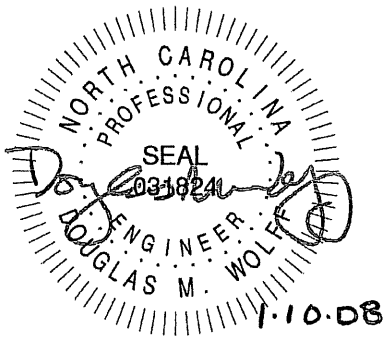


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NEW SOUND CLASS FERRY

Electrical Loads Analysis

Prepared for: North Carolina DOT, Ferry Division • Raleigh, NC

Ref: 07069-001-063-1

Rev. -

January 10, 2008



REVISIONS

REV	DESCRIPTION	DATE	APPROVED
-	Initial Issue	01/10/08	DMW 031824

PURPOSE

Calculate and estimate the electrical power requirements and recommended generator ratings for operation of a proposed 220' × 50' × 12' - 6" vehicle ferry to be owned and operated by the North Carolina Department of Transportation.

PROCEDURE

All known electrical loads are listed or summarized in Appendix A. Motor horsepower values are converted to kW based on data in Reference 1. Each load was assigned a Duty Factor (DF) for each mode of operation and season. These are based on guidance in References 2 and 3, operational requirements, experience, and generally accepted marine practice. Multiple seasons, including Spring/Fall, were evaluated to determine the worst case scenario for both the high and low end.

The total electrical load for each mode of operation/season is summarized on page 1 of Appendix A for the service generators and the emergency generator. Also shown are the percent loading for each mode/season based on selected generator ratings.

SYSTEM DESIGN CONSIDERATIONS

While overloading a generator is an obvious concern, under-loading is a very common problem on small vessels, especially with a system not designed for parallel operation. Most engine manufacturers discourage operation below 30 - 35% of the engine rating, as this can result in increased maintenance and reduced fuel efficiency.

As shown on page 1 of Appendix A, the ship service load estimate varies from a low of 74 kW during mild weather to a high of 118 kW during the summer and winter extremes. This is a significant swing in generator loading and is one reason we recommend multiple, smaller generators operated in parallel; usually resulting in less total installed power, as well as reduced maintenance and fuel consumption.

CONCLUSIONS

Based on NCDOT's request for non-parallel operation and available ratings of John Deere engines, 175 kW generator sets have been selected for ships service loads. If available, smaller marine generator sets in the 135-150 kW range would be recommended.

Based on the connected emergency loads and available ratings of John Deere engines, a 99 kW generator (radiator cooled) is recommended for the emergency generator set.

REFERENCES

1. NFPA-70 National Electric Code, Article 430 – Motors, Motor Circuits, and Controllers.
2. NVIC 2-89, Guide for Electrical Installations on Merchant Vessels and Mobile Offshore Drilling Units.
3. SNAME T&R Bulletin 3-11, Marine Steam Power Plant Heat Balance Practices.

Appendix A

Electrical Loads Analysis Spreadsheet

New Sound Class Ferry

NCDOT

Circuit Description	Connected		Summer			Winter			Spring/Fall			Emerg								
	HP	kW	Transit		Shore		Transit		Shore		Transit		Shore		Transit		Shore			
			DF	LOAD	DF	LOAD	DF	LOAD	DF	LOAD	DF	LOAD	DF	LOAD	DF	LOAD	DF	LOAD		
PH TEP 120V System (Batt/Inverter)																				
Navigation Lighting (Ckt 2)		0.5	1.0	0.5	1.0	0.5	1.0	0.5	1.0	0.5	1.0	0.5	1.0	0.5	1.0	0.5	1.0	0.5	1.0	
PH 12Vdc Pwr Supply (Nav/Elex)		0.5	1.0	0.5	0.3	0.2	1.0	0.5	0.3	0.2	1.0	0.5	0.3	0.2	1.0	0.5	0.7	0.4	0.4	
ACS 12Vdc Pwr Supply (Nav/Elex)		0.2	1.0	0.2	0.3	0.1	1.0	0.2	0.3	0.1	1.0	0.2	0.3	0.1	1.0	0.2	0.7	0.1	0.1	
Fire Detection System		0.2	1.0	0.2	1.0	0.2	1.0	0.2	1.0	0.2	1.0	0.2	1.0	0.2	1.0	0.2	1.0	0.2	1.0	
Interior Comm System/Alarms		1.0	0.5	0.5	0.2	0.2	0.5	0.5	0.2	0.2	0.5	0.5	0.2	0.2	0.5	0.5	1.0	1.0	1.0	
Liferaft/Rescue Boat Floodlights		1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	
Emerg Lig, Bridge Deck		0.4	1.0	0.4	1.0	0.4	1.0	0.4	1.0	0.4	1.0	0.4	1.0	0.4	1.0	0.4	1.0	0.4	1.0	
Emerg Lig, Passenger Deck		0.4	1.0	0.4	1.0	0.4	1.0	0.4	1.0	0.4	1.0	0.4	1.0	0.4	1.0	0.4	1.0	0.4	1.0	
Bow Thruster Control System		0.3	1.0	0.3	0.5	0.2	1.0	0.3	0.5	0.2	1.0	0.3	0.5	0.2	1.0	0.3	1.0	0.3	1.0	
		0.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	
Total Load (kW)		4.5		3.0		2.1		3.0		2.6		2.1		3.0		3.0		2.1	4.3	
TEP Inverter Rating / % Loading:	4.8 kW		62.5%		42.9%		62.5%		42.9%		54.2%		42.9%		62.5%		42.9%		89.4%	
ER TEP 120V System (Battery/Inverter)																				
Circuit Description	HP	kW	DF	LOAD	DF	LOAD	DF	LOAD	DF	LOAD	DF	LOAD	DF	LOAD	DF	LOAD	DF	LOAD	DF	LOAD
ME #1 Control System		0.3	1.0	0.3	0.5	0.2	1.0	0.3	0.5	0.2	1.0	0.3	0.5	0.2	1.0	0.3	1.0	0.3	1.0	0.3
ME #2 Control System		0.3	1.0	0.3	0.5	0.2	1.0	0.3	0.5	0.2	1.0	0.3	0.5	0.2	1.0	0.3	1.0	0.3	1.0	0.3
Interior Comm System/Alarms		1.0	1.0	1.0	0.2	1.0	1.0	1.0	0.2	1.0	1.0	1.0	0.2	1.0	1.0	1.0	1.0	0.2	1.0	1.0
Mchry Monitoring/Alarm System		0.3	1.0	0.3	1.0	0.3	1.0	0.3	1.0	0.3	1.0	0.3	1.0	0.3	1.0	0.3	1.0	0.3	1.0	0.3
ER 24Vdc Pwr Supply (Panel 3D)		0.8	1.0	0.8	0.3	0.2	1.0	0.8	0.3	0.2	1.0	0.8	0.3	0.2	1.0	0.8	0.7	0.6	0.6	0.6
Emerg Lig, Vehicle Deck		0.3	1.0	0.3	1.0	0.3	1.0	0.3	1.0	0.3	1.0	0.3	1.0	0.3	1.0	0.3	1.0	0.3	1.0	0.3
Emerg Lig, Lower Decks		0.5	1.0	0.5	1.0	0.5	1.0	0.5	1.0	0.5	1.0	0.5	1.0	0.5	1.0	0.5	1.0	0.5	1.0	0.5
		0.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0
Total Load (kW)		3.5		3.5		1.8		3.5		3.5		1.8		3.5		3.5		1.8	3.3	3.3
TEP Inverter Rating / % Loading:	4.8 kW		72.9%		38.3%		72.9%		38.3%		72.9%		38.3%		72.9%		38.3%		72.9%	67.9%

New Sound Class Ferry

NCDOT

Circuit Description	Connected HP	Summer						Winter						Spring/Fall					
		Transit	Shore	Maneuver	Transit	Shore	Maneuver	Transit	Shore	Maneuver	Transit	Shore	Maneuver	Transit	Shore	Maneuver			
		DF	LOAD	DF	LOAD	DF	LOAD	DF	LOAD	DF	LOAD	DF	LOAD	DF	LOAD	DF	LOAD		
Crew Qtrs 208/120V Panel																			
HP																			
AHU #3	12.4	0.2	2.5	0.2	2.5	0.2	2.5	0.9	11.2	0.9	11.2	0.9	11.2	0.9	11.2	0.4	5.0		
Crew SR & Head Htrs (6)	3.0	0.0	0.0	0.0	0.0	0.0	0.9	2.7	0.9	2.7	0.9	2.7	0.9	2.7	0.6	1.8	0.6		
BT Rm Space Heater	1.1	0.0	0.0	0.0	0.0	0.0	0.9	1.0	0.7	0.8	0.9	1.0	0.5	0.6	0.5	0.6	0.0		
BT Engine J.W Htr	1.5	0.2	0.3	0.2	0.3	0.0	0.7	1.1	0.7	1.1	0.0	0.0	0.3	0.2	0.3	0.0	0.0		
ER Space Heaters (2)	2.3	0.0	0.0	0.0	0.0	0.0	0.9	2.1	0.7	1.6	0.9	2.1	0.5	1.2	0.5	1.2	0.0		
Tank Rm Space Heaters (2)	2.3	0.0	0.0	0.0	0.0	0.0	0.9	2.1	0.7	1.6	0.9	2.1	0.5	1.2	0.5	1.2	0.0		
Lighting, Crew Qtrs	0.6	1.0	0.6	0.7	0.4	1.0	0.6	1.0	0.6	0.7	0.4	1.0	0.6	0.7	0.4	1.0	0.6		
Crew Galley Receptacles	1.4	0.2	0.3	0.2	0.3	0.2	0.3	0.2	0.3	0.2	0.3	0.2	0.3	0.2	0.3	0.2	0.3		
Crew Galley Receptacles	1.4	0.2	0.3	0.2	0.3	0.2	0.3	0.2	0.3	0.2	0.3	0.2	0.3	0.2	0.3	0.2	0.3		
Crew Qtrs Receptacles	1.4	0.2	0.3	0.2	0.3	0.2	0.3	0.2	0.3	0.2	0.3	0.2	0.3	0.2	0.3	0.2	0.3		
Crew Qtrs Receptacles	1.4	0.2	0.3	0.2	0.3	0.2	0.3	0.2	0.3	0.2	0.3	0.2	0.3	0.2	0.3	0.2	0.3		
Water Heater	6.0	0.3	1.8	0.3	1.8	0.3	1.8	0.3	1.8	0.3	1.8	0.3	1.8	0.3	1.8	0.3	1.8		
	0.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0		
Total Load (kW)	34.8		6.3		6.1		23.6		22.2		22.5		13.4		13.3		13.1		

Circuit Description	Connected HP	Summer						Winter						Spring/Fall					
		Transit	Shore	Maneuver	Transit	Shore	Maneuver	Transit	Shore	Maneuver	Transit	Shore	Maneuver	Transit	Shore	Maneuver			
		DF	LOAD	DF	LOAD	DF	LOAD	DF	LOAD	DF	LOAD	DF	LOAD	DF	LOAD	DF	LOAD		
HVAC 208/120V Panel																			
HP																			
AHU #1	19.0	0.2	3.8	0.2	3.8	0.2	3.8	0.9	17.1	0.7	13.3	0.9	17.1	0.4	7.6	0.4	7.6		
AHU #2	19.0	0.2	3.8	0.2	3.8	0.2	3.8	0.9	17.1	0.7	13.3	0.9	17.1	0.4	7.6	0.4	7.6		
Chill Water Circ Pump #1	3.0	2.5	0.9	2.3	0.9	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	2.3	0.9	2.3		
Chill Water Circ Pump #2	3.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
PH FCU #1	3.0	0.1	0.3	0.1	0.3	0.1	0.3	0.9	2.7	0.7	2.1	0.9	2.7	0.1	0.3	0.1	0.3		
PH FCU #2	3.0	0.1	0.3	0.1	0.3	0.1	0.3	0.9	2.7	0.7	2.1	0.9	2.7	0.1	0.3	0.1	0.3		
Bridge Deck FCU	3.0	0.1	0.3	0.1	0.3	0.1	0.3	0.9	2.7	0.7	2.1	0.9	2.7	0.1	0.3	0.1	0.3		
Aft Control Station FCU	1.5	0.1	0.2	0.1	0.2	0.1	0.2	0.9	1.4	0.7	1.1	0.9	1.4	0.1	0.2	0.1	0.2		
Lavatory Space Heaters (2)	2.3	0.0	0.0	0.0	0.0	0.0	0.9	2.1	0.7	1.6	0.9	2.1	0.0	0.0	0.0	0.0	0.0		
Lavatory Exhaust Fans (2)	0.2	0.5	0.1	0.1	0.0	0.5	0.1	0.5	0.1	0.1	0.0	0.5	0.1	0.1	0.0	0.5	0.1		
HVAC Rm #1 Space Heater	1.1	0.0	0.0	0.0	0.0	0.0	0.9	1.0	0.7	0.8	0.9	1.0	0.0	0.0	0.0	0.0	0.0		
HVAC Rm #2 Space Heater	1.1	0.0	0.0	0.0	0.0	0.0	0.9	1.0	0.7	0.8	0.9	1.0	0.0	0.0	0.0	0.0	0.0		
Energ Gen Rm Space Heater	0.5	0.0	0.0	0.0	0.0	0.0	0.9	0.5	0.7	0.4	0.9	0.5	0.0	0.0	0.0	0.0	0.0		
Bridge Deck Head Fan/Heater	0.6	0.1	0.1	0.1	0.1	0.1	0.9	0.5	0.9	0.5	0.9	0.5	0.0	0.0	0.0	0.0	0.0		
Food Service Eqp/Vending	5.0	0.6	3.0	0.1	0.5	0.6	3.0	0.6	3.0	0.1	0.5	0.6	3.0	0.6	3.0	0.1	0.5		
Lavatory Hand Dryers (2)	4.6	0.2	0.9	0.0	0.0	0.2	0.9	0.0	0.0	0.2	0.9	0.0	0.2	0.9	0.0	0.2	0.9		
Drinking Fountain	0.3	0.2	0.1	0.1	0.0	0.2	0.1	0.2	0.1	0.1	0.0	0.2	0.1	0.1	0.0	0.2	0.1		
Passngr Area Rcpt/Drink Ftn	1.6	0.3	0.5	0.1	0.2	0.3	0.5	0.3	0.5	0.1	0.2	0.3	0.5	0.3	0.5	0.1	0.2		
Passenger Area Receptacles	1.4	0.3	0.4	0.1	0.1	0.3	0.4	0.3	0.4	0.1	0.1	0.3	0.4	0.3	0.4	0.1	0.1		
	0.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0		
Total Load (kW)	72.2		15.9		11.8		53.7		38.8		53.7		23.5		19.4		23.5		

New Sound Class Ferry

NCDOT

Circuit Description	Connected HP	KW	Summer						Winter						Spring/Fall						Emergency			
			Transit		Shore		Maneuver		Transit		Shore		Maneuver		Transit		Shore		Maneuver		DF	LOAD		
			DF	LOAD	DF	LOAD	DF	LOAD	DF	LOAD	DF	LOAD	DF	LOAD	DF	LOAD	DF	LOAD	DF	LOAD	DF	LOAD		
Searchlight #1		0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	
Nav Light Panel (Ckt 1)		0.5	1.0	0.5	0.0	0.0	1.0	0.5	0.0	0.0	1.0	0.5	0.0	0.0	1.0	0.5	0.0	0.0	1.0	0.5	0.0	0.0	1.0	0.5
PH Window Wipers		0.2	1.0	0.2	0.0	0.0	1.0	0.2	0.0	0.0	1.0	0.2	0.0	0.0	1.0	0.2	0.0	0.0	1.0	0.2	0.0	0.0	1.0	0.2
PH Window Defogger		4.5	0.1	0.5	0.0	0.0	0.1	0.5	0.7	3.2	0.0	0.0	0.0	0.7	3.2	0.2	0.9	0.0	0.0	0.2	0.9	1.0	4.5	
ACS Window Wipers		0.2	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	
ACS Window Defogger		1.5	0.0	0.0	0.0	0.0	0.2	0.3	0.7	1.1	0.0	0.0	0.7	1.1	0.5	0.8	0.0	0.0	0.5	0.8	0.0	0.0	0.0	
Lighting, Bridge Dk		0.8	1.0	0.8	1.0	0.8	1.0	0.8	1.0	0.8	1.0	0.8	1.0	0.8	1.0	0.8	1.0	0.8	1.0	0.8	1.0	0.8	1.0	0.8
Lighting, Passenger Dk		1.1	1.0	1.1	0.5	0.6	1.0	1.1	1.0	1.1	0.5	0.6	1.0	1.1	1.0	1.1	0.5	0.6	1.0	1.1	1.0	1.1	1.0	1.1
Lighting, Passenger Dk		1.2	1.0	1.2	0.5	0.6	1.0	1.2	1.0	1.2	0.5	0.6	1.0	1.2	1.0	1.2	0.5	0.6	1.0	1.2	1.0	1.2	1.0	1.2
Lighting, Vehicle Dk		0.7	1.0	0.7	0.5	0.4	1.0	0.7	1.0	0.7	0.5	0.4	1.0	0.7	1.0	0.7	0.5	0.4	1.0	0.7	1.0	0.7	1.0	0.7
Lighting, Vehicle Dk		0.8	1.0	0.8	0.5	0.4	1.0	0.8	1.0	0.8	0.5	0.4	1.0	0.8	1.0	0.8	0.5	0.4	1.0	0.8	1.0	0.8	1.0	0.8
Security Lig, Port Side		0.6	0.0	0.0	1.0	0.6	0.0	0.0	0.0	0.0	1.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Security Lig, Stbd Side		0.6	0.0	0.0	1.0	0.6	0.0	0.0	0.0	0.0	1.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pilothouse Receptacles (6)		1.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.0
Bridge Dk Receptacles (6)		1.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.0
Docking Floodlights, #1 End (2)		1.0	0.0	0.0	0.0	0.0	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.0	0.0	0.0	0.0	0.5	0.5	0.0	0.0	1.0
Docking Floodlights, #2 End (2)		1.0	0.0	0.0	0.0	0.0	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.0	0.0	0.0	0.0	0.5	0.5	0.0	0.0	1.0
Total Load (kW)		17.7		6.2		4.3		7.7		10.0		4.3		11.2		7.4		4.3		8.6		12.6		