Industrial Technology
Business Unit
Marine Propulsion Systems
Commercial Craft Thruster Systems

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Subject: **Performance curves**
Version: Rev03

1. Project and Thruster information

Project information

Vessel type:	ASD Tug
Client :	P & R Water Taxi, Honolulu, Hawaii
Classification:	ABS ✠ A1, ✠ AMS

ZF Marine Krimpen b.v.
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Chamber of Commerce nr. (Rotterdam): 24299979
Company subject to management and control by ZF Friedrichshafen AG, with headquarters in Friedrichshafen (Germany)
www.zf.com/marine - info.thruster@zf.com

Thruster information

Type :	2x ZF AT 7**3**11 WM-FP
Rated Power :	1590 kW – 2131 hp @ 1600 rpm (driven by Caterpillar 3512C with 1678 kW – 2250 hp @ 1800 rpm, Zone 2 Curve 2)
Rated Torque :	9490 Nm
Rated engine speed :	**1800 rpm**
Propeller diameter :	Ø 2100 mm – 83" in nozzle, 4 blades -> **pitch is decreased with 7%** related to the pitch of the propellers for orders 5155 (Tiger 5) / 6771 (Tiger 6 & Tiger 7) / 8225 (Tiger 8) / 8226 (Tiger 9)
Reduction ratio :	**5.213** : 1
Design speed propellers :	6 knots

The propulsion calculation is based on the following data :

- a wake fraction (alteration factor of water into propeller plane) of **w = 0.10**
- a Thrust deduction factor in bollard pull of **t = 0.06**
- blade area ratio of nozzle propellers **Ae / Ao = 0.70**
- **maximum Engine rotation rate = 1650 rpm**.

Important note:

The calculated values in this report are valid for trial conditions:

- *Clean hull and propellers;*
- *Deep water beneath keel (water depth more than 5.5 times the draught of ship);*
- *No current, wind and waves not exceeding Beaufort 2 / Sea State 1*
- *The Bollard Pull Test requirements as given in the ZF Procedure P0300.*

2. Thrust versus Rpm

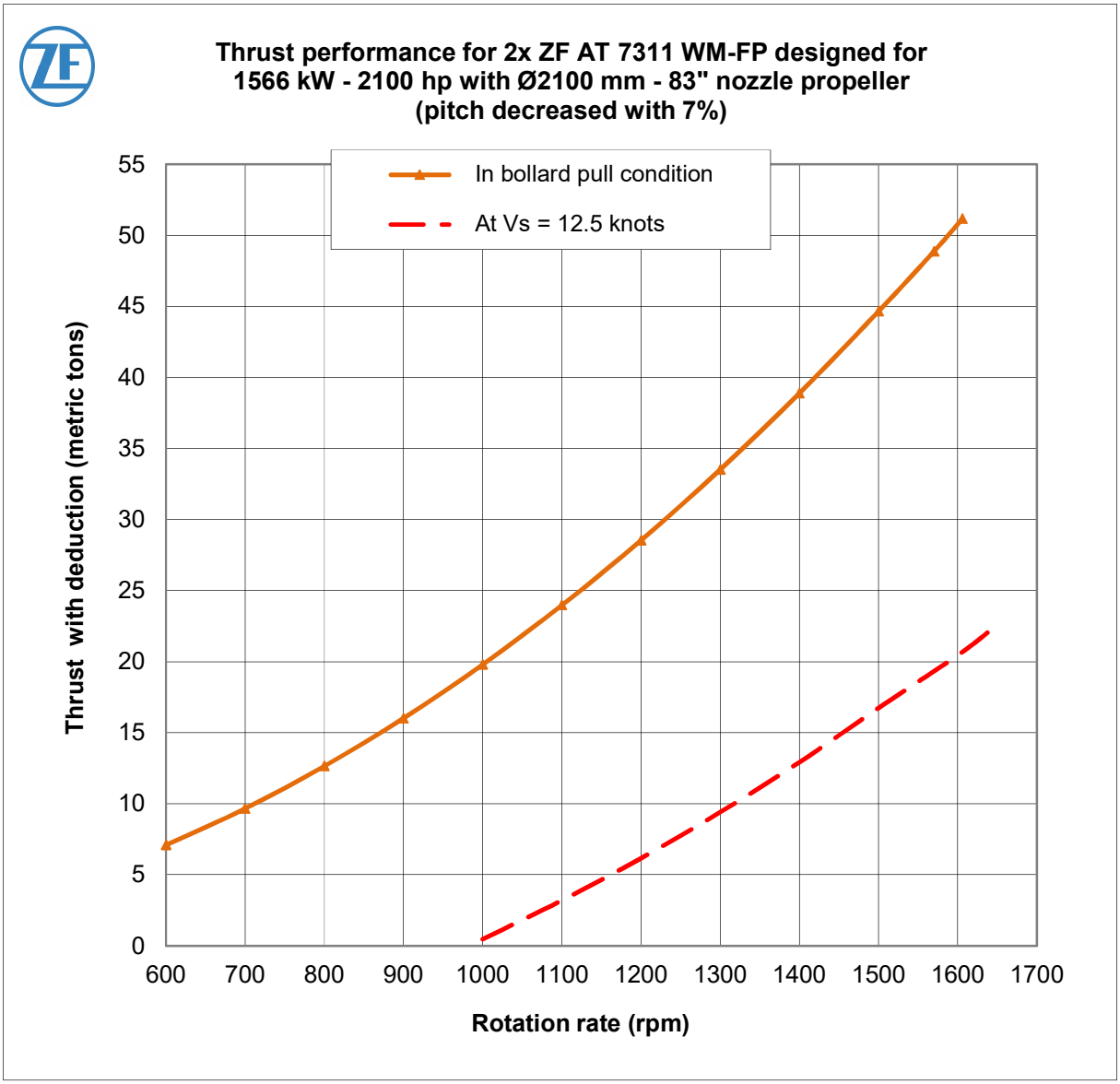


Figure 2.1 **Curves for Thrust versus Rpm**

For bollard pull condition a Thrust deduction factor is assumed: **t = 0.06**.
With this factor incorporated then a Thrust could be delivered of almost **51.2 metric tons** for an engine power of 1678 kW – 2250 hp. This thrust is equal to 51.2 / 1.016 = **50.39 long tons**.

3. Power and Torque versus Rpm

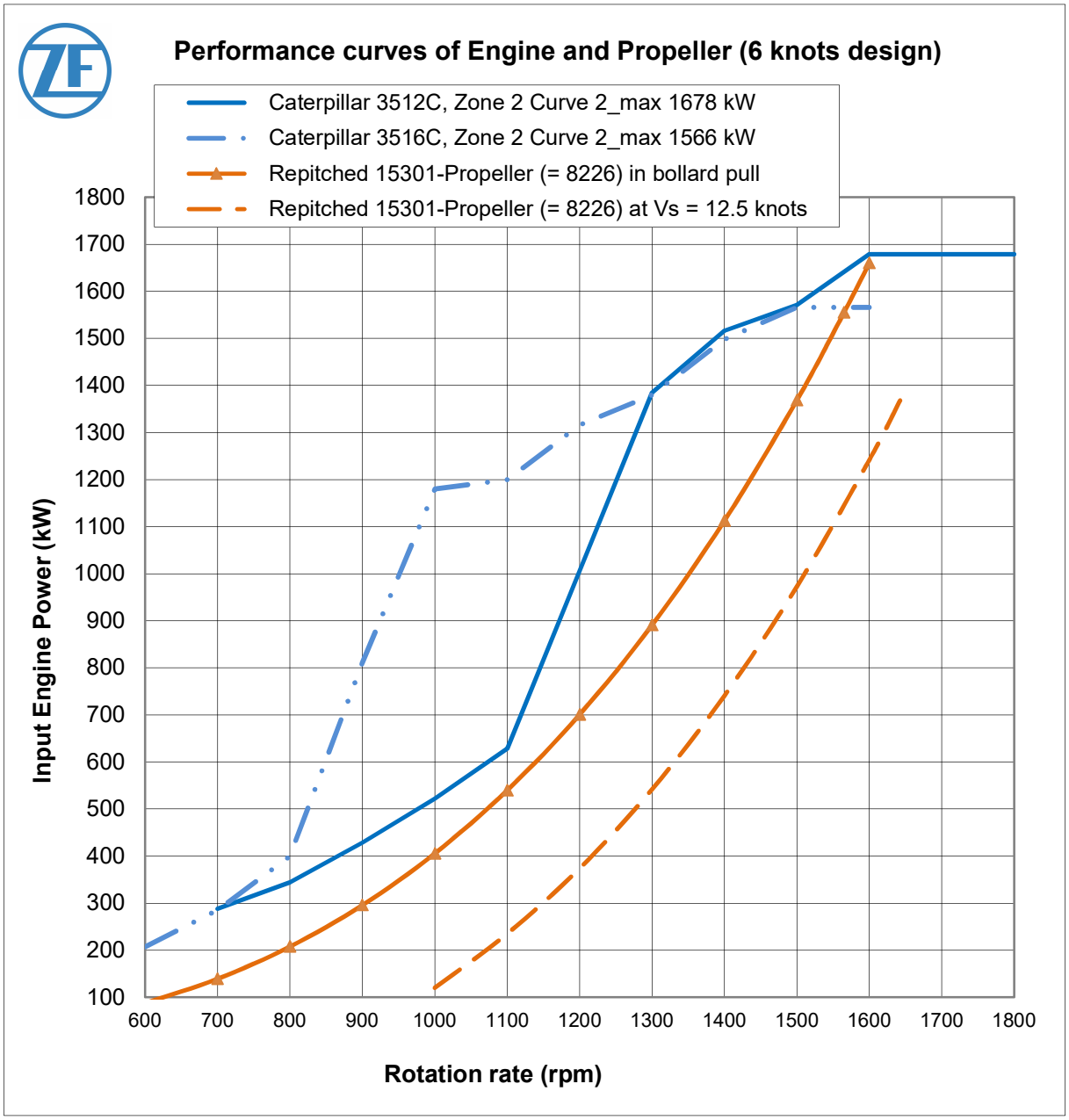


Figure 3.1 Curves for Power versus Rpm

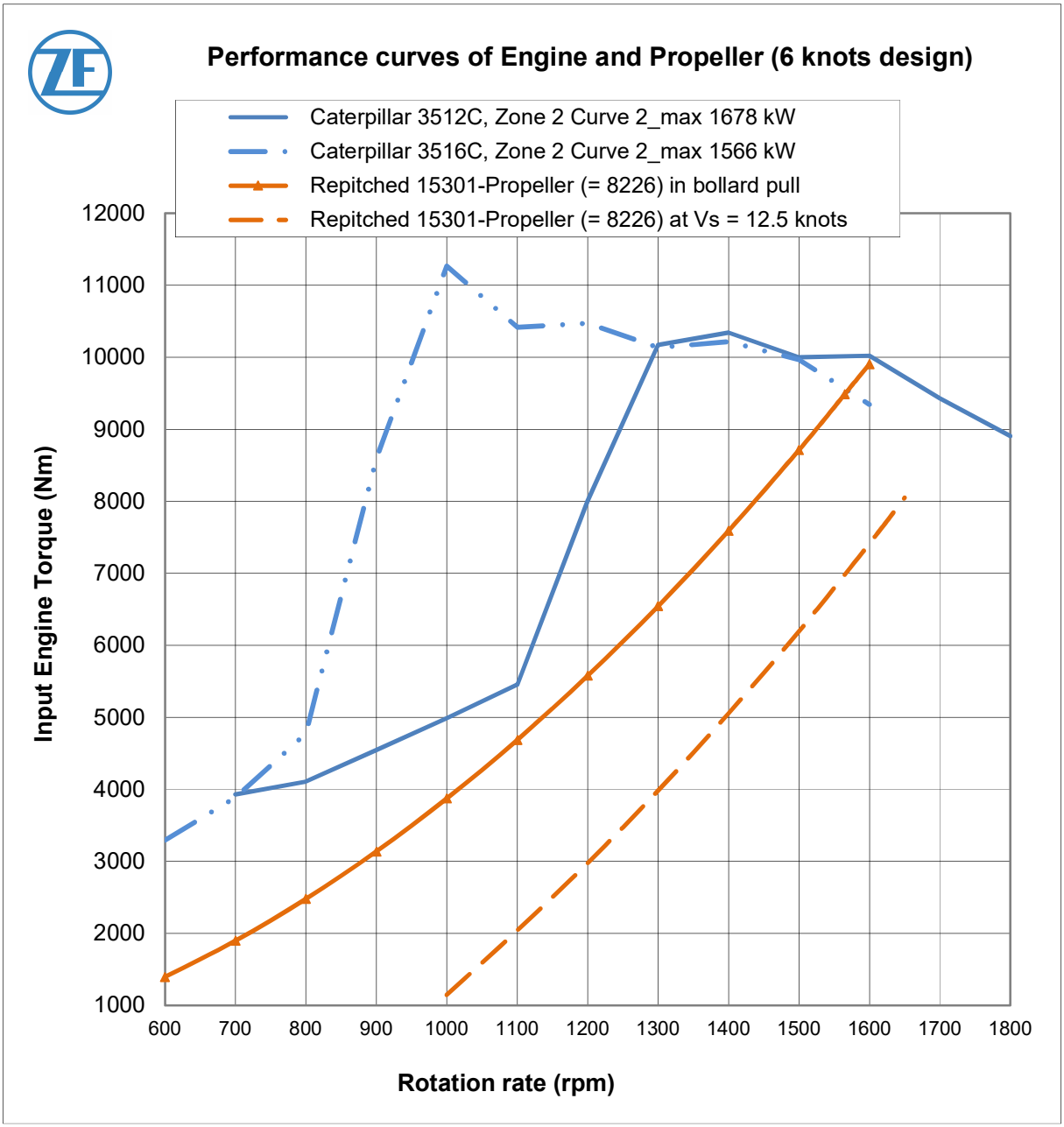
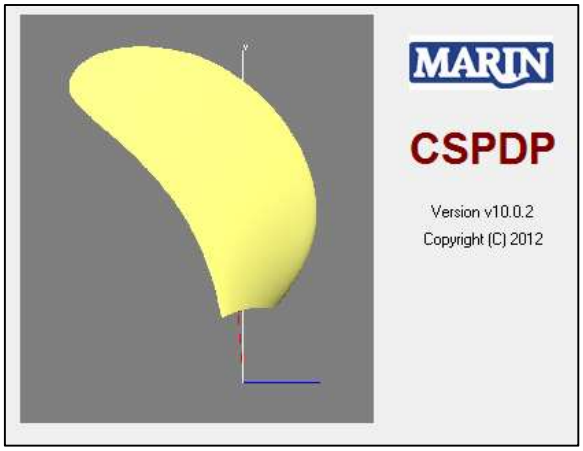


Figure 3.2 Curves for Torque versus Rpm

4. Background

The calculation of the propulsion curves are carried out with the aid of the MARIN propeller design program CSPDP, this program is founded on the directly use of results of systematical model tests several systematic propeller series and is developed for:

- industrial propeller design and selection process
- to be adapted to client specifications and to fulfil the requirement of integration in industrial manufacturing processes. It offers the user a design and selection tool for three types of propellers:
    - B – series, open propellers
    - Ka – series, nozzle propellers
    - Tunnel series.



The calculations made with the propeller design program CSPDP for Open propellers and Nozzle propellers are based on:

- the Wageningen B- and Ka series The Wageningen Propeller Series, MARIN publication 92-001, G. Kuiper.

The calculations made with the propeller design program CSPDP for Tunnel propellers are based on:

- Mitsubishi Technical Bulletin No. 35, Investigations into the Fundamental Characteristics and Operating Performances of Side Thruster.