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POWER SESSION

The Case for Simplicity

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The Case for Simplicity
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Abstract

With a personal perspective beginning in 1977 with the design and construction of DP drilling rigs, DP construction vessels, and DP support vessels, the author will contrast the levels of complexity in state of the art diesel electric power systems against his experience with diesel hydraulic systems. The paper will address the technical issues, cost issues and the human aspects with a focus on developing world markets.
My Mantra:

“Solutions should be elegant in their simplicity.”

Dr. Stanbery’s three engineering criteria:

“It should work fine, fail safe, and last a real long time.”
Introduction

This paper is about simplicity. It deals with dynamic positioning only. It does not deal with mission equipment or the power systems required for mission equipment. What I intend to do is layout a simple robust dynamic positioning philosophy. This philosophy is appropriate for a drilling vessel, a pipelayer, a crane vessel, an accommodation unit, or a rocket launch platform.

The idea for this paper came from two email conversations at the end of February 2013. The first of these conversations was initiated by a request for input on experience with power management and generator controls from competing vendors.

The second was an inquiry from an owner who had been asked by his Naval Architect why we didn’t take his Thrustmaster OD2000 portable thrusters apart then replace the couplings, gears, and pumps with electric motors, a parallel switchboard and generators on the engines.
Conversion Projects

- **Chickasaw**
  - Two 750 HP Retractable Thrusters, HPUs Hull Mounted

- **Titan 2**
  - Eight 1000 HP Swing Down Thrusters, HPUs Containerized

- **Truong Sa (ex Titan 1)**
  - Eight 2000 HP Swing Down Thrusters, HPU’s Containerized

- **McDermott DB30**
  - Eight 2000 HP Retractable Thrusters, HPUs Hull Mounted

- **Titan 3 & 4**
  - Under Negotiation
Power

Maintaining Full Station Keeping Capabilities During a Blackout

Keith Hebert

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NOTE: 4FT SPACING ON EITHER SIDE OF THE CONTAINER MUST BE MAINTAINED FOR PROPER INLET AIR FLOW. A 4FT SPACING MUST BE MAINTAINED ON FRONT AND BACK OF THE CONTAINER AS SHOWN. IF 2 CONTAINERS ARE PLACED SIDE BY SIDE, A GAP OF 8FT IS REQUIRED BETWEEN THEM.
Beginning with the SeDco 445 in 1971, the first DP drilling vessels adopted diesel electric propulsion plants for a number of reasons including:

- Electrically driven thrusters were controllable.
- The power plants were scalable.
- They had an arguable level of redundancy.

At the time microprocessors were new to the market. Components in generator controls, switchboards, SCR systems, shipboard I/C systems, etc. were primarily analog electronics or electrical devices. Digital controls were in their infancy.
The Evolution of Diesel Electric

• Pre-regulation Switchboard – 1977
  – Buss Links

• DP2 Switchboard – 1994
  – One Tie Breaker

• DP3 Switchboard – 1994
  – Two Tie Breakers

• Enhanced Reliability Ring Buss – 2011/12
  – Eight Tie Breakers
Switchboard With Buss Links

G1  G2  G3  G4  G5  G6

SWBD  SWBD  SWBD  SWBD  SWBD  SWBD

XFMR  XFMR  XFMR  XFMR  XFMR  XFMR

SCR  SCR  SCR  SCR  SCR  SCR

T 1  T 2  T 3  T 4  T 5  T 6
DP2 Switchboard

G1  G2  G3  G4  G5  G6

SWBD  SWBD  SWBD  SWBD  SWBD  SWBD

XFMR  XFMR  XFMR  XFMR  XFMR  XFMR

VFD  VFD  VFD  VFD  VFD  VFD

T1  T2  T3  T4  T5  T6
DP3 Switchboard
DP3 Ring Buss
Switchboard
McDermott DB30

• Eight 2000 HP Retractable Thrusters
• Water Cooled
• Mounted in existing sponsons
• 14 Hydraulic Lines

Shipboard Piping
  – Fuel fill and return
  – Cooling water

Shipboard Electrical Cables
  – 2 CAN Buss
  – 1 Six conductor
  – 2 Power (Battery Charger & Emergency Retraction Pump)
HYDRAULIC POWER UNITS
Regulatory Complexity and Bias

As systems have become more complex, the regulatory environment has also become more complex. Beginning with a single sentence in IMO Resolution A.649(16), DP regulations can now be measured by the pound of paper it requires to print them.

- **Resolution A.649(16) 19 Oct. 1989**
  - Dynamic Positioning systems
    - Dynamic positioning systems used as a sole means of position keeping should provide a level of safety equivalent to that provided for anchoring arrangements to the satisfaction of the administration.

- **MSC 38.(63) 19 May 1994**
  - *Reference is made to the Guidelines for Vessels with Dynamic Positioning approved by the Maritime Safety Committee at its 63rd session and disseminated by MSC/Circ. 645.*

- **IMO MSC 645 6 June 1994 – 22 pages**
- **DNV DYNPOS ER Jan 2011 – 33 pages**
- **ABS EHS December 2012 – 80 pages**
Enhanced Reliability

In the recent past, both ABS and DNV have introduced new classifications for vessels design with “Enhanced Reliability”.

Per Section 8 Table 1 of the ABS Guide for Dynamic Positioning Systems and the Part 6 Chapter 26 Section 5 of the DNV rules for ships, the new classifications would appear to apply only to diesel electric propulsion.

While there was a clear need for the regulatory bodies to catch up to the state of the art in diesel electric systems, there is an implicit bias toward the use of diesel electric power systems over any other form of propulsion. My contention is that this contributes to the “That’s how DP2 works.” mindset.
“Gedankenexperiment”
(A Thought Experiment)

Convert an ENSCO 8500 to Diesel Hydraulic
ENSCO 8500 GENERAL INFORMATION

Flag Liberian
Previous Name(s) 
Year Built 2008
Builder KFELS - Singapore
Design Dynamically Positioned DP-2
Classification A. B. S. Maltese Cross A1 column stabilized drilling unit

MAIN DIMENSIONS
Pontoons 56' x 24' x 310'
Moon Pool 30' x 120'
Columns 50' x 45'
Keel to Main Deck 97' 0"
Main Deck 240' W x 255' L

MACHINERY
Main Power (7) EMD series ME20-710G7C - 5,000 (Marine/Continuous) BHP/each; (7) Baylor S855YNV - 643, 3,580 KW generators
Power Distribution NOV-ABB, 25.1 MW, 4,160-volt main power generation distributed through transformers for marine and drilling functions
Emergency Power (1) Cat 3512B, 1,476 HP
Thrusters (8) Flowserve Pleuger WFDS-340-2610, 3,500 HP/each

OPERATING PARAMETERS
Water Depth 8,500'
Maximum Drilling Depth 35,000'
Air Gap 34' @ 55' drilling draft
Transit Speed 3.5 knots @ 45' draft
Variable Drilling Loads 8,000 t
Operating Conditions 8,000 s. tons @ 55'
Survival Conditions 8,000 s. ton @ 45'
Transit Conditions 5,800 s. ton @ 25'

DRILLING EQUIPMENT
Derrick NOV 201' x 46' x 40'; 2,000,000 lb static hook load
Drawworks NOV ADS-30Q, 6,000 HP, 2" Drill Line
Rotary NOV RST 605 hydraulic, 60 1/2" opening, 1,000 ton
Top Drive NOV-TDS-1000 (1000 ton) 7,500 psi, GEB-20B 1150 HP (AC Motor), PH-100
 Drill String Compensator NOV, CMC-H-1000-25, 1000K
Travelling Block NOV HTB 7-72TB-1000, 1,000 ton
Pipe Handling NOV-BR-15 Bridge Racker with Z-Back racking guide arm 3 1/2" - 22", HTV machine up to 22", PR-45-90HS Catwalk machine, AR4500 & ST-120 iron roughnecks, PS30 slips, BX4 & BX5 elevators, 1 x 45' & 1 x 60' telescopic foxholes
Cementing Halliburton HCS Advantage
Mud Pumps (4) Lewco, W-2215, 2,200 HP, 7,500 psi
A Diesel Hydraulic DP2 ENSCO 8500

Existing thrust: 8 x 3,500 HP = 28,000 HP

Worst case DP2 failure as is leaves:
4 x 3,500 HP = 14,000 HP

 Converted thrust: 8 x 3000 HP = 24,000 HP

Worst case DP2 failure converted leaves:
7 x 3000 HP = 21,000 HP

An 8.57% reduction in installed power gives a 50% increase in single point failure holding capability.
What Did I Do?

• I lost 8 each switchboard cells, transformers and VFDs.
• I lost eight AC motors, and all the required auxiliaries including MCC’s to drive fans, cooling water pumps, thruster steering gear, etc.
• I lost miles of cable, cable hangers, and associated penetrations.
• I cleaned the main deck off by reducing the generation requirements and, therefore, the engine room and switchgear room size.
• At the same time I lost piping diameter and pump capacity required to cool the mission equipment generation.
• I lost weight, equipment cost and construction cost.
• Losing weight and moving the thruster HPU’s to the column flats, I gained deck space, deck load and improved my VCG.
• Bonus!!!! I am DP3 Compliant.
A Diesel Hydraulic DP3 ENSCO 8500

Existing thrust: 8 x 3,500 HP = 28,000 HP

Worst case DP2 failure as is leaves:
   4 x 3,500 HP = 14,000 HP

Converted thrust: 8 x 3000 HP = 24,000 HP

Worst case DP2 failure converted leaves:
   6 x 3000 HP = 18,000 HP

An 8.57% reduction in installed power gives a 29% increase in single point failure holding capability.
But isn’t diesel electric more efficient?

Is it? Since this is a paper about simplicity, here is the simple answer; It’s all voodoo, like federal deficit predictions.

- We know the BTU’s in a given volume of MDO.
- We know that the torque is imparted to the water at the propeller tip.
- We know that the BTUs in the MDO are converted into torque at the flywheel by the diesel.
- We know there are efficiency losses in any means of transmission for that torque to the propeller tip.

Making a bunch of assumptions we can calculate the losses in any form of transmission. What we don’t know is the amount of torque we need for a given unit of time. In other words we cannot predict the environment. Consequently, all design points are based upon assumptions.

*It’s kind of like predicting the federal deficit, voodoo.*
Developing World

Ocean News & Technology - August 2013, Page 37:
“Wood Mackenzie predicts huge deepwater drilling expenditure”

Over the next decade
  • 95 new deepwater rigs
  • 37,000 workers

While there have certainly been advances in the delivery system for educational materials, no one has yet figured out how to deliver experience in any really new and creative way.

There will be pressure from local governments to employ nationals. Educated and more importantly experienced locals are not going to just appear. They will have to be developed. The more complex the systems we produce, the more risk we face.
Conclusion

As with my initial reaction to diesel hydraulic propulsion systems, my reaction to early DP supply designs using shaft generators was extremely negative when I first encountered them. The same was true of my opinion of direct drive diesel boats. In both cases I thought they should just build a diesel electric boat. Having had the opportunity to survey Chouest and Harvey Gulf vessels I recognize the virtues of these designs. As they have evolved, they have become simple, robust and appropriate to the their missions.

There is a tendency for all of us to be predisposed to doing things the way we first learned how to do them. My father drove Chevy’s, so I know that Chevy’s are the best car. I learned how to build diesel electric DP vessels from my mentors and peers, so I know, ”That’s how DP2 works.” At least I used to know that. I now know better. I know that simpler is better.