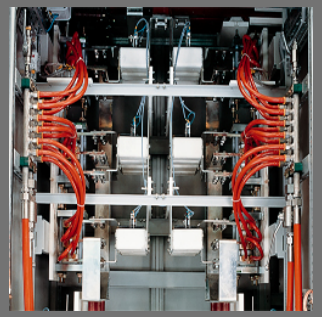
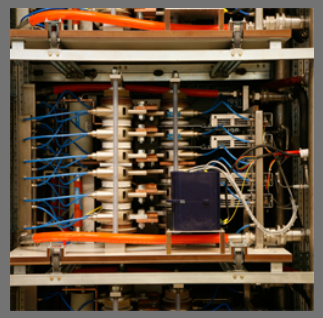
Ingeteam





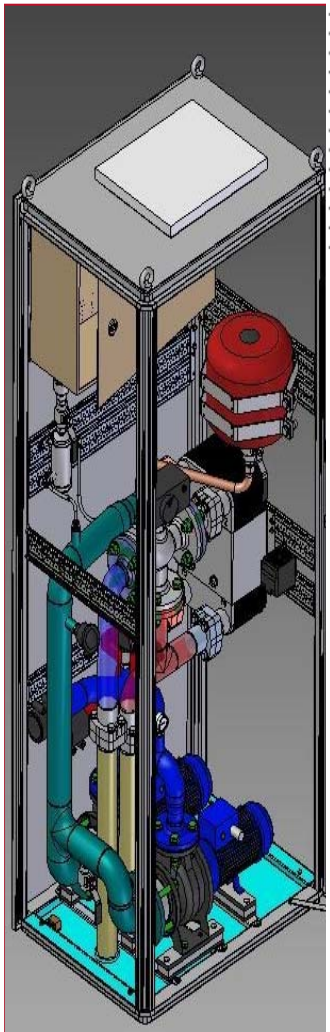



KOMPAKTE WASSERGEKÜHLTE FREQUENZUMRICHTER – WASSER IM ELEKTRORAUM – 10 Jahre transresch

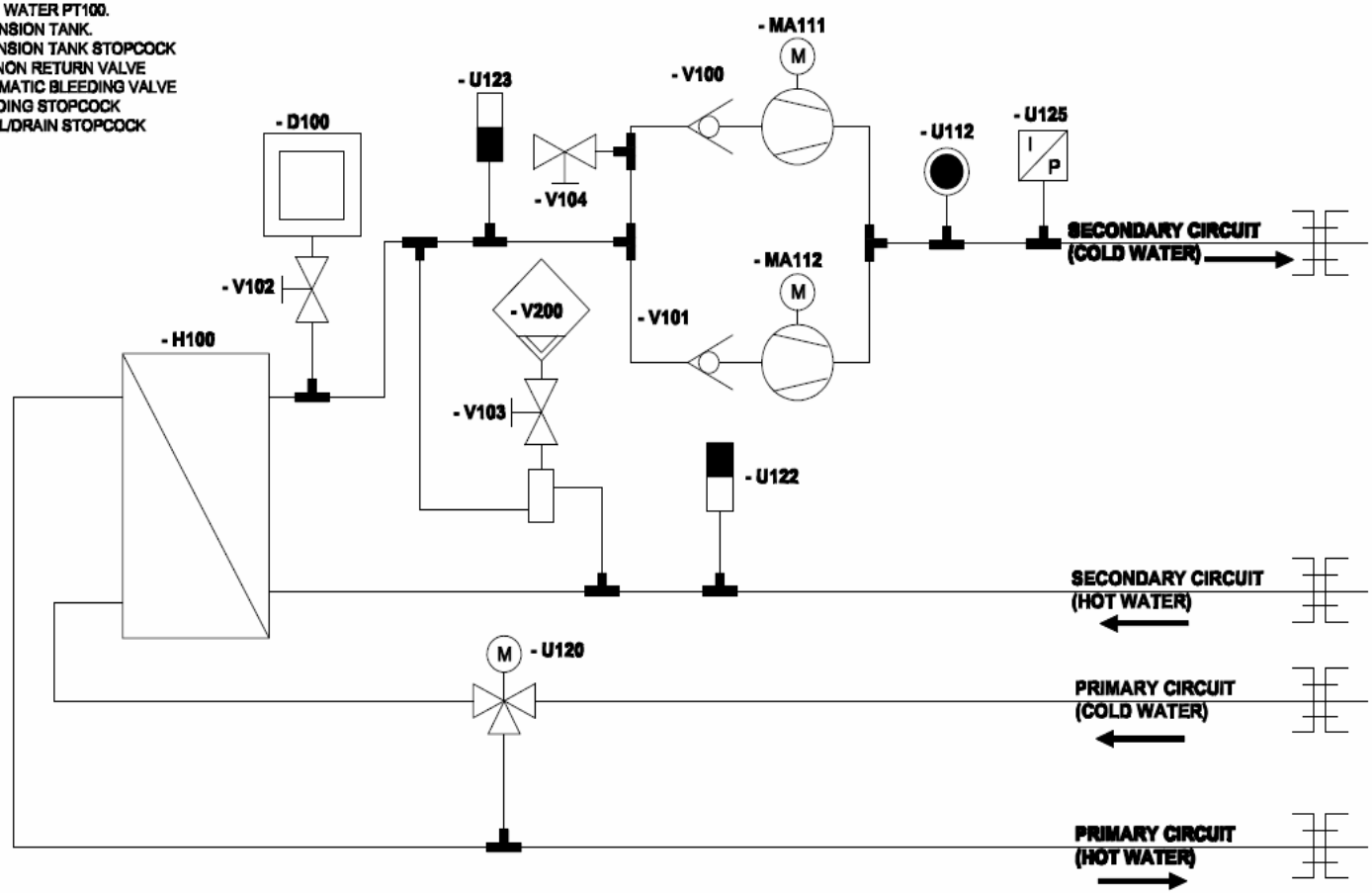
Berlin, 1. April 2009
Mario de Vicente – Ingeteam Technology
mario.devicente@ingeteam.com

Index

WCU Inside - Mechanical 3-D drawing & Hydraulic diagram in LV



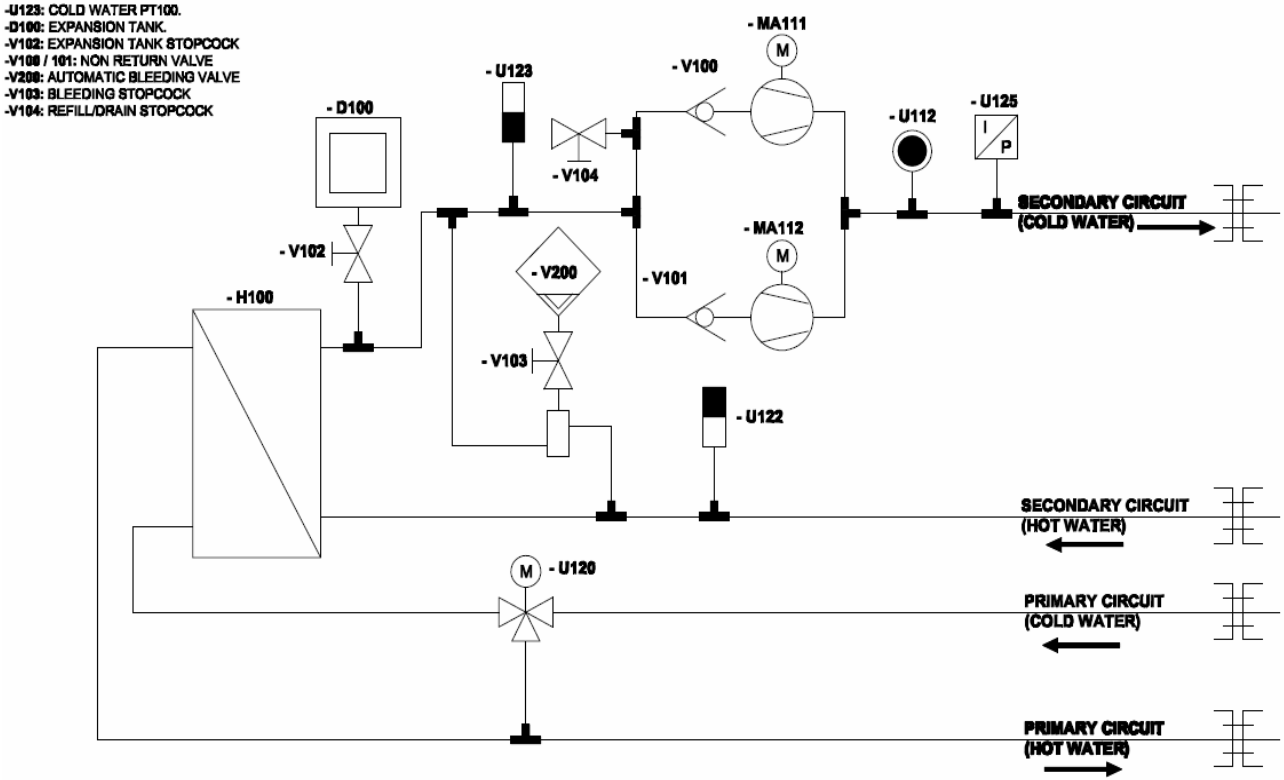
-H100: WATER / WATER HEAT EXCHANGER.
-MA111 / 112: REDUNDANT PUMPS.
-U120: THREE WAY VALVE .
-U112: PRES. GUAGE 0-10 BAR.
-U125: PRES. TRANSDUCER 0-6 BAR 4-20mA.
-U122: HOT WATER PT100.
-U123: COLD WATER PT100.
-D100: EXPANSION TANK.
-V102: EXPANSION TANK STOPCOCK
-V100 / 101: NON RETURN VALVE
-V200: AUTOMATIC BLEEDING VALVE
-V103: BLEEDING STOPCOCK
-V104: REFILL/DRAIN STOPCOCK



Typical diagram with redundant pumps

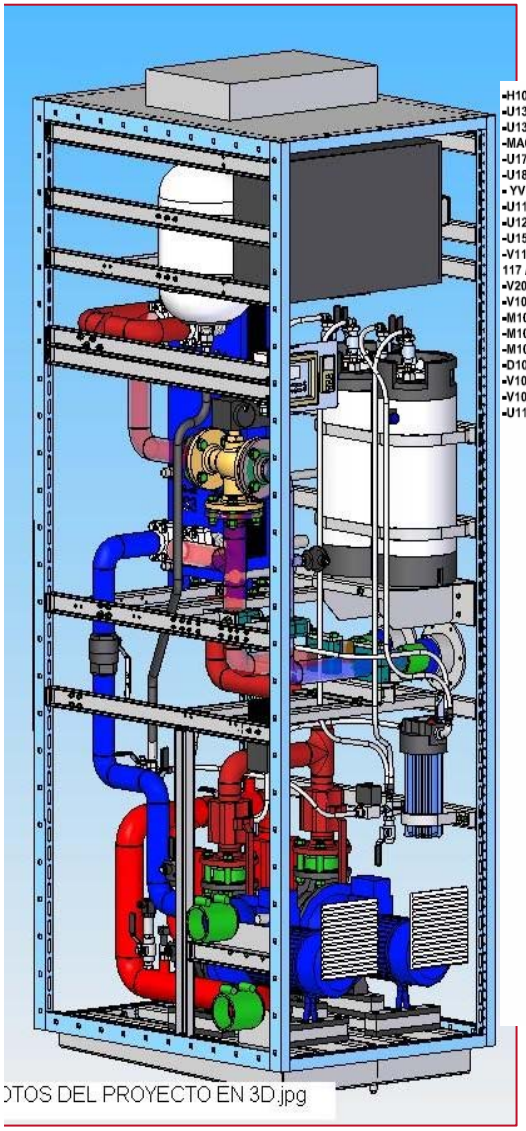
WCU Inside - Picture & Hydraulic diagram in LV

-H100: WATER / WATER HEAT EXCHANGER.
-MA111 / 112: REDUNDANT PUMPS.
-U120: THREE WAY VALVE .
-U112: PRES. GUAGE 0-10 BAR.
-U125: PRES. TRANSDUCER 0-6 BAR 4-20mA.
-U122: HOT WATER PT100.
-U123: COLD WATER PT100.
-D100: EXPANSION TANK.
-V102: EXPANSION TANK STOPCOCK
-V100 / 101: NON RETURN VALVE
-V200: AUTOMATIC BLEEDING VALVE
-V103: BLEEDING STOPCOCK
-V104: REFILL/DRAIN STOPCOCK

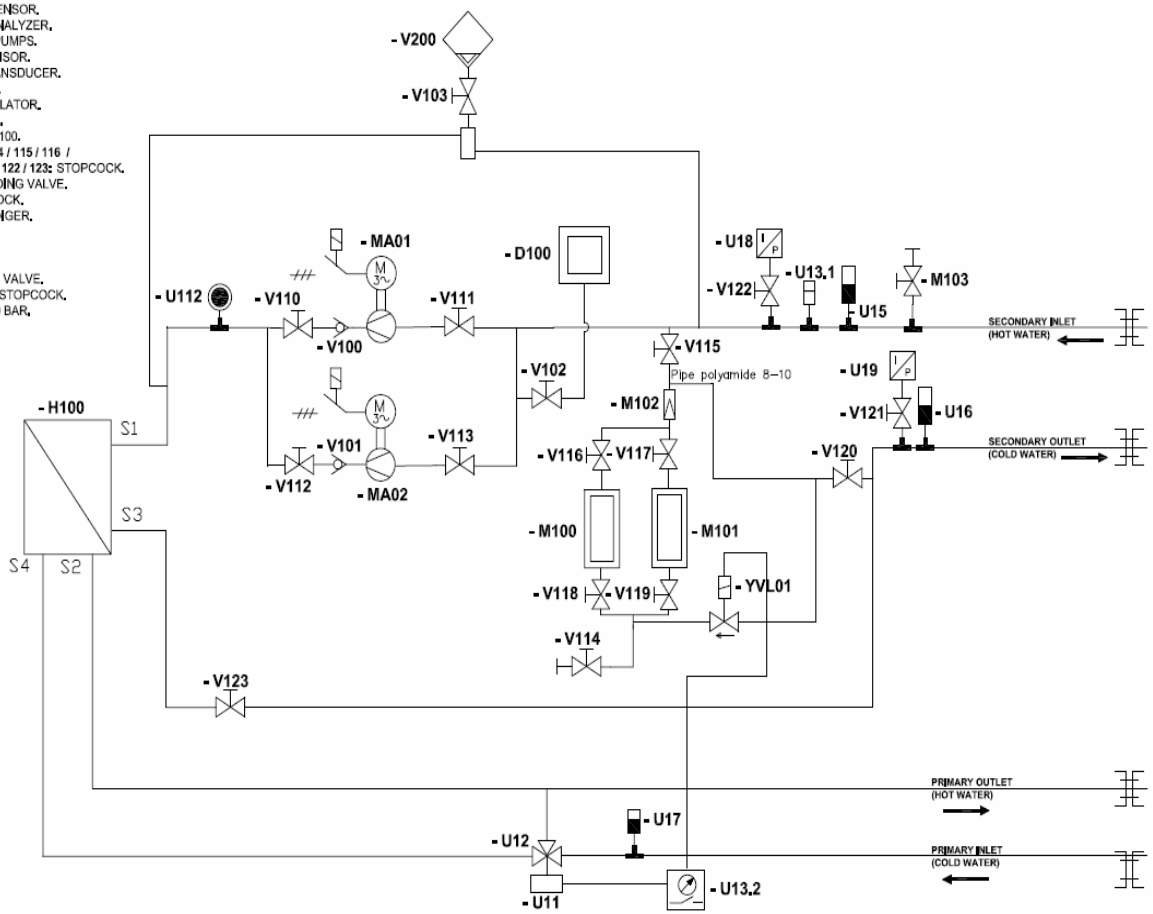


Typical diagram with redundant pumps

WCU Inside - Mechanical 3-D drawing & Hydraulic diagram in MV

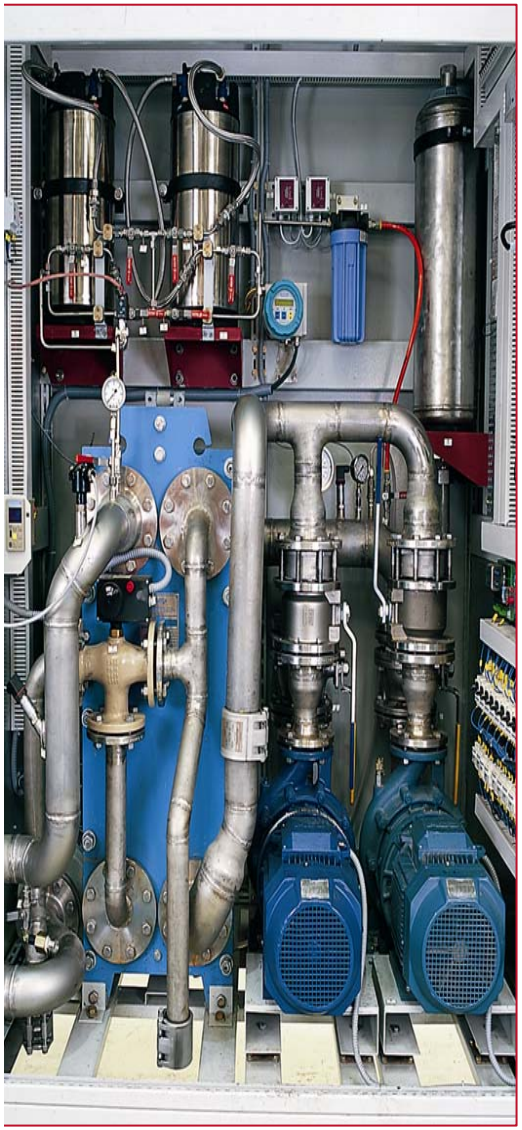


-H100: WATER / WATER HEAT EXCHANGER.
-U13,1: CONDUCTIVITY SENSOR.
-U13,2: CONDUCTIVITY ANALYZER.
-MA01/ 02: REDUNDANT PUMPS.
-U17: TEMPERATURE SENSOR.
-U18 / 19: PRESSURE TRANSDUCER.
- YVL01: ELECTROVALVE.
-U11: ELECTRONIC REGULATOR.
-U12: THREE WAY VALVE .
-U15 / 16: HOT WATER PT100.
-V110 / 111 / 112 / 113 / 114 / 115 / 116 / 117 / 118 / 119 / 120 / 121 / 122 / 123: STOPCOCK.
-V200: AUTOMATIC BLEEDING VALVE.
-V103: BLEEDING STOPCOCK.
-M100 / 101: IONS EXCHANGER.
-M102 : FILTER.
-M103 : DRAIN VALVE.
-D100: EXPANSION TANK.
-V100 / 101: NON RETURN VALVE.
-V102: EXPANSION TANK STOPCOCK.
-U112: PRES. GUAGE 0-10 BAR.

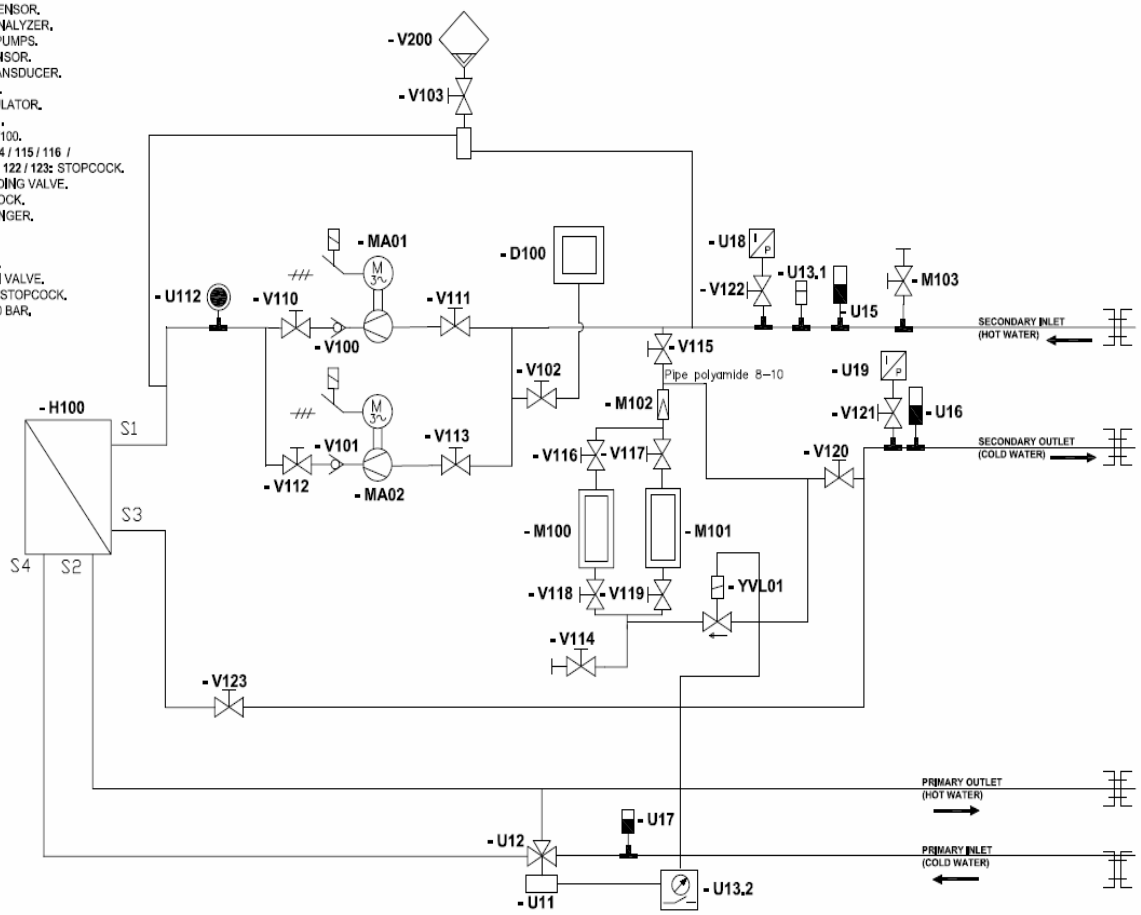


Typical diagram with redundant pumps

WCU Inside - Picture & Hydraulic diagram in MV



-H100: WATER / WATER HEAT EXCHANGER.
-U13,1: CONDUCTIVITY SENSOR.
-U13,2: CONDUCTIVITY ANALYZER.
-MA01/ 02: REDUNDANT PUMPS.
-U17: TEMPERATURE SENSOR.
-U18 / 19: PRESSURE TRANSDUCER.
- YVL01: ELECTROVALVE.
-U11: ELECTRONIC REGULATOR.
-U12: THREE WAY VALVE .
-U15 / 16: HOT WATER PT100.
-V110 / 111 / 112 / 113 / 114 / 115 / 116 / 117 / 118 / 119 / 120 / 121 / 122 / 123: STOPCOCK.
-V200: AUTOMATIC BLEEDING VALVE.
-V103: BLEEDING STOPCOCK.
-M100 / 101: IONS EXCHANGER.
-M102 : FILTER.
-M103 : DRAIN VALVE.
-D100: EXPANSION TANK.
-V100 / 101: NON RETURN VALVE.
-V102: EXPANSION TANK STOPCOCK.
-U112: PRES. GUAGE 0-10 BAR.

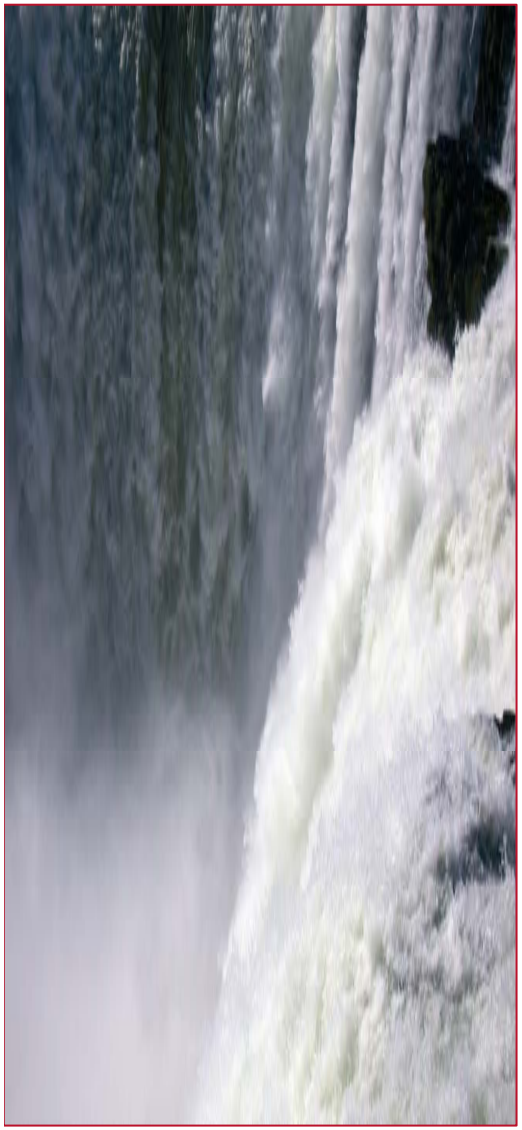


Typical diagram with redundant pumps

WCU Inside - Usual options

- ☑ Redundant Pumps
- ☑ Redundant Heat Exchanger
- ☑ Heat Exchanger made of Titanium
- ☑ Entry Filter – Heat Exchanger
- ☑ Redundant Deionizing Units (only MV)
- ☑ Non-standard Water quality conditions
- ☑ WCU separated from converter

WCU Inside - Coolant



- **Coolant (in Secondary Circuit)**
  - Fresh water in Low Voltage
  - Deionized water in Medium Voltage
- **Antifreezer**:
  - Used below 0ºC in concentrations (up to 50%) for -40ºC.
  - Chemical additives imply incompatibilities with some material.
  - Derating factor applies, due to lower cooling coefficient .
  - Higher pump power required, due to higher density, viscosity.
  - Antifreezer used in LV: Monoetilenglicol / Propilenglicol + Additives.
  - Antifreezer used in MV: Propilenglicol without Additives

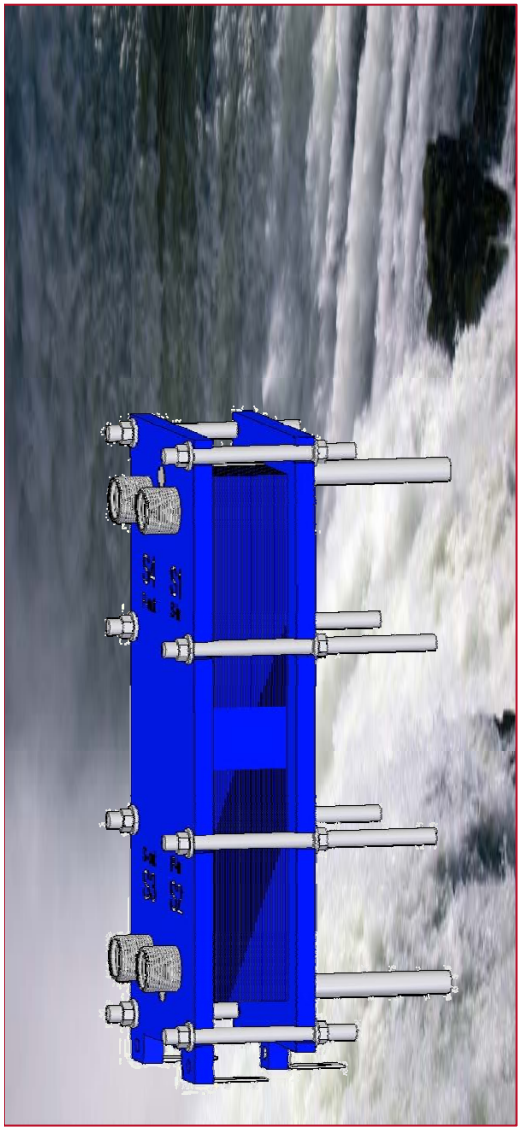
WCU Inside - Overview of commonly used Materials

Component	Material	Comment
Pipes, accessories	• Iron , Carbon Steel	•Requires additional corrosion inhibitors, more intensive maintenance.
	•Stainless Steel	•Good overall. Problems with salt. AISI 304 / 316
	•Cu-Ni alloy, Brass	•In salty environment. Expensive. Not used very much.
	•PVC, PVDF, PEHD	•Used in non-essential marine services. Good behaviour with salt. Poor behaviour in fire. Economical. Easy to install.
Heat Exchanger	• Stainless Steel	• AISI 316. Problems with salt.
	•Titanium	•Works anywhere. Used in marine applications.
Heatsink	• Aluminium Alloy	•Requires controlled water quality. Good relation cost/ heat transfer coefficient (HTC). Only for LV.
	•Copper	•Good Heat transfer coefficient. Expensive.
	•Stainless Steel	•AISI 303, 304, 316. Used mainly in MV due to good corrosion behaviour. HTC only 10% of Alu.

WCU Inside - Pumping system

- WCU is provided with a pumping system that propels the fluid across the secondary circuit, ensuring the necessary flow through the heatsink placed over the semiconductors and other components.
- Automatic switchover from normal to stand-by pump.
- Pumps have hand valves for isolating the defective pump.
- Typical differential pressure: 2-6 bars

WCU Inside - Heat Exchanger



- The Heat Exchanger is an element designed to transfer the heat from the secondary to the primary circuit, providing a stable secondary circuit temperature that ensures a proper converter cooling.

- Main properties:
  - If Salt water:
    - Exchanger with interchangeable plates
  - If Deionized water:
    - Compact with Nickel welds.
    - Interchangeable plates (usually)
  - Rest of exchangers:
    - Compact for smaller units
    - Interchangeable plates for larger units
  - Optional filter to ensure <1mm particles.

WCU Inside - Expansion Tank

- The Expansion Tank has the goal of keeping the pressure constant as well as absorbing the water hammer effects and the increase / decrease of flow in the secondary circuit.
- Typical capacity is in the range of 12 to 50 liters.
- Hydroneumatic accumulator.

WCU Inside - 3-way valve and actuator

- This valve keeps coolant temperature inside the cabinet above the dew point temperature, preventing condensation to appear inside the cabinet.
- The valve is controlled via an electronic actuator, which receives a 4-20 mA signal.
- 2-way valves also serve the same purpose, although less wanted effects such perturbation on primary circuit may occur.

Tair(º C)	Dew point. Min. coolant temperature (ºC)				
	Φ =95%	Φ =80%	Φ = 65%	Φ = 50%	Φ =40%
-20	-20,5	-22,3	-24,4	-27	-29,2
-15	-15,5	-17,4	-19,6	-22,3	-24,6
-10	-10,6	-12,5	-14,8	-17,6	-19,9
-5	-5,6	-7,6	-9,9	-12,9	-15,3
0	-0,6	-2,7	-5,1	-8,2	-10,7
5	4,3	1,9	-0,9	-4	-6,6
10	9,2	6,7	3,7	0,1	-2,6
15	14,2	11,5	8,4	4,6	1,5
20	19,2	16,5	13,2	9,4	6,0
25	24,1	21,4	17,9	13,8	10,5
30	29,1	26,2	22,7	18,4	15,0
35	34,1	31,1	27,4	23,0	19,4
40	39	35,9	32,2	27,6	23,8
45	44,0	40,8	36,8	32,1	28,2
50	49,0	45,6	41,6	36,7	32,8
55	53,9	50,3	46,3	41,1	37

WCU Inside - Deionizing Unit including Filter

- Its function is to deionize the coolant within the secondary circuit, to decrease the conductivity level.
- The deionizing filter prevents particles, like resins in the deionizing unit, from circulating into the secondary circuit.

WCU Inside - Supervision and Monitoring Sensors

- **Conductivity** (only in MV) of coolant in secondary circuit. Depending on the value, more or less water is circulated through the deionizing unit, by means of an EV.
- **Temperature** sensors throughout the circuit to monitor the thermal status of the circuit.
- **Pressure** sensors at entry and exit of the secondary circuit.
- **Flowmeter**: to monitor flow of coolant. not absolutely necesary.

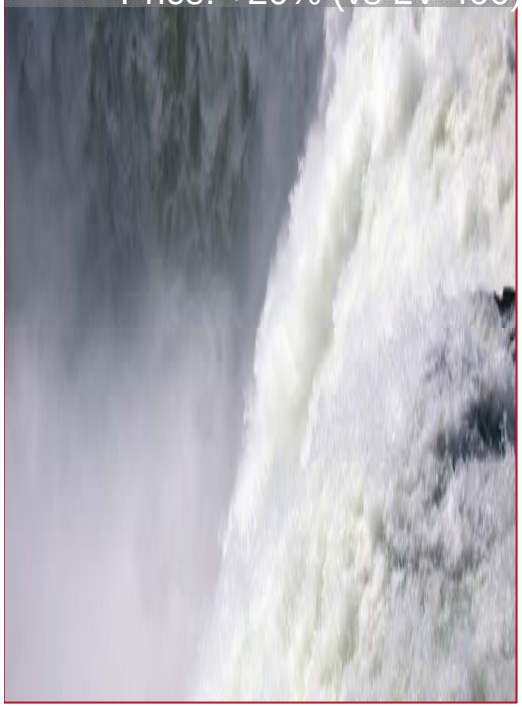
Water vs. Air Cooling: Comparison Table

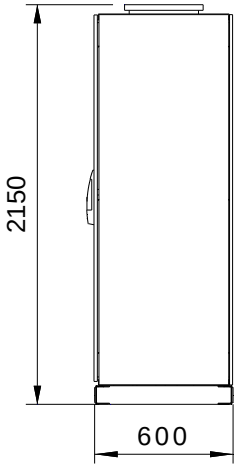
	WATER	FORCED AIR	WHO WINS?
Space / footprint	WCU size is 600-1000 mm, but overall converter size is smallesr for higher power ratings	Overall converter size may be bigger due to lower heat dissipation	AIR for small power ratings. WATER for larger power ratings.
Audible Noise	Typically 55-75 dB	Typically 75 – 85 dB	WATER
Power density	Water is better for cooling small surface areas, and great heat to remove		WATER
Maintenance and spares	More components lead to bigger maintenance and spares	Forced cooling requires little maintenance and spares (fans, filters, thermostats).	AIR
Protection Degree / Inmunity to ambient conditions	IP 31 - 43	IP20 - 22	WATER
Additional instalations needed?	Water cooling Tower + bringing water to converter.	Air conditioning or ventilation may be needed in E-room depending on heat amount	AIR
Arrangement versatility	No limitation due to cooling	Air cooling imposes certain arrangement limitations to follow air convection path..	WATER
Price	For higher power ratings, water cooling is more economical.	For smaller power ratings, air cooling is more economical.	AIR for small power ratings. WATER for larger power ratings.

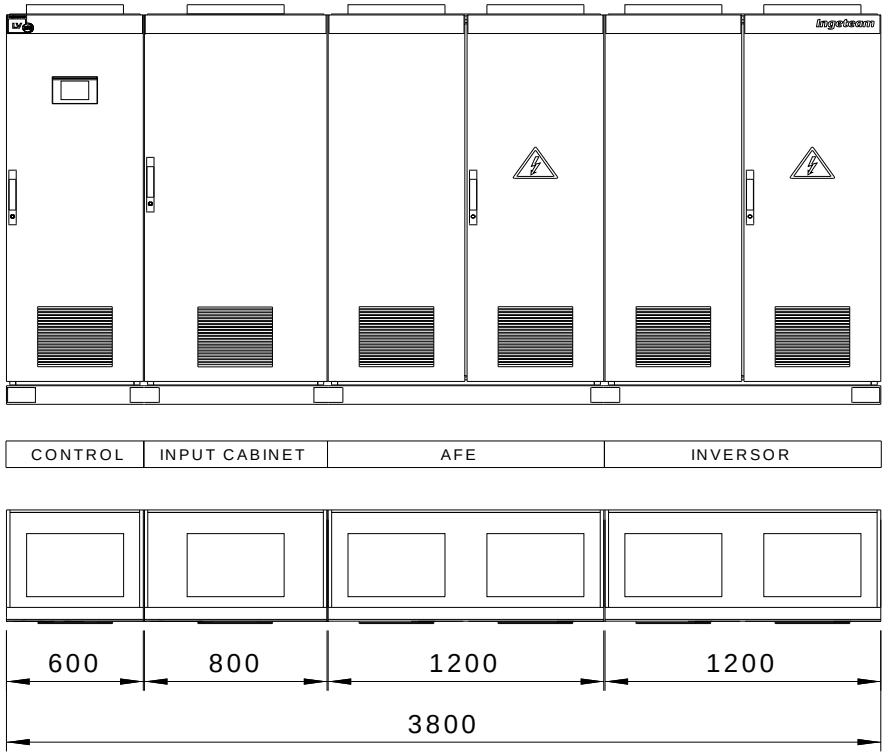
Water vs. Air : Practical example in LV

Ingedrive LV200

- Air cooled / 690 Vac
- AFE + inverter + LCL
- 1600 kVA
- Noise: 78 dB (A)
- Protection degree: IP21
- Switching Freq.: 2,5 kHz
- Price: +20% (vs LV 400)



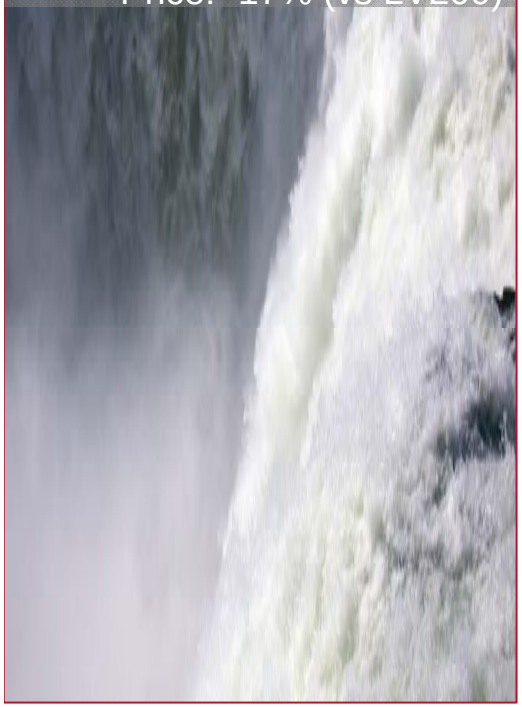


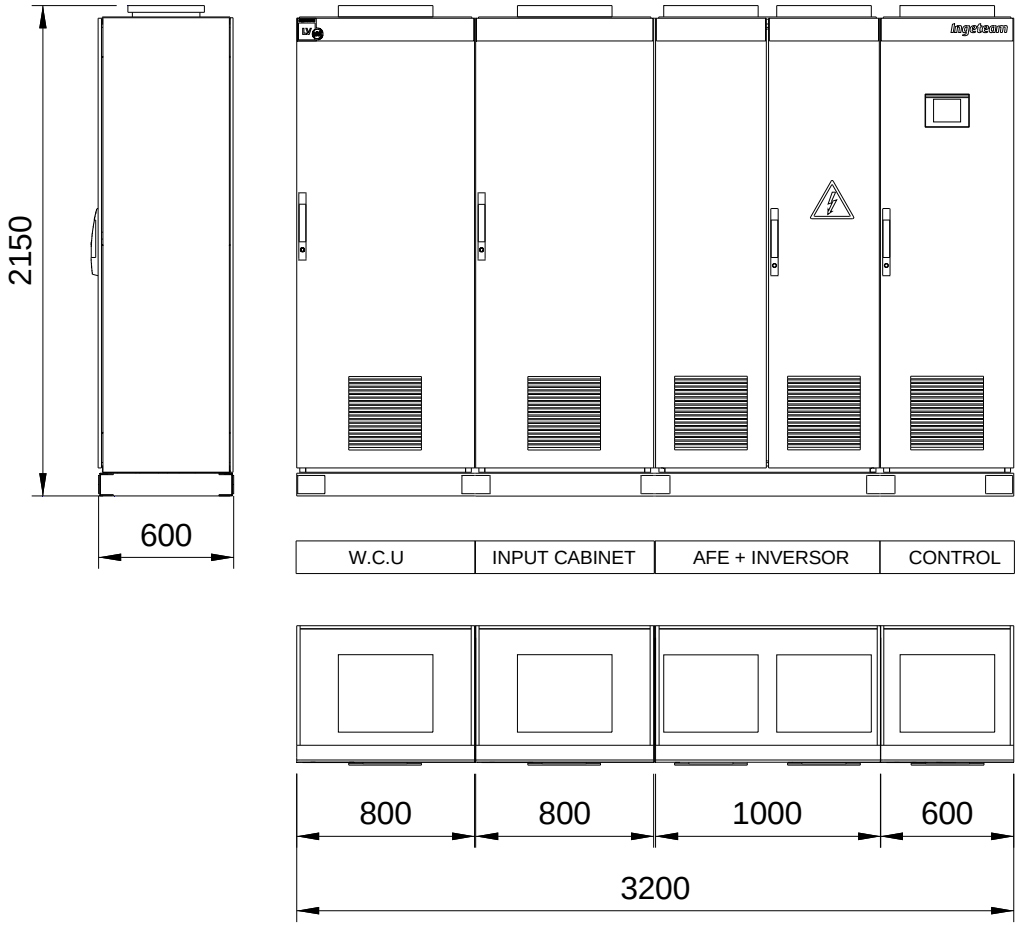


Water vs. Air : Practical example in LV

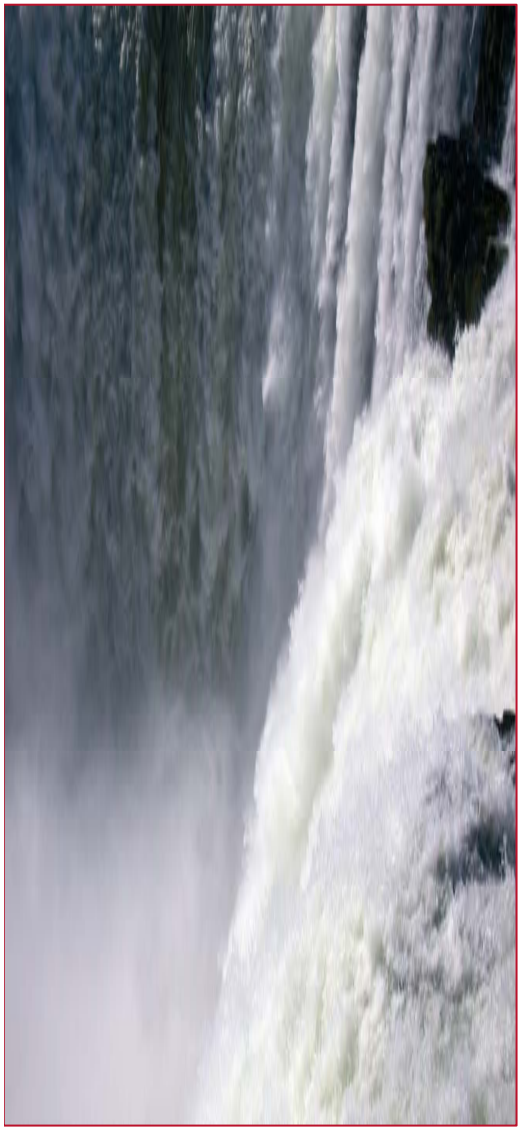
Ingedrive LV400

- Water cooled / 690 Vac
- AFE + inverter + LCL
- 1600 kVA
- Noise: 70 dB (A)
- Protection degree: IP43
- Switching Freq.: 2,5 kHz
- Price: -17% (vs LV200)





Conclusion



- For smaller power ratings Air-cooled frequency converter tend to be more economical, small.
- For larger power ratings Water-cooled frequency converters tend to be more economical, less noisy, and more compact than air-cooled ones.

Ingeteam

Vielen Dank und Viel Erfolg Transresch!