



Control Systems

Imagination at work

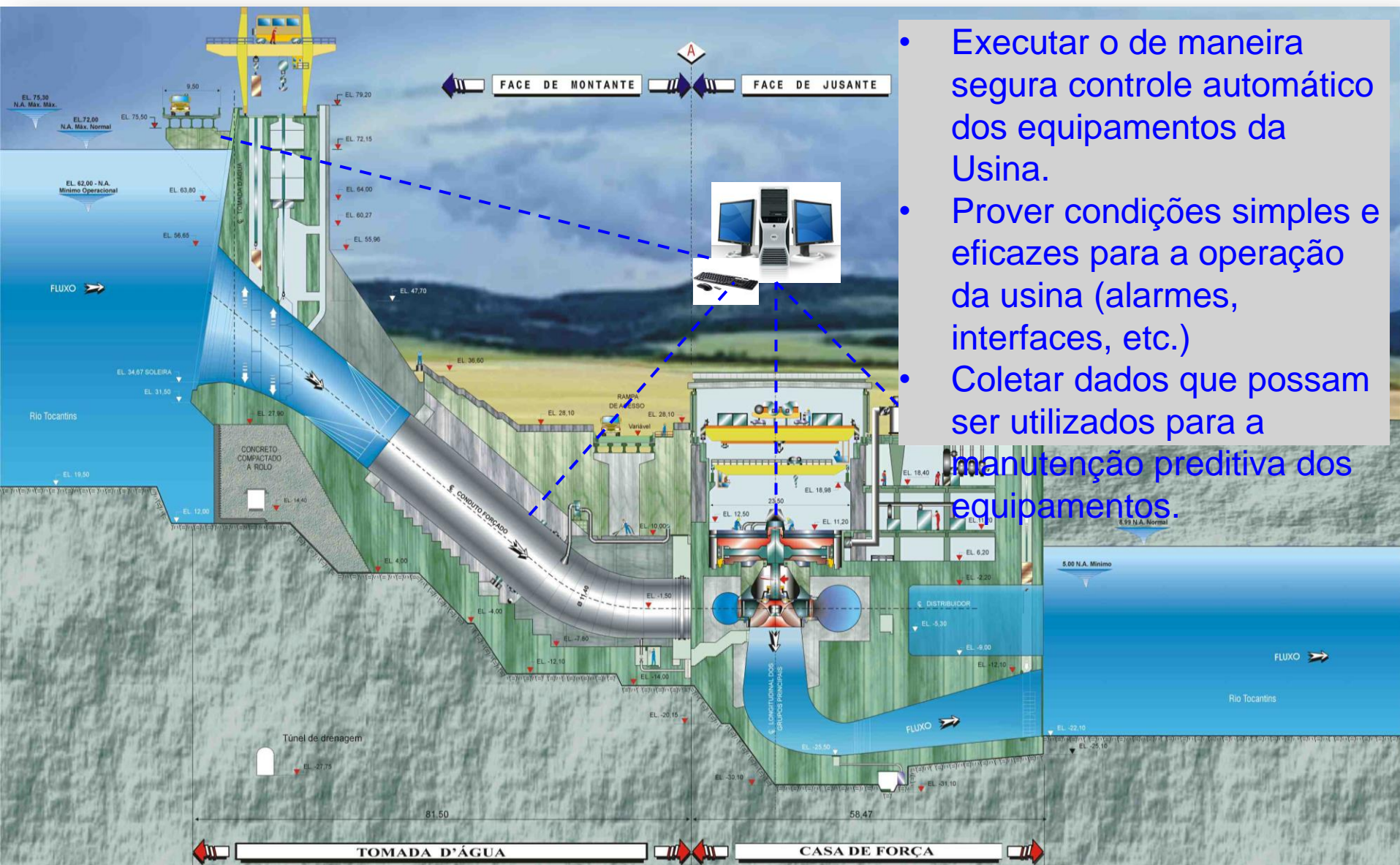
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Sistema Digital de Supervisão e Controle

Introdução



SISTEMA DIGITAL DE SUPERVISÃO E CONTROLE DE USINAS HIDRELÉTRICAS

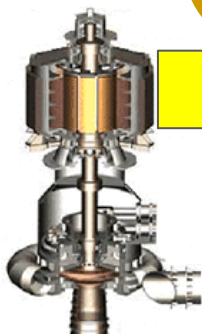
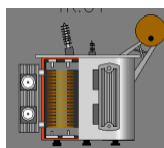
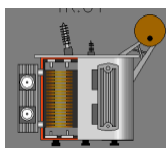


- Executar o de maneira segura controle automático dos equipamentos da Usina.
- Prover condições simples e eficazes para a operação da usina (alarmes, interfaces, etc.)
- Coletar dados que possam ser utilizados para a manutenção preditiva dos equipamentos.

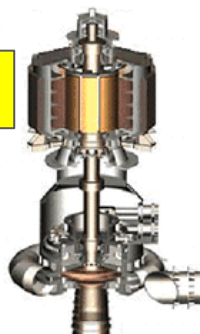
INTRODUÇÃO



- Como a informação de temp. alta chega aos computadores?
- Quem e como controla os equipamentos?
- Etapas básicas do projeto do SDSC.

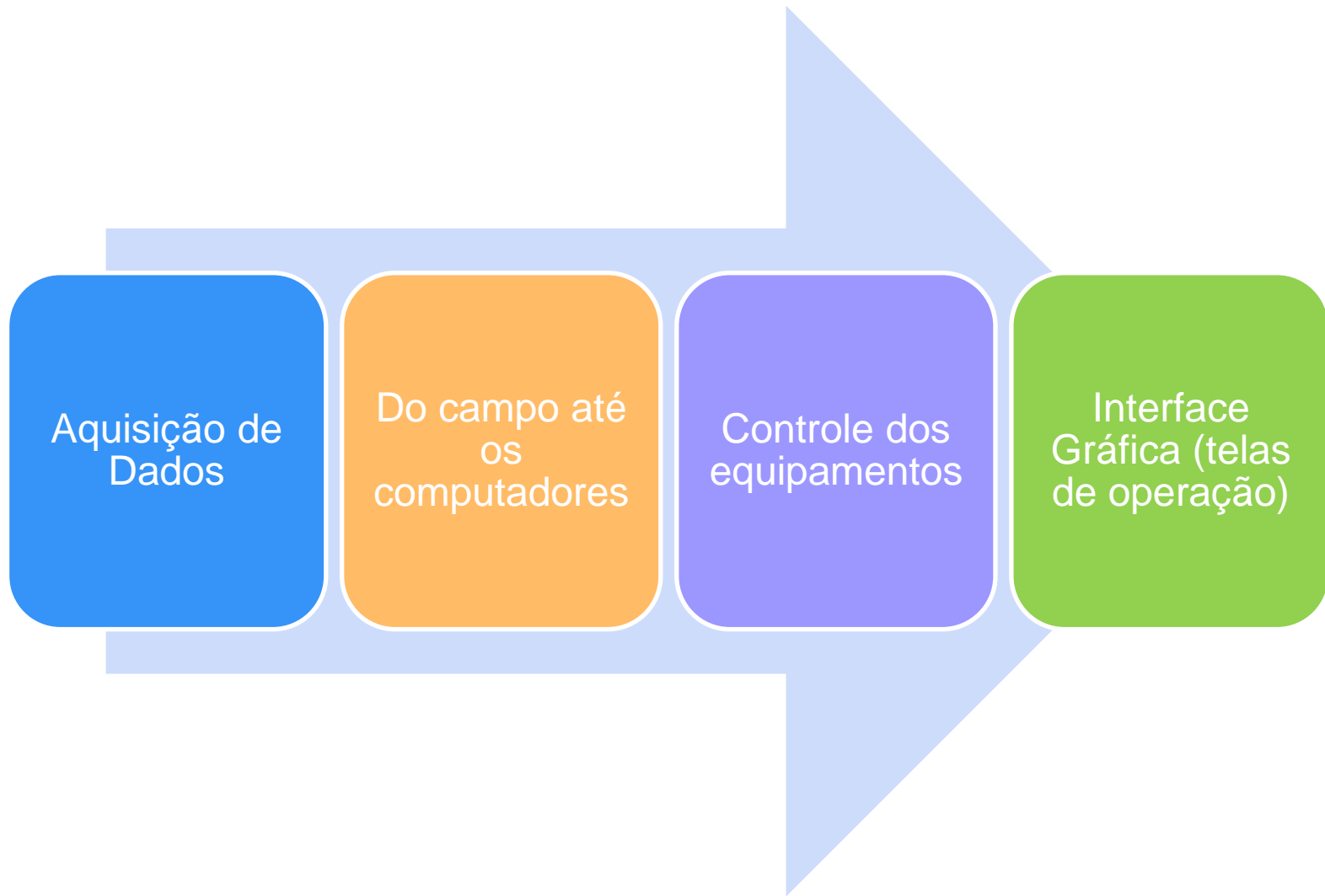


UG1 - Temp alta enr do estator



Poço de drenagem – Bomba 1 - Ligada

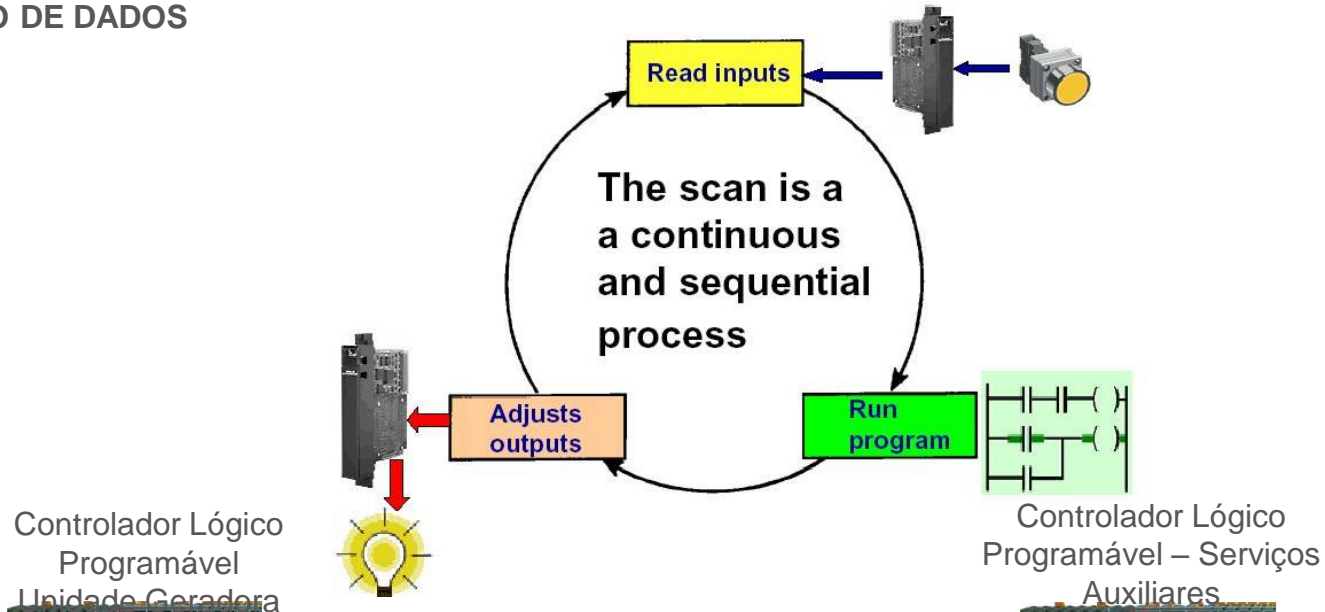




Aquisição de Dados



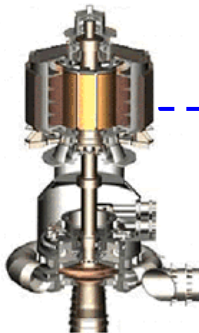
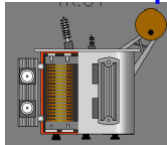
Scan Process



Módulos de:

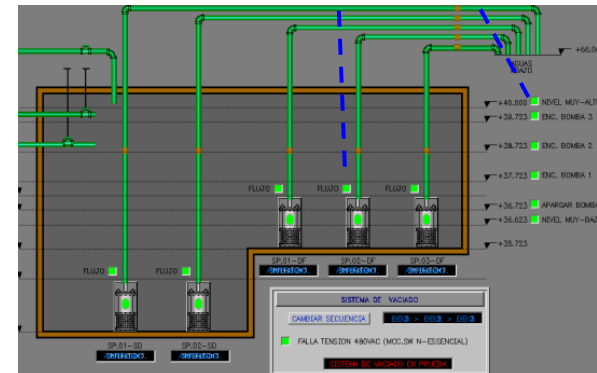
- Entrada Digitais
- Entradas Analógicas
- Saídas Digitais
- Saídas Analógicas
- Comunicação

Controlador Lógico Programável Unidade Geradora



Hydro Technical Training

Controlador Lógico Programável – Serviços Auxiliares



SELEÇÃO DOS SINAIS A SEREM AQUISITADOS

PLC REF. -A001(-A104) -T102	FROM	TAG	DESCRIPTION	MESSAGE		FUNCTION	REV
				1	0		
1	SSB	C101CAA01CK003_XM212	U1 PAR CON RECH TIEMPO MUY LARGO	ACTUADO	N-ACTUAD	111110	2
2	SSB	C101CAA01CH001_XG236	U1 SELECTOR SINCRONIZACION POS	AUTO	MANUAL	0 110	2
3	SSB	C101CAA01EP001_XM248	U1 RELE SINCRONIZADOR	NORMAL	FALLA	201110	0A
4	SSB	C101CAA01EP002_XM248	U1 RELE VERIFICACION SINC	FALLA	N-FALLA	211100	4
5	SSB	C101CAA01GT203_XM248	U1 SSB.U FUSIBLE PT	NORMAL	FALLA	201110	2
6	SSB	C101CAA01GT201_XG242	U1 BARRA MUERTA	DETECTAD	N-DETEC	0 110	2
7			SPARE				2
8	SSB	C101BAC01EG201_XG248	U1 INTERRUPTOR 1G1 BOBINA DISP 1	NORMAL	FALLA	0 000	2
9	SSB	C101BAC01EG202_XG248	U1 INTERRUPTOR 1G1 BOBINA DISP 2	NORMAL	FALLA	0 000	2
10	T1	C101BAT01ED011_XM247	U1 ALIMENTACION CA TR T1	FALLA	N-FALLA	211110	3
11	T1	C101BAT01AH201_XG239	U1 VENTILACION TR T1	CONECTAD	N-CONECT	0 110	2
12	T1	C101BAT01AH201_XM236	U1 VENTILACION TR T1 CONTROL	AUTO	N-AUTO	0 110	2
13	T1	C101BAT01AH201_XM247	U1 VENTILACION TR T1	FALLA	N-FALLA	211110	2
14	T1	C101BAT01ED005_XM247	U1 TAB TR T1 VOLTAJE CONTROL	FALLA	N-FALLA	211110	2
15	T1	C101BAT01EG031_XM212	U1 RELE BUC TR T1 ALARMA	ACTUADO	N-ACTUAD	211110	2
16	T1	C101BAT01CL001SXM220	U1 TANQUE ACEITE TR T1 NIVEL	BAJO	N-BAJO	211110	2
17	T1	C101BAT01CL001SXM216	U1 TANQUE ACEITE TR T1 NIVEL	ALTO	N-ALTO	211110	2
18	T1	C101BAT01CT071_XM215	U1 DEV BAJA O ALTA TR T1 TEMP	ALTA	N-ALTA	211110	4
19	T1	C101BAT01CT001_XM215	U1 ACEITE TR T1 TEMPERATURA	ALTA	N-ALTA	211110	4
20			SPARE				0A
21	FACU	C101SGM03EG031_XM212	U1 TRIP Z1 INCENDIO TR T1	ACTUADO	N-ACTUAD	111110	4
22	FACU	C101SGM03EW024_XM212	U1 TRIP Z2 INCENDIO TR T1	ACTUADO	N-ACTUAD	111110	4
23			SPARE				4
24			SPARE				4
25			SPARE				0A
26	GPP.U	C101CHA01GW044_XM247	U1 GPP.U ALIM RELE PROTECCION	FALLA	N-FALLA	211110	2
27	GPP.U	C101CHA10EW016_XM247	U1 RELE PRT PRINCIPAL GENERADOR	FALLA	N-FALLA	211110	0A
28	GPP.U	C101CHA14EW016_XM247	U1 RELE PRT RESPALDO GENENERADOR	FALLA	N-FALLA	211110	0A
29	GPP.U	C101CHA01GW001_XM247	U1 GPP.U ALIMENTACION 125 VDC	FALLA	N-FALLA	211110	4
30	GPP.U	C101CHA01GW006_XM247	U1 GPP.U ALIM RELE INTERFAZ	FALLA	N-FALLA	211110	0A
31	GPP.U	C101BAW01GT241_XM247	U1 FUS PT PRT CUB CERRE NEUTRO	FALLA	N-FALLA	211110	3
32	GPP.U	C101BAB01GT251_XM247	U1 FUSIBLE PT PRT PRIN CUB SURTO	FALLA	N-FALLA	211110	3



SELEÇÃO DOS SINAIS A SEREM AQUISITADOS

PLC REF. -A002(-A205) -T301	FROM	TAG	DESCRIPTION	UNIT	Vmin	Vmax	Smin	Smax	LOW	V. LOW	HIGH	V. HIGH	REV
1	TGC.U	C101MEU00CE203TXQ029	U1 REG VEL AJUSTE SPT POTENCIA	%	19166	31992	0	100					4
2	TGC.U	C101MEU00CS011TXQ026	U1 TURBINA VELOCIDAD	%	6400	32000	0	212,35					4
3	GTBA	C101MEU65CL001TXQ008	U1 ACUMULADOR PISTON NIV ACEITE	mm	6352	31982	0	1927	1024	671	1376	1897	4
4	GTBH	C101MEU31CP007TXQ005	U1 UNID HID RV PRES ACEITE LINEA	Bar	6400	32000	0	250			187,5		4
5	GTBH	C101MEU31CT001TXQ001	U1 UNID HID RV ACEITE TANQ TEMP	°C	6400	32000	0	150				112,5	4
6			SPARE										0A
7			SPARE										0A
8			SPARE										0A
9			SPARE										0A
10			SPARE										0A
11			SPARE										0A
12			SPARE										0A
13			SPARE										0A
14			SPARE										0A
15			SPARE										0A
16			SPARE										0A

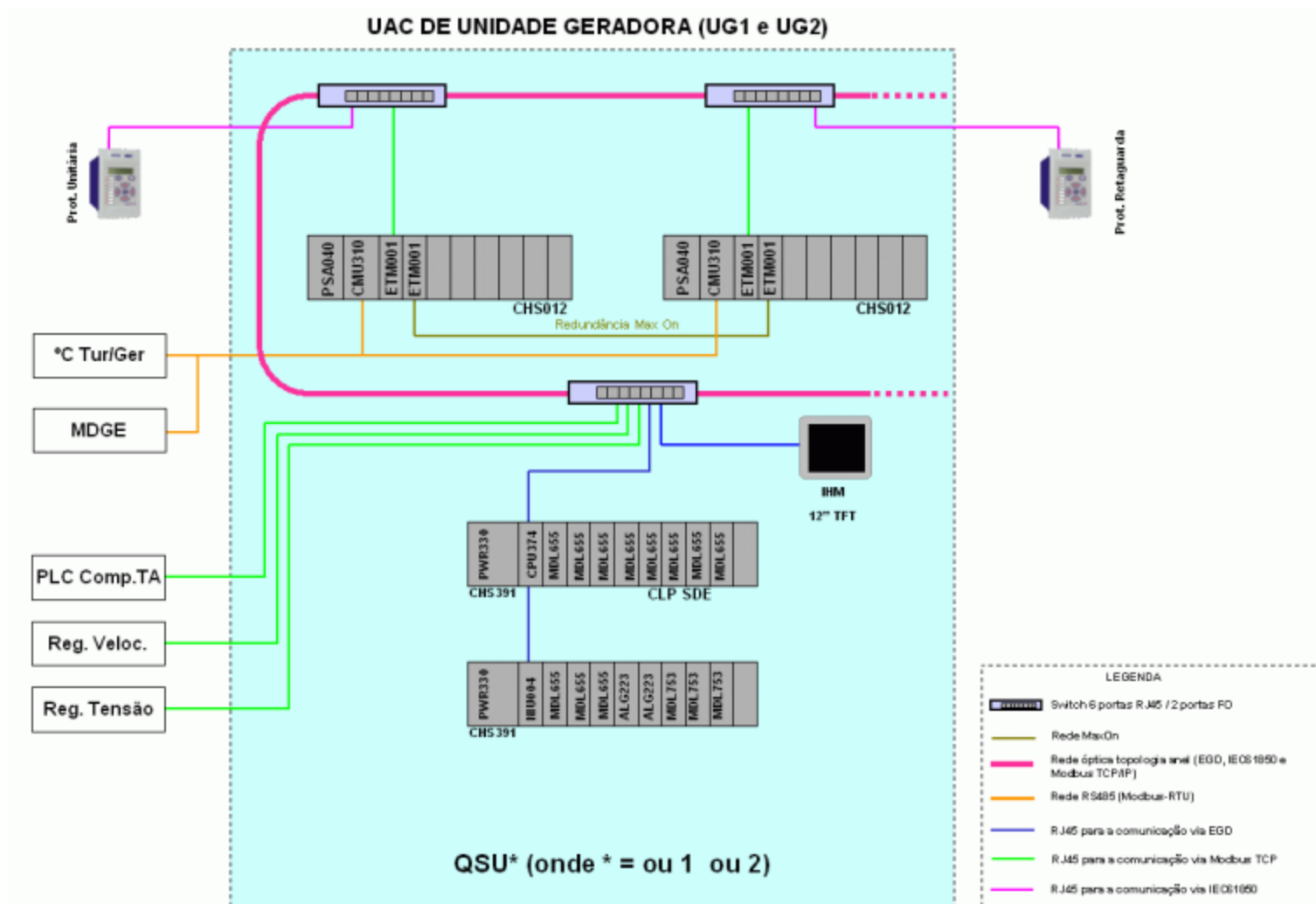
ALSTOM

LOCAL CONTROL BOARD - UNIT 1 - LCB.U1 - DIGITAL INPUTS BY MODBUS

CHANGUINOLA I HPP

TGC-TSLG-N		TAG	DESCRIPTION	MESSAGE		FUNCTION	REV
ADDRESS				1	0		
INTERNAL	EXTERNAL						
%R2002:0	1:0	C101MEU10EZ031_XN211	U1 TSLG-N FALLA MAYOR	ACTUADA	N-ACTUAD	211110	2
%R2002:1	1:1	C101MEU10CE004_XN257	U1 TSLG-N SENAL FREC UNIDAD	PERDIDO	N-PERDID	211110	2
%R2002:2	1:2	C101MEU10EZ033_XN211	U1 TSLG-N SPC FALLA MAYOR	ACTUADA	N-ACTUAD	211110	2
%R2002:3	1:3	C101MEU10EZ041_XN211	U1 TSLG-N FAL MAYOR COMM TSLG-S	ACTUADA	N-ACTUAD	211110	2
%R2003:0	2:0	C101MEU10EG051_XN211	U1 TSLG-N FALLA MENOR	ACTUADA	N-ACTUAD	211110	2
%R2003:1	2:1	C101MEU10EG151_XN211	U1 TSLG-N SPC FALLA MENOR	ACTUADA	N-ACTUAD	211110	2
%R2003:2	2:2	C101MEU10CE005_XN257	U1 TSLG-N FRECUENCIA RED	PERDIDO	N-PERDID	211110	2
%R2003:3	2:3	C101MEU10CE004_XN247	U1 TSLG-N FRECUENCIA UNIDAD	PERDIDO	N-PERDID	211110	2
%R2003:4	2:4	C101MEU10CE003_XN247	U1 TSLG-N SENAL POTENCIA	FALLA	N-FALLA	211110	2
%R2003:6	2:6	C101MEU10EG051_XN247	U1 TSLG-N CAIDA	FALLA	N-FALLA	211110	2
%R2003:11	2:11	C101MEU10EG061_XN211	U1 TSLG-N FAL MENOR COMM TSLG-S	ACTUADA	N-ACTUAD	211110	2
%R2004:0	3:0	C101MEU10EG251_XN242	U1 TSLG-N OPERACION LIMITACION	DETECTAD	N-DETEC	0 110	4
%R2004:3	3:3	C101MEU10DS001_XA223	U1 TSLG-N SELECCION DEL SPT	ANALOG	DIGITAL	0 110	2
%R2004:4	3:4	C101MEU10EG351_XN242	U1 TSLG-N ACTUADORES EN OPERAC	DETECTAD	N-DETEC	0 110	4
%R2004:7	3:7	C101MEU10DS002_XA258	U1 TSLG-N REALIMENTACION	POTENCIA	POSICION	0 110	3
%R2004:8	3:8	C101MEU10DS003_XA214	U1 TSLG-N OPERACION EN RED	AISLAD	PARAL	0 110	2
%R2004:10	3:10	C101MEU10DS004_XA242	U1 TSLG-N ACTIVO	DETECTAD	N-DETEC	0 110	2
%R2004:11	3:11	C101MEU10DS005_XA242	U1 TSLG-N EN PRUEBA	DETECTAD	N-DETEC	0 110	2
%R2005:0	4:0	C101MEU10EZ033_XN247	U1 TSLG-N SPC1	FALLA	N-FALLA	211110	2

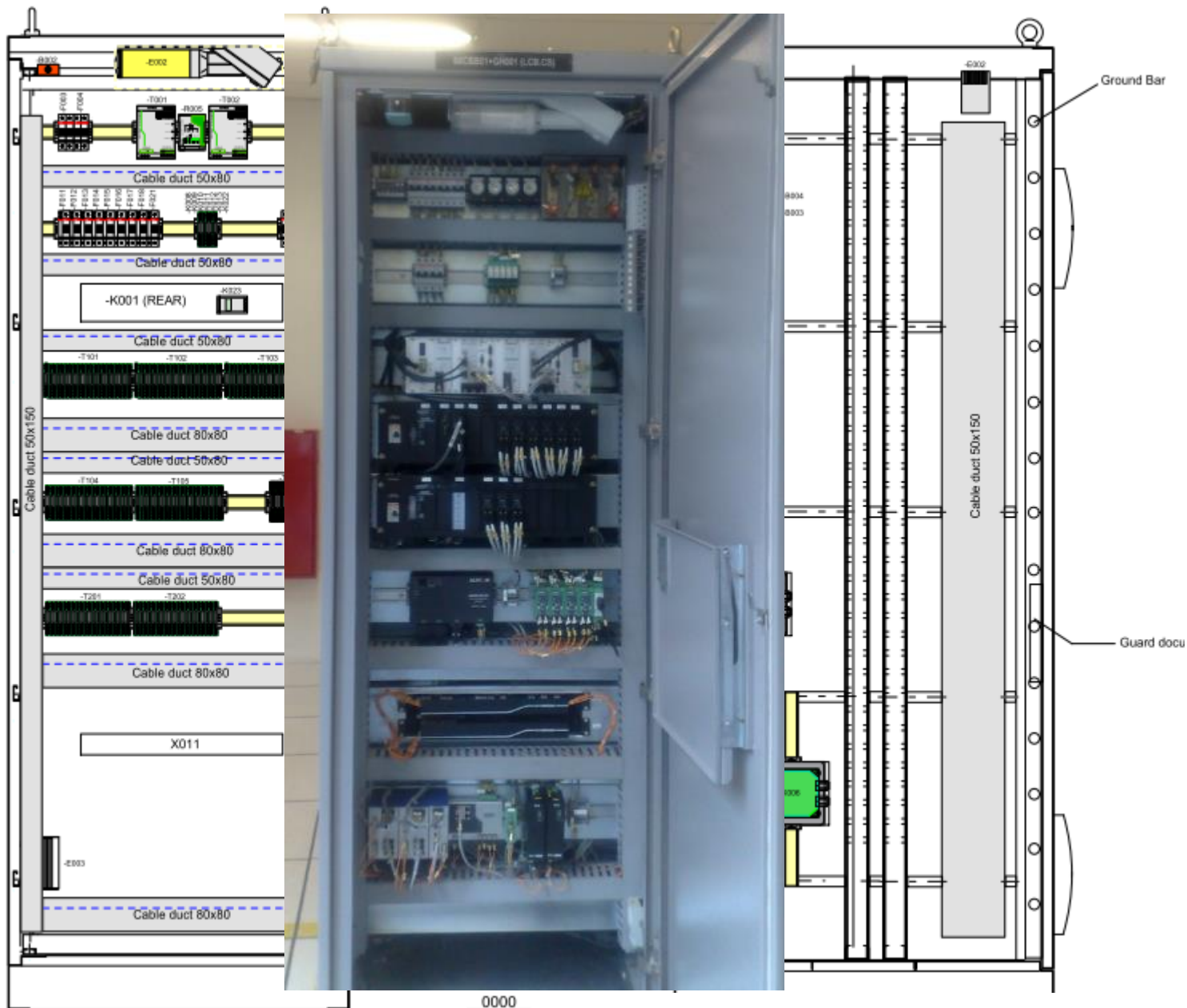
ARQUITETURA CENTRALIZADA



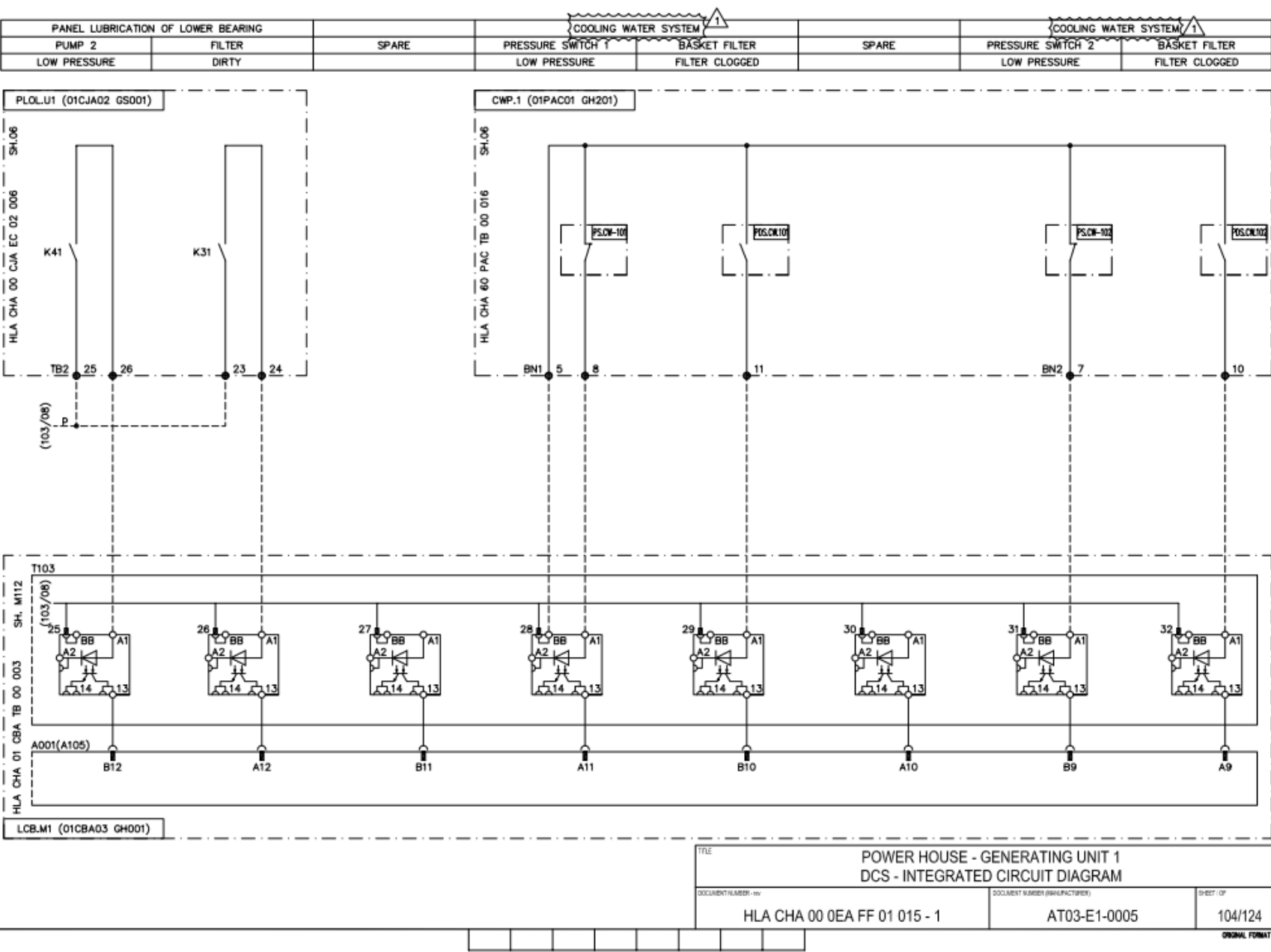
PH EL QUIMBO - Unidad Generadora



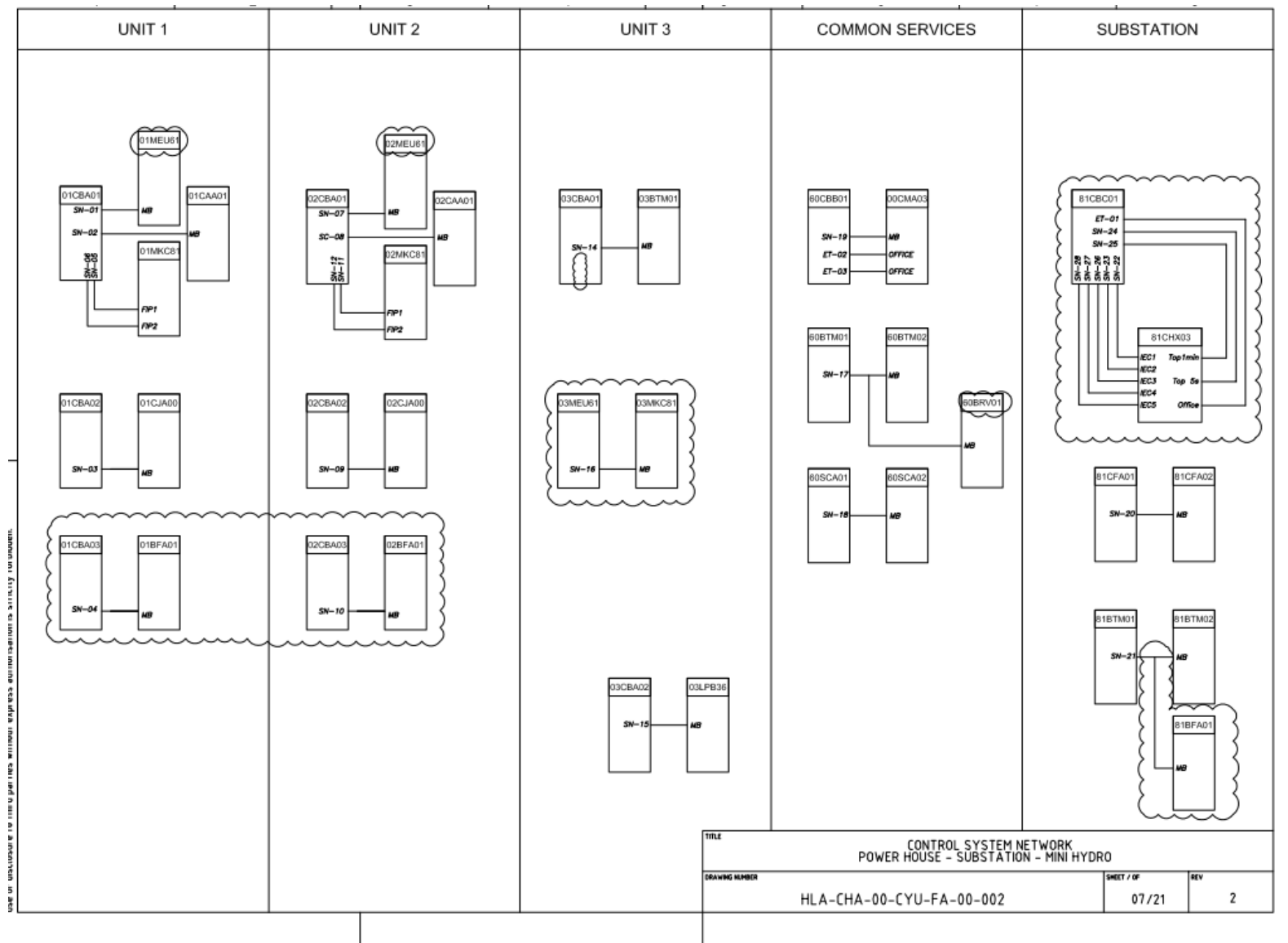
ALOCÇÃO DOS COMPONENTES NOS PAINÉIS



CONEXÃO DO CLP AOS EQUIPAMENTOS DE CAMPO



REDES DE COMUNICAÇÃO COM EQUIPAMENTOS – PROTOCOLO MODBUS RTU (OU OUTROS)



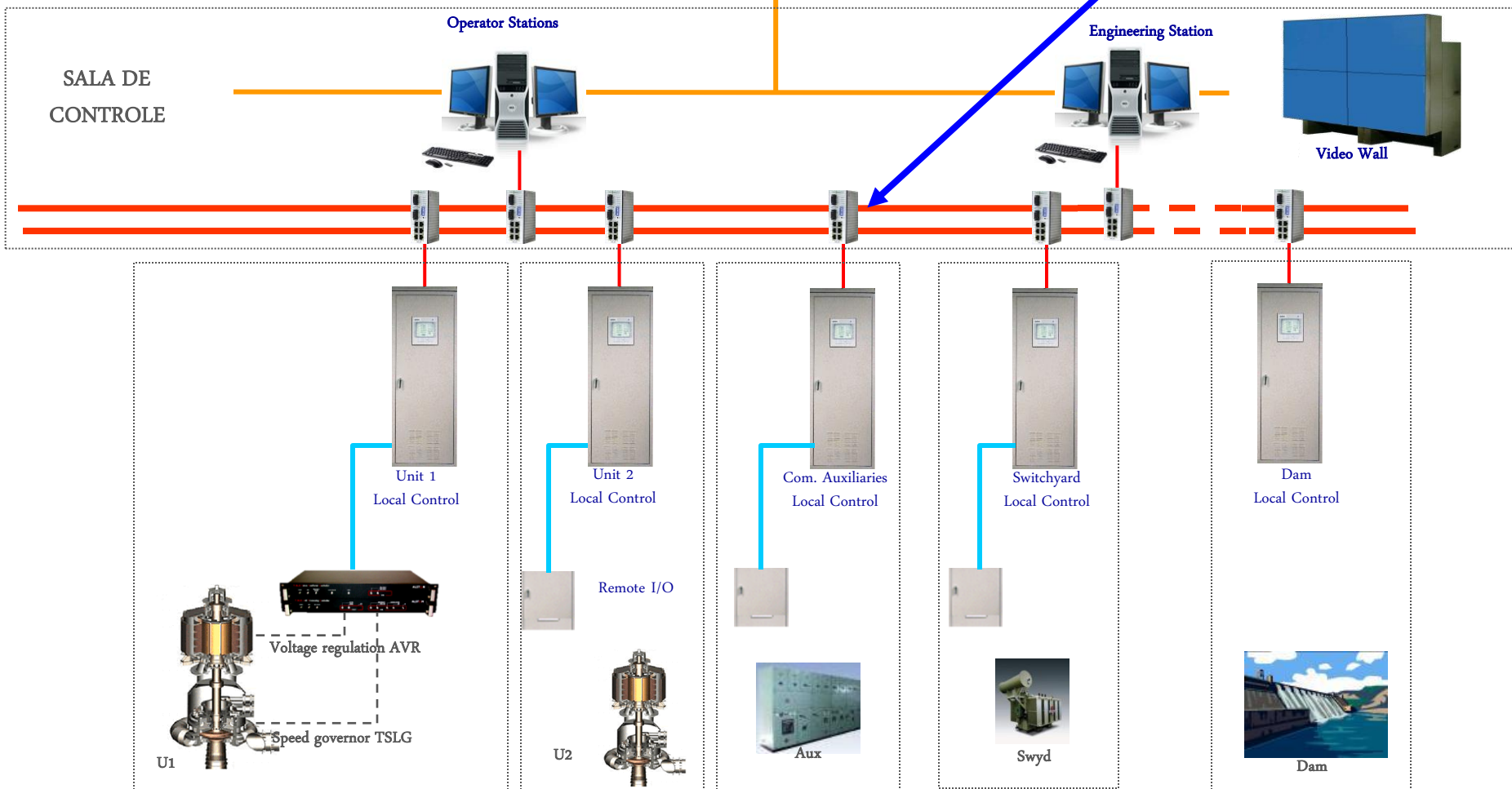
TROCA DE DADOS ENTRE OS CLPS E OS COMPUTADORES DA SALA DE CONTROLE

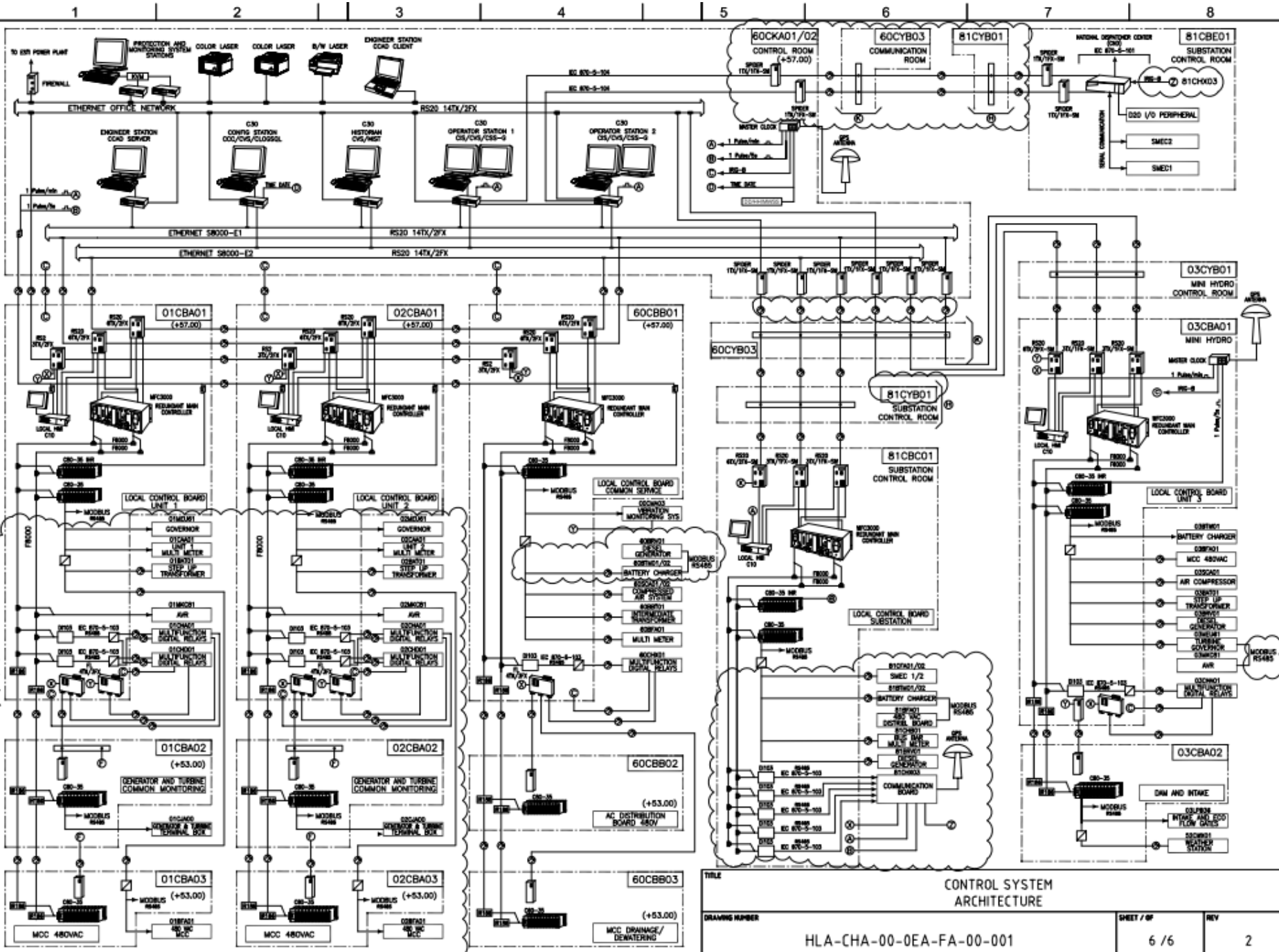


Control: Standard architecture

Mesmo protocolo de comunicação usado nos CLPs e nos computadores do SDSC.

CENTRO REMOTO

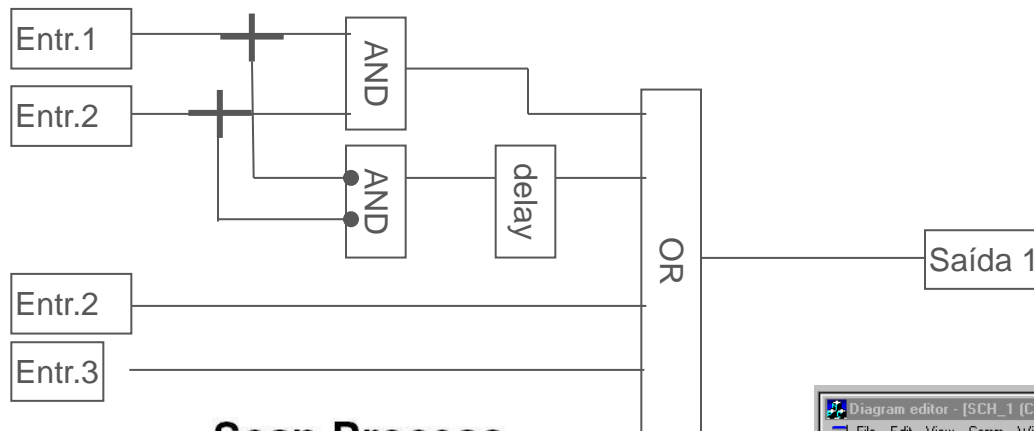




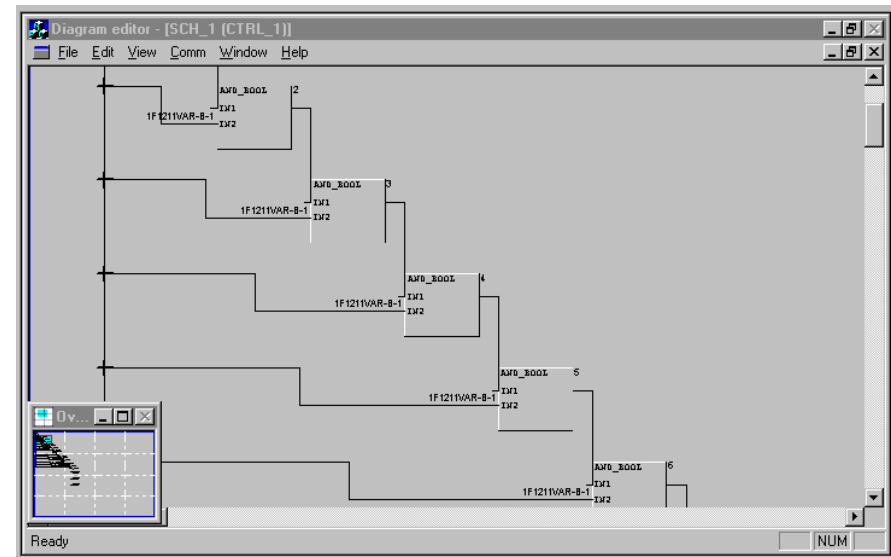
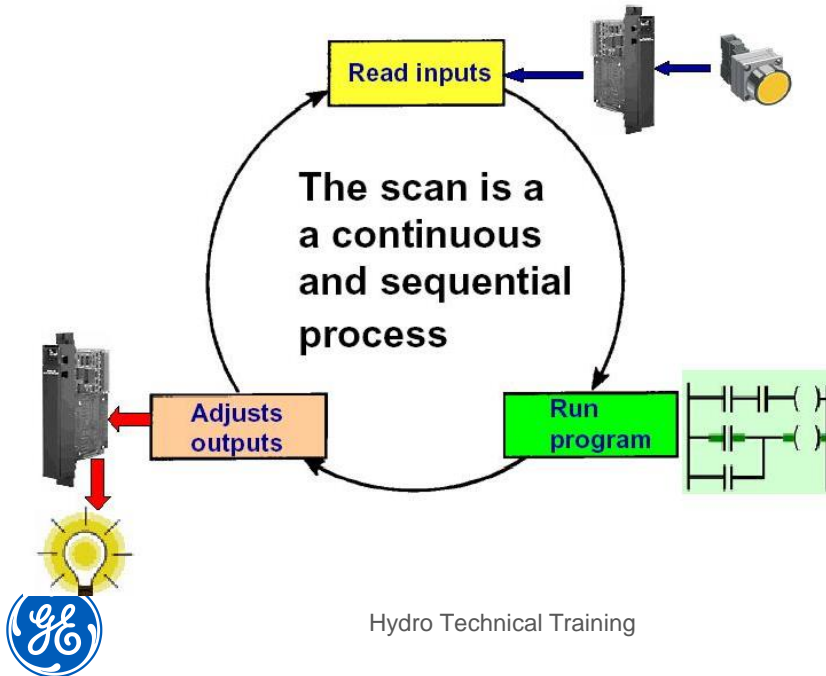
CONTROLE DOS EQUIPAMENTOS DA USINA



CONTROLADOR LÓGICO PROGRAMÁVEL

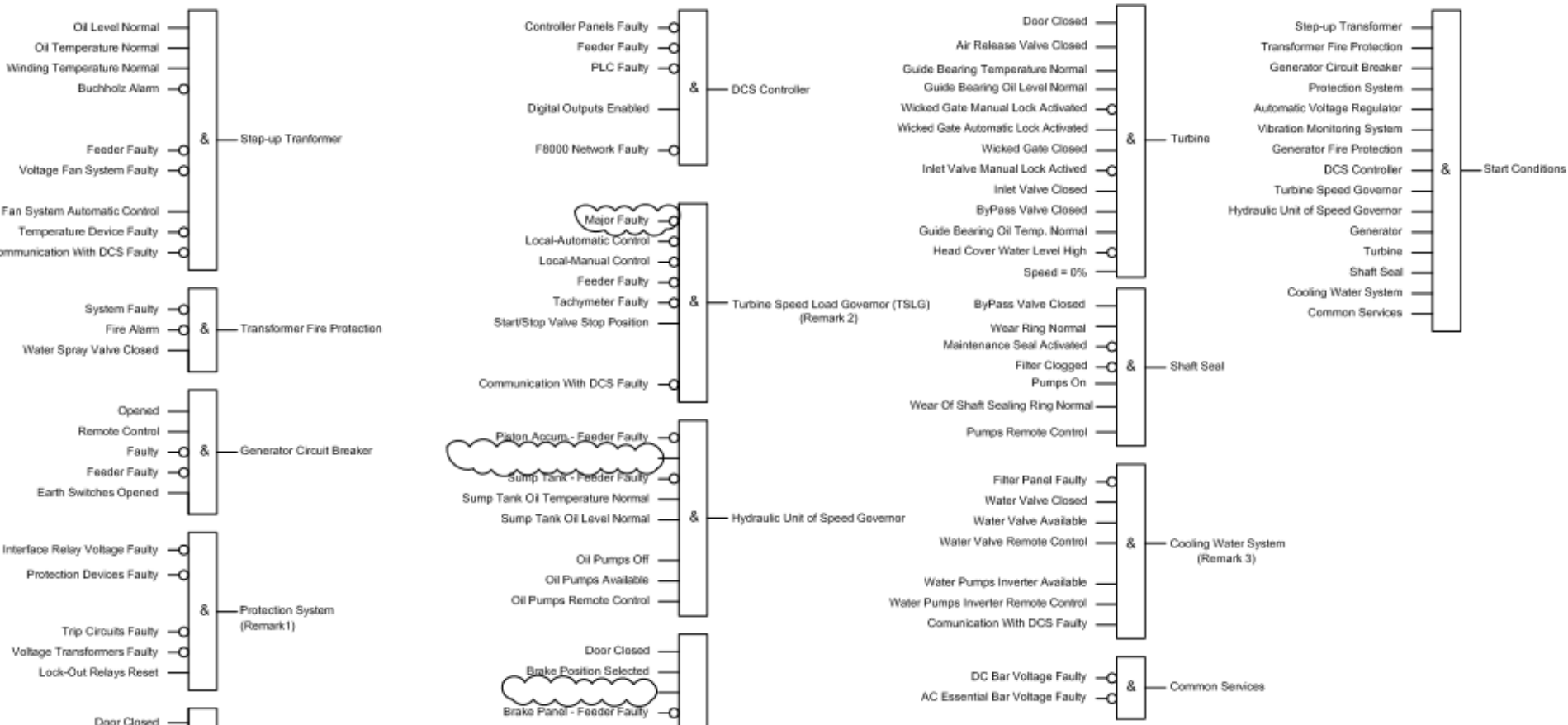


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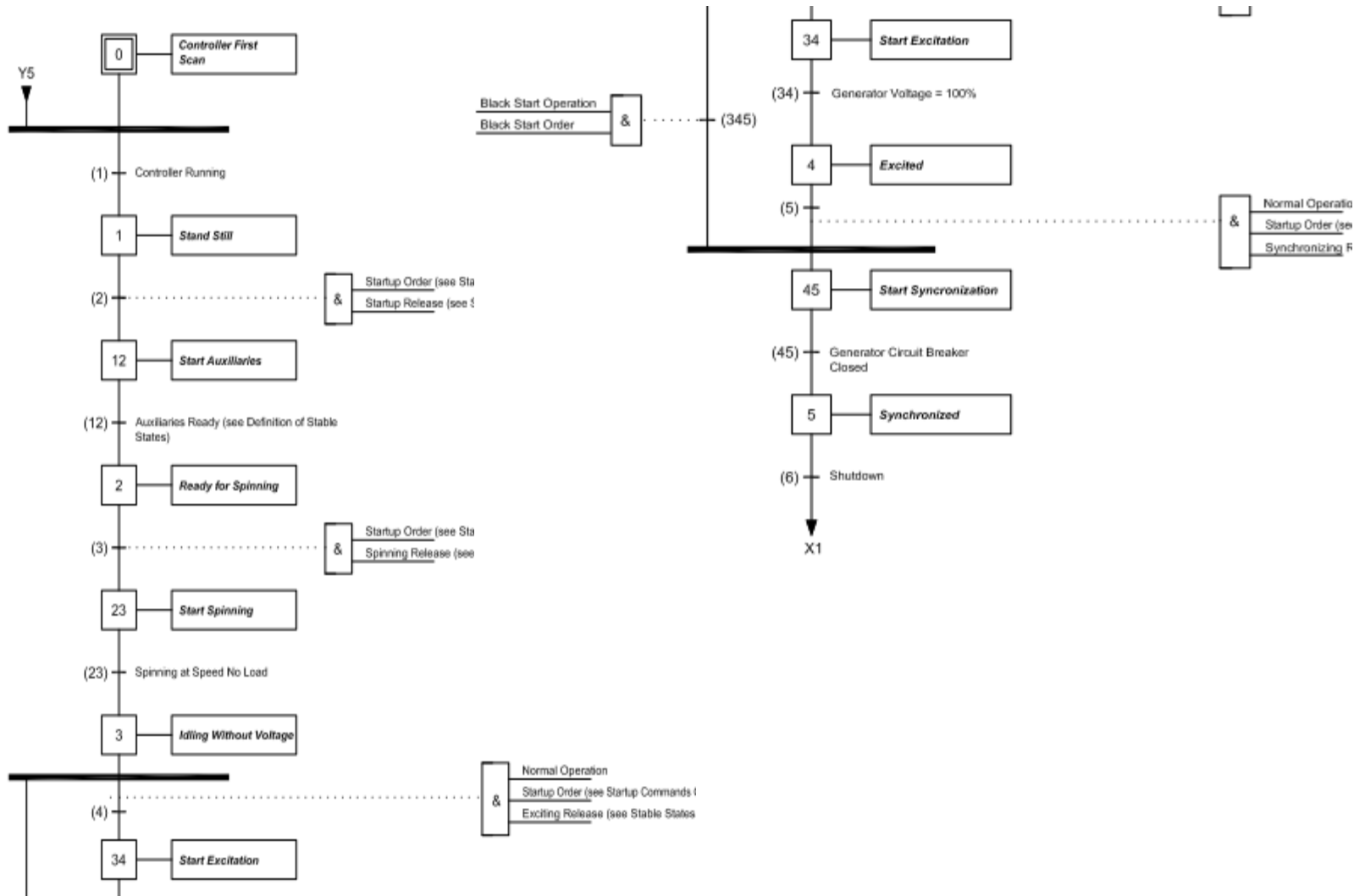


Diagramas Lógicos Básicos Pre-condições de Partida

STARTUP RELEASE



Sequência de Partida

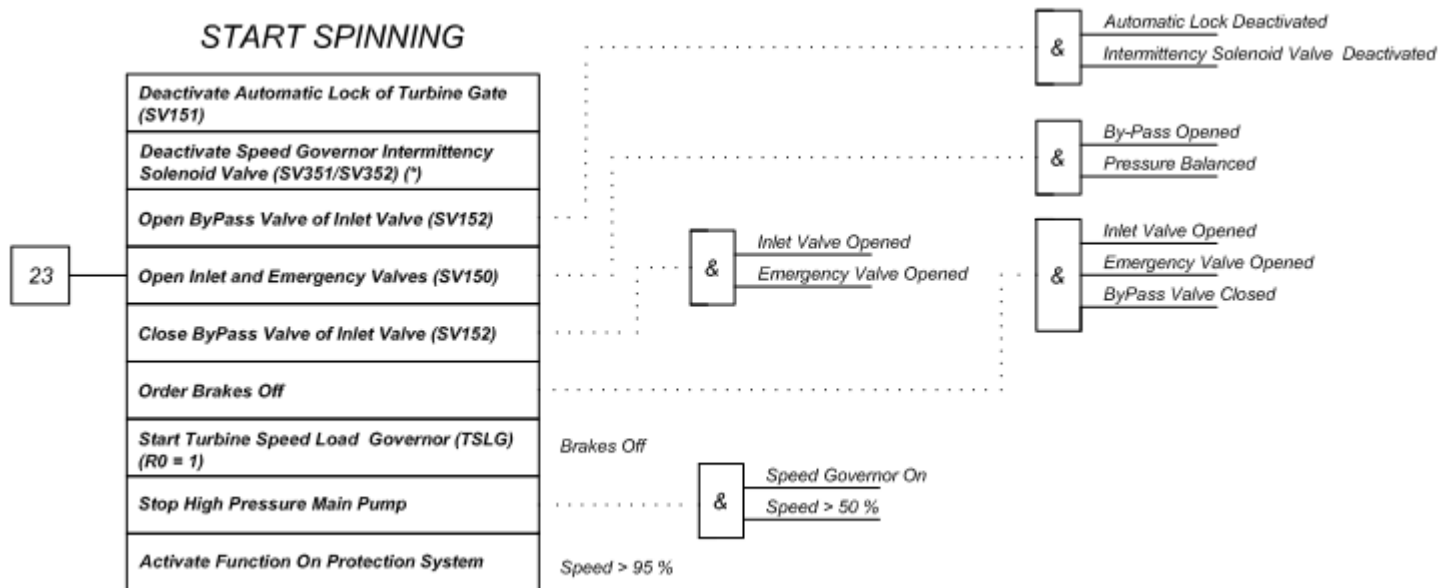


Ações da sequência de partida

START AUXILIARIES

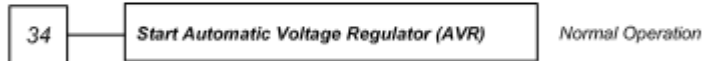
Start High Flow Warning System	-
Order Brakes On	High Flow Warning System On
Start Speed Governor Main Pump	Brakes On
Start Main Cooling Water Pump	Speed Governor Main Pump On
Open Cooling Water Valve	Cooling Water Main Pump On
Start High Pressure Main Pump	Cooling Water Flow Normal
Disable Creep Detector	High Pressure Main Pump On
Energize Speed Governor Intermittency Solenoid Valve (SV351/SV352) (*)	Creep Detector Off
Block Protection Function 81	All Cooling Water Flow Normal

START SPINNING

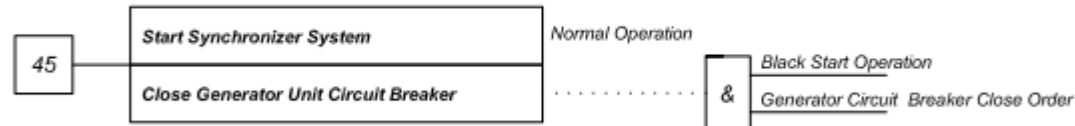


Ações da sequência de partida

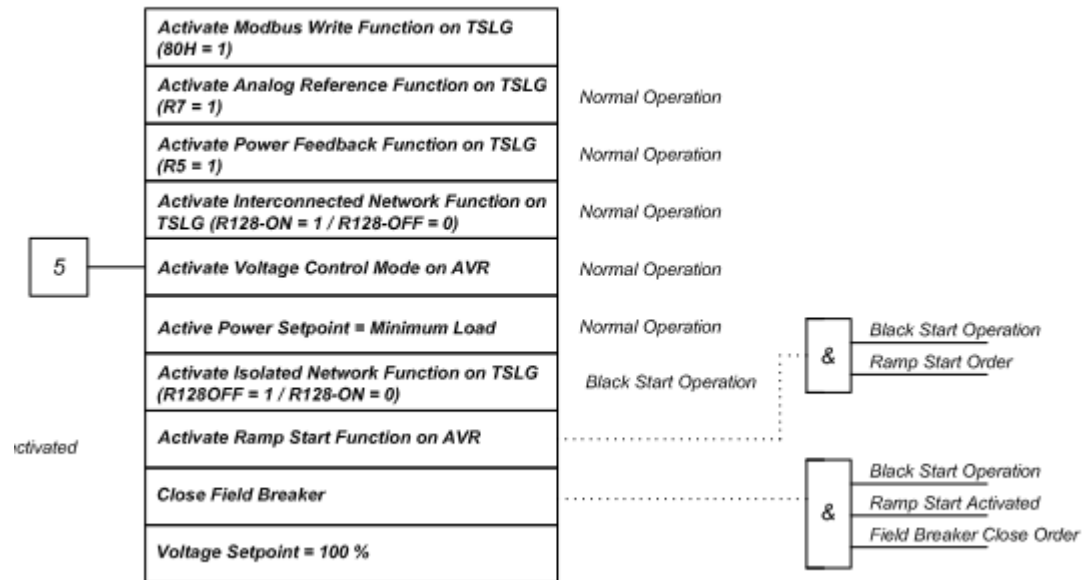
START EXCITATION



START SYNCHRONIZATION

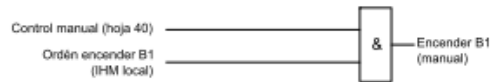


SYNCHRONIZED

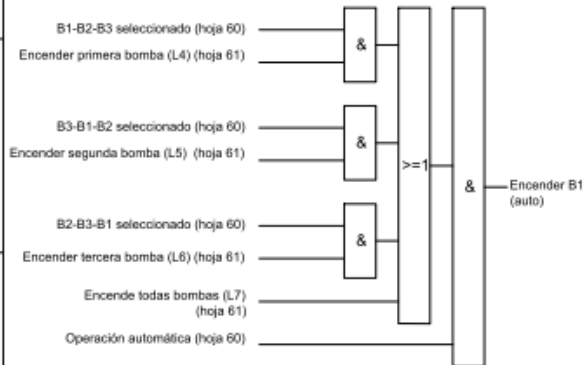


Control de bombas de drenagem

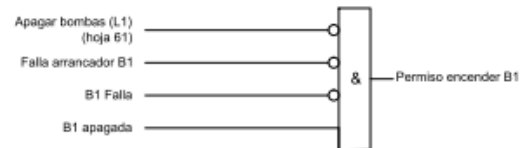
Encender manual:



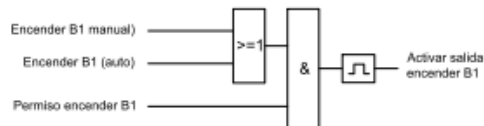
Encender automático



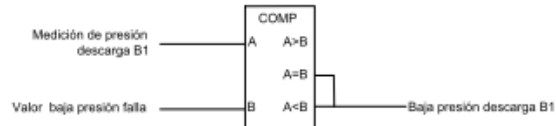
Permiso de encender



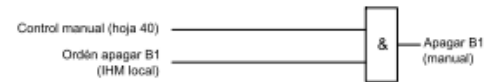
Activación de la salida de encender



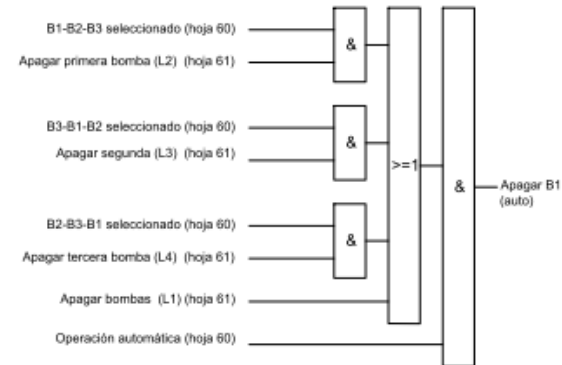
Producción de la señal baja presión en la descarga



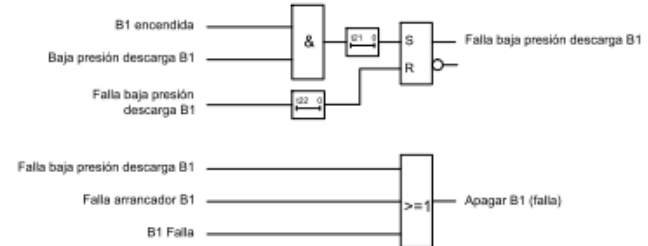
Apagar manual:



Apagar automático



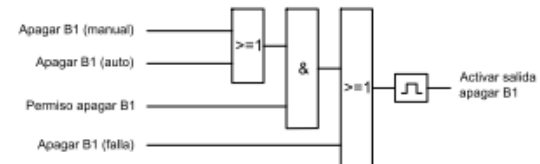
Fallas



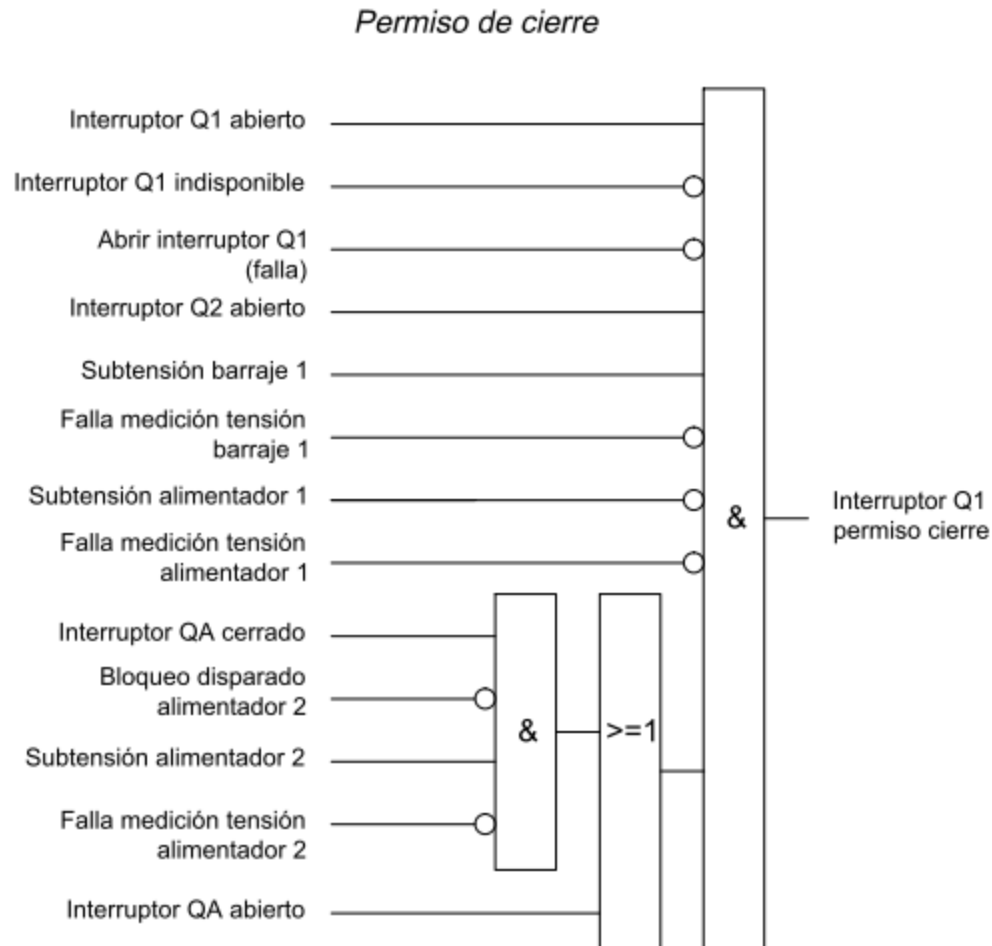
Permiso de apagar



Activación de la salida de apagar



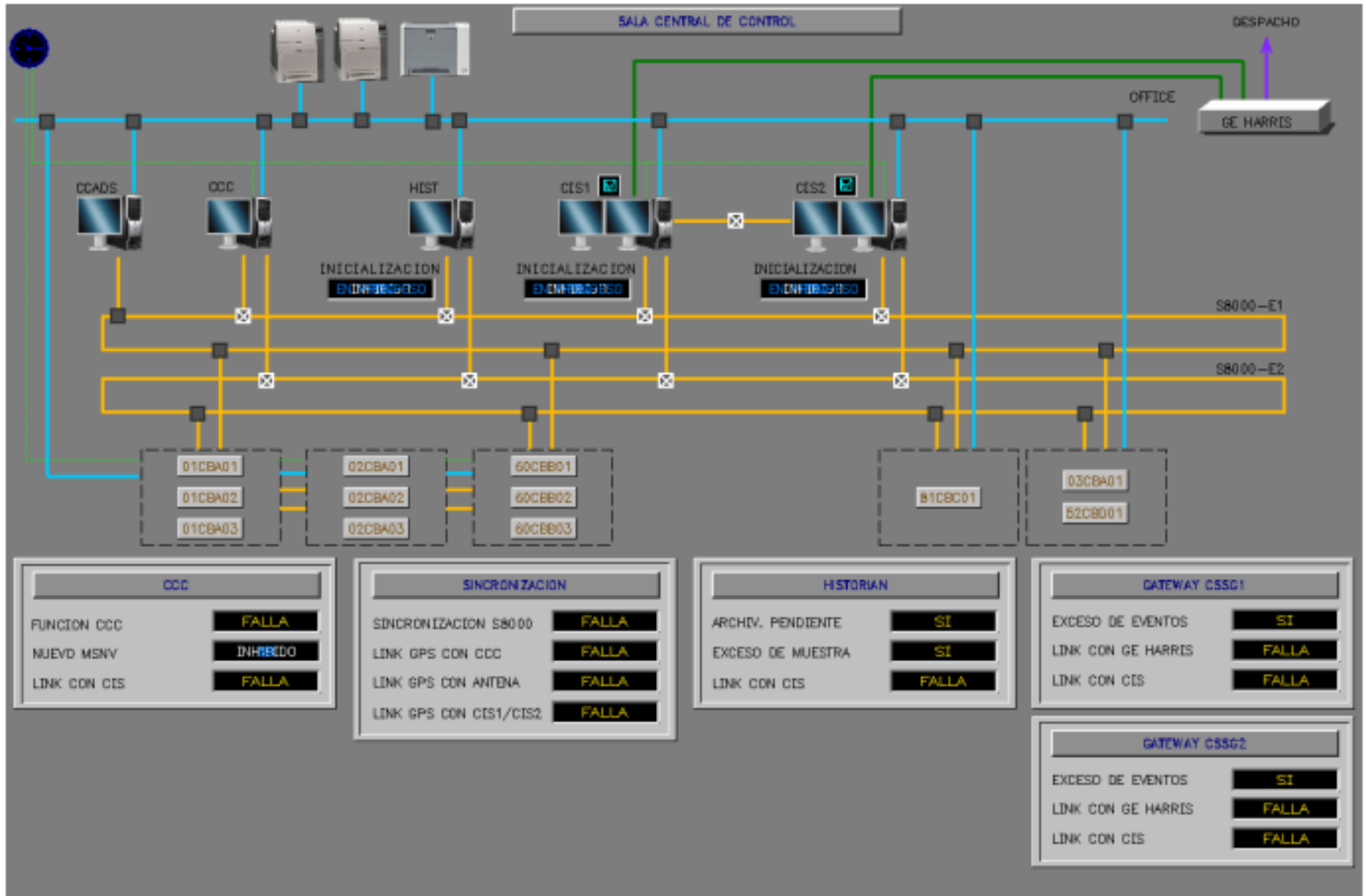
Intertravamento - Segurança



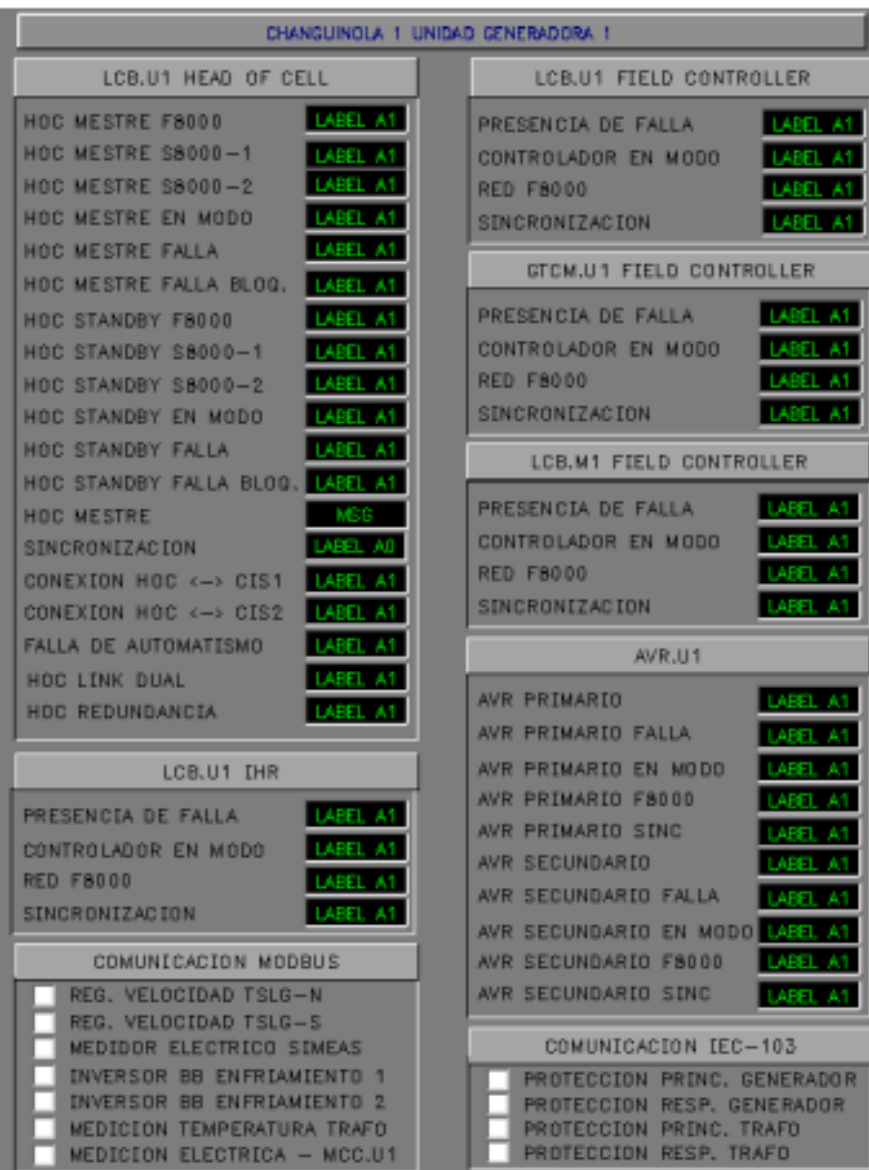
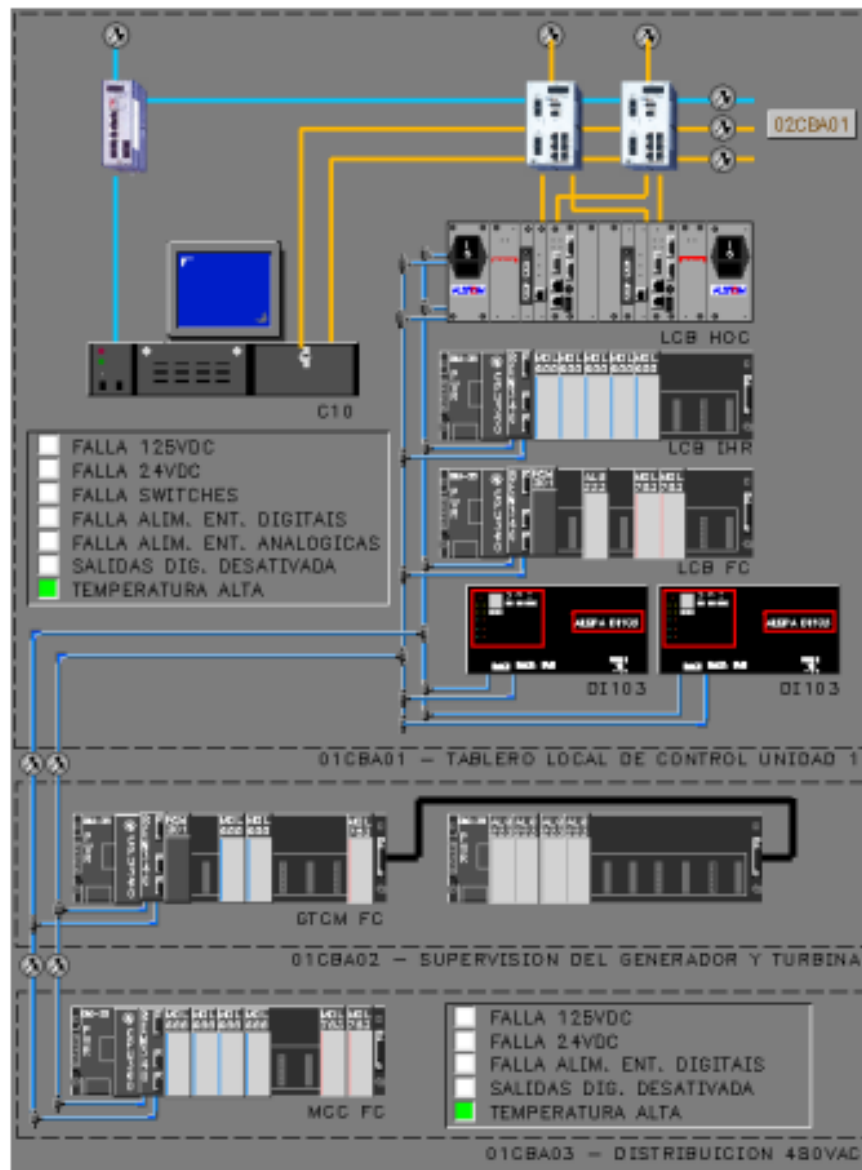
TELAS DO SDSC



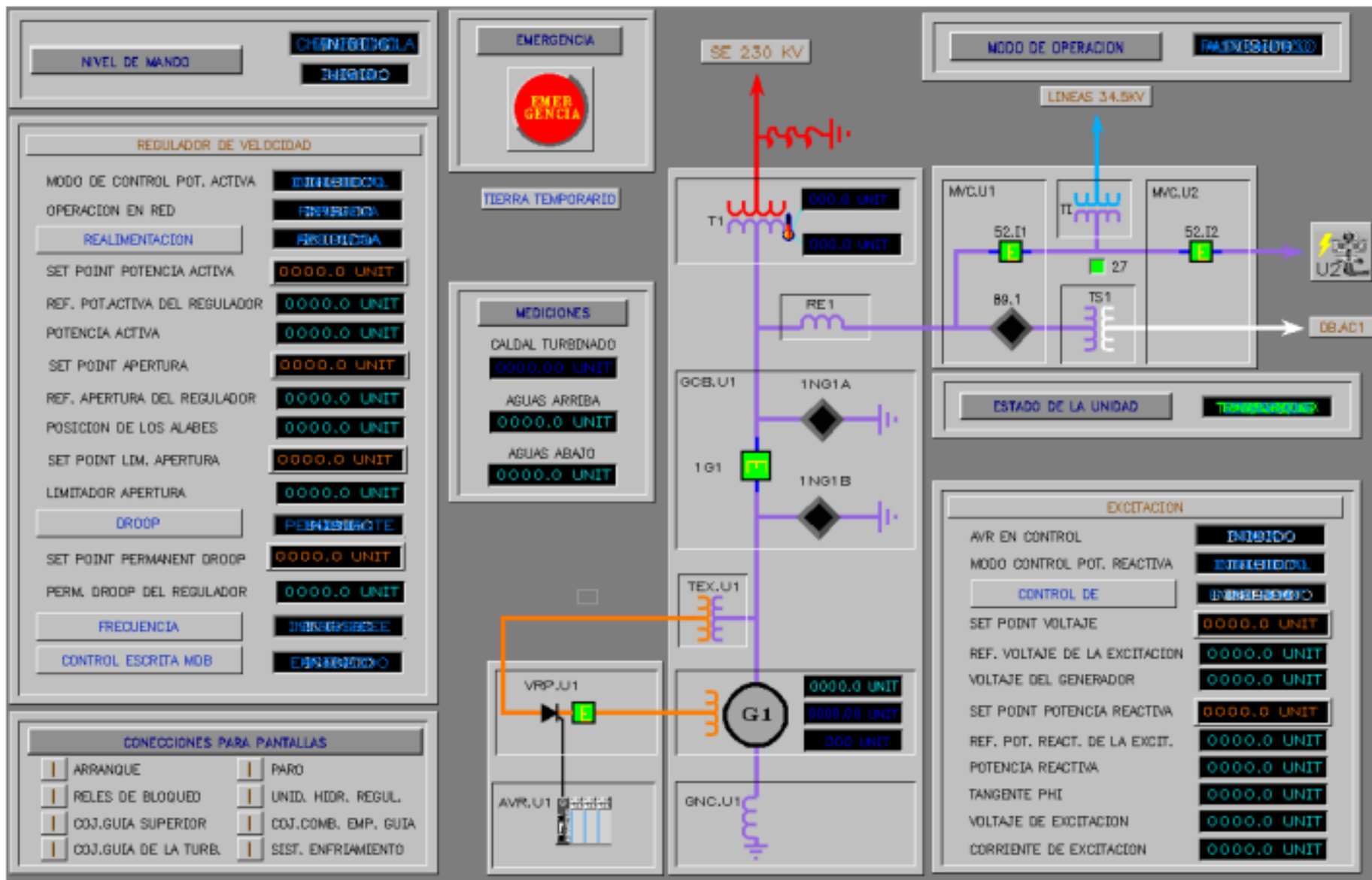
VISÃO GERAL DO SDSC



VISÃO DOS PAINÉIS & CLP'S



CONTROLE DA UNIDADE

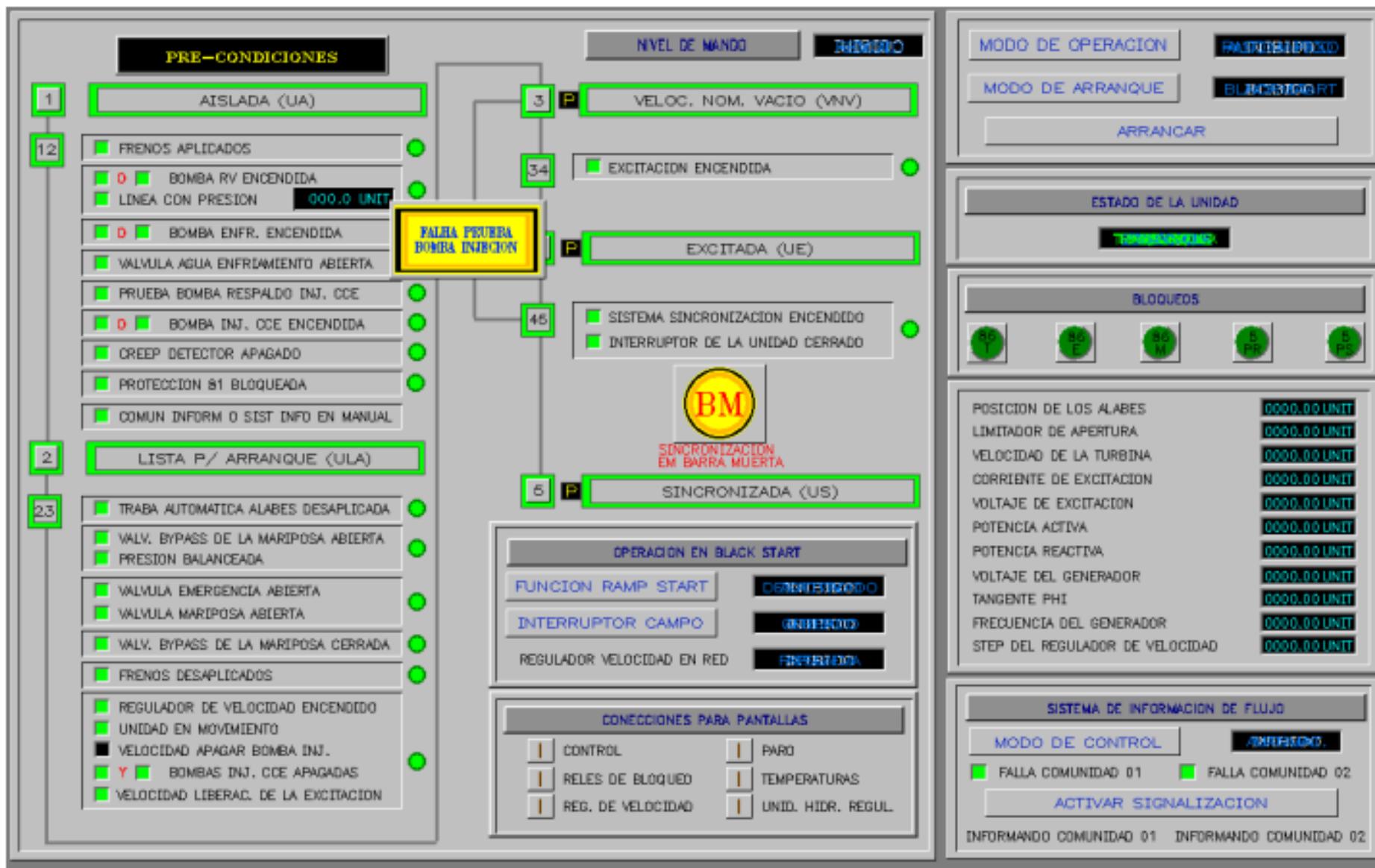


PRE-CONDIÇÕES DE PARTIDA

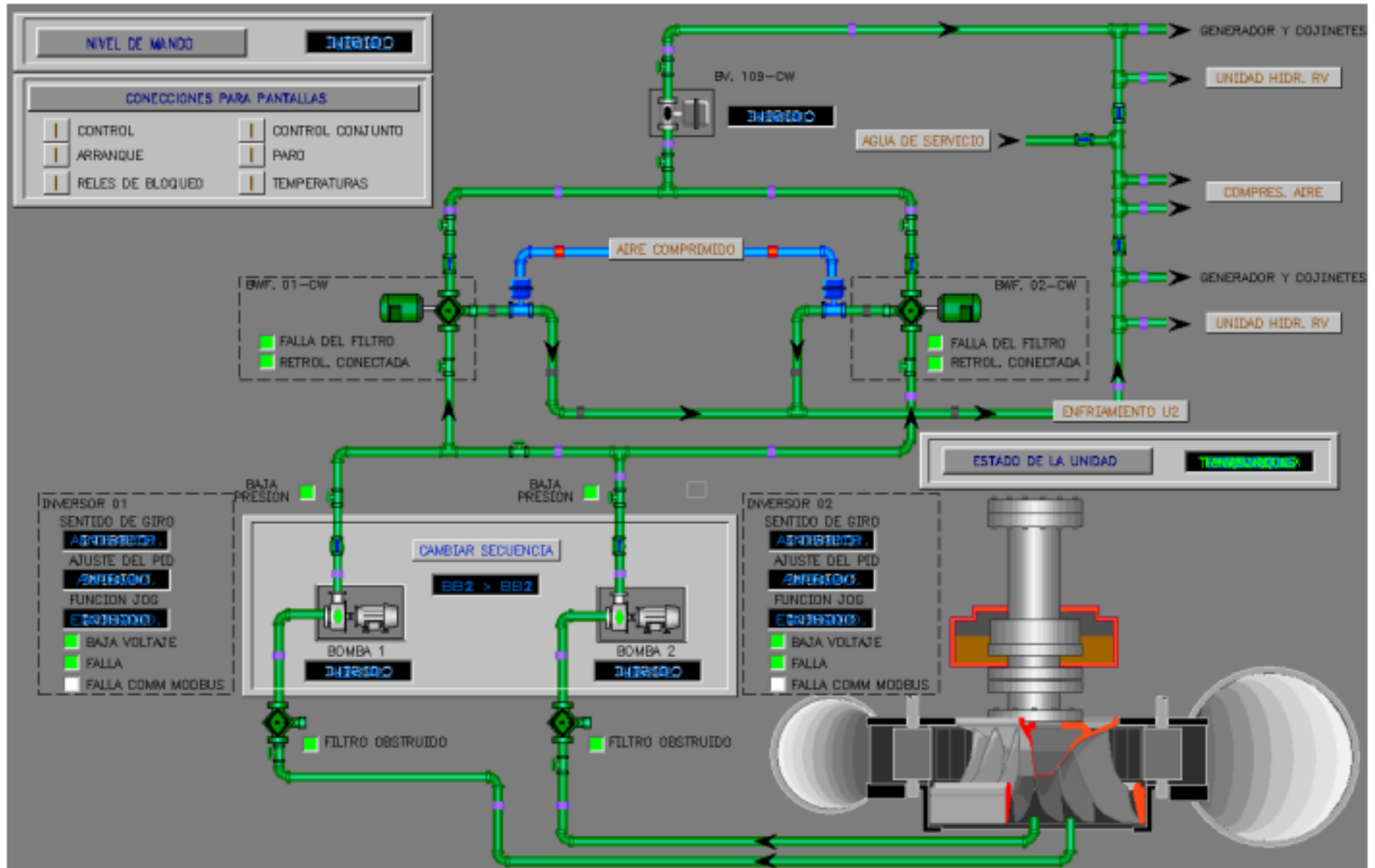
<p>REGULADOR DE VELOCIDAD</p> <ul style="list-style-type: none"> TAB – ALIMENTACION 125VDC NORMAL TSLG – N LISTO TSLG – S LISTO TADT PRINCIPAL NORMAL TADT RESPALDO NORMAL TSLG – CONTROL NO LOCAL AUTOMATICO TSLG – CONTROL NO LOCAL MANUAL VALVULA EMERGENCIA CERRADA LIMITADOR DE APERTURA EN CONDICION 	<p>REGULADOR DE VOLTAJE</p> <ul style="list-style-type: none"> TAB – PUERTA FECHADA RELE DE PROTECCION NORMAL TRANSFORMADOR EXCITACION NORMAL EXCITACION – CONTROL AUTOMATICO EXCITACION – CONTROL REMOTO INTERRUPTOR DE CAMPO ABIERTO COMUNICACION CON DCS NORMAL 	<p>SISTEMA DE PROTECCION</p> <ul style="list-style-type: none"> TAB PROT TRAF0 – VOLT. RELE INTERF. NORMAL PT PROTECCION TRAF0 RELE PROT. PRINCIPAL TRAF0 Y LINEA NORMAL RELE PROT. RESPALDO TRAF0 Y LINEA NORMAL RELE PROT. PRINCIPAL GENERADOR NORMAL FUS PT PROT. PRINC. CUBICULO SURTO RELE PROT. RESPALDO GENERADOR NORMAL FUS PT PROT. RESP. CUBICULO SURTO TAB PROT GEN. – VOLT. RELE INTERF. NORMAL FUS PT PROT. CUBICULO CER. NEUTRO TAB SINC. PAR. – ALIM. 125VDC NORMAL TAB SINC. PAR. – VOLT. CIRC. PAR. NORMAL RELES BLOQUEO ELECTRICO 1 Y 2 REARMADOS RELE BLOQUEO MECANICO REARMADO RELE BLOQUEO PARCIAL SIN RECHAZO REARMADO RELE BLOQUEO PARCIAL CON RECHAZO REARMADO RELE BLOQUEO LINEA CORTA Y TRAF0 REARMADO TAB PARO Y SINC. PT NORMAL 												
<p>ACUMULADOR PISTON</p> <ul style="list-style-type: none"> TAB – ALIMENTACION 125 VDC NORMAL TAB – ALIMENTACION 24 VDC NORMAL 	<p>SISTEMA DE CONTROL</p> <ul style="list-style-type: none"> MFC 3000 SIN FALLA RED F8000 NORMAL PC DEL TAB E/S GEN TUR CONTROL LOCAL SIN FALLA PC DEL TABLERO E/S GEN TUR MONITORIO SIN FALLA PCC DEL TABLERO E/S GEN TUR MCC SIN FALLA TAB CONTROL LOCAL ENTRADA DIGITAL ALIM TAB E/S GEN TUR ENTRADA DIGITAL ALIM TAB CONTROL LOCAL SALIDA DIGITAL ACTIVADA TAB E/S GEN TUR SALIDA DIGITAL ACTIVADA TAB E/S GEN TUR – ALIM ENT ANALOG NORMAL TAB E/S MCC ENTRADA DIGITAL NORMAL TAB E/S MCC SALIDA DIGITAL ACTIVADA LLAVE SINCRONISMO POSICION AUTO RELE SINCRONIZADOR NORMAL RELE VERIFICACION SINCRONISMO NORMAL TP TAB SINCRONISMO PARADA NORMAL 	<p>PRE-CONDICIONES</p>												
<p>UNIDAD HIDR. DEL REGULADOR</p> <ul style="list-style-type: none"> TAB – ALIMENTACION 125 VDC NORMAL TAB – ALIMENTACION 24 VDC NORMAL NIVEL ACEITE TANQUE NO ALTO NIVEL ACEITE TANQUE NO BAJO TEMPERATURA ACEITE TANQUE NO ALTA CAJON BOMBA 1 INSERIDO CAJON BOMBA 1 NORMAL BOMBA 1 CONTROL REMOTO BOMBA 1 APAGADA CAJON BOMBA 2 INSERIDO CAJON BOMBA 2 NORMAL BOMBA 2 CONTROL REMOTO BOMBA 2 APAGADA 	<p>INTERRUPTOR DE LA UNIDAD</p> <ul style="list-style-type: none"> TAB. – ALIM. 125VDC NORMAL MUELLE NORMAL PRESION SF6 NORMAL MOTOR NORMAL INTERRUPTOR ABIERTO INTERRUPTOR – CONTROL REMOTO SECCIONADORA TIERRA GENERADOR ABIERTA SECCIONADORA TIERRA TRANSFORMADOR ABIERTA TP 4 (SSB) NORMAL TP 5 (TGC) NORMAL 	<p>ESTADO DE LA UNIDAD</p> <p>TEMPERATURAS</p>												
<p>INCENDIO TRANSFORMADOR</p> <ul style="list-style-type: none"> SISTEMA CONTRA INCENDIO NORMAL SIN ALARMA INCENDIO VALVULA DILUVIO CERRADA 	<p>CONEXIONES PARA PANTALLAS</p> <table border="0"> <tr> <td>CONTROL</td> <td>CONTROL CONJUNTO</td> </tr> <tr> <td>ARRANQUE</td> <td>PARO</td> </tr> <tr> <td>RELES DE BLOQUEO</td> <td>TEMPERATURAS</td> </tr> <tr> <td>REG. DE VELOCIDAD</td> <td>UNID. HIDR. REGUL.</td> </tr> <tr> <td>COJ.GUIA SUPERIOR</td> <td>COJ.COMB. EMP. GUIA</td> </tr> <tr> <td>COJ.GUIA DE LA TURB.</td> <td>SIST. ENFRIAMIENTO</td> </tr> </table>	CONTROL	CONTROL CONJUNTO	ARRANQUE	PARO	RELES DE BLOQUEO	TEMPERATURAS	REG. DE VELOCIDAD	UNID. HIDR. REGUL.	COJ.GUIA SUPERIOR	COJ.COMB. EMP. GUIA	COJ.GUIA DE LA TURB.	SIST. ENFRIAMIENTO	
CONTROL	CONTROL CONJUNTO													
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<p>INCENDIO GENERADOR</p> <ul style="list-style-type: none"> SISTEMA CONTRA INCENDIO ACTIVADO SIN ALARMA INCENDIO 														



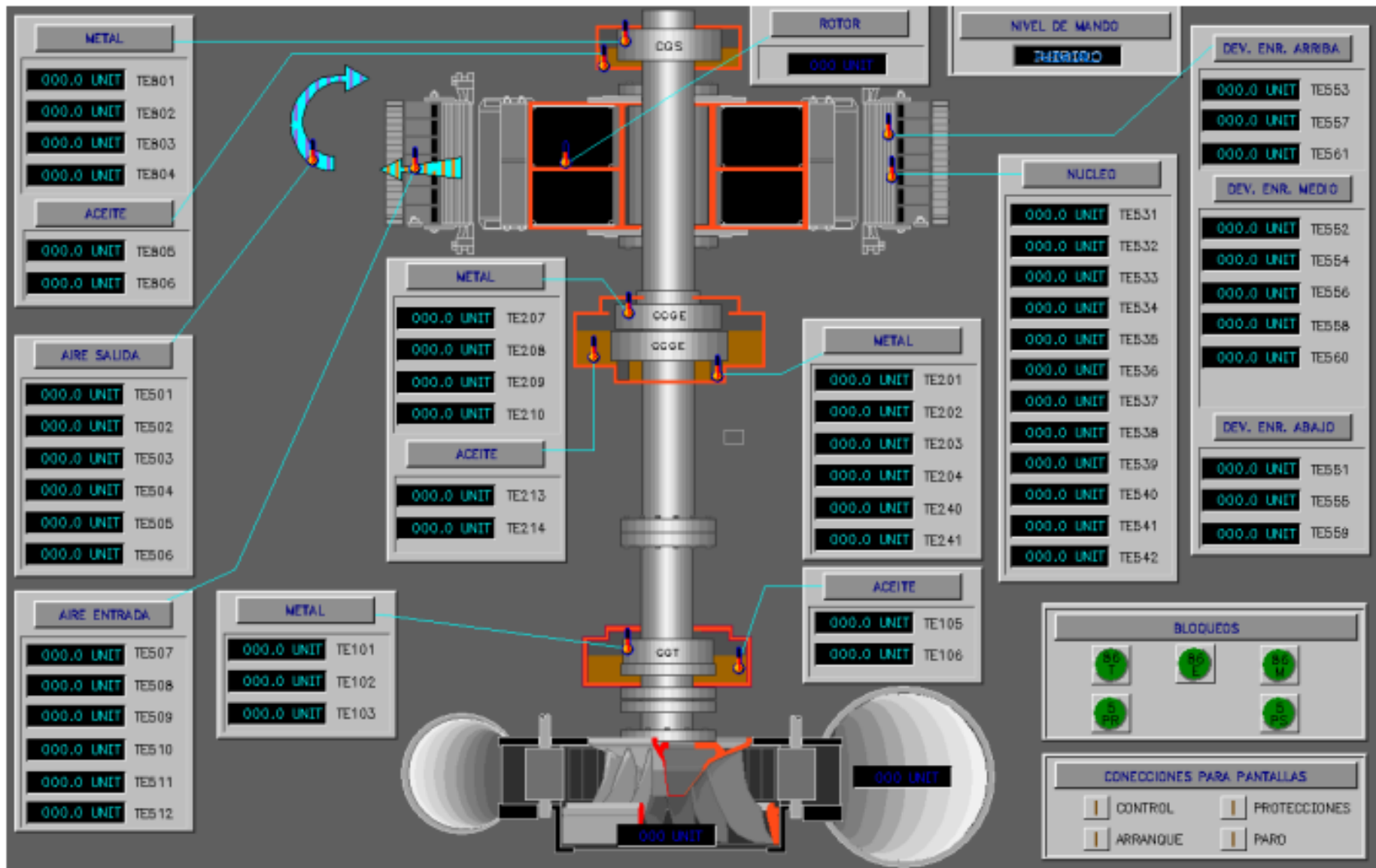
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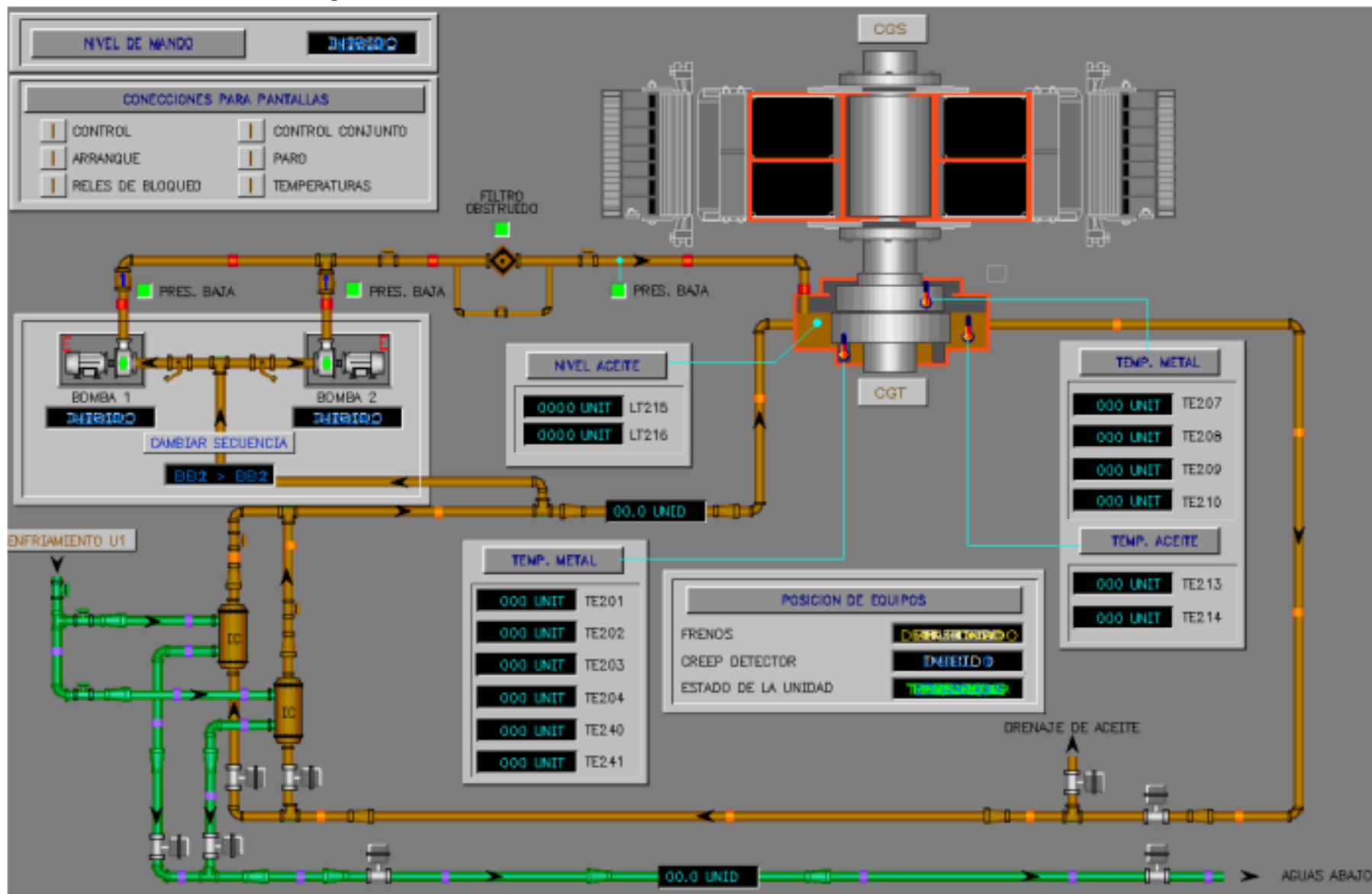
SISTEMA DE RESFRIAMIENTO



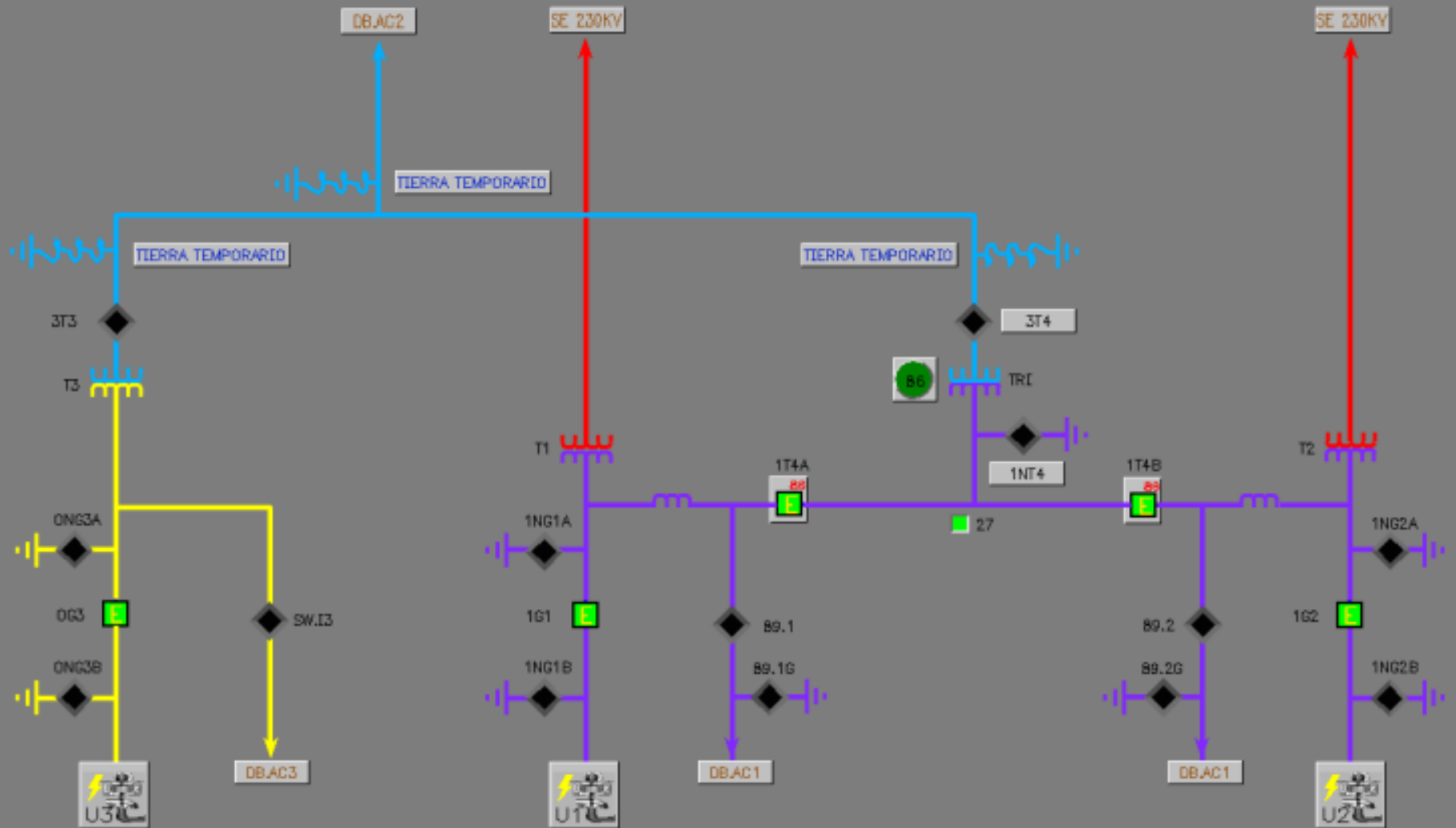
MEDIÇÕES DE TEMPERATURA



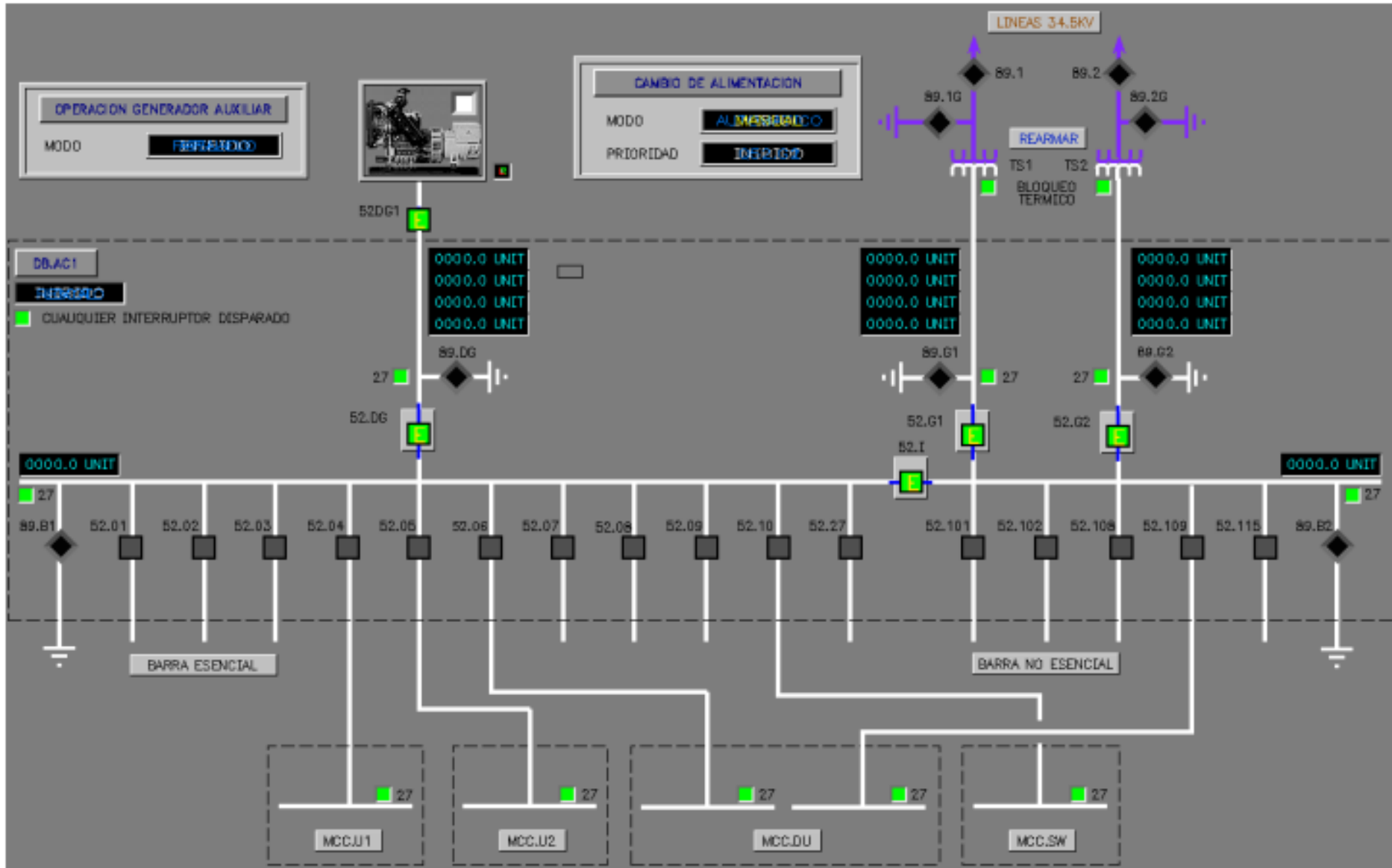
SISTEMA DE LUBRIFICACIÓN



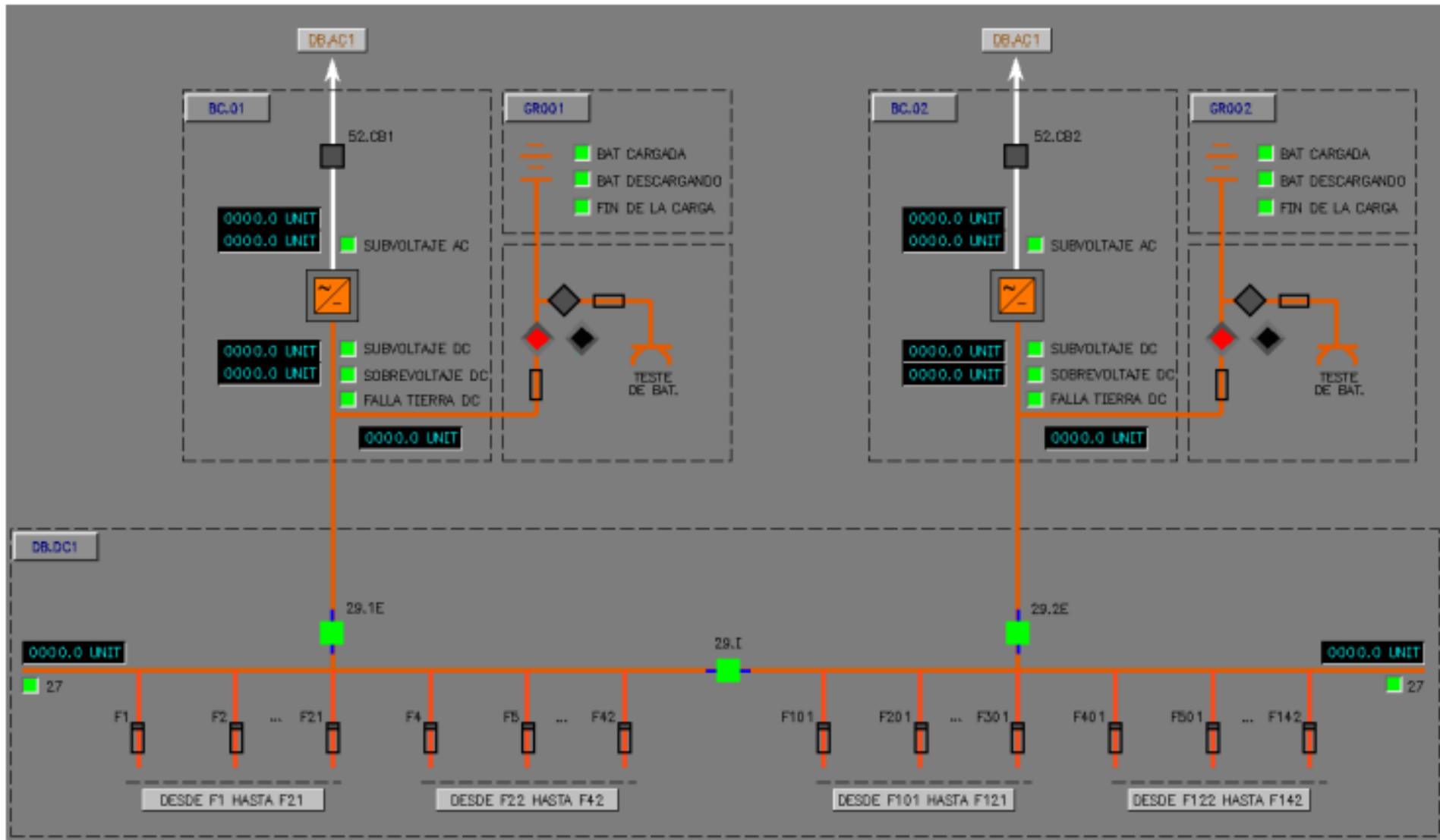
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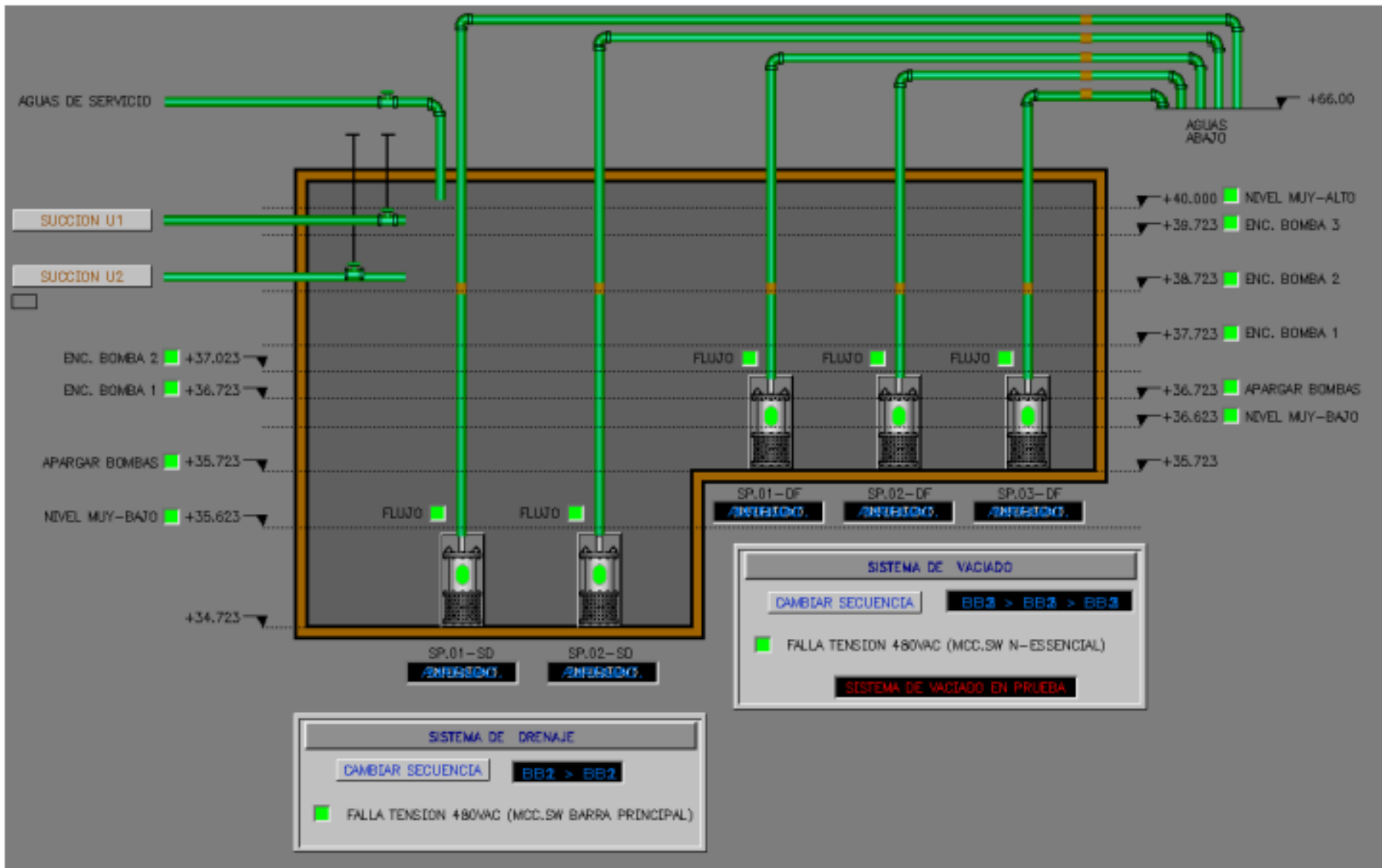
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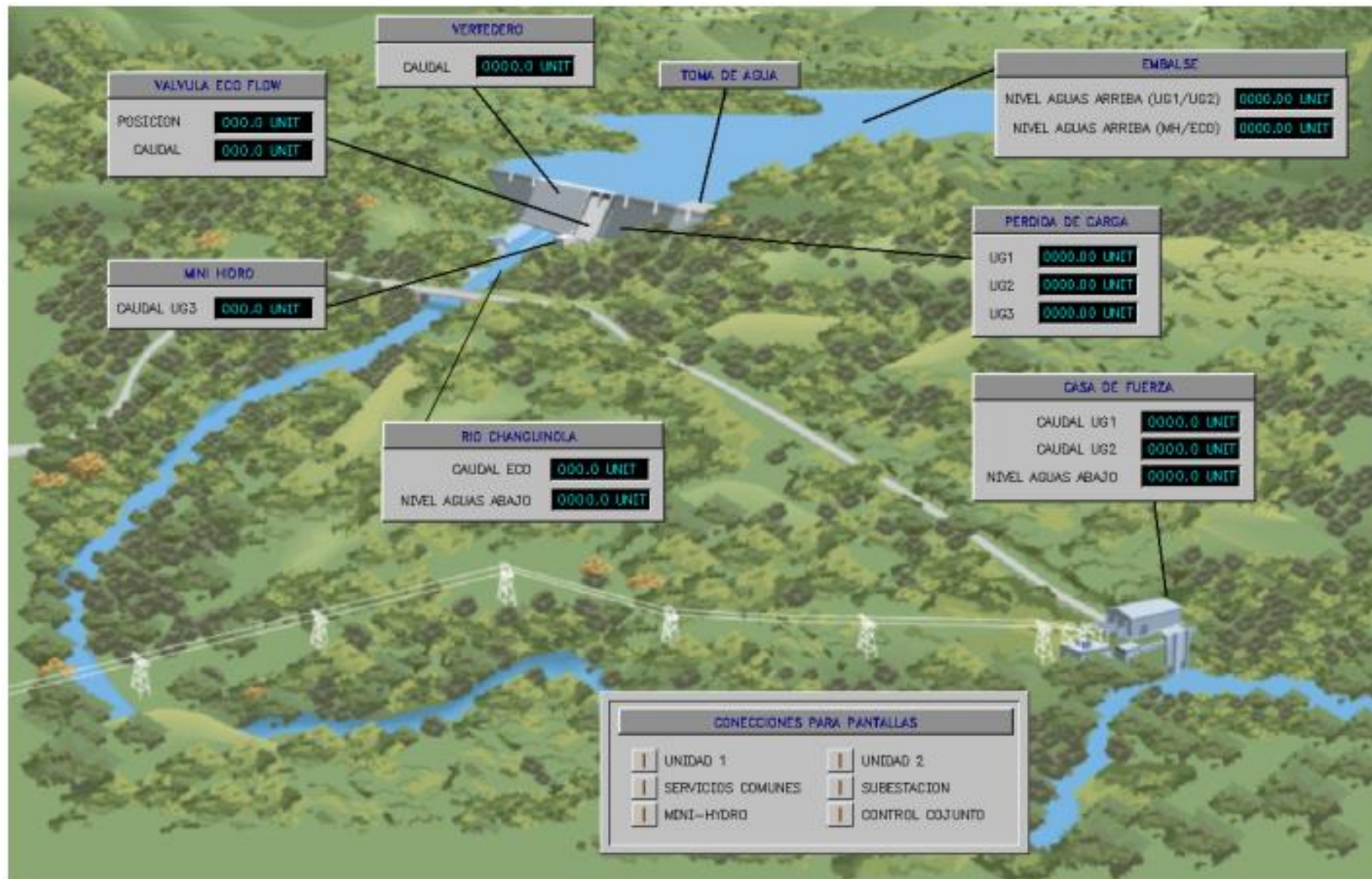
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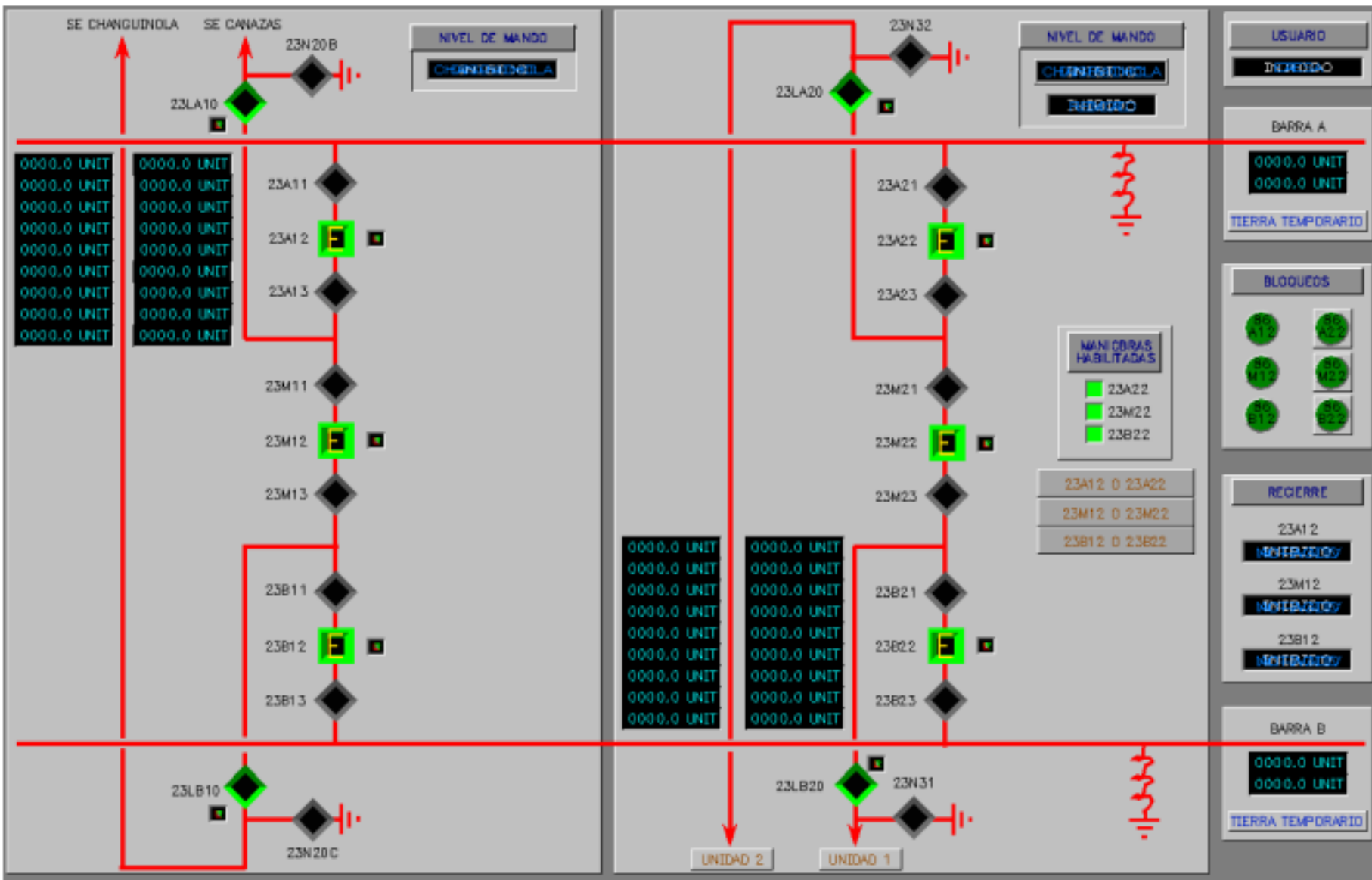
DRENAGEM E ESGOTAMENTO



MEDIÇÕES HIDRÁULICAS



SUBESTAÇÃO



General Overview



Control System lifecycle



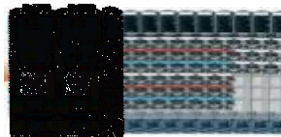
The lifecycle is mainly driven by PLC which are closed to PC lifecycle Very short compare to Turbine & Generator

Controls equipment is made with :

- Purchasing component from the market (PLC, electrical components, cubicle, cables,)
- Programming done internally (regulation models)
- Test (done internally)
- Commissioning (done at site)



Controller



Remote I/O



HUB



Market Controls Overview – Competition

	Controls Only (without machine)	Turnkey (with machine)
Amount of project	K€	M€
Project Schedule	Few months	Few years
Number of competitors	5 to 10	3 to 5
Type of competitor	Major Hydro Players (Voith, Andritz) Major Automation Companies (ABB, Siemens, Emerson) Local Automation/ Engineering Companies	Major Hydro Players (Voith, Andritz) Consortium
Differentiator	<ul style="list-style-type: none">• Plant integrator• Knowledge of Machine• Knowledge of Hydro Process	



Market Controls Overview – Market Trends

- Customer drivers
 - Price
 - Performance
 - Systems Availability
 - More Flexibility & Reliability
 - Grid criteria evolution (strong contribution of Controls)
- Cybersecurity
- Remote Control
- Real time monitoring of the machine



