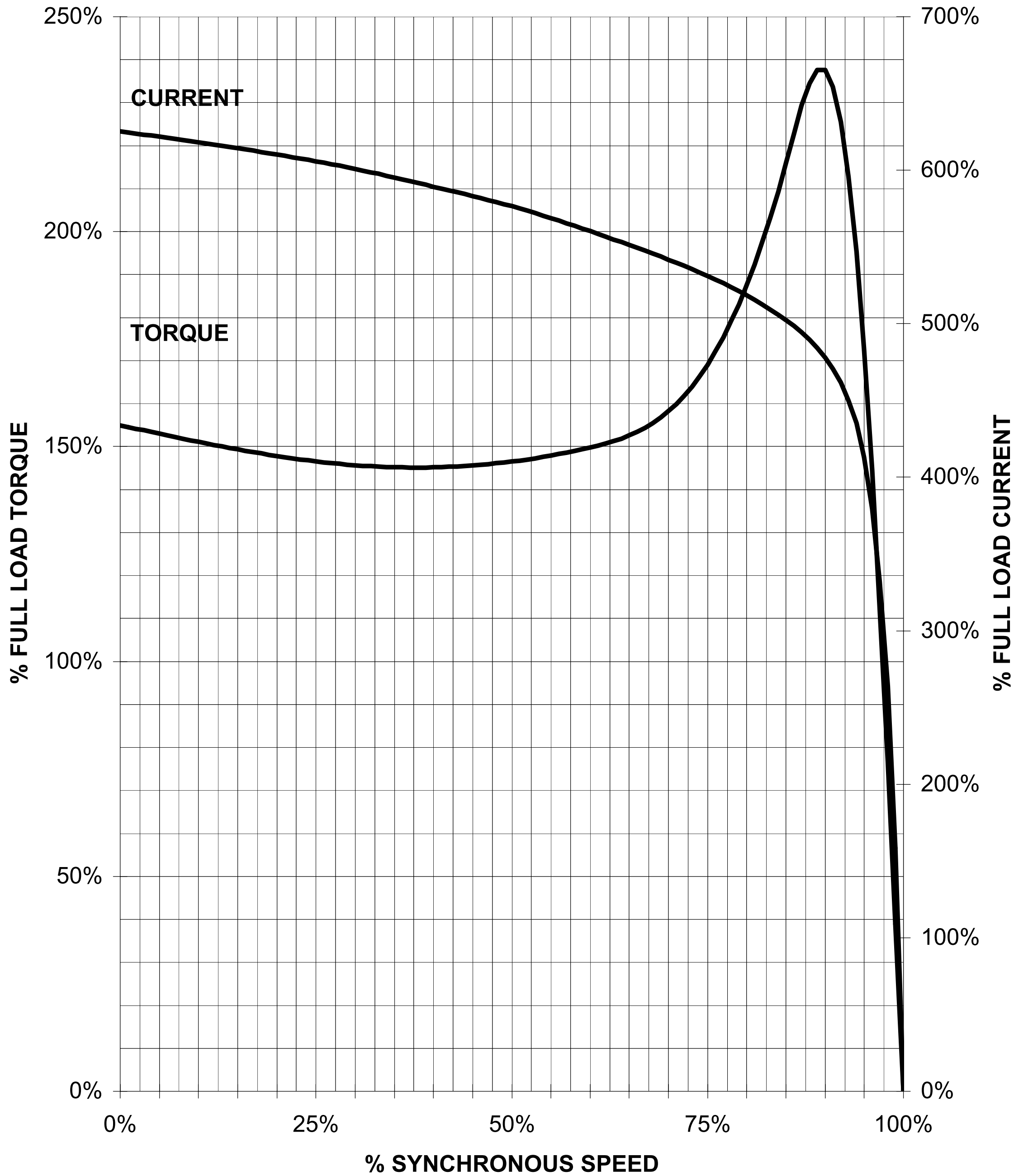


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	75	VOLTS	460	RPM	1800	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	365T	NEMA	B

TORQUE AND CURRENT VS. SPEED



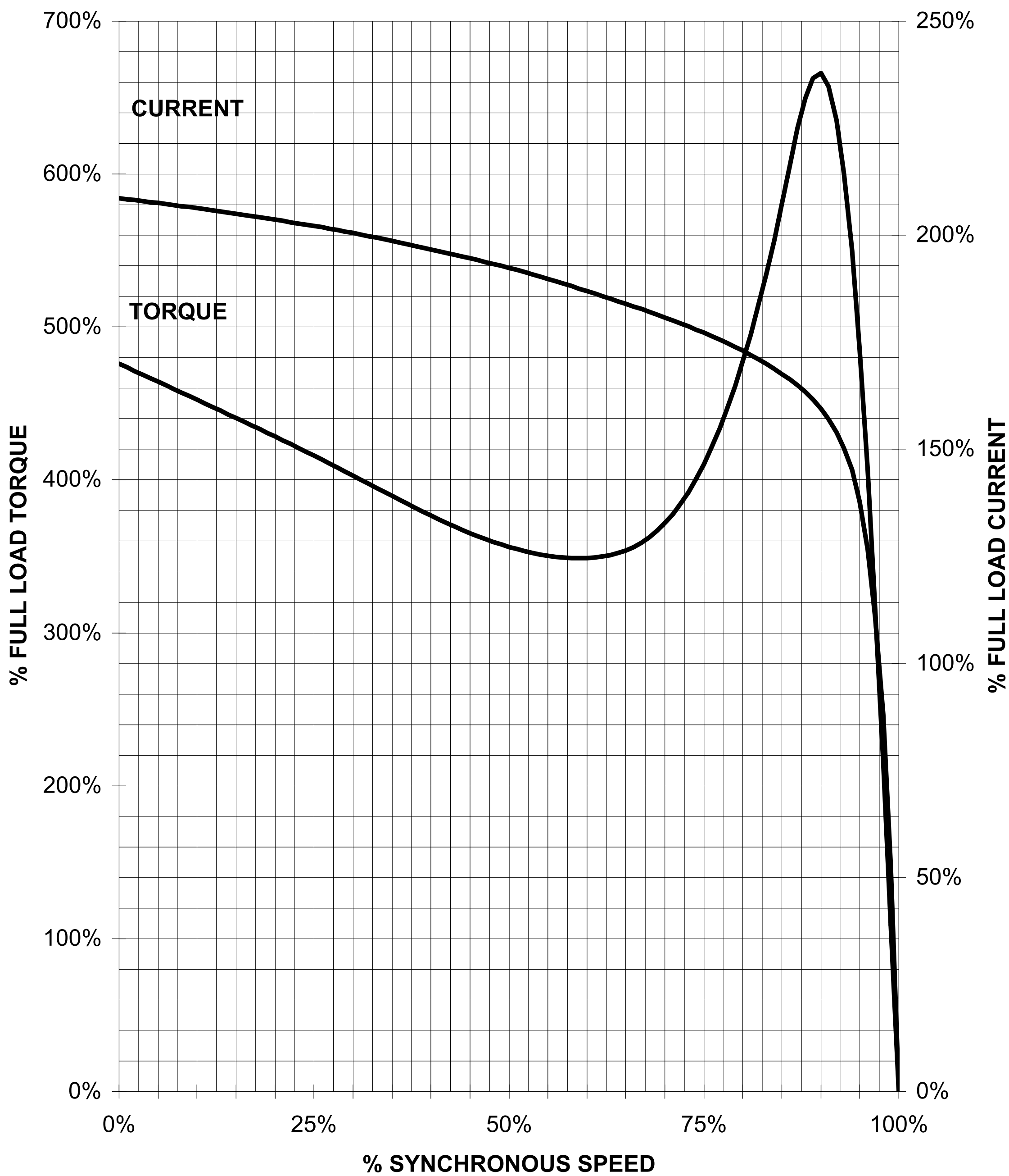
Customer: **PO No.:** **Order No.:**

SIEMENS

Application Manual for NEMA Motors

HP	75	VOLTS	460	RPM	1200	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	405T	NEMA	B

TORQUE AND CURRENT VS. SPEED

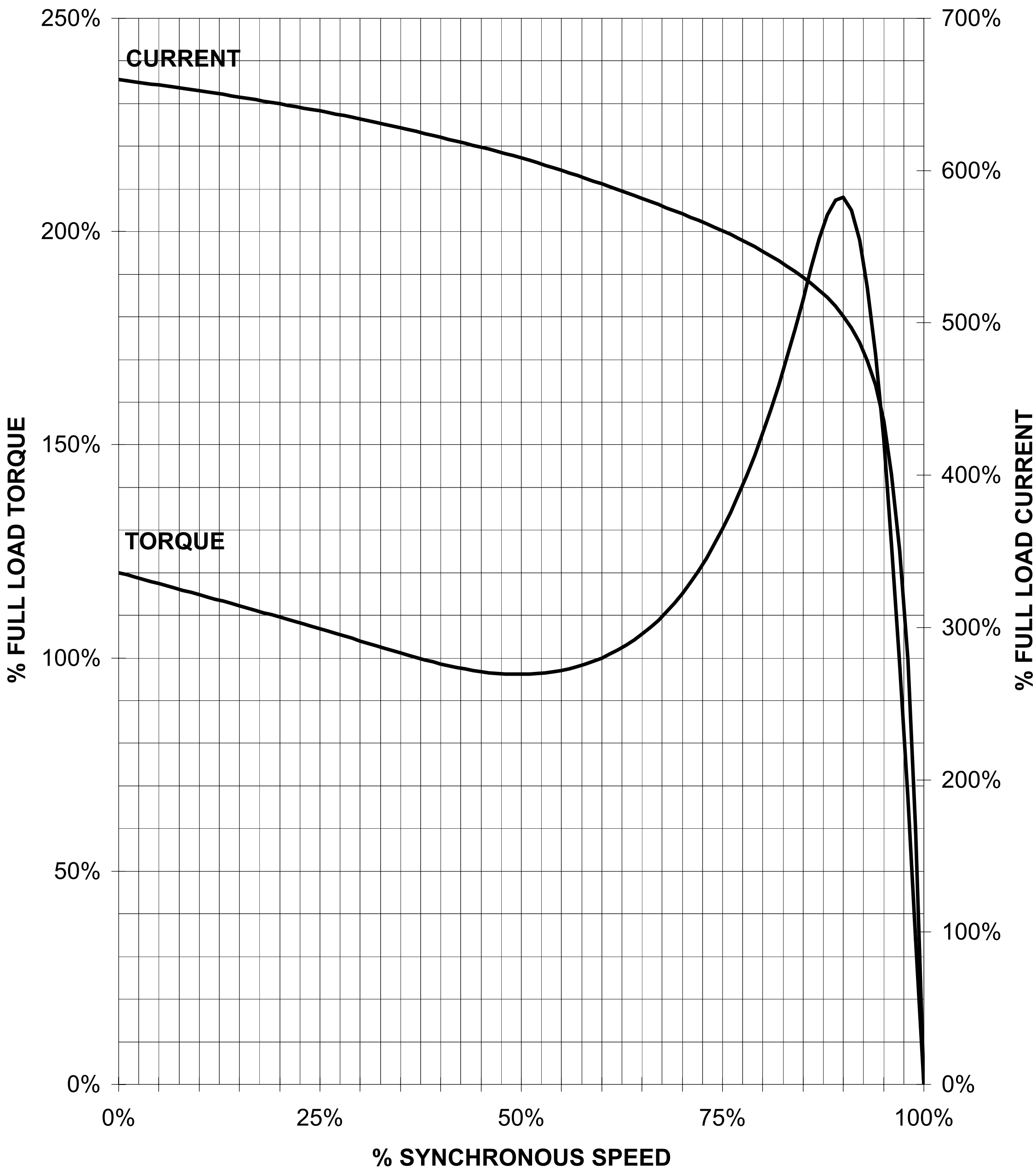


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	100	VOLTS	460	RPM	3600	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	405TS	NEMA	B

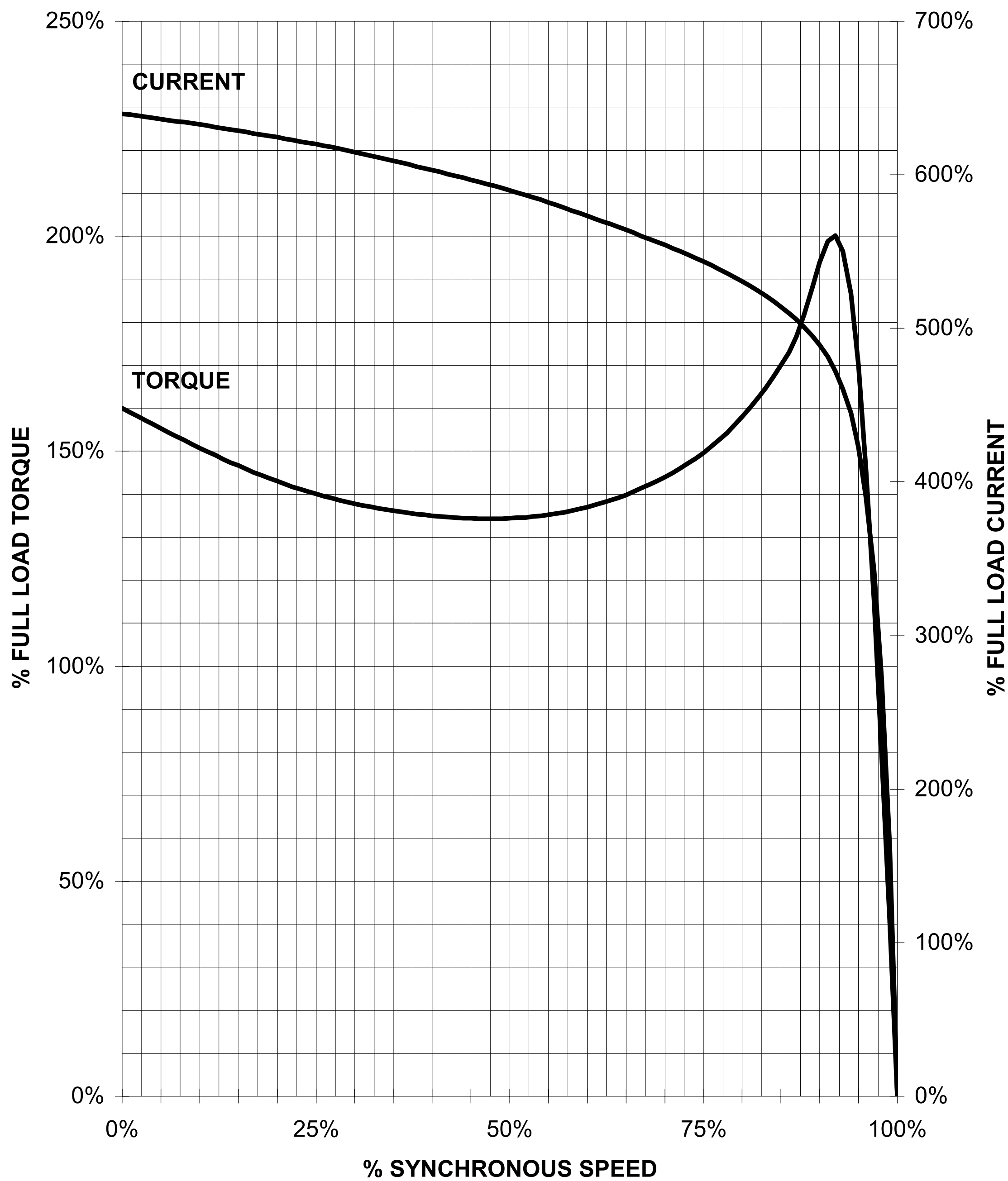
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	100	VOLTS	460	RPM	1800	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	405T	NEMA	B

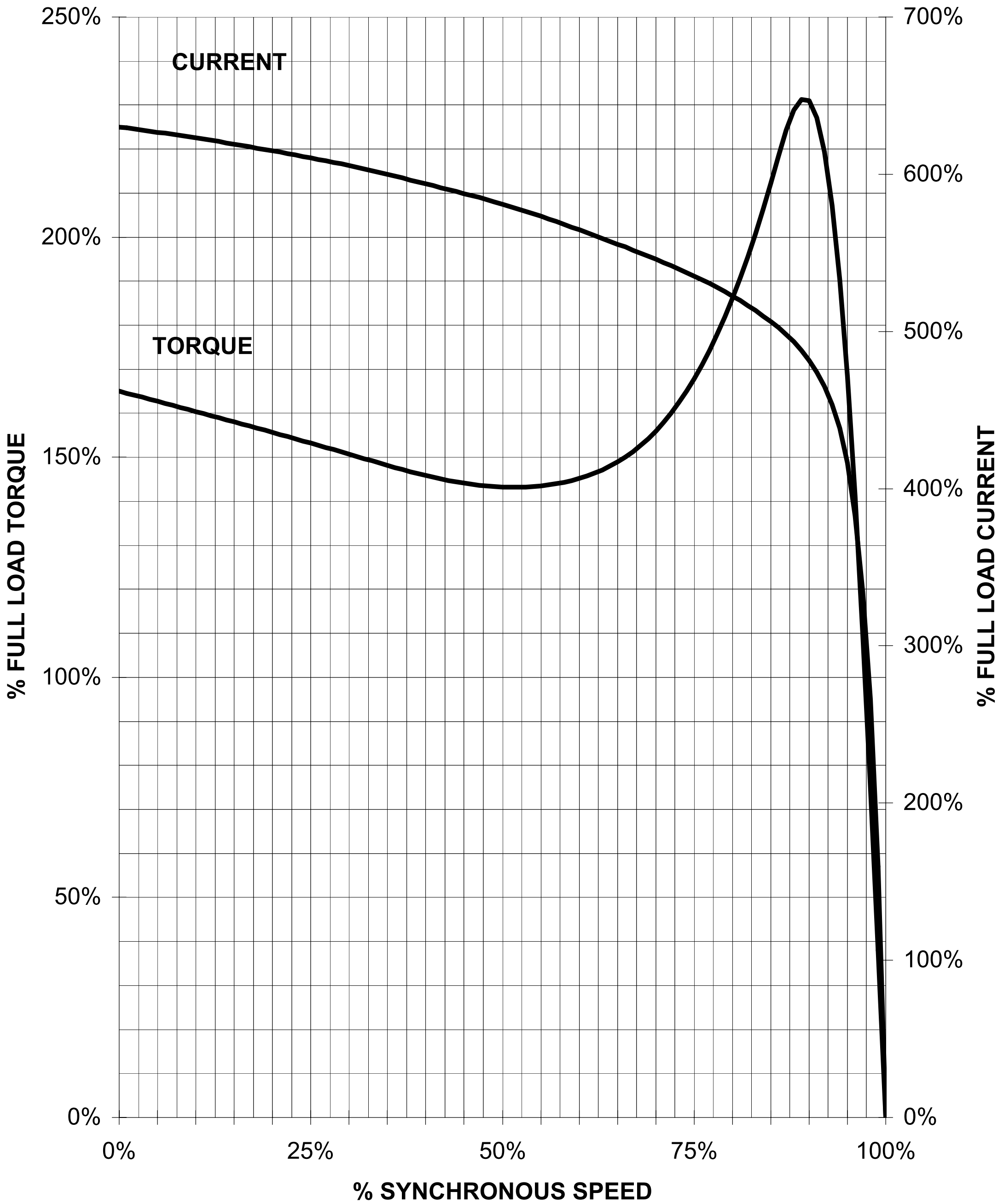
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	100	VOLTS	460	RPM	1200	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	444TS	NEMA	B

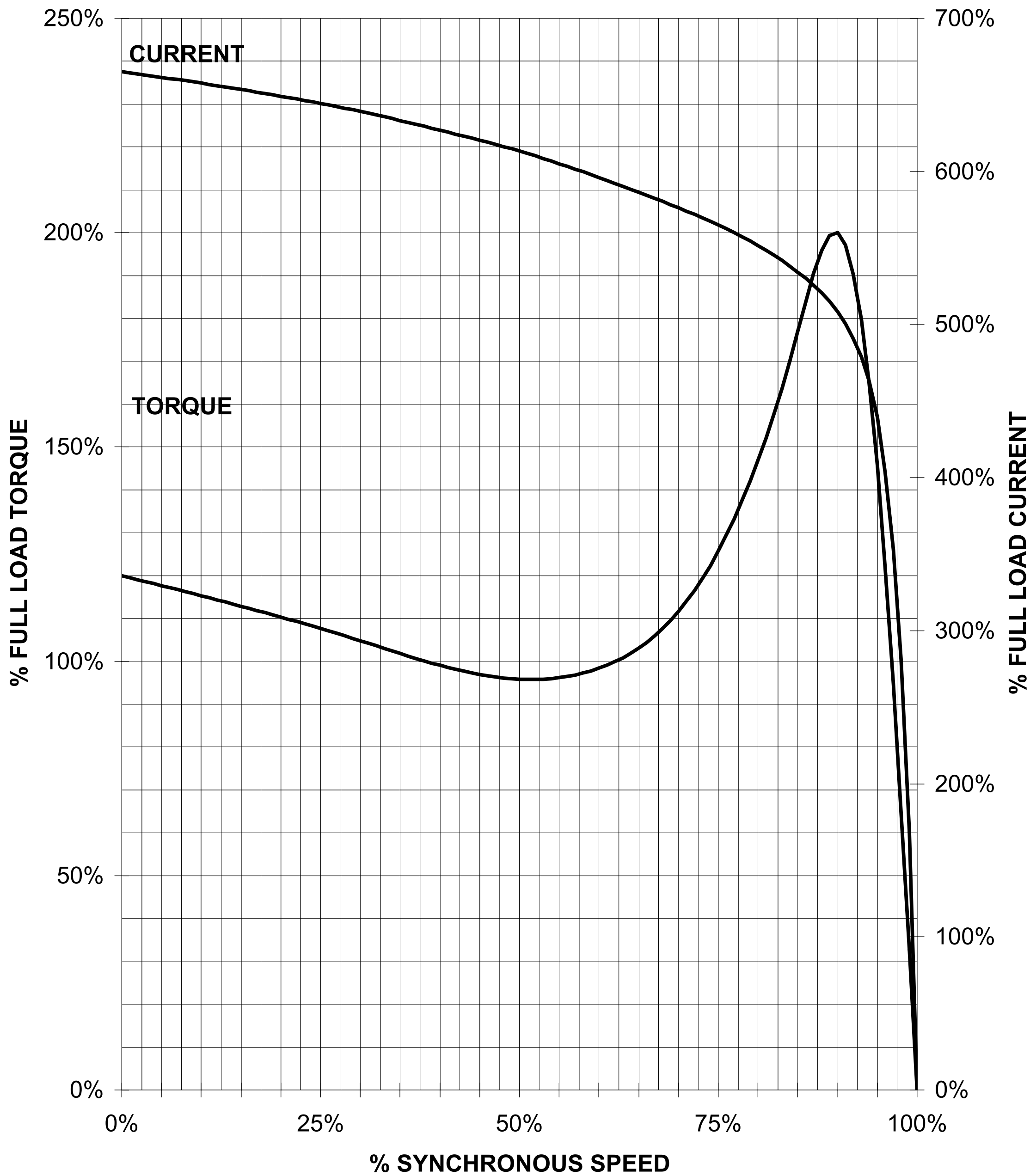
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	125	VOLTS	460	RPM	3600	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	444TS	NEMA	B

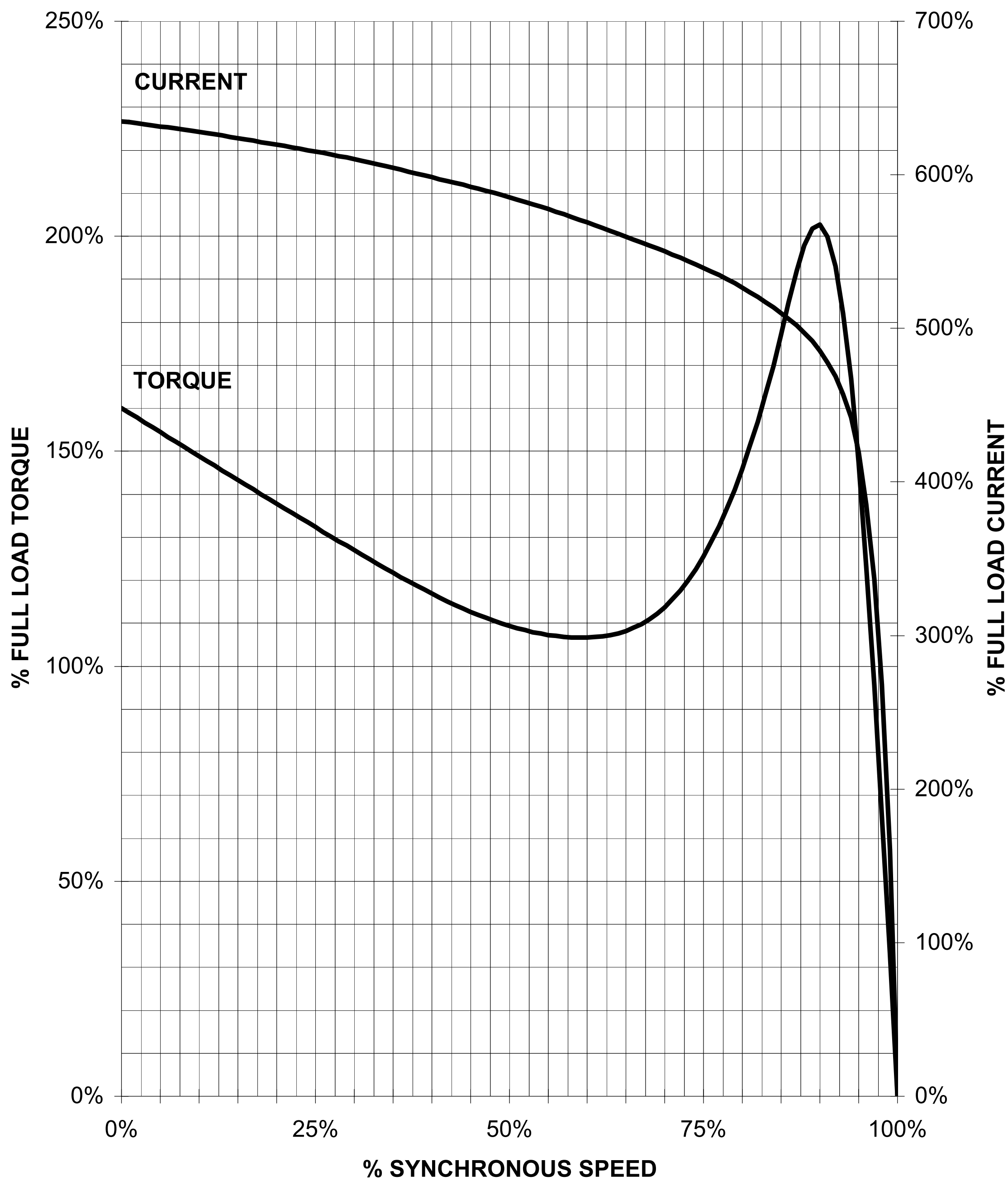
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	125	VOLTS	460	RPM	1800	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	444T	NEMA	B

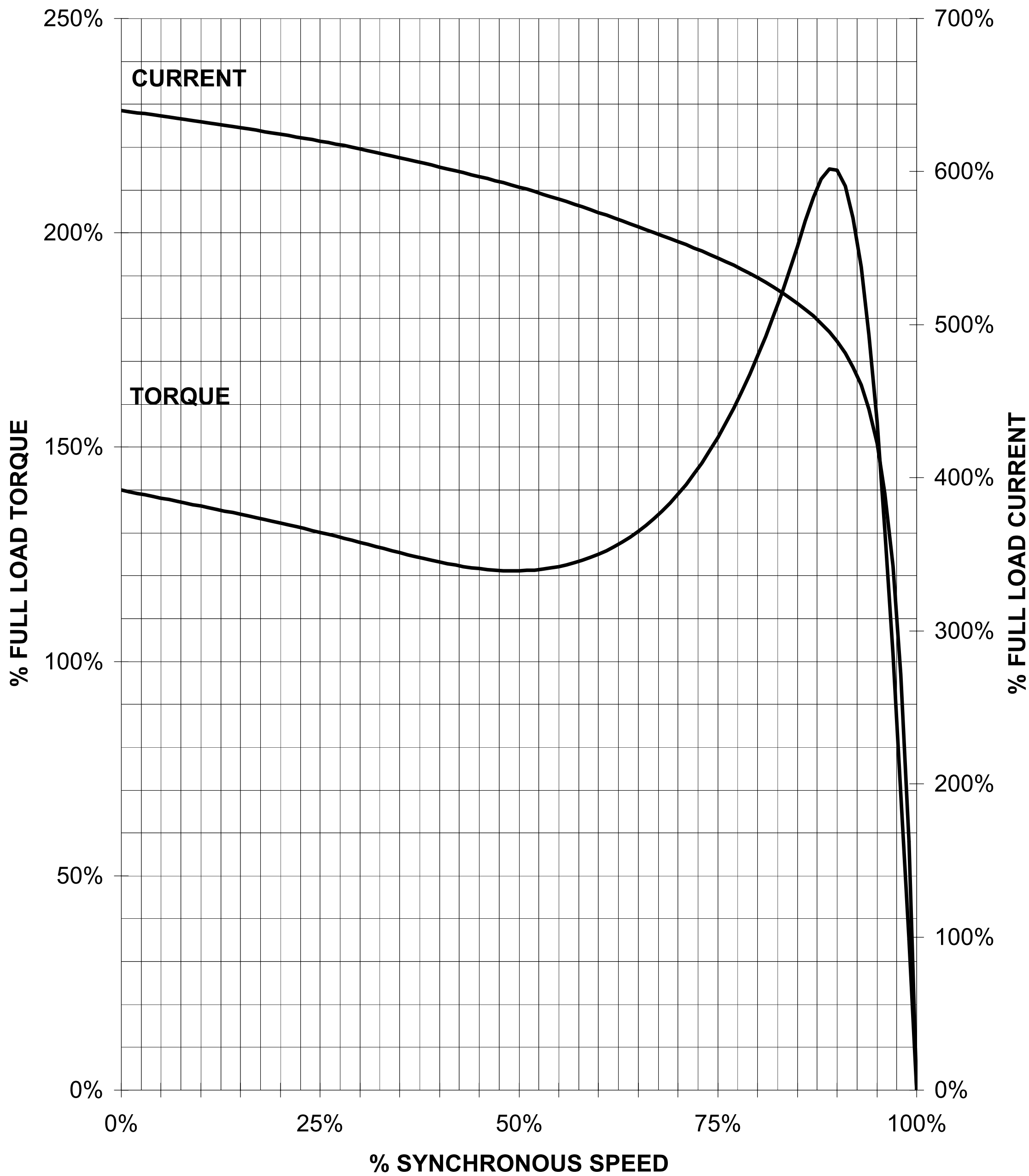
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	125	VOLTS	460	RPM	1200	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	445T	NEMA	B

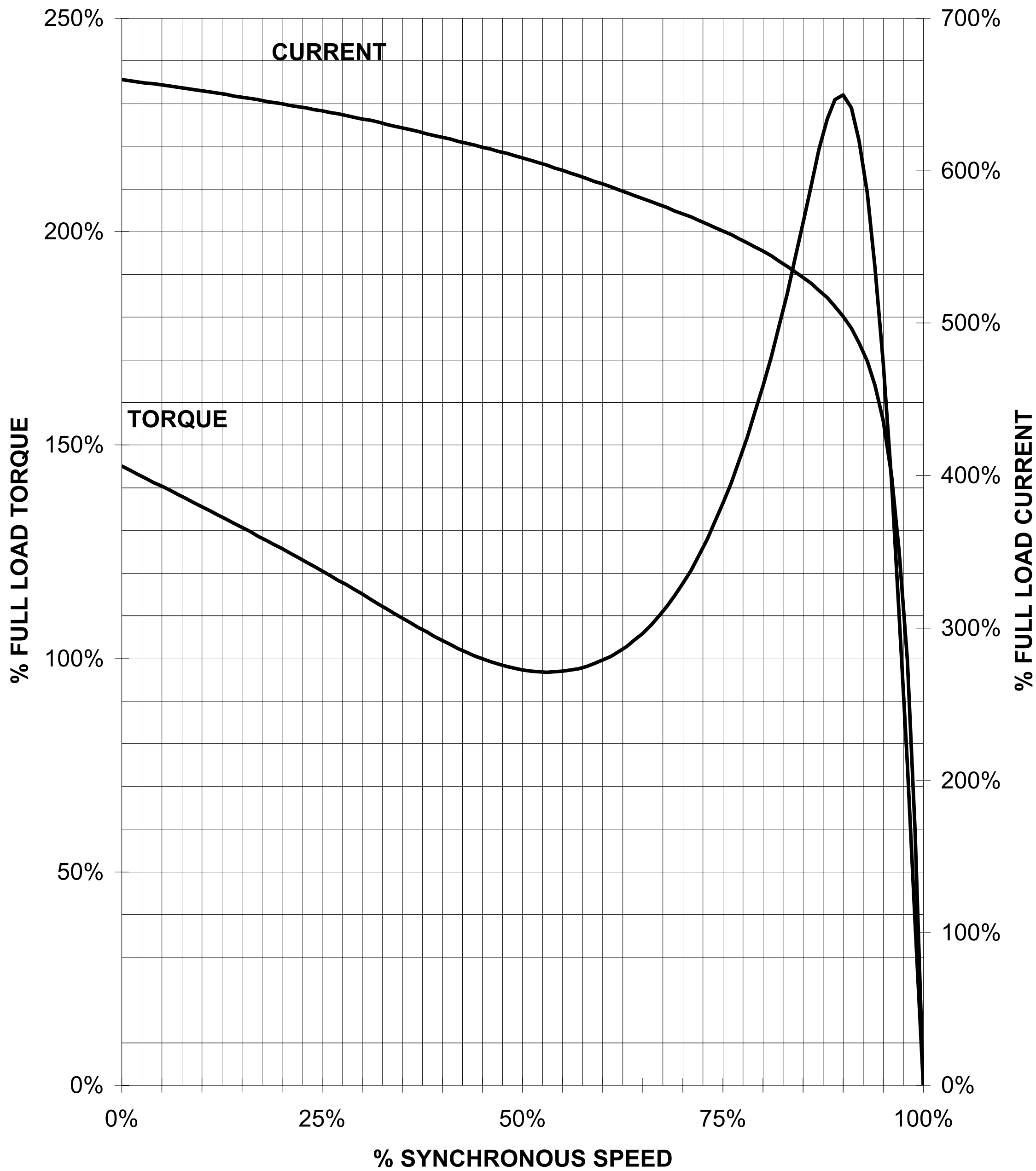
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	150	VOLTS	460	RPM	3600	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	445TS	NEMA	B

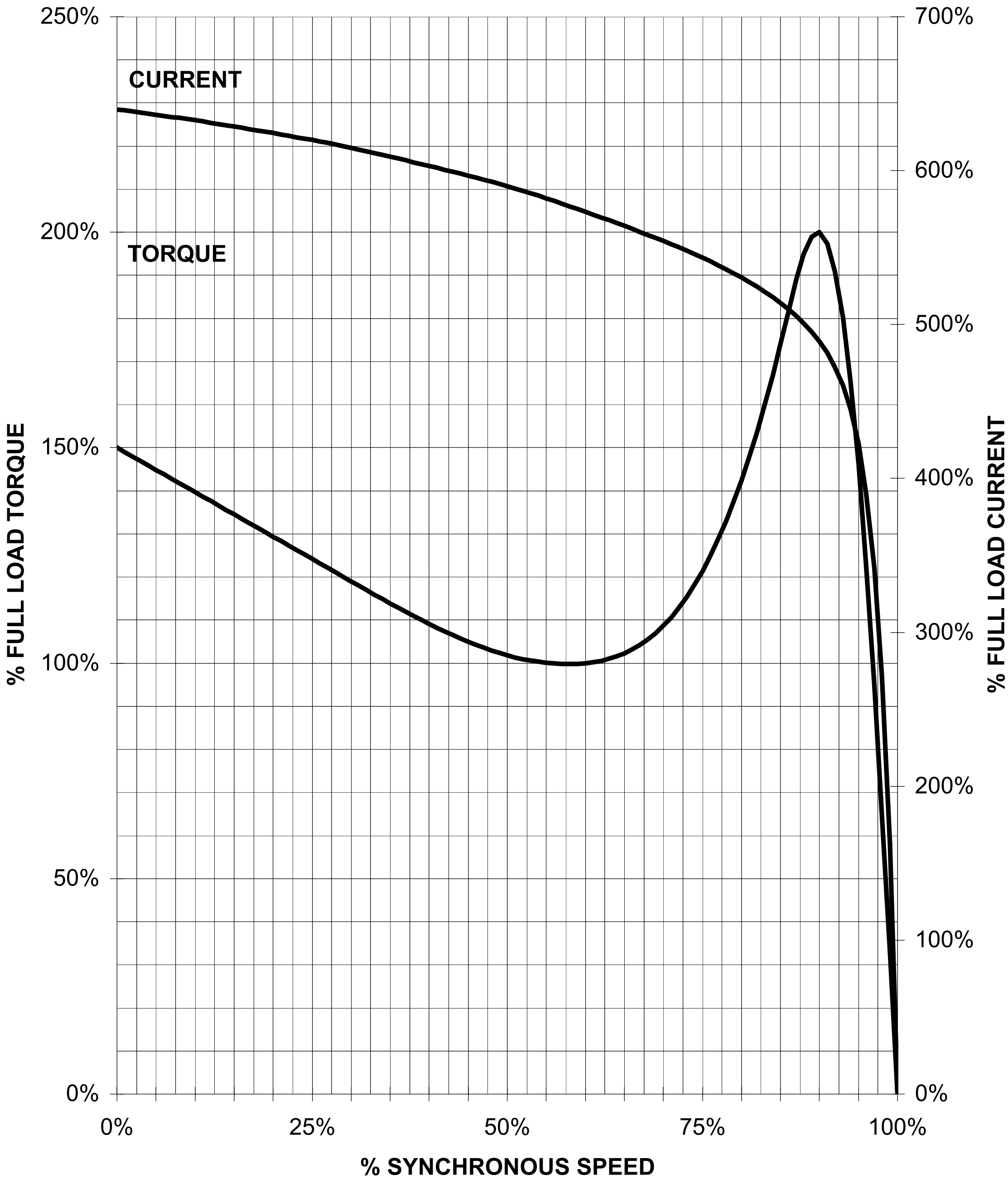
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	150	VOLTS	460	RPM	1800	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	445T	NEMA	B

TORQUE AND CURRENT VS. SPEED

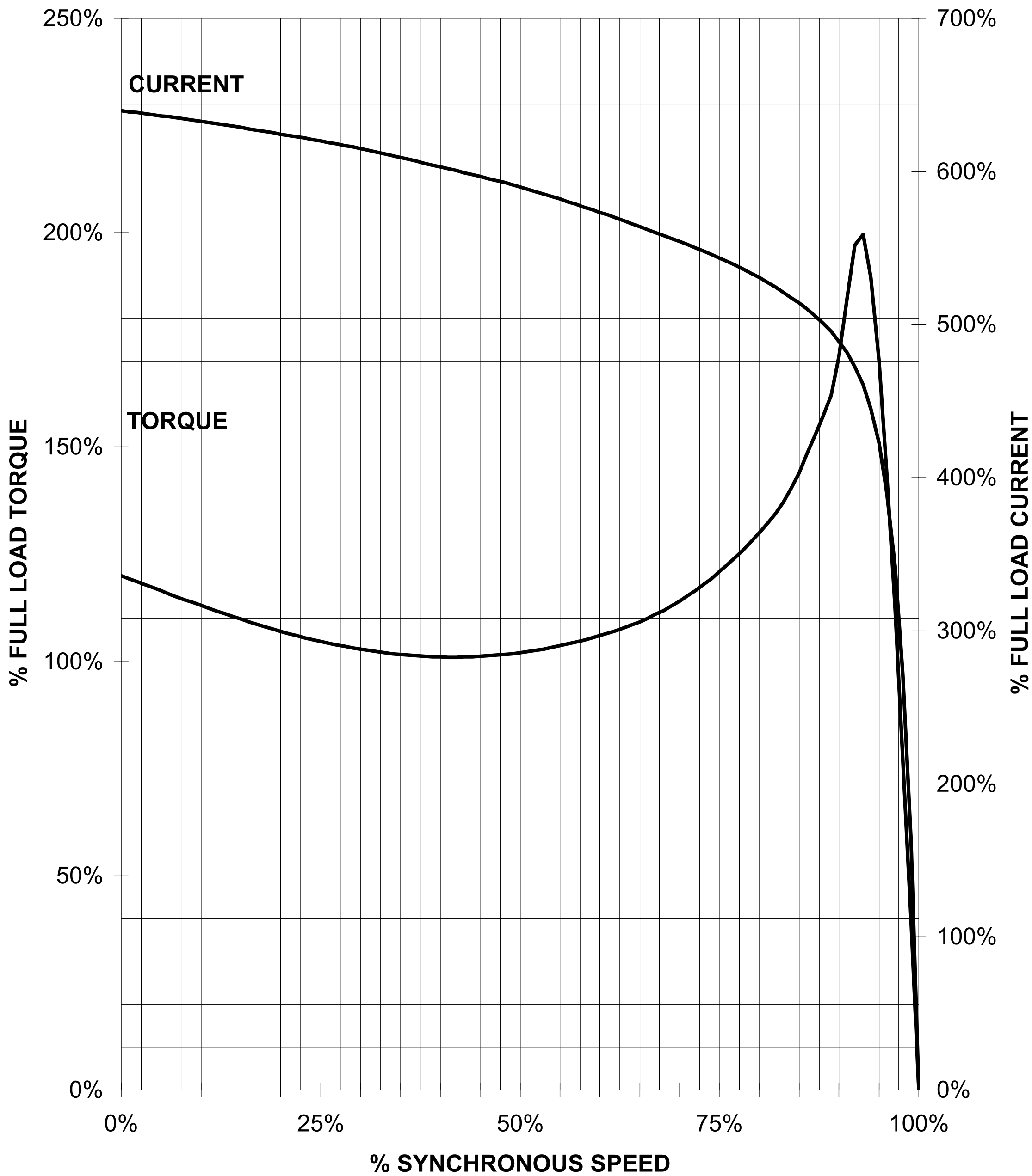


Customer: **PO No.:** **Order No.:**

HP 150 VOLTS 460 RPM 1200 TYPE RGZP(SD)

HZ 60 PHASE 3 FRAME 447T NEMA B

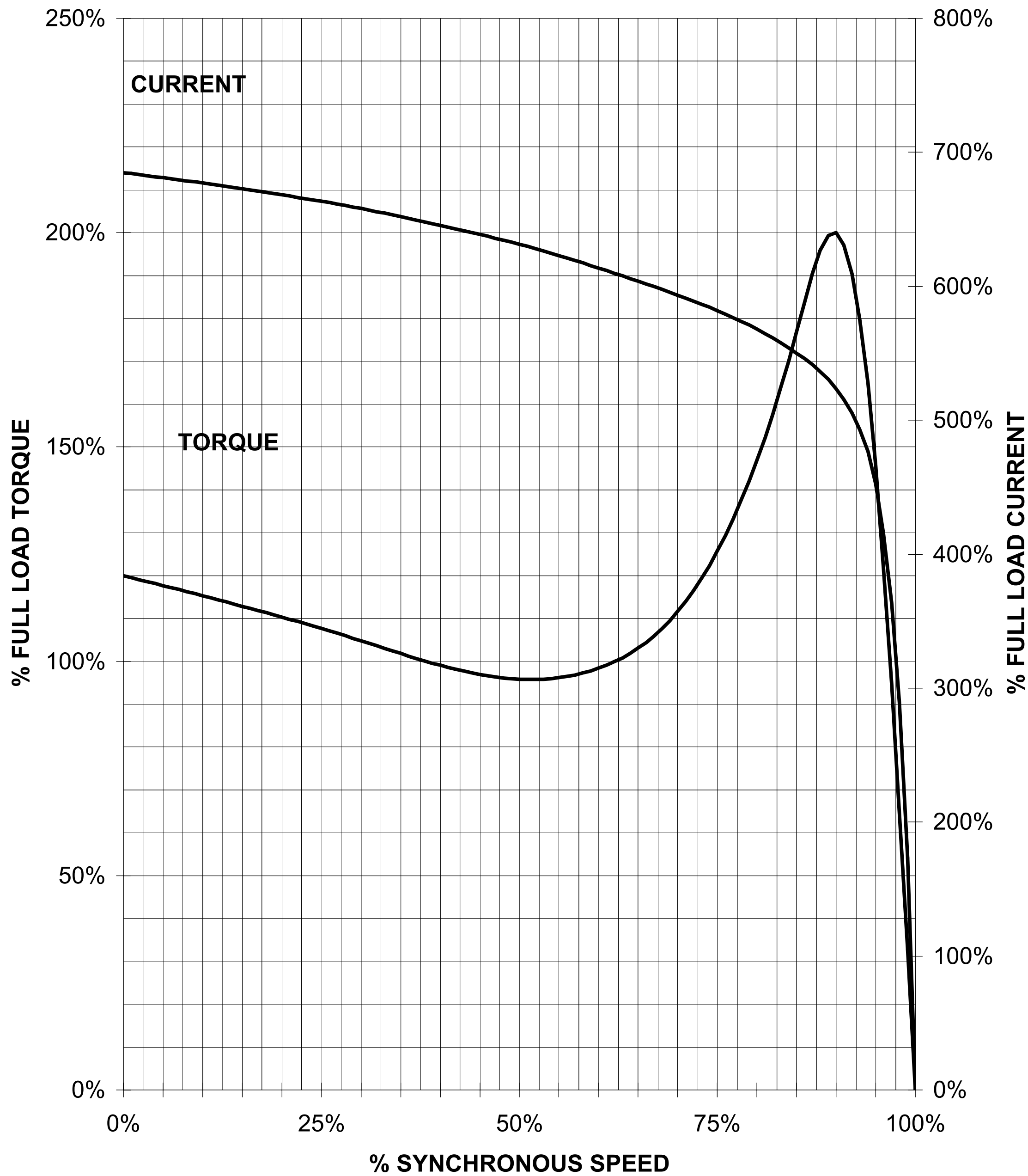
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	200	VOLTS	460	RPM	3600	TYPE	RGZPSD
HZ	60	PHASE	3	FRAME	447TS	NEMA	B

TORQUE AND CURRENT VS. SPEED

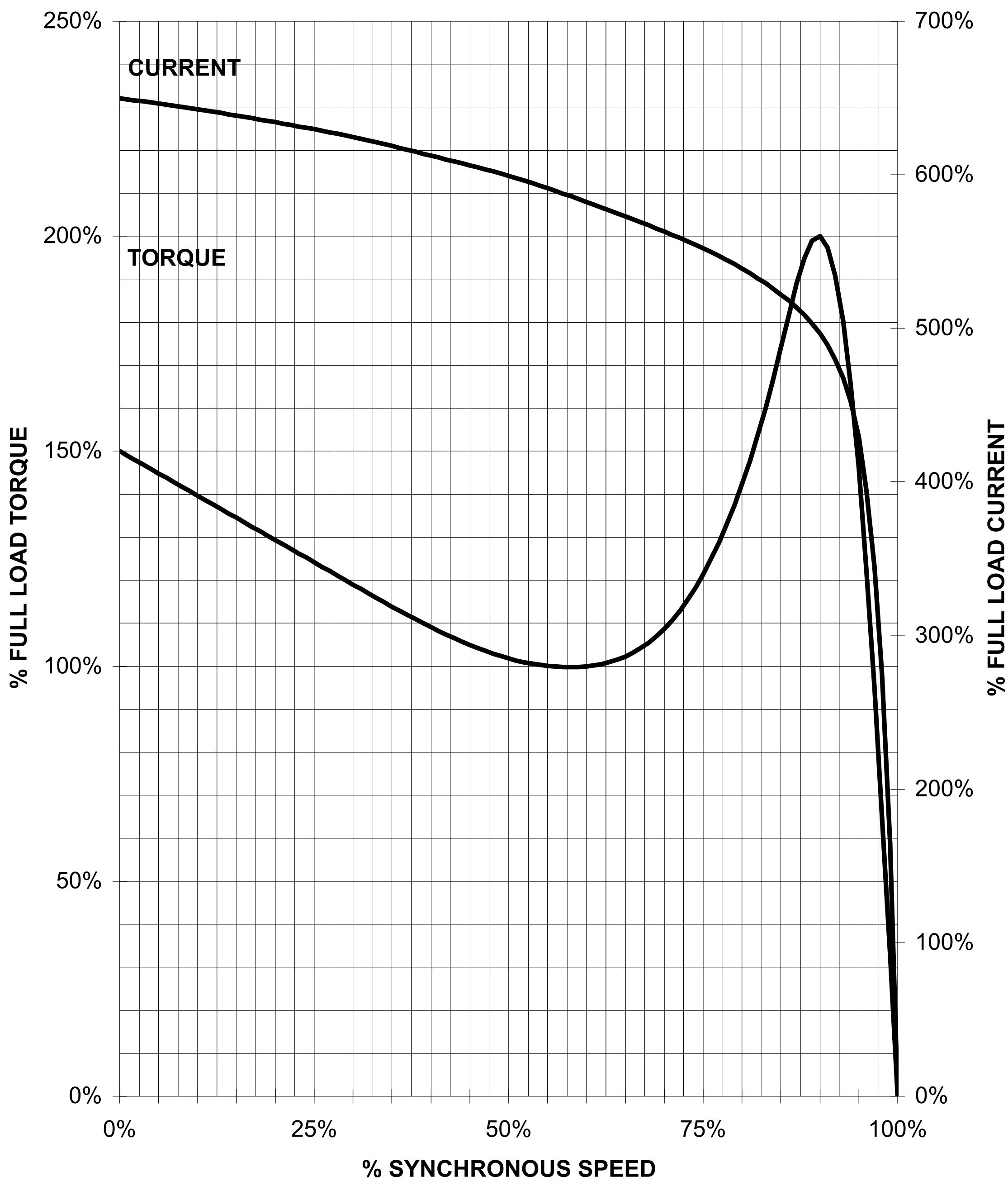


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	200	VOLTS	460	RPM	1800	TYPE	RGZP(SD)
HZ	60	PHASE	3	FRAME	447T	NEMA	B

TORQUE AND CURRENT VS. SPEED

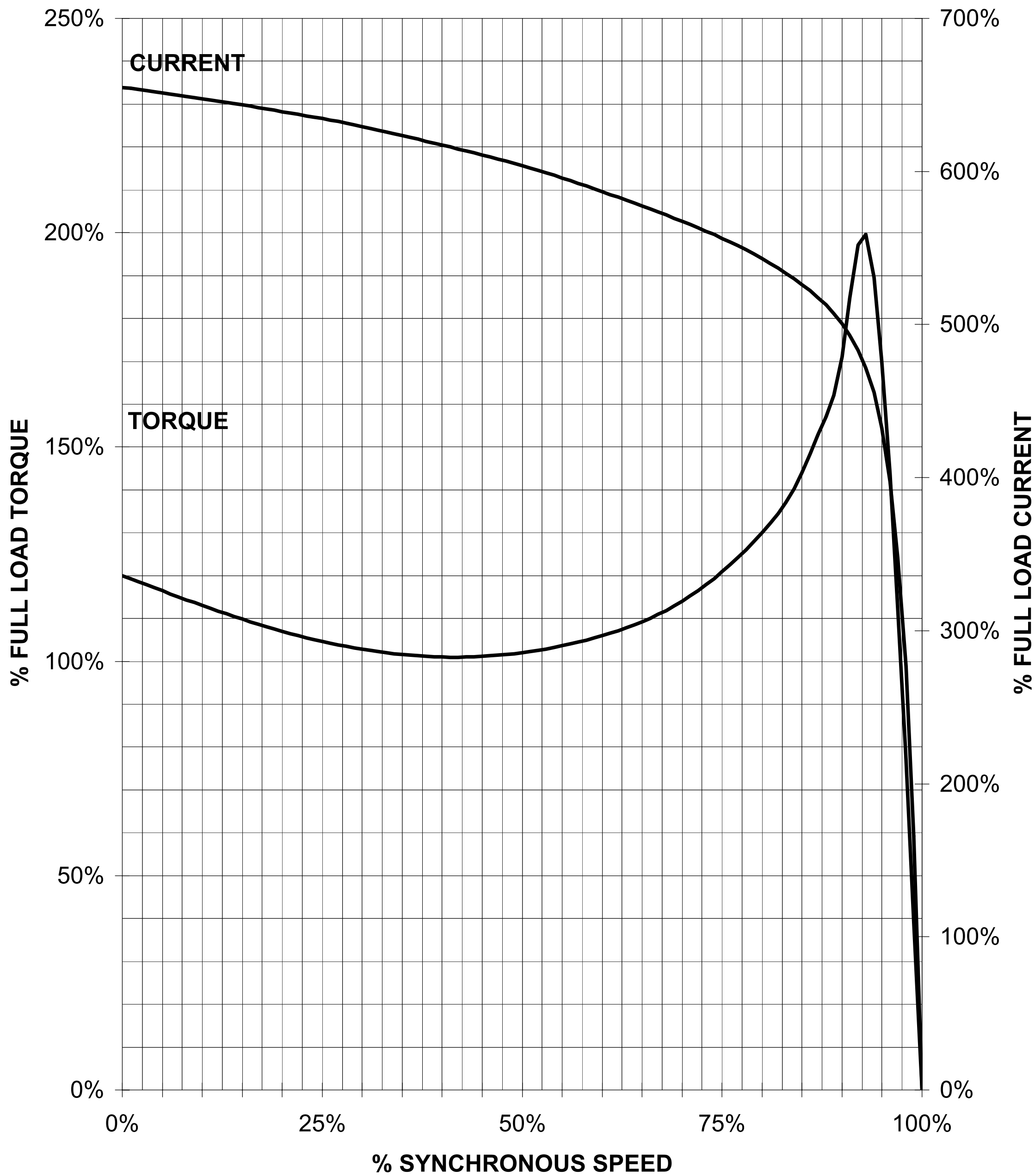


Customer: **PO No.:** **Order No.:**

HP 200 VOLTS 460 RPM 1200 TYPE RGZP(SD)

HZ 60 PHASE 3 FRAME 449T NEMA B

TORQUE AND CURRENT VS. SPEED

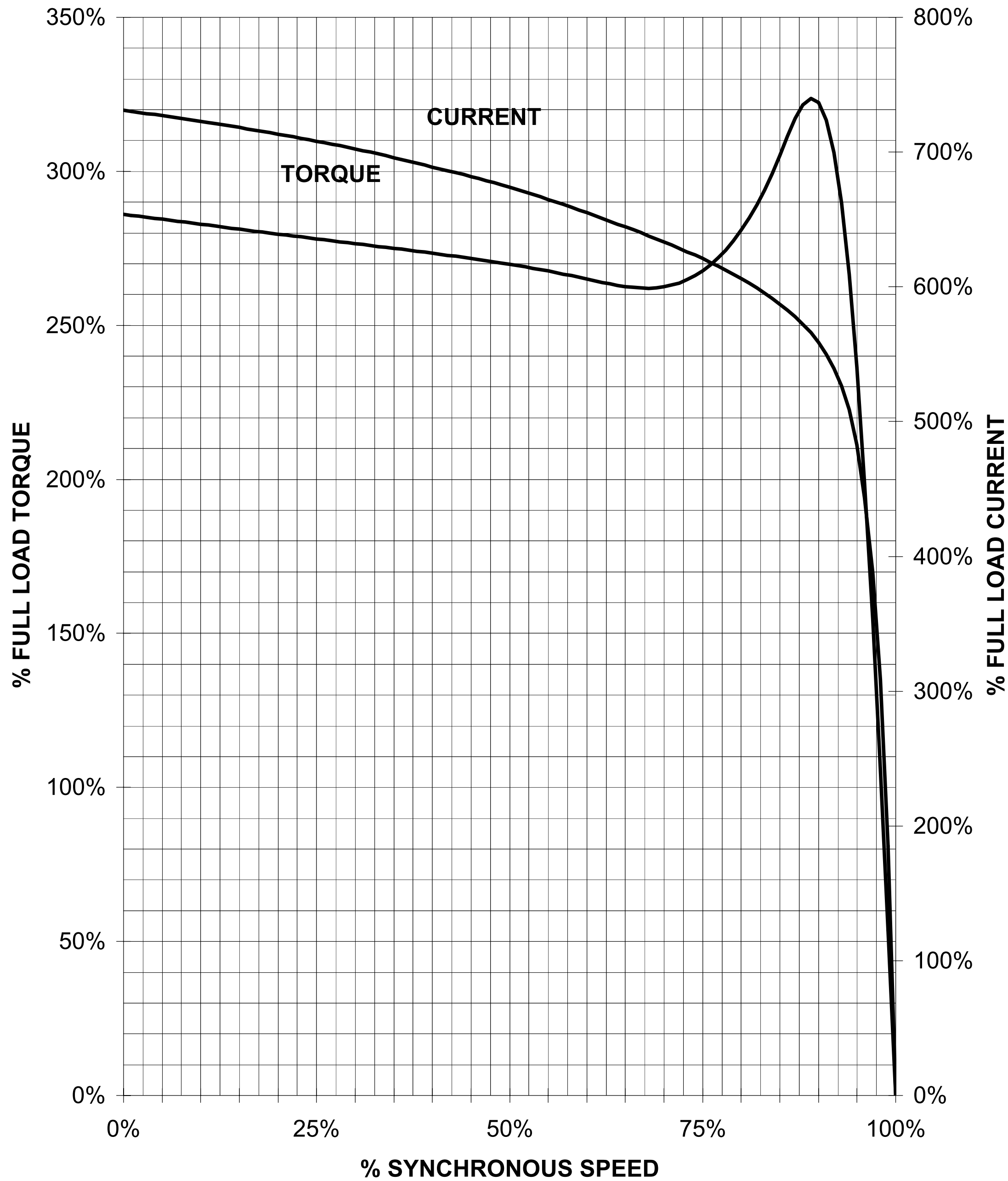


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	1	VOLTS	230/460	RPM	1800	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	143T	NEMA	B

TORQUE & CURRENT VS. SPEED

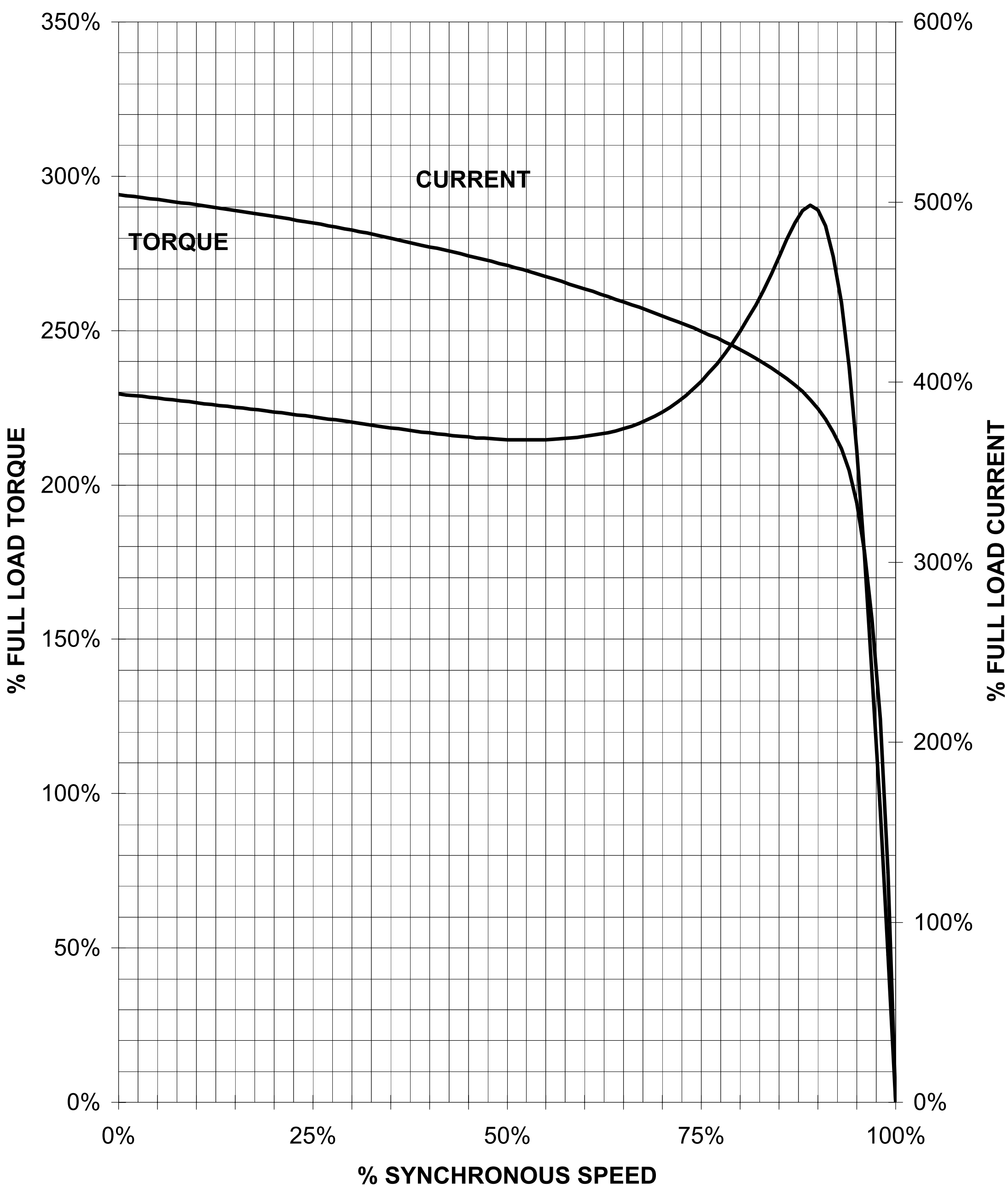


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	1	VOLTS	230/460	RPM	1200	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	145T	NEMA	B

TORQUE & CURRENT VS. SPEED

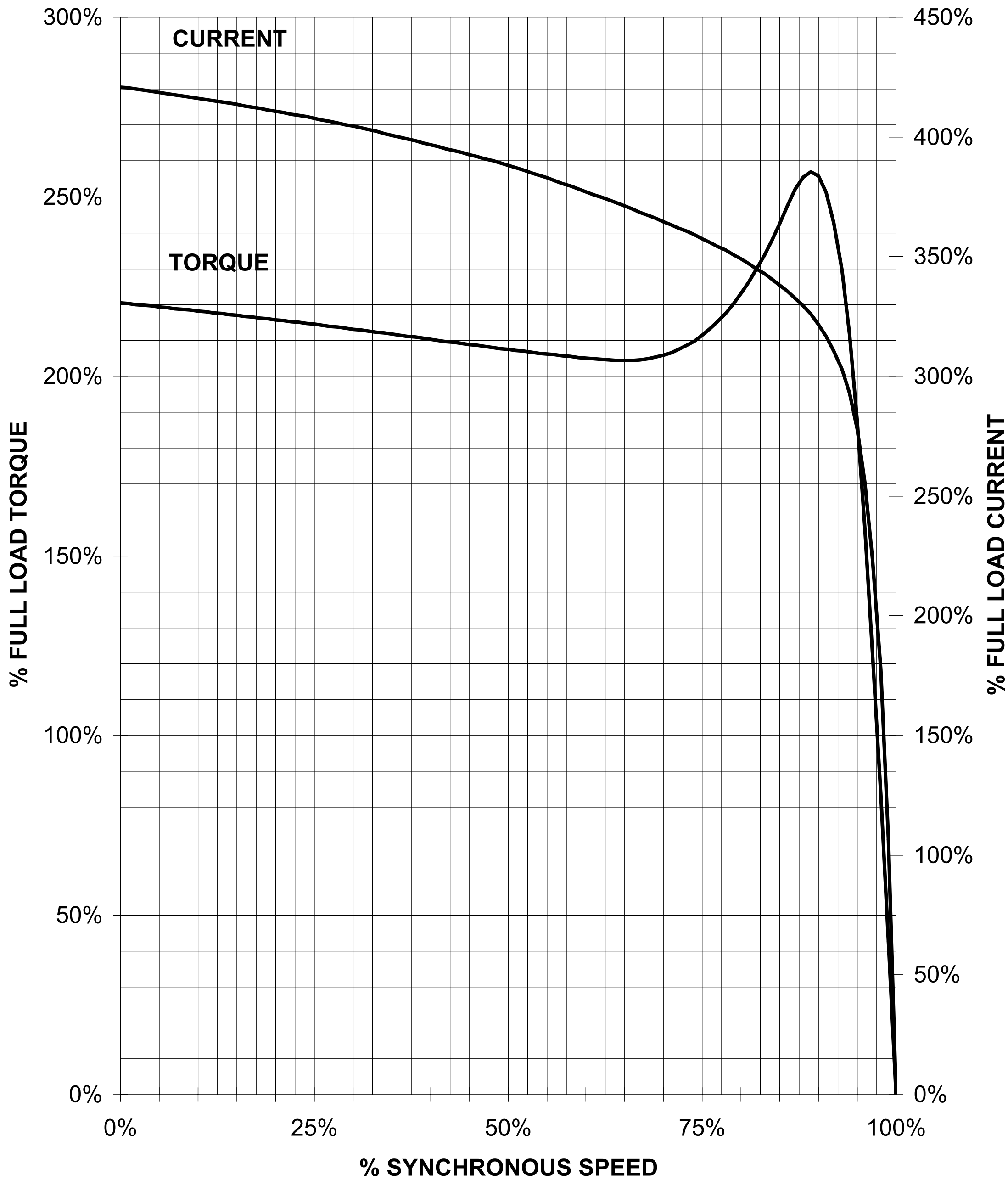


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	1	VOLTS	230/460	RPM	900	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	182T	NEMA	B

TORQUE & CURRENT VS. SPEED

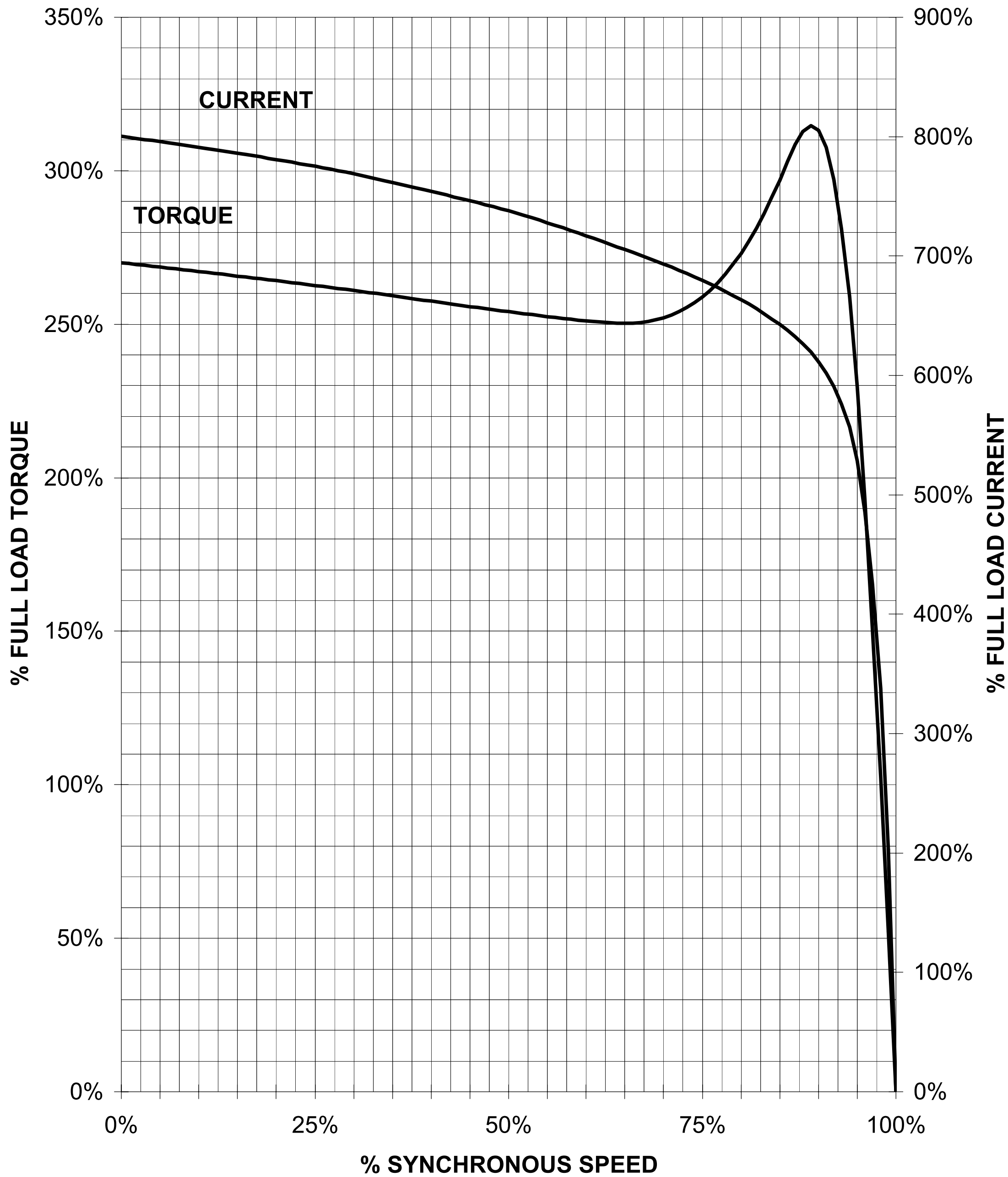


Customer: **PO No.:** **Order No.:**

HP 1.5 VOLTS 230/460 RPM 3600 TYPE RGZZESD

HZ 60 PHASE 3 FRAME 143T NEMA B

TORQUE & CURRENT VS. SPEED

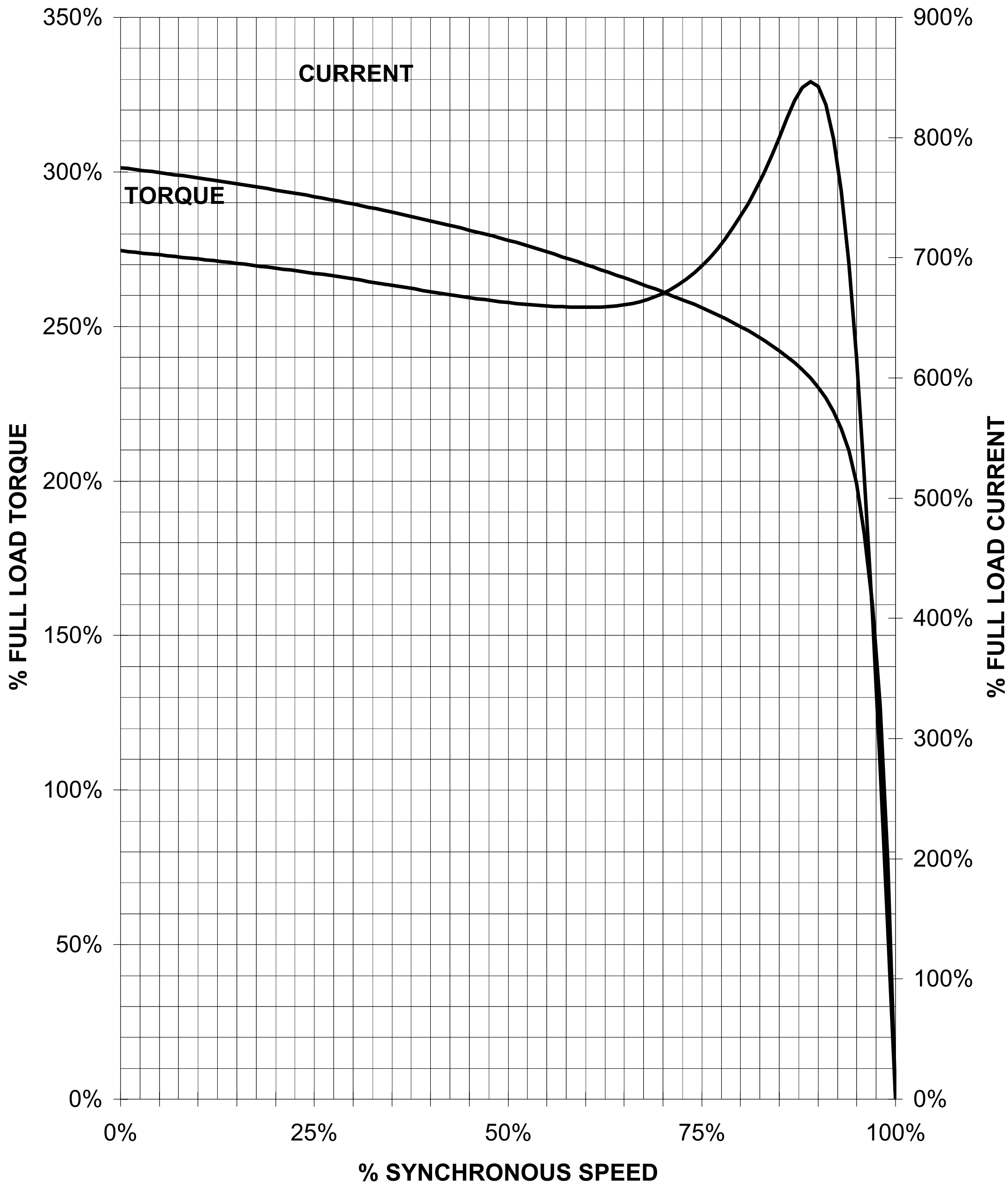


Customer: **PO No.:** **Order No.:**

Application Manual for NEMA Motors

HP	1.5	VOLTS	230/460	RPM	1800	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	145T	NEMA	B

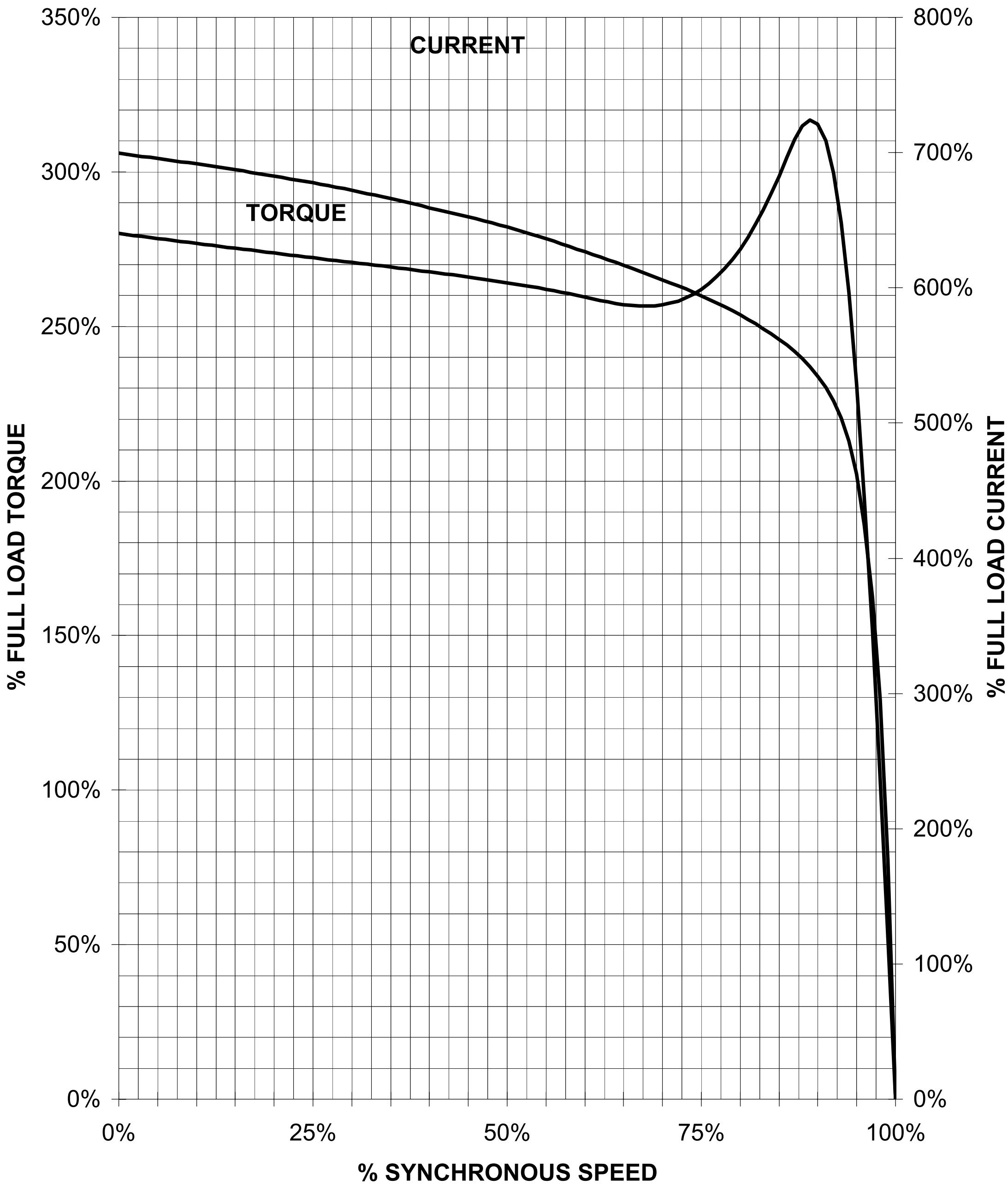
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1.5	VOLTS	230/460	RPM	1200	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	182T	NEMA	B

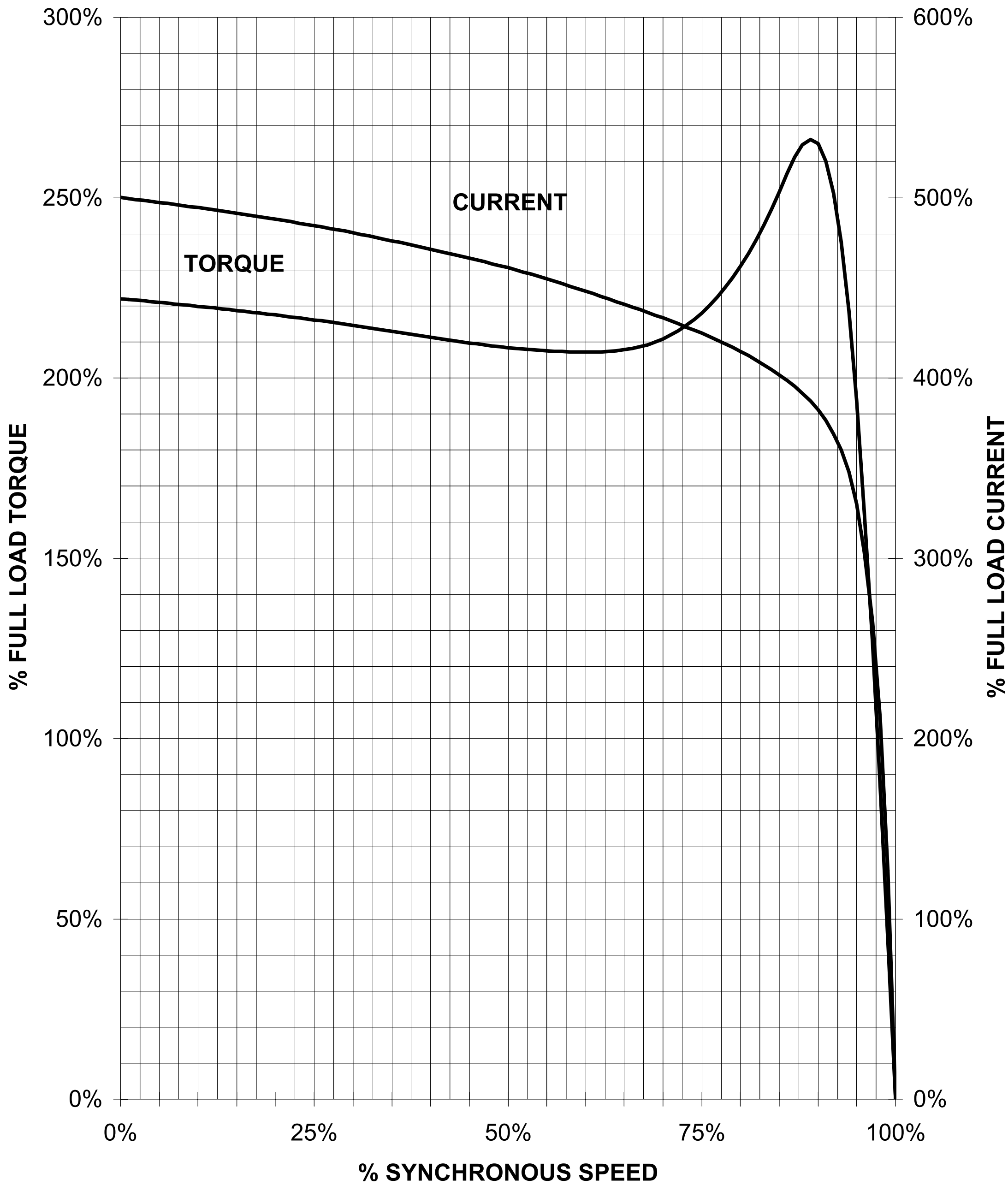
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1.5	VOLTS	230/460	RPM	900	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	184T	NEMA	B

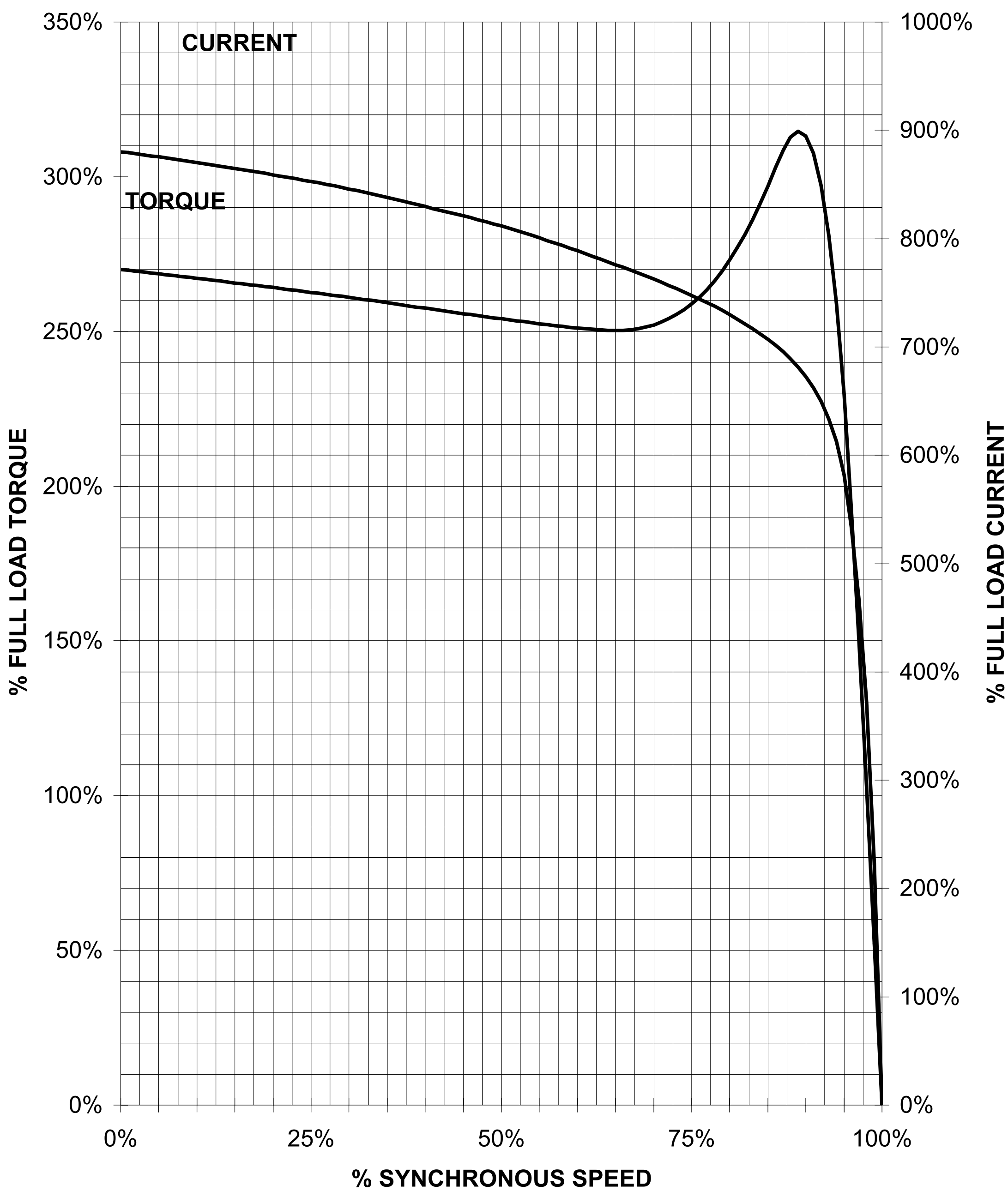
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	2	VOLTS	230/460	RPM	3600	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	145T	NEMA	B

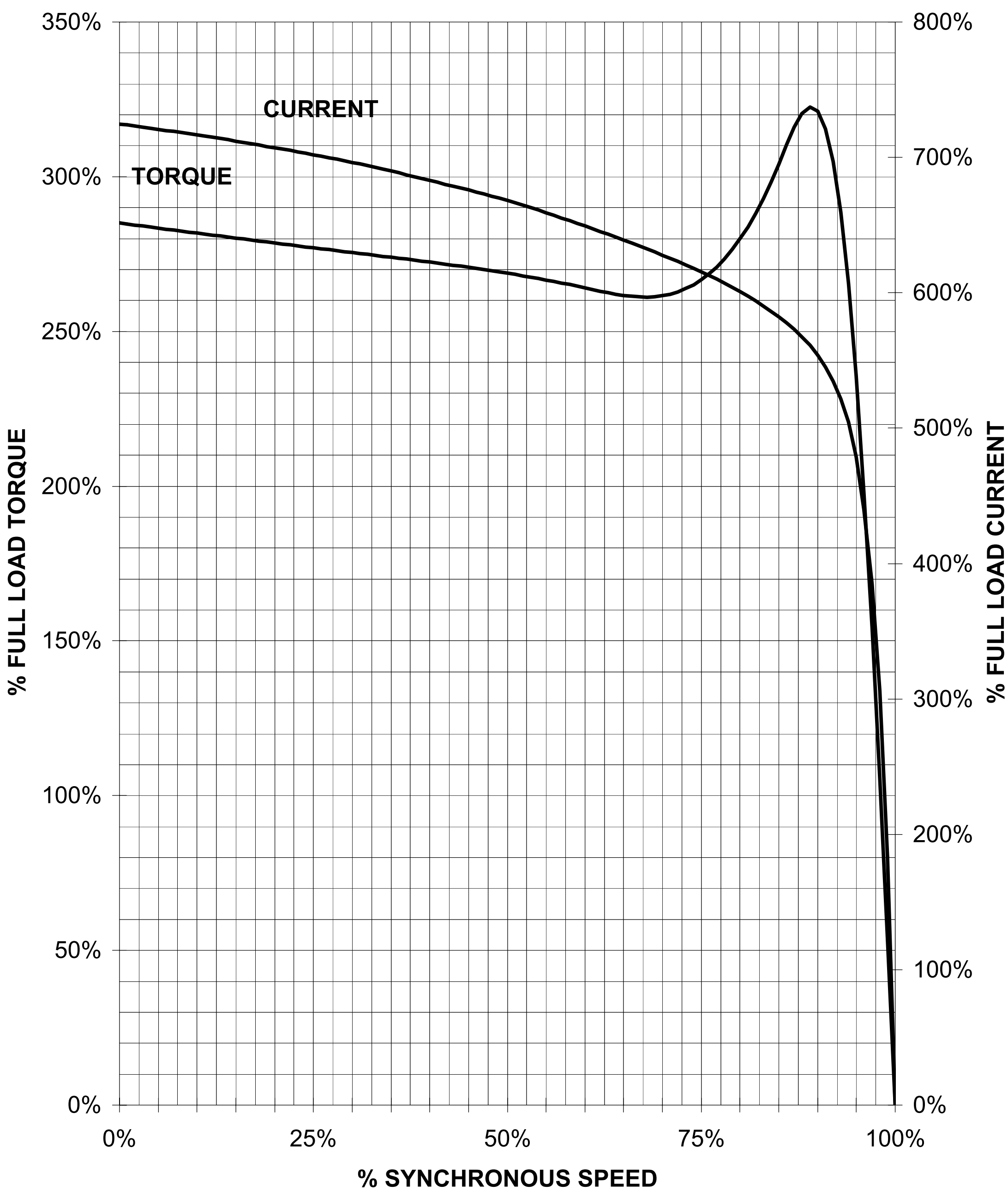
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	2	VOLTS	230/460	RPM	1800	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	145T	NEMA	B

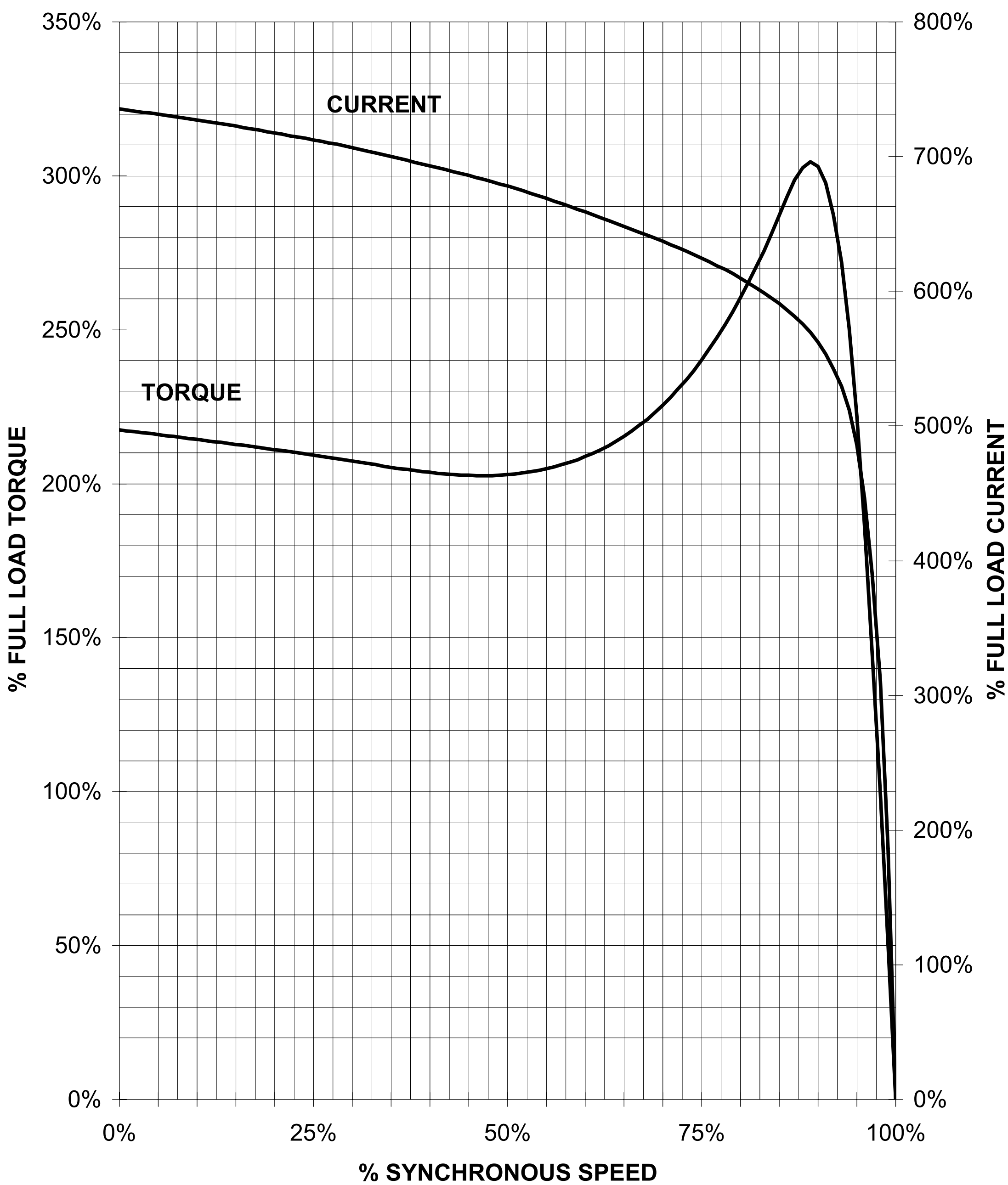
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	2	VOLTS	230/460	RPM	1200	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	184T	NEMA	B

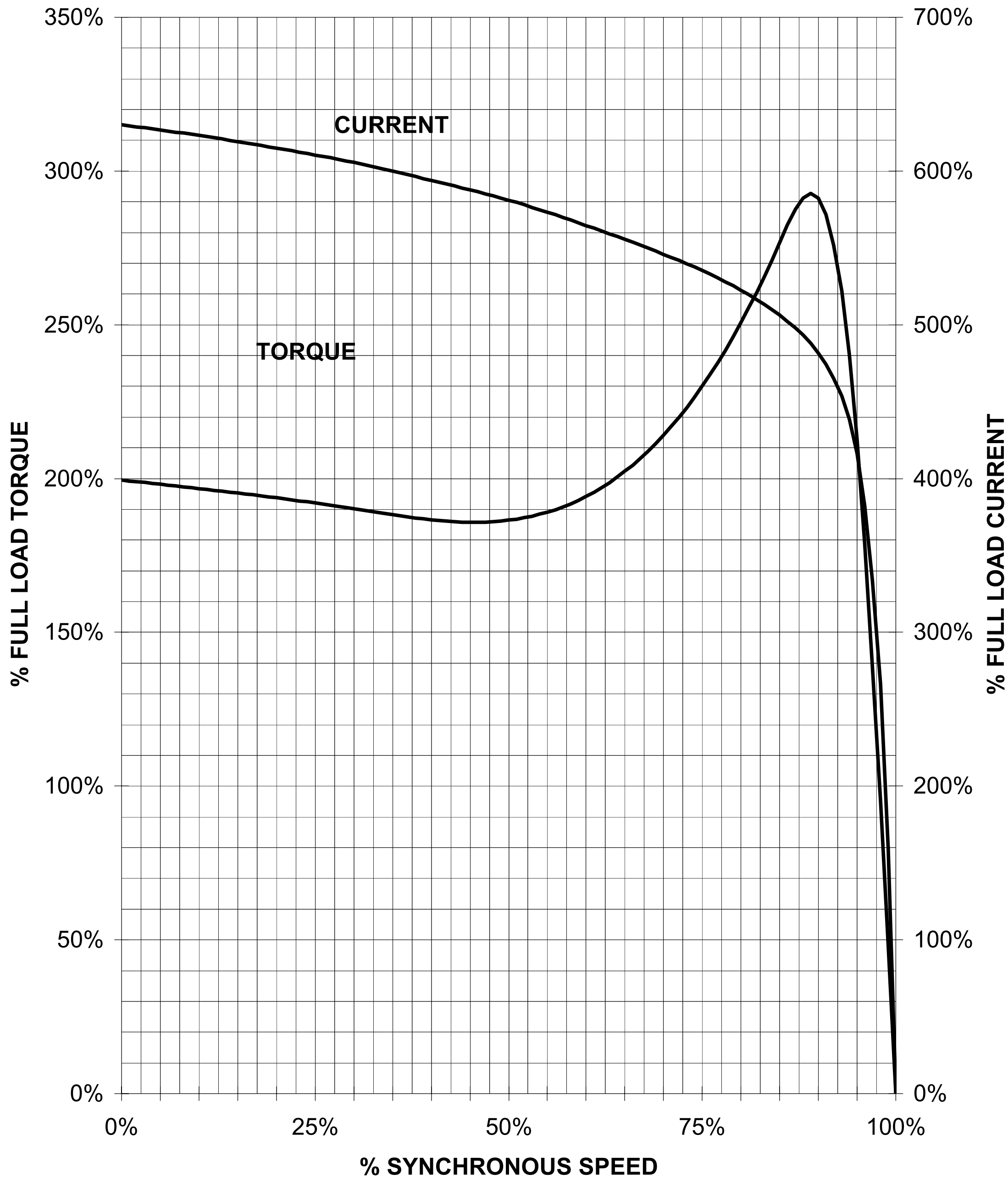
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	2	VOLTS	230/460	RPM	900	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	213T	NEMA	B

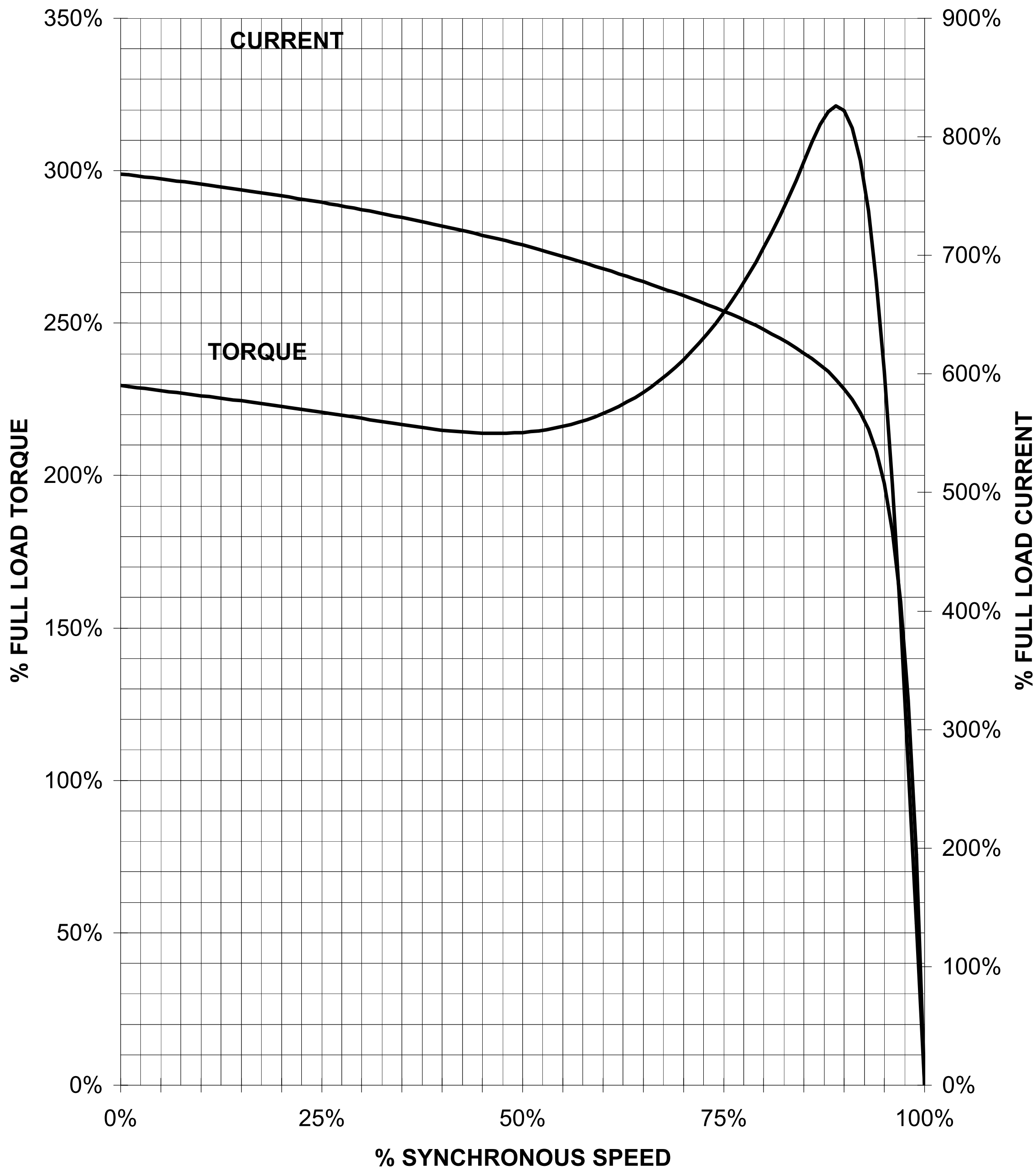
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	3	VOLTS	230/460	RPM	3600	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	182T	NEMA	B

TORQUE & CURRENT VS. SPEED

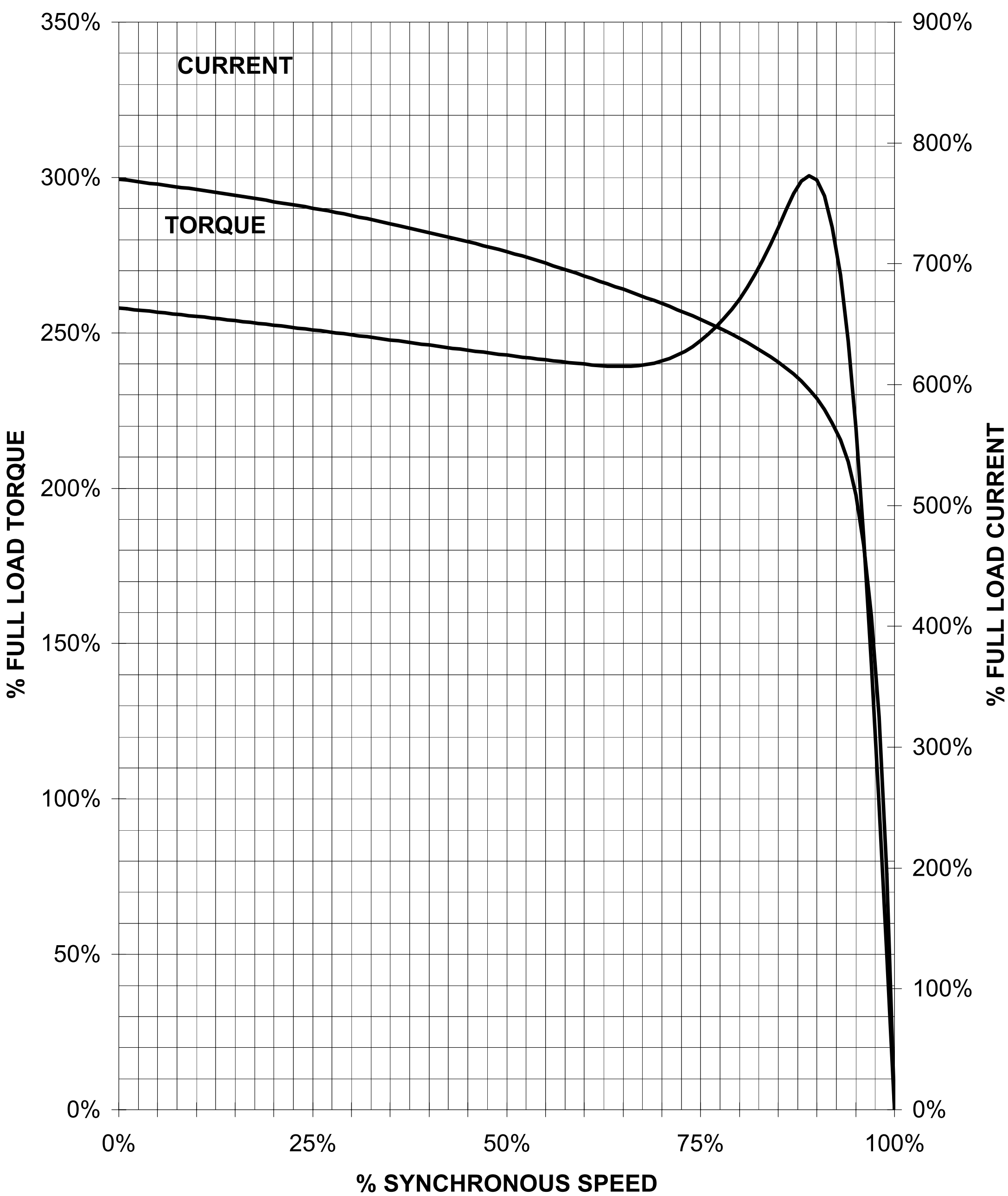


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	3	VOLTS	230/460	RPM	1800	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	182T	NEMA	B

TORQUE & CURRENT VS. SPEED

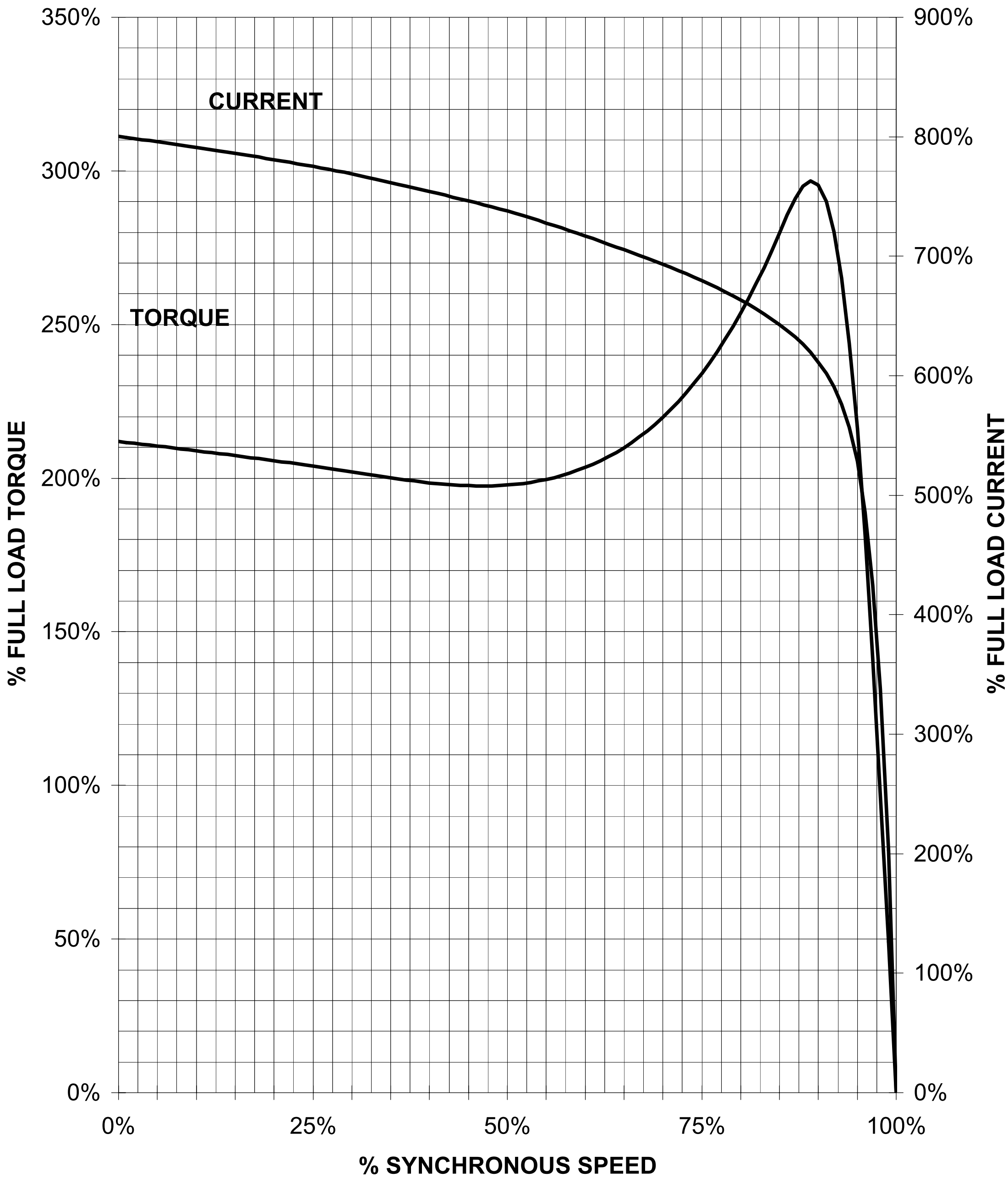


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	3	VOLTS	230/460	RPM	1200	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	213T	NEMA	B

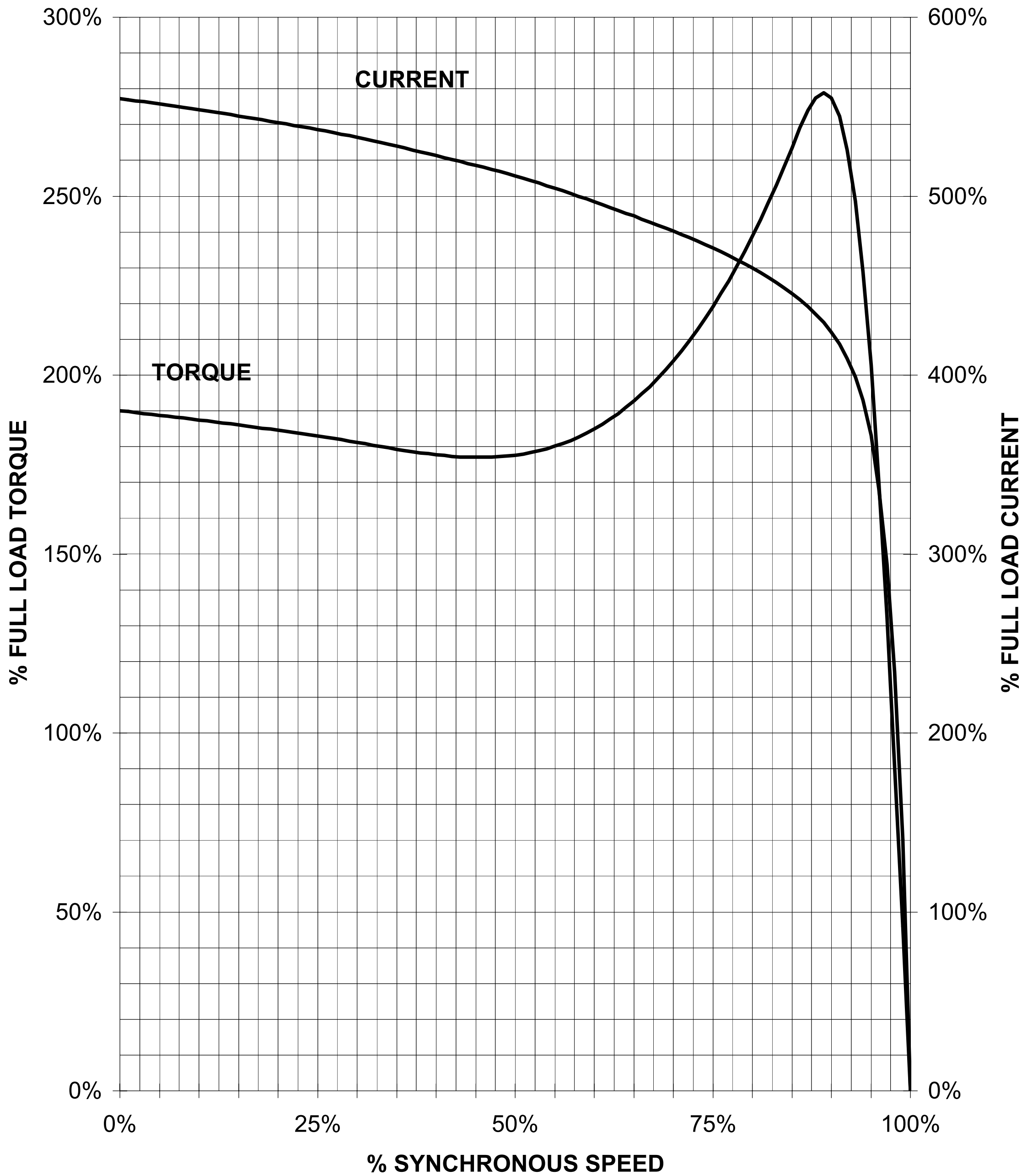
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	3	VOLTS	230/460	RPM	900	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	215T	NEMA	B

TORQUE & CURRENT VS. SPEED

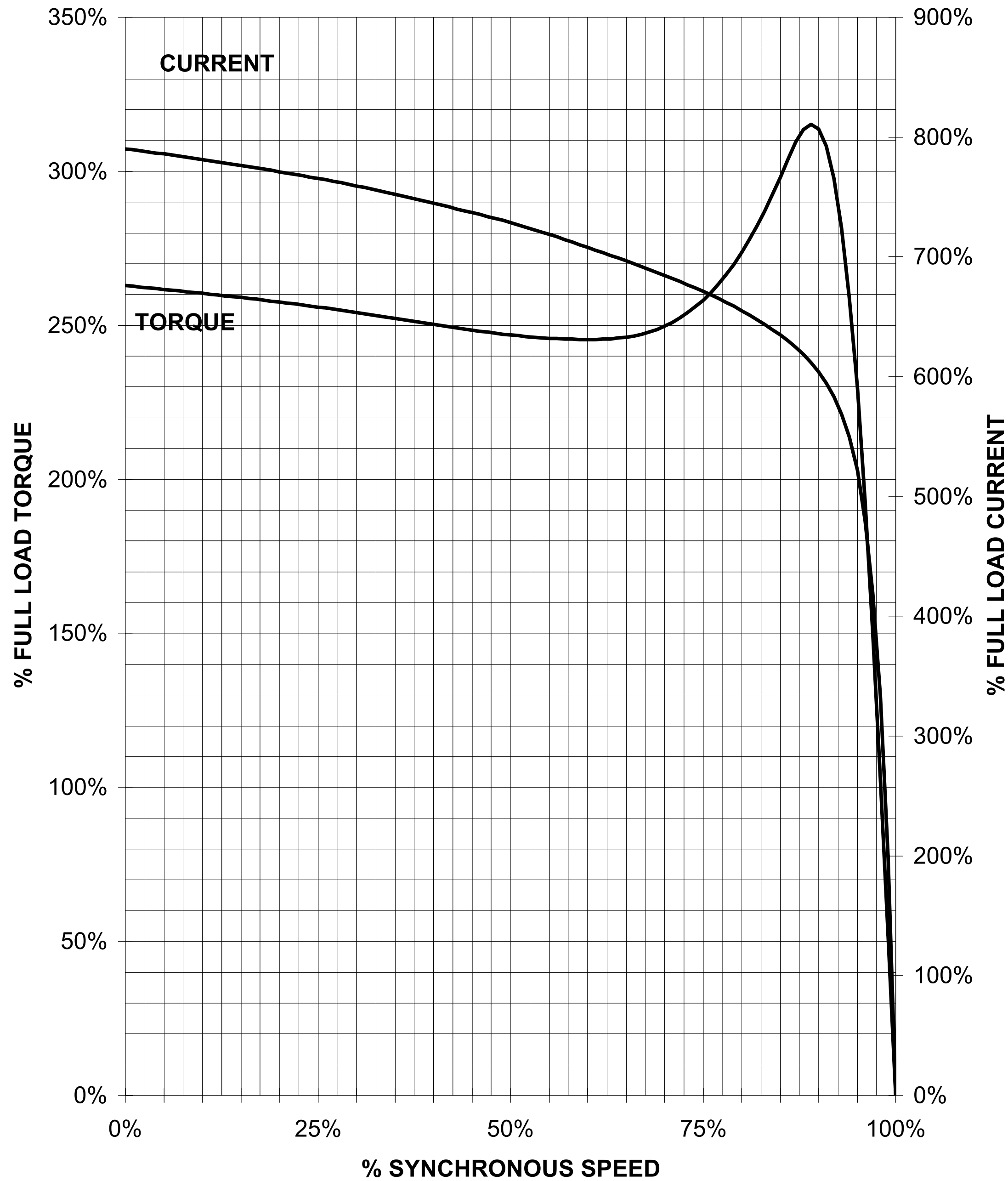


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	5	VOLTS	230/460	RPM	3600	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	184T	NEMA	B

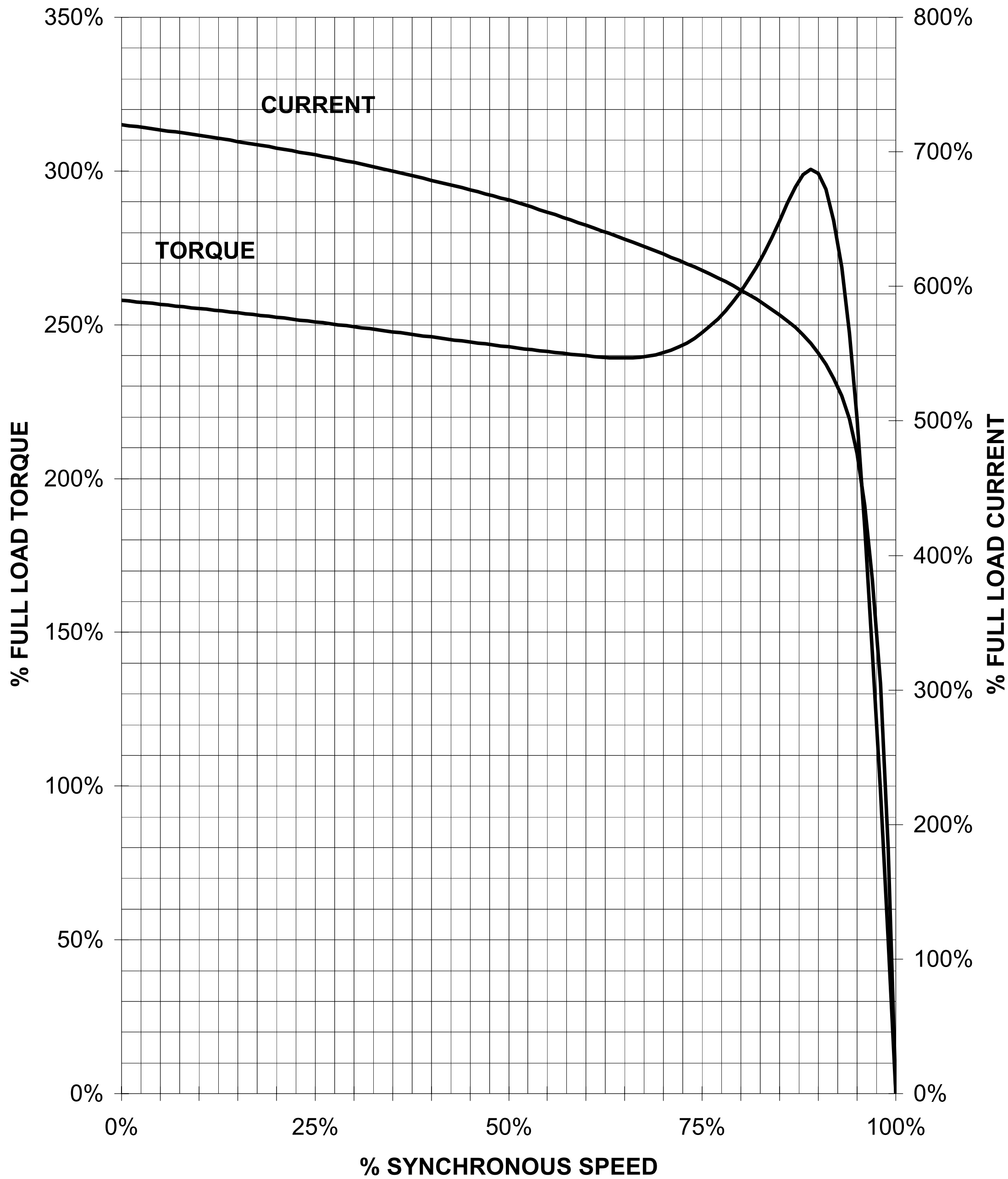
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	5	VOLTS	230/460	RPM	1800	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	184T	NEMA	B

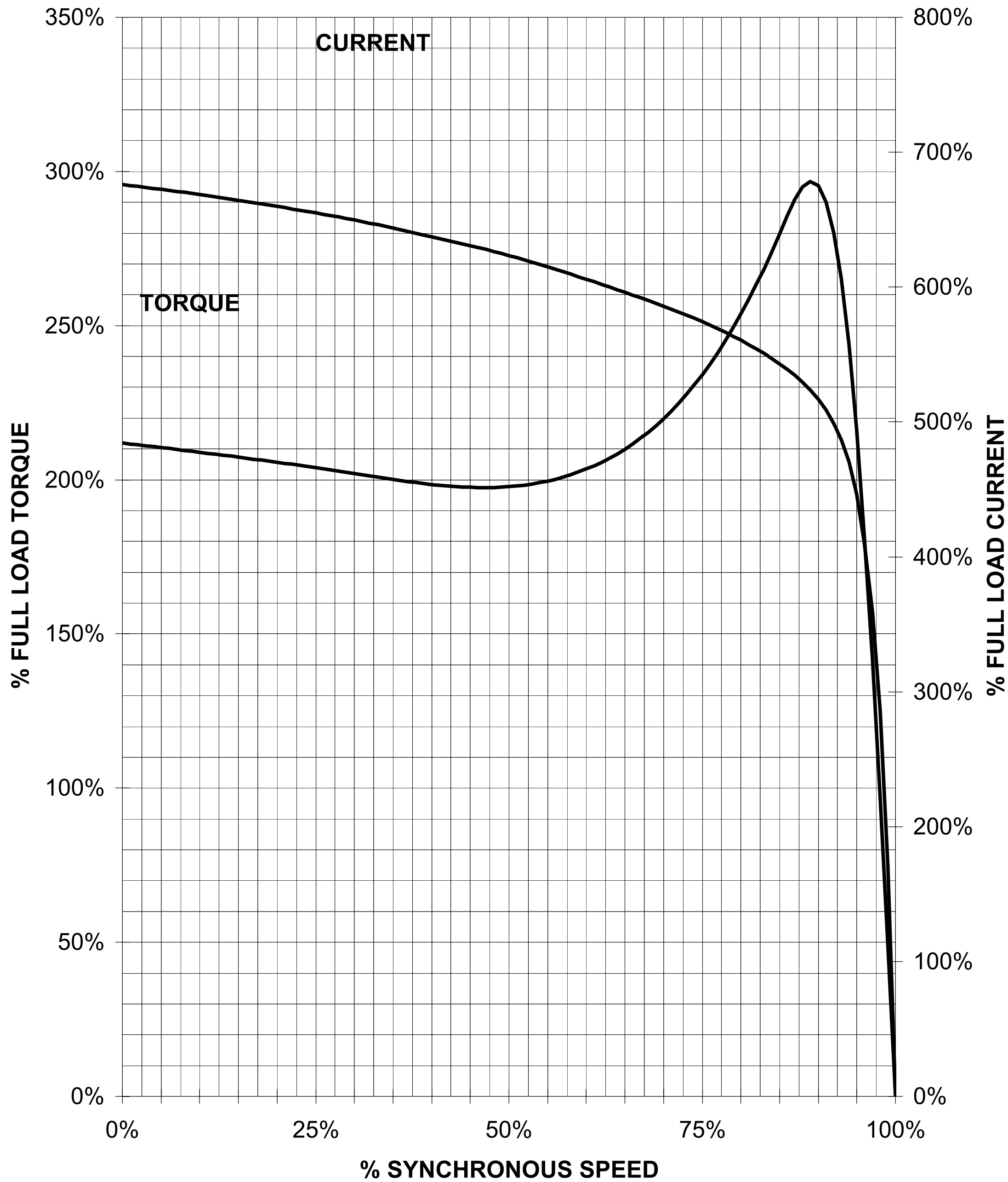
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	5	VOLTS	230/460	RPM	1200	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	215T	NEMA	B

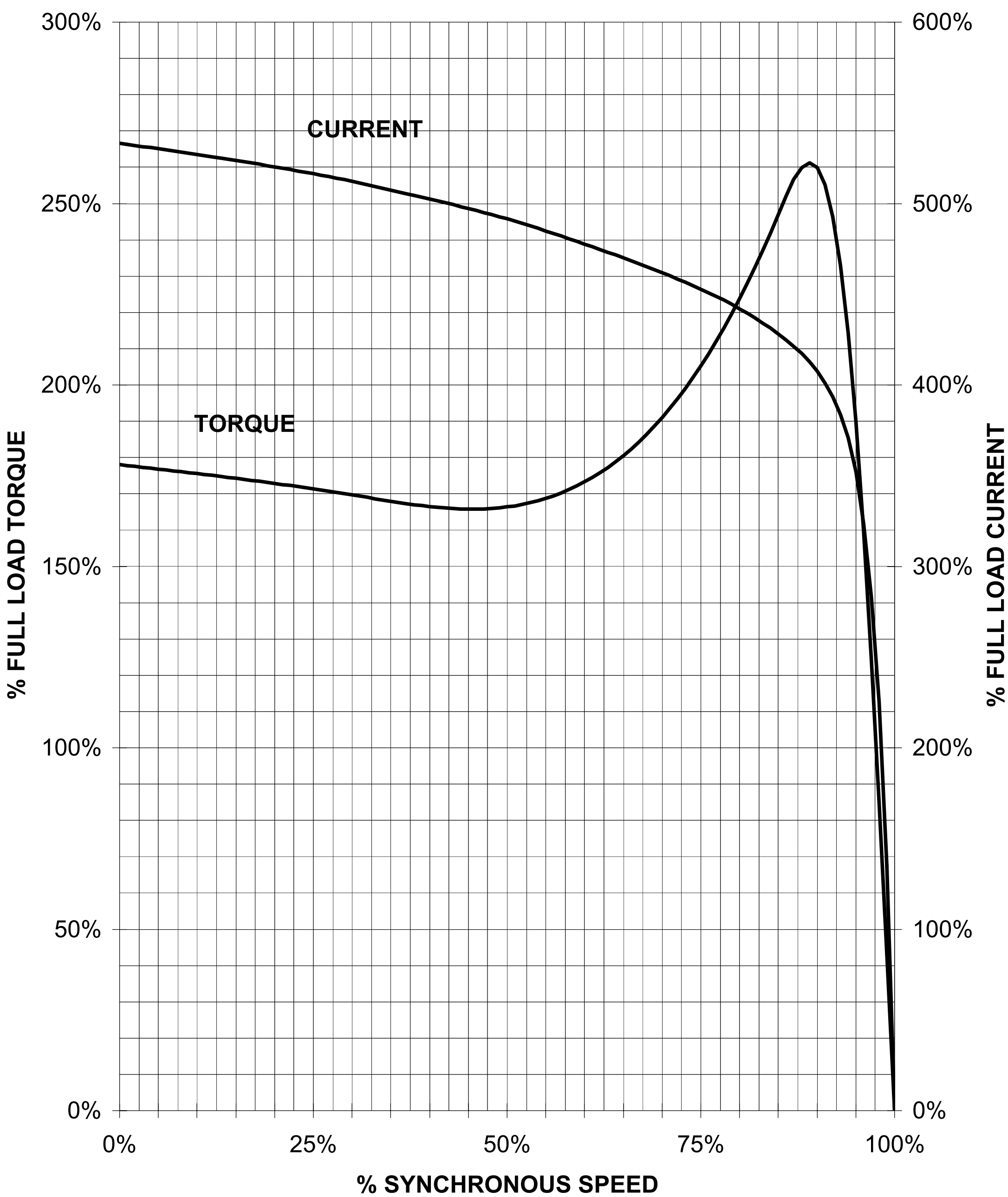
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	5	VOLTS	230/460	RPM	900	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	254T	NEMA	B

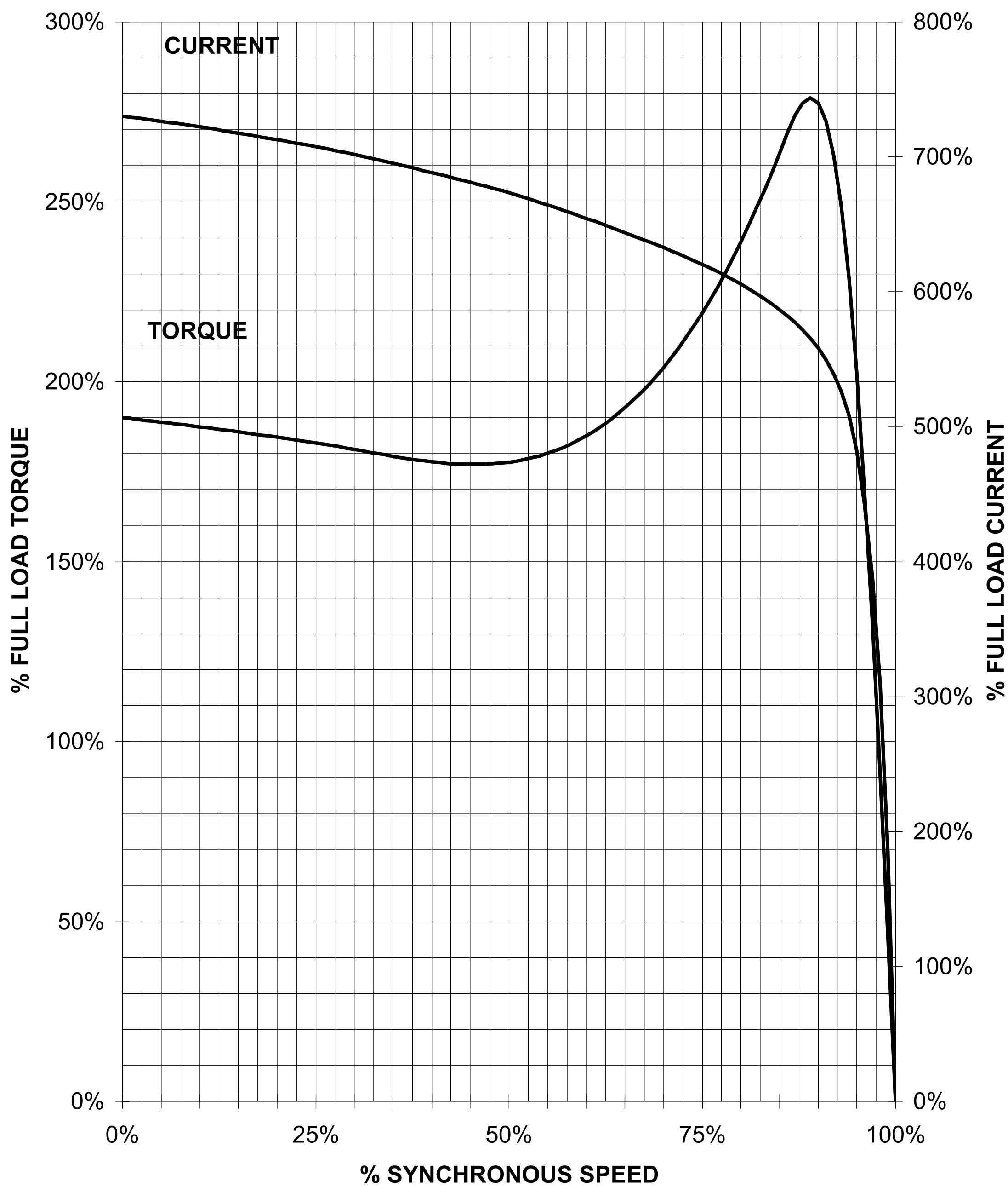
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP 7.5	VOLTS 230/460	RPM 3600	TYPE RGZZESD
HZ 60	PHASE 3	FRAME 213T	NEMA B

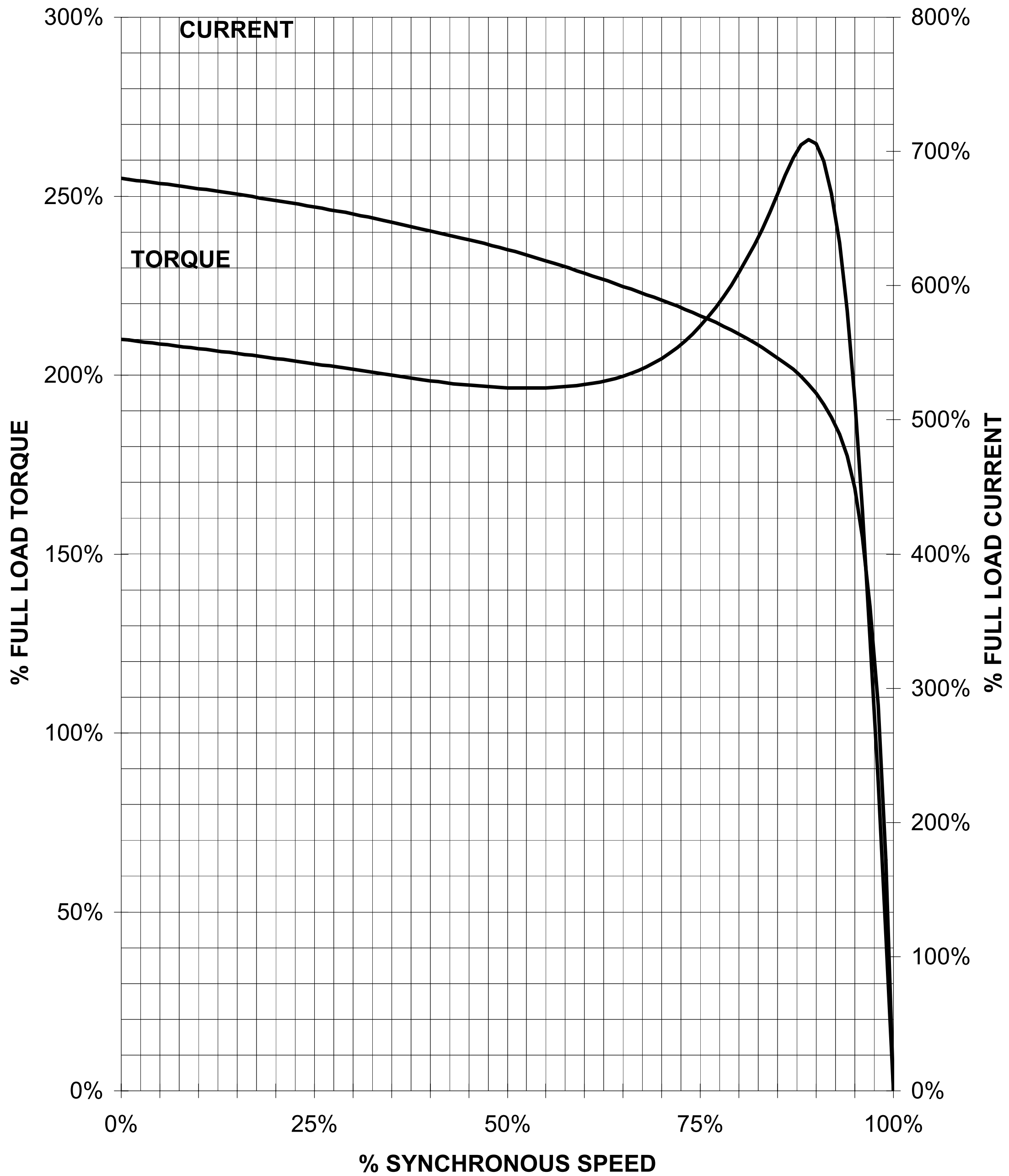
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	7.5	VOLTS	230/460	RPM	1800	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	213T	NEMA	B

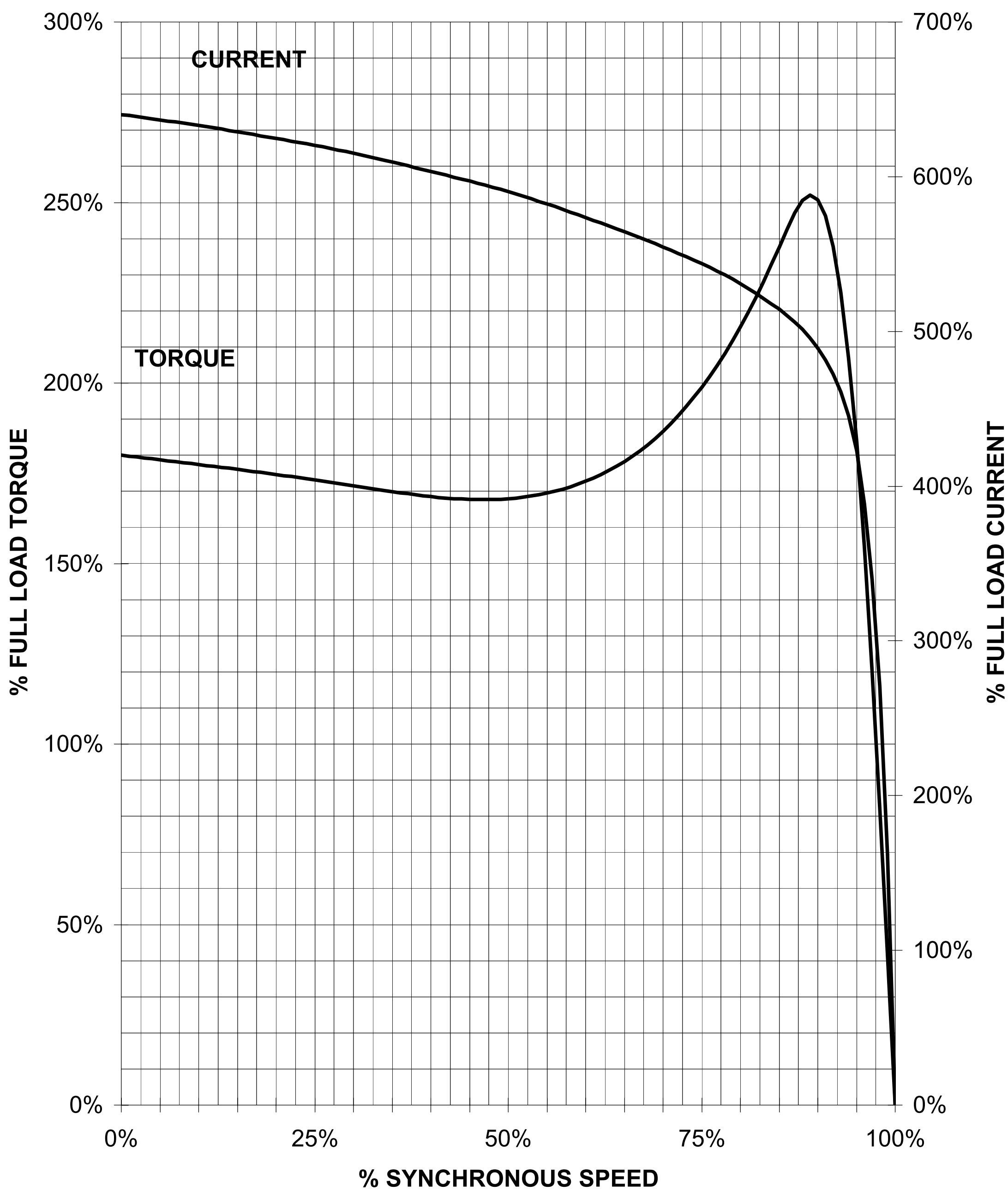
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	7.5	VOLTS	230/460	RPM	1200	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	254T	NEMA	B

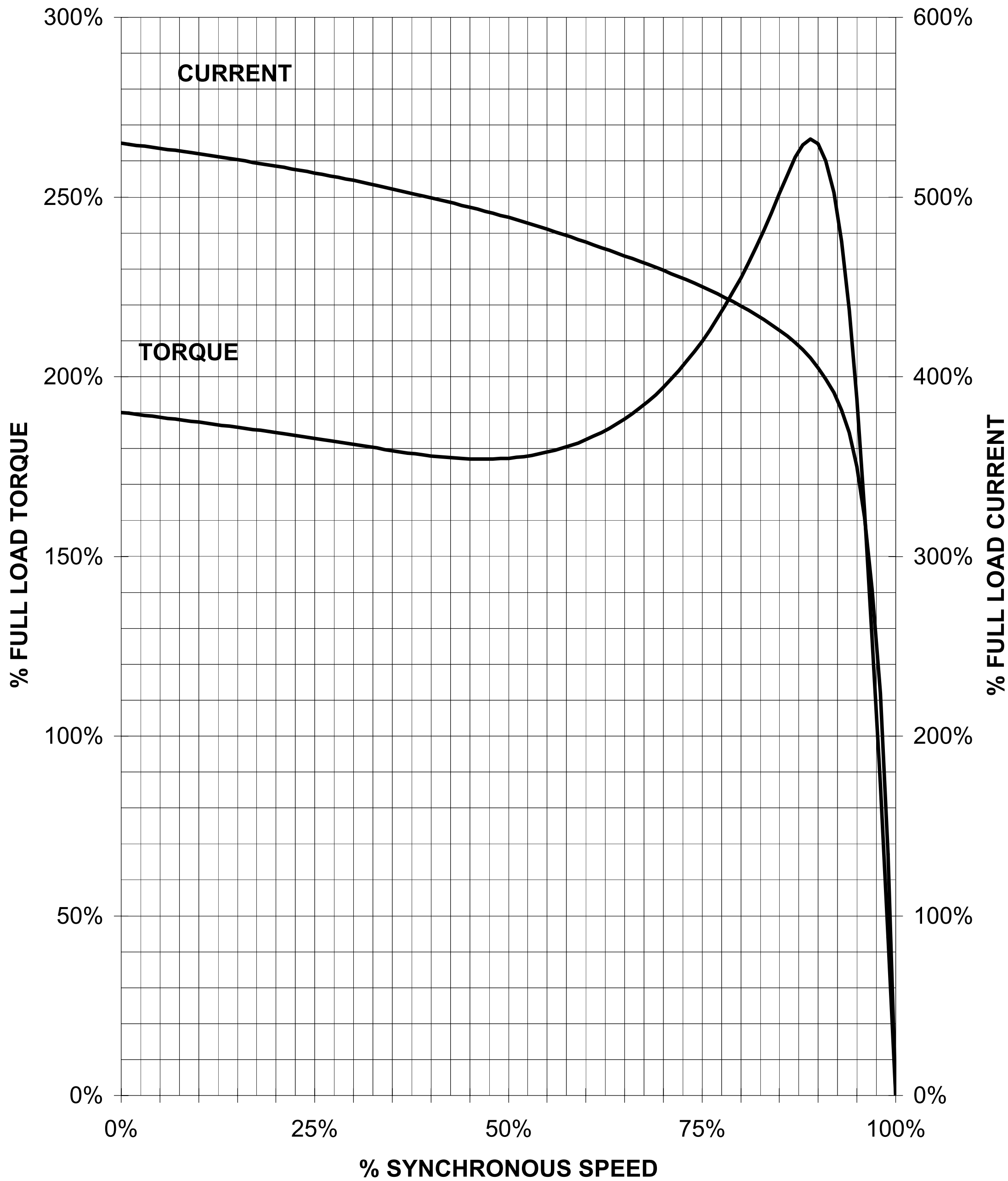
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	7.5	VOLTS	230/460	RPM	900	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	256T	NEMA	B

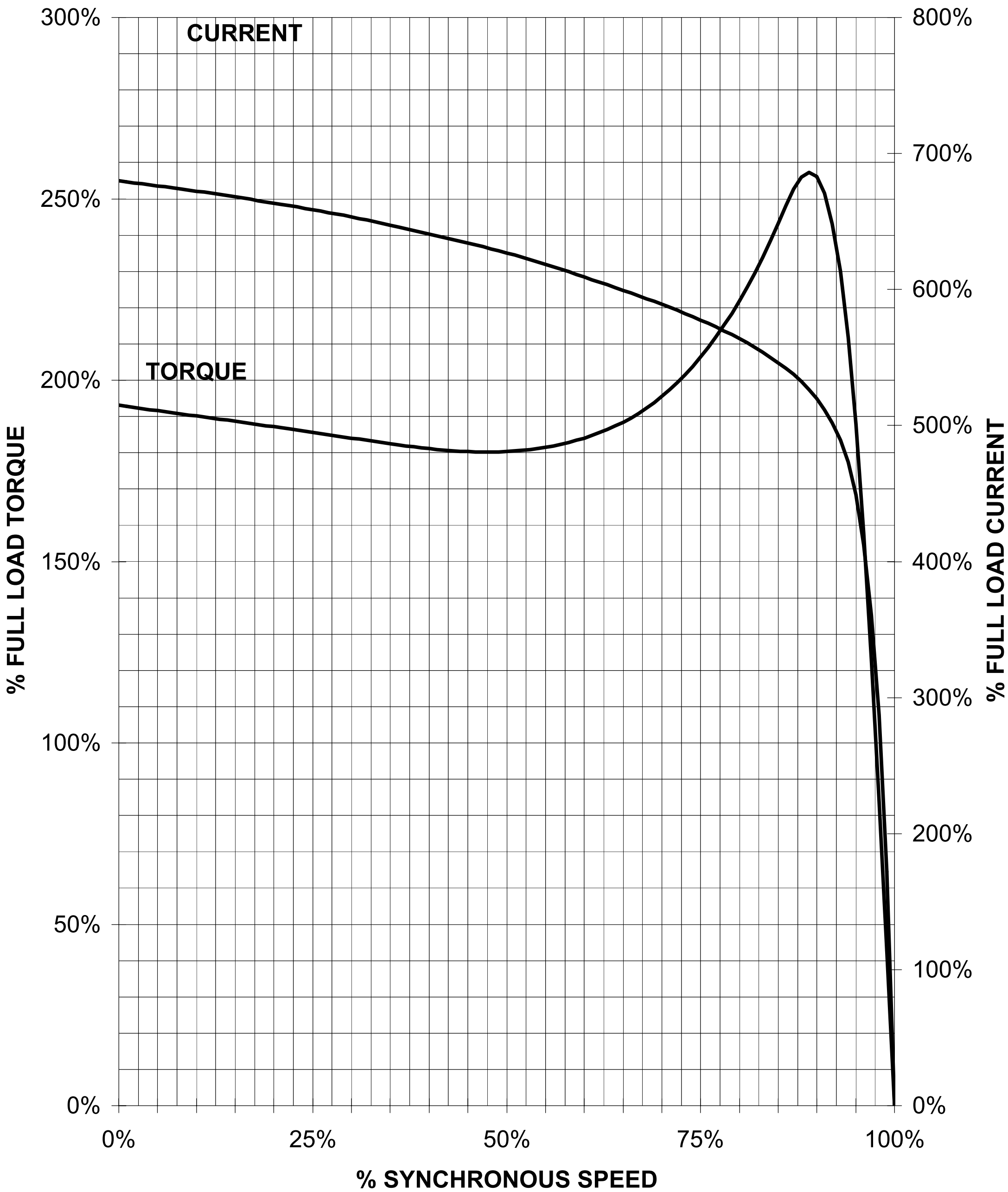
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	10	VOLTS	230/460	RPM	3600	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	215T	NEMA	B

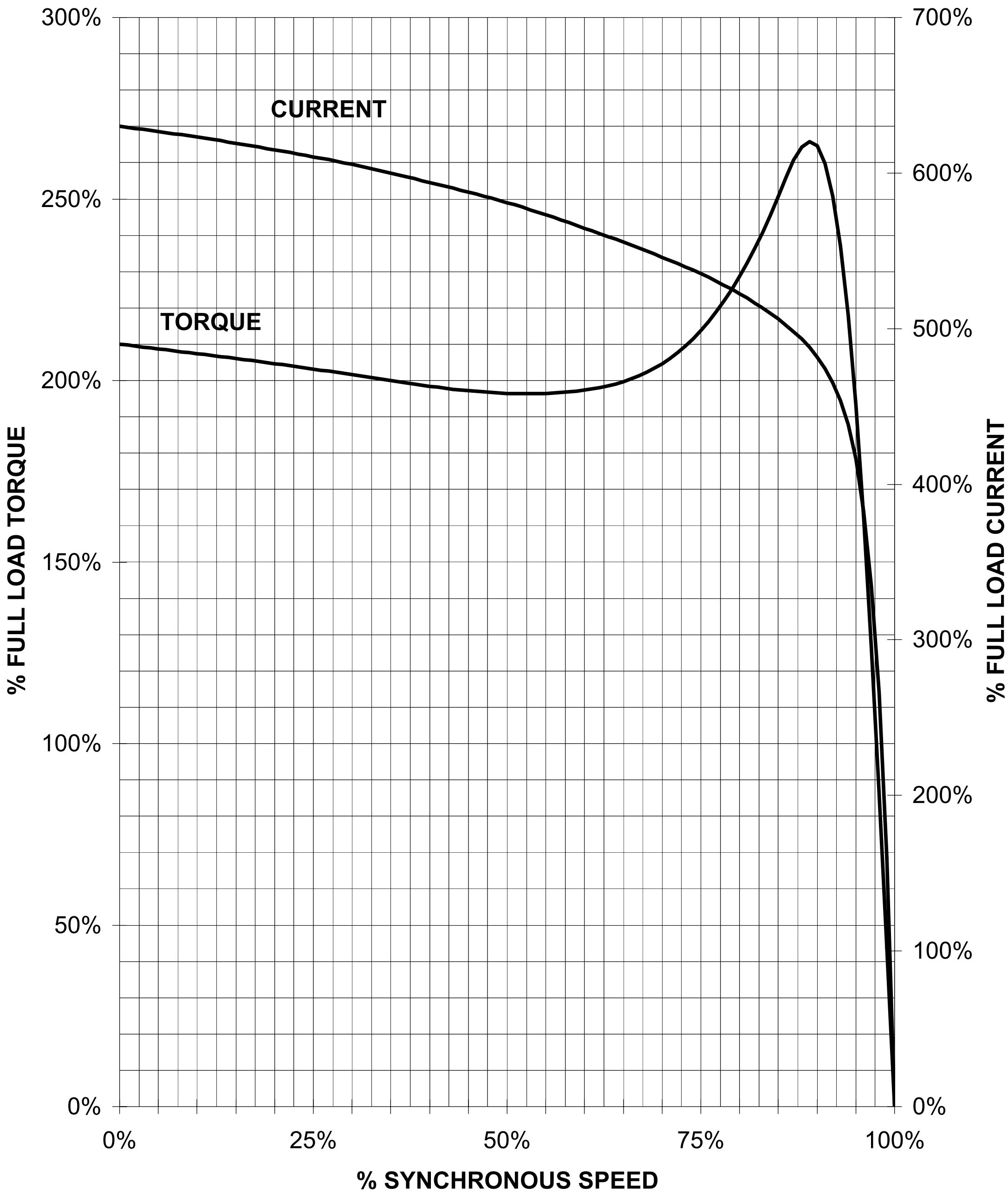
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	10	VOLTS	230/460	RPM	1800	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	215T	NEMA	B

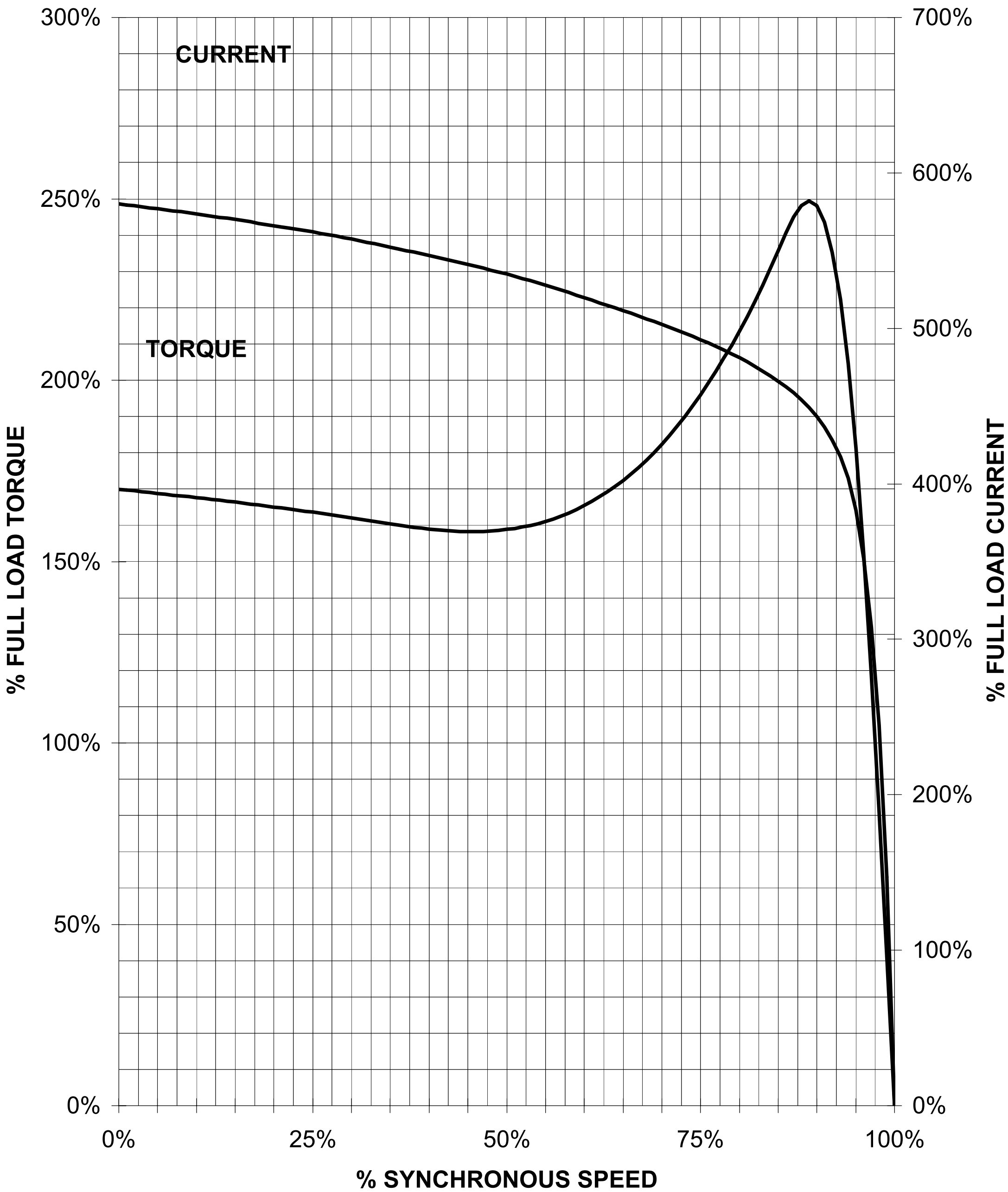
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	10	VOLTS	230/460	RPM	1200	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	256T	NEMA	B

TORQUE & CURRENT VS. SPEED

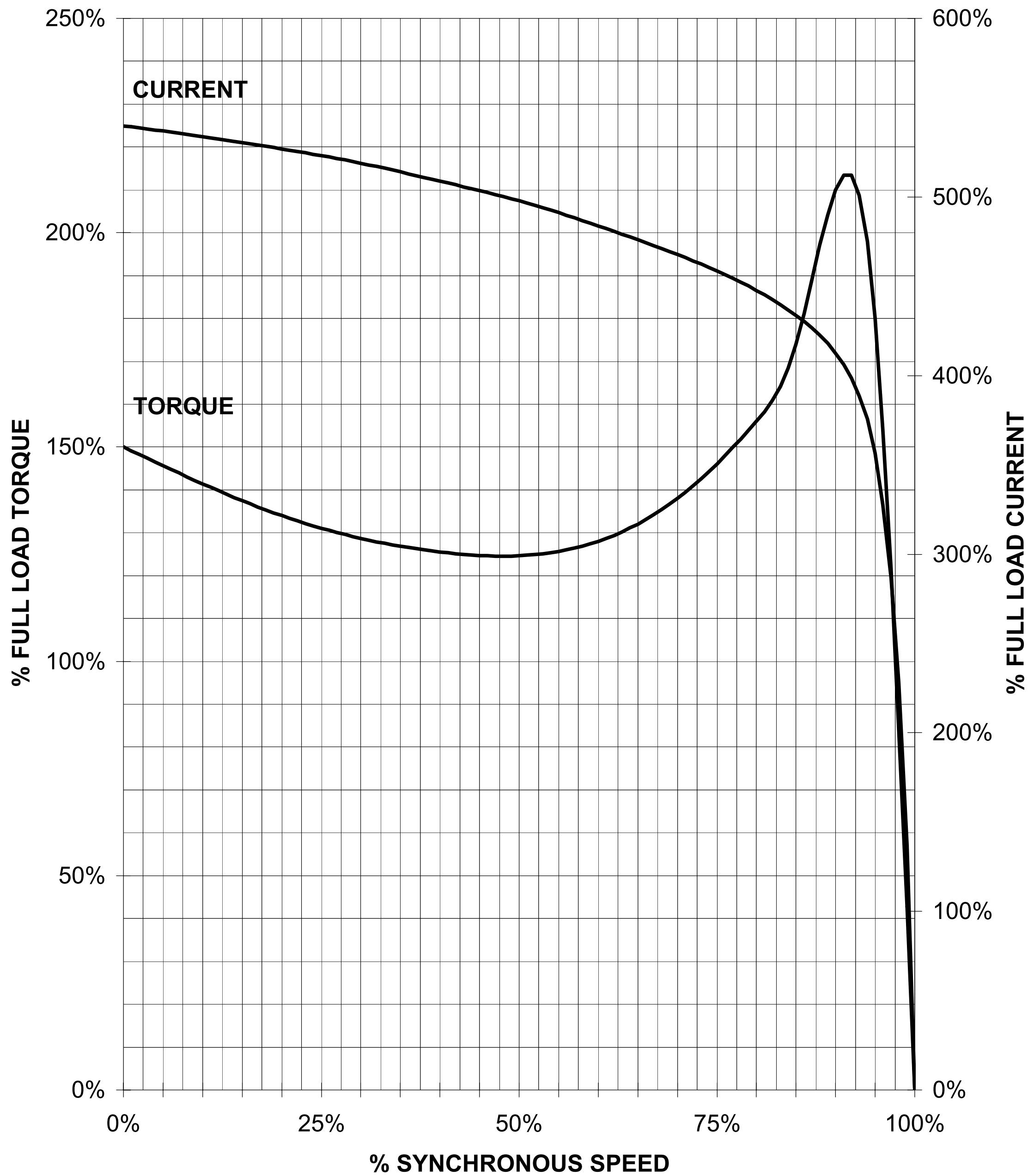


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	10	VOLTS	230/460	RPM	900	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	284T	NEMA	B

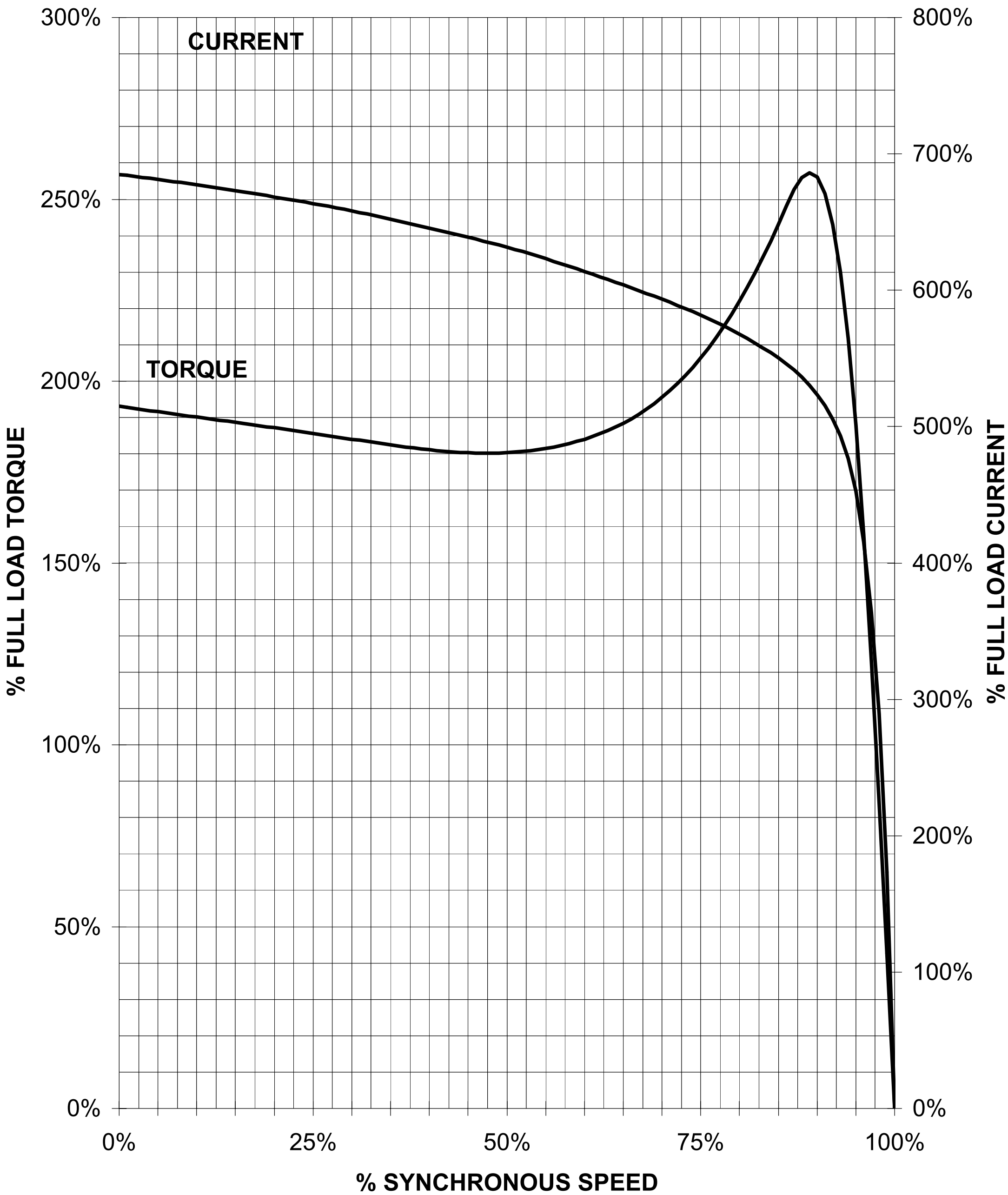
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	15	VOLTS	230/460	RPM	3600	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	254T	NEMA	B

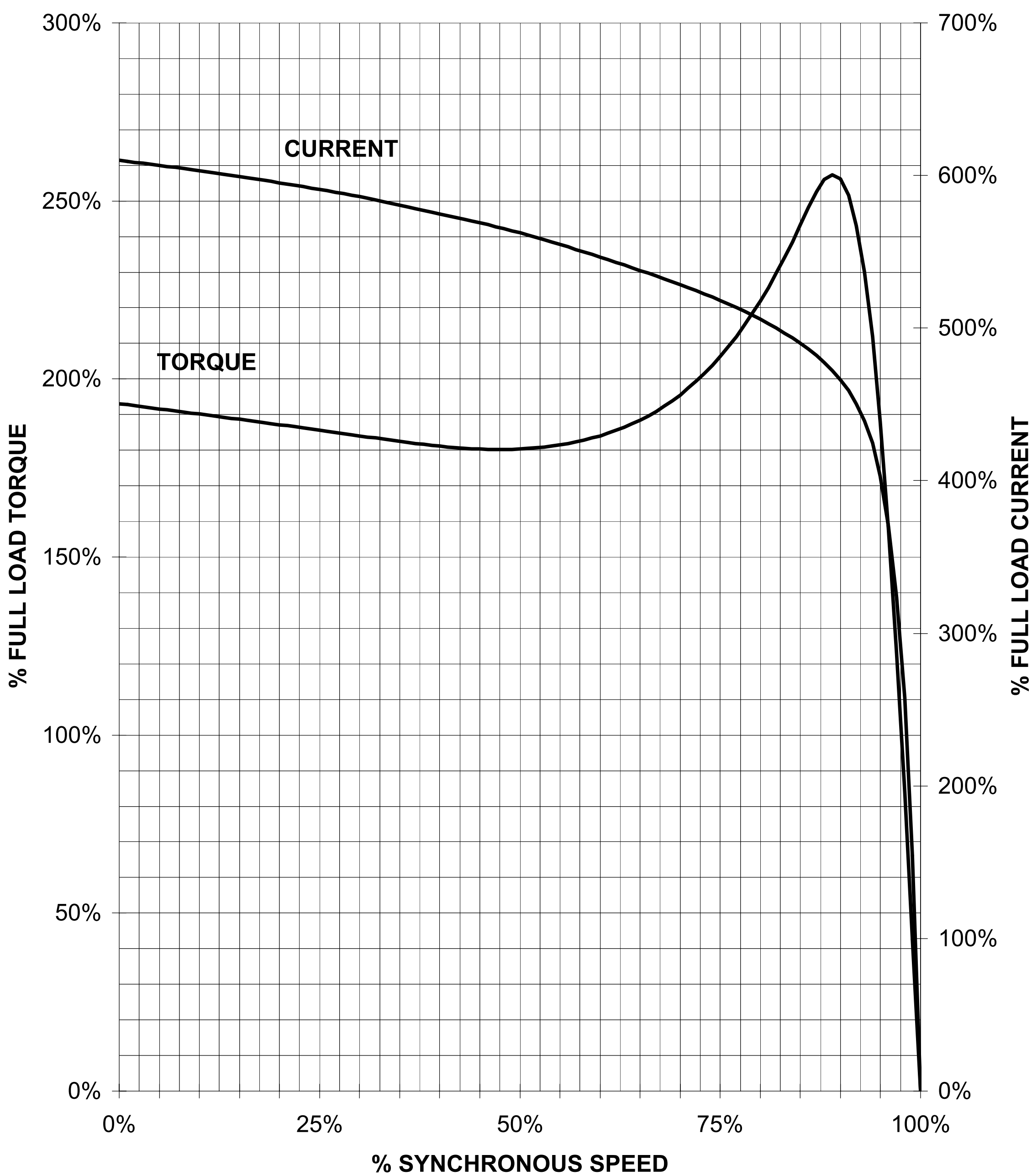
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	15	VOLTS	230/460	RPM	1800	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	254T	NEMA	B

TORQUE & CURRENT VS. SPEED

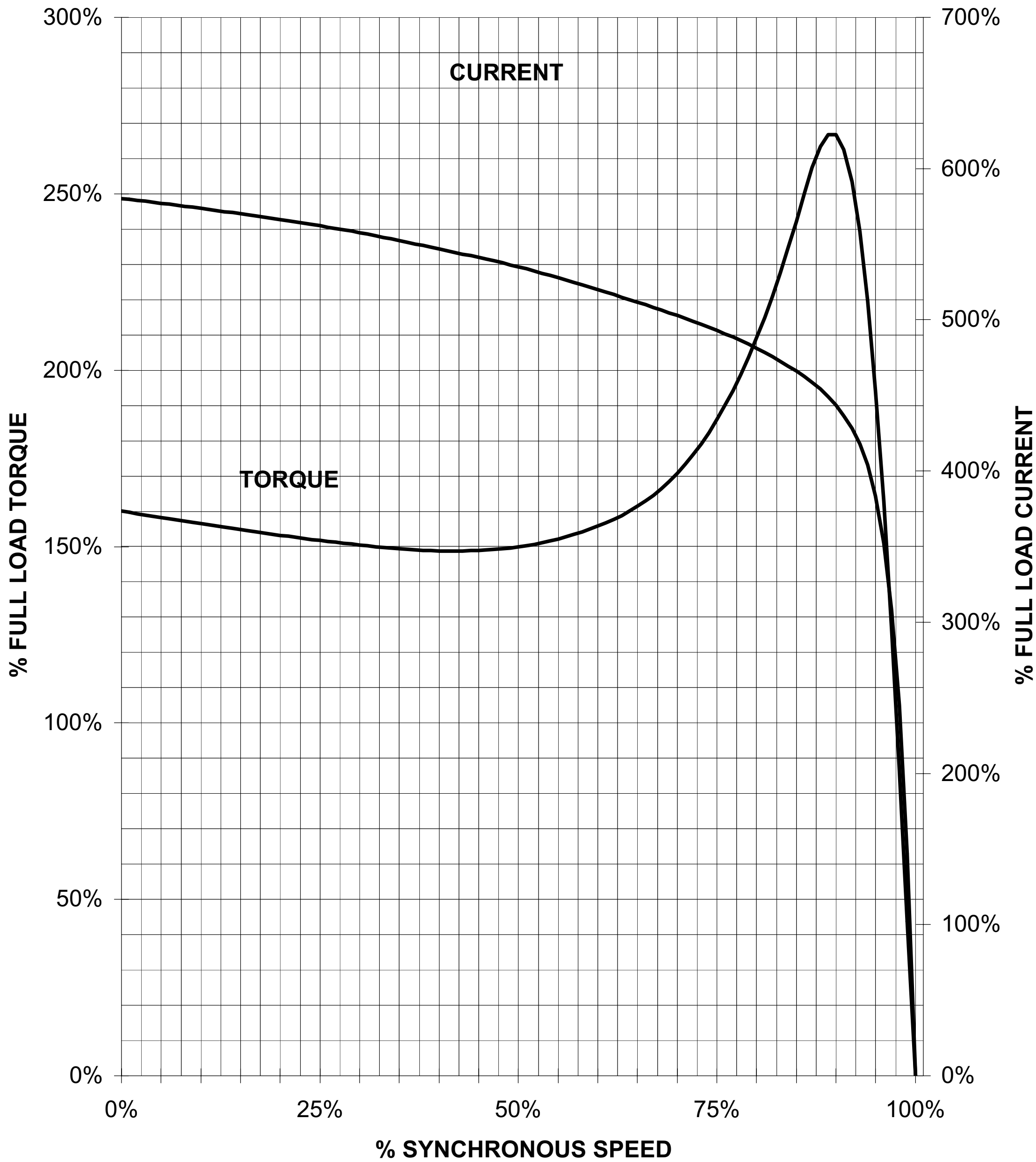


Customer: **PO No.:** **Order No.:**

HP 15 VOLTS 230/460 RPM 1200 TYPE RGZZESD

HZ 60 PHASE 3 FRAME 284T NEMA B

TORQUE AND CURRENT VS. SPEED

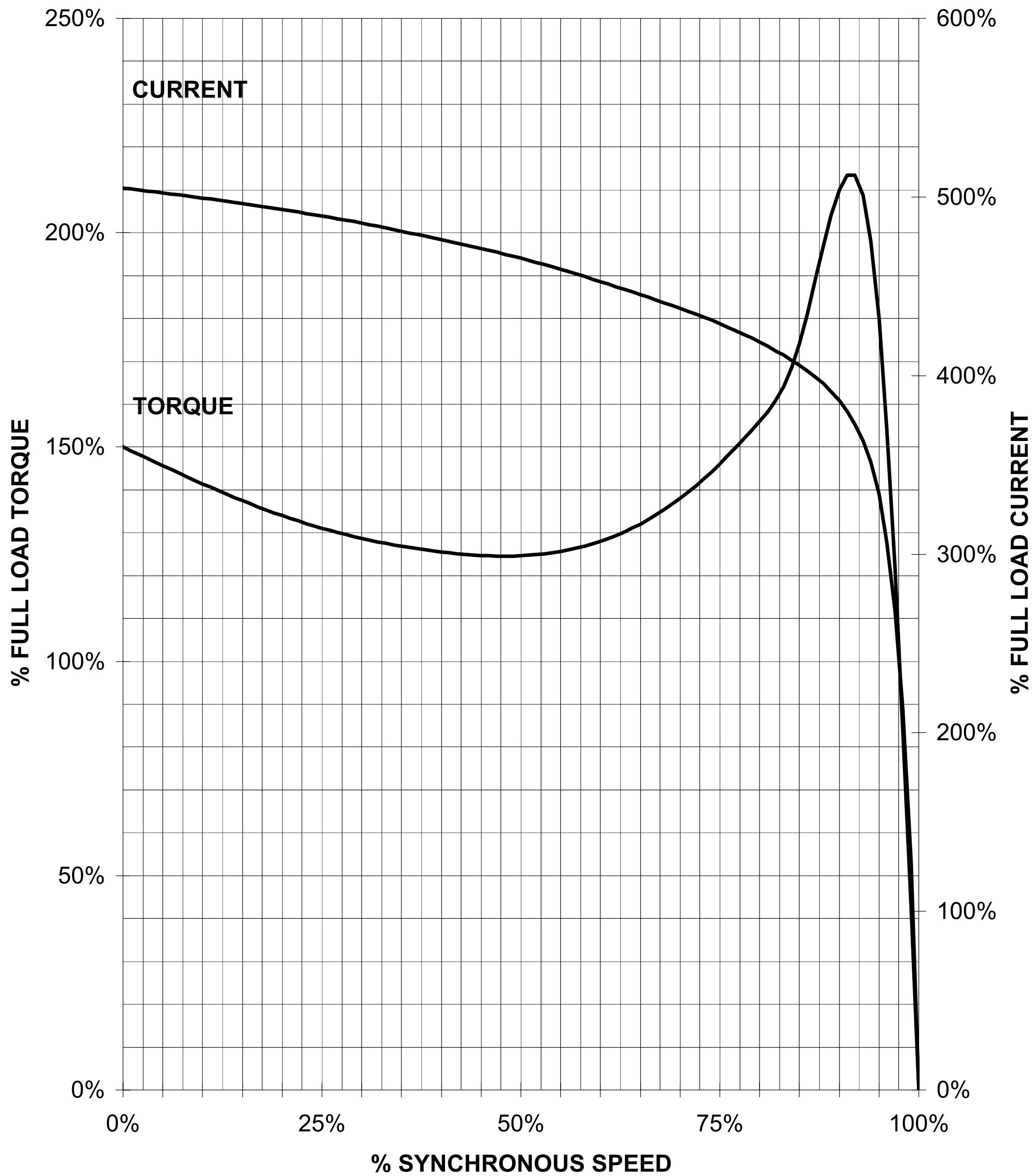


Customer: **PO No.:** **Order No.:**

Application Manual for NEMA Motors

HP	15	VOLTS	230/460	RPM	900	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	286T	NEMA	B

TORQUE AND CURRENT VS. SPEED

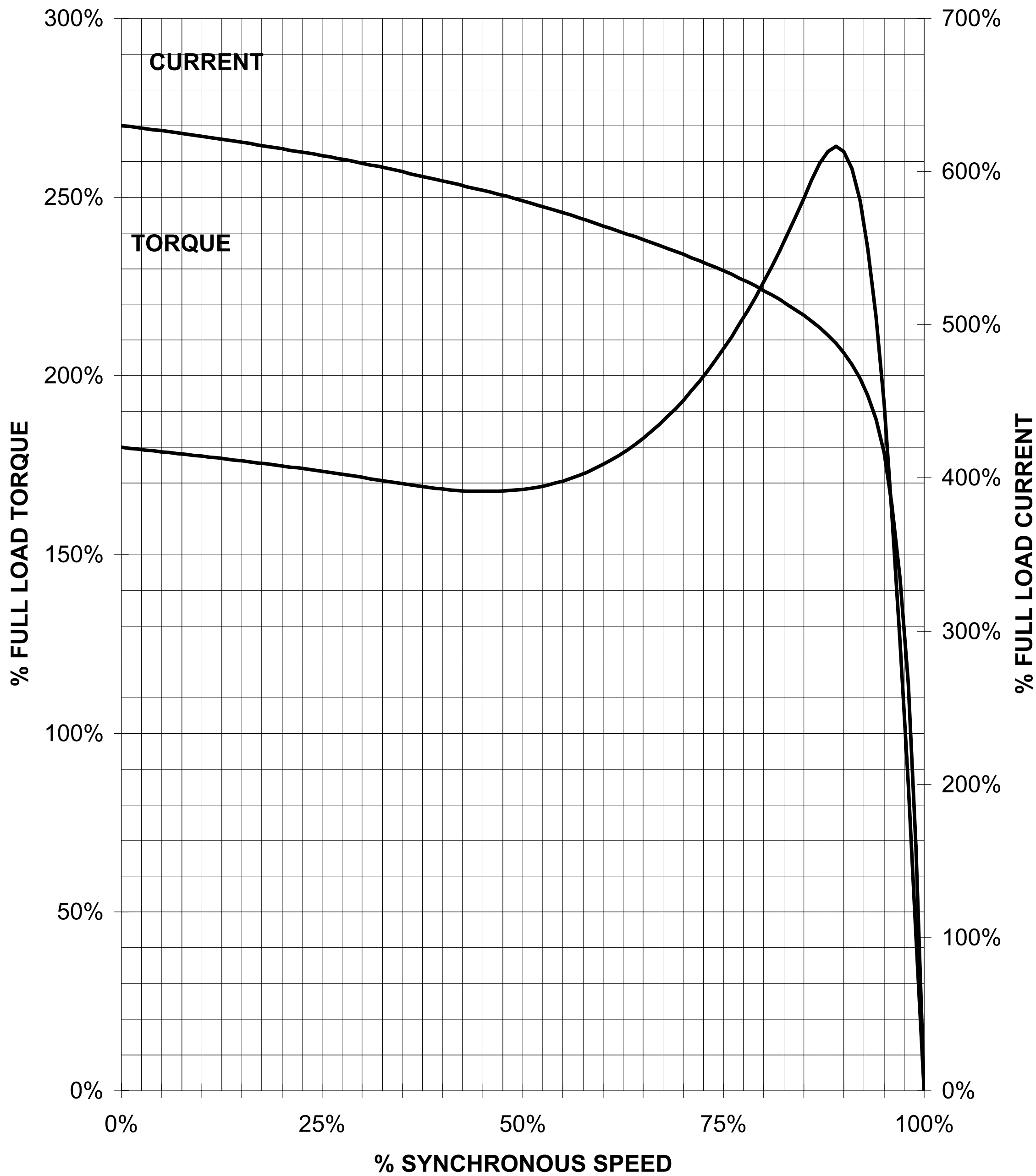


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	20	VOLTS	230/460	RPM	3600	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	256T	NEMA	B

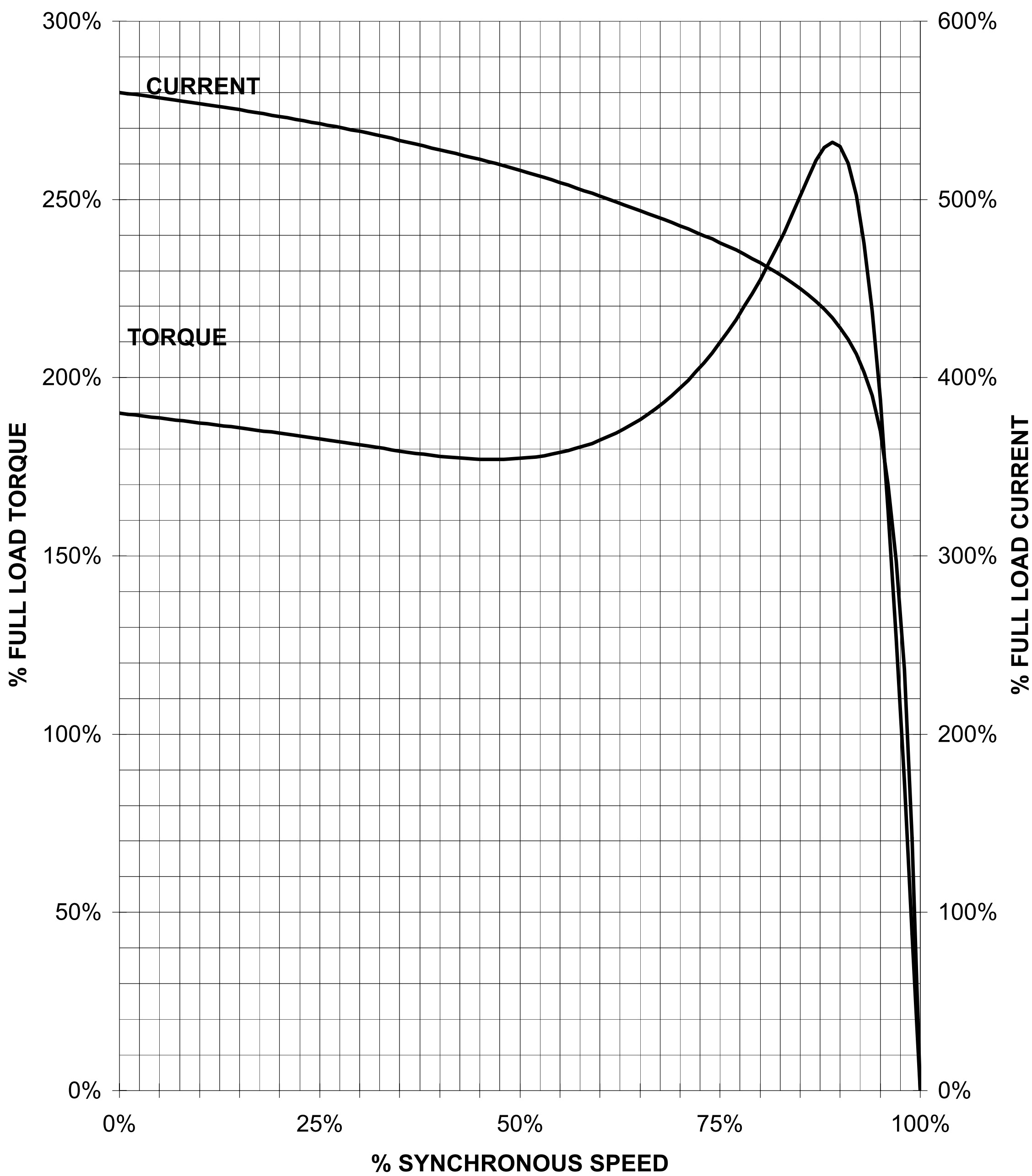
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	20	VOLTS	230/460	RPM	1800	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	256T	NEMA	B

TORQUE & CURRENT VS. SPEED

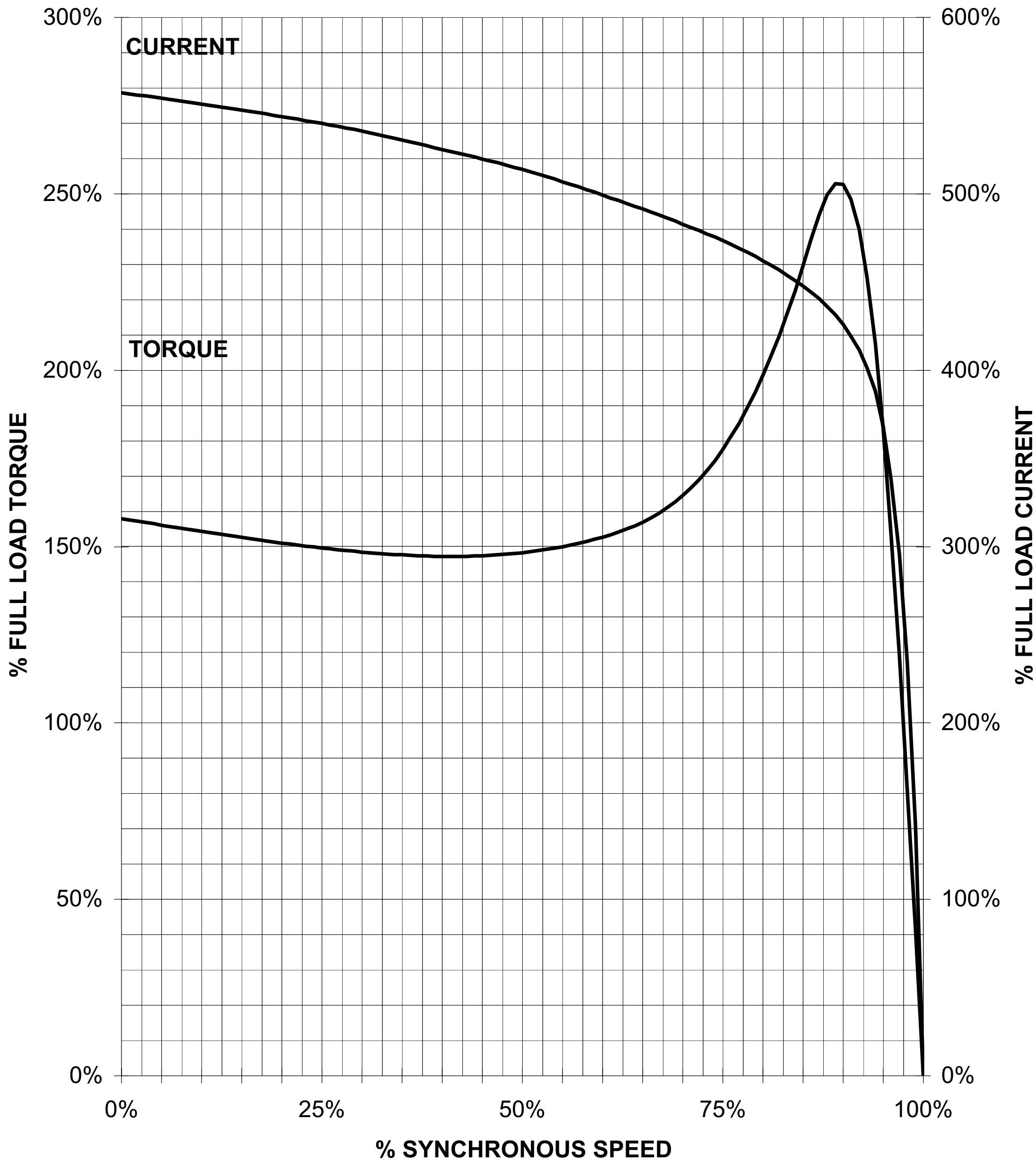


Customer: **PO No.:** **Order No.:**

Application Manual for NEMA Motors

HP	20	VOLTS	230/460	RPM	1200	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	286T	NEMA	B

TORQUE AND CURRENT VS. SPEED

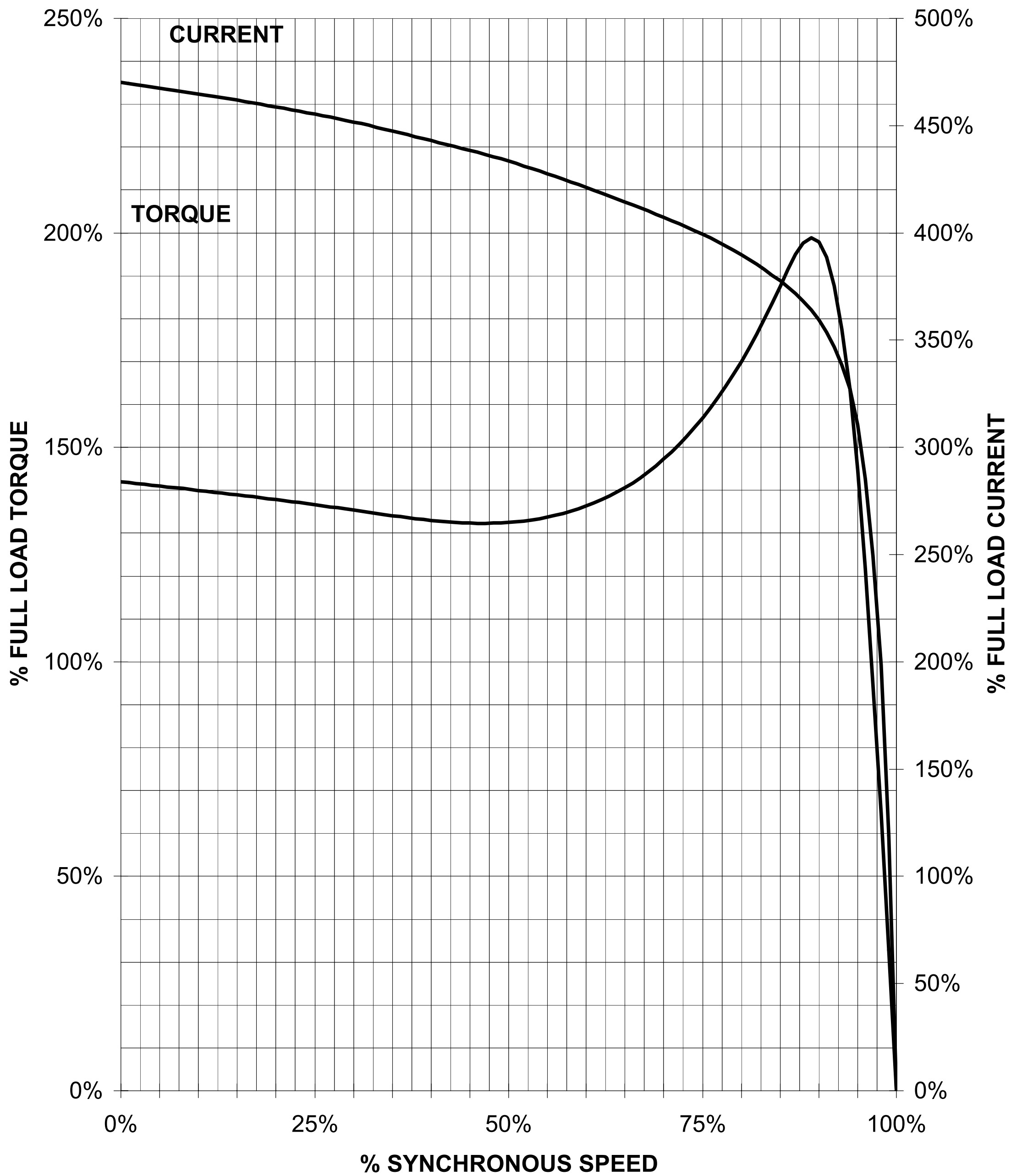


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	20	VOLTS	230/460	RPM	900	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	324T	NEMA	B

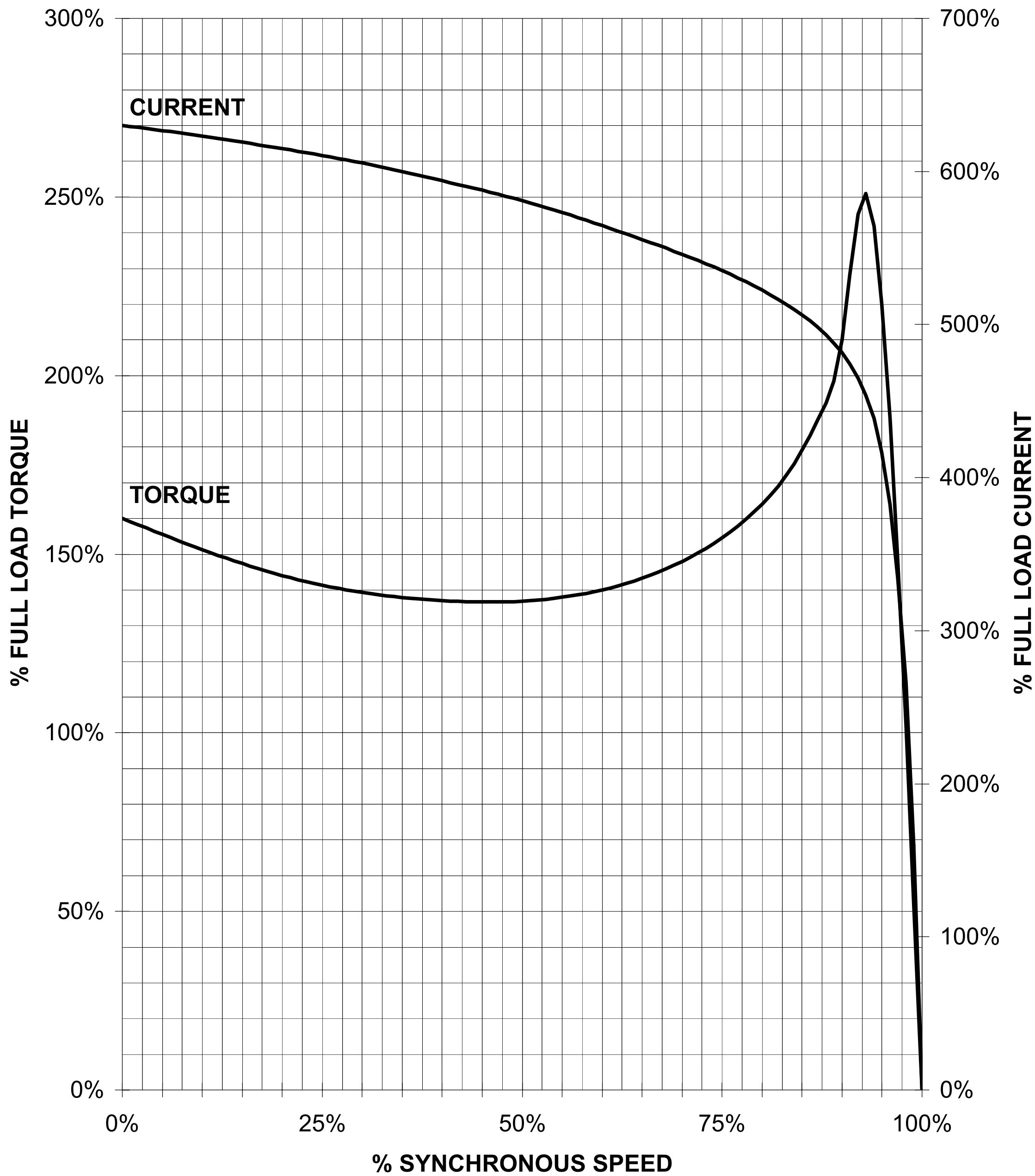
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	25	VOLTS	460	RPM	3600	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	284TS	NEMA	B

TORQUE AND CURRENT VS. SPEED

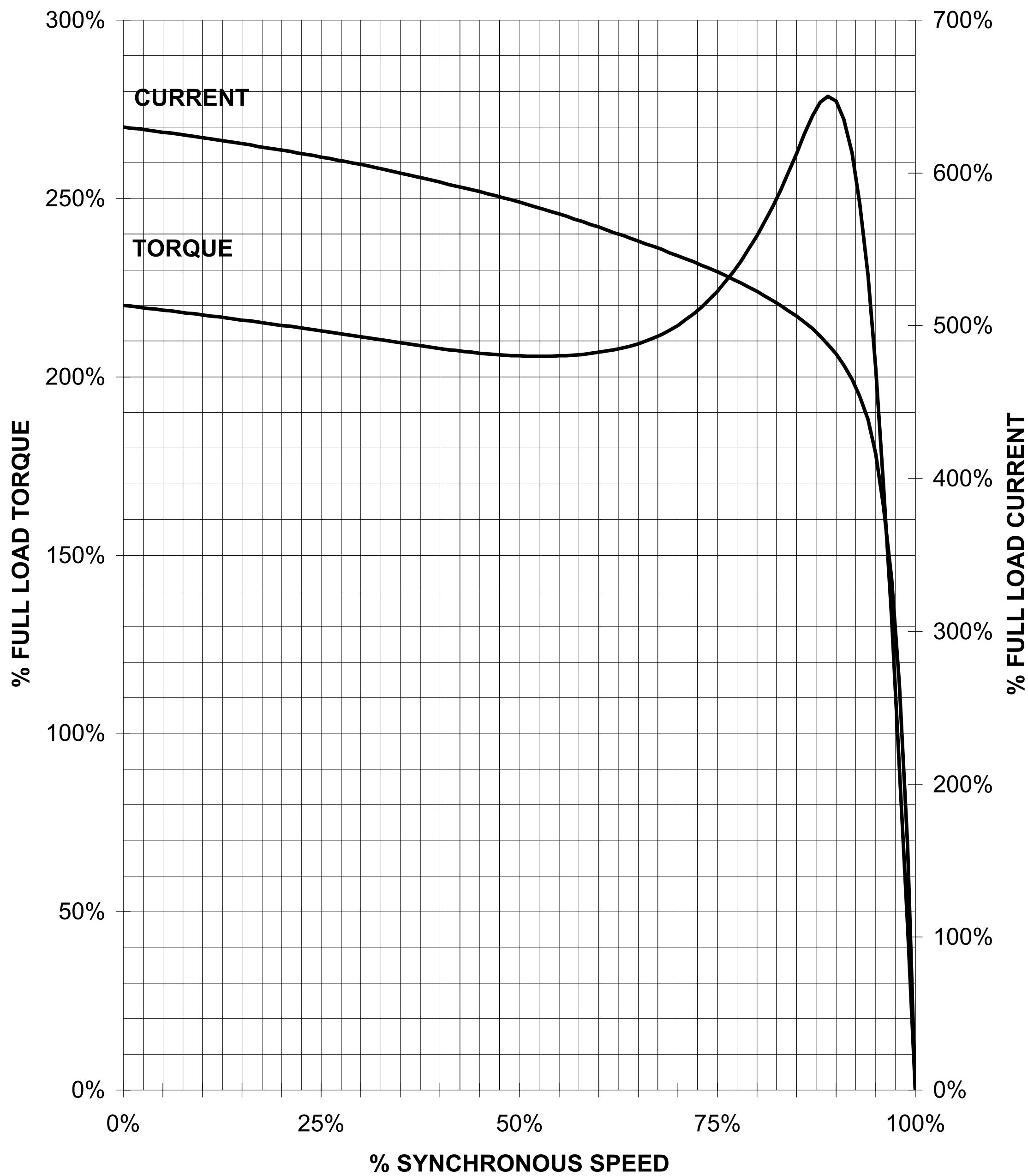


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	25	VOLTS	460	RPM	1800	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	284T	NEMA	B

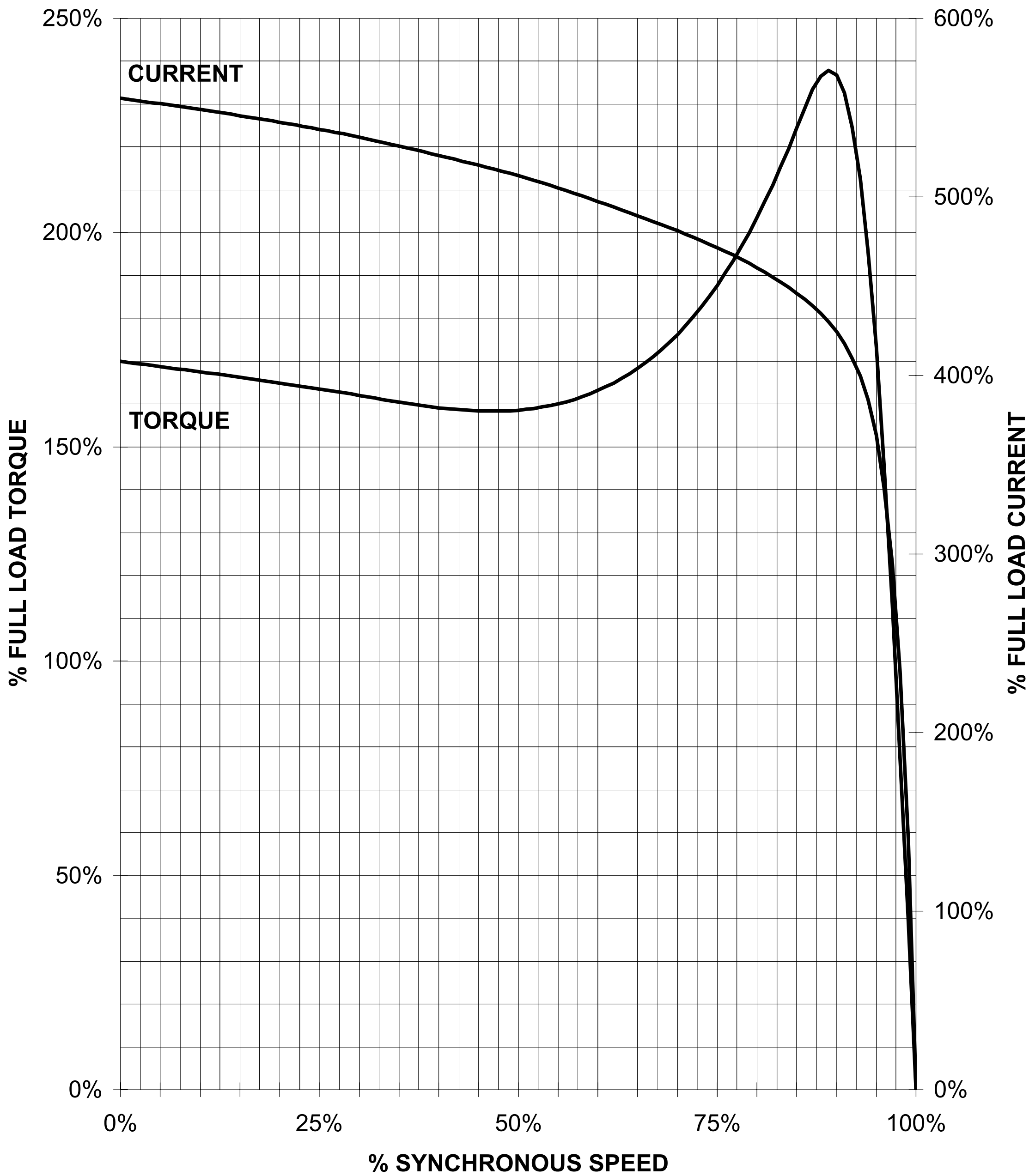
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	25	VOLTS	460	RPM	1200	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	324T	NEMA	B

TORQUE AND CURRENT VS. SPEED

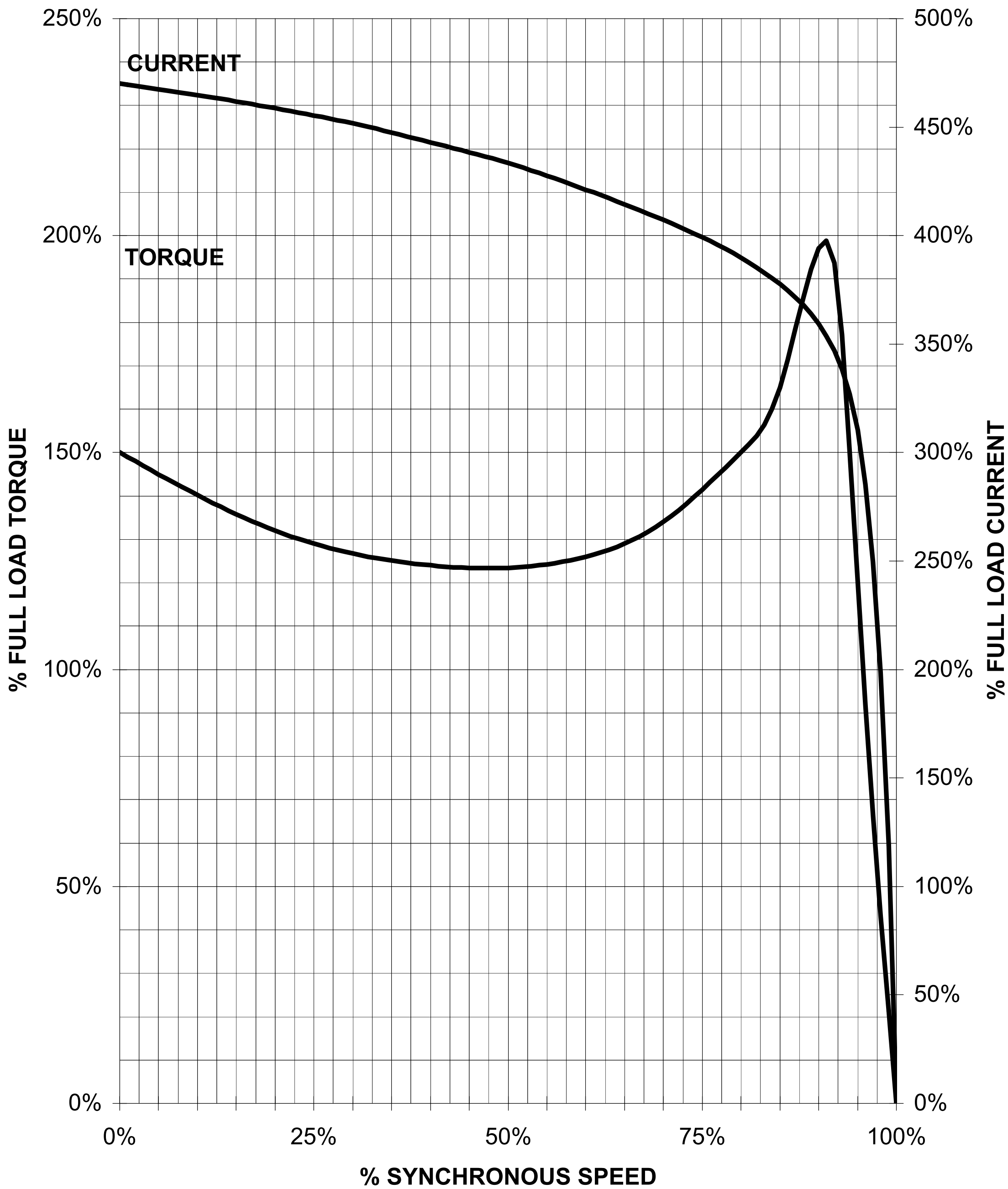


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	25	VOLTS	460	RPM	900	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	326T	NEMA	B

TORQUE AND CURRENT VS. SPEED



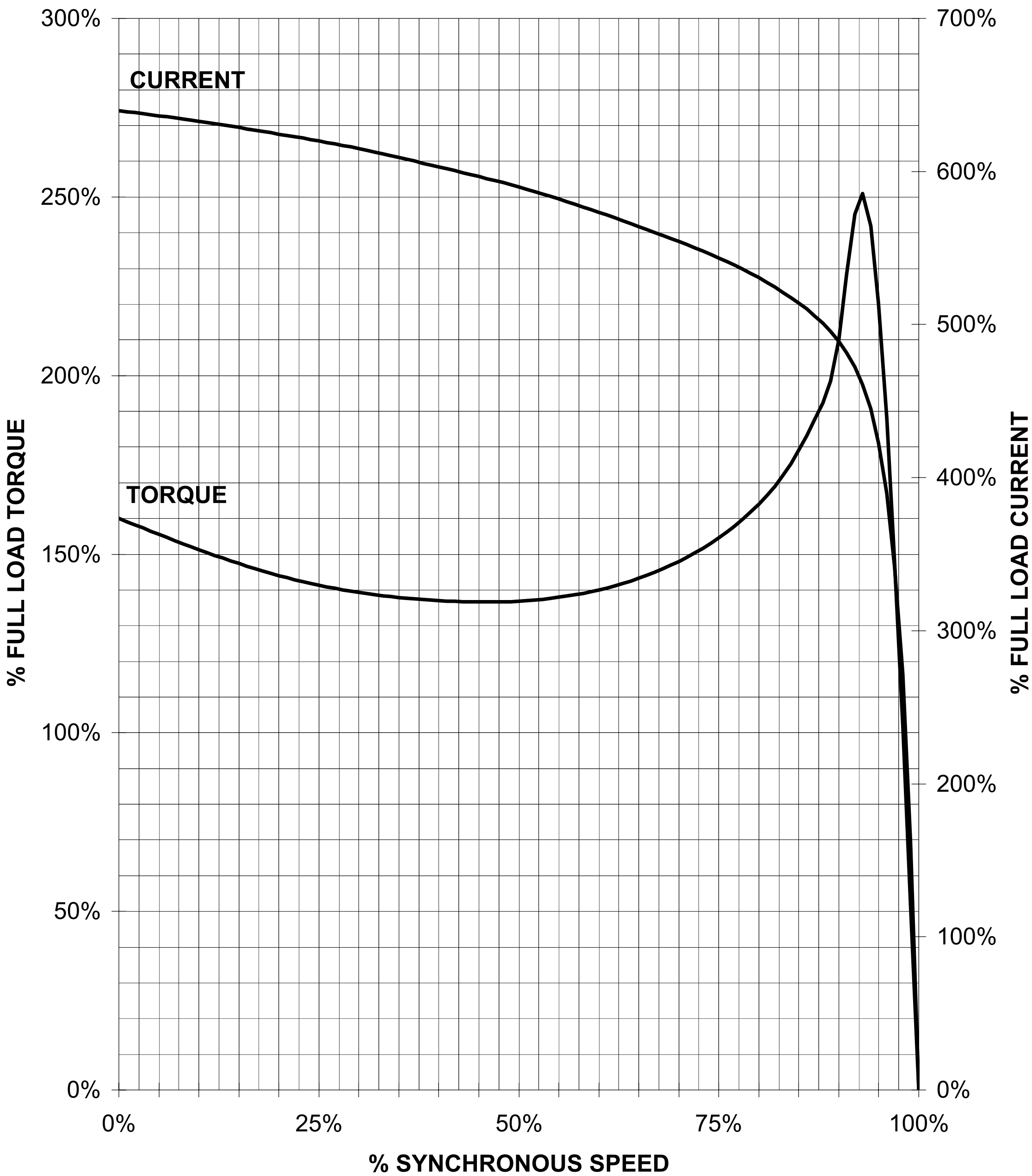
Customer: **PO No.:** **Order No.:**

Application Manual for NEMA Motors

HP 30 VOLTS 460 RPM 3600 TYPE RGZZESD

HZ 60 PHASE 3 FRAME 286TS NEMA B

TORQUE AND CURRENT VS. SPEED

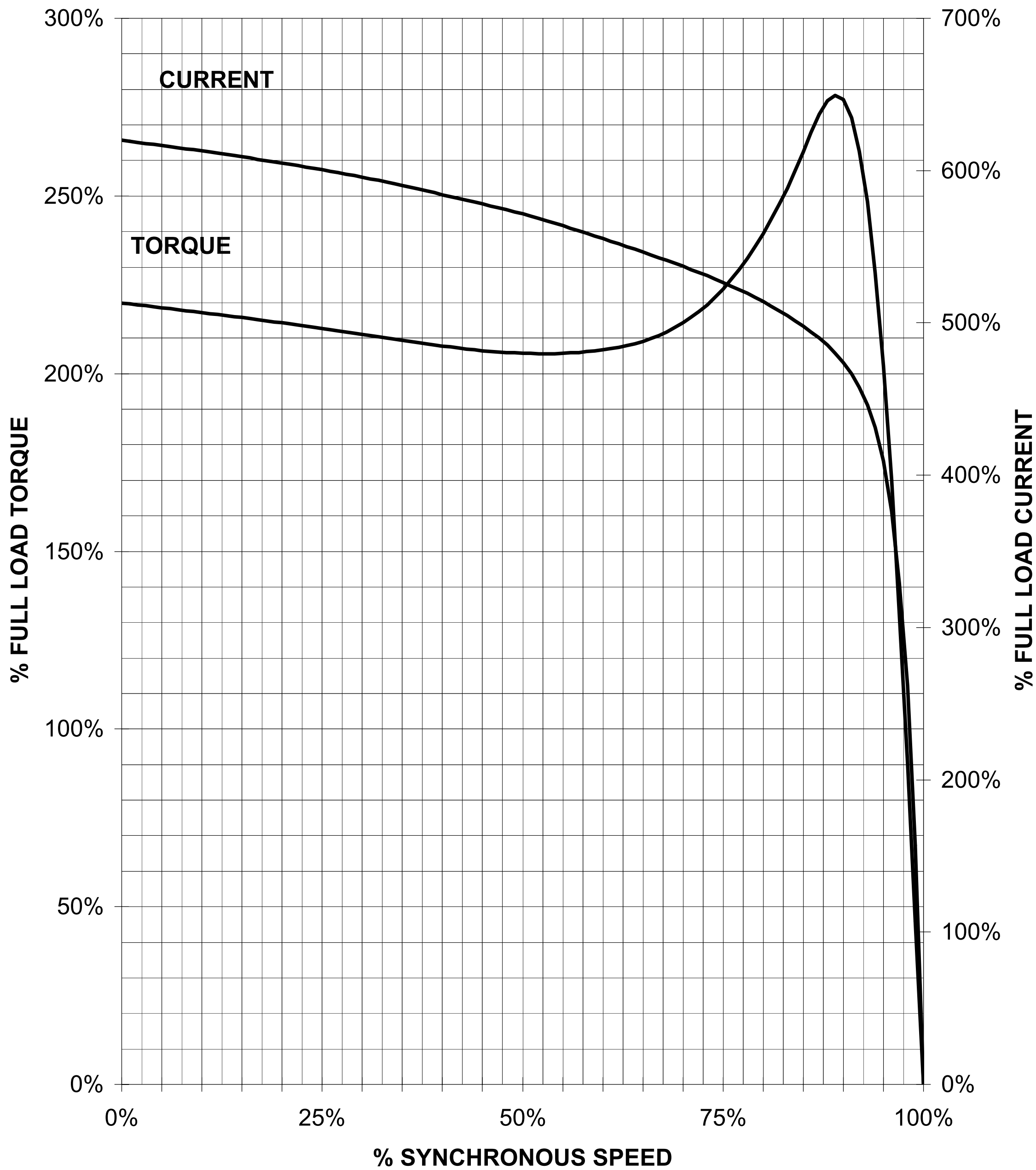


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	30	VOLTS	460	RPM	1800	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	286T	NEMA	B

TORQUE AND CURRENT VS. SPEED

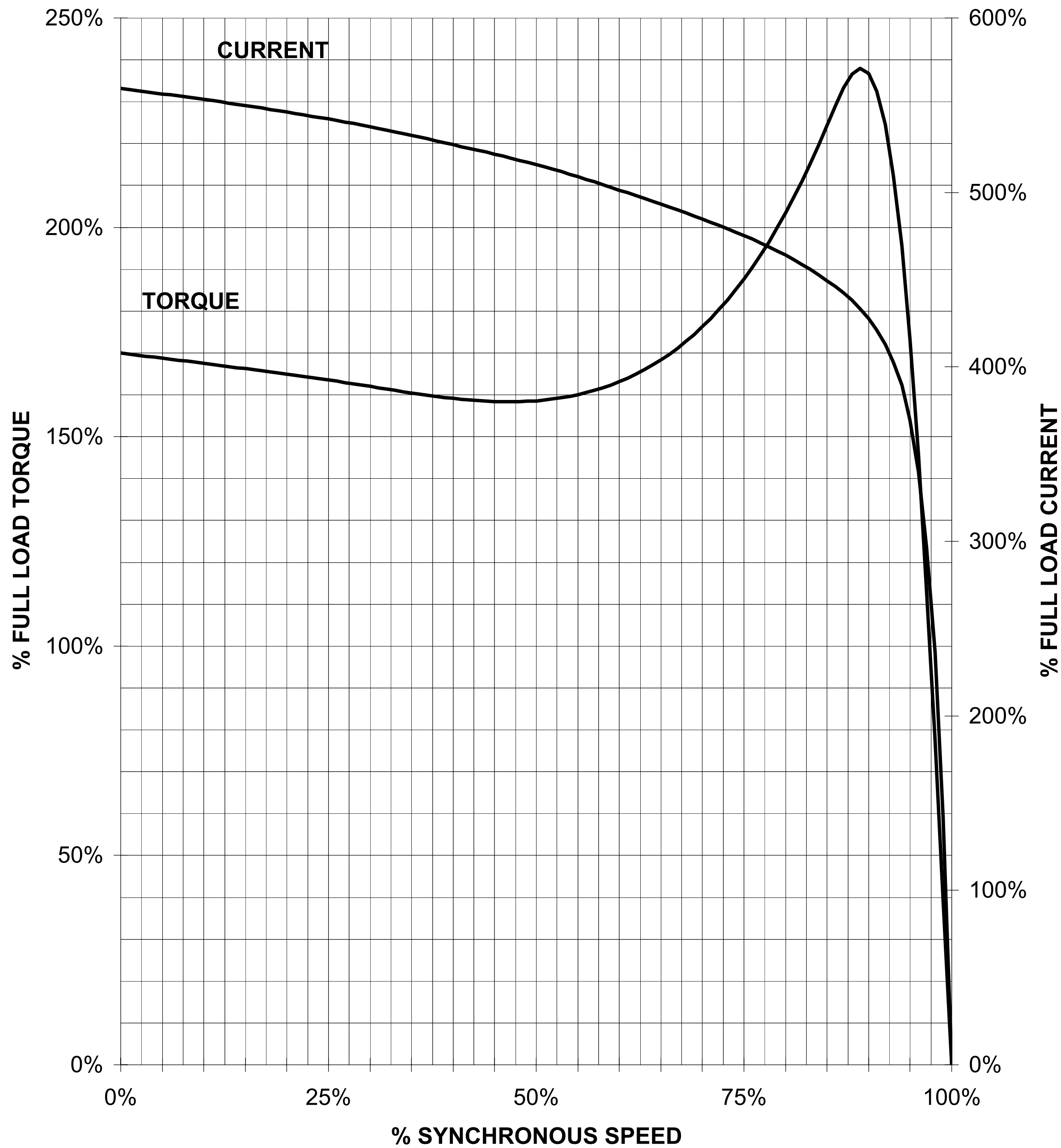


Customer: **PO No.:** **Order No.:**

HP 30 VOLTS 460 RPM 1200 TYPE RGZZESD

HZ 60 PHASE 3 FRAME 326T NEMA B

TORQUE & CURRENT VS. SPEED

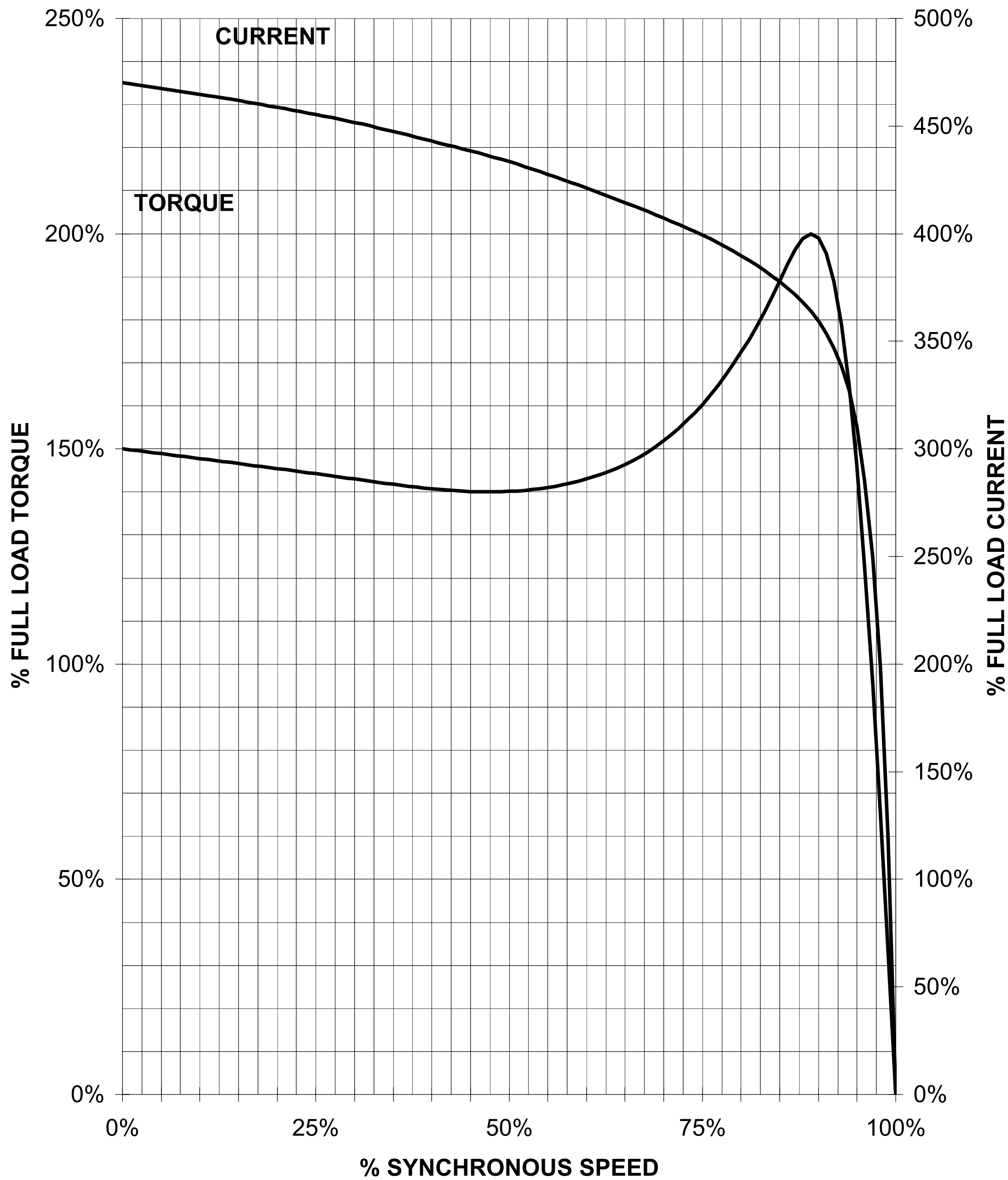


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	30	VOLTS	460	RPM	900	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	364T	NEMA	B

TORQUE & CURRENT VS. SPEED

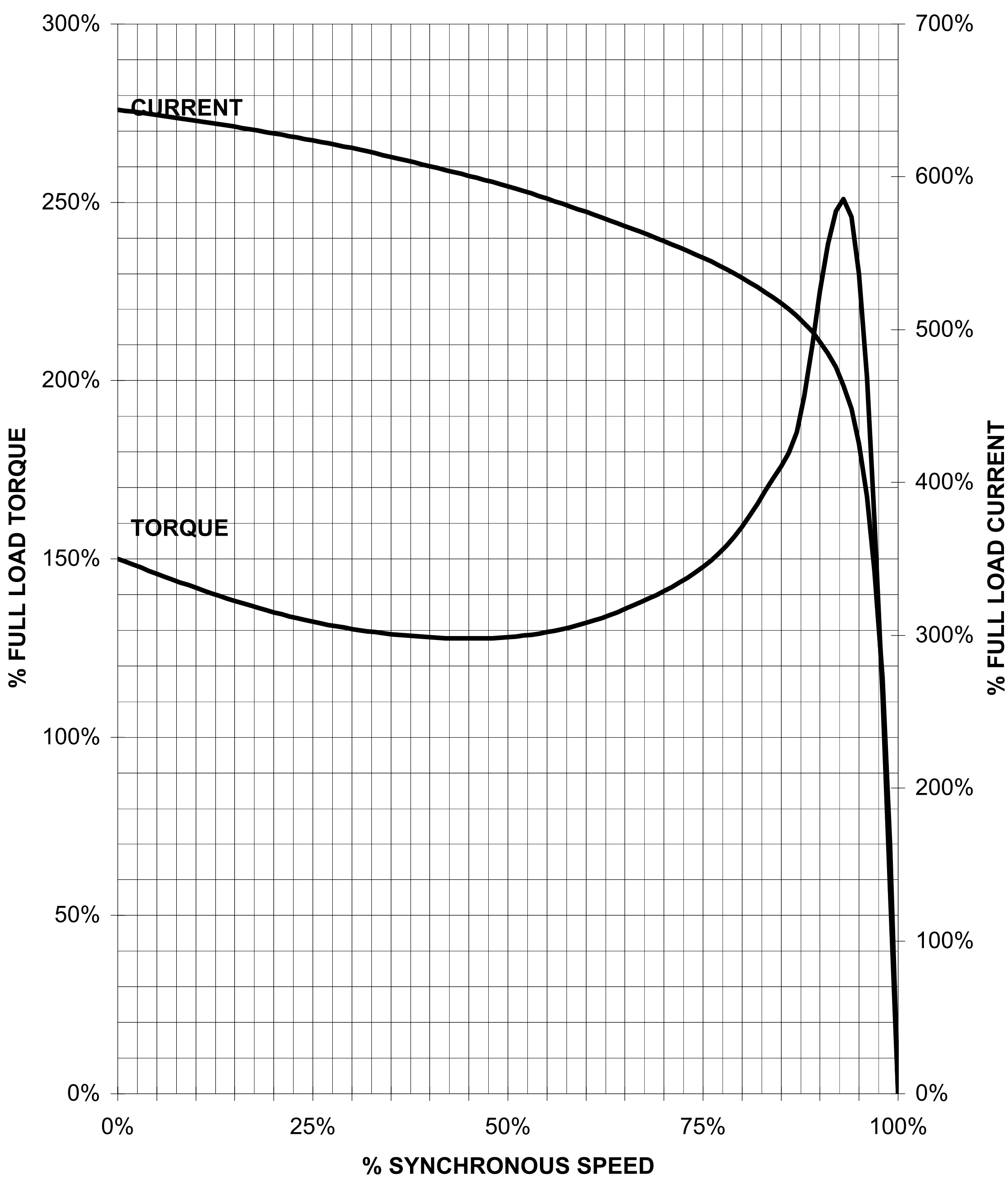


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	40	VOLTS	460	RPM	3600	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	324TS	NEMA	B

TORQUE AND CURRENT VS. SPEED

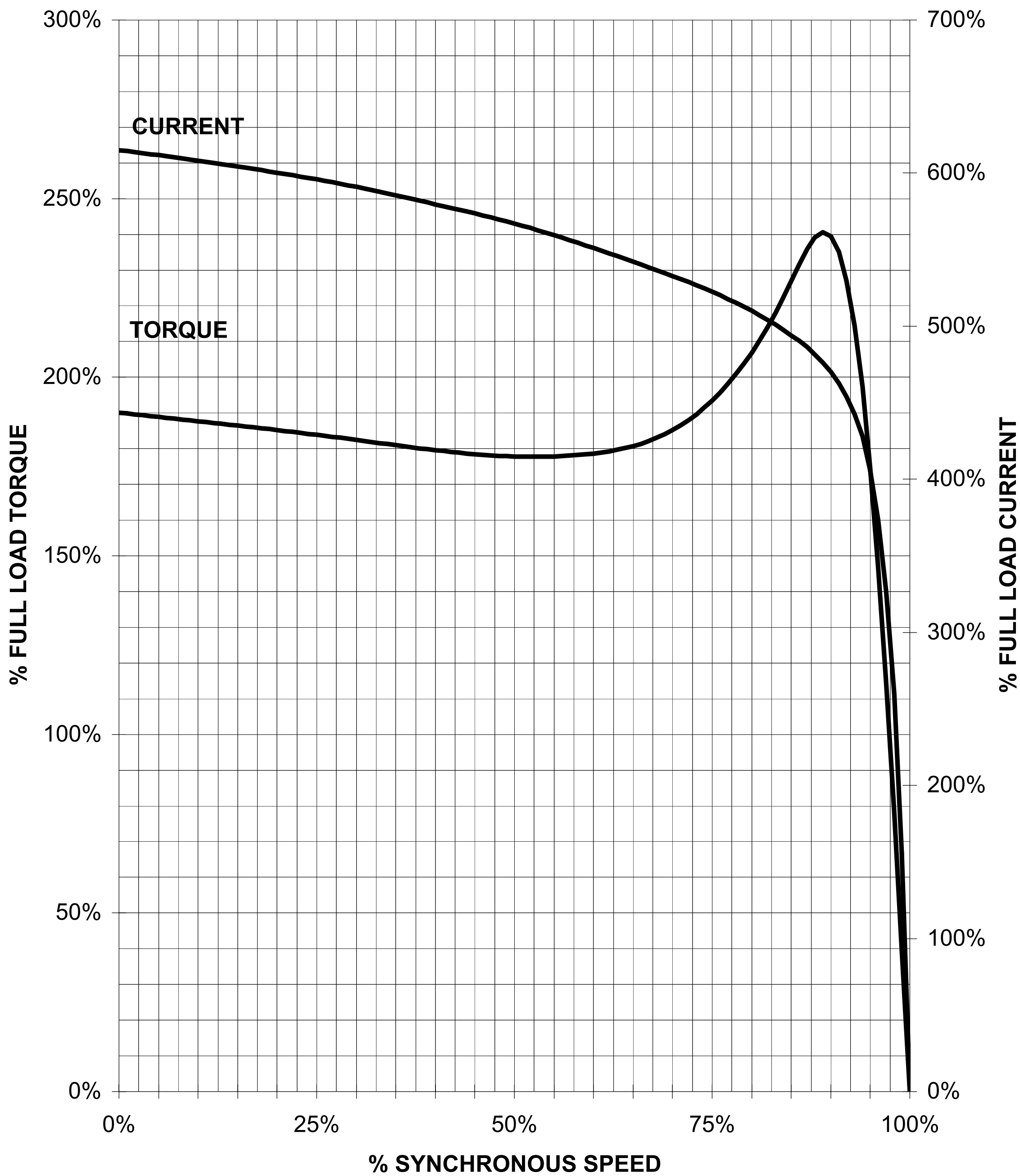


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	40	VOLTS	460	RPM	1800	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	324T	NEMA	B

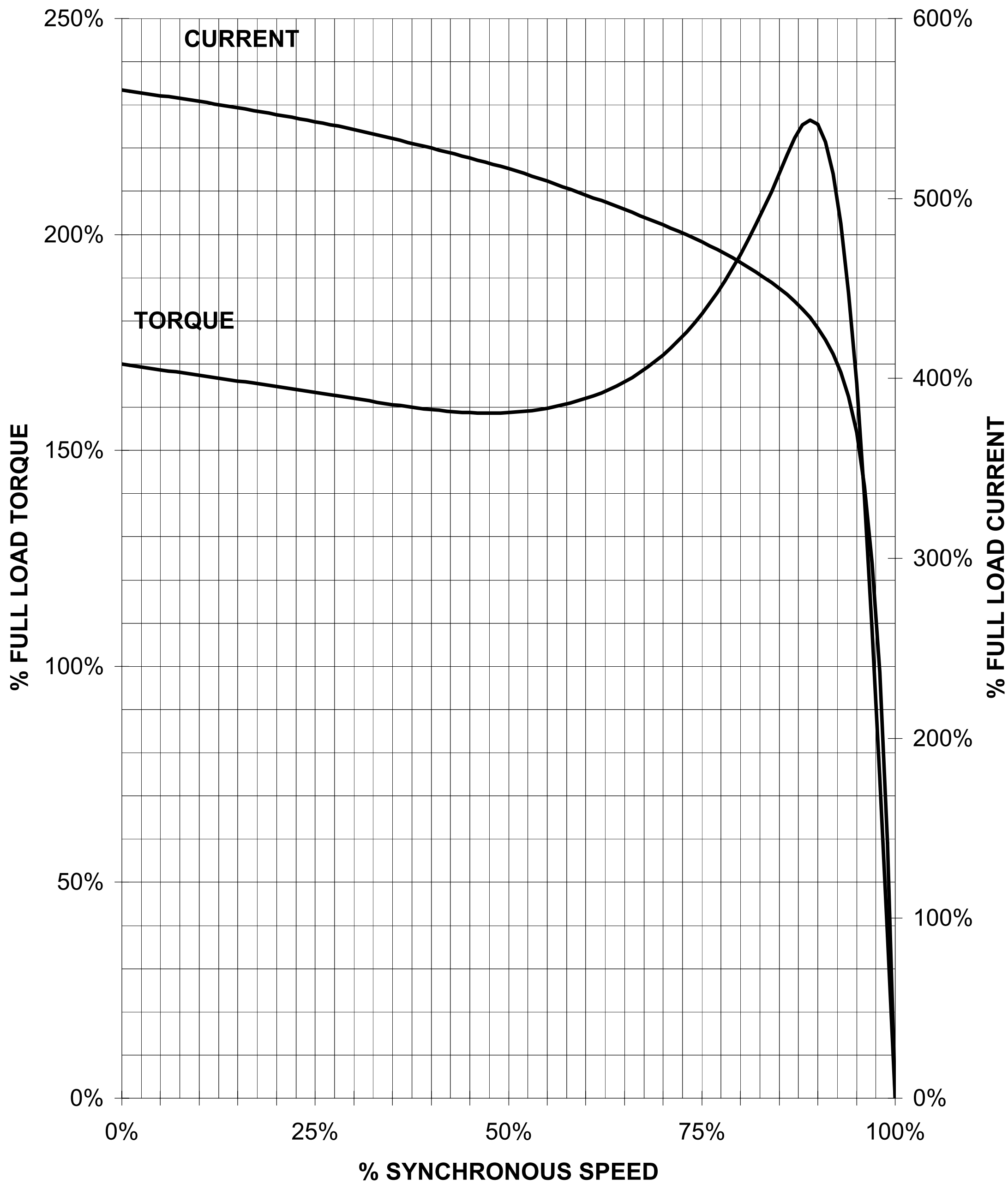
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	40	VOLTS	460	RPM	1200	TYPE	RGZESD
HZ	60	PHASE	3	FRAME	364T	NEMA	B

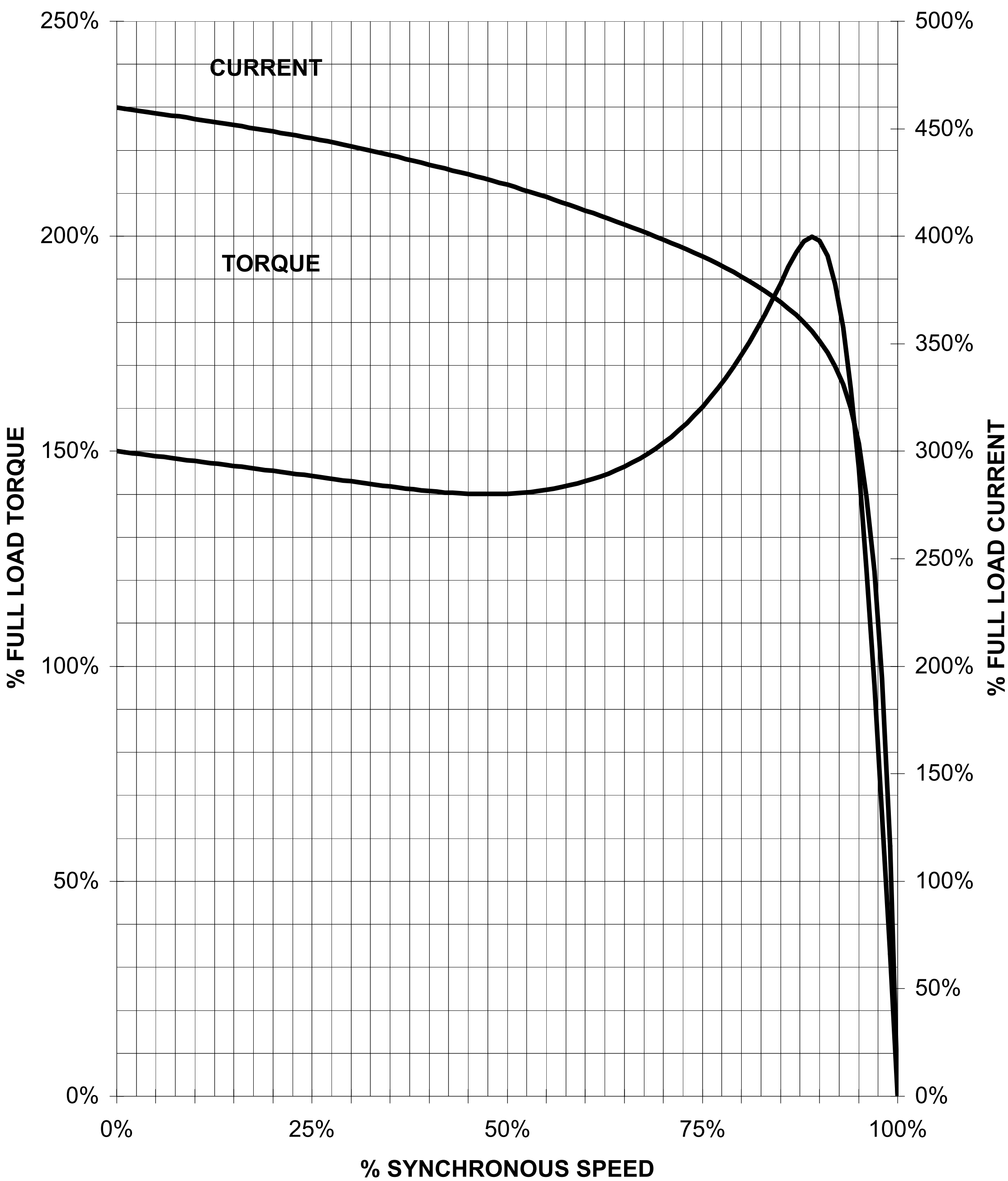
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	40	VOLTS	460	RPM	900	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	365T	NEMA	B

TORQUE AND CURRENT VS. SPEED

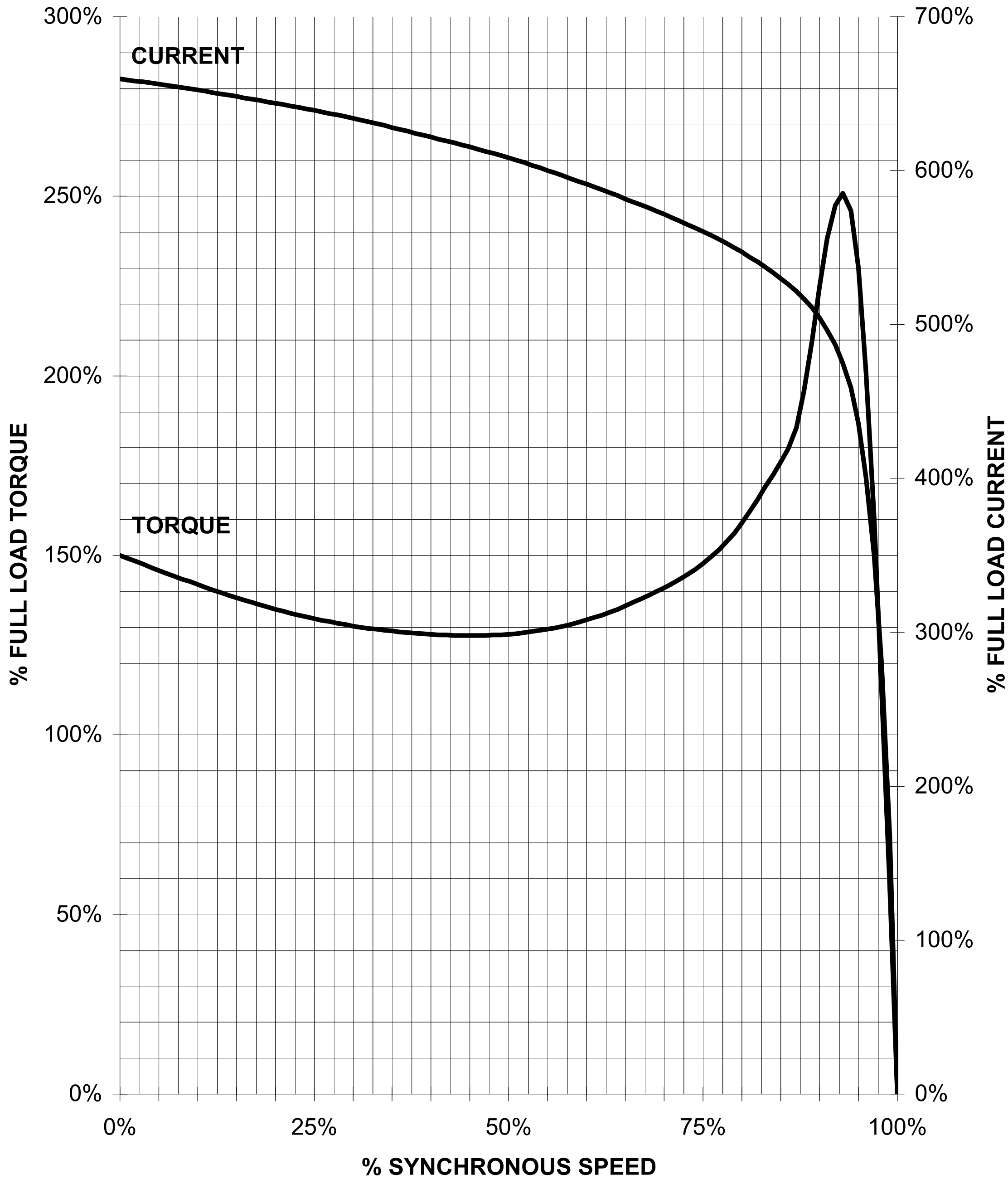


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	50	VOLTS	460	RPM	3600	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	326TS	NEMA	B

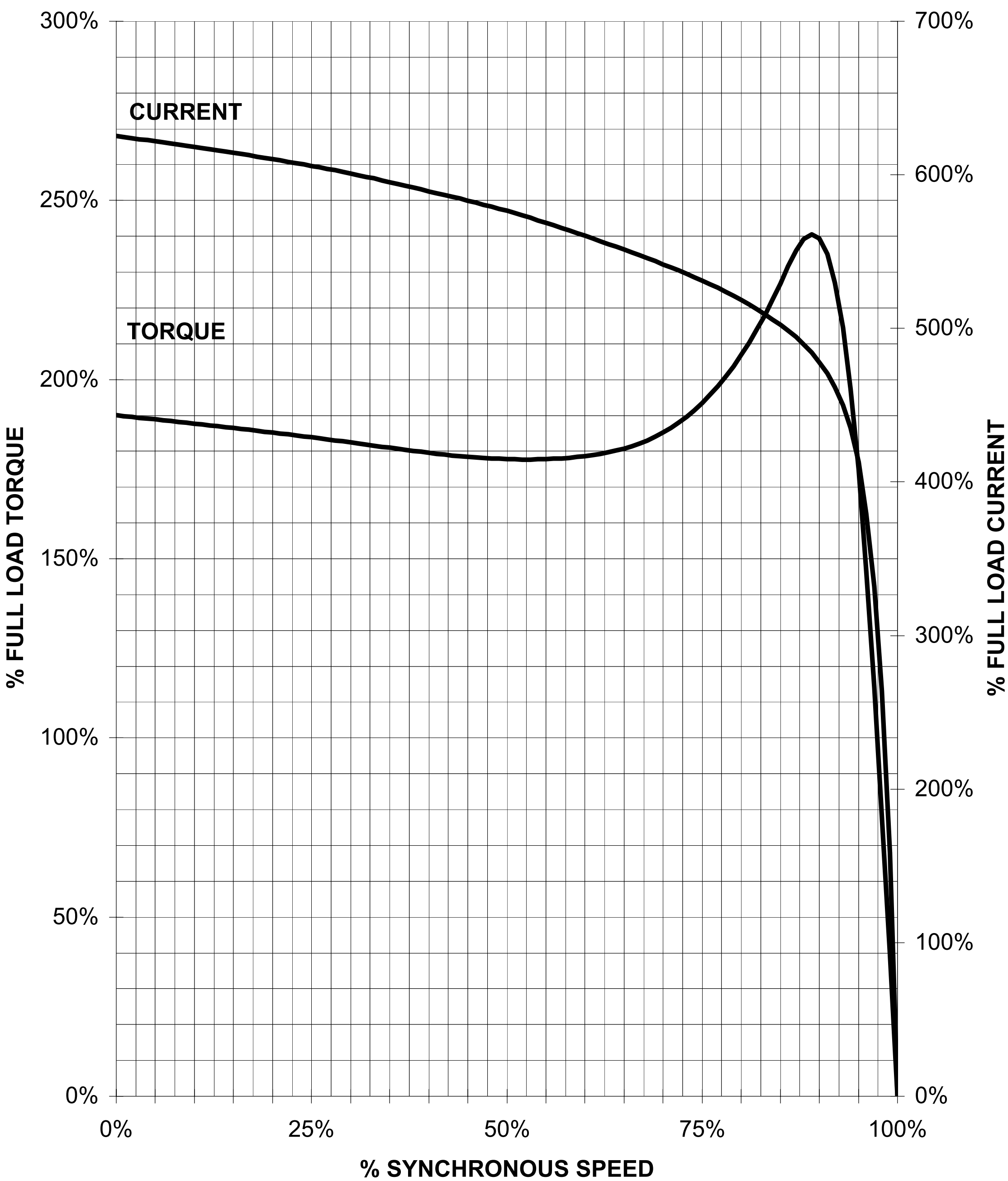
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	50	VOLTS	460	RPM	1800	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	326T	NEMA	B

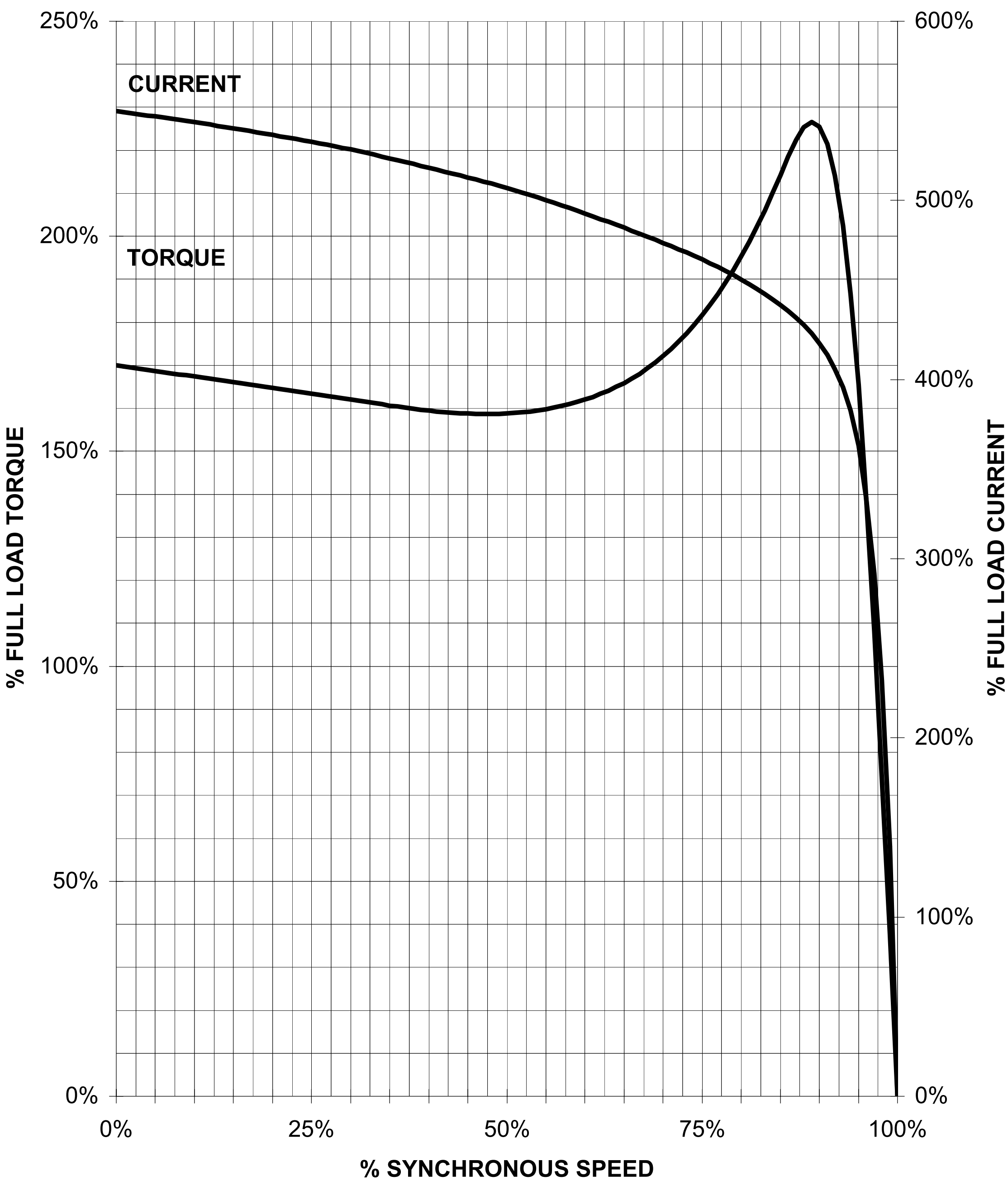
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	50	VOLTS	460	RPM	1200	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	365T	NEMA	B

TORQUE AND CURRENT VS. SPEED

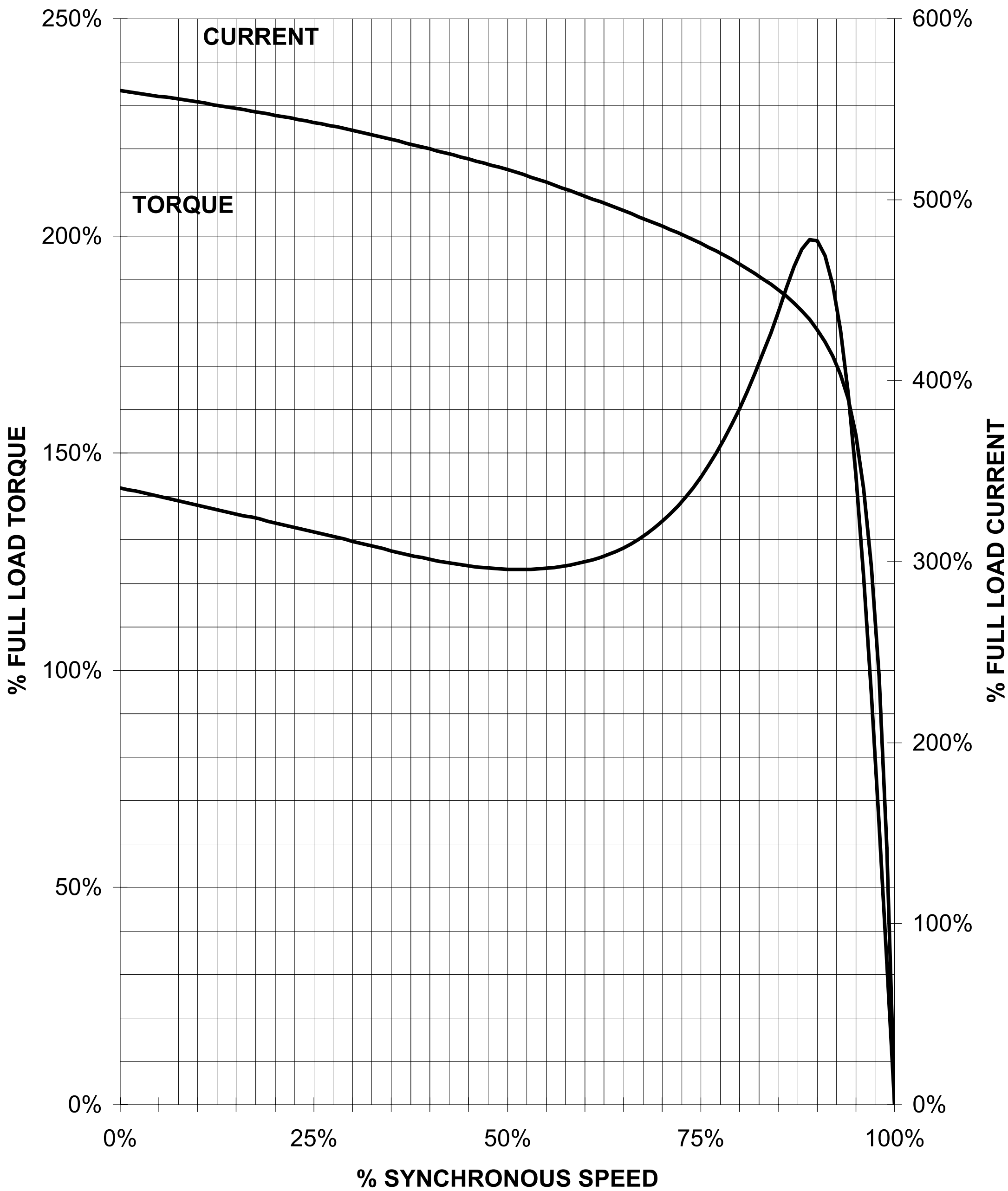


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	50	VOLTS	460	RPM	900	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	404T	NEMA	B

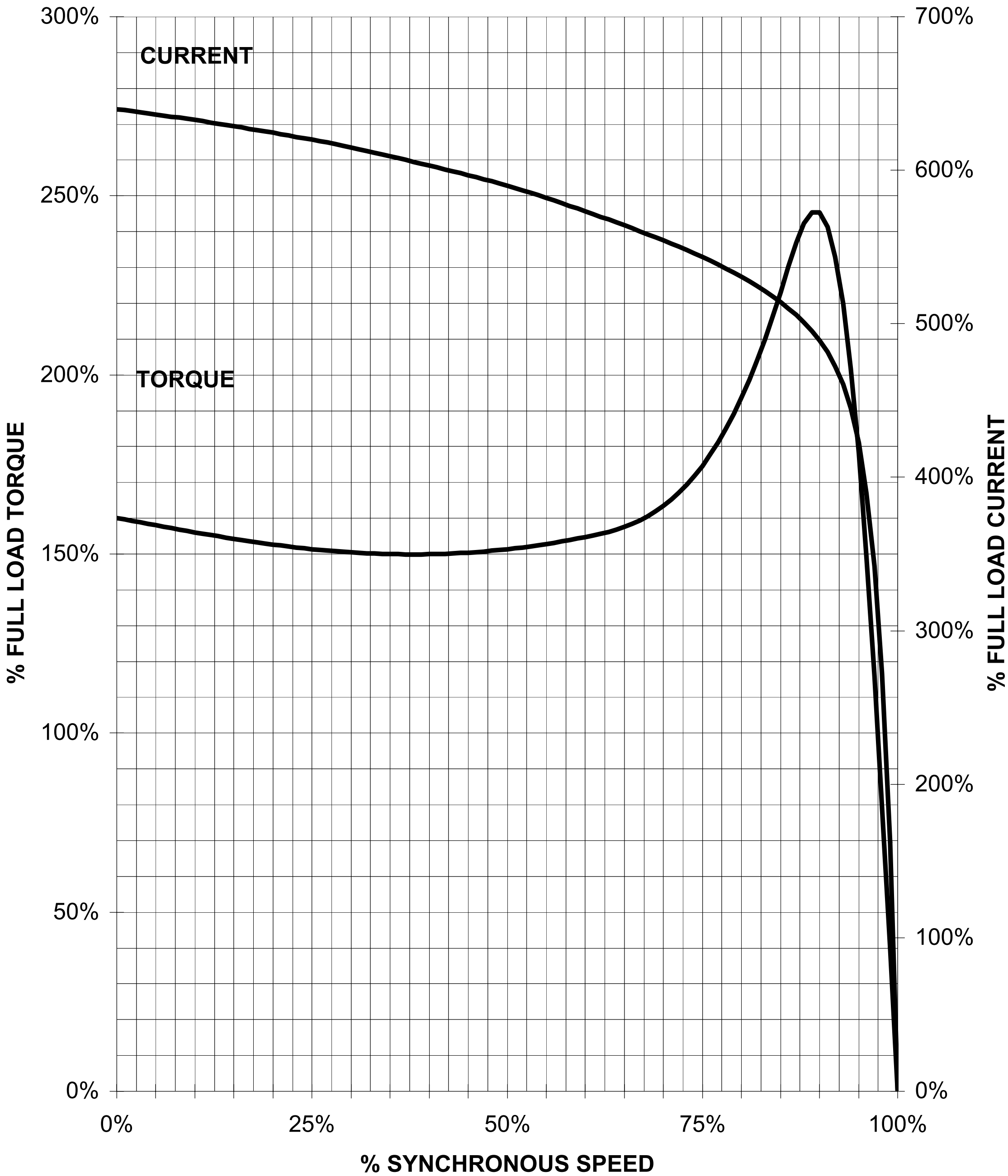
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	60	VOLTS	460	RPM	3600	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	364TS	NEMA	B

TORQUE AND CURRENT VS. SPEED

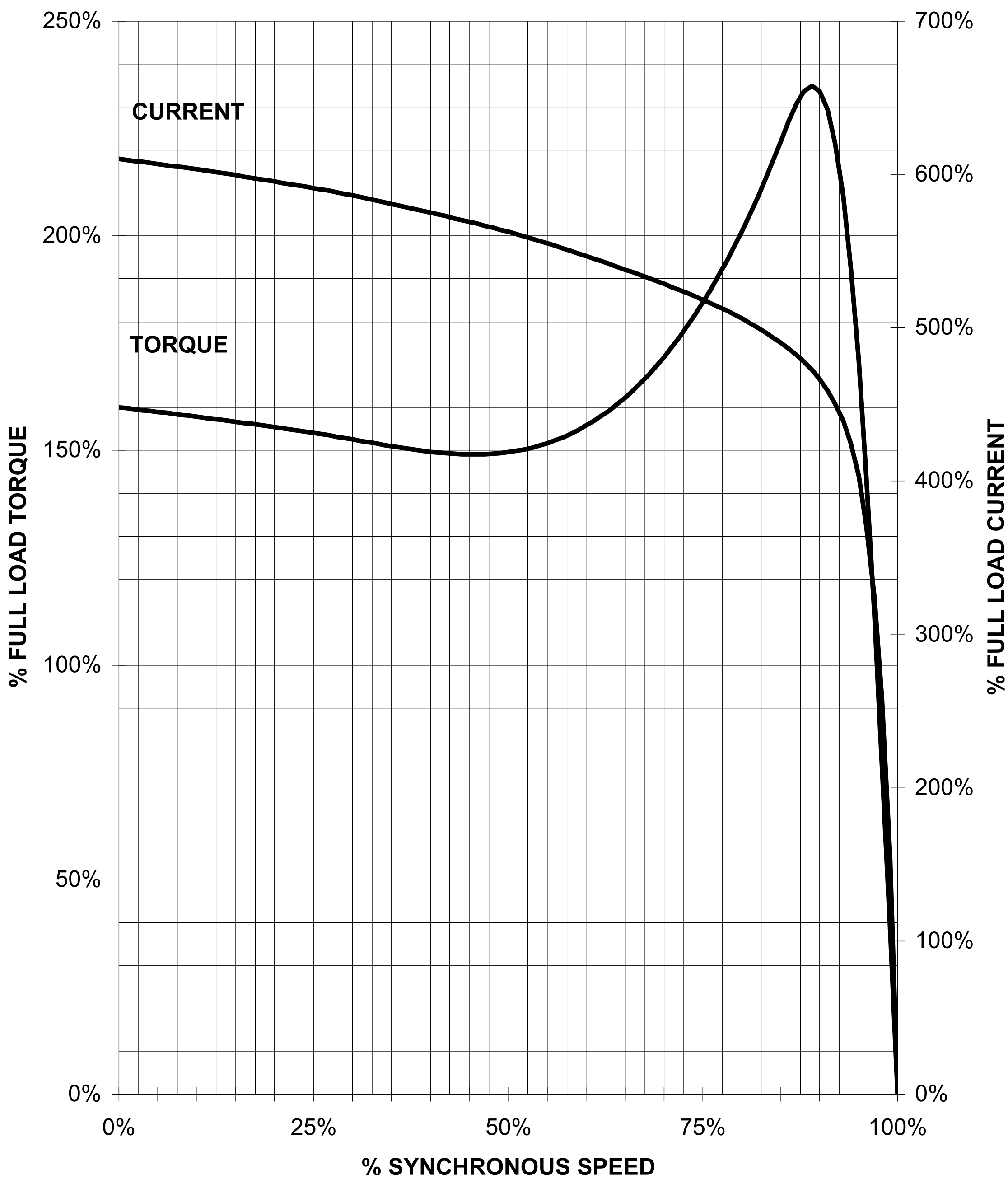


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	60	VOLTS	460	RPM	1800	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	364T	NEMA	B

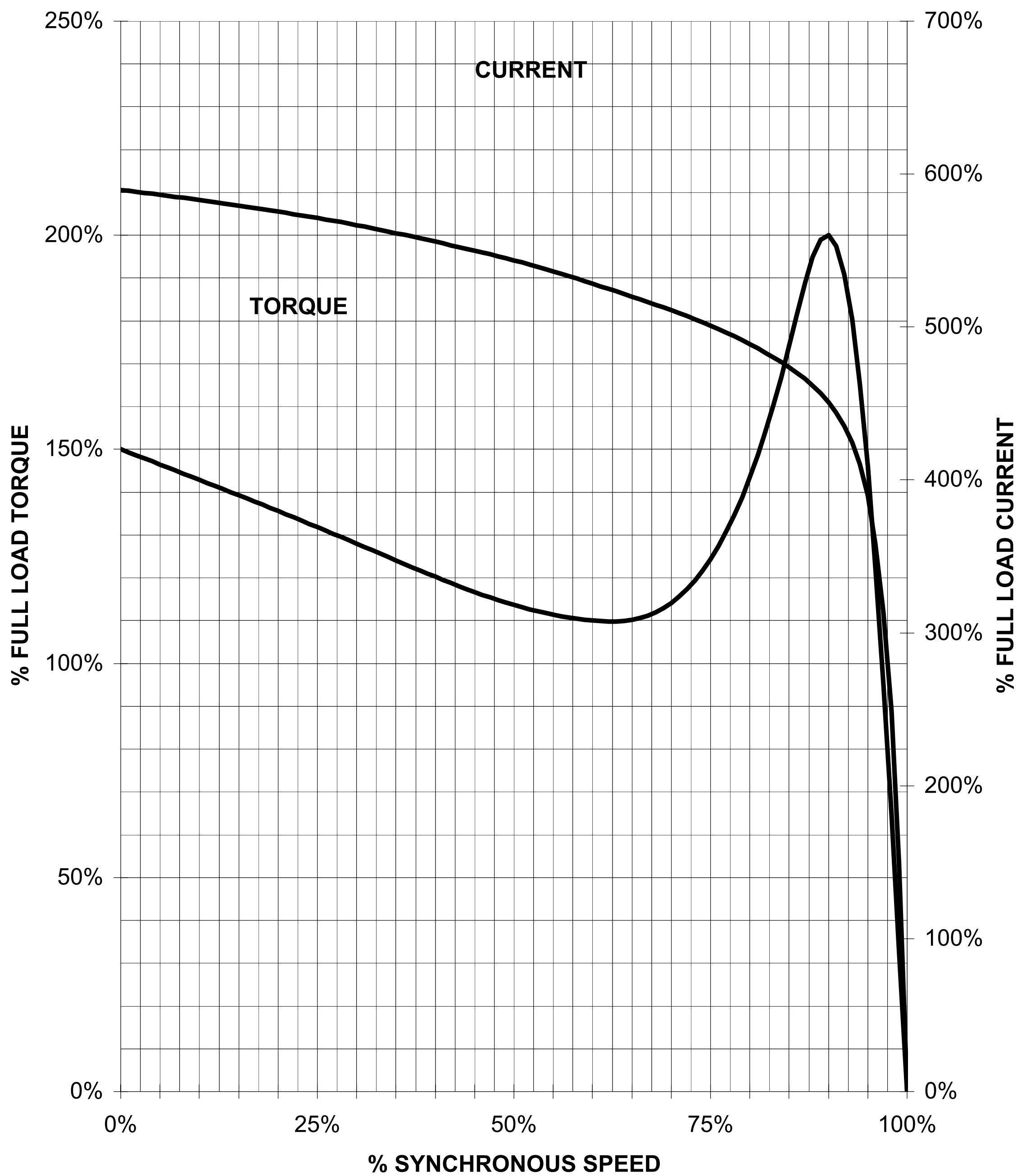
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	60	VOLTS	460	RPM	1200	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	404T	NEMA	B

TORQUE AND CURRENT VS. SPEED



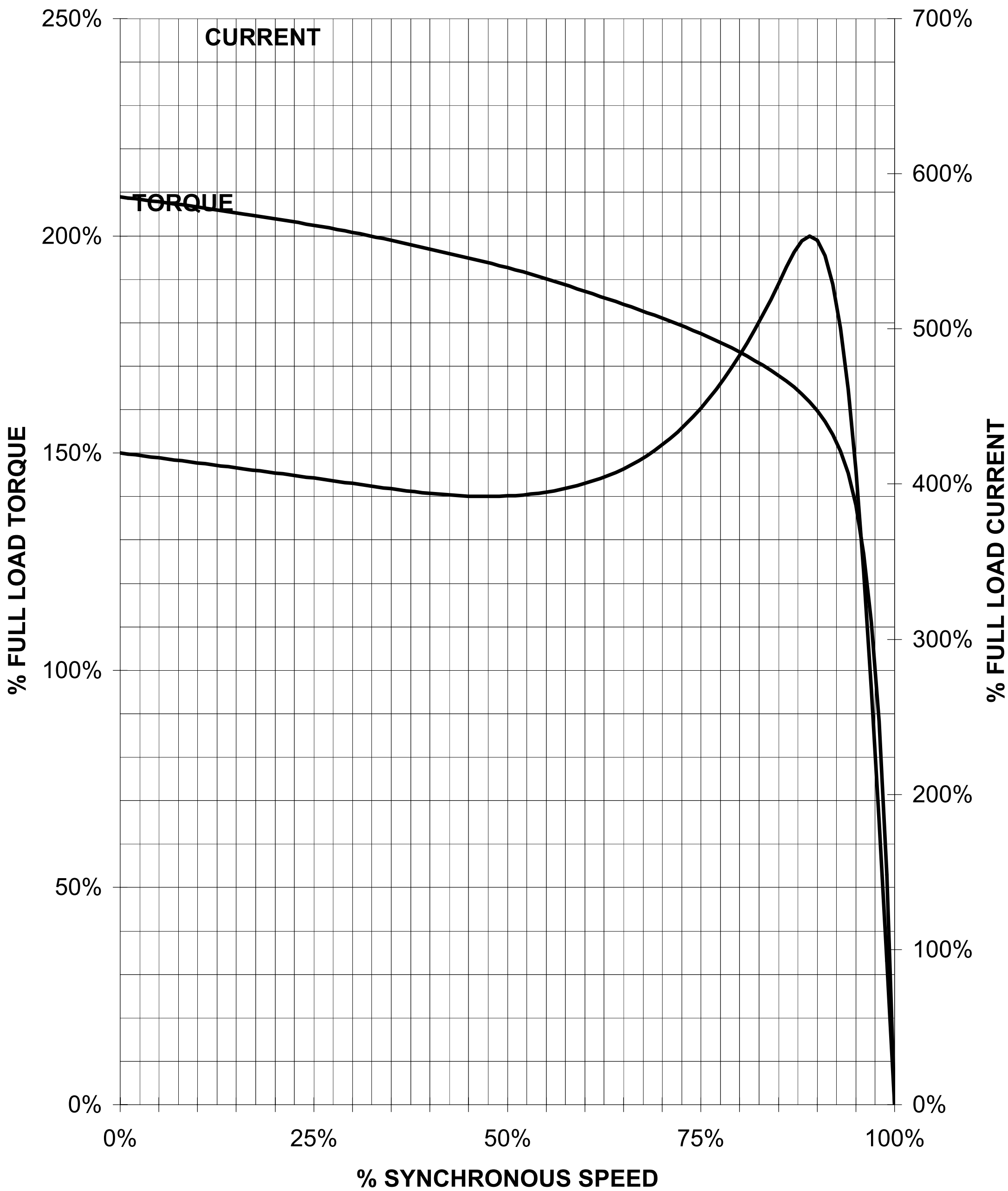
Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

Application Manual for NEMA Motors

HP	60	VOLTS	460	RPM	900	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	405T	NEMA	B

TORQUE & CURRENT VS. SPEED

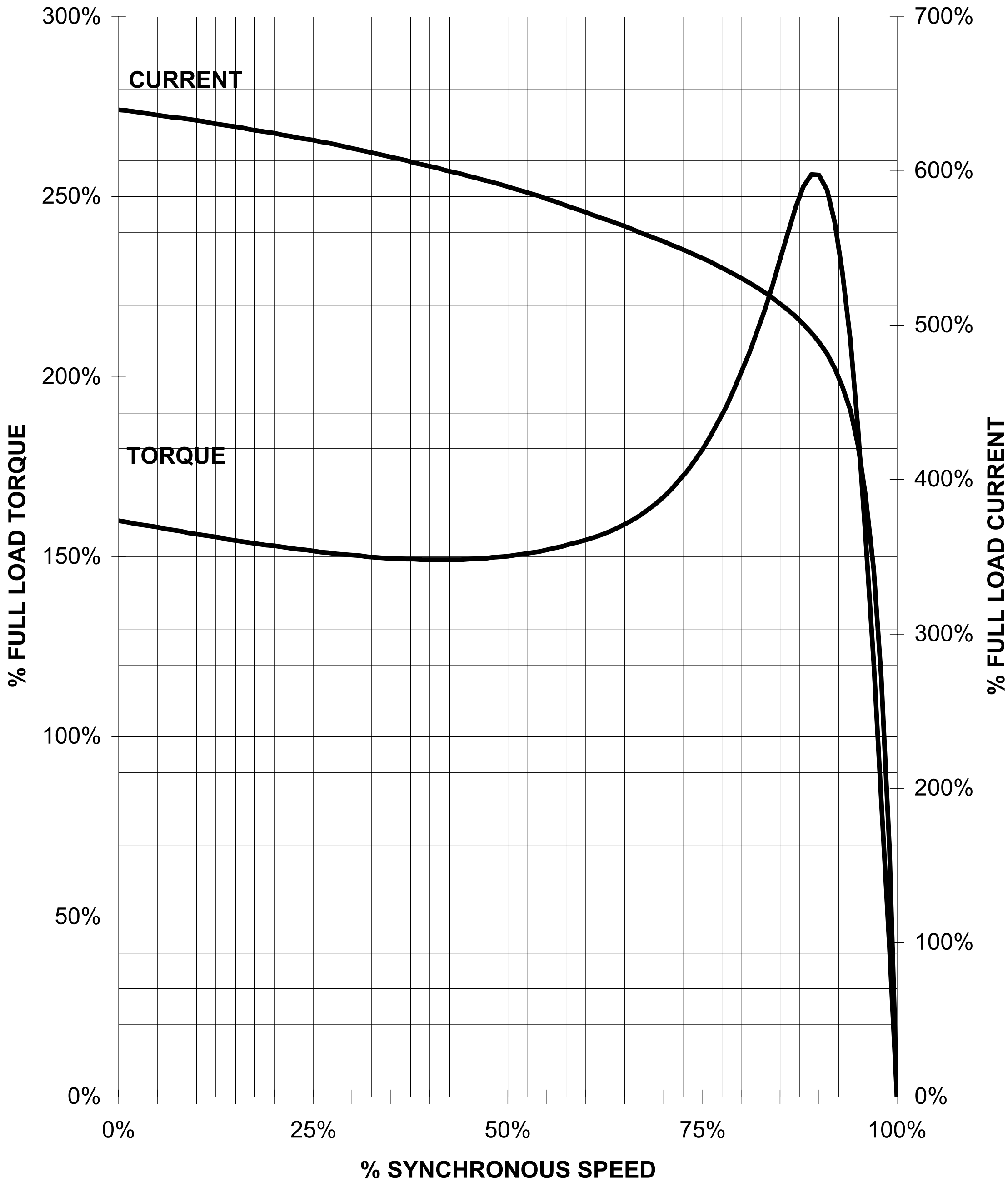


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	75	VOLTS	460	RPM	3600	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	365TS	NEMA	B

TORQUE AND CURRENT VS. SPEED



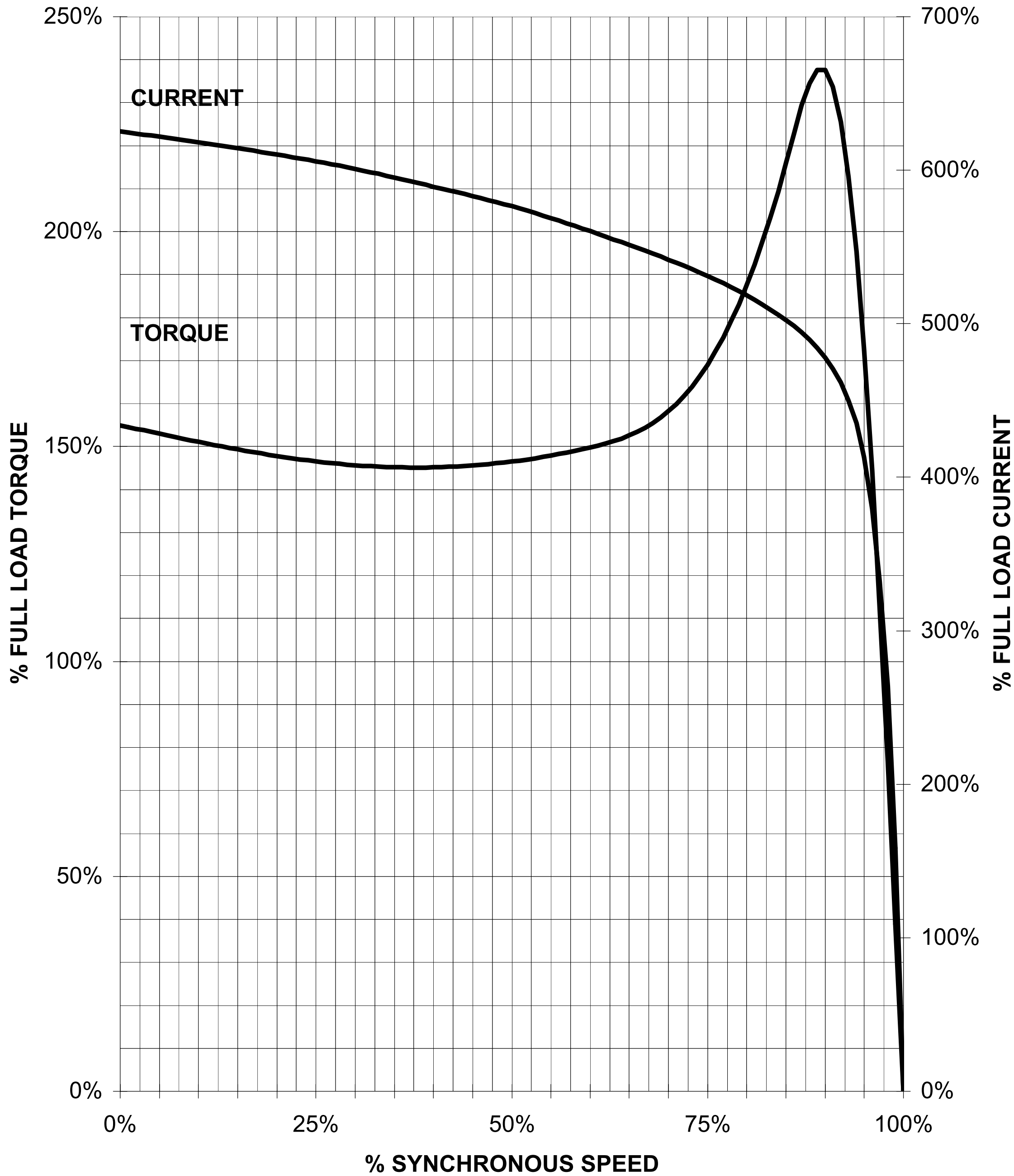
Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

Application Manual for NEMA Motors

HP	75	VOLTS	460	RPM	1800	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	365T	NEMA	B

TORQUE AND CURRENT VS. SPEED

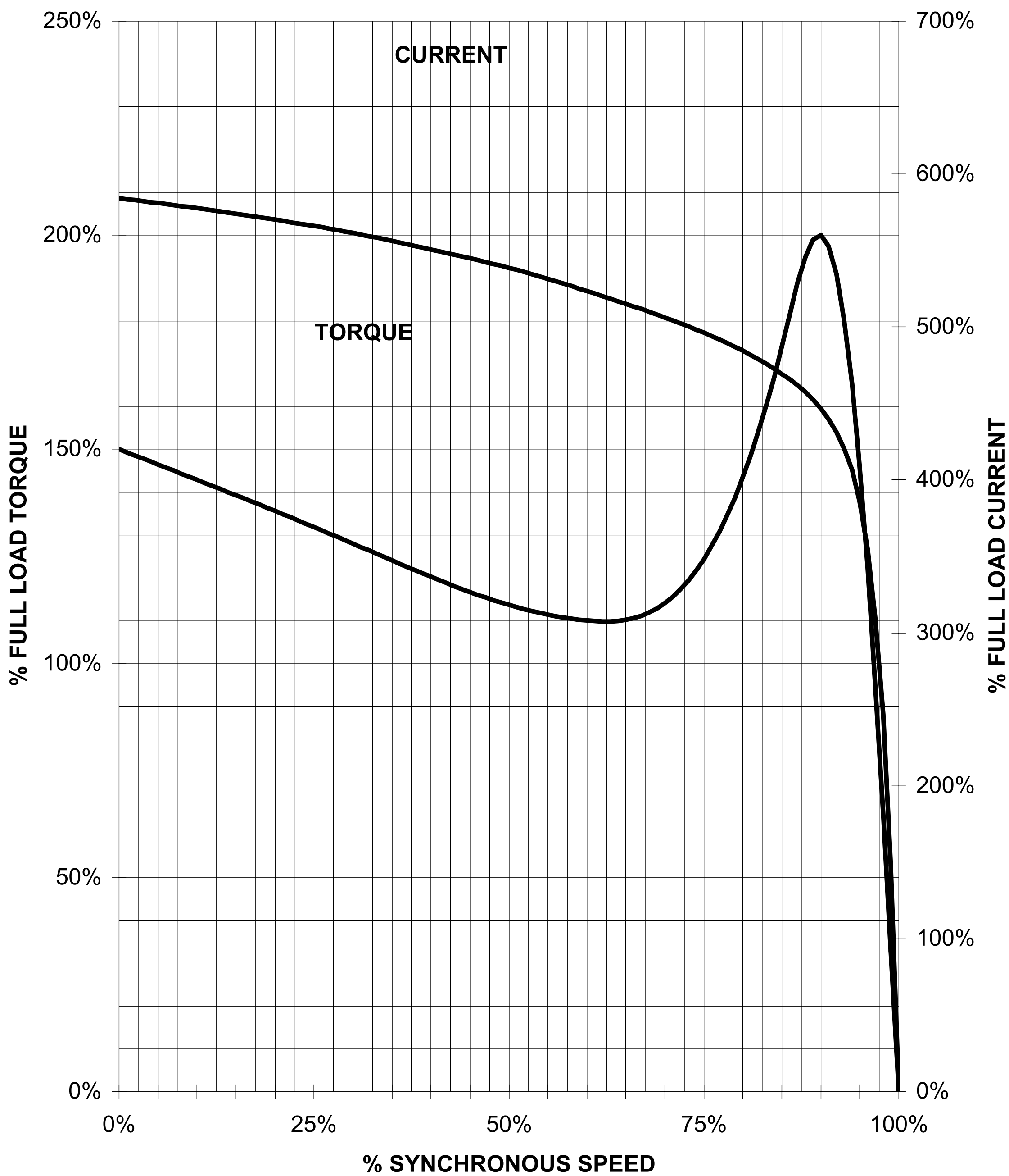


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	75	VOLTS	460	RPM	1200	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	405T	NEMA	B

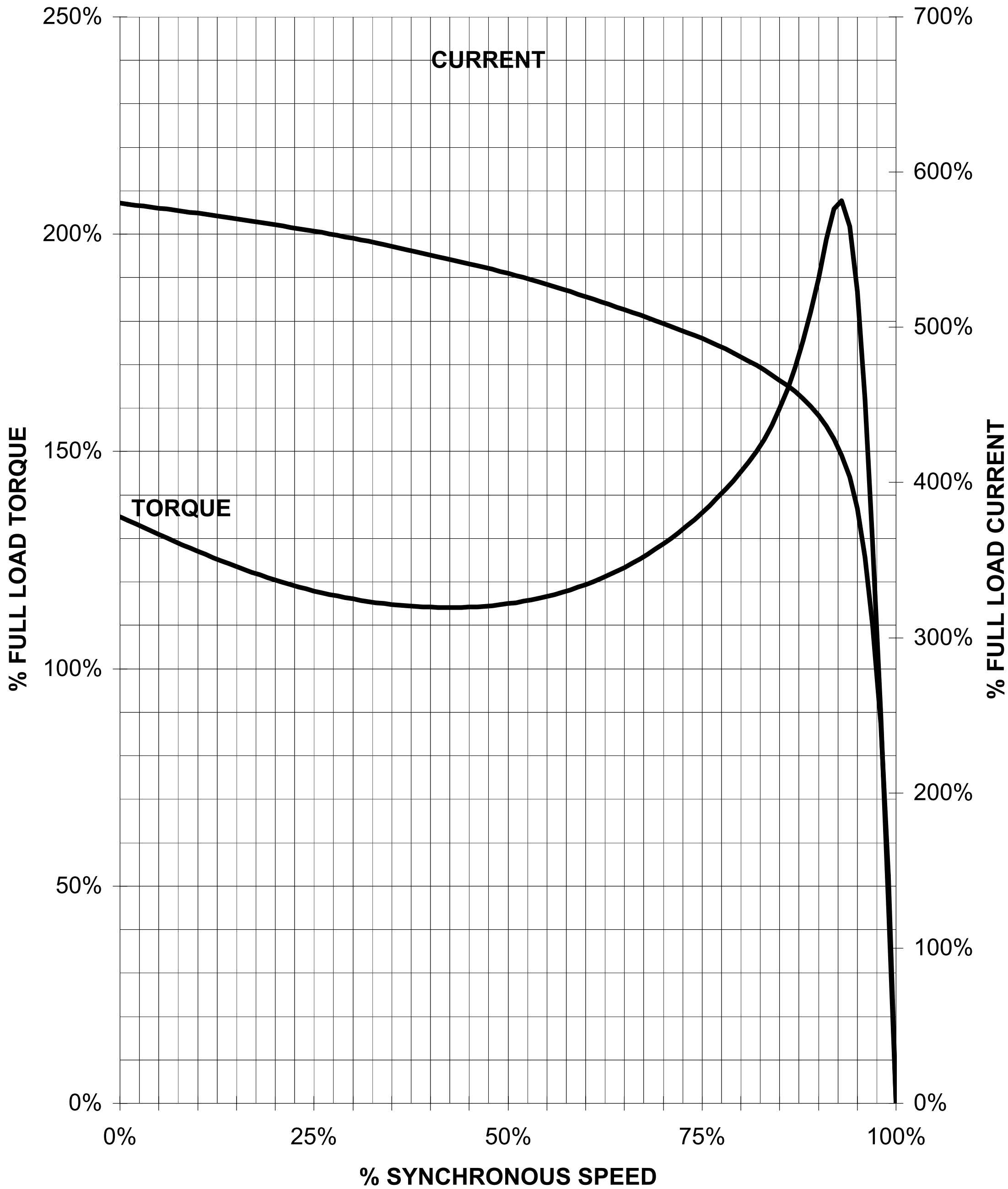
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	75	VOLTS	460	RPM	900	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	444T	NEMA	B

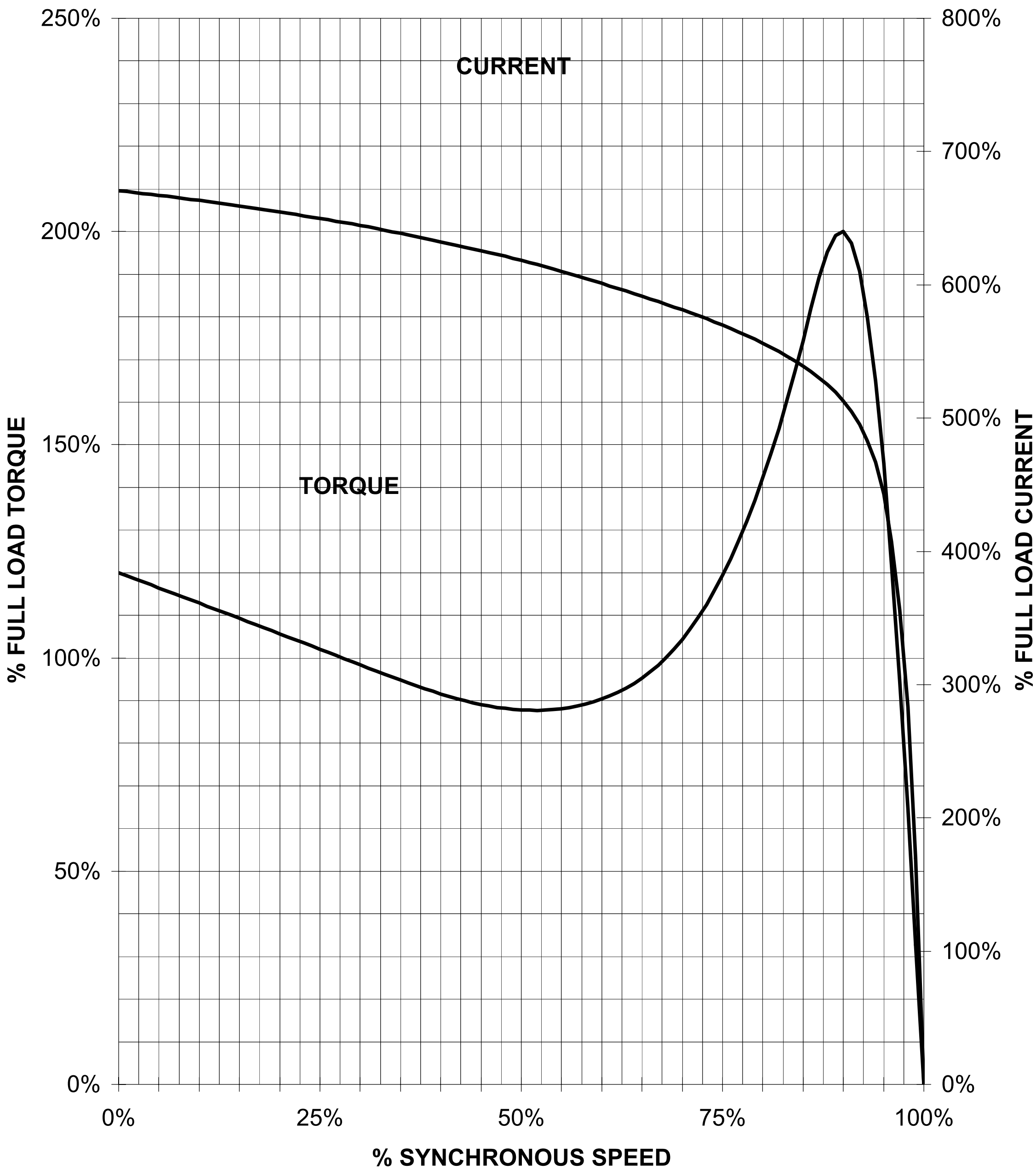
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	100	VOLTS	460	RPM	3600	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	405TS	NEMA	B

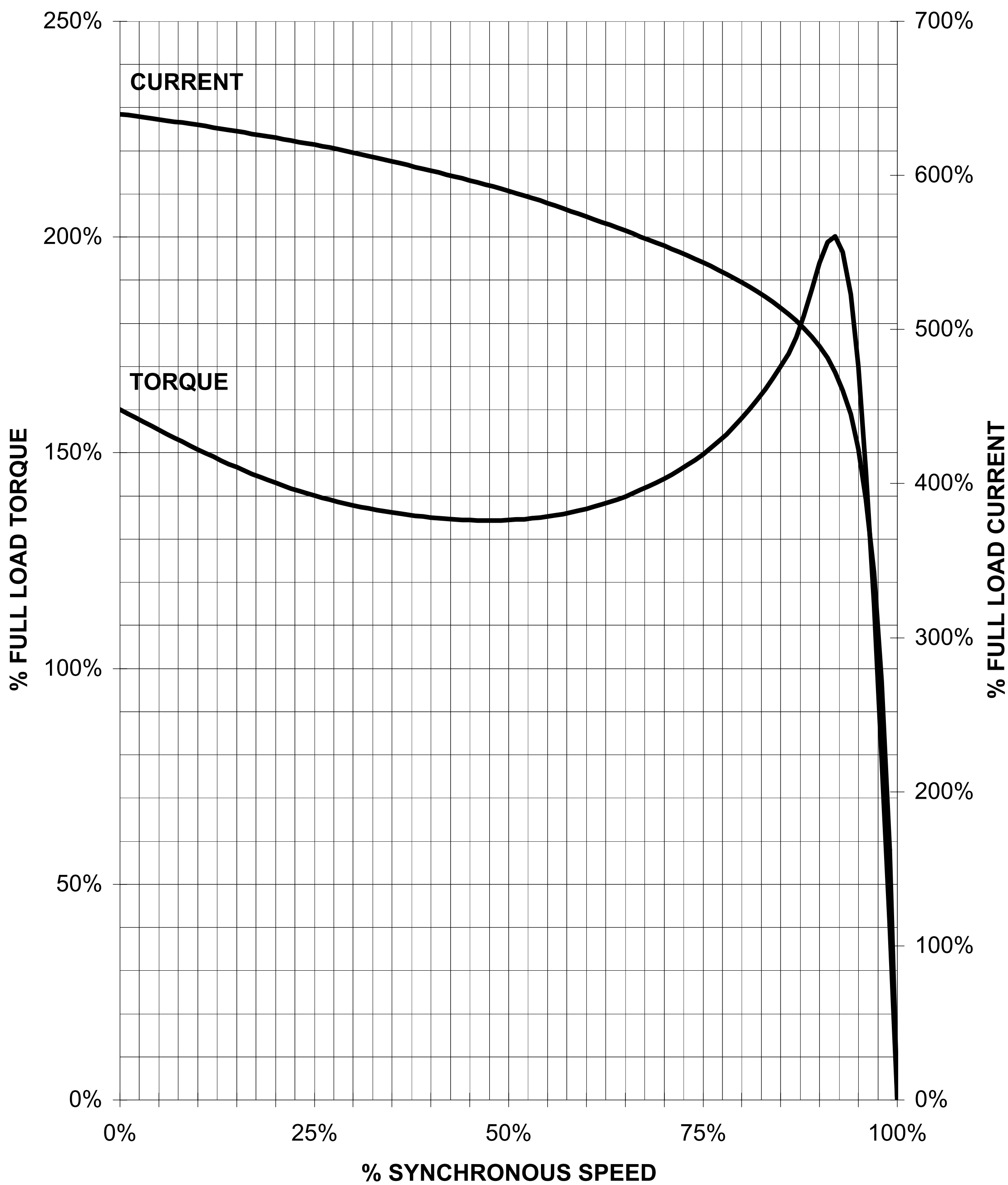
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	100	VOLTS	460	RPM	1800	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	405T	NEMA	B

TORQUE AND CURRENT VS. SPEED



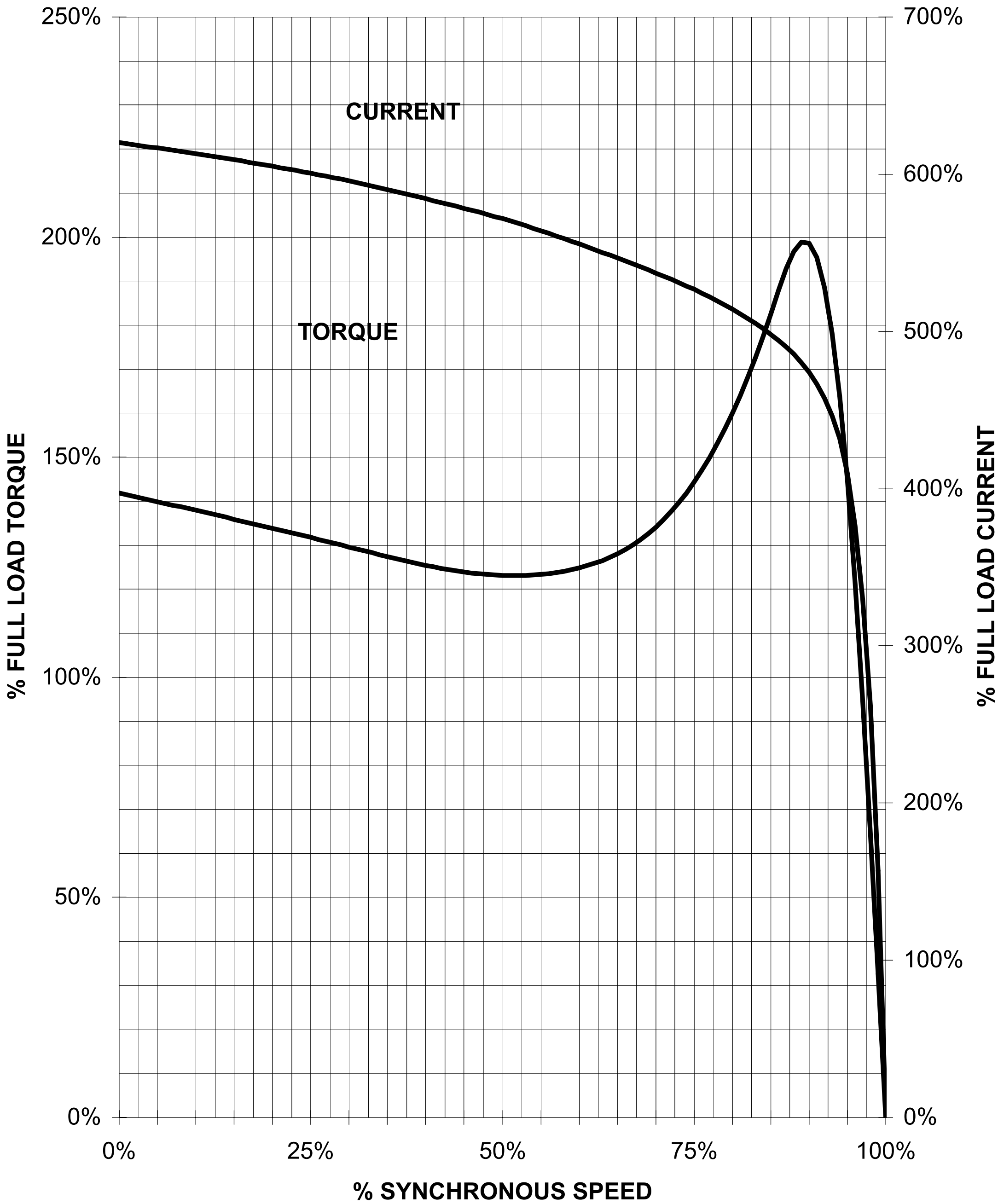
Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

Application Manual for NEMA Motors

HP	100	VOLTS	460	RPM	1200	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	444TS	NEMA	B

TORQUE & CURRENT VS. SPEED

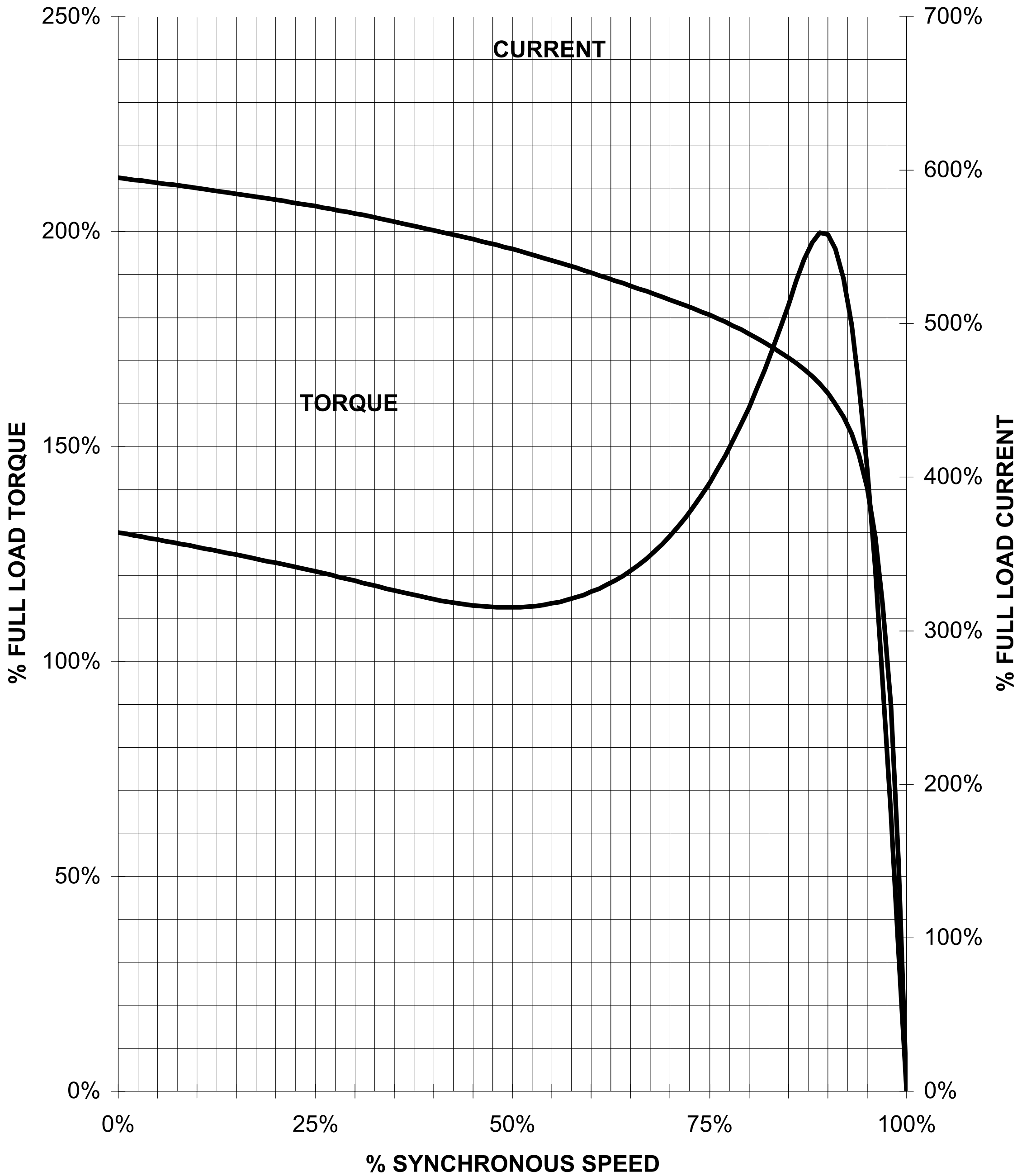


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	100	VOLTS	460	RPM	900	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	445T	NEMA	B

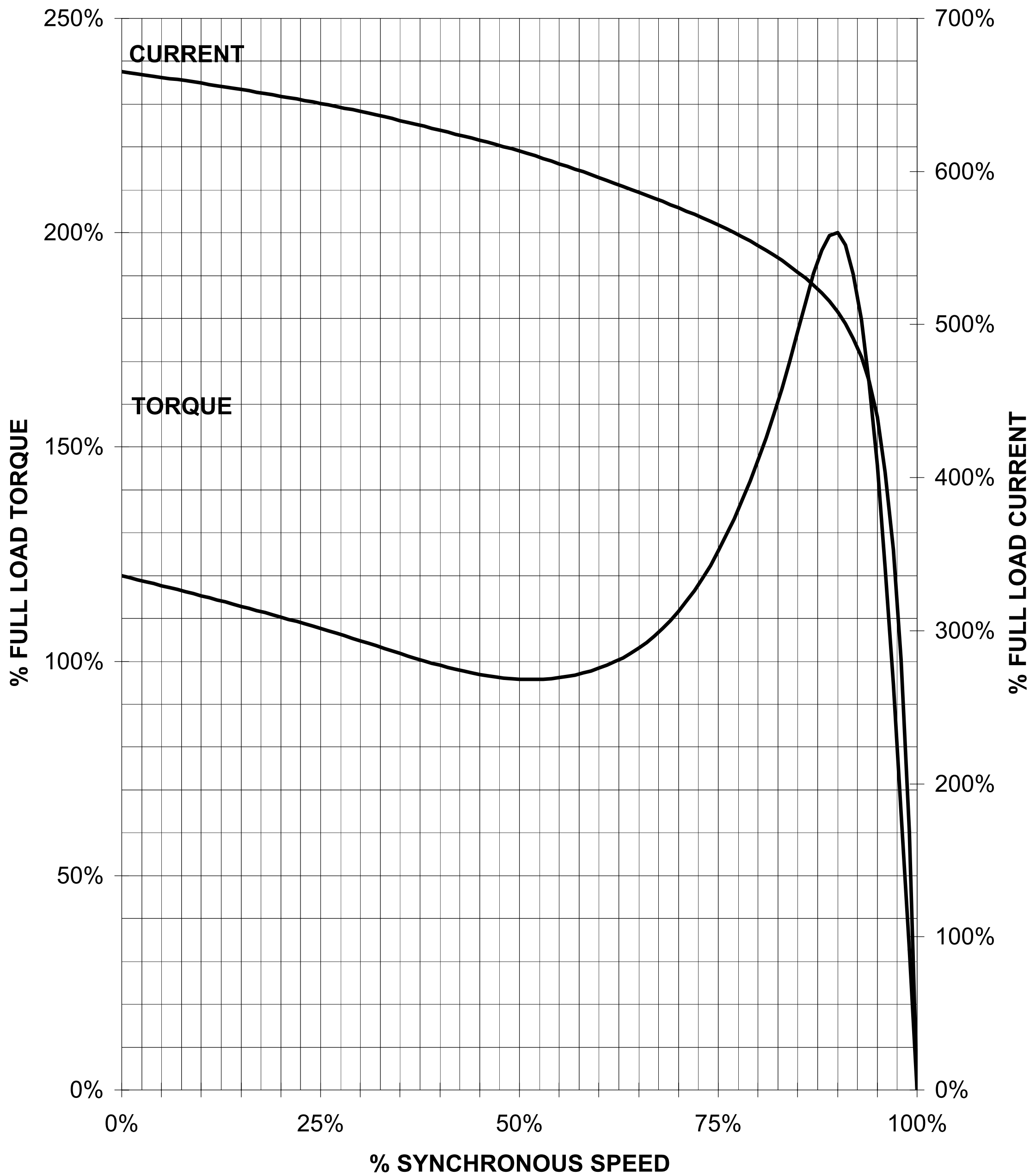
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	125	VOLTS	460	RPM	3600	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	444TS	NEMA	B

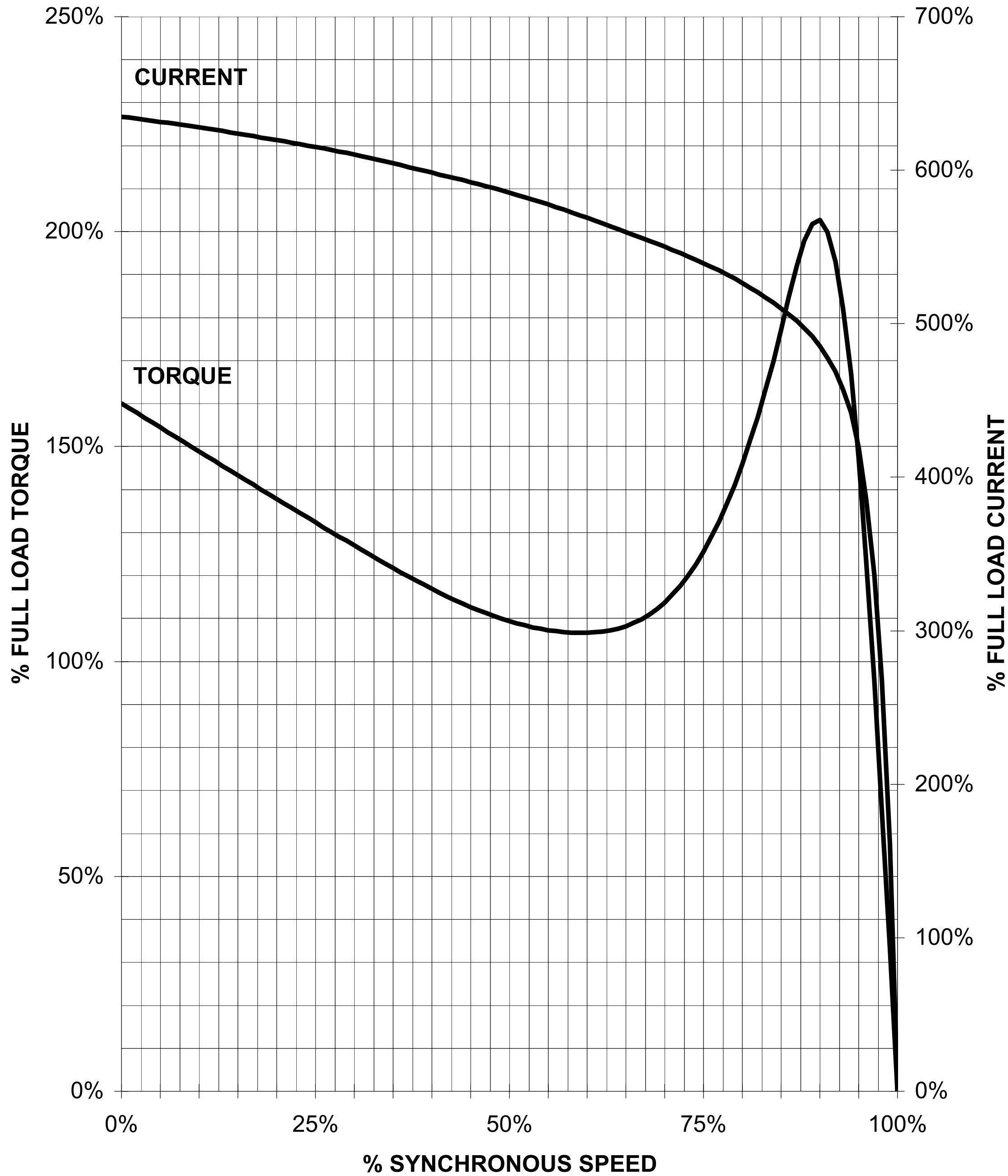
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	125	VOLTS	460	RPM	1800	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	444T	NEMA	B

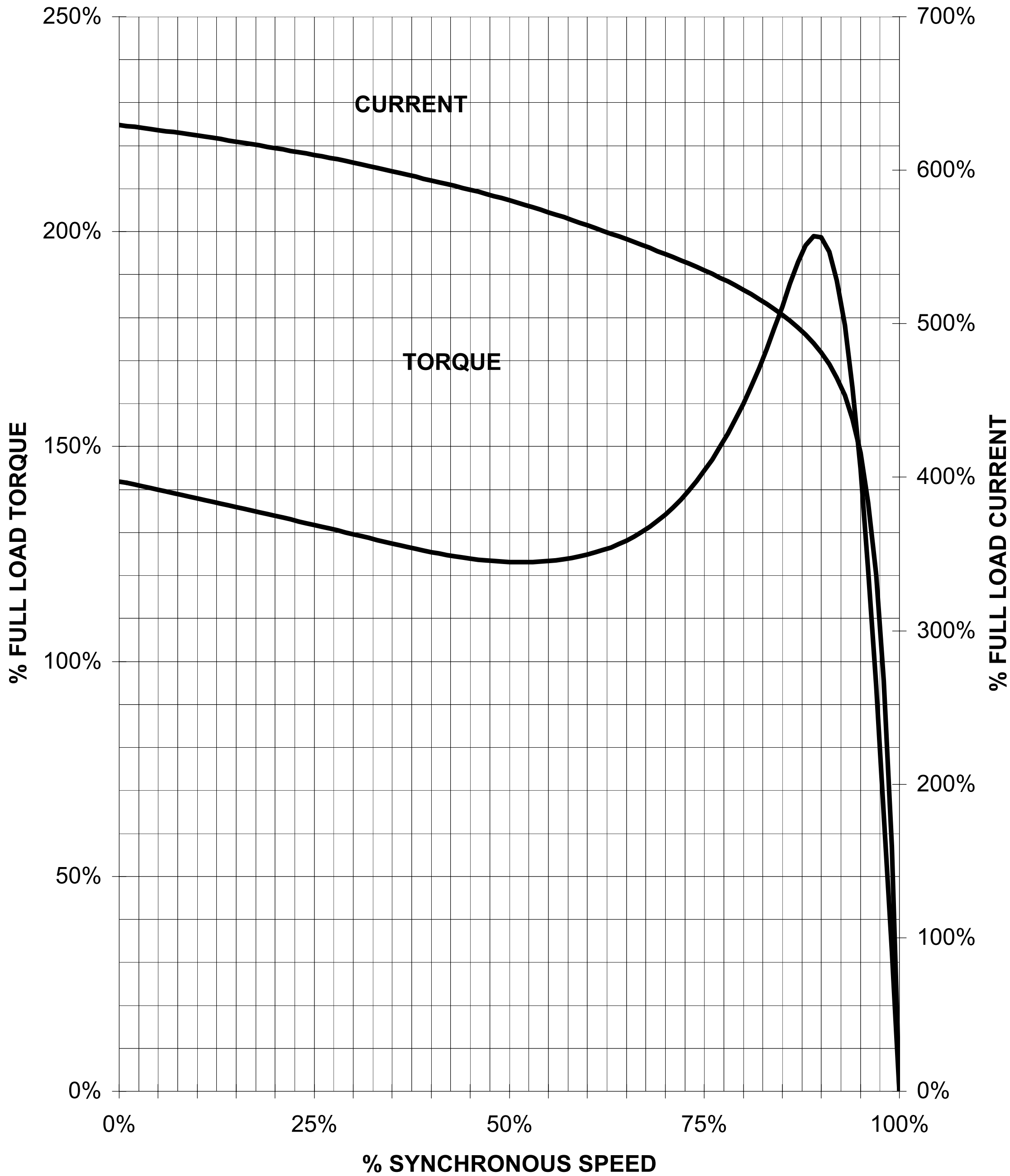
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	125	VOLTS	460	RPM	1200	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	445T	NEMA	B

TORQUE AND CURRENT VS. SPEED

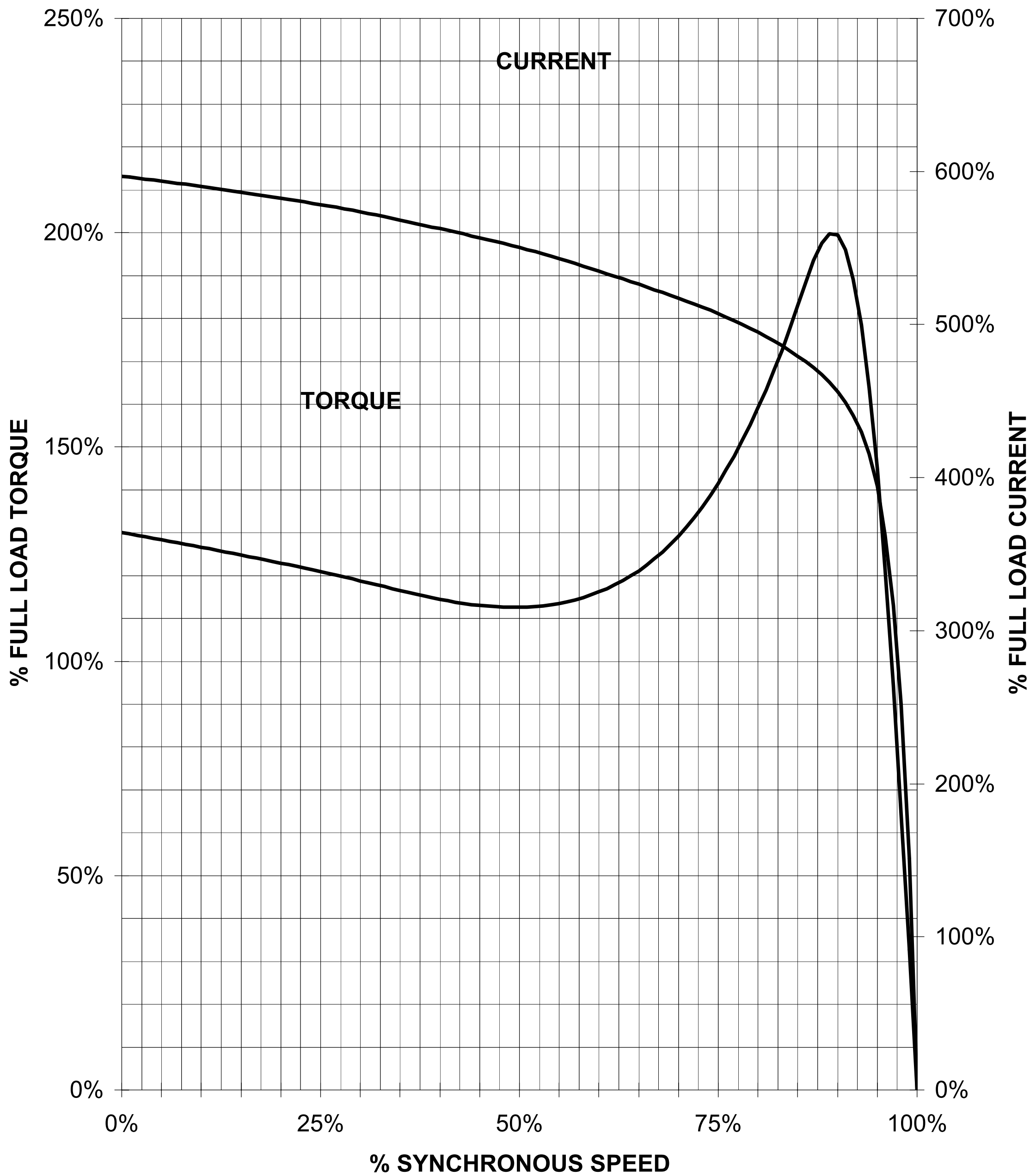


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	125	VOLTS	460	RPM	900	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	447T	NEMA	B

TORQUE AND CURRENT VS. SPEED



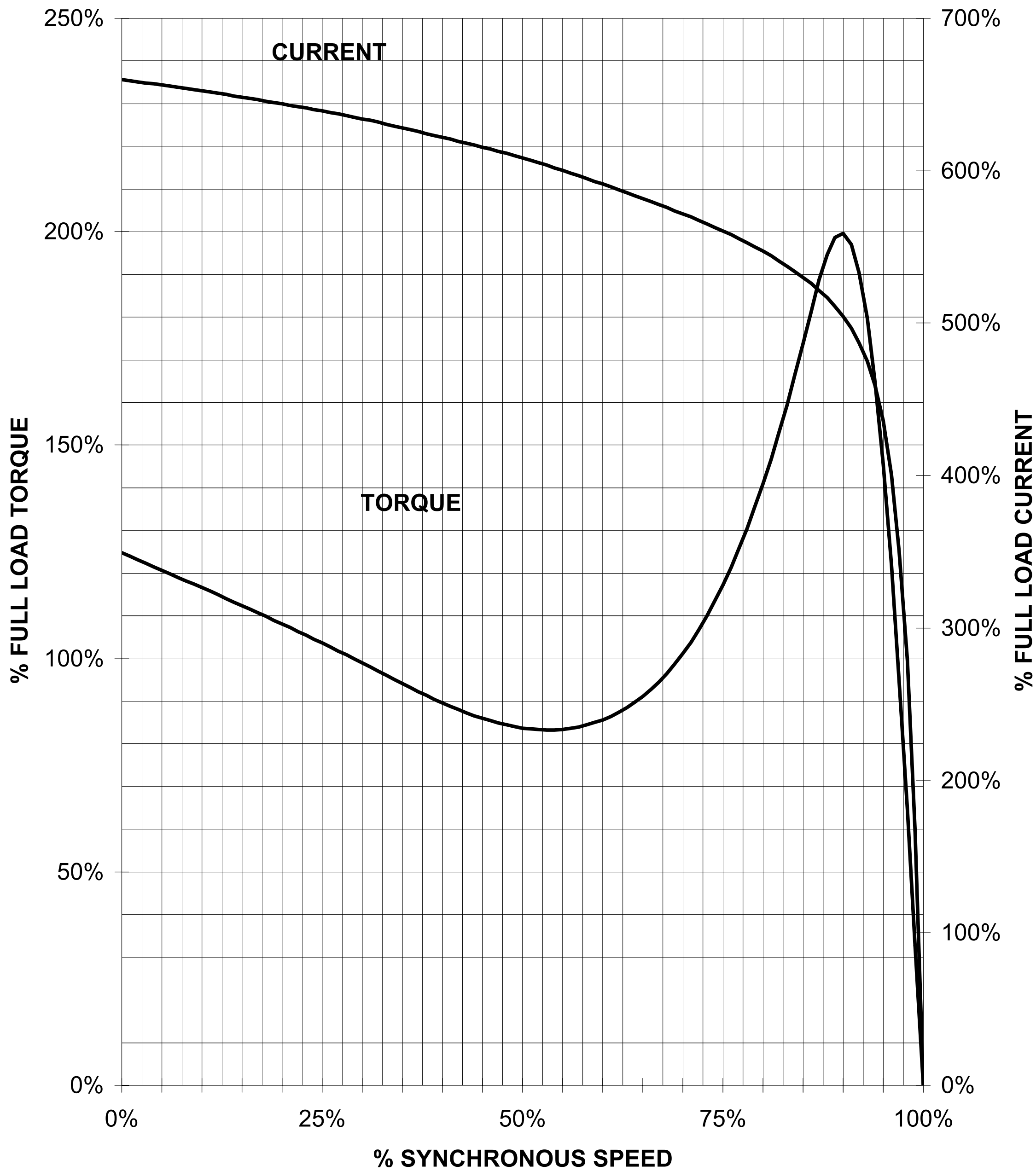
Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP 150 VOLTS 460 RPM 3600 TYPE RGZZESD

HZ 60 PHASE 3 FRAME 445TS NEMA B

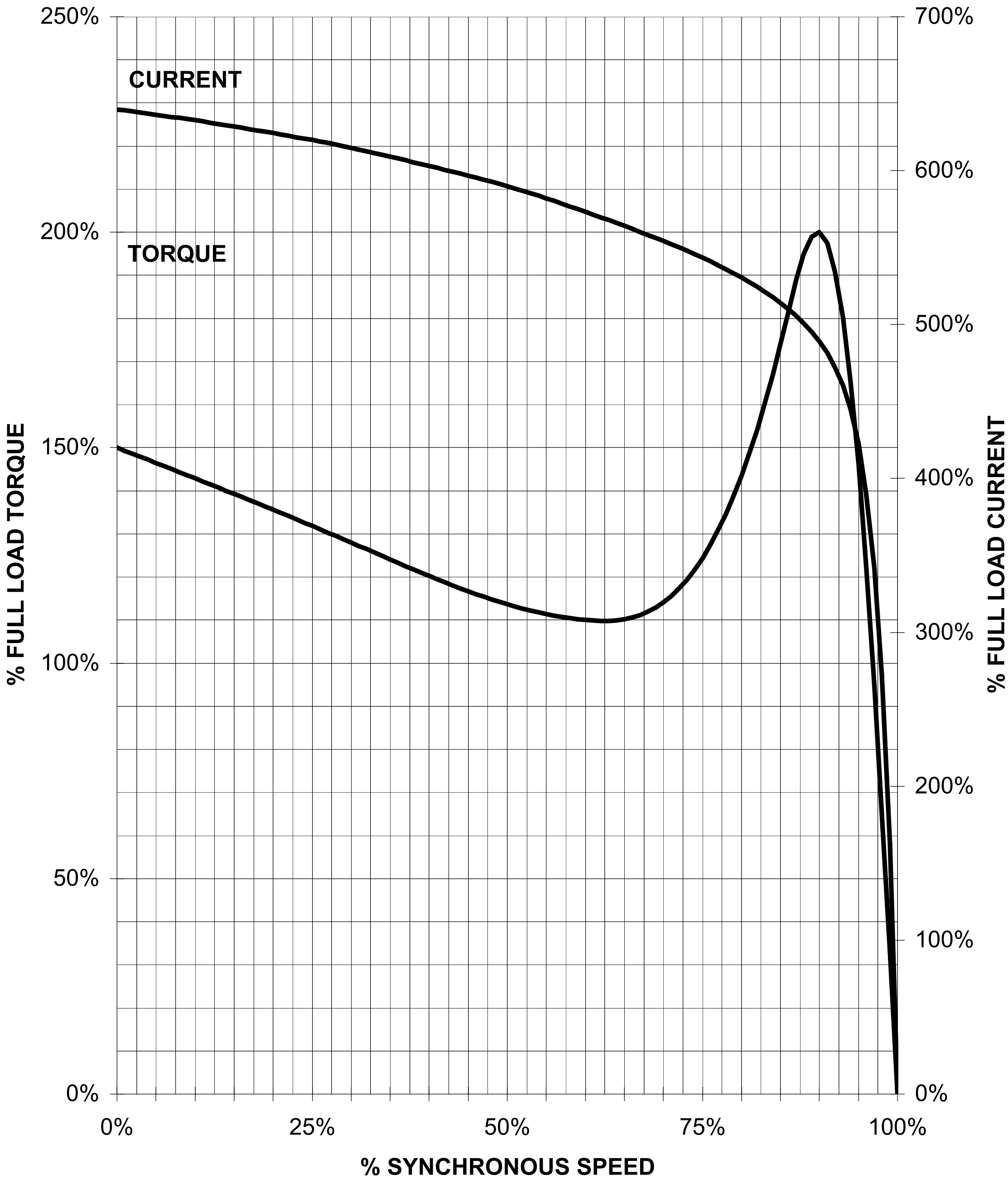
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	150	VOLTS	460	RPM	1800	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	445T	NEMA	B

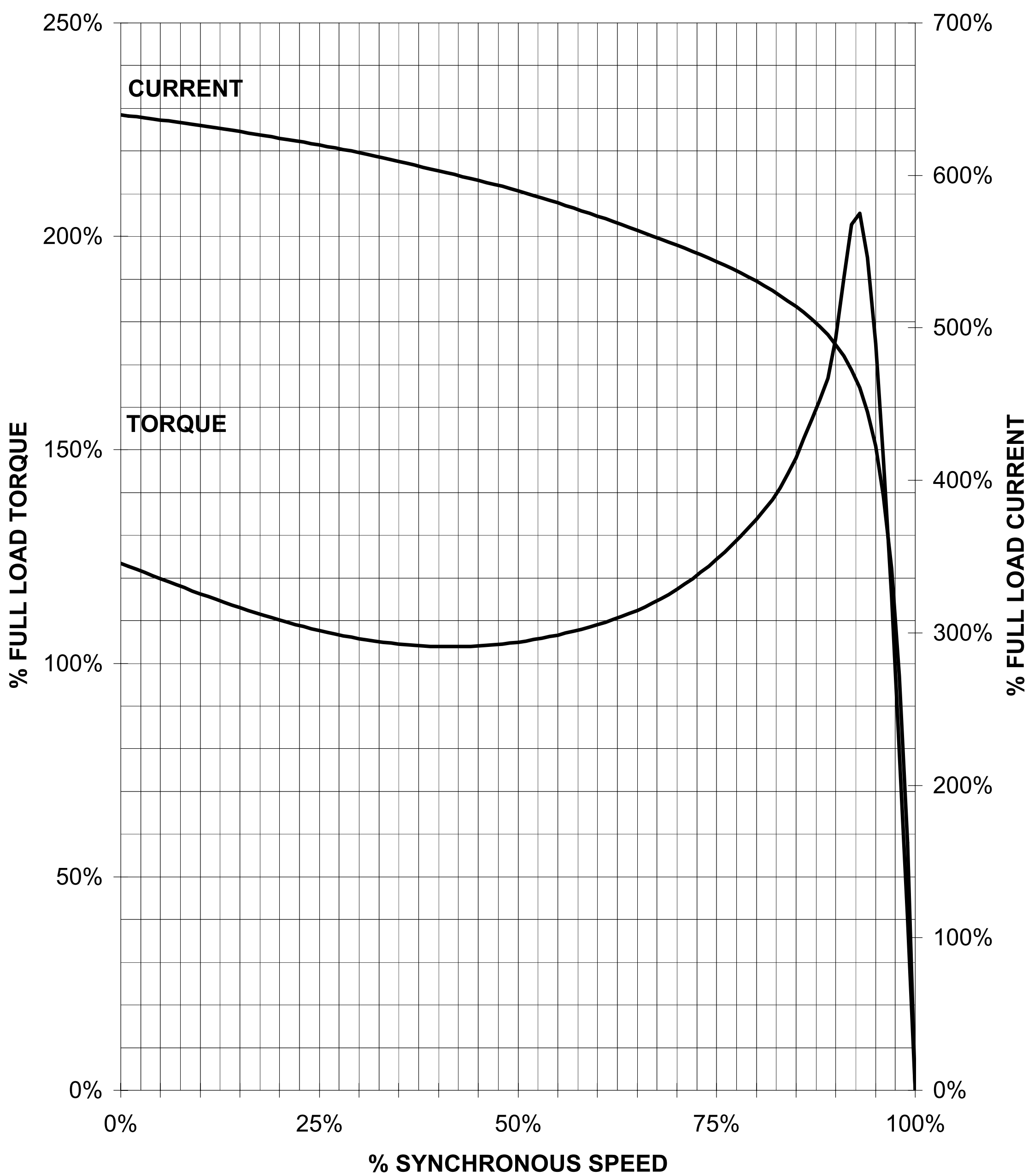
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	150	VOLTS	460	RPM	1200	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	447T	NEMA	B

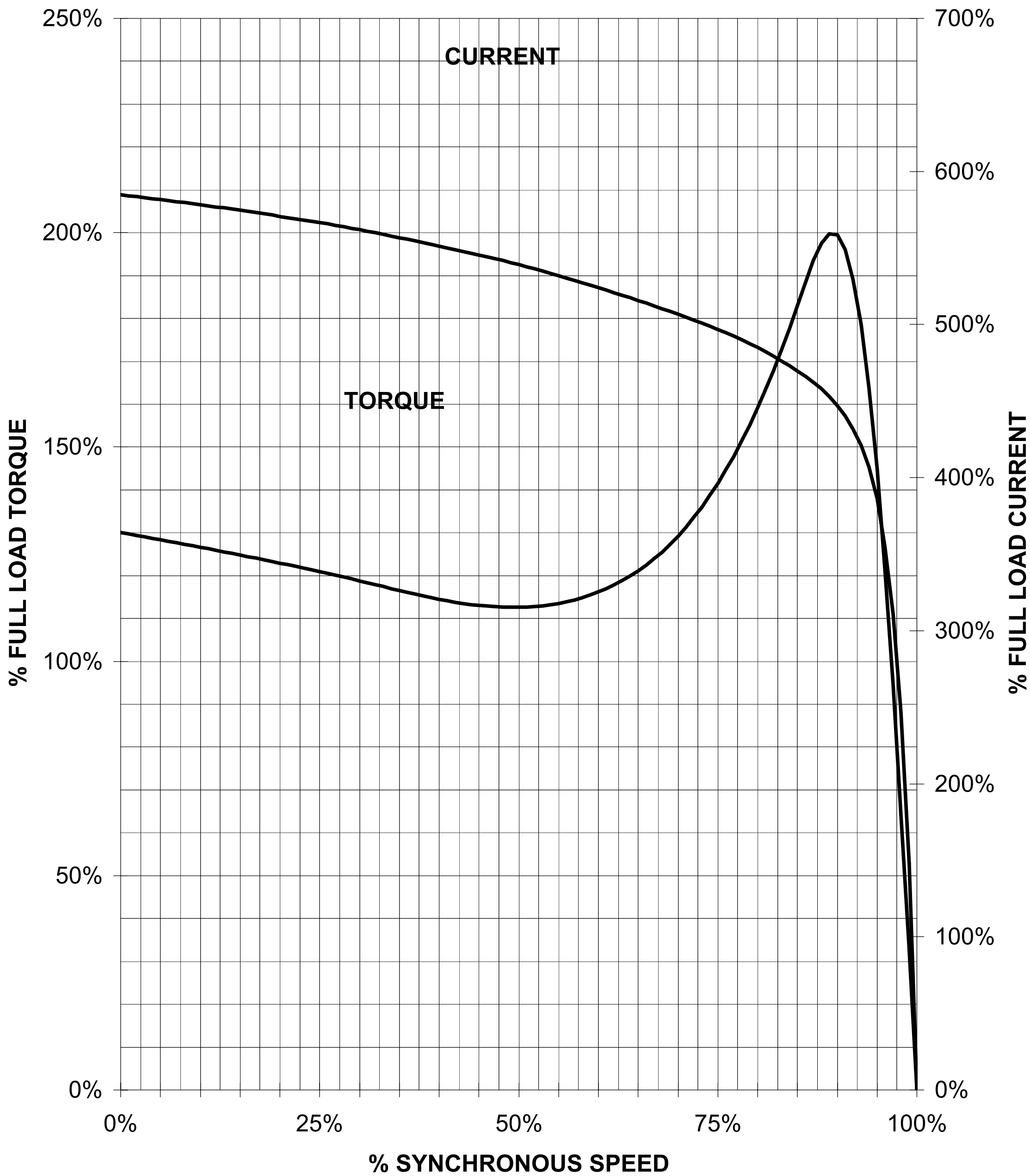
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	150	VOLTS	460	RPM	900	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	447T	NEMA	B

TORQUE AND CURRENT VS. SPEED

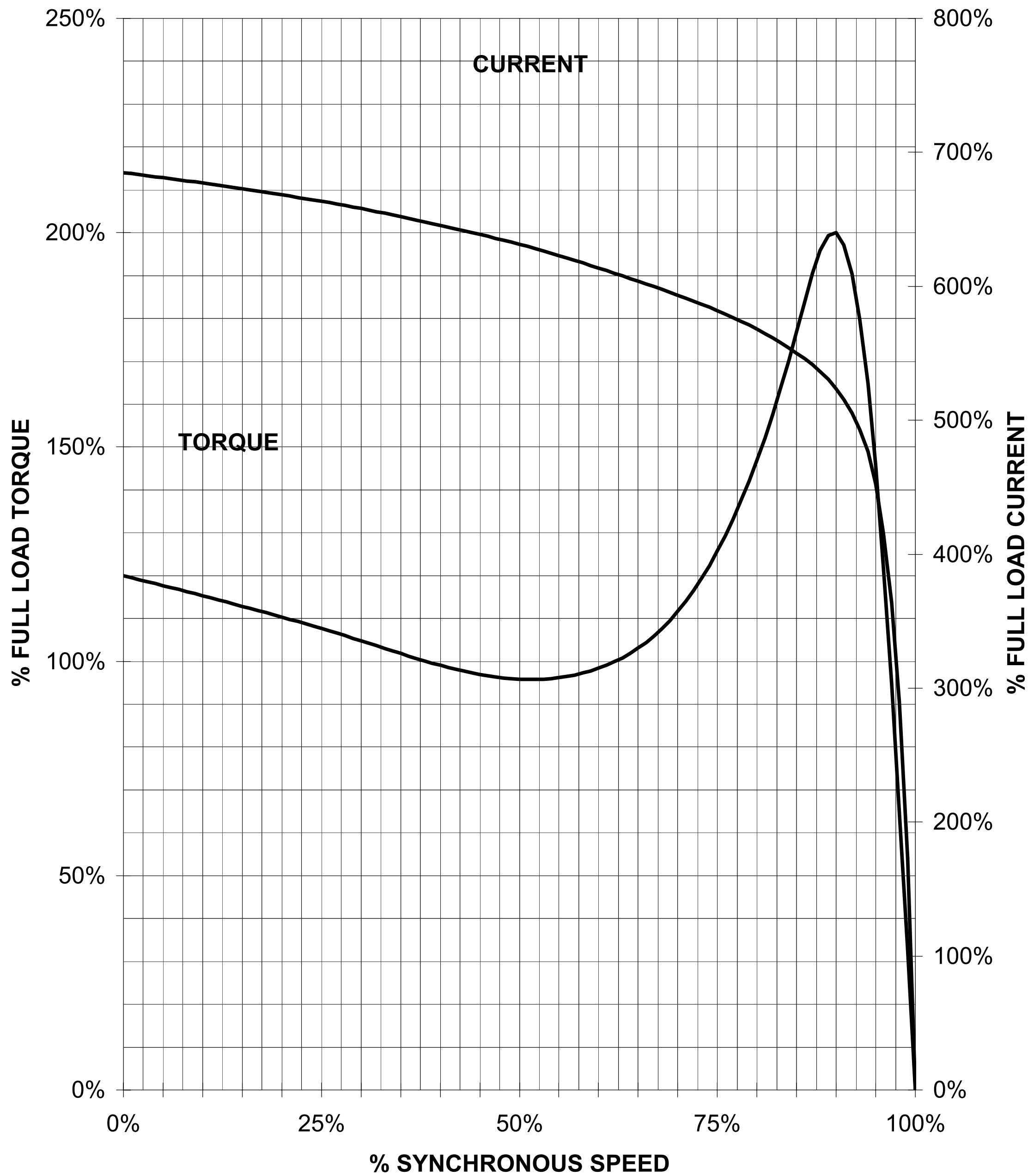


Customer: **PO No.:** **Order No.:**

HP 200 VOLTS 460 RPM 3600 TYPE RGZZESD

HZ 60 PHASE 3 FRAME 447TS NEMA B

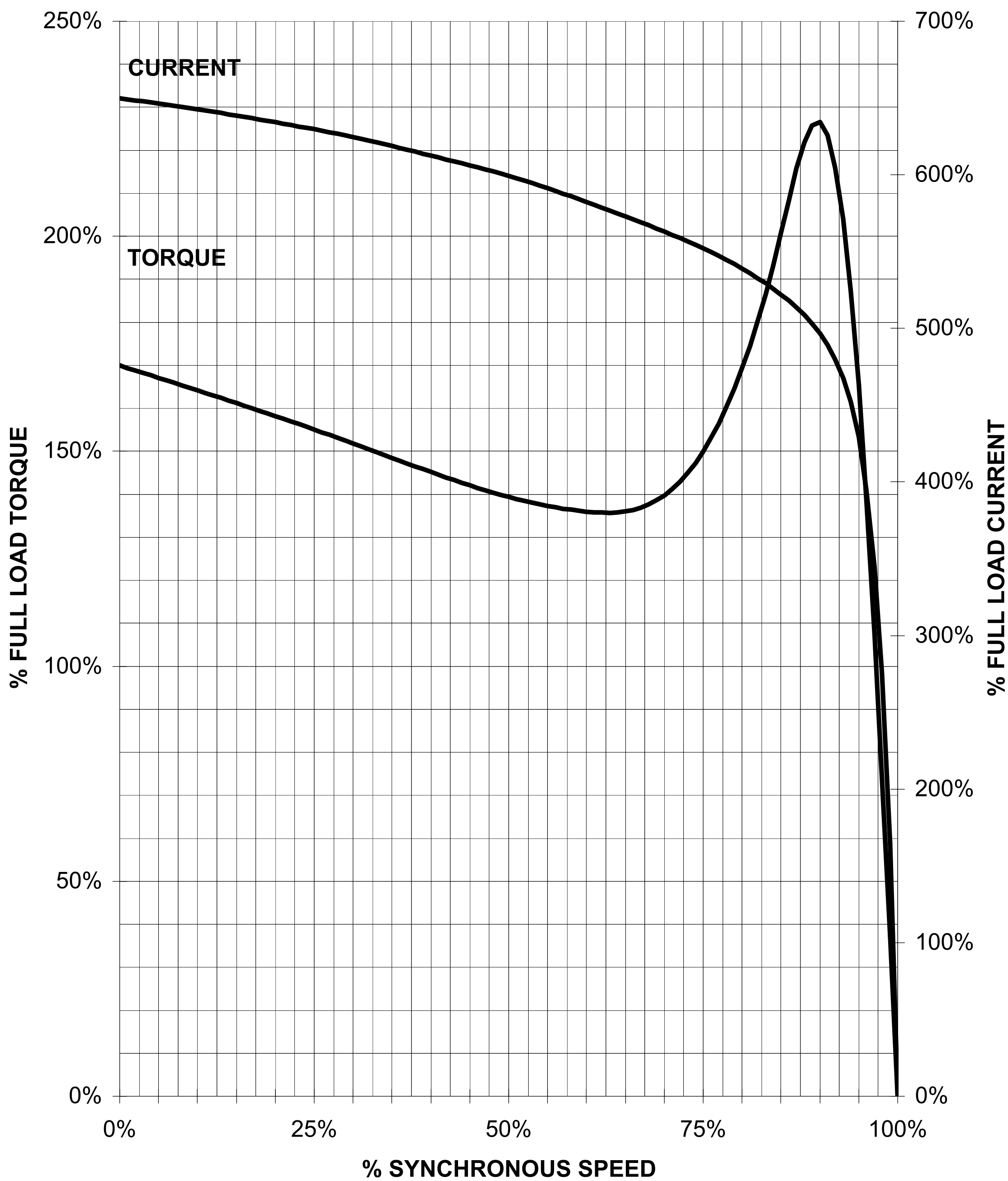
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	200	VOLTS	460	RPM	1800	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	447T	NEMA	B

TORQUE AND CURRENT VS. SPEED

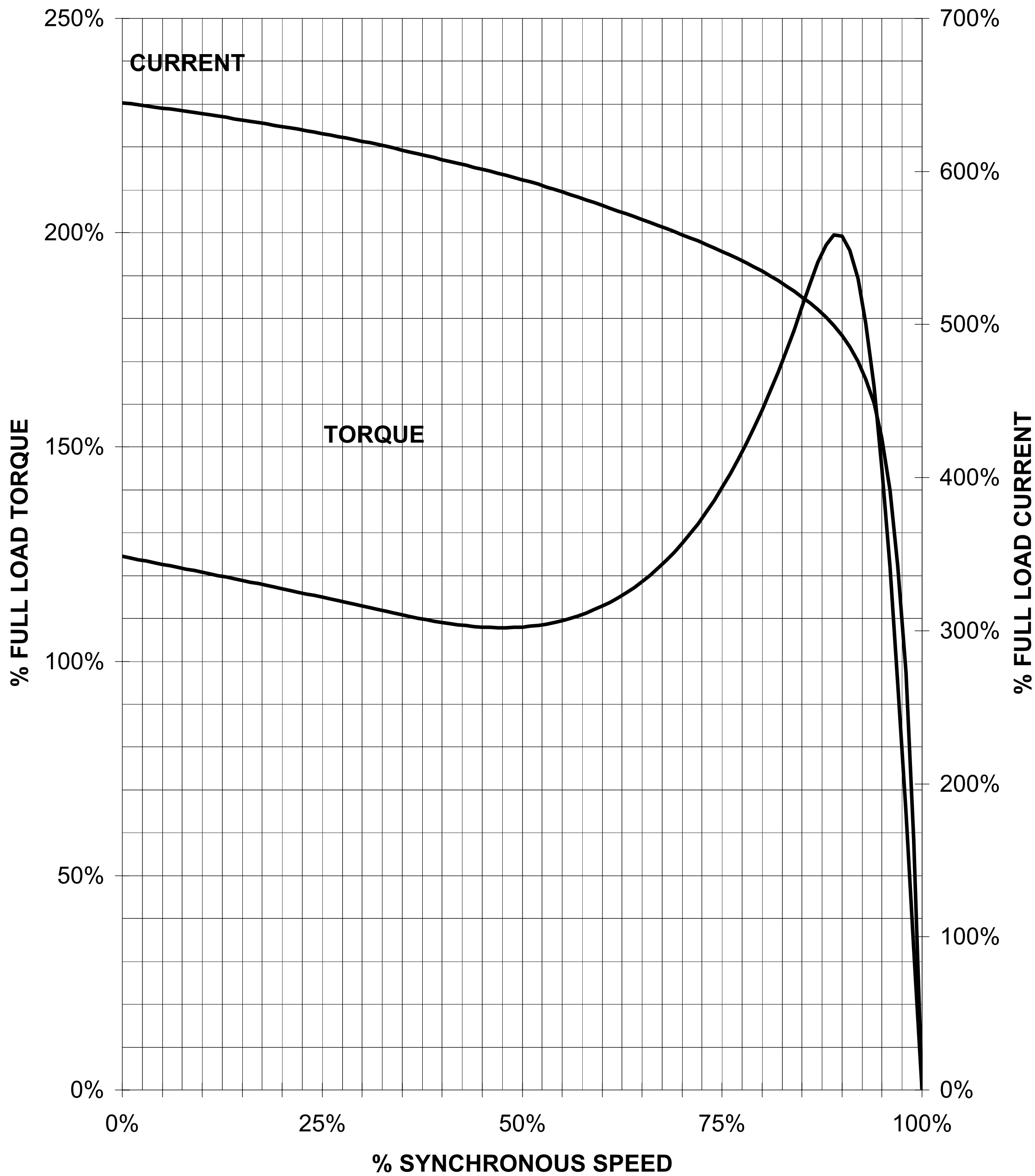


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	200	VOLTS	460	RPM	1200	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	449T	NEMA	B

TORQUE AND CURRENT VS. SPEED

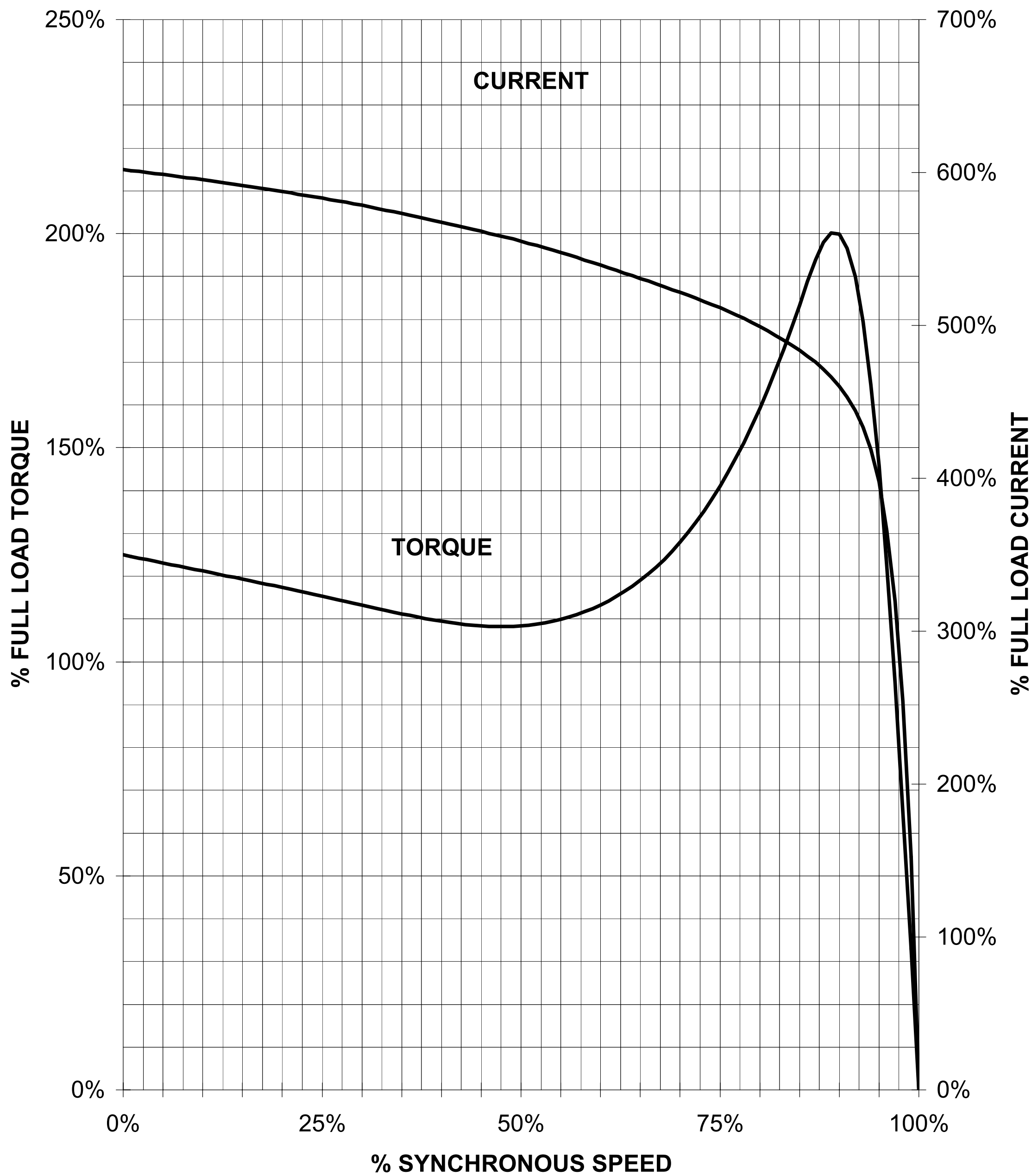


Customer: **PO No.:** **Order No.:**

HP 200 VOLTS 460 RPM 900 TYPE RGZZESD

HZ 60 PHASE 3 FRAME 449T NEMA B

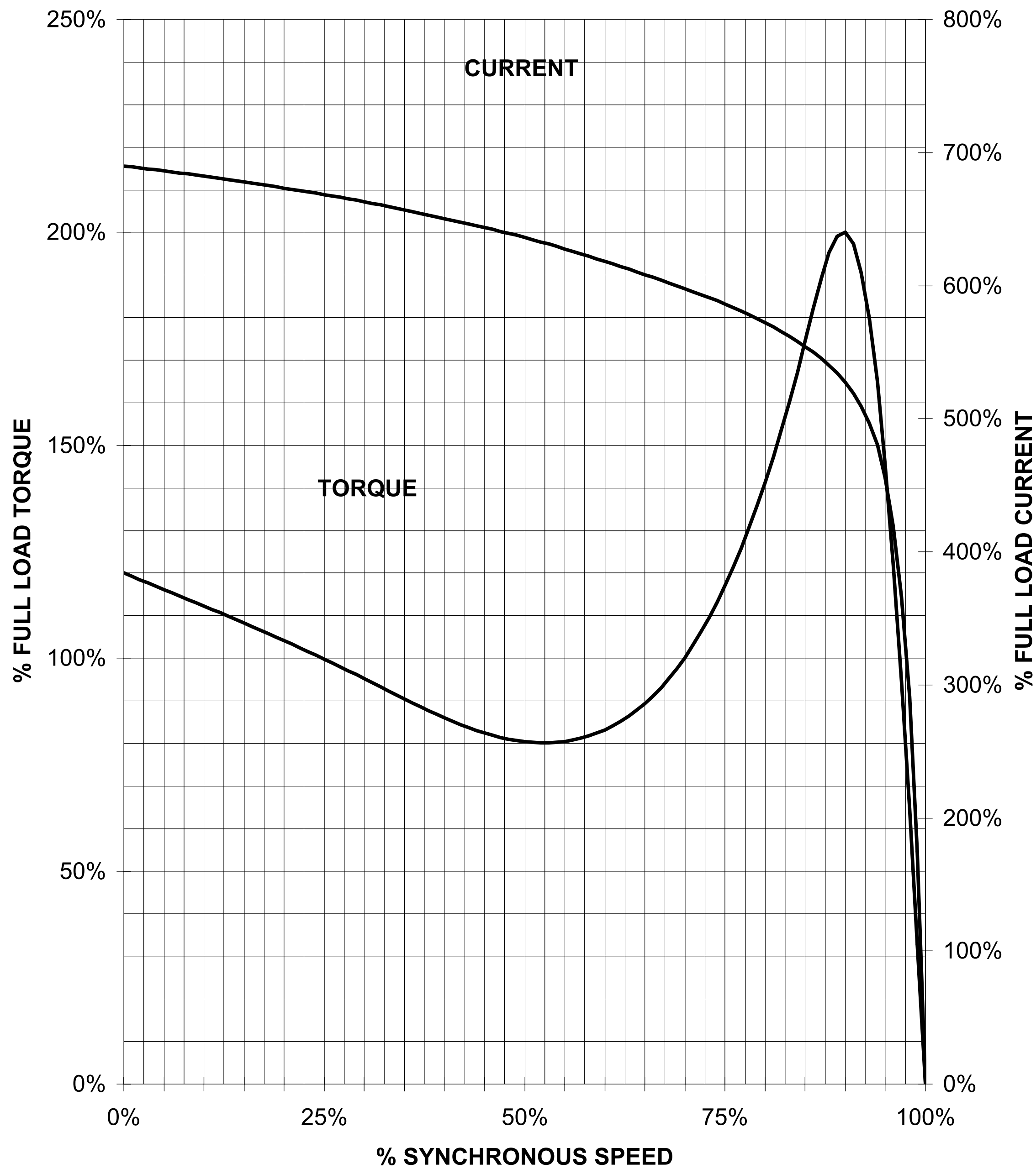
TORQUE AND CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	250	VOLTS	460	RPM	3600	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	449TS	NEMA	B

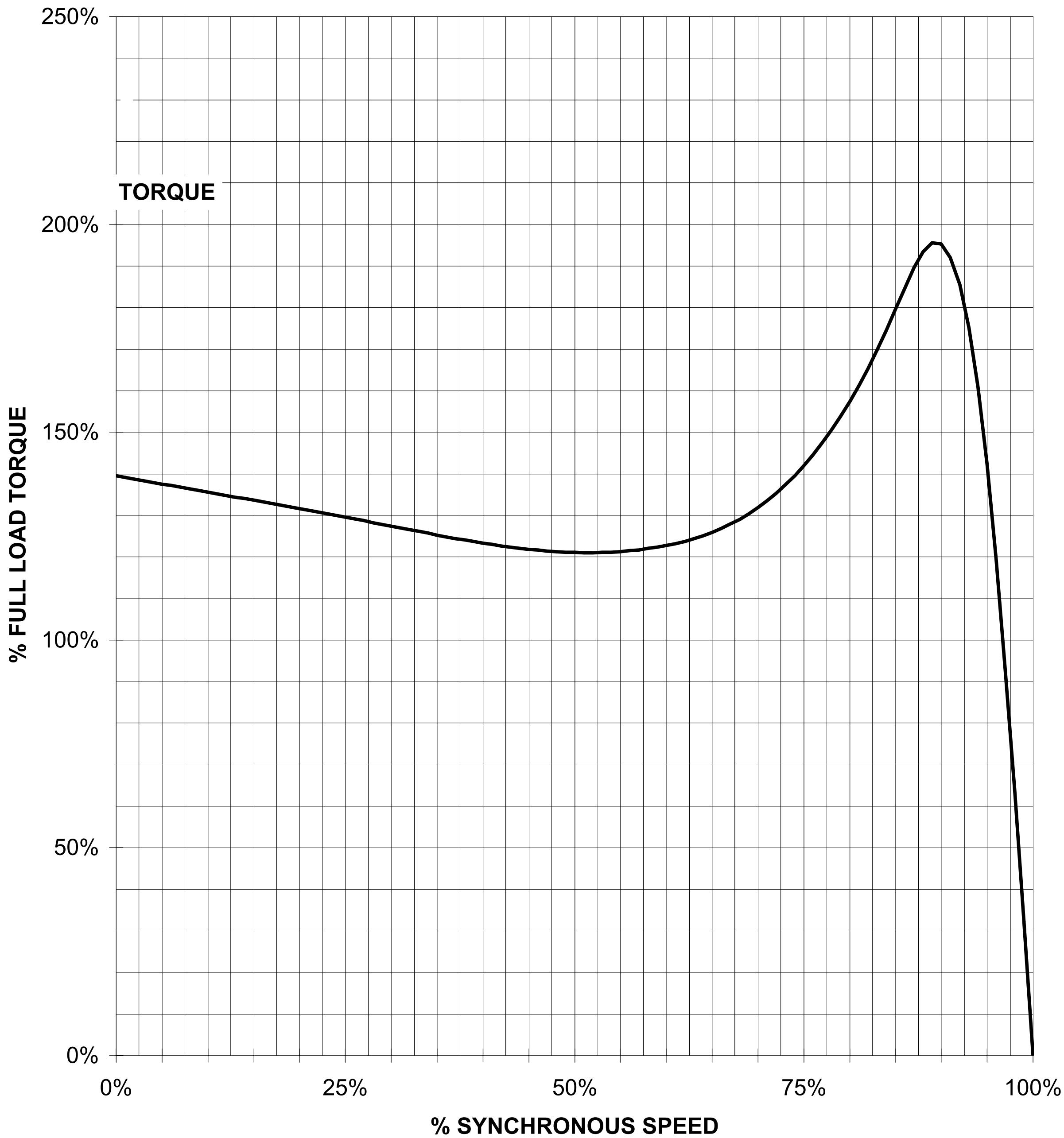
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	250	VOLTS	460	RPM	1800	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	449TS	NEMA	B

TORQUE VS. SPEED

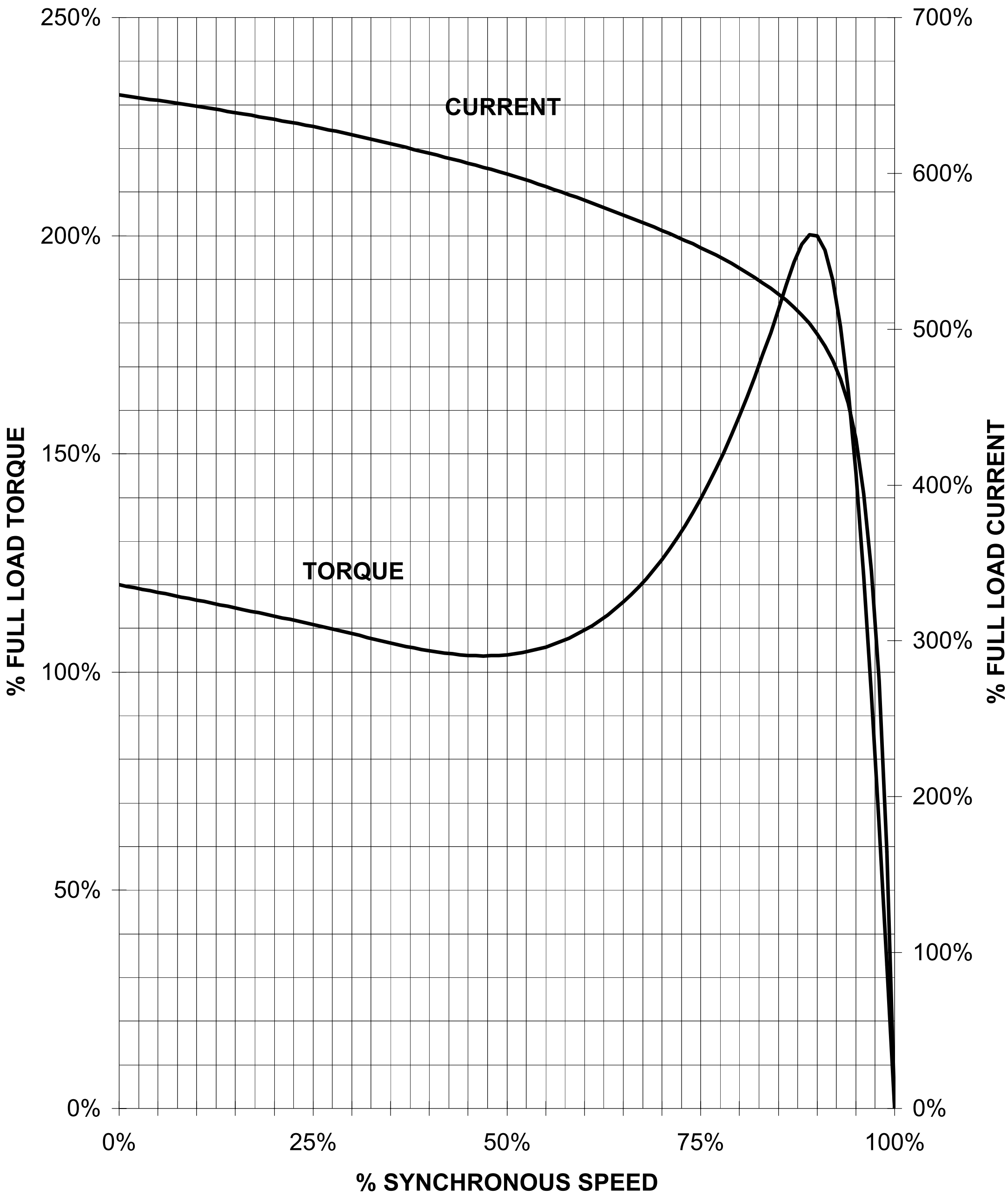


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	250	VOLTS	460	RPM	1200	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	449TS	NEMA	B

TORQUE & CURRENT VS. SPEED

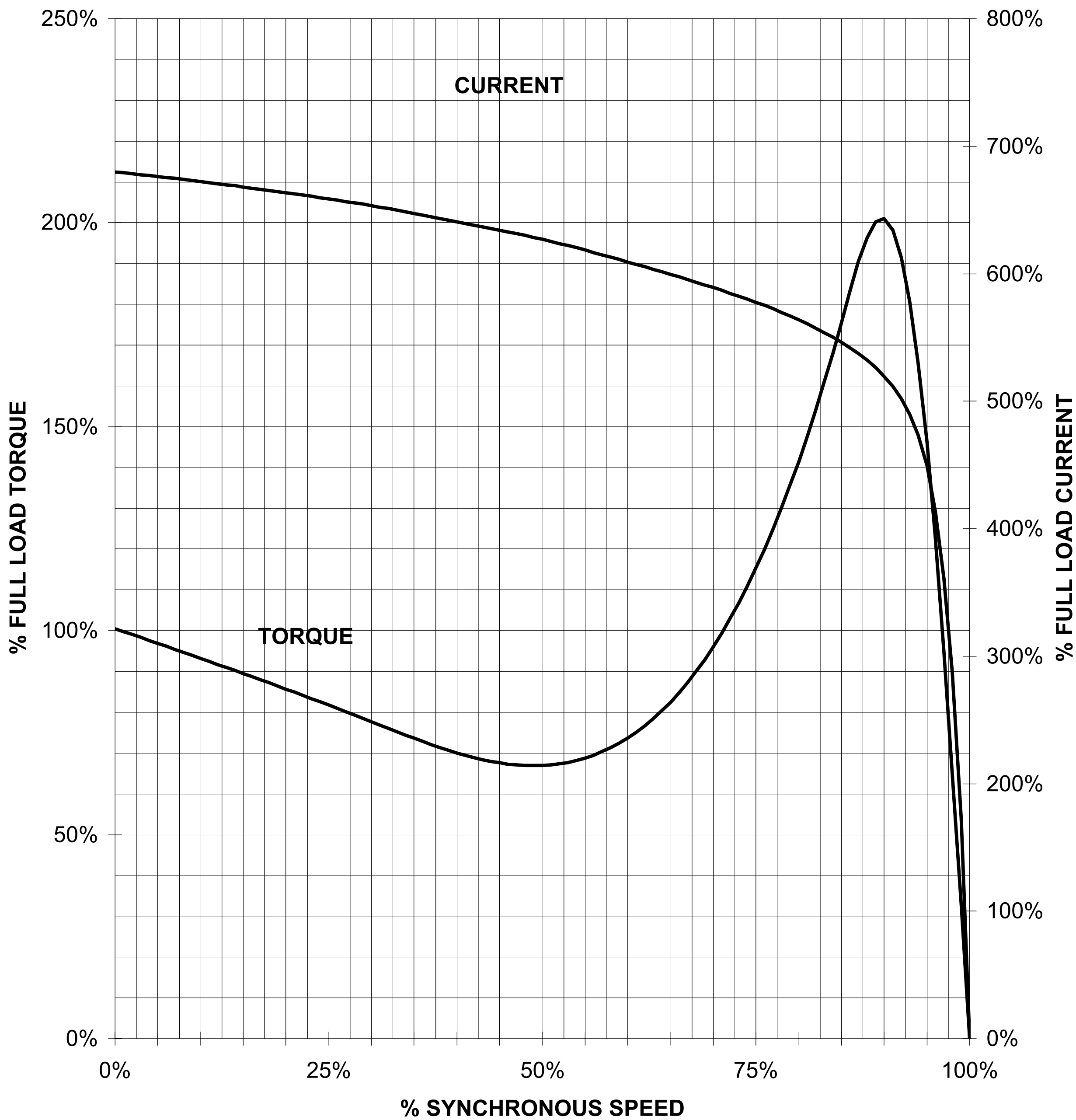


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	300	VOLTS	460	RPM	3600	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	449TS	NEMA	B

TORQUE & CURRENT VS. SPEED

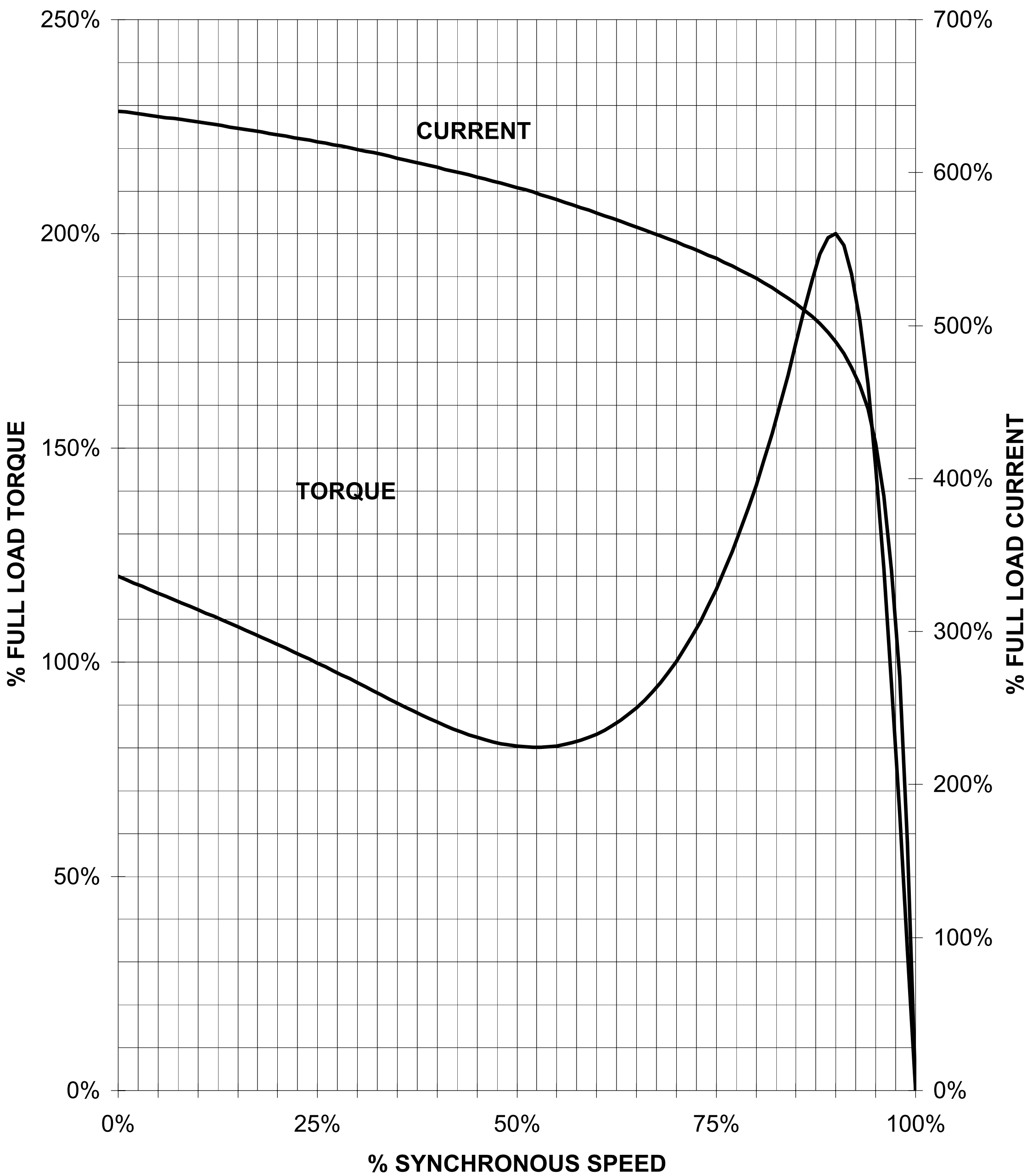


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	300	VOLTS	460	RPM	1800	TYPE	RGZZESD
HZ	60	PHASE	3	FRAME	449TS	NEMA	B

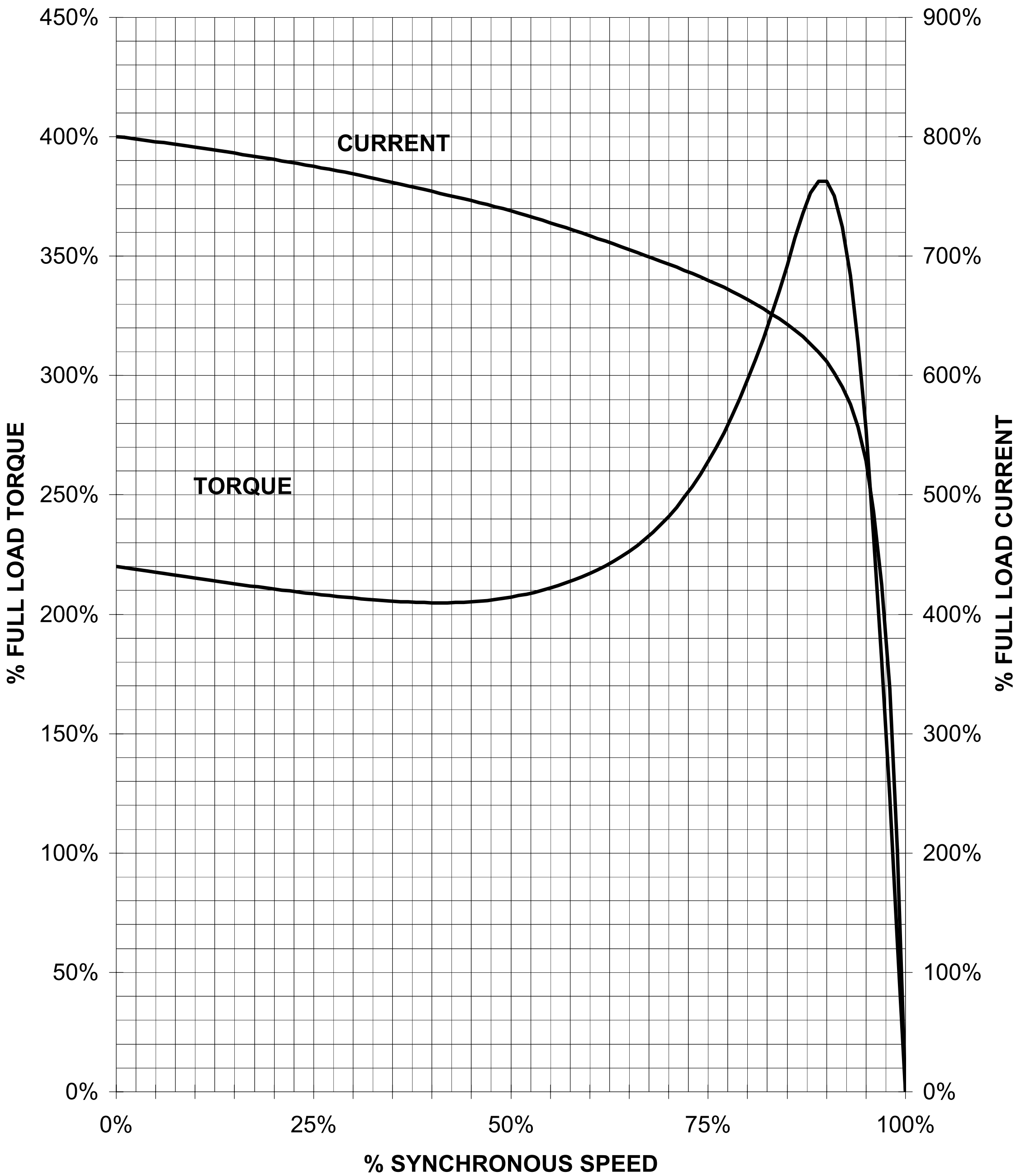
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1.5	VOLTS	460	RPM	3600	TYPE	SD10
HZ	60	PHASE	3	FRAME	182T	NEMA	B

TORQUE & CURRENT VS. SPEED

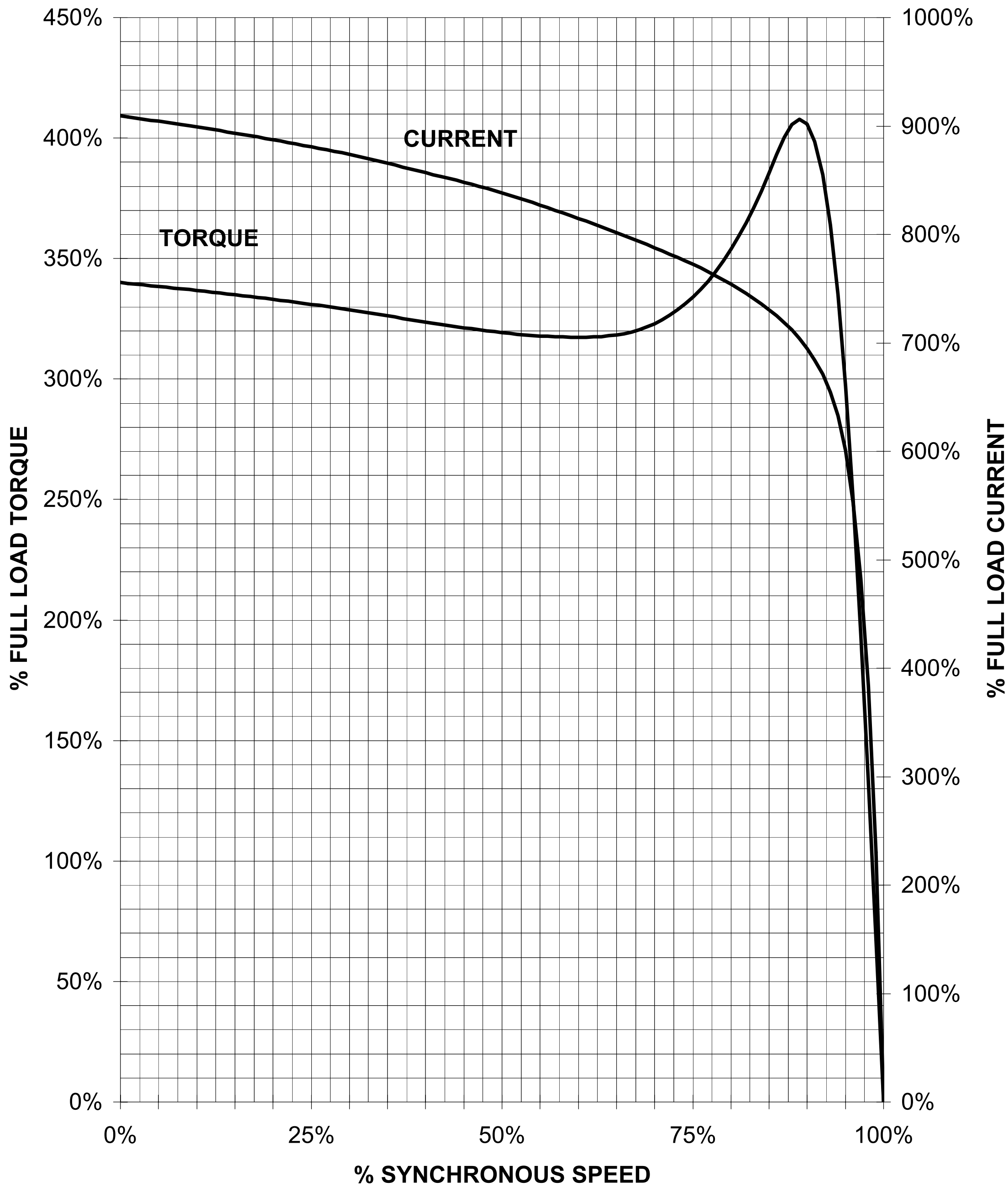


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	1.5	VOLTS	460	RPM	1800	TYPE	SD10
HZ	60	PHASE	3	FRAME	145T	NEMA	B

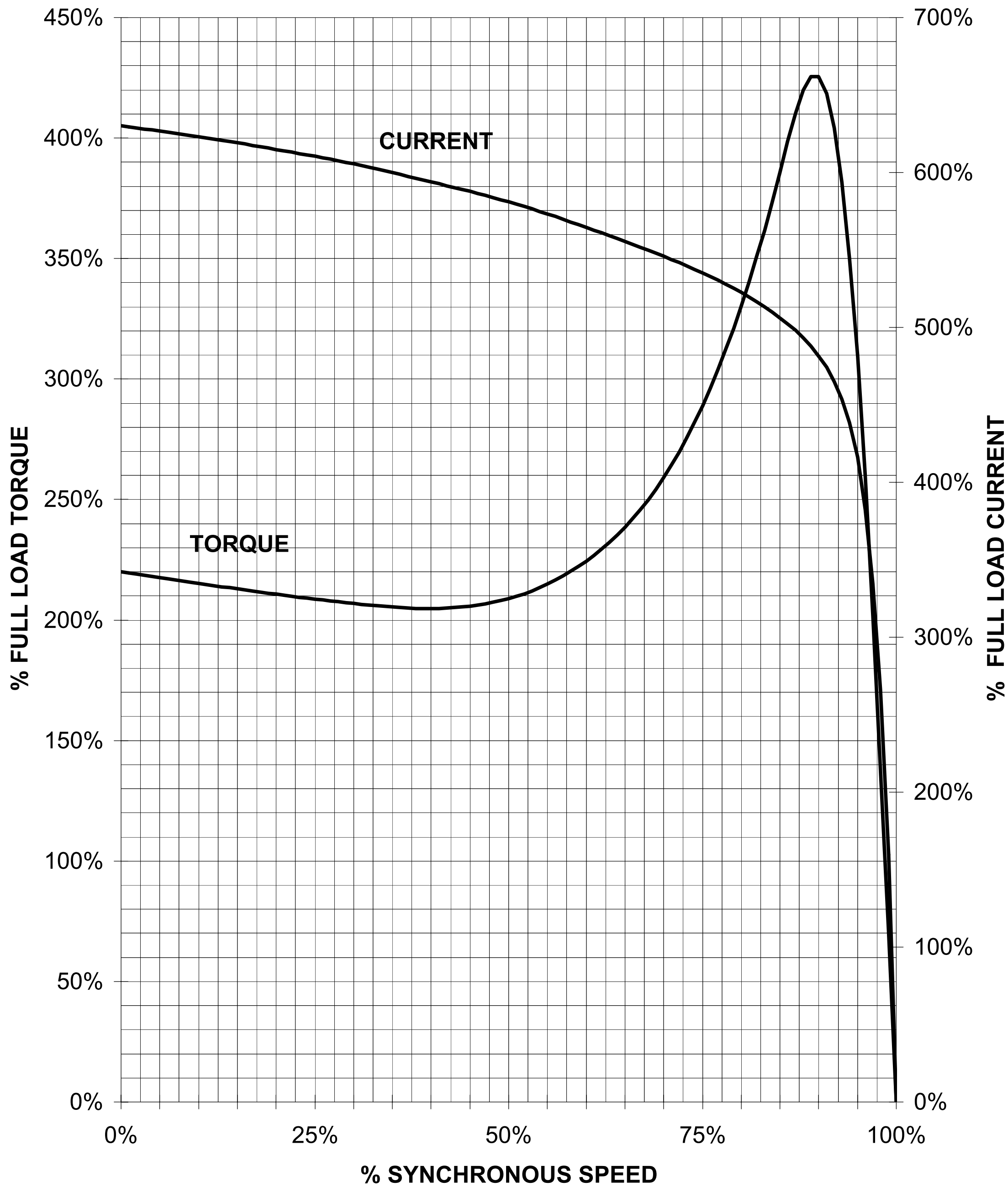
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1.5	VOLTS	460	RPM	1200	TYPE	SD10
HZ	60	PHASE	3	FRAME	182T	NEMA	B

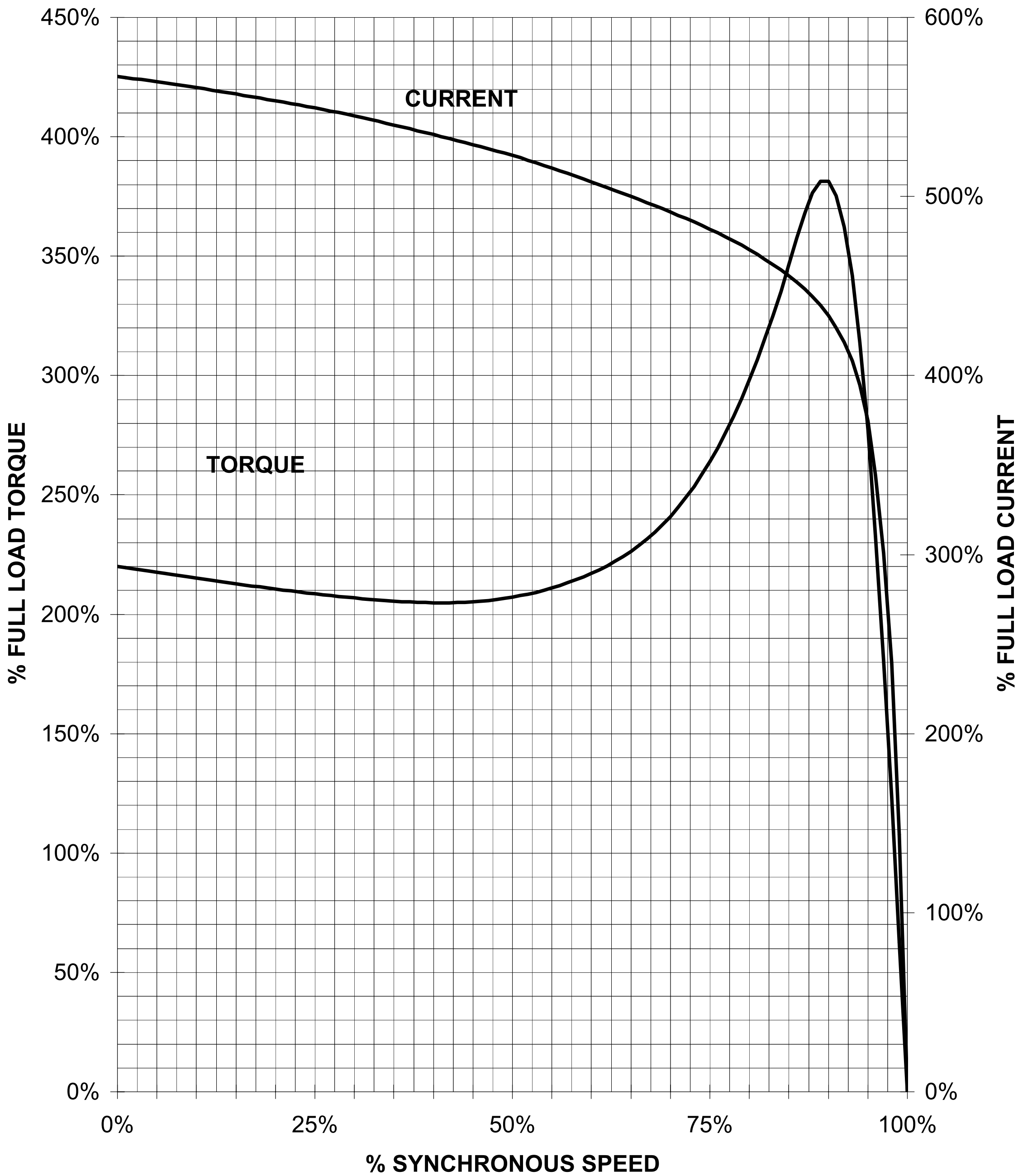
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1.5	VOLTS	460	RPM	900	TYPE	SD10
HZ	60	PHASE	3	FRAME	184T	NEMA	B

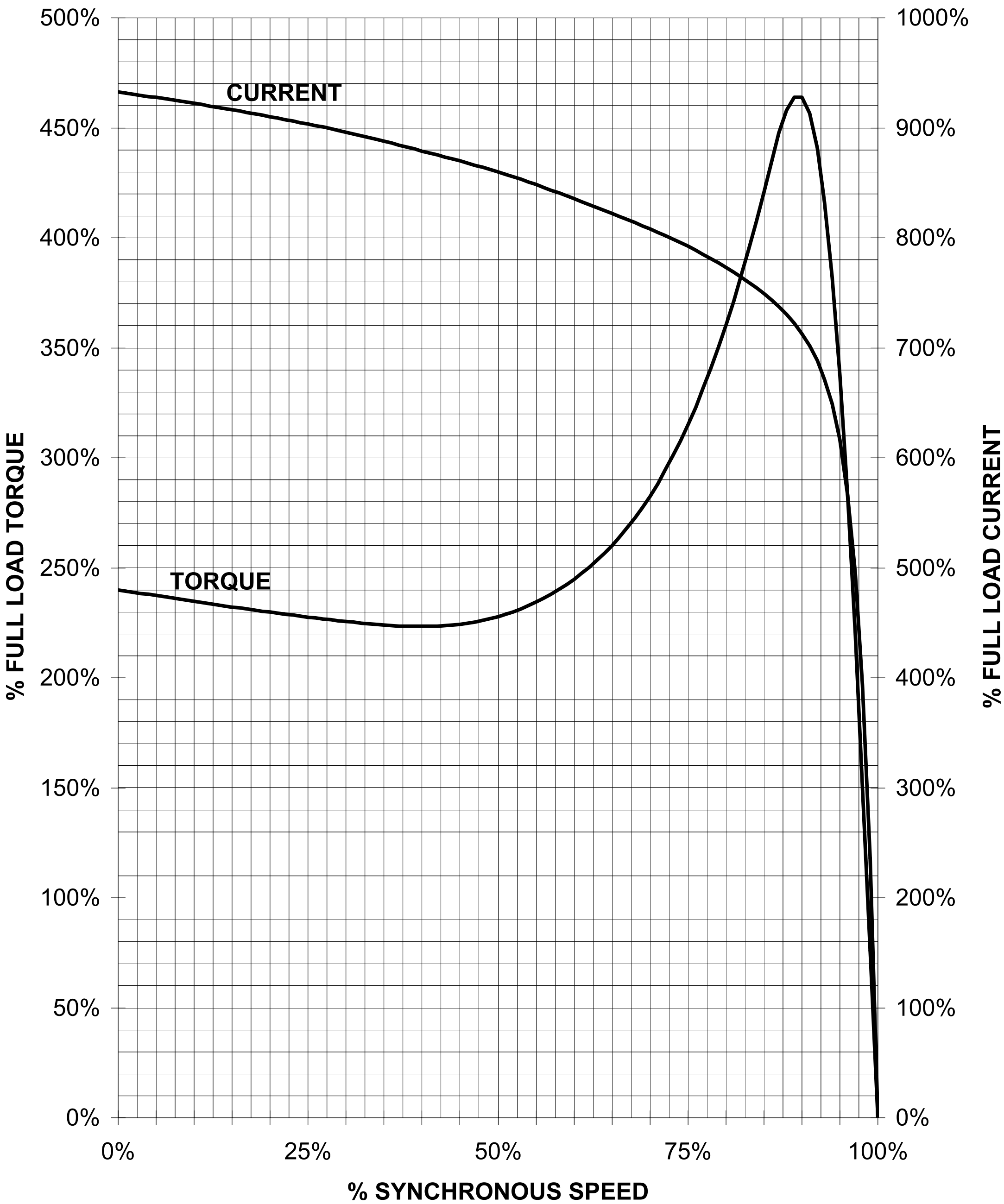
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1	VOLTS	460	RPM	3600	TYPE	SD10
HZ	60	PHASE	3	FRAME	143T	NEMA	B

TORQUE & CURRENT VS. SPEED

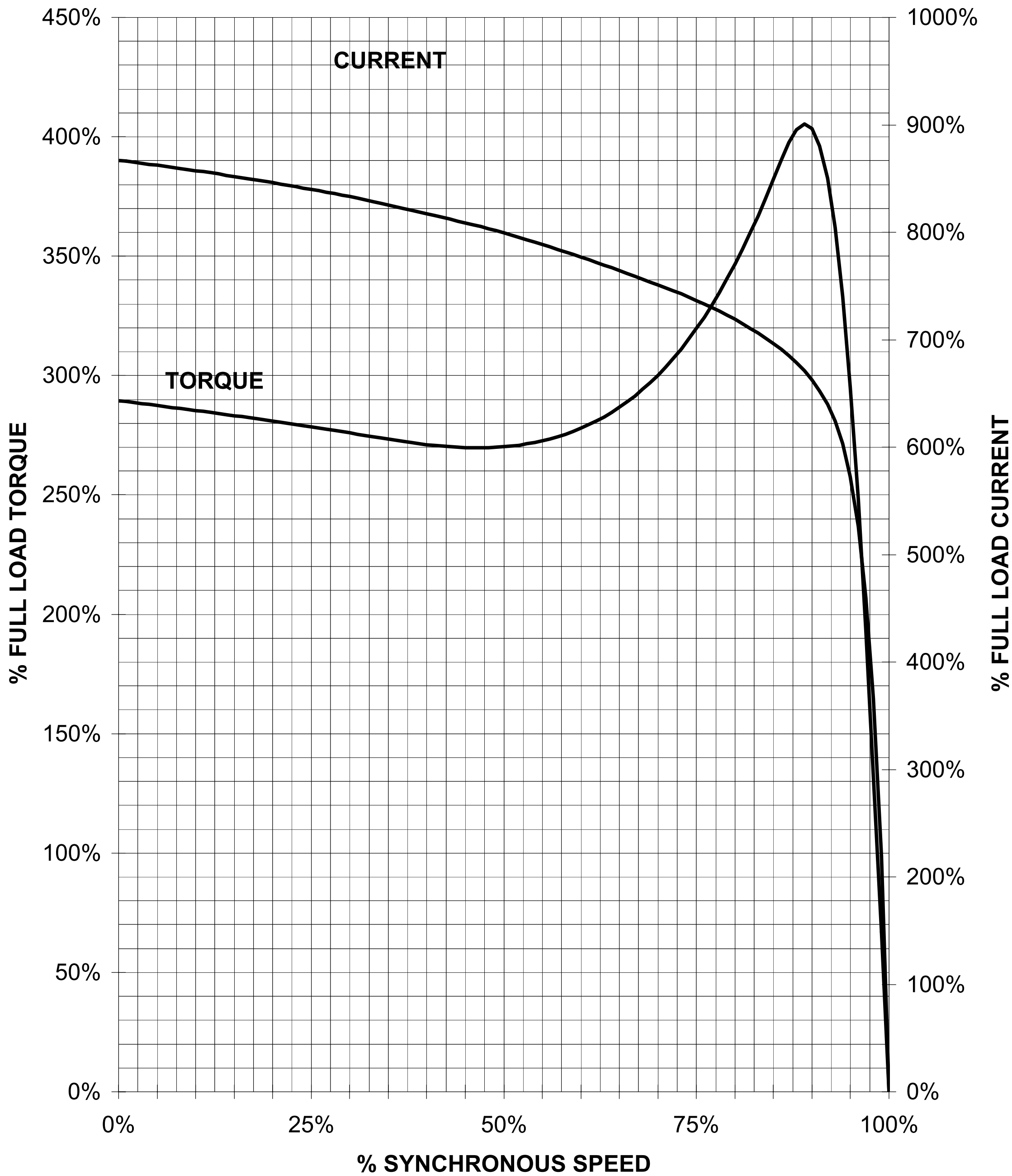


Customer: **PO No.:** **Order No.:**

Application Manual for NEMA Motors

HP	1	VOLTS	460	RPM	1800	TYPE	SD10
HZ	60	PHASE	3	FRAME	143T	NEMA	B

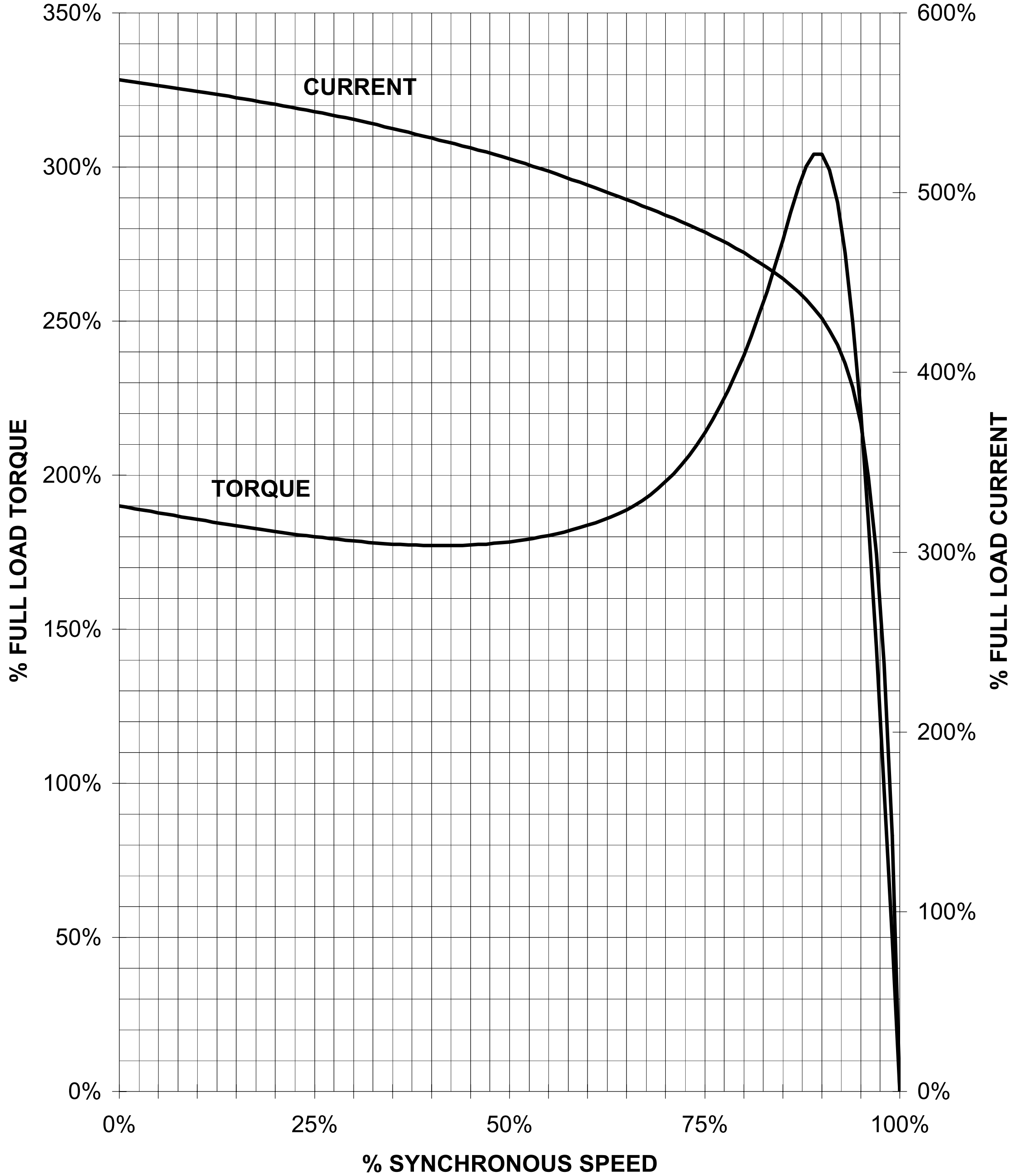
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1	VOLTS	460	RPM	1200	TYPE	SD10
HZ	60	PHASE	3	FRAME	145T	NEMA	B

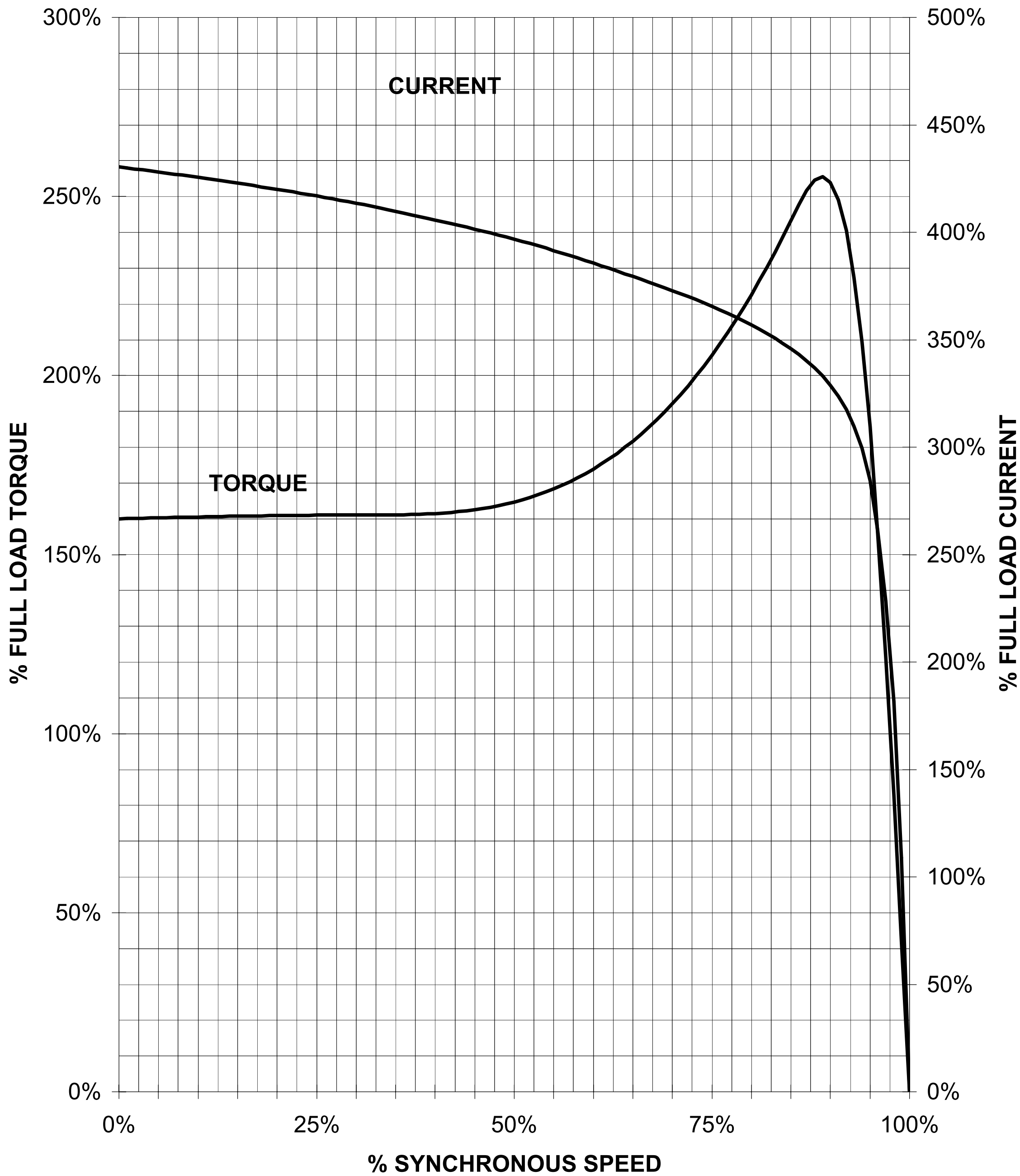
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1	VOLTS	460	RPM	900	TYPE	SD10
HZ	60	PHASE	3	FRAME	182T	NEMA	B

TORQUE & CURRENT VS. SPEED

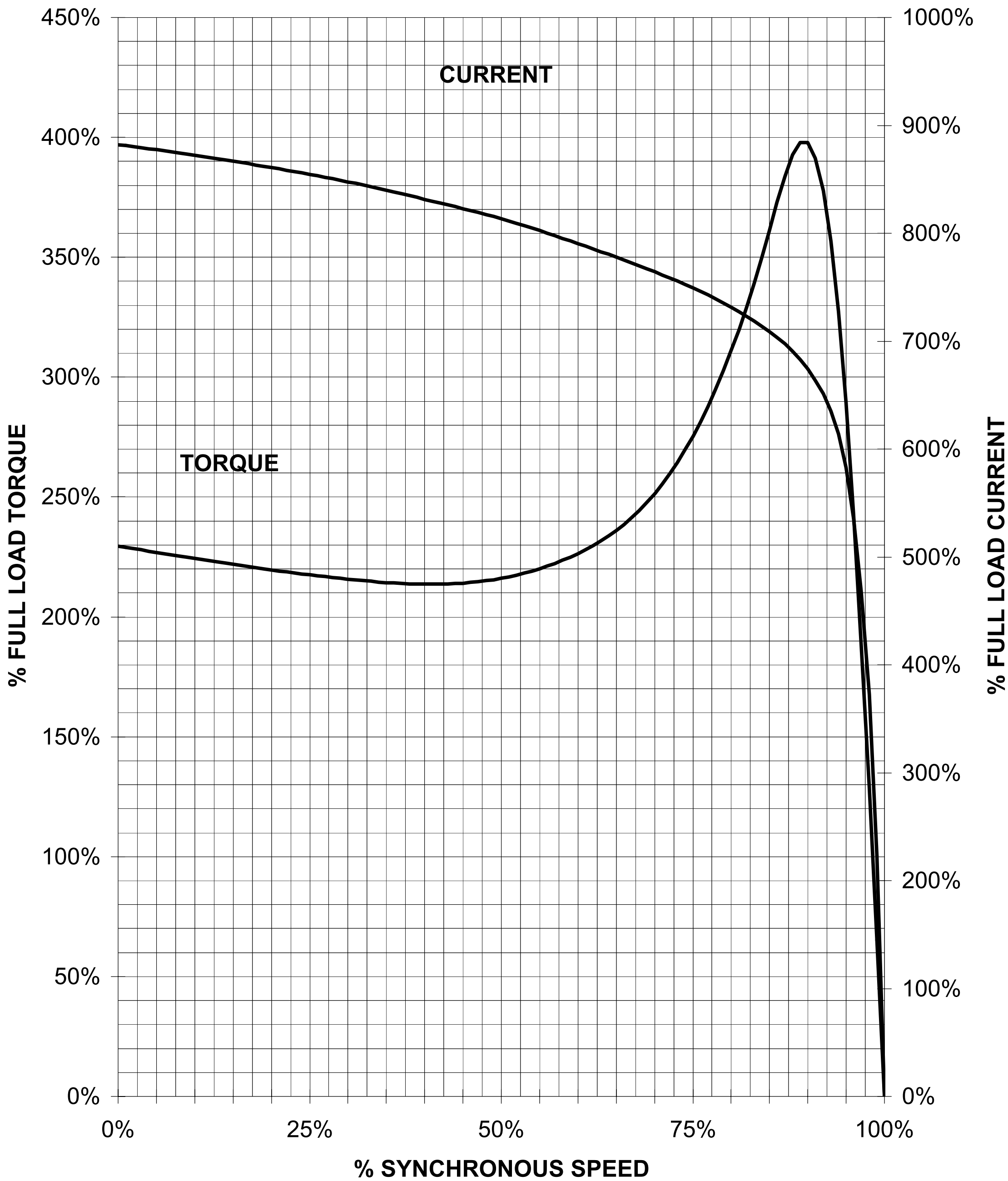


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	2	VOLTS	460	RPM	3600	TYPE	SD10
HZ	60	PHASE	3	FRAME	145T	NEMA	B

TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

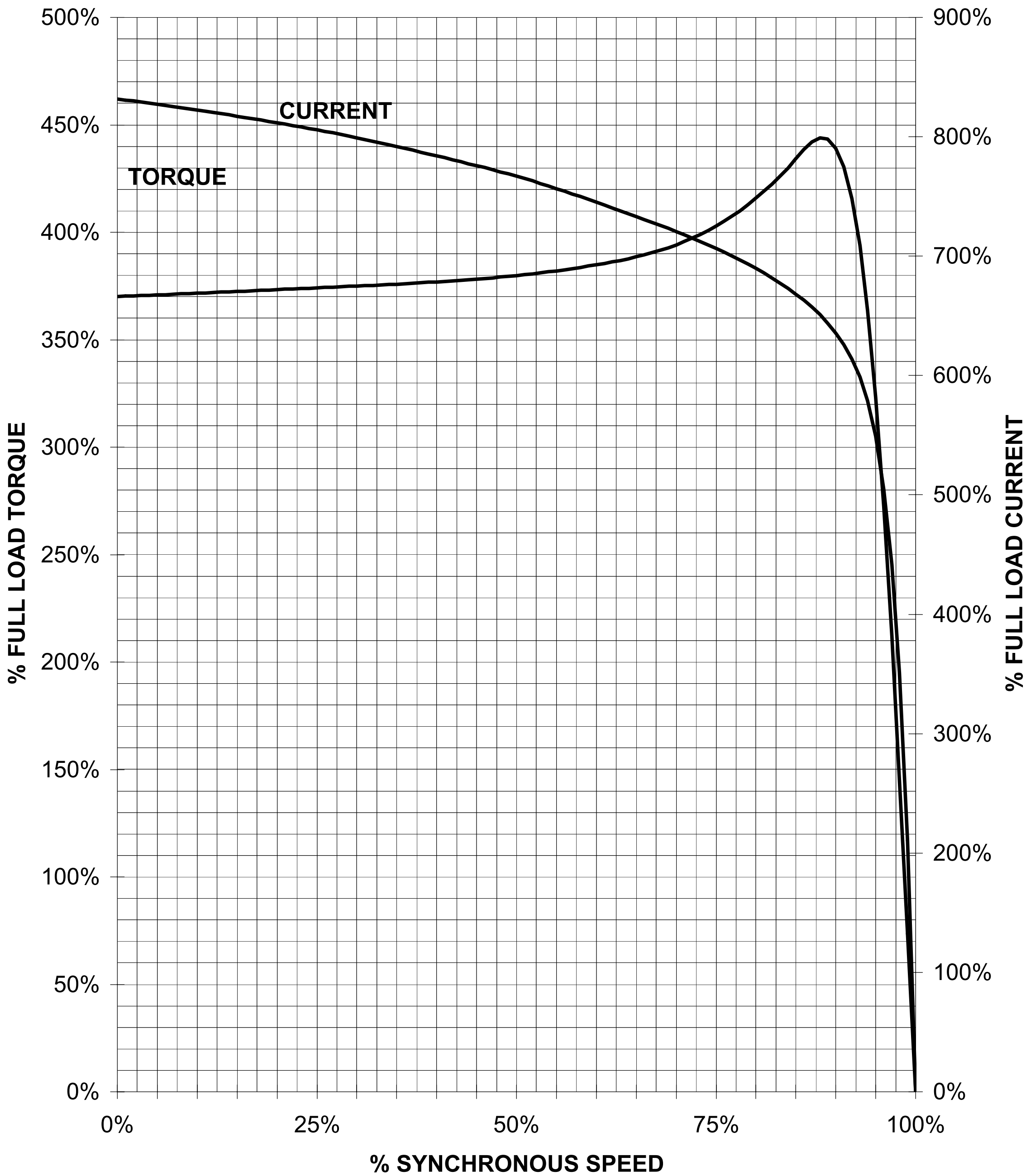
PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

Application Manual for NEMA Motors

HP 2 VOLTS 460 RPM 1800 TYPE SD10

HZ 60 PHASE 3 FRAME 145T NEMA B

TORQUE & CURRENT VS. SPEED

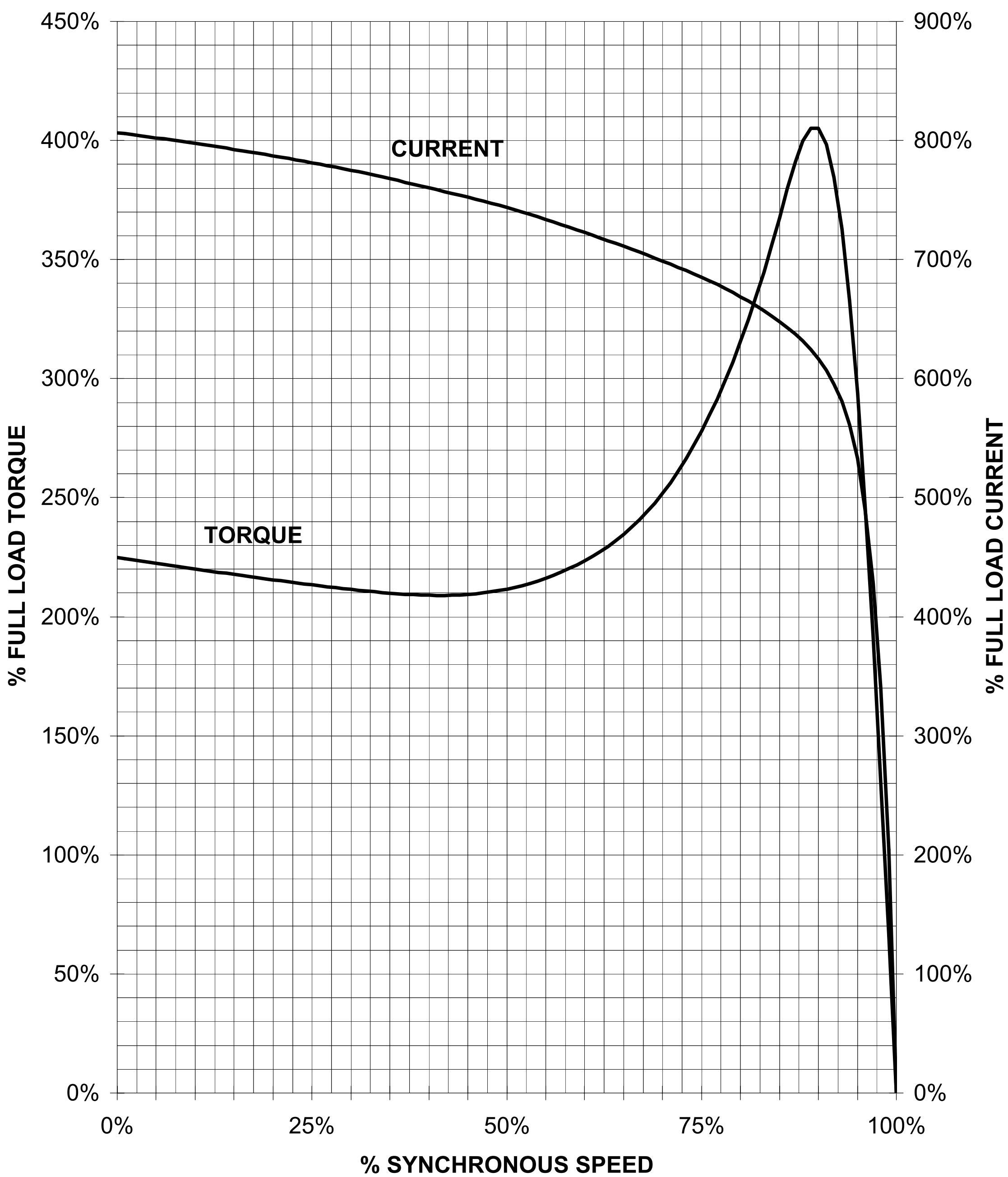


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	2	VOLTS	460	RPM	1200	TYPE	SD10
HZ	60	PHASE	3	FRAME	184T	NEMA	B

TORQUE & CURVE VS. SPEED

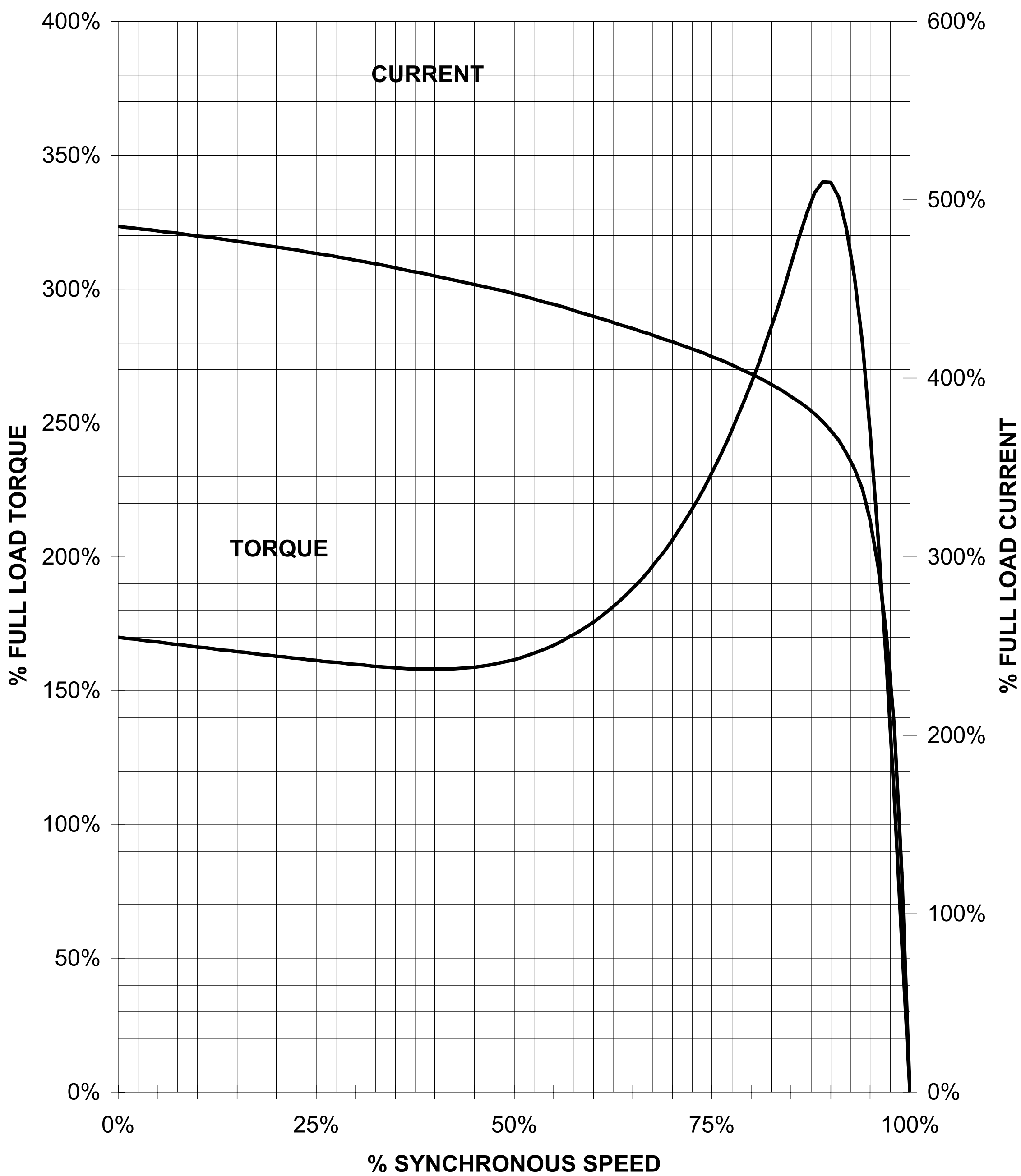


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	2	VOLTS	460	RPM	900	TYPE	SD10
HZ	60	PHASE	3	FRAME	213T	NEMA	B

TORQUE & CURRENT VS. SPEED



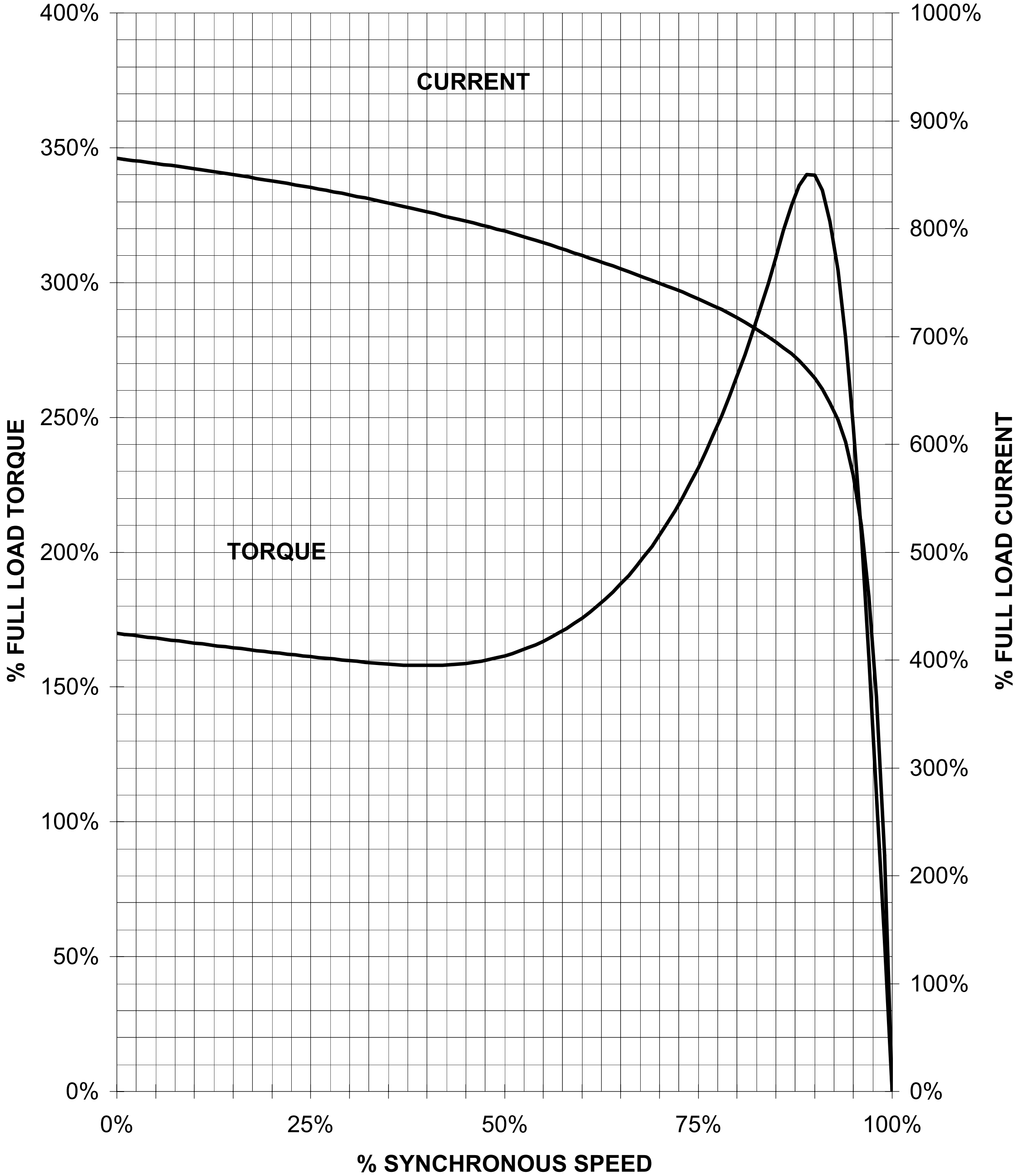
Customer: **PO No.:** **Order No.:**

SIEMENS

Application Manual for NEMA Motors

HP	3	VOLTS	460	RPM	3600	TYPE	SD10
HZ	60	PHASE	3	FRAME	182T	NEMA	B

TORQUE & CURRENT VS. SPEED

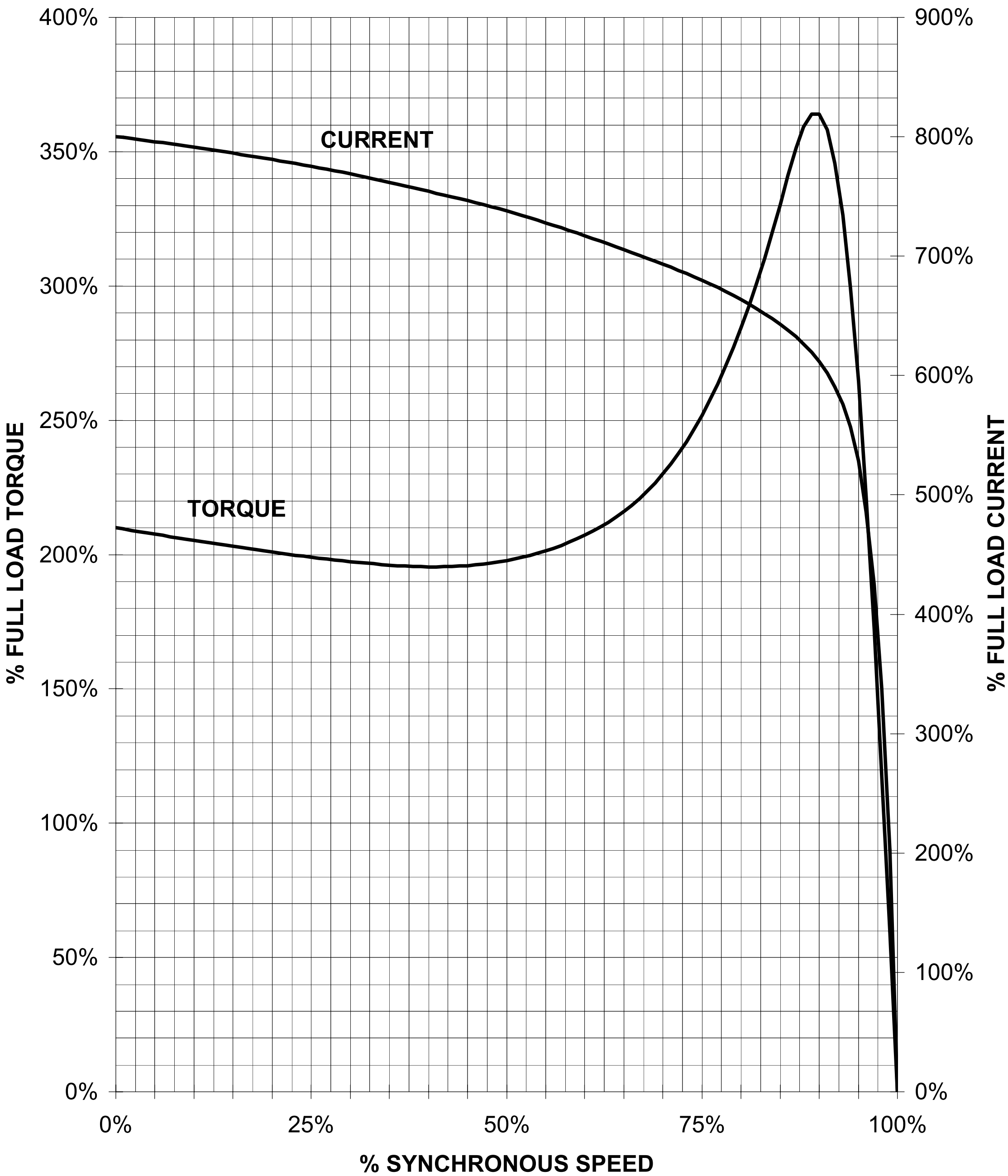


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	3	VOLTS	460	RPM	1800	TYPE	SD10
HZ	60	PHASE	3	FRAME	182T	NEMA	B

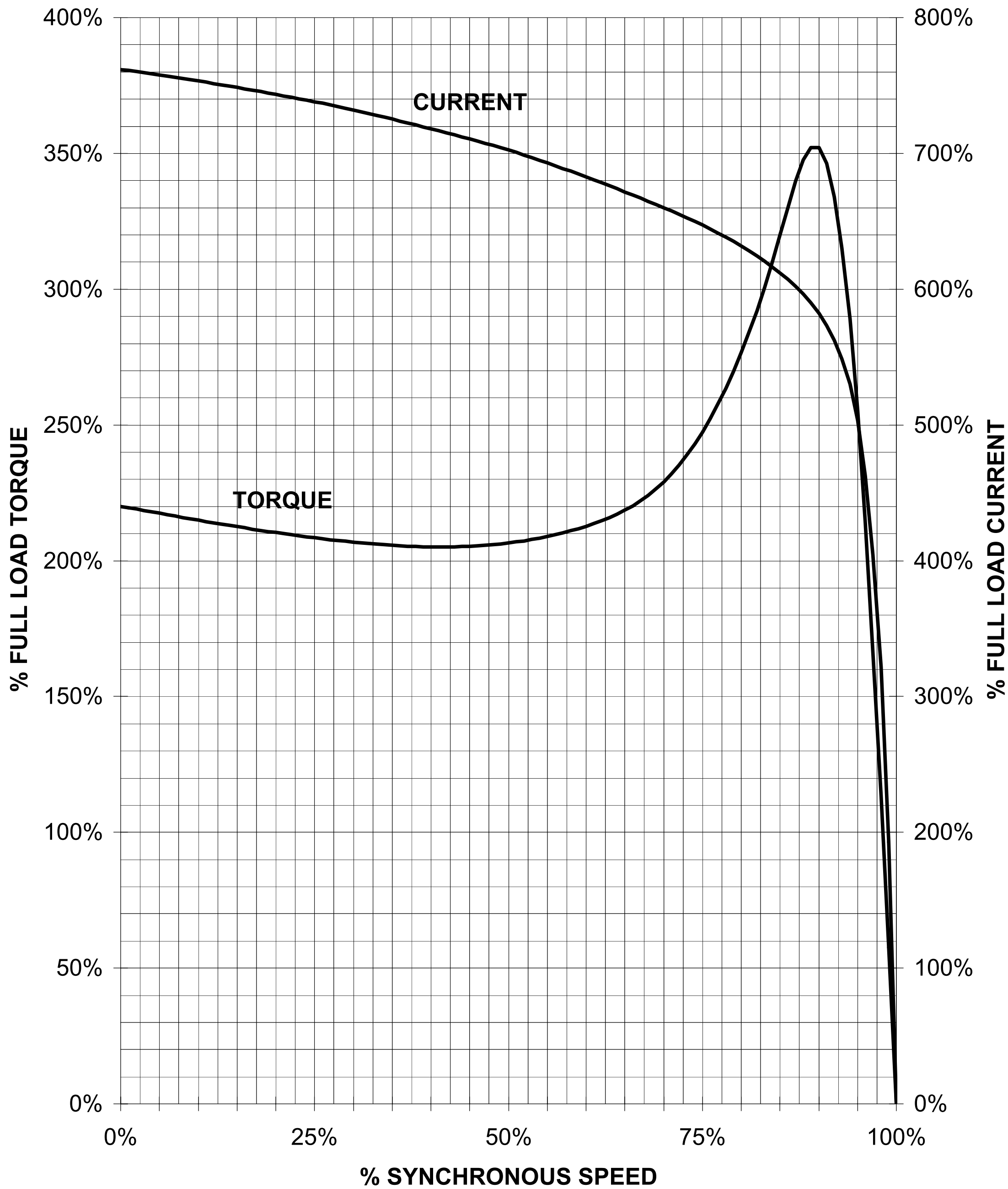
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	3	VOLTS	460	RPM	1200	TYPE	SD10
HZ	60	PHASE	3	FRAME	213T	NEMA	B

TORQUE & CURRENT VS. SPEED

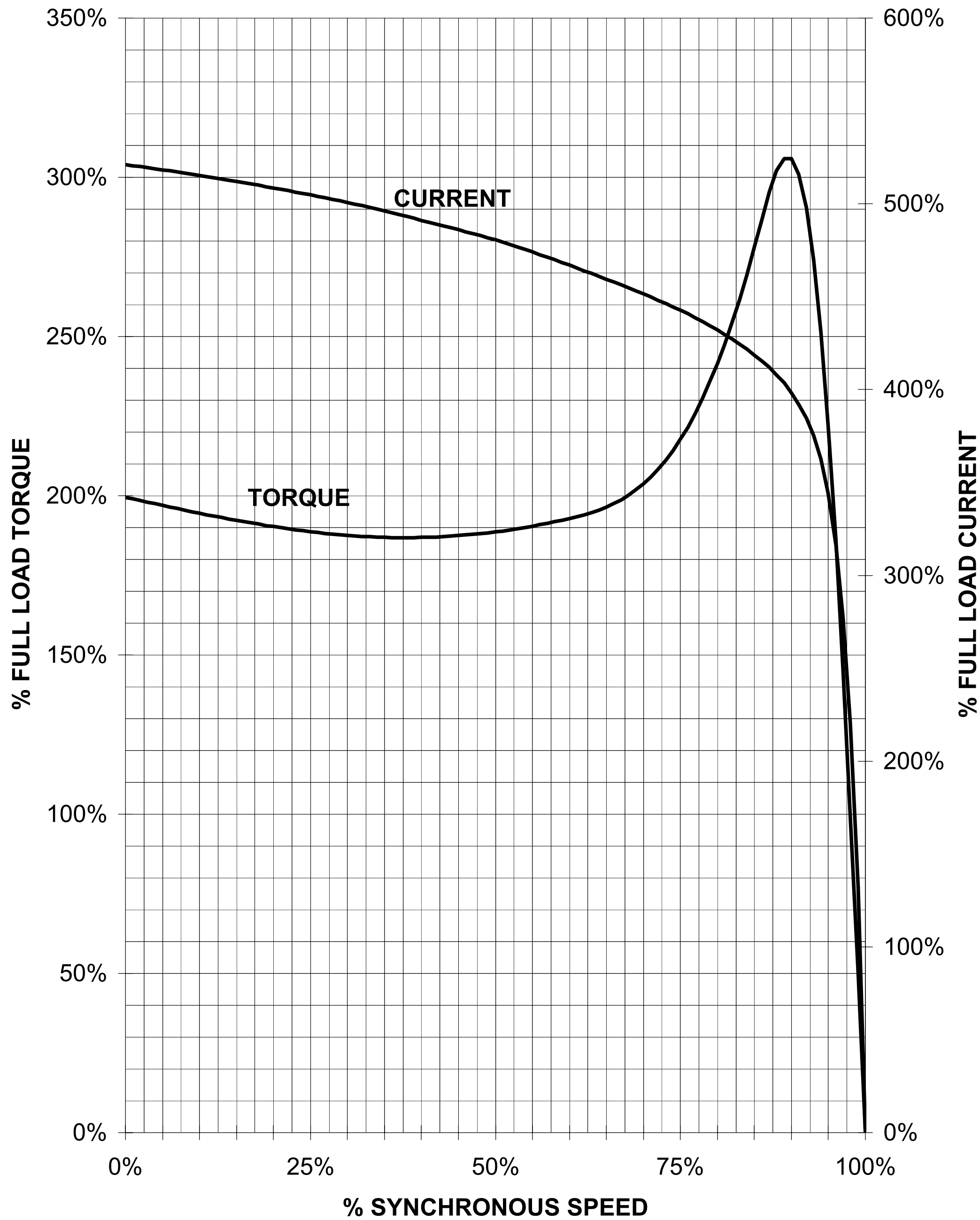


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	3	VOLTS	460	RPM	900	TYPE	SD10
HZ	60	PHASE	3	FRAME	215T	NEMA	B

TORQUE & CURRENT VS. SPEED

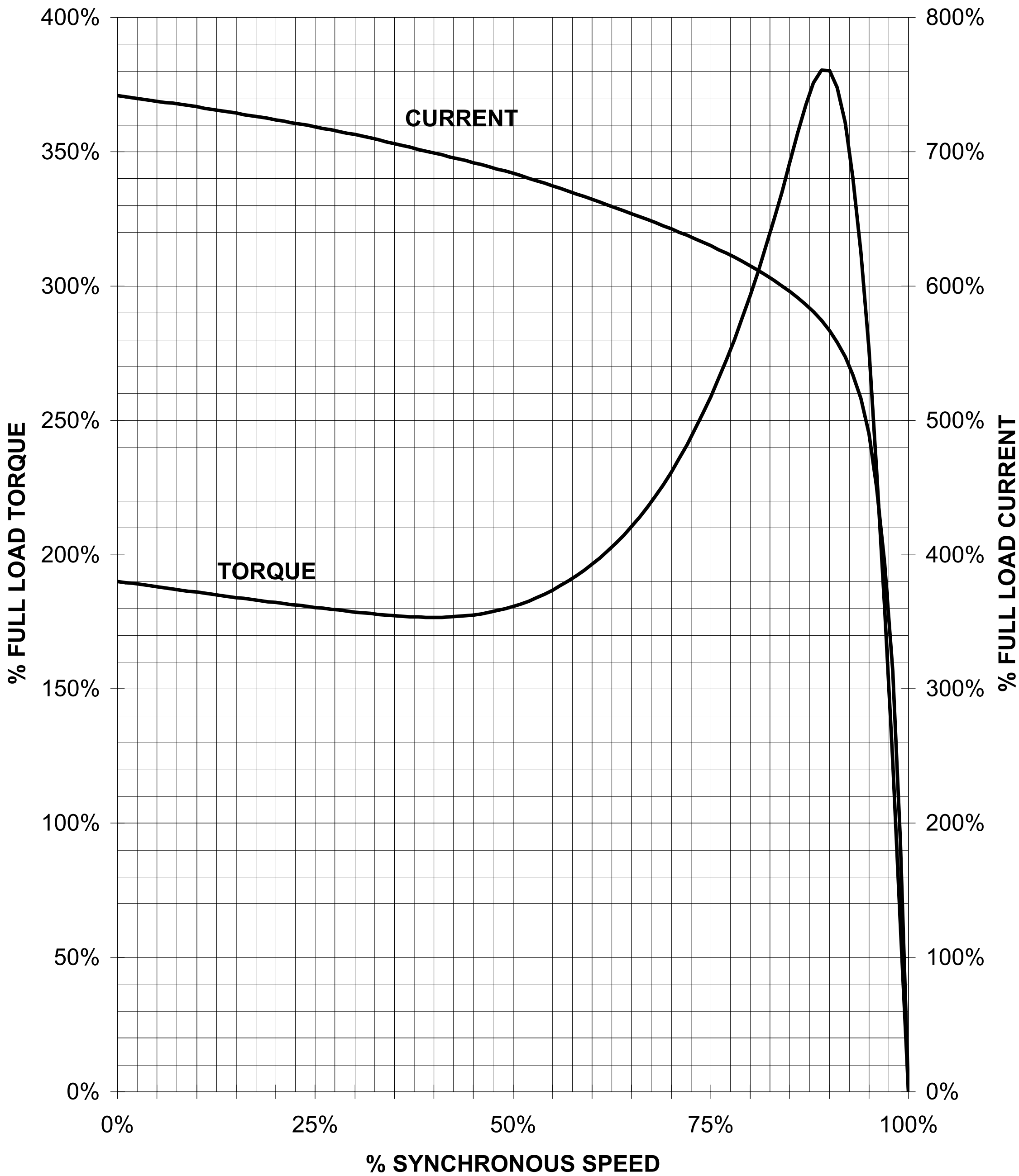


Customer: **PO No.:** **Order No.:**

SIEMENS

HP	5	VOLTS	460	RPM	3600	TYPE	SD10
HZ	60	PHASE	3	FRAME	184T	NEMA	B

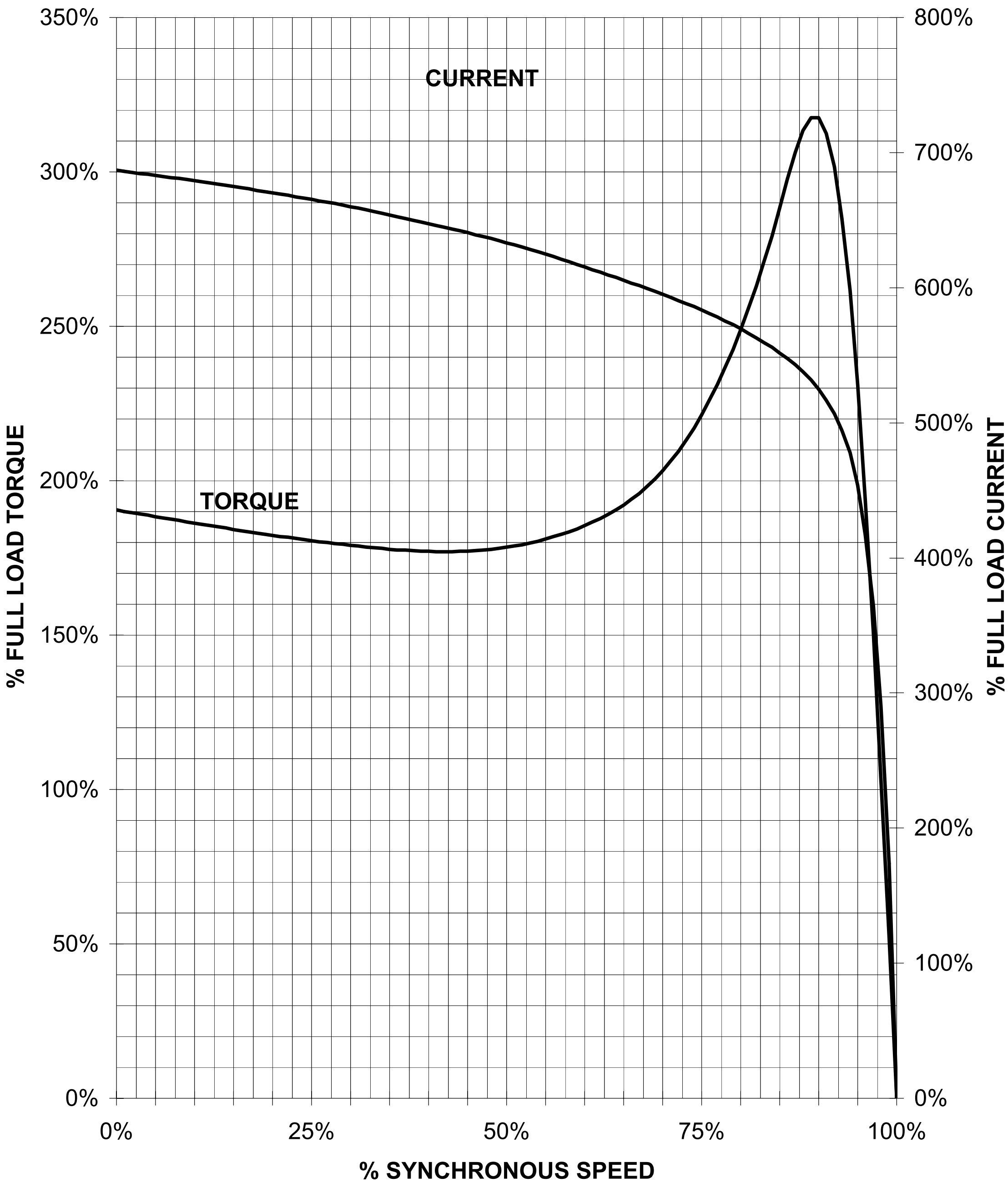
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	5	VOLTS	460	RPM	1800	TYPE	SD10
HZ	60	PHASE	3	FRAME	184T	NEMA	B

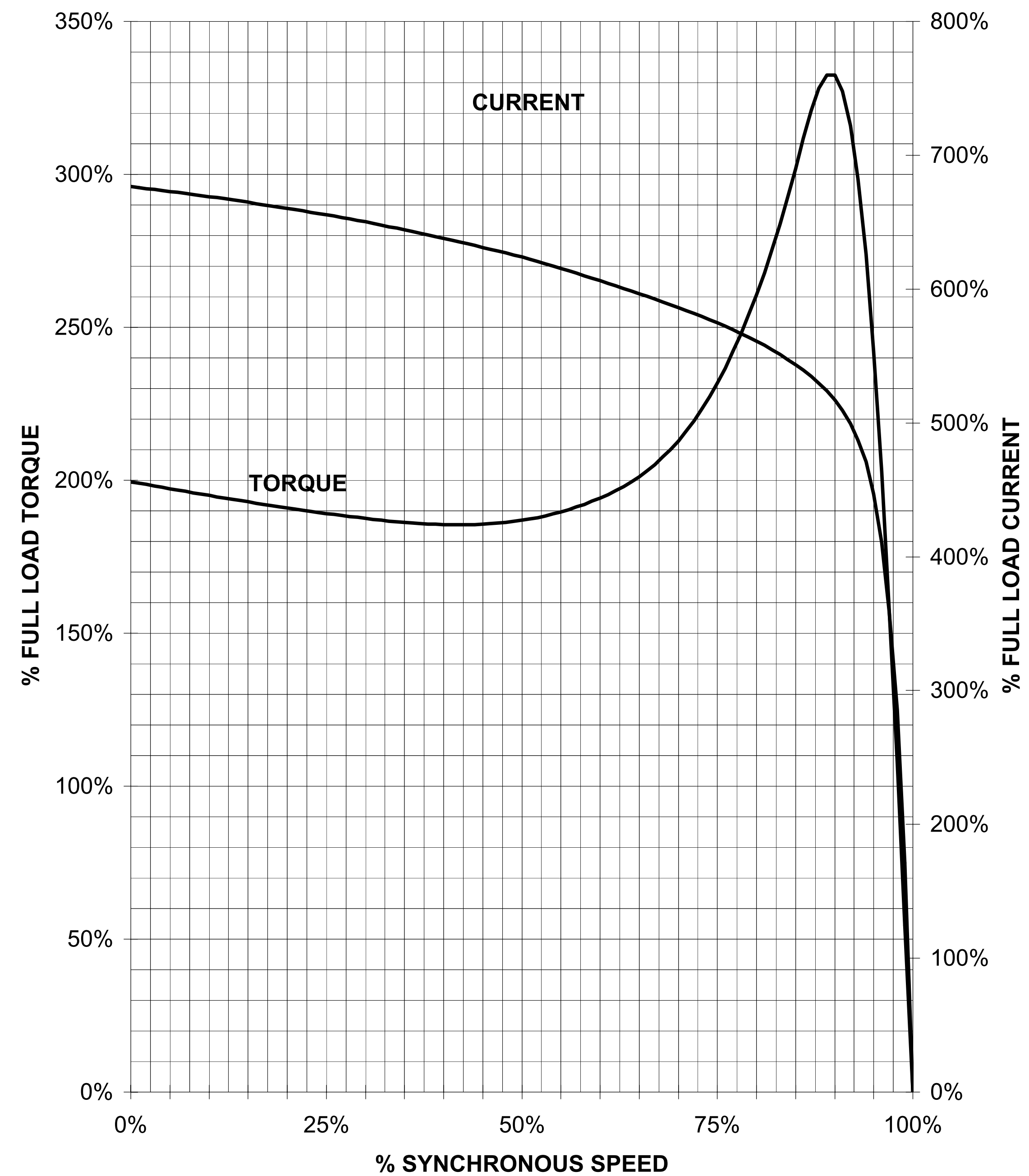
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	5	VOLTS	460	RPM	1200	TYPE	SD10
HZ	60	PHASE	3	FRAME	215T	NEMA	B

TORQUE & CURRENT VS. SPEED

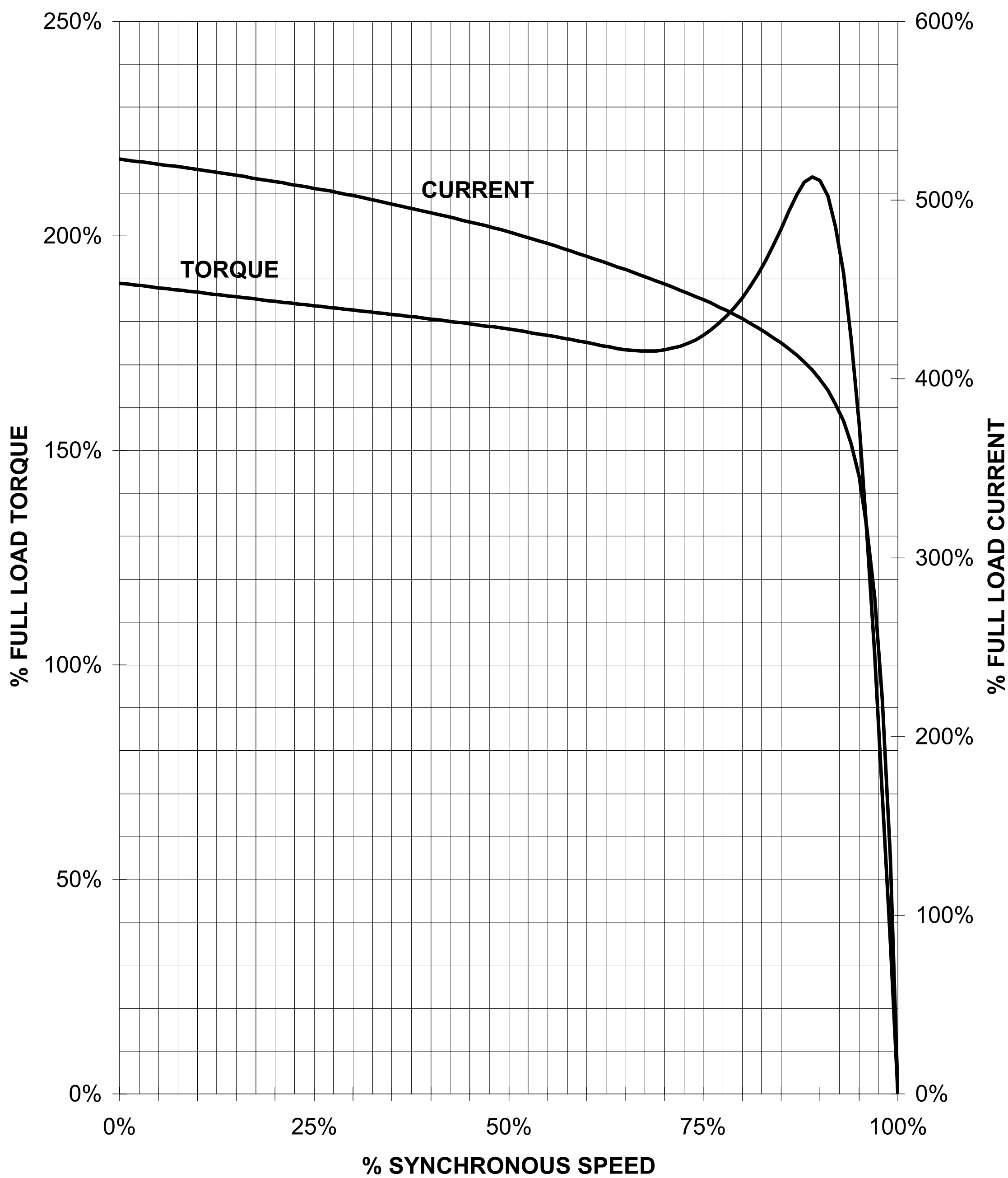


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	5	VOLTS	460	RPM	900	TYPE	SD10
HZ	60	PHASE	3	FRAME	254T	NEMA	B

TORQUE & CURRENT VS. SPEED

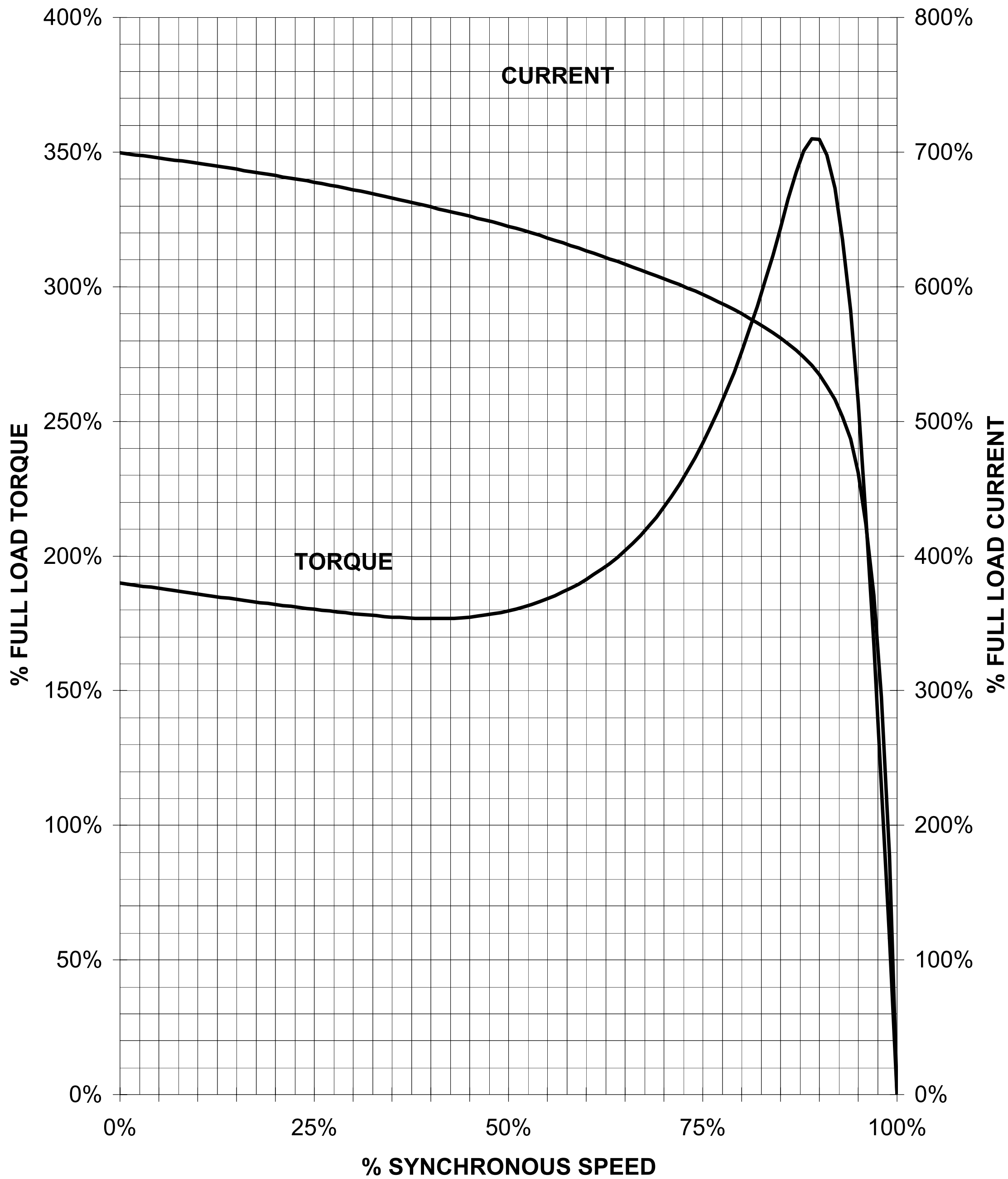


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	7.5	VOLTS	460	RPM	3600	TYPE	SD10
HZ	60	PHASE	3	FRAME	213T	NEMA	B

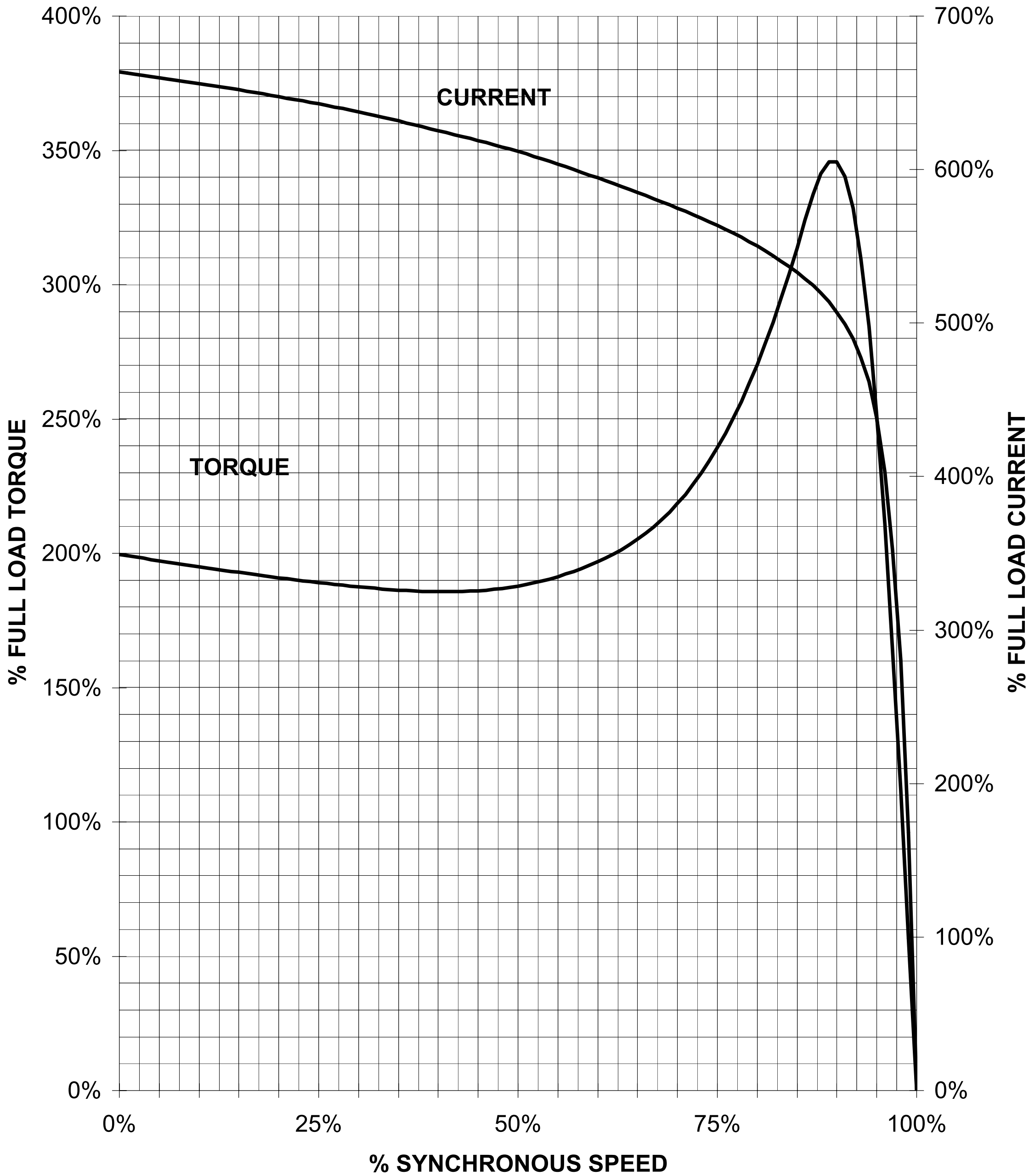
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	7.5	VOLTS	460	RPM	1800	TYPE	SD10
HZ	60	PHASE	3	FRAME	213T	NEMA	B

TORQUE & CURRENT VS. SPEED



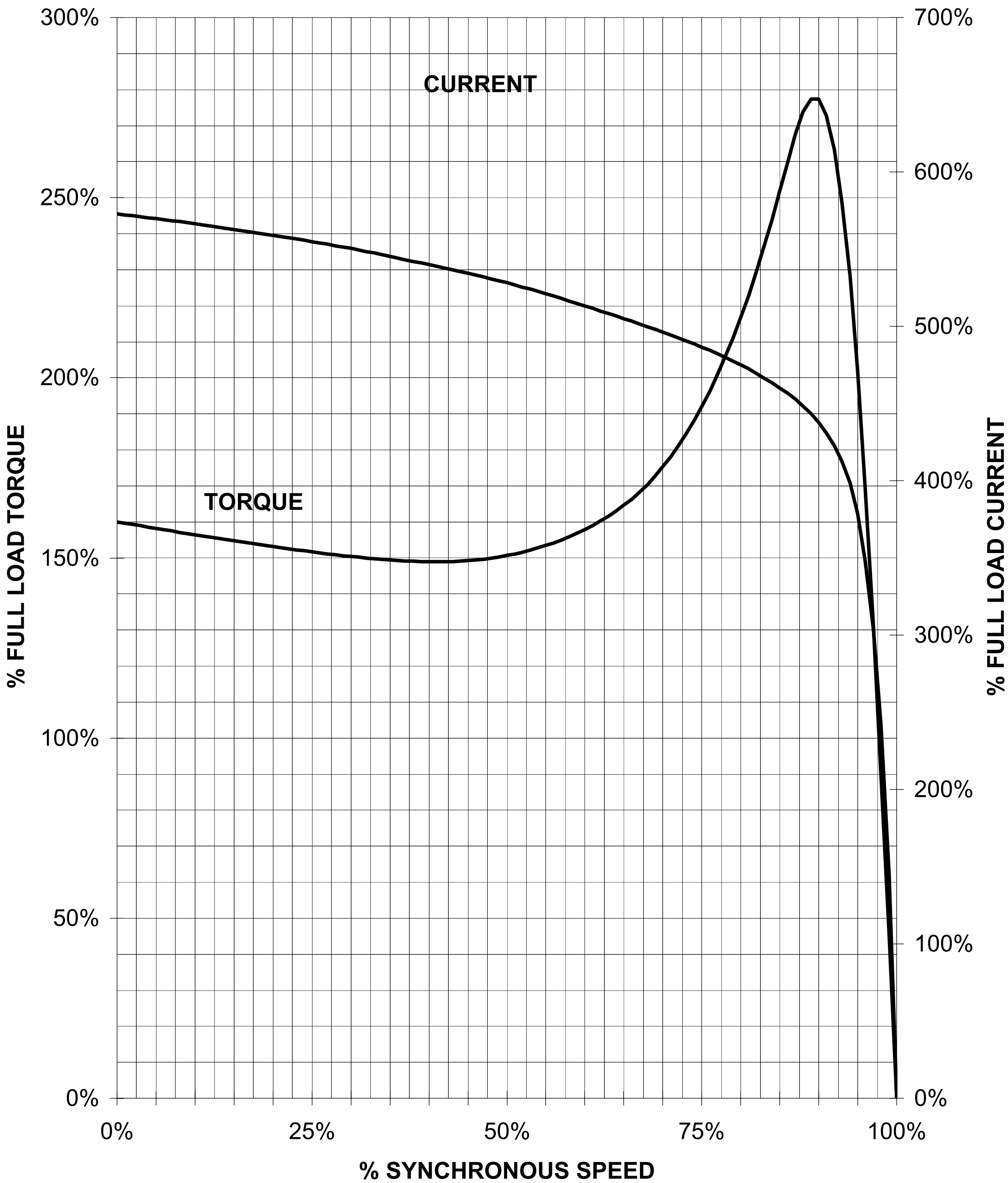
Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

Application Manual for NEMA Motors

HP	7.5	VOLTS	460	RPM	1200	TYPE	SD10
HZ	60	PHASE	3	FRAME	254T	NEMA	B

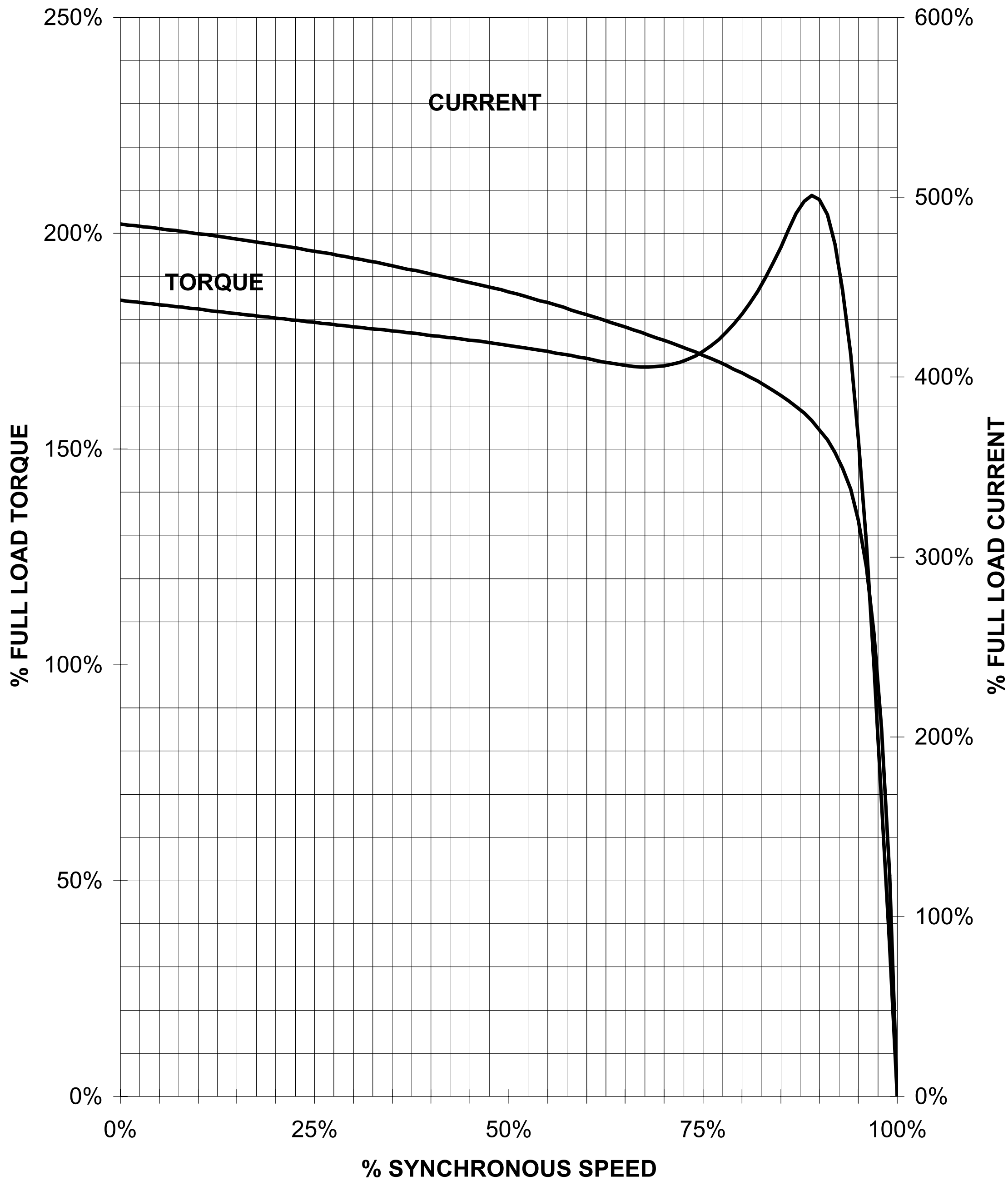
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	7.5	VOLTS	460	RPM	900	TYPE	SD10
HZ	60	PHASE	3	FRAME	256T	NEMA	B

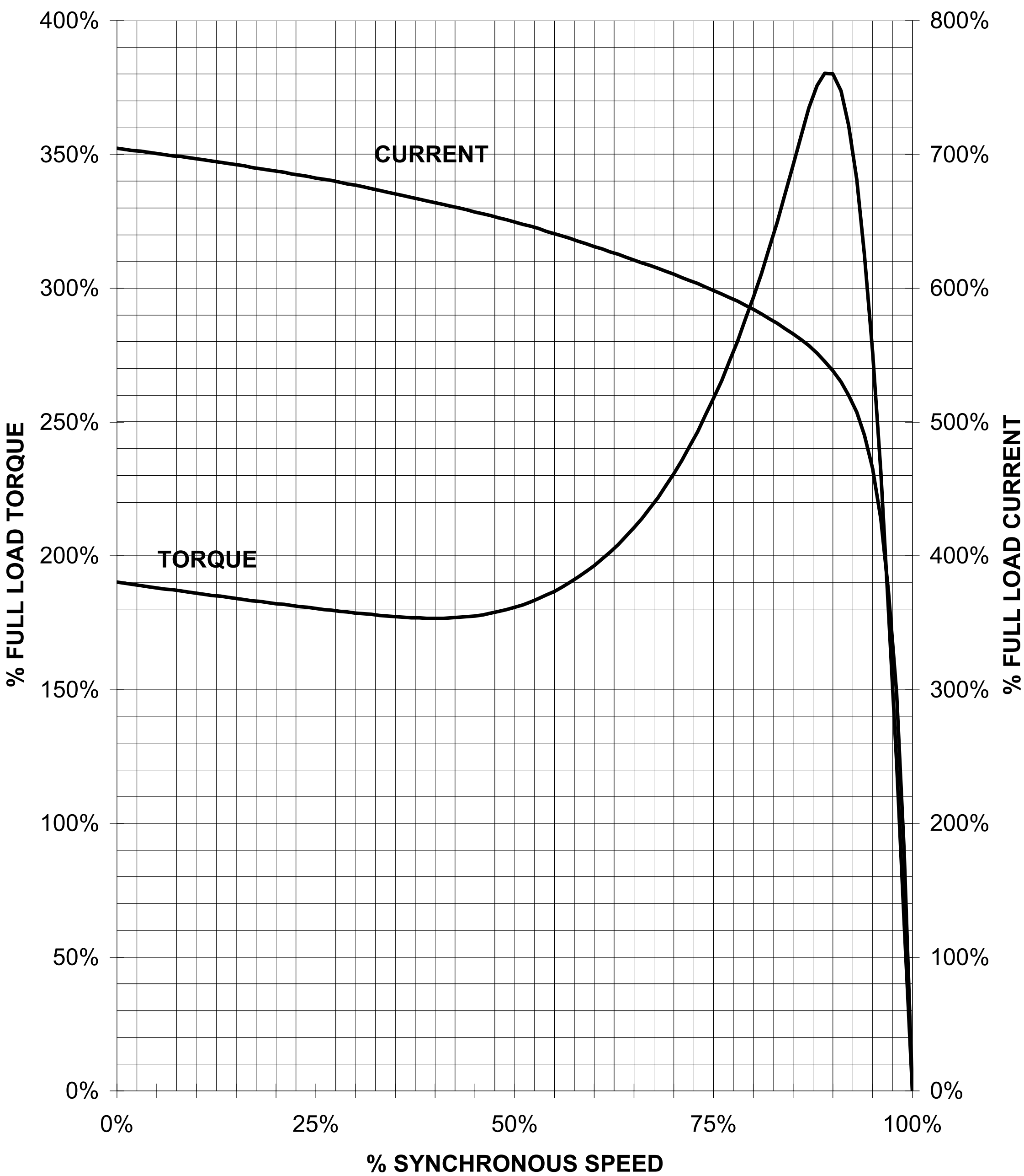
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	10	VOLTS	460	RPM	3600	TYPE	SD10
HZ	60	PHASE	3	FRAME	215T	NEMA	B

TORQUE & CURRENT VS. SPEED

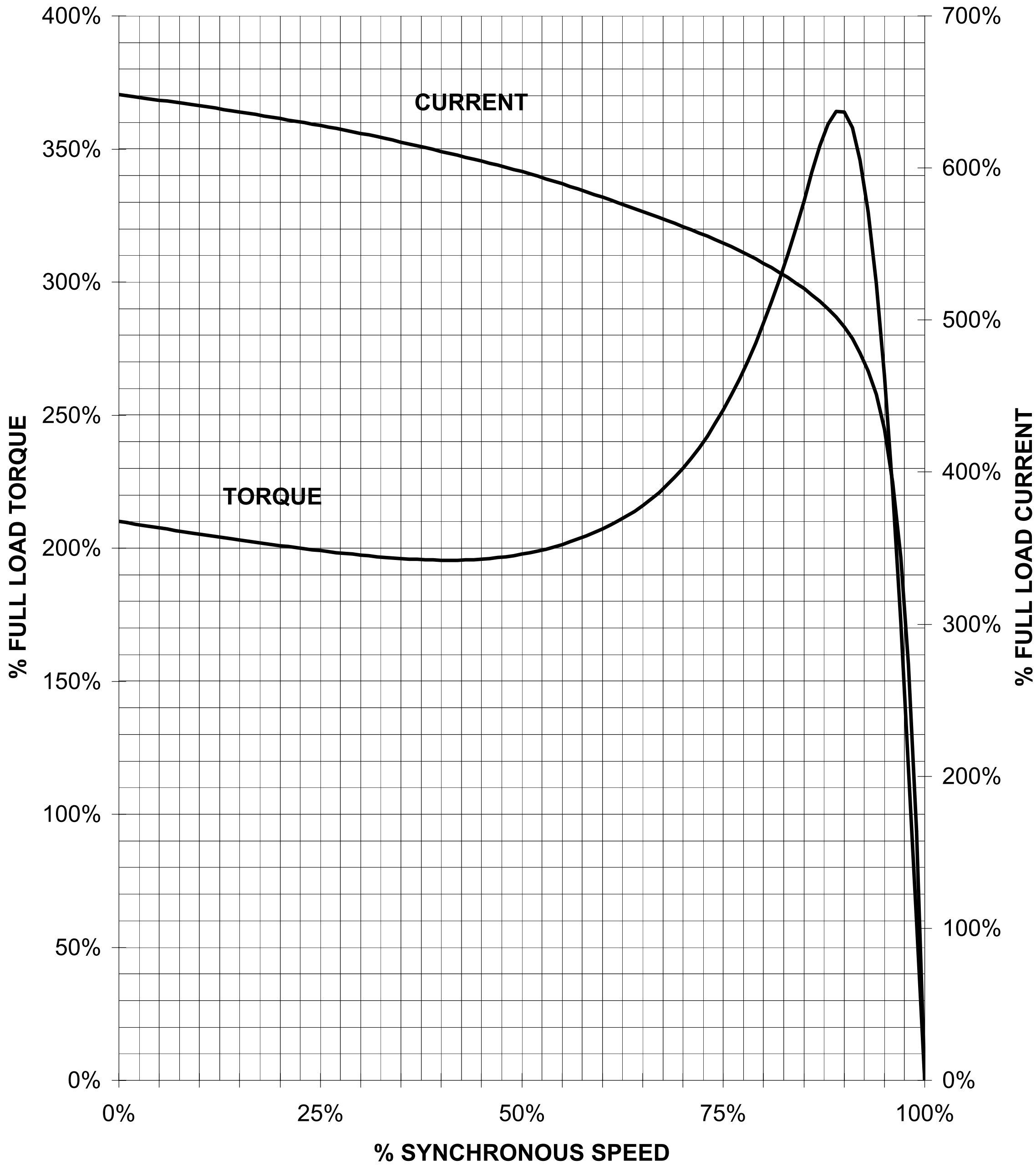


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	10	VOLTS	460	RPM	1800	TYPE	SD10
HZ	60	PHASE	3	FRAME	215T	NEMA	B

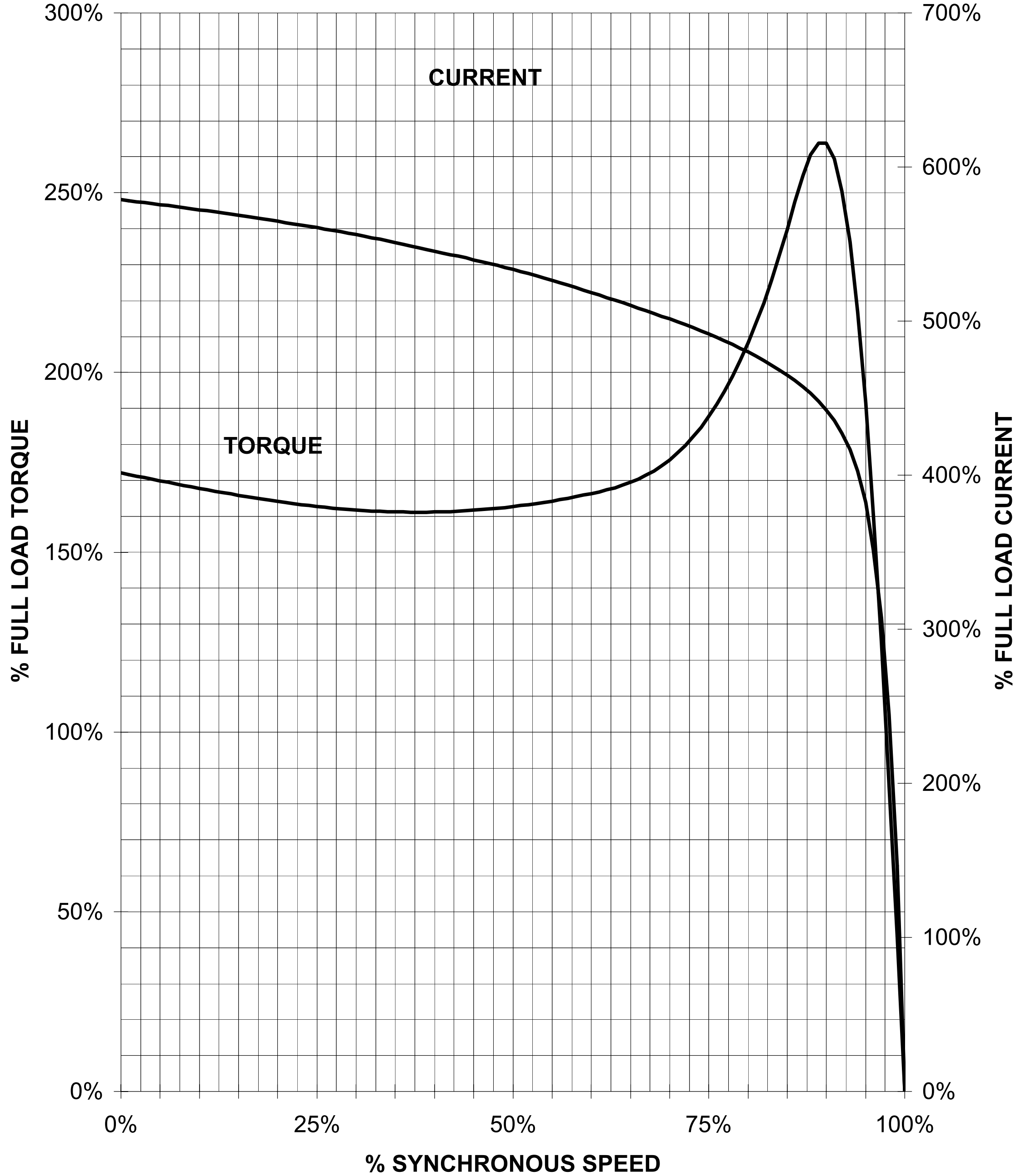
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	10	VOLTS	460	RPM	1200	TYPE	SD10
HZ	60	PHASE	3	FRAME	256T	NEMA	B

TORQUE & CURRENT VS. SPEED

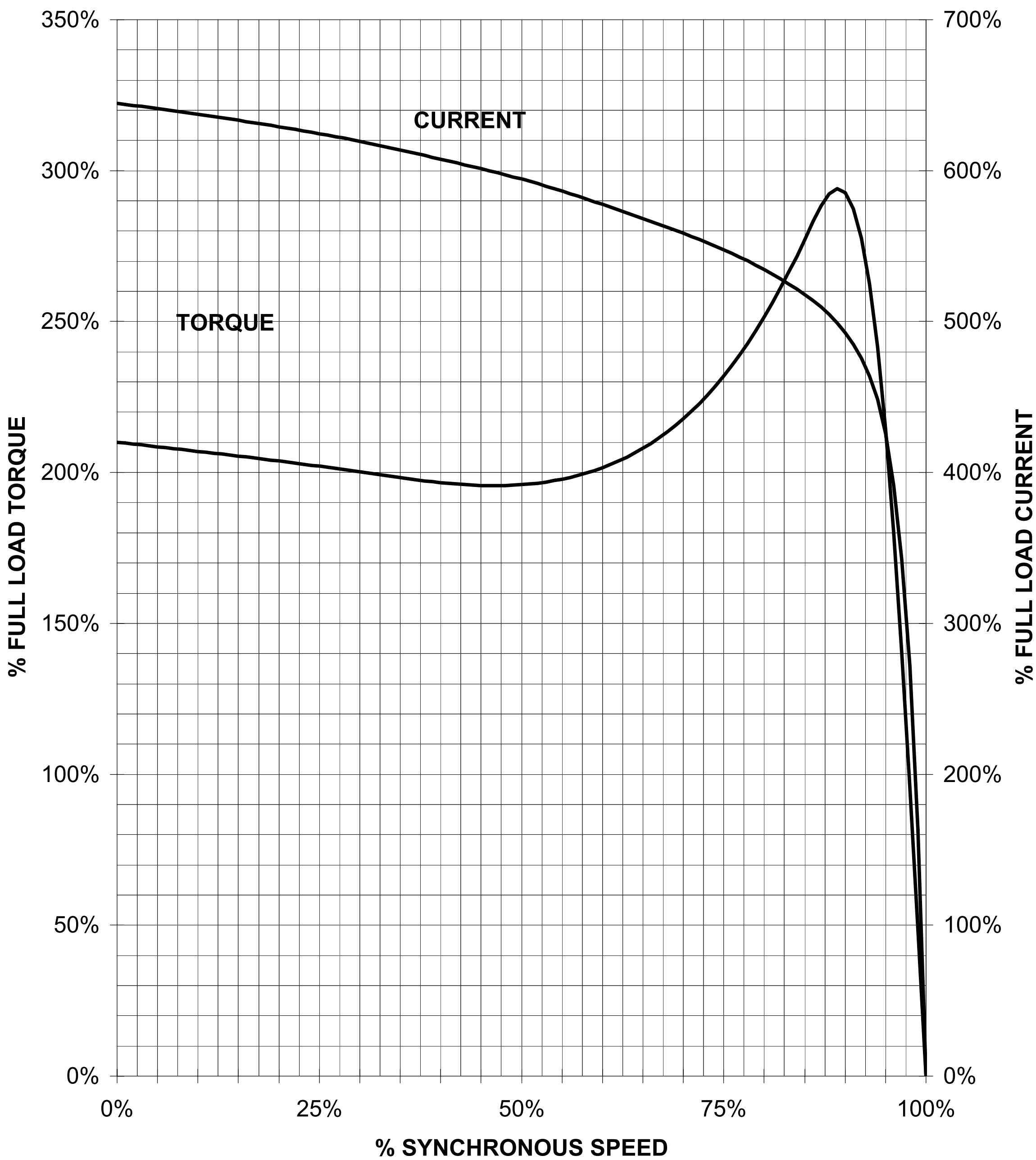


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	15	VOLTS	460	RPM	3600	TYPE	SD10
HZ	60	PHASE	3	FRAME	254T	NEMA	B

TORQUE & CURRENT VS. SPEED

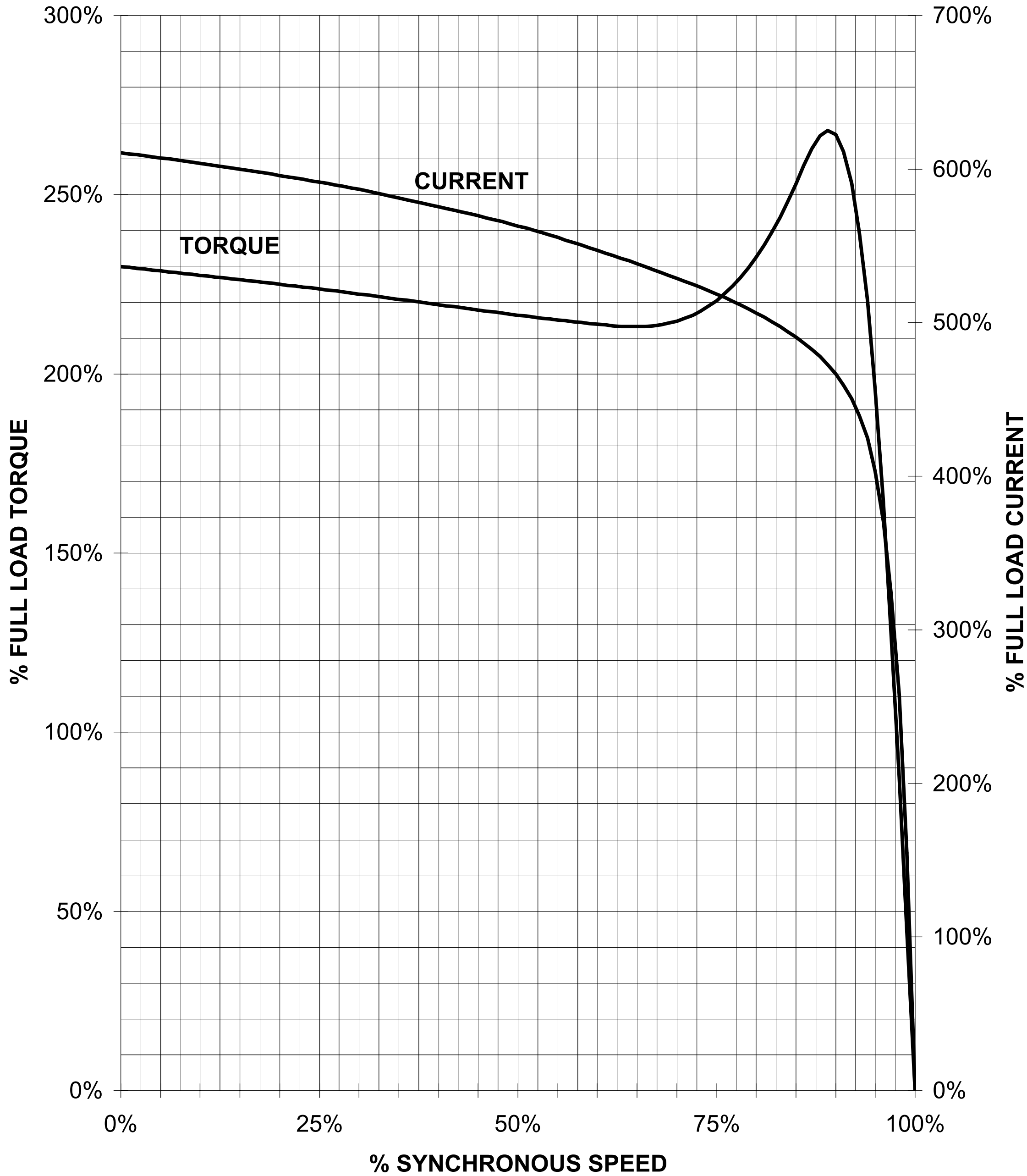


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	15	VOLTS	460	RPM	1800	TYPE	SD10
HZ	60	PHASE	3	FRAME	254T	NEMA	B

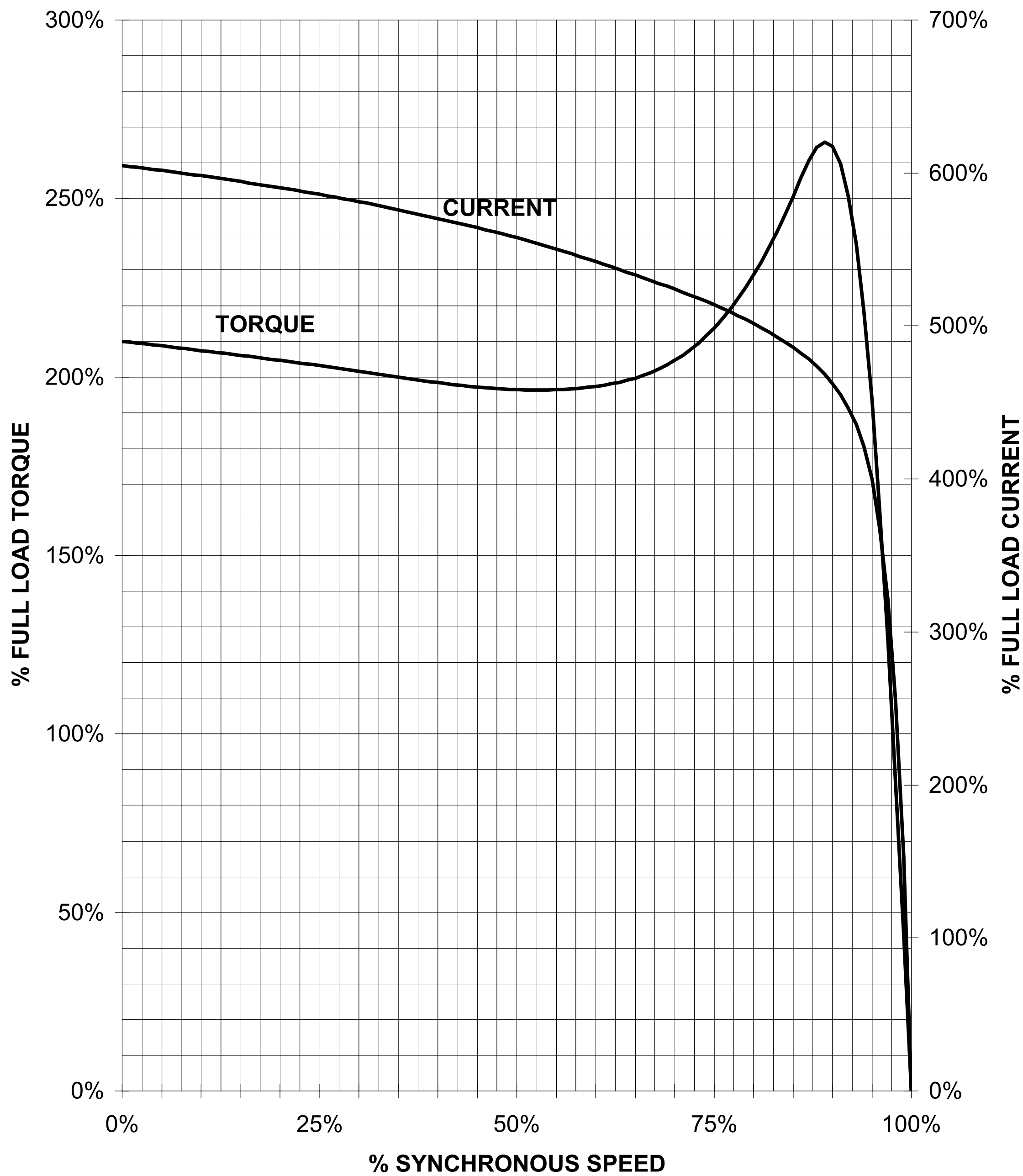
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	20	VOLTS	460	RPM	3600	TYPE	SD10
HZ	60	PHASE	3	FRAME	256T	NEMA	B

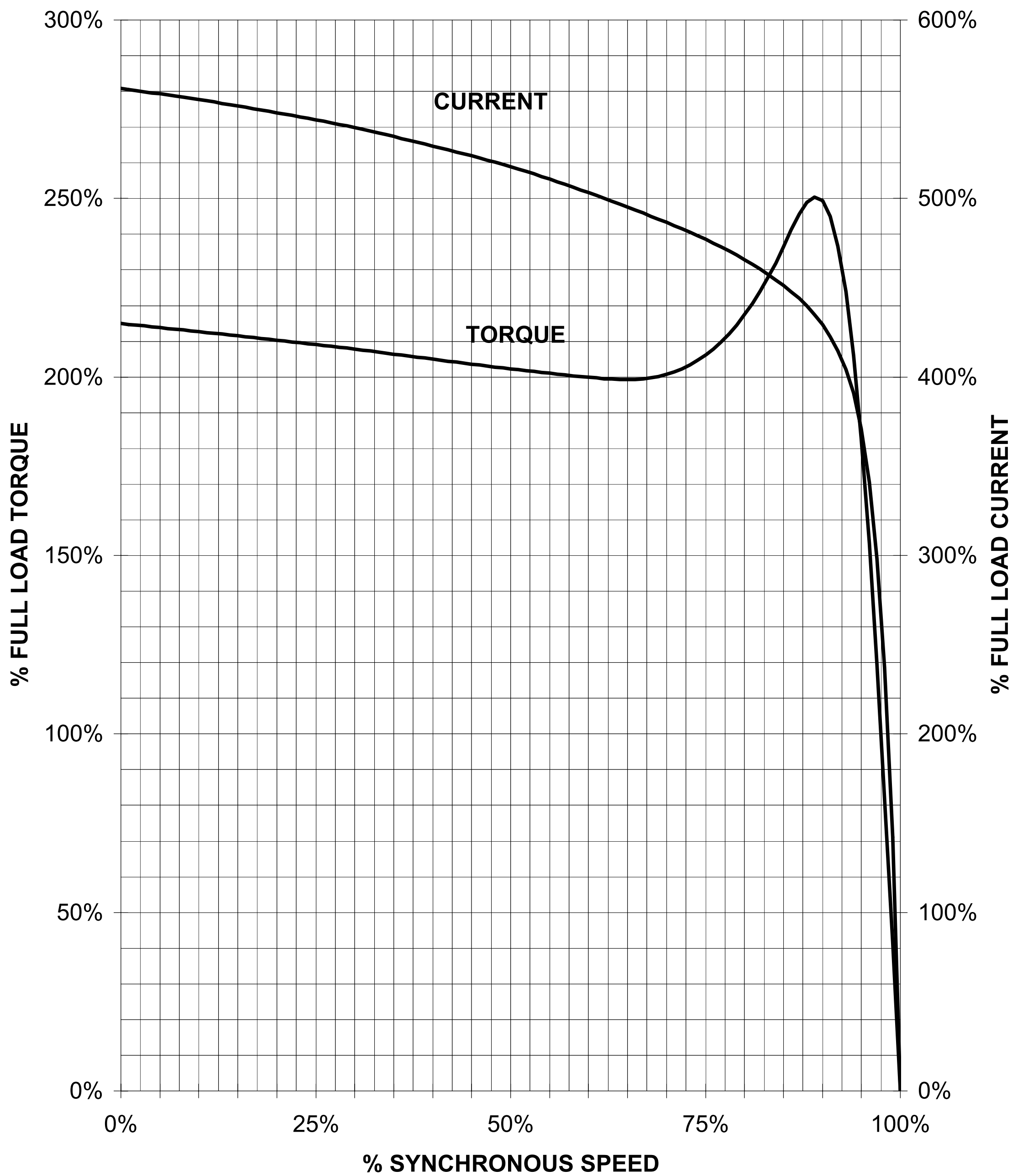
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	20	VOLTS	460	RPM	1800	TYPE	SD10
HZ	60	PHASE	3	FRAME	256T	NEMA	B

TORQUE & CURRENT VS. SPEED

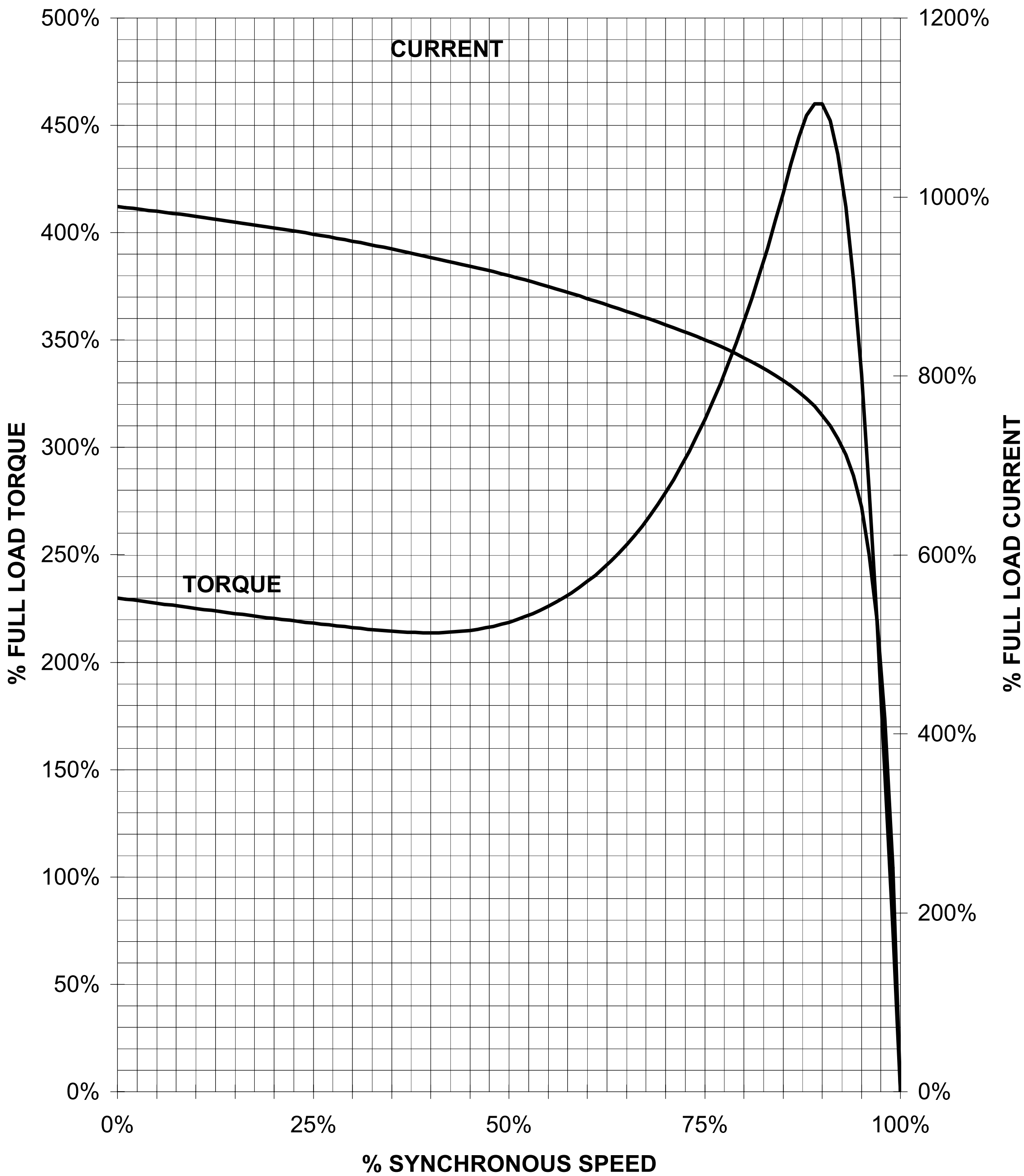


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	1.5	VOLTS	460	RPM	3600	TYPE	SD100
HZ	60	PHASE	3	FRAME	143T	NEMA	B

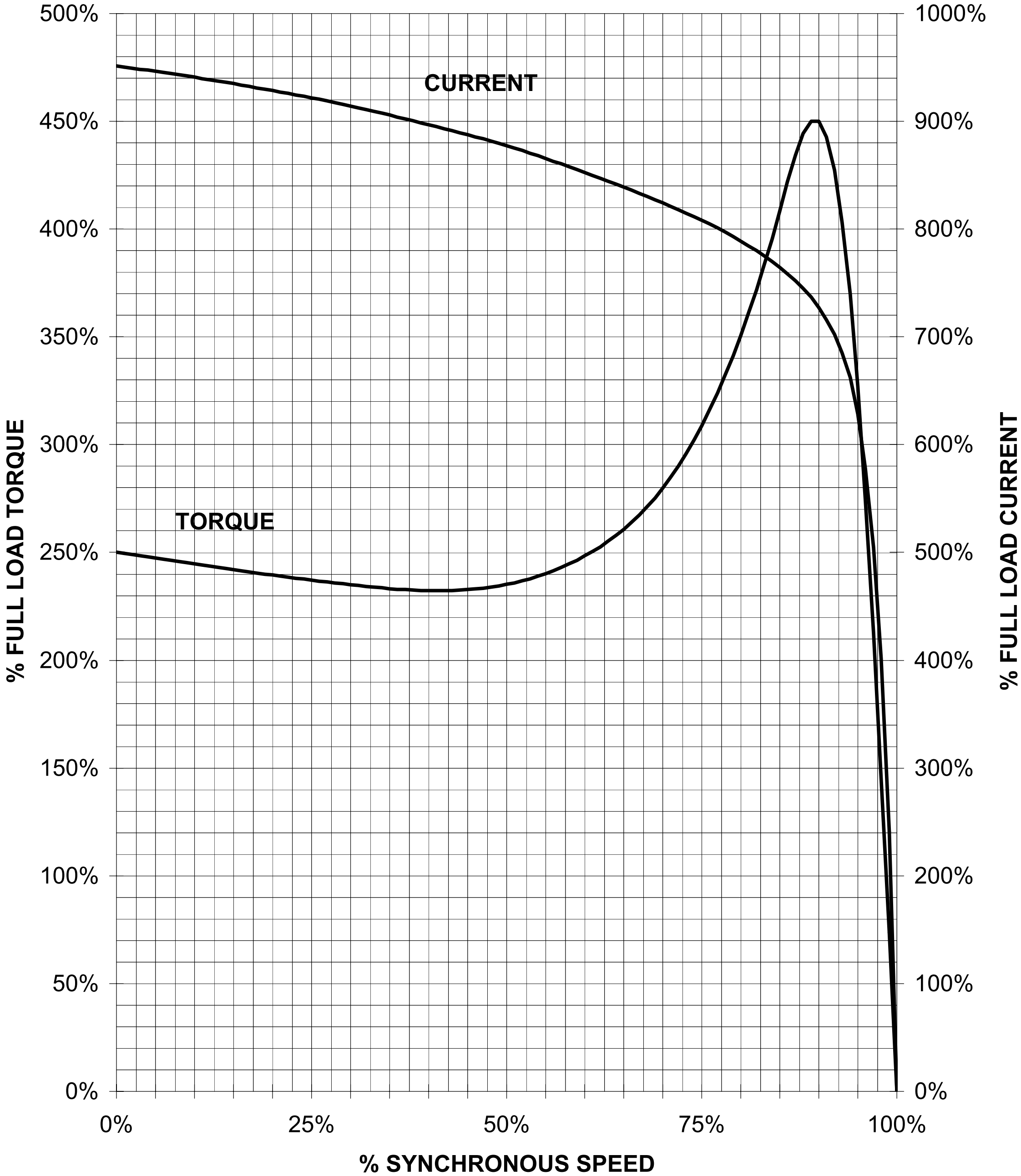
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1.5	VOLTS	460	RPM	1800	TYPE	SD100
HZ	60	PHASE	3	FRAME	145T	NEMA	B

TORQUE & CURRENT VS. SPEED



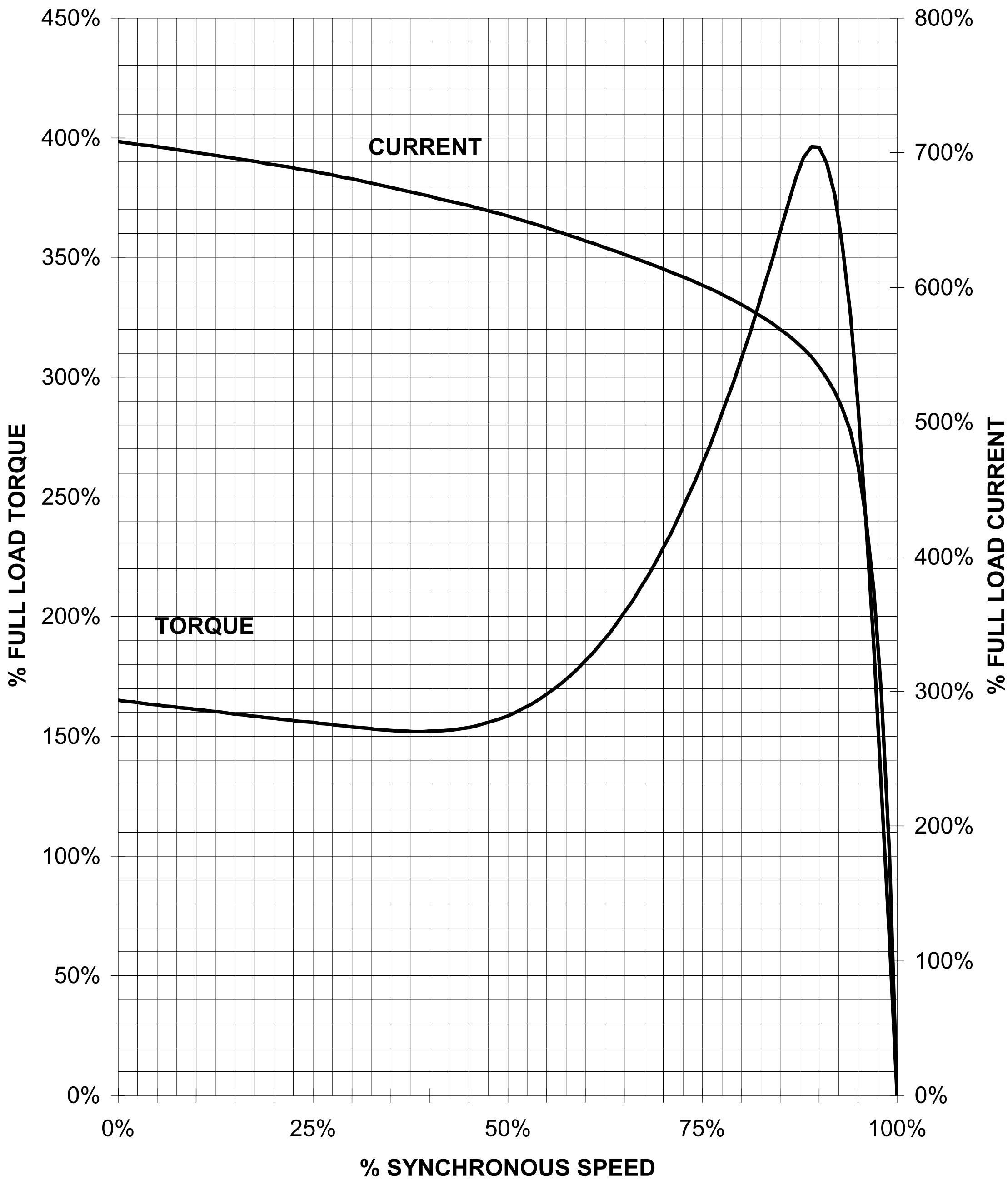
Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

Application Manual for NEMA Motors

HP	1.5	VOLTS	460	RPM	1200	TYPE	SD100
HZ	60	PHASE	3	FRAME	182T	NEMA	B

TORQUE & CURRENT VS. SPEED

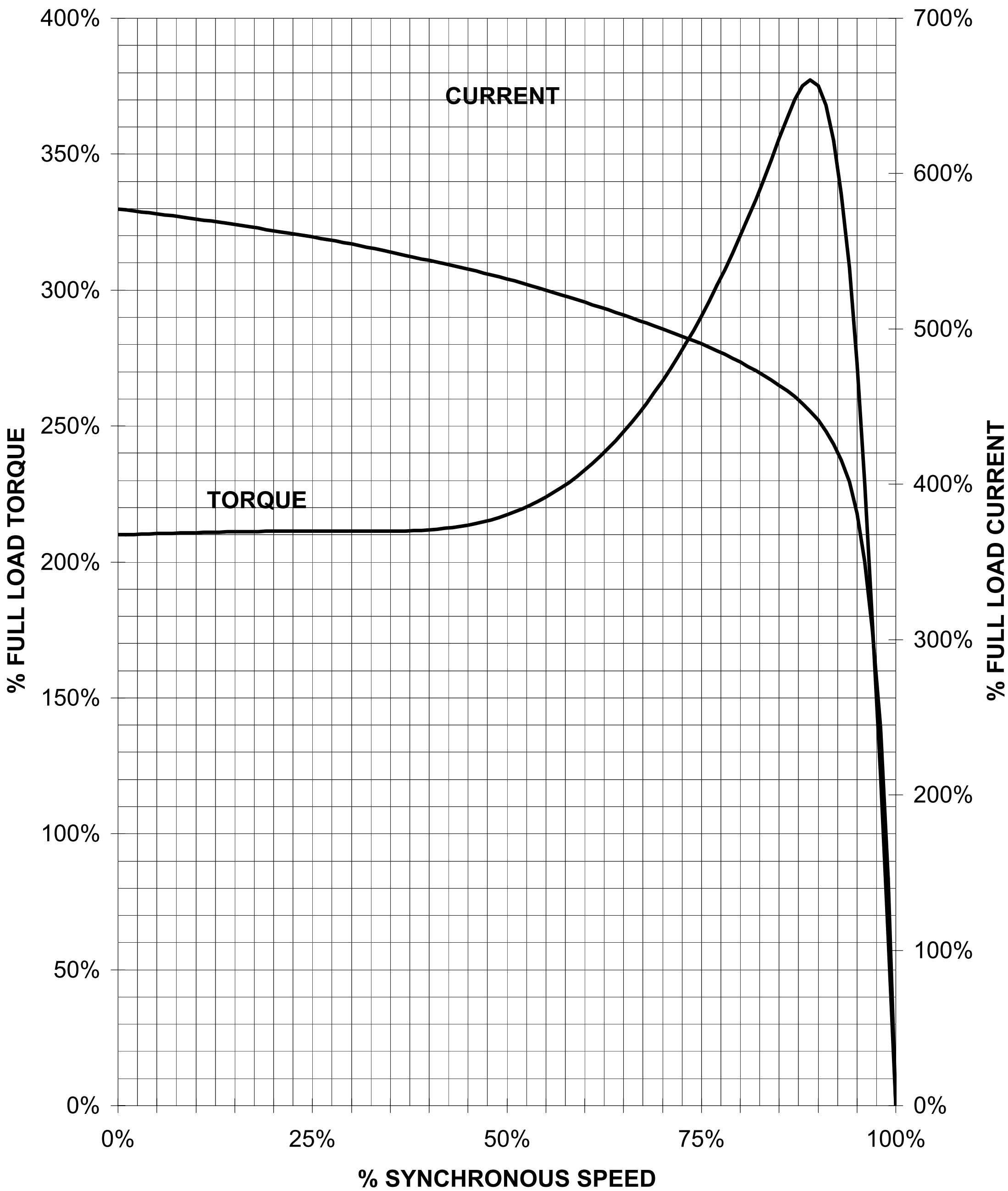


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	1	VOLTS	460	RPM	3600	TYPE	SD100
HZ	60	PHASE	3	FRAME	143T	NEMA	B

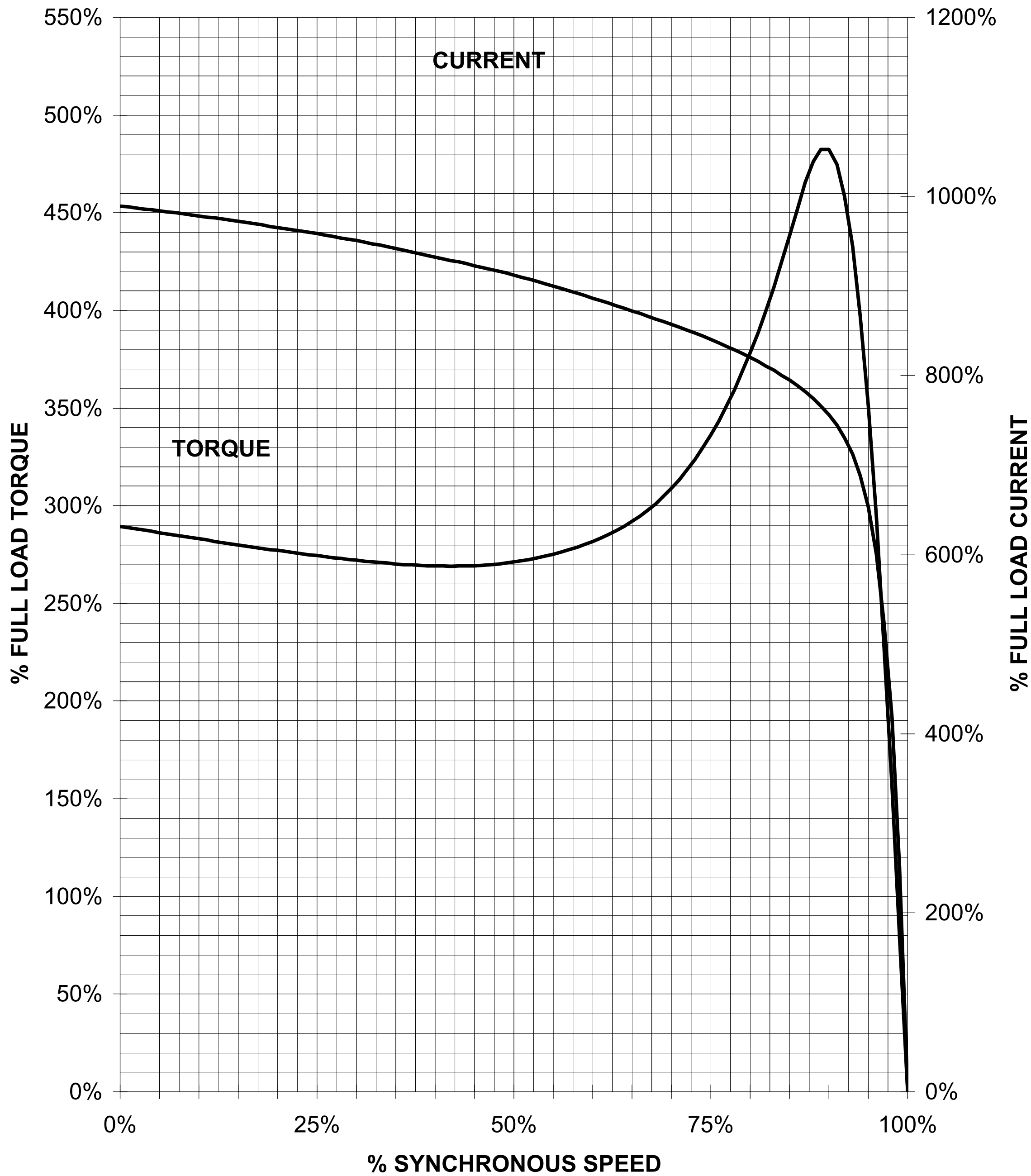
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1	VOLTS	460	RPM	1800	TYPE	SD100
HZ	60	PHASE	3	FRAME	143T	NEMA	B

TORQUE & CURRENT VS. SPEED

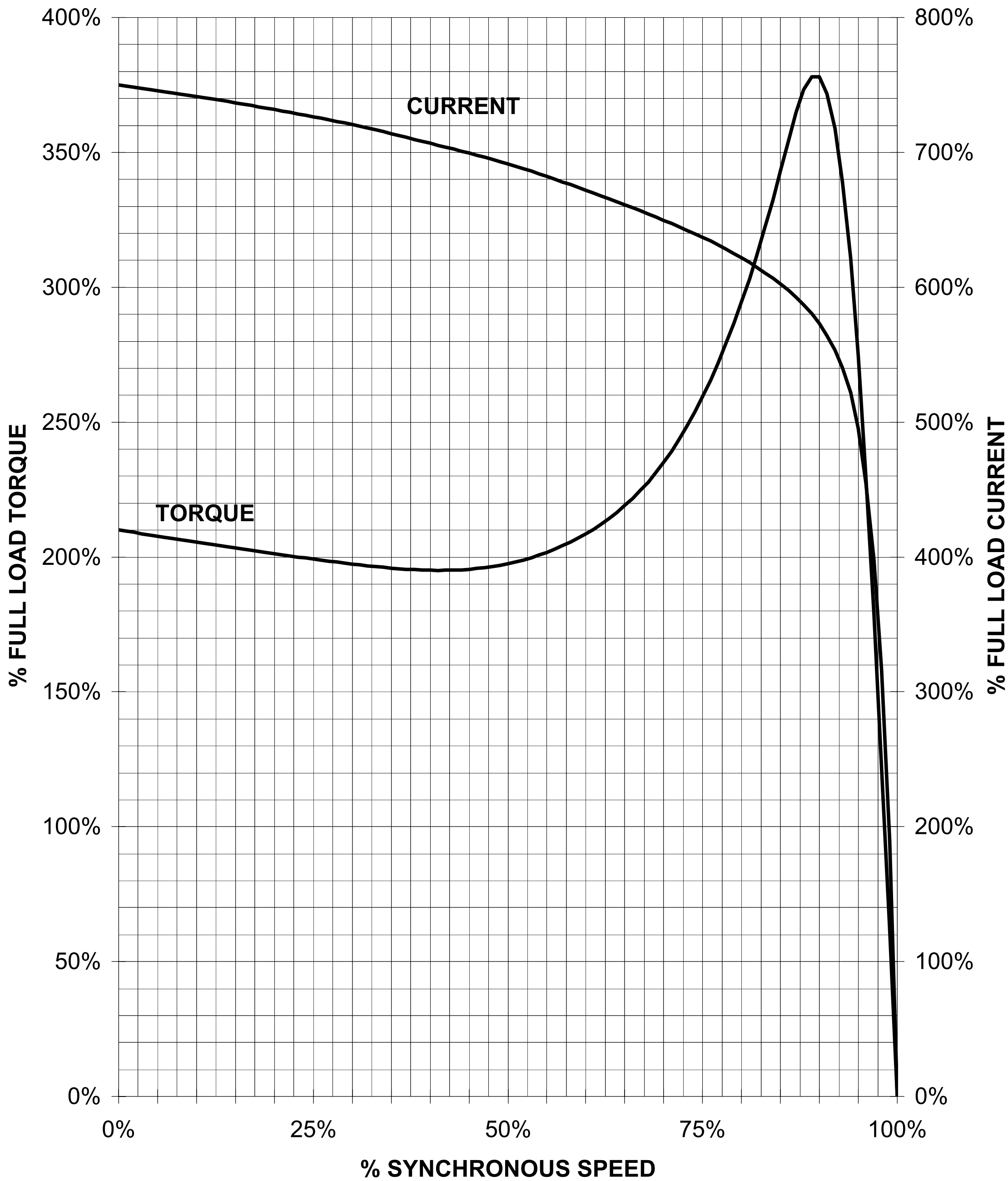


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	1	VOLTS	460	RPM	1200	TYPE	SD100
HZ	60	PHASE	3	FRAME	145T	NEMA	B

TORQUE & CURRENT VS. SPEED

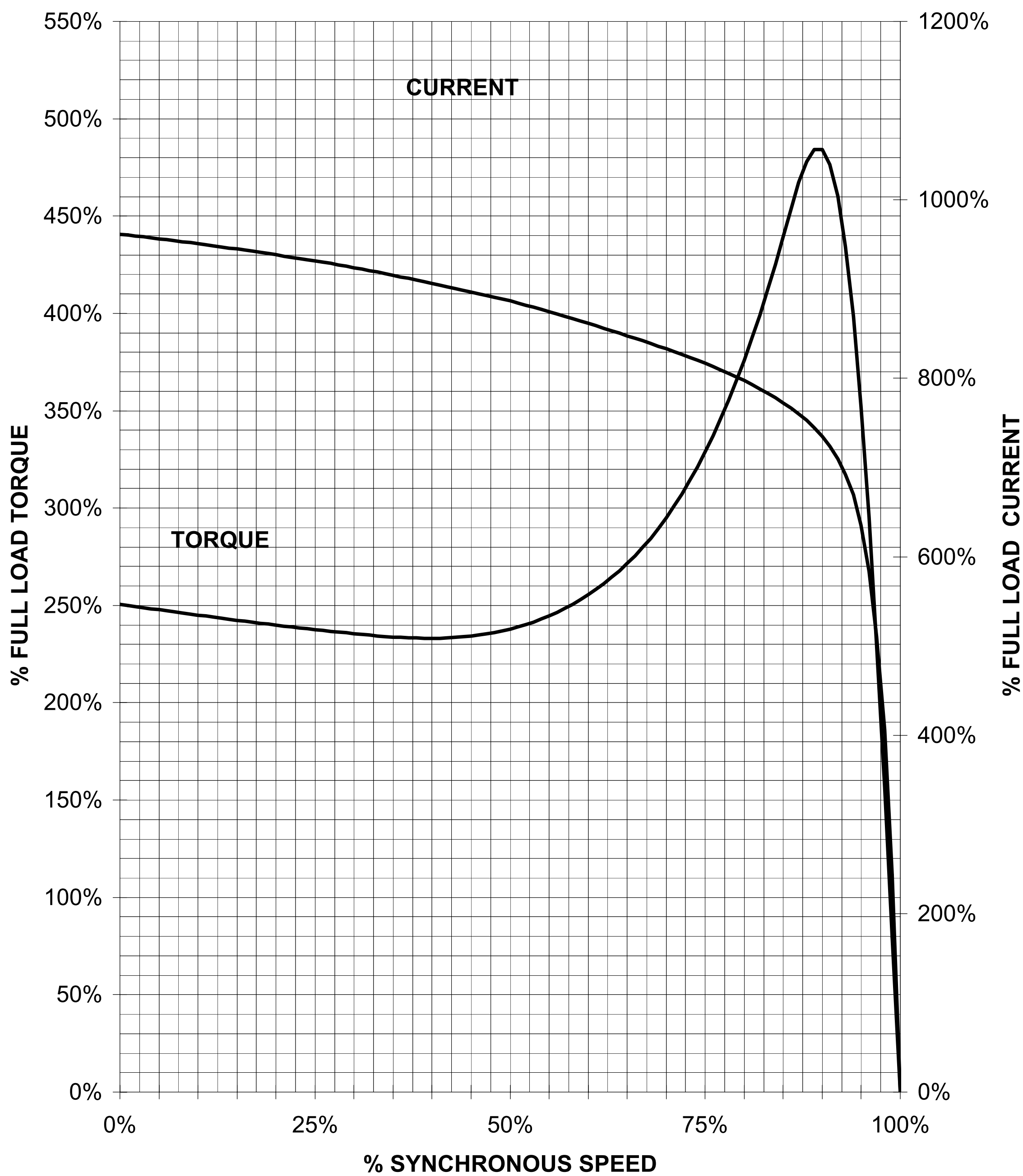


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	2	VOLTS	460	RPM	3600	TYPE	SD100
HZ	60	PHASE	3	FRAME	145T	NEMA	B

TORQUE & CURRENT VS. SPEED

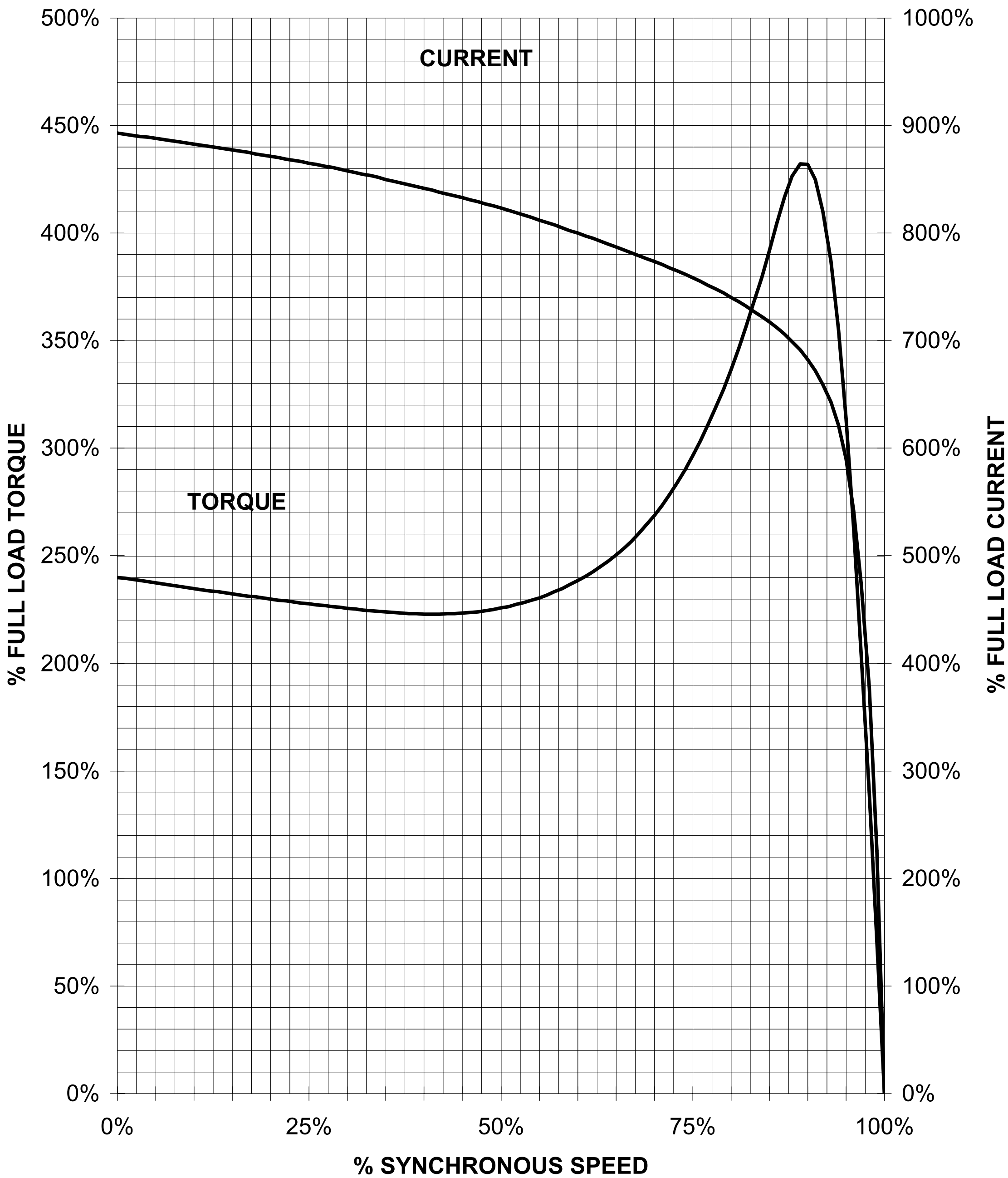


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	2	VOLTS	460	RPM	1800	TYPE	SD100
HZ	60	PHASE	3	FRAME	145T	NEMA	B

TORQUE & CURRENT VS. SPEED

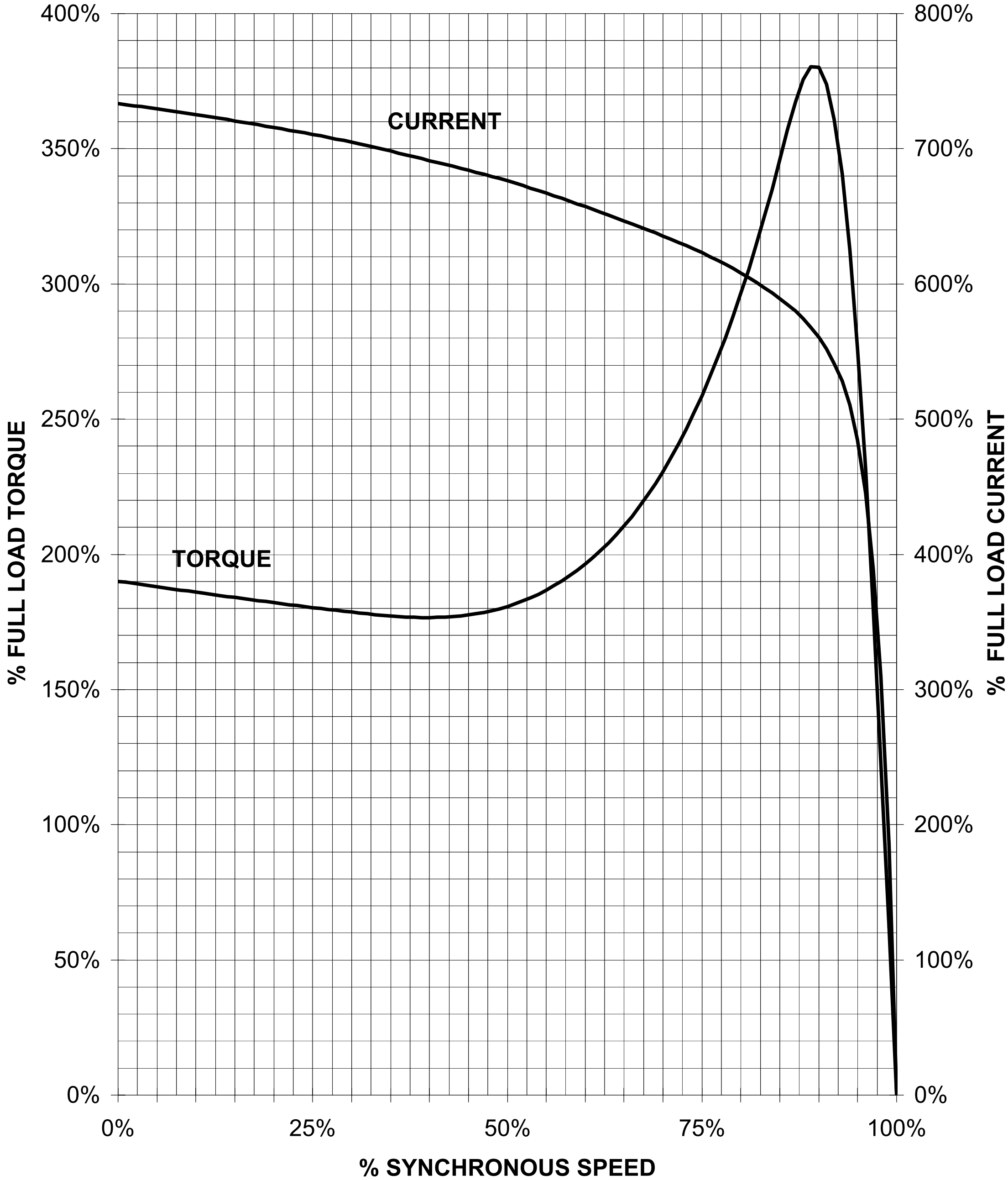


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	2	VOLTS	460	RPM	1200	TYPE	SD100
HZ	60	PHASE	3	FRAME	184T	NEMA	B

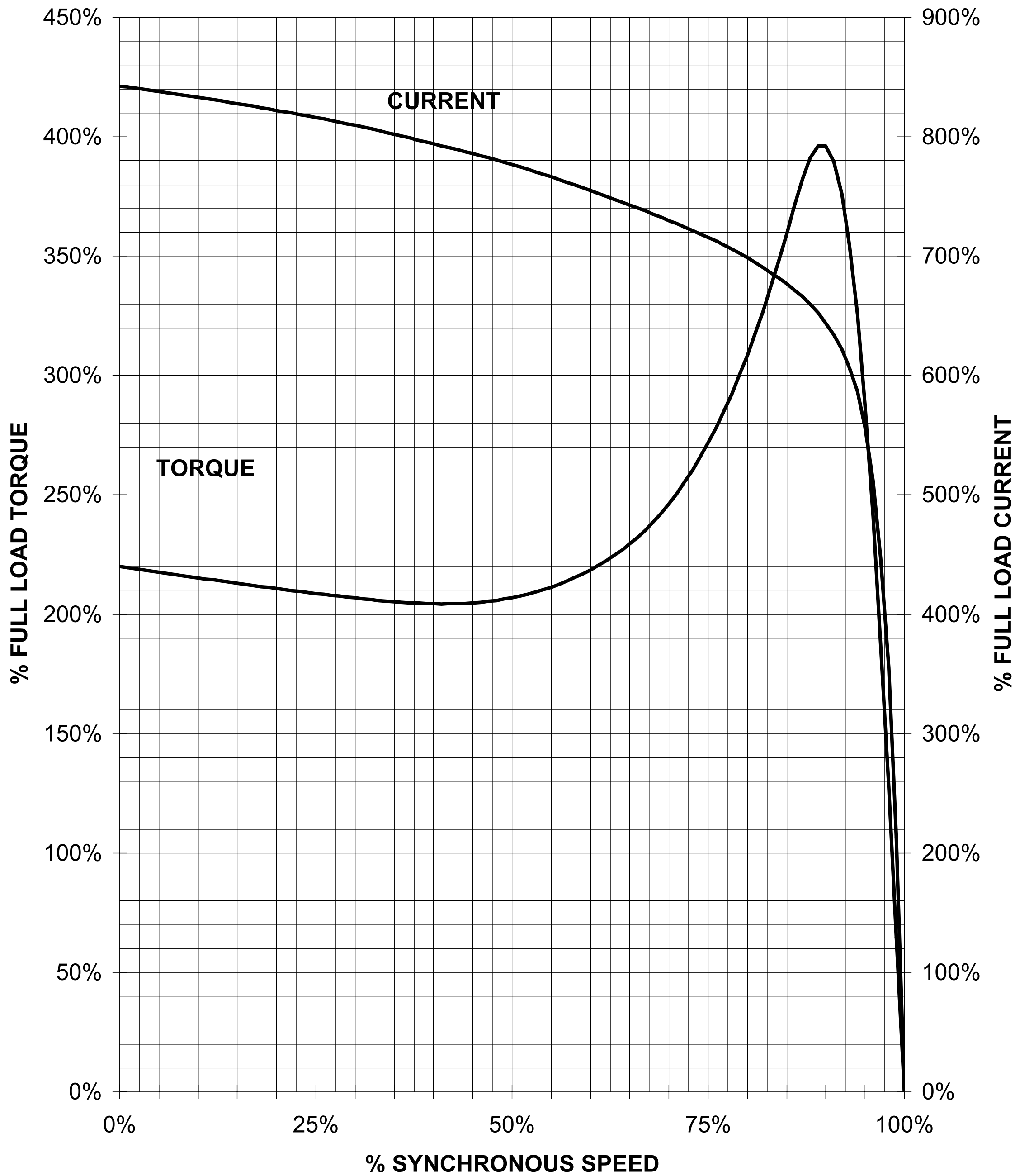
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	3	VOLTS	460	RPM	3600	TYPE	SD100
HZ	60	PHASE	3	FRAME	182T	NEMA	B

TORQUE & CURRENT VS. SPEED

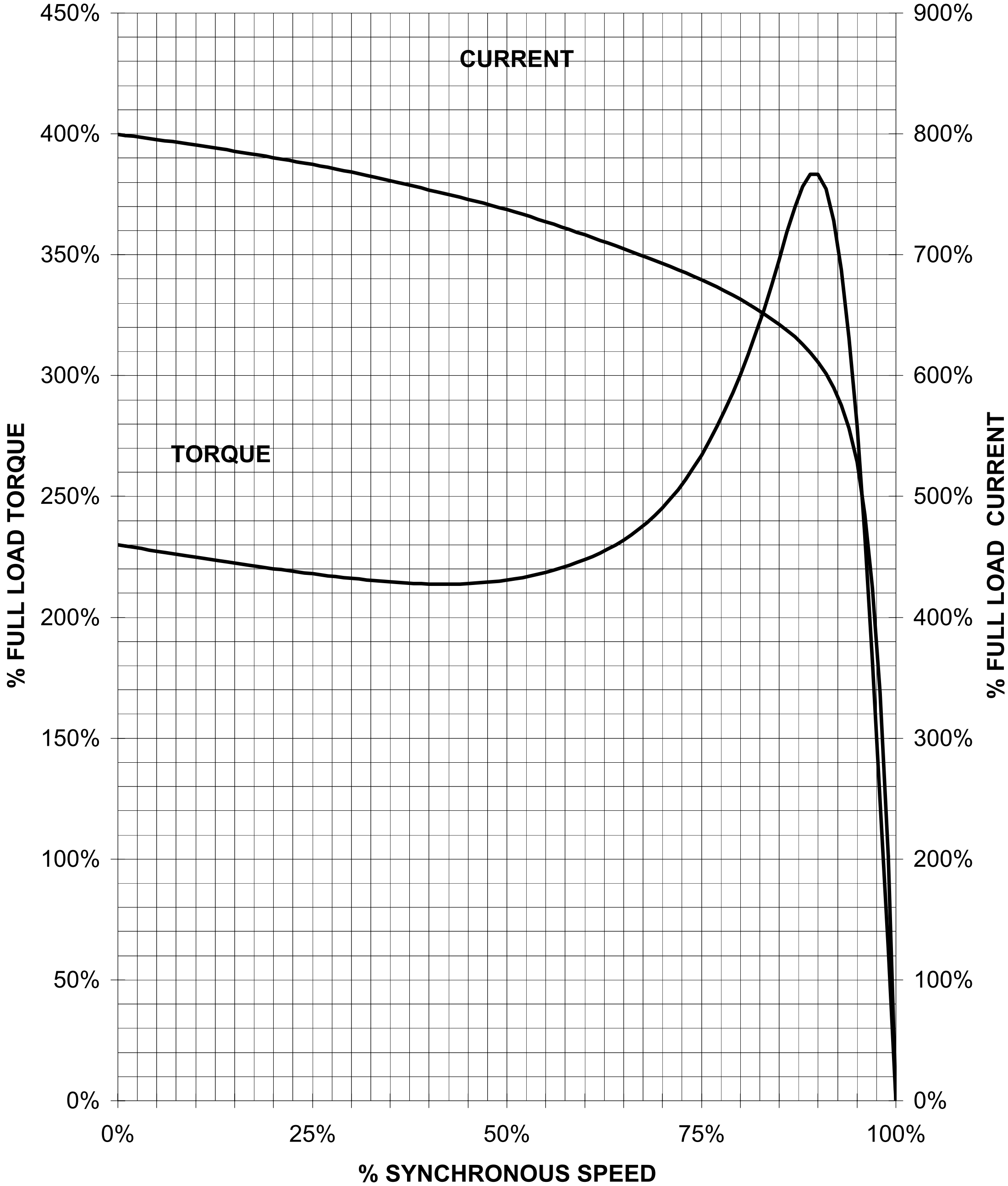


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	3	VOLTS	460	RPM	1800	TYPE	SD100
HZ	60	PHASE	3	FRAME	182T	NEMA	B

TORQUE & CURRENT VS. SPEED

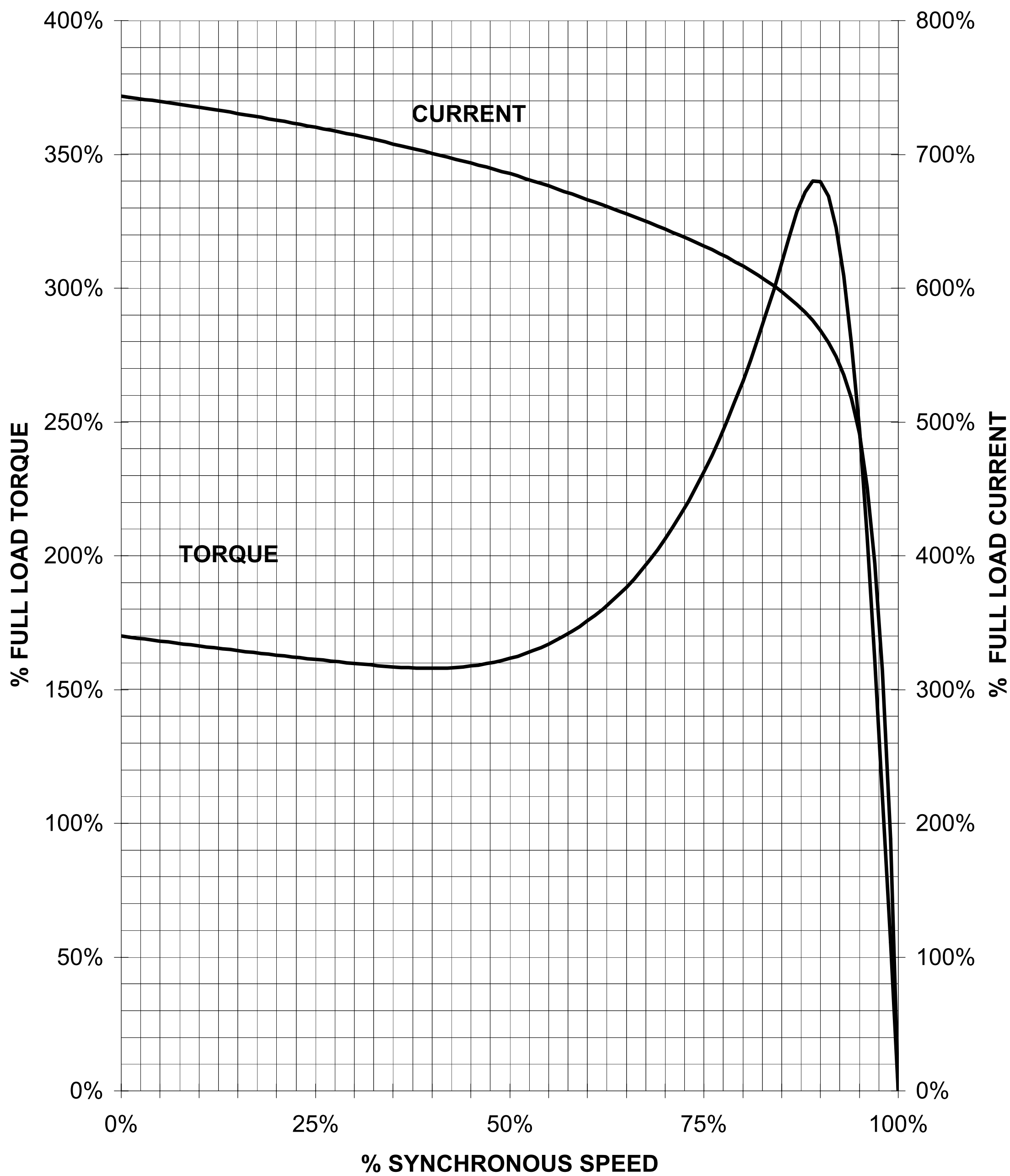


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	3	VOLTS	460	RPM	1200	TYPE	SD100
HZ	60	PHASE	3	FRAME	213T	NEMA	B

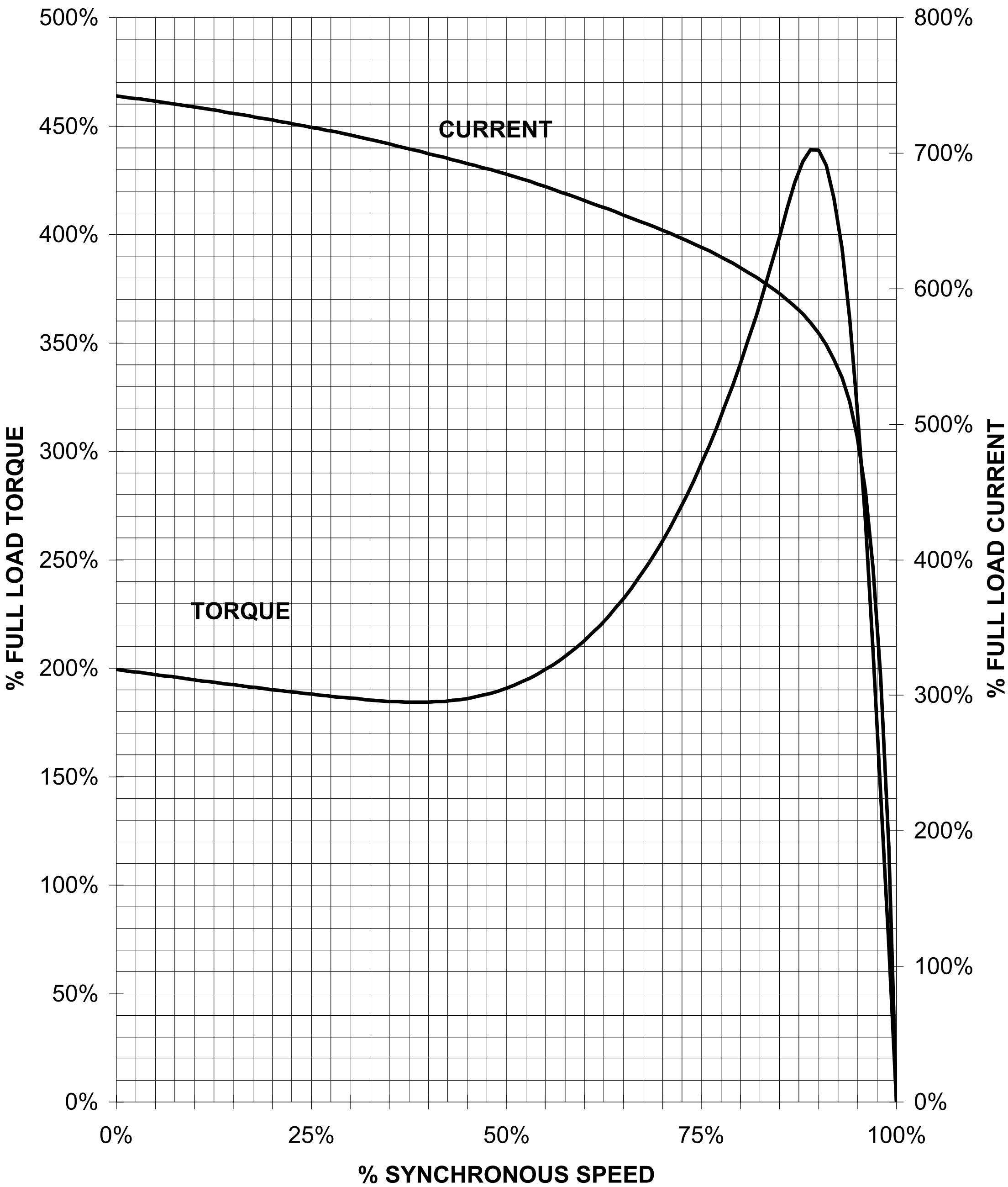
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	5	VOLTS	460	RPM	3600	TYPE	SD100
HZ	60	PHASE	3	FRAME	184T	NEMA	B

TORQUE & CURRENT VS. SPEED

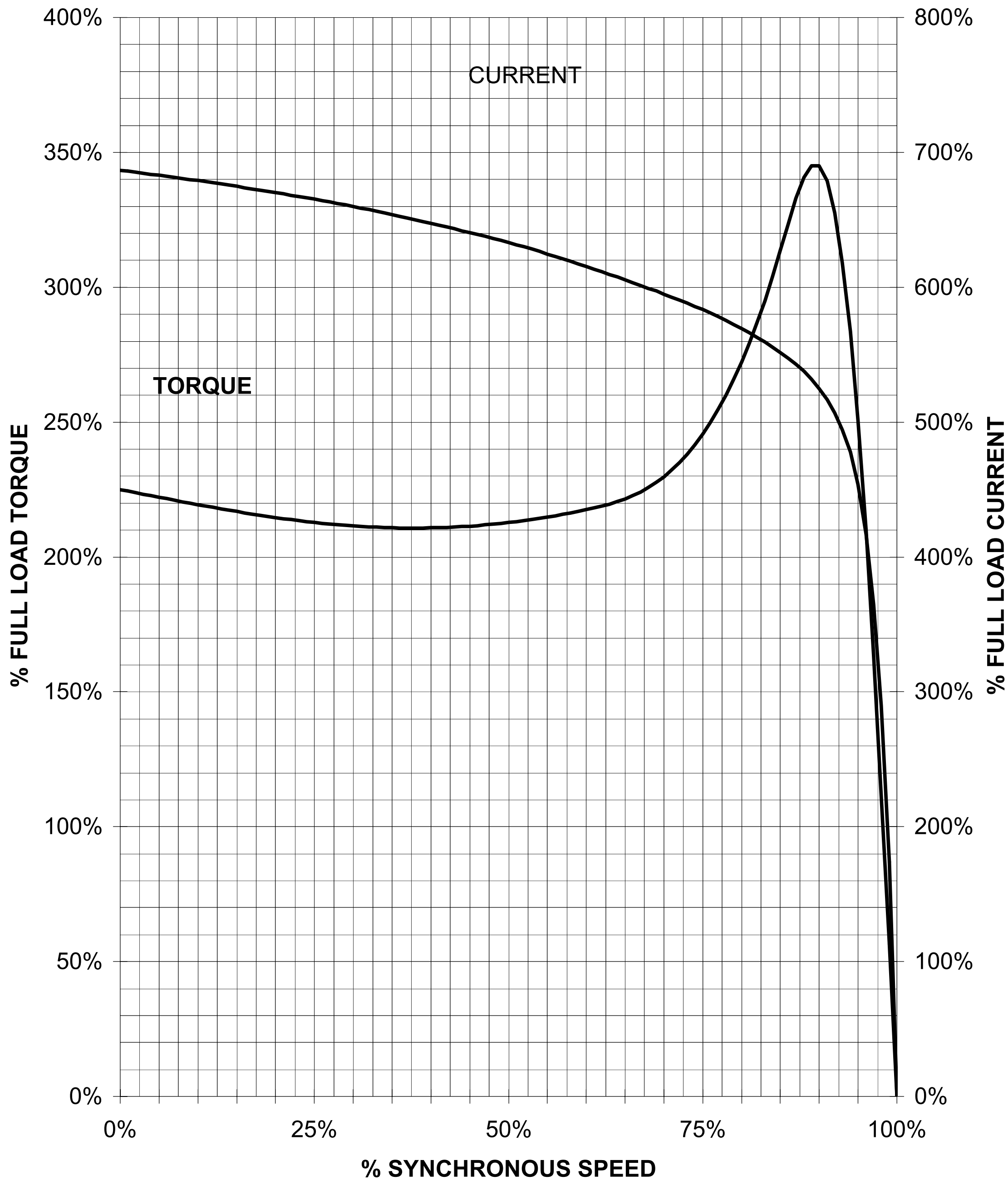


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	5	VOLTS	460	RPM	1800	TYPE	SD100
HZ	60	PHASE	3	FRAME	184T	NEMA	B

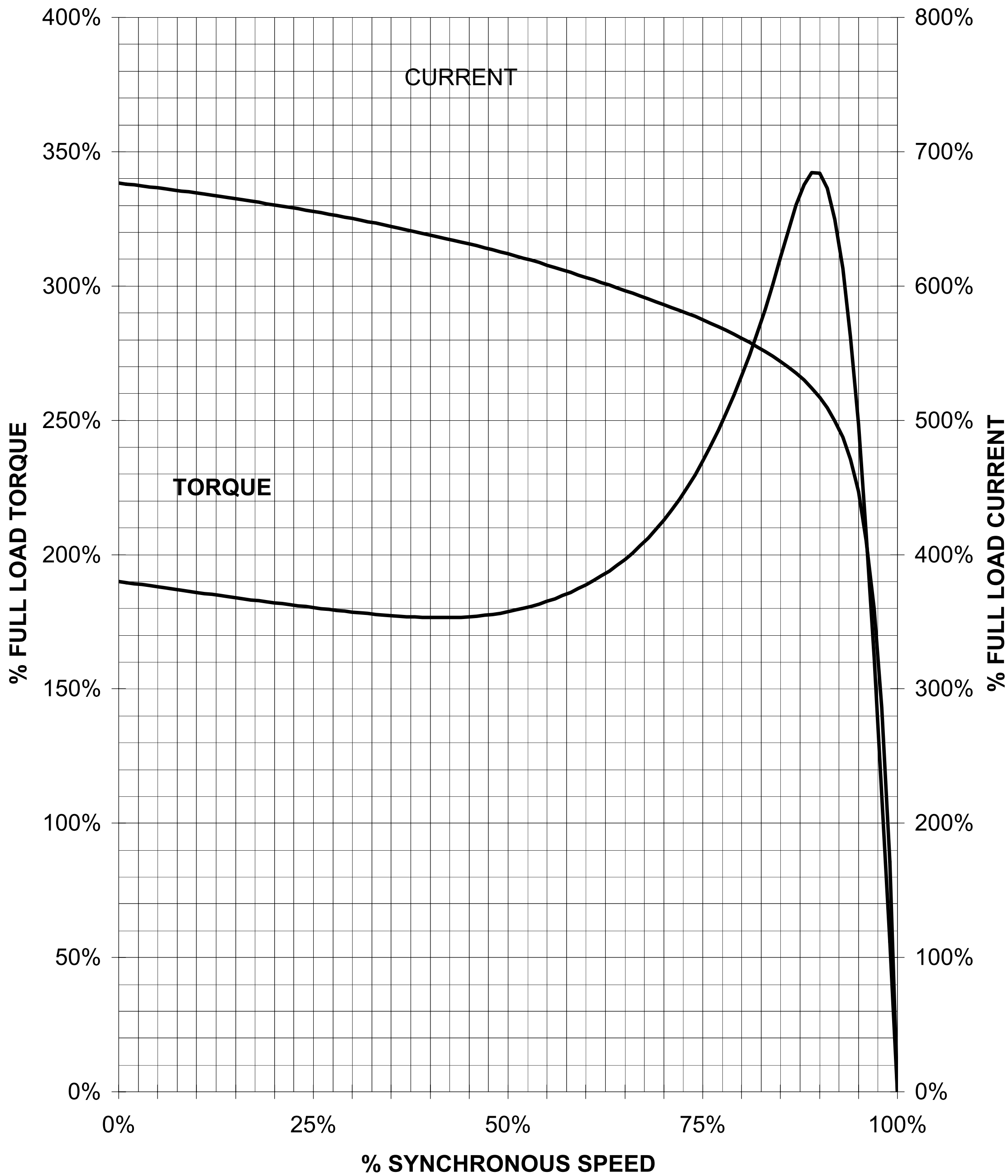
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	5	VOLTS	460	RPM	1200	TYPE	SD100
HZ	60	PHASE	3	FRAME	215T	NEMA	B

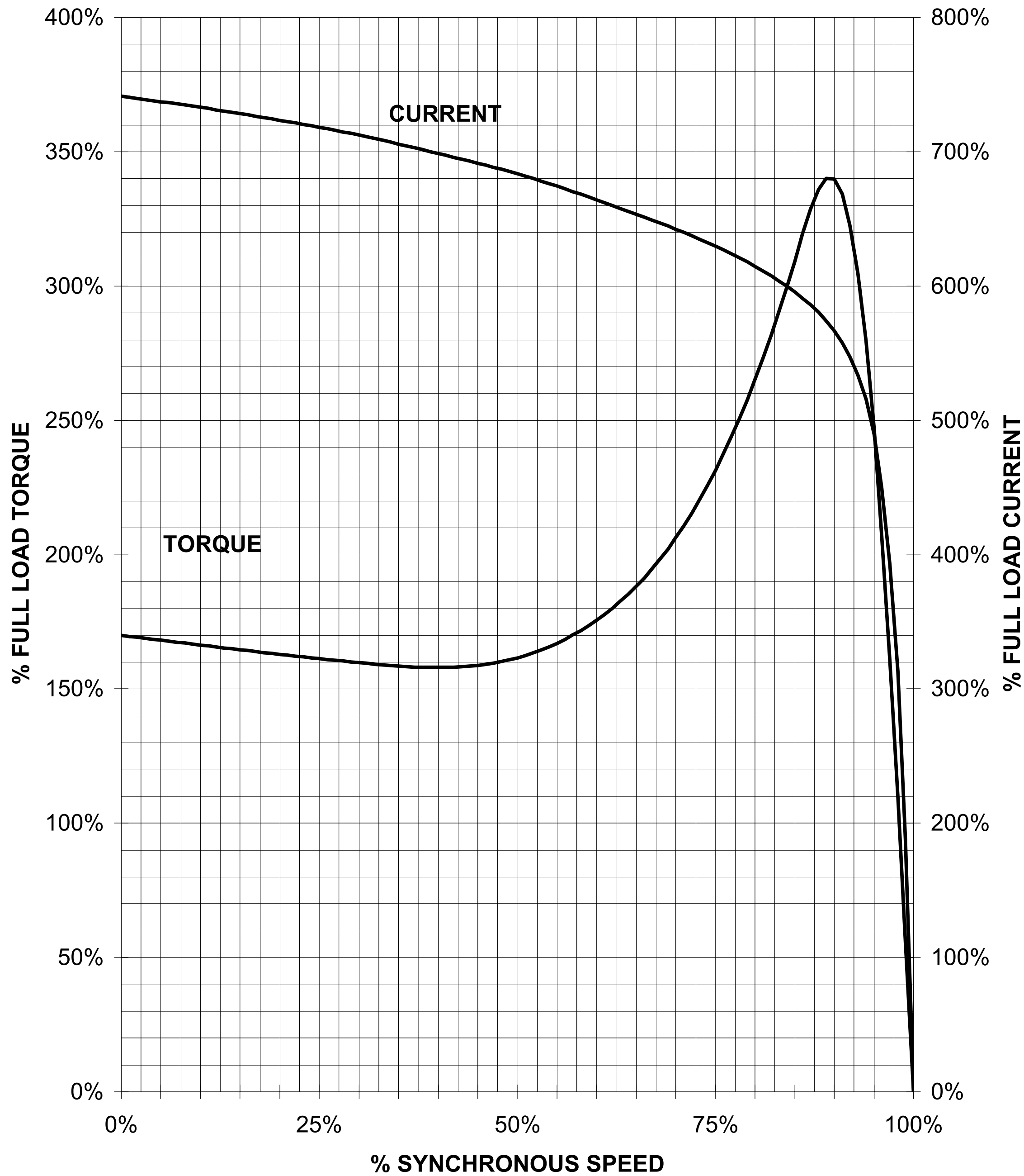
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	7.5	VOLTS	460	RPM	3600	TYPE	SD100
HZ	60	PHASE	3	FRAME	213T	NEMA	B

TORQUE & CURRENT VS. SPEED

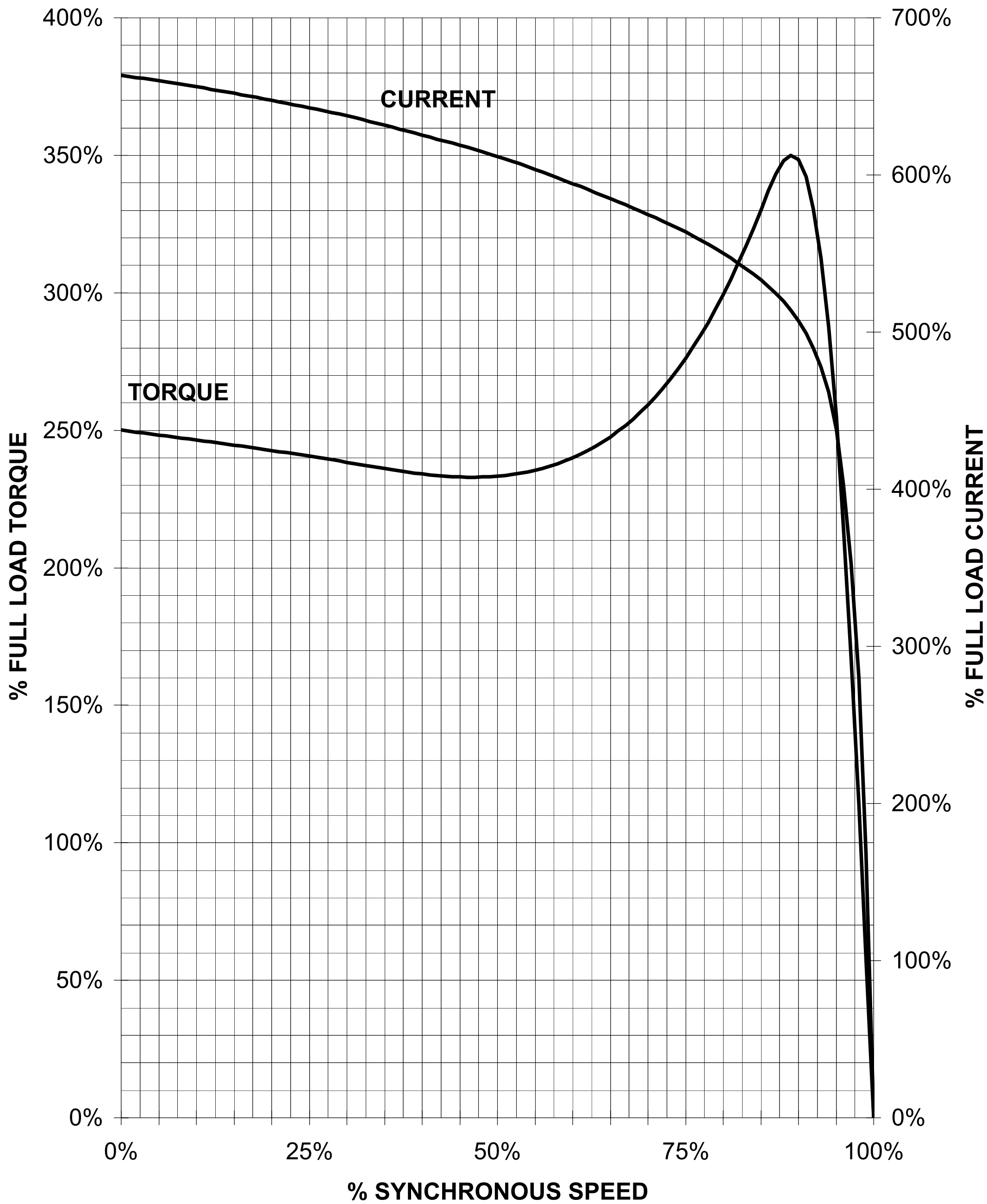


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	7.5	VOLTS	460	RPM	1800	TYPE	SD100
HZ	60	PHASE	3	FRAME	213T	NEMA	B

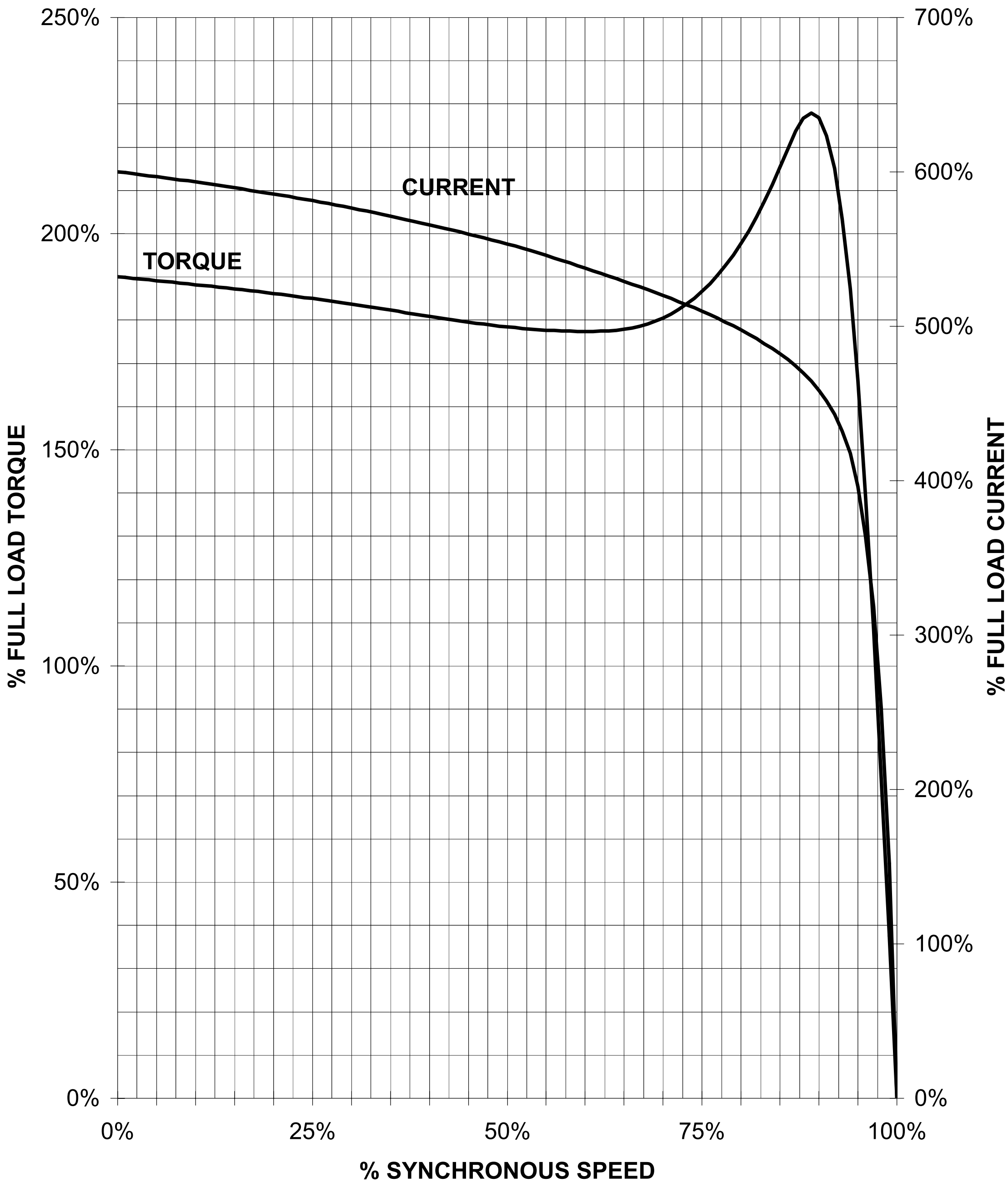
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	7.5	VOLTS	460	RPM	1200	TYPE	SD100
HZ	60	PHASE	3	FRAME	254T	NEMA	B

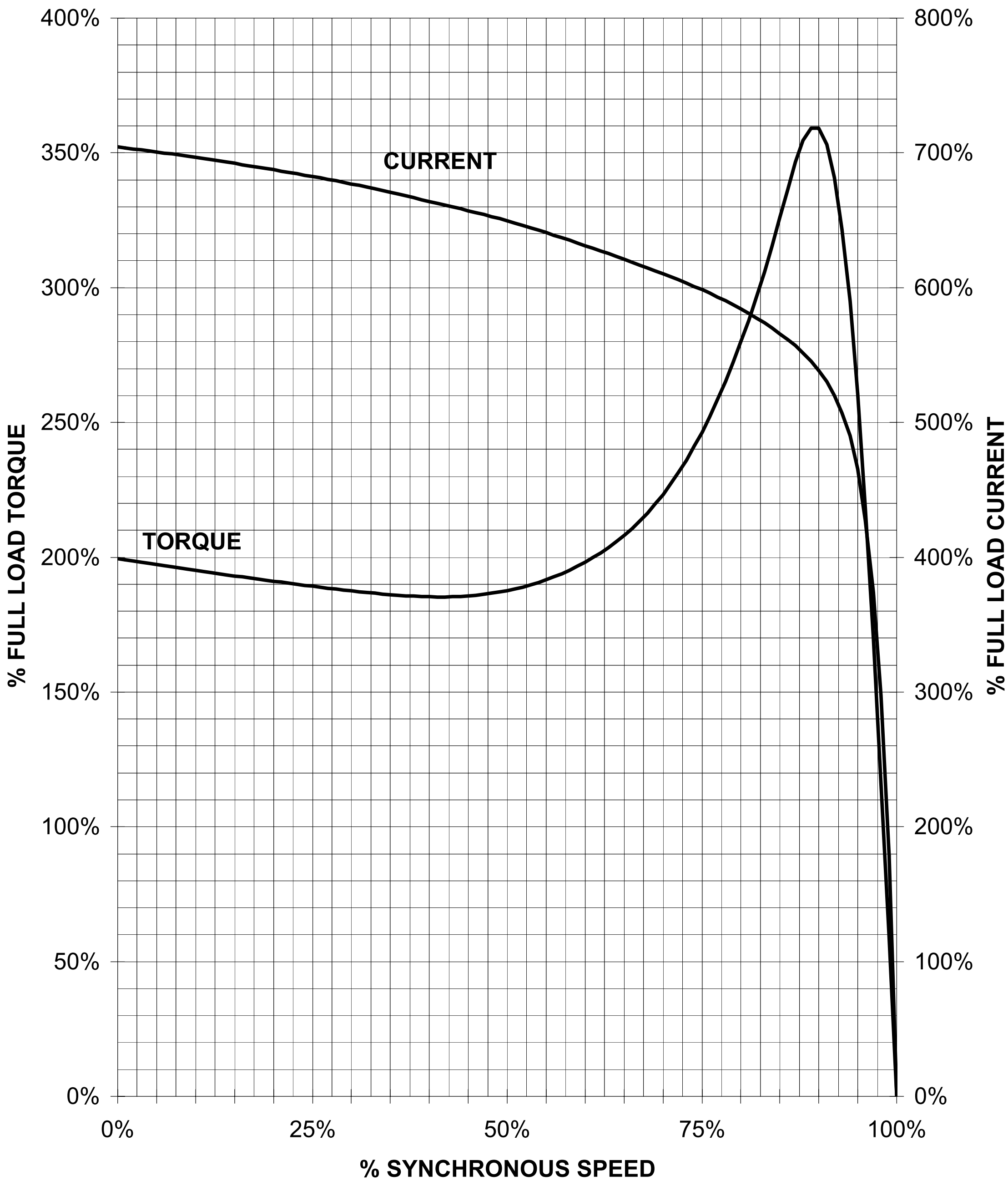
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	10	VOLTS	460	RPM	3600	TYPE	SD100
HZ	60	PHASE	3	FRAME	215T	NEMA	B

TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

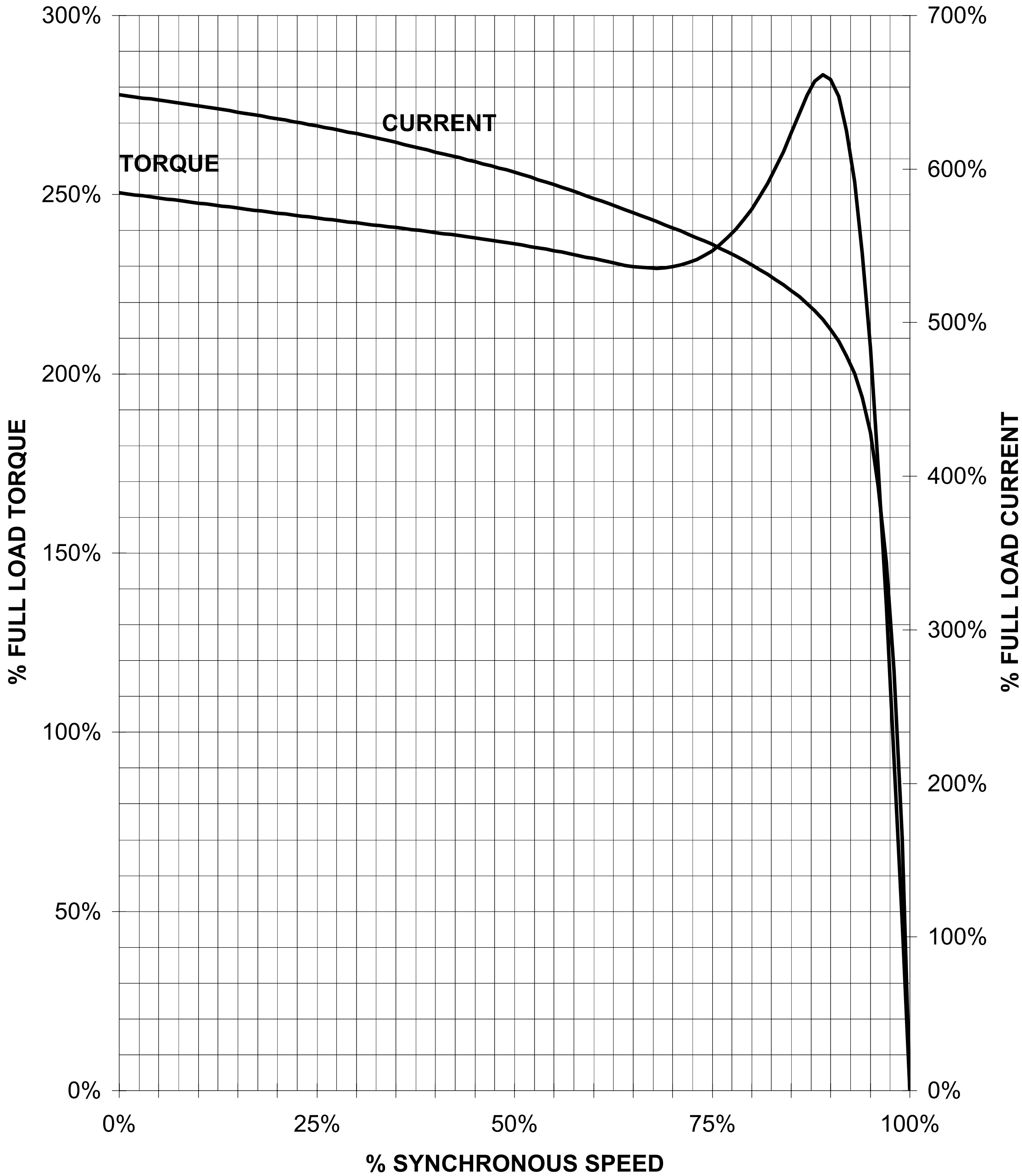
PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

SIEMENS

Application Manual for NEMA Motors

HP	10	VOLTS	460	RPM	1800	TYPE	SD100
HZ	60	PHASE	3	FRAME	215T	NEMA	B

TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

SIEMENS

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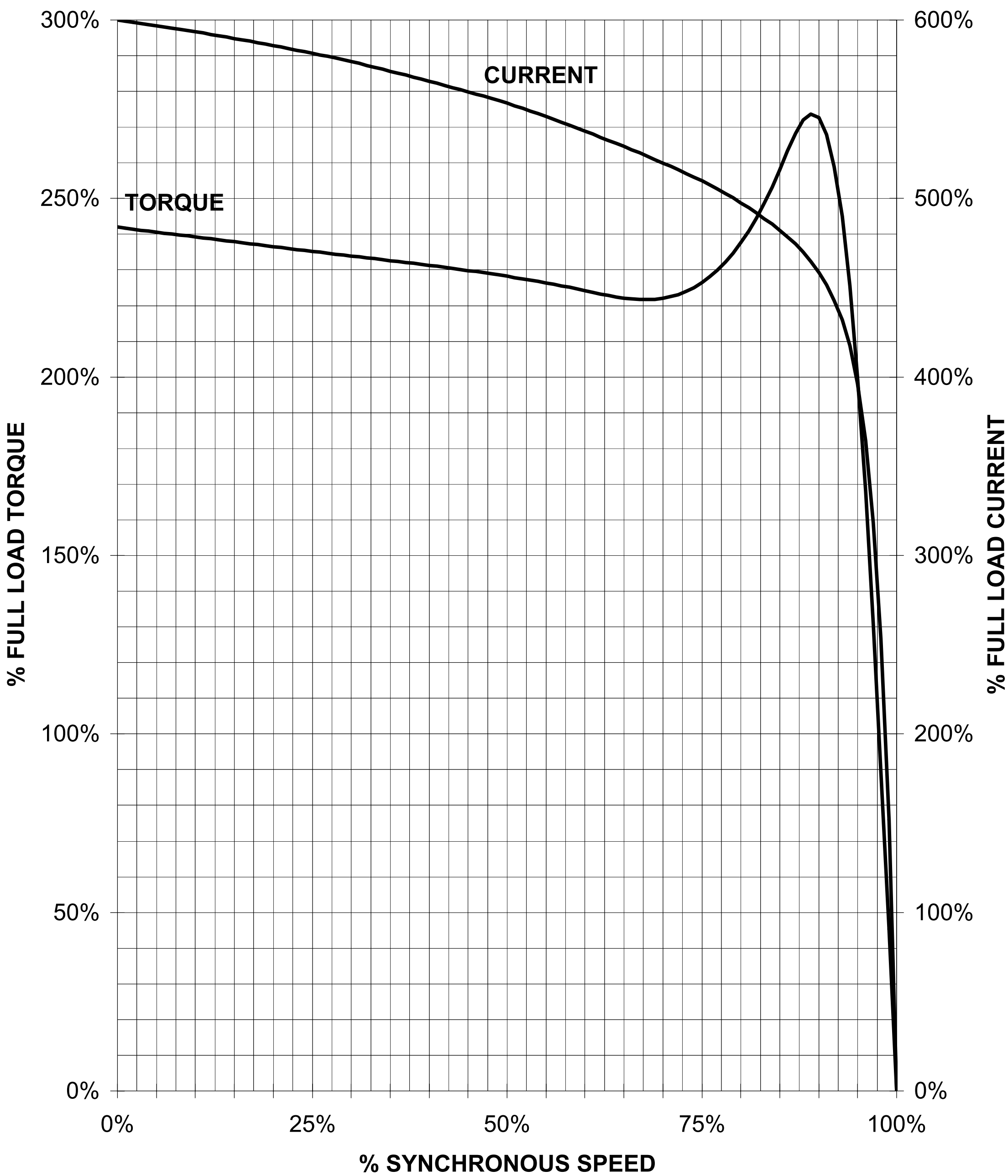
HP	10	VOLTS	460	RPM	1200	TYPE	SD100
HZ	60	PHASE	3	FRAME	256T	NEMA	B

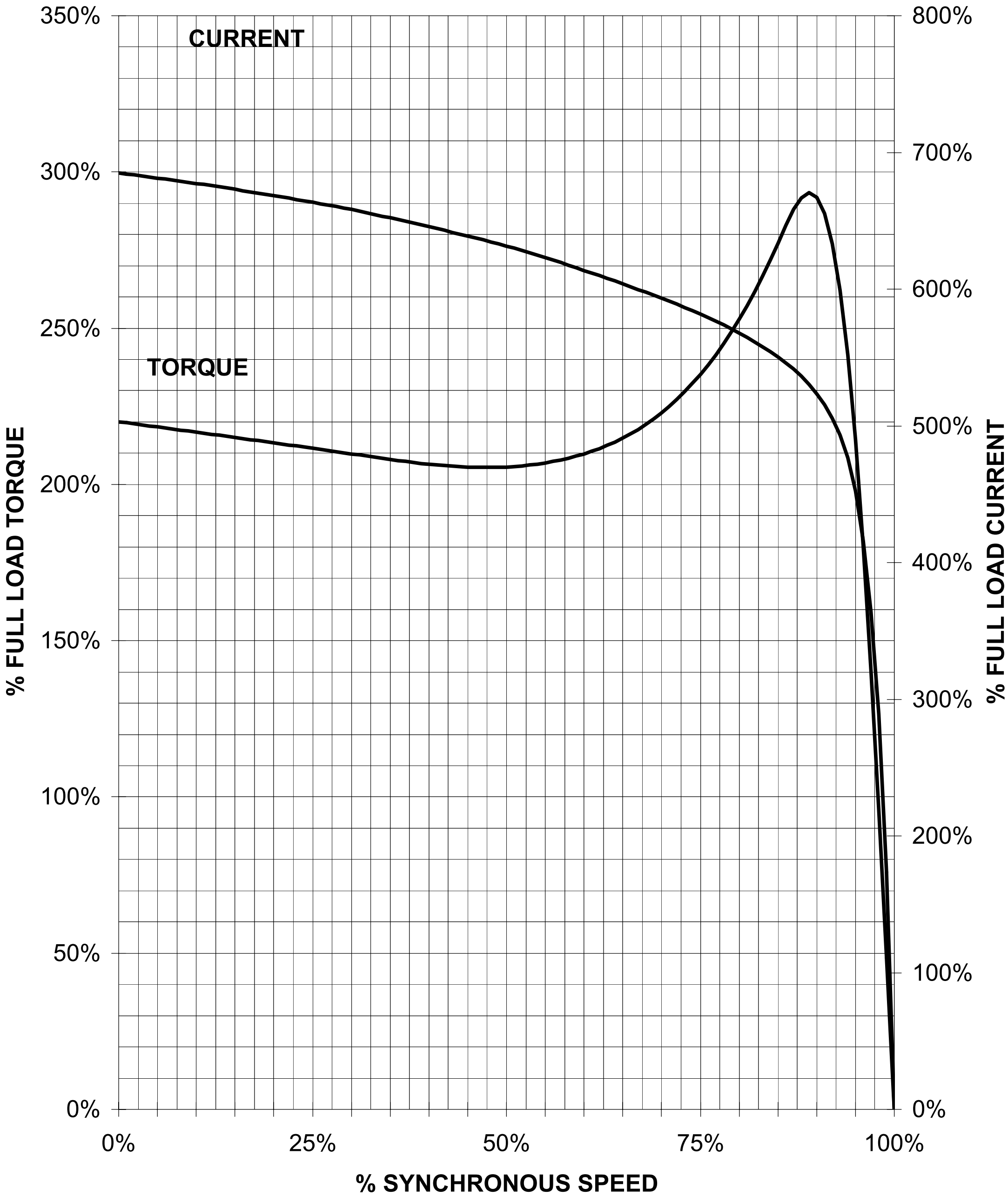
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	15	VOLTS	460	RPM	3600	TYPE	SD100
HZ	60	PHASE	3	FRAME	254T	NEMA	B

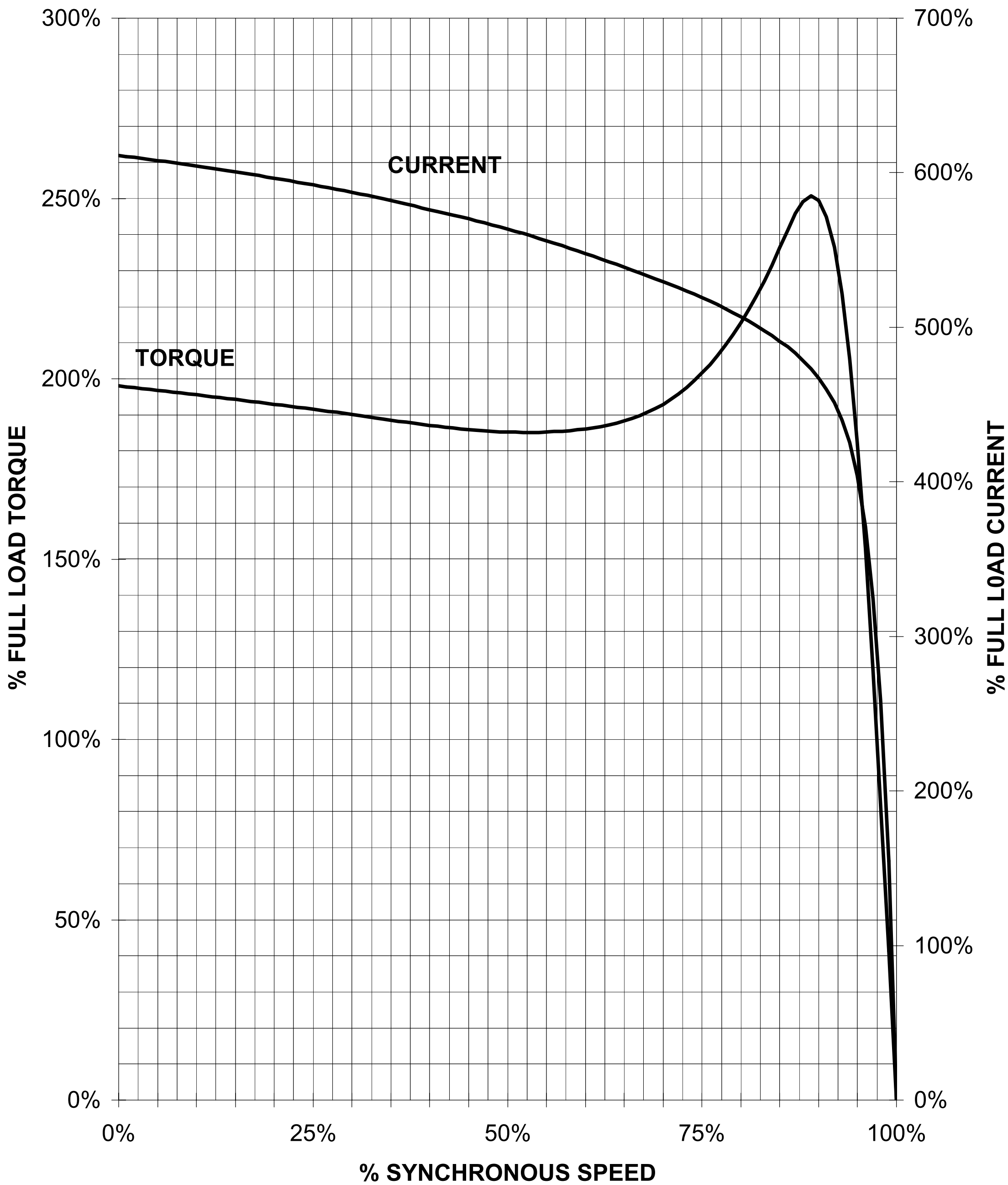
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	15	VOLTS	460	RPM	1800	TYPE	SD100
HZ	60	PHASE	3	FRAME	254T	NEMA	B

TORQUE & CURRENT VS. SPEED

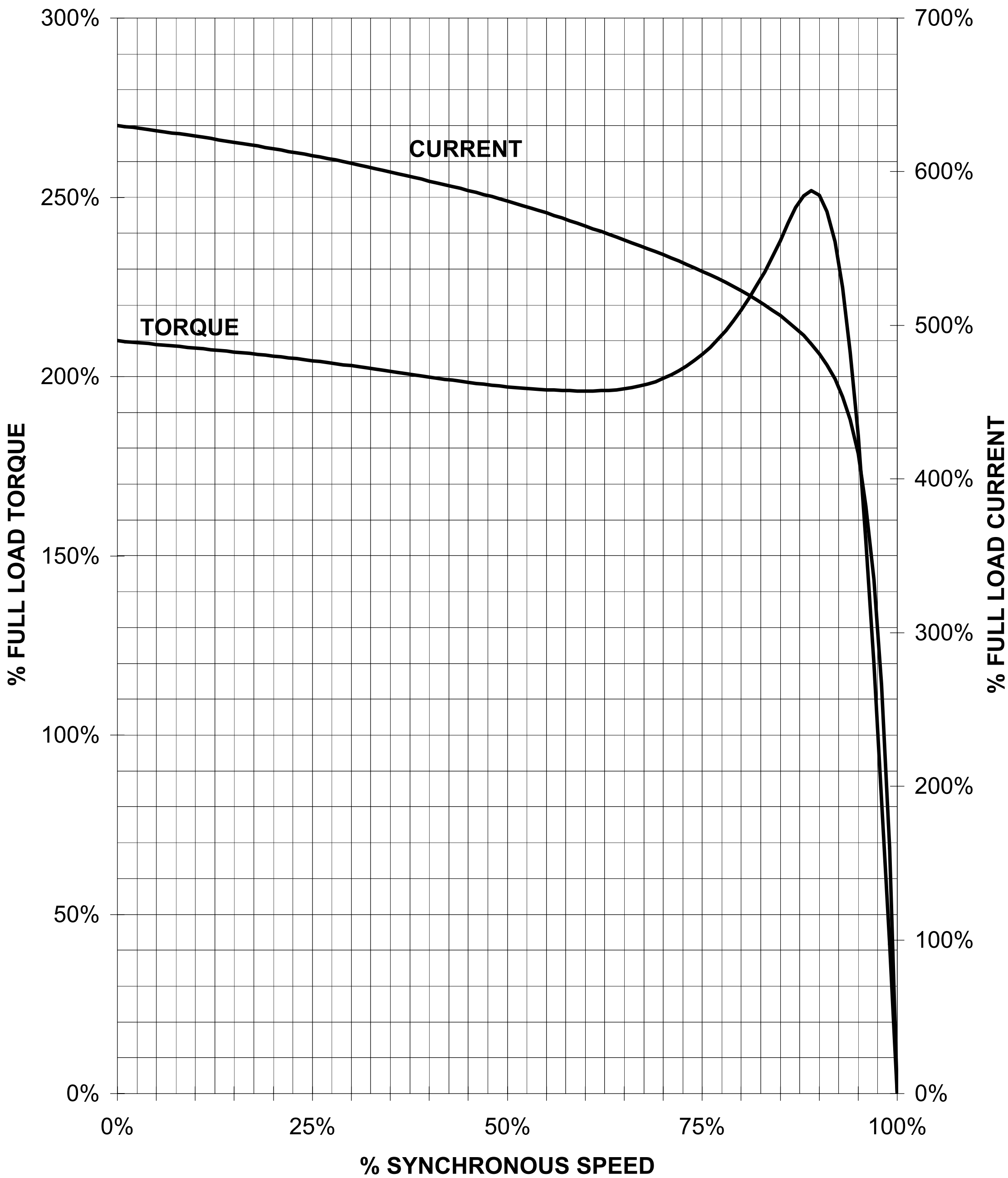


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	20	VOLTS	460	RPM	3600	TYPE	SD100
HZ	60	PHASE	3	FRAME	256T	NEMA	B

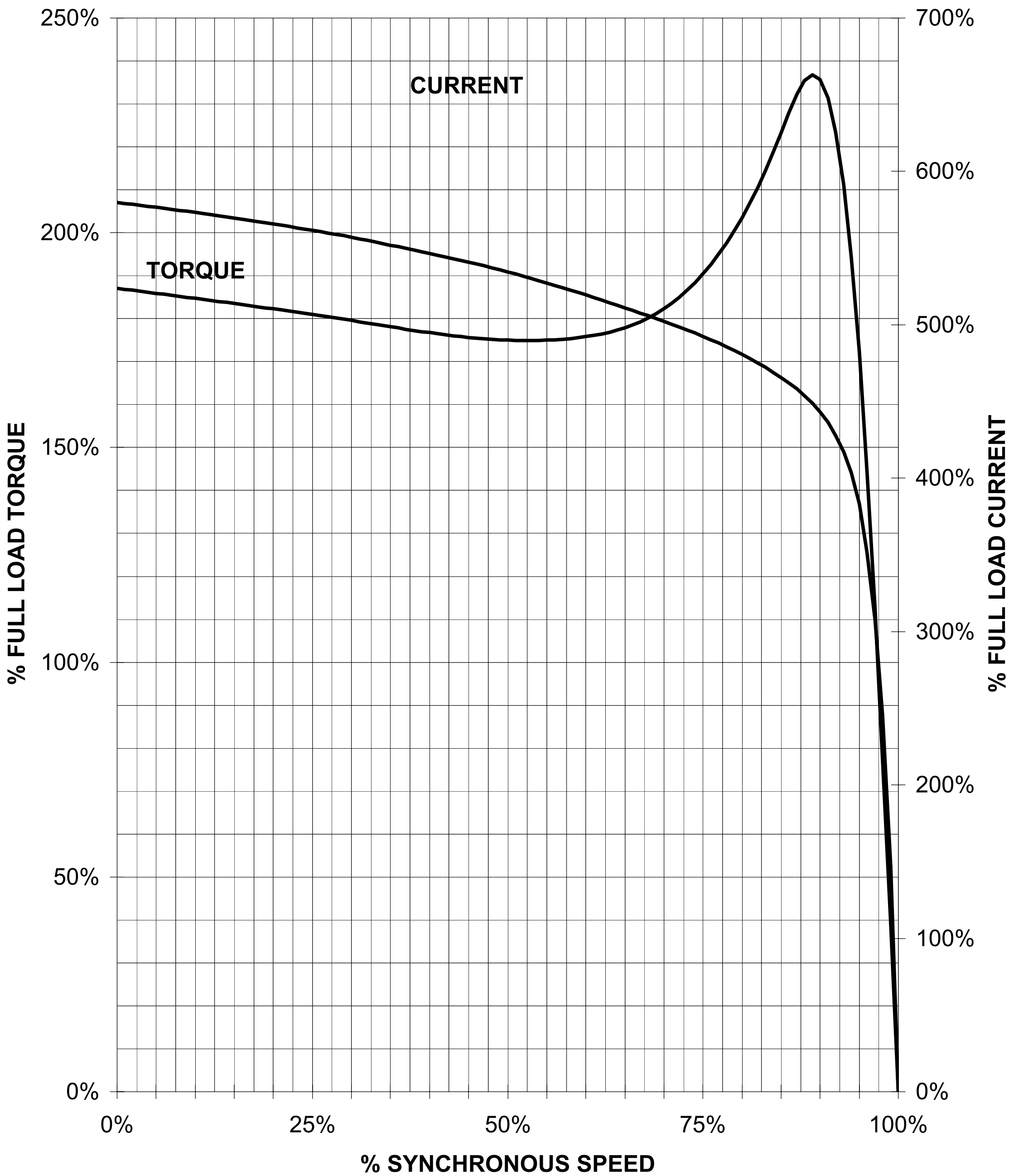
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	20	VOLTS	460	RPM	1800	TYPE	SD100
HZ	60	PHASE	3	FRAME	256T	NEMA	B

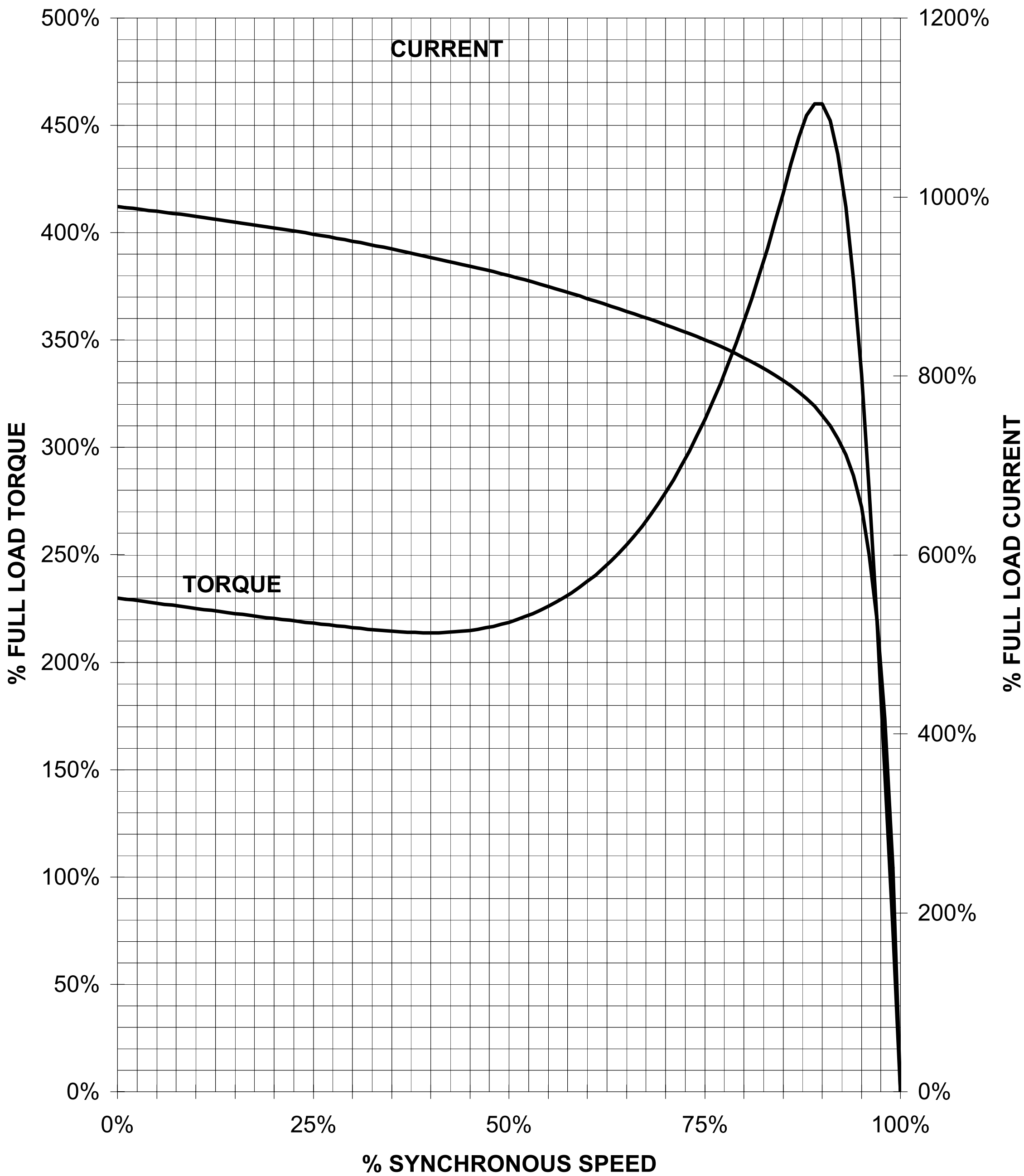
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1.5	VOLTS	460	RPM	3600	TYPE	SD100 IEEE-841
HZ	60	PHASE	3	FRAME	143T	NEMA	B

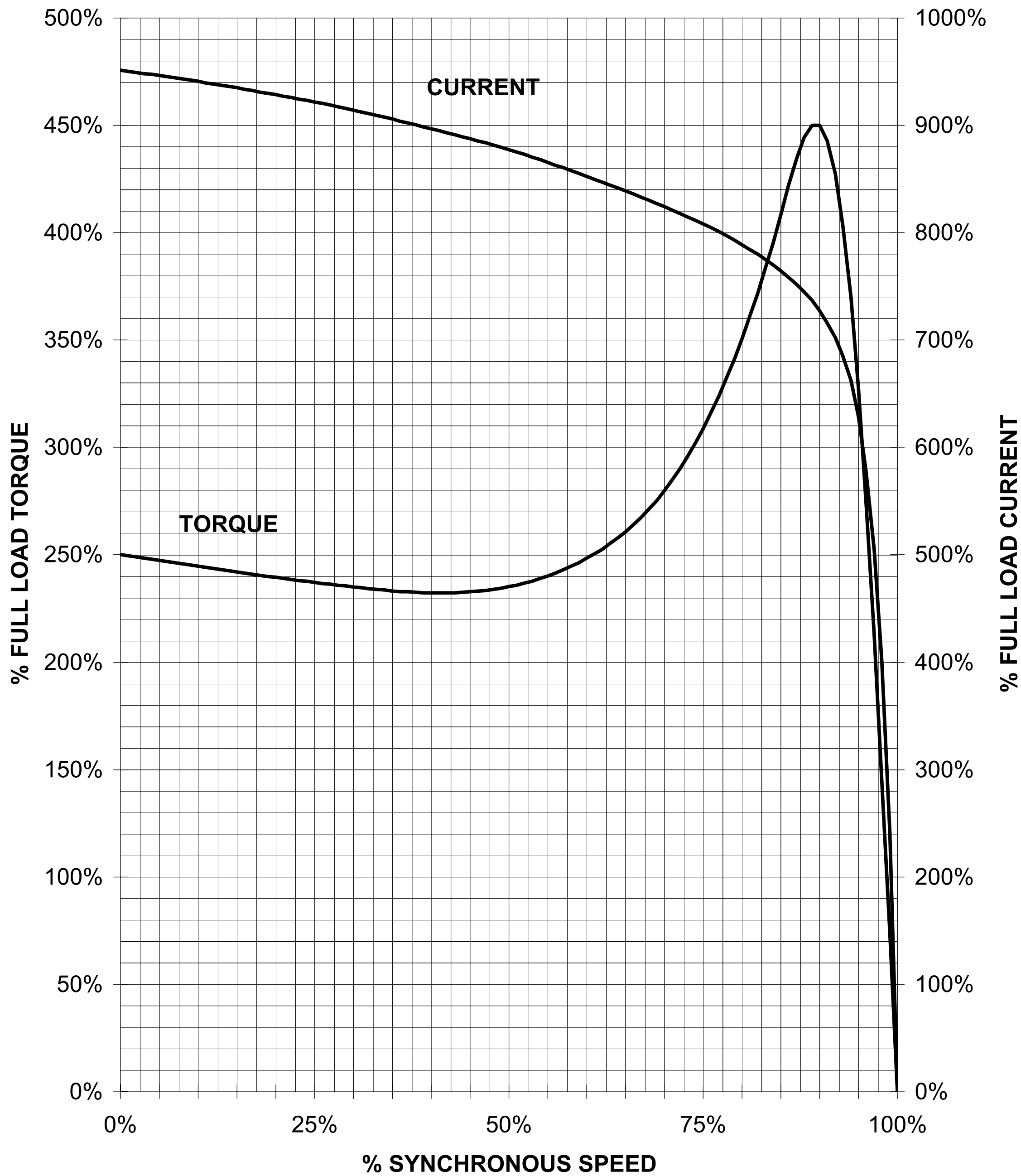
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1.5	VOLTS	460	RPM	1800	TYPE	SD100 IEEE-841
HZ	60	PHASE	3	FRAME	145T	NEMA	B

TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

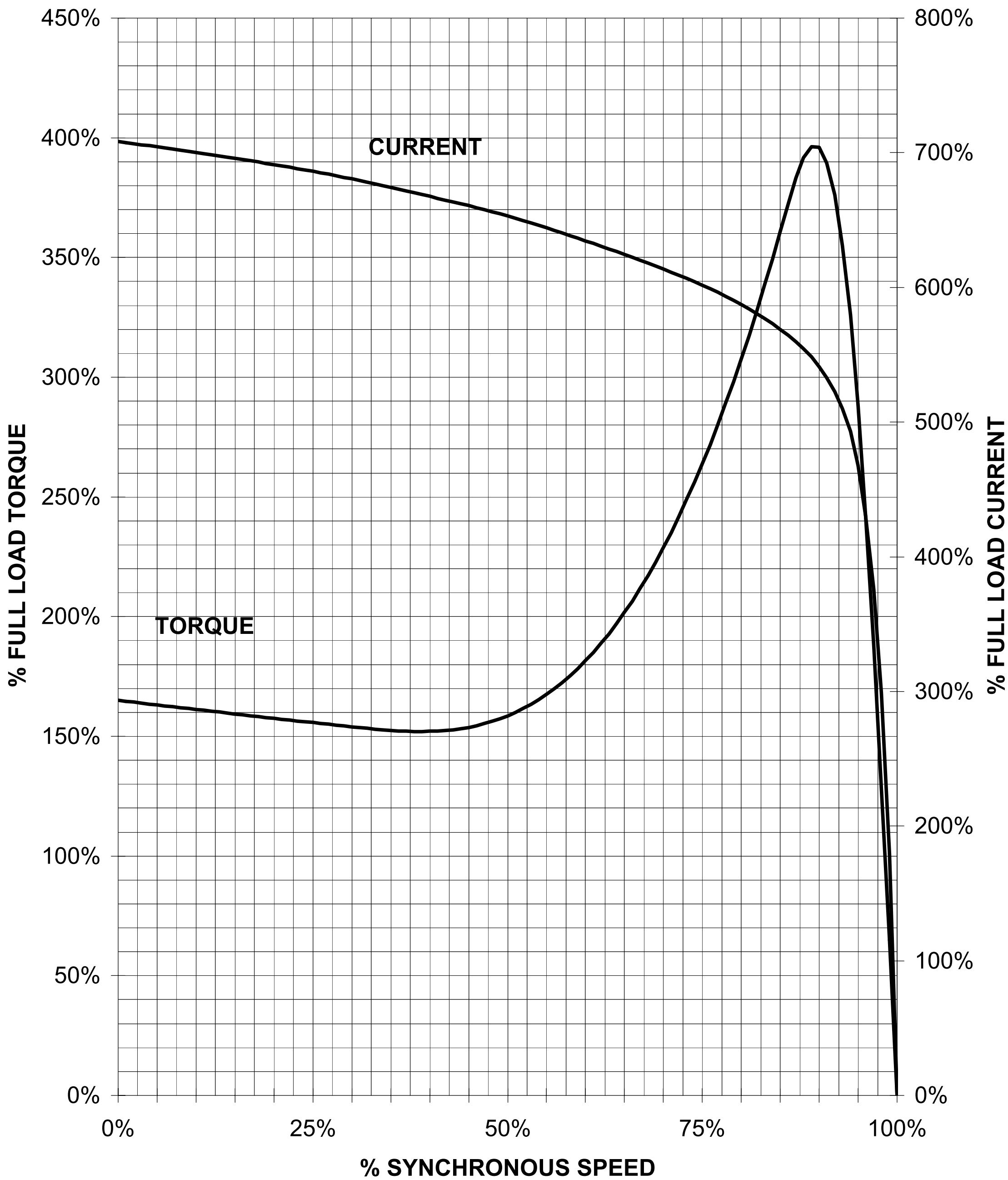
PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

SIEMENS

Application Manual for NEMA Motors

HP	1.5	VOLTS	460	RPM	1200	TYPE	SD100 IEEE-841
HZ	60	PHASE	3	FRAME	182T	NEMA	B

TORQUE & CURRENT VS. SPEED

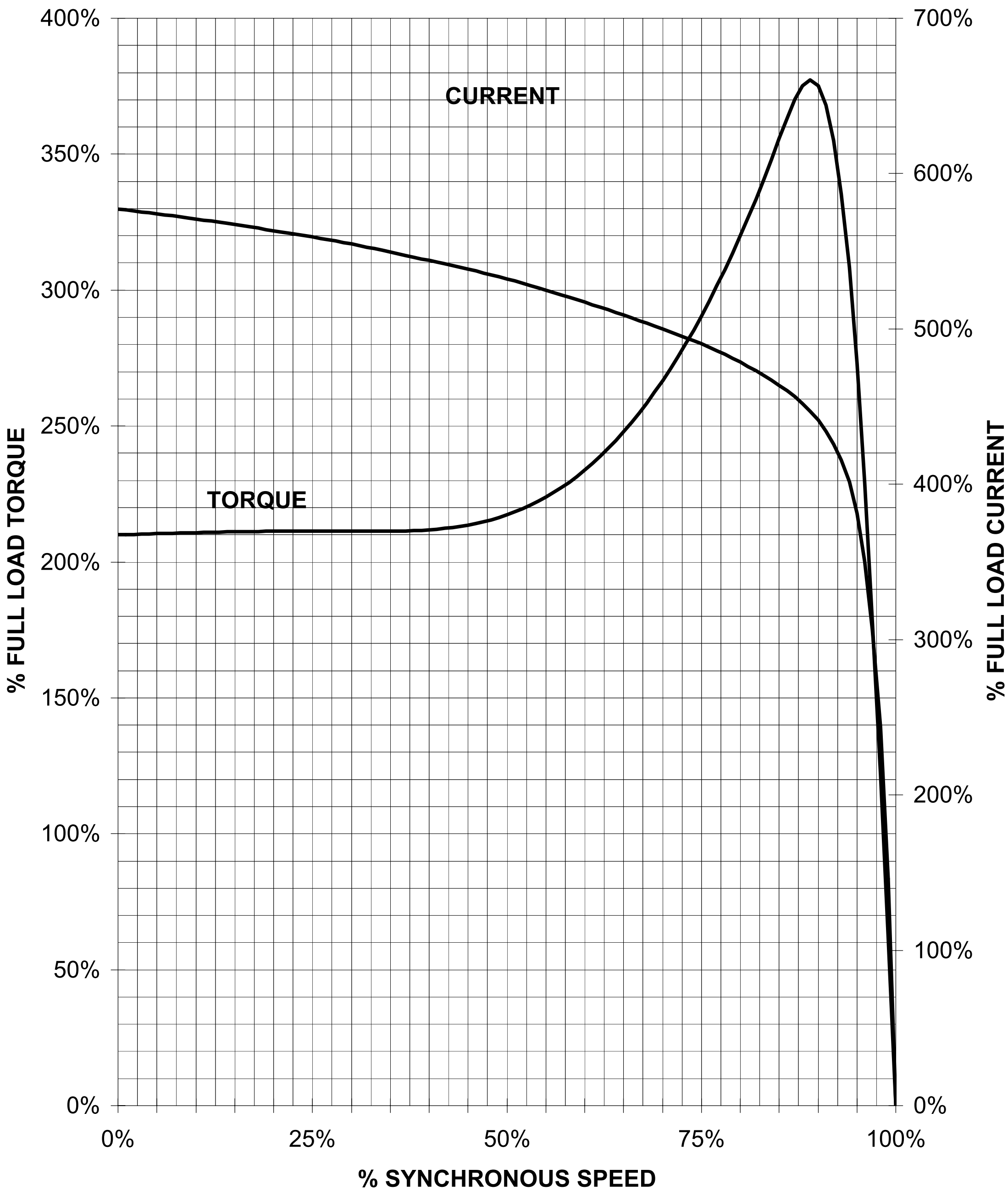


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	1	VOLTS	460	RPM	3600	TYPE	SD100 IEEE-841
HZ	60	PHASE	3	FRAME	143T	NEMA	B

TORQUE & CURRENT VS. SPEED

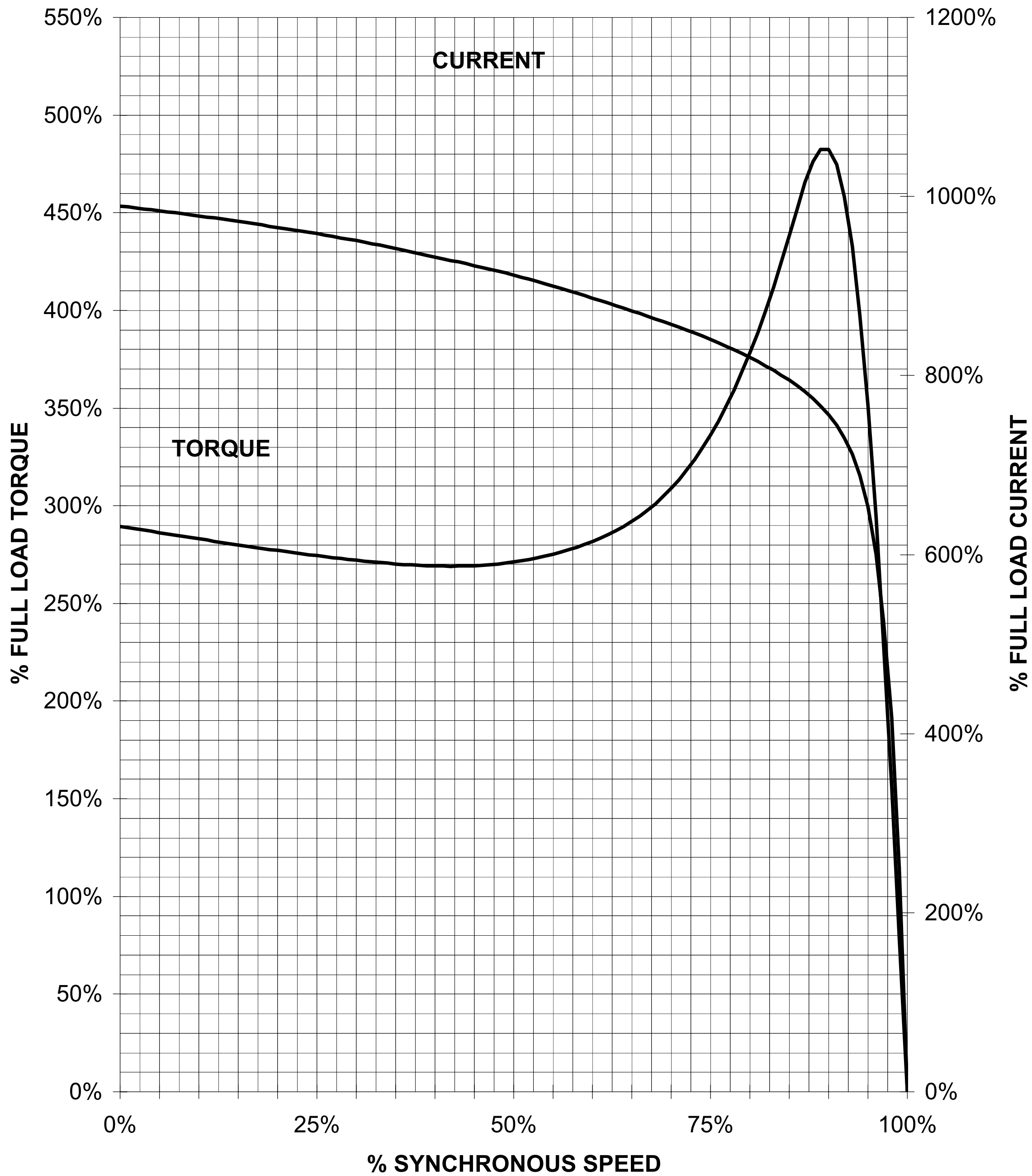


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	1	VOLTS	460	RPM	1800	TYPE	SD100 IEEE-841
HZ	60	PHASE	3	FRAME	143T	NEMA	B

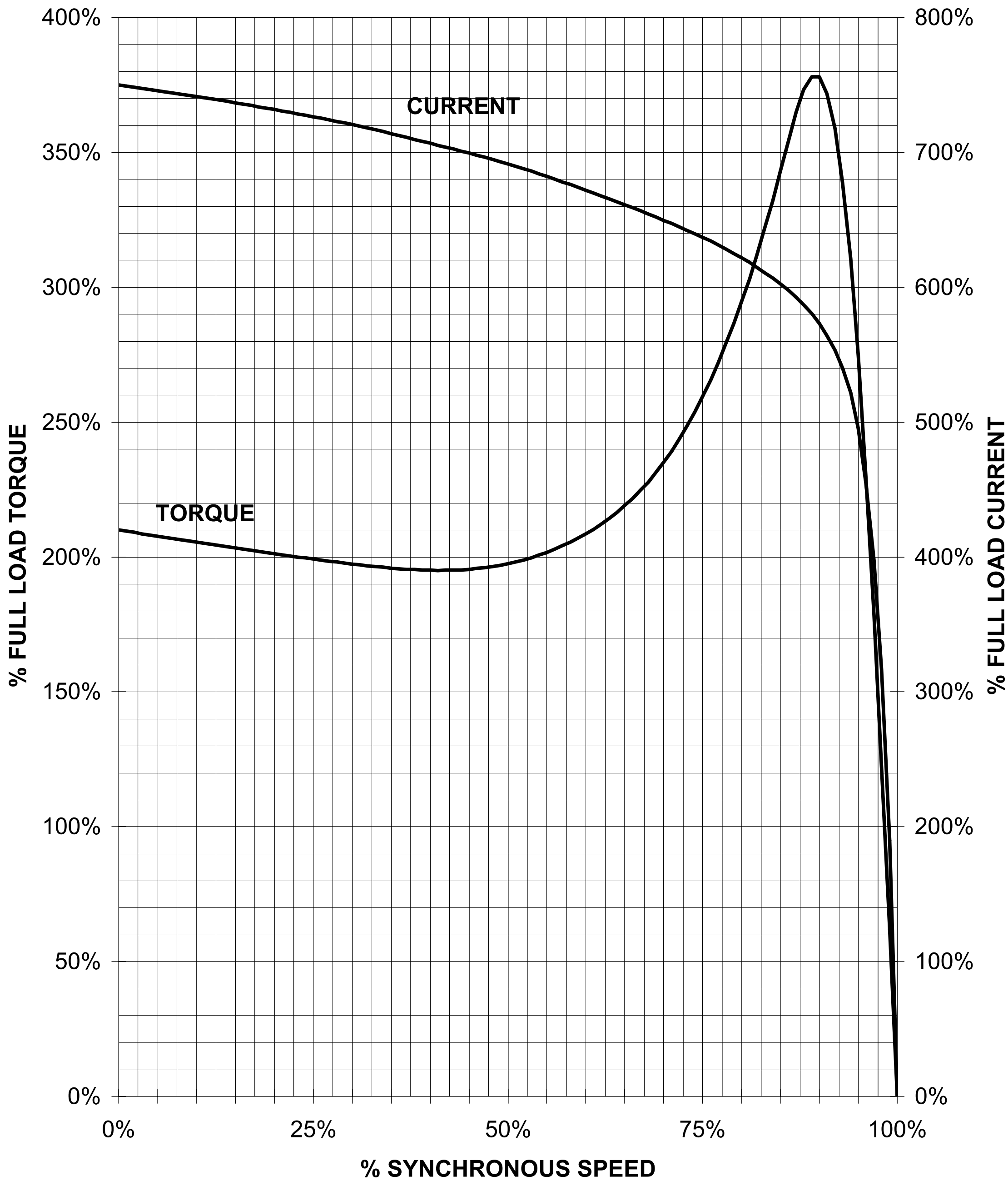
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	1	VOLTS	460	RPM	1200	TYPE	SD100 IEEE-841
HZ	60	PHASE	3	FRAME	145T	NEMA	B

TORQUE & CURRENT VS. SPEED

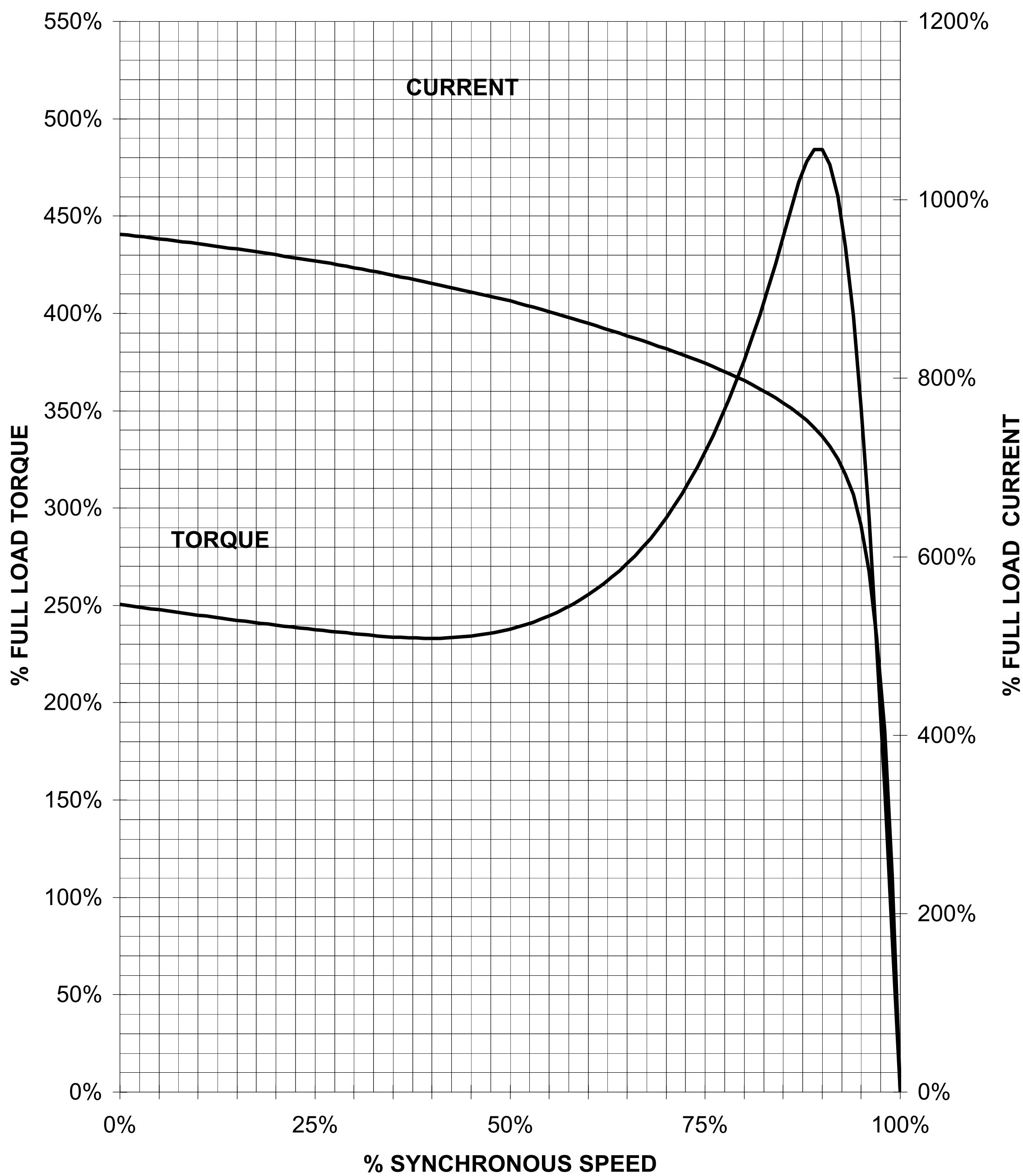


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	2	VOLTS	460	RPM	3600	TYPE	SD100 IEEE-841
HZ	60	PHASE	3	FRAME	145T	NEMA	B

TORQUE & CURRENT VS. SPEED

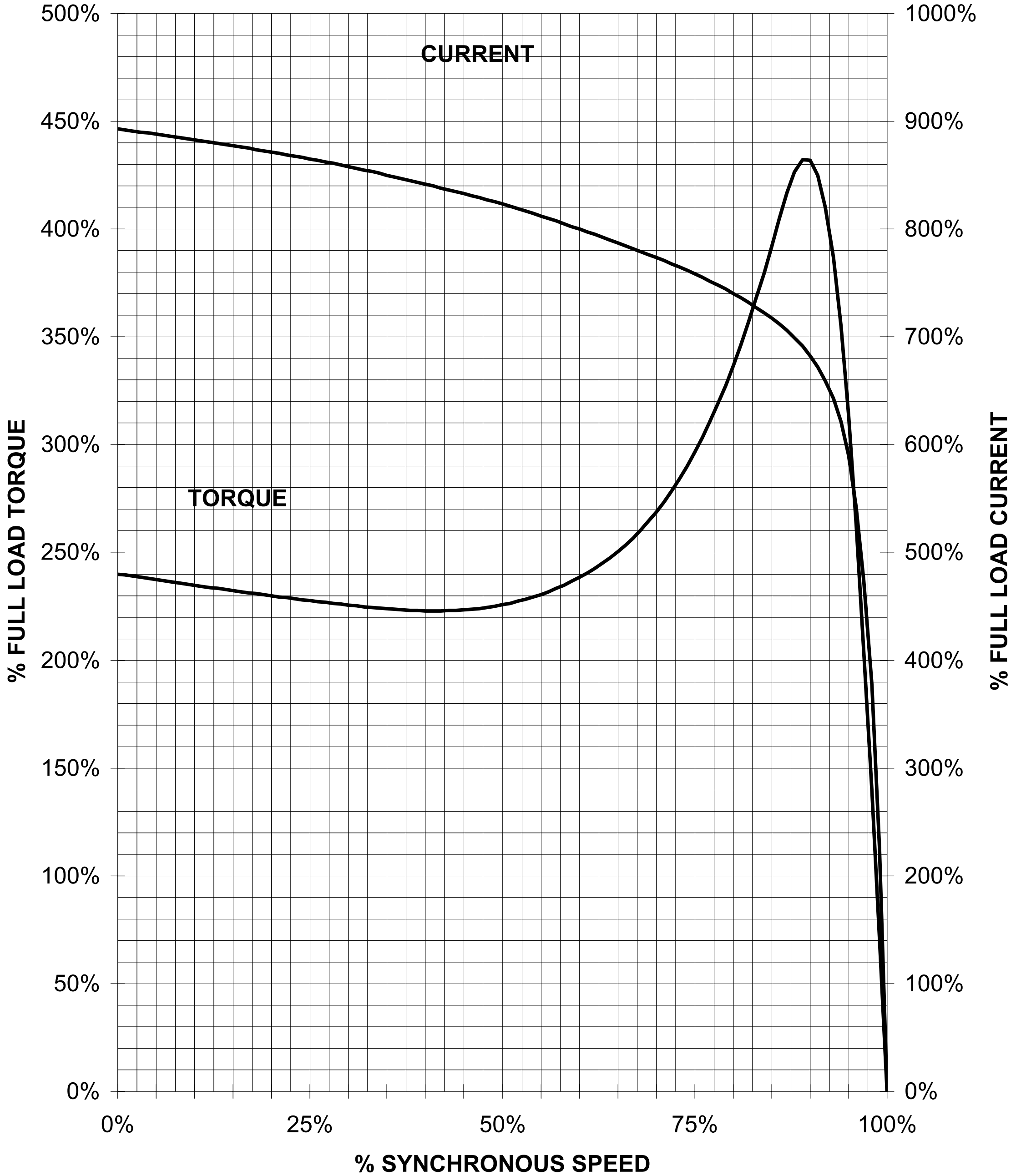


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	2	VOLTS	460	RPM	1800	TYPE	SD100 IEEE-841
HZ	60	PHASE	3	FRAME	145T	NEMA	B

TORQUE & CURRENT VS. SPEED

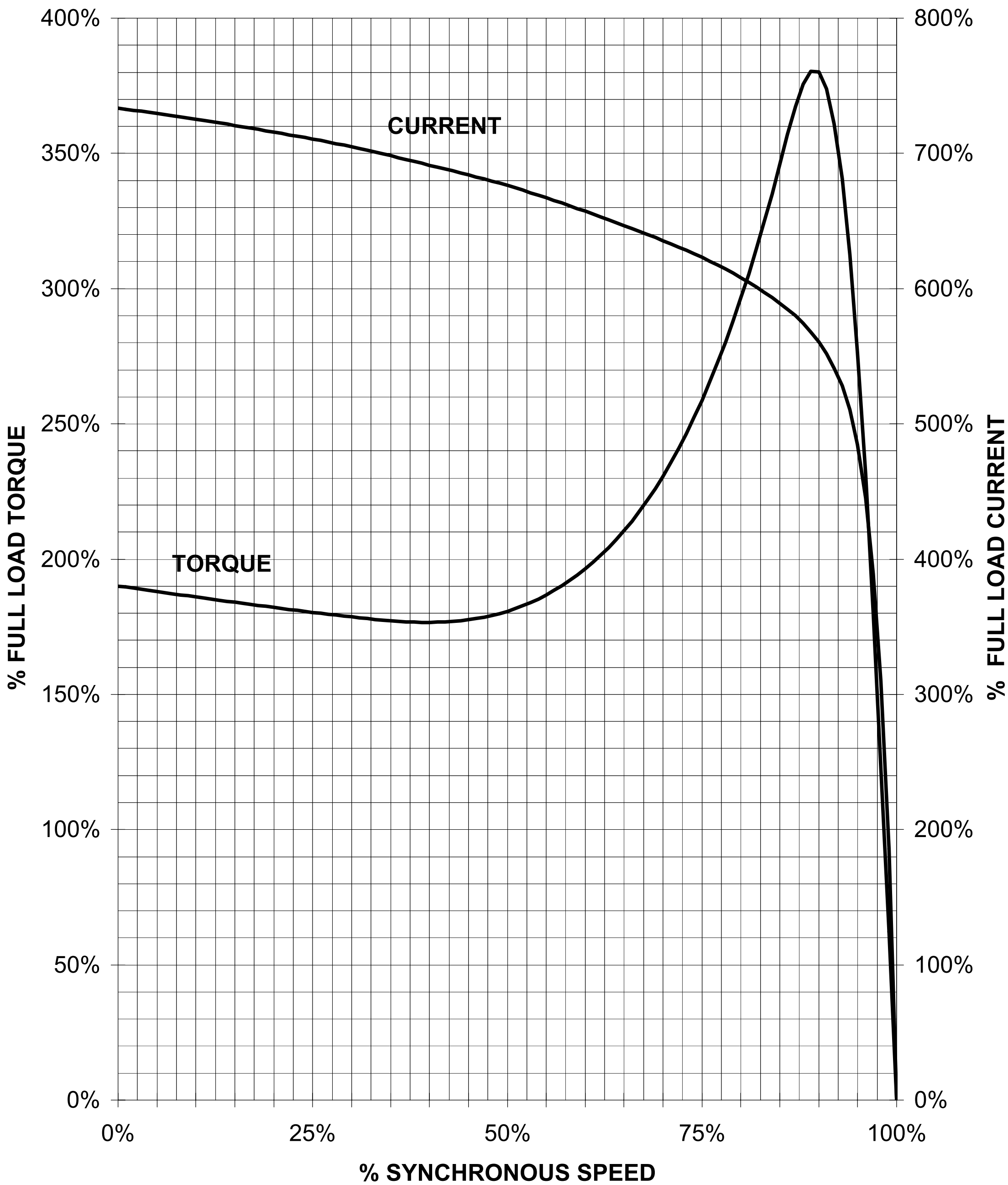


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	2	VOLTS	460	RPM	1200	TYPE	SD100 IEEE-841
HZ	60	PHASE	3	FRAME	184T	NEMA	B

TORQUE & CURRENT VS. SPEED

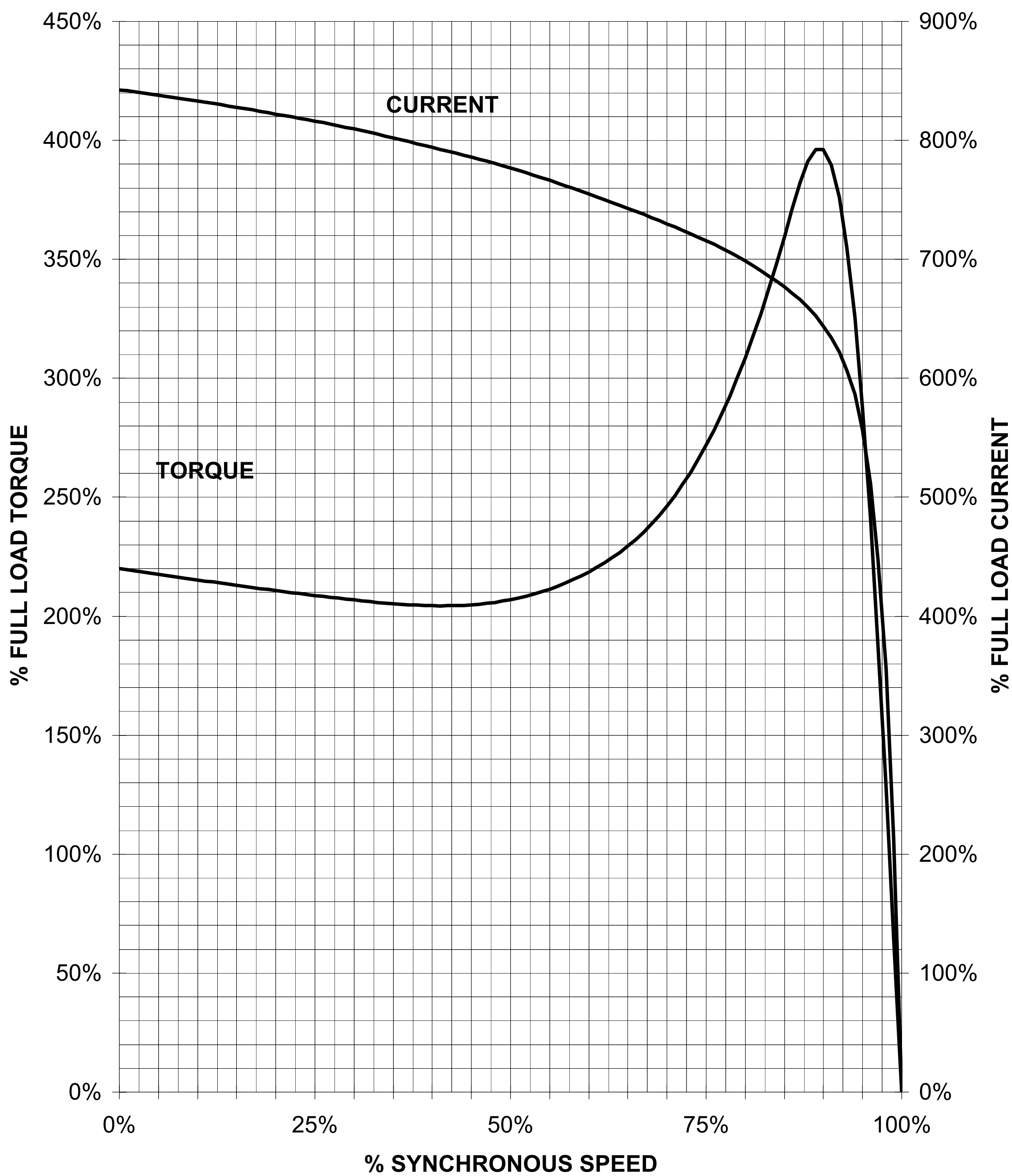


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	3	VOLTS	460	RPM	3600	TYPE	SD100 IEEE-841
HZ	60	PHASE	3	FRAME	182T	NEMA	B

TORQUE & CURRENT VS. SPEED

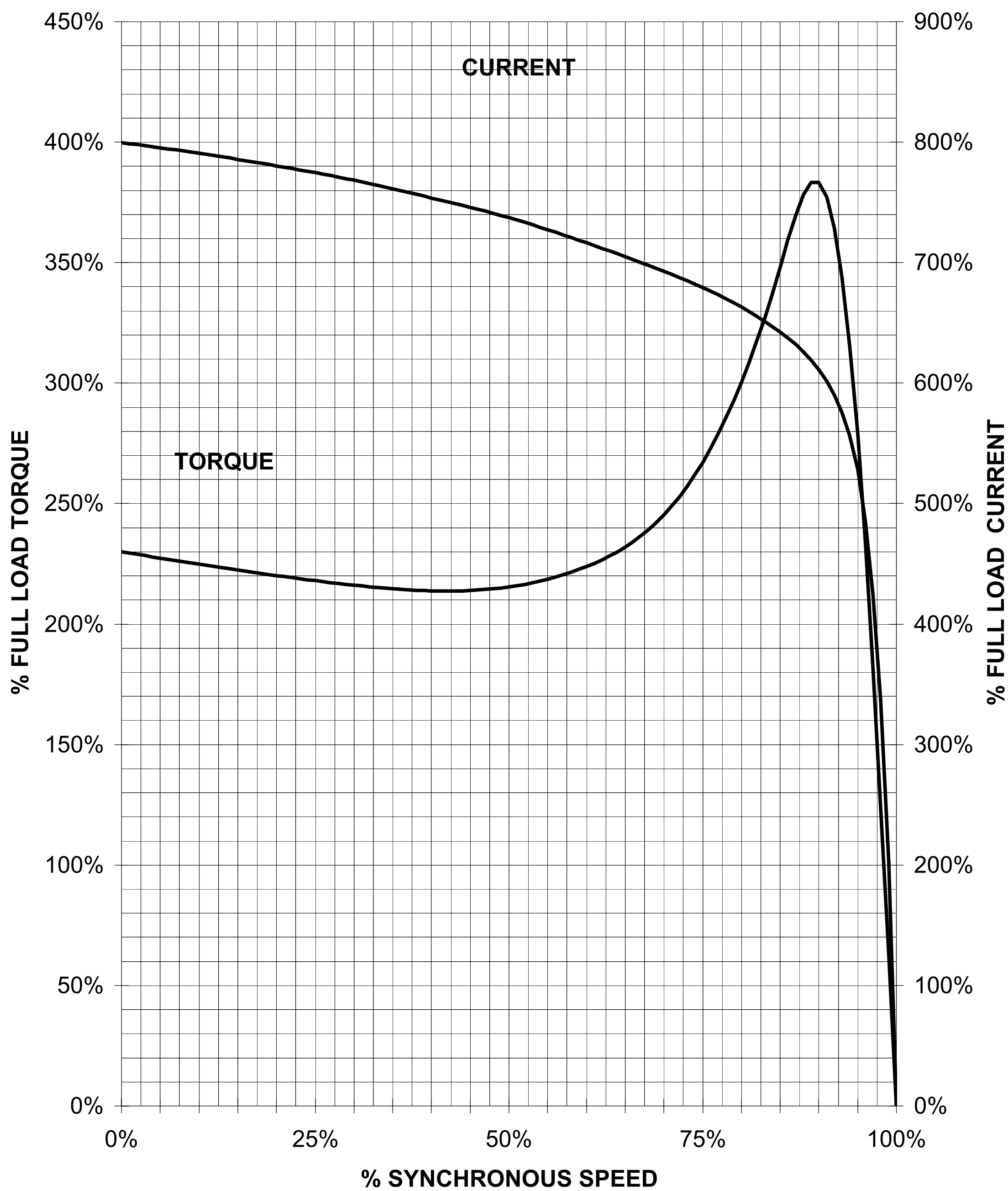


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	3	VOLTS	460	RPM	1800	TYPE	SD100 IEEE-841
HZ	60	PHASE	3	FRAME	182T	NEMA	B

TORQUE & CURRENT VS. SPEED

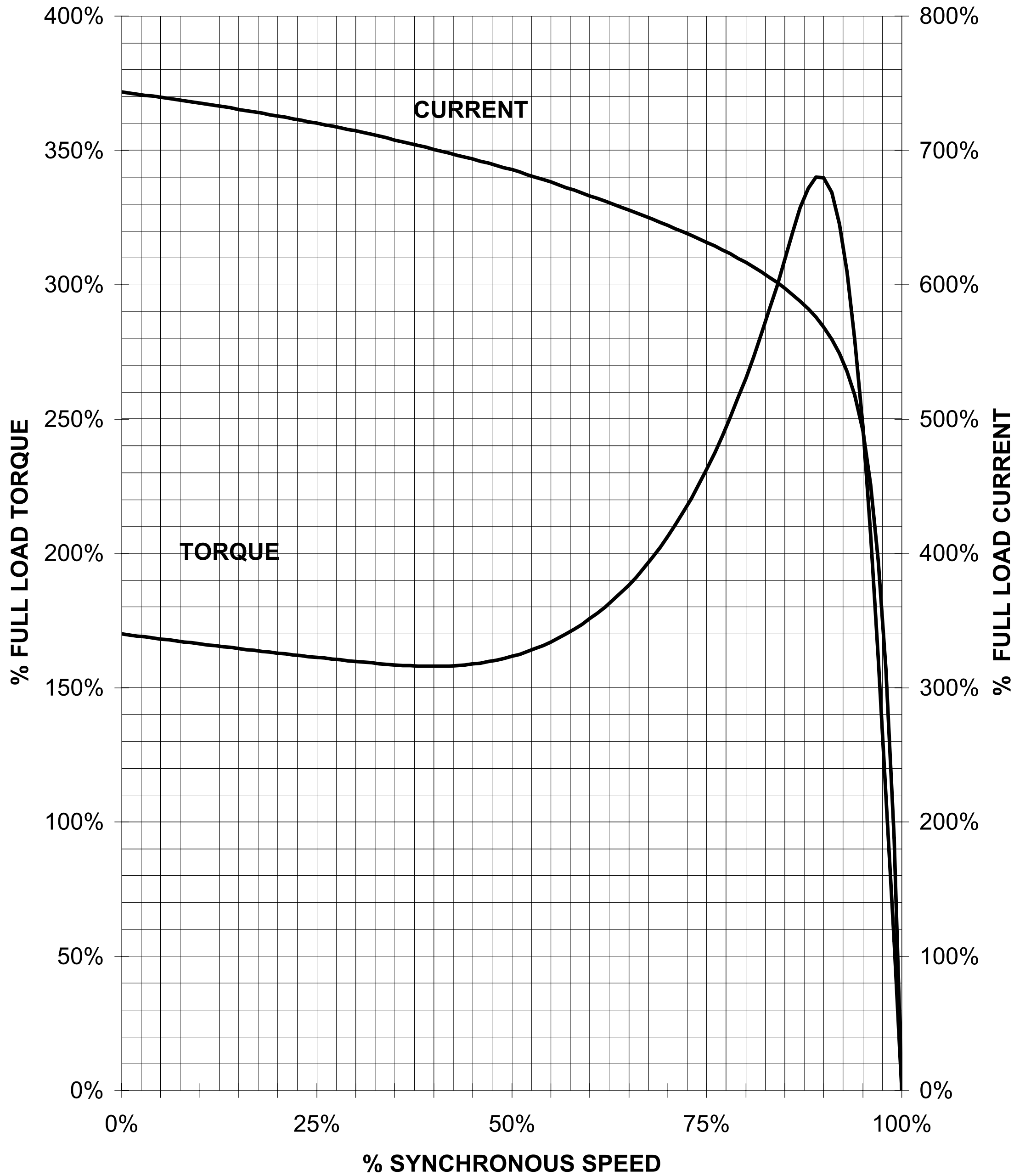


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	3	VOLTS	460	RPM	1200	TYPE	SD100 IEEE-841
HZ	60	PHASE	3	FRAME	213T	NEMA	B

TORQUE & CURRENT VS. SPEED

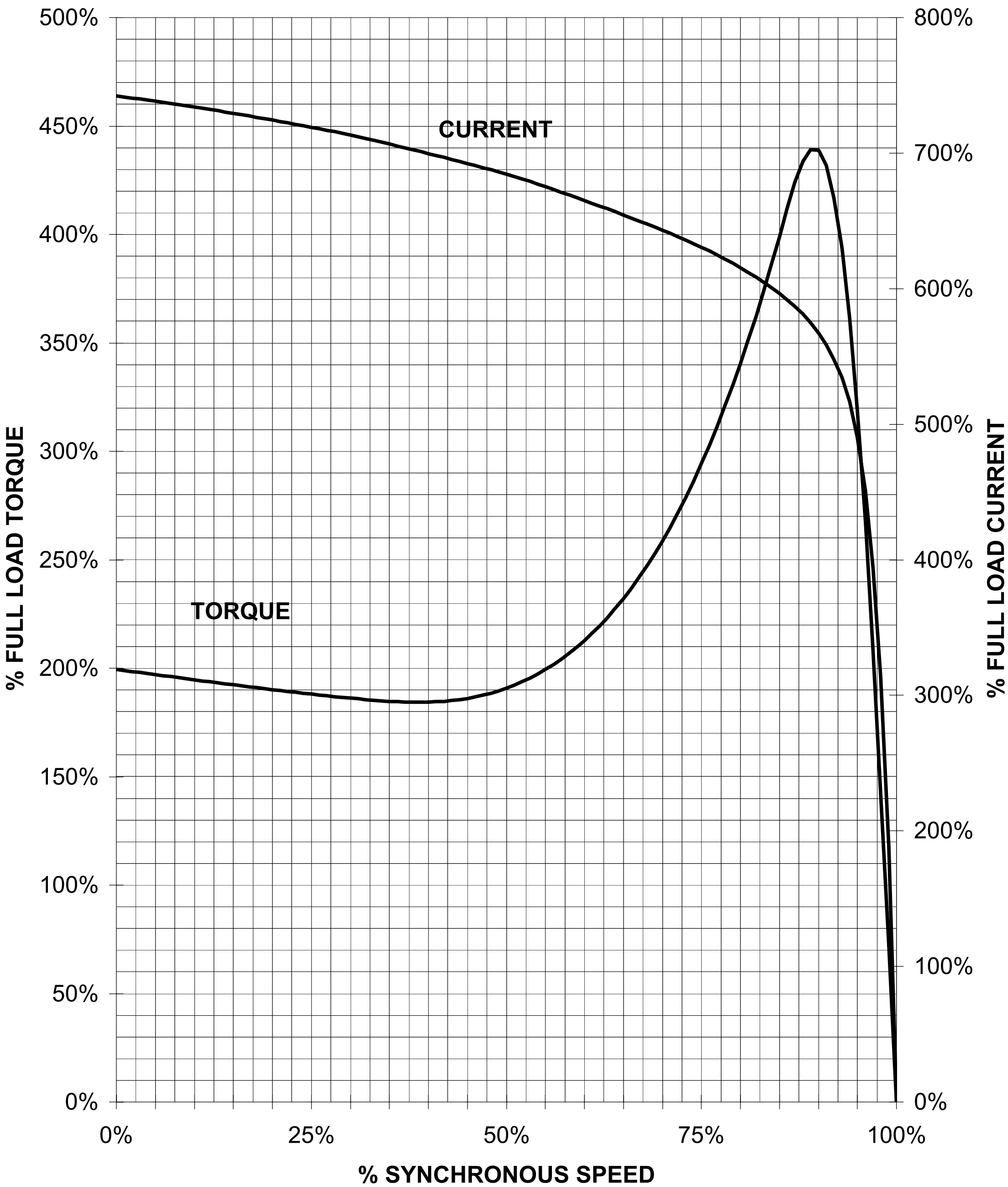


Customer: **PO No.:** **Order No.:**

HP 5 VOLTS 460 RPM 3600 TYPE SD100 IEEE-841

HZ 60 PHASE 3 FRAME 184T NEMA B

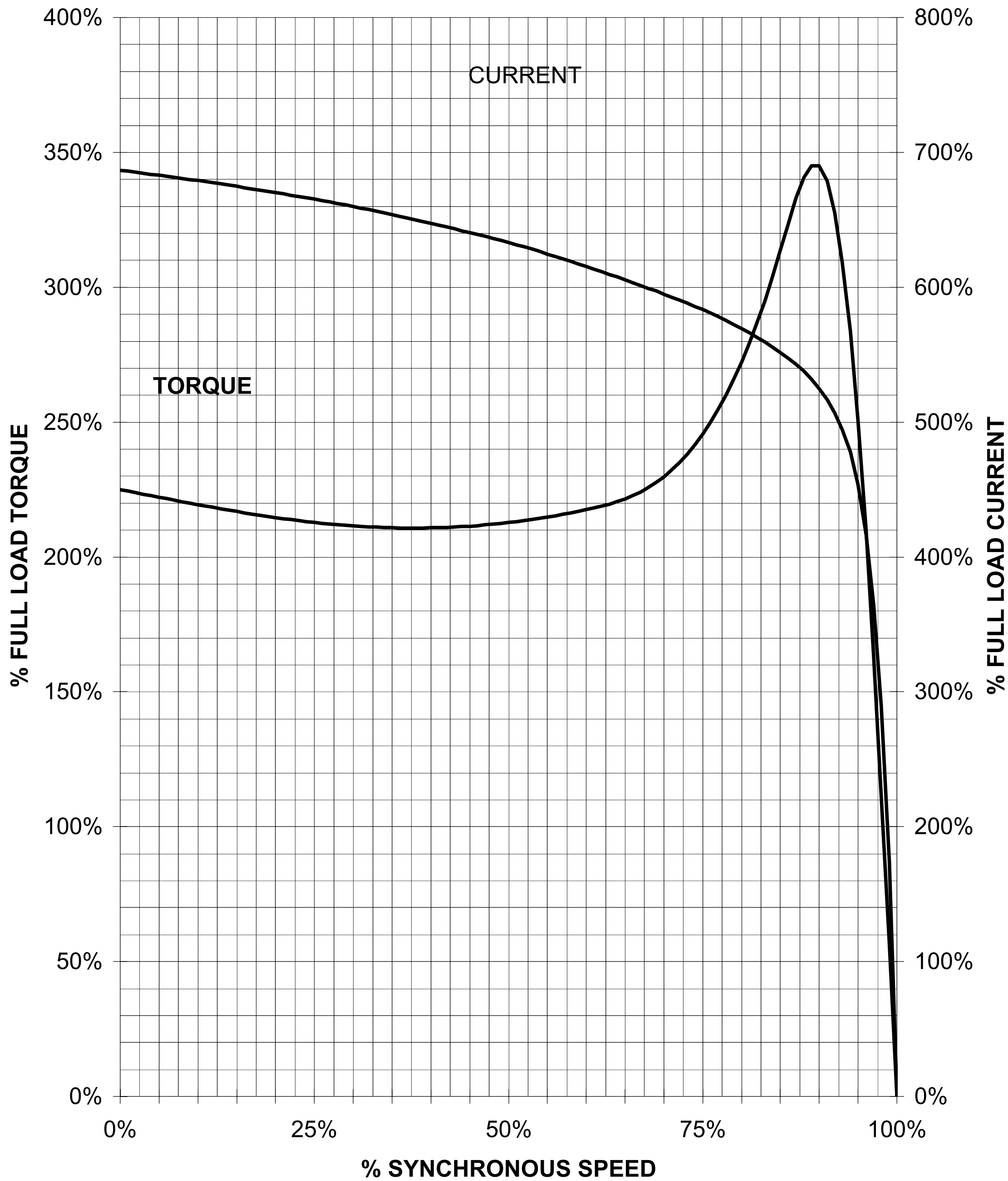
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	5	VOLTS	460	RPM	1800	TYPE	SD100 IEEE-841
HZ	60	PHASE	3	FRAME	184T	NEMA	B

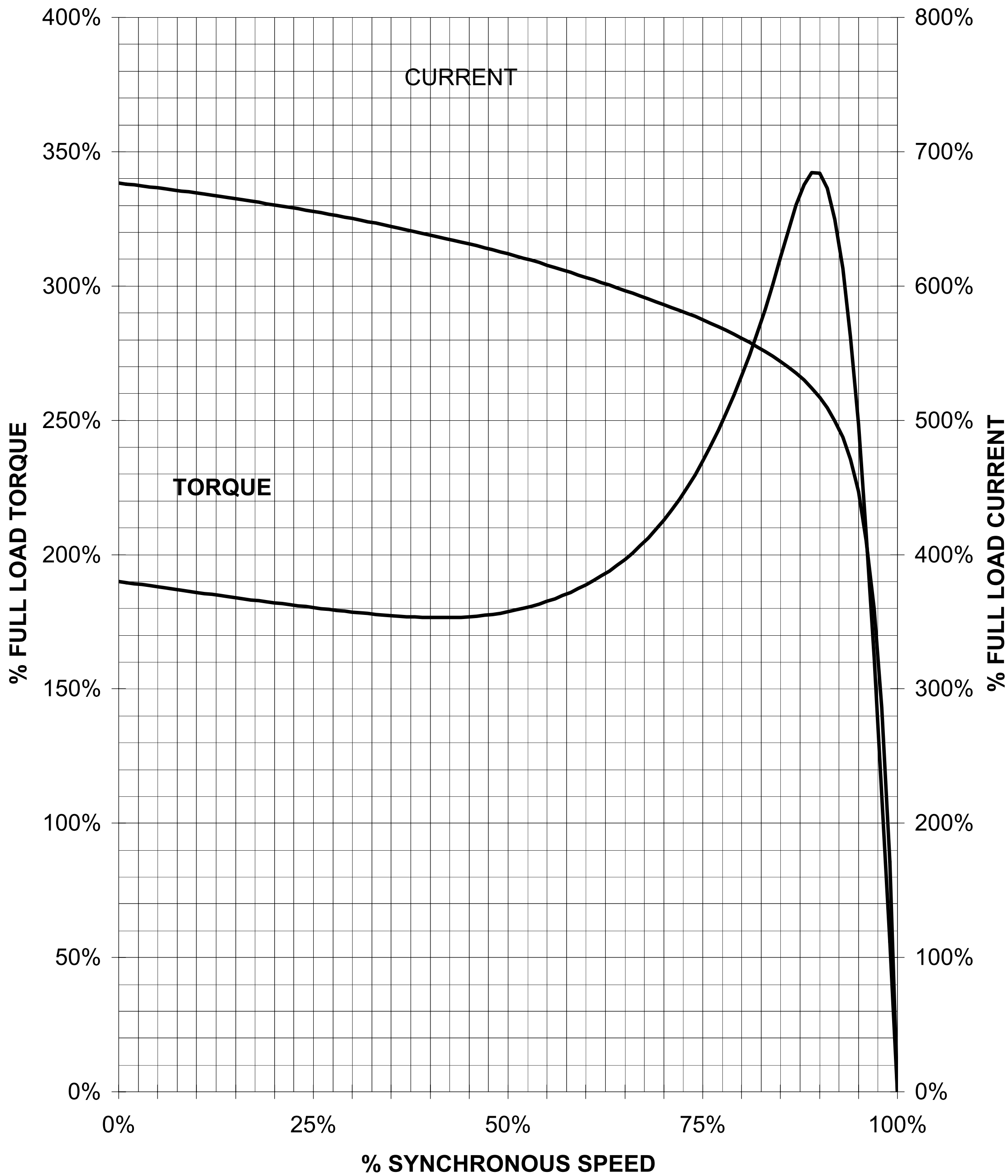
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	5	VOLTS	460	RPM	1200	TYPE	SD100 IEEE-841
HZ	60	PHASE	3	FRAME	215T	NEMA	B

TORQUE & CURRENT VS. SPEED



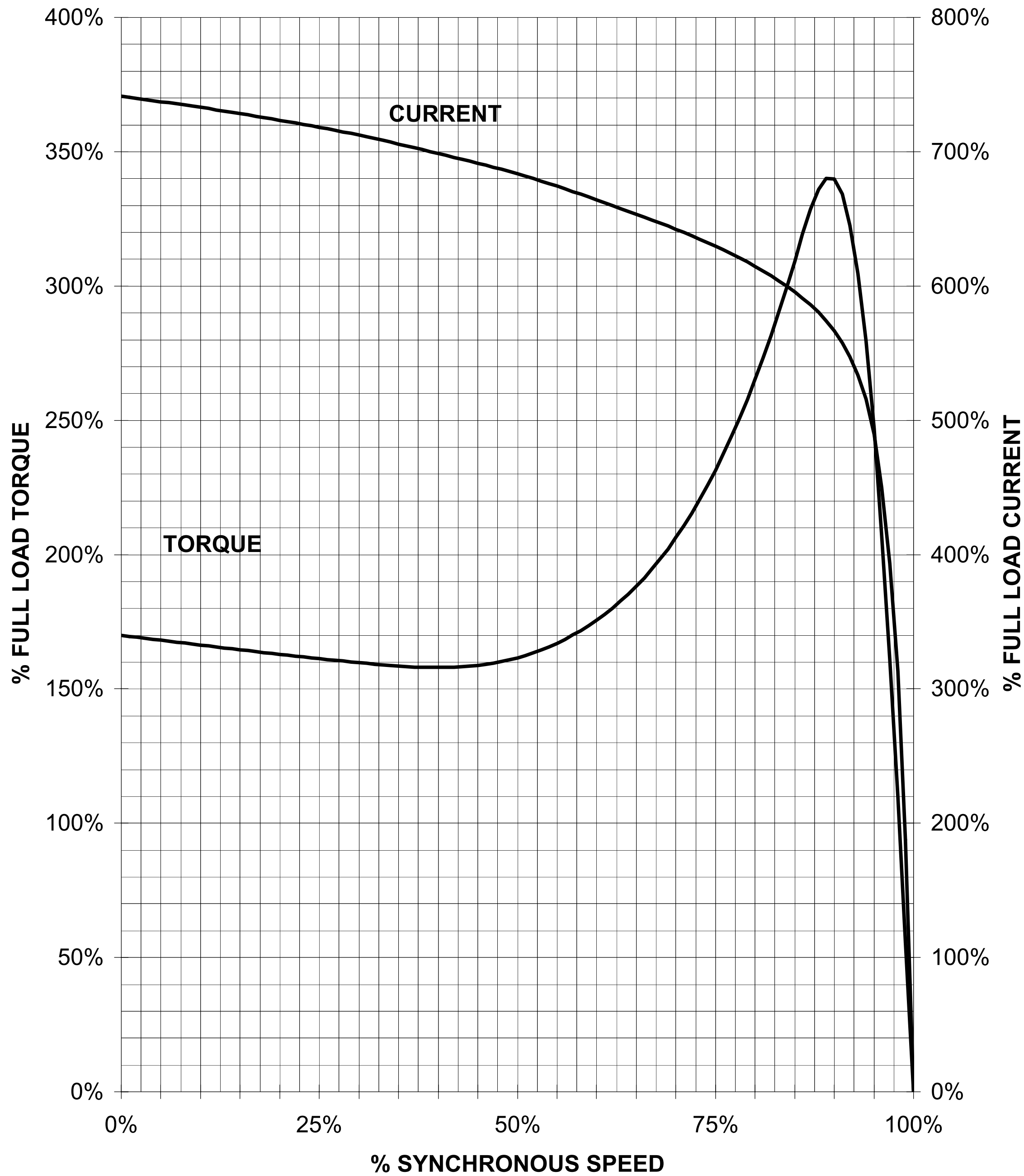
Customer: **PO No.:** **Order No.:**

SIEMENS

Application Manual for NEMA Motors

HP	7.5	VOLTS	460	RPM	3600	TYPE	SD100 IEEE-841
HZ	60	PHASE	3	FRAME	213T	NEMA	B

TORQUE & CURRENT VS. SPEED

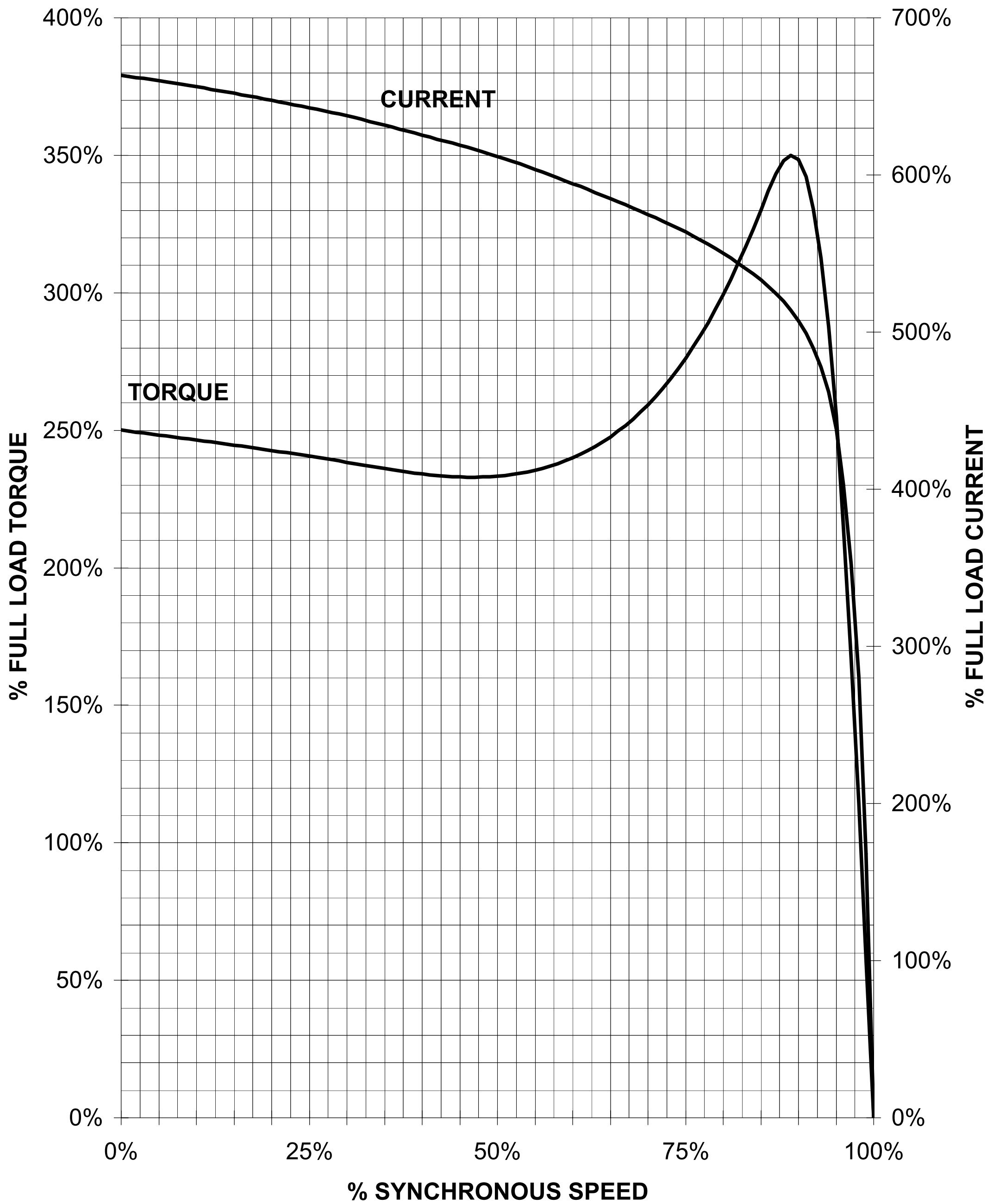


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	7.5	VOLTS	460	RPM	1800	TYPE	SD100 IEEE-841
HZ	60	PHASE	3	FRAME	213T	NEMA	B

TORQUE & CURRENT VS. SPEED

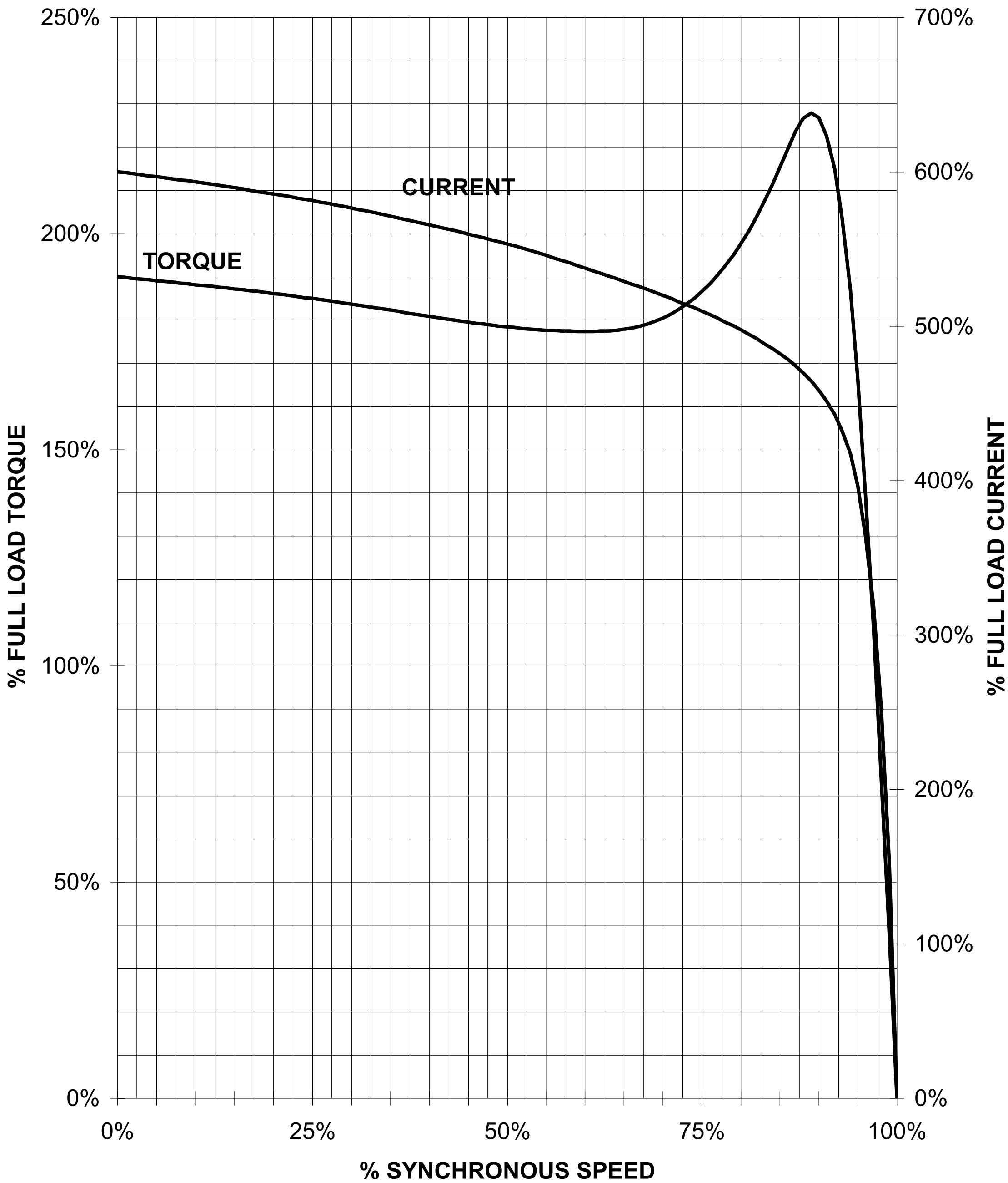


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	7.5	VOLTS	460	RPM	1200	TYPE	SD100 IEEE-841
HZ	60	PHASE	3	FRAME	254T	NEMA	B

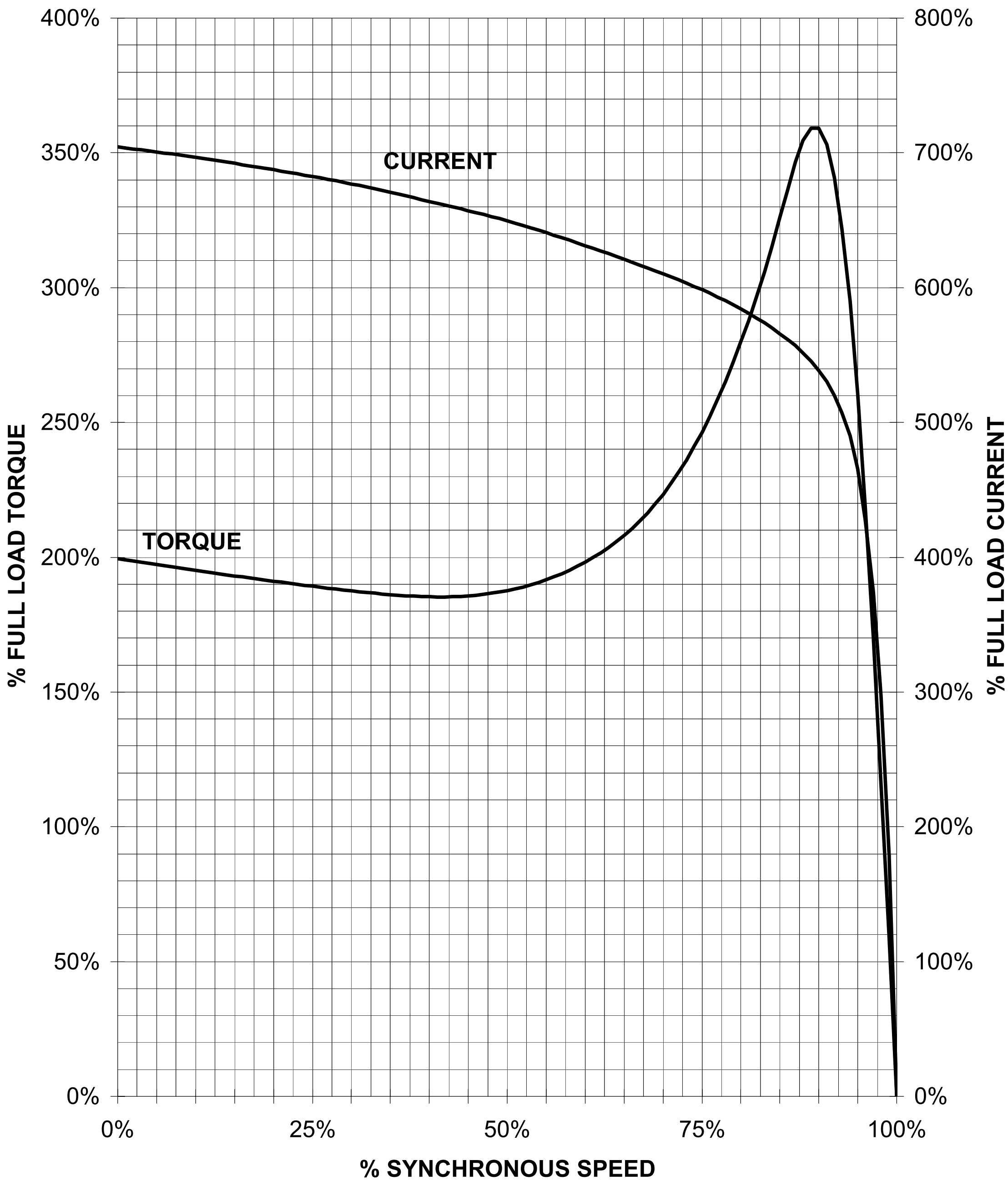
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	10	VOLTS	460	RPM	3600	TYPE	SD100 IEEE-841
HZ	60	PHASE	3	FRAME	215T	NEMA	B

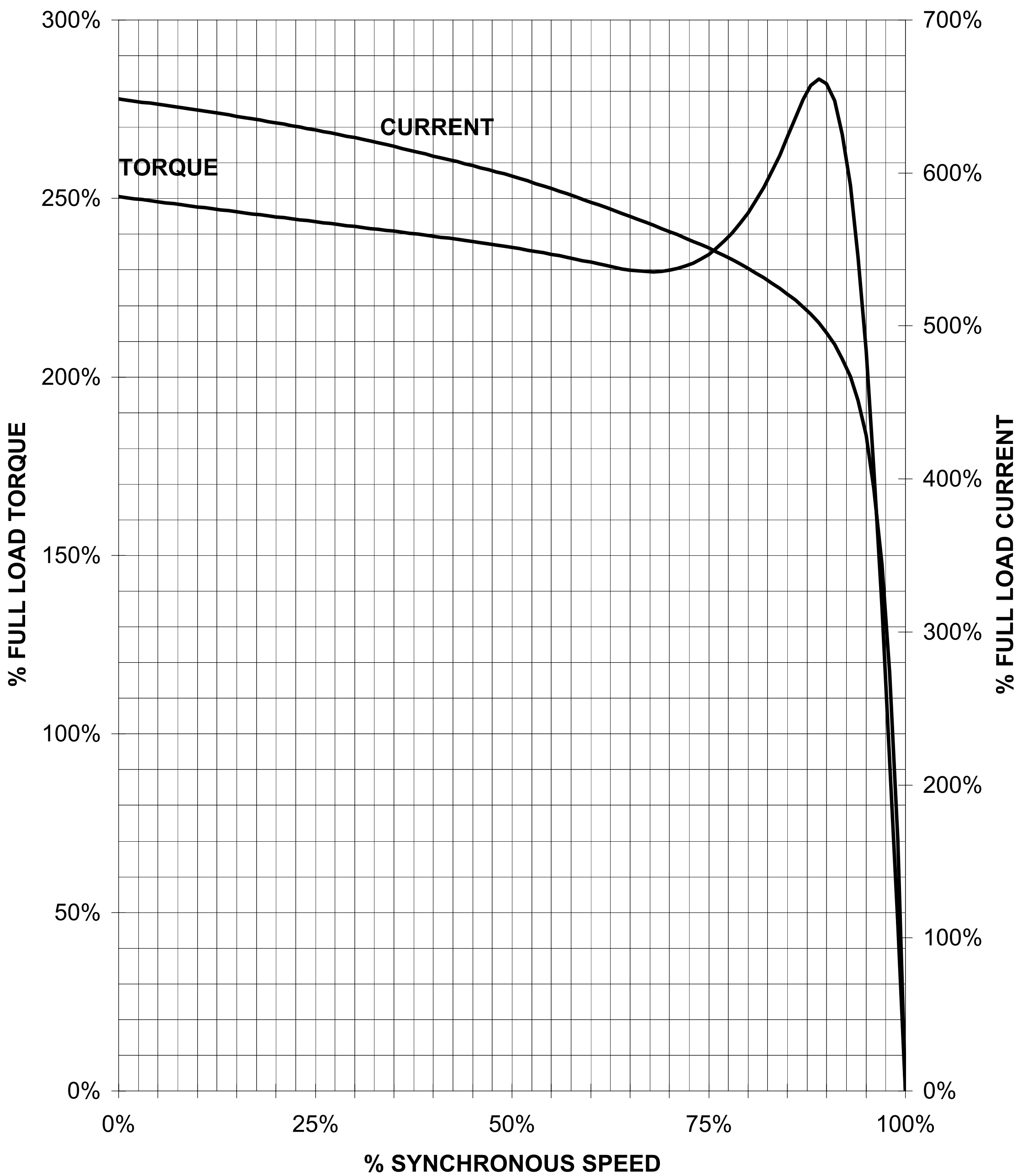
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	10	VOLTS	460	RPM	1800	TYPE	SD100 IEEE-841
HZ	60	PHASE	3	FRAME	215T	NEMA	B

TORQUE & CURRENT VS. SPEED

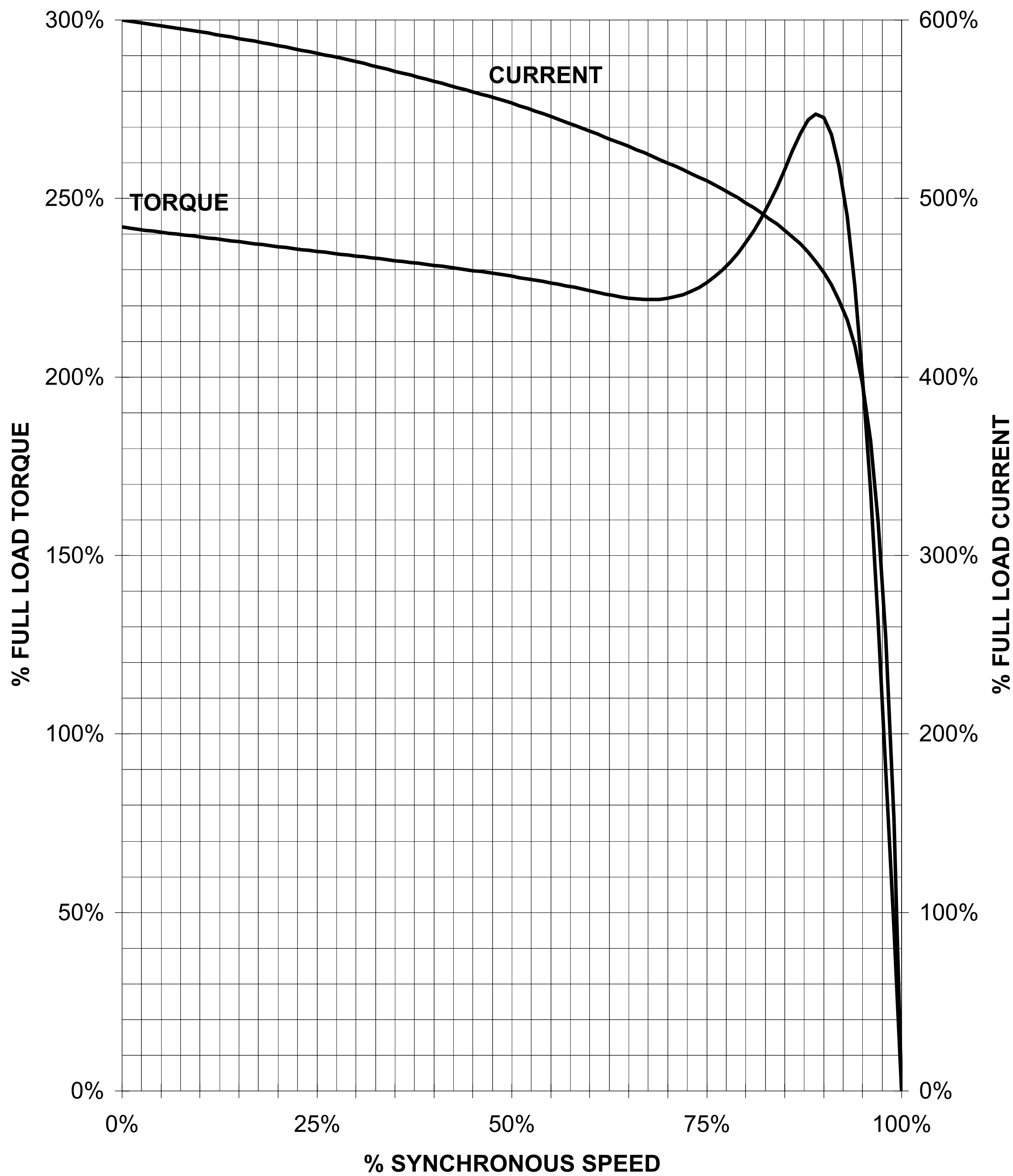


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	10	VOLTS	460	RPM	1200	TYPE	SD100 IEEE-841
HZ	60	PHASE	3	FRAME	256T	NEMA	B

TORQUE & CURRENT VS. SPEED

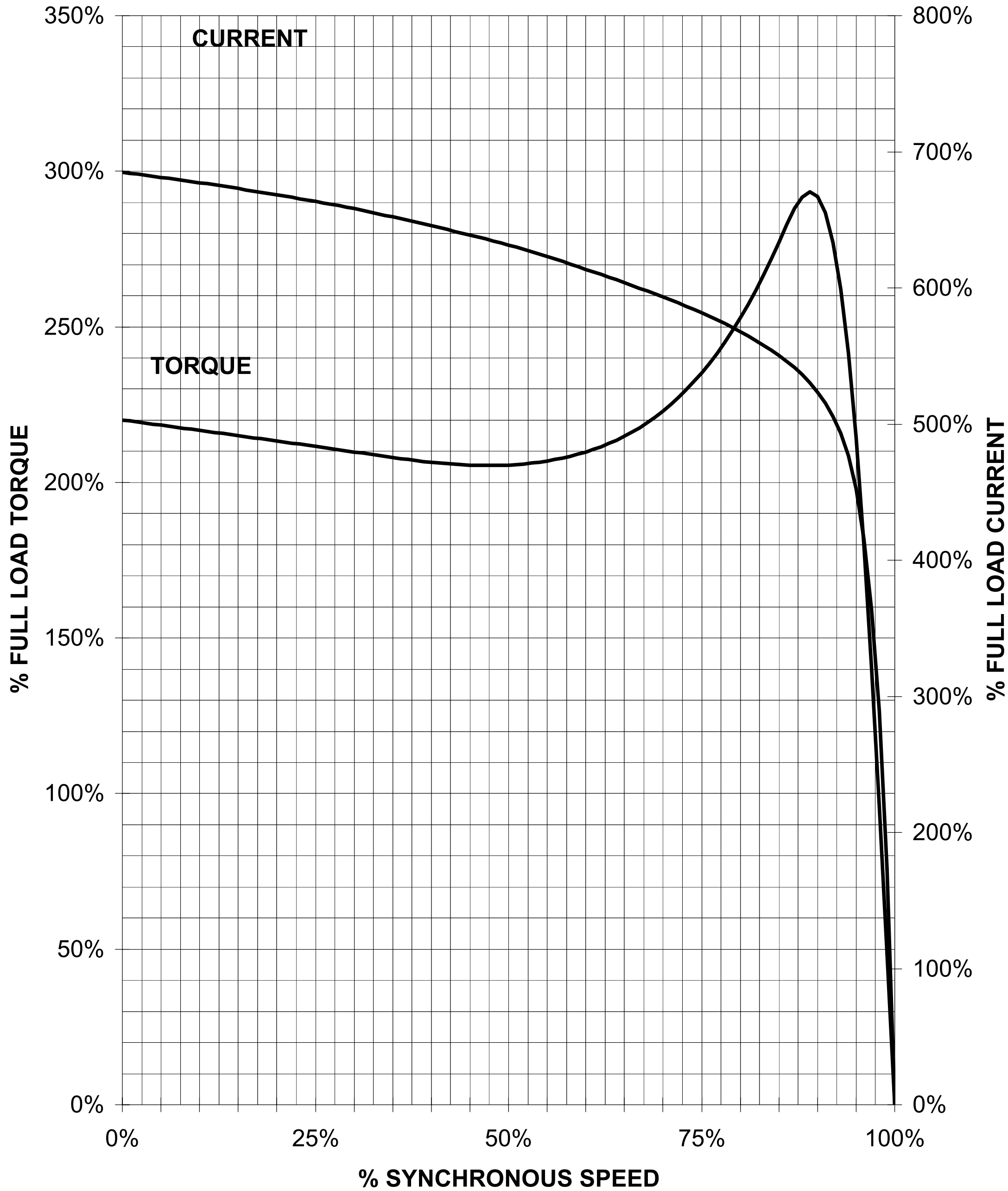


Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

HP	15	VOLTS	460	RPM	3600	TYPE	SD100 IEEE-841
HZ	60	PHASE	3	FRAME	254T	NEMA	B

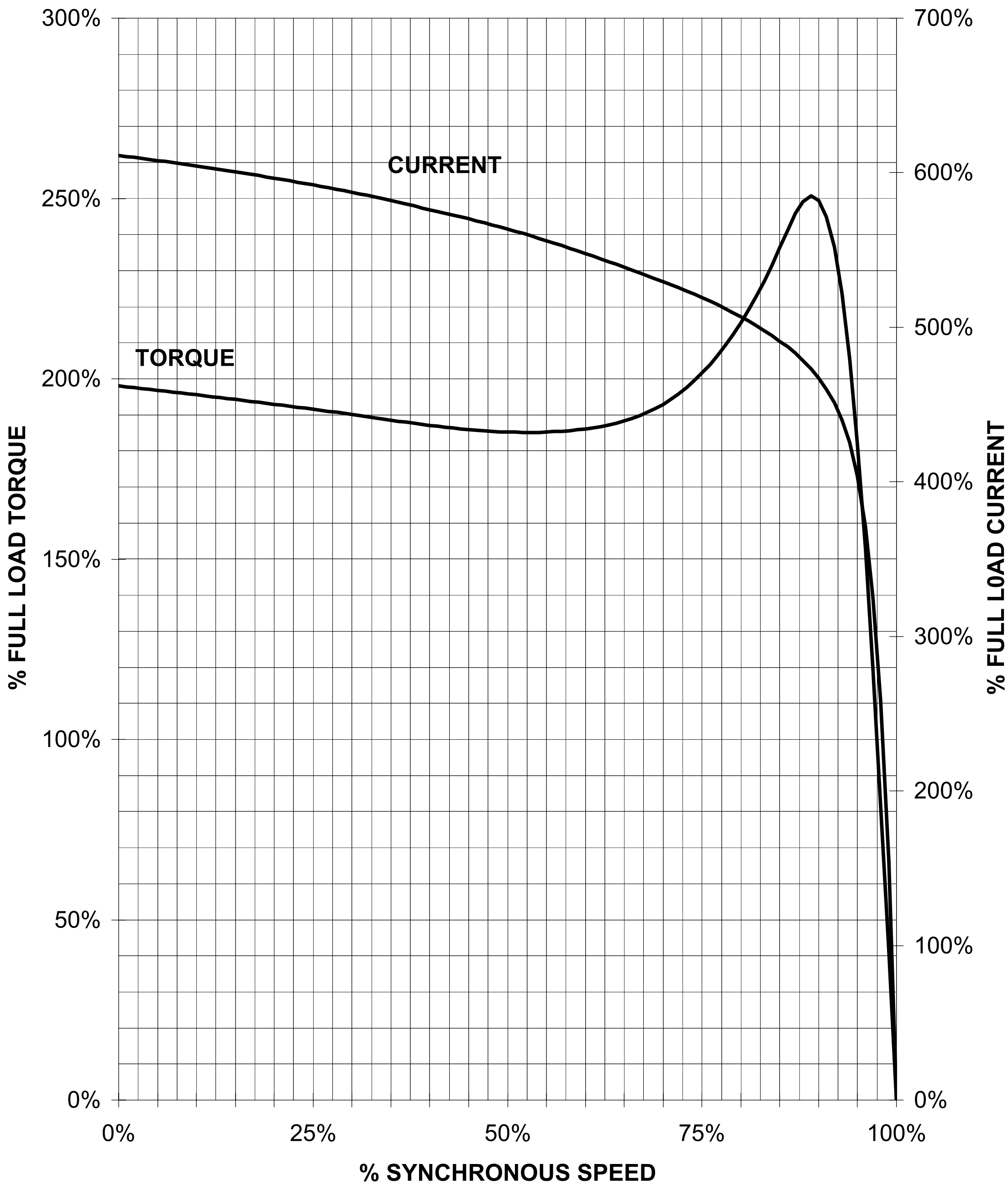
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	15	VOLTS	460	RPM	1800	TYPE	SD100 IEEE-841
HZ	60	PHASE	3	FRAME	254T	NEMA	B

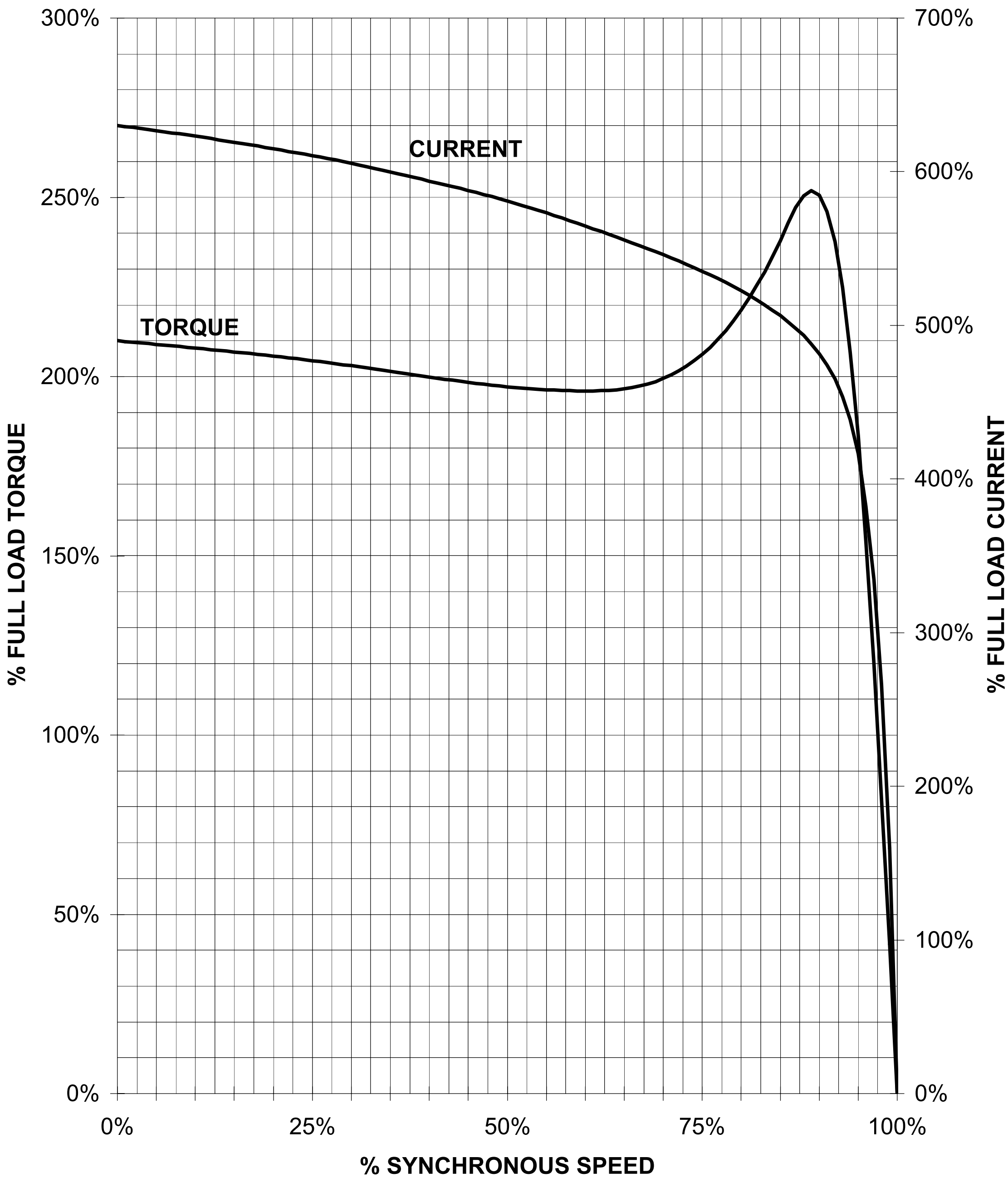
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	20	VOLTS	460	RPM	3600	TYPE	SD100 IEEE-841
HZ	60	PHASE	3	FRAME	256T	NEMA	B

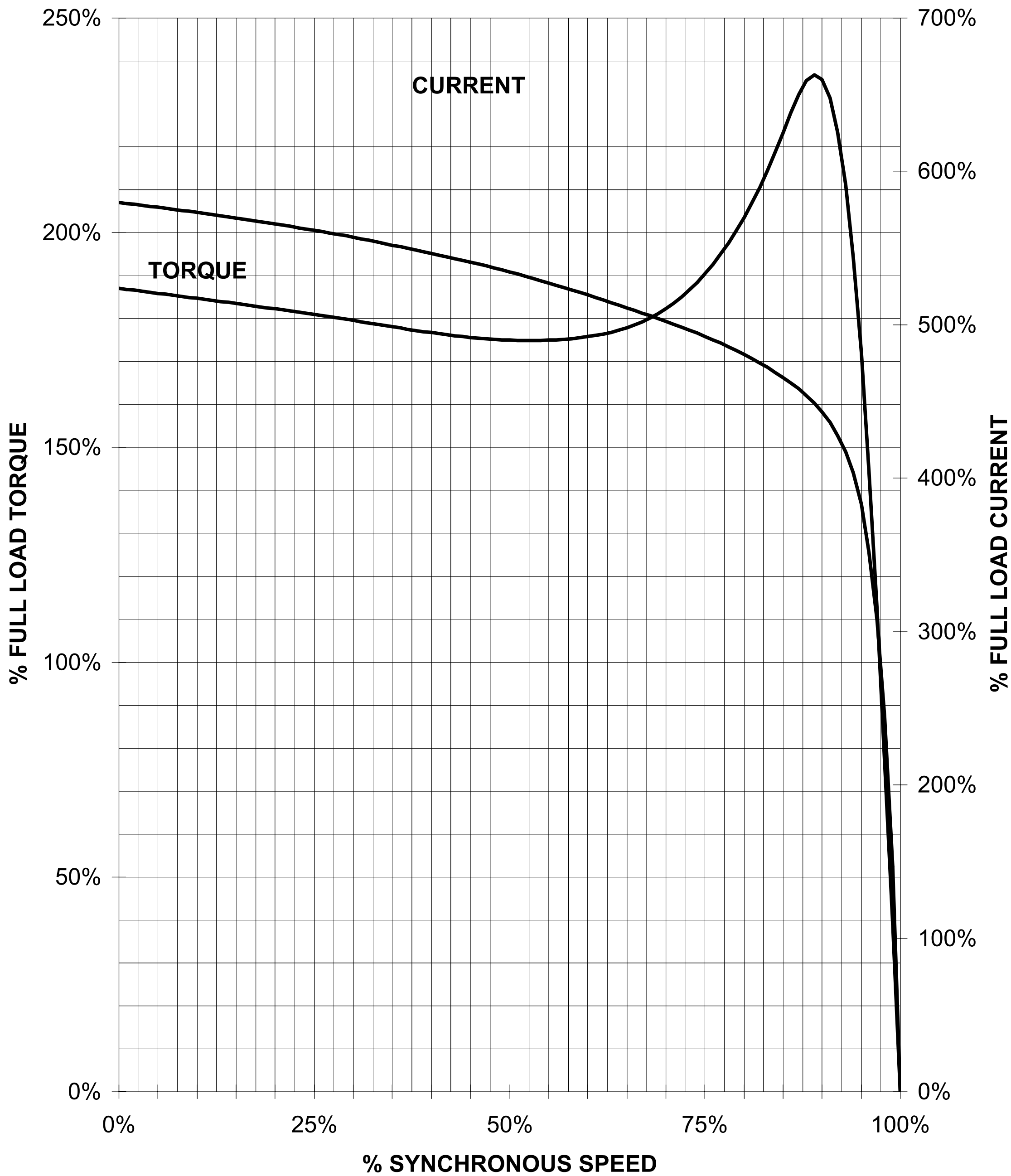
TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

HP	20	VOLTS	460	RPM	1800	TYPE	SD100 IEEE-841
HZ	60	PHASE	3	FRAME	256T	NEMA	B

TORQUE & CURRENT VS. SPEED



Customer: **PO No.:** **Order No.:**

PERFORMANCE BASED ON DESIGN CALCULATIONS. SUBJECT TO CHANGE WITHOUT NOTICE.
REV. 1

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 (180˚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.

External Load Inertia Capability, Wk^2 ($lb\text{-}ft^2$)

	Synchronous Speed, RPM						
	3600	**1800**	**1200**	**900**	**720**	**600**	**514**
	Load Wk^2 (Exclusive of Motor Wk^2), $lb\text{-}ft^2$						
HP							
1	…	5.8	15	31	53	82	118
1.5	1.8	8.6	23	45	77	120	174
2	2.4	11	30	60	102	158	228
3	3.5	17	44	87	149	231	335
5	5.7	27	71	142	242	375	544
7.5	8.3	39	104	208	355	551	799
10	11	51	137	273	467	723	1050
15	16	75	200	400	684	1060	1540
20	21	99	262	525	898	1390	2020
25	26	122	324	647	1110	1720	2490
30	30	144	384	769	1320	2040	2960
40	40	189	503	1010	1720	2680	3890
50	49	232	620	1240	2130	3300	4790
60	58	275	735	1470	2520	3920	5690
75	71	338	904	1810	3110	4830	7020
100	92	441	1180	2370	4070	6320	9190
125	113	542	1450	2920	5010	7790	11300
150	133	640	1720	3460	5940	9230	…
200	172	831	2240	4510	7750	…	…
250	210	1020	2740	5540	…	…	…
300	246	1200	3240	…	…	…	…
350	281	1370	3720	…	…	…	…
400	315	1550	…	…	…	…	…
450	349	1710	…	…	…	…	…
500	381	1880	…	…	…	…	…

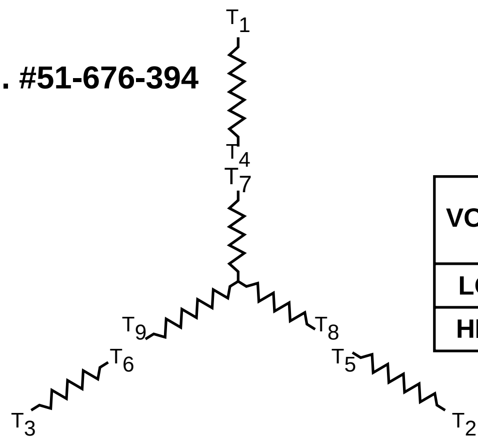
NOTES:
1. Locked rotor and breakdown torques are per NEMA Design A and B for general purpose motors.
2. Class F insulation with standard service factor and temperature rise.
3. Rated voltage and frequency applied.
4. During acceleration period, connected load torque varies as the square of the speed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

Please refer to Section 10 Part 3 for more details on Moment of Inertia.

External Connection Diagrams - Single Speed

DWG. #51-676-394

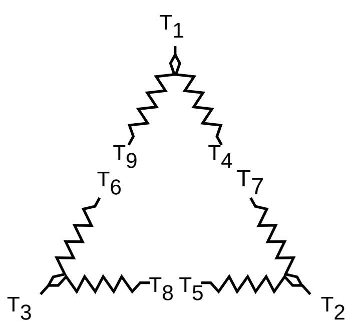
3 PHASE – 9 LEAD – WYE



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

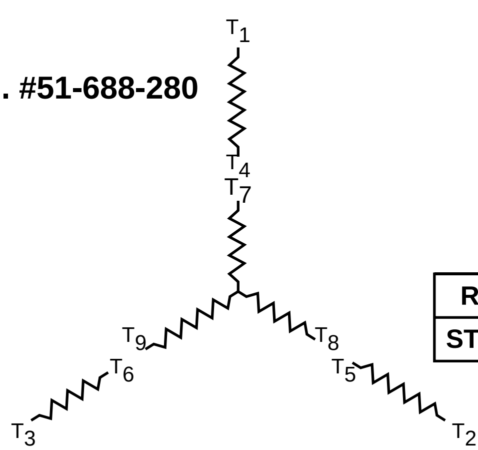
3 PHASE – 9 LEAD – DELTA



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

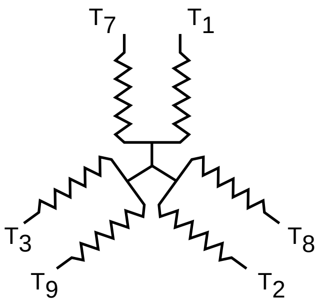


	LINES			CONNECTED TOGETHER	CONN.
	L1	L2	L3		
RUN	$T_1 T_7$	$T_2 T_8$	$T_3 T_9$	$T_4 T_5 T_6$	YY
START	T_1	T_2	T_3	$T_4 T_5 T_6$	Y

External Connection Diagrams - Single Speed

DWG. #51-406-529

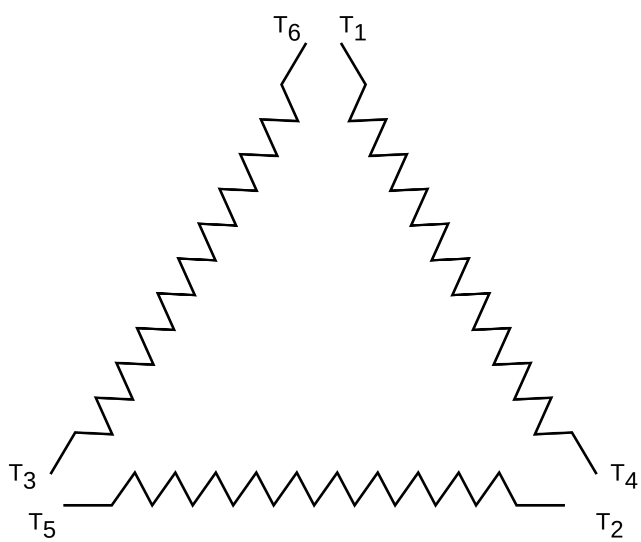
PART WINDING START
3 PHASE – 6 LEAD – WYE



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

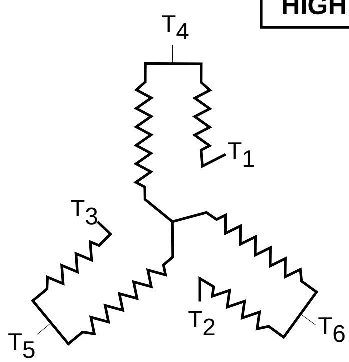
External Connection Diagrams - 2 Speeds

CLASS OF SERVICE AND DWG. NUMBER — **SINGLE WINDING**

#51-110-063

VARIABLE TORQUE

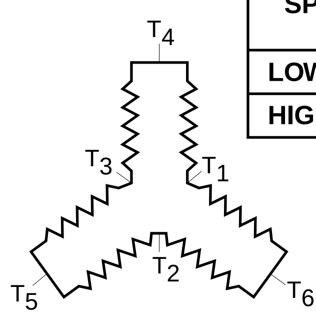
SPEEDS	LINES				CONN.
	L1	L2	L3		
LOW SPEED	T_1	T_2	T_3	T_4 T_5 T_6 OPEN	Y
HIGH SPEED	T_6	T_4	T_5	T_1 T_2 T_3 TOGETHER	YY



#51-110-060

CONSTANT TORQUE

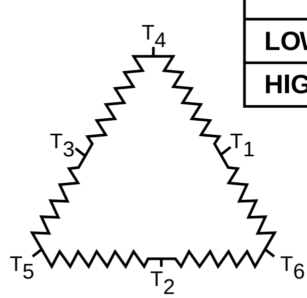
SPEEDS	LINES				CONN.
	L1	L2	L3		
LOW SPEED	T_1	T_2	T_3	T_4 T_5 T_6 OPEN	Δ
HIGH SPEED	T_6	T_4	T_5	T_1 T_2 T_3 TOGETHER	YY



#51-110-069

CONSTANT HORSE-POWER

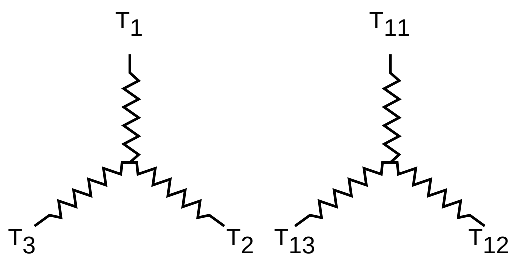
SPEEDS	LINES				CONN.
	L1	L2	L3		
LOW SPEED	T_1	T_2	T_3	T_4 T_5 T_6 OPEN	YY
HIGH SPEED	T_6	T_4	T_5	T_1 T_2 T_3 TOGETHER	Δ



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 when operated on a 60Hz utility sine wave.

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

Reduction Factors for Ambient Temperature and Altitude

Siemens standard motors are designed for operation in a 40°C ambient temperature and 1000m above sea level. For ambient temperatures and altitudes other than 40°C and 1000m, please apply the following factors from Table 1 to your horsepower requirements as shown in the examples below.

Altitude Above Sea Level (meters)	Ambient Temperature						
	30°C	35°C	40°C	45°C	50°C	55°C	60°C
1000	1.06	1.03	1.00	0.96	0.92	0.87	0.82
1500	1.03	1.00	0.97	0.93	0.89	0.84	0.80
2000	1.00	0.97	0.94	0.90	0.86	0.82	0.77
2500	0.95	0.93	0.90	0.86	0.83	0.78	0.74
3000	0.91	0.89	0.86	0.83	0.79	0.75	0.71
3500	0.87	0.84	0.82	0.79	0.75	0.71	0.67
4000	0.82	0.79	0.77	0.74	0.71	0.67	0.63

Table 1 - Ambient & Altitude Reduction Factors (see Notes below)

Notes: Applicable only for sinewave operation on motors from 1 to 200 HP.
Please contact Siemens for the following cases:

- Ambient temperatures or altitudes not listed in Table 1
- Horsepowers greater than 200
- Explosion Proof motors
- Variable Speed Operation
- Operating within the Service Factor

Examples: Calculated HP @ ambient & altitude = BHP / Reduction Factor

#1:

Site Ambient (°C)	50
Site Altitude (m)	2000
Reduction Factor (Table 1)	0.86
Brake Horsepower (BHP)	25
Calculated HP @ amb.& alt.	29.1
Motor HP Selection	30

#2:

Site Ambient (°C)	55
Site Altitude (m)	3500
Reduction Factor (Table 1)	0.71
Brake Horsepower (BHP)	130
Calculated HP @ amb. & alt.	183.1
Motor HP Selection	200

#3:

Site Ambient (°C)	35
Site Altitude (m)	2000
Reduction Factor (Table 1)	0.97
Brake Horsepower (BHP)	55
Calculated HP @ amb. & alt.	56.7
Motor HP Selection	60

#4:

Site Ambient (°C)	30
Site Altitude (m)	4000
Reduction Factor (Table 1)	0.82
Brake Horsepower (BHP)	7
Calculated HP @ amb. & alt.	8.5
Motor HP Selection	10

SIEMENS

Application Manual for NEMA Motors

Section 6

Mechanical Data

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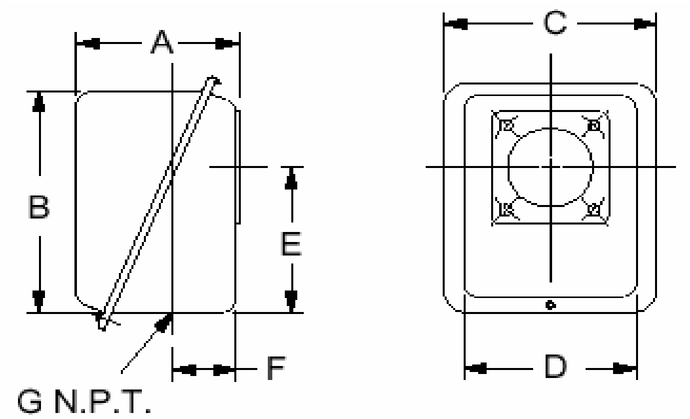
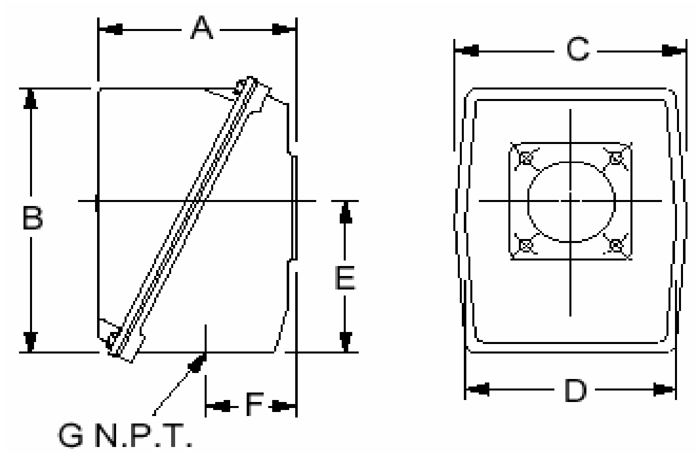
Standard Conduit Boxes -- TEFC-Standard Duty -- Type RGZP



Frame	External Dimensions (in)								Approx. internal volume (in^3)	no. of cover bolts
	A	B	C	D	E	F	G NPT	G Max. Cond.		
140	2.60	4.21	4.10	3.40	2.17	0.96	0.75		19	2
180	2.60	4.21	4.10	3.40	2.17	0.96	0.75		19	2
210	3.60	6.10	5.00	4.80	2.90	1.34	1.00		58	2
250	3.60	6.10	5.00	4.80	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	350	1
400	7.19	9.38	7.00	6.00	6.25	3.38	-	3.00	350	1
444..447	8.06	12.31	10.50	9.50	7.00	3.50	3.00		762	4
449	10.19	15.70	13.50	12.50	8.50	5.00	3.00	-	1696	4

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

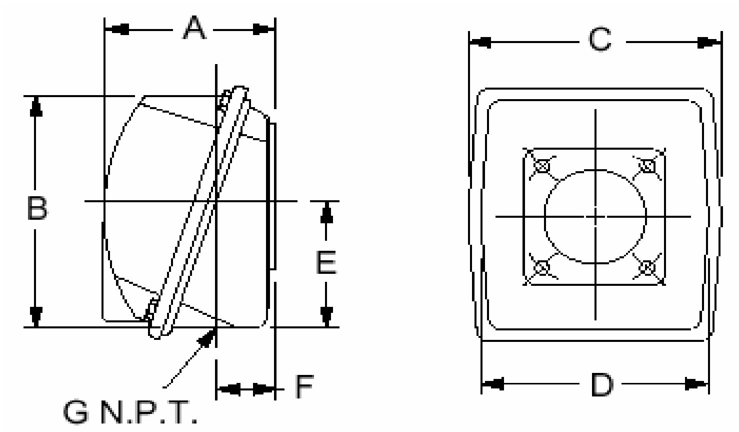
Standard Conduit Boxes -- TEFC-Severe Duty -- Types RGZESD, RGZEESD(X)



Frame	External Dimensions (in)							Approx. internal volume (in^3)	no. of cover bolts
	A	B	C	D	E	F	G		
140	2.68	4.60	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	380	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
444-447	8.06	12.31	10.50	9.50	7.00	3.50	3.00	762	4
449	10.19	15.70	13.50	12.50	8.50	5.00	3.00	1696	4
S449	10.19	15.70	13.50	12.50	8.50	5.00	4.00	1696	4

S449 is type RGZESD, RGZEESD(X) only

Standard Conduit Boxes -- TEFC Explosion Proof -- Type RGZZESD



Frame	External Dimensions (in)							Approx. internal volume (in^3)	no. of cover bolts
	A	B	C	D	E	F	G		
140	3.40	4.90	4.25	3.70	2.28	1.26	0.75	29	4
180	3.40	4.90	4.25	3.70	2.28	1.26	0.75	29	4
210	4.90	6.60	6.80	6.20	2.97	1.61	1.00	100	4
250	4.90	6.60	6.80	6.20	2.97	1.61	1.25	100	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	7.50	6.25	2.75	2.00	280	6
360	8.80	12.50	9.00	8.00	7.75	2.75	3.00	555	6
400	8.80	12.50	9.00	8.00	7.75	2.75	3.00	555	6
444-447	8.80	12.50	9.00	8.00	7.75	2.75	3.00	555	6
449	10.21	14.86	11.38	10.38	10.00	3.38	3.00	970	6

Standard Conduit Boxes -- TEFC-General Purpose Duty -- Types GP10A, GP100A, GP10, GP100

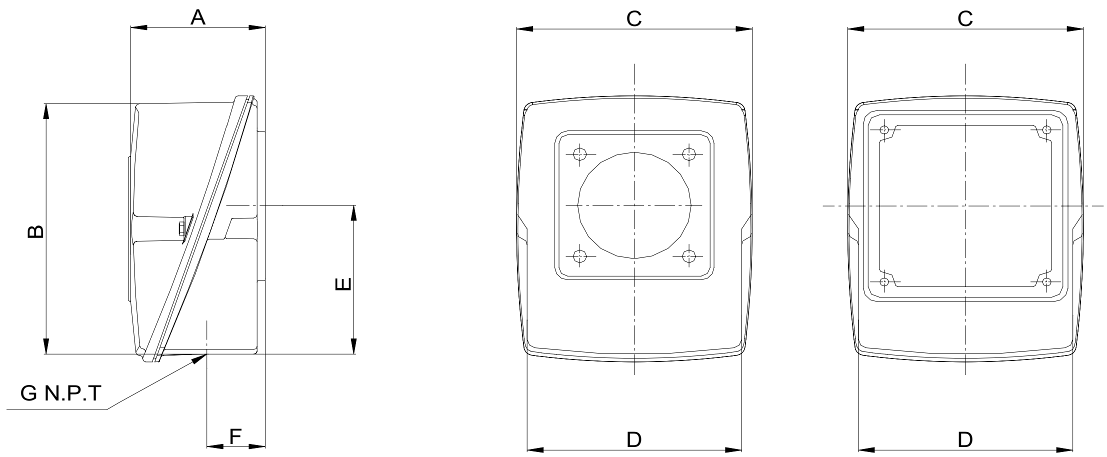
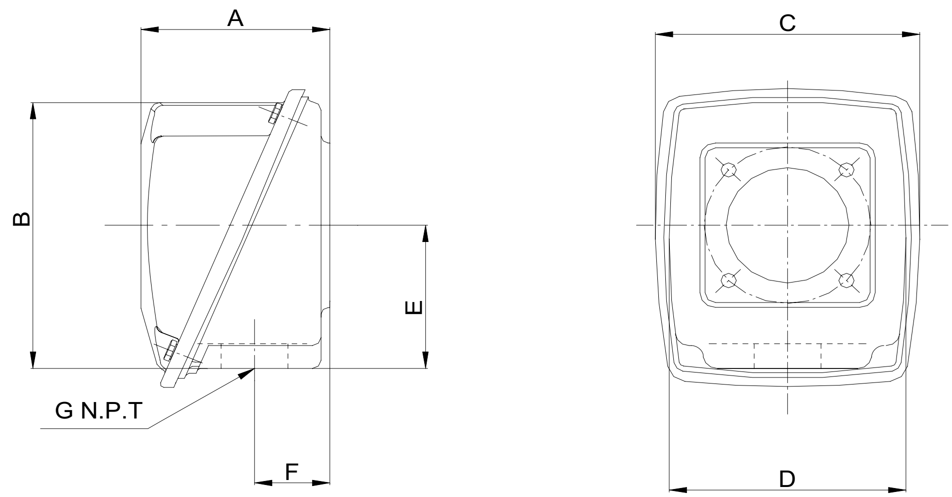


Fig. a   Fig. b

Frame	External Dimensions (in)								Approx. internal volume (in^3)	no. of cover bolts
	A	B	C	D	E	F	G NPT	G Max. Cond.		
140	2.79	5.31	4.41	4.02	2.69	0.95	-	0.75	37	2
180	2.79	5.31	4.41	4.02	2.69	0.95	-	0.75	37	2
210	3.30	6.89	5.71	5.20	3.82	1.18	-	1.00	87	2
250	3.30	6.89	5.71	5.20	3.82	1.18	-	1.25	87	2

Aluminum conduit boxes
Fig. a, GP10 & G100, cast iron frames.
Fig. b, GP10A & G100A, cast aluminum frames.

Standard Conduit Boxes -- TEFC-Severe Duty -- Types SD10, SD100, SD100IEEE



Frame	External Dimensions (in)							Approx. internal volume (in^3)	no. of cover bolts
	A	B	C	D	E	F	G		
140	3.23	5.98	4.96	4.37	2.28	1.18	0.75	41	4
180	3.23	5.98	4.96	4.37	2.28	1.18	0.75	41	4
210	4.24	7.11	5.94	5.32	3.43	1.69	1.00	86	4
250	4.24	7.11	5.94	5.32	3.43	1.69	1.25	86	4

Cast iron conduit boxes

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 by the following formula:

Displacement (P-P mils) = 1000 x Velocity (in/sec) / pi x frequency (Hz) Note: pi = 3.1416.

*** Motors RGZESDX, RGZEESDX, and SD100IEEE841 feature vibration of 0.06 in/sec velocity.

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 Siemens 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) — General Purpose — Severe Duty

Frame	TEFC — General Purpose Type RGZ				TEFC — General Purpose High Efficient Type RGZP				TEFC — High Efficient Severe Duty Type RGZESD				TEFC — NEMA Prem. Efficient Severe Duty Type RGZEESD(X)			
	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 Type DP10				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	6207	25BC02JEE3	6205	30BC02JP3	6206	30BC02JP3	6206
213T - 215T	40BC02JEE3	6308	30BC02JEE3	6208	40BC02JP3	6208	40BC02JP3	6208
254T - 256T	45BC02JEE3	6310	35BC02JEE3	6208	45BC03JP3	6309	45BC03JP3	6309
284TS - 286TS	45BC03JPP3	6312	45BC03JPP3	6211	50BC03JP3	6310	50BC03JP3	6310
284T - 286T	55BC03JPP3	6312	45BC02JPP3	6211	50BC03JP3	6310	50BC03JP3	6310
324TS - 326TS	55BC03JPP3	6312	55BC03JPP3	6212	60BC03JP3	6312	60BC03JP3	6312
324T - 326T	60BC02JPP3	6312	55BC02JPP3	6311	60BC03JP3	6312	60BC03JP3	6312
364TS - 365TS	55BC03JPP3	6311	55BC03JPP3	6311	70BC03JP3	6314	70BC03JP3	6314
364T - 365T	70BC03JPP3	6314	55BC03JPP3	6313	70BC03JP3	6314	70BC03JP3	6314
404TS - 405TS	65BC03JPP3	6313	65BC03JPP3	6313	80BC03JP3	6316	80BC03JP3	6316
404T - 405T	80BC02JPP3	6317	65BC02JPP3	6313	80BC03JP3	6316	80BC03JP3	6316
444TS - 445TS	65BC03JPP3	6313	65BC03JPP3	6313	80BC03JP3	6316	80BC03JP3	6316
444T - 445T	90RU03M0	NU318	65BC03JPP3	6318	90RU03M0	NU318	80BC03JP3	6316
447TS - 449TS	65BC03JPP3	6313	65BC03JPP3	6313	80BC03JP3	6316	80BC03JP3	6316
447T - 449T	90RU03M0	NU318	65BC03JPP3	6318	100RU03M0	NU320	80BC03JP3	6316
S449SS	–	–	–	–	–	–	–	–
S449LS	–	–	–	–	–	–	–	–

Standard Bearings for NEMA Frames — Horizontal Motors GP10(A), GP100(A)

Frame	Types GP10A, GP100A				Types GP10, GP100			
	Drive End		Opposite Drive End		Drive End		Opposite Drive End	
	AFBMA no.	Size	AFBMA no.	Size	AFBMA no.	Size	AFBMA no.	Size
143T - 145T	25BC02JPP3	6205	25BC02JPP3	6205	25BC02JPP3	6205	25BC02JPP3	6205
182T - 184T	30BC02JPP3	6206	30BC02JPP3	6205	30BC02JPP3	6206	30BC02JPP3	6206
213T - 215T	40BC02JPP3	6208	40BC02JPP3	6208	40BC02JPP3	6208	40BC02JPP3	6208
254T - 256T	45BC02JPP3	6209	45BC02JPP3	6209	45BC03JPP3	6309	45BC03JPP3	6309
284TS - 286TS	-	-	-	-	-	-	-	-
284T - 286T	-	-	-	-	-	-	-	-
324TS - 326TS	-	-	-	-	-	-	-	-
324T - 326T	-	-	-	-	-	-	-	-
364TS - 365TS	-	-	-	-	-	-	-	-
364T - 365T	-	-	-	-	-	-	-	-
404TS - 405TS	-	-	-	-	-	-	-	-
404T - 405T	-	-	-	-	-	-	-	-
444TS - 445TS	-	-	-	-	-	-	-	-
444T - 445T	-	-	-	-	-	-	-	-
447TS - 449TS	-	-	-	-	-	-	-	-
447T - 449T	-	-	-	-	-	-	-	-
S449SS	–	–	–	–	–	–	–	–
S449LS	–	–	–	–	–	–	–	–

Standard Bearings for NEMA Frames — Horizontal Motors
SD10, SD100, SD100IEEE841

Frame	Types SD10, SD100				Type SD100IEEE841			
	Drive End		Opposite Drive End		Drive End		Opposite Drive End	
	AFBMA no.	Size	AFBMA no.	Size	AFBMA no.	Size	AFBMA no.	Size
143T - 145T	25BC02JPP3	6205	25BC02JPP3	6205	25BC02JP3	6205	25BC02JP3	6205
182T - 184T	30BC02JPP3	6206	30BC02JPP3	6205	30BC02JP3	6206	30BC02JP3	6206
213T - 215T	40BC02JPP3	6208	40BC02JPP3	6208	40BC02JP3	6208	40BC02JP3	6208
254T - 256T	45BC03JPP3	6309	45BC03JPP3	6309	45BC03JP3	6309	45BC03JP3	6309
284TS - 286TS	-	-	-	-	-	-	-	-
284T - 286T	-	-	-	-	-	-	-	-
324TS - 326TS	-	-	-	-	-	-	-	-
324T - 326T	-	-	-	-	-	-	-	-
364TS - 365TS	-	-	-	-	-	-	-	-
364T - 365T	-	-	-	-	-	-	-	-
404TS - 405TS	-	-	-	-	-	-	-	-
404T - 405T	-	-	-	-	-	-	-	-
444TS - 445TS	-	-	-	-	-	-	-	-
444T - 445T	-	-	-	-	-	-	-	-
447TS - 449TS	-	-	-	-	-	-	-	-
447T - 449T	-	-	-	-	-	-	-	-
S449SS	–	–	–	–	–	–	–	–
S449LS	–	–	–	–	–	–	–	–

Grease and Relubricating Instructions

Grease and Relubricating Instructions

To assist our customers in securing trouble-free service from electric motors, Siemens uses 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. Polyrex EM meets these requirements.

Note: DP10 motors thru 400 frame use a lithium base grease - vs. polyurea thickened. These greases are not compatible!

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 - TEFC Motors, Base Type RGZ

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
S449	14.5	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.

Bearing Grease Capacity

Bearing Grease Capacity for GP10(A), GP100(A), SD10, SD100(IEEE 841)

Frame	Shaft End Bearing		Opposite End Bearing
	Direct Connected	Belted	
140T	0.1 oz.	0.1 oz.	0.1 oz.
180T	0.2	0.2	0.2
210T	0.3	0.3	0.3
250T	0.5	0.5	0.5
280T(S)	-	-	-
320T(S)	-	-	-
360T(S)	-	-	-
400T(S)	-	-	-
440T(S)	-	-	-

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

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
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
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

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.

Belted Service

RECOMMENDED SHEAVE DIAMETERS - TEFC MOTORS

HP	RPM	Frame	Narrow V1 Min. Dia.	Std. V2 Min. Dia.
50	900	404T	8.4	9
60	1800	364T	7.4	7.4
60	1200	404T	8	9
60	900	405T	10	10
75	1800	365T	8.6	9
75	1200	405T	10	10
75	900	444T	9.5	13
100	1800	405T	8.6	10
100	1200	444T	10	11.8
100	900	445T	12	15
125	1800	444T	10.5	12
125	1200	445T	12.4	15.2
125	900	447T	14	18.5
150	1800	445T	10.5	13.2
150	1200	447T	11.6	16.1
150	900	447T	14.6	24.7
200	1800	447T	13.2	15.8
200	1200	449T	14.6	25
200	900	449T	18	-
250	1800	449T	13	18.4
250	1200	449T	18.2	-
250	900	S449LS	19.8	-
300	1800	449T	15.4	24.8
300	1200	S449LS	18.4	-
350	1800	S449LS	15.8	-
350	1200	S449LS	21	-
400	1800	S449LS	18	-

Notes:
1. Example: 3V, 5V, 8V. Sheave face cannot overhand end of shaft.
2. Example: A, B, C, D section. Center of sheave width cannot overhang end of shaft.
3. Do not exceed belt service factor of 1.6. Follow manufacturer's instructions for alignment and belt tensioning. Position sheaves as close to the drive end bearing as possible. (Maximum 1/2" from shaft shoulder).
4. Maximum speed reduction of 5:1.
5. Shaft center distance approximately equal to diameter of largest sheave.
6. All dimensions in inches.

Rotor Weights and Inertias

			High Efficient Totally Enclosed Fan Cooled (TEFC) Types RGZP, RGZPSD		High Efficient Totally Enclosed Fan Cooled (TEFC) Types RGZE, RGZESD, RGZZESD		High Efficient Open Drip-Proof (ODP) Type RGE1	
HP	RPM	Frame	Weight (lb)	Inertia ($lb\text{-}ft^2$)	Weight (lb)	Inertia ($lb\text{-}ft^2$)	Weight (lb)	Inertia ($lb\text{-}ft^2$)
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

			High Efficient Totally Enclosed Fan Cooled (TEFC) Types RGZP, RGZPSD		High Efficient Totally Enclosed Fan Cooled (TEFC) Types RGZE, RGZESD, RGZZESD		High Efficient 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

			High Efficient Totally Enclosed Fan Cooled (TEFC) Types RGZP, RGZPSD		High Efficient Totally Enclosed Fan Cooled (TEFC) Types RGZE, RGZESD, RGZZESD		High Efficient 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

			High Efficient Totally Enclosed Fan Cooled (TEFC) Types RGZ, RGZSD, RGZZSD		High Efficient Totally Enclosed Fan Cooled (TEFC) Types RGZE, RGZESD, RGZZESD		High Efficient Open Drip-Proof (ODP) Type RGE	
HP	**RPM**	**Frame**	**Weight (lb)**	**Inertia (lb-ft^2)**	**Weight (lb)**	**Inertia (lb-ft^2)**	**Weight (lb)**	**Inertia (lb-ft^2)**
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

High Efficient 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

Rotor Weights and Inertias

			High Efficienct Totally Enclosed Fan Cooled (TEFC) Types GP10(A), SD10		NEMA Premium Efficient Totally Enclosed Fan Cooled (TEFC) RGZEESD, GP100(A), SD100(IEEE841)		High Efficient Open Drip-Proof (ODP) Type DP10	
HP	RPM	Frame	Weight (lb)	Inertia (lb-ft²)	Weight (lb)	Inertia (lb-ft²)	Weight (lb)	Inertia (lb-ft²)
0.75	1200	143T	-	-	-	-	9.4	0.115
1	3600	143T	10	0.05	11	???	-	-
1	1800	143T	7.4	0.13	8.7	0.24	6.8	0.029
1	1200	145T	9.7	0.14	10	0.2	9.4	0.115
1	900	182T	12	0.22	14	0.22	-	-
1.5	3600	143T	7.4	0.05	8.9	0.11	5.8	0.053
1.5	1800	145T	7.5	0.14	9.1	0.24	8.6	0.106
1.5	1200	182T	12	0.2	14	0.34	19.6	0.379
1.5	900	184T	16	0.3	18	0.3	-	-
2	3600	145T	9.6	0.06	10	0.12	7.8	0.070
2	1800	145T	9.7	0.15	10	0.24	9.4	0.115
2	1200	184T	14	0.26	17	0.4	24	0.474
2	900	213T	23	0.48	23	0.48	-	-
3	3600	145T	-	-	-	-	11.6	0.155
3	3600	182T	10	0.14	12	0.24	-	-
3	1800	182T	12	0.22	14	0.37	19.6	0.379
3	1200	213T	22	0.48	27	0.77	33	0.96
3	900	215T	29	0.6	29	0.6	-	-
5	3600	182T	-	-	-	-	13.6	0.183
5	3600	184T	13	0.17	16	0.25	-	-
5	1800	184T	16	0.25	17	0.4	24.5	0.474
5	1200	215T	28	0.6	34	0.9	46	1.36
5	900	254T	46	1.36	50	1.36	-	-
7.5	3600	184T	-	-	-	-	21.5	0.417
7.5	3600	213T	27	0.45	32	0.81	-	-
7.5	1800	213T	27	0.6	31	1.03	35	0.96
7.5	1200	254T	44	1.34	60	2.88	48	1.97
7.5	900	256T	59	1.75	64	1.75	-	-
10	3600	213T	-	-	-	-	26	0.51
10	3600	215T	29	0.54	31	0.86	-	-
10	1800	215T	32	0.67	36	1.11	43	1.18
10	1200	256T	56	1.5	71	2.88	69	2.83
10	900	284T	81	-	86	-	-	-
15	3600	215T	-	-	-	-	40	1.11
15	3600	254T	56	0.98	56	1.71	-	-
15	1800	254T	46	1.38	57	2.25	51	1.81
15	1200	284T	73	-	81	-	90	5.33
15	900	286T	97	-	105	-	-	-

Rotor Weights and Inertias

			High Efficient Totally Enclosed Fan Cooled (TEFC) GP10(A), SD10		NEMA Premium Efficient Totally Enclosed Fan Cooled (TEFC) RGZEESD(X)*, GP100(A), SD100(IEEE841)**		High Efficient Open Drip-Proof (ODP) DP10	
HP	RPM	Frame	Weight (lb)	Inertia (lb-ft^2)	Weight (lb)	Inertia (lb-ft^2)	Weight (lb)	Inertia (lb-ft^2)
0.75	1200	143T	-	-	-	-	9.4	0.115
1	3600	143T	10	0.05	11	-	-	-
1	1800	143T	7.4	0.13	8.7	0.24	6.8	0.029
1	1200	145T	9.7	0.14	10	0.2	9.4	0.115
1	900	182T	12	0.22	14	0.22	-	-
1.5	3600	143T	7.4	0.05	8.9	0.11	5.8	0.053
1.5	1800	145T	7.5	0.14	9.1	0.24	8.6	0.106
1.5	1200	182T	12	0.2	14	0.34	19.6	0.379
1.5	900	184T	16	0.3	18	0.3	-	-
2	3600	145T	9.6	0.06	10	0.12	7.8	0.070
2	1800	145T	9.7	0.15	10	0.24	9.4	0.115
2	1200	184T	14	0.26	17	0.4	24	0.474
2	900	213T	23	0.48	23	0.48	-	-
3	3600	145T	-	-	-	-	11.6	0.155
3	3600	182T	10	0.14	12	0.24	-	-
3	1800	182T	12	0.22	14	0.37	19.6	0.379
3	1200	213T	22	0.48	27	0.77	33	0.96
3	900	215T	29	0.6	29	0.6	-	-
5	3600	182T	-	-	-	-	13.6	0.183
5	3600	184T	13	0.17	16	0.25	-	-
5	1800	184T	16	0.25	17	0.4	24.5	0.474
5	1200	215T	28	0.6	34	0.9	46	1.36
5	900	254T	46	1.36	50	1.36	-	-
7.5	3600	184T	-	-	-	-	21.5	0.417
7.5	3600	213T	27	0.45	32	0.81	-	-
7.5	1800	213T	27	0.6	31	1.03	35	0.96
7.5	1200	254T	44	1.34	60	2.88	48	1.97
7.5	900	256T	59	1.75	64	1.75	-	-
10	3600	213T	-	-	-	-	26	0.51
10	3600	215T	29	0.54	31	0.86	-	-
10	1800	215T	32	0.67	36	1.11	43	1.18
10	1200	256T	56	1.5	71	2.88	69	2.83
10	900	284T	81	-	86	-	-	-
15	3600	215T	-	-	-	-	40	1.11
15	3600	254T	56	0.98	56	1.71	-	-
15	1800	254T	46	1.38	57	2.25	51	1.81
15	1200	284T	73	-	95.3	3.94	90	5.33
15	900	286T	97	-	105	-	-	-

*284 Frame and larger
** 256 Frame and larger

Rotor Weights and Inertias

			High Efficient Totally Enclosed Fan Cooled (TEFC) GP10(A), SD10		NEMA Premium Efficient Totally Enclosed Fan Cooled (TEFC) RGZEESD(X)*, GP100(A), SD100(IEEE841)**		High Efficient Open Drip-Proof (ODP) DP10	
HP	RPM	Frame	Weight (lb)	Inertia (lb-ft^2)	Weight (lb)	Inertia (lb-ft^2)	Weight (lb)	Inertia (lb-ft^2)
20	3600	254T	-	-	-	-	49	1.34
20	3600	256T	57	1.07	58	1.95	-	-
20	1800	256T	59	1.59	71	2.83	58	2.06
20	1200	286T	-	-	105	4.52	114	6.75
20	900	324T	-	-	-	-	-	-
25	3600	256T	-	-	-	-	69	2.83
25	3600	284TS	-	-	61.2	1.45	-	-
25	1800	284T	-	-	102.8	4.36	90	4.63
25	1200	324T	-	-	159.0	9.35	133	10.31
25	900	326T	-	-	-	-	-	-
30	3600	284TS	-	-	-	-	79	3.26
30	3600	286TS	-	-	70.5	1.75	-	-
30	1800	286T	-	-	110.5	4.83	98	5.04
30	1200	326T	-	-	169.0	10.20	157	12.13
30	900	364T	-	-	-	-	-	-
40	3600	286TS	-	-	-	-	90	4.63
40	3600	324TS	-	-	98.1	2.99	-	-
40	1800	324T	-	-	160.7	9.39	125	8.14
40	1200	364T	-	-	202.7	14.83	179	16.29
40	900	365T	-	-	-	-	-	-
50	3600	324TS	-	-	-	-	103	5.29
50	3600	326TS	-	-	110.2	3.61	-	-
50	1800	326T	-	-	175.9	10.66	151	9.85
50	1200	365T	-	-	216.2	16.25	220	20.05
50	900	404T	-	-	-	-	-	-
60	3600	326TS	-	-	-	-	145	9.42
60	3600	364TS	-	-	128	4.74	-	-
60	1800	364T	-	-	223.3	16.9	188	14.56
60	1200	404T	-	-	280.7	21.33	281	34.06
60	900	405T	-	-	-	-	-	-
75	3600	364TS	-	-	-	-	164	10.71
75	3600	365TS	-	-	145	5.8	-	-
75	1800	365T	-	-	250.2	19.74	211	16.38
75	1200	405T	-	-	303.6	23.77	342	41.46
75	900	444T	-	-	-	-	-	-

*284 Frame and larger
** 256 Frame and larger

Rotor Weights and Inertias

			High Efficient Totally Enclosed Fan Cooled (TEFC) GP10(A), SD10		NEMA Premium Efficient Totally Enclosed Fan Cooled (TEFC) RGZEESD(X)*, GP100(A), SD100(IEEE841)**		High Efficient Open Drip-Proof (ODP) DP10	
HP	**RPM**	**Frame**	**Weight (lb)**	**Inertia (lb-ft^2)**	**Weight (lb)**	**Inertia (lb-ft^2)**	**Weight (lb)**	**Inertia (lb-ft^2)**
100	3600	365TS	-	-	-	-	239	21.72
100	3600	405TS	-	-	203.8	12.67	-	-
100	1800	404T	-	-	-	-	283	28.75
100	1800	404TS	-	-	-	-	-	-
100	1800	405T	-	-	301.3	23.4	-	-
100	1200	444T	-	-	435.7	45.95	424	65.96
100	900	445T	-	-	-	-	-	-
125	3600	404TS	-	-	-	-	283	28.75
125	3600	444TS	-	-	291.1	20.85	-	-
125	1800	405TS	-	-	-	-	-	-
125	1800	405T	-	-	-	-	362	49.84
125	1800	444TS	-	-	-	-	-	-
125	1800	444T	-	-	489.7	39.25	-	-
125	1200	445T	-	-	520.7	58.45	581	90.39
125	900	447T	-	-	-	-	-	-
150	3600	405TS	-	-	-	-	308	31.36
150	3600	445TS	-	-	330.3	25.06	-	-
150	1800	445T	-	-	468.5	44.97	-	-
150	1800	444TS	-	-	-	-	-	-
150	1800	444T	-	-	-	-	473	65.17
150	1800	445TS	-	-	-	-	-	-
150	1200	445T	-	-	-	-	-	-
150	1200	447T	-	-	606.4	68.56	707	109.93
150	900	447T	-	-	-	-	-	-
200	3600	444TS	-	-	-	-	421	42.86
200	3600	447TS	-	-	399.1	31.3	-	-
200	1800	445TS	-	-	-	-	-	-
200	1800	447TS	-	-	-	-	-	-
200	1800	445T	-	-	-	-	668	92.01
200	1800	447T	-	-	574.2	56.59	-	-

*284 Frame and larger
** 256 Frame and larger

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 finish color is RAL 7030 stone gray.

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. 250 frame RGZZESD motors are skid packed.

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 (all Frames) - Bolted to wooden skids of sufficient height to clear shaft.

Round Frame Motors 140 - 250 Frames are boxed. 280 Frames are flat on a skid; motors are banded to secure to the skid and then shrink wrapped.

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)

RGZE(E)SD 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 2001 specifies 90 dBA sound power
- Contact factory on specific rating

RGZP 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

1800 RPM - TEFC Enclosure - (See Note 1)

RGZE(E)SD 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	61	71	40	50	51	57	55	53	51
	180	63	73	43	54	59	61	57	54	51
	210	65	75	40	58	62	64	59	53	44
	250	67	77	45	54	60	61	62	55	55
	280	66	76	48	56	59	59	61	55	42
	320	64	75	45	52	59	59	57	53	50
	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	76	87	53	64	72	70	68	61	55
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 2001 specifies 90 dBA sound power
- Contact factory on specific rating

RGZP 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

1200 RPM - TEFC Enclosure - (See Note 1)

RGZE(E)SD 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	67	40	48	48	49	50	50	50
	180	68	78	40	48	50	68	56	52	50
	210	62	72	41	48	51	59	54	53	51
	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 2001 specifies 90 dBA sound power
- Contact factory on specific rating

RGZP 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

Severe Duty - TEFC Enclosure – (See Note 1)

Type RGZEESD(X) - 1800 RPM										
HP	Frame	Overall Sound		A-Weighted Sound Pressure Levels [dB(A)] @ 1 Meter Octave Band Center Frequencies [HZ]						
		Pressure dBA	Power dBA	125	250	500	1000	2000	4000	8000
	140	61	71	40	50	51	57	55	53	51
	180	63	73	41	51	57	59	56	51	50
	210	65	75	43	54	59	61	57	54	51
	250	67	77	45	54	60	61	62	55	55
	280	65	76	43	51	55	55	62	59	51
	320	64	75	45	52	59	59	57	53	50
	360	64	75	42	52	56	58	58	57	52
	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	59	49
200	447	74	85	51	63	70	67	68	60	50
250	449T	76	87	53	64	72	70	68	61	55
300	449T	*	*	*	*	*	*	*	*	*
300	S449LS	*	*	*	*	*	*	*	*	*
400	S449LS	*	*	*	*	*	*	*	*	*

Type RGZEESD(X) - 1200 RPM										
HP	Frame	Overall Sound		A-Weighted Sound Pressure Levels [dB(A)] @ 1 Meter Octave Band Center Frequencies [HZ]						
		Pressure dBA	Power dBA	125	250	500	1000	2000	4000	8000
	140	57	67	40	48	48	49	50	50	50
	180	68	78	40	48	50	68	56	52	50
	210	62	72	41	48	51	59	54	53	51
	250	61	71	41	47	50	52	54	56	55
	280	61	72	42	49	55	52	54	56	50
	320	63	73	43	51	57	58	56	51	50
	360	60	71	40	48	53	54	53	52	50
	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
200	447	64	75	45	55	59	60	57	50	42
250	449	64	76	48	56	59	59	57	53	41
200	449T	74	86	57	65	69	70	65	61	52
300	S449LS	75	87	58	65	71	71	65	62	53
400	S449LS	75	87	59	66	71	70	65	61	55

Note 1 - IEEE 841-2001 specifies 90 dBA sound power

* Contact factory for specific rating

General Purpose - TEFC Enclosure – (See Note 1)

3600 RPM

Frame	GP10A Overall Sound Pressure dBA	GP10A Overall Sound Power dBA	GP100A Overall Sound Pressure dBA	GP100A Overall Sound Power dBA	GP10 Overall Sound Pressure dBA	GP10 Overall Sound Power dBA	GP100 Overall Sound Pressure dBA	GP100 Overall Sound Power dBA
140	64	76	64	76	74	83	74	83
180	67	79	67	79	82	90	82	90
210	72	84	72	84	81	90	81	90
250	74	86	74	86	83	93	83	93

1800 RPM

Frame	GP10A Overall Sound Pressure dBA	GP10A Overall Sound Power dBA	GP100A Overall Sound Pressure dBA	GP100A Overall Sound Power dBA	GP10 Overall Sound Pressure dBA	GP10 Overall Sound Power dBA	GP100 Overall Sound Pressure dBA	GP100 Overall Sound Power dBA
140	52	64	52	64	55	64	55	64
180	57	69	57	69	63	72	63	72
210	66	78	66	78	67	77	67	77
250	70	82	70	82	72	83	72	83

1200 RPM

Frame	GP10A Overall Sound Pressure dBA	GP10A Overall Sound Power dBA	GP100A Overall Sound Pressure dBA	GP100A Overall Sound Power dBA	GP10 Overall Sound Pressure dBA	GP10 Overall Sound Power dBA	GP100 Overall Sound Pressure dBA	GP100 Overall Sound Power dBA
140	47	59	47	59	50	58	50	58
180	51	63	52	64	54	63	54	63
210	67	79	67	79	64	73	64	73
250	70	82	70	82	67	77	67	77

Note 1 - IEEE 841-2001 specifies 90 dBA sound power

- Contact factory for specific rating

Severe Duty - TEFC Enclosure – (See Note 1)

3600 RPM

Frame	SD10		SD100		SD100IEEE841	
	Overall Sound		Overall Sound		Overall Sound	
	Pressure dBA	Power dBA	Pressure dBA	Power dBA	Pressure dBA	Power dBA
140	74	83	74	83	74	83
180	82	90	82	90	82	90
210	81	90	81	90	81	90
250	83	93	83	93	83	93

1800 RPM

Frame	SD10		SD100		SD100IEEE841	
	Overall Sound		Overall Sound		Overall Sound	
	Pressure dBA	Power dBA	Pressure dBA	Power dBA	Pressure dBA	Power dBA
140	55	64	55	64	55	64
180	63	72	63	72	63	72
210	67	77	67	77	67	77
250	72	83	72	83	72	83

1200 RPM

Frame	SD10		SD100		SD100IEEE841	
	Overall Sound		Overall Sound		Overall Sound	
	Pressure dBA	Power dBA	Pressure dBA	Power dBA	Pressure dBA	Power dBA
140	50	58	50	58	50	58
180	54	63	54	63	54	63
210	64	73	64	73	64	73
250	67	77	67	77	67	77

Note 1 - IEEE 841-2001 specifies 90 dBA sound power

- Contact factory for specific rating

Mechanical Modifications for Low Temperature TEFC Motors Only

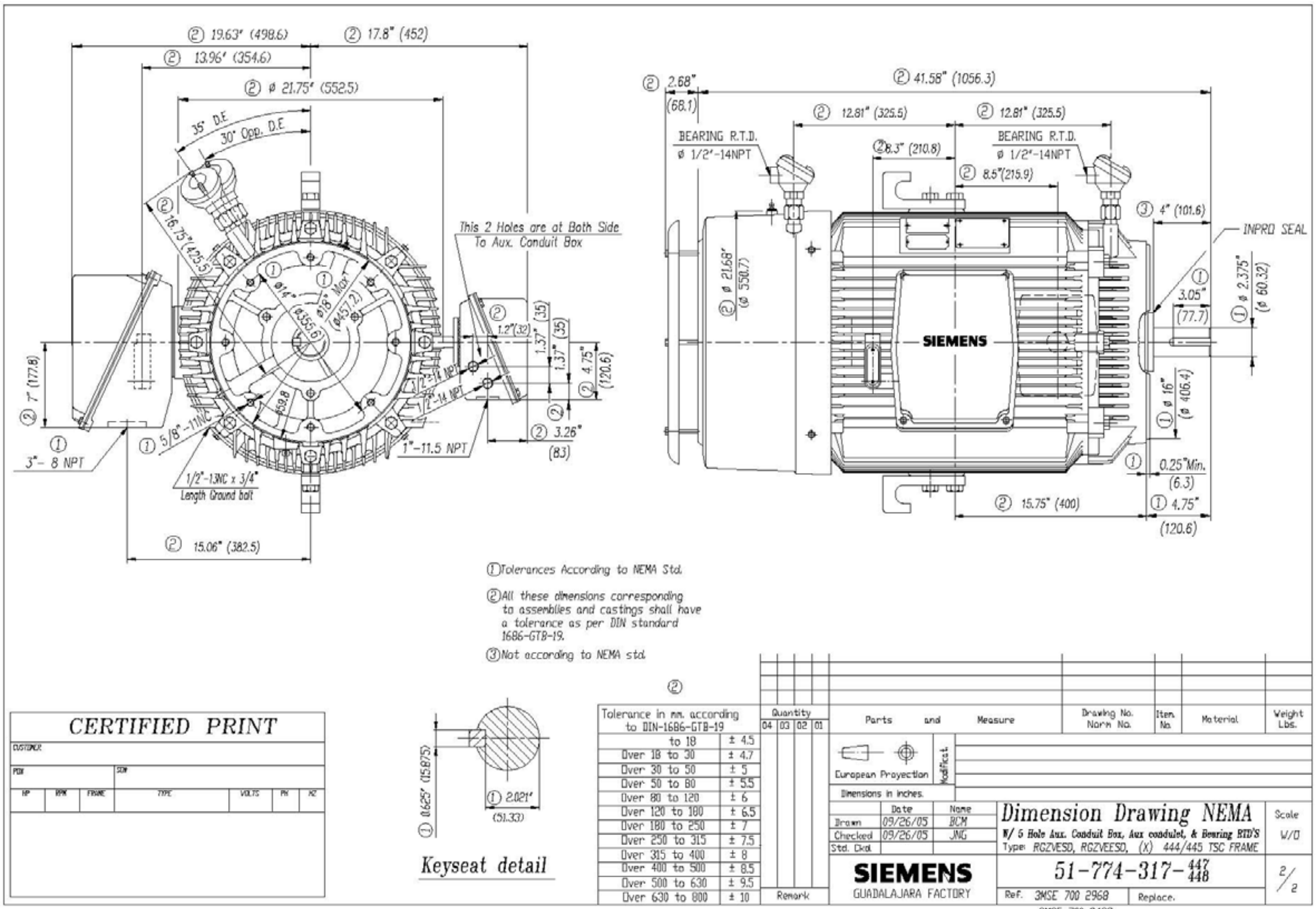
Mechanical Modifications for Low temperature TEFC Motors Only

Min. Temp. °F	°C	Grease Bearing & Housing	Anti-Friction Bearings	Shaft Material	Bearing Housing & Yoke
80	27				
40	4	Standard Polyrex EM	Standard Materials	Standard	Standard
0	-18			Hot-Rolled C-1045 Steel	Cast Iron
-20	-29				
-40	-40	Mobil #28	Standard Materials		
-65	-54		Special Grease	Special Steel	
-90	-68	Silicone Grease	Special Materials Special Grease	Special Steel	

Note: Below -65°F (-54°C) each application to be considered separately - Contact Factory.

Carbon steel eyebolts are used to -25°F (-32°C), below -25°F (-32°C) Austenitic Stainless Steel Eyebolts must be used.

Typical Outline Drawing



SIEMENS

Application Manual for NEMA Motors

Section 7

Accessories

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Space Heaters

Space heaters are used to maintain internal air temperature above the dewpoint during periods of motor shutdown. In this way, water accumulation caused by moisture condensation inside the motor is prevented. Space heaters are recommended for installation in damp locations and should be activated when the motor is de-energized. Space heater capacity is selected, depending on the size of the enclosure, to maintain the temperature within the motor approximately 5^{o} to 10^{o} above the ambient temperature.

The only space heater currently in use for NEMA frame motors is a flexible type. The flexible space heater consists of a heating element enclosed within a silicone rubber jacket. These heaters are tied to the ends of the winding and conform to the shape of the coil end surfaces. Usually, one or more heaters are installed on each end of the stator winding.

The standard space heater data sheet shown on the following page indicates the total space heater wattage required for a particular frame size. Individual space heaters are arranged in series or parallel depending on the supply voltage to obtain the desired total wattage.

Note that for Division 2, we need a T3 (200^{o}) temperature code or higher. The nameplate is marked “Max Surface Temp 200^{o}C.”

Space heater leads will normally be brought to the main conduit box of low voltage (600 volts and below), but can optionally be terminated in a condulet or auxiliary terminal box.

Space Heaters

Space Heater Data		
Frame	**Volts**	**Watts**
140T	115 230	33 65
180T	115 230	33 65
210T	115 230	65 65
250T	115 230 460	65 65 120
250T	115 230 460	65 65 130
280T	115 230 460	130 130 130
320T	115 230 460	130 130 130
360T	115 230 460	130 130 130
400T	115 230 460	260 260 260
440T	115 230 460	260 260 260

Thermal Protective Devices

Thermostats (Klixons*)

Thermostats use a snap-action, bi-metallic, disc-type switch to open or close a circuit upon reaching a pre-selected temperature. When heated, the stresses in the disc cause it to reverse its curvature instantaneously when the bi-metal reaches a predetermined temperature. The action of the disc opens or closes a set of contacts in an energized control circuit. Thermostats are available with contacts for normally open or normally closed operation, but the same device cannot be used for both.

Thermostats are precalibrated by the manufacturer and are not adjustable. The discs are hermetically sealed and are placed on the stator coil end turns. A thermostat can either energize an alarm circuit, if normally open, or de-energize the motor contactor, if normally closed and in series with the contactor. Since thermostats are located on the outer surface of the coil end turns, they sense the temperature at that location. Thermostats are not considered suitable protection for stall or other rapidly changing temperature conditions.

For 140-250 frames, the trip temperature is set at 150^{o}C; for 280 frames & up, the trip temperature is set for 180^{o}C.

Thermostat leads will normally be brought to the main conduit box of low voltage (600 volts and below), but can optionally be terminated in a condulet or auxiliary terminal box.

Thermostats are available for all NEMA frame size motors.

Thermostats are standard on all NEMA size explosion-proof and dust-ignition-proof motors.

*Klixon is a registered trademark of Texas Instruments, Inc.

Thermal Protective Devices

PTC Thermistors

The thermistor temperature sensing system consists of positive temperature coefficient (PTC) sensors embedded in the end turns of the winding and a matched solid state electronic switch in an enclosed control module.

The sensing system can be configured for either three or six thermistors (i. e. one or two per phase). When only motor shutdown is required, there are three, but if a warning indication is desirable (prior to motor shutdown), then an additional set of three thermistors is needed. The resistance of the sensor remains relatively low and constant over a wide temperature band and increases abruptly at a pre-determined temperature or trip point.

When this occurs, the sensor acts as a solid state thermal switch and de-energizes a pilot relay. The relay, in turn, opens the machine's control circuit or the control coil of an external line break contactor to shutdown the protected equipment. When the winding temperature returns to a safe value, the module permits manual reset.

Thermistors are normally provided as a system consisting of a control module with a matched set of sensors. The control module is normally furnished separate from the machine for installation at the location desired by the user, but is available at extra cost. Sensor leads are normally brought to the main conduit box of low voltage (600 volts and below) machines, but can optionally be terminated in a condulet or auxiliary terminal box.

It should be noted that sensors are matched to a particular control module. Consequently, control modules by one manufacturer are not necessarily usable with sensors by another manufacturer.

The positive temperature coefficient (PTC) thermistor system is considered fail-safe since a broken sensor or sensor lead will result in an infinite resistance and develop a response identical to that of an elevated temperature, de-energizing the pilot relay.

Thermal Protective Devices

PTC Thermistors (KTY84-130)

The KTY84-130 silicon temperature sensor is manufactured by NXP (formerly a division of Royal Philips Electronics) and is very similar to the one previously described. When this type of sensing system is used, there are two positive temperature coefficient (PTC) sensors embedded in the end turns of the winding and a matched solid state electronic switch in an enclosed control module.

The resistance of the sensor remains relatively low and constant over a wide temperature band and increases abruptly at a pre-determined temperature or trip point.

When this occurs, the sensor acts as a solid state thermal switch and de-energizes a pilot relay. The relay, in turn, opens the machine's control circuit or the control coil of an external line break contactor to shutdown the protected equipment. When the winding temperature returns to a safe value, the module permits manual reset.

As with the standard PTC sensors, the KYT130-84 thermistors are normally provided as a system consisting of a control module with a matched set of sensors. The control module is normally furnished separate from the machine for installation at the location desired by the user, but is available at extra cost. Sensor leads are normally brought to the main conduit box of low voltage (600 volts and below) machines, but can optionally be terminated in a condulet or auxiliary terminal box.

It should be noted that sensors are matched to a particular control module. Consequently, control modules by one manufacturer are not necessarily usable with sensors by another manufacturer.

The positive temperature coefficient (PTC) thermistor system is considered fail-safe since a broken sensor or sensor lead will result in an infinite resistance and develop a response identical to that of an elevated temperature, de-energizing the pilot relay.

For more information on the KTY130-84 sensor and to obtain a complete data sheet, please click on the following hyperlink:

KTY130-84 sensor

RTD's: Stator and Bearing

Resistance temperature devices (RTD's) are ideal for temperature monitoring of the motor stator and bearings.

In the case of stator RTD's, typically six 100Ω platinum devices are used (i. e. two per phase) on frames 360 and larger complete with an auxiliary terminal box (with terminal strip) opposite to the main conduit box.

RTD's are also commonly used for monitoring bearing temperature. Because of the relatively high cost of this option, bearing RTD's are typically only available on 400 frames and larger, where the RTD's may be viewed as a form of insurance to protect a company's capital investment. Smaller motors costing a few few hundred dollars our less are much more easily replaced than larger ones, which may originally have cost many thousands of dollars.

For the bearing RTD option,, there is one 100Ω platinum device per bearing wired to a connection head and terminal block.

As with most of the other temperature monitoring options, RTD's are considered as part of a system. Readout devices are not included, nor is the means of evaluation and logic control for motor shutdown.

The following two pages show tables of typical temperature vs. resistance of 100Ω platinum RTD's.

Thermal Protective Devices

Resistance Temperature Device (RTD)

Resistance/Temperature Table

392 PLATINUM, 100 OHMS AT 0°C

°C	0	1	2	3	4	5	6	7	8	9
-90	63.61	63.19	62.78	62.37	61.96	61.55	61.14	60.72	60.31	59.90
-80	67.71	67.30	66.89	66.48	66.07	65.66	65.25	64.84	64.43	64.02
-70	71.80	71.39	70.98	70.57	70.16	69.75	69.35	68.94	68.53	68.12
-60	75.87	75.46	75.05	74.65	74.24	73.83	73.43	73.02	72.61	72.20
-50	79.92	79.52	79.11	78.71	78.30	77.90	77.49	77.08	76.68	76.27
-40	83.96	83.56	83.16	82.75	82.35	81.94	81.54	81.14	80.73	80.33
-30	87.99	87.59	87.19	86.78	86.38	85.98	85.58	85.17	84.77	84.37
-20	92.01	91.61	91.20	90.80	90.40	90.00	89.60	89.20	88.80	88.39
-10	96.01	95.61	95.21	94.81	94.41	94.01	93.61	93.21	92.81	92.41
0	100.00	99.60	99.20	98.80	98.41	98.01	97.61	97.21	96.81	96.41

°C	0	1	2	3	4	5	6	7	8	9
0	100.00	100.40	100.80	101.19	101.59	101.99	102.39	102.79	103.18	103.58
10	103.98	104.38	104.77	105.17	105.57	105.96	106.36	106.76	107.15	107.55
20	107.95	108.34	108.74	109.13	109.53	109.93	110.32	110.72	111.11	111.51
30	111.90	112.30	112.69	113.09	113.48	113.87	114.27	114.66	115.06	115.45
40	115.85	116.24	116.63	117.03	117.42	117.81	118.21	118.60	118.99	119.38
50	119.78	120.17	120.56	120.95	121.35	121.74	122.13	122.52	122.91	123.31
60	123.70	124.09	124.48	124.87	125.26	125.65	126.04	126.43	126.83	127.22
70	127.61	128.00	128.39	128.78	129.17	129.56	129.95	130.33	130.72	131.11
80	131.50	131.89	132.28	132.67	133.06	133.45	133.84	134.22	134.61	135.00
90	135.39	135.78	136.16	136.55	136.94	137.33	137.71	138.10	138.49	138.87
100	139.26	139.65	140.03	140.42	140.81	141.19	141.58	141.97	142.35	142.75
110	143.12	143.51	143.89	144.28	144.66	145.05	145.43	145.32	146.20	146.59
120	146.97	147.36	147.74	148.12	148.51	148.89	149.28	149.66	150.04	150.43
130	150.81	151.19	151.58	151.96	152.34	152.72	153.11	153.49	153.87	154.25
140	154.64	155.02	155.40	155.78	156.16	156.55	156.93	157.31	157.69	158.07
150	158.45	158.83	159.21	159.59	159.97	160.35	160.73	161.11	161.49	161.87
160	162.25	162.63	163.01	163.39	163.77	164.15	164.53	164.91	165.29	165.67
170	166.05	166.42	166.80	167.18	167.56	167.94	168.31	168.69	169.07	169.45
180	169.82	170.20	170.58	170.96	171.33	171.71	172.09	172.46	172.84	173.22
190	173.59	173.97	174.34	174.72	175.10	175.47	175.85	176.22	176.60	176.97
200	177.35	177.72	178.10	178.47	178.85	179.22	179.60	179.97	180.34	180.72
210	181.09	181.47	181.84	182.21	182.59	182.96	183.33	183.71	184.08	184.45
220	184.82	185.20	185.57	185.94	186.31	186.69	187.06	187.43	187.80	188.17
230	188.55	188.92	189.29	189.66	190.03	190.40	190.77	191.14	191.51	191.88
240	192.25	192.62	192.99	193.36	193.73	194.10	194.47	194.84	195.21	195.58
250	195.95	196.32	196.69	197.06	197.43	197.80	198.16	198.53	198.90	199.27
260	199.64	200.00	200.37	200.74	201.11	201.47	201.84	202.21	202.58	202.94
270	203.31	203.68	204.04	204.41	204.78	205.14	205.51	205.87	206.24	206.61
280	206.97	207.34	207.70	208.07	208.43	208.80	209.16	209.53	209.89	210.26
290	210.62	210.99	211.35	211.72	212.08	212.44	212.81	213.17	213.53	213.90

Thermal Protective Devices

Resistance Temperature Device (RTD)

Resistance/Temperature Table, continued
392 PLATINUM, 100 OHMS AT 0°C

°C	0	1	2	3	4	5	6	7	8	9
300	214.26	214.62	214.99	215.35	215.71	216.08	216.44	216.80	217.16	217.53
310	217.89	218.25	218.61	218.97	219.34	219.70	220.06	220.42	220.78	221.14
320	221.50	221.86	222.22	222.58	222.95	223.31	223.67	224.03	224.39	224.75
330	225.11	225.47	225.83	226.18	226.54	226.90	227.26	227.62	227.98	228.34
340	228.70	229.06	229.41	229.77	230.13	230.49	230.85	231.20	231.56	231.92
350	232.28	232.63	232.99	233.35	233.71	234.06	234.42	234.78	235.13	235.49
360	235.85	236.20	236.56	236.91	237.27	237.62	237.98	238.34	238.69	239.05
370	239.40	239.76	240.11	240.47	240.82	241.18	241.53	241.88	242.24	242.59
380	242.95	243.30	243.65	244.01	244.36	244.71	245.07	245.42	245.77	246.13
390	246.48	246.83	247.18	247.54	247.89	248.24	248.59	248.94	249.30	249.65
400	250.00	250.35	250.70	251.05	251.41	251.76	252.11	252.46	252.81	253.16
410	253.51	253.86	254.21	254.56	254.91	255.26	255.61	255.96	256.31	256.66
420	257.01	257.36	257.71	258.05	258.40	258.75	259.10	259.45	259.80	260.14
430	260.49	260.84	261.19	261.54	261.88	262.23	262.58	262.93	263.27	263.62
440	263.97	264.31	264.66	265.01	265.35	265.70	266.05	266.39	266.74	267.08
450	267.43	267.77	268.12	268.47	268.81	269.16	269.50	269.85	270.19	270.54
460	270.88	271.22	271.57	271.91	272.26	272.60	272.94	273.29	273.63	273.98
470	274.32	274.66	275.01	275.35	275.69	276.03	276.38	276.72	277.06	277.40
480	277.75	278.09	278.43	278.77	279.11	279.46	279.80	280.14	280.48	280.82
490	281.16	281.50	281.84	282.18	282.52	282.86	283.20	283.55	283.89	284.23
500	284.56	284.90	285.24	285.58	285.92	286.26	286.60	286.94	287.28	287.62
510	287.96	288.30	288.63	288.97	289.31	289.65	289.99	290.32	290.66	291.00
520	291.34	291.67	292.01	292.35	292.69	293.02	293.36	293.70	294.03	294.37
530	294.71	295.04	295.38	295.71	296.05	296.39	296.72	297.06	297.39	297.73
540	298.06	298.40	298.73	299.07	299.40	299.74	300.07	300.40	300.74	301.07
550	301.41									

Thermal Protective Devices

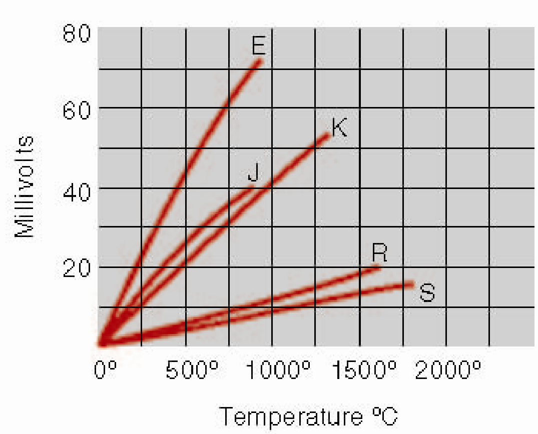
Thermocouples

Thermocouple temperature sensing utilizes a set of six thermocouples embedded in the end turns of the motor winding. A thermoelectric circuit is established causing current to flow when two wires of dissimilar metals are joined at both ends, and one of the ends is heated. By opening the circuit at the center, a voltage can be measured (know as the Seebeck voltage) which is a function of the junction temperature and the composition of the two metals. Various types of thermocouples with different characteristics are available (see voltage vs. temperature graph below).

A set of two thermocouples will be furnished in the stator winding on frames 360 and larger having a maximum winding voltage of 600 V. The type of thermocouple (copper or iron), must be specified on the order. Iron / constantan is the most common.

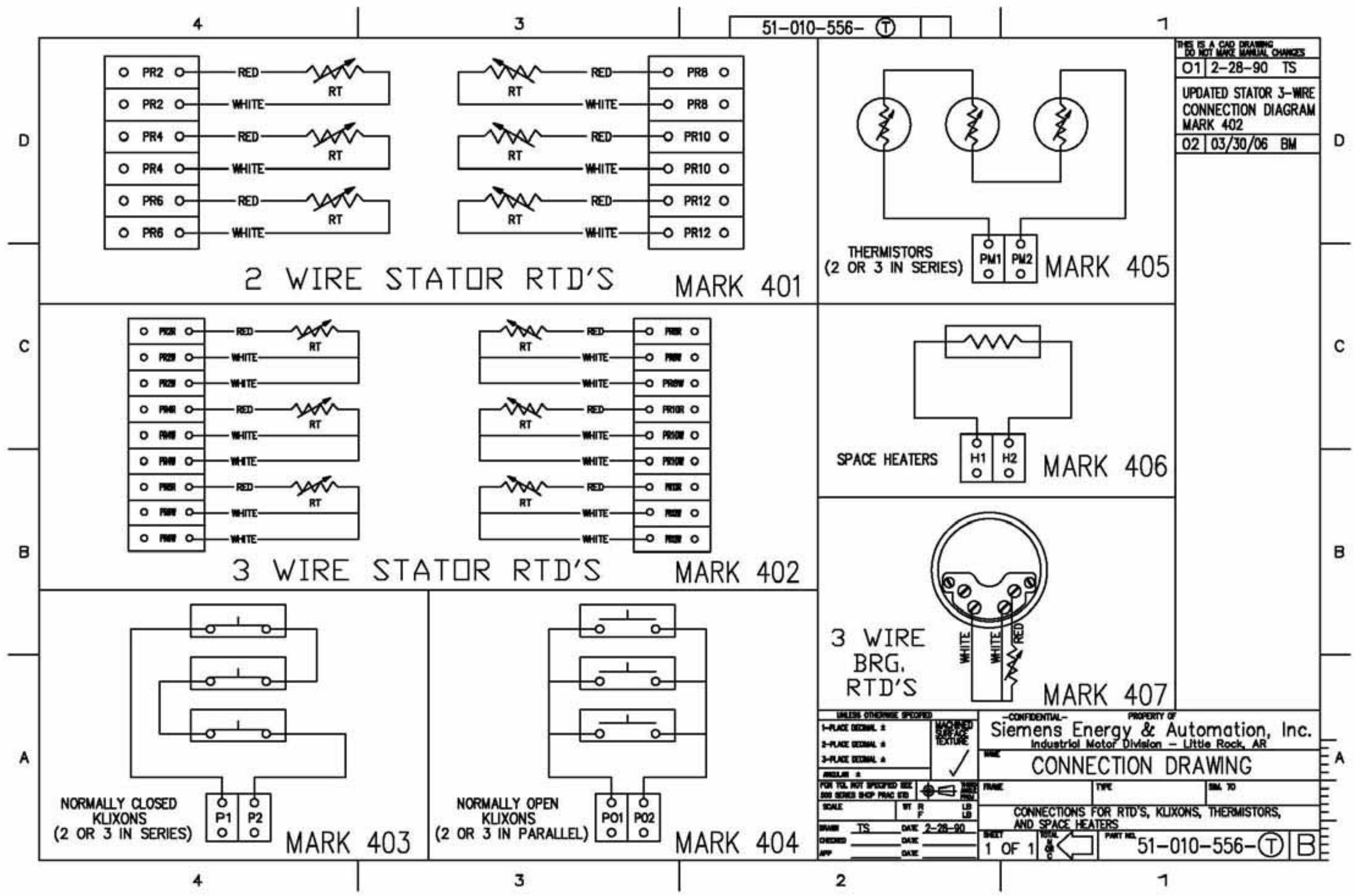
As in the case for thermistors previously described, thermocouples are provided as a temperature monitoring system, which requires a means of converting the resulting voltage to temperature (not included in the scope of supply) as well as temperature readout and / or logic control for motor shutdown.

The leads are normally brought to the main conduit box of low voltage (600 volts and below) machines, but can optionally be terminated in a condulet or auxiliary terminal box.

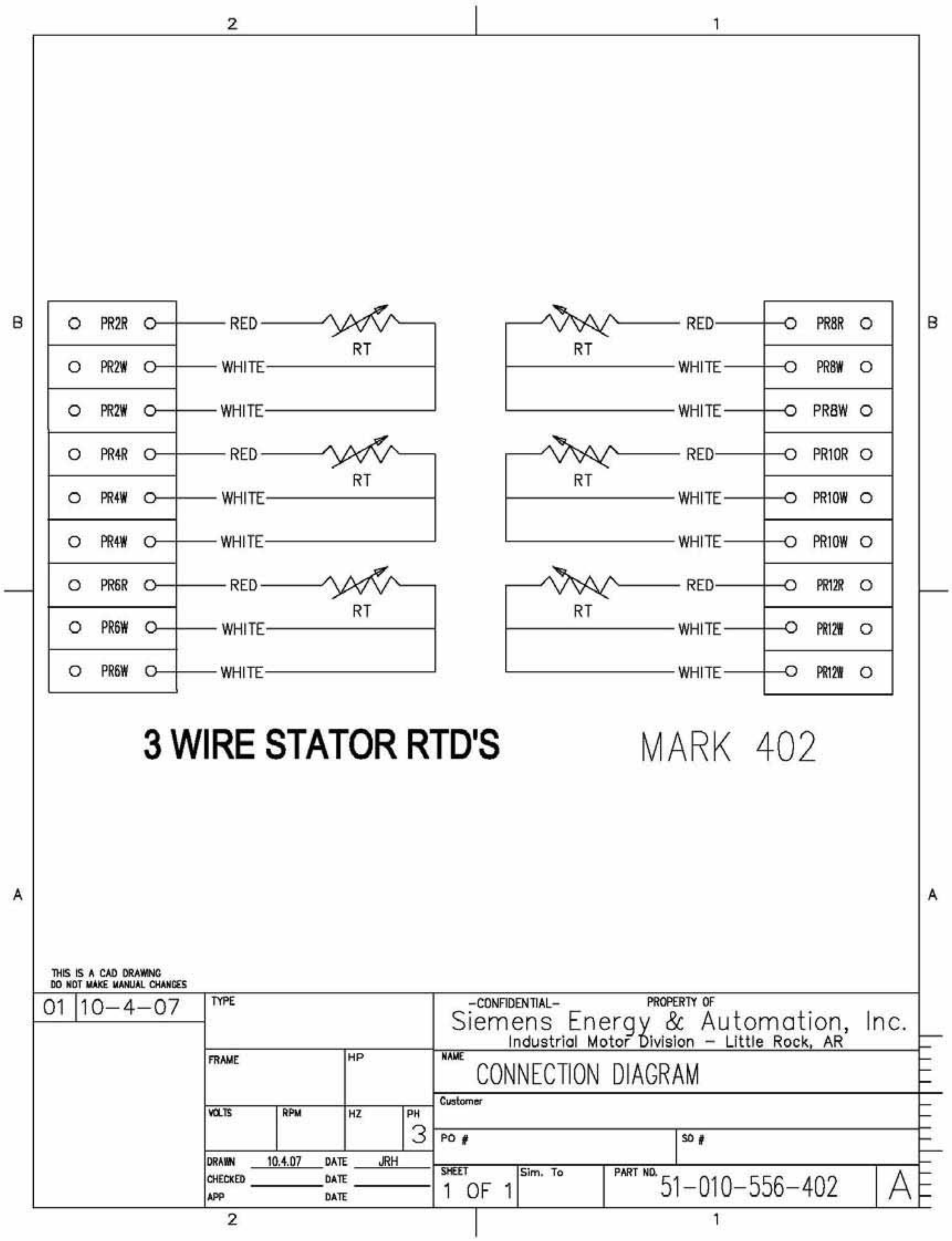


Type	Metals (+ vs. −)
E	Chromel vs. Constantan
J	Iron vs. Constantan
K	Chromel vs. Alumel
R	Platinum vs. Platinum 13% Rhodium
S	Platinum vs. Platinum 10% Rhodium
T	Copper vs. Constantan

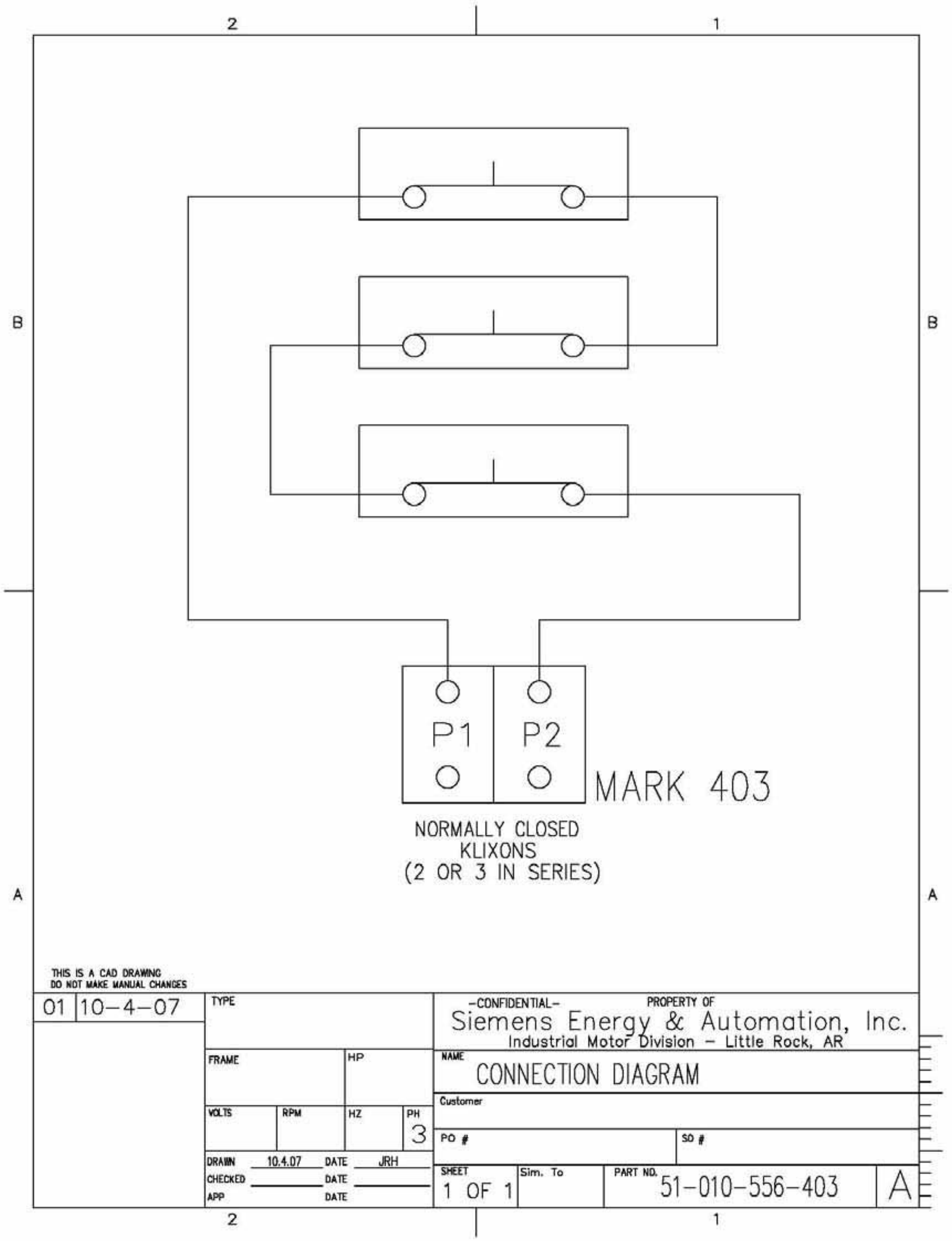
Wiring Diagrams



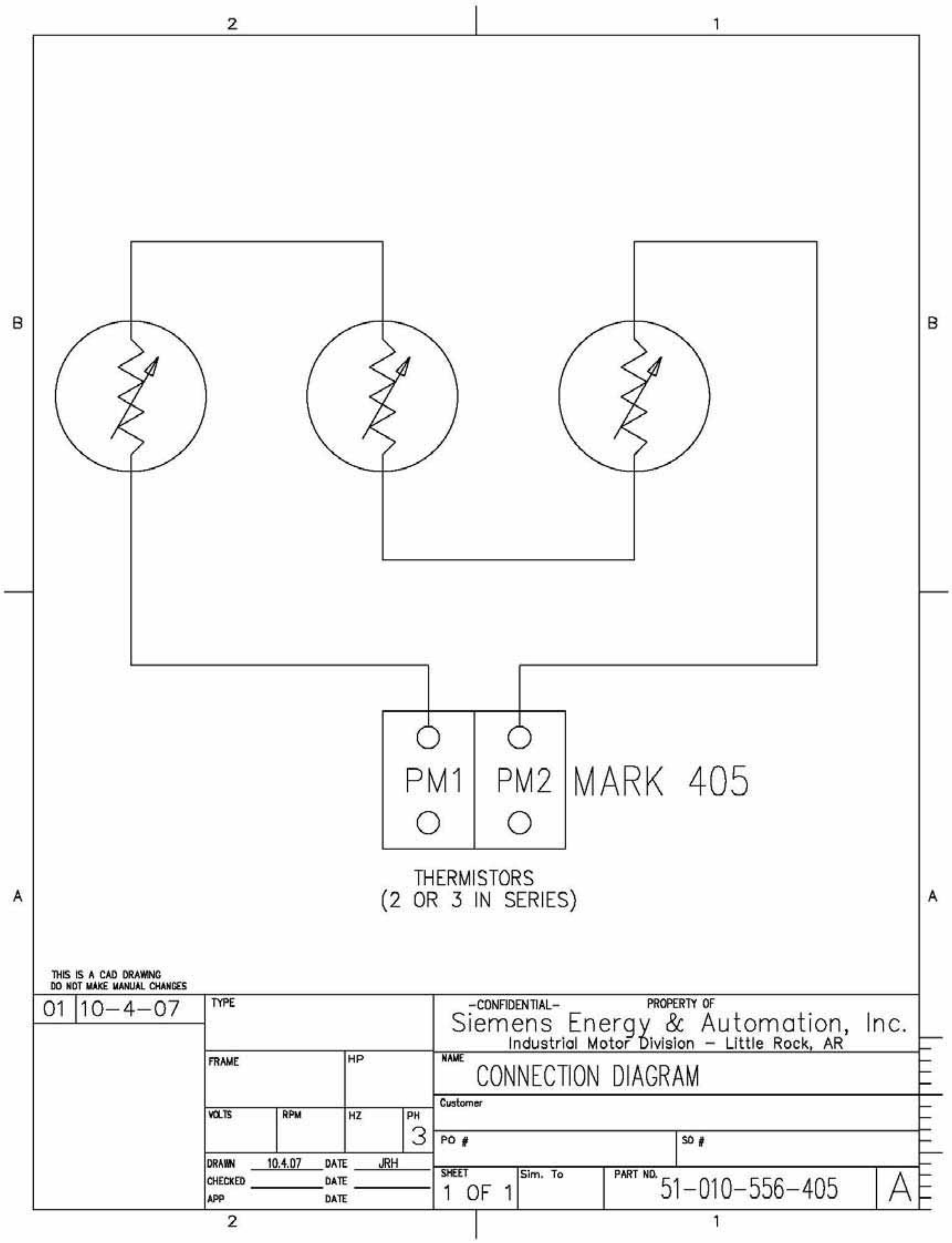
Wiring Diagrams



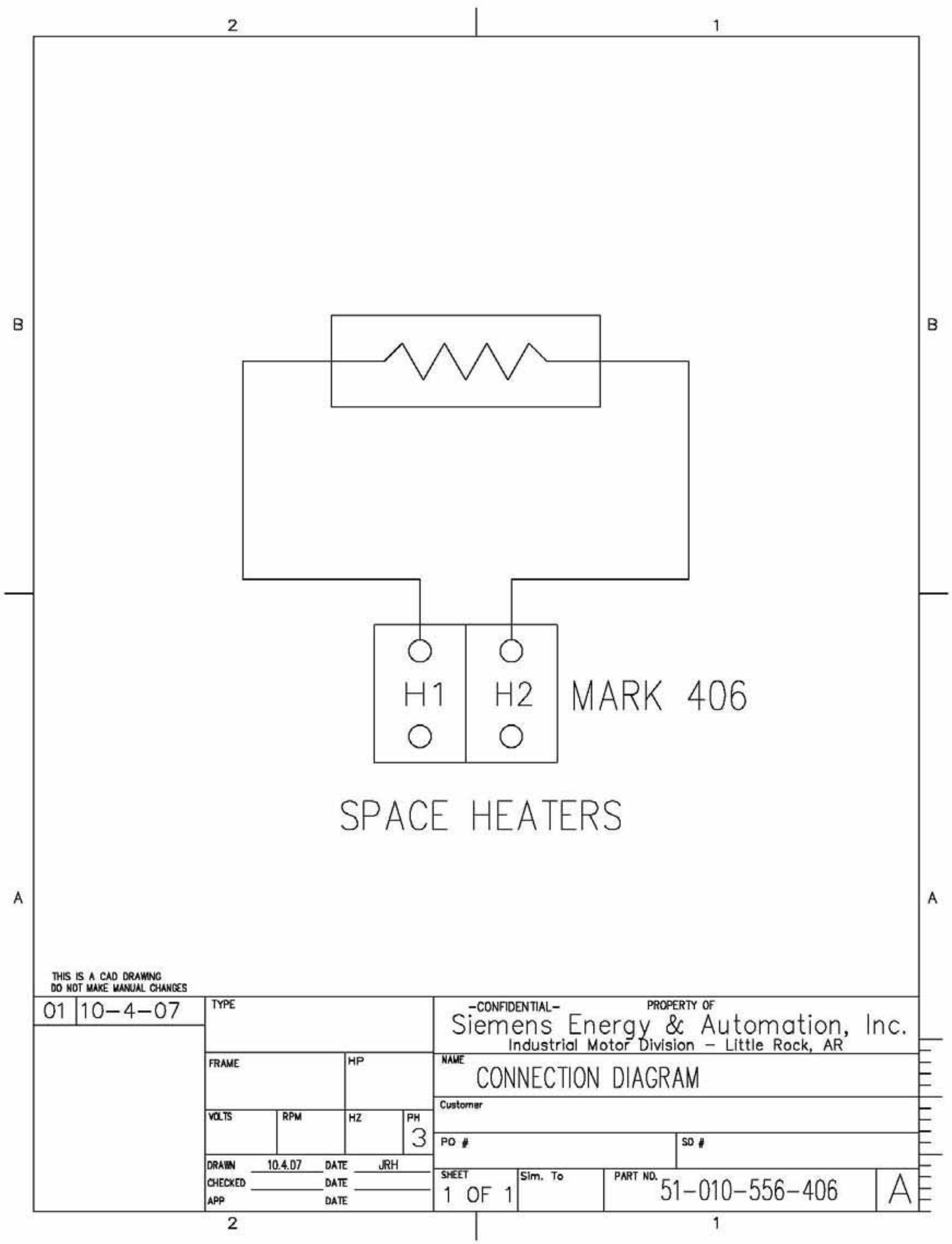
Wiring Diagrams



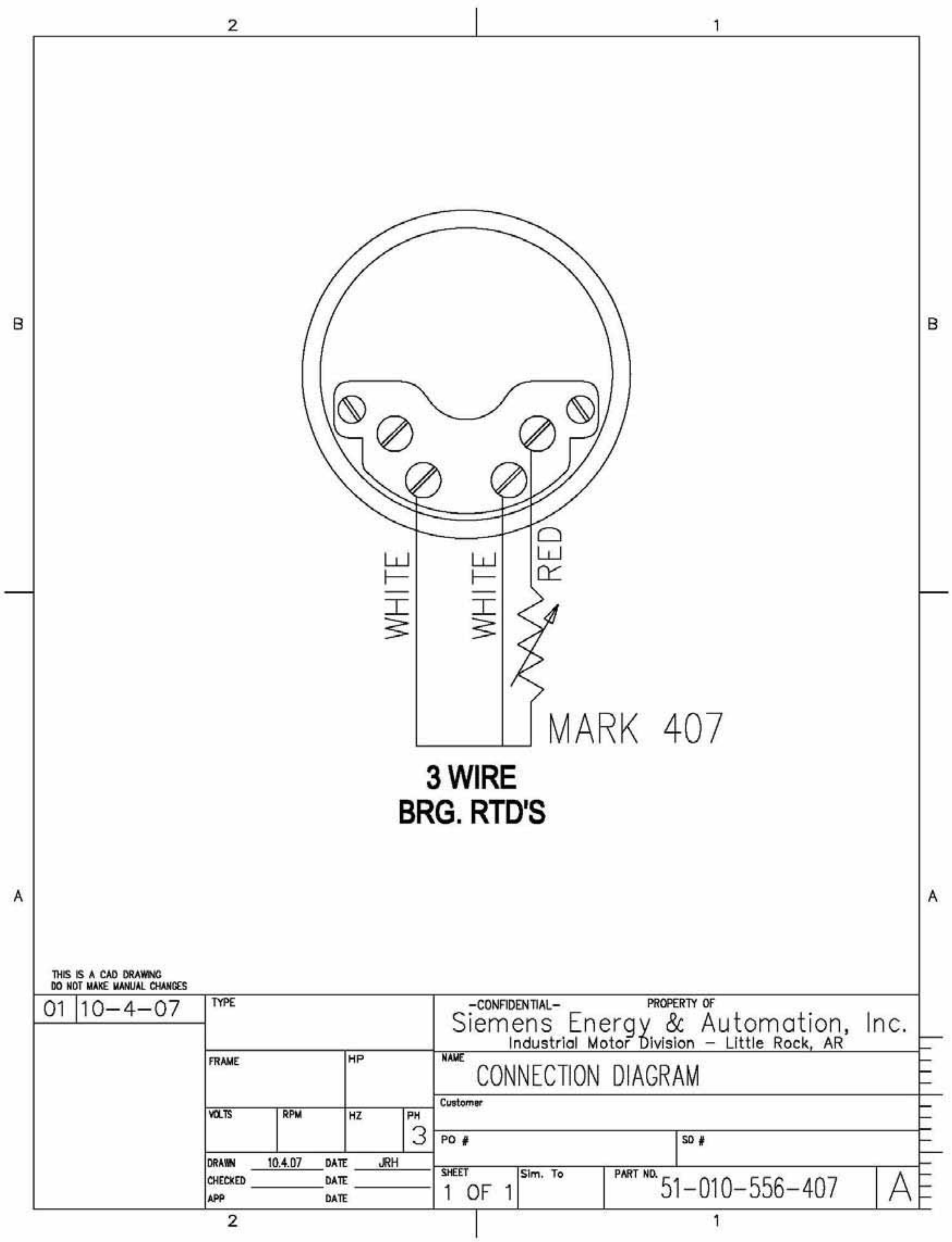
Wiring Diagrams



Wiring Diagrams



Wiring Diagrams



SIEMENS

Application Manual for NEMA Motors

Section 8

Special Information

Part 1	National Electrical Manufacturers Association (NEMA)	1
Part 2	Institute of Electrical and Electronic Engineers (IEEE)	3
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National Electrical Manufacturers Association – NEMA

MG 1 – 2006 "Motors and Generators"

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 – 2006 is divided in the following way:

Section I – General Standards Applying to All Machines
- Part 1 – Referenced Standards and Deviations
- Part 2 – Terminal Markings
- Part 3 – High Potential Tests
- Part 4 – Dimensions, Tolerances, and Mounting
- Part 5 – Classifications 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 machines)
- Part 10 – Ratings – AC and DC Motors
- Part 12 – Tests and Performance – AC and DC Motors
- Part 13 – Frame Assignments for Alternating Current Integral Horsepower Motors
- Part 14 – Application Data – AC and DC Small and Medium Machines
- Part 15 – DC Generators
- Part 18 – Definite Purpose Machines

Section III – Large Machines (larger than 500HP 3600 rpm open machines)
- Part 20 – Large Machines – Induction Machines
- Part 21 – Large Machines – Synchronous Motors
- Part 23 – Large Machines – DC Motors Larger than 1.25 Horsepower per PRM, Open Type
- Part 24 – Large Machines – DC Generators Larger than 1.0 Kilowatt per RPM, Open Type Classification

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
- Part 32 – Synchronous Generators
- Part 33 – Definite Purp. Synchr.Generators for Gen. Set Applications

National Electrical Manufacturers Association – NEMA

The motors manufactured at our factory are designed and manufactured using applicable NEMA Standards as minimum criteria.

MG 2 – 2001 Revision 1, 2007 "Safety Standard for Construction and Guide for Selection, Installation, and Use of Electric Motors and Generators"

This standard provides recommendations for the selection, installation, and use of rotating electric machines in such a manner as to provide for the practical safeguarding of persons and property.

MG 3 – 1974 (R1995, R2000, R2006) "Sound Level Prediction for Installed Rotating Electrical Machines"

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

MG 10 – 2001 (R2007) "Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors"

This standard Provides practical information concerning the proper selection and application of polyphase induction and synchronous motors including installation, operation, and maintenance.

The Institute of Electrical and Electronics Engineers – IEEE

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

IEEE 112 – 2004 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 – 1986 Test Procedure for Airborne Sound Measurements on Rotating

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 – 2002 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

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 recognized A, B, F, and H categories.

The Institute of Electrical and Electronics Engineers – IEEE

IEEE 841 – 2001 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 – 2003 IEEE standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations

IEEE 334 – 2006 IEEE Standard for Qualifying Continuous Duty Class 1E Motors for Nuclear Power Generating Stations

IEEE 344 – 2004 IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations

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

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 541 4th Edition 2004

This standard, together with applicable motor data sheets and job specifications, covers the requirements for form-wound squirrel cage induction motors 500 HP and larger for use in petroleum industry services. It covers machines that have one or more of the following:

1. Critical service applications
2. Larger than 3000 HP (2250kW) for speeds 1800 rom and below
3. 800 HP and larger for 2 pole, enclosed machines, 1250 HP and larger for 2 pole, open machines (WPI or WPII)
4. High inertia loads (in excess of Wk^2 listed in NEMA MG 1)
5. Uses adjustable speed drives as a source of power
6. Is an induction generator
7. Vertical machine rated 500 HP or greater
8. Operates in abnormally hostile environments

API 547 1st Edition 2005

Covers the requirements for form-wound induction motors for use in general-purpose petroleum, chemical and other industrial severe duty applications. These motors:

(a) Are rated 250 hp (185 kW) through 3000 hp (2250 kW) for 4, 6 and 8 pole speeds.

(b) Are rated less than 800 hp (600 kW) for two-pole (3000 or 3600 RPM), motors of totally-enclosed construction.

(c) Are rated less than 1250 hp (930 kW) for two-pole motors of WP-II type enclosures.

(d) Drive centrifugal loads.

(e) Drive loads having inertia values within those listed in NEMA MG 1 Part 20).

(f) Are not induction generators.

First Edition, January 2005.

API 547 was developed to remove some of the burden, allowing engineers to write slimmer specifications for severe-duty general purpose motors with horsepower ranges below those of

API 541 (see above). For critical-duty motors and those with horsepower requirements above the limits of API 547, API 541 remains the standard.

American Petroleum Institute – API
API 610 – 2004

Specifies requirements for centrifugal pumps, including pumps running in reverse as hydraulic power recovery turbines, for use in petroleum, petrochemical and gas industry process services. This standard is applicable to overhung pumps, between-bearings pumps and vertically suspended pumps (see Table 1). Clause 8 provides requirements applicable to specific types of pump. All other clauses of this International Standard are applicable to all pump types. Illustrations are provided of the various specific pump types and the designations assigned to each specific type..

National Electrical Code (N.E.C.)

NFPA 70 (National Fire Protection Association) – 2002 Edition

The purpose of this code is the practical safeguarding of persons and property from hazards arising from the use of electricity.

This code covers the installation of electric conductors, electric equipment, signaling and communications conductors and equipment, and their fiber optic cables and raceways for the following:

1. Public and private premises, including buildings, structures, mobile homes, recreational vehicles, and floating buildings.

2. Yards, lots parking lots, carnivals, and industrial substations.

3. Installations of conductors and equipment that connect to the supply of electricity.

4. Installations used by the electric utility, such as office buildings, warehouses, garages, machine shops, and recreational buildings, that are not an integral part of a generating plant, substation, or control center.

Hazardous Location Classifcations

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

Classifcation

There are three main categories of classification:

1. Division
2. Class
3. Group

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 Classifcations

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 groups can exist only under Class II category.

Underwriters Labratories Labeling

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

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

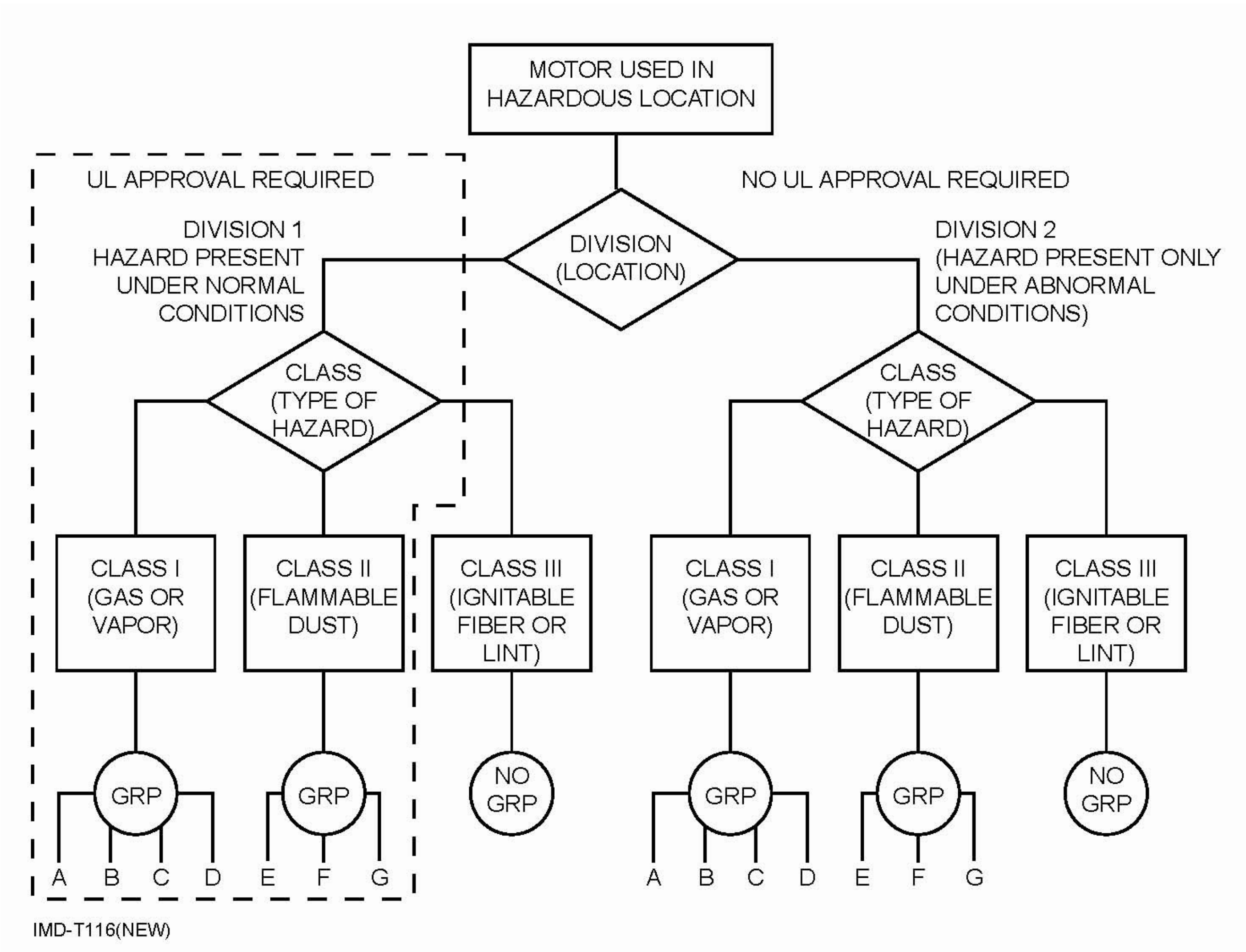
The following chart should help understanding where U.L. label is required.

U.L. Requirements

	Class I	Class II	Class III
Division 1	■	■	
Division 2			

■ – Color indicates U.L. label required.

Hazardous Location Classifcations



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 protection.

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^{o}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 the explosion is of much greater intensity. Standard explosion-proof motors are not useable below -25^{o}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 friction sparks in case of any small stones or metal objects 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 III motors.

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

Motors rated ¾ 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 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 only be used 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^{o}C.

Conclusion

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

Recognized UL Component Mark for Canada and the US

This new UL Recognized Component Mark, which became effective April 1, 1998, may be used on components certified by UL to both Canadian and U.S. requirements. Although UL had not originally planned to introduce a combined Recognized Component Mark, the popularity of the Canada/U.S. Listing and Classification Marks among clients with UL certifications for both Canada and the United States has led to the new Mark.

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 exisiting 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 (2002) Article 500-8(B) lists the preferred markings in part as follows:

Maximum Temperature		Temperature Class (T Code)
C°	F°	
450	842	T1
300	572	T2
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 – CSA

Most motors sold and used in Canada require C.S.A. certification. This involves submitting design details and testing of motors. Below is a tabulation of motors which are presently certified to C.S.A. standards. Auxilairy 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 39020 (Mexico):

Type	Principle	Max HP	Insul.	Max Volts	Frames	Phase	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 & T	3	50, 60	1, 2, 4
RGV	Squirrel Cage	600	B, F	600	140T to 440T & T	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 & T	3	50, 60	1, 2, 4
RGZV	Squirrel Cage	300	B, F	600	140T to 440T & T	3	50, 60	1, 3, 4
RGZV-IL	Squirrel Cage	300	B, F	600	213LP(H) to 449LP(H)	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 the 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 – CSA

II. Motors for Hazardous Locations (Div 1) – C.S.A. Certification File No. LR 39020 (Mexico)

These motors are for continuous or intermittent duty:

Hazardous Location, Class, or Group	Motor Type	Max RPM	Insul.	Max Volts	Frames	Phase	Freq.
I C & D, II E, F & G	RGZZ	3600	B	600	143T to 449T & TS	3	50, 60
I C & D, II E, F & G	RGZZ	3600	F	600	284T & TS to to 449T & TS	3	50, 60
I D	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). Any warning labels must be bilingual (English-French).

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

Requirements for motors not included in the 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.

Canadian Standards Association – CSA

CSA INTERNATIONAL

Certificate of Compliance

Certificate: 1740199 (LR 39020) **Master Contract:** 153422

Project: 1740199 **Date Issued:** 2006/02/17

Issued to: **Siemens, Sociedad Anomina de**
Capital Variable Siemens SA de CV
Fabrica Guadalajara
Camino a la Tijera 1
Km 3.5 Carretera Guadalajara-Moreli
Tlajomulco de Zuñiga, Jalisco 45640
Mexico
Attention: Mr. L. C. Verduzco

The products listed below are eligible to bear the CSA Mark shown with adjacent indicators 'C' and 'US'

C US

Issued by: Babu Patel P. Eng.

Authorized by: Gabriel Lippa, C.E.T., Product Group Manager

PRODUCTS

CLASS 4211 01 - MOTORS AND GENERATORS
CLASS 4211 81 - MOTORS AND GENERATORS - Certified to US Standards

Three phase squirrel cage induction motors Type GP10, GP10-A, GP100, GP100-A, SD10, SD100 and SD100 IEEE841, 20 HP Max, 3600 RPM Max, 600V max, 50/60 Hz., TEFC, Class F or H, 40C Ambient, Continuous Duty, Service Factor 1.15, NEMA Frame 140T - 250T.

Notes:

The 'C' and 'US' indicators adjacent to the CSA Mark signify that the product has been evaluated to the applicable CSA and ANSI/UL Standards, for use in Canada and the U.S., respectively. This 'US' indicator includes products eligible to bear the 'NRTL' indicator. NRTL, i.e. National Recognized Testing Laboratory, is a designation granted by the U.S. Occupational Safety and Health Administration (OSHA) to laboratories which have been recognized to perform certification to U.S. Standards.

DQD 507 Rev. 2004-06-30

Canadian Standards Association – CSA

CSA INTERNATIONAL

Certificate:	1740199 (LR 39020)	**Master Contract:**	153422
Project:	1740199	**Date Issued:**	2006/02/17

(a) Additional letters and number are added to motor part number representing electrical and mechanical variation.

(b) Zeros of frame designation may be replaced by numbers representing different size.

(c) Motors are horizontal, vertical, C, D or P flange.

APPLICABLE REQUIREMENTS

CAN/CSA-C22.2 No. 100 - Motors and Generators

UL Std No. 1004 - Electric Motors

Addresses of Standard Agencies

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

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

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

C.S.A
178 Rexdale Boulevard
Rexdale (Toronto)
Ontario, Canada
M9W 1R3

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

SIEMENS

EG-Konformitätserklärung / *EC-declaration of conformity*

No. 664.11005.21

Bevollmächtigter: *Authorized representative*	**Siemens AG** **Automation and Drives** **Standard Drives**
Anschrift: *Address:*	**91056 Erlangen** **Deutschland**
Hersteller: *Manufacturer:*	**SIEMENS, S.A. DE C.V.** **Fabrica Guadalajara, Mexico**
Produktbezeichnung: *Product description:*	**Drehstrom-Asynchronmotor mit Käfigläufer /** **Three-phase induction motor with squirrel-cage** **Typen / Types:** RG... RGZ... HSRGZ... RGK... GP... SD ... 1LA... 1RA... 1LE... 1PC... **Achshöhe /Shaft Height:** 2.62 – 11.0 Inches **Bemessungsleistungen bis / Rated output up to :** 500 HP
	Einphasenmotor mit Käfigläufer / **Single-phase motor with squirrel-cage** **Typen / Types:** 1LF... 1RF ..., **Achshöhe / Shaft Height :** 2.62 – 5,25 Inches **Bemessungsleistungen bis / Rated output up to :** 10 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 / IEC 60204-1 EN / IEC 60034

Das bezeichnete Produkt ist zum Einbau in eine andere Maschine bestimmt. Die Inbetriebnahme ist solange untersagt, bis die Konformität des Endproduktes mit der Richtlinie 98/37/EG festgestellt ist.

Erstausgabe / First edition: 21.10.99
Bad Neustadt, den 17.02.2006

i.V. ....
Thomas Werbinek
Head of Research and Development Motors

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

664.11005.21 Seite 2

EC declaration of conformity

ENGLISH

...

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

73/23/EEC 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 the following standards:

...

The named product is intended for fitting in another machine. Commissioning is prohibited until such time as the end product has been proved to conform to the provisions of Directive 98/37/EC .

...

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.

Déclaration de conformité CE

FRANÇAIS

...

Le produit sus-mentionné est conforme aux prescriptions des Directives Européennes suivantes :

73/23/CEE Directive du Conseil visant l'harmonisation des législations des Etats membres relatives aux matériels électriques destinés à l'utilisation dans certaines limites de tension, modifiée par la Directive 93/68/CEE du Conseil

...

La conformité du produit sus-mentionné aux prescriptions de ces directives est démontrée par sa conformité intégrale aux normes suivantes :

...

Le produit sus-mentionné est destiné exclusivement à l'incorporation dans une autre machine. La mise en service est proscrite tant que la conformité du produit final avec la Directive 98/37/CE n'a pas été constatée .

....

Cette déclaration n'est pas une assurance de qualités dans le sens de la responsabilité du produit. Les indications de sécurité de la documentation de produit sont à suivre.

Declaración de conformidad CE

ESPAÑOL

...

El producto designado cumple con las prescripciones de las siguientes directivas europeas:

73/23/CEE Directiva del Consejo para la armonización de la legislación de los estados-miembro relativa a materiales eléctricos a ser utilizados dentro de márgenes de tensión definidos, modificada por la Directiva 93/68/CEE

...

La conformidad con las prescripciones de estas Directivas queda justificada por haberse cumplido totalmente las siguientes normas:

...

El producto designado está destinado a la incorporación en otra máquina. No se permite la puesta en servicio hasta tanto no se haya comprobado que el producto final cumple con la Directiva 98/37/CE .

...

Esta declaración no garantiza características según la responsabilidad sobre productos.
Han de observarse las indicaciones de seguridad en la documentación del producto.

Dichiarazione di conformità CE

ITALIANO

...

Il prodotto indicato soddisfa le norme delle seguenti Direttive CEE:

73/23/CEE Direttiva del consiglio per l'armonizzazione delle norme giuridiche degli Stati membri relativamente alle caratteristiche del materiale elettrico destinato ad essere adoperato entro taluni limiti di tensione, modificata dalla Direttiva 93/68/CEE del Consiglio.

...

La conformità ai requisiti delle presenti direttive viene provata dal completo rispetto delle seguenti norme:

...

Il prodotto indicato è destinato ad essere integrato in un'altra macchina. Ai sensi della dichiarazione del costruttore la messa in servizio non è consentita fino a quando non è stabilita la conformità del prodotto finale alla Direttiva 98/37/CE.

...

La presente dichiarazione non assicura le caratteristiche del prodotto ai sensi della legge per la responsabilità del produttore. Osservare le avvertenze relative alla sicurezza contenute nella documentazione relativa al prodotto.

EC-konformitetsförklaring

SVENSKA

...

Den märkta produkten överensstämmer med föreskrifterna i följande europeiska direktiv:

73/23/EEC Direktiv från rådet för anpassning av medlemsstaternas rättsliga föreskrifter angående elektriska drivmedel för användning inom bestämda spänningsgränser, ändrade genom RL 93/68/EEC av rådet.

...

Överensstämmelse med föreskrifterna i dessa direktiv styrks genom det absoluta respekterandet av följande normer:

...

Den märkta produkten är ägnad att monteras i en annan maskin. Idrifttagandet är ej tillåtet innan ändproduktens konformitet med direktiv 98/37/EC är fastställd

...

Denna deklaration får inte uppfattas som försäkran om egenskaper enligt krav i produktansvar. Laktta säkerhetsanvisningarna i den medlevererade produktdokumentationen.

Section 9

Testing

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TESTING

All Siemens motors are given a routine line test per NEMA MG1 and IEEE-112.

ROUTINE TEST

Routine test consists of the following items tested in accordance with IEEE standard 112.

- No Load Current
- No Load Speed
- Locked-Rotor Current
- Winding Resistance
- High Potential
- Bearings/Vibration Check

Vibration data is NOT recorded with a routine test.
If required, please add per the following table.

Test report of routine test is based on IEEE Std. 112 Form A-1 and includes complete nameplate information.

TESTING

Routine Test including Vibration data:

SIEMENS ENERGY AND AUTOMATION, INC.
LITTLE ROCK PLANT
REPORT OF ROUTINE TEST

Purchaser:
Order#:
P.O.#:
Motor Design:
Date of Test: 08-23-2007

NAMEPLATE DATA

HP	Speed RPM	Phase	HZ	Volts	Amps	
5	1730	3	60	575	5.2	
Type	**Frame**	**Ambient °C**	**NEMA**	**KVA**	**INS**	**SF**
RGZZESD	184TC	40	B	J	F	1.0

TEST CHARACTERISTICS

		No Load			Stator		Locked Rotor			Diel'C Test
Volts	HZ	RPM	Amps	KW	Resistance	Volts	Hz	Amps	Phase	KV
573	60	1800	2.1	0.28	4.7718	575	60	36.8	3	2.58
						143	60	6.4	1	

Vibration			
	DEV: 0.0114 IPS	DEH: 0.0127 IPS	DEA: 0.0090 IPS
	ODEV: 0.0113 IPS	ODEH: 0.0136 IPS	

Note: 3 Phase Locked Rotor Amps are maximum current levels and are not test data for these motors.

Vibration data is NOT recorded with a routine test.
If required, please add per the following table.

TESTING

COMPLETE TEST

Complete test consists of following items tested in accordance with NEMA andIEEE-112 test standards.

- Full Load Heat Run
- Temperature Rise at F.L.
- Winding Resistance
- Rated F.L. Slip
- No Load Current
- Breakdown Torque
- Locked Rotor Torque-Amps
- High Potential Tests
- Efficiencies @ 100, 75, 50 Percent Load
- Power Factor @ 100, 75, 50 Percent

Load Test report of complete test is based on IEEE Std. Form A-2 and includes complete nameplate information.

TESTING

CALIBRATION TESTS

Calibration test consists of 0-125% rated load test measurement of speed, torque, current, power factor and efficiency, at rated voltage. Data is curve plotted on Siemens standard format. Foot mounted motors only.

NOISE TESTS

Noise test to verify sound levels can be performed. These tests are conducted per procedures defined in IEEE-85. Tests are performed under no load conditions.

SIEMENS

Application Manual for NEMA Motors

Section 10

Special Applications

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Power Factor Correction

Power factor is the ratio of actual power used in a circuit expressed in watts or kilowatts to the power which is apparently being drawn from the line (apparent power) expressed in volt amperes or kilovolt amperes. Power factor is generally expressed in percent.

Low power factor increases the power company's cost of supplying actual power because more current must be transmitted than is actually used to perform useful work. This additional transmitted current increases the cost incurred by the power company and is directly billed to the industrial consumer by means of power factor clauses in the rate schedules. Low power factor reduces the load handling capability of the industrial plants electrical system as well as the load handling capabilities of the power company's generators, transmission lines and transformers.

When the volt ampere product (KVA) exceeds the actual power (KW), a component known as reactive power (KVAR) is present. The operating current consists of two parts: one which results in useful work and another known as reactive current which merely bounces energy back and forth. Both generate heat in the wires or conductors. The reactive current is always present in inductive load devices. Although reactive current is actually part of the total current indicated by amp meter reading, reactive power does not register on a kilowatt hour meter.

The inductive reactance of the A.C. induction motor causes the motor current to lag behind the motor voltage, and thereby causes the power factor to drop below unity. This can be offset by the addition of capacitors connected across the motor terminals on the load side of the motor starter. Power factor correction capacitors are generally connected to the motor in such a manner that they are automatically removed from the system as the power source is removed from the motor. The capacitor causes the current to lead the voltage which tends to offset the lagging current caused by the motor reactance thereby improving the system power factor. The capacitive current in the capacitors opposes the inductive current in the induction motor.

Power Factor Correction

Over correction of power factor by the addition of excessive capacitance is dangerous to the motor and driven equipment; therefore, it is undesirable. Over correction of power factor by the addition of excessive capacitance must be avoided because:

1. Over correction of power factor may cause damage to the A.C. induction motor as well as the driven equipment. The power factor correction capacitors are electrical energy storage devices. When the motor is de-energized, the capacitor which remains connected in parallel to the motor can maintain the motor voltage. If the motor is re-energized after a short time, the motor voltage and the line voltage may be additive, and dangerously high currents and torques may result. Although this condition is present only for a short time, it can result in dangerously high transient currents and torques which in turn can cause physical damage to the motor's power transmission devices and the driven load. The important consideration is time. The motor voltage will normally decay in five seconds or less, therefore, the motor should not be re-energized before five seconds has elapsed.

2. Regenerative effect on motors. The motor power factor should not be corrected on motors connected to loads which are capable of causing the motor to rotate at speeds above synchronous motor speed when the motor is de-energized. The addition of power factor correction capacitors to motors connected to overhauling loads must be done with extreme care. Although the motor and its connected capacitors are de-energized, continued rotation of the rotor combined with the stored energy in the capacitor causes the motor to act as an alternator (A.C. generator). The voltage thus generated in the A.C. motor severely strains the capacitors and may be sufficient to cause destruction of the capacitors. When power factor correction is required on A.C. motors connected to overhauling loads, contact the factory for technical assistance.

Power Factor Correction

3. Excessive capacitance applied to an A.C. induction motor will correct the power factor of other inductive loads connected to the same power supply source. Since the same power supply system is used to supply power to many inductive loads, over correction at one load point will correct the power factor at another load point. The user that over corrects the power factor of this inductive load does not receive additional financial benefits from the power company even though he is aiding the power company by allowing it to supply power having a leading current (current leads the voltage) to other customers on the same supply system.

For the above reasons, the power factor of an A.C. induction motor should not be corrected above 95%. The amount of capacitance expressed as KVAR required for power factor correction can be determined by use of the following formula:

$$\frac{.746 \times HP}{EFF} \quad X \quad \text{Factor from adjoining table = KVAR to correct power factor}$$

EFF = Motor efficiency as a decimal

Example: KVAR required to correct power factor of a 60 HP,
1800 RPM, 460 volt motor from 87 to 95 =

$$\frac{.746 \times 60}{.917} \quad X \quad .238 = 11.6$$

This value will probably fall between standard sizes available. The next lower standard size is usually selected.

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Application Manual for NEMA Motors

Desired Power Factor in Percent

A = Uncorrected Motor Power Factor in Percent

A	85	86	87	88	89	90	91	92	93	94	95
60	.714	.741	.769	.794	.822	.850	.878	.905	.939	.971	1.005
61	.679	.706	.732	.759	.787	.815	.843	.870	.904	.936	.970
62	.645	.672	.698	.725	.753	.781	.809	.836	.870	.902	.936
63	.613	.640	.666	.693	.721	.749	.777	.804	.838	.870	.904
64	.580	.607	.633	.660	.688	.716	.744	.771	.805	.837	.871
65	.549	.576	.602	.629	.657	.685	.713	.740	.774	.806	.840
66	.518	.545	.571	.598	.626	.654	.682	.709	.743	.775	.809
67	.488	.515	.541	.568	.596	.624	.652	.679	.713	.745	.779
68	.459	.486	.512	.539	.567	.595	.623	.650	.684	.716	.750
69	.429	.456	.482	.509	.537	.565	.593	.620	.654	.686	.720
70	.400	.427	.453	.480	.508	.536	.564	.591	.625	.657	.691
71	.372	.399	.425	.452	.480	.508	.536	.563	.597	.629	.663
72	.343	.370	.396	.423	.451	.479	.507	.534	.568	.600	.634
73	.316	.343	.369	.396	.424	.452	.480	.507	.541	.573	.607
74	.289	.316	.342	.369	.397	.425	.453	.480	.514	.546	.580
75	.262	.289	.315	.342	.370	.398	.426	.453	.487	.519	.553
76	.235	.262	.288	.315	.343	.371	.399	.426	.360	.492	.526
77	.209	.236	.262	.289	.317	.345	.373	.400	.434	.466	.500
78	.183	.210	.236	.263	.291	.319	.347	.374	.408	.440	.474
79	.156	.183	.209	.236	.264	.292	.320	.349	.381	.413	.447
80	.130	.157	.183	.210	.238	.266	.294	.321	.355	.387	.421
81	.104	.131	.157	.184	.212	.240	.268	.295	.329	.361	.395
82	.078	.105	.131	.158	.186	.214	.242	.269	.303	.335	.369
83	.052	.079	.105	.132	.160	.188	.216	.243	.277	.309	.343
84	.026	.053	.079	.106	.134	.162	.190	.217	.251	.283	.317
85	-	.027	.053	.080	.108	.136	.164	.191	.225	.257	.291
86		-	.026	.053	.081	.109	.137	.167	.198	.230	.265
87			-	.027	.055	.082	.111	.141	.172	.204	.238
88				-	.028	.056	.084	.114	.145	.177	.211
89					-	.028	.056	.086	.117	.149	.183
90						-	.028	.058	.089	.121	.155
91							-	.030	.061	.093	.127
92								-	.031	.063	.097
93									-	.032	.066
94										-	.034
95											-

Methods of Starting Three Phase A.C. Induction Motors

The purpose of all motor starters is to provide a means of connecting the motor to the power supply thereby accelerating the motor and connected load from standstill to normal operating speed.

The following items should be considered when selecting a motor starter for a specific three phase A.C. induction motor and motor load.

1. The power source (phase, voltage, frequency).
2. The starting torque requirements of the load.
3. Power source restrictions concerning amperage draw.

Three phase A.C. Induction motor starters can be classified into three basic categories.

A. Full Voltage Type
The full voltage type of across-the-line starter simply connects the motor directly to the power source.

B. Reduced Voltage Type
Reduced voltage starters cause a voltage, lower than that of the power source, to be impressed on the motor terminals in order to reduce motor inrush current and starting torque.

Example:
a. Autotransformer
b. Series Resistor
c. Series Reactor

C. Increment Type
Increment starters use various motor reconnecting techniques to reduce motor inrush current and starting torque. Normal line voltage is maintained at the motor terminals.

Example:
a. Part Winding
b. Star Delta

Full Voltage Start

General

Across-the-line starting is the most basic and widely used method of starting squirrel cage induction motors and is, therefore, used as a basis for comparing other starting methods.

Operation

A pilot device (such as a start push button) closes the line contactor to connect the motor directly to the line.

Advantages

1. The across-the-line starter is the most simple A.C. motor starting device and, therefore, the least expensive. It provides reliable, trouble-free operation with low maintenance costs.

2. The across-the-line starter allows A.C. motor to develop its maximum starting torque.

Caution:

1. The high inrush current (approximately 6 to 7 times the name-plate full load current) may be in excess of that allowed by the power source.

2. The high motor starting torque may cause excessive shock loading to the driven equipment.

3. The high starting current may cause a temporary reduction in motor terminal voltage. This voltage drop will reduce the motor starting torque by the square of the voltage ratio. An excessive voltage drop may cause dimming of lights or cause magnetic relays to “trip out”.

Reduced Voltage Start Autotransformer

General

The autotransformer starter is classified as a reduced voltage starter. It is a device with which the applied motor voltage can be reduced below that of the line voltage. Both motor starting current and torque, therefore, will be reduced below those values obtained with across-the-line starting.

Any standard three phase induction motor may be used with an autotransformer starter. The starter portion of the autotransformer start connects the motor leads to the reduced voltage output winding of the autotransformer. After a preset time delay (normally 10 to 20 seconds) the starter connects the motor leads to the full line voltage.

Operation

Two autotransformer starter designs are used, the open-circuit transition and the closed-circuit (Korndorfer) transition types. Both manual and magnetic open or closed circuit transition autotransformers are available. During switching from reduced voltage starting to full applied line voltage operation, however, a voltage is continuously applied to the motor terminals from the moment of reduced voltage starting and during the switching to full line voltage operation:

Reduced Voltage Start Autotransformer

Advantages:

1. Starting torque per starting amp ratio equal to that of the across-the-line starter.

2. The most desirable starting current and starting torque can be selected by means of reconnecting the motor leads to the 50%, 65% or 80% output taps of the autotransformer. The characteristics of the motor load and allowable accelerating times establish the best tap connection.

% Tap	% LT	% LRA
50	25	27
65	42	45
80	64	66

Where:

% LT = Starting torque expressed as a percentage of the value encountered during across-the-line starting.

% LRA = Starting current drawn from the power lines expressed as a percentage of the value encountered during across-the-line starting. This value includes the approximate required auto-transformer magnetization current.

NOTE: Both % locked torque and % locked rotor current vary approximately as the square of the voltage applied to the motor.

3. Limited motor noise and vibration during starting.

4. On the closed circuit transition type starter, voltage transients during the transition period are minimized which reduces the possibility of unacceptable performance of other electrical components within the same plant.

Reduced Voltage Start Autotransformer

Caution:

1. The autotransformer output tap may have to be changed to a higher percentage voltage value if the load torque and/or inertia exceeds that which the motor can accelerate within the required starting period.

2. The transfer from reduced voltage to full voltage operation should be delayed until the motor speed is high enough to insure that the current change during switching will not exceed power company requirements.

3. The starter as well as the motor should be evaluated for applications requiring starting. For autotransformer starters, NEMA states that one 15 second starting period every four minutes for a total of four per hour is acceptable. The majority of standard induction motors are capable of four 15 second starting periods per hour.

Primary Resistor or Reactor Starting

Operation

Resistor type starters introduce a resistor bank, in series with the motor windings.

The initial current surge through the motor is limited by the resistors. Simultaneously, a voltage drop develops across the resistors, reducing the voltage applied to the motor. At reduced voltage, the motor torque capability is reduced.

As the motor begins to accelerate, it produces a counter emf, opposing the applied voltage and further reducing the initial current surge. As the current surge is reduced, the voltage drop across the resistor bank diminishes while that of the motor is increased. This increases motor torque while current inrush is diminishing. The net result is a smooth and gradual accelerating cycle without open transients in the motor windings.

An adjustable timing device on the starter is preset to initiate a run contactor at the proper time during the accelerating period. This function closes a run contactor, shorting across the resistors. The start contactor then opens, removing the resistors from the circuit.

Reactor type starters follow the same sequence for starting, with the exception that the reactors remain shorted after the final stage of acceleration. As implied, the reactors are core wound devices, having adjustable voltage taps. These devices limit the initial motor current surge by an inherent tendency to oppose a sudden changing condition of current and voltage.

Primary Resistor or Reactor Starting

Advantages

The resistor or reactor controllers are of the closed transition type since the lines to the motor are not opened during transfer to the run condition.

Resistors supplied provide 65% voltage but have taps at 80% to allow for adjustment. Reactors have 50%, 65% and 80% taps. All controllers are connected for 65% voltage as standard.

Current drawn from the line upon starting is reduced to approximately the value of the tap used. Starting torque is reduced to approximately the value of the tap squared. For example, with connections to the 65% taps, current inrush will be approximately 65% of full-voltage. Starting torque will be about 42% of that developed under full-voltage starting.

Any standard motor may be used. No special windings or connections are needed.

Caution:

The motor will not start if the breakaway torque required of the load exceeds that which the motor can develop on the starting connection.

Full impact of inrush current and torque are then experienced at transfer from the start to run connection.

Increment Starting (Part Winding Start – 1/2 Winding Method)

General

Part winding starting, 1/2 winding type, is the most commonly used method of increment starting of A.C. induction motors. The 1/2 winding method of part winding starting requires the use of a specific motor starter with an A.C. induction motor having two parallel stator windings suitably connected internally for part winding starting.

The starter must be capable of energizing, with full line voltage, 1/2 of the motor winding, then after a slight time delay (not to exceed 3 seconds) energizing the complete winding in parallel with the first half of the motor winding.

Advantages:

1. Starting current is reduced to 60 to 65% of the value encountered if the motor were started across-the-line.

2. Starting torque is approximately 45 to 50% of the value encountered if the motor were started across-the-line.

3. Continuous connection of the motor to line during the transition period minimizes voltage fluctuation during the transition period.

4. Can be applied to most 4, 6 and 8 pole motor designs.

Increment Starting (Part Winding Start – 1/2 Winding Method)

Caution:

1. Motor to be part winding started must be designed and built properly to insure that two parallel stator windings are provided.

2. The motor will not start if the torque demanded by the load exceeds that developed by the motor on the first step or when 1/2 of the motor winding is energized. When the second half of the winding is energized, the normal starting torque (same as across-the-line starting) is available to accelerate the load.

3. By use of two-step start winding starting, the inrush current is divided into two steps thus providing the power source's line voltage regulators sufficient time to compensate for voltage drop caused by motor starting.

4. Motor heating on first-step operation is greater than that normally encountered on across-the-line start. Therefore, elapsed time on the first step of the part winding start should not exceed three seconds.

5. When the first half of the winding is energized, a slight increase in electrical noise and vibration may be encountered.

Increment Starting (Star-Delta)

General

Star-Delta starting is a method of increment starting used with a three phase A.C. induction motor to reduce the initial values of motor starting current and torque compared to those values obtained with across-the-line starting.

Both ends of each phase winding is brought into the motor conduit box. The starter is designed to connect these windings in star on the first step. After a preset time delay, the starter will disconnect from the star configuration and reconnect in delta for continuous operation.

The voltage impressed across each phase of the motor winding during the first step (Star connection) of a Star-start Delta-run motor is lower than the voltage which would be impressed across each phase of the motor if across-the-line starting were used. This lower voltage results in lower starting current and torque.

Three phase A.C. induction motors having Star-Delta winding connections are popular in Europe because supply voltages of 220 and 380 are used. Motors wound for 220/380 volts may be started across-the-line on either 220 or 380 volts or may be operated at Star-start Delta-run on 220 volts.

Operation

Two types of Star-Delta starters are used, the open-circuit transition and the closed-circuit transition types. Both types connect the motor windings in Star on the first step. After a predetermined time interval, the timer causes the starter contactors to reconnect the motor windings in the Delta or “run” connection.

Increment Starting (Star-Delta)

Advantages:

1. Starting torque per starting amp ratio equal to that of the across-the-line starter.

2. Starting current is reduced to approximately 33% of the value encountered if the motor were started across-the-line.

3. Soft start - Starting torque is approximately 33% of the value encountered if the motor were started across-the-line. This low starting torque is often desirable to softly accelerate loads having high inertia and low retarding torque (Example - centrifuges and unloaded compressors). The low starting current during the starting period allows the motor to withstand a longer acceleration time than an equivalent sized across-the-line start motor. The Star-Delta motor, however, will accelerate only slightly more inertia than the across-the-line motor since the thermal capacity of both motors is the same. To accelerate a specific inertia, the Star-Delta motor will produce a lower temperature rise within the motor than an equivalent sized across-the-line start motor because the longer acceleration time allows the heat in the motor to be more efficiently dissipated to the housings and surrounding atmosphere.

4. Can be adapted to most 2, 4, 6; and 8 pole motor designs.

5. May be started as frequently as an across-the-line start motor if the retarding torque of the load is negligible.

6. Limited motor noise and vibration during starting.

7. On the open-circuit transition type, no resistors are required.

8. On the closed-circuit transition type, voltage fluctuation during the transition period is minimized.

Increment Starting (Star-Delta)

Caution:

1. Motor started on Star connection and operated on the Delta connection must be specifically designed for Star-Delta.

2. The motor will not start if the torque demanded by the load exceeds that developed by the motor on the Star connection. When the motor is connected in Delta, normal starting torque is available to start load.

3. The transfer from Star to Delta should be delayed until the motor speed is high enough to insure that the current change during switching will not exceed power source requirements. Generally, the starter timer should be set so that switching from Star to Delta occurs at 80 to 90% of full-load speed.

4. On the open-circuit transition type, line voltage fluctuation can result during the transition period due to sudden current changes.

Summary

Figure (1) summarizes in chart form the motor starting performance with these various starting methods.

To this point, we have reviewed these various starting methods and their effect on inrush current, line current and starting torque. Our major concern is the motor; to get it started and up to speed as rapidly as the load permits. Figure (2) shows why this is necessary. This is a typical speed current curve, and illustrates that inrush current remains high throughout most of the accelerating period.

If the power system on which this motor is to operate cannot stand this inrush at full voltage, and a means of reduced voltage or increment start is elected, then we must be aware of the effect on current and torque as displayed in Figure (1).

Bear in mind also, the motor does not recognize the type of starter being used. It interprets what is received at the motor terminals as applied voltage, and that which appears at the shaft as a torque to be overcome. It is recognizing two factors; voltage and load torque.

An increasing number of specifications are being written which state that the motor must be capable of starting with 90% or 80%, or 70% voltage, and must be capable of momentary operation with a voltage dip to 90%, or 80% or 70% voltage.

This introduces three points for consideration.

1. Will the motor develop enough torque at start to initiate rotation of the load?
2. Will the motor be capable of maintaining rotation during accelerating period?
3. Will the motor have sufficient torque to sustain rotation during periodic voltage dips?

Summary

Figure (3) displays a family of motor speed torques for terminal voltages of 100%, 90%, 80% and 70% rated voltage. The speed torque requirement of a centrifugal pump is also shown as a typical load curve.

1. The motor will break away and begin rotating as long as more torque is generated at locked rotor than the load requires. In this example the motor will start under any one of the four voltage conditions.

2. As long as the motor is generating more torque than required by the load the motor will continue to accelerate. This will continue until the torque developed by the motor is equal to the torque required by the load. Acceleration will stop and the motor will attempt to operate the driven device at this speed. If the speed is too low for the driven device the torque condition of either the motor or the driven device must be changed to increase the speed to acceptable value.

3. When the voltage dip occurs the motor performance will be in accordance with the speed torque curve for this reduced value. The motor will continue to operate as long as the intersection of the load curve and the motor speed torque curve occurs above the breakdown torque point of the motor. The closer this operating point approaches the breakdown point the quicker the motor will overheat and therefore the shorter time the motor can successfully withstand the voltage dip.

General Comparison of Characteristics of Various Methods of Motor Starting
Reduced-Voltage Starting

	Autotransformer			Primary Resistance		Reactor			Part Winding		Wye (Star) – Delta
	50% Tap	65% Tap	80% Tap	65% Tap	80% Tap	50%	65%	80%	2-Step	3-Step	
Starting current drawn from line as % of that which would be drawn upon full-voltage starting.	25%	42%	64%	65%	80%	50%	65%	80%	50%	25%	33.3%
Starting torque developed as % of that which would be developed on full-voltage starting.	25%	42%	64%	42%	64%	25%	42%	64%	50%	12.5%	33.3%
	Increase slightly with speed.			Increase greatly with speed.							
Smoothness of acceleration	Second in order of smoothness			Smoothest of reduced-voltage type. As motor gains speed, currennt decreases. Voltage drop across resistor or reactor decreases and motor terminal voltage increase.					Fourth in order of smoothness.		Third in order of smoothness.
Allowable accelerating times (typical)	30 seconds			5 seconds			15 seconds		2-3 Seconds Limited by motor design.		45-60 Seconds Limited by motor design.
Starting current and torque	Adjustable within limits of various taps.								Fixed		

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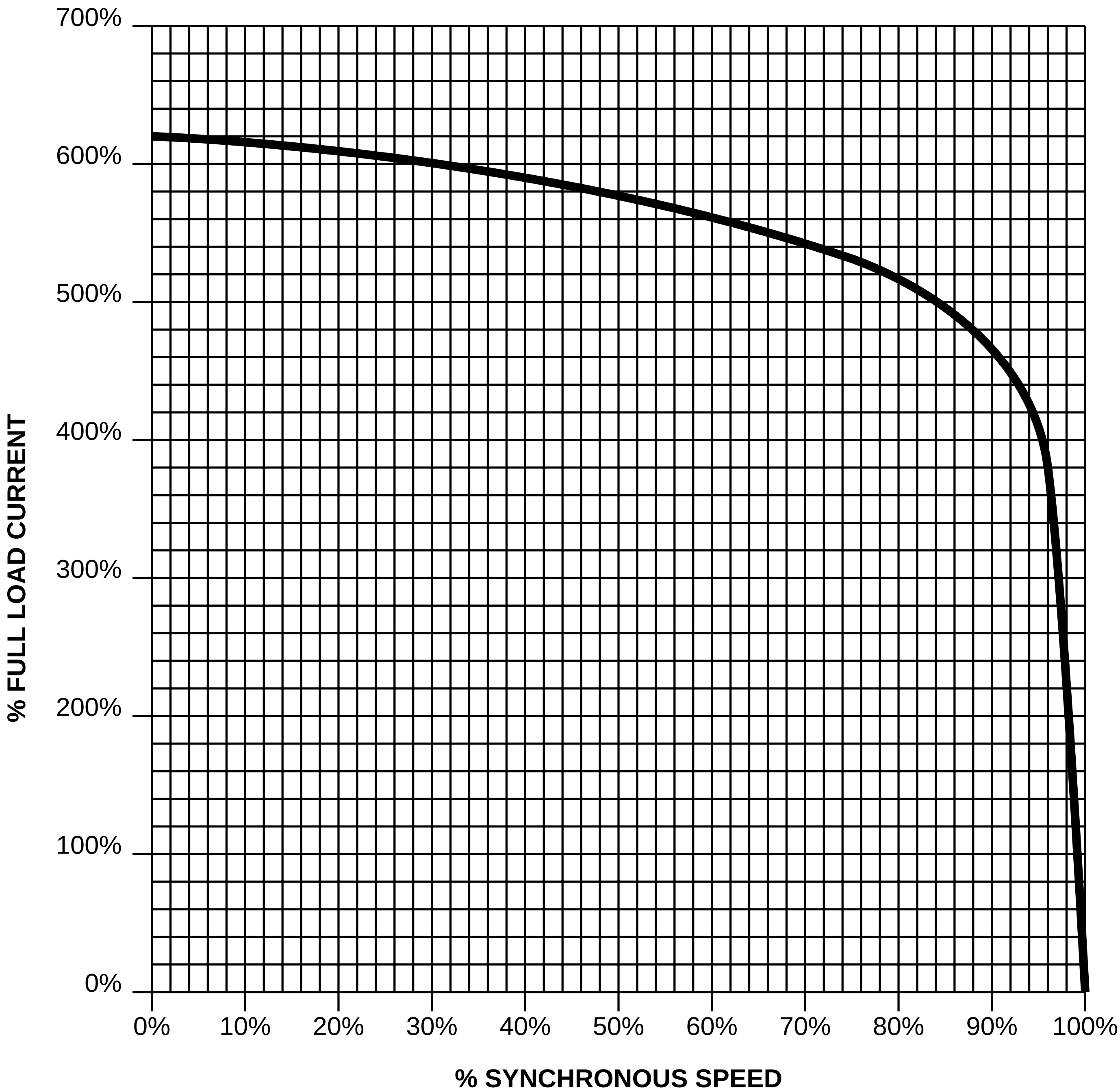
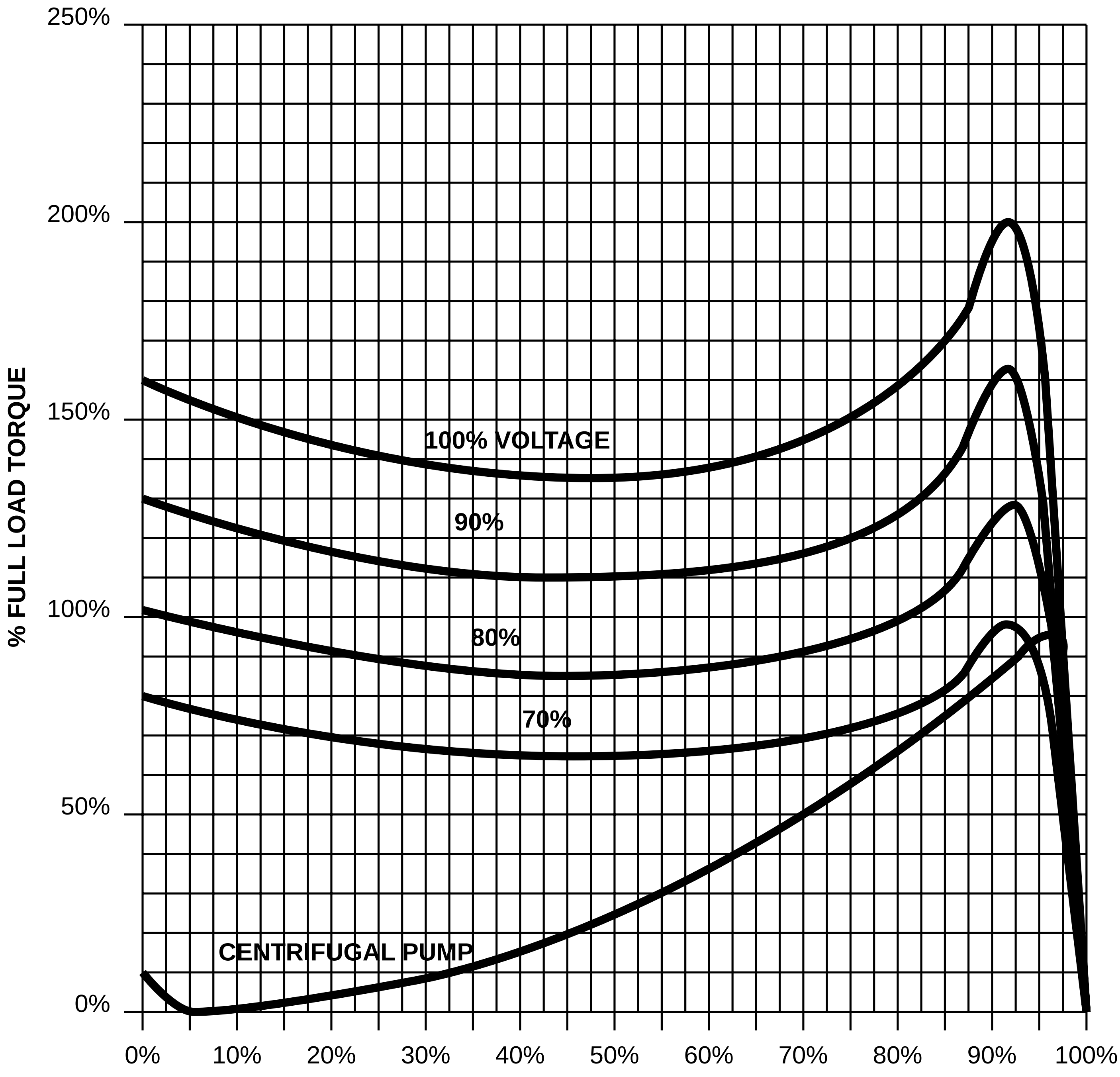
Typical Current vs Speed
Squirrel Cage Induction Motor



Typical Motor Speed Torque Curves at Various Voltages and Load Curve



Duty Cycles and Inertia

Horsepower Variations

Many machines work on a definite duty cycle that repeats at regular intervals. If the values of power required during the cycle, and the length of their durations are known, then the rating of the motor required can be calculated by the root-mean square (RMS) method:

> Multiply the square of the horsepower required for each part of the cycle by the duration in seconds. Divide the sum of these results by the effective time in seconds to complete the whole cycle. Extract the square root of this last result. This gives the rms horsepower. If the motor is stopped for part of the cycle, only 1/3 of the rest period should be used in determining the effective time for open motors (enclosed motors use 1/2 of the rest period). This is due to the reduction in cooling effect when motor is at rest.
>
> **Example:**
> Assume a machine operation, where an open motor operates at a 8 HP load for 4 minutes, 6 HP load for 50 seconds, 10 HP load for 3 minutes, and the motor is at rest for 6 minutes.

$$\text{RMS HP} = \sqrt{\frac{(8^2 \text{ x } 240) + (6^2 \text{ x } 50) + (10^2 \text{ x } 180) =}{240 + 50 + 180 + \frac{360}{3}}}$$

$$\sqrt{59.6} = 7.7 \text{ HP}$$

Use 7.5 HP Motor

Accelerating Time

For fast repeating cycles involving reversals and deceleration by plugging, the additional heating due to reversing and external WK^2 loads must be taken into consideration. Consequently a more elaborate duty cycle analysis than devised is required. It is necessary to know the torque, time and motor speed for each portion of the cycle, such as acceleration, running with load, running without load, deceleration, and at rest.

For such detailed duty cycles it is sometimes more convenient to calculate on the basis of torque required rather than on the horsepower basis.

Accelerating Time

$$\text{time, sec.} = \frac{WK^2 \text{x (change in rpm)}}{\text{308 x torque (lb-ft) average from motor}}$$

The above formula can be used when the accelerating torque is substantially constant. If the accelerating torque varies considerably, the accelerating time should be calculated in increments: the average accelerating torque during the increment should be used and the size of the increment used depends on the accuracy required. The following equation should be used for each increment:

$$\text{time, sec.} = \frac{WK^2 \text{ x rpm}}{308 \text{ x } (T-T_L)}$$

WK^2 = moment of inertia, $lb\text{-}ft^2$ of system (motor + load)

RPM = motor speed

TL = motor torque, lb-ft at a given speed

T = load torque, lb-ft at the same speed

Accelerating Time

Moment of Inertia (WK^2)

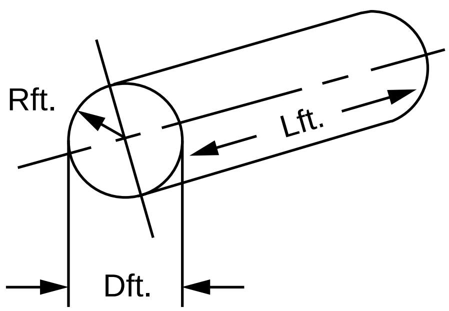
The radius of gyration K, depends on the shape of the object, and the axis of rotation. An unsymmetrical object will have a different K depending on the orientation of the axis of rotation. In the formula for calculating "accelerating time" the product of weight W and the square of the radius of gyration K^2 appears. This will hold true in any formula whenever the moment of inertia is of concern.

Formulas for WK^2, based on specific weights of metals, can be found in Table 1.

In Table 2, WK^2 of solid cylinders per inch of length is given.

Accelerating Time

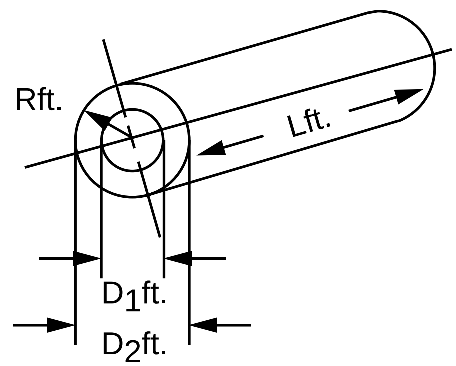
(a) Circluar Cylinder



$WK^2 = 170.4\ w\ LD^4$

w = weight of material

(b) Hollow Circluar Cylinder



$WK^2 = 170.4\ w\ L\ X$

$(D_2^4 - D_1^4)$

WEIGHT OF MATERIAL

lbs/cu. in.

1. Magnesium 0.0628
2. Aluminum 0.0924
3. Cast Iron 0.260
4. Steel 0.282
5. Copper 0.318
6. Bronze 0.320
7. Lead 0.411

TABLE 1

WK^2 of Steel Shafting and Disc

To determine the WK^2 of a given shaft or disc multiply the WK^2 given below, by the length of the shaft, or thickness of disc, in inches. To determine inertias of solids of greater diameter than shown below, multiply the nearest tenth of the diameter by 10^4 or move decimal point 4 places to the right and multiply by length as above. For hollow shafts, subtract WK^2 of inside diameter from WK^2 of outside diameter and again multiply by length.

Diameter (inches)	WK^2 ($LB.Ft.^2$)	Diameter (inches)	WK^2 ($LB.Ft.^2$)	Diameter (inches)	WK^2 ($LB.Ft.^2$)
3/4	0.00006	10-1/2	2.35	32	201.8
1	0.0002	10-3/4	2.58	33	228.2
1-1/4	0.0005	11	2.83	34	257.2
1-1/2	0.001	11-1/4	3.09	35	288.8
1-3/4	0.002	11-1/2	3.38	36	323.2
2	0.003	11-3/4	3.68	37	360.7
2-1/4	0.005	12	4.00	38	401.3
2-1/2	0.008	12-1/4	4.35	39	445.3
2-3/4	0.011	12-1/2	4.72	40	492.8
3	0.016	12-3/4	5.11	41	543.9
3-1/2	0.029	13	5.58	42	598.8
3-3/4	0.038	13-1/4	5.96	43	658.1
4	0.049	13-1/2	6.42	44	721.4
4-1/4	0.063	13-3/4	6.91	45	789.3
4-1/2	0.079	14	7.42	46	861.8
5	0.12	14-1/4	7.97	47	939.3
5-1/2	0.177	14-1/2	8.54	48	1021.8
6	0.25	14-3/4	9.15	49	1109.6
6-1/4	0.296	15	9.75	50	1203.1
6-1/2	0.345	16	12.61	51	1302.2
6-3/4	0.402	17	16.07	52	1407.4
7	0.464	18	20.21	53	1518.8
7-1/4	0.535	19	25.08	54	1636.7
7-1/2	0.611	20	30.79	55	1761.4
7-3/4	0.699	21	37.43	56	1898.1
8	0.791	22	45.09	57	2031.9
8-1/4	0.895	23	53.87	58	2178.3
8-1/2	1.000	24	63.86	59	2332.5
8-3/4	1.13	25	75.19	60	2494.7
9	1.27	26	87.96	66	3652.5
9-1/4	1.41	27	102.3	72	5172.0
9-1/2	1.55	28	118.31	78	7125.0
9-3/4	1.75	29	136.14	84	9584.0
10	1.93	30	155.92	90	12629.0
10-1/4	2.13	31	177.77	96	16349.0

Equivalent WK²

$$\text{Equivalent } WK^2 = WK^2 \times \left(\frac{N}{N_b}\right)^2$$

W = weight of the rotating part in pounds

K = radius of gyration of the rotating part in feet

N = speed of the rotation part in RPM

N_b = speed of the motor shaft in RPM

It should be noted that if there is gearing or belting between the rotating part and the motor, this must be taken into account, and the figure used for the WK^2 of the rotating part must be adjusted to a WK^2 equivalent to direct connection to the motor shaft. By the use of the above equation, it is possible to calculate the WK^2 of a system including several rotating parts, which are rotating at different speeds. The WK^2 of each part is adjusted to its equivalent WK^2, and the equivalent WK^2 figures are added together to obtain the WK^2 of the whole system.

High WK^2 Acceleration

When starting a high WK^2 load, step-starting may be required to maintain the torque necessary to accelerate the mass. Care must be taken in choosing resistor capacity to dissipate the heat resulting from the starting currents.

Data required to determine the correct motor for a high WK^2 load.

1. WK^2 of load
2. Torque required
3. Duty cycle

Equivalent WK^2

Example:

200 lbs-ft for 5 seconds accelerates load to 1150 rpm; 50 lbs-ft for 10 seconds does work required; 200 lbs-ft for 5 seconds decelerates load to standstill; 12 seconds at rest (1/3 off-time is used for open motors).

$$\text{Total cycles time} = 5 + 10 + 5 + \frac{12}{3} = 24 \text{ seconds}$$

$$\text{rms torque} = \sqrt{\frac{(200^2 \times 5) + (50^2 \times 10) + (200^2 \times 5)}{24}}$$

$$\text{rms torque} = 133.1 \text{ lb. ft.}$$

$$\text{HP} = \frac{\text{rms torque} \times 1150}{5250}$$

$$\text{HP} = \frac{133.1 \times 1150}{5250} = 29.15$$

Therefore, use motor rated 30 HP, 1150 rpm

Note: The above example is calculated on the basis of rms torque rather than rms HP. The additional heating due to the nature of the duty cycle has been taken into consideration.

Information Required for Proper Selection Involving High Inertia or Duty Cycle

It is recommended that the Little Rock Electrical Application Department be supplied with the following information:

1. Load WK^2 at motor shaft.
2. Number of starts, stops or reversal per unit of time.
3. HP load and length of each operating period.
4. Length of standing idle periods.
5. Method of stopping.
6. Special torque requirements of motor, such as need to break away heavy friction load from rest; need to bring heavy inertia load up to speed (or down to stop) in specified period of time; need to have high pull-out torque to carry momentary overloads.

Horsepower Determination

Determination of HP Requirements

The horsepower required can often be determined from the factual information or power requirements for specific operations. Where the force o torque required is known, one of the equations below may be used to calculate the horsepower required by constant load characteristics.

Power for Transition

$$HP = \frac{\text{Force (lbs) x ft. per min.}}{33{,}000}$$

Power for Rotation

$$HP = \frac{\text{Torque (lbs.-ft.) x RPM}}{5{,}250}$$

Power to Drive Pumps

$$HP = \frac{\text{Gal. per min. x total head (inc. friction) x specific gravity}}{\text{3,960 x eff. of pump}}$$

$$\text{Where friction head (ft)} = \frac{\text{pipe length (ft) x [velocity of flow (fps)]}^2 \text{ x .02}}{\text{5,367 x eff. of pump}}$$

Power to Hoist a Load

$$HP = \frac{\text{Weight (lbs) x feet per min. x } \sin\theta}{33{,}000}$$

θ = Angle of hoist with horizontal

Power to Drive Fans

$$HP = \frac{\text{Cu. ft. gas per min. x water gage pressure (in.)}}{\text{6,350 x efficiency}}$$

Efficiencies for fans range between 50 and 80 percent.

Formulas and General Data

To Find		Three Phase Formulas
Amperes when HP is known	=	$\frac{746 \times HP}{1.73 \times E \times Eff \times PF}$
Amperes when KW is known	=	$\frac{1000 \times KW}{1.73 \times E \times PF}$
Amperes when KVA is known	=	$\frac{1000 \times KVA}{1.73 \times E}$
Kilowatts Input (KW)	=	$\frac{1.73 \times E \times I \times PF}{1000}$
Kilovolt Amperes (KVA)	=	$\frac{1.73 \times E \times I}{1000}$
Horsepower Output (MP)	=	$\frac{1.73 \times E \times I \times Eff \times PF}{746}$

PF = Power Factor as a Decimal
EFF = Efficiency as a Decimal
T = Torque in LB-FT
f = Frequency in Hz
I = Current in Amperes
E = Voltage in Volts
KW = Power in Kilowatts
KVA = Apparent Power in Kilovolt Amperes
HP = Output in Horsepower
N = Motor Sped in RPM
Ns = Synchronous Speed in RPM
P = Number of Poles

Synchronous Speed - Frequency - Number of Poles of AC Motors

$Ns = \frac{120 \times f}{P}$ $f = \frac{P \times Ns}{120}$ $P = \frac{120 \times f}{Ns}$

Horsepower - Torque - Speed

$HP = \frac{T \times N}{5250}$ $T = \frac{5250 \times HP}{N}$ $N = \frac{5250 \times HP}{T}$

Locked Rotor Current I_{LR} From Nameplate Data - Three Phase

$$ILR = \frac{577 \times HP \times KVA/HP}{E}$$

NEMA KVA Code Letters

Code	KVA/HP	Code	KVA/HP
A	0 - 3.14	L	9.0 - 9.99
B	3.15 - 3.54	M	10.0 - 11.19
C	3.55 - 3.99	N	11.2 - 12.49
D	4.0 - 4.49	P	12.5 - 13.99
E	4.5 - 4.99	R	14.0 - 15.99
F	5.0 - 5.59	S	16.0 - 17.99
G	5.6 - 6.29	T	18.0 - 19.99
H	6.3 - 7.09	U	20.0 - 22.39
J	7.1 - 7.99	V	22.4 & UP
K	8.0 - 8.99		

Example: For a 100 HP motor, 3 phase, 460 volts, KVA Code G

$$1_{LR} = \frac{577 \times 100 \times (5.6 \text{ to } 6.29)}{460}$$

1_{LR} - 702 to 789 Amperes

Formulas and General Data

Effect of Line Voltage on Locked Rotor Current (Approx.)

Locked Rotor Amperes (LRA) is directly proportional to applied voltage.

$$LRA = LRA \text{ at nameplate voltage } \times \frac{\text{Applied Voltage}}{\text{Nameplate Voltage}}$$

Example:15 HP - 1800 RPM - 254T Frame - RGZ - Standard Efficiency Motor is rated 116 AMPS Locked Rotor at 460 Volts. What are the Locked Rotor AMPS at 495 Volts?

$$LRA = 116 \times \frac{495}{460} = 125 \text{ AMPS}$$

General Approximations (Rules of Thumb)

At 3600 RPM a motor develops 1.5 LB-FT of Torque per HP at Rated HP Output
At 1800 RPM a motor develops 3.0 LB-FT of Torque per HP at Rated HP Output
At 1200 RPM a motor develops 4.5 LB-FT of Torque per HP at Rated HP Output
At 900 RPM a motor develops 6.0 LB-FT of Torque per HP at Rated HP Output

At 575 Volts a 3 Phase motor draws 1.00 AMP per HP at Rated HP Output
At 460 Volts a 3 Phase motor draws 1.25 AMP per HP at Rated HP Output
At 230 Volts a 3 Phase motor draws 2.50 AMP per HP at Rated HP Output

Temperature Conversion Table

Find known temperature in ˚C/˚F column. Read converted temperature in ˚C or ˚F column.

˚C	˚C/˚F	˚F
-40.0	-40.0	-40.0
-37.2	-35.0	-31.0
-34.4	-30.0	-22.0
-32.2	-25.0	-13.0
-29.4	-20.0	-4.0
-26.6	-15.0	5.0
-23.8	-10.0	14.0
-20.5	-5.0	23.0
-17.8	0.0	32.0
-15.0	5.0	41.0
-12.2	10.0	50.0
-9.4	15.0	59.0
-6.7	20.0	68.0
-3.9	25.0	77.0
-1.1	30.0	86.0
1.7	35.0	95.0
4.4	40.0	104.0
7.2	45.0	113.0
10.0	50.0	122.0
12.8	55.0	131.0
15.5	60.0	140.0
18.3	65.0	149.0
21.1	70.0	158.0
23.9	75.0	167.0
26.6	80.0	176.0
29.4	85.0	185.0

˚C	˚C/˚F	˚F
32.2	90.0	194.0
36.0	95.0	203.0
37.8	100.0	212.0
40.5	105.0	221.0
43.4	110.0	230.0
46.1	115.0	239.0
48.9	120.0	248.0
51.6	125.0	257.0
54.4	130.0	266.0
57.1	135.0	275.0
60.0	140.0	284.0
62.7	145.0	293.0
66.5	150.0	302.0
68.3	155.0	311.0
71.0	160.0	320.0
73.8	165.0	329.0
76.5	170.0	338.0
79.3	175.0	347.0
82.1	180.0	356.0
85.0	185.0	365.0
87.6	190.0	374.0
90.4	195.0	383.0
93.2	200.0	392.0
96.0	205.0	401.0
98.8	210.0	410.0
101.6	215.0	419.0

Fahrenheit to Centigrade

$$(^\circ F - 32)\,\frac{5}{9} = {}^\circ C$$

Centigrade to Fahrenheit

$$\left(^\circ C \times \frac{9}{5}\right) + 32 = {}^\circ F$$

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$HP = \frac{T \times N}{5250}$ $\quad T = \frac{5250 \times HP}{N}$ $\quad N = \frac{5250 \times HP}{T}$

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-37.2	-35.0	-31.0	36.0	95.0	203.0
-34.4	-30.0	-22.0	37.8	100.0	212.0
-32.2	-25.0	-13.0	40.5	105.0	221.0
-29.4	-20.0	-4.0	43.4	110.0	230.0
-26.6	-15.0	5.0	46.1	115.0	239.0
-23.8	-10.0	14.0	48.9	120.0	248.0
-20.5	-5.0	23.0	51.6	125.0	257.0
-17.8	0.0	32.0	54.4	130.0	266.0
-15.0	5.0	41.0	57.1	135.0	275.0
-12.2	10.0	50.0	60.0	140.0	284.0
-9.4	15.0	59.0	62.7	145.0	293.0
-6.7	20.0	68.0	66.5	150.0	302.0
-3.9	25.0	77.0	68.3	155.0	311.0
-1.1	30.0	86.0	71.0	160.0	320.0
1.7	35.0	95.0	73.8	165.0	329.0
4.4	40.0	104.0	76.5	170.0	338.0
7.2	45.0	113.0	79.3	175.0	347.0
10.0	50.0	122.0	82.1	180.0	356.0
12.8	55.0	131.0	85.0	185.0	365.0
15.5	60.0	140.0	87.6	190.0	374.0
18.3	65.0	149.0	90.4	195.0	383.0
21.1	70.0	158.0	93.2	200.0	392.0
23.9	75.0	167.0	96.0	205.0	401.0
26.6	80.0	176.0	98.8	210.0	410.0
29.4	85.0	185.0	101.6	215.0	419.0

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