U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

BRANCH TECHNICAL POSITION 6-4

CONTAINMENT PURGING DURING NORMAL PLANT OPERATIONS

REVIEW RESPONSIBILITIES

Primary - Organization responsible for the review of component integrity issues related to engineered safety features

Secondary - None

A. BACKGROUND

This branch technical position pertains to system lines which can provide open paths from the containment to the environs during normal plant operation (e.g., lines of the containment purge and vent systems). It supplements the position taken in Standard Review Plan (SRP) Section 6.2.4.

While the containment purge and vent systems provide plant operational flexibility, their designs must consider the importance of minimizing the release of containment atmosphere to the environs following a postulated loss-of-coolant accident (LOCA). Therefore, plant designs must not rely on their routine use.

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The need for purging during reactor operation is not always anticipated in the design of plants, and therefore design criteria for the containment purge system are not fully developed. The purging experience varies considerably from plant to plant. Some plants do not purge during reactor operation, some purge intermittently for short periods, and some purge continuously. There is similar disparity in the need for, and use of, containment vent systems at operating plants.

Containment purge systems have been used in a variety of ways (e.g., to alleviate certain operational problems like excess air leakage into the containment from pneumatic controllers, to reduce airborne activity within the containment to facilitate personnel access during reactor power operation, and to control the containment pressure, temperature, and relative humidity). Containment vent systems typically relieve the initial containment pressure buildup caused by the heat load imposed on the containment atmosphere during reactor power ascension or periodically relieve the pressure buildup due to the operation of pneumatic controllers. However, the purge and vent lines provide open paths from the containment to the environs. If a LOCA occurs during containment purging when the reactor is at power, the calculated accident doses should be within 10 CFR Part 100 guideline values.

The sizing of the purge lines in most plants is based on the need to control the containment atmosphere during refueling operations. This need has resulted in very large lines (about 42 inches in diameter) to penetrate the containment. As normally these are the only lines permitting some degree of control over the containment atmosphere to facilitate personnel access, some plants have used them for containment purging during normal plant operation. Under such conditions, calculated accident doses could be significant; therefore, the use of these large containment purge and vent lines should be restricted to cold shutdown conditions and refueling operations and they must be sealed closed in all other operational modes.

The design and use of the purge and vent lines should achieve acceptable calculated offsite radiological consequences and ensure that emergency core cooling system (ECCS) effectiveness is not degraded by a reduction in the containment back pressure.

Purge system designs acceptable for nonroutine use during normal plant operation can be achieved with additional purge lines.

The size of these lines should be limited so that in a LOCA, assuming the purge valves are open and subsequently close, the radiological consequences calculated in accordance with Regulatory Guides 1.3 and 1.4 would not exceed 10 CFR Part 100 guideline values. Also, the maximum time for valve closure should not exceed five seconds so that the purge valves would be closed before the onset of fuel failures following a LOCA. Similar concerns apply to vent system designs.

The size of the purge lines should be about eight inches in diameter for pressurized-water reactor (PWR) plants. This line size may be overly conservative from a radiological viewpoint for the Mark III boiling-water reactor (BWR) plants and the high-temperature gas reactor (HTGR) plants because of containment or core design features; therefore, larger line sizes may be justified. For any proposed line size, however, the applicant must demonstrate that the radiological consequences of a LOCA would be within 10 CFR Part 100 guideline values. In summary, the acceptability of a specific line size is a function of the site meteorology, containment design, and radiological source term for the reactor type (e.g., BWR, PWR, or HTGR).

B. BRANCH TECHNICAL POSITION

The systems that purge the containment for the reactor operational modes of power operation, startup, hot standby and hot shutdown (i.e., the on-line purge system) should be independent of the purge system used for the reactor operational modes of cold shutdown and refueling.

1. The on-line purge system should be designed in accordance with the following criteria:

   A. GDC 54 requires that the reliability and performance capabilities of containment isolation valves reflect the safety importance of isolating the systems penetrating the containment boundary; therefore, the performance and reliability of the purge system isolation valves should be consistent with the operability assurance program of SRP Section 3.10. The design basis for the valves and actuators should include the buildup of containment pressure for the LOCA break spectrum and the supply line and exhaust line flows as a function of time up to and during valve closure.

   B. The number of supply and exhaust lines should be limited to one supply line and one exhaust line to improve the reliability of the isolation function as required by GDC 54 and to facilitate compliance with the requirements of 10 CFR Part 50, Appendix K, for the containment pressure used in the evaluation of ECCS effectiveness and 10 CFR Part 100 for offsite radiological consequences.

   C. The size of the lines should not exceed about eight inches in diameter without detailed justification for larger line sizes to improve the reliability and performance capability of the isolation and containment functions as required by GDC 54 and to facilitate compliance with the requirements of 10 CFR Part 50, Appendix K, for the containment pressure used in evaluating ECCS effectiveness and 10 CFR Part 100 for the offsite radiological consequences.

   D. As required by GDC 54, the containment isolation provisions for the purge system lines should meet the standards appropriate to engineered safety features (i.e., quality, redundancy, testability and other appropriate criteria) to reflect the importance to safety of isolating these lines. GDC 56 establishes explicit requirements for isolation barriers in purge system lines.

   E. To improve the reliability of the isolation function addressed in GDC 54, instrumentation and control systems isolating the purge system lines should be independent and actuated by diverse parameters (e.g., containment pressure, safety injection actuation, and containment radiation level). Furthermore, if energy is required to close the valves, at least two sources of energy must be provided, either of which can effect the isolation function.

   F. Purge system isolation valve closure times, including instrumentation delays, should not exceed five seconds to facilitate compliance with 10 CFR Part 100 for offsite radiological consequences.

   G. Isolation valve closure must not be prevented by debris which could become entrained in the escaping air and steam.

2. The purge system should not be relied on for temperature and humidity control within the containment.

3. The need for purging of the containment should be minimized by containment atmosphere cleanup systems within the containment.

4. The availability of the isolation function and the leakage rate of the isolation valves during reactor operation should be tested.

5. The following analyses should justify the containment purge system design:

   A. An analysis of the radiological consequences of a LOCA should be done for a spectrum of break sizes, and the instrumentation and setpoints that will actuate the purge valve closures should be identified. The source term in the radiological calculations should be based on a calculation under the terms of 10 CFR Part 50, Appendix K, to the extent of fuel failure and the concomitant release of fission products and the fission product activity in the primary coolant. A pre-existing iodine spike should be considered in determining primary coolant activity. The volume of containment in which fission products are mixed should be justified, and the fission products from the above sources should be assumed to be released through the open purge valves during the maximum interval required for valve closure. The radiological consequences should be within 10 CFR Part 100 guideline values.

   B. An analysis which demonstrates the acceptability of the provisions made to protect structures and safety-related equipment (e.g., fans, filters, and ductwork) located beyond the purge system isolation valves against loss of function in the environment created by the escaping air and steam.

   C. An analysis of the reduction in the containment pressure caused by the partial loss of containment atmosphere during the accident for ECCS back pressure determination.

   D. The maximum allowable leak rate of the purge isolation valves should be specified case by case with appropriate consideration for valve size, maximum allowable leakage rate for the containment (as defined in 10 CFR Part 50, Appendix J), and, where appropriate, the maximum allowable bypass leakage fraction for dual containments.
