Life Is On | Schneider Electric

LNG Ship Motor Starting Analysis

By Schneider Electric
Motor Management Competency Center

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Executive Summary

Case context

In LNG ship power system where energy efficiency is the major objective in design phase, the generation sources could be sized relatively close to the steady-state load demand. With motors as major loads on such application, the power system engineer and designer has often to deal with the electrical and thermal constraints on the equipment. Therefore the selection of motor starting control is a key task in the design phase, subject to functional, economical and installation constraints.

The case deals with the MV distribution and motor control for 2 Liquid Natural Gas (LNG) vessels, designed as among the biggest and the most energy-efficient ones in the world. The customer's system is composed of 4 generators and there is a need for a solution to start several motors of different power in specific configurations, considering the electrical and thermal constraints on the equipment.

Schneider Electric's motor management solution

The Motor Management Competency Center made early functional analyses and provided electrical distribution and motor control prescription. It modeled and simulated motor starting solutions, and studied the network stability during the start.

The final solution recommended the use of Motorpact Sequential Smart Start (S3) to start several motors with one soft starter. It also included a variable speed drive for the starting of the largest motor on the ship. This solution ensures the stability and safety, and contributes to the customer's objective: the optimization of the power plant's size (20% fuel savings).

Case profile

System composed of 4 generators, with the interest in the possibility to start 3 motors: BOG compressor 780 kW, HD compressor 1100 kW, and compander 2500 kW

Case challenge

Studying the feasibility of starting several motors of different power in specific operating configurations, considering the electrical and thermal constraints on the equipment

Solution

- 40 MCset 6,6kV
- 50 Motorpact RVSS S3, FVS, and VSD bypass panels
- 2 MV drives in partnership (Spain)

Results

- Optimized solution for motor starting
- Stability & safety of equipment and personel
- Contribution to 20% fuel savings

Case study's technical aspects

The case's technical details to take into account

The customer, a ship-owner involved in bulk liquid transportation, increased their fleet with 2 new Liquid Natural Gas (LNG) vessels.

These new ships, among the biggest and most energy-efficient ones in the world (174 000 m^3 of LNG), brought a new challenge to the customer: a need for a motor-starting solution which avoids the increasing of the generators' size and thus contributes to ensure 20% OPEX savings compared to the best-in-class LNG vessels.

The system was composed of 4 generators DFDG of 4.315 MVA rated power. The customer was interested in starting 3 motors, all operated at 6.6 kV, 60 Hz:

Motor	Motor starting current at 100% rate voltage	Starting time at 100% rate voltage
BOG compressor, 780 kW	6.1 x nominal current	24 seconds
HD compressor, 1100 kW	5.2 x nominal current	4.5 seconds
Compander, 2500 kW	6.4 x nominal current	10 seconds

In order to find a motor-starting solution, the main stress constraints on equipments during motor starting period have to be studied, both in case of starting without any assistance, and with soft-starter devices.

The Motor Management Competency Center's contribution

Schneider Electric experts made some prescription activities such as:

- Early functional analysis, electrical distribution and motor control prescription
- Motor starting solutions modelling and transient simulation, network stability studies
- Solution and equipment optimization.

The Motor Management Competency Center concluded that the motor starting implied high constraints to the system and thus gave the following recommendations:

- A Variable Speed Drive (VSD) would be more effective to start the 2.5 MW Compander, allowing the meeting of the motor's thermal constraints.
- The starting of 780 kW (BOG compressor) shall be done with a soft-starter, but in normal operating conditions Direct-On-Line (DOL) would also be possible.
- The starting of 1100 kW motor can be made DOL, however the impact on the network and the parallel loads would be greatly reduced by using soft-starter.
- In case of unavailability of VSD for the Compander starting, an emergency start with soft-starter is possible.

20%

OPEX savings needed (fuel savings) with the motor-starting solution

Operation	Number of DFDG	Base load per generator (% kWe)	Event	Conclusion
Cargo loading at terminal with gas burning	3	43%	BOG running & 2nd start 1100 kW HD Compressor starting	DOL questionable Soft-starter possible
Before Departure at terminal	3	34%	2500 kW Compander starting	DOL impossible
	3	34%	Compander starting	Soft-starter not possible
Before departure with terminal with gas burning	3	34%	780 kW BOG starting	DOL possible
	3	40%	BOG running & 2500 kW Compander starting	DOL impossible
	3	40%	BOG running & 2500 kW Compander starting	Soft-starter impossible
Voyage	2	51%	780 kW BOG starting	DOL impossible
	2	51%	780 kW BOG starting	Soft-starter possible
	2	60%	BOG running & 2500 kW Compander starting	DOL impossible
Emergency Compander start	4	30%	BOG running & 2500 kW Compander starting	Emergency soft-starter possible

Synthesis of simulation results

The solution and its benefits

The solution in details

After consulting its Motor Management Competency Center, Schneider Electric provided the customer with an internal arc classified, complete and integrated solution for multi-motor starting in a single marine switchboard, with a simple installation, and a reduced maintenance:

- 40 MCset 6.6 kV
- 50 Motorpact RVSS S3, FVS and VSD bypass panels
- 2 MV drives in partnership (Spain).

Schneider Electric mobilized on a continuous basis its technical and commercial forces to understand and optimized the customer solution.

A dynamic model of the electrical network was developed to ensure its stability and safety whatever the modes of operations defined by the customer.

Motor Management benefits

The proposed multi-motor MV soft-starting solution ensures flexibility in evolutions of the operating & management modes, reduces carbon footprint and provides a solid contribution to the customer's critical energy consumption reduction plan.

The customer benefits from:

- Upstream engineering support
- Reliability (Marine Certification)
- Contribution to OPEX savings: -20% fuel consumption
- Accurate optimization of the motor starting
- Continuous consulting on different aspects relative to the motors and their characteristics.

> "Thanks to our expert analyses, we succeeded in optimizing the motor starting equipment and thus contribute to the customer project commitment to reduce the fuel consumption by 20%."
>
> - Delcho Penkov, Schneider Electric Motor Management Competency Center Expert

Motor Management solution domains featured in this solution:

Expert Services for Motor Applications	
Software	
Analyses	✓
Services	✓
Advanced Motor Control	
Auto-transformer starters	
Soft starters	✓
Variable speed drives	✓
Power Quality	
Power factor correction: capacitor banks	
Harmonic mitigation	
Transformers	
Motor Protection and Control	
Protection relays	
Switchboards and motor starters	✓
Motor Asset Management	
Portfolio management	
Operation performance	
Asset condition assessment	

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