Base Load Power Hub (BLPH)

BATTERY SIZING CALCULATION AND LOAD LIST

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1 ELECTRICAL LOADS CALCULATION

1.1 CONTROL PANEL TECHNICAL DATA ABSTRACT

- NCCP INTERNAL POWER DISSIPATION: 250 W (*at full load*)
- MAXIMUM CHARGING CURRENT [X1]: 55.00 A
- MAXIMUM CHARGING VOLTAGE [X2]: 27.00 Vdc
- BATTERY CHARGER SYSTEM EFFICENCY (*typ.*) [X3]: 92%
- BATTERY CHARGER POWER FACTOR (*typ.*) [X4]: 97% *(at full load)*

POWER CONSUMPTION FROM 230VAC POWER SUPPLY [X5] = [X1] x [X2] / [X3] = 1615 W

= [X5] / [X4] = 1665 VA < 1.7 kVA

1.2 REQUIRED LOAD AUTONOMIES (WORST CASE)

The battery bank must be sized considering the following autonomy for each load as follows:

1) NAVAIDS CENTRAL CONTROL PANEL (NCCP) (w/o 230Vac): 4 days (= 96 hours)
2) MAIN MARINE YELLOW LIGHT 1 (IALA STD): 4 days (= 96 hours)
3) MAIN MARINE YELLOW LIGHT 2 (IALA STD): 4 days (= 96 hours)
4) BOAT LANDING STATUS LIGHT (FLASHING 2Hz): 4 days (= 96 hours)
5) MEDIUM INTENSITY AOL 1 (RED STEADY BURNING): 4 days (= 96 hours)
6) MEDIUM INTENSITY AOL 2 (RED STEADY BURNING): 4 days (= 96 hours)
7) MEDIUM INTENSITY AOL 3 (RED STEADY BURNING): 4 days (= 96 hours)
8) MEDIUM INTENSITY AOL 4 (RED STEADY BURNING): 4 days (= 96 hours)
9) PHOTOCELL SYSTEM: 4 days (= 96 hours)
10) VISIBILITY METER: 4 days (= 96 hours)

1.3 MAIN ASSUMPTIONS

The battery bank sizing calculation is done with the following assumptions:

1. The marine yellow lights (5NM) are activated accordingly to the photocell and the fog detector, therefore in the worst case (no-sun day and/or visibility < 2NM) they are always activated throughout the day (24h/day).
2. The marine yellow lights flashing code is the following (IALA STD):

LIGHT	0.4	sec.
DARK	0.5	sec.
LIGHT	0.4	sec.
DARK	0.5	sec.
LIGHT	1.2	sec.
DARK	12.0	sec.
PERIOD	15.0	sec.

According to the flashing code above, the marine signal lights have a duty cycle of 13.33% and therefore the day/night use is 12h x 0.1666 = 1.6h. It means 3.2 hours of activation per day.

3. The boat landing status light is activated accordingly to the remote command provided by the F&G System therefore in the worst case (incipient fire or gas leakage) it is always activated throughout the day (24h/day).
4. The boat landing status light flashing code is the following:

LIGHT	0.25	sec.
DARK	0.25	sec.

According to the flashing code above, the boat landing status light has a duty cycle of 50% and therefore the day/night use is 12h x 0.5 = 6h. It means 12 hours of activation per day.

5. The aeronautical obstruction lights are always activated throughout the day (24h/day) irrespective of what is detected by the photocell or the visibility meter.
6. The aeronautical obstruction lights have a duty cycle of 100% (steady burning) and therefore the day/night use is 12h x 1 = 12h. It means 24 hours of activation per day.

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1.4 ELECTRICAL LOAD LIST

ITEM	PART DESCRIPTION	EQUIPMENT	UNIT NUMBER	UNIT POWER CONSUMPTION [W]	TOTAL POWER CONSUMPTION [W]	DAY USE [h/day]	NIGHT USE [h/day]	DAY ENERGY [Wh/day]	NIGHT ENERGY [Wh/day]	TOTAL ENERGY [Wh/day]
1	SUPERVISOR SYSTEM CPU (SICE255)	NCPP	2	2	**4,0**	12,0	12,0	48,0	48,0	**96,0**
2	SUPERVISOR SYSTEM DI (SICE256)	NCPP	2	0,5	**1,0**	12,0	12,0	12,0	12,0	**24,0**
3	SUPERVISOR SYSTEM LCD (SICE259)	NCPP	1	1,6	**1,6**	12,0	12,0	19,2	19,2	**38,4**
4	MAIN MARINE LIGHT U-CODER (SICE266)	NCPP	2	1	**2,0**	10,4	10,4	20,8	20,8	**41,6**
5	BOAT LANDING FLASHER (SICE266)	NCPP	1	1	**1,0**	6,0	6,0	6,0	6,0	**12,0**
6	DC/AC INVERTER SYSTEM FOR AOL	NCPP	2	15	**30,0**	12,0	12,0	360,0	360,0	**720,0**
7	CURRENT MONITORING RELAY FOR AOL	NCPP	2	2,6	**5,2**	12,0	12,0	62,4	62,4	**124,8**
8	ASTRONOMICAL TIME SWITCH	NCPP	1	0,9	**0,9**	12,0	12,0	10,8	10,8	**21,6**
9	SIL2 RELAY FOR REMOTE CONTROLS/COMMANDS	NCPP	3	1	**3,0**	12,0	12,0	36,0	36,0	**72,0**
10	BATTERY CHARGER SYSTEM (DC SIDE)	NCPP	2	0,03	**0,1**	12,0	12,0	0,7	0,7	**1,4**
11	NETWORK ANALYZER	NCPP	2	1,3	**2,6**	12,0	12,0	31,2	31,2	**62,4**
12	EARTH INSULATION MONITORING RELAY (24VDC)	NCPP	1	0,2	**0,2**	12,0	12,0	2,4	2,4	**4,8**
13	EARTH INSULATION MONITORING RELAY (230VAC)	NCPP	2	0,2	**0,4**	12,0	12,0	4,8	4,8	**9,6**
14	INTERFACE RELAY (energized)	NCPP	3	0,3	**0,9**	12,0	12,0	10,8	10,8	**21,6**
15	POWER RELAY (energized)	NCPP	1	1	**1,0**	12,0	12,0	12,0	12,0	**24,0**
16	MAIN MARINE LIGHT (5NM YELLOW)	LIGHT	2	15	**30,0**	1,6	1,6	48,0	48,0	**96,0**
17	BOAT LANDING STATUS LIGHT (FLASHING 2Hz)	LIGHT	1	32	**32,0**	6,0	6,0	192,0	192,0	**384,0**
18	AERONAUTICAL OBSTRUCTION LIGHT CAP168 (MIOL-C)	LIGHT	4	54	**216,0**	12,0	12,0	2592,0	2592,0	**5184,0**
19	BATTERY TEMPERATURE PROBE	SENSOR	1	0,5	**0,5**	12,0	12,0	6,0	6,0	**12,0**
20	PHOTOCELL SYSTEM	SENSOR	1	0,5	**0,5**	12,0	12,0	6,0	6,0	**12,0**
21	VISIBILITY METER (Ex)	SENSOR	1	2,5	**2,5**	12,0	12,0	30,0	30,0	**60,0**
TOTAL DAILY ENERGY REQUESTED BY LOAD [Wh/day]										**7022,2**

2 BATTERY SIZING CALCULATION

2.1 BATTERY CELL DATA

- CELL TYPE: SMG (VRLA Gel)
- CELL MANUFACTURER: FIAMM
- BATTERY CELL QUANTITY: 12
- CELL NOMINAL VOLTAGE: 2.00 Vpc
- CELL MINIMUM VOLTAGE (END OF DISCHARGE): 1.80 Vpc
- MAXIMUM VOLTAGE (DURING FLOAT CHARGE): 2.25 Vpc

2.2 BATTERY BANK DATA

- REQUESTED BATTERY BANK AUTONOMY: 4 days = 96 hours
- BATTERY BANK NOMINAL VOLTAGE: 24.00 Vdc
- BATTERY BANK MINIMUM VOLTAGE (END OF DISCHARGE): 21.60 Vdc
- BATTERY BANK MAXIMUM VOLTAGE: 27.00 Vdc

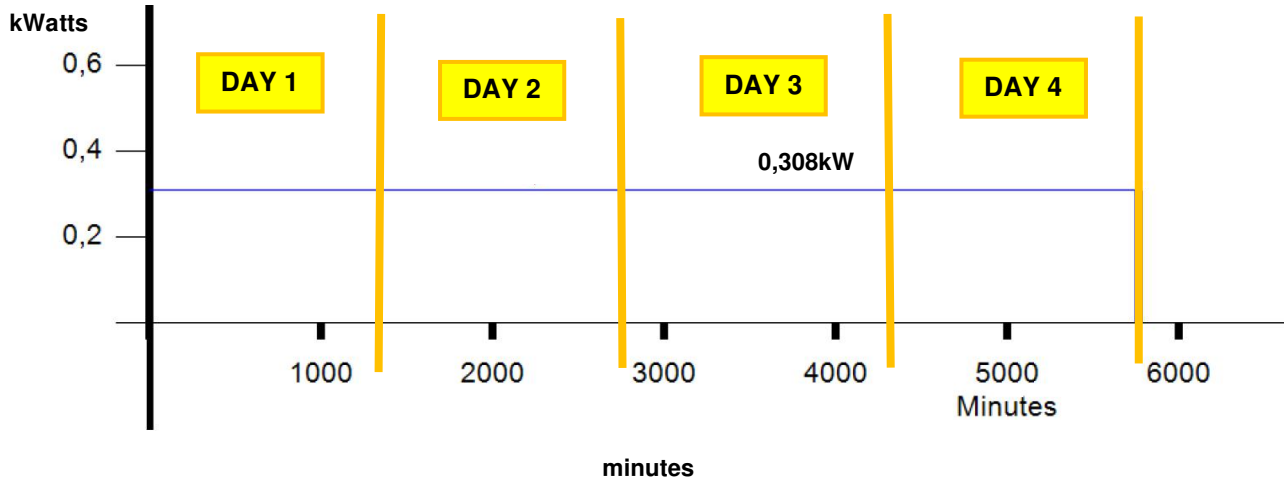
2.3 ELECTRICAL LOAD CALCULATION

- TOTAL DAILY ENERGY REQUIRED BY LOADS [X1]: 7022.2 Wh/day
- INCREASING FOR CONTINGENCY [X2]: 5%

TOTAL DAILY ENERGY INCLUDING CONTINGENCY [X3] = [X1] + [X2] ≈ 7375 Wh/day

AVERAGE POWER CONSUMPTION BY LOADS = [X3] / 24 [h/day] = 307.3 W ≈ 0.308kW

2.4 LOAD PROFILE



3 BATTERY BANK SIZING TOOL (BY CELL MANUFACTURER)

3.1 DERATING FACTORS FOR BATTERY SIZING

- DESIGN MARGIN (DoD) **[X4]**: 1.10
- AGING FACTOR **[X5]**: 1.25
- MINIMUM OPERATING TEMPERATURE **[X6]**: 0.971 (25°C)

3.2 BATTERY CALCULATION WORKSHEET IEEE 1115-2014

Design temperature: 25 °C		Minimum cell voltage: 1,800 V		Elect. gravity: N/A		Element type: SMG – Gel OpzV tubular plates	
PERIOD	(2) LOAD (kW)	(3) LOAD CHANGE (kW)	(4) DURATION OF PERIOD (min)	(5) TIME TO END OF SECTION (min)	(6) K Factor	(7) (3) x (6) (3) x 1000 x (6) / Num. of cells Val. pos.	Val. neg.
Section 1							
1	A1 = 0,31	A1 - 0 = 0,31	M1 = 5760	M1 = 5760	46,330	1.189,13	
					Sub Total	1.189,13	0,00
					Total 1	**1.189,13**	

3.3 BATTERY CALCULATION INCLUDING DE-RATING FACTORS

- MAXIMUM REQUIRED SECTION SIZE **[X7]**: 1189.13 Ah

TOTAL CORRECTION FACTOR [X8] = [X4] x [X5] x [X6] = 1.335

REQUIRED BATTERY BANK SIZE = [X7] x [X8] = 1587.43 Ah

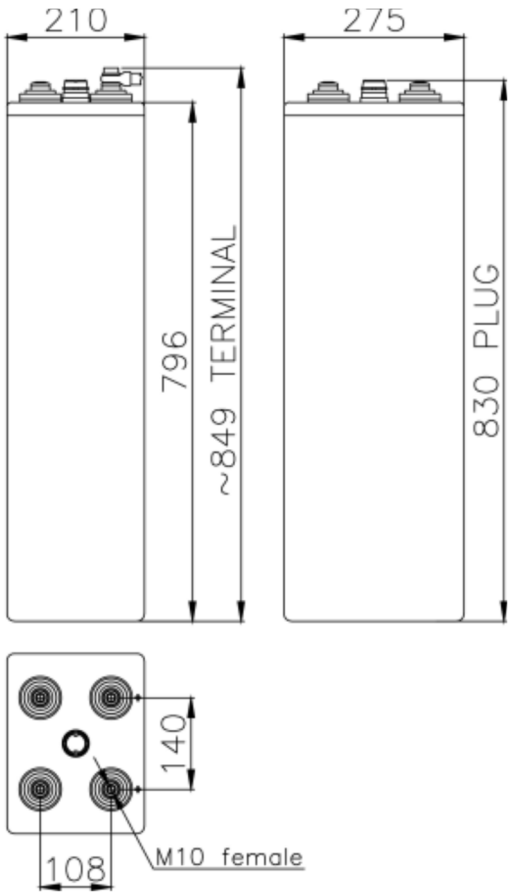
THE REQUIRED CELL SIZE IS 1587.43 Ah THEREFORE CELL FIAMM SMG 1680 IS REQUIRED

3.4 BATTERY BANK DATA

- SELECTED CELL TYPE: SMG 1680
- CELL MANUFACTURER: FIAMM
- BATTERY BANK CELL QUANTITY: 12
- BATTERY CELL CAPACITY FOR 10 HOURS (C10): 1680 Ah (@ 1.80Vpc) @ 20°C
- SHORT-CIRCUIT CURRENT (FULLY CHARGED): 11730 A
- INTERNAL RESISTANCE: 2.04 mΩ
- MARGIN AVAILABLE: +6%
- REAL BACK-UP TIME: 6109 min

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3.5 BATTERY LAYOUT



3.6 HEAT GENERATION

3.6.1 POWER DISSIPATED DURING CONTINUOUS FLOAT OPERATION

The power dissipation can be assumed equal to the product ***Vfloat x Ifloat***, from which it results:

- FLOAT VOLTAGE PER CELL **[X9]**: 2.25 V*cell*
- NOMINAL CAPACITY (C10) **[X10]**: 1680 Ah
- NUMBER OF CELLS IN SERIES **[X11]**: 12

POWER DISSIPATED DURING FLOAT [X12] = 0.99 [mA/Ah] x [X9] x [X10] x [X11] / 1000 ≈ 44.91 W

DAILY HEAT GENERATION DURING FLOAT = [X12] x 24 [h/day] = 1077.75 Wh ≈ 1.078kWh

3.6.2 POWER DISSIPATED DURING A DISCHARGE

A rough estimation of power dissipated can be made by applying the following formula:

$$\boldsymbol{P = Rint \times I^2 \times Ncells}$$

where:

- INTERNAL RESISTANCE OF EACH CELL ($\boldsymbol{Rint}$) [X13]: 0.17 mΩ
- DISCHARGE CURRENT PER STRING ($\boldsymbol{I}$) [X14]: P/V = 308/24 ≈ 12.8 A

POWER DISSIPATED DURING DISCHARGE [X15] = [X13] x [X14] ^{2} x [X11] = 335.97 mW ≈ 0.336 W

DAILY HEAT GENERATION DURING DISCHARGE = [X15] x 96 [h] = 32.25 Wh

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