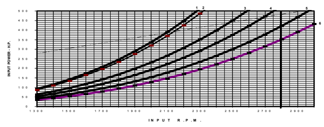
WE PUT HORSEPOWER TO WORK

Today's leader
in
tomorrow technology

TWIN DISC WATERJETS



CONTENTS

TWIN DISC WATER JETS

JET SELECTION GUIDE

ISSUE DATE: 01/02/01

TWIN DISC JETS		CURRENT RANGE

The "TWIN DISC JETS" series of Waterjets is the culmination of over **25 years** design and manufacturing experience in marine propulsion systems.

The Waterjets feature the latest in Waterjet Propulsion technology with a complete range of models from the DJ60 to the DJ200 Series matching engines from 30HP to 3750HP diesels.

Case study examples of **TWIN DISC** Waterjets are available worldwide.

Range of DOEN "AQUAPEL SERIES" Waterjets				
Model No.		***Max. Rec. Power Input***		
DJ60	(152mm)	100HP / 75kw	–	5500RPM
DJ80	(203mm)	302HP / 225kw	–	4500RPM
DJ85	(216mm)	402HP / 300kw	–	4200RPM
DJ100	(254mm)	302HP / 225kw	–	3600RPM
DJ105	(267mm)	335HP / 250kw	–	3400RPM
DJ110	(280mm)	402HP / 300kw	–	3200RPM
DJ130	(330mm)	503HP / 375kw	–	2800RPM
DJ140	(356mm)	805HP / 600kw	–	2600RPM
DJ142	(356mm) (2 Stage)	1073HP / 800kw	–	2400RPM
DJ160	(406mm)	1073HP / 800kw	–	2250RPM
DJ170	(432mm)	1670HP / 1250kw	–	2100RPM
DJ200 SERIES **INCLUDING**				
DJ200	(508mm)	1950HP / 1450kw	–	1800RPM
DJ220	(559mm)	2346HP / 1750kw	–	1600RPM
DJ260	(660mm)	3285HP / 2450kw	–	1350RPM
DJ280	(711mm)	3750HP / 2800kw	–	1250RPM
TWIN DISC WATERJETS TO MATCH ENGINES larger than 1450kw are made to order and to individual intake specifications.				

NOTE: BOOSTER JETS CAN BE PROVIDED TO ORDER FROM THE DJ130 AND UPWARDS.

Twin Disc srl
Via Dei Calzolai 92, 55040 Capezzano Pianore (Lu) Italy
Tel:+39 0584 969696, Fax:+39 0584 969692
E–mail Address: info@twindiscpropulsion.com

MODEL RANGE

The Twin Disc series of waterjets is a range of 12 axial flow models representing the latest technology and matching gasoline and marine diesel engines from 30HP to 3750HP. The range includes the DJ142 two stage unit specifically designed for the growing demand for high speed craft operating at 45+ knots.

The Principal of waterjet propulsion simply utilises Newton's Third Law of Motion:
"Every action has an equal and opposite reaction".

Water is drawn into the intake body of the Jet, and is discharged at the steering nozzle. The axial flow impeller, driven by the engine, pumps high volumes of water flowing through the Jet and discharging at the steering nozzle thus creating a forward thrust, which propels the vessel.

All TWIN DISC JETS jet models are supported by a comprehensive range of high thrust impellers ensuring correct selection and accurate matching of Jet and engine combination.

The large range of jet models, each with comprehensive range of impeller designs gives optimised matching and high propulsive efficiencies, at least equivalent to the best propeller systems at planing speeds.

All Jets are designed and manufactured in corrosion resistant aluminium castings and stainless steel fittings with sacrificial anodes for cathodic protection. The mounting face of the Jet is close to the transom, with part of the intake tunnel moulded (for fiberglass vessels) or fabricated (for aluminium/steel vessels).

This installation method allows the entire Jet to be quickly mounted to the vessel. It also has the added advantage of allowing for some flexibility in placement of the Jet, allowing the Jet to be mounted as far aft as possible. This simple mounting system eliminates the need for two holes, one in the transom and the other in the bottom of the boat. It also simplifies the sealing of the waterjet to the hull and eliminated the need for a complex bolting of flanges at the keel line.

All TWIN DISC JETS jet models feature a unique Teflon sealed Steering System which minimizes discharge flow disturbance and channels 100% of thrust into turning effort. Steering is actuated via an inboard mounted tiller and from the DJ100 upwards, controlled by a manual hydraulic system.

The high thrust, split ducted, reverse bucket provides full thrust at any steering nozzle angle, resulting in excellent maneuverability and provides an infinite range of ahead, zero, or astern speeds. There are several hydraulic reverse bucket control systems available to suit every application.

The repairs and maintenance of all TWIN DISC JETS Jet models is simple. There is a separate stator assembly and impeller casing/wear ring, which allows easy access to rotating points for periodic inspection and service. The Bearing Housing Assembly is designed as a separate entity, which can be removed without dismantling the unit or removing the main shaft.

Not all hull forms are suitable for Jet applications.

The design of the vessel should be optimised to suit the specific criteria required of the vessel and the hull shape and size are suitable for the displacement.

PLANING MONOHEDRAN VESSELS HIGH SPEEDS 25 KNOTS PLUS

1. Design for a minimum speed of 25 knots at laden displacement. This should be at cruise mode.
2. The propulsive efficiency of direct coupled waterjets increases as the boat speed increases over 25 knots.
3. Constant deadrise (monohedran hulls) are preferred lines in vessels operating in the 25 knot plus speed region. These shapes give better directional stability, handling and performance.
4. The Deadrise angle of the boat should generally be between 8° and 25° to stop aerated water entering the Jet intake and causing cavitation.
5. The hull should be true and without hooks.
6. There should be no obstructions to the water flow in front of the intake tunnel. Keels or planing strakes should be eliminated for 2 metres in front of the intake tunnel. These items are generally acceptable outside the intake areas. The intake ramp leading from the keel line to the intake tunnel must be even and less than 15°. (Single installations in monohulls or catamarans).
7. An easy rising bow stem is ideal for planing vessels. A deep fine forefoot should be avoided as this leads to poor handling and bow steer.
8. Monohedran hulls (constant deadrise from a point approximately midship to the transom) are excellent for high speed applications and the trim angle remains constant during planing as speed increases.

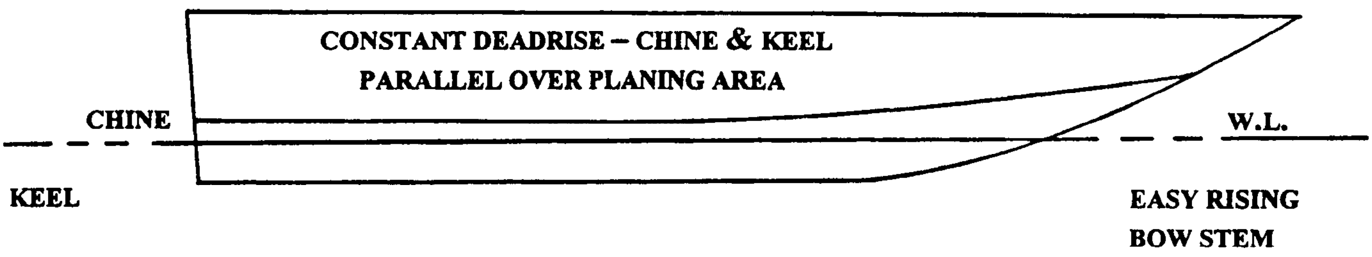
Refer Diagram 1 — Page 3

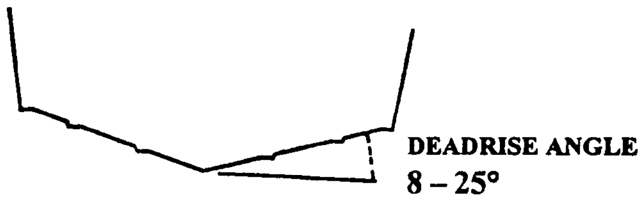
MULTI HULLS
HIGH SPEEDS 25 KNOTS PLUS

Waterjets are suitable for most multi–hull vessels. The resistance of some of these vessels can be higher than monohedran hulls. Consult Pacific Jets on all applications.

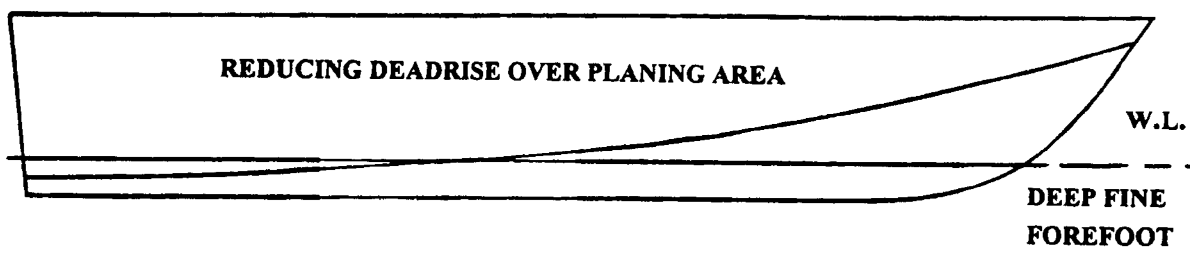
DIAGRAM 1

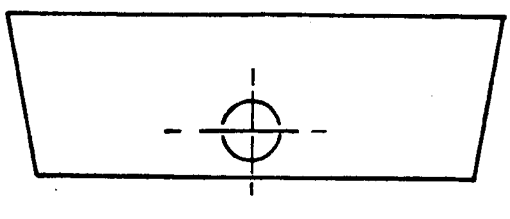
GOOD PLANING WATERJET HULL





POOR PLANING WATERJET HULL





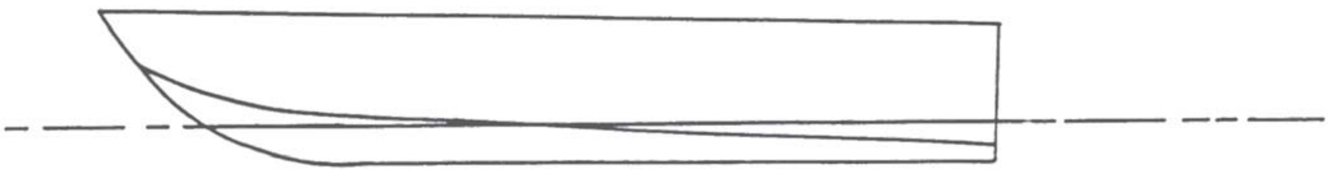
SEMI-PLANING VESSELS
10-25 KNOTS

1. Warped Hulls

These hulls have a chine that drops continually from the bow to the stern – so they have a constantly dropping deadrise angle over the planing area to often quite flat sections at the transom.

This hull shape produces a flat planing attitude and is very good for load carrying craft. With relatively lower power inputs, warped hull will plane quickly and give good ride characteristics due to the flatter trim angle.

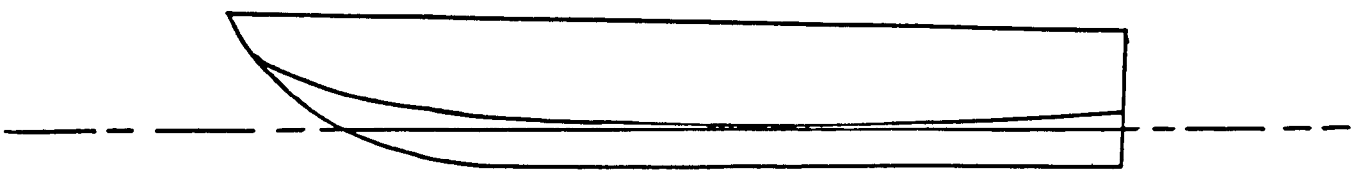
NOTE: The hull resistance for some vessels can be high in the semi planing speed range.



2. Rocker

This hull form has a chine that drops continuously from the bow to amidships and then increases as it approaches the transom.

This hull shape is ideal for or vessels operating in a semi–planing condition or Displacement Applications.



DISPLACEMENT HULLS
SLOW SPEEDS 0-10 KNOTS

Pure displacement hulls have a **NATURAL DISPLACEMENT SPEED** (NDS) which directly relates to the WLL and the resistance of their hull shape.

The **NATURAL DISPLACEMENT Speed Guide Table** can be used as a guide in determining appropriate boat speed depending on whether the hull has a **LOW** or **HIGH** hull resistance.

The Natural Displacement Speeds of a pure displacement hull shape should not be exceeded.

Displacement craft require moderate power inputs to achieve their NDS. The power to weight ratio (HP/tonne) to achieve NDS varies from approximately 5 HP/tonne for low resistance hulls to 15 HP/tonne for high resistance hulls.

Total Power (HP) = **Power to weight ratio** (HP/tonne) **x** **All Up Weight** (tonne)

For multiple Jet applications divide the total power by the number of Jets to get the power required per Jet. Select an engine at least equal to or of greater power than required, within the RPM band of the selected Jet model (Refer RPM –V's– HP curves – Impeller performance curves)

Model No.	MAX. HP/RPM	Model No.	MAX. HP/RPM
DJ85	120 @ 3000	DJ130	300 @ 2000
DJ100	150 @ 2600	DJ140	350 @ 1850
DJ105	210 @ 2400	DJ160	480 @ 1600
DJ110	240 @ 2300	DJ170	550 @ 1500

NOTE:

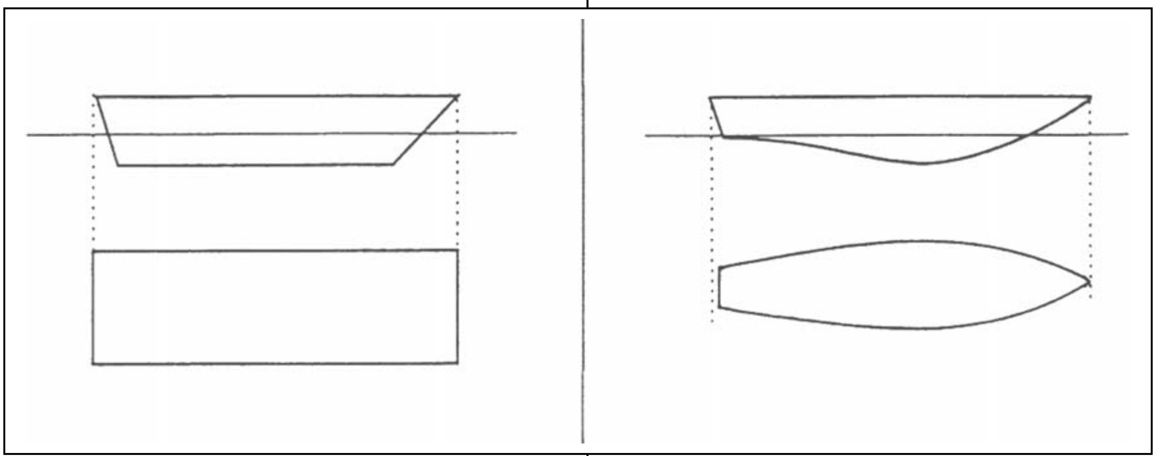
The natural displacement Speed Guide Table makes several assumptions when determining whether a vessel has a LOW or HIGH hull resistance and MUST be used as a GUIDE only. It does not take into consideration variables in the hull such as beam, deadrise, longitudinal, vertical, horizontal centre of gravity etc. which will affect hull resistance

FOR ACCURATE SPEED ESTIMATES HULL RESISTANCE DATA
is required to superimpose on the Dynamic Thrust Curves of the various Jet Models.

DISPLACEMENT VESSELS
0-10 KNOTS

These vessels have a **NATURAL DISPLACING SPEED** (N.D.S.)which is a function of their length and efficiency or resistance of their hull shape, rather than the power input, or their displacement.

High Resistance	Low Resistance
– Low length to beam Ratio. (Less than 3:1) – Flat bow shape. (landing crafts / barges) – Large areas of submerged transom. – Heavy displacement.	– High length to beam Ratio. (Greater than 3:1) – Conventional Vee bow. – Minimum area of submerged transom. – Light displacement



NOTE:
- The Jet must be submerged at least up to the Jet driveshaft to prime when the vessel is stationary. For vessels with low transom emerson, modifications to the hull may be necessary.
- A deadrise of a minimum of 8° is recommended at the transom to avoid air entering the Jet intake.
- Appendages such as keels/strakes should be kept clear in front of the Jet intake, in order to stop possible cavitation. (Refer Pacific Jets for the correct distance as this distance will vary depending on Jet Model selected).

The basic information required to select a TWIN DISC JETS Jet to match an engine and vessel is contained in the APPLICATION CHECKLIST.

Once this information is available it is possible to select an appropriate Jet Model (or multiple of Jets).

Each Jet Model has maximum recommended displacements at maximum power inputs. This is summarized in the JET SELECTION – BY DISPLACEMENT table.

NOTE:

1. THESE SELECTION TABLES are a guide only and utilize only one factor in the selection process (**DISPLACEMENT**). Other factors including waterline length, engine selection, hull shape and intended usage influence the final Jet selection for optimum propulsive efficiencies.
2. Tables assume that the hull shape selected is suitable for the intended use and speed. The Jet is installed correctly and there are no keels, appendages or aeration.
3. Laden displacements listed in the table are **MAXIMUM**. Displacements well below the maximum All Up Weight (A.U.W.) are required for best propulsive efficiency.
4. A.U.W, in the grey area will generally result in reduced propulsive efficiency and may have application restrictions.
5. Table assumes that the trim of the vessel is optimised for the intended use and speed.

ALL APPLICATIONS MUST BE CHECKED BY TWIN DISC APPLICATION DEPARTMENTS PRIOR TO ORDER OR CONSTRUCTION, ESPECIALLY APPLICATIONS WHICH FALL IN THE SHADED DISPLACEMENT AREAS

HIGH SPEED VESSELS
PLANING MONOHEDRAN HULLS

Maximum All Up Weight (A.U.W.) tonnes @ Maximum R.P.M.

TWIN DISC JETS	**Jet Model**		**10 20 30 40 50**
DJ85	Single Jet	2.5 T max	
	Twin Jet	5.5 T max	
	Triple Jet	9.0 T max	
DJ100	Single Jet	3.5 T max	
	Twin Jet	8.0 T max	
	Triple Jet	12.0 T max	
DJ105	Single Jet	4.0 T max	
	Twin Jet	9.0 T max	
	Triple Jet	14.0 T max	
DJ110	Single Jet	5.0 T max	
	Twin Jet	10.0 T max	
	Triple Jet	17.0 T max	
DJ130	Single Jet	7.0 T max	
	Twin Jet	17.0 T max	
	Triple Jet	22.0 T max	
DJ140	Single Jet	9.0 T max	
	Twin Jet	20.0 T max	
	Triple Jet	33.0 T max	
DJ142	Single Jet	7.0 T max	
	Twin Jet	18.0 T max	
	Triple Jet	28.0 T max	
DJ160	Single Jet	12.0 T max	
	Twin Jet	26.0 T max	
	Triple Jet	43.0 T max	
DJ170	Single Jet	12.0 T max	
	Twin Jet	26.0 T max	
	Triple Jet	43.0 T max	
DJ200	Single Jet	17.0 T max	
	Twin Jet	38.0 T max	
	Triple Jet	60.0 T max	
DJ220	Single Jet	22.0 T max	
	Twin Jet	49.0 T max	
	Triple Jet	78.0 T max	

DISPLACEMENT HULLS

Maximum All Up Weight (A.U.W.) tonnes @ Maximum R.P.M.

TWIN DISC JETS	Jet Model		10 20 30 40 50
DJ85	Single Jet	6 T	
	Twin Jet	13 T	
	Triple Jet	22 T	
DJ100	Single Jet	8 T	
	Twin Jet	17 T	
	Triple Jet	28 T	
DJ105	Single Jet	9 T	
	Twin Jet	20 T	
	Triple Jet	30 T	
DJ110	Single Jet	10 T	
	Twin Jet	22 T	
	Triple Jet	38 T	
DJ130	Single Jet	15 T	
	Twin Jet	33 T	
	Triple Jet	60 T	
DJ140	Single Jet	20 T	
	Twin Jet	45 T	
	Triple Jet	90 T	
DJ160	Single Jet	26 T	
	Twin Jet	60 T	
	Triple Jet	95 T	
DJ170	Single Jet	30 T	
	Twin Jet	66 T	
	Triple Jet	108 T	
DJ200	Single Jet	36 T	
	Twin Jet	80 T	
	Triple Jet	130 T	
DJ220	Single Jet	42 T	
	Twin Jet	90 T	
	Triple Jet	142 T	

The Speed Guide Table relates power to weight ratios (HP/Tonne) for a given **WATERLINE LENGTH** (W.L.L.) to boat speed.

With a known engine HP, the A.U.W. of the vessel and the W.L.L., plot a vertical line from the W.L.L. to the HP/tonne curve and draw a horizontal line to read off the boat speed (knots).

If the engine power is not selected, but W.L.L. and expected boat speed are known, plot a horizontal and vertical line, and their intersection will give the required power to weight ratio (HP/tonne).

Once the required power to weight ratio (HP/tonne) is established from the Speed Guide Table, the total power requirement is obtained by:

Total Power = Power/Weight Ratio (HP/Tonne) **x** **All Up Weight** (A.U.W.) (Tonnes)

For multiple Jet installations divide total power by the number of Jets to give the power output required per engine.

Select an engine HP, at least equal to or greater than that required from the Speed Guide Table.

The selected engine must have an RPM range within the impeller band of the selected Jet. (Refer to the **POWER/RPM PERFORMANCE CURVES** for the various TWIN DISC JETS Jet models).

If the hull resistance information of the vessel is known, this can be superimposed over the Jet's **Dynamic Thrust Curves** to obtain more accurate speed estimates.

In the absence of hull resistance data, the information on the application checklist is required.

Dynamic Thrust Curves are typical for a given Jet. Different impeller/nozzle combinations will deviate slightly from stated curves.

Steps For Using Hull Resistance Data And Dynamic Thrust Curves

1. Obtain vessel hull resistance data. This may be represented as a force versus speed or can be represented as effective power versus speed.

2. In order to plot the vessel resistance onto the Dynamic Thrust curves, resistance information must be converted to the correct units. Please find typical conversion factors:

Newtons to lbfs	→	Newton x 02248	=	lbsf
Km/h to knots	→	Km/h x 0.5399	=	knots
mph to knots	→	mph x 0.8689	=	knots

effective power to resistance (lbsf)

$$\text{Resistance (lbsf)} = \frac{\text{Power effective (kW)} \times 437}{\text{Velocity (knots)}}$$

3. If it is a multiple installation then the resistance data must be divided by the number of units. For example: In a twin installation only half the resistance is plotted onto the dynamic thrust curves etc.

4. With the vessel resistance now superimposed onto the Dynamic Thrust curves we can now use this information to determine:

   a) If an engine is already selected, then maximum speed can be predicted. Where the resistance curve crosses the rated horsepower contour, plot down vertically to the horizontal axis and read off speed.

   b) If a certain speed is required, then horse power required can be determined. From the horizontal axis at required speed, plot up vertically until you cut the resistance curve. Read off at this point the corresponding horsepower contour.

   c) Procedure (b) can be applied all along the resistance curve to determine horsepower required to do a range of speeds. These horsepower figures can then be related to the applicable impeller performance curve and the engine RPM, at the various speeds.

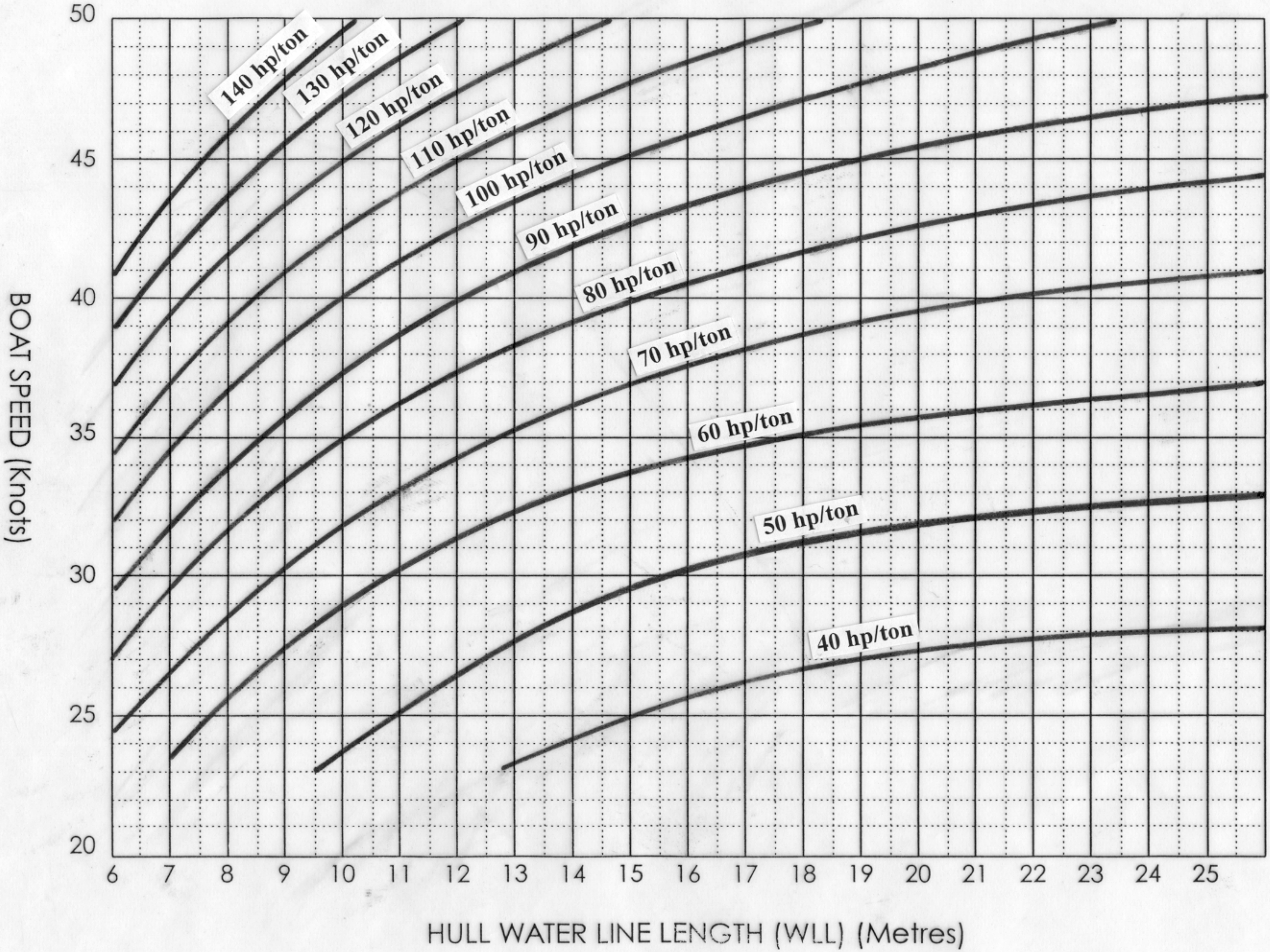
POWER / WEIGHT PERFORMANCE CURVES

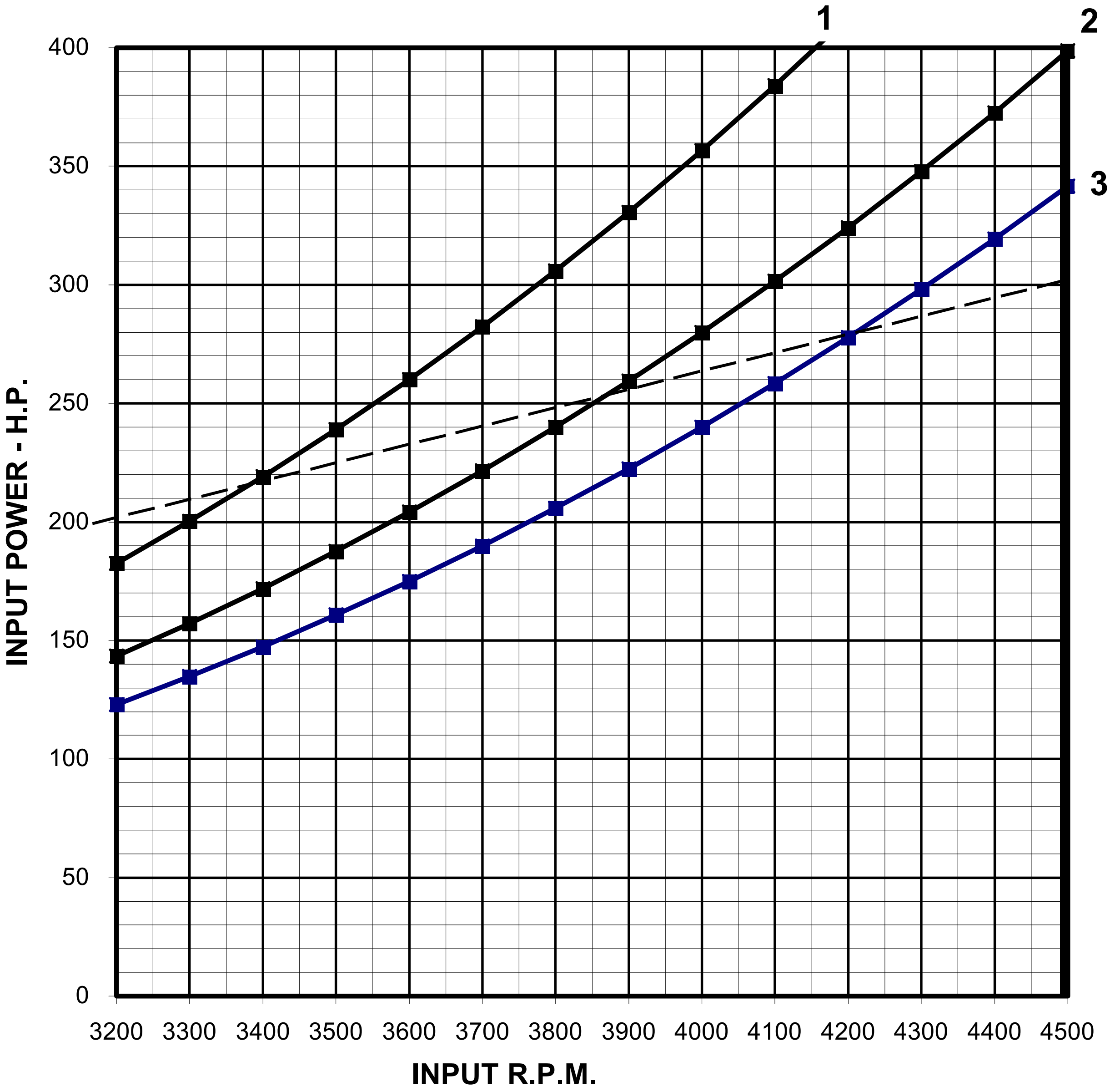
- ✪ Using the "Speed Guide Table" plot a vertical line corresponding to the waterline length of the craft (m).
- ✪ For best propulsive efficiency, plan for a minimum speed of 25 knots.
- ✪ At the point where the vertical line intersects the nominated boat speed on the horizontal axis, read off the required power/weight ratio (HP/tonne).

OR

- ✪ Where the vertical line intersects the HP/tonne curve, read off the boat speed in knots.
- ✪ Speeds predicted from this table are approximate only, eg. deep vee hulls may be 2–3 knots slower.
- ✪ Short waterline vessels (5–9 metres) may also be slower than curve estimates. The curves also assume an efficient hull shape and the trim of the vessel is optimised.
- ✪ Should an accurate speed estimate be required, hull resistance data can be superimposed over the Jet Dynamic Thrust Curves.

SPEED GUIDE TABLE

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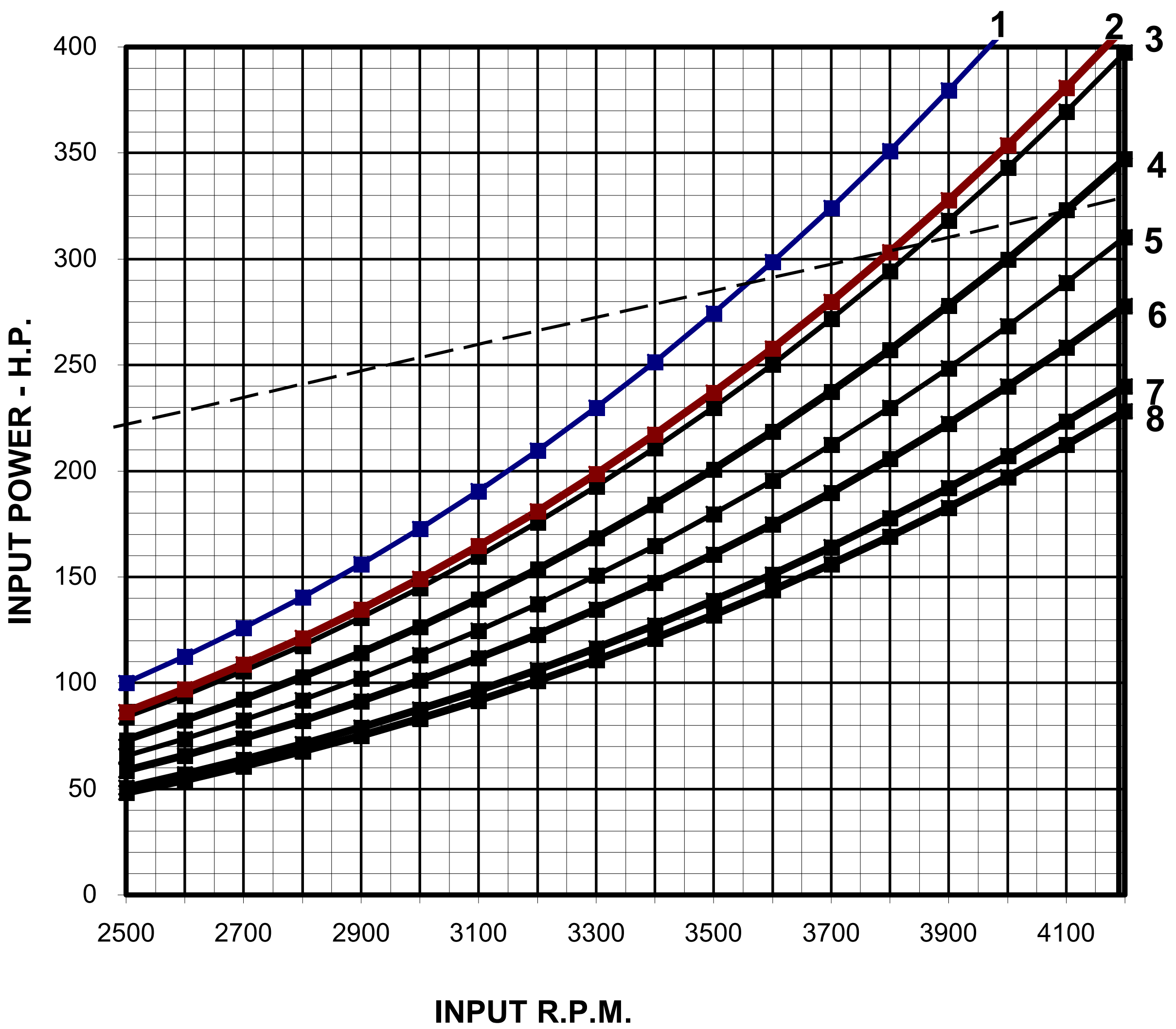
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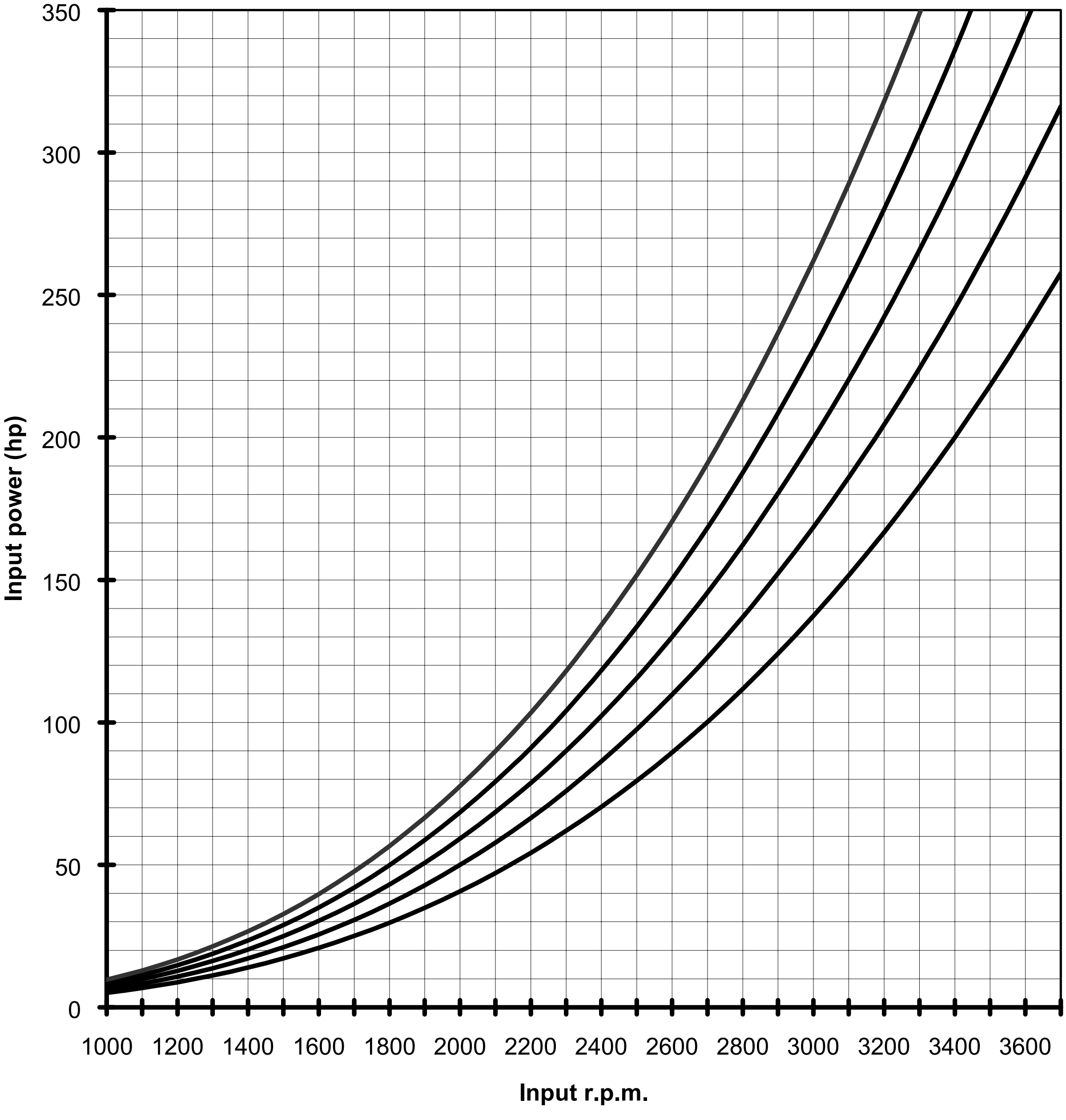
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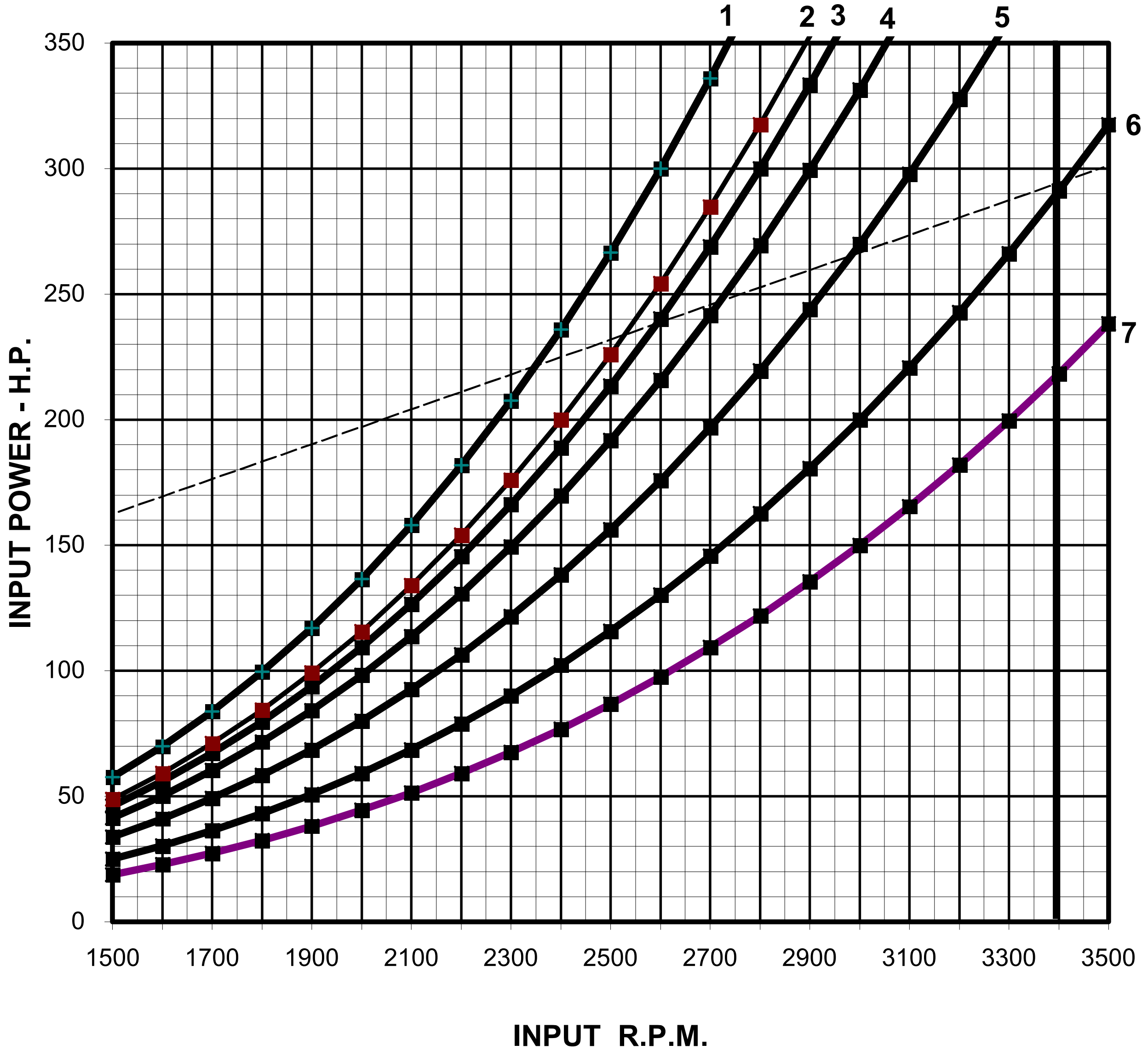
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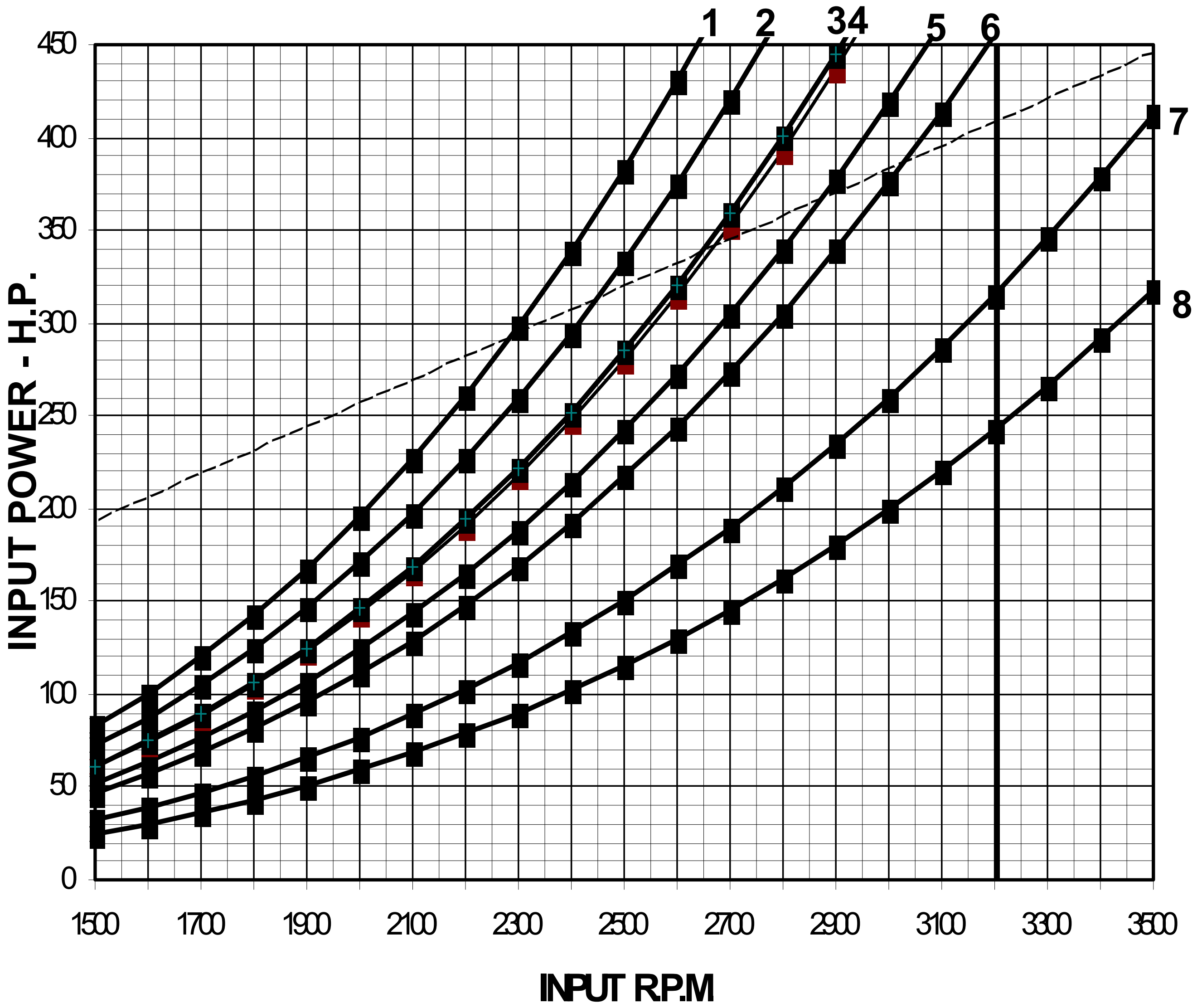
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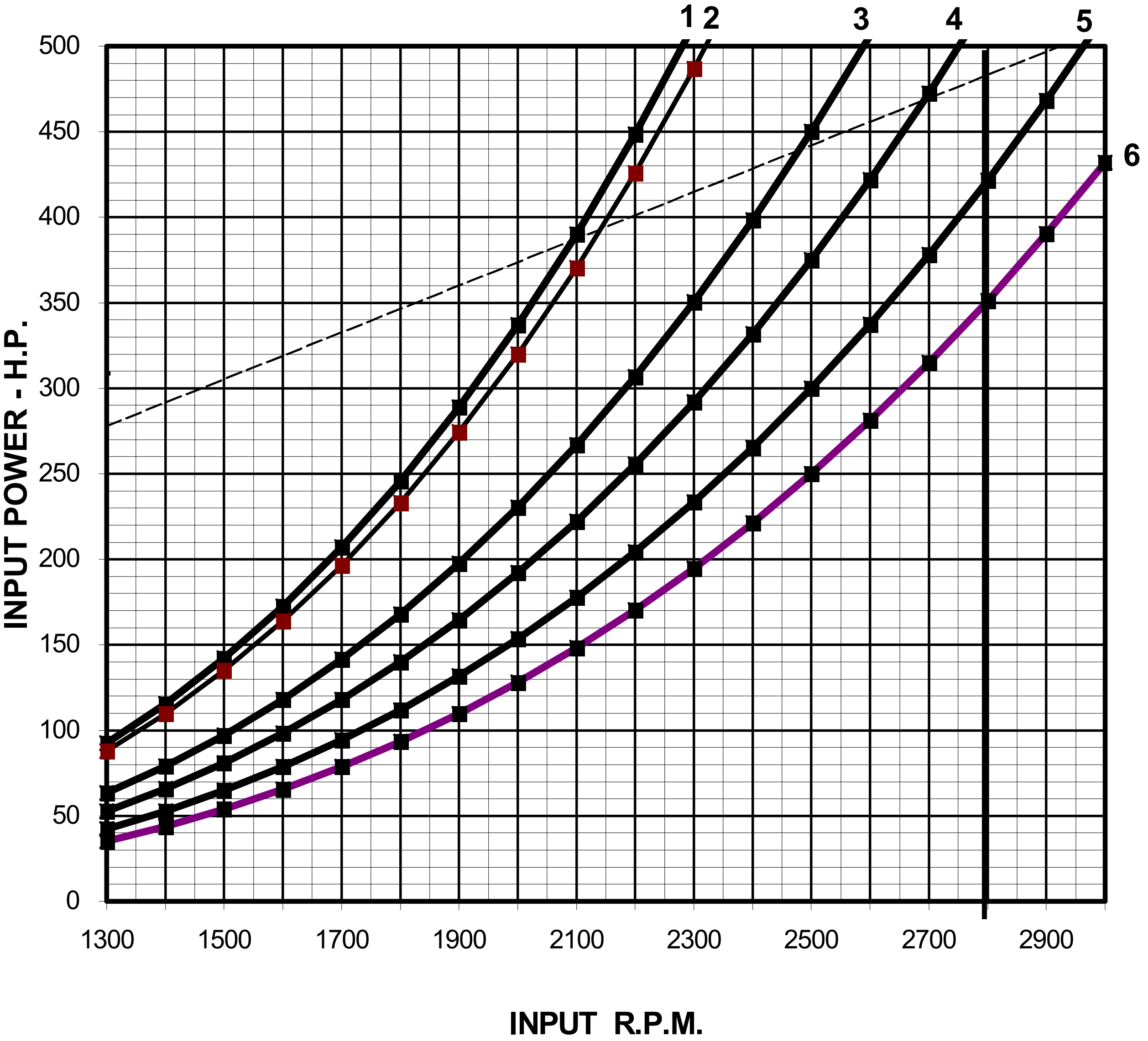
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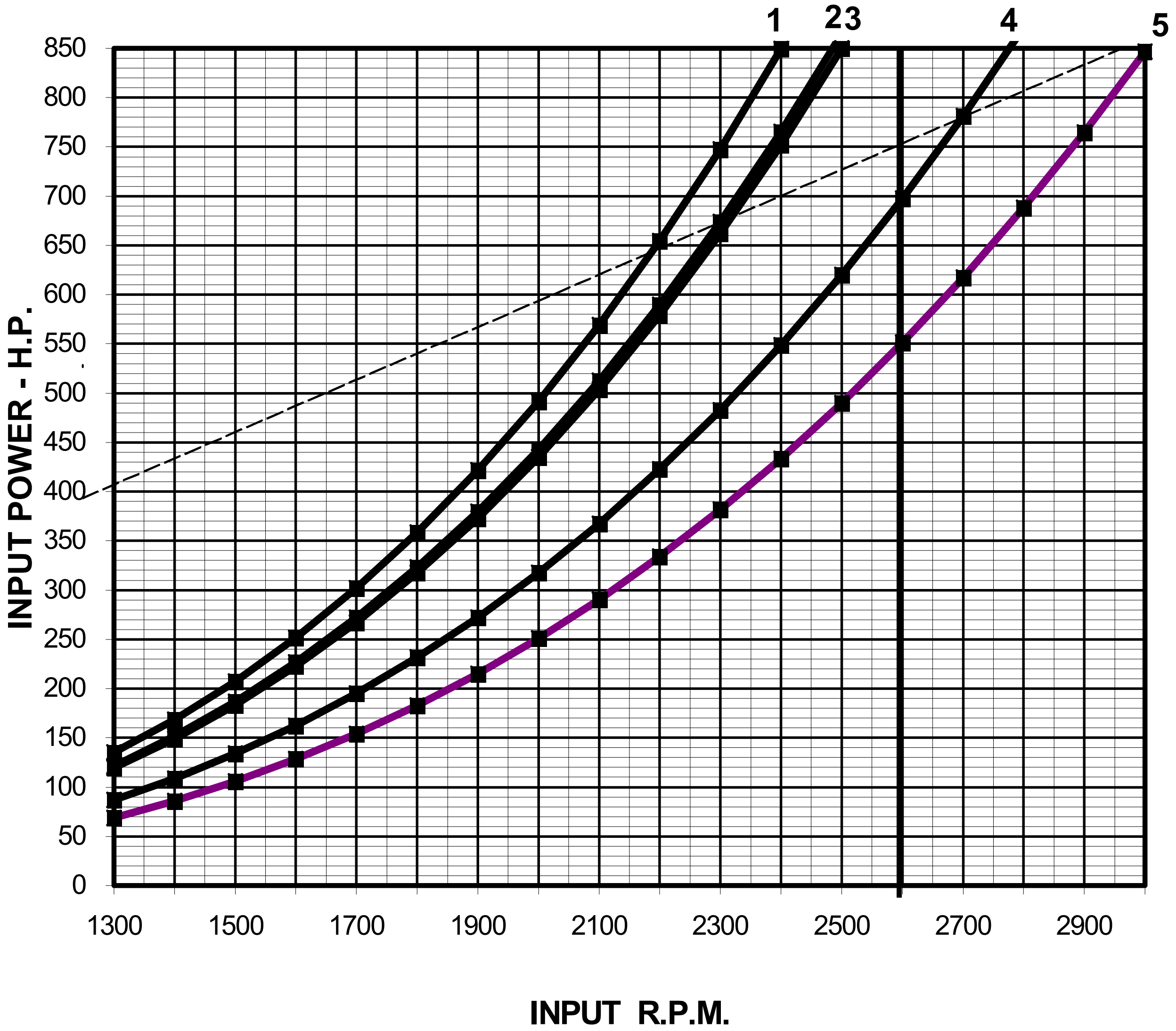
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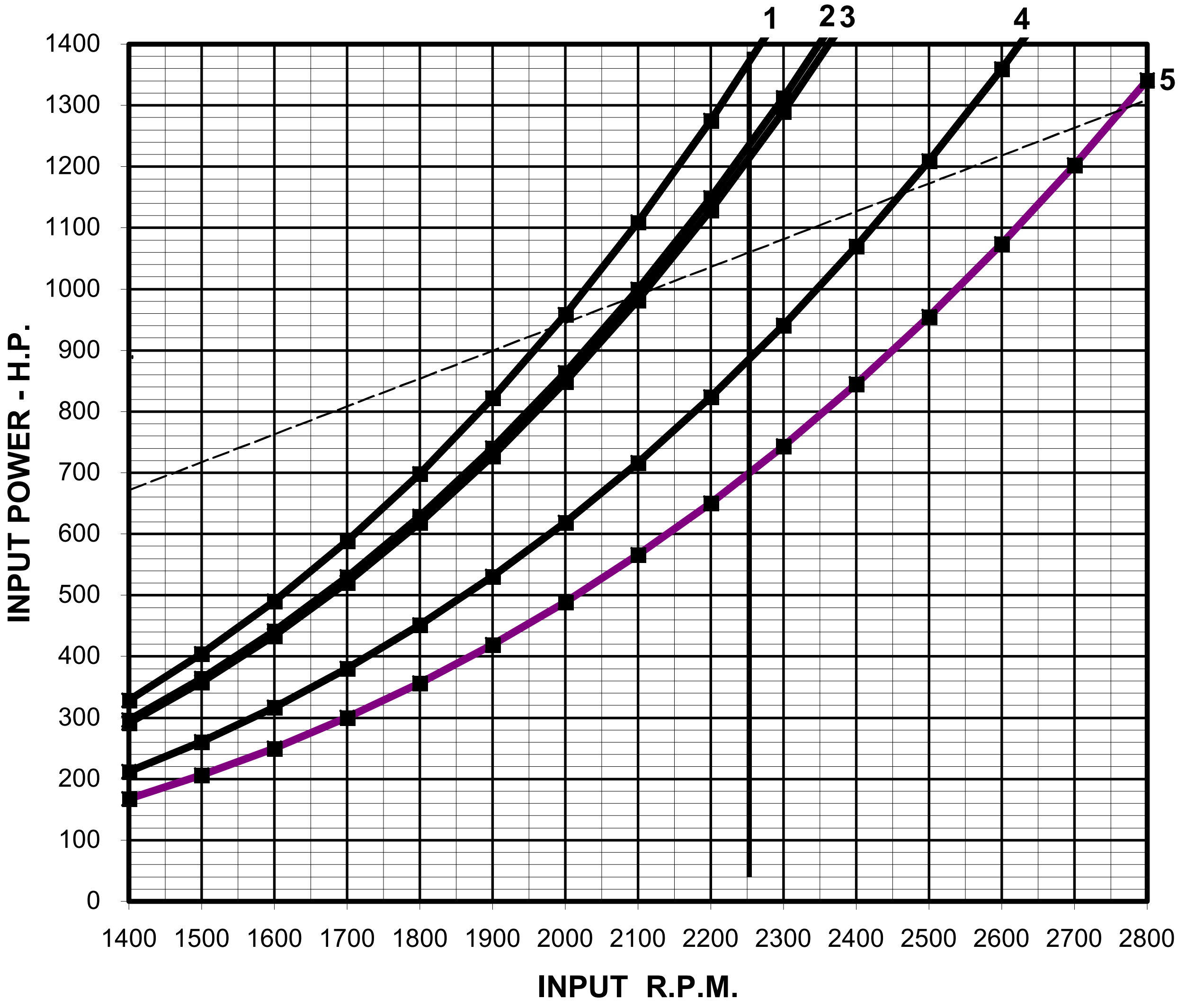
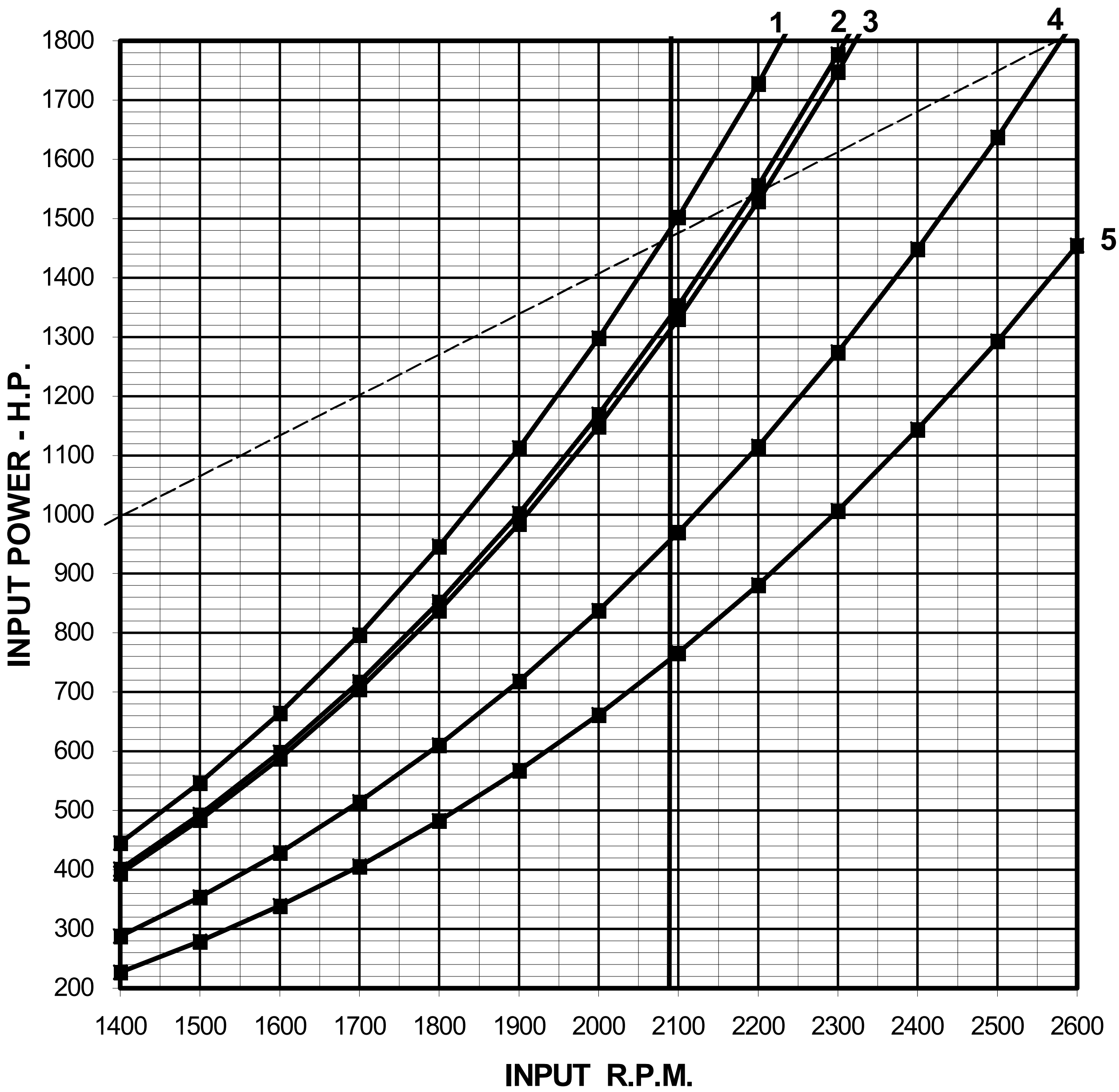
MODEL NO

Performance Curve DJ160

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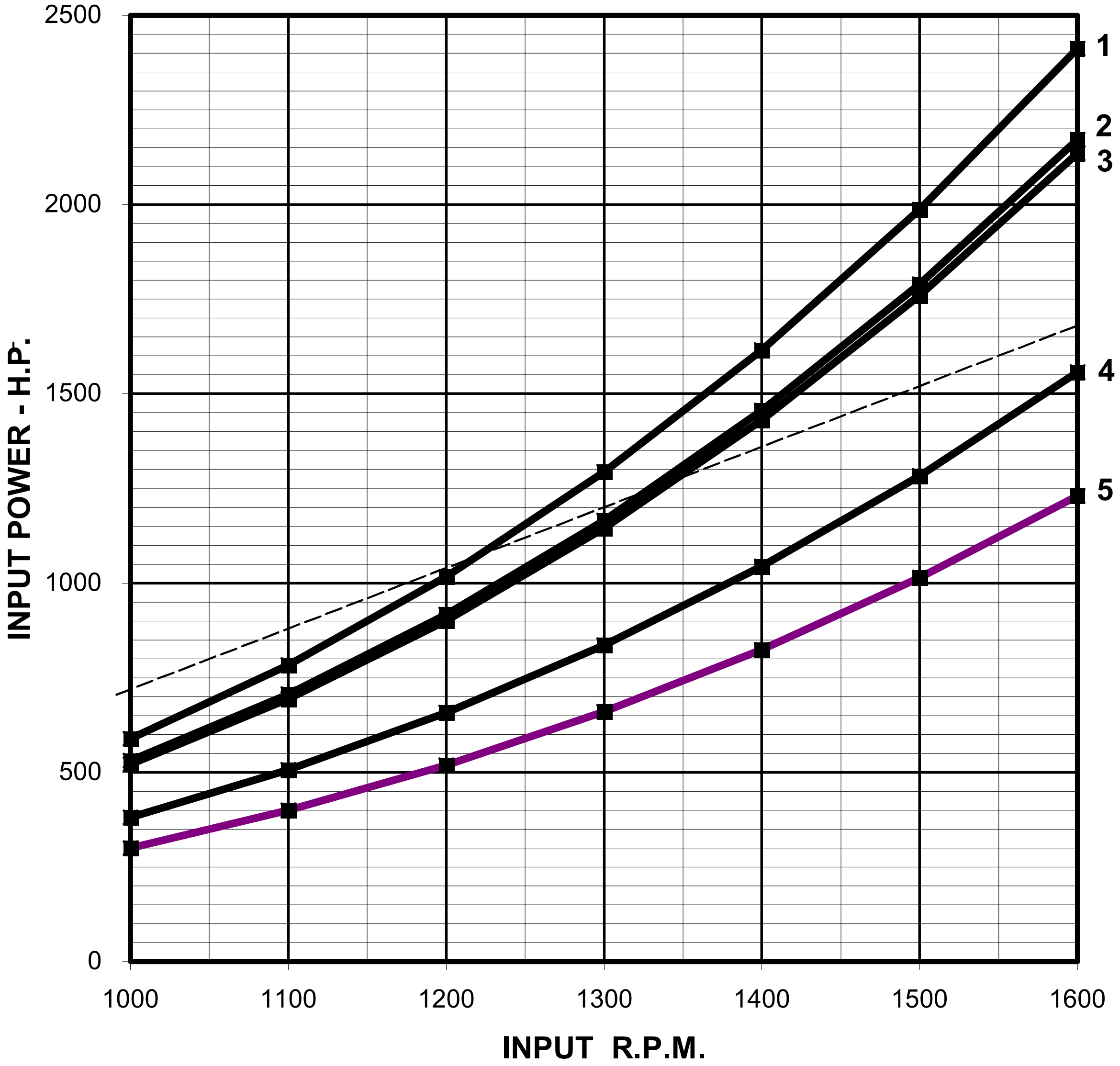
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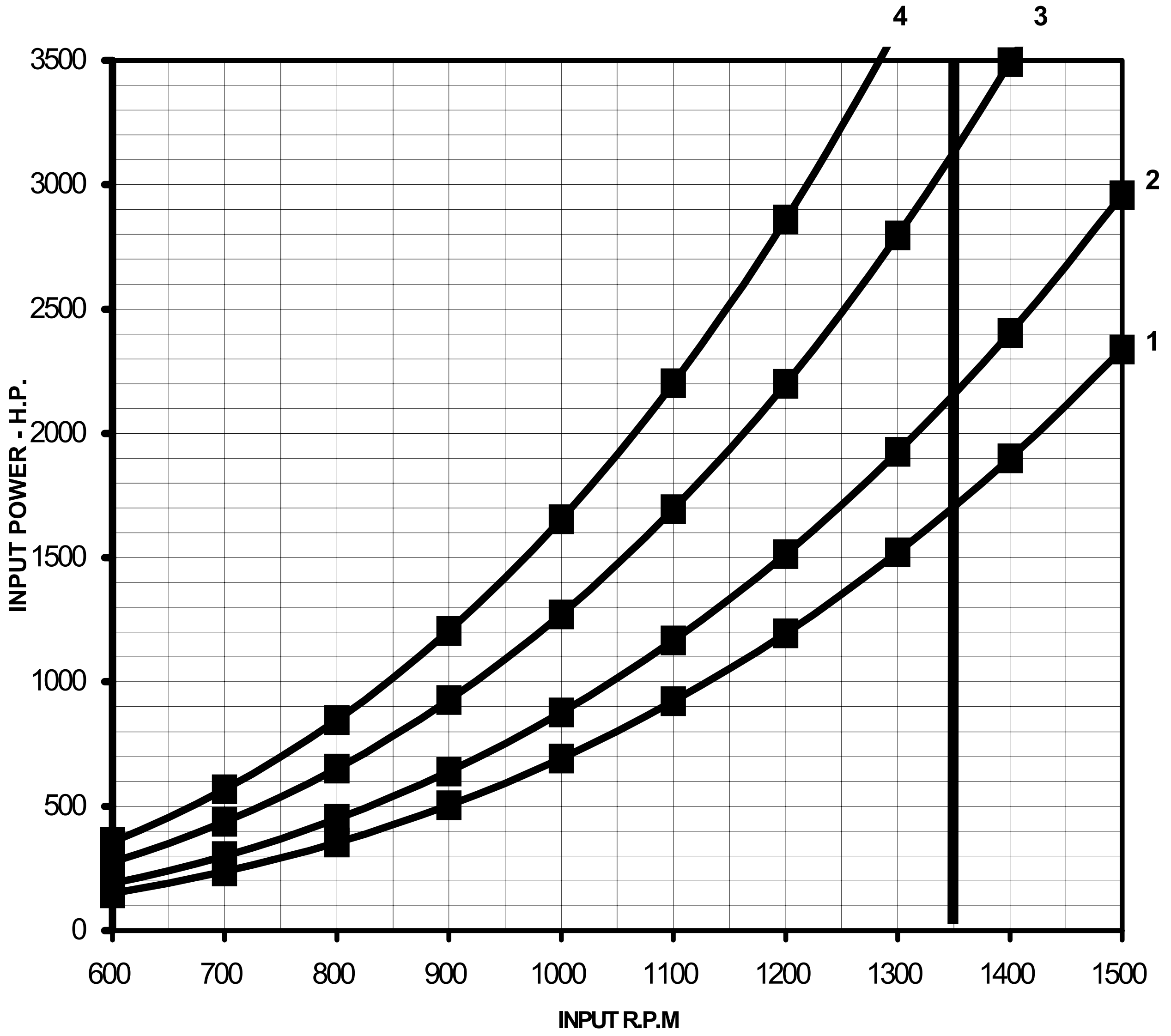
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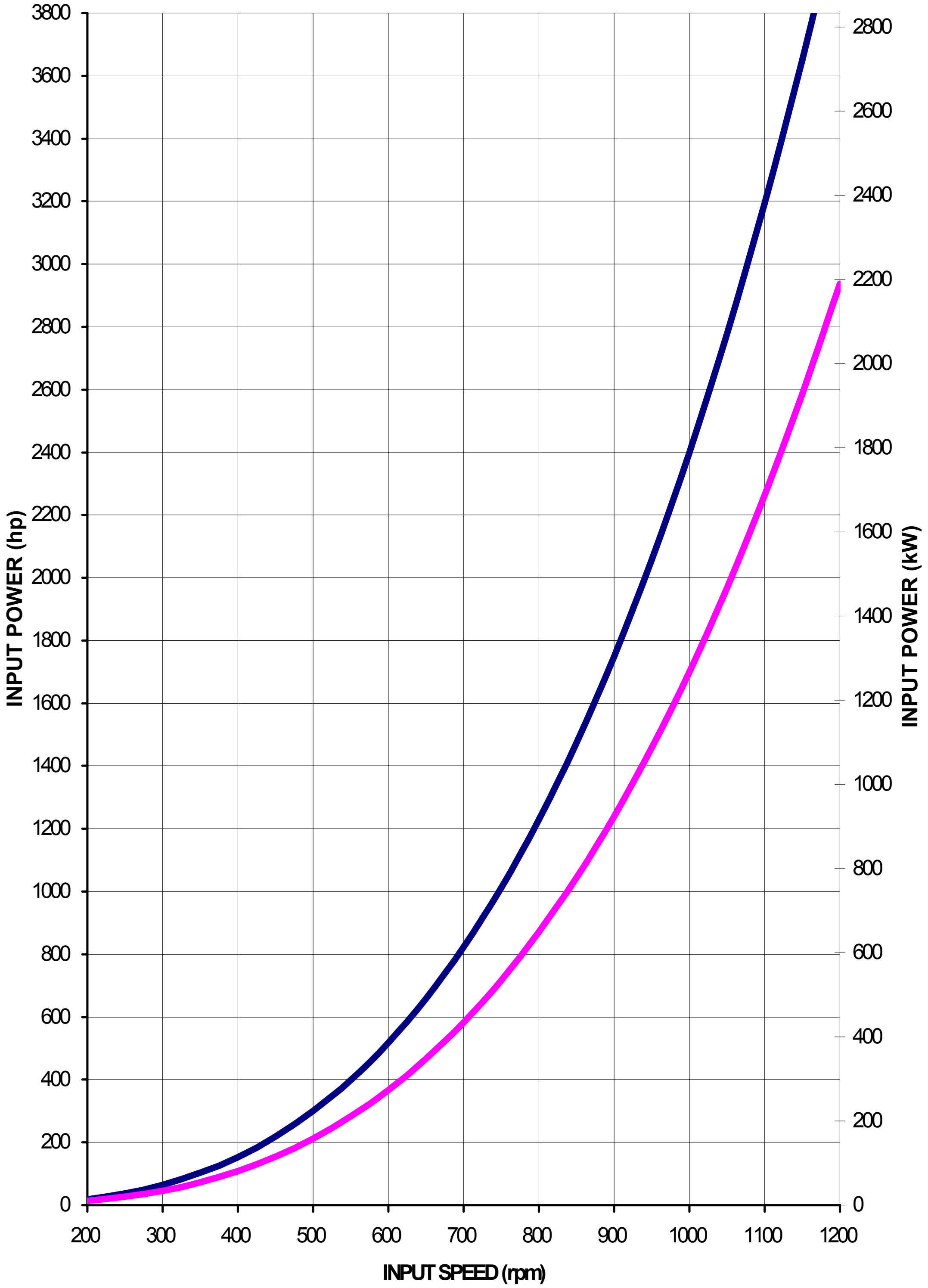
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1000
800
600
400
200
0
INPUT POWER (kW)
200
300
400
500
600
700
800
900
1000
1100
1200
INPUT SPEED (rpm)