Bepro 6/30

June 28, 1982

Docket No. 50-237
LS05-82 -06-098

Mr. L. DelGeorge
Director of Nuclear Licensing
Commonwealth Edison Company
Post Office Box 767
Chicago, Illinois 60690

Dear Mr. DelGeorge:

SUBJECT: SEP TOPIC III-4.C, INTERNALLY GENERATED MISSILES
DRESDEN 2

Enclosed is our final evaluation of SEP Topic III-4.C. It is based on a Safety Analysis Report which you supplied on May 17, 1982, and other information available on Docket No. 50-237.

The evaluation will be a basic input to the integrated safety assessment of your facility. It may be changed in the future if your facility design is changed or if NRC criteria is modified before completion of the integrated assessment.

Sincerely,

SE04
DSU USE (16)

Paul O'Connor, Project Manager
Operating Reactors Branch No. 5
Division of Licensing

Enclosure:
As stated

cc w/enclosure:
See next page

6/28/82

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ENCLOSURE

SAFETY EVALUATION REPORT
DRESDEN UNIT 2
SYSTEMATIC EVALUATION PROGRAM
TOPIC: III-4.C INTERNALLY GENERATED MISSILES

I. INTRODUCTION

Missiles which are generated internally to the reactor facility (inside or outside containment), may cause damage to structures, systems and components that are necessary for the safe shutdown of the reactor facility or accident mitigation and to the structures, systems and components whose failure could result in a significant release of radioactivity. The potential sources of such missiles are valve bonnets, and hardware retaining bolts, relief valve parts, instrument wells, pressure containing equipment such as accumulators and high pressure bottles, high speed rotating machinery, and rotating segments (e.g., impellers and fan blades).

Scope of Review

The scope of review is as outlined in the Standard Review Plan (SRP) Section 3.5.1.1, "Internally Generated Missiles (Outside Containment," and SRP Section 3.5.1.2, "Internally Generated Missiles (Inside Containment)." The review specifically excludes SRP Section 3.6.1, "Plant Design for Protection Against Postulated Piping Failures in Fluid Systems Outside Containment," 3.6.2, "Determination of Break Locations and Dynamic Effects Associated with the Postulated Rupture of Piping," as well as those SRP sections dealing with natural phenomena (including missiles generated by natural phenomena), missiles generated outside the facility, and turbine missiles.

II. REVIEW CRITERIA

The acceptability of the design of protection for facility structures, systems and components from internally generated missiles is based on meeting the following criteria:

1. General Design Criterion 4, "Environmental and Missiles Design Bases" with respect to protecting structures, systems and components against the effects of internally generated missiles to maintain their essential safety functions.

2. Regulatory Guide 1.13, "Spent Fuel Storage Facility Design Basis" as related to the spent fuel pool systems and structures being capable of withstanding the effects of internally generated missiles, and preventing missiles from impacting stored fuel assemblies.

3. Regulatory Guide 1.27, "Ultimate Heat Sink for Nuclear Power Plants" as related to the ultimate heat sink being capable of withstanding the effects of internally generated missiles.

III. RELATED SAFETY TOPICS AND INTERFACES

Review Areas Outside the Scope of this Topic

As stated previously, this review specifically excludes the following:

1. SRP Sections 3.6.1, "Plant Design for Protection Against Postulated Piping Failure in Fluid Systems Outside Containment" - This matter will be covered under Safety Topic III.5.B, "Piping Break Outside Containment."

2. SRP Section 3.6.2, "Determination of Break Locations and Dynamic Effects Associated with the Postulated Rupture of Piping" - This matter will be covered under Safety Topic III-5.A, "Effects of Pipe Break on Structures, Systems and Components Inside Containment."

3. Natural Phenomena - This matter will be covered under Safety Topics III-6, "Seismic Design Considerations" and III-4.A, "Tornado Missiles."

4. Turbine Missiles - This matter will be covered under Safety Topic III-4.B, "Turbine Missiles."

Interfaces with Other SEP Safety Topics

Satisfactory resolution of the following safety topics will depend, at least in part, on the satisfactory resolution of this topic:

1. Topic VII-3, "Systems Required for Safe Shutdown"

2. Topic VII-4, "Effects of Failure in Non-Safety Related Systems On Selected Engineered Safety Features"

3. Topic IX-1 "Fuel Storage"

4. Topic IX-3, "Station Service and Cooling Water System"

5. Topic II-3.C, "Safety-Related Water Supply (Ultimate Heat Sink)."

IV. REVIEW GUIDELINES

Systems and components needed to perform safety functions were identified as those listed in SRP Section 3.2.2, "Systems Quality Group Classification."

1. Systems needed to perform safety functions (safe plant shutdown or accident mitigations) are:

a. Reactor Coolant Pressure Boundary

b. Reactor Coolant Recirculation System

c. Low Pressure Coolant Injection and Containment Cooling System

d. Control Rod Drive Hydraulic System

e. Shutdown Reactor Cooling System

f. Core Spray

g. Main Steam System

h. Feedwater System

i. Isolation Condenser System

j. Reactor Building Closed Cooling Water System

k. Service Water and Emergency Water

l. Condensate Storage System

m. Ventilation Systems

n. Reactor Head Cooling System

o. Diesel Generator Auxiliary Systems

p. Standby Liquid Control System

q. Compressed Air System

r. High Pressure Coolant Injection System

2. Systems whose failure may result in release of unacceptable amounts of radioactivity:

a. Spent Fuel Pool Cooling and Cleanup System

b. Standby Gas Treatment Systems

c. Liquid Waste Processing System

d. Gaseous Waste Processing System

e. Reactor Water Cleanup System

3. Additionally, there are instrumentation and electrical items which are necessary to support safe shutdown operations. These items include the diesel generators, station batteries and DC distribution panels, 4KV/480V switchgears, and the main control room.

V. REVIEW AND EVALUATION

1. Systems Needed to Perform Safety Functions

a. Reactor Coolant Pressure Boundary

The reactor coolant pressure boundary, up to the containment isolation valves, is located in the reactor building. The portion of the reactor coolant system inside the drywell is completely enclosed by a six foot, six inch thickness of reinforced concrete. The reactor building walls enclosing the remainder of the reactor coolant system up to the outboard containment isolation valves are reinforced concrete 18 inches thick. These physical barriers offer protection against internal missile sources from other areas of the plant disabling safe shutdown systems inside of the drywell area and the reactor building.

The reactor vessel is a cylindrical vessel with a gasketed removable upper head. The vessel upper head is held in position by studs. It is extremely unlikely that any of these studs will become a missile because of the reactor head vent and main steam pressure relief valves. Therefore, these studs are not exposed to sufficient pressure to create an accelerating force sufficient to cause them to become missiles. Should the vessel be struck by a missile then no rupture is expected because the vessel shell wall thickness is greater than 6 inches of steel.

The thirteen pressure relief valves, which include five Automatic Blowdown System (ABS) valves, have the potential for becoming missile sources. All of the relief valves are mounted on the main steam lines. The positions of the pressure relief valves are such that if any parts blow off the relief valves, they would not strike and disable all of the redundant emergency core cooling systems, which include HPCI, LPCI, and Core Spray. Should one of these systems become damaged its redundant counterpart, which is routed on the opposite side of the reactor vessel would be available to shutdown the reactor.

A portion of the feedwater system does form a part of the reactor coolant pressure boundary and is a potential target of relief valve missiles. Should the feedwater system be disabled by a relief valve missile, its loss would be mitigated by:

(1) depressurization of the vessel thru the feedwater pipe rupture and/or the ABS.

(2) use of ECCS to obtain a safe shutdown condition after depressurization.

The loss of the main steam system, one train of LPCI, or one recirculation piping loop could be mitigated by the same method presented for loss of the feedwater system. The two trains of LPCI and the two recirculation piping loops are separated by distance and the reactor vessel itself. Therefore, only one train of LPCI or one recirculation loop is assumed impaired by an internal missile. The surviving train of LPCI is adequate to assure safe shutdown in the event of loss of main steam, one LPCI system, or a recirculation loop.

Instrumentation generally requires some penetration into the reactor coolant system. These penetrations are usually small and take the form of welded wells. The wells are not credible missiles but should one fail, it will not cause serious damage to the reactor coolant system or compromise its safety due to its orientation. The resulting opening (break) in the piping would be small and would be mitigated with the ECCS.

The possibility that potential missiles may also result from destructive overspeeding of one of the primary coolant pumps in the event of a pipe break in the pump discharge was also reviewed. Any potentially damaging impeller missile ejected from the pump would have its energy greately minimized by the massive steel pump casing. Hence, a primary pump missile would be much less severe than a missile created by one of the relief valves, which has already been shown to result in acceptable consequences. In summary, based on our evaluation, we conclude that the reactor coolant pressure boundary, because of its equipment design features, component arrangement, e.g., separation, and alternative methods to accomplish core cooling, will not be detrimentally affected considering internally generated missiles from the sources as identified above. However, should a missile create a break in the reactor coolant pressure boundary, the emergency core cooling system redundancy will keep the core cooled after vessel depressurization.

b. Recirculation System

The recirculation system consists of two separate pump loops and each loop is located at points approximately 180^{0} apart with the reactor vessel between them. The recirculation system contains several potential missile sources. These sources include two recirculation pumps, two pump suction isolation valves, two pump discharge isolation valves, and two ring manifold isolation valves. It is assumed that a missile generated from a recirculation loop will remove the loop and any of the target systems listed below. Further, it is assumed that the recirculation system is a target of the main steam pressure relief valves (see "Reactor Coolant Pressure Boundary").

The possible targets for missiles generated by the recirculation system are:

(1) Control Rod Hydraulic Units (east and west banks)

(2) Isolation Condenser Return

(3) Feedwater A or B

(4) ECCS

(5) Main Steam A or B.

If the control rod hydraulic units are lost by a missile, then the control rods will scram because of differential cooling water pressure. The plant can then be safely shutdown using engineered safe shutdown methods, e.g., Automatic Blowdown System (ABS), Control Rod Drive System and/or the Emergency Core Cooling System. The standby liquid control system also serves as a backup to the control rod hydraulic system.

For any of the other targets listed above, the reactor will scram in a normal manner. The reactor can then be safely shutdown by the vessel depressurizing through the postulated pipe ruptures (or by using ABS) followed by use of the ECCS.

Based on our evaluation we conclude that the recirculation system will not generate missiles that will preclude the plant from being safely shutdown.

c. <u>Low Pressure Coolant Injection (LPCI)/Containment Cooling System (CCS)</u>

The low pressure coolant injection system and containment cooling system are provided for the removal of shutdown heat from the reactor under both normal and various accident conditions. The LPCI/CC system includes two separate circulation loops. Each loop includes a heat exchanger, two main system pumps and associated valves, piping, and instrumentation. The two loops are cross-connected by a single header, but the header is valved so that if one loop is lost, then the other loop is not lost. The heat exchanger and the two main system pumps for each separate, cross-tied loop are located in separate rooms on elevation 476'-6" of the reactor building. Protection against potential missiles is provided by routing each loop piping along opposite reactor building structure walls as much as possible. Therefore, only one LPCI loop is subject to impairment by an internal missile from any single source.

The LPCI mode is redundant to the two 100% capacity loops of the core spray system. Since it is impossible for both core spray loops to be damaged by any internal missile (see item f) loss of a LPCI loop would not prevent safe reactor shutdown because one LPCI loop and a core spray loop would survive.

The LPCI system piping and valves are located in the reactor building and inside the drywell. The LPCI system is located on both sides of the reactor vessel, which makes it impossible for a LPCI missile to damage the LPCI piping associated with both loops.

However, LPCI generated missiles could impair:

(1) Main Steam Lines

(2) Feedwater Lines

(3) Recirculation Manifold or Risers.

The loss of one LPCI and any of the above targets can be mitigated by depressurizing the vessel through the postulated pipe rupture (or by ABS) followed by the use of the surviving ECCS train. Based on our evaluation, we conclude that the LPCI system will not generate missiles nor be struck by missiles from other sources that will preclude the plant from being safely shutdown.

d. Control Rod Hydraulic System

The Control Rod Hydraulic System furnishes the pressurized water for the CRD system for insertion and withdrawal of the reactor control rods. The control rod hydraulic units are located on elevation 517'-6" of the reactor building. The CRD valves are not considered to be missile generators and therefore, not capable of damaging safe shutdown equipment. The control rod hydraulic water supply pumps are enclosed and cannot interact with any shutdown systems.

Even if the control rod hydraulic system was damaged by an internal missile, the standby liquid control system serves as a backup reactor shutdown method, and is capable of making and holding the reactor core subcritical. Due to the physical arrangement of these two systems, an internal missile could not disable both systems.

e. Shutdown Reactor Cooling System

The Dresden Unit 2 shutdown reactor cooling system is utilized during normal shutdown and it is activated when the reactor vessel is cooled below $350^{o}F$. The shutdown reactor cooling system has three loops and each loop contains a heat exchanger. Essential shutdown cooling equipment outside the drywell is located in separate rooms, thereby, preventing the possibility of missiles affecting redundant loops. Inside the drywell, the two suction and injection lines are connected to the reactor recirculation system at points 180^{o} apart.

If a missile damaged one of the shutdown cooling system loops, the remaining two loops are adequate to cool the reactor. Also, the isolation condenser system and the ECCS can cool the reactor in a safe manner.

f. Core Spray

The core spray system is not normally operating and its loss would not result in a demand on that system nor impair safe shutdown. In addition, the LPCI system serves as a backup to the core spray system function. Further, there are two independent core spray systems routed on opposite sides of the plant. Each core spray system has a 100% capacity pump and the two pumps are located in separate pump cubicles in the reactor building. Missiles generated by one core spray pump would not affect the other pump. There is a cross-tie between the two core spray loops at elevation 517'-6" however, the access valves between the loops are located in each pump cubicle. Therefore, no one missile can damage the cross-tie so that both core spray loops are rendered inoperable. As stated before, the LPCI system is redundant to the core spray system.

g. Main Steam

The main Steam System is contained in the drywell, steam tunnel, and turbine building. This system consists of four, 20-inch steam lines, which carry steam from the reactor vessel to the turbine generator. Four inboard isolation valves are located inside the drywell and four isolation valves are located outside the drywell. The four, 20 inch headers expand into four 24 inch lines outside containment.

Within the drywell, missiles could be generated from either the pressure relief valves or main steam isolation valves. A missile from these sources could disable either the feedwater, reactor water cleanup system, LPCI, main steam, core spray, or recirculation piping.

Loss of the main steam and feedwater systems can be handled by depressurizing the vessel thru the pipe rupture and then using ECCS and the ABS system, if necessary.

Loss of the main steam and a LPCI system or recirculation piping could be mitigated by vessel depressurization via the pipe rupture (or ABS system) and then using the surviving train of LPCI.

Loss of either the core spray or reactor water cleanup system is discussed in item 'f' and 'k' and, has been shown that it would not prevent the reactor from being safely shutdown.

A missile generated by the main steam system outside of the drywell would remain confined within the walls of the steam tunnel. The licensee stated that there is a possibility that a main steam system missile could impair the HPCI system injection line. However, the redundant ECCS lines would be unaffected, viz., core spray, LPCI and ABS. A main steam line missile in the turbine building would not affect safe shutdown of the plant.

Based on our evaluation we conclude that missiles generated by the main steam system, will not preclude the plant from being safely shutdown, and therefore, is acceptable.

h. Feedwater Coolant Injection

The feedwater coolant injection system consists of three reactor feed pumps. Only two pumps are required for normal operations with the third pump serving as a standby.

Inside containment, the only missile source from the feedwater system would be from the reactor vessel isolation valves. The potential targets would include HPCI, core spray, LPCI, main steam piping and isolation valves, and the recirculation pump and suction piping. All possible interactions are discussed in other sections of this report, e.g., "Core Spray", "LPCI," etc. Therefore, in the event of a feedwater system missile generated inside of containment, the reactor can be safely shutdown.

Outside of containment, the feedwater system pumps are physically separated and isolated in their own cubicles in the turbine building. Therefore, a pump generated missile would not affect other safety systems.

Should the feedwater system be disabled by an internal missile from another source, then the loss of the feedwater system would be mitigated by:

(1) depressurization of the vessel thru the feedwater system rupture and/or the Automatic Blowdown System.

(2) use of ECCS to obtain a safe shutdown condition after depressurization.

i. Isolation Condenser

The isolation condenser system is located inside the drywell and in the reactor building. It is a passive heat sink auxiliary unit used to provide reactor core cooling in the event that the reactor is isolated from the main condenser.

Inside the drywell, the source of potential missiles from the isolation condenser are the isolation valves. The only target is the recirculation loop B piping. With the loss of both the loop B recirculation piping and the isolation condenser system, the vessel will depressurize through the pipe rupture. Safe shutdown is then accomplished via the ECCS A train.

Outside containment, the isolation condenser piping is located in areas containing no high pressure systems or the equipment is physically separated from the main steam system, feedwater system, and ECCS piping and components by concrete walls. Hence a missile generated from this portion of the isolation condenser can have no affect on these systems and therefore, safe shutdown of the plant is not in jeopardy.

j. High Pressure Coolant Injection (HPCI) System

The HPCI system is a standby safety system used to mitigate a LOCA or reactor isolation in conjunction with failure of the isolation condenser cooling system. The HPCI is located in the turbine building and consists of a turbine, booster pump, main pump, and piping, valves, and instrumentation.

The pumps and turbine are located in a separate, reinforced concrete enclosure. Therefore, any sources of missiles within the reactor building will not damage HPCI and vise versa. In the event that the HPCI system was disabled by a missile, the plant can be safely shutdown using ABS and LPCI.

k. Other Systems That Are Passive Relative to Safe Shutdown

The following systems were listed by the licensee as being needed to perform safety functions:

(1) Reactor Building Closed Cooling Water System
(2) Service Water System
(3) Condensate Storage System
(4) HVAC Systems and the Control Room Ventilation System

(5) Reactor Head Cooling

(6) Compressed Air System

(7) Emergency Diesel Generator Auxiliary Systems

(8) Standby Liquid Control System

The licensee stated that these systems are either well isolated by barriers or they are not required to accomplish safe shutdown in the event of their loss. Further, the above systems are either low energy or normally not operating and, therefore, not capable of generating missiles. For the purpose of completeness we have listed these systems which were identified by the licensee as systems needed to perform safety functions. We have reviewed the above systems and conclude that these systems either; do not pose a missile hazard to safe shutdown systems, are well isolated by plant structures, or are not needed for safe shutdown.

2. Systems Whose Failure May Release of the Unacceptable Amounts of Radioactivity

a. Spent Fuel Pool Cleanup System

The spent fuel pool cooling system removes residual heat from the spent fuel stored in the pool. The spent fuel pool cooling system is designed to clarify the pool water and to remove the residual heat produced by the stored spent fuel elements while maintaining the pool water temperature at or less than 125^{o}F. The spent fuel pool cooling system is a one train system and consists of two cooling pumps and two heat exchangers, a filter, surge tanks, and associated piping and valves. The spent fuel pool pump draws water from the pool, circulates it through the heat exchangers, and returns it to the pool. Service water cools the spent fuel pool heat exchangers.

The spent fuel cooling system is a low energy system, therefore, it will not generated missiles. Each cleanup filter and demineralizer is located in a separate cubicle surrounded by concrete walls. Missiles generated by other systems could not penetrate these walls and damage these components. Therefore, there is no possibility of radiation release.

The pumps and heat exchangers are protected from missiles due to their compartmentalization. Should the equipment become inoperable due to missile damage, there is sufficient time to effect repairs or arrange for alternate cooling such as fire hoses or to take suction from the skimmer surge tanks.

In our judgement, missile damage to this system will not result in significant radiological consequences.

b. Standby Gas Treatment System (SGTS)

The standby gas treatment system is provided to prevent ground level escape of airborne radioactivity from the reactor building under isolation conditions and to remove radioactive particulates and halogens from exhaust gases when a high radiation condition exists. The SGTS is a two train system and each train is separated by concrete walls. Therefore, SGTS generated missiles are contained, e.g., fan failure.

Since the standby gas treatment system is not normally operating, separated from the offgas system, and, finally, not required for safe shutdown, then should it be impaired by an internally generated missile, safe shutdown of the plant is not in jeopardy.

c. Liquid Waste Processing System

The liquid radwaste system collects, treats, stores, and disposes of all the radioactive liquid waste.

The liquid waste system is a low energy system and is not capable of generating a missile and it is enclosed by concrete walls. Therefore, it is not a target for other missile sources. However, should this system be impaired by a missile, then any leakage will be contained by the radwaste building sufficiently to allow for cleanup and repair. We conclude that failure of this system will not result in significant radiological consequences.

d. Gaseous Waste Processing System

The principal source of radioactive gas is the condenser air ejector effluent. This gas enters the offgas system where it is delayed from 30 minutes to allow decay of short live isotopes. The gas is then discharged thru HEPB filters.

The licensee stated that the offgas system has already been analyzed for failure and shown to result in doses that are a small fraction of 10 CFR Part 100 guidelines. That analyses stated that radioactivity in the offgas or containment purge would be detected by the stack monitors and diverted to the standby gas treatment system. Radioactive releases into the reactor building will be handled by the standby gas treatment system. Breaks in either the offgas or containment purge systems outside the reactor building can be isolated by isolation valves inside the reactor building. We conclude that the offgas and containment purge system can perform their functions safely given internally generated missiles.

e. Reactor Water Cleanup (RWC) System

The RWC system is not required for safe shutdown. The major components of the RWC system are completely separated from other shutdown systems by concrete walls. Therefore, internal missiles generated by other systems will not effect the RCW system. The high pressure suction and injection lines are not enclosed by these concrete walls, but they are routed in such a way as to prevent a missile originating from the RWC system from damaging other equipment. Therefore, internal missiles generated by these RWC lines will not endanger any systems required for safe shutdown.

3. Electrical Systems Which Are Necessary to Support Those Fluid Systems Needed to Perform Safety Functions

a. Diesel Generators

The onsite diesel generators have adequate capacity to serve as emergency electrical power source. The diesel generators and their fuel sources are located in separate reinforced concrete cells. Therefore, any missiles generated by the diesel generator would not impair safe shutdown systems.

Since the emergency diesel generators are physically and structurally separated so that internally generated missiles cannot disable safe shutdown systems and, since these systems are normally not operating, we conclude, based on our evaluation, that the emergency diesel generators will not generate a missile event such that safe-shutdown of the plant is in jeopardy.

b. Station Batteries and D.C. Distribution Panels

A total of three station battery systems (250V, 125V and 24/48V) are provided. One 250V battery is provided to serve the larger loads such as d-c motor driven pumps and valves. One 125V battery is provided to supply the power required for exit emergency lighting and all d-c control functions such as that required for control of the 4KV breakers, 480V breakers, various control relays and annunciators. Two 24/48V batteries are provided to supply the neutron monitoring system.

The Unit 2 batteries and d-c distribution panels are located above the control room at elevation 549'-0". The batteries are located in rooms having concrete block walls with each battery further protected by an angle iron rack enclosure. The concrete block barriers provide the battery systems with protection against internal missiles generated from other systems.

Because of their low energy and mass, we do not consider the station batteries to be a credible source of missiles. Further, an internally generated missile would not impair both divisions of the station batteries. Based on our evaluation, we conclude that the station batteries are adequately protected and or separated to preclude damage by an internally generated missile.

c. 4160V and 480V Switchgear

The safety-related electrical loads are split between two essential divisions consisting of 4160V and 480V switchgear. A pair of 4160V switchgear, are located on the south side reactor building at elevation 545'-6 and a second pair are located on elevation 534'-6" near the control room. There are two 480 volt switchgear located on the south side of the reactor building at elevation 570'-0". The 480V switchgear provides the electrical power for operation of all auxiliaries up to and including 200 hp in size.

The only potential missile source located near the 4160V, 480V switchgears are the intake and return lines of the isolation condenser. These lines are located behind concrete walls and therefore pose no danger to the switchgear.

Location of the motor control centers in the plant would make it impossible for one missile to destroy more than one electrical division of MCC's.

d. Control Room

The control room is located at the east end of the turbine building. There are no potential missile sources internal to the control room which could damage the control room. The control room boundary is protected by reinforced concrete walls which provide protection from potential missile sources outside the control room.

VI. CONCLUSIONS

Based on our review of the systems and components needed to perform safety functions, we conclude that the design of protection from internally generated missiles meets the intent of the criteria listed in Section II - REVIEW CRITERIA.