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THE IMPLEMENTATION STUDY OF THE LOCAL ELECTRICAL HEATING SYSTEMS AT A NAVY SHIP

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Abstract*. It is known that the central heating efficacy system is lower than the normal level for a navy ship. A lot of equipments have the level of the temperature increased specially during summer days so it is need to implement supplementary local electrical heating system. These systems must be navalizedin accordance with the specification of the STANAG rules.*

1. General data

The individual heating electrical installation ensures the improvement of thermic comfort in a ship's compartments by:

- completion of the caldarine centralised heating system through the introduction of electric radiators in living compartments specified by the beneficiary that have the purpose of ensuring thermic comfort even in winter conditions when the already existent centralised system cannot cope with temperatures below 10ºC ;
- completion of the air conditioning centralised system through the introduction in living compartments specified by the beneficiary of acclimatizations aggregations that have the purpose of ensuring thermic comfort even in summer conditions when the already existent centralised system cannot cope with temperatures over 30ºC .

The project has its foundations in the UM 02006's request through the research needs and coresponds to the project called ''The electrical installation for living compartments' individual heating on the 'Mărăşeşti' Frigate''.

2. Technical requirements

2.1 Living compartments' electrical heating installation

The living compartments' electrical heating installation is dimensioned considering the heat that is necessary in the absence of centralised heating.
The thermostat functioning of electrical heating is allowed in a buffer regime with the existent steam heating installation.

2.1.1 The calculation of the necessary heat Q_{tot}

The heat losses are composed of: losses through walls and losses through ventilation.

a. The heat losses through walls Q_p

These are calculated through the following equations:

$Q_p = \sum Q_j$ *(W)*

$Q_j = K_j \cdot S_j (t_i - t_e) j$ *(W)*

$K_j = \frac{1}{\frac{1}{\alpha_1} + \sum \frac{\delta}{\lambda} + \frac{1}{\alpha^2}} \left(\frac{W}{m^2 k}\right)$

where:

Q_p – quantity of heat lost through walls *(W)*
Q_j – quantity of heat lost through the wall „*j*" *(°K)*
K_j – heating transmision coeficient $\left(\frac{W}{m^2 k}\right)$
t_i – considered room temperature (°K)
t_e – exterior temperature that corresponds to the wall „j" *(°K)*
S_j – considered wall surface *(m^2)*
α_1 – interior convection coeficient $\left(\frac{W}{m^2 k}\right)$
α_2 – exterior convection coeficient $\left(\frac{W}{m^2 k}\right)$
δ – thickness of the component layers of the wall *(mm)*
λ – heat transfer rate coeficient $\left(\frac{W}{m K}\right)$

b. The heat losses through ventilation Q_v

Because the ventilation of the heated rooms is natural, these losses are small and the calculation will take into account 10% of the heat lost through ventilation at the number of air changes (*n*).

$Q_v = V \cdot n \cdot \gamma \cdot c \cdot \Delta t$ *(W)*

c. The calculation of the necessary heat Q_{tot}

$Q_{tot} = Q_p + Q_v$

d. The calculation of the cooling capacity Q_{rac} (*Btu/h*)

$Q_{rac} = 0{,}7 Q_{tot}$

Necessary data in the calculation

- Electrical power necessary for heating $1 Kcal/h = 0.001163\ KW$
- Power necessary for cooling 1 *Kcal/h* = 3,96832 *Btu/h*
- Electrical power necessary for cooling 1 *Btu/h* = 0,000293 *kW*
- Exterior air temperature $t_e = -25^oC = 248K$
- Air specific weight at -25^oC $\gamma = 1.413\ (Kg/m^3)$
- Air specific heat $c = 1005\ (J/KgK)$
- Sea water temperature $t_a = 0^oC = 273K$
- Heat transmission coefficient for the heater $K_2 = 6.97 \div 8.75$ $\left(\frac{W}{m^2 k}\right)$
- Thermic convection coefficients $\alpha_1 = 8.15\ \frac{W}{mK}$ – for the interior of the room

$\alpha'_2 = 29.1 \frac{W}{mK}$ –for the wall next to the room

$\alpha''_2 = 58.1 \frac{W}{mK}$ –for the exterior walls

The results of the calculations are centralised in Table 1

No.	**Room name**	**Volume** *(m^3)*	**Heat necessary** Q_{tot} *(Kcal/h)*	**Heating capacity** $P_î$*(kW)*	**Cooling capacity** Q_{rac} *(Btu/h)*	**Cooling capacity** P_r*(kW)*
			Command Deck			
1.	Radio compartment st.105..110 Bb	23	860	1	2390	0.7
2.	Radio compartment st.105..110 Tb	27	1110	1	3083	0.7
			Captain’s Deck Bow			
1.	XO Office Cst.116...120Bb	19	774	0.9	2150	0.63
2.	XO Compartment cst.120...124Bb	19	774	0.9	2150	0.63
3.	Accountancy office cst.105...113 Bb	40	1548	1.8		
4.	Accountancy office cst.97...110 Tb	40	1548	1.8		
5.	Operator Cst.80...85 Tb	38	1462	1.7		
			Superstructure Deck			
1.	CIC Compartment Cst.125..132	90	2485		6903	2
2.	Cabin3 of. Cst.120..125 Bb	30	1160		3222	0,94
3.	Secrecy cabin Cst.122..125Tb	19	774		2150	0,62
4.	Cabin2 of. Cst.114..119Bb	40	1548	1.8		
5.	Cabin2 of. Cst. 115..120 Tb	30	1160	1.35		
6.	Cabină 2 of. Cst. 107..111 Bb	27	1032	1.2		
7.	Cabin 2 of. 110..115 Tb	35	1376	1.6		
8.	Comp. Console SV1 Cst. 103..109 Tb	25	967		2686	0,78
9.	Comp.CDC Cst. 85..92 Tb	40	1548	1.8		
10.	Comp.CSV2 Cst. 80..88 Bb	25	967		2686	0,78
11.	Comp. MR Cst. 46..52	46	1720	2	4778	1,4
			Main Deck			
1.	Officer’s messroom Cst. 113..120	135	5224		14511	4,25
2.	OOW Compartment Cst. 85..92 Tb	20	775	0.9	2153	0,63
			Middle Deck I			
1.	Cabin 2 of. Cst. 140..144 Bb	17	688	0.8		
2.	Cabin 2 of. Cst. 140..144 Tb	15	602	0.7		
3.	Cabin 2of. Cst. 135..139 Bb	18	690	0.8		
4.	Cabin 2 of. Cst. 135..139 centru	18	690	0.8		
5.	Cabin 2 of. Cst. 135..139 Tb	18	690	0.8		
6.	Cabin 2 of. Cst. 130..135 Bb	24	946	1.1		
7.	Cabin 2 of. Cst. 130..135 Tb	24	946	1.1		
8.	Cabin 2 of. Cst. 126..130 Bb	22	860	1		
9.	Cabin 2 of. Cst. 126..130 Tb	22	860	1		
10.	Cabin 1 of. Cst. 119..125 Bb	28	1118	1.3		

11.	Cabin 1 of. Cst. 1112..118 Bb	28	1118	1.3		
12.	Decl petty officer's messroom Cst. 112..125 Tb	125	4837		13436	3,93
13.	PCM Cst. 60..66 Tb	60	2322	2.7		
14.	Cabin 2MM Cst. 62..66 Bb	12	430	0.5		
15.	Cabin 2MM Cst. 58..62 Bb	14	516	0.6		
16.	Cabin 2MM Cst. 55..58 Bb	12	430	0.5		
17.	Cabin 2MM Cst. 51..55 Bb	12	430	0.5		
18.	Cabin 2MM Cst. 47..51 Bb	12	430	0.5		
19.	Cabin 2MM Cst. 38..41 Bb	18	690	0.8		
20.	Cabin 2MM Cst. 35..38 Bb	14	516	0.6		
21.	Cabin 2MM Cst. 35..40 Tb	15	602	0.7		
22.	Cabin 2MM Cst. 35..40 Tb	15	602	0.7		
23.	Cabin 2MM Cst. 35..40 Tb	28	1118	1.3		
24.	Cabin 4MM Cst. 31..35 Bb	30	1160	1.4		
25.	Cabin 2MM Cst. 25..30 Bb	17	688	0.8		
26.	Cabin 2MM Cst. 25..30 centru	17	688	0.8		
27.	Engine petty officer's messroom Cst. 25..35 Tb	95	3697	4.3	10270	3
28.	Mess Bb Cst. 15..25	100	3869	4.5	10747	3,15
29.	Mess Tb Cst. 15..25	100	3869	4.5	10747	3,15
30.	Comp. MR123 Tb Cst. 8..15	33	1277		3547	1,04
Middle deck II						
1.	Barracks16 mil. Cst. 119..126 Tb	83	3181	3.7		
2.	Barracks 24 mil. Cst. 112..119 Tb	83	3181	3.7		
3.	Barracks 20 mil. Cst. 103..112 Bb	90	3439	4		
4.	Cabin 4MM Cst. 103..107 Tb	23	860	1		
5.	Cabin 2MM Cst. 107..112 Tb	30	1160	1.3		
6.	Cabin 4MM Cst. 99..102 Bb	25	967	1.1		
7.	Cabin 4MM Cst. 98..102 Tb	27	1032	1.2		
8.	Cabin 4MM Cst. 95..99 Bb	25	967	1.1		
9.	Cabin 4MM Cst. 91..95 Bb	25	967	1.1		
10.	Cabin 4MM Cst. 91..95 Tb	25	967	1.1		
11.	PCC Pv Cst. 83..88 Tb	50	1892	2.2		
12.	Barracks 28 mil. Bb Cst. 15..25	120	4643	5.4		
13.	Barracks 28 mil. Tb Cst. 15..25	120	4643	5.4		
14.	Barracks 32 mil. Cst. 8..15	160	6191	7.2		

2.2 Compartments' air conditioning installation

The comparments' air conditioning installation present on board has been dimensioned for the climate conditions specific for the Black Sea navigation area:

SUMMER	Air temperature	Relative humidity	Enthalpy
Exterior air	+ 30°C	65%	17.8 kcal/kg
Interior air	+ 23°C	50%	11.0 kcal/kg
			6.8 kcal/kg

The installation is aided by 3 air condition aggregations, each with a debit of 8 000 mc/h which ensures the air exchange in compartments with values between 4 ÷ 6 sch/h in sailors, petty officers and officers compartments, 6 ÷ 8 sch/h in superior officers compartments, 8 ÷ 10 sch/h in public spaces.

The transport of air towards the conditioned spaces is made through the tubing system SPIRODUCT, double, with air isolation layer.The air distribution in the compartments is made through air ceiling and walls distributors, made by KLIMORPoland, with air debit adjustment possibilities both from within the system to balance the installation and from the exterior depending of the needs of the crew.

As is has been used before, the installation existent on board is not very efficient in guaranteeing a right climate environment for the present needs. As the ship is capable of reaching other navigation areas besides the Black Sea, the climate calculation parametres must corespond to the limitless navigation area which, as ISO-7547 states, are:

SUMMER	Air temperature	Relative humidity	Enthalpy
Exterior air	+ 35°C	70%	24.0 kcal/kg
Interior air	+ 27°C	50%	13.4 kcal/kg
			10.6 kcal/kg

It is noticed that the enthalpy difference is bigger then the one in the present system which would have required a bigger cooling power. In order to reduce the necessary cooling power, modern ships use the recirculation of the interior air up to values of about 40%. The existent installation is not allowing the air recirculation.

As the tubing system on the ship cannot suffer important changes without affecting the compartments, the improvement is proposed through the use of individual air conditioning.

Choosing the cooling capacity coresponds to the usual accepted method and it reaches the value of 70% of the necessary heating of the compartment.

For the living compartments the values are indicated in Table 1 which resulted through the use of the necessary heat calculation in point 2.1.

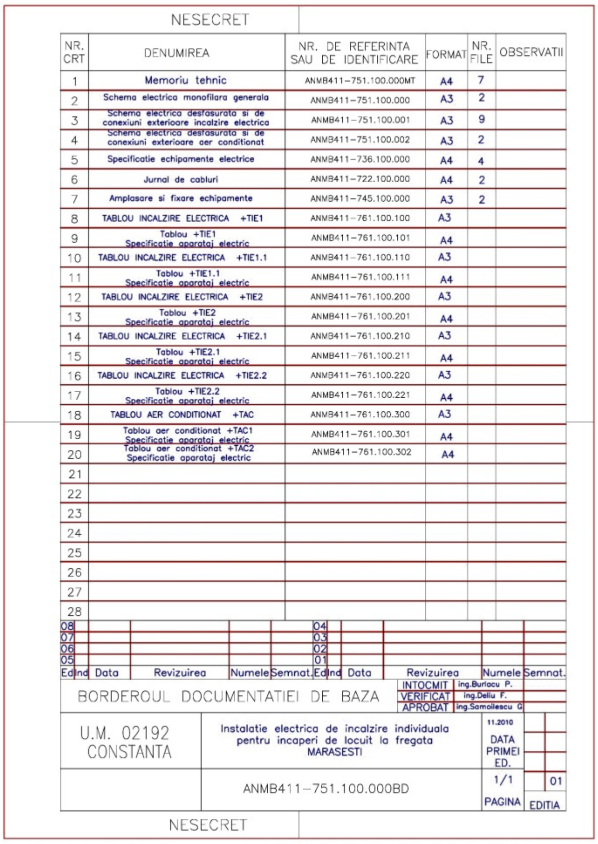
The electrical radiators powering will be made through the 3x380V ship's electrical network, which ensures the power reserve required by these new consumers. The wiring is ensured by 2 separate electrical networks by grouping the bow consumers which require 51.4 kW and the stern consumers which require 48 kW.

The powering of the air conditioning aggregates is made through the 3x220V ship's electrical network because, at required individual powers, the equipment is manufactured only in the 3x220V and 50 Hz network. The wiring is also made through 2 separate networks by grouping the bow consumers which require 7.18kW and the stern consumers which require 8.16 kW.

3. Functional needs

The functional needs reffer to the following:

- The ensuring of power for electrical heating, on the 3x380V network up to a value of 79.5 kW;
- The ensuring of power for air conditioning, on the 3x220V network up to a value of 12.3 kW;
- The ensuring of powering, command and individual electrical protection of electrical radiators which will come with a thermostat and a switch;
- The ensuring of powering, command and individual protection of installed air conditioning systems.



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1	Memoriu tehnic	ANMB411-751.100.000MT	A4	7	
2	Schema electrica monofilara generala	ANMB411-751.100.000	A3	2	
3	Schema electrica desfasurata si de conexiuni exterioare incalzire electrica	ANMB411-751.100.001	A3	9	
4	Schema electrica desfasurata si de conexiuni exterioare aer conditionat	ANMB411-751.100.002	A3	2	
5	Specificatie echipamente electrice	ANMB411-736.100.000	A4	4	
6	Jurnal de cabluri	ANMB411-722.100.000	A4	2	
7	Amplasare si fixare echipamente	ANMB411-745.100.000	A3	2	
8	TABLOU INCALZIRE ELECTRICA +TIE1	ANMB411-761.100.100	A3		
9	Tablou +TIE1 Specificatie aparataj electric	ANMB411-761.100.101	A4		
10	TABLOU INCALZIRE ELECTRICA +TIE1.1	ANMB411-761.100.110	A3		
11	Tablou +TIE1.1 Specificatie aparataj electric	ANMB411-761.100.111	A4		
12	TABLOU INCALZIRE ELECTRICA +TIE2	ANMB411-761.100.200	A3		
13	Tablou +TIE2 Specificatie aparataj electric	ANMB411-761.100.201	A4		
14	TABLOU INCALZIRE ELECTRICA +TIE2.1	ANMB411-761.100.210	A3		
15	Tablou +TIE2.1 Specificatie aparataj electric	ANMB411-761.100.211	A4		
16	TABLOU INCALZIRE ELECTRICA +TIE2.2	ANMB411-761.100.220	A3		
17	Tablou +TIE2.2 Specificatie aparataj electric	ANMB411-761.100.221	A4		
18	TABLOU AER CONDITIONAT +TAC	ANMB411-761.100.300	A3		
19	Tablou aer conditionat +TAC1 Specificatie aparataj electric	ANMB411-761.100.301	A4		
20	Tablou aer conditionat +TAC2 Specificatie aparataj electric	ANMB411-761.100.302	A4		
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BORDEROUL DOCUMENTATIEI DE BAZA

INTOCMIT	ing.Burlacu P.
VERIFICAT	ing.Deliu F.
APROBAT	ing.Samoilescu G

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Instalatie electrica de incalzire individuala pentru incaperi de locuit la fregata MARASESTI

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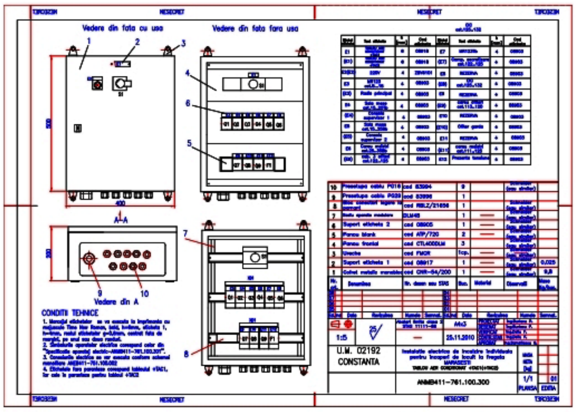

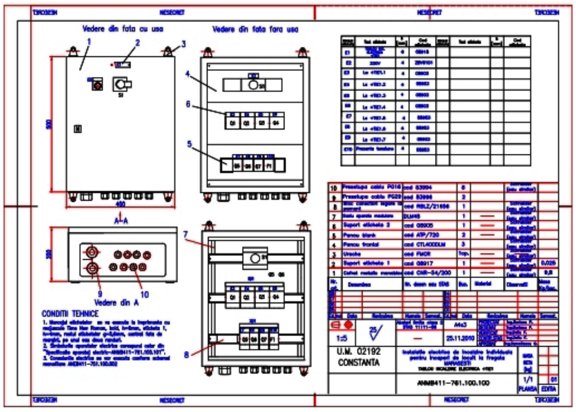

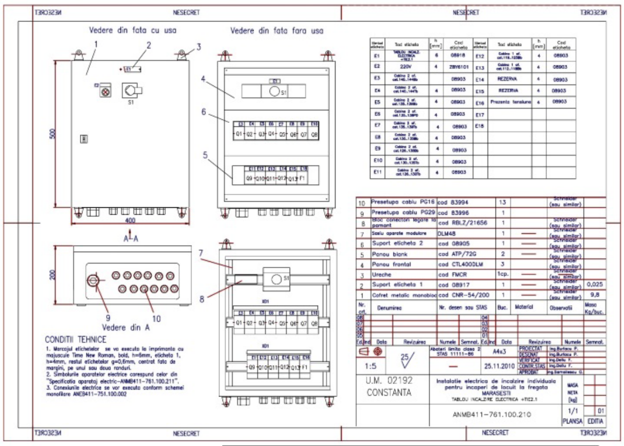
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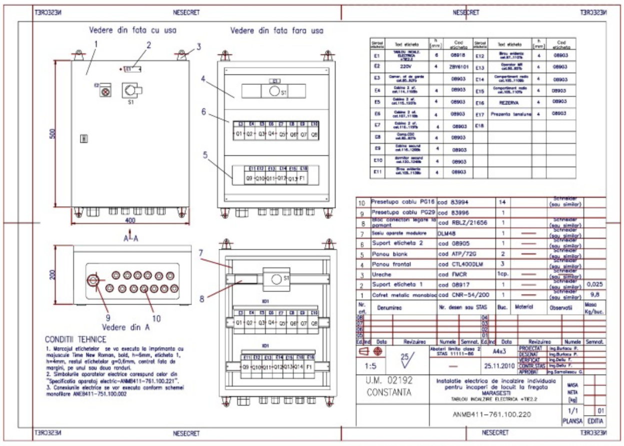
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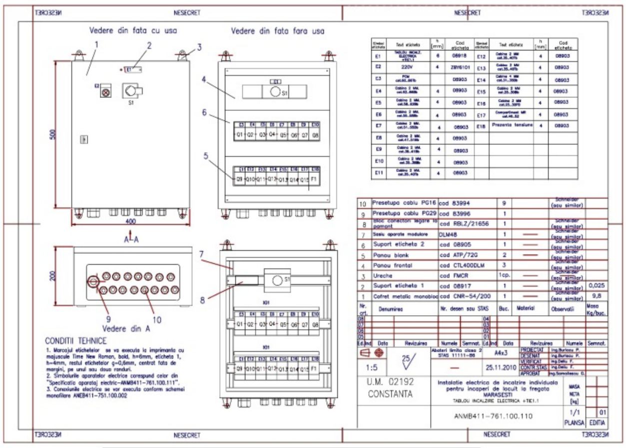
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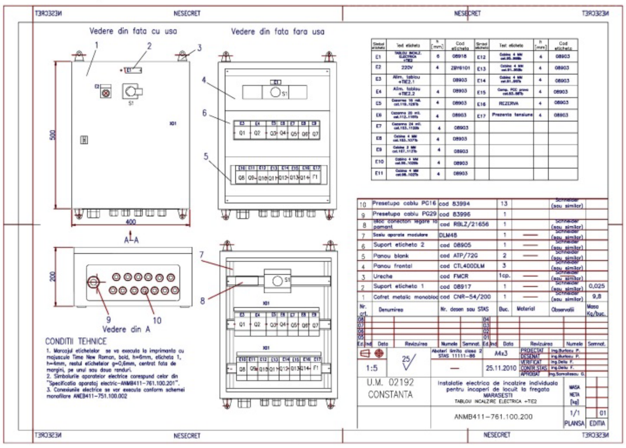
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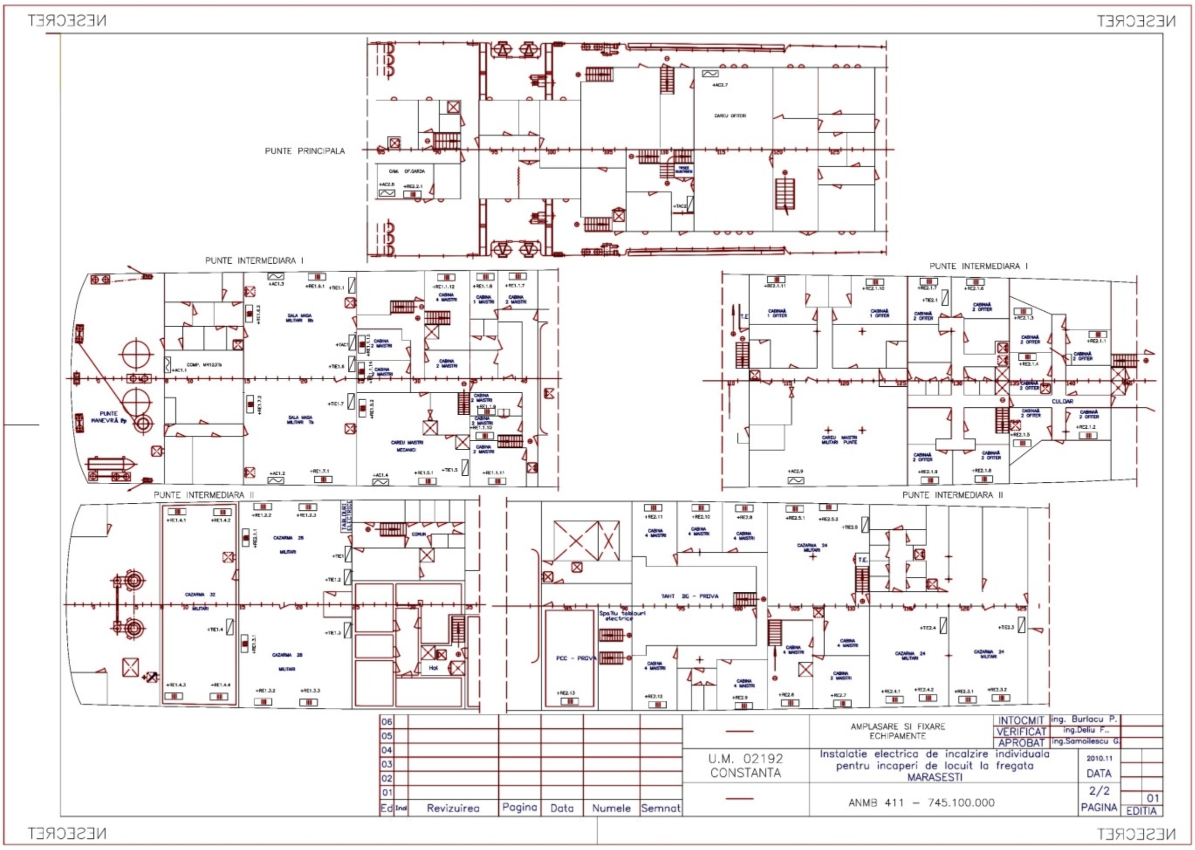
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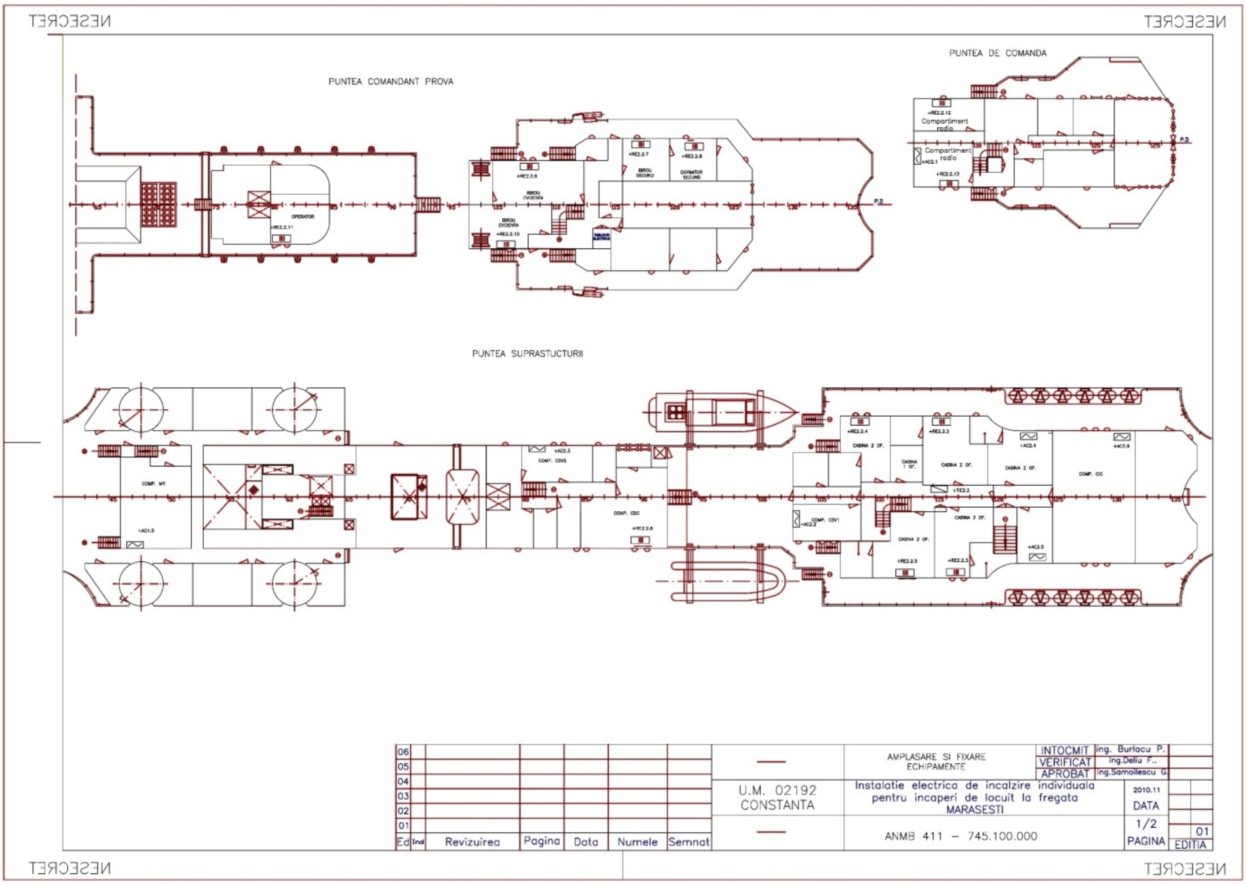
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4. Adopted technical sollution

4.1 The structure of the electrical radiators powering system

The electrical radiators powering system structure results from the electric sketch, drawing ANMB 411 – 751.100.001 and is comprised of 5 powering pannels TIE 2, TIE 2.1, TIE 2.2 şi TIE 1, TIE 1.1.

Through pannel +TIE1 powering for the stern area is ensured through pannel TPD1 stern.

Through pannel +TIE2 powering for the bow area is ensured through pannel TPD2 bow.

4.2 The structure of the air conditioning aggregations powering system

The already existent air conditioning individual machines are powered at the moment from the 220V electrical network.

In order to avoid overcharging the electrical network, an indepedent network system comprised of two smaller networks, both powered from the sections of the 3x220V main pannels.

One is powered from TPD2 bow which, through the dedicated panel +TAC2 powers the machines in the bow area and the second is powered from TPD1 stern which, through +TAC1, powers the machines in the stern area.

The pannels +TAC ensure the electrical powering and the individual protection of the air conditioning aggregations, wired locally through connecting branches.

4.3 Equipment placement

The equipment placement is corelated with the ship’s needs. The exact placement will be decided during construction, depending on local conditions.

4.4 Cable network

The system uses its own cable network noted in the cable log ANMB 411 – 722.100.000.

These cables will be tied on the existent cable paths through the technology already used on board for the tying of cables, distance between them and the passing through walls.

The cable lenghts are aproximate, the exact ones will be decided during construction.