Dynamic Natural Convection – Passive Cooling for the LWR Fleet

NuVision Engineering Inc. is pleased to present this proposal for the demonstration of Dynamic Natural Convection technology. For this project, NuVision Engineering is acting as the Principal Investigator (PI) and we are teamed with DYNAC Systems and our university research partner, Mississippi State University.

Dynamic Natural Convection is a trade name for a technology being developed by NuVision, and our technology partner, DYNAC Systems. Dynamic Natural Convection is an engineered solution to mitigate the effects of a loss of AC power and to remove decay heat from the reactor core. The system is independent from electric power and can mitigate most losses from random equipment failures and severe accidents that have occurred in the history of Light Water Reactors (LWRs).

The technology has the potential to substantially benefit the nation's economy, environment and stake holders including the Nuclear Industry, the United States Electric Power System and all of its consumers.

An Opportunity to Improve Safety and Reduce Costs of the LWR Fleet

There are more than 90 operating LWRs in the United States and more than 400 worldwide. These reactors provide reliable carbon free electricity. Nuclear power provides about 20% of the electricity in the United States and 11% of the world's electricity. Safely and reliably maintaining this power source is of great importance to the national economy, the public and the environment.

As a result of Fukushima, the NRC developed additional recommendations to protect the US Nuclear Fleet. These recommendations included the following requirements related to Station Blackout.

- Establish a minimum coping time of 8 hours for loss of alternating current with minimum human intervention
- Establish onsite equipment, procedures and training for extended loss of alternating current for a coping time of 72 hours
- Pre-plan and pre-stage equipment for delivery to the site in 72 hours
- These requirements must be diverse and protected from external events

While these new requirements provided enhanced safety to the public, it did not provide additional protection to save the asset. These new requirements also significantly increased the utility's operating and maintenance budget.

DNC Technology

Dynamic Natural Convection is an engineered solution to mitigate the effects of loss of AC power and to remove decay heat from the reactor core. Following a reactor trip and loss of power, this unique technology will redirect and use the energy of the decay heat to passively cool the reactor core, thus eliminating the need for electricity to power the safety systems. This is a passive system that starts immediately after loss of AC power without the need for human intervention. As a result, core cooling starts immediately, mitigating the effects of decay heat on the fuel rods. The system, independent from electric power, can mitigate most losses due to random equipment failures and severe accidents that have occurred in the history of light water reactors.

Dynamic Natural Convection systems can be retro-fitted onto all US operating nuclear power plants to improve safety and mitigate Station Blackout issues. This applies to both Pressurized Water Reactors (PWRs) and Boiling Water Reactors (BWRs). Dynamic Natural Convection is also applicable to new plant construction.

Proposed Development Program

The Dynamic Natural Convection system utilizes a uniquely designed condensing ejector that we refer to as a Conjector. NuVision and DYNAC have already conducted a 100kW small scale test that demonstrated and verified the feasibility of the Conjector concept.

This proposed Research and Development program will build upon the previous testing performed using a 100kW design to validate the proof of concept. The Conjector that will be used in operating NPPs will be somewhere in the range of 15MW – 25MW. This program will design and fabricate a roughly half scale 1MW Conjector and test stand that will be used to characterize the Conjector.

The scope and tasks of this project include:

- Design of the 1MW Conjector and test facility
- Fabrication of the 1MW Conjector and test facility
- Assembly and commissioning of the test facility
- Performance of the test program
- Creation of final report

In support of the work above to characterize and validate a range of operating conditions at 1MW scale, we will also reconfigure and utilize the available 100kW Conjector and test rig to examine and model the water /steam mixing inside the conjector. This work should assist in optimizing the internal design of the Conjector.

The deliverables for the program will consist of a report describing the testing and associated characterization of the Conjector.

Summary

NuVision is confident that the Dynamic Natural Convection technology we are developing will significantly improve both the safety margins and the competitive economics of the LWR fleet, allowing these plants to contribute to US power generation needs and grid security and stability long into the future.