# ANALYSIS OF A POSTULATED REFUELING ACCIDENT

# INSIDE THE CONTAINMENT BUILDING

Indian Point Units 2 and 3
Docket Nos. 50-247 and 50-286

March, 1977

## INTRODUCTION

A postulated drop of a fuel assembly in the reactor cavity was analyzed in the Final Safety Analysis Reports (FSAR), for Indian Point Units 2 and 3. The assumptions used in these analyses are described in Section 14.2 of the FSARs. The results of the analyses indicated that the releases following a postulated fuel handling accident inside the Vapor Containment Building (VCB) were substantially less than the 10 CFR Part 100 limits.

By letter, dated January 17, 1977, the NRC requested a detailed evaluation of the potential refueling accident inside the Vapor Containment Building of Indian Point Units 2 and 3, using the assumptions specified in Regulatory Guide 1.25, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Fuel Handling Accident in the Fuel Handling and Storage Facilities". To comply with this request, the analyses that were performed in the FSARs were reviewed and a detailed reanalysis of the postulated accident has been performed.

## DESCRIPTION OF ANALYSES

The possibility of a fuel handling accident is very remote because of many administrative controls and physical limitations that are imposed on fuel handling operations.

In the unlikely event that a refueling accident should occur in the Vapor Containment Building, a variety of equipment will assure exposure guidelines set forth in 10 CFR Part 100 are not exceeded. The first constraint on the releases is the building itself. The VCB is designed to contain any potential radiological

release from the reactor and associated systems located within the building. To accomplish this function, the structure is designed such that all pathways to the outside can be isolated and made airtight.

In addition, all exhausts from the VCB Ventilation System and the VCB Pressure Relief System are expelled through in-line high efficiency particulate (HEPA) and charcoalbed filter systems and are released through the plant vent. There is no bypass around the HEPA and charcoalbed filters.

The Technical Specifications for both Units 2 and 3 require that the containment ventilation and purge systems including the radiation monitors which initiate VCB ventilation isolation, be tested and verified to be operable prior to the start of refueling operations. In addition, the Technical Specifications require that the equipment door and at least one door in each personnel air lock be properly closed. At least one isolation valve in each line penetrating the containment which provides a direct path from containment atmosphere to the outside must also be operable or locked closed. No path exists, therefore, which is not closed or cannot be quickly isolated either locally or remotely.

The Technical Specifications for both Units also requires that radiation levels inside the containment be continuously monitored during refueling operations. The following instrumentation can be used to provide this monitoring function:

1. Channel R-11 Containment Air Particulate Monitor

This monitor measures air particulate radioactivity inside the containment building. A continuous sample is taken from the inlet of two recirculation air filtration units located on diametrically opposite sides of the containment building. On a high radiation indication, the channel will alarm in the Central Control Room and will automatically indicate closure of the containment purge supply and exhaust duct valves, and pressure relief line valves.

2. Channel R-12 Containment Radio-Gas Monitor

This channel measures radio-gas activity of the air sampled by Channel R-11. Sampling for this channel is also continuous. On a high radiation level indication, this channel will also alarm in the Central Control Room and initiate containment ventilation and purge system isolation.

3. Channel R-13 Plant Vent Air Particulate Monitor

This channel measures air particulate radioactivity sampled from the 105 foot elevation of the plant vent. Sampling is done continuously. On a high radiation indication, this channel alarms in the Central Control Room.

4. Channel R-14 Plant Vent Radio-Gas Monitor

This channel measures radio-gas activity at the 105 foot elevation of the plant vent. The activity is monitored continuously. On a high radiation indication, this channel alarms in the Central Control Room.

5. Channel R-2 Containment Area Radiation Monitor

This monitor is located at the 80 foot elevation in the Containment Building. The detector will alarm in the Central Control Room on a high radiation indication.

6. Channel R-7 In-Core Instrument Room Area Radiation Monitor

This monitor is located at the seal table inside the Containment Building. The detector will alarm in the Central Control Room on a high radiation indication.

7. Local Radiation Monitors

During refueling operations, air particulate and radio-gas radiation monitors are installed inside the Containment Building near where fuel movement is being made. The monitors alarm locally on a high radiation indication.

The Technical Specifications for both Indian Point Units 2 and 3, also require that direct communication between the Central Control Room and the refueling cavity manipulator crane be available at all times whenever fuel is being moved in

the VCB. Should a refueling accident take place in the VCB, containment isolation would be initiated immediately by the operators in the Central Control Room. This action would assure that all potential paths from the VCB to the outside atmosphere are closed and the building is leak-tight. All systems required to assure this isolation capability of the VCB are designed to meet safeguards equipment standards. This equipment is also designed to withstand the seismic loads for which all safeguards equipment is designed. In addition, this equipment is designed to withstand any single failure and still perform its required function.

To assure conservatism, no automatic or operator action to initiate VCB isolation is assumed to take place for 10 minutes following the postulated refueling accident. The gaseous releases resulting from this postulated accident are assumed to escape from the VCB through the building vent and purge systems for this 10 minute period. No releases to the outside of the VCB are assumed to occur other than that which is passed through the building ventilation and purge systems. Should a VCB isolation valve fail to close when the isolation signal is initiated, indicating lights in the Central Control Room will alert the operator to the problem. Action could then be taken to assure that VCB isolation has been achieved. Potential releases through paths other than the purge and ventilation exhaust ducts would be precluded by the tortuous routes, the interposing fluid systems and the restricted flow paths that exist and that would have to be overcome before an outside release could take place.

ASSUMPTIONS MADE FOR THE ANALYSES

The assumptions made in performing these analyses of a postulated refueling accident inside the VCB, conform with the positions that are outlined in Regulatory Guide 1.25. The assumptions which are described in Regulatory Guide 1.25, are as follows:

1. The postulated accident is assumed to occur at the earliest time after reactor shutdown at which fuel movement is permitted to occur. Section 3.8 of the Technical Specifications for Indian Point Units 2 and 3 require that no movement of the fuel shall take place until the reactor has been subcritical for at least 90 and 100 hours respectively. The postulated accident is assumed to occur at these times.

2. The values assumed for individual fission product inventories are calculated assuming full power operation at the end of core life immediately preceeding shutdown. The saturation inventories and dose conversion factors used are as presented in TID-14844. A peaking factor of 1.65 was used to determine these inventories.

3. Gap iodine activity is assumed to be 10% of the total saturation inventory in the fuel rod. All of the gap activity in the damaged rods is assumed to be released.

4. Iodines released from the pool are considered to consist of 75% inorganic and 25% organic forms of iodine.

5. The effective pool decontamination factors (DFp) for the pool is taken to be 100. Studies performed in Section 14.2 of the Indian Point Unit 2 and 3 FSARs to determine the activity release characteristics following a postulated fuel handling accident indicate that this value for DFp is very conservative. Decontamination factors five to ten times greater are expected as a result of the "scrubbing" effect of the water. In the interest of complying with the Regulatory Guide, however, the lower, more conservative value for DFp was used in the analyses.

6. The radioactive material is assumed to disperse in the building so that the release rate from the building is equivalent to a uniform release of all of the activity over a two hour period.

7. The conservative assumptions for atmospheric diffusion outlined in Regulatory Guide 1.25 were used in the analyses. The calculations were based on a Pasquill diffusion category F, and a uniform wind direction. In addition, a conservatively small wind velocity of 0.7 m/sec., was assumed.

8. The conservative assumptions outlined in Regulatory Guide 1.25 for determining approximations of thyroid dose from inhalation of released radioactive iodine were followed.

In addition to the assumptions outlined in Regulatory Guide 1.25 and described above, additional conservatisms were used in calculating potential radiation release following the postulated accident. These additional conservative assumptions are as follows:

1. All rods in the damaged assembly are assumed to be ruptured in the accident such that the entire gap iodine inventory for the assembly is released.

2. Closure times for the VCB ventilation isolation valves are required to be 2 seconds or less. Section 3.8 of the Technical Specifications for both Units 2 and 3, require that these valves be tested and verified to be operable along with the rest of the containment vent and purge system prior to refueling operations. Consequently, there is assurance that the valves will close within the required time if required to do so. For the purposes of the release analyses, no activation of the valves is assumed for 10 minutes following the postulated accident.

3. Releases from the VCB through the building ventilation and purge systems were assumed to begin immediately following the postulated accident at the rate specified by Regulatory Guide 1.25. In fact, the VCB is a very large building and the exhaust ports for the ventilation and purge systems are located in different areas and

on different levels in the VCB than the point of release at the surface of the refueling pool from the postulated failed fuel assembly. The radioactive gases from the postulated refueling accident will actually take a number of minutes to reach the ventilation and purge exhaust ducts.

4. No plate-out of the gaseous iodine is assumed to occur within the ventilation and purge exhaust ducts.

5. HEPA and charcoalbed filters are installed in the VCB ventilation and purge exhaust ducts such that all flow must pass through them. However, no credit for decontamination of the postulated gaseous releases by the filters is assumed.

6. No credit is taken for the operation of charcoal filtration systems located within the VCB. The following such charcoal filter systems could be available to remove iodine from a postulated refueling accident inside the VCB.

   a. In-Containment Air Recirculation Cooling and Filtration System

      There are five fan cooler - charcoal filtration units inside the Containment Building. Each of these cooler - filter units contains in excess of about 500 pounds of activated impregnated charcoal and can be used to remove iodine that could be released from a fuel handling accident inside the Containment Building. When operated, the charcoal in each unit will filter 8000 cubic feet of air per minute.

   b. Kidney Filtration System

      Two kidney filter units are located inside the VCB. These filter units are designed to remove gaseous iodine from the containment building and have individual capacities of 8000 cubic feet of air per minute.

7. No credit has been assumed for the continuous decay of radioactive gases released following the postulated refueling accident.

8. No credit is taken in the atmospheric diffusion calculations for elevated release points from the plant. A ground level release is assumed.

RESULTS OF THE ANALYSES

The calculated offsite limiting doses were found to be a small fraction of the 10 CFR Part 100 Guidelines. For Indian Point Unit 2, the maximum offsite thyroid dose was calculated to be 22.01 Rem. For Indian Point Unit 3, this dose was calculated to be 37.82 Rem.

No facility equipment changes, or changes to the Technical Specifications are required at either Unit to assure that these very conservatively calculated offsite consequences of a postulated refueling accident are well within the 10 CFR Part 100 exposure guidelines over the facility lifetime. Actually, should such an accident occur, it is very unlikely that any offsite exposures at all would result.

For the purposes of these analyses, many "worse case" and overly conservative assumptions have been made. These assumptions make the calculation of conservative values for the releases following a postulated refueling accident inside the VCB easier to determine. Because the doses resulting from these calculated releases are so small compared with the regulation limits, no attempt has been made to determine more realistic dose rates at this time.