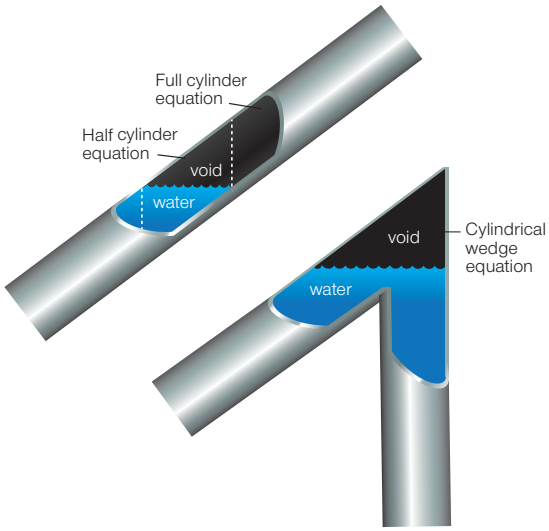
Gas Voids Analyses

The presence of non-condensable gas (NCG) in power plant systems is undesirable because it may have immediate and significant effects on pump performance, or initiate long-term failure mechanisms on equipment, such as pump shaft fatigue, wear ring degradation, bearing wear, or seal wear. In addition, water hammer associated with the sudden increase in pump discharge piping pressure when systems are placed into service is a concern. AREVA is prepared with plant analyses expertise to support your needs.

Instances of gas accumulation in emergency core cooling (ECCS), residual/decay heat removal (RHR/DHR), and containment spray (CS) systems have led to a number of events in the industry. In response to these events, the NRC requested in Generic Letter GL 2008-01 that utilities evaluate their systems to ensure gas accumulation is maintained at quantities lower than the amounts that challenge system operability.

Evaluating the effects of accumulated gas in plant safety system piping is a complex problem, and over-simplified solutions may leave plant systems vulnerable.

Methodology Supports Realistic Placement of Voids (Size and Location)



Features and Benefits

- Analysis models are generated using an automated process – detailed phenomenological calculations are produced for each scenario
- Voids of any size and location can be characterized and analyzed (subject to the geometrical limitations of the system)
- Sensitivity studies on void size, location, and combination are quickly performed
- Challenges to DHR/RHR relief valve setpoints are assessed
- Detailed analyses are produced quickly enough to support plant operability assessments
- Uninspectable runs of pipe can be addressed using conservative assumptions for void volume
- NCG volume and location acceptance criteria are developed or confirmed
- Locations of additional vent piping are identified
- Force time histories sufficient for input into structural analyses are produced
- Availability of margins can be evaluated
- Results support plant void management programs consistent with the NEI 09-10 guideline
- Compliance with licensing/regulatory

Experience

AREVA's integrated engineering and licensing approach results in technically robust solutions that cost-effectively meet regulatory obligations.

AREVA supported a customer in a complete revision of their GL 2008-01 program and associated procedures to meet the regulatory requirements regarding mitigation of gas voids in ECCS systems. AREVA also supported the customer's disposition of existing voids providing timely and robust technical evaluations.

AREVA's multi-discipline team of expert thermal-hydraulic and structural analysts can perform complex water hammer, void transport, and structural analyses in support of a complete revision of the customer's GL 2008-01 program. Based on in-depth understanding of the technical aspects and the regulatory position on gas voiding in ECCS systems, AREVA is able to develop an innovative and highly cost-effective approach that will help our customers perform quick operability determinations without needing to perform extensive computations or costly modifications. This innovative approach helps the customer meet all current regulatory obligations while giving them flexibility to reduce impact on plant and personnel.

Plant Information
- Operating procedures
- Known void locations
- Sources of gas
- System geometry
- System walkdowns
- Component parameters
- Operating experience

AREVA Methodology
- Water hammer benchmarks
- Void transport benchmarks
- Void builder

Analyses
- Water hammer analysis
- Void tranport analysis

Plant GL 08-01 Program
- Void acceptance criteria
- Updated procedures
- Other mitigating actions

Drawing on extensive experience in GL 2008-01 program implementation and varied plant modifications, AREVA can also recommend several enhancements to the ECCS piping system to allow for additional flexibility and operability. AREVA's exclusive Nuclear Grade Air Trap (NGAT) solution can simplify inspection methodologies and frequencies, reducing overall dose and cost associated with implementing GL 2008-01 programs.

Applications

AREVA has developed and benchmarked methodologies for performing detailed plant-specific analyses of both void transport and water hammer. Non-obvious system vulnerabilities due to phenomenological complexities such as voids of varying sizes simultaneously occurring in multiple locations, or void expansion resulting from swap-over to the plant sump are quickly identified so that mitigating actions can be taken.

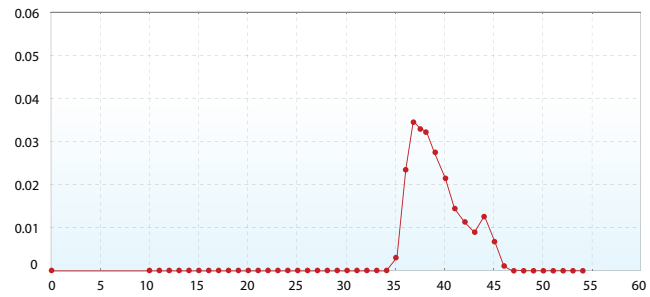
Once the plant-specific system geometry and void location files are populated, the automated process places voids in stable configurations based on user defined volumes and locations. Analytical models can be quickly produced for subsequent sensitivity studies, which provide deeper insights of the void phenomena than empirical or qualitative evaluations.

Results

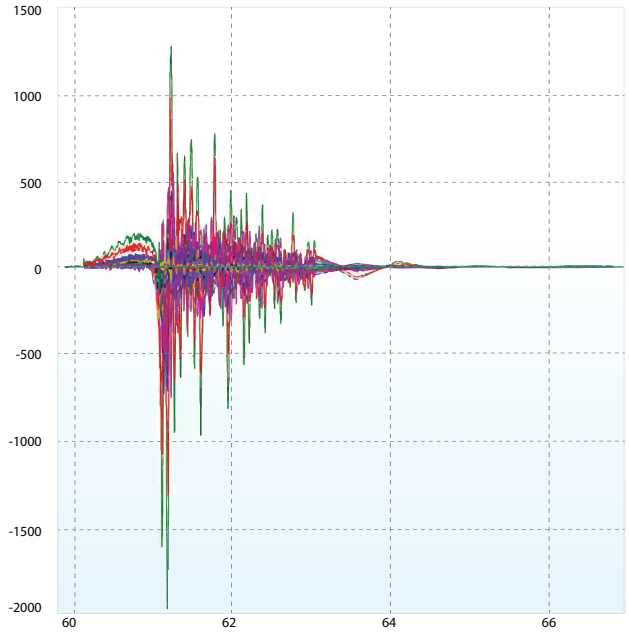
Void Transport
Void fraction at the pump inlet is tracked in the plot (upper chart, pictured on right) to confirm pump criteria are met. Sensitivity studies on void size and location are feasible.

Water Hammer
A comprehensive load plot is presented in the lower chart, pictured right. This overview plot is useful for identifying the location and magnitude of the largest loads. The effects of parameter sensitivity studies on peak loads can quickly be assessed by using this plot.

Void fraction at pump inlet due to pump start with NCG in the system



System pipe loads due to pump start with NCG in the system



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