ROLE OF SAFETY ANALYSIS IN ESTABLISHING CONTAINMENT OPERATING LIMITS

P.R. Gomes-Feder
Reactor Safety and Operational Analysis Department
Ontario Hydro
700 University Ave., Toronto

J. Low
Bruce NGS 'A' Nuclear Safety Department
Ontario Hydro

SUMMARY

All nuclear reactors are designed and operated to meet the fundamental criterion of public safety which is defined in the Reactor Siting Guide as radiological dose limits. The containment system plays an important role in ensuring that public dose limits are not exceeded following a reactor accident. Safety analysis of the containment system demonstrates that the public dose limits are not exceeded and defines the operating limits of systems and components associated with containment performance. When the operating limits are determined, they become operating requirements. If a system or component fails to meet these limits, action is required to correct the fault within a certain period of time or else the affected unit or units will be shutdown.

With the aging of Ontario Hydro's nuclear stations, the performance of some system components has changed compared to the original design specifications. Using the containment system as an example, several changes in performance have taken place over the past 5 to 10 years such as an increase in containment leakage, leaking of instrument air actuators, etc. Since containment structural leakage is currently a licensing limit for all stations, this parameter is closely monitored. At stations where the measured containment leakage is close to the licensing limit, significant effort is required frequently to locate leaks identified from test results and to fix them either through maintenance or replacement of components.

The design intent of the station must be met even though aging effects or other factors have changed the station performance and the ability to meet operating limits. Therefore, it is important to ensure that the technical basis for the operating limits is appropriate and consistent for all stations, and that the recommended operating limits are properly implemented. The technical basis shows which components and parameters are significant for meeting the system's effectiveness criteria. For the containment system, based on the fundamental safety concern of public dose, the effectiveness criteria are ensuring dose limits are not exceeded, ensuring structural integrity and ensuring adequate time for implementing an off-site emergency response if warranted.

An appropriate and consistent technical basis for operating limits has several benefits. It provides an assurance of public safety, and ensures that shutdowns only occur when necessary from a public safety perspective. Stations should not suffer needless economic hardships because of arbitrary operating limits.

In the development of a technical basis for containment operating limits, the sensitivity of the plant response to each containment component and parameter is identified for the design basis accident which poses the greatest challenge to meeting the effectiveness criteria. The role of a single parameter in the overall plant response is often unknown and difficult to know but it can be determined from operating experience, engineering judgment, risk assessment or a detailed sensitivity analysis. Sensitivity analyses provide a well-supported technical basis for operating limits. For the containment system operating limits, the most important plant response is public dose.

The methodology for determining the operating limits of a component or parameter is to calculate the public dose while varying the value of the component or parameter beyond its Safety Analysis Envelope value. Only one parameter at any one time deviates outside the envelope. All other components and parameters are kept at their safety analysis values. If the presence of a turbulent containment leakage component has been confirmed at a station, the analysis value for containment structural leakage should include this turbulent component. The PATRIC and FPDOSE computer codes developed in the Reactor Safety and Operational Analysis Department (RSOAD) of Ontario Hydro are used to calculate the public dose. Repressurization times are calculated since they are a measure of the time available for implementing an off-site emergency response. The REPRES computer code developed in RSOAD is used to calculate repressurization times.
The results of the sensitivity analysis can be grouped into two categories:

- public dose is insensitive to the value of the parameter or component. Some examples of containment parameters which exhibit this behaviour are containment structural laminar leakage, compressed gas in-leakage, containment operating pressure and temperature.
- public dose is very sensitive to the value of the parameter or component from a certain point onwards. This value is chosen as the impairment value. In this state, there is a reduction in system capability which impairs the system's ability to meet its full design capability. Thus, the system is considered to be unavailable. If repairs within a short period of time cannot correct the fault, the affected unit or units will be shutdown. Some examples of containment parameters which exhibit this behaviour are vacuum building main chamber pressure, and dousing tank water level.

These sensitivity analyses support the technical basis for the containment operating limits. Updating of the documentation of the technical basis for containment operating limits provides confidence that the design intent of the containment system is maintained for the station life. The recommendations of the sensitivity analyses determine which components and parameters need to be included in setting the licensing limits, and determine the licensing limits for these significant components and parameters.