RACE TARGET *Cooling System*

Mario Palomba **(ENEA)**

Safety issues related to the target cooling

The use of **Uranium target** involves safety issues about consequences of an hypothetical rupture of the cooling system. In order to avoid this or to mitigate the consequences, some technical precautions were undertaken:

- Two barriers between the target and the reactor cooling water:
  - Aluminum cladding;
  - Target cooling container;
- An extended analysis of possible troubles;
- Two independent primary cooling loops coupled by an heat exchanger with a secondary loop;
- Passive/active systems designed in order to avoid the loss of target refrigeration.

Possible troubles

Three main type of accidents can be envisaged:

- Local loss of flow → Hot Spot → Local burn of target cladding → Uranium dispersion in the target cooling water;
- A general loss of cooling flow;
- Target container rupture.

Local loss of cooling flow

This type of event can be managed by:

- A second barrier that will prevent the dispersion of uranium particles in the reactor pool water;
- A set of alarm devices, based on continuous sampling of the target cooling water, will warn if there is a dispersion of radioactive particles;
- If there is a radioactive leakage → beam stop → pollution confined in the target cooling water without effects on the reactor water.

General loss of cooling flow

This very unlikely event (see below) is managed by a quick shut-down of the beam:

- In case of complete loss of cooling flow, the “grace time” (few seconds) allows to detect the event and to stop the electron beam before the window/cladding rupture;
- Several sensors could be installed in order to detect this event (see below);
- Even in case of Target/Cladding failure, the second barrier will prevent the reactor pool water contamination.

Target container rupture

The rupture of the target container is a very unlikely event:

- No significant stress or temperature increase neither in case of LOFA;
- Nevertheless, because of first barrier effect, the reactor cooling water would not be polluted.

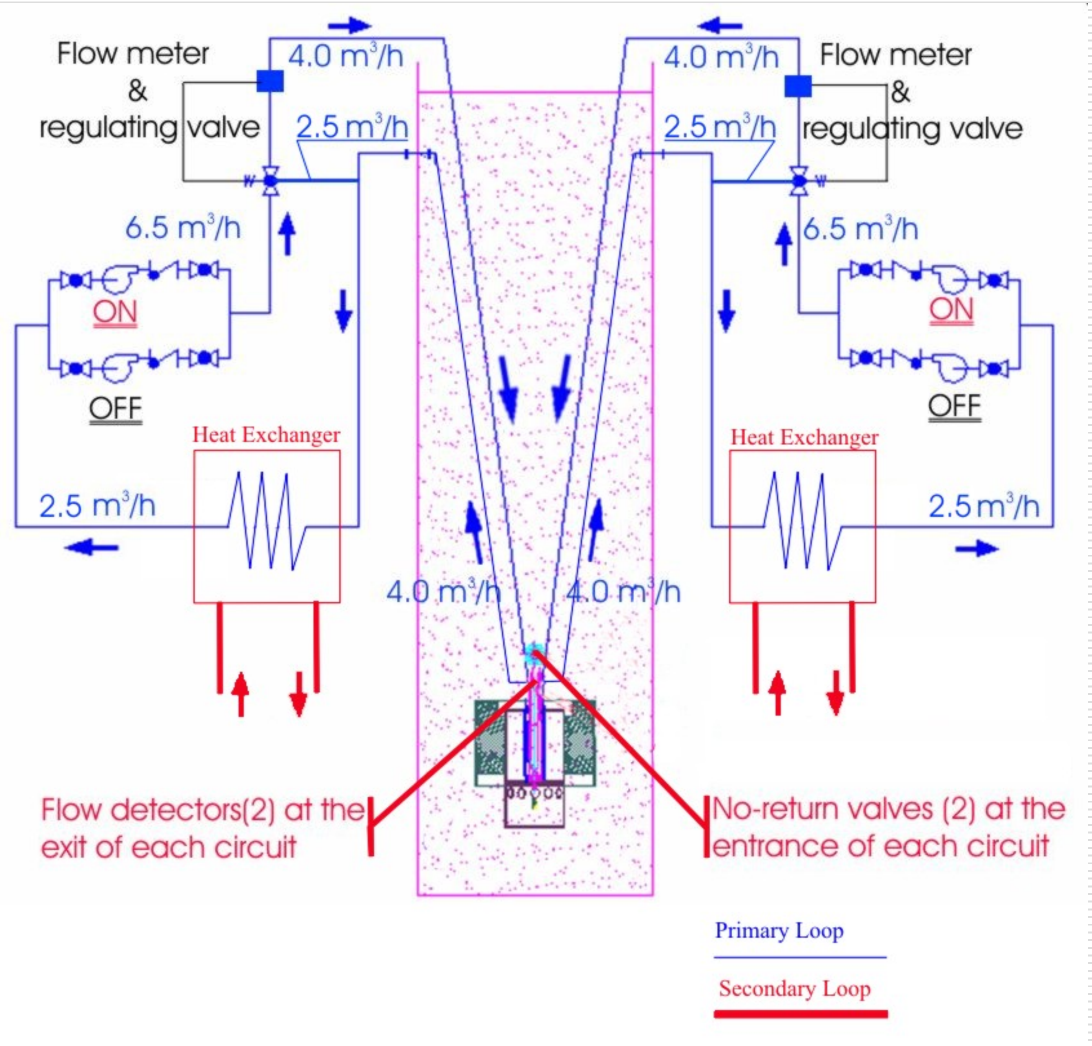
Target Cooling System

Design Criteria
&
description

Design Criteria:

- ❖ Target could contain some fission products → the design of the circuit was carried to insure a very high safety level;
- ❖ That means: even if a major accident occurs → the target will not be damaged or, in any case, the possible contamination will be confined inside the primary target loop.

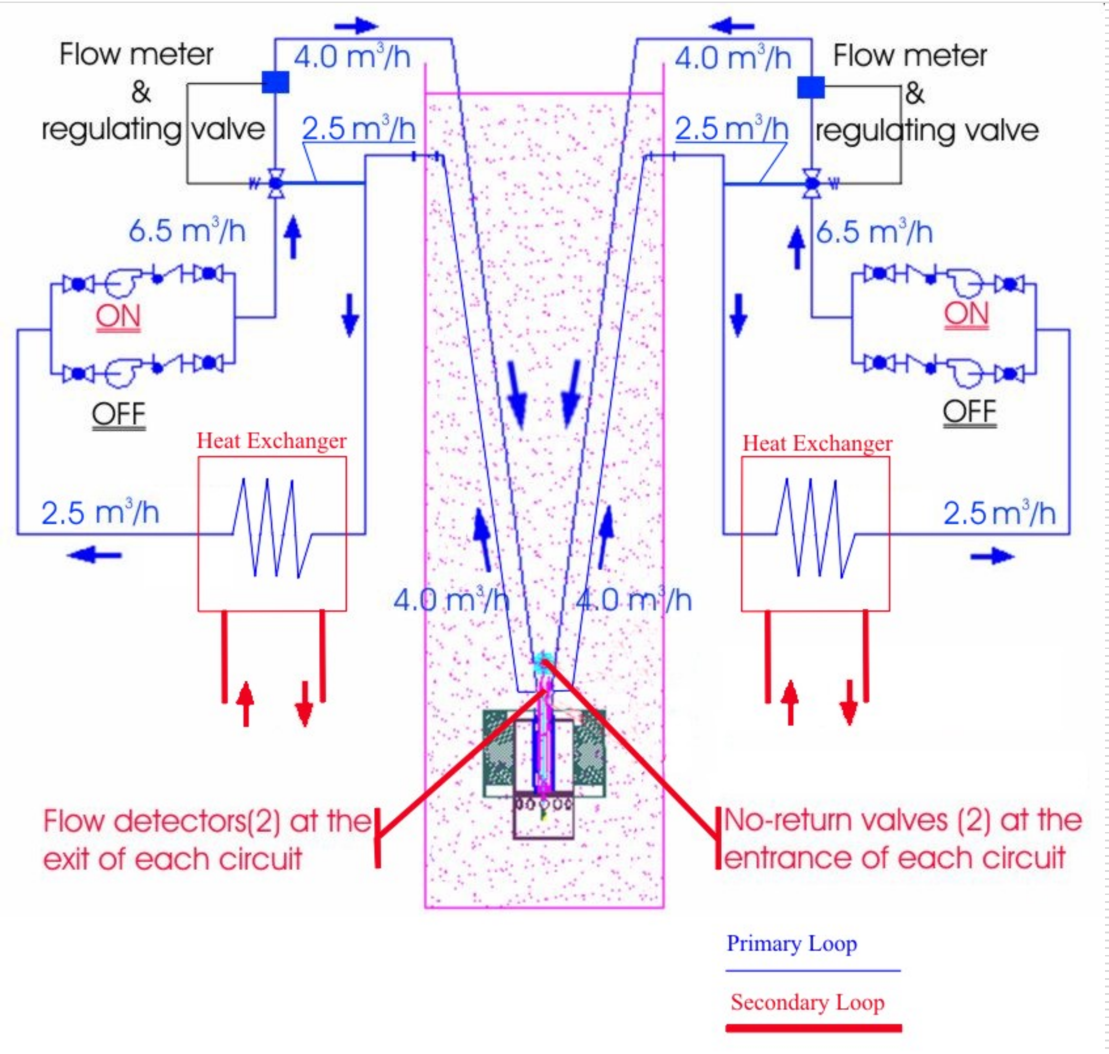
According with this requirement, some technical shrewdness were adopted.



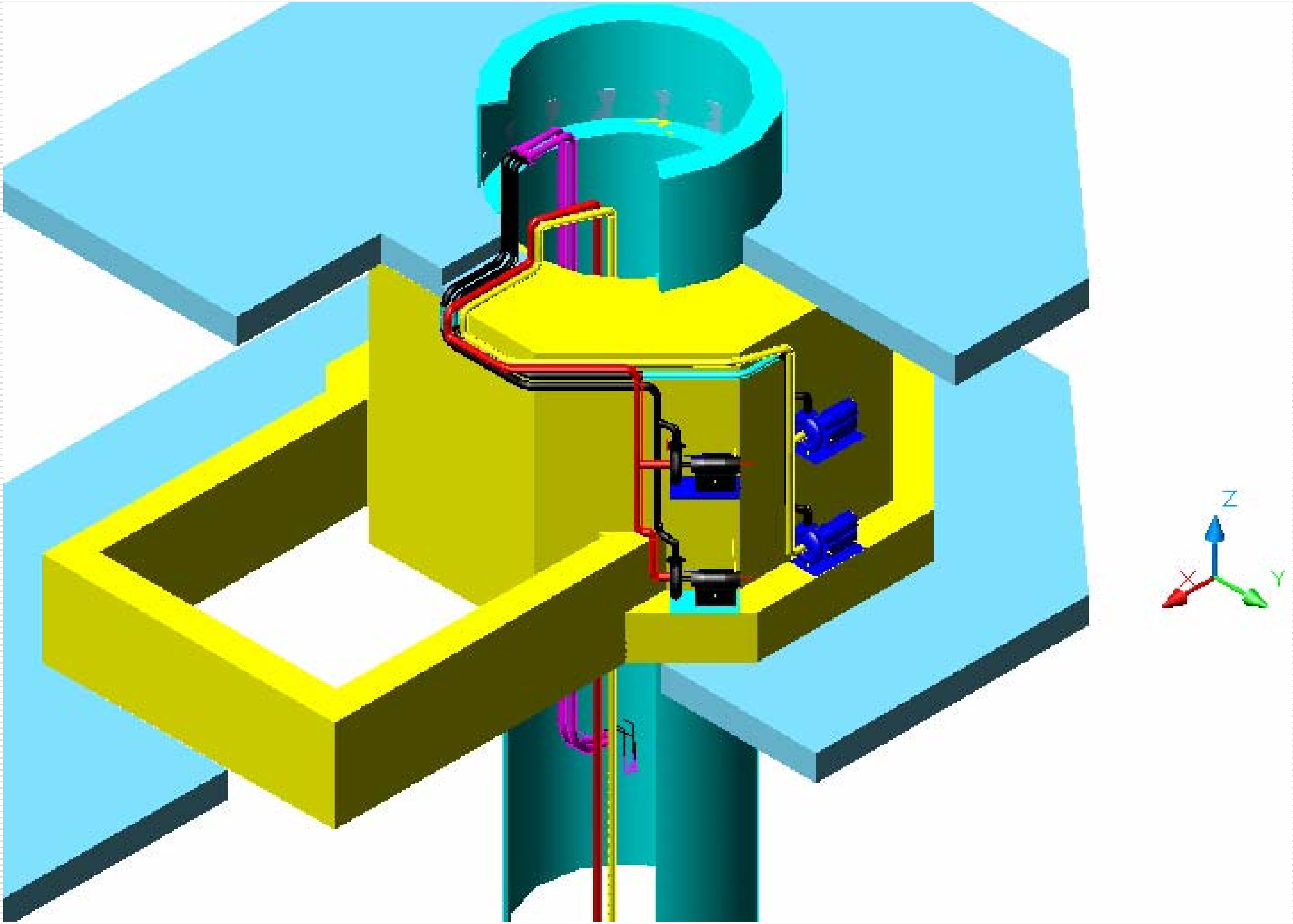
Cooling circuit characteristics:

- 2 Circuits (primary & secondary);
- 2 Independent (identical) loops (primary);
- Each group has an independent power supply;
- 2 Pumps for each loop (1 working + 1 ready to start);
- Total cooling needed flow rate: (indicative for ~30 kW) ~ 8 m^3/h (4.0 m^3/h for each loop);
- Flow rate regulated by a 3-way regulating valve and a by-pass loop;
- Flow rate capability for each pump = ~ 6.5 m^3/h;
- Piping diameter = 1.5"
- 2 Flow meters at the exit of the cooler;
- Pressure & temperature detectors in every interesting point of each loop;
- Holes (anti-siphon holes) just under the water level in the pool;

- A rupture of secondary loop (loss of secondary flow) is not critical: **the thermal capacity of the whole primary circuit allows the safe shut-down of the system without consequences.**



CONDITION	WORKING MODE
Normal	Both loops are operating. One pump for each loop is running at a flow rate of 6.5 m^3/h. The regulating valves keeps the flow rate at the nominal value of ~ 4.0 m^3/h in each loop.
Pump Failure (seizure, electromotor failure, loss of power and s.o.)	The valve of the working circuit opens completely and immediately so the flow rate is = 6.5 m^3/h (> 80 % of the normal flow rate); After few seconds the secondary pump of the failed circuit starts and the flow rate increase till the normal value.
Complete failure of 1 loop (pipe break, loss of power and s.o.)	The valve of the working circuit opens completely and immediately so the flow rate is = 6.5 m^3/h (> 80 % of the normal flow rate) **the Electron Beam is shut down ASAP (probably few minutes).**
Loss of flow rate at the exit of the one loop (pipe break into the pool)	The valve of the working circuit opens completely and immediately so the flow rate = 6.5 m^3/h (> 80 % of the normal flow rate) **the Electron Beam is shut down ASAP (probably few minutes).**
Loss of flow rate at the exit of **both** loops	**The Electron Beam is shut down IMMEDIATELY (few SECONDS).**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