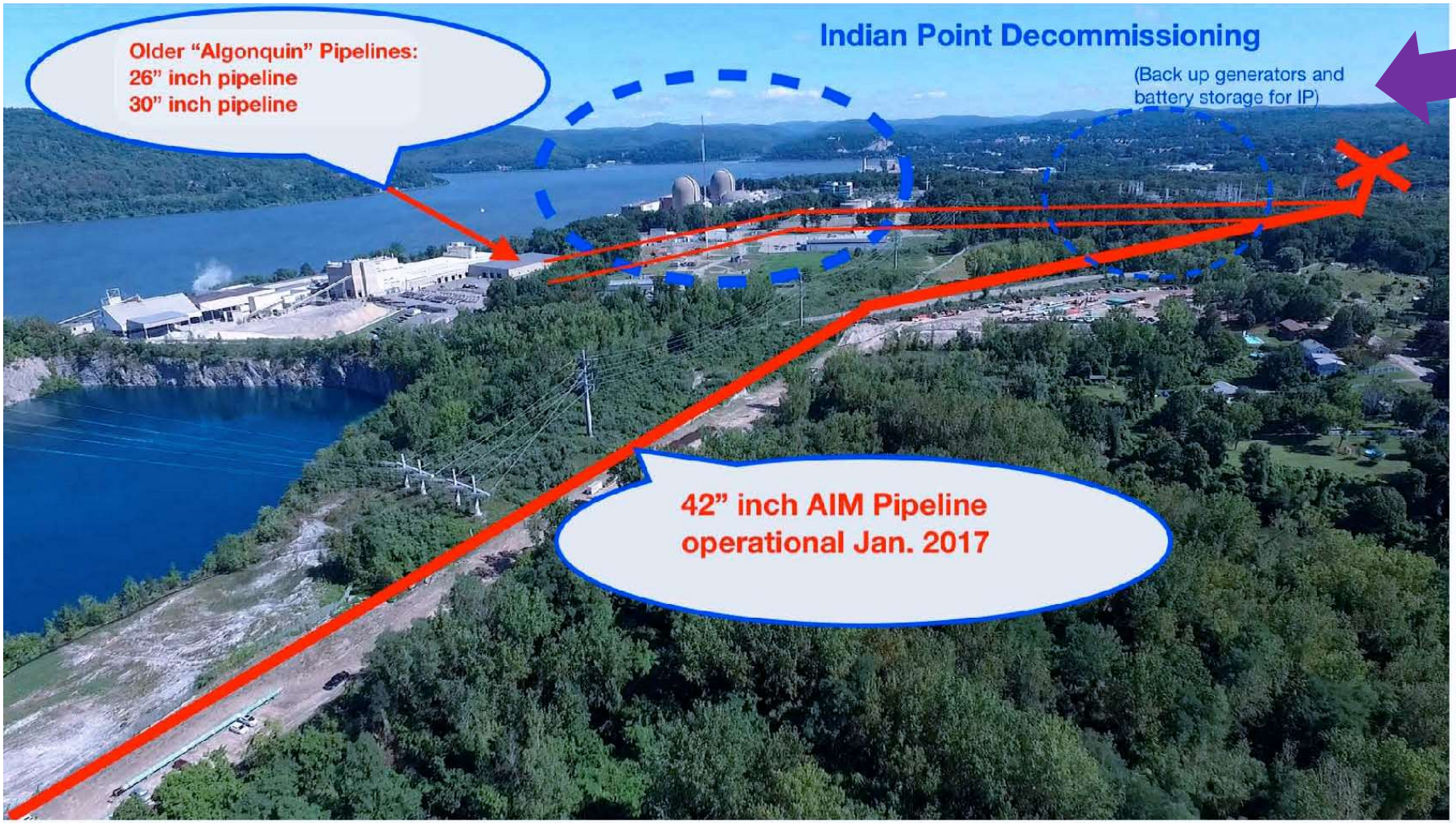
Loss of Power Risk During Indian Point Decommissioning

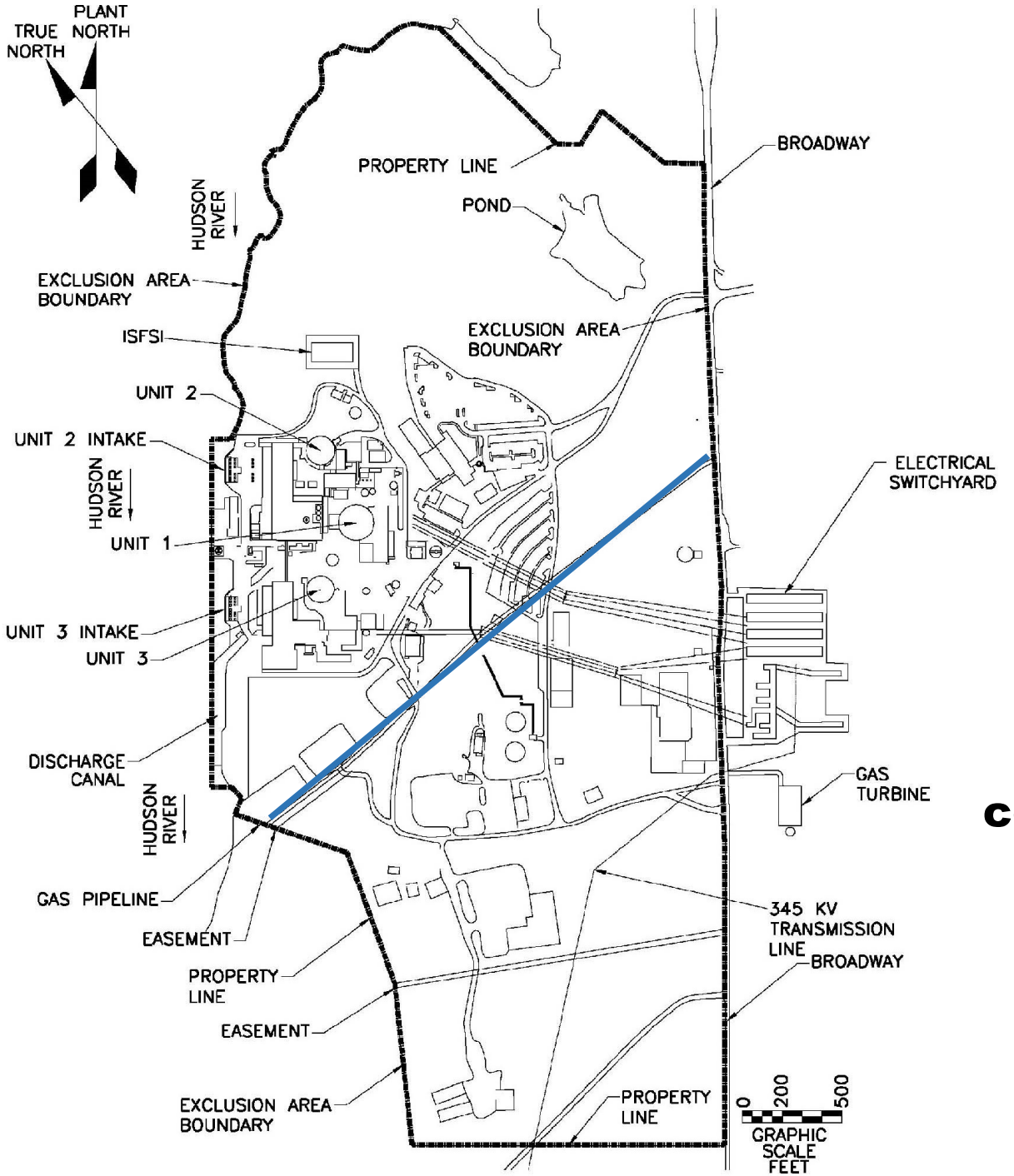
Dave Lochbaum
September 2022

The New York State Department of Public Service provided very helpful and much appreciated feedback on the initial draft of this evaluation.

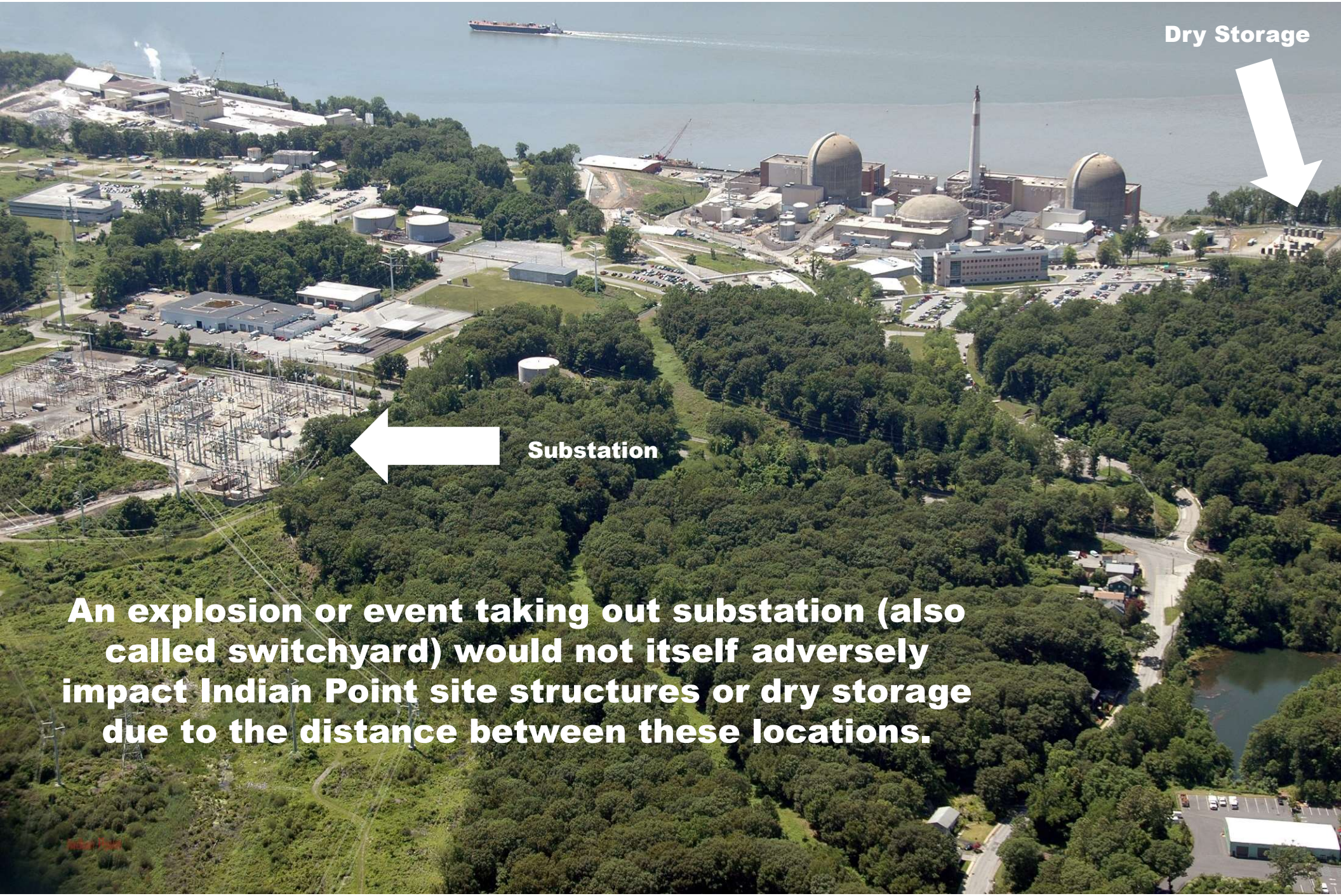


CO-LOCATION OF INDIAN POINT AND AIM PIPELINES

During a presentation during the Indian Point Closure Task Force/Decommissioning Oversight Board meeting on September 22, 2022, Tina Volz-Bongar expressed concern about the potential impact on nuclear safety if a pipeline event took out power supplies to the site.



The substation (switchyard) located across Broadway from the site has multiple transmission line connections to the offsite electrical power grid.



An explosion or event taking out substation (also called switchyard) would not itself adversely impact Indian Point site structures or dry storage due to the distance between these locations.

Report of the U.S. Nuclear Regulatory Commission
Expert Evaluation Team on Concerns Pertaining to
Gas Transmission Lines Near the Indian Point Nuclear Power Plant

April 8, 2020

The team determined that, even though Entergy (the plant owner) and the NRC made some optimistic assumptions in analyzing potential rupture of the 42-inch natural gas transmission pipeline, the Indian Point reactors remain safe. The team drew two key conclusions related to this statement.

- **A rupture of the newly installed 42-inch natural gas transmission pipeline that runs near Indian Point is unlikely.** This pipeline was installed using modern techniques, stringent quality standards, and construction precautions that limit the likelihood of later pipeline damage. This stretch of pipeline was designated as a high consequence area under Department of Transportation requirements, meaning that additional inspection, integrity threat assessment, pipe remediation, and documentation requirements apply. Given the remaining operating life of Units 2 and 3 (mere weeks to a year, respectively), the risk of a pipeline rupture affecting the reactor units is very small.
- **If a rupture occurred on the stretch of 42-inch pipeline near Indian Point, the nuclear power plant would remain protected.** The plant's safety systems are all far from the pipeline. They are two or more times the "potential impact radius" that the U.S. Department of Transportation designates for protecting people from pipeline ruptures and also far outside the distance where heat flux would be high enough to affect wooden structures, let alone the robust concrete structures that house the plant's safety equipment.[1] The potential impact radius bounds most pipe rupture impacts observed in real-life accidents. In a more detailed transient analysis, the team found that the robust concrete structures housing the plant's safety-related equipment, spent fuel pool, and dry fuel storage containers would withstand the heat and pressure impacts of an explosion or fire that could follow a pipeline explosion. The safety-related equipment would be able to safely shut down the reactors and maintain them in a safe shutdown condition. Equipment or structures outside these buildings could be affected, but these serve as backups or alternatives to the safety-related equipment. The team also conducted a risk assessment to consider the uncertainties of the events that could unfold at Indian Point and found that the risk of serious consequences from a postulated pipeline rupture was very small.

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Using this formula for the 42-inch, 850-psig gas pipeline at Indian Point results in a potential impact radius of 845 feet. Doubling this number results in an expanded impact radius of 1,690 feet. This radius would extend into the SOCA; however, it would not impact any safety-related structures.[60]

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These methods of analysis give the team confidence that the robust concrete structures housing safety-related equipment inside the Indian Point SOCA, over 2,300 feet from the 42-inch AIM pipeline, would continue to function to safely shut down the plant and maintain it in a safe state. Therefore, a jet or cloud fire would not be expected to affect safe shutdown of the Indian Point reactors.

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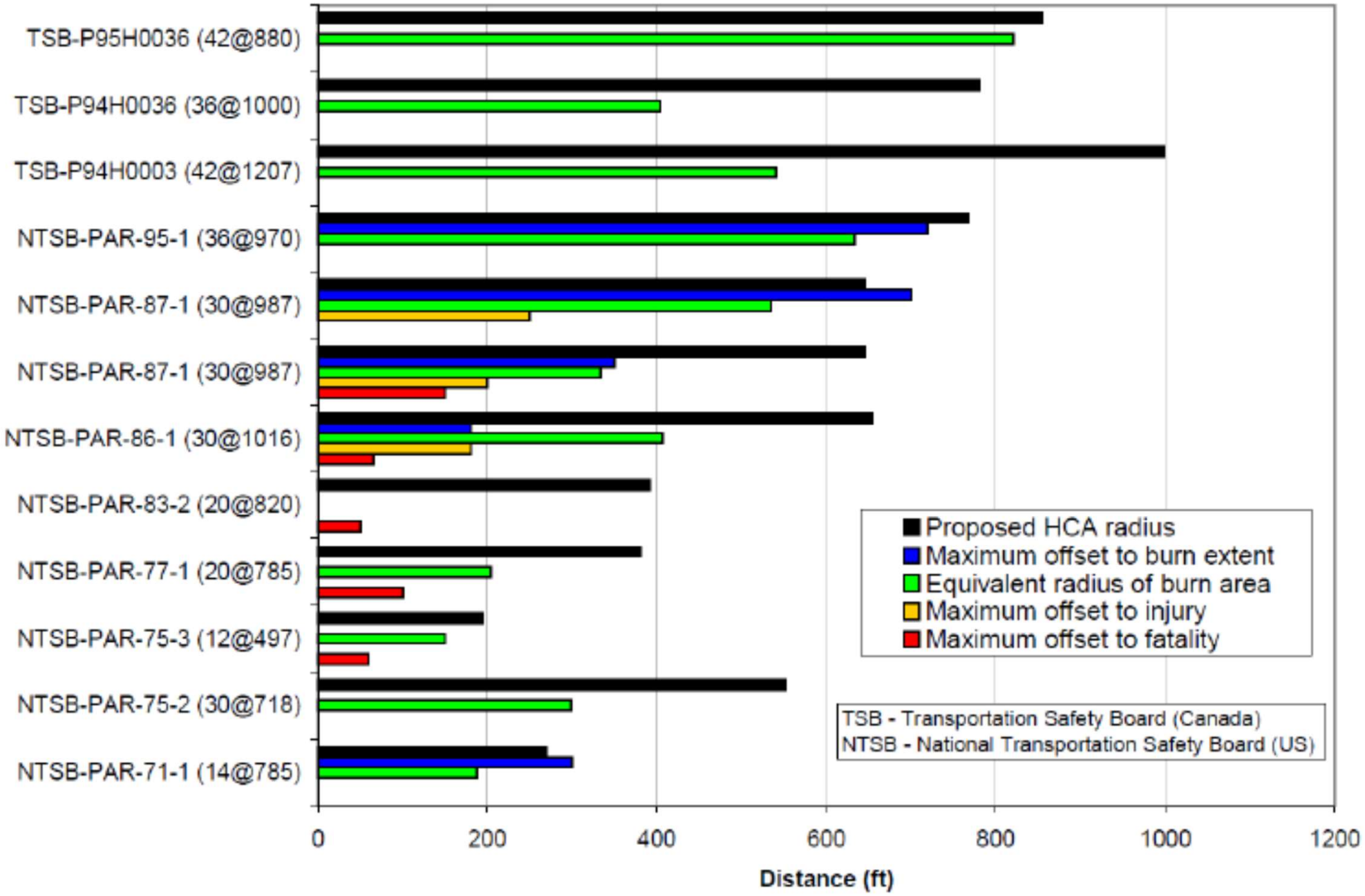
The NRC team reviewing the 42-inch pipeline following a critical report by the NRC's Inspector General of the agency's initial assessment found no nuclear safety threat.

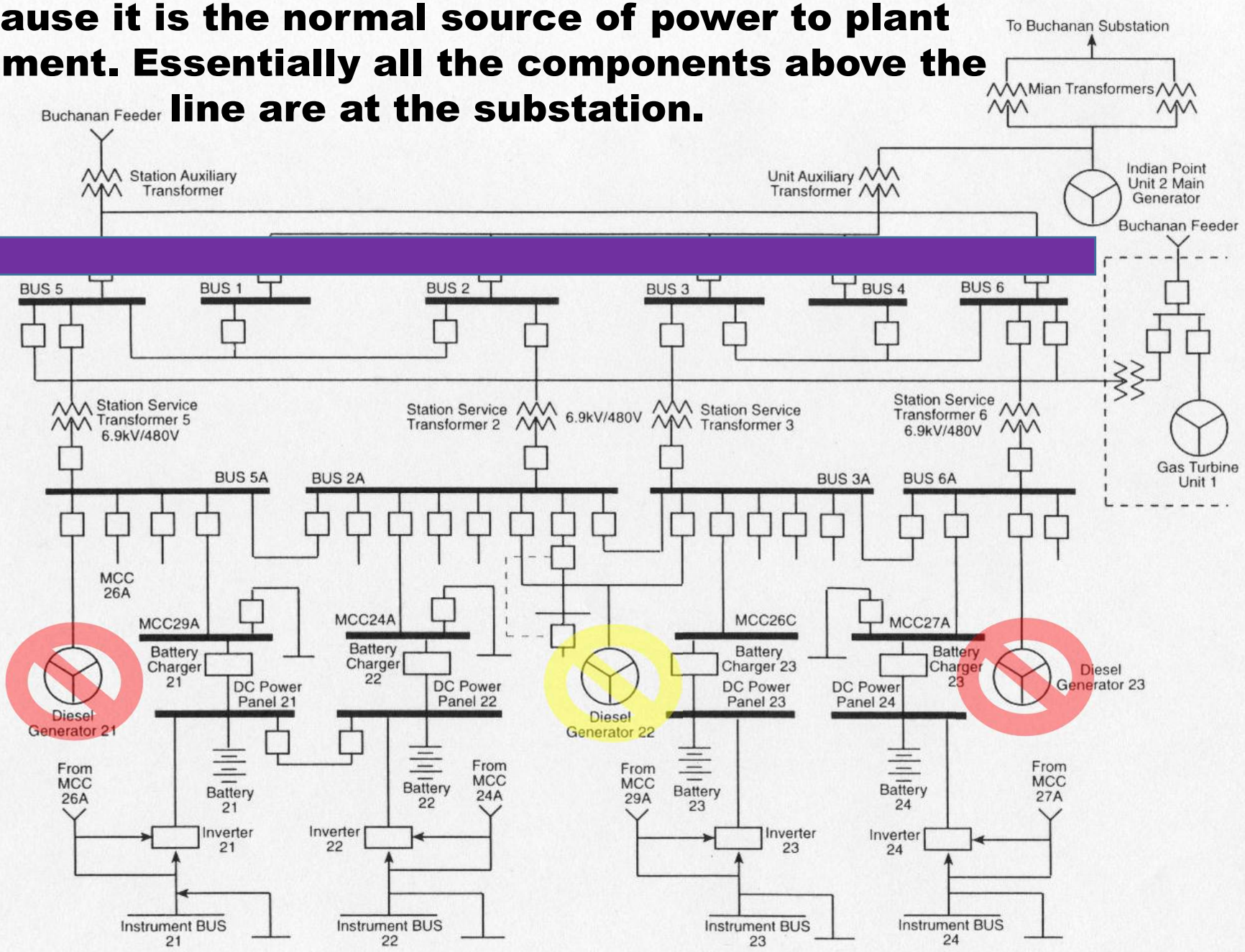
Source: ML20100F635



The 42-inch pipeline is at least 1,580 feet from the Indian Point protected area (security fence), beyond the danger zones of past pipeline events.

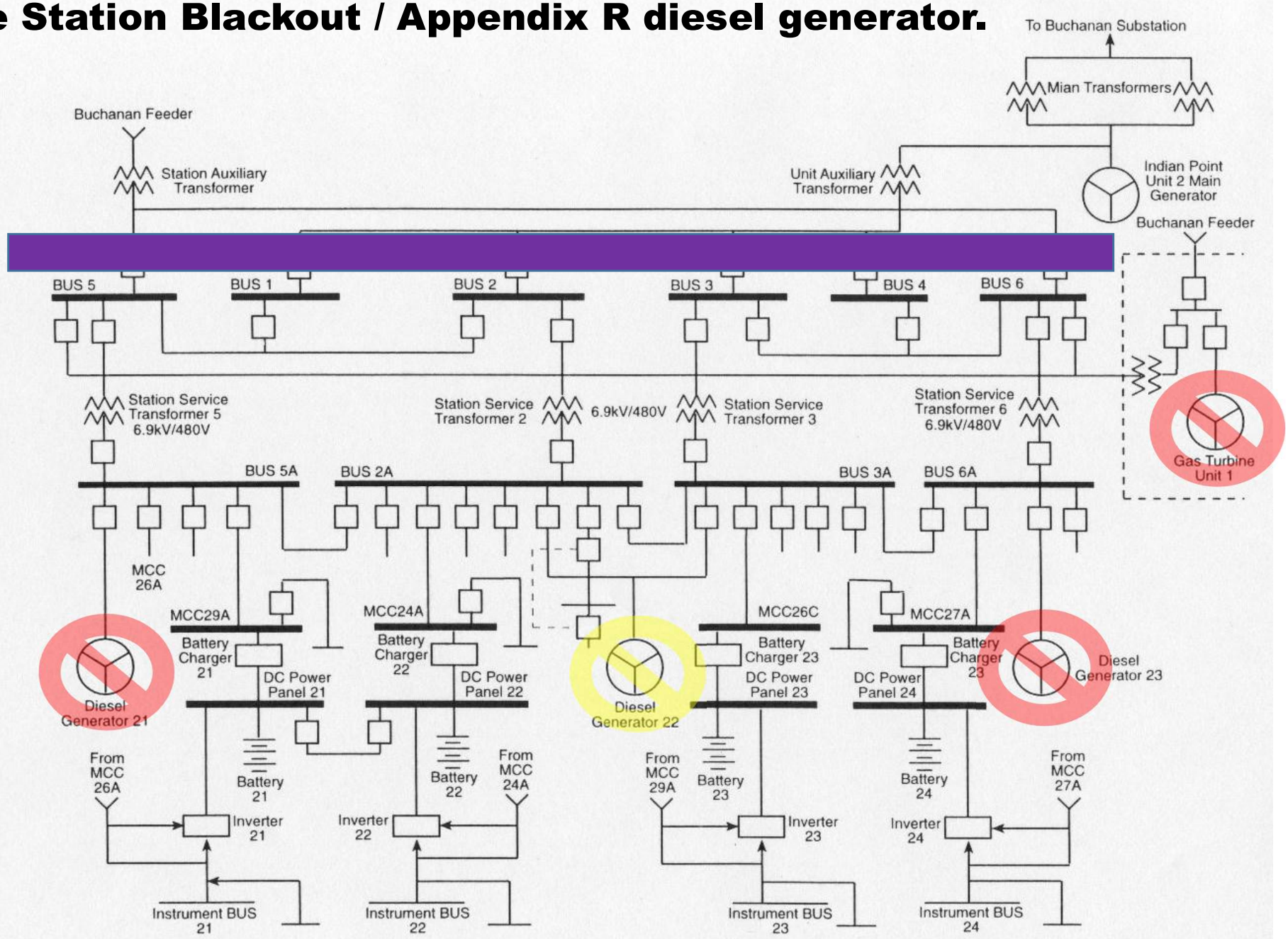
Source: ML20100F635
Figure 8

Loss of the substation could indirectly affect safety because it is the normal source of power to plant equipment. Essentially all the components above the line are at the substation.



The emergency diesel generators are no longer required for the shutdown reactors. EDG 22 (and EDG 33 on Unit 3) are being kept available as backup.

In 2008, the role of the Gas Turbines was replaced by the Station Blackout / Appendix R diesel generator.



Source: ML090410062

The SBO / App R diesel generator is below the line, but not shown on this schematic.

IP2 DEFUELED SAFETY ANALYSIS REPORT

SBO / Appendix R Diesel Generator and Electrical Distribution System
TRM 3.8.B

3.8 ELECTRICAL POWER

3.8.B SBO / Appendix R Diesel Generator and Electrical Distribution System

TRO 3.8.B The SBO / Appendix R Diesel Generator and Electrical Distribution System shall be FUNCTIONAL

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. SBO / Appendix R diesel generator is NON-FUNCTIONAL.	A.1 Restore the SBO / Appendix R diesel generator to FUNCTIONAL status.	30 days

Unit 2 and Unit 3 each have an SBO/App R diesel generator that is required at all times. An SBO/App R diesel generator can be out-of-service (a.k.a. broke) for up to 30 days. The Unit 2 SBO/App R diesel generator can supply power to Unit 3, and vice-versa.

Source: ML20259A213

Loss of Spent Fuel Pool Cooling Event

If power from the offsite grid is lost and the Unit 2 SBO/App R diesel generator is unavailable and EDG 22 is unavailable and EDG 33 is unavailable and the Unit 3 SBO/App R diesel generator is unavailable, the systems cooling the Unit 2 and Unit 3 spent fuel pools stop performing that function.

Calculations show that it would take 41 hours for the Unit 2 spent fuel pool to reach boiling and 36 hours for the Unit 3 spent fuel pool to boil. (As time passes and fission byproducts radioactively decay, the time-to-boil lengthens.)

Spent fuel is protected from overheating damage even if the water is boiling as long as the level is above the top of the fuel. Until power and cooling is restored, workers can prevent spent fuel damage by adding makeup water to the pool to compensate for boil-off losses. Fire trucks with their diesel-powered pumps and hoses can supply the needed makeup flow.

Table 2-1 – IP2 DBAs

UFSAR Section	Postulated Accident or Transient	Defueled Applicability
14.1.1	Uncontrolled Rod Cluster Control Assembly Withdrawal from a Subcritical or Low Power Startup Condition	Not Applicable
14.1.2	Uncontrolled Rod Cluster Control Assembly Bank Withdrawal at Power	Not Applicable
14.1.3	Incorrect Positioning of Part-Length Rods	Not Applicable
14.1.4	Rod Cluster Control Assembly Drop	Not Applicable
14.1.5	Chemical and Volume Control System Malfunction	Not Applicable
14.1.6	Loss of Reactor Coolant Flow	Not Applicable
14.1.7	Startup of an Inactive Reactor Coolant Loop	Not Applicable
14.1.8	Loss of External Electrical Load	Not Applicable
14.1.9	Loss of Normal Feedwater	Not Applicable
14.1.10	Excessive Heat Removal Due to Feedwater System Malfunctions	Not Applicable
14.1.11	Excessive Load Increase Incident	Not Applicable
14.1.12	Loss of all AC Power to the Station Auxiliaries	Not Applicable
14.1.13	Likelihood and Consequences of Turbine-Generator Unit Overspeed	Not Applicable
14.2.1	Fuel-Handling Accidents	Applicable
14.2.1.1	Fuel-Handling Accident in Fuel-Handling Building	Applicable
14.2.1.2	Refueling Accident Inside Containment	Not Applicable
14.2.1.3	Fuel Cask Drop Accident	Applicable - Deemed to not be Credible – See discussion in (1) below
14.2.2	Accidental Release-Recycle of Waste Liquid	Applicable – Dose dependent on volatilized components and is addressed in Section 14.2.3
14.2.3	Accidental Release - Waste Gas	Applicable
14.2.4	Steam-Generator Tube Rupture	Not Applicable
14.2.5	Rupture of a Steam Pipe	Not Applicable
14.2.6	Rupture of a Control Rod Mechanism Housing - Rod Cluster Control Assembly Ejection	Not Applicable
14.3	Loss-of-Coolant Accidents	Not Applicable
14.4	Anticipated Transients Without Scram	Not Applicable

(1) Section 14.2.1.3 of the IP2 UFSAR states:

"As discussed in Section 9.5.6.4, Control of Heavy Loads Program, and Section 9.5.7.1, FSB 110-Ton Ederer Single Failure Proof Gantry Crane, the IP2 fuel storage building spent fuel cask handling operations are now conducted using a single-failure-proof 110-Ton Ederer Gantry Crane that conforms to the requirements in NUREG-0554 (Single-Failure-Proof Cranes for Nuclear Power Plants, May 1979). The Ederer Gantry Crane performs spent fuel cask handling activities without the necessity of having to postulate the drop of a spent fuel cask. With the Ederer crane's 110-ton main hoist qualified as single-failure-proof, the crane is used as part of a single-failure-proof handling system for critical lifts as discussed in Revision 1 of

Entergy submitted the Permanently Defueled Technical Specifications to the NRC identifying the reduction in number of Design Basis Accidents (DBAs) due to the permanent cessation of reactor operations and permanent removal of fuel from the reactor vessel.

In the defueled condition, many accidents can no longer occur and therefore their risk no longer needs to be managed.

Source: ML19105B241

Entergy

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Anthony J. Vitale
Site Vice President

10 CFR 50.71(e)

NL-20-066

September 14, 2020

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: Indian Point Unit No. 2 10 CFR 50.71(e) Submittal

Indian Point Nuclear Generating Unit No. 2
Docket No. 50-247
Renewed Facility License No. DPR-26

Entergy submitted the Defueled Safety Analysis Report to the NRC identifying the hazards remaining during decommissioning.

Source: ML20259A199

Three postulated accidents after permanent shutdown and removal of fuel from the reactor vessel were analyzed:

1. **Fuel handling accident involving fuel movement until all the spent fuel has been transferred into dry storage.**

2. **Inadvertent release of radioactive gas.**

3. **Drop of a high integrity container (HIC) filled with radioactive resins.**

Source: ML20259A199 Chapter 6

Fuel Handling Accidents

1. **Fuel handling accident in fuel storage building**

   The accident postulates damage to a spent fuel assembly being moved underwater in the spent fuel pool when the Fuel Support Building ventilation fan is not running to dissipate the radioactivity released.

   Assuming the accident happens 30 days after removal from the reactor core and all the fuel rods in the assembly are damaged, the total dose at the exclusion area boundary is 0.47 Rem, below the 1.0 Rem Protective Action Guideline for evacuation/sheltering.

   Because fuel was removed from the reactor core considerably longer than 30 days ago, the dose at the boundary would be considerably less than 0.47 Rem if the accident were to occur today.

Source: ML20259A199 Chapter 6

Fuel Handling Accidents

1. **Fuel cask drop accident**

   The accident postulated a fully loaded cask dropping from 5 feet above the spent fuel pool water surface to the bottom of the 43-feet deep pool.

   The estimated radiation dose to onsite workers and offsite members of the public would be less than for the fuel handling accident in the fuel storage building.

   As noted in an earlier slide, the fuel cask drop accident was evaluated even though considered non-credible due to use of single-failure proof cranes (i.e., loss of power or failure of brakes, etc. cannot result in a cask being dropped).

Source: ML20259A199 Chapter 6

Inadvertent Release of Radioactive Gas

The accident postulated rupture of a Waste Gas Decay Tank containing 50,000 Curies of Dose-Equivalent Xenon-133 without crediting the auxiliary building ventilation system or any other system for mitigating the release.

The estimated total dose at the exclusion area boundary was estimated to be 0.30 Rem, below the 0.50 Rem limit.

With cessation of reactor operation, the production of radioactive gas was also curtailed. Little to no waste gas remains onsite to be released inadvertently (or advertently).

A separate analysis of the inadvertent release of radioactive liquid was not performed because its consequence would be less than from a gas release.

Source: ML20259A199 Chapter 6

Drop of a High Integrity Container (HIC)

The accident postulated dropping a HIC onto another HIC with the contents of both breached canisters being engulfed in a fire that aerosolizes the material.

The estimated total dose at the exclusion area boundary was estimated to be 0.47 Rem, below the 0.50 Rem limit.

Source: ML20259A199 Chapter 6

Entergy

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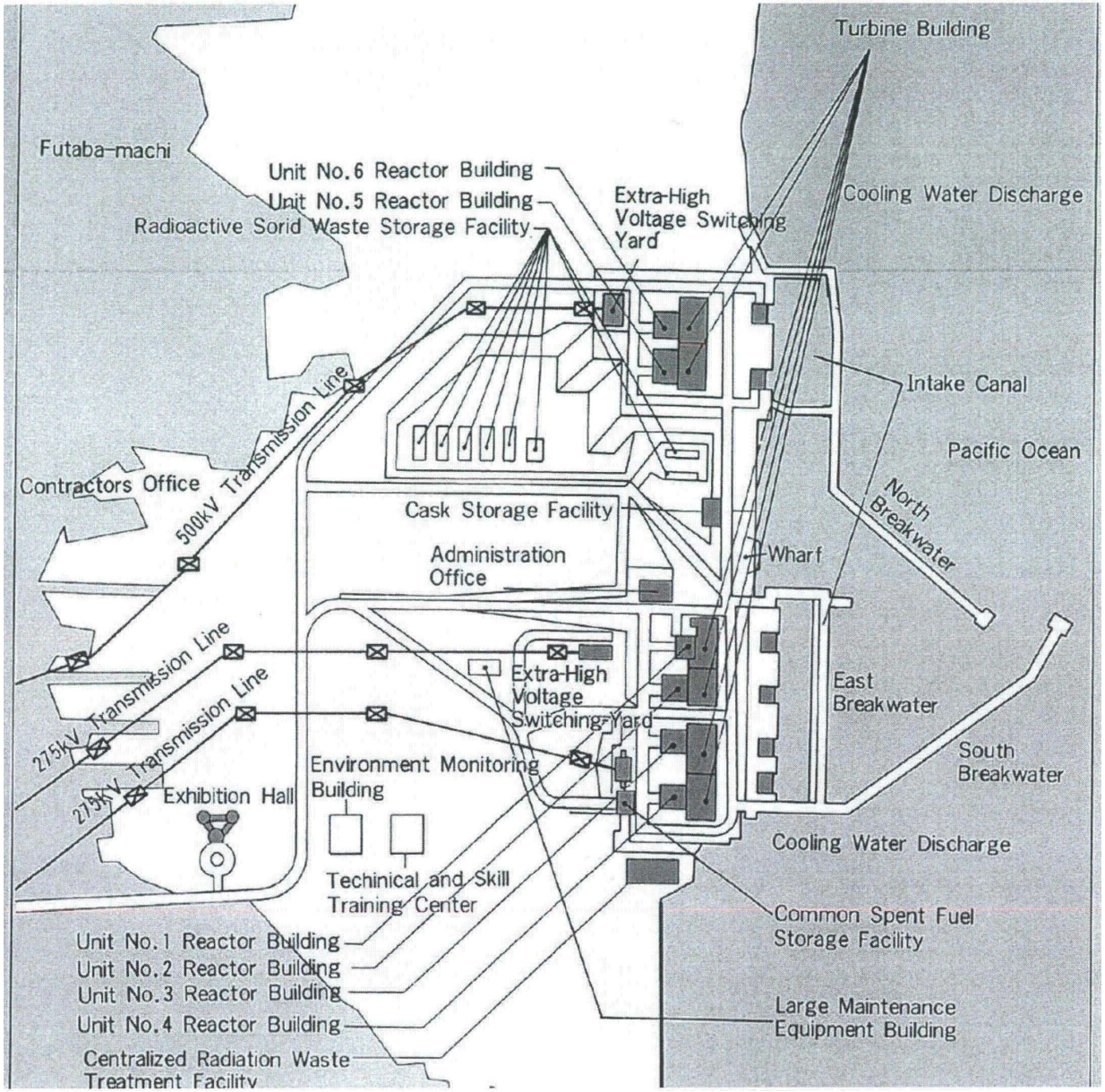
Renewed Facility License No. DPR-26

A pipeline event taking out the substation should not cause one of these accidents. But even if it did, the consequences would not require evacuation or sheltering of the public.

Fukushima's Loss of Power and Consequences



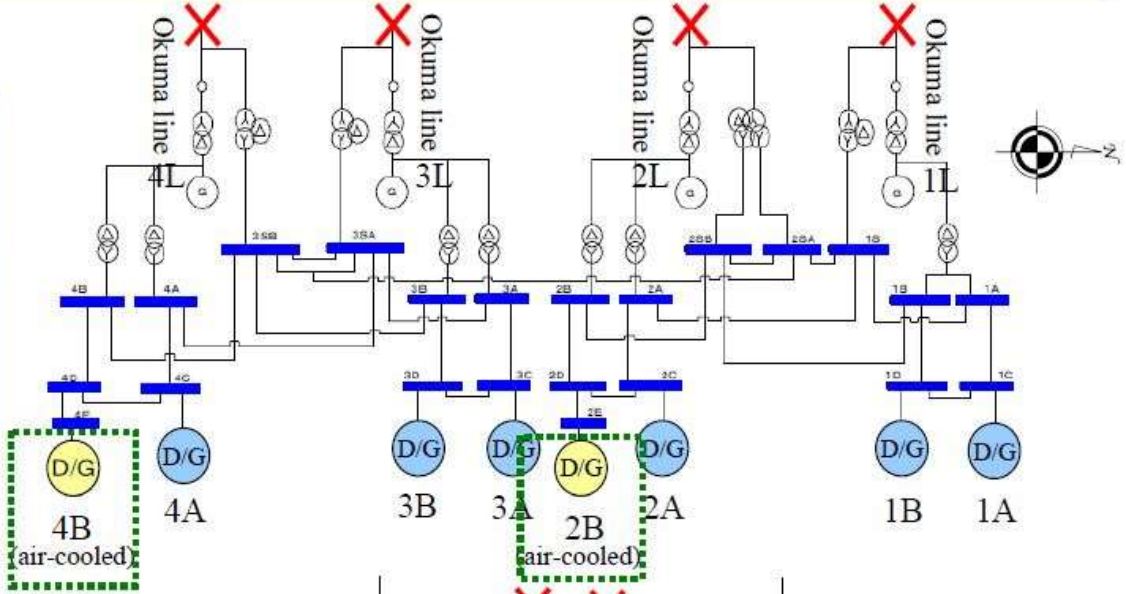
On March 10, 2011, the Fukushima Daiichi nuclear plant in Japan had three operating reactors, three reactors shut down for outages, seven spent fuel pools, and over 400 spent fuel assemblies in dry casks.

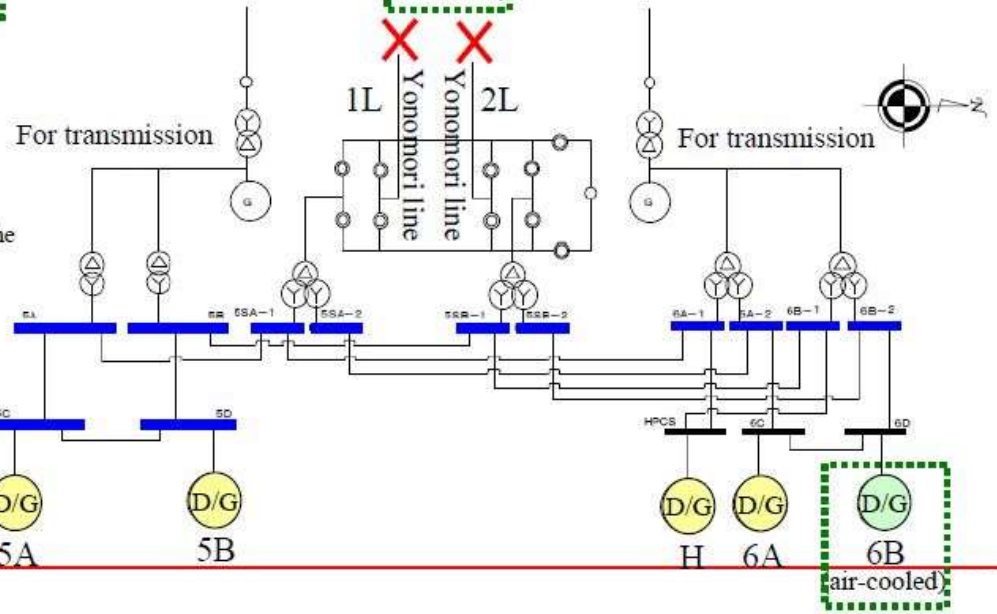
Like Indian Point, Fukushima had three tiers of power supplies: (1) offsite power grid, (2) onsite emergency diesel generators, and (3) batteries sized to last at least 8 hours. It was assumed that offsite power would be restored or an onsite diesel generator fixed within those 8 hours.

Damage to Fukushima Daiichi (Power supply)

Damage to emergency diesel generators（ D/G）

- All emergency D/Gs in Units 1 to 5 were stopped and resulted in AC power loss.
- One air-cooling emergency D/G in Unit 6 could continue its operations and the power supply was maintained.





: Shut down due to effects of the earthquake

: Power panel was damaged or submerged due to the effects of the tsunami

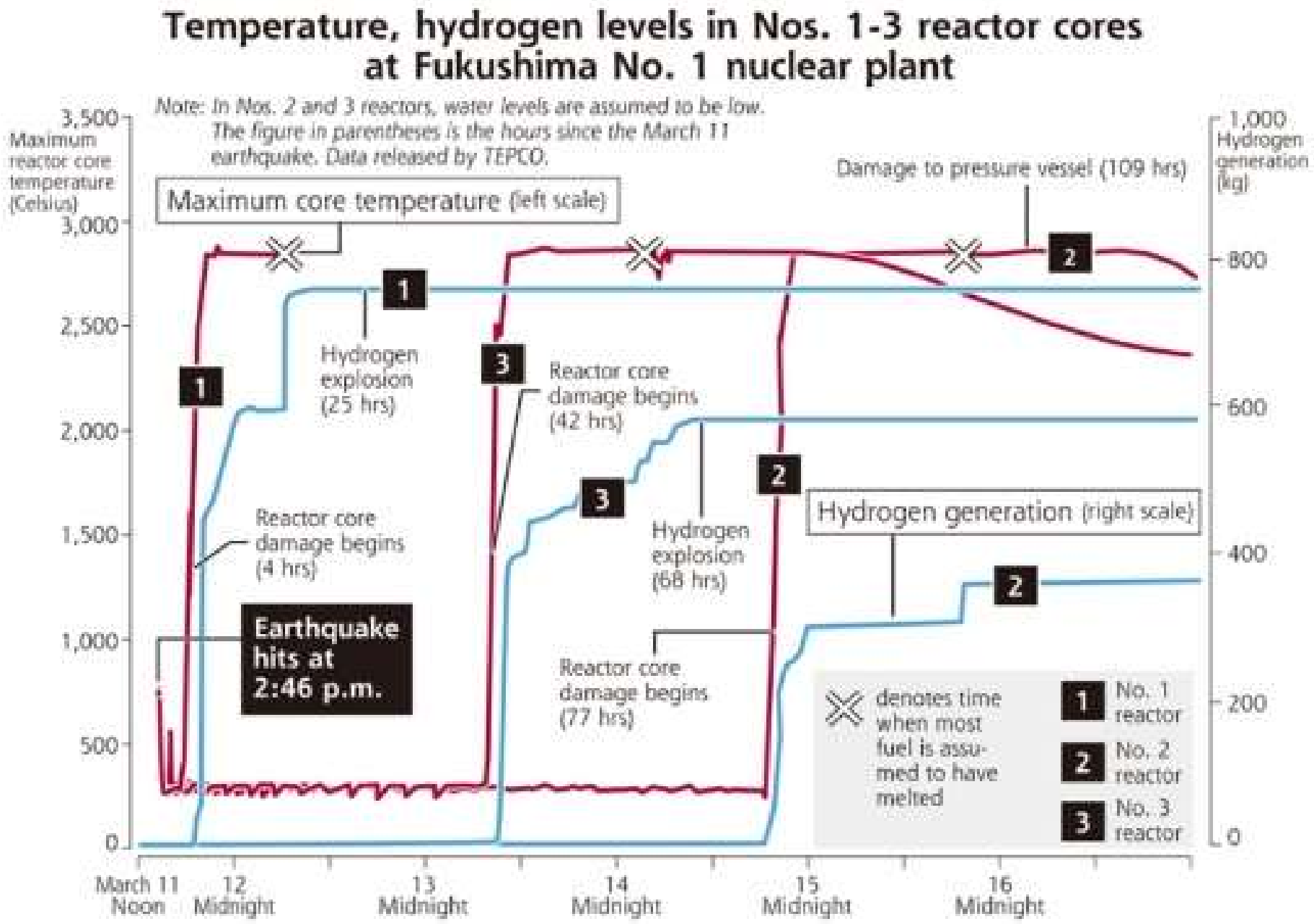
D/G : Still operable after the tsunami

D/G : M/C and related equipment were submerged due to the effects of the tsunami

D/G : Main unit was submerged due to the effects of the tsunami

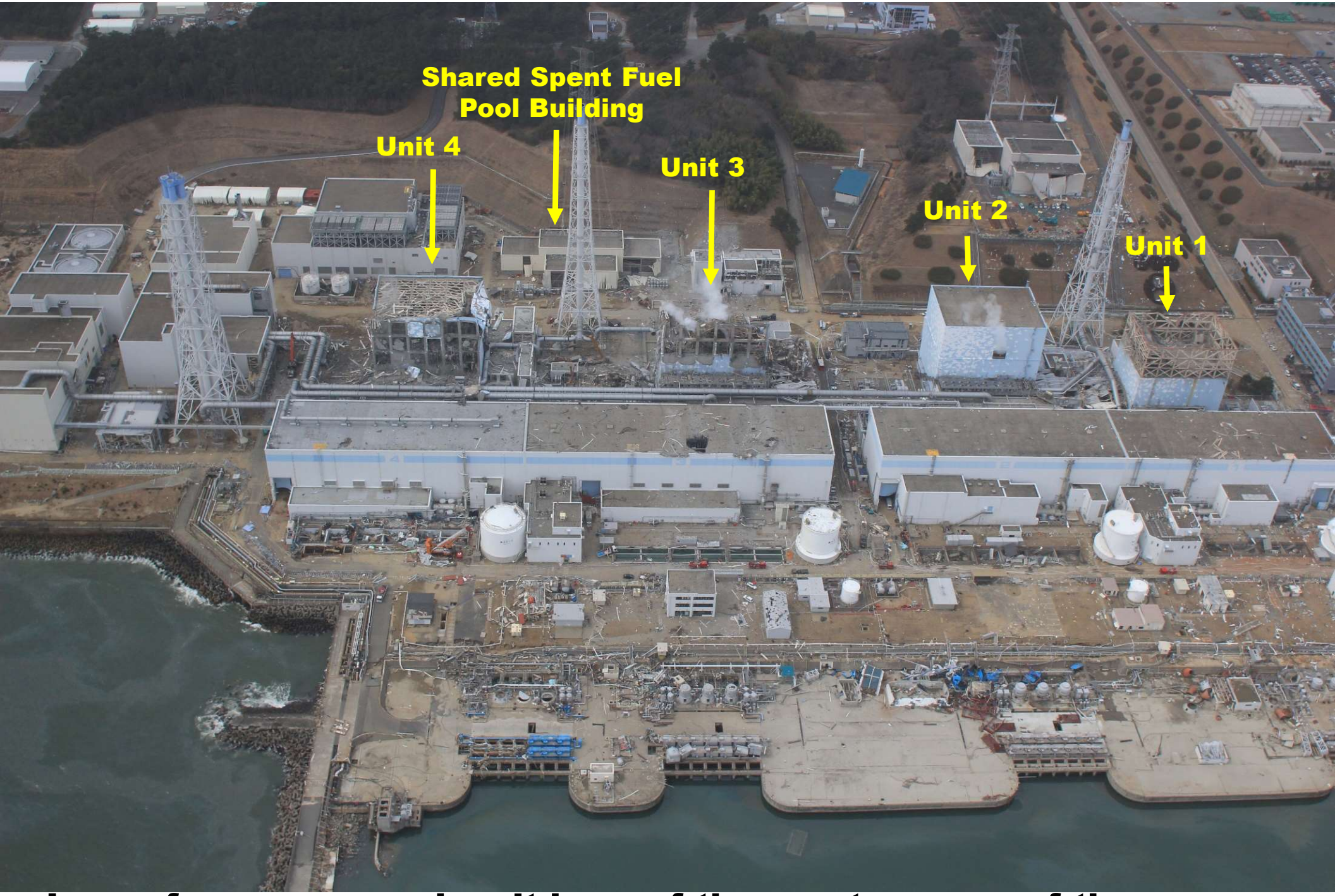
TEPCO

On March 11, 2011, an earthquake disconnected the plant from its offsite electrical power grid. 55 minutes later, a tsunami created by the earthquake flooded the site and disabled the emergency diesel generators.



Offsite power and onsite EDGs were unavailable for about 9 days. When the 8-hour restoration assumption proved invalid, the Unit 1, 2, and 3 reactor cores melted.

Fukushima's seven spent fuel pools and its dry casks loaded with spent fuel suffered no fuel damage due to overheating.



Loss of power caused meltdown of the reactor cores of the three operating units. Fuel in the three shut down units, in seven spent fuel pools, and in dry casks was undamaged.

Summary and Conclusion

The 42-inch pipeline does not pass close enough to vital plant structures and components at Indian Point to cause damage by force and heat of a pipeline rupture.

The substation is not needed to prevent or mitigate an accident. Thus, if the substation were lost due to a pipeline event, severe weather, sabotage, or other cause, there would be no adverse nuclear safety consequences.

Even in the unlikely event that loss of the substation caused a fuel handling event, inadvertent release of radioactive gas or drop of a high integrity container, evacuation and/or sheltering of the public would not be required.