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Advanced Cooling Tubes

Flexible Cooling Solution for Spent Fuel Pools

Modular and flexible decay heat removal in spent fuel pools with first-of-a-kind heat exchanger modules

Challenge

Increased or modified heat removal can be required due to:

- Increased decay heat (mixed oxide fuel assemblies, re-racking measures or higher burn-up rates)
- New safety requirements (diversification of the existing heat removal system)
- Implementation of an emergency heat removal system.

Despite relatively low decay heat during the post-operational phase, the pre-existing costly heat removal chain has to stay in operation.

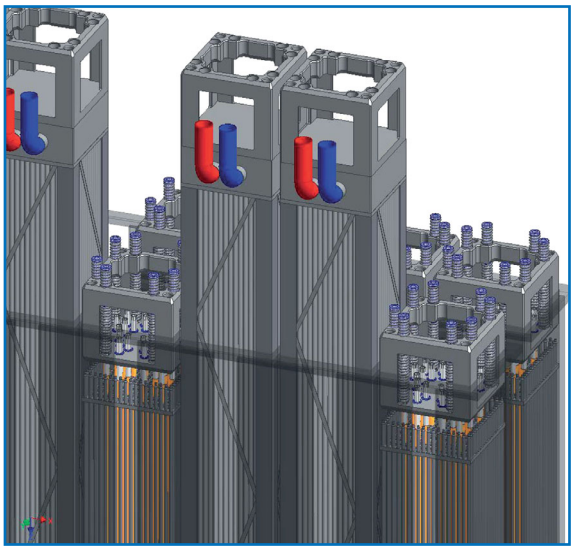
Retrofitting heat exchangers to the pool liner requires requalification of the spent fuel pool‘s seismic integrity, which is time consuming and costly.

Solution

The Advanced Cooling Tubes (ACT) are inserted into the spent fuel pool as an additional or diverse cooling device to strengthen or replace existing heat removal systems.

The cooling modules have a similar shape to the fuel assemblies and therefore fit in most fuel racks. Using existing structures within the pool as mounts avoids recertification. The total heat removal capability of the heat sink can be adjusted through modular combination of several ACT.

During the post-operational phase a combination of ACT and dedicated cooling system can bypass the expensive operational heat removal chain. ACT modules can be used in an active, passive or hybrid way dependent on the selected heat sink technology.



Schematic drawing of ACT inside a fuel rack

Customer benefits

- Cost efficiency because of a short project phase and the elimination of seismic and other recertification
- Cools reliably during normal operation, accident conditions and in post-operational phase
- Integrates easily into existing fuel racks
- Cost-effective cooling solution for the post-operational phase
- Increases flexibility of capacity by combining ACT modules and inserting additional modules as needed

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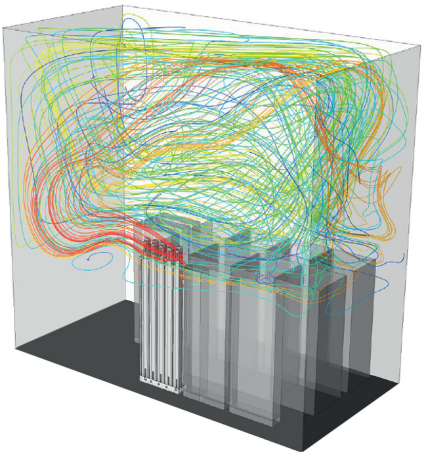
Technical information

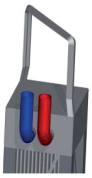
- ACT modules are tube bundle heat exchangers.
- Inlet and outlet are located at the top to facilitate connection and installation.
- Passive flow on shell side (fuel pool water).
- Design features such as flexible piping and screw fittings allow for easy assembly and installation.
- The cooling modules can be handled the same way as fuel assemblies due to the similar shape.
- ACT modules are placed directly in the position of a fuel assembly.
- Heat removal is realized actively by pumping the coolant through the tube bundle and removing the heat with standard heat exchangers to a heat sink, for example the atmosphere.



Thermal-hydraulic calculation as part of the development process: flow path lines visualize the steady flow inside the fuel pool

PWR design

VVER design



BWR design

References

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Japan: feasibility study for Japanese nuclear power plants (2017)

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